

APPLICATION NOTE

# AC500 CONDITION MONITORING FAQ



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# 1 Introduction

## 1.1 Scope of the document

The most raised questions, regarding condition monitoring with the AC500-CMS are listed here. Technical details about the module FM502 can be found in the [data sheet](#).

## 1.2 Compatibility

The application example explained in this document have been used with the below engineering system versions.

- AC500 PLC V2 PM592
- CMS Module FM502
- Terminal Base TF501

## 2 FAQs

### 2.1 Measurement with FM502

Details regarding bandwidth, accuracy, dynamic range, environment can be found in the [data sheet](#) and are not mentioned here.

In this chapter questions regarding the FM502 as well as the CMS\_IO\_AC500\_V24.lib are answered.

#### 2.1.1 What is the sample rate of the system?

The sample rate, as well as the record length can be individually configured for each channel. The sample rate can be specified between 100 Hz and 50 kHz possible values are listed below:

- 50 kHz
- 25 kHz
- 12.5 kHz
- 6.25 kHz
- 3.13 kHz
- 1.56 kHz
- 0.78 kHz
- 0.39 kHz
- 0.2 kHz
- 0.1 kHz

#### 2.1.2 Can all 16 channels be sampled at the same time

Yes, all channels are sampled simultaneously.

#### 2.1.3 Which sensor types can be connected?

The analog channels of the FM502 can be configured as IEPE or as +-10 V. IEPE and voltage sensors can be connected. Current sensors need an additional external shunt resistor.

To connect proximity sensors (e.g. used in friction bearings with oil film support) the +-10 V input can be used, but the operating range of the typical available sensors (or better their interface electronics) has to be considered which is typically higher: Either a voltage divider is used OR the operation range will be limited accordingly (-> a larger distance range should be considered to cover the needed mechanical distance).

#### 2.1.4 What is the maximum distance between FM502 and the sensor?

The maximum tested cable length for the EMC limits is 100 m. Larger distances e.g. >200 m are possible if the noise level is typical and the used cable matches needed high frequency limits. These are properties of sensors and cable only, not of FM502.

#### 2.1.5 How is the data from the measurements stored?

For each configured channel and encoder, a WAV file is created during the measurement. The WAV files from one measurement are packed in a zip file. The structure of the file can be found in the online help.

[PLC Automation with V2 CPUs](#) > [Libraries and solutions](#) > [AC500 V2 libraries](#) > [FM502-CMS library](#) > [System technology](#) > [WAV file format](#)

## 2.1.6 When measuring as fast as possible. How long is the gap between two measurements, where no data is sampled?

This is depending on the number of configured channels, the sampling rate and the number of samples.

A measurement cycle can be split into 3 parts.

1. The real measurement where the inputs are sampled
2. A digital filtering and down sampling of the data and the packing into a zip archive
3. The transfer of the zip archive from the FM502 to the PM592

Following pictures give an overview how long these times are.

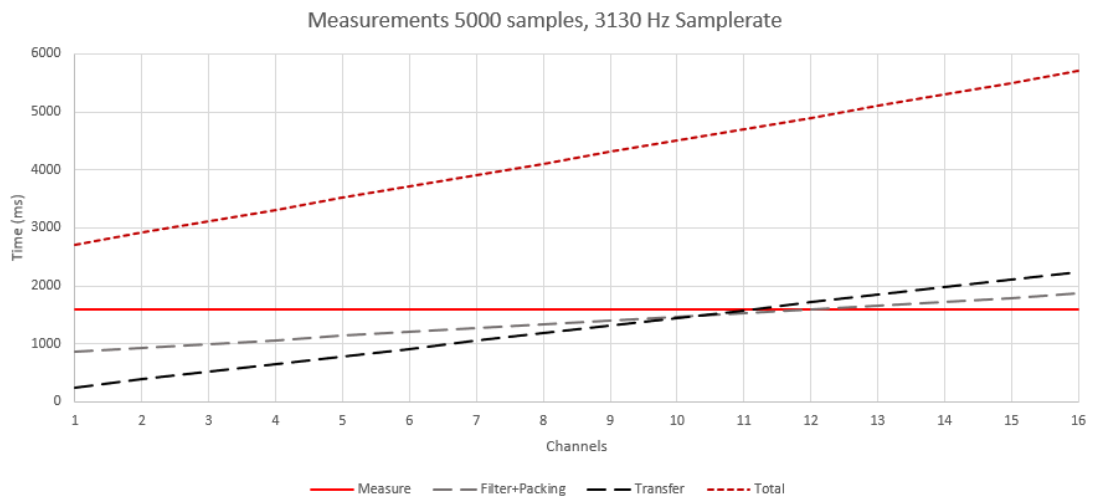


Figure 1 Impact of the number of configured channels at constant sampling rate and number of samples

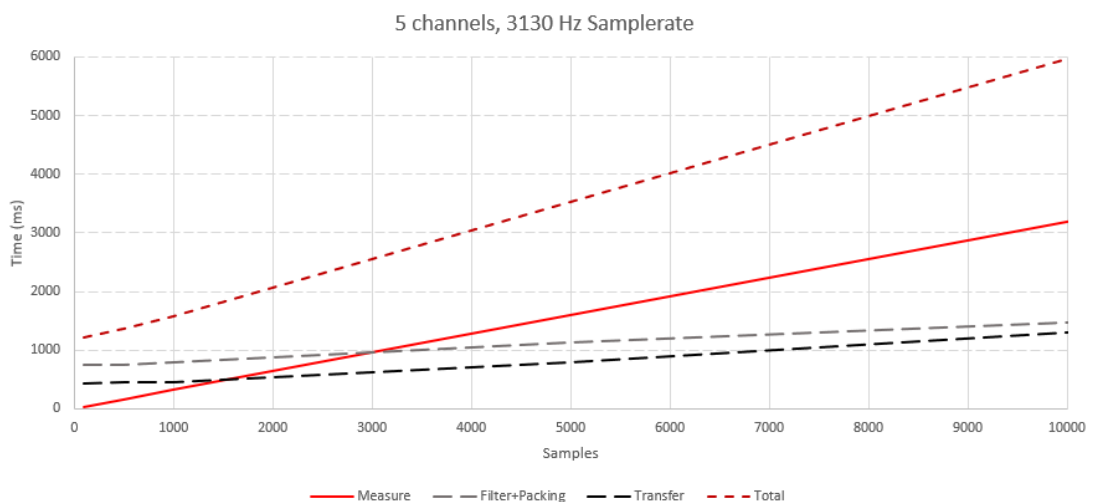


Figure 2 Impact of the record length at constant sampling rate and number of channels

### 2.1.7 Are real-time values available?

Yes, the FM502 can provide a real-time value for each channel. This is only the absolute value. No filtering or RMS calculation is done inside the FM502.

### 2.1.8 What is the highest possible sample rate of real-time values?

The minimum task cycle time is 1 ms same also for the bus cycle time of the FM502. With one sample per ms a sample rate of 1000 Hz can be realized. Whenever either the task or the bus cycle time cannot be hold, also the sample rate is wrong.



#### CAUTION!

During the file transfer from FM502 to PM592 the bus is occupied and the bus cycle time for the real-time with 1 ms cannot be hold. In this case a cycle time of 10 ms, so a sample rate of 100 Hz is realistic.



Note: Use a separate task which is only responsible for the sampling. This task should have the highest priority. All further processing should be done in a slower task with less priority.



#### CAUTION!

When doing frequency analysis with the real-time data make sure that the highest possible frequency (bandlimit) is lower than  $0.5 * \text{sample rate}$ .<sup>1</sup>

### 2.1.9 Are real-time values also available as WAV file?

The real-time values are DINT variables which can be sampled into an array. With the help of the "WAVE\_FILE\_AC500\_V24.lib" the array can be saved as wave file. This has to be done in the IEC program.

### 2.1.10 It is possible to add an encoder to the FM502?

Yes, it is. The FM502 has inputs for an encoder with A, B & Z channel on board. The mode of the encoder can be configured in the FM502 settings.

### 2.1.11 Is the encoder information also stored as WAV file?

Yes, if the encoder is used to synchronize WAV files the encoder is also stored as WAV file.

### 2.1.12 Is it possible to connect more than one encoder to the FM502?

The FM502 has only one encoder module onboard. The encoder, counter, PWM module [CD522](#) can be added on the IO bus. This module has two more encoder channels available. An encoder trace from this IO module cannot be synced with the wave files.

<sup>1</sup> See Nyquist-Shannon Theorem

### 2.1.13 The CMS\_IO\_MEAS\_CTRL function block needs INST as input. What shall I add here?

Under Resources there is in Global Variables the List "CMS\_IO0" inside this list there is "zCMS\_IO\_INIT0". The function block needs the address of this instance. So it is

$$\text{INST} := \text{ADR}(\text{zCMS\_IO\_INIT0})$$

for all function blocks of the CMS\_IO library.

### 2.1.14 Which frequency resolution does the system have?

This is pending on the setting of the channels.

$$\Delta f = \frac{\text{Samplerate}}{\text{NextPow2}(\text{NrSamples})}$$

In case of having a channel configured with 3125 Hz sample rate and 3000 samples the frequency resolution is:

$$\Delta f = \frac{3125 \text{ Hz}}{\text{NextPow2}(3000)} = \frac{3125}{4096} \text{ Hz} = 0.763 \text{ Hz}$$

### 2.1.15 How many files can the system store?

This is pending on the settings of the channels. The flashdisk in the PM592 has 4 GB

In case of using five channels with 3000 samples the zip file size is about

$$(\text{sizeSamples} + \text{sizeHeader}) \cdot \text{nrChannels} = (3000 \cdot 4 + 50) \cdot 5 = 60250 \text{ B} = 58.838 \text{ KB}$$

With the flashdisk size of 4 GB approx. 70000 of these files could be stored.

In case of measuring every 10 seconds and storing all files on the flashdisk the flashdisk will be full within eight days.

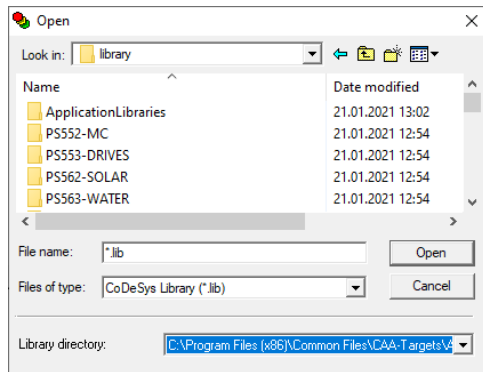
$$70000 \text{ measures} \cdot \frac{1 \text{ min}}{6 \text{ measures}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \cdot \frac{1 \text{ days}}{24 \text{ h}} = 8.1 \text{ days}$$

## 2.2 Analysis

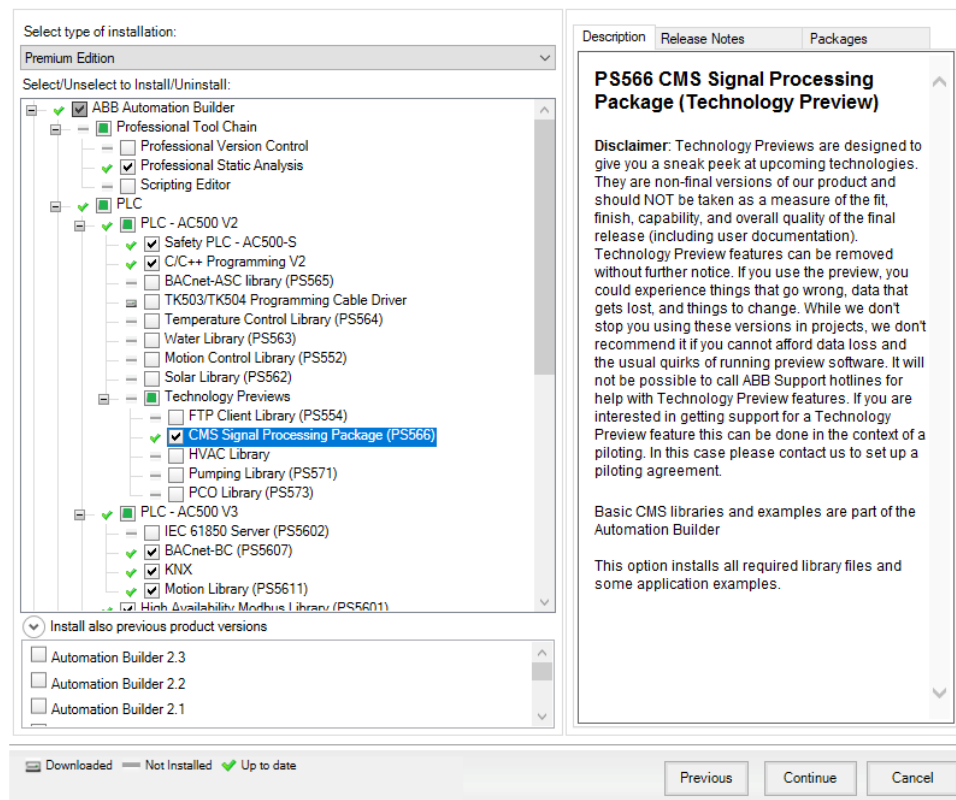
In this chapter questions regarding the SP\_AC500\_V28.lib are answered.

### 2.2.1 I cannot find the SP\_AC500\_V28.lib. Where it is located?

The SP library is an application library. Please check the folder “ApplicationLibraries”



In case the library is not in this folder make sure that you have the signal processing package installed.



### 2.2.2 Which functionalities are included in the Signal Processing library?

Following picture shows all included function blocks in the package in AB version 2.4.1.

A detailed description of the blocks can be found here:

C:\Users\Public\Documents\AutomationBuilder\Examples\PS566-CMS\Signal Processing V2\LibraryDocumentation



**FILE HANDLING FUNCTIONS**

SP\_READ\_WAV\_APP

**BASIC SIGNAL PROCESSING FUNCTION BLOCKS**

SP\_CORRELATION\_App  
 SP\_DIFFERENTIATE\_App  
 SP\_FFT\_RMS\_App  
 SP\_FIR\_FILTER\_App  
 SP\_HIGH\_PASS\_FILTER\_App  
 SP\_INTEGRATE\_App  
 SP\_INTERPOLATE\_App  
 SP\_LOW\_PASS\_FILTER\_App  
 SP\_MATH\_App  
 SP\_PHASE\_OFFSET\_TIME\_App  
 SP\_REMOVE\_OFFSET\_App  
 SP\_RESAMPLE\_App  
 SP\_RMS\_App  
 SP\_SORT\_App  
 SP\_SPEED\_ESTIMATION\_App  
 SP\_SPEED\_KEYPHASOR\_App  
 SP\_STATISTICS\_App

**ADVANCED SP FUNCTION BLOCKS**

SP\_ENVELOPE\_App  
 SP\_FFT\_CMPL\_POLAR\_App  
 SP\_HARMONICS\_App  
 SP\_HISTOGRAMM\_App  
 SP\_MAGFFT\_App  
 SP\_MAGFFT\_ENERGY\_App  
 SP\_MAGFFT\_OVERLAP\_AVG\_App  
 SP\_PEAKS\_App  
 SP\_PHASE\_OFFSET\_FREQ\_App  
 SP\_REAL\_CEPSTRUM\_App

**MISCELLANEOUS**

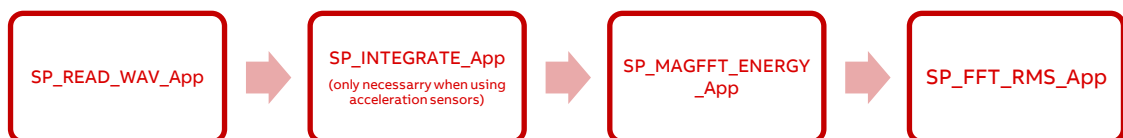
SP\_FREE\_DATA\_App

**STRUCTURE**

SP\_DATA\_TYPE\_App  
 SP\_STATISTICS\_TYPE\_App

**2.2.3 Can I calculate a filtered Velocity RMS value with the library?**

Yes, this is possible by using multiple of in 2.2.2 mentioned function blocks. The program flow could then be:



A function block which is calculating this KPI Value is part of the application examples

C:\Users\Public\Documents\AutomationBuilder\Examples\PS566-CMS\Signal Processing V2

**2.3 Connectivity****2.3.1 How can I get the measurements from the flashdisk of the PM592 to my local file server?**

The PLC can be a FTP server, it is possible to download the measurements from the flashdisk to a local server with any FTP client. Furthermore, the PM592 can also act as FTP client and upload the files to any FTP server in the network.

**2.3.2 Is it possible to publish KPI values like the VRMS value to a cloud solution?**

The PM592 can use the MQTT functionality to publish data to any MQTT broker.

### **2.3.3 Can I use OPC UA to access the KPI values?**

No, OPC UA is only supported in AC500 V3. The FM502 is not yet available for V3 PLCs.

### **2.3.4 Is it possible to include the CMS system in other networks like Profinet, Profibus, Can or EtherCat?**

Yes, the terminal base **TF521** has two slots for couplers which can be used for fieldbus communication.

### **2.3.5 Is it possible to combine the CMS system with a safety PLC?**

Yes, the safety PLC can be added to the coupler slots. Safety IOs can be added to the IO Bus or via Profinet/ Profisafe. The analogue inputs of the FM502 are non-safe inputs.

### **2.3.6 Is it possible to include the CMS system into a high availability application?**

Yes, it is. In case the sensors are redundant both PLCs can measure in parallel. If the sensors are not redundant and connected to both PLCs only the primary PLC must be allowed to measure.

## 2.4 Visualization

The AC500 CMS system doesn't have any possibility to display the data as a plot.

The AC500 can calculate the data, that should be plotted like an FFT. The data itself is available in an array.

The CP600 gives the possibility to plot up to 1000 data points in an X-Y scatter diagram which can be used to display the time or frequency signal, an envelope, an orbit, or further graphs.

More complex plots like e.g. a waterfall diagram need to be done by 3<sup>rd</sup> party software.





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