User's Guide

# SLP33xD-IOL

# Smart Single-Point Load Cell

METTLER TOLEDO

# SLP33xD-IOL Smart Single-Point Load Cell

METTLER TOLEDO Service

Essential Services for Dependable Performance of your SLP33xD-IOL Smart Single-Point Load Cell

Congratulations on choosing the quality and precision of METTLER TOLEDO. Proper use of your new equipment according to this manual and regular calibration and maintenance by our factory-trained service team ensures reliable and accurate operation, protecting your investment. Contact us for a service agreement tailored to your needs and budget. Further information is available at www.mt.com/service.

There are several important ways to ensure you maximize the performance of your investment:

1. Register your product: We invite you to register your product at www.mt.com/productregistration so we can contact you about enhancements, updates and important notifications concerning your product.
2. Contact METTLER TOLEDO for service: The value of a measurement is proportional to its accuracy – an out of specification scale can diminish quality, reduce profits and increase liability. Regular service from METTLER TOLEDO will ensure accuracy and optimize uptime and equipment life.
    a. Installation, Configuration, Integration and Training: Our service representatives are factory-trained, weighing equipment experts. We ensure that your weighing equipment is ready for production in a cost effective and timely fashion and that the operating staff is trained for success.
    b. Initial Calibration Documentation: The installation environment and application requirements are unique for every industrial scale so performance must be tested and certified. To ensure production quality and provide a quality system record of performance we provide a calibration service. The accuracy is documented in the calibration certification documents.
    c. Periodic Calibration Maintenance: A Calibration Service Agreement provides on-going confidence in your weighing process and documentation of compliance with requirements. We offer a variety of service plans that are scheduled to meet your needs and designed to fit your budget.

## FCC Notice

This device complies with Part 15 of the FCC Rules and the Radio Interference Requirements of the Canadian Department of Communications. Operation is subject to the following conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his or her expense.

- Declaration of Conformity is available at http://glo.mt.com/global/en/home/search/compliance.html/compliance/.

IO-Link is an industrial communications networking standard (IEC 61131-9) managed by the industry association Profibus and Profinet International.

# Warnings and Cautions

- READ this manual BEFORE operating or servicing this equipment and FOLLOW these instructions carefully.
- SAVE this manual for future reference.

| | |
|---|---|
| | ⚠ CAUTION |
| | THE SLP33xD-IOL IS INTENDED TO BE USED FOR PROCESS CONTROL AND IS NOT APPROVED AS A SAFETY COMPONENT. WHEN USED AS A COMPONENT PART OF A SYSTEM, ANY SAFETY CIRCUITS MUST BE INDEPENDENT OF THE SLP33xD-IOL. |
| | ⚠ CAUTION |
| | THE SLP33XD-IOL IS NOT INTRINSICALLY SAFE! DO NOT USE IN HAZARDOUS AREAS CLASSIFIED AS DIVISION 1, ZONE 0, ZONE 20, ZONE 1 OR ZONE 21 BECAUSE OF COMBUSTIBLE OR EXPLOSIVE ATMOSPHERES. FAILURE TO COMPLY WITH THIS WARNING COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE. |
| | ⚠ WARNING |
| | WHEN THIS EQUIPMENT IS INCLUDED AS A COMPONENT PART OF A SYSTEM, THE RESULTING DESIGN MUST BE REVIEWED BY QUALIFIED PERSONNEL WHO ARE FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF ALL COMPONENTS IN THE SYSTEM AND THE POTENTIAL HAZARDS INVOLVED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE. |
| | ⚠ CAUTION |
| | DO NOT INSTALL, DISCONNECT OR PERFORM ANY SERVICE ON THIS EQUIPMENT BEFORE POWER HAS BEEN SWITCHED OFF AND THE AREA HAS BEEN SECURED AS NON-HAZARDOUS BY PERSONNEL AUTHORIZED TO DO SO BY THE RESPONSIBLE PERSON ON-SITE. |
| | ⚠ CAUTION |
| | ONLY PERMIT QUALIFIED PERSONNEL TO SERVICE THE LOAD CELL. EXERCISE CARE WHEN MAKING CHECKS, TESTS AND ADJUSTMENTS THAT MUST BE MADE WITH POWER ON. FAILING TO OBSERVE THESE PRECAUTIONS CAN RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE. |
| | *NOTICE* |
| | OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES. |

# Disposal of Electrical and Electronic Equipment

In conformance with the European Directive 2012/19/EC on Waste Electrical and Electronic Equipment (WEEE) this device may not be disposed of in domestic waste. This also applies to countries outside the EU, per their specific requirements.

Please dispose of this product in accordance with local regulations at the collecting point specified for electrical and electronic equipment.

If you have any questions, please contact the responsible authority or the distributor from which you purchased this device.

Should this device be passed on to other parties (for private or professional use), the content of this regulation must also be related.

Thank you for your contribution to environmental protection.

# Contents

# 1 Introduction

The SLP33xD-IOL includes the latest connectivity standard among the METTLER TOLEDO product portfolio and is one of the fastest single-point load cell with integrated connectivity on the market. The IO-Link communication interface enables the load cell to connect to any PLC or automation system, without using an additional electronic unit beside the IO-Link Master. The SLP33xD-IOL single-point load cell provides weight information, as well as status and condition monitoring to your automation system – rapidly and reliably.

### 1.1.1. Clarifications

- In this guide we use the designation "d" for the minimum measurement interval, which is technically possible, thanks to the advanced on-board digital signal processing (DSP) libraries. For the approved minimum measurement interval according to OIML R60 and Handbook 44 we use the designation “e”. The technically possible measurement interval or resolution “d” is smaller than “e”.
- In this guide we make the distinction between the terms "calibration" and “adjustment”. “Calibration” is nothing else but comparing the load cell’s output signal (weight value) to known reference standards and recording the values. “Adjustment” implicates that the load cell’s output signal (weight value) is adjusted to said reference standards in order to show the same values. When the adjustment process is finished, the load cell output signal will display the same weight value of the reference standard within the repeatability error.

## 1.2. SLP33xD-IOL Overview

Standard SLP33xD-IOL single-point load cell features:

- Mounting holes on opposite ends and sides of the load cell to connect to:
  - a firm base or foundation supporting the load cell, and to
  - a weighing pan or other weighing structure which holds the product to be weighed in place for the weighment.
- 5-pin M12 industrial connector for IO-Link connectivity, Class A


Figure 1-1: SLP33xD-IOL Connector and LED

- Multicolor LED indicating Smart5™ alarm levels (Green, Blue, Yellow, Orange, Red)

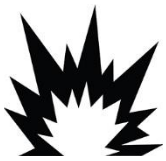
- Printed type plates indicating product number, serial number, country of manufacturing, metrology approval details, and other approvals and declarations
- Factory adjustment parameters to adjust for environment temperature changes, non-linearity, hysteresis, and creep. By specifying the local acceleration due to gravity (g-value) or equivalently GEO code (METTLER TOLEDO's g-value codes) the load cell is ready to measure.

## 1.3. Specifications

For detailed specifications see the Datasheet on the download page:

SLP33xD Load Cells Download Page - METTLER TOLEDO (mt.com)

## 1.4. Environmental Protection



**⚠ CAUTION**

THE SLP33XD-IOL IS NOT INTRINSICALLY SAFE! DO NOT USE IN HAZARDOUS AREAS CLASSIFIED AS DIVISION 1, ZONE 0, ZONE 20, ZONE 1 OR ZONE 21 BECAUSE OF COMBUSTIBLE OR EXPLOSIVE ATMOSPHERES. FAILURE TO COMPLY WITH THIS WARNING COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE.

## 1.5. Inspection and Shipping Content Checklist

Verify the content and inspect the package immediately upon delivery. If the shipping container is damaged, check for internal damage and file a freight claim with the carrier if necessary. If the container is not damaged, remove the SLP33xD-IOL load cell from its package, noting how it was packed, and inspect it for damage. Do not use the cable for lifting, always lift the aluminum body. If the unit is damaged, do not apply power and contact your local METTLER TOLEDO representative. Take a picture if possible if the unit is damaged for evidentiary purposes. The packaging material has been selected for the lowest environmental impact and can be recycled.

If it is necessary to re-ship the load cell, it is best to use the original shipping box. The load cell must be packed correctly to ensure safe transportation.

Please read the safety instructions before using this device.

Additional documentation can be found online here:

SLP33xD Load Cells Download Page - METTLER TOLEDO (mt.com)

The shipping box includes:

- One SLP33xD-IOL load cell
- Calibration Certificate
- CE Declaration of Conformity (Europe only)
- Quick installation guide

# 1.6. Model Identification

The SLP33xD-IOL model number is located on the type-plate attached to the load cell along with the serial number. Figure 1-2 shows an example of the type-plate.

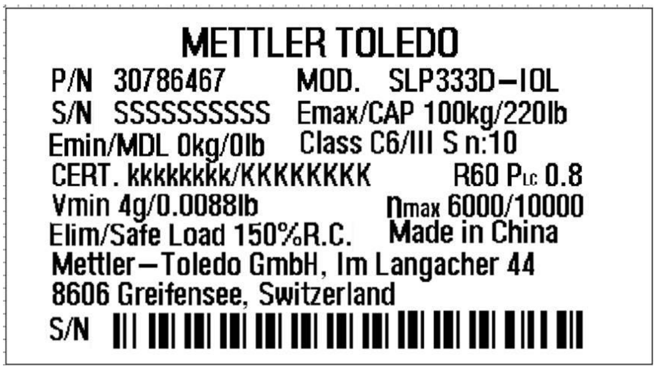



Figure 1-2: SLP33xD-IOL type plate example

# 1.7. Dimensions, Order Information

The SLP33xD-IOL load cell is available in 3 different sizes, SLP331D, SLP332D, and SLP333D. The model family covers rated capacities from 10 kg to 500 kg. Several rated capacities are available in multiple sizes, providing high flexibility for machine builders to select the most suitable model. For dimensions and drawings please visit the product download page:

SLP33xD Load Cells Download Page - METTLER TOLEDO (mt.com)

Please note that the cable with M12 connector needs about 100 mm space to avoid any damage. If space in the machine is limited, cables with right angle connectors shall be used.

## 1.7.1. Electronic in the Load Cell

The SLP33xD-IOL single-point load cell has an onboard electronic, that performs the digital signal processing, adjusts to environmental conditions, and communicates to the automation/control system via IO-Link. Furthermore, the electronic performs all the scale functions such as zero and tare handling and adjustment to external reference weights. The weight value is transmitted to the automation/control system via an IO-Link Master unit, together with status and alarm information.

Figure 1-3 shows the position of the electronic board in the load cell. Although the board is covered with potting material, contact of these areas with other parts of the machine must be avoided.

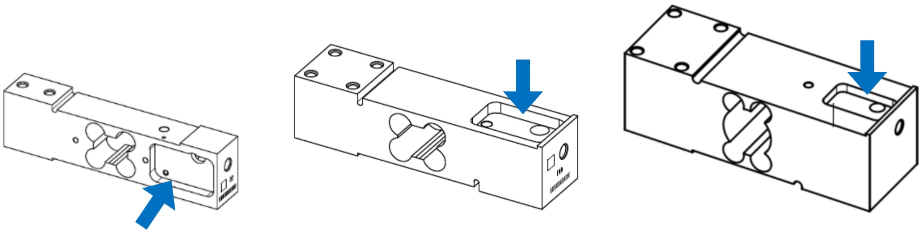


Figure 1-3: Position of the electronic board in the SLP331, SLP332, and SLP333D load cells

### 1.7.2. Order Information

Table 1-1 lists the item numbers of available load cell models. Please note that each model is available in two accuracy versions, OIML C3 and C6 classes (NTEP 5000/10000).

Table 1-1: SLP33xD-IOL Sizes and Rated Capacities

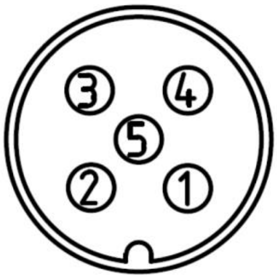
| | Item number | | | | | |
|---|---|---|---|---|---|---|
| | SLP331D-IOL | | SLP332D-IOL | | SLP333D-IOL | |
| Accuracy / Rated Capacity | OIML C3 / NTEP 5000 | OIML C6 / NTEP 10000 | OIML C3 / NTEP 5000 | OIML C6 / NTEP 10000 | C3 OIML / NTEP 5000 | C6 OIML / NTEP 10000 |
| 10 kg / 22 lb | 30801836 | 30786457 | | | | |
| 20 kg / 44 lb | 30801837 | 30786458 | | | | |
| 30 kg / 66 lb | 30801838 | 30786459 | 30801841 | 30786462 | | |
| 50 kg / 110 lb | 30801839 | 30786460 | 30801842 | 30786463 | 30801830 | 30786466 |
| 100 kg / 220 lb | 30801840 | 30786461 | 30801843 | 30786464 | 30801831 | 30786467 |
| 150 kg / 330 lb | | | | | 30801832 | 30786468 |
| 200 kg / 440 lb | | | 30801844 | 30786465 | 30801833 | 30786469 |
| 300 kg / 660 lb | | | | | 30801834 | 30786470 |
| 500 kg / 1100 lb | | | | | 30801835 | 30786471 |

## 1.8. Communication

The SLP33xD-IOL single-point load cells are IO-Link sensors. IO-Link is a serial, bi-directional point-to-point connection for signal transmission and energy supply. IO-Link sensors are connected to an IO-Link Master unit (not provided by METTLER TOLEDO) which is then connected to any fieldbus or backplane bus system. IO-Link sensors can be used practically in any automation control system.

The SLP33xD-IOL load cells work according to IO-Link Specification V1.1. The SLP33xD-IOL load cells support the fastest, COM3 = 230.4 kbaud data transmission rate. The transmitted cyclic data is 64 bit, which results in a 200 Hz update rate. In other words, the weighing result (plus status information) is transmitted 200 times every second. For more details on data structure see Chapter 3, Operation.

The SLP33xD-IOL load cells are equipped with a 5-pin M12 connector. The load cell can be connected to any IO-Link Master port specified as Class A. Figure 1-4 shows the pin layout of the M12 plug.




1 L+ (typ. 24 VDC)
2 DI/IQ (digital input/output)
3 L- (0 VDC), connected to the load cell body
4 C/Q (switching and communication line)
5 not used

Figure 1-4: Pin layout of the SLP33xD-IOL load cell

# 2 Installation

This Chapter is intended to cover the mechanical and electrical installation in a non-hazardous environment. For more information to installation in hazardous environments please refer to additional load cell documentation and details of the hazardous approvals.

## 2.1. General Considerations

Properly engineered and designed weighing system under consideration of all safety relevant design precautions like wind load resistance, thermal expansion etc. is assumed. Load cell installation requires mechanical and electrical skills and shall only be performed by trained and authorized personnel.

Be cautious when welding in the vicinity of the load cell. Stray current can destroy the load cell; therefore, do not pass welding current through the load cell! Whenever welding on a scale or other machine with load cells, ground the welding device as close to the work as possible. Never weld closer than 1.2 meter (4 feet) to any load cell without removing the load cell.

Regarding the strength of the foundation please consider that the surface supporting the load cell, the weighing pan or other container and the load to be weighed are strong enough to avoid deflection. Deflecting floors or supporting structures can lead to inaccuracy of the weighing result. In case of a weak foundation or deflection please reinforce the foundation and contact your engineering team to get support. In order to achieve increased stiffness of the weighing system support structure, e.g., attaching / enlarging / thickening stiffening braces can be a good approach.

Unleveled load cells can result in inaccurate results. To achieve high accuracy of your machines and products a general rule of thumb can be applied: horizontal leveling must be within 0.5° in any direction. This is similar to an upward or downward slope of 1mm (1/32inch) per 100mm (4inches).

## 2.2. Mechanical Installation

A load cell is integrated into the weighing system, so it is part of it. It needs to be integrated into the load flow thus that load is completely carried by the load cell. That makes the load cell a safety relevant part in the design.

The load should be always introduced parallel to the primary loading axis to avoid errors and inaccuracy caused by misalignment, off-center or torsional moments, transverse and lateral forces.

SLP33xD-IOL load cells are so called single-point load cells, which means only one load cell is required to build a scale. The single-point load cell requires a firm foundation or support structure, and a holder or container to keep the load in place for the measurement. This holder or container can be a simple plate (“platter”), just like the grocery scale in a supermarket or a very complex mechanical structure, e.g., used for material dosing. The single-point load cells are moment insensitive by design and weigh within tolerance regardless of where the load is placed on the platter. The max. platter size in Table 2-1 indirectly describes the maximum offset of the center of gravity (CoG) of the product to be weighed from the load cell center line (see Figure 2-1 for details). When designing your machine using SLP33xD-IOL load cells, consider the max. platter size. This gives you the limits for which the center of gravity of the weighing container (platter) and the product together should stay in.

Table 2-1: SLP33xD-IOL Max. Platter Size Specifications

| | SLP331D-IOL | SLP332D-IOL | SLP333D-IOL |
|---|---|---|---|
| Rated Capacity, kg | 10, 20, 30, 50, 100 | 30, 50, 100, 200 | 50, 100, 150, 200, 300, 500 |
| Max. platter size mm (in) | 400x400 (15.7x15.7) | | 600x600 (23.6x23.6) |

To install the SLP33xD-IOL load cells you will need a leveling tool, e.g., a water level, and torque wrench to fasten the mounting bolts.

Table 2-2 shows the mounting bolt requirements and sizes as well as the torque required to install the bolts.

Table 2-2: SLP33xD-IOL Mounting Bolt and Torque Specifications

| | SLP331D-IOL | SLP332D-IOL | SLP333D-IOL |
|---|---|---|---|
| Rated Capacity, kg | 10, 20, 30, 50, 100 | 30, 50, 100, 200 | 50, 100, 150, 200, 300, 500 |
| Bolt material, grade | Stainless steel, 8.8 or higher | | |
| Bolt thread size | M6 | | M8 |
| Torque, nominal, Nm (ft-lb) | 10 (7.5) | | 25 (18) |

Ideally, the CoG of the platter and the load to be weighed is on the axis of action of the single point load cell. This is in the middle of the load cell. However, the CoG can be anywhere within the max. platter size, it will not impact the measurement accuracy beyond the specified values in the datasheet. The red arrow on Figure 2-1 shows where the product and therefore the CoG can be placed. Please note that the platter (green plate) is not centered around the mounting holes, but around the center of the load cell.

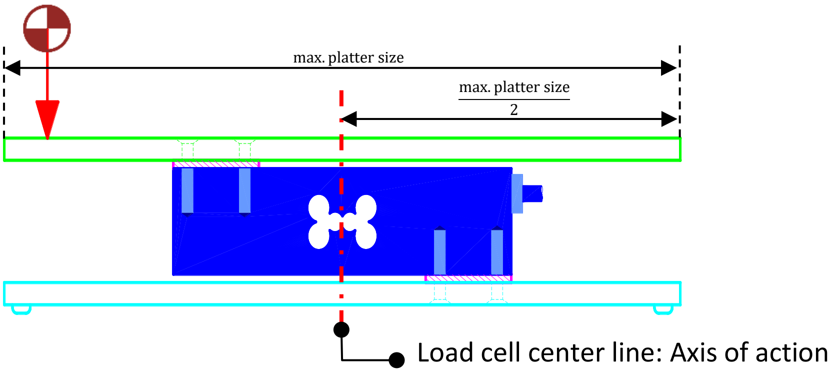



Figure 2-1: Load to be weighed can be placed withing max. platter size on a single-point load cell

To install the SLP33xD-IOL load cells you need a rigid base plate or support structure and a rigid platter or container. Make sure the deflection of the support and the platter are uniform, and the vertical alignment stays less than 0.5°.

Mount the load cell with its longitudinal axis horizontally between 2 plates or frames.

The upper plate (green on Figure 2-1) is the load receptor (platter). Ideally the load cell's vertical center line (primary loading axis) is placed at the center of the load receptor.

The upper platter and lower plate are mounted to the load cell's horizontal surfaces by using stainless steel bolts. If possible do not use countersunk screws, as they can introduce a side force on the load cell. It is recommended to install spacer plates to create clearance to accommodate load cell deflection under load. Spacers must be solid and cover the entire mounting surfaces of the load cell. E.g., just using washers for spacing is not allowed.

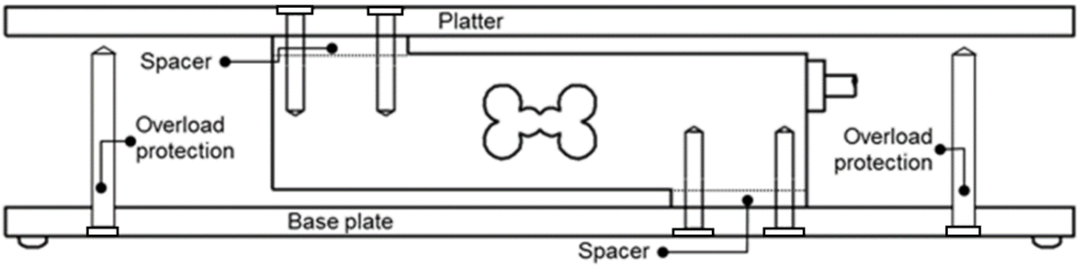



Figure 2-2: Mechanical installation of single point load cells with overload protection

Overload stop protection is recommended for every machine design since the SLP33xD-IOL single-point load cells do not have mechanical overload protection. It can be realized by using threaded stems in the design, see Figure 2-2 for example. Once the load cell is in place and the mounting bolts are fastened with the recommended torque values, add load up to the scale capacity to the center of the scale. Drive the threaded stem to make contact with the platter (or with base plate); you will see changes in the weighing measurement. (The load cell must be connected to the PLC or automation system to observe the weighing signal.) Reverse the threaded stem slightly (approx. 30° turn) and lock it with a locking nut.

The SLP33xD-IOL load cells can also be installed upside-down, meaning the supporting structure is above the load cell, and the weighing platter or container is hanging underneath. To activate this mode, refer to 'reverse mode' and its description in Chapter 3, Operation. Considerations regarding load introduction, leveling, overload protection, etc. are still valid in the reverse mode.

## 2.3. Electrical Installation

A load cell is meant to measure mass. Every mass is attracted by the earth gravimetric field, the resulting force is named "load". The load cell transforms the load into an electrical signal. Since the gravity level varies at different locations on earth, also the electrical signal from load cell varies by the location. Thus, adjustment to the location of the load cell is required, the local acceleration due to gravity (g-value) must be specified during installation.

Before said adjustment can be done, the SLP33xD-IOL load cell must be connected to an IO-Link Master unit by an electrical cable equipped with M12 5-pin connectors.

Figure 2-3: SLP33xD-IOL single-point load cells and cable with M12 connectors

The next step is to locate and download the IO-Link Device Description file, IODD. For that visit https://ioddfinder.io-link.com/ and search for METTLER TOLEDO.

Installation steps of the IODD file in various automation systems can be found on the product download page, SLP33xD Load Cells Download Page - METTLER TOLEDO (mt.com).

Once the SLP33xD-IOL load cell is connected to the PLC or automation system and the IODD file is installed, the local adjustment can take place. For details of the adjustment possibilities and processes see Chapter 3, Operation. It is also possible to enter the local g-value in the SLP33xD-IOL load cell with 6 digits after the comma (9.xxxxxx $m/s^2$) or to specify the GEO Code. List of GEO Code values based on location information can be found in Appendix A.

The GEO code system was developed with the first electronic scales by METTLER TOLEDO to map the local acceleration due to gravity (g-value) values to an integer parameter. Values of g-factor from 9.77039 to 9.83239 m/s2 correspond to integer numbers from 0 to 31. Table 2-3 lists the center of each range of the g-factor and the corresponding GEO Code. Appendix A contains the GEO Code values depending on altitude, latitude, and elevation above sea level.

Table 2-3: Gravity values mapped to integer numbers (GEO Code)

| g-value ($m/s^2$) | GEO Code |
|---|---|
| 9.770390 | 0 |
| 9.772378 | 1 |
| 9.774367 | 2 |
| 9,776356 | 3 |
| 9.778347 | 4 |
| 9.780338 | 5 |
| 9.782330 | 6 |
| 9.784323 | 7 |
| 9.786316 | 8 |
| 9.788311 | 9 |
| 9.790306 | 10 |
| 9.792302 | 11 |
| 9.794299 | 12 |
| 9.796297 | 13 |
| 9.798295 | 14 |
| 9.800295 | 15 |

| g-value ($m/s^2$) | GEO Code |
|---|---|
| 9.802295 | 16 |
| 9.804296 | 17 |
| 9.806298 | 18 |
| 9.808300 | 19 |
| 9.810304 | 20 |
| 9.812308 | 21 |
| 9.814313 | 22 |
| 9.816319 | 23 |
| 9.818326 | 24 |
| 9.820333 | 25 |
| 9.822341 | 26 |
| 9.824351 | 27 |
| 9.826361 | 28 |
| 9.828371 | 29 |
| 9.830383 | 30 |
| 9.832396 | 31 |

The resolution or step size of the GEO Code system (the difference between two adjacent values) is approx. 0.002 $m/s^2$. In the SLP33xD-IOL single-point load cells a high-resolution GEO Code system is implemented. Therefore, the GEO Code values can be specified with 2 decimal places. E.g., the GEO Code can be 19.12 or 19.68. The step size of the high-resolution GEO Code system is 0.00002 $m/s^2$.

In case the actual g-value it is known for the place of installation it is also possible to directly enter it during the configuration of the load cell. This g-value is internally converted into the high-resolution GEO Code system. During the conversion the g-value is rounded to the nearest high-resolution GEO Code value.

## 2.4. Corner Load Test for Quality Check

Once the mechanical and electrical installation is finished, it is recommended to do a corner load test. As far as the machine design allows, place a load close to scale capacity in each corner of the weighing platter, or as far as possible from the center of the load cell, but still within the specified max. platter size (see Table 2-1). The displayed weigh value shall be within the measurement errors specified in the datasheet.

It is also good practice to check the machine’s performance on a regular basis by comparing the displayed weight values to known reference standards (test weights). Extending the regular check with corner load test can unveil potential deterioration in the mechanical installation and thus in the weighing performance.

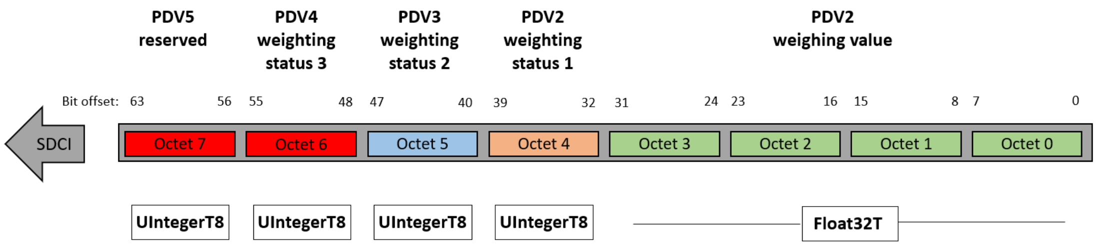
# 3 Operation

This chapter gives an overview about the functionalities when operating an SLP33xD IO-L single point load cell in a siemens automation system. For different automation systems, e. g. Rockwell, the appearance may differ, but the content is the same.

## 3.1. Data Structure

The process Data Input structure is listed in the table below. The measured weight value is transmitted in the first four Octets (Octet 0 – 3) as a 32-bit floating-point number. Octets 4, 5, and 6 contain status information about the measured weight value and about the load cell itself. Reserved bits are not used for data transmission.

| Process data input | Index 40 | Subindex 0 | RecordT (64 Bit) |
|---|---|---|---|
| | | | |
| Weight Value | | Octet 0 - 3 | Float32T (32 Bit) |
| | | | |
| Device status 1 | | Octet 4 | UIntegerT (8 Bit) |
| Net Mode | | | BooleanT (1 Bit) |
| Motion | | | BooleanT (1 Bit) |
| Center of zero | | | BooleanT (1 Bit) |
| Smart5 Level5 Alarm | | | BooleanT (1 Bit) |
| Data OK | | | BooleanT (1 Bit) |
| Heartbeat | | | BooleanT (1 Bit) |
| Reserved | | | BooleanT (1 Bit) |
| Reserved | | | BooleanT (1 Bit) |
| | | | |
| Device status 2 | | Octet 5 | UIntegerT (8 Bit) |
| Reserved | | | BooleanT (1 Bit) |
| Reserved | | | BooleanT (1 Bit) |
| Smart5 Level4 Alarm | | | BooleanT (1 Bit) |
| Smart5 Level3 Alarm | | | BooleanT (1 Bit) |
| Smart5 Level2 Alarm | | | BooleanT (1 Bit) |
| Reserved | | | BooleanT (1 Bit) |
| Reserved | | | BooleanT (1 Bit) |
| Reserved | | | BooleanT (1 Bit) |
| | | | |
| Device status 3 | | Octet 6 | UIntegerT (8 Bit) |
| Process Type | | | UIntegerT (3 Bit) |
| New weight update | | | BooleanT (1 Bit) |
| Process Status | | | UIntegerT (4 Bit) |




Octet 4

- Net Mode: The SLP33xD-IOL load cell can deliver gross or net Weight Value.
  - False (0): Gross weight value is transmitted
  - True (1): Net weight value is transmitted
- Motion: It provides information about the changes in the weight value
  - False (0): no motion, the weight value is stable
  - True (1): the weight value is changing, unstable
- Center of zero:
  - False (0): Current weight value is not within ±1/2d of zero
  - True (1): Current weight value is within ±1/2d of zero
- Smart5 Level5 Alarm: If a Level5 (Red) Alarm is active, this bit changes to True (1)
  - False (0): no active Level5 Alarm
  - True (1): Level5 Alarm active
- Data OK: The sensor delivers valid weighing data, which means the Digital Signal Processing unit is working.
  - False (0): Current weight value is unavailable for user
  - True (1): Current weight value is available for user
- Heartbeat: The bit changes from 0 to 1 and from 1 to 0 in every second. It indicates that the sensor is working and transmitting data. This bit can be used during troubleshooting or can be monitored constantly by the control system to ensure the sensor is working.

Octet 5 contains the Smart5 status information. If a Smart5 alarm is raised, the respective bit flips to True (1) in Octet 5.

- Smart5 Level4 Alarm:
  - False (0): No Level4 alarm active
  - True (1): Level4 alarm active

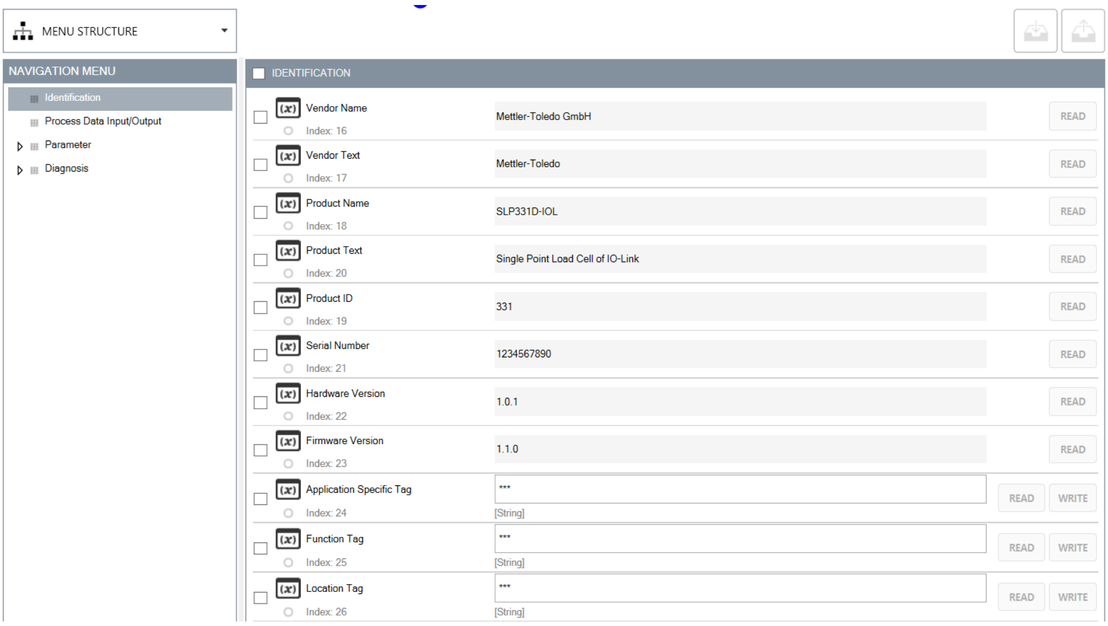
- Smart5 Level3 Alarm:
    - False (0): No Level3 alarm active
    - True (1): Level3 alarm active
- Smart5 Level2 Alarm:
    - False (0): No Level2 alarm active
    - True (1): Level2 alarm active

Octet 6

- Process Type, 3 bits:
    - None (0): Normal mode, no zero/tare/adjustment operation
    - Zero (1): Zeroing is in process
    - Tare (2): Taring is in process
    - Adjustment (3): Adjustment is in process
- New weight update, 1 bit:
    - Reserved
- Process Status, 4 bits:
    - Successful (0): The process is finished and successful
    - In progress (1): The process is ongoing
    - User action required (2): User needs to place weight on the load cell
    - Failed (3): The process is failed.
    - Aborted (4): The process is aborted by user
    - Timeout (5): The process is timeout

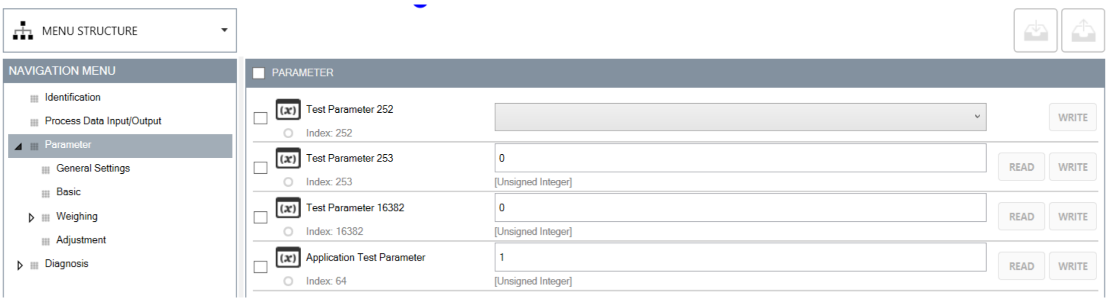
# 3.2. IODD Details

## 3.2.1. Identification




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| Vendor name | Index 16 | Subindex 0 | StringT (19 Byte) | RO |
| Factory setting | Mettler-Toledo GmbH | | | |
| Vendor text | Index 17 | Subindex 0 | StringT (14 Byte) | RO |
| Factory setting | Mettler-Toledo | | | |
| Product Name | Index 18 | Subindex 0 | StringT (11 Byte) | RO |
| | SLP33xD-IOL | | | |
| Product Text | Index 20 | Subindex 0 | StringT (33 Byte) | RO |
| Factory setting | Single Point Load Cell of IO-Link | | | |
| Product ID | Index 19 | Subindex 0 | StringT (3 Byte) | RO |
| | 331, 332, or 333, depending on the model | | | |
| Serial Number | Index 21 | Subindex 0 | StringT (10 Byte) | RO |
| | xxxxxxxx | | | |
| Hardware Version | Index 22 | Subindex 0 | StringT (5 Byte) | RO |
| | x.x.x | | | |
| Firmware Version | Index 23 | Subindex 0 | StringT (5 Byte) | RO |
| | x.x.x | | | |
| Application Specific Tag | Index 24 | Subindex 0 | StringT (32 Byte) | RW |
| Factory setting | *** | | | |
| Function Tag | Index 25 | Subindex 0 | StringT (32 Byte) | RW |
| Factory setting | *** | | | |
| Location Tag | Index 26 | Subindex 0 | StringT (32 Byte) | RW |
| Factory setting | *** | | | |

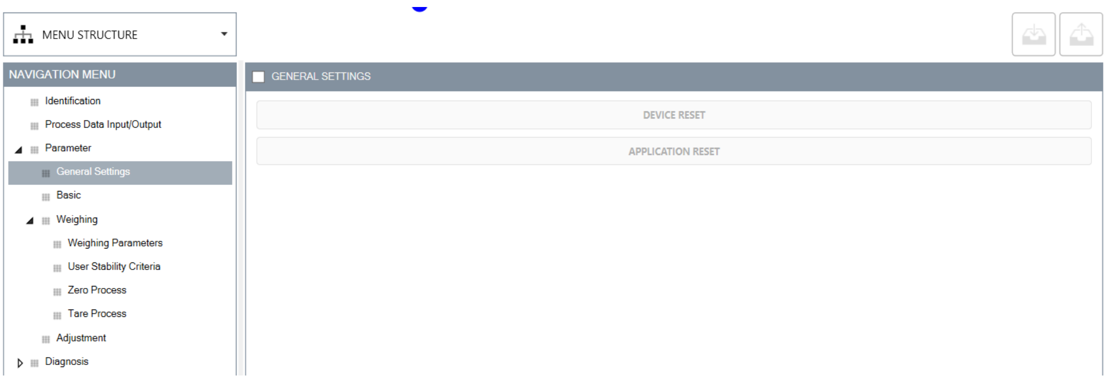
### 3.2.2. Parameters




These fields are only used by METTLER TOLEDO for internal testing purposes during production.

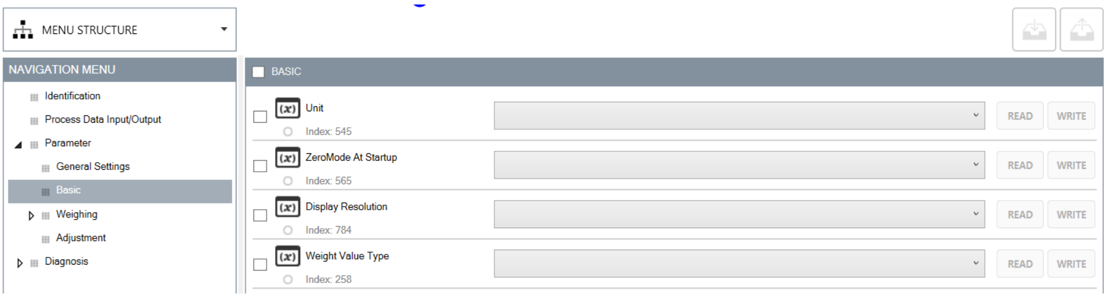
| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| Test Parameter 252 | Index 16 | Subindex 0 | UIntegerT (8 Bit) | WO |
| Value Range | 0 = A Appear<br>1 = A Disappear<br>2 = B Appear<br>3 = B Disappear | | | |
| Test Parameter 253 | Index 17 | Subindex 0 | UIntegerT (8 Bit) | RW |
| Factory setting | 0 | | | |
| Test Parameter 16382 | Index 18 | Subindex 0 | UIntegerT (32 Bit) | RW |
| Factory setting | 0 | | | |
| Application Test Parameter | Index 20 | Subindex 0 | UIntegerT (32 Bit) | RW |
| Factory setting | 1 | | | |

#### 3.2.2.1. General Setting



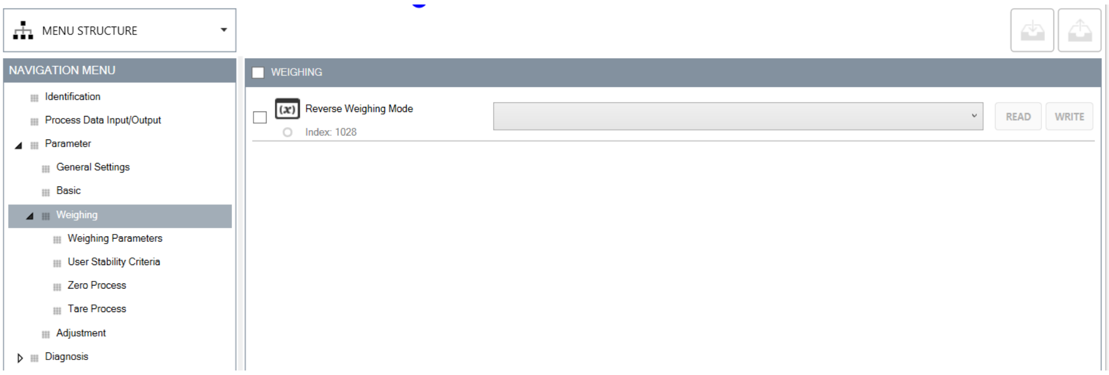

| System Commands | Text | Description |
|---|---|---|
| 128 | Device Reset | Reset the load cell |
| 129 | Application Reset | Reset the test parameters |

### 3.2.2.2. Basic



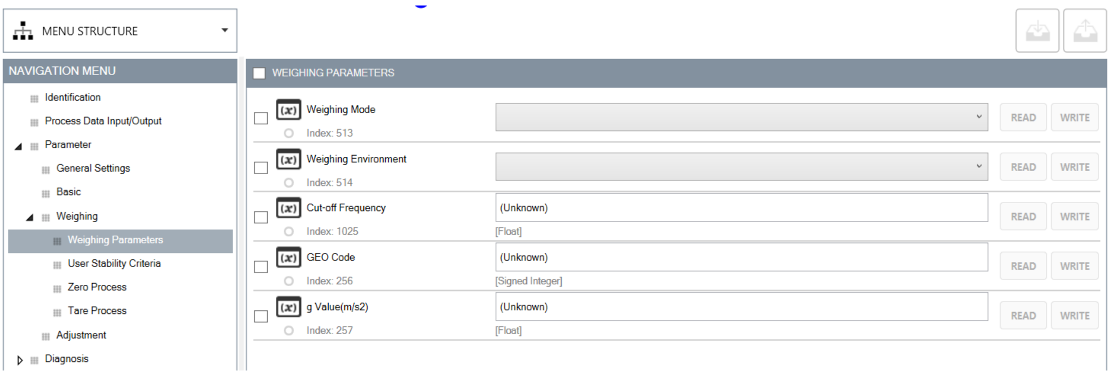

| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| Unit | Index 545 | Subindex 0 | UIntegerT (8 Bit) | RW |
| Weight value type within the Process Data Input (Defined in 3.1). The default value is 1 (kg). | | | | |
| Value range | 0<br>**1**<br>7 | g<br>**kg**<br>lb | | |
| Zero Mode at Startup | Index 565 | Subindex 0 | UIntegerT (32 Bit) | RW |
| In normal mode 0, the device specifies a new zero reference point at startup as soon as a stable condition has been achieved. In mode 1, the device will use the last saved zero value. The default value is 0(Normal mode). | | | | |
| Value range | **0**<br>1<br>2 | **Normal mode**<br>Last zero<br>Each zero | | |
| Display Resolution | Index 784 | Subindex 0 | IntegerT (8 Bit) | RW |
| This parameter increases/decreases the weight value resolution up to factor 100. The default value is 0(Standard). | | | | |
| Value range | -6<br>-5<br>-4<br>-3<br>-2<br>-1<br>**0**<br>1<br>2<br>3<br>4<br>5<br>6 | Factor 100 lower<br>Factor 50 lower<br>Factor 20 lower<br>Factor 10 lower<br>Factor 5 lower<br>Factor 2 lower<br>**Standard**<br>Factor 2 higher<br>Factor 5 higher<br>Factor 10 higher<br>Factor 20 higher<br>Factor 50 higher<br>Factor 100 higher | | |
| Weight Value Type | Index 258 | Subindex 0 | UIntegerT (16 Bit) | RW |
| Weight value type within the Process Data Input (Defined in 3.1). The default value is 0 (Gross weight). | | | | |
| Value range | **0**<br>1<br>2 | **Gross weight**<br>Tare weight<br>Net weight | | |

### 3.2.2.3. Weighing




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Reverse Weighing Mode** | **Index 1028** | **Subindex 0** | **UIntegerT (8 Bit)** | **RW** |
| This parameter is used to set the weighing system to the reverse weighing mode, e.g., when the load cell is mounted on an overhead structure. This weighing mode is specially designed for the vertical compression type digital load cell which is used by the customer as a tension type load cell. The default value is 0(Disabled). | | | | |
| Value range | **0**<br>1 | **Disable**<br>Enabled | | |

#### 3.2.2.3.1. Weighing Parameters




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Weighing Mode** | **Index 513** | **Subindex 0** | **UIntegerT (8 Bit)** | **RW** |
| Gets or sets the current weighing mode setting. The default value is 1 (Stable). | | | | |
| Value range | **0**<br>1<br>2 | Normal weighing<br>Filling/Dosing, Reserved<br>Dynamic weighing | | |
| **Weighing Environment** | **Index 514** | **Subindex 0** | **UIntegerT (8 Bit)** | **RW** |
| Current environment condition setting. The more unstable the environment, the greater the filtering strength. The default value is 2(Standard). | | | | |
| Value range | 0<br>1<br>**2**<br>3<br>4 | Very stable environment<br>Stable environment<br>**Standard environment**<br>Unstable environment<br>Very unstable environment | | |
| **Cut-off Frequency** | **Index 1025** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| Set the cut-off frequency of the fixed filter. The unit is Hertz (Hz).<br>This parameter will only be activated when the weighting mode is set to 2. The default value is 0 (Disabled). | | | | |
| Value range | **0**<br>0.001 ~ 20.0 | **Disabled**<br>Cut off frequency | | |

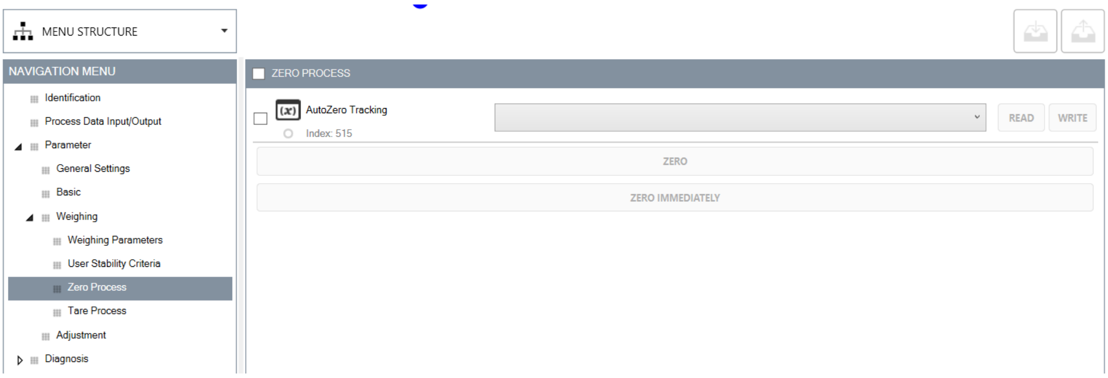
| GEO Code | Index 256 | Subindex 0 | IntegerT (8 Bit) | RW |
|---|---|---|---|---|
| GEO code. The default value is 12. | | | | |
| Value range | -1<br>0 ~ 31 | Disabled<br>GEO Code | | |
| **g Value (m/s2)** | **Index 256** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| Local high-precision gravity acceleration value. Users configure either GEO code or g Value. The default value is 9.794299. | | | | |
| Value range | 9.770390 ~ 9.832396 | | | |

### 3.2.2.3.2. User Stability Criteria


| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Observation Time for Weighing** | **Index 1029** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| It is used to modify the current user-defined weighing stability judgment condition - measurement time, in seconds (s) | | | | |
| Value range | 0.0 – 4.0 | seconds | | |
| **Stability Limit for Weighing** | **Index 1030** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| It is used to modify the current user-defined weighing stability judgment condition - Allowable deviation, unit: display resolution value (d, that is, the minimum division value displayed) | | | | |
| Value range | 0.0 – 1000.0 | d | | |
| **Observation Time for Tare** | **Index 1031** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| It is used to modify the current user-defined tare stability judgment condition - measurement time, in seconds. | | | | |
| Value range | 0.0 – 4.0 | seconds | | |
| **Stability Limit for Tare** | **Index 1032** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| It is used to modify the current user-defined tare stability judgment condition - Allowable deviation, unit: display resolution value (d, that is, the minimum division value displayed) | | | | |
| Value range | 0.0 – 1000.0 | d | | |
| **Observation Time for Zero** | **Index 1033** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| It is used to modify the current user-defined zero stability judgment condition - measurement time, in seconds | | | | |
| Value range | 0.0 – 4.0 | seconds | | |
| **Stability Limit for Zero** | **Index 1034** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |

| | | | | |
|---|---|---|---|---|
| It is used to modify the current user-defined zero stability judgment condition - Allowable deviation, unit: display resolution value (d, that is, the minimum division value displayed) | | | | |
| Value range | 0.0 – 1000.0 | d | | |
| **Observation Time for Adjustment** | **Index 1035** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| It is used to modify the current user-defined adjustment stability judgment condition - measurement time, in seconds | | | | |
| Value range | 0.0 – 4.0 | seconds | | |
| **Stability Limit for Adjustment** | **Index 1036** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| It is used to modify the current user-defined adjustment stability judgment condition - Allowable deviation, unit: display resolution value (d, that is, the minimum division value displayed) | | | | |
| Value range | 0.0 – 1000.0 | d | | |

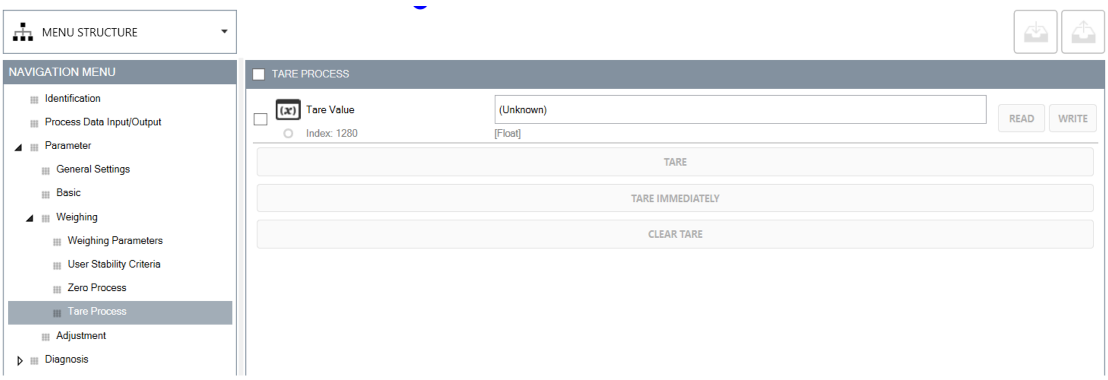
3.2.2.3.3. Zeroing Process




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **AutoZero Tracking** | **Index 515** | **Subindex 0** | **UIntegerT (8 Bit)** | **RW** |
| Setting of automatic zero tracking function. | | | | |
| Value range | 0<br>1 | Disabled<br>Enabled | | |

| System Commands | Text | Description |
|---|---|---|
| 160 | Zero | Sets a new zero with the stable weight value. |
| 161 | Zero Immediately | Sets a new zero immediately, regardless of device stability |

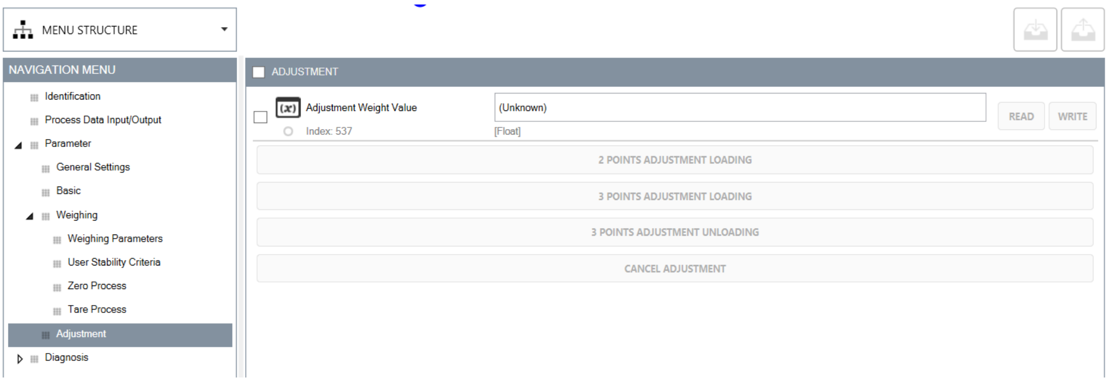
3.2.2.3.4. Taring Process



| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Tare Value** | **Index 1280** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| Read current tare value, write preset tare value in kg. The Rated Capacity depends on the actual load cell model. Rated Capacity can be as high as 500 kg for SLP333D-IOL. | | | | |
| Value range | 0 – Rated Capacity | | | |

| System Commands | Text | Description |
|---|---|---|
| 162 | Tare | Sets a new tare value with the next stable weight value |
| 163 | Tare Immediately | Tare the device immediately and independently of device stability. |
| 164 | Clear Tare | Clear the tare value |

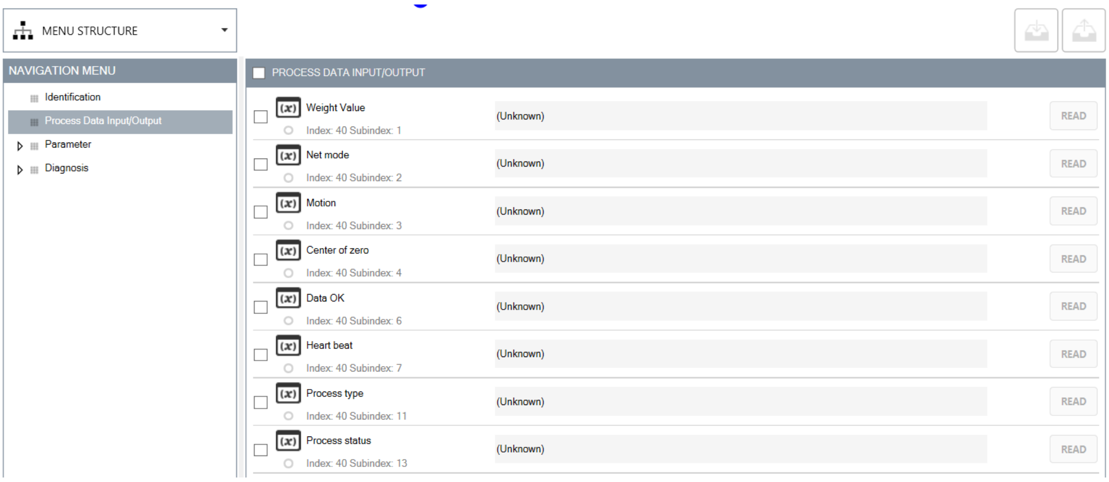
3.2.2.4. Adjustment




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Adjustment weight value** | **Index 537** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| Adjustment weight value in the unit set by user (g, kg, etc.). | | | | |
| Value range | Values are accepted between 1% of Rated Capacity and 100% Rated Capacity, in the unit set by user, e.g., g or kg. E.g., a 10 kg load cell can be adjusted with reference weights between 0.1 kg and 10 kg. Values below 1% of Rated Capacity are not accepted for adjustment. | | | |

| System Commands | Text | Description |
|---|---|---|
| 176 | 2 Points Adjustment Loading | |
| 177 | 3 Points Adjustment Loading | |
| 178 | 3 Points Adjustment Unloading | |
| 179 | Cancel Adjustment Process | |
| 180 | 5 Points Adjustment Linearization, loading and unloading | |

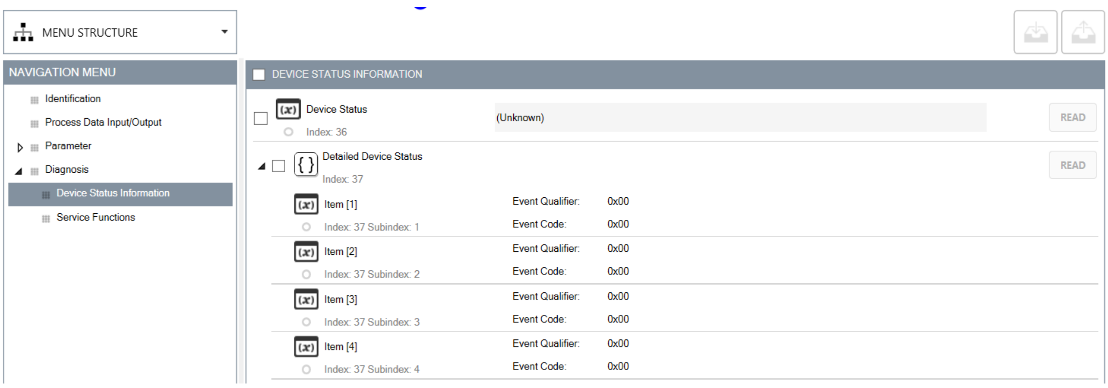
## 3.2.3. Process Data Input for IO-Link Master unit




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Weight value** | **Index 40** | **Subindex 1** | **Float32T (32 Bit)** | **RO** |
| Weight value in kg, 32-bit floating point | | | | |
| **Net mode** | **Index 40** | **Subindex 2** | **BooleanT (1 Bit)** | **RO** |
| Value range | 0<br>1 | The displayed weight value is gross weight<br>The displayed weight value is net weight | | |
| **Motion** | **Index 40** | **Subindex 3** | **BooleanT (1 Bit)** | **RO** |
| Value range | 0<br>1 | Current weight value is stable<br>Current weight value is unstable | | |
| **Center of zero** | **Index 40** | **Subindex 4** | **BooleanT (1 Bit)** | **RO** |
| Value range | 0<br>1 | Current weight value is not within ±1/2d of zero<br>Current weight value is within ±1/2d of zero | | |
| **Data OK** | **Index 40** | **Subindex 6** | **BooleanT (1 Bit)** | **RO** |
| Value range | 0<br>1 | Current weight value is unavailable for user<br>Current weight value is available for user | | |
| **Heartbeat** | **Index 40** | **Subindex 7** | **BooleanT (1 Bit)** | **RO** |
| Value range | 0 - 1 | Switches every second from 0 to 1 and back from 1 to 0 | | |
| **Process type** | **Index 40** | **Subindex 11** | **UintegerT (3 Bit)** | **RO** |
| Value range | 0<br>1<br>2<br>3 | None<br>Zero<br>Tare<br>Adjustment | | |
| **Process status** | **Index 40** | **Subindex 13** | **UintegerT (4 Bit)** | **RO** |
| Value range | 0<br>1<br>2<br>3<br>4<br>5 | Successfully<br>In progress<br>User action required: place weight<br>Failed<br>Aborted by user<br>Timeout | | |

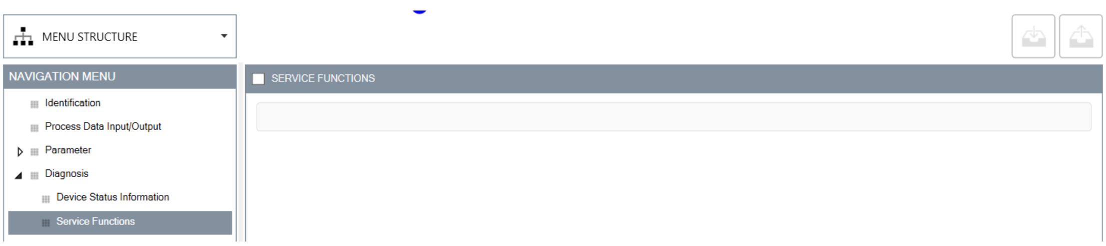
## 3.2.4. Diagnostics

**Device Status information**




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Device Status** | **Index 36** | **Subindex 0** | **Float32T (32 Bit)** | **RO** |
| Indicator for the current device condition and diagnosis state | | | | |
| Value range | 0 | Device is OK | | |
| | 1 | Maintenance required | | |
| | 2 | Out of specification | | |
| | 3 | Functional check required | | |
| | 4 | Failure, load cell must be replaced | | |
| | 5 to 255 | Reserved | | |
| **Detailed Device Status** | **Index 37** | **Subindex 1** | **Float32T (32 Bit)** | **RO** |
| List of all currently pending events in the device. | | | | |
| **Detailed Device Status** | **Index 37** | **Subindex 2** | **Float32T (32 Bit)** | **RO** |
| List of all currently pending events in the device. | | | | |
| **Detailed Device Status** | **Index 37** | **Subindex 3** | **Float32T (32 Bit)** | **RO** |
| List of all currently pending events in the device. | | | | |
| **Detailed Device Status** | **Index 37** | **Subindex 4** | **Float32T (32 Bit)** | **RO** |
| List of all currently pending events in the device. | | | | |

### Service Functions




| System Commands | Text | Description |
|---|---|---|
| **131** | **Back-to-box** | **Set all parameters to factory default values. Factory reset** |

## 3.2.5. Events

| Code | Name | Description |
|---|---|---|

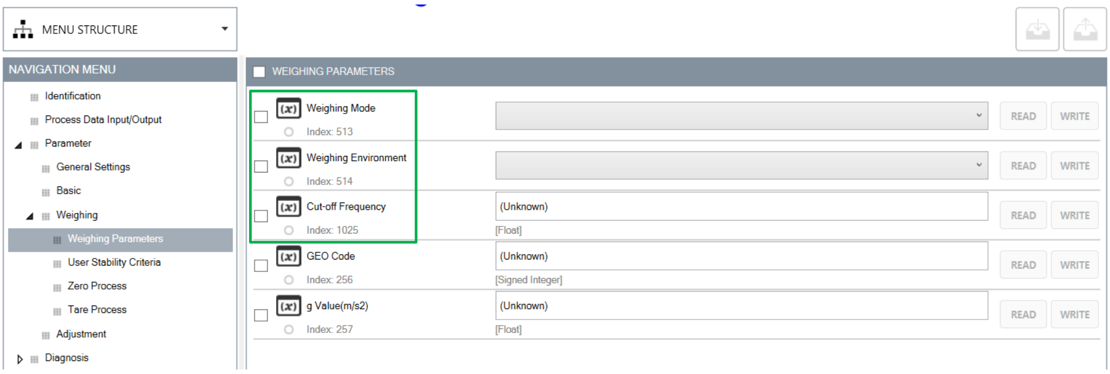
| | | |
|---|---|---|
| 0x8000<br>32768d | Device application error - no details | Service has been refused by the device application and no detailed information of the incident is available |
| 0x8011<br>32785d | Index not available | Access occurs to a not existing index |
| 0x8012<br>32786d | Subindex not available | Access occurs to a not existing subindex |
| 0x8020<br>32800d | Service temporarily not available | Parameter is not accessible due to the current state of the device application |
| 0x8021<br>32801d | Service temporarily not available local control | Parameter is not accessible due to an ongoing local operation at the device |
| 0x8022<br>32802d | Service temporarily not available device control | Parameter is not accessible due to a remote triggered state of the device application |
| 0x8023<br>32803d | Access denied | Write access on a read-only parameter |
| 0x8030<br>32816d | Parameter value out of range | Written parameter value is outside its permitted value range |
| 0x8033<br>32819d | Parameter length overrun | Written parameter length is above its predefined length |
| 0x8034<br>32820d | Parameter length underrun | Written parameter length is below its predefined length |
| 0x8035<br>32821d | Function not available | Written command is not supported by the device application |
| 0x8036<br>32822d | Function temporarily unavailable | Written command is not available due to the current state of the device application |
| 0x8040<br>32832d | Invalid parameter set | Written single parameter collides with other actual parameter settings |
| 0x8041<br>32833d | Inconsistent parameter set | Parameter inconsistencies were found at the end of block parameter transfer, device plausibility check failed |
| 0x8082<br>32898d | Application not ready | Read or write service is refused due to a temporarily unavailable application |
| 0x8041<br>32833d | Inconsistent parameter set | Parameter inconsistencies were found at the end of block parameter transfer, device plausibility check failed |
| 0x8CA1<br>36001d | Cell overload than operation limit | Cell overload than operation limit = 150% capacity |
| 0x8CA2<br>36002d | Bridge detection error | Strain gauge bridge detection error |
| 0x8CA3<br>36003d | Factory parameters error | Factory parameters error |
| 0x8D05<br>36101d | Humidity detection (LC) error | Humidity detection (LC) error |
| 0x8D69<br>36201d | Cell overload than normal limit | Cell overload than normal limit = 110% capacity or higher load |
| 0x8D6A<br>36202d | Cell underload | Cell underload, load is below -110% rated capacity |
| 0x8D6B<br>36203d | Temperature detection (NiPt/PT) error | Temperature detection (NiPt/PT) error |
| 0x8D6C<br>36204d | Temperature Gradient detection (NiPt/PT) error | Temperature Gradient detection (NiPt/PT) error |
| 0x8D6D<br>36205d | Temperature detection (LC) error | Temperature detection (LC) error |
| 0x8D6E<br>36206d | Temperature Gradient detection (LC) error | Temperature Gradient detection (LC) error |
| 0x8D6F<br>36207d | Voltage detection (AD) error | Voltage detection (AD) error |
| 0x8D70<br>36208d | Humidity Gradient detection (LC) error | Humidity Gradient detection (LC) error |
| 0x8D71<br>36209d | Adjustment failure | Adjustment failure |

| | | |
|---|---|---|
| 0x8DCD 36301d | Load times detection alarm | Load times detection alarm |
| 0x8DCE 36302d | Zeroing failed, out of range | Zero failed, out of range |

Some events related to Smart5 alarms, for that see chapter 3.5. There are recommended actions for each Smart5 alarm.

## 3.3. Filter Settings

There are three parameters related to filter setting, the path is "Parameter"-"Weighing"-"Weighing parameters".




| Parameter | Index | Subindex | Data Type | RW |
|---|---|---|---|---|
| **Weighing Mode** | **Index 513** | **Subindex 0** | **UIntegerT (8 Bit)** | **RW** |
| Gets or sets the current weighing mode setting. The default value is 1(Stable). | | | | |
| Value range | **0**<br>1<br>2 | Normal weighing<br>Filling/Dosing, Reserved<br>Dynamic weighing | | |
| **Weighing Environment** | **Index 514** | **Subindex 0** | **UIntegerT (8 Bit)** | **RW** |
| Current environment condition setting. The more unstable the environment, the greater the filtering strength. The default value is 2(Standard). | | | | |
| Value range | 0<br>1<br>**2**<br>3<br>4 | Very stable environment<br>Stable environment<br>**Standard** environment<br>Unstable environment<br>Very unstable environment | | |
| **Cut-off Frequency** | **Index 1025** | **Subindex 0** | **Float32T (32 Bit)** | **RW** |
| Set the cut-off frequency of the fixed filter.<br>This parameter will only be activated when the weighting mode is set to 3. The default value is 0(Disabled). | | | | |

"Weighing Mode" is related to the static weighing or dynamic weighing.

| Value | Application |
|---|---|
| 1 | Normal weighing. Static filtering algorithm with long settling time for highest precision. |
| 2 | Reserved. |
| 3 | Dynamic weighing. Dynamic filtering algorithm for unstable weighing objects. |

"Weighing Environment" is related to the filter strength. User can choose the proper value according to the application environment. When the environment is very stable, user should choose lower value (0); when the environment is unstable, for example in a vibrational environment, user should choose higher value (4). The higher value means stronger filter.

"Cut-off frequency" is only valid when "weighing mode" is set to 2 (Dynamic weighing). Users can set the cut-off frequency directly to get the best filter effect.

## 3.4. Adjustment Process

Modern single-point load cells with onboard microprocessor and digital signal processing (DSP) can adjust for changes in the environment temperature, as well as for non-linearity and hysteresis effects. In many cases by specifying the local gravity (for details see Chapter 2, Installation) the SLP33xD-IOL load cell is ready to measure and will deliver accurate results. However, it is possible to adjust the load cell after the installation to account for mechanical effects, which are not (and cannot be by nature) considered in the factory adjustment parameters. Before we describe the adjustment process in detail, the background of strain gage load cell adjustment is reviewed.

### 3.4.1. Strain gage load cell raw behavior

Measuring mechanical deformation by means of resistance changes in strain gages organized in a Wheatstone-bridge is a several decades old principle to weigh. Ideally, the load cell (the sensor) response should be a straight line, resulting the exact weight of the applied load. In reality, the response curve is not a straight line, and it depends on the loading direction, increasing or decreasing load. The behavior can be characterized with non-linearity and hysteresis parameters, see Figure 3-1.

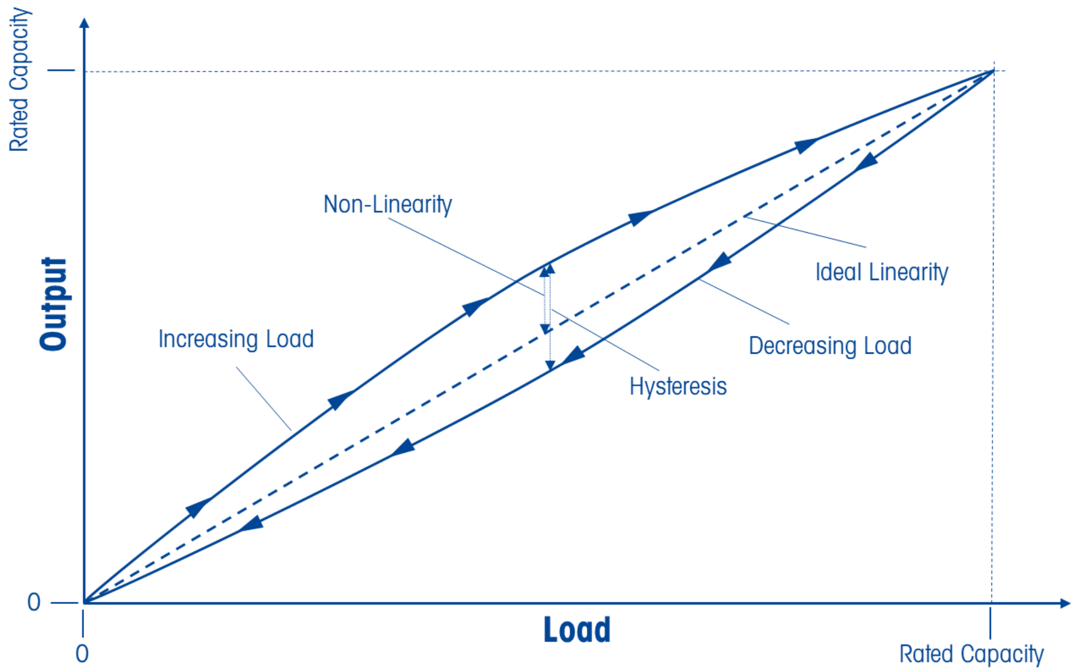



Figure 3-1: Response curve of a typical aluminum strain gage load cell to increasing and decreasing loads (loading and unloading curves, respectively)

### 3.4.2. Load cells with onboard adjustment

Modern load cells are manufactured with onboard microprocessor and digital signal processing (DSP) capabilities. Thanks to these units, the response curve of the load cell can be adjusted in the factory, and the effects of non-linearity and hysteresis are significantly reduced. Furthermore, the load cell can adjust to changes in the environment temperature as well as for creep effects. This results in increased accuracy, and the response curve of a modern load cell is very close to the ideal, straight line.

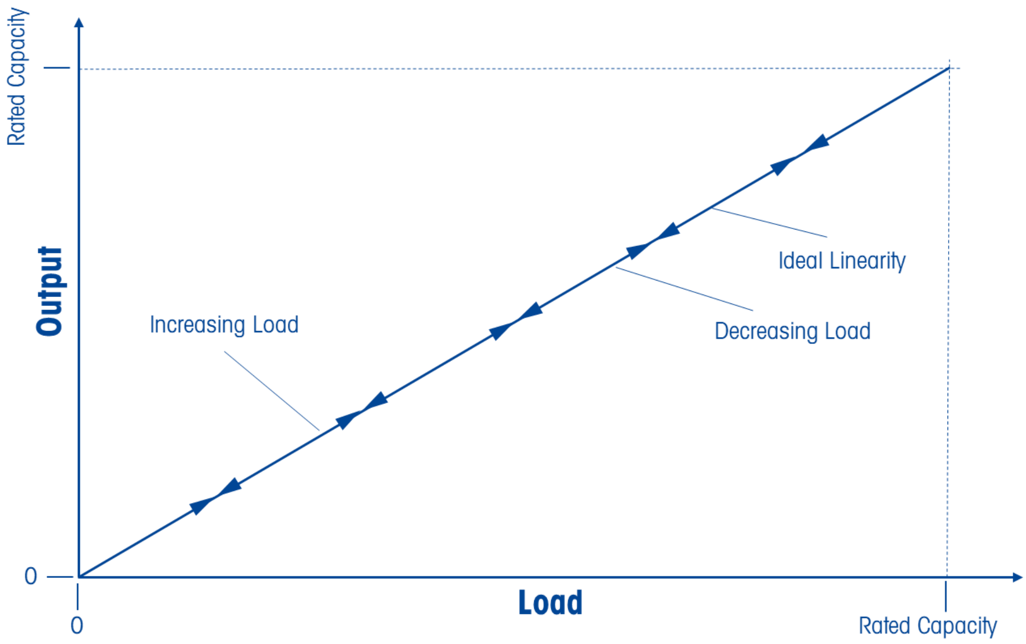



Figure 3-2: Modern load cells use onboard microprocessor and DSP libraries to achieve better accuracy, and to provide a linear response curve

### 3.4.3. Changes when the load cell is installed

In various machine designs the installed single point load cells experience a different mechanical environment, unlike the setup during factory calibration. Depending on the design, a different pre-load is applied, and the weighing structure installed on the load cell might cause bypass forces dropping the calibration accuracy. The adjustment parameters defined during factory calibration might not provide the expected accuracy performance, thus a new set of parameters is required.

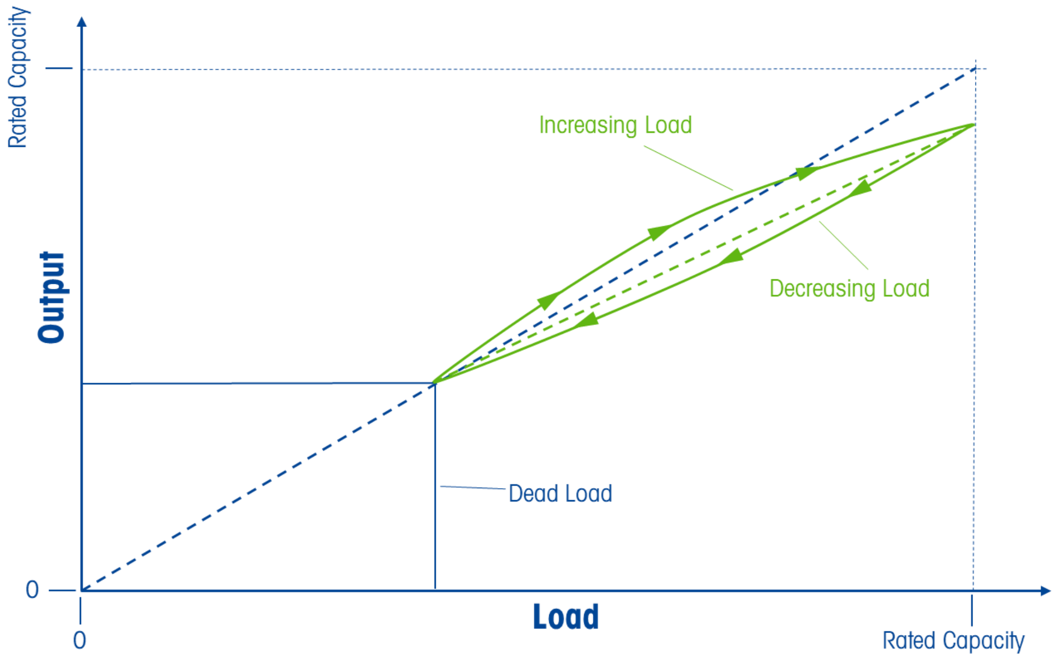



Figure 3-3: Impacts of the mechanical environment can reduce measurement accuracy

### 3.4.4. TwinCal™, loading and unloading adjustment

**Thanks to TwinCal™, an extended adjustment process supported by the new SLP33xD-IOL single-point load cells, the weighing accuracy of the load cell can be optimized after installation, and the impact of the mechanical integration on accuracy can be eliminated. TwinCal™ allows to calibrate and adjust the full loading and unloading cycle, and thus remove the unwanted effects of the mechanical environment on linearity and hysteresis. This will result in new parameters for non-linearity and hysteresis adjustment, thus increasing the weighing accuracy of the machine. Other parameters defined during factory calibration (adjustment for environment temperature changes, creep) will remain in place.**

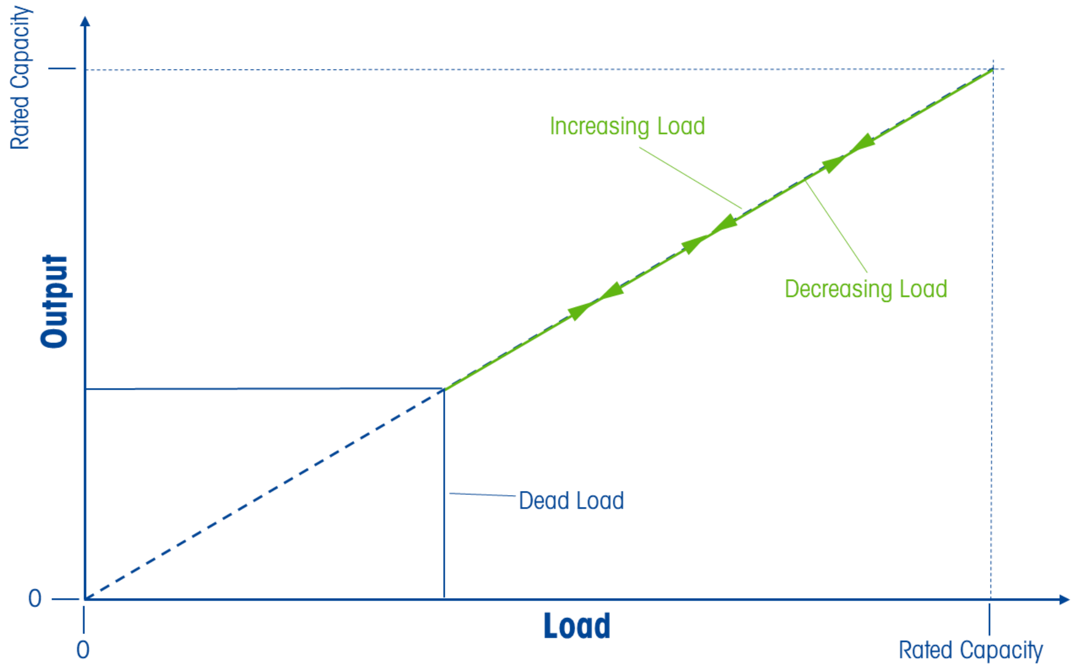



**Figure 3-4: Optimal accuracy achieved after a full cycle adjustment**

**Furthermore, depending on the application, there is the possibility to select the better suited adjustment curve. E.g., for loss-in-weight feeders the unloading curve provides the optimal measurement performance. By doing that, the accuracy can be further improved.**

### 3.4.5. Cancel all ongoing calibration processes

Click the button: “CANCEL ADJUSTMENT”, and then all ongoing process will be closed.

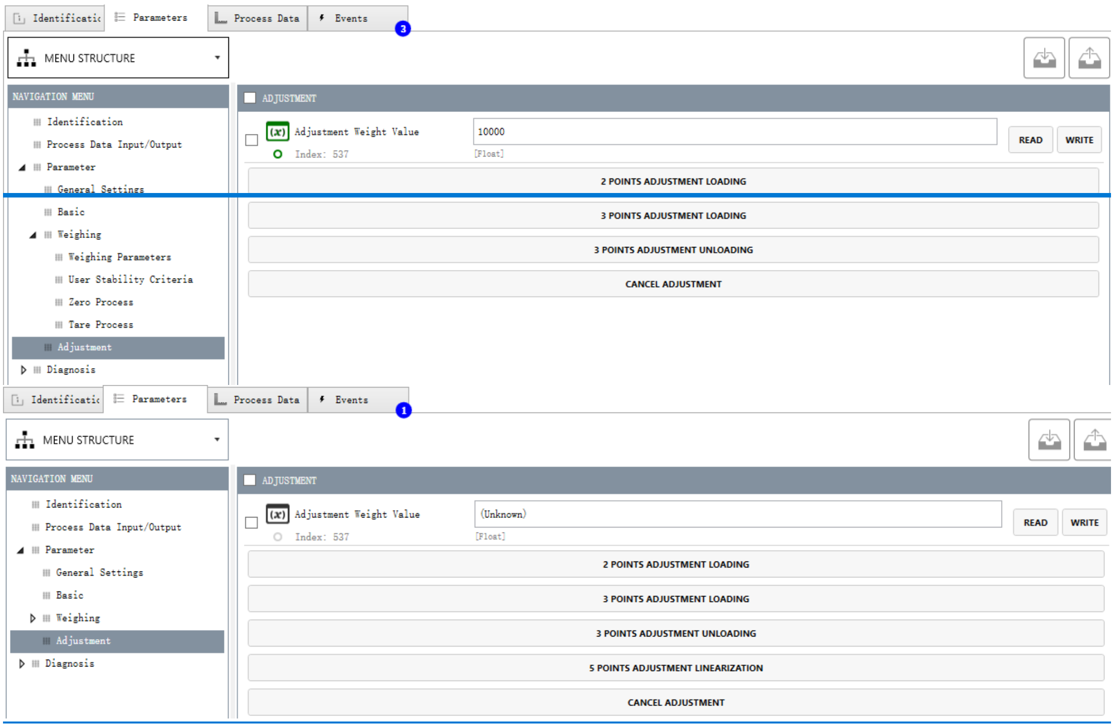



Figure 3-5: Adjustment menu

### 3.4.6. 2-point adjustment

**Step 0: Start the process**

Set the adjustment weight value defined in Section 3.2.2.4. Click the button “2 POINTS ADJUSTMENT LOADING” in above picture “Figure 3-5 Menu of Adjustment” to start the adjustment process

**Step 1: Empty the scale**

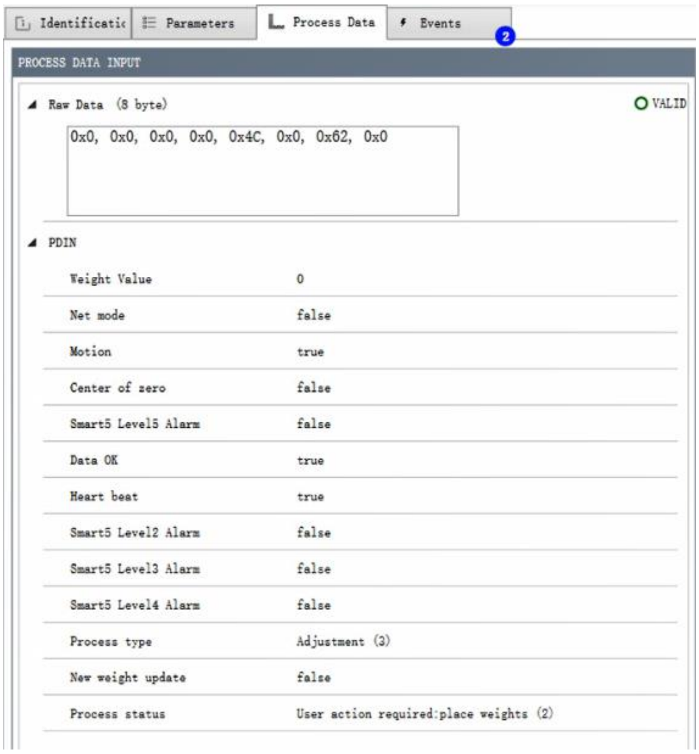



Figure 3-6: Empty the scale

**If there is weight on the scale, please empty the scale as shown in the figure above, and then the "Process status" will change to "In process".**

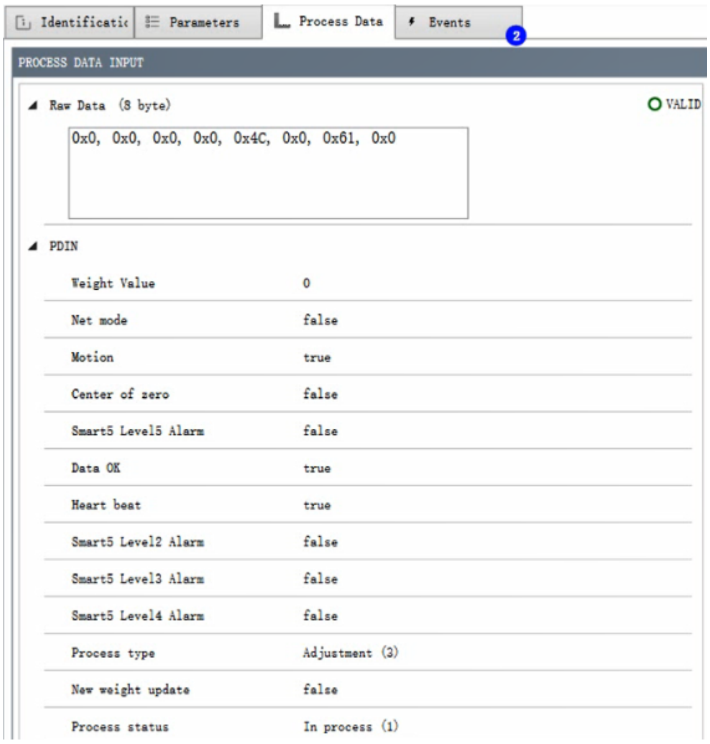



Figure 3-6-1: In process

**Step 2: Load weight**


Figure 3-7: Load weight

Please follow the prompts to load the adjustment weight and wait for a few seconds for the reading to stabilize.

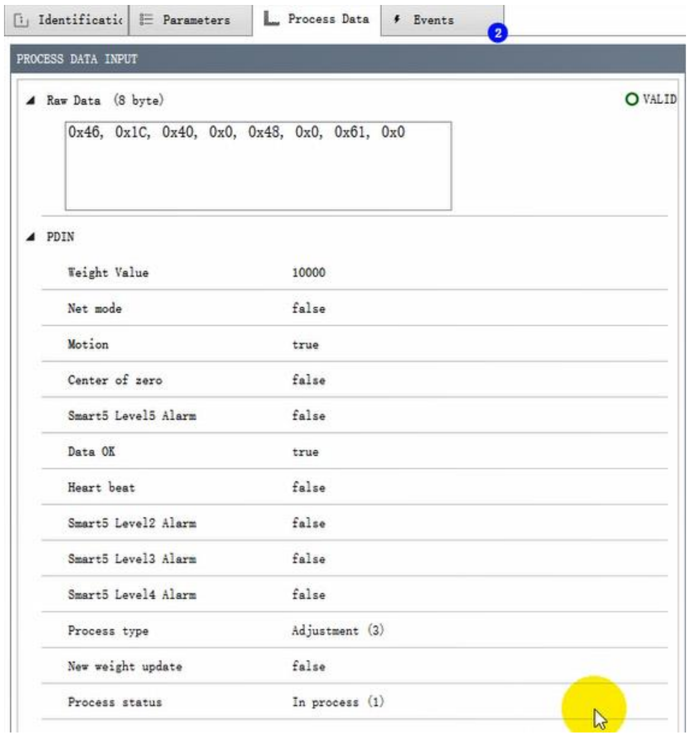



Figure 3-7-1: In process

The “Process status” will change to “In process”.

**Step 3: Unload the weight**

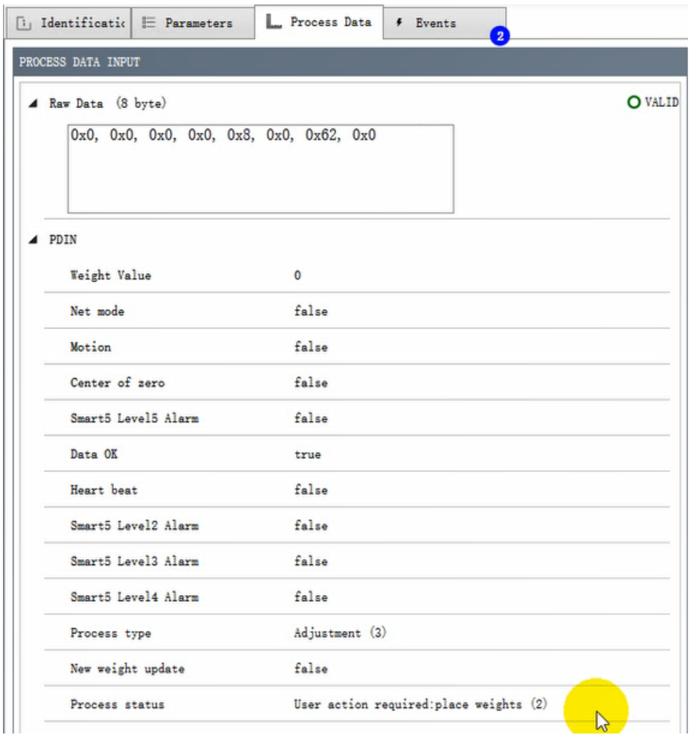



Figure 3-8: Unload the weight

Please empty the scale again.

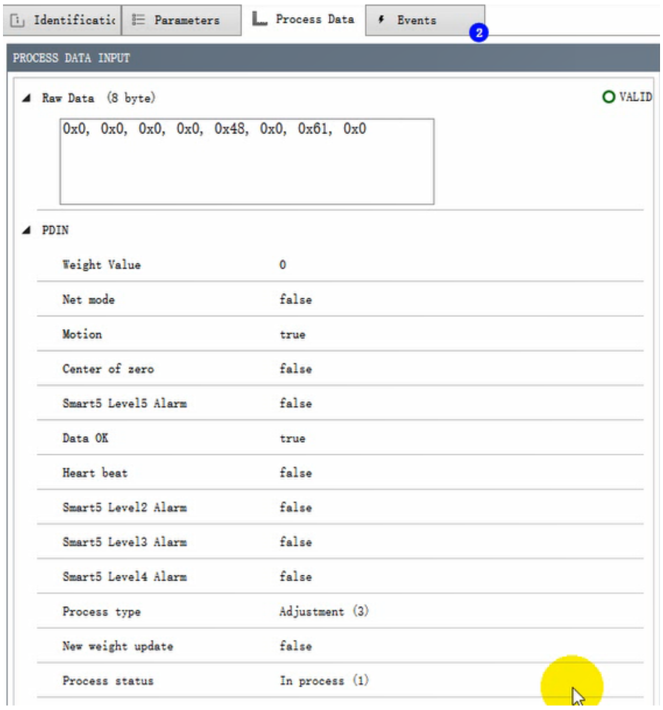



Figure 3-8-1: In process

**Step 4: End of adjustment process**

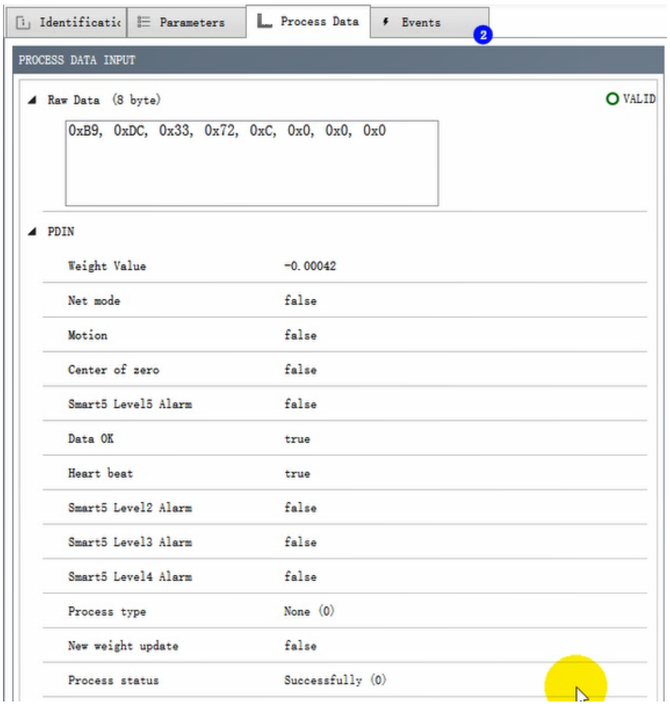



Figure 3-9: End of adjustment

## 3.4.7. 3-Points adjustment (loading)

**Step 0: Empty the scale and start the process**

Please empty the scale and then click the button "3 POINTS ADJUSTMENT LOADING" in above picture "Figure 3-5 Menu of Adjustment" to start the adjustment process

**Step 1: Load weight 1**

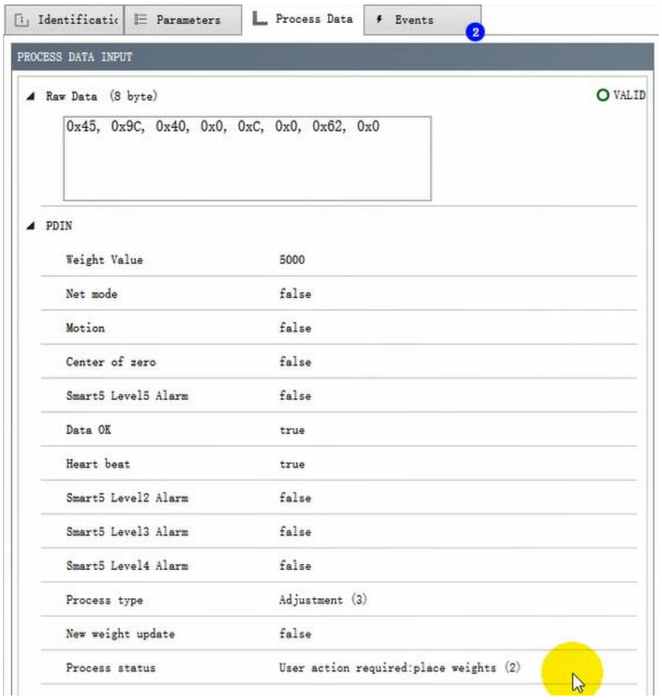



Figure 3-10: Load weight 1

Please follow the prompts to load half adjustment weight and wait for a few seconds for the reading to stabilize.

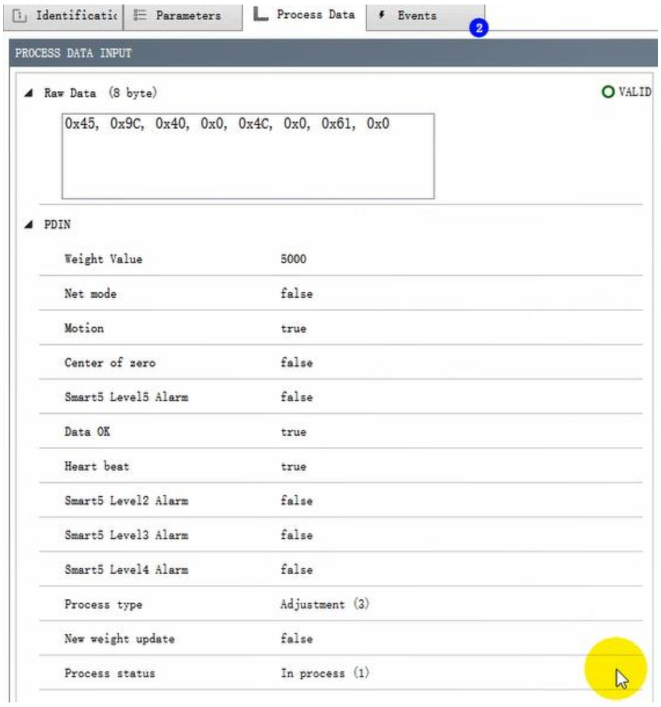
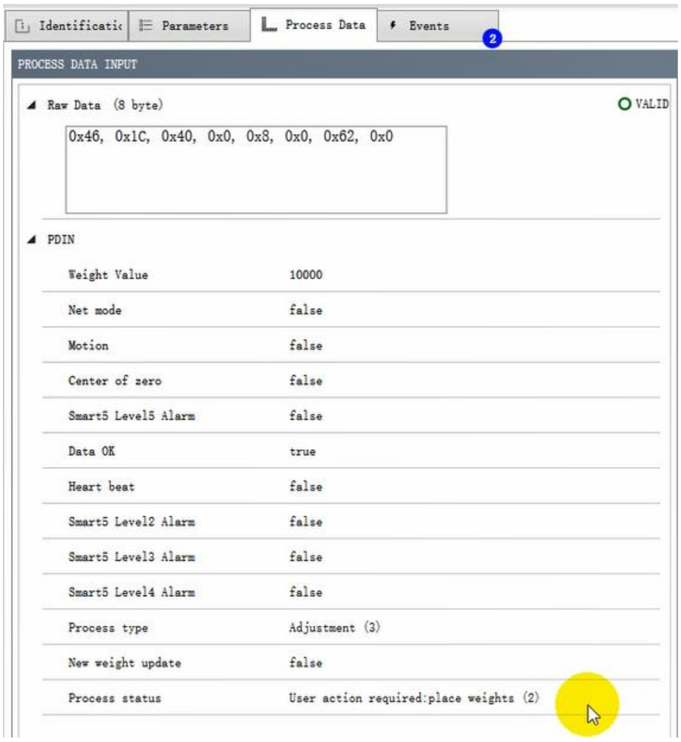
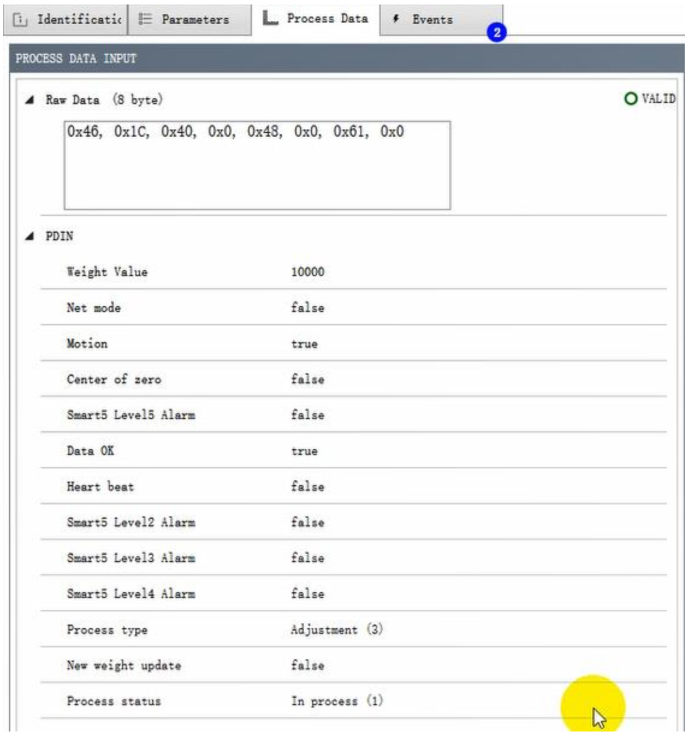



Figure 3-10-1: In process (Load weight 1)

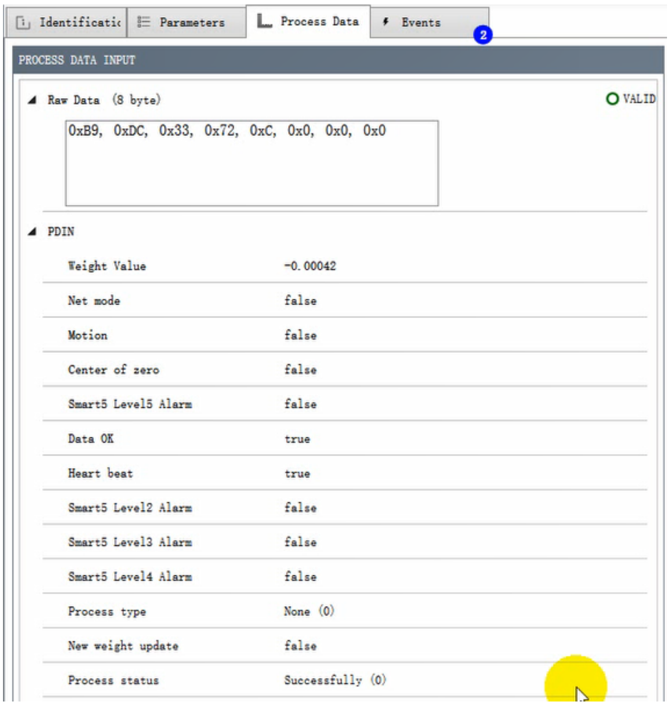
**Step 2: Load weight 2**




Please follow the prompts to load full adjustment weight and wait for a few seconds for the reading to stabilize.



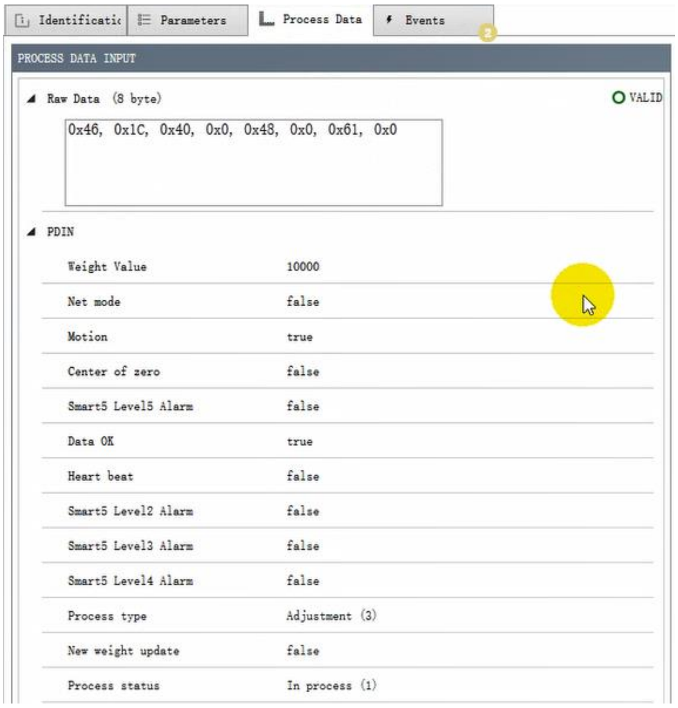

**Step 3: End of adjustment process**




### 3.4.8. 3-Points adjustment (unloading)

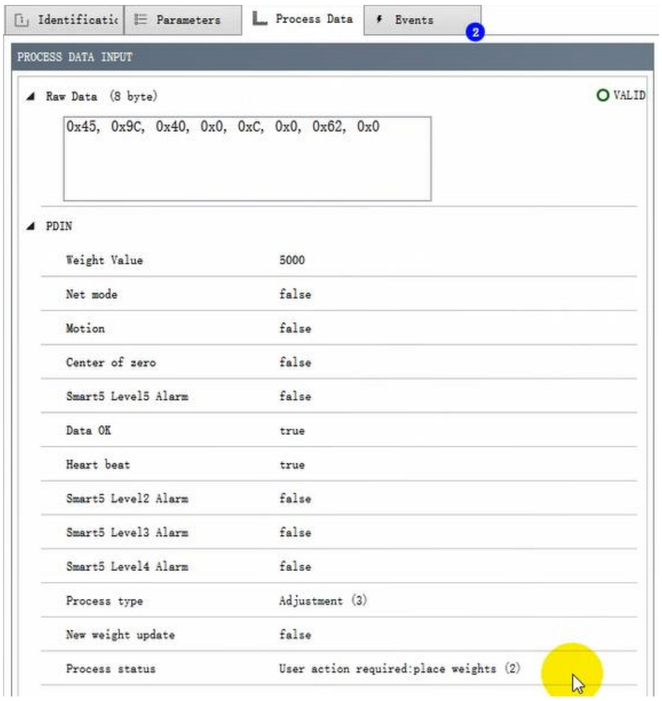
**Step 0: Load weight (full capacity) on the scale and start the process**

Please load the full adjustment weight on the scale and then clink the button “3 POINTS ADJUSTMENT UNLOADING” in above picture “Figure 3-5 Menu of Adjustment” to start the adjustment process

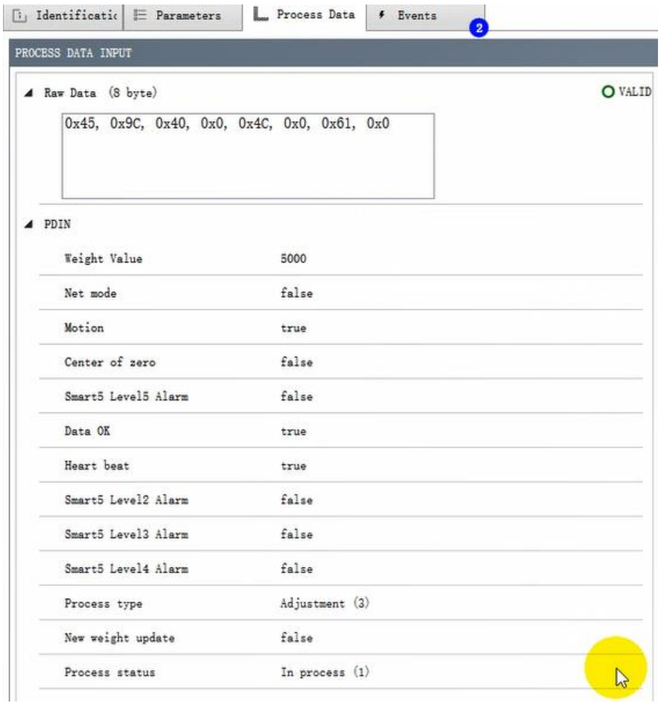



**The "Process status" will change to "In process".**

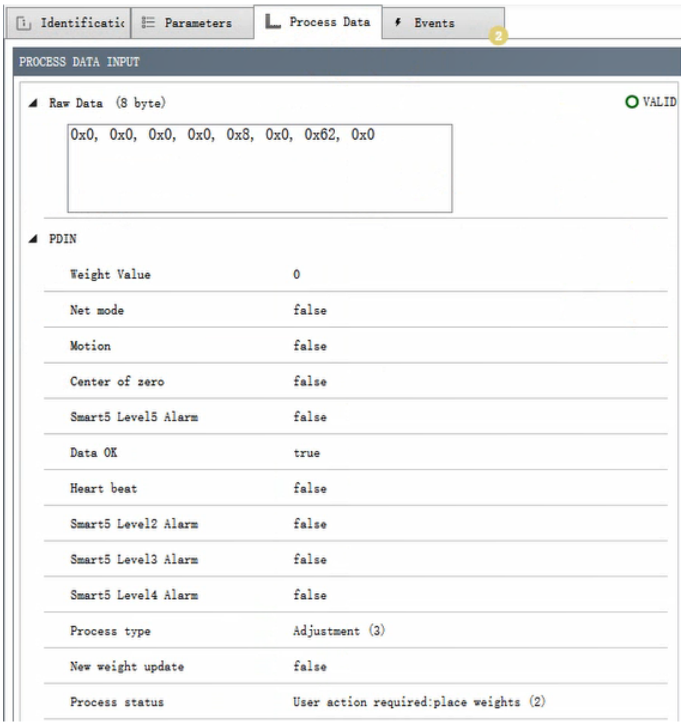
### Step 1: Unload weight 1



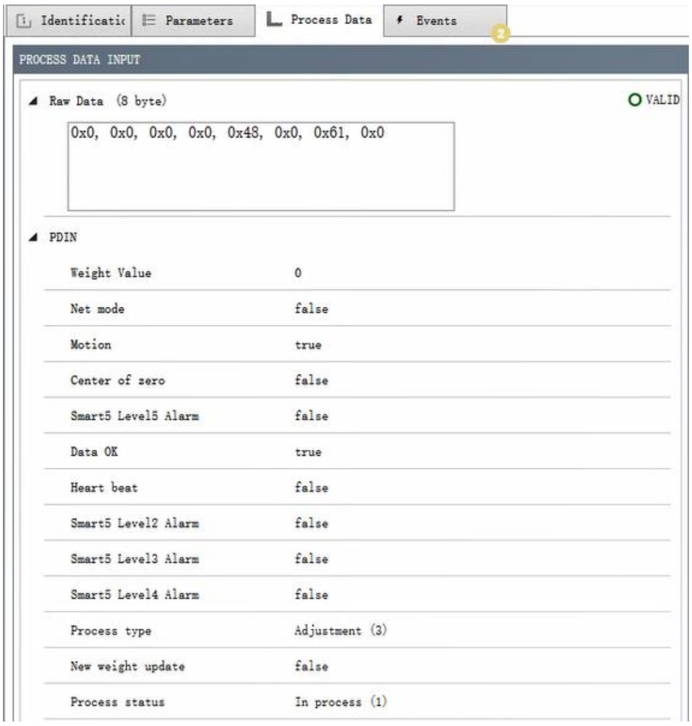

Please unload weight and let the weight on the scale become half capacity and wait for a few seconds for the reading to stabilize.



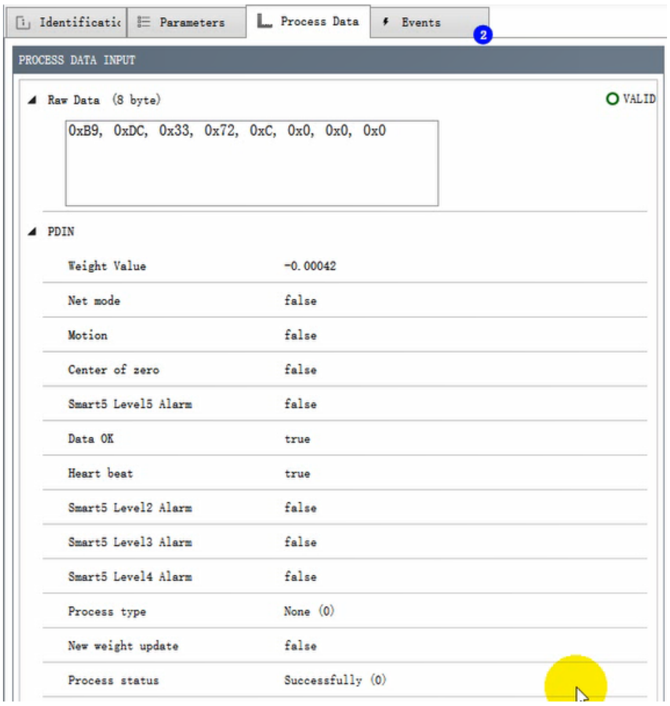

**Step 2: Unload weight 2**




Please empty the scale and wait for a few seconds for the reading to stabilize.




**Step 3: End of adjustment process**




## 3.4.9. 5-point Adjustment Linearization, Loading and unloading adjustment, TwinCal™

**Step 0: Empty the scale and start the process**

**Please empty the scale and then clink the button “5 POINTS ADJUSTMENT LINEARIZATION” in above picture “Figure 3-5 Menu of Adjustment” to start the adjustment process**

**Step 1: Load weight 1**

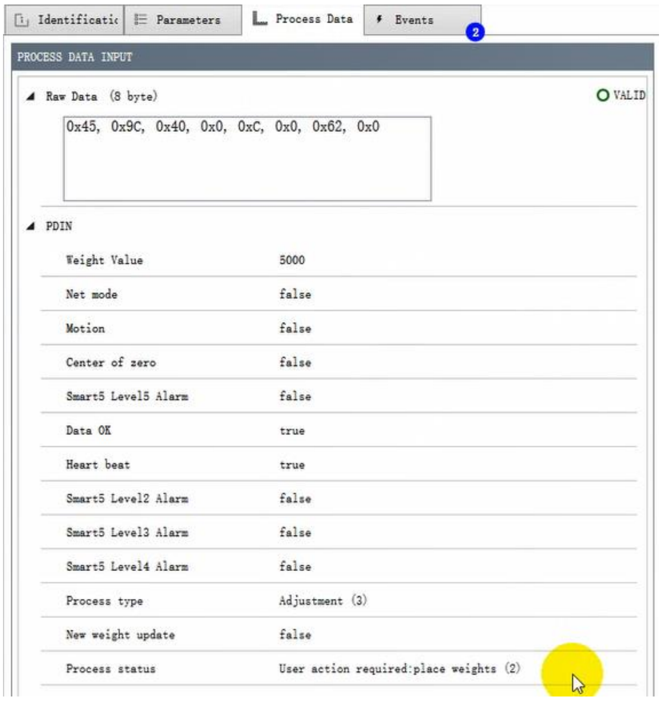



Figure 3-10: Load weight 1

Please follow the prompts to load half adjustment weight and wait for a few seconds for the reading to stabilize.

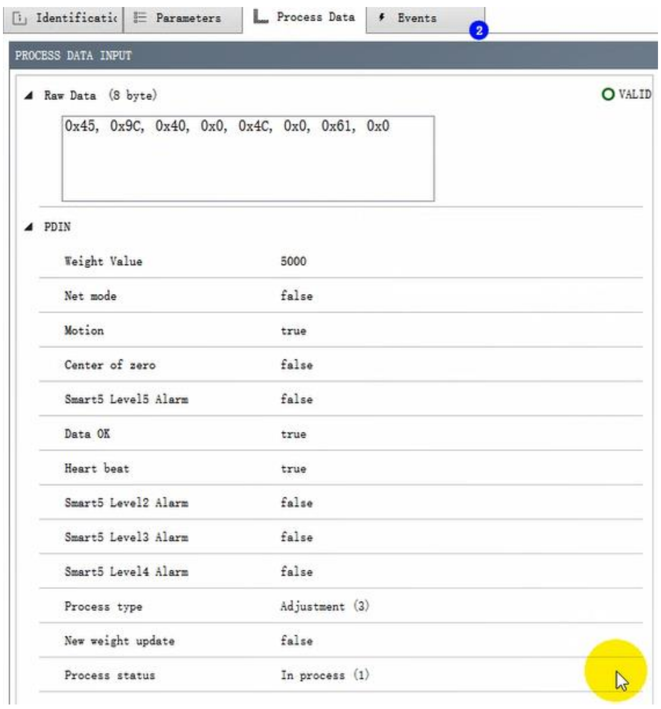
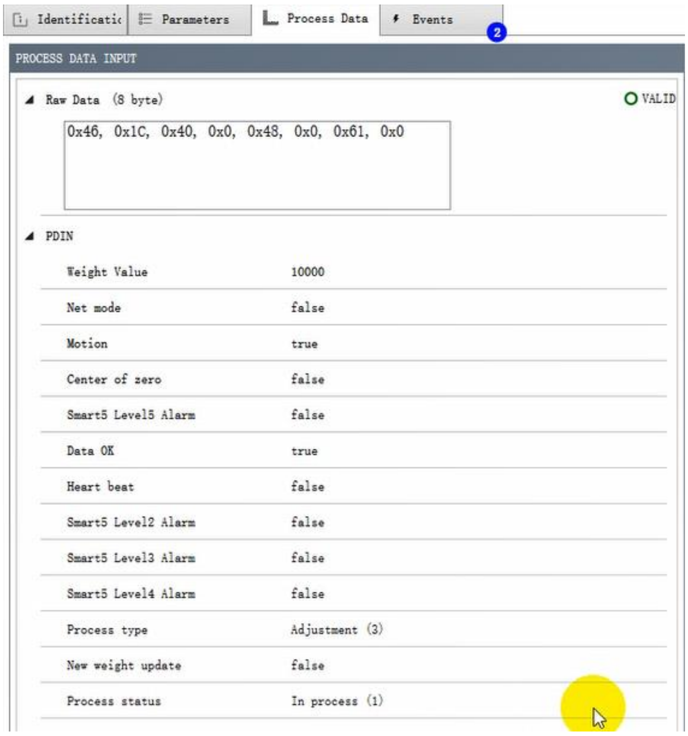


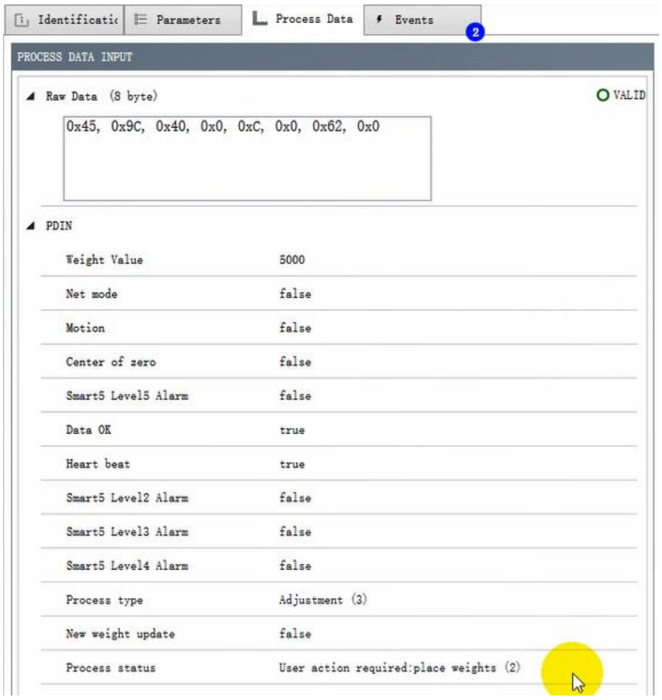

Figure 3-10-1: In process(Load weight 1)

**Step 2: Load weight 2**

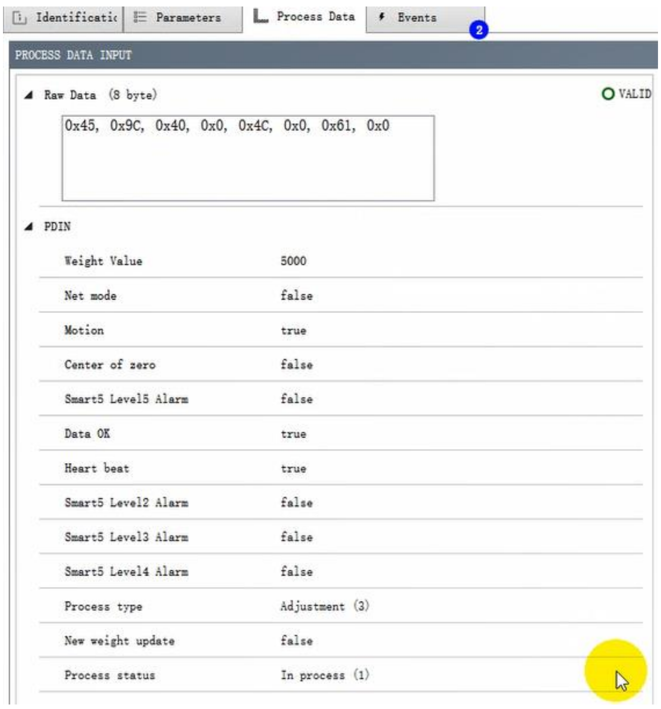

Please follow the prompts to load the full adjustment weight and wait for a few seconds for the reading to stabilize.



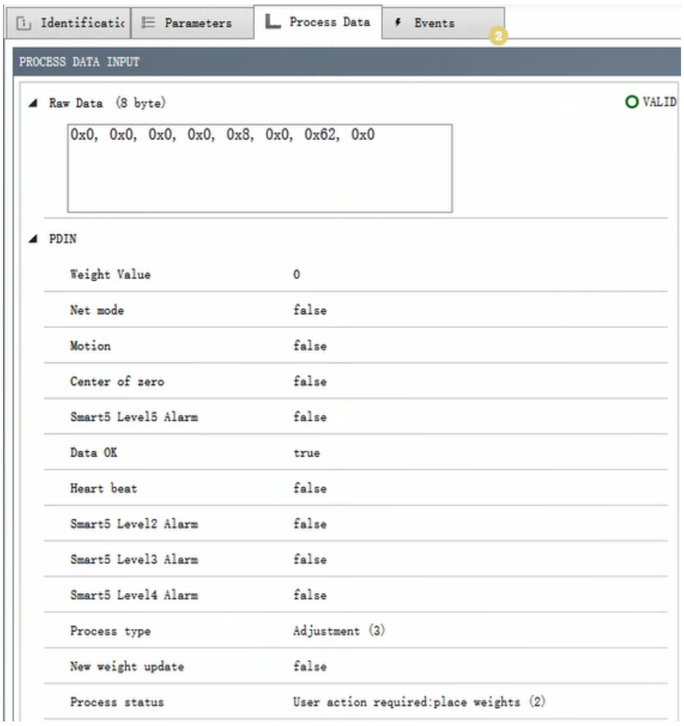

### Step 3: Unload weight 1



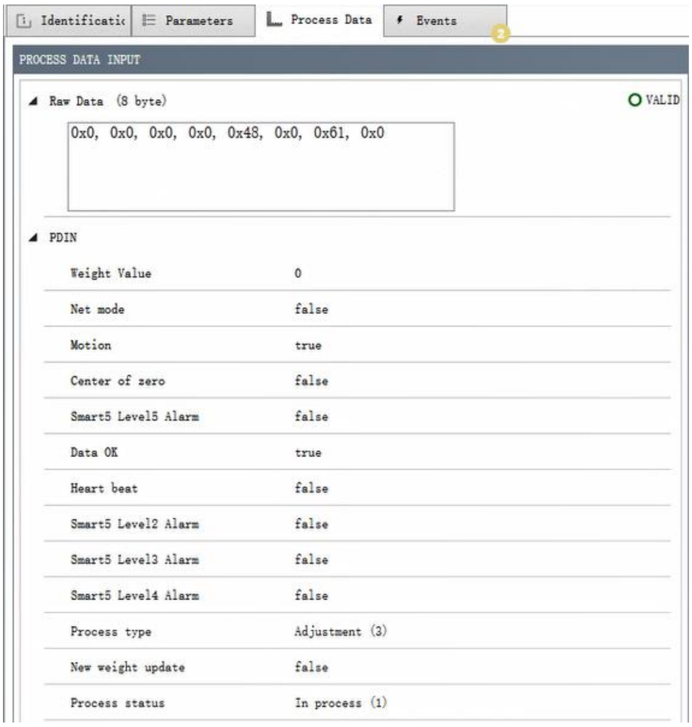

Please unload weight and let the weight on the scale become half adjustment weight and wait for a few seconds for the reading to stabilize.



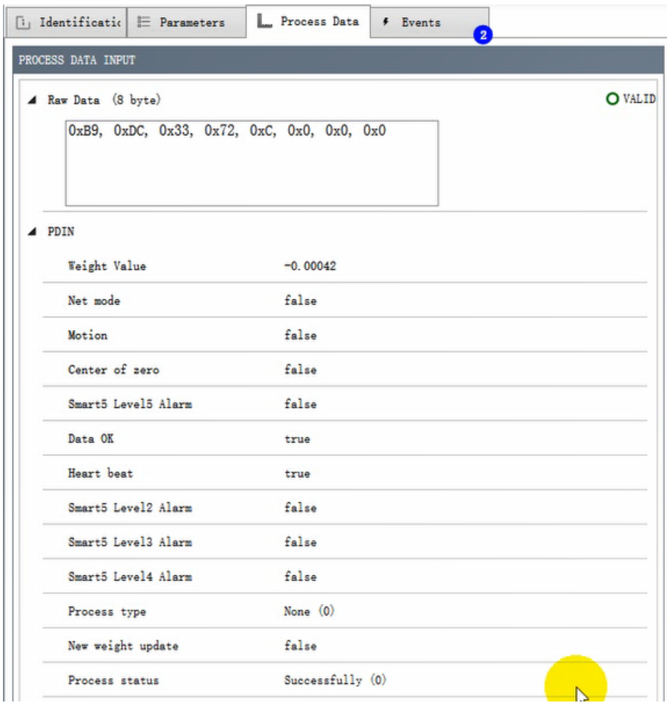

**Step 4: Unload weight 2**




Please empty the scale and wait for a few seconds for the reading to stabilize.




**Step 5: End of adjustment process**




## 3.5. Smart5™ Alarms

SMART5™ alarm management system is aligned with industry standards, such as NAMUR NE107, ISA TR 18.2.2 201; and IEC 62682.

SMART5™ monitors equipment operating status, logs events, and communicates error status to the customer, providing alarm and error message collection functions.

The SMART5™ status of the sensor is demonstrated by means of 5 different colored indicators, which are also reflected in real time in the device status word (corresponding to the SMART5™ bit). SMART5™ status of the sensor is categorized according to the figure below.

| Graphical Indication | Rank | Type | Description | Result |
|---|---|---|---|---|
|  | 5 | Catastrophic weighing error | Wrong weight / equipment Failure. | Alarm stops operation: Clearing the alarm will not reset the condition – the device must be repaired/replaced to eliminate the alarm. |
|  | 4 | Imminent failure | Wrong weight / equipment failure expected based on predictive algorithms and sensors like temperature, humidity. | Alarm indicates failure is imminent within a period of one week or more. The alarm can be reset but will re-occur each day until the cause is eliminated. |

| | | | | |
|---|---|---|---|---|
| | 3 | Out of specification | Wrong Operator Actions or device / application is operating out of specification. | Alarm and log the event. Alarms are only generated / transmitted at the request of the customer. |
| | 2 | Predictive Alarm | Routine test, Calibration or Preventative maintenance must be undertaken. | Alarm and log the event. Alarms are only generated / transmitted at the request of the customer. |
| | 1 | Normal Condition | Unit is operating correctly. | No Action required. |

The user can read the SMART5™ level 2 to 5 bits from Process Data Input.

Event codes show the specific alarms that appear and require different responses.

| Level | Event Code | Description | Recommended Actions |
|---|---|---|---|
| 5 | 0x8CA1 | Sensor load exceeds 150% of rated capacity range | Call MT service for a replacement sensor. The sensor is very likely damaged. |
| | 0x8CA2 | Sensor bridge damage | Call MT service for a replacement sensor. The strain gages and/or Wheatstone bridge is damaged. |
| | 0x8CA3 | Factory parameter error | Call MT service for a replacement sensor. Factory parameters compromised. |
| 4 | 0x8D05 | Sensor humidity out of range | Move the sensor/machine to a low humidity environment |
| 3 | 0x8D71 | Adjustment error | Attempt adjustment again, something went wrong during the previous adjustment process. |
| | 0x8D6B<br>0x8D6D | Sensor temperature is outside the normal range (-10~40 °C) | Check the temperature around the sensor.<br>If the temperature is in range, call MT service, the load cell might be damaged. |
| | 0x8D69 | Sensor load exceeds 110% of rated capacity | Identify the cause of the overload.<br>Check sensor performance, calibration may be required.<br>If the performance is normal, continue to use it.<br>If the performance is not normal, replace the sensor with a new one. |
| | 0x8D6A | Sensor underload | Identify the cause of the underload.<br>Check sensor performance, calibration may be required.<br>If the performance is normal, continue to use it.<br>If the performance is not normal, replace the sensor with a new one. Call MT service for replacement. |

| | | | |
|---|---|---|---|
| | 0x8D6F | Supply voltage out of range | Check supply voltage |
| | 0X8D6C<br>0x8D6E | Sensor temperature gradient changes out of range | Temperature changes too quickly, stabilize temperature in the room where the machine with the load cell is installed and wait 30 minutes before using it. |
| | 0x8D70 | Sensor humidity gradient changes out of range | Humidity changes too quickly, wait 30 minutes before using it |
| 2 | 0x8DCE | Zeroing failed, out of range | Unload the sensor, zero it again |
| | 0x8DCD | Sensor loading counter reached 1 M weighing events | Sensor performed at least 1 million weighing measurements, check sensor performance, e.g., by placing known reference weight on it. |

# A GEO Codes

When the SLP33xD-IOL is calibrated with test weights it assumes the currently entered GEO code as its base line. From there on one can relocate the load cell (and the machine) without the need to retest again, by just entering a new GEO code.

If the load cells will not be relocated after test weight calibration or a test weight calibration will be done after relocation, the GEO code has no relevance.

## A.1. Transferring Factory Calibration to Other Locations

The GEO code feature provided in the SLP33xD-IOL permits calibration readjustment due to changes in elevation or latitude without reapplying test weights. The load cell comes with the factory calibration at GEO code 12. To achieve proper weight readings the GEO code must be changed to the current location. As a machine manufacture one might change the GEO code twice; first to the own location where the machines are built and then again to the end-users' location to achieve correct measurements also there.

## A.2. On-site Adjustment

1. Use the GEO code chart (Table A-1) on the following pages to determine the GEO code for the altitude and latitude where the load cell is currently located and where it will be calibrated with test weights.
2. Enter this GEO value into the GEO code parameter in the **Weighing** menu (Section 3.2.2.3.). This step is required if the scale shall be relocated again w/o test weight calibration.
3. Immediately after entering the GEO code, perform a zero and span adjustment using accurate test weights.
4. If the scale will be shipped to a different location without recalibration on-site, you need to change the GEO code to the altitude and latitude of the new location before using it there.

Using the GEO code value for calibration adjustment is not as accurate as re-applying certified test weights and re-calibrating the scale in a new location.

Table A-1: GEO Adjustment Values

| Latitude North or South, in Degrees and Minutes | Height Above Sea Level, in Meters | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 325 | 650 | 975 | 1300 | 1625 | 1950 | 2275 | 2600 | 2925 | 3250 |
| | 325 | 650 | 975 | 1300 | 1625 | 1950 | 2275 | 2600 | 2925 | 3250 | 3575 |
| | Height Above Sea Level, in Feet | | | | | | | | | | |
| | 0 | 1060 | 2130 | 3200 | 4260 | 5330 | 6400 | 7460 | 8530 | 9600 | 10660 |
| | 1060 | 2130 | 3200 | 4260 | 5330 | 6400 | 7460 | 8530 | 9600 | 10660 | 11730 |
| 0° 0'–5° 46' | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 5° 46'–9° 52' | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 0 |
| 9° 52'–12° 44' | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 |
| 12° 44'–15° 6' | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 |
| 15° 6'–17° 0' | 7 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 |
| 17° 10'–19° 2' | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 |
| 19° 2'–20° 45' | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 |
| 20° 45'–22° 22' | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 4 | 3 |
| 22° 22'–23° 54' | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 4 |
| 23° 54'–25° 21' | 9 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 |
| 25° 21'–26° 45' | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 |
| 26° 45'–28° 6' | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 5 |
| 28° 6'–29° 25' | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 6 | 6 |
| 29° 25'–30° 41' | 11 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 6 |
| 30° 41'–31° 56' | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 7 |
| 31° 56'–33° 9' | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 |
| 33° 9'–34° 21' | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 8 | 8 |
| 34° 21'–35° 31' | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 8 |
| 35° 31'–36° 41' | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 |
| 36° 41’–37° 50’ | 14 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 |
| 37° 50’–38° 58’ | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 |
| 38° 58’–40° 5’ | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 |
| 40° 5’–41° 12’ | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 11 | 11 |
| 41° 12’–42° 19’ | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 11 |
| 42° 19’–43° 26’ | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 |
| 43° 26’–44° 32’ | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 |
| 44° 32’–45° 38’ | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 |
| 45° 38’–46° 45’ | 18 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 |
| 46° 45’–47° 51’ | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 14 |

| Latitude North or South, in Degrees and Minutes | Height Above Sea Level, in Meters | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 325 | 650 | 975 | 1300 | 1625 | 1950 | 2275 | 2600 | 2925 | 3250 |
| | 325 | 650 | 975 | 1300 | 1625 | 1950 | 2275 | 2600 | 2925 | 3250 | 3575 |
| | Height Above Sea Level, in Feet | | | | | | | | | | |
| | 0 | 1060 | 2130 | 3200 | 4260 | 5330 | 6400 | 7460 | 8530 | 9600 | 10660 |
| | 1060 | 2130 | 3200 | 4260 | 5330 | 6400 | 7460 | 8530 | 9600 | 10660 | 11730 |
| 47° 51’–48° 58’ | 19 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 |
| 48° 58’–50° 6’ | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 15 | 15 |
| 50° 6’–51° 13’ | 20 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 15 |
| 51° 13’–52° 22’ | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 16 | 16 |
| 52° 22’–53° 31’ | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 16 |
| 53° 31’–54° 41’ | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 17 | 17 |
| 54° 41’–55° 52’ | 22 | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 17 |
| 55° 52’–57° 4’ | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 |
| 57° 4’–58° 17’ | 23 | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 19 | I9 | 18 |
| 58° 17'–59° 32' | 24 | 23 | 23 | 22 | 2\2 | 21 | 21 | 20 | 20 | 19 | 19 |
| 59° 32'–60° 49' | 24 | 24 | 23 | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 19 |
| 60° 49'–62° 9' | 25 | 24 | 24 | 23 | 23 | 22 | 22 | 21 | 21 | 20 | 20 |
| 62° 9'–63° 30' | 25 | 25 | 24 | 24 | 23 | 23 | 22 | 22 | 21 | 21 | 20 |
| 63° 30'–64° 55' | 26 | 25 | 25 | 24 | 24 | 23 | 23 | 22 | 22 | 21 | 21 |
| 64° 55'–66° 24' | 26 | 26 | 25 | 25 | 24 | 24 | 23 | 23 | 22 | 22 | 21 |
| 66° 24'–67° 57' | 27 | 26 | 26 | 25 | 25 | 24 | 24 | 23 | 23 | 22 | 22 |
| 67° 57'–69° 35' | 27 | 27 | 26 | 26 | 25 | 25 | 24 | 24 | 23 | 23 | 22 |
| 69° 5'–71° 21' | 28 | 27 | 27 | 26 | 26 | 25 | 25 | 24 | 24 | 23 | 23 |
| 71° 21'–73° 16' | 28 | 28 | 27 | 27 | 26 | 26 | 25 | 25 | 24 | 24 | 23 |
| 73° 16'–75° 24' | 29 | 28 | 28 | 27 | 27 | 26 | 26 | 25 | 25 | 24 | 24 |
| 75° 24'–77° 52' | 29 | 29 | 28 | 28 | 27 | 27 | 26 | 26 | 25 | 25 | 24 |
| 77° 52'–80° 56' | 30 | 29 | 29 | 28 | 28 | 27 | 27 | 26 | 26 | 25 | 25 |
| 80° 56'–85° 45' | 30 | 30 | 29 | 29 | 28 | 28 | 27 | 27 | 26 | 26 | 25 |
| 85° 45'–90° 00' | 31 | 30 | 30 | 29 | 29 | 28 | 28 | 27 | 27 | 26 | 26 |