STELLIO: advanced heliostat field control and power grid system - Closing the power tower efficiency loop

1. Overview

Masermic is a specialist for state of the art control systems hard & software, communication networks and power grid technologies for parabolic trough, heliostat and PV solar fields.

Successfully realized commercial projects and intensive R&D&Innovation activities during the last years have been our contribution to improve solar field performance in terms of reliability, effectivity & investment cost, thus increasing their feasibility.

We see solar field as a cubic frame which's boundaries are established by four main concepts: 1: Collector Control System.2: Collectors Solar Field Control System 3: Collectors Solar Field Power Grid. 4: Collectors Solar Field Management System. Tackling these four concepts as a unique and synergetic framework opens the possibility to important advances in the efficiency and reliability of the Solar Fields.

Certainly, as advancing the state-of-the-art of solar field solutions needs multi-technological teams, Masermic, as part of the Stellio Team, is collaborating with the companies **SBP (www.sbp.de)** and **Ingemetal (www.ingemetalsolar.com**).

Regarding the Stellio advanced heliostat Solar Field, the methodological approach followed and the resulting solar field control and power supply architecture is described, using a large (~1'000'000 m²) heliostat field as an example.

2. Stellio Heliostat Solar Field Strategy

2.1. Stellio Heliostat Control Unit (HCU)

The Stellio HCU is an autonomous heliostat tracking control system with I/O for sensors and linear actuators. On the HCU, tracking and calibration algorithms are running. It is developed and assembled in compliance with automotive standards & guaranties. Maximum power consumption per Stellio heliostat is 180 W, which significantly simplifies solar power grid topology. Average tracking power consumption per heliostat is < 15 W. It is an optimized low power technology.

Calibration of the Stellio Heliostat is one of key technologies, in order to achieve the excellent performance offered. It is based on 4 main steps:

Step 1: Carried out in the Solar Field Workshop, the main tasks are several measurements: Primary axis elevation angle (accuracy < 0,01°, linear drives reference offset identification (accuracy < 0.005°), linear drives fixing point (accuracy < 0.05mm), primary and secondary axis orthogonality (Accuracy < 0.01°, mirror perpendicularity error (accuracy < 0.01°), and finally optical center stow position measurement.

Step 2: Carried out in the Solar Field; it is related to the automatic tower target based error identification. Here the main tasks are: Linear drive real spindle identification, primary axis azimuthal orientation identification, pylon stow position erection perpendicularity, and drive backlash identification.

For this step, manual intervention is not required; instead, it is performed in automatic mode from the heliostat field control system (HFCS) unit in the central control room.

Step 3: Automatic tower target based precise offset correction. During the first year of operation, this step is automatically performed several times during normal operation.

Step 4: Automatic tower target based auto-adaptive tracking precision checking. The auto-adaptive calibration process of each Stellio heliostat is regularly repeated during its full lifetime.

2.2. Stellio Heliostat Field Control System (HFCS)

The solar field communications protocol established is the industrial redundant Ethernet MODBUS TCP/IP – MODBUS RTU. Solar field monitoring status updating time for ~20K heliostats is about 1 second. Remote HCU firmware updating of the solar field (20K heliostats) is accomplished in less than 2 minutes. Time/date synchronization is achieved with a precision of < 10 ms.

2.3. Stellio Heliostat Field Power Grid (HFPG)

The HFPG features a symmetric grid distribution within 12 sectors, like the communication topology. The low power consumption of the heliostats and the HCU power supply strategy gives the possibility to move all heliostats of the solar field at the same time. It is possible to power-off the solar field at night, otherwise equivalent night time average consumption is < 0.5 W per heliostat.

2.4. Stellio Heliostat Field Management System (HFMS)

Stellio Solar Field management system for the control and monitoring of the solar field, including equipment maintenance history, view of real-time and history data events, history display with integrated trend data graphics, alarms grouping, filtering, inhibiting, and maintenance management.

3. Stellio Outcomes

Main outcomes and characteristics of a solar field using Stellio control and power supply technology can be summarized as follows:

Superior Effectivity: Solar field monitoring status updating time (20K heliostat) ≈ 1sec. Remote HCU firmware updating of the solar filed (20K heliostats) in < 2 minutes. Time/date synchronization with a precision of <10 ms.

Improved Feasibility: Result for pointing accuracy in horizontal / vertical direction: ~0.8 mrad / ~0.6 mrad. Average Power consumption while tracking is < 15 W, night time average power consumption < 0.5 W per heliostat.

Reduced Investment: Stellio technology means investment savings and fast (mostly automatic) setting up and commissioning of the solar field, plus improved criteria for low cost maintenance.

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