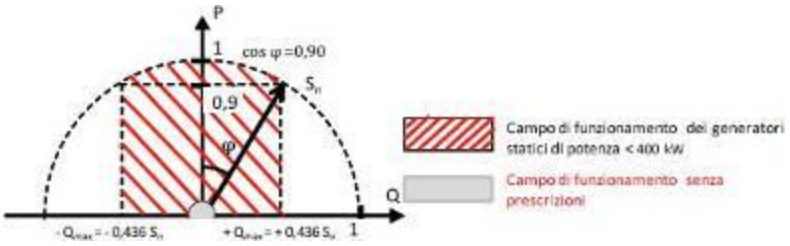
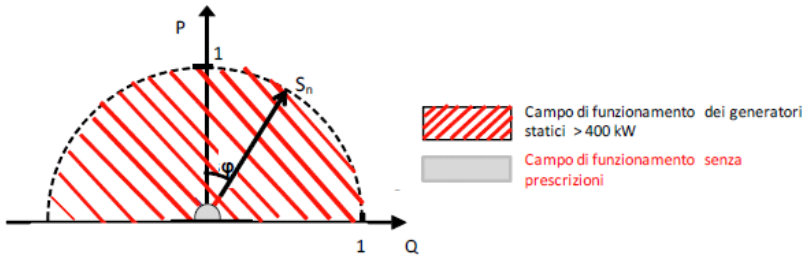
N.6.1 Verifica della capability di erogazione della potenza reattiva ***/reactive power production capability***	
Potenza massima dell'impianto di destinazione: *Maximum power of the destination plant:*	☐ PV $_{plant}$ < 400 KW *(see picture 1A)* ☒ PV $_{plant}$ ≥ 400 KW *(see picture 1B)* ☐ Wind generator *(see picture 1C)*
Tollerance:	ΔQ ≤ ±5% for each measured points For values of P≤10%*Sn → ΔQ ≤ ±10%Sn
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 %) .....:	68
Input voltage .....:	700V (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,**	

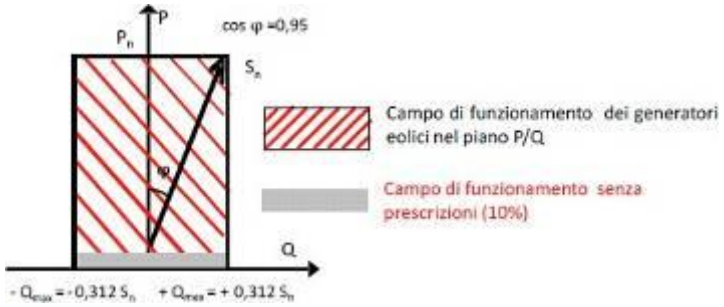
Picture 1A



Picture 1B



Picture 1C



Test 1: Q Zero (Q = 0 %Sn)

This test verifies the capability of the inverter to provide a fixed value of reactive power. In addition, it is verified the Q control mode.

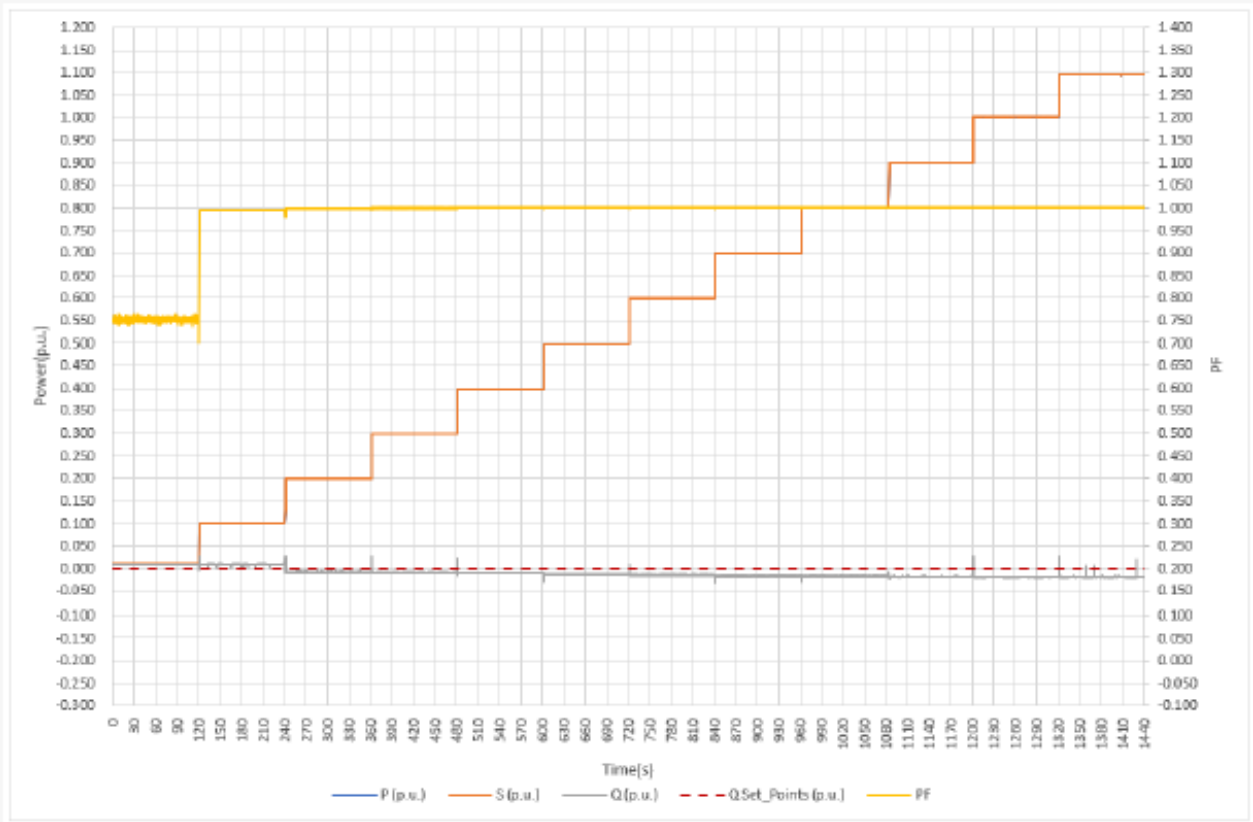
Allowed tolerance for reactive power measurements is to be considered inside ±5 %Sn.

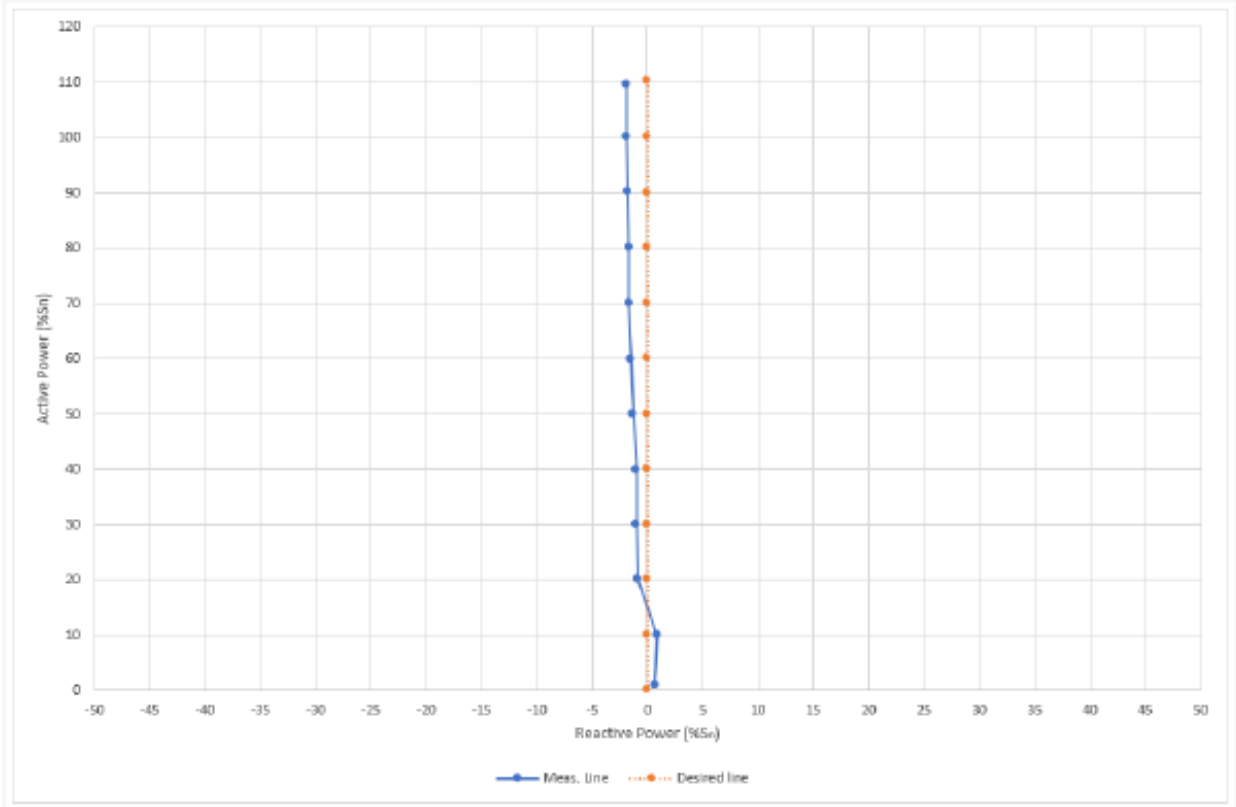
Test results are offered in table below.

Rectangular Curve (Q=0%Pn)						
P Desired (%Sn)	**Power (kW)**	**P measured (%Sn)**	**Q measured (%Sn)**	**Q Desired (%Sn)**	**Q Deviation (±5%Sn)**	**Power Factor (cos φ)**
0(1)	0.671	0.8	+0.7	**0.0**	--	0.752
10	7.965	10.0	+0.9	**0.0**	+0.9	0.996
20	15.968	20.0	-0.9	**0.0**	-0.9	0.999
30	23.936	29.9	-1.0	**0.0**	-1.0	0.999
40	31.897	39.9	-1.0	**0.0**	-1.0	1.000
50	39.860	49.8	-1.3	**0.0**	-1.3	1.000
60	47.915	59.9	-1.5	**0.0**	-1.5	1.000
70	55.970	70.0	-1.7	**0.0**	-1.7	1.000
80	63.984	80.0	-1.7	**0.0**	-1.7	1.000
90	72.026	90.0	-1.8	**0.0**	-1.8	1.000
100	80.065	100.1	-1.9	**0.0**	-1.9	1.000
110	87.621	109.5	-1.9	**0.0**	-1.9	1.000

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

Rectangular Curve (Q = 0 %Sn)





Test 2: Semicircular Curve (S = 48.43 %Sn)

This test verifies the capability of the inverter to provide a fixed value of reactive power. In addition, it is verified the Q control mode.

Allowed tolerance for reactive power measurements is to be considered inside ±5 %Sn.

Test results are offered in tables below.

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)	1.055	1.3	+48.8	--	--	0.027
5(1)	4.209	5.3	+48.7	--	--	0.107
10	8.205	10.3	+48.7	**+48.4**	+0.3	0.206
15	12.202	15.3	+48.7	**+48.4**	+0.3	0.299
20	16.187	20.2	+48.7	**+48.4**	+0.3	0.384
25	20.158	25.2	+48.6	**+48.4**	+0.2	0.460
30	24.168	30.2	+48.6	**+48.4**	+0.2	0.528
35	28.201	35.3	+48.7	**+48.4**	+0.3	0.587
40	32.172	40.2	+48.7	**+48.4**	+0.3	0.637
45	36.297	45.4	+48.7	**+48.4**	+0.3	0.681
50	40.285	50.4	+48.7	**+48.4**	+0.3	0.719
55	44.243	55.3	+48.7	**+48.4**	+0.3	0.751
60	48.238	60.3	+48.6	**+48.4**	+0.2	0.778
65	52.227	65.3	+48.6	**+48.4**	+0.2	0.802
70	56.215	70.3	+48.5	**+48.4**	+0.1	0.823
75	60.219	75.3	+48.4	**+48.4**	0.0	0.841
80	64.213	80.3	+48.3	**+48.4**	-0.1	0.857
85	68.221	85.3	+48.2	**+48.4**	-0.2	0.870
90	72.240	90.3	+48.2	**+48.4**	-0.2	0.882
95	76.258	95.3	+48.1	**+48.4**	-0.3	0.893
100	79.126	98.9	+48.0	**+48.4**	-0.4	0.900
105(2)	79.124	98.9	+48.0	**+48.4**	-0.4	0.900
110(2)	79.124	98.9	+48.0	**+48.4**	-0.4	0.900

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

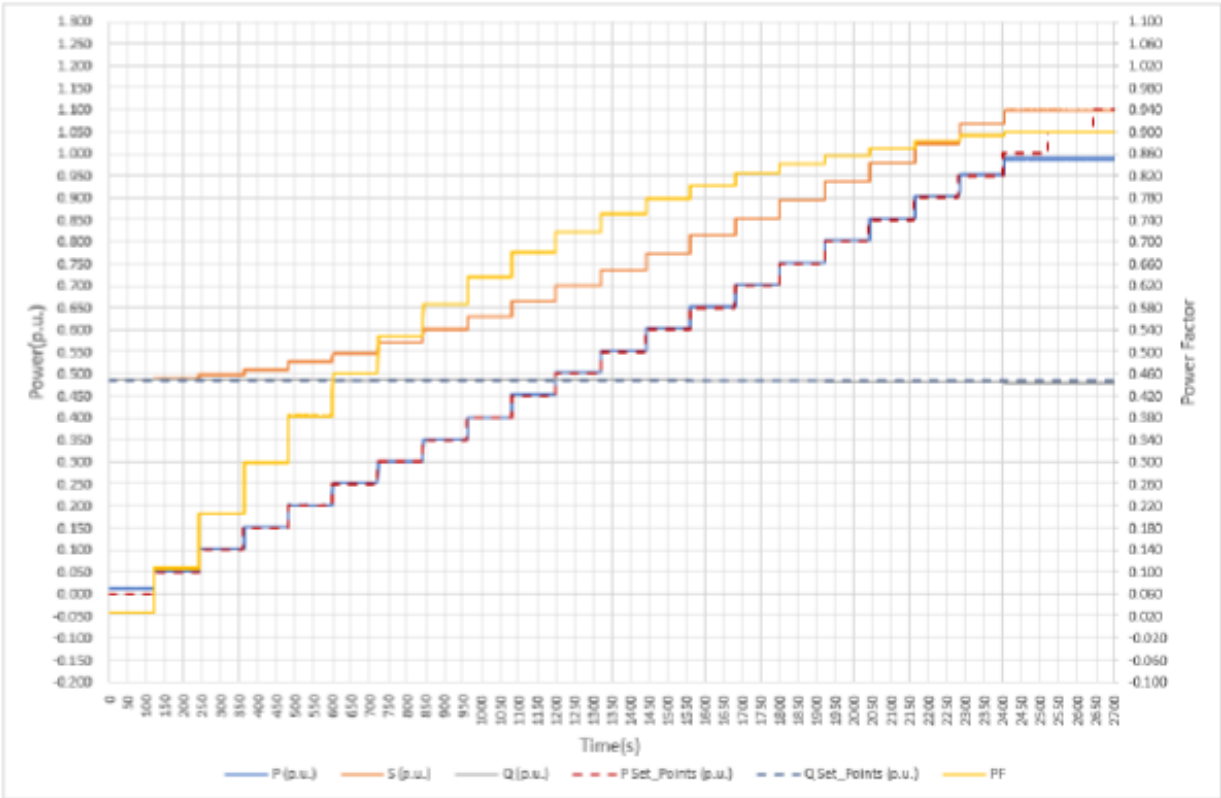
(2) The desired value of active power has not been reached due to fixed reactive power is 48.4%Sn of the Inverter.

Rectangular Curve (Q=48.43%Sn / Capacitive)						
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)	0.420	0.5	-48.7	--	--	0.011
5(1)	3.605	4.5	-48.8	--	--	0.092
10	7.608	9.5	-48.8	-48.4	-0.4	0.191
15	11.594	14.5	-48.9	-48.4	-0.5	0.284
20	15.588	19.5	-49.0	-48.4	-0.6	0.370
25	19.587	24.5	-49.1	-48.4	-0.7	0.446
30	23.595	29.5	-49.3	-48.4	-0.9	0.514
35	27.634	34.5	-49.4	-48.4	-1.0	0.573
40	31.599	39.5	-49.5	-48.4	-1.1	0.623
45	35.706	44.6	-49.6	-48.4	-1.2	0.669
50	39.609	49.5	-49.5	-48.4	-1.1	0.707
55	43.572	54.5	-49.4	-48.4	-1.0	0.740
60	47.564	59.5	-49.4	-48.4	-1.0	0.769
65	51.540	64.4	-49.5	-48.4	-1.1	0.793
70	55.541	69.4	-49.5	-48.4	-1.1	0.814
75	59.538	74.4	-49.5	-48.4	-1.1	0.833
80	63.532	79.4	-49.5	-48.4	-1.1	0.848
85	67.534	84.4	-49.6	-48.4	-1.2	0.862
90	71.519	89.4	-49.6	-48.4	-1.2	0.874
95	75.526	94.4	-49.7	-48.4	-1.3	0.885
100	78.261	97.8	-48.0	-48.4	+0.4	0.898
105(2)	78.257	97.8	-48.0	-48.4	0.4	0.898
110(2)	78.848	98.6	-48.0	-48.4	0.4	0.900

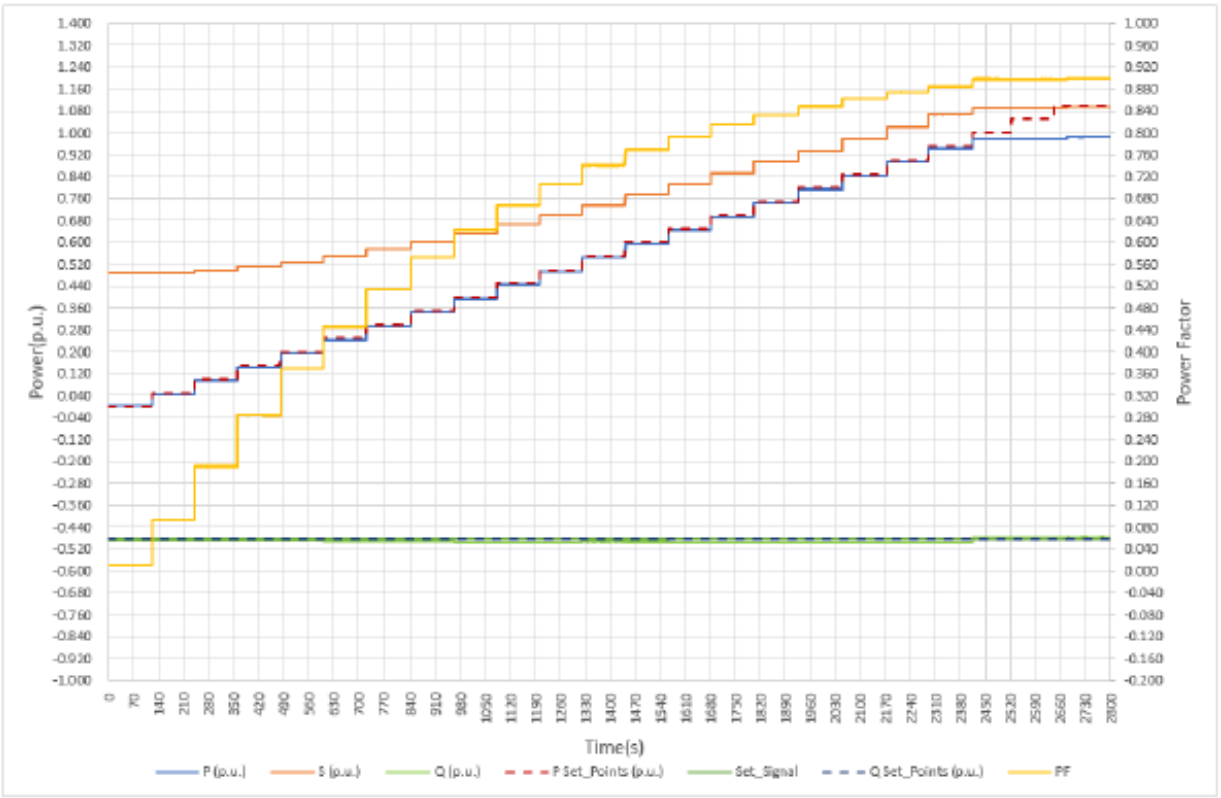
(1) According to point N.6.1 for lower values of generated active power (P≤10 %Sn), deviations in the reactive power are allowed up to a 10 %Sn.

(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 = 48.43 %Sn / Inductive)



Rectangular Curve (Q = 48.43 %S_n / Capacitive)



Test 3: Triangle Curve (PF=±0.8)

This test verifies the capability of the inverter to provide a fixed value of power factor. In addition, it is verified the PF control mode.

The maximum tolerance considered for the measured Power Factor is ± 0.01, for measurements above 10%Sn.

Test results are presented in the following table and graphs:

Triangle Curve (PF = 0.8 / inductive)						
P desired (%Pn)	**Power (kW)**	**P measured (%Pn)**	**Q measured (%Pn)**	**Power factor measured (cos φ)**	**Power factor desired (cos φ)**	**Power factor deviation (± 0.01cos φ)**
0(1)	0.659	0.8	1.1	0.590	--	--
5(1)	3.997	5.0	4.0	0.781	--	--
10	8.025	10.0	7.7	0.793	**0.800**	-0.007
15	12.043	15.1	11.3	0.799	**0.800**	-0.001
20	16.052	20.1	15.0	0.801	**0.800**	+0.001
25	20.052	25.1	18.6	0.802	**0.800**	+0.002
30	24.040	30.1	22.3	0.803	**0.800**	+0.003
35	28.041	35.1	26.0	0.803	**0.800**	+0.003
40	31.999	40.0	29.6	0.804	**0.800**	+0.004
45	36.049	45.1	33.4	0.804	**0.800**	+0.004
50	40.127	50.2	37.1	0.804	**0.800**	+0.004
55	44.217	55.3	40.9	0.804	**0.800**	+0.004
60	48.177	60.2	44.5	0.804	**0.800**	+0.004
65	52.182	65.2	48.2	0.804	**0.800**	+0.004
70	56.172	70.2	51.8	0.805	**0.800**	+0.005
75	60.164	75.2	55.4	0.805	**0.800**	+0.005
80	64.164	80.2	59.0	0.805	**0.800**	+0.005
85	68.176	85.2	62.7	0.806	**0.800**	+0.006
90	70.584	88.2	64.9	0.806	**0.800**	+0.006
95(2)	70.585	88.2	64.9	0.806	**0.800**	+0.006
100(2)	70.587	88.2	64.8	0.806	**0.800**	+0.006

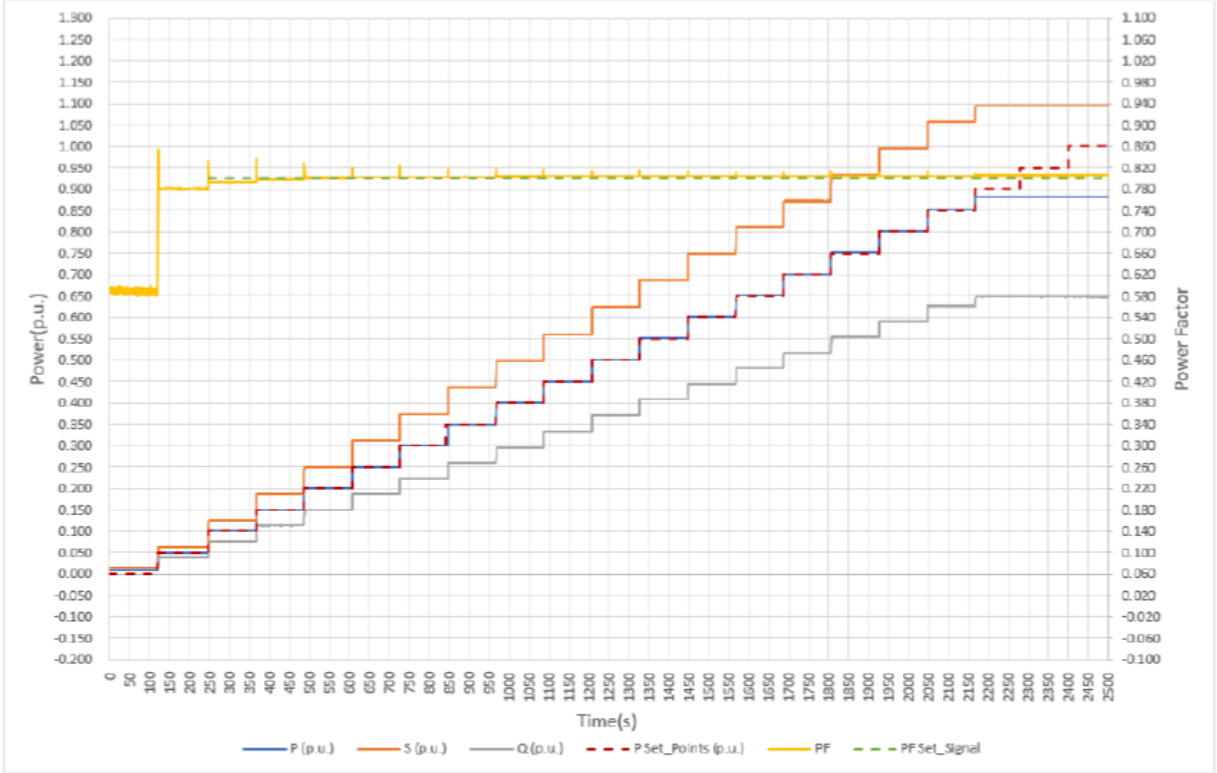
(1) No tolerance of Power Factor was defined when active power level below 10%Pn
(2) The desired value of active power has not been reached due to power factor is 0.8 of the Inverter.

Triangle Curve (PF = 0.8 / Capacitive)						
P desired (%Sn)	Power (kW)	P measured (%Pn)	Q measured (%Pn)	Power factor measured (cos φ)	Power factor desired (cos φ)	Power factor deviation (± 0.01cos φ)
0(1)	0.666	0.8	-0.9	0.673	--	--
5(1)	3.944	4.9	-3.8	0.794	--	--
10	7.901	9.9	-7.4	0.799	0.800	-0.001
15	11.877	14.8	-11.2	0.799	0.800	-0.001
20	15.833	19.8	-14.9	0.798	0.800	-0.002
25	19.788	24.7	-18.7	0.798	0.800	-0.002
30	23.743	29.7	-22.4	0.798	0.800	-0.002
35	27.686	34.6	-26.2	0.797	0.800	-0.003
40	31.587	39.5	-29.9	0.797	0.800	-0.003
45	35.602	44.5	-33.8	0.797	0.800	-0.003
50	39.631	49.5	-37.7	0.796	0.800	-0.004
55	43.638	54.5	-41.5	0.796	0.800	-0.004
60	47.542	59.4	-45.2	0.796	0.800	-0.004
65	51.477	64.3	-48.9	0.796	0.800	-0.004
70	55.441	69.3	-52.5	0.797	0.800	-0.003
75	59.402	74.3	-56.2	0.797	0.800	-0.003
80	63.376	79.2	-59.9	0.798	0.800	-0.002
85	67.347	84.2	-63.6	0.798	0.800	-0.002
90	69.737	87.2	-65.0	0.801	0.800	+0.001
95(2)	69.735	87.2	-65.0	0.801	0.800	+0.001
100(2)	69.734	87.2	-65.1	0.801	0.800	+0.001

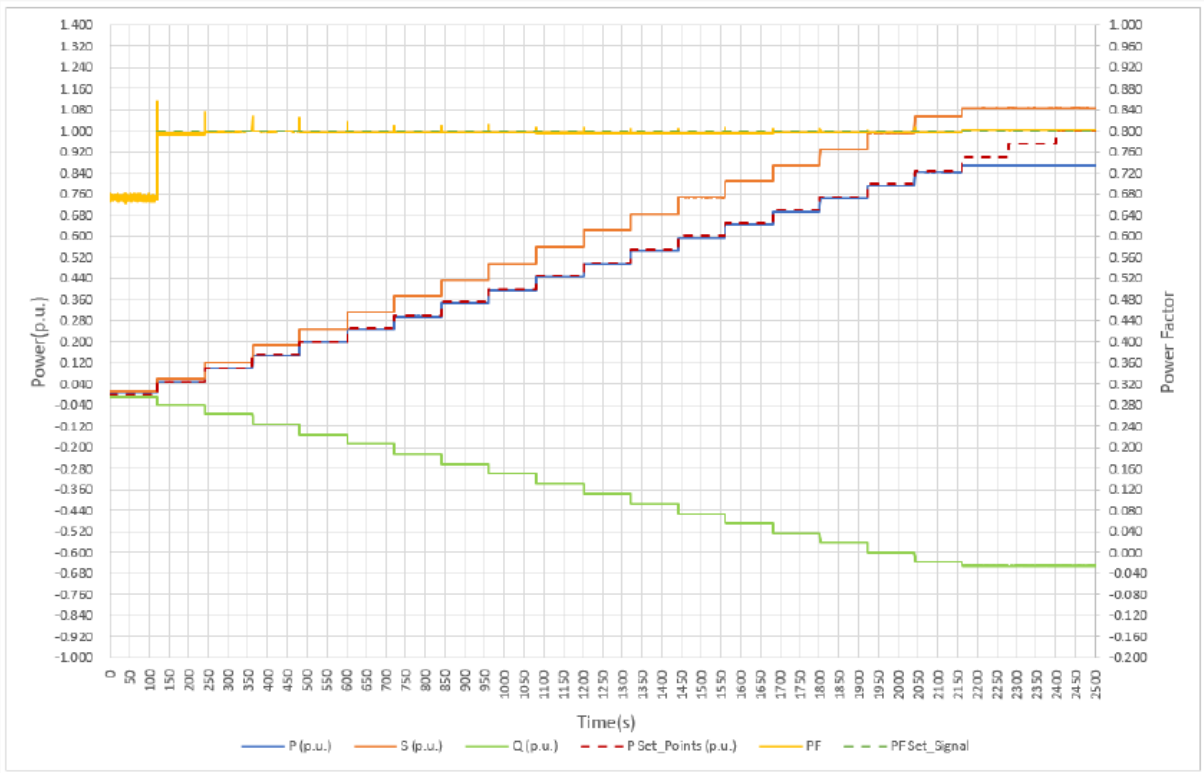
(1) No tolerance of Power Factor was defined when active power level below 10%Pn
(2) The desired value of active power has not been reached due to power factor is 0.8 of the Inverter.

Test results are represented at the diagrams below.

Triangle Curve (PF = 0.8 / inductive)



Triangle Curve (PF = 0.8 / Capacitive)



Test 4: Semicircle Curve (S = 110 %Sn)

This test verifies the capability of the inverter to provide a fixed value of apparent power.

Test results are offered in the tables below.

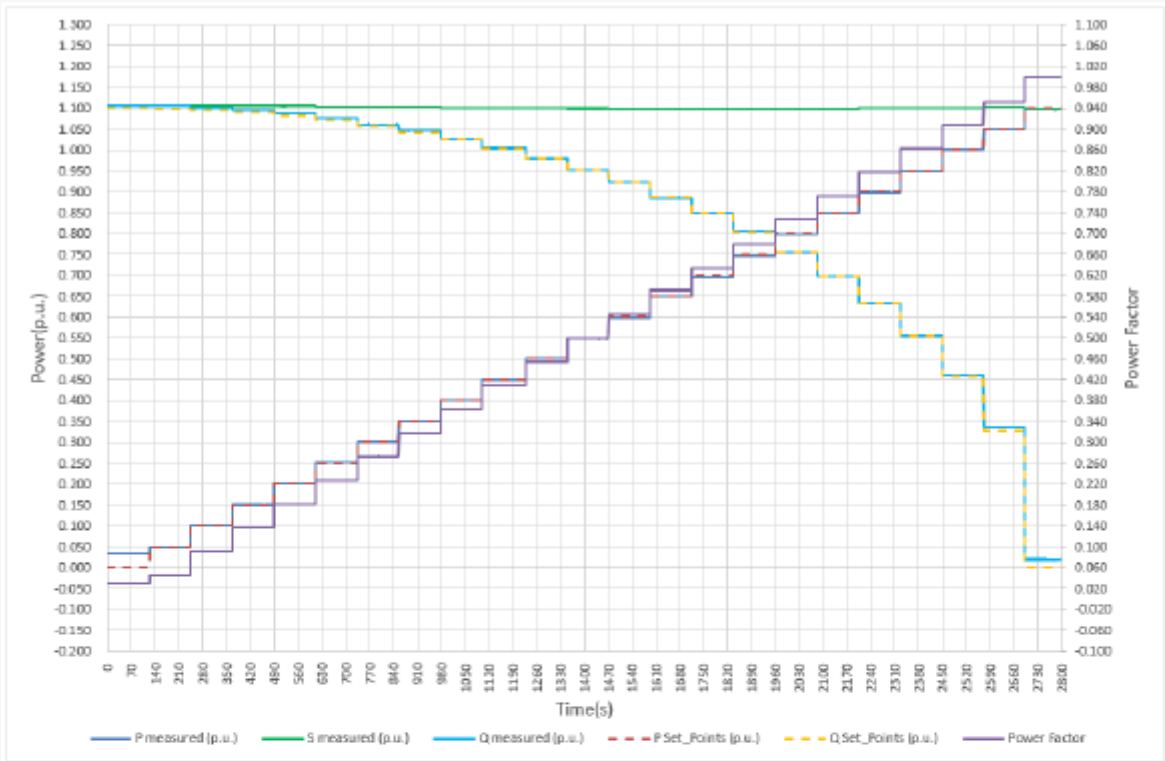
Semicircle Curve (S = 110 %Sn / Inductive)						
P Desired (%Sn)	P measured (%Sn)	S measured (%Sn)	Power Factor (cos φ)	Q measured (%Sn)	Q desired (%Sn) (2)	Q deviation (±5%Sn)
0(1)	3.4	110.7	0.031	+110.6	+110.0	--
5(1)	5.1	110.7	0.046	+110.6	+109.9	--
10	10.1	110.7	0.092	+110.2	+109.5	+0.7
15	15.1	110.6	0.136	+109.6	+109.0	+0.6
20	20.2	110.5	0.183	+108.7	+108.2	+0.5
25	25.2	110.5	0.228	+107.6	+107.1	+0.5
30	30.2	110.4	0.274	+106.2	+105.8	+0.4
35	35.0	110.3	0.318	+104.6	+104.3	+0.3
40	40.1	110.2	0.364	+102.6	+102.5	+0.1
45	45.0	110.1	0.409	+100.5	+100.4	+0.1
50	50.0	110.1	0.455	+98.0	+98.0	0.0
55	54.9	110.0	0.499	+95.3	+95.3	0.0
60	59.9	109.9	0.545	+92.2	+92.2	0.0
65	65.0	109.9	0.592	+88.6	+88.7	-0.1
70	69.6	109.9	0.634	+85.0	+84.9	+0.1
75	74.7	109.9	0.680	+80.6	+80.5	+0.1
80	79.8	109.9	0.726	+75.5	+75.5	0.0
85	84.9	109.9	0.772	+69.8	+69.8	0.0
90	90.0	110.0	0.818	+63.3	+63.2	+0.1
95	95.0	110.1	0.863	+55.5	+55.5	0.0
100	100.0	110.1	0.908	+46.0	+45.8	+0.2
105	105.0	110.3	0.952	+33.8	+32.8	+1.0
110	109.5	109.8	0.997	+3.8	+0.0	+3.8

(1) According to point N.6.1 for lower values of generated active power (P≤10 %Sn), deviations in the reactive power are allowed up to a 10 %Sn.
(2) The desired Q is calculated from Q = -√ (S^2 - P^2).

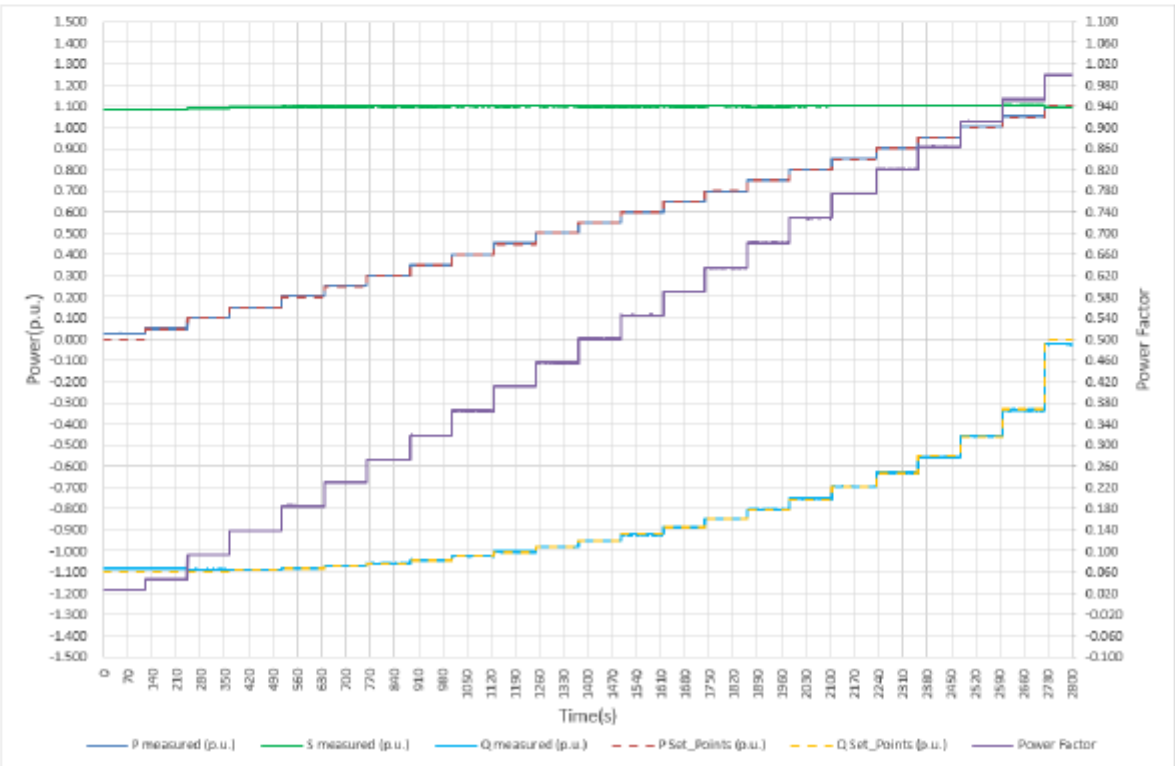
Semicircle Curve (S = 110 %Sn / Capacitive)						
P Desired (%Sn)	P measured (%Sn)	S measured (%Sn)	Power Factor (cos φ)	Q measured (%Sn)	Q desired (%Sn) (2)	Q deviation (%Sn)
0(1)	2.9	108.4	0.0	-108.3	-110.0	--
5(1)	5.1	108.5	0.0	-108.4	-109.9	--
10	10.1	108.9	0.1	-108.5	-109.5	+1.0
15	15.2	109.6	0.1	-108.6	-109.0	+0.4
20	20.3	109.9	0.2	-108.0	-108.2	+0.2
25	25.2	110.0	0.2	-107.0	-107.1	+0.1
30	30.0	110.0	0.3	-105.8	-105.8	+0.0
35	35.1	110.0	0.3	-104.2	-104.3	+0.1
40	40.1	110.0	0.4	-102.4	-102.5	+0.1
45	45.2	110.0	0.4	-100.3	-100.4	+0.1
50	50.1	110.0	0.5	-97.9	-98.0	+0.1
55	55.1	110.0	0.5	-95.2	-95.3	+0.1
60	60.0	110.0	0.5	-92.2	-92.2	-0.0
65	65.0	110.0	0.6	-88.7	-88.7	+0.0
70	69.9	110.0	0.6	-85.0	-84.9	-0.1
75	75.0	109.9	0.7	-80.4	-80.5	+0.1
80	80.2	110.0	0.7	-75.4	-75.5	+0.1
85	85.2	110.0	0.8	-69.6	-69.8	+0.2
90	90.3	110.1	0.8	-62.9	-63.2	+0.3
95	95.3	110.3	0.9	-55.7	-55.5	-0.2
100	100.5	110.3	0.9	-45.6	-45.8	+0.2
105	105.2	110.4	1.0	-33.6	-32.8	-0.8
110	109.6	109.7	1.0	-2.2	0.0	-2.2

(1) According to point N.6.1 for lower values of generated active power (P≤10 %Sn), deviations in the reactive power are allowed up to a 10 %Sn.
(2) The desired Q is calculated from Q = -√ (S^2 - P^2).

Semicircle Curve (S = 110 %Sn / Inductive)



Semicircle Curve (S = 110 %Sn / Capacitive)



Semicircle Curve; Capacitive vs Inductive