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Knick

Application Report

Cost Effective and Reliable Monitoring of Photovoltaic Plants using Specialized Isolation Amplifiers

Background
In many cases, the investments intended to increase the efficiency of solar energy plants require a dispro-portionately high financial expenditure. On the other hand, centrally installed current and voltage metrology in the inverters based on isolation amplifiers can kill two birds with one stone: It increases the efficiency while saving money because it makes decentralized measurements superfluous.

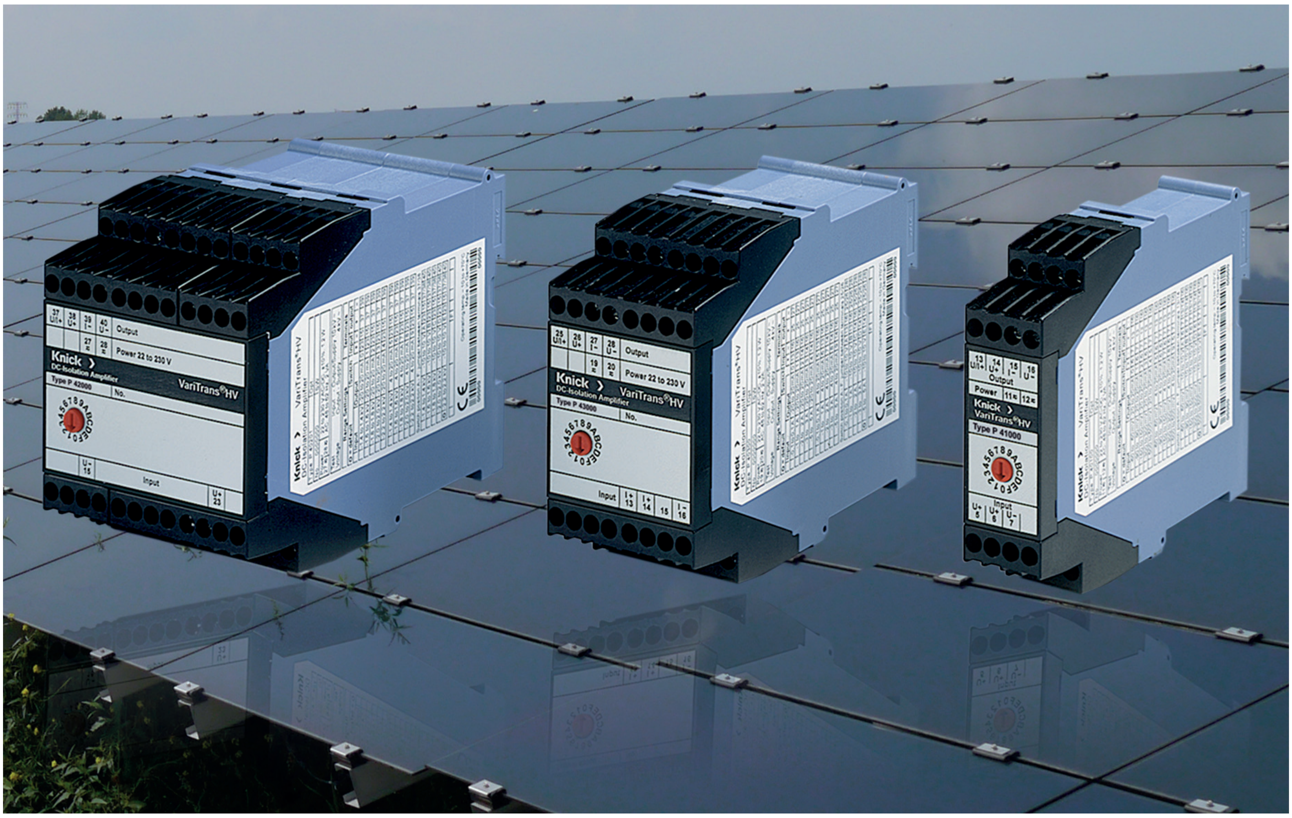

Image 1: VariTrans P 40000 high-voltage isolation amplifier

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Now that the phase of pure research and prestige objects in solar plants has come to an end and government support has been cut back, the highest priority in the competition of suppliers and systems is optimal cost-effectiveness. The main focus here is placed on the highest possible energy yield to ensure efficient plant operation. But at the same time one needs to keep an eye on the expenditures required for continuously improving the plant efficiency. Increasing the efficiency by the last tenth of a percentage point doesn't help if the costs increase disproportionately and the amortization time extends by months or even years. An increase in the efficiency with little or even no expenditure would be ideal – a real challenge.

So the decisions when technically designing a solar plant always have to stand up to a cost-benefit consideration. Naturally, there is no sense in saving at the cost of the (electrical) safety: A reliable plant operation also improves the cost-effectiveness when compared with designs in which a higher efficiency could be reached but plant sections exhibit increased probability of performance losses or even fail completely in practical operation. So the point is to create an ideal balance between expenditure and benefit.

Unfortunately, low effort and low costs often oppose the goal of increasing the reliability, efficiency and safety. But the intelligent use of suitable components can reduce the total costs for a plant. Centrally utilized high-quality measuring technology facilitates relevant savings at other points. Isolation amplifiers for exact current and voltage measurement in central inverters can make decentralized measurement superfluous. Not only are the costs for many components omitted; also the expenditure for their installation and the procurement of suitable measurement conditions in the decentralized plant sections are obviated.

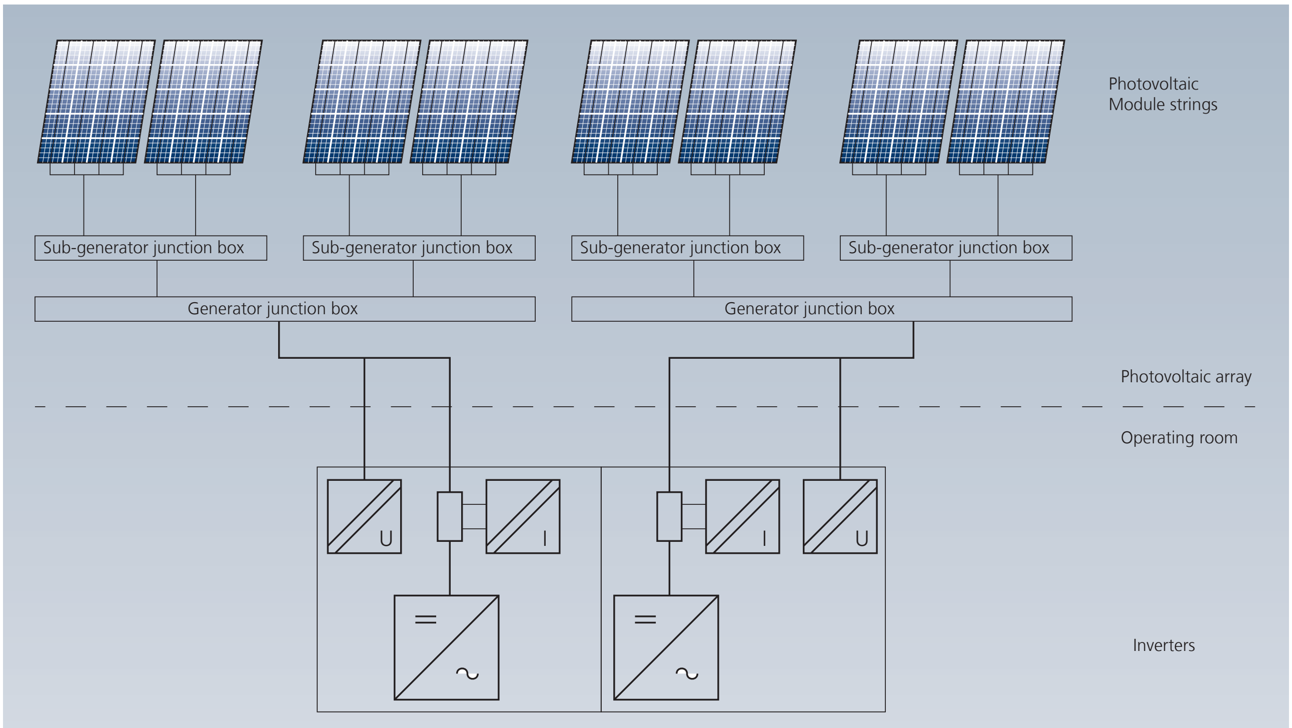

Image 2: Solar energy plant with centralized plant monitoring

System design influences efficiency and costs

Modern photovoltaic plants comprise two main components: The PV array made of solar modules for converting the irradiating sun energy into electrical energy and an inverter system that converts the direct current of the solar module and couples it into the AC grid. Large plants are often implemented with central inverters.

A typical topology of such solar plants combines strings of series-connected PV modules in sub-generator junction boxes. The total current generated through parallel connection is led to upstream generator terminal boxes where again several branches are connected in parallel and the resulting total current is led through a large cross-section cable to the inverter.

Central inverters can be modularly equipped up to the megawatt range. The solar arrays are currently designed for system voltages up to 1000 V and they supply currents of several hundred amps per inverter. The inverters are correspondingly rated for input voltages of up to 1000 V DC. It is very likely that in future the system voltage will be increased to 1500 V to prevent losses; so components are already now being designed for the higher voltage level.

Electrical plant parameters are registered both for MPP tracking, i.e. the control of the power output, as well as for detecting malfunctions. To accomplish that, among other things the currents and voltages are measured on the DC side. The above-mentioned system voltages require a suitable measurement-system isolation to protect both the operating personnel as well as the control and evaluation systems. So the measurements are taken through isolation amplifiers with a correspondingly high galvanic isolation.

Safety and reliability through suitable components

For the voltage measurement, compact components are available which can directly register the occurring voltages with great precision. The DC currents are measured via shunts (measuring resistors) with downstream isolation amplifiers. They have a (differential) input in the mV range. They likewise need a high isolation because they must reliably galvanically isolate the system voltage, e.g. 1000 V, as a common-mode load.

The 1000-V plants require a protective separation of 1000 V AC/DC according to EN 61140. With an increase of the system voltage to 1500 V, the requirements placed on protective separation increase accordingly.
Protective separation is achieved through double insulation, which guarantees a safety margin of 100 percent. For cost reasons, a safety margin is omitted in some plants. However, this can lead to dangerous conditions with severe consequences for the manufacturer and the operator. Products that guarantee standard-conformant protective separation even for the coming 1.5-kV plants are readily available.

The isolation amplifiers of the VariTrans P 41000 series (current measurement) and VariTrans P 42000 (voltage measurement) from Knick provide protective separation up to 1100 V according to EN 61140 (overvoltage category OV III / pollution degree PD 2). In the P 41100/P 42100 versions, protective separation is guaranteed up to 1800 V AC/DC (OV III and PD 2). Using these isolation amplifiers, photovoltaic systems which guarantee compliance with applicable safety standards can now be constructed. And the devices are fit for the future since they already cover the requirements placed on rising system voltages. A failure rate (MTBF) of 96 years makes them safe and dependable.

Reversal of the financial trap

The isolation amplifiers precisely measure the total currents of larger plant sections, which allows early detection of impairments in certain plant sections such as defective strings. Users can immediately react, thus preventing yield losses. The slightly higher costs for the precise measurement including the design with safety margin and standard-conformant protective separation are more than compensated: The centralized layout allows cutting out the decentralized measurements of the branch currents. A string failure can be easily located with portable measurements on site and then immediately repaired. The plant concept is significantly simplified through the centralized layout of the measurements, which brings along corresponding cost benefits. And the safety and reliability of the solar plant increases at the same time.

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