
USER MANUAL

Terra AC wallbox

Load management



This document aims to describe the implementation of load management on the ABB Terra AC product line. It describes the strategies and the various load management topologies (with installation and configuration options). After reading this manual, one should be able to understand which load management options are available for the Terra AC charger and how these can be set.

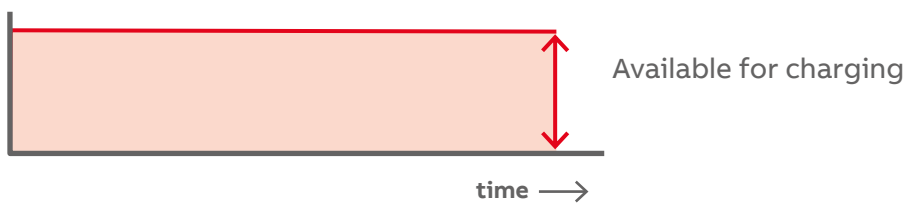
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1. Implementations

There are roughly two strategies possible to derate the power output of the Terra AC charger. You can either use static load management or dynamic load management.

1.1. Static mode

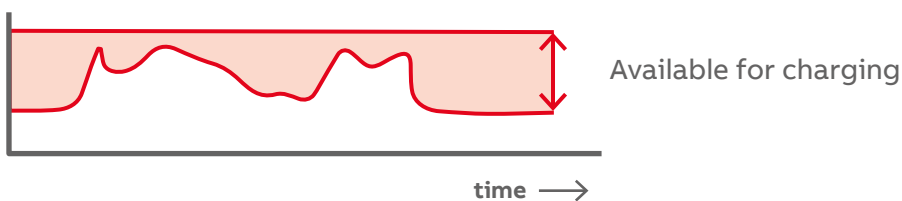


Load management can be static or dynamic. For static load management (SLM) the charging power is a fixed value, set as a calculation of grid capacity and other sources of power consumption. In this set-up the fixed charging power is distributed between all connected vehicles. The risk of installation tripping is eliminated as consumption is capped at a maximum load value.

Static Load Management is recommended when only chargers have to be managed.

Static Load Management ensures an even distribution of energy and maximizes grid capacity with no additional cost added as energy management system.

1.2. Dynamic mode



Dynamic Load Management (DLM) optimizes the charging infrastructure as it allows for dynamic change of available power by immediate reaction to capacity changes. DLM means gives the possibility to balance the power distribution to all EVs and taking full volume whenever the capacity is available.

Dynamic Load Management is recommended when the available power is impacted by other devices of the local grid.

Using DLM brings the full potential in a charging infrastructure, by protecting the local grid from overload when full usage and giving best power share allocation depending on specific application needs.

2. Local vs Cloud

2.1 Local load management

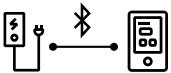
Local load management can be implemented as either static or dynamic, for single charger use or multiple charger installs.

setting can be done via the Terra Config and ChargerSync™ app.

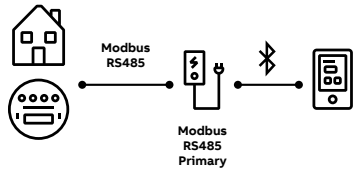
In single charger set-up the charger is the controller, so in this case the commissioning and LM

in multiple charger set-ups the local controller is primary and controls load management.

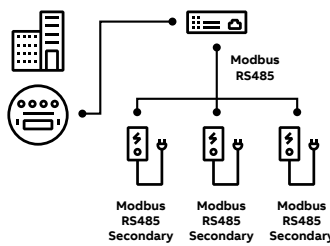
Static w/ single charger



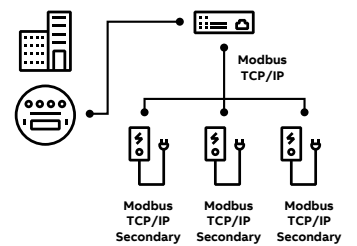
Dynamic w/ single charger



Dynamic w/ multiple chargers via local controller



Dynamic w/ multiple chargers via local controller

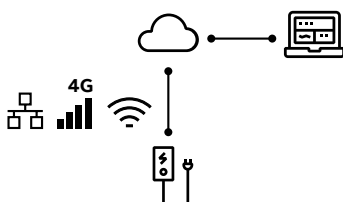


2.2. Load management via cloud

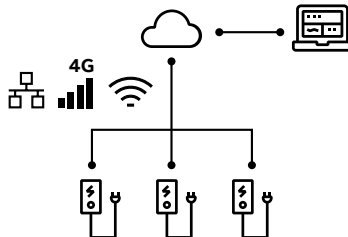
Load management via cloud is recommended for big installations, multiple chargers scenario. Can be implemented as either static, hybrid or dynamic, however best results can be obtained with a dynamic implementation.

The Cloud is the controller in this case and the set-up is done via the ChargerSync™ portal. The commissioning of the chargers as well as connection to a smart meter / controller is done via the TerraConfig app.

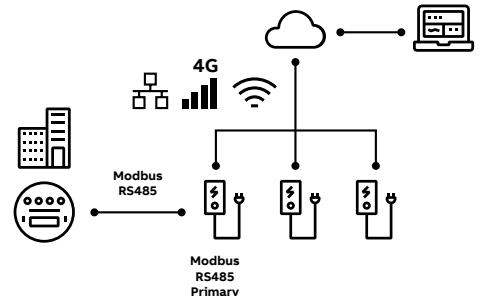
Static w/ single charger



Hybrid w/ multiple chargers



Dynamic w/ multiple chargers



3. Installation

The charging site needs to be well prepared to serve the specific application charging requirements. This includes the provision of the means to do proper load balancing, in case this is required. Therefore, it is essential to have a good understanding of the configurations and topologies possible.

3.1. Static Load Management

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Topologies available for Static Load Management

For static load management no external device is required. The installation of the TACWB (Terra AC Wallbox) suffices.

The settings can be done via the TerraConfig app, ChargerSync™ app and ChargerSync™ portal.

3.2. Hybrid and Dynamic Load Management

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Topologies available for Hybrid and Dynamic Load Management

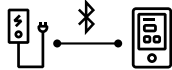
Dynamic charging with Terra AC can be done with:

- **Hybrid load management:** no connection to a smart meter. The set-up of the chargers change based on internal meter readings. Load management changes are configured from the ChargerSync™ portal.
- **Dynamic load management:** a connection to a smart meter exists to inform

on the consumption of the building and/or other charging stations.

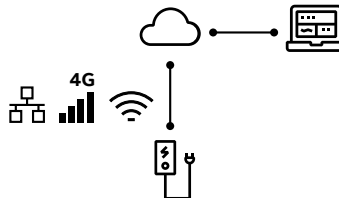
For Dynamic Load Management, the connection to a smart meter can be done either via RS-485 for Modbus RTU (option available across the TACWB portfolio) or to a controller via an ethernet connection for Modbus TCP/IP (option available for TACWB display and UL variants).

Static w/ single charger



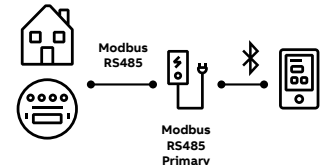
In the case of static load management with single charger, there is no need to have an external communication channel and/or device. Configuration can be done locally using the installer (TerraConfig) or user (ChargerSync™) applications.

Static w/ single charger



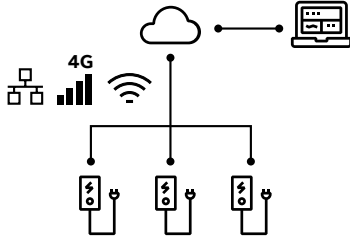
In the case of static load management with single charger it is possible to remotely set charging limits. For this topology an internet connection with a cloud based controlling system is required (either to the ABB ChargerSync™ backoffice or an external backoffice that supports static load management). This connection can be realized by using LAN, WiFi or 4G (depending on Terra AC model).

Dynamic w/ single charger

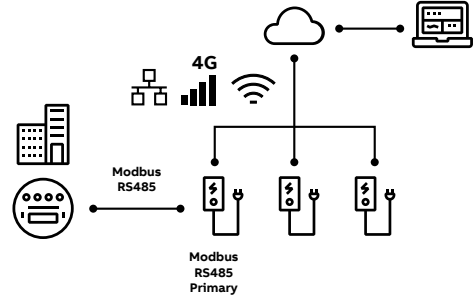


In the case of dynamic load management with single charger to be able to dynamically change the charging power output, the charger itself needs to be connected to an external energy meter using Modbus RS-485. Configuration can be done locally using the installer (TerraConfig) application.

Hybrid w/ multiple chargers



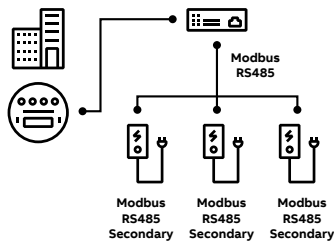
Dynamic w/ multiple chargers



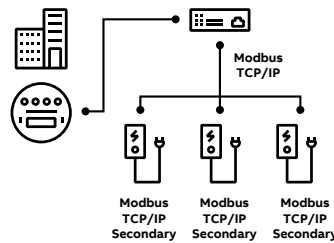
The hybrid load management with multiple chargers topology is a special case of dynamically balancing the load of multiple chargers. It uses a fixed capacity limit that is used to dynamically change the power output of multiple chargers. For this topology only a stable internet connection to all the chargers that are to be controlled is required (either to the ABB ChargerSync™ backoffice or an external backoffice that supports hybrid load management with multiple chargers). This connection can be realized by using LAN, WiFi or 4G (depending on Terra AC model).

For the topology above an internet connection (either to the ABB ChargerSync™ backoffice or an external backoffice that supports dynamic load management with multiple chargers) is required, in addition to connection to an external smart meter using Modbus RS-485. This connection can be realized by using LAN, WiFi or 4G (depending on Terra AC model).

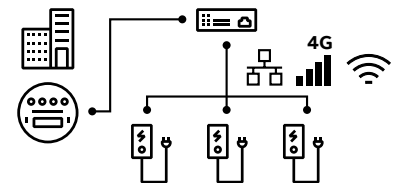
Dynamic w/ multiple chargers via local controller



Dynamic w/ multiple chargers via local controller



Dynamic w/ multiple chargers via local controller

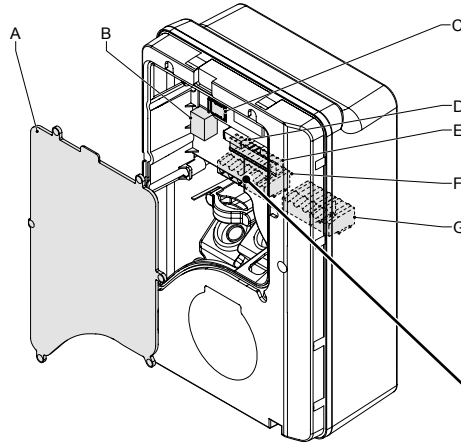


Dynamic load balancing with multiple chargers can also be done locally, with the use of a local controller. The chargers that are to be controlled should be connected to this local controller. Various means are available that can be used to connect the chargers to this local controller, including Modbus RS-485, Modbus TCP/IP (only for display and UL variants), LAN, WiFi and 4G (only available in some Terra AC models). The local controller should moreover be connected to an external meter to be able to perform dynamic load

management. The site configuration of this specific topology is heavily dependent on the technical properties of this local controller. Therefore, it is recommended to understand the way in which the specific controller that you would like to use communicates with both our chargers and the external energy meter.

3.2.1. RS-485 connection for Modbus RTU

-
- A. Maintenance cover
- B. Primary Ethernet connection
- C. Socket for a Nano-M2M SIM card
- D. Smart meter connection
- E. Terminal block for dry contacts input and output
- F. Terminal block for the AC input
- G. Terminal block for the EV charge cable or the socket



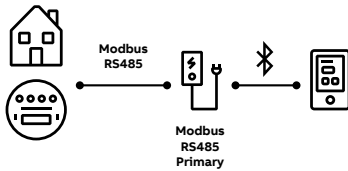
A terminal block is present (D) to facilitate the RS-485 – Modbus RTU connection.

A number of the topologies mentioned above require Modbus RTU (RS-485) communication. For these topologies, it is necessary to create a RS-485 – Modbus RTU connection. In the figure below, it is shown how the RS-485 – Modbus RTU connection can be established (on the Terra AC charger).

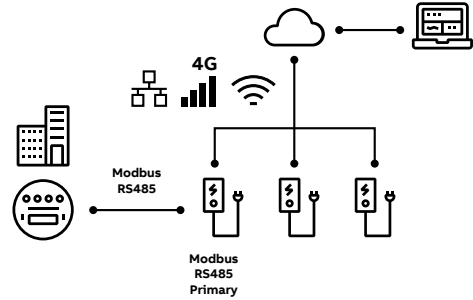
RS-485 connection for Modbus RTU

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- Modbus RTU–RS-485 topology available

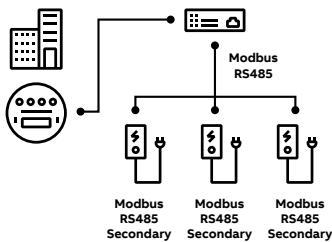
Dynamic w/ single charger



Dynamic w/ multiple chargers



Dynamic w/ multiple chargers via local controller



3.2.2. Ethernet connection for Modbus TCP/IP

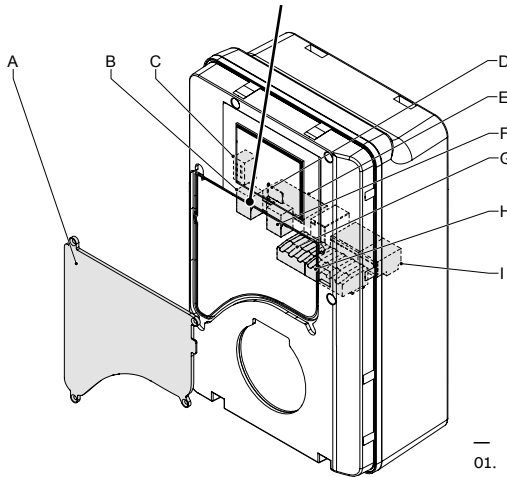
Ethernet connection (B) is present to facilitate the Modbus TCP/IP connection.

This option is available for display and UL variants of the TACWB family.

Other topologies might need to use Modbus TCP/IP. In the figure below, it is shown how the ethernet connection for Modbus TCP/IP can be established (on the Terra AC charger). Please note that in this configuration, the LAN/ethernet port is used for Modbus TCP/IP communication. It is therefore not possible to use this port for internet communication anymore.

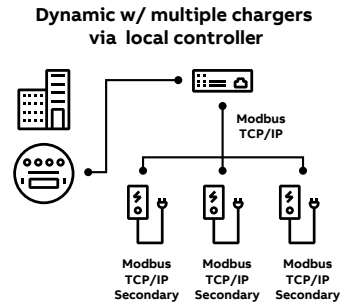
- 01
- A. Maintenance cover
- B. Primary Ethernet connection
- C. Electrical pulse connector
- D. Socket for a Nano-M2M SIM card
- E. Terminal block for the AC input
- F. Secondary Ethernet connection for Ethernet daisy-chain
- G. Smart meter connection
- H. Terminal block for dry contacts input
- I. Terminal block for the EV charge cable or the socket

Ethernet connection for Modbus TCP/IP



— 02
Modbus TCP/IP topology available

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Please be aware that not all energy meter models and local controllers are supported. Have a look on the Modbus documentation to see which energy meter models are currently supported.

For energy meter and controller models compatibility please review the TAC Modbus Communication.

4. Configuration

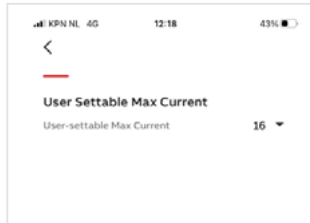
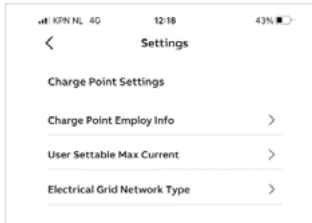
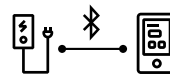
4.1. Static Load Management

To configure the Static load management the apps and portals can be used.

4.1.1. Configuration via the TerraConfig App

The internal charging limit (i.e. the absolute charging capacity of the TACWB. This limit is to be set by the installer/commissioner and cannot be modified by the end user) can be set at install and commissioning via the TerraConfig app within Settings – User Settable Max Current. The max current can be set at in increments of 1 A within the range of 6–32 A.

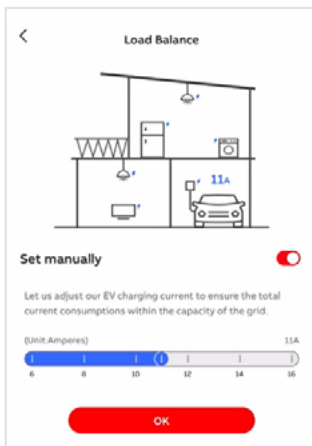
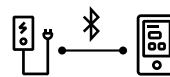
Static w/ single charger



4.1.2. Configuration via the ChargerSync™ App

The charging limit can be set manually in increments of 1A. This allows the end user to adjust the charging behavior depending on preferences/needs (e.g. energy rate, speed of charge).

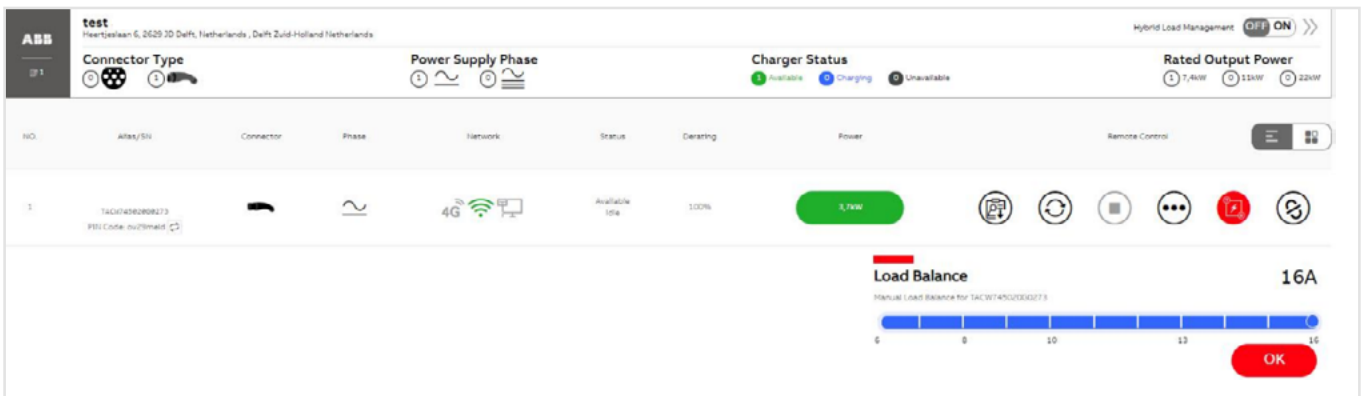
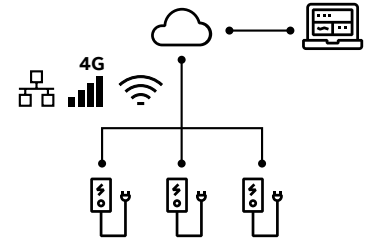
Static w/ single charger



4.1.3. Configuration via the ChargerSync™ Portal

Similar to the ChargerSync™ App, with the ChargerSync™ Portal a limitation can be set in 1 A increments for any selected charger.

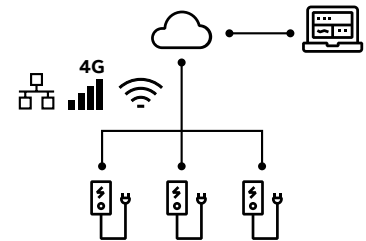
Hybrid w/ multiple chargers



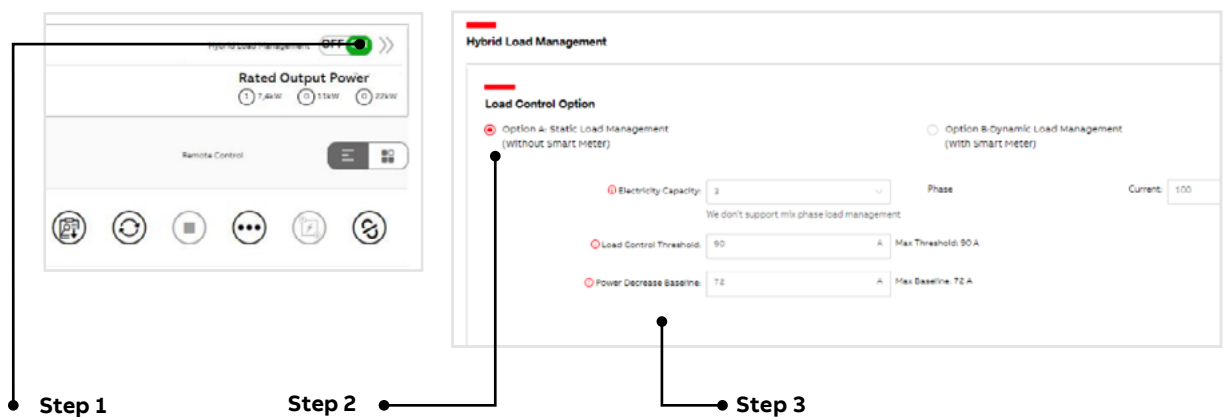
4.2. Hybrid Load Management

Hybrid Load Management brings a level of flexibility in absence of a smart meter. Hybrid Load Management is recommended for multiple charger installations.

Hybrid w/ multiple chargers



4.2.1. Configuration via the ChargerSync™ Portal



Set the Electricity Capacity, Load Control Threshold and Power Decrease Baseline.

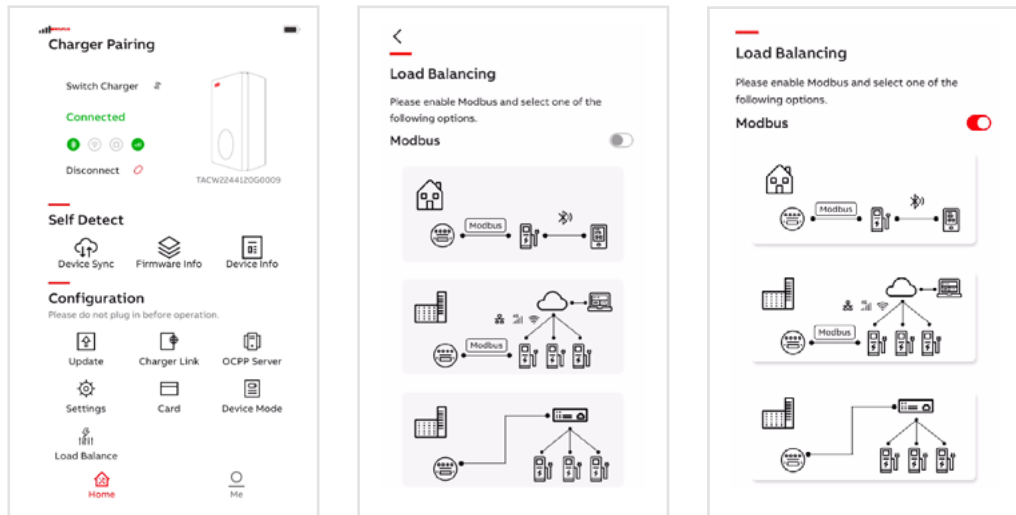
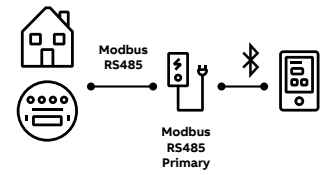
4.3. Dynamic Load Management

Dynamic load management gives an additional level of flexibility by informing on the overall consumption (chargers and external consumers). This enables maximum usage of the grid capacity by ensuring an immediate reaction to changes within the consumption level.

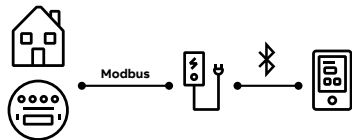
4.3.1. Configuration via the TerraConfig App

To configure the Modbus smart meter the Terra-Config app needs to be used (v 1.6.1 or higher). The path is: [Main page] → [Load Balance] → enable Modbus → select scenario → configure meter as per the following options.

Dynamic w/ single charger

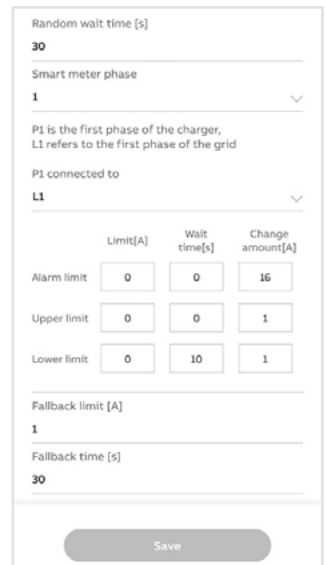
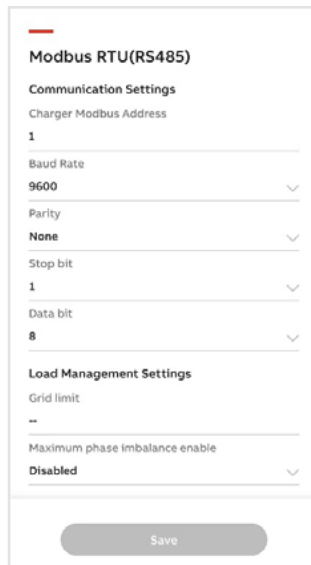


• **Single charger (Charger as Primary)**
Available for Modbus RTU – RS-485 only



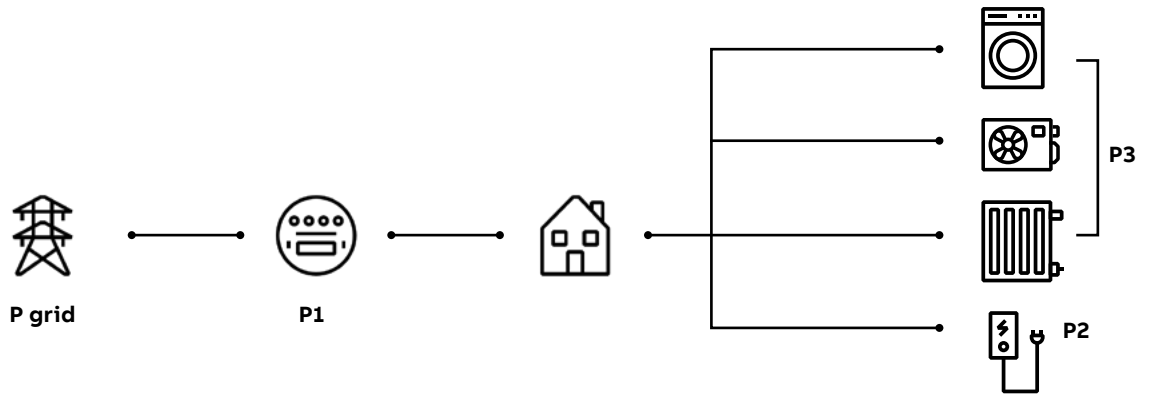
In this scenario the charger is Modbus Primary. Generally recommended for home installation: one charger – one meter.

In this scenario the load management decision comes from the embedded charger algorithm.



To be able to configure dynamic load management for a single charger in the TerraConfig application, it is necessary to understand the various input variables and affiliated charging behavior. In this section, a general overview of

the dynamic load management strategy for single charger and the input variables of the load balancing algorithm of Terra AC chargers are explained.



The essential elements of the load management system:

- The maximum current capacity of the grid or its sub grid system, marked as **P grid**
- Smart meter with Modbus interface to monitor the real time current of the grid or its subsystems, reporting total consumption, marked as **P1**
- Controllable load target, in this case, the charging EV, marked as **P2**
- Other loads, in this case, other operating home electric appliances (AC, induction cooking, etc.) marked as **P3**.

Assuming a house like the diagram above is a sub grid system (ignore the line loss):

$$P1 = P2 + P3$$

This system can be realized as a minimum system of load management, consider the maximum current capacity is 100 Amps, for safety and margin consideration, the controlled power limit should be controlled under 90 Amps (**Pmax**). Consider the wallbox can draw as much as 32 Amps, when the **P3** is lower than $90 - 32 = 58$ Amps, EV can be charged at full allocation. In case the **P3** (other loads) is above 58 A, the charger embedded load balancing mechanism will lower the charging capacity and protect the fuse.

The simplest algorithm can be marked as:

$$P2 = f(Pmax, P1)$$

Pmax can be set via the Terra Config and Charger-Sync™ apps under the field: Load Threshold.

P1 is information obtained from the Smart Meter via the Modbus RTU–RS-485 interface.

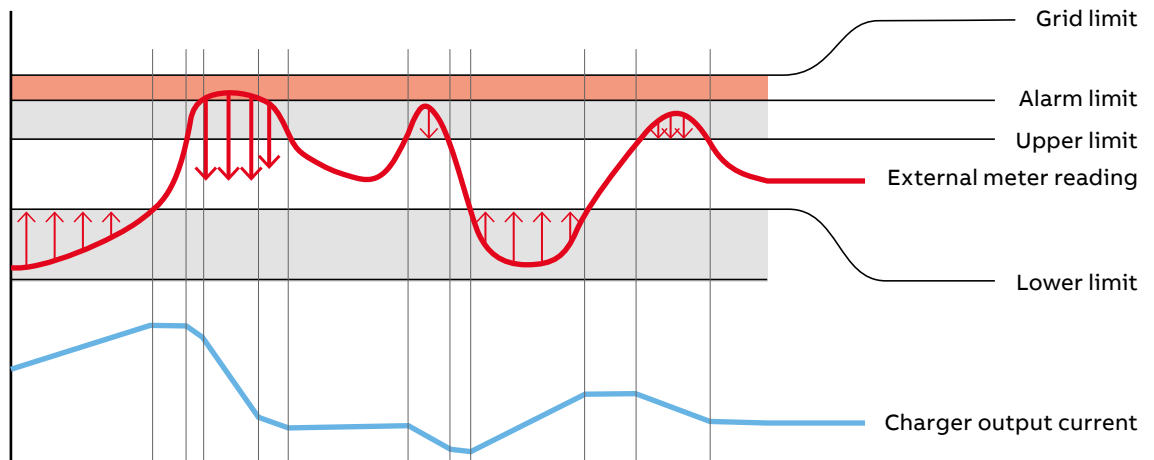
Although the general behavior of dynamic load balancing, as explained above, is quite well known, the load balancing algorithm implemented within the Terra AC is more sophisticated. Various input variables and a more complex load management algorithm has been created to support all various use cases.

To support installers in their commissioning process, ABB provides default values for various input variables of the algorithm. The installer should seamlessly perform the commissioning of dynamic load management for a single charger (by setting only a few input variables). More information about the default values that are used for these cases can be found later in this section.

The Terra AC charger also gives room to specific needs with support on manual input (to change the load management behavior of the charger).

Load management behavior

—
Load management
limits and behavior



The charger will gently increase/decrease power when in the gray areas, it will quickly decrease by a lot when it is in the red area.

The figure shows the total current of one of the phases, based upon the data that is obtained from the external meter. In the graph, we can identify various regions for which a specific behavior of the charger is expected.

1. White area: area between the Upper limit and Lower limit. This is considered a safe area for the charger to operate at its current power output. Within this region, there is no reason to change the output current of our Terra AC charger.
2. Gray area – below the Lower limit: when the energy meter provides meter data to show sufficient room to change configuration the Terra AC charger will start increasing the power output (if the charger is below its maximal rated current) by a certain amount (configurable in TerraConfig).
3. Gray area – between the Upper limit and Alarm limit: the charger must also decrease power output in periods that the external meter provides information that there is limited current available (since it might be used by other electrical appliances). In this region (the gray area between the 'Upper limit' and 'Alarm limit'), the charger will decrease its power output by a certain amount (configurable in TerraConfig).
4. Red area – between the Alarm limit and Grid limit (Electrical capacity), an immediate response is needed to avoid overcurrent and to protect the fuse. If the external meter gives information to the charger that the current of a particular phase is in this area, the charger will react by decreasing the power output by a considerable amount (configurable in TerraConfig).

Next to this normal behavior, there are still some 'special' load management cases to discuss. First of all, the Fallback limit [A] and Fallback time [s]. These two variables are related to a connection loss between the external meter and the Terra AC charger. In normal operation, the charger can only change its power output every 5 seconds (at minimum) or at the frequency in which it receives messages from the external meter (since this is the information the charger uses to do dynamic load balancing). There could, however, be situations in which the communication between the charger and external meter is lost. In such cases, the charger will change its power output to the Fallback limit [A] after a Fallback time [s] period in which the charger did not receive messages from the external energy meter.

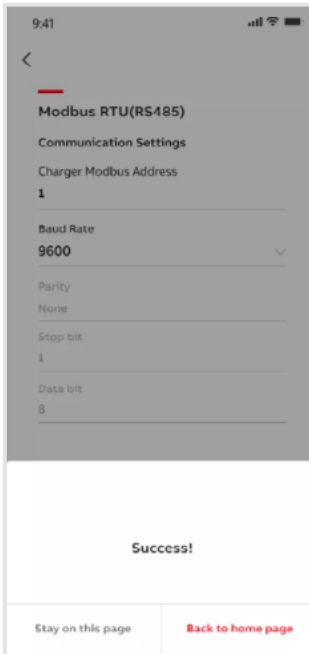
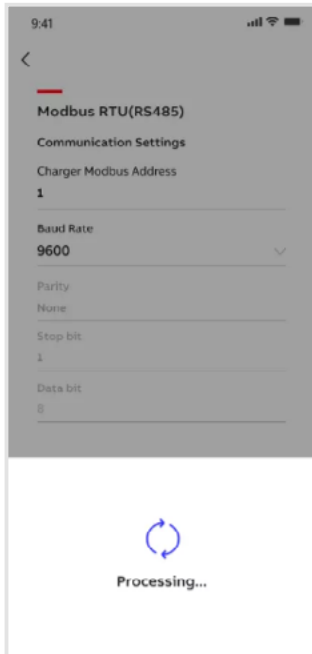
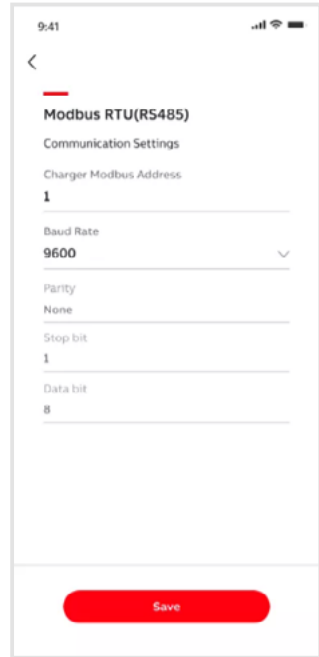
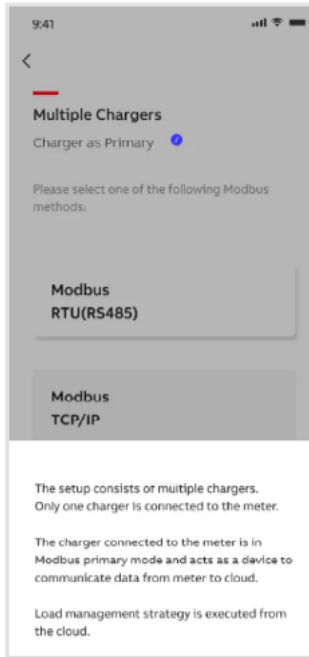
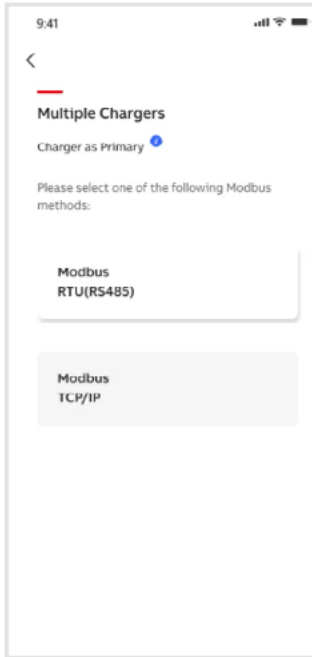
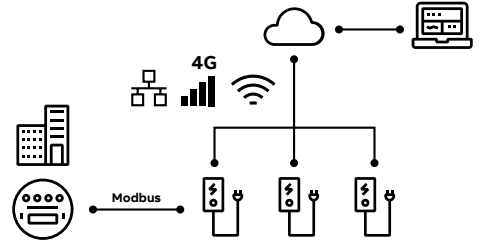
Another special input variable (that is applicable for certain countries or customers) is the 'Maximum phase imbalance enable' variable. In some countries, it is regulated that the total current that is drawn from the grid should be equally divided between the various phases. The delta between two separate phases should thereby not exceed a certain limit (mostly measured in Amperes). By using this variable, our charger takes into account the maximal imbalance and changes its power output accordingly. This functionality is mostly useful for chargers that charge 1 phase or two phase cars (since this might contribute to a phase imbalance).

Within the table below, the various input variables of the single load management are shown and further explained.

Variable	Unit	Description	Default value
Grid limit	Ampere (A)	This variable can be explained as the maximum limit (in Ampere) of the (grid) connection for which load balancing should be done.	none (must be set)
Maximum phase imbalance enable	Ampere (A)	This value can be explained as the maximum delta (in Ampere) between two separate phases that is to be pursued (e.g. due to local legislations).	disabled
Random wait time	Seconds (s)	This is a random wait time (in seconds) for chargers to start charging again from 'pause' mode, to avoid sudden changes in the power consumed from the grid (useful for sites with more than one charging station).	10
Smart meter phase	Number of phases (n)	This variable is used to identify whether a 1 phase or 3 phase energy meter is used for metering purposes.	none (must be set)
P1 connected to	Phase (n)	With this variable, we would like to verify which grid phase is connected to which phase of the charger (to be able to do proper load balancing).	none (must be set)
Alarm limit (Limit)	Ampere (A)	This is the limit (in Ampere) for which the charger will react by decreasing the power output by a significant amount.	Grid limit [A] – 1 [A]
Alarm limit (wait time)	Seconds (s)	This variable can be explained by the time (in seconds) the algorithm checks the obtained external meter values are above the alarm limit, before it reacts by reducing the power output by a certain amount.	1
Alarm limit (Change amount)	Ampere (A)	This variable can be explained as the amount (in Ampere) of power output that will be decreased at the moment the meter values from the external meter are in the red alarm zone.	50% of maximal rated current
Upper limit (Limit)	Ampere (A)	This is the limit (in Ampere) for which the charger will react by decreasing the power output by a small amount.	Grid limit [A] – 3 [A]
Upper limit (wait time)	Seconds (s)	This variable can be explained by the time (in seconds) the algorithm checks the obtained external meter values are above the upper limit, before it reacts by reducing the power output by a certain amount.	5
Upper limit (Change amount)	Ampere (A)	This variable can be explained as the amount (in Ampere) of power output that will be decreased at the moment the meter values from the external meter are in the gray 'Upper limit' zone.	1
Lower limit (Limit)	Ampere (A)	This is the limit (in Ampere) for which the charger will react by increasing the power output by a small amount.	Grid limit [A] – 6 [A]
Lower limit (wait time)	Seconds (s)	This variable can be explained by the time (in seconds) the algorithm checks the obtained external meter values are below the lower limit, before it reacts by increasing the power output by a certain amount.	5
Lower limit (Change amount)	Ampere (A)	This variable can be explained as the amount (in Ampere) of power output that will be increased at the moment the meter values from the external meter are in the gray 'Lower limit' zone.	1
Fallback limit	Ampere (A)	This is the power output limit (in Ampere) that will be used by the charger at the moment there is no network connection for a certain number of seconds.	0
Fallback time	Seconds (s)	This variable can be explained by the time (in seconds) that the charger should wait in the case of a network connection issue before the charger goes into 'Fallback state' with its affiliated Fallback limit	30

• **Multiple chargers (Charger as Primary)**
Available for Modbus RTU – RS-485 only

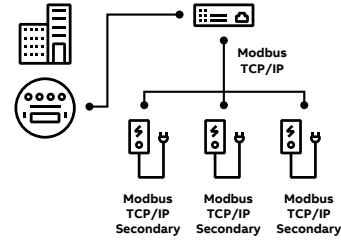
In this scenario one charger of the multiple-charger installation is Modbus Primary and acts as interface to inform the cloud on the smart meter information. Load management strategy is executed from the cloud.



• **Multiple chargers (Charger as Secondary)**

Available for Modbus RTU – RS-485 and Modbus TCP/IP.

In this scenario all chargers are Modbus Secondary. Load management strategy is executed from the local controller.



Multiple chargers (Chargers as Secondary) via Modbus RTU – RS-485

The screenshots show the configuration process for Modbus RTU(RS485):

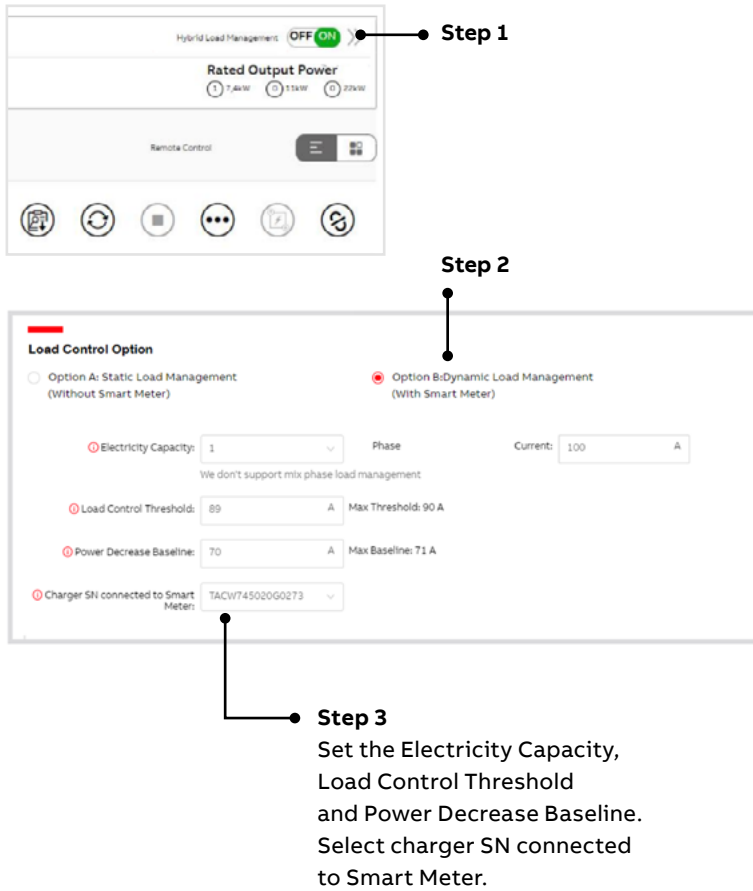
- Screenshot 1:** 'Multiple Chargers' screen with 'Chargers as Secondary' selected. Two options are shown: 'Modbus RTU(RS485)' and 'Modbus TCP/IP'.
- Screenshot 2:** 'Modbus RTU(RS485)' configuration screen. Fields include: Modbus address of secondary charger (1), Baud Rate (9600), Parity (None), Stop bit (1), and Data bit (8). A red 'Save' button is at the bottom.
- Screenshot 3:** An error message: 'Oops, something went wrong. Please try again.' with buttons for 'Stay on this page' and 'Back to home page'.
- Screenshot 4:** A success message: 'Settings Saved. The red error LED will start blinking if the charger fails to connect within 60sec.' with buttons for 'Stay on this page' and 'Back to home page'.

Multiple chargers (Chargers as Secondary) via Modbus TCP/IP

The screenshots show the configuration process for Modbus TCP/IP:

- Screenshot 1:** 'Multiple Chargers' screen with 'Chargers as Secondary' selected. Two options are shown: 'Modbus RTU(RS485)' and 'Modbus TCP/IP'.
- Screenshot 2:** 'Modbus TCP/IP' configuration screen. A red warning message says: 'Please disable LAN in Charger Link before configure Modbus TCP/IP, otherwise a failure will arise.' with a 'Go disable LAN' link. Fields include: IP address (Please input parameter), Mask address (255.255.0.0), Gateway address (192.168.0.1), and Server port (500). A red 'Save' button is at the bottom.
- Screenshot 3:** A success message: 'Settings Saved. The red error LED will start blinking if the charger fails to connect within 60sec.' with buttons for 'Stay on this page' and 'Back to home page'.
- Screenshot 4:** An error message: 'Oops, something went wrong. Please try again.' with buttons for 'Stay on this page' and 'Back to home page'.

4.3.2. Configuration via the ChargerSync™ Portal



Step 1

Hybrid Load Management: OFF ON

Rated Output Power

7.4kW 11.5kW 22kW

Remote Control

Step 2

Load Control Option

Option A: Static Load Management (Without Smart Meter)

Option B: Dynamic Load Management (With Smart Meter)

Electricity Capacity: 1 Phase Current: 100 A

We don't support mix phase load management

Load Control Threshold: 89 A Max Threshold: 90 A

Power Decrease Baseline: 70 A Max Baseline: 71 A

Charger SN connected to Smart Meter: TACW745020G0273

Step 3

Set the Electricity Capacity, Load Control Threshold and Power Decrease Baseline. Select charger SN connected to Smart Meter.

This online load balancing algorithm can be extended by using a prioritization functionality. With this functionality, you can prioritize the power output of certain chargers over others. Chargers assigned in the VIP group always get maximum capacity and do not decrease capacity once a new charger is activated. The Dynamic

Load Management algorithm instructs the charging stations to adapt in real time to changes on load. The profiles optimize usage based on install preferences, with High and Medium groups as the changing variables (in terms of power output) of the Load Management algorithm.

5. Load management methodologies

Using the various topologies mentioned before, the maximal power output of the Terra AC charger can be limited by one of the following means (of which the most common ones are already mentioned in this document):

- TerraConfig mobile application
 - **Dynamic load management with single charger:** an algorithm that dynamically changes the power output of the charger (configurable via the TerraConfig application).
 - **Static load management with single charger:** within the TerraConfig application, installers are able to set a static limit on the power output of the charger.
 - **Fallback limit (static):** this derating can be configured using the TerraConfig application and is used at the moments there is a connection loss.
 - **Local random delay limit (static):** for some countries, it is required that the power output is limited at the start of a charging session. This random delay limit will derate the power output of the charging station for a certain time period at the beginning of a charging session.
 - ChargerSync™ mobile application
 - **Static load management with single charger:** within the ChargerSync™ application, users are able to set a static limit on the power output of the charger.
 - **Scheduling limit (static):** a schedule can be deployed on the charger (using the ChargerSync™ application), that includes a time period in which the charger should provide limited power output.
 - External controlling system (static or dynamic, dependent on external controlling system capabilities)
 - **Dry Input/Output (I/O):** the Dry I/O contacts can be used to influence the power output of the charger (e.g. by pausing a charging session, I=0), using an external controlling system.
 - **Modbus RTU (RS-485):** external controlling systems that are connected via Modbus RTU (RS-485) are able to change the power output of the charger.
 - **Modbus TCP/IP:** external controlling systems that are connected via Modbus TCP IP (which is possible for some of our Terra AC models) are able to change the power output of the charger.
 - **Open charge point protocol (OCPP):** using Smart Charging profiles that are part of OCPP, external controlling systems are able to change the power output of the charger (e.g. by using the ChargerSync™ webportal, an external backoffice or local OCPP server).
 - **Remote random delay limit (static):** for some countries, it is required that the power output is limited at the start of a charging session. This random delay limit will derate the power output of the charging station for a certain time period at the beginning of a charging session.
 - **Rotary Switch (static):** in some of our Terra AC models, a rotary switch is present that can be used to limited the power output of our charging station.
 - **Cable limit (static):** the charging cable that is used to charge a car, might have different technical properties compared to the charging station. If the maximal current of the charging cable is lower than the maximal current of the charger, the output power of the charging station will also be limited.
- Various means can be used simultaneously to meet certain application requirements: example - a house owner might want to derate the maximal power output of a 32 Ampere (A) Terra AC charger to 16 A to not blow the fuse, but also has a network operator connected to its device that wants to lower the power output of the charger in certain time periods to keep the grid stable and prevent a local electricity blackout.
- To be able to serve these specific use cases, the Terra AC charger takes into account all the limitations that are set by the various means mentioned above. The final maximal current output of our Terra AC charger will be according to the lowest value from these various power limitation methods. In general, electric vehicles must be able to react within 5 seconds to the power limit command obtained from the charger. The charger may, therefore, not send any other power limitation commands within this time period (of 5 seconds).



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