MODEL 190iD

DIGITAL LOAD CELL

USER MANUAL

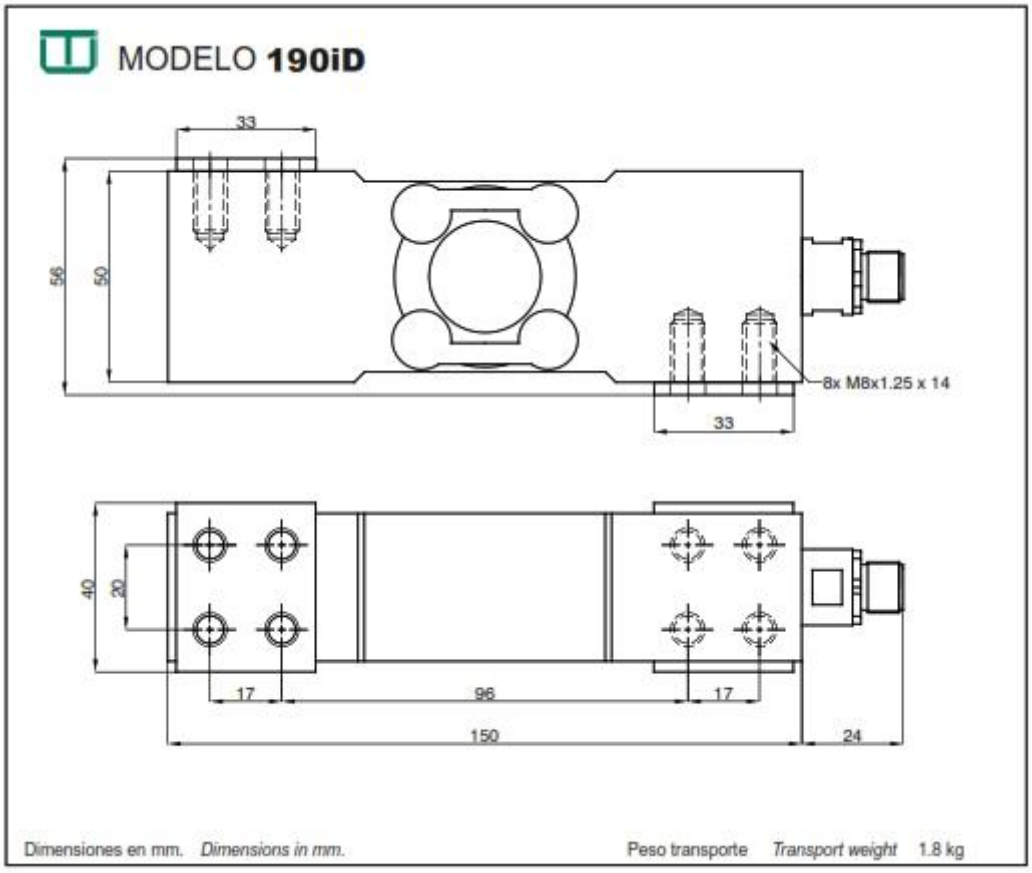
INDEX

GENERAL DESCRIPTION

The digital load cell 190iD is manufactured in stainless steel and IP68 / IP69K hermetical sealed.
It is especially suitable for dynamic weighing applications in harsh environments.

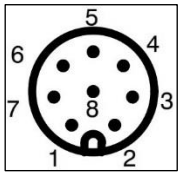
The digital load cell is provided with CAN-Bus output and uses the CANopen protocol (CiA 301).

1.1 Dimensions



1.2 Electrical connection

The load cell is supplied with an 8 pins M12x1 male connector (code A)



PIN	Signal
1	U_B
2	GND
3	CAN H In
4	CAN L In
5	–
6	CAN L Out
7	CAN H Out
8	Shield

The shield is connected to the load cell body

1.3 Specifications

SPECIFICATIONS		
Nominal capacities (Ln)	15-20-30-50	kg
Accuracy class	3000	n_{LC} OIML
Minimum dead load Service load Safe load limit	0 150 200	%Ln %Ln (1)) %Ln (1)
Total error	< ±0.017	%Sn (2)
Repeatability error	< ±0.006	%Sn
Temperature effect: - On zero - On sensitivity	 < ±0.01 < ±0.006	 %Sn / 5°C %Sn / 5°C
Creep error (30 minutes)	< ±0.016	%Sn
Temperature compensation Temperature limits	-10 … +40 -20 … +70	°C °C
Nominal output (Sn) No load output Power supply Supply current	1000000 ±0.05% ±0.1 9 … 30 50	counts (3) %Sn V DC mA (max.)
Conversion speed	200	Hz
CAN Interface Protocol Data rate	CAN2.0A CANopen CiA 301 50 – 1000	 Kbit/s
Maximum deflection (at Ln)	0.3 – 0.5	mm

(1) Only central loads on the load cell. Not for off-center loads.
(2) Total error: Non-Linearity and Hysteresis
(3) User programmable

2 SYSTEM DESCRIPTION

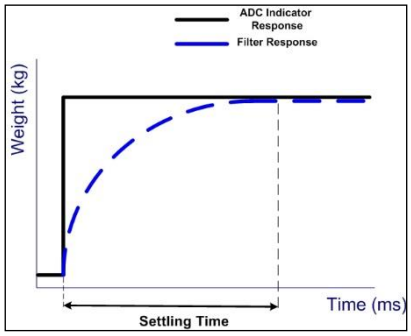
2.1 Digital Filter

The firmware of the load cell incorporates a selectable digital filter system.

- For dynamic weighing:
  High speed digital low pass filter, FIR or IIR defined by its cut-off frequency and fast response (see table).
- For static weighing:
  IIR filters with some feedback moving average filter blocs (FIR) defined by the stabilization time (see table) which allows to obtain a more stable reading.

Filter number	Type	Cut-Off frequency	Stabilization Time 100% Settling time (*)
0	OFF	–	–
10	FIR (high speed)	42 Hz	180 ms
20		17 Hz	230 ms
30		7 Hz	370 ms
40		3,5Hz	370 ms
50		2 Hz	370 ms
60		1Hz	370 ms
70	IIR	25 Hz	260 ms
80		15 Hz	190 ms
90		5 Hz	330 ms
100	Moving Average	–	360 ms
110		–	640 ms
120		–	1285 ms
130		–	1775 ms
140		–	1275 ms
150		–	2790 ms
160		–	3265 ms

(*): Settling time for the filter output after changing the input signal (resolution 6000 divisions).



Filter response respect to a weight change at input, showing the stabilization time (Settling Time).

The filter number can be modified by writing in the appropriate entry from the object dictionary.

2.2 CAN-Bus characteristics

The implementation of the CAN-Bus follows the CAN2.0A recommendation. The load cell receives and transmits messages with 11-bit identifiers, but it is tolerant to messages with 29-bit identifiers.

By default, the bit rate for the CAN communication is 250 Kbit/s and the Node ID of the load cell is 127 (0x7F). The bit rate and the Node ID can be modified by writing in the appropriate entry of the object dictionary.
Any change in these parameters takes effect after a RESET of the load cell.

All cables, connectors and termination resistors used in CAN-Bus must meet the requirements of the standard ISO 11898-2.

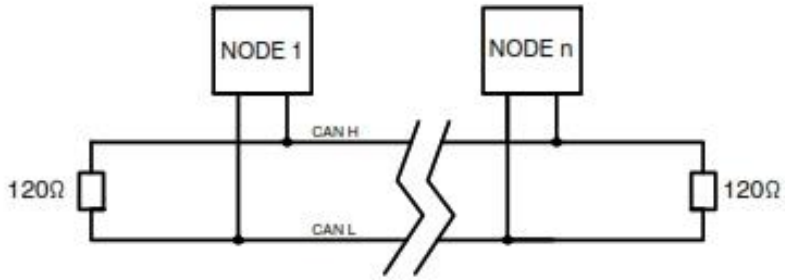
2.2.1 Bus length and bit rate

The maximum bit rate on the CAN-Bus for data transfer is limited by the bus length. The following table shows the maximum permissible bus length for each bit rate of the load cell:

Bit rate [Kbit/s]	Max. Bus length [m]
50	1000
125	500
250	250
500	100
1000	25

2.2.2 CAN-Bus termination

To avoid signal reflections on the CAN-Bus the data line must be closed by 120Ω termination resistors placed at each bus extremity.



3 Configuration and calibration using CANopen

3.1 Calibration Seal

The calibration seal prevents access to the protected parameters (marked with P in the attributes of the object in the object dictionary) and software update. For modifying these parameters, performing an automatic calibration or a SW update, the calibration seal must be “opened”.
This calibration seal can be consulted by reading it from the SDO register [2302sub1]. It can be opened by writing (“1”) or closed (“0”) in the SDO register.
Opening the calibration seal by writing a “1” in the register will automatically increment the calibration counter [2301sub1]. When this calibration counter reaches 65000, no more calibration or SW updates can be performed. After modifying protected parameters or calibration, the calibration seal must be “closed”; with the calibration seal “opened” the “Not Legal Weight” bit in the weight status will be set.

3.2 Configuration

The scale definition is made using 3 parameters from the object dictionary:

- Maximum capacity (MAX), defined in the SDO register [[2100sub5]:
  Defines the maximum weight capacity of the scale. This value must be introduced with resolution in “g” or “kg”, like is defined in the parameter “Unit” [2100sub12].
- Scale division (DIV), defined in the SDO register [2100sub6]:
  Defines the distance between any two scale marks, possible values are 1, 2, 5, 10, 20, 50, 100, 200 and 500.
- Decimal point (DP), defined in the SDO register [2100sub11]:
  Defines the number of decimals for the weight values.

Due to that the weight value in the TPDO is transmitted in integer format to the PLC or CANopen master, the weight value must be adjusted using the DP parameter.
Besides, there are SDO registers [2000sub1] to [2000sub3] that contain the weight values expressed in floating point format.

<u>Some examples:</u>

1. Scale 6kg / 2g with load cell 15kg (15000g)
   MAX = 6000 (in g)
   DIV = 2
   DP = 0 (without decimal point)
   The output of the scale will change form 0 …. 5998, 6000, 6002
   The maximum number of scale divisions n = 3000
2. Scale 6kg / 0.02g with load cell in g
   MAX = 6000
   DIV = 2
   DP = 2
   The output of the scale will change from 0 … 599998, 600000, 600002 with the meaning 0g, … 5999.98g, 6000.00g, 6000.02g
   Maximum number of scale divisions n = 300000

Keep in mind that the maximum number of divisions n of the scale is limited to 1000000. Modifying any of the parameters MAX, DIV and DP which causes n > 1000000 will be rejected and will cause an error message.

3.3 Numeric Calibration

If the calibration coefficients for zero [2300sub2] and gain [2300sub3] are known, a numeric calibration can be performed writing the values in the corresponding registers. This is especially suitable in case of replacing a load cell, the values for Zero and Gain of the “old” one can be used to do a fast start up without certificated test weights. These parameters are protected, so the calibration seal must be “open”. Nevertheless, we recommend calibrating with masses if maximum precision for the weighing system is required.

3.4 Zero Calibration

Make sure that the scale is unloaded (no weight on it) and start the automatic zero calibration writing a “1” in the register [2302sub4]. The zero-calibration process can be controlled by reading the “Calibration Status” register [2302sub2]. After successful calibration this register is set to “2” (or to “4” in case of error) and should be reset by the “Reset calibration Status to Idle” command (writing “128” to the “Calibration Status).

3.5 Gain Calibration with masses

To perform a gain calibration, place a certified test weight on the scale and activate the automatic gain calibration writing a “1” in the register [2301sub2].
Previously the value of the applied test weight must be programmed in the Test Weight register [2300sub1]. Please take in mind that the value of the test register can’t be 0 and must not be greater than the maximum capacity (MAX) adjusted to the decimal point (DP).

Examples for maximum value for the test weight depending on MAX and DP:

1. MAX = 6000, DP = 0: → Test weight ≤ 6000
2. MAX = 6000, DP = 1: → Test weight ≤ 60000
3. MAX = 6000, DP = 2: → Test weight ≤ 600000

Examples for programming test weight adjusted to the decimal point (DP):

1. Test weight: 3987,3g / DP = 0
   The value 3987 must be written in the test weight register
2. Test weight: 3987,3g / DP = 1
   The value 39873 must be written in the test weight register
3. Test weight 3987,3g / DP = 2
   The value 398930 must be written in the test weight register

3.6 Save changes permanently

The changes made in the configuration parameters and in the calibrations are not permanent and disappear after a reset. To save them permanently in Non-Volatile Memory (EEPROM) the function “Save Calibration” [2004sub2] must be performed (see ”Save calibration” in 4.4.2).

4 CANopen profile

For the CANOpen network the digital load cell is considered as an NMT slave. This means that its state can be modified by an NMT master present on the bus. The 190iD load cell is always quite on the CAN-Bus until the NMT master sends the “Start node” command and the load cell changes to the “Operational Mode”. When the load cell is in operational mode the TPDO1 is used to transmit the gross or the net weight and the weight status. Gross or net weight is sent depending on the RPDO selection. The default value is the gross weight.

The RPDO1 can be used to set/reset tare, to launch a zero command or to reset the load cell.
Additionally the RPDO1 can be used for a quick selection if gross or net weight is transmitted in the TPDO1.

The load cell can handle SYNC messages when the register [1800sub2] in the communication profile is set to 1.

By default, the COB-ID (Communication Object Identifier) is 127 (0x7F) and can be modified by writing the appropriate entry from the object dictionary. The change of identifier takes effect after resetting the load cell.

4.1 PDOs

4.1.1 Transmit Process Data Objects (TPDO)

The weight and the status are sent cyclically to the CAN-Bus using TPDO1.
The TPDO1 is send 50 times per second, this frequency can be modified by writing the appropriate entry of the object dictionary.

The format of the TPDO1 is:

32bit	16bit
Weight	Status

The first field is carrying out the weight information (Gross or Net value) and the second the weight status.
The Status field has the following meaning:

0x0001 → Underload Flag
0x0002 → Overload Flag
0x0004 → Stability
0x0008 → Zero Indicator
0x0010 → Tare Indicator
0x0020 → ADC Error
0x0040 → ADC Fault
0x0080 → Temperature sensor alarm
0x0100 → Low battery alarm
0x0200 → Not legal weight (1)
0x0400 → max. number of calibrations reached
0x0800 – 0x8000 → reserved for future extensions

(1) The flag “Not legal weight” is set in the following conditions:

- ADC malfunction (ADC Error or ADC Fault flag is set)
- Low battery alarm
- Temperature sensor malfunction
- Power supply too low (flag “Low battery alarm” is set)
- Calibration switch is open

TPDO2, TPDO3 and TPDO4 are not implemented.

4.1.2 Receive Process Data Objects (RPDO)

The RPDO1 can be used for Zero-Setting, Set or Reset the tare, quick selection of the Gross or Net weight as the data contained in TPDO1.

The format of RPDO1 is:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Gross/Net	Load Cell RESET	–	–	–	Zero	Set Tare	Clear Tare

Setting the corresponding bit will launch the associated command.
The “Set Tare” and “Zero” commands are executed when the weight is stable; if the weight is in motion, the correspond command is pending until weight stability is reached.
Please take in mind that the selection of Gross or Net weight is transmitted in TPDO1 (Bit 7) must be transmitted with the desired value every time a zero or tare command is sent.

RPDO2, RPDO3 and RPDO4 are not implemented.

4.2 Network Management

The Heartbeat control is used for the error control. A heartbeat message is sent once per second to the CAN-Bus.

The Segment Data transfer for SDO is implemented.

The Block Transfer protocol is not used.

4.3 Communication Profile

The critical communication parameters are defined in the communication segment.

As defined in the CANopen protocol, the little-endian format is used, e.g. integer value 10 is expressed as 0x0A00 or 0x0A000000.

4.4 Object Dictionary

Abbreviations used in tables:

Attributes:
- P metrological parameter can only be written if calibration seal is open
- RO read only
- WO write only
- R/W read / write

Types:
- FPS32 32-bit IEEE754 floating point (single)
- I32 signed 32-bit integer
- UI32 unsigned 32-bit integer
- I16 signed 16-bit integer
- UI16 signed 16-bit integer
- UI8 unsigned 8-bitinteger

The object directory of the CANopen communication is described in the following tables.

4.4.1 Communication segment tables

INDEX	Sub-Index	Name	Type	Attribute	Default	Meaning
1000	0	Device Type	UI32	RO		
1001	0	Error Register	UI8	RO		
1003	0	# of errors	UI8	RO	1	Predefined Error Filed
	1	Standard Error Field	UI32	RO	0	
1005	0	COB ID SYNC	UI32	R/W	0x00000080	
1008	0	Manufacturer device name	STRING	R/W	UTILCELL 190iD	
1014	0	COB ID EMCY	UI32	RO	#NodeID+0x80	
1015	0	Inhibit EMCY Time	UI16	R/W	0	
1017	0	Producer Heartbeat Time	UI16	R/W	1000	
1018	0	# of entries	UI8	RO	4	Identity Object
	1	Vendor ID	UI32	RO	0x319	
	2	Product Code	UI32	RO	0xC001	
	3	Revision number	UI32	RO	1	
	4	Serial number	UI32	RO	-	Load cell serial number
1029	0	# of error Classes	UI8	RO	2	Error behavior
	1	Communication Error	UI8	RO	0	
	2	Specific Error Class	UI8	RO	-	
1200	0	# of entries	UI8	RO	2	Server SDO Parameter
	1	COB ID Client to Server	UI32	RO	#NodeID + 0x600	
	2	COB ID Server to Client	UI32	RO	#NodeID + 0x580	
1400	0	# of entries	UI8	RO	5	Receive PDO Communication Parameter
	1	COB ID	UI32	R/W	#NodeID + 0x200	
	2	Transmission Type	UI8	R/W	-	
	3	Inhibit Time	UI16	R/W	-	

	4	Compatibility Entry	UI8	R/W	-	
	5	Event Timer	UI16	R/W	3000	

INDEX	Sub-Index	Name	Type	Attribute	Default	Meaning
1600	0	# of entries	UI8	RO	1	Receive PDO Mapping Parameter
	1	Mapping Entry 1	UI32	RO	0x20060108	
1800	0	# of entries	UI8	RO	5	Transmit PDO Communication Parameter
	1	COB ID	UI32	R/W	#NodeID + 0x180	
	2	Transmission Type	UI8	R/W	254	1 … SYNC / 254 … event
	3	Inhibit Time	UI16	R/W	0	
	4	Compatibility Entry	UI8	R/W	-	
	5	Event Timer	UI16	R/W	20	Update rate for TPDO [20ms]
1A00	0	# of entries	UI8	RO	2	
	1	Mapping Entry 1	UI32	R/W	0x20010420	Weight for TPDO
	2	Mapping Entry 2	UI32	R/W	0x23010210	Weight Status

4.4.2 Manufacturer segment tables

INDEX	Sub-Index	Name	Type	Attribute	Default	Meaning
2000	0	# of entries	UI8	RO	3	
	1	Gross Weight	FPS32	RO		Gross Weight
	2	Net Weight	FPS32	RO		Net Weight
	3	Tare Weight	FPS32	RO		Tare Weight
2001	0	# of entries	UI8	RO	5	
	1	Gross Weight	I32	RO		Gross weight
	2	Net Weight	I32	RO		Net Weight
	3	Tare Weight	I32	RO		Tare Weight
	4	Weight for TPDO1	I32	RO		Gross or net weight transmitted in TPDO1
	5	Filtered ADC sample	I32	RO		Filtered ADC value
2004	0	# of entries	UI8	RO	2	
	1	Save Setup	UI8	WO	0	Save general parameters
	2	Save calibration	UI8	WO & P	0	Save calibration parameters
	Note: “Save SetUp” and “Save Calibration” are performed writing a “1” to the appropriate register “Save Calibration” command is only available when calibration seal [2302sub1] is open					
2006	0	# of entries	UI8	RO	1	
	1	Direct command 1	UI8	WO	0	Direct bitwise command
	Direct command 1: Setting a *command bit* to '1' executes the corresponding function.					

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Gross/Net	Load Cell RESET	–	–	–	Zero	Set Tare	Clear Tare

2007	0	# of entries	UI8	RO	2		

	1	CAN baud rate	UI8	R/W	2	Range 0 … 4; 0 = 50kBit, 1= 125kBit, 2= 250kBit, 3= 500kBit, 4=1MBit
	2	CAN Address	UI8	R/W	1	CANopen network address 1 … 127
	These values are saved in EEPROM when a write occurs to index [2004sub1] (Save Setup) and takes effect after next power-on.					

INDEX	Sub-Index	Name	Type	Attribute	Default	Meaning
2100	0	# of entries	UI8	RO	10	
	1	Serial number	UI32	RO	–	Load Cell Serial Number
	2	LC capacity	UI32	RO	–	Load Cell Capacity
	3	SW version	UI32	RO	–	Software version
	4	SW checksum	UI32	RO	–	Software Checksum (CRC-32)
	5	MAX (1), (2)	UI32	R/W & P	–	Maximum scale capacity
	6	DIV (1), (3)	UI32	R/W & P	1	Scale division
	7	FILTER (1)	UI32	R/W & P	6	Filter configuration, see Digital Filter in 2.1
	8	BAND (1), (4)	UI32	R/W & P	1	For weight stability detection (0 … 3)
	9	ZERO TRACK (1), (5)	UI32	R/W & P	1	Zero track range (0 … 6)
	10	ZERO RANGE (1), (6)	UI32	R/W & P	0	Zero setting range (0 … 1)
	11	DP (1), (7)	UI32	R/W & P	0	Decimal Point (0 … 3)
	12	UNIT (1), (8)	UI32	RO	0	Units (0 … 3)

Notes:

(1) These parameters cannot be changed with the calibration seal closed [2301sub1] and are saved in the EEPROM when a write occurs to index [2004sub2].

(2) Maximum scale capacity can't be higher than the load cell capacity

(3) The scale division must be 1, 2, 5, 10, 20, 50, 100, 200 or 500

(4) Stability detection
Stability is reached when the weight doesn't change more than the BAND (in divisions) in 0.5 seconds
Meaning of BAND: 0 → OFF (weight always marked as stable); 1 → 1 division; 2 → 2 divisions; 3 → 3 divisions

(5) Zero Track limits
0 → OFF (function is deactivated); 1 → limit is ± 0,5 divisions; 2 → limit is ± 1 division; 3 → limit is ± 2 divisions; 4 → limit is ± 3 divisions;
5 → limit is ± 4 divisions; 6 → limit is ± 5 divisions

	(6) Zero Setting Range 0 → limit for zero setting is 1,9% of MAX 1 → limit for zero setting is MAX (7) Decimal Point Range 0 → No decimal point; 1 → 0.0; 2 → 0.00; 3 → 0.000; (8) Meaning for Units 0 → g; 1 → kg; 2 → lb; 3 → t Depends on the load cell model and capacity

INDEX	Sub-Index	Name	Type	Attribute	Default	Meaning
2300	0	Number of entries	UI8	RO	3	
	1	Test Weight	I32	R/W		Test weight applicated during gain calibration
	2	Zero parameter	I32	R/W& P		Zero calibration in counts
	3	Gain parameter	I32	R/W& P		Result of gain calibration
	Zero and Gain parameter are the result of the corresponding calibration or by direct write. These parameters saved in EEPROM with [2004sub2] (Save calibration)					
2301	0	Number of entries	UI8	RO	2	
	1	Calibration counter	UI16	RO	–	When reaches 65000 no more calibrations can be performed
	2	Weight Status	UI16	RO	–	See Status in Transmit Process Data Objects (TPDO)4.1.1
	Weight status is included in the TPDO1 in 4.1.1					

INDEX	Sub-Index	Name	Type	Attribute	Default	Meaning
2302	0	Number of entries	UI8	RO	4	
	1	Calibration seal	UI8	R/W	0	State of the calibration seal
	2	Calibration status	UI8	R/W	–	State status
	3	Perform Gain calibration	UI8	WO& P		A test weight [2300sub1] <>0 is required
	4	Perform Zero Calibration	UI8	WO& P	–	

DEFINITION Calibration seal

0 → Calibration seal closed
1 → Calibration seal open
Opening the seal increments automatically the calibration counter.
If the calibration seal is open, the bit 8 of the Weight Status (NOT LEGAL) is set.

DEFINITION Calibration status

0x00	0	→	Idle
0x01	1	→	Zero calibration in progress
0x02	2	→	Zero calibration finished successfully
0x04	4	→	Zero calibration not performed (error)
0x08	8	→	Gain calibration in progress
0x10	16	→	Gain calibration finished successfully
0x20	32	→	Gain calibration not performed (error)
0x40	64	→	Cancel calibration
0x80	128	→	Reset calibration status to idle

DEFINITION Perform GAIN / ZERO calibration

Write “1” in the register starts the calibration

5 Notes

5.1 Firmware Update

The firmware of the load cell can be updated via PC.

For this purpose, we have a PC Software for Windows which allows an easy update of the firmware.

Additionally, a CAN-Bus interface is needed; the provided Bootloader PC program uses the converter “PCAN-USB” from PEAK-Systems (reference IPEH-002021 or the opto-decoupled version IPEH-002022).
You can find more information at: http://www.peak-system.com

5.2 EDS File

For easy configuration of the PLC or any other CANopen Master, the file “190iD.eds” can be provided with all the complete definitions of the CANopen Object directory.

6 Revision history

Revision	Date	SW Version	Changes
00	18/12/20	V1.0000	First revision