

Universal Data Acquisition and Monitoring System for insula- tion condition monitoring of high voltage machines

UDL-8000 V5

Application Manual

**Rotor Flux Monitoring for Salient Pole Rotors
(FLMS + M8009)**

This publication supersedes all earlier versions, Specifications subject to change.

16.FLMS.304.201 Rev 5

Revision History

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1	Reference Sensor Voltage Polarity added	October 2020	RH/FK
2	Parameter Extension	January 2021	RH/FK
3	Update to V5	October 2022	RH/FK
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5	Updates for UDL-DataClient	August 2024	RH/FK

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List of Abbreviations

PD	Partial Discharge
A/D	Analogue to Digital Converter
D/A	Digital to Analogue Converter
PRPD	Phase Resolved Partial Discharge Pattern
UTC	Coordinated Universal Time

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1 Read This First!

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1.1 Warranty and Product Support

It is recommended that you thoroughly inspect the contents of the UDL-8000 Monitoring System packaging immediately upon receipt. Compare the contents to the packing list/invoice shipped with the instrument. Unless is notified promptly of any missing or damaged item, we cannot accept responsibility for its replacement. Contact your nearest Customer Service Center or national distributor immediately.

We warrants the UDL-8000 products for normal use and operation within specifications for a period of two years from the date of shipment. Spares, replacement parts and repairs are warranted for 90 days. The instrument's firmware has been thoroughly tested and is thought to be functional, but is supplied without warranty of any kind covering detailed performance.

Products not made by Manufacturer are covered solely by the warranty of the original equipment manufacturer. Under the warranty, the supplier will repair or, at its option, replace any product returned within the warranty period to a authorized service center. However, this will be done only if the product is determined after examination by the manufacturer to be defective due to workmanship or materials, and not to have been caused by misuse, neglect or accident, or by abnormal conditions or operation.

NOTE: This warranty replaces all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. The Manufacturer shall not be liable for any special, incidental, or consequential damages, whether in contract or otherwise. The client will be responsible for the transportation and insurance charges for the return of products to the service facility.

For Further Technical Information and application information of the device, please read the Knowledgebase at the end of this document or to the available/applicable IEC / EN Standards.

1.2 About this Manual

This manual is an extension to the main manual and describes the specific features and functions of the Rotor Flux Monitoring for salient pole rotors. The Rotor Flux Monitoring (FLMS) acquisition module is specifically designed for rotor flux monitoring of salient pole rotors on 4 pole turbo generators or hydro generators.

This manual is built up as follows

- Chapter 2
Introduction of the Rotor Flux Monitoring
- Chapter 3
Application Description
- Chapter 4
Hardware and Software requirements
- Chapter 5
Hardware Module M8009
- Chapter 6
Acquisition Module Configuration
- Chapter 7
Acquisition Module Data Presentation

2 Introduction

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The flux monitoring is used to monitor the insulation condition of the rotor winding of small 4 pole turbo generators or hydro generators with salient pole rotors.

By measuring the flux of the rotor - full or partial short circuits in the rotorpole winding can be detected.

The UDL-8000 with the hardware module M8009 and the software module FLMS is specially designed for this type of application and allows an easy and simple monitoring of the rotor insulation without any big modification of the machine for the sensor installation.

The following illustration show the standard UDL-8000 system with the central controller and one single module, installed in the 28TE DIN Rail enclosure.

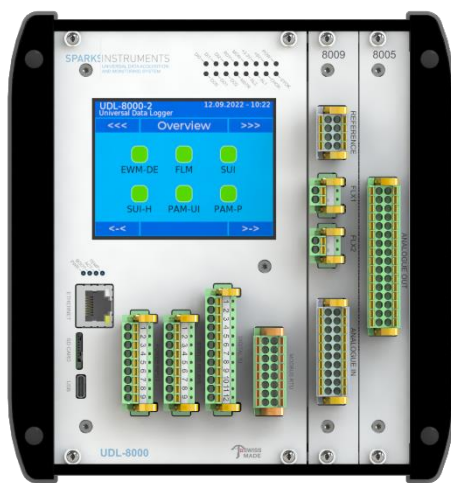


Figure 1: UDL-8000 System for rotor flux monitoring

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3 Application Description

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The rotor insulation is monitored by installing a flux probe or also called airgap search coil within the airgap (Hall Probes are not supported by the M8009 input card). One probe is generally installed in radial direction on the stator side, directly on the stator tooth. The signal cable is either passed along the pressure finger or through one of the air ducts.

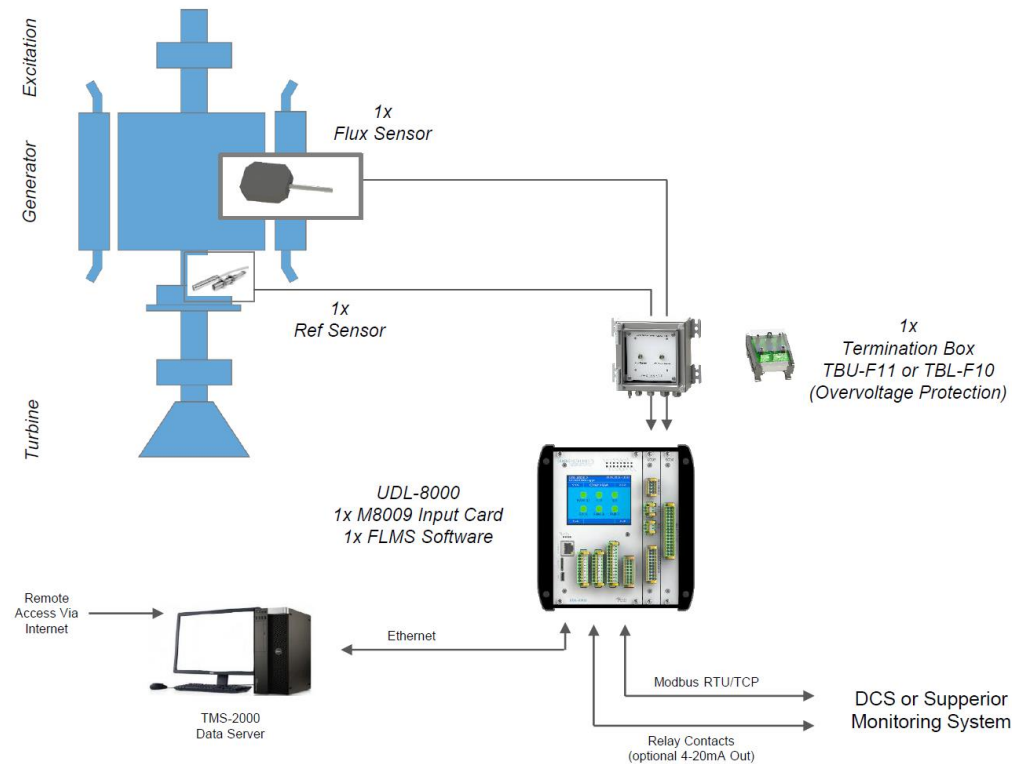


Figure 2: UDL-8000 System for rotor flux monitoring

Each pole induces a voltage in the installed sensor while passing in front of it. The system converts the induced voltage into the flux density, which is the base for any further calculation.

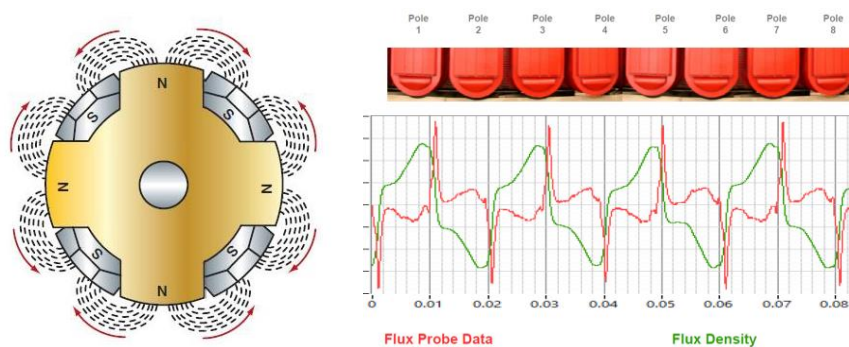


Figure 3: Measurement results of the rotor flux monitoring.

A reference sensor (tacho / keyphazor) is used to synchronise the data acquisition versus the rotor pole position.

3.1 Measurement and Analysis of the rotor flux monitoring

The flux probe data (red) is first converted by the acquisition system to the flux density (green), which represents the true magnetic field of the pole.

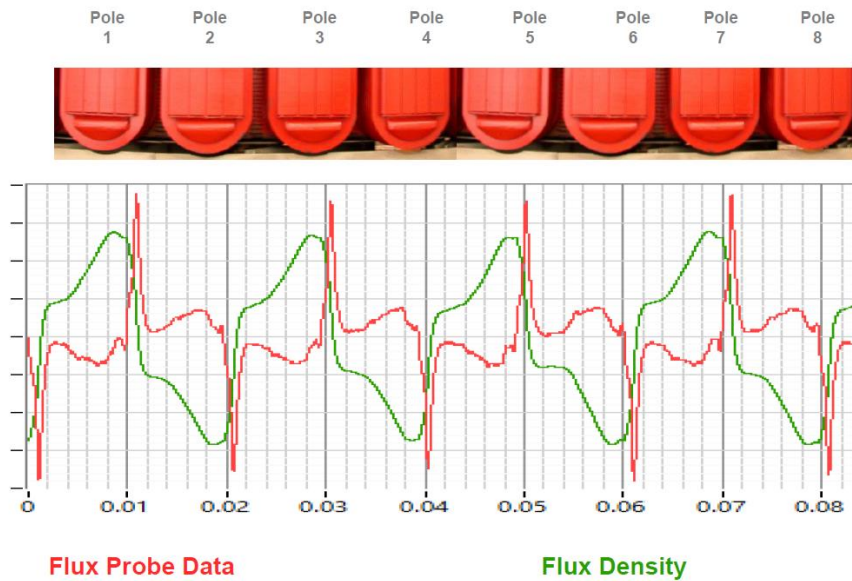


Figure 5: Rotor Flux Data Details

As the flux density varies with a change of the airgap, a direct analysis based on the flux data cannot be made. A special algorithm within the acquisition system is used to determine the roundness and possible eccentricity of the rotor. The result of this algorithm is a reference curve (blue) which is the base for the error calculation of each pole.

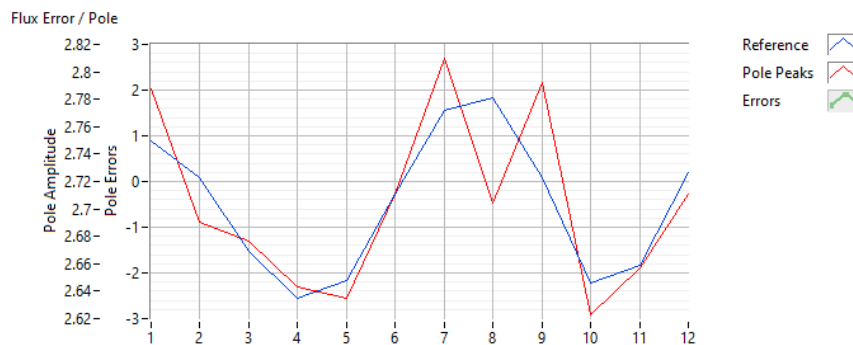


Figure 6: Flux density per pole (red) with reference (blue)

Further the errors for each pole are calculated as

$$Pole_x \text{ Error} = \frac{|Pole_x \text{ Value}| - |Reference_x \text{ Value}|}{|Reference_x \text{ Value}|} \times 100$$

3.2 General parameter handling

The UDL-8000 system is capable to handle 8 Channels with 8 parameters per channel. This gives a total of 64 parameters.

The addressing of the parameters is fixed and depends on the acquisition module, input channel and parameter channel. Refer to the general user manual for a complete addressing information of the UDL-8000 system.

The first 64 channels (0..63) are reserved for the controller, channels 64..127 are for the acquisition module 1, 128..191 for the software module 2 etc.

These channels are called channel ID's and the structure is kept identical for the Modbus RTU interface and for the UDL-DataServer.

In order to identify the location of the specific parameter, simply add the following numbers depending on the software module ID:

- Acquisition module ID 1: 64
- Acquisition module ID 2: 128
- Acquisition module ID 3: 192
- Acquisition module ID 4: 256
- Acquisition module ID 5: 320
- Acquisition module ID 6: 384
- Acquisition module ID 7: 448

3.3 Calculated parameters

Note: Add the offset depending on the Acquisition module ID.

Channels not listed up here are not used.

One of the two reference inputs can be selected to trigger the acquisition.

The Rotor Flux Input Channel is the input signal from the flux probe. Various parameters are calculated from the rotor flux profile of this channel. The acquisition module calculated the flux density signal and add the result as a virtual channel 3.

Channel number 4 to 8 are 4-20mA input channels typically used to provide load information from the generator's control system.

The error of each coil is stored under the subchannels of the 4-20mA inputs and are determined by the FDZC point and the quality factor.

3.3.1 Reference Channel – CH1

The following parameters are calculated from channel 1

CH ID	Calculation Type	Unit	Remarks
0	Frequency of Reference	Hz	
1	RPM of Reference	rpm	CH1 * 60s
2	RMS Amplitude	V	

Table 1: FLM Parameter Table, Reference - Channel 1

3.3.2 Flux Sensor Input – CH2

The following parameters are calculated from channel 2

CH ID	Calculation Type	Unit	Remarks
8	Flux Reference Max. Amplitude	V	
9	Flux Reference Min. Amplitude	V	
10	Flux Reference Roundness		

Table 2: FLMS Parameter Table, Flux Reference Channel

3.3.3 Flux Density – CH3

The following parameters are calculated based on Flux Density & Reference

CH ID	Calculation Type	Unit	Remarks
16	Magnetic Flux Max. Peak	V	Absolute value
17	Magnetic Flux Min. Peak	V	Absolute value
18	Magnetic Flux Peak to Peak	V	Max-Min value
19	Magnetic Flux Max. Error	%	Versus Reference
20	Magnetic Flux Max. Error Pole #		Versus Reference
21	Magnetic Flux Max. Error Neighbour Pole	%	Versus Neighbour Pole
22	Magnetic Flux Max. Error Neighbour Pole #		Versus Neighbour Pole

Table 3: FLMS Parameter Table, Flux Density Channel

3.3.4 Process Parameters – CH4..CH8

The following parameters are calculated from channel 4-8

CH ID	Calculation Type	Unit	Remarks
24	Mean – CH4	A*	
32	Mean – CH5	A*	
40	Mean – CH6	A*	
48	Mean – CH7	A*	
56	Mean – CH8	A*	

Table 4: FLMS Parameter Table, Operation Parameters

* by default all process parameter channels are set as input of 4-20mA with the unit “A”.
The channel rescaling (e.g. 4-20mA = 0..300MW) and the Unit assignment must be done in the parameter channel configuration at the specific channel ID.

4 Hardware & Software Requirements

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The UDL-8000 monitoring system used for Rotor Flux monitoring can be equipped with up to 7 hardware modules, providing a system with up to 56 analogue input channels.

For the complete monitoring, the following equipment is required for the acquisition:

- 1x UDL-8000 Controller
- 1x Hardware Module M8009
- 1x Software Module FLM
- UDL-Configurator Software for the configuration of the system
- UDL-Monitor Software for instant data presentation on a windows computer
- UDL-DAQ Software (optional) for direct data acquisition control of the rotor flux measurement

For automatic long-term trending and data storage, the UDL-DataServer is required. The UDL-DataServer offers continuous data recording simultaneously over multiple devices across an ethernet network (LAN/WAN). All data is stored within an SQL database and are presented on a windows-based application software. Further Details about the functions of the rotor flux monitoring within the UDL-DataClient can be found within the documentation of the UDL-DataServer.

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5 Hardware Module M8009

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5.1 Module Description

For the measurement of the flux probe data, the interface module M8009 is used. The Module has the following key features:

- Reference / Trigger input +/-24V or 240VAC Line with +24VDC or -24VDC Power supply
- Measurement of the rotor flux profile provided by a rotor flux probe (ASC Type).
- 5x 4-20mA Inputs for data recording of operation data of the generator.

5.2 Module Overview and Technical Specifications

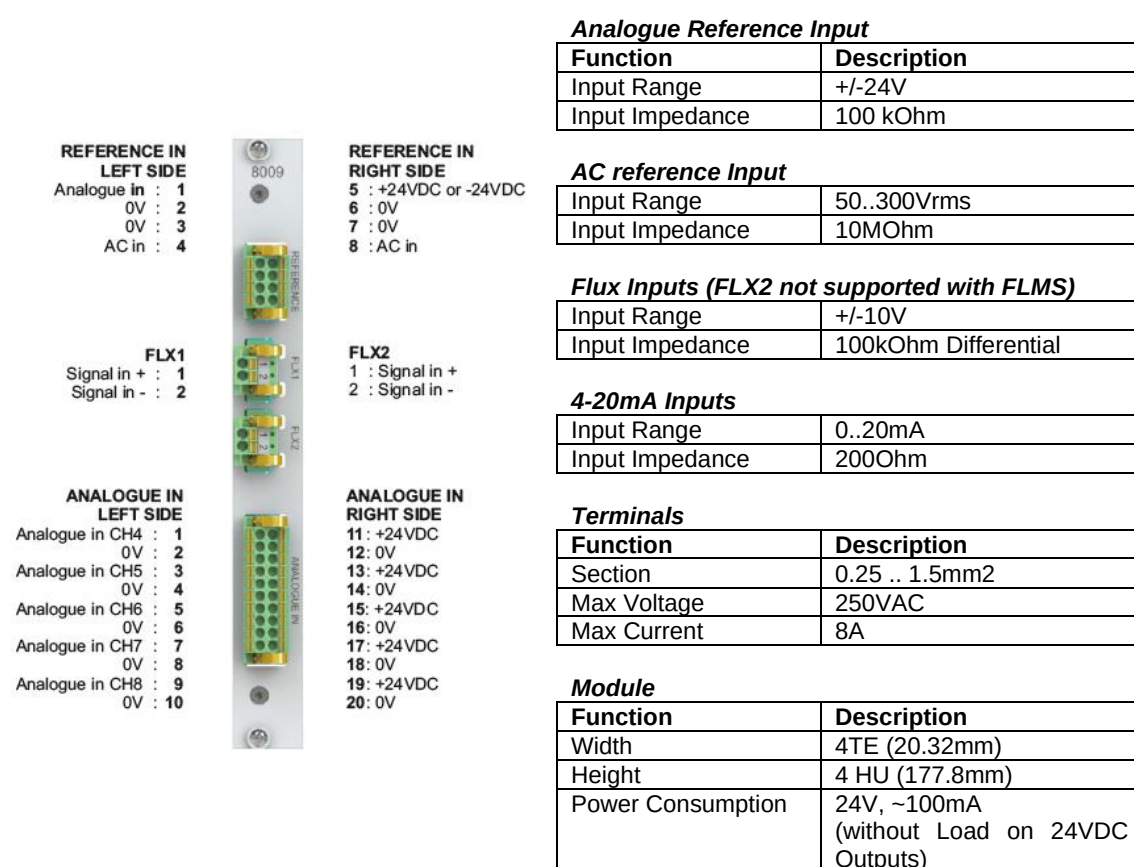


Figure 7: Technical Specifications of the M8009

5.3 Module Function Overview

The M8009 includes 2 reference inputs with different voltage ranges one for Generator AC Voltage up to 300Vrms with optical insulation and a second one with an input range of +/-30V, typically used for signals from a proximity probe.

The rotor flux signal input includes an overvoltage protection and a signal conditioning interface for the acquisition of the flux probe data.

The channels 4-8 are 4-20mA input channels with 200 Ohm input impedance. All 5 Channels share same ground connection.

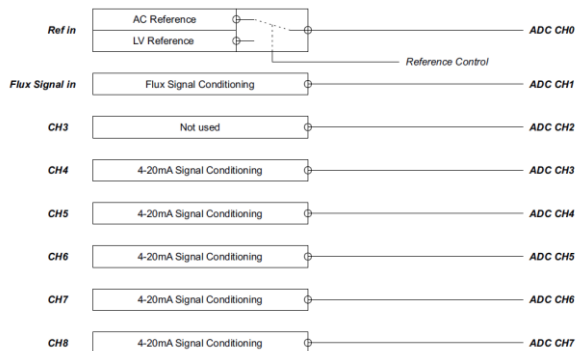


Figure 8: M8009 Operation Principle

5.4 Module Terminal Connections

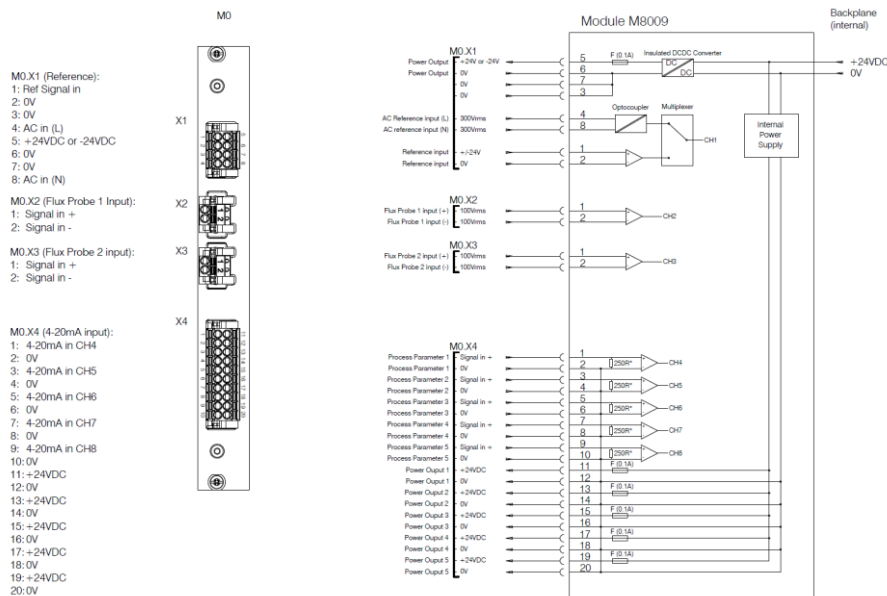


Figure 9: M8009 Terminal Connections

6 Acquisition Module Configuration

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The main acquisition configuration is supplied by a template which can be loaded under “Acquisition Modules” → “Change” → button “Load” (FLM).

Whenever possible, do not change the advanced acquisition parameter settings, unless it is known what should be done. In any doubts, please contact Sparks Instruments for advice for any changes of the Advanced Acquisition Settings

6.1 Advanced Acquisition Module Configuration

Figure 10: UDL-Configurator – Advanced Acquisition Module Configuration

The above configuration will acquire the input voltages with a sampling Rate of 20480 Samples/second. The calculation is started as soon 20480 Samples are ready from the Analogue Digital Converter, which represents 1 second of data. The ACQ Blocksize must be set in such way, that at least 3 full revolutions are within the data block.

For the configuration of the FLMS Acquisition module, some basic calculations must be made. The formulas below indicate how to calculate the requested setting parameters.

In order to determine the number of poles, use the following formula:

$$\# \text{ Poles} = \frac{\text{Grid Frequency [Hz]}}{\left(\frac{\text{Rotation Speed [rpm]}}{60s} \right)} \times 2$$

Example 500rpm/50Hz: $\frac{50\text{Hz}}{\left(\frac{500 \text{ rpm}}{60s} \right)} \times 2 = 12 \text{ Poles}$

In order to determine the rpm, based on the number of poles:

$$rpm = \frac{60s \times \text{Grid Frequency [Hz]} \times 2}{\# \text{ of poles}}$$

Example 12poles/50Hz: $\frac{60s \times 50Hz \times 2}{12} = 500rpm$

Time for 1 Revolution: Revolution Time [s] = $\frac{60s}{\text{Rotation Speed[rpm]}}$

Example 500rpm/50Hz: $\frac{60s}{500rpm} = 0.12s$

The time within the Acquisition block is determined as:

$$\text{Acquisition Time} = \frac{\text{Sampling Rate } [1/s]}{\text{Acquisition Blocksize}}$$

Example 20'480S/s & 20480 Blocksize: $\frac{20480S/s}{20480} = 1s$

It is suggested, that the sampling rate is set to 20'480 which is the standard setting for the Rotor Flux Monitoring and the block size is adapted to the speed of the machine.

Important Note:

If the FLMS is acquired together with the partial discharge monitoring (PDBAS/PDSTD/PDSIM) on the same controller, the main sampling rate required for the PD Module is used as main Sampling Rate, which is fixed to 51'200 (as the sampling clock is used to trigger the PD pulse sampling), therefore with this configuration the sampling rate for the rotor flux monitoring is set to 25'600, which is ½ of the sampling rate of the PD acquisition:

RPM / #Poles	Blocksize / Acquisition Times
>250rpm <24 Poles	With Sampling Rate 20'480: Blocksize: 20'480, 1s With Sampling Rate 25'600: Blocksize: 25'600, 1s
125rpm < x < 250rpm 48 poles > x > 24Poles	With Sampling Rate 20'480: Blocksize: 40'960, 2s With Sampling Rate 25'600: Blocksize: 51'200, 2s
75rpm < x < 125rpm 80 poles > x > 48 Poles	With Sampling Rate 20'480: Blocksize: 61'440, 3s With Sampling Rate 25'600: Blocksize: 76'800, 3s

Table 5: Advanced – Acquisition Blocksize depending on Rotation Speed.

The Trigger signal is used to determine one revolution of the rotor. The Trigger function must be activated with the following parameters

Parameter	Description
Module	Reserved Parameter
Level	Threshold Level, the way of direction is determined by the "mode"
Min Level	Min Level determines if a reference signal is valid
Mode	Defines the edge control of the trigger. <u>Rising Edge</u> Use this setting if the reference signal is positive (e.g. 0..+24V) <u>Falling Edge</u> Use this setting if the reference signal is negative (e.g. 0..-24V)
Edge Control	The Edge control is used for machine which changes its rotation direction, as it can be often found in pump storage powerplants. The default setting is "-1", indicating the Edge control is determined by the "Mode" Define any number of 0..511 to assign a parameter channel, used for the "control of the sense of rotation". In case power (MW) information shall be used for the Edge Control, use a Math/Logic function to make sure the result is set either to "0" or to "1" e.g. for positive and negative power information. If the result of the used parameter is 0, the Edge control is used as defined under "mode" If the result of the used parameter is 1, the Edge control is used inversed of the defined "mode". Further on, if the edge control is set to "1", the rotor flux data is analysed backwards in order to show the pole 1 data at the same position, even the machine rotates in the opposite direction.
Denoising Tf	Filter Parameter Tf
Denoising Ts	Filter Parameter Ts

Table 6: Advanced – Acquisition parameters

6.1.1 Denoising Parameters

The denoising is a special filtering feature for the reference signal detection and uses a very efficient filtering technique in order to avoid the use of large CPU resources during the acquisition of the data.

Depending on the type of signal (AC source or Reference Pulse) the denoising parameters might affect the original reference signal. The following graphs shows the effect of the denoising parameters T_f and T_s when using a pulse type reference source.

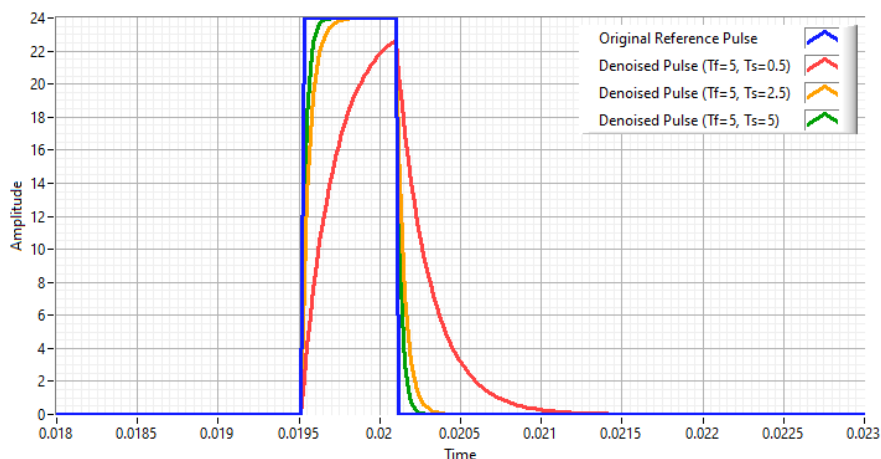


Figure 11: Denoising Effect on a 600us second pulse

When using a pulse for the references, typically $T_f=5$ and $T_s=2.5$ are good values to start with, and in case there is too much noise, the T_s parameter can be slightly increased. However, if the system is synchronised with an AC voltage, and the AC voltage has too much noise on it, reduce the T_s parameter to about 0.5.

6.2 Basic Acquisition Module Configuration

Within the basic acquisition module configuration, the main acquisition parameters can be defined.

Each Software module has its application specific parameters.

The screenshot shows the 'Acquisition Modules' configuration window. At the top, there is a table with columns: No., Type, Description, and Used Modules. The table lists five modules: 0 (INT, Internal Controller Functions), 1 (FLMS, Rotor Flux Monitoring (Salient Pole)), 2 (none), 3 (none), 4 (none), and 5 (none). Module 1 is selected. To the right of the table are buttons for 'Change', 'Save', and 'Set to Default'. Below the table, there are two tabs: 'Basic' and 'Advanced'. The 'Basic' tab is active, showing several parameters with input fields or dropdowns: TRG_Offset (0), Poles (12), Pk Trhld [%] (50), Error Reference (Spline), Reference Source (LV Reference), and Min Sync (1).

Figure 12: FLMS Module specific parameters

Parameter	Description
TRG Offset	Defines the offset between the reference signal and the rotor flux profile in Samples defined by the sampling rate. The value can be set positive or negative and shall be adjusted in such way, the first pole is shown towards positive direction.
Poles	Define the number of poles of the rotor. The acquisition module will search for the defined number of poles, if the number of poles are not found, all calculation results will be set to 0.
Pk Trhld[%]	Defines the peak threshold in % of the maximum peak signal of the pole. The threshold is determined to find the exact peak value. Typically 50% (half of the pole signal response) has to be used.
Error Reference	The Error reference is used for the calculation of the errors <u>Spline (default value)</u> Use this setting to automatically compensate rotor roundness, eccentricity etc. <u>Linear</u> This setting uses the “statistical mean” value over all pole peaks as a reference for the error calculation.
Reference Source	Selection of the Reference source: <u>AC Reference</u> Use the AC input terminals, supporting reference voltages up to 300Vrms <u>LV Reference (default value)</u> Use the LV Reference input with an input range of +/-30Vpp, a signal typically provided by a proximity probe.
Min Sync	Defines the minimum value of the voltage reference signal, in order to determine if the machine is running or not.

Table 7: Basic – Acquisition parameters

6.3 Alarm Configuration

By default, the following alarms are configured, note that the channel id needs to be calculated based on the acquisition module number. Alarm Mode in brackets are configured but not activated.

CH ID	Calculation Type	Alarm Mode	Threshold AL1 low lvl	Delayed	Threshold AL2 low lvl	Delayed
16	Flux Max Peak	(below)	3	Yes, 10s	2	Yes, 10s
17	Flux Min Peak	(below)	3	Yes, 10s	2	Yes, 10s
18	Flux Peak-Peak	(above)	2	Yes, 10s	3	Yes, 10s
19	Flux Max Error vs Ref	outside	+/-10%	Yes, 10s	+/-20%	Yes, 10s
20	Flux Max Error vs Neighbour	(outside)	+/-10%	Yes, 10s	+/-20%	Yes, 10s

Table 8: Default Alarm Configurations

As the channel numbers depend on the index of the acquisition module, the assignment to the alarm relay and the digital outputs must be done manually, after the initial configuration.

6.4 4-20mA Output Configuration

In general, the channel 19 (Magnetic Flux Max. Error) is used for analogue output to provide the information to the DCS. As the value can vary between -100% and +100% (defined within the parameter configuration under min / max scale), the midrange of the 4-20mA (equal to 0% Error) is set at 12mA.

CH ID	Calculation Type	Min Scale	Max Scale	Min Output	Max output
19	Flux Max Error vs Ref	-50%	+50%	4mA	20mA

Table 9: Default 4-20mA Configurations

6.5 MIMIC Visualization Configuration

Use one of the templates representing the machine and it is recommended to use the following channels:

CH ID	Calculation Type	Si Notation	Digits
16	Flux Max Peak	no	2
17	Flux Min Peak	no	2
19	Flux Max Error vs Ref	no	1
20	Flux Max Error vs Ref Pole#	no	0

Table 10: Default Mimic Channels

As there are maximum 8 channels which can be presented, it is suggested to indicate additionally rotation speed, active power and reactive power if available.

6.5.1 Local Visualization Mimic example

As the visualization is fully customizable, the graphics below show an example of a possible visualization layout:

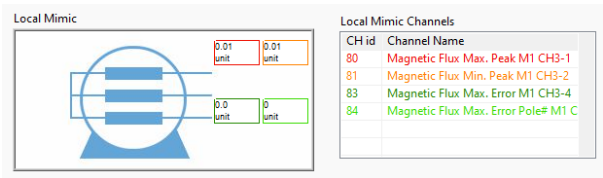


Figure 13: FLMS Example of a local visualisation mimic

6.5.2 External Visualization Mimic example

A similar visualization layout can be used to present the mimic within the UDL-Monitoring Software.

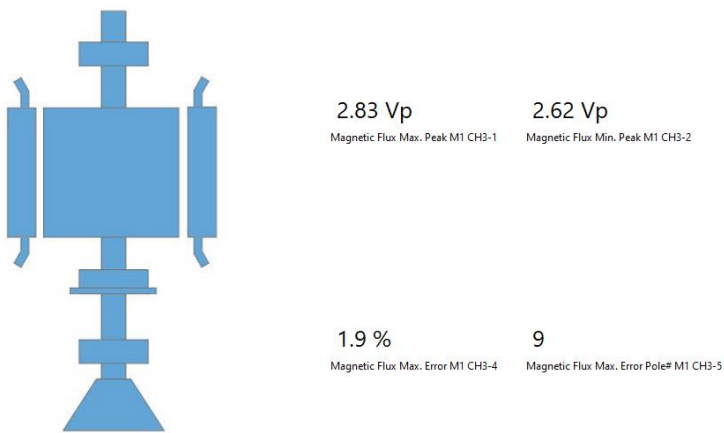


Figure 14: FLMS Example of an external visualisation mimic

6.6 Data Recording

In order to avoid excessive data recording which will occupy a lot of disk space, it is recommended to use the following recording options.

6.6.1 Data Recording based on alarm

It shall be evaluated, if in case of an alarm other acquisition parameters should also be recorded. This is especially required, if the data other acquisition modules are linked together with the rotor flux monitoring.

The screenshot shows the 'Alarm Recording' configuration interface. It consists of three main panels: 'Recordings', 'Used Acquisition Modules', and 'Recording Modes'. Below these panels is a section for 'Alarm Recording' settings.

- Recordings:** A list box containing 'Standard'. Below it are 'Add' and 'Remove' buttons.
- Used Acquisition Modules:** A list box containing '0 - INT', '1 - FLMS' (checked), '2 - none', '3 - none', '4 - none', '5 - none', '6 - none', and '7 - none'. Below it are 'Add' and 'Remove' buttons.
- Recording Modes:** A list box containing 'Alarmed' (checked) and 'Time Intervalled'. Below it are 'Add' and 'Remove' buttons.
- Alarm Recording:** A section with a 'Use' checkbox (checked), a 'No of Recordings' spinner set to 5, and an 'Interval [min]' spinner set to 10.

Figure 15: Typical recording configuration for alarm-based recording

Whenever an alarm of the specific acquisition module is active, 5 recordings with an interval of 10 minutes are saved. The counter for the number of recordings is restarted once all of the recorded data are saved.

6.6.2 Data Recording based on time interval

In order to avoid a lot of recordings of the same data, the time intervalled data recording shall be used. This recording memorizes the rotor pole profile while the Magnetic Flux error is at highest during the defined time interval. After the time interval is reached, the rotor pole profile is stored and a new memorizing is started. The result of that recording is a rotor flux profile with the highest error during the defined time interval.

The screenshot shows the 'Time Interval Recording' configuration interface. It consists of three main panels: 'Recordings', 'Used Acquisition Modules', and 'Recording Modes'. Below these panels is a section for 'Time Interval Recording' settings.

- Recordings:** A list box containing 'Standard'. Below it are 'Add' and 'Remove' buttons.
- Used Acquisition Modules:** A list box containing '0 - INT', '1 - FLMS' (checked), '2 - none', '3 - none', '4 - none', '5 - none', '6 - none', and '7 - none'. Below it are 'Add' and 'Remove' buttons.
- Recording Modes:** A list box containing 'Alarmed' (checked) and 'Time Intervalled' (checked). Below it are 'Add' and 'Remove' buttons.
- Time Interval Recording:** A section with a 'Use' checkbox (checked), a 'Channel ID' spinner set to 83, a 'max' dropdown for 'Channel ID', a '2' spinner for 'Interval [hour]', a 'none' dropdown for 'Condition', a '0' spinner for 'Channel ID', and a '0' spinner for 'Value'.

Figure 16: Typical recording configuration for value interval-based recording

Parameter	Description
Channel ID	Define the channel id of the sensitive coil parameter
Max/min	Define the “memory mode” of the interval. Data are memorized if a new parameter value is larger (max) or smaller (min) of the previous data
Intervall hour	Define the time interval of the memorization
Condition	Define, if the data shall be acquired only while a parameter condition is met, e.g. record data if the machine runs at a minimum active power.
Channel ID	Define the channel id of the condition parameter
Value	Define the threshold of the condition parameter

Table 11: Time interval-based recording.

This recording configuration will record the flux profile every 2 hours while the Magnetic Flux Error (channel 83) was at its highest magnitude.

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7 Acquisition Module Data Presentation

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The measured rotor flux data uses for the raw data presentation and the parameter calculations the FLMS Acquisition module. The data presentation window is used for the UDL-Monitor as well as within the UDL-DAQ software. The UDL-DAQ software additionally offers the operator to change the Basic acquisition module settings in the same way as it can be changed with the UDL-Configurator software, except accompanied with the measured results (typically done during commissioning)

The rotor flux profile is acquired based on the trigger signal and the data is shown for one revolution of the rotor. Within the time signal graph, the reference sensor signal (AC voltage or Reference Sensor data), the Flux Probe Signal (Red), the Flux Density Signal (blue) are shown.

At the right side of the window, the pole overview graph is showing the results from each pole on a polar graph form. The orange dashed line indicating 5% of error. The blue line is representing the reference curve, used for the error calculation and the green lines along the reference curve representing the error of each pole.

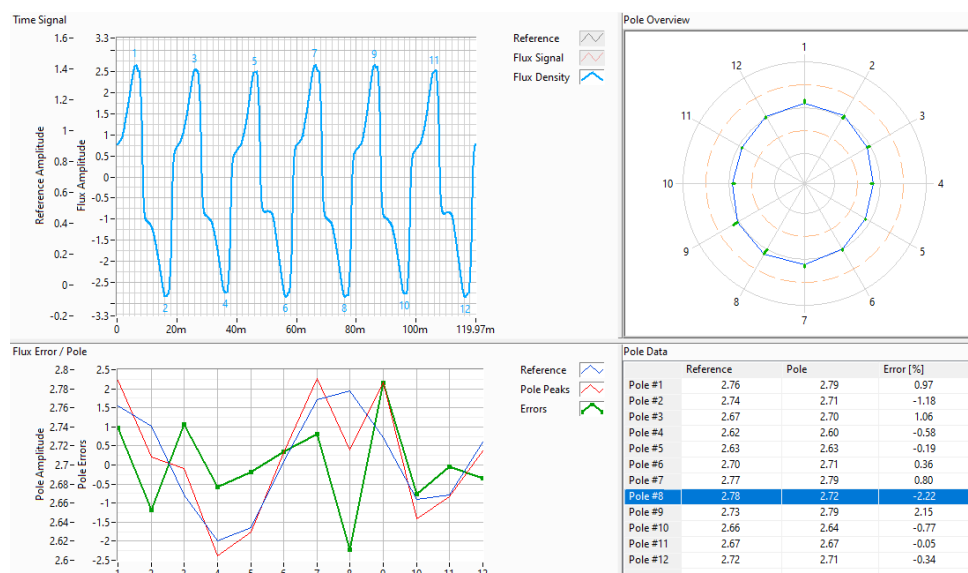


Figure 17: FLMS Acquisition Module Data Presentation

At the bottom left, the peaks of each pole and the calculated reference is shown, using the Y-Axis "Pole Amplitude". The calculated error is shown per pole as well.

At the right side the numeric values of each pole are shown in a table form and the highlighted row indicating the pole with the highest error.

8 UDL-DataClient

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This chapter covers the information for the visualization of the measured data within the centralized data server / client software UDL-DataClient.

While the basic version of the UDL-DataClient presents only one visualization at a time, the UDL-DataClient Pro supports multi window data presentation while the content and the operation of the windows remain the same.

The measured rotor flux data is updated once the complete acquisition module is finished, and the update rate depends on the number of used modules

8.1 Typical Window Layouts

While the window layout depends greatly on the used monitor resolution, the number of windows presented at the same time also on the operator's preference. The layouts shown within this manual shall give some ideas about the possibilities provided by this software.

8.1.1 Layout for the UDL-8000 Pro

Screen Resolution: 1280 x 800 - WXGA

Using the touchpanel PC for data visualisation allowing to use the benefit of multiple data presentation. However, generally data analysis will then be performed on a connected Desktop computer with a larger screen.

To be placed

Figure 18: UDL-8000 Pro local data visualisation (FLMS Rotor Flux Profile)

To be placed

Figure 19: UDL-8000 Pro local data visualisation (Polar View)

As with the limited screen size, the time series data (trend) is placed as a separate view

To be placed

Figure 20: UDL-8000 Pro local data visualisation (Trend)

8.1.2 Layout for Desktop Computers

Screen Resolution: 2560 x 1440 – WQHD - recommended

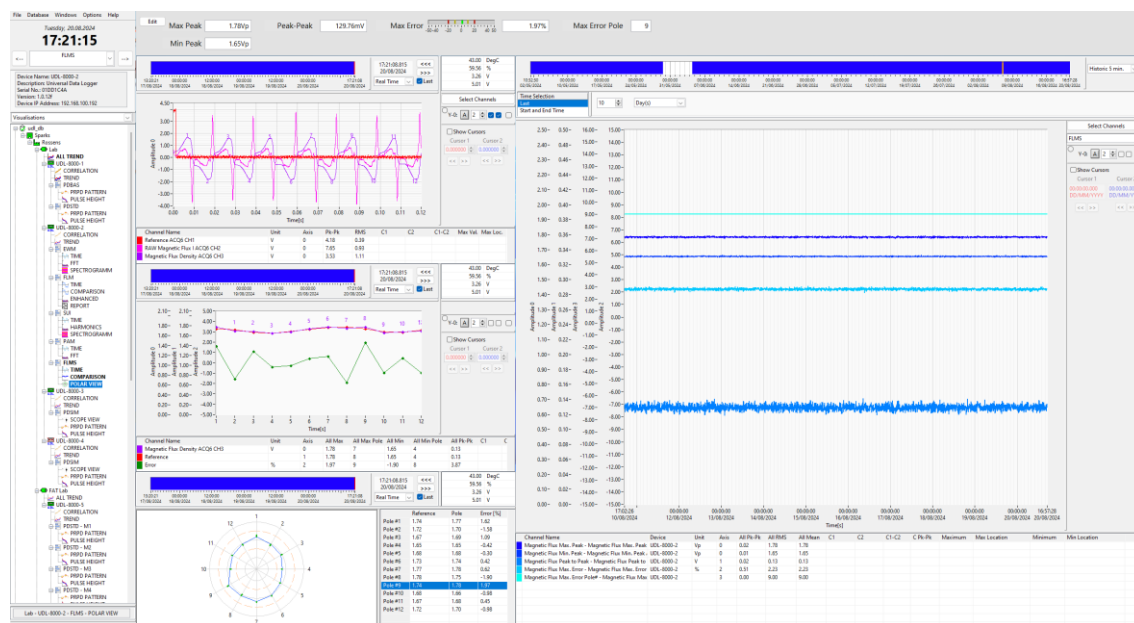


Figure 21: UDL-DataClient desktop data visualisation (FLMS & Trend)

8.2 Data Visualizations

The functions, use and configuration of overview pages and trend are common for all types of acquisition modules and are described in the general user manual of the UDL-

DataClient. The Update Rate of the windows depend on the number of acquisition modules used.

8.2.1 TIME (Rotor Flux Profile Data)

The Time view shows the rotor profile data over one revolution. It also contains the flux density which is used for the evaluation of the rotor pole windings.

The visualization is separated into 3 parts:

Window Part	Description
Top	The Top Part contains the time selection of the shown dataset
Middle	In the middle the selected data is presented
Bottom	At the bottom of the window, calculated results are shown

Table 12: Separation of visualisation information

The graph below shows the reference sensor, the sensor signal and the calculated flux density.

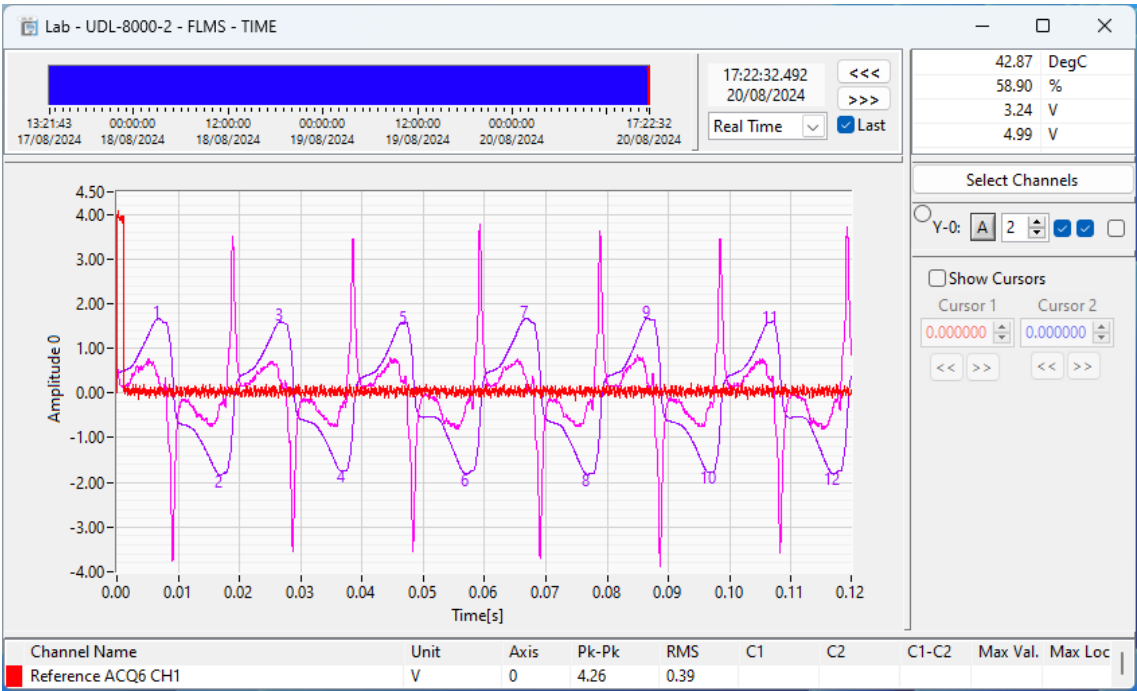


Figure 22: Time Data Presentation

But generally, only the flux density is used for the data presentation.

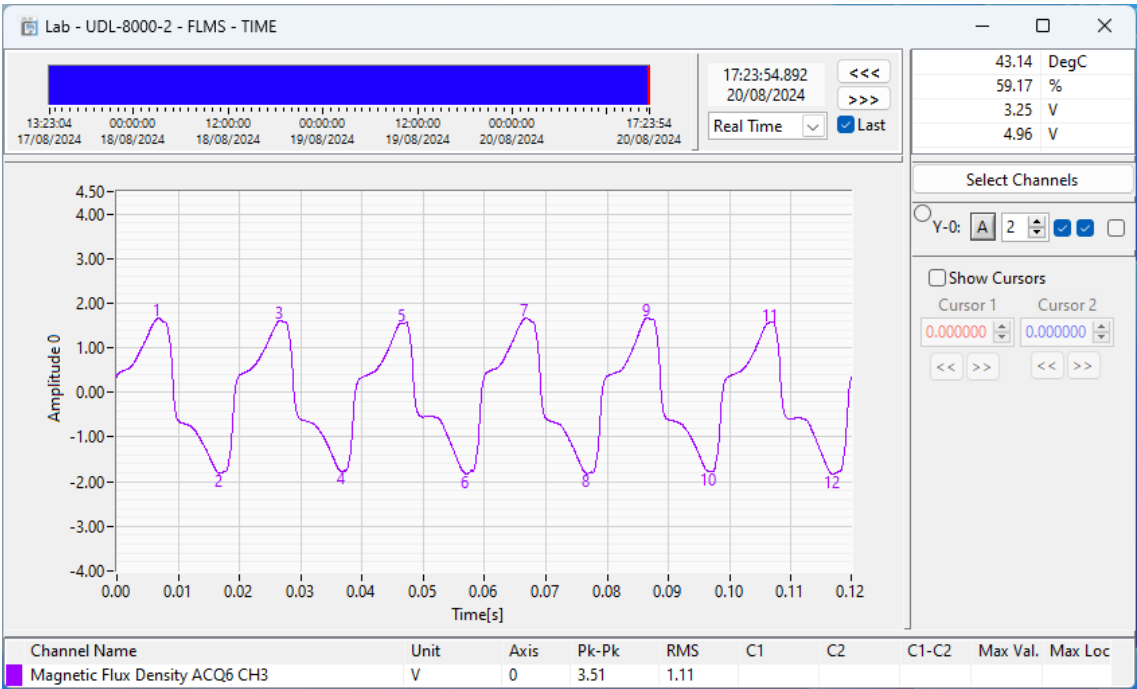


Figure 23: Time Data Presentation with flux density only

8.2.1.1 Time Selection

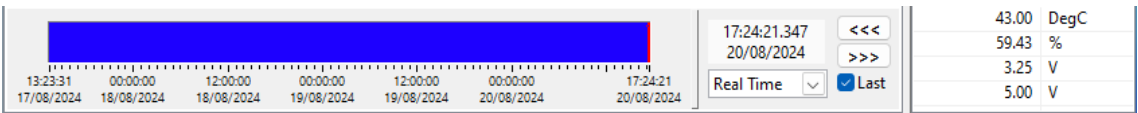


Figure 24: Time Selection

The blue bar shows all the available data records within the database, and the specific dataset can be picked by moving the red cursor at the time of interest.

The time selection in the middle allows to select the time more precisely as

Element	Description
Time Stamp	Enter the timestamp of interest manually. It is also possible to copy/paste the timestamp from another window or from a cursor timestamp. Right click into the timestamp field and assign the timestamp to the “master timestamp 1” or “master timestamp 2” in order to select the dataset of multiple windows with one single time definition.
Button left / right	Jump one record to the left (earlier) or right (later)
Data table selection	Choose between Realtime Data- and Historic Datasets
Last dataset	Select the last data record

Table 13: Time Selection parameters

At the very right side of the time selection view are the operating parameters shown. Up to 4 parameters can be assigned to the “recording header” which will be shown on every raw data visualisation window.

8.2.1.2 Data Presentation

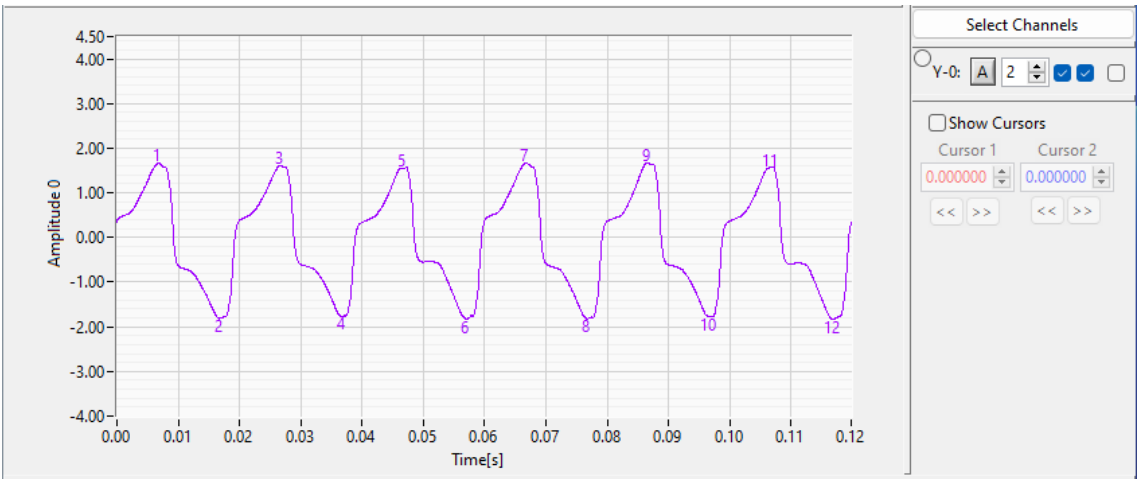


Figure 25: Rotor Flux Data Presentation

With the button “select channels” the channels of the specific module can be activated. Generally, there is a reference signal (to trigger the acquisition), the flux profile data and the flux density data to be selected.

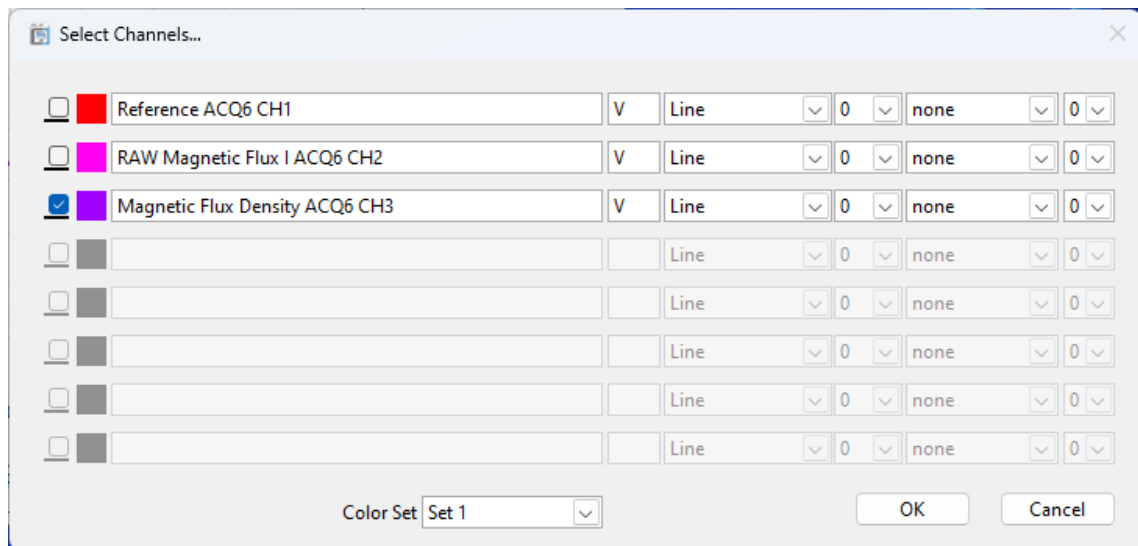


Figure 26: Channel Selection

Mark the Checkbox to activate the channel, click on the color box to change the color of the trace. Select the line type, the line thickness and sample points if wanted. At the very right side, assign the trace to the specific axis, this is especially used, whenever data with different scaling's are shown in the same graph. At the bottom of the window, a new color set can be assigned. Press the "OK" button to accept new changes and close the window.

At the right side of the graph are the settings for the individual used axis, press the little circle next to the "A" button to enlarge the axis configuration

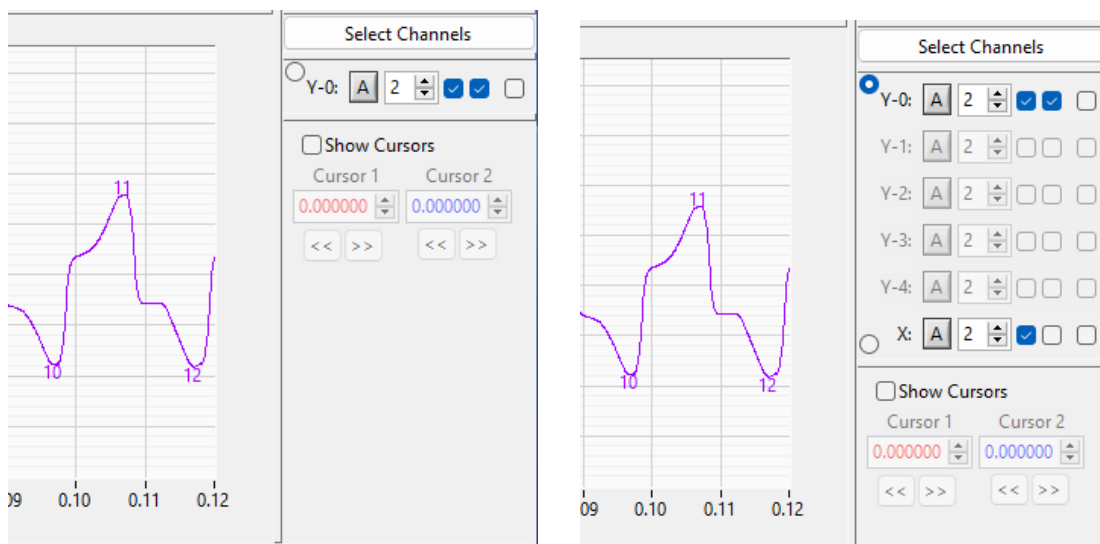


Figure 27: Axis Configuration

Depending on the assigned channels to the traces, more axis can be configured. Press the little “A” button to autoscale the specific axis. The number is used to select the number of digits in the axis and also in the calculation result table. The checkboxes next to it, allows to activate the major and minor grid lines. The checkbox at the very right is used to show the data either as floating point (unchecked) or in Si notation (checked). Si notation allows to automatically convert any number into k, m, M instead of exponents. It is also possible to manually adjust the axis range by entering the minimum and maximum value of the specific axis. Press the round circle at the bottom of the axis configuration to minimize this view.

Below the axis configuration 2 cursors can be activated in order to read out values of the shown traces. Mark the checkbox to activate the cursors:

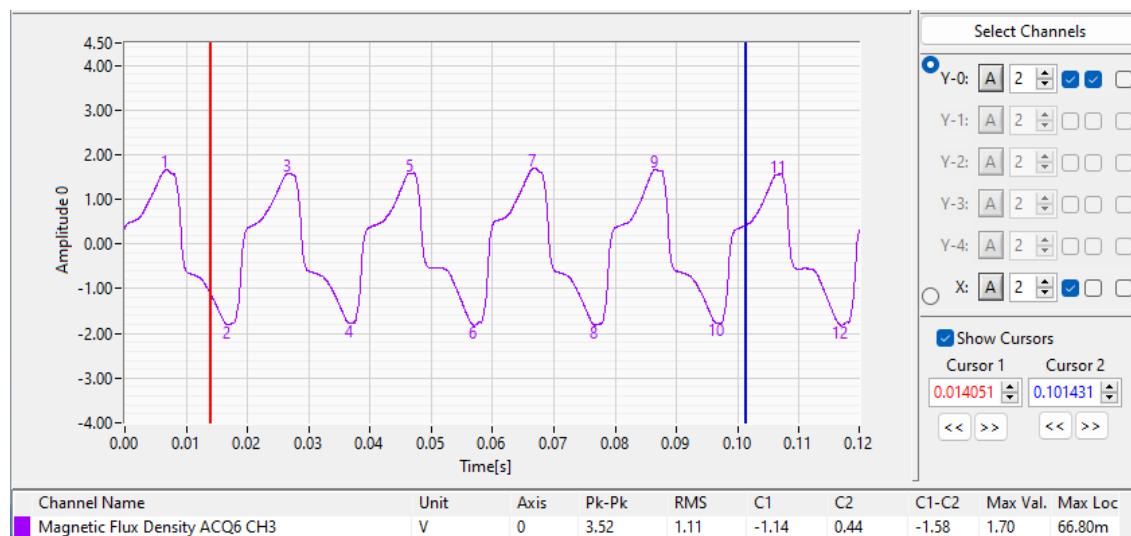


Figure 28: Reading out datapoints with cursors.

8.2.1.3 Calculated Results

At the bottom of the visualisation window are the results calculated from the rotor flux profile shown.

Channel Name	Unit	Axis	Pk-Pk	RMS	C1	C2	C1-C2	Max Val.	Max Loc
Magnetic Flux Density ACQ6 CH3	V	0	3.53	1.11					

Table 14: Calculated Results without cursors

If the cursors are activated, the calculation results table is showing calculated values between the 2 cursors

Channel Name	Unit	Axis	Pk-Pk	RMS	C1	C2	C1-C2	Max Val.	Max Loc
Magnetic Flux Density ACQ6 CH3	V	0	3.52	1.11	-1.14	0.44	-1.58	1.70	66.80m

Table 15: Calculated Results with cursors results

8.2.2 COMPARISON

The comparison view is showing the rectified peak value of each pole signal with the calculated reference line, representing the roundness or misalignment of the rotor within the stator.

Based on the 2 graphs, the error is shown for each individual pole.

The handling of the visualization is done in the same way as the TIME view of the rotor flux profile. Refer to the chapters before for details of the usage.

The visualization is separated into 3 parts:

Window Part	Description
Top	The Top Part contains the time selection of the shown dataset
Middle	In the middle the selected data is presented
Bottom	At the bottom of the window, calculated results are shown

Table 16: Separation of visualisation information

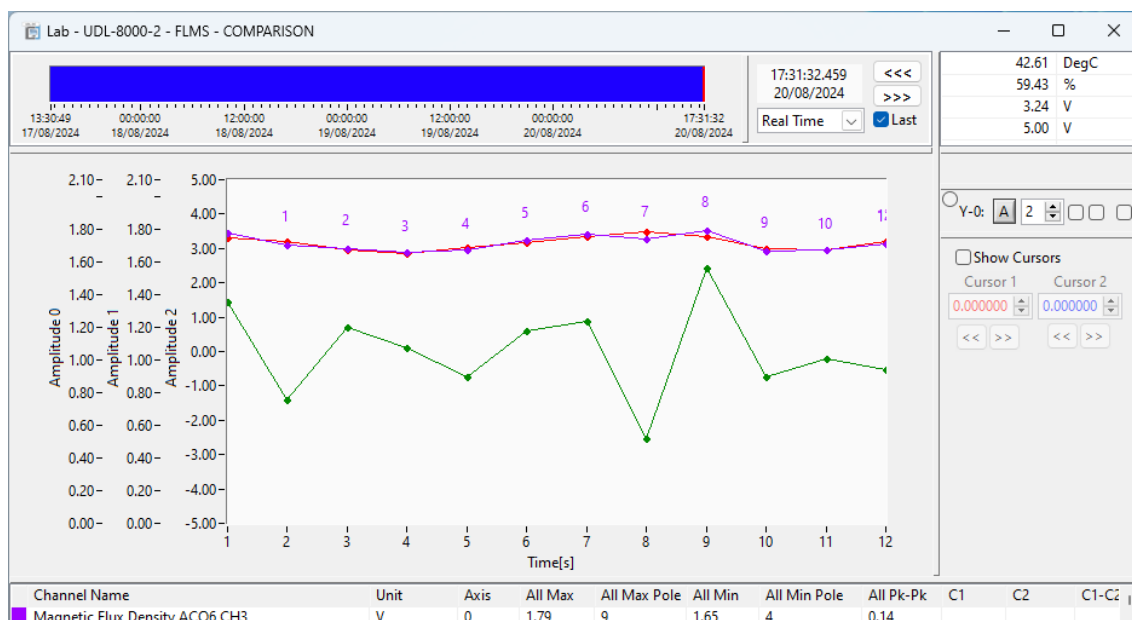


Figure 29: Pole Responses over one revolutions

8.2.3 POLAR

The polarview shows the pole profile over one revolution in a polar plot. Aside of the polar graph, a table with the results of each individual pole is shown.

The visualization is separated into 2 parts:

Window Part	Description
Top	The Top Part contains the time selection of the shown dataset
Bottom	In the Bottom the selected data is presented

Table 17: Separation of visualisation information

Within the table of each pole value, the pole with the highest error is marked blue.

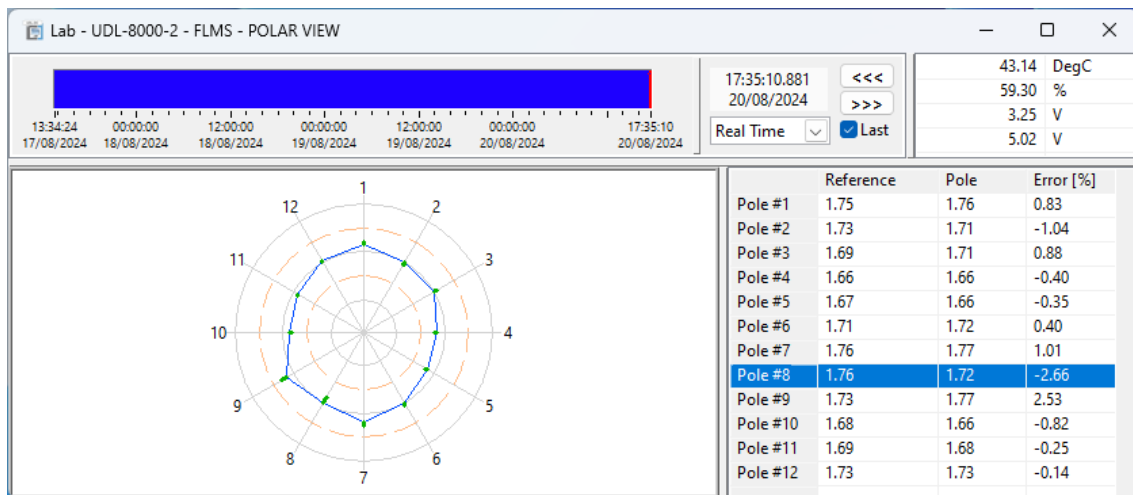


Figure 30: polar data view with pole result details