ASM PROCESS

FOR THYRO-P

IMPLEMENTATION AND PARAMETERIZATION

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CONTENTS

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1. IN GENERAL

The ASM (automatic synchronization on multiple controller applications) procedure is a patent development of Advanced Energy. This application note applies only in combination with Thyro-P operating instructions.
At an early stage synchronization processes have been developed which allow significant advantages for management of large amounts of energy.
The newest process for "network synchronization" of power controllers is the ASM process which reacts automatically to mains load changes and therefore sets optimal mains load ratios for the application.

Mains load optimization means in "technical" terms:
· Reduction of periodical load peaks
· Reduction of system perturbations
· Minimized design (transformer, feed in and other installation)

Main load optimization means in "economical" terms:
· Minimization of operating costs
· Minimization of investment costs

2. APPLICATION

2.1 SYSTEM CONFIGURATION

The system components, whose loads operate with ASM processes, are connected to the same supply. The power controllers, which will be operating in ASM procedure, have to be wired and parameterized in advance. For the parameter calculation please use the data given in chapter 3 and 4.

3. POWER CONTROLLER

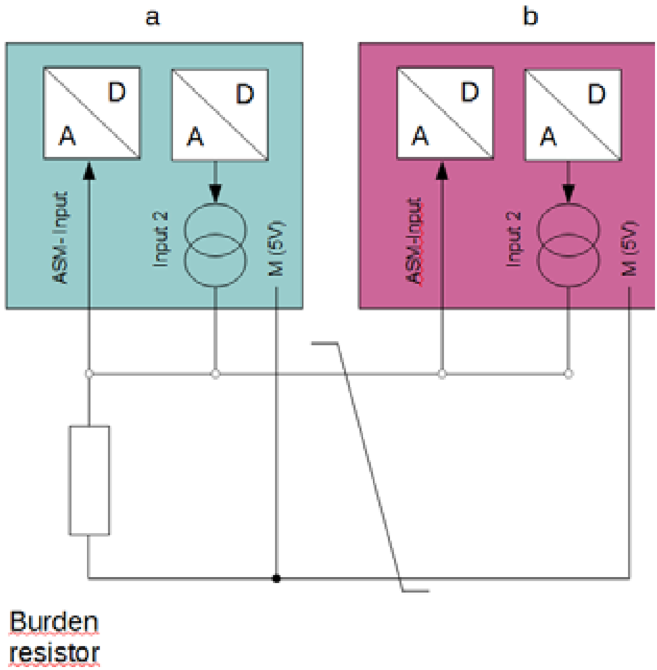
3.1 REQUIREMENTS

The ASM procedure requires the following standards:
· Groups of Thyro-P 1P or Thyro-P 2P to the same power supply
· All Thyro-P power controllers are equipped with a ASM control unit
· ASM wiring from ASM input to output 2 at each device (for details see operating instructions of Thyro-P)
· Operating mode TAKT
· 2 or more power controllers
· Thyro-Tool Family is available for parameterization

In principle it is possible to have simultaneously operation of Thyro-P and Thyro-M power controllers with the same ASM synchronization. For further information please contact Advanced Energy.

3.2 WIRING OF THE POWER CONTROLLER

For the application of ASM process it is necessary to wire the power controller together with a shared load resistor. ASM input and output 2 of each device have to be connected with each other and to one shared load resistor (therefore all ASM inputs and outputs 2 are connected with each other). In addition the reference potential (terminal X5.1.13) of all devices has to be connected to the other end of the burden resistor. The wiring scheme for 2 power controllers (unit a, unit b) can be seen in the following figure.

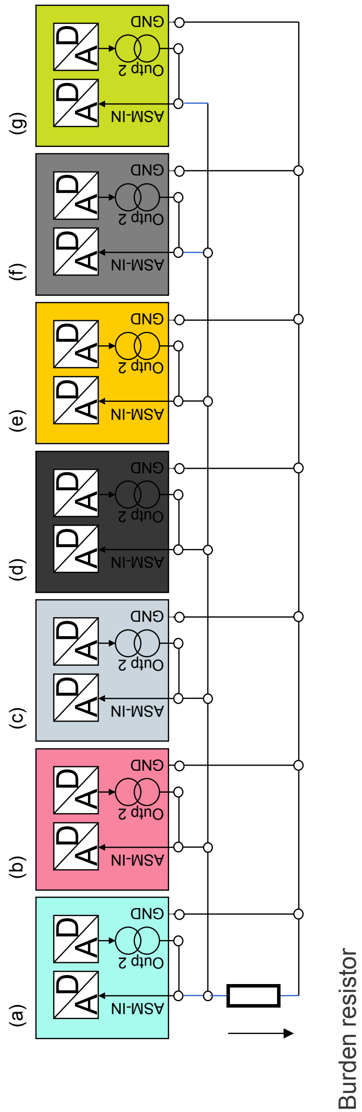


Only the involved control terminals of the power controller for ASM process are shown. To avoid pertubations, wiring has to be done with shielded/ twisted cables. The output 2 (of each power controller) has an proportional current in addition to load current, so that the total load is shown on burden resistor. As the ASM input connected to burden resistor, every power controller receives the current information about total load of the system, in consideration of respective parameterization. When evaluating its own load, every power controller had the option to participate actively in mains load optimization.

It is recommended to use ASM process with a higher total number of power controllers within an ASM network. Due to the fact that in many cases multiple power controller configurations are used for high power applications.

At a system of e.g. 7 power controllers of type Thyro-P 2P 500-280 HF, a power of 7 * 242 kW = 1,7 MW has to be optimized.

Regarding the illustration the wiring should to be done e.g. for 7 power controller (a-g). Wiring scheme of the power controller in ASM process:



Before using ASM process, the parameterization has to be done.

4. PARAMETERIZATION OF THE POWER CONTROLLER

The ASM parameterization of all Thyro-P's, which are involved in ASM process, results from the input of each calculated parameter value AD_P_ASM_I_SUMME. The value is the same for all Thyro-P power controllers. For a simple calculation of each value, the usage of the following table is possible for up to 20 power controller.

On the yellow marked fields, it is necessary to entry the following values to calculate parameter AD_P_ASM_I_SUMME:
· Number of phases of load
· Type voltage and type current of power controller
· Max. current of analog output 2 (in general: 20 mA)
· Max. burden resistor voltage (in general: 10 V)
· ASM reserve of modulation

It is necessary to specify the ASM reserve of modification due to prevention by load values via nominal modulation so that analog output 2 of power controller is not operating towards maximum and therefore the ASM process works less optimal. The actual occuring modulation of the power controller depends not only on set point but also on limiting values (Imax, Umax, Pmax). The entered data leads to calculation of burden resistor R_{burden}.

According to this result, one values will be choosen which is available as unit (lower or equal). This value will be chosen als Rburden and be inserted in the calculation table. The occurring data at burden from maximal burden voltage to maximal power loss will be calculated in the table.

The calculated parameter value AD_P_ASM_I_SUMME has to be entered into all power controllers via Thyro-Tool Family:
SYSTEM/Manual value inquiry/Storage space 318 (AD_P_ASM_I_SUMME)

Thereby the parameterization of ASM process is completed for all power controllers.

4.1 CALCULATION TABLE

The following table is available as EXCEL document and can be used for calculation of parameter AD_P_ASM_I_SUMME.

INPUT OF POWER CONTROLLER TYPE DATA AND LOAD								
NUMBER OF PHASES OF LOAD RESISTANCE				3				
orange fields are input fields								
NO.	TYPE SPECIFICATION		NOMINAL MODULATION	POWER	$I_{DAC\ 2}$ [MA] 100%	$I_{DAC\ 2}$ [MA] 100% + 6% ASM-RESERVE	POSSIBLE CONTROL-LER-RE-SERVE FOR MODULA-TION	$I_{ASM\ MAX}$
	VOLTAGE	CUR-RENT	$I_{CONTROLLER}$ AT $I_{LOAD\ NOM.}$ [A]	$P_{NOM.}$ [W]				
1	400	280	198,0	137.178	18,868	20,000	41,41%	209,9
2	400	280	198,0	137.178	18,868	20,000	41,41%	209,9
3	400	280	198,0	137.178	18,868	20,000	41,41%	209,9
4	400	170	160,5	111.198	15,294	16.212	5,92%	170,1
5	400	170	160,5	111.198	15,294	16.212	5,92%	170,1
6	400	170	160,5	111.198	15,294	16.212	5,92%	170,1
7	400	170	160,5	111.198	15,294	16.212	5,92%	170,1
8	400	170	160,5	111.198	15,294	16.212	5,92%	170,1
9	400	170	160,5	111.198	15,294	16.212	5,92%	170,1
10	400							
11	400							
12	400							
13	400							
14	400							
15	400							
16	400							
17	400							
18	400							
19	400							
20	400							
TOTAL		1.860	1.557	1.078.721	148,370	157,273	5,92%	

ANALOG VALUES		SELECT MODULATION RESERVE		
I DAC 2 $_{MAX.}$ [MA]	20.000	ASM-MODULATION RESERVE SELECTED	6.00%	
$U_{BURDEN\ MAX.}$ [V]	10.000			
BURDEN RESISTOR				
CALCULATION		R_{BURDEN} CALCULATED =	63.584	OHM
		$U_{BURDEN\ 100\%}$, CALCULATED	9.43	V
		$P_{BURDEN\ MAX}$ (INCL. MODULATION RESERVE) =	1.573	W
SELECTION		R_{BURDEN}, SELECTED =	56.000	OHM
		$U_{BURDEN\ MAX}$. =	8.807	V
		$P_{BURDEN\ MAX}$ (INCL. 6 % MODULATION RESERVE) =	1.385	W
PARAMETER SETTING				
			209.880	A
PARAMETER SETTING AD_P_ASM_I_SUMME („SUMMENSTROM“) =			210	A

5. FUNCTION

In case of ASM process, it operates as dynamic process, e.g. automated synchronization to set point and load changes. Mains load optimization is an overlaying process to the operating mode which manages the switch on points in the operating mode TAKT and thereby reduces the periodical switch on peaks.

The power controller with ASM process interacts just as a power controller in operating mode TAKT, i.e. control algorithm, limitations etc. work unchanged.

5.1 EXAMPLE OF FUNCTION OF ASM PROCESS

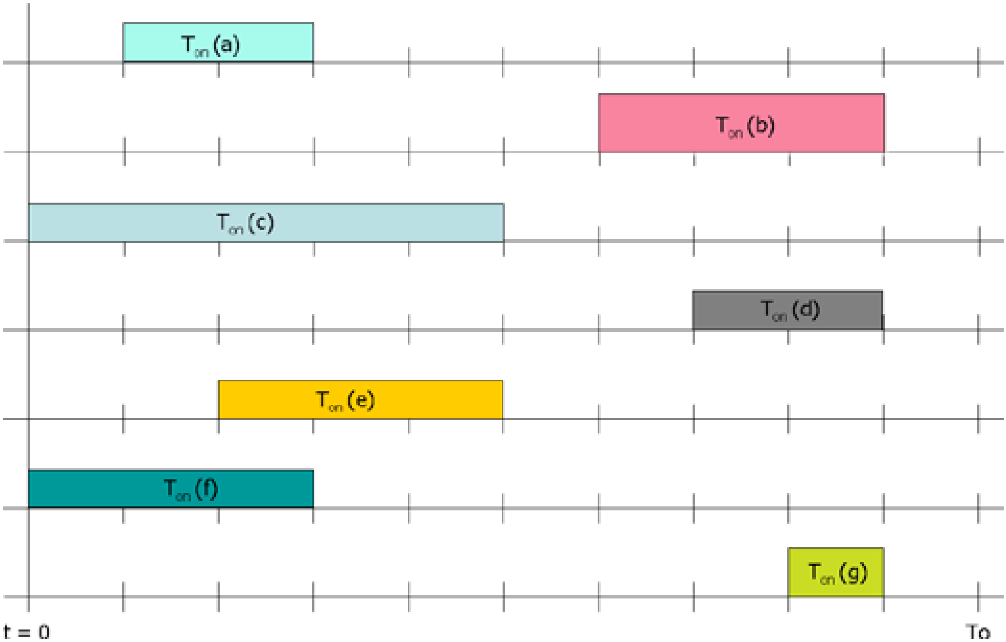
The following figure shows the single loads of 7 power controllers in TAKT operation mode with different switch on points T_{ON} as well as different load values.

The power controllers are not synchronized and add up to the total load which can be seen at the bottom of the figure.

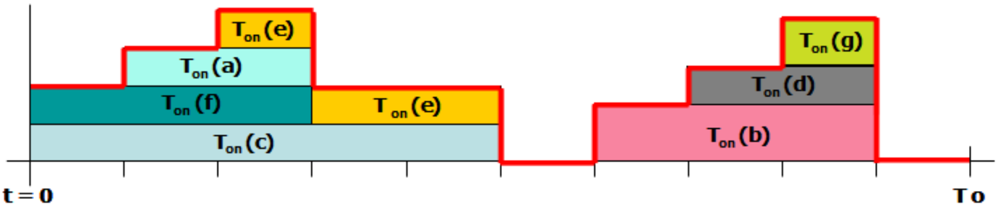
In this regard the example is only for the purpose of illustration but it does not show the worst-case scenario.

EXAMPLE WITHOUT SYNCHRONIZAT ION

SINGLE LOADS OF THE 7 POWER CONTROLLERS (A)–(G))



TOTAL LOAD OF THE 7 NON-SYNCHRONIZED POWER CONTROLLERS (A)–(G)



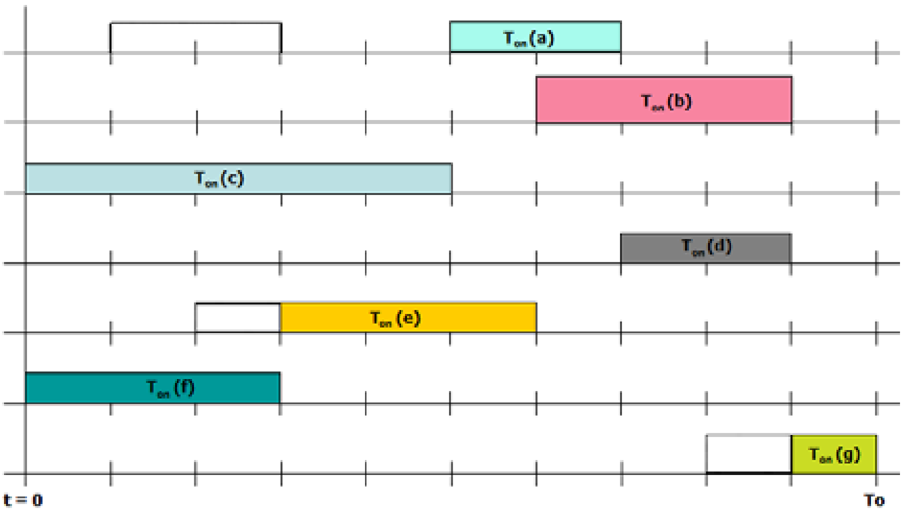
The total load has besides considerably amplitudes also zero values as well as a distinctive, disturbing dynamic-proportion.

To reduce resulting issues synchronization processes can be used which bring different improvements.

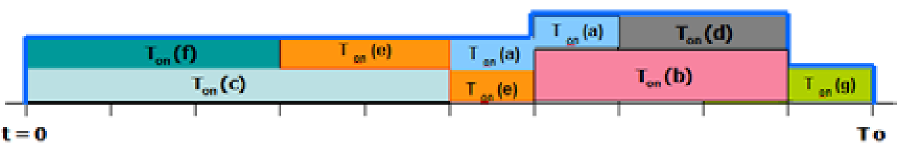
The ASM process offers optimal load ratios because it adjusted itself dynamically for set point changes as well as for load changes. The following figure shows the impacts of ASM process for given set point and load settings on the example mentioned above

EXAMPLE WITH SYNCHRONIZAT ION

SINGLE LOADS OF THE 7 NON-SYNCHRONIZED POWER CONTROLLERS (A)–(G)



TOTAL LOAD OF THE 7 SYNCHRONIZED POWER CONTROLLERS (A) - (G)



The impacts of synchronization can be seen on the shifted load curves of the power controllers (a), (e) and (g).

The existing "load valleys", due to no synchronization, are raised by adaption of graphs (a), (e) and (g) and at the same time the peaks of total load are reduced considerably.

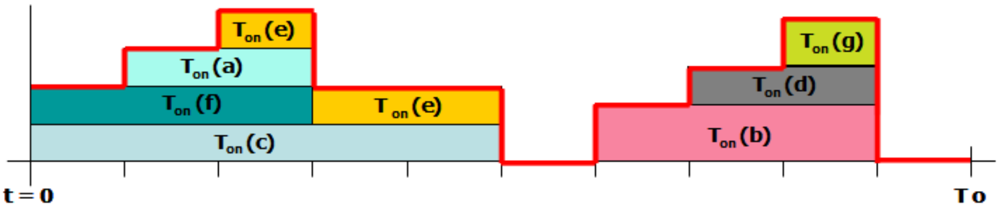
The dynamic of system load and thereby the system perturbations are reduced significantly without distinctive total peaks loads and load valleys.

The following figure shows the direct comparison of non-synchronized and synchronized power controllers, whereas the worst-case scenario is not illustrated here

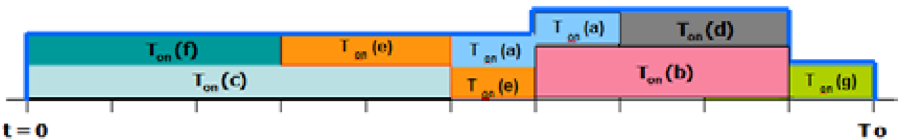
EXAMPLE

COMPARISON WITH AND WITHOUT SYNCHRONIZATION

Total load of the 7 non-synchronized power controllers (a)–(g)



Total load of the 7 synchronized power controllers (a)–(g)



This figure shows how power controllers have varied the switch on points of load for the given set point and load case.

The maximum values of total load are in this example about 3 : 2.

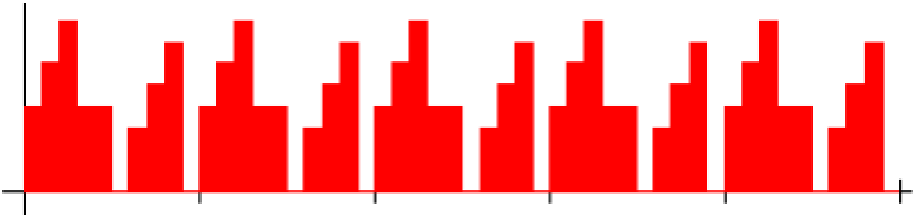
The dynamic ratio is like 2,1 : 1.

The figure above shows the load cycle for interval period T_0.

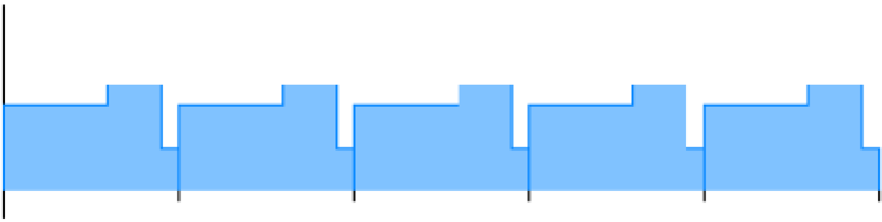
In comparison following figure shows the same graph for 5 TAKT-periods again without set point or load changes.

EXAMPLE
8 TAKT PERIODS IN COMPARISON

Total load of the 7 non-synchronized power controllers (a) - (g)



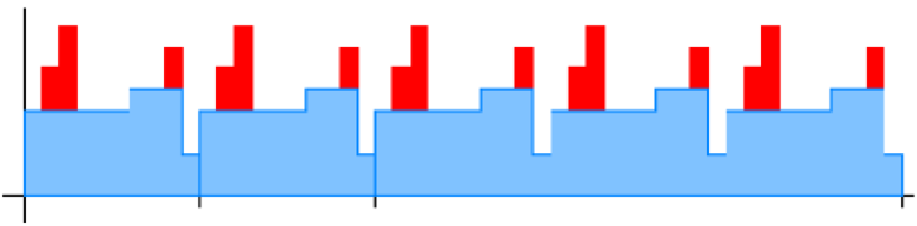
Total load of the 7 synchronized power controllers (a) - (g)



It still becomes apparent how advantageous the reduction is of dynamic ratio as well as maximum values of system load with ASM process.
The synchronized power controllers operate with advantageous small dynamic ratios, i.e. with optimal system load.
The following figure shows both curves in combined illustration.

EXAMPLE
5 TAKT PERIODS IN COMPARISON

Total load with / without in one figure



6. CONCLUSION

In case of the ASM process (automated synchronization of multiple controller applications), changes in set point and load (for instance due to temperature-dependent load) are included in mains load optimization online. Especially when using heating elements with a large aging effect, which during new operation have high current amplitudes with short startup time, lower investment cost may be achieved.

The benefits of mains load optimization mean in technical terms:
· reduction of the periodic mains peak demand
· reduction of system perturbation
· reduced installation size (transformer, mains supply, cable installation etc.)

Mains load optimization economical means:
· reduced operating expenses
· reduced investment costs

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Specifications are subject to change without notice.