



## DTC P0AA6 - High Voltage Isolation Fault

Product Family	Fault Supported
Orion BMS [Original] (24 - 180 Cell)	YES
Orion BMS 2 (24 - 180 Cell)	YES
Orion JR [Original] (16 Cell)	NO
Orion JR 2 (16 Cell)	NO

### FAULT DESCRIPTION

This code is set when the BMS measures an isolation breakdown between the high voltage battery and the BMS low voltage power ground. A breakdown in isolation can be caused by ruptured or leaking cells, high voltage cabling insulation that has rubbed off and come into contact with low voltage systems, condensation, use of non-isolated equipment, by an intentionally non-isolated design, or by other causes.

**SAFETY WARNING: This error code may indicate an unsafe condition that exists in the battery pack and care must be taken to avoid risk of short circuit and risk of personal injury from shock while investigating the error as simply touching a cell could cause a shock.** While this error tends to indicate a real problem, there are certain situations that can cause a false positive.

**This error code is an informational code only and does not change the behavior of the BMS.** It will not cause the BMS to stop charge or discharge in any way (but other external controllers may be setup to do so).

The isolation fault detection circuit in the Orion BMS applies a very weak, slow (about 1 Hz) AC signal on the negative wire on the total pack voltage sensor and measures the amount of signal degradation to determine if a breakdown in isolation has occurred. The fault is triggered when the 60 second average of the "Isolation Shortest Wave" parameter drops below a pre-set voltage (dependant on how sensitive the isolation fault circuit is configured in the profile settings). For most systems, this indicates the BMS is measuring less than about 150k ohms of resistance between the high voltage battery and the low voltage system, but external factors such as parasitic capacitance between the high voltage and low voltage systems can artificially increase or decrease the measurement.

**NOTE:**

A false positive may be triggered if a large amount of capacitance is present between the battery pack and the low voltage system causing the signal to degrade. Some DC:DC converters or inverters may have large filtering capacitors which can cause false positives and other equipment designed to measure breakdown in isolation may also cause signal degradation.

Fault Code	Fault Description	Possible Trouble Area
P0AA6	Significant isolation breakdown between the high voltage battery pack assembly and logic ground is detected.	<ul style="list-style-type: none"><li>• High Voltage Battery Assembly</li><li>• Cell Wiring Assembly</li><li>• Internal BMS Fault</li></ul>

## **FAULT BEHAVIOR**

This fault can either be **Informational Only** (does not alter the operation of the BMS in any way), or it can be configured to **Inhibit Primary Outputs** on start-up (requires firmware V3.6.x or newer).

## **FAULT THRESHOLDS**

Fault will trigger when the following condition is satisfied	(a)
(a) The shortest wave (average) measured drops below the minimum threshold	Measured shortest wave response falls below minimum threshold indicating a likely breakdown in isolation.

## **DIAGNOSTIC STEPS**

<p><b>1.</b></p>	<p><b>Determine if the system is supposed to be isolated.</b></p> <p>If the overall system is intentionally designed to be non-isolated, isolation fault detection should be disabled on the "Fault Settings" tab of the BMS utility. Determining whether the system should be isolated or not is beyond the scope of the BMS itself and should be determined by the qualified persons or engineers responsible for the application design.</p>
<p><b>2.</b></p>	<p><b>Determine if there are other isolation detection circuits connected.</b></p> <p>Other isolation fault detection circuits operating on the same battery pack may interfere with each other and cause false readings and so only one isolation detection circuit should be used.</p> <p><b>NOTE:</b> Simply disabling the isolation fault detection circuit on the BMS (under "Fault Settings" in the utility) may not fully disconnect the internal isolation detection circuit. On certain BMS models the Total Pack Voltage harness may need to be unplugged from the unit.</p>
<p><b>3.</b></p>	<p><b>Check the instantaneous isolation "shortest wave" reading.</b></p> <p>The instantaneous value for the isolation fault detection can be monitored in the Orion BMS utility by looking at the "Shortest Wave" measurement on the Live Text Data screen and selecting the "Advanced Parameters." Every BMS unit has some variation for the maximum and minimum readings, but the readings are generally between 1.4 and 4.8, with the higher number meaning better isolation. Over 4.5 generally indicates insulation over 1M ohm and below 1.5 indicates a likely dead short, but external factors can change the exact numbers.</p>
<p><b>4.</b></p>	<p><b>Download the freeze frame for the fault code using the BMS Utility.</b></p> <p>The BMS will normally produce a freeze frame on the "Diagnostic Trouble Codes" screen in the BMS Utility when this fault code occurs that contains a comprehensive list of BMS data parameters at the time the fault occurred. <b>It is strongly recommended that the freeze frame be downloaded from the BMS and saved to disk before the fault is cleared again</b> as this data may assist in the future if further diagnostics are required. <u>Additionally this freeze frame data may be requested by Technical Support if further assistance is required.</u></p> <p><b>NOTE:</b> Only Fault Codes with a (F) next to them have freeze frame data available for download. If there is no (F) next to the fault, there is no stored freeze frame available and this step can be skipped.</p> <p>Steps to download the Freeze Frame:</p> <ol style="list-style-type: none"> <li>1) Connect to the BMS using the Orion BMS utility.</li> <li>2) Click the "Diagnostic Trouble Codes" tab at the top.</li> </ol>

	<p>3) Select the correct fault code by clicking on the ID on the left side of the screen to initiate the Freeze Frame retrieval.</p> <p>4) Once the retrieval process is complete, click the "Export (CSV)" button to save the freeze frame data to the computer disk.</p>
<p><b>5.</b></p>	<p><b>If the isolation is degraded only when cold, it may be due to condensation.</b></p> <p>Water may condense on cold cables, battery terminals or other exposed connections and create a path for current to travel to the chassis or low voltage system. Additionally, conductors and cells may expand and contract and physically come into contact with other parts.</p>
<p><b>6.</b></p>	<p><b>Attempt to isolate various systems to determine the cause.</b></p> <p>If the isolation is degraded according to the shortest wave value, attempt to remove or disconnect various systems while monitoring the shortest wave measurement in the Orion BMS to see if removing a system improves the isolation number.</p> <p>For example, if a battery charger can be disconnected or fully isolated from the battery pack, disconnect it and look to see if the isolation improves. If isolation improves after removing a part, investigate the cause of isolation breakdown or replace the defective system.</p> <p><b><u>SAFETY WARNING:</u> Care must be taken to prevent personal injury and prevent shorting cells since a cell may be shorted to the chassis causing the chassis to be "hot." Simply touching a cell and the chassis may cause a shock.</b></p> <p>If safe to do so, disconnect any device which may have extra capacitance to ground (chargers, inverters, DC:DC converters or any cabling which may have excessive parasitic capacitance.</p>
<p><b>7.</b></p>	<p><b>Look for isolation faults within the battery pack.</b></p> <p>If the shortest wave measurement is still showing degraded isolation after the above steps have been performed, look for isolation faults within the battery pack.</p> <p>Isolation faults may occur due to leaked electrolyte, liquids shorting to the chassis, battery terminals shorted to the chassis, chafed wiring, conductive debris or other causes. As before, care must be taken while inspecting the battery pack to prevent personal injury and prevent shorting cells since a cell may be shorted to the chassis causing the chassis to be "hot."</p>
<p><b>8.</b></p>	<p><b>Test the isolation fault detection circuit functionality.</b></p>

	<p>On the original Orion BMS unit, try disconnecting the total pack voltage sensor connector (the 8 pin connector with 2 wires). On the newer Orion 2 BMS unit, try disconnecting the first cell group connector (isolation is now measured from the cell 1 negative reference on the first connector). Ensure that the “shortest wave” measurement reads over 4.5. If the value fails to rise above 4.5v this may indicate an internal fault with the unit itself requiring servicing.</p>
<b>9.</b>	<p><b>If the problem persists, contact technical support.</b></p> <p>If all above steps fail to determine the cause of the fault then additional support is needed.</p> <p><b>Please contact the company or reseller that the BMS was originally purchased from for additional questions, warranty claims, repair requests and technical support.</b></p>