Jomitek I3 - Voltage synchronisation guide

Purpose of the voltage synchronisation system

Jomitek's I3 power sensors come in two versions. The I3+ version includes voltage inputs allowing it to measure 3-phased voltages in addition to the base current measurement, while the I3 version only measures current.

The purpose of the voltage synchronization system is to enable a Jomitek I3+ sensor to share its voltage measurement with several regular I3 sensors over an ethernet connection. This feature enables monitoring of substations using only a single I3+ sensor with several I3 sensors while allowing for complete power measurements on all sensors.

Network architecture

The voltage synchronisation system requires three essential components:

1. A Jomitek configured MikroTik ethernet switch.
2. A Jomitek I3+ sensor configured as master, measuring both currents and voltages.
3. A Jomitek I3 sensor configured as slave, measuring only currents.

Figure 1 shows how to connect these components. Please pay attention to the fact that all I3 sensors in a voltage synchronization network must be connected directly to the same Jomitek configured MikroTik ethernet switch.

The Mikrotik router allows secure communication between I3 sensors and your backend. We have tested OpenVPN and IPSec VPN from the router to our in-house server, which has worked great. Using VPN we don't see a need for the sensors to use HTTPS, FTPS, etc since VPN fully secures the existing channels of communication. That said, the Mikrotik router can also act as a HTTPS to HTTP converter if needed. The router will additionally act as an NTP server that the sensors will query for time retrieval, and it can serve Telnet content via an SSH tunnel.

Theory of synchronisation

The Jomitek configured MikroTik ethernet switch periodically broadcasts an ethernet package used as a recurring time synchronization reference for the master as well as the slave sensors.

When the master and slave sensors receive the synchronization package they set an internal time stamp, and the master sensor then calculates and broadcasts its voltage and phase information to all the slave sensors in the network.

Using the information received from the master sensor combined with the synchronization reference time stamp, the slave sensors calculate the phase difference between their locally measured current and the remotely measured voltage. This phase difference is used to calculate RMS power values. Since all voltage data recreated on the slave sensor are based on RMS values, it is not possible to inspect the voltage time series on the slave sensors.

Configuring the sensors

Voltage synchronization requires one sensor, preferably an, I3+ to be configured as master and one or more I3 to be configured as slaves.

Master sensor

To configure a sensor as master sensor, the `voltage_sync` flag should be set to '`MASTER`' via the web interface. Refer to figure 2.

Make sure the setting is saved, and restart the sensor for the change to take effect. After the restart the sensor will broadcast its voltage and phase information to the slave sensors.

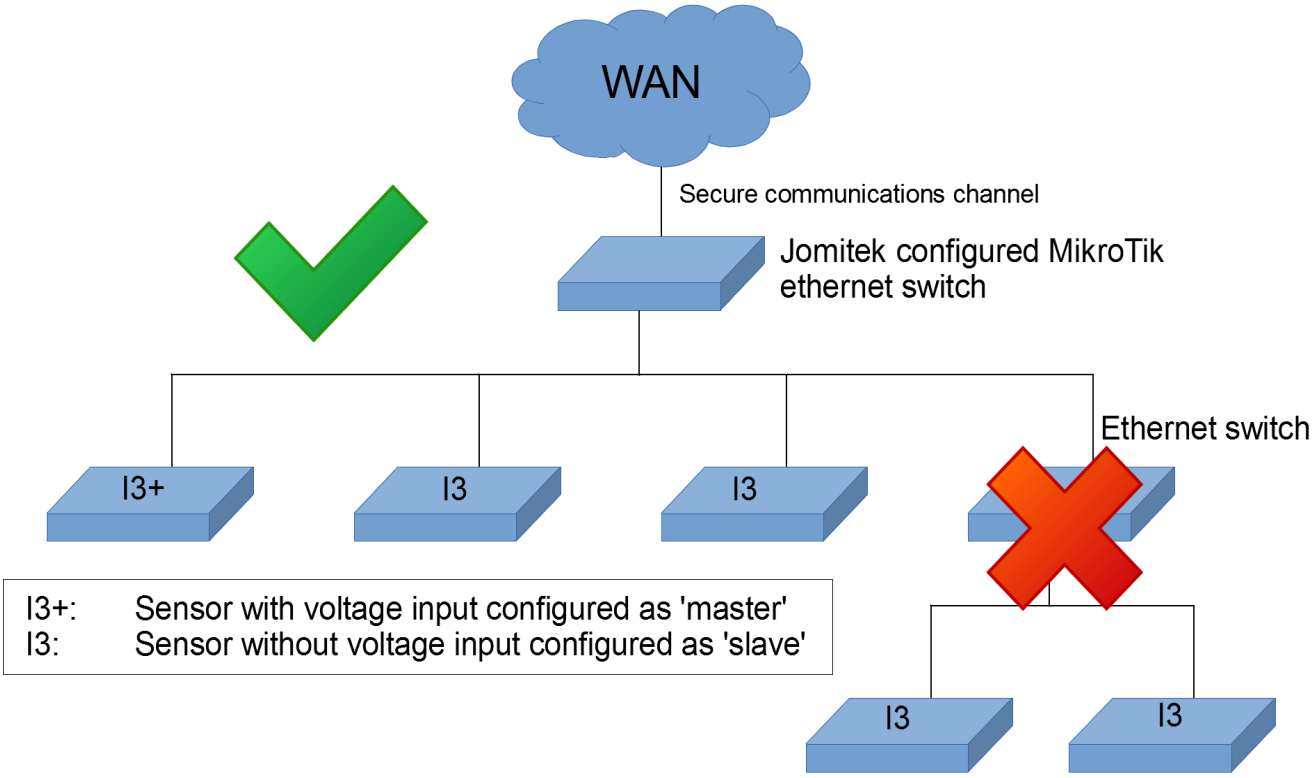

Figure 1: Network diagram showing how to connect master and slave configured sensors. Sensors should only be connected directly through the Jomitek MikroTik switch with no other network switches layered in between. While only one master sensor should be configured for any given installation, there is no limit to the number of slaves sensors.

Slave sensor

To configure a sensor as slave sensor, the `voltage_sync` flag should be set to 'SLAVE' via the web interface. Refer to figure 2.

Make sure the setting is saved, and restart the sensor for the change to take effect. After the restart the sensor will receive voltage and phase information from the master sensor.

Disabling voltage synchronization

To disable voltage synchronization, the `voltage_sync` flag should be set to 'DISABLE' via the web interface. Refer to figure 2.

Make sure the setting is saved, and restart the sensor for the change to take effect. Voltage synchronization will now be disabled on the device.

Data interpretation on the slave sensor

Since only voltage RMS levels rather than full time series measurements are shared by the master sensors, the voltage measurement snapshots on the slave sensors will show a voltage level of zero.

The computed phase difference between remotely measured voltages and locally measured currents on the slave sensor is noise sensitive. It is therefore recommended to use long integration times (`average_time` $>$ 20 and `quick_time` $>$ 20) for RMS values. RMS integration times can be configured under: `settings` $\rightarrow$ `i3` $\rightarrow$ `post_processing`.

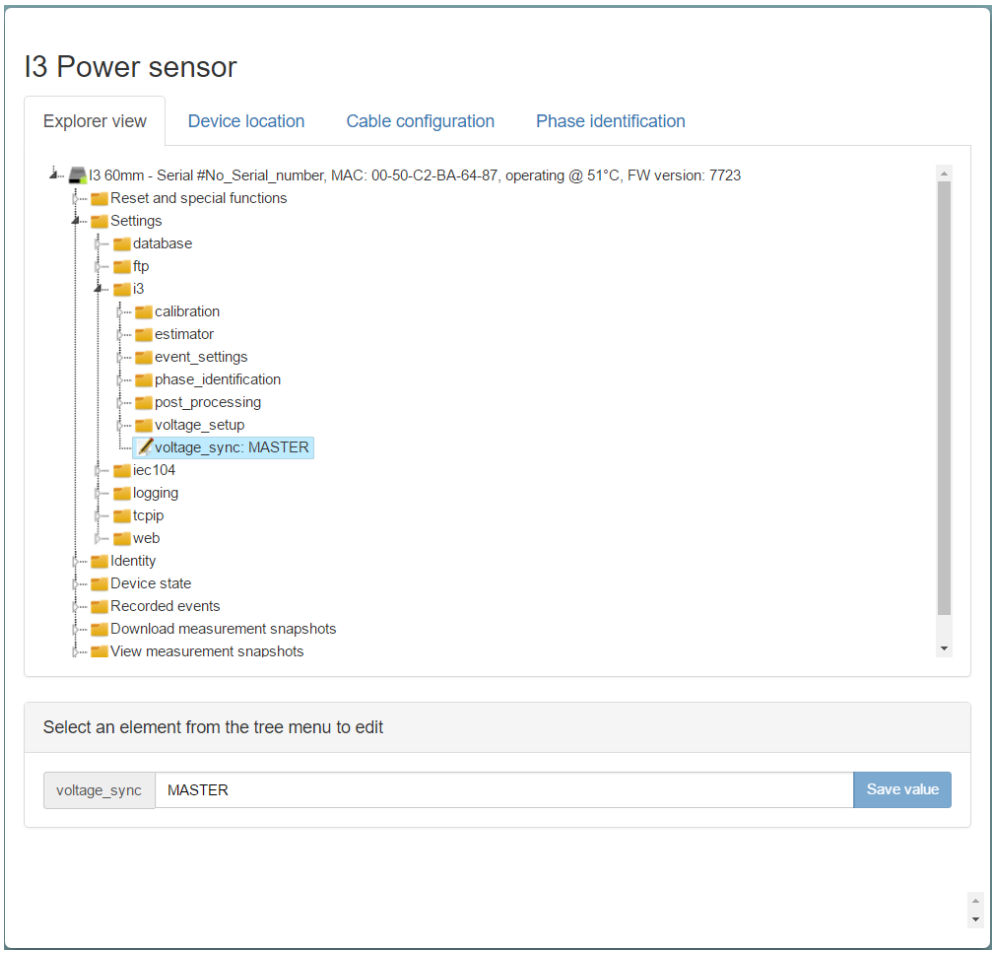

Figure 2: The voltage_sync flag can be set to either 'MASTER', 'SLAVE' or 'DISABLE' in the web interface. In this figure the flag is set to 'MASTER'.