EAGLE EYE
POWER SOLUTIONS

Vigilant Battery Monitoring System - FAQs

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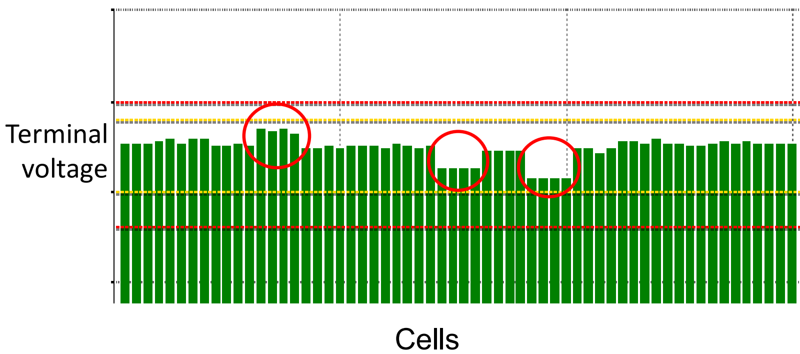
Note: The term ‘cell’ is used throughout this information, however it can be taken to denote a cell, jar, monobloc (bloc) or unit

What is ‘parasitic current’ in a distributed battery monitoring system?

In a distributed BMS, the sensor modules are connected across each cell and in series with each other. The supply current is therefore held to come from the charger at the end of the line. However, as they are in series, the *same* current *must* flow through all the sensors (Ohms law). Unfortunately, the power supplies of the sensors vary in efficiency and regulation, and there can be differences in the current each one draws. Any additional current must be drawn from the cell, and in some cases, this can have a long-term detrimental effect on the cell itself.



The above is a graph of the terminal voltages of an actual battery installation, where each distributed BMS sensor module takes its power from 4 cells.

Vigilant is a distributed battery management system, does it have any parasitic effect on the cells?

No. Although each sensor in the Vigilant system is connected to the terminals of a cell, unlike other distributed sensor systems the power for the sensors is supplied from the system manager. No power for the sensors comes from the cells. The only power drawn from the cell is a momentary test current, once a day.

How does the Vigilant system test for cell and strap resistance? Is it safe for the cell? Is the discharging of the cell during the test significant?

Each sensor draws a robust test current for a very short time from each cell, this results in a small momentary change in the terminal voltage. The waveshape and parameters of the change in the terminal voltage are analyzed, and from this the Vigilant machine learning algorithms can determine not only the cell and strap resistance, but also the state of health of the cell.

The sensors analyze the cell energy and automatically optimize the test current to maintain a safe level of test. The actual energy drawn from the cell during the test is insignificant to the battery and is not detrimental to the cell in any way.

I’ve heard that it’s not possible to determine the state of health of standby lead acid cells from their resistance/impedance, how does the Vigilant do it?

The battery and BMS industry have relied on resistive (Ohmic) measurements for the last 30 years or so, and it’s true that resistance doesn’t give an early indication of cell failure or deterioration.

Resistance/impedance/conductance changes little until the cell has deteriorated to maybe 70-60% of its initial capacity, when it begins to rise exponentially and is more useful to analyze, however the battery can be at risk by this stage.

The Vigilant system is the result of 4 years of study, development, and testing, undertaken together with one of Scotland's premier technical universities. Vigilant does not only use resistance in its calculations. There are other parameters that are much more sensitive in the early stages of cell deterioration, which are measured and integrated into a machine learning algorithm. This can give an accurate picture of the state of heath of the cell from the very early stages of deterioration.

Vigilant leads the world in its analysis of the state of health of Lead-acid standby battery systems.

What is a machine learning algorithm?

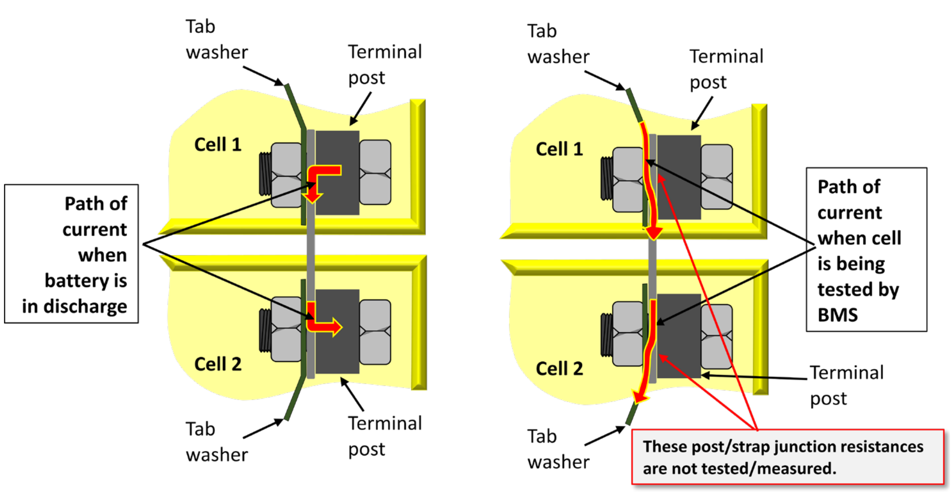
Machine learning algorithms have been around since the 1970s. They are superb at solving optimization, classification and pattern recognition problems and, due to advances in technology, are increasingly being used for other solutions (such as driving cars). Rather than being provided a specific set of parameters (x + y = ?), machine learning systems are capable of being trained to work out variable relationships between the inputs and outputs and, when applied to battery state of health, this training and analysis continues throughout the life of the cells. They form the basis of most artificial intelligence systems and can provide very accurate solutions to complex problems.

NERC stipulates that I must monitor for battery ground faults, can the Vigilant monitor for ground faults in the battery?

A ground fault monitoring system is available integrated in the Vigilant monitor/manager.

Why does the Vigilant system use custom designed post attachments and not just use tab washers to connect the sensors to the battery cell interconnections?

Many battery monitoring systems use quick and simple tab washers to connect their sensors to the cells. The problem with tab washers is that if you are measuring cell and strap connection resistances, the current path of the discharge current of the battery is not the same path as the test current drawn from the cell being measured. Strap resistances are tiny, typically 50μohms or less; by measuring a different current path, the intercell connection is not being measured.



Vigilant uses a range of custom attachments which are designed wherever possible to attach the sensor directly to the battery posts, the only way to obtain true readings. The Insulation Displacement Connectors (IDC) in the attachments have a dual role: the battery cables can be terminated at the exact length required for a neat installation, and IDC connectors allow fast and secure attachments to the battery.
(For further information see FAQs: 7)

Some specifications call for battery continuity to be monitored, can Vigilant do this?

Yes, uniquely Vigilant monitors the float current in the battery by accurately measuring the potential difference across the cell interconnections; this enables reliable detection if the battery has a continuity fault.

No other BMS manufacturer offers battery state of health, how does the Vigilant system calculate risk, and how can it cover all eventualities?

No estimation system is perfect; however, the Vigilant battery state of health integrates over 12 separate functions, parameters and values, many of which are themselves the result of contributory algorithms. Examples of some contributing parameters would be:

- ✓ *Individual cell condition:* This important parameter is a key factor in the overall state of the battery.
- ✓ *Ripple voltage:* an algorithm calculates the deterioration of the cells due to excess ripple.
- ✓ *Cell temperature:* Not ambient, which isn't the best indicator, but the actual temperature of every cell is measured. Excursions from 25ºC/75ºF are calculated daily for contribution to cell deterioration and reduction of service life.
- ✓ *Number and depth of discharges:* The deterioration of the battery is calculated from these figures and incorporated into the BaR algorithm

Nine further factors are integrated into a complex machine learning algorithm and from this the risk factor for the battery is calculated.

You say that an Electrolyte Level Monitoring system can be integrated with the Vigilant system, does that bring any advantages?

Yes, the electrolyte level sensors can be controlled from the Vigilant monitor/manager and the ELM monitor/controller is then not required. Functions such as calibration, reset, selection of Lead-acid or Nickel-Cadmium cells, identification of the cell number with low electrolyte and email notification of problems are all possible from the monitor/manager when the ELM is integrated with the Vigilant sensors.

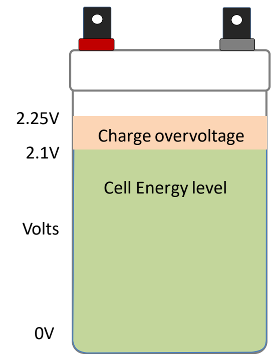
The Vigilant is a relatively new system, how do I know it will perform as specified?

The Vigilant system is the result of a 4-year development by a company with extensive experience in the design and development of monitoring and measuring systems, particularly in the field of battery monitoring. The design team who designed and developed the Vigilant have over 60 years of experience in the battery industry and have won several national and international awards for innovation and advanced technology. The Vigilant system has been extensively tested as part of a collaborative government supervised project and passed all the tests with flying colors. With the introduction of machine learning algorithms, float current and other unique features the Vigilant system is significantly in advance of any other battery monitoring system available today.

Why do you think it is necessary to use a robust test current to measure and calculate cell internal resistance?

Standby batteries are subject to a float current all their service lives in order to counteract internal discharge and maintain them for instant use. The resulting float voltage contains a gassing overvoltage of approximately 150 millivolts per cell on top of the cell's fully-charged natural open-circuit voltage.

Cell internal resistance/impedance is calculated by drawing a current from the cell in a pulse pattern and measuring the change in the terminal voltage. If too low a test current is used, several factors which can adversely affect the measurement come into play



- The measured change in terminal voltage will be too small to come from the cell itself, but will come from the overvoltage, mainly influenced by the charger. If the float current changes the measurement will be different.
- Battery system noise and ripple can obscure a small test current and lead to adulterated readings
- A low-test current means a small response signal; the smaller the signal the less accurate the measurement can be.

Why don't you use a Hall-effect transducer to measure float current?

With the high accuracy measurement system in the Vigilant sensors it is not necessary to use an external current transducer, however there are problems with using Hall-effect to measure very low currents. If a low current Hall-effect (say 5 Amps) is subject to a very high current, such as in a battery discharge, it can saturate and suffer from a condition called remanence. That means it retains a substantial unpredictable offset, which defeats any possibility of trending.

Also, Hall-effects are very sensitive to changes in temperature, particularly when measuring very low current, and this can significantly affect the accuracy of the measurement.

Why is it important to measure the negative post temperature specifically?

It is recognized in the battery industry that the negative post of the cell is the most sensitive to internal temperature variation, and if 'acid creep' is experienced it is inevitably at the negative terminal post first. The negative post is often at a slightly higher temperature than the positive post and in any case terminal posts are a much better indicator of internal temperature than the plastic cell casing, which is a thermal insulator and influenced by the ambient temperature. The Vigilant sensor is designed to have an excellent thermal connection to the negative post and is also insulated against the effects of changes in the ambient.

Does the Vigilant system use Hall-effect sensors to monitor charge and discharge currents?

No, in most battery systems the Vigilant system measures all currents, float, charge and discharge using its Advanced Multi-Function (AMF) sensors. The high accuracy measuring circuit within each sensor can measure most charge and discharge currents, depending on the battery architecture. Except for very high current measurement, purchasing additional Hall-effect transducers is normally not necessary; Vigilant can do this for multiple strings.

I don't have any mains power available in the battery room, can the Vigilant be powered from the battery DC, or do I have to make other arrangements?

Three models of Vigilant system monitor/manager are available, which can be supplied by batteries ranging from 48volts (24 volts by special request) up to 600volts DC. Also, if preferred, any Vigilant system can be powered from a standard mains power supply at 24VDC.

You say that in addition to cell condition Vigilant measures cell resistance; is there any advantage in measuring resistance over impedance or conductance?

A two-year study into these three resistance parameters by the Electrical Power Research Institute of America (EPRI), using three market-leading battery test instruments, concluded that there was no material difference in the effectiveness of any of the three. In addition, conductance is defined as the reciprocal (1/Ω) of resistance, so there are effectively only two true Ohmic testing methods, AC (impedance) and DC (resistance).

The total EPRI data, with thousands of cells tested, showed conclusively that although there was some correlation between resistance and cell condition, resistance, impedance or conductance alone could not be relied upon to detect deterioration until loss of capacity had exceeded around 30-40%.

Vigilant measures and displays resistance as a part of a complex algorithm together with other parameters, which change more rapidly than resistance, to estimate the condition of the cell in the early stages of deterioration; resistance alone cannot do this.

Many battery monitoring manufacturers only measure ambient, or specimen cell temperatures. Why do they believe that is sufficient and why do you believe it is not?

Some battery monitors don't have an architecture that allows individual cell temperatures to be easily monitored without significant changes being made in the hardware of the system.

Other systems, as a way of reducing the price of their systems in a competitive environment, comply with the recommendations of I.E.E.E. 1491, which recommends that a minimum of 10% of the individual battery cells should be monitored for temperature.

We believe that monitoring the ambient temperature alone or, say, 10% of the battery is a waste of money. What is the point of monitoring the ambient, or cell 14, say, if cell 43 is going into thermal runaway? Monitoring all cells in a thermal map of the battery can give important information about the airflow and thermal hotspots in the battery room and the general health of the battery overall. Last but not least, it's the temperature that the cell itself experiences that can cause deterioration and allow detection of thermal runaway, not the ambient.

Not all BMS manufacturers' measure battery ripple voltage, do you think this is an important parameter? Can it affect battery service life?

There are conflicting opinions about ripple, it is indisputable however that ripple currents have a heating effect on the battery. Electrochemical cells contain a large capacitance, called plate surface capacitance, or Helmholtz double-layer capacitance. This capacitance supplies the 'instantaneous' energy supplied by the cell during a discharge, before the electrochemical generator kicks in. Ripple currents cause the ions in the double-layer capacitance to oscillate, causing a heating effect; the higher the ripple current the stronger the heating effect and that is undesirable, as it may lead to thermal runaway.

Several papers about ripple frequencies in battery float charge show that over time excessive ripple can cause accelerated deterioration throughout a battery, from heating and gassing effects. *(e.g. Kotub Uddin, University of Warwick; C&D Technologies: Charger Ripple effects on VRLA batteries)*

The effects of ripple current in battery cells can be many times that of the DC float current (I^2R), and we believe that AC ripple, in addition to heating effects, can cause the same deterioration in battery cells as it can in capacitors, the worse the ripple, the more serious the effect on the cell, and the shorter the service life.

A factor that is not normally mentioned, is that charge acceptance (efficiency) when the battery is fully charged can be as low as 40%, however discharge efficiency is still high. Therefore, if the oscillating ripple current reverses the float current (remember the float current is only low milliamps), over time the battery energy can be reduced, a situation known as 'walkdown'.

"In tests large amounts of low frequency ripple have been shown to reduce the state of charge/state of health of a battery from 100% to as low as 70%" (AJ Harrison , INTELEC 89).

This energy reduction is not likely to be apparent in the voltage at the cell terminals and may not be detectable until the battery is called upon to discharge in support the critical load.

Do the Vigilant system sensors have to be pre-programmed with their cell identification number?

No, to make the installation quick and simple Vigilant sensors are automatically assigned the number of the cell they are monitoring during the installation process.

Do I need different sensor modules for different cell types/sizes?

No, a single Vigilant sensor can monitor and measure any cell from a 1.2-volt Nickel-Cadmium up to a 16 volt Lead-acid monobloc/jar.

Do I need long runs of cable in wiring looms to install the Vigilant system?

No, one of the advantages of a distributed system is that long runs of multiple cables (wiring looms) are not required. A significant disadvantage of long cable runs is that they act as aerials for system noise. The first distributed battery monitoring system was designed in 1997 by Vigilant company personnel, and the advantages of modern distributed BM systems mean that they have since become the 'go to' system of choice. Pre-terminated serial cable is simple, low noise, inexpensive and quick to install, and links the sensor modules to the monitor/manager. Connection in a loop (ring) system means that even if the cable is cut, all the sensor modules will still operate correctly.

Why should I install a battery monitoring system and, if so, why the Vigilant system and not a competitor?

The fact that you have invested in a backup battery to support your critical systems means that they *are* critical systems. However, in surveys of many industry sectors: *Financial services, Industrial, Healthcare, Public sector, IT services, Services, E-commerce, Retail, Technology, health services, Communications, Transportation, Media, Education, Agriculture and Defense*, **95%** of standby battery users have reported multiple power outages in any 24 month period (Ponemon institute) and, indispensable as standby battery systems are, the industry recognizes that they are the most vulnerable part of the whole supply system. Various studies of power failure in standby battery systems and data centers have all concluded that the highest cause of actual power failure (in excess of 65%) are caused by a failure of the backup batteries (Frost &

Sullivan, Ponemon institute). It makes complete sense then, to ensure that your backup batteries will work when called on to do so, by monitoring and managing them.

So why choose Vigilant?

Because whereas most BMS available today have designs that are at least 15-20 years old, Vigilant is the result of 4 years of concentrated development by a highly regarded design team that has been in the battery industry for many tens of years, truly understands battery systems, and has many awards for innovation and advanced technology. Using advanced modern technology and 'intelligent' machine learning algorithms Vigilant offers cell State of Health (SoH) and a Battery at Risk (BaR) of failure factor, as well as true float current, and is designed to be the most comprehensive and forward-thinking battery monitoring system available, significantly more advanced than any other system on the market today.

Do you have an on-board long term memory to store captured data, or do you rely on the user's computer/network?

The Vigilant monitor/manager has sufficient reliable long term (SSD) memory on board to store the 'normal' activity of 60 cells for up to 20 years. The on-board memory can be optionally expanded to give in excess of 20 years under the same conditions for 240 cells/units. It is strongly recommended however, that in line with ISO 9000 recommendations the user download copies of the stored data to an off-site repository.

What mounting options for the system are available?

The monitor/manager comes with a fitment for attachment to 35mm DIN rail, and a section of DIN rail is provided for wall-mounting. The sensors are very flexible and can be mounted in several ways; it fits neatly into a holster and can be quickly removed if the cell needs to be changed or maintenance carried out. The holster is designed to be fitted to Unistrut or DIN rail; it also has double sided tape in place, which will adhere strongly to any clean flat surface, such as the cell itself or slotted plastic trunking.

Is there a maximum current that the system itself can measure?

The sensors use the cell interconnects as current measurement shunts, so the maximum discharge current the system can capture depends on the resistance of the cables and interconnects available. In general the system itself has a range of up to 1000+ Amps. If a higher range is required, an external Hall-effect transducer can be provided.

What does 'power supply via comms system' (for the sensors) mean?

Unlike the its competitors, with distributed (module-type) sensor systems (whether 1, 2 or 4 cells are measured per sensor), the Vigilant sensors are not powered by the individual battery cells The power for the Vigilant sensors is distributed via the communications cable; the sensors take no power from the individual cells, except a minute amount for the daily cell state of health pulse test.

Is the Vigilant monitor universal for any battery system voltage?

There are three battery-powered variants:

- 36 - 72V
- 90 - 300V
- 280 - 580V

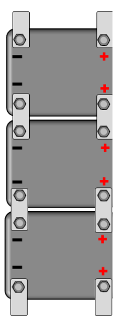
All of the above variants can also be powered by a mains power supply with an output of 24volts DC

Does the Vigilant system comply with NERC and I.E.E.E. 1491 requirements?

Yes, the Vigilant Expert fully complies with both NERC and I.E.E.E. requirements

Can the Vigilant Expert measure every connection resistance in dual post cells?

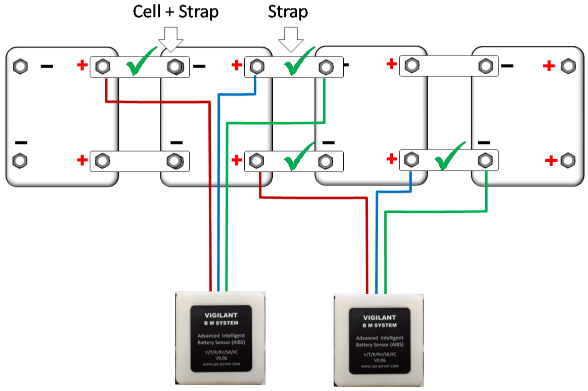
The dual post configuration is sometimes used to increase the current capacity of the system, and also has the benefit of a more even current draw from the plates during a heavy discharge.



These cells have dual terminals, i.e. two positive and two negative posts, which are connected in parallel. While this design of cell has advantages, unless the user is prepared to pay for double the number of monitoring points, a cost-effective solution for the measurement of strap & connection resistance can pose a problem for a Battery Monitoring System (BMS).

How does the Vigilant measure dual-post cells?

Exceptionally, the Vigilant system is able to measure both positive and negative post/strap connection resistances in dual post systems without increasing the number of sensors in the system overall. At the same time, since the unique Vigilant multifunction sensors measure current as well as cell parameters, accurate float, charge and discharge currents can be measured in both current paths.



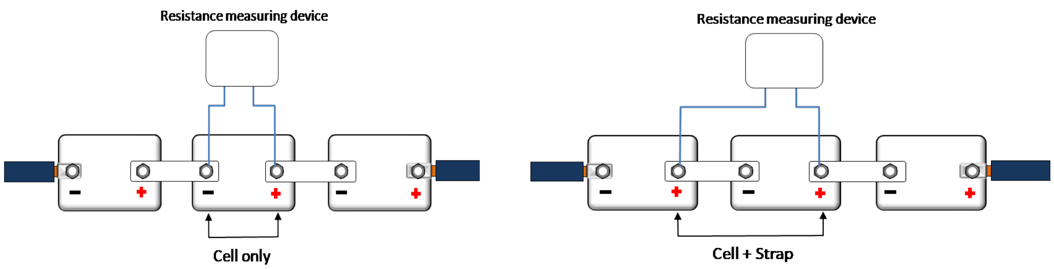
As can be seen in the above drawing, each alternate sensor monitors an alternate strap, and a cell plus strap. For each cell, one strap and connection resistance is measured discretely and one strap and connection resistance is measured together with the cell internal resistance.

Since the measurement system in the Vigilant is highly accurate (better than 7 micro-Ohms strap resistance resolution) and the cell resistance measurement includes parameters other than the internal resistance, a minute rise in the cell plus strap resistance can be detected and an alarm triggered.

In this way the Vigilant system uniquely measures all the cells and strap/connection resistances in a dual terminal post battery system.

Measurement of resistance in straps & connections – cell included

Today almost all battery monitoring systems are designed to measure the cell or unit internal resistance or impedance. Now however, strap and connection resistance has become a concern, particularly in systems where higher discharge currents are required. Most BMS were designed many years ago without this feature and adding connection resistance has caused some difficulty for several manufacturers.

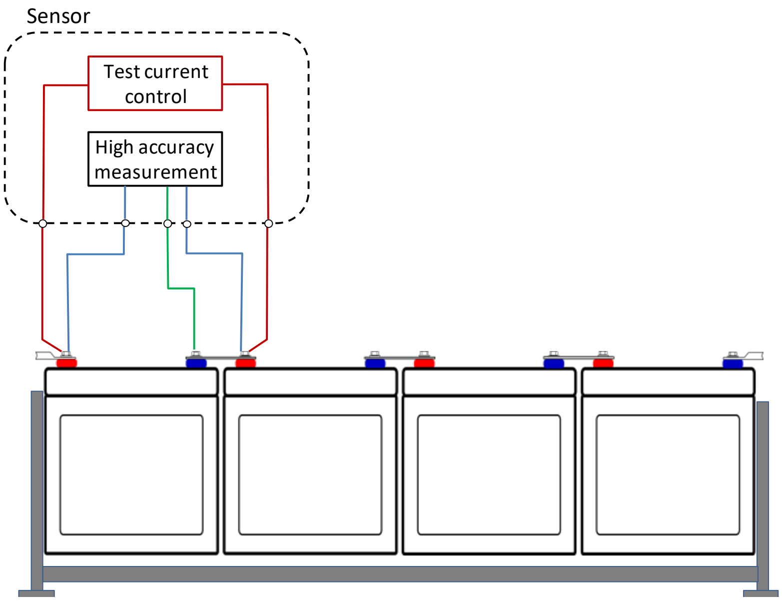


One or two manufacturers have now added dedicated strap and connection resistance to their systems however, and others are connecting the standard battery post connections (left, above), normally connected to the positive and negative posts, to the far end of the strap (right, above), which has the effect of including the strap and connection resistance in the cell resistance measurement

The strap/connection resistance is very low however, and can be as low as 15-20 micro-Ohms, whereas the cell could be as much as several milliohms, 500 to a thousand times higher, therefore including the strap in the cell's internal resistance is acceptable only if the resolution of the cell internal resistance measurement is much more accurate than normal and other cell internal parameters are monitored which allow the strap and cell resistance increase to be detected

The Vigilant system strap/bus bar measurement

Vigilant has an extremely accurate, high quality measurement system, so accurate it can measure down to 2 microvolts, even in the presence of system electrical noise



In order to measure strap and interconnection resistance, the sensor draws a momentary current through both the cell and the adjacent strap and interconnections (the red wires). It then measures the volts drop across the strap (blue and green wires); since the sensor knows the exact amount of test current flowing through the strap, by Ohms law, the volts drop from one side of the strap and interconnection to the other, divided by the exact test current (V/I=R) gives the resistance of the strap and interconnections.
Specially designed battery post connectors, unlike tab washers, ensure that the interconnection resistances are included in the measurement.

True float current

Because Vigilant can accurately measure the resistance of the strap(s), it is possible to use this resistance to also accurately calculate the float current, which is once again Ohms law (see 33).
The float current passing through the strap causes a tiny voltage (microvolts) difference between one side and the other. This voltage divided by the resistance of the strap gives the float current.

Charge and discharge current

Depending on the strap resistance, charge and discharge currents can be accurately calculated in the same way, up to an approximate maximum of 800 Amps. A separate hall-effect sensor is not normally required, saving a significant amount of expenditure in cost and installation time.

How often does the Vigilant scan the battery?

- **Voltage, float current, temperature & ripple:** These parameters are scanned continuously, one cell after another, but only saved every 15 minutes. If there is a discrepancy the user is notified immediately

- **Discharge current:** A user-designated standard sensor measures current continuously, looking for a discharge condition. A discharge causes the system to begin fast scanning the voltage and temperature of the individual cells

Float current and Hall-effect transducers

The float currents of lead-acid batteries are affected by the cell construction and constituents but is generally in the region of 0.5 – 1 mA per Ampere/hour of battery rating. Thus, in a healthy 250 A/h battery the float current is liable to be typically in the region of 150 to 210 mA.

Hall-effect transducers: Hall-effect transducers are rated *at their maximum rating and* are not really sensitive enough to measure very low currents accurately; for example, if a 50 Amp 1% accurate transducer is used for float current, the unit can only be accurate to 50 milliamps, or 25 – 30% of the signal. At a few tens or hundreds of milliamps the measurement just becomes noise.

Float current levels of 50-100 milliamps, can be lost in the noise level of the transducer measurement.

Then, Hall-effects are subject to remanence, i.e. where a low current transducer is subject to sudden high currents, such as a battery discharging or charging, the core will saturate and an offset value will be retained on the transducer of a few Amps.
The lower the measurement current rating of the transducer, the more it is affected; thus, unless designed with special additional circuits, Hall-effects cannot be used for accurate alarm level measurement or trending of very low currents.

Additionally, very low current Hall-effects are subject to relatively large measurement variations with temperature; also, split-core transducers cannot be used for currents in the region of tens of milliamps, whether specially designed or not, as their sensitivity is very significantly reduced.
(Source: LEM SA. World-leading manufacturer of current sensors)

How does the Vigilant system measure float current?

All the Vigilant sensors have a unique high accuracy circuit (resolving down to 2 microvolts) specifically to measure the cell interconnection resistances, which are often only a few tens of microohms. This accuracy enables the resistance of the interconnection, and the volts drop across it to be used to calculate the float current passing through the cell interconnections.

All of the calculated float currents are then combined in a unique filtered averaging technique to give a very accurate value for the battery float current.
All the measurement circuits are re-calibrated for accuracy every 24 hours.

Vigilant battery circuit continuity: The very low current accuracy feature of the Vigilant enables the system to determine whether float current is flowing or not and thus alarm on a battery circuit-break.

Are the battery leads fuse protected in the Vigilant?

a. **Sensor protection:** The external circuits between the sensors and the cells/units are protected by fuses. There are fuses in both power cables; they are situated on PCBs on the connections to the cell terminals.

b. **Monitor protection:** The monitor is fused both at the battery connections and at the input of the monitor.

Does the Vigilant require access to the internet to carry out its algorithm calculations?

No internet or external access is required for any function that the Expert carries out, other than data view and download. The system may be accessed via the internet to view or download data, however it is expected that this access will be carried out via the user's firewall.

Who is the Data Custodian?

The data custodian is the person responsible for the administration of, and access to, the company's data.

As the Vigilant will be owned by the user company, and integrated into the company's network, that person will be appointed by the company. It is likely to be the person who has responsibility for the company's standby batteries. The BMS manufacturers do not have access to any data collected by the Vigilant system, except by special written agreement.

What data can be downloaded from the BMS?

All collected data residing on the Vigilant monitor/manager web server may be accessed via internal networks (if the battery is on-site or available to those networks, - such as remote sites coupled to the company net by wireless or land-line). The system appears as a web site, and can be accessed and navigated as such. If the system is accessed via the internet, again it will be accessible by use of a URL exactly the same as any website.

All data will remain in the Vigilant memory for the life of the SSD memory (see the Vigilant Expert data sheet). Download of the data to a company database can be achieved at any time by CSV files, Modbus or DNP3, when available.

Does the Vigilant system require to be connected to a computer, a network or the internet in order to function?

No, the Vigilant BMS is designed to be an autonomous system and does not require any external connections in order to function. It will scan, store and interpret data for the life of the system, even if never connected to any computer or network. If required, the two volt-free relay contacts can be used as its only connection to any external system.

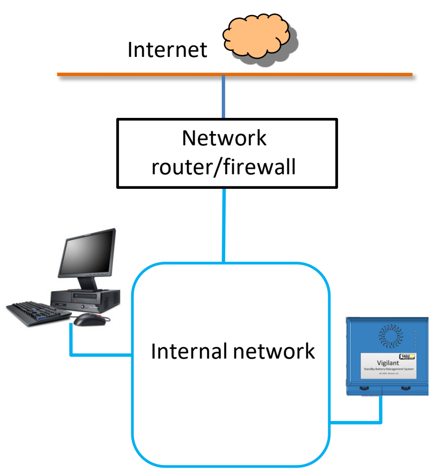
Do the processor self-checks conform with PRC-005?

The main processor in the monitor is monitored by a watchdog timer external to the processor. This watchdog is 'patted' by the main processor every few seconds, which maintains the status quo. If the main processor stalls or stops for any reason then the watchdog circuit is not patted and it will then attempt to restart the processor. If the processor fault is severe enough that the processor can't start then the communications with the users system cease.

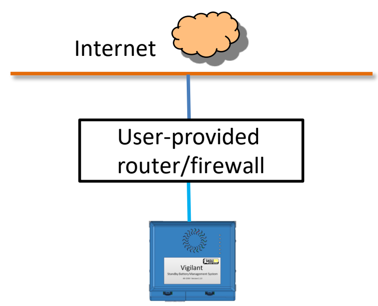
The Vigilant software in the main processor pulls in (‘makes’) C/O relay 2 on start-up. The watchdog circuit external to the processor operates as above. If the processor freezes, the watchdog will attempt to reset processor; if the processor doesn’t respond the relay will drop out and will not be reactivated, giving an alarm signal. This fulfils the PRC 005 requirement.

Who has responsibility for Vigilant cyber security once the system is installed?

Like any other item of purchased equipment, the responsibility for the security of the equipment rests with the owner/user.
Although the Vigilant system contains microprocessors it is not a user-controlled computer; its software is dedicated to its function (like that of a hi-fi system) and the only alterations the user can make is to the password-protected settings file, containing, for example, the number of cells in the battery, the battery designation, the alarm limit levels, etc..



The BMS is contacted by an IP address assigned by the user



The router is provided and addressed by the user. The system is contacted by an IP address assigned by the user

The Vigilant BMS has no executive function, other than that allocated to its two assignable volt-free relay contacts by the user. Whether the system is connected to an internal network or to the internet, as shown above, it will appear to the user as a website and can be navigated as such. It does not require a dedicated program on the user’s computers, either to function or to be viewed. Normal cyber-security for protection from external sources will be provided BMS via the company’s security protocols.