Technical Information Document

Sunny Central UP (-US)

Agenda

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1. Efficiency

The conversion efficiency of the inverter is defined by the ratio of AC output power to DC input power. The main losses occur as waste heat due to switching and conducting losses inside the IGBT's of the inverter and due to the inductance of the sine filter choke. Depending on the methodology of measuring the efficiency, the self-consumption of the inverter can also be integrated into the efficiency calculation as it is done with the CEC efficiency rating.
The conversion efficiency strongly depends on the DC voltage with the highest efficiency being experienced at the lowest possible DC voltage for this type of inverter bridge topology.

a) Efficiency without auxiliary losses

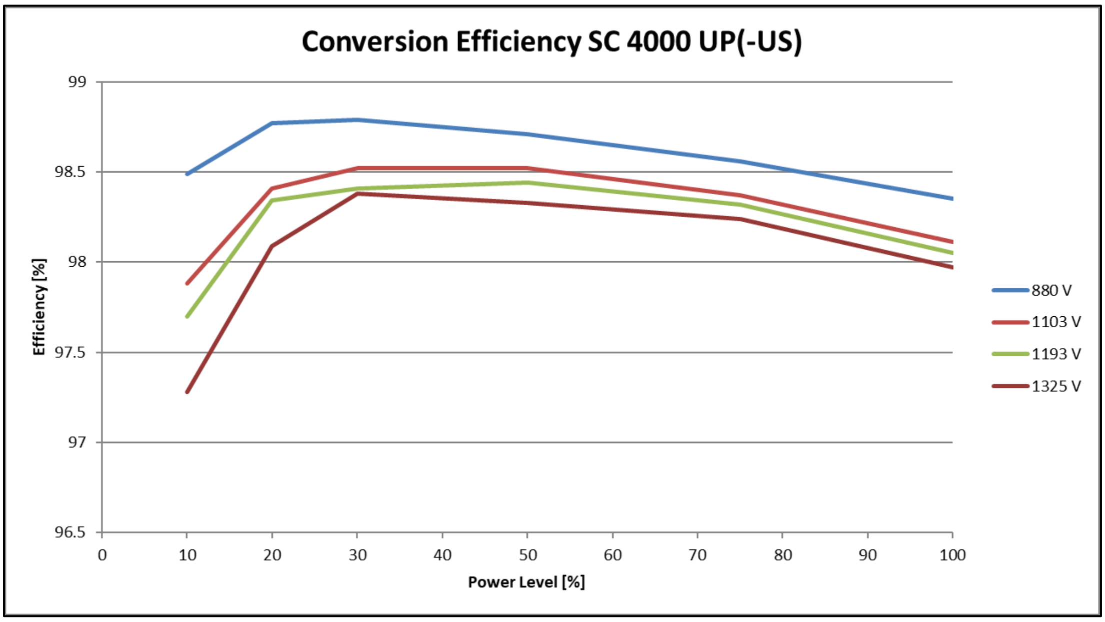


Figure 1: Efficiency without aux. losses at 25 °C measured according to IEC 61683

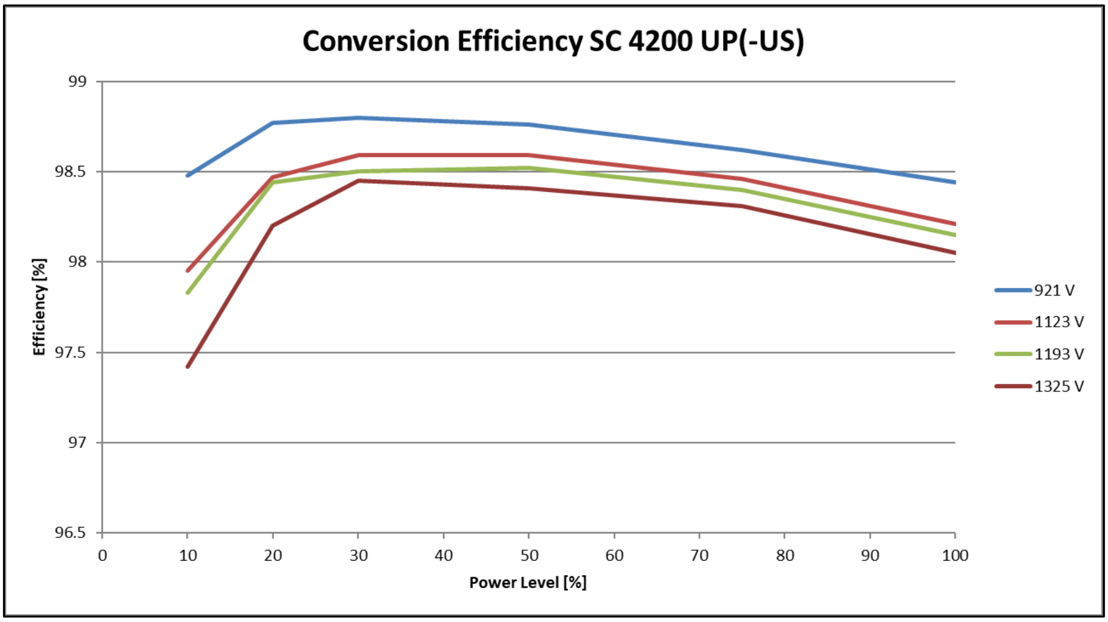


Figure 2: Efficiency without aux. losses at 25 °C measured according to IEC 61683

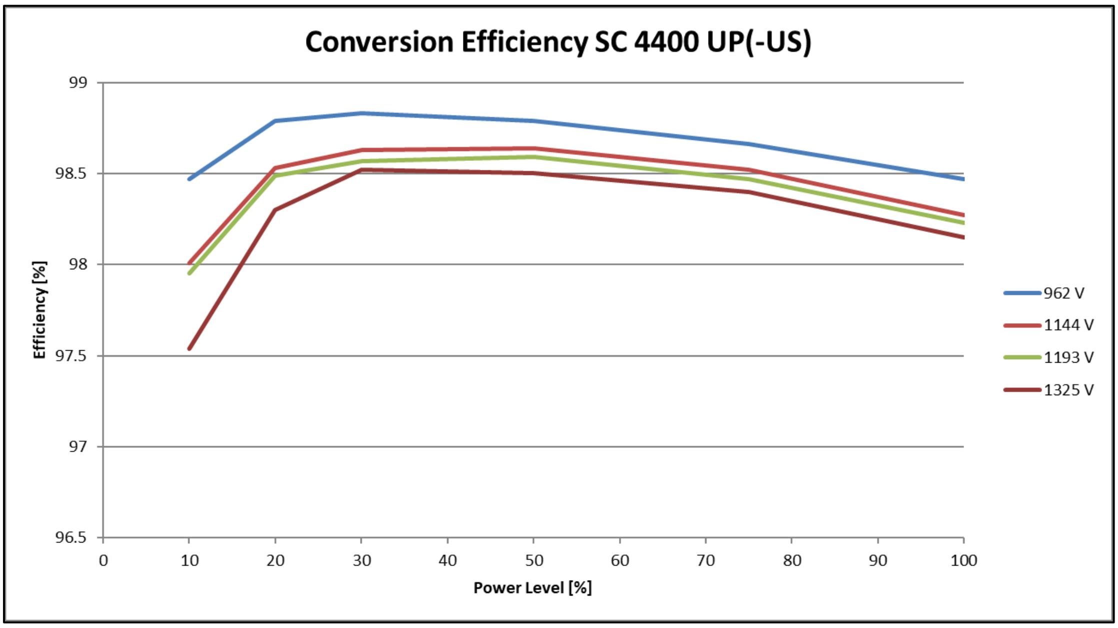


Figure 3: Efficiency without aux. losses at 25 °C measured according to IEC 61683

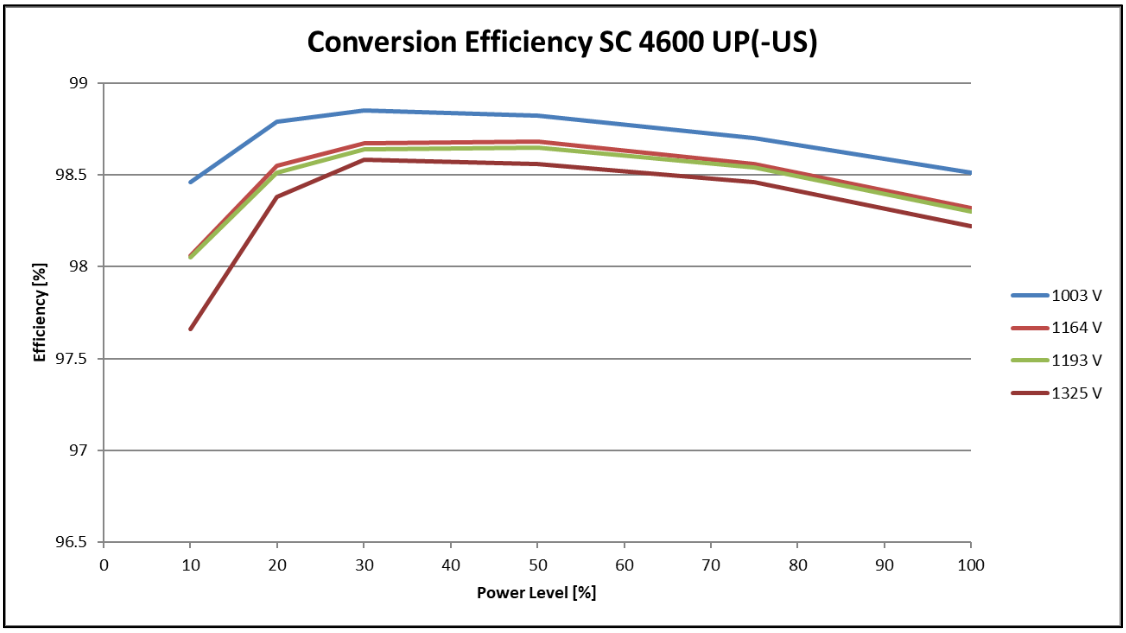


Figure 4: Efficiency without aux. losses at 25 °C measured according to IEC 61683

b) Efficiency with auxiliary losses

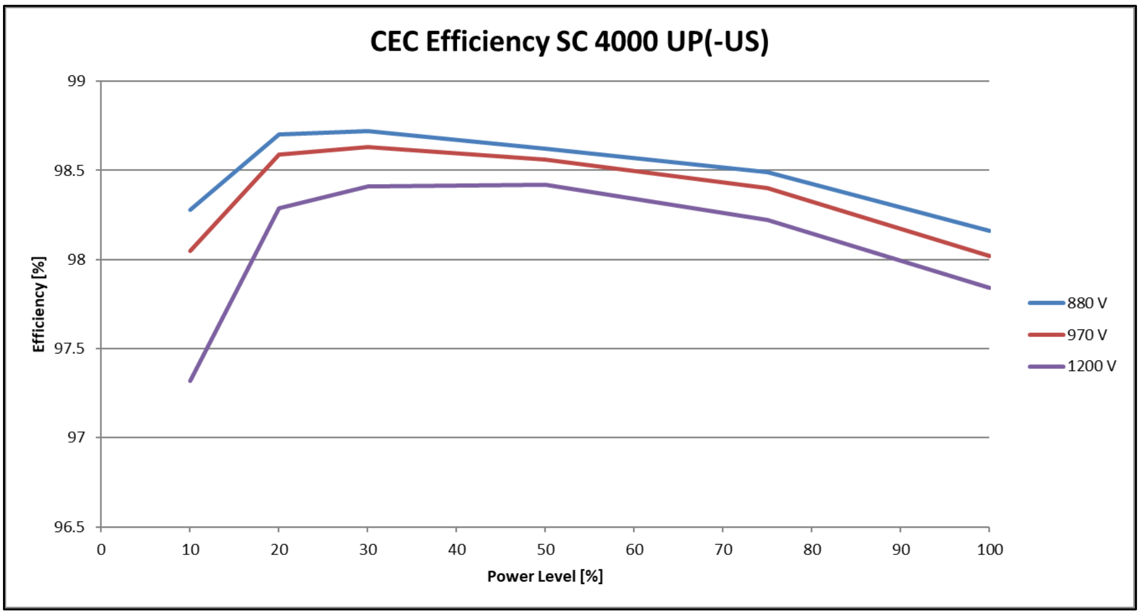


Figure 5: Efficiency with aux. losses at 25 °C

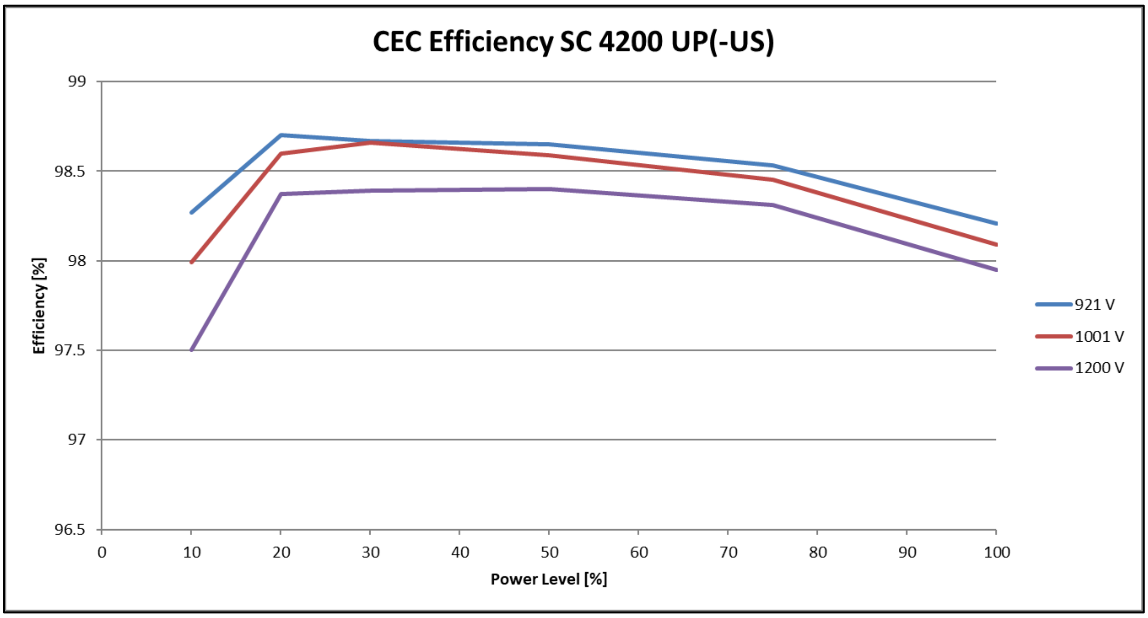


Figure 6: Efficiency with aux. losses at 25 °C

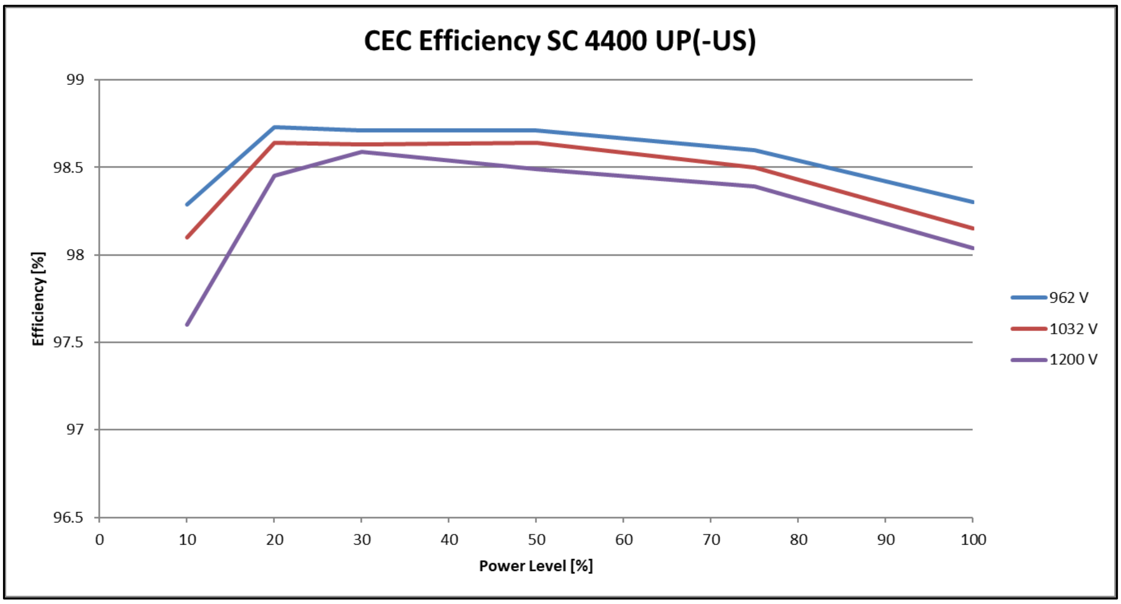


Figure 7: Efficiency with aux. losses at 25 °C

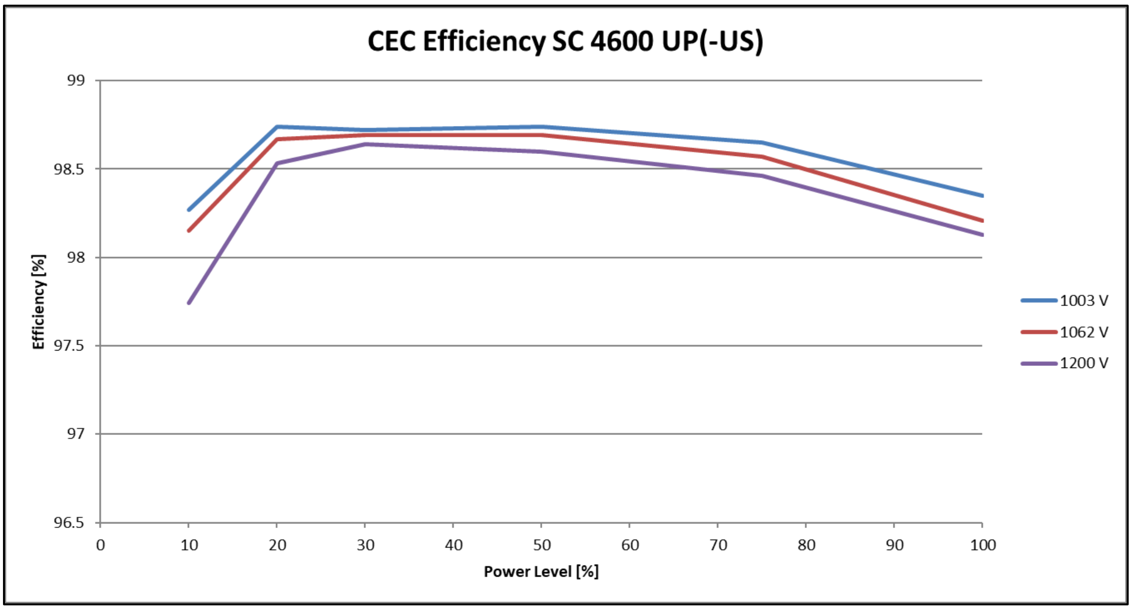


Figure 8: Efficiency with aux. losses at 25 °C

c) Calculated CEC & EuroETA efficiency

CEC Efficiency with Aux losses SC 4000 UP(-US)							
VDC\PAC	10%	20%	30%	50%	75%	100%	CEC
880 V	98.28%	98.70%	98.72%	98.62%	98.49%	98.16%	98.53%
970 V	98.05%	98.59%	98.63%	98.56%	98.40%	98.02%	98.44%
1200 V	97.32%	98.29%	98.41%	98.42%	98.22%	97.84%	98.23%
							98.40%
CEC Efficiency with Aux losses SC 4200 UP(-US)							
VDC\PAC	10%	20%	30%	50%	75%	100%	CEC
921 V	98.27%	98.70%	98.67%	98.65%	98.53%	98.21%	98.55%
1001 V	97.99%	98.60%	98.66%	98.59%	98.45%	98.09%	98.48%
1200 V	97.50%	98.37%	98.39%	98.40%	98.31%	97.95%	98.29%
							98.44%
CEC Efficiency with Aux losses SC 4400 UP(-US)							
VDC\PAC	10%	20%	30%	50%	75%	100%	CEC
962 V	98.29%	98.73%	98.71%	98.71%	98.60%	98.30%	98.62%
1032 V	98.10%	98.64%	98.63%	98.64%	98.50%	98.15%	98.52%
1200 V	97.60%	98.45%	98.59%	98.49%	98.39%	98.04%	98.39%
							98.51%
CEC Efficiency with Aux losses SC 4600 UP(-US)							
VDC\PAC	10%	20%	30%	50%	75%	100%	CEC
1003 V	98.27%	98.74%	98.72%	98.74%	98.65%	98.35%	98.65%
1062 V	98.15%	98.67%	98.69%	98.69%	98.57%	98.21%	98.58%
1200 V	97.74%	98.53%	98.64%	98.60%	98.46%	98.13%	98.47%
							98.57%

Table 1: Calculated CEC efficiency with Aux losses

Conversion Efficiency SC 4000 UP(-US) (IEC 61683)								
VDC\PAC	5%	10%	20%	30%	50%	75%	100%	EuroETA
880 V	97.75%	98.49%	98.77%	98.79%	98.71%	98.56%	98.35%	98.61%
1103 V	96.54%	97.88%	98.41%	98.52%	98.52%	98.37%	98.11%	98.33%
1193 V	96.07%	97.70%	98.34%	98.41%	98.44%	98.32%	98.05%	98.23%
1325 V	95.18%	97.28%	98.09%	98.38%	98.33%	98.24%	97.97%	98.07%
Conversion Efficiency SC 4200 UP(-US) (IEC 61683)								
VDC\PAC	5%	10%	20%	30%	50%	75%	100%	EuroETA
921 V	97.71%	98.48%	98.77%	98.80%	98.76%	98.62%	98.44%	98.65%
1123 V	96.66%	97.95%	98.47%	98.59%	98.59%	98.46%	98.21%	98.40%
1193 V	96.32%	97.83%	98.44%	98.50%	98.52%	98.40%	98.15%	98.33%
1325 V	95.44%	97.42%	98.20%	98.45%	98.41%	98.31%	98.05%	98.17%
Conversion Efficiency SC 4400 UP(-US) (IEC 61683)								
VDC\PAC	5%	10%	20%	30%	50%	75%	100%	EuroETA
962 V	97.68%	98.47%	98.79%	98.83%	98.79%	98.66%	98.47%	98.68%
1144 V	96.77%	98.01%	98.53%	98.63%	98.64%	98.52%	98.27%	98.46%
1193 V	96.55%	97.95%	98.49%	98.57%	98.59%	98.47%	98.23%	98.40%
1325 V	95.70%	97.54%	98.30%	98.52%	98.50%	98.40%	98.15%	98.26%
Conversion Efficiency SC 4600 UP(-US) (IEC 61683)								
VDC\PAC	5%	10%	20%	30%	50%	75%	100%	EuroETA
1003 V	97.66%	98.46%	98.79%	98.85%	98.82%	98.70%	98.51%	98.70%
1164 V	96.86%	98.06%	98.55%	98.67%	98.68%	98.56%	98.32%	98.50%
1193 V	96.77%	98.05%	98.51%	98.64%	98.65%	98.54%	98.30%	98.47%
1325 V	95.94%	97.66%	98.38%	98.58%	98.56%	98.46%	98.22%	98.34%

Table 2: Calculated EutoETA efficiency without Aux losses

d) Efficiency at higher ambient temperature

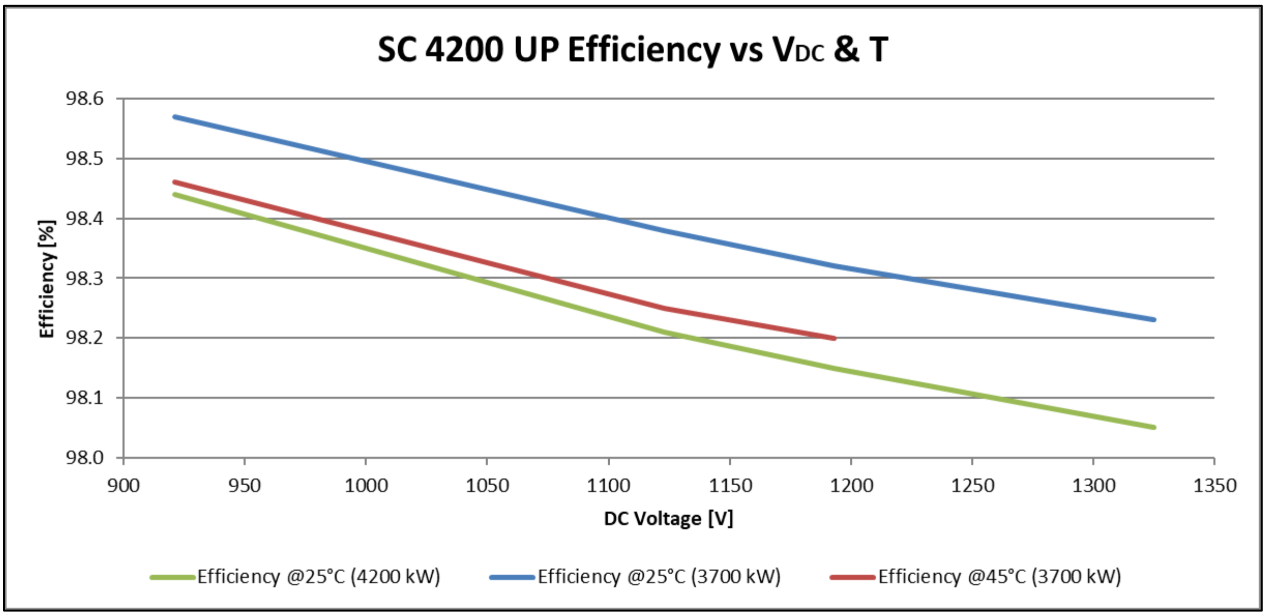


Figure 9: Conversion efficiency at different temperature and DC voltage

e) Efficiency in dependence of Power Factor

Test date open

Figure 10: Efficiency in dependence of Power Factor

2. Auxiliary Consumption

The inverter converts DC to AC power which requires some auxiliary power for the control, communication and cooling system. The amount of auxiliary power depends on the ambient temperature and on the produced output power. The auxiliary power is drawn from the AC side at the inverter terminals.
If the available PV power exceeds 100% of the DC power which can be converted by the inverter per nameplate rating, the inverter produces some more AC power in order to compensate for its internal losses. That way the effective auxiliary consumption of the inverter is 0 kVA as soon as the DC power exceeds 100%.

a) Auxiliary consumption on a sunny day

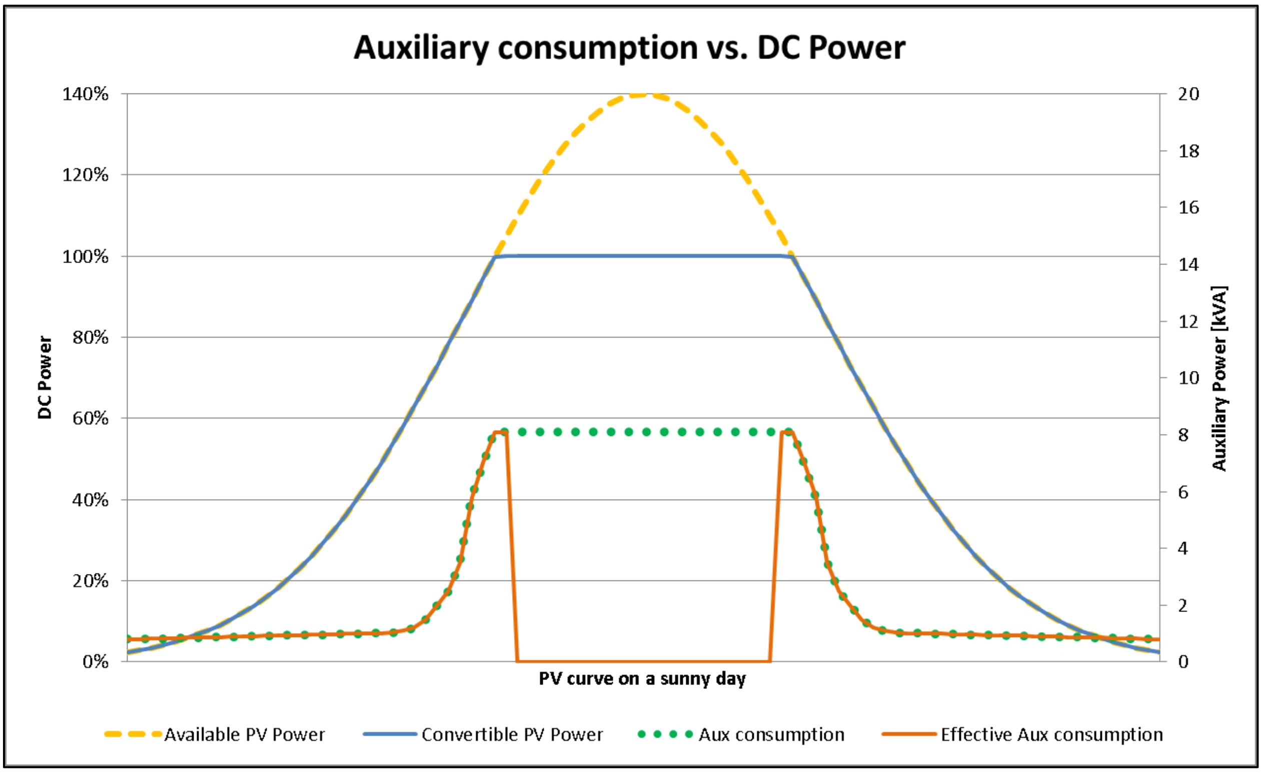


Figure 11: Auxiliary power consumption on a sunny day at 25°C

b) Auxiliary consumption on a cloudy day

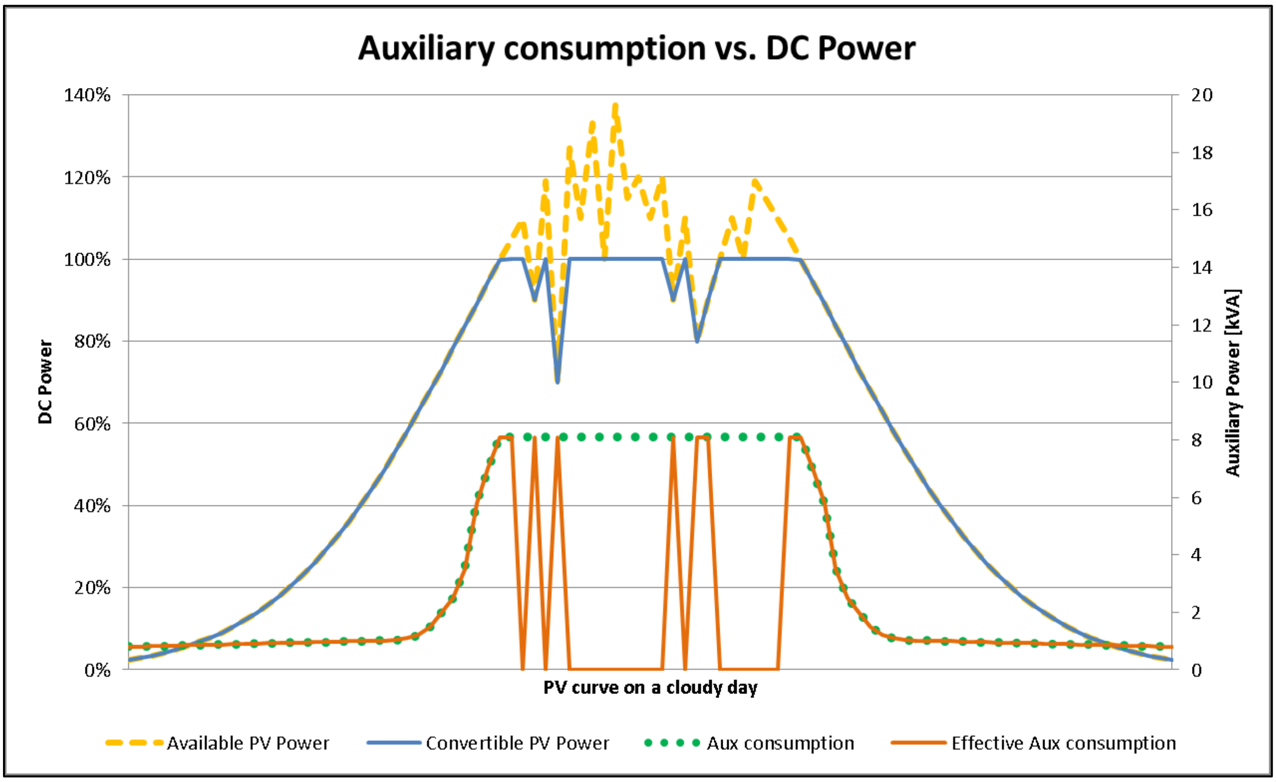


Figure 12: Auxiliary power consumption on a cloudy day at 25°C

3. Harmonics and flicker

Harmonics occur as integer multiples of the fundamental frequency which is typically 50 Hz or 60 Hz in electronic power grids. Harmonic currents cause voltage drops which superimpose the nominal grid voltage resulting in distortion of the sine wave of the grid voltage. Harmonics can be generated by non-linear loads or from power electronic means with high frequent switching transistors (for example by an inverter).
The inverter control and the filter design have a big impact on the harmonics generated by the inverter. The measured harmonics will also vary with the grid frequency, the grid impedance and the initial level of harmonic stress in the grid.
The system solution which uses a Dy transformer for the connection to the MV grid has a different harmonic spectrum as the Delta winding of the transformer does not allow a zero sequence system to develop. Thus the corresponding harmonics (all multiples of the 3rd order) equal zero on the MV side. This effect is shown in Figure 9. Additionally the Sunny Central UP(-US) actively compensates harmonics up to the 7th order by its internal control, thus producing a total harmonic current (THC) of less than 1%.

a) Measurements according to IEEE 1547 (60Hz)

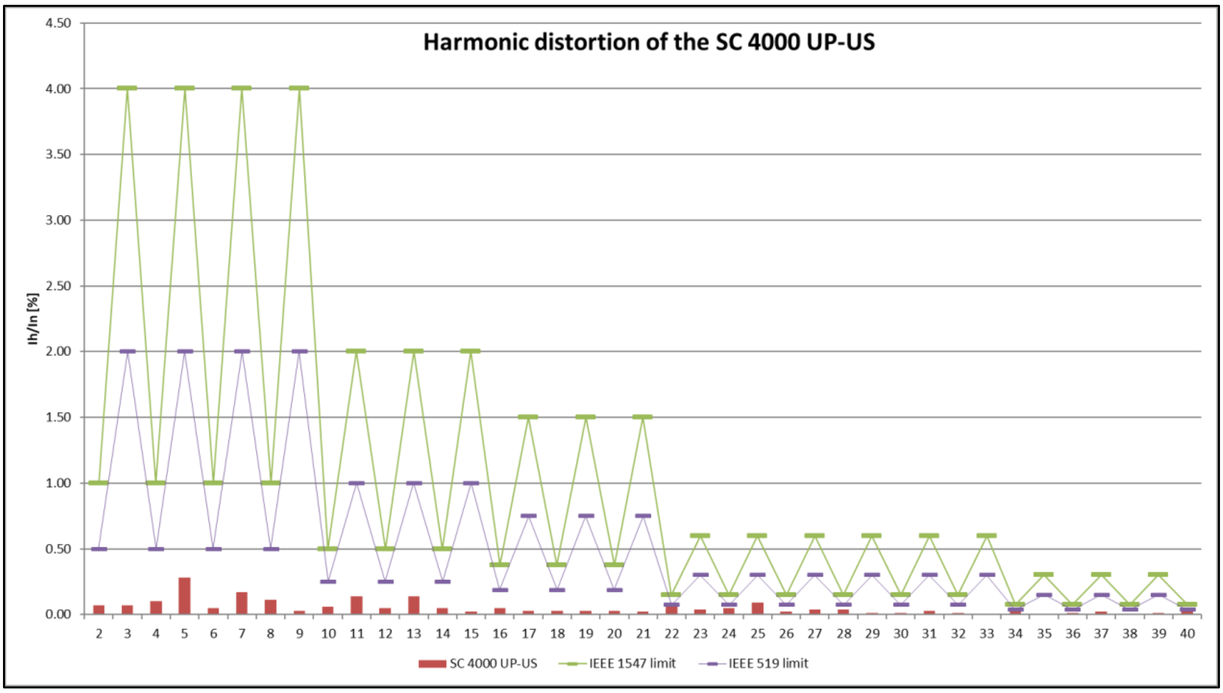


Figure 13: Harmonic distortion compared to the limits defined by IEEE 1547 and IEEE 519

Order	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
L1 [%]	0.07	0.07	0.10	0.25	0.04	0.16	0.10	0.02	0.03	0.14	0.01	0.11	0.05	0.02	0.02	0.03	0.01	0.03	0.03	0.01
L2 [%]	0.07	0.04	0.09	0.28	0.05	0.13	0.10	0.03	0.04	0.12	0.05	0.10	0.03	0.02	0.03	0.01	0.03	0.01	0.01	0.02
L3 [%]	0.04	0.04	0.09	0.26	0.02	0.17	0.11	0.03	0.06	0.12	0.04	0.14	0.03	0.01	0.05	0.02	0.02	0.03	0.03	0.02
Order	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**TDD**
L1 [%]	0.06	0.04	0.04	0.09	0.02	0.02	0.02	0.01	0.00	0.02	0.01	0.00	0.03	0.00	0.01	0.02	0.00	0.01	0.02	**0.42**
L2 [%]	0.03	0.03	0.05	0.05	0.02	0.04	0.03	0.01	0.01	0.03	0.01	0.00	0.03	0.00	0.01	0.02	0.00	0.00	0.03	**0.41**
L3 [%]	0.06	0.04	0.02	0.06	0.01	0.02	0.04	0.01	0.01	0.03	0.00	0.00	0.03	0.00	0.01	0.02	0.00	0.01	0.03	**0.43**

Table 3: Harmonic distortion of the SC 4000 UP(-US) per phase at 1325 V_{DC} and 100% P_{AC} (60 Hz)

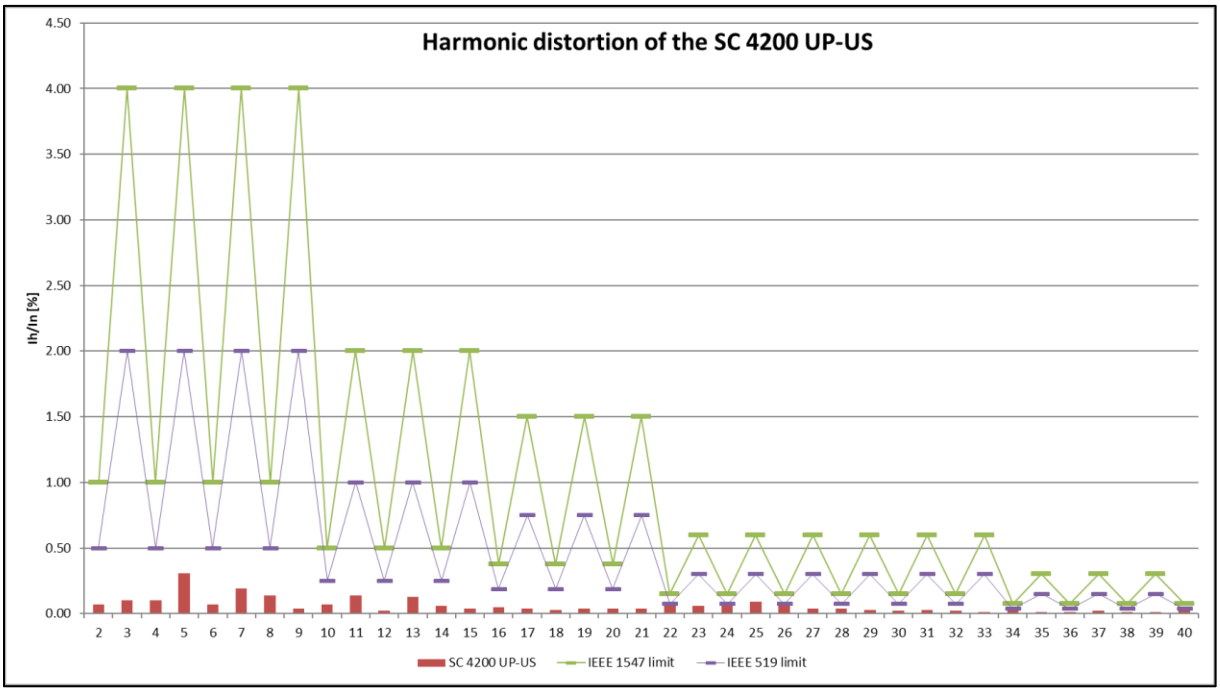


Figure 14: Harmonic distortion compared to the limits defined by IEEE 1547 and IEEE 519

Order	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
L1 [%]	0.07	0.06	0.10	0.26	0.02	0.19	0.10	0.01	0.07	0.13	0.02	0.12	0.04	0.01	0.04	0.02	0.01	0.04	0.03	0.01
L2 [%]	0.07	0.10	0.09	0.31	0.07	0.14	0.14	0.04	0.05	0.14	0.02	0.08	0.06	0.04	0.01	0.04	0.03	0.01	0.04	0.03
L3 [%]	0.02	0.05	0.09	0.28	0.05	0.18	0.12	0.04	0.07	0.14	0.01	0.13	0.04	0.03	0.05	0.03	0.03	0.02	0.04	0.04
Order	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**TDD**
L1 [%]	0.06	0.03	0.04	0.09	0.04	0.00	0.04	0.01	0.02	0.03	0.01	0.00	0.02	0.01	0.01	0.02	0.00	0.01	0.02	**0.44**
L2 [%]	0.04	0.06	0.07	0.04	0.08	0.04	0.03	0.03	0.02	0.02	0.02	0.00	0.03	0.01	0.01	0.02	0.01	0.01	0.03	**0.48**
L3 [%]	0.03	0.04	0.03	0.05	0.05	0.04	0.01	0.02	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.02	0.01	0.01	0.03	**0.45**

Table 4: Harmonic distortion of the SC 4200 UP(-US) per phase at 1325 V_{DC} and 100% P_{AC} (60 Hz)

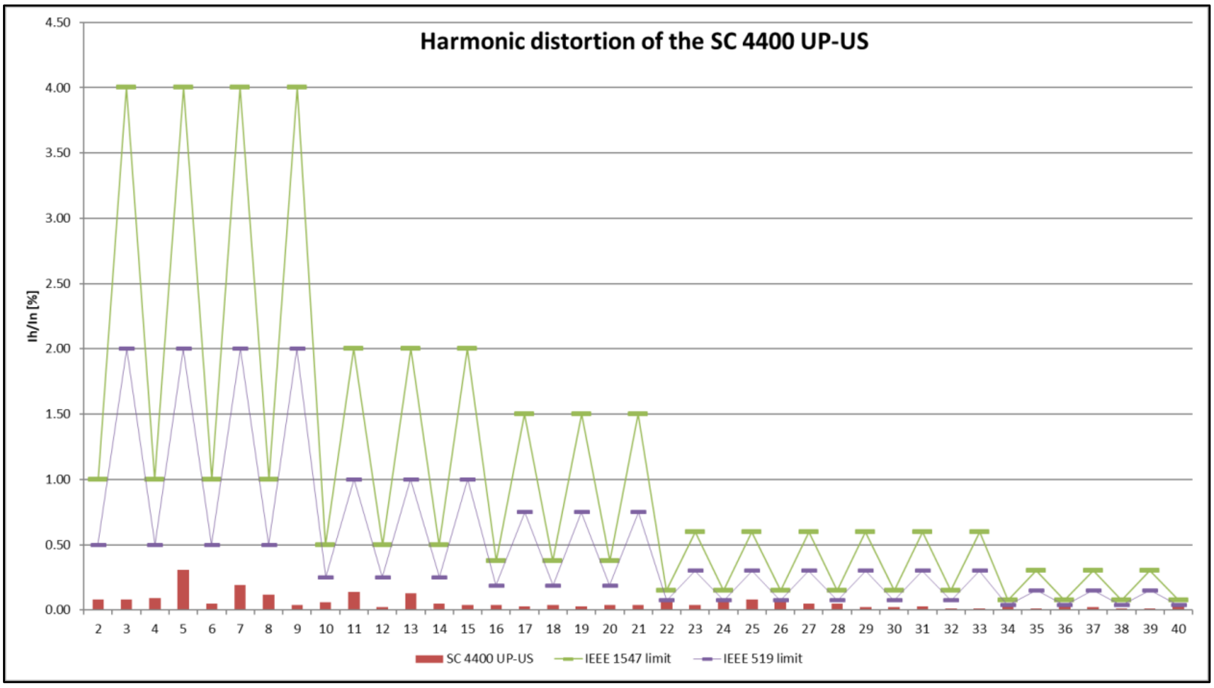


Figure 15: Harmonic distortion compared to the limits defined by IEEE 1547 and IEEE 519

Order	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
L1 [%]	0.08	0.08	0.09	0.26	0.01	0.19	0.10	0.02	0.06	0.13	0.02	0.12	0.04	0.01	0.04	0.02	0.02	0.03	0.03	0.02
L2 [%]	0.07	0.06	0.09	0.31	0.03	0.15	0.12	0.02	0.05	0.14	0.02	0.07	0.05	0.04	0.01	0.03	0.02	0.01	0.03	0.02
L3 [%]	0.06	0.03	0.09	0.27	0.05	0.18	0.11	0.04	0.06	0.13	0.02	0.13	0.04	0.03	0.04	0.02	0.04	0.02	0.04	0.04
Order	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**TDD**
L1 [%]	0.07	0.03	0.01	0.08	0.03	0.02	0.05	0.01	0.02	0.03	0.01	0.01	0.02	0.01	0.02	0.02	0.00	0.01	0.02	**0.45**
L2 [%]	0.03	0.04	0.06	0.03	0.06	0.04	0.03	0.02	0.01	0.02	0.01	0.00	0.02	0.01	0.01	0.02	0.00	0.01	0.02	**0.46**
L3 [%]	0.06	0.04	0.05	0.06	0.04	0.05	0.03	0.02	0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.01	0.03	**0.45**

Table 5: Harmonic distortion of the SC 4400 UP(-US) per phase at 1325 V_{DC} and 100% P_{AC} (60 Hz)

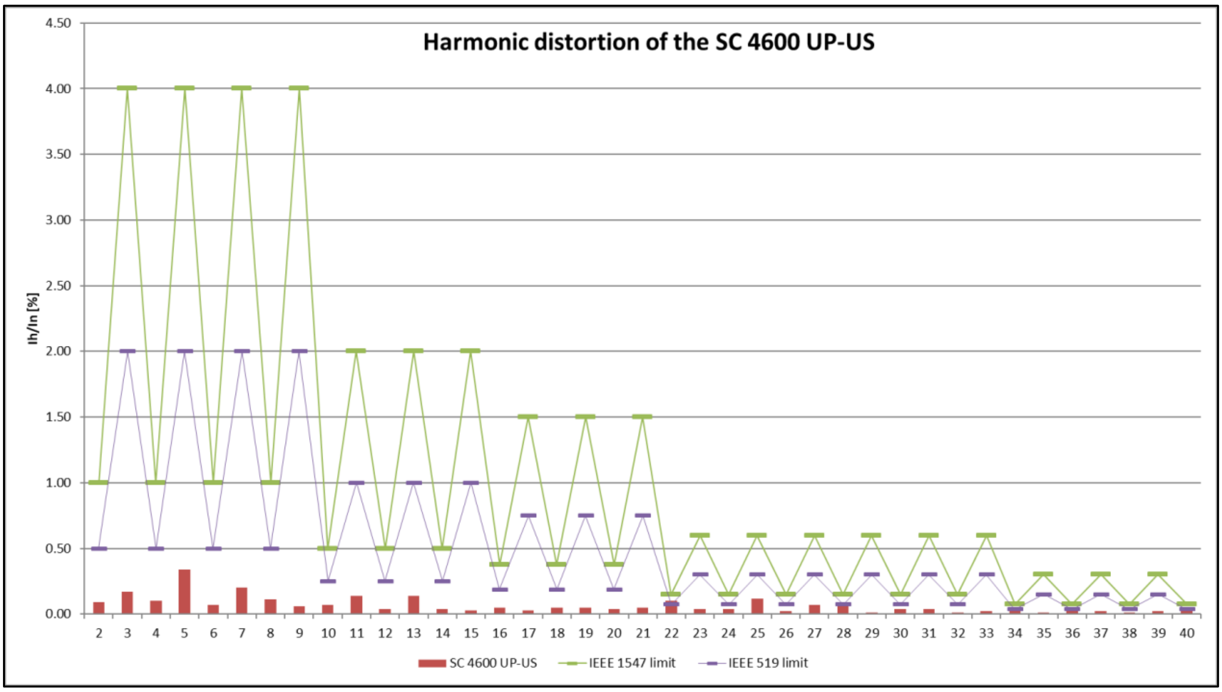


Figure 16: Harmonic distortion compared to the limits defined by IEEE 1547 and IEEE 519

Order	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
L1 [%]	0.08	0.17	0.09	0.26	0.07	0.20	0.10	0.06	0.07	0.12	0.03	0.14	0.03	0.03	0.05	0.01	0.05	0.05	0.03	0.05
L2 [%]	0.09	0.16	0.09	0.34	0.05	0.17	0.11	0.04	0.07	0.14	0.04	0.07	0.03	0.02	0.03	0.02	0.04	0.04	0.01	0.04
L3 [%]	0.08	0.04	0.10	0.27	0.02	0.18	0.10	0.02	0.06	0.13	0.01	0.12	0.04	0.01	0.03	0.03	0.03	0.01	0.04	0.03
Order	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**TDD**
L1 [%]	0.10	0.02	0.04	0.12	0.02	0.07	0.09	0.01	0.04	0.04	0.01	0.02	0.03	0.00	0.02	0.02	0.01	0.02	0.02	**0.52**
L2 [%]	0.06	0.02	0.01	0.08	0.01	0.06	0.08	0.01	0.03	0.04	0.00	0.01	0.02	0.00	0.02	0.01	0.00	0.01	0.02	**0.51**
L3 [%]	0.05	0.04	0.03	0.05	0.02	0.04	0.03	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.02	0.00	0.02	0.02	**0.44**

Table 6: Harmonic distortion of the SC 4600 UP(-US) per phase at 1325 V_{DC} and 100% P_{AC} (60 Hz)

b) Measurements according to VDE AR-N 4110 (50Hz)

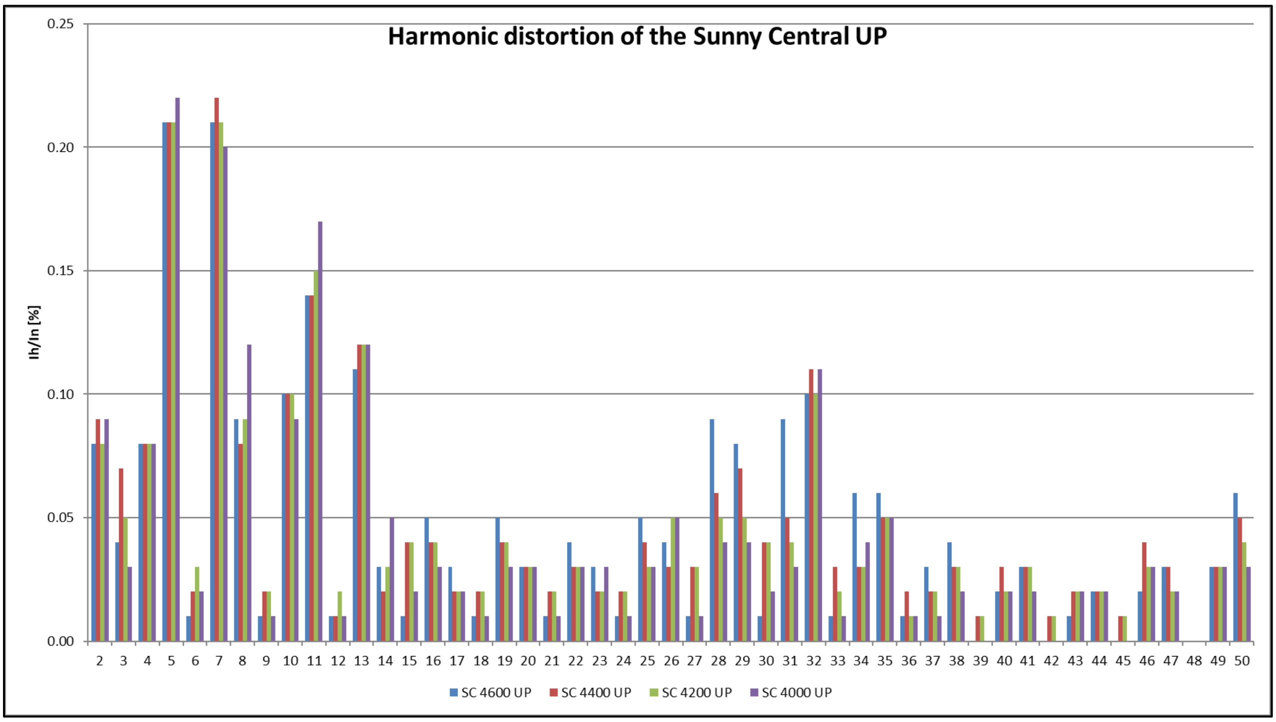


Figure 17: Harmonic distortion of SC 4XXX UP at 100% P_{AC} (50 Hz)

Order	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Iv/In [%]	0.09	0.03	0.08	0.22	0.02	0.20	0.12	0.01	0.09	0.17	0.01	0.12	0.05	0.02	0.03	0.02	0.01
Order	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
Iv/In [%]	0.03	0.03	0.01	0.03	0.03	0.01	0.03	0.05	0.01	0.04	0.04	0.02	0.03	0.11	0.01	0.04	0.05
Order	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**THC**	
Iv/In [%]	0.01	0.01	0.02	0.00	0.02	0.02	0.00	0.02	0.02	0.00	0.03	0.02	0.00	0.03	0.03	**0.45**	

Table 7: Total Harmonic distortion of the SC 4000 UP at 100% P_{AC} (50 Hz)

Order	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Iv/In [%]	0.08	0.05	0.08	0.21	0.03	0.21	0.09	0.02	0.10	0.15	0.02	0.12	0.03	0.04	0.04	0.02	0.02
Order	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
Iv/In [%]	0.04	0.03	0.02	0.03	0.02	0.02	0.03	0.05	0.03	0.05	0.05	0.04	0.04	0.10	0.02	0.03	0.05
Order	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**THC**	
Iv/In [%]	0.01	0.02	0.03	0.01	0.02	0.03	0.01	0.02	0.02	0.01	0.03	0.02	0.00	0.03	0.04	**0.45**	

Table 8: Total Harmonic distortion of the SC 4200 UP at 100% P_{AC} (50 Hz)

Order	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Iv/In [%]	0.09	0.07	0.08	0.21	0.02	0.22	0.08	0.02	0.10	0.14	0.01	0.12	0.02	0.04	0.04	0.02	0.02
Order	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
Iv/In [%]	0.04	0.03	0.02	0.03	0.02	0.02	0.04	0.03	0.03	0.06	0.07	0.04	0.05	0.11	0.03	0.03	0.05
Order	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**THC**	
Iv/In [%]	0.02	0.02	0.03	0.01	0.03	0.03	0.01	0.02	0.02	0.01	0.04	0.03	0.00	0.03	0.05	**0.46**	

Table 9: Total Harmonic distortion of the SC 4400 UP at 100% P_{AC} (50 Hz)

Order	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Iv/In [%]	0.08	0.04	0.08	0.21	0.01	0.21	0.09	0.01	0.10	0.14	0.01	0.11	0.03	0.01	0.05	0.03	0.01
Order	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
Iv/In [%]	0.05	0.03	0.01	0.04	0.03	0.01	0.05	0.04	0.01	0.09	0.08	0.01	0.09	0.10	0.01	0.06	0.06
Order	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**THC**	
Iv/In [%]	0.01	0.03	0.04	0.01	0.02	0.03	0.01	0.01	0.02	0.00	0.02	0.03	0.00	0.03	0.06	**0.46**	

Table 10: Total Harmonic distortion of the SC 4600 UP at 100% P_{AC} (50 Hz)

c) Harmonics with reactive power operation

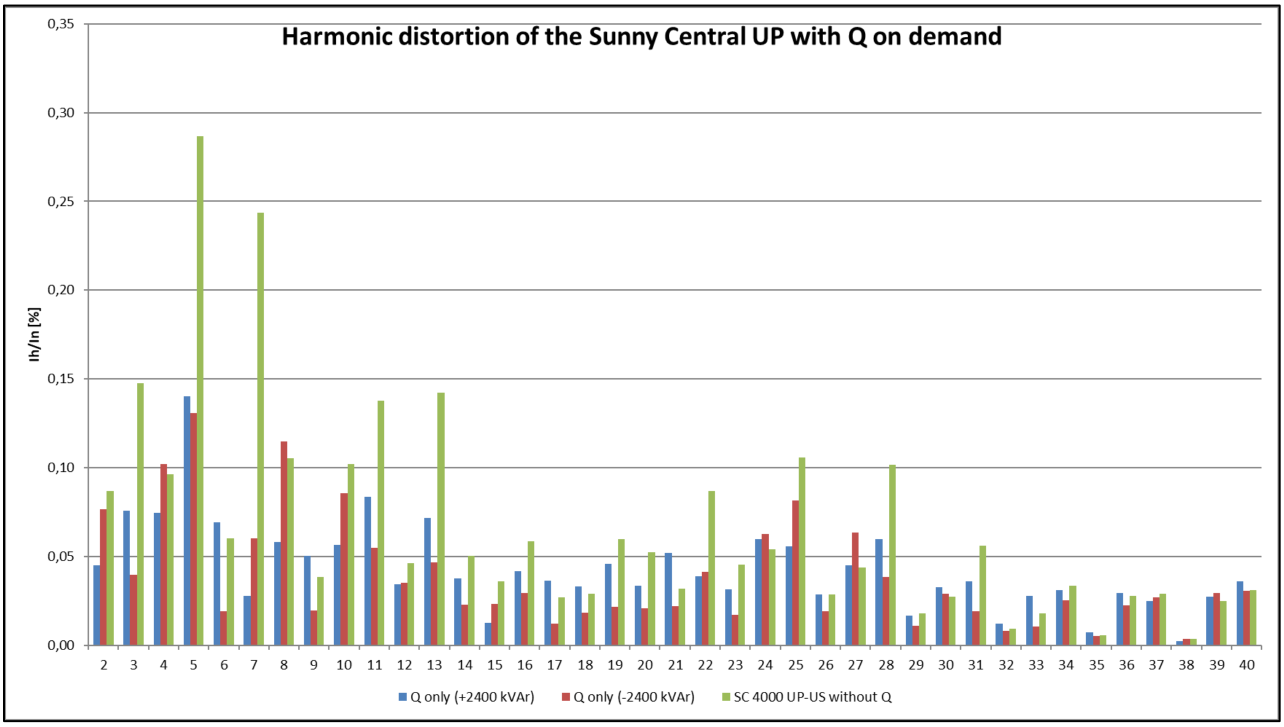


Figure 18: Harmonic distortion comparison of SC 4000 UP-US with pure reactive power of +/-2400 kVAr (60%Sn)

d) Flicker

Grid impedance angle	30°	50°	70°	85°
Flicker coefficient $c(\Psi_k)$	2.08	1.82	1.36	1.17
Short-term flicker, P_{st}	0.10	0.09	0.07	0.06

Table 11: Flicker data of the SC 4000 UP

Grid impedance angle	30°	50°	70°	85°
Flicker coefficient $c(\Psi_k)$	2.88	2.53	1.93	1.36
Short-term flicker, P_{st}	0.14	0.13	0.10	0.07

Table 12: Flicker data of the SC 4200 UP

Grid impedance angle	30°	50°	70°	85°
Flicker coefficient $c(\Psi_k)$	1.75	1.57	1.22	0.88
Short-term flicker, P_{st}	0.09	0.08	0.06	0.04

Table 13: Flicker data of the SC 4400 UP

Grid impedance angle	30°	50°	70°	85°
Flicker coefficient $c(\Psi_k)$	1.87	1.64	1.24	1.50
Short-term flicker, P_{st}	0.09	0.08	0.06	0.08

Table 14: Flicker data of the SC 4600 UP

4. Reactive Power

The inverter can provide reactive power in addition to the active power which is produced by conversion of incoming DC power. The resulting apparent power which is defined by the inverter's nameplate rating is calculated by geometric addition of reactive and active power.
The reactive power provision can be defined either via Power Factor (max. cosφ=0.8) or as a fix Q value. Since the reactive power is independent of the active power provision of the inverter, it is possible to provide the max. reactive power at any time respecting the limits defined by the apparent power value of the inverter at different ambient temperatures. The inverter can provide up to 60% of its nameplate rating as reactive power disconnecting only when the active power drops below 0.2% of the inverters rated power.
Reactive power has an impact on the frequency-dependent voltage drop at the sinus filter choke so that the minimum MPP voltage depends on the applied power factor. This effect is illustrated in the below pictures.

a) P/Q diagram Sunny Central UP @35°C

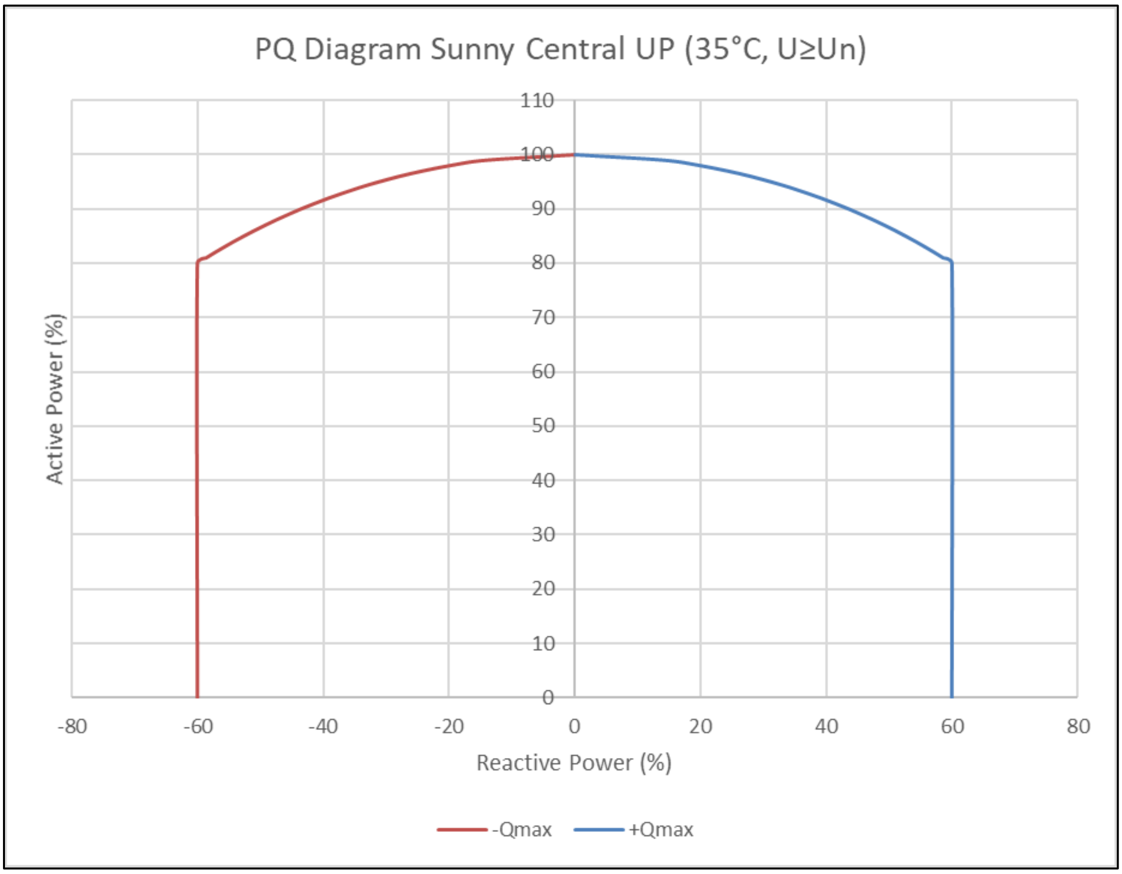


Figure 19: P/Q diagram at 35°C and grid voltage U ≥Un

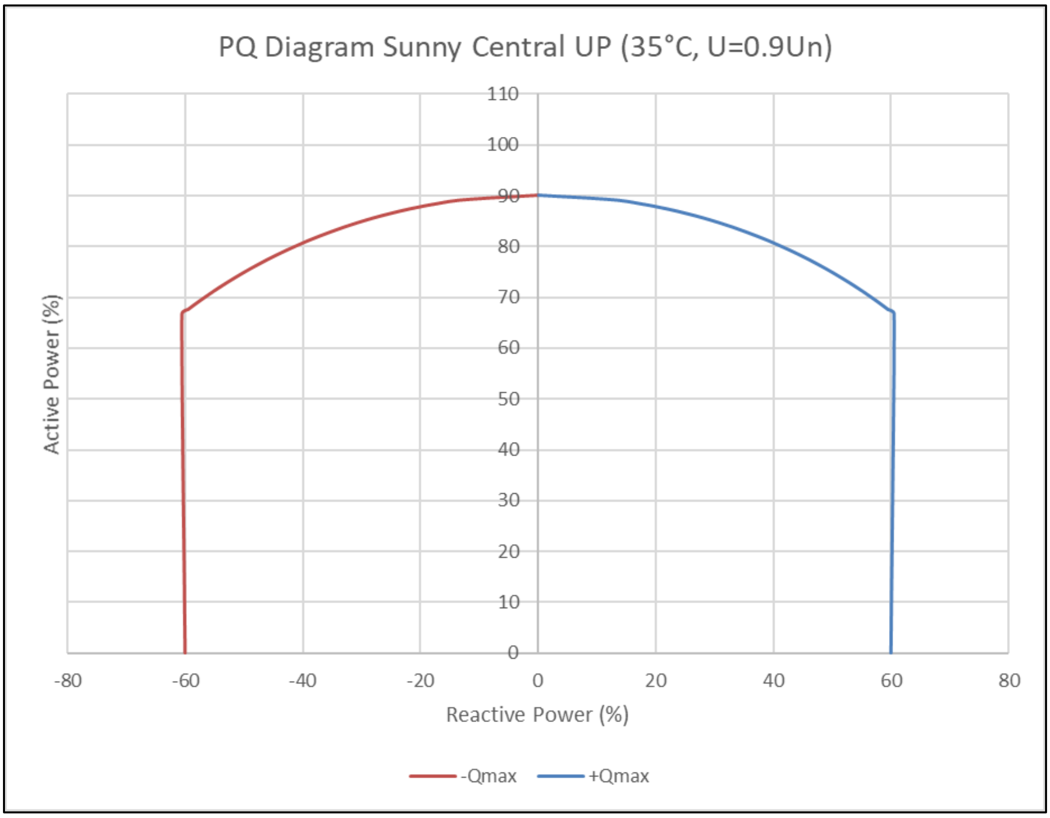


Figure 20: P/Q diagram at 35 °C and grid voltage U = 0.9Un

b) P/Q diagram Sunny Central UP @50°C

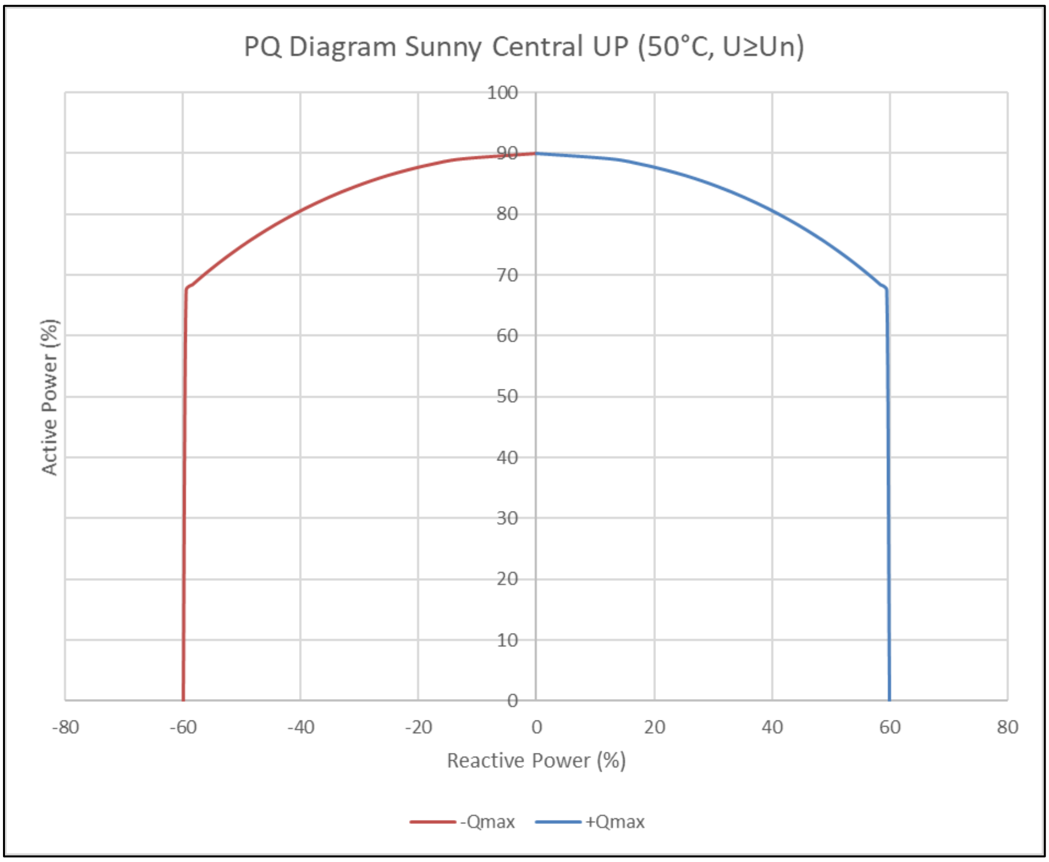


Figure 21: P/Q diagram at 50°C and grid voltage U ≥Un

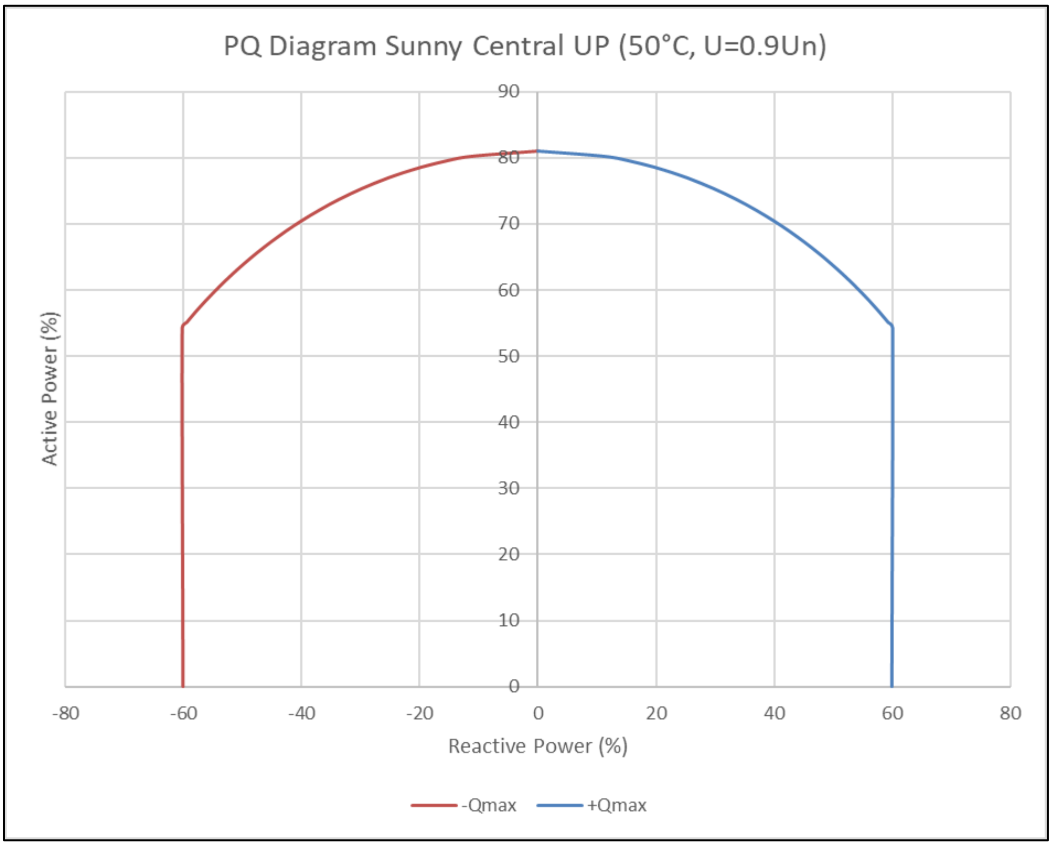


Figure 22: P/Q diagram at 50°C and grid voltage U =0.9Un

c) Minimum MPP Voltage with reactive power @60 Hz

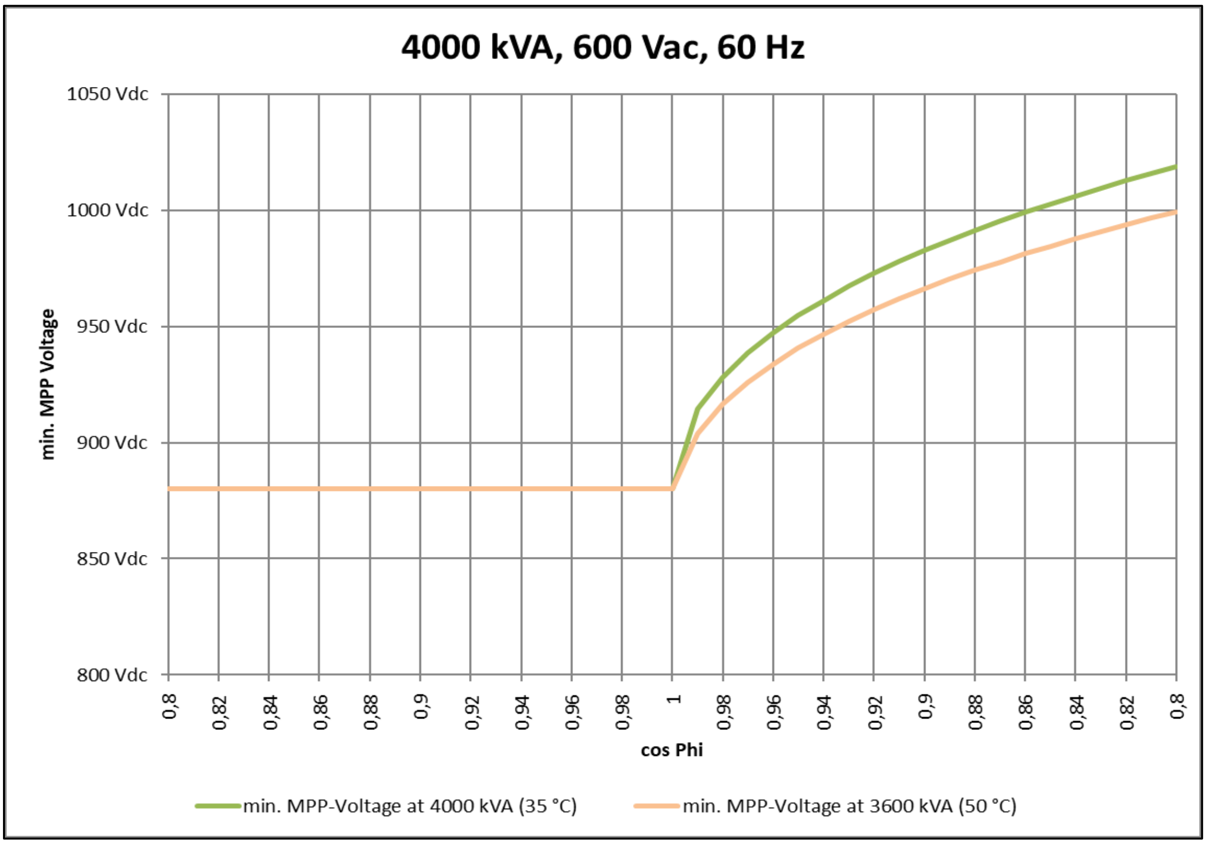


Figure 23: Minimum MPP Voltage of SC 4000 UP(-US) at 60 Hz

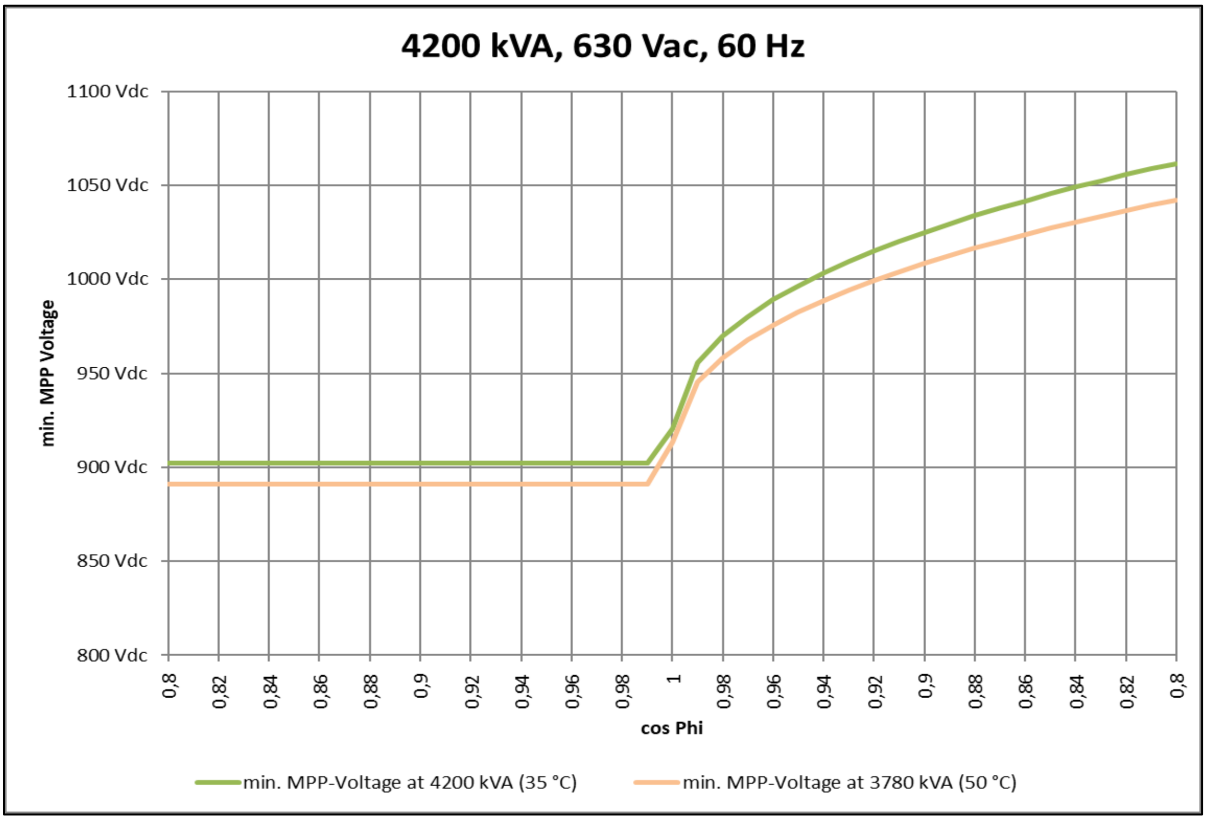


Figure 24: Minimum MPP Voltage of SC 4200 UP(-US) at 60 Hz

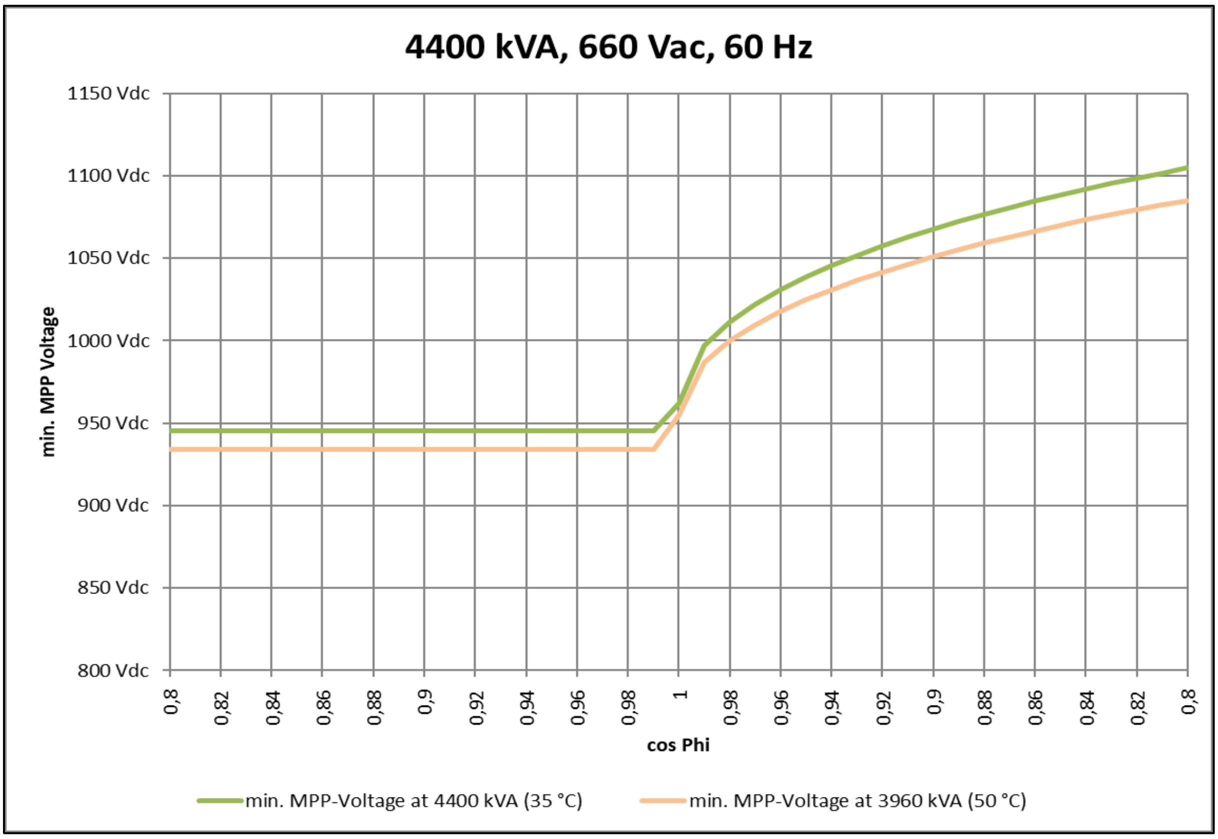


Figure 25: Minimum MPP Voltage of SC 4400 UP(-US) at 60 Hz

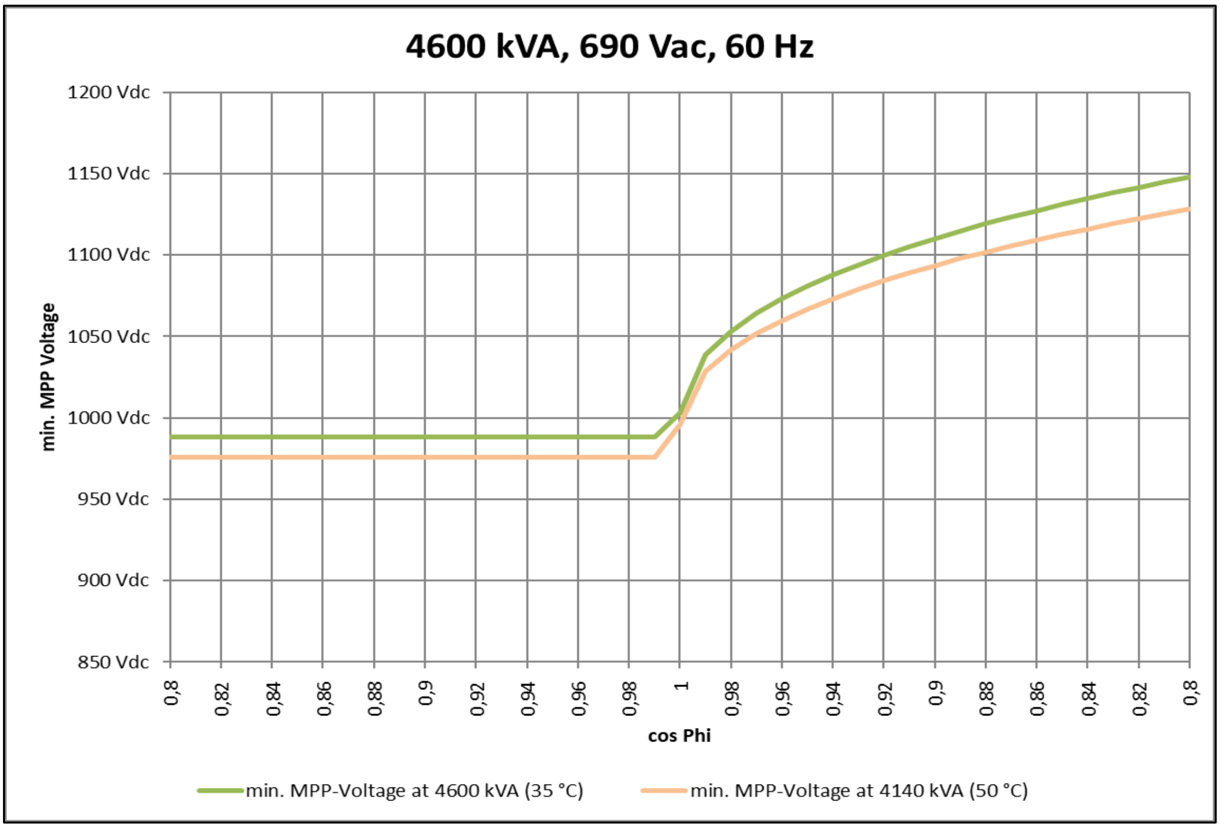


Figure 26: Minimum MPP Voltage of SC 4600 UP(-US) at 60 Hz

d) Minimum MPP Voltage with reactive power @50 Hz

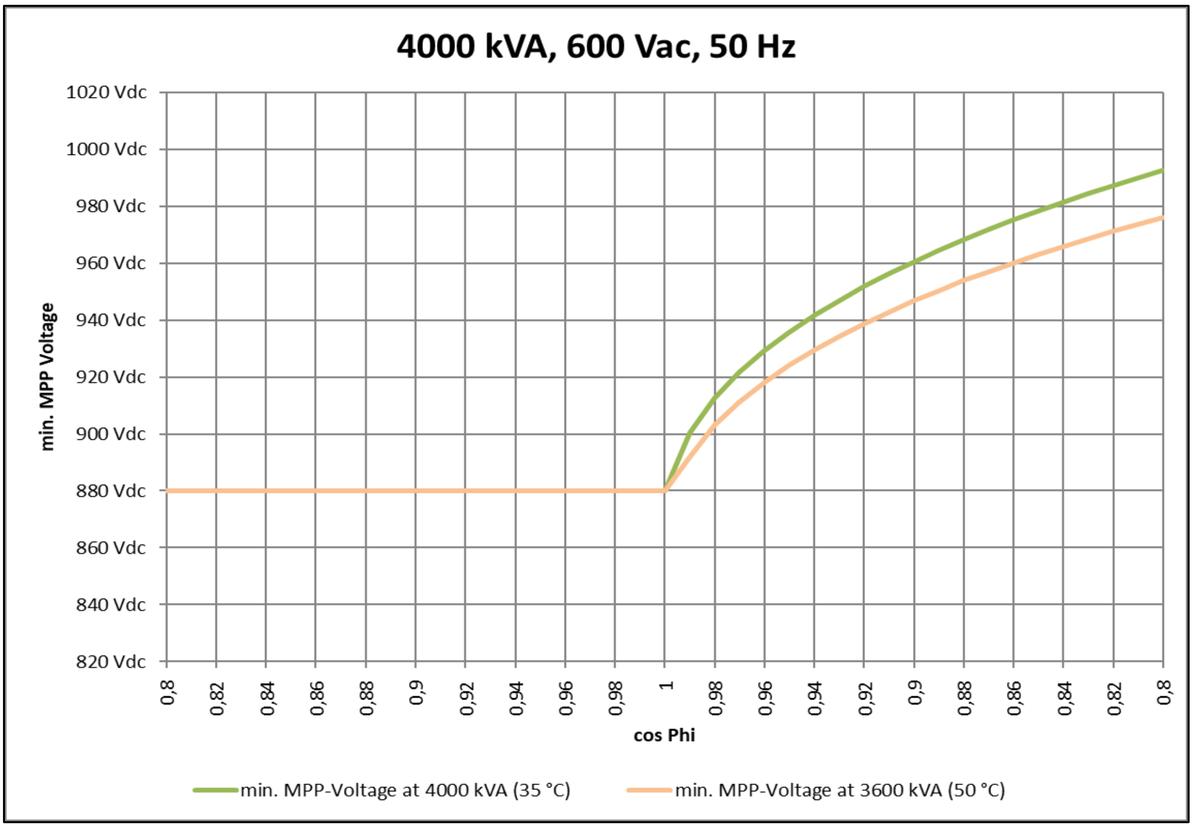


Figure 27: Minimum MPP Voltage of SC 4000 UP(-US) at 50 Hz

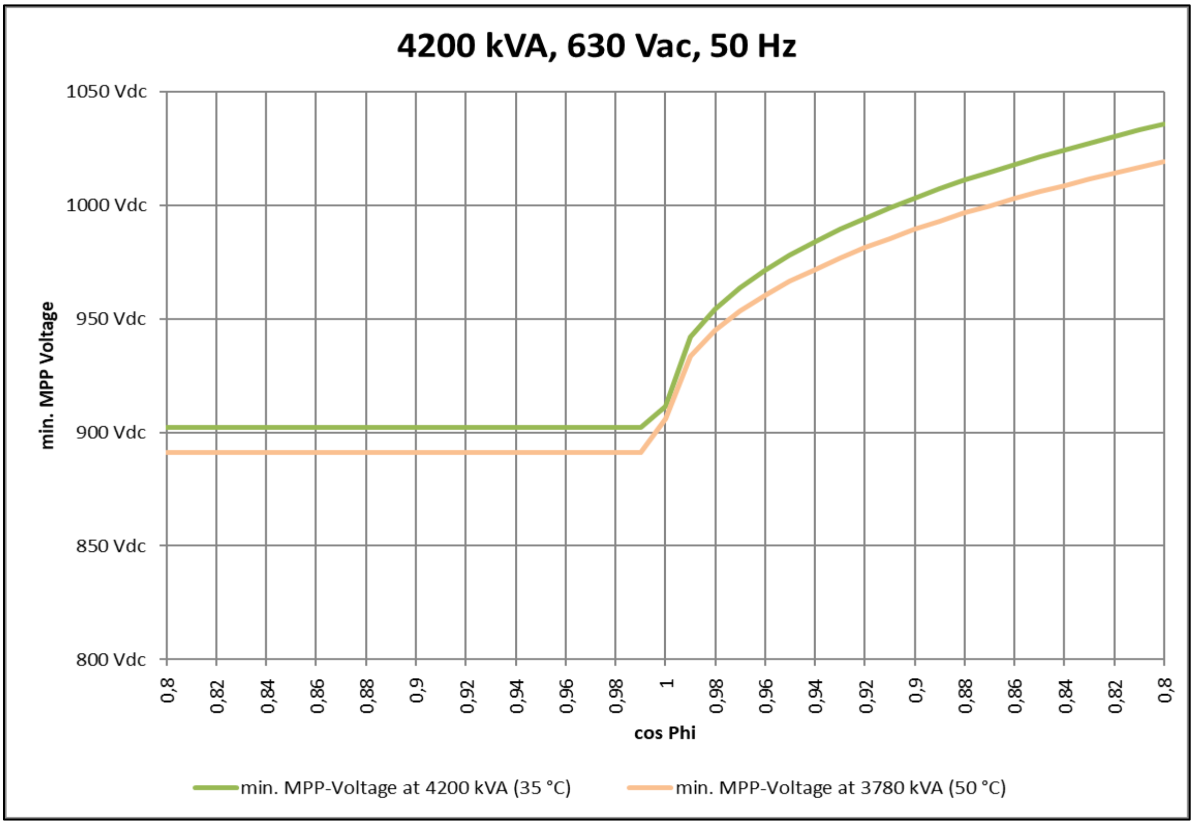


Figure 28: Minimum MPP Voltage of SC 4200 UP(-US) at 50 Hz

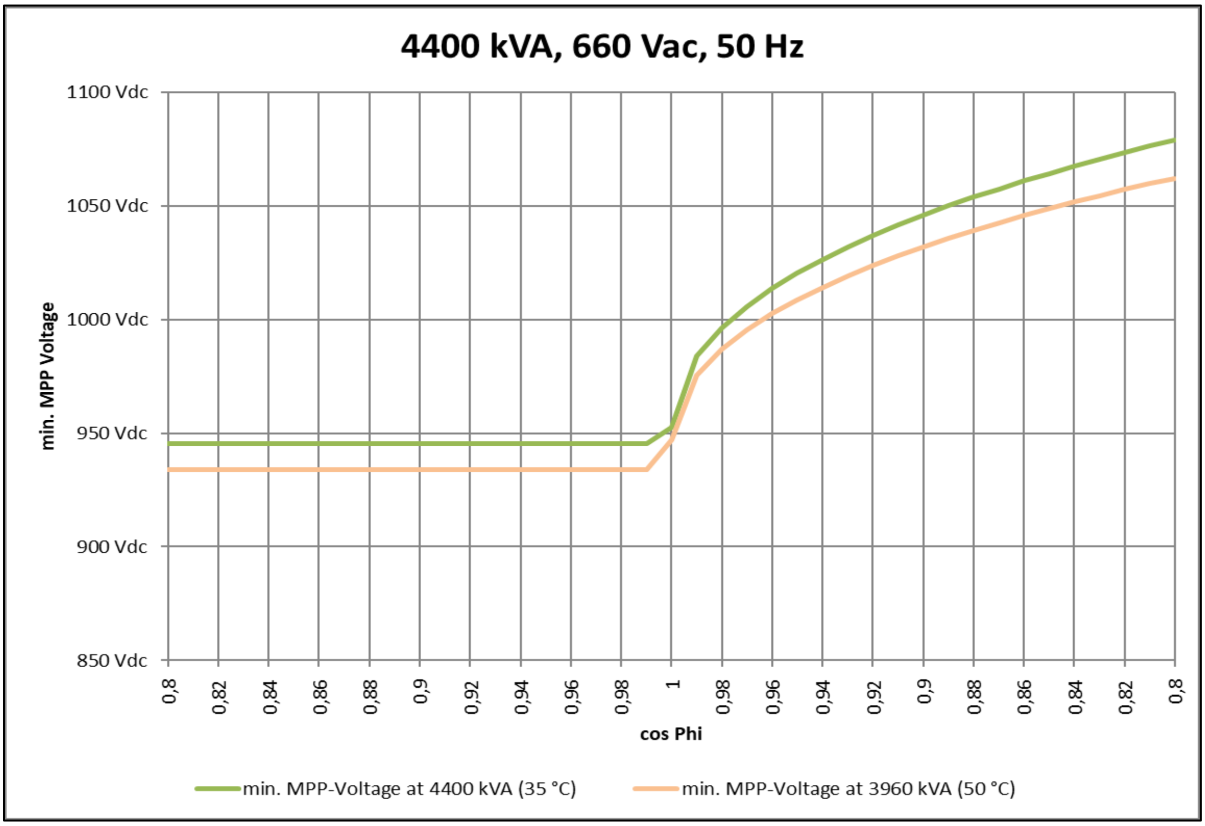


Figure 29: Minimum MPP Voltage of SC 4400 UP(-US) at 50 Hz

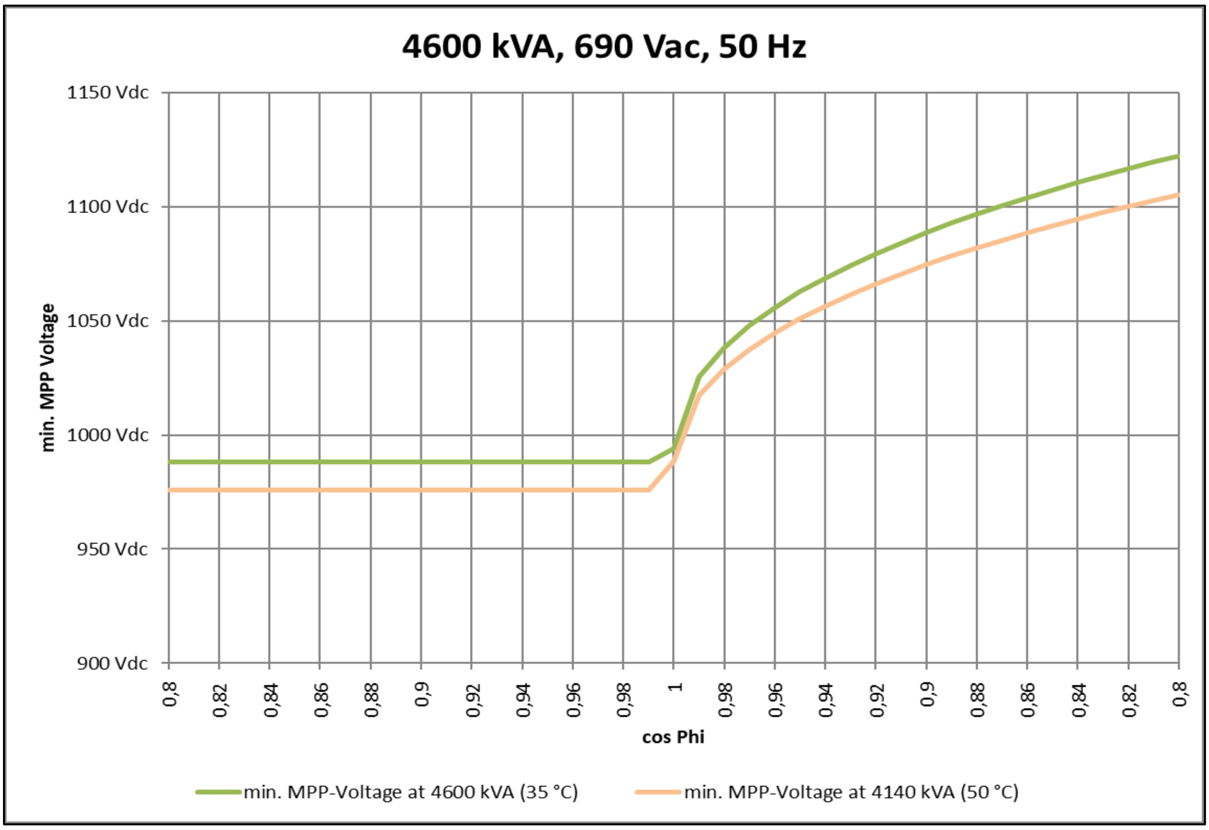


Figure 30: Minimum MPP Voltage of SC 4600 UP(-US) at 50 Hz

5. De-rating

The thermal management of the inverter decides about de-rating conditions in dependence of ambient temperature, DC voltage and altitude.
Above 25°C the output power of the inverter has to be reduced in dependence of the DC voltage. High DC voltage causes switching losses at the IGBTs which significantly contribute to the heat rise inside the inverter. With rising ambient temperature the maximum operation DC voltage with full load needs to be reduced between 25°C and 50°C in order to support the inverter's thermal management.
The lower density of air with rising altitude reduces the cooling effect. The inverter can produce its full power output at altitudes up to 3,000m with only reducing slightly the max. temperature for operation with nominal power. An adaptation starts above 1,000m and results in a linear shift to lower max. temperature also aligned with the temperature drop at high altitudes.

a) De-rating due to DC voltage

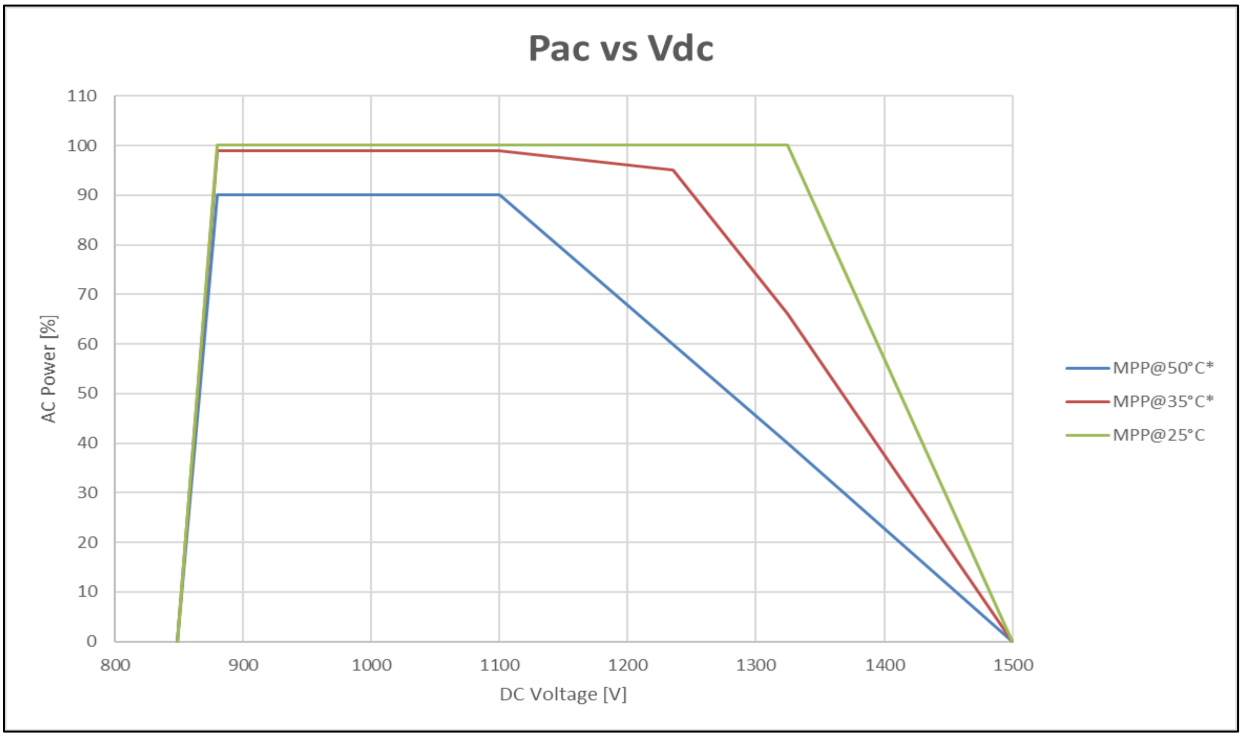


Figure 31: De-rating depending on DC voltage

*Max. DC Voltage and AC power varies for the different power classes as in the below table

T/Vdc/Sac dependency		**SC 4000 UP**	**SC 4200 UP**	**SC 4400 UP**	**SC 4600 UP**
Temperature	AC Power	**Max. DC Voltage**			
35°C	100%	1050 V	1000 V	1000 V	1025 V
50°C	90%	1100 V	1050 V	1000 V	1040 V
Temperature	DC Voltage	**Max. AC Power**			
35°C	1235 V	93.3%	94.5%	95.7%	97.1%
50°C	1100 V	90%	Tbd	Tbd	Tbd

b) De-rating at high Altitudes

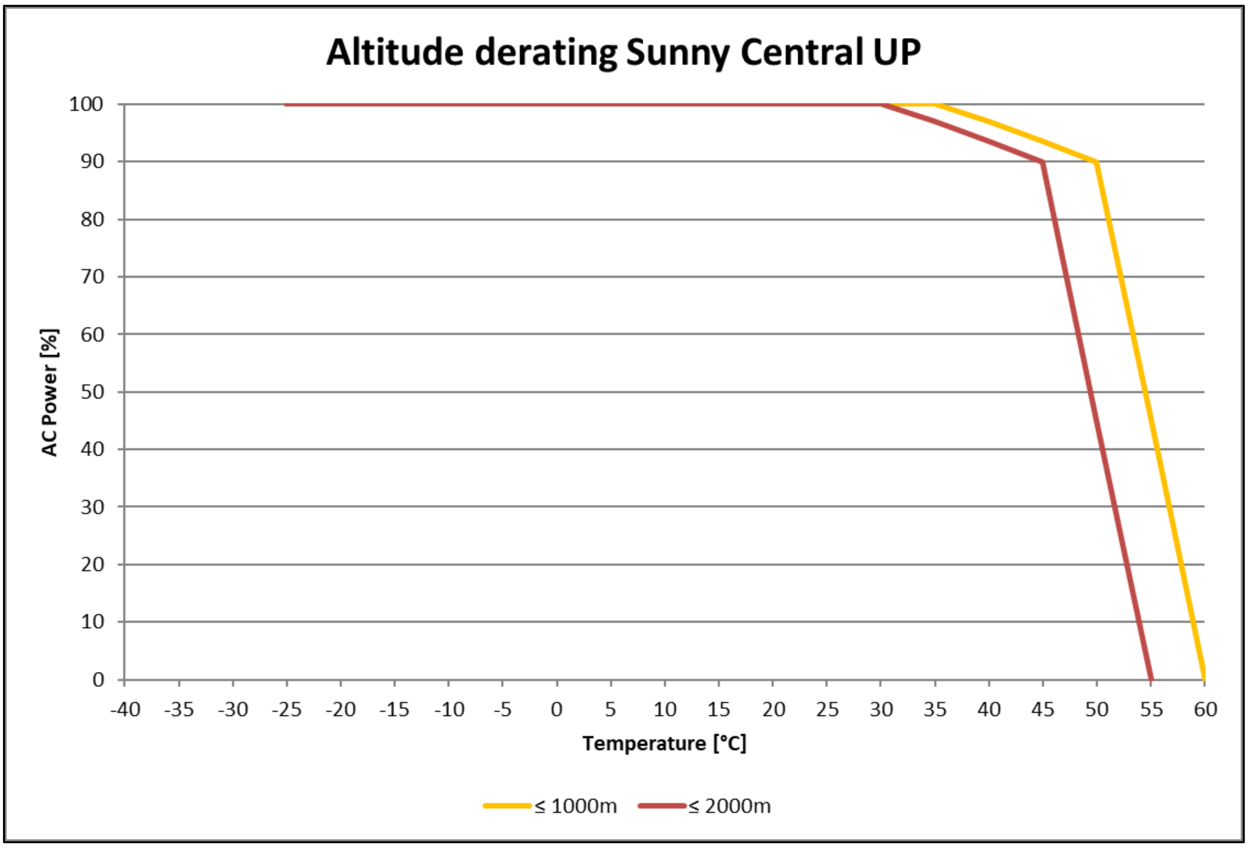


Figure 32: Linear de-rating at high altitudes

6. Ride Through capabilities

The inverter has the capability to support the grid by remaining online or by reactive power feed-in during a temporary change of the grid voltage beyond preset low voltage (LV) and high voltage (HV) thresholds. The below figure describes the max. voltage ride-through (VRT) capabilities of the SC XXXX UP(-US). If the max. disconnecting delay time at specific voltage levels is exceeded, the inverter switches off and reconnects to the grid when the voltage returns to the preset nominal operation window.
A project specific VRT window can be defined with the parameters described in the inverter's operation manual.
The inverter will also ride through abnormal frequency events with the capability of reducing the output power at high frequency scenarios. Within a frequency range of +/- 3Hz of the nominal frequency the inverter can operate permanently. The ride-through capabilities are described below with similar possibilities to adjust the window as for the voltage ride-through.

a) Voltage Ride Through

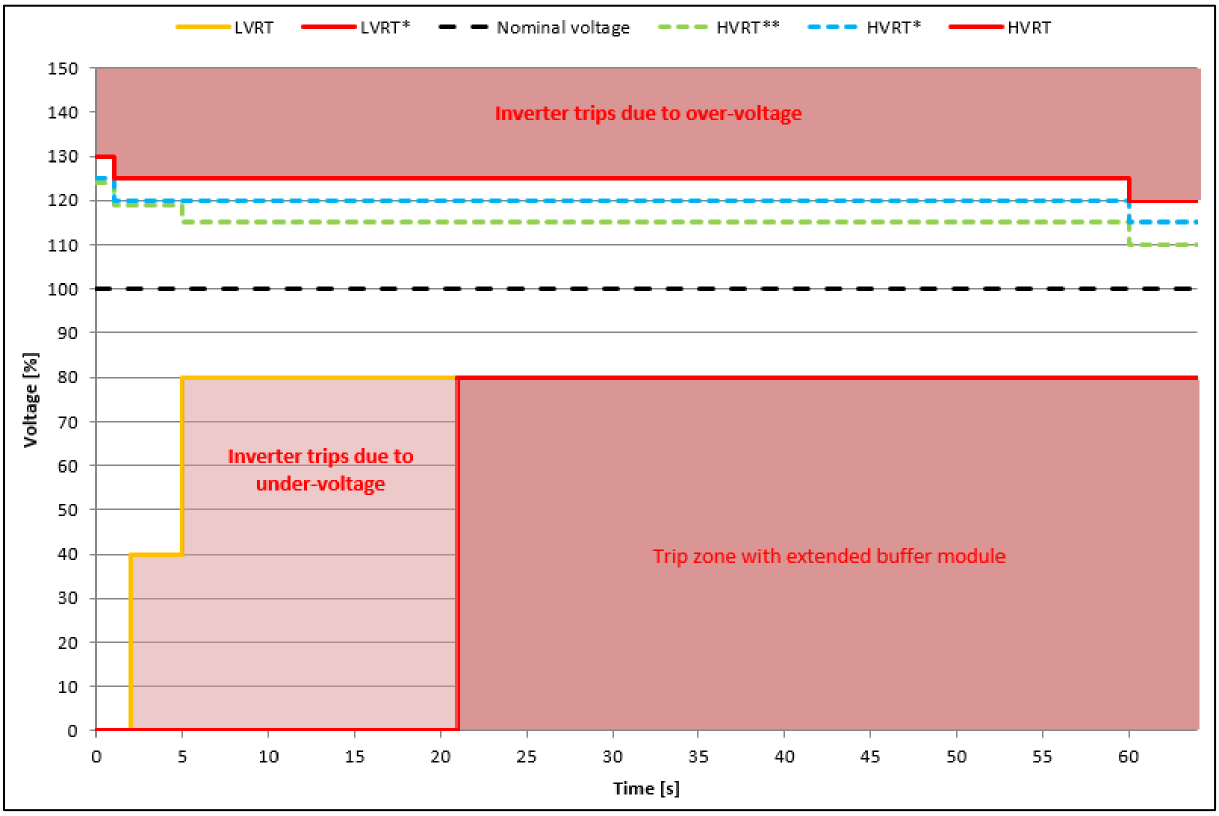


Figure 33: LVRT/HVRT capabilities

LVRT* → includes extended buffer module
HVRT* → SC 4400 UP(-US)
HVRT** → SC 4600 UP(-US)

b) Frequency Ride Through

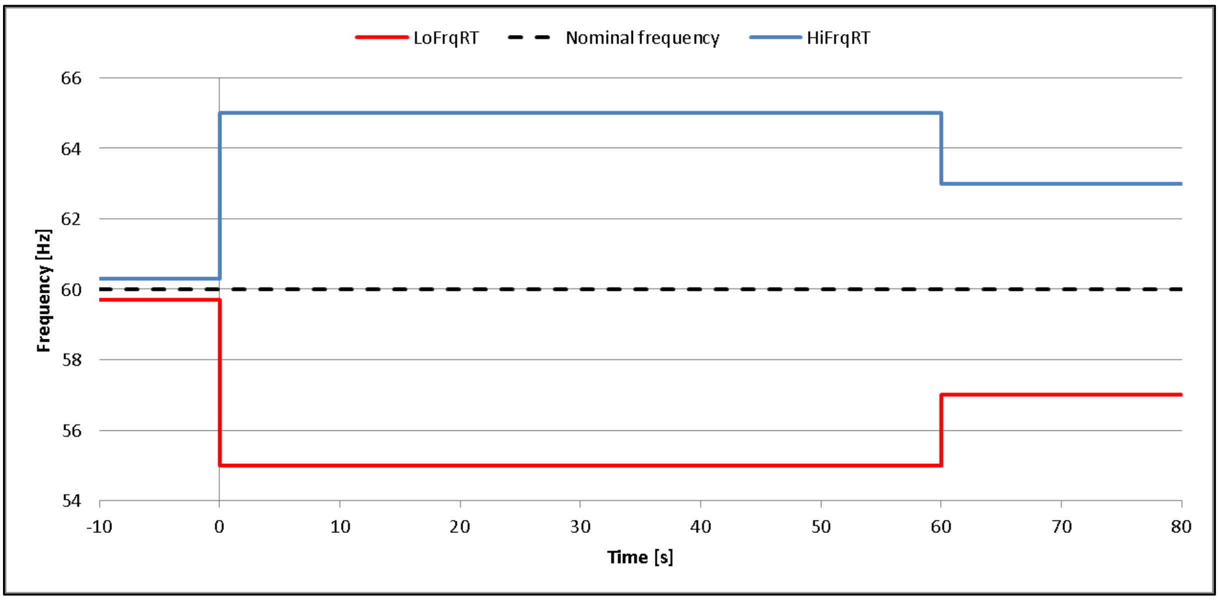


Figure 34: LoFrqRT/HiFrqRT capabilities (60 Hz)

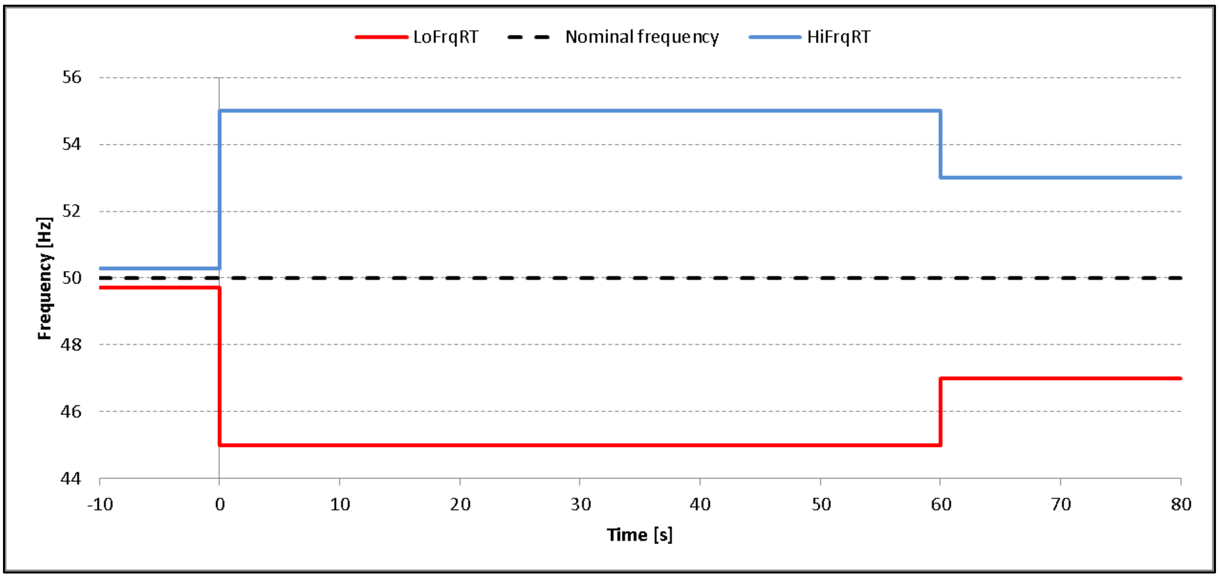
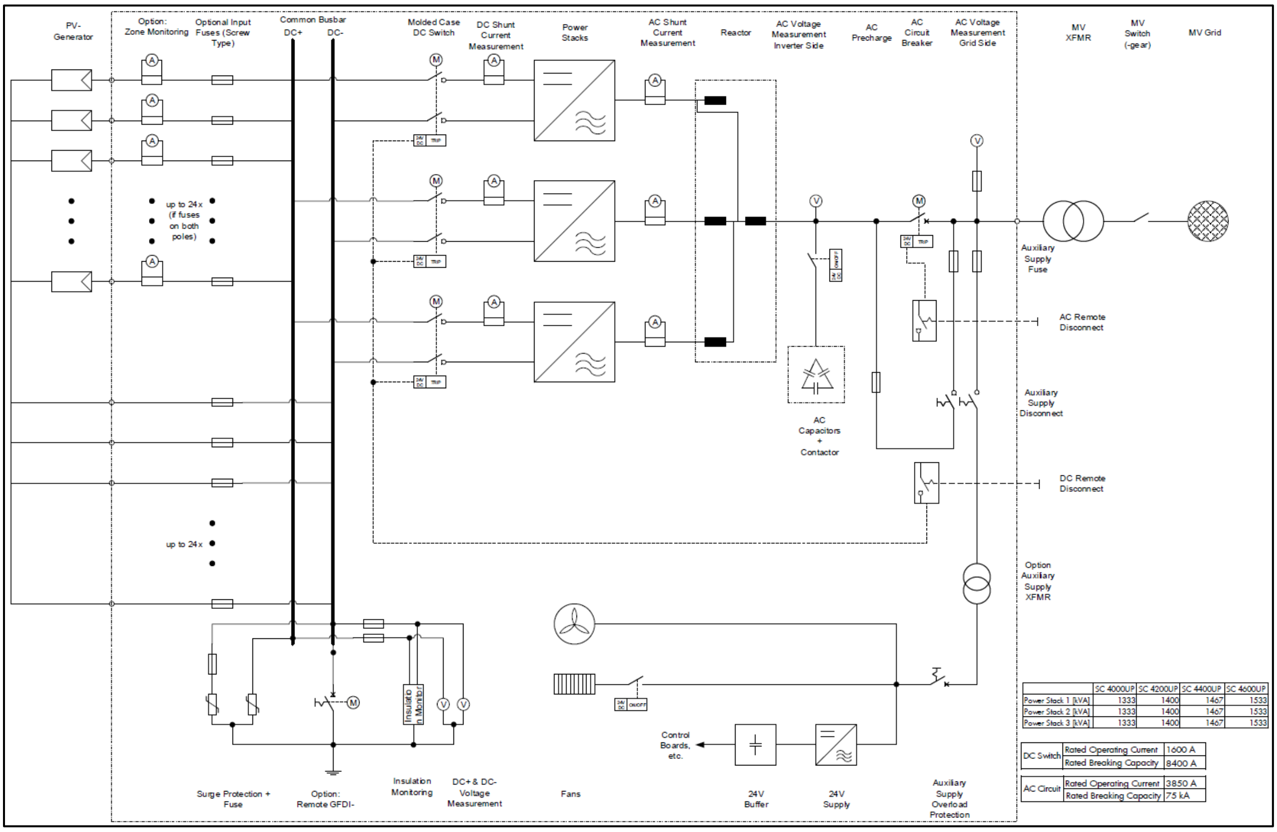


Figure 35: LoFrqRT/HiFrqRT capabilities (50 Hz)

7. Single line diagram



	SC 4000UP	SC 4200UP	SC 4400UP	SC 4600UP
Power Stack 1 [kVA]	1333	1400	1467	1533
Power Stack 2 [kVA]	1333	1400	1467	1533
Power Stack 3 [kVA]	1333	1400	1467	1533

DC Switch	Rated Operating Current	1600 A
	Rated Breaking Capacity	8400 A

AC Circuit	Rated Operating Current	3850 A
	Rated Breaking Capacity	75 kA

Figure 36: Single line diagram SC 4XXX UP(-US)

Note: This Single line diagram is a simplified overview and does not represent all possible options

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