



Electronic Heat Cost Allocator
GRADUS
User Manual

Table of Contents

1	APPLICATION AND FUNCTION	3
2	CONTENTS OF PACKAGE.....	3
3	GENERAL INFORMATION.....	3
4	GENERAL MOUNTING INFORMATION.....	3
5	DISPLAY / DISPLAY CYCLE.....	4
5.1	Display before and during installation.....	4
5.2	Default display of GRADUS after installation.....	5
5.3	Further status displays.....	5
6	CONSUMPTION CALCULATION	6
7	DETECTION OF ACCUMULATED HEAT	6
8	PLUG ON / MANIPULATION DETECTION	7
9	TECHNICAL DATA.....	7
10	INTERFACES AND OPTIONS	8
10.1	Optical (infrared) interface	8
10.2	Radio interface wireless M-Bus (optional).....	8
10.2.1	Technical data radio.....	8
10.2.2	Radio configuration.....	8
10.2.3	Activation of the radio interface.....	9
11	HINT FLAGS	9
11.1	Hint description.....	10
12	DECLARATION OF CONFORMITY	10
13	MANUFACTURER	10
14	CONTACT.....	10

1 APPLICATION AND FUNCTION

This heat cost allocator is designed for the measurement of the consumed thermal energy on radiators and pipes in a heating system.

2 CONTENTS OF PACKAGE

- 40 electronic heat cost allocators
- 1 package with 40 seals
- 1 mounting manual

The heat conductors have to be ordered separately! A package of heat conductors contains 40 pieces.

Article codes, mounting accessories and additional equipment you can find in the mounting instructions and the prices list.

3 GENERAL INFORMATION

- The technical regulations of EN 834 must be observed.
- This product fulfils the requirements of the European Council Directive on Electromagnetic Compatibility (EMC Directive) 2004/108/EC.
- All information and requirements of the mounting manual, user manual and mounting instructions must be observed.
- If the information and requirements in the mounting manual, user manual and mounting are not strictly followed, or if the installation is shown to be faulty, any resulting expenses will be charged to the company responsible for the installation.
- All specifications and instructions listed on the data sheet and in the Application Notes must be adhered to.
- Within a billing project, it is not permitted to use different types of heat cost allocators.
- Instruments with activated radio function are not allowed on air freight.
- The temperature sensor cables must not be kinked, rolled up, lengthened or shortened.
- To clean the heat cost allocator use a slightly moist cloth.
- To protect against damage and dirt the heat meter should only be removed from the packaging directly before installation.
- Instruments which have been replaced or exchanged must be disposed of according to relevant environmental regulations.
- It is important to note that the acknowledged state of the art technology rules and the relevant legal restraints (international and local; see "Relevant Norms / Standards / Literature") are to be observed.
- The installation has to be performed by authorized, skilled persons.
- The heat cost allocator left the factory in conformance with all applicable safety regulations. All maintenance and repair work is to be carried out only by qualified and authorized technical personnel.
- Further information can be obtained at www.engelmann.de.

4 GENERAL MOUNTING INFORMATION

- All information and requirements of the mounting manual and mounting instructions must be observed.
- The different types of installation and the mounting accessories to be used in each case are listed in the mounting instructions.
- After installation of the heat conductor mount the heat cost allocator.
- Insert the seal into the opening on the underside.
- The heat cost allocator starts the operation mode automatically (plug on detection).

5 DISPLAY / DISPLAY CYCLE

The heat cost allocator has a liquid crystal display with 7 digits and special characters. After the installation the values are shown in a permanent display cycle.

5.1 Display before and during installation

- When delivered the GRADUS is in Sleep mode. This is indicated in the display with the flashing “SLEEP” (**fig. 1: A**).
- Shortly after the placement of the GRADUS to the aluminum conductor the configuration starts.
 - if a compact device is mounted appears for about 3 seconds “CONFIG” (**fig. 1: B**).
 - If a remote sensor is installed appears for about 3 seconds “CONF FF” (**fig 1: C**).
- Then the display cycle starts.
- If a start date for the start of counting is programmed in GRADUS then “GO dd.mm” (e.g. “GO 01.09”) appears on the display and remains until reaching the starting month (**fig 1: D**).
- After the completion of the internal configuration or upon reaching the preset starting month the display cycle starts (**5.2 und 5.3**).
- Make sure that the GRADUS is permanently attached to the required mounting location.
- Make sure that the EHKV is sealed (manipulation).

fig 1 (A-D): Displayed status information before and during installation

S	L	E	E	P
---	---	---	---	---

A. Sleep mode (display flashing/ interval 1 sec)

C	O	N	F	I	G
---	---	---	---	---	---

B. Configuration display compact device
(approx. 3 sec)

C	O	N	F		F	F
---	---	---	---	--	---	---

C. Configuration display when remote sensor is
connected (approx. 3 sec)

G	O		0	1.	0	9
---	---	--	---	----	---	---

D. If programmed: starting month of recording
data (e.g. 01.09 -> first of September).
Displayed until starting month is reached.

5.2 Default display of GRADUS after installation

The following image shows the default display cycle of Engelmann factory setting.

Figure 2: Display cycle (factory setting)

<div>R</div> <div>0 0 0 0 0 0 0</div>	1. Current consumption (R = radio version)
<div>B</div> <div>R</div> <div>A N 3 1. 1 2</div>	2. Billing date (AN = annual/ B = Billing relevant data)
<div>B</div> <div>R</div> <div>0 0 0 0 0 0 0</div>	3. Billing date consumption
<div>C</div> <div>R</div> <div>5 1 6 2 7</div>	4. Checksum for billing date consumption (C= checksum)
<div>8</div> <div>R</div> <div>8 8 8 8 8 8 8</div>	5. Segment test (see also Fig. 3)

It should be noted that some of the standard 7-segments elements have been expanded by including more segments to increase the readability of the status indicators. These are visible in the segment test and are shown below:



Figure 3: segment test (enlarged view)

5.3 Further status displays

The following status displays are shown for information purposes in addition to the standard display cycle, when parameterized, or a mode changes is initiated by internal algorithm.

- 1-sensor mode-mode is selected:



- Product scale is selected: The entered radiator output in watts is displayed (e.g. 750 W):



- The check sum for the current consumption has been selected: These appear on the display loop directly after the current consumption:

C					
R	4	2	0	3	9

- If the algorithm in the standard 2-sensor operation mode detects accumulated heat, the device switches to 1-sensor mode. This is displayed as "1F HEAt" (please see also 7 Detection of accumulated heat).

R	1	F		H	E	A	t
---	---	---	--	---	---	---	---

- If the GRADUS is in storage mode and the ambient temperature drops below 0°C then "COLd" is displayed.

	C	O	L	d
--	---	---	---	---

- If the GRADUS is opened after mounting on the radiator but within the mounting time frame (waiting period), appears "OPEN" (please see also 8)

B					
R	O	P	E	N	

- If the GRADUS is opened outside the mounting time frame (waiting period), appears "OPEN C" (C = Contact) in the display cycle. Here, it is assumed that there is a manipulation of the GRADUS. (please see also 8).

	O	P	E	N	C
--	---	---	---	---	---

- If a reset of the manipulation detection (OPEN C) is performed, the display shows "STBY". (please see also 8).

	S	T	B	y
--	---	---	---	---

6 CONSUMPTION CALCULATION

Due to the radiator exponent is part of the calculation algorithm and thus a basis for calculating of the counting process of the GRADUS, the following formula is used to calculate the consumption value:

$$\text{consumption value} = \text{display value} * K_c * K_Q$$

7 DETECTION OF ACCUMULATED HEAT

The detection of accumulated heat is carried out by the internal calculation algorithm. Here are several averages of detected temperature values calculated permanently. When these average values falls below a certain threshold, the algorithm detects the heat accumulation and changes in the internal 1-sensor operation mode (1F HEAt). If the threshold is exceeded again, it takes up to 6 hours to change back into the standard 2- sensor mode and the heat accumulation signaling is terminated. The change in the 1-sensor (heat accumulation)-mode does not affect the functionality of your GRADUS, due to the fact that this behavior is part of the internal calculation algorithm and thus to the approval of the GRADUS.

8 PLUG ON / MANIPULATION DETECTION

Plug on detection:

The GRADUS has a plug on detection

After plug on to the heat conductor the EHKV changes to the operating mode, the radio transmission (optional) start automatically.

Manipulation detection:

The GRADUS is equipped with a manipulation detection.

If the plug on/manipulation switch is for 5 seconds in the mounted position, the event “plug on” is triggered and configuration starts (see also 5.1).

If the GRADUS is removed within 1 hour after its initial installation on the heat conductor, the display shows “OPEN”. By re-install the device within this mounting time frame, then “CONFIG/CONF FF” appears again on the display and the standard display cycle continues.

Repeated removing and re-installing can be done within the mounting time frame several times; but the mounting time frame is not extended.

Only at the end of the mounting time frame for installation (waiting period), the measurement function of GRADUS is enabled!

If the GRADUS is removed after the end of the mounting time frame for installation from the heat conductors or fitted again after the end of the mounting time frame, the display shows “OPEN C” in the display cycle. Here manipulation is suspected. The “OPEN C” hint persists after re-install the GRADUS and will appear in the display cycle.

By using the “Device Monitor” software (register parameterization –reset removal detection) the hint “OPEN C can be reset.

The display briefly shows “STBY”, then “CONFIG” / “CONF FF” appears and the device continue with recording data by displaying standard display cycle.

If the reset is performed on the removed GRADUS, the “STBY” appears on the display and will persist until the re-install of the device. After re-install the display briefly shows “CONFIG” / “CONF FF” and the device continue with recording data by displaying standard display cycle.

9 TECHNICAL DATA

Standard and approval	EN 834:2013; A1.01.2013 approved to German HKVO
Dimensions	height 95 mm / width 38 mm / depth 30 mm
Ambient temperature	-25 °C – 60 °C
Temperature range Medium 2-sensor mode	35 °C – 95 °C
Temperature range Medium 1-sensor mode	55 °C – 95 °C
Temperature range Medium remote sensor mode	35 °C – 105 °C
Start of enumerating at temperature difference	3 K
Protection class	IP41 (mounted)
Power supply	3 V lithium battery

Battery lifetime, estimated	11 years + 1 year storage
Data storage	132 monthly values and 132 semi-monthly values
Display	7 digits + special characters
Interfaces	Standard: infrared
	Optional: wireless M-Bus
Remote temperature sensor	
Sensor type	NTC preaged
Length of cable	2 m
Dimensions of cover	height 26 mm / width 12 mm / depth 10 mm

10 INTERFACES AND OPTIONS

10.1 Optical (infrared) interface

For the communication with the optical interface an optocoupler and the 'Device Monitor' is necessary. The optocoupler and the 'Device Monitor' software are available as accessory equipment.

Baud rate: 2400 baud

10.2 Radio interface wireless M-Bus (optional)

The radio interface is for the transmission of meter data (absolute values).

General information about the radio interface:

During installation of radio components the presence of bulky obstacles directly over or in front of the housing must be avoided.

The transmission quality (range, telegram processing) of radio components can be negatively influenced by instruments or equipment with electromagnetic emissions, such as telephones (particularly LTE mobile radio standard), wi-fi routers, baby monitors, remote control units, electric motors, etc.

In addition, the construction of the building has a strong influence on the transmission range and coverage.

The factory-setting of the clock in the heat cost allocator is standard (winter) Central European Time (GMT +1).

There is no automatic changeover to daylight savings (summer) time.

The radio function is deactivated upon delivery (factory-setting). See section 'Activation of the radio interface'.

10.2.1 Technical data radio

Frequency	868 MHz
Transmission power	up to 12 dBm
Protocol	wireless M-Bus based on EN 13757-3
Selectable modes	S1 / T1 / C1
Telegrams	<ul style="list-style-type: none"> short telegram AMR (in conformity to OMS-Spec_Vol2_Primary_v301): serial number, date/time, current consumption, due date, due date value, hint flag, time of hint flag long telegram for walk-by read-out: serial number, date/time, current consumption, due date, due date value, 15 monthly values, 15 half monthly values, hint flag, time of hint flag
Encryption	AES: Advanced Encryption Standard; key length: 128 bits

10.2.2 Radio configuration

Parameter	Possible settings	Factory setting (Battery lifetime, estimated: 11 years + 1)
Mode	S1 / T1 / C1; unidirectional	T1; unidirectional
Transmission period	00:00 - 24:00; any time period in the day	7:00 am - 7:00 pm

Transmission interval	120 seconds - 240 minutes	120 seconds
Weekdays	Monday – Sunday (any weekday)	Monday - Friday
Weeks in a month	1 – 4 (4: uninterrupted, incl. a possible 5 th week)	1 - 4 (4: uninterrupted, incl. a possible 5 th week)
Months	1 - 12	1 - 12
Radio activation date	annual, variable (except 29.02.)	not set
AES-128-Encryption	<ul style="list-style-type: none"> - encrypted: <ul style="list-style-type: none"> - Master Key - random key per instrument - activated / not activated 	Master Key; not activated
Type of telegram	<ul style="list-style-type: none"> - short telegram AMR (OMS-Spec_Vol2_Primary_v301) - long telegram walk-by 	Long telegram walk-by

10.2.3 Activation of the radio interface

The radio interface **leaves the factory deactivated**. After putting the heat cost allocator on the heat conductor the radio interface will be activated automatically.

When the radio interface is activated an “R” is shown permanently left below in the LCD.

If using the compact mode, for one hour after activation the heat cost allocator transmits in installation mode. This means that format telegrams and compact telegrams are sent alternately.

11 HINT FLAGS

The GRADUS recognizes two sorts of display modes for hints: the integrated hint mode and the separate hint mode. In the integrated hint mode the hints are added to the display loop as supplementary indicators. Concerning the separate hint mode the display switches from the operating mode into this hint mode and the appendant hints are shown permanently in the display.

The hints are shown generally with an H put in front and the hint code (for example H 02).

The device recognizes eight hint causes possible that can also occur in combination with each other.

Hint	Description
H 01	Memory error; during access to database an error occurred.
H 02	Unexpected reset by POR, RAM-parity, access violation
H 04	Lifetime > 10 years / > 11 years
H 08 (= OPEN C)	A removal of the GRADUS from the heat conductor was detected.
H 16	Break of one of the measuring sensors
H 32	Short circuit of one of the measuring sensors
H 64	Reset by watch dog timer
H 128	Remote sensor is mounted

The hints “128”, “64” and “4” are an exception. These three hints have no influence to the device’s correct function. The hints “128” and “64” are not displayed; however all three hints (4, 64, 128) can be read out together with the current measuring values and are integrated in the radio telegram.

Another exception is the hint H 08. It is displayed as “OPEN (C)”.

Devices with the hints “H 32”, “H 16” and “H 01” (these hints are permanently shown in the display) must be changed at once and sent to the supplier for an inspection.

At the hint’s first appearance date and time will be recorded in addition. This is shown in the radio as well as in the IR telegram. If the same hint occurs again, the date will not be changed. So you will be able to comprehend, when a hint occurred for the first time. If a new hint occurs, the date will be updated.

When the hints “lifetime > 10 years / > 11 years” and “remote sensor is mounted” are logged, the date will not be recorded.

11.1 Hint description

Hint	Effect	Possible cause
Memory error; during access to database an error occurred	No calculations are carried out. The register for consumption is not being updated.	Defective component
Unexpected reset by POR, RAM-parity, access violation	No influence to the calculation	The measurements since the last storage of data in the E ² PROM are lost (max. one hour).
Lifetime > 10 years / > 11 years	No influence to the calculation	Long operating time
A removal of the GRADUS from the heat conductor was detected	No influence to the calculation	A removal of the GRADUS from the heat conductor
Break of one of the measuring sensors	No calculations are carried out. The register for consumption is not being updated.	A defect on the calculator circuit board
Short circuit of one of the measuring sensors	No calculations are carried out. The register for consumption is not being updated.	A defect on the calculator circuit board
Reset by watch dog timer	No influence to the calculation	The measurements since the last storage of data in the E ² PROM are lost (max. one hour).
Remote sensor is mounted	No influence to the calculation	Remote sensor was mounted.

12 DECLARATION OF CONFORMITY

For the product described in this document we confirm, as the manufacturer, that it meets the fundamental requirements according to the Directive 1999/5/EC (R&TTE).

The complete signed declaration can be found at **www.engelmann.de**.

13 MANUFACTURER

Engelmann Sensor GmbH
 Rudolf-Diesel-Str. 24-28
 69168 Wiesloch-Baiertal – Germany

14 CONTACT

Maddalena S.p.A.
 Via G.B. Maddalena, 2/4
 33040 Povoletto (UD) – Italy
 Tel.: +39.0432.634811
 Fax.: +39.0432.634820
www.maddalena.it