

1.1 Master HV and Master LV HE battery thresholds

Information about battery thresholds 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 (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 discharged	Set	≤ 3325 mV	10 sec.
	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:			
Over temperature warning charging	Set warning	≥ 43 °C	5 sec.
	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 charge	Set warning	≤ 1 °C	5 sec.
	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:			
Over temperature warning discharging	Set warning	≥ 53 °C	5 sec.
	Clear warning	< 52 °C	5 sec.

Name	Type of condition (set/clear)	Condition	Time
Over temperature discharging	Set	$\geq 55\text{ }^{\circ}\text{C}$	25 sec.
	Clear	$< 53\text{ }^{\circ}\text{C}$	20 sec.
Over temperature critical discharging	Set fail safe	$\geq 60\text{ }^{\circ}\text{C}$	85 sec.
Under temperature warning discharge	Set warning	$\leq -19\text{ }^{\circ}\text{C}$	5 sec.
	Clear warning	$> -18\text{ }^{\circ}\text{C}$	5 sec.
Under temperature discharge	Set	$\leq -20\text{ }^{\circ}\text{C}$	25 sec.
	Clear	$> -19\text{ }^{\circ}\text{C}$	20 sec.
Under temperature critical discharge	Set fail safe	$\leq -25\text{ }^{\circ}\text{C}$ and discharge current $> 1\%$ battery capacity	85 sec.
Temperatures deviation:			
Maximum cell temperature deviation in string	Set warning	Difference highest and lowest cell temperature $\geq 15\text{ }^{\circ}\text{C}$	5 minutes
	Clear warning	Difference highest and lowest cell temperature $< 12\text{ }^{\circ}\text{C}$	5 minutes
Current:			
Exceeding maximum charge current	Set warning	$> 0.6\text{C}$	10 sec.
	Clear warning	$\leq 0.6\text{C}$	10 sec.
Exceeding maximum discharge current	Set warning	$> 1.0\text{C}$	10 sec.
	Clear warning	$\leq 1.0\text{C}$	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 discharged	Set	≤ 3325 mV	10 sec.
	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:			
Over temperature warning charging	Set warning	≥ 48 °C	5 sec.
	Clear warning	< 47 °C	5 sec.
Over temperature charging	Set	≥ 50 °C	25 sec.
	Clear	< 48 °C	20 sec.
Over temperature critical charging	Set fail safe	≥ 55 °C and charge current $> 5\%$ battery capacity	85 sec.
Under temperature warning charge	Set warning	≤ 1 °C	5 sec.
	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:			
Over temperature warning discharging	Set warning	≥ 53 °C	5 sec.
	Clear warning	< 52 °C	5 sec.
Over temperature discharging	Set	≥ 55 °C	25 sec.
	Clear	< 53 °C	20 sec.
Over temperature critical discharging	Set fail safe	≥ 60 °C	85 sec.
Under temperature warning discharge	Set warning	≤ -19 °C	5 sec.
	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 current	Set warning	> 1.0C	10 sec.
	Clear warning	<= 1.0C	10 sec.
Exceeding maximum discharge current	Set warning	> 1.5C	10 sec.
	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 discharged	Set	≤ 3325 mV	10 sec.
	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:			
Over temperature warning charging	Set warning	≥ 38 °C	5 sec.
	Clear warning	< 37 °C	5 sec.
Over temperature charging	Set	≥ 40 °C	25 sec.
	Clear	< 38 °C	20 sec.
Over temperature critical charging	Set fail safe	≥ 50 °C and charge current $> 5\%$ battery capacity	85 sec.
Under temperature warning charge	Set warning	≤ 1 °C	5 sec.
	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:			
Over temperature warning discharging	Set warning	≥ 48 °C	5 sec.
	Clear warning	< 47 °C	5 sec.
Over temperature discharging	Set	≥ 50 °C	25 sec.
	Clear	< 48 °C	20 sec.
Over temperature critical discharging	Set fail safe	≥ 60 °C	85 sec.
Under temperature warning discharge	Set warning	≤ -19 °C	5 sec.
	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 current	Set warning	> 0.7C	10 sec.
	Clear warning	<= 0.7C	10 sec.
Exceeding maximum discharge current	Set warning	> 1.0C	10 sec.
	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:			
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 discharged	Set	≤ 3325 mV	10 sec.
	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:			
Over temperature warning charging	Set warning	≥ 43 °C	5 sec.
	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	≥ 55 °C and charge current $> 5\%$ battery capacity	85 sec.
Under temperature warning charge	Set warning	≤ 1 °C	5 sec.
	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:			
Over temperature warning discharging	Set warning	≥ 48 °C	5 sec.
	Clear warning	< 47 °C	5 sec.
Over temperature discharging	Set	≥ 50 °C	25 sec.
	Clear	< 48 °C	20 sec.
Over temperature critical discharging	Set fail safe	≥ 60 °C	85 sec.
Under temperature warning discharge	Set warning	≤ -19 °C	5 sec.
	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 current	Set warning	> 0.7C	10 sec.
	Clear warning	<= 0.7C	10 sec.
Exceeding maximum discharge current	Set warning	> 1.0C	10 sec.
	Clear warning	<= 1.0C	10 sec.