SVALE SAT SV-SPS1 programmable antenna rotating and positioning system

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Nomenclature

SVALE SAT-SPS1 is a proper, responsive, Ethernet based system containing outdoor units and a web-based graphical user interface with a server and various other hardware.

Type SVALE SAT SV-SP1 contains all hardware, which enables positioning, controlling, maintaining and visually monitoring the Eastern and Western parabolic antennas located at the NMHH premises.

Type SVALE SAT SV-SP1V2 contains all hardware, which enables positioning, controlling, maintaining and visually monitoring the Kontroll parabolic antenna located at the NMHH premises.

Type SVALE SAT SV-SPS1 3D contains all hardware, which enables monitoring and measuring artificial satellites on geostationary and other types of orbits. It also contains all necessary equipment needed for this.

The SVALE SAT SV-SPS1 programmable antenna rotating and positioning system

SVALE SAT SV-SPS1 contains an antenna positioning system and an accompanying web-based user interface. This system is used at the NMHH site at Visegrádi street to operate an artificial satellite monitoring system. The system provides the positioning, the control of positioning and the observation of many antennas through a web-based user interface. These include 2 240 cm diameter Grante manufactured and 1 135 cm diameter Gibertini manufactured parabolic antennas, as well as 1 RF HAMDESIGN PRIME FOCUS DISH type 120 cm diameter mesh parabolic antenna. The system supports the handling of fixed antennas as well. Full functionality towards the user is provided by a web server, which can be accessed via an internet browser with a username and password on a graphical interface. Login requires authentication data, so only admins or authorized personnel can have access.

The web application is connected to a central server, which forwards commands towards the rotating unit, hence it is able to control the rotation of the antenna motors and can position antennas as desired, while monitoring the movement via sensors. The rotating unit comes with Ethernet access, which makes controlling the unit possible. Remote access is also provided through this port, making control from a distance possible via Command Line Interface commands.

With the help of a plugin and 1-1 HD cameras the movement of every antenna can be monitored via the web-based interface. Uploading photos of fixed antennas is also possible.

Basic functions of the complete system

- Full functionality towards the user is provided by a web server, which can be accessed via a web browser on a graphical interface after authentication.
- The rotating and positioning control unit can store any number of satellite coordinates (this function is limited by the available free storage space) and can lock any antenna on any satellite.
- The web interface can control any number of units together. This way by using a database all antenna positioning can be managed by only one IP address.
- Position soft tuning for scanning satellites and saving the coordinates into editable data records.
- Common database for every antenna for flexible usage and for handling satellites with orbit overlaps. Built-in position support (for when more satellites are at the same position) and state saving function (active, inactive, temporary hold).
- Antenna and satellite datasheet interface.
- Import/export function for the simple copying of databases and reusage of data in Excel and CSV file formats.
- Locking on a given satellite and automatic tuning as well as signal strength measurements.
- Continuous display of coordinates with the help of value and real-time range.

- Locking on to one satellite after another in a specified group, automatic tuning and signal strength measurement.
- Transponder list import.
- HD camera stream for each of the 3 antennas.
- Extensive configurability regarding operating parameters and the control interface.
- Position lock logging by recording the actual lock on and the deviation, both with timestamps. Monitoring other system parameters.
- Webservice based remote control, via VPN router.
- Establishing communication with the superior measuring system.
- Usage of teamcast (UTSv20) equipment for signal strength measurement and tuning.
- Implementing parameterizable acceleration for position with actuator in manual for automatic mode.
- Receiving measurement data during the tuning of fixed antennas.
- Plug-in driver GUI / Graphical and spreadsheet visualization of settings.
- Personalized settings: the system can store settings of different users; reloading these settings is also supported.
- Exporting and saving all data is supported.
- Management of identifiers: identifiers related to relevant parameters to the database operations are also enabled (T1-Site; A1-Antenna; K1-Cable etc.).
- Management of available physical cables is supported on the interface by cable ID.
- For form-like spreadsheets a set form is provided, which lowers the chance of errors during data entry.
- Access to current position values of antennas on the antenna page.
- Attachment management:
- option to add unique identifiers to uploaded documents,
    - document title is shown in tooltips where displaying it is not possible,
    - drop-down menu for easier access to documentations,
    - documents can be assigned to different devices,
    - warning indications for file type limits.
- Sort and filter by site and antenna in schedule view.
- Common mode parabolic antenna control (4 pieces).
- Store any number of satellite positions (limited by storage space).
- Display satellite- and antenna information.
- Storage of transponders related to satellites.

Communication interface

SVALE SAT SV-SPS1 antenna rotating and positioning system connects to the satellite monitoring system via web service. A server-client architecture was developed between the controllers of the various antennas and the central control computer. Antenna positioning and query of actual positions are done by the WS client function of the satellite monitoring system, meaning all query and control commands are handled by the WS server of the system. Endpoints are realized as a RESTful JSON web service.

The web service supports the following features:

- request of antenna use, antenna allocation release,
- rotation of antenna to any position,
- rotation of antenna to position stored in a database,
- stopping antenna movement,
- query of current antenna position and error states,
- query of stored master data,
- modification of arrayed data (database import/export, antenna data, satellite data, schedule/in use table, etc.).

The subsystems of SVALE SAT SV-SPS1

SVALE SAT SV-SPS1 has 3 different available subsystems.

SVALE SAT SV-SP1

Figure 1: SVALE SAT SV-SP1 system

The base purpose of this system is to provide a responsive, Ethernet based user interface for controlling, managing and visually observing antennas on a common interface, and to support communication through a web service with a superior system, with the help of a common database. It also supports the remote antenna control alongside an appropriate Command Line Interface command list.

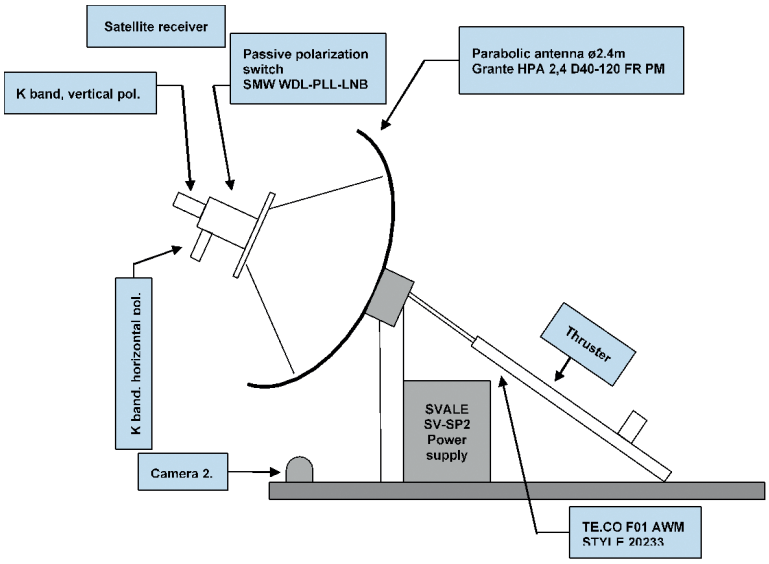

Figure 2: simplified block diagram of the SVALE SAT SV-SP1 system

Specific functions of the SVALE SAT SV-SP1 include rotation in the azimuth plane.

The central control of the system is achieved by a PIC micro controller, which ensures control over a web-based user interface, the handling of the database containing the satellite coordinates and the control of the rotating and positioning hardware through the analog control electronics designed specifically for this purpose. It also processes the positioning of the antennas, including positional error correction.

Control of the positioning motor is done by an analog control chip with a 24 V 1 kHz PWM signal. Power supply to the motor is provided by a 300 W toroid transformer. The actuator type is MecVel ALI4 with a SIKO WV36M type mechanical clamping adapter. Control is implemented with a WV36M/SSI type absolute encoder, providing high resolution, compensation for errors in positioning and the ability to assume predefined base positions after a blackout.

The system is equipped with many defensive functions. The position of the antennas is kept between the values defined in the software by the end position monitoring system. A hardware-based endpoint switch is built into the system, which helps prevent any mechanical damage in case of any type of error or overshot.

The system is also equipped with overcurrent protection, which stops the motor in case the current consumption exceeds the values defined in the software. The ‘watchdog’ function of the micro controller monitors the controller continuously and restarts it in case of a detected error. The whole system is contained in an IP65 housing. Manual operation is provided on the outdoor units housing, including the ability to fully interrupt power supply.

For visual observation of the system 1-1 HD IP based cameras are implemented for all 3 outdoor antennas.

SVALE SAT SV-SP1V2

Figure 3: SVALE SAT SV-SP1V2 system

This system is the improved version of the SVALE SAT SV-SP1 and is capable of rotation in the azimuth plane as well as rotation of the LMB block.

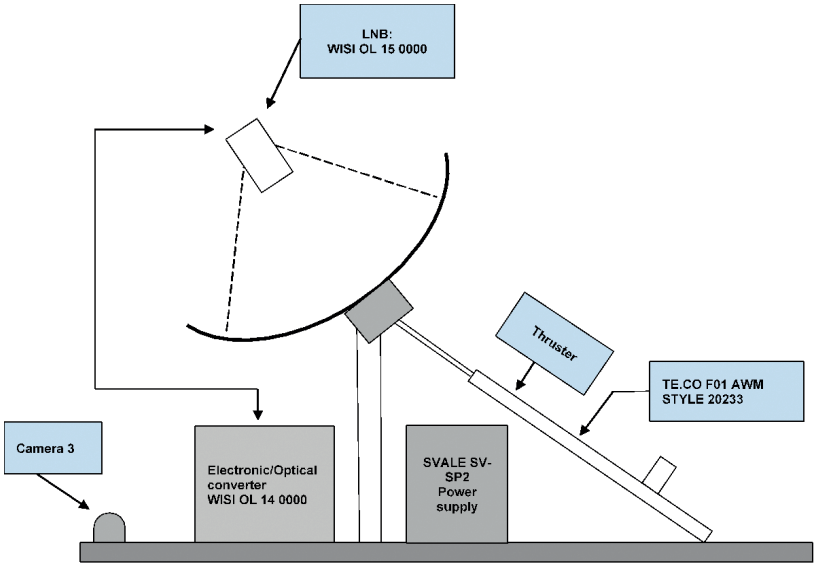

Figure 4: simplified block diagram of the SVALE SAT SV-SP1V2 system

The system is identical to SVALE SAT SV-SP1, except for the ability to rotate the LNB block (tilt function). This feature is realized by a separate micro controller. The two controllers communicate via asynchronous transfer mode. Tilt rotation is done by a 42HSG60-1504A type step motor. Tilt control is supplied by 12 V DC, for which a separate power supply was implemented in the control housing.

ALI4 linear actuator	Power supply: 24 V DC Power: 150 W Max. force: 6.8 kN max. speed: 7mm/s Control: 1 kHz-5.8 kHz PWM (max 99% duty cycle) Total stroke: 300 mm (only 60-80% was utilized) Protection category: IP65 Limit switches: Hall-sensor
WV36M/SSI absolute encoder	Type: rotation absolute encoder Power supply: 5 V DC (5 V – 30 V DC) Communication interface: SSI Interface: RS485 Data rate: 100 kbps (100 kbps – 2 Mbps) Protection category: IP65
AC power supply	300 VA toroid 2x12 V, Functions: - Built-in short circuit protection / current limiter - State feedback - Output voltage fine-tuning
LNB and its rotator (only in SVALE SAT SV-SP1V2)	Selected Quad 40mm LNB Multiswitch 42HSG60-1504A 0.68 Nm step motor 1:100 drive SV-SC2LNB control card
SV-SC2 control card	Functions: -H-bridge with FET for PWM DC motor control: max 50 V / 20 A, max 99% duty cycle - RS485 - TTL converter - 5 V power supply control
JUSTICIA IIP-L-3130F HD IP camera	Resolution: 1.3 Mpx Focus: 3.6 mm Power supply: 12 V / max 1 A Functions: - Remote control - Night mode Protection category: IP65
SV-SP2 outdoor housing:	IP65 outdoor housing, removable cover, controls, display.

Table 1: Specifications of SVALE SAT SV-SP1 and SVALE SAT SV-SP1V2 components

SVALE SAT SV-SPS1 3D

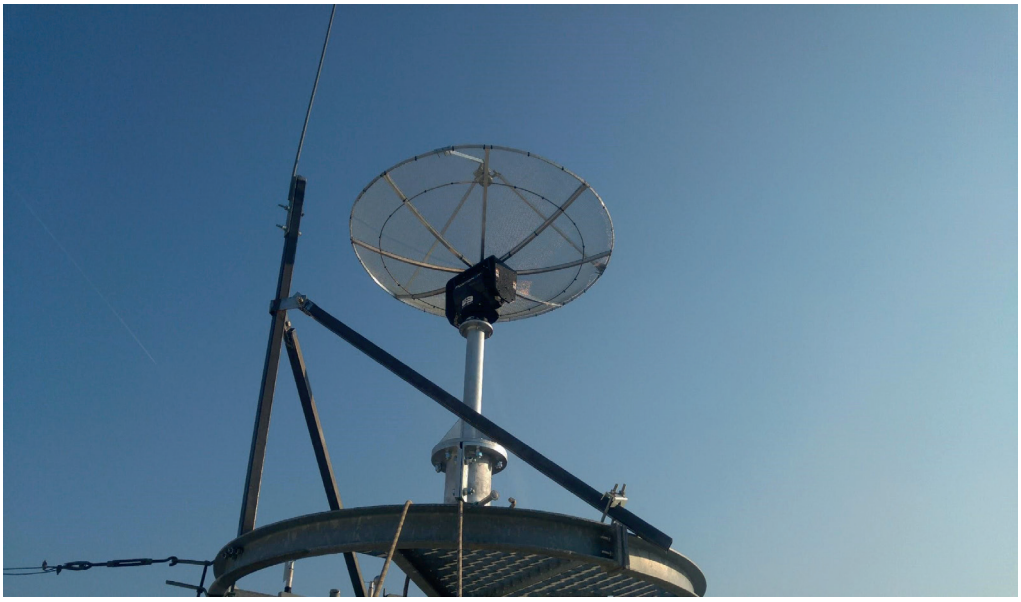

Figure 5: SVALE SAT SV-SPS1 3D system

The purpose of this system is to provide measurement data for artificial satellites on geostationary and other types of orbits. Contains the integration of a new type of antenna rotation system and new measurement capabilities. Can carry out precision positioning while connected to the satellite measurement system. Consequently, the adjustment of the antennas in the azimuth and elevation planes is ensured. Antenna position settings must be done on the web-based interface. Correct positioning can be checked with the help of the observation camera.

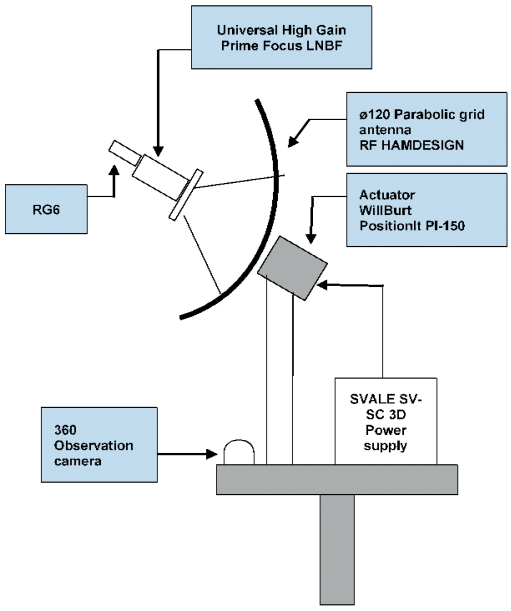

Figure 6: simplified block diagram of the SVALE SAT SV-SPS1 3D system

Specific functions of the SVALE SAT SV-SPS1 3D system include antenna rotation in both azimuth and elevation planes.

Communication and signal level matching between the Will-Burt PositionIt PI-150 and the antenna rotating server is done by the SV-SPS1 control unit. This unit connects to the actuator via RS485 on Pelco-D protocol. The control card connects to the central server via Ethernet and provides the necessary power supply for the PI-150 unit, which is 24 V DC. It also provides remote surveillance by being able to shut it down and turn it on.

RF Hamdesign manufactured 120 cm diameter mesh parabolic antenna	Diameter: 120 cm Antenna type: prime focus Frame material: aluminium Reflector dish material: steel mesh Operating frequency range: Ku band (10.7 ... 12.75 GHz) Gain: 38.9 ... 39.8 dBi Offset angle: 26.37° Elevation setting: 13 °... 48 ° F/D: 0.62 Wind load: 118 km/h
Will-Burt PositionIt PI-150 antenna rotator	Type: 360° rotation unit Power supply: 24 V DC Interface: RS485 Data rate: 2400 baud Protection category: IP68
LNB Inverto Black Ultra Prime Focus	Output connector: F-type female Conversion gain: 53 ... 63 dB Operating temperature: -25°C ... 60°C Output impedance: 75 Ω.
SV-SC 3D control card	Toroid transformer design Input: 230 V AC 50 Hz / 1 A Output: 24 V DC / max. 6.5 A Functions: -Control by microcontroller -RS485 - TTL converter -5 V power supply generation -24 V power supply control
Dahua DH-IPC HDW1230SP HD IP camera	Resolution: 2 Mpx Focus: 2.8 mm Power supply: 12 V / max 1 A Functions: - Remote control - Night mode Protection category: IP65
SV-OH1 outdoor housing:	IP65 outdoor housing, removable cover

Table 2: Specifications of SVALE SAT SV-SP1 3D components