Installation Manual

eTower

Lithium Iron Phosphate Battery Modules

Manufactured By Freedom Won (Pty) Ltd

Kimbult Industrial Park, Unit C3 & C4

9 Zeiss Road

Laser Park, Honeydew

2040

South Africa

www.freedomwon.co.za

Technical and Installation Assistance – Contact:

Please contact your Freedom Won Distributor or Reseller Installer for technical and installation support. A directory of Distributors and Reseller Installers is available at www.freedomwon.co.za.

For advanced support please contact support@freedomwon.co.za.

Update Record:

Revision Number	Update Summary	Updated By	Date of Issue
0	First Release	Antony English	01 October 2021

Thank you for choosing eTower for your energy storage needs. Freedom Won is a leading high-quality brand and we pride ourselves in customer satisfaction and great service. We hope that you find this manual helpful and complete, but please do reach out to us if you have any additional requirements or queries.

1. Introduction

This manual is intended to assist an installer with the installation and commissioning of the eTower lithium iron phosphate (LiFePO4) energy storage modules. This document is not intended to provide detailed information of the inner workings of eTower 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 non-standard inverter interfaces 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 eTower. Freedom Won however is available at the contact details on page one to provide direct support that specifically relates to the battery interfacing with supported third-party inverter brands.

2. Product Description

The eTower range presently includes only the e5000 module, which has been designed specifically for enabling small economical storage solutions that can be upgraded conveniently and cost effectively over time.

The product **includes all accessories required to enable fast and convenient installation**. Although rack mounting is possible, the modules are primarily designed for easy stacking into a tower through the inclusion of a plastic moulded pedestal that is placed underneath each module in the tower. Further convenience is offered through the inclusion of the required communication and power cables along with module connecting busbars.

The eTower is designed primarily for systems that need to start with 5kWh initially with a view to growing the storage capacity over time in 5kWh increments up to 20kWh.

For designs that require 10kWh or more initially the Freedom LiTE Home and Business range may be a preferred solution depending on customer preferences and needs.

Freedom Won offers the following ranges in the LiFePO4 technology:

1. Lite 12V
2. **eTower**
3. Lite Home and Business
4. Lite HV Home and Business
5. Lite Marine
6. Lite Mobility (golf carts, forklifts etc)
7. Lite Commercial (including Lite Commercial 52V, HV, and HV+)

8. Lite Industrial

This manual covers only the eTower. Please refer to the manuals specific to the other ranges for help with those models.

The eTower voltage is 52V nominal (to suit so called “48V” systems). This higher nominal voltage of 52V (compared to 48V nominal batteries) offers superior performance and efficiency owing to lower DC currents in the battery and in the inverter.

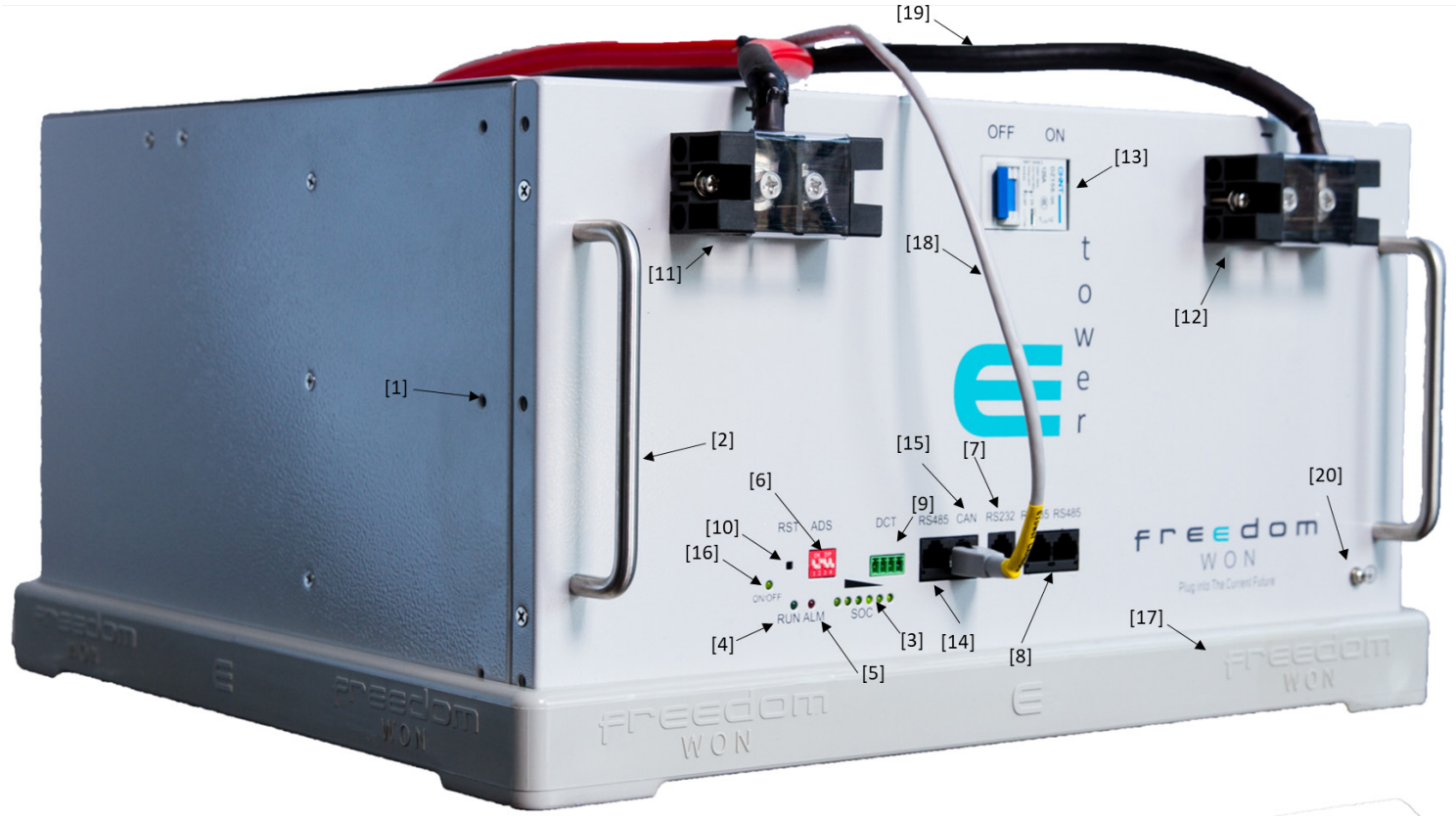
2.1 External Features Summary

An image with numbered labels is provided in Figure 2.1 and described below. Additional detail is provided in Section 2.2.

Tabulation Descriptions from Figure 2.1:

1. Fixing threads for 19” rack mount brackets if required
2. Carrying handles
3. State of Charge (SoC) capacity indication LED’s
4. Run indication
5. Warning LED
6. Address dip switches
7. RS232 Interface RJ11 plug
8. RS485 dual interface inter module communication bus RJ45plugs
9. Digital Output Dry Contacts (DCT)
10. Reset Button
11. Positive Terminal
12. Negative Terminal
13. Circuit Breaker
14. Inverter RS485 Interface RJ45 plug
15. Inverter CAN Bus Interface RJ45 plug
16. On/Off indication LED
17. Plastic Pedestal
18. CAN Bus Communication Cable
19. DC power cables
20. Earthing Point

Figure 2.1 Labelled Image of the eTower with four modules stacked together (Labelling corresponds with the text)



2.2 External Features Detailed Information

Below provides more detailed information pertaining to the external features listed in 2.1 above.

2.2.1 19” Rack Bracket Fixing Points

The eTower modules can be installed into a standard 19” rack. There are three fixing threads on each side of the module near the front, as indicated, that match the 19” rack mount brackets available from Freedom Won on request. The primary installation arrangement is intended to be stacking the modules into a tower using the inter-module pedestal, but for applications requiring 19” rack mounting the required brackets can be installed in minutes. Please specify how many of these brackets are required when ordering eTower.

2.2.2 Carrying handles

Two carrying handles are fitted to the front face of each module to ensure easy and safe handling and lifting onto the pedestal. Freedom Won recommends two people for stacking the eTower modules.

2.2.3 State of Charge Indication

The State of Charge (SoC) of the battery is indicated by six green LED's as a percentage of the module's maximum energy storage value in kWh. These LED's are numbered one to six where number one is the LED positioned furthest to the right and number six is the furthest to the left. The LED indicating the present top SoC range flashes when the battery is receiving charge current. The SoC level allocation to each LED illumination combination is provided in table 2.2 below.

Table 2.2 State of Charge (SoC) Indicator Capacity Matrix under Discharging/Inactive and Charging states

Capacity Status	LED Capacity Indicator											
	Discharging or Inactive (no current flow)						Charging					
	●	●	●	●	●	●	●	●	●	●	●	●
	LED1	LED2	LED3	LED4	LED5	LED6	LED1	LED2	LED3	LED4	LED5	LED6
0~16.6%	Light on	Light off	Light off	Light off	Light off	Light off	Flash	Light off	Light off	Light off	Light off	Light off
16.6~33.2%	Light on	Light on	Light off	Light off	Light off	Light off	Light on	Flash	Light off	Light off	Light off	Light off
33.2~49.8%	Light on	Light on	Light on	Light off	Light off	Light off	Light on	Light on	Flash	Light off	Light off	Light off
49.8~66.4%	Light on	Light on	Light on	Light on	Light off	Light off	Light on	Light on	Light on	Flash	Light off	Light off
66.4~83.0%	Light on	Light on	Light on	Light on	Light on	Light off	Light on	Light on	Light on	Light on	Flash	Light off
83.0~100%	Light on	Light on	Light on	Light on	Light on	Light on	Light on	Light on	Light on	Light on	Light on	Flash

2.2.4 Run Indication LED

The green "run" LED is illuminated whenever the battery is in a running or ready state, i.e. when the BMS is on and there are no faults.

2.2.5 Warning LED

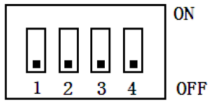
The red "Warning" LED illuminates if there is an active alarm or fault. The LED is otherwise not illuminated. If this LED comes on there is likely a cell over voltage fault if the battery is at 100% SoC at the time. If the battery is at a low SoC the warning will most likely relate to a low SoC alarm (SoC below 10%) or a low cell voltage alarm, which would normally only occur below 10% SoC anyway.

2.2.6 Address Dip Switches Block

The block with four binary dip switches must be set to a specific configuration that allocates the address of the eTower module. Each module must have its own address beginning with

one and counting consecutively upwards. The module that has the communication cable connected to the inverter must always be set with address 01. To simplify the setup, set the top module to address 01 and connect this module's external communication CAN or RS485 port to the inverter, then increase consecutively through the addresses for each successive module below the top one. The dip switch numbering and on/off positions are illustrated in Figure 2.2 and follows a normal binary sequence where the least significant bit is on the far left.

Figure 2.2 Dip Switch Numbering and On/Off Positions



The dip switch settings for each module according to its address are to be set as shown in Table 2.2. For a system without the ability to interface between the battery and the inverter, all dip switches must be left switched off.

Table 2.2 Dip Switch Positions for Address Numbers 1 to 15.

	#1	#2	#3	#4
0	OFF	OFF	OFF	OFF
1	ON	OFF	OFF	OFF
2	OFF	ON	OFF	OFF
3	ON	ON	OFF	OFF
4	OFF	OFF	ON	OFF
5	ON	OFF	ON	OFF
6	OFF	ON	ON	OFF
7	ON	ON	ON	OFF
8	OFF	OFF	OFF	ON
9	ON	OFF	OFF	ON
10	OFF	ON	OFF	ON
11	ON	ON	OFF	ON
12	OFF	OFF	ON	ON
13	ON	OFF	ON	ON
14	OFF	ON	ON	ON
15	ON	ON	ON	ON

Note that is it important to set these dip switches correctly to ensure proper communication and system operation!

Although the eTower communication protocol can accommodate up to 15 modules, the recommended limit is four modules per system because systems that require more than 20kWh are usually better accommodated by the **Freedom Won LiTE** range of high-performance batteries.

2.2.7 RS232 Interface RJ11 Plug

This RS232 interface RJ11 plug port is used only for connecting a PC to the battery for firmware updates, settings updates, real time battery data monitoring, and troubleshooting. These functions are reserved for Freedom Won technicians or authorised service centres.

2.2.8 RS485 dual interface inter-module communication bus RJ45 plugs

This RS485 bus is used to link the communications of all parallel connected modules in the tower so that relevant data can be received by Address Number 01 Module (Module 01), which is in turn relayed from Module 01 to the inverter over CAN Bus or RS485. There are two ports on each module so that the communication cables can be "daisy chained" across all the modules. These cables are standard ethernet cables, and one is included with each module that is made to the exact right length to jump from one module to the next adjacent module whether mounted on the pedestals or in a 19" rack.

2.2.9 Digital Output Dry Contacts (DCT)

The Digital Output "Dry" Contacts (DCT) include DO1 (pins 1 and 2) and DO2 (pins 3 and 4), which are normally closed potential free contacts. DO1 opens when the battery has any type of fault protection enforced. DO2 opens the battery raises a low State of Charge alarm. Do not exceed 2A though these contacts. If a higher current is required to drive your external device use an interposing relay that is controlled by the battery and in turn controls your external device that requires more than 2A.

2.2.10 Reset Button

Reset Button – When the battery is in a dormant state the reset button can be pressed with a suitably narrow object to "wake up" the BMS. If the battery is in a fault or alarm state, the reset button may be pressed to clear the alarm or fault to restore normal operation. The button must be pressed for about five seconds to initiate a reset – while holding the reset button down, the SoC indicator LED's should cycle right to left and then left to right. Once this initial LED sequence begins you can let go of the button.

2.2.11 Positive Terminal

The positive terminal is equipped with two fastening points supplied with M6x16mm bolts to accommodate interconnecting busbars and cable lugs. Busbars must be staggered to alternate between left and right terminals when connecting towers of two or more modules. See Figure 2.3 showing a four-module eTower. The top module is fitted with two 35mm^2 cables to accommodate the maximum power capability of the battery stack. One cable lug is fitted onto the same terminal as the busbar and the other cable lug onto the second terminal.

Figure 2.3 Four-Module eTower

2.2.12 Circuit Breaker

Each eTower module is fitted with a 125A DC rated circuit breaker to provide overcurrent and short circuit protection as well to switch the battery module onto and off the DC bus. Once the modules are all connected and it is safe to apply power to the DC bus, switch on all the module circuit breakers in quick succession starting with the top module set at address 01. The SoC and On and Run LED's should illuminate. The breaker serves as the means to disconnect the battery from the DC bus. After switching off the breaker and thus disconnecting the module from an external voltage source such as the inverter, the BMS will shut itself down after 24 hours of inactivity. There is no way to force off the BMS and nor would it ever be necessary.

2.2.13 Inverter RS485 Interface RJ45 Plug

This plug is used to connect the battery external control communications to RS485 compatible inverters (see Freedom Won Inverter Interfacing Guide). The eTower is packaged with a cable suitable for use with the Voltronic range of inverters such as the Axpert. For assistance with other inverter types running on RS485 communications please contact Freedom Won.

Although not needed when using the supplied cable, for information, the pin configuration of this interface plug is as follows:

RS485 Inverter Interface Plug Pin Configuration	
RJ45 Plug Pin Numbers	Corresponding Signal Wires
1, 8	RS485-B
2, 7	RS485-A
3, 4, 5, 6	No Connection

2.2.14 Inverter CAN Bus Interface RJ45 Plug

This interface is used to connect to CAN Bus compatible inverters and system controllers. There are two cable types with differing pin configurations included in each eTower package, one to suit Victron, and the other to suit what Freedom Won describes as Type 1 CAN Bus inverters. See the Freedom Won Inverter Interfacing Guide for complete details.

Although not needed when using the supplied cables, for information, the pin configuration of this interface plug is as follows:

CAN Inverter Interface Plug Pin Configuration	
RJ45 Plug Pin Numbers	Corresponding Signal Wires
1, 2, 3, 6, 7	No Connection
4	CANH
5	CANL

2.2.15 On/Off indication LED

On/Off indication LED – This LED is illuminated green whenever the battery management system (BMS) is active.

2.2.16 Plastic Pedestal

The moulded plastic pedestal is a Freedom Won innovation that allows rapid installation on site by stacking the modules into a tower using the pedestal as an interface between each module as well as a convenient stand, upon which to place the bottom module. The pedestal is designed to structurally withstand the weight of up to six modules placed into a tower, however in most instances a system that requires this many eTower modules would be better served by the Freedom Won LiTE Home and Business range of high-performance batteries.

2.2.17 CAN Bus Communication Cable

In this photo the battery is shown with a CAN Bus cable, which is connected to a CAN Bus compatible inverter system. This cable is part of the included accessories. See 2.2.14.

2.2.18 DC Power Cables

The power cables supplied with the eTower are 35mm^2 in cross sectional area. Ensure that sufficient of these cables are used to match the power of the connected inverters or DC chargers. The positive cable is red, and the negative cable is black.

2.2.19 Earthing Point

For eTower modules installed into a cabinet this earth point may be used to ground all module casings to the cabinet ground.

3. Detailed Specifications

Table 2.1 provides an overview of important data pertaining to the eTower e5000 modules. The table provides data specific to the four configurations i.e. a single e5000 module, two modules stacked together, three modules stacked together, and four modules stacked together.

Table 2.1 eTower Specification Sheet (next page)

Range overview specification sheet

freedom WON
PLUG INTO THE CURRENT FUTURE

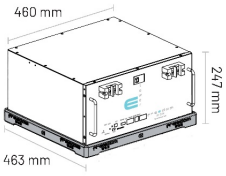
eTower

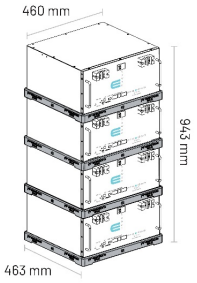
Modular LiFePO4 energy storage from your trusted high performance battery partner.

The following specifications pertain to the Freedom Won eTower modular stackable battery, designed for smaller residential and light commercial applications with options of 1,2,3, or 4 modules in a tower per system.

Modular LiFePO4 Energy Storage Specification Sheet

	1 x e5000	2 x e5000	3 x e5000	4 x e5000
Total Energy Capacity [kWh]	5	10	15	20
Energy, 80% DoD [kWh] 1	4	8	12	16
Energy, 90% DoD [kWh] 1	4,5	9	13,5	18
Current Capacity [Ah]	100	200	300	400
Max/Cont. Charge Current [A] 2	80/70	144/126	216/189	288/252
Max/Cont. Charge Power [kW] 2	4,2/3,6	7,7/6,6	11,2/9,8	15,0/13,1
Max/Cont. Discharge Current [A] 2	100/90	180/162	270/243	360/324
Max/Cont. Discharge Power [kW] 2	5,2/4,7	9,4/8,4	14,0/12,6	18,7/16,8
Max Recommended Inverter Total Rated Power (cont.) [kVA]	5kVA	8kVA	12kVA	15kVA
Nominal Voltage [V]	52V, to suit 48V Inverters, min 47V, max 56V *do not connect modules in series - (for high voltage batteries, refer to Freedom Won LiTE HV ranges)			
Combined weight [kg]	45	90	135	180
Installation method	Stacked horizontally onto each other to form a tower with pedestals included, (one per module) or 19 inch rack mounted with brackets (cabinet excluded). Vertical mounting on floor or wall (shelf/bracket) with terminals facing upwards also acceptable. Generally up to 4 x e5000's per system (for larger capacity requirements, see Freedom Won LiTE ranges)			
Dimensions when e5000 placed horizontally: Height x Width x Depth (Front to rear) (mm)	Single unit with pedestal: 247x460x463	2 module tower with pedestals: 479x460x463	3 module tower with pedestals: 711x460x463	4 module tower with pedestals: 943x460x463
Dimensions exclude busbars on front Module height equates to 5U (U = standard 19" rack unit)	Single unit without pedestal: 222x440x443			





DC Leads to Inverter or DC Bus per positive & negative connection - minimum cable size [mm²] *cables included – see included accessories	1 x 35mm	1 x 35mm	2 x 35mm	2 x 35mm

tower Range overview specification sheet

freedom WON
PLUG INTO THE CURRENT FUTURE

eTower (specs continued)

Enclosure	Steel – painted white, rated for indoor use only, out of direct sun and away from other heat sources.
DC Connection - Integrated Terminals on Front	2 x M6 bolts each for positive and for negative terminals for DC leads to inverter and busbars for connection of parallel e5000's in tower or rack configuration.
Tower Interconnecting Busbars - minimum cross section area [mm^2] *busbars included - see included accessories	70 (17mm x 4mm busbar available in accessories) *note that the Freedom Won busbar accessories are designed for the pedestal tower dimensions not for 19" rack mounting, which has different spacing.
Communication and Control Interfaces (See manual for further details)	• CAN Bus (RJ45 Socket x 1) - for interfacing with compatible inverters and system controllers (the eTower is fully compatible with all common CAN bus compatible brands). • RS485 (RJ45 Socket x 1) - for interfacing with the Voltronics Axpert range of inverters equipped with a RS485 lithium battery interface and the applicable firmware. • RS232 (RJ45 Socket x 1) - for interfacing with a PC for firmware and setting updates (only by Freedom Won technicians). • RS485 (RJ45 x 2) - for the communication connection of parallel batteries up to four in tower. • Digital Outputs x 2 - for controlling external relays based on pre-set functions.
Protection	Internal electronic protection including overcurrent, cell under and over voltage, temperature out of range, weak cell detection, minimum SOC control, active voltage based charge current limiting. *do not short circuit or connect in reverse polarity!
Human Interface	• State of Charge Display (0 to 100% indicated by six green LED's) • Alarm LED (red) • Run LED (green) • On LED (green) • BMS Reset Button • Main On/Off Switch • Serial RS232 Plug for Programming via PC (by Freedom Won only) • Dip Switch block for selecting module addresses.
Warranty 3	10 years limited warranty
Design Life 4	>15 years
Included Accessories	• Plastic pedestal for tower stacking (cleats for 19" rack not included but available from Freedom Won if required). • DC cables standard 1,8m long in 35mm^2 single core with M6 terminal lugs on one end, red for positive and black for negative. • Interconnecting tower busbars drilled and cut to length for single tier jumps using tower pedestals, with heat shrink covering, red for positive and black for negative. • Interconnecting RS485 parallel battery communication cables for interconnecting the tower modules' communication RJ45 sockets (standard ethernet cables may also be used). • Inverter interface CAN Bus cable at 1,8m length for connecting compatible CAN bus equipped Victron inverters • Inverter interface CAN Bus cable at 1,8m length for connecting compatible CAN bus equipped Type 1 inverters e.g. Sunsynk, Growatt, Solis, Goodwe (see Freedom Won Interfacing Guide for full details). • Inverter interface RS485 cable at 1,8m length for connecting Voltronic/Axpert Inverters
Packaging	One e5000 per cardboard box complete with above included accessories.
Certificate of Compliance	UN 38.3 / IEC 62619

Notes to Specification Sheet

1 DoD = Depth of Discharge, max recommended 90% DoD, recommended 80% DoD for average daily discharge, 70% DoD on average for optimal life. Max permissible DoD is 100%.
2 Max discharge and charge (current and power) duration – 5 minutes per 30-minute cycle.
3 Refer to e tower warranty document for further details.
4 Assumed moderate cycling and ideal conditions of temperature, charge and discharge rates, and depth of discharge per cycle.

The maximum current for each model is governed by the rating of the built-in circuit breaker and the BMS. There is no noticeable cell temperature rise during operation and no active cooling of the cells is required. The time limit for operation at the maximum current is 5 minutes in a 30-minute cycle. To ensure that the circuit breaker does not trip in normal operation and to prevent overloading of the BMS power electronics, it is advised that the design of the system aims to remain at or below the continuous current value under most scenarios.

The absolute maximum allowable voltage when fully charged is 56V, however a more typical inverter charge setting range is 55.5V to 55.8V, depending on the inverter voltage tracking accuracy in preventing a voltage overshoot above 56V. The voltage normally used when setting up the inverter for 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 command the compatible connected inverter with CAN Bus or RS485 interface to stop discharging the battery 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. A voltage of 48V or even lower can be observed in systems without a CAN Bus interface or where the standby current draw on the inverter has caused the battery to be discharged below 10% SoC. The BMS will eventually cut off the battery from the DC bus at around 46V to protect the cells from undervoltage.

The dimensions given are for the principal outlines of the aluminium housing and exclude items that protrude such as the lifting handles and DC terminals.

The eTower modules are primarily designed to stand on the floor on the supplied pedestal but if space is a problem, they can also be placed on end against a wall with the front panel facing upwards.

4. Packaging, Transport, Handling and Mounting

4.1.1 Packaging

The eTower modules are packaged with protective foam and placed inside a cardboard box. The box is easily handled by two people.

The eTower is available from Freedom Won in singles or per crate, with a crate containing 12 eTower e5000 modules. For storage or transport, the boxes may be stacked four high. The crates may be stacked two high.

The eTower boxes and crates must be kept dry.

4.1.2 Transport

Although the eTower incorporates the safe LiFePO4 lithium cell design, it is unfortunately classified along with all lithium batteries as dangerous goods Class 9 Miscellaneous and UN 3480. When shipped by sea the package must be labelled as such using the correct label (Fig 3.1). The eTower box has this label printed on it already, so this is only required if shipped inside another crate or packaging. The packaging design must also comply with the dangerous goods regulations, so should always be transported in its original packaging.

For sea freight and road freight the transporter will require the Safety Data Sheet for the product, which is available from your distributor or from Freedom Won.

Figure 3.1 eTower Dangerous Goods Label for Sea Freight

4.1.3 Handling

The individual eTower modules require no special handling considerations since the weight is such that two people can easily carry it in the box. The 12 module crates require a pallet trolley to move and a forklift for loading and offloading.

The installation of the eTower is easily performed manually by two people.

4.1.4 Mounting

The first eTower module can be placed on the floor or a stand or shelf on its supplied pedestal, with units stacked on top of it, each sitting on their own pedestal, see Figure 2.3 for an example of a system stacked with four modules. The eTower must be placed on a firm level surface to ensure that the tower remains stable. The pedestal is designed to comfortably withstand the weight of six eTower modules. Stacking more in a tower is not recommended as the tower may become unstable.

Installation into 19” racks is made possible by ordering the angle brackets required from Freedom Won. The eTower is exactly five standard rack units high (5U). Two brackets are required per module.

If floor mounting on the pedestal is not suitable for a given application the eTower may also be installed with the terminals facing upwards, preferably not directly on the floor, but on a stand or shelf or wall mount bracket. Wall mount brackets are available from Freedom Won on request, which must be ordered along with the 19” rack mount brackets, because they are incorporated into the wall mounting system.

Ensure that the eTower is mounted at least 0.5m away from any heat source, and away from direct sunlight in a dry cool area free of moisture.

5. Environmental Requirements

No specific venting is required since the eTower emits no hazardous gases, however air circulation may be required to ensure room temperature is maintained at reasonable levels, preferably below 30˚C (see eTower warranty for information regarding upper temperature limits for hot environments).

Room heating may be required in cold climates to keep the room above 0˚C, since charging of the eTower is not permitted below 0˚C. Ambient environments that regularly exceed 35˚C should employ room cooling if practicable to ensure optimal eTower service life.

Temporary storage or transport of the battery is permitted in the range -20˚C to 45˚C, however extended storage longer than 60 days should be between 0˚C and 30˚C.

The eTower IP rating is IP20.

6. Connecting the Freedom Lite

6.1 Power Cables

The eTower is simple to connect and the required accessories are all included in the box. The supplied tower interconnecting busbars must be connected as illustrated in Figure 2.3, making sure to put the red on the positive and the black on the negative – observe the + and – signs near the terminals. The supplied 35mm^2 cables to connect to the inverter must be connected to the top eTower module, one cable per pole is required for inverters up to 10kVA, and two per pole for inverters up to 20kVA. The lugs for the eTower end of the DC cables are already fitted and the terminal bolts are long enough to accommodate both a busbar and a lug on the same terminal when required. Torque all terminal bolts to 12N.m.

***Caution:* Prior to connecting any of the positive and negative cables and busbars to the inverter and eTower modules, be sure to check that the main battery circuit breaker is *switched off* on all eTower modules and that the inverter is also switched off. This will ensure that there are no short circuits between the loose ends of the cables and prevent the risk of metal tools causing a short circuit.**

The DC cable cross sectional area is based on an acceptable voltage drop with the inverter being mounted on the wall adjacent to the eTower with a maximum cable run of 5m (note however that the standard cable length is 1,8m, longer cables are available on request or can be made up by the installer).

Cable runs longer than 5m should be assessed and larger cables. Double Insulation welding cable is recommended.

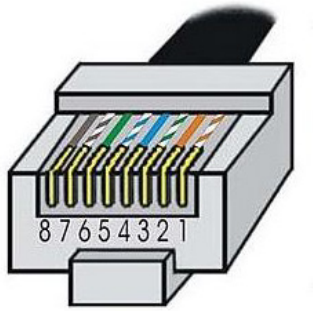
The cables may be routed through trunking and connected into the inverter on the positive and negative terminals respectively. The inverter terminals on most inverters can then be used for linking up the charge controller(s) to the DC Bus. On Installations where there are too many inverters and/or charge controllers to connect to the DC bus using the inverter terminals as a junction point a DC connector box is required.

6.2 Control Cables – Overview

For controlling external devices, you will need to connect the CAN Bus cable or RS485 cable depending on the inverter, which allows the Battery Management System inside the eTower to control and interface with these devices. The cables used are CAT5e or CAT6 Ethernet cables with RJ45 plugs.

Cables are included in the eTower box for most inverter options. See 2.2.13 and 2.2.14 for details on cable pin configurations should you need to make your own cables. Figure 5.1 provides the pin numbering of the RJ45 connector.

Fig 5.1 Pin Configuration for standard RJ45 plug



6.3 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 eTower BMS can transmit messages and commands in CAN protocol to provide information to, but more importantly to control, external devices. CAN allows great versatility and provides a simple 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 eTower 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 a wide range of inverters – see the Freedom Won Inverter Interfacing Guide for more information.

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 of all Lite's connected
ii. Discharge Current Limit of all Lite's connected
iii. Actual State of Charge (minimum of all lights connected)
iv. Actual Battery Temperature (highest of all lights connected)
v. Actual Voltage
vi. Actual Current (total of all Lite's connected)
vii. Maximum real time charge voltage setpoint
viii. Battery Name
ix. Highest Cell Voltage of all Lite's connected
x. Lowest Cell Voltage of all Lite's connected.
xi. Firmware Version
xii. Ah capacity of all batteries connected

The CAN 2.0 Part A and Part B standard uses the SAE J1939 standard in the eTower. It is necessary to install a 120 Ohm resistor on each extreme end of the CAN cable (splices or branch connections do not require a resistor). Most devices operating on CAN have two plugs to connect an incoming cable in and then outgoing cable 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 Freedom Won (if you are using Victron then you can use the Victron supplied resistors). SMA and Victron operate on this basis for example. The eTower however is designed to always be one of the end-of-line devices, and hence has only one CAN port, and has a built-in termination resistor.

Ingeteam for example 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.

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

Most inverter brands use 500kbps BAUD rate and so does the eTower. Systems requiring 250kbps are not compatible with the eTower. Consider using a Freedom LiTE battery programmed to operate at 250kbps if this BAUD rate must be used.

6.4 Parallel Configurations

It is permissible to connect multiple eTower e5000 modules in parallel. It may however be more cost effective to purchase one Freedom LiTE model of the applicable size than connecting multiple eTower units in parallel. The eTower is more intended as a solution where 5kWh is adequate for the starting point of the system but where future expansion is planned in multiple phases.

One eTower must be programmed as the Master by setting it to Address 01 (see 2.2.6), while the rest of the eTower modules connected to the DC bus are programmed as Slaves by default when they have addresses of 02 or higher. A total of 15 eTower modules can be connected in parallel, however for this capacity level there are better solutions from the Freedom LiTE Business and Commercial ranges.

Each eTower module communicates with the master module through an independent RS485 bus by “daisy chaining” the modules together using standard Ethernet cables with and RJ45 plugs. Note that these cables are included in the eTower box.

New units can be placed in parallel with old units up to about 5 years or 1 500 cycles, after which it is preferable to trade in for a new unit(s) should a capacity upgrade be required.

7. Programming the eTower

The eTower firmware and parameter programming is performed only by Freedom Won or authorised distributors and instruction of such is outside the scope of this manual.

8. Switching on the eTower

The Lite is fitted with an "ON/OFF" breaker. When this breaker is switched on the DC terminals of the eTower may immediately become live if the BMS is active. If the BMS is not active and the eTower detects an external voltage source the BMS will come alive, observed by the illumination of LED's on the front panel.

Note: On some inverters there is a large inrush current when switching on the DC supply. It is important in these instances to pre-charge the DC bus. With Victron this can be achieved by switching on the PV to the MPPT's to allow them to apply voltage to the DC bus before closing the battery breaker. If this option is not available, you can switch on the AC input power to the Victron inverter as this allows the inverter to place voltage on the DC bus (it may be necessary to unplug the Ve.Bus cable from the GX device to allow the inverter to energise). If you are using inverters that cannot do this, you will need to use a pre charge resistor.

To switch off the DC output from the eTower switch off the breaker. To switch off the power to the BMS, press the reset button for 3 seconds and release. If this is not done the BMS will shut down automatically after 24 hours anyway.

9. Settings Required for Setting up Inverters and Charge Controllers

The maximum and continuous discharge currents for the eTower in configurations of one to four are provided in Table 2.1. The charge current limit should be observed for the current limit settings of the inverter(s). The 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 eTower 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 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 cut off 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 by internally disconnecting the cells from the terminals. The breaker will remain ON. Once the problem is cleared the eTower module may reconnect.

Frequent occurrences of this situation 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 without communication is:

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

In non-CAN/R485 systems fitted with DC solar charge controllers (SCC) the AC charger should stop charging at 53.5V to allow the remainder of the charge to be performed by the SCC.

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.

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.

10. Accessories

Freedom Won includes the following accessories inside the eTower box as not additional charge:

Table 9.1 List of Accessories

Item	Description
1 x Plastic pedestal	For stacking multiple eTower modules on top of each other without requiring a cabinet
2 x DC Cables	Standard 1,8m long supplied in 35mm^2 single core with M6 terminal lugs on one end, red for positive and black for negative
2 x Interconnecting tower busbars	Drilled and cut to length for single tier jumps using tower pedestals, with heat shrink covering, red for positive and black for negative.
1 x Interconnecting RS485 parallel battery communication cables	For interconnecting the tower modules' communication RJ45 sockets (standard ethernet cables may also be used).
1 x Victron inverter system interface CAN Bus cable	1,8m length for connecting compatible CAN bus equipped Victron inverters (GX devices)
1 x "Type 1" inverter interface CAN Bus cable	1,8m length for connecting compatible CAN bus equipped "Type 1" inverters e.g. Sunsynk, Growatt, Solis, Goodwe
1 x Voltronic Inverter interface RS485 cable	1,8m length for connecting Voltronic/Axpert Inverters using their RS485 interface port

The following accessories are available at a nominal charge:

Table 9.2 List of Accessories

Item	Description
19" Rack Mounting Brackets	Two are required to install the eTower modules inside a 19" rack cabinet.
Wall mount bracket	For mounting the eTower modules on a wall with the terminals facing upwards, must be combined with the 19" rack mounting brackets.
CAN Bus Inverter Interfacing Cables	If the cable supplied with the eTower is not long enough Freedom Won supplies longer versions to suit the "Type 1" CAN Bus inverters and the SMA Sunny Island inverters. Specify which one is required when ordering.
RS485 Inverter Interfacing Cable	If the cable supplied with the eTower is not long enough Freedom Won supplies longer cables for the Voltronic range of RS485 inverters.

11. Warranty and Repair

The eTower 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 eTower indicates an internal problem, please contact Freedom Won or the installer that installed the system, who will need to return the unit to Freedom Won for inspection.

The warranty will not cover 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 4 000 cycles at an average of 70% DoD, whichever should first occur. The battery is required to provide at least 60% of its new capacity at the end of this period or cycle count. The BMS records the number of cycles used. If you suspect that your eTower is delivering substantially below its minimum performance, please contact your distributor or installer for an investigation. If the unit is found to be underperforming it must be returned to Freedom Won and it will be serviced such that the minimum performance guarantee is again restored, or Freedom Won will decide that it needs to be replaced.

For more detailed warranty information please refer to the Freedom Won eTower Warranty Document.

12. Expected Product Life

The eTower is expected to operate for about 15 years in a daily cycling scenario for more than 5 000 cycles with an average of 70% DoD per cycle. For occasional cycling applications (for typical load shedding for instance, as is experienced in some countries) the expected service life is up to 20 years.

13. 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 your approved Freedom Won supplier for assistance.

Table 14.1 Troubleshooting Guide

No	Problem Description	Cause/Solution
1	The battery displays an alarm when the beaker is switched on and will not connect	The most likely cause is that the battery has been connected to another module or multiple modules that has/have a vastly different State of Charge and the battery being switched on is running into overcurrent I charge or discharge. If this is indeed the problem, switch off all the other modules and either charge or discharge the problem module until its voltage is within one volt of the others, and then switch the others back on. If this is not the problem, it could be caused by inrush current to the inverter – pre-charge the DC bus before switching on the battery.
2	The battery alarm comes on and disconnects when at 100% SoC	Once of the cells might be reaching its maximum voltage value. Try reducing the charge voltage setting on the inverter by to 55.5V and reset the battery by pressing the reset button for 6 seconds
3	The alarm light comes on at low SoC	This could simply be the low SoC alarm that comes on below 10% SoC. It could also be a low cell voltage alarm. Increase the minimum pack voltage to 49V, or charge the battery above 10% SoC
4	The LED's do not switch off when I switch off the breaker	This is not a concern, the BMS will shut down after 24 hours of inactivity
4	My battery will not charge at more than 20A	The eTower has an automatic charge limit feature where the maximum charge current is reduced to 20A using the internal MOSFET controller if the charge current exceeds 85A for too long. This condition will be cancelled once the charge current has reduced to zero i.e. when the battery is fully charged.
5	The inverter has shut down	If the battery SoC is below 10% the inverter will be commanded to shut down. To restore the system you will need grid power, generator power, or solar power to recharge the battery to above 15%