

## Technical Information

# Control of the Active Power Feed-In at the Grid-Connection Point with the SMA CLUSTER CONTROLLER



To control the generated power of a PV system that is directly fed into the grid, the SMA Cluster Controller\* has proved its value as a central controlling unit in many large-scale PV power plants. However, what is the situation when there are other loads in a PV system and the active power feed-in is to be controlled directly at the grid-connection point?

The Cluster Controller can also offer potential solution approaches for this application case. From firmware version 1.02.12.R, the Cluster Controller can integrate an external measurement source for the active power feed-in at the grid-connection point and thus create the prerequisite for control of the active power feed-in at the grid-connection point. This document describes the solution approach of such a closed-loop control in greater detail. In addition to explanations of the required system components (inverter and control and measurement equipment), it provides valuable information on configuration of the PV system.

This document does not replace the valid user manuals and installation manuals of the products used.

\* In this document, the SMA Cluster Controller is referred to as Cluster Controller.

# 1 Differences between Open-Loop and Closed-Loop Control

## Open-Loop Control

In the control of a PV system, external setpoints (e.g. for power limitation) are transferred directly to the inverters. This feature is used, for example, in large PV systems with direct active power feed-in. The Cluster Controller assumes the role of a central communication unit in this case. It can process all kinds of signal setpoints and pass these on to the inverters. An external company (e.g. a direct marketer or electric utility company) thus has direct access to the PV system and can, for example, directly limit the inverter's nominal PV system power. Limitation of the inverter's generated active power has a direct affect on the grid-connection point as no loads exist in the system (see Figure 1).

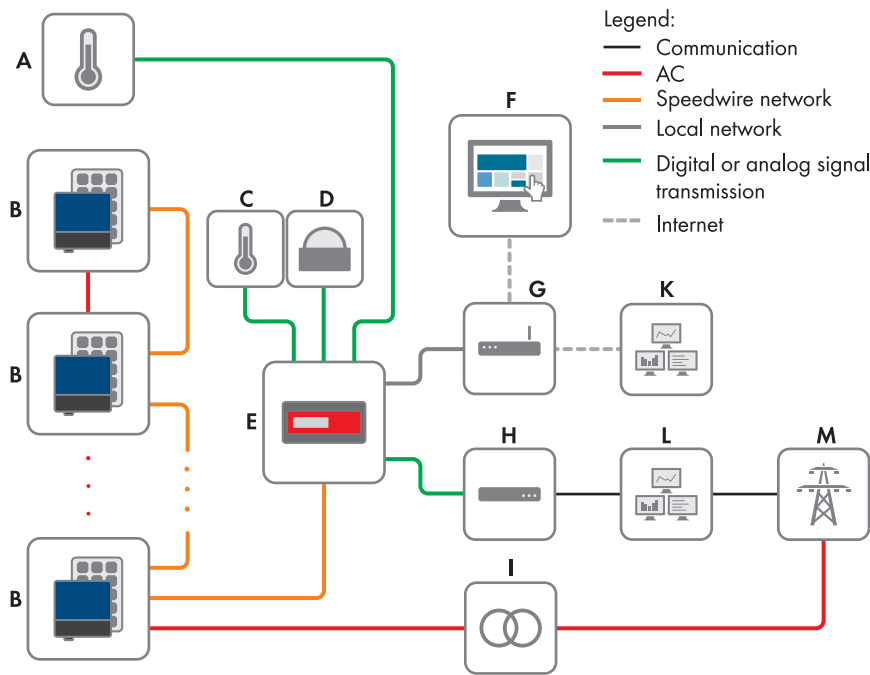


Figure 1: Example of a decentralized large-scale PV power plant with Cluster Controller and implementation of grid operator setpoints via open-loop control

Position	Explanation
A	Module temperature sensor
B	Inverter and PV modules
C	Outside temperature sensor
D	Irradiation sensor
E	Cluster Controller
F	Sunny Portal
G	Router
H	Ripple control receiver or remote terminal unit
I	Grid station
K	Control room
L	Grid control room
M	Utility grid

## Closed-Loop Control

In the case of systems with self-consumption (see Figure 2), the proportion of grid feed-in depends on the current consumption which can also fluctuate over time. A typical requirement for these systems is that the active power feed-in at the grid-connection point is to be limited to a predefined maximum value, for example. A central closed-loop control is required for this, which uses the setpoint, the actual measurement value at the grid-connection point, and the currently generated active power to automatically calculate a required power limitation (output value) of the inverters.

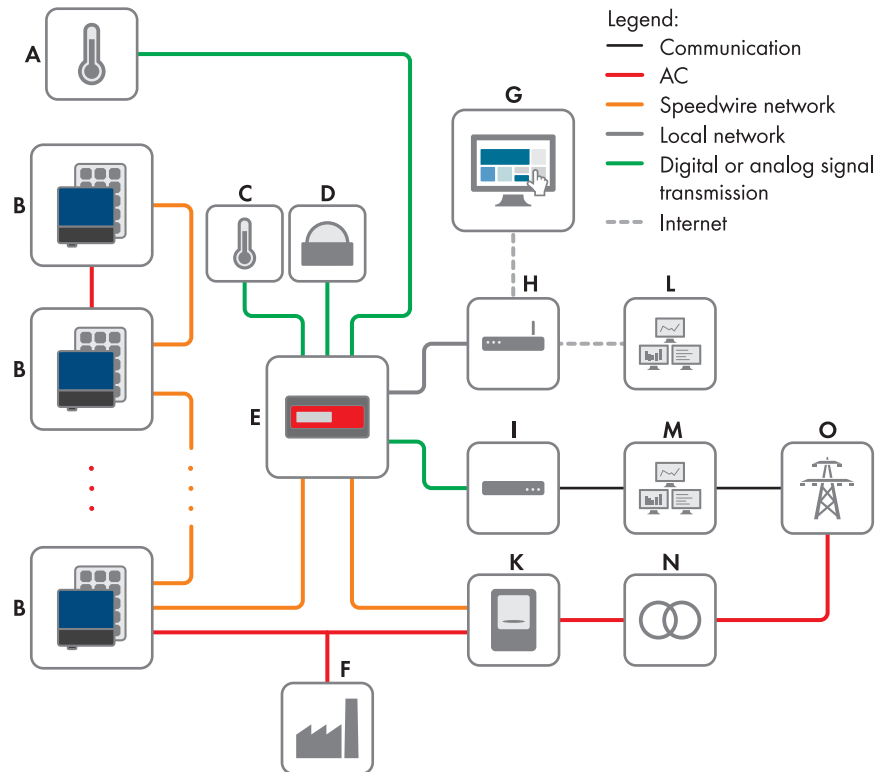


Figure 2: Example of a decentralized large-scale PV power plant with Cluster Controller and implementation of grid operator setpoints via closed-loop control

Position	Explanation
A	Module temperature sensor
B	Inverter and PV modules
C	Outside temperature sensor
D	Irradiation sensor
E	Cluster Controller
F	Industrial load
G	Sunny Portal
H	Router
I	Ripple control receiver or remote terminal unit
K	Energy meter
L	Control room
M	Grid control room
N	Grid station
O	Utility grid

**Possible Application Cases for Active Power Control:**

- PV systems with self-consumption and the requirement to limit the active power feed-in at the grid-connection point to 0 watts (Zero Export)

Such applications can be required in very weak utility grids.

- PV systems with self-consumption and restricted maximum active power feed-in at the grid-connection point
- PV systems with self-consumption, additional producers (e.g. PV arrays) and the requirement to limit the active power feed-in at the grid-connection point

With such applications, the PV proportion can make a significant contribution to closed-loop control without the necessity for communication with the other producers in the PV system.

## 2 Required System Components for Active Power Control

**Central communication unit for system configuration, measured value processing, and closed-loop control**

- ☐ SMA Cluster Controller from firmware version 1.02.12.R:
  - Device type "CLCON-10" for maximum of 75 SMA Speedwire devices
  - Device type "CLCON-S-10" for maximum of 25 SMA Speedwire devices

**Required authorizations for using the Cluster Controller**

You carry out configuration of the active power control via the user interface of the Cluster Controller in the **Installer** user group.

To configure the SMA inverters, you also require your personal SMA Grid Guard code (application form is available at [www.SMA-Solar.com](http://www.SMA-Solar.com))

**Measuring device for active power feed-in at the grid-connection point**

- ☐ For PV systems with total current < 63 A via three line conductors: SMA Energy Meter (device type: EMETER-10)
- ☐ For PV systems with total current > 63 A: SMA Energy Meter (device type: EMETER-10) from firmware version 1.02.04.R and three current transformers for 5 A secondary current (e.g. ABB CM-CT series)

**Supported SMA Inverters:**

SMA Inverters	From inverter firmware version
Sunny Tripower:	
• STP 50-40 / STP 50-US-40	1.01.19.R
• STP 20000TL-30 / STP 25000TL-30	2.81.07.R
• STP 15000TLEE-10 / STP 20000TLEE-10	2.63.03.R
• STP 15000TL-10 / STP 17000TL-10	2.62.04.R
• STP 5000TL-20 / STP 6000TL-20 / STP 7000TL-20 / STP 8000TL-20 / STP 9000TL-20 / STP 10000TL-20 / STP 12000TL-20	2.53.02.R
• STP 12000TL-US-10 / STP 15000TL-US-10 / STP 20000TL-US-10 / STP 24000TL-US-10	2.80.00.R
• STP 30000TL-US-10	2.81.00.R
Sunny Boy:	
• SB 3000TL-21 / SB 3600TL-21 / SB 4000TL-21 / SB 5000TL-21 / SB 6000TL-21	2.80.02.R
• SB 2500TLST-21 / SB 3000TLST-21	2.80.22.R

**Visualization**

- ☐ Sunny Portal for visualizations in preconfigured diagrams and creation of individual pages

### 3 Configuration and Commissioning of Active Power Control

Due to the numerous configuration options for the Cluster Controller, only the most important steps for configuration and commissioning of active power control at the grid-connection point are described below. Note that all settings are made via the integrated web server of the Cluster Controller.

Additional configuration options are described in the user manual of the Cluster Controller.

#### 3.1 Standardization to the Total System Power

All specifications for active power limitation of the system (setpoint) are given as a percentage of the total system power. By default, the Cluster Controller always determines the total of the nominal AC power of all the inverters in the system as a value for the total system power. However, this value can also be changed manually if, for example, the peak power of the PV modules in watts is to be taken as the total system power, or if additional producers exist in the system. If this is the case, the value of the total system power can be adjusted manually.

To do this, you must select the entry **User-defined** in the **Total system power** drop-down list (A) and then enter the required value in the input field (B).

Configuration is carried out under **Cluster Controller > Grid management services > General settings**.

The screenshot shows a web interface for 'General settings'. Under the 'Plant control' section, there is a 'Total system power' dropdown menu currently set to 'User-defined', which is highlighted with a green box and labeled 'A'. Below it is an input field for 'User-defined total system power' containing the text '1 - 4000000000 W', also highlighted with a green box and labeled 'B'.

Figure 3: Manual adjustment of the total system power value (example)

#### 3.2 Selecting the Operating Mode Closed-Loop Control

By default, the operating mode **open-loop control** is selected in the Cluster Controller. For closed-loop control, however, you must select operating mode **closed-loop control** (C). Note here that all setpoints for active power limitation are automatically adopted for closed-loop control.

Configuration is carried out under **Cluster Controller > Grid management services > General settings**.

The screenshot shows the 'General settings' web interface. Under the 'Plant control' section, the 'Operating mode' dropdown menu is set to 'Closed-loop control', which is highlighted with a green box and labeled 'C'.

Figure 4: Select operating mode **closed-loop control**

### 3.3 Selecting Measurement Source for System Active Power at the Grid-Connection Point

To record the actual value, that is, the measured system active power at the grid-connection point, you must select the measurement source used ( **D** ). The Cluster Controller can receive and process the actual value in three ways:

- via the SMA Energy Meter (recommended)  
If there are multiple SMA Energy Meters in the PV system, you must ensure that the SMA Energy Meter intended for active power measurement at the grid-connection point is used by the Cluster Controller as a measurement source for closed-loop control (see user manual of the SMA Cluster Controller).
- via actual value setpoint through, for example, a SCADA system via Modbus TCP
- via signal setpoint of a three-phase active power measuring device with a current output for 4 to 20 mA

The parameter **Sum of inverter performance** is required only for test purposes.

Configuration is carried out under **Cluster Controller > Settings > Grid connection**.

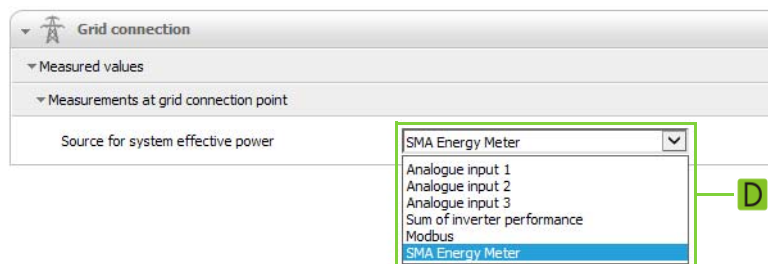


Figure 5: Select measurement source for the actual value (example)

### 3.4 Selecting Signal Source for Setpoint

The setpoint for limitation of the active power feed-in at the grid-connection point is specified as a % of the total system power. Note that the setpoint, in the case of closed-loop control, always refers to the grid-connection point and not to the inverter.

For the setpoint, you must select at least one signal source ( **E** ). If your grid operator requires that the PV system feeds in 0 watts, you must select **Manual specification** as signal source and enter the value **0** in the input field **Active power** ( **F** ).

Configuration is carried out under **Cluster Controller > Grid management services > Active power**.

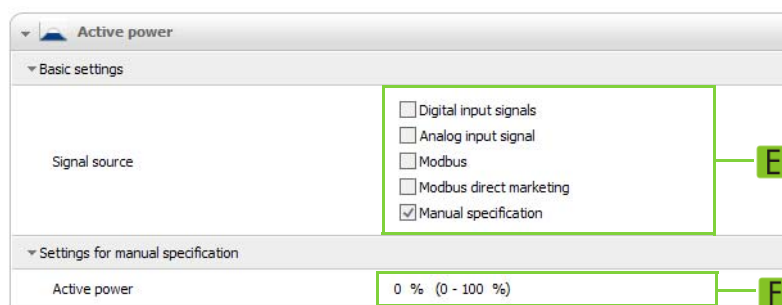


Figure 6: Select signal source and enter active power (example)

### 3.5 Configuring the Inverter for Closed-Loop Control

In addition to the settings options that relate to the Cluster Controller, you must also adjust the following inverter settings for closed-loop control:

- Configure the inverter for higher-level closed-loop control
- Configure behavior of inverters at output value "0%"
- Configure control speed of inverters

#### Configure the inverter for higher-level closed-loop control

In order for the inverters to be able to receive output values from the Cluster Controller in the course of closed-loop control, you must configure the inverters appropriately. To do this, you must select the inverter parameter **Operating mode Active power** in the system view and then the entry **Act. power lim. via PV system ctrl** in the drop-down list (G).

Configuration is carried out under "Name of your system" > Settings > Equipment & device control system (Solar Inverters) > Configuration of feed-in management.

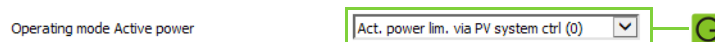


Figure 7: Configure the inverter for higher-level closed-loop control

#### Configure behavior of inverters at output value "0%"

In closed-loop control, the inverters receive the setpoints for power reduction continually as a calculated output value. If the output value "0%" (= complete power reduction), there are two variants via which the inverter can reduce its power to the required 0 watts:

- Opening the grid relay
- Blocking only active power feed-in with closed grid relay as before

With operating mode **closed-loop control**, to achieve dynamic regulation of the active power feed-in, only the active power feed-in should be blocked and the grid relay should remain closed. To do this, you must select the inverter parameter **Grid disconnection at 0% specification** and the entry **No** in the drop-down list (H). Note that with a 0-watt closed-loop control in the PV system, there is always a base load (self-consumption) of approx. 25 W x number of inverters in the PV system. This results in minor control deviations.

Configuration is carried out under "Name of your system" > Settings > Equipment & device control system (Solar Inverters) > Configuration of feed-in management.

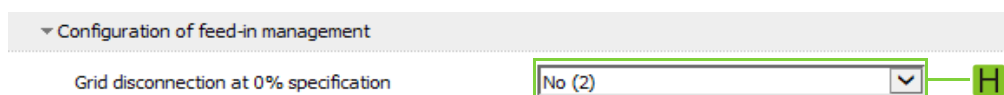


Figure 8: Configure behavior of inverters at output value "0%"

#### Configure control speed of inverters

For appropriate control speed in the range of 3 to 10 seconds, you must enter the value **200** for the inverter parameter **Active power gradient** (I).

Configuration is carried out under "Name of your system" > Settings > Equipment & device control system (Solar Inverters) > Inverters.



Figure 9: Configure control speed of inverters

### 3.6 Configuring Behavior of Inverters in the Event of No Setpoint or a Failure in Communication (Fallback)

Fallback is an operating mode in the Cluster Controller used for grid management services. It controls the feed-in behavior of the inverters in the event of a communication failure. The inverters must fulfill the system requirements (see Section 2, page 4). There are two types of fallback:

- Fallback in the event of missing or invalid external setpoint
- Fallback in the event of failure of Speedwire communication between Cluster Controller and SMA inverters

You can activate and configure both types independently of each other. Make the following settings in each case:

- Activate/deactivate fallback (**K**)
- Enter a time period after which, a lack of data transmission from the higher-level component is to be recognized as an error (**L**)
- Enter active power limitation of the inverters in the event of recognized error (**M**)

SMA recommends that you coordinate activation and configuration of the fallback with the grid operator.

#### Configure fallback in the event of missing or invalid external setpoint

Note that, with exclusively manual specification of the active power limitation (signal source **Manual specification**), fallback configuration is not possible.

Configuration is carried out under **Cluster Controller > Grid management services > Active power > Fallback settings**.

▼ Fallback settings		
Fallback activated	Yes	K
Fallback activates after	43200 s (10 - 999999 s)	L
Active power	100 % (1 - 100 %)	M

Figure 10: Configure fallback for missing or invalid external setpoint (example)

#### Configure fallback in the event of failure of Speedwire communication between Cluster Controller and SMA inverters

Configuration is carried out under **"Name of your system" > Settings > Equipment & device control system (Solar Inverters) > Act. power lim. via PV system ctrl.**

▼ Act. power lim. via PV system ctrl		
Operating mode for absent plant control	Use fallback setting (2)	K
Fallback active power P	0,00 % (0,00 - 100,00 %)	L
Timeout	6 s (5 s - 24,00 h)	M

Figure 11: Configure fallback in the event of failure of Speedwire communication between Cluster Controller and inverters (example)

### 3.7 Visualization and Measured Values

The Sunny Portal is available for visualization of active power control at the grid-connection point. In Sunny Portal you can quite easily configure your own pages with corresponding diagrams (see user manual "SUNNY PORTAL / SMA CLUSTER CONTROLLER - Creating a Page for the Visualization of the Active Power Feed-in at the Grid-Connection Point" at [www.SMA-Solar.com](http://www.SMA-Solar.com)).

In the future, SMA will make additional preconfigured pages available as part of the Sunny Portal updates.

In addition, you can use the Modbus interface of the Cluster Controller to visualize measured values using a higher-level communication unit (e.g. a SCADA system) (see the technical description "SMA CLUSTER CONTROLLER Modbus® Interface" at [www.SMA-Solar.com](http://www.SMA-Solar.com)).



## 4 FAQs

### **Does a reduction in the active power feed-in to 0 watts really mean "0"?**

Since this is closed-loop control, the active power feed-in at the grid-connection point is always controlled dependent on the consumption or the switching on or off of loads. As a result, oscillations occur in the range of three to ten seconds. This transient response can be influenced by the inverter parameter **Active power gradient** (see Section 3.5, "Configure control speed of inverters"). Note also that with a 0-watt closed-loop control in the PV system, there is always a base load (self-consumption) of approx. 25 W x number of inverters in the PV system. This results in minor control deviations.

### **How is the actual value of the active power feed-in via the three line conductors measured?**

With closed-loop control, the cumulative power value over all three line conductors is taken.

### **Can additional producers in the system also be taken into account?**

Yes - in this case, however, only the total system power can be influenced by the closed-loop control setpoints.