# TEST REPORT

## IEC/EN 62509

## Battery charge controllers for photovoltaic systems - Performance and functioning

| | |
|---|---|
| **Report reference No**. ..... : | 201216059GZU-001 |
| Tested by (printed name and signature) ..... : | Tommy Zhong<br>Technical Manager |
| Approved by (printed name and signature) ..... : | Jason Fu<br>Supervisor |
| Date of issue ..... : | 15 Jun., 2021 |
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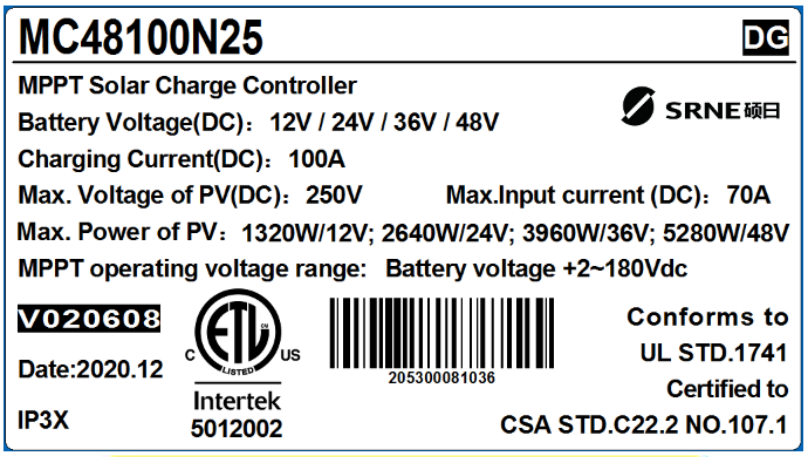
| Testing location ..... : | Same as above |
| Address ..... : | Same as above |
| **Applicant's Name** ..... : | SRNE Solar Co., Ltd |
| Address ..... : | 4-5F, 13A Wutong Island, Neihuan Rd, Xixiang, Bao`an, SHENZHEN Guangdong 518100, China |
| **Test specification** | |
| Standard..... : | ☒ IEC 62509: 2010 and/or<br>☒ EN 62509: 2011 |
| Test procedure ..... : | Performance and functioning test |
| Non-standard test method ..... : | N/A |
| **Test Report Form No**. ..... : | IEC/EN62509_a |
| TRF originator . ..... : | Intertek |
| Master TRF ..... : | dated 2012-07 |
| **Test item description** ..... : | MPPT Solar Charge Controller |
| Trademark ..... : | SRNE硕日 |
| Manufacturing site ..... : | SRNE Solar Co., Ltd<br>Room 301, Building 5, Fuxing Road, No. 36, Chang'an Town, DONGGUAN CITY, Guangdong, China |
| Model and/or type reference ..... : | MC4860N15, MC4860N25, MC4870N15, MC4870N25<br>MC4885N15, MC4885N25, MC48100N15, MC48100N25 |

| | | | | | |
|---|---|---|---|---|---|
| Rating(s)..... : | Model | MC4860N15 | MC4860N25 | MC4870N15 | MC4870N25 |
| | Battery Voltage (DC) | 12V / 24V / 36V / 48V | | | |
| | Charging Current | 60A | | 70A | |
| | Max. Voltage of PV (DC) | 150V | 250V | 150V | 250V |
| | Max. PV Input Current | 50A | 40A | 50A | 40A |
| | Max. Power of PV | 800W/12V, 1600W/24V, 2400W/36V, 3200W/48V | | 920W/12V, 1840W/24V, 2760W/36V, 3680W/48V | |
| | MPPT Operating Voltage Range | Battery Voltage+2 ~ 120Vdc | Battery Voltage+2 ~ 180Vdc | Battery Voltage+2 ~ 120Vdc | Battery Voltage+2 ~ 180Vdc |
| | Model | MC4885N15 | MC4885N25 | MC48100N15 | MC48100N25 |
| | Battery Voltage (DC) | 12V / 24V / 36V / 48V | | | |
| | Charging Current | 85A | | 100A | |
| | Max. Voltage of PV (DC) | 150V | 250V | 150V | 250V |
| | Max. PV Input Current | 70A | | | |
| | Max. Power of PV | 1100W/12V, 2200W/24V, 3300W/36V, 4400W/48V | | 1320W/12V, 2640W/24V, 3960W/36V, 5280W/48V | |
| | MPPT Operating Voltage Range | Battery Voltage+2 ~ 120Vdc | Battery Voltage+2 ~ 180Vdc | Battery Voltage+2 ~ 120Vdc | Battery Voltage+2 ~ 180Vdc |
| | Protection Degree | IP3X | | | |

Copy of marking plate





**Note:**

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation.
3. The labels of the other models are same as above except the model name and ratings.

Summary of testing:
The sample(s) tested complied with the requirement of IEC 62509: 2010 & EN 62509: 2011.

| **Test case verdicts** | |
|---|---|
| Test case does not apply to the test object : | N/A |
| Test item does meet the requirement .....: | P(ass) |
| Test item does not meet the requirement ...: | F(ail) |

| **Testing** | |
|---|---|
| Date of receipt of test item .....: | 16 Dec., 2020 |
| Date(s) of performance of test .....: | 16 Dec., 2020 – 09 Jun., 2021 |

General remarks

The test results presented in this report relate only to the object tested.
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"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a comma (point) is used as the decimal separator.

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

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**General product information:**
Product covered by this report is a solar charge controller. This product can keep monitoring the solar panel's generating power and tracking the highest voltage and current values (VI) in real time, enabling the system to charge the battery in maximum power. It's non-isolating between PV and battery circuit. It's designed to be used in off-grid photovoltaic systems to coordinate operation of the solar panel to charge battery.

| Clause | Requirement - Test | Result - Remark | Verdict |
|---|---|---|---|
| 4 | Functionality and performance requirements of a PV BCC | | P |
| 4.1 | General | | P |
| 4.2 | Applicability of requirements | | P |
| 4.3 | Battery lifetime protection requirements | | P |
| 4.3.1 | Prevent leakage current from battery to PV generator | | P |
| | The BCC shall limit leakage current flowing from the battery to the PV generator in order to prevent battery discharging at night. The allowable reverse current on the PV side shall be $\leqslant$ 0,1 % of the BCC rated input current when the battery voltage is equal to the rated voltage. | | P |
| | Compliance shall be verified by test according to 5.2.1. | | P |
| 4.3.2 | Basic battery charging functions | | P |
| 4.3.2.1 | General | | P |
| | The BCC shall provide appropriate charging set-points and load disconnect set-points for the specific battery technology or technologies it is intended to be used for. | Bulk charge / float charge mode | P |
| 4.3.2.2 | Protect battery from over-charge | | P |
| | The BCC shall cut out or regulate the charging current to avoid over-charging of the battery according to battery manufacturer recommended end of charge set-point. | | P |
| | Compliance shall be determined by test according to 5.2.2. | No deviation between set-point and actual measured point | P |
| 4.3.2.3 | Protect battery from over-discharge | | P |
| | The BCC shall have a provision to prevent the battery from over-discharging either by directly interrupting the current to the load, or by a trip signal to enable an external piece of equipment to stop the current to the load, or an alarm. | Over-charging is prevented by automatically interrupting the charging current. | P |
| | If battery over-discharge protection is achieved by means of audible or visible alarms that prompt the system user to disconnect all or non-essential load, this shall be clearly stated in the operation manual. | Over-discharge is prevented by automatically interrupting the load current. | N/A |
| | If over-discharge protection is reliant on the installation of an external device that provides over-discharge protection (such as an inverter), this fact shall be clearly stated in the installation manual. | Integral control circuit | N/A |

| Clause | Requirement - Test | Result - Remark | Verdict |
|---|---|---|---|
| | Battery over-discharge protection can be triggered by a battery voltage measurement, a state of charge calculation, a combination of both or other algorithms. The protection set-points may be current compensated. Battery over-discharge protection set-point shall be verifiable by testing. The BCC documentation and/or interface shall clearly specify the algorithms and criteria used to establish the load disconnect and reconnect set-points. | Battery over-discharge protection is triggered by a battery voltage measurement | P |
| | Compliance shall be determined by test according to 5.2.3. | | P |
| 4.3.2.4 | Set-point accuracy | | P |
| | The BCC measurement accuracy for voltage set-points for charge control shall be ±1 % or better. For load disconnect it shall be ±2 % or better. | Deviation is Max -0.99% | P |
| | Compliance shall be determined by test according to 5.2.2 and 5.2.3. | | P |
| 4.3.3 | Charging regime | | P |
| 4.3.3.1 | General | | P |
| | The BCC shall be matched to the specific battery technology for its intended use to ensure that correct charging set-points are implemented. The PV BCC can use a variety of methods to ensure correct charging of batteries, the requirements in this clause include some of the possible solutions and do not limit other solutions. | | P |
| 4.3.3.2 | Required charging stages | | P |
| | As a minimum, PV battery charge controllers shall have bulk and float charging stages. | Bulk and float charging stages employed | P |
| 4.3.3.3 | Recommended charging stages | | P |
| | In addition to the requirements of 4.3.3.2, battery charge controllers should provide equalize charge periodically to the battery. The periodicity of equalise charge should be more than 7 days. | | P |
| 4.3.3.4 | Adjustable charging set-points | | P |
| | In order to ensure correct charging regime for the battery type, charging set-points should be adjustable or automatically selected either by means of individual set-point adjustment, or by battery type selection or self-detection of type of battery. This can be achieved by hardware means or software through user interface or by adjusting set-points as directed in manuals. | | P |

| Clause | Requirement - Test | Result - Remark | Verdict |
|---|---|---|---|
| | The specific charging regime used depends on the battery technology specified. A guide for the battery set-points for testing purposes where such information is unavailable from the manufacturer is given in Annex A. | | N/A |
| | Self-adaptive set-points based on advanced algorithms shall be able to be verified using information provided by the user interface and the BCC documentation. No specific test procedure has been developed for devices employing these advanced techniques.<br><br>NOTE: Adjustable set-points may not be required for BCCs intended for low power applications (< 250 W) and for a particular type of battery. | | N/A |
| 4.3.3.5 | Temperature compensated charging set-points | | P |
| | Bulk, float, and other high voltage or end of charge set-points should be temperature compensated. Temperature compensation if provided should be in accordance with battery manufacturer recommendations for the particular type of battery. Temperature compensated set-points shall be identifiable from the charge controller documentation.<br><br>NOTE Lead acid battery manufacturers typically specify a temperature compensation coefficient of –5 mV/°C/Cell. | | P |
| 4.3.3.6 | Voltage drop compensation for set-point measurement | | P |
| | The BCC should provide a means to compensate for voltage drop in battery cables, or provide installation instructions to minimise voltage drop. | Wire length and size is recommended in installation instruction. | P |
| | If the battery charge controller has the provision for battery sense cables, it shall be able to operate with or without these. This is to protect the unit against unintended disconnection of the battery sense cables. This requirement is tested according to 5.2.2 and 5.2.3 by performing the test with and without the sense wires connected at 25 °C test conditions. | No provision for battery sense cables | N/A |
| 4.3.4 | Set-point security | | P |
| | Charging set-points shall be secured against change other than by a deliberate and qualified action. | | P |

| Clause | Requirement - Test | Result - Remark | Verdict |
|---|---|---|---|
| | Compliance shall be determined by inspection of the unit and accompanying operating instructions.<br><br>NOTE 1 This clause does not apply to battery charge controllers with fixed set-points.<br>NOTE 2 The use of a tool or password are acceptable means of protection. | | P |
| 4.3.5 | Load disconnect capability | | N/A |
| | Where over-discharge protection is provided by means of load disconnect functionality the load disconnect and reconnect set-points shall be verified by testing according 5.2.3. | No the function of discharging to load | N/A |
| | The load could be either a load directly switched or a load controlled by the BCC by other means. In the case of a BCC directly switching the load this should be provided by means of an integrated load breaking switching device. | | N/A |
| | If a BCC has multiple load disconnect set-points, these shall be verifiable by testing and able to be determined from the BCC user interface and/or clearly written in documentation.<br><br>NOTE Battery over discharge protection is a mandatory feature (see 4.3.2.3). BCC load disconnection capability is recommended only, but it must be achieved by other external means if not provided by the BCC, as it is essential for battery lifetime protection. | | N/A |
| 4.4 | Energy performance requirements | | P |
| 4.4.1 | Stand by self-consumption | | P |
| | With no PV input or load the self-consumption of a PV BCC shall be as detailed in Table 1, when the battery voltage is equivalent to 2,1 V/Cell ± 2 %, and the ambient temperature is 25 °C ± 2 °C.<br><br>NOTE The limits given in Table 1 are intended for the charge controller function in “night time” mode. Where there are other peripheral equipment such as load management devices, displays, data loggers and others that share the power supply of the BCC, these shall be disabled or disconnected from the BCC if possible. | Max 49.4mA | P |
| | Compliance shall be determined by test according to 5.3.1. | | P |
| 4.4.2 | BCC efficiency | | P |

| Clause | Requirement - Test | Result - Remark | Verdict |
|---|---|---|---|
| | Power efficiency of the BCC shall be evaluated from 10 % to 100 % of the rated charging current, at a battery voltage equivalent to 2,2 V/Cell ± 2 % and at ambient temperature of 25 °C ± 2 °C. | | P |
| | The efficiency shall be determined by test according to 5.3.2 | | P |
| 4.5 | Protection and fail safe requirements | | P |
| 4.5.1 | Thermal performance | | P |
| | The BCC shall be capable of handling rated input current/power from the generator and, simultaneously, rated load current to load terminals (if provided) for at least 1 h at the manufacturer's specified maximum rated ambient operating temperature ± 2 °C. Battery voltage shall be 2,2 V/Cell ± 2 %. | | P |
| | Compliance shall be determined by test according to 5.4.1.<br><br>NOTE Depending on the relative ratings of PV input and loads terminals, this test may result in battery charge or discharge conditions. | | P |
| 4.5.2 | Overcurrent operation | | P |
| 4.5.2.1 | PV side | | P |
| | The BCC shall not be damaged by excessive current from the PV generator up to 125 % of the full rated current. The BCC shall continue to operate normally after such an event and shall not require manual resetting.<br><br>NOTE The reset time for any automatic resetting trip mechanism, should be no longer than the time indicated in the manufacturer's instructions, if specified. | | P |
| | Compliance shall be determined by test according to 5.4.2. | | P |
| 4.5.2.2 | Load side | | N/A |
| | If the BCC has a load terminal, this terminal shall be current protected to prevent over loads from causing damage to the operation of the essential PV BCC functions. | No load side | N/A |
| | Compliance shall be determined by test according to 5.4.3. | | N/A |
| | The rating of the load terminals should match the requirement of the intended applications. | | N/A |
| 4.5.3 | PV generator and battery reverse polarity | | P |

| Clause | Requirement - Test | Result - Remark | Verdict |
|---|---|---|---|
| | The BCC shall be protected from reverse polarity connection of the PV generator or the battery by hardware or by documented procedure and markings.<br><br>NOTE The preferred method of protection against reverse polarity is by hardware means, but procedural documentation is allowed. This is a concern during installation and battery replacement. | Determined by test according to 5.4.5 for PV generator reverse polarity test.<br>It doesn't have battery reverse polarity protect function and connection by documented procedure and markings. | P |
| | Compliance shall be determined by test according to 5.4.4 and 5.4.5. | | P |
| 4.5.4 | Open circuit on battery terminals (no battery connection) | | P |
| | BCC with load terminals shall be protected from damage to itself and protect the load from the open circuit voltage of the PV generator in the case of battery disconnection. | No load terminal | N/A |
| | Compliance shall be determined by test according to 5.4.6. | | P |
| 4.6 | User interface requirements | | P |
| 4.6.1 | General | | P |
| | The user interface of a BCC should include any of the following types; LCD screen, LED indicators, audible alarms, relay contacts, other computer interface or other analogue or digital interface. The interface can provide the user with valuable information about the system operation if implemented properly. | LCD screen | P |
| | The user interface may be integrated into another system component separate from the BCC such as an additional control/logging/interface unit that can be physically connected to the BCC or operate via wireless communication. | | P |
| 4.6.2 | Operational information | | P |
| 4.6.2.1 | General | | P |
| | The level of information provided to the user is determined by the intended application and its specific requirements. | | P |
| | The user interface of the charge controller should provide information such as detailed in 4.6.2.2. | | P |
| 4.6.2.2 | Recommended operation information | | P |

| Clause | Requirement - Test | Result - Remark | Verdict |
|---|---|---|---|
| | · An indication of charging status (i.e. charging or not charging).<br>· An indication of load-disconnect state (or over discharge protection status).<br>· An indication of the state-of-charge of the connected battery. | | P |
| | Other additional operational information displayed by the unit may include but is not limited to: | | P |
| | · Charging set-points.<br>· Battery voltage.<br>· Charging current.<br>· Energy input/output. | | P |
| 4.6.3 | User adjustable set-points and parameters | | P |
| | If user-adjustable set-points or parameters are provided, the user interface shall provide a facility to modify and display those adjustments as specified in 4.3.3.4.<br><br>NOTE This clause does not apply to battery charge controllers with fixed set-points. | | P |
| | Compliance shall be determined by inspection of the unit and accompanying user/installation manual. | | P |
| 4.6.4 | Alarms | | P |
| | The following conditions should be signalled by the user interface: | | P |
| | · Low battery state of charge / Low battery voltage / Low availability.<br>· Load disconnect.<br>· BCC trip (e.g. by over temperature). | | P |
| | Visible and/or audible alarms, clearly identifiable by the system user, shall be triggered within the unit in case of any of the above conditions occurring. Audible alarms shall be time limited and revert to a visible alarm or be pulsed. | LCD screen | P |
| | Compliance shall be determined by test according to 5.2.2 and 5.2.3. | | P |

| | | | |
|---|---|---|---|
| 5 | Tests | | P |
| 5.1 | General conditions for tests | | P |
| 5.1.1 | Setup and preconditioning for tests | | P |
| 5.1.2 | DC power sources for testing | | P |
| 5.1.3 | General test setup | | P |
| 5.1.4 | Reverse current test setup | | P |
| 5.1.5 | Charging cycle test setup | | P |
| 5.1.6 | Efficiency, thermal performance and PV overcurrent test setup | | P |
| 5.2 | Battery lifetime protection tests | | P |
| 5.2.1 | Battery to PV generator leakage current test | | P |
| 5.2.2 | Charging cycle tests | (see appended table 5.2.2) | P |
| 5.2.3 | Load disconnect / load reconnect test | No load connection | N/A |
| 5.3 | Energy performance tests | | P |
| 5.3.1 | Standby self-consumption test | (see appended table 5.3.1) | P |
| 5.3.2 | Efficiency test | (see appended table 5.3.2) | P |
| 5.4 | Protection and fail safe tests | | P |
| 5.4.1 | Thermal performance test | (see appended table 5.4.1) | P |
| 5.4.2 | PV overcurrent protection test | (see appended table 5.4.2) | P |
| 5.4.3 | Load over current protection test | (see appended table 5.4.3) | P |
| 5.4.4 | Battery reverse polarity test | | N/A |
| 5.4.5 | PV generator reverse polarity test | (see appended table 5.4.5) | P |
| 5.4.6 | Battery open circuit test | | P |
| 5.5 | User interface tests | | P |

| 5.2.2 | Table: Charging cycle tests | | | |
|---|---|---|---|---|
| Ambient temperature | Mode | Set-point | Measured | Deviation % |
| 25 °C | Buck charge | 57.6V | 57.03V | -0.99% |
| | Equalization charge | 58.4V | 58.78V | 0.65% |
| | Float charge | 55.2V | 54.87V | -0.60% |
| 50 °C | Buck charge | 57.6V | 57.26V | -0.59% |
| | Equalization charge | 58.4V | 58.81V | 0.70% |
| | Float charge | 55.2V | 55.16V | -0.07% |

| 5.2.3 | Table: Load disconnect / load reconnect test | | | |
|---|---|---|---|---|
| Ambient temperature | Mode | Set-point | Measured | Deviation % |
| 25 °C | LVD | N/A | N/A | N/A |
| | LVR | N/A | N/A | N/A |
| 50 °C | LVD | N/A | N/A | N/A |
| | LVR | N/A | N/A | N/A |

| 5.3.1 | Table: Standby self-consumption test | |
|---|---|---|
| Battery voltage | Measured | Limit |
| 12.5 V | 49.4mA | 50mA |
| 25V | 26.83mA | 50mA |
| 37.5V | 18.77mA | 50mA |
| 50V | 15.18mA | 50mA |

| 5.3.2 | **Table: Efficiency test** (for model MC4870N25) | | | | | | |
|---|---|---|---|---|---|---|---|
| Charging current | Output voltage | Output current | Output power | Input voltage | Input current | Input power | Power efficiency |
| 10% | 49.16 | 7.82 | 384.43 | 83.52 | 4.76 | 397.46 | 96.72% |
| 20% | 49.35 | 15.83 | 781.21 | 77.46 | 10.30 | 797.78 | 97.92% |
| 30% | 49.55 | 23.85 | 1181.77 | 80.99 | 14.81 | 1199.47 | 98.52% |
| 40% | 49.74 | 31.67 | 1575.27 | 78.71 | 20.32 | 1598.93 | 98.52% |
| 50% | 49.93 | 39.44 | 1969.24 | 80.54 | 24.83 | 1999.98 | 98.46% |
| 60% | 50.11 | 47.11 | 2360.68 | 78.88 | 30.41 | 2399.05 | 98.40% |
| 70% | 50.29 | 54.78 | 2754.89 | 80.48 | 34.79 | 2800.04 | 98.39% |
| 80% | 50.48 | 62.26 | 3142.88 | 80.97 | 39.51 | 3198.97 | 98.25% |
| 90% | 50.67 | 69.70 | 3531.70 | 80.60 | 44.67 | 3599.93 | 98.10% |
| 100% | 50.59 | 70.93 | 3588.35 | 75.99 | 48.30 | 3670.41 | 97.76% |
| Discharging | -- | -- | -- | -- | -- | -- | -- |

| 5.3.2 | **Table: Efficiency test** (for model MC48100N25) | | | | | | |
|---|---|---|---|---|---|---|---|
| Charging current | Output voltage | Output current | Output power | Input voltage | Input current | Input power | Power efficiency |
| 10% | 49.5 | 10.2 | 504.9 | 130.9 | 4.05 | 530.15 | 95.23% |
| 20% | 49.9 | 20.4 | 1018.0 | 131.9 | 8.01 | 1056.5 | 96.35% |
| 30% | 50.4 | 30.6 | 1542.2 | 131.9 | 12.02 | 1585.4 | 97.27% |
| 40% | 50.7 | 40.6 | 2058.4 | 132.1 | 15.97 | 2109.6 | 97.57% |
| 50% | 51.1 | 50.4 | 2575.4 | 132.1 | 19.95 | 2635.3 | 97.72% |
| 60% | 51.4 | 60.0 | 3084.0 | 132.2 | 23.93 | 3163.5 | 97.48% |
| 70% | 52.6 | 69.2 | 3640.0 | 126.7 | 29.36 | 3719.9 | 97.84% |
| 80% | 52.2 | 78.8 | 4113.3 | 132.1 | 31.89 | 4212.7 | 97.64% |
| 90% | 52.5 | 88.0 | 4620.0 | 132.1 | 35.85 | 4735.8 | 97.55% |
| 100% | 53.0 | 96.8 | 5130.4 | 132.2 | 39.81 | 5262.9 | 97.48% |
| Discharging | -- | -- | -- | -- | -- | -- | -- |

| 5.4.1 | **Table: Thermal performance test** (for model MC4870N25) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sequence | A (V) | B (A) | C (W) | D (V) | E (A) | F (W) | G (V) | H (A) | I (W) | J (°C) |
| 1 | 57.71 | 62.15 | 3586.35 | 57.71 | 62.15 | 3586.35 | 129.85 | 28.07 | 3644.85 | 40 |
| 2 | 57.71 | 62.11 | 3583.99 | 57.71 | 62.11 | 3583.99 | 129.85 | 28.07 | 3644.89 | 40 |
| 3 | 57.70 | 62.10 | 3582.87 | 57.70 | 62.10 | 3582.87 | 129.85 | 28.07 | 3644.97 | 40 |
| 4 | 57.70 | 62.16 | 3586.54 | 57.70 | 62.16 | 3586.54 | 129.85 | 28.07 | 3645.20 | 40 |
| 5 | 57.70 | 62.12 | 3584.61 | 57.70 | 62.12 | 3584.61 | 129.85 | 28.06 | 3643.88 | 40 |
| 6 | 57.70 | 62.12 | 3584.30 | 57.70 | 62.12 | 3584.30 | 129.85 | 28.08 | 3645.89 | 40 |
| 7 | 57.70 | 62.12 | 3584.36 | 57.70 | 62.12 | 3584.36 | 129.85 | 28.08 | 3645.72 | 40 |
| 8 | 57.70 | 62.12 | 3584.21 | 57.70 | 62.12 | 3584.21 | 129.85 | 28.09 | 3647.00 | 40 |
| 9 | 57.70 | 62.13 | 3584.68 | 57.70 | 62.13 | 3584.68 | 129.85 | 28.09 | 3647.01 | 40 |
| 10 | 57.70 | 62.11 | 3583.89 | 57.70 | 62.11 | 3583.89 | 129.85 | 28.07 | 3644.80 | 40 |
| 11 | 57.70 | 62.12 | 3584.29 | 57.70 | 62.12 | 3584.29 | 129.85 | 28.07 | 3645.25 | 40 |
| 12 | 57.70 | 62.12 | 3584.66 | 57.70 | 62.12 | 3584.66 | 129.85 | 28.07 | 3645.26 | 40 |
| 13 | 57.70 | 62.13 | 3585.31 | 57.70 | 62.13 | 3585.31 | 129.85 | 28.07 | 3644.85 | 40 |
| 14 | 57.70 | 62.15 | 3586.28 | 57.70 | 62.15 | 3586.28 | 129.85 | 28.07 | 3644.89 | 40 |
| 15 | 57.70 | 62.12 | 3584.65 | 57.70 | 62.12 | 3584.65 | 129.85 | 28.07 | 3644.97 | 40 |
| 16 | 57.71 | 62.11 | 3584.00 | 57.71 | 62.11 | 3584.00 | 129.85 | 28.07 | 3645.20 | 40 |
| 17 | 57.71 | 62.12 | 3584.45 | 57.71 | 62.12 | 3584.45 | 129.85 | 28.06 | 3643.85 | 40 |
| 18 | 57.70 | 62.17 | 3587.21 | 57.70 | 62.17 | 3587.21 | 129.85 | 28.08 | 3645.89 | 40 |
| 19 | 57.71 | 62.15 | 3586.35 | 57.71 | 62.15 | 3586.35 | 129.85 | 28.08 | 3645.72 | 40 |
| 20 | 57.71 | 62.11 | 3583.99 | 57.71 | 62.11 | 3583.99 | 129.85 | 28.09 | 3647.00 | 40 |
| 21 | 57.71 | 62.09 | 3582.87 | 57.71 | 62.09 | 3582.87 | 129.85 | 28.09 | 3647.01 | 40 |
| 22 | 57.71 | 62.15 | 3586.54 | 57.71 | 62.15 | 3586.54 | 129.85 | 28.07 | 3645.26 | 40 |
| 23 | 57.71 | 62.12 | 3584.61 | 57.71 | 62.12 | 3584.61 | 129.85 | 28.07 | 3644.85 | 40 |
| 24 | 57.70 | 62.12 | 3584.21 | 57.70 | 62.12 | 3584.21 | 129.85 | 28.07 | 3644.89 | 40 |
| 25 | 57.70 | 62.13 | 3584.68 | 57.70 | 62.13 | 3584.68 | 129.85 | 28.07 | 3644.97 | 40 |
| 26 | 57.70 | 62.11 | 3583.89 | 57.70 | 62.11 | 3583.89 | 129.85 | 28.07 | 3645.20 | 40 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 57.70 | 62.12 | 3584.29 | 57.70 | 62.12 | 3584.29 | 129.85 | 28.06 | 3643.88 | 40 |
| 28 | 57.70 | 62.12 | 3584.66 | 57.70 | 62.12 | 3584.66 | 129.85 | 28.08 | 3645.89 | 40 |
| 29 | 57.70 | 62.13 | 3585.31 | 57.70 | 62.13 | 3585.31 | 129.85 | 28.08 | 3645.72 | 40 |
| 30 | 57.70 | 62.15 | 3586.28 | 57.70 | 62.15 | 3586.28 | 129.85 | 28.09 | 3647.00 | 40 |
| 31 | 57.70 | 62.12 | 3584.65 | 57.70 | 62.12 | 3584.65 | 129.85 | 28.09 | 3647.01 | 40 |
| 32 | 57.70 | 62.11 | 3584.00 | 57.70 | 62.11 | 3584.00 | 129.85 | 28.07 | 3645.50 | 40 |
| 33 | 57.70 | 62.12 | 3584.45 | 57.70 | 62.12 | 3584.45 | 129.85 | 20.37 | 2645.31 | 40 |
| 34 | 57.70 | 62.17 | 3587.21 | 57.70 | 62.17 | 3587.21 | 129.85 | 28.07 | 3644.80 | 40 |
| 35 | 57.71 | 62.15 | 3586.35 | 57.71 | 62.15 | 3586.35 | 129.85 | 28.07 | 3645.25 | 40 |
| 36 | 57.71 | 62.11 | 3583.99 | 57.71 | 62.11 | 3583.99 | 129.85 | 28.07 | 3645.50 | 40 |
| 37 | 57.71 | 62.09 | 3582.87 | 57.71 | 62.09 | 3582.87 | 129.85 | 20.37 | 2645.31 | 40 |
| 38 | 57.71 | 62.15 | 3586.54 | 57.71 | 62.15 | 3586.54 | 129.85 | 28.07 | 3644.80 | 40 |
| 39 | 57.71 | 62.12 | 3584.61 | 57.71 | 62.12 | 3584.61 | 129.85 | 28.07 | 3645.25 | 40 |
| 40 | 57.71 | 62.11 | 3584.30 | 57.71 | 62.11 | 3584.30 | 129.85 | 28.07 | 3645.26 | 40 |
| 41 | 57.71 | 62.11 | 3584.36 | 57.71 | 62.11 | 3584.36 | 129.85 | 28.07 | 3644.85 | 40 |
| 42 | 57.71 | 62.11 | 3584.21 | 57.71 | 62.11 | 3584.21 | 129.85 | 28.07 | 3644.89 | 40 |
| 43 | 57.71 | 62.12 | 3584.68 | 57.71 | 62.12 | 3584.68 | 129.85 | 28.07 | 3644.97 | 40 |
| 44 | 57.70 | 62.11 | 3583.89 | 57.70 | 62.11 | 3583.89 | 129.85 | 28.07 | 3645.20 | 40 |
| 45 | 57.70 | 62.12 | 3584.29 | 57.70 | 62.12 | 3584.29 | 129.85 | 28.06 | 3643.88 | 40 |
| 46 | 57.70 | 62.13 | 3584.66 | 57.70 | 62.13 | 3584.66 | 129.85 | 28.08 | 3645.75 | 40 |
| 47 | 57.70 | 62.14 | 3585.31 | 57.70 | 62.14 | 3585.31 | 129.85 | 28.08 | 3645.72 | 40 |
| 48 | 57.70 | 62.15 | 3586.28 | 57.70 | 62.15 | 3586.28 | 129.85 | 28.09 | 3647.00 | 40 |
| 49 | 57.70 | 62.12 | 3584.65 | 57.70 | 62.12 | 3584.65 | 129.85 | 28.09 | 3647.01 | 40 |
| 50 | 57.70 | 62.11 | 3584.00 | 57.70 | 62.11 | 3584.00 | 129.85 | 28.07 | 3645.26 | 40 |
| 51 | 57.70 | 62.12 | 3584.45 | 57.70 | 62.12 | 3584.45 | 129.85 | 28.07 | 3644.85 | 40 |
| 52 | 57.71 | 62.16 | 3587.21 | 57.71 | 62.16 | 3587.21 | 129.85 | 28.07 | 3644.89 | 40 |
| 53 | 57.71 | 62.15 | 3586.35 | 57.71 | 62.15 | 3586.35 | 129.85 | 28.07 | 3644.97 | 40 |
| 54 | 57.70 | 62.11 | 3583.99 | 57.70 | 62.11 | 3583.99 | 129.85 | 28.07 | 3645.20 | 40 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 55 | 57.70 | 62.09 | 3582.87 | 57.70 | 62.09 | 3582.87 | 129.85 | 28.06 | 3643.88 | 40 |
| 56 | 57.71 | 62.15 | 3586.54 | 57.71 | 62.15 | 3586.54 | 129.85 | 28.08 | 3645.89 | 40 |
| 57 | 57.71 | 62.12 | 3584.61 | 57.71 | 62.12 | 3584.61 | 129.85 | 28.07 | 3645.50 | 40 |
| 58 | 57.71 | 62.11 | 3583.89 | 57.71 | 62.11 | 3583.89 | 129.85 | 20.37 | 2645.31 | 40 |
| 59 | 57.71 | 62.11 | 3584.29 | 57.71 | 62.11 | 3584.29 | 129.85 | 28.07 | 3644.80 | 40 |
| 60 | 57.71 | 62.12 | 3584.66 | 57.71 | 62.12 | 3584.66 | 129.85 | 28.07 | 3645.25 | 40 |

A: output voltage of battery terminal
B: output current of battery terminal
C: output power of battery terminal
D: output voltage of DC socket
E: output current of DC socket
F: output power of DC socket
G: input voltage of PV simulator
H: input current of PV simulator
I: input power of PV simulator
J: ambient temperature

| **5.4.1** | **Table: Thermal performance test** (for model MC48100N25) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sequence | A (V) | B (A) | C (W) | D (V) | E (A) | F (W) | G (V) | H (A) | I (W) | J (°C) |
| 1 | 57.49 | 89.24 | 5130.94 | 57.49 | 89.24 | 5130.94 | 149.86 | 35.12 | 5262.90 | 40 |
| 2 | 57.49 | 89.24 | 5130.67 | 57.49 | 89.24 | 5130.67 | 149.86 | 35.13 | 5264.40 | 40 |
| 3 | 57.49 | 89.23 | 5130.09 | 57.49 | 89.23 | 5130.09 | 149.86 | 35.12 | 5262.90 | 40 |
| 4 | 57.49 | 89.23 | 5129.84 | 57.49 | 89.23 | 5129.84 | 149.86 | 35.12 | 5262.90 | 40 |
| 5 | 57.49 | 89.24 | 5129.95 | 57.49 | 89.24 | 5129.95 | 149.86 | 35.12 | 5262.90 | 40 |
| 6 | 57.49 | 89.24 | 5130.31 | 57.49 | 89.24 | 5130.31 | 149.86 | 35.12 | 5262.90 | 40 |
| 7 | 57.49 | 89.25 | 5130.85 | 57.49 | 89.25 | 5130.85 | 149.86 | 35.10 | 5259.90 | 40 |
| 8 | 57.49 | 89.24 | 5130.85 | 57.49 | 89.24 | 5130.85 | 149.86 | 35.09 | 5258.40 | 40 |
| 9 | 57.49 | 89.24 | 5130.76 | 57.49 | 89.24 | 5130.76 | 149.86 | 35.11 | 5261.40 | 40 |
| 10 | 57.49 | 89.24 | 5130.04 | 57.49 | 89.24 | 5130.04 | 149.86 | 35.11 | 5261.40 | 40 |
| 11 | 57.49 | 89.23 | 5130.17 | 57.49 | 89.23 | 5130.17 | 149.86 | 35.12 | 5262.90 | 40 |
| 12 | 57.49 | 89.24 | 5130.49 | 57.49 | 89.24 | 5130.49 | 149.86 | 35.12 | 5262.90 | 40 |
| 13 | 57.50 | 89.24 | 5130.85 | 57.50 | 89.24 | 5130.85 | 149.86 | 35.11 | 5262.20 | 40 |
| 14 | 57.50 | 89.22 | 5129.96 | 57.50 | 89.22 | 5129.96 | 149.86 | 35.11 | 5261.85 | 40 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 57.49 | 89.24 | 5130.76 | 57.49 | 89.24 | 5130.76 | 149.86 | 35.12 | 5262.90 | 40 |
| 16 | 57.49 | 89.23 | 5130.14 | 57.49 | 89.23 | 5130.14 | 149.86 | 35.12 | 5262.90 | 40 |
| 17 | 57.49 | 89.24 | 5130.40 | 57.49 | 89.24 | 5130.40 | 149.86 | 35.11 | 5262.20 | 40 |
| 18 | 57.49 | 89.23 | 5130.22 | 57.49 | 89.23 | 5130.22 | 149.85 | 35.12 | 5262.20 | 40 |
| 19 | 57.49 | 89.23 | 5130.22 | 57.49 | 89.23 | 5130.22 | 149.86 | 35.11 | 5261.85 | 40 |
| 20 | 57.50 | 89.21 | 5129.06 | 57.50 | 89.21 | 5129.06 | 149.85 | 35.11 | 5261.50 | 40 |
| 21 | 57.49 | 89.25 | 5131.11 | 57.49 | 89.25 | 5131.11 | 149.86 | 35.12 | 5262.90 | 40 |
| 22 | 57.49 | 89.25 | 5131.29 | 57.49 | 89.25 | 5131.29 | 149.86 | 35.12 | 5262.90 | 40 |
| 23 | 57.49 | 89.22 | 5129.51 | 57.49 | 89.22 | 5129.51 | 149.85 | 35.11 | 5261.05 | 40 |
| 24 | 57.49 | 89.22 | 5129.60 | 57.49 | 89.22 | 5129.60 | 149.85 | 35.12 | 5262.55 | 40 |
| 25 | 57.50 | 89.19 | 5128.17 | 57.50 | 89.19 | 5128.17 | 149.85 | 35.12 | 5262.55 | 40 |
| 26 | 57.49 | 89.19 | 5127.99 | 57.49 | 89.19 | 5127.99 | 149.85 | 35.11 | 5261.05 | 40 |
| 27 | 57.49 | 89.24 | 5130.85 | 57.49 | 89.24 | 5130.85 | 149.85 | 35.12 | 5262.55 | 40 |
| 28 | 57.49 | 89.24 | 5130.94 | 57.49 | 89.24 | 5130.94 | 149.85 | 35.13 | 5264.05 | 40 |
| 29 | 57.50 | 89.24 | 5131.02 | 57.50 | 89.24 | 5131.02 | 149.85 | 35.12 | 5262.55 | 40 |
| 30 | 57.49 | 89.23 | 5130.27 | 57.49 | 89.23 | 5130.27 | 149.85 | 35.12 | 5262.55 | 40 |
| 31 | 57.50 | 89.23 | 5130.65 | 57.50 | 89.23 | 5130.65 | 149.85 | 35.12 | 5262.55 | 40 |
| 32 | 57.49 | 89.24 | 5130.31 | 57.49 | 89.24 | 5130.31 | 149.85 | 35.12 | 5262.55 | 40 |
| 33 | 57.49 | 89.24 | 5130.40 | 57.49 | 89.24 | 5130.40 | 149.85 | 35.10 | 5259.55 | 40 |
| 34 | 57.50 | 89.25 | 5131.29 | 57.50 | 89.25 | 5131.29 | 149.85 | 35.09 | 5258.05 | 40 |
| 35 | 57.50 | 89.24 | 5131.20 | 57.50 | 89.24 | 5131.20 | 149.85 | 35.11 | 5261.05 | 40 |
| 36 | 57.49 | 89.24 | 5130.58 | 57.49 | 89.24 | 5130.58 | 149.85 | 35.11 | 5261.05 | 40 |
| 37 | 57.49 | 89.24 | 5130.40 | 57.49 | 89.24 | 5130.40 | 149.85 | 35.12 | 5262.55 | 40 |
| 38 | 57.49 | 89.23 | 5130.35 | 57.49 | 89.23 | 5130.35 | 149.85 | 35.12 | 5262.55 | 40 |
| 39 | 57.50 | 89.24 | 5130.67 | 57.50 | 89.24 | 5130.67 | 149.85 | 35.12 | 5262.55 | 40 |
| 40 | 57.50 | 89.24 | 5131.02 | 57.50 | 89.24 | 5131.02 | 149.85 | 35.11 | 5261.85 | 40 |
| 41 | 57.50 | 89.22 | 5130.23 | 57.50 | 89.22 | 5130.23 | 149.85 | 35.11 | 5261.85 | 40 |
| 42 | 57.49 | 89.24 | 5130.85 | 57.49 | 89.24 | 5130.85 | 149.85 | 35.11 | 5261.50 | 40 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 43 | 57.49 | 89.23 | 5130.23 | 57.49 | 89.23 | 5130.23 | 149.86 | 35.12 | 5262.90 | 40 |
| 44 | 57.49 | 89.24 | 5130.67 | 57.49 | 89.24 | 5130.67 | 149.85 | 35.12 | 5262.55 | 40 |
| 45 | 57.50 | 89.23 | 5130.64 | 57.50 | 89.23 | 5130.64 | 149.85 | 35.11 | 5261.85 | 40 |
| 46 | 57.50 | 89.26 | 5132.45 | 57.50 | 89.26 | 5132.45 | 149.85 | 35.12 | 5262.20 | 40 |
| 47 | 57.49 | 89.23 | 5130.13 | 57.49 | 89.23 | 5130.13 | 149.85 | 35.11 | 5261.50 | 40 |
| 48 | 57.49 | 89.23 | 5130.22 | 57.49 | 89.23 | 5130.22 | 149.85 | 35.11 | 5261.50 | 40 |
| 49 | 57.50 | 89.21 | 5129.06 | 57.50 | 89.21 | 5129.06 | 149.85 | 35.12 | 5262.55 | 40 |
| 50 | 57.50 | 89.25 | 5131.74 | 57.50 | 89.25 | 5131.74 | 149.85 | 35.12 | 5262.55 | 40 |
| 51 | 57.50 | 89.25 | 5131.74 | 57.50 | 89.25 | 5131.74 | 149.85 | 35.11 | 5261.05 | 40 |
| 52 | 57.50 | 89.22 | 5129.78 | 57.50 | 89.22 | 5129.78 | 149.85 | 35.12 | 5262.55 | 40 |
| 53 | 57.49 | 89.22 | 5129.60 | 57.49 | 89.22 | 5129.60 | 149.86 | 35.12 | 5262.90 | 40 |
| 54 | 57.50 | 89.19 | 5128.17 | 57.50 | 89.19 | 5128.17 | 149.86 | 35.11 | 5261.40 | 40 |
| 55 | 57.50 | 89.19 | 5128.44 | 57.50 | 89.19 | 5128.44 | 149.85 | 35.12 | 5262.55 | 40 |
| 56 | 57.50 | 89.24 | 5131.38 | 57.50 | 89.24 | 5131.38 | 149.85 | 35.13 | 5264.05 | 40 |
| 57 | 57.50 | 89.24 | 5131.56 | 57.50 | 89.24 | 5131.56 | 149.85 | 35.12 | 5262.55 | 40 |
| 58 | 57.50 | 89.24 | 5131.02 | 57.50 | 89.24 | 5131.02 | 149.85 | 35.12 | 5262.55 | 40 |
| 59 | 57.50 | 89.23 | 5130.63 | 57.50 | 89.23 | 5130.63 | 149.85 | 35.12 | 5262.55 | 40 |
| 60 | 57.50 | 89.23 | 5130.83 | 57.50 | 89.23 | 5130.83 | 149.85 | 35.12 | 5262.55 | 40 |

A: output voltage of battery terminal
B: output current of battery terminal
C: output power of battery terminal
D: output voltage of DC socket
E: output current of DC socket
F: output power of DC socket
G: input voltage of PV simulator
H: input current of PV simulator
I: input power of PV simulator
J: ambient temperature

| 5.4.2 | **Table: PV overcurrent protection test** (for model MC4870N25) | | | | | | |
|---|---|---|---|---|---|---|---|
| Sequence | Output voltage (V) | Output current (A) | Output power (W) | Input voltage (V) | Input current (A) | Input power (W) | Ambient temperature (°C) |
| 1 | 48.01 | 58.03 | 2786.02 | 72.32 | 39.86 | 2882.68 | 25 |
| 2 | 48.01 | 58.01 | 2785.06 | 72.32 | 39.85 | 2881.95 | 25 |
| 3 | 48.01 | 57.99 | 2784.10 | 72.32 | 39.86 | 2882.68 | 25 |
| 4 | 48.01 | 57.98 | 2783.62 | 72.32 | 39.86 | 2882.68 | 25 |
| 5 | 48.01 | 58.01 | 2785.06 | 72.33 | 39.86 | 2883.07 | 25 |
| 6 | 48.01 | 58.02 | 2785.54 | 72.32 | 39.85 | 2881.95 | 25 |
| 7 | 48.01 | 58.01 | 2785.06 | 72.33 | 39.86 | 2883.07 | 25 |
| 8 | 48.00 | 58.02 | 2784.96 | 72.32 | 39.86 | 2882.68 | 25 |
| 9 | 48.00 | 58.01 | 2784.48 | 72.32 | 39.86 | 2882.68 | 25 |
| 10 | 48.01 | 58.02 | 2785.54 | 72.32 | 39.86 | 2882.68 | 25 |
| 11 | 48.00 | 58.02 | 2784.96 | 72.32 | 39.86 | 2882.68 | 25 |
| 12 | 48.00 | 58.02 | 2784.96 | 72.32 | 39.86 | 2882.68 | 25 |
| 13 | 48.01 | 58.01 | 2785.06 | 72.32 | 39.85 | 2881.95 | 25 |
| 14 | 48.01 | 58.03 | 2786.02 | 72.32 | 39.86 | 2882.68 | 25 |
| 15 | 48.01 | 58.01 | 2785.06 | 72.32 | 39.86 | 2882.68 | 25 |
| 16 | 48.01 | 57.99 | 2784.10 | 72.32 | 39.87 | 2883.40 | 25 |
| 17 | 48.01 | 57.98 | 2783.62 | 72.32 | 39.87 | 2883.40 | 25 |
| 18 | 48.01 | 58.02 | 2785.54 | 72.32 | 39.86 | 2882.68 | 25 |
| 19 | 48.01 | 58.02 | 2785.54 | 72.32 | 39.86 | 2882.68 | 25 |
| 20 | 48.01 | 58.01 | 2785.06 | 72.32 | 39.86 | 2882.68 | 25 |
| 21 | 48.01 | 58.03 | 2786.02 | 72.32 | 39.86 | 2882.68 | 25 |
| 22 | 48.01 | 58.01 | 2785.06 | 72.32 | 39.86 | 2882.68 | 25 |
| 23 | 48.01 | 57.99 | 2784.10 | 72.32 | 39.85 | 2881.95 | 25 |
| 24 | 48.01 | 57.98 | 2783.62 | 72.32 | 39.87 | 2883.40 | 25 |
| 25 | 48.00 | 58.01 | 2784.48 | 72.32 | 39.86 | 2882.68 | 25 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 26 | 48.00 | 58.02 | 2784.96 | 72.32 | 39.87 | 2883.40 | 25 |
| 27 | 48.00 | 58.01 | 2784.48 | 72.32 | 39.87 | 2883.40 | 25 |
| 28 | 48.00 | 58.01 | 2784.48 | 72.32 | 39.85 | 2881.95 | 25 |
| 29 | 48.00 | 58.02 | 2784.96 | 72.33 | 39.86 | 2883.07 | 25 |
| 30 | 48.00 | 58.01 | 2784.48 | 72.32 | 39.86 | 2882.68 | 25 |
| 31 | 48.00 | 58.02 | 2784.96 | 72.32 | 39.86 | 2882.68 | 25 |
| 32 | 48.00 | 58.02 | 2784.96 | 72.32 | 39.86 | 2882.68 | 25 |
| 33 | 48.01 | 58.02 | 2785.54 | 72.32 | 39.86 | 2882.68 | 25 |
| 34 | 48.01 | 58.01 | 2785.06 | 72.32 | 39.86 | 2882.68 | 25 |
| 35 | 48.01 | 58.03 | 2786.02 | 72.32 | 39.85 | 2881.95 | 25 |
| 36 | 48.01 | 58.01 | 2785.06 | 72.32 | 39.86 | 2882.68 | 25 |
| 37 | 48.01 | 57.99 | 2784.10 | 72.32 | 39.86 | 2882.68 | 25 |
| 38 | 48.01 | 57.98 | 2783.62 | 72.33 | 39.87 | 2883.80 | 25 |
| 39 | 48.01 | 58.02 | 2785.54 | 72.33 | 39.87 | 2883.80 | 25 |
| 40 | 48.01 | 58.02 | 2785.54 | 72.32 | 39.86 | 2882.68 | 25 |
| 41 | 48.01 | 58.01 | 2785.06 | 72.33 | 39.86 | 2883.07 | 25 |
| 42 | 48.00 | 58.03 | 2785.44 | 72.33 | 39.86 | 2883.07 | 25 |
| 43 | 48.00 | 58.02 | 2784.96 | 72.33 | 39.86 | 2883.07 | 25 |
| 44 | 48.00 | 58.01 | 2784.48 | 72.32 | 39.86 | 2882.68 | 25 |
| 45 | 48.00 | 58.02 | 2784.96 | 72.32 | 39.85 | 2881.95 | 25 |
| 46 | 48.00 | 58.02 | 2784.96 | 72.33 | 39.86 | 2883.07 | 25 |
| 47 | 48.00 | 58.02 | 2784.96 | 72.33 | 39.86 | 2883.07 | 25 |
| 48 | 48.00 | 58.01 | 2784.48 | 72.33 | 39.87 | 2883.80 | 25 |
| 49 | 48.01 | 58.03 | 2786.02 | 72.33 | 39.87 | 2883.80 | 25 |
| 50 | 48.00 | 58.01 | 2784.48 | 72.33 | 39.86 | 2883.07 | 25 |
| 51 | 48.01 | 57.99 | 2784.10 | 72.33 | 39.86 | 2883.07 | 25 |
| 52 | 48.01 | 57.98 | 2783.62 | 72.33 | 39.85 | 2882.35 | 25 |
| 53 | 48.01 | 58.02 | 2785.54 | 72.33 | 39.86 | 2883.07 | 25 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 54 | 48.01 | 58.02 | 2785.54 | 72.33 | 39.86 | 2883.07 | 25 |
| 55 | 48.01 | 58.01 | 2785.06 | 72.33 | 39.86 | 2883.07 | 25 |
| 56 | 48.01 | 58.03 | 2786.02 | 72.33 | 39.86 | 2883.07 | 25 |
| 57 | 48.01 | 58.01 | 2785.06 | 72.33 | 39.86 | 2883.07 | 25 |
| 58 | 48.01 | 57.99 | 2784.10 | 72.33 | 39.86 | 2883.07 | 25 |
| 59 | 48.00 | 57.98 | 2783.04 | 72.33 | 39.86 | 2883.07 | 25 |
| 60 | 48.00 | 58.01 | 2784.48 | 72.32 | 39.86 | 2882.68 | 25 |

| **5.4.2** | **Table: PV overcurrent protection test** (for model MC48100N25) | | | | | | |
|---|---|---|---|---|---|---|---|
| Sequence | Output voltage (V) | Output current (A) | Output power (W) | Input voltage (V) | Input current (A) | Input power (W) | Ambient temperature (°C) |
| 1 | 47.99 | 99.72 | 4785.56 | 71.93 | 69.95 | 5031.50 | 25 |
| 2 | 47.98 | 99.82 | 4789.36 | 71.93 | 69.94 | 5030.78 | 25 |
| 3 | 48.01 | 99.76 | 4789.48 | 71.93 | 69.96 | 5032.22 | 25 |
| 4 | 47.99 | 99.71 | 4785.08 | 71.93 | 69.96 | 5032.22 | 25 |
| 5 | 47.98 | 99.68 | 4782.65 | 71.93 | 69.94 | 5030.78 | 25 |
| 6 | 48.01 | 99.67 | 4785.16 | 71.93 | 69.95 | 5031.50 | 25 |
| 7 | 48.01 | 99.54 | 4778.92 | 71.92 | 69.96 | 5031.52 | 25 |
| 8 | 47.99 | 99.65 | 4782.20 | 71.93 | 69.97 | 5032.94 | 25 |
| 9 | 47.99 | 99.54 | 4776.92 | 71.93 | 69.95 | 5031.50 | 25 |
| 10 | 47.99 | 99.65 | 4782.20 | 71.93 | 69.96 | 5032.22 | 25 |
| 11 | 47.98 | 99.66 | 4781.69 | 71.93 | 69.95 | 5031.50 | 25 |
| 12 | 47.98 | 99.68 | 4782.65 | 71.93 | 69.94 | 5030.78 | 25 |
| 13 | 47.99 | 99.69 | 4784.12 | 71.93 | 69.95 | 5031.50 | 25 |
| 14 | 47.99 | 99.72 | 4785.56 | 71.93 | 69.96 | 5032.22 | 25 |
| 15 | 48.01 | 99.82 | 4792.36 | 71.93 | 69.96 | 5032.22 | 25 |
| 16 | 48.02 | 99.76 | 4790.48 | 71.93 | 69.94 | 5030.78 | 25 |
| 17 | 48.02 | 99.71 | 4788.07 | 71.93 | 69.94 | 5030.78 | 25 |
| 18 | 47.99 | 99.68 | 4783.64 | 71.93 | 69.95 | 5031.50 | 25 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19 | 47.97 | 99.67 | 4781.17 | 71.93 | 69.96 | 5032.22 | 25 |
| 20 | 47.98 | 99.54 | 4775.93 | 71.94 | 69.97 | 5033.64 | 25 |
| 21 | 47.99 | 99.65 | 4782.20 | 71.93 | 69.95 | 5031.50 | 25 |
| 22 | 47.99 | 99.66 | 4782.68 | 71.93 | 69.96 | 5032.22 | 25 |
| 23 | 48.01 | 99.68 | 4785.64 | 71.93 | 69.95 | 5031.50 | 25 |
| 24 | 47.99 | 99.69 | 4784.12 | 71.93 | 69.94 | 5030.78 | 25 |
| 25 | 47.98 | 99.72 | 4784.57 | 71.93 | 69.95 | 5031.50 | 25 |
| 26 | 48.01 | 99.82 | 4792.36 | 71.93 | 69.96 | 5032.22 | 25 |
| 27 | 48.01 | 99.76 | 4789.48 | 71.93 | 69.96 | 5032.22 | 25 |
| 28 | 47.99 | 99.71 | 4785.08 | 71.93 | 69.94 | 5030.78 | 25 |
| 29 | 47.99 | 99.68 | 4783.64 | 71.93 | 69.95 | 5031.50 | 25 |
| 30 | 47.99 | 99.65 | 4782.20 | 71.93 | 69.96 | 5032.22 | 25 |
| 31 | 47.98 | 99.66 | 4781.69 | 71.92 | 69.97 | 5032.24 | 25 |
| 32 | 47.98 | 99.68 | 4782.65 | 71.93 | 69.95 | 5031.50 | 25 |
| 33 | 48.01 | 99.69 | 4786.12 | 71.94 | 69.96 | 5032.92 | 25 |
| 34 | 48.01 | 99.72 | 4787.56 | 71.93 | 69.95 | 5031.50 | 25 |
| 35 | 47.99 | 99.82 | 4790.36 | 71.93 | 69.94 | 5030.78 | 25 |
| 36 | 47.99 | 99.76 | 4787.48 | 71.93 | 69.96 | 5032.22 | 25 |
| 37 | 47.99 | 99.71 | 4785.08 | 71.92 | 69.96 | 5031.52 | 25 |
| 38 | 47.98 | 99.68 | 4782.65 | 71.93 | 69.94 | 5030.78 | 25 |
| 39 | 47.98 | 99.67 | 4782.17 | 71.92 | 69.95 | 5030.80 | 25 |
| 40 | 47.99 | 99.54 | 4776.92 | 71.93 | 69.96 | 5032.22 | 25 |
| 41 | 47.99 | 99.65 | 4782.20 | 71.92 | 69.97 | 5032.24 | 25 |
| 42 | 48.01 | 99.66 | 4784.68 | 71.93 | 69.95 | 5031.50 | 25 |
| 43 | 48.02 | 99.66 | 4785.67 | 71.93 | 69.96 | 5032.22 | 25 |
| 44 | 47.99 | 99.68 | 4783.64 | 71.93 | 69.95 | 5031.50 | 25 |
| 45 | 47.99 | 99.69 | 4784.12 | 71.93 | 69.94 | 5030.78 | 25 |
| 46 | 47.97 | 99.72 | 4783.57 | 71.93 | 69.95 | 5031.50 | 25 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 47 | 47.98 | 99.82 | 4789.36 | 71.93 | 69.96 | 5032.22 | 25 |
| 48 | 47.99 | 99.76 | 4787.48 | 71.93 | 69.96 | 5032.22 | 25 |
| 49 | 47.99 | 99.71 | 4785.08 | 71.92 | 69.94 | 5030.08 | 25 |
| 50 | 48.01 | 99.68 | 4785.64 | 71.93 | 69.95 | 5031.50 | 25 |
| 51 | 47.99 | 99.67 | 4783.16 | 71.93 | 69.94 | 5030.78 | 25 |
| 52 | 48.01 | 99.54 | 4778.92 | 71.93 | 69.95 | 5031.50 | 25 |
| 53 | 47.99 | 99.65 | 4782.20 | 71.93 | 69.96 | 5032.22 | 25 |
| 54 | 47.98 | 99.66 | 4781.69 | 71.93 | 69.97 | 5032.94 | 25 |
| 55 | 48.01 | 99.68 | 4785.64 | 71.93 | 69.95 | 5031.50 | 25 |
| 56 | 48.01 | 99.69 | 4786.12 | 71.93 | 69.96 | 5032.22 | 25 |
| 57 | 47.99 | 99.72 | 4785.56 | 71.93 | 69.95 | 5031.50 | 25 |
| 58 | 47.99 | 99.82 | 4790.36 | 71.93 | 69.94 | 5030.78 | 25 |
| 59 | 47.99 | 99.76 | 4787.48 | 71.93 | 69.95 | 5031.50 | 25 |
| 60 | 47.98 | 99.71 | 4784.09 | 71.93 | 69.96 | 5032.22 | 25 |

| **5.4.3** | **Table: Load over current protection test** | | | | | | |
|---|---|---|---|---|---|---|---|
| Sequence | Battery voltage (V) | Battery current (A) | Battery power (W) | Load voltage (V) | Load current (A) | Load power (W) | Ambient temperature (°C) |
| 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 3 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 4 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 6 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 7 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 8 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 9 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 10 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 11 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 13 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 14 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 15 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 16 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 17 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 18 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 19 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 20 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 21 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 22 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 23 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 24 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 25 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 26 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 27 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 28 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 29 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 30 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 31 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 32 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 33 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 34 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 35 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 36 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 37 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 38 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 39 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 40 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 41 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 42 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 43 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 44 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 45 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 46 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 47 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 48 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 49 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 50 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 51 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 52 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 53 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 54 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 55 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 56 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 57 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 58 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 59 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 60 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

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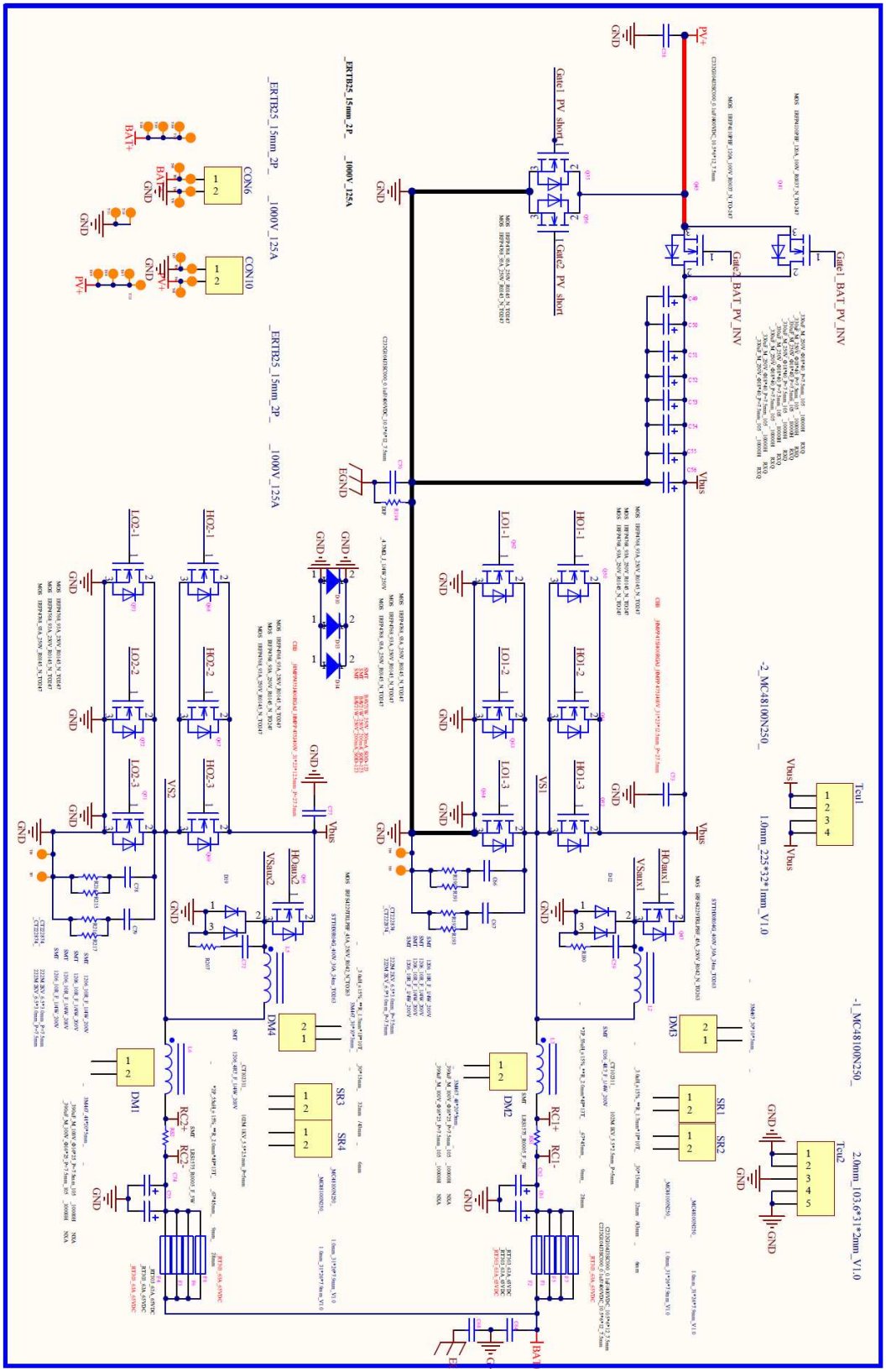
| **5.4.5** | **Table: PV generator reverse polarity test** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sequence | Battery voltage (A) | Battery current (A) | Battery power (W) | Load voltage | Load current | Load power | PV voltage (V) | PV current (A) | PV power (W) |
| 1 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 2 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 3 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 5 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 6 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 7 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 8 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 9 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 10 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 11 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 12 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 13 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 14 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 15 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 16 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 17 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 18 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 19 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 20 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 21 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 22 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 23 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 24 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 25 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 26 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 27 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 28 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 29 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |
| 30 | 0.00 | 0.00 | 0.00 | / | / | / | 2.4 | 39.99 | 94.4 |

Appendix 1: Circuit diagram

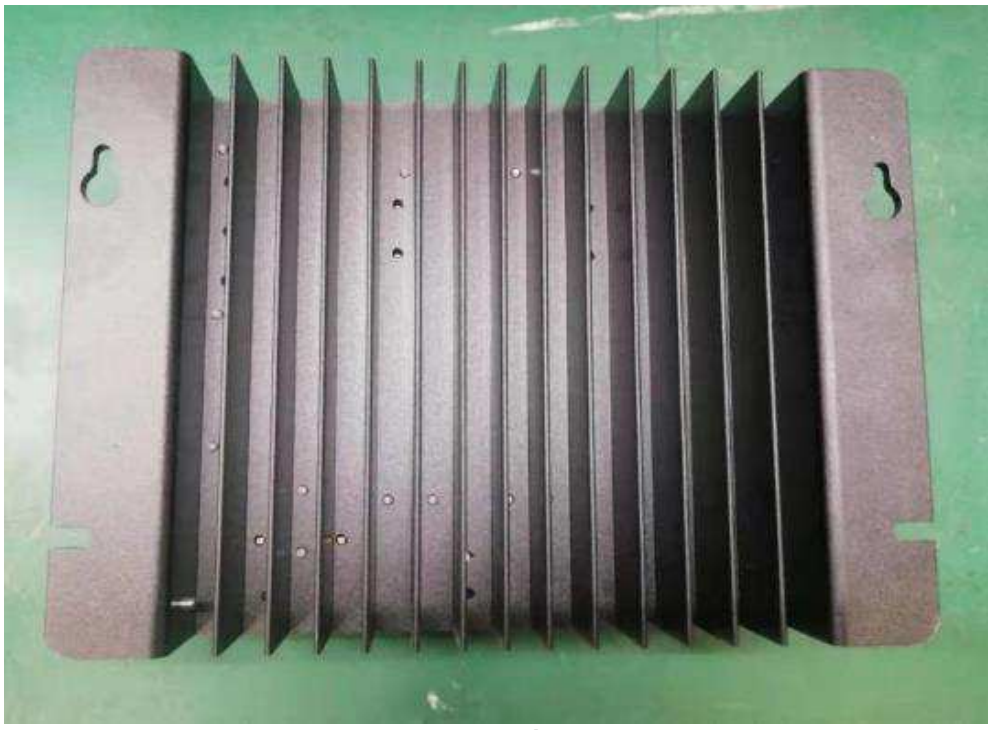


Appendix 2: Photos


**Overall view**

**Side view**

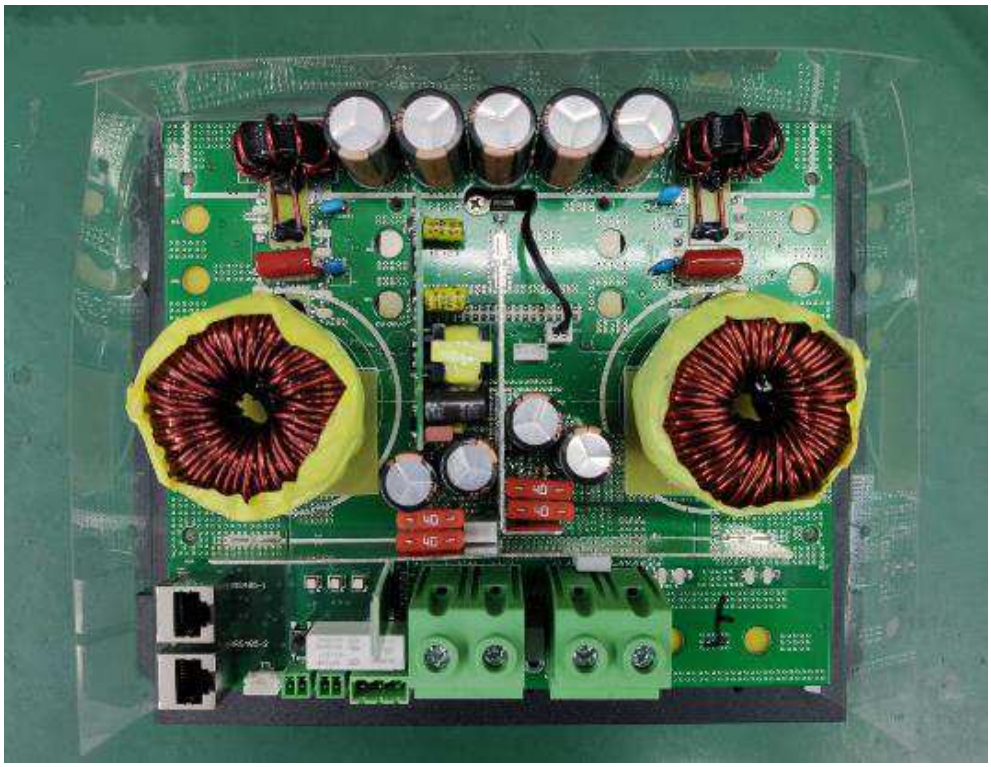
Appendix 2: Photos



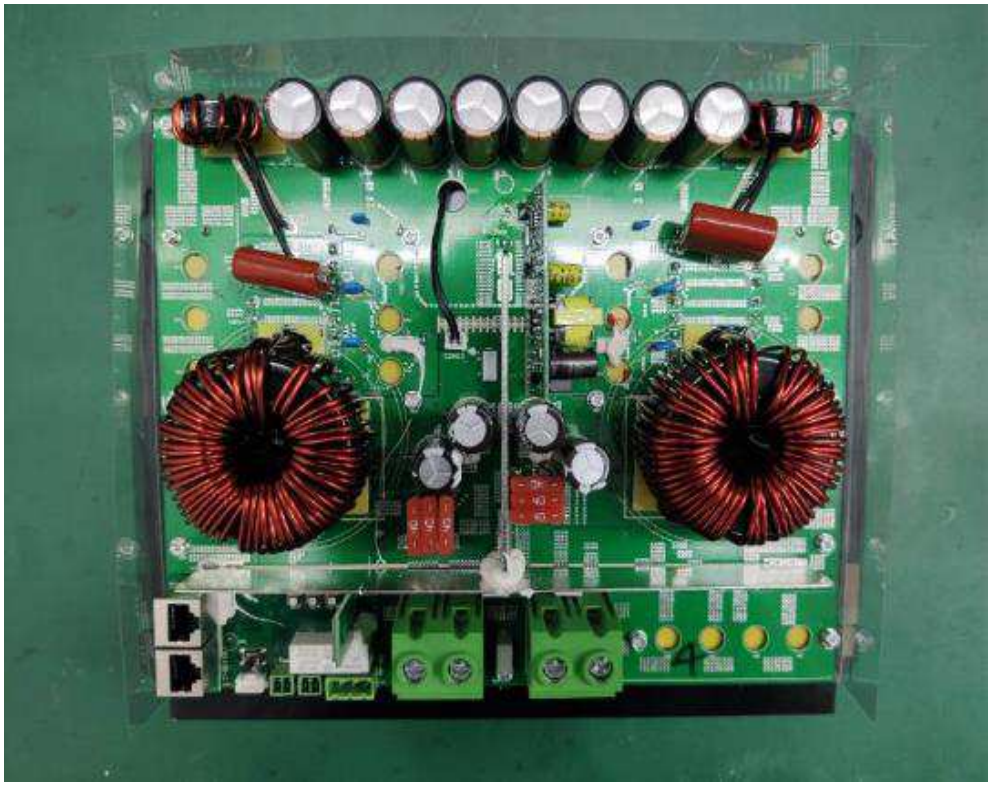
**Bottom view**

**Terminal view**

Appendix 2: Photos



**Internal view of MC4860N15, MC4860N25, MC4870N15, MC4870N25**



**Internal view of MC4885N15, MC4885N25, MC48100N15, MC48100N25**
**(End of the report)**