Technische Information

SMA Data Manager M / SMA Data Manager L –

Available active and reactive power

Functional Description, Configuration and Commissioning

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1 Functions

The available active and reactive power function uses sensor values and feedback from the inverters in the system to estimate the maximum amount of active and reactive power available.

Applications:

- Maintenance/power limitation: How much energy was not fed into the grid due to power limitation?
- Curtailment: What power does the power plant feed in when the power limitation is lifted?

The available active and reactive power are calculated using an algorithm developed by SMA. The values are calculated and made available at an update rate of 1/500 ms (EDML) or 1/60 s (EDMM). The estimated values for active and reactive power can be viewed on the UI and retrieved via the Modbus server of the SMA Data Manager.

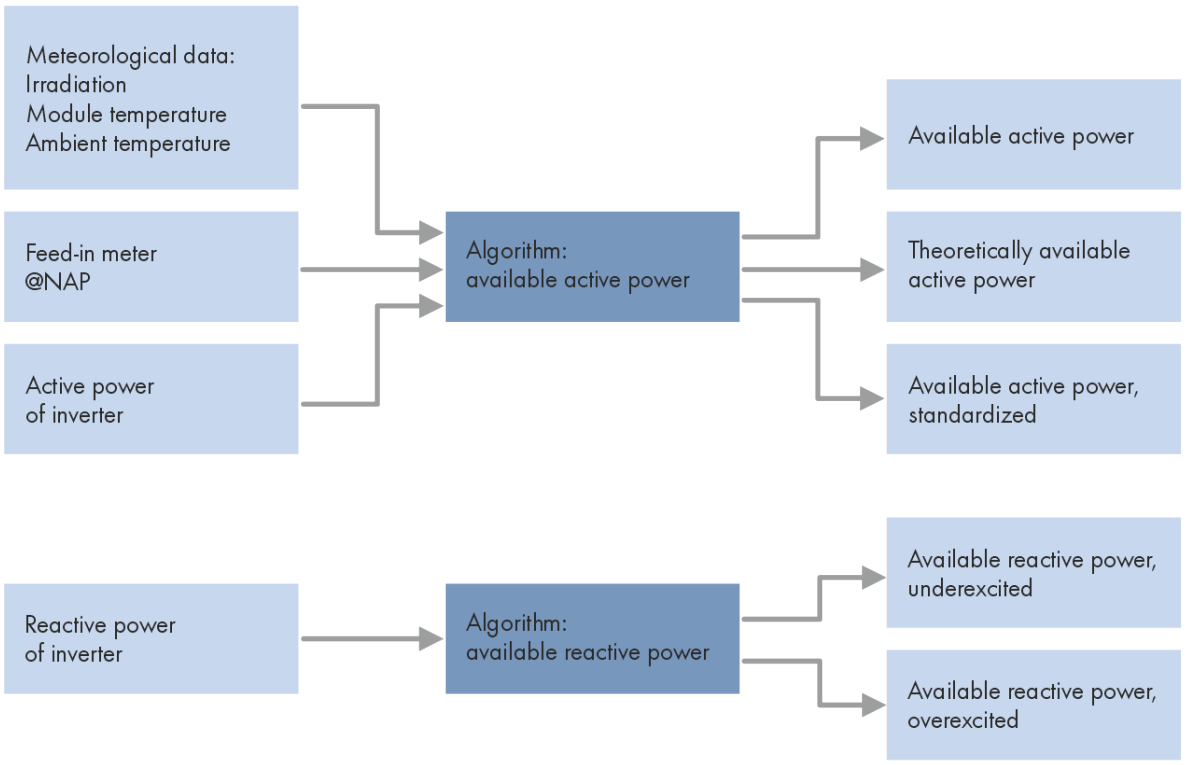

Figure 1: Schematic figure of the "Available active and reactive power" function.

2 Functional Principle

2.1 Commissioning

First, the commissioning of the "Available active and reactive power" function is explained for active power, then for reactive power. Figure **1** shows the measured values entering the algorithm and the output values of the calculation.

In order for the algorithm to calculate the available active power, the following meters and sensors must be configured as shown in Figure **1**:

- Feed-in meter at point of interconnection
- Irradiation sensor[1]
- Module Temperature Sensor[1]
- Ambient Temperature Sensor[1]

2.1.1 Example configuration in Device Management

All sensors must be added under Device Management. In addition, a meter must be designated as a feed-in meter. Figure **2** below shows an example configuration.

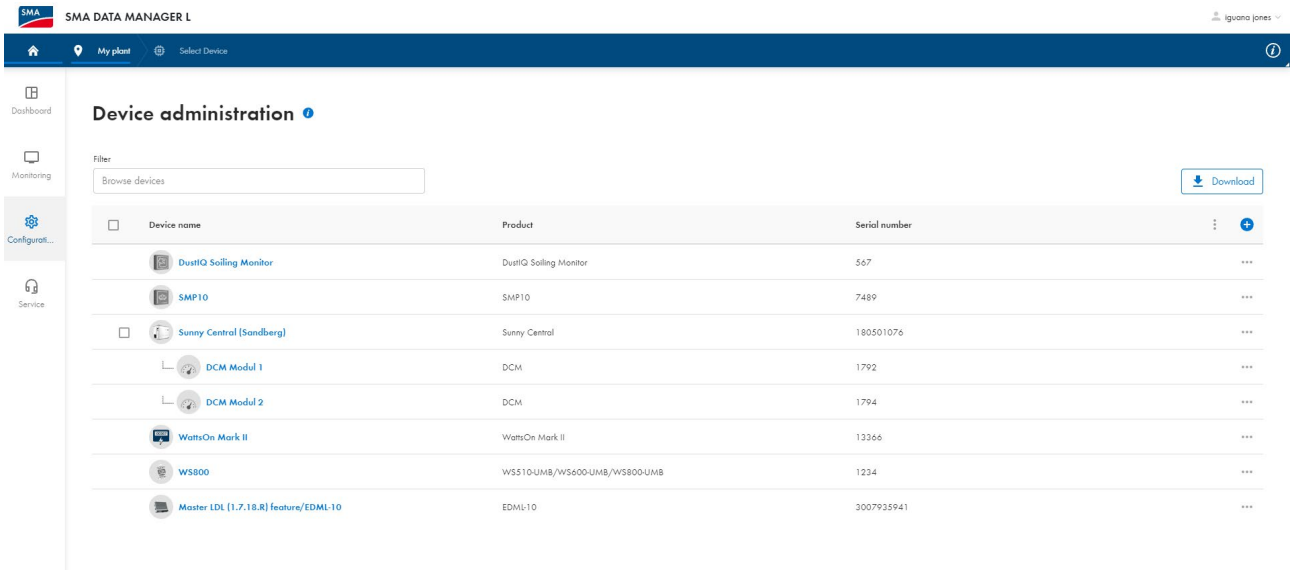

Figure 2: Device configuration for calculating the available active power

1 Connected directly to the EDMM-20 or via Modbus TCP to the EDMM-10, EDMM-20, or EDML-10

2.1.2 Assignment of sensors

Requirement:

- ☐ The Modbus server must be active if the values are to be subsequently provided via Modbus.
- ☐ The irradiation sensor, module temperature sensor, and ambient temperature sensor must be added and configured (see SMA Data Manager manual).

Procedure:

1. Go to **Configuration** > **Sensor assignment**.
2. Assign the irradiation sensor, module temperature sensor, and ambient temperature sensor via + **Assign sensor**.

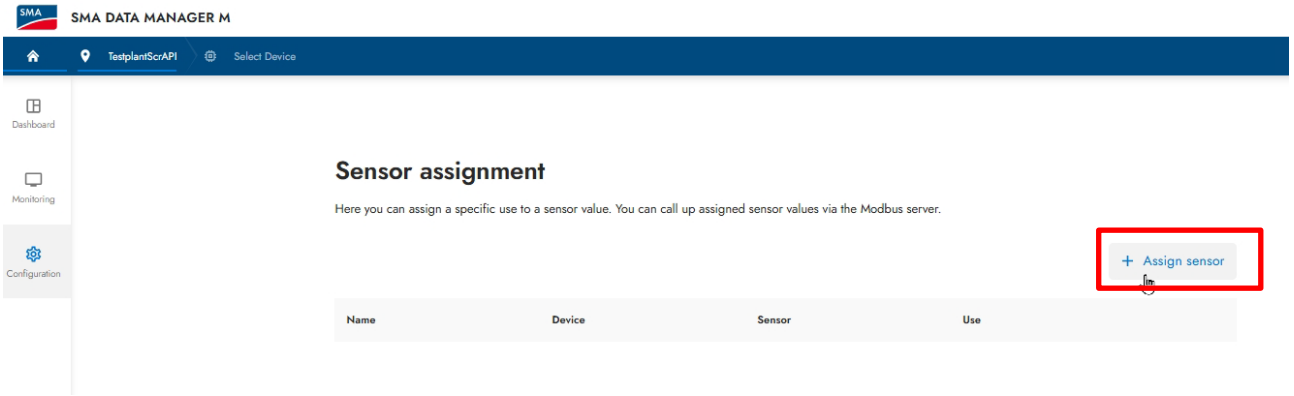

Figure 3: Assignment of sensors.

3. Select the appropriate use for the sensor value and complete the configuration.

2.1.3 Measured values of sensors

If there are multiple irradiation sensors, either a sensor in the middle of the system should be used or an average value of the sensors should be written via Modbus registers from a SCADA system. Irradiation sensors at module level deliver better results here than global radiation sensors. When averaging values across multiple sensors, more accurate values for the available active power can be expected. A combination of global radiation sensors and sensors at the module level is not recommended.

If the sensors have been successfully assigned, the sensor values are available in the following measured values:

- Measurement.Env.ExInSol (Irradiation on external sensor)
- Measurement.Mdul.TmpVal (Module temperature)
- Measurement.Env.TmpVal (External temperature)

2.1.4 Parameters for calculating active power

In order for the algorithm to calculate the available active power, the following parameters must be set correctly at system level:

- Parameter.Plnt.DcWRtg → *DC power of PV modules*

- Parameter.Plnt.W*Rtg* → *Rated active power at point of interconnection*

For the available reactive power, additional parameters must be set correctly:

- Parameter.Inverter.VAMaxIn*Rtg*
- Parameter.Inverter.VAMaxOutRtg
- Parameter.Inverter.VArMaxQ1Rtg
- Parameter.Inverter.VArMaxQ2Rtg
- Parameter.Inverter.VArMaxQ3Rtg
- Parameter.Inverter.VArMaxQ4Rtg

2.2 Output values

After commissioning, the currently available active power is read from the following instantaneous values:

- **Measurement.Operation.WAval:** Available active power. Corresponds to the actual measured active power without power limitation and when all PV inverters are feeding in. When individual PV inverters in the system are switched off, this value shows an estimate of the active power, assuming that all PV inverters are feeding into the grid.
- **Measurement.Operation.AvalTheo:** Available active power. Corresponds to the actual measured active power without power limitation and when all PV inverters are feeding in. When the system is curtailed, this value shows an estimate of the active power without curtailment and for all PV inverters.
- **Measurement.Operation.CurAvailPlnt:** Available active power, normalized to system power Parameter.Plnt.WRtg. Expressed as a percentage.

The term "measurement" is somewhat misleading here, because it refers to a value that has been calculated from measurements based on assumptions. The term "measurement" refers here to the category of data points: They can be found under "Instantaneous values" and are updated at intervals of 60 seconds for EDMM and 500 milliseconds for EDML.

The value of the available reactive power can be read from the following four measured values:

- **Measurement.Operation.CurAvailVArUnExt**: Available reactive power, underexcited.
- **Measurement.Operation.CurAvailVArUnExtNom**: Available reactive power, underexcited and normalized to the system power **Parameter.Plnt.WRtg**. Expressed as a percentage.
- **Measurement.Operation.CurAvailVArOvExt**: Available reactive power, overexcited.
- **Measurement.Operation.CurAvailVArOvExtNom**: Available reactive power, overexcited and normalized to the system power **Parameter.Plnt.WRtg**. Expressed as a percentage.

The entire function is available to all users and is enabled by default. No sensors are required to calculate the available reactive power.

2.3 Algorithms for available active power

To calculate the available active power, the algorithm proceeds as follows:

1. Retrieving measured values from connected sensors

2. Calculation of the base value for the expected feed-in
3. Correction with self-learning algorithm in EDML-10
4. Determination and output of the minimum correction value, value of the available inverter power, and the maximum possible power at the point of interconnection

Figure **4** shows the basic functioning of the algorithm.

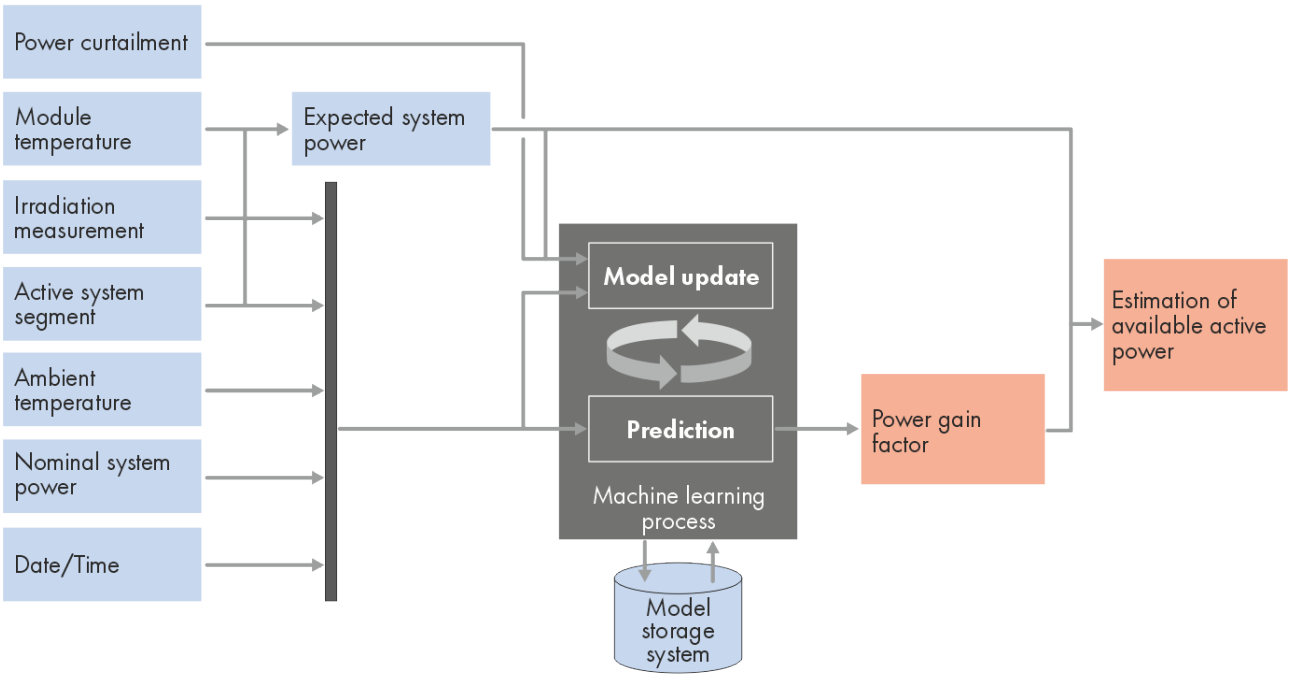

Figure 4: Block diagram of the algorithm

The expected system output P_{Exp} is calculated using the following formula:

$$P_{Exp} = P_{DC} * \frac{Irr}{1000\,W/m^2} * \left(1 + y * (T - 25°C)\right)$$

Formula 1: Expected feed-in based on IEC-61724-1 PR-STC

with:

P_{DC} = PV power installed (DC side) in W

Irr = direct solar irradiation in W/m²

T = module temperature in °C

γ = temperature coefficient -0.004 1/K

In order to account for system-specific deviations from (Formel 1), the expected power is corrected using a gain factor.

$$P_{Avail} = P_{Exp} * Gain$$

Formula 2: Corrected expected system power

The factor $Gain$ is determined using a machine learning process based on the calculated expected power (Formel 1) and the measured power at the point of interconnection.

$$Gain = F(Irr, T_{amb}, Zeit)$$

with:

Irr =direct solar irradiation in W/m²

T_{amb} = external temperature value in °C

Time = Date/Time

The gain factor starts at 1 when the system is started up. When the system is in normal operation, the gain factor adjusts to the observed values. Normal operation mean:

- At least 50% of the plant inverters in feed-in
- No external active power limitation available

Finally, the available active power is limited to the available active power of all inverters and to the maximum possible power at the point of interconnection:

$$P_{Avail,limit} = min(P_{Avail}, P_{Inv,Avail}, P_{PCC})$$

Formula 3: limited available active power

with:

P_{Avail} = available active power (Formel 2:)

$P_{Inv,Avail}$ = Total available active power of all inverters (provided by Sunny Central UP inverters)

P_{PCC} = maximum possible power at the point of interconnection, limited by the reactive power supplied at the point of interconnection

Restrictions of the algorithm

- Battery inverters are not taken into account for the available active power. The parameters can still be configured, but the result of the algorithm will then be incorrect.
- There must be no loads in the system. Loads in the system distort the calculation result.
- Compatible with the following SMA inverters: central inverters, inverters with SMA Speedwire, Sunny Tripower Core2.

3 List of measured values/parameters

The measured values and parameters without referenced Modbus register addresses can only be viewed and adjusted via the Data Manager user interface.

Channel	Name	Modbus Register address	Type of access
Measurement.Operation.WAval	Available system power	31545	RO
Measurement.Operation.CurAvailPlnt	Availability of generating system	32193	RO
Measurement.Operation.WAvalTheo	Theoretically available system power	32191	RO
Measurement.Operation.CurAvailVArUnExt	Available underexcited reactive power	32187	RO
Measurement.Operation.CurAvailVArUnExtNom	Available underexcited reactive power	32197	RO
Measurement.Operation.CurAvailVArOvExt	Available overexcited reactive power	32189	RO
Measurement.Operation.CurAvailVArOvExtNom	Available overexcited reactive power	32199	RO
Measurement.Internal.Metering.PCCMs.TotPlntW	Power at the grid connection point	-	-
Measurement.Env.ExInSol	Irradiation on external sensor	34623	RW
Measurement.Mdul.TmpVal	Module temperature	34621	RW
Measurement.Env.TmpVal	External temperature	34609	RW
Parameter.Plnt.DcW*Rtg*	Nominal system power (DC)	-	-
Parameter.Plnt.W*Rtg*	Total system power	41463	RW
Parameter.Inverter.VAMaxIn*Rtg*	Rated apparent power VAMaxInRtg		
Parameter.Inverter.VAMaxOutRtg	Rated apparent power VAMaxOutRtg	-	
Parameter.Inverter.VArMaxQ1Rtg	Rated Reactive Power VArMaxQ1Rtg	-	
Parameter.Inverter.VArMaxQ2Rtg	Rated Reactive Power VArMaxQ2Rtg	-	
Parameter.Inverter.VArMaxQ3Rtg	Rated Reactive Power VArMaxQ3Rtg	-	

Parameter.Inverter. VArMaxQ4Rtg	Rated Reactive Power VArMaxQ4Rtg	-

Table 1: Parameter description


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