

# SENTINEL

Comprehensive Monitoring for Critical Battery Systems



## LEM Battery Monitoring

LEM is a Swiss company and a global market leader with over 35 years of experience in providing innovative and high quality solutions for measuring electrical parameters. Its current and voltage transducers are used in a broad range of applications in industrial, traction, energy & automation and automotive markets. This advanced technology is now integrated into the most cost effective intelligent transducer for the battery standby applications and LEM has become a world class supplier of choice.

LEM is a high growth global company with approximately 900 employees worldwide. It has production plants in Geneva (Switzerland), Machida (Japan), Beijing (China) and regional sales offices close to its customers locations

## Critical business environments – power back-up

Businesses today live in an increasingly mission critical environments.

At LEM we embrace new and emerging technologies to provide innovative products that set the industry standards and lead the way to keeping the most mission critical computers and telecommunications systems running and ensuring that business is always “as usual”.

In a more competitive global environment senior management are seeking more market and business information placing pressure on power systems to support their needs. Battery back-up systems are critical in this process and with LEMs Battery Management components we are able to play a vital role to monitor and support the power back-up systems to make sure business continues as normal.

## The World of standby battery back-up

Standby battery systems are a large and important part of the back-up power for both UPS and telecommunication applications.

The constant high performance of each monbloc/cell within a battery is therefore vital to guarantee that the battery is able to support the load when required. The continuous monitoring of each monobloc/cell is therefore paramount to make sure that it performs when required.

The problems with VRLA are already well known: sulphation of plates, grid corrosion and excessive gassing to name a few. With the LEM range of components you will be able monitor and identify the cause of the problem before the failure has an impact on the battery performance.



The world's largest Battery Energy Storage System (BESS Alaska) monitored with LEM current transducers

## LEM Approach to battery management

Through a network of authorised channel partners LEM is able to deliver its innovative range of components to key partners, who with their own added value adapt the components into a range of turn key solutions for the end user market.

### The benefits of battery management

Continuous monitoring of battery performance and parameters:

Will give you enhanced system reliability and system resilience. Reduces frequent site inspections for manual measurements.

Avoids any business interruption due to battery failures.

During a power failure you can be sure that the critical load is still supported.

Increase your peace of mind.

### Predictive monitoring

Battery trending data provides you with advance warning of failing cells and the whole battery system.

Allows the user to plan selective replacement.

### Early detection of failures

That would otherwise cause a system crash at power outage. Allows the user to spread the replacement cost avoiding a large capital spend.

### Extended battery life

With real time information the user can replace the faulty cell at a planned time to avoid impact on other cells and reduce costs.

### Cost effective method

A planned cost effective method rather than a reactive emergency maintenance.

### User benefits

Personnel safety increased.

User friendly and graphical display.

### Battery Management features provided by LEM components

LEM provides a full range of Battery Management components that accurately measure crucial parameters needed to assure the user that the battery system is healthy and available to perform when needed.

Features of LEMs Battery Monitoring:

#### Individual cell voltage measurement

To determine the imbalance between cells in a battery string to provide additional information that a potential cell is failing.

#### String and battery voltage measurement

Provides an early indication that the cell is failing.

#### Individual impedance measurement

A major indicator for trending the performance of a cell for failure.

#### Individual cell temperature measurement

Mapping out the heat of the battery

Essential in the detection of potential thermal runaway

Important when cells are installed in a battery cabinet

### Progressive “alarm” management

Fully programmable for key parameters that indicate an issue needs to be addressed.

Settings on:

Voltage

Impedance

Temperature.

### Easy to Install

Installation is fast and inexpensive with snap-in pre-terminated cables.

### History Trending

Provides user with information over time to review performance of the cells.

Trending of impedance data over time can be vital in detecting a failing cell.

### Discharge and recharge performance data

Float and discharge current measurements per string.

Different current values between strings can indicate failing cells. Storage of cell information during a discharge for view later.

### Innovative technology

The system on chip digital sensor.



Sentinel

## Component Configuration

The Sentinel is at the heart of LEMs Battery Management components that set the measurement standards within the industry

### Sentinel

Sentinel is the first single integrated circuit (system-on chip) monitoring for VRLA and flooded cells that provides measurement for individual cells and monoblocs for internal temperature, voltage and impedance as standard. Each module monitors an individual cell or monobloc, from 2 to 12 volts nominal, reporting over a proprietary communications bus to a Battery Data Logger (BDL).

The function of the Sentinel is to derive key electrical parameters under test to determine the ability of the

battery to perform in the event of a mains failure.

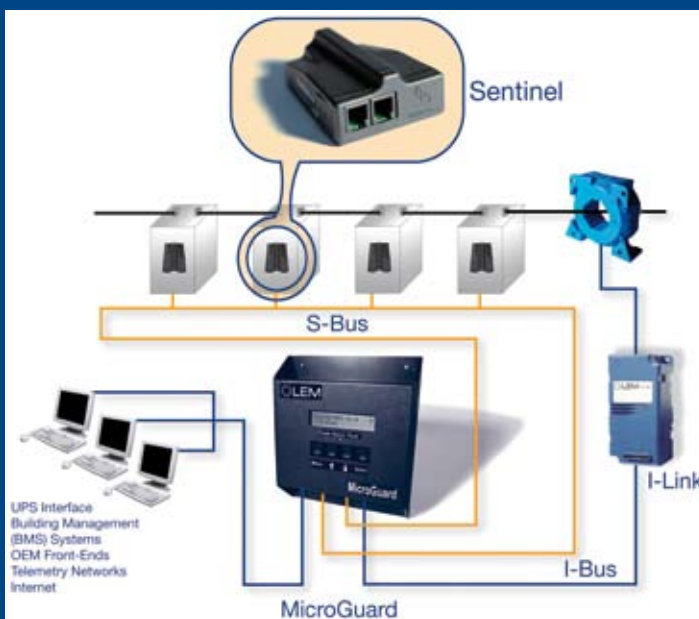
Up to 250 Sentinel modules can be accessed via a single serial bus, making installation extremely easy as pushing plugs into sockets using pre-terminated data bus cables.

Each Sentinel has an integrated temperature sensor for the continuous measurement of individual cell skin temperature. This is essential in the detection of potential thermal runaway and also enables intelligent temperature controlled charging profiles. Not subject to the restrictions of a single ambient sensor, cell skin temperature is more accurate and reliable.

The measurement of individual cell temperature enables thermal mapping of the battery, which until now has only been available as an expensive additional service cost.

LEM's unique True Energy Layer method of impedance measurement, together with a more robust test current ensures accurate and repeatable results every time. The Sentinel's impedance test method perturbs only the cell under test. High currents through sections of the battery are not required and DC links are not disturbed by any oscillations.

Cell internal impedance is available as standard. Internal impedance is closely related to the ability of the cell to deliver current and the trending of cell impedance is a powerful tool in ensuring reliability. Each Sentinel transducer measures its own cell, at frequencies carefully chosen to comply with telecommunications standards; no perturbation is seen by the battery as a whole.



Component Configuration

## MicroGuard

Designed to integrate with the Sentinel cell/bloc intelligent interface module, the MicroGuard is a cost-effective Battery Data Logger for monitoring batteries of up to 250 cells or monoblocs. Batteries larger than 250 blocs may be monitored by cascading the MicroGuard monitors. Up to 30 monitors can be cascaded by using the RS485 ports and setting the address in the MicroGuard menu system. The MicroGuard is designed to scan the individual cells and site environmental parameters continuously, comparing them against programmable limits in order to detect and report anomalous data.

Cell voltages, alarms, cell impedances, current, temperatures and discharge profiles, are stored, either for automatic download on a programmable day & time or for retrieval by the telemetry system.

The MicroGuard is the only low cost system to monitor individual cell temperatures. Monitoring individual cell temperatures can be

instrumental in preventing thermal runaway, which some cell technologies, such as VRLA, SLA, AGM or GEL can be prone to, particularly in non-temperature controlled environments.

A Data buffer memory is included for up to six months data storage, dependent on system activity and the number of cells or blocs monitored.

The MODBUS external communications protocol is available as standard.

During discharges the system will accurately record the individual cell voltage and current, allowing vital information about each cell's discharge performance to be viewed in graphical format.

Individual cell internal impedance is available as standard. Internal impedance is closely related to the ability of the cell to deliver current and the trending of cell impedance is a powerful tool in ensuring reliability.

Although the impedance or resistance changes little during the period when the cell is fault

free, it is known to increase towards the end of service life, or as the cell fails due to various failure modes.

A programmable alarm window can be set to notify the user of any deviation from the norm. The signal used is carefully designed to comply with telecom standards of noise interference.

Trending of cell impedance can significantly assist in predicting cell and monobloc failures.

The MicroGuard tests the impedance of each cell or monobloc via the Sentinel modules. Normally each cell is tested once per day and the results averaged over 7 days to counteract variations due to system noise. Each averaged value is then stored for trending.

It is important to ensure that the test signal is robust and penetrates the cell's energy layer, to obtain a response from the cell itself (instead of just testing the charger). LEM's high current impedance test methods are verified by an independent testing authority for accuracy and reliability.



Cell Impedance test



MicroGuard

### MicroGuard Gateway

The Gateway is an OEM version of the advanced Battery Data Logger MicroGuard, a cost effective interface that bridges the Sentinel Bus and the OEMs own equipment. The MODBUS external communication protocol is available for the OEM to obtain the valuable battery data. The Gateway is designed to provide the system integrator with the same functionality as the MicroGuard without the display, keyboard system and housing

This Component is ideal for the OEM companies that want to interface LEM technology into their own user display system.

### I-Link & Current Transducers

LEM current transducers may be integrated into the Battery Data Logger via the I-Link module. The I-Link allows float and discharge current

transducers to be connected directly to the I-Bus communication to inform the Battery Data Logger that a charge/discharge activity is taking place. An I-Link module is required for each string of batteries and up to 8 strings per Battery Data Logger.

When supplied with 24 volts, the I-Link will provide a +/- 15 volt output to power the LEM current measurement transducers that include the HTA, HTR, HAX and HOP range of components.

### S-Bus Converter

This is another ideal OEM component that allows the OEM/system-integrator to communicate directly with the Sentinel modules via the S-Bus. The S-Bus Converter connects to a PC serial port for the user who wishes to use his own monitoring program to obtain the cell information via the Sentinel modules. Each S-Bus converter will be able to communicate up to 125 Sentinels.

## Accessories

### Communication Leads

The S-Bus that connects the Sentinels to the MicroGuard (Battery Data Logger) comes in a number of different lengths of communication leads. It is recommended that the installer uses the 400mm lead to connect the Sentinels into a loop.

400mm, 2m, 5m, 10m, 15m

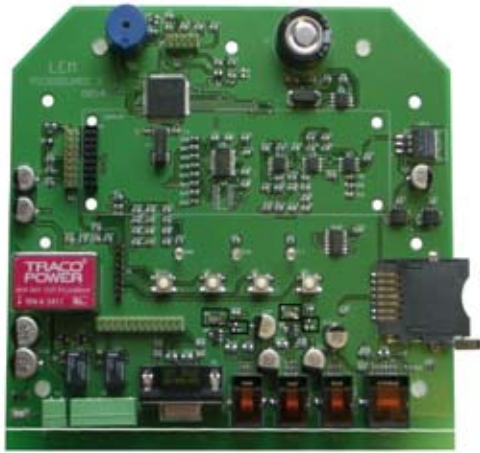
### Power & Sense Leads

The power and Sense leads that connect the Sentinel to the battery come in two lengths : 250mm, 400mm

### Kelvin Washers

A washer is required on each cell terminal to connect the power and sense leads. Accommodates 6, 8, 10, & 12mm hardware.

# Gateway - I-Link - Accessories



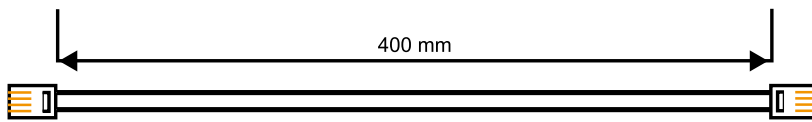
MicroGuard Gateway



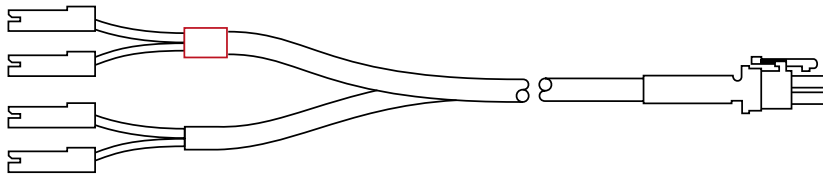
I-Link



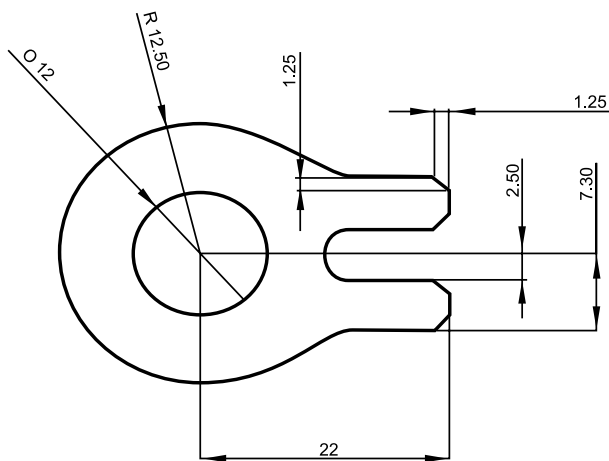
S-Bus Converter



Communication Leads



Power and Sense Leads



Kelvin Washers

**Switzerland**

LEM SA  
8, Chemin des Aulx  
CH-1228 Plan-les-Ouates  
Tel. +41 22 706 11 11  
Fax +41 22 794 94 78  
e-mail: lsa@lem.com

**U.S.A & Canada & Mexico**

Central Office: LEM U.S.A., Inc.  
11665 W Bradley Road  
USA Milwaukee, WI 53224  
Tel. +1 414 353 07 11  
Fax +1 414 353 07 33  
Toll free: 1 800 236 53 66  
e-mail: lus@lem.com

**China**

Beijing LEM Electronics Co. Ltd  
No. 1 Standard Factory  
Building B, Airport Industrial  
Area, Beijing, China  
Post code : 101300  
Tel. +86 10 80 48 31 78  
Fax +86 10 80 48 43 03  
e-mail: bj@lem.com

**Japan**

LEM Japan K.K.  
2-1-2 Nakamachi  
J-194-0021 Machida-Tokyo  
Tel. +81 42 725 81 51  
Fax +81 42 728 81 19  
e-mail: ljp@lem.com

**Austria**

LEM Components  
Am Concorde Park 2/F  
A-2320 Schwechat  
Tel. +43 1 903 60 10 40  
Fax +43 1 903 60 10 42  
e-mail: jsc@lem.com

**BeNeLux**

LEM Belgium sprl-bvba  
Route de Petit-Roeulx, 95  
B-7090 Braine-le-Comte  
Tel. +32 67 55 01 14  
Fax +32 67 55 01 15  
e-mail: lbe@lem.com

**France**

LEM France Sarl  
15 avenue Galois  
F-92340 Bourg-la-Reine  
Tel. +33 1 45 36 46 20  
Fax +33 1 45 36 06 16  
e-mail: lfr@lem.com

**Germany**

LEM Deutschland GmbH  
Frankfurter Strasse 74  
D-64521 Gross-Gerau  
Tel. +49 61 529 30 10  
Fax +49 61 528 46 61  
e-mail: postoffice.lde@lem.com

**Italy**

LEM Italia Srl  
via V. Bellini, 7  
I-35030 Selvazzano Dentro, PD  
Tel. +39 049 805 60 60  
Fax +39 049 805 60 59  
e-mail: lit@lem.com

**Russia**

TVELEM  
Marshall Budionny Str.11  
170023 Tver / Russia  
Tel. +74 82 244 40 53  
Fax +74 82 244 40 53  
e-mail: tvelem@lem.com

**Spain**

LEM Components  
Apartado 142  
E-08500 VIC  
Tel. +34 93 886 02 28  
Fax +34 93 886 60 87  
e-mail: sl@lem.com

**United Kingdom and Eire**

LEM UK Ltd  
West Lincs Investment Centre  
Whitemoss Business Park  
Skelmersdale, Lincs WN8 9TG  
Tel. +44 1 695 71 25 60  
Fax +44 1 695 71 25 61  
e-mail: luk@lem.com



LEM SA  
8, Chemin des Aulx, CH-1228 Plan-les-Ouates  
Tel. +41 22 706 11 11, Fax +41 22 794 94 78  
e-mail: lsa@lem.com; www.lem.com