



Installation Manual

Freedom Lite Home and Business

Range of Lithium Iron Phosphate Battery Modules

Manufactured by Freedom Won (Pty) Ltd

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1. Introduction

This manual is intended to provide assistance to an installer for the installation and commissioning of the range of **Freedom Lite** lithium iron phosphate (LiFePO₄) energy storage modules. This document is not intended to provide detailed information of the inner workings of Freedom Lite that is not relevant to a person that is performing the installation and final commissioning. Supplementary information relating to programming of the built in battery management system for specific applications is available to approved integrators directly from Freedom Won.

This manual does not attempt to cover all the details pertaining to the setup of third party equipment in relation to the interface and necessary functionality to work with the Lite. Freedom Won however is available at the contact details on page one to provide direct support where necessary for supported third party brands.

2. Product Description

The Freedom Lite technology is available in various standard sizes to meet all residential, commercial and industrial applications ranging from 5kWh up to 2500kWh. Larger systems are provided by Freedom Won based on specific project requirements by installing multiple units in parallel.

Freedom Won offers the following ranges in the LiFePO₄ technology:

1. Lite 12V
2. Lite Mini (note this range is only available for volume orders in specific countries, please enquire with Freedom Won Sales)
3. **Lite Home and Business**
4. Lite HV Home and Business
5. Lite Marine
6. Lite Mobility (golf carts, forklifts etc)
7. Lite Commercial
8. Lite Industrial

This manual covers the standard voltage models of the **Lite Home and Business** range from 5kWh up to 80kWh. Please refer to the manuals specific to the other ranges.

The standard Lite voltage is 52V nominal (to suit 48V systems). The Freedom Lite HV range is designed for specific **Higher Voltage** inverters such as those from Ingeteam (Ingecon 1Play 3TL and 6TL). Custom voltages for various UPS systems are available on request. The Lite Commercial range varies from 52V to 800V depending on customer requirements. The Industrial range varies from approximately 500V to 800V depending on customer requirements.

For some of the Home and Business models there are **High Power (HP)** models also available for instances where a high power output is required for short term high power UPS

applications or where momentary high loads are experienced. These models are essentially standard Lite models that have upgraded circuit breakers and conductors. The HP upgrade adds 6kW to the output power in the Home models. The jump is larger in the Business models – please refer to HP specification sheet in this manual.

The Lite Marine range of lithium batteries is available on request with similar specifications to the Home range including 26V and 13V options to suit 24V and 12V systems respectively. These models are water resistant (IP65) and designed for mounting on the floor or horizontal deck and have dimensions that are different to the Lite Home models. For more information on these models please contact Freedom Won.

Table 2.1 provides an overview of the 52V Freedom Lite Home and Business range. There are eight Freedom Lite models in the Home and Business range, as included in the tables, classified in terms of energy capacity.

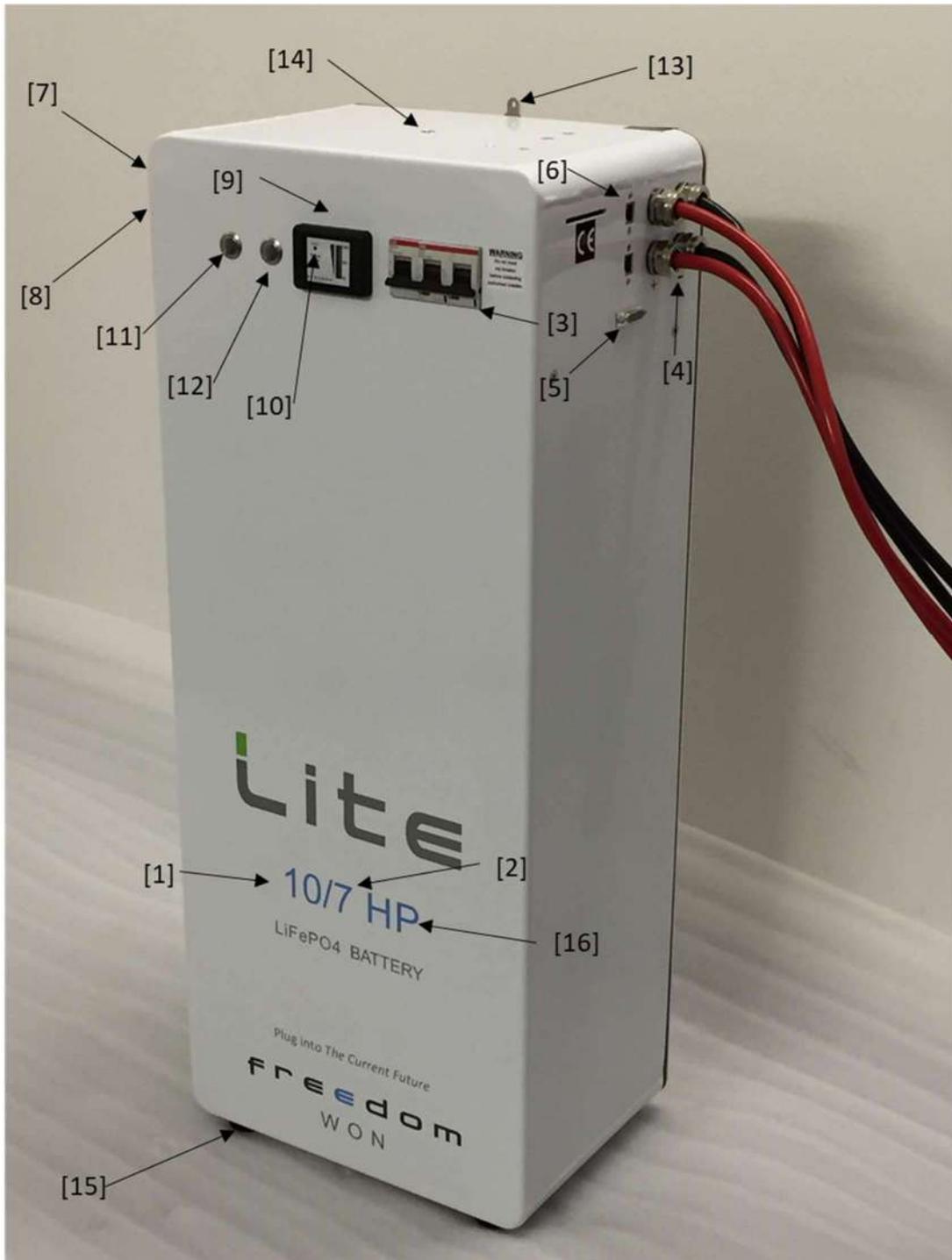
An image with numbered labels pertaining to the following paragraphs is provided in Figure 2.1. The model number denotes with the first number [1] the total energy storage capacity in kWh of each model. The second number [2] denotes the average amount of energy in kWh that should be withdrawn per cycle (on average) in order to optimise the life of the lithium cells. This equates to 70% of the total for each model i.e. 70% depth of discharge (DoD). **Note that all Freedom Lite batteries offer a maximum of 90% DoD as standard.**

The range is designed with a tall and slim profile with the “Home” models intended to be wall mounted (floor mounting is also possible – all models are supplied standard with plastic feet). The larger “Business” range is floor standing with aluminium feet with plastic pads on the underside.

The Ah capacity is also provided in the tables for each model for easy reference.

The maximum current for each model is governed by the rating of the built in circuit breaker [3], which has been sized well below the maximum current capability of the lithium cells. For this reason there is no noticeable temperature rise during operation and no cooling of the cells is required. There is no specific time limit for operation at the maximum current, however to ensure that the circuit breaker does not trip in normal operation it is advised that the design of the system aims to remain at or below the continuous current value.

Figure 2.1 Labelled Image of the Freedom Lite Home 10/7 (Labelling corresponds with the text)



1. Gross Capacity
2. 70% Capacity recommended for daily cycling (max available is 90%)
3. Breaker
4. Power Cables
5. DB15 Analogue and Relay Control Port

6. *CAN Bus Sockets x 2 (RJ45) (one socket must contain a termination resistor if end of line)*
7. *DB9 Programming Port (not visible in photo)*
8. *Reset Button (not visible in photo)*
9. *State of Charge Display*
10. *Error Lite*
11. *On Button*
12. *Off Button*
13. *Lifting Eye Bolt Hard Point*
14. *Safety Retaining Tab for Floor Mount Option*
15. *Feet*
16. *Power Level Designator (absent for standard model) – note, the HP models have become the new standard models as of 1 April 2019 and the HP upgrade is no longer available*

All standard Freedom Lite models operate at a nominal voltage of 52V, which suits the most commonly available residential battery inverters.

The absolute maximum voltage when fully charged is 56V, however a more typical setting is 55.5V. The voltage normally used as the minimum cut off is 48V, however this will not typically be reached if operating down to 90% Depth of Discharge (DoD). The BMS will trip the battery breaker beforehand at 10% SoC (90% DoD) which roughly equates to 49,0V). Under high load the voltage may drop to 48V whilst still above 10% SoC.

The weight of each model is given in the tables. The Freedom Lite Home 5/4 can be manually lifted by two people onto its hanging points. The larger units require lifting equipment of varying degrees for handling and installation as explained later in this document.

The dimensions given are for the principle outlines of the aluminium housing and exclude items that protrude such as the DC cable glands and the circuit breaker handle.

The DC cables exit the unit through glands located on the **top right hand side** of the casing and vary in number according to the model [4 in Figure 2.1]. The correct cable lugs for connecting these leads to the inverter must be in hand when doing an installation. If there are several inverters and charge controllers that need to be connected to the battery it is advisable to install a DC connector box to use as a junction point from which to branch out to all the battery connected equipment.

A DB15 plug [5 in Figure 2.1] is located below the DC fly lead glands for connection in installations where an analogue or dry contact interface compatible inverter or charge controller is used. Where dry contact control is required an **external relay must be installed**, which will be controlled by the control pins in the DB15 plug (more detail later in manual).

Table 2.1 Freedom Lite Range Overview – Standard Power/Current Output

Freedom Lite	Home 5/4	Home 10/7	Home 15/11	Home 20/14	Home 30/21	Business 40/28	Business 60/42	Business 80/56
Max Energy [kWh]	5	10	15	20	30	40	60	80
Energy, 70% DoD [kWh] (1)	3,5	7	11	14	21	28	42	56
Energy, 90% DoD [kWh]	4,5	9	13,5	18	27	36	54	72
Current Capacity [Ah]	100	200	300	400	600	800	1200	1600
Max/Cont. Current [A] (2)	250/200	250/200	375/300	375/300	750/600	750/600	1000/800	1000/800
Max/Cont. Power [kW] (2)	13,0/10,4	13,0/10,4	19,5/15,6	19,5/15,6	39,0/36,4	39,0/36,4	52,0/31,2	52,0/31,2
Max Recommended Inverter Rated Power (cont.) [kVA]	8	8	12	12	24	24	36	36
Nominal Voltage [V]	52V, to suit 48V Inverters, min 47V, max 56V							
Weight [kg]	60	108	158	211	310	412	613	811
Dimensions on or against wall - Height x Width x Depth [mm]	550x372x265	916x372x265	916x540x265	916x712x265	953x1044x265	1850x584x310	1850x859x310	1858x1142x310
Enclosure	Aluminium – powder coated white front rated for indoor use							
DC Connection – Fly Leads, [no. per electrode] (3)	1x 50mm ²	1 x 50mm ²	2 x 50mm ²	2 x 50mm ²	2 x 90mm ²	2 x 90mm ²	2 x 120mm ²	2 x 120mm ²
External Interfacing – (4)	<p><i>DB15 Plug</i> – 48V Relay Control and Analogue Outputs. Relay control – Separate Remote Enable for Inverter, Charger, Solar Charge Controller and a Multi-Purpose Programmable Output. Analogue Outputs – 0-5V Signals for Charge Current Limit, State of Charge.</p> <p><i>RJ45 Socket x 2</i> – CAN Bus for Interfacing with Compatible Inverters and System Controllers, connection of parallel batteries.</p>							
Protection	Shunt Trip Circuit Breaker sized to suit max current, can be tripped by BMS if critical fault, manual reset. Includes overcurrent, cell under and over voltage, temperature, weak cell detection, minimum SOC control							
Human Interface	State of Charge Display (0 to 100%), Error light, Error Reset Button, Serial RS232 Plug for Programming, WiFi remote monitoring (optional accessory)							
Warranty [5]	10 years (or 3 500 cycles) warranty for average 70% DoD, and max 90% DoD							
Service Life [5]	15 years (or 5 500 cycles) expected life at 70% DoD (1), 20 years (>7 000 cycles) at 50% DoD							

Notes to Table 2.1

- 1) DoD = Depth of Discharge, recommended 70% DoD on average for extended life, 50% DoD on average for optimal life – max for normal operation 90% DoD, max for system in standby 100% DoD.
- 2) Applies to both charge and discharge. Max load duration not time limited. 2 x Max overload can be handled for 2 seconds
- 3) Fly Leads 1,8m long, power cable Red = Positive, Black = Negative, conductors in table refer to one electrode i.e. per positive and negative connections
- 4) The hardwired control is via a DB15 plug and the CAN control is via a ethernet cable (may be non-standard pin configuration for some inverters). If Hard Wired control is required enquire about Freedom Won accessories eg control harness, contactor box, relay box.
- 5) End of Life (EoL) defined as cell dropping to 60% of Beginning of Life (BoL) capacity for expected life and 70% of BoL capacity for warranty.

Two RJ45 sockets [6] are provided, one for connecting the CAN interface from the battery to the system controller or directly to the inverter depending on the brand, and another for connecting the battery to another battery or for a termination resistor (more detail later in manual).

A DB9 Serial Connector [7 - concealed] is fitted to the upper left hand side of the housing for use by technicians for programming the required profile onto the BMS. The required profile is typically loaded by Freedom Won prior to delivery but installers are advised to obtain a DB9 RS232 to USB adapter cable (Figure 2.2) to allow Freedom Won to program batteries remotely on behalf of the installer via the installer’s Windows laptop if necessary. The DB9 plug must have the male pins and can be supplied by Freedom Won.

An error reset button [8 - concealed] is positioned adjacent to the DB9 plug.

Freedom Lite is also fitted with a State of Charge (SoC) display [9], which includes a red LED error indicator [10] and below it a “low power” indicator.

Figure 2.2 RS232 DB9 (male) to USB Adapter for Programming Freedom Lite Profiles



The ON button [11] and OFF button [12] are located beside the SoC display.

The Lite Home range is intended to be wall mounted, but if a sturdy wall is not available floor mounting is an option. The Lite is supplied with a securing tab at the top in the middle as part of the rear cover to secure the battery against the wall to prevent it from tipping

over [13]. **Note:** this tab must not be used to support the weight of the Lite, only to ensure it does not topple over when mounted on the floor. This tab is not suitable for securing the Lite in a moving vehicle where vibration could occur.

All Lite's have feet as standard, whether needed or not [15].

A hard point is supplied on the top [14] for inserting an eye bolt for hoisting onto the wall mountings. The Lite 30/21 and above are supplied with permanently installed eye bolt(s).

The power level of models manufactured prior to 1 April 2019 is designated [16] by the following:

1. no designator = standard,
2. HP = High Power,
3. XHP = Extra High Power

Models manufactured from 1 April onwards have no power designation as only one power rating is available – in general the original HP model has become the new single model for the respective size.

3. Transport, Handling and Mounting

The Freedom Lite units are packaged in protective layering and fastened into a wooden crate with feet, which allows lifting with a forklift or a pallet jack. The Freedom Lite Home 5/4 and 10/7 models are easily handled by two people. The 15/11 and 20/14 models may be manually handled by sufficient people but are best handled by a pallet jack or forklift. The 30/21, 40/28, 60/42 and 80/56 models must be handled with care by a forklift or pallet jack of the required lifting capacity rating.

If it is necessary to transport the larger units (typically 40/28 and larger) up or down multiple stairs in order to get them to the point of installation in the premises it may be preferable to deliver the unit with the lithium cells separate and then Freedom Won will fit them into the unit on site. This must be arranged with Freedom Won at the time of order placement and will attract a nominal fee for labour plus transport and accommodation where applicable. This service is not available in all countries. Please enquire with Freedom Won Sales.

The "Home" series is designed for wall mounting in order to preserve room and floor space and offer a convenient obstruction free and aesthetically pleasing solution. Each model is fitted to the wall using two Rawl Bolts. The Rawl Bolts are inserted into correct diameter pre drilled holes in the wall. **The bolts must first be tightened substantially so that the internals of the Rawl Bolt have gripped tightly into the wall, and then the bolt must be turned out slightly with the head protruding so that about 5mm of the bolt shank is visible. This pre-tightening prevents the bolt from being pushed into the wall when mounting the Lite.** The Freedom Lite has two keyhole shaped holes in the reverse, which are shaped to fit over the bolt heads and then a narrowed section secures around the bolt shank as the unit is lowered into its final position. The 5/4, 10/7 and 15/11 models are hung using M8 bolts whilst the 20/14 and 30/21 models are hung on M10 bolts. The centre to centre spacing of these bolts

must be applicable to the model being installed. It is critical that these bolts are mounted within 1mm of the correct dimension and must be perfectly level.

Figure 3.1 Bolt Mounting Keyhole on Rear of Lite Casing – Warranty Seal also visible



All models have hard points on top for fitting eye bolts. The 30/21 and upwards models are supplied with one or two permanently fixed eye bolts but the other models are supplied with a thread point only (remove the plastic cap from the hole and replace after installation). These eye bolts can be used for hoisting the unit up to the required height for fitting to the wall. This is easily achieved by drilling a Diameter 16mm hole in the wall about 800mm above the mounting bolts, inserting a steel rod of 16mm diameter and using a chain block of adequate lifting capacity to lift the Freedom Lite up to the required height. The hole for the steel rod must be angled about 10 degrees downwards into the wall so that the inserted rod is also at this angle, which prevents the chain block hook from sliding off. The 5/4 is not fitted with an eye bolt attachment point because it is light enough to be handled manually. The eye bolt(s) on the models up to the Lite 20/14 can be removed after installation and the hole in the wall closed up with filler. Ensure that you have one M12 x 1,75 thread eye bolt rated for 450kg or more for the models that are not supplied with permanently fixed eye bolts.

Figure 3.2 Eye bolt Example



Figure 3.3 Eye bolt Installation on a Lite 10/7 model (remove after installation)



The units can alternatively be lifted to the right height and onto the hanging bolts using a high-lift pallet jack such as shown in Figure 3.4 or a site assembled gantry with electric winch as shown in Figure 3.5. This gantry is available from Freedom Won as an accessory and is available with various gantry widths.

Figure 3.4 High Lift Pallet Jack



Fig 3.5 Site Assembled Gantry with Electric Winch



Caution:

1. *Great care must be taken to ensure that the Rawl Bolt has properly located into the narrowed section of the mounting hole before removing the support.*
2. *Handle the Freedom Lite with great care when lifting and manoeuvring. It should remain either lying flat on its back, one a long side, or vertically upright (it should not be placed upside down or on its front face. When manoeuvring through a doorway on its long side be certain to pack spacing foam to prevent damage to the plugs and glands.*
3. *Do not allow the pallet jack to over centre if it is a model with forks longer than the lower arms*
4. *Take care not to knock any of the protruding items against obstacles during handling such as the DC cabling and plugs and the circuit breaker handle.*
5. *Take care not to scratch the Lite during handling. Packaging foam should be used to protect the paint when being handled on a trolley or pallet jack.*
6. *Always ensure that lifting equipment and slings are adequately rated for the lifting weight.*
7. *Ensure that the eye bolts are fully screwed into the hard point thread on the top of the unit before lifting.*
8. *Wear personal protective equipment such as safety shoes and gloves while handling and mounting the Freedom Lite*
9. *Always ensure that you have enough people on hand to perform the operation safely, i.e. at least one person to guide and stabilise and one person to hoist or handle the pallet jack.*
10. *The gantry can be configured for wall mounting – when using the gantry in this configuration absolute care must be taken to prevent the gantry from being pulled over by non vertical tension on the rope.*

4. Connecting up the Freedom Lite

4.1 Power Cables

The Freedom Lite is simple to connect to the battery inverter. First of all you will connect the 48V positive and negative cables to the inverter terminals using the applicable lugs.

Caution: Prior to connecting the positive and negative cables to the inverter be sure to check that the main battery circuit breaker is switched off. This will ensure that there are no short circuits between the loose ends of the cables.

The cables are supplied with the Freedom Lite, permanently fixed into the unit and secured onto the casing using compression cable glands. Attach crimp plugs to the ends of both cables ensuring that the correct terminal size is used and also to match the size of the cable. The positive cable is red and the negative cable is black. This is confirmed by + and – signs

on the battery casing beside the respective cables. See Tables 2.1 for the cable size and quantity fitted to each Freedom Lite model. The cable sizes are based on the inverter being mounted on the wall adjacent to the Freedom Lite battery so that the cable run is less than 3m (note however that the standard cable length is 1,8m, longer cables available in request).

Longer runs should be assessed and larger cables considered for extending the Freedom Lite cables, minimising voltage drop. Double Insulation welding cable is recommended. Multiple lengths are used instead of using larger cable so as to ensure easier routing and bending of cables in trunking.

The cables may be routed through trunking and connected into the inverter on the positive and negative terminals respectively. The inverter terminals on most inverters can then be used for linking up the charge controller(s) to the DC Bus. On Installations where there are too many inverters and/or charge controllers to connect to the DC bus using the inverter terminals as a junction point a DC connector box is required. The battery cables can be separately routed directly to separate equipment (inverters and charge controllers) – if this is done the installer must take care to ensure that any one of the cable pairs will not be overloaded. The cables for each pole are connected together inside the battery.

4.2 Control Cables – Overview

For controlling external devices you will need to connect the control wiring that allows the Battery Management System inside the Freedom Lite to control and interface with these devices.

There are two connection options on the Freedom Lite. One is a DB15 plug. The mating harness can be purchased from Freedom Won. The other is an ethernet cable plugged into the RJ45 plug.

The connection of the cables depends on the model of inverter and the method of control. There are three main control options for the inverter, namely:

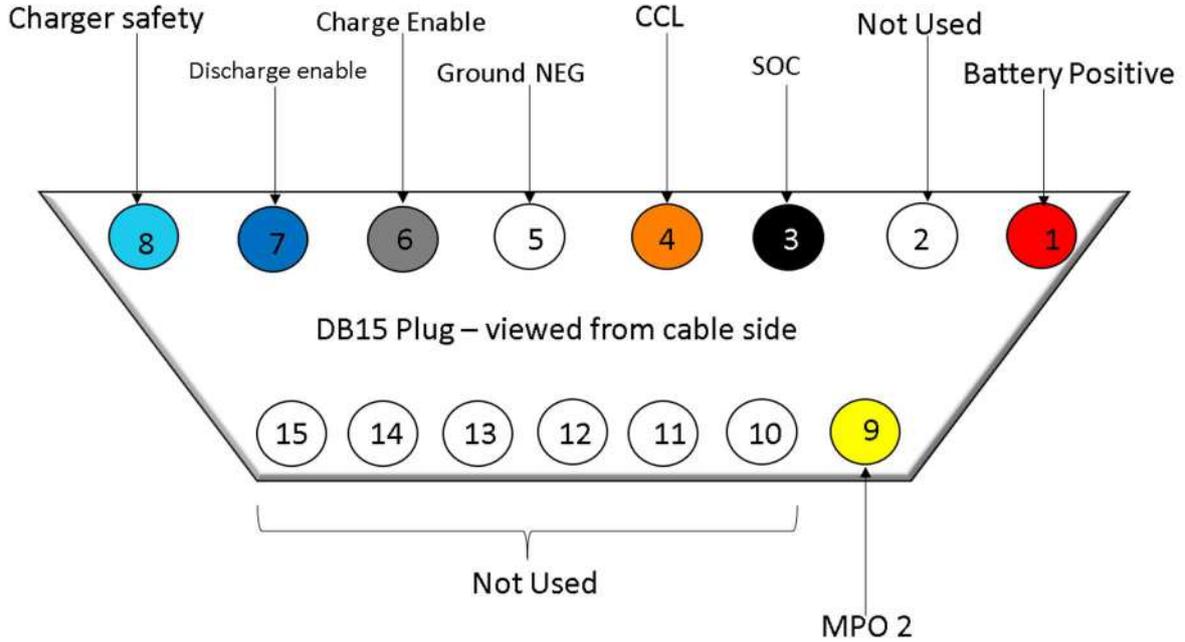
1. hard wired potential free contacts that are connected to auxiliary inputs or remote on/off switches on the inverter and charge controller,
2. analogue 0-5V,
3. or CAN Bus.

The Lite does not contain internal relays for Option 1, so external relays are required, which are controlled by the relay coil driver wires from the DB15 plug. Freedom Won supplies relay boxes for this purpose, pre-wired for the DB15 harness.

A fourth option exists for inverters that do not have an interface, namely the control of external contactors on the AC input and Output and on the DC PV cable circuit to ensure that no overcharge or discharge can occur.

The DB15 control cable contains 12 wires, each of a different colour, of which eight are used. Table 4.1 below provides the DB15 pin configuration for the control cable and the colour coding for the Freedom Won supplied cable (refer to Accessories section).

Figure 4.1 DB15 Plug Pin Configuration and Freedom Won Supplied Cable Colour Coding.



Further explanation of the functions is laid out in Table 4.1

Table 4.1 Description of Functions on DB15 Plug

Wire Colour in 12 Core Control Cable Supplied by Freedom Won	Pin Number on DB15 Plug	Wire Function	Remarks
Red	1	Battery Positive (depends on battery voltage – standard 52V)	Used to supply power to external control relay coils and contactors
N/A	2	Not Used	
Black	3	State of Charge (SoC) Signal – 0-5V Analogue Output	Provides a linear analogue signal where 0V = 0% and 5V = 100% - used for inverters with 0-5V inputs for retrieving SoC and for remote SoC displays
Orange	4	Charge Current Limit (CCL) Signal – 0-5V Analogue Output	Provides a linear analogue signal where 0V = 0A allowed for charge and 5V = 100% of battery charge current capacity - used for inverters and charge controllers with 0-5V inputs for retrieving the maximum allowed charge current in real time
White	5	Battery Negative	Provides a negative for contactor coils that are operated by control relay and a negative reference for the analogue signals
Grey	6	Solar Charger Enable Open Drain Relay Driver Signal Output	Provides a current drain to sink current through an external control relay coil that is provided with battery power on the coil power supply terminal from Pin 1. When the relay is closed the Solar Charger is enabled to begin charging. When the relay is open the Solar Charger must be disabled to prevent over charging the battery
Blue	7	Discharge (Inverter) Enable Open Drain Relay Driver Signal Output	Provides a current drain to sink current through an external control relay coil that is provided with battery power on the coil power supply terminal from Pin 1. When the relay is closed the inverter is enabled to begin discharging (supplying power to the loads from the battery). When the relay is open the inverter output must stop discharging the battery to prevent over discharging
Turquoise	8	Inverter Charge Enable Open Drain Relay Driver Signal Output	Provides a current drain to sink current through an external control relay coil that is provided with battery power on the coil power supply terminal from Pin 1. When the relay is closed the AC Charger in the inverter is enabled to begin charging. When the relay is open the AC Charger must be disabled to prevent over charging the battery
Yellow	9	Multi-purpose Output Open Drain Relay Driver Signal Output	Provides a current drain to sink current through an external control relay coil that is provided with battery power on the coil power supply terminal from Pin 1. The Multi-purpose output can be programmed for various functions based on SoC, voltage, and temperature ranges. Please enquire with Freedom Won for programming of this output.
N/A	10	Not Used	
N/A	11	Not Used	
N/A	12	Not Used	
N/A	13	Not Used	
N/A	14	Not Used	
N/A	15	Not Used	

The CAN Bus connection is made using the RJ45 plug with the pin configuration on the battery plug end provided in Table 4.2.

Table 4.2 Colour Coding and Pin Configuration for CAN Bus Control Cable

RJ45 Pin No.	Standard Ethernet Cable Colours	Wire Function
Pin 7	Brown/White	CAN High
Pin 8	Brown	CAN Low

For Victron systems using the Color Control or Venus the pin configuration is straight through and therefore a standard ethernet cable can be used. For other inverters such as SMA this configuration is such that a special cable is required – please refer to the respective inverter brands manuals for their pin configuration or contact Freedom Won for assistance. Special cables for all the supported inverter brands are available from Freedom Won (see accessories section).

3.1.1 Hard Wired Control – Detailed Description

This method of control is used when the inverter or charge controller is fitted with a remote enable (or on/off) switch, or inputs that can be used to enable or disable the respective functions as required. An example of equipment containing this type of interface is the range of Victron Multiplus and Quattro inverters.

The digital control signals are provided by an external relay using a normally open pole pair. One wire in each pair is referred to as NO (Normally Open) and the other as COM (Common). The relay control circuit in the Freedom Won Relay Box (see accessories section) is designed to carry loads up to 5A. Should a larger draw be required an additional external relay must be used. These pairs are not fused. In the case of the Victron range it is not necessary to install a fuse on the remote enable or Auxiliary Inputs (AI's) but it would be prudent to include a 5A fuse for other control applications that do not have current limit protection.

The following functions are available for this type of installation:

1. Charger Enable – this is achieved using a pair of potential free contacts from a relay inside the external Relay Box. This relay is normally open and is only closed if the Battery Management System (BMS) is 'satisfied' that the battery may receive a charge current. The closing of this relay will then enable the external charge equipment. The standard parameters for determining this are programmed into the BMS by Freedom Won prior to delivery. Freedom Won or certain approved installers are able to alter these parameters if a non-standard configuration is required. The standard configuration is to enable the mains charger (inside the inverter) so that it may begin charging if the mains (grid) power is available and only if:
 - i. there are no errors (trouble codes) registered by the BMS that would affect the ability of the battery to safely receive a charge (there are numerous protection algorithms and not all are detailed here)

- ii. the voltage of any individual cell is below the maximum cell voltage setting (3.75V)
 - iii. the temperature of the pack is inside of its operating range for charging (0 to 50°C)
 - iv. The SoC has dropped to a pre-defined level (usually 30%). This is so that the grid is not used for charging unless it becomes really necessary.
2. Inverter Enable - this is achieved using a pair of potential free contacts from a relay inside the external Relay Box. This relay is normally open and is only closed if the Battery Management System (BMS) is satisfied that the battery may provide a discharge current. The closing of this relay will then enable the external discharge equipment, namely the inverter (note this is intended to control the inverter section of the inverter/charger device independently of the charger in the same device). The standard parameters for determining this are programmed into the BMS by Freedom Won prior to delivery. Freedom Won or approved installers are able to alter these parameters if a non-standard configuration is required. The standard configuration is to enable the inverter (discharge of the battery) so that it may begin providing power to the load only if:
 - i. there are no errors (trouble codes) registered by the BMS that would affect the ability of the battery to safely provide a discharge current (there are numerous protection algorithms and not all are detailed here)
 - ii. the voltage of any individual cell is above the minimum cell voltage setting (2.8V)
 - iii. the temperature of the pack is inside of its operating range for discharge (-20 to 55°C)
 - iv. The State of Charge (SOC) is above the defined minimum discharge setting (usually 10%)
 - v. If this relay has had to disable the inverter because of reaching the minimum setting in (iv) above it will not re-enable until the State of Charge (SOC) has risen above the defined minimum re-enable SOC (usually 20%)
 - vi. The defined delay time for a repeated operation of this relay has elapsed (3 minutes)
3. Solar Charge Controller Enable – this is achieved using a pair of potential free contacts from a relay inside the external Relay Box. This relay is normally open and is only closed if the Battery Management System (BMS) is satisfied that the battery may receive a charge current. The closing of this relay will then enable the external charge equipment, in this case a Solar Charge Controller with a remote enable switch. The standard parameters for determining this are programmed into the BMS by Freedom Won prior to delivery. Freedom Won or approved installers are able to alter these parameters if a non-standard configuration is required. The standard configuration is to enable the solar charge controller so that it may begin charging if:
 - i. there are no errors (trouble codes) registered by the BMS that would affect the ability of the battery to safely receive a charge (there are numerous protection algorithms and not all are detailed here)

- ii. the voltage of any individual cell is below the maximum cell voltage setting (3.75V)
 - iii. the temperature of the pack is inside of its operating range for charging (0 to 50°C)
 - iv. The State of Charge (SOC) has dropped below a defined level since the last charge enable period (99%).
 - v. The defined delay time for a repeated operation of this relay has elapsed (3 minutes)
4. Charge Current Limit (CCL) – some inverters or solar charge controllers may be equipped with an analogue input that allows the BMS to supply the charge current limit. If this charge current limit supplied by the BMS is above the maximum capacity of the charger then the unit will operate at this maximum value. The output signal is 0-5V (representing 0-100%) and is connected to the external measuring input using the battery ground. Both wires are provided in the control cable.
 5. State of Charge (SoC) – 0-5V analogue output representing 0-100% SoC

Caution – do not allow the analogue wires to touch any other wires during installation while the BMS is powered up. This may cause damage to the internal circuitry of the BMS. It can be seen whether the BMS has power if the SOC display lights are illuminated.

3.1.2 CAN Bus Control – Detailed Description

CAN is a widely used communication protocol in systems with many devices that must report their status or send commands to other devices on the same network. The Freedom Lite BMS can transmit messages and commands in CAN protocol to provide information to, but more importantly to control, external devices. The type of control functions are similar to the hard wired option but CAN allows more versatility and provides a simpler installation because there are only two wires required in this form of communication, namely CAN High and CAN Low. In order for an inverter or charge controller to be controlled by CAN it must first of all be equipped with a CAN interface as well as a suitable method of connecting the CAN wires. Further to this the Freedom Lite BMS must be programmed with a CAN messaging profile that is developed for the inverter or charge controller being used. This profile must be specifically developed for each inverter model or model range. To date Freedom Won has developed CAN profiles for the following equipment:

- SMA Sunny Island Battery Inverters
- Ingeteam Sun Storage Battery Inverters
- Victron Multiplus and Quattro Battery Inverters and MPPT Controllers via the Color Control GX and Venus system controllers
- Studer
- Imeon
- Solax
- Goodwe
- MLT Drives (2019 models onwards)
- Socomec

- Koyoe
- Growatt (HPS and PCS ranges)

Freedom Won welcomes any requests to produce BMS CAN profiles for other inverters that are CAN equipped for BMS interface.

The CAN interface can provide the following functionality to compatible devices:

- i. Charge Current Limit
- ii. Discharge Current Limit
- iii. Actual State of Charge
- iv. Actual Temperature
- v. Actual Voltage
- vi. Actual Current
- vii. Maximum real time charge voltage
- viii. Minimum real time discharge voltage
- ix. Battery Name

The CAN 2.0 Part A and Part B standard uses the SAE J1939 standard in the Lite. It is necessary to install a 120 Ohm resistor on each extreme end of the CAN cable (splices do not require a resistor). Most devices operating on CAN have two plugs to connect in and then out again on the CAN Bus. The first and the last device in the chain must have a termination resistor plugged into the spare (second) plug. These resistor plugs are available from the inverter manufacturer and from Freedom Won. SMA, Imeon, Solax and Victron operate on this basis. Ingeteam has a separate CAN terminal block for bare wires to be inserted from the BMS and these units have an internal resistor fitted into the device. From August 2018 all Freedom Lite models have two CAN plugs for parallel configurations (Figure 4.2) and allowing fitment of the termination resistors on the end of line units. Where one Lite is installed or where it is the end of line CAN device, **the Lite must be fitted with a termination resistor.**

The Lite is not supplied with termination resistors as these are generally supplied with the inverter equipment eg. Victron Color Control is supplied with 2 x termination resistors. For parallel Lite configurations installed on inverter systems where these resistors are not supplied, it is necessary to purchase two from Freedom Won.

The third-party device manuals must be referenced for all details regarding connecting the CAN interface.

Most brands use 500kbps. If 250kbps is required it is available on the Lite with a specific profile loaded.

4.3 Parallel Configurations

It is permissible to connect multiple Freedom Lite's in parallel provided that the Freedom Lite model size used is the same throughout. It is however more cost effective to purchase one larger Freedom Lite model than connecting multiple units in parallel. This type of

installation should be reserved for future expansion where it is not feasible to purchase a model large enough upfront for future requirements (financial constraints).

One Lite is programmed as the Master, while the rest of the Lite's connected to the DC bus are programmed as Slaves. A total of 10 units can be connected in parallel.

For installations using hard wired control to control the inverter or charge controller, the NO and COM dry contact pairs from external relays controlled by the Master Lite via the DB15 plug are used (see further in manual for more information on the dry contact pairs).

The Master Lite must be connected to the slave Lite's via the CAN Bus using standard LAN cable.

Where CAN Bus is used to control the inverter(s) and charge controller(s), the CAN Bus from any battery (preferably the Master) can be connected to the inverter directly or the system controller, depending on the product brand. **As of August 2018 all Freedom Lite Home and Business models are shipped with hardware that enables them to be configured either as a master or as a slave.** This is achieved by providing two RJ45 sockets on the battery – refer to Figure 4.2. On the master, one socket is used for an end of line (termination) resistor, and the other socket for connecting to the next item of equipment, whether it be a slave battery, an inverter, a solar charge controller, or system controller. On a slave, each socket is used to connect to another item of equipment.

Figure 4.2 Picture Showing 2 x RJ45 Sockets for CAN Bus and DB15 Plug for Analogue and Relay Control

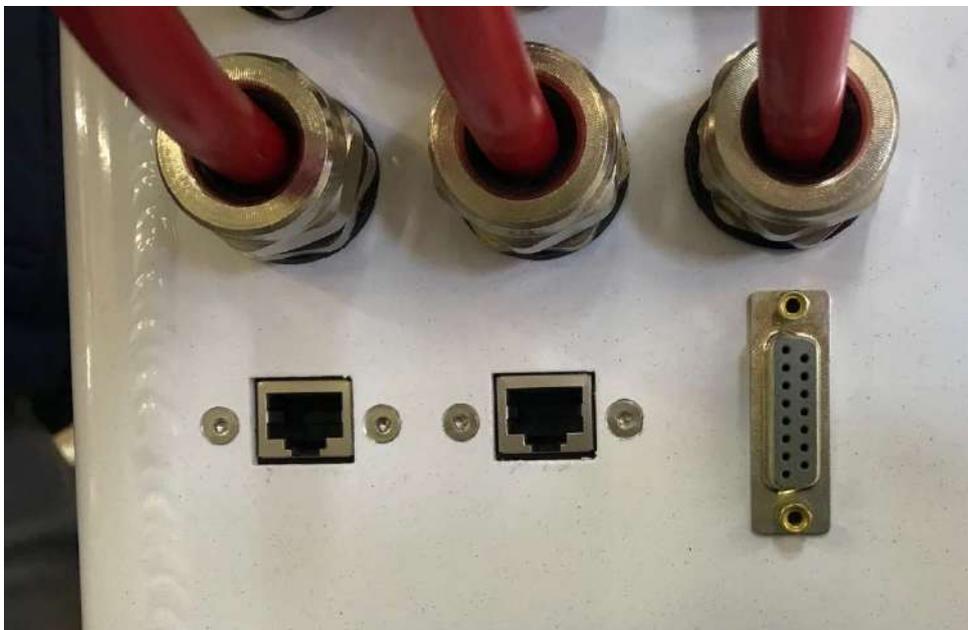
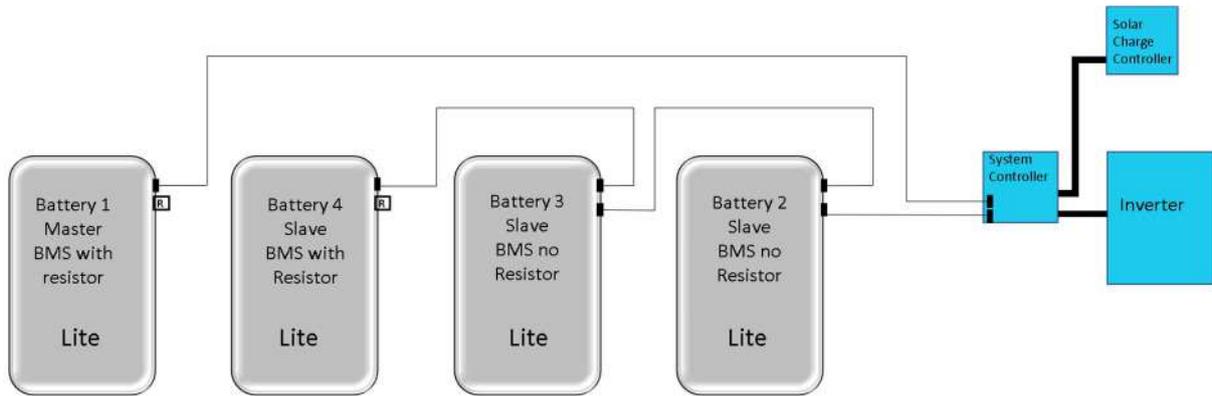


Figure 4.2 CAN Bus Connection Example with Four Lites



All units are normally shipped with a standalone profile on them. Master units will require a master profile that includes a parameter input for the number of slaves to be connected. Slave units need specific slave profiles giving them their address in the system. The profiles will need to be programmed by Freedom Won remotely via a connected PC or can be pre-configured in the factory if Freedom Won is made aware of which Lites will be used as masters and slaves prior to dispatch. Lites programmed as slaves in the factory are labelled “SLAVE” with the slave number (address) for systems with multiple slaves.

Freedom Won offers a fair trade in on Freedom Lite’s on the purchase of new units, which is an option for somebody wishing to expand their battery capacity instead of installing parallel units. Please request more detail from Freedom Won if this is your upgrade preference.

New units can be placed in parallel with old units up to about 4 years or 1 300 cycles, after which it is preferable to trade in for a new larger unit.

4. Programming the Freedom Lite

The serial DB9 connector on the left hand side of the Freedom Lite is used for setting up the profile of the BMS. A serial to USB adaptor is required for connecting Freedom Lite to a computer and the computer must have the correct utility software installed. Programming of the BMS is intended only as a function to be performed by Freedom Won and approved installers. The manual on how to operate the BMS along with the utility is available to approved installers from Freedom Won. Write access to the BMS profile is password protected, however users and owners may request read only access.

As the user of a Freedom Lite there are some parameters that you may request to be customised. The most important of which is the minimum SoC (or maximum DoD) that the BMS may allow. The standard setting is 10% SoC (or 90% DoD), which is accompanied by the standard 10 year or 3500 cycle warranty, whichever should first occur. Note however that it is the responsibility of the installer and owner to ensure that on average the battery is not discharged below 70% DoD on a daily or frequent basis i.e. only occasionally should a lower DoD be allowed. The operating data is recorded by the BMS. For applications where total

life cycle is less of a concern than performance, the maximum DoD can be set to 100%. This will result in a warranty of 5 years or 2500 cycles, whichever should first occur. Where life cycle is of paramount importance the average DoD should be 50% with no change in the standard warranty but an extended expected life of more than 7000 cycles or 20 years.

5. Switching on the Lite

The Lite is fitted with an “ON” button. Press this button to switch on the BMS inside the battery. Once the BMS has been energised you will observe the SoC display come to life with the SoC level. Confirm at this stage that the error lite is not illuminated. If it is, contact Freedom Won. If the Reduced Power light is illuminated, do not be concerned, it should extinguish after the battery has been in operation for a few hours.

Once the BMS has been energised, the main breaker may be switched on by pushing the breaker upwards. Ensure beforehand that you have secured the DC cables to their proper locations and that the rest of the system is ready to receive battery voltage.

Note: On some inverters there is a large inrush current when switching on the DC supply. This may trip the battery breaker. Should this occur it is necessary to immediately push down the breaker handle to reset it, and then immediately attempt a second switch on. If the breaker trips again it is because of an error on the BMS and Freedom Won should be contacted to assist with diagnosing and clearing the error.

To switch off the DC output from the Lite, pull down the breaker. To switch off the power to the BMS, press the “OFF” button situated to the right of the “ON” button. This will also trip the breaker if it is still on at the time. The Lite must be switched off fully when not in use to prevent self-discharge.

Fig 5.1 “ON” and “OFF” Buttons



6. Settings Required for Setting up Inverters and Charge Controllers

The maximum and continuous discharge currents for the respective models are provided in Table 2.1. For charge current settings the same limit can be used as the continuous discharge current, however this is usually not possible owing to limitations of the charger or of the incoming grid supply. An average recommended charge current is one third of the continuous rating of the battery. This will usually ensure that the combination of the mains charger and the Solar Charge Controller (SCC) does not exceed the maximum continuous charge current, although this must be specifically checked.

The voltage settings for the Freedom Lite range of nominally 52V batteries when operating in a system where the BMS can control the external devices as explained above are as follows:

- Minimum (cut off) – 47V (the Lite should never reach this low voltage but is it good to have this set as a redundancy protection measure.
- Low Battery Voltage Warning (if applicable, often used to revert back to grid power in increased self-consumption applications because it approximates 30% SoC) – 51V
- Max Charge Voltage – 55,8V (Bulk, Absorption and Float are all set to this value)

If the BMS is not able to control the external devices with remote enable functions then the voltages must be set at slightly conservative values. This is to reduce the likelihood that an outlying cell will reach its voltage limit ahead of the pack, which the external devices would not be aware of because they can only monitor the total pack voltage. Using a lower pack voltage to monitor and control charging and a higher voltage for discharge will allow a greater spread in cell voltage values without any of them reaching their limits. The BMS inside the Freedom Lite will deal with an excessive spread of cell voltages by balancing them out using the cell tap wires attached to each cell and its internal circuitry. If a cell voltage does reach its limit the BMS will be forced to intervene. This would be either by:

- switching off a contactor on the AC in, AC out, or PV DC input as mentioned earlier in this manual,

or if the relevant one of these functions does not exist in a particular system,

- the BMS shutting down the main breaker on the battery

Frequent occurrences of these two situations is not desirable so the voltages should be set to the following to reduce this occurrence to abnormal circumstances:

- Minimum (cut off) – 49V
- Low Battery Voltage Warning (if applicable) – 51V
- Max Charge Voltage – 55.5V

A voltage can also be set according to user requirements on the inverter depending on how much battery power may be used before grid power will take over from the battery (if it is available). It should be determined based on how much battery SoC is desired at all times as a minimum to ensure adequate capacity to handle a grid outage or load shedding. The daily cycling depth is also a consideration for the user in terms of battery service life.

The recommended voltage for forcing the inverter back to grid power in a self-consumption setup is:

- 52,0V for approximately 60% DoD
- 51,0V for approximately 70% DoD

The voltage that the AC charger should stop charging at to allow the remainder of the charge to be performed by the Solar Charge Controller (SCC) is fitted is:

- 53.5V as the maximum voltage to which the grid charger should be allowed to reach

The SCC voltage set point would be set to 55,8V if BMS control is functional and 55,5V without BMS control. Note that it may be necessary to use a slightly lower voltage initially if the cells have not had sufficient balancing time – if the battery trips prior to reaching 55,5V it is because one cell has reached its maximum too early. Try starting with 54,5V and then after several days of balancing increasing it to 55,5V. For Victron systems the Lite controls this voltage maximum automatically.

Note: For applications where voltages are measured during high current discharge it might be necessary to adjust slightly the values given above to cater for cell internal resistance.

Note: For systems with an interface between the battery and the rest of the system it is advisable to use SoC for controlling charge and discharge algorithms as this is the only accurate method – using voltage as described above is only an approximation.

7. Accessories

Freedom Won offers the following accessories:

Table 7.1 List of Accessories

Item	Description
Relay Box	Available in 1,2,3 and 4 relay options for controlling the functions outlined in Table 4.1. See Table 8.1 for wiring details.
DC Contactor Box – 100A	Used for breaking the PV DC negative cables on all strings in order to stop PV charge as controlled by the battery (see Table 4.1). Max 100A capacity. Contains a 100A DC Contactor and control relay pre-wired into a plastic enclosure with a DB15 plug.
DC Contactor Box – 200A	Used for breaking the PV DC negative cables on all strings in order to stop PV charge as controlled by the battery (see Table 4.1). Max

	200A capacity. Contains a 100A DC Contactor and control relay pre-wired into a plastic enclosure with a DB15 plug.
DB15 Harness	Pre-wired to connect the battery DB15 plug to the items above, or for connecting to terminals on other devices (with the DB15 plug removed on one end).
120 Ohm Termination Resistor – RJ45	For plugging into the second CAN port for an end of line Battery (usually these are supplied with CAN Enabled inverters and hence it is generally not necessary to purchase from Freedom Won.
RS232 to USD Adapter	This is needed for programming the Lite models from the Lite 5/4 to the 60/42 via the DB9 plug.
CANdapter	This is required for programming the Lite 80/56 model and larger via the DB9 plug.
Eye Bolt M12	Required for lifting models 10/7 to 20/14 using the hard point on top of the battery – for installation onto the wall
Gantry	Used for lifting Lite's onto wall mount bolts as well as lifting the floor standing models into the upright position. Available with various width gantries (narrower to suit contracted installations). Fitted with 3 500kg electric winch, includes lithium battery and built in charger. Can be disassembled and reassembled in minutes for easy transportation.

8. Typical Installations

Some examples of how to integrate Freedom Lite into a battery backup and solar installations are provided below.

8.1 Hard Wired Control Installations eg. Victron

Victron provides a range of battery inverters that are equipped with auxiliary inputs that provide a method for independently enabling the charger and the inverter. This range includes the models known as Multiplus and Quattro, providing sizes from 500VA up to 15kVA. The charger and inverter enable potential free control wires are provided by a relay box accessory available from Freedom Won. The relay box outputs are simply connected to the Auxiliary Input 1 and 2 respectively (or three pole connector on the smaller units). The relay box relays are controlled by the control pins in the DB15 plug as described in Fig 4.1.

These Victron inverters offer a range of features and are extremely robust, usually carrying a 5 year manufacturer warranty. They can be synchronised to offer three phase (one unit per phase) and can also be connected in parallel to increase power per phase. More than one

unit can be fitted to the same Freedom Lite. In such cases one becomes a master and they are connected together using “Ve. Bus” connector cables.

To get the inverter to work with this external control it is necessary to install version XXXX 4XX of the firmware so that the “Assistants” programs are available. To ascertain what firmware you have on your device you must find the label providing such on the microprocessor chip on the main PC Board (remove the front cover, the number is preceded by the word “HEX”). This number must be provided when requesting the XXXX 4XX version. To load firmware onto Victron inverters the MKIII programming dongle is required for connecting to your PC.

There are several assistants that can be used depending on the type of installation as described later. Table 8.1 provides the connection details for the relay box control cable for the applicable inverter chargers and solar charge controllers. Note that the relay box can be ordered with either one, two, three or four relays. Upon ordering the relay box the functions required in below table must be stipulated.

Table 8.1 Hard Wired Control Cable Connection Details for the applicable Victron Multiplus and Quattro Inverter Chargers and Blue Solar Charge Controllers

Relay No.	Wire Colour in 12 Core Control Cable from Relay Box	Wire Function [NO = Normally Open, COM = Common]	Connection on Victron Inverter
1	Orange	Charger Enable NO	Aux 1 – Terminal 1
	Grey	Charger Enable COM	Aux 1 – Terminal 2
2	Yellow	Inverter Enable NO	Aux 2 – Terminal 1
	Blue	Inverter Enable COM	Aux 2 – Terminal 2
3	Red	Solar Charge Controller Enable NO	Remote Enable – Terminal 1
	Turquoise	Solar Charge Controller Enable COM	Remote Enable – Terminal 2
	White	Not used	Not used
	Pink	Not used	Not used
	Brown	Not used	Not used
4	Purple	Multi-Purpose Output NO	Connected as required
	Green	Multi-Purpose Output COM	Connected as required
	Black	Not Used	Not used

The BMS assistants are loaded using the Victron configuration software and a profile is set up including assigning the Aux Inputs to their proper functions and setting the voltage limits according to the Freedom Lite requirements. Please reference the Victron Energy website (www.victronenergy.com) or contact Freedom Won for more detail and assistance with setting up your Victron inverter for operation with the Freedom Lite lithium BMS.

8.1.1 Victron Inverter as Backup Power Only

In this setup the Victron inverter operates only for providing backup power to the AC loads when the grid is off. There is no solar power. It is possible however to programme the inverter to start a generator when necessary to provide power instead of the grid.

In this instance it is rarely worth installing a Color Control or Venus system controller and therefore a hard wired control between the battery and the inverter will be used.

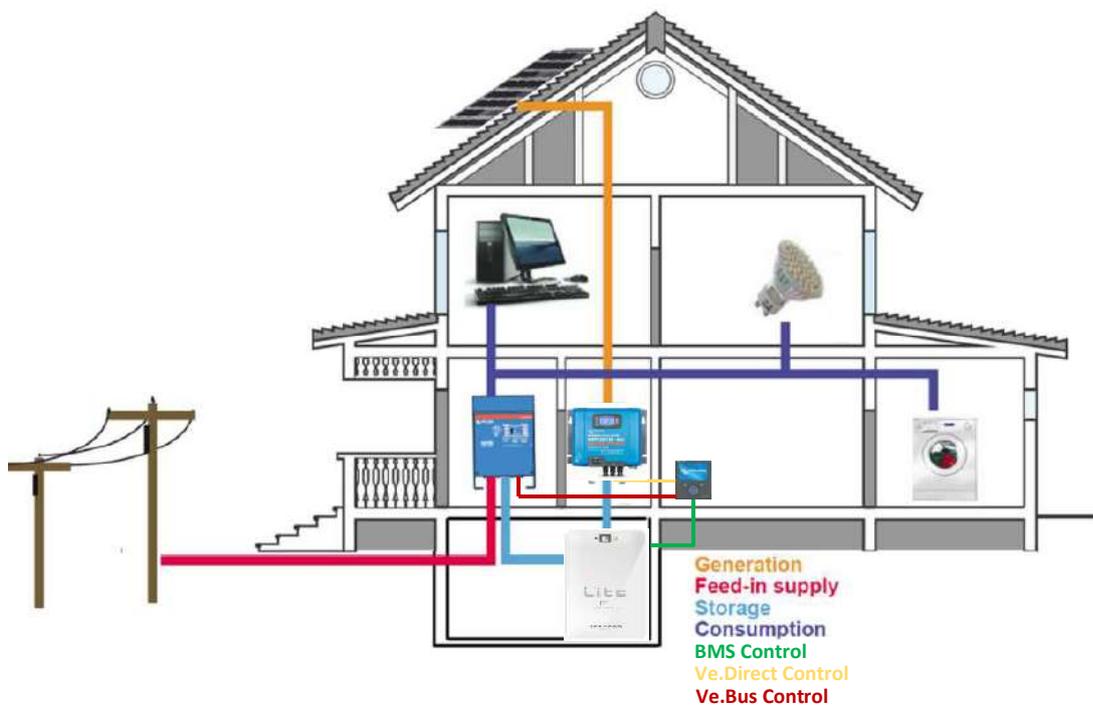
For this setup the Lynx Ion BMS assistant is to be used. The Victron documents explaining how to configure this assistant are available on line. Table 8.1 provides the Lite connection details for the control wiring using Aux 1 and Aux 2 on the inverter, which are programmed for their respective functions using the assistant.

8.2 Victron CAN Interface Systems

For systems incorporating solar power Freedom Won only supports Victron systems that include the Color Control or Venus controller.

Figure 8.1 below provides a schematic of a PV solution with battery backup and a connection to the grid.

Figure 8.1 Example of a Grid Connected PV System with Battery Backup using a Freedom Lite, Victron Multiplus or Quattro Inverter Charger and a Blue Solar Charge Controller



In Figure 8.1 the grid is connected to the input AC 1 terminals of the Multiplus or Quattro battery inverter (with a Quattro the AC 2 input can be used to connect a generator). The AC 1 output is connected to the house circuits that require battery backup (with a Quattro the AC 2 output can be connected to non-essential loads for automatic load shedding in a grid outage). The 48V DC connections on Freedom Lite are connected to both the inverter and the solar charge controller (SCC). There is also a BMS CAN Bus control connection between the Freedom Lite and the Color Control system controller (a Venus controller can also be used). Multiple inverter and SCC units can be installed in parallel and also in three phase configuration.

Note that to comply with the legislation of your country it may be a requirement to include an appropriate anti-islanding device between the grid supply and the inverter. The Victron inverter does have a transfer switch that disconnects the grid from back feeding when the grid power is down but may not comply with local legislation. In this case the Multigrid model can be used.

The inverter will within 20ms transfer power in the house to battery backup if the grid power fails. This is sufficiently fast to prevent appliances from being affected. The unit can also exclude voltages higher than a user adjustable value within a 20ms period.

Once transferred to battery power the inverter will continue to operate until the BMS instructs it to stop on CAN Bus. This should only occur if the Freedom Lite has dropped to 10% SoC (90% DoD). The inverter will then not function off battery until either the solar charge controller has recharged the battery to at least 20% SoC and will thereafter continue to operate provided that the SoC remains above 10%. When grid power is restored the inverter will immediately revert back to the grid source. The system design should be based on assuming only 70% DoD will be used on a routine basis with 90% DoD being the absolute cut-off for occasional scenarios.

The Victron Multiplus and Quattro inverters and the Blue Solar charge controllers are connected to the Color Control or Venus. For grid connected systems the ESS assistant should be installed on the Multiplus/Quattro. For off grid systems no assistants are required on the Color Controller/Venus.

It is also possible to configure the Victron inverter to feed energy to the grid if the battery voltage is above a defined value. This must be set up properly using the configuration software and the connection must be authorised by the utility and any other applicable body in your country.

Note that the above diagram is a simplification. In many household installations the inverter may not be intended to run heavy consumers such as electric geysers, stoves and household heating. These are often connected to the grid directly and do not pass through the inverter or connected to AC 2 output of the inverter.

It is also necessary to ensure that the AC output of the inverter is fed to either a separate Distribution Board (DB) or to a section of the main DB that is physically apart from the incoming utility supply and the other breakers that are fed from the utility directly. This is to ensure that it is practical to clearly label the inverter output section of the DB so that it is clearly evident that this section will remain live despite the utility incomer being off. Observe the relevant regulations

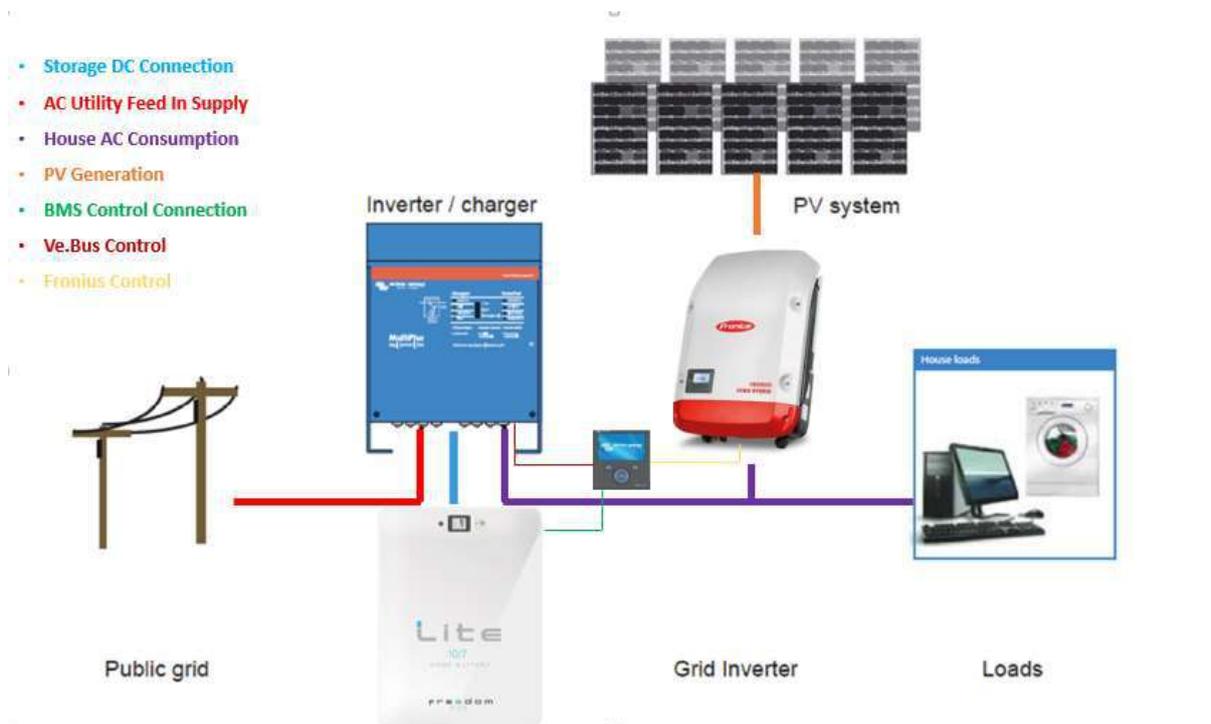
Several important settings must be correctly configured in the Color Control, Multiplus/Quattro, and charge controller. The correct firmware versions must also be installed in each case. Please refer to Victron manuals or contact Freedom Won for assistance with this.

8.3 Victron Inverter and Grid Tie Inverter

The main alternative to installing a DC charge controller is shown in Figure 8.2. This system incorporates a grid tie inverter (GTI) or PV inverter on the consumption side of the battery inverter.

Aside Note: It is also possible to install a GTI on the grid side of the battery inverter but this option is not recommended when connected to an unreliable grid because the PV potential cannot be utilized during an outage as the GTI will shut down without the grid power being present.

Figure 8.2 Installation Example using a Victron Battery Inverter and a Grid Tie Inverter with a Freedom Lite 10/7



In this installation the Freedom Lite controls the system through the Color Control using CAN Bus. The Color Control in turn controls the PV inverter and the Multiplus/Quattro. The Multiplus can control most PV inverters using frequency shift on the AC output. Compatible GTI's will measure this variation in frequency and adjust the power put into the consumption side AC bus accordingly, but it is preferable to use the Fronius models because additional control can be used from the Color Control making for a more robust system, especially where grid feed in is not allowed on a grid connected system. The battery inverter will determine when to 'throttle' back the GTI based on its own power (current) measurements. If the combination of the house consumption and the ability for the inverter to place charge into the battery is not sufficient to consume all the power the GTI can deliver there are two options for the battery inverter. If it is set up for feeding back to the grid, it can do so, which would mean that the GTI need not be 'throttled' back. If it is not set up for feeding back to the grid and the voltage of the Freedom Lite has reached its

maximum, OR the Freedom Lite has disabled the charger, it will reduce the power delivery of the GTI to that which is equivalent to the consumption in the house at that time.

This setup should be configured with ESS on the Victron system and the necessary additional assistants and settings must be added for the PV inverter.

This option using a GTI is typically more expensive than using a DC SCC but it is useful if a system already exists using a GTI to which a battery inverter and Freedom Lite is to be added, because the GTI can usually be retained. Also, the GTI's are more suitable for larger installations (around 30kW plus) because SCC's are not made for much more than 5kWp PV power (they can be connected in parallel however up to 15 units. GTI's do typically have a much higher maximum PV voltage input, which reduces the amount of parallel connections required on the panels and thus makes installation easier.

8.4 System and Product Variations

The systems above are only examples of how to incorporate a Freedom Lite into a total solution based on Victron products.

Other inverter brands can be incorporated into the same types of configurations so long as they have the right interfacing requirements, such as SMA Sunny Island battery inverter incorporated with a SMA Sunny Boy GTI. Hybrid inverters that essentially contain both the battery inverter/charger function as well as the SCC in one unit can also be used.

Specific instructions on connecting to and configuring the following inverters, GTI's and SCC's can be obtained from Freedom Won:

1. SMA Sunny Island Battery Inverters
2. Ingeteam Sun Storage Battery Inverters
3. Victron Multiplus and Quattro Battery Inverters and MPPT Controllers via the Color Control GX and Venus system controllers
4. Studer
5. Imeon
6. Solax
7. Goodwe
8. Koyoe
9. MLT Drives (2019 onwards)
10. Socomec
11. Axpert Mk11
12. Growatt (HPS and PCS ranges)

13. Warranty and Repair

The Freedom Lite is sealed with a tamper proof warranty seal. It may not be opened by anyone other than Freedom Won and installers or repairers that have been explicitly approved by Freedom Won. The warranty on the unit will be void if the seal is damaged or missing.

If the Freedom Lite indicates an internal problem please contact Freedom Won or the installer that installed the system. Freedom Won will arrange that it is inspected and repaired.

The warranty will not cover damage to the control wiring resulting from draw of excessive current or any damage resulting from lightning. Damage caused by physical means to the battery housing, external and internal fittings, such as impact with other objects, or being dropped, is not covered by the warranty.

The standard warranty period is 10 years or 3500 cycles, whichever should first occur. The battery is required to provide at least 70% of its new capacity at the end of this period or cycle number. The BMS records the number of cycles used. If you suspect that your Freedom Lite is delivering substantially below its minimum performance please contact Freedom Won for an investigation. We will request that you fully charge the battery and switch on a defined load and measure the operating time in order for us to estimate the amount of energy produced until the battery has reached 70% DoD. If the unit is found to be underperforming it will be serviced such that the minimum performance guarantee is again restored. Freedom Won may arrange for an on-site service or for collection of the unit for servicing at our facility. This will be mostly determined by the geographic location, ease of access to or removal of the unit, and size of the unit.

For more detailed warranty information please contact Freedom Won.

14. [Expected Product Life](#)

Freedom Lite is designed for optimal life cycle cost, which is a fraction of any other battery technology available on the market, in particular from 25% to 35% of the lifecycle cost of the range of lead acid and associated variants on the market. Please contact Freedom Won if you would like more detailed information for comparison with lead acid batteries than what is available on our web site.

Freedom Lite is expected to operate for about 15 years in a daily cycling scenario with an average of 70% DoD. For 3 cycles per week (for typical load shedding for instance as is experienced in some countries) the service life expected is 20 years or more.

For applications where the cost per kWh delivered by the battery during its lifetime is of prime importance (i.e. maximum return on investment) we recommend that the battery be sized for an average cycle discharge of 50% DoD. In a daily cycling scenario such as for optimal solar self-consumption and off grid systems the expected service life is then 20 years or more than 7000 cycles. The defined end of life in this instance occurs when the battery capacity falls to 60% of the new capacity.

15. Troubleshooting Guide

Most issues with the Freedom Lite can be resolved using the guide below. If a problem cannot be resolved after referencing this table please contact Freedom Won or your approved Freedom Won supplier.

Table 14.1 Troubleshooting Guide

No	Problem Description	Cause/Solution
1	Eye bolts do not screw into hard point on top of Freedom Lite	Check that you have the correct eye bolt with the correct thread pitch – M12 x 1,75
2	The rawl bolt head does not fit into the hole on the back of Freedom Lite (wall mounted models)	Check that you are using the correct size Rawl Bolt as specified in this manual and that you have after positively tightening the internal gripping collar turned the bolt out again so that there is about 5mm of the bolt shank exposed so that the back plate can fit easily behind the bolt head. If the wall is uneven it may be necessary to turn the bolt head out a little more. Do not turn it so far out that there is less than the full thread length engaging on the internal locking collar.
3	The Freedom Lite has no voltage on the main output cables	Check that you have switched on the main breaker switch. Note – only turn this on once you are satisfied that you have completed the installation and that there are no DC or control wires that can short out or touch ground or other wires. Also ensure that you are ready to accept AC voltage onto the inverter output before switching this breaker on. Also confirm that you have energised the BMS first by pressing the “ON” button for 3 seconds and as evidenced by the lights on the SoC display.
4	The main breaker switch keeps tripping each time I attempt to switch it on	There are four potential causes: <ol style="list-style-type: none"> 1. High inrush current on certain inverters – Try to close the breaker twice in quick succession – the second attempt must be within a second, before the inverter capacitors discharge again. This reduces the inrush current on the second closing attempt. 2. Error on the BMS. Check whether the red error light is illuminated on the SOC display. You can try to reset the error by pressing the RESET button for about 2 seconds and release. This should clear the error and allow you to switch on the main breaker. If this does not work then switch off the BMS by pressing the “OFF” button. Then switch the BMS back on after 10 seconds and try again to switch on the breaker. 3. Short circuit on the DC Bus or faulty inverter or MPPT causing high currents 4. In a system with multiple Lites in parallel the reason could be that the battery you are trying

		<p>to switch on is at a different voltage to the others – the voltages must be the same on all batteries when switching them onto a common DC bus.</p> <p>If none of the above are the problem you will need to reset the BMS with a Windows PC. Contact Freedom Won or your authorised installer for assistance with this.</p> <p>It will be necessary to establish the reason for the error before continuing with normal operation of the system. Repeated tripping is damaging for the breaker.</p>
5	After resetting the BMS the main breaker still will not stay up.	<p>This is most likely because the battery is fully discharged and the BMS is protecting the cells from further discharge. Ensure that there is no chance of load being applied to the battery by isolating the AC output from the inverter. Ensure that the AC input to the inverter is live so that the charger may begin charging the battery after you switch it on. Alternatively an MPPT can be used for this immediate charge if there is sunshine at the time. This charge should increase the battery voltage to prevent further tripping. This problem should not occur if the inverter control is working properly.</p> <p>If this does not work it is because the battery has been discharged too deeply and will need to be reset by Freedom Won using your Windows PC. Please contact Freedom Won.</p>
6	I have switched off the main battery breaker switch to prevent discharge of the battery but the SOC display lights are still on.	<p>The BMS and SoC display receive power directly from the battery and therefore the “OFF” Button must be pressed to switch off the internal electronics.</p>
7	The inverter will not come on even though the inverter switch is selected to ‘on’.	<p>The enable command may not be coming from the BMS or may not be properly connected to the inverter or the inverter may not be properly configured to deal with the enable command. If you are using a hard wired interface you can confirm whether the enable signal is coming from the inverter by checking to see if there is continuity between the Inverter Enable NO and COM wires. If not, then a battery parameter is outside of limits, most likely SoC or cell voltage, or there is a critical error on the BMS. Try resetting the BMS. If this does not work charge the battery and the inverter control should be re-enabled. If there is continuity then the problem lies with the control wire connection to the inverter or the inverter setup. Refer to the inverter manual or setup information to ensure that you have connected and set up the inverter properly.</p> <p>If you are running on a CAN Bus control with a compatible inverter and you are not observing the correct enable response from the inverter check that the</p>

		CAN High and CAN Low wires are connected properly (ensure that you have the High and Low the right way around and that you have connected the end of line 120 Ohm resistor in the applicable place(s)). If this is not the problem then you need to confirm that you have the right CAN profile programmed onto the BMS for the inverter in use (baud rate or CAN messages may be for another inverter brand) or that you have configured the inverter or system controller correctly. Contact Freedom Won for assistance
8	The charger will not come on even though there is power on the AC input of the inverter and the charger is activated in the inverter settings	The battery might be full. Try discharging the battery for a while and observe if the charger then comes on. If not then the fault finding process is similar to above.
9	The Freedom Lite error light keeps illuminating after each reset	If the battery voltage is within limits this should not ordinarily occur. Contact Freedom Won or an approved installer for assistance with determining the problem. If the main breaker does not trip it is not a critical error and you may continue using the battery while you make contact for assistance.
10	The pack voltage is within limits but the main breaker still trips seemingly at random	This could be caused by many things but is most likely because the current draw is exceeding the battery current limit setting. Measure the current with a tong tester while drawing your maximum typical load to determine if you are exceeding the rated current for the respective Freedom Lite model. If it is not the current causing the trip it could be a weak cell or extreme temperature of the surroundings. Both are unlikely. If the problem persists contact Freedom Won.