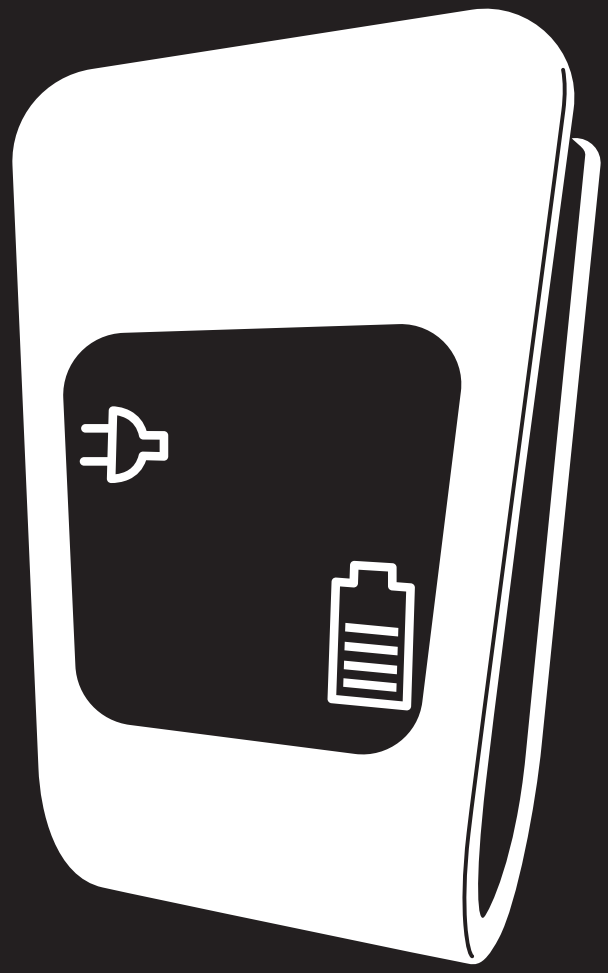
CTEK

USER MANUAL

NANOGRID™

MULTILINGUAL MANUAL



Contents

INTRODUCTION

The load balancing protects your power grid from overload. The load balancing is called NANOGRID™ and is available in three different levels.

This manual focuses on CHARGESTORM CONNECTED 2 NANOGRID™ configuration.

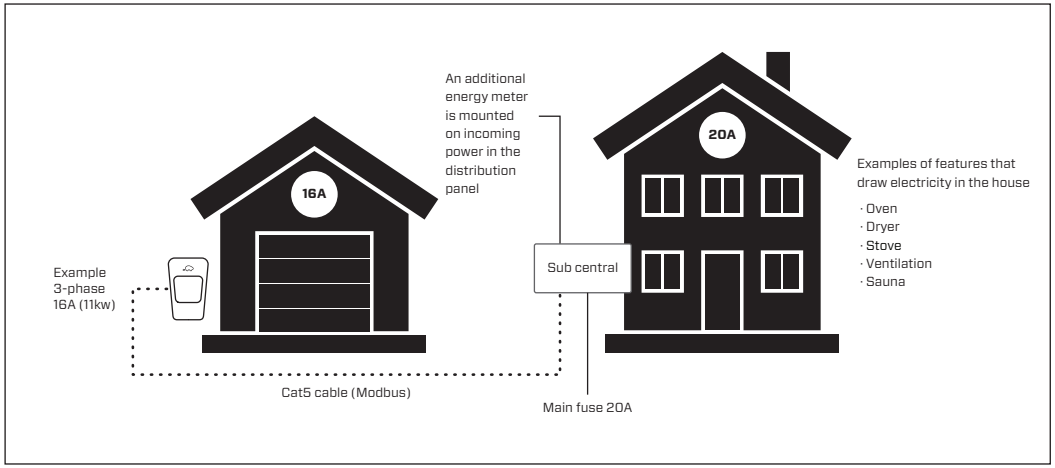
To install the home load balancing kit, follow the attached manual in the kit.

Three levels of NANOGRID™

The level of NANOGRID™ is given by the premises and demands of function. Select correct level for your needs.

NANOGRID™ home

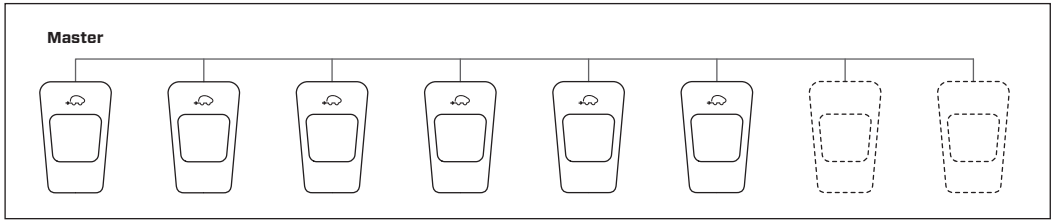
NANOGRID™ home is used at villas, summerhouses, guest houses etcetera. NANOGRID™ home has support for a single charging station.



The power of the charger will automatically be set at no risk of overload.

NANOGRID™ local

NANOGRID™ local is used for tenants, companies, parking spaces etcetera. It is suitable for installations for up to 12 charge points. For local NANOGRID™ license is needed. For dual outlet article number 810-00048, for single outlet article number 901-00018.

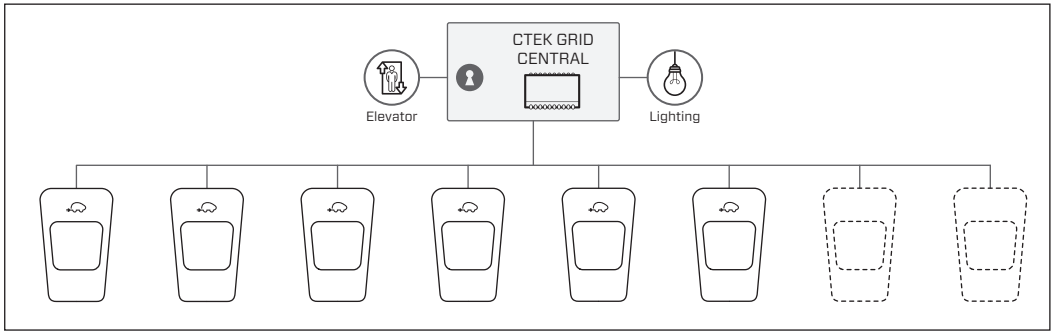


When many electric vehicles charge at the same time, load balancing can be necessary to prevent overload. If there is an overload, the system automatically adjusts the power of the charging stations or stops them completely.

NANOGRID™ grid central

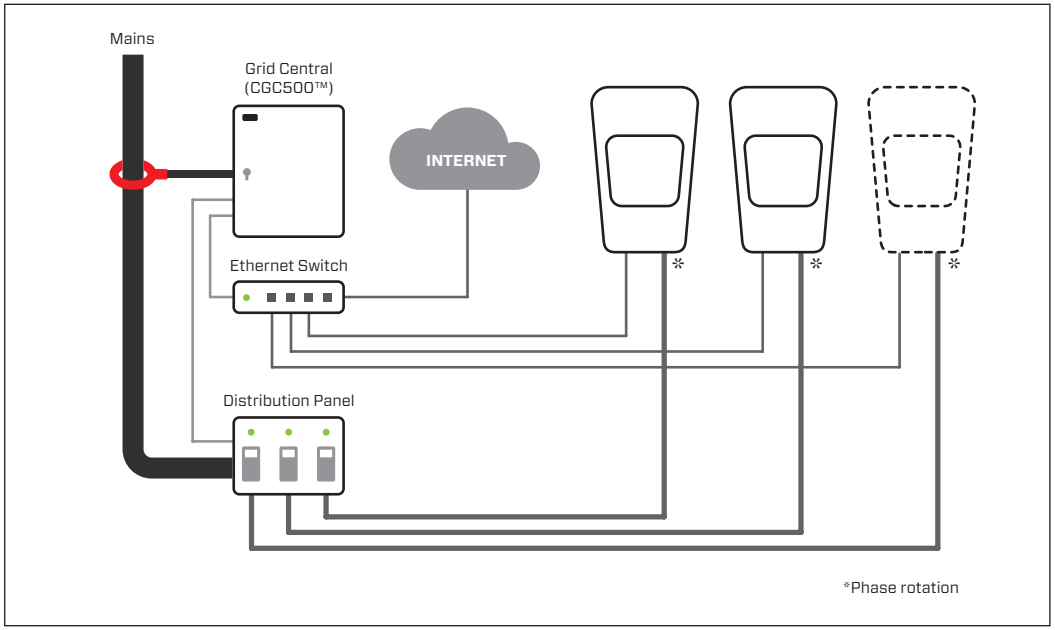
NANOGRID™ grid central is used for parking lots, real estates, industries, etcetera. The NANOGRID™ grid central is available in two versions:

- **CGC100:** Applicable for installations for up to 70 charge points.
- **CGC500:** Applicable for installations for up to 500 charge points.



The grid central is a separate compact device cabinet that contains a charge control unit, an energy meter and a transformer measurement equipment. The grid central manages the charging stations and the external loads such as lighting, ventilation, elevator.

Deployment of the NANOGRID™



To install the power and network cables to the stations, refer to the CHARGESTORM CONNECTED 2 USER MANUAL. The manual is available at https://chargestorm.se/en/manuals/

NOTE: Manuals are also available for older stations, such as the CHARGESTORM CONNECTED 1. Make sure that you refer to the correct installation manual when you install the power supply and the network cables.

For information about IT-Net installations, refer to "To connect stations used in IT-Net" on page 9.

Installation procedure

NOTE: It is possible to install chargers and at a later step configure and enable a site.

NOTE: To create the correct configuration file, make sure that you have all information about the installation available.

Example of the typical installation procedure:

1. Do a plan of the phase rotation of the chargers.
2. Write down the amperage of the protective fuses.
3. Install the chargers according to the phase rotation plan.
4. Configure the NANOGRID™ master with the NANOGRID™ file.
5. Make sure that the installation is correctly done.

To plan the phase rotation

The phase rotation creates an even load on a larger installation site. Many EVs use a 1-phase for charging and thus only draw current on the L1 in the EVSE outlet. If the phase rotation is not applied, the L1 fuse can easily overload and the fuse blow.

1. Divide all the chargers into three groups; RST, STR and TRS.
2. Install all the chargers in each group with the phase rotation that follows:
   a. RST group with L1, L2, L3
   b. STR group with L2, L3, L1
   c. TRS group with L3, L1, L2
3. Make sure that you save all the chargebox identities and what group they belong to before the configuration.

Example 20 chargers:

- **RST group: 1, 4, 7, 10, 13, 16, 19**
- **STR group: 2, 5, 8, 11, 14, 17, 20**
- **TRS group: 3, 6, 9, 12, 15, 18**

NANOGRID™ local/grid central configuration

The NANOGRID™ installation must be configured correctly for the load balancing to do the correct decisions and actions. The most important configuration is the configuration of the NANOGRID™ controller unit. The NANOGRID™ controller unit has two variants:

- **CTEK GRID CENTRAL (CGC):** A controller unit that is dedicated to the task of load balancing. The control unit is usually installed in a separate cabinet.
- **Master Controller Unit (Master):** A controller unit that also operates as a regular charging station. The external surface is typically the same as a controlled charging station.

NOTE: For more information about advanced and optional configuration, refer to "Advanced configuration" on page 7.

The information in this section is applicable to both CGC and Master.

The NANOGRID™ configuration file

The NANOGRID™ configuration file is placed on the NANOGRID™ controller.

The NANOGRID™ configuration file defines:

- Nodes to be load balanced.
- How each node is electrically connected to the grid.
- The load balancing schedule.
- Fallback current.
- Physical fuses.
- External meters.

The configuration file is named nanogrid.ini and it contains:

- General NANOGRID™ configuration.
- Node configuration.

The nanogrid.ini file must be edited or created with a text editor that understands and respects UNIX-style line-endings, for example Notepad++.

General configuration includes, but is not limited to, configuration of the NANOGRID™ scheduler. Refer to "To select load balancing scheduler" on page 7.

Different node types

The two most common node types are:

- **Fuse:** A distribution board. The fuse node cannot be controlled but the fuse node limits the quantity of the available electrical capacity.
- **Station:** A NANOGRID™ compliant charging station. The station node can be directly controlled by the NANOGRID™ controller.

Distribution boards (fuse) node type

A distribution board is described by one of the fuse types. The basic format of a fuse node is:

```
[GROUP-1]
type=fuse
rating=32
parent=MAINPANEL
```

Definitions:

[GROUP-1]	The identity of the fuse node. It must be unique for each node in the configuration file.
type=fuse	Defines that this is a fuse type node.
rating=32	The upper limit of the node that must not be exceeded when the charging capacity to station nodes is set. This is typically the rating of the fuse, in this case 32 A. The fuse is assumed to have 3 phases, all connected up- and downstream.
parent=MAINPANEL	Defines to which distribution board this node is connected to upstream. In this case, a distribution board with the identity MAINPANEL. This means that this node is electrically downstream from the node MAINPANEL. To set this fuse node as the grid connection point, the parent value should be the same as the identity value. Refer to the note and example below. The grid connection point has itself as a parent in the configuration.

NOTE: Each configuration file gives a tree graph of the electrical connections that are applicable for the local NANOGRID™ installation. This means that each node has a direct parent except for one node which is the grid connection point. Refer to the example below:

```
[MAINPANEL]
type=fuse
rating=40
parent=MAINPANEL
```

Station node type

The basic format of a station node is:

```
[NG-STATION-1]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST
```

Definitions:

[NG-STATION-1]	The identity of the station node. It has to be unique for each node in the configuration file. It also has to correspond with the chargebox identity parameter set on the charging station. For more information, refer to the CHARGESTORM CONNECTED 2 USER MANUAL.
type=station	Defines that this is a station type node.
parent=MAINPANEL	Defines the distribution board the station is connected to. In this case, a distribution board with the identity MAINPANEL. This means that the station is electrically downstream from the node MAINPANEL.
outlet/size=2	Defines that the station is equipped with 2 EVSEs (“outlets”).
outlet/1/fallback_ current=8	Integer value that states what current capacity (in Ampere) must be assigned to an EV connected to the first EVSE in case the charging station loses the connection with the NANOGRID™ controller. Accepted values are 0 or >=6 (6 A or larger). A value of 0 (zero) means that charging will not be allowed if the station loses contact with the NANOGRID™ controller. The fallback current is 8 A in the example.
outlet/2/fallback_ current=8	Fallback current for the second EVSE. Refer to the description above.

PhaseRotation=RST	States how the charging station is connected to the grid supply. A combination of: • R (Grid L1) • S (Grid L2) • T (Grid L3) • x (Unconnected) In the example, the station is connected to grid phases L1, L2, and L3. In that order (not rotated). **NOTE: A 1-phase, single-EVSE station could have a PhaseRotation of either Rxx, Txx or Sxx.**

IMPORTANT: Nodes of type station cannot be set as parents, as they can only be end nodes.

IMPORTANT: The outlet/x/fallback_current parameter will default to 0 A (charging is not possible) by the NANOGRID™ controller if it is missing.

NOTE: Make sure that the combined fallback currents do not assign too much in the event of a local NANOGRID™ controller or network failure.

NOTE: For more information about the fallback and offline behavior, refer to "Offline and fallback behavior" on page 11.

To do before you configure a NANOGRID™ installation

1. Make sure that the NANOGRID™ compliant units are in operation.
2. Make sure that the units have applicable licenses.
3. Make sure that the local electrical grid conditions are known.
4. Make sure that the electrical installation is completed and will not be changed in the near future.
5. Make sure that the units contain a correct LAN configuration.
6. Make sure that applicable firmware is in operation. Version R3.11.14 or later is recommended.

To install the nanogrid.ini configuration file

- Install the nanogrid.ini file via the CTEK CHARGE PORTAL web interface, a third party CSMS backend, or upload the nanogrid.ini file through the NANOGRID™ controller web interface, refer to "To install the nanogrid.ini configuration file through the controller web interface" on page 5.

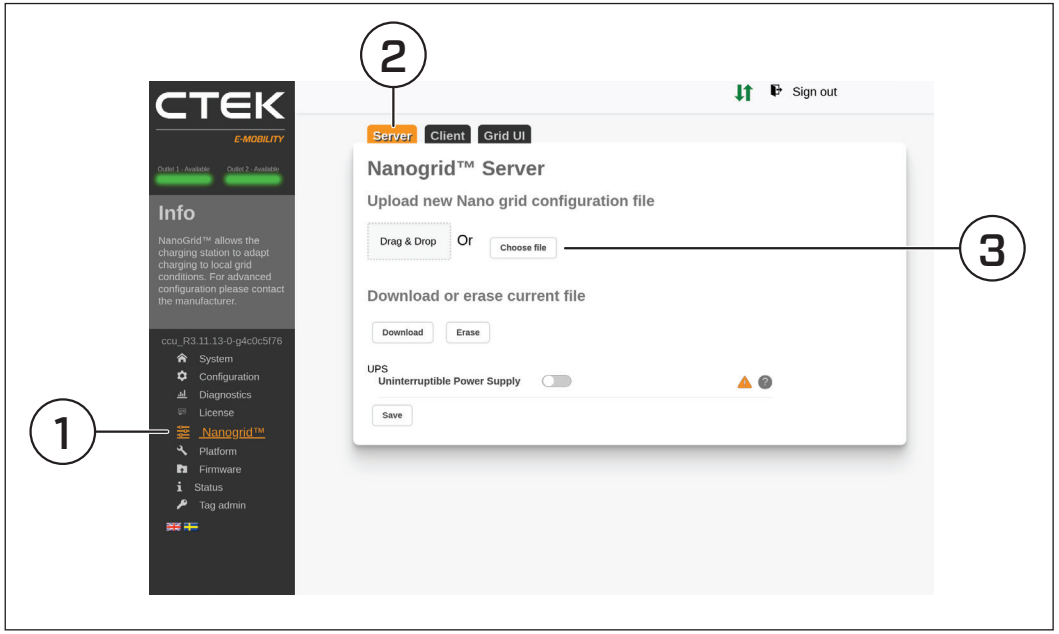
NOTE: The nanogrid.ini configuration file must only be placed on the controller unit. Failure to install the file on the local controller unit or failure to limit installation to the local controller unit will result in undesired behavior.

NOTE: If the nanogrid.ini configuration file is written incorrectly the NANOGRID™ controller will send a StatusNotification with the NgErrorConfiguration error to the CSMS backend, and ignore the file.

To install the nanogrid.ini configuration file through the controller web interface

- Refer to the CGC500 INSTALLATION MANUAL for instructions on how to access the web interface on the CGC500 GRID CONTROLLER.
- Refer to the CHARGESTORM CONNECTED 2 USER MANUAL for instructions on how to access the web interface on a CHARGESTORM CONNECTED 2 station.

1. In the web interface, go to “NANOGRID™” in the left menu.



2. Select the "Server" tab.
3. Do one of the procedures that follow.
   a Push the “Choose file” button to open a file dialog window and select the file.
   b. Drag and drop the nanogrid.ini file at the grey “Drag & Drop” area.
4. Press the “Upload" button to transfer the nanogrid.ini file to the NANOGRID™ controller.

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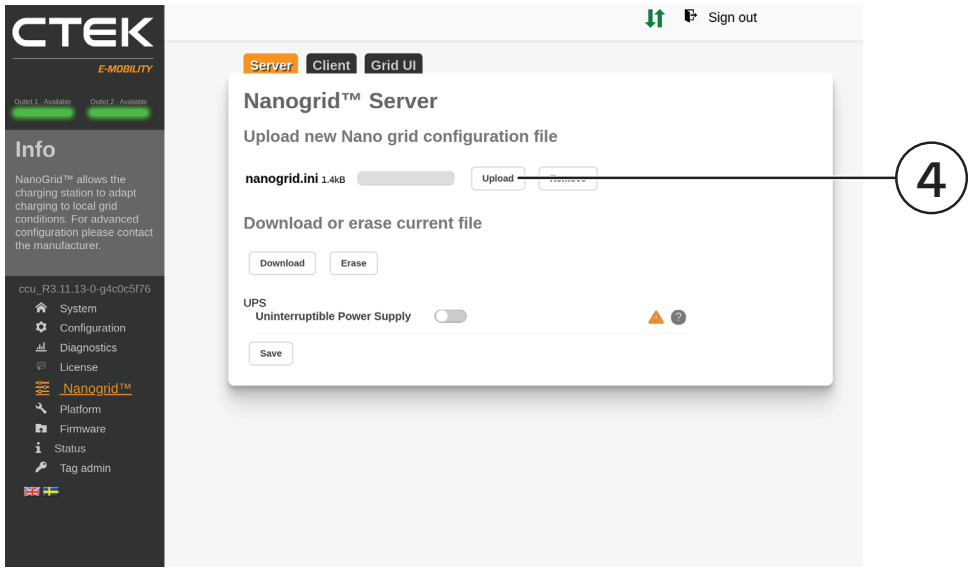


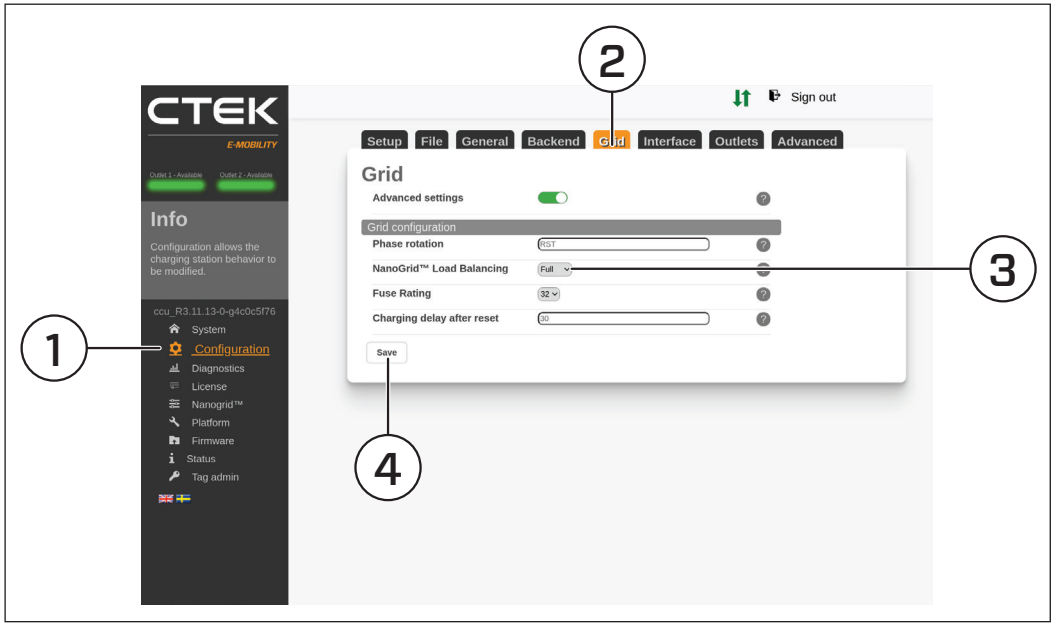
5. Restart the NANOGRID™ controller to use a new or modified nanogrid.ini. The file is currently only processed at system startup.

IMPORTANT: Any existing nanogrid.ini configuration file on the controller will be replaced when you install a new file through the web interface.

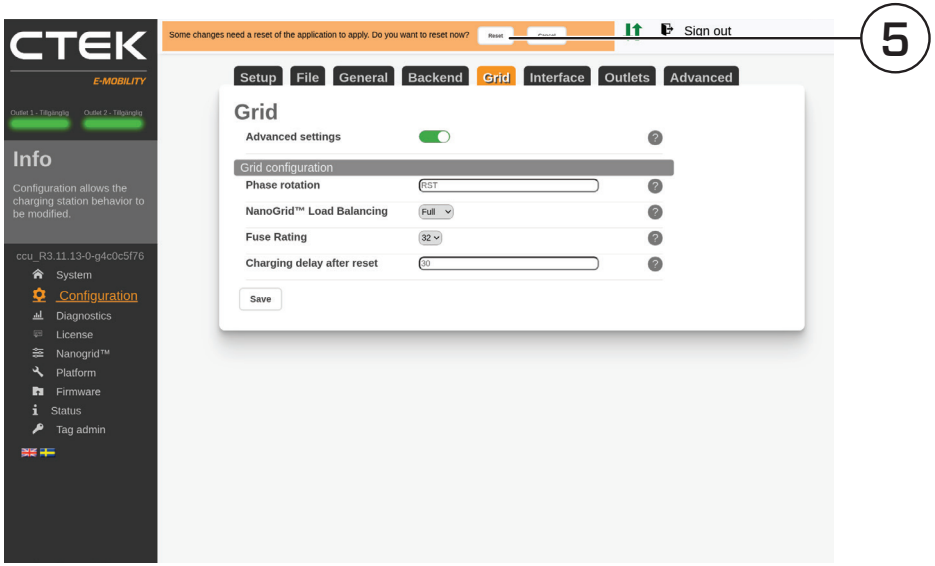
To do a client (station) configuration

Note: Refer to the CHARGESTORM CONNECTED 2 USER MANUAL for instructions on how to access the web interface on a CHARGESTORM CONNECTED 2 station.

1. In the web interface, go to “Configuration” in the left menu.



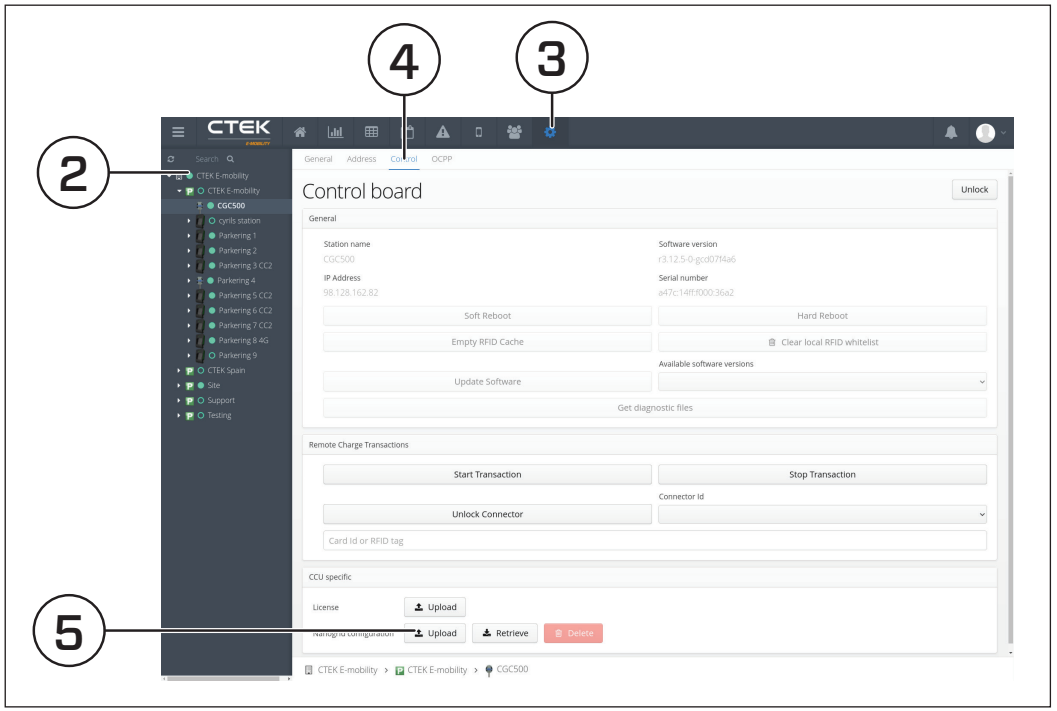
2. Select the "Grid" tab.
3. Make sure that “NANOGRID Load Balancing” is set to “Full”.
4. If the value is not set to “Full,” change the value in the drop-down and press the “Save” button.
5. When prompted, push the “Reset” button on top of the web interface page to reset the applications on the station and apply new settings.



To install the nanogrid.ini configuration file through the CHARGE PORTAL web interface

1. Make sure that the NANOGRID™ controller has been successfully set up to use the CHARGE PORTAL OCPP backend.
2. Select the NANOGRID™ controller node in the left menu.

Note: The illustration shows an example for the controller “CGC500”.



3. Select the "cog" icon.
4. Select the “Control” tab.
5. Push the NANOGRID™ configuration "Upload" button to select and install the nanogrid.ini file.

To install the nanogrid.ini configuration from a 3rd party CSMS (backend)

- Speak to your CSMS support for information.

Advanced configuration

To select load balancing scheduler

The scheduler controls how the scheduling (load balancing) will be done. Three schedulers are available:

EQUAL: This scheduler tries to keep a fair distribution among EVSEs with charging EVs.

FIFO: First in first out scheduling. The EVSEs with the longest charging session are prioritized.

SIMPLEFEEDBACK: A feedback-based scheduler that can be abbreviated as SFB in nanogrid.ini. This is the recommended scheduler.

- Set the scheduler parameter at the top-level category to select scheduler.

EN

NOTE: The value is case-insensitive.

```
[General]
scheduler=SIMPLEFEEDBACK
```

Note: If the value is missing or incorrect, the EQUAL will be used as the default scheduler for the load balancing.

For more information about the schedulers, refer to "The NANOGRID™ schedulers" on page 12.

To do an additional fallback configuration for phase-switching supported stations

If a station is phase-switching it has the capability to either provide 3-phase current or a 1-phase current, on either phase.

Note: The station node will inform the controller if it has phase-switching capabilities. Only the FIFO and SIMPLEFEEDBACK schedulers support phase-switching station nodes.

1. Do an additional fallback configuration in the nanogrid.ini file.

Example:

```
[STATIC-1]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RTS
```

```
[SWITCHING-A]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/1/fallback_output=2
outlet/2/fallback_current=8
outlet/2/fallback_output=3
PhaseRotation=TRS
```

Note: STATIC-1 is a “normal” non-phase-switching station node. The outlet/x/fallback_output parameter configures a phase-switching station to set which output must be provided if it goes offline. This parameter is only used for a phase-switching station and will be ignored for other charging stations.

2. Use one of the values that follow:

- **0:** No output (charging is not allowed).
- **1:** 3-phase output.
- **2:** 1-phase L1.
- **3:** 1-phase L2.
- **4:** 1-phase L3.

Feedback from non-EVSE loads

If a node has an external load that is measured by an energy meter, the scheduler takes it into consideration.

For example, if a fuse both has a charging station and large fan attached, the load of the fan is measured and the scheduler takes it into consideration when it controls the charging station.

Example:

```
[SHARED-BOARD]
type=measuredfuse
meter="modbus/1/1"
rating=20
parent=MAINPANEL
```

```
[STATION-1]
type=station
parent=SHARED-BOARD
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RTS
```

The meter="modbus/1/1" parameter value is used by the controller to communicate with the energy meter:

Definitions:

modbus	The controller must use the modbus communication protocol to read values from the energy meter.
1	The energy meter communication wire is connected to the first serial port of the controller.
1	The modbus device address of the energy meter, in this example 1. The address is configured on the energy meter.

NOTE: For CHARGESTORM CONNECTED 2 stations, modbus/2/1 and modbus/2/2 are reserved for the EVSE EV feedback modbus energy meters that are located inside the station. This applies if you use a NANOGRID™ local master controller.

NOTE: Modbus TCP energy meters are also supported. Currently we support Carlo Gavazzi EM24 series.

NOTE: Port 1 is the only available port on the CGC500

Example:

```
meter=modbus/192.168.0.123 to add a meter which has IP-address 192.168.0.123
```

Distribution board that measures the whole load

If a node has an energy meter attached that measures the load at the point, for example the aggregated load of the sub nodes, the scheduler can use that information to make its scheduling.

This contrasts with the measured fuse where only the external load is measured. The aggregated fuse is the sum of non-EV loads and EV loads.

Example:

```
[SHARED-BOARD]
type=aggregatedfuse
meter="modbus/1/1"
rating=20
parent=MAINPANEL
```

[STATION-1]
type=station
parent=SHARED-BOARD
outlet/size=2
outlet/1/fallback_current=6
outlet/2/fallback_current=6
PhaseRotation=RTS

For information about the meter="modbus/1/1" parameter value, refer to "Feedback from non-EVSE loads" on page 8.

EMS Configuration

If a node has an EMS (Energy Management System) attached that announces the available current in the grid, the scheduler can use that information to make its scheduling.

In this case, the available current through the distribution board will be set to the minimum of the rating and what the EMS reports as available.

EMS devices can be configured on a distribution board, for example nodes of type:

- fuse
- measuredfuse
- aggregatedfuse

An EMS is added with the configuration:

[MAINPANEL]
type=fuse
rating=200
parent=MAINPANEL
ems=ehub:192.168.200.12
emsfallback=100

Definitions:

[MAINPANEL]	The identity of the fuse node to add the EMS to.
ems= ehub:192.168.200.12	The endpoint of the EMS. It consists of the EMS <type>:<address>. In the example the type is ehub and the address is 192.168.200.12.
emsfallback=100	The fallback current in Ampere to use if connection to the EMS device is lost.

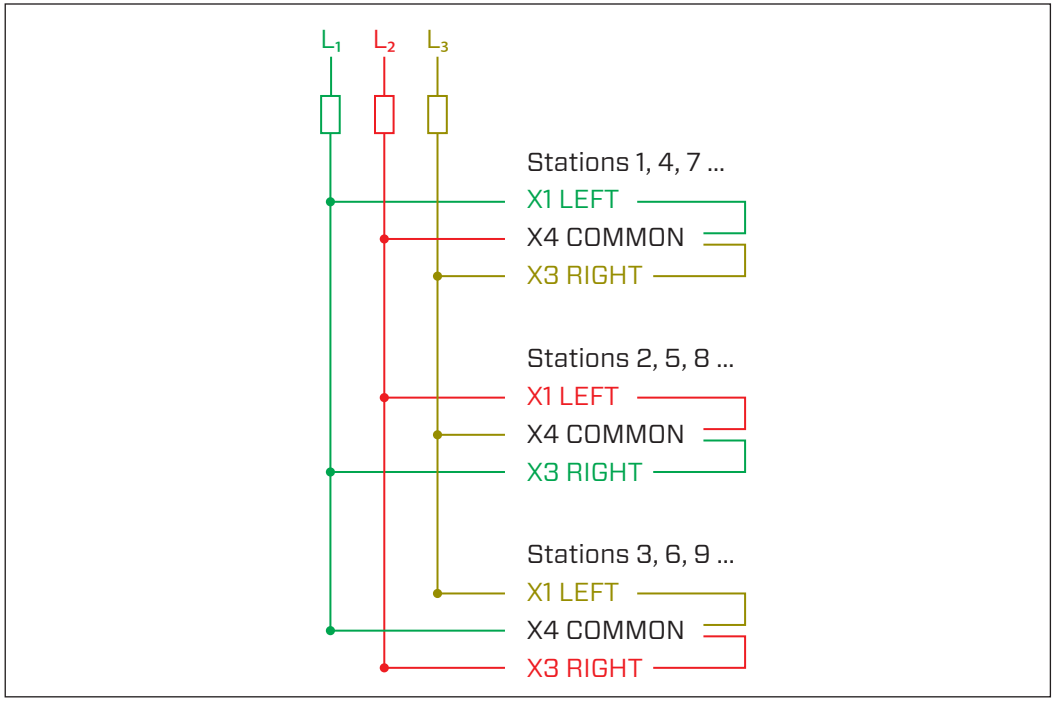
NOTE: Currently the only supported device is the Ferroamp EnergyHub. Use the device type ehub to enable the Ferroamp EnergyHub.

NOTE: The emsfallback configuration is a required parameter. If missing, the EMS will not be set up properly by the NANOGRID™ controller.

NOTE: The EMS is considered offline (fallback is used) if no successful communication with the device has occurred in a 30 second period.

To connect stations used in IT-Net

- Connect stations used in IT-net as shown in the schematic illustration.



To do the main fuse configuration

- Configure NANOGRID™ with a main fuse setting equal to the fuse value divided by 1.732 (the square root of three) and round down to the nearest value.

For example, for fuse rating 63 A set the fuse configuration parameters to 63/1.732 ≈ 36A.

To do the EVSE mapping

Each station and EVSE must be configured to reflect how the input phases are connected and how the measured current values are mapped to those phases. Refer to the schematic illustration in "To connect stations used in IT-Net" on page 9.

- Map the EVSEs according to the table. It is important to configure the phase and EVSE mappings correctly and according to the charging station type.

Station number	EVSE	Map current to	Electrical load
1,4,7	LEFT	L1	L1 to common L2
	RIGHT	L3	L3 to common L2
2,5,8	LEFT	L2	L2 to common L3
	RIGHT	L1	L1 to common L3
3,6,9	LEFT	L3	L3 to common L1
	RIGHT	L2	L2 to common L1

An example configuration, where there is a 63 A fuse in the input distribution panel, called MAINPANEL. However, according to the rule in "To connect stations used in IT-Net" on page 9, MAINPANEL is configured with 36 A. (63 / sqrt(3) = 36).

NOTE: Start the line with the # character to add comments in the nanogrid.ini file.

NOTE: If the 2 phases connected to each EVSE (EV connector), is connected to L1 & L2 on the input terminal, or if they must be connected to L1 & L3 depends on the type of the charging station. Refer to the manual of the charging station.

```
[MAINPANEL]
type=aggregatedfuse
# The rating is the actual fuse 63A / sqrt(3) = 36A, this is done as this
# is an IT-net installation.
rating=36
parent=MAINPANEL
```

```
[CC2-1]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RxT
```

```
[CC2-2]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=SxR
```

```
[CC2-3]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=TxS
```

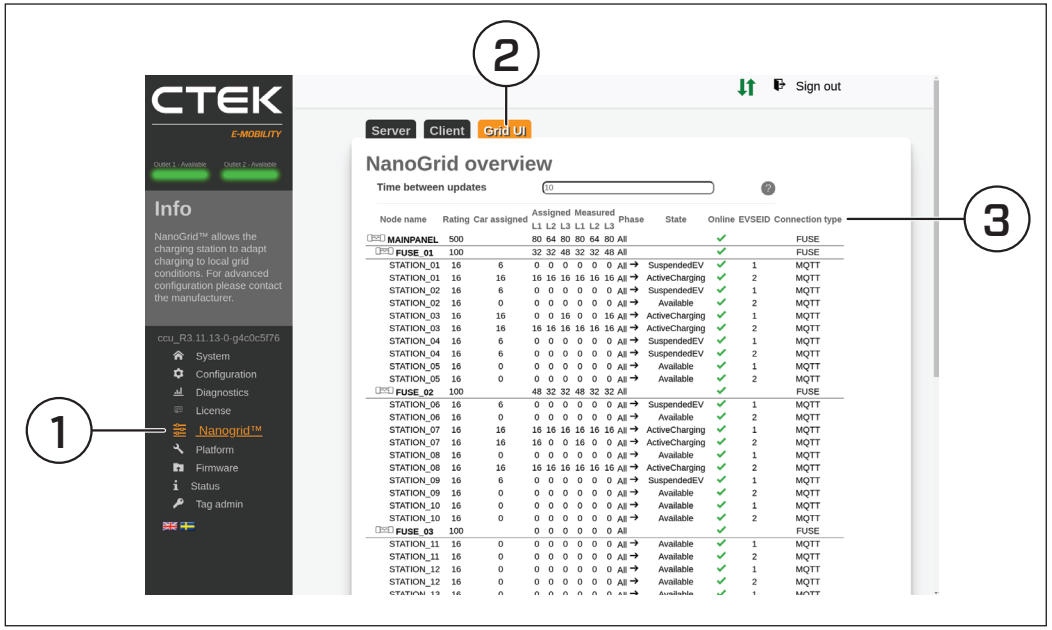
Monitoring/Verification

To monitor and verify the NANOGRID™ installation through the NANOGRID™ controller web interface

The NANOGRID™ controller web interface has a tool called “GRID UI” that can be used to monitor and verify the NANOGRID™ installation.

- Refer to the CGC500 INSTALLATION MANUAL for instructions on how to access the web interface on the CGC500 GRID CONTROLLER.
- Refer to the CHARGESTORM CONNECTED 2 USER MANUAL for instructions on how to access the web interface on a CHARGESTORM CONNECTED 2 station.

1. In the web interface, go to “NANOGRID” in the left menu
2. Select the “GRID UI” tab.



3. Refer to the definitions in the table for more information about the "GRID UI" tab.

Node name	Identity name of the node.
Rating	Fuse or station rating.
Car assigned	Charging capacity that has been assigned to the station by the NANOGRID™ controller. This is the maximum charging current that is reported to any connected EV.
Assigned	Charging capacity that has been assigned to the station by the NANOGRID™ controller, per phase.
Measured	Current draw per phase, reported by the station to the NANOGRID™ controller.

Phase	Phase(s) used by the EVSE, either All, L1, L2 or L3.
State	State of the EVSE, including but not limited to: • Available: No EV connected. • ActiveCharging: An EV is connected and is charging. • SuspendedEV: An EV is connected but does not request charging. • VehicleReady: An EV is connected that requests charging, but no assignment is available from the EVSE, the NANOGRID™ controller has set assignment to zero for the EVSE. • Pause: An EV is connected that does not request charging and there is no assignment available from the EVSE. • Faulty: The EVSE is faulted. • Penalty: An EV has drawn too much current.
Online	Station connection status: offline or online.
EVSE ID	1 or 2. For dual EVSE stations: • 1: Left EVSE • 2: Right EVSE For single EVSE stations: • 1: Right EVSE
Connection Type	FUSE: fuse node MQTT: station node. The MQTT communication protocol is used to communicate between stations and the NANOGRID™ controller.

Software description

NOTE: Many illustrations in the examples below are screenshots from the CHARGESTORM CONNECTED 2 / GRID CONTROLLER web interface NANOGRID™ "GRID UI" tab.

Firmware upgrade of station nodes

The first time a station connects to the NANOGRID™ controller, it will report its currently installed firmware version.

The controller will change the firmware of the station if it is necessary by transferring a binary file to it and start a firmware install. This means that the controller can both upgrade and "downgrade" the firmware of the station, as it is preferred that the controller and stations use the compatible version.

If the firmware is installed successfully, the station will automatically restart to complete the installation.

If there are any connected EVs to the station, the restart will be delayed until all EVs have been disconnected. All available EVSEs are temporarily disabled until the restart has been done.

NOTE: If the station is connected to an OCPP backend, it will send FirmwareStatusNotification.req notifications.

Automatic configuration of station nodes and controller

The first time a station connects to the NANOGRID™ controller, the station will report the configuration parameters to the controller (per EVSE) as follows:

- Fuse rating: the EVSE fuse rating.
- Minimum allowed charging current: the minimum assignment required from the controller to start a charging session. This value is usually 6 A, but other settings can change it. The minimum required charging current cannot be below 6 A.
- Phases connected: Which phases, in relation to the main grid, is used by the EVSE. This can be all 3 (3-phase EVSE) or 1 of L1, L2, L3 (1-phase EVSE).
- Phase switching supported: determines if the EVSE supports phase-switching, in example the function to supply 3-phase current or output to a 1- phase.
- Primary phase: Which phase, in relation to the main grid, is the main phase in the EVSE charging socket. This is the phase which 1-phase EVs will use.

The controller will use the configuration information set locally in the station during load balancing.

The NANOGRID™ controller will also report configuration from the nanogrid.ini configuration file to the station:

- Phase rotation: how the station is connected to the grid. If this value is different from the station local configuration, the station will apply the value from the controller and restart. This will make the station re-calculate how the EVSE phases are connected in relation to the grid. These are re-sent to the controller.
- Fallback configuration

The Phase rotation and fallback configuration in the nanogrid.ini configuration file overwrites local station configuration values, if it is different.

Offline and fallback behavior

The NANOGRID™ controller considers a station to be offline when no communication has been received from the station for 60 seconds.

The station is offline if it has not received any communication from the NANOGRID™ controller for 60 seconds.

When a station is offline, the NANOGRID™ controller will reserve the configured fallback value(s) to the station. This reservation is subtracted from the total available charging capacity for the NANOGRID™ installation.

The station will only let a charging EV to draw (at most) the configured fallback value.

Example:

Distribution Board MAINPANEL 50 A with 4 EVSEs.

STATION_1: EVSE1 (16 A)

STATION_1: EVSE2 (16 A)

STATION_2: EVSE3 (16 A)

STATION_2: EVSE4 (16 A)

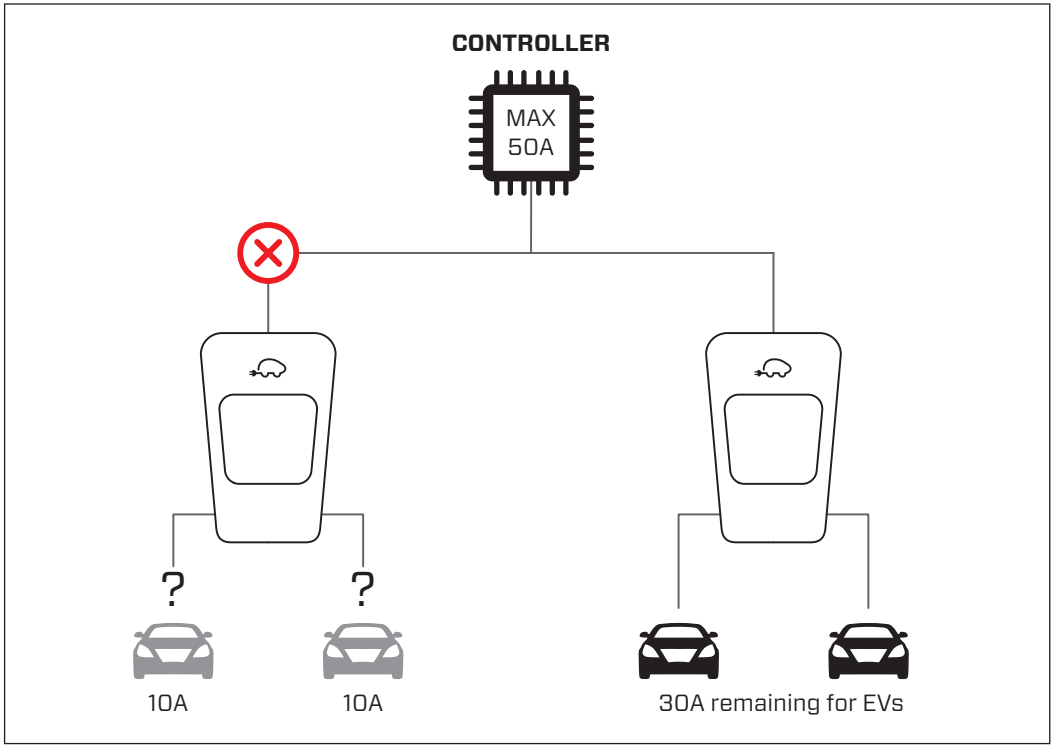
All EVSEs have fallback configured to 10 A. outlet/1/fallback_current=10 & outlet/2/fallback_current=10 in the nanogrid.ini configuration file.

- STATION_2 has two charging EVs, STATION_1 has both EVSEs available. EVSE3 and EVSE4 are assigned 16 A each.

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		32	32	32	32	32	32	All		✓		FUSE
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT
STATION_02	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	2	MQTT

- STATION_1 goes offline, the controller reserves 10 A (for each EVSE) of the total capacity, thus 30 A remains for charging. Assignment to EVSE3 is reduced.

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		50	50	50	30	30	30	All		✓		FUSE
STATION_01	16	10	10	10	10	0	0	0	All →	Available	✗	1	MQTT
STATION_01	16	10	10	10	10	0	0	0	All →	Available	✗	2	MQTT
STATION_02	16	14	14	14	14	14	14	14	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	2	MQTT



The NANOGRID™ schedulers

The NANOGRID™ schedulers are used to balance the load among connected stations. In most scenarios, the recommended scheduler is SIMPLEFEEDBACK.

EQUALSHARE scheduler

The EQUALSHARE scheduler tries to keep a fair distribution of capacity among EVSEs.

1. Any offline EVSE is allocated their respective configured fallback capacity.
2. The number of EVSEs with charging EVs are counted (Count).
3. Total available capacity is calculated (TotCap).
4. Each charging EVSE gets assigned (TotCap/Count) Ampere.

Example:

Setup: Distribution Board MAINPANEL 50 A with 4 EVSEs.
STATION_1: EVSE1 (16 A)
STATION_1: EVSE2 (16 A)
STATION_2: EVSE3 (16 A)
STATION_2: EVSE4 (16 A)

1. No EVs connected at the start: thus, 0 A assignment:

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		0	0	0	0	0	0	All		✓		FUSE
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT

2. EVs connect to EVSE 1, 2 and 3. Each EVSE receives an assignment of 50 A / 3 ≈ 16 A from the EQUALSHARE scheduler:

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		48	48	48	32	32	32	All		✓		FUSE
STATION_01	16	16	16	16	16	11	11	11	All →	ActiveCharging	✓	1	MQTT
STATION_01	16	16	16	16	16	10	10	10	All →	ActiveCharging	✓	2	MQTT
STATION_02	16	16	16	16	16	11	11	11	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT

3. A fourth EV connects to the available EVSE. Each EVSE receives an assignment of 50 / 4 ≈ 12 A from the EQUALSHARE scheduler:

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		48	48	48	44	44	44	All		✓		FUSE
STATION_01	16	12	12	12	12	11	11	11	All →	ActiveCharging	✓	1	MQTT
STATION_01	16	12	12	12	12	10	10	10	All →	ActiveCharging	✓	2	MQTT
STATION_02	16	12	12	12	12	11	11	11	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	12	12	12	12	12	12	12	All →	ActiveCharging	✓	2	MQTT

FIFO scheduler

The FIFO scheduler operates on a first in, first out basis, FIFO. EVSEs with the longest charging duration are prioritized. EVSEs with charging EVs are assigned the reported EV current draw + 3 A.

Example:

Setup: Distribution Board MAINPANEL 50 A with 4 EVSEs.
STATION_1: EVSE1 (16 A)
STATION_1: EVSE2 (16 A)
STATION_2: EVSE3 (16 A)
STATION_2: EVSE4 (16 A)

1. No EVs connected at the start: thus, 0 A assignment:

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		0	0	0	0	0	0	All		✓		FUSE
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT

2. EVs connected to EVSE 1, 2 and 3:

- EV1 draws 16 A
- EV2 draws 16 A
- EV3 draws 13 A

All EVSEs gets allocated their maximum assignment from the FIFO scheduler: 16 A.

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		48	48	48	45	45	45	All		✓		FUSE
STATION_01	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	1	MQTT
STATION_01	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	2	MQTT
STATION_02	16	16	16	16	16	13	13	13	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT

3. A fourth EV connects to the available EVSE. As there is no available capacity to charge another EV (minimum required is 6 A), the EVSE gets no current assignment:

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		48	48	48	45	45	45	All		✓		FUSE
STATION_01	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	1	MQTT
STATION_01	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	2	MQTT
STATION_02	16	16	16	16	16	13	13	13	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	VehicleReady	✓	2	MQTT

4. EV1 disconnects, EV4 receives an assignment of 16 A from the FIFO scheduler:

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		48	48	48	44	44	44	All		✓		FUSE
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_01	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	2	MQTT
STATION_02	16	16	16	16	16	13	13	13	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	16	16	16	16	15	15	15	All →	ActiveCharging	✓	2	MQTT

SIMPLEFEEDBACK scheduler

The SIMPLEFEEDBACK scheduler uses the EVSE energy meter feedback to assign the capacity. Each EVSE periodically reports the EV current draw to the controller.

Assignment is done individually per phase. If an EVSE uses a single-phase for charging (either physically connected, or the connected EV only draws on one phase), that will be considered.

1. Any offline EVSE is allocated their respective configured fallback capacity.
2. EVSEs with charging EVs are assigned the reported EV current draw + 3 A. EVSEs with the longest charging duration are being prioritized if the total capacity limit has been reached.
3. Remaining EVSEs with charging EVs but invalid feedback (e.g. broken energy meter) share the remaining capacity equally. Similar to EQUALSHARE.

Example:

Setup: Distribution Board MAINPANEL 50 A with 4 EVSEs.
STATION_1: EVSE1 (16 A)
STATION_1: EVSE2 (16 A)
STATION_2: EVSE3 (16 A)
STATION_2: EVSE4 (16 A)

1. No EVs connected at the start: thus, 0 A assignment:

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		0	0	0	0	0	0	All		✓		FUSE
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_01	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT

2. EVs connected to EVSE 1, 2:

- EV1 draws 14 A
- EV2 draws 6 A

EVSE1 receives an assignment of 16 A as 14 + 3 = 17, but EVSE maximum allowed is 16 A. EVSE2 receives an assignment of 9 A as 6 + 3 = 9.

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		25	25	25	20	20	20	All		✓		FUSE
STATION_01	16	16	16	16	16	14	14	14	All →	ActiveCharging	✓	1	MQTT
STATION_01	16	9	9	9	9	6	6	6	All →	ActiveCharging	✓	2	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	1	MQTT
STATION_02	16	0	0	0	0	0	0	0	All →	Available	✓	2	MQTT

3. EV3 connects to EVSE3, EV4 connects to EVSE4:

- EV3 draws 16 A
- EVSE4 reports that energy meter values are invalid!

EVSE3 receives an assignment of 16 A from the SIMPLEFEEDBACK scheduler. EVSE4 receives an assignment of the remaining capacity of the grid: 50 –16 – 9 – 16 = 9 A

Node name	Rating	Car assigned	Assigned L1	Assigned L2	Assigned L3	Measured L1	Measured L2	Measured L3	Phase	State	Online	EVSEID	Connection type
MAINPANEL	50		50	50	50	36	36	36	All		✓		FUSE
STATION_01	16	16	16	16	16	14	14	14	All →	ActiveCharging	✓	1	MQTT
STATION_01	16	9	9	9	9	6	6	6	All →	ActiveCharging	✓	2	MQTT
STATION_02	16	16	16	16	16	16	16	16	All →	ActiveCharging	✓	1	MQTT
STATION_02	16	9	9	9	9				All →	ActiveCharging	✓	2	MQTT

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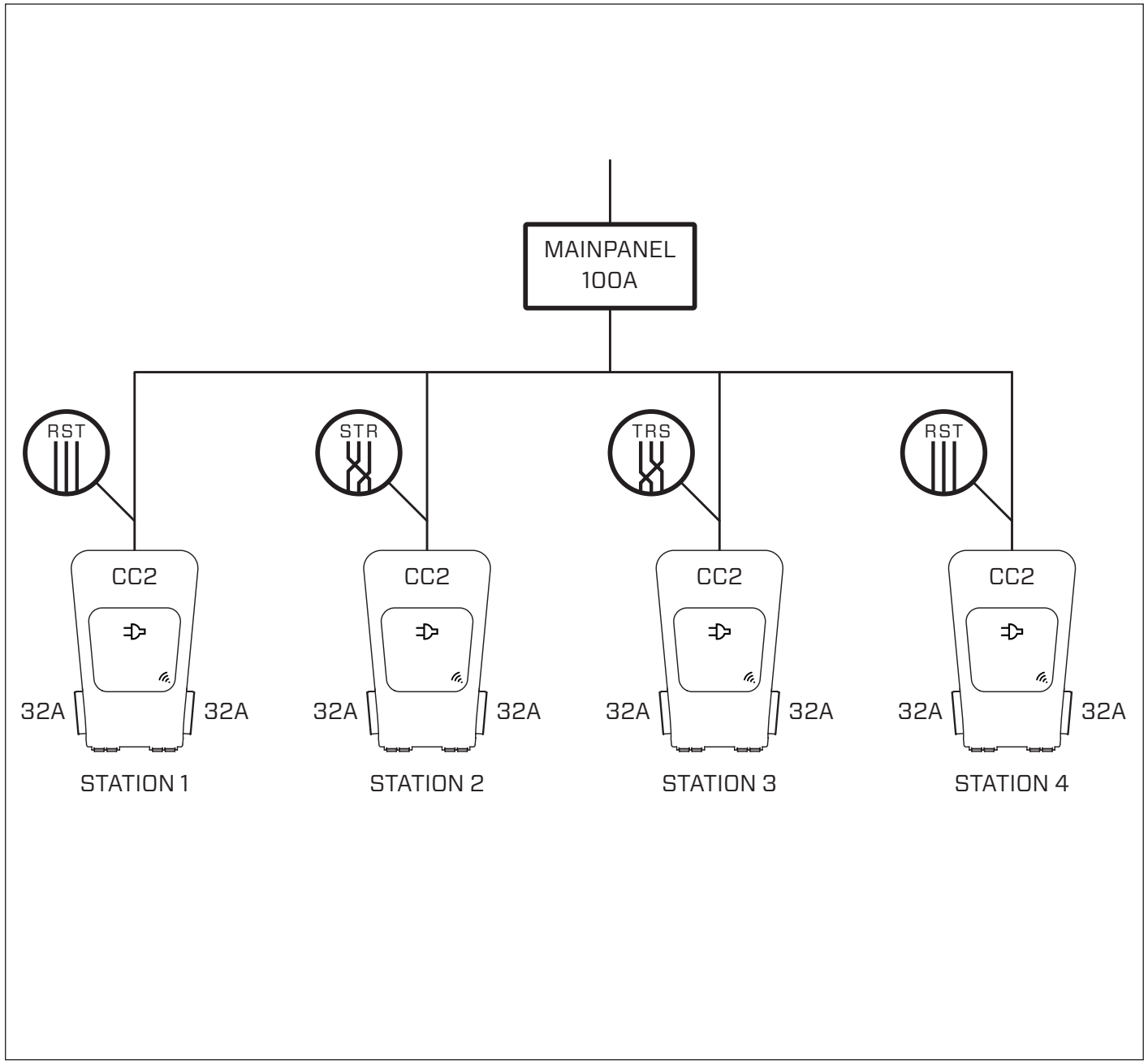
Appendix

Glossary of terms/abbreviations/acronyms

Controller	The NANOGRID™ controller, a GRID CONTROLLER, e.g. CGC500 or a LOCAL CONTROLLER, is a charging station which operates as a controller and a station node.
CSMS	Charging Station Management System.
EMS	Energy Management System.
EV	Electric Vehicle.
EVSE	Electric Vehicle Supply Equipment. A station can have 1 or more EVSEs. The CHARGESTORM CONNECTED 2 stations have 1 or 2 EVSEs.
Load	The current load used in the grid. It comes from the charging EVs or other.

Complete installation examples

4-station installation, NANOGRID™ local

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scheduler=SIMPLEFEEDBACK

[[MAINPANEL]
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parent=MAINPANEL
rating=100

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type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST

[STATION_02]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=STR

[STATION_03]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=TRS

[STATION_04]
type=station
parent=MAINPANEL
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST
```

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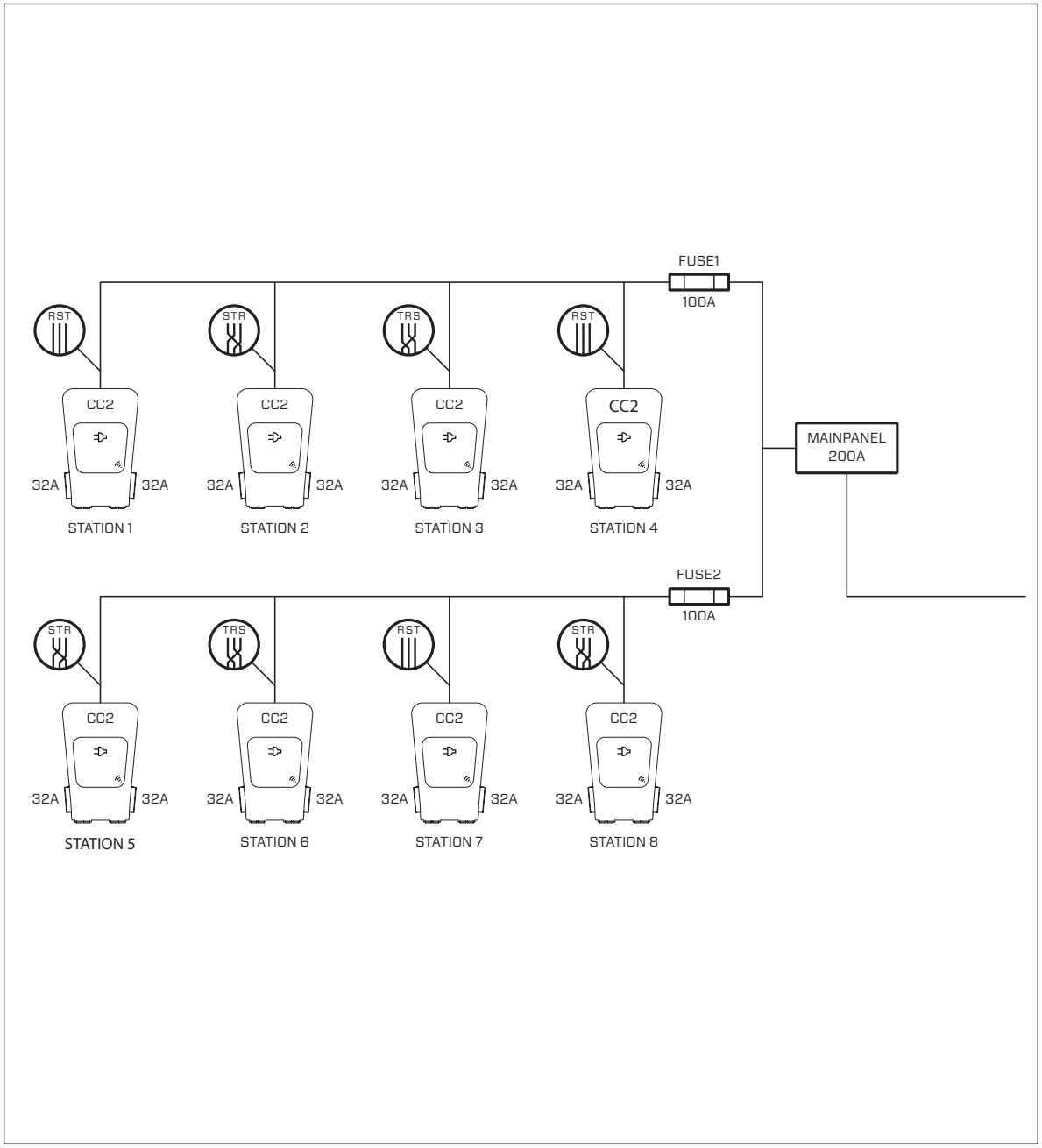
8-station installation with sub-fuses, NANOGRID™ local




```
[General]
scheduler=SIMPLEFEEDBACK

[MAINPANEL]
type=fuse
parent=MAINPANEL
rating=200

[FUSE_01]
type=fuse
parent=MAINPANEL
rating=100

[FUSE_02]
type=fuse
parent=MAINPANEL
rating=100

[STATION_01]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST

[STATION_02]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=STR

[STATION_03]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=TRS

[STATION_04]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST

[STATION_05]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=STR

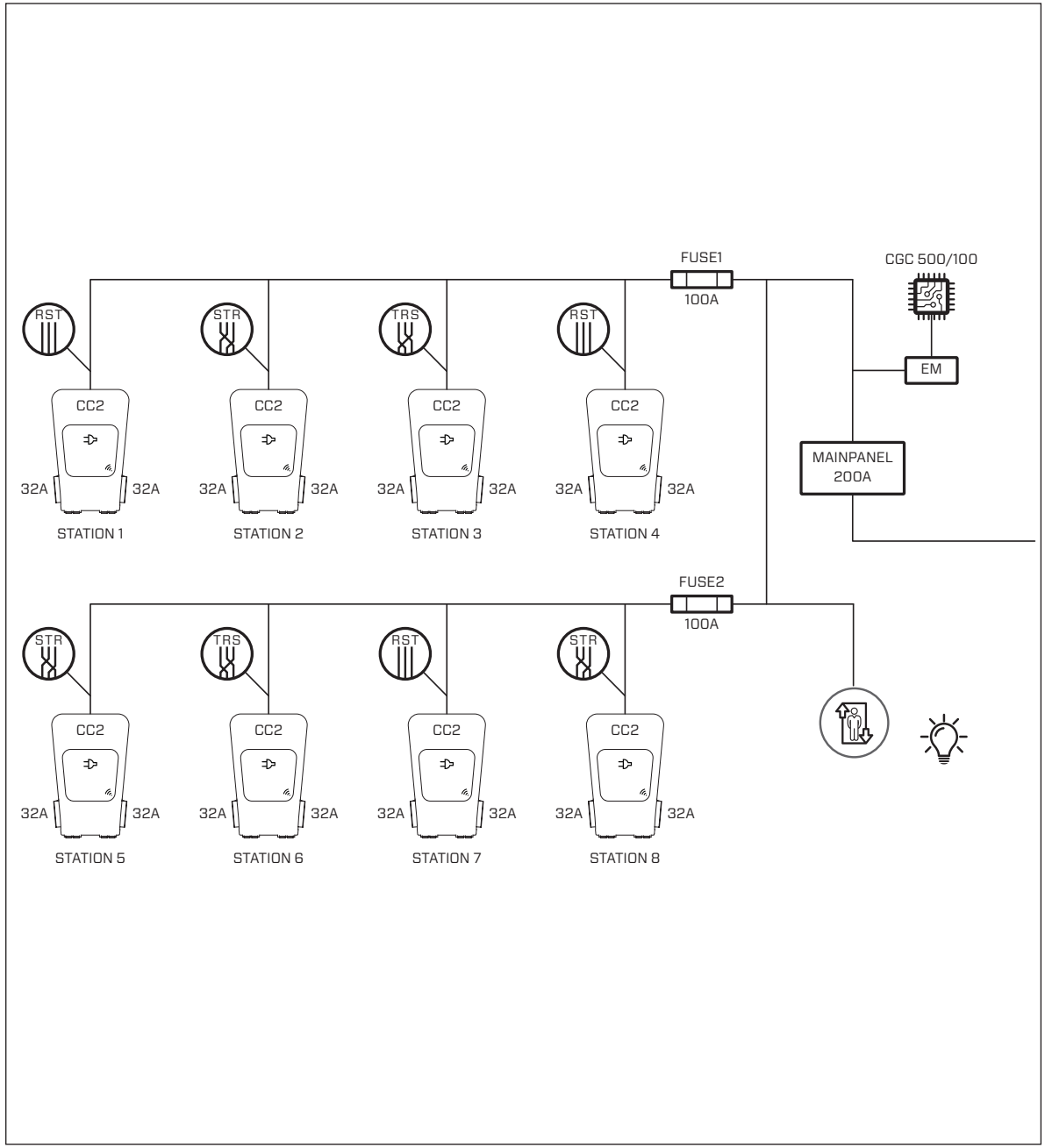
[STATION_06]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=TRS

[STATION_07]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST

[STATION_08]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=STR
```

8-station installation with sub-fuses, NANOGRID™ grid central CGC500/CGC100

Measuring the EVSE and the external load.



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scheduler=SIMPLEFEEDBACK

[MAINPANEL]
type=aggregatedfuse
meter="modbus/1/123"
parent=MAINPANEL
rating=200

[FUSE_01]
type=fuse
parent=MAINPANEL
rating=100

[FUSE_02]
type=fuse
parent=MAINPANEL
rating=100

[STATION_01]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST

[STATION_02]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=STR

[STATION_03]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=TRS

[STATION_04]
type=station
parent=FUSE_01
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST

[STATION_05]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=STR

[STATION_06]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=TRS

[STATION_07]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=RST

[[STATION_08]
type=station
parent=FUSE_02
outlet/size=2
outlet/1/fallback_current=8
outlet/2/fallback_current=8
PhaseRotation=STR

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