Technical Information

Direct Marketing Interface

1 Introduction

The German Renewable Energy Sources Act (EEG) 2014 Sec. 5(9) defines "direct marketing" as the sale of photovoltaic electricity to third parties through the public electricity grid. This definition covers not only sales of photovoltaic electricity to large consumers, but also the marketing of electricity on power exchanges. Trading PV electricity on a power exchange is a technically and administratively challenging process, which is why PV electricity is usually traded through a direct marketing company, or a "direct marketer" for short (EEG 2014 Sec. 5(10)).

The basic principles of EEG 2014 (Sec. 2(2)) describe direct marketing as a market model intended to drive the market integration of electricity generated from renewable energy sources. A fixed feed-in tariff has been reserved for small PV systems (EEG 2014 Sec. 37(2)), but will likely be eliminated sometime in the future. The market incentives provided by direct marketing are intended to drive the development of efficient, profitable power generation technologies. To accomplish this, EEG 2014 sets out transitional periods as well as special incentive mechanisms.

Direct marketing has been the only available market model for incentivizing electricity exported by PV systems with peak power levels of 500 kW or more since the enactment of EEG 2012. The EEG amendment introduced in 2014 lowered this threshold to 100 kWp as of January 1, 2016 (Sec. 37(2)(2)). Almost all the electricity fed in from these systems receives the optional market premium (EEG 2014 Sec. 34). The EEG 2014 also allows PV electricity to be marketed through "regional direct marketing" or "other direct marketing", but these alternatives are difficult and expensive to implement, and thus not widely adopted.

The purpose of the market premium is to financially support the development of technology and practical experience with integrating renewable electricity into the power trading market. The market premium is designed to offset the difference between the revenue generated from trading power on an exchange and the feed-in tariff fixed in the EEG for relatively small PV systems.

The market premium ("MP") - see Annex 1, EEG 2014 - is calculated based on the average price paid for PV electricity on the power exchange at the end of the monthly settlement period (the "monthly market value", or "MW" for short). The market premium is the difference between the standard value (German: "anzulegender Wert", or "AW" for short) and the monthly market value: MP = AW - MW.

On average, the PV system operator ends up receiving as much income as the feed-in tariff. The PV system operator's actual income at any given time, however, may vary depending on fluctuations in the price paid on the power exchange. There are three possible scenarios:

- Scenario 1: Power exchange price = Monthly market value

  The PV system operator receives incentives that are worth as much as the feed-in tariff.
- Scenario 2: Power exchange price < Monthly market value

  The PV system operator receives incentives that are worth less than the feed-in tariff.
- Scenario 3: Power exchange price > Monthly market value

  The PV system operator receives incentives that are worth more than the feed-in tariff.

The following figure illustrates these three scenarios:

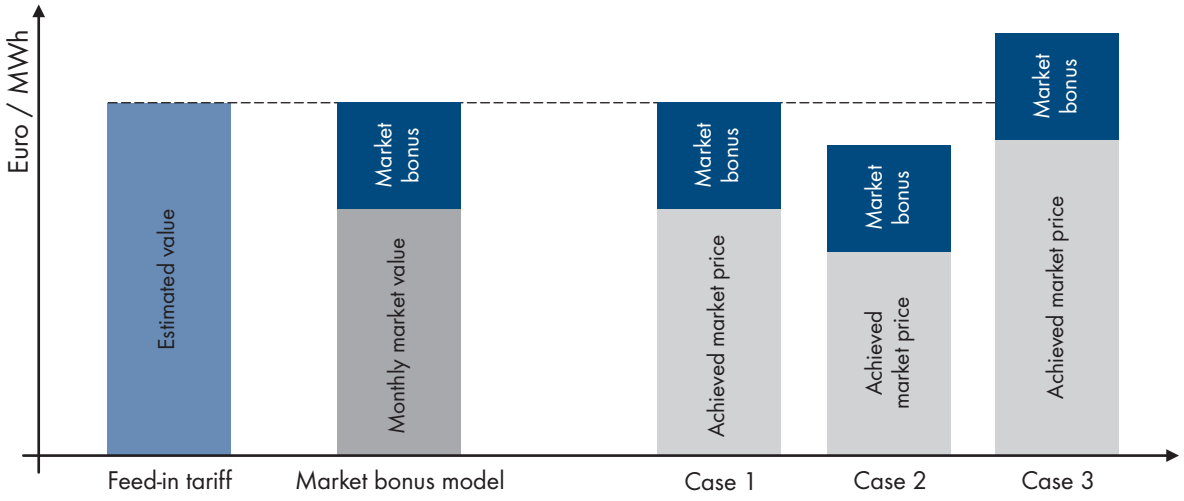

Figure 1: Incentives depend on power exchange prices

Management Premium

EEG 2014 eliminated the management premium set out in EEG 2012. To ensure a smooth transition, however, EEG 2014 increased the standard value for PV electricity by 0.4 cents per kilowatt-hour (EEG 2014 Sec. 100).

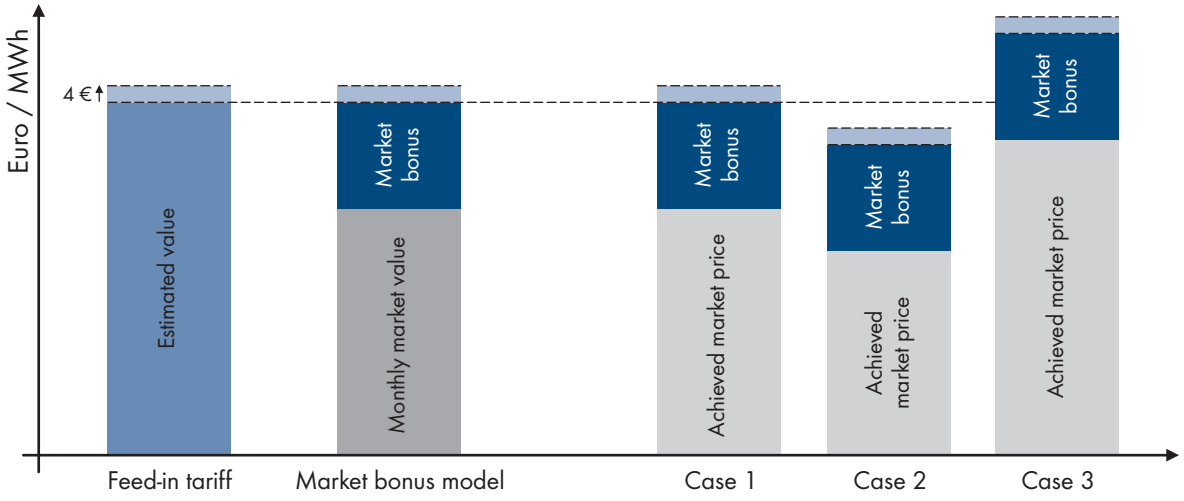

Figure 2: Management Premium

2 Direct Marketing with SMA Products

Under EEG 2014, PV systems can only be used for direct marketing if they can be remotely controlled by the direct marketer (EEG 2014 Sec. 36). In other words, the direct marketer must have a secure communications channel through which it can instantly look up the PV system's current feed-in power and set the levels at which the PV system must curtail its feed-in power. The law states, however, that curtailment limits set by the direct marketer must be overruled by any limits set for feed-in management purposes (e.g. curtailment of feed-in power by the grid operator).

The following figure shows the communication links used by a PV system set up for direct marketing with SMA technology:

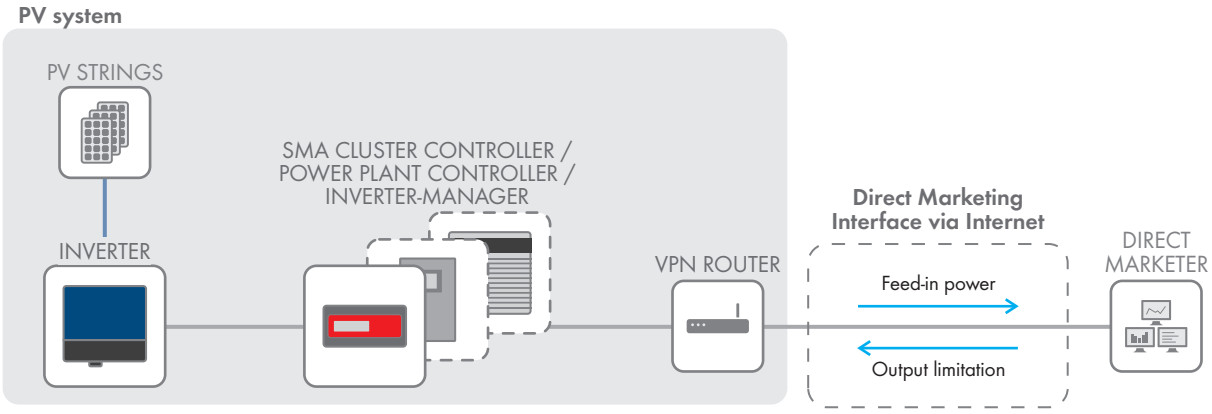

Figure 3: Direct marketing with SMA products

EEG does not specifically regulate the direct marketing interface, leaving it up to PV system manufacturers and direct marketers (or their IT solution providers) to negotiate the details themselves. The next two subchapters provide technical details on the SMA direct marketing interface in the SMA Cluster Controller, SMA Power Plant Controller and SMA Inverter Manager.

2.1 Direct Marketing with the SMA Cluster Controller

A direct marketer can use the SMA Cluster Controller as a central communication unit for remotely controlling the PV system. To support this functionality, the SMA Cluster Controller comes with an Ethernet interface based on Modbus® TCP. The Modbus® protocol was expanded to comply with EEG 2014 starting with firmware version 1.01.16.R (October 2014). The SMA Cluster Controller accepts and passes on control signals from the direct marketer to the PV system without affecting the grid operator's feed-in management activities. Priority is always given to the setpoint with the lowest power setting. This includes setpoints provided by manual limits or control signals such as integrated digital/analog inputs.

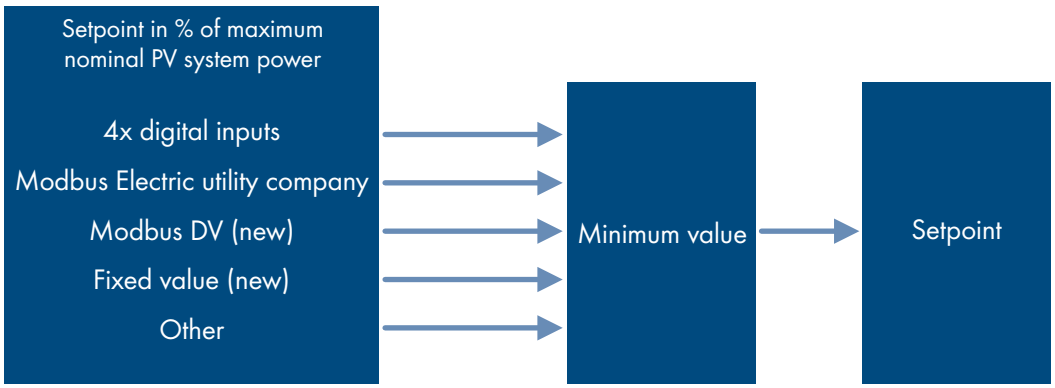

Figure 4: The SMA Cluster Controller selects and applies the lowest available setpoint from various sources

A VPN router can provide a VPN tunnel to secure data transmissions between the SMA Cluster Controller and the direct marketer. VPN routers are available from SMA Service (truecon M2M from Hy Line, Falcon from Westermo).

The Modbus® interface not only meets the legal requirement for real-time tracking of active feed-in power data, but also provides a full array of features for reading PV system data. System operators can also use the SMA Cluster Controller's wide range of functions for data logging, service and central monitoring:

- License-free access to the SMA Cluster Controller's Modbus® interface
- Feed-in management and direct marketing bundled in one device
- Access to all the benefits of the SMA Cluster Controller as a central control unit
- Maximum system transparency from logging curtailment commands
- Access additional PV system data and inverter data
- Advanced monitoring, visualization and alarm functionality in connection with Sunny Portal
- Superior PV system reliability by defining PV system behavior in the event of a communication failure

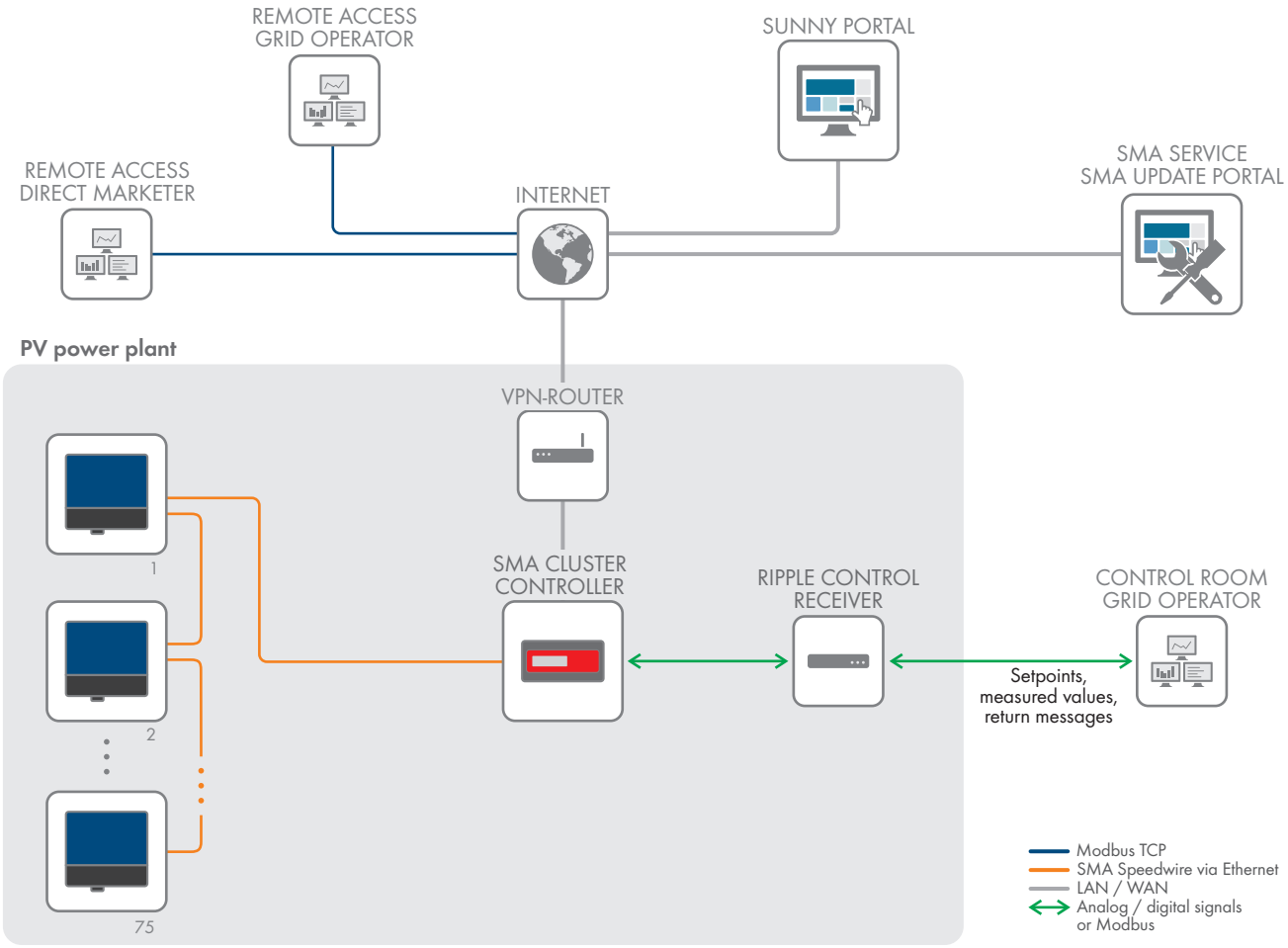

Figure 5: PV system design with distributed inverters, an SMA Cluster Controller and remote access for direct marketers and grid operators

SMA currently offers two versions of the SMA Cluster Controller. Only the CLCON-10 provides an additional Modbus® register for direct marketers to set the power setpoint. CLCON-S-10 is a scaled-down version with the exact same functionality, except only the electric utility company can curtail power via Modbus.

Curtailment Options for SMA Cluster Controller Versions	CLCON-S-10	CLCON-10
Direct marketer via Modbus	no	yes
Utility company via Modbus	yes	yes
Manual setpoint (fixed value)	yes	yes

Curtailment Options for SMA Cluster Controller Versions	CLCON-S-10	CLCON-10
Setpoint set via digital inputs	yes	yes
Setpoint set via analog input	yes	yes
Number of inverters	25	75

The following table lists the most important Modbus® registers that can be used by direct marketers. The setpoints are shown as a percentage of maximum nominal PV system power.

Register	Description	Use	Format	Unit	Access (R/W)
Usable registers under EEG 2014					
30775	PV system's current active power	Real-time feed-in monitoring under EEG 2014	S32	W	R
40493	Active power setpoint as a % of nominal PV system power for the direct marketer	Power curtailment under EEG 2014	S16	%	W
Additional usable registers					
30007	Modbus® data change: Counter value is increased if new data is available.	Live bit, real-time monitoring of PV system availability	U32		R
31235	Active power setpoint, digital I/O in %	Listens for current active power setpoint on the digital input	U32	%	R
31237	Active power setpoint, analog input in %	Listens for current active power setpoint on the analog input	U32	%	R
31239	Active power setpoint in %, set by electric utility company via Modbus®	Checks for a current active power setpoint from the electric utility company	U32	%	R
31241	Active power setpoint in %, set by direct marketer via Modbus®	Notification of the current active power setpoint set by the direct marketer.	U32	%	R
31243	Resulting setpoint in % (lowest available value of all setpoints)	Notification of the effective active power setpoint transmitted to the PV system.	U32	%	R
34653	Status of digital inputs (Group I)	Listens for a parallel active power setpoint on the digital input.	U32		R
34637	Active power setpoint in mA over analog current input	Listens for current active power setpoint on the analog input	S32	mA	R
41167	Active power setpoint in %, set manually	Checks for an active power setpoint that was manually set by the PV system operator.	U32	%	R

Visit www.SMA-Solar.com for a detailed description of all Modbus® registers and guidance on implementing the Modbus® interface.

2.2 Direct Marketing with the SMA Power Plant Controller

The SMA Power Plant Controller can be used in much the same way as an SMA Cluster Controller to give a direct marketer access to a PV system, as shown below.

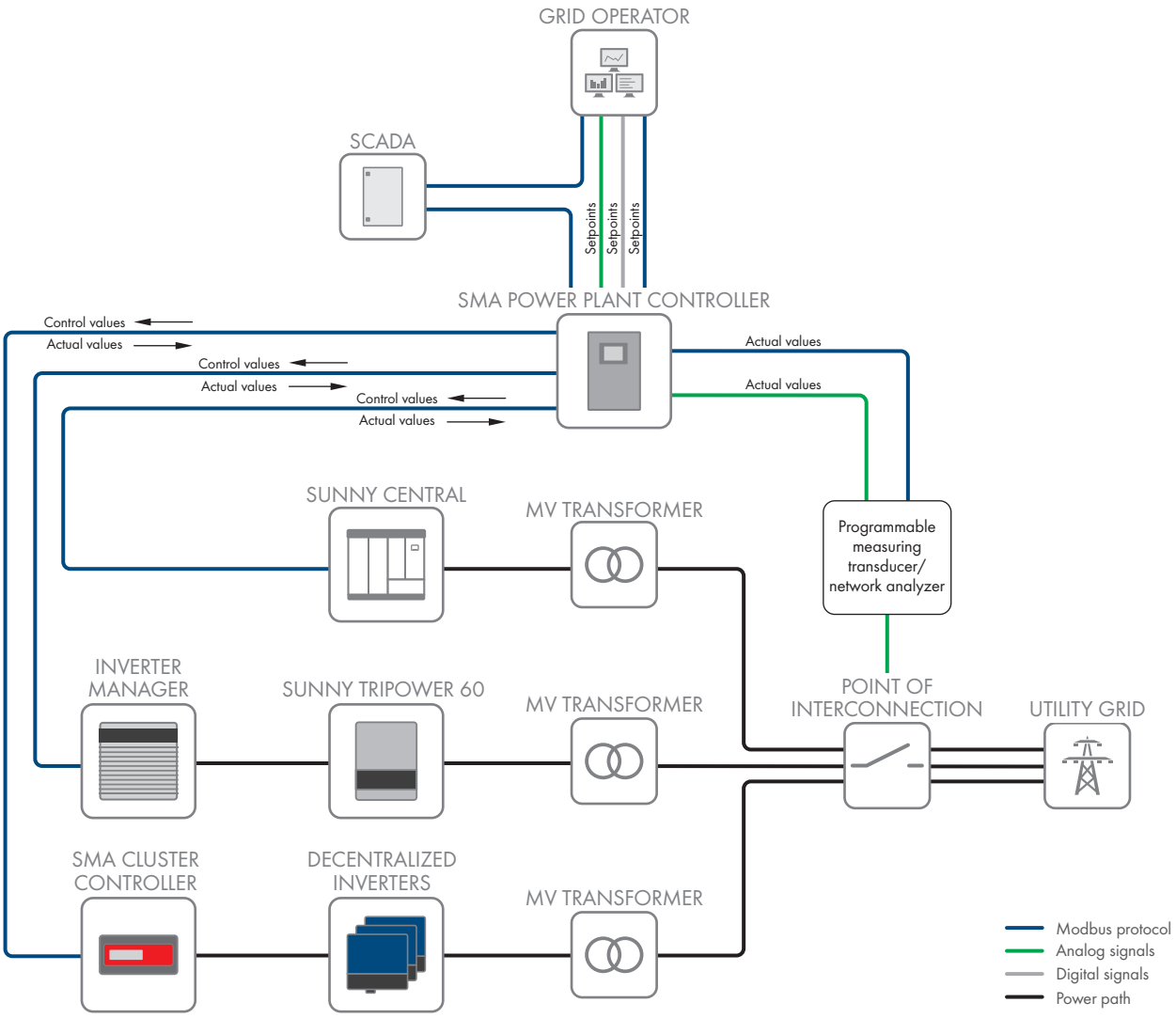

Figure 6: Schematic diagram of a PV system based on the SMA Power Plant Controller

The following table lists the most important Modbus® registers that can be used by direct marketers.

ADR (DEC)	Description / Return Code	CNT (WORD)	Format	Display	Type	Access
189 + 190	Default external measured value active power (MW)	2	S32	Scalar	FIX3	RW
215	PV park active power setpoint, direct marketing interface (according to German EEG law) (%) [AtPwrCtlSpntDS] (if selected, the Power Plant Controller will choose the smaller of AtPwrCtlSpnt or AtPwrCtlSpntDS)	1	S16	Scalar	FIX2	RW

ADR (DEC)	Description / Return Code	CNT (WORD)	Format	Display	Type	Access
261	Switch the transmission of active power setpoints 1 = [% x 1000] 0=[MW x 1000]	1	U16	Scalar	Status	RO
262 + 263	PV park active power setpoint (in MW or %) [AtPwrCtlSpnt]	2	S132	Scalar	FIX3	RO
343	PV park active power setpoint, direct marketing interface (according to German EEG law) (%) [AtPwrCtlSpntDS] (if selected, the Power Plant Controller will choose the smaller of AtPwrCtlSpnt] or AtPwrCtlSpntDS])	1	S16	Scalar	FIX2	RW

2.3 Direct Marketing with the Sunny Tripower 60 and the SMA Inverter Manager

The SMA Inverter Manager can be used in much the same way as an SMA Cluster Controller to give a direct marketer access to a PV system. Figure 7 shows the basic configuration of a PV system with a Sunny Tripower 60 and an SMA Inverter Manager. Communications with the direct marketer go through an encrypted Ethernet connection established by a VPN router using the SMA Inverter Manager's SunSpec® Modbus® interface. Extensive documentation of the SMA Inverter Manager's Modbus® interface is available in the technical information "SUNNY TRIPOWER 60 - SunSpec®-Modbus®-Interface" at www.SMA-Solar.com.

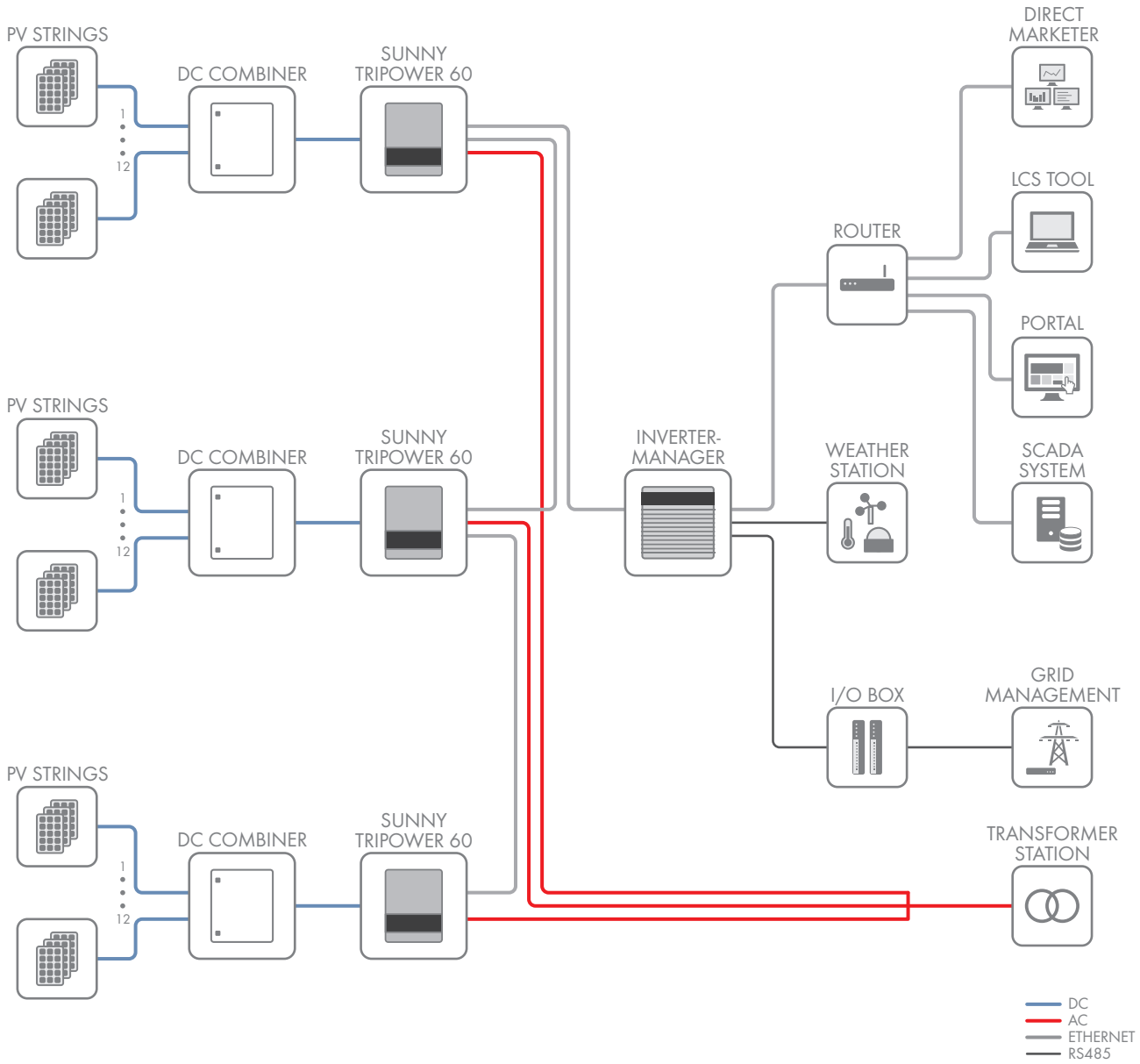

Figure 7: Schematic diagram of a PV system with the Sunny Tripower 60 and the SMA Inverter Manager

The following table lists the most important Modbus® registers that can be used by direct marketers.

NO. (DEC)	Description / Number Code(s)	CNT (WORD)	Format	Access
1	Power limit setpoint set by direct marketer Percentage value representing the maximum active power of system (Reg. 6) to two decimal places. A value of 10000 means 100%. A value of 0x8000 (NaN) means that no setpoint has been set. Valid values from 0 to 10000.	1	U16	RW
2	Manual power limit that has been set via Sunspec® Modbus®. Percentage value representing the maximum active power of system (Reg. 6) to two decimal places. A value of 10000 means 100%.	1	U16	RW
3	Power limit set by the electric utility company via the IO box. Percentage value representing the maximum active power of system (Reg. 6) to two decimal places. A value of 10000 means 100%. A value of 0x8000 (NaN) means that no setpoint has been set.	1	U16	RW
4	Minimum of all power limit settings. The nominal PV system power is curtailed to this value. Percentage value representing maximum active power of the system to two decimal places. A value of 10000 means 100%.	1	U16	RW
5	The PV system's current active power, shown in kW to one decimal place. A value of 600 means 60.0 kW.	1	U16	RW
6	Maximum active power of the system as a whole number. A value of 60 means 60 kW.	1	U16	RW
7	Meter for checking the connection (Watchdog). The meter is incremented one step every 200 ms. The meter restarts at 0 after reaching 65535.	1	U16	RW