

<b>APPLICATION NOTE</b>	<b>PQ-1505-guho-02-en</b>
-------------------------	---------------------------

<b>Product Group</b>	<b>PQ: PQ Analyzers</b>
<b>Product</b>	<b>MAVOWATT 230/240/270</b>
<b>Application</b>	<b>Measurements at output of a frequency converter (FC)</b>
<b>Users</b>	<b>Manufacturers or service personnel of FCs or FC driven motors or of machines containing such devices (pumps, compressors, elevators, electric-powered vehicles, ...)</b>

### 1. Background/Task



Nowadays the electric motors of variable speed drives (VSD) are mostly powered by electronic frequency converters. For most diverse reasons measurements of electrical parameters need to be performed on such devices. Power and energy measurements at the supply input of a FC are usually not a problem for power analyzers but most of them fail when these parameters shall be measured at the output side. When activating the anti-aliasing filter in the MAVOWATT 2XX series Power Analyzers it is possible to get workable results also directly at the FC driven motor.

### 2. Restrictions

Rotating field frequency range: 15 ... 100 Hz approx.

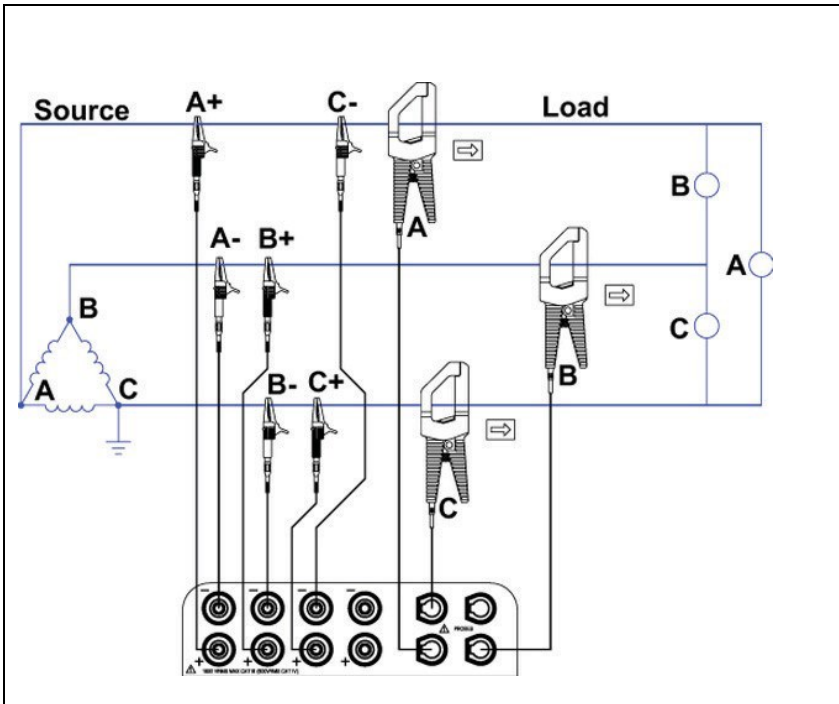
Switching (chopper) frequency range: 6 ... 16 kHz approx. (usual for motors < 50 kW approx.)

### 3. Required Equipment

	<p><b>MAVOWATT 230, 240 or 270 three-phase energy and power disturbance analyzer</b> with standard accessories (measurement cables with alligator clips, power pack)</p>
	<p><b>Flexible AC Current Probes</b> 3 ea. DRANFLEX/METRAFLEX 300MXBL or 1 ea. DRANFLEX/METRAFLEX 3003MXBL</p> <p>Note: Conventional transformer type current probes usually cannot be used because of low accuracy at frequencies below 30 Hz.</p>

## 4. Preparation

### Connecting the Measurement Inputs

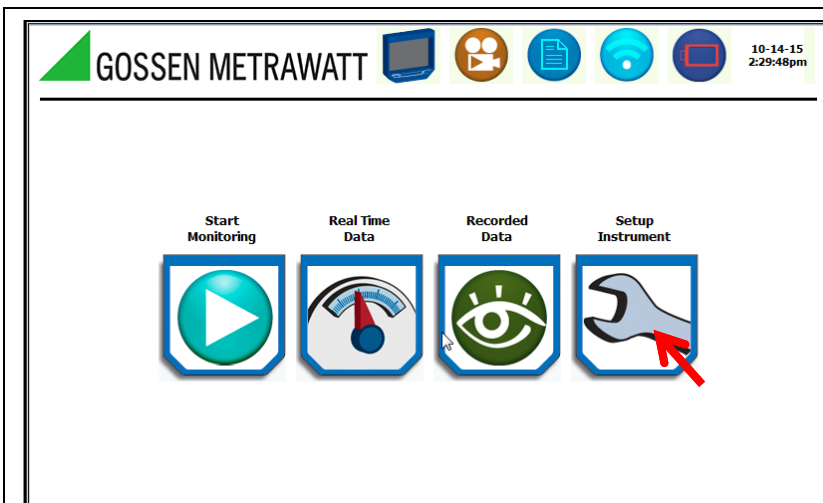


The voltage and current measurement inputs are connected in accordance with the *3-phase delta* connection scheme.

Note:

The instrument also calculates phase voltage and power relative to a virtual neutral point. If star connection is used for the motor windings and the neutral point is accessible, the *3-phase wye* connection scheme can also be used.

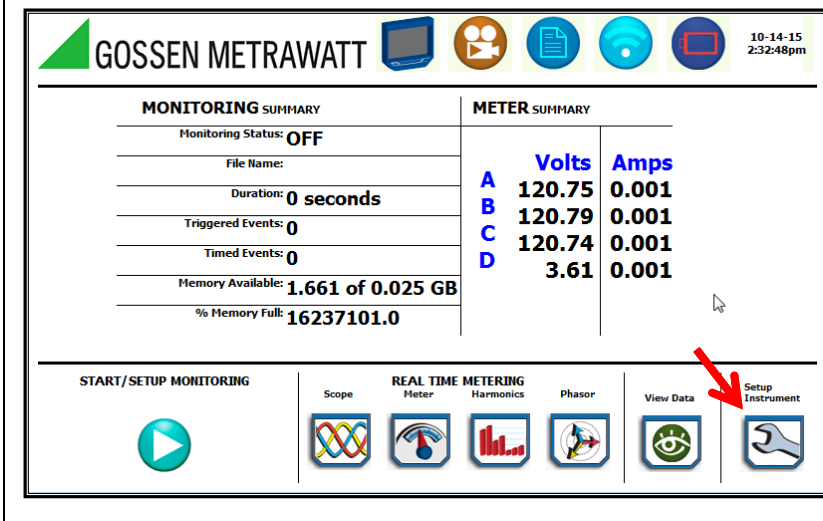
## 5. Settings

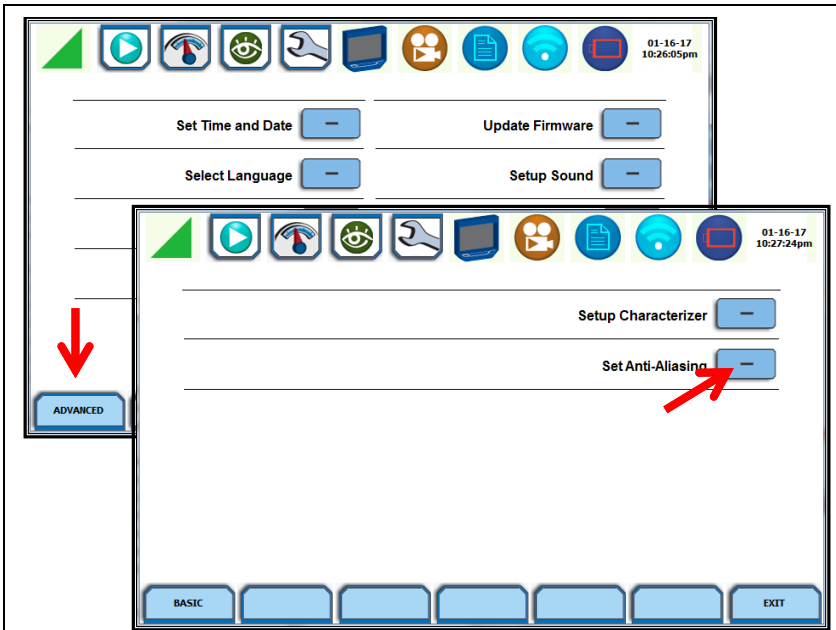


Tap the **Setup Instrument** icon in the initial window or overview page.

Note:

You can always return to the initial window or overview page by tapping the company logo in the upper left-hand corner.



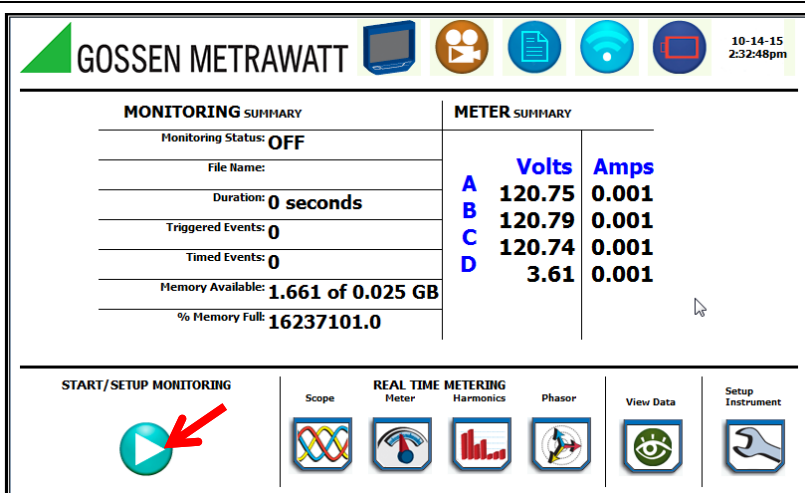


Tap **Set Anti-Aliasing** in the selection page for ADVANCED device setting parameters.

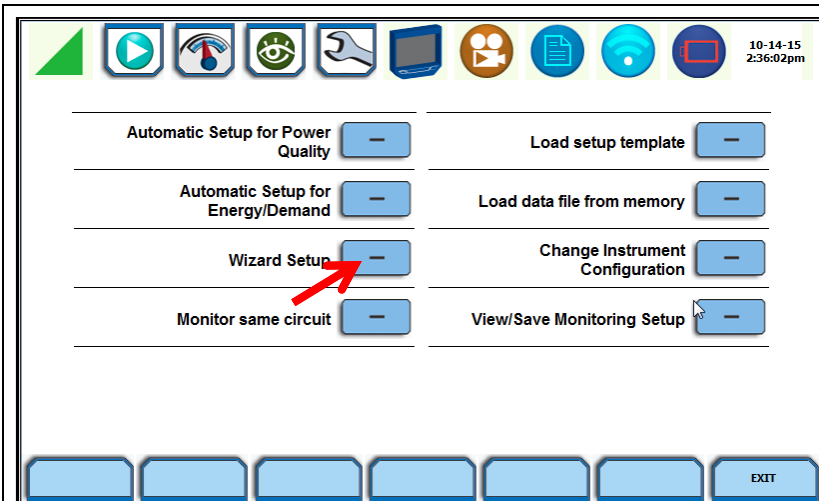


Switch the anti-aliasing filter **ON**. Then exit the function and the previous dialog box by tapping **EXIT**.

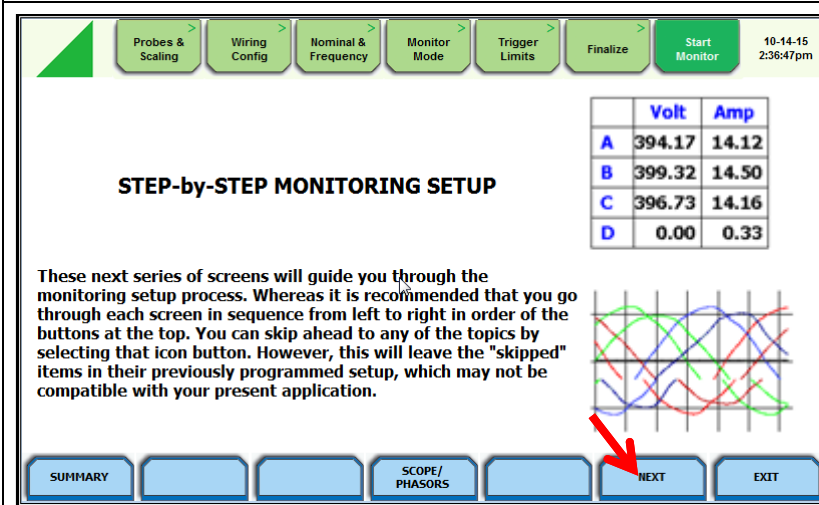
Note:  
For measurements at the outputs of electronic frequency converters, the filter must be switched on so that the instrument can synchronize itself to the low, rotating field frequency.



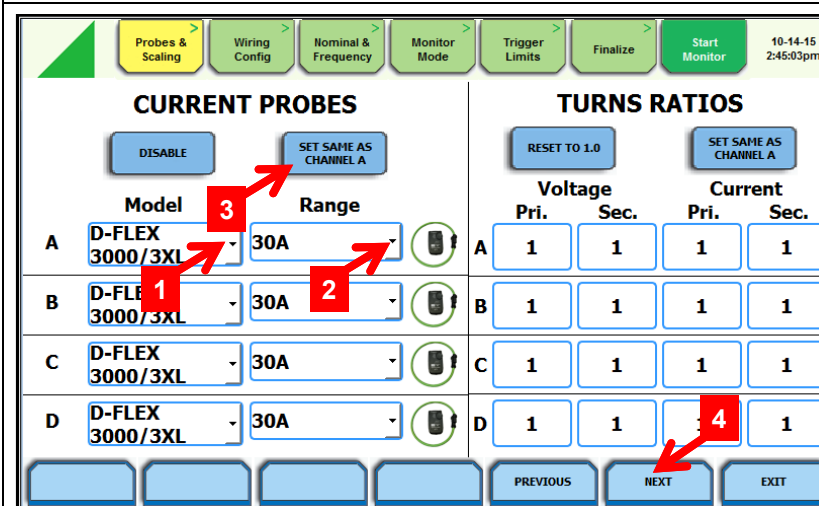
After returning to the overview page, tap the **START/SETUP MONITORING** icon.



Tap **Setup Wizard** in the selection list for measuring and monitoring parameters.



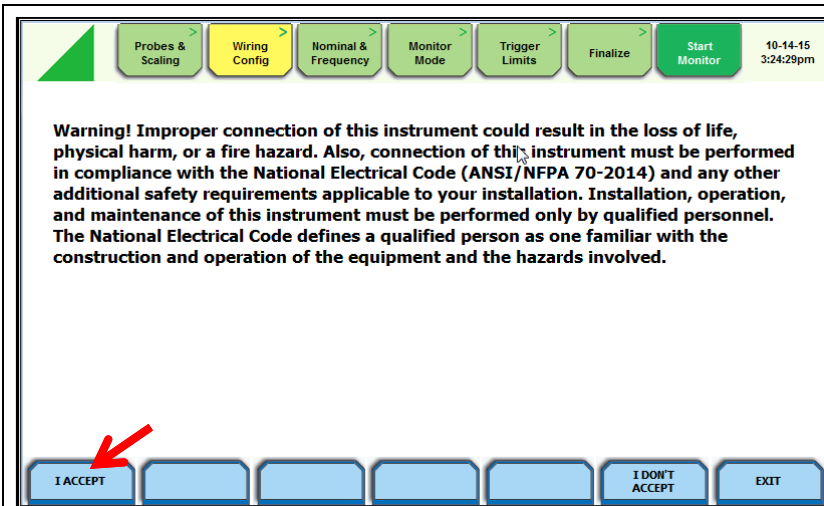
Read the displayed operating instructions and then tap **NEXT**.



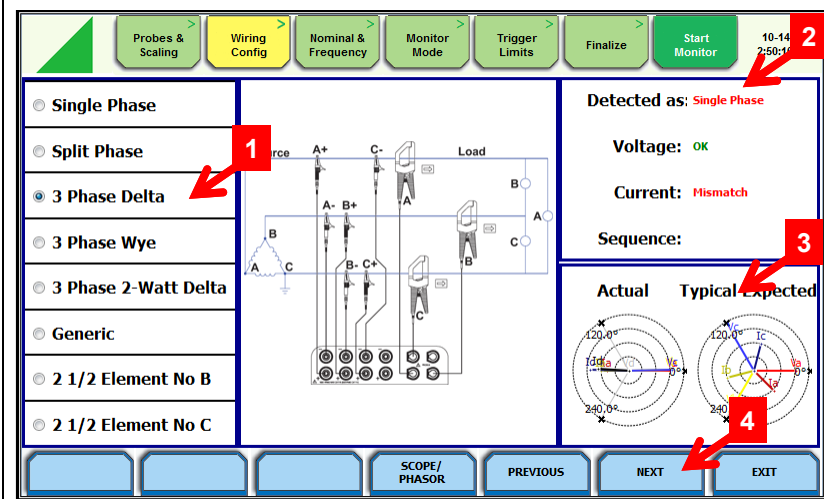
Select the **utilized current probes** [1] for all channels in the setup page for *Probes & Scaling*, as well as their **selected measuring ranges** [2 and 3], and then tap **NEXT** [4].

Notes:

- In order to obtain reliable measured values, motor current must be within 10% to 120% of the measuring range.
- Due to the fact that current is not measured at channel D, the setting for this channel is irrelevant.



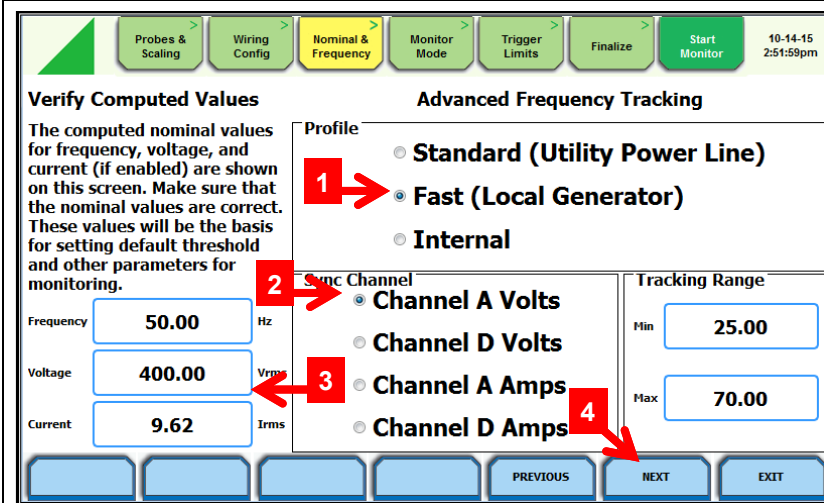
Acknowledge that you have read the warning which now appears by tapping **I ACCEPT**.



Select the **3-phase delta** connection scheme [1] in the setup page for *Wiring Configuration*.

If the motor is now started at nominal speed, the instrument determines whether or not the voltage and current values are high enough and if their phase angles match the selected connection scheme [2]. The results are displayed and can be checked on the basis of the vector diagram [3].

Then tap **NEXT** [4].

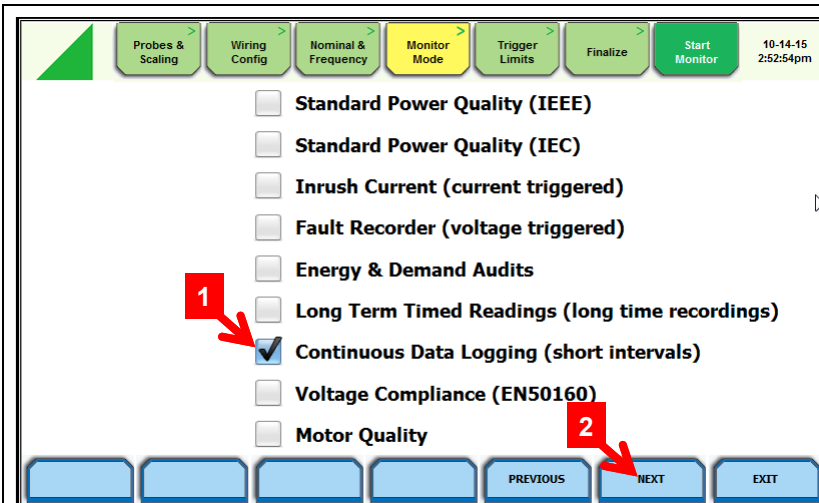


Select the **Fast** [1] profile for *Frequency Tracking* in the setup page for *Nominal (values) & Frequency*.

**Channel A Volts** or **Channel A Amps** can be selected for the *Sync Channel* [2].

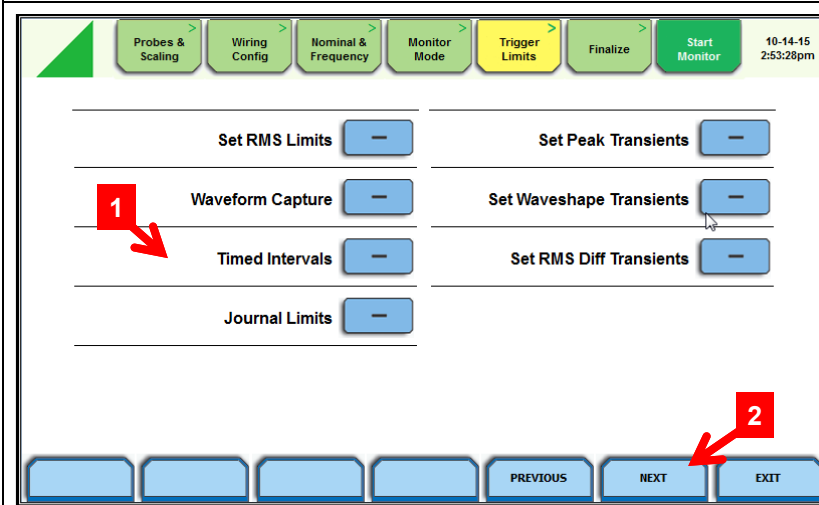
In the event that limit monitoring is required for voltage, current or frequency, check to make sure that the right *nominal values* have been entered *and* correct them if necessary [3].

Then tap **NEXT** [4].

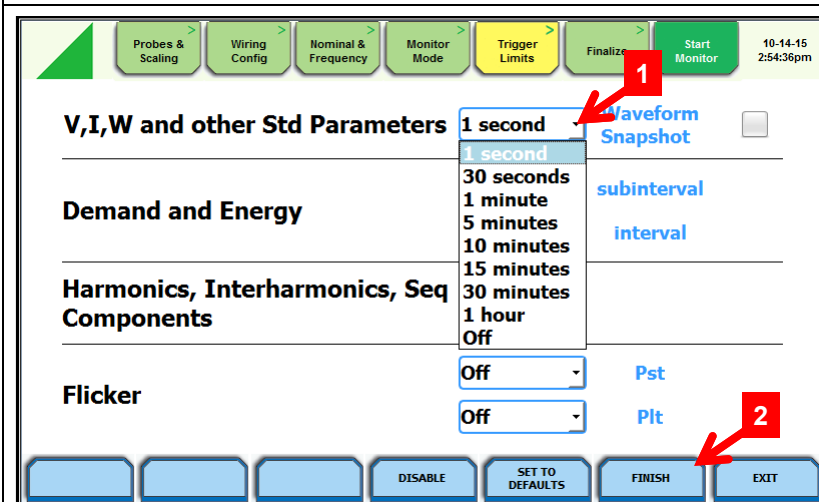


Measurements performed at frequency converter outputs usually involve power measurements over relatively short periods of time (a few minutes or hours) without the detection of voltage dips, interruptions etc.

**Continuous Data Logging** is a suitable setting for the *Monitor Mode* in this case. Select this mode [1] and then tap **NEXT** [2].

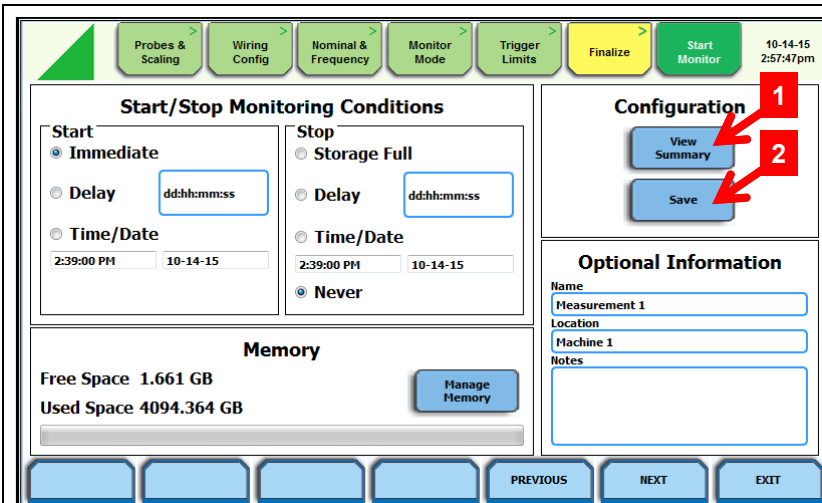


In the *Continuous Data Logging* monitor mode, all standard measured quantities (voltage, current, power etc.) are measured once every second as a default setting. In the event that a larger sampling interval is desired, tap **Timed Intervals** [1], or otherwise **NEXT** [2].

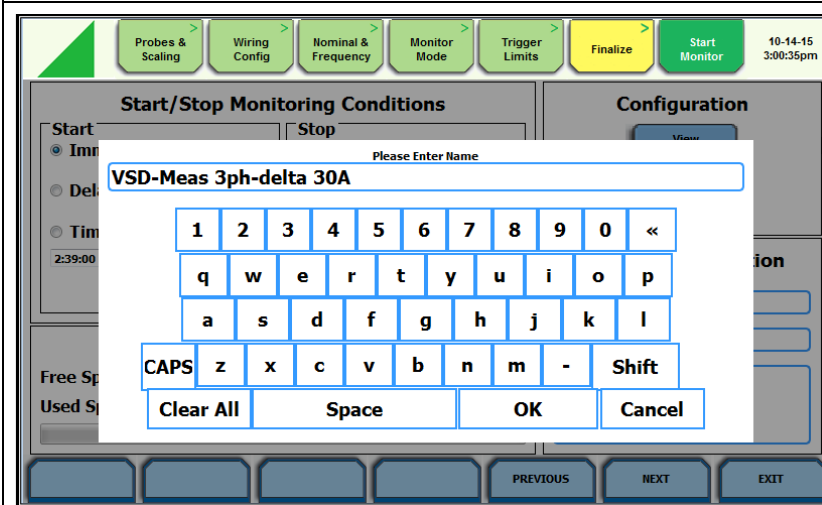


In the *Timed Intervals* setup window you're provided with the option of selecting a different logging interval [1], which is then acknowledged by tapping **FINISH** [2].

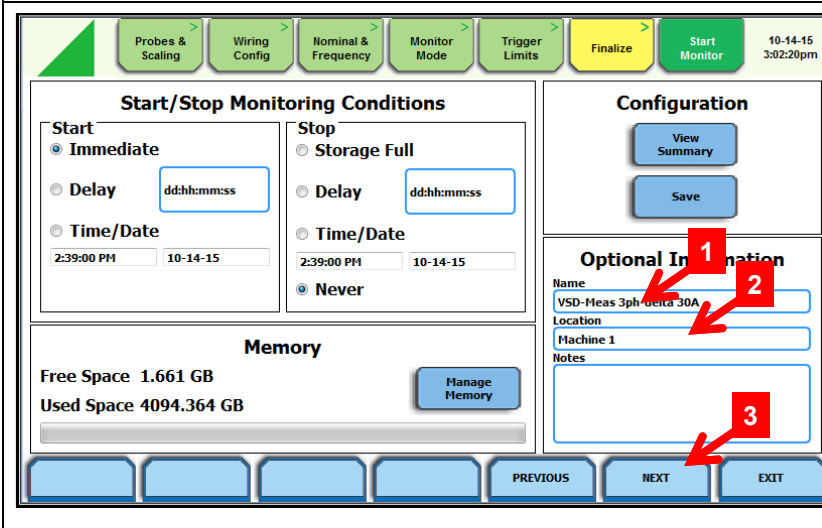
Note:  
In the case of logging intervals of greater than 1 second, the minimum, maximum and mean values which occur during the interval are recorded for all Standard Parameters. For harmonics, interharmonics and asymmetrical components the mean and maximum values will be logged but as the anti-aliasing filter is activated it is only meaningful to record these parameters if the asymmetrical components are of interest.



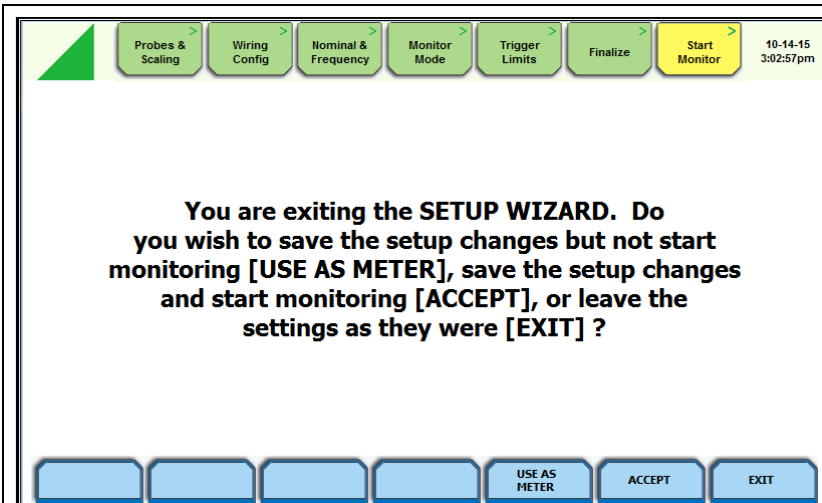
In the *Finalize* dialog box which then appears, you can display the selected settings for review by tapping **View Summary** [1] and save them to a device configuration file for later use by tapping **Save** [2].



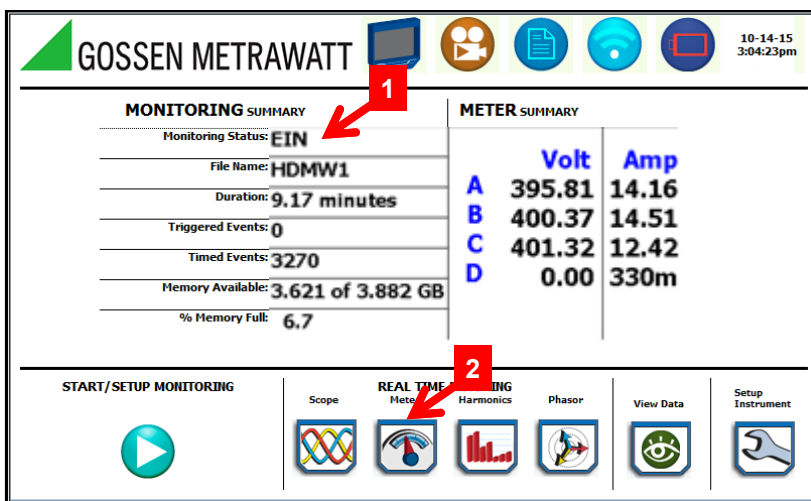
For saving the file, you're prompted to enter a filename with the help of a keypad which appears at the screen. Use a meaningful filename for this purpose.



If the current configuration will only be used for viewing live measurement data at the instrument, tap **NEXT** [3]. However, if you want to record the measurement data a **Name** must be assigned to the recording [1], and you also have the option of entering further information concerning the measurement **Location** [2], as well as additional **Notes**. Then tap **NEXT** [3].



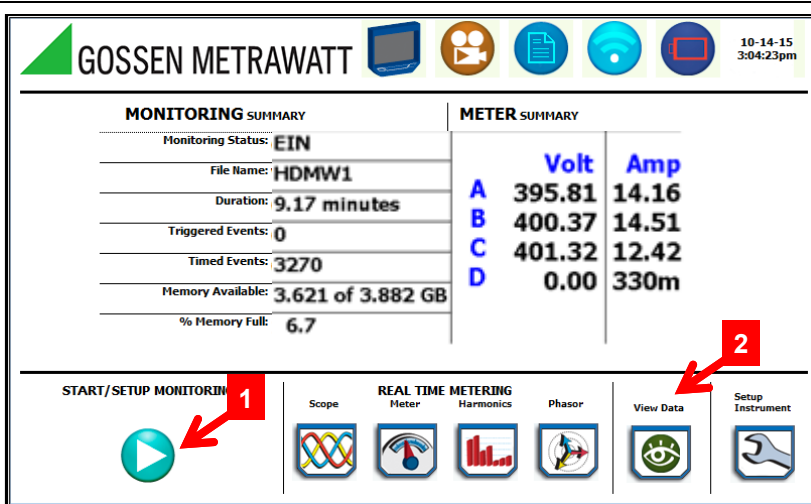
The following message prompts you to make an appropriate decision and tap the corresponding button.



The display then returns to the overview page.

If a recording has been started, the *Monitoring Status*, i.e. **ON** [1], and other recording parameters appear there under *MONITORING SUMMARY* after a brief initialization period.

Regardless of whether or not recording has been started, you can jump to the live measurement data display by tapping the **Meter** icon [2].

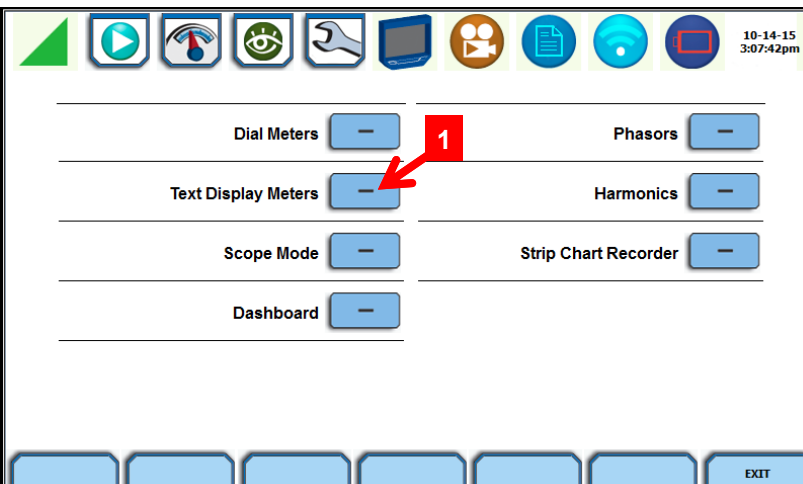


In order to stop a running recording, tap the appropriate icon [1] in the overview page.

Regardless of whether or not recording has been started, you can jump to a display of the recorded measurement data by tapping **View Data** [2].



## 6. Viewing and Analysing Data



10-14-15  
3:07:42pm

Dial Meters  Phasors

Text Display Meters  Harmonics

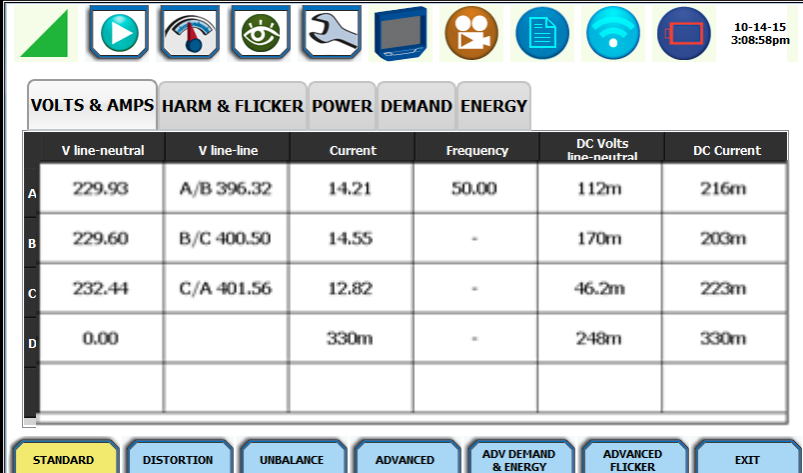
Scope Mode  Strip Chart Recorder

Dashboard

EXIT

Live measurement data can be displayed in various viewing formats. As a rule, display as numeric values (**Text Display Meters** [1]) makes most sense for frequency converter power measurements.

However, with the exception of the **Harmonics** view, all of the other display formats are fundamentally usable.



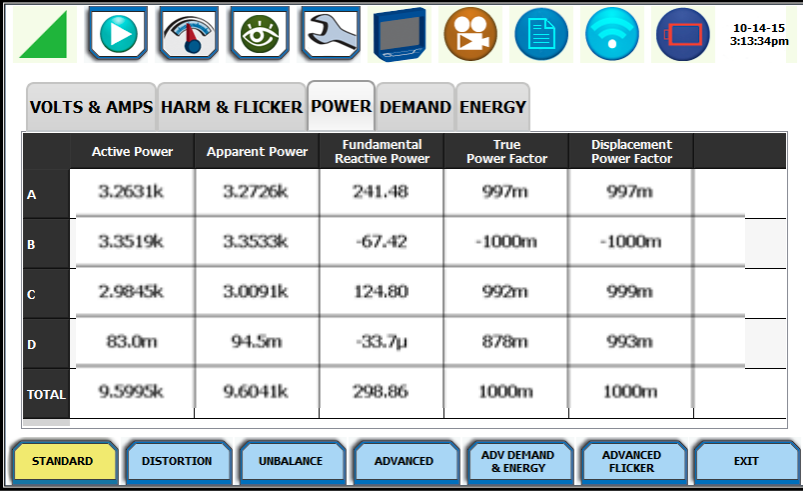
10-14-15  
3:08:58pm

**VOLTS & AMPS** HARM & FLICKER POWER DEMAND ENERGY

	V line-neutral	V line-line	Current	Frequency	DC Volts line-neutral	DC Current
A	229.93	A/B 396.32	14.21	50.00	112m	216m
B	229.60	B/C 400.50	14.55	-	170m	203m
C	232.44	C/A 401.56	12.82	-	46.2m	223m
D	0.00		330m	-	248m	330m

STANDARD DISTORTION UNBALANCE ADVANCED ADV DEMAND & ENERGY ADVANCED FLICKER EXIT

Display of momentary **Volts & Amps** as numeric measured values



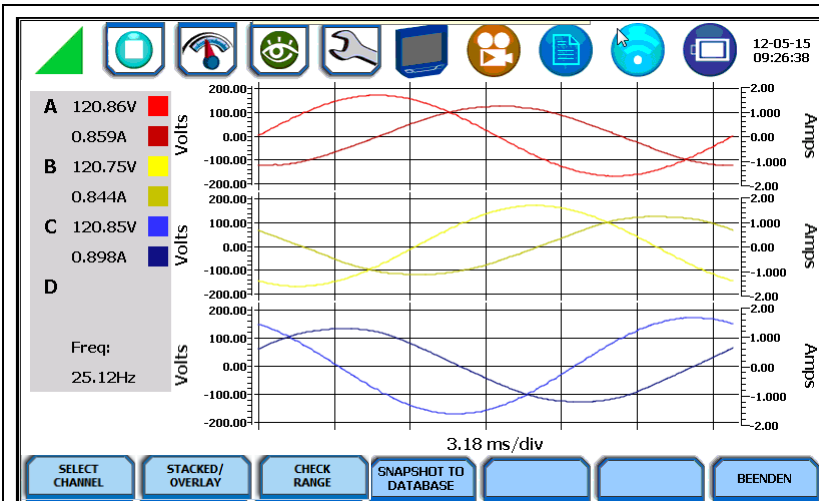
10-14-15  
3:13:34pm

**VOLTS & AMPS** HARM & FLICKER **POWER** DEMAND ENERGY

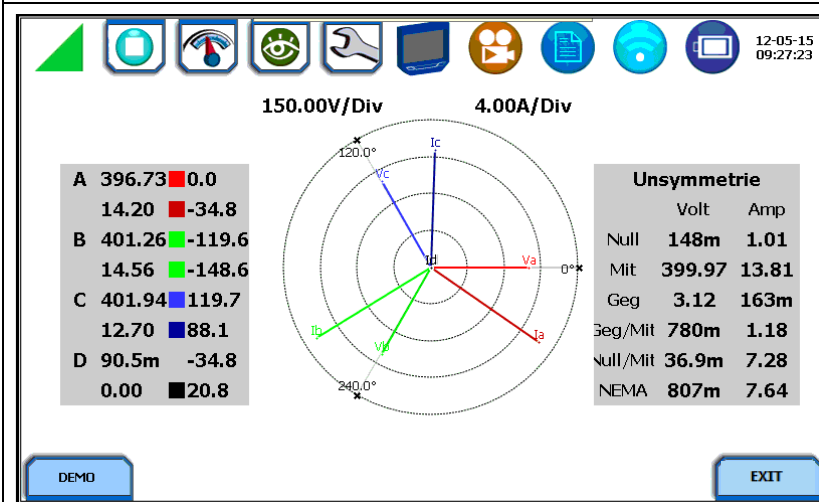
	Active Power	Apparent Power	Fundamental Reactive Power	True Power Factor	Displacement Power Factor
A	3.2631k	3.2726k	241.48	997m	997m
B	3.3519k	3.3533k	-67.42	-1000m	-1000m
C	2.9845k	3.0091k	124.80	992m	999m
D	83.0m	94.5m	-33.7μ	878m	993m
TOTAL	9.5995k	9.6041k	298.86	1000m	1000m

STANDARD DISTORTION UNBALANCE ADVANCED ADV DEMAND & ENERGY ADVANCED FLICKER EXIT

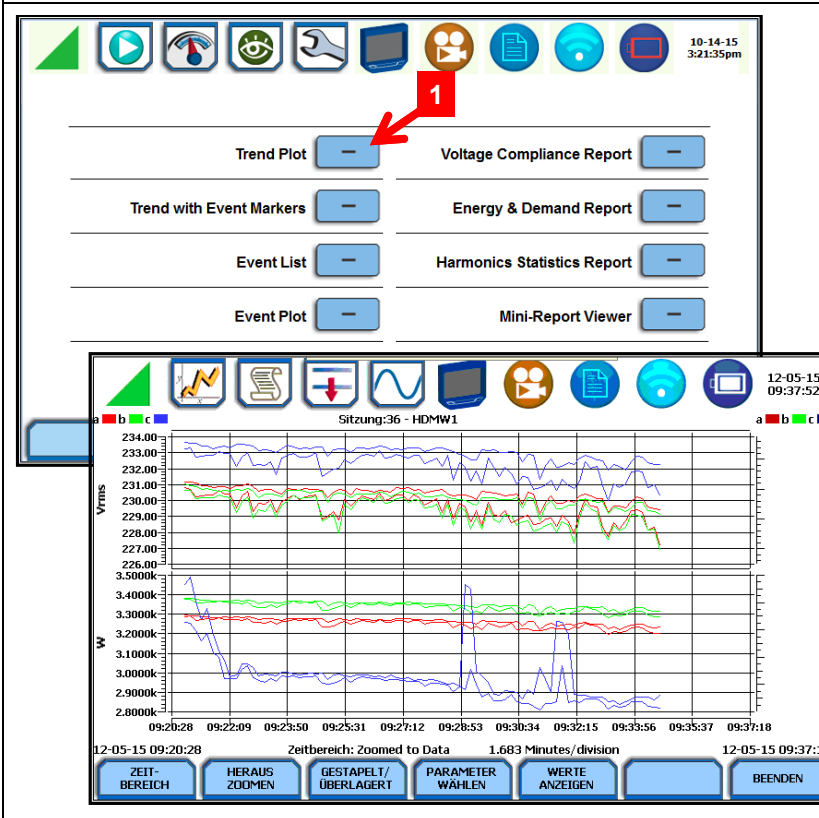
Display of momentary **Power** quantities as numeric measured values



Display of momentary **Volts & Amps** in the scope mode showing the filtered signals



Display of momentary **Volts & Amps** in the phasors view



The data recorded in the *Continuous Data Logging* mode can be displayed at the instrument as a **Trend Plot** and analyzed.

This task can of course be implemented more conveniently and comprehensively at a PC with the help of DranView software.

## 7. Measurement Examples

Figure 1:

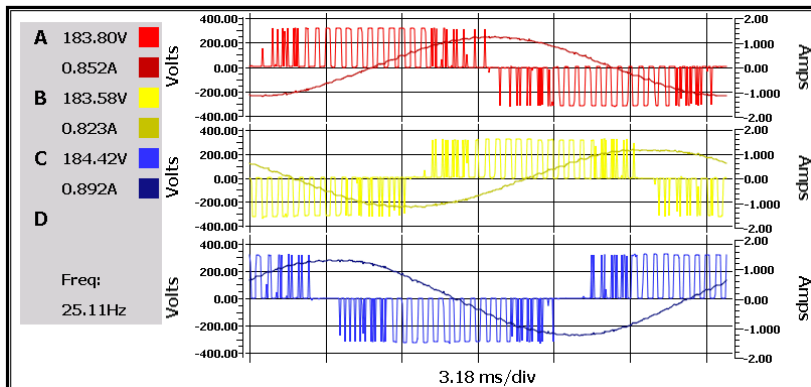


Figure 1 shows the waveforms of the non-filtered (Anti-Aliasing = OFF) output voltages and currents at a chopper frequency of **6 kHz** and rotation frequency of 25.11 Hz.

The displayed voltage rms values of 183.5 V are not correct (too high).

Figure 2:

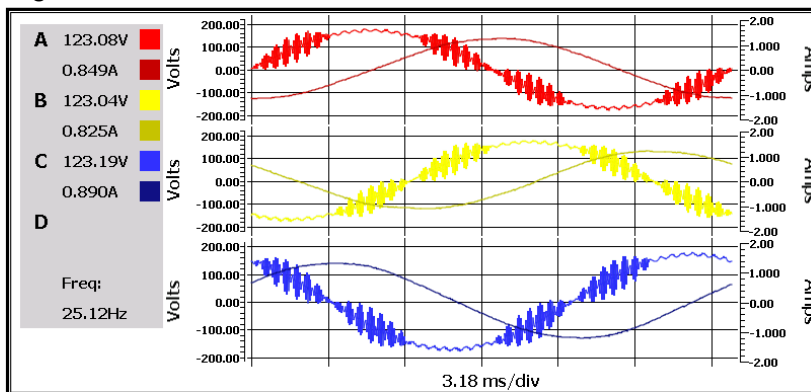


Figure 2 shows the waveforms of the same signals being filtered (Anti-Aliasing = ON). At 6 kHz there is not yet a full effectiveness of the filter so some "noise" is still visible on the voltage waveforms.

But the displayed voltage rms values of 123.0 V come already close to the correct value which would be 120 V.

Figure 3:

	VOLT	AMP	HARM & FLICKER	LEISTUNG	BEDARF	ENERGIE
	L-N Spannung [V]	L-L Spannung [V]	Strom [A]	Frequenz [Hz]	L-N DC-Spannung [V]	DC-Strom [A]
A	71.10	A/B 123.11	0.849	25.12	0.192	0.032
B	71.10	B/C 123.07	0.824	-	0.161	0.016
C	71.15	C/A 123.26	0.887	-	0.125	0.027
D	0.549		0.034	-	0.171	0.034

Figure 3 shows the corresponding momentary **Volts & Amps** as numeric measured values.

Figure 4:

	VOLT	AMP	HARM & FLICKER	LEISTUNG	BEDARF	ENERGIE
	Wirkleistung [W]	Scheinleistung [VA]	Verschiebungs-Blindleistung [VAR]	Wirk-LF	Verschiebungs-LF DPF (cos-phi)	
A	26.84	60.35	52.36	0.445	0.456	
B	24.88	58.68	51.49	0.424	0.435	
C	28.76	63.08	54.34	0.456	0.467	
D	0.006	0.019	-0.000	0.342	0.784	
GESAMT	80.48	177.48	158.19	0.453	0.453	

Figure 4 shows the corresponding momentary **Power** quantities as numeric measured values.

Figure 5:

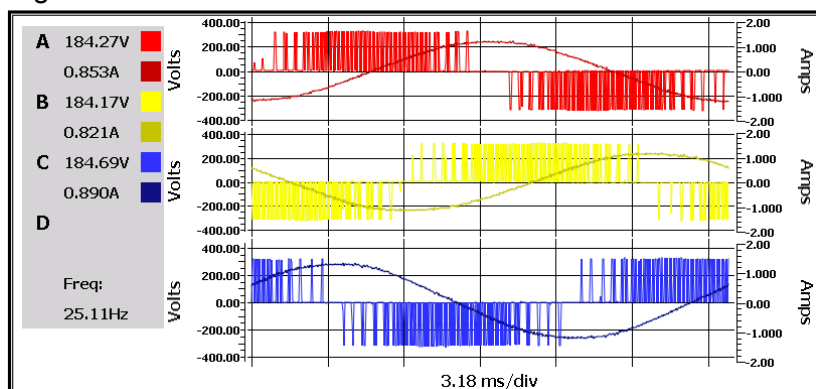


Figure 5 shows the waveforms of the non-filtered (Anti-Aliasing = OFF) output voltages and currents at a chopper frequency of **10 kHz** and rotation frequency of 25.11 Hz.

The displayed voltage rms values of 184.5 V again are not correct.

Figure 6:

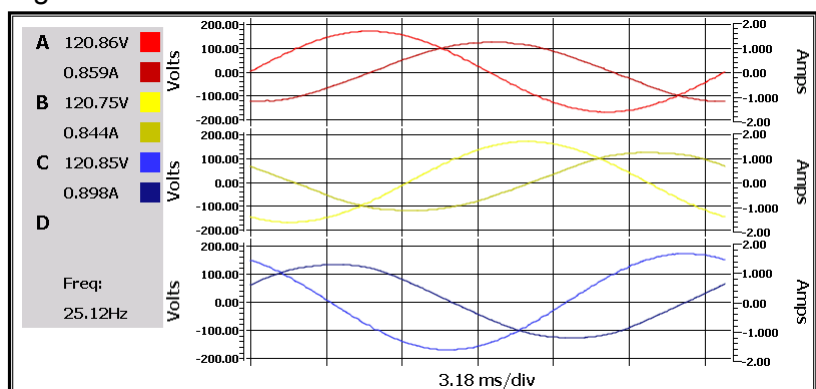


Figure 6 shows the waveforms of the same signals being filtered (Anti-Aliasing = ON). At 10 kHz the filter shows full effectiveness so the voltage waveforms look “clean”.

The displayed voltage rms values of 120.8 V are now correct.

Figure 7:

	VOLT	AMP	HARM & FLICKER	LEISTUNG	BEDARF	ENERGIE
	L-N Spannung [V]	L-L Spannung [V]	Strom [A]	Frequenz [Hz]	L-N DC-Spannung [V]	DC-Strom [A]
A	70.15	A/B 121.50	0.851	25.13	0.202	0.031
B	70.15	B/C 121.44	0.825	-	0.162	0.013
C	70.14	C/A 121.51	0.891	-	0.107	0.027
D	0.407		0.034	-	0.176	0.034

Figure 7 shows the corresponding momentary **Volts & Amps** as numeric measured values.

Figure 8:

	VOLT	AMP	HARM & FLICKER	LEISTUNG	BEDARF	ENERGIE
	Wirkleistung [W]	Scheinleistung [VA]	Verschiebungs-Blindleistung [VAR]	Wirk-LF	Verschiebungs-LF DPF (cos-phi)	
A	27.18	59.86	52.73	0.454	0.458	
B	24.58	58.01	51.86	0.424	0.428	
C	29.03	62.48	54.67	0.465	0.469	
D	0.006	0.014	-0.000	0.447	0.242	
GESAMT	80.79	178.58	159.26	0.452	0.452	

Figure 8 shows the corresponding momentary **Power** quantities as numeric measured values.