CELL GUARD

Application Note 001 – Example Usage

Applicable to Part No(s): CGAXPXGXHXVX

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Revision History

Revision	Comment	Author	Date
0.1	Creation of Document	Joe Holdsworth	27/02/2023

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Purpose of this Document

This application note describes the purpose of Cell Guards measurement capability/features and example usage of them. It is aimed at someone who, perhaps for the first time, would like to set the unit up for their specific application and good starting values if they are to use the wake and/or function pin on the unit.

Overview

Measurement Parameters

1. Absolute pressure [mBar]
2. Air temperature [°C]
3. Volatile Organic Compounds (VOC's) [parts per million]
4. Absolute air water content [milli grams/m^3]
5. Relative humidity [%]
6. Dew point temperature [°C]
7. 3 axis acceleration [+-24g] *

*Optional – see part numbering

Other Features

1. configurable CAN bus speed
2. configurable CAN bus address
3. 500mA function pin
4. Low power monitoring mode

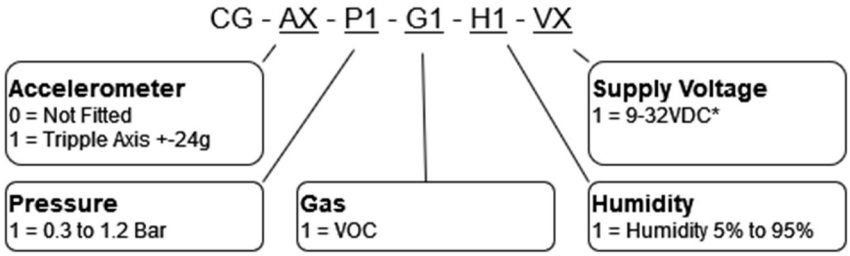
Sensor Options

This manual is applicable to all versions of Cell Guard.

Part Number Ordering Details

Default Part Number: **CGA0P1G1H1V1**

*16 to 32VDC is not tested to ISO standards



Sensor CAN Overview

- Can Messages Identifier: 11bit
- Data Format (all messages): Intel
- Termination: Unterminated (no 120 Ohm termination resistor)
- Default CAN Bus Speed: 500 kbps
- Default CAN Start Address (decimal): 0x30A (778)

Unit Specification

For detailed specifications please see the manual or specification sheet.

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Sensor General Usage and Suggested Settings

Overview

Cell Guard covers the aspects of battery pack health monitoring that a standard Battery Management System does not.

- Detection of Cell Venting
  - The first sign of a thermal event/battery catching fire, detected using the pressure, air temperature and VOC sensor.
- Moisture Ingress
  - Potential to damage electronics and batteries
  - Dangerous in terms of electric shock risk to vehicle and occupants (even if contactors drop out)
- Dew Point and Battery Thermal Control
  - If the battery pack is actively cooled Cell Guard can calculate the temperature the pack can be cooled down to before moisture may form on the cooled surface.
- Impact Detection
  - Measures acceleration in 3 axis and can flag if the pack has experienced a certain g over a certain amount of time. i.e. an impact that might damage it.

For configuring the unit over CAN please refer to the detailed instructions in the user manual.

Detection of Cell Venting

Absolute Pressure

Cell Guard measures absolute pressure in mBar, this enables monitoring of pressure in the space it is installed. This is useful because if a battery starts to produce gas, which is a sign that a thermal event is underway it can be detected by a rise in pressure.

If using the function pin/wake feature of Cell Guard a good max threshold for pressure is 1150 mBar.

Using pressure as a way of detecting a potential thermal event works best if the battery pack is sealed and the breather port is small (allowing pressure build up).

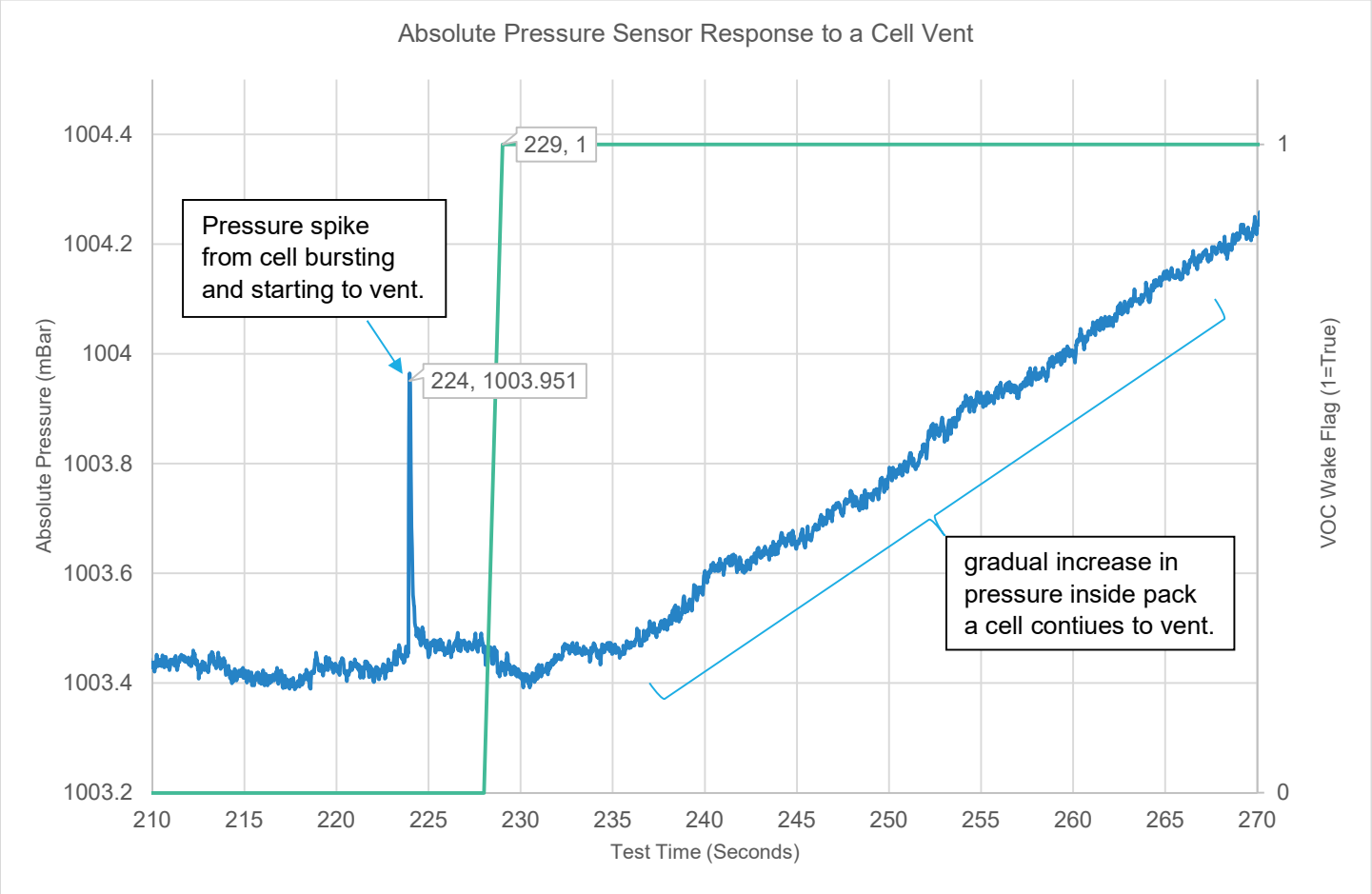

FIGURE 1 PRESSURE INCREASE IN A BATTERY PACK FROM A CELL VENT (SIMILAR RESULTS FOR LFP AND NMC)

Air Temperature

The unit measures Air Temperature in °C, this can be used to indicate if ambient pack temperature and therefore pack temperature itself is too high.

In the event of cell venting/thermal event in the pack air temperature can be used to detect this.

The length of time from a vent or a cell catching fire and being able to detect this as an increase in air temperature can vary greatly depending on pack volume etc.

As well as being used for cell thermal events this parameter can also be used for thermal conditioning of a battery pack in terms of an input into a thermal control system.

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Volatile Organic Compound Sensor

The unit outputs a value for VOC's in parts per million. A battery pack can naturally contain VOC's due to materials used in its construction. If using the function pin and wake feature of the unit it is important to make sure that the threshold is above the background VOC level.

A good starting value for this threshold is 50ppm above the ambient level. If the ambient VOC is not known a starting value of 75ppm is reasonable. This threshold should be tested to avoid false alerts and in some cases where there is a lot of background VOC's present this sensor may not be suitable.

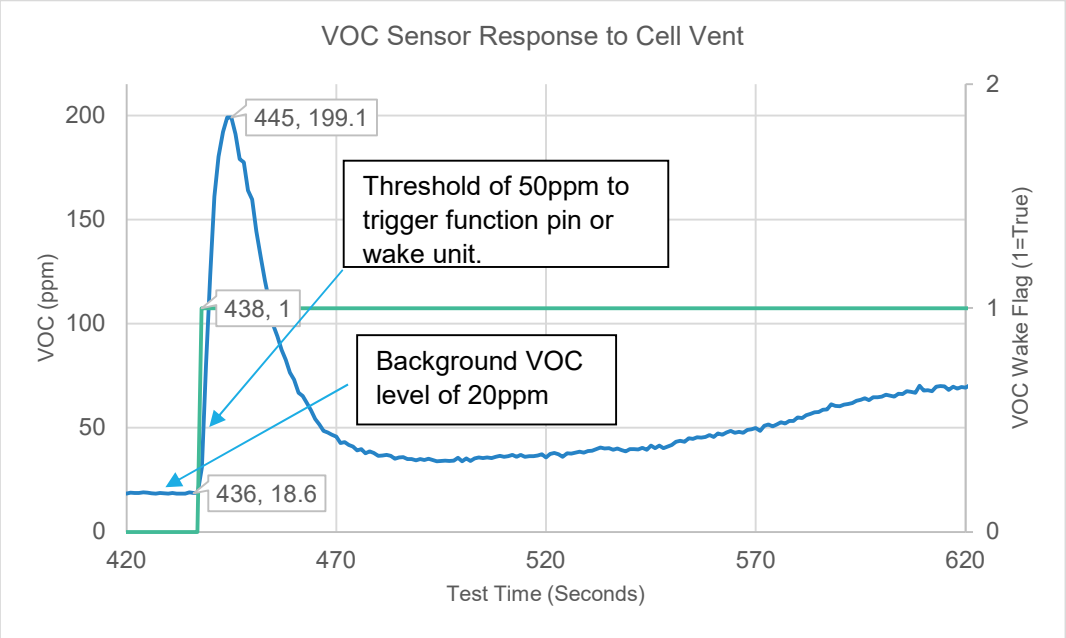


FIGURE 2 VOC PPM RESPONSE TO AN 18650 NMC CELL VENT IN BATTERY PACK WITH ~40LTR OF FREE AIR SPACE

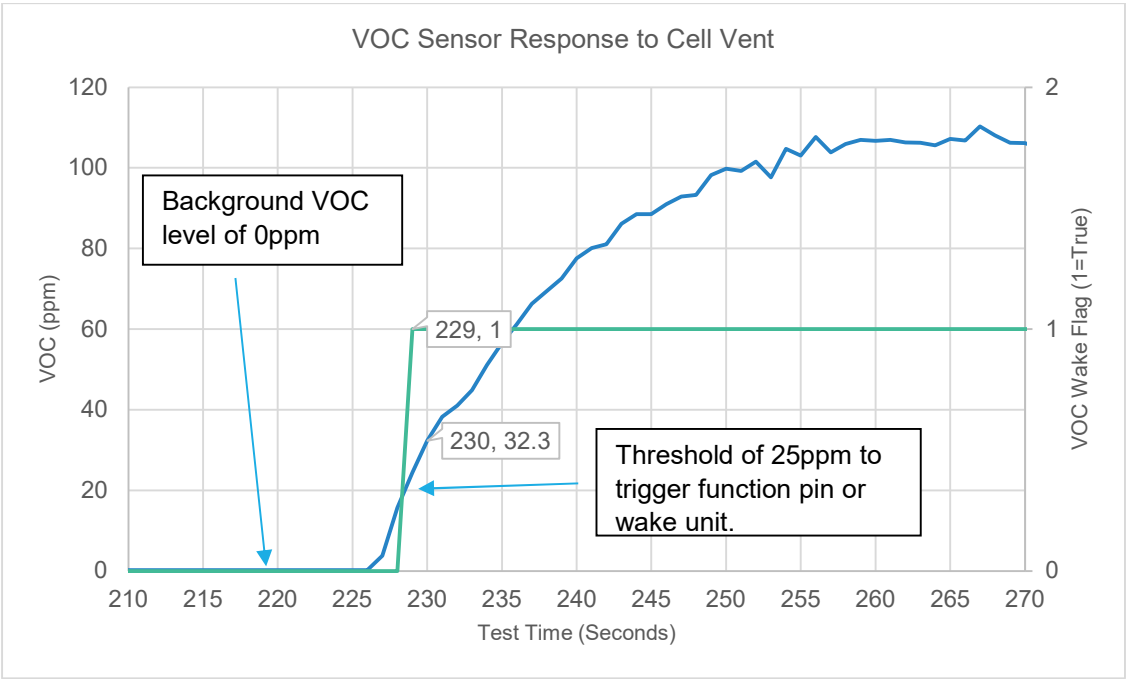


FIGURE 3 VOC PPM RESPONSE TO AN 18650 LFP CELL VENT IN A BATTERY PACK WITH ~40LTR OF FREE AIR SPACE

Moisture Ingress

The sensor measures relative humidity, this can be useful to detect water ingress in a pack. The higher the relative humidity the more water is dissolved in the air, if it is close to saturation point (>95% relative humidity) this can indicate that water is within the pack. This water ingress as well as damaging electronics can cause a high voltage risk as follows:

1. Moisture enters the battery.
2. Water pools and connects the battery positive or negative to the chassis.
3. If fitted an Insulation Monitoring Device will detect this and if configured will open the battery contactor.
4. As the fault remains in the battery this will not remove the high voltage connection to the chassis.

Dew Point and Battery Thermal Control

Dew point temperature is a calculation performed by Cell Guard, this is useful as it indicates the surface temperature at or below which moisture will start forming on that surface.

For actively cooled packs this is useful for thermal control, for example if the relative humidity is 50% and air temperature within the pack is 24°C the dew point is 13°C which means that if the cells are cooled beneath this temperature moisture will start forming on them.

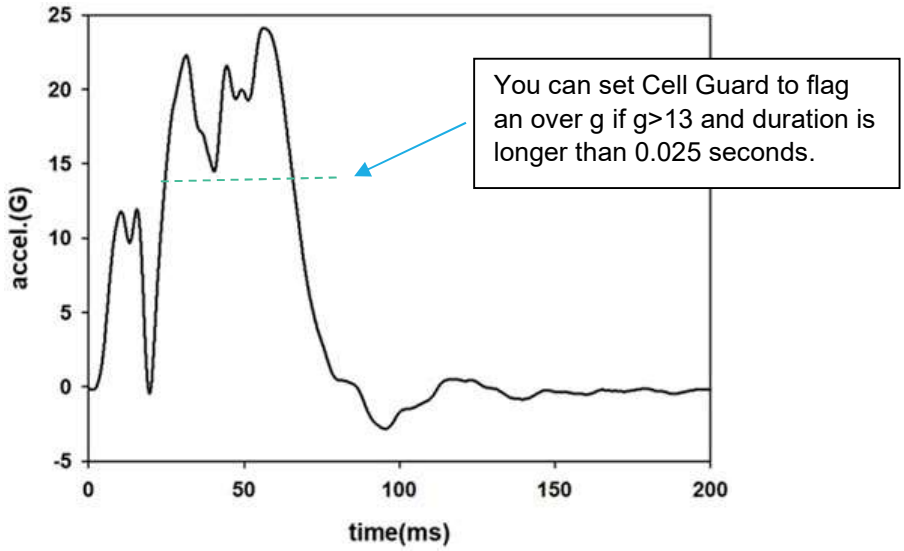
Thus a cooling system can use the dew point parameter to control the minimum temperature of the battery to cool down to.

Impact Detection

Cell guard is available with an optional triple axis +-24g Accelerometer. The unit can be configured to wake and turn on the function pin above a specified g and duration at that g.

This is extremely useful to know if the pack has been subject to an impact that might damage it.

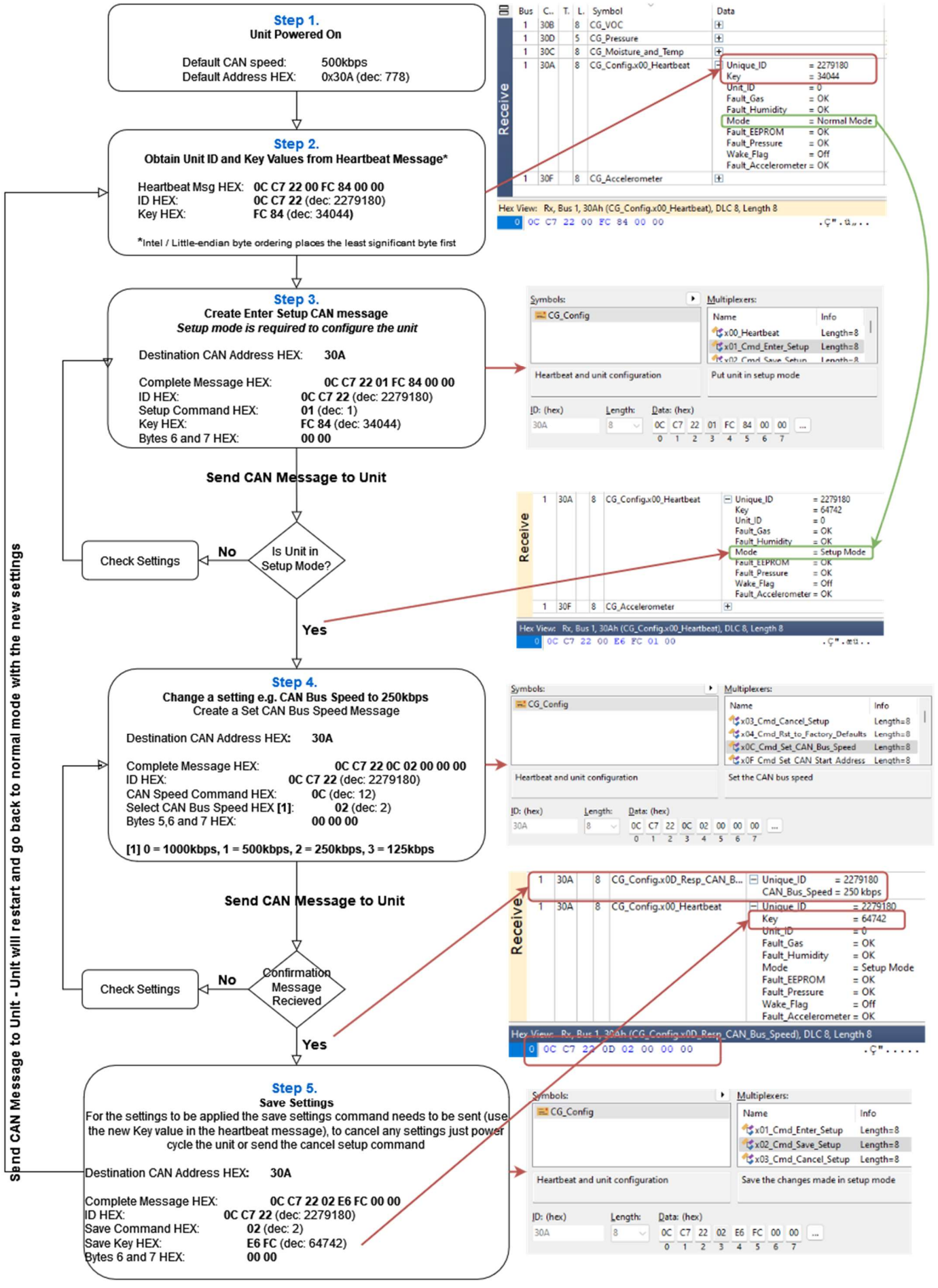
Although vehicles have airbag sensors which protect the occupant, Cell Guards accelerometer can be used to protect the occupants by ensuring the battery remains safe to use.



(Ref Effects of an integrated safety system for swivel seat arrangements in frontal crash)

FIGURE 4 A 20 MPH GENERIC FRONTAL VEHICLE PULSE FROM A CHASSIS MOUNTED ACCELEROMETER

How to Configure and Use Wake Feature and Function Pin



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The unit needs to be in setup mode to perform the below steps. These set of instructions assumes you are at step 4 in “Workflow to Configure a Unit” above.

This example shows how to configure Cell Guard to turn on the function pin and wake up (if in low power mode) if a VOC ppm above 50ppm is detected.

At step 4 above, create a x4D_Cmd_Set_VOC_Wake message.

In this message set the **Wake_VOC_Max** value to 50ppm and set the **Wake_Off_On_IO** to on (this will turn on the function pin when a VOC ppm of over 50 is detected and wake the unit, where by it will start transmitting data on CAN again.

If the unit is already awake and a VOC ppm of over 50 is detected the wake flag in the CAN data will still be shown.

How to Put the Unit in Low Power/Silent mode

Low power mode is useful if you want the unit to continue monitor the environment but use low power (~3mA). In this mode the unit does not transmit data on CAN but continue to monitor the environment within the battery pack.

Unlike configuring the unit, Cell Guard does not need to be in setup mode for this to work, it can be sent at any time whilst the unit is in normal mode.

Cell Guard will enter low power mode if the **x12_Cmd_Set_Unit_Mode CAN** message is sent to the unit with the power mode set to “Silent Mode”.

Cell Guard will exit this mode if a:

CAN command is sent telling the unit to go back to normal power mode.

Threshold if reached, e.g. the unit is configured to wake on air temperature being over 40 °C.

Wiring Example

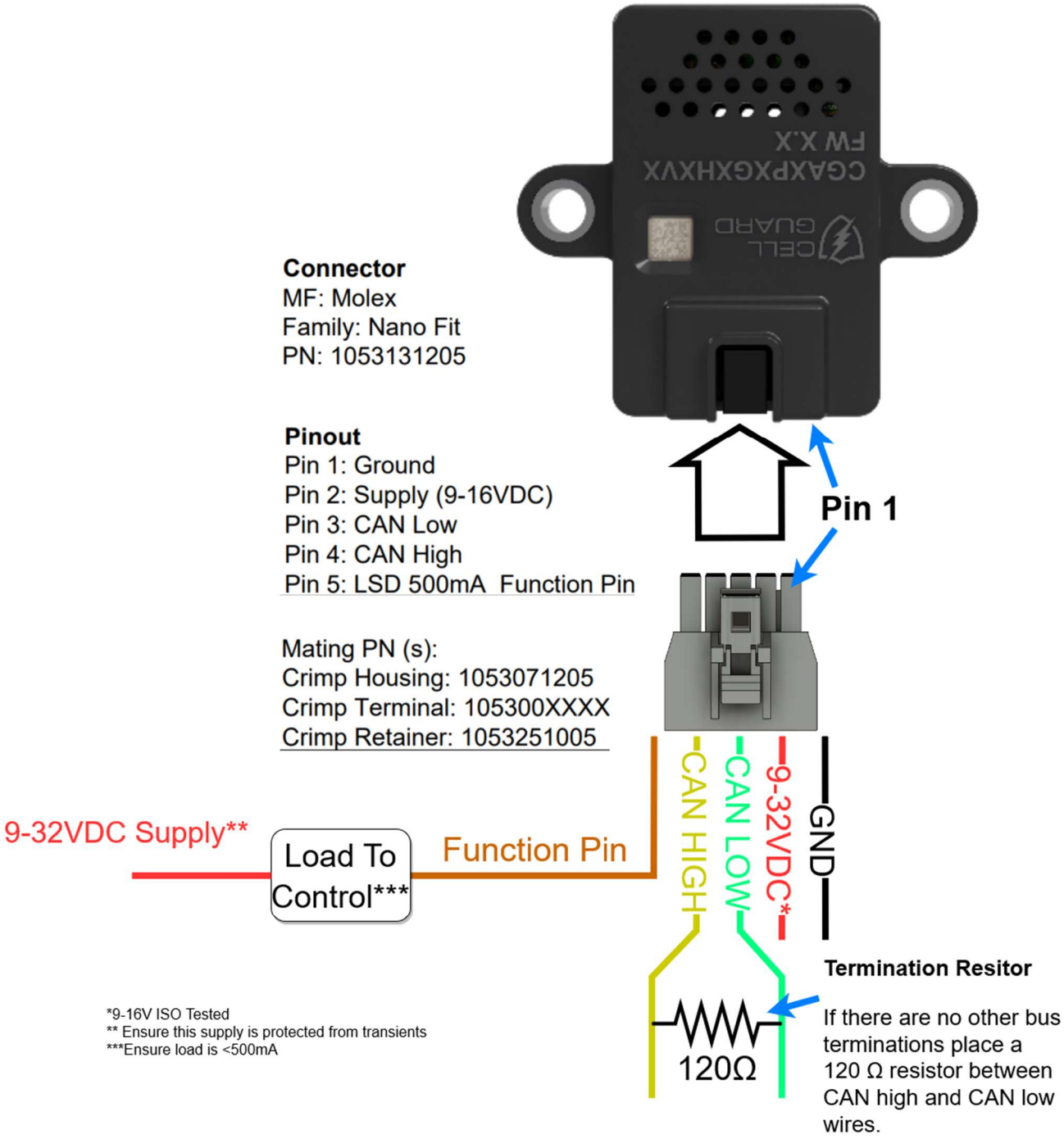

FIGURE 5 WIRING EXAMPLE

Mechanical

Mounting

Mount using 2 x M5 bolts with torque setting 4Nm for dry (3Nm Lube).

Mount near breather port (if possible and fitted) and/or where vented gases are expected to travel. Mount so moisture does not pool around sensor. Mount away from anticipated direction of cell vent (not directly over the venting cell).

Recommend 1 sensor per 80 liters of free air volume or 1 per half height 19 inch rack.

Dimensions

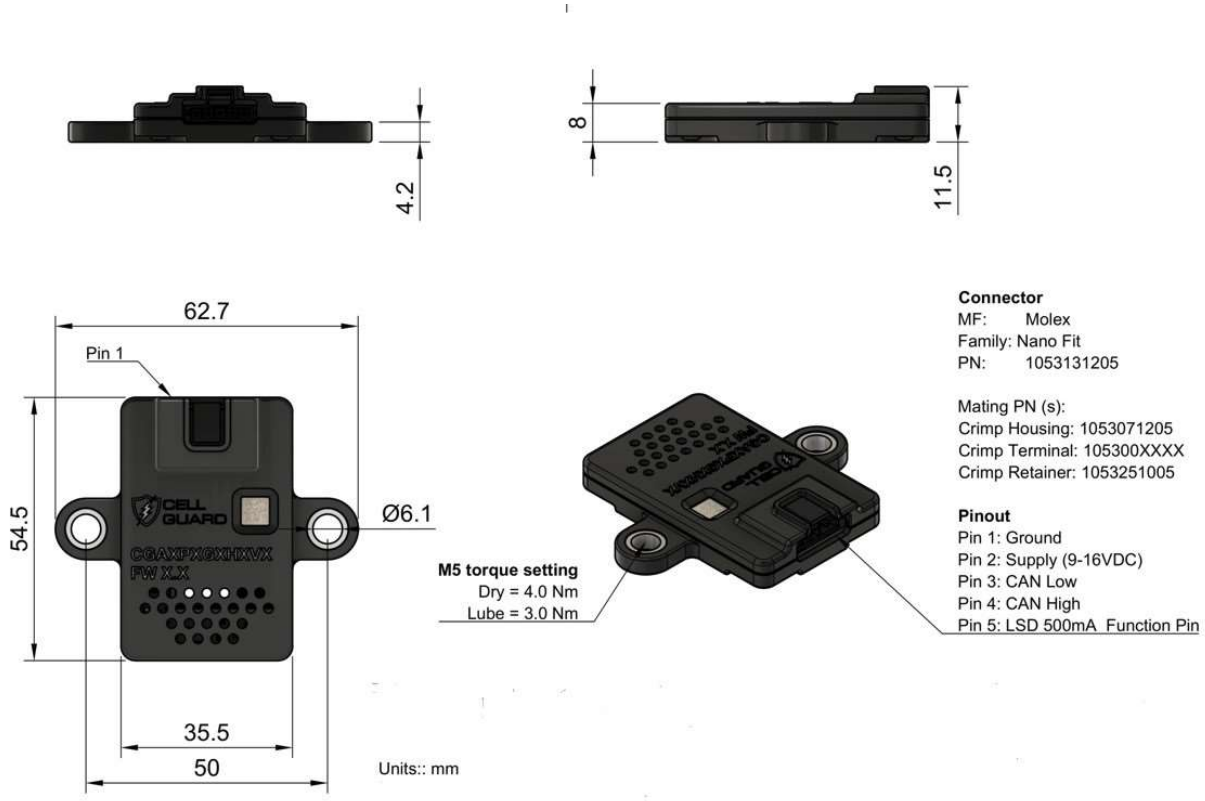

FIGURE 6 SENSOR DIMENSIONS

Suggested Installation

Install inside the battery enclosure near breather port (if fitted), avoid installing where moisture might pool, do not install immediately in path of anticipated battery vent direction (this may damage the sensor before it can detect a vent). If it is the accelerometer variant, ideally the sensor is aligned with the axis of the vehicle to ease processing of data.

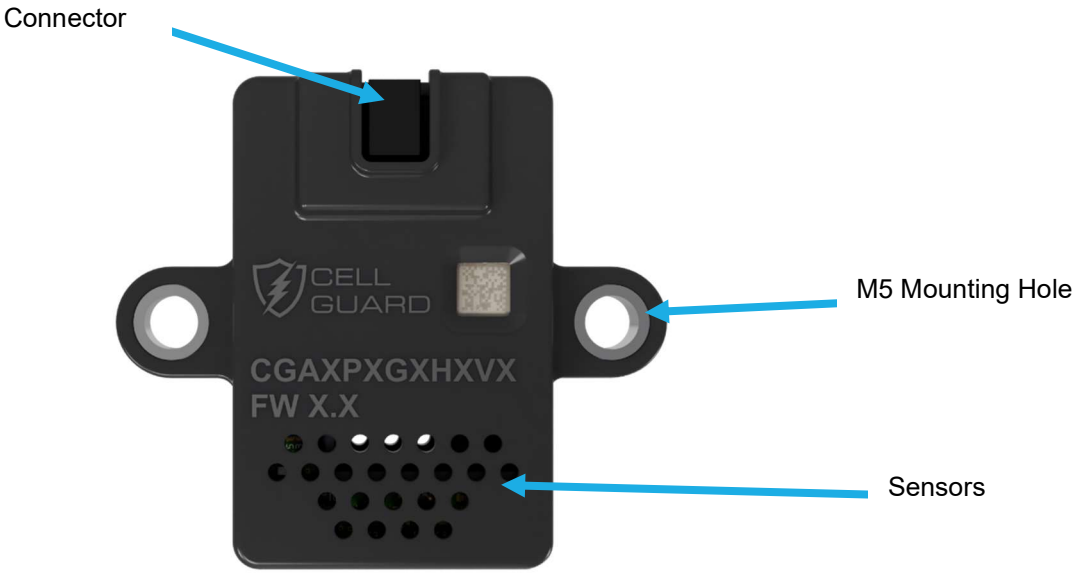

FIGURE 7 EXTERNAL FEATURES

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