Frequently Asked Questions | Li-ion Tamer® GEN 3

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Li-ion Tamer GEN 3 FAQs

Q 1: What are the stages of Lithium-ion Battery Failure?

A:

- Stage 1: Abuse
  - Electrical (over-charge/discharge, or internal manufacturing defects).
  - Thermal (external heating or operating the battery outside its specified temperature).
  - Mechanical (physical damage to the cell).
- Stage 2: Initial cell venting (off-gas event)
  - The battery electrolyte will convert to gas increasing the internal pressure and venting to the outside through pressure relief vent or rupture. This gas release is distinctly different than the release of gases at thermal runaway and often occurs several minutes prior to thermal runaway.
- Stage 3: Thermal Runaway
  - With increasing internal battery pressure and temperature, the separator will melt down and rupture, releasing smoke and potentially igniting the electrolyte solvent. Thermal runaway enables propagation of abuse and failure to adjacent cells, with any resulting fire further increasing the risk.

Q 2: What is the Li-ion Tamer GEN 3 system?

A:

- The Li-ion Tamer GEN 3 system is an advanced lithium-ion battery off-gas detection system that provides early detection of ongoing battery abuse across a wide range of battery storage environments (modular, containerized, large scale). It also includes distributed temperature and humidity sensing, increased sensor counts per controller, and improved event storage capabilities.

Q 3: What are the differences between GEN 3 and GEN 2+?

A:

- The table below lists the differences between Li-ion Tamer GEN 2+ and GEN 3:

Features	GEN 2+	GEN 3
Controller Capacity	12 monitoring and 3 reference sensors	100 total sensors
Environmental Monitoring	Battery electrolyte VOCs	• Battery electrolyte VOCs • Temperature • Relative humidity
Configuration	Controller DIP switches	Software user interface
Event Logging	Relative time-stamped event log	• Time-stamped event log • Time series database (sensor measurements)
Diagnostics	Sensor status LED	• Sensor/ hub status LEDs • Detailed error messages

Q 4: What gases does Li-ion Tamer detect?

A:

- Li-ion Tamer is designed to respond to volatile organic compounds (VOCs) which are emitted during a lithium-ion battery off-gas event that occurs prior to thermal runaway. The initial off-gas event consists of primarily battery electrolyte solvent vapours.
- The off-gas event may also be referred to as the initial cell venting and is defined as the event in which the cell case vents due to a rise in the internal pressure of the cell.
- Li-ion Tamer will also detect the composition of gases (CO, H_2 , hydrocarbons, etc.), released at thermal runaway.

Q 5: Does Li-ion Tamer detect the initial cell venting of different Lithium-ion Chemistries?

A:

- Lithium-ion battery chemistry refers to anode and cathode chemistry, such as LFP (Lithium Ferro-Phosphate or lithium iron phosphate) or NMC (Nickel Manganese Cobalt).
- Yes, Li-ion Tamer can detect the initial cell venting (off-gassing) of different lithium-ion battery chemistries. It does this by detecting the presence of battery electrolyte solvent vapours which are common to all battery chemistries. It is agnostic towards the types of anode and cathode chemistries used.

Q 6: How do you stop thermal runaway?

A:

- Li-ion Tamer can detect off-gassing of different lithium-ion battery chemistries; it does this by detecting the presence of battery electrolyte solvent vapours which are common to all batteries.
- The off-gas event, or cell venting, is a distinct stage in the stages of a battery failure which occurs prior to the onset of thermal runaway for most forms of battery abuse.
- Off-gas events are the earliest indicator of thermal runaway and once detected provides sufficient time to initiate containment measures, such as automatically isolating the components of the ESS or otherwise placing it in a safe condition. This action provides a barrier to the onset of thermal runaway.
- Other mitigating actions can be explored based on system constraints, including increased cooling, local alarms, remote alarms and ventilation activation to remove flammable gas accumulation.

Q 7: Doesn’t Battery Management Systems (BMS) provide sufficient protection?

A:

- No, despite the presence of BMSs, thermal runaway events are occurring. BMSs monitor temperature and electrical loading but these systems may have insufficient resolution or granularity at a cell level allowing an initial cell failure to occur. BMSs may also experience sensor failure.
- The Li-ion Tamer product provides an independent and reliable monitoring solution for all lithium-ion batteries and is an essential safety layer within a Failure Modes Effects Analysis (FMEA) for improving the overall safety.

Q 8: Can Li-ion Tamer tell me where the off-gas event has occurred?

A:

- Every Li-ion Tamer system deployed will deliver on single cell off-gas event detection, which will allow subsequent localized investigation.
- Li-ion Tamer systems can be designed to suit customer needs, whether it be maximum granularity for faster investigation, targeted mitigating action or cost effectiveness.

Q 9: How many minutes of early warning does Li-ion Tamer provide?

A:

- The Li-ion Tamer product typically provides between 2 and 30 minutes warning of a thermal runaway event. The severity of the abuse factor greatly affects the amount of time between the cell venting and thermal runaway.
- When using the UL 9540A recommended failure method (overheating), Li-ion Tamer consistently delivers early warning with many different types of cell manufacturers, chemistries, and form factors.

Q 10: What is the physical arrangement of the hardware?

A:

- The Li-ion Tamer GEN 3 system consists of a distributed sensor network that is aggregated at a Controller.
- There are two types of sensors:
  - Monitoring sensors: placed near the battery racks and monitor for off-gas events.
  - Reference sensors: distributed in potential nuisance alarm locations to increase system reliability.
- Groups of sensors are daisy-chained together and routed back to a Hub.
- Hubs provide power to all sensors connected via the daisy-chain.
- Hubs can be powered by a Power over Ethernet (PoE) Switch or by a 12VDC supply.
- Hubs are connected to an Ethernet Switch, which connects to the Controller.
- The Controller has a couple of communication protocols:
  - Modbus TCP/IP output (native to the controller)
  - Relay output (via an auxiliary relay module)

Q 11: What is the detection level?

A:

- The Li-ion Tamer sensor has been designed to operate in a binary state; either in a normal or alarm state. This allows Li-ion Tamer to focus on the smallest presence of an off-gas event in any concentration as an abnormal condition for immediate alarm reporting.
- The proprietary event detection algorithm is also based around a rate of gas generation consistent with an off-gas event or cell venting occurring.

Q 12: Does Li-ion Tamer meet ESS Codes and Standards?

A:

- Li-ion Tamer meets NFPA 855 4.2.9.2 and NFPA 855 9.3.
  - NFPA 855 4.2.9.2

    The Energy Storage Management System (ESMS) shall electrically isolate the components of the ESS or place it in a safe condition if potentially hazardous temperatures or other hazardous conditions are detected.

    Li-ion Tamer helps meet this by detecting hazardous conditions other than temperature.
  - NFPA 855 9.3

    Thermal Runaway Protection. Where required by Table 9.2, a listed device or other approved method shall be provided to preclude, detect, and minimize the impact of thermal runaway.

    Li-ion Tamer helps detect events that preclude thermal runaway (i.e. the initial cell venting) as well as being able to detect the gases released by thermal runaway.
  - NFPA 69 8.3.1

    Combustible Concentration Limit. The combustible concentration shall be maintained at or below 25 percent of the LFL, for all foreseeable variations in operating conditions and material loadings.

    Li-ion Tamer detects the presence of combustible gas mixtures and can initiate ventilation to control explosive atmospheres.
- Li-ion Tamer is CE/ UKCA marked, IEC 61010 compliant and FM 6540 approved for Battery Electrolyte Solvent Vapours (ex. DEC, DMC, EMC).

Q 13: Is there third-party testing of Li-ion Tamer?

A:

- Yes, the Li-ion Tamer system has been tested by many third-party entities. Li-ion Tamer participated in a joint-industry program to increase the safety of lithium-ion batteries organized by DNV-GL. DNV-GL showed in their testing that Li-ion Tamer was able to prevent thermal runaway. (https://www.dnvgl.com/maritime/publications/Technical-Reference-for-Li-ion-Battery-Explosion-Risk-and-Fire-Suppression-report-download.html)
- Li-ion Tamer was tested by Energy Safety Response Group (ESRG) alongside aspirating smoke detectors and commercial gas detectors. ESRG shows in their testing that Li-ion Tamer was able to reliably provide the earliest warning of battery abuse through initial cell venting detection. (https://buildings.honeywell.com/content/dam/hbtbt/en/documents/downloads/li-ion-tamer/hon-ba-nexceris-2021-test-summary-report.pdf)
- Li-ion Tamer has been implemented in UL 9540A tests to generate supplemental information for select customers.

Q 14: How can you be sure Li-ion Tamer works in my systems' airflow?

A:

- Li-ion Tamer has been extensively tested in many different battery environments, under varied ventilation conditions. During the applications engineering process, the ESS air flow patterns are considered to ensure the system operates within its performance envelope.
- If you have a specific battery configuration that requires off-gas detection; individual assessment or testing can be conducted. Additionally, if UL9540A testing is going to be performed, Li-ion Tamer hardware can be implemented for evaluating product functionality.

Q 15: How do you know if the Li-ion Tamer GEN 3 system is functioning properly?

A:

- Li-ion Tamer has multiple methods of communicating self-diagnosed error states.
- Both the sensors and hubs have LED status indicators, and all error states are communicated to the Controller for user notification.
- Refer to the User Manual (Doc. 37141) for details on the error states, as well as troubleshooting recommendations.