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EMS700

Manual for operating the measuring device

Manual version: 230103

Context

1 About the device

The EMS700 device is intended for processing signals from force sensors, moment sensors or other sensors working on the principle of a resistance bridge. It has a built-in powerful battery that enables long-term measurement in the field. Together with a suitable sensor, it is mainly used for checking force settings on machines, portable weighing, pressure measurement, etc.

Fig. 1 EMS700 device

2 Sensor connection

The force sensor is connected to the device using a 7-pole ODU connector, MINI SNAP F series. Specific types of connectors are listed below, signal wiring is shown in fig. 2.

- Connector on the device: *GH0F1C-P07LCC0-0000*
- Sensor connector with the diameter of the cable 3 mm: *S10F1C-P07MCC0-3000*
- Sensor connector with the diameter of the cable 4.5 mm: *S10F1C-P07MCC0-4500*

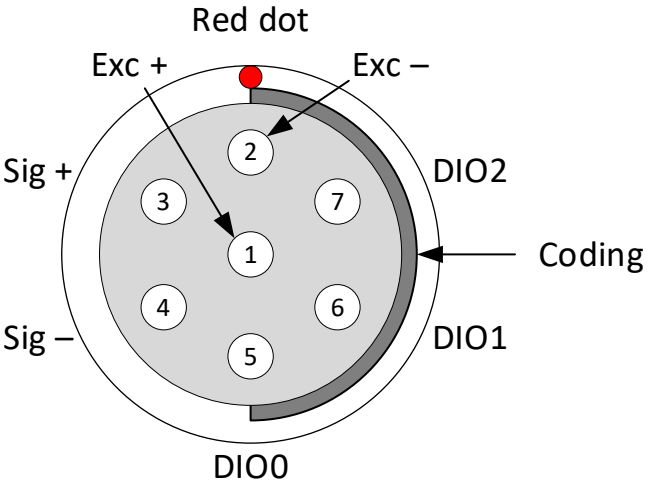

Fig. 2. Signals on the sensor connector pins, view of the wire connection side

The connector on the sensor is also used to encode the sensor number. The sensor is coded by connecting pin 1 (Exc +) to pins 5, 6 or 7, according to Table 1.

Table. 1. Coding of the sensor in the connector

Sensor code	Connected pins
0	---
1	1 – 5
2	1 – 6
3	1 – 5, 1 – 6
4	1 – 7
5	1 – 5, 1 – 7
6	1 – 6, 1 – 7
7	1 – 5, 1 – 6, 1 – 7

3 Switching the device on and off

The device is switched on with the button located at the bottom of the device (Fig. 1). The button is pressed and held until the manufacturer's name appears on the display. Then the button must be released. If the button was kept pressed for a longer time (more than 8 seconds), the device would be switched off again. Turning on the device is indicated by the functional display, not by the LED located next to the button. It is designed to check the battery charging. If the device is powered by the USB, the display backlight is automatically switched on. If it is powered by a battery, the display backlight must be turned on manually in the menu *Settings* → *Backlight*.

Switching off the device is done with the same button as switching it on. The button is pressed and held until the display turns off. Then the button can be released.

4 Battery charging

The device is powered by a powerful Li-Po battery, which enables long-term operation in the field. The battery status is shown on the display at the top right. When the battery is charged, the battery pictogram on the display is filled. By gradually discharging the accumulator, the filling decreases. When the battery is completely discharged, the device displays a warning message and turns off after a few seconds.

The battery starts charging immediately after connecting to the USB interface. The icon on the display will change to PC, which indicates that the device is powered by the USB interface. At the same time, the indicator light next to the power button lights up, indicating that the battery is charging. When the battery is fully charged, the light goes out. It is possible to work with the device normally while connected to the USB interface during charging.

5 Device control

The device is controlled using four buttons located below the display. Above each button in the bottom line of the display is a one-word description of its function. As you use the buttons, their functions change dynamically, and so do their descriptions.

In basic mode, after switching on the device, four buttons are active:

Menu Main menu

Fnc Display MIN/MAX values

Rel Enable / disabled relative measurement

Rec Data recording

After entering the main menu, individual menu items are selected using the buttons. When scrolling through items, the buttons have the following meaning:

Back Leave selected menu

↑ Move up

↓ Move down

Select Select item

5.1 Main menu

The main menu items are: *Profiles*, *Sensors*, *Data*, *Settings*, *System*.

5.1.1 Profiles

In the *Profiles* submenu, it is possible to define 4 profiles with the name Profile followed by a serial number. A new profile is created by selecting the *Add* option. Profile settings can be changed through the submenu.

Profiles → Activate

During the measurement, **only one profile is always active**, which contains all the settings. Activation / deactivation is done by selecting the *Activate* or *Deactivate* menu option. Activating the current profile automatically deactivates the previously active profile. If no profile is active, the device will not measure, it will only display a message.

Profiles → Sensor ID

Each profile must have an assigned sensor. Either a specific sensor from the sensor database is assigned to the profile or the option of automatic sensor recognition (**AUTO**) is selected. The system can only recognize sensors added to the database, which can be found in the *Sensors* submenu. The sensor is recognized through the ID encoded in the connector according to Table 1.

Profile → Sampling rate

In this menu, you can enter the speed of sampling and display of data on the display. The EMS700 allows you to set sampling rates: 1, 2, 5, 10, 20, 50, 100 and 1000 Hz.

Note. When setting the sampling rate, you should be aware that the higher the sampling rate (= measurement rate) you set, the less accurate the result you will get. For normal measurements, we recommend setting a speed of 2 or 5 Hz, higher speeds are especially suitable for recording fast events in the device's memory

Profiles → Num. Format

In the Num. Format option, you can enter the number display format on the device display, number of decimal places. It is possible to enter 0 to 4 decimal places. Please note, that by setting a larger number of decimal places, you will not automatically achieve higher measurement accuracy. The accuracy of the measurement is mainly determined by the sampling rate and also by the characteristics of the ADC converter. Therefore, we recommend setting the format to *AUTO*. With this setting, the device itself will ensure the optimal number of decimal places in view of the range of the sensor and the speed of measurement.

Profiles → Calibration

Calibration is described in a separate part of the manual.

Profiles → Delete

Deletes selected profile.

5.1.2 Sensors

The *Sensors* submenu is essentially a database of sensors stored in the device's memory. It is possible to add a maximum of 8 sensors, which are marked with the name Sensor and serial number. New sensors are added by selecting *Add*. Each sensor has these parameters:

Sensors → Units

Units in which the measured value is shown on the display.

Sensors → Fn

The Fn submenu has 2 items. The nominal range of the sensor, which is entered via the keyboard and the units in which the range is entered. If the user does not know the exact sensitivity value or has an unknown sensor, it is advisable to enter a value between 1 and 2. Subsequently, a load calibration must be performed.

Sensors → Cfn

The Cfn parameter is the sensitivity of the sensor at nominal load which is specified by the manufacturer. It is entered in mV/V units.

Sensors → C0

Parameter C0 is sensor zero, signal at zero load. It is entered in mV/V units. If the value is not known, it is left at the value 0

Sensors → Delete

Deletes the selected sensor from the database.

5.1.3 Data

The menu allows viewing and graphical display of recorded data.

Data → Profile

Active profile number during data measurement.

Data → Data Number

The number of data recorded in the device memory.

Data → Sampling Rate

Sampling rate used when recording data.

Data → MIN MAX AVG

A menu with the maximum, minimum and average value from the measured data will be displayed.

Data → Values

After entering the menu, the recorded data can be viewed. In the left column is the serial number of the data, and in the right column is the measured value with units. The data is scrolled using the button ↑ and ↓. The **Jump** button is used to speed up scrolling with a large number of measured data. The size of the jump is calculated according to the number of measured data.

Data → Graph

After entering the *Graph* submenu, a graphical history of all recorded data is displayed. By pressing the **Zoom** button, the number of displayed data will decrease by 128. The button can be pressed repeatedly, up to the number of displayed data 128, by pressing again, the display will return to the initial zoom. You can switch

between displayed groups of data using the arrows → and ←. Index of the displayed data as well as the total number of recorded data are shown on the display at the top left.

Data → Send Data

Sends all measured data via serial line to PC.

Data → Delete Data

Deletes the recorded data.

5.1.4 Settings

The submenu contains the items *Connection*, *Language*, *Backlight*, *Shutdown*, *Transmitter*, *g coefficient*. The meaning of the first four items is obvious, the description of the Transmitter and g coefficient items is as follows.

Settings → Transmitter

In the *Transmitter* submenu, the device can be set to the function of continuous data transmission. When this function is enabled, the device will start sending displayed data to the USB serial interface. This function is active up to a sampling rate of 10 Hz.

Settings → g coefficient

The magnitude of the gravitational acceleration is set in the *g coefficient* submenu. In different places of the Earth, the gravitational acceleration is different, in Central Europe it has a value of 9.81 ms^{-2} (default value).

5.1.5 System

The *System* submenu does not allow any settings, but some basic system parameters can be read here, e. g. software version and sensor supply voltage.

5.2 Fnc button

After pressing the **Fnc** button, the maximum and minimum value of the measured data since the device was turned on or since the last pressing of the **RST** button is displayed. The **RST** button is used to set new initial values of max. and min. data, press the **Fnc** button to return to the main screen.

5.3 Rel button

By pressing this button, the data on the display is set to zero and the device starts measuring relatively. Press again to return to the original (absolute) measurement. The relative measurement is indicated by the dark background of the button.

5.4 Rec button, data recording

The **Rec** button starts data recording in the device's memory. The data will start to be written immediately after pressing the button, or after confirming the warning message that the previous data will be overwritten. Data recording can be interrupted at any time by pressing the **Rec** button again. Data recorded until then will remain stored in the device's memory. If the recording is not interrupted manually, the recording is finished by filling the entire memory, which has a capacity of 10000 data.

Data is written at the same rate as the sampling rate set in the *Menu* → *Profiles*. During recording, normal measurement takes place, the number of recorded data is displayed in the upper left corner of the display.

At a sampling and writing speed of 50, 100 and 1000 Hz, the measured data is no longer displayed on the display. Only the data logging message is displayed.

Information about recorded data can be found in *Menu* → *Data*. The data can also be viewed on a computer to which it can be transferred in two ways:

1. By selecting *Menu* → *Data* → *Send Data*, all data will be sent via the USB interface. The computer must be ready to read and decode the data. Data is sent in json format.
2. The data is read on demand, using a suitable program. An Excel program that can be used to read the data is available on the manufacturer's website.

The USB interface behaves like a virtual COM port, the transfer parameters are set in *Menu → Settings → Connection*. Here is possible to enable or disable data transfer.

6 Device setup procedure

The setup of the device is described on three specific examples given below.

6.1 Example 1, device setup with one sensor

In the case of a single sensor function, the sensor need not have any code as defined in Table 1, or it may have any code. Assume that the sensor has no code, which actually means it has a code of 0. The sensor label is **Sensor 0** and its parameters are: range **Fn** = 5 kN, sensitivity **Cfn** = 1.4966 mV/V, zero **C0** = – 0 .0037 mV/V.

Setup procedure

1. First, the sensor is registered in the sensor database. Procedure: *Menu* → *Sensors* → *Add* → *Sensor 0*.
2. Its parameters are written into the sensor. Display units, nominal range (**Fn**), sensitivity (**Cfn**) and sensor zero (**C0**).
3. A new profile will be created: *Menu* → *Profiles* → *Add* → *Profile 1*.
4. The sensor is assigned to the new profile: *Menu* → *Profiles* → *Profile 1* → *Sensor ID* → *0*.
5. Sampling rate of **5Hz** will be set.
6. We set the number of decimal (*Menu* → *Profiles* → *Profile 1* → *Num. Format*) places to **AUTO**
7. We will not calibrate the sensor, we assume that the parameters **Fn**, **Cfn** and **C0** are correct. If the system needs to be calibrated, the procedure is given in a separate section.
8. We activate the profile by selecting *Menu* → *Profiles* → *Profile 1* → *Activate.*
9. Sensor and profile are set. We can go back to the main screen and start measuring.

6.2 Example 2, device setup with two sensors and with automatic identification

The device is supposed to work with two sensors that, according to Table 1, have coded ID 1 and 2 in the connector. After connecting the sensor, the device should automatically recognize the ID of the connected sensor and set its parameters.

Setup procedure

1. First, we add sensor 1 to the database: *Menu* → *Sensors* → *Add* → *Sensor 1*.
2. We set its parameters: Units, Fn, Cfn, C0
3. We will repeat the same procedure for the sensor 2.
4. We create profile 1: *Menu* → *Profiles* → *Add* → *Profile 1*
5. We set sensor ID in profile 1 submenu: *Profiles* → *Profile 1* → *Sensor ID* → *AUTO*. This sets the automatic selection of the sensor, taking into account all the sensors registered in the database (submenu *Sensors*).
6. We will set other items: *Sampling Rate*, *Num. Format*.

7. We activate the profile.

After connecting the sensor, an identification message will be displayed, which must be confirmed. The device is able to identify only those sensors that are registered in the database.

6.3 Example 3, device setup with two sensors and two profiles

The procedure is exactly the same as in example 2, only **Profile 2** is added. In the menu for sensor ID, the following is set: *Profiles* → *Profile 2* → *ID sensor* → *AUTO*. In both profiles, it is selected from the same sensor database, so adding another profile may seem pointless. However, different profiles can have different parameters like sampling rate and number of decimals. For example, for normal measurements, Profile 1 with a sampling frequency of 5 Hz will be used. To record faster events, Profile 2 will be used, in which the sampling frequency will be set to 1000 Hz.

7 Calibration

By calibration we understand the adjustment of the system consisting of the sensor and the electronic unit so that the displayed value corresponds as best as possible to the actual load of the sensor. The EMS700 device allows you to perform calibration in two ways:

- Calibration by setting parameters
- Calibration by loading the sensor

7.1 Calibration by setting parameters

For this method of calibration, it is necessary to have precisely measured sensor parameters, especially sensitivity. The parameters **Fn**, **Cfn** and **C0** are entered into the device in the *Sensors* submenu and the calibration is complete.

The measurement after calibration is as accurate as the sensor parameters were accurately measured. This method is less accurate than the real load on the sensor, but it works in many cases. In some cases, for example, when calibrating sensors with large ranges (100 kN and more), even the only usable. However, if possible, we recommend calibrating using the real load sensor method.

7.2 Calibration by loading the sensor

This is a more accurate method than in the previous case, its accuracy is limited only by the accuracy of the loading device (weights or loading machine). This type of calibration can only be done for a specific sensor that must be set in the *Profiles* submenu. For example, before calibration of sensor no. 1 must be set *Menu* → *Profiles* → *Profile 1* → *Sensors* → *1*. **AUTO** setting is not enough. If the sensor identification was set to **AUTO**, the *Calibration* menu will not be displayed at all. The sampling rate should be set to 1, 2 or 5 Hz to ensure sufficient accuracy. Next, the calibration procedure of sensor no. 1 with parameters Fn = 5 kN, Cfn = 1.4966 mV/V, C0 = – 0.0037 mV/V which is assigned in Profile 1.

Calibration procedure

1. Main menu: *Menu* → *Profiles* → *Profile 1* → *Calibration* → *Calibrate*
2. The prompt **Unload the sensor** appears on the display, while the measured value is also displayed. The sensor must be relieved enough that the measured value is less than 25% of the sensor range. In our case, 25% of 5 kN = 1.25 kN. If the sensor is loaded more, an error message will be displayed and calibration will not be possible. If the load is within tolerance, press the **Next** button.

3. The prompt **Load the sensor** appears on the display, while the measured value continues to be displayed. The sensor is loaded with a known force, preferably the same as the range of the sensor, in our case 5 kN. The force can be smaller, but must be at least 10% of the range (10% from 5 kN = 0.5 kN). If the force is less than 10%, an error message is displayed and the calibration is aborted. (Note: a simple rule applies when choosing the loading force. The closer the load force is to the sensor's nominal range, the more accurate the calibration.) If the force is within tolerance, wait for the data to stabilize and press the **Next** button.
4. Use the keyboard to enter the load force. After entering the force, the device calculates the calibration coefficients and, if everything went well, displays the message **Successful calibration**. By confirming the message, the calibration is completed.

The success of the calibration can also be verified by checking the calibration coefficients in the submenu: *Menu* → *Profiles* → *Profile 1* → *Calibration* → *Calibrate*. Coefficient **Ak** should be different from value of 1 and **Bk** from 0.

8 Calculations

The displayed force is calculated according to the formula:

$$F = \frac{Fn}{Cfn*Uc} * Us * Ak - B0$$

Fn – nominal sensor range, is entered in the sensor parameters

Cfn – sensor sensitivity [mV/V], is entered in the sensor parameters

Uc – sensor supply voltage, the value can be found in the *System* submenu

Us – measured sensor output voltage, Measured by internal ADC

Ak – sensitivity calibration coefficient, default value Ak = 1

B0 – zero offset, default value B0 = C0 * (Fn / Cfn), C0 is sensor zero offset [mV/V]

9 Parameters

Input

– Sensor type	strain gauge bridge
– Sensor sensitivity	0.5 ... 7 mV/V
– Min. bridge resistance	250 Ω
– Sensor power supply	2.5 V

Measurement parameters

– ADC resolution	24 bits
– Number of digits on the display	max 5
– Sampling rate of measurement and recording	1, 2, 5, 10, 20, 50, 100, 1000 Hz
– Max. number of recorded data	10000

PC connection

– Type	virtual COM Port
– Connector type	USB-C
– Baud rate	9600 ... 115 200 Bd
– Connection parameters	8 bits, 1 stop bit, no parity

Device power supply

- Battery voltage 3,7 V
- Battery capacity 2600 mAh
- Operating time with fully charged battery min. 30 hours
- Charging voltage (USB) 5 V

10 Service

Procedure for factory reset:

A factory reset will erase all profile, sensor and calibration settings.

- Switch off the device, if necessary, hold down the power button longer. If the device does not switch off after 10 seconds, it is damaged, the device is suitable for manufacturers to repair.
- Unscrew the 6 screws from the bottom and open the device. There is a button on the right side of the circuit board. Hold down this button and switch on the device. The device will switch on and **FR** will appear in the upper left corner. After 1-2 minutes, the device will start working normally.
- After resetting the device, a new setting of profiles and sensors is required, as all data except the internal supply voltage have been deleted.

If the above procedure does not help, it is necessary to send the device to the manufacturer, the current contact can be found on the manufacturer's website.