

1.1 Master HV and Master LV HE battery thresholds

Information about battery tresholds are compatible with the following Master firmware versions:

- Master HV 1.7 or higher
- Master LV 1.17 or higher

1.1.1 **HE100 - 150 - 200 Battery Module default**

Table 1 - List of threshold conditions and time-outs of the Lithium-Ion HE100 - 150 - 200 Battery Module default

| Name | Type of condition | Condition | Time |
|--|-------------------|--|-----------|
| | (set/clear) | | |
| Cell voltages: | , , , | | |
| Voltage cell almost charged | Set | >= 3950 mV | 10 sec. |
| | Clear | < 3900 mV | 10 sec. |
| Voltage cell charged | Set | >= 4000 mV | 20 sec. |
| | Clear | < 3950 mV | 10 sec. |
| Over voltage cell warning | Set warning | >= 4100 mV | 40 sec. |
| | Clear warning | < 4000 mV | 20 sec. |
| Over voltage cell critical | Set fail safe | >= 4200 mV | 45 sec. |
| Voltage cell almost | Set | <= 3325 mV | 10 sec. |
| discharged | Clear | > 3375 mV | 10 sec. |
| Voltage cell discharged | Set | <= 3000 mV | 20 sec. |
| | Clear | > 3325 mV | 10 sec. |
| Under voltage cell warning | Set warning | <= 2750 mV | 40 sec. |
| | Clear warning | > 3000 mV | 20 sec. |
| Under voltage cell critical | Set fail safe | <= 2600 mV | 45 sec. |
| Maximum cell voltage deviation in string | Set warning | Difference highest and lowest cell voltage >= 300 mV and lowest cell voltage >= 3325 | 5 minutes |
| | Clear warning | Difference highest and lowest cell voltage < 240 mV and lowest cell voltage >= 3325 | 5 minutes |
| Temperatures Charging: | 1 | | -1 |
| Over temperature warning | Set warning | >= 43 °C | 5 sec. |
| charging | Clear warning | < 42 °C | 5 sec. |
| Over temperature charging | Set | >= 45 °C | 25 sec. |
| | Clear | < 43 °C | 20 sec. |
| Over temperature critical charging | Set fail safe | >= 50 °C and charge current > 5% battery capacity | 85 sec. |
| Under temperature warning | Set warning | <= 1 °C | 5 sec. |
| charge | Clear warning | > 2°C | 5 sec. |
| Under temperature charge | Set | <= 0 °C | 25 sec. |
| | Clear | > 1°C | 20 sec. |
| Under temperature critical charge | Set fail safe | <= -5 °C and charge current > 5% battery capacity | 85 sec. |
| Temperatures Discharging: | • | , | l |
| Over temperature warning | Set warning | >= 53 °C | 5 sec. |
| discharging | Clear warning | < 52 °C | 5 sec. |



| Name | Type of condition (set/clear) | Condition | Time |
|--|-------------------------------|--|-----------|
| Over temperature | Set | >= 55 °C | 25 sec. |
| discharging | Clear | < 53 °C | 20 sec. |
| Over temperature critical discharging | Set fail safe | >= 60 °C | 85 sec. |
| Under temperature warning | Set warning | <= -19 °C | 5 sec. |
| discharge | Clear warning | > -18 °C | 5 sec. |
| Under temperature | Set | <= -20 °C | 25 sec. |
| discharge | Clear | > -19 °C | 20 sec. |
| Under temperature critical | Set fail safe | <= -25 °C and discharge current > | 85 sec. |
| discharge | | 1% battery capacity | |
| Temperatures deviation: | | | |
| Maximum cell temperature deviation in string | Set warning | Difference highest and lowest cell temperature >= 15°C | 5 minutes |
| | Clear warning | Difference highest and lowest cell temperature < 12°C | 5 minutes |
| Current: | | | |
| Exceeding maximum charge | Set warning | > 0.6C | 10 sec. |
| current | Clear warning | <= 0.6C | 10 sec. |
| Exceeding maximum | Set warning | > 1.0C | 10 sec. |
| discharge current | Clear warning | <= 1.0C | 10 sec. |



1.1.2 HE100 - 150 - 200 Battery Module performance

Table 2 – List of threshold conditions and time-outs of the Lithium-Ion HE100 - 150 - 200 Battery Module performance

| Name | Type of condition (set/clear) | Condition | Time |
|---------------------------------------|-------------------------------|------------------------------------|-----------|
| Cell voltages: | | | • |
| Voltage cell almost charged | Set | >= 4100 mV | 10 sec. |
| | Clear | < 4050 mV | 10 sec. |
| Voltage cell charged | Set | >= 4150 mV | 20 sec. |
| | Clear | < 4100 mV | 10 sec. |
| Over voltage cell warning | Set warning | >= 4175 mV | 40 sec. |
| | Clear warning | < 4150 mV | 20 sec. |
| Over voltage cell critical | Set fail safe | >= 4200 mV | 45 sec. |
| Voltage cell almost | Set | <= 3325 mV | 10 sec. |
| discharged | Clear | > 3375 mV | 10 sec. |
| Voltage cell discharged | Set | <= 3000 mV | 20 sec. |
| | Clear | > 3325 mV | 10 sec. |
| Under voltage cell warning | Set warning | <= 2750 mV | 40 sec. |
| | Clear warning | > 3000 mV | 20 sec. |
| Under voltage cell critical | Set fail safe | <= 2600 mV | 45 sec. |
| Maximum cell voltage | Set warning | Difference highest and lowest cell | 5 minutes |
| deviation in string | | voltage >= 300 mV and lowest cell | |
| | | voltage >= 3325 | +_ |
| | Clear warning | Difference highest and lowest cell | 5 minutes |
| | | voltage < 240 mV and lowest cell | |
| Temperatures Charging: | | voltage >= 3325 | |
| Over temperature warning | Set warning | >= 48 °C | 5 sec. |
| charging | Clear warning | < 47 °C | 5 sec. |
| Over temperature charging | Set | >= 50 °C | 25 sec. |
| Over temperature charging | Clear | < 48 °C | 20 sec. |
| Over temperature critical | Set fail safe | >= 55 °C and charge current > 5% | 85 sec. |
| charging | Set fall safe | battery capacity | 05 300. |
| Under temperature warning | Set warning | <= 1 °C | 5 sec. |
| charge | Clear warning | > 2°C | 5 sec. |
| Under temperature charge | Set | <= 0 °C | 25 sec. |
| onder temperature enarge | Clear | > 1°C | 20 sec. |
| Under temperature critical | Set fail safe | <= -5 °C and charge current > 5% | 85 sec. |
| charge | Sec rail saic | battery capacity | 03 300. |
| Temperatures Discharging: | 1 | | |
| Over temperature warning | Set warning | >= 53 °C | 5 sec. |
| discharging | Clear warning | < 52 °C | 5 sec. |
| Over temperature | Set | >= 55 °C | 25 sec. |
| discharging | Clear | < 53 °C | 20 sec. |
| Over temperature critical discharging | Set fail safe | >= 60 °C | 85 sec. |
| Under temperature warning | Set warning | <= -19 °C | 5 sec. |
| discharge | Clear warning | > -18 °C | 5 sec. |
| | Set | <= -20 °C | 25 sec. |



| Name | Type of condition (set/clear) | Condition | Time |
|--|-------------------------------|--|-----------|
| Under temperature discharge | Clear | > -19 °C | 20 sec. |
| Under temperature critical discharge | Set fail safe | <= -25 °C and discharge current > 1% battery capacity | 85 sec. |
| Temperatures deviation: | | | |
| Maximum cell temperature deviation in string | Set warning | Difference highest and lowest cell temperature >= 15°C | 5 minutes |
| | Clear warning | Difference highest and lowest cell temperature < 12°C | 5 minutes |
| Current: | | | • |
| Exceeding maximum charge | Set warning | > 1.0C | 10 sec. |
| current | Clear warning | <= 1.0C | 10 sec. |
| Exceeding maximum | Set warning | > 1.5C | 10 sec. |
| discharge current | Clear warning | <= 1.5C | 10 sec. |



1.1.3 **HE300 Battery Module default**

Table 3 – List of threshold conditions and time-outs of the Lithium-Ion HE300 Battery Module default

| Name | Type of condition (set/clear) | Condition | Time |
|---------------------------------------|-------------------------------|------------------------------------|-----------|
| Cell voltages: | | | • |
| Voltage cell almost charged | Set | >= 3950 mV | 10 sec. |
| | Clear | < 3900 mV | 10 sec. |
| Voltage cell charged | Set | >= 4000 mV | 20 sec. |
| | Clear | < 3950 mV | 10 sec. |
| Over voltage cell warning | Set warning | >= 4100 mV | 40 sec. |
| | Clear warning | < 4000 mV | 20 sec. |
| Over voltage cell critical | Set fail safe | >= 4200 mV | 45 sec. |
| Voltage cell almost | Set | <= 3325 mV | 10 sec. |
| discharged | Clear | > 3375 mV | 10 sec. |
| Voltage cell discharged | Set | <= 3000 mV | 20 sec. |
| | Clear | > 3325 mV | 10 sec. |
| Under voltage cell warning | Set warning | <= 2750 mV | 40 sec. |
| | Clear warning | > 3000 mV | 20 sec. |
| Under voltage cell critical | Set fail safe | <= 2600 mV | 45 sec. |
| Maximum cell voltage | Set warning | Difference highest and lowest cell | 5 minutes |
| deviation in string | | voltage >= 300 mV and lowest cell | |
| | | voltage >= 3325 | |
| | Clear warning | Difference highest and lowest cell | 5 minutes |
| | | voltage < 240 mV and lowest cell | |
| | | voltage >= 3325 | |
| Temperatures Charging: | | | |
| Over temperature warning | Set warning | >= 38 °C | 5 sec. |
| charging | Clear warning | < 37 °C | 5 sec. |
| Over temperature charging | Set | >= 40 °C | 25 sec. |
| | Clear | < 38 °C | 20 sec. |
| Over temperature critical | Set fail safe | >= 50 °C and charge current > 5% | 85 sec. |
| charging | | battery capacity | |
| Under temperature warning | Set warning | <= 1 °C | 5 sec. |
| charge | Clear warning | > 2°C | 5 sec. |
| Under temperature charge | Set | <= 0 °C | 25 sec. |
| | Clear | > 1°C | 20 sec. |
| Under temperature critical | Set fail safe | <= -5 °C and charge current > 5% | 85 sec. |
| charge | | battery capacity | |
| Temperatures Discharging: | | | |
| Over temperature warning | Set warning | >= 48 °C | 5 sec. |
| discharging | Clear warning | < 47 °C | 5 sec. |
| Over temperature | Set | >= 50 °C | 25 sec. |
| discharging | Clear | < 48 °C | 20 sec. |
| Over temperature critical discharging | Set fail safe | >= 60 °C | 85 sec. |
| Under temperature warning | Set warning | <= -19 °C | 5 sec. |
| discharge | Clear warning | > -18 °C | 5 sec. |
| <u> </u> | Set | <= -20 °C | 25 sec. |



| Name | Type of condition (set/clear) | Condition | Time |
|--|-------------------------------|--|-----------|
| Under temperature discharge | Clear | > -19 °C | 20 sec. |
| Under temperature critical discharge | Set fail safe | <= -25 °C and discharge current > 1% battery capacity | 85 sec. |
| Temperatures deviation: | | | |
| Maximum cell temperature deviation in string | Set warning | Difference highest and lowest cell temperature >= 15°C | 5 minutes |
| | Clear warning | Difference highest and lowest cell temperature < 12°C | 5 minutes |
| Current: | • | | |
| Exceeding maximum charge | Set warning | > 0.7C | 10 sec. |
| current | Clear warning | <= 0.7C | 10 sec. |
| Exceeding maximum | Set warning | > 1.0C | 10 sec. |
| discharge current | Clear warning | <= 1.0C | 10 sec. |



1.1.4 HE300 Battery Module performance

Table 4 – List of threshold conditions and time-outs of the Lithium-Ion HE300 Battery Module performance

| Name | Type of condition (set/clear) | Condition | Time |
|----------------------------------|-------------------------------|------------------------------------|--------------------|
| Cell voltages: | 1, , , | | 1 |
| Voltage cell almost charged | Set | >= 4100 mV | 10 sec. |
| | Clear | < 4050 mV | 10 sec. |
| Voltage cell charged | Set | >= 4150 mV | 20 sec. |
| | Clear | < 4100 mV | 10 sec. |
| Over voltage cell warning | Set warning | >= 4175 mV | 40 sec. |
| | Clear warning | < 4150 mV | 20 sec. |
| Over voltage cell critical | Set fail safe | >= 4200 mV | 45 sec. |
| Voltage cell almost | Set | <= 3325 mV | 10 sec. |
| discharged | Clear | > 3375 mV | 10 sec. |
| Voltage cell discharged | Set | <= 3000 mV | 20 sec. |
| | Clear | > 3325 mV | 10 sec. |
| Under voltage cell warning | Set warning | <= 2750 mV | 40 sec. |
| | Clear warning | > 3000 mV | 20 sec. |
| Under voltage cell critical | Set fail safe | <= 2600 mV | 45 sec. |
| Maximum cell voltage | Set warning | Difference highest and lowest cell | 5 minutes |
| deviation in string | | voltage >= 300 mV and lowest cell | |
| | | voltage >= 3325 | |
| | Clear warning | Difference highest and lowest cell | 5 minutes |
| | | voltage < 240 mV and lowest cell | |
| | | voltage >= 3325 | |
| Temperatures Charging: | T | T | T_ |
| Over temperature warning | Set warning | >= 43 °C | 5 sec. |
| charging | Clear warning | < 42 °C | 5 sec. |
| Over temperature charging | Set | >= 45 °C | 25 sec. |
| Occupations and the selections | Clear | < 43 °C | 20 sec. |
| Over temperature critical | Set fail safe | >= 55 °C and charge current > 5% | 85 sec. |
| charging | Caturanina | battery capacity <= 1 °C | Г |
| Under temperature warning charge | Set warning | | 5 sec. |
| | Clear warning | > 2°C <= 0 °C | 5 sec. 25 sec. |
| Under temperature charge | Set Clear | >1°C | + |
| Under temperature critical | Set fail safe | <= -5 °C and charge current > 5% | 20 sec. 85 sec. |
| Under temperature critical | Set fall safe | battery capacity | 65 Sec. |
| charge Temperatures Discharging: | | Dattery Capacity | |
| Over temperature warning | Set warning | >= 48 °C | 5 sec. |
| discharging | Clear warning | < 47 °C | 5 sec. |
| Over temperature | Set | >= 50 °C | 25 sec. |
| discharging | Clear | < 48 °C | 20 sec. |
| Over temperature critical | Set fail safe | >= 60 °C | 85 sec. |
| discharging | | | |
| Under temperature warning | Set warning | <= -19 °C | 5 sec. |
| discharge | Clear warning | > -18 °C | 5 sec. |
| | Set | <= -20 °C | 25 sec. |



| Name | Type of condition (set/clear) | Condition | Time |
|--|-------------------------------|--|-----------|
| Under temperature discharge | Clear | >-19 °C | 20 sec. |
| Under temperature critical discharge | Set fail safe | <= -25 °C and discharge current > 1% battery capacity | 85 sec. |
| Temperatures deviation: | | | |
| Maximum cell temperature deviation in string | Set warning | Difference highest and lowest cell temperature >= 15°C | 5 minutes |
| | Clear warning | Difference highest and lowest cell temperature < 12°C | 5 minutes |
| Current: | | | • |
| Exceeding maximum charge | Set warning | > 0.7C | 10 sec. |
| current | Clear warning | <= 0.7C | 10 sec. |
| Exceeding maximum | Set warning | > 1.0C | 10 sec. |
| discharge current | Clear warning | <= 1.0C | 10 sec. |