DEWETRON

OXYGEN TRAINING
> Formulas, Statistics, Filters

CONTENT

DEWETRON

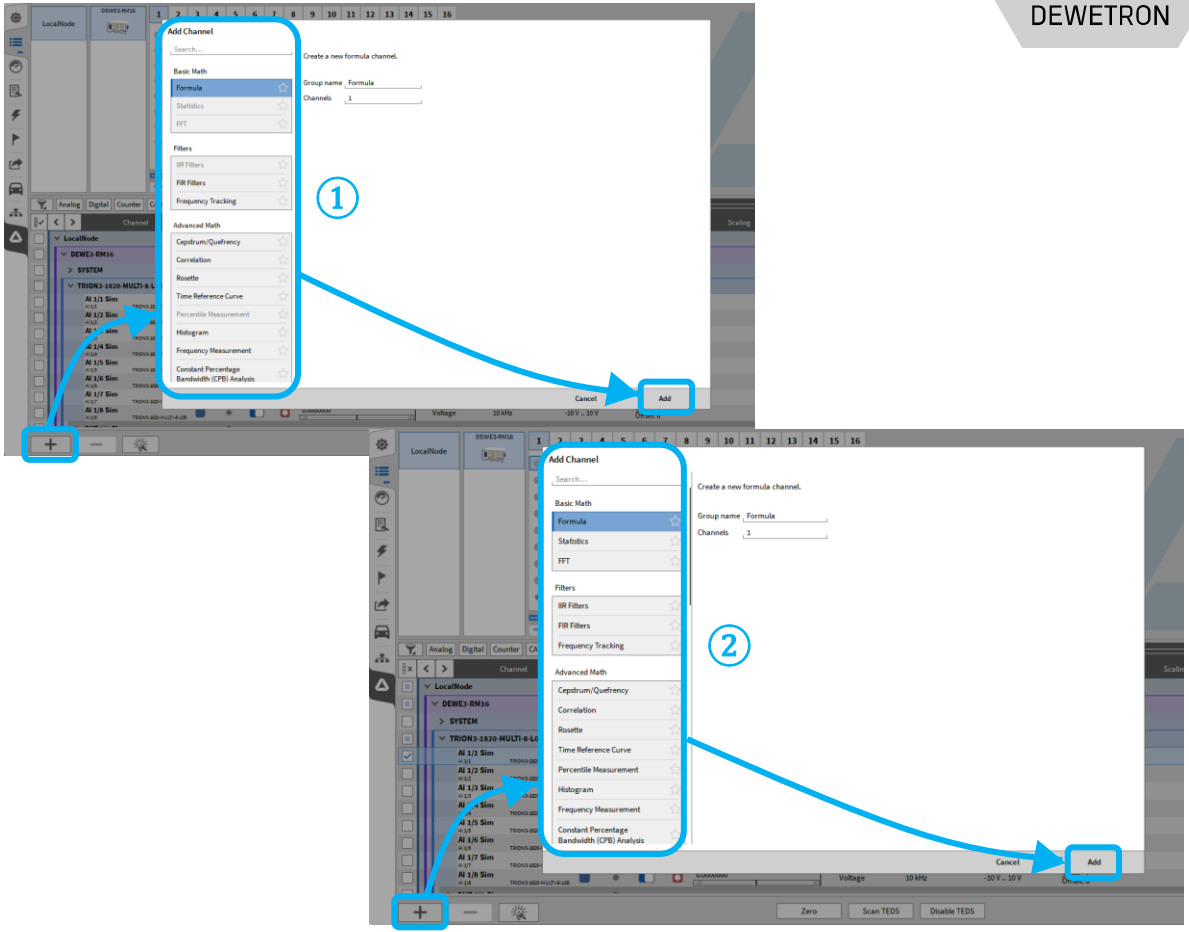
ADD MATH CALCULATIONS TO THE MEASUREMENT SETUP

DEWETRON

① To create
- > Formulas
- > FIR Filter
- > Frequency Tracking
- > Cepstrum/Quefrency
- > Correlation
- > Rosette calculations
- > Time Reference Curve
- > Histogram
- > Frequency Measurement
- > Constant Percentage Bandwidth (CPB)
- > Order analysis modules
- > Power Group
- > Sound Level
- > Modal Test
- > Tape Sensor
- > Resolver
- > Matrix Sampler

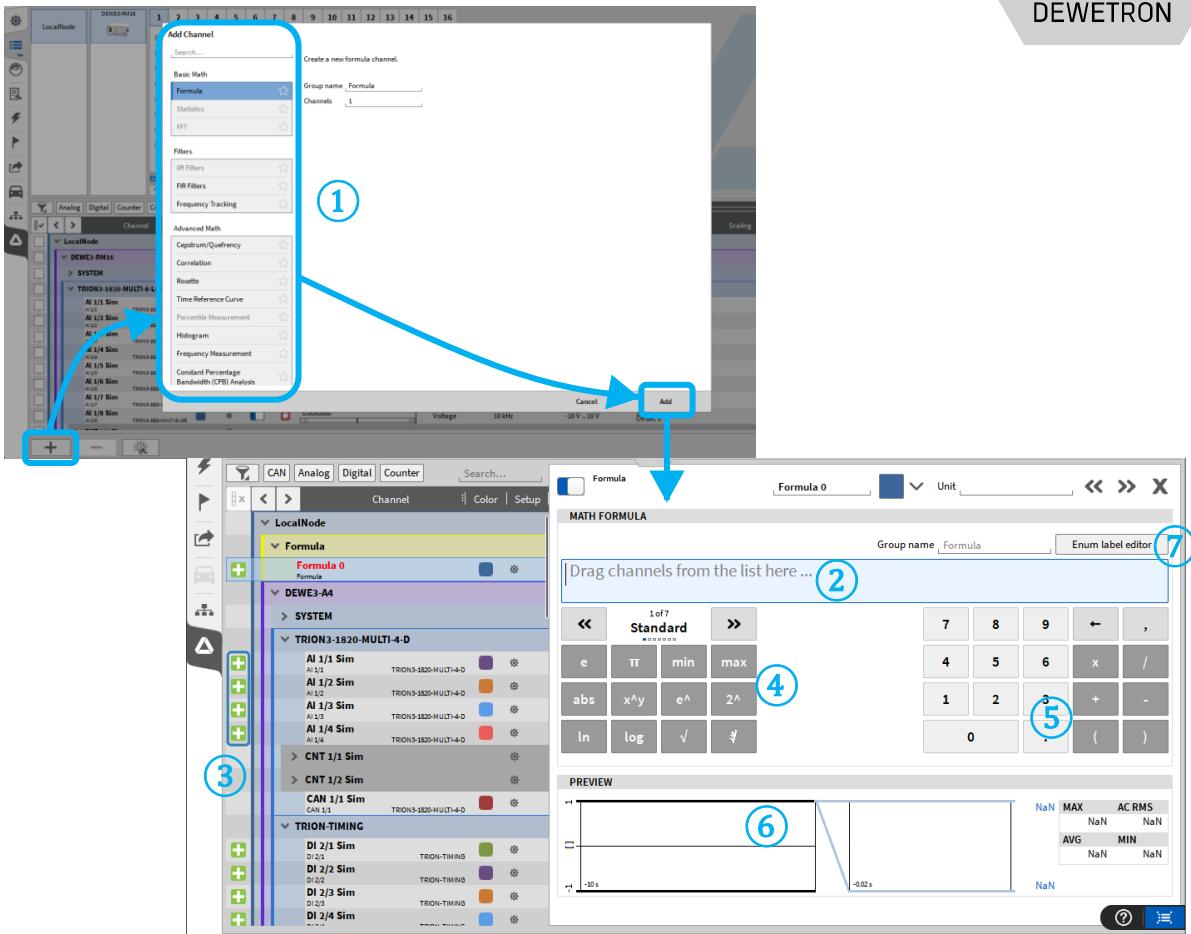
Press the + button. Select the proper calculation and press *Add*

② Reference channels must be selected before creating
- > Statistics
- > FFT
- > IIR Filter
- > Percentile Measurement
- > Array Statistics
- > Swept sine analysis
- > Psophometers



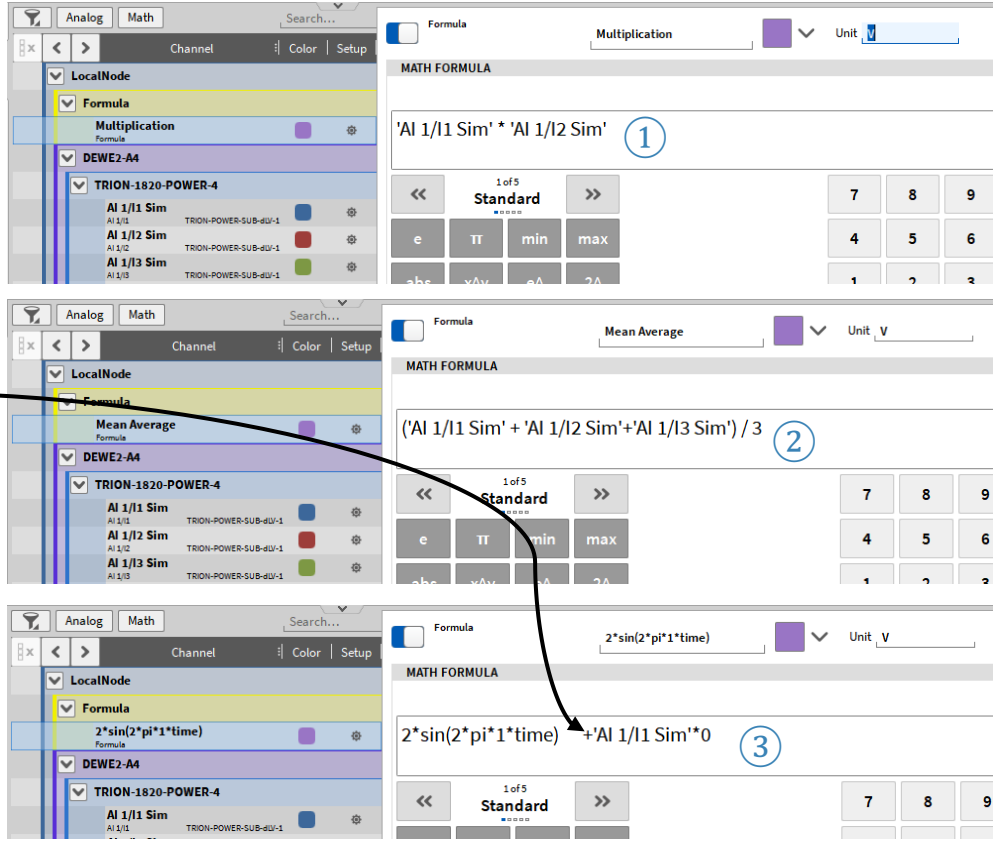
CREATING A FORMULA

①	Press the + button, select *Formula* and press *Add* Formula editor will open afterwards
②	Formula Input field
③	Press the + button to add a channel to the input field or use drag-and-drop
④	Selection of math functions
⑤	Numeric pad with basic mathematic operations
⑥	Preview of the formula output
⑦	Enum label editor Sets up text labels for specific values



SIMPLE EXAMPLES

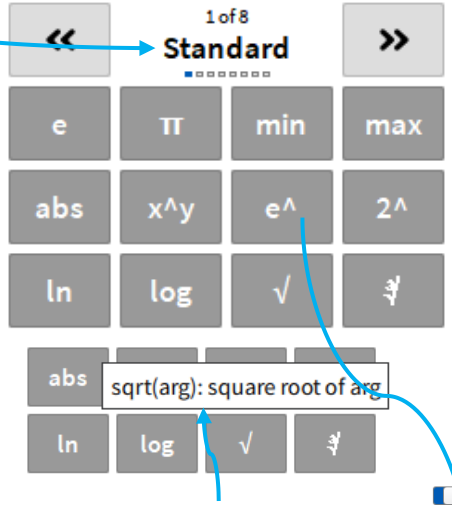
①	Multiplication of 2 signals
②	Mean average of 3 signals
③	2*sin(2*pi*1*time) *+chx/x*0* required to determine the correct time base Channels can have different sample rates, thus OXYGEN needs one time reference in each formula



MATHEMATICAL OPERATIONS – STANDARD OPERATIONS

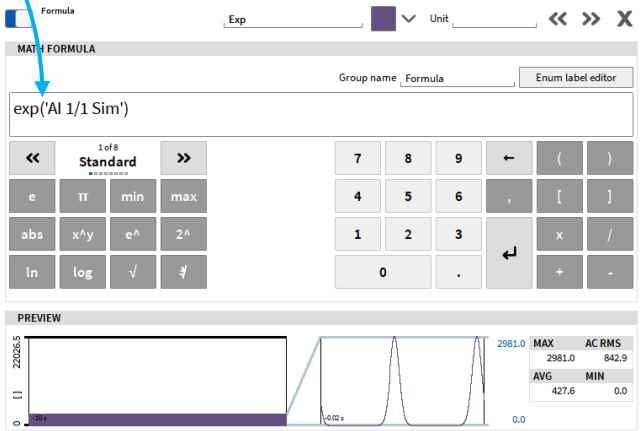
DEWETRON

1. Standard operations
2. Trigonometric operations
3. Logical operations
4. Measurement operations
5. Rolling
6. Generators
7. Misc
8. Header



Tool tips pop up when the mouse remains on one operation

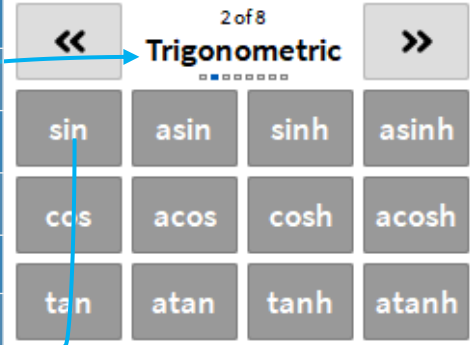
Function	Description	Syntax
e	Euler's number	e
π	Constant Pi	pi
min	Minimum of two values	min(x,y)
max	Maximum of two values	max(x,y)
abs	Absolute value	abs(value)
x^y	Exponential function with arbitrary basis	pow(x,y)
e^	Exponential function with basis e	exp(x)
2^	Exponential function with basis 2	exp2(x)
ln	Natural logarithm to basis e	ln(x)
log	Common logarithm to basis 10	log(x)
√	Square root	sqrt(x)
∛	Cube root	cbrt(x)



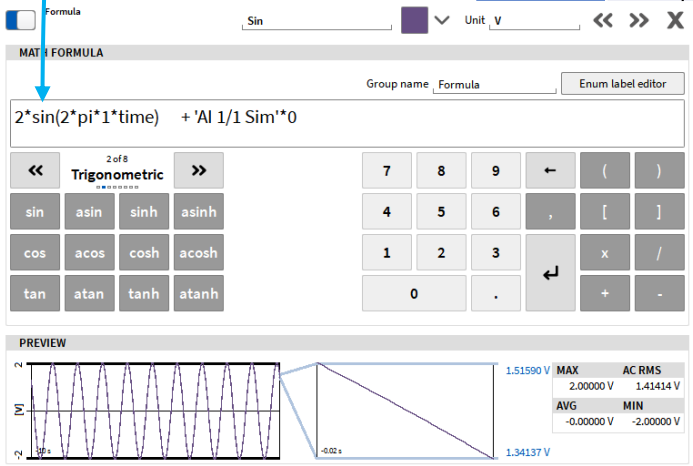
MATHEMATICAL OPERATIONS – TRIGONOMETRIC

DEWETRON

1. Standard operations
2. Trigonometric operations
3. Logical operations
4. Measurement operations
5. Rolling
6. Generators
7. Misc
8. Header



Function	Description	Syntax
sin	Sine	sin(x)
asin	Arc sine	asin(x)
sinh	Hyperbolic sine	sinh(x)
asinh	Arc hyperbolic sine	asinh(x)
cos	Cosine	cos(x)
acos	Arc cosine	acos(x)
cosh	Hyperbolic cosine	cosh(x)
acosh	Arc hyperbolic cosine	acosh(x)
tan	Tangent	tan(x)
atan	Arc tangent	atan(x)
tanh	Hyperbolic tangent	tanh(x)
atanh	Arc hyperbolic tangent	atanh(x)



MATHEMATICAL OPERATIONS – LOGIC

DEWETRON

1. Standard operations
2. Trigonometric operations
3. Logical operations
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5. Rolling
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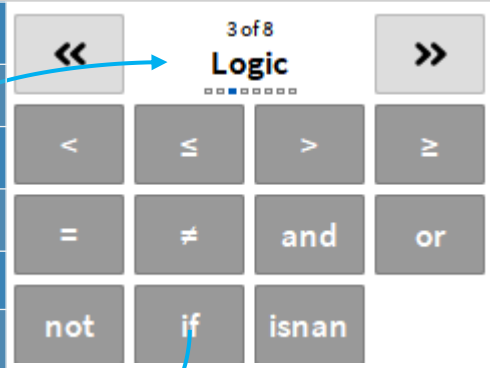
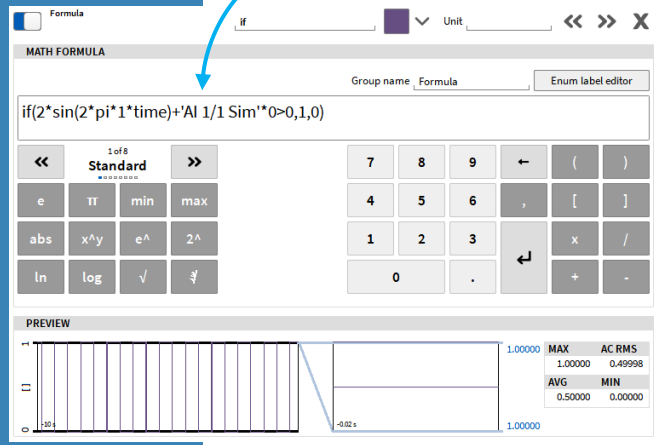
7. Misc
8. Header





Function	Description	Syntax
<	If 'value1' is less than 'value2', the result is 1.0 else 0.0	value1 < value2
≤	If 'value1' is less than or equals 'value2', the result is 1.0 else 0.0	value1 <= value2
>	If 'value1' is greater than 'value2', the result is 1.0 else 0.0	value1 > value2
≥	If 'value 1' is greater than or equals 'value 2', the result is 1.0 else 0.0	value1 >= value2
=	If 'value 1' equals 'value 2', the result is 1.0 else 0.0 (Two NaNs do not compare equal	value1 == value2
≠	If 'value 1' is different than 'value 2', the result is 1.0 else 0.0	value1 != value2
and	Logic and: value1 != 0.0 and value2 != 0.0 → 1.0 value1 = 0.0 and value2 != 0.0 → 0.0 value1 != 0.0 and value2 = 0.0 → 0.0 value1 = 0.0 and value2 = 0.0 → 0.0	value1 and value2
or	Logic or: value1 != 0.0 or value2 != 0.0 → 1.0 value1 = 0.0 or value2 != 0.0 → 1.0 value1 != 0.0 or value2 = 0.0 → 1.0 value1 = 0.0 or value2 = 0.0 → 0.0	value1 or value2
not	Logic negation: If value = 0.0, the result is 1.0, else 0.0	not value
if	If condition is true, the result is 'true_val', otherwise 'false_val'	if(condition,true_val,false_val)
isnan	If value is NaN, result is 1.0, 0.0 otherwise	isnan(value)

MATHEMATICAL OPERATIONS – MEASUREMENT

DEWETRON

1. Standard operations
2. Trigonometric operations
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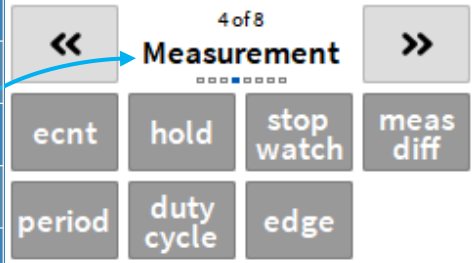
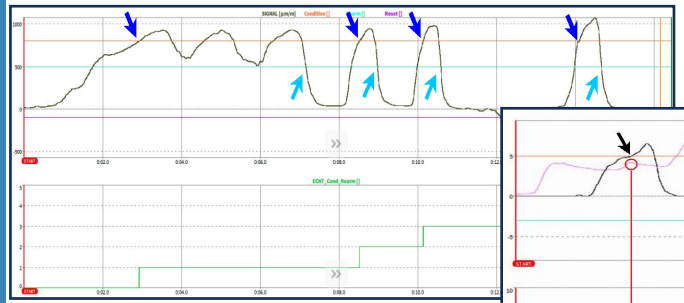
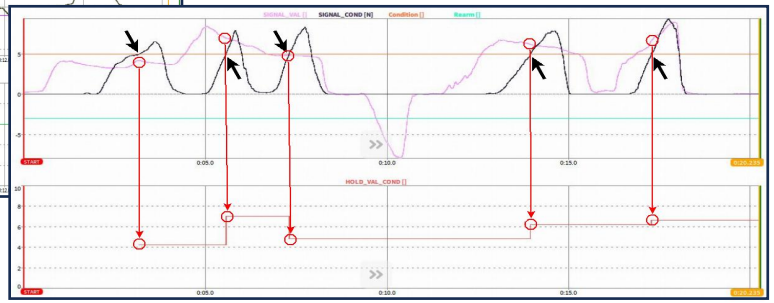
8. Header



Function	Description	Syntax
ecnt[1]	Count number of edges on condition; condition is mandatory, rearm and reset parameter optional	ecnt(cond,rearm,reset)
hold[2]	Hold value at trigger condition; value and condition parameters are mandatory, init and rearm optional	hold(value,cond,init,rearm)
stopwatch[3]	Measure the timespan between two conditions in seconds; start and stop condition is both mandatory, reset is optional	stopwatch(start_cond,stop_cond, reset)
measdiff[4]	Measure the value difference of one channel between two conditions	measdiff(val,cond1,cond2)
period[5]	Measure the period duration in seconds between consecutive conditions with optional rearm condition	Edge(cond,rearm)
dutycycle[6]	Measure the dutycycle (from 0 to 1) between consecutive conditions with optional rearm condition	Dutycycle(cond,rearm)
edge[7]	Generate positive edge on cond with rearm condition	Edge(cond,rearm)





MATHEMATICAL OPERATIONS – MEASUREMENT

DEWETRON

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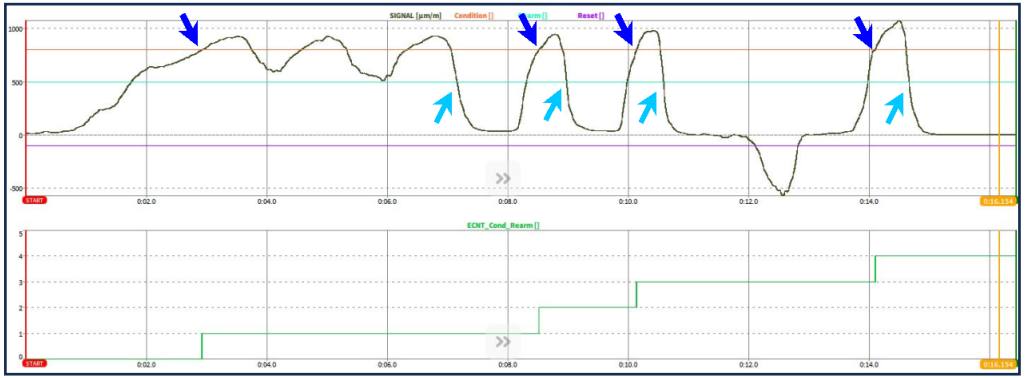
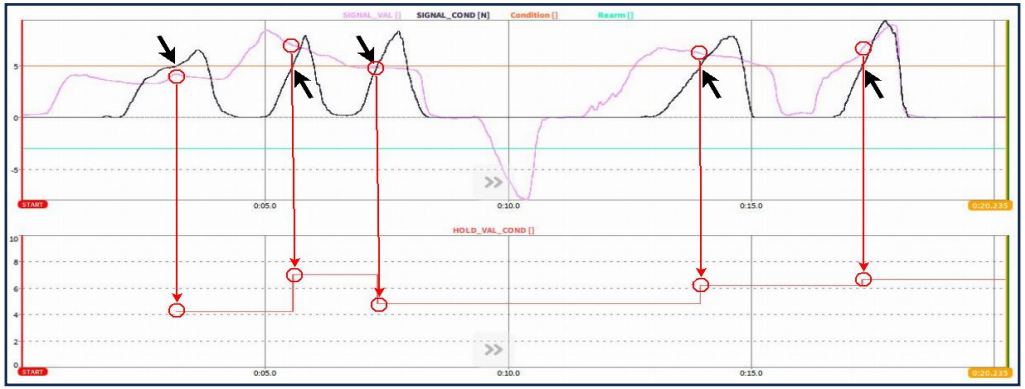
ecnt('SIGNAL'>800,'SIGNAL'<500)



hold('SIGNAL_VAL','SIGNAL_COND'>5)



MATHEMATICAL OPERATIONS – ROLLING

DEWETRON

1. Standard operations
2. Trigonometric operations
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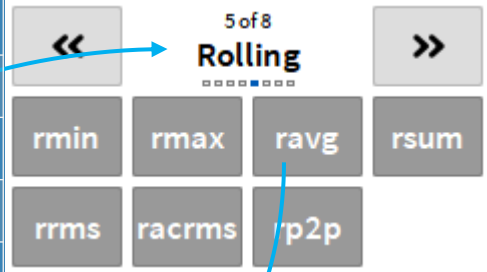
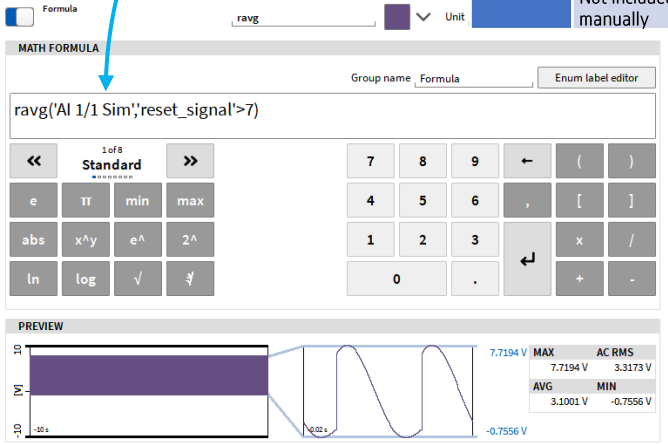
4. Measurement operations
5. Rolling
6. Generators
7. Misc
8. Header



Function	Description	Syntax
rmin[8]	Measure rolling overall minimum of a channel during a measurement with optional reset condition	rmin(value,reset)
rmax[8]	Measure rolling overall maximum of a channel during a measurement with optional reset condition	rmax(value,reset)
ravg[8]	Measure rolling overall average of a channel during a measurement with optional reset condition	ravg(value,reset)
rrms[8]	Measure rolling overall RMS of a channel during a measurement with optional reset condition	rrms(value,reset)
rsum[8]	Measure rolling overall sum of a channel during a measurement with optional reset condition	rsum(value,reset)
racrms[8]	Measure rolling overall ACRMS of a channel during a measurement with optional reset condition; Not included in the selection and must be typed manually	racrms(value,reset)
rp2p[8]	Measure rolling overall Peak-to-Peak of a channel during a measurement with optional reset condition; Not included in the selection and must be typed manually	Rp2p(value,reset)



MATHEMATICAL OPERATIONS – GENERATORS

DEWETRON

1. Standard operations
2. Trigonometric operations
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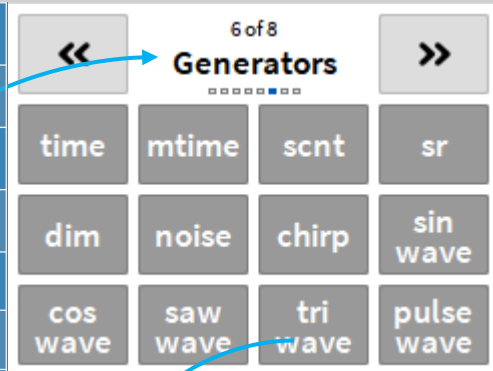
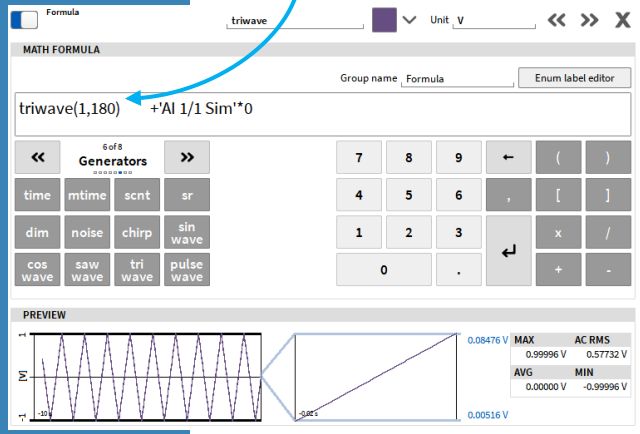
7. Misc
8. Header





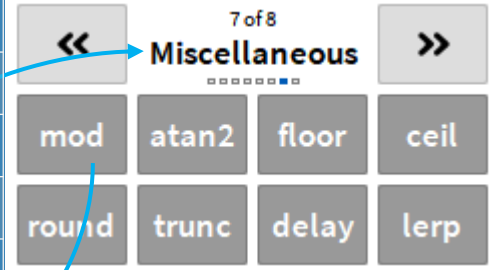
Function	Description	Syntax
time*	Returns the elapsed time since acquisition (re)start in seconds	time
mtime*	Returns the elapsed time since measurement star in secondst	mtime
scnt*	Counts the number of samples since acquisition (re)start	scnt
sr*	Returns the Sample Rate in Hz	sr
dim	When multiplied to an array channel x * dim, the output shows the current index of the bin. [1,2...n]. For scalar the index is 0.	dim
noise	Creates Noise signal in the range [-x...+x]	noise(x)
chirp	Creates a chirp signal with frequency from f0 to f1 within d seconds.	chirp(f0,f1,d)
sinwave	Creates a sinus wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	sinwave(f,phi)
coswave	Creates a cosines wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	coswave(f,phi)
sawwave	Creates a saw wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	sawwave(f,phi)
triwave	Creates a triangle wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	triwave(f,phi)
pulsewave	Creates a rectangle wave with frequency f , duty cycle d and optional phase phi. By default a phase shift of 0 rad is applied.	pulsewave(f,d,phi)

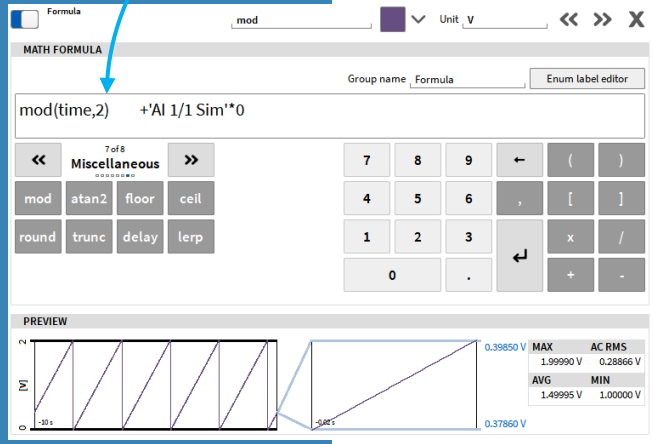
* A channel to which the function refers must be specified, i.e. in the following manner: 'Ref_Ch'*0+time

MATHEMATICAL OPERATIONS – MISC

DEWETRON

1. Standard operations
2. Trigonometric operations
3. Logical operations
4. Measurement operations
5. Rolling
6. Generators
7. Misc
8. Header



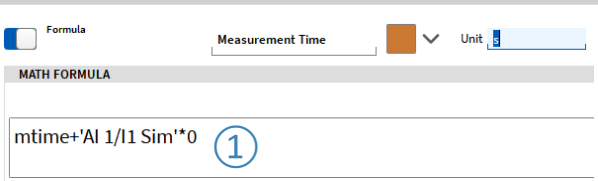


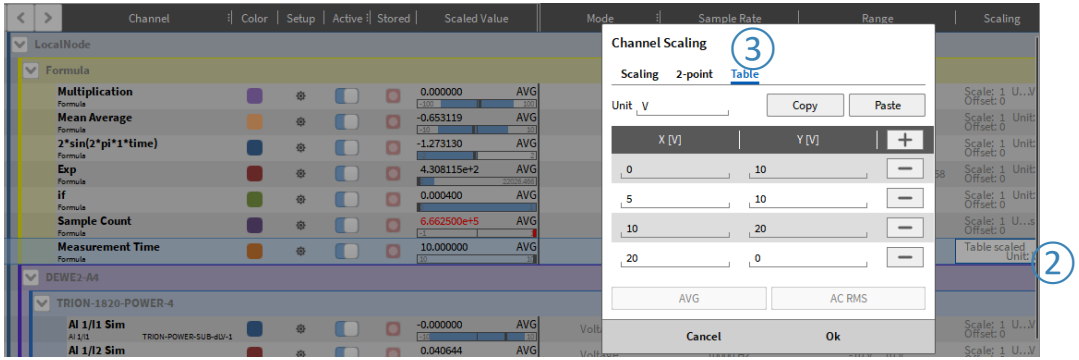
Function	Description	Syntax
mod	Remainder of division x/y, sign of x	mod(x,y)
atan2	Arc tangent of y/x using signs of arguments to determine the correct quadrant	atan2(y,x)
floor	Rounds x towards minus infinity	floor(x)
ceil	Rounds x towards plus infinity	ceil(x)
round	Round to nearest integer	round(x)
trunc	Round x towards zero	trunc(x)
delay	Delay a signal x for N samples with an optional initial value y0 by default 0	delay(x,N,y0)
lerp	Continue a series of values with lerp(a,b,t)=(1-t)*a+t*b. This allows you to interpolate or continue the straight line for any t values. An example is the starting value a=10, the second value is 15. lerp equals a for t=0, lerp equals b for t=1. For t values between 0 and 1, interpolationtakes place between a and b.	lerp(a,b,t)

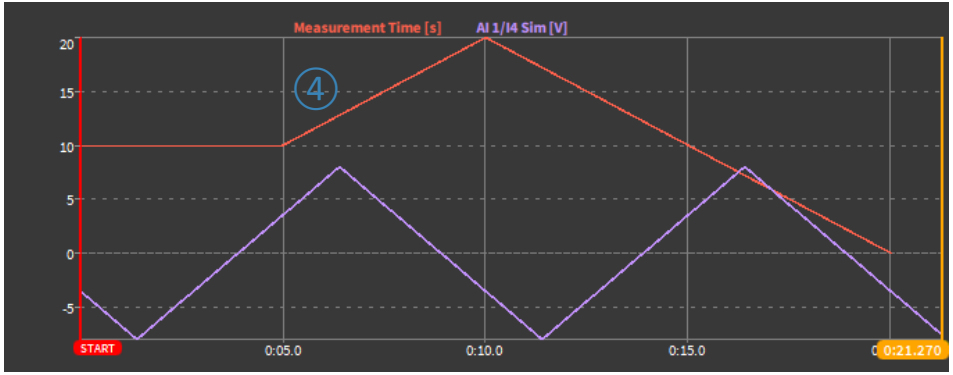
MATHEMATICAL OPERATIONS – MEASUREMENT TIME

DEWETRON

①	Measurement time function can be used to generate reference curves in time domain. Create a formula determining the measurement time.
②	Open the scaling options of this channel which are accessible in the Channel List
③	The table scaling can be used to define the boundary points of the reference curve
④	Can be displayed in a Recorder to check if the channel(s) exceeds the limit or is within the limit







MATHEMATICAL OPERATIONS – MEASUREMENT TIME

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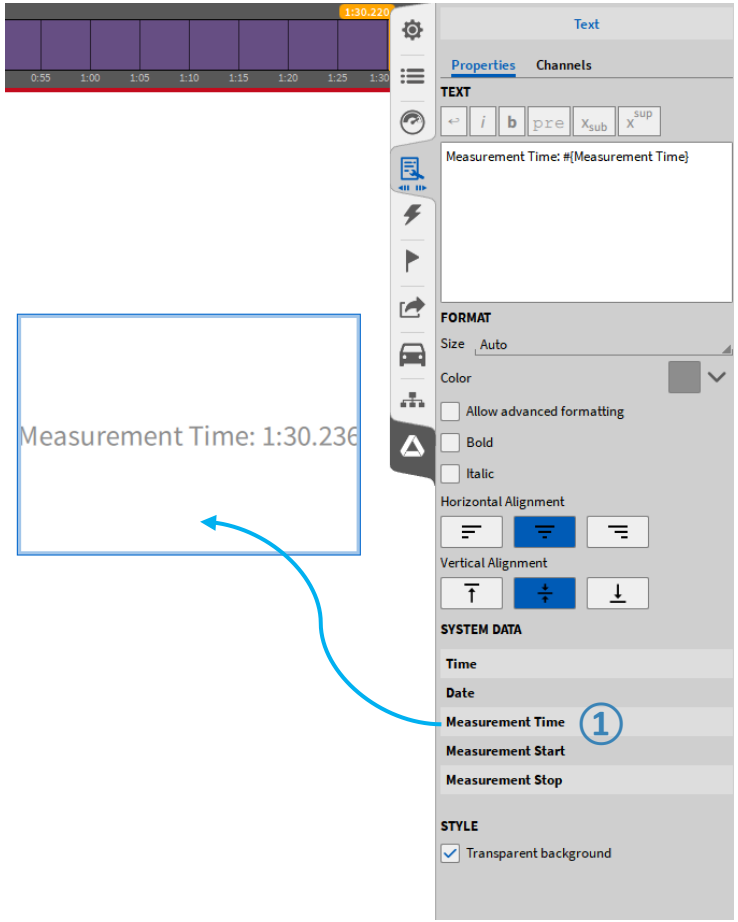
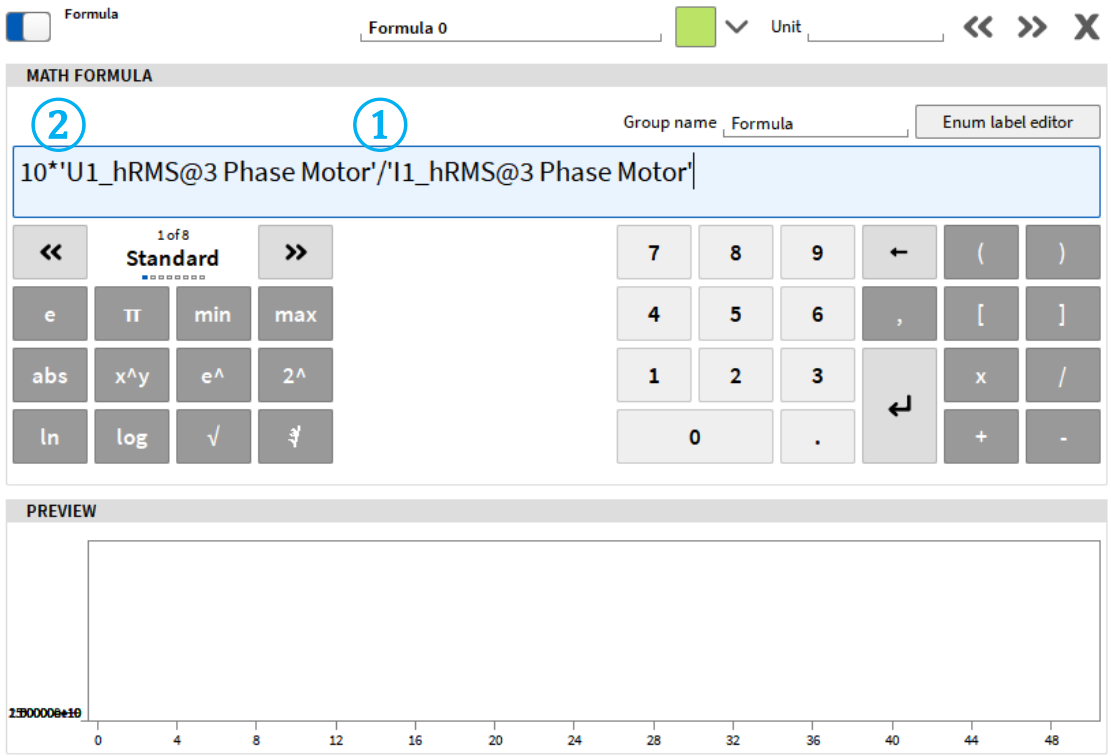
① Measurement time can be easily displayed on the screen as it can be dragged and dropped to a Text instrument directly from its properties



ARRAY MATH FORMULAS

DEWETRON

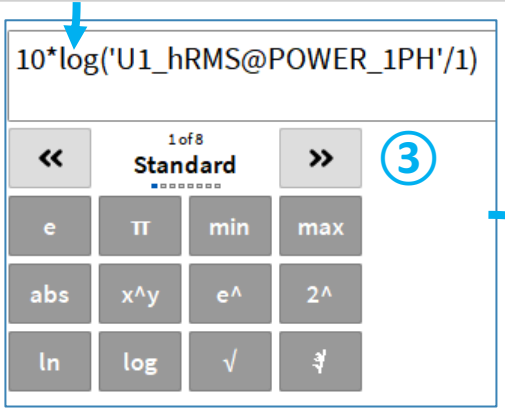
	Array channels such as Harmonics, FFT or CPB channels can be used in Formulas
①	Basic math operations for arrays with same dimensions supported: + - * /
②	Operations (+ - * /) with constants supported
	Output is always a new array channel with same dimensions

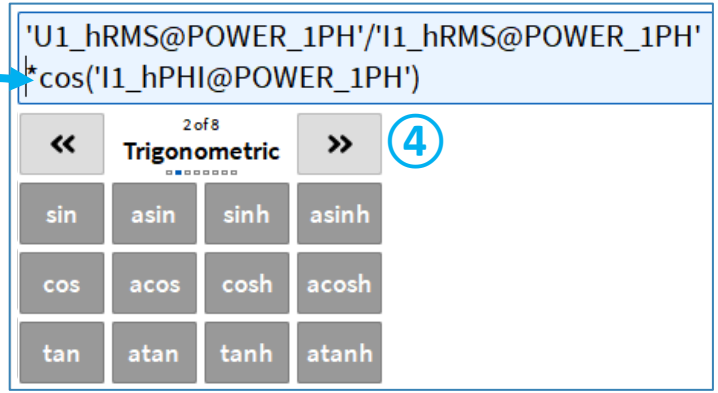


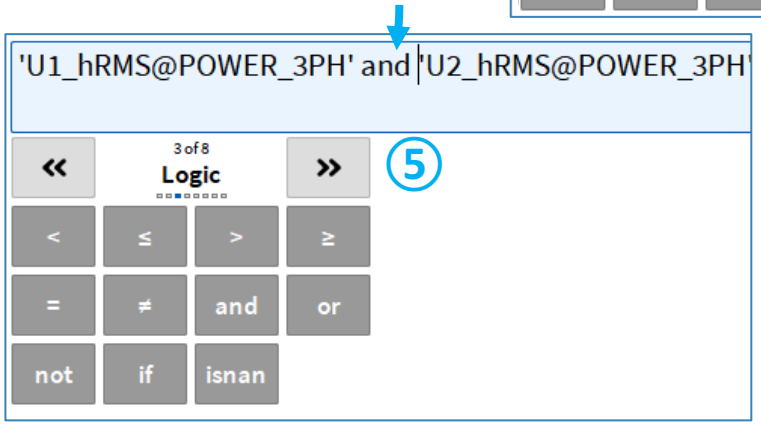
ARRAY MATH FORMULAS

DEWETRON

	Possibility to use
③	Standard operators
④	Trigonometric operators
⑤	Logic operators



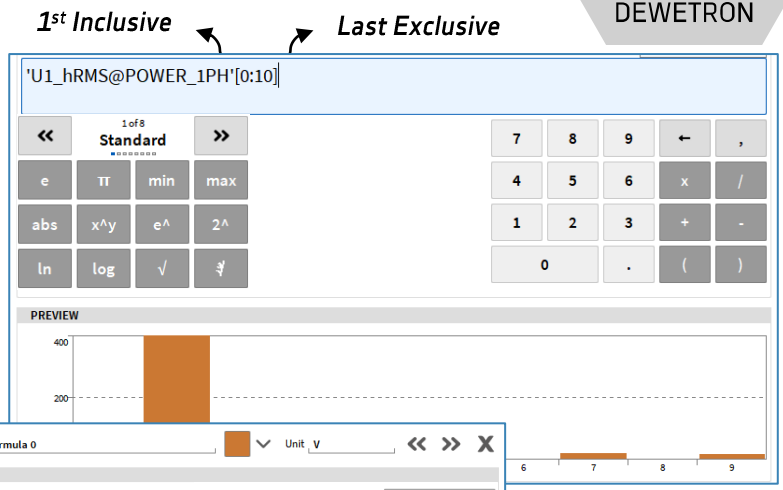


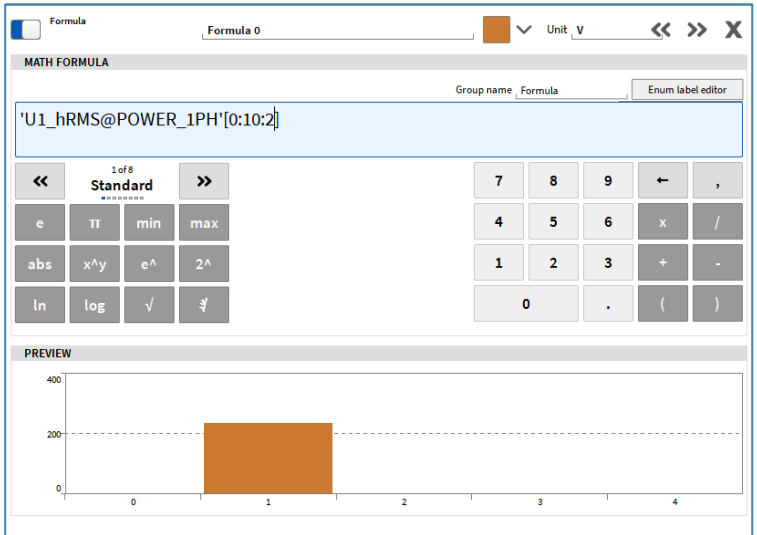


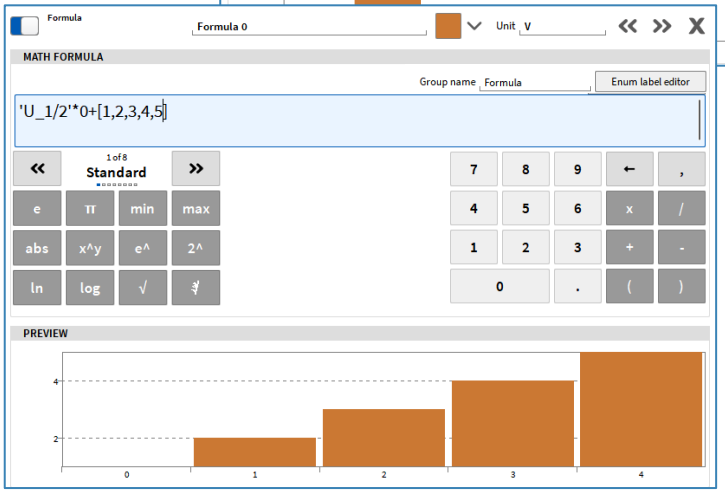
ARRAY MATH FORMULAS

DEWETRON

- Exctraction of adjacent elements into a new array in C++ / Python syntax (⑥)
  - First element of array is always 0!
  - Optional step size definition (⑦)
- Creation of arrays with constants (⑧)

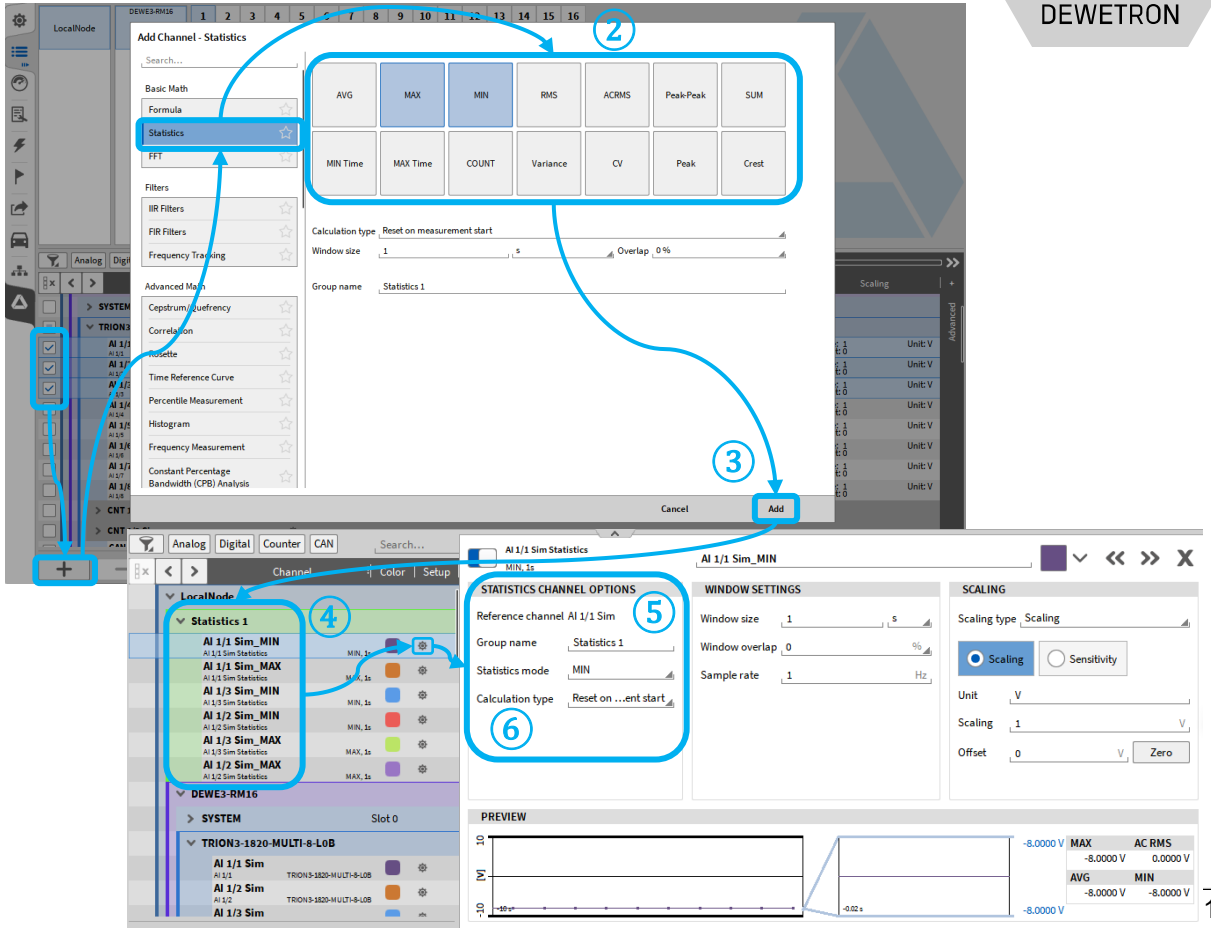






CREATING STATISTICS

①	Select one or several channels by checking their check boxes and press the + button
②	Select *Statistics*, choose the proper calculations (several can be selected) and the desired time window
③	Press *Add* afterwards to create these channels
④	A separate output channel for each reference channel and calculation is created
⑤	Changes can still be applied by entering the settings of the desired channel via the *Gear* button
⑥	Select if calculation (starting at acquisition start) shall be reset at recording start



CALCULATION REMARKS

Calculation remarks can be seen on the right hand side

If rolling (overall) statistics, i.e. maximum value during the measurement are required, refer to the functions in the table below which are available in the formula setup

These formulas are reset at measurement start

Additionally, user defined reset events can be defined, i.e. ch1 decreases 0

racrms and *rp2p* are not available in the menu but can be typed into the formula editor manually

$$AVG = \frac{1}{N}\sum_{i=1}^{N} SignalLevel_i$$

$$MIN = MIN\{SignalLevel_i\}$$

$$MAX = MAX\{SignalLevel_i\}$$

$$ACRMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(SignalLevel_i - AVG)^2}$$

$$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(SignalLevel_i)^2} = \sqrt{AVG^2 + ACRMS^2}$$

i = 1...N

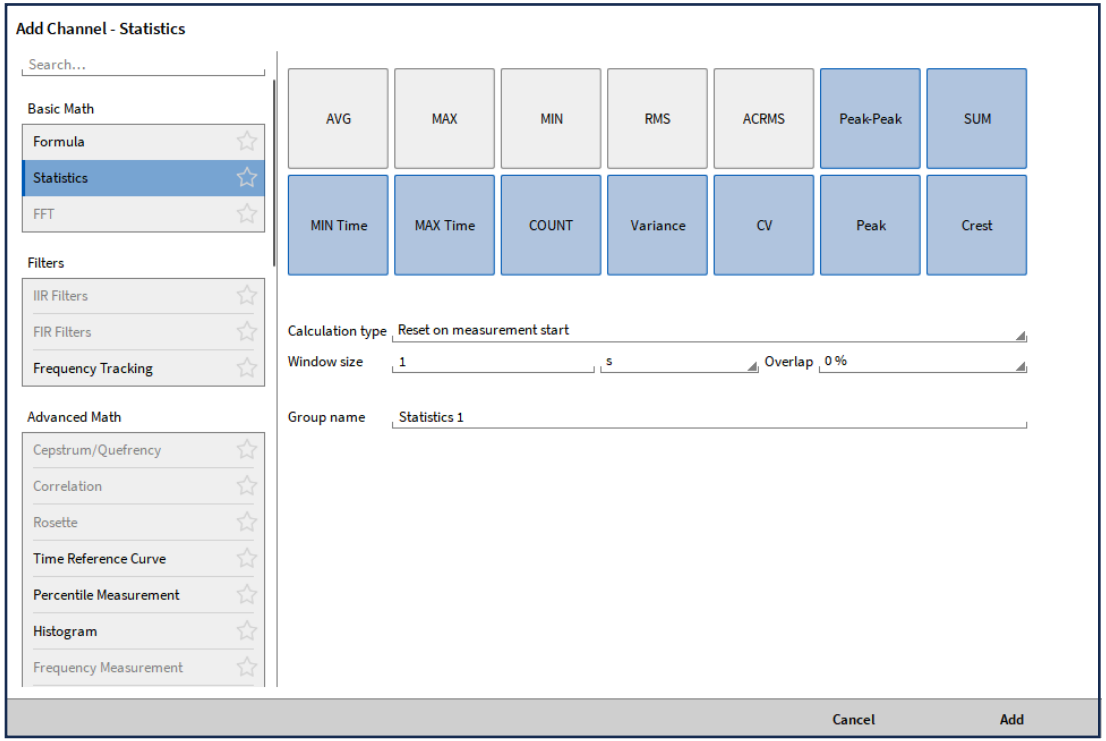
*N = Sample Rate of Input Channel * Window Size*

rmin	Measure rolling overall minimum of a channel during a measurement with optional reset condition	rmin(value,reset)
rmax	Measure rolling overall maximum of a channel during a measurement with optional reset condition	rmax(value,reset)
ravg	Measure rolling overall average of a channel during a measurement with optional reset condition	ravg(value,reset)
rrms	Measure rolling overall RMS of a channel during a measurement with optional reset condition	rrms(value,reset)
rsum	Measure rolling overall sum of a channel during a measurement with optional reset condition	rsum(value,reset)
racrms	Measure rolling overall ACRMS of a channel during a measurement with optional reset condition; Not included in the selection and must be typed manually	racrms(value,reset)
rp2p	Measure rolling overall Peak-to-Peak of a channel during a measurement with optional reset condition; Not included in the selection and must be typed manually	Rp2p(value,reset)

FURTHER STATISTICS (AVAILABLE SINCE R6.1)

DEWETRON

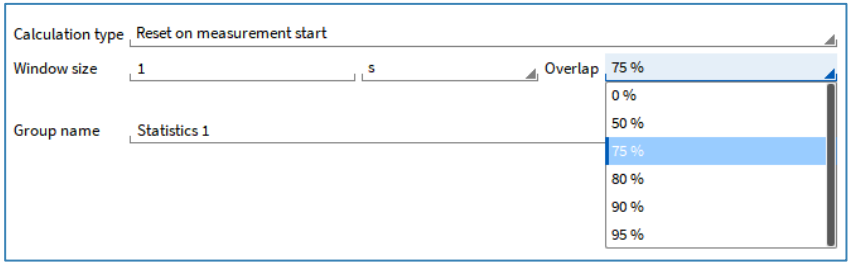
- *Peak-Peak:* Calculates the peak-peak value
- *SUM:* Calculates the sum
- *MIN Time:* Determines the time, where the minimum of the signal was reached
- *MAX Time:* Determines the time, where the maximum of the signal was reached
- *COUNT:* Counts the number of samples in one measurement block
- *Variance:* Calculates the variance (squared ACRMS value)
- *Coefficient of Variance (CV):* Calculates the Coefficient of variance (division of ACRMS and AVG)
- *Peak:* Calculates the peak value
- *Crest:* Calculates the crest factor (division of the MAX and RMS value)

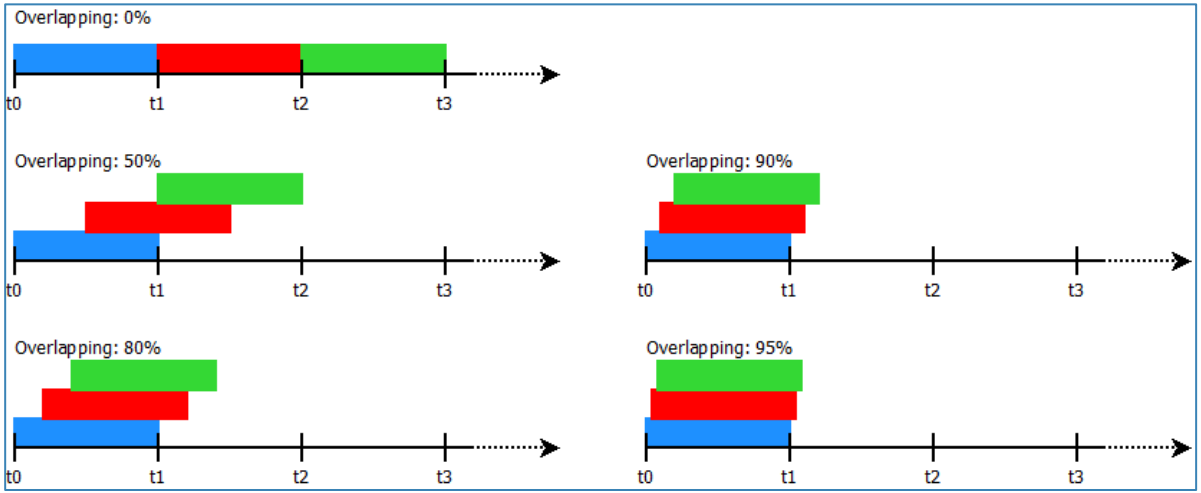


OVERALPPING STATISTICS (AVAILABLE SINCE R6.1)

DEWETRON

- Overlapping Window size
  - 0 % (behaviour until now)
  - 50 %
  - 75 %
  - 80 %
  - 90 %
  - 95 %

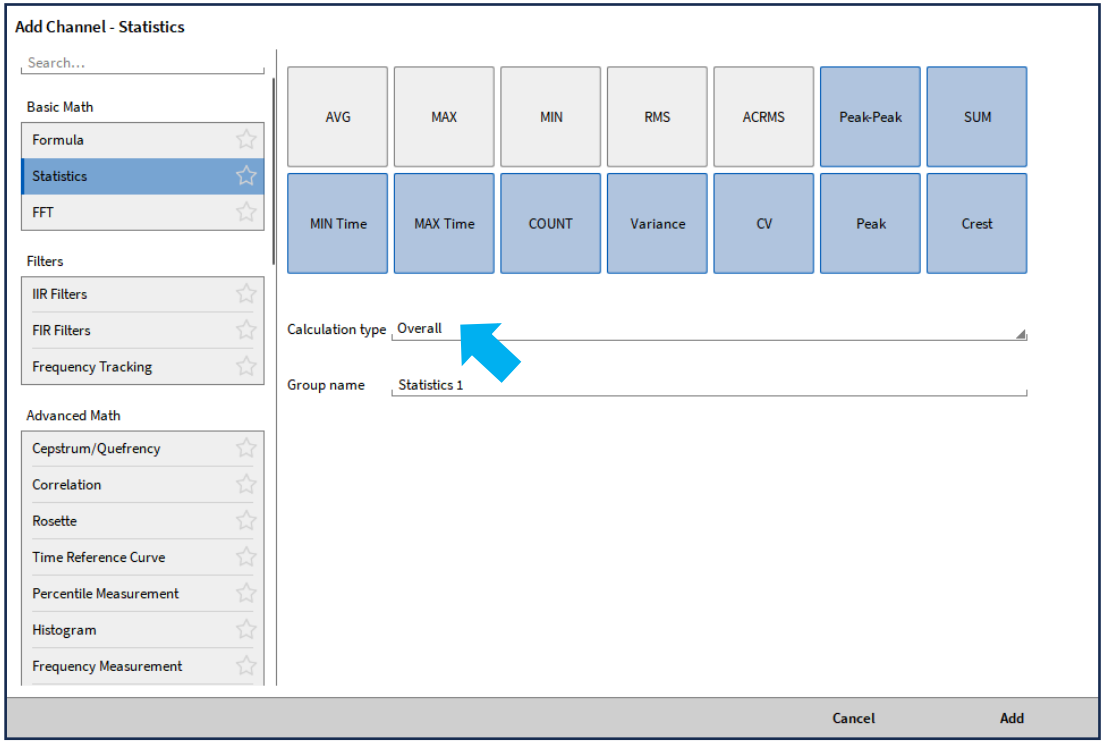




OVERALL STATISTICS (AVAILABLE SINCE R6.1)

DEWETRON

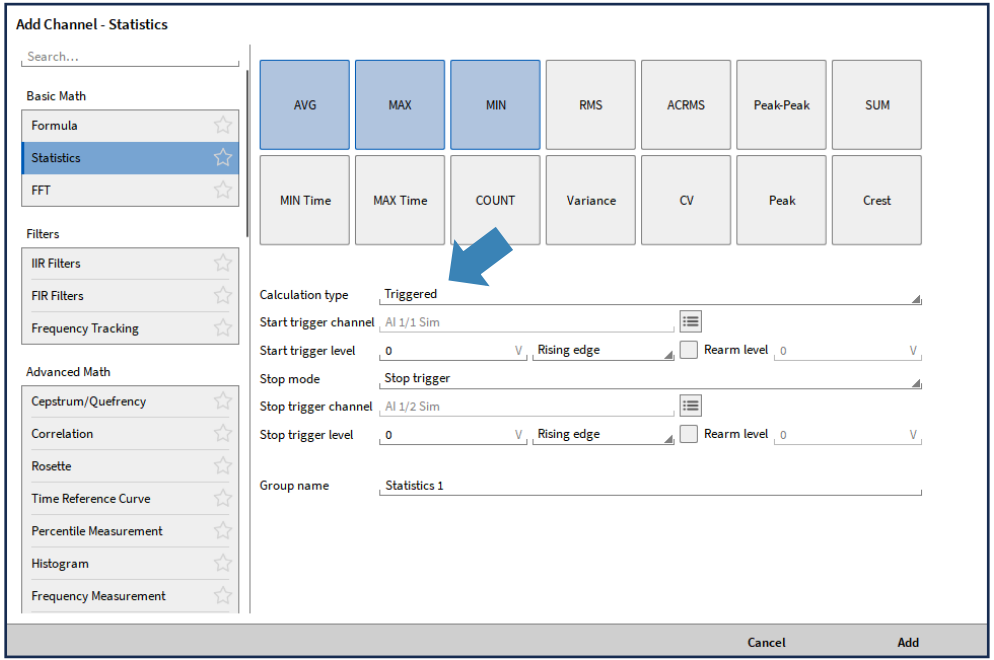
- Outputs one overall value from recording start to recording end
  - → Reset on measurement start
- No time history included

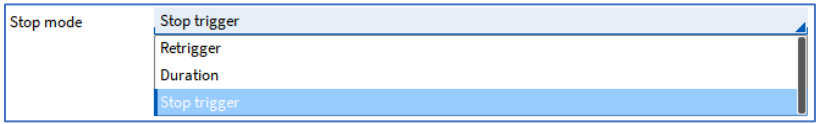


TRIGGERED STATISTICS (AVAILABLE SINCE R6.2)

DEWETRON

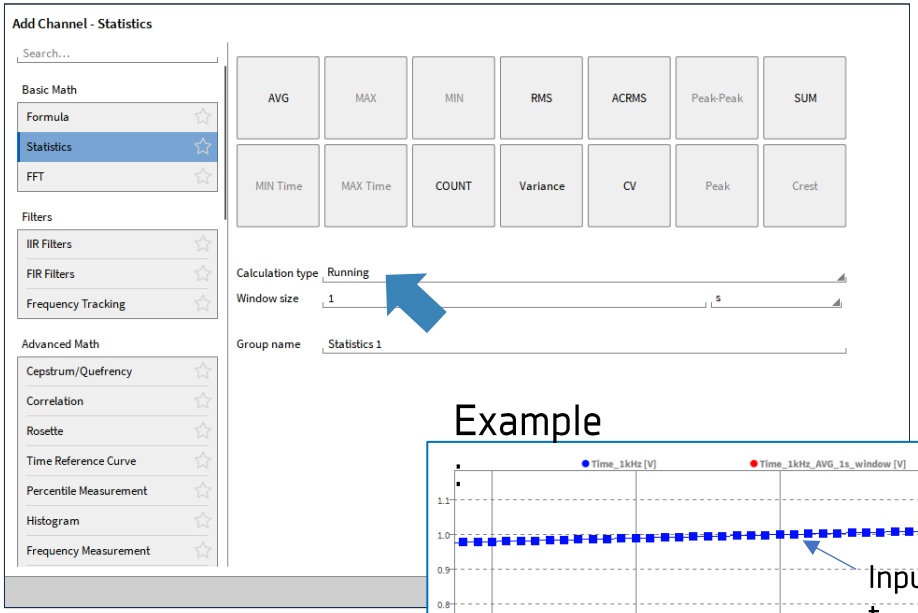
- Begins statistics calculation on trigger
- Trigger event can be on rising or falling edge
- Stop modes:
  - Retrigger
  - Duration
  - Stop trigger



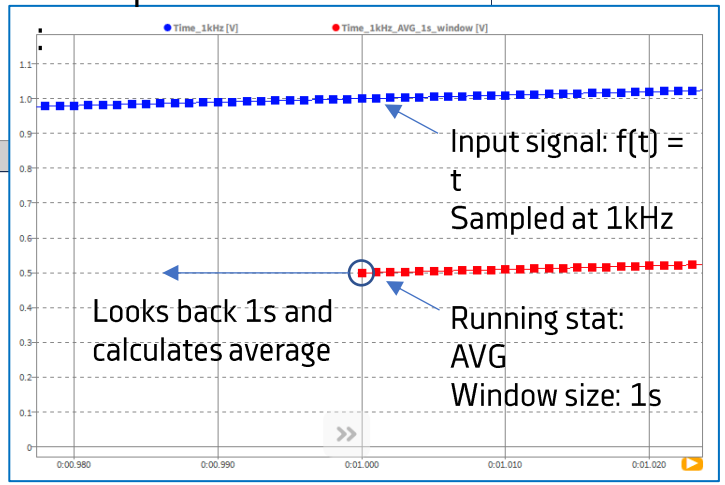


RUNNING STATISTICS (AVAILABLE SINCE R6.2)

- Inherits sample rate of input channel
- Looks back the window size on each new sample
- Calculates statistic for this „look back“-window

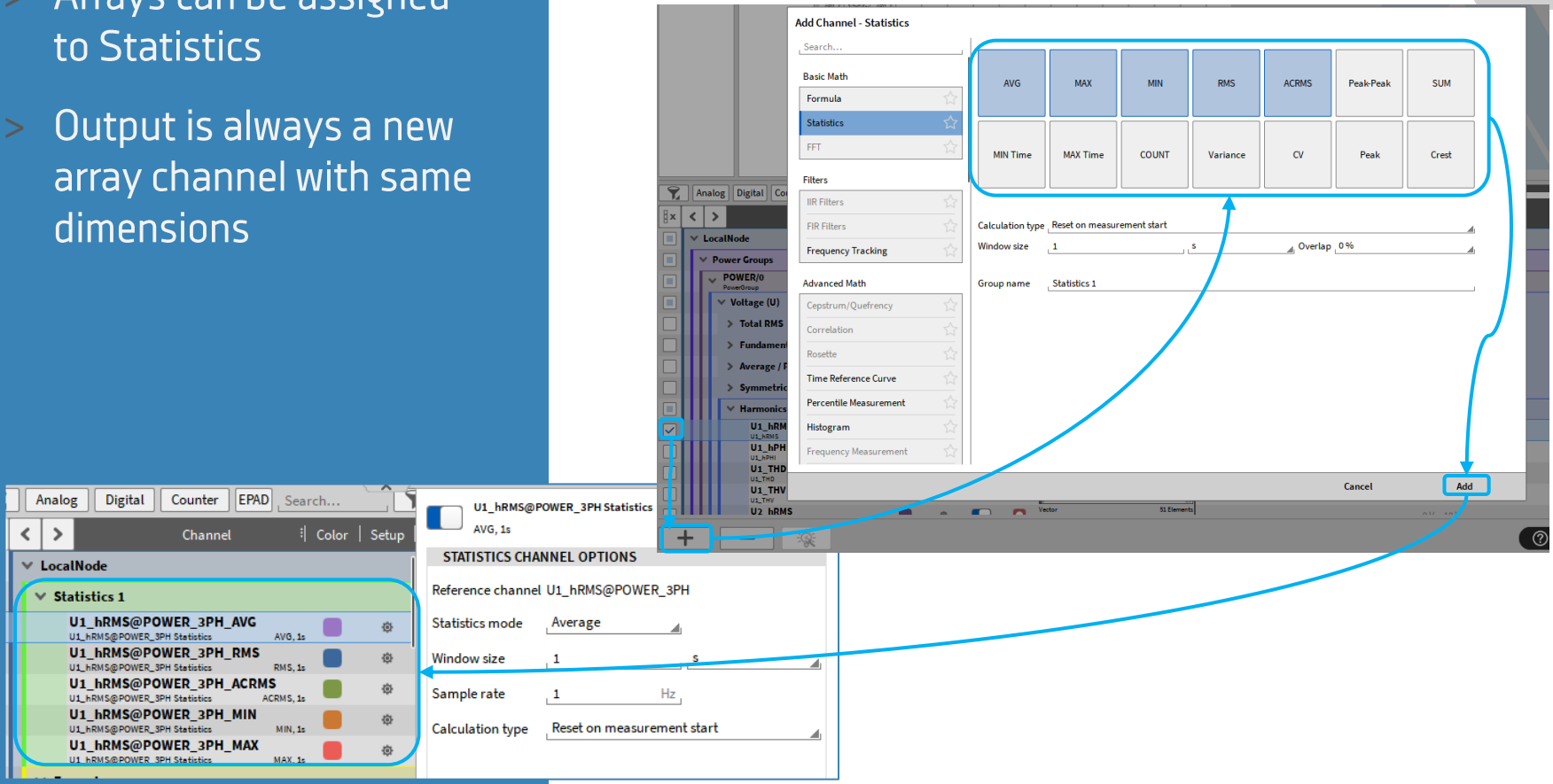


Example



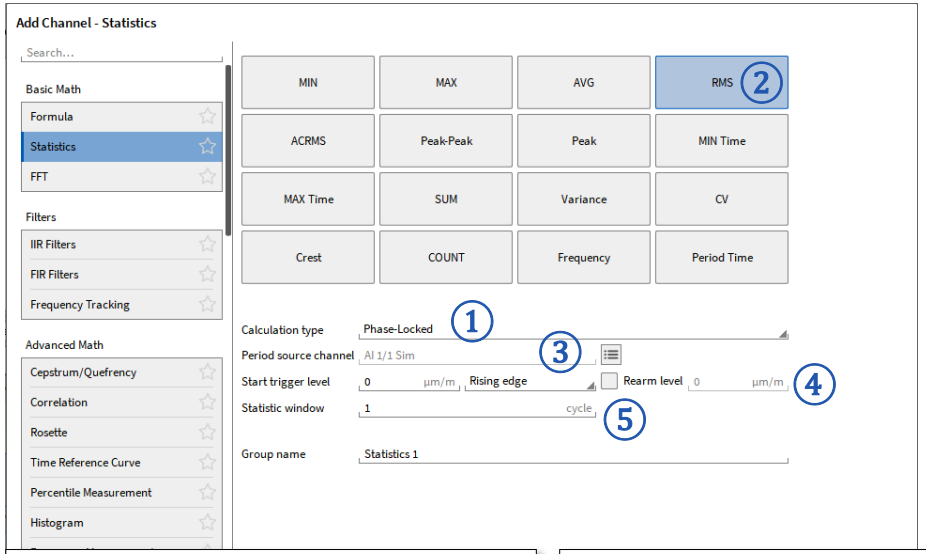
ARRAY MATH STATISTICS

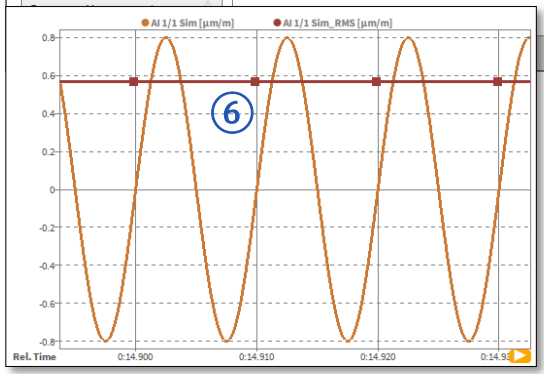
- Arrays can be assigned to Statistics
- Output is always a new array channel with same dimensions

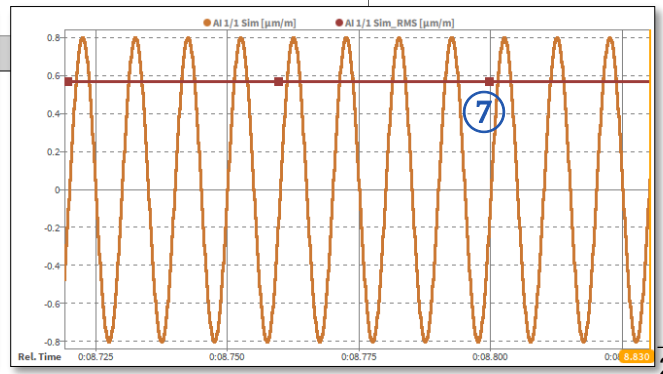


Phase-Locked Statistics

①	Phase-Locked Calculation type allows to calculate statistics quantities for one or multiple periods of a signal
②	Select a statistics calculation e.g. RMS
③	The period source channel is the same as the initial selected channel by default, this means the period is detected by AI 1/1 Sim and the RMS is also Calculated for AI 1/1 Sim
④	The period detection can be set like for the triggered calculation type
⑤	The window for, in this case, RMS calculation is set to 1 cycle.
⑥	RMS every cycle (statistics window = 1)
⑦	RMS every 4 cycles (statistics window = 4)

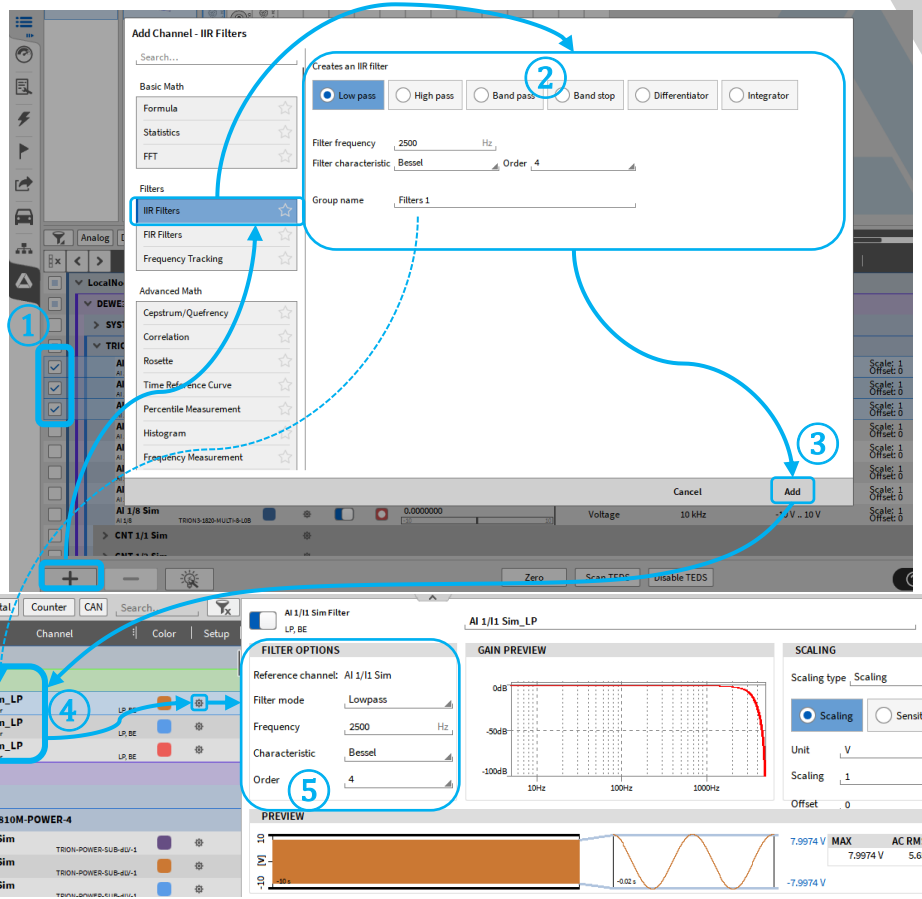






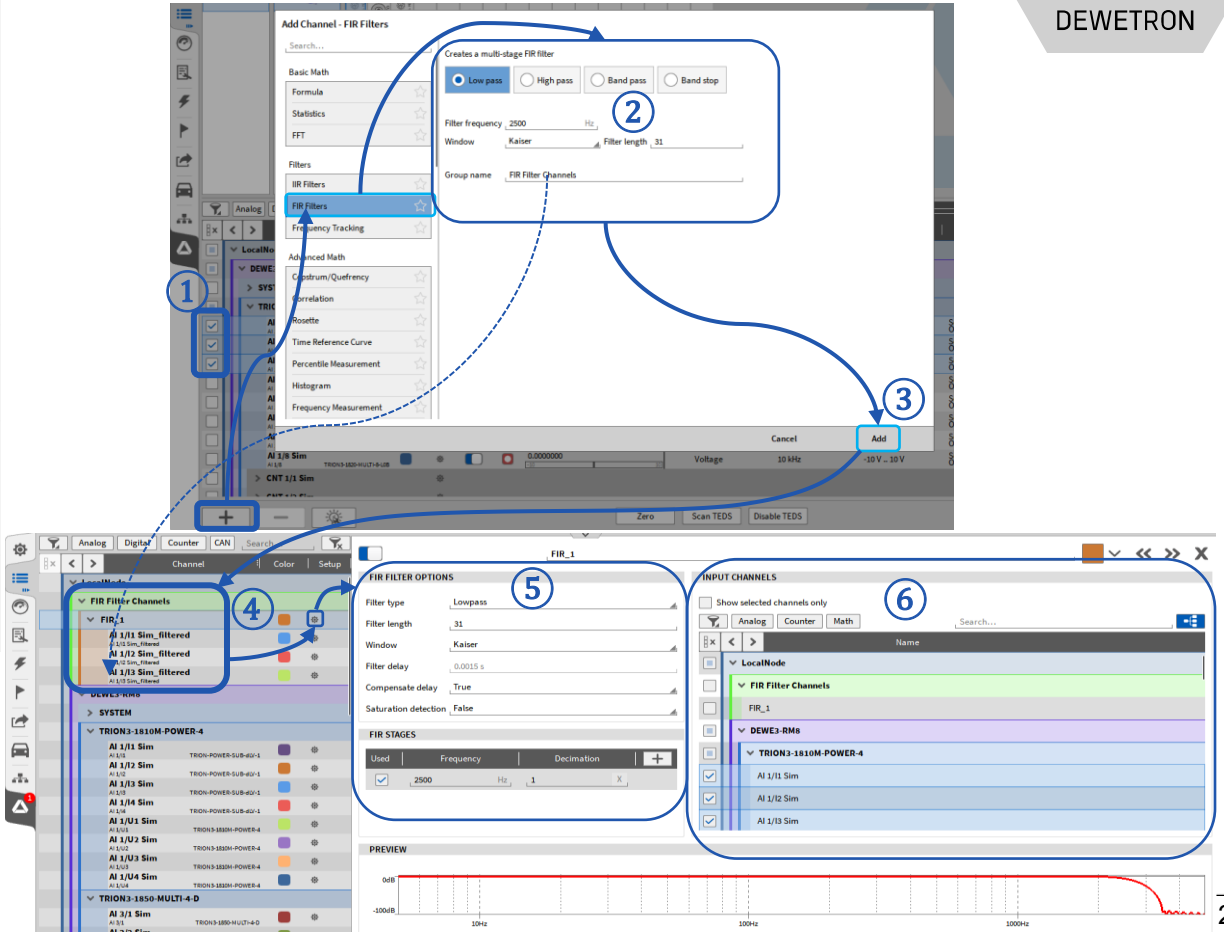
CREATING IIR-FILTERS

①	Select one or several channels to be filtered by checking their check boxes and press the + button
②	Select *Filters*, choose the proper one and its settings
③	Press *Add* afterwards to create these channels
④	A separate output channel for each filtered reference channel is created
⑤	Changes can still be applied by entering the settings of the desired channel via the *Gear* button



CREATING FIR-FILTERS

①	Select one or several channels to be filtered by checking their check boxes and press the + button
②	Select *Filters*, choose the proper one and its settings
③	Press *Add* afterwards to create these channels
④	A separate output channel for each filtered reference channel is created
⑤	Changes can still be applied by entering the settings of the desired channel via the *Gear* button
⑥	Additional channels can be added or deselected



FILTER SETTINGS

DEWETRON

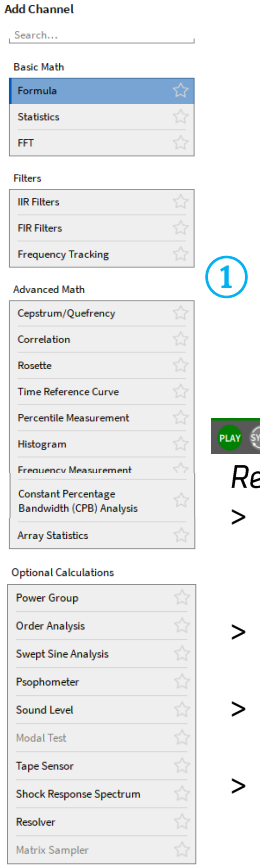
Available Filters:
- Lowpass
- Highpass
- Bandpass
- Bandstop
- Integrator (Single or Double)
- Differentiator (Single or Double)

- Lowpass & Highpass:
  - $f_{C\,max} = \frac{f_S}{2} - 50\ Hz$
  - Bessel, Butterworth, Chebyshev I and Chebyshev II characteristic
  - 2^{nd}, 4^{th}, 6^{th}, 8^{th} or 10^{th} order
- Bandpass & Bandstop
  - $f_l = 0\ \ldots\ f_h - 1\ Hz$
  - $f_h = f_l + 1\ Hz\ \ldots\ \frac{f_S}{2} - 50\ Hz$
  - Bessel, Butterworth, Chebyshev I and Chebyshev II characteristic
  - 2^{nd}, 4^{th}, 6^{th}, 8^{th} or 10^{th} order
- Integrator & Differentiator
  - Single or Double Integration/Differentiation
  - Enable low (Integrator) or high (Differentiator) frequency component filtering
    - $f_{C\,max} = \frac{f_S}{2} - 50\ Hz$
    - Bessel or Butterworth characteristic
    - 2^{nd}, 4^{th}, 6^{th}, 8^{th} or 10^{th} order
- Why filter frequency components during Integration / Differentation or not?
- → Integration of a velocity:
- With filtering enabled (no DC components), this calculation determines only the distance travelled from one data sample to the next one
- With filtering disabled (DC components included), this calculation determines the entire travelled distance as the determined distance from one data sample to the next is summed up

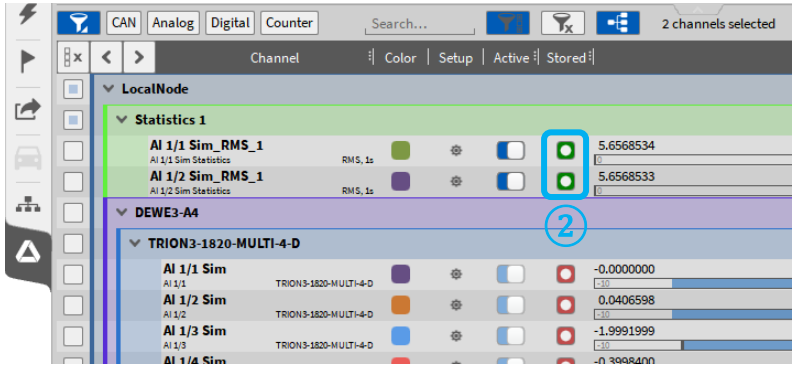
OFFLINE MATH – ADDING CALCULATIONS TO THE DATA FILE

DEWETRON

①	Basic Math, Filters, Advanced Math and optional Calculations can be created offline
②	Offline created channels are marked with a green *Stored* button
③	Any changes to a data file can be stored with the *Store* button



①



③

Remarks:

- *Possibility to edit settings of software channels in *.dmd-files. Function must be activated once after opening *.dmd-file (④)*

④

- *All existing channels and calculations created with + button can be edited if source channels are stored*
- *It is also possible to edit the settings of hardware channels, but only the name and the unit.*
- *Please keep in mind that the results of an offline calculated channel can differ from an online calculated channel, i.e. filters as they are oscillating at the beginning*