

N.6.1 Verifica della capability di erogazione della potenza reattiva

/reactive power production capability

Potenza massima dell'impianto di destinazione:

Maximum power of the destination plant:

- ☒ PV_{plant} < 400 KW (see picture 1A)
☒ PV_{plant} ≥ 400 KW (see picture 1B)
☐ Wind generator (see picture 1C)

Tolerance:

$\Delta Q \leq \pm 5\%$ for each measured points
For values of $P \leq 10\% \cdot S_n \rightarrow \Delta Q \leq \pm 10\% S_n$

Sampling:

For each of the 11 levels of active power, 1 values of inductive reactive power and 1 values of capacitive reactive power must be recorded, as **averaged values in 1 min**, based on the measurements at the **fundamental frequency in a window of 200ms**,

Ambient temperature (°C):

25

Humidity (RH %):

70

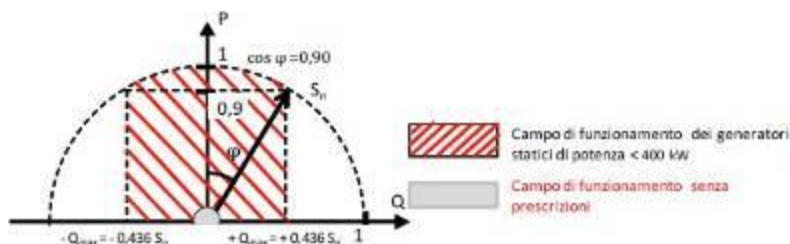
Input voltage:

780V (typical value specified by the manufacturer)

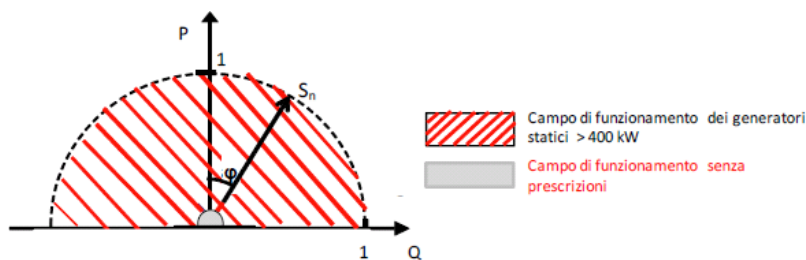
Deviation for wind generator (FC e DFIG) - N,6,1,2:

Test performed according: IEC 61400-21 Ed, 2, §, 6,7,1 and §, 7,7,1,

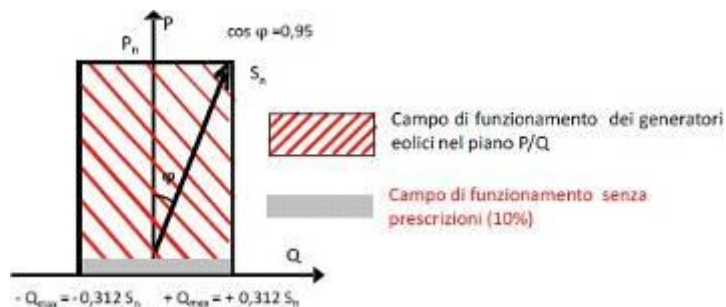
Picture 1A



Picture 1B



Picture 1C



Test model: AZZURRO 3PH 50KTL-V3

Rectangular Curve (Q=0%Sn)						
P Desired (%Sn)	Power DC (kW)	P measured (%Sn)	Q measured (%Sn)	Q Desired (%Sn)	Q Deviation (±5%Sn)	Power Factor (cos φ)
0 ⁽¹⁾	1.0	1.9	-0.9	0.0	--	0.900
5 ⁽¹⁾	2.6	5.0	-1.2	0.0	--	0.973
10	5.2	10.1	-1.3	0.0	-1.3	0.992
15	7.7	15.1	-1.3	0.0	-1.3	0.996
20	10.3	20.2	-1.3	0.0	-1.3	0.998
25	12.8	25.3	-1.3	0.0	-1.3	0.999
30	15.4	30.3	-1.3	0.0	-1.3	0.999
35	18.0	35.3	-0.8	0.0	-0.8	0.999
40	20.5	40.3	-0.4	0.0	-0.4	0.999
45	23.1	45.4	-0.2	0.0	-0.2	1.000
50	25.7	50.4	-0.1	0.0	-0.1	1.000
55	28.2	55.4	-0.9	0.0	-0.9	1.000
60	30.8	60.4	-0.2	0.0	-0.2	1.000
65	33.3	65.4	+0.1	0.0	+0.1	1.000
70	35.9	70.4	+0.4	0.0	+0.4	1.000
75	38.5	75.3	+0.6	0.0	+0.6	1.000
80	41.0	80.3	+0.6	0.0	+0.6	1.000
85	43.6	85.3	+0.6	0.0	+0.6	1.000
90	46.1	90.2	+0.7	0.0	+0.7	1.000
95	48.7	95.2	+0.7	0.0	+0.7	1.000
100	51.2	100.1	+0.7	0.0	+0.7	1.000
105	54.0	105.0	+0.3	0.0	+0.3	1.000
110	56.4	110.1	+0.7	0.0	+0.7	1.000

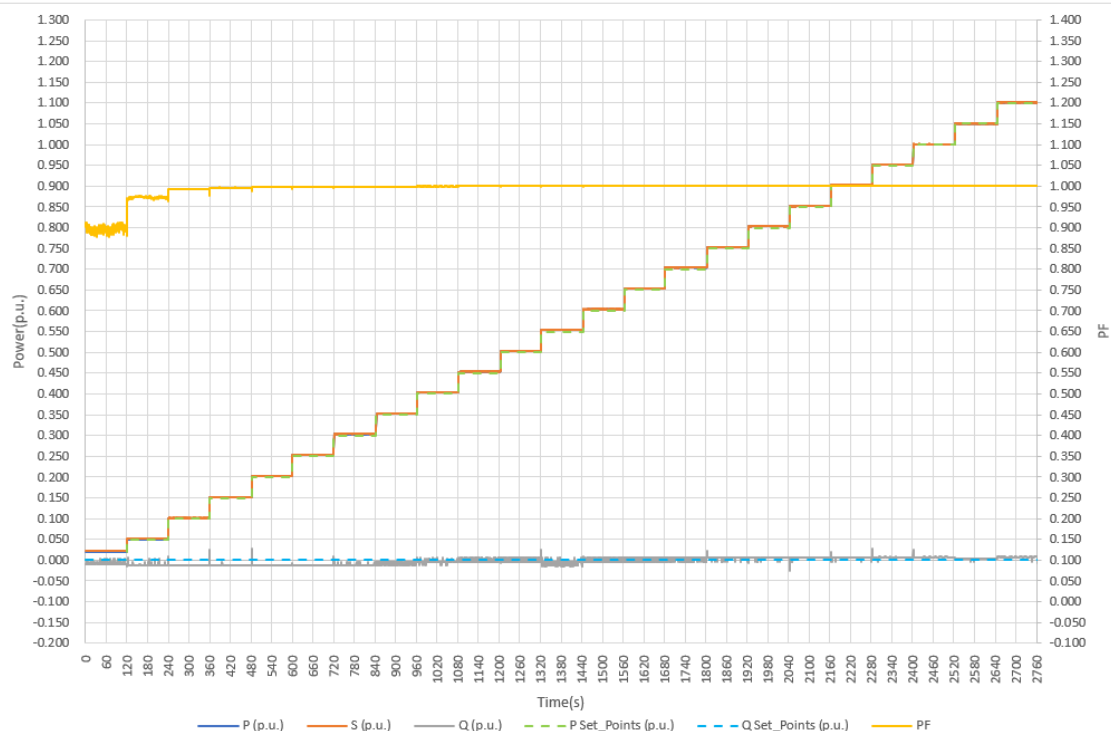
Rectangular Curve (Q=48.43%Sn / Inductive)						
P Desired (%Sn)	Power DC (kW)	P measured (%Sn)	Q measured (%Sn)	Q Deviation (%Sn)	Q Deviation (±5%Sn)	Power Factor (cos φ)
0 ⁽¹⁾	1.043	1.5	+48.5	--	--	0.031
5 ⁽¹⁾	2.786	5.0	+48.5	--	--	0.102
10	5.302	10.0	+48.5	+48.4	+0.1	0.202
15	7.814	15.0	+48.5	+48.4	+0.1	0.296
20	10.350	20.1	+48.5	+48.4	+0.1	0.382
25	12.865	25.1	+48.5	+48.4	+0.1	0.459
30	15.406	30.1	+48.5	+48.4	+0.1	0.527
35	17.965	35.1	+48.5	+48.4	+0.1	0.587
40	20.531	40.2	+48.5	+48.4	+0.1	0.639
45	22.992	45.1	+48.5	+48.4	+0.1	0.681
50	25.553	50.1	+48.4	+48.4	0.0	0.719
55	28.113	55.1	+48.5	+48.4	+0.1	0.751
60	30.675	60.1	+48.5	+48.4	+0.1	0.778
65	33.183	65.0	+48.5	+48.4	+0.1	0.802
70	35.739	70.0	+48.5	+48.4	+0.1	0.822
75	38.324	75.1	+48.5	+48.4	+0.1	0.840
80	40.884	80.1	+48.5	+48.4	+0.1	0.855
85	43.440	85.0	+48.5	+48.4	+0.1	0.868
90	46.018	90.0	+48.5	+48.4	+0.1	0.880
95	48.617	95.1	+48.6	+48.4	+0.2	0.891
100	51.205	100.1	+48.6	+48.4	+0.2	0.900
105 ⁽²⁾	52.012	101.1	+48.4	+48.4	0.0	0.902
110 ⁽²⁾	52.047	101.5	+48.4	+48.4	0.0	0.903

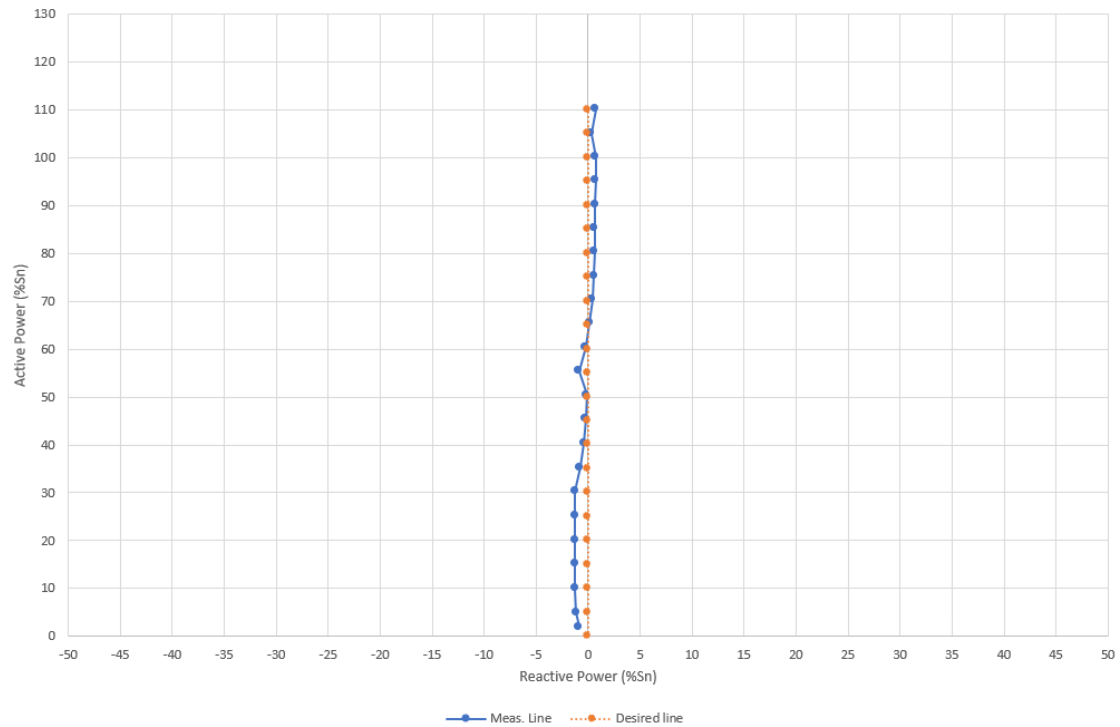
Rectangular Curve (Q=48.43%Sn / Capacitive)						
P Desired (%Sn)	Power DC (kW)	P measured (%Sn)	Q measured (%Sn)	Q desired (%Sn)	Q Deviation ($\pm 5\%$ Sn)	Power Factor (cos ϕ)
0 ⁽¹⁾	1.009	0.6	-48.4	--	--	0.013
5 ⁽¹⁾	3.093	4.8	-48.4	--	--	0.098
10	5.659	9.9	-48.4	-48.4	-0.1	0.200
15	8.227	15.0	-48.4	-48.4	-0.1	0.296
20	10.684	19.9	-48.4	-48.4	-0.1	0.380
25	13.250	25.0	-48.4	-48.4	0.0	0.458
30	15.764	30.0	-48.4	-48.4	-0.1	0.526
35	18.323	35.0	-48.4	-48.4	-0.1	0.586
40	20.838	40.0	-48.4	-48.4	-0.1	0.636
45	23.401	45.0	-48.4	-48.4	-0.1	0.680
50	25.963	50.1	-48.4	-48.4	-0.1	0.718
55	28.523	55.1	-48.4	-48.4	-0.1	0.751
60	31.085	60.1	-48.4	-48.4	-0.1	0.778
65	33.644	65.1	-48.4	-48.4	-0.1	0.802
70	36.151	70.0	-48.4	-48.4	-0.1	0.822
75	38.708	75.0	-48.4	-48.4	-0.1	0.840
80	41.267	80.0	-48.4	-48.4	-0.1	0.855
85	43.824	84.9	-48.4	-48.4	-0.1	0.868
90	46.378	89.9	-48.4	-48.4	-0.1	0.880
95	48.933	94.8	-48.4	-48.4	-0.1	0.891
100	51.230	99.3	-48.4	-48.4	0.0	0.899
105 ⁽²⁾	51.951	100.0	-48.4	-48.4	0.0	0.900
110 ⁽²⁾	52.033	100.7	-48.4	-48.4	0.0	0.901

(1) According to point N.6.1 for lower values of generated active power ($P \leq 10\%$ Sn), deviations in the reactive power are allowed up to a 10%Sn.

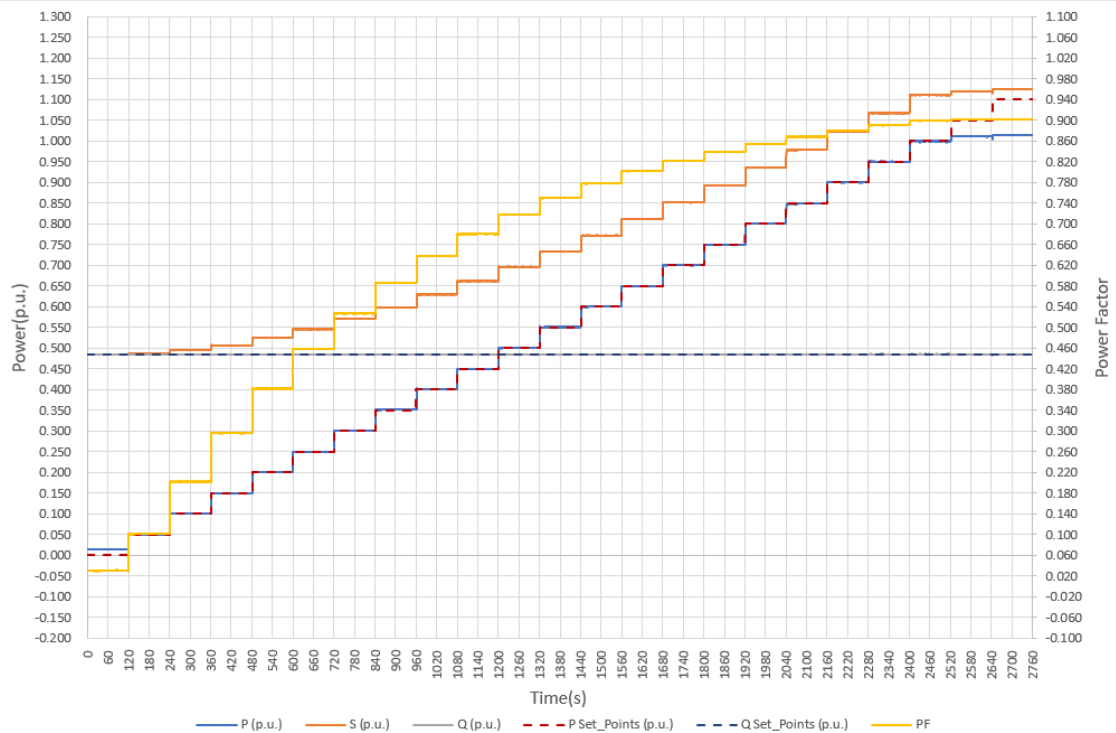
(2) The desired value of active power has not been reached due to fixed reactive power is 48.4%Sn of the Inverter.

Rectangular Curve (Q = 0 %Sn)

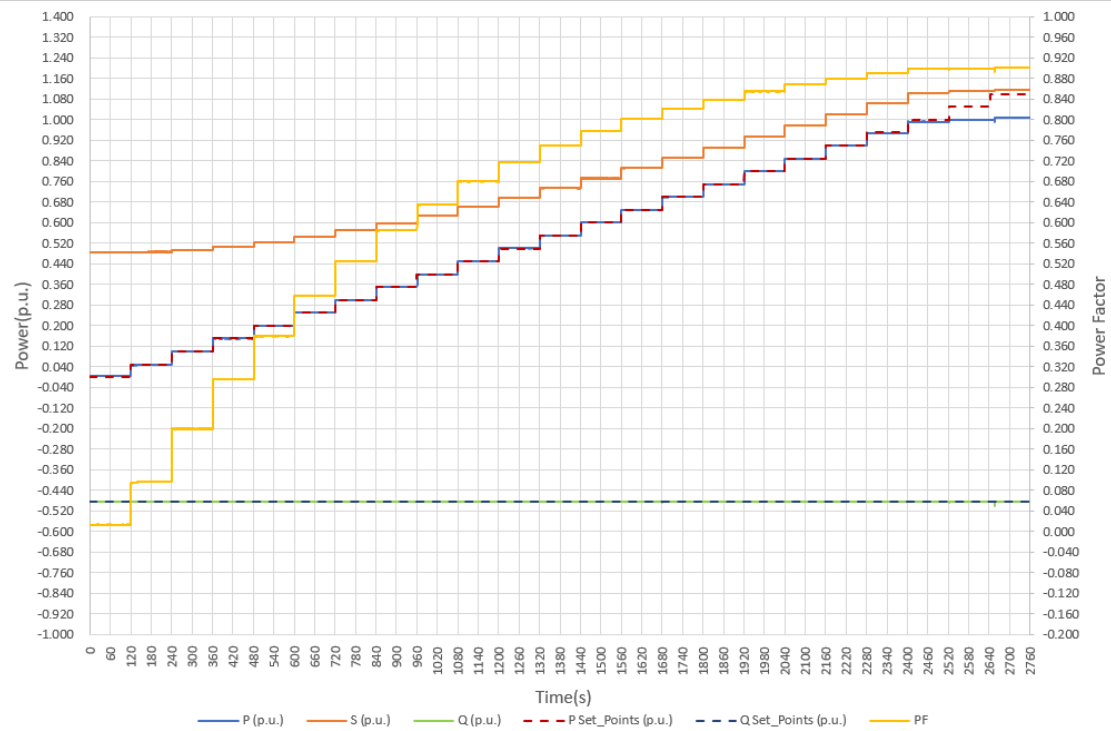




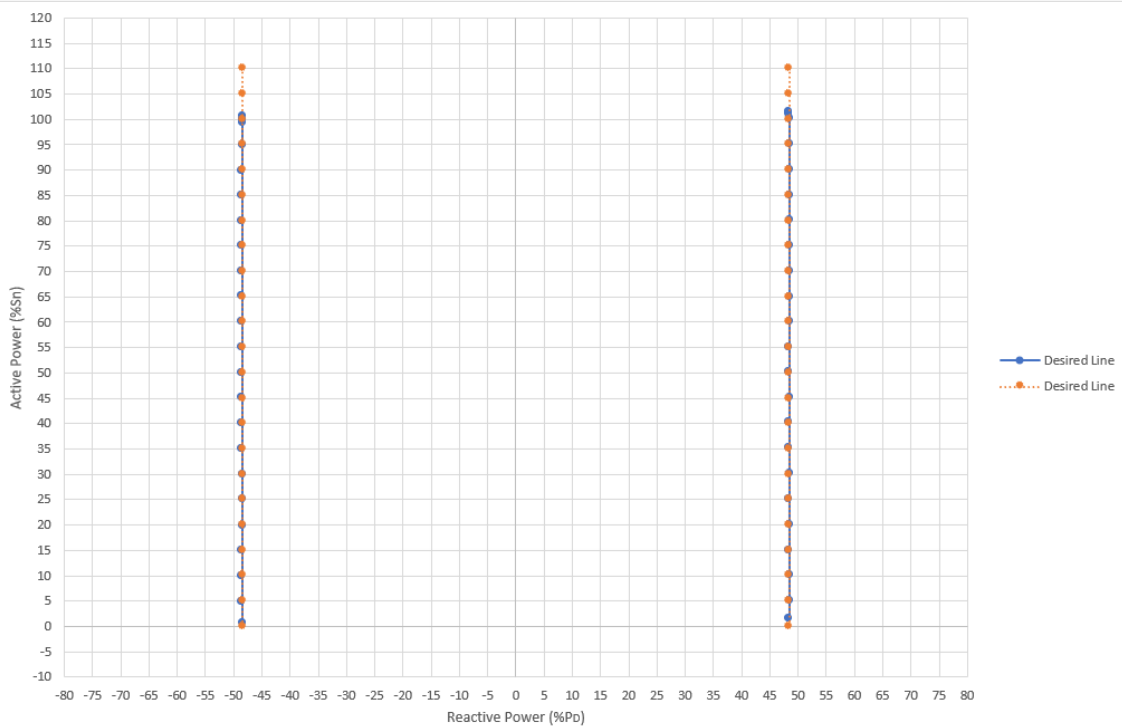
Rectangular Curve (Q = 48.43 %Sn / Inductive)



Rectangular Curve (Q = 48.43 %S_n / Capacitive)



Rectangular Curve (Capacitive vs Inductive)

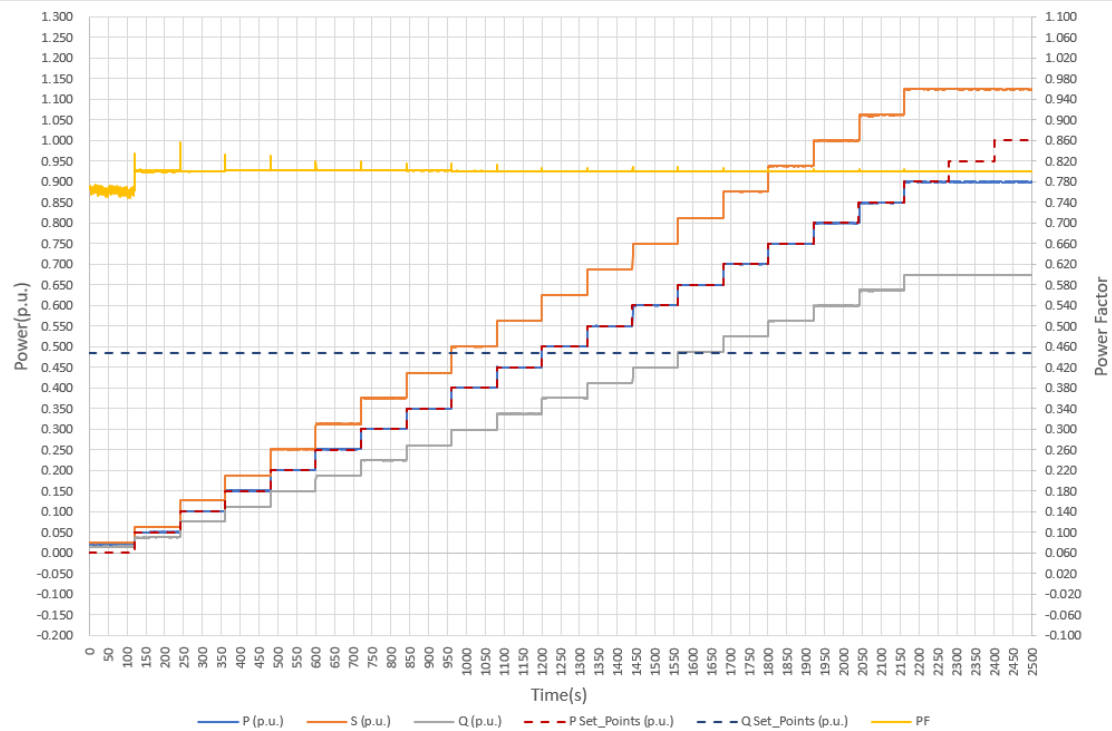


Test model: AZZURRO 3PH 50KTL-V3						
Triangular Curve (PF = 0.8 / inductive)						
P desired (%Sn)	Power DC (kW)	P measured (%Sn)	Q measured (%Sn)	Power factor measured (cos φ)	Power factor desired (cos φ)	Power factor deviation ($\pm 0.01\cos \varphi$)
0 ⁽¹⁾	1.040	1.9	1.6	0.765	--	--
5 ⁽¹⁾	2.605	5.1	3.8	0.801	--	--
10	5.172	10.2	7.6	0.800	0.800	0.000
15	7.660	15.1	11.2	0.802	0.800	+0.002
20	10.221	20.2	15.0	0.802	0.800	+0.002
25	12.737	25.1	18.7	0.802	0.800	+0.002
30	15.303	30.1	22.4	0.802	0.800	+0.002
35	17.812	35.0	26.1	0.802	0.800	+0.002
40	20.378	40.1	29.9	0.801	0.800	+0.001
45	22.941	45.1	33.7	0.800	0.800	0.000
50	25.504	50.1	37.6	0.800	0.800	0.000
55	28.064	55.1	41.3	0.800	0.800	0.000
60	30.623	60.1	45.0	0.800	0.800	0.000
65	33.184	65.0	48.7	0.800	0.800	0.000
70	35.789	70.1	52.5	0.800	0.800	0.000
75	38.351	75.1	56.3	0.800	0.800	0.000
80	40.907	80.0	60.0	0.800	0.800	0.000
85	43.505	85.0	63.7	0.800	0.800	0.000
90	46.183	90.0	67.4	0.800	0.800	0.000
95 ⁽²⁾	46.185	90.0	67.4	0.800	0.800	0.000
100 ⁽²⁾	46.189	90.0	67.4	0.800	0.800	0.000

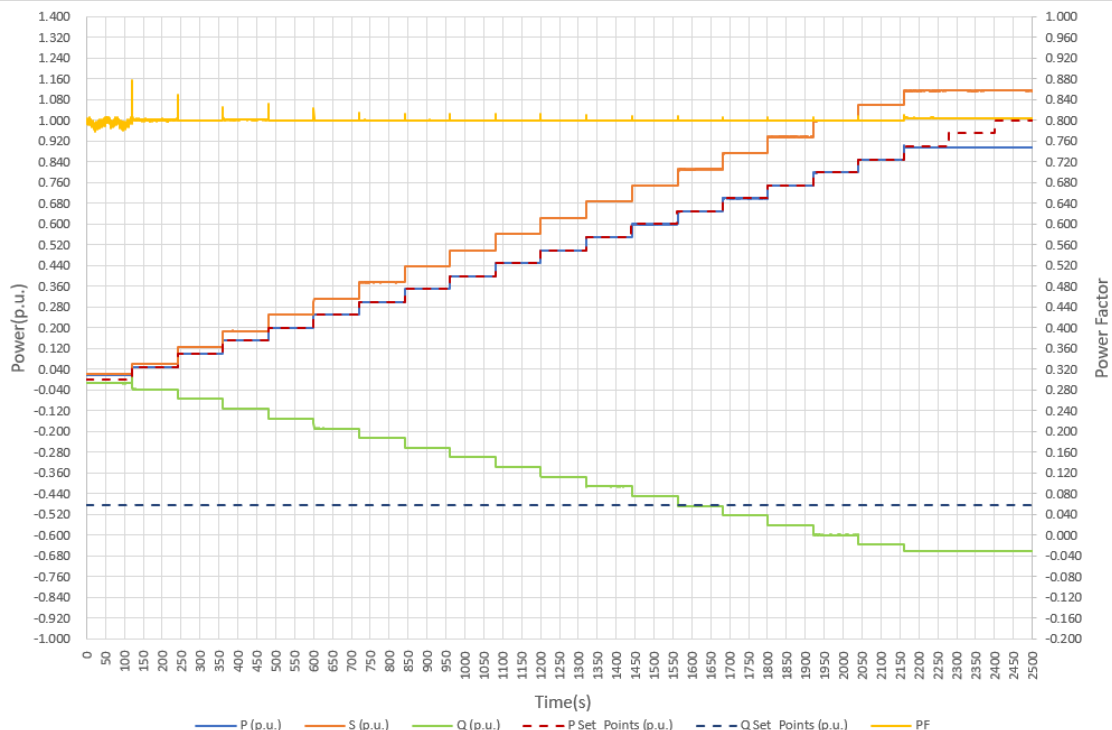
Triangular Curve (PF = 0.8 / Capacitive)						
P desired (%Sn)	Power DC (kW)	P measured (%Sn)	Q measured (%Sn)	Power factor measured (cos φ)	Power factor desired (cos φ)	Power factor deviation ($\pm 0.01\cos \varphi$)
0 ⁽¹⁾	1.042	1.8	-1.4	0.797	--	--
5 ⁽¹⁾	2.580	4.9	-3.7	0.801	--	--
10	5.147	10.0	-7.5	0.800	0.800	0.000
15	7.765	15.1	-11.3	0.801	0.800	+0.001
20	10.325	20.1	-15.1	0.800	0.800	0.000
25	12.891	25.0	-18.8	0.800	0.800	0.000
30	15.458	30.0	-22.5	0.800	0.800	0.000
35	18.017	35.0	-26.2	0.801	0.800	+0.001
40	20.583	40.0	-30.0	0.800	0.800	0.000
45	23.197	45.0	-33.8	0.800	0.800	0.000
50	25.758	49.9	-37.4	0.800	0.800	0.000
55	28.369	55.0	-41.2	0.800	0.800	0.000
60	30.970	60.0	-45.0	0.800	0.800	0.000
65	33.580	65.0	-48.7	0.800	0.800	0.000
70	36.188	70.0	-52.4	0.800	0.800	0.000
75	38.796	75.0	-56.1	0.800	0.800	0.000
80	41.420	79.9	-59.9	0.800	0.800	0.000
85	44.078	85.0	-63.6	0.801	0.800	+0.001
90	46.598	89.7	-66.2	0.805	0.800	+0.005
95 ⁽²⁾	46.600	89.7	-66.2	0.805	0.800	+0.005
100 ⁽²⁾	46.604	89.6	-66.2	0.805	0.800	+0.005

(1) No tolerance of Power Factor was defined when active power level below 10%Sn.
(2) The desired value of active power has not been reached due to power factor is 0.8 of the Inverter.

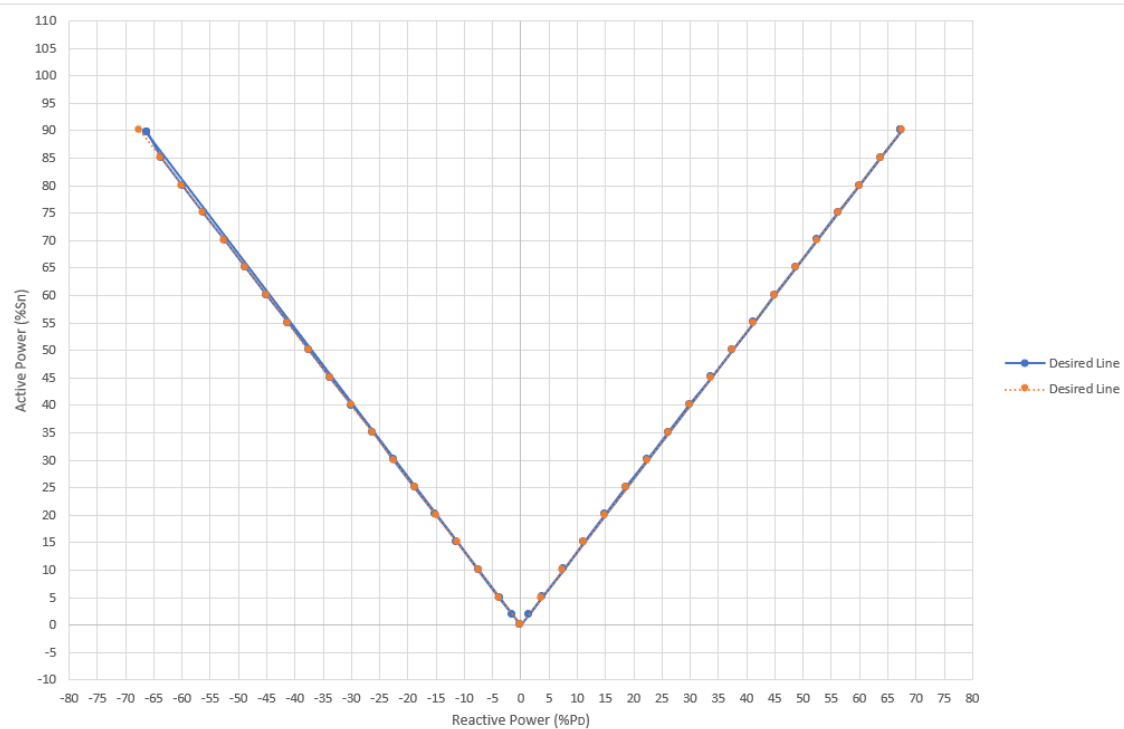
Triangular Curve (PF = 0.8 / inductive)



Triangular Curve (PF = 0.8 / Capacitive)



Triangular Curve (Inductive vs Capacitive)

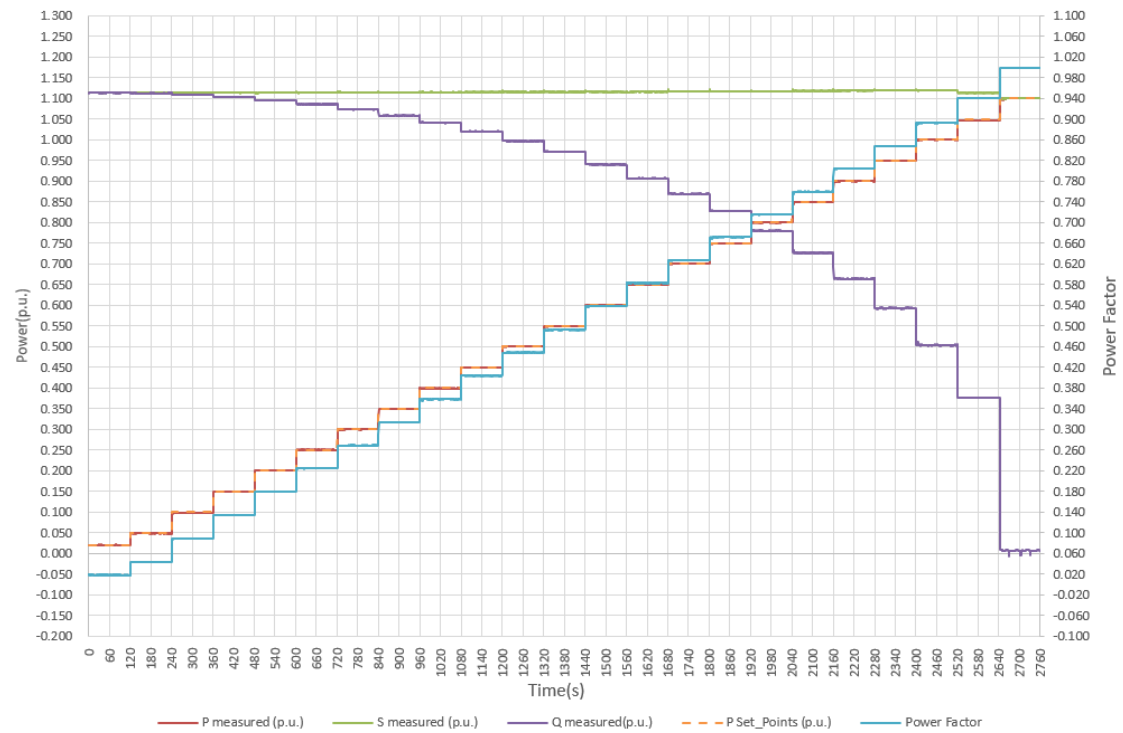


Test model: AZZURRO 3PH 50KTL-V3						
Semicircle Curve (S = 110 %Sn / Inductive)						
P Desired (%Sn)	P measured (%Sn)	S measured (%Sn)	Power Factor (cos φ)	Q measured (%Sn)	Q desired (%Sn) ⁽²⁾	Q deviation (±5%Sn)
0 ⁽¹⁾	2.1	111.4	0.018	+111.4	+110.0	--
5 ⁽¹⁾	4.9	111.4	0.044	+111.3	+109.9	--
10	9.9	111.4	0.089	+111.0	+109.5	+1.5
15	15.0	111.4	0.135	+110.4	+109.0	+1.4
20	20.1	111.4	0.180	+109.6	+108.2	+1.4
25	25.1	111.5	0.225	+108.6	+107.1	+1.5
30	30.0	111.5	0.269	+107.4	+105.8	+1.6
35	35.0	111.5	0.314	+105.9	+104.3	+1.6
40	40.0	111.5	0.358	+104.1	+102.5	+1.6
45	45.1	111.6	0.404	+102.1	+100.4	+1.7
50	50.1	111.6	0.449	+99.7	+98.0	+1.7
55	55.0	111.6	0.493	+97.1	+95.3	+1.8
60	60.1	111.6	0.538	+94.0	+92.2	+1.8
65	65.1	111.6	0.583	+90.7	+88.7	+2.0
70	70.1	111.7	0.628	+86.9	+84.9	+2.0
75	75.1	111.7	0.672	+82.7	+80.5	+2.2
80	80.0	111.8	0.716	+78.0	+75.5	+2.5
85	85.0	111.8	0.760	+72.7	+69.8	+2.9
90	90.1	111.9	0.805	+66.4	+63.2	+3.2
95	95.0	112.0	0.848	+59.3	+55.5	+3.8
100	100.0	112.0	0.893	+50.3	+45.8	+4.5
105	104.8	111.4	0.941	+37.7	+32.8	+4.9
110	110.1	110.1	1.000	+0.7	+0.0	+0.7
Semicircle Curve (S = 110 %Sn / Capacitive)						
P Desired (%Sn)	P measured (%Sn)	S measured (%Sn)	Power Factor (cos φ)	Q measured (%Sn)	Q desired (%Sn) ⁽²⁾	Q deviation (%Sn)
0 ⁽¹⁾	2.1	110.0	0.019	-109.9	-110.0	--
5 ⁽¹⁾	5.0	109.9	0.046	-109.8	-109.9	--
10	10.0	110.0	0.091	-109.5	-109.5	0.0
15	15.1	110.0	0.137	-108.9	-109.0	+0.1
20	20.0	109.9	0.182	-108.0	-108.2	+0.2
25	25.1	109.8	0.229	-106.9	-107.1	+0.2
30	30.1	109.9	0.273	-105.7	-105.8	+0.1
35	35.0	110.0	0.318	-104.3	-104.3	0.0
40	40.1	110.0	0.364	-102.5	-102.5	0.0
45	45.0	110.0	0.409	-100.3	-100.4	+0.1
50	50.1	109.9	0.456	-97.8	-98.0	+0.2
55	55.0	110.0	0.500	-95.2	-95.3	+0.1
60	60.0	110.2	0.544	-92.5	-92.2	-0.3
65	65.1	110.5	0.589	-89.3	-88.7	-0.6
70	70.0	110.7	0.633	-85.7	-84.9	-0.8
75	75.0	110.7	0.677	-81.5	-80.5	-1.0
80	80.0	110.7	0.723	-76.4	-75.5	-0.9
85	85.0	110.7	0.768	-70.8	-69.8	-1.0
90	90.0	110.8	0.812	-64.6	-63.2	-1.4
95	95.0	111.0	0.856	-57.3	-55.5	-1.8
100	99.1	111.1	0.893	-50.1	-45.8	-4.3
105	104.1	110.1	0.945	-35.9	-32.8	-3.1
110	110.0	110.1	1.000	+0.7	0.0	+0.7

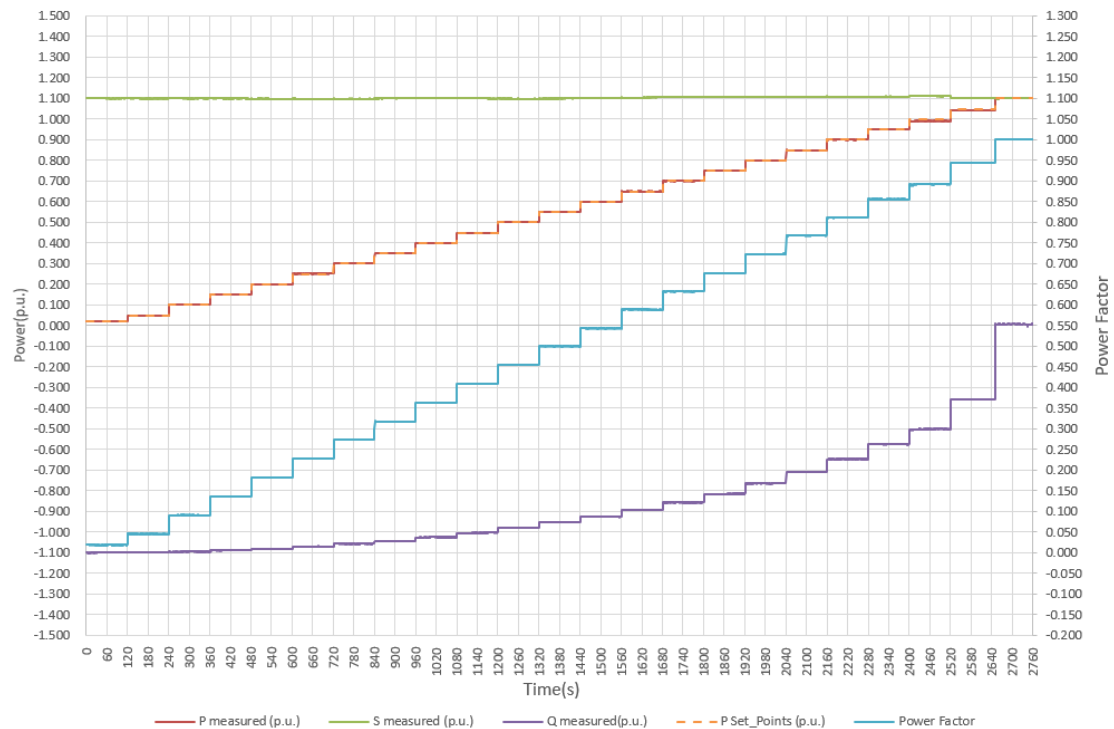
(1) According to point N.6.1 for lower values of generated active power ($P \leq 10$ %Sn), deviations in the reactive power are allowed up to a 10 %Sn.

(2) The desired Q is calculated from $Q = -\sqrt{(S^2 - P^2)}$.

Semicircle Curve (Sn = 110 %Sn / Inductive)



Semicircle Curve (Sn = 110 %Sn / Capacitive)



Triangular Curve (Inductive vs Capacitive)

