

THE MEASURABLE DIFFERENCE.



DEWETRON

▼

OXYGEN TRAINING > POWER





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- > Creating a Power Group
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- > Data Visualization
- > Harmonics & Interharmonics
- > Higher Frequency Grouping
- > Supraharmonics
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- > Flicker
- > Rolling Computations
- > Mechanical Power
- > dQ Analysis
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GENERAL FEATURES



Benefits of a DEWTRON POWER ANALYZER

- > Full flexible input configuration
- > Simple setup within seconds
- > Individual phase groups (up to 9 phases per PowerGroup)
- > Free selectable sync channel
- > Unlimited recording (only limited by harddisk space)

Type	Hardware	Bandwidth	Samplerate	Phasecount
DEWE3-PA8	TRION3-1810M-POWER-4	5 MHz	10 MS/s	16
DEWE2-PA7	TRION-1820-POWER-4	5 MHz	2 MS/s	12
DEWE2-A7	TRION-1820-POWER-4	5 MHz	2 MS/s	12
DEWE2-A4L	TRION-1820-POWER-4	5 MHz	2 MS/s	8

In addition to the great measurement functions of OXYGEN, the POWER-Option enables the detailed analysis of the phase values and total values in L-N configuration (each total and fundamental):

- > Voltage (RMS, AVG, PHI, Peak-Peak) → OPT-POWER-BASIC
- > Current (RMS, AVG, PHI, Peak-Peak) → OPT-POWER-BASIC
- > Active Power (AVG, PHI) → OPT-POWER-BASIC
- > Reactive Power (AVG) → OPT-POWER-BASIC
- > Apparent Power (AVG) → OPT-POWER-BASIC
- > Power Factor (AVG) → OPT-POWER-BASIC
- > Fundamental Frequency (0.2 – 200 kHz) → OPT-POWER-BASIC
- > Harmonics (up to 1000th order) → OPT-POWER-ADV
- > Interharmonic (up to 1000.5th order) → OPT-POWER-ADV
- > Higher Frequencies (2-9 kHz Grouping) → OPT-POWER-ADV
- > Voltage Fluctuation → OPT-POWER-ADV
- > Flicker Emission → OPT-POWER-ADV
- > Mechanical Power Computation → OPT-POWER-ADV
- > Rolling Computations → OPT-POWER-EXP



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CREATING A POWER GROUP

- 1 Open the Channel List
- 2 Select the desired Sample Rate (min. 10 kHz, calculation disabled below)
- 3 If current transducers are used, open the scaling menu of the current channel and enter the scaling factor
- 4 Press the Add Power Group button

The screenshot shows the DEWETRON software interface. At the top, there is a hardware rack view with a 'LocalNode' and 'DEWE2-44' module. Below it is a channel list table. A blue arrow labeled '1' points to the channel list icon. Another blue arrow labeled '2' points to the 'Sample Rate' column in the channel list. A third blue arrow labeled '3' points to the 'Scaling' column in the channel list. A fourth blue arrow labeled '4' points to the 'Add Power Group' button (represented by a sun icon) at the bottom of the interface. A 'Channel Scaling' dialog box is open, showing the 'Scaling' tab selected. The dialog has fields for 'Unit' (set to 'V'), 'Scaling' (set to '1'), and 'Offset' (set to '0'). There are 'Zero', 'Cancel', and 'Ok' buttons at the bottom of the dialog.

Channel	Color	Setup	Active	Stored	Scaled Value	Mode	Sample Rate	Range	Scaling
LocalNode									
DEWE2-44									
TRION-1820-POWER-4									
AI 1/I1 Sim	Blue	⊗	☑	☑	0.203488	AVG	5000 Hz	-10 V .. 10 V	Scale: 1 U...V Offset: 0
AI 1/I2 Sim	Red	⊗	☑	☑	0.043825	AVG	5000 Hz	-10 V .. 10 V	Scale: 1 U...V Offset: 0
AI 1/I3 Sim	Green	⊗	☑	☑	-6.000000	AVG	5000 Hz	-10 V .. 10 V	Scale: 1 U...V Offset: 0
AI 1/I4 Sim	Orange	⊗	☑	☑	-1.200000	AVG	5000 Hz	-10 V .. 10 V	Scale: 1 U...V Offset: 0
AI 1/U1 Sim	Blue	⊗	☑	☑	1.360000e+3	AVG	5000 Hz	-2000 V .. 2000 V	Scale: 1 U...V Offset: 0
AI 1/U2 Sim	Red	⊗	☑	☑	-1.400000e+3	AVG	5000 Hz	-2000 V .. 2000 V	Scale: 1 U...V Offset: 0
AI 1/U3 Sim	Green	⊗	☑	☑	0.000000	AVG	5000 Hz	-2000 V .. 2000 V	Scale: 1 U...V Offset: 0
AI 1/U4 Sim	Orange	⊗	☑	☑	0.000000	AVG	5000 Hz	-2000 V .. 2000 V	Scale: 1 U...V Offset: 0



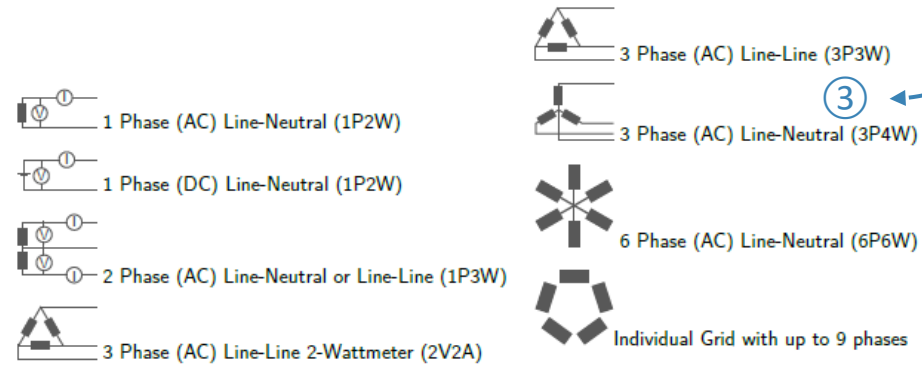
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POWER GROUP SETTINGS – WIRING TYPE

- ① Select the correct Wiring type of the DUT
Wiring schematics below will demonstrate the individual wiring
- ② Assign the current and voltage channels from the Channel List to the Power Group via drag and drop
- ③ Overview of the predefined schematics available here;
Additional information and connection schemes can be found in the manuals

Configure at least one Phase via Drag'n'Drop from the channel list





CREATING A POWER GROUP

- ① After drag and dropping all channels into the schematics, a value preview will be available
 - ② The calculated power values will be automatically added as separate channels to the Channel List
 - ③ Single channel's phase values and total values in L-N configuration can be accessed by further expanding the Channel List;
- Listed channels will depend on the Wiring type
- Creation of several and different Power Groups in one setup supported

The screenshot displays the DEWETRON software interface for configuring a power group. The main window shows a schematic diagram with three channels (1, 2, 3) and their respective power values. The left sidebar contains a 'Channel List' with various power and energy metrics. The right sidebar shows a 'LocalNode' configuration for the 'POWER/0' power group, with a detailed list of channels and their values.

Channel List (Left Sidebar):

- LocalNode
 - Power Groups
 - POWER/0
 - Voltage (U)
 - Total RMS
 - Fundamental
 - Average / PP
 - Symmetrical Components
 - Current (I)
 - Total RMS
 - Fundamental
 - Average / PP
 - Symmetrical Components
 - Active Power (P)
 - Total
 - Fundamental
 - Reactive Power (Q)
 - Total
 - Fundamental
 - Apparent Power (S)
 - Total
 - Fundamental
 - Power Factor (PF)
 - Total
 - Fundamental
 - Energy (W)
 - Fundamental
 - Total
 - F_fund

LocalNode Configuration (Right Sidebar):

- LocalNode
 - Power Groups
 - POWER/0
 - Voltage (U)
 - Total RMS
 - U_tRMS
 - U1_tRMS
 - U2_tRMS
 - U3_tRMS
 - U12_tRMS
 - U23_tRMS
 - U31_tRMS
 - Fundamental
 - U_fundRMS
 - U1_fundRMS
 - U1_fundPHI
 - U2_fundRMS
 - U2_fundPHI
 - U3_fundRMS
 - U3_fundPHI
 - U12_fundRMS
 - U12_fundPHI
 - U23_fundRMS
 - U23_fundPHI
 - U31_fundRMS
 - U31_fundPHI

Schematic Diagram (Center):

Channel Mapping: L1, L2, L3, N. Channel 1: 5.66A, 923.78V, -8.15W. Channel 2: 5.66A, 923.77V, -8.13W. Channel 3: 4.62A, 0.00V, 0.00W.

Input Channel and Sync Channel Sample Rate: > 200kHz, accuracy



POWER GROUP SYNC SETTINGS

① Synchronization Channel for fundamental frequency detection; Freely definable, per Default Voltage of Phase 1

② Minimum fundamental frequency input field ($0.2 \text{ Hz} - f_{\text{max}}$)

③ Maximum fundamental frequency input field ($f_{\text{min}} - 0.1 * \text{SR} [\text{Hz}]$)

④ Threshold of the amplitude of the synchronization channel that needs to be exceeded for fundamental frequency detection, per default $>0.1\%$

⑤ Maximum update rate of the output channels, 1ms per default; 1 ... 5000 ms

⑥ For DC applications, Update rate for power calculations

⑦ Subsampling factor selection for calculation load reduction

Wiring type [Settings](#)

SYNC SETTINGS

Calculation sync source:

Input channel:

AI 1/U1 Sim ①

Minimum fundamental frequency: Default ②

Maximum fundamental frequency: Default ③

Minimum detection threshold: Default ④

Maximum update rate: Default ⑤

Time interval: 200 ⑥ ms

Channel Subsampling: Auto ⑦

Samplerate	Subsampling Factor
$\leq 2 \text{ MS/s}$	1 (= no Subsampling)
$> 2 \text{ MS/s} - 4 \text{ MS/s}$	2
$> 4 \text{ MS/s} - 6 \text{ MS/s}$	3
$> 6 \text{ MS/s} - 8 \text{ MS/s}$	4
$> 8 \text{ MS/s}$	5

Samplerate	Minimum Fundamental
$< 10 \text{ kHz}$	None
$10 \text{ kHz} - 20 \text{ kHz}$	0.2 Hz
$20 \text{ kHz} - 1 \text{ MHz}$	0.2 Hz
$1 \text{ MHz} - 2 \text{ MHz}$	0.5 Hz
$2 \text{ MHz} - 4 \text{ MHz}$	1 Hz
$> 5 \text{ MHz}$	2 Hz

Minimum fundamental frequency

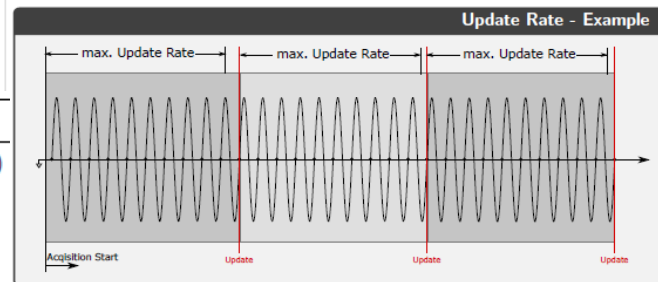
This input field holds the setting for the minimum fundamental frequency in Hz which can be measured (lower limit). The following settings are available:

- **Default:** Standard setting, uses 0.2 Hz internally (up to 1MS/s) and $>0.5 \text{ Hz}$ above. The actual value is the lower bound of the F_{fund} channel range.
- **0.2 .. f_{max} Hz:** User defined setting, the possible range is between Default and 100 Hz.

Maximum fundamental frequency

This input field holds the setting for the maximum fundamental frequency in Hz which can be measured (upper limit) The following settings are available:

- **Default:** Standard setting, uses 1500 Hz internally ($>20 \text{ kS/s}$). The actual value is the upper bound of the F_{fund} channel range.
- **Auto:** Uses 1/10 of Samplerate
- **$f_{\text{min}} .. \text{Samplerate}/10 \text{ Hz}$:** User defined setting, the possible range is between f_{min} and 1/10 of Samplerate.

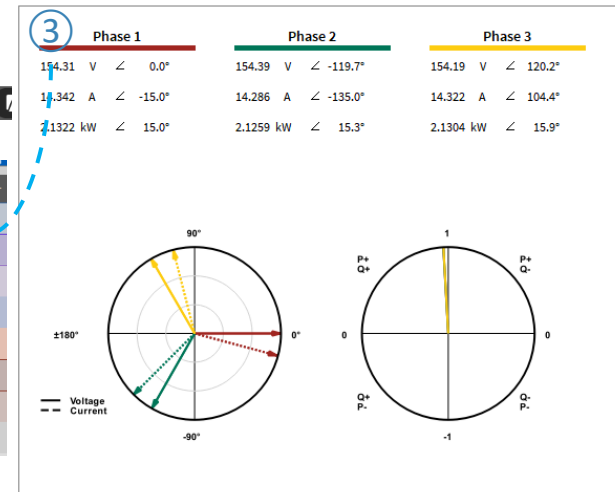
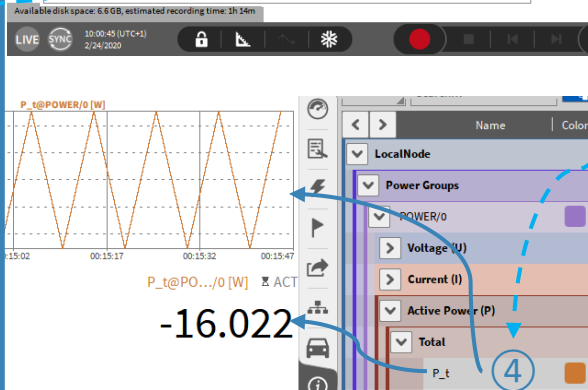
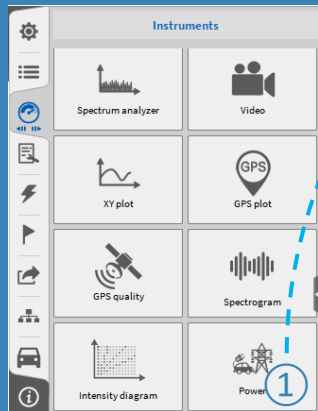
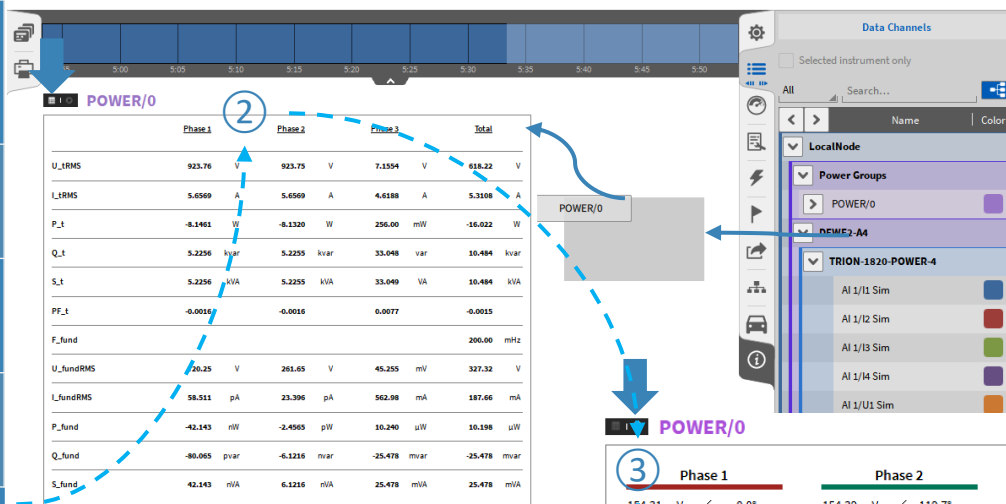




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DATA VISUALIZATION

- 1 Power instrument for general data overview
- 2 Drag and drop Power group to the instrument to get an RMS value overview
- 3 Or a vectoral visualisation of the voltages and currents
- 4 All Power channels can be added to others displays like Recorders or Meters





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HARMONICS

- ① Enable Harmonics calculation
- ② Select a harmonics grouping type
- ③ Specify the maximum harmonics order
1 ... 1000; Default: 50
- ④ Specify the maximum THD harmonics
order; 1 ... 1000; Default: 40
- ⑤ Optionally enable supra harmonics
- ⑥ Optionally enable calculation of Voltage
Line-Line Harmonics & THD

Active Power (P)

- Total
- Fundamental
- Harmonic

Reactive Power (Q)

- Total
- Fundamental
- Harmonic

Apparent Power (S)

- Total
- Fundamental
- Harmonic

OXY-OPT-POWER-ADV required

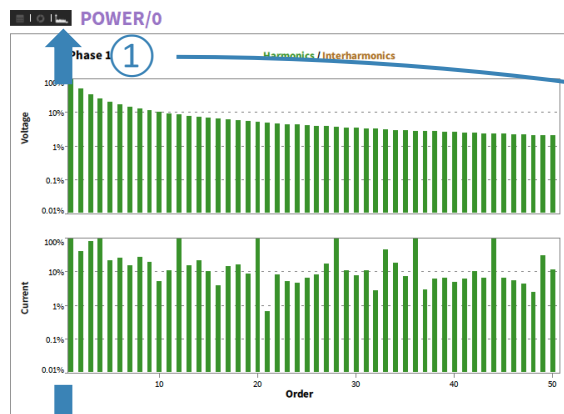
- > Harmonics from 0 to 1000th order
- > Interharmonics from 0.5 to 49th order
- > Higher Frequencies from 2 to 9 kHz
- > Supraharmonics from 8 to 150 kHz
- > Calculations comply with IEC 61000 4-7



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HARMONICS VISUALIZATION

- ① Additional window in the Power Instrument for Harmonics
- ② Higher frequencies can be enabled in instrument settings
- ③ Cursors can be enabled in instrument settings
- ④ Harmonics can be displayed phase-wise



Power

COLOR THEME

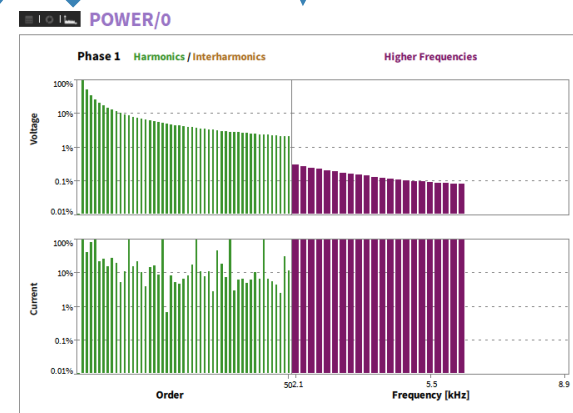
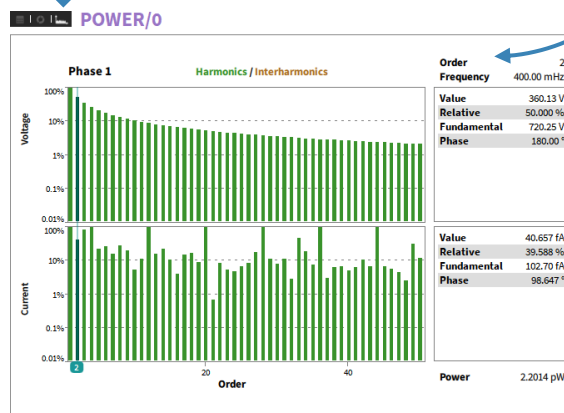
Default

HARMONICS

Show higher frequencies

Show cursor

Phase 1





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HARMONICS VISUALIZATION CONT'D

- ① Voltage Harmonics table included in Power Instrument
- ② Current Harmonics table included in Power Instrument
- ③ Power Harmonics table included in Power Instrument

POWER/O

Phase 1 (THD: 5.13%)				Phase 2 (THD: 11.07%)				Phase 3 (THD: 4.78%)				
Order	RMS	%	PHI	RMS	%	PHI	RMS	%	PHI	RMS	%	PHI
0	5.38V	5.85%	-180.00°	8.96V	11.01%	0.00°	3.58V	4.10%	-180.00°			

POWER/O

Phase 1 (THD: 24.46%)				Phase 2 (THD: 9.94%)				Phase 3 (THD: 7.70%)				
Order	RMS	%	PHI	RMS	%	PHI	RMS	%	PHI	RMS	%	PHI
0	108.29mA		0.00°	36.42mA	24.71%	-180.00°	52.56mA	33.53%	-180.00°			

POWER/O

Order	RMS	Phase 1		Phase 2		Phase 3	
		W	%	W	%	W	%
0	-582.31mW	-17.27%		-326.40mW	-4.21%	188.42mW	6.91%
1	3.37W	100.00%		7.75W	100.00%	2.73W	100.00%
2	-58.90mW	-1.75%		85.81mW	-1.11%	25.88mW	0.95%
3	-6.48mW	-0.19%		-3.69mW	-0.11%	923.06μW	0.03%
4	-400.30μW	-0.01%		397.29μW	0.01%	511.47μW	0.02%
5	-9.55μW	-0.00%		47.50μW	0.00%	394.33μW	0.01%
6	-31.62μW	-0.00%		177.74μW	0.00%	138.66μW	0.01%
7	25.86μW	0.00%		150.64μW	0.00%	7.77μW	0.00%
8	-70.94μW	-0.00%		-648.29μW	-0.01%	261.08μW	0.01%
9	-55.63μW	-0.00%		38.61μW	0.00%	120.66μW	0.00%
10	-2.78μW	-0.00%		-42.58μW	-0.00%	17.73μW	0.00%
11	-11.21μW	-0.00%		-48.97μW	-0.00%	-35.13μW	-0.00%
12	-9.11μW	-0.00%		26.08μW	0.00%	-159.09μW	-0.00%
13	18.35μW	0.00%		-44.58μW	-0.00%	15.16μW	0.00%
14	-690.84nW	-0.00%		-3.39μW	-0.00%	536.32nW	0.00%
15	-703.32nW	-0.00%		-8.74μW	-0.00%	-3.53μW	-0.00%
16	6.39μW	0.00%		16.11μW	0.00%	-5.62μW	-0.00%
17	750.32nW	-0.00%		-15.43μW	-0.00%	12.08μW	0.00%
18	3.56μW	0.00%		18.49μW	0.00%	7.46μW	0.00%
19	-88.75nW	-0.00%		17.85μW	0.00%	-4.87μW	-0.00%
20	-1.49μW	-0.00%		-8.53μW	-0.00%	1.55μW	0.00%
21	930.35nW	0.00%		6.19μW	0.00%	-687.86nW	-0.00%
22	-401.56nW	-0.00%		-3.96μW	-0.00%	-4.30μW	-0.00%
23	-1.14μW	-0.00%		3.87μW	0.00%	-2.17μW	-0.00%
24	4.48μW	0.00%		555.68nW	0.00%	-2.17μW	-0.00%
25	-328.03nW	-0.00%		-1.72μW	-0.00%	-1.18μW	-0.00%
26	-463.26nW	-0.00%		1.04μW	0.00%	144.55nW	0.00%
27	377.78nW	0.00%		-1.52μW	-0.00%	-286.50nW	-0.00%
28	93.35nW	0.00%		1.21μW	0.00%	772.65nW	0.00%
29	-57.01nW	-0.00%		1.76μW	0.00%	-965.00nW	-0.00%
30	281.23nW	0.00%		-531.62nW	-0.00%	-37.29nW	-0.00%
31	407.21nW	0.00%		1.39μW	0.00%	-154.77nW	-0.00%
32	24.33nW	0.00%		-706.72nW	-0.00%	822.62nW	0.00%
33	205.10nW	0.00%		282.37nW	0.00%	-553.94nW	-0.00%
34	850.72nW	0.00%		1.23μW	0.00%	461.18nW	0.00%
35	-16.06nW	-0.00%		-1.33μW	-0.00%	572.09nW	0.00%
36	49.92nW	0.00%		-319.41nW	-0.00%	-22.97nW	-0.00%
37	21.95nW	0.00%		-386.15nW	-0.00%	80.71nW	0.00%
38	400.42nW	0.00%		348.75nW	0.00%	-388.88nW	-0.00%
39	9.52nW	0.00%		-97.19nW	-0.00%	-260.65nW	-0.00%
40	63.96nW	0.00%		-832.32nW	-0.00%	-198.90nW	-0.00%
41	8.55nW	0.00%		-504.11nW	-0.00%	-231.80nW	-0.00%
42	84.41nW	0.00%		92.33nW	0.00%	-76.54nW	-0.00%
43	-18.61nW	-0.00%		-992.81nW	-0.00%	28.65nW	0.00%
44	39.27nW	0.00%		-38.92nW	-0.00%	34.88nW	0.00%
45	-60.30nW	-0.00%		-105.73nW	-0.00%	-230.99nW	-0.00%
46	71.00nW	0.00%		72.1μW	0.00%	130.96nW	0.00%



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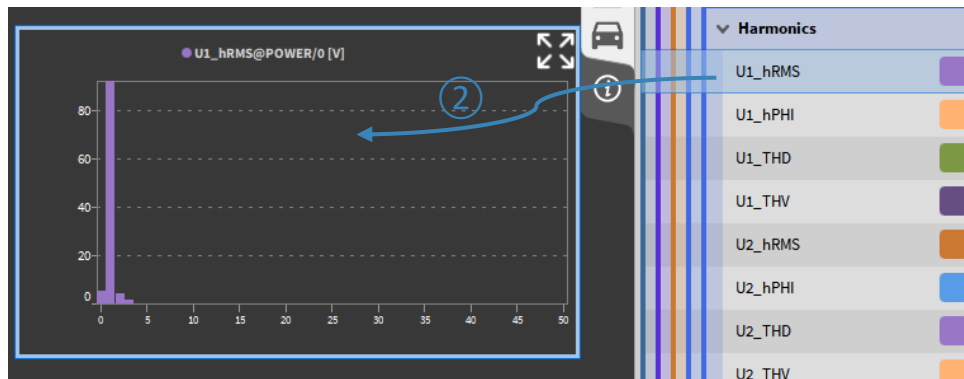
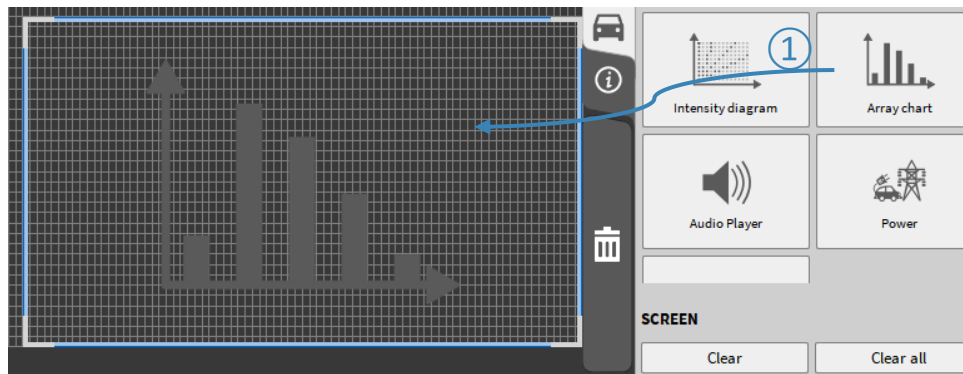
HARMONICS VISUALIZATION CONT'D

① Drag and drop the Array Chart to the screen...

② ...and assign any Harmonics channel

Supports:

- Harmonics
- Interharmonics
- Higher Frequency Groupings
- Supraharmonics





GROUPING MODE - NONE

ADVANCED SETTINGS

Harmonics Flicker

Harmonics / Interharmonics grouping

Grouping type:

None

Type 1 - IEC61000-4-7 5.6 (9)

Type 2 - IEC61000-4-7 5.5.1 (8)

Maximum harmonic order:

Maximum THD harmonic order:

Symbol	Description
Y_c	RMS Magnitude of FFT-Bin
Y_h	RMS Magnitude of Harmonic Order h (Grouping "None")
$Y_{sg,h}$	RMS Magnitude of Harmonic Order h (Grouping "Type 1")
$Y_{g,h}$	RMS Magnitude of Harmonic Order h (Grouping "Type 2")
NP	Number of fundamental Periods
h	Harmonic Order

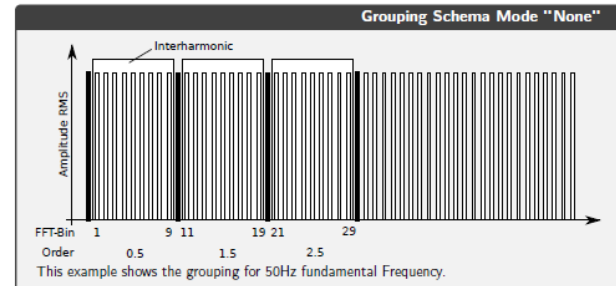
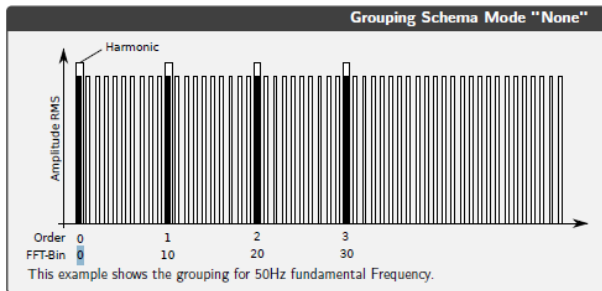
- > When this mode is selected, only the harmonic bins are taken for generation of the harmonic data. $Y_h = Y_c[NP \cdot h]$
- > When this mode is selected, all bins (except of harmonic bin) are taken for generation of the interharmonic data.

$$Y_{gh} = NaN$$

$$NP = 1$$

$$Y_{gh} = \sqrt{\sum_{k=1}^{N-1} Y_c[NP \cdot h + k]^2}$$

$$NP > 1$$





GROUPING MODE - TYPE 1 – IEC61000-4-7-5.6

ADVANCED SETTINGS

Harmonics Flicker Mechanical Rolling Computations

Harmonics / interharmonics grouping

Grouping type:

None

Type 1 - IEC61000-4-7 5.6 (9)

Type 2 - IEC61000-4-7 5.5.1 (8)

Maximum harmonic order: 50

Maximum THD harmonic order: 40

Symbol	Description
Y_c	RMS Magnitude of FFT-Bin
Y_h	RMS Magnitude of Harmonic Order h (Grouping "None")
$Y_{sg,h}$	RMS Magnitude of Harmonic Order h (Grouping "Type 1")
$Y_{g,h}$	RMS Magnitude of Harmonic Order h (Grouping "Type 2")
NP	Number of fundamental Periods
h	Harmonic Order

- > When this mode is selected, the harmonics are grouped according to IEC61000-4-7 Section 5.6

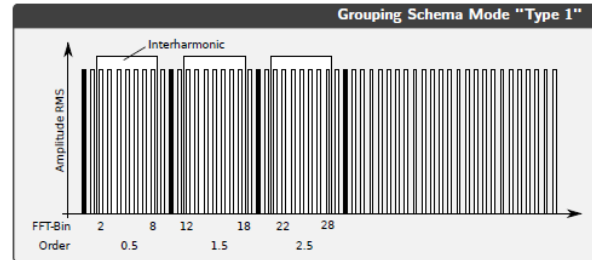
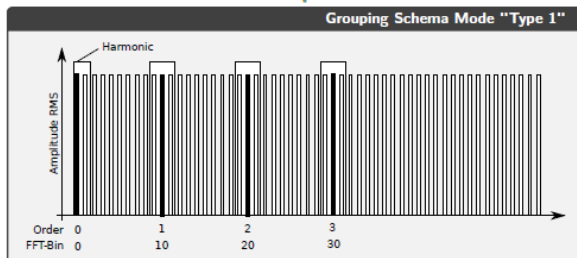
$$Y_{sg,h} = Y_c[NP \cdot h] \quad NP < 2$$

$$Y_{sg,h} = \sqrt{\sum_{k=1}^1 Y_c[NP \cdot h + k]^2} \quad NP \geq 2$$

- > When this mode is selected, the Interharmonics are grouped according to IEC61000-4-7 Section 5.6

$$Y_{isg,h} = NaN \quad NP \leq 2$$

$$Y_{isg,h} = \sqrt{\sum_{k=2}^{N-2} Y_c[NP \cdot h + k]^2} \quad NP > 2$$





GROUPING MODE - TYPE 2 – IEC61000-4-7-5.5.1

ADVANCED SETTINGS

Harmonics Flicker Mechanical Rolling Computations

Harmonics / interharmonics grouping

Grouping type:

None

Type 1 - IEC61000-4-7 5.6 (9)

Type 2 - IEC61000-4-7 5.5.1 (8)

Maximum harmonic order:

Maximum THD harmonic order:

Symbol	Description
Y_c	RMS Magnitude of FFT-Bin
Y_h	RMS Magnitude of Harmonic Order h (Grouping "None")
$Y_{sg,h}$	RMS Magnitude of Harmonic Order h (Grouping "Type 1")
$Y_{g,h}$	RMS Magnitude of Harmonic Order h (Grouping "Type 2")
NP	Number of fundamental Periods
h	Harmonic Order

- > When this mode is selected, the harmonics are grouped according to IEC61000-4-7 Section 5.5.1

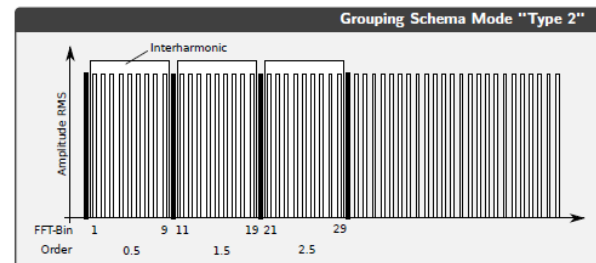
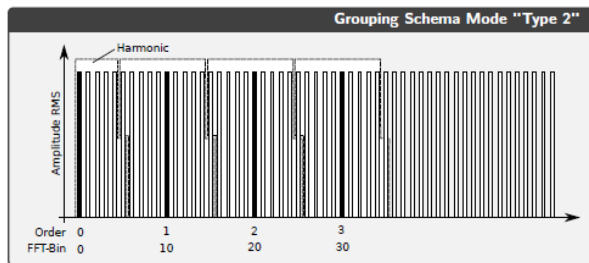
$$Y_{g,h} = Y_c[NP \cdot h] \quad NP < 2 \quad (7.4)$$

$$Y_{g,h} = \sqrt{\frac{1}{2}Y_c \left[NP \cdot h - \frac{N}{2} \right]^2 + \sum_{k=-\frac{N}{2}+1}^{\frac{N}{2}-1} Y_c [NP \cdot h + k]^2 + \frac{1}{2}Y_c \left[NP \cdot h + \frac{N}{2} \right]^2} \quad NP \geq 2 \quad (7.5)$$

- > When this mode is selected, all bins (except of harmonic bin) are taken for generation of the interharmonic data.

$$Y_{i,g,h} = NaN \quad NP = 1$$

$$Y_{i,g,h} = \sqrt{\sum_{k=1}^{N-1} Y_c [NP \cdot h + k]^2} \quad NP > 1$$





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HARMONICS/INTERHARMONICS - OUTPUT CHANNELS

Active Power (P)

- Total
- Fundamental
- Harmonic
 - P1_h Power
 - P1_THP Power
 - P2_h Power
 - P2_THP Power
 - P3_h Power
 - P3_THP Power

Reactive Power (Q)

- Total
- Fundamental
- Harmonic
 - Q1_h Power
 - Q2_h Power
 - Q3_h Power

Apparent Power (S)

- Total
- Fundamental
- Harmonic
 - S1_h Power
 - S2_h Power
 - S3_h Power

Voltage (U)

- Total RMS
- Fundamental
- Average / PP
- Symmetrical Components
- Harmonics
 - U1_hRMS Power
 - U1_hPHI Power
 - U1_THD Power
 - U1_THV Power
 - U2_hRMS Power
 - U2_hPHI Power
 - U2_THD Power
 - U2_THV Power
 - U3_hRMS Power
 - U3_hPHI Power
 - U3_THD Power
 - U3_THV Power
- Interharmonics
 - U1_ihRMS Power
 - U2_ihRMS Power
 - U3_ihRMS Power

Current (I)

- Total RMS
- Fundamental
- Average / PP
- Symmetrical Components
- Harmonics
 - I1_hRMS Power
 - I1_hPHI Power
 - I1_THD Power
 - I1_THC Power
 - I2_hRMS Power
 - I2_hPHI Power
 - I2_THD Power
 - I2_THC Power
 - I3_hRMS Power
 - I3_hPHI Power
 - I3_THD Power
 - I3_THC Power
- Interharmonics
 - I1_ihRMS Power
 - I2_ihRMS Power
 - I3_ihRMS Power

POWER/0

- Voltage (U)
 - Total RMS
 - Fundamental
 - Average / PP
 - Symmetrical Components
 - Harmonics
 - U1_hRMS U1_hRMS
 - U1_hPHI U1_hPHI
 - U1_THD U1_THD
 - U1_THV U1_THV
 - U2_hRMS U2_hRMS
 - U2_hPHI U2_hPHI
 - U2_THD U2_THD
 - U2_THV U2_THV
 - U3_hRMS U3_hRMS
 - U3_hPHI U3_hPHI
 - U3_THD U3_THD
 - U3_THV U3_THV
 - U12_hRMS U12_hRMS
 - U12_THD U12_THD
 - U23_hRMS U23_hRMS
 - U23_THD U23_THD
 - U31_hRMS U31_hRMS
 - U31_THD U31_THD

Voltage Line-Line Harmonics & THD

U12_hRMS
U12_THD
U23_hRMS
U23_THD
U31_hRMS
U31_THD



HIGHER FREQUENCY GROUPING

- > The Higher Frequency Grouping is orientated on fixed frequency bands (see IEC/EN61000-4-7 Appendix B)

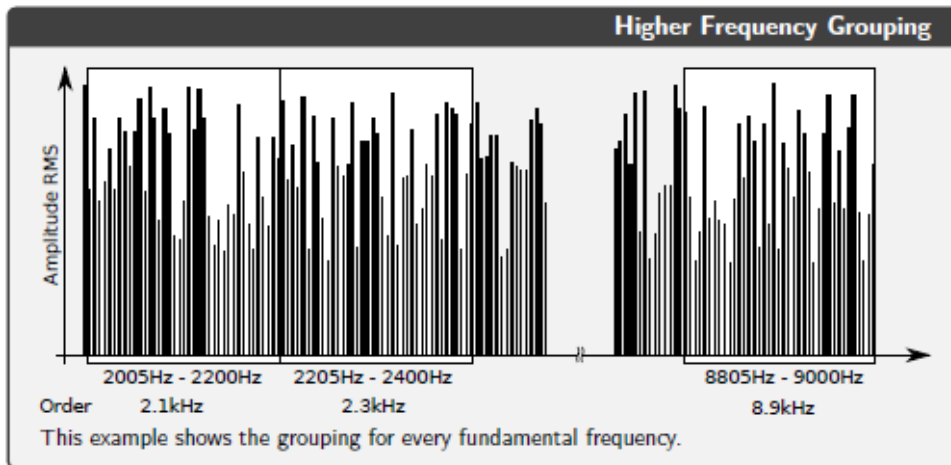
$$Y_{B,b} = \sqrt{\sum_{f=b-95\text{Hz}}^{b+100\text{Hz}} Y_{C,f}^2}$$

Voltage (U)

- Total RMS
- Fundamental
- Average / PP
- Symmetrical Components
- Harmonics
- Interharmonics
- Higher Frequency Grouping**
 - U1_hfRMS Power
 - U2_hfRMS Power
 - U3_hfRMS Power

Current (I)

- Total RMS
- Fundamental
- Average / PP
- Symmetrical Components
- Harmonics
- Interharmonics
- Higher Frequency Grouping**
 - I1_hfRMS Power
 - I2_hfRMS Power
 - I3_hfRMS Power



Symbol	Description
$Y_{C,f}$	RMS Magnitude of FFT-Bin
$Y_{B,b}$	RMS Magnitude of Higher Frequency Order b



SUPRAHARMONICS

- > Unlike the other grouping methods, the Supraharmonics are aggregated in time
- > Minimum Sample rate = 1 MHz

ADVANCED SETTINGS

Harmonics Flicker Mechanical Rolling Computations

Harmonics / interharmonics grouping

Grouping type:

None

Type 1 - IEC61000-4-7 5.6 (9)

Type 2 - IEC61000-4-7 5.5.1 (8)

Maximum harmonic order: 50

Maximum THD harmonic order: 40

Enable supra harmonics

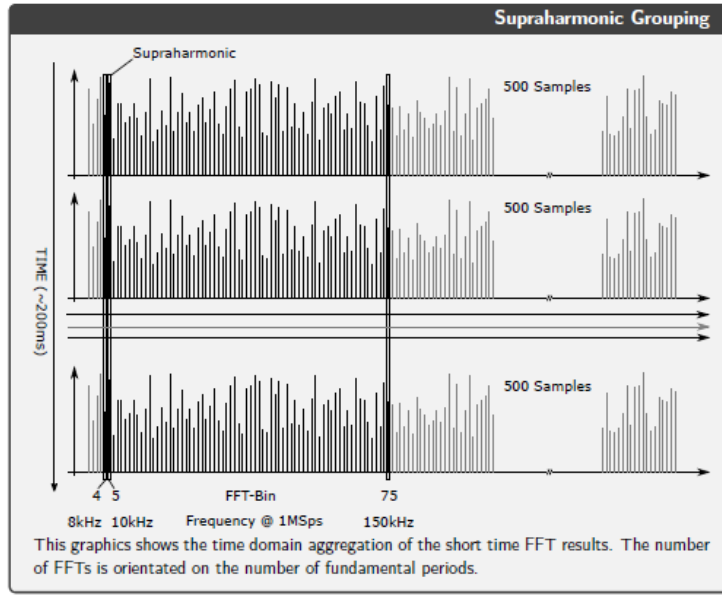
Symbol	Description
$Y_{C,b}$	RMS Magnitude of FFT-Bin b
$Y_{SH,i,min}$	Minimum RMS Magnitude of Supraharmonics order i
$Y_{SH,i,avg}$	Average RMS Magnitude of Supraharmonics order i
$Y_{SH,i,max}$	Maximum RMS Magnitude of Supraharmonics order i
NP	Number of fundamental periods (10 @ 50Hz, 12 @ 60Hz)
N_{FFT}	Number of Short Time FFTs in time interval of NP
SR	Samplerate

$$N_{FFT} = \frac{NP \cdot SR}{500}$$

$$Y_{SH,b,min} = \min(Y_{C,b})$$

$$Y_{SH,b,avg} = \text{avg}(Y_{C,b})$$

$$Y_{SH,b,max} = \max(Y_{C,b})$$



Voltage (U)

- Total RMS
- Fundamental
- Average / PP
- Symmetrical Co
- Harmonics
- Interharmonics
- Supraharmonics**
 - U1_shMIN Power
 - U1_shMAX Power
 - U1_shAVG Power
 - U2_shMIN Power
 - U2_shMAX Power
 - U2_shAVG Power
 - U3_shMIN Power
 - U3_shMAX Power
 - U3_shAVG Power

Current (I)

- Total RMS
- Fundamental
- Average / PP
- Symmetrical Components
- Harmonics
- Interharmonics
- Supraharmonics**
 - I1_shMIN Power
 - I1_shMAX Power
 - I1_shAVG Power
 - I2_shMIN Power
 - I2_shMAX Power
 - I2_shAVG Power
 - I3_shMIN Power
 - I3_shMAX Power
 - I3_shAVG Power

VOLTAGE FLUCTUATION AND FLICKER EMISSION

ADVANCED SETTINGS

① **Harmonics** **Flicker** Mechanical d/q Rolling

Flicker analysis according to IEC61000-4-15:2011

Weighting type: ②

Autodetection

230V / 50Hz 230V / 60Hz

120V / 50Hz 120V / 60Hz

Nominal voltage: ③ 120 min

Aggregation time of Pst: ③ 10 min

Aggregation time of Plt: 120 min

Short-circuit apparent power: ④ 50 MVA

Sign convention: Active (inverted current channels)

Grid impedance angles: 30;50;70;85 °

d-Parameter evaluation

Steady state threshold: 0.2 %

Steady state window length: 1 s

Steady state detection level: 3.3 %

Working conditions for voltage fluctuation:

Fundamental Frequency	10 to 1000 Hz
Nominal Voltage	> 5% of Input Range
Weighting Functions	120V/50Hz, 120V/60Hz, 230V/50Hz, 230V/60Hz
Aggregation Time Pst	1 to 60 min
Aggregation Time Plt	1 to 1440 min
Short Circuit Apparent Power	0.001 to 10 000 MVA

Measurement parameters according to IEC61000-4-15 and IEC61400-21 Section 7.3.

Flicker Analysis procedure

- > Switch on the Feature ①
- > Select the Weighting Type ② for your Application. Use Autodetection in low voltage grids (120V/230V). If you want to use the Voltage Fluctuation Algorithm outside these Conditions, please select the weighting type manually and insert the nominal voltage in ③
- > Change the Aggregation Time of Pst and Plt if needed ④
- > Go back to Measurement Screen, take an indicator instrument and assign the U[i]_fluc_ready Channel
- > Take a Table Instrument and assign the U[i]_fluc_Pst Channels or any other Instrument to visualize the Voltage Fluctuation Values
- > Wait for Channel Ready
- > Start the Recording

VOLTAGE FLUCTUATION AND FLICKER EMISSION



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Voltage (U)

- ▶ Total RMS
- ▶ Fundamental
- ▶ Average / PP
- ▶ Symmetrical Components
- ▶ Harmonics
- ▶ Interharmonics
- ▶ Higher Frequency Grouping
- Flicker**
- U1_fluc_ready
- U1_fluc_Pinst
- U1_fluc_Pst
- U1_fluc_PIt
- U1_fluc_dc
- U1_fluc_d_max
- U1_fluc_td
- U2_fluc_ready
- U2_fluc_Pinst
- U2_fluc_Pst
- U2_fluc_PIt
- U2_fluc_dc
- U2_fluc_d_max
- U2_fluc_td
- U3_fluc_ready
- U3_fluc_Pinst
- U3_fluc_Pst
- U3_fluc_PIt
- U3_fluc_dc
- U3_fluc_d_max
- U3_fluc_td

Current (I)

- ▶ Total RMS
- ▶ Fundamental
- ▶ Average / PP
- ▶ Symmetrical Components
- ▶ Harmonics
- ▶ Interharmonics
- ▶ Higher Frequency Grouping
- Flicker**
- I1_fluc_ready
- I1_fluc_Pinst_30
- I1_fluc_Pst_30
- I1_fluc_PIt_30
- I1_fluc_Pinst_50
- I1_fluc_Pst_50
- I1_fluc_PIt_50
- I1_fluc_Pinst_70
- I1_fluc_Pst_70
- I1_fluc_PIt_70
- I1_fluc_Pinst_85
- I1_fluc_Pst_85
- I1_fluc_PIt_85
- I2_fluc_ready
- I2_fluc_Pinst_30
- I2_fluc_Pst_30
- I2_fluc_PIt_30
- I2_fluc_Pinst_50
- I2_fluc_Pst_50
- I2_fluc_PIt_50
- I2_fluc_Pinst_70
- I2_fluc_Pst_70
- I2_fluc_PIt_70
- I2_fluc_Pinst_85
- I2_fluc_Pst_85
- I2_fluc_PIt_85
- I3_fluc_ready
- I3_fluc_Pinst_30
- I3_fluc_Pst_30
- I3_fluc_PIt_30
- I3_fluc_Pinst_50
- I3_fluc_Pst_50
- I3_fluc_PIt_50
- I3_fluc_Pinst_70
- I3_fluc_Pst_70
- I3_fluc_PIt_70
- I3_fluc_Pinst_85
- I3_fluc_Pst_85
- I3_fluc_PIt_85

Output Channels:

9.5.1 $U[i]_{fluc_Pst}$

The short-term flicker severity

9.5.2 $U[i]_{fluc_PIt}$

The long-term flicker severity

$$U[i]_{fluc_PIt} = \sqrt[3]{\frac{1}{N} \sum_{k=0}^{N-1} U[i]_{fluc_Pst}[k]^3} \quad \text{Unit : A} \quad (9.7)$$

Parameters according to

IEC61000-4-15 and
IEC61400-21 Section 7.3.

9.5.3 $U[i]_{fluc_Pinst}$

The instantaneous flicker sensation

9.5.4 $U[i]_{fluc_ready}$

Indicator value for steady state of algorithm filters

9.5.5 $I[i]_{fluc_Pst}[\psi]$

The short-term flicker emission severity according to IEC61400-21 Section. $\psi \in [30^\circ, 50^\circ, 70^\circ, 85^\circ]$

9.5.6 $I[i]_{fluc_PIt}[\psi]$

The long-term flicker emission severity. $\psi \in [30^\circ, 50^\circ, 70^\circ, 85^\circ]$

9.5.7 $I[i]_{fluc_Pinst}[\psi]$

The instantaneous flicker emission sensation. $\psi \in [30^\circ, 50^\circ, 70^\circ, 85^\circ]$

9.5.8 $U[i]_{fluc_dc}$

Steady state voltage change

9.5.9 $U[i]_{fluc_dmax}$

Maximum voltage change during a voltage change characteristic

9.5.10 $U[i]_{fluc_td}$

Duration of Voltage change below 3.3%.



FLICKER EMISSION – THEORETICAL BACKGROUND

Sign convention:

Grid impedance angles:

d-Parameter evaluation

Steady state threshold: %

Steady state window length: s

Steady state detection level: %

- Short Term Voltage fluctuations evaluate the voltage change characteristics according to IEC61000-4-15. For this analysis, the half-period rms values from the voltage channels are calculated internally.
- Explanation of the evaluation of the d-Parameter

Symbol	Description
$S_{K, fic}$	This is the short circuit power of the fictitious grid. To be given for one phase in MVA!
U_N	Nominal Voltage (U_{L-N}) of the analyzed grid.
ψ_K	Phase Angle of the Grid Impedance (pre-defined with 30/50/70/85 deg)
R_{fic}	Fictitious Ohmic impedance
X_{fic}	Fictitious Reactive impedance
f_N	Nominal Frequency (50 or 60 Hz, depending on the selected Weighting)

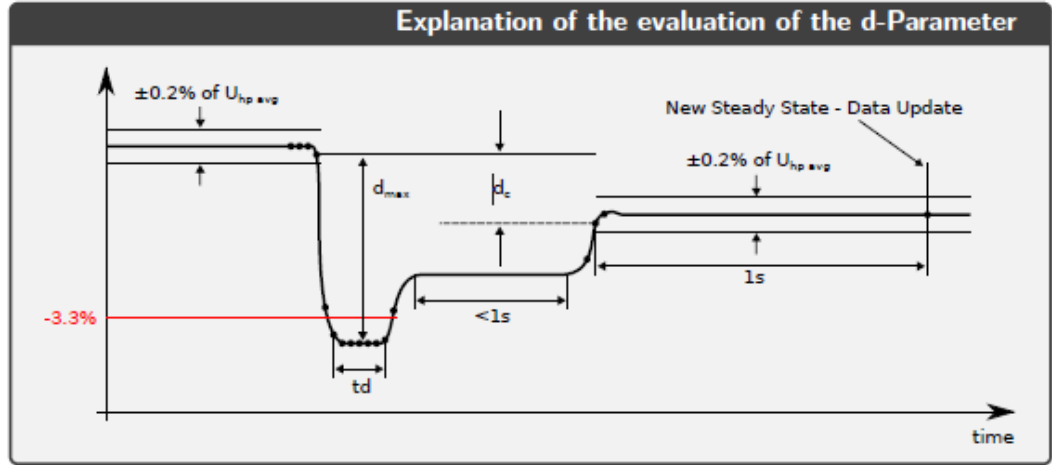
$$S_{K, fic} = \frac{U_N^2}{\sqrt{R_{fic}^2 + X_{fic}^2}} \quad \text{Unit : VA}$$

$$Z_{fic} = \sqrt{R_{fic}^2 + X_{fic}^2} = \frac{U_N^2}{S_{K, fic}} \quad \text{Unit : } \Omega$$

$$R_{fic} = Z_{fic} \cdot \cos(\psi_K) \quad \text{Unit : } \Omega$$

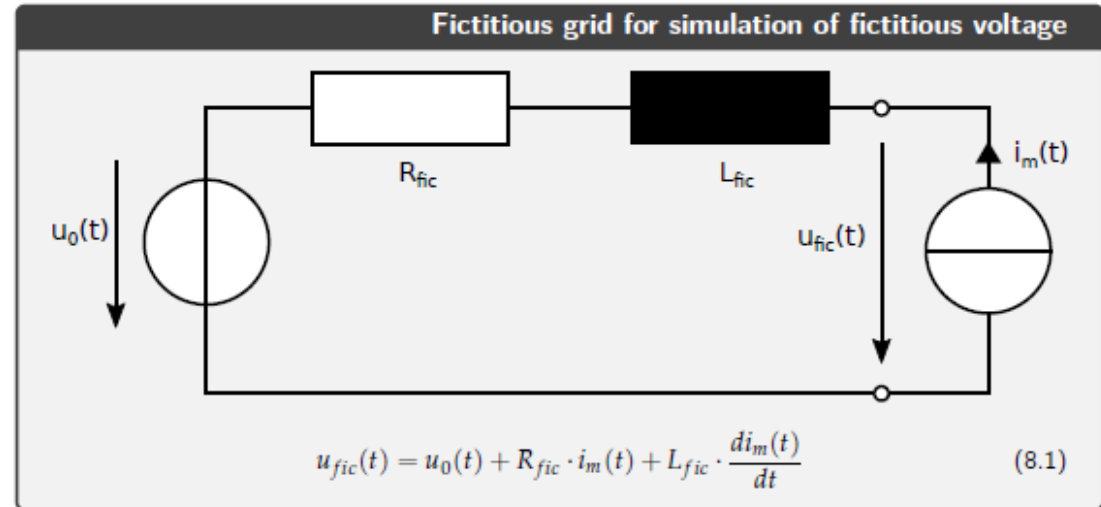
$$X_{fic} = Z_{fic} \cdot \sin(\psi_K) \quad \text{Unit : } \Omega$$

$$L_{fic} = \frac{X_{fic}}{2 \cdot \pi \cdot f_N} \quad \text{Unit : H}$$



- d-Parameters can be modified since Oxygen 6.6

- > Flicker Emission is the Analysis of the virtually generated voltage fluctuation caused by the emitted current. This analysis procedure is described in the IEC61400-21 Standard. It uses a fictitious grid for simulation of a fictitious voltage, which is then processed with the flicker algorithm to get the Pst, fic.





FLICKER ANALYSIS – AUTO DETECTION & AGGREGATION TIME

ADVANCED SETTINGS

Harmonics **Flicker**

Flicker analysis according to IEC61000-4-15:2011

Weighting type:

Autodetection

230V / 50Hz 230V / 60Hz

120V / 50Hz 120V / 60Hz

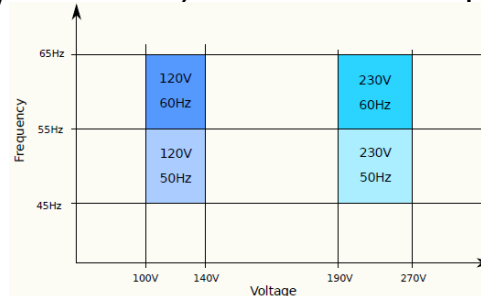
Nominal voltage: V

Aggregation time of Pst: min

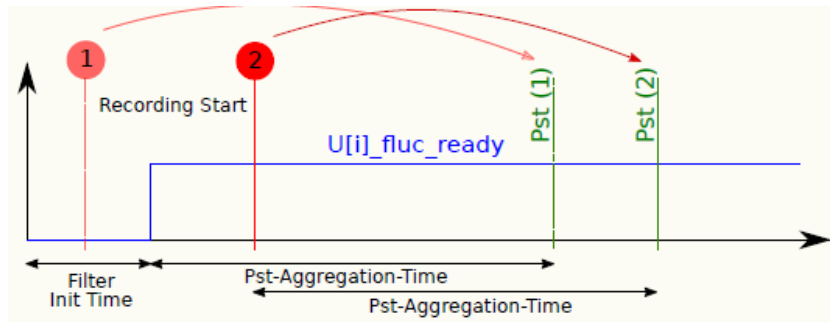
Aggregation time of Plt: min

Short-circuit apparent power: MVA

➤ The Auto-Detection Mode is useful for the most applications. In the following graph you can see, which Mode is applied under different circumstances.



➤ Pst/Plt Aggregation Time: If the Recording is started before ready (1), the aggregation is started when ready. When recording is started while ready (2), the aggregation will be started with the recording start..





ROLLING COMPUTATIONS - GENERAL

ADVANCED SETTINGS

Harmonics Flicker Mechanical d/q **Rolling** ←

Enable rolling period calculation

Nominal frequency: 50 Hz

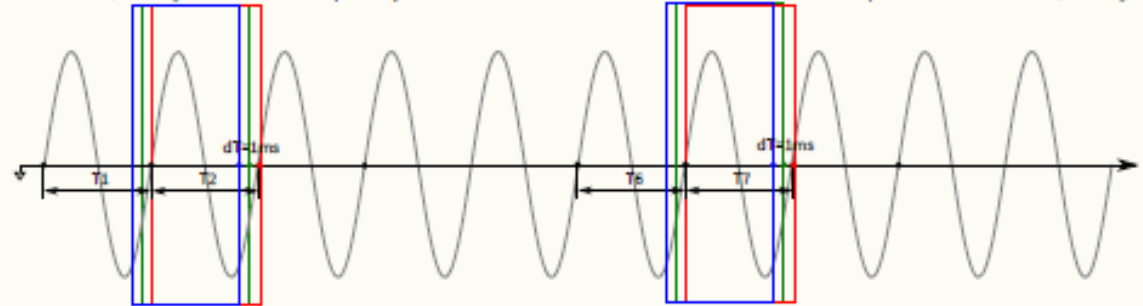
Nominal frequency threshold: 10 %

Update rate: 1 ms

Window length: 1 cycles

- ① Enable/Disable Rolling Calculation
- ② Selector for nominal frequency fallback
- ③ Input field for frequency threshold. If a frequency is detected within the nominal frequency threshold %, the rolling window size is the actual period duration. Otherwise, e.g. in the case of a voltage interruption, where no frequency can be measured, the window size is the inverse nominal frequency.

The following graph shows the details of the operation principle. It is similar to a moving average calculation, but with a variable window size, which depends on the actual measured fundamental frequency. If the calculate window size exceeds the maximum allowed size, which is given by $(1/\text{Nominal Frequency}) * (1 + \text{Frequency Threshold}/100)$, the window size is set to $1/\text{Nominal Frequency}$.



Usecase: Testing of Renewable Energy Sources according to IEC 61400-21 and FGW-TR3 where some tests require the analysis of fast transitions

ROLLING COMPUTATIONS – OUTPUT CHANNELS



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Voltage (U)

Total RMS

- U_tRMS Power
- U1_tRMS Power
- U2_tRMS Power
- U3_tRMS Power
- U12_tRMS Power
- U23_tRMS Power
- U31_tRMS Power
- U1_tRMS_rc Power
- U2_tRMS_rc Power
- U3_tRMS_rc Power
- U12_tRMS_rc Power
- U23_tRMS_rc Power
- U31_tRMS_rc Power

Fundamental

Average / PP

Symmetrical Components

- U_fundUNBAL+ Power
- U_fundUNBAL- Power
- U_fundUNBAL0 Power
- U_fundRMS_SYM+ Power
- U_fundRMS_SYM- Power
- U_fundRMS_SYM0 Power
- U_fundRMS_SYM+ Power
- U_fundRMS_SYM- Power
- U_fundRMS_SYM0 Power
- U_fundRMS_SYM+ Power
- U_fundRMS_SYM- Power
- U_fundRMS_SYM0 Power
- U_fund_SYM+_rc Power
- U_fund_SYM-_rc Power
- U_fund_SYM0_rc Power
- U1_fund_cos_rc Power
- U1_fund_sin_rc Power
- U2_fund_cos_rc Power
- U2_fund_sin_rc Power
- U3_fund_cos_rc Power
- U3_fund_sin_rc Power

Current (I)

Total RMS

- I_tRMS Power
- I1_tRMS Power
- I2_tRMS Power
- I3_tRMS Power
- I1_tRMS_rc Power
- I2_tRMS_rc Power
- I3_tRMS_rc Power

Fundamental

Average / PP

Symmetrical Components

- I_fundUNBAL+ Power
- I_fundUNBAL- Power
- I_fundUNBAL0 Power
- I_fundRMS_SYM+ Power
- I_fundRMS_SYM- Power
- I_fundRMS_SYM0 Power
- I_fundRMS_SYM+ Power
- I_fundRMS_SYM- Power
- I_fundRMS_SYM0 Power
- I_fund_P_SYM+_rc Power
- I_fund_P_SYM-_rc Power
- I_fund_P_SYM0_rc Power
- I_fund_Q_SYM+_rc Power
- I_fund_Q_SYM-_rc Power
- I_fund_Q_SYM0_rc Power
- I1_fund_cos_rc Power
- I1_fund_sin_rc Power
- I2_fund_cos_rc Power
- I2_fund_sin_rc Power
- I3_fund_cos_rc Power
- I3_fund_sin_rc Power

Active Power (P)

Total

- P_t Power
- P1_t Power
- P2_t Power
- P3_t Power
- P_t_rc Power
- P1_t_rc Power
- P2_t_rc Power
- P3_t_rc Power

Fundamental

- P_fund Power
- P1_fund Power
- P1_fundPHI Power
- P2_fund Power
- P2_fundPHI Power
- P3_fund Power
- P3_fundPHI Power
- P_fund_rc Power
- P1_fund_rc Power
- P2_fund_rc Power
- P3_fund_rc Power

Symmetrical Components

- P_fund_SYM+_rc Power
- P_fund_SYM-_rc Power
- P_fund_SYM0_rc Power

Reactive Power (Q)

Total

- Q_t Power
- Q1_t Power
- Q2_t Power
- Q3_t Power
- Q_t_rc Power
- Q1_t_rc Power
- Q2_t_rc Power
- Q3_t_rc Power

Fundamental

- Q_fund Power
- Q1_fund Power
- Q2_fund Power
- Q3_fund Power
- Q_fund_rc Power
- Q1_fund_rc Power
- Q2_fund_rc Power
- Q3_fund_rc Power

Symmetrical Components

- Q_fund_SYM+_rc Power
- Q_fund_SYM-_rc Power
- Q_fund_SYM0_rc Power

Apparent Power (S)

Total

- S_t Power
- S1_t Power
- S2_t Power
- S3_t Power
- S_t_rc Power
- S1_t_rc Power
- S2_t_rc Power
- S3_t_rc Power

Fundamental

- S_fund Power
- S1_fund Power
- S2_fund Power
- S3_fund Power
- S_fund_rc Power
- S1_fund_rc Power
- S2_fund_rc Power
- S3_fund_rc Power

Power Factor (PF)

Total

Fundamental

Symmetrical Components

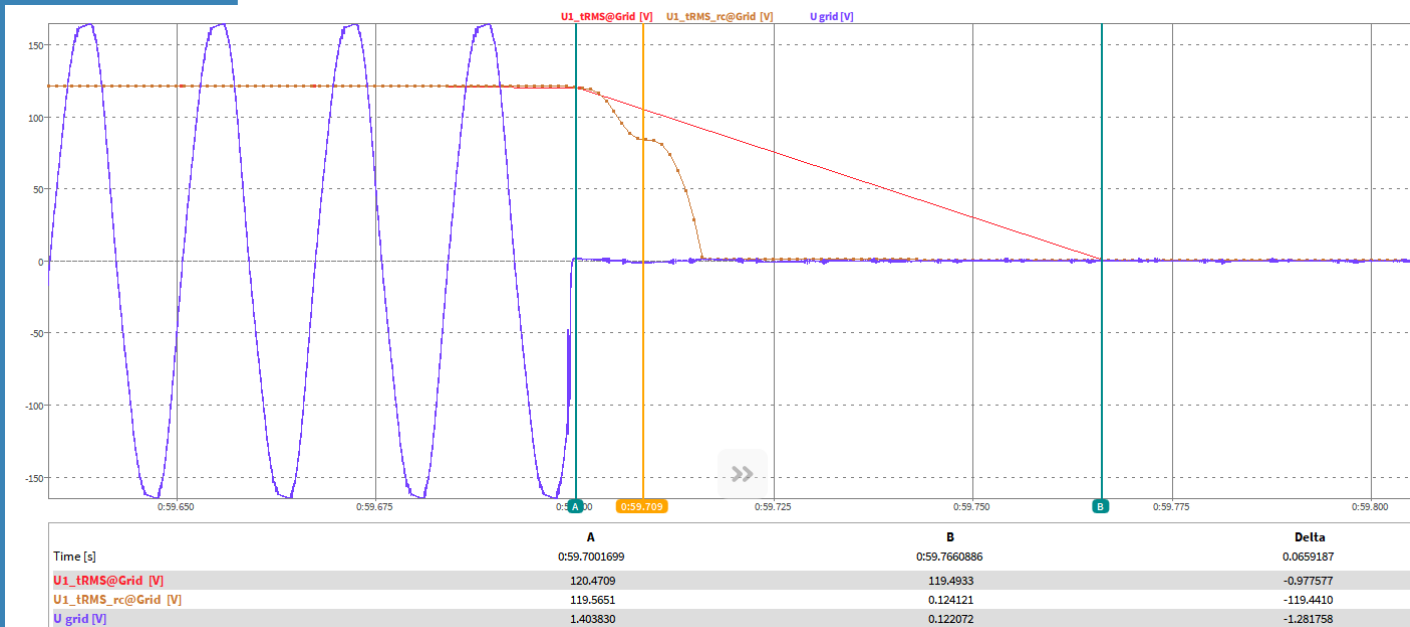
- PF_fund_SYM+_rc Power
- PF_fund_SYM-_rc Power
- PF_fund_SYM0_rc Power

ROLLING COMPUTATIONS – EXAMPLE 60 HZ GRID



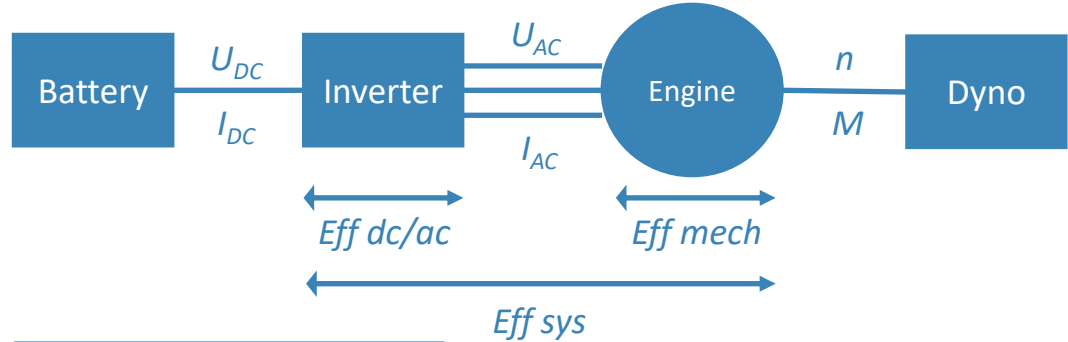
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- > Whenever the voltage drops the frequency cannot be detected anymore and the calculation interval switches to a fixed time. The last calculated value (U1_tRMS in figures) can be seen at marker A and the next calculated value of the fixed time at marker B. Therefore, there is no information available during the drop, neither are correct values. For the rolling computations (with extension _rc) it can be seen though, that the calculation goes on and we still get values every 1 ms.





MECHANICAL POWER COMPUTATION + DC-POWER

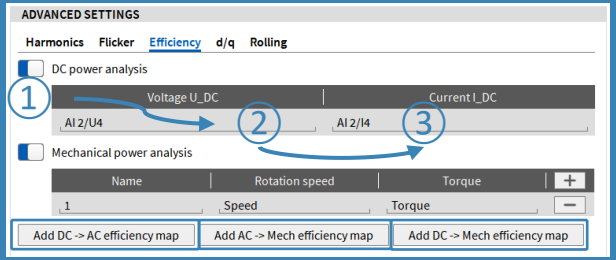


Efficiency		
Eff_dc_ac	■	⚙️
Eff_dc_ac		
I_DC	■	⚙️
I_DC		
U_DC	■	⚙️
U_DC		
P_DC	■	⚙️
P_DC		
Eff_mech	■	⚙️
Eff_mech		
Eff_sys	■	⚙️
Eff_sys		

3 different Efficiency maps can be created

- U_{DC} vs I_{DC} vs Eff_{dc_ac}
- n_{mech} vs M_{mech} vs Eff_{mech}
- U_{DC} vs I_{DC} vs Eff_{sys}

- > Channels are updated every calculation cycle given by calculation sync source (same as electrical power).
- > This way, DC-POWER and AC-POWER are synchronised



- 1 Enable/Disable DC power calculation
- 2 Add Voltage U_{DC}
- 3 Add Current I_{DC}

The **Efficiency** Tab includes DC Power Analysis and Mechanical Power Analysis

OXY-OPT-POWER-ADV required



MECHANICAL POWER COMPUTATION + DC-POWER

ADVANCED SETTINGS

Harmonics Flicker **Efficiency** d/q Rolling

DC power analysis

Voltage U_DC | Current I_DC

Drop channel here | Drop channel here

Mechanical power analysis

Name	Rotation speed	Torque	
1	Speed	Torque	-

Add AC -> Mech efficiency map

Mechanical

- P_mech_1
- n_mech_1
- M_mech_1
- P_mech_2
- n_mech_2
- M_mech_2

Efficiency

- Eff_dc_ac
- I_DC
- U_DC
- P_DC
- Eff_mech
- Eff_sys

$$P_{mech} = \frac{1}{N} \sum_{n=0}^N speed[n] \cdot torque[n] \cdot \frac{2 \cdot \pi}{60}$$

$$n_{mech} = \frac{1}{N} \sum_{n=0}^N speed[n]$$

$$M_{mech} = \frac{1}{N} \sum_{n=0}^N torque[n]$$

$$Eff_{mech} = \begin{cases} \frac{P_i}{P_{mech}} \cdot 100 & \text{if } P_{mech} < 0 \\ \frac{P_{mech}}{P_i} \cdot 100 & \text{if } P_{mech} \geq 0 \end{cases}$$

- ① Enable/Disable mechanical power calculation
- ② Add mechanical "phase"
- ③ Input field for rotation speed channel (unit must be rpm)
- ④ Input field for torque channel (unit must be Nm)

- > Channels are updated every calculation cycle given by calculation sync source (same as electrical power).
- > Up to 6 Mechanical Pairs (n & M) can be added.
- > Each Mechanical Power P_mech_x is added up to P_mech for Efficiency Calculation

OXY-OPT-POWER-ADV required

ADVANCED SETTINGS

Harmonics Flicker Mechanical **d/q** Rolling

D/Q Analysis **1**

Mechanical angle: **2**

Number of poles-pairs: **3**

Angle offset: **4** ° Detect

Output samplerate: **5** Hz

POWER/0

PowerGroup

- > Voltage (U)
- > Current (I)
- > Active Power (P)
- > Reactive Power (Q)
- > Apparent Power (S)
- > Power Factor (PF)
- > Energy (W)
- ▼ **Mechanical Power**
 - Ud ⚙
 - Uq ⚙
 - Id ⚙
 - Iq ⚙

- 1 Enable dQ analysis feature
- 2 Assign the angle channel
- 3 Enter th number of pole-pairs according to your engine
- 4 Drive the DUT with an auxikiary engine at constant speed and press the *Detect* button to measure the angle offset or enter it manually
- 5 Define the output rate of the output channels

OXY-OPT-POWER-ADV required

d-Axis Voltage, reduced with block-wise average to given output samplerate.

$$U_d^* = \frac{2}{3} \cdot \left(U_{1N} \cdot \cos(\theta) + U_{2N} \cdot \cos(\theta - \frac{2\pi}{3}) + U_{3N} \cdot \cos(\theta + \frac{2\pi}{3}) \right)$$

$$U_d = \frac{red_SR}{SR} \cdot \sum_{i=0}^{\frac{SR}{red_SR}} U_d^*$$

Unit : V

q-Axis Voltage, reduced with block-wise average to given output samplerate.

$$U_q^* = \frac{2}{3} \cdot \left(-U_{1N} \cdot \sin(\theta) - U_{2N} \cdot \sin(\theta - \frac{2\pi}{3}) - U_{3N} \cdot \sin(\theta + \frac{2\pi}{3}) \right)$$

$$U_q = \frac{red_SR}{SR} \cdot \sum_{i=0}^{\frac{SR}{red_SR}} U_q^*$$

d-Axis Current, reduced with block-wise average to given output samplerate.

$$I_d^* = \frac{2}{3} \cdot \left(I_1 \cdot \cos(\theta) + I_2 \cdot \cos(\theta - \frac{2\pi}{3}) + I_3 \cdot \cos(\theta + \frac{2\pi}{3}) \right)$$

$$I_d = \frac{red_SR}{SR} \cdot \sum_{i=0}^{\frac{SR}{red_SR}} I_d^*$$

q-Axis Current, reduced with block-wise average to given output samplerate.

$$I_q^* = \frac{2}{3} \cdot \left(-I_1 \cdot \sin(\theta) - I_2 \cdot \sin(\theta - \frac{2\pi}{3}) - I_3 \cdot \sin(\theta + \frac{2\pi}{3}) \right)$$

$$I_q = \frac{red_SR}{SR} \cdot \sum_{i=0}^{\frac{SR}{red_SR}} I_q^*$$



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DELAY COMPENSATION – TRION-POWER- CURRENT INPUT

AMPLIFIER OPTIONS

Mode: Voltage

Range: 10 V

LP filter: Auto

8 Butterworth

Delay compensation: 0 **1** nsec

Effective delay comp.: 0 **2** nsec

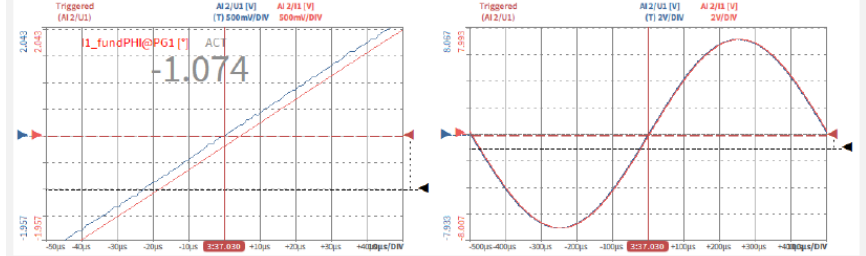
1 Input field for target delay compensation in nanoseconds (ns). Allowed range is +/-10000ns. Negative Values shifts the current backwards in time, positive forward.

2 Display of effective set delay compensation, the resolution is fixed to 100ns.

Current and voltage signals are often not perfectly synchronous due to group delays from the sensors.

To compensate this delay (phase shift) between voltage and current input, a new function was added to the TRION-POWER hardware. This function is also known as Deskew.

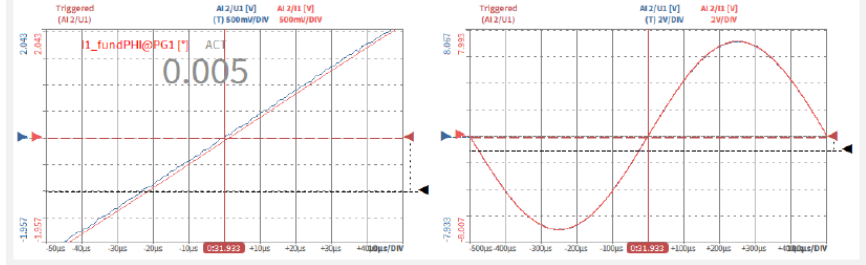
Before adding a compensation value, in this example (Sine Signal with 1 kHz fundamental frequency), the current lags a few degree. This can be seen in the scope as well as in the phase shift of the fundamental:



After adjusting the value to

$$t = \frac{1}{1000\text{Hz}} \cdot \frac{1}{360^\circ} \cdot (-1.074^\circ) \cdot 10^9 = -2983\text{ns} \quad (6.1)$$

the result is now nearly perfect:



EXERCISE – LET'S DO A ONE-PHASE POWER MEASUREMENT!



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