Phoenix Contact Solution Kit

Photovoltaics

No. 1– String Monitoring

For internal use only

Contents

1. The application

As an operator you are looking for a system with which your equipment can be stably operated. Moreover, you require monitoring and diagnostic data to be provided for the actual control function. This Phoenix Contact system is exactly the right automation system to meet your demands.

Within the solar industry there are calls for a functional and suitable control system for a demanding environment. The establishment of an automation technology system according to industry standards is a clear advantage.

Applications for the widest range of areas can be implemented based on the hardware. – Modular in hardware and software -

2. The solution

Efficient acquisition of string currents

With an overall monitoring system, DC energy of a string group can be monitored by a so-called reference cell. The reference cell can be regarded as a small, separate string. The output signal of the reference cell is connected to an analog input module as a standard analog signal. The measured values of the reference cell are processed in the controller according to the characteristic curve and are correlated with the processed energy values of the generated strings, thereby making a qualitative message about energy generation possible. The string current is measured using a measuring transducer, e.g., MCR SL CUC.

The measuring transducer output signal is a standard analog signal and is connected to the analog input module IB IL AL. A specific diagnosis concerning the state and function of individual modules is virtually impossible in this way and repair work is only feasible with relatively severe diagnostic efforts.

The temperature of the module is often measured with a temperature sensor, messages about the thermal state of individual modules are not possible. The main output signal of the temperature sensor is also a standard analog signal or PT 100 or PT 1000. There are two, four or eight channel versions of the IB IL TEMP module and these can be selected according to the number of engaged sensors.

The more convenient solution is single string current monitoring. Each individual string is measured, which in turn is composed of individual modules.

There are three measurement methods, among others. One method is to use the measuring transducer, which has already been described under overall string current monitoring.

Another method is that a shunt resistor switched in series to the strings records the string current. The voltage drop of the shunt resistor, typically up to some 100 mV, is changed to a standard analog signal by means of a converter module, e.g., Mini MCR SHUNT ... and can be correspondingly integrated into the control system. Similar to the procedure first described, the string conductor can be guided through the MCR CUC... converter module. With this method the DC signal is changed to a standard analog signal by means of the corresponding electronics.

Measurements with the hall sensor have the advantage that they are electrically isolated from the voltage occurring at solar modules of up to several hundred volts and thereby offer protection for people and the measuring unit.

If you have a larger photovoltaic system, it is not sufficient to merely measure the generator or AC side. In this case, the operator should have access to detailed information about the state of the individual panels or strings. A photovoltaic power plant works efficiently as long as all units are functioning properly. It is, therefore, important that all relevant data is readily available. With the SCK-M-8 S-20A Solarcheck module from Phoenix Contact, you can determine, for example, individual string currents and the total voltage of a panel unit. Up to eight strings are recorded per module. In combination with the Modbus SCK-C communication module, a total of eight Solarcheck modules can be transmitted to the higher-level control system via Modbus RTU. Consequently, a Solarcheck unit supplies the data of a maximum of 64 strings. According to Modbus RTU specifications, up to 31 devices can be processed. This means that a total of 1984 strings can be measured in a photovoltaics application with Solarcheck modules.

Measuring AC energy

A further important aspect of this configuration regarding the functioning of the PV system is the energy fed into the electrical grid. This energy can be measured with appropriate energy meters. Data for fed energy can be read out using an ILC 170 ETH 2TX controller via a serial interface, e.g., Modbus RTU, Ethernet, Modbus TCP or a manufacturer-specific interface. Electrical values can be imported directly into the Phoenix Contact fieldbus system via the EMpro MA 400 electrical energy management module. Another way of measuring is to read out this data directly from the inverter. Inverters also have serial or Ethernet interfaces. For both measurement types, the corresponding function blocks are available for the Phoenix Contact AUTOMATION WORX automation system.

Processing data

The values recorded on the AC and DC side must be presented at the controller for further processing. It is for this purpose that analog signals are converted to the appropriate format by means of the analog technology library. In the user program these values are, for example, used to determine the efficiency of the PV system component of the calculation algorithms. The data gathered is further processed and saved for further analysis, for example, via an SQL library in a database, by e-mail or ftp. All data calculated at the controller is correlated and made available to the operator as diagnostic data.

Data transmission

Depending on requirements, there is an option of transmitting the processed data via various communication paths for the purpose of further processing. One possibility is to send the measured data in a text file, e.g., csv format, as an e-mail using the IT library or to upload it onto an FTP server. In this way, it is possible to process the measured data of the PV system using the appropriate software tools, so that it can be viewed by the operator via the Internet on a website.

Representation in a web browser has the advantage that no special visualization software needs to be purchased in order to display the system data. For the sake of completeness it should be mentioned that a critical system state, such as a string failure, can also be sent as an SMS. The function blocks required for this are also components of the IT library.

The following components are necessary for creating a string monitoring system:

Control technology from Phoenix Contact

- ILC1xx / ILC3xx / RFC470
- IB IL RS 485/422-PRO-PAC

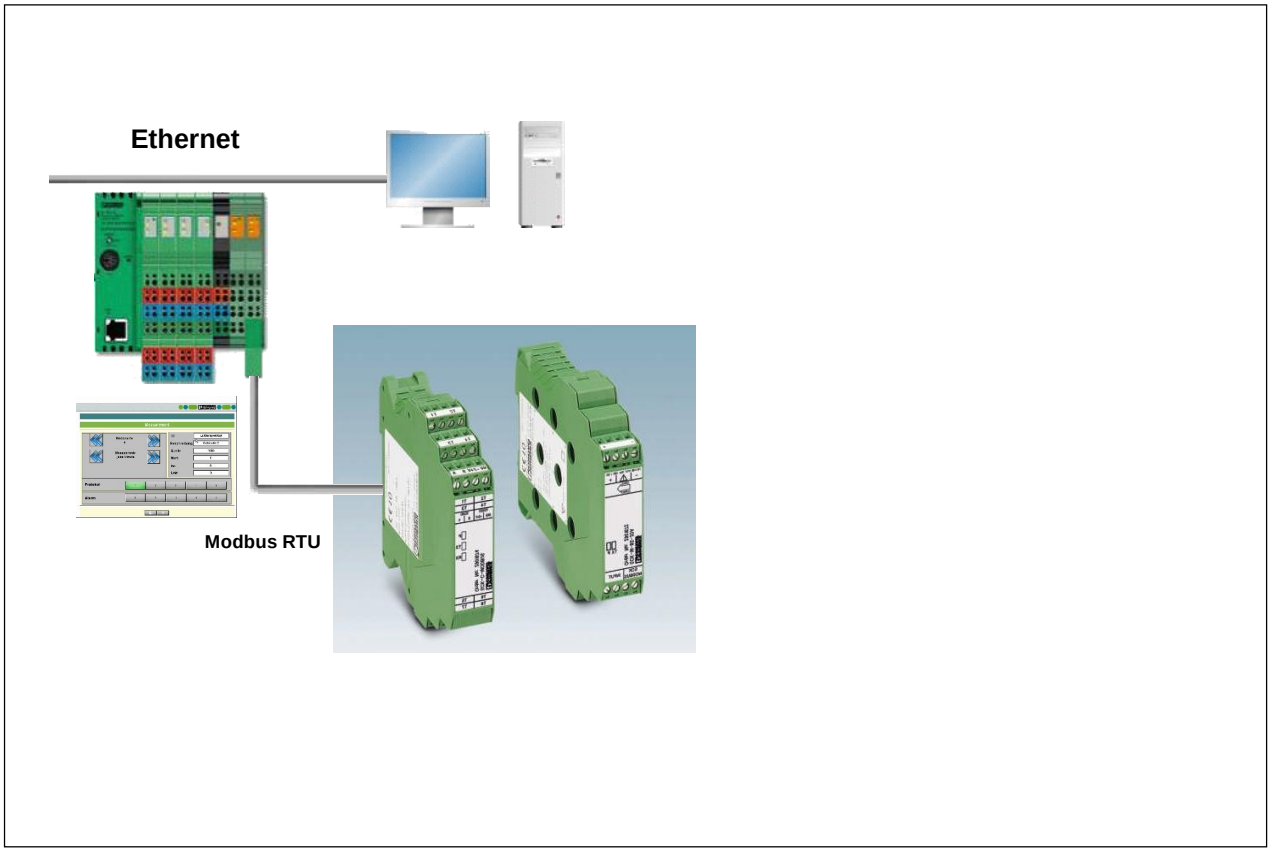
- PC WORX as the programming environment
  - AX software suite 2010
  - PC WORX PRO LIC

- Function block libraries
  - EDCL_V0_8x

- Visualization
  - Visu+ or OPC-based visualization software
  - SQL database-based systems
  - Web-based system (AxWeb) or portal solutions

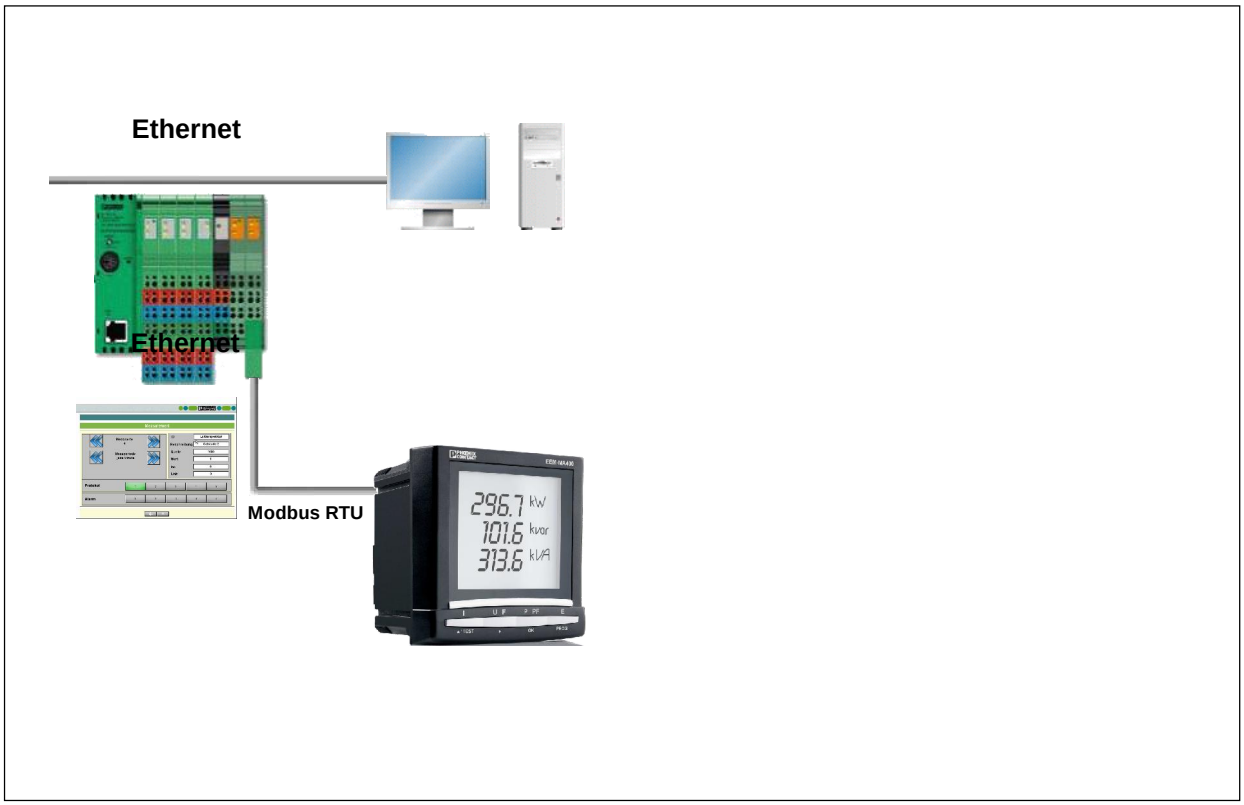
- Measuring module
  - SCK-M-8S-20A
- Communication module
  - SCK-C-MODBUS

3. System overview



Measuring string currents on the generator (DC) - side

Table header (Arial bold 9pt)			
2985330	ILC 150 ETH	2901674	SCK-C-MODBUS communication module
2863627	IL RS 485/422-PRO- PAC	2901672	SCK-M-8S-20A measuring module
2985660	AX software suite 2010		EDCL_V0_8x
2985385	PC WORX PRO LIC		



Measuring AC energy

Table header (Arial bold 9pt)			
2985330	ILC 150 ETH	2901364	EEM-MA400
2863627	IL RS 485/422-PRO- PAC	2901365	EEM-RS485-MA400
2985660	AX software suite 2010	2901366	EEM-MA600
2985385	PC WORX PRO LIC	2901367	EEM-RS485-MA600
2901363	EEM-MA250	2901373	EEM-ETH-MA600
			EDCL_V0_8x

You will find a detailed overview of PHOENIX CONTACT products for the photovoltaics industry in the PV brochure from PHOENIX CONTACT

4. System knowledge

Knowledge of the following topics is a requirement for using our solutions:

- PC WORX
- Communications technology, specif. Modbus RTU/TCP, Ethernet
- Network technology
- Measuring technology

Based on these fundamentals, a one-week workshop is recommended to broaden one's practical knowledge.

We also offer our service portfolio

- Project engineering, system retrofit & upgrade
- Service contracts
- Training, workshops

5. Competitors

In addition to the competitors listed below, there are additional companies operating in different regions that offer self-contained monitoring systems. In relevant projects, however, only the following competitors in the market need to be considered.

Carlo Gavazzi

Wago

Beckhoff

Tixi

6. References

Solarcheck Spain

Monitoring Italy

Mage Solar

7. Glossary

GCB	Generator connection box
Shunt	Resistor for current measurement
String	Unit composed of several solar modules
Solar module	Converts solar energy to current
Inverter	Converts DC to AC
Inverter	See inverter
Crystalline modules	Solar modules made of silicon
Thin-film module	Also amorphous modules. Material is not crystalline (randomized) silicon. These modules are more efficient and are more flexible than crystalline modules in the area of application
Diode terminal block	Modular terminal block with integrated free-wheeling diode to protect solar modules. Especially designed for thin-film modules
Web portal	Data logger of, e.g., energy data, which then can be called up by the end user via an Internet browser.
SUNCLIX	Plug-in connectors to connect solar modules
Surge protection	Products to protect communication devices, solar modules, and inverters
Terminal blocks	Connection element for electrical wires
Tracking	Position of the sun on the tracked solar module
Monitoring	Permanent recording and saving of system data and alarm information
PV emergency stop	An operating unit to switch off solar modules in an emergency, e.g., fire on a PV system.