FIRE SAFETY PRODUCTS AND SYSTEMS

Fire protection for
Lithium-ion Battery Energy Storage Systems

High performance battery storage brings an elevated risk for fire. Our detection and suppression technologies help you manage it with confidence.
usa.siemens.com/lithium-ion

Today's energy infrastructure
is undergoing a radical transformation.

As overall demand for energy increases in our modern world – so does the use of renewable sources like wind and solar. As the use of these variable sources of energy grows – so does the use of energy storage systems. Energy storage is a key component in balancing out supply and demand fluctuations. Today, lithium-ion battery energy storage systems (BESS) have proven to be the most effective type and, as a result, installations are growing fast.

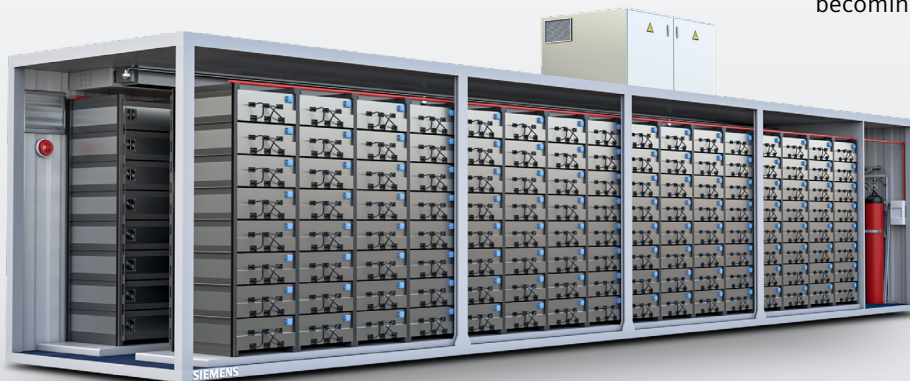### Stationary lithium-ion battery energy storage systems – a manageable fire risk

Lithium-ion storage facilities contain high-energy batteries containing highly flammable electrolytes. In addition, they are prone to quick ignition and violent explosions in a worst-case scenario. Such fires can have significant financial impact on organizations and create a deadly hazard for those on site. Rapid detection of electrolyte gas particles and extinguishing are the key to a successful fire protection concept. Since December 2019, Siemens has been offering a VdS-certified fire detection concept for stationary lithium-ion battery energy storage systems.*

Critical to the BESS application is early detection of a pending event. Early detection allows mitigation steps to be carried out long before a potentially disastrous event, such as lithium-ion battery

"thermal runaway," occurs. By leveraging patented dual-wavelength detection technology inside each FDA241 device, Siemens fire protection has increased the level of protection in modern-day BESS facilities.

Through Siemens research with multiple lithium-ion battery manufacturers, the FDA unit has proven to detect a pending battery fire event up to 5 times faster than competitive detection technologies. This translates into earlier transmission of danger signals to the resident battery management and fire alarm systems. These systems initiate mitigation actions such as battery charger "E-stop," battery isolation and application specific actions such as sprinkler activation.

With 5 times faster detection capability, Siemens fire detection products contribute to stationary lithium-ion battery energy storage systems becoming a very manageable risk.

Lithium-ion storage facilities house high-energy batteries containing highly flammable electrolytes.

*The FDA241 has a VdS approval (no. S 619002) and performance verification as an early warning detection device for Lithium-ion battery off gas detection. This VdS approval can be used to meet NFPA 855 requirements through equivalency allowance in NFPA 72 section 1.5. Currently there are no other global product performance standards for the detection of Lithium-ion battery off gas.

Earliest possible detection
with the FDA241 aspirating smoke / "Off-Gas Particle" (OGP) detector

Our Solution

Aspirating smoke detectors continuously draw air samples from the areas requiring protection and evaluate them for the presence of particles of combustion (e.g., smoke, etc.). They ensure reliable fire detection in demanding application areas, where earliest possible fire detection is essential and business continuity is paramount.

The FDA241 detects lithium-ion electrolyte vapor (also known as lithium-ion 'off-gas' particles) early and reliably thanks to its patented dual-wavelength optical detection technology. The FDA241 is the ideal solution for early detection of electrical fires. In addition to controlling the automated extinguishing system, the fire protection system triggers all other necessary battery management system control functions.
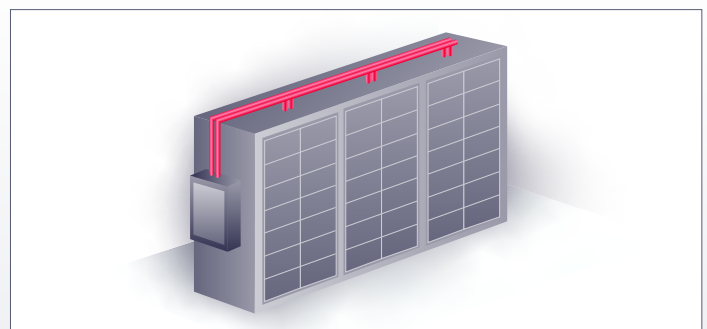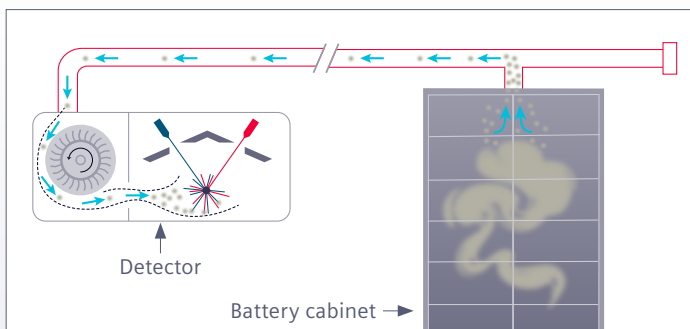
Aspirated smoke and off-gas detection systems

As its name implies – "aspirated" smoke and off-gas detection systems use an "aspirator" mounted in a detector unit. The detector connects to a sample pipe network mounted within the area or object being protected. Using the suction from the aspirator, air is continuously sampled and transported to the detection chamber for analysis for particles of combustion and lithium-ion electrolyte vapor.

Lithium-ion battery cabinet protection

In the BESS application each sample pipe extends from the FDA detector to monitor specific areas of interest. It is key to mount the pipe/sample holes where the smoke and off-gas particles will appear. This is largely dependent on battery enclosure geometry and HVAC airflow patterns which can be unique in each application. The system designer should consider these factors as well as location of cabinet exhaust ports in each cabinet protection design layout.

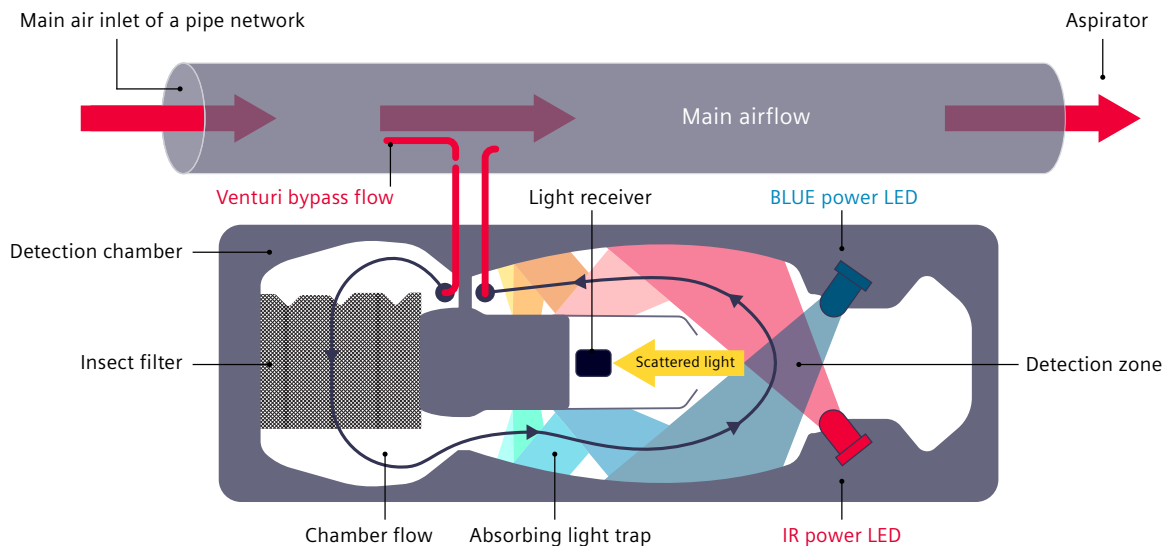# Siemens aspirated smoke and Off-Gas Particle detection

A patented smoke and particle detection technology which excels at smoke and lithium-ion battery off-gas detection.

## How does ASD "Off-Gas Particle" (OGP) detection work?

Using a unique aspirator, a portion of air is drawn into the sample pipe network which mounted on the lithium-ion battery racks and passed into a detection chamber. The detection chamber is specially designed to be highly sensitive to smoke and off-gas particles. Typically, aspirating smoke detectors can be several hundred times more sensitive than traditional point type smoke detectors.

The Siemens Aspirated Off-Gas Particle detector presented uses a patented optical dual-wavelength technology which combines blue and infrared light scattering to discriminate between smoke particles and dust/steam particles and most importantly lithium-ion battery "Off-Gas Particles".

Main air inlet of a pipe network — Aspirator

Main airflow

Venturi bypass flow — Light receiver — BLUE power LED

Detection chamber

Insect filter — Scattered light — Detection zone

Chamber flow — Absorbing light trap — IR power LED

The chart above illustrates the aerodynamic design of the Siemens aspirated smoke and "OGP" detection chamber. A venturi bypass is forcing only a small portion of air into the detection chamber. Smoke and dust particles are detected by a highly sensitive optical measurement arrangement. An optimized chamber airflow assures no separation of smoke and dust particles and prevents surface contamination.
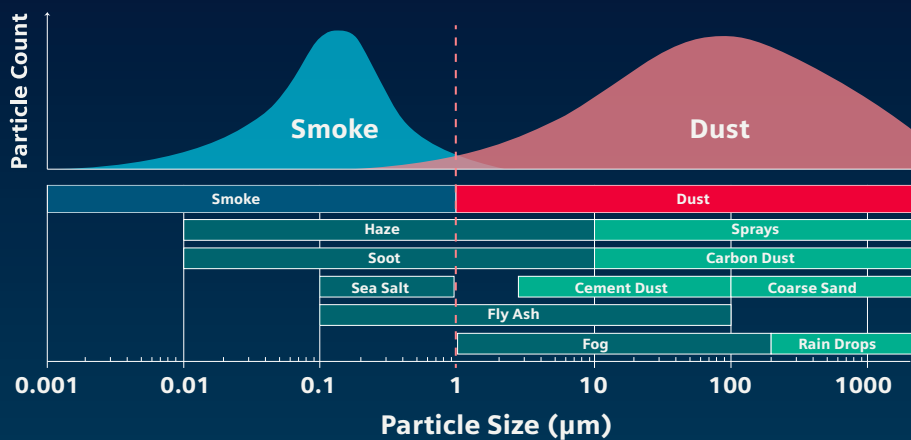
This chart illustrates the array of particles commonly found within an ambient environment. These particles range from gases on the far-left end (smallest particles – smaller than 0.001 microns) to sand on the far right (largest particles larger than 100 microns).

Airborne particulate matter

As depicted in the illustration above, different types of particles fit within a range of particle sizes from small to large. The blue and red curves graphically represent the particle distribution across the range of particle sizes demonstrating how the particles are detected using dual-wavelength technology.

The various particle types can be categorized as large particles (greater than 1 micron) best detected by infrared light scattering, and small particles (less than 1 micron), including smoke, that are effectively detected by blue light scattering. In the patented dual-wavelength detection chamber, the red and blue light scatter signals are accurately combined using precision algorithms to detect by-products of fire and lithium-ion battery off-gas particles. These same algorithms reject the effects of deceptive phenomena – providing resistance to unwanted alarm conditions not found in other smoke detection technologies.

It is important to note that Siemens' patented dual wavelength technology is not a gas detector. It leverages infrared and blue light energy to accurately perform particle detection. Targeted lithium-ion off-gas particles are not pure gases – they are by-products of overheated lithium-ion electrolytes. These vaporized electrolyte particles fall within the blue region making it easily detectable by the FDA241 unit.

All these facts add up to increased value in Siemens FDA smoke and lithium-ion off-gas detection technology providing 5 times faster detection for the safety of lithium-ion battery energy storage systems.

High performance, high value smoke and lithium-ion off-gas detection solution

FDA241 touches all the bases for lithium-ion battery storage facility fire detection needs.

Intelligent Classification of Airborne Particles

The patented dual-wavelength detection technology uses two wavelengths – blue and infrared, enabling Off-Gas Particle or "OGP" detection. The term "OGP" refers to detection of small off-gas particles produced in the earliest stages of lithium-ion battery overheating and those commonly found in flaming fires.

By quantifying the size and concentration of the sampled particles, FDA241 detectors differentiate between smoke, dust, and steam. This results in greater detection reliability and a high immunity to deceptive phenomena which prevents downtimes and costs caused by false alarms.

Lithium-ion "Off-Gas Particle" Detection

The FDA241 unit offers proven reliability in early detection of lithium-ion battery Off-Gas particles during the "pre-thermal runaway" period of battery failure. This early warning is key to initiating mitigation actions such as E-Stop to avoid a catastrophic thermal runaway event within the BESS facility.

Each FDA detector offers three modes of operation: ultrasensitive, auto-discrimination, and robust. Alternatively, each alarm threshold can be custom programmed according to design documents.

The FDA241 also provides a single 4-20 mA analog output which can be programmed to continuously transmit smoke level or airflow rate to a monitoring system compatible with standard 4-20 mA signals.
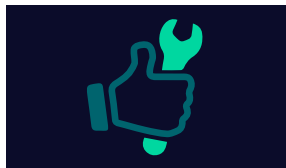
Easy Installation and Integration

FDA detector units support simplified "out-of-the-box" installation, meaning there are limited number of steps for the installer to complete the installation process.

The installer follows system design documents to mount the FDA detector to a permanent surface. Install air sampling pipe network as shown on design drawings and locate FDA air sampling holes at the appropriate locations in the sample pipe network to enable efficient detection of the lithium-ion off-gas particles.

The FDA detector is easily interfaced to a Siemens fire alarm control panel.

Low Maintenance and Long Product Lifecycle

A patented dual-wavelength particle detection chamber internal to the detector has been specially designed to keep dust ingress to an absolute minimum.

For sites with high airborne dust concentrations a VdS-certified air filter cartridge is available. The FDA supports a native "purge function" – a programmable feature which uses a 3rd-party device to blow-back dust particles which may have built up within the sample pipe network.

These features contribute to the extended product lifespan and lower end-user maintenance costs – even if the ambient environmental conditions are dusty and dirty.

Advantages of using blue and infrared light scattering

As stated before, the principle of blue scattered light on particles enables detection of very small smoke and lithium-ion battery off-gas particles. Theoretically blue scattered light on particles is 16 times stronger than using infrared light, assuming very small particles like lithium-ion battery electrolyte off-gases (Rayleigh Scattering). In many cases smoke particles are too big to be Rayleigh scatters so that the well documented Mie scattering model or increasingly complicated models for soot apply.

Innovative technology and outstanding reliability

The aspirating smoke detector FDA241 from Siemens use two wavelengths to differentiate between smoke and deceptive phenomena. This enables increased detection reliability even in the most demanding environments. In addition, FDA241 can be directly integrated into a fire protection system from Siemens.

Features and Benefits

- Siemens FDA detectors use two wavelengths enabling differentiation between smoke and deceptive phenomena.
- Patented dual-wavelength detection technology reliably detects lithium-ion off-gas particles, enabling early warning of pending lithium-ion battery thermal runaway event.
- Designed for increased detection reliability even in the most demanding environmental conditions.
- FDA detectors are easily integrated into a fire protection system from Siemens.

Applications

- Lithium-ion Battery Energy Storage Systems (BESS)
  - Solar generation facilities
  - Wind generation facilities
- UPS applications – lithium-ion battery based
  - Telecommunication facilities
  - Computer rooms
  - Data centers
  - Hospitals
  - Clean rooms
- Demand management applications (load balancing)
  - Critical manufacturing facilities
  - Industrial plants
  - Distribution centers / warehouses
  - Transportation facilities / Metro stations

Information in this publication is based on
current specifications.The company reserves
the right to make changes in specifications and
models as design improvements are introduced.