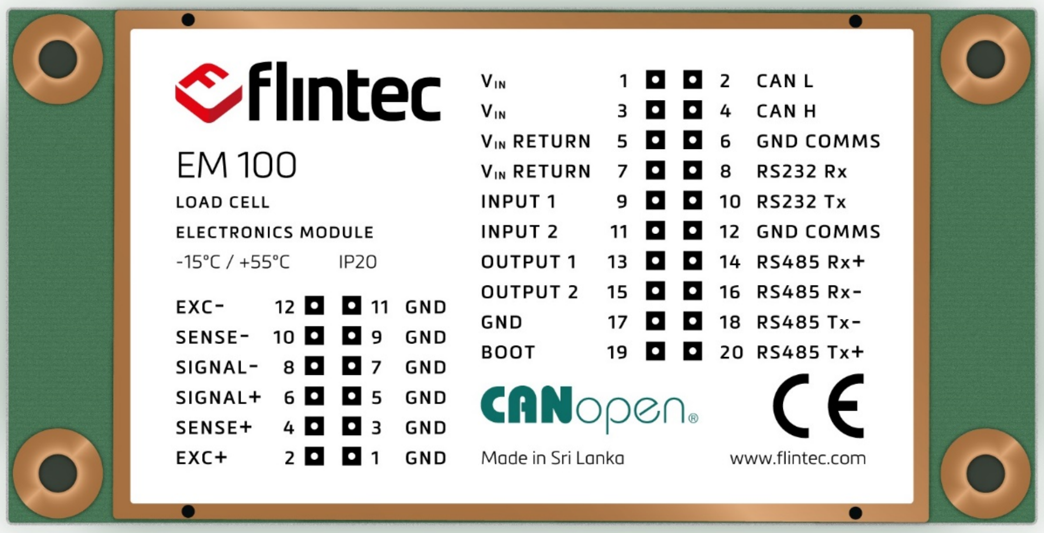
User Manual



EM100-F

v1.5 February 2020

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1. EM100 Module

1.1. Introduction

The Electronics Module, EM100-F, is a precise amplifier with integral 24-bit sigma-delta analogue-to-digital converter for weighing and force measurements with strain gauge sensors. The module includes an extensive selection of standard weighing and calibration functions for accurate static or dynamic weighing applications. Its high-speed measuring rate, advanced filters and optimised software functions are especially useful for gravimetric filling and other dynamic processes.

The EM100-F model is an approved accuracy class III module examined under OIML R61. The measurement module forms part of an approved (‘*legal-for-trade*’) weighing system. The EM100-F can be used in ‘*legal-for-trade*’ and industrial applications.

The device features a CAN interface with support for the CANopen protocol as well as full-duplex RS-232 and RS-485 interfaces. A USB interface has been included for ease of use and is only for configuration, setup and firmware upgrade.

Communication to the module is based on ASCII characters sent to a variety of serial interfaces making it easy to connect to a PC, PLC or other devices. Setup of the module is simple using a terminal emulation program or FDC application software (*available from Flintec.com*).

1.2. Disclaimer

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NOTICE: The contents of this manual are subject to change without notice.

1.3. Safety Instructions

CAUTION: READ this manual BEFORE operating or servicing this equipment. FOLLOW these instructions carefully. SAVE this manual for future reference. DO NOT allow untrained personnel to operate, clean, inspect, maintain, service, or tamper with this equipment. ALWAYS DISCONNECT this equipment from the power source before cleaning or performing maintenance.

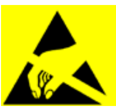
CALL Flintec for parts, information, and service.

WARNING: Only permit qualified personnel to service this equipment. 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.

WARNING: For continued protection against shock hazard connect to properly grounded outlet only. Do not remove the ground prong.

WARNING: Disconnect all power to this unit before removing the fuse or servicing.

WARNING: Before connecting/disconnecting any internal electronic components or interconnecting wiring between electronic equipment always remove power and wait at least thirty (30) seconds before any connections or disconnections are made. Failure to observe these precautions could result in damage to or destruction of the equipment or bodily harm.



CAUTION: Observe precautions for handling electrostatic sensitive devices.

2. Specification

EM100-F	
Application	Bottling/Filling
Bridge Excitation	+5V_{DC}
Load-Cell/Sensor	4-Wire or 6-Wire
Accuracy Class	X(0,2); X(0,5); X(1); X(2)
Weighing Range	Single Interval, Multi-Range or Multi-Interval
Verification Scale Interval	10,000
Minimum Input Sensitivity	0.05µV/Count
Certified Accuracy	0.3µV/vsi
Resolution (External)	±350,000 counts
Minimum Load Cell Impedance	58.3Ω (1x350Ω; 4x350Ω; 4x1100Ω; 6x350Ω)
Maximum Load Cell Impedance	1100Ω
Maximum Analogue Input Range	±15mV Bipolar (±3mV/V @ +5V_{DC} Excitation)
Conversion Rate	75sps to 1200sps (Dependent on Settings)
Communication Protocols	USB CDC (Config & Setup Only)
RS-232 (N-bits, Parity, Stop-bit)	9.6k, 14.4k, 19.2k, 38.4k, 57.6k, 115.2k, 230.4k, & 460.8kbits/s (8-N-1)
RS-485 (Half & Full-Duplex)	9.6k, 14.4k, 19.2k, 38.4k, 57.6k, 115.2k, 230.4k, & 460.8kBits/s
CANopen Data Rate	10k, 20k, 50k, 125k, 250k, 500k, 800k, 1MBit/s
Power Supply	+9.6V_{DC} to +32V_{DC}
Digital Input (30V_{DC}max, >10kΩ Input Impedance)	2
Digital Output (Open-Drain +30V_{DC}max, 300mWmax)	2
Filter Mode	Selectable FIR/IIR Filters
Calibration	Software Calibration & Setup
Weight/Measurement Functions	Zero; Gross; Tare; Net; Filter etc.
Operating Temperature Range	-15°C to +55°C
Storage Temperature	-30°C to +70°C
Regulations/Standards	OIML R-61-1:2006 & EN 45501:2015
Dimensions (L x W x D in mm)	80 x 40 x 16.6mm
DIN Rail Mounting	Optional Adaptor Board Available
IP Protection Rating	IP20

3. Getting Started

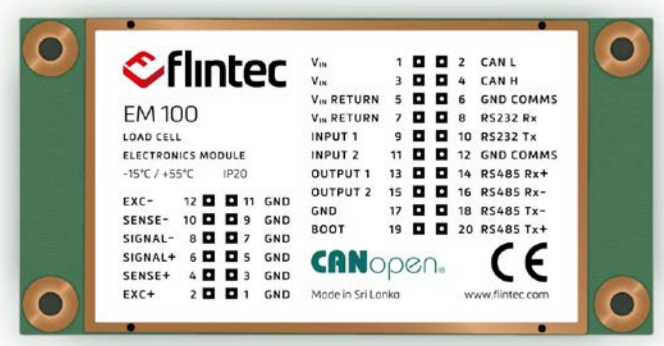
You will require:

- PC or PLC with RS-232, RS-485 or CANopen communication ports.
- Load-cell/scale with test weights or a load-cell simulator.
- +12V$_{DC}$-24V$_{DC}$ power supply capable of delivering approximately 200mA.
- A suitable ASCII communication software e.g. Hyper-Terminal, Putty, TeraTerm etc. or Flintec Device Configuration (FDC) application software. Download the latest copy of FDC from the Flintec website (www.flintec.com).

Note: The Flintec FDC application was developed in-conjunction with the '***Peak System***' USB to CAN adaptor. If using the CANopen interface AND the FDC application, only use the '***Peak System***' adaptor. See website below for more details. For all other interfaces listed above, generic adaptors can be used in accordance with the manufacturer's instructions and drivers.

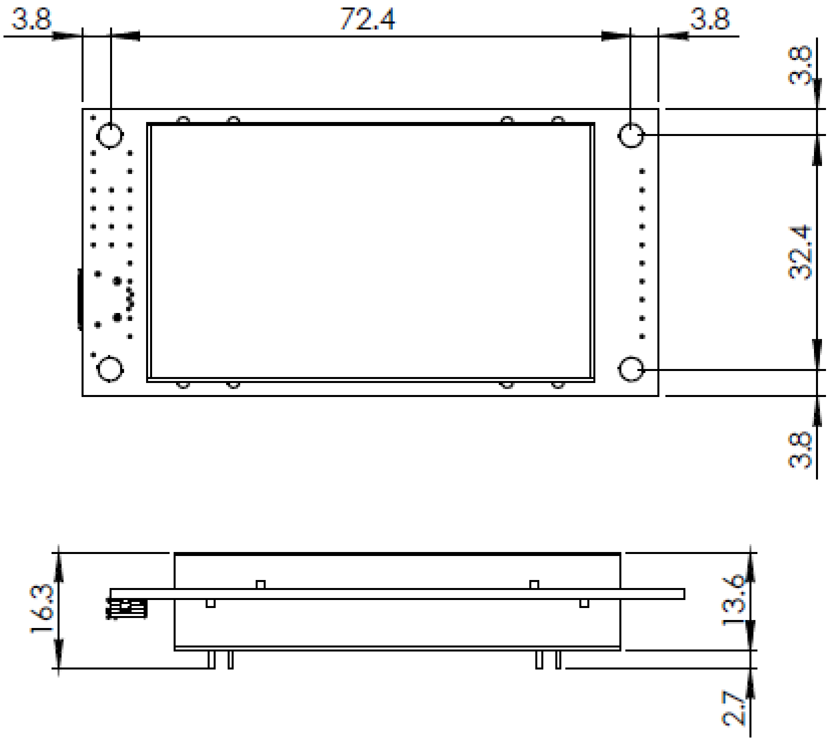
https://www.peak-system.com/PCAN-USB.199.0.html?&L=1

3.1. Labelling

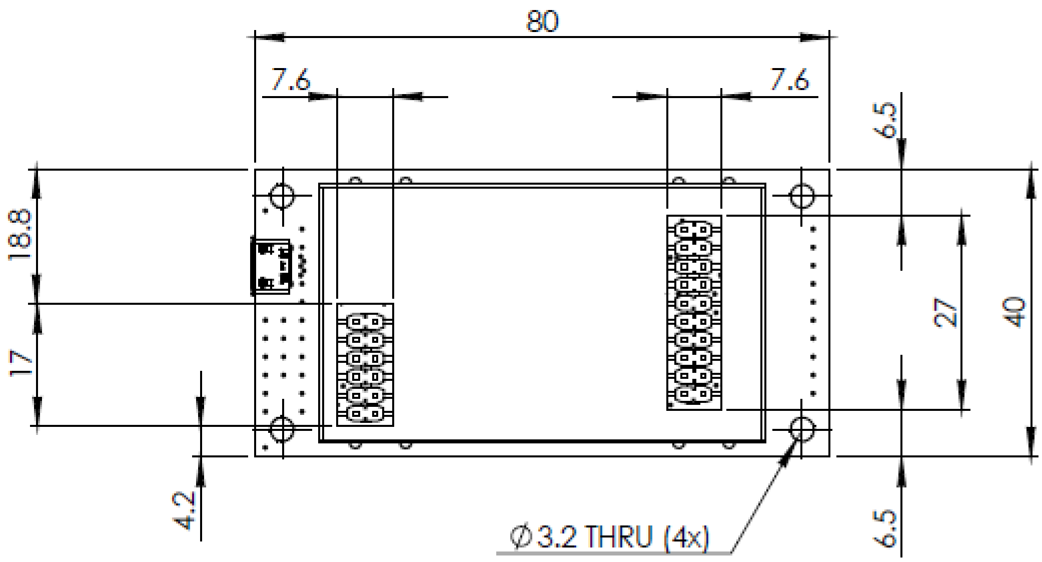


3.2. Dimensions

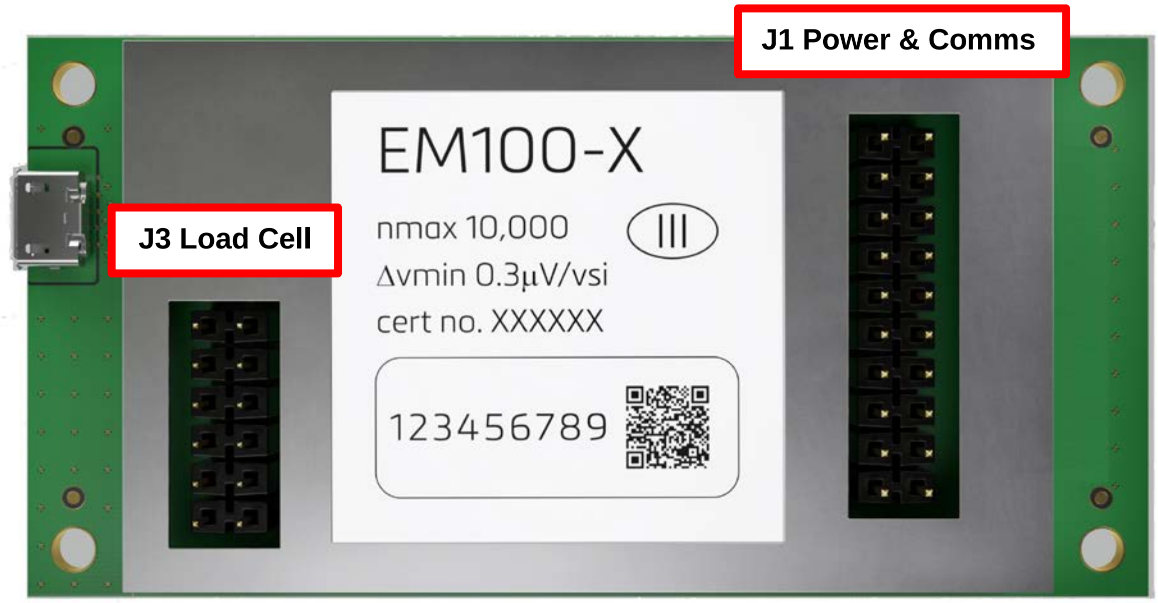
External Dimensions (Top Side)



External Dimensions (Underside)



3.3. Connections



J1 Power & Comms

V_{IN}	1	2	CAN L
V_{IN}	3	4	CAN H
V_{IN} RETURN	5	6	GND COMMS
V_{IN} RETURN	7	8	RS232 Rx
INPUT 1	9	10	RS232 Tx
INPUT 2	11	12	GND COMMS
OUTPUT 1	13	14	RS485 Rx+
OUTPUT 2	15	16	RS485 Rx-
GND	17	18	RS485 Tx-
BOOT	19	20	RS485 Tx+

J3 Load Cell

EXC-	12	11	GND
SENSE-	10	9	GND
SIGNAL-	8	7	GND
SIGNAL+	6	5	GND
SENSE+	4	3	GND
EXC+	2	1	GND

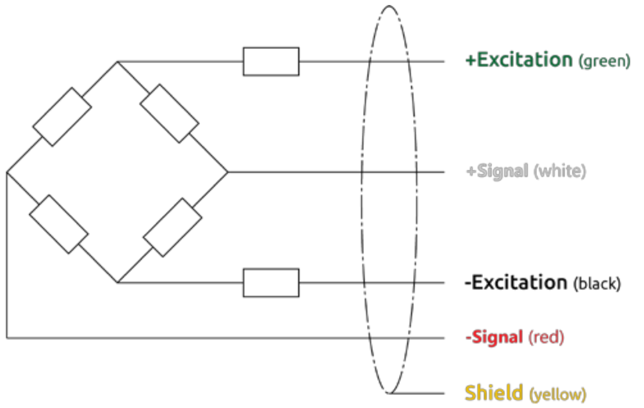
3.3.1. Load-Cell Connections

Connect the input using the colour coding for Load-cell connections:

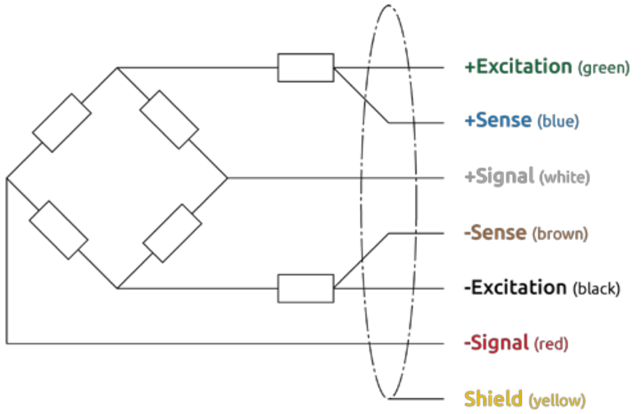
EM100 J3 Load-Cell Pin-Out	Function
2	Excitation+
4	Sense+
6	Signal+
8	Signal-
10	Sense-
12	Excitation-
1, 3, 5, 7, 9 & 11	GND

Note: If using 4-wire configuration, tie the Excitation+ (***EXC+***) to the Sense+ (***S+***) & Excitation- (***EXC-***) to the Sense- (***S-***) for correct configuration.

4-Wire Connection:



6-Wire Connection:



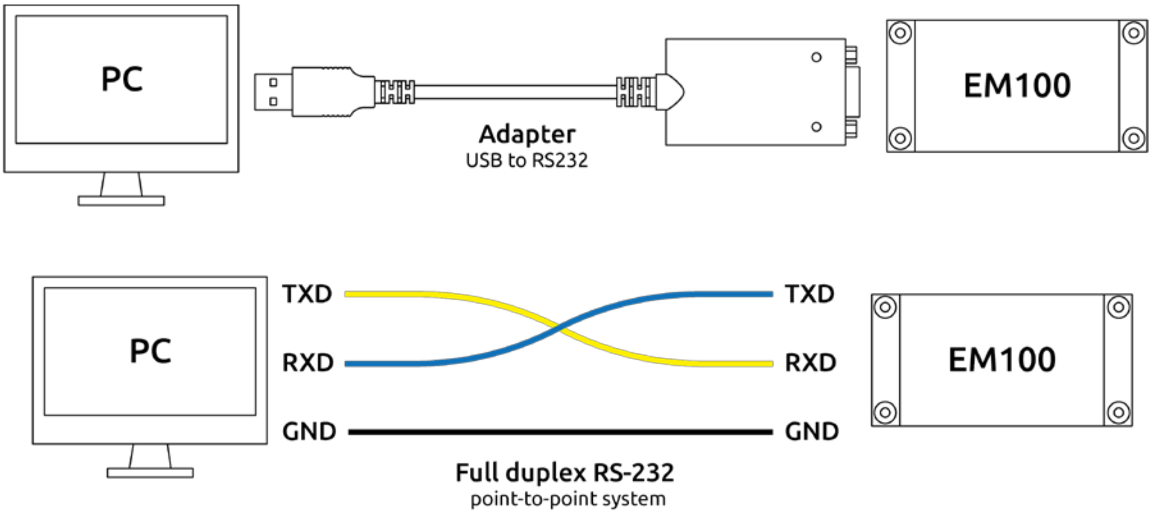
3.3.2. Power Connection

The power supply is designed to accept a +12V_{DC} or +24V_{DC} supply. The power supply ground is not the same potential as the comms or main chassis ground pins. Only use the appropriate power and return pins for the supply, all comms and GPIOs pins to be referenced to the associated comms or main chassis ground.

EM100 J1 Pin Number	Pin Name	Function
1 & 3	Vin	Power Supply Input.
5 & 7	Vin Return	Power Supply Input GND.
17	GND	Main Chassis GND.
6 & 12	GND C	Communications GND.
9	Input 1	GPIO Input.
11	Input 2	GPIO Input.
13	Output 1	GPIO Output (Open-Drain).
15	Output 2	GPIO Output (Open-Drain).
19	Boot	Firmware Upgrade Facility.
2	CAN L	CANopen Differential Pin-.
4	CAN H	CANopen Differential Pin+.
8	RS-232 RX	Serial Port Input.
10	RS-232 TX	Serial Port Output.
14	RS-485 RX+	Differential Rx+ Pin.
16	RS-485 RX-	Differential Rx- Pin.
20	RS-485 TX+	Differential Tx+ Pin.
18	RS-485 TX-	Differential Tx- Pin.

Note: If using the USB port to setup and configure, it should be noted when a power cycle or software reset (see '***SR***' command) is applied, the USB cable may require disconnecting, then reconnecting after powered up.

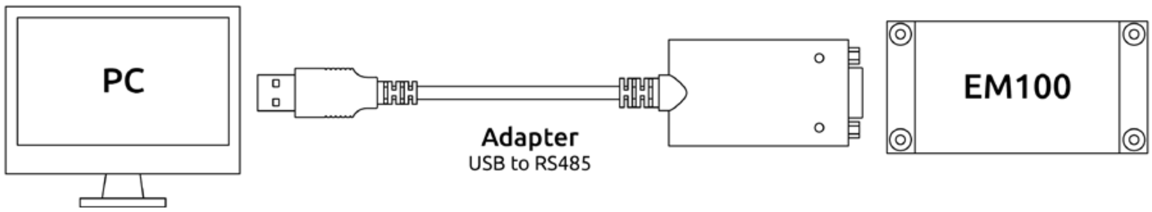
3.3.3. RS-232 Connection

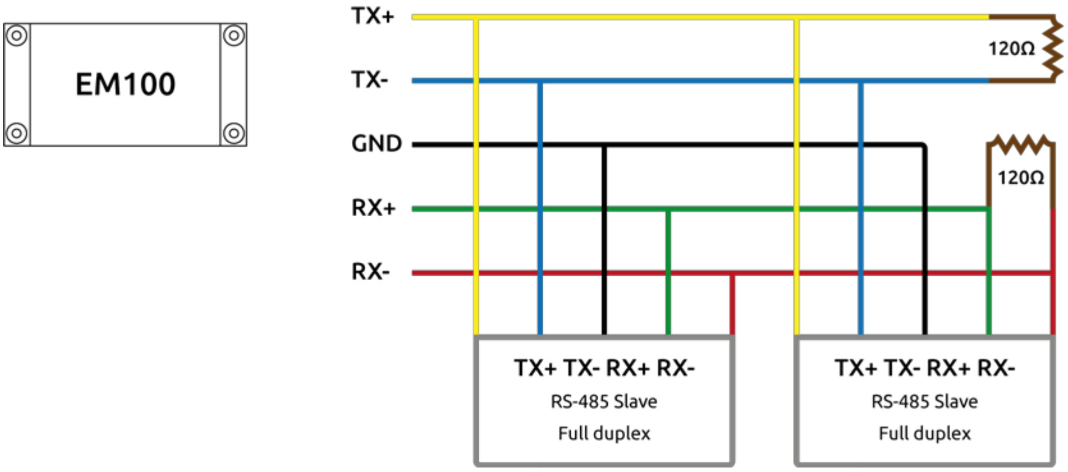


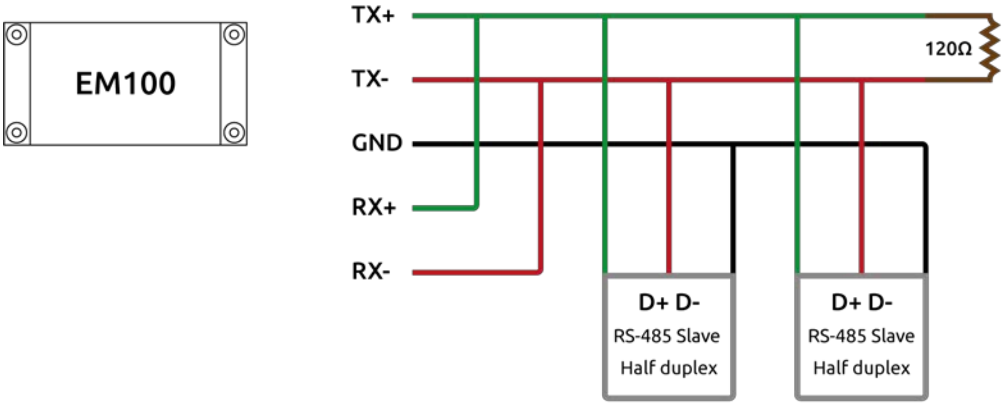
3.3.4. RS-485 Connection

The RS-485 network requires a 120Ω termination resistor at both the host end (EM100) and at the furthest point in the network. The EM100 has a software selectable terminator built-in (see '***STR***' command).

Note: For half-duplex (RS-485) operation tie RS-485 TX+ with RS-485 RX+ and RS-485 TX- with RS-485 RX-.

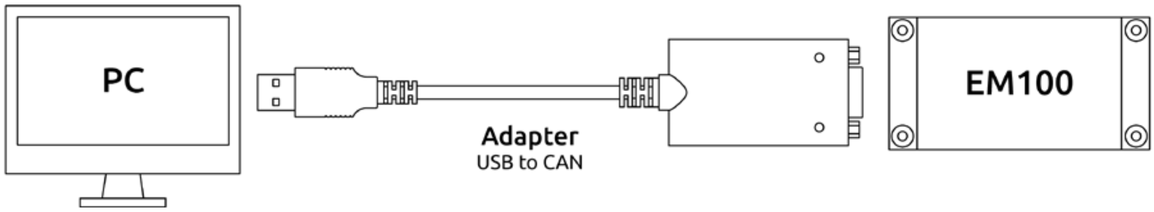


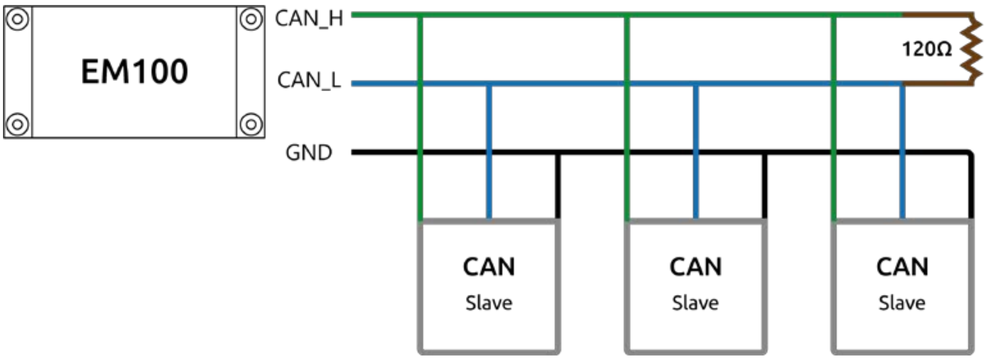




3.3.5. CANopen Connection

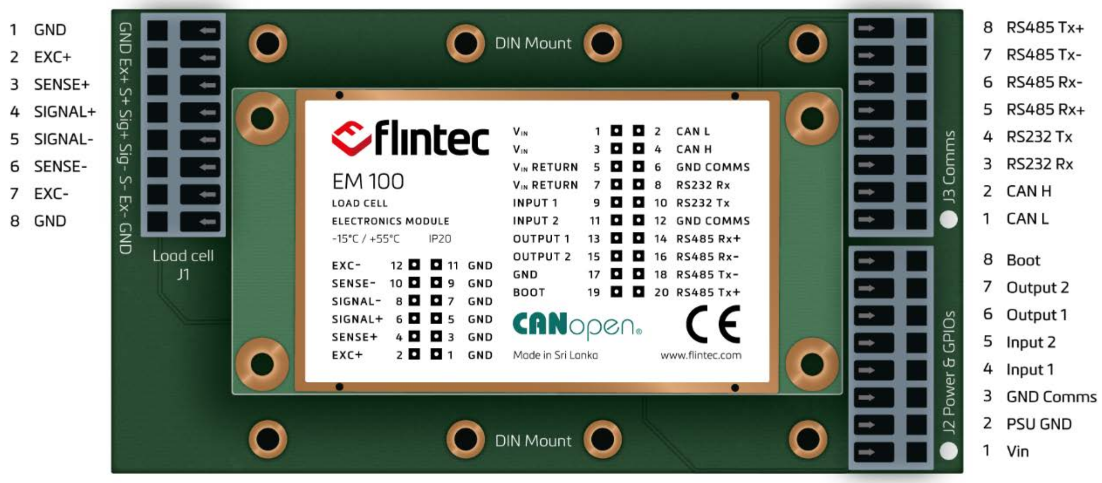
Note: For the CAN network to operate properly, it is necessary to place a 120Ω termination resistor at both the host end (EM100) and at the furthest point in the network. The EM100 has a software selectable terminator built-in (see '***CTR***' command).

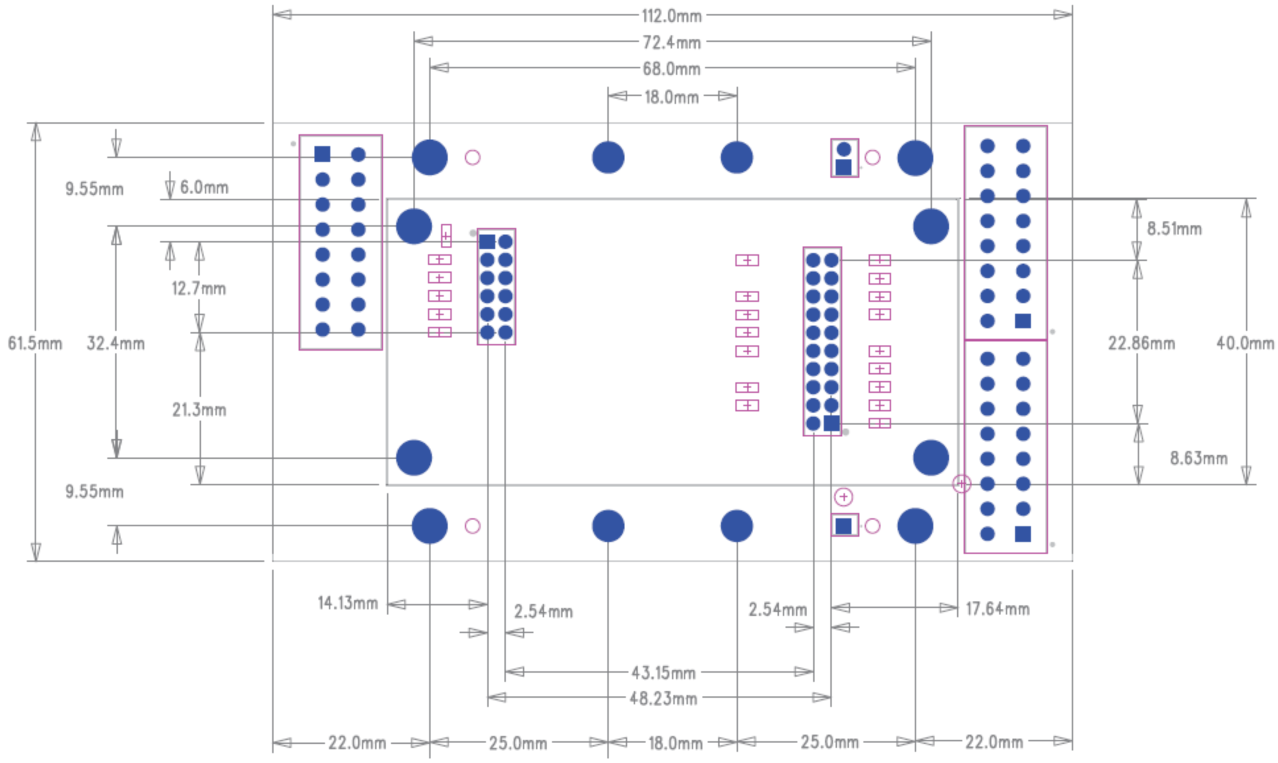




3.3.6. USB Connection

3.3.7. EM100 with Adaptor Board





3.4. Driver Check

During the first session, it may be necessary for the PC to install appropriate drivers. If using a CAN adaptor or USB-to-serial converter, consult the manufacturer for instructions and latest drivers.

If using the USB CDC connection, the following driver from STMicroelectronics will need to be installed. View the ST.com website for the latest revision:

http://www.st.com/en/development-tools/stsw-stm32102.html

An installation manual is available from the Flintec website (www.flintec.com).

3.5. Calibration

3.5.1. Calibration Commands

The calibration of EM100 is only possible after opening a calibration sequence. See '***Calibration Commands***' Chapter for more details on the following commands.

Command **CE**:	Calibration Enable – Returns the current TAC value.
Command **CM1/CM2/CM3**:	Calibrate Maximum Display – Sets the max. allowable display value.
Command **CI**:	Calibrate Minimum – Sets the minimum allowable display value.
Command **MR**:	Multi-Range/Multi-Interval.
Command **DS**:	Display Step Size – Sets the output incremental step size.
Command **DP**:	Decimal Point – Sets the position of the output decimal point.
Command **CZ**:	Calibrate Zero – Sets the system zero-point.
Command **CG**:	Calibrate Gain – Sets the system gain.
Command **ZT**:	Zero Tracking – Enabled/disabled.
Command **IZ**:	If applicable: Correction of System Zero.
Command **TM**:	If applicable: Tare Mode (check if '*legal-for-trade*' application).
Command **ZR**:	If applicable: Zero Range – sets the zero range manually.
Command **ZI**:	If applicable: Initial Zero Range.
Command **WT**:	If applicable: Warm-Up Time.
Command **FD**:	If applicable: Reset to factory default settings.
Command **CS**:	Save Calibration data (TAC automatically incremented by 1).

3.5.2. Preparing for Calibration

- Check the Maximum value of the display is set sufficiently for the application (see '***CM n***').
- Check the Minimum value of the display is set sufficiently for the application (see '***CI***').
- Check the Zero-Tracking has been turned off (see '***ZT***').
- Check the Warm-Up time is not set to a high value (see '***WT***').
- Check the No-Motion window conditions reasonably defined (**Default:** NR=1, NT=1000).

3.5.3. Calibration Sequence

Example: Setup of zero-point, span and decimal point.

The chosen calibration weight has the value 5000 (increments). That could be 500g, 5kg or 5000kg. We calibrate with 500g. The decimal point is set up by command ***DP'x'*** (x=1, 2 or 3), here 1 figure after the decimal point. A measured weight of 500g is displayed as 500.0.

Master Sends	Slave Responds With	Meaning
CE↵	E+00019 (example)	TAC Counter=19.
Adjust Zero: The Scale must be Empty – No Load!		
CE 19↵	OK	Calibration Sequence Active.
CZ↵	OK	System Zero-Point Saved.
Adjust Gain: First put the Calibration Weight on the Scale (here 500g).		
CE 19↵	OK	Calibration Sequence Active.
CG 5000↵	OK	Setting Span.
CG↵	G+005000	Request: Span 5000divisions.
CE 19↵	OK	Calibration Sequence Active.
DP 1↵	OK	Setting Decimal Point 00000.0.
CE 19↵	OK	Calibration Sequence Active.
CS↵	OK	Save Calibration Data.

The zero-point, span and decimal point position were saved into the non-volatile memory; the calibration counter (TAC) will be incremented.

4. Commands Overview

Command	Factory Default	Parameter Range	Description
A'n'	Zero.	0…2dec.	Allocation Source for a Set-Point (Gross, Net or Average).
AC	N/A.	N/A.	Abort Cycle.
AD	Zero.	0…255dec.	Set Device Address (0=perm active).
AG	20000 10000.	±33000dec. (mV/V)	Absolute Gain Calibration.
AZ	Zero.	±33000dec. (mV/V)	Absolute Zero-Point Calibration.
BR	9600.	9600…460800dec.	Baud-Rate.
CE	No Default.	0…65535dec.	Open Calibration Sequence. Read TAC Counter.
CG	20,000.	1…99999dec.	Set Calibration Gain (Span).
CI	-99999.	-99999…0dec.	Minimum Output Value.
CL	No Default.	N/A.	Close Device Communication.
CM1	99999.	1…99999dec.	Set Maximum Output Value (n=1).
CM2	Zero.	0…99999dec.	Set Maximum Output Value (n=2).
CM3	Zero.	0…99999dec.	Set Maximum Output Value (n=3).
CS	No Default.	N/A.	Save Calibration Data.
CTR	Zero.	0…1dec.	CAN Termination Resistor Selector.
CZ	No Default.	N/A.	Set Calibration Zero Point (No-Load).
DI	N/A.	N/A.	Filling Status.
DP	3.	0…6dec.	Set Decimal Point Position.
DS	1.	1, 2, 5, 10, 20, 50, 100, 200, 500dec.	Set Display Step Size.
DX	Zero.	0…1dec.	Set Duplex Mode.
FD	No Default.	N/A.	Restore Factory Default Settings.
FFV	0101.	N/A.	Identify Firmware Version.
FL	3.	0…8dec.	Filter Cut-Off Frequency.
FM	Zero.	0…1dec.	Filter Mode.
FPN	No Default.	N/A.	Get Device ID.
GA	No Default.	N/A.	Get Triggered Average Value.
GD	N/A.	N/A.	Get Last Dosed Weight.
GG	No Default.	N/A.	Get Gross Value.
GH	No Default.	N/A.	Get Hold Weight.
GL	No Default.	N/A.	Get Data String (Average, Gross, Status).
GM	No Default.	N/A.	Get Peak Value.
GMV	No Default.	N/A.	Get mV/V Value.

GN	No Default.	N/A.	Get Net Value.
GO	No Default.	N/A.	Get Peak-to-Peak Value.
GS	No Default.	N/A.	Get ADC Sample.
GT	No Default.	N/A.	Get Tare Value.
GV	No Default.	N/A.	Get Valley Value.
GW	No Default.	N/A.	Get Data String (Net, Gross, Status).
H'n' (H0/H1)	999999dec.	±999999dec.	Hysteresis Set-Points.
HT	Zero.	0…65535dec.	Hold-Time for All Set-Points.
HW	No Default.	N/A.	Hold Weight - Broadcast Message.
IN	No Default.	0000…0011bin.	External Input State.
IO	Zero.	0000…0011bin.	External Output State.
IS	No Default.	N/A.	Get System Status.
IZ	No Default.	N/A.	Correction of System Zero.
MR	Zero.	0…1dec.	Set Multi-Range/Multi-Interval.
MT	Zero.	0…3000dec.	Measuring Time for Averaging (ms).
NA	1.	1…127dec.	CAN Network Address.
NR	1.	0…65535dec.	No-Motion Range.
NS 1	1.	1…127dec.	CAN Network Address (as NA).
NS 2	500.	10, 20, 50, 125, 250, 500, 800, 1000dec.	CAN Network Speed (kBits/sec).
NT	1000.	1…65535dec.	No-Motion Time-Period (ms).
OF	Zero.	0…3dec.	Output Format of Data String GL & GW.
OM	Zero.	0000…0011bin.	External Output Mask.
OP	No Default.	1…255dec.	Open Communications.
PD1	No Default.	0, 1, 2, 3, 4, 8, 12dec.	Pre-Fill Mode.
PD2	No Default.	0…50dec.	In-Flight Correction Value.
PD3	N/A.	0..65535dec.	Average Time Zero Check Load Cell.
PD4	N/A.	0..65535dec.	Delay Time Tare Average Value.
PD5	N/A.	0..65535dec.	Average Time Tare Weight Value.
PD6	N/A.	0..65535dec.	Delay Time After Pre-Filling Value.
PD7	N/A.	0..65535dec.	Blanking Time After Coarse Valve Shuts Off.
PD8	N/A.	0..65535dec.	In-Flight Delay Time After Fine Valve Shuts Off.
PD9	N/A.	0..65535dec.	Dosed Weight Average Time.
PD10	N/A.	0..99999dec.	Zero Tolerance Value.
PD11	N/A.	0..99999dec.	Tare Reference Weight Value.
PD12	N/A.	0..99999dec.	Tare Weight Tolerance Value.
PD13	N/A.	0..99999dec.	Pre-Fill Level 1st Setpoint Value.

PD14	N/A.	0..99999dec.	Fine-Fill Weight Value.
PD15	N/A.	0..99999dec.	Filling Weight Value.
PD16	N/A.	0..99999dec.	In-Flight Weight Value.
PD17	N/A.	0..99999dec.	Pre-Fill Level 2nd Setpoint Value.
PD18	N/A.	0..65535dec.	Filling Timeout Value.
PD19	N/A.	0..65535dec.	Underweight Post-Fill Time Value.
PD20	N/A.	0..99999dec.	Tare Interval Value.
PD21	N/A.	0..65535dec.	Bag Rupture Blanking Value.
RM	N/A.	N/A.	Reset Peak Value.
RMV	No Default.	N/A.	Reset Tare to mV/V.
RS	N/A.	0…99999999dec.	Read Serial Number.
RT	N/A.	N/A.	Reset Tare.
RZ	No Default.	N/A.	Reset Zero Point.
S’n’ (S0/S1)	-999999.	±999999dec.	Set-Point Setups.
SA	N/A.	N/A.	Send Triggered Average Value Continuously.
SBR	Zero.	0…1dec.	RS-485 Biasing Resistor Selector.
SC	N/A.	N/A.	Start Cycle.
SD	Zero.	0…65535dec.	Start Delay.
SDD	N/A.	N/A.	Save Dosing Parameters.
SG	N/A.	N/A.	Send Gross Value Continuously.
SL	N/A.	N/A.	Send Data String (Average, Gross, Status) Continuously.
SMV	No Default.	N/A.	Send mV/V Value Continuously.
SN	N/A.	N/A.	Send Net Value Continuously.
SP	N/A.	0…99999dec.	Preset Tare Value.
SR	N/A.	N/A.	Software Reset.
SS	N/A.	N/A.	Save Set-Point Parameter Values to Non-Volatile Memory.
ST	N/A.	N/A.	Set Tare.
STR	Zero.	0…1dec.	RS-485 Termination Resistor Selector.
SW	N/A.	N/A.	Send Data String (Net, Gross, Status) Continuously.
SX	N/A.	N/A.	Send ADC Sample Continuously.
SZ	N/A.	N/A.	System Zero Value.
TD	20.	0…255dec.	Transmit Delay (ms).
TE	Zero.	0…1dec.	Trigger Edge.
TH	No Default.	N/A.	Trigger Hold Value.
TL	999999.	0…999999dec.	Trigger Level Value.
TM	Zero.	0…3dec.	Tare Mode.
TMV	No Default.	N/A.	Apply Tare to mV/V.

TN	Zero.	0…1dec.	Set/Clear Non-Volatile Tare.
TR	No Default.	N/A.	Software Trigger.
UR	Zero.	0…7dec.	Output Averaging Update Rate.
WP	N/A.	N/A.	Save Setup Data to Non-Volatile Memory.
WT	Zero.	0…65535dec.	Warm-Up Time (secs).
ZI	Zero.	0…999999dec.	Initial Zero Range.
ZN	Zero.	0…1dec.	Set/Clear Non-Volatile Zero.
ZR	Zero.	0…999999dec.	Manually Set Zero Range.
ZT	Zero.	0…255dec.	Enable/Disable Zero Tracking.

5. Command Descriptions

5.1. System Diagnostic Commands – FPN, FFV, IS, SR, RS

Use these commands to get the model type, firmware version or device status. These commands are sent without parameters.

5.1.1. FPN Get Device Identity

Master Sends	Slave Responds With
FPN↵	P:EM100-F.

The response to this request giving the identity of the device. This is particularly useful when trying to identify different model types on the same bus.

5.1.2. FFV Get Firmware Version

Master Sends	Slave Responds With
FFV↵	V:01.00 (example).

The response to this request gives the firmware version of the device.

5.1.3. IS Get Device Status

Master Sends	Slave Responds With
IS↵	S:067000 (example).

The response to this request comprises of two 3-digit decimal values (067 and 000), which can be decoded according to the table below:

Leftmost 3-digit Value	Rightmost 3-digit Value
1 Signal Stable (No Motion).	1 (Not Used).
2 Zeroing Action Performed.	2 (Not Used).
4 Tare Active.	4 (Not Used).
8 Centre Zero.	8 (Not Used).
16 Input 1.	16 (Not Used).
32 Input 2.	32 (Not Used).
64 Output 1 Active (Set-Point).	64 (Not Used).
128 Output 2 Active (Set-Point).	128 (Not Used).

- The example decodes the result **S:067000** as follows:
- Signal Stable (no motion) [=1].
- Zero Action Performed [=2].
- Tare Not Active [=0].
- Weight <> 0 [=0].
- Input 1 Not Active [=0].
- Input 2 Not Active [=0].
- Output 1 Active [=64].
- Output 2 Not Active [=0].

5.1.4. SR Software Reset

Master Sends	Slave Responds With
SR↵	OK.

This command will respond with '***OK***' and after maximum 400ms performs a complete reset. It has the same functionality as power cycle (OFF → ON). Any calibration, setup or setpoint changes must be preserved using the '***CS***', '***WP***' or '***SS***' commands.

5.1.5. RS Read Serial Number

Master Sends	Slave Responds With	Meaning
RS↵	S+12345678	Request: SN=12345678.

Issuing the '***RS***' command will return the serial number in the format S+12345678.

5.2. Calibration Commands – CE, CM'n', CI, MR, DS, DP, CZ, CG, ZT, FD, IZ, ZR, ZI, TM, TN, ZN, AG, AZ, WT

Note: All changes to the calibration commands must be stored in non-volatile memory using the '***CS***' command.

5.2.1. CE Read TAC Counter/Open Calibration Sequence

With this command, you can read the TAC counter (Traceable Access Code) or you can open a calibration sequence.

Master Sends	Slave Responds With	Meaning
CE↵	E+00011 (example)	TAC Counter=11.
CE 11↵	OK	Calibration Sequence Active.

This command must be issued **PRIOR** to any attempt to set the parameters in the calibration group of commands. In '*legal-for-trade*' applications the TAC counter can be used to check if critical parameters have been changed without re-verification. After each calibration save ('***CS***') the TAC counter increases by 1.

5.2.2. CM 'n' Set Maximum Output Value

This command ('***CM n***' with n=1, 2 or 3) is used to set up the maximum output value (respective the switching point in multi range applications). Permitted values are from 0 to 99999.

Master Sends	Slave Responds With	Meaning
CM 1↵	M+030000	Request: CM 1=30000dec.
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
CM 1 50000↵	OK	Setup: C<1=50000dec.

This value will determine the point at which the output will change to '***oooooooo***', signifying over-range respective the point at which the output will change the measuring range/interval size.

Application	CM 1=Max 1	CM 2=Max 2	CM 3=Max 3
Single Range	CM 1=1…99999	CM 2=0 (means CM 2 Not used)	CM 3=0 (means CM 3 Not used)
Dual Range or Dual Interval	CM 1=1…MAX 1	CM 2=MAX 1…99999	CM 3=0 (means CM 3 Not used)
Triple Range or Triple Interval	CM 1=1…MAX 1	CM 2=MAX1…MAX2	CM 3=MAX2…99999

It is necessary: 1 ≤ MAX1 < MAX2 < MAX3 ≤ 99999.

Note: The range, in which a scale can be set to zero (‘***SZ***’) or automatic zero-tracking (‘***ZT***’) is active, is ±2% of CM value.

Factory Default: CM 1=99999, CM 2=0, CM 3=0.

5.2.3. CI Set Minimum Output Value

This command is used to set up the minimum output value. Permitted values are –99999 to 0. This value will determine the point at which the output will change to ‘***uuuuuuuu***’, signifying ‘*under-range*’ condition.

Master Sends	Slave Responds With	Meaning
CI↵	I+000009	Request: CI=-9dec.
CE↵	E+00011 (example)	Request: TAC Counter CE11
CE11↵	OK	Calibration Sequence Active
CI-10000↵	OK	Setup: CI=-10,000dec.

Note: In bipolar applications (e.g. force- or torque measurements) this parameter defines the max. output value for input signals with negative sign.

Factory Default: –99999.

5.2.4. MR Set Multi-Range/Multi-interval

This command is only relevant, if CM 2 > 0 or CM 3 > 0. Is this the case, then this command defines, if the application is multi-range or multi-interval. Permitted values are 0 (Multi-interval) or 1 (Multi-range).

Master Sends	Slave Responds With	Meaning
MR↵	M:00000	Request: MR=0 (Multi-Interval).
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
MR 1↵	OK	Setup: MR=1 (Multi-Range).

Note: Single range applications ignore this parameter.

Factory Default: 0 [Single Range].

5.2.5. DS Set Display Step Size

This command allows the output to step up or down by a unit other than 1. Permitted values are 1, 2, 5, 10, 20, 50, 100, 200 and 500.

Master Sends	Slave Responds With	Meaning
DS↵	S+00000	Request: Step Size 2.
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
DS 50↵	OK	Setup: Step Size=50.

'*Legal-for-trade*' applications allow for up to 10,000 intervals. The allowed step size must be considered.

Factory Default: 1.

5.2.6. DP Set Decimal Point Position

This command allows the decimal point to be positioned anywhere between left-most and right-most digits of the 5-digit output result. Permitted values are 0, 1, 2, 3, 4 and 5. Position 0 means no decimal point.

Master Sends	Slave Responds With	Meaning
DP↵	P+00003	Request: Position of Decimal Point.
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
DP 0↵	OK	Setup: No Decimal Point.

Factory default: 3.

5.2.7. CZ Set Calibration Zero Point

This is the reference point for all weight calculations and is subject to TAC control.

Master Sends	Slave Responds With	Meaning
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
CZ↵	OK	Setup: Zero Point.

Factory Default: Approx. 0mV/V input signal.

5.2.8. CG Set Calibration Gain (Span)

This is the reference point for calibration under load and is subject to TAC control.

Permitted values are from 1 to 99999.

Master Sends	Slave Responds With	Meaning
CG↵	G+10000	Request: Calibration Weight=10,000dec.
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
CG 15000↵	OK	Setup: Calibration Weight=15,000dec.

For calibrating an input signal near the display maximum (‘***CM***’) will give the best system performance. The minimum calibration load of at least 20% is recommended. If the calibration weight smaller than 1% of display maximum (‘***CM***’), the EM100 will respond with an error message (‘***ERR***’).

Factory Default: 20,000=2.000mV/V input signal.

5.2.9. ZT Enable/Disable Zero-Tracking

This command enables or disables the zero-tracking. ZT=0 disables the zero-tracking and ZT=1 or higher enables the zero-tracking. Issuing the command without any parameter returns the current ‘***ZT***’ value.

Permitted values are 0 to 255.

Master Sends	Slave Responds With	Meaning
ZT↵	Z:001	Request: ZT Status.
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
ZT 0↵	OK	Setup: ZT=Disable.

Zero-tracking will be performed only on results less than ‘***ZT***’ range at a rate of 0.4 d/sec, where d=display step size (see ‘***DS***’ command). The zero can only be tracked to ±2% of maximum (see ‘***CM n***’ command).

ZT=1 means ±0.5d.

ZT=100 means ±50d.

Factory Default: 0 [Disabled].

5.2.10. FD Reset to Factory Default Settings

This command puts the EM100 back to a known state. The data will be written to non-volatile memory and the TAC will be incremented by 1.

Master Sends	Slave Responds With	Meaning
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
FD↵	OK	Factory Default Settings.

Note: All calibration and setup information will be lost by issuing this command! The Baud-rate will revert to 9600Baud after a factory reset (a hardware or software reset is necessary to initiate the changes).

5.2.11. IZ Correction of System Zero

This command can correct the system zero after a successful calibration, e.g. to correct the unknown weight of a mounting accessory which was used to hold the calibration weight during the calibration procedure. A simple parallel shift of the gain curve the sensitivity of the scale will stay unaffected.

Master Sends	Slave Responds With	Meaning
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
IZ↵	OK	System Zero Corrected.

5.2.12. ZR Zero Range

Sets the zero range manually – this is the range in increments within which the weighing scale can be zeroed. Issuing the '**ZR**' command without any parameter will return the current value. Permitted values are between the lower limit of 0 (= factory default setting) and the upper limit of 999999. A value of zero enables the standard zero range of +/-2% of max.

Master Sends	Slave Responds With	Meaning
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
ZR 100↵	OK	Setup: Zero Range=100dec.

5.2.13. ZI Initial Zero Range

Define the initial zero range (0...999999 d). If '***ZI***' is non-zero the device will perform an automatic Set-Zero when the weight stabilizes with the No-Motion settings and the weight is within the '***ZI***' range.

Master Sends	Slave Responds With	Meaning
CE↲	E+00011 (example)	Request: TAC Counter CE11.
CE 11↲	OK	Calibration Sequence Active.
ZI 100↲	OK	Setup: Initial Zero Range=100dec.

Factory Default: 0.

5.2.14. TM Tare Mode

This command sets the tare mode. The tare modes are defined in the table below.

Master Sends	Slave Responds With	Meaning
CE↲	E+00011 (example)	Request: TAC Counter CE11.
CE 11↲	OK	Calibration Sequence Active.
TM 1↲	OK	Setup: Tare Mode=1.

TM	Allow Tare of Negative Values	Clear Preset Tare at Return to Range 1
0 (Default)	Yes	Yes
1	No	Yes
2	Yes	No
3	No	No

For OIML R76 compatible applications a tare mode of 1 must be used.

Factory Default: 0.

5.2.15. TN Set/Clear Non-Volatile Tare

This command sets the tare mode to volatile or non-volatile. Value range is 0 or 1; Factory default is 0 (volatile). If set to 1 (Non-Volatile), every set/clear tare will write the value directly to non-volatile memory.

Master Sends	Slave Responds With	Meaning
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
TN↵	T:000	Actual Setting: TN=Volatile.
TN 1↵	OK	Setup: TN=Non-Volatile.

Note: Any changes made by the automatic taring function will not be written to non-volatile memory).

Factory Default: 0 [Volatile].

5.2.16. ZN Set/Clear Non-Volatile Zero

This command sets the zero mode to volatile or non-volatile. Value range is 0 or 1; Factory default is 0 (Volatile). If set to 1 (Non-Volatile), every set/clear zero will write the value directly to non-volatile memory.

Master Sends	Slave Responds With	Meaning
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
ZN↵	Z:000	Actual Setting: ZN=Volatile.
ZN 1↵	OK	Setup: ZN=Non-Volatile.

Factory Default: 0 [Volatile].

5.2.17. AZ Absolute Zero Point Calibration (eCal)

The command '***AZ***' is used as reference point for all weight calculations and will setup in mV/V.

Permitted values are ±33000 (±3.3000mV/V).

Master Sends	Slave Responds With	Meaning
AZ↵	Z+000796	Request: Zero Point @ 0.0796mV/V.
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
AZ 00500↵	OK	New: Zero Point @ 0.0500mV/V.

Factory Default: 000000dec. @ 0.0000mV/V input signal.

5.2.18. AG Absolute Gain Calibration (eCal)

The command '***AG***' is used as absolute gain (or measuring range) for all weight calculations and will setup in mV/V. Permitted values are ±33000 (±3.3000mV/V).

Master Sends	Slave Responds With	Meaning
AG↵	G+001868+01000	Request: AG Status.
CE↵	E+00011 (example)	Request: TAC Counter CE11.
CE 11↵	OK	Calibration Sequence Active.
AG 11200 5000↵	OK	New: Gain 5000dec. @ 1.12mV/V.

Factory Default: 10,000d @ 2.0000mV/V input signal.

5.2.19. WT Warm-Up Time

Sets the warm-up time – this command defines a time interval between 0 and 65535secs after power on where the output value will be set to '***uuuuuuuu***' to avoid false readings during the initial stabilisation period.

Master Sends	Slave Responds With	Meaning
WT↵	W+00000	Request: Warm-Up Time=0sec.
CE↵	E+00011 (example)	Request: TAC Counter CE 11.
CE 11↵	OK	Calibration Sequence Active.
WT 20↵	OK	Setup: Warm-Up Time=20sec.
CE 11↵	OK	Calibration Sequence Active.
CS↵	OK	Calibration Values Saved.

Factory Default: 0 [0secs].

5.3. Motion Detection Commands – NR, NT

The motion detection facility provides a means of disabling certain functions whenever a condition of instability, or '*motion*', is detected. The '*no-motion*' or '*stable*' condition is achieved whenever the signal is steady for the time-period set by '***NT***', during which it cannot fluctuate by more than '***NR***' increments. The '*stable*' condition activates the relevant bit in the System Status ('***IS***') result.

Following functions are disabled if motion is detected: Calibrate Zero '***CZ***' Calibrate Gain '***CG***' Set Zero '***SZ***' and Set Tare '***ST***'. After such a command, the system returns an error '***ERR***', if the signal is not '*stable*'.

5.3.1. NR Set No-Motion Range

This is the range within which the weighing signal can fluctuate and still be considered as '*stable*'. Permitted values are from 0 to 65535.

Master Sends	Slave Responds With	Meaning
NR↲	R+000010	Request: NR=10dec.
NR 2↲	OK	Setup: NR=2dec.
WP↲	OK	Setup Saved.

Example: For NR=2 the fluctuations within a maximum of ±2d, in the period '***NT***', will be considered '*stable*'.
Factory Default: 1 [±1divisions].

5.3.2. NT Set No-Motion Time

This is the time-period (in milliseconds) over which the weight signal is checked to be '*stable*' or not. The weight signal must vary less than '***NR***' divisions over the time-period '***NT***' to be considered '*stable*'.

Permitted values are from 0 to 65535ms.

Master Sends	Slave Responds With	Meaning
NT↲	T+001000	Request: NT=1000ms.
NT 500↲	OK	Setup: NT=500ms.
WP↲	OK	Setup Saved.

If the value of '***NT***'=500ms, the output must not fluctuate more than '***NR***' increments within 500ms to be considered '*stable*'.

Factory Default: 1000 [1000ms].

5.4. Filter Setting Commands – FM, FL, UR

FIR or IIR Filters (selected with '***FM***' command) are provided to eliminate most unwanted disturbances. The command '***FL***' is used to define the filter settings, whilst the command '***UR***' is used to define an averaging of up to 128 measurement values. Please note that these filters are applied immediately after the A/D converter and therefore affect all aspects of the weighing operation.

5.4.1. FM Filter Mode

This command defines the filter mode. Choose the filter mode for your application.

Permitted values are '***0***' for IIR filter and '***1***' for FIR filter.

Master Sends	Slave Responds With	Meaning
FM↵	M:00000	Request: FM=0 (IIR Filter).
FM 1↵	OK	Setup: FM=1 (FIR Filter).
WP↵	OK	Setup Saved.

The IIR filter operates as 2nd order low pass filter with Butterworth characteristics. The attenuation is 40dB/decade (12 dB/octave). The digital FIR filter works as a low-pass filter with quick response (see Mode Characteristics tables).

Factory Default: 0 [IIR filter].

5.4.2. FL Filter setting

This command defines the -3dB filter cut-off frequency.

Master Sends	Slave Responds With	Meaning
FL↵	F:00006	Request: FL=6 (1Hz IIR).
FL 1↵	OK	Setup: FL=1.
WP↵	OK	Setup Saved.

The permitted settings are from 0 to 8 (see Mode Characteristics tables).

Factory Default: 3 [Filter 3].

Mode 0 (IIR Filter) Settings/Characteristics

‘FL’ Setting	Settling Time ms (0.1%)	Cut-Off Frequency (Hz)	Attenuation at 200Hz (dB)	Output Sampling Rate (samples/sec)*
0	No Filtering	-	-	1200
1	60	18	>50	600
2	135	8	>65	600
3	290	4	>75	600
4	385	3	>80	600
5	580	2	>85	600
6	1160	1	>100	600
7	2350	0.5	>110	600
8	4500	0.25	>120	600

Mode 1 (FIR Filter) Settings/Characteristics

‘FL’ Setting	Settling Time ms (0.1%)	-3dB Cut-Off Frequency (Hz)	Damping Frequency at -20dB (Hz)	Damping Frequency at -40dB (Hz)	Stopband Attenuation (dB)	Output Sampling Rate (samples/sec)*
0	14	18	127	164	>100	1200
1	60	19.7	53.1	65.9	>100	600
2	120	9.8	26.6	32.9	>100	300
3	180	6.5	17.3	21.4	>100	200
4	248	4.9	13.2	16.5	>100	150
5	300	3.9	10.6	13.2	>100	120
6	360	3.2	8.6	10.7	>100	100
7	450	2.8	7.3	9.1	>100	85.75
8	480	2.5	6.6	8.2	>100	75

*Output Rate = Value/2^{UR} samples/sec.

5.4.3. UR Update Rate & Averaging

Depending on the selected filter mode this command defines an averaging for the output value. The permitted settings are from 0 to 7 (see table below). The average value is always calculated from 2^{UR} measurement values.

Master Sends	Slave Responds With	Meaning
UR↵	U:00003	Request: Averaging of 8 Values.
UR 7↵	OK	Setup: Averaging of 128 Values.
WP↵	OK	Setup Saved.

UR	0	1	2	3	4	5	6	7
Average of 2^{UR} Values	1	2	4	8	16	32	64	128

Factory Default: 0 [No Averaging].

5.5. Taring & Zeroing Commands – SZ, RZ, ST, RT, SP, TMV, RMV

The following commands allow you to set/reset the zero and tare values. The zero set up during calibration remains the '*true zero*' but the new '*current zero*' can be set up by using the '***SZ***' command. If the '***SZ***' command is issued and accepted, all weight values will then be based on the new '*current zero*'. The zero value will be subject to the zero-tracking function if enabled. If the weight signal is not '*stable*' (as defined by the No-Motion range '***NR***' and the No-Motion time '***NT***') then both the set zero '***SZ***' and set tare '***ST***' commands will be disabled. Also, the Set Zero '***SZ***' command is not allowed if the new zero value required and the '*calibration zero*' differ by more than 2% of the '***CM***' value (maximum allowable value).

5.5.1. SZ Set System Zero

This command sets a new '*current zero*' which is then the basis of all weight values until further updated by the zero-tracking function, another '***SZ***' command or the '*reset zero*' command '***RZ***'.

Master Sends	Slave Responds With	Meaning
SZ↵	OK	Set Zero Performed.

The '***SZ***' command will fail (responding with '***ERR***') if the new '*current zero*' is more than 2% (of the '***CM***' value) higher or lower than the '*true zero*' set during calibration. The '***SZ***' command will also fail if the weight signal is not '*stable*' as defined by the no-motion range ('***NR***') and the no-motion time ('***NT***'). If the weight signal is '*stable*', the response to the Device Status command ('***IS***') will show the '*signal stable*' bit active and the '***SZ***' command will be accepted ('***OK***'). If the '*signal stable*' bit is not active, the '***SZ***' command will be rejected and the EM100 will respond with '***ERR***'.

5.5.2. RZ Reset Zero

This command cancels the SZ command and the zero reading reverts to that set by the '**CZ**' command during calibration.

Master Sends	Slave Responds With	Meaning
RZ↵	OK	Zero Point CZ Active.

The EM100 responds to the '***RZ***' command with either '***OK***'. If '***OK***' is returned, the '*zero action performed*' bit in the Device Status ('***IS***') response will be set to '***0***'.

5.5.3. ST Set Tare

This command will activate the net weighing function by storing the current weight value as a tare value. The weight signal must be '*stable*' within the limits set by '***NR***' (No-Motion Range) and '***NT***' (No-Motion Time) commands for the '*signal stable*' bit to be active and set tare command to be accepted.

Master Sends	Slave Responds With	Meaning
ST↵	OK	Tare Performed/Net Operation.

If the weight signal is '*stable*', the response to the Device Status command ('***IS***') will show the '*signal stable*' bit active and the '***ST***' command will be accepted ('***OK***'). If the 'signal stable' bit is not active, the '***ST***' command will be rejected and the EM100 will respond with '***ERR***'.

5.5.4. RT Reset Tare

This command resets the tare and the weighing signal returns to gross mode.

Master Sends	Slave Responds With	Meaning
RT↵	OK	Tare De-Activated/Gross Performed.

The EM100 responds to the '***RT***' command with either '***OK***' or '***ERR***'. If OK is returned, the '*tare active*' bit in the Device Status ('***IS***') response will be set to '***0***'.

5.5.5. SP Set Preset Tare

This command sets a tare value.

Master Sends	Slave Responds With	Meaning
SP↵	T+000000	Tare Value.
SP 1000↵	OK	Setup Tare Value 1000dec.

Factory Default: 0.

5.5.6. TMV Set Tare (mV/V)

This command will activate the mV/V net function (only for mV/V output) by storing the current value as a tare value. The weight signal must be '*stable*' within the limits set by '***NR***' (No-Motion Range) and '***NT***' (No-Motion Time) commands for the '*signal stable*' bit to be active and set mV/V tare command to be accepted. This does not modify the '*tare active*' bit in the Device Status ('***IS***') as this is only weight.

Master Sends	Slave Responds With	Meaning
TMV↵	OK	Tare Performed/Net Operation.

5.5.7. RMV Reset Tare (mV/V)

This command resets the mV/V tare and the value returns to gross mode.

Master Sends	Slave Responds With	Meaning
RMV↵	OK	Tare De-Activated/Gross Performed.

5.6. Output Commands – GG, GN, GT, GS, GMV, GW, GA, GL, OF, GH, TH, GM, RM, GO, GV, HW

Note: Several output commands refer to commands, timing plots or other related information can be found in future sections e.g. *5.12 Trigger Section*.

5.6.1. GG Get Gross Value

Master Sends	Slave Responds With	Meaning
GG↵	G+001.100	Gross Value: 1100dec.

5.6.2. GN Get Net Value

Master Sends	Slave Responds With	Meaning
GN↵	N+001.000	Net Value: 1000dec.

5.6.3. GT Get Tare Value

Master Sends	Slave Responds With	Meaning
GT↵	T+000.100	Tare Value: 100dec.

5.6.4. GS Get ADC Sample Value

This command retrieves the analogue to digital Converter (ADC) value. This can be useful during development or when calibrating to see how much of the ADC range is being used.

Master Sends	Slave Responds With	Meaning
GS↵	S+01257850	ADC Value: 01257850dec.

For service purposes, it may be helpful to note the '***GS***' values for the '*no-load*' or '*zero*' output and when the '*calibration load*' is applied.

5.6.5. GMV Get mV/V Value

Master Sends	Slave Responds With	Meaning
GMV↵	M+12345	mV/V Value: 1.2345mV/V.

5.6.6. GW Get Data String (Net, Gross & Status)

Issuing the '***GW***' command, which has no parameters, will return the net weight, the gross weight, the status and the checksum values, all combined into one single string in the format:

W+000100+001100010F

The first two sections of the return string comprise the net weight and gross weight results, followed by two hexadecimal characters, which represent two bit-mapped status indicators. The last two hexadecimal characters represent the checksum, which is the inverse of the sum of all the ASCII values of the string, not including the checksum characters.

W	+000100	+001100	0	1	0F
Leading Character signifies the GW	Net Weight excluding decimal point.	Gross Weight excluding decimal point.	First Status Nibble	Second Status Nibble	Checksum

STATUS	Value=1	Value=2	Value=4	Value=8
Status Bit-1	Not Used	Not Used	Output 1 Active	Output 2 Active
Status Bit-2	Signal Stable	Set Zero Performed	Tare Active	Not Used

The check sum is the complement value of the sum of all ASCII values within the data string without the check sum itself.

Master Sends	Slave Responds With	Meaning
GW↵	W+000100+0011005109 (example)	Net Value: +000100dec. (no decimal point) Gross Value: +001100dec. (no decimal point) Status bit 1: 5hex. (Not Used). Status bit 2: 1hex. Checksum: 09hex.

5.6.7. GA Get Triggered Average Value

This command reads the measurement result of a measurement cycle. The measurement value has been averaged according the defined measuring time.

Master Sends	Slave Responds With	Meaning
GA↲	A+001.100	Request: 1100g.

Note: For preventing errors during the read out of the data, the register '***GA***' has stored the value 999999 at the beginning of the measurement cycle. The measurement result can only be read after the defined measuring time '***MT***' has been elapsed and before a new measurement cycle has been started.

5.6.8. GL Get Data String (Average, Gross & Status)

Master Sends	Slave Responds With	Meaning
GL↲	L+00100+001005109 (example).	Average Value: +000100dec. (no decimal point). Gross Value: +001100dec. (no decimal point) Status bit 1: 5 (Not Used). Status bit 2: 1hex. Checksum: 09hex.

For check sum, status bit 1 and status bit 2, see command '***GW***' (chapter 5.6.5).

5.6.9. OF Output Format for Data String GW & GL

This command puts the range information and/or the decimal point into the '*long*' data string of the '***GW***' and '***GL***' output responses.

Master Sends	Slave Responds With	Meaning
CE↲	E:00012 (example)	Request: TAC Counter CE12.
CE 12↲	OK	Calibration Sequence Active.
OF 1↲	OK	Setup: OF=1

Note: Changes to this command must be saved using the '***CS***' command. This command also adds/removes the range field (decimal point is unaffected) for Get Gross '***GG***' and Get Net '***GN***' commands.

Output Format

Parameter Setting	Range Information	Decimal Point in GW & GL Response
0 (Factory Default)	No	No
1	Yes	No
2	No	Yes
3	Yes	Yes

E.g. when the range information is selected, the data strings will change from G+000000 to Gn+000000, where 1 ≤ n ≤ 3.

5.6.10. GH Get Hold Value

Issuing the '***GH***' command without parameters will return the current hold weight in the format N+000100 from the currently addressed EM100. All other channels must be requested one-by-one.

Master Sends	Slave Responds With	Meaning
OP 1↵	OK	Open Device #1.
GH↵	N+01.100	Hold Weight Value: 1100dec.

5.6.11. TH Trigger Hold Value

Saves the weight value of the last '***GH***' reading (not a broadcast message).

Master Sends	Slave Responds With	Meaning
TH↵	OK	Save actual weight value.

5.6.12. GM Get Peak Value

The peak value is the maximum value since the last Reset Peak '***RM***' command was issued.

Master Sends	Slave Responds With	Meaning
GM↵	M+051.100	Peak Value: 51100dec.

5.6.13. RM Reset Peak Value

Resets the peak value.

Master Sends	Slave Responds With	Meaning
RM↵	OK	Reset Peak Value.

5.6.14. GO Get Peak-to-Peak Value

The peak-to-peak value is the difference between the peak value and the valley value.

Master Sends	Slave Responds With	Meaning
GO↵	O+091.100	Peak-to-Peak Value: 91100dec.

5.6.15. GV Get Valley Value

The valley value is the minimum value since the last Reset Peak ‘***RM***’ command was issued.

Master Sends	Slave Responds With	Meaning
GV↵	V+000.100	Valley Value: 100dec.

5.6.16. HW Hold Weight

Issuing the ‘***HW***’ command without parameters (broadcast command) will latch the current net weight in a register for later readout in all EM100s in a common network regardless of their individual addresses.

Master Sends	Slave Responds With	Meaning
HW↵	No Response	Hold Weight Value in Register.

Note: EM100 will not respond to the broadcast command ‘***HW***’.

5.7. Auto–Transmit Commands – SG, SN, SX, SMV, SA, SL, SW

The following commands allow the gross weight or net weight values to be continuously sent. Continuous transmission starts as soon as the relevant command has been issued and finishes when any valid command (The new command is executed by the EM100). The continuous transmission will also stop when an invalid command is received responding with '***ERR***'.

5.7.1. SG Send Gross Value Continuously

Master Sends	Slave Responds With	Meaning
SG↵	G+001.100	Gross Value: 1100dec.

5.7.2. SN Send Net Value Continuously

Master Sends	Slave Responds With	Meaning
SN↵	N+001.000	Net Value: 1000dec.

5.7.3. SX Send ADC Sample Value Continuously

Master Sends	Slave Responds With	Meaning
SX↵	S+01257850	ADC Sample Value: 01257850dec.

5.7.4. SMV Send mV/V Sample Value Continuously

Master Sends	Slave Responds With	Meaning
SMV↵	M+12345	mV/V Value: 1.2345mV/V

5.7.5. SA Send Triggered Average Value Continuously

This command will start to auto-transmit measurement value of the current trigger cycle. Unlike other auto-transmit commands, this command signals the start of a triggered cycle by sending the value -999999 and once a full measurement period has elapsed the calculated average will be transmitted and the '***TL***' value has been reached.

Master Sends	Slave Responds With	Meaning
SA↵	OK	Auto-Transmit: Started Trigger Average.
SA↵	-999999	Auto-Transmit: Trigger Period Not Elapsed.
SA↵	A+123456	Auto-Transmit: Averaged Value Ready and Trigger Level Reached.

5.7.6. SL Send Data String Continuously (Average, Gross & Status)

Master Sends	Slave Responds With	Meaning
SL↵	L+00100+001005109 (example).	Average Value: +000100dec. (no decimal point). Gross Value: +001100dec. (no decimal point). Status bit 1: 5 (Not Used). Status bit 2: 1hex. Checksum: 09hex.

For check sum, status bit 1 and status bit 2 see command '***SW***' (chapter 5.7.6).

5.7.7. SW Send Data String Continuously (Net, Gross & Status)

Issuing the '***SW***' command, which has no parameters, will return continuously the net weight, the gross weight, the status and the checksum values, all combined into one single string in the format:

W+000100+001100010F

For more detailed information of the data string see command '***GW***' (*chapter 5.6.5*).

Master Sends	Slave Responds With	Meaning
SW↵	W+000100+0011005109 (example).	Net Value: +000100dec. (no decimal point). Gross Value: +001100dec. (no decimal point). Status bit 1: 5hex (Not Used). Status bit 2: 1hex. Checksum: 09hex.

STATUS	Value=1	Value=2	Value=4	Value=8
Status Bit-1	Not Used.	Not Used.	Output 1 Active.	Output 2 Active.
Status Bit-2	Signal Stable.	Set Zero Performed.	Tare Active.	Not Used.

The checksum is the reciprocal value of the sum of all ASCII values within the data string without the check sum itself.

5.8. Commands for External I/O Control – IN, OM, IO

5.8.1. IN Read Status of Logic Inputs

Master Sends	Slave Responds With	Meaning
IN↵	IN:0000	Input 1 & 2 Low.
IN↵	IN:0001	Input 1 High, Input 2 Low.
IN↵	IN:0010	Input 1 Low, Input 2 High.

The status response is in the form of a 4-digit code where 0=false and 1=true (inputs are active '*high*'). The least significant bit corresponds to Input 1.

5.8.2. OM Control of Logic Outputs by Host Application

The logic outputs can be controlled by the host application (as opposed to the normal internal set-points). They are enabled by the '***OM***' command (or '***IM***') and the appropriate 4-digit code. When '***OM***' is set to zero, the user controlled logical outputs are disabled defaulting back to operation with set-points.

Master Sends	Slave Responds With	Meaning
OM↵	OM:0000	Output Disabled. Refer to Set-Point Status.
OM↵	OM:0001	Setting Output 1 Enabled.
OM↵	OM:0011	Setting Output 1 & 2 Enabled.

A logic **'*1*'** bit in the code enables the corresponding logic output to be controlled by the host application using the '***IO***' command (or '***IM***'). A logic **'*0*'** in the code leaves the corresponding logic output controlled by the internal set-point. Output 1 is the least significant bit.

Master Sends	Slave Responds With	Meaning
OM 0001↵	OK	Enable Output 1.
OM 0011↵	OK	Enable Outputs 1 & 2.

5.8.3. IO Read/Modify Status of Logic Outputs

This command reads and can modify the status of the logic outputs (if enabled by the '***OM***' command). The status response is in the form of a 4-digit code where 0=false and 1=true (outputs are normally open, open-drain MOSFETs), the least significant bit corresponds to Output 1.

Master Sends	Slave Responds With	Meaning
IO↵	IO:0001	Output 1 Set.
IO↵	IO:0010	Output 2 Set.

The status of the outputs can be changed by issuing the '***IO***' command with the appropriate 4-digit code e.g. IO 0001. The status of the logic outputs is normally determined by the internal set-points or manually setting the '***IO***' and '***OM***' (or '***IM***') output mask.

Master Sends	Slave Responds With	Meaning
IO 10↵	OK	Set Output 1 Set.
IO 11↵	OK	Set Outputs 1& 2 Set.

5.9. Set-Point Output Commands – S'n', H'n', A'n', HT

Each logic output can be assigned to an independent set-point value (***S'n'***) with a corresponding hysteresis/switch action (***H'n'***) and allocation (***A'n'*** – source is the Gross, Net or Average weight).

Note: All changes to the set-point commands must be stored in non-volatile memory using the '***SS***' command.

5.9.1. S'n' Set-Point Value

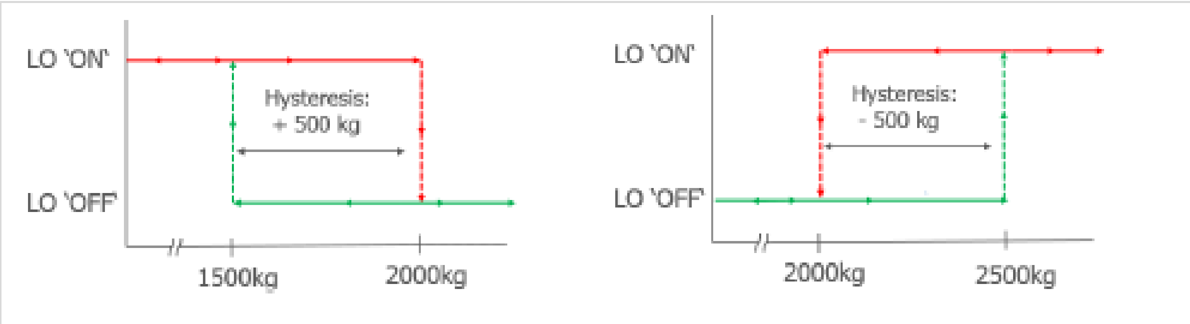
A set-point is the trigger level that causes action of the output channel, according to the settings of the controls ***A'n'*** and ***H'n'***.

Master Sends	Slave Responds With	Meaning
S0↵	S0:+010000	Request: Set-Point S0=10,000dec.
S0 3000↵	OK	Setup: Set-Point S0=3000dec.
S1↵	S1:+011000	Request: Set-Point S1=11000dec.
S1 5000↵	OK	Setup: Set-Point S1=5000dec.

5.9.2. H'n' Hysteresis & Switching Action for Set-Point

The set-point switching logic is defined by the numeric value **and** polarity of the hysteresis.

Examples of the switching actions for a set-point value of 2,000kg.



Master Sends	Slave Responds With	Meaning
H0↵	H0:+000001	Request: Setup Hysteresis of Set-Point S0.
H0 100↵	OK	Setup: Positive Hysteresis +100dec. for Set-Point S0.
H1↵	H1:+000001	Request: Setup Hysteresis of Set-point S1.
H1 -5000↵	OK	Setup: Negative Hysteresis -5000dec. for Set-Point S1.

Allowed hysteresis values are within the range from –999999 to +999999 at a step size of 1.

5.9.3. A'n' Source Allocation for Set-Point

Set the source for set-point **'*n*'**. This source will trigger the required action of the output channel, according to the settings of the controls ***S'n'*** and ***H'n'***.

Choose the source for the set-point ***'n'***.

0 – Gross Weight

1 – Net Weight

2 - Average Weight

Master Sends	Slave Responds With	Meaning
A0↵	A0:+00000	Request: Setup Net for Set-Point S0.
A0 1↵	OK	Setup: Source Net for Set-Point S0.
A1↵	A1:+00001	Request: Setup Net for Set-Point S1.
A1 1↵	OK	Setup: Source Net for Set-Point S1.

5.9.4. HT Hold-Time for All Set-Points

This command defines the hold-time for the set-point limit. The signal must exceed the set-point limit continuously at least for this time-period before a switch event will be initiated.

Master Sends	Slave Responds With	Meaning
HT↵	T+00000	Request: HT=0ms.
HT 200↵	OK	Setup: HT=200ms.

Note: This setup will affect both set-points.

Permitted value range is 0 to 65535ms.

Factory Default: 0 [0ms].

5.10. Communication Setup Commands – AD, NA, NS, BR, DX, CL, OP, TD, CTR, STR, SBR

Note: All changes to the communications commands must be stored in non-volatile memory using the '***WP***' command.

5.10.1. AD Device Address – Serial Channel

This command can set up the device address in the range from 0 to 255.

Master Sends	Slave Responds With	Meaning
AD↵	A:000	Request: Address 0.
AD 49↵	OK	Setup: Address 49.

Setting the device address to '***0***' will cause the device to be permanently active, listening and responding to every command on the bus without the need for an '***OP***' command.

Note: After editing the address save the changes (using '***WP***' command) first then restart the device.

5.10.2. NA Network Address – CANopen

Master Sends	Slave Responds With	Meaning
NA↵	A:001	Request: Show CANopen Interface Address.
NA 15↵	OK	Setup: Set CANopen Address to 15.

Factory Default: 1.

5.10.3. NS Network Settings – CANopen

The command **NS** [Param] [New Value] can be used to set up the CANopen address and bit rate.

Master Sends	Slave Responds With	Meaning
NS 0↵	D:7814	Request: Show Device Type.
NS 1↵	A:001	CANopen Address is 1.
NS 2↵	B:500	CANopen Address Bit-Rate 500kBits/sec.
NS 2 1000	OK	Set the CANopen Bit-Rate to 1MBits/sec.

Factory Default: NS 1=1, NS 2=500 [NS 1=1 CANopen Address 1; NS 2=500 500kBits/s].

5.10.4. BR Baud-Rate – Serial Channel

The following Baud-rates can be setup: 9600, 14400, 19200, 38400, 57600, 115200, 230400 and 460800Baud. The data-rate will only be active when the new Baud-rate has been saved with the '***WP***' command and a power cycle or software reset '***SR***' applied.

Master Sends	Slave Responds With	Meaning
BR↵	B:9600	Request: 9600Baud.
BR 230400↵	OK	Setup: 230400Baud.

Factory Default: 9600 [9600Baud].

5.10.5. DX Full-Duplex – Serial Channel

Master Sends	Slave Responds With	Meaning
DX↵	X:000	Request: DX=0 (Half-Duplex).
DX 1↵	OK	Setup: DX=1 (Full-Duplex).

Factory Default: 0 [Half-Duplex].

5.10.6. CL Close Device Address 'n'

Master Sends	Slave Responds With	Meaning
CL 3↵	OK	Close Device #3.
CL↵	OK	Close All Connected Devices.

5.10.7. OP Open Device

This command, if sent without parameters, requests the address or device number of the active device on the bus. If sent with parameters, this enables the device defined by the parameters. The requested device acknowledges its readiness and responds to all bus commands until a further '***OP***' command arrives with a different address or a '***CL***' command is received.

Master Sends	Slave Responds With	Meaning
OP↵	O:00003	Request: Device #3 is Open.
OP 14↵	OK	Setup: Open Device #14.

5.10.8. TD Transmission Delay

This command allows equipment attached to the bus to reconfigure to and from receiver and transmitter. Time delays from 0 to 255ms are available before any response from the EM100 is sent. This delay may be necessary in some two wire applications (half-duplex). The delay is only applicable when '***DX***' command is set to zero (half-duplex mode).

It should be noted, using '***TD***' with high delay may cause any command sent during this delay period to be ignored until the delay period has elapsed. If using the auto search feature e.g. FDC application software, this may take some time!

Master Sends	Slave Responds With	Meaning
TD↵	T+00020	Request: Delay Time 20ms.
TD 100↵	OK	Setup: Delay set to 100ms.

Factory Default: 20 [20ms].

5.10.9. CTR Set CAN Bus Termination Resistance

Master Sends	Slave Responds With	Meaning
CTR↵	T:000	Termination Z: Disabled.
CTR 0↵	OK	CAN Bus Termination Z Disabled.
CTR 1↵	OK	CAN Bus Termination Z Active.

Factory Default: 0 [Termination Off].

5.10.10. STR Set RS-485 Termination Resistance

Master Sends	Slave Responds With	Meaning
STR↵	T:000	Termination Resistor: Disabled.
STR 0↵	OK	RS-485 Termination Z Disabled.
STR 1↵	OK	RS-485 Termination Z Active.

Factory Default: 0 [Termination Off].

5.10.11. SBR Set RS-485 Biasing Resistance

Master Sends	Slave Responds With	Meaning
SBR↵	B:000	Biasing Resistors: Disabled.
SBR 0↵	OK	RS-485 Biasing Resistors Disabled.
SBR 1↵	OK	RS-485 Biasing Resistors Active.

Factory Default: 0 [Biasing Off].

5.11. Save Calibration & Setup Data Commands – CS, WP, SS, SDD

The calibration and setup parameters can be divided in 4 groups:

Calibration: '***CE***', '***CM'n***", '***CI***', '***MR***', '***DS***', '***DP***', '***CZ***', '***CG***', '***ZT***', '***FD***', '***IZ***', '***ZR***', '***ZI***', '***TM***', '***TN***', '***ZN***', '***WT***", & '***OF***' saved by command '***CS'***.

Setup: '***FL***', '***FM***', '***UR***', '***NR***', '***NT***', '***AD***', '***NA***', '***NS***', '***BR***', '***DX***', '***TD***', '***CTR***', '***STR***', '***SBR***', '***SD***', '***MT***', '***TE***', '***HT***', '***TR***', '***TL***', saved by command '***WP'***.

Set-Points: ***'S0***', '***S1***', '***H0***', '***H1***', '***A0***', '***A1***' saved by command '***SS'***.

Dosing: '***DI***', '***SC***', '***AC***', '***GD***', '***DT***', ***'DP1-DP21***', '***TR***' saved by command '***SDD'***.

Note: Calibration data can only be saved if the TAC code is known and precedes the '***CS***' command. The setup data and set-point data will be stored in non-volatile memory using the '***WP'***, '***SS***' **&** '***SDD***' commands.

5.11.1. CS Save Calibration Data

This command results in the calibration data being saved causing the TAC to be incremented.

Master Sends	Slave Responds With	Meaning
CE↵	E+00013	Request: TAC Counter CE13.
CE 13↵	OK	Calibration Sequence Active.
CS↵	OK	Calibration Values Saved.

The '***CS***' command saves changes made using '*Calibration*' group commands. The Output Format command '***OF***' is also included. The command returns '***ERR***' unless it is preceded by the '***CE xx***'.

5.11.2. WP Save Setup Parameters

The settings of the following groups, '*Filter*' ('***FL***', '***FM***', '***UR***'), '*No-motion*' ('***NR***', '***NT***'), '*Communications*' ('***AD***', '***NA***', '***NS***', '***BR***', '***DX***', '***TD***', '***CTR***', '***STR***', '***SBR***'), & '*Trigger*' ('***SD***', '***MT***', '***TE***', '***HT***', '***TR***', '***TL***') will be saved in non-volatile memory using the '***WP***' command.

Master Sends	Slave Responds With	Meaning
WP↵	OK	Setup Data Saved.

5.11.3. SS Save Set-Point Parameters

The set-points (***S'n'***), the set-point hysteresis (***H'n'***) and the set-point allocation (***A'n'***) will be saved in non-volatile memory using the '***SS***' command.

Master Sends	Slave Responds With	Meaning
SS↵	OK	Set-Point Parameter Saved.

5.11.4. SDD Save Dosing Setup Parameters

This command will save the ‘*Dosing*’ parameters to non-volatile memory.

Master Sends	Slave Responds With	Meaning
SDD↵	OK	Request: Dosing Parameters Saved.

5.12. Trigger Commands – SD, MT, TE, TR, TL

Note: All changes to the trigger commands must be stored in non-volatile memory using the '***WP***' command.

5.12.1. SD Start Delay Time

This command defines a time delay between the trigger and the start of the measurement.

Setting range: 0ms to 65535ms.

Master Sends	Slave Responds With	Meaning
SD↵	S+00100	Request: SD=100ms.
SD 200↵	OK	Setup: SD=200ms.

Factory Default: 0 [0ms].

5.12.2. MT Measuring Time

This command defines the measuring time for the averaged measurement result.

Setting range: 0ms to 3000ms.

Master Sends	Slave Responds With	Meaning
MT↵	M+00100	Request: MT=100ms.
MT 500↵	OK	Setup: MT=500ms.

Note: The setting MT=0 disables the trigger function and the averaging.

Factory Default: 0 [Trigger Function Disabled].

5.12.3. TE Trigger Edge

This command defines the trigger edge. Allowed settings are '***0***' for falling edge and '***1***' for rising edge. This command can only be used in conjunction with a hardware trigger on the digital input channel 1.

Master Sends	Slave Responds With	Meaning
TE↵	E:001	Request: TE=1 (Rising Edge).
TE 0↵	OK	Setup: TE=0 (Falling Edge).

Factory Default: 0 [Falling Edge].

5.12.4. TR Software Trigger

This command starts a measurement cycle. Its execution can be compared to a hardware trigger on the digital input channel 1.

Master Sends	Slave Responds With	Meaning
TR↵	OK	Trigger Event.

Note: If a measurement cycle is already active, the unit will respond with '***ERR***'.

5.12.5. TL Trigger Level

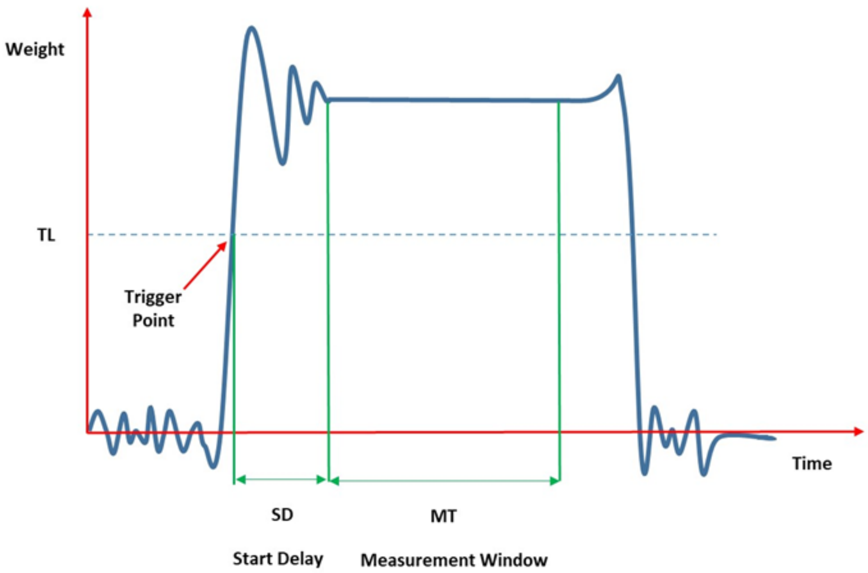
This command defines a level for a rising edge trigger on the measurement signal. Setting range: 0 to 999999.

Master Sends	Slave Responds With	Meaning
TL↵	T+999999	Request: TL=999999.
TL 100↵	OK	Setup: TL=100.

In the example, a new measurement cycle would automatically start, if the signal exceeds 100d (e.g. 100.0g; trigger commands '***SD***' & '***TL***').

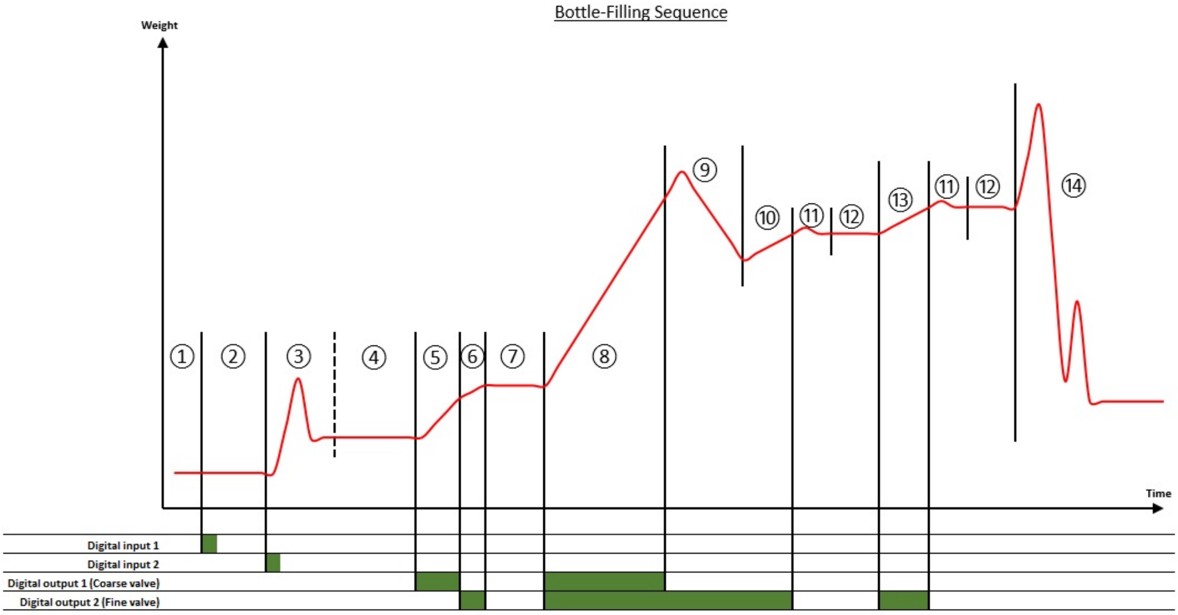
Note: All trigger possibilities are always available in parallel. If a software trigger (command '***TR***') or a hardware trigger (Digital Input 1) will be used the trigger level should be set to its maximum value (TL=999999). This setting disables the trigger level.

Factory Default: 999999.



5.13. Filling Commands – DI, SC, AC, GD, DT, PD1 to PD21, TR

Note: All setups should be stored with the '***SDD'*** command before power-off. The filling process is controlled by the dosing parameters. The parameters are related to the sections shown in the filling cycle.



Phases:

1) Waiting for Start Trigger (Digital Input 1).
2) Zero Check Averaging.
3) Trigger 2 (Digital Input 2 or F/W Trigger) Starts Tare Delay.
4) Tare Weight Averaging.
5) First Pre-fill.
6) Second Pre-fill.
7) Delay after Pre-fill.
8) Coarse Filling.
9) Blanking Time after Coarse Fill.
10) Fine Filling.
11) In-flight Delay.
12) Dosed Weight Averaging.
13) Post-Filling.
14) Bottle Off. Filling Sequence Complete.

The parameters for the filling process are read and set through the 'Read/Modify Dose Parameter' commands. The following commands enable the setup and control of the built-in filling controller program. The program assumes that the coarse filling valve is connected to Output 1 and the fine filling valve is connected to Output 2. A rising edge on Input 1 will initiate the zero-check function of the load cell (load-cell OK) and a rising edge on Input 2 will initiate the filling cycle.

Note: See '***TR***' command for soft triggering.

PD'n' Read/Modify Dosing Parameters

Issuing the '***PD***' command with one parameter (***PD'n'***) will return the value of the n'th parameter in the format **P15:+00500**. Issuing the '***PD***' command with two parameters (**PDn x**) will change the n'th parameter to the value x.

Note: In this version of software all the parameters will be set to zero by the factory default ('***FD***') command.

Filling Process

The filling process is started by a '*Start Cycle*' command from the gateway once the EM100 filling parameters have been loaded. Once started, the filling process can be either waiting for a trigger or be in the process of filling. While waiting for the trigger, the filling cycle can be started by a '*Trigger*' command. If a '*Trigger*' is sent while filling is in progress the EM100 will respond with a 'Not ready' message.

If '***PD5***' is not zero, the EM100 will wait '***PD4***' milliseconds before determining the tare weight by averaging the weight for '***PD5***' milliseconds. If '***PD5***' is zero a tare of zero will be used and no tare phase takes place.

If '***PD1***' is not zero the EM100 will pre-fill in the mode as set by '***PD1***' until the weight reaches '***PD13***', then a second pre-fill takes place until the weight reaches '***PD17***'. Then if '***PD6***' is not zero the EM100 will turn off the valves and wait '***PD6***' milliseconds. Then the EM100 will enter the main filling phase with both valves opened until '***PD14***' & '***PD15***', where the coarse valve will be closed and fine-filling will continue until target weight '***PD15***', where all valves are closed (if the coarse valve has been closed by external command, fine-filling will just continue anyway: the fine fill will just have started somewhat earlier).

After the filling is complete the actual dosed weight is measured by averaging the weight for '***PD9***' milliseconds, and a difference from the actual desired weight is calculated and used to fine-tune the cut-off setting for the fine-fill phase. If '***PD19***' is not zero and the dosed weight is less than the desired filling weight, then the fine filling is resumed for '***PD19***' milliseconds and the new dosed weight is averaged. The post fill step will be repeated until the measured weight is higher than or equal to the desired filling weight. The new weight is not used in the calculation of the in-flight value. The PLC monitors the qualifier field bits (byte 16 – 17, bit 13) and ask for the dosed weight when ready.

The filling cycle can be aborted at any time. The '***AC***' command terminates the filling process completely. After that you must issue a '***SC***' command before you can trigger another filling. Whilst any valves are open the filling rate is monitored according to which valves are open. If a direct command alters the valve state, the monitoring changes its internal control slope according to the new setting. In this way the master PLC may introduce different filling algorithms while still maintaining monitoring of the filling slope.

In the post-fill situation, the EM100 checks the weight increases.

5.13.1. DI Filling Status

Issuing the '***DI***' command will return a result in the format **I:000** (only low byte).

Master Sends	Slave Responds With	Meaning
DI↵	I:000	Request: Status Filling.
DI↵	I:068	Status: Dose Program Running, Tare Out of Range (No Filling).

This result can be decoded according to the table below:

Low Byte Filling Status	High Byte Filling Status
0 Idle.	0 Idle.
1 Coarse Valve Open.	256 Waiting for 2nd Trigger.
2 Fine Valve Open.	512 Bottle On, Calculating Tare.
4 Dose Program Running.	768 Pre-Filling.
8 Not Used.	1024 Main Filling.
16 Not Used.	1280 Fine Filling.
32 Not Used.	1536 In-Flight Delay.
64 Tare Out of Range – No Filling this Cycle.	1792 Post Fill Calculation.
128 Zero Out of Range.	2048 Post Filling.

5.13.2. SC Start Cycle

Issuing the '***SC***' command (has no parameters), will start the filling cycle, i.e. the '*Dose Program Running*' status bit will be set, the program will wait for a trigger pulse on input 0. If the load-cell zero-check function is not required, set '***PD3***' to '**0**'. The system then waits for a trigger pulse on input 1.

5.13.3. AC Abort Cycle

Issuing the '***AC***' command (has no parameters), will abort the filling cycle immediately, i.e. the '*Dose Program Running*' status bit will be reset, the valves will be shut off and the dosing program will stop.

5.13.4. GD Get Last Dosed Weight

Issuing the '***GD***' command, will return the last dosed weight value in the format **D+01.100**.

Master Sends	Slave Responds With	Meaning
GD↵	D+01.100	Request: Dosed Weight 1100 d.

5.13.5. DT Get Last Tare Weight

Issuing the '**DT**' command, will return the last tare weight value recorded by the filling program, in the format **T+00.500**.

Master Sends	Slave Responds With	Meaning
DT↵	T+00.500	Request: Tare Weight 500 d.

5.13.6. PD1 Pre-Fill Mode

Secondary pre-filling model: add to the values of the 1st pre-filling mode.

Master Sends	Slave Responds With	Meaning
PD1↵	P1:+00000	Request: No Pre-Filling.
PD1 2↵	OK	Status: Pre-Filling with fine valve only.

5.13.7. PD2 In-Flight Correction

Correction factor for the in-flight value in percent.

Range: 0-50%.

Master Sends	Slave Responds With	Meaning
PD2↵	P2:+00010	Request: In-Flight Correction=10%.
PD2 25↵	OK	Setup: Set In-Flight Correction to 25%.

5.13.8. PD3 Average Time Zero Check Load-Cell

Time (in ms) during which the load-cell zero check average is calculated.

Range: 0-65535ms.

Master Sends	Slave Responds With	Meaning
PD3↵	P3:+00200	Request: Zero-Check Time=200ms.
PD3 400↵	OK	Setup: Set Zero-Check Time to 400ms.

5.13.9. PD4 Delay Time Tare Average

Delay time (in ms) between the trigger pulse being applied to input 1 and the start of the tare averaging.

Range: 0-65535ms.

Master Sends	Slave Responds With	Meaning
PD4↵	P4:+00200	Request: Delay Time=200ms.
PD4 100↵	OK	Setup: Set Delay Time to 100ms.

5.13.10. PD5 Average Time Tare Weight

This is the time the tare weight average is calculated. This function allows the correct tare value to be acquired despite possible vibrations on a (rotating) filling machine.

Master Sends	Slave Responds With	Meaning
PD5↵	P5:+00300	Request: Tare Average Time=300ms.
PD5 250↵	OK	Setup: Set Tare Average Time to 250ms.

Range: 0-65535ms.

5.13.11. PD6 Delay Time After Pre-Filling

Delay time at the end of pre-filling, after valve(s) shut off.

Range: 0-65535ms.

Master Sends	Slave Responds With	Meaning
PD6↵	P6+00000	Request: Delay Time=0ms.
PD6 250↵	OK	Setup: Set Delay Time to 250ms.

5.13.12. PD7 Blanking Time After Coarse Valve Shut-Off

After the coarse valve shuts off, a weight peak may occur because of a surge or splash of the product being filled.

Master Sends	Slave Responds With	Meaning
PD7↵	P7+00100	Request: Blanking Time=100ms.
PD7 250↵	OK	Setup: Set Blanking Time to 250ms.

Range: 0-65535ms.

5.13.13. PD8 In-Flight Delay After Fine Valve Shut-Off

After the fine valve shuts off, a weight peak may occur because of a surge or splash of the product being filled.

Master Sends	Slave Responds With	Meaning
PD8↵	P8+00100	Request: Delay Time=100ms.
PD8 250↵	OK	Setup: Set Delay Time to 250ms.

Range: 0-65535ms.

5.13.14. PD9 Dosed Weight Average Time

This is the time the filled weight average is calculated. This function allows you to acquire the correct filled weight despite possible vibrations on a (rotating) filling machine.

Master Sends	Slave Responds With	Meaning
PD9↵	P9+00100	Request: Average Time=100ms.
PD9 500↵	OK	Setup: Set Average Time to 500ms.

Range: 0-65535ms.

5.13.15. PD10 Zero Tolerance

Load-cell zero tolerance check (in increments). This is the allowable deviation from the unloaded load cell zero (no bottle or box). If the unloaded load-cell zero is outside this window, the filling process will not start. This function can easily check to see if a load-cell has been over-loaded.

Master Sends	Slave Responds With	Meaning
PD10↵	P10+00100	Request: Load-Cell Zero Check Tol=100d.
PD10 5000↵	OK	Setup: Set Tolerance to 5,000d.

Range: 0…99999 increments.

Example: PD10 5000 means that the zero point of unloaded load-cell must be within the window ±5,000.0g relative to the reference zero [when cal. 1 kg=10,000 increments].

5.13.16. PD11 Tare Reference Weight

Tare reference weight (in increments). This is the nominal weight of the empty bottle/box.

Master Sends	Slave Responds With	Meaning
PD11↵	P11+00400	Request: Tare Reference Weight=400d.
PD11 230↵	OK	Setup: Set Tare Reference Weight=230d.

Range: 0…99999 increments.

5.13.17. PD12 Tare Weight Tolerance

Tare weight tolerance (in increments). This is the allowable deviation of the tare weight (bottle or box). If the tare weight value is outside this window the filling process will not start.

Master Sends	Slave Responds With	Meaning
PD12↵	P12+00020	Request: Tare Weight Tolerance=20d.
PD12 50↵	OK	Setup: Set Tare Weight Tolerance=50d.

Range: 0…99999 increments.

Example: PD12 20 means the deviation of tare weight is 2.0g [when cal. 1kg=10,000 increments].

5.13.18. PD13 Pre-Fill Level 1st Set-Point

Pre-fill level (in increments). This is the weight value required at the end of the 1st pre-filling process.

Master Sends	Slave Responds With	Meaning
PD13↵	P13+00500	Request: Pre-Filling Level=500d.
PD13 750↵	OK	Setup: Set Pre-Filling Level=750d.

Range: 0…99999 increments.

Example: PD13 750 means pre-filling with 75.0g [when cal. 1kg=10.000 increments].

5.13.19. PD14 Fine-Fill Weight

Fine-fill weight (in increments). This is the part of the total filling weight carried out by the fine filling valve.

Master Sends	Slave Responds With	Meaning
PD14↵	P14+00500	Request: Fine-Fill Weight=500d.
PD14 1000↵	OK	Setup: Set Fine-Fill Weight=1000d.

Range: 0…99999 increments.

Example: PD14 1000 means fine-filling with 100.0g [when cal. 1kg=10.000 increments].

5.13.20. PD15 Filling Weight

This is the target filling weight (in increments).

Master Sends	Slave Responds With	Meaning
PD15↵	P15+04000	Request: Filling Weight=4000d.
PD15 500↵	OK	Setup: Set Filling Weight=500d.

Range: 0…99999 increments.

Example: PD15 500 means total filled weight is 500.0g [when cal. 1kg=10,000 increments].

Remark: Coarse filling weight is automatically calculated as the result of:

filling weight minus fine filling weight minus in-flight weight.

5.13.21. PD16 In-Flight Weight

In-flight weight (in increments) is the weight falling into the container after the fine valve shuts off.

Master Sends	Slave Responds With	Meaning
PD16↵	P16+00108	Request: In-Flight Weight=108d.
PD16 200↵	OK	Setup: Set In-Flight Weight=200d.

Range: 0…99999 increments.

Example: PD16 108 means an In-flight weight value of 10.8g [when cal. 1kg=10,000 increments].

Note: Refer to the correction factor '***PD2***', the shut off setpoint for the fine valve will be optimized for the next filling cycle etc.

5.13.22. PD17 Pre-Fill Level – 2nd Set-Point

Pre-fill level (in increments) is the weight acquired at the end of the 2nd pre-filling process.

Master Sends	Slave Responds With	Meaning
PD17↵	P17+00550	Request: Pre-Fill Level=550d.
PD17 750↵	OK	Setup: Set Pre-Fill Level=750d.

Range: 0…99999 increments.

Example: PD17 750 means a secondary pre-fill level of 75.0g [when cal. 1kg=10,000 increments].

5.13.23. PD18 Filling Timeout

The EM100 subtracts the various delays and average times (‘***PD3***’ to ‘***PD9***’) from the timeout period ‘***PD18***’ and uses the ‘remaining’ fill time and fill-weight to calculate a minimum filling slope. If the weight doesn’t stay between this minimum slope and twice the minimum slope the EM100 aborts the filling cycle and reports a filling failure. The filling cycle will also be aborted if the timeout value ‘***PD18***’ expires.

Master Sends	Slave Responds With	Meaning
PD18↵	P18+02000	Request: Timeout=2000ms.
PD18 3000↵	OK	Setup: Set Timeout=3000ms.

Range: 0...65535ms.

Note: If PD18=0, the timeout is disabled.

5.13.24. PD19 Underweight Post-Fill Time

If the averaged dosed value is less than the required weight this parameter controls the post fill time in milliseconds. After post-filling the dosed weight is recalculated. If this parameter is zero no post filling occurs.

Master Sends	Slave Responds With	Meaning
PD19↵	P19+00080	Request: Post-Fill Time=80ms.
PD19 100↵	OK	Setup: Set Post-Fill Time=100ms.

Range: 0...65535ms.

Note: If PD19=0, the post-filling is disabled.

5.13.25. PD20 Tare Interval

In some cases where the object being filled is not a new bottle but a box that is being emptied after each fill, the tare function is not necessary in every filling cycle. When parameter 20 is zero, taring only takes place in the very first filling cycle. When parameter 20 is 1 (one, default) the taring takes place in every filling cycle. Otherwise parameter 20 can be set to the number of filling cycles which must occur before a tare measurement is taken again.

Master Sends	Slave Responds With	Meaning
PD20↵	P20+00001	Request: Tare each Filling Cycle.
PD20 100↵	OK	Setup: Set Tare at Each 100^{th} Filling Cycle.

Example: PD20 100, means next tare after 100 filling processes.

5.13.26. PD21 Bag Rupture Blanking

The control of filling slope is disabled for '***PD21***' milli-seconds from opening the coarse valves to allow oscillation on the weight during the first part of the filling.

Master Sends	Slave Responds With	Meaning
PD21↵	P21+00200	Filling Slope Disabled for 200ms.
PD21 500↵	OK	Setup: Set Filling Slope Disabled for 500ms.

5.13.27. TR Trigger

This command will start the measuring cycle in the same way as the hardware trigger input.

Master Sends	Slave Responds With	Meaning
TR↵	OK	Request: Trigger Started.

Note: This function can be used as a soft trigger to start a filling process.

6. CANopen Interface

6.1. General Interface Specification

Interface	CAN2.0B
Identifiers Used	11-bit Transmit and Receive Identifiers. Tolerates 29-bit Identifiers.
Default Bit-Rate	500kBit/second.
NMT Mode	Slave. On start-up the EM100 waits for an NMT start message or SDO request before transmitting anything (Note: This does not conform exactly to the CIA standard).

EM100 uses both Node Guarding and Heartbeat modes.

Node Guarding

The NMT master polls the network to obtain a data telegram from each node containing its current communication state and a toggle-bit. If a node does not respond to the request of the NMT-master within the '*Node Life-Time*', it is assumed the node has failed. Also, the NMT-slaves monitor whether they have received a request from the NMT-master within their '*Life-Time*'. If it takes longer than the '*Life-Time*' of a node, the NMT-slave assumes that the NMT-master itself has failed and if in an '*Operational*' state, it returns to a '*Pre-Operational*' state.

Guard Time is the time in ms.

Index [100C] and [100D] are used if index [1017] is zero.

Note: Where network bandwidth is limited, or the application is safety sensitive, heartbeat mode, is the preferred method to use node operation assurance.

Heartbeat

The heartbeat parameter is set by the NMT Master or the configuration tool in the EM100 slave node. The interval (in ms) between two heartbeat messages, the '*Heartbeat Interval*' of a heartbeat producer is configured via index [1017]. A value of zero disables the heartbeat mechanism.

Heartbeats save network bandwidth since it does not require the NMT master to poll the slaves. If index [1017] is non-zero the Heartbeat protocol is used, otherwise the Node-Guard protocol is used.

6.1.1. PDOs

Once set to '*Operational State*', the EM100 will produce TPDOs constantly (see table below).

Depending on the data-rate set for the CANopen network, the high number of readings (>1200 per second) can exceed what can be consumed by the NMT master. Equally the update rate may be affected when there are multiple units on the network and/or lower communication speeds used.

The '***UR***' command should be used to balance the network load by reducing the traffic.

PDO Definitions

PDO	Data	When
TPDO1 COB-ID 0x180-	Net/Gross.	Default TPDO at NMT start. Sent every time new reading is ready. Refresh time controlled by '***UR***' parameter.
TPDO2 COB-ID 0x280-	Average Weight ('***GA***') Check-Weigher applications.	1.New measurement ready ('***GA***') 2. Module waiting for trigger.
TPDO3 COB-ID 0x380-	Tare Weight ('***GT***').	When new tare value set ('***GT***').
TPDO4 COB-ID 0x480	Net Reading (mV/V).	Sent every time new reading is ready. Refresh time controlled by '***UR***' parameter. Under-range reading will be indicated as 0x7FFFFFFF and over-range as 0x80000000.
RPDO1 COB-ID 0x200-	Command Select Gross/Net/Set Tare/Clear Tare/Set System Zero/Clear System Zero (All execute silently-no response is sent).	Sent by CAN Master Node.
RPDO2 COB-ID 0x300-	Command Start Measure/Stop Trigger. Check-Weigher mode Set Trigger: Start Filling cycle: Filling mode (All	Sent by CAN Master Node.

	execute silently – no response is sent).	
RPDO3 COB-ID 0x400-	Command Set Tare mV/V. Reset Tare mV/V. Stream Net mV/V. All execute silently – no response is sent. When other streaming (Net or Gross weight) is activated, mV/V is switched off.	Sent by CAN Master Node.
RPDO4	Not used.	

6.1.2. TPDO Frame (TPDO1, TPDO2 & TPDO3)

Sent: CAN Slave Node → CAN Master Node

32-bit	16-bit	8-bit	8-bit
Weight	Status (see table below)	0	0

Status Values	Indication
0x0001	Under Range
0x0002	Over Range
0x0008	Centre Zero
0x0010	No Motion
0x0020	Tare Set
0x0080	ADC Error
0x0100	Set Point 0
0x0200	Set Point 1

6.1.3. TPDO Frame (TPDO4)

Sent: CAN Slave Node → CAN Master Node

32-bit	16-bit	8-bit	8-bit
mV/V Value	Status (see table below).	0	0

Status Values	Indication
N/A	Under Range
N/A	Over Range
N/A	Centre Zero
0x0010	No Motion
N/A	Tare Set
0x0080	ADC Error
N/A	Set Point 0
N/A	Set Point 1

6.1.4. Receive PDOs (RPDO1, RPDO2 & RPDO3)

Sent: CAN Master Node → Slave Node

RPDO1

A PDO1 received by the EM100 will execute a '*single command*' selected by the bit set in the data frame (see below table) e.g. 0x0001 = Reset Zero.

Byte 0	b7	b6	b5	b4	b3	b2	b1	b0
Command								
Decimal								

Byte 1	b15	b14	b13	b12	b11	b10	b9	b8
Command	SG	SN			ST	RT	SZ	RZ
Decimal	128	64			08	04	02	01

RPDO2

A PDO2 received by the EM100 will execute a '*single command*' selected by the bit set in the data frame (see below table) e.g. 0x1000 = Software Trigger.

Byte 0	b7	b6	b5	b4	b3	b2	b1	b0
Command								
Decimal								

Byte 1	b15	b14	b13	b12	b11	b10	b9	b8
Command	TR							
Decimal	128							

RPDO3

A PDO3 received by the EM100 will execute a '*single command*' selected by the bit set in the data frame (see below table) e.g. 0x0001 = Reset mV/V Tare.

Byte 0	b7	b6	b5	b4	b3	b2	b1	b0
Command								
Decimal								

Byte 1	b15	b14	b13	b12	b11	b10	b9	b8
Command		SMV					TMV	RMV
Decimal		64					2	1

Note: When the EM100 receives the RPDO, it executes the command selected by the lowest significant bit set in the data frame (see below table). If more than one bit is set, the others will be ignored.

6.1.5. SDOs

The CANopen SDO is a confirmed service, an over-run does not occur if the CANopen controller only communicates with the EM100 in the ‘Pre-Operational’ state. When an SDO has been received by the controller no further communication takes place until the service has been acknowledged (or a timeout occurs).

SDOs

Are only available on request (see complete Object Directory).

They can be used for the complete setup of the EM100 via the CAN bus master e.g.:

Filter setting: Index 2100, Sub-index 4.

Filter Mode setting: Index 2100, Sub-index 9.

They can be used to get information regarding all the commands available e.g.:

Net Weight: Index 2900, Sub-index 2.

ADC Sample: Index 2900, Sub-index 7.

6.2. Communication Profile

Abbreviations used in tables:

ro	Read Only.
rw	Read/Write.
wo	Write Only.
const	Constant.
UI8	Unsigned Integer 8-bit.
UI16	Unsigned Integer 16-bit.
UI32	Unsigned Integer 32-bit.
REAL32	32-bit IEEE754 Floating Point.
STR	String.
TPDO	Transmit PDO.
RPDO	Receive PDO.
TAC	Traceable Access Code (incremented when saved). Get the current TAC value by reading index 2300,3. Write the same TAC value to this index to enable calibration. When the calibration is saved, the TAC value auto increments by one.

6.2.1. Object Dictionary

The EM100 object directory of the CANopen communication system is described below.

6.2.1.1. Communication Segment

Index	Sub Index	Name	Type	Attribute	Default Value	Description
1000	0	Device Type.	UI32	ro	0.	Non-standard device profile.
1001	0	Error Register.	UI8	ro	0.	Bit 0: Generic Error. Bit 1: Comms Error. Bit 2: Manufacturer Specific Error.
1002	0	Manufacturer Status Register.	UI32	ro	0.	Not Used.
1005	0	COB-ID Sync Message.	UI32	rw	80hex.	COB_ID of the Sync Message.
1006	0	Comms Cycle Period.	UI32	rw	0.	Not Used.
100C	0	Guard Time.	UI16	rw	320dec.	Cycle-Time in ms. Set by NMT master. 100Chex. and 100Dhex. are used if index 1017 is set to zero.

100D	0	Life Time Factor.	UI8	rw	3.	Set by NMT master.
1010	2	Save Comms Segment	UI32	wo	-	Save Comms Parameters.
1014	0	COB_ID Emergency Message.	UI32	ro	80h+NodeID.	COMB_ID of the emergency object.
1017	0	Heartbeat Time.	UI16	rw	0.	Producer heartbeat time in ms. If index 1017hex. is non-zero, heartbeat protocol is used, otherwise Node Guard protocol is used.
1018	0 1 2 3 4	Identity Object. Vendor ID. Product Code. Revision No. Serial No.	UI8 UI32 UI32 UI32 UI32	ro ro ro ro ro	4. 044Ahex. - - -	Identity Object. Vendor ID. Product code. Revision No. Serial No.
1400	0 1 2	No. of Entries. COB-ID of PDO1. Transmission Type.	UI8 UI32 UI8	ro rw rw	2. 200H+NodeID. FEhex.	Comms parameters of RPDO1 Using CANopen Addressing Asynchronous Comms.
1401	0 1 2	No. of Entries. COB-ID of PDO2. Transmission Type.	UI8 UI32 UI8	ro rw rw	2. 300H+NodeID. FEhex.	Comms parameters of RPDO2 Using CANopen Addressing. Asynchronous Comms.
1402	0 1 2	No. of Entries. COB-ID of PDO3. Transmission Type.	UI8 UI32 UI8	ro rw rw	2. 400H+NodeID. FFhex.	Comms parameters of RPDO3 Using CANopen Addressing Asynchronous Comms.
1403	0 1 2	No. of Entries. COB-ID of PDO4. Transmission Type.	UI8 UI32 UI8	ro rw rw	2. 500H+NodeID. FFhex.	Comms parameters of RPDO4 Using CANopen Addressing Asynchronous Comms.
1600	0 1	No. of Entries. Command Byte.	UI8 UI32	ro ro	1. 20060308hex.	Parameter Mapping of RPDO1. Bitwise Mapping.
1601	0 1	No. of Entries. Command Byte.	UI8 UI32	ro ro	1. 20060408hex.	Parameter Mapping of RPDO2. Bitwise Mapping.
1602	0	No. of Entries.	UI8	ro	0.	Parameter Mapping of RPDO3.
1603	0	No. of Entries.	UI8	ro	0.	Parameter Mapping of RPDO4.
1800	0 1 2 3	No. of Entries. COB-ID of PDO. Transmission Type. Inhibit Time.	UI8 UI32 UI8 UI16	ro rw rw rw	3. 180H+NodeID FFhex. 1hex.	Comms Parameters TPDO1.
1801	0 1 2 3	No. of Entries. COB-ID of PDO. Transmission Type. Inhibit Time.	UI8 UI32 UI8 UI16	ro rw rw rw	3. 280H+NodeID. FFhex. 1hex.	Comms Parameters TPDO2.

1802	0 1 2 3	No. of Entries. COB-ID of PDO. Transmission Type. Inhibit Time.	UI8 UI32 UI8 UI16	ro rw rw rw	3. 380H+NodeID. FFhex. 1hex.	Comms Parameters TPDO3.
1803	0 1 2 3	No. of Entries. COB-ID of PDO. Transmission Type. Inhibit Time.	UI8 UI32 UI8 UI16	ro rw rw rw	3. 480H+NodeID. FFhex. 1hex.	Comms Parameters TPDO4.
1A00	0 1 2	No. of Entries Mapped TPDO1. 1st Object. 2nd Object.	UI8 UI32 UI32	ro const const	2. 29000120hex. 29000D20hex.	Mapping Parameters TPDO1. 32-bit IEEE 754 Floating Point Weight Reading. Weight Status.
1A01	0 1 2	No. of Entries Mapped TPDO2. 1st Object. 2nd Object.	UI8 UI32 UI32	ro const const	2. 29000630hex. 29000D20hex.	Mapping Parameters TPDO2. 32-bit IEEE 754 Floating Point Average Reading. Status.
1A02	0 1 2	No. of Entries Mapped TPDO3. 1st Object. 2nd Object.	UI8 UI32 UI32	ro const const	2. 29000320hex. 29000D20hex.	Mapping Parameters TPDO3. 32-bit IEEE 754 Floating Point Tare Reading. Status.
1A03	0	No. Mapped Entries in TPDO4.	UI8	ro	0.	Mapping Parameters TPDO4.

6.2.1.2. Manufacturer Segment

6.2.1.2.1. Save Parameters

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2004	0	No. of Entries.	UI8	ro	5	No. of Entries.
	1	Dummy.	UI8	wo	-	Not Used.
	2	Save Calibration	UI8	wo	0.	Save Calibration Settings (TAC).
	3	Save General.	UI8	wo	0.	Save General Settings.
	4	Save Dosing.	UI8	wo	0.	Save Dosing Settings.
	5	Save Set-Point.	UI8	wo	0.	Save Set-Point Settings.

6.2.1.2.2. Filling Cycle

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2005	0	No. of Entries.	UI8	ro	3	No. System Entries.
	1	Start Command.	UI8	wo	-	Start Cycle.
	2	Stop Command.	UI8	wo	-	Stop Cycle.
	3	Trigger Command.	UI8	wo	-	Trigger Filling.

6.2.1.2.3. Gateway Parameters

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2006	0	No. of Entries.	UI8	ro	4.	No. System Entries.
	1	Dummy.	UI8	wo	-	Not Used.
	2	Set Factory Default.	UI8	wo	0.	Set Factory Defaults (TAC).
	3	Command Byte1.	UI8	wo	0.	See RPDO1.
	4	Command Byte2.	UI8	wo	0.	See RPDO2.

6.2.1.2.4. General Parameters

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2100	0	No. of Entries.	UI8	ro	24.	No. of Entries.
	1	Dummy.	I32	rw	-	Not Used.
	2	Dummy.	I32	rw	-	Not Used.
	3	Dummy.	I32	rw	-	Not Used.
	4	Filter Setting.	I32	rw	3.	Filter Setting.
	5	Dummy.	I32	rw	-	Not Used.
	6	Logic Outputs.	I32	rw	0.	Digital Outputs.
	7	Logic Inputs.	I32	ro	0.	Digital Inputs.
	8	Measure Time.	I32	rw	0.	Measuring Time.
	9	Filter Mode.	I32	rw	0.	Filter Mode.
	10	No-Motion Range.	I32	rw	1.	No Motion Range.
	11	No-Motion Time.	I32	rw	1000.	No Motion Time.
	12	Output Mask.	I32	rw	0.	Digital Outputs Mask.
	13	Dummy.	I32	rw	-	Not Used.
	14	Start Delay.	I32	rw	0.	Start Delay.
	15	Dummy.	I32	rw	-	Not Used.
	16	Dummy.	I32	rw	-	Not Used.
	17	Update Rate.	I32	rw	0.	Update Rate.
	18	Zero Tracking.	I32	rw	0.	Zero Track (TAC).
	19	Dummy.	I32	rw	-	Not Used.
	20	Dummy.	I32	rw	-	Not Used.
	21	Dummy.	I32	rw	-	Not Used.
	22	Reserved.	I32	rw	1.	Do Not Change.
	23	Preset Tare.	I32	rw	0.	Preset Tare.
	24	Warm-Up Time.	UI16	rw	0.	Transmit Readings Only When Time Elapsed.

6.2.1.2.5. Bottle Filling Mode Parameters

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2200	0	No. of Entries.	UI8	ro	21.	No. of Entries.
	1	Pre-Fill Mode.	I32	rw	0.	Pre-Fill Mode.
	2	In-Flight Correction.	I32	rw	0.	In-Flight Correction.
	3	Time Zero Check.	I32	rw	0.	Average Time Zero Check.
	4	Time Delay Tare.	I32	rw	0.	Delay Time Tare Average.
	5	Tare Time Weight.	I32	rw	0.	Average Time Tare Weight.
	6	Delay Time Pre-fill.	I32	rw	0.	Delay Time After Pre-Filling.
	7	Blanking Time After Coarse Valve OFF.	I32	rw	0.	Blanking Time After Coarse Valve Shuts Off.
	8	In-Flight Delay After Fine OFF.	I32	rw	0.	In-Flight Delay Time After Fine Valve Shuts Off.
	9	Dosed Weight Time	I32	rw	0.	Dosed Weight Average Time.
	10	Zero Tolerance.	I32	rw	0.	Zero Tolerance.
	11	Tare Ref Weight.	I32	rw	0.	Tare Reference Weight.
	12	Tare Weight Tol.	I32	rw	0.	Tare Weight Tolerance.
	13	Pre-Fill Level 1st Set-Point.	I32	rw	0.	Pre-Fill Level 1st Setpoint.
	14	Fine-Fill Weight.	I32	rw	0.	Fine-Fill Weight.
	15	Filling Weight.	I32	rw	0.	Filling Weight.
	16	In-Flight Weight.	I32	rw	0.	In-Flight Weight.
	17	Pre-Fill Level 2nd Set-Point.	I32	rw	0.	Pre-Fill Level 2nd Setpoint.
	18	Filling Timeout Value.	I32	rw	0.	Filling Timeout Value.
	19	Underweight Post-Fill Time.	I32	rw	0.	Underweight Post-Fill Time.
	20	Tare Interval.	I32	rw	0.	Tare Interval.
	21	Bag Rupture Blanking.	I32	rw	0.	Bag Rupture Blanking.

6.2.1.2.6. Calibration Parameters

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2300	0	No. of Entries.	UI8	ro	24.	No. of Entries.
	1	Absolute Gain.	I32	rw	20000.	Absolute Gain Calibrate (TAC).
	2	Absolute Zero.	I32	rw	0.	Absolute Zero Calibrate (TAC).
	3	Calibrate Enable.	I32	rw	0.	Calibrate Enable (Enable TAC).
	4	Calibrate Gain.	I32	rw	20000.	Calibrate Gain (TAC).
	5	Dummy.	I32	rw	-	Not Used.
	6	Dummy.	I32	rw	-	Not Used.
	7	Calibrate Max 1.	I32	rw	999999	Calibrate Max 1 (TAC).
	8	Calibrate Min.	I32	rw	-999999	Calibrate Min (TAC).
	9	Dummy.	I32	rw	-	Not Used.
	10	Calibrate Zero.	I32	rw	0.	Calibrate Zero (TAC).
	11	Decimal Point.	I32	rw	3.	Decimal Point (TAC).
	12	Display Step Size.	I32	rw	1.	Display Step Size (TAC).
	13	Multi Range.	I32	rw	0.	Multi-Range/Multi-Interval (TAC)
	14	Calibrate Max 2.	I32	rw	0.	Calibrate Max 2 (TAC).
	15	Calibrate Max 3.	I32	rw	0.	Calibrate Max 3 (TAC).
	16	Initial Zero Range.	I32	rw	0.	Initial Zero Range (TAC).
	17	Zero Range.	I32	rw	0.	Zero Range (TAC).
	18	Tare Mode.	I32	rw	0.	Tare Mode (TAC).
	19	Non-Volatile Tare.	I32	rw	0.	Non-Volatile Tare (TAC).
	20	Non-Volatile Zero.	I32	rw	0.	Non-Volatile Zero (TAC).
	21	ADC Counts Zero.	UI32	ro	0.	ADC Counts at Zero Calibrate.
	22	ADC Counts Span.	UI32	ro	0.	ECAL ADC Counts at Span Calibrate.
	23	Correct Zero.	UI32	wo	0.	Correct Zero Post-Cal (TAC).
	24	Calibration Weight.	UI32	rw	20000.	ECAL Weight Parameter (TAC).

6.2.1.2.7. Dose Information

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2400	0	No. of Entries.	UI8	ro	1.	No. of Entries.
	1	Dose Info.	UI16	ro	-	Filling Status.

6.2.1.2.8. Set-Point Limits

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2600	0	No. of Entries.	UI8	ro	2.	No. of Entries.
	1	Set-Point 1.	I32	rw	5000.	Set-Point value 1.
	2	Set-Point 2.	I32	rw	10000.	Set-Point value 2.

6.2.1.2.9. Set-Point Hysteresis

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2700	0	No. of Entries.	UI8	ro	2.	No. of Entries.
	1	Set-Point 1.	I32	rw	1.	Set-Point 1 Hysteresis.
	2	Set-Point 2.	I32	rw	1.	Set-Point 2 Hysteresis.

6.2.1.2.10. Set-Point Source

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2800	0	No. of Entries.	UI8	ro	2.	No. of Entries.
	1	Set-Point 1.	UI8	rw	0.	Set-Point 1 Source.
	2	Set-Point 2.	UI8	rw	0.	Set-Point 2 Source.

6.2.1.2.11. Data Access

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2900	0	No. of Entries.	UI8	ro	13	No. of Entries.
	1	Gross Weight.	Real32	ro	-	Gross Weight.
	2	Net Weight.	Real32	ro	-	Net Weight.
	3	Tare.	Real32	ro	-	Tare.
	4	Dosed Weight.	Real32	ro	-	Dosed Weight.
	5	Dosed Tare.	Real32	ro	-	Dosed Tare.
	6	Average Weight.	Real32	ro	-	Average Weight.
	7	ADC Sample.	I32	ro	-	ADC Sample.
	8	Device ID.	UI32	ro	-	Device ID.
	9	Firmware Version.	UI32	ro	-	Firmware Version.
	10	Device Status.	UI32	ro	-	Device Status.
	11	Dummy.	UI32	ro	-	Not Used.
	12	Serial No.	UI32	ro	-	Serial No.
	13	Qualifier.	UI32	ro	-	Extended Status – see TPDOs.

6.2.1.2.12. Tare Zero Commands

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2C00	0	No. of Entries.	UI8	ro	4	No. of Entries.
	1	Set Tare.	UI8	wo	0.	Set Tare (Tare ON).
	2	Reset Tare.	UI8	wo	0.	Reset Tare (Tare OFF)
	3	Set System Zero.	UI8	wo	0.	Set System Zero (Zero ON).
	4	Reset System Zero.	UI8	wo	0.	Reset System Zero (Zero OFF).

6.2.1.2.13. E-Cal Commands

Index	Sub Index	Name	Type	Attribute	Default Value	Description
2D00	0	No. of Entries.	UI8	ro	4	No. of Entries.
	1	E-Cali (Factory).	UI32	ro	0	E-Cal Intercept Value.
	2	E-CalG (Factory).	Real32	ro	0.0	E-Cal Gain Value.
	3	mV/V Reading.	I32	ro	0	Get mV/V Reading.
	4	Enable mV/V Tare.	Bool	wo	0	Enable mV/V Tare Action.
	5	Remove mV/V Tare.	Bool	wo	0	Remove mV/V Tare Action.

6.3. CANopen Frames

A CANopen data telegram or frame is constructed as below. The EM100 uses expedited transfer only i.e. each communication is contained within one frame (not sent over several).

For CANopen purposes an EM100 module is the 'Server' and CAN Master is the 'Client'.

6.3.1. SDO CAN Frame

This has 4 components:

The COB-ID uniquely identifies what communication type it is and its destination (request) OR origin node (response).

Specifier – indicates to the EM100 a command or response.

Parameter – which object (index) is to be read or written.

Data – the data read or written to the object.

COB-ID

Hex Value	Transmission
600Hex.	Master → EM100.
580Hex.	EM100 → Master.

The node ID is added to this value so to communicate with node 4.

Master node → EM100 node uses 604Hex.

EM100 node → Master node uses 584Hex.

The command specifier is broken down as follows:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SP			Reserved	N		E	S

SP:

1 = Write object value to EM100 (SDO Download request)

2 = Read object value from EM100 (SDO Upload request and response)

3 = Confirmation of write (ACK)

4 = Abort SDO transfer.

When data is being written to or returned from the node the following applies:

for upload requests they are 0.

E: 1 = expedited i.e. data is in bytes 4-7 (always true).

S: 1 = if data size is defined.

N: If S = 1, then the number of data bytes that do not contain data (of bytes 4-7).

6.4. Overall CAN Frame

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
	Specifier	Parameter Location			Data			
	Specifier	Index Lo Byte	Index Hi Byte	Sub-Index	Data Byte 0	Data Byte 1	Data Byte 2	Data Byte 3

Examples using node ID 1: All values are Hexadecimal.

SDO READ

Master node requests the Vendor ID located at Index 1018, Sub Index 1.

Master Transmits

Transmit Master → EM100 COB-ID 600H+Node ID	Request	Index Lo	Index Hi	Sub-Index	Data 1	Data 2	Data 3	Data 4
601	40	18	10	1	00	00	00	00

EM100 Responds ACK

Transmit EM100 → Master COB-ID 580H+Node ID	Response	Index Lo	Index Hi	Sub-Index	Data 1	Data 2	Data 3	Data 4
581	43	18	10	1	4A	04	00	00

EM100 Responds NACK (example shows a response to an out of range sub-index)

Transmit EM100 → Master COB-ID 580H+Node ID	Response	Index Lo	Index Hi	Sub-Index	Data 1	Data 2	Data 3	Data 4
581	80	17	10	FF	11	00	09	06

Returned data shows the error 06090011 – Sub-Index FF does not exist.

In the CANopen standard, this is called an ‘SDO Abort Code’.

6.4.1. SDO Write

Master node write filter located at Index 1017, Sub Index 4.

Master Transmits

Transmit master → EM100 COB-ID 600H+Node ID	Request	Index Lo	Index Hi	Sub-Index	Data 1	Data 2	Data 3	Data 4
601	23	00	21	04	03	00	00	00

EM100 Responds ACK

Transmit EM100 →Master COB-ID 580H+Node ID	Response	Index Lo	Index Hi	Sub-Index	Data 1	Data 2	Data 3	Data 4
581	60	00	21	04	00	00	00	00

EM100 Responds NACK (example shows a response to an out of range sub-index).

Transmit EM100 → Master COB-ID 580H+Node ID	Response	Index Lo	Index Hi	Sub-Index	Data 1	Data 2	Data 3	Data 4
581	80	00	21	FF	00	00	09	06

Returned data shows the SDO Abort Code 06090011 – Sub-Index FF does not exist.

6.4.2. NMT Master Message

The NMT master message is used by the master node to switch a node OR all nodes into a specified NMT state. There is no acknowledge response – the node will simply go to state (if possible).

COB- ID	Requested Action	Transmit master → EM100 Node ID
	Byte 1	**Byte 2**
000	01Hex. = Start. 02Hex. = Stop. 80Hex. = Pre-operational. 81Hex. = Reset Node. 82Hex. = Reset Communication.	01 – 127decimal. OR 00 (Broadcast).

6.4.3. Heartbeat Message

This is sent by an individual node when the heartbeat protocol is activated. It contains only one byte, indicating the NMT State.

COB-ID	NMT State
700 + Node ID.	0 = Boot-up. 4 = Stopped. 5 = Operational. 127 = Pre-Operational. Note: bit-7 is reserved.

6.4.4. Emergency Message

This is sent by an individual node to warn of an error condition in the internal functioning of that node.

Transmit EM100->Master COB-ID 80H+Node ID	Error Code		Error Registered	Manufacturer Specific Error				
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
81	10	81	00	00	00	00	00	00

The above shows the error code 8110 which is CAN overrun (i.e. objects are lost).

Emergency Objects:

Abort Code (Hex.)	Description
8110	Monitoring – CAN Over-run (objects lost).
8120	Monitoring – CAN in error passive mode.
8130	Monitoring – Node Guarding or heartbeat error.
8140	Monitoring – Recovering from bus off.
8210	Protocol – PDO not processed due to error length.
8220	Protocol – PDO length exceeded.

6.4.5. SDO Abort Codes

Abort Code (Hex.)	Description
05030000	Toggle Bit not alternated.
05040000	SDO Protocol timed out.
05040001	Client server command specifier not valid.
05040005	Out of memory.
06010000	Unsupported access to an object.
06010001	Attempt to read a write only object.
06010002	Attempt to write to a read only object.
06020000	Object does not exist in the object dictionary.
06040043	General parameter compatibility.
06040047	General internal compatibility in the device.
06060000	Access failed due to a hardware error.
06070010	Data type does not match. Length of service parameter does not match.
06070012	Data type does not match. Service parameter too long.
06070013	Data type does not match. Service parameter too short.
06090011	Sub-Index does not exist.
06090030	Out of range parameter (write access only).
06090031	Value of parameter is too high.
06090032	Value of parameter is too low.
06090036	Maximum value is less than the minimum.
08000000	General error.
08000020	Data cannot be transferred or stored to the application.

7. Approved Applications

The term '*Approved*' applies whenever the weighing application is intended to be used for '*legal-for-trade*' weighing – that is, trade transactions and certain medical applications. Such applications are bound by the legal metrology regulations of the relevant governments around the world, most countries will comply with either the relevant ENs (Euro Norms) or the relevant OIML (*Organisation Internationale de Métrologie Légale*) recommendations.

The EM100 has been approved as a component for use in weighing systems according to OIML recommendation R61, the highest performance level approved being Class III, 10,000 intervals (e) and n x 10,000 intervals (n=2, 3). The notified approval body is the Danish Electronics, Light & Acoustics (DELTA/Force).

This approval will allow the use in approved weighing systems throughout Europe and in many other countries of the World. To achieve approval for an application, it will be necessary to satisfy the relevant governmental trading standards authority that the requirements of the various rules and regulations have been satisfied. This task is greatly simplified if the key components of the weighing system, namely the load cells and the weighing indicator or digitizer, are already approved as '*components*'. Usually, discussions with the appropriate weighing equipment approvals officers at the relevant national weights & measures office will then reveal the extent of any pattern testing that may be necessary to ensure compliance.

7.1. Restrictions in Approved Applications

A variety of performance restrictions must come into force. These restrictions are the number of display divisions, which become limited to 10,000 divisions and the sensitivity per display division which becomes 0.3µV per division. Once installed in the application, an '*approved*' application will require '*stamping*' by an officer of the relevant governmental department. This certifies the equipment or system as being in accordance to the relevant regulations and within calibration limits.

7.2. The Traceable Access Code (TAC)

The user software must then provide a guard against improper access of the calibration commands (see '*Calibration Commands*' section). The EM100 features the '*Traceable Access Code*' or TAC method of controlling the access to the calibration commands group. This means a code is maintained within the device and is incremented whenever any change to any of the calibration commands is saved. When performing the '*stamping*' test, the appropriate officer will make a note of the TAC value and advise the user that any change to this code which occurs prior to the regular re-inspection by the trading standards office, will result in legal prosecution of the user. The user software is required as a condition of approval, to make the TAC available to the weight display indicator or console, on demand.