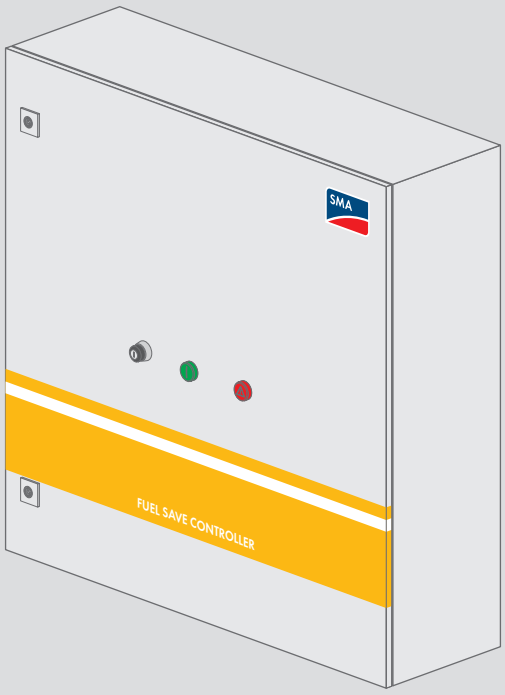
Technical Information

Use of Gensets in PV Diesel Hybrid Systems with SMA Fuel Save Controller 2.0



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1 Information on this Document

1.1 Validity

This document is valid for the device type "FSC-20-M" (SMA Fuel Save Controller 2.0) from software version 2.06.

1.2 Content of this Document

This document is a summary of the information that is to be observed when using gensets and genset controllers in photovoltaic diesel hybrid systems with SMA Fuel Save Controller. The main focus here is on the communication interface requirements and the Genset Controller configuration.

This document does not replace the documentation included with the SMA Fuel Save Controller.

1.3 Nomenclature

Complete designation	Designation in this document
SMA Fuel Save Controller 2.0	Fuel Save Controller
Sunny Tripower, Sunny Central CP XT, Sunny Central Storage	Inverters
Electric generator with combustion engine	Genset
System for the regulation and control of electric generators with combustion engine	Genset controller

2 Requirements for the Optimum Operation of the Gensets

Together with SMA inverters, the Fuel Save Controller is a system solution for the installation of PV diesel hybrid systems through the integration of PV power plants into local utility grids based on gensets. The Fuel Save Controller continuously monitors the power output of the SMA inverters as well as the operating state of the gensets and loads. On this basis, the SMA Fuel Save Controller controls the SMA inverters and adjusts its output power, where necessary. This will ensure a stabile operation of the PV diesel hybrid system.

In combined operation with the genset controllers, the SMA Fuel Save Controller must fulfill the following tasks for this:

- Recording Data on the Current Operating State of the Gensets
- Specifying Sufficient Reserve Power of the Gensets

Recording Data on the Current Operating State of the Gensets

The SMA Fuel Save Controller requires continuous data on the current operating state of the gensets, e.g. the active and reactive power as well as the operating mode. The SMA Fuel Save Controller records information on the current operating state by measuring electrical parameters or via communication with a genset controller. For successful communication, the SMA Fuel Save Controller and the genset controller must have communication interfaces that are based on identical principles and industry standards (see Section 4, page 8).

Specifying Sufficient Reserve Power of the Gensets

In order that the energy supply in the PV diesel hybrid system can be assured independently of the fluctuating PV energy supply, the gensets must be able to make sufficient reserve power available at all times. The SMA Fuel Save Controller can support the gensets by directly or indirectly specifying the reserve power of the gensets.

- **Direct specification of the reserve power**

  The SMA Fuel Save Controller sends a setpoint with the required reserve power directly to the genset controller. The genset controller controls the connection and disconnection of the gensets corresponding to this setpoint. For this, the SMA Fuel Save Controller and genset controller must have communication interfaces that are based on identical principles and industry standards (see Section 4, page 8).

- **Indirect specification of the reserve power**

  The SMA Fuel Save Controller issues setpoints for the power output to the PV inverters. When determining the setpoint, the SMA Fuel Save Controller takes into consideration the connection and disconnection thresholds of the genset controllers. The prerequisite for this is that the power management of the SMA Fuel Save Controller and the genset controllers operate on the same principles (see Section 3, page 5).

i Connection and disconnection of the gensets

In the PV diesel hybrid system, the connection and disconnection of the gensets is performed exclusively by the genset controllers. The SMA Fuel Save Controller issues setpoints or recommendations to the genset controllers for this.

3 Power Management

3.1 Power Management Principles

In this document, power management is considered to be the load-dependent connection and disconnection of the genset in a PV diesel hybrid system. Here, the gensets can be either connected and disconnected manually or be operated with an automatic power management system that issues the commands for connection and disconnection. The power management of the SMA Fuel Save Controller works exclusively with gensets that have an automatic power management system. Depending on the current load situation and the current PV generation, the SMA Fuel Save Controller issues recommended actions to the power management system of the gensets.

The SMA Fuel Save Controller supports the following principles, with which the genset controller power management can operate:

- Absolute Power Management with Reserve Power Requirement in kW
- Relative Power Management with Consideration of the Gensets Remaining Active after Disconnection
- Relative Power Management with Consideration of the Currently Active Gensets

Absolute Power Management with Reserve Power Requirement in kW

The reserve power of a genset is the difference between the nominal power and the current active power output and, with power management, is taken into consideration as follows:

- The connection of the gensets is dependent on the current reserve power of all active gensets.
- The disconnection of the gensets is primarily dependent on the reserve power of the remaining active gensets after a disconnection. A disconnection hysteresis is also taken into consideration. If the reserve power threshold is only reached temporarily, the disconnection hysteresis prevents the premature disconnection of the genset.
- Furthermore, a setpoint for the reserve power requirement of the PV power plant can be transmitted to the genset system if the communication interface is capable of this (see Section 4, page 8).

The use of the absolute power management is recommended for a known reserve power requirement, because the system behavior of the gensets is more closely oriented to the current load situation than to the nominal power of the gensets.

Relative Power Management with Consideration of the Gensets Remaining Active after Disconnection

With relative power management, the connection and disconnection thresholds are determined in relation to the nominal power of the gensets and issued as a percentage value. The connection and disconnection thresholds are defined according to the following principle:

- Connection of the gensets is dependent on the nominal power of the currently active gensets. A typical connection threshold is 90% of the nominal power.
- Disconnection of the gensets is dependent on the nominal power of the gensets still active after a disconnection. A typical disconnection threshold is 70% of the nominal power.

Relative Power Management with Consideration of the Currently Active Gensets

With relative power management, the connection and disconnection thresholds are determined in relation to the nominal power of the gensets and issued as a percentage value. The connection and disconnection thresholds are defined according to the following principle:

- Connection of the gensets is dependent on the nominal power of the currently active gensets. A typical connection threshold is 90% of the nominal power.
- Disconnection of the gensets is dependent on the nominal power of the gensets currently active. A typical disconnection threshold is 40% of the nominal power.

Operation with a genset controller that does not operate in accordance with one of the power management principles presented here

If the genset controller does not operate in accordance with one of the power management principles presented here, the SMA Fuel Save Controller power management must be deactivated and the operator of the PV diesel hybrid system must ensure the constant availability of sufficient reserve power via the genset system.

If the genset controller does not operate in accordance with one of the power management principles presented here and the SMA Fuel Save Controller power management is not deactivated, this can lead to the repeated connection and disconnection of gensets in the PV diesel hybrid system and therefore to an inefficient operation. Furthermore, the reserve power availability can be insufficient in certain operating states, which can trigger a power outage in the entire PV diesel hybrid system.

Coordination with SMA Solar Technology AG

Genset controllers can, in principle, also operate with power management principles or with communication interfaces that are not described in this document. Whether these genset controllers can be installed with the SMA Fuel Save Controller must be coordinated with SMA Solar Technology AG on a case by case basis.

3.2 Power Management Examples

Three gensets with differing nominal powers and priorities are connected and disconnected by one shared power management system. The priorities of the gensets are stored in the genset controller.

Genset	Nominal power	Priority
Genset 1	500 kW	3
Genset 2	430 kW	2
Genset 3	550 kW	1

Example 1: Absolute power management with reserve power requirement

reserve power requirement: 220 kW

Disconnection hysteresis: 60 kW

Switching procedure	Initial situation	Connection or disconnection condition
Connection	Genset 3 is active.	At a load of more than 330 kW (550 kW − 220 kW), genset 2 will start.
	Genset 2 and genset 3 are active.	At a load of more than 760 kW (430 kW + 550 kW − 220 kW), genset 1 will start.
Disconnection	Genset 2 and genset 3 are active.	At a load of less than 270 kW (550 kW - 220 kW − 60 kW), genset 2 will stop.
	Genset 1, genset 2 and genset 3 are active.	At a load of less than 700 kW (430 kW + 550 kW - 220 kW − 60 kW), genset 1 will stop.

Example 2: Relative power management with consideration of the gensets remaining active after disconnection

Connection threshold: 90% of the nominal power

Disconnection threshold: 70% of the nominal power

Switching procedure	Initial situation	Connection or disconnection condition
Connection	Genset 3 is active.	At a load of more than 495 kW (90% of 550 kW), genset 2 will start.
	Genset 2 and genset 3 are active.	At a load of more than 882 kW (90% of (430 kW + 550 kW)), genset 1 will start.
Disconnection	Genset 2 and genset 3 are active.	At a load of less than 385 kW (70% of 550 kW), genset 2 will stop.
	Genset 1, genset 2 and genset 3 are active.	At a load of less than 686 kW (70% of (430 kW + 550 kW)), genset 1 will stop.

Example 3: Relative power management with consideration of the currently active gensets

Connection threshold: 90% of the nominal power

Disconnection threshold: 40% of the nominal power

Switching procedure	Initial situation	Connection or disconnection condition
Connection	Genset 3 is active.	At a load of more than 495 kW (90% of 550 kW), genset 2 will start.
	Genset 2 and genset 3 are active.	At a load of more than 882 kW (90% of (430 kW + 550 kW)), genset 1 will start.
Disconnection	Genset 2 and genset 3 are active.	At a load of less than 392 kW (40% of (430 kW + 550 kW)), genset 2 will stop.
	Genset 1, genset 2 and genset 3 are active.	At a load of less than 592 kW (40% of (500 kW + 430 kW + 550 kW)), genset 1 will stop.

4 Genset Controller with Compatible Communication Interfaces

4.1 Overview of Genset Controllers

The functional scope of the genset controllers has a massive impact on the quality with which the SMA Fuel Save Controller can control and monitor the gensets. The following features are of particular advantage.

Qualified load measurement

The genset controllers are continuously measuring the current, voltage, active and reactive power and determine from this data the current power required by the loads. For a qualified load measurement, the following conditions must be fulfilled:

- The measured values for current, voltage, active and reactive power must be updated every 300 ms at the latest.
- The measured values for current, voltage, active and reactive power may deviate from the actual values by 1% of the entire measurement range.
- The calculated power values are exchanged between SMA Fuel Save Controller and genset controller every 150 ms at the latest.

If a genset controller fulfills these requirements, a quality test can be provided by SMA Solar Technology AG upon request. For the genset controllers mentioned in this document, the quality test has already been carried out by SMA Solar Technology AG (for results see the following table).

If genset controllers without qualified load measurement are used in a photovoltaic diesel hybrid system, the entire active and reactive power of the PV diesel hybrid system must, in addition, be measured at a central location.

Dynamic reserve power requirement

Based on the continuously changing values for PV power and power requirement of loads, the SMA Fuel Save Controller determines the setpoint for the reserve power of the gensets. The SMA Fuel Save Controller sends this setpoint cyclically to the genset controller when requesting dynamic reserve power. The genset controller controls the connection and disconnection of the gensets corresponding to this setpoint.

Dynamic disconnection of Gensets (order option of Fuel Save Controller)

If PV inverter and battery inverter are making sufficient energy available for a safe electricity supply of the loads, the Fuel Save Controller can initiate the dynamic disconnection of all gensets. For this, the Fuel Save Controller sends a request to the Genset controller to stop all gensets. After receiving this request, the genset controllers ignore their individual settings for power management and switch off the gensets.

After the dynamic disconnection of the gensets, the genset controller receive a remote start-up request from the Fuel Save Controller. In accordance with their individual settings for power managment, the genset controllers switch the gensets once again on or off.

Qualified Genset Controllers

Genset controller	Qualified load measurement	Dynamic reserve power requirement	Dynamic disconnection of the gensets	see
ComAp InteliGen NTC and ComAp InteliSys NTC series	yes	only with ComAp IGS-NT-Hybrid firmware	no	Section 4.2, page 9
DEIF AGC series	yes	no	no	Section 4.3, page 9
DSE8610 series (from firmware version V6)	yes	no	no	Section 4.4, page 9

Genset controller	Qualified load measurement	Dynamic reserve power requirement	Dynamic disconnection of the gensets	see
DSE8610 MKII series	yes	no	no	Section 4.4, page 9
Woodward easYgen 3000 series with CAN communication interface	yes	yes	yes	Section 4.5, page 10
Woodward easYgen 3000 series with Modbus/TCP communication interface	no	yes	no	Section 4.5, page 10

4.2 Genset Controllers of the ComAp InteliGen NTC and ComAp InteliSys NTC Series

The genset controllers of the ComAp InteliGen NTC (ComAp IS-NTC) and ComAp InteliSys NTC (ComAp IS-NTC) series are available via a Modbus/TCP communication interface.

These genset controllers are capable of processing a setpoint for the dynamic reserve power requirement of the PV power plant. In order that the dynamic reserve power requirement of the SMA Fuel Save Controller can be transmitted to the genset controllers, the following requirements must be fulfilled:

- The genset controllers of the ComAp InteliGen NTC and ComAp InteliSys NTC series must be equipped with the ComAp IGS-NT-Hybrid firmware.
- The function for the dynamic reserve power requirement must be activated in the user interface of the SMA Fuel Save Controller.

Genset controllers of the ComAp InteliGen NTC and ComAp InteliSys NTC series must be configured for use with the SMA Fuel Save Controller (for these settings on the genset controllers see user manual of the Fuel Save Controller).

4.3 Genset Controllers of the DEIF AGC Series

In order to ensure that the SMA Fuel Save Controller can reach the genset controllers of the DEIF AGC series, these genset controllers must be equipped with a Modbus/ TCP communication interface (see manufacturer's manual).

These genset controllers do not support the dynamic reserve power requirement of the PV power plant. When using genset controllers of the DEIF AGC series with the SMA Fuel Save Controller, the default settings of the manufacturer are used (for further information on the default settings see manufacturer's manual of the DEIF AGC series).

4.4 Genset Controllers of the DSE8610 Series and DSE8610 MKII Series

The genset controllers of the DSE8610 and DSE8610 MKII series are available via a Modbus/TCP communication interface (DSE: Deep Sea Electronics).

These genset controllers do not support the dynamic reserve power requirement of the PV power plant. Genset controllers of the DSE8610 and DSE8610 MKII series must be configured for use with the SMA Fuel Save Controller (for these settings on the genset controllers see user manual of the Fuel Save Controller).

4.5 Genset Controllers of the Woodward easYgen 3000 Series

Genset controllers of the Woodward easYgen 3000 series offer the following communication interfaces:

- CAN communication interface at the connection **CAN#1** of the genset controller (recommended)
- Modbus/TCP communication interface with Ethernet gateway ESENET by proconX

The genset controllers of the Woodward easYgen 3000 series are capable of processing a setpoint for the dynamic reserve power requirement of the PV power plant. In order that the dynamic reserve power requirement of the SMA Fuel Save Controller can be transmitted to the genset controllers, the function for dynamic reserve power requirement must be activated.

Via the CAN communication interface, genset controllers of the Woodward easYgen 3000 series can receive the remote start-up request for dynamic disconnection of the gensets.

Genset controllers of the Woodward easYgen 3000 series must be configured for use with the SMA Fuel Save Controller (for these settings on the genset controllers see user manual of the Fuel Save Controller).

4.6 Genset Controllers without Compatible Communication Interface

If the genset controller does not have a communication interface that is compatible with the SMA Fuel Save Controller, direct data exchange between the genset controller and the SMA Fuel Save Controller is not possible. In this case, the SMA Fuel Save Controller must take measurements of the electrical power at the gensets. Furthermore, the SMA Fuel Save Controller must receive feedback signals from the circuit breakers of the gensets (GCBs) via its digital inputs. Without direct data exchange, the priorities defined in the genset controller can not be taken into consideration by the SMA Fuel Save Controller.

i Coordination with SMA Solar Technology AG

Genset controllers can, in principle, also operate with power management principles or with communication interfaces that are not described in this document. Whether these genset controllers can be installed with the SMA Fuel Save Controller must be coordinated with SMA Solar Technology AG on a case by case basis.

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