

| | | X1-Hybrid-3.7-D-C | X1-Hybrid-4.6-D-C | X1-Hybrid-5.0-D-C |
|--|---|-----------------------|------------------------|-----------------------|
| | X1-Hybrid-3.0-D-C | X1-Hybrid-3.7-D-E | X1-Hybrid-4.6-D-E | X1-Hybrid-5.0-D-E |
| Micro-generator | X1-Hybrid-3.0-D-E | X1-Hybrid-3.7-N-C | X1-Hybrid-4.6-N-C | X1-Hybrid-5.0-N-C |
| Type reference | X1-Hybrid-3.0-N-C | X1-Hybrid-3.7-N-E | X1-Hybrid-4.6-N-E | X1-Hybrid-5.0-N-E |
| | X1-Hybrid-3.0-N-E | X1-Fit-3.7C, | X1-Fit-4.6C, | X1-Fit-5.0C, |
| | | X1-Fit-3.7E | X1-Fit-4.6E | X1-Fit-5.0E |
| Maximum | | | | |
| continuous | 3000VA | 3680VA | 3680VA | 3680VA |
| rating | | | | |
| Manufacturer | SolaX Power Netwo | ork Technology (Zhe | jiang) Co. , Ltd. | |
| Address | No.288 Shizhu Road, Tonglu Economic Development Zone, Tonglu City, Zhejiang Province 310000, P. R. CHINA. | | | |
| Tel | +86(0571)-56260011 | | | |
| Fax | +86(0571)-56075753 | | | |
| Email | info@soalxpower.com | | | |
| Web site | www.solaxpower.com | | | |
| standard | Technical regulation 3.3.1 for electrical energy storage facilities | | | |
| Signed | Guo Huawei | | | |
| On behalf of | SolaX Power Network Technology (Zhejiang) Co. , Ltd. | | | |
| the generating un | it manufacturer/supp | lier declaration. | | |
| I certify on behalf | of the company nam | ed above as a manu | facturer/supplier of g | enerating units, that |
| all products manu | ufactured/supplied by | the company with th | ne above generating | unit Type reference |
| number will be | manufactured and te | ested to ensure tha | t they perform as s | stated in this Type |
| Verification Test | Report, prior to ship | ment to site and that | at no site modificatio | ons are required to |
| ensure that the product meets all the requirements of 'standard' as above. | | | | |



1、Voltage and frequency protection

| Protection. Frequency tests | | | | | Ρ |
|-----------------------------|---------------------------|-----------------------------|-----------|------------|-----------------|
| Function | Default setting Trip test | | | | |
| | Frequency | Disconnection time limit | Frequency | Disco t | nnection ime |
| U/F stage 1 | 47.5Hz | 0.2s | 47.50Hz | 0. | 181s |
| O/F stage 1 | 51.5Hz | 0.2s | 51.52Hz | 0. | 113s |

| Protection. Under Voltage | | | | | Р |
|---------------------------|---------|-----------------------------|---------|----------------|--------------------|
| Parameter | Voltage | Disconnection time limit | Voltage | Disconne li | ection time mit |
| Protection limit | 0.85Un | 50s | 0.80Un | 0 | .2s |
| Actual Setting | 195.5V | 50s | 184.0V | 0 | .2s |
| Trip test | Voltage | Disconnection time | Voltage | Disconne | ection time |
| L1 | 195.5V | 49.62s | 184.0V | 0.1 | 176s |

| Protection.Over Voltage | | | | | Р |
|-------------------------|---------|-----------------------------|---------|-----------------|-------------------|
| Parameter | Voltage | Disconnection time limit | Voltage | Disconne lin | ction time nit |
| Protection limit | 1.10Un | 60s | 1.15Un | 0. | 2s |
| Actual Setting | 253.0V | 60s | 264.5V | 0.1 | 2s |
| Trip test | Voltage | Disconnection time | Voltage | Disconne | ction time |
| L1 | 253.1V | 59.82s | 264.6V | 0.1 | 50s |



2、Tolerance of frequency deviations

a) Frequency Change

| Rate of change of frequency (ROCOF) immunity | | | | | Р |
|--|-----------|---------|---------|---------------------|----------------|
| | Frequency | | Change | Result | Poquiromont |
| | Begin | End | Change | (disconnect or not) | Requirement |
| a) | 49.0 Hz | 51.0 Hz | + 2Hz/s | Stay connected | Stay connected |
| b) | 51.0 Hz | 49.0 Hz | - 2Hz/s | Stay connected | Stay connected |

b) Power response to under-frequency

| Active power at under-frequency | | | | | Р |
|---|----------------|----------------|-------------------|---------------------|----------------|
| Test sequence | Voltage (V) | Current (A) | Frequency (Hz) | Active Power (W) | Primary source |
| Test a) | 230.9 | 15.9 | 49.99 | 3680.0 | PV generator |
| Test b) | 230.8 | 15.9 | 49.50 | 3675.1 | PV generator |
| Test c) | 231.0 | 15.9 | 49.00 | 3678.7 | PV generator |
| Test d) | 230.8 | 15.9 | 48.50 | 3674.5 | PV generator |
| Test e) | 230.8 | 15.9 | 48.00 | 3674.4 | PV generator |
| Test f) | 230.8 | 15.9 | 47.50 | 3674.3 | PV generator |
| Supplementary information: During the test, under-frequency protection is disabled. | | | | | |

c) Transient voltage phase jumps

| Transient voltage p | Р | | |
|-----------------------|-----------------|-------------|-----------------|
| | Start Frequency | Change | Confirm no trip |
| Positive Vector Shift | 49.5 Hz | +20 degrees | No trip |
| Negative Vector Shift | 50.5 Hz | -20 degrees | No trip |



3. Start-up and reconnection

a) Eastern Denmark

| Starting to generate electrical power Automatic reconnection after tripping | | | | Р | |
|--|---------------------------------|--|---|--|--|
| | Min.voltage | for connected to grid | 195.5V | | |
| | Max.voltage | e for connected to grid | | 253.0 V | |
| Setting values | Min.Freque | ncy for connected to grid | | 49.9Hz | |
| | Max.Freque | ency for connected to grid | | 50.1Hz | |
| | Observatior | n time (180s) | | 180s | |
| Test: | | | | | |
| | | Voltage c | onditions | | |
| a) start up for vol | tage range | <85%U _n for twice of setting observation time | >110%U _l obs | n for twice of setting ervation time | |
| Connecti | on: | No connection | No | connection | |
| Limit | | No connection allowed | | | |
| b) in voltage rang | je at start up | □≥85%U _n within twice of setting observation time | □≤110%U _n within twice of setting observation time | | |
| Reconnection time | e[s] | 187s | 189s | | |
| Limit: | | Reconnection after setting observation time(180s) | | | |
| Gradient | | P 1 10.0 V 2 500 V 200 s | 2.50k/ | 61.3 5 819 5 −10.8 A A757 5 A120 A A757 5 A120 A (17 9月 2020) 11:35:45 | |
| c) In voltage range | e after | \geq 85%U _n for twice of setting | ≤110%U | n for twice of setting | |
| Percennection time | | | ODS | | |
| | ຍ[8] | 2005 | | 1045 | |
| Limit: | Reconnection after setting obse | ervation tim | ne(≥180s) | | |



| Gradient | | | | |
|---|---|--|--|--|
| | 3 1 10.0 V 2 500 V 100 s | 5.00K次/秒 5.00K次/秒 5M点 -44.8 V 10:34:49 | | |
| | Frequency | conditions | | |
| d) start up for frequency range | <49.9Hz for twice of setting observation time | >50.1Hz for twice osetting observation time | | |
| Connection | No connection | No connection | | |
| Limit | No connection allowed | | | |
| e) in frequency range at start up | ≥49.9Hz witnin twice of setting observation time | <50.1Hz witnin twice of setting observation time | | |
| Reconnection time[s] | 192s | 195s | | |
| Limit: | Reconnection after setting observation time(≥180s) | | | |
| Gradient | □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ | ● 96.0 s 109 A ● 97.7 s -10.8 A A781 s A120 A ■ 109 A ● 87.7 s -10.8 A A781 s A120 A ■ 109 | | |
| f) In frequency range after frequency failture | □49.9Hz for twice of setting observation time | □50.1Hz for twice of setting observation time | | |
| Reconnection time[s] | 192s | 195s | | |
| Limit: | Reconnection after setting observation time(≥180s) | | | |





b) Western Denmark

| Starting to generate electrical power Automatic reconnection after tripping | | | | Р |
|--|-------------|--|---|---------|
| | Min.voltage | for connected to grid | | 195.5V |
| | Max.voltage | e for connected to grid | | 253.0 V |
| Setting values | Min.Freque | ncy for connected to grid | | 49.8Hz |
| | Max.Freque | ency for connected to grid | | 50.2Hz |
| | Observatior | n time (180s) | | 180s |
| Test: | | | | |
| Voltage conditions | | | | |
| a) start up for voltage range | | <85%U _n for twice of setting observation time | >110%Un for twice of settir observation time | |
| Connection: | | No connection | No connection | |
| Limit | | No connection allowed | | |
| b) in voltage range at start up | | □≥85%U _N within twice of setting observation time | □≤110%U _n within twice of setting observation time | |
| Reconnection time[s] | | 187s | 189s | |
| Limit: | | Reconnection after setting obs | ervation tim | e(180s) |



| Gradient | 1 20.0 V 200 s | 1015 109A 1015 109A 105 109A 105 109A 105 109A 105 109A 105 109A 105 109A 1059135 |
|--------------------------------------|---|---|
| c) In voltage range after | ≥85%Un for twice of setting | \leq 110%U _n for twice of setting |
| voltage failture | observation time | observation time |
| Reconnection time[s] | 184s | 187s |
| Limit: | Reconnection after setting obs | ervation time(≥180s) |
| Gradient | D D 20.0 V 200 V 200 S | ● 53.3 s ● 837 5 ● 109 A ● 837 5 ● 108 A A784 s A120 A ● 4120 A ● 4120 A ● 108 A ● |
| | Frequency | conditions |
| d) start up for frequency range | <49.8Hz for twice of setting observation time | >50.2Hz for twice of setting observation time |
| Connection | No connection | No connection |
| Limit | No connect | ion allowed |
| e) in frequency range at start up | ≥49.8Hz witnin twice of setting observation time | ≤50.2Hz witnin twice of setting observation time |
| Reconnection time[s] | 184s | 187s |
| Limit: | Reconnection after setting | g observation time(≥180s) |



| Gradient | 1e k 1≇11 2 2 2 2 2 2 2 2 2 0 V 2 2 0 V 2 2 0 V 2 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 0 V 2 0 V V V V V V V V V V V V V | ● 107 5 109 A ● 853 5 - 10.8 A A776 5 A 120 A ■ 107 5 109 A ● 107 5 109 A ■ 108 A A776 5 A 120 A ■ 108 A ■ 1 |
|-----------------------------|---|--|
| f) In frequency range after | ≥49.8Hz for twice of setting | ≤50.2Hz for twice of setting |
| Reconnection time[s] | 184s | 184s |
| Limit: | Reconnection after setting obse | ervation time(≥180s) |
| Gradient | Tek ⊭⊥ 2 2 2 2 2 2 2 2 2 2 0 0 2 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 | |



4. power response to overfrequency

a) Eastern Denmark

| Power response to overfrequency | | | | | | | | | | | | | P |) | | | | | | | | | | | |
|---|--|-----------------------|----------------------|----------|-----------------------|---|----------|------------|------------|------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|--|-----|------|--|
| | | | | Para | ame | ter | | | | | | R | lan | ge | | | | | | De | efa | ult | set | ting | |
| Setting valu | ies | Т | hresh | old | freq | uen | cy f⊦ | RO | | 5 | 60.2 | 2 Hz | z to | 50 | .5 | Hz | | | | | 5 | 0.5 | Hz | 2 | |
| | | | | D | roop |) | | | | | 2 | 2 % | to | 12 | % | | | | | | | 4 % | 6 | | |
| Test: | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2-min | a) 50.00⊦ | z b) 50.50Hz c) 50.55 | | 55H | Ηz | z d) 50.70Hz | | | e) 50.95Hz | | f) 50.70Hz | | łz | | | | | | | | | | | | |
| mean value | g) | 50.8 | 50.55Hz H) 50.50Hz | | | | | i) 50.00Hz | | | | | | | | | | | | | | | | | |
| Graph of M | Graph of Measurement a) to i) : Active power output>80%P _{Emax} | | | | | | | | | | | | | | | | | | | | | | | | |
| 4000 3500 2500 2000 1500 500 0 1000 500 0 1000 500 10000 1000000 | 19:11:20 19:12:00 19:12:39 19:13:18 | 19:14:36 19:14:36 | 19:15:16 19:15:55 | 19:16:34 | 19:17:52 (19:17:52 | (19:18:32 19-10-11 | 19:19:50 | 19:20:29 | 19:21:08 | D 19:21:48 | T19:22:2/ | 19:23:45 | 19:24:24 | 19:25:04 | 19:25:43 | 19:26:22 | 19:27:01 | 19:27:40 | 19:28:20 | 19:28:59 | | 51.2 51 50.8 50.6 50.4 50.2 50 49.8 49.6 49.4 | | | |



b) Western Denmark

| Power response to overfrequency | | | | | | | | | | | Р | | | | | | | | | |
|---------------------------------|-------------------------|----------------|----------------|-------|----------------|--------------|-------|-----------------|-------------------|-------|----------------|-------|-----------------|-------------|-------|-------------------------|-------|----------|-----|------------|
| | | | | | Р | aram | nete | r | | | | | F | Ran | ge | | | Defaul | t s | etting |
| Setting va | lues | | - | Thre | esho | ld fre | que | ency | ′ f _{RC} |) | | 50.2 | : H | z to | 50. | 5 Hz | | 50.2 | 2 | Hz |
| | | | | | | Droo | эр | | | | | 2 | 2 % | o to | 12 🤉 | % | | 5 | % |) |
| Test: | | | | | | | | | | | | | | | | | | | | |
| 2-min | 2) 5 | | J-7 | ь) | 50.2 | ~~~~ | | 50 ⁻ | | - | d) (| 51 A | പ | | |) 7∩⊔- | f) | 50 2547 | | |
| mean value | | 0.001 | IZ | 0) | 50.2 | JUL | 0) | 50.7 | 101 | 12 | u) t |)1.4 | | 2 6 | ;) 50 | 0.70112 | , יי | 50.25112 | ç | J) 50.00H2 |
| Graph of I | Measur | emer | nt a) | to | g) : / | Active | e po | wer | r ou | itpu | t>8 | 0%F | > _{En} | nax | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| 4000 | | | | | | | | | | | | | | | | | | 52 | | |
| 3500 | | | | | | | | | | | | | - | _ | | | | 51 5 | | |
| 3000 | | | | L | | | | | | | | | | | | | | 51.5 | | |
| 2500 | | | | | | | _ | | | | | | | | | | | 51 | | |
| 2000 | | | | ſ | | | _ | | | | | | | | | | | 50.5 | | |
| 1500 | | | _ | - | | | • | | | | | | | | | | | 50 | | |
| 1000 | | | | | | | | | | | | | | | | | | - 50 | | |
| 500 | | | | | | | | | | | | | | | | | | 49.5 | | |
| 0 | | | | | | | | | | | | | | | | | | 49 | | |
| 9:43 |):13):43 1:14 | 2:14 | 2:44 3:14 | 3:45 | l:15 l:45 | 5:15 5:45 | 5:16 | 5:46 7:16 | :46 | 3:17 | 3:47 | :47 |):17 |):48 -18 | 1:48 | 2:18 2:48 3:19 | 3:49 | | | |
| 19:49 | 19:50 19:50 19:51 | 19:51 19:52 | 19:52 19:53 | 19:53 | 19:54 19:54 | 19:55 | 19:56 | 19:56 19:57 | 19:57 | 19:58 | 19:58 10-50 | 19:59 | 20:00 | 20:00 | 20:01 | 20:02 20:02 20:03 | 20:03 | | | |
| | | | | | | D2/1 | | | | | 112/1 | 1-) | | | | | | | | |
| | | | | | | | vvj | | | ΝLQ | 05(1 | 12) | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

Ρ



5、Reactive power control

| Reactive | nowor | control |
|----------|-------|---------|
| Reactive | power | CONTROL |

Test 1: Power Factor control

| Cos φ set=0.9 (inductive) | | | | | | | | | | |
|--|--|--|---|--|--|--|--|--|--|--|
| Power - Bin (P/Sn) | Active power [W] | Apparent power [VA] | Reactive power [Var] | Power factor [cosφ] | ΔCosφ | LIMIT Δcosφ_max | | | | |
| 10% | 337.4 | 374.5 | -163.0 | 0.9006 | 0.0006 | ±0.01 | | | | |
| 20% | 731.2 | 815.0 | -360.0 | 0.8972 | -0.0028 | ±0.01 | | | | |
| 30% | 1107.4 | 1228.6 | -532.5 | 0.9012 | 0.0012 | ±0.01 | | | | |
| 40% | 1476.6 | 1648.4 | -732.7 | 0.8958 | -0.0042 | ±0.01 | | | | |
| 50% | 1845.6 | 2054.1 | -901.6 | 0.8985 | -0.0015 | ±0.01 | | | | |
| 60% | 2211.9 | 2457.5 | -1071.2 | 0.9000 | 0.0000 | ±0.01 | | | | |
| 70% | 2575.9 | 2860.4 | -1243.7 | 0.9005 | 0.0005 | ±0.01 | | | | |
| 80% | 2943.1 | 3266.5 | -1417.1 | 0.9010 | 0.0010 | ±0.01 | | | | |
| 90% | 3308.7 | 3670.7 | -1589.2 | 0.9014 | 0.0014 | ±0.01 | | | | |
| 100% | 3315.8 | 3677.7 | -1591.0 | 0.9016 | 0.0016 | ±0.01 | | | | |
| Cos φ set=0.9 (capacitive) | | | | | | | | | | |
| Power - Bin | Active power | Apparent | Reactive | Power factor | | LIMIT | | | | |
| (P/Sn) | EL A / I | | | | ΔCosΦ | | | | | |
| (1, , e.i.) | [vv] | power [VA] | power [Var] | [cosφ] | | Δcosφ_max | | | | |
| 10% | [vv] 369.2 | power [VA] 410.9 | power [Var] 180.4 | [cosφ] 0.8985 | -0.0015 | Δcosφ_max ±0.01 | | | | |
| 10% 20% | 269.2 740.3 | power [VA] 410.9 823.4 | power [Var] 180.4 360.3 | [cosφ] 0.8985 0.8992 | -0.0015 | Δcosφ_max ±0.01 ±0.01 | | | | |
| 10% 20% 30% | [vv] 369.2 740.3 1106.5 | power [VA] 410.9 823.4 1239.8 | power [Var] 180.4 360.3 559.3 | [cosφ] 0.8985 0.8992 0.8924 | -0.0015 -0.0008 -0.0076 | Δcosφ_max ±0.01 ±0.01 ±0.01 | | | | |
| 10% 20% 30% 40% | [VV] 369.2 740.3 1106.5 1471.4 | power [VA] 410.9 823.4 1239.8 1639.0 | power [Var] 180.4 360.3 559.3 722.0 | [cosφ] 0.8985 0.8992 0.8924 0.8978 | -0.0015 -0.0008 -0.0076 -0.0022 | Δcosφ_max ±0.01 ±0.01 ±0.01 ±0.01 | | | | |
| 10% 20% 30% 40% 50% | [vv] 369.2 740.3 1106.5 1471.4 1845.7 | power [VA] 410.9 823.4 1239.8 1639.0 2049.2 | power [Var] 180.4 360.3 559.3 722.0 890.3 | [cosφ] 0.8985 0.8992 0.8924 0.8978 0.9007 | -0.0015 -0.0008 -0.0076 -0.0022 0.0007 | Δcosφ_max ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 | | | | |
| 10% 20% 30% 40% 50% 60% | [vv] 369.2 740.3 1106.5 1471.4 1845.7 2215.5 | power [VA] 410.9 823.4 1239.8 1639.0 2049.2 2454.6 | power [Var] 180.4 360.3 559.3 722.0 890.3 1056.7 | [cosφ] 0.8985 0.8992 0.8924 0.8978 0.9007 0.9026 | -0.0015 -0.0008 -0.0076 -0.0022 0.0007 0.0026 | $ \Delta \cos \varphi _{max} $ ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 | | | | |
| 10% 20% 30% 40% 50% 60% 70% | [vv] 369.2 740.3 1106.5 1471.4 1845.7 2215.5 2575.7 | power [VA] 410.9 823.4 1239.8 1639.0 2049.2 2454.6 2849.6 | power [Var] 180.4 360.3 559.3 722.0 890.3 1056.7 1219.0 | [cosφ] 0.8985 0.8992 0.8924 0.8978 0.9007 0.9026 0.9039 | -0.0015 -0.0008 -0.0076 -0.0022 0.0007 0.0026 0.0039 | $ \Delta \cos \varphi max $ ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 | | | | |
| 10% 20% 30% 40% 50% 60% 70% 80% | [vv] 369.2 740.3 1106.5 1471.4 1845.7 2215.5 2575.7 2943.1 | power [VA] 410.9 823.4 1239.8 1639.0 2049.2 2454.6 2849.6 3251.9 | power [Var] 180.4 360.3 559.3 722.0 890.3 1056.7 1219.0 1383.4 | [cosφ] 0.8985 0.8992 0.8924 0.8978 0.9007 0.9007 0.9026 0.9039 0.9050 | -0.0015 -0.0008 -0.0076 -0.0022 0.0007 0.0026 0.0039 0.0050 | $ \Delta \cos \varphi_max $ ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 | | | | |
| 10% 20% 30% 40% 50% 60% 70% 80% 90% | [vv] 369.2 740.3 1106.5 1471.4 1845.7 2215.5 2575.7 2943.1 3296.6 | power [VA] 410.9 823.4 1239.8 1639.0 2049.2 2454.6 2849.6 3251.9 3634.5 | power [Var] 180.4 360.3 559.3 722.0 890.3 1056.7 1219.0 1383.4 1530.1 | [cosφ] 0.8985 0.8992 0.8924 0.8978 0.9007 0.9026 0.9039 0.9050 0.9070 | -0.0015 -0.0008 -0.0076 -0.0022 0.0007 0.0026 0.0039 0.0050 0.0070 | $ \Delta \cos \phi_max $ ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 ±0.01 | | | | |
| 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% | [vv] 369.2 740.3 1106.5 1471.4 1845.7 2215.5 2575.7 2943.1 3296.6 3306.9 | power [VA] 410.9 823.4 1239.8 1639.0 2049.2 2454.6 2849.6 3251.9 3634.5 3644.7 | power [Var] 180.4 360.3 559.3 722.0 890.3 1056.7 1219.0 1383.4 1530.1 1532.1 | [cosφ] 0.8985 0.8992 0.8924 0.8978 0.9007 0.9026 0.9039 0.9050 0.9050 0.9070 0.9074 | -0.0015 -0.0008 -0.0076 -0.0022 0.0007 0.0026 0.0039 0.0050 0.0050 0.0070 0.0074 | $ \Delta \cos \phi_max $ ±0.01 | | | | |
| 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% | [vv] 369.2 740.3 1106.5 1471.4 1845.7 2215.5 2575.7 2943.1 3296.6 3306.9 | power [VA] 410.9 823.4 1239.8 1639.0 2049.2 2454.6 2849.6 3251.9 3634.5 3644.7 | power [Var] 180.4 360.3 5559.3 722.0 890.3 1056.7 1219.0 1383.4 1530.1 1532.1 Cos φ set=1.0 | [cosφ] 0.8985 0.8992 0.8924 0.8978 0.9007 0.9026 0.9039 0.9050 0.9050 0.9070 0.9074 | -0.0015 -0.0008 -0.0076 -0.0022 0.0007 0.0026 0.0039 0.0050 0.0070 0.0074 | $ \Delta \cos \varphi_max $ ±0.01 | | | | |



| | | | | Manufacture Decl | aration for Denmark | <u> </u> |
|----------------|--------------|--------------|--------|------------------|---------------------|----------|
| 10% | 366.4 | 367.5 | -28.0 | 0.9971 | -0.0029 | ±0.01 |
| 20% | 735.9 | 736.3 | -25.0 | 0.9994 | -0.0006 | ±0.01 |
| 30% | 1101.7 | 1102.0 | -25.0 | 0.9997 | -0.0003 | ±0.01 |
| 40% | 1474.2 | 1484.8 | -176.8 | 0.9929 | -0.0071 | ±0.01 |
| 50% | 1844.6 | 1853.2 | -178.0 | 0.9954 | -0.0046 | ±0.01 |
| 60% | 2208.1 | 2215.4 | -179.2 | 0.9967 | -0.0033 | ±0.01 |
| 70% | 2572.4 | 2578.7 | -179.5 | 0.9976 | -0.0024 | ±0.01 |
| 80% | 2958.5 | 2965.7 | -207.0 | 0.9976 | -0.0024 | ±0.01 |
| 90% | 3316.8 | 3322.9 | -200.3 | 0.9982 | -0.0018 | ±0.01 |
| 100% | 3679.9 | 3685.5 | -200.5 | 0.9985 | -0.0015 | ±0.01 |
| Tost 2: Automa | tic Power Ea | eter control | | | | |

Test 2: Automatic Power Factor control

Lock-in: 1.05Vn (Vn and 1.1 Vn with steps of 0.01)

Lock-out: 1.00Vn (0.9 Vn and Vn with steps of 0.01)

| P/Pn[%] setpoint | P[W] | P/Pn [%] | Vout/Vn | Q[Var] | Cos φ measured | Cos φ Set-point | ΔCosφ | LIMIT Δcosφ_max |
|---------------------|--------|----------|---------|---------|--------------------------|---------------------------|---------|--------------------|
| 10 | 416.5 | 11.3% | 1.02 | -27.0 | 0.9979 | 1.00 | -0.0021 | ±0.01 |
| 20 | 783.0 | 21.3% | 1.02 | -24.0 | 0.9995 | 1.00 | -0.0005 | ±0.01 |
| 30 | 1149.6 | 31.2% | 1.02 | -23.3 | 0.9998 | 1.00 | -0.0002 | ±0.01 |
| 50 | 1878.7 | 51.1% | 1.02 | -26.0 | 0.9999 | 1.00 | -0.0001 | ±0.01 |
| 60 | 2242.4 | 60.9% | 1.02 | -30.0 | 0.9999 | 1.00 | -0.0001 | ±0.01 |
| 60 | 2244.3 | 61.0% | 1.06 | -454.0 | 0.9801 | 0.98 | 0.0001 | ±0.01 |
| 75 | 2787.6 | 75.8% | 1.06 | -898.7 | 0.9518 | 0.95 | 0.0018 | ±0.01 |
| 90 | 3328.4 | 90.4% | 1.06 | -1388.8 | 0.9229 | 0.92 | 0.0029 | ±0.01 |
| 100 | 3675.9 | 99.9% | 0.98 | -62.8 | 0.9999 | 1.00 | -0.0001 | ±0.01 |

Response time measurement: Standard characteristic curve for $\cos \phi$ (P)

| Power step under applied cosφ(P)-curve setted through control panel | Measured cosφ | Active Power [W] | Apparent Power [VA] | Reactive Power [Var] | Response time to new reactive power set value [s] | Settling time limit [s] |
|--|------------------|---------------------|------------------------|-------------------------|---|-------------------------------|
| 20% P _{max} , cosφ=1.0 | 0.9997 | 779.5 | 779.6 | -20.1 | | |
| 50% P _{max} , cosφ=1.0 | 0.9999 | 1875.2 | 1875.4 | -26.3 | | |
| 90% P _{max} , cosφ=0.92 | 0.9229 | 3328.7 | 3606.7 | -1388.7 | 3.4 | 10 |
| | | | | | | |



| 90% P _{max} , cosφ | =0.92 | 0.9 | 229 | 3328 | 3.6 | 3606 | .6 | -138 | 8.6 | | | |
|-----------------------------|----------------|-----------|--------------|-----------------|-----------------|------------------------|-----------|------------------|-------------------|----------------------------|------------------|--------------------|
| 50% P _{max} , cosφ | =1.0 | 0.9 | 999 | 1864 | 1.7 | 1865 | .0 | -25. | .6 | | 2.2 | 10 |
| 20% P _{max} , cosφ | =1.0 | 0.9 | 997 | 776 | .6 | 777. | 1 | -20. | .1 | | | |
| Test 3: Q con | trol | | | | | <u> </u> | | | | | | |
| | | | | Q=0 | Cmax | (Q _{cmax} = | =43.6 | 6% Sn) | | | | |
| Power-Bin (P/Sn) | Activ power | /e [W] | App: powe | arent r [VA] | Rea Po [\ | active ower /Ar] | Re Pov | active wer/Sn | Re Pov se | active ver/Sn tpoint | Deviation [%] | ΔQ/Sn limit [%] |
| 10% | 403. | .5 | 165 | 58.0 | 16 | 608.2 | 4: | 3.7% | 4: | 3.6% | 0.1% | +/-2% |
| 20% | 768. | .7 | 178 | 34.0 | 16 | 510.0 | 4: | 3.7% | 4: | 3.6% | 0.1% | +/-2% |
| 30% | 1133 | 8.8 | 196 | 8.5 | 16 | 609.0 | 4: | 3.7% | 4: | 3.6% | 0.1% | +/-2% |
| 40% | 1499 |).7 | 219 | 98.7 | 16 | 607.8 | 4 | 3.7% | 4: | 3.6% | 0.1% | +/-2% |
| 50% | 1866 | 5.1 | 246 | 61.7 | 16 | 05.2 | 4: | 3.6% | 4: | 3.6% | 0.0% | +/-2% |
| 60% | 2228 | 8.6 | 274 | 13.7 | 16 | 600.5 | 43 | 3.5% | 4: | 3.6% | -0.1% | +/-2% |
| 70% | 2589 |).7 | 304 | 1.1 | 15 | 94.1 | 4: | 3.3% | 4: | 3.6% | -0.3% | +/-2% |
| 80% | 2950 | .8 | 335 | 50.7 | 15 | 87.4 | 4: | 3.1% | 4: | 3.6% | -0.5% | +/-2% |
| 90% | 3275 | i.6 | 363 | 86.7 | 15 | 6.08 | 42 | 2.9% | 4: | 3.6% | -0.7% | +/-2% |
| 100% | 3275 | 5.4 | 363 | 36.5 | 15 | 80.0 | 42 | 2.9% | 4: | 3.6% | -0.7% | +/-2% |
| | | | | Q= Q | _max (| (Q _{Lmax} = | -43. | 6% Sn) | | | | |
| Power-Bin (P/Sn) | Activ power | /e [W] | App: powe | arent r [VA] | Rea Po [\ | active ower /Ar] | Re Pov | active wer/Sn | Rea Pov set | active ver/Sn point | Deviation [%] | ΔQ/Sn limit [%] |
| 10% | 433. | .8 | 165 | 52.9 | -15 | 595.0 | -4 | 3.3% | -4: | 3.6% | -0.3% | +/-2% |
| 20% | 795. | .5 | 178 | 32.9 | -15 | 596.0 | -4 | 3.4% | -43 | 3.6% | -0.2% | +/-2% |
| 30% | 1159 | 9.6 | 197 | 74.0 | -15 | 598.0 | -4 | 3.4% | -4: | 3.6% | -0.2% | +/-2% |
| 40% | 1525 | i.8 | 221 | 1.7 | -16 | 601.0 | -4 | 3.5% | -43 | 3.6% | -0.1% | +/-2% |
| 50% | 1892 | 2.5 | 248 | 80.8 | -16 | 604.2 | -4 | 3.6% | -43 | 3.6% | 0.0% | +/-2% |
| 60% | 2249 | 9.9 | 276 | 63.6 | -16 | 604.3 | -4 | 3.6% | -43 | 3.6% | 0.0% | +/-2% |
| 70% | 2612 | 2.3 | 306 | 67.8 | -16 | 608.9 | -4 | 3.7% | -43 | 3.6% | 0.1% | +/-2% |
| 80% | 2972 | 2.7 | 338 | 32.2 | -16 | 613.3 | -4 | 3.8% | -4: | 3.6% | 0.2% | +/-2% |
| 90% | 3303 | 8.0 | 367 | 7.8 | -16 | 617.9 | -4 | 4.0% | -4: | 3.6% | 0.4% | +/-2% |
| 100% | 3303 | 9.3 | 367 | 78.1 | -16 | 618.0 | -4 | 4.0% | -4: | 3.6% | 0.4% | +/-2% |

Ρ



6、Control functions

Control functions

Test 1: Absolute power constraint

Pnl is the designation for rated power supplied by an energy storage facility.

Pno denotes the nominal power absorbed by an energy storage facility.

| Set-point P/ Pnl [%] | Set-point P [W] | Measured P [W] | Accuracy [%] | Required accuracy of Set-point P [%] |
|----------------------|-----------------|----------------|--------------|---|
| 10% | 368 | 363.8 | -1.14% | ±5% |
| 20% | 736 | 742.9 | 0.94% | ±5% |
| 30% | 1104 | 1124.9 | 1.89% | ±5% |
| 40% | 1472 | 1506.2 | 2.32% | ±5% |
| 50% | 1840 | 1881.0 | 2.23% | ±5% |
| 60% | 2208 | 2259.0 | 2.31% | ±5% |
| 70% | 2576 | 2634.1 | 2.26% | ±5% |
| 80% | 2944 | 3006.9 | 2.14% | ±5% |
| 90% | 3312 | 3377.6 | 1.98% | ±5% |
| 100% | 3680 | 3692.3 | 0.33% | ±5% |

Note:

Accuracy of the control performed and of the set point must not deviate by more than $\pm 5\%$ of the set point value or $\pm 0.5\%$ of rated power, depending which yields the highest tolerance.

| Set-point P/ Pno [%] | Set-point P [W] | Measured P [W] | Accuracy [%] | Required accuracy of Set-point P [%] |
|----------------------|-----------------|----------------|--------------|---|
| 10% | -368 | -374.3 | 1.71% | ±5% |
| 20% | -736 | -730.3 | -0.77% | ±5% |
| 30% | -1104 | -1087.7 | -1.48% | ±5% |
| 40% | -1472 | -1445.6 | -1.79% | ±5% |
| 50% | -1840 | -1803.3 | -1.99% | ±5% |
| 60% | -2208 | -2163.5 | -2.02% | ±5% |
| 70% | -2576 | -2522.6 | -2.07% | ±5% |
| 80% | -2944 | -2886.5 | -1.95% | ±5% |
| 90% | -3312 | -3248.7 | -1.91% | ±5% |
| 100% | -3680 | -3609.9 | -1.90% | ±5% |



Test 2: Ramp rate constraint function

| • | | | | | |
|--|---|---|---|--------------------------------|-----------------------------|
| Test sequence | Measured stable active power of start point P[W] | Measured stable active power of end point P[W] | Time elapsed [s] (from start to time for output power last entered 5% tolerance band around the set-point) | Power gradient [%P₀/min] | Ramp rate limit[%P₀/min] |
| 100% P _{nl} to 5% P _{nl} | 3691.4 | 177.1 | 504 | 11.4 | ≥1% and ≤20% |
| 5% P _{nl} to 100% P _{nl} | 181.6 | 3692.3 | 572 | 10.0 | ≥1% and ≤20% |
| | | | | | |
| 100% Pno to 5% Pno | -3609.1 | -185.4 | 456 | 12.2 | ≥1% and ≤20% |
| 5% P _{no} to 100% P _{no} | -189.1 | -3611.7 | 520 | 10.7 | ≥1% and ≤20% |