Failsafe Mode Descriptions and Behaviors

Failsafe Type	Failsafe Description
Voltage Failsafe	Operation Mode: Non-operating This failsafe condition is triggered whenever a critical cell voltage based fault is encountered. This can be caused by an open (disconnected) tap wire (an open wire fault code), any populated cell which is reading a voltage below 0.09 volts or if a cell voltage reads over 5 volts. In a configuration with remote modules, a communication failure between the main BMS unit and any remote unit will also result in a voltage failsafe condition. Because the BMS cannot protect the cells if the accuracy of the cell voltages voltages are compromised, the BMS is forced to enter into a non-operating failsafe mode. When the BMS enters into this voltage failsafe condition, the BMS will begin to gradually de-rate the charge and discharge current limits from their last known value down to 0 to prevent charging and discharging. The amount of time to de-rate the limits is specified in the profile and is designed to provide some usable time of the battery after the failure has occurred. The gradual current limit reductions are intended to alert the operator to the fact there is a problem while providing enough power to allow the application to come to a safe stop. This is particularly useful if the application is an electric vehicle or application where having some available power for a short period of time may be useful. This error condition should always be investigated and the cause corrected prior to clearing the code or continued use of the battery. Operational Impact: ● All discharging and charging is prohibited by the BMS. ● The primary enable relay outputs are all switched off.

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Current Failsafe	Operation Mode: Degraded Operation The BMS assumes the current sensor is either maxed out, damaged, disconnected or if the BMS is configured for no current sensor at all. In this mode, the current sensor is disabled and will measure 0 amps. The BMS will continue to operate and protect the batteries purely using voltage based conditions. However, all functions relying on the current sensor are disabled. Care should be taken to correct this issue as quickly as possible, but it is possible to continue using the battery pack in this failsafe condition. Operational Impact: ● Internal resistance calculations disabled (both cell and total pack) ● Open cell voltage calculations disabled for both pack and individual cell calculations. The open cell voltages will read the same as the instantaneous voltage readings. This results in highly inaccurate state of charge drifts. ● State of charge calculation becomes erratic. This cannot be accurately calculated and will be guessed purely on voltage and based on drift points. Drift points are based on open cell voltages, so SOC will vary considerably and should not be trusted to be totally accurate. ● Charge and discharge current limits switch to a voltage failsafe calculation mode and may be higher or lower than they should be. However, they will rapidly adjust if voltages approach minimum or maximum levels. ● Over-Current protection is no longer available (cell voltages may provide some level of current limiting, but this is only based on cell voltages and not measured current). **The BMS cannot enforce over current limit protections since current is unknown in the event of a current sensor fault.** All current sensor readings are thrown out by the BMS (coulomb counting is suspended, open cell voltage calculations are disabled and internal resistance calculations are not performed). State of Charge will be determined purely based on cell voltage (in accordance with the SOC Drift Table) while this failsafe mode is active.
Input Power Supply Failsafe	Operation Mode: Degraded Operation The BMS does not have adequate or stable input power and is unable to reliably operate. **The input power supply must be greater than 8vDC to prevent this failsafe mode.** This failsafe mode will set a diagnostic trouble code which will remain for later diagnostics but will automatically restore normal operations once

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	normal operating voltage has been met. Orion BMS 2 units can operate through voltage sags (cold cranking) at voltages down to approximately 4.5v for brief periods less than 5 seconds without causing this failsafe mode. <u>Operational Impact:</u> ● All primary relay outputs are inhibited. This is done because a relay or contactor powered by the same power source as the BMS may fail to operate, or may intermittently operate at too low of a voltage. ● All internal data logging (event recording, freeze frame recording, lifetime data collection) is suspended during this failsafe condition. ● 0-5v analog outputs remain active but cannot be guaranteed to be accurate. ● Charge and Discharge current limit values are reduced to 0A. ● The current sensor input is no longer trusted during this failsafe condition.
Relay Failsafe	<u>Operation Mode: Degraded Operation</u> The BMS has detected that it is unable to fully terminate either charge or discharge (current is still entering / leaving the battery pack despite the respective relays being switched off or the published current limits are being exceeded). In this failsafe mode the BMS will terminate power to all 4 primary relays (Charge Enable, Charger Safety, Discharge Enable and Multi Purpose Enable). This failsafe will only activate if the offending relay is enabled in the settings profile (disabled relays are ignored). <u>Operational Impact:</u> ● All primary relay outputs are inhibited. ● Charge and Discharge current limits are reduced to 0A.
Interlock Failsafe	<u>Operation Mode: Normal Operation</u> This failsafe mode is informational only but is used to indicate that both Charge Power and Ready Power are energized at the same time.

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Fault Code Failsafe Chart

DTC Code	Fault Description	Failsafe Behavior
P0A0A	Internal Heatsink Thermistor Fault	Disables Cell Balancing
P0A0B	Internal Software Fault	No Failsafe Behavior
P0A0C	Highest Cell Voltage Too High Fault	No Failsafe Behavior
P0A0D	Cell Voltage Over 5 Volts Fault	Voltage Failsafe
P0A0E	Lowest Cell Voltage Too Low Fault	No Failsafe Behavior
P0A0F	Cell ASIC Fault	No Failsafe Behavior
P0A1F	Internal Cell Communication Fault	Voltage Failsafe
P0A02	Weak Pack Fault	No Failsafe Behavior
P0A04	Open Wiring Fault	Voltage Failsafe
P0A05	Input Power Supply Fault	Input Power Supply Failsafe
P0A06	Charge Limit Enforcement Fault	Relay Failsafe
P0A07	Discharge Limit Enforcement Fault	Relay Failsafe
P0A08	Charger Safety Relay Fault	Relay Failsafe
P0A09	Internal Hardware Fault	No Failsafe Behavior
P0A9C	Battery Thermistor Fault	No Failsafe Behavior
P0A10	Pack Too Hot Fault	No Failsafe Behavior
P0A12	Cell Balancing Stuck Off	No Failsafe Behavior
P0A80	Weak Cell Fault	No Failsafe Behavior
P0A81	Fan Monitor Fault	No Failsafe Behavior
P0AA6	High Voltage Isolation Fault	No Failsafe Behavior
P0AC0	Current Sensor Fault	Current Failsafe
P0ACA	Charge Interlock Fault	Interlock Failsafe

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P0AFA	Low Cell Voltage Fault	Voltage Failsafe
P0560	Redundant Power Supply Fault	No Failsafe Behavior
U0100	External Communications Fault	Voltage Failsafe *(only if the BMS is being used in a master / series configuration).

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