SAFETY-BOY

User's manual

Rev.	Date	Reason

1. INTRODUCTION

1.1. Cautions

READ this manual BEFORE operating or servicing the instrument.
FOLLOW these instructions carefully.
SAVE this manual for future use.

	CAUTION Installation and maintenance of this instrument must be allowed to qualified personnel only. Be careful when you make inspections, testing and adjustment with the instrument on. Make the electrical connections in the absence of the power supply. Do not observe this precaution can be dangerous. DO NOT allow untrained staff to operate, clean, inspect, repair or tamper with this tool

1.2. Symbols

The following are the symbols used in the manual to draw the reader's attention:

	Attention! This operation must be performed by qualified personnel.
	Pay attention to the following.
	Read more.
	The message shown on the display is blinking.
	The message shown on the display is fix.

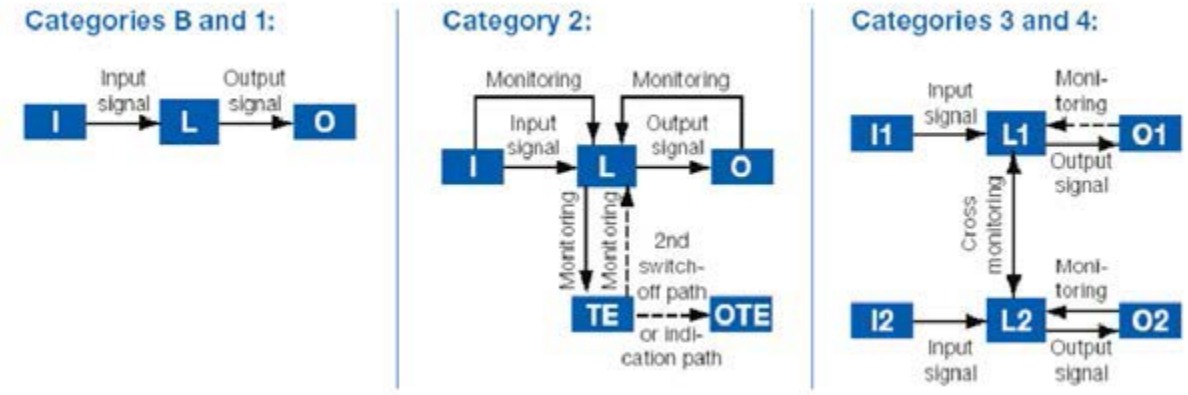
1.3. Introduction to safety

SAFETY-BOY-OEM is housed in a holder to be hooked directly on DIN / OMEGA. The coupling is designed for use with DIN rails (EN60715).

SAFETY-BOY is a redundant system for the limitation of the load, manufactured in compliance with the Performance Level PL d, according to ISO standard EN13849-1, corresponding to the Safety Integrity Level (SIL 2 IEC 62061).

Performance Level (EN 13849-1)	Probability of Failure per Hour [1/h]	SIL Level (EN IEC 62061)
b	$3 \cdot 10^{-6} \leq PFH_D < 10^{-5}$	SIL 1
c	$10^{-6} \leq PFH_D < 3 \cdot 10^{-6}$	SIL 1
d	$10^{-7} \leq PFH_D < 10^{-6}$	SIL 2
e	$10^{-8} \leq PFH_D < 10^{-7}$	SIL 3

Table of correspondence PL-SIL



Through the programming of 2 levels (pre-alarm and alarm) the load detected is constantly checked and eventually the lockout relay is activated. Other possible alarm conditions are monitored: imbalance of the 2 acquisition channels, load cells connections missing, incorrect power supply, self-diagnosis. The instrument also has two optional analog outputs with a working range 4÷20mA, respectively associated with the two weight acquisition channels.

Each channel has a separate logic. Both channels are verified an independent "watchdog" (category 3 according to EN13849). Each channel is provided with: a ADC converter that acquires the signal of the load cell, a microcontroller that receives the data from the ADC, two control relays.

Each microcontroller has a "watchdog" interior, an external voltage monitor and data memory (EEPROM). Both microcontrollers are monitored by an independent extra "watchdog" able to send the alarm relay in case the system does not work properly. The diagnostic system also provides continuous monitoring of the load cell cables and indicates a possible anomaly. Furthermore, if the analog or digital power supplies come out from the operation fields a specific alarm condition is determined. If there were no conditions to work correctly, the relays would be immediately put in an alarm state (de-energized).

The parameter settings are made through four mechanical buttons and the visualization is on 4 red display (7-segment red LED 7mm). Each relay has a LED to indicate its status.

2. SPECIFICATIONS

2.1. Display

Display: Numeric 4-digit 7-segment red LED (h 7 mm)
Led: 4 LED indicators that indicate the status of the relay outputs

2.2. Power

Power supply: 10 to 30VDC protected against inverted polarity.
Protection with self-resetting fuse.
Consumption: Max 6W
Insulation: Class III (only the card)

2.3. Keyboard:

N. 4 mechanical buttons

2.4. Dimensions

Dimensions of the board: 134mm x 107mm x 30mm (WxHxD) including terminal lockouts
Installation: With 4 screws or on a DIN rail or on a OMEGA bar

2.5. Connections

Plug-in terminals screw pitch 5.08mm, 3.81mm for the cells

2.6. Sensor inputs

2 load cells independent inputs with the following characteristics.
Load cell power supply short-circuit protected.
Linearity: <0.01% of full scale
Temperature drift: <0.002% of full scale/°C
Internal resolution: 24-bit
Weight display resolution: Up to 10.000 divisions on the payload
Measuring range: From -3.9mV/V to +3.9mV/V
Digital Filter: Selectable 0.25Hz to 3Hz
Zero and full scale Calibration: Auto (theoretical) or executable from the keyboard.
Control cable interruption cell: Present

2.7. Outputs

Alarm outputs: 4 relays internally wired
Relay contact rating: 24 or 48VDC/VAC; 2A
N2 optional Analog Outputs: Current 4÷20mA
Resolution: 16-bit
Calibration: Digital from keypad
Impedance: 300Ω Maximum
Linearity: 0.03% of full scale
Temperature drift: 0.001% of full scale/°C

2.8. Microcontrollers

2 microcontrollers with cross-checking
Micro Characteristic: 32-bit ARM Cortex-M0
Memory Program Code: 32 Kbytes FLASH reprogrammable on-board RS232
Data memory: 8 Kbytes

2.9. Electromagnetic compatibility

Compliance with: EN61000-6-2, EN61000-6-3 for EMC
EN61010-1 for Electrical Safety
EN13849-1 parts of the systems of control related to the security

2.10. Environnemental conditions

Operating temperature: -10°C ÷ +50°C
Storage temperature: -20°C ÷ +60°C
Humidity: 85% non-condensing

WARNINGS
The following procedures must be executed by qualified personnel. All connections should be done when the instrument is turned off.

3. INSTALLATION

3.1. General

The SAFETY-BOY is composed of a base board housed in a plastic case for DIN rail 35mm, which can be optionally added when ordering the board with dual analog output. The SAFETY-BOY should not be immersed in water, undergo water jets and cleaned or washed with solvents. Do not expose to heat or direct sunlight.

3.2. Dimensions

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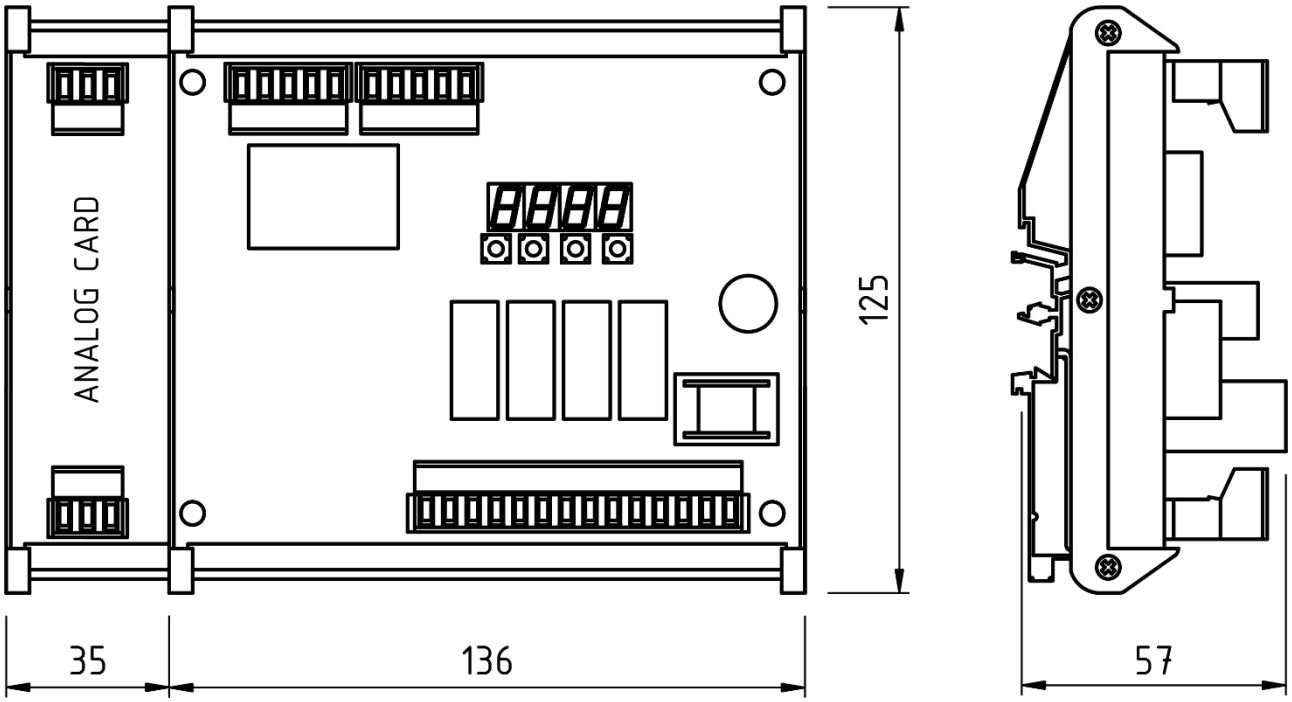
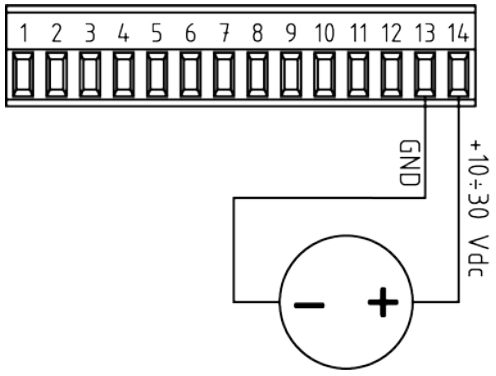


3.3. Electrical Installation

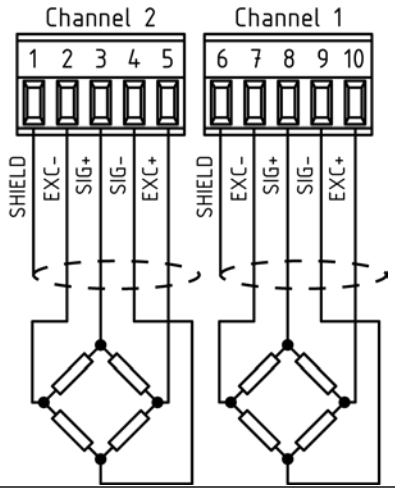
The SAFETY-BOY uses for the electrical connection 5,08mm removable terminal lockouts.
The load cell cable must be shielded and channeled away from the power cables to prevent electromagnetic interference.

3.3.1. Power supply of the instrument

The instrument is supplied via terminals 13 and 14. The power supply cable must be channeled separately from other cables. The supply voltage is electrically isolated.
Supply voltage: 10-30VDC, max 6W



3.3.2. Load cells connection



The load cell cable must not be channeled with other cables, but must follow their own path. The supply voltage of the cells is 4VDC and is protected by a temporary short circuit. The measuring range of the instrument involves the use of load cells with a sensitivity of up to 3.9mV/V. The load cell cable must be connected to the terminal 1÷5 for channel 2 and the terminal 6÷10 for channel 1. Connect the shield to the relative cell clamp.
The instrument is designed for the connection of double bridge load cell (redundant), with acquisition of the dual-channel signal. If the load cell cable involves the use of remote sense, connect these wires with the load cell power supply wires.

3.3.3. Relay output connection

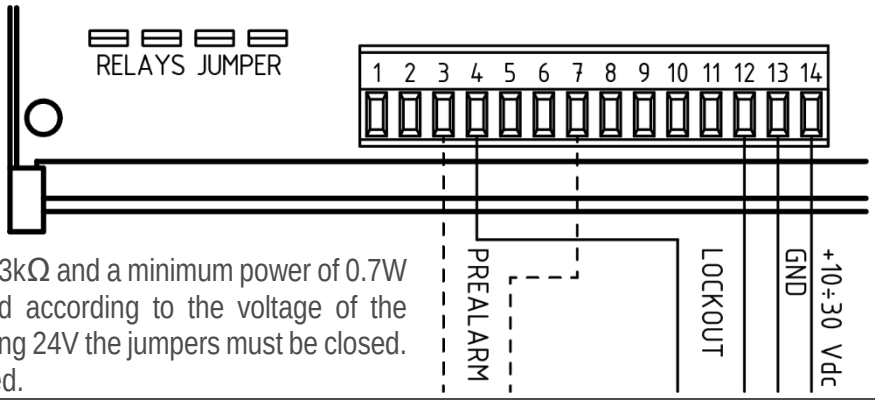
To meet the safety requirements the pre-alarm and locking outputs are both obtained with 2 relays in series, driven by two microcontrollers. The series connection is made inside the instrument, in such a way that they are available on the terminal contacts for the loads of pre-alarm and lock. The contacts of the relays used are normally open and are closed during normal operation in the absence of the alarm.

3.3.3.1. Wiring diagram for the installer

NUM.	TERMINAL LOCKOUT 14P PITCH 5:08
3	Prealarm Contact
7	Prealarm Contact
4	Lockout Contact
12	Lockout Contact

The prealarm and lockout circuits use a supply voltage different from the supply voltage of the load limiter.
The prealarm and lockout circuits must be correctly wired before powering the load limiter.

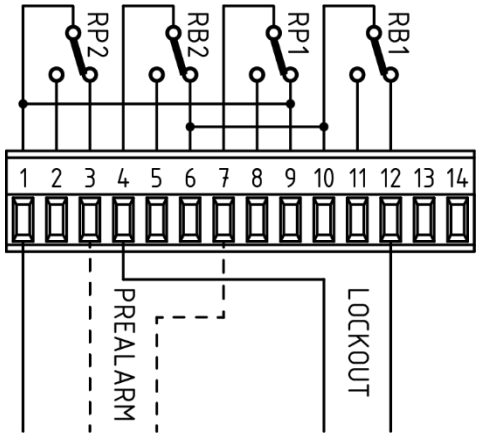
Observe the safety contacts (24 or 48VDC/VAC, 2A)
In the case of a voltage of 24V, the load should have a maximum impedance of 1kΩ and a power of 0.5W.
In the case of a voltage of 48 V the load must have an impedance up to 3kΩ and a minimum power of 0.7W
The instrument must be configured according to the voltage of the contacts: either 24 or 48V. When using 24V the jumpers must be closed. With 48V the jumper must be opened.



The environment where the apparatus is installed can normally be subject to strong magnetic fields and electrical noise caused by the machines present, then it is good to adopt the normal precautions to avoid that they affect the typical signals of an electronic apparatus.

3.3.3.2. Internal wiring diagram

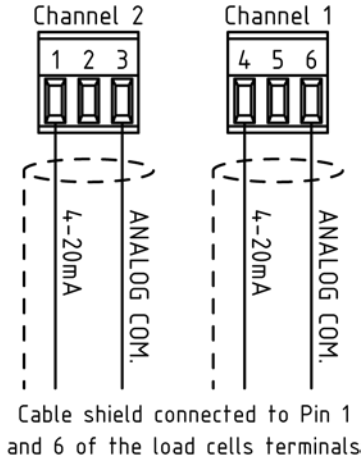
NUM.	14P TERMINAL STRIP PITCH 5.08
1	RP2 Prealarm Relay channel 2 COM
2	RP2 Prealarm Relay channel 2 NC
3	RP2 Prealarm Relay channel 2 NO
4	RB2 Lockout Relay channel 2 COM
5	RB2 Lockout Relay channel 2 NC
6	RB2 Lockout Relay channel 2 NO
7	RP1 Prealarm Relay channel 1 COM
8	RP1 Prealarm Relay channel 1 NC
9	RP1 Prealarm Relay channel 1 NO
10	RB1 Lockout Relay channel 1 COM
11	RB1 Lockout Relay channel 1 NC
12	RB1 Lockout Relay channel 1 NO



3.4. Connecting optional analog outputs

The analog outputs are located on the optional boards positioned on the right of the base board (SAFETY-BOY).
The operation range provided is 4 to 20mA. The maximum load is 300Ω.
To realize the connection, use a shielded cable, taking care to connect only one of the two ends to the terminal 3 or 6 (screen), to the terminal lockout used for the connection of the load cells.
To make the connection use an appropriate shielded cable as short as possible and separated from the power cables.

NUM.	TERMINAL STRIP 3P PITCH 5:08
1	+mA Analog Output 2
2	
3	GND Analog Output 2
4	+mA Analog Output 1
5	
6	GND Analog Output 1



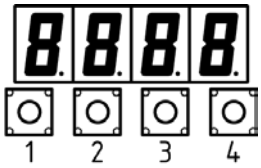
4. INSTRUMENT FRONT PANEL

The SAFETY-BOY is equipped with a 4-digit display, 4 status LED relay and 4 keys.
In this operating mode the display shows the weight.
The set-up parameters are easily accessed and modified through the use of the 4 front buttons used to select, edit, confirm and save the new settings.

4.1. Display

In the programming procedure, the display shows the sequence of parameters and their values that allow the operator to configure the instrument.

4.2. Use of the keys



The instrument is programmed by 4 keys located below the display. Since there is no identification on the board, to facilitate the user, on this manual, the keys are identified by numbers from 1 to 4 from left to right.
During the programming procedures pay attention to any temperatures above 50°C which may occur near the keys and to any voltages which may occur on the electronic board. The voltages do not usually exceed 30VDC.

NUM.	FUNCTION KEY IN SET-UP MENU	NUM.	SET-UP PARAMETERS
1	Back to the previous menu.	1	Increase the blinking digit / select the previous value.
2	Go to the next menu.	2	Decrease the blinking digit / select the next value.
3	Exit the Set-up menu/Go back to upper level.	3	Select the next digit. If the blinking digit is the last on the right go back to the firs digit on the left.
4	Enter the menu/Enter the set-up/confirm selected parameters	4	Confirm and save the value set

To exit and save the changed data, press the Key 3 until the indicator returns to the operating mode.

5. DISPLAY INDICATIONS

The display check is done when switching the instrument on. Then it appears an identification code of the software and its version. It is important to communicate this code in case of request for assistance. If during the ignition of the instrument the operating alarm are not recognized, a contacts initial test is done

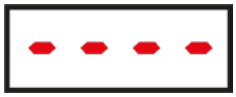
During this phase, the relays are energized to verify proper operation. The test of the contacts is run in 4 phases:

1. Check the condition of the opening of the contacts.
2. Check the prealarm contact closure referred to the MICRO 1, and the alarm contact referred to the micro 2.
3. Control the operation of the "watchdog", during this phase the closed contacts at point 2 are opened for a short period.
4. Check the closure of the alarm contact referred to the micro-1 and the prealarm contact referred to the micro-2.

5.1. Reporting errors

In this operating mode, the display may report the following error codes.
Normally, the display indicates current measure of the load cells. In this condition, you can start a procedure for programming the instrument.

5.1.1. Weight not valid when switching ON



At switching on, before the acquisition of the signal and awaiting the execution of the automatic zero weight, the display shows a message of invalid weight.

5.1.2. Reporting of overload

When the gross weight exceeds by more than 9 divisions the maximum capacity of the weighing system, or when the weight value is greater than the maximum value displayable, the screen displays this message.

5.1.3. Underweight reporting

When the gross weight is negative and greater than 4 digits, the screen displays this message of underweight.

5.2. Alarms

ALARM	DISPLAY	RELAY ACTION
Load cell connection missing: The last displayed digit identifies the load cell channel reference. If the error occurs on both channels, the error displayed first is the one referred to channel 1.		Prealarm + Lockout
Wrong load cell connection: The last displayed digit identifies the load cell channel reference. If the error occurs on both channels, the error displayed first is the one referred to channel 1.		Prealarm + Lockout
Load cell signal out of negative range: The signal of the load cells is lower than -3.9mV/V, probably due to a connection error. The last displayed digit identifies the load cell channel reference. If the error occurs on both channels, the error displayed first is the one referred to channel 1.		Prealarm + Lockout

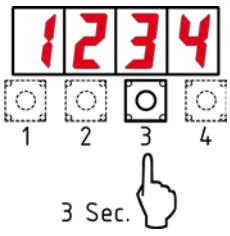
ALARM	DISPLAY	RELAY ACTION	
Load cell signal out of positive range: The signal of the load cells is higher than +3.9mV / V, probably due to a connection error. The last displayed digit identifies the load cell channel reference. If the error occurs on both channels, the error displayed first is the one referred to channel 1.		Prealarm Lockout	+
Faulty relay contact: The instrument monitors the voltages on the relay contacts continuously. In case of non-closure or opening of the contacts you receive this alarm.		Prealarm Lockout *	+
Faulty watchdog: When swithched on, the instrument checks the proper functioning of the "watchdog" signal. If an error occurs, you receive this alarm.		Prealarm Lockout *	+
Unprogrammed prealarm threshold	No message	Prealarm	
Unprogrammed lockout threshold	No message	Prealarm Lockout	+
Weight difference between the channels: The load cells weight signal does not match. If there is a difference higher than the programmed weight value you receive this alarm.		Prealarm Lockout *	+
Internal fault: Channels connection missing. The microcontroller communication between the 2 channels is absent.		Prealarm Lockout *	+
Internal fault: Hardware. Internal voltage levels out of range or intervention of the watchdog		Prealarm Lockout *	+
Internal fault: Missing load cells signal acquisition. In this case there is a system fault signal acquisition. The last displayed digit identifies the load cell channel reference. If the error occurs on both channels, the error displayed first is the one referred to channel 1		Prealarm Lockout	+
Internal fault: Memory set-up parameters. The control system of the data stored in the memory found an error.		Prealarm Lockout	+
Weight calibration missing: This message indicates that calibration is missing. To eliminate this message, perform the calibration procedure as described in the next pages of this manual. This message appears after the reset of the instrument parameters.			

CAUTION: To meet safety requirements, alarms marked with the * symbol, remain active even if the condition that caused the alarm is no longer detectable. To restore operation, you must first remove power to the instrument.

5.3. Viewing, zeroing weight

After being calibrated, at power on the display shows the current weight.

5.3.1. Weight visualization of the second weighing channel

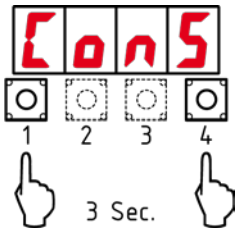


Press and hold for 3 seconds the Key 3 to display the weight of the second channel. The weight value of the cell channel 2 is "flashing", to be distinguished from the weight value display of the first cell channel. To return to display cell channel 1, press and hold the 3 Key for 3 seconds.

6. CONFIGURATION

6.1. General

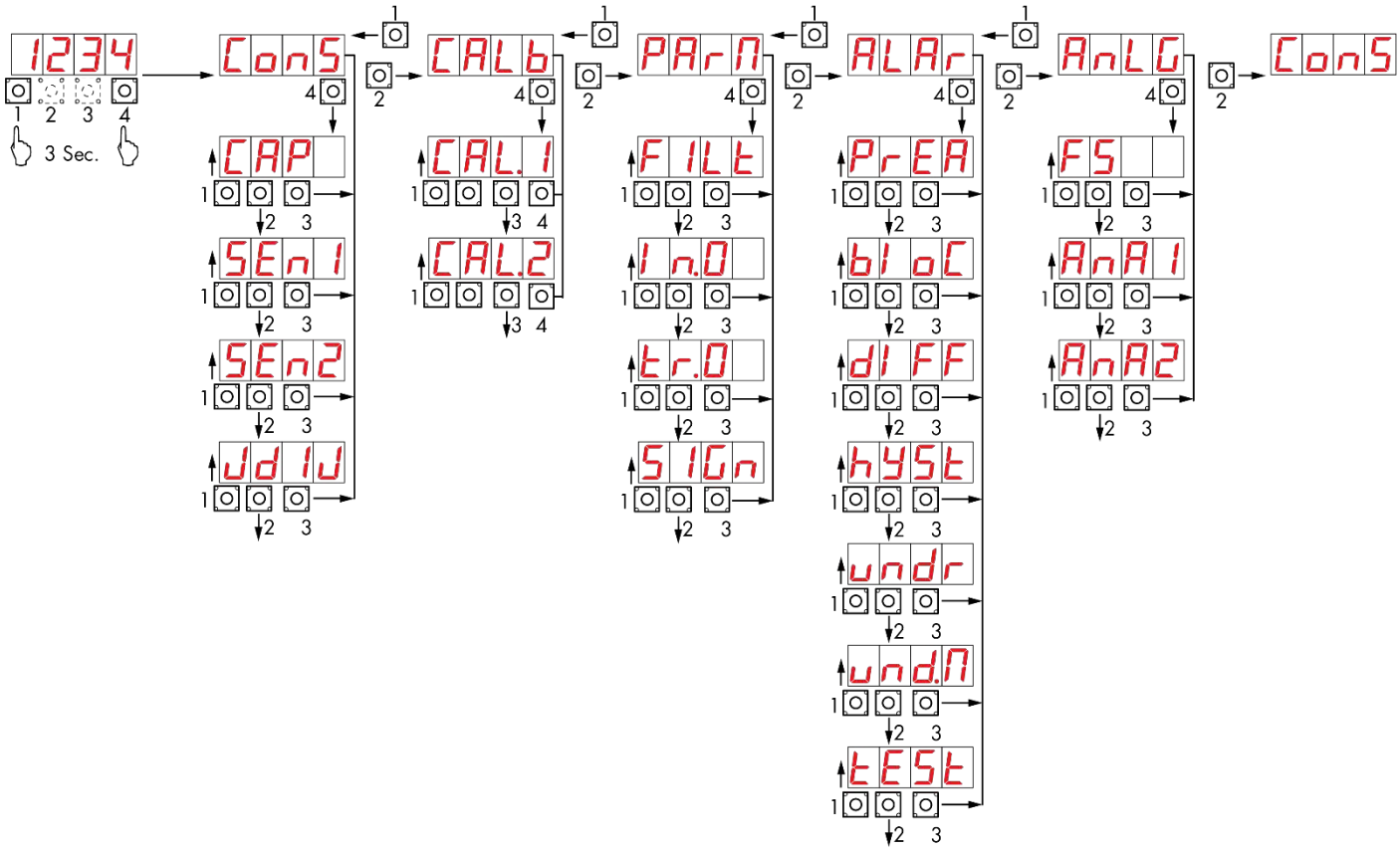
All functions of the SAFETY-BOY can be activated and modified by accessing a simple setup menu. All settings selected or activated remain stored even after switching off the unit.
The SAFETY-BOY is preconfigured with a default setting. On the following pages are shown the "Default" values of each parameter. With the first installation in the field, changes are necessary to obtain a correct indication of the displayed weight.
The settings of the setup menu can be changed using the 4 front buttons.
The setup parameters are grouped into a number of main menus.
To access the setup menu press simultaneously for 3 seconds, the keys 4 and 1. The display shows the message Cons which is the first main menu. Use buttons 1 and 2 to select the menu you want to change. Press the 4 key to enter the selected menu.



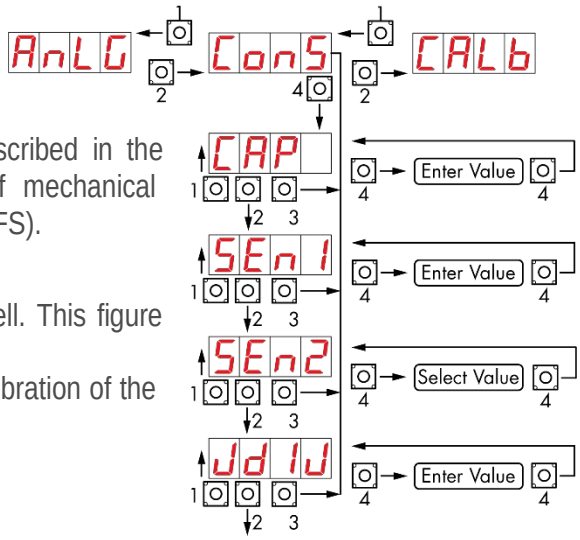
NUM.	FUNCTION KEY IN SET-UP MENU	NUM.	FUNCTION KEY IN SET-UP PARAMETERS
1	Back to the previous menu.	1	Increase the blinking digit / select the previous value.
2	Go to the next menu.	2	Decrease the blinking digit / select the next value.
3	Exit the Set-up menu/Go back to upper level.	3	Select the next digit. If the blinking digit is the last on the right go back to the firs digit on the left.
4	Enter the menu/Enter the set-up/confirm selected parameters	4	Confirm and save the value set

Note: To exit and save the changed data, press Key 3 until the unit returns to the operating mode.

6.2. Chart menu



6.3. Configuration parameters



By setting the parameters listed below, the SAFETY-BOY full scale theoretical calibration is performed.
You must complete these steps with the zero-calibration described in the following page. The procedure ensures, in the absence of mechanical problems, a good accuracy of the system (maximum error <1% FS).

6.3.1. ***CAP**: Capacity of the weighing system*

Defines the value corresponding to the capacity of the load cell. This figure represents the full-scale value of the weighing system.
Following the change of the parameter value, the datasheet calibration of the weight is recalculated.
Values: 1 to 9999
Unit: Same visualization
Default: 1000

6.3.2. ***SEn**X: Sensitivity of the channel load cells*

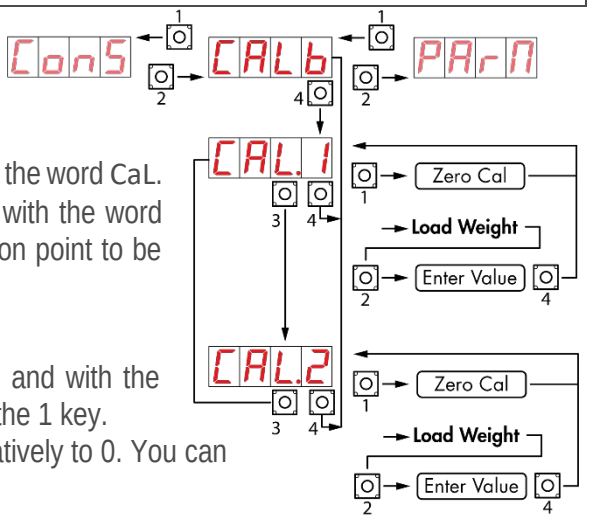
Set the value corresponding to the mV/V sensitivity. Accepted values are between 0.5 and 4 mV/V. If no values are programmed, the value assumed is 2mV/V.
Following the change of the sensitivity value the datasheet calibration is recalculated.
Range: 0.5000 to 4.0000 mV/V
Default: 2.0000

6.3.3. *JdIJ: Division value*

The relationship between the flow rate of the system and the MEASUREMENT unit represents the resolution of the system (number of divisions).
Following the change of the flow rate, the division value is automatically selected to the best of 5000 divisions.
Following the change of the division value, if not changed the capacity of the system, the datasheet calibration is recalculated.

6.4. Calibration

CAUTION: At switching off without exiting the set-up menu, all the programming done is not saved.
Note. In case the system gives linearity error after calibration, it is necessary to check that the weighing system is free of any mechanical constrains.



The calibration method described herein must be performed with the use of sample weight and/or pre-weighed product.
Before proceeding with the scale calibration always perform the zero calibration.
During calibration the display shows the weight intermittently with the word CaL.
During linearization the display shows the weight intermittently with the word LinN, where N is displayed instead of the number of linearization point to be set (from 1 to 5 linearization points).

6.4.1. *Zero calibration*

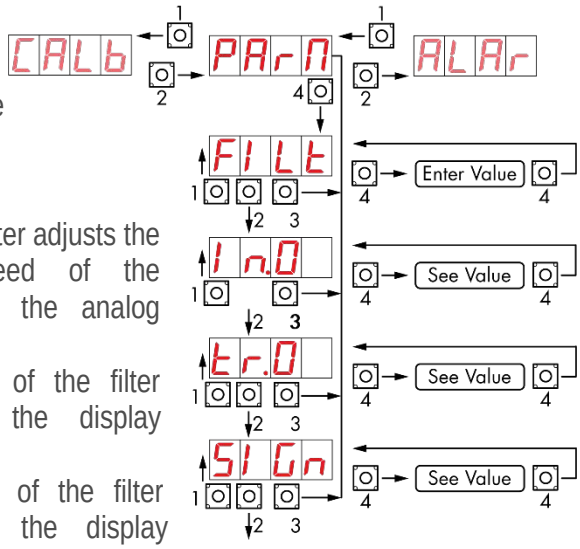
Run the operation with the scale empty (including the fix tare) and with the weight stable. The zero point of the system is done by pressing the 1 key.
The displayed weight is reset and the display shows CaL alternatively to 0. You can repeat this operation several times.

6.4.2. *Full scale calibration*

Before doing this, put the dead loads on the scale and wait for the stabilization. The display shows a weight value.
Press the 2 key to adjust the weight. The display shows 0000 with the first digit blinking.
Use Keys 1, 2 and 3 to set the weight. Once you have set the weight value, press Key 4. The display shows Cal alternatively with the weight value. Press again Key 4 to return to the main menu.
If the entered value is greater than the resolution of the instrument, the weight is not accepted and the display shows an error message.
It's always possible to repeat the full-scale calibration.

6.5. Weighing parameters

The parameters included in this menu allow to adjust the timing of the display update, the acquisition and the visualization of the load cell signal.



6.5.1. ***FILt***: *Weight filter*

VALUE	ADC UPDATE	RESPONSE
0	16,7Hz	3
1	16,7Hz	2,5
2	12,5Hz	1,5
3	12,5Hz	1
4	10Hz	0,7
5	10Hz	0,55
6	8,3Hz	0,4
7	6,2Hz	0,35
8	6,2Hz	0,3
9	4Hz	0,25

This parameter adjusts the refresh speed of the display and the analog output.
Low values of the filter speed up the display refresh.
High values of the filter slow down the display refresh.
Default: 5

6.5.2. ***In.0***: *Autozero at power on*

This parameter defines the maximum resettable weight upon power on.
This operation corresponds to a zero calibration of the system and is executed only if the weight is stable and below the set value.
Value from 0 to the value of the CAP parameter.
Default: 0

6.5.3. ***tr.0***: *Zero tracking*

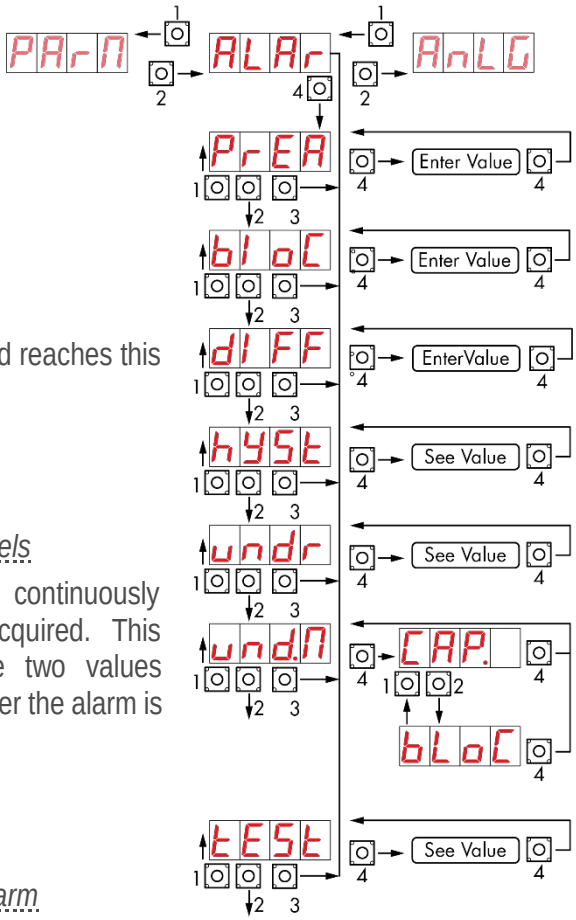
VALUE	CHANGE
0	Control OFF
1	0,5 div/sec
2	1 div/sec
3	2 div/sec
4	3 div/sec

This function allows a momentary zero calibration compensating the eventual temperature drift of the weight. At power off, it automatically returns to the previous calibration.
The maximum weight resettable by this parameter is 2% of the range of the system.
To disable this feature, use the value 0.
Default: 0

6.5.4. ***SIGn***: *Load cell signal test*

The signal from the load cells is given in mV/V with 2 decimals of resolution.

6.6. Alarm parameters



6.6.1. ***PrEA:*** *Prealarm threshold*

The load threshold is expressed in absolute value. When the load reaches this threshold, the contact opens for prealarm.
Values: 1 to 9999
Unit: Same visualization
Default: 1000

6.6.2. ***BloC****: Lockout threshold*

The load threshold is expressed in absolute value. When the load reaches this threshold, the lockout contact opens.
Values: 1 to 9999
Unit: Same visualization
Default: 1000

6.6.3. ***diff****: Max load difference between two channels*

The load values detected by the 2 acquisition channels are continuously compared by 2 microcontrollers exchanging the values acquired. This parameter represents the maximum deviation between the two values (parameter is expressed as "weight"): when the difference is higher the alarm is activated. You cannot program this parameter to 0.
Values: 1 to 9999
Unit: Same visualization
Default: 1000

6.6.4. ***hySt****: Setpoint hysteresis for block and prealarm*

Setting the setpoint hysteresis value of the prealarm and lockout relay, with respect to the setpoint value. In the case of a parameter programmed at 0, a fixed hysteresis corresponding to 2 divisions is applied.
Values: from 0 to CAP
Default: 0

6.6.5. ***undr****: Block setpoint for negative load*

Load setpoint as a percentage with a decimal, with respect to the capacity of the weighing system or with respect to the value of the block setpoint. The operating mode can be selected using the appropriate und.N parameter. When the negative load reaches this value, the block contact opens.
Values from 0 to 100
Default:0

6.6.6. ***und.N****: Use of the block setpoint for negative loading*

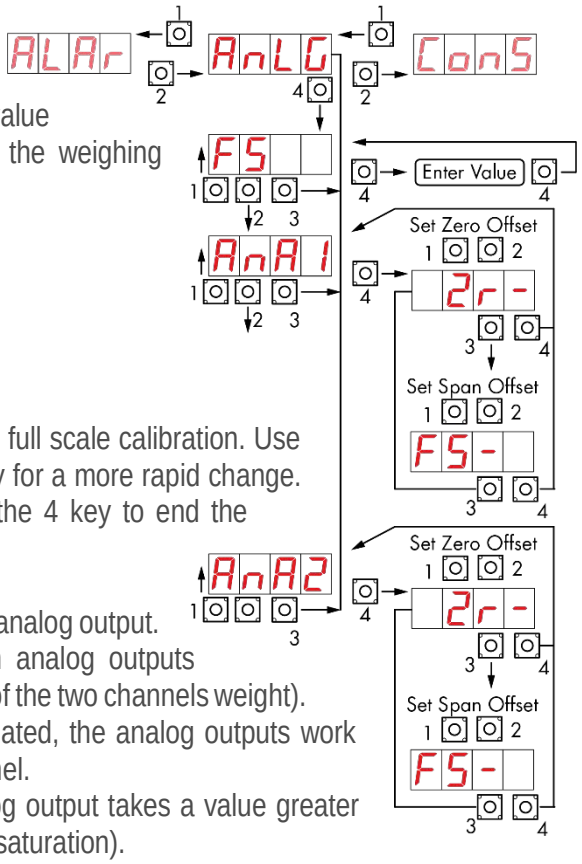
Selecting the mode of use of the negative load setpoint. The percentage load setpoint can refer to the capacity of the weighing system or the value of the block setpoint.

6.6.7. ***tEst****: Contact autotest*

In addition to the contacts lockout test carried out continuously by the instrument, this process is done with an automatic contacts test. The relays are opened and closed in sequence and the voltage of each contact is measured. At the end of the sequence a message is displayed:

PASS Test OK
FAIL Incorrect functioning

6.7. Analog outputs



6.7.1. ***FS***: *Full scale analog output*

Weight corresponding to the full-scale of the analog output, this value may be different from the value of the maximum capacity of the weighing system.
Values: 1 to 9999
Unit: Same visualization
Default: 1000

6.7.2. ***ANA1***: *Analog output 1 Calibration*

6.7.3. ***ANA2***: *Analog output 2 Calibration*

Measure with a tester the analog output to perform the zero and full scale calibration. Use keys 1 and 2 to adjust the analog output, press and hold the key for a more rapid change. Use 3 key to select the Zero or Full-Scale calibration. Press the 4 key to end the calibration of the analog output.
The analog output signal is updated at a frequency of 2Hz
The same filter used for the weight display value is applied to the analog output.
In case of normal operation mode (no alarm detected), both analog outputs operate with the average value of the weight (arithmetic average of the two channels weight).
In the presence of the alarms, the weight average is not calculated, the analog outputs work individually with the weight value of the corresponding cell channel.
When the weight exceeds the programmed full scale, the analog output takes a value greater than the full-scale value of the analog output up to a limit value (saturation).
When the weight is negative, the output takes a value lower than the zero value, up to a limit value (saturation).

7. EU DECALARATION OF CONFORMITY

We, SENSY SA, certify that the DoC issued under our sole responsibility and belongs to the following product:

Apparatus model/Product:

SAFETY-BOYOEM, SAFETY-BOY24, SAFETY-BOY

Type:

Weighing instrument

The object of the declaration described above used as indicated in the installation manual and use, is in conformity with the relevant Union harmonized legislation:

Machinery Directive 2006/42/EU and subsequent amendments
The following harmonized standards and technical specification have been applied:
EN 13849-1:2008
EN 13849-2:2008

Directive EMC 2014/30/EU Electromagnetic Compatibility
The following harmonized standards and technical specification have been applied:
EN 61000-6-2:2005
EN 61000-6-3:2007 + A1 2011

Directive LVD 2014/35/EU Low Voltage Directive
The following harmonized standards and technical specification have been applied:
EN 61010-1:2011

Date : May 31st 2018

JM Gillet
Production Manager

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