

**RHF-Active design guide**



**Main**

Product type	Active harmonic filter for reduction of the harmonic distortion of variable frequency drives or other non linear loads. This filter reduces the THD of the current from typically 35% to below 5%.
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**SiC-MOSFET based RHF-Active**

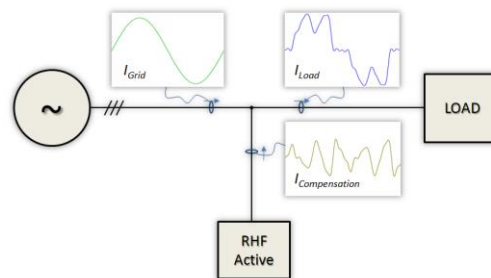
Available size	15A / 30A / 55A (parallel)
Supply voltage	3 • 380 - 480V (+10% / -15%) 50Hz/60Hz (+/- 2%)
Technology	SiC-Power MOSFET's and Schottky Diodes allows for very high efficiency and also enables switching frequency of 50kHz, which results in efficient elimination of high harmonics.

**3-Level IGBT Based RHF-Active**

Available size	100A (parallel setups possible)
Supply voltage	3 • 380 - 415V (+10% / -15%) 50Hz/60Hz (+/- 2%)
Technology	SiC-Power MOSFET's and Schottky Diodes allows for very high efficiency and also enables switching frequency of 50kHz, which results in efficient elimination of high harmonics.

**Sizing recommendation**

Active Harmonic Filters are parallel filter circuits injecting harmonics into the supply. These Harmonics have phase shift of 180° compared to the harmonics in the system. Therefore the injected Harmonics are eliminating the Harmonics seen from the mains supply. The following picture helps to verify the principle.



Based on this parallel topology, the required filter current is not equal to the load current.

**Harmonic Current evaluation**

The following equation can be used for evaluation of the required harmonic filter current based on existing THDi and input current.

$$I_{HFC} = \sqrt{\frac{I_{RMS}^2}{1 + \frac{1}{(THDi - THDi_{target})^2}}} * 1.062$$

When improving the line current with an active filter, the mains voltage distortion will improve, which leads to a higher distortion of the load current. Therefore its recommended to add safety factor (1.062). This factor is based on experience and may differ significant depending on mains condition. The factor is based on Active filter with SiC technology. Using the 3-Level IGBT a factor of 1,071 should be used.

**Input current of drives**

In order to calculate the required harmonic current, the I<sub>RMS</sub> of the Load is required. Most frequently used load is a VFD. The designated input current stated by the VFD supplier are referring to the maximum possible input current. This may differ significant mainly depending on mains voltage. Therefore the following table can be used as a estimation of the input current based on motor load and corresponding voltage. The calculated values are based on Motors with IE3 efficiency or higher. Motors with lower efficiency will likely cause higher input currents.

The results shown in the tables are indicating the required compensation current. In order to calculate the required filter current the factor 1,062 (SiC) or 1,071 (3-Level IGBT) should be used.

All values are approximations and are not a suitable for substitute of a harmonic analysis.

Estimation table for required harmonic compensation current

Reference list for 5% THDi / 380V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	7,2	2,7	2,4	2,1
5,5	9,9	3,7	3,3	2,8
7,5	13,5	5,0	4,5	3,9
11,0	19,8	7,4	6,6	5,7
15,0	27,0	10,0	8,9	7,8
18,5	33,4	12,4	11,0	9,6
22,0	39,7	14,7	13,1	11,4
30,0	54,1	20,1	17,9	15,5
37,0	66,7	24,8	22,0	19,2
45,0	81,1	30,1	26,8	23,3
55,0	99,2	36,8	32,8	28,5
75,0	135,2	50,2	44,7	38,9
90,0	162,3	60,3	53,6	46,6
110,0	198,3	73,7	65,5	57,0
132,0	238,0	88,4	78,6	68,4
160,0	288,5	107,1	95,3	82,9
185,0	333,6	123,9	110,2	95,9
200,0	360,6	133,9	119,1	103,6
220,0	396,7	147,3	131,0	114,0
250,0	450,8	167,4	148,9	129,5
280,0	504,9	187,5	166,8	145,1

Estimation table for required harmonic compensation current

Reference list for 5% THDi / 400V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	6,9	2,5	2,3	2,0
5,5	9,4	3,5	3,1	2,7
7,5	12,8	4,8	4,2	3,7
11,0	18,8	7,0	6,2	5,4
15,0	25,7	9,5	8,5	7,4
18,5	31,7	11,8	10,5	9,1
22,0	37,7	14,0	12,4	10,8
30,0	51,4	19,1	17,0	14,8
37,0	63,4	23,5	20,9	18,2
45,0	77,1	28,6	25,5	22,1
55,0	94,2	35,0	31,1	27,1
75,0	128,5	47,7	42,4	36,9
90,0	154,2	57,3	50,9	44,3
110,0	188,4	70,0	62,2	54,1
132,0	226,1	84,0	74,7	65,0
160,0	274,1	101,8	90,5	78,8
185,0	316,9	117,7	104,7	91,1
200,0	342,6	127,2	113,2	98,4
220,0	376,9	140,0	124,5	108,3
250,0	428,2	159,0	141,5	123,1
280,0	479,6	178,1	158,4	137,8

Estimation table for required harmonic compensation current

Reference list for 5% THDi / 415V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	6,6	2,5	2,2	1,9
5,5	9,1	3,4	3,0	2,6
7,5	12,4	4,6	4,1	3,6
11,0	18,2	6,7	6,0	5,2
15,0	24,8	9,2	8,2	7,1
18,5	30,5	11,3	10,1	8,8
22,0	36,3	13,5	12,0	10,4
30,0	49,5	18,4	16,4	14,2
37,0	61,1	22,7	20,2	17,6
45,0	74,3	27,6	24,5	21,3
55,0	90,8	33,7	30,0	26,1
75,0	123,8	46,0	40,9	35,6
90,0	148,6	55,2	49,1	42,7
110,0	181,6	67,5	60,0	52,2
132,0	217,9	80,9	72,0	62,6
160,0	264,2	98,1	87,3	75,9
185,0	305,4	113,4	100,9	87,8
200,0	330,2	122,6	109,1	94,9
220,0	363,2	134,9	120,0	104,4
250,0	412,8	153,3	136,4	118,6
280,0	462,3	171,7	152,7	132,8

Estimation table for required harmonic compensation current

Reference list for 5% THDi / 480V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	5,7	2,1	1,9	1,6
5,5	7,9	2,9	2,6	2,3
7,5	10,7	4,0	3,5	3,1
11,0	15,7	5,8	5,2	4,5
15,0	21,4	8,0	7,1	6,2
18,5	26,4	9,8	8,7	7,6
22,0	31,4	11,7	10,4	9,0
30,0	42,8	15,9	14,1	12,3
37,0	52,8	19,6	17,4	15,2
45,0	64,2	23,9	21,2	18,5
55,0	78,5	29,2	25,9	22,6
75,0	107,1	39,8	35,4	30,8
90,0	128,5	47,7	42,4	36,9
110,0	157,0	58,3	51,9	45,1
132,0	188,4	70,0	62,2	54,1
160,0	228,4	84,8	75,5	65,6
185,0	264,1	98,1	87,2	75,9
200,0	285,5	106,0	94,3	82,0
220,0	314,0	116,6	103,7	90,2
250,0	356,9	132,5	117,9	102,5
280,0	399,7	148,4	132,0	114,9

Estimation table for required harmonic compensation current

Reference list for 10% THDi / 380V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	7,2	2,7	2,4	2,1
5,5	9,9	3,7	3,3	2,8
7,5	13,5	5,0	4,5	3,9
11,0	19,8	7,4	6,6	5,7
15,0	27,0	10,0	8,9	7,8
18,5	33,4	12,4	11,0	9,6
22,0	39,7	14,7	13,1	11,4
30,0	54,1	20,1	17,9	15,5
37,0	66,7	24,8	22,0	19,2
45,0	81,1	30,1	26,8	23,3
55,0	99,2	36,8	32,8	28,5
75,0	135,2	50,2	44,7	38,9
90,0	162,3	60,3	53,6	46,6
110,0	198,3	73,7	65,5	57,0
132,0	238,0	88,4	78,6	68,4
160,0	288,5	107,1	95,3	82,9
185,0	333,6	123,9	110,2	95,9
200,0	360,6	133,9	119,1	103,6
220,0	396,7	147,3	131,0	114,0
250,0	450,8	167,4	148,9	129,5
280,0	504,9	187,5	166,8	145,1

Estimation table for required harmonic compensation current

Reference list for 10% THDi / 400V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	6,9	2,3	2,0	1,7
5,5	9,4	3,1	2,7	2,3
7,5	12,8	4,2	3,7	3,1
11,0	18,8	6,2	5,4	4,6
15,0	25,7	8,5	7,4	6,2
18,5	31,7	10,5	9,1	7,7
22,0	37,7	12,4	10,8	9,1
30,0	51,4	17,0	14,8	12,5
37,0	63,4	20,9	18,2	15,4
45,0	77,1	25,5	22,1	18,7
55,0	94,2	31,1	27,1	22,9
75,0	128,5	42,4	36,9	31,2
90,0	154,2	50,9	44,3	37,4
110,0	188,4	62,2	54,1	45,7
132,0	226,1	74,7	65,0	54,8
160,0	274,1	90,5	78,8	66,5
185,0	316,9	104,7	91,1	76,9
200,0	342,6	113,2	98,4	83,1
220,0	376,9	124,5	108,3	91,4
250,0	428,2	141,5	123,1	103,9
280,0	479,6	158,4	137,8	116,3

Estimation table for required harmonic compensation current

Reference list for 10% THDi / 415V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	6,6	2,2	1,9	1,6
5,5	9,1	3,0	2,6	2,2
7,5	12,4	4,1	3,6	3,0
11,0	18,2	6,0	5,2	4,4
15,0	24,8	8,2	7,1	6,0
18,5	30,5	10,1	8,8	7,4
22,0	36,3	12,0	10,4	8,8
30,0	49,5	16,4	14,2	12,0
37,0	61,1	20,2	17,6	14,8
45,0	74,3	24,5	21,3	18,0
55,0	90,8	30,0	26,1	22,0
75,0	123,8	40,9	35,6	30,0
90,0	148,6	49,1	42,7	36,0
110,0	181,6	60,0	52,2	44,0
132,0	217,9	72,0	62,6	52,9
160,0	264,2	87,3	75,9	64,1
185,0	305,4	100,9	87,8	74,1
200,0	330,2	109,1	94,9	80,1
220,0	363,2	120,0	104,4	88,1
250,0	412,8	136,4	118,6	100,1
280,0	462,3	152,7	132,8	112,1

Estimation table for required harmonic compensation current

Reference list for 10% THDi / 480V				
VFD Load / Total VFD Load [kW]	I <sub>INPUT</sub> [A]	Compensation Current Req. from 45% THDi [A]	Compensation Current Req. from 40% THDi [A]	Compensation Current Req. from 35% THDi [A]
4	5,7	1,9	1,6	1,4
5,5	7,9	2,6	2,3	1,9
7,5	10,7	3,5	3,1	2,6
11,0	15,7	5,2	4,5	3,8
15,0	21,4	7,1	6,2	5,2
18,5	26,4	8,7	7,6	6,4
22,0	31,4	10,4	9,0	7,6
30,0	42,8	14,1	12,3	10,4
37,0	52,8	17,4	15,2	12,8
45,0	64,2	21,2	18,5	15,6
55,0	78,5	25,9	22,6	19,0
75,0	107,1	35,4	30,8	26,0
90,0	128,5	42,4	36,9	31,2
110,0	157,0	51,9	45,1	38,1
132,0	188,4	62,2	54,1	45,7
160,0	228,4	75,5	65,6	55,4
185,0	264,1	87,2	75,9	64,0
200,0	285,5	94,3	82,0	69,2
220,0	314,0	103,7	90,2	76,2
250,0	356,9	117,9	102,5	86,6
280,0	399,7	132,0	114,9	96,9