

**Distributed Energy Storage System**

**Factory test report**

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| **Project name：**TROES\_100kW |
| **Model：**100kW/552kWh Containerized Energy Storage System |
| **Gateway number：** 999000001678 |
| **Testing time：**2021-06-17 |

**Testing Item list**

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| **NO.** | **Testing Item** |
| 1 | Appearance and insulation inspection |
| 2 | Power distribution test |
| 3 | BMS parameter tuning test |
| 4 | Environmental control system test |
| 5 | Remote control and remote signaling test |
| 6 | Remote commissioning and remote testing test |
| 7 | Protection testing |
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| --- | --- |
| **1、Appearance and insulation inspection** | |
| **1.1 Appearance inspection** | |
| Inspection content | Visual observation:  1. The appearance of the container is normal, the paint is intact and there is no peeling, rust, cracks, scratches, obvious deformation, etc., and all doors should be able to open and close normally;  2. The inside of the container is dry and free of stagnant water or water stains;  3. The cabinet is installed tightly and will not fall over due to vibration;  4. Adjacent cabinets are arranged neatly, and the cabinets are fixed;  5. The internal assembly and wiring of the container are complete, the wiring is standardized, the cable and wire connection is reliable, there is no damage, disconnection, the screws are tight, there is no exposed cable, and the system is well grounded;  6. Labels, silk screens, identification plates, nameplates are complete and clear, and dangerous live objects have been properly protected, or warning signs, etc.;  7. The cable tie should be even, and no sharp corners should be left at the cut; |
| Inspection result | 🗹Pass Declined |
| **1.2 Insulation inspection** | |
| Inspection content | 1. Use insulation withstand voltage tester, test voltage: 2800V, 60Hz;  2. Test time: 1 minute;  3. Test object: between the charged conductive circuits and the ground; between the electrically unconnected charged conductive circuits;  4. Test requirements: no breakdown or flashover at the test site; |
| Inspection result | 🗹Pass Declined |
| **2, Power distribution test** | |
| Inspection content | 1. Turn on the main switch of the secondary power supply of the system, and the secondary system should be able to powered on normally;  2. Turn on the power switch of the air conditioner, and the air conditioner should be energized normally;  3. Turn on the lighting system and the power switch of the socket, the socket should be able to supply power normally, and turn on the lighting switch, lighting should be able to illuminate normally;  5. Turn on the power switch of the equipment, and the secondary equipment should be able to power on normally;  6、Turn on the control power switch, the control system should be able to power on normally; |
| Inspection result | 🗹Pass Declined |
| **3、BMS parameter tuning test** | |
| Inspection result | 1. Modify the BMS parameter setting through the host computer/HMI;  2. Check whether the BMS setting value has been modified successfully through the host computer; |
| Inspection data | |  |  |  | | --- | --- | --- | | Setting item | Setting value | Setting result | | BC1 upper limit of cell voltage | 3.56V | 3.56V | | BC1 upper limit of cell voltage | 3.6V | 3.6V | | BC1 lower limit of cell voltage | 2.9V | 2.9V | | BC1 lower limit of cell voltage | 2.7V | 2.7V | | BC1 upper limit of the monomer temperature | 46℃ | 46℃ | | BC1 upper limit of the monomer temperature | 56℃ | 56℃ | | BC1 limit of monomer temperature | 6℃ | 6℃ | | BC1 lower the lower limit of the monomer temperature | -6℃ | -6℃ | |
| Inspection result | 🗹Pass Declined |
| **4，Environmental control system test** | |
| **4.1 Fan remote switch test** | |
| Inspection content | 1. Set the environmental control system to remote-control mode;  2. Control the battery room fan to turn on through the host computer/HMI, and all the fans in the battery drawer should be started;  3. Control the battery room fan to turn off through the host computer/HMI, and all battery drawer fans should be turned off; |
| Inspection data | |  |  | | --- | --- | | Control content | Response result | | Start | Start | | Off | Off | |
| Inspection result | 🗹Pass Declined |
| **4.2 Air conditioner remote switch test** | |
| Inspection content | 1. Set the environmental control system to remote-control mode;  2. Control No. 1 air conditioner to turn on through the host computer/HMI, and No. 1 air conditioner should be turned on;  3. Control No. 1 air conditioner to shut down through the host computer/HMI, and No. 1 air conditioner should be shut down;  4. Control No. 2 air conditioner to turn on through the host computer/HMI, and No. 1 air conditioner should be turned on;  5. Control No. 2 air conditioner to shut down through the host computer/HMI, and No. 1 air conditioner should be shut down; |
| Inspection data | |  |  |  |  |  | | --- | --- | --- | --- | --- | | Control content | NO.1 air conditioner turned on | NO.1 air conditioner shut off | NO.2 air conditioner turned on | NO.2 air conditioner shut off | | Result | ON | OFF | ON | OFF | |
| Inspection result | 🗹Pass Declined |
| **4.3 Air conditioning refrigeration test** | |
| Inspection content | 1. When the No. 1 air conditioner is turned on, set the refrigeration stop temperature and the refrigeration hysteresis temperature of the No. 1 air conditioner so that the refrigeration stop temperature + the refrigeration hysteresis temperature <the ambient temperature of the No. 1 air conditioner;  2. Observe whether the No. 1 air conditioner starts to cool;  3. In the refrigeration state of No. 1 air conditioner, set the refrigeration stop temperature of No. 1 air conditioner so that the refrigeration stop temperature is greater than the ambient temperature of No. 1 air conditioner;  4. Observe whether the No. 1 air conditioner stops cooling;  5. When the No. 2 air conditioner is turned on, set the refrigeration stop temperature and the refrigeration hysteresis temperature of the No. 2 air conditioner so that the refrigeration stop temperature + the refrigeration hysteresis temperature <the ambient temperature of the No. 2 air conditioner;  6. Observe whether the No. 2 air conditioner starts to cool;  7. In the refrigeration state of No. 2 air conditioner, set the refrigeration stop temperature of No. 2 air conditioner so that the refrigeration stop temperature is greater than the ambient temperature of No. 2 air conditioner;  8. Observe whether the No. 2 air conditioner stops cooling; |
| Inspection data | |  |  |  |  | | --- | --- | --- | --- | | NO.1 AC | Current T | Start T(℃) | Respond result | | 28.5℃ | 28℃ | Start | | Current | Stop T(℃) | Respond result | | 28.4℃ | 29℃ | Stop |  |  |  |  |  | | --- | --- | --- | --- | | NO.2 AC | Current T | Start T(℃) | Respond result | | 27.5℃ | 27℃ | Start | | Current | Stop T(℃) | Respond result | | 28℃ | 29℃ | Stop | |
| Inspection result | 🗹Pass Declined |
| **4.4 Automatic control test of environmental control system** | |
| Inspection content | 1. Set the environmental control system to local control mode;  2. Set the "Battery room fan start temperature" (lower than the current temperature) through the host computer/HMI, all battery drawer fans should be started, wait for a period of time, all air conditioners should be turned on;  3. When the fan is started and the air conditioner is on, set the "Battery Room Fan Shutdown Temperature" (higher than the current temperature) through the host computer/HMI, all battery drawer fans should be turned off, wait for a period of time, all air conditioners should be turned off; |
| Inspection data | |  |  |  |  |  | | --- | --- | --- | --- | --- | | Battery room fans | Current T | Fans start T(℃) | Whether Fans start | Whether AC turned on | | 31.3℃ | 29℃ | Start | Start | | Current | Fans stop T(℃) | Whether fans turned off | Whether AC turned off | | 31.2℃ | 33℃ | Off | Off | |
| Inspection result | 🗹Pass Declined |
| **5、Remote control and remote signaling test** | |
| **5.1 Circuit breaker position signal test** | |
| Inspection content | 1. Manually turn on each battery circuit breakers, and check whether each circuit breaker is shown closed on the host computer/HMI;  2. Manually disconnect each battery circuit breakers, and check whether each circuit breaker is shown off on the host computer/HMI;  3. Manually turn on the confluence circuit breaker QF5, and check whether QF5 is connected on the host computer/HMI;  4. Manually disconnect the bus circuit breaker QF5, and check whether QF5 is disconnected on the host computer/HMI; |
| Inspection data | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Connected | | Disconnected | | | Host computer | HMI | Host computer | HMI | | QF61 | On | On | Off | Off | | QF62 | On | On | Off | Off | | QF63 | On | On | Off | Off | | QF64 | On | On | Off | Off | | QF5 | On | On | Off | Off | |
| Inspection result | 🗹Pass Declined |
| **5.2 Contactor and switch control test** | |
| Inspection content | When the positive and negative contactors have remote control conditions, perform the following tests:  1. Control the closing of the positive and negative contactors of each cluster through the upper computer, and check whether each contactor is closed on the upper computer/HMI;  2. Control the disconnection of the positive and negative contactors of each cluster through the host computer, and check whether each contactor is disconnected on the host computer/HMI;  3. Control the closing of the positive and negative contactors of each cluster through the HMI, and check whether each contactor is closed on the HMI;  4. Control the disconnection of the positive and negative contactors of each cluster through the HMI, and check whether each contactor is disconnected on the HMI; |
| Inspection data | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Connection control | | | | | | | Contactor + | Host computer | HMI | Contactor - | Host computer | HMI | | KM61+ | On | On | KM61- | On | On | | KM62+ | On | On | KM62- | On | On | | KM63+ | On | On | KM63- | On | On | | KM64+ | On | On | KM64- | On | On | | Disconnection control | | | | | | | Contactor + | Host computer | HMI | Contactor - | Host computer | HMI | | KM61+ | Off | Off | KM61- | Off | Off | | KM62+ | Off | Off | KM62- | Off | Off | | KM63+ | Off | Off | KM63- | Off | Off | | KM64+ | Off | Off | KM64- | Off | Off | |
| Inspection result | 🗹Pass Declined |
| **6、Remote commissioning and remote testing test** | |
| **6.1、System remote commissioning test** | |
| Inspection content | 1. When the system is standing still, check the consistency of the battery, and the difference between the highest and lowest cell voltage should be within a certain range;  2. Start the charging/discharging of the system, and the battery temperature should be within the normal range;  3. The temperature and humidity of the container should be within the normal range;  4. The battery voltage and current sampling of each cluster should be normal, and the total bus voltage and total current sampling should be normal;  5. The data of the host computer/HMI should be displayed normally; |
| Inspection data | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | BS 1 | BS 2 | BS 3 | BS 4 | | Cell Max voltage | 3.3242V | 3.3256V | 3.3266V | 3.3286V | | Cell No. | 187 | 221 | 45 | 14 | | Cell Min voltage | 3.3180V | 3.3208V | 3.3204V | 3.3213V | | Cell No. | 143 | 112 | 128 | 105 | | Module Max T | 32.9℃ | 32.9℃ | 32.7℃ | 32.6℃ | | Module No. | 45 | 44 | 45 | 39 | | Module Min T | 28.0℃ | 27.9℃ | 27.5℃ | 27.8℃ | | Module No. | 76 | 10 | 73 | 7 | | String voltage | 796.4V | 796.4V | 796.2V | 796.0V | | String current | -14.1A | -14.7A | -14.6A | -14.6A | |  | Total voltage | Total Current | Total power | Total SOC | | 796.3V | -58.8A | -50KW | 33.2% | | Ambient T | 33.1℃ | | | | | Ambient humidity | 59.1%RH | | | | |
| Inspection result | 🗹Pass Declined |
| **6.2、Energy storage charge and discharge remote adjustment test** | |
| Inspection content | When the system is ready and has charging and discharging conditions, perform the following tests:  1. Set the control mode of the energy storage host computer;  2. Set the active power to charge and discharge through the host computer, check whether the remote adjustment is successful, and record the actual data;  3. Set the energy storage HMI control mode;  4. Set the active power to charge and discharge through the HMI, check whether the remote adjustment is successful, and record the actual data; |
| Inspection data | |  |  |  | | --- | --- | --- | | Setup value | HMI control | | | Charging exact value | Discharging exact value | | 30kW | -27.5KW | 32.6KW | | 50kW | -47.2KW | 53.0KW | |
| Inspection result | 🗹Pass Declined |
| **7、Protection testing** | |
| **7.1、Communication failure test** | |
| Inspection content | When the system is ready and has charging and discharging conditions, perform the following tests:  1. Start the system to charge, unplug the gateway network cable, the system should not stop charging;  2. Start the system to charge and unplug the RTU network cable. After a period of time, the system should stop charging. After the RTU network cable is restored, the system should not resume charging;  3. Start charging the system and unplug the PCS network cable/485 line. After a period of time, the system should stop charging. After the PCS network cable/485 line is restored, the system should not resume charging;  4. Start the system to charge and unplug the BMS network cable. After a period of time, the system should stop charging. After the BMS network cable is restored, the system should not resume charging;  5. Test the discharge according to the above steps; |
| Inspection data | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Charging | | Discharging | | | Network interrupt | network recovery | Network interrupt | network recovery | | Gateway | Continue charge | Continue charge | Continue discharge | Continue discharge | | RTU | Stop charge | Stop charge | Stop discharge | Stop discharge | | PCS | Stop charge | Stop charge | Stop discharge | Stop discharge | | BMS (each strings) | Stop charge | Stop charge | Stop discharge | Stop discharge | |
| Inspection result | 🗹Pass Declined |
| **7.2、Single cell overvoltage alarm test** | |
| Inspection content | 1. Start the system to charge and record the highest voltage of single battery cell;  2. Set the cluster BMS "cell battery voltage over upper limit alarm value" through the host computer/HMI to make it less than the current highest cell voltage value of the single battery;  3. Observe whether the system stops charging;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  | | --- | --- | | Charge power | -30KW | | Maximum voltage of battery cell | 3.2979V | | Set single cell overvoltage alarm value | 3.28V | | Result | Stop charging | | Pass or not | Pass | |
| Inspection result | 🗹Pass Declined |
| **7.3、Single cell undervoltage alarm test** | |
| Inspection content | 1. Start the system to discharge and record the lowest voltage of cluster battery cells;  2. Set the string BMS "cell battery voltage lower limit alarm value" through the host computer/HMI to make it greater than the current minimum cell voltage value of the cluster battery;  3. Observe whether the system stops discharging;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  | | --- | --- | | Discharge power | 30KW | | Minimum Cell voltage | 3.2922V | | Set single undervoltage alarm value | 3.3V | | Result | Stop | | Pass or not | Pass | |
| Inspection result | 🗹Pass Declined |
| **7.4、String overvoltage warning test** | |
| Inspection content | 1. Start the system to charge and record the battery string voltage;  2. Set the cluster BMS "cluster voltage over upper limit alarm value" through the host computer/HMI to make it smaller than the cluster battery cluster voltage;  3. Observe whether the system stops charging;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  | | --- | --- | | Charge power | -30KW | | Maximum voltage of battery string | 789V | | Set string cell overvoltage alarm value | 788V | | Result | Stop | | Pass or not | Pass | |
| Inspection result | 🗹Pass Declined |
| **7.5、String undervoltage warning test** | |
| Inspection content | 1. Start the system to discharge and record the cluster battery voltage;  2. Set the cluster BMS "String voltage lower limit alarm value" through the host computer/HMI to make it greater than the cluster battery cluster voltage;  3. Observe whether the system stops discharging;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  | | --- | --- | | Discharge power | 30KW | | String voltage | 792V | | Set string undervoltage alarm value | 793V | | Result | Stop | | Pass or not | Pass | |
| Inspection result | 🗹Pass Declined |
| **7.6、High temperature warning test** | |
| Inspection content | 1. Start the system to charge/discharge and record the highest module temperature of the string battery;  2. Set the string BMS "temperature over upper limit alarm value" through the host computer/HMI to make it less than the highest module temperature of the string battery;  3. Observe whether the system stops charging/discharging;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  |  |  | | --- | --- | --- | --- | | Charging power | -30KW | Discharging power | 30KW | | Module highest T | 27.4°C | Module highest T | 28.5°C | | Set high temperature alarm value | 27°C | Set high temperature alarm value | 28°C | | Result | Stop | Result | Stop | |
| Inspection result | 🗹Pass Declined |
| **7.7、Low temperature warning test** | |
| Inspection content | 1. Start the charging/discharging of the system and record the minimum module temperature of the string battery;  2. Set the string BMS "temperature lower limit alarm value" through the host computer/HMI to make it greater than the minimum module temperature of the string battery;  3. Observe whether the system stops charging/discharging;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  |  |  | | --- | --- | --- | --- | | Charging power | -30KW | Discharging power | 30KW | | Module lowest T | 27.5°C | Module lowest T | 27.1°C | | Set low temperature alarm value | 28°C | Set low temperature alarm value | 28°C | | Result | Stop | Result | Stop | |
| Inspection result | 🗹Pass Declined |
| **7.8、Current overcurrent alarm test** | |
| Inspection content | 1. Start the charging/discharging of the system and record the current of the string battery;  2. Set the string BMS "current over upper limit overload alarm value" through the host computer/HMI, so that the rated current \* current over upper limit overload alarm value <cluster battery cluster current;  3. Observe whether the system stops charging/discharging;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  |  |  | | --- | --- | --- | --- | | Charging power | -35KW | Discharging power | 30KW | | String current | 10.1A | String current | 9.7A | | Set over-current alarm value | 90A×10%=9A | Set over-current alarm value | 90A×10%=9A | | Result | Stop | Result | Stop | |
| Inspection result | 🗹Pass Declined |
| **7.9、Current short circuit protection test** | |
| Inspection content | 1. Start the system to charge/discharge and record the string current of the battery;  2. Set the string BMS "current short-circuit protection value" through the host computer/HMI, so that the rated current \* current short-circuit protection value <cluster battery cluster current;  3. Observe whether the system stops charging/discharging and whether the cluster contactor is disconnected;  4. Change the fixed value back to the original value. |
| Inspection data | |  |  |  |  | | --- | --- | --- | --- | | Charging power | -40KW | Discharging power | 40KW | | String current | 11.6A | String current | 13.2A | | Set short-circuit protection value | 90A×10%=9A | Set short-circuit protection value | 90×10%=9A | | Result | Contactor off, system shut down | Result | Contactor off, system shut down | |
| Inspection result | 🗹Pass Declined |
| **8, Charge and discharge response time test** | |
| Inspection content | 1. Set PCS to shutdown;  2. Set the system to charge through the host computer/HMI;  3. Record the time from when the command is issued to when the system starts to charge;  4. Set PCS to shutdown;  5. Set the system discharge through the host computer/HMI;  6. Record the time from when the command is issued to the start of the system's discharge; |
| Inspection data | |  |  | | --- | --- | | Shutdown-charging response time (s) | ＜10S | | Shutdown-discharge response time (s) | ＜10S | |
| Inspection result | 🗹Pass Declined |
| **9、E-stop testing** | |
| Inspection content | 1. Start the charging/discharging of the system;  2. Press the emergency stop button of the control cabinet;  3. Observe whether the system shuts down normally and whether the contactor is disconnected;  4. Start the charging/discharging of the system;  5. Press the emergency stop button outside the container;  6. Observe whether the system shuts down normally and whether the contactor is disconnected; |
| Inspection result | 🗹Pass Declined |
| **10、FPS testing** | |
| Inspection content | 1. Start the charging/discharging of the system;  2. Simulate flood warning;  3. Observe whether the system shuts down normally and whether the contactor is disconnected;  4. Start the charging/discharging of the system;  5. Simulate the smoke alarm in the battery room;  6. Observe whether the system shuts down normally and whether the contactor is disconnected;  7. Start the system to charge/discharge;  8. Simulate the smoke alarm in the PCS room;  9. Observe whether the system shuts down normally and whether the contactor is disconnected; |
| Inspection result | 🗹Pass Declined |
| **11、High-power charging and discharging and system cycle efficiency test** | |
| Inspection content | 1. Discharge the system to the protection cut-off state. After standing for 30 minutes, start charging with full power (set according to the site conditions) to the charging cut-off state; record the maximum temperature of the module, the pole, and the temperature at the connection of each switch during the charging process; Record the charging power W1 (BMS statistics) from the charging start to the charging cut-off state of the system;  2. After the system is fully charged and allowed to stand for 60 minutes, start the discharge with full power (set according to the site conditions) to the discharge cut-off state; record the maximum temperature of the module, the pole, and the temperature of each switch connection during the discharge; record the system discharge from the start Discharge power W2 in the whole process to discharge cut-off state (BMS statistics);  3、Combine charging and discharging data for system efficiency calculation, and efficiency calculation formula N=W2/W1 \*100%；  4、Combine the charge and discharge data to calculate the charge and discharge depth of the system, and the depth of charge calculation formula：N=W1/Q \*100% ；Depth of discharge calculation formula：N=W2/Q \*100% ；（Q：system capacity） |
| Inspection data | |  |  |  |  | | --- | --- | --- | --- | | Charge | | Discharge | | | PCS power required | -100KW | PCS power required | 100KW | | PCS actual input power | -94.5KW | PCS actual output power | 106KW | | Cell highest T | 31.3°C | Cell highest T | 31.2°C | | Pole highest T | 29.3°C | Pole highest T | 31.4°C | | Disconnector connection T | 34.2°C | Disconnector connection T | 35.3°C | | Charge to the charging cut-off voltage, the meter records the charge energy W1（PCS） | 563KWh | Discharge to discharging cut-off voltage, the meter records the discharge energy W2（PCS） | 507KWh | | Charge to the charging cut-off voltage, the meter records the charge energy W1（BMS） | 538KWh | Discharge to discharging cut-off voltage, the meter records the discharge energy W2（BMS） | 525KWh |   Energy storage system round trip efficiency：   |  |  |  | | --- | --- | --- | | N=W2/ W1\*100% | PCS | DC side | | 90.05% | 97.58% |   Energy storage system charge and discharge depth：Q is 552.9 kWh   |  |  |  |  | | --- | --- | --- | --- | | DC side depth charge | | DC side depth discharge | | | N=W1/Q \*100% | 97.46% | N=W2/Q\*100% | 95.11% | |
| Inspection result | 🗹Pass Declined |
| **12, Testing conclusion** | |
| Final conclusion | 🗹Pass Declined |