

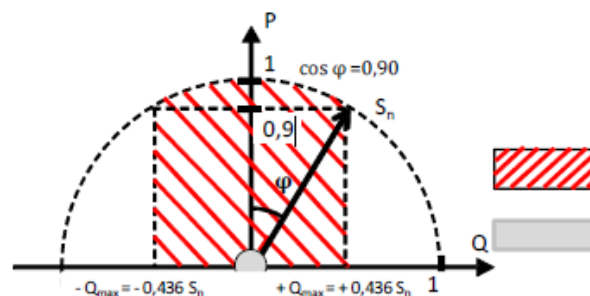
N.6.1 Test on the capability to supply reactive power

P

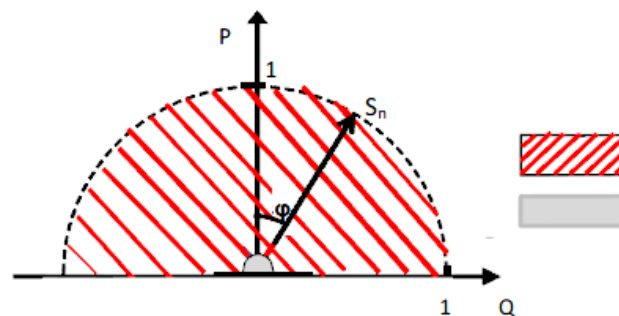
For static generators are planned capabilities differ depending on the total power:

- for generators in power plants less than 400 kW: The inverter must have a minimum capability of type 'semicircular limited' with $\cos \varphi$ between 0.90 in absorption and 0.90 in supply (See. Figure 15 , the characteristics of the type of Figure 16, however, are recommended as they allow to provide grid services, may be subject to compensation) The Q measured on the limit of capability curve in correspondence with a predetermined value of P. For low values of the active power generated ($P \leq 10\% \cdot S_n$) are allowed deviations in the supply of reactive power measured at the limit of capability curve in correspondence with a predetermined value of P, up to a maximum of 10% of S_n .
- for generators in power plants totaling more than or equal to 400 kW: the inverter must have a capability of type 'semicircular' whose area of work is internal to the diagram of Figure 16. At the time of compliance with the performance requirements of specific capability in the band $P \leq 10\% \cdot S_n$ is not required as it will be subject to appropriate regulation by the Authority.

For both types of static generators, the active power that can be delivered by them in the basic condition of operation at nominal voltage and $\cos \varphi = 1$ coincides with the rated apparent power of the generator itself.



Capability for static generators in power plants < 400 kW
(limited semicircular characteristic).



Picture 16-Capability for static generators in power plants > 400 kW
(circular characteristic).

S_n : nominal apparent power which can be supplied to U_n nominal voltage.

Q_{max} : maximum reactive power which can be supplied at nominal apparent power

N.6.1.1 Execution and registration proof applicable to static generators

P

Measurements can be made either through acquisition campaign in the field (p.es on a test system) or on a test bench, provided it is representative of the actual operating conditions of the generator (availability of primary source simulated as shown in Annex Q).

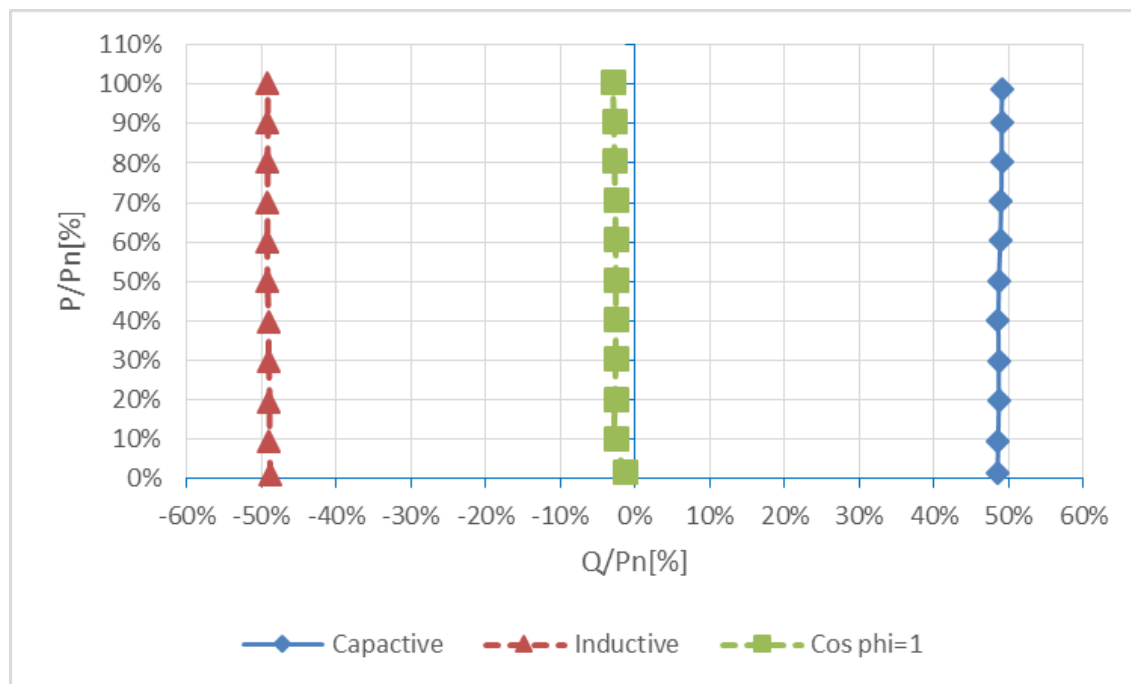
For the execution of the test are given the following requirements.

- The drive must be set so that it can absorb respectively (inductive behavior) and supply (capacitive behavior), the maximum reactive power available at each level of the active power output according to your capability.
- It regulates at this point the source d.c. in order to make available at least the full rated active power of the generator under test; further adjustments are possible during the test, so that the source is not limiting for the performance to be measured.
- It regulates (either through source control or by setting in the control system of the converter under test), the active power for values in the 11 intervals $[0 \pm 5]\%$, $[10 \pm 5]\%$; ...; $[100 \pm 5]\%$ of rated apparent power, you make the measurement of active power in steady state after about 1 minute after completion of the adjustment (1-min average values calculated based on the measured values of the frequency of fundamental window of 200 ms).
- For each of the 11 levels of active power will have to record a value of the reactive power inductive and capacitive 1 for that, as average values for 1 min calculated on the basis of the measures at the fundamental frequency of the window of 1s. Also, the power factor must be detected and reported as an average for 1 minute.

In addition to measures of setting the limit values of the reactive power, you will have to record the measured values by setting the reactive power delivered to 0 ($\cos \varphi = 1$).

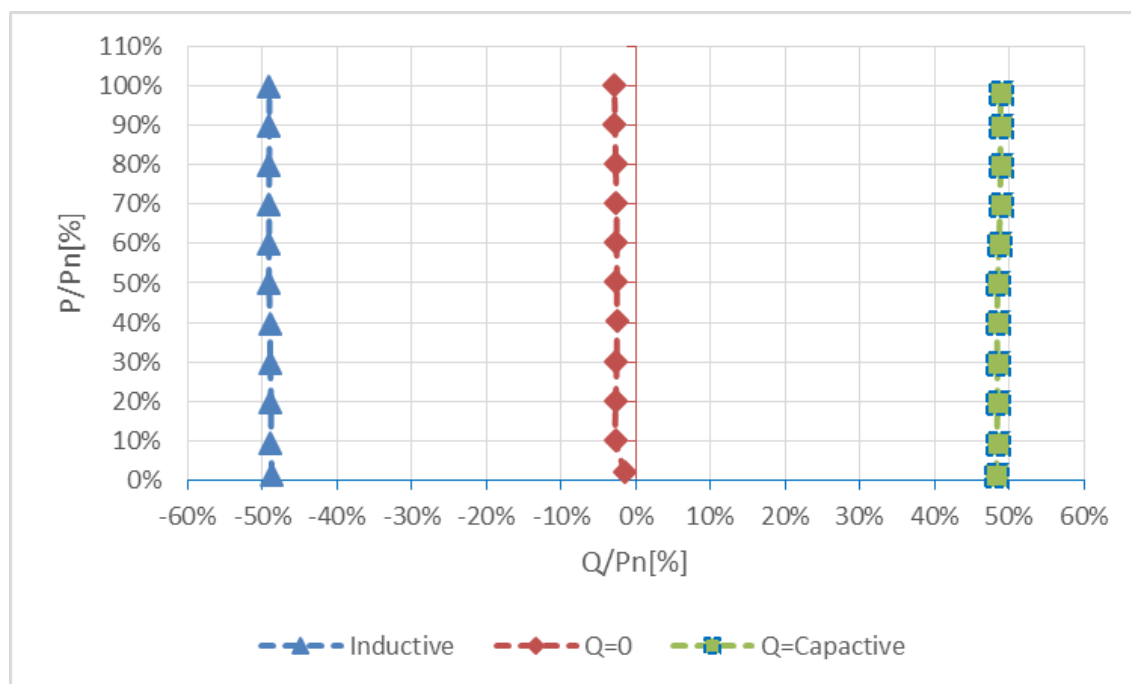
N.6.1.1 Execution and registration proof applicable to static generators Systems with < 400kW							P
AZZURRO 3PH 3.3KTL-V1							
-Qmax (inductive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm 5\%$	0,034	0,011	-1,467	-0,489	0,068	0,023	0,0234
10% $\pm 5\%$	0,280	0,093	-1,469	-0,490	0,316	0,105	0,1872
20% $\pm 5\%$	0,588	0,196	-1,469	-0,490	0,627	0,209	0,3713
30% $\pm 5\%$	0,893	0,298	-1,473	-0,491	0,938	0,313	0,5186
40% $\pm 5\%$	1,197	0,399	-1,473	-0,491	1,249	0,416	0,6308
50% $\pm 5\%$	1,500	0,500	-1,477	-0,492	1,559	0,520	0,7125
60% $\pm 5\%$	1,804	0,601	-1,477	-0,492	1,871	0,624	0,7737
70% $\pm 5\%$	2,105	0,702	-1,476	-0,492	2,182	0,727	0,8187
80% $\pm 5\%$	2,406	0,802	-1,477	-0,492	2,492	0,831	0,8523
90% $\pm 5\%$	2,705	0,902	-1,475	-0,492	2,803	0,934	0,8779
100% $\pm 5\%$	3,004	1,001	-1,477	-0,492	3,113	1,038	0,8974
+Qmax (capacitive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm 5\%$	0,040	0,013	1,456	0,485	0,068	0,023	0,0271
10% $\pm 5\%$	0,285	0,095	1,458	0,486	0,316	0,105	0,1919
20% $\pm 5\%$	0,592	0,197	1,461	0,487	0,627	0,209	0,3757
30% $\pm 5\%$	0,898	0,299	1,460	0,487	0,938	0,313	0,5238
40% $\pm 5\%$	1,202	0,401	1,459	0,486	1,249	0,416	0,6360
50% $\pm 5\%$	1,504	0,501	1,461	0,487	1,559	0,520	0,7173
60% $\pm 5\%$	1,808	0,603	1,467	0,489	1,871	0,624	0,7765
70% $\pm 5\%$	2,109	0,703	1,471	0,490	2,182	0,727	0,8203
80% $\pm 5\%$	2,410	0,803	1,472	0,491	2,492	0,831	0,8534
90% $\pm 5\%$	2,709	0,903	1,472	0,491	2,803	0,934	0,8786
100% $\pm 5\%$	2,966	0,989	1,474	0,491	3,067	1,022	0,8955
Q=0							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm 5\%$	0,057	0,019	-0,042	-0,014	0,068	0,023	0,8036
10% $\pm 5\%$	0,301	0,100	-0,079	-0,026	0,316	0,105	0,9667
20% $\pm 5\%$	0,607	0,202	-0,079	-0,026	0,627	0,209	0,9913
30% $\pm 5\%$	0,911	0,304	-0,077	-0,026	0,938	0,313	0,9965
40% $\pm 5\%$	1,214	0,405	-0,076	-0,025	1,249	0,416	0,9980
50% $\pm 5\%$	1,516	0,505	-0,076	-0,025	1,559	0,520	0,9987
60% $\pm 5\%$	1,819	0,606	-0,077	-0,026	1,871	0,624	0,9991
70% $\pm 5\%$	2,120	0,707	-0,078	-0,026	2,182	0,727	0,9993
80% $\pm 5\%$	2,421	0,807	-0,081	-0,027	2,492	0,831	0,9994
90% $\pm 5\%$	2,720	0,907	-0,083	-0,028	2,803	0,934	0,9995
100% $\pm 5\%$	3,019	1,006	-0,087	-0,029	3,113	1,038	0,9996

Graph of capability curves valid for inverter : AZZURRO 3.3KTL-V1



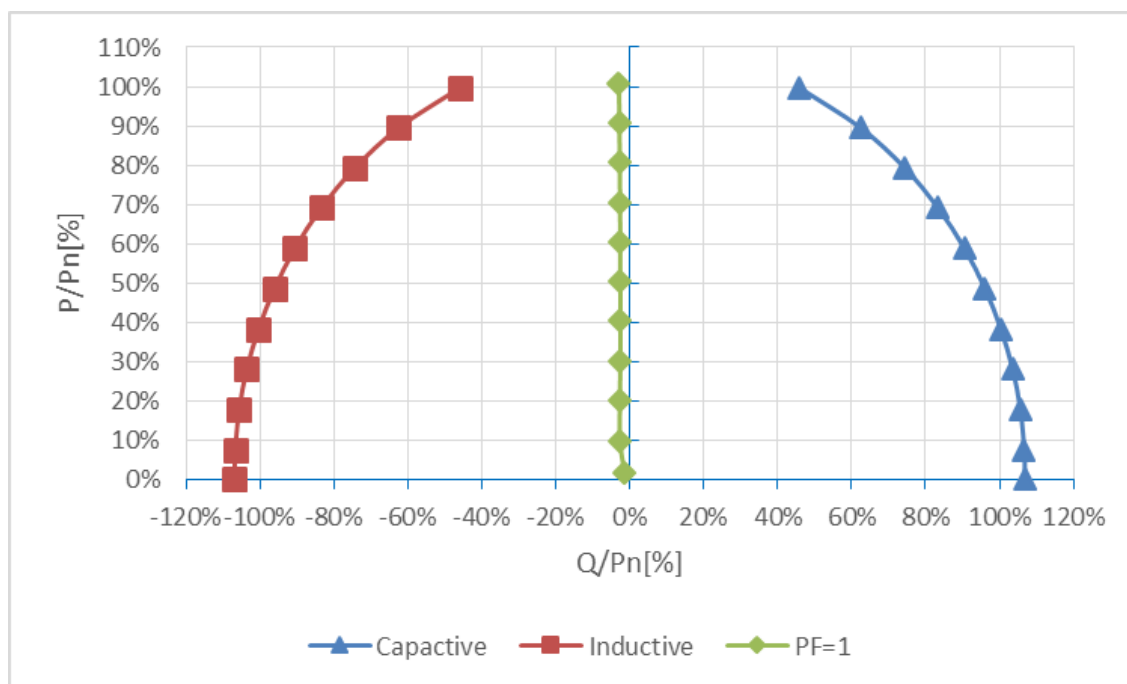
AZZURRO 12KTL-V1							
-Qmax (inductive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm$ 5%	0,137	0,011	-5,852	-0,488	0,269	0,022	0,0235
10% $\pm$ 5%	1,116	0,093	-5,861	-0,488	1,258	0,105	0,1871
20% $\pm$ 5%	2,342	0,195	-5,862	-0,488	2,499	0,208	0,3710
30% $\pm$ 5%	3,559	0,297	-5,874	-0,490	3,737	0,311	0,5182
40% $\pm$ 5%	4,772	0,398	-5,875	-0,490	4,976	0,415	0,6305
50% $\pm$ 5%	5,978	0,498	-5,893	-0,491	6,211	0,518	0,7122
60% $\pm$ 5%	7,186	0,599	-5,892	-0,491	7,452	0,621	0,7733
70% $\pm$ 5%	8,388	0,699	-5,889	-0,491	8,690	0,724	0,8184
80% $\pm$ 5%	9,585	0,799	-5,890	-0,491	9,927	0,827	0,8520
90% $\pm$ 5%	10,779	0,898	-5,885	-0,490	11,165	0,930	0,8777
100% $\pm$ 5%	11,968	0,997	-5,890	-0,491	12,403	1,034	0,8972
+Qmax (capacitive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm$ 5%	0,158	0,013	5,805	0,484	0,269	0,022	0,0272
10% $\pm$ 5%	1,136	0,095	5,814	0,484	1,258	0,105	0,1918
20% $\pm$ 5%	2,359	0,197	5,825	0,485	2,499	0,208	0,3754
30% $\pm$ 5%	3,577	0,298	5,820	0,485	3,738	0,311	0,5236
40% $\pm$ 5%	4,789	0,399	5,816	0,485	4,976	0,415	0,6357
50% $\pm$ 5%	5,994	0,500	5,827	0,486	6,210	0,518	0,7171
60% $\pm$ 5%	7,202	0,600	5,849	0,487	7,452	0,621	0,7763
70% $\pm$ 5%	8,404	0,700	5,866	0,489	8,691	0,724	0,8200
80% $\pm$ 5%	9,601	0,800	5,871	0,489	9,929	0,827	0,8531
90% $\pm$ 5%	10,794	0,899	5,870	0,489	11,166	0,930	0,8785
100% $\pm$ 5%	11,804	0,984	5,875	0,490	12,205	1,017	0,8952
Q=0							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm$ 5%	0,228	0,019	-0,177	-0,015	0,269	0,022	0,7890
10% $\pm$ 5%	1,202	0,100	-0,321	-0,027	1,259	0,105	0,9658
20% $\pm$ 5%	2,418	0,202	-0,324	-0,027	2,500	0,208	0,9911
30% $\pm$ 5%	3,629	0,302	-0,307	-0,026	3,737	0,311	0,9964
40% $\pm$ 5%	4,837	0,403	-0,304	-0,025	4,974	0,415	0,9980
50% $\pm$ 5%	6,040	0,503	-0,307	-0,026	6,210	0,517	0,9987
60% $\pm$ 5%	7,248	0,604	-0,309	-0,026	7,452	0,621	0,9991
70% $\pm$ 5%	8,446	0,704	-0,311	-0,026	8,689	0,724	0,9993
80% $\pm$ 5%	9,644	0,804	-0,326	-0,027	9,928	0,827	0,9994
90% $\pm$ 5%	10,837	0,903	-0,336	-0,028	11,166	0,930	0,9995
100% $\pm$ 5%	12,027	1,002	-0,346	-0,029	12,403	1,034	0,9996
Note: The inverter produces reactive power according to the circular characteristic. The priority is always given by the reactive power. The tests had been performed on the AZZURRO 12KTL-V1 and AZZURRO 3.3KTL-V1 are valid for the AZZURRO 11KTL-V1, AZZURRO 8.8KTL-V1, AZZURRO 6.6KTL-V1, AZZURRO 5.5KTL-V1, AZZURRO 5KTL-V1 and AZZURRO 4.4KTL-V1 since it is identical in hardware and software construction.							

Graph of capability curves valid for inverter : AZZURRO 12KTL-V1



N.6.1.1 Execution and registration proof applicable to static generators Systems with $\geq 400\text{kW}$							P
Test result: AZZURRO 3.3KTL-V1							
-Qmax (inductive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos ϕ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm 5\%$	0,015	0,005	-3,206	-1,069	0,092	0,031	0,0047
10% $\pm 5\%$	0,230	0,077	-3,200	-1,067	0,313	0,104	0,0717
20% $\pm 5\%$	0,539	0,180	-3,168	-1,056	0,625	0,208	0,1678
30% $\pm 5\%$	0,846	0,282	-3,107	-1,036	0,935	0,312	0,2627
40% $\pm 5\%$	1,154	0,385	-3,010	-1,003	1,246	0,415	0,3579
50% $\pm 5\%$	1,462	0,487	-2,882	-0,961	1,557	0,519	0,4524
60% $\pm 5\%$	1,769	0,590	-2,715	-0,905	1,867	0,622	0,5459
70% $\pm 5\%$	2,076	0,692	-2,502	-0,834	2,177	0,726	0,6385
80% $\pm 5\%$	2,382	0,794	-2,229	-0,743	2,487	0,829	0,7303
90% $\pm 5\%$	2,688	0,896	-1,872	-0,624	2,796	0,932	0,8206
100% $\pm 5\%$	2,992	0,997	-1,377	-0,459	3,103	1,034	0,9083
+Qmax (capacitive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos ϕ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm 5\%$	0,013	0,004	3,205	1,068	0,092	0,031	0,0042
10% $\pm 5\%$	0,229	0,076	3,200	1,067	0,313	0,104	0,0714
20% $\pm 5\%$	0,538	0,179	3,168	1,056	0,625	0,208	0,1674
30% $\pm 5\%$	0,846	0,282	3,107	1,036	0,935	0,312	0,2627
40% $\pm 5\%$	1,154	0,385	3,010	1,003	1,246	0,415	0,3580
50% $\pm 5\%$	1,462	0,487	2,881	0,960	1,557	0,519	0,4524
60% $\pm 5\%$	1,769	0,590	2,714	0,905	1,867	0,622	0,5461
70% $\pm 5\%$	2,076	0,692	2,501	0,834	2,177	0,726	0,6386
80% $\pm 5\%$	2,383	0,794	2,228	0,743	2,487	0,829	0,7304
90% $\pm 5\%$	2,690	0,897	1,869	0,623	2,797	0,932	0,8212
100% $\pm 5\%$	2,992	0,997	1,375	0,458	3,104	1,035	0,9086
Q=0							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos ϕ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm 5\%$	0,057	0,019	-0,042	-0,014	0,068	0,023	0,8036
10% $\pm 5\%$	0,301	0,100	-0,079	-0,026	0,316	0,105	0,9667
20% $\pm 5\%$	0,607	0,202	-0,079	-0,026	0,627	0,209	0,9913
30% $\pm 5\%$	0,911	0,304	-0,077	-0,026	0,938	0,313	0,9965
40% $\pm 5\%$	1,214	0,405	-0,076	-0,025	1,249	0,416	0,9980
50% $\pm 5\%$	1,516	0,505	-0,076	-0,025	1,559	0,520	0,9987
60% $\pm 5\%$	1,819	0,606	-0,077	-0,026	1,871	0,624	0,9991
70% $\pm 5\%$	2,120	0,707	-0,078	-0,026	2,182	0,727	0,9993
80% $\pm 5\%$	2,421	0,807	-0,081	-0,027	2,492	0,831	0,9994
90% $\pm 5\%$	2,720	0,907	-0,083	-0,028	2,803	0,934	0,9995
100% $\pm 5\%$	3,019	1,006	-0,087	-0,029	3,113	1,038	0,9996

Graph of capability curves valid for inverter :



Test result: AZZURRO 12KTL-V1							
-Qmax (inductive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos ϕ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm$ 5%	0,063	0,005	-12,821	-1,068	0,247	0,021	-0,0048
10% $\pm$ 5%	0,915	0,076	-12,803	-1,067	1,248	0,104	0,0713
20% $\pm$ 5%	2,125	0,177	-13,142	-1,095	2,499	0,208	0,1538
30% $\pm$ 5%	3,358	0,280	-13,237	-1,103	3,737	0,311	0,2460
40% $\pm$ 5%	4,589	0,382	-12,764	-1,064	4,975	0,415	0,3383
50% $\pm$ 5%	5,816	0,485	-12,199	-1,017	6,211	0,518	0,4304
60% $\pm$ 5%	7,047	0,587	-11,507	-0,959	7,452	0,621	0,5222
70% $\pm$ 5%	8,273	0,689	-10,641	-0,887	8,690	0,724	0,6138
80% $\pm$ 5%	9,499	0,792	-9,544	-0,795	9,928	0,827	0,7054
90% $\pm$ 5%	10,724	0,894	-8,093	-0,674	11,165	0,930	0,7982
100% $\pm$ 5%	11,951	0,996	-6,045	-0,504	12,403	1,034	0,8923
+Qmax (capacitive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos ϕ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm$ 5%	0,063	0,005	12,819	1,068	0,247	0,021	-0,0047
10% $\pm$ 5%	0,915	0,076	12,801	1,067	1,248	0,104	0,0713
20% $\pm$ 5%	2,195	0,183	12,636	1,053	2,498	0,208	0,1713
30% $\pm$ 5%	3,418	0,285	12,507	1,042	3,738	0,311	0,2637
40% $\pm$ 5%	4,640	0,387	12,201	1,017	4,975	0,415	0,3555
50% $\pm$ 5%	5,861	0,488	11,729	0,977	6,210	0,518	0,4470
60% $\pm$ 5%	7,090	0,591	11,045	0,920	7,453	0,621	0,5402
70% $\pm$ 5%	8,313	0,693	10,155	0,846	8,691	0,724	0,6334
80% $\pm$ 5%	9,538	0,795	9,016	0,751	9,929	0,827	0,7267
90% $\pm$ 5%	10,759	0,897	7,564	0,630	11,166	0,931	0,8180
100% $\pm$ 5%	11,977	0,998	5,517	0,460	12,403	1,034	0,9083
Q=0							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos ϕ)
	[kW]	p.u.	[kVA]	p.u.	[kW]	p.u.	
0% $\pm$ 5%	0,226	0,019	-0,333	-0,028	0,269	0,022	0,5615
10% $\pm$ 5%	1,199	0,100	-0,325	-0,027	1,258	0,105	0,9642
20% $\pm$ 5%	2,415	0,201	-0,322	-0,027	2,499	0,208	0,9912
30% $\pm$ 5%	3,626	0,302	-0,308	-0,026	3,737	0,311	0,9964
40% $\pm$ 5%	4,833	0,403	-0,303	-0,025	4,975	0,415	0,9980
50% $\pm$ 5%	6,036	0,503	-0,306	-0,026	6,211	0,518	0,9987
60% $\pm$ 5%	7,241	0,603	-0,309	-0,026	7,452	0,621	0,9991
70% $\pm$ 5%	8,441	0,703	-0,317	-0,026	8,691	0,724	0,9993
80% $\pm$ 5%	9,636	0,803	-0,325	-0,027	9,929	0,827	0,9994
90% $\pm$ 5%	10,827	0,902	-0,335	-0,028	11,165	0,930	0,9995
100% $\pm$ 5%	12,015	1,001	-0,348	-0,029	12,403	1,034	0,9996
Note: The inverter produces reactive power according to the circular characteristic. The priority is always given by the reactive power. The tests had been performed on the AZZURRO 12KTL-V1 and AZZURRO 3.3KTL-V1 are valid for the AZZURRO 11KTL-V1, AZZURRO 8.8KTL-V1, AZZURRO 6.6KTL-V1, AZZURRO 5.5KTL-V1, AZZURRO 5KTL-V1 and AZZURRO 4.4KTL-V1 since it is identical in hardware and software construction.							

Graph of capability curves valid for inverter :

