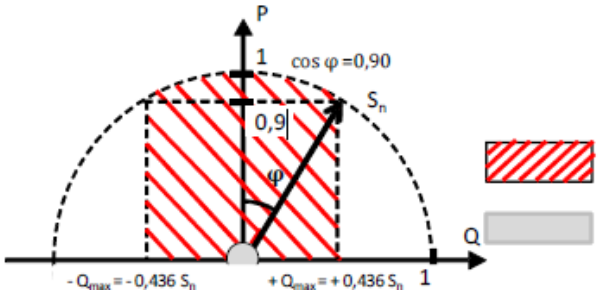
N.6.1 Test on the capability to supply reactive power	P

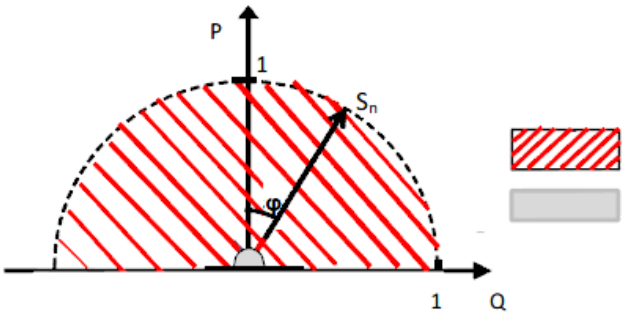
For static generators are planned capabilities differ depending on the total power:

- for generators in power plants less than 400 kW: The inverter must have a minimum capability of type 'semicircular limited' with cosφ 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 ≤ 10% * Sn) 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 Sn.
- 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≤10%*Sn 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 cosφ=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 Un 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 ± 5]%, [10 ± 5]%; ...; [100 ± 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 less than 400kW	**P**

Test result: AZZURRO 3PH HYD20000 ZSS

-Qmax (inductive)

Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,901	0,050	-8,793	-0,489	1,037	0,058	0,201
10% ±5%	1,829	0,102	-8,747	-0,486	2,045	0,114	0,205
20% ±5%	3,663	0,203	-8,715	-0,484	3,905	0,217	0,388
30% ±5%	5,433	0,302	-8,704	-0,484	5,704	0,317	0,530
40% ±5%	7,257	0,403	-8,720	-0,484	7,563	0,420	0,640
50% ±5%	9,075	0,504	-8,737	-0,485	9,420	0,523	0,720
60% ±5%	10,883	0,605	-8,752	-0,486	11,274	0,626	0,779
70% ±5%	12,648	0,703	-8,768	-0,487	13,089	0,727	0,822
80% ±5%	14,446	0,803	-8,745	-0,486	14,941	0,830	0,856
90% ±5%	16,281	0,905	-8,762	-0,487	16,834	0,935	0,881
100% ±5%	18,069	1,004	-8,778	-0,488	18,684	1,038	0,900

+Qmax (capacitive)

Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,914	0,051	8,802	0,489	1,026	0,057	0,203
10% ±5%	1,861	0,103	8,723	0,485	2,046	0,114	0,209
20% ±5%	3,633	0,202	8,721	0,485	3,844	0,214	0,385
30% ±5%	5,462	0,303	8,738	0,485	5,703	0,317	0,530
40% ±5%	7,244	0,402	8,732	0,485	7,519	0,418	0,638
50% ±5%	9,061	0,503	8,725	0,485	9,377	0,521	0,720
60% ±5%	10,852	0,603	8,719	0,484	11,214	0,623	0,780
70% ±5%	12,657	0,703	8,714	0,484	13,070	0,726	0,824
80% ±5%	14,455	0,803	8,709	0,484	14,922	0,829	0,857
90% ±5%	16,249	0,903	8,706	0,484	16,773	0,932	0,881
100% ±5%	18,086	1,005	8,706	0,484	18,685	1,038	0,901

Q=0

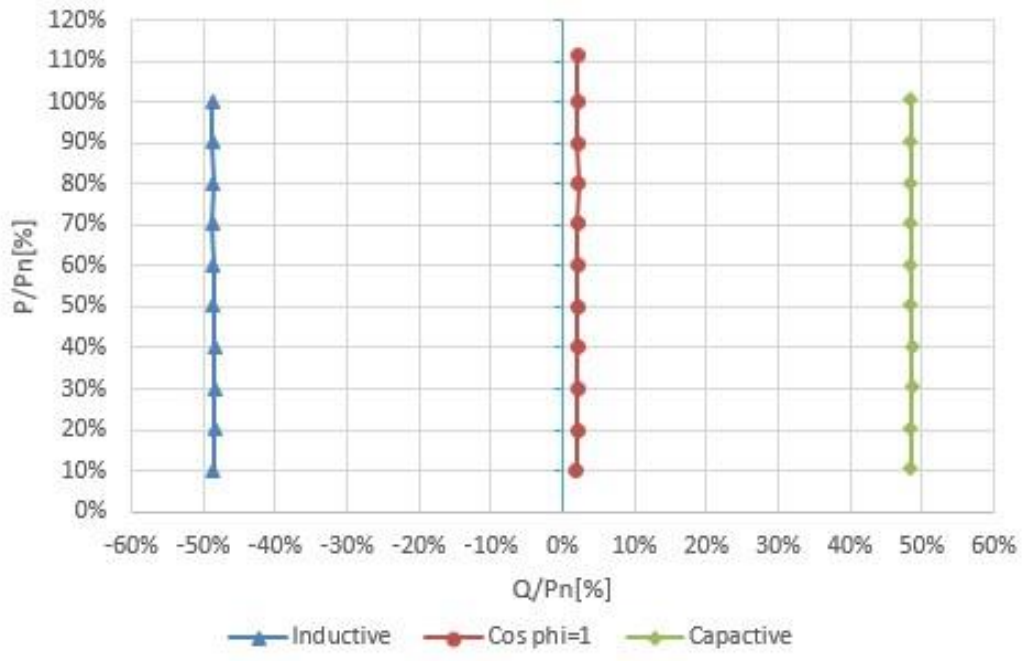
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,956	0,053	0,367	0,020	1,036	0,058	0,933
10% ±5%	1,848	0,103	0,352	0,020	1,945	0,108	0,982
20% ±5%	3,587	0,199	0,362	0,020	3,716	0,206	0,995
30% ±5%	5,396	0,300	0,363	0,020	5,564	0,309	0,998
40% ±5%	7,211	0,401	0,361	0,020	7,422	0,412	0,999
50% ±5%	9,043	0,502	0,363	0,020	9,303	0,517	0,999
60% ±5%	10,858	0,603	0,380	0,021	11,172	0,621	0,999
70% ±5%	12,657	0,703	0,375	0,021	13,029	0,724	0,999
80% ±5%	14,437	0,802	0,387	0,021	14,872	0,826	0,999
90% ±5%	16,170	0,898	0,377	0,021	16,670	0,926	0,999
100% ±5%	18,010	1,001	0,370	0,021	18,586	1,033	0,999

Test result: AZZURRO 3PH HYD5000 ZSS							
-Qmax (inductive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,041	0,01	-2,493	-0,50	0,096	0,02	0,017
10% ±5%	0,449	0,09	-2,489	-0,50	0,511	0,10	0,178
20% ±5%	0,961	0,19	-2,480	-0,50	1,028	0,21	0,361
30% ±5%	1,469	0,29	-2,472	-0,49	1,543	0,31	0,511
40% ±5%	1,975	0,40	-2,463	-0,49	2,058	0,41	0,626
50% ±5%	2,479	0,50	-2,455	-0,49	2,572	0,51	0,711
60% ±5%	2,981	0,60	-2,446	-0,49	3,087	0,62	0,773
70% ±5%	3,482	0,70	-2,438	-0,49	3,603	0,72	0,819
80% ±5%	3,980	0,80	-2,430	-0,49	4,115	0,82	0,853
90% ±5%	4,476	0,90	-2,422	-0,48	4,629	0,93	0,879
100% ±5%	4,970	0,99	-2,414	-0,48	5,142	1,03	0,899
+Qmax (capacitive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,050	0,01	2,370	0,47	0,098	0,02	0,021
10% ±5%	0,460	0,09	2,379	0,48	0,511	0,10	0,190
20% ±5%	0,971	0,19	2,389	0,48	1,027	0,21	0,377
30% ±5%	1,478	0,30	2,400	0,48	1,542	0,31	0,525
40% ±5%	1,985	0,40	2,410	0,48	2,058	0,41	0,636
50% ±5%	2,487	0,50	2,421	0,48	2,572	0,51	0,717
60% ±5%	2,989	0,60	2,432	0,49	3,087	0,62	0,776
70% ±5%	3,488	0,70	2,443	0,49	3,601	0,72	0,819
80% ±5%	3,987	0,80	2,455	0,49	4,115	0,82	0,852
90% ±5%	4,482	0,90	2,466	0,49	4,628	0,93	0,876
100% ±5%	4,976	1,00	2,478	0,50	5,141	1,03	0,895
Q=0							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,066	0,01	-0,081	-0,02	0,093	0,02	0,573
10% ±5%	0,491	0,10	-0,045	-0,01	0,510	0,10	0,994
20% ±5%	0,980	0,20	-0,086	-0,02	1,018	0,20	0,994
30% ±5%	1,488	0,30	-0,084	-0,02	1,533	0,31	0,998
40% ±5%	1,993	0,40	-0,078	-0,02	2,047	0,41	0,999
50% ±5%	2,497	0,50	-0,045	-0,01	2,561	0,51	0,999
60% ±5%	3,001	0,60	0,063	0,01	3,075	0,61	0,999
70% ±5%	3,505	0,70	0,080	0,02	3,588	0,72	0,999
80% ±5%	4,007	0,80	0,089	0,02	4,102	0,82	0,999
90% ±5%	4,507	0,90	0,103	0,02	4,614	0,92	0,999
100% ±5%	5,007	1,00	0,113	0,02	5,127	1,03	0,999

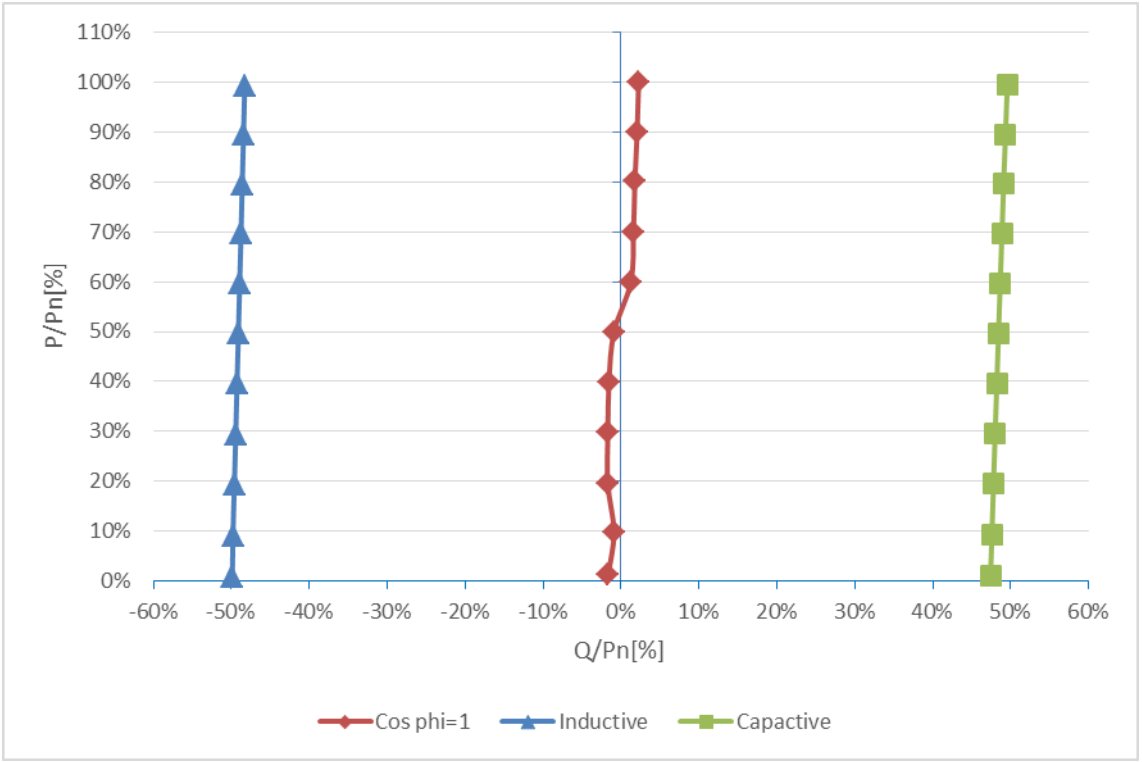
Note:
The inverter produceses reactive power according to the circular chratcteristic. The priority is always given by the reactive power.

The tests had been performed on the AZZURRO 3PH HYD20000 ZSS and AZZURRO 3PH HYD5000 ZSS is valid for the AZZURRO 3PH HYD15000 ZSS, AZZURRO 3PH HYD10000 ZSS, AZZURRO 3PH HYD8000 ZSS and AZZURRO 3PH HYD6000 ZSS since it is similar in hardware and just power derated by software.

Graph of capability curves valid for inverter : AZZURRO 3PH HYD20000 ZSS



Graph of capability curves valid for inverter : AZZURRO 3PH HYD5000 ZSS



N.6.1.1 Execution and registration proof applicable to static generators Systems with equal or more than 400kW	P

Test result: AZZURRO 3PH HYD20000 ZSS

-Qmax (inductive)

Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,844	0,042	-19,903	-0,995	1,326	0,066	0,0424
10% ±5%	2,007	0,100	-19,898	-0,995	2,493	0,125	0,1003
20% ±5%	4,038	0,202	-19,887	-0,994	4,539	0,227	0,1990
30% ±5%	6,089	0,304	-19,441	-0,972	6,597	0,330	0,2989
40% ±5%	8,095	0,405	-18,705	-0,935	8,608	0,430	0,3972
50% ±5%	10,114	0,506	-17,448	-0,872	10,626	0,531	0,5015
60% ±5%	12,076	0,604	-16,159	-0,808	12,598	0,630	0,5986
70% ±5%	14,081	0,704	-14,453	-0,723	14,613	0,731	0,6978
80% ±5%	16,063	0,803	-12,198	-0,610	16,602	0,830	0,7964
90% ±5%	18,088	0,904	-8,903	-0,445	18,634	0,932	0,8972
100% ±5%	20,217	1,011	0,570	0,028	20,784	1,039	0,9994

+Qmax (capacitive)

Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,857	0,043	19,904	0,995	1,343	0,067	0,0430
10% ±5%	2,011	0,101	19,898	0,995	2,510	0,125	0,1006
20% ±5%	4,044	0,202	19,887	0,994	4,562	0,228	0,1992
30% ±5%	6,081	0,304	19,434	0,972	6,610	0,331	0,2986
40% ±5%	8,117	0,406	18,677	0,934	8,656	0,433	0,3986
50% ±5%	10,145	0,507	17,479	0,874	10,636	0,532	0,5027
60% ±5%	12,107	0,605	16,190	0,810	12,609	0,630	0,5999
70% ±5%	14,112	0,706	14,485	0,724	14,623	0,731	0,6991
80% ±5%	16,094	0,805	12,229	0,611	16,613	0,831	0,7976
90% ±5%	18,119	0,906	8,934	0,447	18,644	0,932	0,8984
100% ±5%	20,248	1,012	0,601	0,030	20,795	1,040	0,9996

Q=0

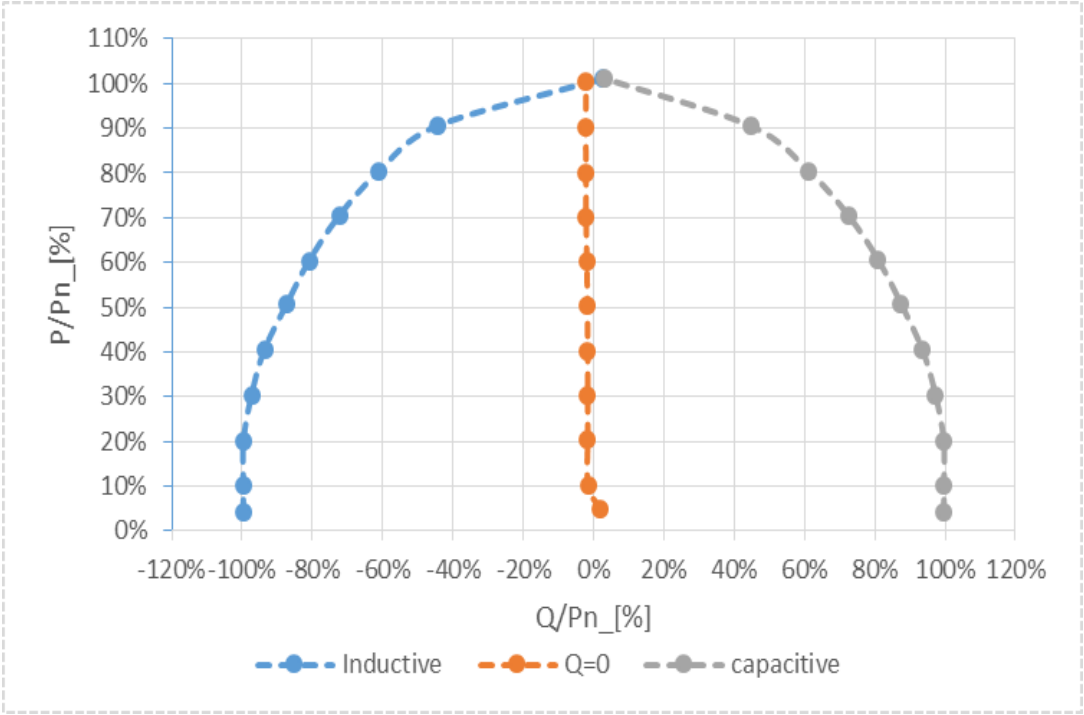
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	1,001	0,050	0,458	0,023	1,079	0,054	0,9046
10% ±5%	2,030	0,102	-0,314	-0,016	2,132	0,107	0,9882
20% ±5%	4,067	0,203	-0,331	-0,017	4,210	0,210	0,9967
30% ±5%	6,074	0,304	-0,338	-0,017	6,261	0,313	0,9984
40% ±5%	8,037	0,402	-0,338	-0,017	8,272	0,414	0,9991
50% ±5%	10,096	0,505	-0,352	-0,018	10,386	0,519	0,9994
60% ±5%	12,065	0,603	-0,398	-0,020	12,412	0,621	0,9995
70% ±5%	14,049	0,702	-0,446	-0,022	14,457	0,723	0,9995
80% ±5%	16,027	0,801	-0,448	-0,022	16,503	0,825	0,9996
90% ±5%	18,061	0,903	-0,450	-0,023	18,608	0,930	0,9996
100% ±5%	20,084	1,004	-0,448	-0,022	20,710	1,035	0,9997

Test result: AZZURRO 3PH HYD5000 ZSS							
-Qmax (inductive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,027	0,005	-4,884	-0,977	0,134	0,027	0,0056
10% ±5%	0,390	0,078	-4,863	-0,973	0,501	0,100	0,0799
20% ±5%	0,913	0,183	-4,809	-0,962	1,024	0,205	0,1864
30% ±5%	1,432	0,286	-4,684	-0,937	1,543	0,309	0,2924
40% ±5%	1,952	0,390	-4,497	-0,899	2,064	0,413	0,3982
50% ±5%	2,473	0,495	-4,242	-0,848	2,585	0,517	0,5037
60% ±5%	2,994	0,599	-3,905	-0,781	3,106	0,621	0,6085
70% ±5%	3,514	0,703	-3,461	-0,692	3,626	0,725	0,7125
80% ±5%	4,034	0,807	-2,868	-0,574	4,145	0,829	0,8149
90% ±5%	4,552	0,910	-2,006	-0,401	4,663	0,933	0,9149
100% ±5%	5,032	1,006	0,239	0,048	5,135	1,027	0,9972
+Qmax (capacitive)							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,077	0,015	4,882	0,976	0,184	0,037	0,0158
10% ±5%	0,387	0,077	4,863	0,973	0,501	0,100	0,0794
20% ±5%	0,911	0,182	4,808	0,962	1,023	0,205	0,1862
30% ±5%	1,432	0,286	4,683	0,937	1,544	0,309	0,2924
40% ±5%	1,950	0,390	4,497	0,899	2,063	0,413	0,3979
50% ±5%	2,474	0,495	4,240	0,848	2,586	0,517	0,5039
60% ±5%	2,994	0,599	3,902	0,780	3,106	0,621	0,6086
70% ±5%	3,513	0,703	3,459	0,692	3,626	0,725	0,7126
80% ±5%	4,034	0,807	2,865	0,573	4,146	0,829	0,8152
90% ±5%	4,554	0,911	1,996	0,399	4,666	0,933	0,9158
100% ±5%	5,036	1,007	0,305	0,061	5,139	1,028	0,9979
Q=0							
Power-BIN	Active power		Reactive power		DC power		Power factor (cos φ)
	[kW]	p.u.	[kVar]	p.u.	[kW]	p.u.	
0% ±5%	0,066	0,013	-0,081	-0,016	0,093	0,019	0,5728
10% ±5%	0,491	0,098	-0,045	-0,009	0,510	0,102	0,9940
20% ±5%	0,980	0,196	-0,086	-0,017	1,018	0,204	0,9937
30% ±5%	1,488	0,298	-0,084	-0,017	1,533	0,307	0,9976
40% ±5%	1,993	0,399	-0,078	-0,016	2,047	0,409	0,9986
50% ±5%	2,497	0,499	-0,045	-0,009	2,561	0,512	0,9991
60% ±5%	3,001	0,600	0,063	0,013	3,075	0,615	0,9994
70% ±5%	3,505	0,701	0,080	0,016	3,588	0,718	0,9995
80% ±5%	4,007	0,801	0,089	0,018	4,102	0,820	0,9996
90% ±5%	4,507	0,901	0,103	0,021	4,614	0,923	0,9997
100% ±5%	5,007	1,001	0,113	0,023	5,127	1,025	0,9997

Note:
The inverter produceses reactive power according to the circular chratcteristic. The priority is always given by the reactive power.

The tests had been performed on the AZZURRO 3PH HYD20000 ZSS and AZZURRO 3PH HYD5000 ZSS is valid for the AZZURRO 3PH HYD15000 ZSS, AZZURRO 3PH HYD10000 ZSS, AZZURRO 3PH HYD8000 ZSS and AZZURRO 3PH HYD6000 ZSS since it is similar in hardware and just power derated by software.

Graph of capability curves valid for inverter : AZZURRO 3PH HYD20000 ZSS



Graph of capability curves valid for inverter : AZZURRO 3PH HYD5000 ZSS