

# SIGMA S6100 S/LS Module



## Shaft / Grid Operation

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## 1 Preface

The SELCO SIGMA S6100 S/LS module provides integrated bus bar monitoring, frequency stabilization, voltage stabilization, check/automatic synchronisation and active/reactive load sharing. The S6100 module relies upon the measurements and calculations broadcasted by its partner SELCO SIGMA S6000 IO/P module. The S6000 provides integrated protection, basic I/O and data acquisition. Finally, the S6100 module will operate as an interface between the optional SELCO SIGMA S6600/S6610 Power Manager and the engine related signals (e.g. start/stop, engine fail etc.).

The S6100 module includes advanced functionality which provides features for parallel operation between auxiliary generators and shaft / grid sources.

## 2 Function

Parallel operation with a shaft generator or a grid can be split up in three phases:

- Auto-Synchronization
- Load Sharing
- Unloading

### 2.1 Auto-Synchronization

When the shaft generator or the grid is to be connected to an auxiliary generator, or multiple parallel running auxiliary generators, it is necessary to conduct “reverse synchronization”. Reverse synchronization is done by letting the S6100 module attached to the shaft/grid control the voltage/frequency of the auxiliary generator(s) through the **FREQ. IN / VOLT IN.** inputs of the auxiliary S6100 module(s). The S6100 module of the shaft/grid will then close the shaft/grid circuit breaker when the parameters are matched.

### 2.2 Load Sharing

Load sharing works more or less in the same way as it does in a system consisting of auxiliary generators. However, the difference is that the voltage and frequency stabilization is disabled on the S6100 modules of the auxiliary generators (by connecting the **F/V DISABLE** input to **GND**). This causes the S6100 modules of the auxiliary generators to follow the voltage and frequency of the shaft generator or grid. The shaft/grid load sharing schemes are described later in this document (Peak import, fixed import, fixed export and excess export).

### 2.3 Unloading

Before disconnecting the shaft or grid, load should be transferred to the auxiliary generators. This is done by connecting the **UNLOAD** input of the shaft/grid S6100 module to **GND**. Activating the **UNLOAD** input of the shaft/grid S6100 module will make it transfer the load to the auxiliary generator, where after the shaft/grid S6100 will breaker.

### 3 Auto-Synchronization

#### 3.1 Connections between the S6100 modules.

1. Shaft/Grid S6100 ANALOG OUT 1 VDC connects to the FREQ. IN input on the S6100 module of each and every auxiliary generator.
2. Shaft/Grid S6100 ANALOG OUT 2 VDC connects to the VOLT IN input on the S6100 modules of each and every auxiliary generator.
3. F/V CTRL DISABLE input on the S6100 of each auxiliary generator connects to an auxiliary switch on the shaft/grid circuit breaker.

#### 3.2 Shaft/Grid S6100 Configuration:

```
WRITE SYS SPEEDCTRL MODE FREQOUT  
WRITE SYS SPEEDCTRL OUT ANAOUT1  
WRITE SYS SPEEDCTRL ANAOUT SIGNAL VOLT  
WRITE SYS SPEEDCTRL ANAOUT VOLTMIN -1.000  
WRITE SYS SPEEDCTRL ANAOUT VOLTMAX 1.000  
WRITE SYS VOLTCTRL MODE VOLTOUT  
WRITE SYS VOLTCTRL OUT ANAOUT2  
WRITE SYS VOLTCTRL ANAOUT SIGNAL VOLT  
WRITE SYS VOLTCTRL ANAOUT VOLTMIN -1.000  
WRITE SYS VOLTCTRL ANAOUT VOLTMAX 1.000  
WRITE SYS PWRSOURCE SHAFT
```

#### 3.3 Procedure without an S6600/S6610 module:

UNLOAD input on shaft/grid S6100 is at GND level, which means that ANALOG OUT 1 and ANALOG OUT 2 are inactive. One or more auxiliary generators are running.

UNLOAD on shaft/grid S6100 is opened. ANALOG OUT 1 and ANALOG OUT 2 becomes active, which means that the remote control (voltage matching / auto-synchronization) of the auxiliary generators is initiated (through the VOLT. IN / FREQ. IN inputs of the S6100 modules of each one of the auxiliary generators).

The closure of the Shaft/Grid circuit breaker put the F/V CTRL DISABLE on the S6100 modules of the auxiliary generators to GND, which disables the voltage and frequency stabilization function of the auxiliary generators. ANALOG OUT 1 and ANALOG OUT 2 become inactive. Load sharing is still active among the auxiliary generators.

The shaft/grid is disconnected through use of the UNLOAD signal on the shaft/grid S6100 module. Activating UNLOAD on the shaft/grid S6100 will enable ANALOG OUT 1 and ANALOG OUT 2. The shaft/grid S6100 will transfer the load to the auxiliary generators and trip then shaft/grid breaker when the load transfer is completed.

### **3.4 Proceduren with an S6600/S6610 module:**

OFF DUTY input of the S6100 on the shaft/grid generator is at GND level, which means that the ANALOG OUT 1 and ANALOG OUT 2 of the shaft/grid S6100 are inactive. One or more auxiliary generators are running.

The OFF DUTY input of the S6100 on the shaft/grid generator is opened, which means that the ANALOG OUT 1 and ANALOG OUT 2 of the shaft/grid S6100 becomes active. This initiates the remote voltage matching / auto-synchronizing of the auxiliary generators.

The closure of the shaft/grid circuit breaker enables the F/V CTRL DISABLE on the S6100 modules of the auxiliary generators, which disables the voltage and frequency stabilization function of the auxiliary generators. ANALOG OUT 1 and ANALOG OUT 2 become inactive. Load sharing is still active among the auxiliary generators.

The shaft/grid is disconnected through use of the OFF DUTY signal on the shaft/grid S6100 module. Activating OFF DUTY on the shaft/grid S6100 will make the S6600/S6610 start auxiliary generators to compensate for the lost shaft/grid. The shaft/grid will be “stopped” once the capacity has been replaced by auxiliary power.

### **3.5 Configuration Parameters**

The various configuration parameters of the S6100 module on the shaft/grid have similar function/influence as those on the S6100 modules of the auxiliary generators. However, it should be noted that the shaft/grid S6100 module controls the voltage/frequency of the auxiliary generators (by remote) and not the voltage/frequency of the shaft/grid. It is therefore important not to make the control too “aggressive” as the load and number of parallel running (auxiliary) generators are dynamic parameters in the equation.

## 4 Load Sharing Schemes

The S6100 module includes load sharing schemes other than the traditional proportional scheme.

There are four schemes, which can only be used in connection with a shaft/grid source.

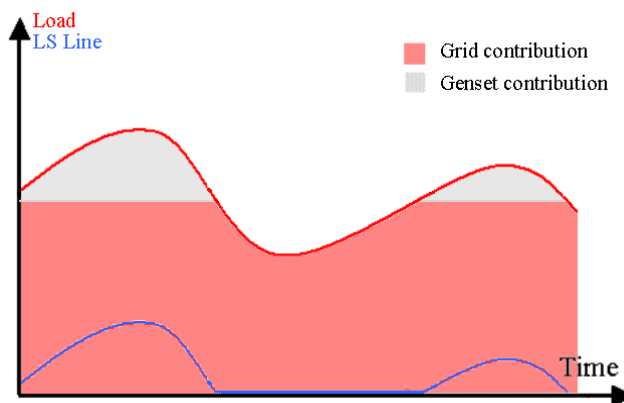
- Fixed import (shaft and grid)
- Peak import (shaft and grid)
- Fixed export (grid only)
- Excess export (grid only)

The S6100 of the shaft/grid control the load by the parallel lines (LS signal). The S6100 modules of the auxiliary generators will adjust their loads according to the parallel lines signal.

- The blue line on the graphs below shows the LS signal of the shaft/Grid S6100.
- The red line shows the total load.
- The pink line shows the capacity provided by the shaft/grid.
- The grey line shows the capacity provided by the auxiliary generators.

### 4.1 Fixed Import

This scheme imports capacity from the shaft/grid by a fixed amount (configured as a percentage of the shaft/grid capacity). The auxiliary generators will provide additional capacity, if so required.

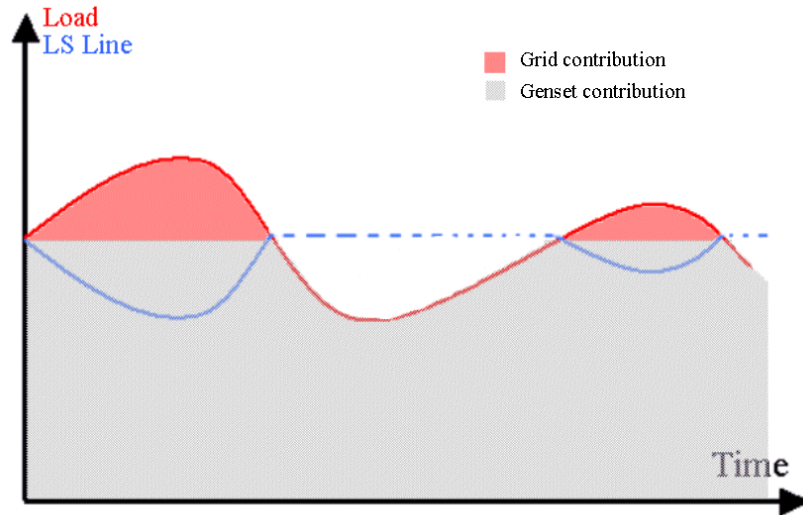


Shaft/grid S6100 Configuration:

```
WRITE SYS PWRIMPORT ENABLED YES
WRITE SYS PWRIMPORT MAX 100
WRITE SYS PWRIMPORT MODE FIXED
WRITE SYS PWRIMPORT VALUE 25
WRITE SYS PWRSOURCE SHAFT
```

## 4.2 Peak Import

This scheme draws on the auxiliary generators until a certain load is reached. The remaining capacity is provided by the shaft/grid.



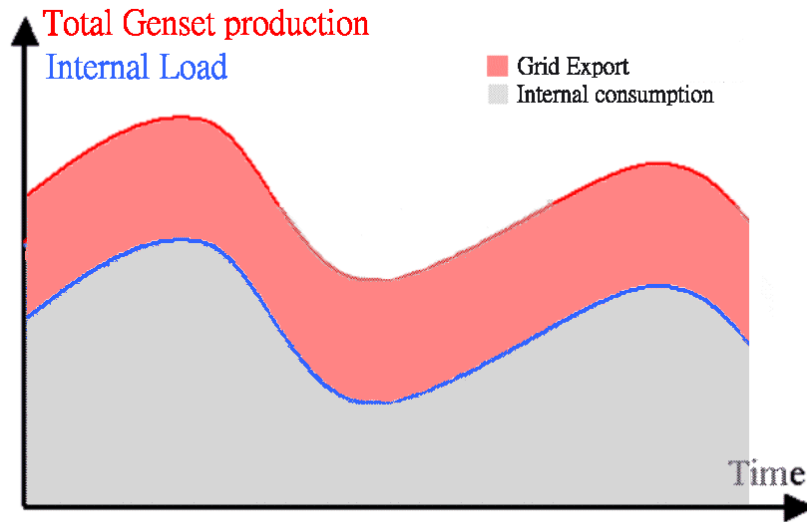
Shaft/grid S6100 Configuration:

```
WRITE SYS PWRIMPORT ENABLED YES
WRITE SYS PWRIMPORT MAX 100
WRITE SYS PWRIMPORT MODE PEAK
WRITE SYS PWRIMPORT VALUE 25
WRITE SYS PWRSOURCE SHAFT
```

## 4.3 Fixed Export

The scheme exports a certain amount of capacity to the grid. The S6100 of the grid forces the S6100 modules of the auxiliary generators to produce a certain amount of “reverse power” into the grid S6100.



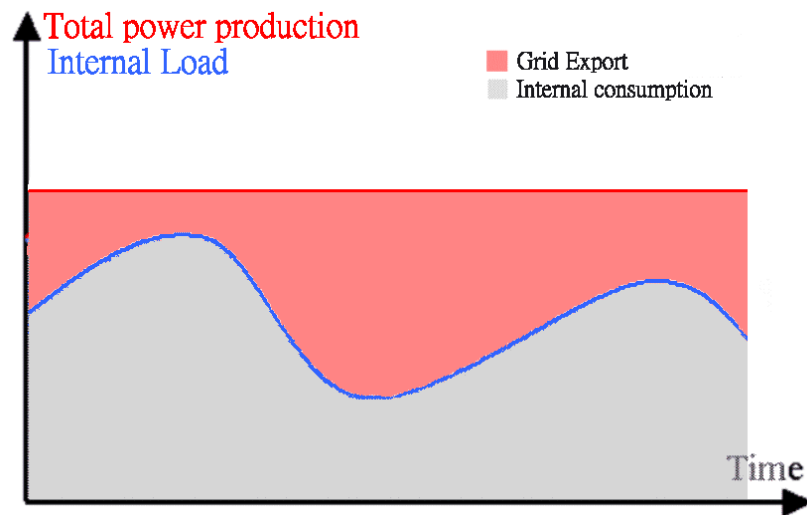


Grid S6100 Configuration:

```
WRITE SYS PWREXPORT ENABLED YES
WRITE SYS PWREXPORT MAX 100
WRITE SYS PWREXPORT MODE FIXED
WRITE SYS PWREXPORT VALUE 25
WRITE SYS PWRSOURCE GRID
```

#### 4.4 Excess Export

This scheme exports excess power to the grid. The auxiliary generators are operated a fixed capacity.



Grid S6100 Configuration:

WRITE SYS PWREEXPORT ENABLED YES  
WRITE SYS PWREEXPORT MAX 100  
WRITE SYS PWREEXPORT MODE EXCESS  
WRITE SYS PWREEXPORT VALUE 25  
WRITE SYS PWRSOURCE GRID