

# PART C1 – ISOSINT SENSOR

## TABLE OF CONTENTS

### C1.1 Foreword

- C1.1.1 Measure System Layout
- C1.1.2 Intended Use
- C1.1.3 Safety Notes
- C1.1.4 Installation
- C1.1.5 Maintenance
- C1.1.6 Dismantling the Sensor

### C1.2 Start UP

### C1.3 Specific video pages

- C1.3.1 Sensor Diagnostics
- C1.3.2 Hardware Interface
- C1.3.3 Sensor Calibration

### C1.4 Calibration Procedures

- C1.4.1 Creating a linearization curve
- C1.4.2 Associating a curve to a recipe
- C1.4.3 Modifying an existing curve
- C1.4.4 Calculating the measure correction offset






### C1.5 Zero Profile

### C1.6 Maintenance

## APPENDIX

1. About ionizing radiations
2. Description of operation
3. Absorption curve or linearization curve

## C1. ISOSINT SENSOR

Meaning of the pictograms used in the present document.	
	is used to evidence a generic residual risk to be, in case, taken in consideration and reduced by the machine maker or by the final user.
	is used to evidence the residual risk related to the presence of ionizing radiations.
	is used to evidence a possible signals/data exchange between the line PLC and the measuring system.
	is used for important advices.
	refer to instruction manual.



### WARNING

Any MAINTENANCE activity to Be made on sensor AND ITS scanner, in order to clean them or changing WORN-OUT AND BROKEN parts, must be done with the production plant stopped and the measuring system not powered.

These activities must be effectuated by expert workers in mechanic and electric installation, aware of inherent risks of these activities.

THE NON OBSERVANCE OF THESE RULES COULD CAUSE A SERIOUS DAMAGE TO THE WHOLE SYSTEM AND ALSO GENERATE A SITUATION OF SERIOUS HAZARDS FOR THE OPERATORS, WITH POSSIBLE INJURY AND DAMAGE FOR THEIR HEALTH.

Contact the Help Desk of Electronic Systems spa  
to have more information about the specific activities  
by mailing to

[service@electronicsystems.it](mailto:service@electronicsystems.it)

phone: +39.0321.928270

## C1.1 FOREWORD

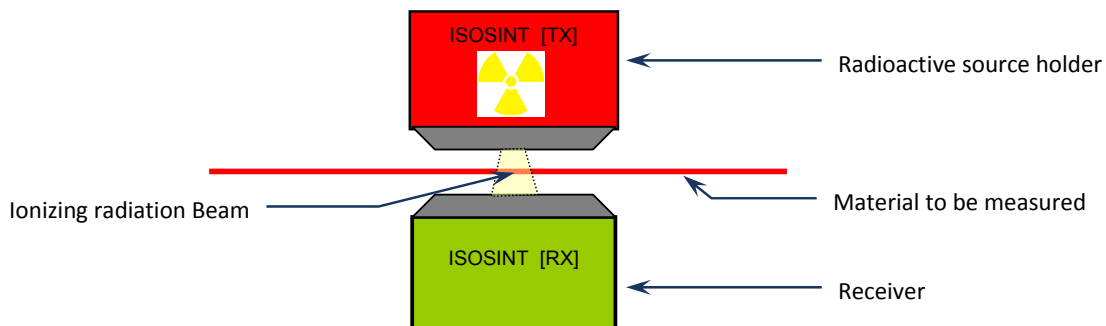
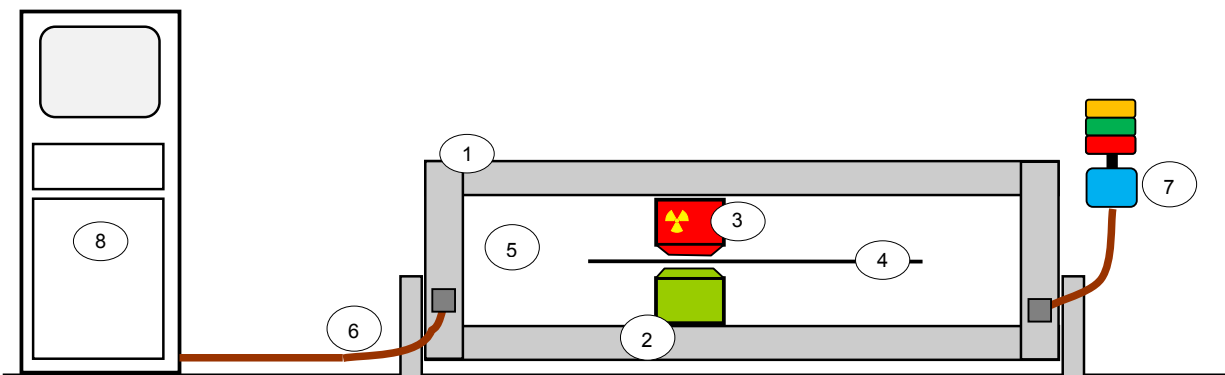
The ISOSINT sensor is used to measure basic weight and thickness of foil products. It consists of an emitter containing a Beta type radioactive source (electron emission) and a detector of the ionizing radiation with ionizing chamber.

The source emits an electron beam that is collimated and directed towards a detector. This produces a current proportional to the amount of radiation received. A metal shutter is installed immediately before the source and does/does not allow the radiation to be emitted outside of the source holder. The emitter and detector are placed opposite to one another at a distance generally from 10 to 25 cm, which is enough for the transit of the foil material being measured.

### C1.1.1 Measure System Layout

Below you see a simplified diagram of the measure system with indicated the most important areas.

1. SCAN BRIDGE
2. MEASURE DEVICE RECEIVER
3. MEASURE DEVICE EMITTER (SOURCE HOLDER WITH RADIO-ISOTOPE CAPSULE INSIDE)
4. MATERIAL SHEET TO BE MEASURED
5. GARAGE (PARKING) POSITION
6. CONNECTION CABLES (SUPPLY & SIGNAL CABLES)
7. LIGHT DEVICE OF THE SOURCE HOLDER STATUS
8. OPERATOR AND CONTROL CONSOLE



### C1.1.2 Intended Use

The ISOSINT measure sensor is designed to be installed exclusively on scanners manufactured by Electronic SYSTEMS spa to measure basic weight and/or thickness of foil or rolled materials.

The sensor is not suitable for installation in environments with explosion hazard according to the following ATEX ratings: Zone 0, Zone 20, Zone 1, Zone 2, and Zone 22.

See system main specifications in the following table.

Sources used		Radioisotope	Half-life	Measure Range g/m <sup>2</sup>		
		<sup>147</sup> Pm	2.5 yrs	5 – 50		
		<sup>85</sup> Kr	10.5 yrs	10 – 1000		
		<sup>90</sup> Sr	28.5 yrs	100 – 5000		
Detector		ionizing chamber				
Material passage gap	[mm]	<sup>147</sup> Pm	<sup>85</sup> Kr	<sup>90</sup> Sr		
		≤ 10	≤ 15	≤ 30		
Working temperature, standard	[°C]	10 to 45				
Working temperature, extended	[°C]	10 to 60	(with dedicated cooling system)			
Compressed air specifications						
Pressure	[bar]		6 – 8			
Temperature	[°C]		10 – 35			
Powders	[µm]		< 10			
Oil			total absence			
Condensate			total absence			
Max consumption	[nl / min]		250			

Maximum intervals recommended for replacement of the radioactive source:

Source	working life [years]	measuring life [years]	radiosotope nature
<sup>147</sup> Pm	10	3	solid
<sup>85</sup> Kr	10	7	gas
<sup>90</sup> Sr	10	10	solid

Working life: duration of the capsule containing the radioactive substance, as suggested by the producer; after this period the sealing of the capsule is not more guaranteed.

Measuring life: period where the performance of the gauge is not significantly reduced.

### C1.1.3 Safety Notes

The gauge has been developed in respect of the European Community standards (CE).

It can work only if properly installed on the scanning frame, suitable to move it across the web under measure, with the foreseen safety sequences.

The status of the Source holder used in the gauge is displayed by means of a light advisor, next to the scanner (see the next table).

When the gauge is in parking position, the shutter of the source holder is closed for preventing the exit of the radiation beam.

The source holder can be opened for maintenance purpose only by Electronic SYSTEMS technicians or other authorized and skilled personnel, specifically trained for this purpose.

The isodose radiation curves are included in the User Manual set; these isodose diagrams have been evaluated with the gauge at the centre of the scanner, in absence of sheet product inside the gap and without other obstacles could interfering with the radiation.

**The user, in respect of the local authority rules, according to these isodose curves or basing on radiation measures directly done on site by an expert and authorized person, defines, if necessary, the restricted access area around the gauge, while working.**

**The restricted access area, if any, must be clearly indicated with specific signs.**

**If needed, the access to the restricted area, could be limited by installing proper mechanical or optical barriers, that generate a digital signal any time someone enter inside. This signal is used by the measuring system to close automatically the shutter of the source holder.**

The access to the restricted area must be respected only when the shutter of the source holder is open, usually no limitation access to this area is due when the shutter is closed.

The operator can force the shutter closed, at any time, by turning off the Source Selector on the local panel located next to the scanner, outside the restricted access zone.


### Operative use

When the gauge is measuring (usually when it is scanning across the web), the operators must be informed to respect the following rules:

- Avoid to enter the restricted area when the gauge is in measure, in accordance with the below Status Table.
- If, for operative needs, the operator must enter in the restricted area, the source shutter of the gauge must be closed by means of the local selector panel.
- Inform the manager about any kind of damage should occur on the gauge. In case the damage cannot handled directly by the user maintenance, contact the technical service of the firm Electronic Systems (+39.0321.928270 – mail: service@electronicsystems.it)

Exhibit close to the gauge, outside the restricted area and in a visible position for the operators, a table with the radioactive sign and the meaning of the lights colors of the advisor.

### STATUS TABLE

Lamps status			 <b>RESTRICTED AREA ACCESS</b>	<i>Remarks</i>
Red	Green	Orange		
<b>ON</b>	<b>OFF</b>	<b>D.C.</b>	<b>NOT PERMITTED</b>	The shutter is opened Presence of radiation beam outside the measuring unit
<b>OFF</b>	<b>ON</b>	<b>D.C.</b>	<b>PERMITTED</b>	The source holder is closed No radiation beam outside the measuring unit
<b>OFF</b>	<b>OFF</b>	<b>D.C.</b>	<b>PERMITTED</b>	The scanner is not powered No radiation beam outside the measuring unit

The Orange light, does not have any relevance for the shutter status.

Off → gauge stop scanning


Blinking → gauge about to start scanning in few seconds

On → gauge is scanning or, if it steady in a fixed position, it is measuring and it can start at any time.

### Important NOTICE

 <b>Electronic Systems s.p.a.</b>	DOMINO Measure System		ISOSINT SENSOR	6/40
	july 2013	Rev. 1.05b_A		
Vietata la riproduzione e la comunicazione a terzi senza autorizzazione scritta. Reproduction and distribution forbidden without written permission.				

The local lights panel is equipped with an electronic device checking continuously that the RED lamp is working; in case the RED lamp fails, the shutter closes immediately and an alarm is displayed on the operator Console. To get the gauge working again, the lamp must be substituted with a new one

 <b>Electronic Systems s.p.a.</b>	DOMINO Measure System		ISOSINT SENSOR	7/40
	july 2013	Rev. 1.05b_A		
Vietata la riproduzione e la comunicazione a terzi senza autorizzazione scritta. Reproduction and distribution forbidden without written permission.				

For a safe use of the gauge, the following conditions must exist:

- ❑ The sensor case is mechanically fixed to the shuttle moving up and down across the produced sheet. The user must evaluate the possible risk of impacts caused by material accidentally transported by the sheet; in this case a barrier should be installed immediately before the scanner to avoid that objects with significant energy ( i.e. more than 6000J ) may collide against the ISOSINT case.
- ❑ Suitable measures should also be taken to avoid that the sheet charges electrostatic to a very high degree (fields above 50kV), in order to avoid possible corruption of the measure.
- ❑ If sudden changes of the measure or of maximum emission are observed, check integrity of the mylar foil and replace it if broken.

#### C1.1.4 Installation

The ISOSINT measure sensor must be installed exclusively by technicians directly appointed by Electronic SYSTEMS spa. These technicians should also make the connection to a grounding point supplied by the Customer. Only persons with specific radioactive materials licenses from the U.S. Nuclear Regulatory Commission, or a state authority regulating in place of the U.S. NRC may install system components containing radioactive materials or affecting radiation safety.

The installation must take place when the production plant is stopped.

#### C1.1.5 Maintenance

All repair and/or cleaning works inside the emitter case [containing the radioactive sources] must be carried out by technicians directly appointed by Electronic SYSTEMS S.p.a. and licensed by the radiation control authority for the particular location.


The user can carry out only the following operations:

- C1.1.5.1 Wipe the outer surfaces of the ISOSINT case using products suitable for stainless steel surfaces (such as, anti-silicon products or nitro-solvents).
- C1.1.5.2 Replace the Mylar foil every six months or when accidentally ripped due to particular process conditions (such as, broken film).
- C1.1.5.3 Inspect and clean the inside of the receiver case, which does not have the radioactive source..
- C1.1.5.4 Replace any failed components inside the receiver case.

Prior to carrying out any of the above mentioned operations, ensure that:

- ❑ The sensor is in the garage position.
- ❑ The sensor is not energized (both electric and pneumatic circuits)
- ❑ The plant is not running (this is to guarantee maximum safety to the service man).
- ❑ The shutter of the source holder is closed

Since radiogenic material is present, the above operations should be entrusted to properly trained technicians, duly authorized to work near the sensor, in compliance with the regulations in force in the country where the measure system is installed.

 <b>Electronic Systems s.p.a.</b>	DOMINO Measure System		ISOSINT SENSOR	8/40
	july 2013	Rev. 1.05b_A		
Vietata la riproduzione e la comunicazione a terzi senza autorizzazione scritta. Reproduction and distribution forbidden without written permission.				

### C1.1.6 Dismantling the Sensor

If the measure sensor using a radioactive source is to be dismantled or in case of source depletion, the Customer/User should adhere to the following procedure for final disposal (*for more details, refer to the procedure illustrated in the document "KrSr - Radioisotope Source Replacement&Disposal - v 1-2 – EN"*).

#### *Italy:*

When the source is depleted, the sensor becomes "radioactive waste" and as such should be disposed of as provided for in Art.104 of the presidential decree D.P.R. No. 185/64. The radioactive capsule should be removed exclusively by certified Personnel.

Transport should be entrusted to an Authorized Carrier holding a special permit (D.M.), copy of which should be requested by the Customer/User.

This should also request a certificate of transport and disposal indicating the place of disposal (we recommend NUCLECO, an ENEA-AGIP joint company).

Communication of the source disposal should be given to the U.S.S.L. (local offices of the National Health Service), Ispettorato del Lavoro (Department of Labour), INAIL (work-related accident insurance body) and also to the Prefecture if a 'Nulla Osta' authorization was granted.

#### *United States of America*

Only licensed persons or radioactive waste disposal sites may receive the radioactive components at the end of their useful life. Only licensed persons may dismount the radioactive gauge head and only persons with Department of Transportation hazardous materials shipping training can prepare the package for transport.



## C1.2 Start UP

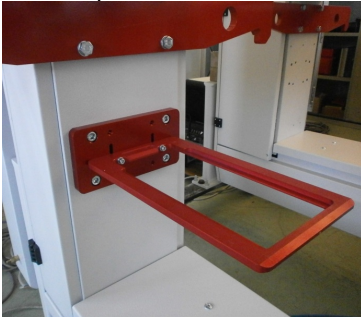
Once the gauge heads are installed, switch on the main console.

The gauge heads have been already tested and calibrated at Electronic Systems laboratory, nevertheless due to the dismount and remount phases of the sensor and scanner structure, it is necessary to proceed with a full recalibration of the system. The procedure is mainly automatic but it is necessary to check if some condition are satisfied.

The described procedure is normally carried out at system start-up, but it is good practice to repeat it on a regular basis, usually a check every four months is recommended to keep the sensor well calibrated at all times, but this period could be reduced in case the system is used in heavy working and environmental condition.

Prior starting the procedure, ensure that:

- The production line is stopped
- The measure system has been switched on for 30 minutes minimum
- No material is present across the scanner
- The sample holder at one side of the scanner is free.



Enable a suitable user profile (default "Maintenance technician"). The operator user profile is not entitled to carry out the calibration procedure.

Go to the page "**Sensor→Calibration**" described in the paragraph §C1.3.3

Start the automatic procedure for acquiring the "Zero profile" procedure as described in the paragraph §C1.5

Generated the linearization curve for the type of products to be produced in the plant, following the procedure described in the paragraph §C1.4

### C1.3 Specific Video Pages

This paragraph details the video pages that are used to control the sensor for diagnostic purposes, for calibration procedures and measure checks.

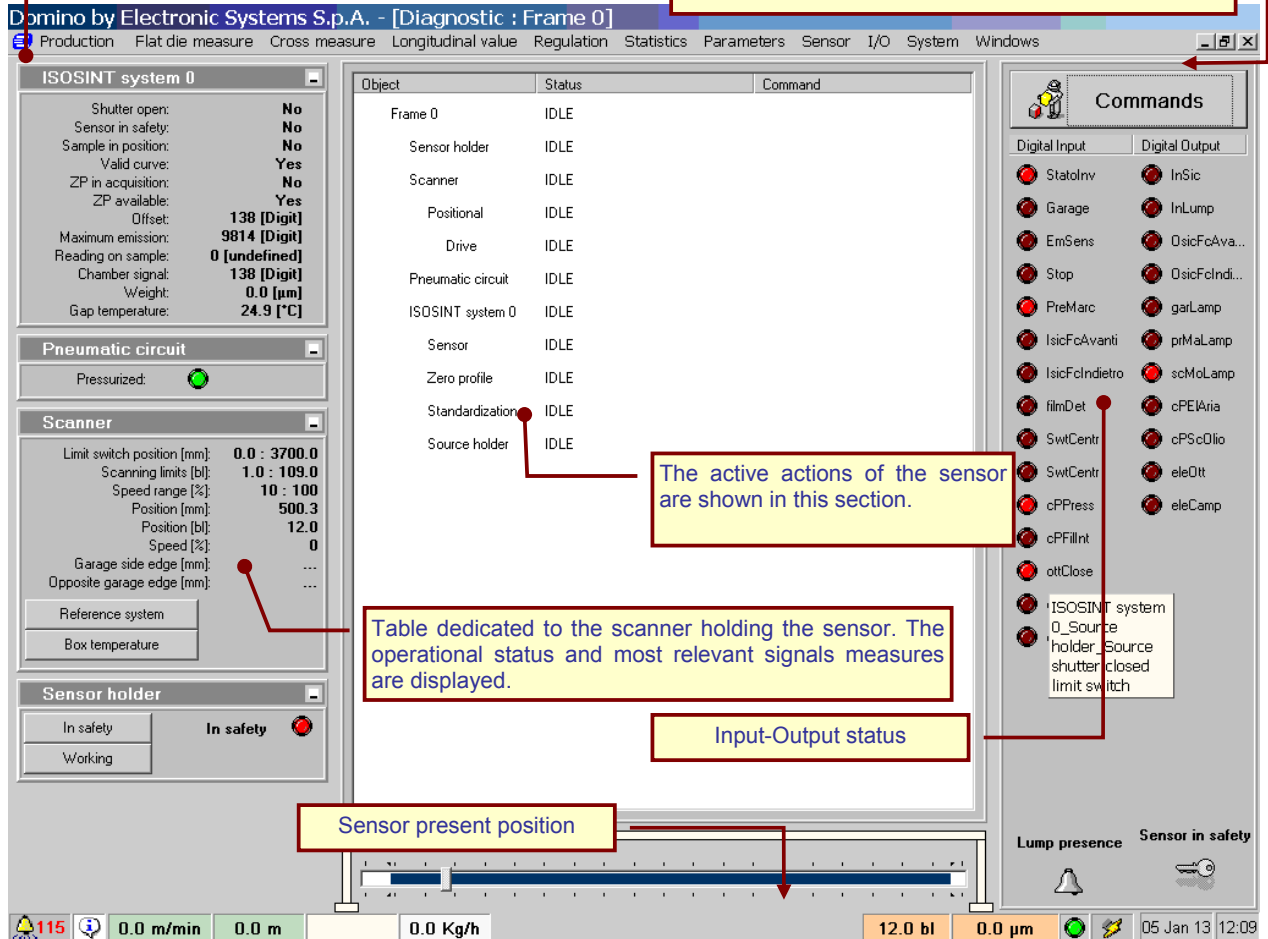
#### C1.3.1 Sensor Diagnostic

This page is selected from the menu **Sensor→Diagnostic sensor**.

The page below, shows the information referred to a standard ISOSINT sensor.

Tables dedicated to the installed sensor; the operational status is displayed with the most relevant signal measures

By clicking on Command, to display multilevel windows and get to the desired command.  
**Note:** some commands, in some situation, are locked at system level and do not produce any action.



**ISOSINT system 0**

Shutter open:	No
Sensor in safety:	No
Sample in position:	No
Valid curve:	Yes
ZP in acquisition:	No
ZP available:	Yes
Offset:	138 [Digit]
Maximum emission:	9814 [Digit]
Reading on sample:	0 [undefined]
Chamber signal:	138 [Digit]
Weight:	0.0 [µm]
Gap temperature:	24.9 [°C]

**Pneumatic circuit**

Pressurized: ●

**Scanner**

Limit switch position [mm]:	0.0 : 3700.0
Scanning limits [bl]:	1.0 : 109.0
Speed range [%]:	10 : 100
Position [mm]:	500.3
Position [bl]:	12.0
Speed [%]:	0
Garage side edge [mm]:	...
Opposite garage edge [mm]:	...

Reference system  
Box temperature

**Sensor holder**

In safety ●  
Working

Object	Status	Command
Frame 0	IDLE	
Sensor holder	IDLE	
Scanner	IDLE	
Positional	IDLE	
Drive	IDLE	
Pneumatic circuit	IDLE	
ISOSINT system 0	IDLE	
Sensor	IDLE	
Zero profile	IDLE	
Standardization	IDLE	
Source holder	IDLE	

**Commands**

Digital Input	Digital Output
Statolnv	InSic
Garage	InLump
EmSens	OsicFcAva...
Stop	OsicFcIndi...
PreMarc	garLamp
IsicFcAvanti	prMaLamp
IsicFcIndietro	scMoLamp
filmDet	cPEVria
SwtCentr	cPScOlio
SwtCentr	eleDtt
cPPress	eleCamp
cPFillnt	
ottClose	
ISOSINT system 0_Source holder_Source shutter closed limit switch	

**Input-Output status**

**Sensor present position**

**Status Bar:** 115, 0.0 m/min, 0.0 m, 0.0 Kg/h, 12.0 bl, 0.0 µm, 05 Jan 13 12:09

Tables dedicated to the installed sensor; the operational status is displayed with the most relevant signal measures

By clicking on Command, to display multilevel windows and get to the desired command.  
**Note:** some commands, in some situation, are locked at system level and do not produce any action.

The active actions of the sensor are shown in this section.

Table dedicated to the scanner holding the sensor. The operational status and most relevant signals measures are displayed.

Input-Output status

Sensor present position

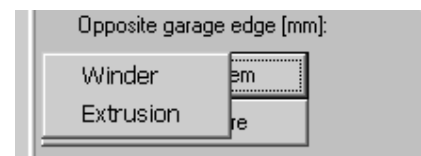
### C1.3.1.1 ISOSINT System

- ❑ **Shutter open**  
This indicates whether the shutter of the source holder is open, which enables emission of the ionizing beam.
- ❑ **Sensor in safety: N.U. (Sensor in the safety position: Not Used)**
- ❑ **Sample in position**  
This indicates whether the reference sample in the emitter (if fitted) was placed in a suitable position to be measured.
- ❑ **Valid curve**  
This indicates whether a linearization curve is enabled that is valid for measuring purposes.
- ❑ **ZP in acquisition**  
This indicates whether the zero profile acquisition procedure is in progress.
- ❑ **ZP available**  
This indicates whether a valid zero profile is available and being used.
- ❑ **Offset**  
Signal value corresponding to the minimum emission detected during the last standardization (with the shutter closed).
- ❑ **Maximum emission**  
Signal value corresponding to the maximum emission detected during the last standardization (with the shutter open and no material between the emitter and the receiver).
- ❑ **Chamber signal**  
Current value of the signal coming from the measure sensor
- ❑ **Basis weight**  
Standardized measure from the sensor in the unit of measure configured (basic weight).
- ❑ **Gap temperature**  
Current air temperature near the measure gap.

### C1.3.1.2 Scanner

- ❑ **Limit switch position**  
These are the most remote positions that the sensor cannot exceed.
- ❑ **Scanning limits**  
Scanning limits in use as they have been set in the recipe.
- ❑ **Speed range**  
Minimum and maximum limits that are allowed for the scanning speed.
- ❑ **Position [mm]**  
Current position referred to end of travel on parking side.
- ❑ **Position [cm]**  
Current position of the sensor referred to the preset reference system
- ❑ **Speed**  
Measure scanning speed expressed as a percentage of the maximum speed that can be obtained.
- ❑ **Garage side edge, Opposite garage edge**  
These indicate the positions of the two edges as they are detected by the ISOSINT sensor or by the photocells installed onto it (if any).

The button **<Reference system>** allows selecting either of the reference systems according to which the cart cross position can be displayed:



### C1.3.1.3 Sensor Holder

When you click the button **<In safety>**, the shutter closes. In the models fitted with the FastGap option, this also causes the measure gap to increase by moving away the emitter and the receiver (the red LED comes on). When you click the button **<Working>**, the sensor gets ready to measure (the green LED comes on).

### C1.3.1.4 Input – Output Status Warning Lamps

A number of LEDs are used to indicate the actual status of the Inputs and Outputs digital signals.



Digital Inputs	
Statolnv	Scanner drive status: fault in progress if on
Garage	Garage button input status
Stop	Scanning stop button input status
PreMarc	Pre-run button input status
FilmDet	Film detection input status
ottClose	Closed shutter RLS input status
ottOpen	Open shutter RLS input status
campPos	Input status for reference sample in measure position

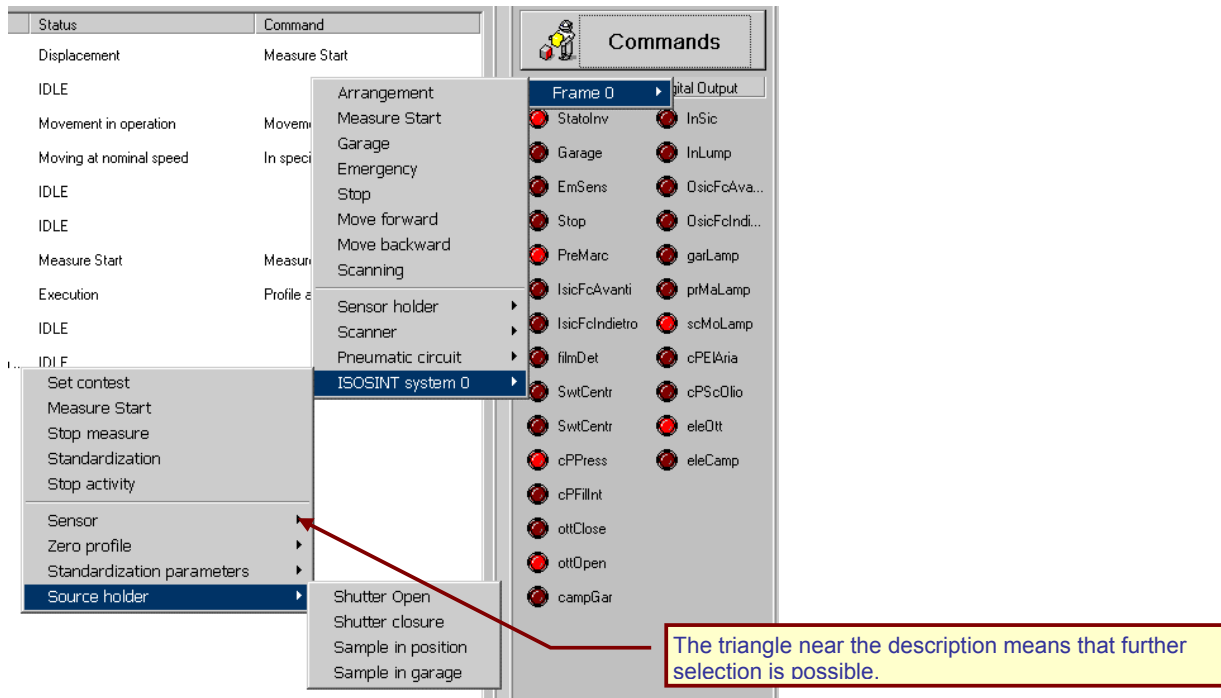
Digital Outputs	
InSic	Sensor in safety position
InLump	Sensor in lump sequence
garLump	Sensor lamp in garage
scMoLamp	Scanner lamp in motion
eleOtt	Shutter solenoid valve control output status
eleCamp	Reference sample solenoid valve control output status

### C1.3.1.5 Commands

When you click the button **<Commands>**, a menu is displayed that makes more options available, as shown below.

### **ATTENTION !**

**Pay the utmost attention when using direct controls! These controls are useful for diagnostic purposes, but can cause conflicts of use in the system with consequent possible measure system malfunction.**



<b>Set contest</b>	cancels any pending operations in the scanner and gets it ready for correct use	
<b>Measure Start</b>	starts measuring	
<b>Garage</b>	brings the sensor to the parking position	
<b>Emergency</b>	emergency stop	
<b>Stop</b>	fast stop	
<b>Scanning</b>	starts scanning	
<b>Sensor Interface</b>	► <b>In safety</b>	the shutter closes; also, in the models fitted with the FastGap option, it causes the measure gap to increase (the emitter and receiver are moved away)
	► <b>Working</b>	the sensor gets ready to measure
<b>Scanner</b>	► <b>Move forward</b>	the sensor moves forward, stops when the 'Stop' control is operated or when it reaches end of travel (logic or hardware)
	► <b>Move backward</b>	same as above, but backward
	► <b>Reset encoder</b>	resets the sensor-holder cart position encoder to zero <b>ATTENTION !</b> after this operation, the cart position is displayed on the basis of the position where the reset was made: <b>USE THIS CONTROL ONLY WHEN YOU ARE SURE THAT THE CART POSITION IS CORRECT.</b>
	► <b>Stop</b>	stops scanning
	► <b>Positioner</b>	► <b>Drive</b> NOT USED
<b>BETA system</b>	► <b>Set contest</b>	cancels any pending operations in the scanner and gets it ready for correct use
	► <b>Measure Start</b>	starts measuring
	► <b>Stop measure</b>	stops measuring
	► <b>Standardization</b>	carries out standardization as this is configured
	► <b>Stop activity</b>	stops all sensor activities

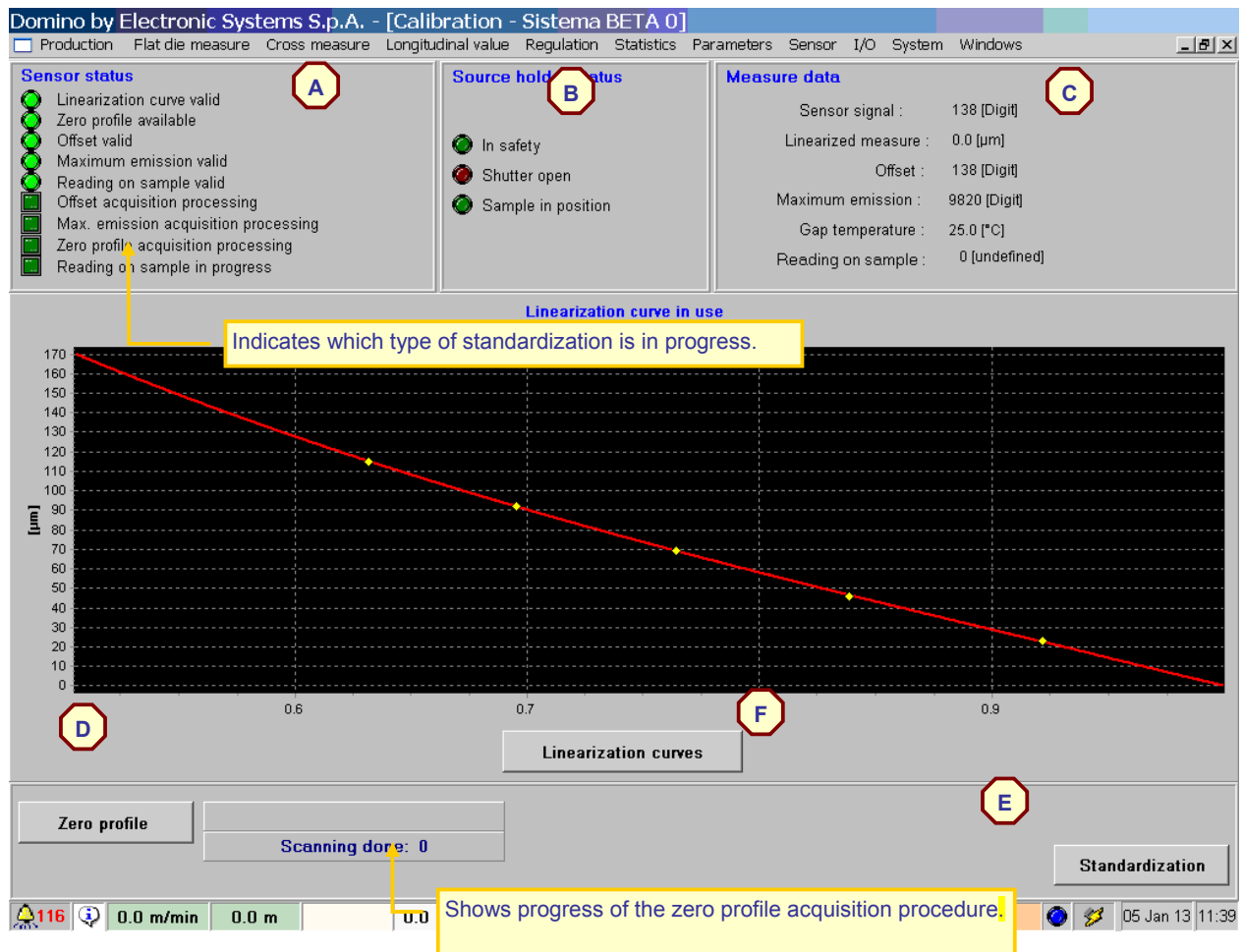
► Sensor	► Profile acquisition ► Burst acquisition ► Stop	acquires the profile throughout the scan acquires a sequence of measures as it is configured stops the acquisition activity selected
► Zero profile	► Start ► Stop ► Store ► Cancel	starts the zero profile procedure stops the zero profile procedure stores the zero profile acquired deletes the zero profile stored
► Standardization	► Offset ► Maximum emission ► Stop activity	acquires minimum signal acquires maximum signal terminates the activity selected
► Source holder	► Shutter Open ► Shutter closure ► Sample in position  ► Sample in garage	opens the shutter for ionizing beam emission closes the shutter to stop beam emission the reference sample inside the source is placed in a suitable position to be measured the reference source inside the source is placed in the parking position

### C1.3.2 Hardware Interface

For an overview of the interface used to control the sensor, gain access to the diagnostic page [<I/O→Diagnostics>](#) and to the "logically structured" display in particular. See detailed instructions in the USER MANUAL.

### C1.3.3 Sensor Calibration Page

Gain access to this page from [<Sensor→ Sensor calibration>](#)



#### C1.3.3.1 [A] Sensor Status

- |  |   |
|--|---|
| <input type="checkbox"/> <b>Linearization curve valid</b>            | if the LED is off, either the linearization curve currently defined in the work program is incorrect. |
| <input type="checkbox"/> <b>Zero profile available</b>               | if off, it indicates that no zero profiles are stored.  |
| <input type="checkbox"/> <b>Offset valid</b>                         | if off, it indicates that at least one offset acquisition was carried out.                            |
| <input type="checkbox"/> <b>Maximum emission valid</b>               | if off, it indicates that at least one maximum emission acquisition was carried out                   |
| <input type="checkbox"/> <b>Offset acquisition processing</b>        | if on, it warns that an offset acquisition cycle is in progress                                       |
| <input type="checkbox"/> <b>Max. emission acquisition processing</b> | if on, it warns that a maximum emission acquisition cycle is in progress.                             |
| <input type="checkbox"/> <b>Zero profile acquisition processing</b>  | if on, it warns that the zero profile acquisition procedure is in progress                            |

#### C1.3.3.2 [B] Source Holder Status

- |  |   |
|--|---|
| <input type="checkbox"/> <b>In safety</b>          | if on, it indicates that the shutter is closed and the FastGap device (if fitted) is enabled. |
| <input type="checkbox"/> <b>Shutter open</b>       | if on, it indicates that the shutter is open  |
| <input type="checkbox"/> <b>Sample in position</b> | if on, the inner reference sample is in a suitable position to be measured                    |

#### C1.3.3.3 [C] Measure Data

The values of instant signals that are correctly acquired, are reported here.

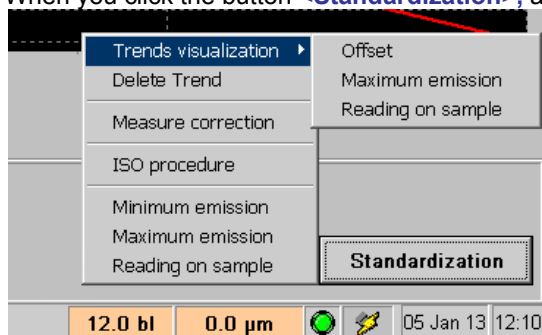
#### C1.3.3.4 [D] Zero Profile

When you click the button **<Zero Profile >**, a menu is displayed that makes more options available, as shown below. (A triangle near the description means that further selection is possible)

Procedure start	starts the zero profile acquisition procedure (measuring the maximum emission throughout the scan).
Procedure stop	stops the acquisition procedure prematurely; data acquired are lost.
Delete the stored profile	deletes the zero profile being used
Actual profile storage	stores the zero profile acquired and makes it operational
Visualization	displays the zero profile in use and the zero profile acquired

#### C1.3.3.5 [E] Standardization

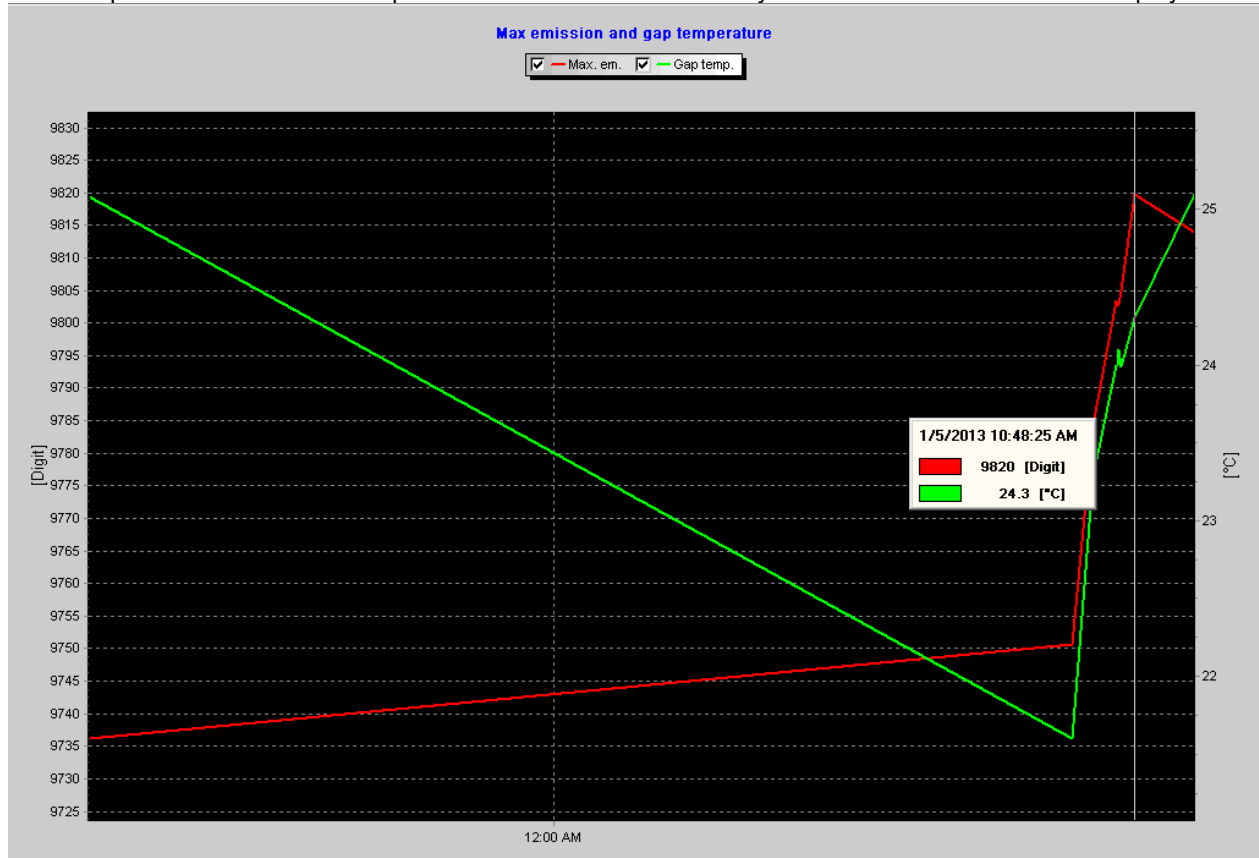
When you click the button **<Standardization>**, a menu is displayed that includes the following options:



Maximum emission	starts the acquisition cycle for the signal coming from the ionizing chamber and associates it to the maximum emission parameter.
Minimum emission	starts the acquisition cycle for the signal coming from the ionizing chamber and associates it to the offset parameter.

Measure correction	starts a procedure that allows correcting the measure being standardized using the curve and work parameters.
Trends visualization	displays the trends of previous standardizations; the graphs show the trend of the offset, max emission and gap temperature values
Delete Trend	deletes the trends of previous standardizations from the memory.
ISO procedure	interactive procedure to certificate the gauge accuracy with respect a reference master sample

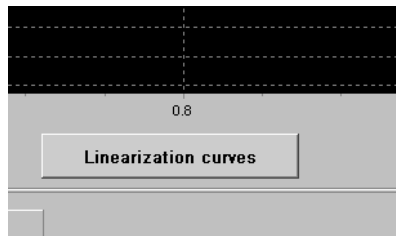
Example of max emission and gap temperature trend; for each standardization event it is indicated the date and time was performed and the correspondent values. In the similar way the trend of the offset can be displayed.



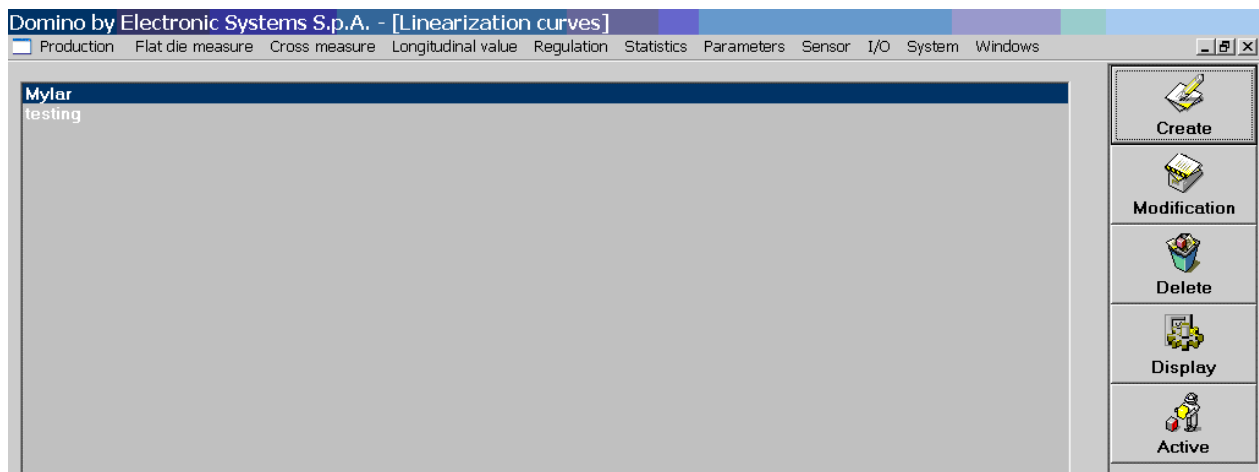


### C1.3.3.6 [F] Linearization Curves

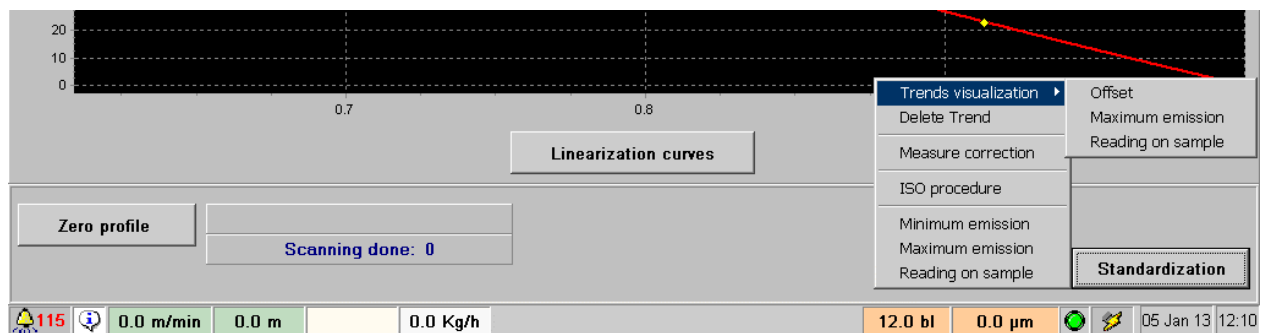
When you click the button **<Linearization curves>**,



you gain access to the interactive procedure for the construction of the linearization curve relating to a certain material. The starting window prompts the list of available linearization curves and a selection of possible actions, as follows:



- <Create>** to create interactively a new curve
- <Modification>** to change data of a curve that already exists
- <Delete>** to delete the selected curve
- <Display>** to display the graph of the selected curve
- <Active>** to enable the curve immediately; the curve is normally enabled after a production change, but through this control you can make the curve selected operational without creating a recipe that includes the curve in question. Pay attention in using this command because the actual recipe could indicate a different curve name, generating confusion. Use this command only to check temporally the behavior of the selected curve, then select again the right working recipe.



## C1.4 CALIBRATION PROCEDURES

To linearize the signal coming from the ionizing chamber in engineering units of measure that can be used for thickness or basic weight, you should determine a calibration curve. Generally, a calibration curve should be obtained for each different type of material (the specific weight changes). However, when minor differences are involved, you can use the same curve and correct the measure in other manners.

### C1.4.1 Creating a new linearization curve

To create a new calibration curve, prepare a certain number of material samples suitable to be placed in the special Plexiglas sample holder supplied with the measure system.

#### C1.4.1.1 Preparation of the samples

According to the case, sample measures can be taken as follows:

- basic weight/m<sup>2</sup>
  - o using 1 dm<sup>2</sup> of material to be weighed and then multiplying the result by 100
- thickness
  - o using an high accuracy micrometer with a probe of proper geometry and calibrated pressure
  - o using 1 dm<sup>2</sup> of material to weight it and then calculating its thickness on the basis of its specific weight according to the formula *thickness = weight / specific weight*

Sample measures should be extremely accurate since measure system accuracy depends on this operation.

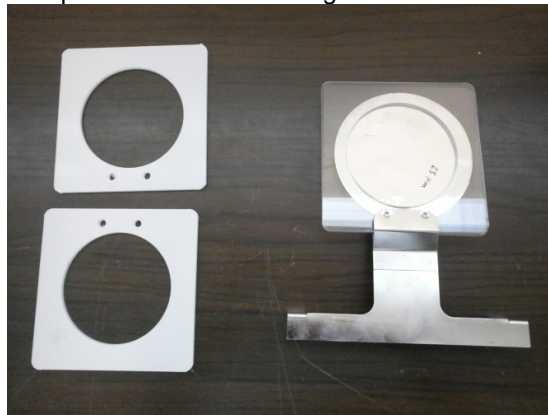
To create a significant curve, at least three samples of different value have to be available.

The thickness or basis weight of the samples should cover their typical range of production; the samples should include at least one sample from the thinnest production, one sample from the thickest production and other samples in intermediate basic weight or thickness (minimum 3 samples per curve).

In case only samples of the same value (or very close values) are available, use single, double and triple overlapped samples to have the three points.

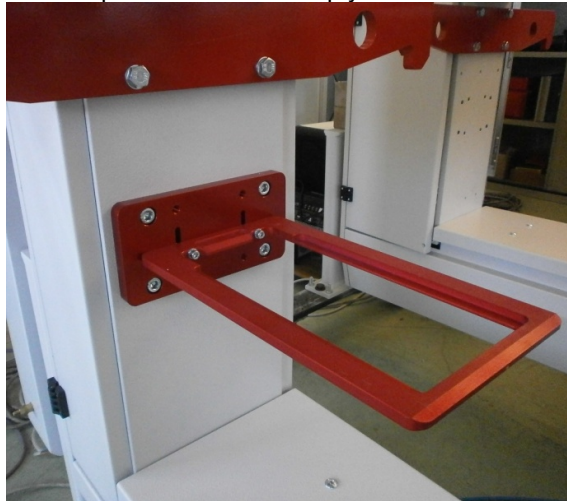
In case only one sample is available, the generated curve is assumed to be exponential and centered on the declared measure.

The samples have to be fitted in the provided Lexan or Plexiglass holders.



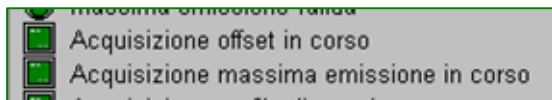
#### C1.4.1.2 Calibration procedure

Before to proceed, ensure that the sample holder fork is empty



and do the following preliminary steps.

1. Enable a suitable user profile. The Operator user profile is not entitled to carry out this procedure.
2. Gain access to the page **Sensor→Calibration**
3. Start the automatic offset acquisition procedure. First click the button **<Standardization>** and then select the option **<Minimum emission >** (minimum emission is also called offset).
4. Wait for the minimum emission acquisition procedure to terminate. The corresponding green LED should go off.



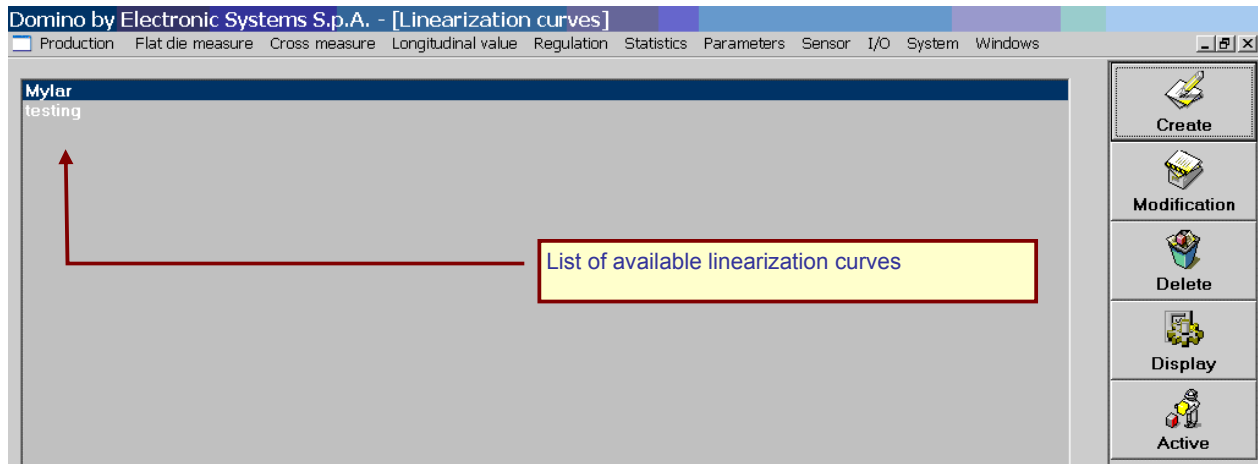
**Offset and maximum emission acquisition status LED's**

5. Similarly start the automatic maximum emission acquisition procedure by selecting the option **<Maximum emission>** and wait for the acquisition procedure to come to an end. Now, the new offset and maximum emission values will be available and displayed in the box "Measure data".

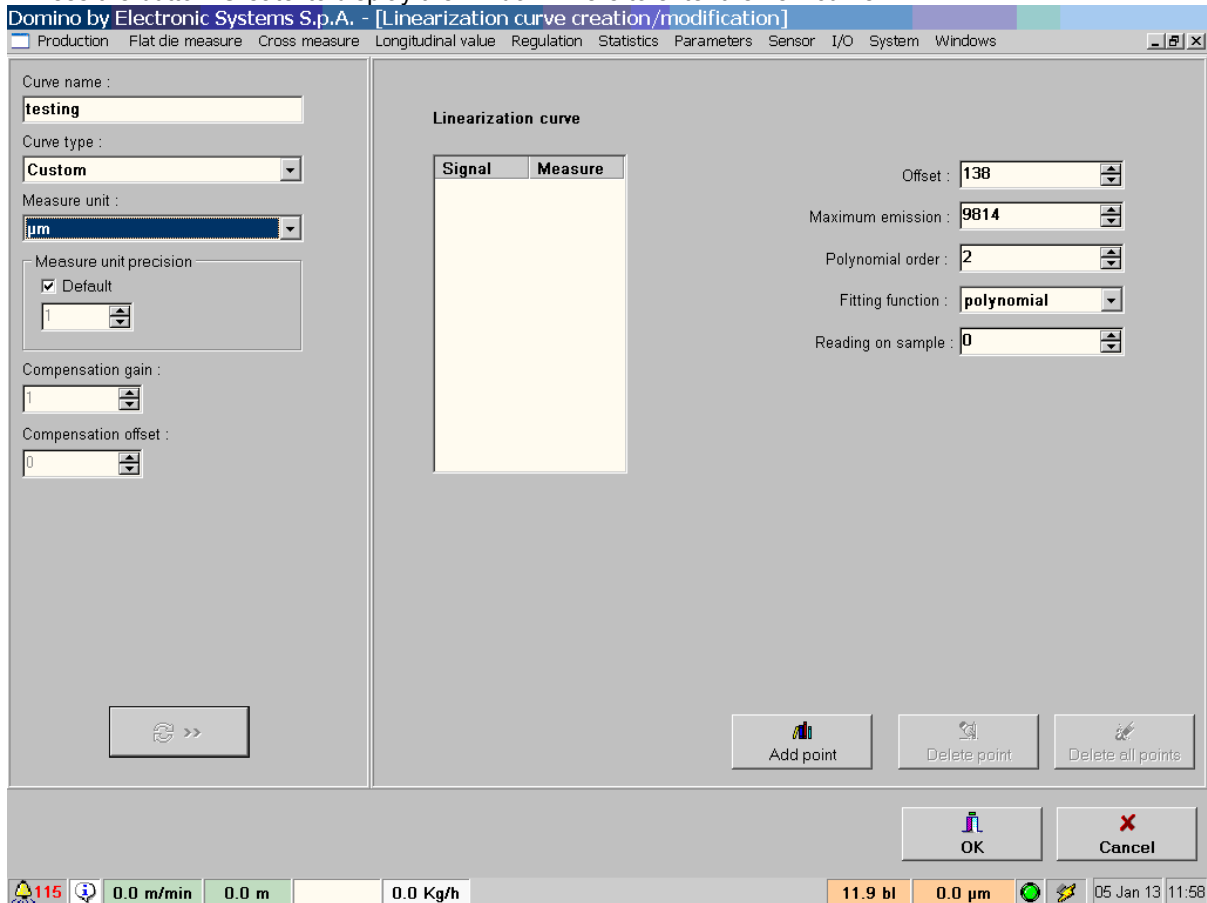
Measure data	
Sensor signal :	138 [Digit]
Linearized measure :	0.0 [µm]
Offset :	138 [Digit]
Maximum emission :	9820 [Digit]
Gap temperature :	25.0 [°C]
Reading on sample :	0 [undefined]

## PROCEDURE:

1. Select the option **<Linearization curve>** to open the curve archives window



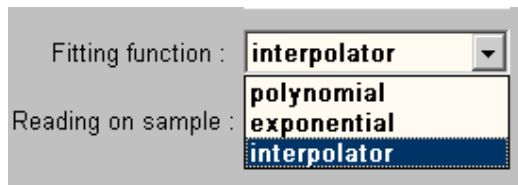
2. Press the button 'Create' to display the window where to enter the new curve.



3. Enter the name identifying the new curve in a univocal manner; normally name/code of the material in use.
4. In the field "Curve type" select the Custom type curve.
5. Select desired measure unit which should be compatible with the measures of the samples available

**ATTENTION:** this unit must be defined once during the start up of the system, it must be coherent with the unit used for the graphics displayed in the different pages. This measure remain always the same for all the next calibration

6. The recently acquired emission values are automatically entered in the right part of the window. Enter the curve name.
7. Set gain value at 1 and offset at zero.
8. In the field **"Fitting function"**, select **"polynomial"** if at least three sample are available;



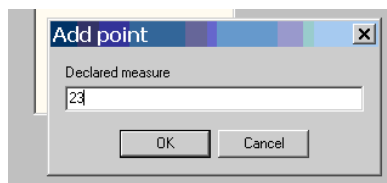
the value of the parameter **"Polynomial order"** has to be less or equal the number of the samples used to generate the curve.

In case only one sample is available, select **"exponential"**.

This is a generally valid way to proceed; special situations should be analyzed separately. Refer to §C1.4.1.3 for more details on the Fitting function.

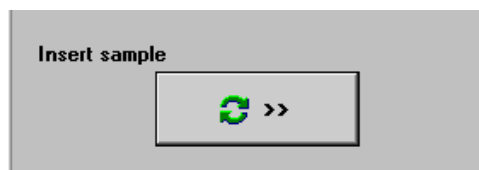
9. Press the button **<Add point>**

A box is displayed with a field where to enter the measure value of the sample available (samples can be put in at random).



Press OK to confirm.

The sensor will automatically move to a wait position waiting for the sample to be positioned. The message **"Insert sample"** will be displayed.



10. Place the sample in the sample-holder fork in forward position (toward the middle of the scanner). In this manner, when the sensor goes to the parking position, it also moves the sample holder, which guarantees repeatability of the measure position of the sample. Make sure that the Plexiglas sample holder slides freely in the fork.



Sample to be calibrated

11. Press the button with the green arrows to run sample value acquisition.



The sensor will move automatically above the sample, displaying and advise for this status.



Check that the sample holder slides freely backward and does not get jammed and tilted which would cause wrong signal acquisition



12. Upon acquisition completion, the sensor goes back to the wait position and the new signal value, relating to the declared sample just measured, appear in the table.



Domino by Electronic Systems S.p.A. - [Linearization curve creation/modification]

Production Flat die measure Cross measure Longitudinal value Regulation Statistics Parameters Sensor I/O System Windows

Curve name : **testing**

Curve type : **Custom**

Measure unit : **µm**

Measure unit precision : ☒ Default **1**

Compensation gain :

**Linearization curve**

Signal	Measure
8974	23

Offset : **138**

Maximum emission : **9814**

Polynomial order : **2**

Fitting function : **polynomial**

Reading on sample : **0**

Repeat the procedure from when you pressed the button 'Add point' (step 9) for each sample to be measured. Remember that minimum 3 samples are required to generate a valid table. Also, the samples should be entered all during the same calibration session. It is not good practice to add new samples to an existing curve after some days. The curve obtained in this way may be incorrect.

Domino by Electronic Systems S.p.A. - [Linearization curve creation/modification]

Production Flat die measure Cross measure Longitudinal value Regulation Statistics Parameters Sensor I/O System Windows

Curve name : **testing**

Curve type : **Custom**

Measure unit : **µm**

Measure unit precision : ☒ Default **1**

Compensation gain :

Compensation offset :

**Linearization curve**

Signal	Measure
8974	23
8220	46
7511	69

Offset : **138**

Maximum emission : **9814**

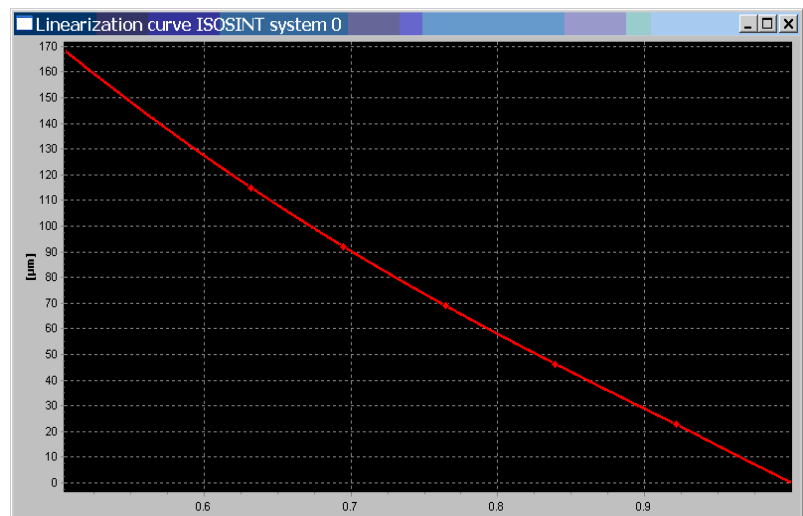
Polynomial order : **2**

Fitting function : **polynomial**

Reading on sample : **0**

At the end of the procedure, press the button **<Close>** to close the window and save the newly added curve.

The new curve is now also visible in the list together with the other curves. After this procedure has completed and the curve has stored, it is important to see its shape to realize if something was wrong. Select the curve from the list and click on the icon "Display"; the curve should appear similar to the figure on the right.



### C1.4.1.3 Fitting function

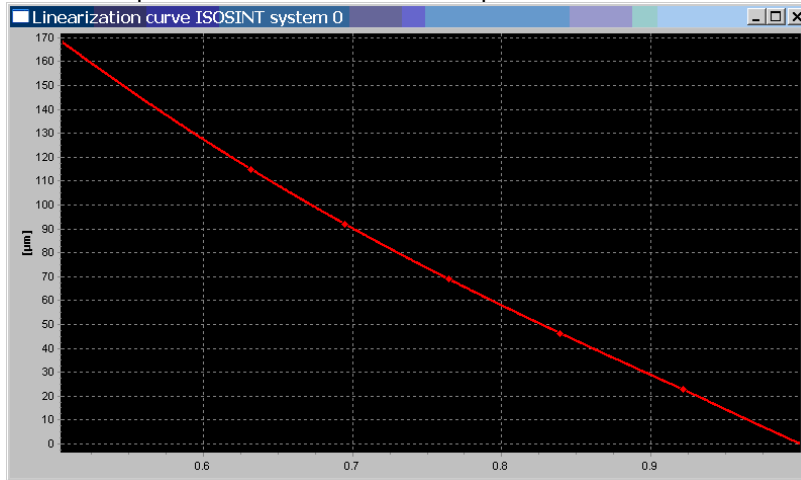
The values couples in the table, represent a point in a Cartesian plane where the ordinate is related to the value of the sample in the specific unit and the abscissa the correspondent value in digit of the ionization chamber signal, as sampled by the A/D converter.

From this limited number of points, to create a continuous curve, an interpolation function must be used; the system gives three type of functions to give more flexibility in the different situation that could occur.

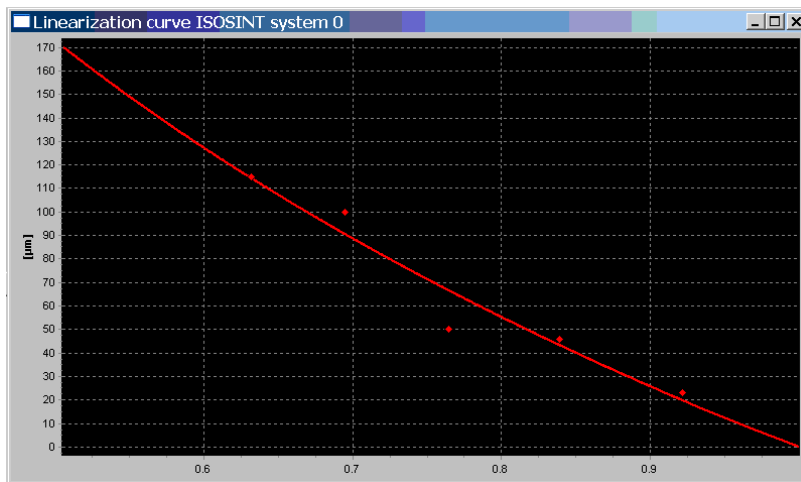
#### Polynomial

The curve will go through the points with the scope to minimize the distance from them; the curve is not forced to cross over each point.

In this example the curve is so close to the points that it seems to cross over each one.

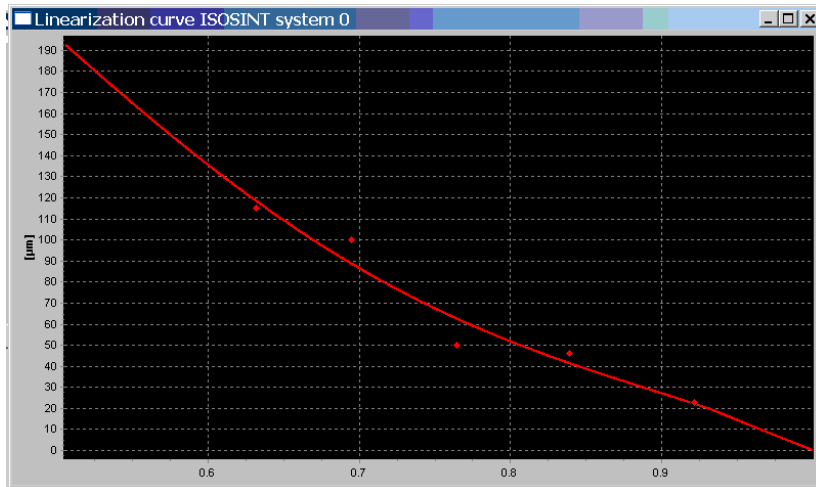


In this example the curve is not always to close the points.





To have a tight curve, the order of the polynomial has to be increased; the result could produce a distortion of the curve.



When happens it means that:

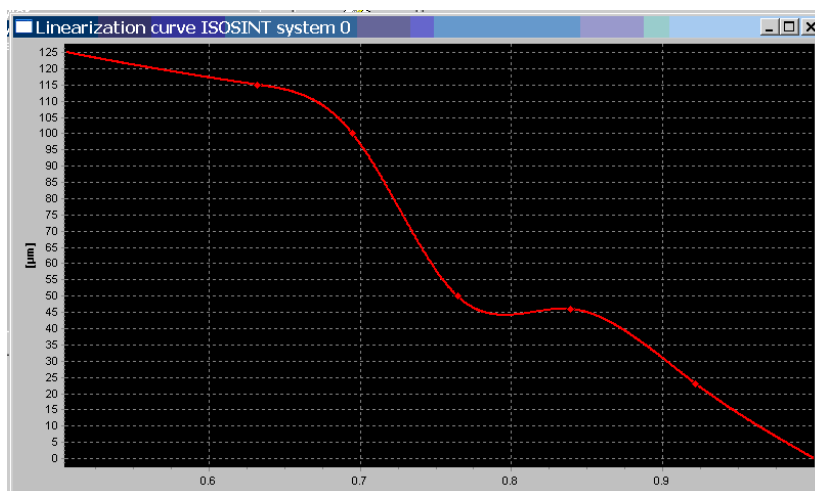
- ☐ the values of the selected samples is not accurate
- ☐ the samples are not homogeneous or of different nature
- ☐ during the procedure something happens to compromise the acquisition
- ☐ the samples have measure values too close to each other; in this case it is necessary to find new samples with bigger difference
- ☐ due to the fact the reading spot is very small it is important to be sure that average measure made with laboratory gauges on the whole sample is really representative of the measure in the spot.
- ☐ the type of product and its internal structure strongly affect the absorbance behavior of the radiation; in these cases the opportunity to use a different fitting function.

Of course, as final result, it happens that when measuring with the ISOSINT gauge one of the sample used for generating the linearization curve, the measure is not the one declared. To adjust this residual error, the procedure described in the §C1.4.4 must be used.

### Interpolator.

The curve is forced to pass over each point of the table.

The effect is to have an optimal correspondence with the expected value when one sample used to generate the curve is measured by the ISOSINT gauge, nevertheless the use of this function evidence much more possible distortion of the curve.





## Exponential

The used curve is the exponential representing the ideal absorbance law:

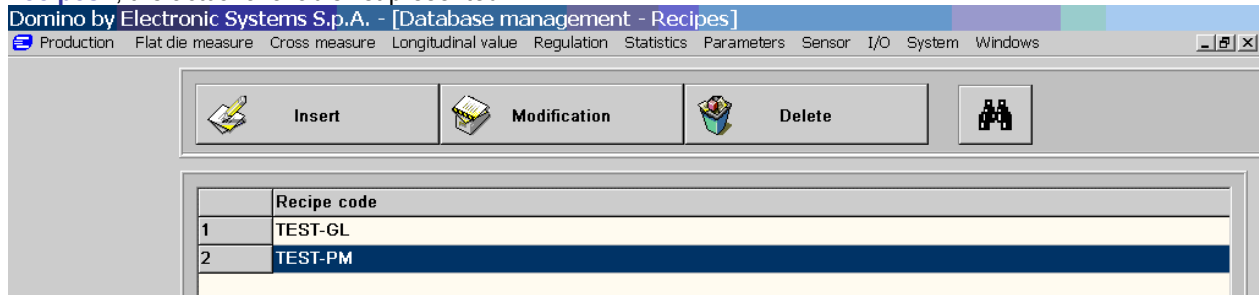
$$I = I_0 \cdot e^{-\frac{G}{\mu}}$$

Where the parameter  $I_0$ ,  $\mu$ , are calculated to minimize the distance of the exponential function from each available point in the table.



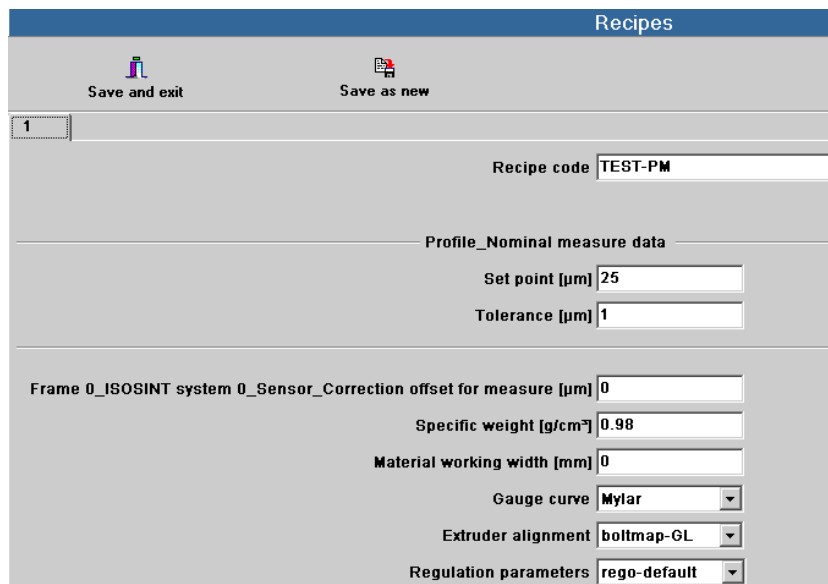
### C1.4.2 Associating a curve to a recipe

To associate an existing curve to a recipe, select the recipe desired in the page **<Parameters → Archives → Recipes>**, the actual available list presented.



Display the parameters of a specific recipe, by selecting it and clicking **<Modification>** or using **<Insert>** to create a new recipe.

Select the desired curve among the available ones presented in the list box **"Gauge curve"** and save the article as changed clicking on the icon **"Save and exit"**.



Recipe code: TEST-PM

Profile\_Nominal measure data

Set point [µm]: 25

Tolerance [µm]: 1

Frame 0\_ISOSINT system 0\_Sensor\_Correction offset for measure [µm]: 0

Specific weight [g/cm³]: 0.98

Material working width [mm]: 0

Gauge curve: Mylar

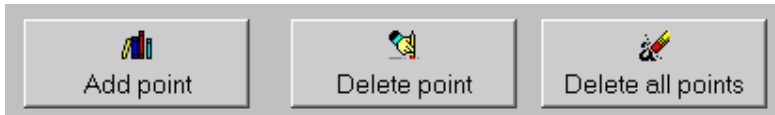
Extruder alignment: boltmap-GL

Regulation parameters: rego-default

### C1.4.3 Modifying an existing curve

You can change an existing linearization curve in either of the two following manners:

- ❑ Select the page **<Sensor>Calibration>** and then access the interactive procedure through the button **<Linearization curve>**. Select the curve to be changed from the list and click the button **<Modification>**. Cancel all the contained points, clicking on the button **"Delete all points"**

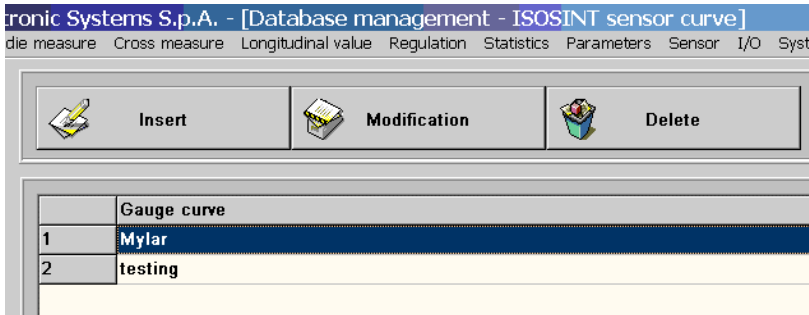


Proceed then as detailed in § C1.4.1.

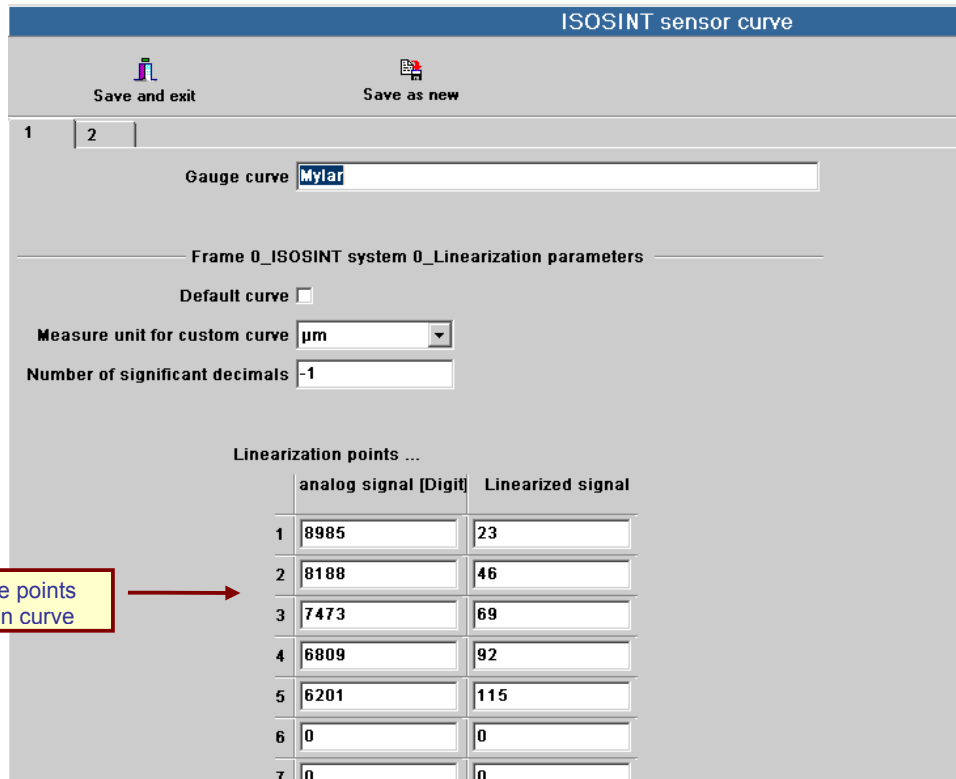
**Attention:**

*Avoid to cancel only part of the stored points and adding new ones, this method could generate not coherent results with the existing. For this reason this method should be applied exclusively by trained personnel since the curve could be easily and unduly altered; as a result, unreliable measures might be produced.*

- ❑ Access the curve selected directly from the parameter menu: **<Parameters>Archives>ISOSINT sensor curve>**



Select the curve that you want to change and click the button **<Modification>** to access the curve table.



	analog signal [Digit]	Linearized signal
1	8985	23
2	8188	46
3	7473	69
4	6809	92
5	6201	115
6	0	0
7	0	0

Table of coordinates of the points making up the linearization curve

12

... Linearization points

	analog signal [Digit]	Linearized signal
10	0	0

Minimum emission [Digit] 138  
Maximum emission [Digit] 9736  
Reading on sample [Digit] 0  
Fitting function polynomial  
Fitting polynomial order 3  
Default linearization curve name Kr85 [transparent PE]  
Declared sample value 0  
Sample measured value 0  
Multiplicative gain of curve ordinates 1  
Additive offset for curve ordinates 0

### ATTENTION:

The direct change of this data can produce unexpected effect to the final resulting curve.

It is strongly recommended after the modification, to check the curve shape as illustrated in the §C1.4.1.2 and verify the result by measuring a sample of product and comparing the value with the effective measure.

### TIP.

Prior to changing the content of the curve, to avoid to lose the original data, it is recommended to make a copy of the original curve.

To create a new calibration curve starting from an existing one, proceed as following:

- ☐ Select the curve to modify as previously explained
- ☐ Change the name in the field

ISOSINT sensor curve

Save and exit

Save as new

12

Gauge curve Mylar

- ☐ Save as new curve clicking on the icon “Save as new”

From now on, any change on of the content will be saved using this name. at the end click the button icon “Save and exit” to confirm your changes and quit.

The relevant parameter could be changed are the following:

### ☐ Default curve

Click here to use one among the internal already available curves, to be selected in the field “Default linearization curve name”.

In this cave the existing table is not considered but not lost and can be reused at any time.

Default linearization curve name

Declared sample value

Sample measured value

Multiplicative gain of curve ordinates

Additive offset for curve ordinates

Kr85 [transparent PE]

Kr85 [transparent PE]

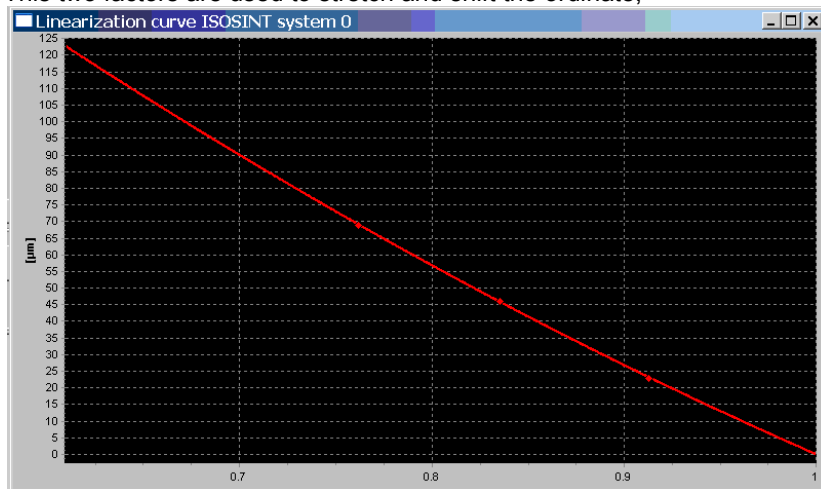
Kr85 1000 mCi [mylar - 20 mm gap]

Sr90 10 mCi [Sr1]

Sr90 10 mCi [Sr2]

- ☐ **Multiplicative gain of curve ordinates**
- ☐ **Additive offset for curve ordinates**

This two factors are used to stretch and shift the ordinate;



their used is suitable when the measures on the same product produce a systematic proportional error over a wide range that can be compensate by multiplying a factor, or to compensate a measure error that is constant over a wide range.

#### C1.4.4 Calculating the measure correction factor

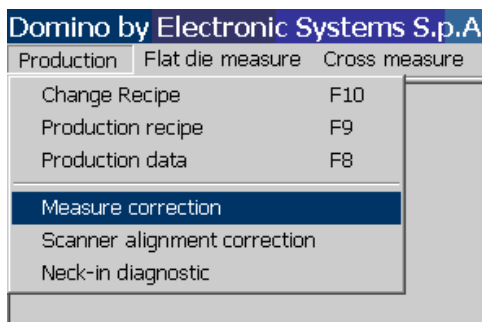
Calibrations performed with the procedures previously detailed allow optimum sensor characterization. However, sometimes this is not enough to guarantee that measure is correct to the accuracy required.

As already said, the calibration curve depends on material density. If this varies, even by a small amount, a measure calculation error may result, mainly if the system was configured for measuring thickness and not weight/sq m (basic weight).

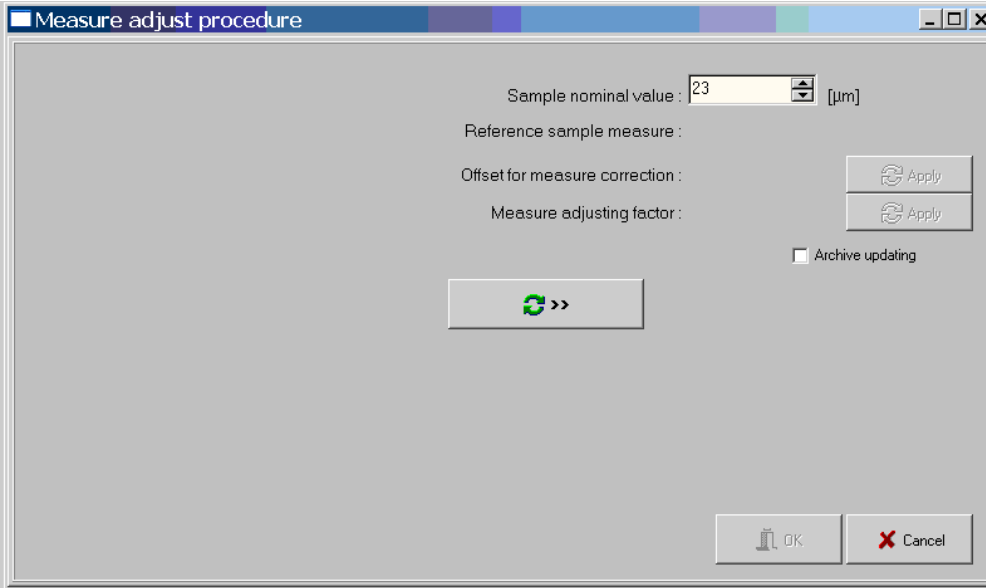
In this case, the user should carry out systematic checks, typically at the beginning of each new production, by aligning the system-supplied measure with the measure taken in the lab.

Proceed as follows:

1. Take a sample of stable material from on-going production.
2. Accurately measure thickness or basis weight in the lab on the basis of current system configuration.
3. Start the automatic procedure clicking on < **Production → Measure correction** > from the top menu.



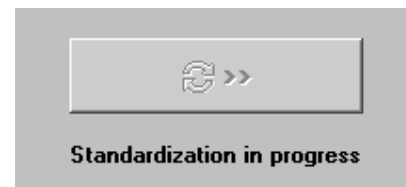
4. Enter the nominal value of the sample, in the right measure unit,



then click on the icon



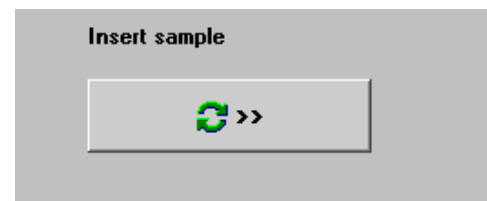
The status message advising that a new standardization is in progress.



Once the standardization has completed, the gauge head moves to the waiting position leaving the sample holder free.



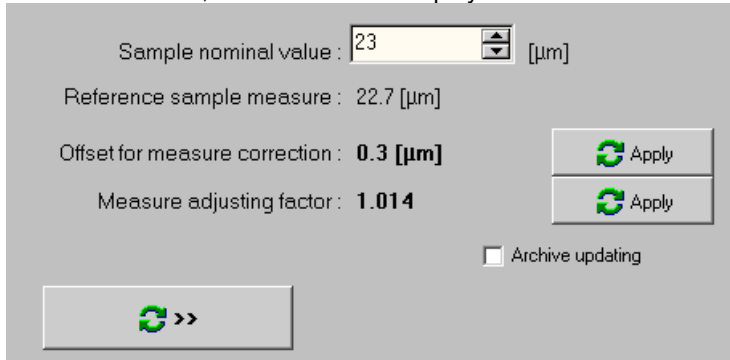
Then this status message appears



5. Place now the sample in the special Lexan or Plexiglass sample holder, supplied with the measure system.
6. Click the button to continue the test. The gauge head will move onto the sample and take sample measures.



After the measure, the software will display:



Sample nominal value : 23 [μm]

Reference sample measure : 22.7 [μm]

Offset for measure correction : 0.3 [μm] Apply

Measure adjusting factor : 1.014 Apply

☐ Archive updating

»

- **Sample nominal value:** declared value of sample measure that was read.
- **Offset for measure correction:** necessary offset to correct the read value and get it equal to the declared value
- **Measure adjusting factor:** multiplying factor to correct the read value and get it equal to the declared value

Values widely different from 1 for the gain and more then 15% of the declared value for the offset, could not be reliable. In these cases, check if you have implemented the procedure correctly or using the proper linearization curve. If the case, generate a new calibration curve.

To get effective the calculated correcting factors, chose which one has to be used then click the correspondent button **<Apply>**.

Usually the most advisable way is to select the Offset factor, that is always available in the recipe table. Uses the Multiplying factor only if present in the recipe.

**WARNING: APPLY ONLY ONE BETWEEN THE TWO FACTORS.**

The correction is immediately executive once applied, nevertheless it is has temporary vldity and will be lost the first time the production recipe is changed.

In case this correction must be considered to be permanent, it is necessary to store it in the original recipe stored in the archive. To do this, tick the relating check box **"Archive updating"** before applying the correction.

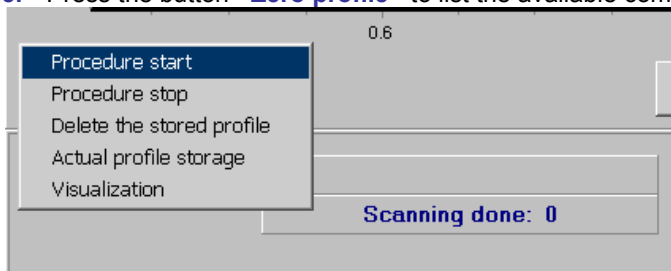


## C1.5 Zero Profile

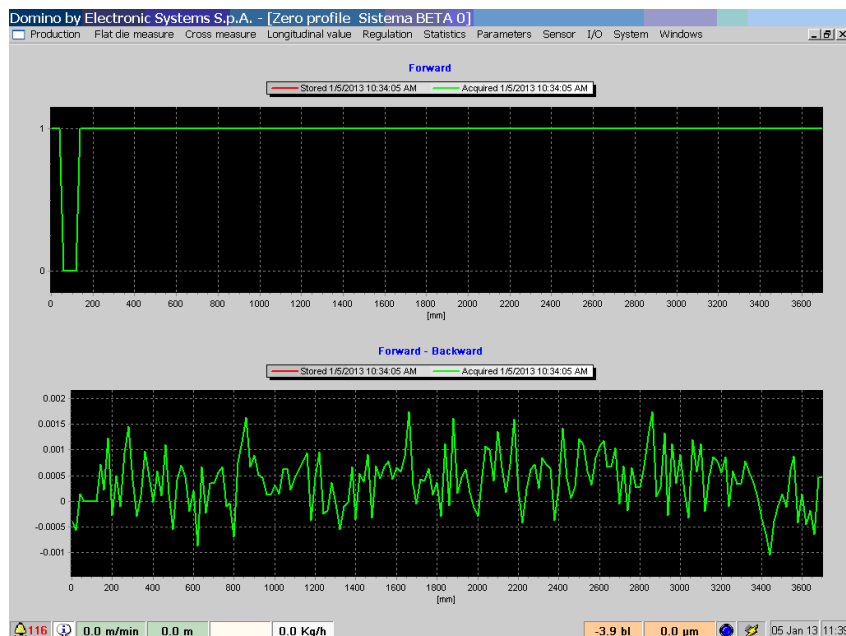
The procedure 'Zero Profile' is used to reduce to zero the effects of some factors of mechanical nature that cause a reading error to the sensor. Without this procedure, the profile displayed might be inaccurate. The error amount depends on the scanner model and wear. To cancel or reduce this error, it is necessary to effectuate the zero profile procedure.


Proceed as follows to obtain the zero profile:

1. Ensure that the measure system is switched on from half hour at least at ambient temperature close to working temperature
2. No material should be present in the sensor gap. The procedure should be carried out with the plant stopped.
3. Enable a suitable user profile. The 'Operator' user profile is not entitled to run this procedure.
4. Select the page **<Sensor → Calibration>**.
5. Press the button **<Zero profile>** to list the available command and then click **<Procedure start>**



6. To attend the completion of the procedure; a bar of progression allows to hold under control the advancement of the acquisition of the profile
7. At the end of the foreseen number of scanning, the sensor will automatically be stopped in the position of parking.
8. The profile acquired can be displayed using the function **<Zero profile → Display>**



 <b>Electronic Systems s.p.a.</b>	DOMINO Measure System		ISOSINT SENSOR	34/40
	july 2013	Rev. 1.05b_A		
Vietata la riproduzione e la comunicazione a terzi senza autorizzazione scritta. Reproduction and distribution forbidden without written permission.				

The upper graph contains the error stored during forward motion, the lower graph contains the difference between toward and backward travels. The green traces correspond the newly acquired profile, the red lines indicate information stored the previous time. Sometimes, it is useful to compare these two profiles to evaluate the deterioration of the emitter/receiver alignment, which is the main cause for the residual error (excess wear of bearings, sliding rails, belts, etc.)

Once displayed the result, store the zero profile acquired through the command **<Actual profile storage>** .

To make sure that the entire operation was carried out successfully, we advise to start sensor scanning and check that the profile is really flat when no material is present.

**Note:**

The zero profile procedure totally recovers the existing error only if the system is in perfect condition both from the mechanical and electronic points of view. The sliding guides should be kept in perfect condition. Clean and grease them about every six months according to the model and work conditions, working temperature and dust in the environment. Also, it is necessary to replace the sliding bearings with intervals varying from 1 to 3 years approximately.

Contact the Customer Service if the air profile is not flat after acquiring the zero profile.

## C1.6 MAINTENANCE

Routine maintenance and lubrication activities may be performed by the gauge user. Any operations inside the radioactive gauge head housing, or its mounting, dismounting, or relocation must be performed by a person licensed by the Nuclear Regulatory Commission or an authorized state agency. Users may also replace the Mylar window following the procedures in this manual, replace burned out indicator lamps and verify their function by operating the shutter

To carried out these activities, the following rules must be observed:

- ☐ The gauge must be in parking position.
- ☐ The scanner and gauge must be switch off.
- ☐ The plant must be shut down in order to give the best safe condition for the maintenance personnel.
- ☐ The above activities must be carried out by trained personnel.

The following activities have to be made periodically.

In some cases it is necessary to have available specific products for greasing and cleaning:

**Product A: Product for Greasing.**

Lithium mineral based (e.g. WUERTH Art. 0893 538)

**Product B: Product for generic cleaning of any surface.**

Detergent / Degreaser for all metallic, plastic and rubber surfaces, aqueous base type, (e.g. WUERTH art. 0893 118 2-5)

**Product C: Product for intensive cleaning of metallic surfaces like Stainless steel, Chrome, Bras, Aluminum and enameled or anodized surfaces.** (e.g. WUERTH Art. 0893-121 2-5)

**Product D: Product to lubricate the transmission belts like silicon spray** (e.g. WUERTH Art. 0893-221)

**Frequency 4 weeks (1 month)**

- Check if the main circuit air pressure is 5,5 bar ( $\pm 0,5$ ), adjust it to this value if not.
- Clean the two boxes of the gauge using product B or C
- Check the air treatment filter cartridge, change it if needed. Check if there is excessive presence of water inside; in this case it is advisable to install a dry unit before the filter

**Frequency 6 months**

- Verify air pipes connection, absence of air leak
- Clean the scanner rails using the product C and grease them with product A
- Check the scanning belts, improve the coupling with their pulleys, using silicon spray
- Zero profile check (no product inside the scanner frame)
- If necessary start a new zero profile acquisition procedure; this procedure clears the existing systematic errors if the system is in good operating condition both mechanically and electronically.

**Frequency 12 months (1 year)**

- Substituting the metalized mylar film windows every 12 months or in case of its damage.

**Frequency 2 years**

- Scanner bearings substitution

**Frequency 5 years**

If the sensor is installed on a scanning frame, substitute:


- Cable chain
- Scanning belts
- Motor/shaft transmission belts

The above periods can be reduced in case the plant condition is particularly heavy.

**Source holder and Radioactive Capsule**

The use of the radioactive capsule contained in the source holder, is subject to the local authority regulatory authority. In all installations the user must perform the following operations:.

All gauges		Frequency
1	Verify operation of the SHUTTER ON/OFF warning lights	Every 6 months
Additional Operations for Strontium-90 gauges		
	Collect a leak test sample and have it analyzed by a licensed vendor.	Every 6 months
	Return annual inventory to regulatory authority	Every 12 months

 <b>Electronic Systems s.p.a.</b>	DOMINO Measure System		ISOSINT SENSOR	36/40
	july 2013	Rev. 1.05b_A		
Vietata la riproduzione e la comunicazione a terzi senza autorizzazione scritta. Reproduction and distribution forbidden without written permission.				

## APPENDIX

### 1. About the Ionizing Radiation

Three types of radio isotopes are used:  $^{147}\text{Pm}$  (Prometium),  $^{85}\text{Kr}$  (Krypton), and  $^{90}\text{Sr}$  (Strontium). Each radio isotope is characterized by energy measured in KeV, activity measured in Bq (Bequerel) and half-life measured in years.

The higher the radioisotope energy, the greater the capacity of the electrons to penetrate into a body. The radio isotope  $^{147}\text{Pm}$  has the lowest energy, the radio isotope  $^{90}\text{Sr}$  the highest.

Currently, the activity of a radio isotope is expressed in MBq (millions of Bequerel) that replaced the obsolete unit of measure mCi (thousandths of a Curie). The relation  $1 \text{ mCi} = 37 \text{ MBq}$  applies.

The activity value of a radio isotope is an index of the amount of electrons emitted in the unit of time, which in turn is strictly connected to the amount of available instable atoms (atoms that are potentially capable of emitting an electron). The greater the activity, the stronger the current signal produced by the detector.

Each radio isotope disintegrates rather rapidly in time. Disintegration consists in the reduction of available instable atoms over the time. The rule governing disintegraton is exponential type. Each isotope is characterized by a half-life time indicating after how much time initial activity reduces to half. The three isotopes have the following half-life times:

$^{147}\text{Pm}$	2.5 years
$^{85}\text{Kr}$	10.5 years
$^{90}\text{Sr}$	28.5 years

In practice, this means that for each year that elapses, the source activity decreases of the following amounts compared to the activity of the previous year:

24.2%	for $^{147}\text{Pm}$
6.4%	for $^{85}\text{Kr}$
2.4%	for $^{90}\text{Sr}$

For example, if an  $^{85}\text{Kr}$  source has an initial activity equal to 14,800 MBq (400 mCi), after two years its actual activity will decrease to:

$$14800 \cdot (100\% - 6.4\%) \cdot (100\% - 6.4\%) = 12977 \text{ MBq (374 mCi)}$$

## 2. Description of Operation

The ionizing radiation passing through the detector window, ionizes the gas that is there. The ions that are generated, are collected by the anode thanks to an electric field obtained by applying negative direct voltage (generally in the range  $-300V$  to  $-400V$ ) to the outer wall. A current signal is generated that is proportional to the amount of radiation collected. If a foil of material is placed in the gap, the ionizing beam reaching the detector will be attenuated and, consequently, also the current signal will decrease.

Obviously, the amount of electrons that reach the ionizing chamber is inversely proportional to the mass of the material in the measure gap, more precisely to material thickness. The material under measure usually is a foil characterized by determined thickness and density.

A foil material is normally characterized by its thickness (unit of measure:  $\mu m$  or  $mm$ ) or basic weight (unit of measure:  $g/m^2$ ). The basic weight value indicates how many grams one square meter of foil weighs. In the case of homogenous materials (i.e., having constant density), the relation between thickness and basic weight corresponds to the density of material:  $density = basic\ weight / thickness$ . This means that you can determine the basic weight when you know thickness and density or vice versa.

In consideration of the units of measure, the following relations apply:

Thickness	<b>S</b> [ $\mu m$ ]
Basic Weight	<b>G</b> [ $g/m^2$ ]
Density	<b><math>\rho</math></b> [ $g/cm^3$ ] or [ $kg/dm^3$ ]

$$G = \rho \cdot S$$

ex.:

the basic weight of a polypropylene film in thickness  $25\ \mu m$  and density  $0.91\ g/cm^3$ , is equal to:

$$G = 25 \cdot 0.91 = 22.75\ g/m^2$$

All this does not apply if the material is not homogenous, i.e. if its density may change from place to place. This happens with materials that were expanded by absorbing air, or rolled materials consisting of several layers of different matters.

In all such cases, the current signal produced by the ionizing chamber depends mainly on the real mass of the foil in the measure gap and, then, on its basic weight. For this reason, the ISOSINT sensor should be considered suitable to measure foil basic weight and can be used to measure thickness only in the case of homogenous foils.

Attenuation of the ionizing radiation basically occurs following absorption and diffusion on behalf of the material.

In the first case, part of the electrons passing through the material totally gives out its initial energy in the shocks against the molecular structure and cannot reach the ionizing chamber.

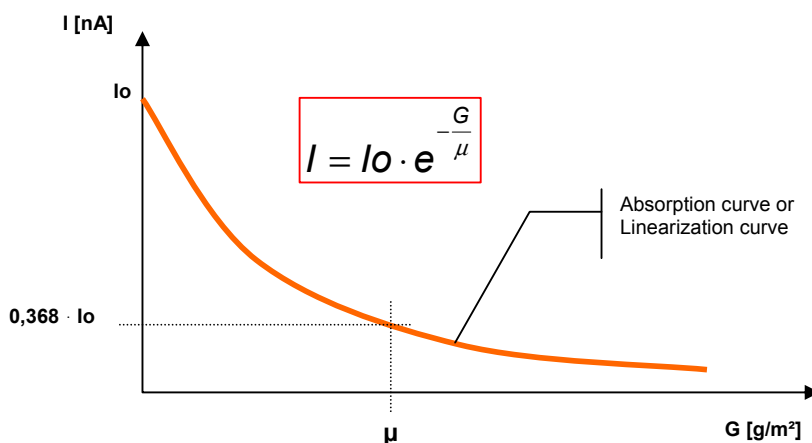
In the second case, part is deviated from the correct trajectory because of '*flexible*' shocks against the molecular structure. Consequently, even though these electrons maintain enough energy to reach the ionizing chamber, actually they do not reach it since they follow an unfavorable trajectory.



### 3. Absorption Curve or Linearization Curve

Attenuation of the radiation (and, consequently, current signal reduction) is not linear relative to the increase of the basic weight of the foil put in between, but follows an almost exponential trend. This curve is usually referred to as absorption curve or linearization curve. When you know it, you can find out the foil basic weight by means of the current value.

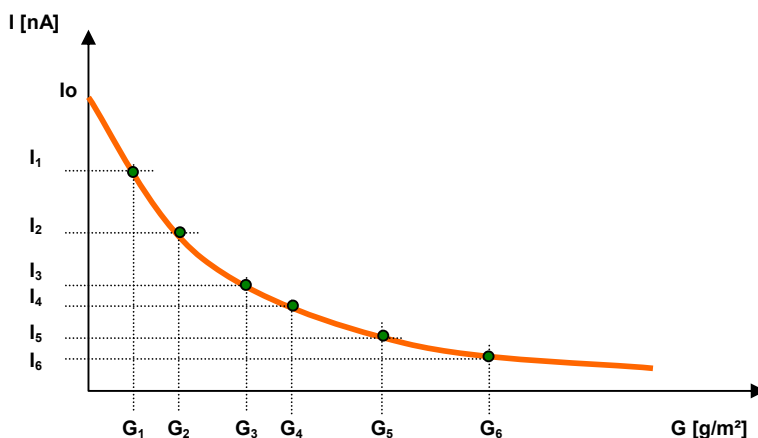
In the ideal case of zero diffusion and with a homogenous material under measure, the trend of electron beam attenuation can be approximated rather accurately by means of an ideal exponential curve.




The factor  $\mu$  is typical of the material being measured and is referred to as mass factor. It is the foil basic weight that would reduce the current signal value down to 36.8% relative to maximum value  $I_0$  (without material).

In reality, since diffusion does exist and due to the detection features of the ionizing chamber, the exponential behavior can be used as a first approximation only in a few cases.

The absorption curve is built by experimentation using several foils of known basic weight to which respective currents are associated. Knowing these points allows building the linearization curve by interpolation.



 <b>Electronic Systems s.p.a.</b>	DOMINO Measure System		ISOSINT SENSOR	40/40
	july 2013	Rev. 1.05b_A		
Vietata la riproduzione e la comunicazione a terzi senza autorizzazione scritta. Reproduction and distribution forbidden without written permission.				

Knowing the absorption curve of the material under measure is a necessary but not sufficient condition to determine the basic weight of the foil being measured. Other factors should be considered to this aim. The most significant factors are detailed below:

❑ Cocking between emitter and receiver.

Caused by the sensor shuttle translation.

❑ Pass Line.

The different position of the film in the measuring gap, in particular condition could cause not negligible variation in the attenuation of the radiation beam.

❑ Ionization chamber and X-ray tube drift

Caused by working temperature changes.

❑ Dirt.

Dirt on the radiation window changes attenuation of the ionization beam.

❑ Air column.

Changing of the air density (caused by temperature and humidity changes) between emitter and receiver.

❑ Statistic noise

Current signal variation generated by the receiver and related to the ionization chamber characteristics and source type.

❑ Measuring spot

The measuring spot is the sheet surface portion across which passes the radiation beam. Therefore, measure relates to the overall mass of such portion of the sheet surface.

❑ Ionization chamber delay

The ionization chamber reacts to a beam intensity variation with a delay; its behavior can be approximated to a first order low pass filter.

To compensate the measure errors due to these factors, some specific actions are adopted, both hardware and software.