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App note 0034

Time adjust

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		Hardware	Firmware	Software ENVIS
1.0	1.10.2024	ARTIQ, SMC, SMY, SMZ, NOVAR 2700	$\geq$ 4.0	$\geq$ 2.0

Contents

1 Time in devices

Time in devices is controlled by RTC (real time clock) circuit which is battery backed-up, so after power loss of device, time is still kept. However changes of temperature and humidity can introduce inaccuracy and can be delayed or overtaken compared to real time. Better accuracy of time, for purpose of time stamps in archive or events, can by reached by it's synchronisation with real time using one of few methods.

1.1 Set or adjust time

Device time can be adjusted or set.

Time adjustment corrects the time while maintaining the integrity of recorded data. It prevents duplicate records and ensures proper spacing when a forward adjustment is needed. The adjustment only works if the time difference between the instrument's current time and the target time is within 26 hours. Requests for adjustments with a larger time difference are ignored. The success of the adjustment should be verified by reading and comparing the register again. If the time difference exceeds 26 hours, the time must be set instead.

Set time sets the time to user requested value without respect to recording consistency and because of that all archives have to be deleted.

1.2 Time synchronisation

Time can be synchronised automatically with one of methods described bellow or adjusted with command through communication interface of device. Time adjustment is possible with KMB message (using *ENVIS.Daq* program), writing into modbus register for time time adjustment or with IEC 104 message.

If any time synchronisation method is set, time adjustment with message is still possible.

1.2.1 Synchronisation timeout

It is possible to set a synchronisation timeout in the devices – time interval, during which time should be synchronised, otherwise the device will indicate that time is not synchronised. When time is adjusted, countdown of timeout is reset. If set timeout limit is exceeded since the last time adjustment, an indication is shown.

2 Synchronisation

Device time can be adjusted with command or synchronised automatically with one of few clock sources using method described bellow. Settings of time synchronisation can be done using *ENVIS.Daq* program, in the *Settings* window, *Time and Date* tab. There is also possible to adjust or set device time.

2.0.1 Settings via *ENVIS.Daq* program

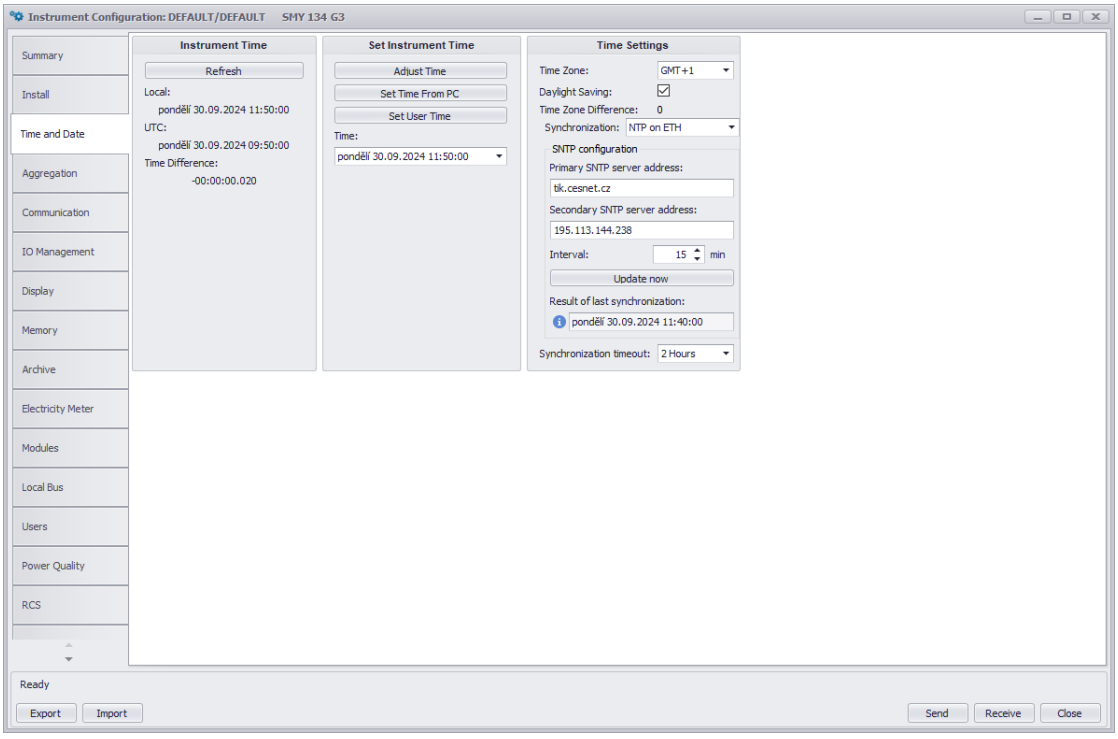
Time and its synchronisation can be set using *ENVIS.Daq* program, in the *Settings* window, on *Time and Date* tab.

Instrument Time can be seen on the left side. There is local time in the device (shifted from UTC with time zone and daylight savings), UTC time in the device a difference of time compared to actual PC.

Set Instrument Time can be in the second part. Options are:

- Adjust Time
  - gentle adjustment of device time
- Set Time From PC
  - set device time same as time of PC
  - deletes archives in the device
- Set User Time
  - set user time specified bellow into device
  - deletes archives in the device

Time Settings in the last part can change time zone, enable daylight saving, set synchronisation of the device (individual methods described bellow) and synchronisation timeout.



Obrázek 1: Time and synchronisation settings using *ENVIS.Daq* program

2.1 None (no synchronisation)

Device time is not synchronised automatically with any clock source. In this way, time can has measuring inaccuracy. This is good for measuring without critical time accuracy or if the time synchronisation is made with adjustment messages, for example automatically send messages from superior system.

2.2 PPS and PPM

PPS (pulse per second) and PPM (pulse per minute) are synchronization methods using precise clock signal pulses sent every second or every minute. The device adjusts its time with each pulse to maintain accuracy. The choice between PPS and PPM depends on the clock signal source used.

Although second pulses offer more accurate and precise time adjustments, they are also more sensitive to timing differences. If the time difference exceeds 0.5 seconds, the time may be adjusted incorrectly, causing a time shift. This can occur if the clock signal source is unavailable or the device has been turned off for an extended period. Minute pulses can accurately adjust the time for differences up to 0.5 minutes.

Clock signal source can be for example precise pulse generators or GPS receivers.

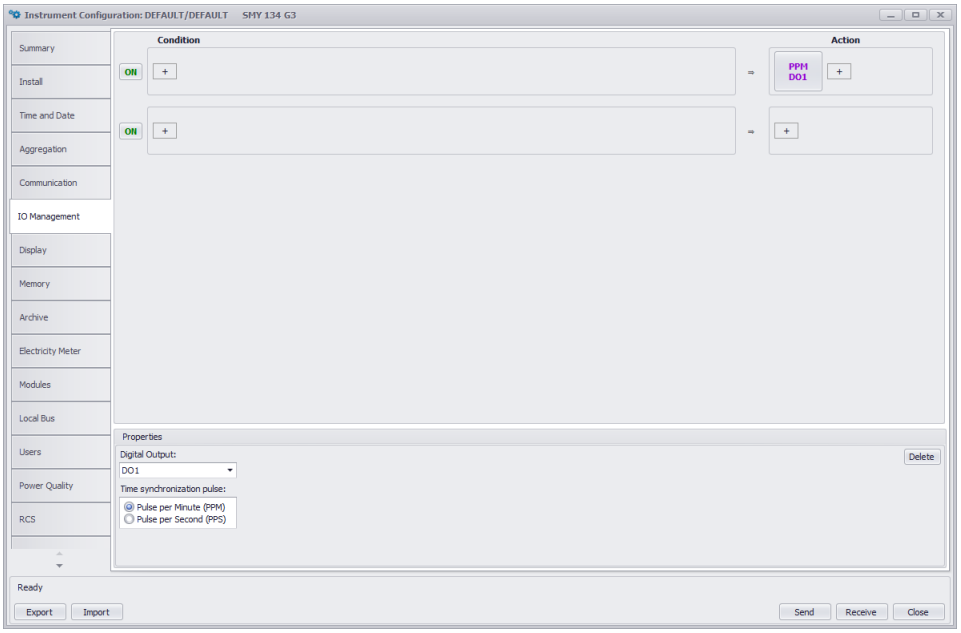
For use of PPS or PPM, it is necessary to have device with digital input.

2.2.1 Device as a pulse source

KMB device can also act as a clock signal pulses source. Settings is done in *ENVIS.Daq* program, in the *Settings* window, on *IO Management* tab. If input condition stays empty, signal output is enabled immediately and continuously; output action is time synchronisation output. There can be set seconds or minutes pulses and digital output pin, where pulse is.

Even with this is enabled, device time can be still synchronised or adjusted for higher accuracy of the system.

For use of device as PPS or PPM source, it is necessary to have device with digital output.



Obrázek 2: PPS/PPM settings using *ENVIS.Daq* program

2.3 NMEA

NMEA is data protocol used with PPS or PPM signals. Some sources can send with pulses also message with actual time at moment of pulse send. Adjusted device is not only synchronised, but also adjusted to the actual time and there is no risk of time shift when pulses are not available or device is turned off.

For use of NMEA and PPS or PPM, it is necessary to have device with communication interface and digital input.

2.4 NTP

NTP (Network Time Protocol) is network protocol for synchronisation of time with accuracy under 10ms, with ideal conditions under 1ms. It works on the principle of synchronisation time of device with time of server including delay compensation caused by latency. NTP uses UDP connection on port 123.

For functional NTP in the device, IP address or DNS name of server (two can be set) has to be set and device has to be able to connect to them – remember that in isolated networks. Next, synchronisation interval of time, how often device synchronises its time with NTP server needs to be set.

SNTP (Simple Network Time Protocol) is lightweight version of NTP used also in KMB devices. Compared to NTP, it does not calculate with traffic latency between device and NTP server, which adds non-critical inaccuracy (delay) of time, but significantly reduces demands.

For use of NTP, it is necessary to have device with Ethernet interface.

2.5 PTP

PTP (Precision Time Protocol) is network protocol for accurate synchronisation of time with accuracy under 1µs. It works on the principle of synchronisation time with server including accurate latency delay compensation by measuring transmission time. Because of that, it is more accurate but also more demanding, so it is suitable for critical systems. PTP uses UDP connection on ports 319 and 320.

For synchronisation using PTP, device with compatible FW and Ethernet interface is required. IP address of server has to be set and the device has to be able to connect to it – remember that in isolated networks.

For use of PTP, it is necessary to have device with Ethernet interface.

2.6 Grid frequency

Frequency of the grid can be also used for time synchronisation of the device. Even there can be short-term deviations of grid frequency, long-term frequency keeps accurate value.

While using grid frequency time synchronisation, devices measure long-term frequency of the grid in a matter of few days. If time difference between the device and the grid is measured, device time is adjusted. It is required to have stable grid without power loss, otherwise frequency can not be measured correctly and time will not be adjusted.

3 Summary

- Generally the most simple and reliable method for time synchronisation is **NTP**, however the device has to be able to connect to the NTP server.
- Alternatively, it is possible to use the **time adjust messages**, send automagically from superior system, which needs to have accurate time source or time synchronised. This method is also easy implementable.
- In critical environments, **PTP** can be used. It is important to have stable connection with low latency or having own clock source.
- Accurate and easy method is use of GPS receiver and **PPM** pulses. Or with higher stability requirement, **PPS** is also possible. For higher accuracy of PPS and PPM, they can be extended with **NMEA** commands. Disadvantage of PPS, PPM and eventually NMEA is a necessity to have GPS receiver or another pulse source.

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