



APPLICATION GUIDE FOR AC DAISY CHAINING OPTION

Proper sizing of fuses and cables when using AC Daisy Chaining

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1 INTRODUCTION

This paper deals with the new AC Daisy Chaining option, which can be used in combination with the Fronius Tauro commercial inverter series.

In the following chapters, you will be given an insight into the innovative design options as well as important safety information that will help you to design and choose the right cabling. In addition, practical examples with different system sizes will help you understand the AC Daisy Chaining option in detail.

Furthermore, the combination of SnapINverters and Tauro in connection with AC Daisy Chaining is also explained.

2 AC DAISY CHAINING OPTION

The Fronius Tauro is available with a design option known as AC DAISY CHAINING, offering greater flexibility in system design and huge potential for BOS cost savings.

2.1 What is AC Daisy Chaining?

AC Daisy Chaining is available as an option with the Fronius Tauro. With this option, a rudimentary AC distributor is integrated in the AC section, which enables several inverters to be linked on the AC side. With the special AC section in the device for cable connections, it is possible to connect several devices of up to 200 kW directly to one another. This results in enormous savings on AC cables and other components such as AC distributors or AC disconnectors. For a 200 kW unit in the PV array, AC Daisy Chaining would have the following impact:

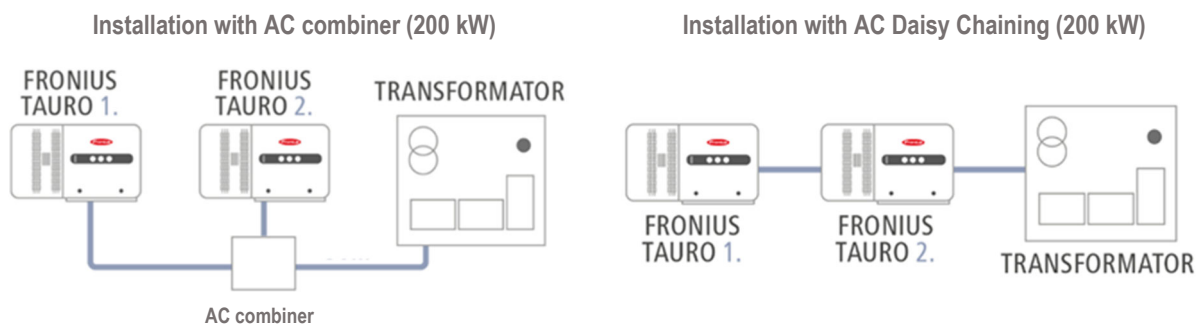


Figure 1: Comparison of system design 1 with AC distributor and system design 2 with AC Daisy Chaining option

The PV block on the left of the image shows two cables, each with a 100 kW inverter. Due to the distance and the cable cross-section, several AC combiner boxes would be needed on the way to the transformer in order to bring the AC cables together at a single point.

By contrast, when using the AC Daisy Chaining option – shown on the right of the image – two 100 kW inverters, four 50 kW inverters or a mixture of the two variants can be connected to each other on the AC side and a joint AC cable to the transformer/main connection [AD2] can be installed. This example not only saves on AC combiner boxes, but also one third of the AC cables. This ultimately generates huge savings in the BOS costs.

3 CORRECT APPLICATION OF AC DAISY CHAINING

When using this new option, selecting the right cable cross-section and fuses is crucial. To select the right cables, it helps to think of an imaginary single inverter with the same total power output as the real inverters. For example, when using AC Daisy Chaining with two Tauro Eco 50-3-D, think of an inverter with an output of 100 kW and select the appropriate fuse rating accordingly.

The most important question regarding safety and installation standards is then: which cable needs to be fitted to which fuse? Furthermore, it is smart to consider cable losses as well. Just because a smaller cross-section can theoretically be used, it is not always the best option to go for the smallest and therefore cheapest cable. **Losses in cables can be significant and should be considered every time.**

The following examples are calculated with the German cabling standard. Please always consider your local rules.

3.1 AC Daisy Chaining with Tauro

Since AC Daisy Chaining is a new design option available with the Fronius Tauro, this product series will always be involved. AC Daisy Chaining can bring many advantages. When using this option it is crucial that the right cables and fuses are chosen. It is important that the fuses protect all downstream cables and devices.

3.2 Fuse sizes

Fuses (breakers, etc.) come in several different ratings. In this paper we will only consider “NH fuses”, as they are commonly available, easy to install and cheap. The following table shows different NH fuses and ratings.

		SIZE OF NH FUSES			
		00	1	2	3
RATING [A]	6				
	10				
	16				
	20				
	25		25		
	32		32		
	40		40		
	50				
	63		63	63	
	80		80	80	
	100		100	100	
	125		125	125	
	160		160	160	
			200	200	
			224	224	
			250	250	
				315	315
				355	355
				400	400
					500
				630	

Table 1: NH fuse sizes

3.3 Current carrying capacity with buried cables

The current carrying capacity of cables can be used to calculate which cross-section and which fuse is required for the respective system. It makes a difference to the current carrying capacity whether a cable is buried underground or whether it is exposed. The following examples deal with systems where the cables are buried.

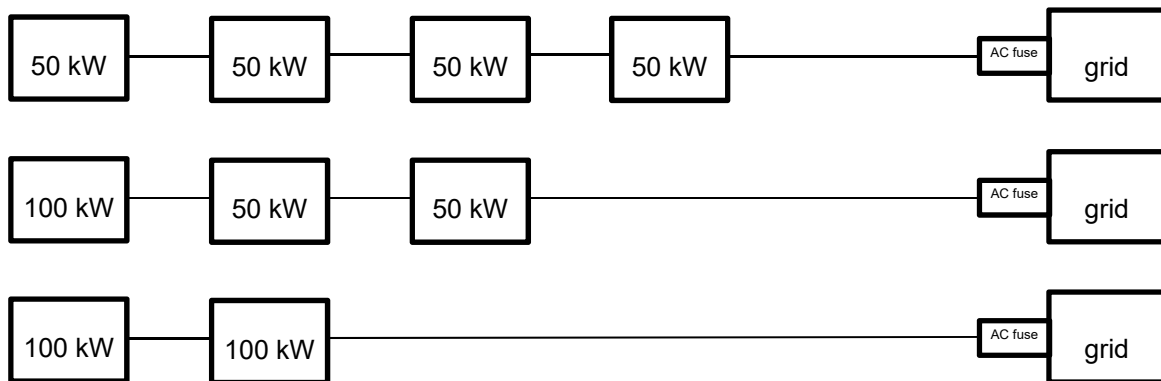
The following examples are calculated with the German cabling standard. Please always consider your local rules.

Cross-section [in mm]	1.5	2.5	4	6	10	16	25	35	50	70	95	120	150	185	240
	Carrying capacity [in A]														
NYY	27	36	47	59	79	102	133	159	188	232	290	318	359	406	473
NYCWY	27	39	49	59	79	102	133	160	190	234	280	319	357	402	463
NAYY	-	-	-	-	-	-	102	123	144	179	215	245	275	313	364
NAYCWY	-	-	-	-	-	-	103	123	145	180	216	246	276	313	362

Table 2: Current carrying capacity of buried cables based on DIN VDE 0 298-4

3.3.1 200 kW Daisy Chain

Since Fronius Tauro commercial inverters are available in 50, 99 and 100 kW versions, there are three possible ways to establish a 200 kW system with Tauro devices.



Picture 1: Possible setup of 200 kW Tauro system

It does not matter what type of Tauro (ECO 100, ECO 50, 50) is used and in which position it is actually placed. The total AC operating current of the system is important for selecting the right fuse and therefore choosing the right cables. When choosing the cable we look for the smallest possible aluminium cable (NAYY) cross-section which is capable of handling the current.

Total AC operating current: ~290 A per phase (200,000 W / 3 phases / 230 V)

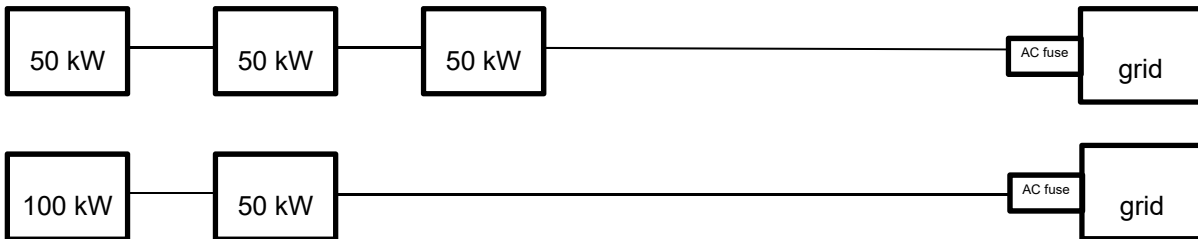
Next biggest fuse size: 315 A

Min. cross-section of aluminium cable: 240 mm²

This means: every cable combination with cables starting from 240 mm² and bigger is allowed!

3.3.2 150kW Daisy Chain

Since Fronius Tauro commercial inverters are available in 50, 99, and 100 kW versions, there are three possible ways to establish a 150 kW system with Tauro devices.



Picture 2: Possible setup of 150 kW Tauro system

It does not matter what type of Tauro (ECO 100, ECO 50, 50) is used and in which position it is actually placed. The total AC operating current of the system is important for selecting the right fuse and therefore choosing the right cables. When choosing the cable we look for the smallest possible aluminium cable (NAYY) cross-section which is capable of handling the current.

Total AC operating current: ~217 A per phase (150,000 W / 3 phases / 230 V)

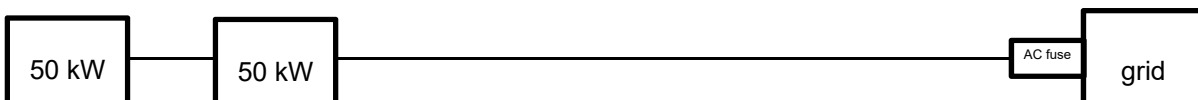
Next biggest fuse size: 224 A

Min. cross-section of aluminium cable: 120 mm²

This means: every cable combination with cables starting from 120 mm² and bigger is allowed!

3.3.3 100kW Daisy Chain

Fronius Tauro commercial inverters are available in 50, 99, and 100 kW versions, there is only one possible configuration that can include AC Daisy Chaining within a 100 kW system.



Picture 3: Possible setup of 100 kW Tauro system

It does not matter what type of Tauro (ECO 50, 50) is used and in which position it is actually placed. The total AC operating current of the system is important for selecting the right fuse and therefore choosing the right cables. When choosing the cable we look for the smallest possible aluminium cable (NAYY) cross-section which is capable of handling the current.

Total AC operating current: ~145 A per phase (100,000 W / 3 phases / 230 V)

Next biggest fuse size: 160 A

Min. cross-section of aluminium cable: 70 mm²

This means: every cable combination with cables starting from 70 mm² and bigger is allowed!

3.4 Current carrying capacity for cables above ground

As stated before, it makes a difference to the current carrying capacity whether a cable is buried underground or whether it is exposed. The following examples deal with systems where the cables are installed above ground.

The following examples are calculated with the German cabling standard. Please always consider your local rules.

Cross-section [in mm]	1.5	2.5	4	6	10	16	25	35	50	70	95	120	150	185	240
	Carrying capacity [in A]														
NY Y	19,5	25	34	43	59	79	106	129	157	199	246	285	326	374	445
NY CWY	19,5	26	34	44	60	80	108	132	160	202	249	289	329	377	443
NAY Y	-	-	-	-	-	-	82	100	119	152	186	216	246	285	338
NAY CWY	-	-	-	-	-	-	83	101	212	155	189	220	249	287	339

Table 3: Current carrying capacity of cables above ground based on DIN VDE 0 298-4

3.4.1 200kW Daisy Chain

It does not matter what type of Tauro (ECO 100, ECO 50, 50) is used and in which position it is actually placed. The total AC operating current of the system is important for selecting the right fuse and therefore choosing the right cables. When choosing the cable we look for the smallest possible aluminium cable (NAY Y) cross-section which is capable of handling the current.

Total AC operating current: ~290 A per phase (200,000 W / 3 phases / 230 V)

Next biggest fuse size: 315 A

Min. cross-section of aluminium cable: 240 mm²

This means: every cable combination with cables starting from 240 mm² and bigger is allowed!

3.4.2 150kW Daisy Chain

It does not matter what type of Tauro (ECO 100, ECO 50, 50) is used and in which position it is actually placed. The total AC operating current of the system is important for selecting the right fuse and therefore choosing the right cables. When choosing the cable we look for the smallest possible aluminium cable (NAY Y) cross-section which is capable of handling the current.

Total AC operating current: ~217 A per phase (150,000 W / 3 phases / 230 V)

Next biggest fuse size: 224 A

Min. cross-section of aluminium cable: 150 mm²

This means: every cable combination with cables starting from 150 mm² and bigger is allowed!

3.4.3 100kW Daisy Chain

It does not matter what type of Tauro (ECO 50, 50) is used and in which position it is actually placed. The total AC operating current of the system is important for selecting the right fuse and therefore choosing the right cables. When choosing the cable we look for the smallest possible aluminium cable (NAYY) cross-section which is capable of handling the current.

Total AC operating current: ~145 A per phase (100,000 W / 3 phases / 230 V)

Next biggest fuse size: 160 A

Min. cross-section of aluminium cable: 70 mm²

This means: every cable combination with cables starting from 70 mm² and bigger is allowed!

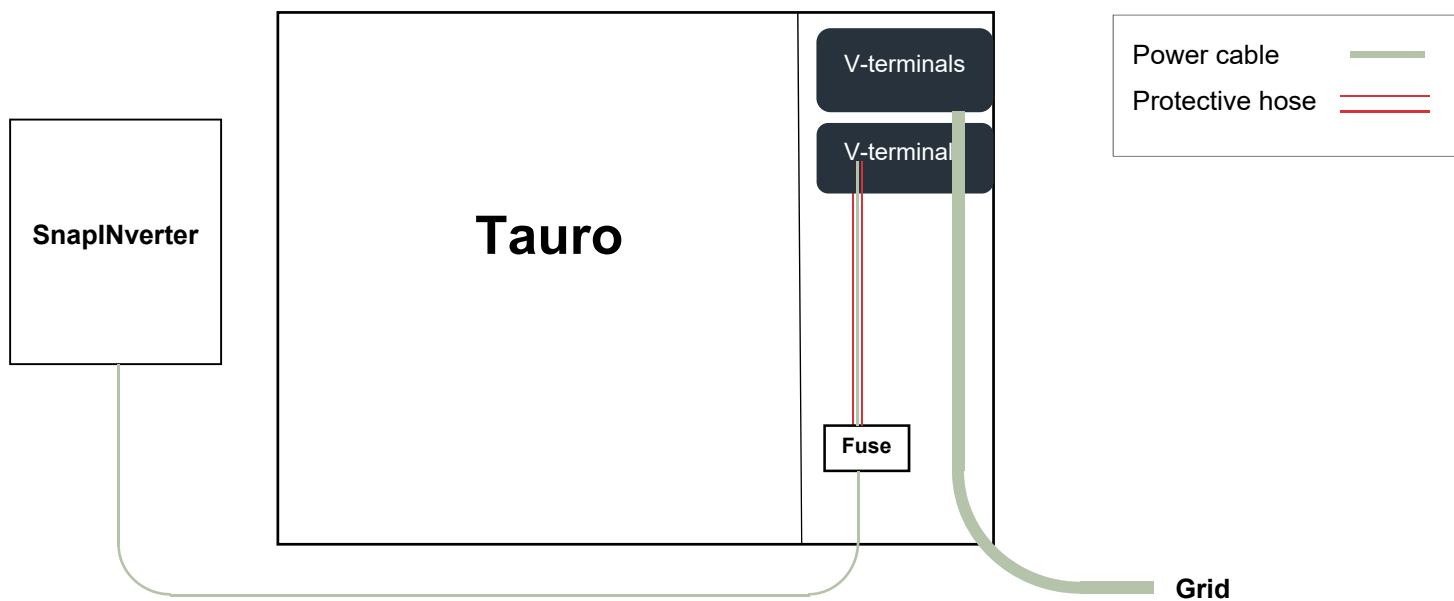
Attention: Temperature deratings and other factors have not been taken into account here. Always ensure proper cable handling while burying or using cable trays. Please also adhere to local regulations concerning cabling and fusing.

4 AC DAISY CHAINING WITH SNAPINVERTERS

It is also possible to use the Tauro AC Daisy Chaining option in combination with the Fronius SnapINverter series. Since only the Fronius Tauro can be ordered with the AC Daisy Chaining pre-installed, the Fronius SnapINverters always have to be positioned at the beginning of the chain.

4.1 Fusing and installation

When connecting a Fronius SnapINverter to a Fronius Tauro using AC Daisy Chaining, a fuse to protect the SnapINverter and the cable connected to it is essential. Please note that even the largest SnapINverter has to be fused with max. 80 A.



Picture 4: Cable installation of SnapINverter Symo 20 and Tauro ECO-100-D

It is important to also consider the proper fusing of the cables inside the inverter. **Please keep in mind that the inside of the Tauro can get hot (up to 70°C) and cold (see temperature operating range) and it is necessary to select a fuse that can operate under high temperatures as well.**

The cable for the SnapINverter has to be protected inside the Tauro to be “short-circuit-safe”. This means some sort of protective hose should be used. This protective hose also helps to protect the cable itself from high temperatures. In this case, the cable may be a small cross-section cable running to the SnapINverter. If no protection is used, then the cable must be the same size and meet the same specifications as the grid cable.

To install the fuse inside the AC connection area of the Tauro, the C-bar, which is screwed to the inverter, has to be replaced with a top-hat rail. A standard fuse holder or circuit breaker can then be fitted to it.

A “communication daisy chain” between the Tauro and SnapINverter is not possible. Each inverter has to be connected individually to the network by a LAN cable.

The grid cable still has to be designed for the maximum power of the entire inverter system as usual.

4.2 Example

4.2.1 20 kW Symo with Tauro ECO 100-3-D

The total AC operating current of the system is important for selecting the right fuse and therefore choosing the right cables. When choosing the cable we look for the smallest possible aluminium cable (NAYY) cross-section which is capable of handling the current.

Total AC operating current: ~174 A per phase (120,000 W / 3 phases / 230 V)

TAURO+SYMO

Next biggest fuse size: 200 A

Min. cross-section of aluminium cable: 95 mm²

This means: every cable combination with cables starting from 95 mm² and bigger is allowed!

SYMO

Min. fuse rating: 30 A

Min. cross-section of CU cable: 4 mm²

For the sake of loss reduction and due to the potential high temperatures inside the Tauro, it is recommended to choose a larger cross-section and a higher fuse rating (80 A fuses are allowed for the Symo 20).

Attention: A cable lug will be needed to connect a small cable cross-section to the Tauro, as the V-terminals only allow 35 mm² as a minimum cross-section.