

Title: **MANUFACTURING  
SPECIFICATION FOR A  
CONTAINERISED MICROGRID  
GENERATOR AND ENERGY  
STORAGE SYSTEM**

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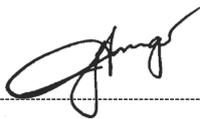
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## **Executive Summary**

The energy landscape in South Africa is undergoing rapid changes, several of which challenges the traditional electrical utility model [20]. Eskom needs to adapt and provide alternative electrical energy products and services that satisfy customer needs, especially in circumstances and areas where traditional grid connected electricity supplies are currently uneconomical and / or unaffordable.

Such products and services must align with Eskom Distribution's strategic objective to grow and sustain sales. One such opportunity to be exploited is to harness the abundant and renewable solar energy resource that South Africa is so richly blessed with, to supply smaller and remote communities in the lower or selective customer LSM levels, with electrical energy derived from solar photovoltaic electrical energy generation and battery energy storage. Eskom's RT&D has researched the options available towards developing a containerised solar generator solution that will form an integral part of Eskom's journey towards the intended Just Energy Transition (JET). As a result, RT&D designed and developed a prototype solar generator [21] that has now reached a point in development, that will allow Eskom DX to replicate this prototype design to energise this part of the JET initiative through dedicated Eskom in-house manufacturing of a containerised Microgrid Generator and Energy Storage system.

This internally Eskom focussed standard aims to set the specific technical requirements, solely based on the RT&D prototype, which will ensure achievement of economies of scale as well as replicated as a standardised solution and system.

## 1. Introduction

The Distribution Group (DX) strategic objective to grow and retain sales by providing competitive products and services. As such flexible distributed energy resources (DER) was identified as one of the vehicles to be utilised to achieve this objective. An opportunity exists to deploy containerised Solar Photovoltaic (PV) and Battery Energy Storage (BES) systems as DX's initial venture into this market. Eskom Research, Testing and Development piloted the concept of a Containerised Microgrid Solar Photovoltaic Generator and Battery Energy Storage System, and the first assembly line was established at Komati Power Station [21]. DX executive committee approved the establishment of an assembly line at Eskom Park, Witbank and/or Komati Power Station to manufacture the second batch of shipping containers and to install renewable system energy components, battery energy storage and control equipment in these containers.

This specification only provides for the manufacture of the initial batch of 40 containers and has been drafted based on the prototype as built by RT&D at the Komati Power Station site [21]. It is foreseen that the specification will be reviewed based on the knowledge and experience gained during this phase of manufacturing and deployment of the first batch of containers in the various OUs.

The deployment of this technology necessitated the development of a suite of documents required for the planning, design, asset creation, maintenance and operations of equipment and systems in the DX operating environment. This document is the first of these standards and will be augmented in the near future as more related DX standards become available.

## 2. Supporting clauses

### 2.1 Scope

This document contains the functional requirements for a Containerised Microgrid Solar Photovoltaic Generator and Battery Energy Storage System.

#### 2.1.1 Purpose

The purpose of the document is to provide verifiable system requirements of a Containerised Microgrid Solar Photovoltaic Generator and Battery Energy Storage System.

#### 2.1.2 Applicability

This document shall apply only to the manufacturing of Containerised Microgrid Solar Photovoltaic Generator and Battery Energy Storage Systems at Eskom Park, Witbank and/or Komati Power Station.

## 2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

### 2.2.1 Normative

- [1] 240-170000103 Lithium iron phosphate batteries standard
- [2] 240-75655504 Corrosion Protection Standard for New Indoor and Outdoor Eskom Equipment, Components, Materials and Structures Manufactured from Steel Standard.
- [3] IEC 60068 Environmental Testing, all parts
- [4] IEC 60204-1 Safety of machinery – Electrical equipment of machines – Part 1: General requirements
- [5] IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)
- [6] IEC 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

- [7] IEC 61215-1:2021 Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements
- [8] IEC 61215-2:2021 Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 2: Test procedures
- [9] IEC 61326-1:2020 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
- [10] IEC 61730-1:2016 Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction.
- [11] IEC 61730-2:2016 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing.
- [12] IEC 62109-1:2010 Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
- [13] IEC 62109-2:2011 Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters
- [14] IEC 62619:2022 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications
- [15] NRS 097-2-1:2017 Small-scale Embedded Generation, Utility Interface
- [16] SANS 121:2011 Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.
- [17] SANS 61000-6-2, 3 and 4: Electromagnetic compatibility (EMC)
- [18] SANS 657:2011 Steel tubes for non-pressure purposes.
- [19] UL 1741: 2021 Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

**2.2.2 Informative**

- [20] 240-108650238 Distribution Group Business Plan
- [21] RES/IRR/22/1963489 Containerised Microgrid Solution Interim Report

**2.3 Definitions**

**2.3.1 General**

Definition	Description	Reference
<b>air mass</b>	Numerical value used to give an overall measure of the amount of atmosphere through which solar radiation must pass	SANS959-1
<b>area electric power system (Area EPS)</b>	An EPS that serves Local EPSs	IEEE1547
<b>battery management system</b>	Electronic system associated with a battery, which monitors and/or manages its state, calculates secondary data, reports that data and/or controls its environment to influence the battery’s safety, performance and/or service life and has the functions to cut off in case of overcharging, overcurrent and overheating.	240-170000103
<b>bi-directional meter</b>	Meter that measures the active energy (Wh) flow in both directions (import and export) and either displays the balance of the imported and exported energy in a single register meter (net metering) or displays both imported and exported energy in separate registers	NRS097-2-4

Definition	Description	Reference
<b>black start</b>	Start-up of an electric power system from a blackout through internal energy resources	SATS62786:2020
<b>charge controller (regulator)</b>	Battery charge and discharge regulator that prevents overcharging and over-discharging of a battery in a photovoltaic system by reducing the photovoltaic current, or by disconnecting the load	SANS959-1
<b>cycle of battery</b>	Sequence of a discharge followed by a charge, or a charge followed by a discharge under specified conditions	SANS959-1
<b>depth of discharge (DoD)</b>	Percentage of rated capacity discharged from a battery	SATS62786:2020
<b>distributed energy resource (DER)</b>	Generators, including loads having a generating mode (such as electrical energy storage systems) connected to the low or medium voltage distribution network, with their auxiliaries, protection and connection equipment	SATS62786:2020
<b>distributed energy resource (DER) unit</b>	An individual DER device inside a group of DERS that collectively form a system	IEEE1547
<b>distributed energy resource managing entity (DER Managing Entity)</b>	An entity that monitors and manages the DER through the local DER communication interface. The DER managing entity could be for example a utility, an aggregator, a building energy management system, or other	IEEE1547
<b>distributed energy resource operator (DER operator)</b>	The entity responsible for operating and maintaining the distributed energy resource.	IEEE1547
<b>export kWh</b>	Active energy exported by the customer (delivered energy)	NRS097-2-4
<b>HTML5</b>	HTML5 is a new version of HTML with new functionalities with markup language with Internet technologies. Language in HTML does not have support for video and audio. HTML5 supports both video and audio.	
<b>hybrid power plants</b>	Multi-sources system with at least two kinds of energy generation technology	IEC/TS 62257-9-7:2019
<b>import kWh</b>	Active energy imported by the customer (received energy)	NRS097-2-4
<b>inverter</b>	Device that changes DC input into AC output or vice versa	SANS959-1
<b>island</b>	A condition in which a portion of an Area EPS is energized solely by one or more Local EPSs through the associated PCCs while that portion of the Area EPS is electrically separated from the rest of the Area EPS on all phases to which the DER is connected. When an island exists, the DER energizing the island may be said to be "islanding"	IEEE1547
<b>planned islanding</b>	The ability to decide when to form a microgrid	
<b>unplanned islanding</b>	The ability of the microgrid to react automatically when it detects a problem with the grid	
<b>seamless islanding</b>	The ability for a microgrid to form a planned or unplanned island without any interruption to loads.	
<b>dynamic islanding</b>	The ability of the system to adapt to unplanned events, such as a loss of generation or a fault, once the microgrid has formed	
<b>local DER communication interface</b>	A local interface capable of communicating to support the information exchange requirements specified in this standard for all applicable functions that are supported	IEEE1547
<b>local electric power system (Local EPS)</b>	An EPS contained entirely within a single premises or group of premises	IEEE1547
<b>point of common coupling (PCC)</b>	The point of connection between the Area EPS and the Local EPS	IEEE1547
<b>point of connection - grid-tied (POC)</b>	Physical connection point on the distribution network where a generating plant is connected	SATS62786:2020

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Definition	Description	Reference
<b>point of DER connection (PoC)</b>	The point where a DER unit is electrically connected in a Local EPS and meets the requirements of this standard exclusive of any load present in the respective part of the Local EPS	IEEE1547
<b>renewable energy (REN)</b>	Energy from a source that is not depleted when used	IEC/TS 62257-9-7:2019
<b>small-scale embedded generator (SSEG)</b>	Embedded generator rated at up to 100 KVA which includes the energy conversion device (devices), the static power converter (converters), if applicable, and the control and protection gear within a customer’s network that operates in synchronism with low-voltage networks. For avoidance of any doubt, the point of generator connection must be at low voltage even if the point of utility supply is not at low voltage.	NRS097-2-1
<b>stand by generators</b>	An installation that incorporates alternative supplies intended to supply, either continuously or occasionally, all or part of the installation with the following supply arrangements: a) supply to an installation or part of an installation which is not connected to the main supply of a supplier; b) supply to an installation or part of an installation as an alternative to the main supply of a supplier; and c) appropriate combinations of the above.	NRS097-2-4
<b>standard test conditions (STC)</b>	Conditions where the irradiance is 1 000 W/m <sup>2</sup> , the temperature of the photovoltaic cell is 25 °C and the air mass is 1,5 (SEE air mass)	SANS959-1
<b>curtailment of generators</b>	A control system required that will measure the import of electricity from the utility and when it reaches a set point of embedded generator capacity, the control system will start to curtail the inverters down to ensure that a minimum amount of power is being drawn into the point of supply.	NRS097-2-4
<b>Low voltage</b>	≤1000V	

**2.3.2 Disclosure classification**

**Confidential:** the classification given to information that may be used by malicious/opposing/hostile elements to harm the objectives and functions of Eskom Holdings Limited.

**2.4 Abbreviations**

Abbreviation	Description
<b>ABS</b>	Acrylonitrile butadiene styrene
<b>AC</b>	Alternating Current
<b>ACDC</b>	AC to DC
<b>ACG</b>	Armoured cable gland
<b>ACGIH</b>	American Conference of Governmental Industrial Hygienists
<b>AES</b>	Advanced Encryption Standard
<b>AH</b>	Authentication Header
<b>AHD</b>	Analog High Definition
<b>AMB</b>	
<b>API</b>	Application programming interface
<b>ATA</b>	Advanced Technology Attachment
<b>AUTO</b>	Automatically
<b>AWG</b>	American Wire Gauge

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Abbreviation	Description
BCP	Bulk copy program
BES	Battery Energy Storage
BESS	Battery Energy Storage System
BFD	Bidirectional Forwarding Detection
BGP	Border Gateway Protocol
BMS	Battery Management System
BNC	Bayonet Nut Connector
BTU	Battery Tripping Unit
CAN	Controller Area Network
CAT	Category
CCTV	Closed-Circuit Television
CD	Compact Disc
CE	Conformité Européenne (European Economic Area Standard)
CG	Compression Gland
CGI	Computer Generated Imagery
CIF	Common Intermediate Format or Common Interchange Format
CMOS	Complementary metal-oxide-semiconductor
CMRR	Common-mode Rejection Ratio
CO	Change Over
COM	Common
CPU	Central Processing Unit
CR	Lithium Round
CT	Current Transformer
CVBS	Composite Video Baseband Signal
CVI	Composite Video Interface
DC	Direct Current
DCDC	DC to DC
DCF	
DDNS	Dynamic DNS
DER	Distributed Energy Resource
DHCP	Dynamic Host Configuration Protocol
DIN	Deutsches Institut für Normung
DMA	Direct memory access
DNS	Domain Name System
DSCP	Differentiated Services Code Point
DSP	Digital Signal Processor
DTE	Data Terminal Equipment
DVR	Digital Video Recorder
DX	Eskom Distribution
EAC	Eurasian Conformity
ECMP	Equal-cost multi-path
EIA	Electronic Industries Alliance
EMC	Electromagnetic Compatibility
EN	Europäische Norm (European Standard)
EPS	Electric Power System
ESP	Encapsulating Security Payload
FCC	Federal Communications Commission
FDD	Frequency Division Duplex
FPGA	Field Programmable Gate Arrays
GB	Gigabyte
GPS	Global Positioning System
GUI	Graphical User Interface
HC	High Cubed
HD	High Definition

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Abbreviation	Description
HDCVI	High Definition Composite Video Interface
HDD	Hard Disk Drives
HDMI	High Definition Multimedia Interface
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IGMP	Internet Group Management Protocol
IO	Input output
IP	Ingress Protection
IP	Internet Protocol
IPC	
IPIP	Internet Protocol Tunnelling Through Internet Protocol
IR	Infra-red
Isc	Short Circuit Current
JET	Just Energy Transition
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LSM	Living Standards Measure
LTE	Long Term Evolution
LV	Low Voltage
LVD	Low Voltage Directive
MAC	Media Access Control
MB	Megabyte
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MDI	Medium-dependent Interface
MDIX	Medium-dependent Interface Crossover
MEM	Memory
MIPSBE	Microprocessor without Interlocked Pipelined Stages
MLPPP	Multilink Point-to-Point Protocol
Modem	Modulator-Demodulator
MP	Mega Pixel
MPPT	Maximum Power Point Tracking
MTBF	Mean Time Between Failures
MTU	Maximum Transmission Unit
MVA	Megavolt-amperes
NAT	Network Address Translation
NC	Normally Closed
NO	Normally Open
NRS	
NTP	Network Time Protocol
NTSC	National Television Standards Committee
ONVIF	Open Network Video Interface Forum
PAL	Phase Alternate Line
PC	Personal Computer
PCC	Point of Common Coupling
PCM	Pulse-Code Modulation
PIR	Passive Infrared
PM	Project Manager
POC	Point of Connection
PPP	Point-to-Point Protocol

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Abbreviation	Description
PPTP	Point-to-Point Tunnelling Protocol
PSK	Phase Shift Keying
PSU	Power Supply Unit
PV	Photovoltaic
RAM	Reliability, Availability and Maintainability
REN	Renewable Energy
RF	Radio Frequency
RH	Relative Humidity
ROHS	Restriction of Hazardous Substances
RPM	Revolutions Per Minute
RTSP	Real Time Streaming Protocol
SANS	South African National Standard
SAT	Site Acceptance Test
SATA	Serial Advanced Technology Attachment
SCADA	Supervisory Control and Data Acquisition
SCOT	Steering Committee of Technology
SD	Secure Digital
SDHC	Secure Digital High Capacity
SDRAM	Synchronous Dynamic Random Access Memory
SIA	Serial Interface Adaptor
SIM	Subscriber Identity Module
SIT	Site Integration Test
SLD	Single Line Diagram
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SSD	Solid State Drive
SSH	Secure Socket Shell
SSEG	Small Scale Embedded Generator
SSTP	Secure Socket Tunnelling Protocol
STC	Standard Test Condition
STD	Standard
STP	Spanning Tree Protocol
TB	Terabyte
TCP	Transmission Control Protocol
TDD	Time Division Duplex
THD	Total Harmonic Distortion
TIA	Telecommunications Industry Association
TVI	Transport Video Interface
TX	Transmission
UDP	User Datagram Protocol
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus
UTP	Unshielded twisted pair
UV	Ultraviolet
VDC	Volt Direct Current
VESA	Video Electronics Standards Association
VGA	Video Graphics Array
VLAN	Virtual Local Area Network
Voc	Open Circuit Voltage
VPN	Virtual Private Network
VRF	Virtual Routing and Forwarding
VT	Voltage Transformer

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## **2.5 Roles and responsibilities**

During the execution phase, the appointed project manager (PM) will be responsible to ensure that the constructed and delivered product complies with this specification, or the agreed and approved deviations.

## **2.6 Process for monitoring**

The Distribution SCOT DER/SSEG Study Committee shall evaluate the performance of Containerised Microgrid Solar Photovoltaic Generator and Battery Energy Storage Systems once installed, operated and maintained by the relevant DX operating units.

## **2.7 Related/supporting documents**

Not applicable

## **3. Technical requirements**

### **3.1 System description**



**Figure 1: Containerised Microgrid Solar Photovoltaic Generator and Battery Energy Storage System**

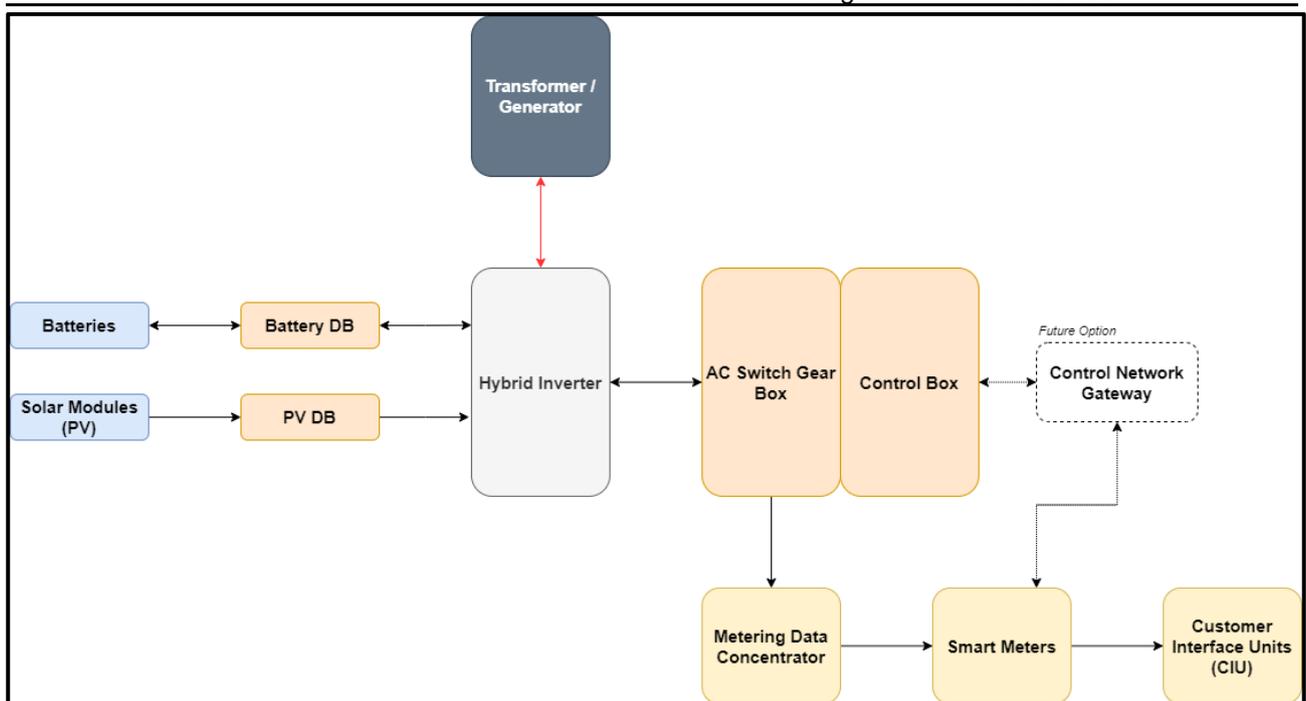


Figure 2: Hybrid inverter system

This functional specification includes the following components:

1. Standard shipping containers
2. Mechanical Structures
3. PV panels
4. Energy storage system
5. Inverters and chargers
6. Control system
7. AC distribution board
8. Battery distribution board
9. PV distribution board
10. Temperature control
11. Fire prevention system

### 3.2 Functional requirements

1. System minimum power rating – 30 kW continuous
2. Peak power (off grid) - 2 times of rated power, 10 sec
3. Storage capacity – 60 kWh minimum, expandable to 160 kWh
4. Voltage rating – 240 V, single phase
5. Current rating – 125 A
6. Container size 40 ft (12 m) High cubed
7. LV grid size – 30 prepaid customers maximum.

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- 8. Control Mode:
  - a) Frequency control mode
  - b) Volt-var control mode
- 9. Communication:
  - a) 3G/LTE cellular network
  - b) Dual WAN failover (multi router setup)
  - c) Utilises control centre APN linked SIM cards
  - d) Remote engineering interface capable and available over IPsec VPN encrypted channel
  - e) Monitoring interface capable and available over IEC 61850/DNP 3

### 3.3 System specifications

#### 3.3.1 Container

The Containerised Microgrid Solar Photovoltaic Generator and Battery Energy Storage System shall be installed in a standard shipping container with the following dimensions:

- 1. 40 feet (12 Meter)
- 2. High Cubed (HC)

Corrosion protection shall be applied to the shipping container according to 240-75655504 [2]

#### 3.3.2 Mechanical Structures

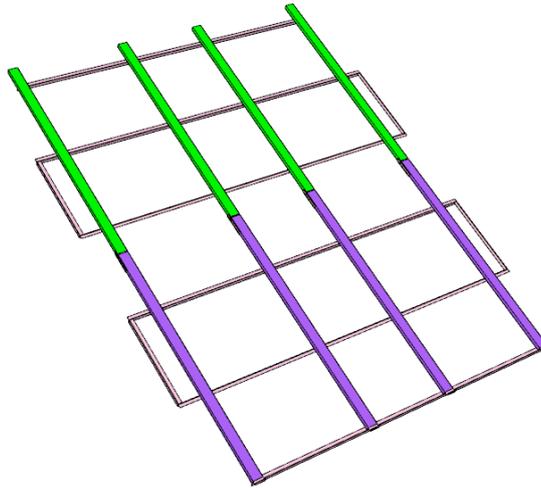
##### 3.3.2.1 Mechanical standards

All steel, nuts and bolts shall comply to the following standards:

No	Item	Standard
1	All steel items, listed below, shall comply to the DX corrosion protection specification.	240-75655504 [2] SANS 121 [16]
1.1	Square tube	SANS 657 [18]
1.2	Lip channel	Cold formed
1.3	Angle iron	Mild steel
1.4	Flatbar	Mild steel
1.5	Round Tube	SANS 657 [18]
1.6	Butterfly hinge	Mild steel
1.7	Drop side hinge	Mild steel
1.8	Galvanized Bolts and Nuts	240-75655504 [2]

**3.3.2.2 Bill of materials**

**3.3.2.2.1 Bottom structure middle**



**Figure 3: Bottom structure middle**

No	Item	Qty
1	Lip Channel (100mm x 50mm x 20mm x 3mm) Length: 2.6m	12
2	Lip Channel (100mm x 50mm x 20mm x 3mm) Length: 2.7m	12
3	Angle Iron (40mm x 40mm x 2.5mm) Length: 1m	12
4	Angle Iron (40mm x 40mm x 2.5mm) Length: 3.8m	12
5	Angle Iron (40mm x 40mm x 2.5mm) Length: 3.38m	6
6	Angle Iron (40mm x 40mm x 2.5mm) Length: 0.2m	24
7	Angle Iron (40mm x 40mm x 2.5mm) Length: 0.1m	12
8	Flatbar (50mm x 3mm) Length: 0.09m	12
9	Square Tube (38mm x 38mm x 3mm) Length: 2.725m	12
10	Square Tube (38mm x 38mm x 3mm) length: 4.7m	12
11	STD 16mm Drop side hinges 118mm (L) x 54mm (W) x 50mm (H) x 8mm (T) (16MMDSH)	12
12	Butterfly Hinge 60mmx70mm Heavy duty	12
13	M10 x 20mm Hex head (Hi - tensile Steel)	48
14	M10 x 120mm Hex head (Hi - tensile Steel)	24
15	Nyloc nuts M10 (Hi - tensile Steel)	72
16	M8 x 60mm Hex head (Hi - tensile Steel)	24
17	Nyloc nuts M8 (Hi - tensile Steel)	24

3.3.2.2.2 Bottom structure side right

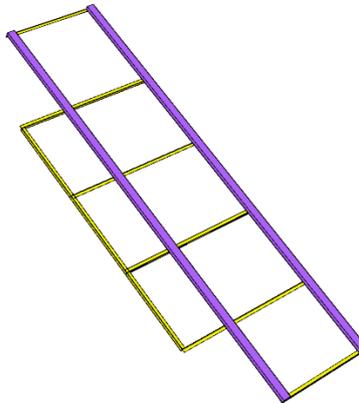


Figure 4: Bottom structure side right

No	Item	Qty
1	Lip Channel (100mm x 50mm x 20mm x 3mm) Length: 5.32m	2
2	Angle Iron (40mm x 40mm x 2.5mm) Length: 1.9m	4
3	Angle Iron (40mm x 40mm x 2.5mm) Length: 2.1m	2
4	Angle Iron (40mm x 40mm x 2.5mm) Length: 3.08m	1
5	Square Tube (38mm x 38mm x 3mm) Length: 3.29m	1
6	Square Tube (38mm x 38mm x 3mm) Length: 5.025m	1
7	Square Tube (38mm x 38mm x 3mm) length: 3.238m	1
8	Bolt M10 x 20mm Hex head (Hi - tensile Steel)	4
9	Bolt M8 x 60mm Hex head (Hi - tensile Steel)	6
10	Nyloc nuts M10 (Hi - tensile Steel)	4
11	Nyloc nuts M8 (Hi - tensile Steel)	6

3.3.2.2.3 Bottom structure side left

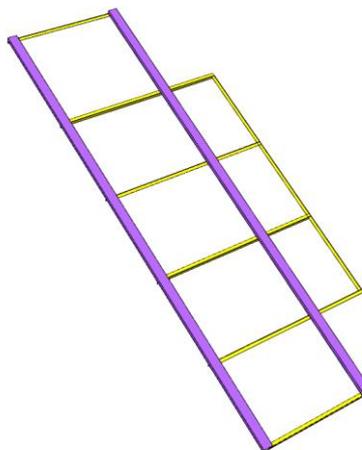


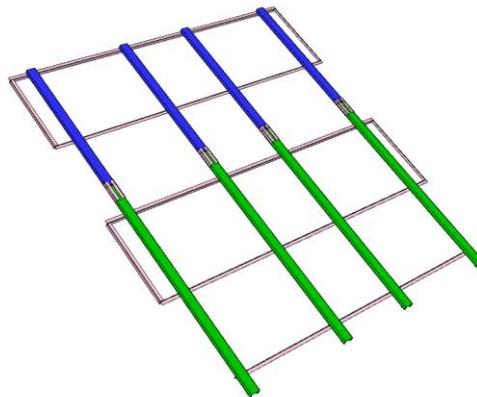
Figure 5: Bottom structure side left

No	Item	Qty
1	Lip Channel (100mm x 50mm x 20mm x 3mm) Length: 5.32m	2
2	Angle Iron (40mm x 40mm x 2.5mm) Length: 1.9m	4
3	Angle Iron (40mm x 40mm x 2.5mm) Length: 2.1m	2

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4	Angle Iron (40mm x 40mm x 2.5mm) Length: 3.08m	1
5	Square Tube (38mm x 38mm x 3mm) Length: 3.29m	1
6	Square Tube (38mm x 38mm x 3mm) Length: 5.025m	1
7	Square Tube (38mm x 38mm x 3mm) length: 3.238m	1
8	Bolt M10 x 20mm Hex head (Hi - tensile Steel)	4
9	Bolt M8 x 60mm Hex head (Hi - tensile Steel)	6
10	Nyloc nuts M10 (Hi - tensile Steel)	4
11	Nyloc nuts M8 (Hi - tensile Steel)	6

**3.3.2.2.4 Top structure**



**Figure 6: Top structure**

No	Item	Qty
1	Lip Channel (100mm x 50mm x 20mm x 3mm) Length: 2.6m	12
2	Lip Channel (100mm x 50mm x 20mm x 3mm) Length: 1.75m	12
3	Angle Iron (40mm x 40mm x 2.5mm) Length: 1m	12
4	Angle Iron (40mm x 40mm x 2.5mm) Length: 3.8m	12
5	Angle Iron (40mm x 40mm x 2.5mm) Length: 3.38m	3
6	Angle Iron (40mm x 40mm x 2.5mm) Length: 0.2m	24
7	Angle Iron (40mm x 40mm x 2.5mm) Length: 0.1m	12
8	Flatbar (50mm x 3mm) Length: 0.09m	36
9	Square Tube (38mm x 38mm x 3mm) Length: 1.26m	12
10	Square Tube (38mm x 38mm x 3mm) length: 2.35m	12
11	STD 16mm Drop side hinges 118mm (L) x 54mm (W) x 50mm (H) x 8mm (T) (16MMDSH)	12
12	Butterfly Hinge 60mmx70mm Heavy duty	12
13	M10 x 20mm Hex head (Hi - tensile Steel)	48
14	M10 x 120mm Hex head (Hi - tensile Steel)	24
15	Nyloc nuts M10 (Hi - tensile Steel)	72
16	M8 x 60mm Hex head (Hi - tensile Steel)	24
17	Nyloc nuts M8 (Hi - tensile Steel)	24

3.3.2.2.5 Bottom bracket

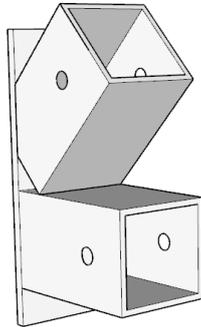


Figure 7: Bottom bracket

No	Item	Qty
1	Flatbar (50mm x 5mm) Length: 0.15m	12
2	Square Tube (50mm x 50mm x 3mm) Length: 0.08m	24

3.3.2.2.6 Middle bracket

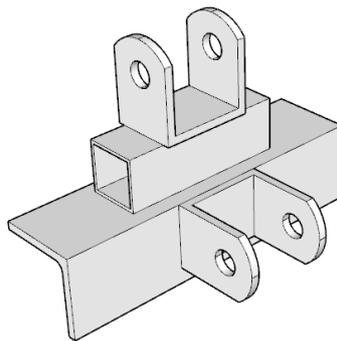


Figure 8: Middle bracket

No	Item	Qty
1	Square Tube (38mm x 38mm x 3mm) Length: 0.1m	12
2	Angle Iron (50mm x 50mm x 5mm) Length: 0.2m	12

3.3.2.2.7 Top bracket

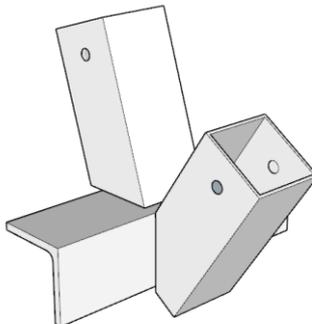
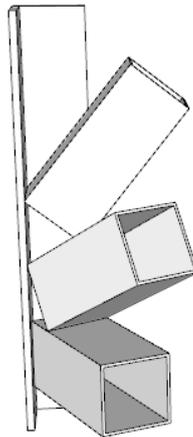


Figure 9: Top bracket

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No	Item	Qty
1	Angle Iron (50mm x 50mm x 5mm) Length: 0.2m	12
2	Square Tube (50mm x 50mm x 3mm) Length: 0.12m	24

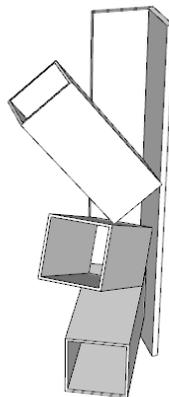
**3.3.2.2.8 Side bracket right**



**Figure 10: Side bracket right**

No	Item	Qty
1	Angle Iron (50mm x 50mm x 5mm) Length: 0.3m	1
2	Square Tube (50mm x 50mm x 3mm) Length: 0.12m	3

**3.3.2.2.9 Side bracket left**



**Figure 11: Side bracket left**

No	Item	Qty
1	Angle Iron (50mm x 50mm x 5mm) Length: 0.3m	1
2	Square Tube (50mm x 50mm x 3mm) Length: 0.12m	3

3.3.2.2.10 Battery rack



Figure 12: Battery Rack and Inverter Bay

No	Item	Qty
1	Square Tube (50mm x 50mm x 3mm) Length: 0.956m	8
2	Square Tube (50mm x 50mm x 3mm) Length: 2.57m	8
3	Square Tube (50mm x 50mm x 3mm) Length: 2.47m	4
4	Square Tube (50mm x 50mm x 3mm) Length: 0.4m	8
5	Angle Iron (40mm x 40mm x 2.5mm) Length: 0.5m	120
6	Flatbar (40mm x 3mm) Length: 0.453m	16
7	Angle Iron (50mm x 50mm x 5mm) Length: 0.05m	12

3.3.2.2.11 Antenna mast

No	Item	Qty
1	Square Tube (50mm x 50mm x 3mm) Length: 0.2m	2
2	Square Tube (38mm x 38mm x 3mm) Length: 0.2m	4
3	Square Tube (32mm x 32mm x 3mm) Length: 1m	2
4	Square Tube (32mm x 32mm x 3mm) Length: 1.5m	2
5	Round Tube (50mm x 2mm) Length: 0.5m	2
6	Bolt M10 x 20mm Hex head (Hi - tensile Steel)	8
7	Nut M10 (Hi - tensile Steel)	8
8	Bolt M8 x 60mm Hex head (Hi - tensile Steel)	2
9	Nyloc nuts M8 (Hi - tensile Steel)	2

3.3.2.2.12 Trunking layout

No	Item	Qty
1	Cable tripper (Wire Mesh Cable Rack) (150mm (W) x 50mm (H)) Length: 5.2m	4
2	Cable tripper (Wire Mesh Cable Rack) (150mm (W) x 50mm (H)) Length: 2.4m	2
3	Cable tripper (Wire Mesh Cable Rack) (100mm (W) x 90mm (H)) Length: 3m	7
4	Cable tripper (Wire Mesh Cable Rack) (100mm (W) x 50mm (H)) Length: 0.85m	2
5	Cable tripper (Wire Mesh Cable Rack) (100mm (W) x 50mm (H)) Length: 2.4	1
6	Cable tripper (Wire Mesh Cable Rack) (50mm (W) x 50mm (H)) Length: 3	9

3.3.2.2.13 Unistrut layout

No	Item	Qty
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1	Cable Trunking (Uni-strut) (41mm x 41mm x 3mm) Length: 2.25m	1
2	Cable Trunking (Uni-strut) (41mm x 41mm x 3mm) Length: 1.4m	3
3	Cable Trunking (Uni-strut) (41mm x 41mm x 3mm) Length: 0.65m	2
4	Cable Trunking (Uni-strut) (41mm x 41mm x 3mm) Length: 0.5m	1
5	Cable Trunking (Uni-strut) (41mm x 41mm x 3mm) Length: 2.2m	2
6	Spring Nut M8 x 41mm	32
7	Bolt M8 x 25mm Hex head	32
8	M8 spring washer	32

**3.3.2.2.14 Auxiliary mounting points**

No	Item	Qty
1	Square Tube (32mm x 32mm x 3mm) Length: 0.2m	2
2	Square Tube (32mm x 32mm x 3mm) Length: 0.1m	6
3	Tek Screws 5.5mm x 16mm (steel)	6
4	Nut M30 (Hi - tensile Steel)	2

**3.3.2.2.15 Air conditioner bracket**

No	Item	Qty
1	Flatbar (50mm x 5mm) Length: 0.15m	4
2	Cable Trunking (Uni-strut) (41mm x 41mm x 3mm) Length: 0.5m	4

**3.3.2.2.16 Structure joints**

No	Item	Qty
1	Square Tube (32mm x 32mm x 3mm) Length: 0.75m	4
2	Square Tube (32mm x 32mm x 3mm) Length: 0.2m	4
3	Bolt M8 x 40mm Hex head (Hi - tensile Steel)	16
4	Nyloc nuts M8 (Hi - tensile Steel)	16

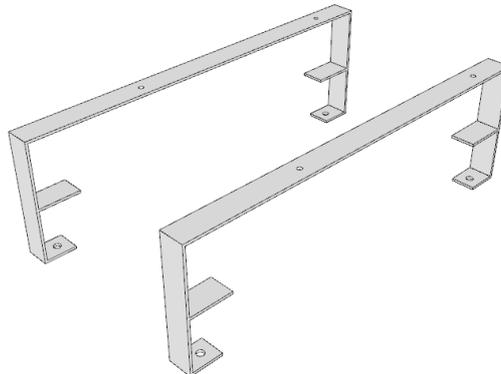
**3.3.2.2.17 Server bracket**



**Figure 13: Server bracket**

No	Item	Qty
1	Square Tube (20mm x 20mm x 2mm) Length: 0.130m	4
2	Flatbar (25mm x 5mm) Length: 0.06m	4
3	Flatbar (20mm x 2mm) Length: 0.02m	2

**3.3.2.2.18 Alarm and DVR bracket**



**Figure 14: Alarm and DVR bracket**

No	Item	Qty
1	Flatbar (20mm x 2mm) Length: 0.12m	4
2	Flatbar (20mm x 2mm) Length: 0.33m	2
3	Flatbar (20mm x 2mm) Length: 0.035m	4
4	Flatbar (20mm x 2mm) Length: 0.025m	4

**3.3.2.2.19 Transport mount**

No	Item	Qty
1	Hexagon coupling nut M10 (PV structure transport mount)	24
2	Bolt M10 x 100mm Hex head (Hi - tensile Steel)	24
3	Nut M10 (Hi - tensile Steel)	48

**3.3.3 Solar System**

**3.3.3.1 PV panels**

No	Item	Specifications
1	Critical	
1.1	Type	Mono crystalline / Mono percium
1.2	Dimensions Absolute Maximum Size	L:2112mm x W:1052mm
1.3	Manufacturer	Tier 1
2	Electrical data (STC)	
2.1	Nominal Max. Power (Pmax)	Minimum 450
2.2	Opt. Operating Voltage (Vmp)	< 46V
2.3	Opt. Operating Current (Imp)	< 11.5 A
2.4	Open Circuit Voltage (Voc)	< 56 V
2.5	Short Circuit Current (Isc)	< 12 A
2.6	Module Efficiency	20% or better
2.7	Operating Temperature	-40°C ~ +85°C
2.8	Max. System Voltage	1000V
2.9	Module Fire Performance	Class C (IEC 61730-2 [11])
2.10	Max. Series Fuse Rating	20 A
3	Mechanical data	
3.1	Cell Type	Mono-crystalline
3.2	Dimensions Absolute Maximum Size	L:2112mm x W:1052mm
3.3	Weight	< 30 kg
3.4	Frame	Anodized aluminium alloy

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3.5	Junction-Box	IEC 60529 [5] - IP68, 3 bypass diodes
3.6	Cable	4 mm <sup>2</sup> (IEC), 12 AWG (UL)
3.7	Cable Length (Including Connector)	Minimum 300 mm, preferably 1100mm
3.8	Connector	Genuine MC4
4	General	
4.1	Product certification	IEC 61215 [7], IEC 61730 [11]
4.2	Linear performance warranty	12 Year product warranty, 25-year linear power warranty
4.3	Annual degradation	<0.6%/year over 25 years

**3.3.3.2 Bill of materials**

No.	Item	Qty
1	Earth spike	5
2	Non insulated ring lug 10-12mm	4
3	Non insulated ring lug 10-6mm	14
4	Nyloc nuts and bolts M5 x 20mm	62
5	M5 x 10 washers	62
6	Panel Flex Cable 10mm <sup>2</sup> Green/Yellow	40m
7	PV Bare End Clamp, height 35mm (no bolts and channel nuts)	60
8	PV Bare Inter Clamp, height 35mm (no bolts and channel nuts)	120
9	PV MC4 in-line Female Coupling Connector 4mm <sup>2</sup> Complete (Housing and terminal)-DCF Downloaded	16
10	PV MC4 in-line Male Coupling Connector 4mm <sup>2</sup> Complete (Housing and terminal)-DCF Downloaded	16
11	PV Module Earthing Ground Plate for Solar panel mounting	80
12	Solar cable 4mm <sup>2</sup> black Rated Voltage 600/1000VAC	100m
13	Solar cable 4mm <sup>2</sup> red Rated Voltage 600/1000VAC	100m
14	Solar PV MODULE not bigger than (L:2112mm x W:1052mm)	64
15	Tek Screws 5.5 x 50mm (steel)	200

**3.3.4 Energy storage system**

**3.3.4.1 Batteries**

No	Item	Specifications
1	Critical	
1.1	Battery type	Lithium-Ion LiFePO4
1.2	Installation Style	19" rack mounted
1.3	Nominal Voltage (V)	48
1.4	Nominal Capacity (Wh)	3552
1.5	Depth of Discharge (DoD)	95%
1.6	Discharge rate	0.5C or better
1.7	Communication	RS485, CAN
1.8	Cycle Life	>6000 @ 95% DoD (25°C)
1.9	Inverter Compatibility	Grid-tie hybrid - UPS Inverters to be compatible to the selected batteries and to the battery communication.
2	Basic Parameters	
2.1	Recommend Charge/Discharge Current (A)	37
2.2	Max. Charge/Discharge Current (A)	74 or better
2.3	Peak Charge/Discharge Current (A)	100A@15sec
2.4	Configuration (max. in 1 battery group)	8pcs or more
3	General	

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3.1	Dimension Maximum (mm)	442 (W) x 420 (D) x 135 (H)
3.2	Certification	IEC62619 [14]/ CE / UN38.3
3.3	Design life	10+ Years (25°C)
3.4	Working Temperature	0°C-50°C Charge
3.5		-10°C-50°C Discharge
3.6	Shelf Temperature	-20°C-60°C
3.7	Protective class	IP20
3.8	Cooling type	Natural Cooling
3.9	IP rating of enclosure	IP20
3.10	Humidity	5% ~ 85%
3.11	Reference to standards	240-170000103 [1]

**3.3.4.2 Bill of materials**

No	Item	Qty
1	3.5kWh Li-Ion Battery, 19-inch rack mountable (Quantity depends on DX application)	52
2	Battery Cable Kit 2m (25mm <sup>2</sup> )	13
3	Compatible Low Voltage Communication Hub for selected batteries	1
4	Tek Screws 5.5 x 25mm	240
5	Non insulated ring lug 6-6mm	70
6	Non insulated ring lug 6-8mm	6
7	Non insulated ring lug 10-8mm	5
8	Non insulated ring lug 35-8mm	50
9	Panel Flex Cable 10mm <sup>2</sup> Green/Yellow	20m
10	Permoweld Single Flex 35mm <sup>2</sup> Black Double insulated Cable	100m
11	Heatshrink Red 50mm Diameter	0.5m
12	Heatshrink Black 50mm Diameter	0.5m

**3.3.5 Inverters and chargers**

**3.3.5.1 Grid-tie hybrid inverter**

No	Item	Specifications
1	Inverter Type	8kW Hybrid Inverter
1.1	Compliance	NRS097-2-1 [15]
1.2	Parallel operation	Minimum 4
2	Battery Input Data	
2.1	Battery Type	Lithium-Ion LiFePO4
2.2	Battery Voltage Range	40~60V
2.3	Communication with BMS	RS485; CAN
2.4	Charging Strategy for Li-Ion Battery	Self-Adaptation to BMS Inverter settings adapt automatically to battery management system (BMS) - no manual settings must be used to configure inverter/battery
2.5	Max. Charging Current	190A or more
2.6	Max. Discharging Current	190A
3	PV String Input Data	
3.1	Max. DC Input Power	10400W or more
3.2	PV Input Voltage	370V (100V~500V)
3.3	MPPT Range	125~425V
3.4	Full Load DC Voltage Range	240~425V
3.5	Start-up Voltage	150V
3.6	PV Input Current	22A+22A
3.7	No. of MPPT Trackers	2

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No	Item	Specifications
3.8	No. of Strings Per MPPT Tracker	2+2
4	AC Output Data	
4.1	Rated AC Output and UPS Power	8000W
4.2	Max. AC Power	8800W
4.3	Peak Power (off-grid)	2 times of rated power, 10 sec
4.4	AC Output Rated Current	33.4A/35A
4.5	Max AC Output Current	36.7A/38.5A
4.6	Max Continuous AC Passthrough	50A
4.7	Output Frequency and Voltage	50Hz; 230Vac (single phase)
4.8	Wave form	Pure sine wave
4.9	Grid Type	Single phase
4.1	Current Harmonic Distortion	THD<3% (Linear load<1.5%)
5	AC Input Data	NRS097-2-1 [15] Compliant
5.1	Rated AC Voltage	230Vac single phase
5.2	Max. AC Power	8800W
5.3	Max Continuous AC Passthrough	50A
5.4	Input Frequency	50Hz
5.5	Grid Type	Single phase
6	Efficiency	
6.1	Max. Efficiency	97% or better
6.2	MPPT Efficiency	96% or better
7	Protection	
7.1	PV Arc Fault Detection	Integrated
7.2	PV Input Lightning Protection	Integrated
7.3	Anti-islanding Protection	Integrated
7.4	PV String Input Reverse Polarity Protection	Integrated
7.5	Insulation Resistor Detection	Integrated
7.6	Residual Current Monitoring Unit	Integrated
7.7	Output Over-Current Protection	Integrated
7.8	Output Shorted Protection	Integrated
7.9	Output Over Voltage Protection	Integrated
8	Certifications and Standards	
8.1	Grid Regulation	NRS097-2-1 [15]
8.2	Safety Regulation	IEC62109-1[12], IEC62109-2 [13]
8.3	EMC	SANS 61000 [17]
9	General Data	
9.1	Operating Temperature Range	-25~60°C, >45°C Derating
9.2	Cooling	Fan or natural convection
9.3	Noise	<30db
9.4	Communication with BMS	RS485; CAN
9.5	Monitoring	Modbus over Ethernet / Modbus over RS485
9.6	Size (H x W x D)	670 x 420 x 233 mm
9.7	Protection Degree	IP21 or better
9.8	Installation Style	Wall-mounted

**3.3.5.2 UPS**

No	Item	Specifications
1	Inverter Type	5kW UPS Inverter
1.1	Rated power	5000W
1.2	AC voltage regulation	230Vac ± 5%

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No	Item	Specifications
2	Battery Input Data	
2.1	Battery Type	Lithium-Ion LiFePO4
2.2	Battery Voltage Range	40~60V
2.3	Communication with BMS	RS485; CAN
2.4	Charging Strategy for Li-Ion Battery	Self-Adaptation to BMS Inverter settings adapt automatically to battery management system (BMS) - no manual settings must be used to configure inverter/battery
2.5	Max. Charging Current	50A
2.6	Max. Discharging Current	50A
3	AC Output Data	
3.1	Rated AC Output and UPS Power	5000W
3.2	Peak Power (off-grid)	10000W, 5 sec
3.3	Transfer Time (AC Mode to Batt Mode)	0ms
3.4	Transfer Time (Inverter to Bypass)	4ms
3.5	Wave form	Pure sine wave
3.6	Output Frequency and Voltage	50Hz; 230Vac (single phase)
3.7	Grid Type	Single phase
3.8	Current Harmonic Distortion	THD<5% (non-linear load), THD<3% (linear load)
4	AC Input Data	NRS097-2-1 Compliant
4.1	Rated AC Voltage	230Vac single phase
4.2	Max. AC Power	5000W
4.3	Max Continuous AC Passthrough	50A
4.4	Input Frequency	50Hz
4.5	Grid Type	Single phase
5	Efficiency	
5.1	Max. Efficiency	93% or better
6	Protection	
6.1	Residual Current Monitoring Unit	Integrated
6.2	Output Over-Current Protection	Integrated
6.3	Output Shorted Protection	Integrated
6.4	Output Over Voltage Protection	Integrated
7	General Data	
7.1	Operating Temperature Range	-10~50°C
7.2	Cooling	Fan or natural convection
7.3	Noise	<55db
7.4	Communication with BMS	RS485 / CAN
7.5	Monitoring	RS232
7.6	Size (D x W x H)	140 x 303 x 525 mm
7.7	Protection Degree	IP21
7.8	Installation Style	Wall-mounted

**3.3.5.3 Bill of materials**

No	Item	Qty
1	Grid-tie hybrid inverter	4
2	UPS	1

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**3.3.6 Control System**

**3.3.6.1 Data Server**

No	item	Specifications
1	Server	Processor family: Intel Xeon E-2100/2200 series, Intel Core i3, Intel Pentium Processor speed: up to 4 GHz Processor cores: 4 or 2 Processor count: 1 Internal memory: 16 GB Internal memory type: DDR4-SDRAM Memory layout (slots x size): 1 x 16 GB HDD size: 3.5 inch HDD interface: Serial ATA HDD slots: 2 Network Controller: 2 port 1 Gigabit Ethernet adapters Power supply: 290 W Chassis type: Rack (1U), 19-inch rack mount 2 compatible hard drives must be included: 1TB 3.5-inch SATA - 7200 RPM, with matching server mounting brackets Operating system license to be included: None Storage controller: 2 Slot compatible controller included Minimum dimensions (H x W x D): 4.32 x 43.46 x 38.22 cm (HxWxD) Weight: 6 kg minimum 9.46 kg maximum Infrastructure management: Remote server management software included to securely configure, update or monitor the server Warranty Server: Warranty includes 3-years parts, 3-years labour, 3-years on-site support with next business day response
2	Monitor	VESA (100mmx100mm) Mount 1080p 21.5" Monitor with VGA port
3	Keyboard and mouse	Wireless Combo with USB receiver

**3.3.6.2 Alarm system**

No	item	Specifications
1	Alarm Hub	Supports up to 32 wireless inputs, 4 wireless output expanders (868MHz) Offers multiple communication methods: LAN + Wi-Fi + 3G/4G Up to 2-ch. on-board video verification Offers reliable protection utilizing two-way wireless technology Communicates up to 800 m (in open area) Supports arming/disarming by swiping card with built-in proximity reader Supports viewing event video via mobile client and email SIA-Contact ID protocol compatible
2	Indoor PIR Detector (2 required)	Wireless internal 10m PIR detector with pet immunity function Detection range: 10 m x 10 m, 85 degrees RF 868MHz Offers reliable protection utilizing two-way wireless technology Pet immunity up to 24 kg PIR motion detection Tamper alarm, intruder alarm Communicates up to 800 m (in open areas)
3	Wireless Magnetic Contact	Communication Frequency: 868 MHz Function of preventing wireless data conflict.

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No	item	Specifications
		Two-ways Communication: 800 (open area). 3V button battery (2 years)
4	Wireless Tag (5 required)	RF Frequency 13.56 MHz
5	Wireless external siren	RF 868MHz, AES-128 encryption Two-way wireless communication Reports exception automatically Adjustable volume: low, medium, and high Front and rear panel tamper-proof Protection level: IP65 Outdoor installation Flashing blue LED for alarm indication 3 kinds of alarm sounds: fire alarm, intrusion alarm, and panic alarm
6	Wireless Outdoor External Detector (4 required)	RF 868MHz Two-way wireless AES-128 encryption Detection range: 10m*10m, 90 degrees 2 PIR+Microwave detection Pet immunity: 24kg Anti-masking, anti-blocking Weatherproof sealed optics Communication distance: 800M (in open area)

**3.3.6.3 Digital video recorder (DVR)**

No	Item	Specifications
1	<b>System</b>	
1.1	Main Processor	Industrial-grade processor
1.2	Operating System	Embedded Linux
1.3	Operating Interface	Web; Local GUI
2	<b>Motion detection</b>	
2.1	Motion detection	8-channel: Secondary filtering for human and motor vehicle, reducing false alarms caused by leaves, rain and lighting condition change
3	<b>Audio and Video</b>	
3.1	Analog Camera Input	8 channels, BNC: adaptive access by default; HDCVI, AHD, TVI and CVBS access can be configured.
3.2	Camera Input	<ol style="list-style-type: none"> <li>1. CVI: 5 MP, 4 MP, 1080p@25/30 fps, 720p@50/60 fps, 720p@25/30 fps.</li> <li>2. TVI: 5 MP, 4 MP, 1080p@25/30 fps, 720p@25/30 fps.</li> <li>3. AHD: 5 MP, 4 MP, 1080p@25/30 fps, 720p@25/30 fps.</li> <li>4. CVBS: PAL/NTSC</li> </ol>
3.3	IP Camera Input	Up to 12 channels of IPC access IP channels by default + 8 channels (analog channels are converted to IP channels) incoming bandwidth: 64 Mbps, recording bandwidth: 64 Mbps and outgoing bandwidth: 64 Mbps
3.4	Encoding Capacity	Main Stream: All channel 5M-N@ (1 fps–10 fps); 4M-N/1080p@ (1 fps–15 fps); 1080N/ 720p/960H/D1/CIF @ (1 fps–25/30 fps)  Sub stream: D1/CIF (1 fps–15 fps)
3.5	Dual-stream	Yes

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No	Item	Specifications
3.6	Video Bit Rate	32 kbps–6144 kbps
3.7	Audio Sampling	8 kHz, 16 bit
3.8	Audio Bit Rate	64 kbps
3.9	Video Output	1 HDMI, 1 VGA HDMI/VGA: 1920 × 1080, 1280 × 1024, 1280 × 720
3.11	Third-party Camera Access	ONVIF, RTSP, compliant
4	<b>Compression Standard</b>	
4.1	Video Compression	H.265+; H.265; H.264+; H.264
4.2	Audio Compression	G.711a; G.711u; PCM
5	<b>Network</b>	
5.1	Network Protocol	HTTP; HTTPS; TCP/IP; IPv4; RTSP; UDP; SMTP; NTP; DHCP; DNS; DDNS; P2P
5.2	Mobile Phone Access	iOS, Android
5.3	Interoperability	ONVIF 21.06; CGI Conformant
5.4	Browser	Chrome, IE9 or later, Firefox
5.5	Network Mode	Single-address mode
6	<b>Recording Playback</b>	
6.1	Record Mode	General, motion detection, alarm.
6.2	Recording Playback	1/4/8/9 channels
6.3	Backup Method	USB device and network
6.4	Playback Mode	Instant playback, general playback, event playback, tag playback
7	<b>Alarm</b>	
7.1	General Alarm	Motion detection, video loss, tampering
7.2	Anomaly Alarm	No disk, disk error, low space, offline, IP address conflict, MAC address conflict
7.3	Alarm Linkage	Record; snapshot (panoramic); local alarm output; IPC external alarm output; access controller; audio; buzzer; log, pre-set; email
8	<b>Ports</b>	
8.1	Audio Input	1-channel RCA 8-channel BNC (Coaxial Audio)
8.2	Audio Output	1-channel RCA
8.3	Two-way Talk	Yes (share the same audio input with the first channel)
8.4	HDD Interface	1 SATA port, up to 16 TB. The maximum HDD capacity varies with environment temperature.
8.5	USB	2 USB ports (USB 2.0)
8.6	HDMI	1
8.7	VGA	1
8.8	Network Port	1 (10/100 Mbps Ethernet port, RJ-45)
9	<b>General</b>	
9.1	Power Supply	12 VDC, 1.5 A
9.2	Power Consumption	<7 W
9.3	Net Weight	0.57 kg (1.26 lb)
9.4	Gross Weight	1.05 kg (2.31 lb)
9.5	Product Dimensions	198.3 mm × 203.4 mm × 41.5 mm (W × D × H)
9.6	Packaging Dimensions	332.0 mm × 240.0 mm × 64.0 mm (13.07" × 9.45" × 2.52") (W × D × H)
9.7	Operating Temperature	−10 °C to +55 °C (+14 °F to +131 °F)
9.8	Operating Humidity	0%–90% (RH)

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No	Item	Specifications
9.9	Installation	Desktop
9.10	Certifications	FCC: Part 15 Subpart B, CE: CE-LVD: EN 60950-1/IEC 60950-1, CE-EMC: SANS 61000-6-2, 3 and 4[17]; EN 55032; EN50130; EN 55024

**3.3.6.4 24-Port Gigabit Ethernet Managed Switch**

No	Item	Specifications
<b>1</b>	<b>General</b>	
1.1	Feature	Web-based user interface and management utility
<b>2</b>	<b>Hardware features</b>	
2.1	Standards and Protocols	IEEE 802.3i IEEE 802.3u IEEE 802.3ab IEEE 802.3x IEEE 802.1q IEEE 802.1p
2.2	Interface	24 10/100/1000Mbps RJ45 Ports AUTO Negotiation/AUTO MDI/MDIX
2.3	Network Media	10BASE-T: UTP category 3, 4, 5 cable (maximum 100m) EIA/TIA-568 100Ω STP (maximum 100m) 100BASE-TX: UTP category 5, 5e cable (maximum 100m) EIA/TIA-568 100Ω STP (maximum 100m) 1000BASE-T: UTP category 5, 5e, 6 or above cable (maximum 100m) EIA/TIA-568 100Ω STP (maximum 100m)
2.4	Fan Quantity	Fanless
2.5	Physical Security Lock	No
2.6	Power Supply	100-240VAC, 50/60Hz
2.7	Dimensions (W x D x H)	(294 x 180 x 44 mm)
2.8	Mounting	Rack Mountable
2.9	Max Power Consumption	14.19W (220V/50Hz)
2.10	Max Heat Dissipation	48.39 BTU/h
<b>3</b>	<b>Performance</b>	
3.1	Switching Capacity	48Gbps
3.2	Packet Forwarding Rate	35.7Mpps
3.3	MAC Address Table	8K
3.4	Packet Buffer Memory	4.1Mbit
3.5	Jumbo Frame	10KB
<b>4</b>	<b>Software features</b>	
4.1	Quality of Service	Support Port-based/802.1p/DSCP priority Support 4 priority queues Rate Limit Storm Control
4.2	L2 Features	IGMP Snooping V1/V2/V3 Static Link Aggregation Port Mirroring Cable Diagnostics Loop Prevention
4.3	VLAN	Supports up to 32 VLANs simultaneously (out of 4K VLAN IDs) MTU/Port/Tag VLAN
4.4	Transmission Method	Store-And-Forward

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No	Item	Specifications
5	Others	
5.1	Certification	FCC, CE, RoHS
5.2	Package Contents	Managed Switch Power Cord Installation Guide Resource CD Rackmount Kit Rubber Feet
5.3	Environment	Operating Temperature: 0°C~40°C (32°F~104°F) Storage Temperature: -40°C~70°C (-40°F~158°F) Operating Humidity: 10%~90% non-condensing Storage Humidity: 5%~90% non-condensing

**3.3.6.5 Routers**

No	Item	Specifications
1	General Specifications	
1.1	Integrated Antenna	high gain 21dBi LTE antenna
1.2	Architecture	MIPSBE
1.3	CPU	QCA9531
1.4	CPU core count	1
1.5	CPU nominal frequency	650 MHz
1.6	Dimensions	391 x 391 x 227 mm
1.7	Operating System	Stand-alone operating system based on Linux kernel with at least the following features: Configuration <ul style="list-style-type: none"> <li>• MAC-based access for initial configuration</li> <li>• Standalone Windows GUI configuration tool</li> <li>• Advanced web-based configuration interface</li> <li>• Android and iOS-based configuration tool</li> <li>• Powerful command-line configuration interface with integrated scripting capabilities, accessible via local terminal, serial console, telnet and SSH</li> <li>• API</li> </ul> Backup/Restore <ul style="list-style-type: none"> <li>• Binary configuration backup saving and loading</li> <li>• Configuration export and import in human-readable text format</li> </ul> Firewall <ul style="list-style-type: none"> <li>• Stateful filtering</li> <li>• Source and destination NAT</li> <li>• NAT helpers (H323, PPTP, SIP, FTP, IRC, TFTP)</li> <li>• Internal connection, routing and packet marks</li> <li>• Filtering by IP address and address range, port and port range, IP protocol, DSCP and many more</li> <li>• Address lists</li> <li>• Custom Layer7 matcher</li> <li>• IPv6 support</li> <li>• PCC - per connection classifier, used in load balancing configurations</li> <li>• RAW filtering to bypass connection tracking.</li> </ul> Routing <ul style="list-style-type: none"> <li>• Static routing</li> <li>• Virtual Routing and Forwarding (VRF)</li> </ul>

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No	Item	Specifications
		<ul style="list-style-type: none"> <li>• Policy based routing</li> <li>• Interface routing</li> <li>• ECMP routing</li> <li>• IPv4 dynamic routing protocols: RIP v1/v2, OSPFv2, BGP v4</li> <li>• IPv6 dynamic routing protocols: RIPng, OSPFv3, BGP</li> <li>• Bidirectional Forwarding Detection (BFD)</li> </ul> <p>VPN</p> <ul style="list-style-type: none"> <li>• IPsec – tunnel and transport mode, certificate or PSK, AH and ESP security protocols.</li> <li>• IKEv2 support</li> <li>• AES-NI hardware acceleration support for IPsec</li> <li>• Point to point tunnelling ( OpenVPN, PPTP, PPPoE, L2TP, SSTP)</li> <li>• Advanced PPP features (MLPPP, BCP)</li> <li>• Simple tunnels (IPIP) IPv4 and IPv6 support</li> <li>• 6to4 tunnel support (IPv6 over IPv4 network)</li> <li>• VLAN – IEEE802.1q Virtual LAN support, Q-in-Q support</li> </ul> <p>DHCP</p> <ul style="list-style-type: none"> <li>• Per interface DHCP server</li> <li>• DHCP client and relay</li> <li>• Static and dynamic DHCP leases</li> <li>• RADIUS support</li> <li>• Custom DHCP options</li> <li>• DHCPv6 Prefix Delegation (DHCPv6-PD)</li> <li>• DHCPv6 Client</li> </ul> <p>Tools</p> <ul style="list-style-type: none"> <li>• Ping, traceroute</li> <li>• Bandwidth test</li> <li>• Packet sniffer</li> <li>• Telnet, SSH</li> <li>• E-mail and SMS send tools</li> <li>• Automated script execution tools</li> <li>• File Fetch tool</li> <li>• Advanced traffic generator</li> <li>• WoL (Wake on LAN) sending</li> </ul> <p>Other features</p> <ul style="list-style-type: none"> <li>• Dynamic DNS update tool</li> <li>• NTP client/server and synchronization with GPS system</li> <li>• SNMP</li> </ul>
1.8	Size of RAM	64 MB
1.9	Storage size	16 MB
1.10	Storage type	FLASH
1.11	MTBF	Approximately 200'000 hours at 25°C
1.12	Tested ambient temperature	-40°C to 60°C
<b>2</b>	<b>Powering Specifications</b>	
2.1	Number of DC inputs	1 (PoE-IN)
2.2	Max power consumption	6 W
2.3	Cooling type	Passive
2.4	PoE in	802.3af/at

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No	Item	Specifications
2.5	PoE in input Voltage	12-57 V
<b>3</b>	<b>Mobile Specifications</b>	
3.1	2G Category	Class12
3.2	2G bands	2 (1900MHz) / 3 (1800MHz) / 5 (850MHz) / 8 (900MHz)
3.3	3G Category	R7 (21Mbps Downlinks, 5.76Mbps Uplink)
3.4	3G bands	1 (2100MHz) / 2 (1900MHz) / 5 (850MHz) / 8 (900MHz)
3.5	LTE Category	4 (150Mbps Downlink, 50Mbps Uplink)
3.6	LTE FDD bands	1 (2100MHz) / 2 (1900MHz) / 3 (1800MHz) / 7 (2600MHz) / 8 (900 MHz) / 20 (800MHz)
3.7	LTE TDD bands	38 (2600MHz) / 40 (2300MHz)
<b>4</b>	<b>Ethernet Specifications</b>	
4.1	10/100 Ethernet ports	1
<b>5</b>	<b>Peripherals Specifications</b>	
5.1	Number of SIM slots	1 Modem (Micro SIM)
5.2	MiniPCI-e slots	1
<b>6</b>	<b>Certification and Approvals Specifications</b>	
6.1	Certification	CE, EAC, ROHS
6.2	IP	IP54

**3.3.6.6 DER Controller**

No	Item	Specifications
<b>1</b>	<b>Critical</b>	
1.1	Type	Embedded controller with real-time processor and reconfigurable FPGA,
<b>2</b>	<b>Processor</b>	
2.1	Processor unit 1	Xilinx Kintex-7 7K70T FPGA for high-speed control, inline processing, and custom timing and triggering
2.2	- Number of flip-flops	82 000
2.3	- Number of 6-input LUTs	41 000
2.4	- Number of DSP slices (18 x 25 multipliers)	240
2.5	- Block RAM	4 860 kbits
2.6	- Number of DMA channels	16
2.7	Processor unit 2	1.33 GHz dual-core Intel Atom E3825 processor
2.8	Memory - Processor	1 GB DDR3L - 8.5 GB/s
2.9	Memory - Solid State Drive	SSD: 4 GB -
2.10	Memory - SD removable card	SD and SDHC standards, up to 32 GB - 10 MB/s
2.11	Real -Time Clock accuracy	200 ppm, 40ppm @ 25°C
2.12	CMOS Battery	Typical battery life with power applied: 10 years
2.13		Typical battery life when stored (85°C): > 5 years
2.14	Operating System	Linux Real-Time
2.15	Application software	LabVIEW Run-time Engine to run LabVIEW-RT applications (2016 or later)
2.16	Driver software	LabVIEW FPGA Module (2016 or later) NI-RIO Device Drivers (2016 or later)
<b>3</b>	<b>Inputs &amp; Outputs</b>	
3.1	Network/Ethernet Port	2 x Gigabit Ethernet (10Base-T, 100Base-TX, and 1000Base-T Ethernet) IEEE 802.3
3.2	USB Ports	2 x host ports, USB 2.0, Hi-Speed, 480 Mb/s, type A connector 1 x device port, USB 2.0, Hi-Speed, 480 Mb/s, type B connector

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No	Item	Specifications
3.3	RS-232 Serial Port	1 x 115 200 bps, 5/6/7/8 data bits, 1/2 stop bits, odd/even parity
3.4	RS-485/422 (DTE) Serial Port	1 x 115 200 bps, 5/6/7/8 data bits, 1/2 stop bits, odd/even parity, 4-wire/2-wire, 60 Vdc isolation
3.5	I/O Slots for C-Series I/O modules	4 x
<b>4</b>	<b>Power Requirements</b>	
4.1	Type	Dual for redundancy (V1 primary, V2 Backup)
4.2	Voltage	9 - 30 Vdc
4.3	Maximum Power Consumption	40W
<b>5</b>	<b>General Data</b>	
5.1	Operating Temperature	-20 °C to 55 °C
5.2	Operating humidity	10% RH to 90% RH, noncondensing
5.3	Ingress protection	IP20
5.4	Cooling	Natural convection
5.5	Maximum Size (W x H x D)	220 x 89 mm x 110 mm
5.6	Installation Style	Panel-mounted
<b>6</b>	<b>Certifications and Standards</b>	
6.1	Voltage / Measuring	Category I
6.2	Temperature	IEC-60068-2-1 [3] and IEC-60068-2-2 [3]
6.3	Humidity	IEC 60068-2-56 [3] and IEC 60068-2-56 [3]
6.4	Vibration and Shock	IEC 60068-2-64 [3], IEC 60068-2-6 [3], IEC 60068-2-27 [3]
6.5	Safety Regulation	IEC61010-1 [6], IEC62109-2 [13]
6.6	EMC	IEC 61326-1 [9], SANS 61000-6-2, 3 and 4 [17]

**3.3.6.7 Analog Input Module**

No	Item	Specifications
<b>1</b>	<b>Critical</b>	
1.1	Type	Industrial, C Series analog input
<b>2</b>	<b>Input Characteristics</b>	
2.1	Number of channels	32 single ended or 16 differential
2.2	Resolution	16-bit
2.3	Sampling rate	250 kS/s
2.4	Input ranges	±10 V, programmable for ±200 mV, ±1 V, ±5 V, and ±10 V
2.5	Overvoltage Protection	30 V channel to channel
2.6	Input impedance (AI-to-COM)	
2.7	- Powered on	>10 GΩ in parallel with 100 p
2.8	- Powered off	4.7 kΩ min
2.9	Input bias current	±100 pA
2.10	Crosstalk (at 100 kHz)	< -65 dB
2.11	CMRR (DC to 60 Hz)	100 dB
<b>3</b>	<b>Power Requirements</b>	
3.1	Type	Supplied from chassis
3.2	Power consumption active mode	625 mW max
<b>4</b>	<b>General Data</b>	
4.1	Connector type	D-Sub, male, 37 pin
4.2	Operating Temperature	Better than -20 °C to 55 °C
4.3	Operating humidity	10% RH to 90% RH, noncondensing
4.4	Ingress protection	IP40
4.5	Installation Style	Chassis mount
<b>5</b>	<b>Certifications and Standards</b>	

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No	Item	Specifications
5.1	Voltage / Measuring	Category I
5.2	Temperature	IEC-60068-2-1 and IEC-60068-2-2)
5.3	Humidity	IEC 60068-2-56 and IEC 60068-2-56
5.4	Vibration and Shock	IEC 60068-2-64, IEC 60068-2-6, IEC 60068-2-27
5.5	Safety Regulation	IEC61010-1[6], IEC62109-2 [13]
5.6	EMC	IEC 61326-1 [9], SANS 61000-6-2, 3 and 4 [17]

**3.3.6.8 Digital Input Module**

No	Item	Specifications
1	<b>Critical</b>	
1.1	Type	Industrial, C Series sinking digital input
2	<b>Input Characteristics</b>	
2.1	Number of channels	32
2.2	Input type	Sinking
2.3	Speed	250 µs or better
2.4	Input ranges	12 V and 24 V
2.5	Logic levels	
2.6	- OFF state	
2.7	Input voltage ≤5 V	≤5 V
2.8	Input current ≤150 µA	≤150 µA
2.9	- ON state	
2.10	Input voltage ≥10 V	≥10 V
2.11	Input current ≥330 µA	≥330 µA
2.12	Overvoltage Protection	30 V channel to channel
2.13	Input impedance (AI-to-COM)	30 kΩ ± 5%
3	<b>Power Requirements</b>	
3.1	Type	Supplied from chassis
3.2	Power consumption active mode	410 mW max
4	<b>General Data</b>	
4.1	Connector type	D-Sub, male, 37 pin
4.2	Operating Temperature	Better than -20 °C to 55 °C
4.3	Operating humidity	10% RH to 90% RH, noncondensing
4.4	Ingress protection	IP40
4.5	Installation Style	Chassis mount
5	<b>Certifications and Standards</b>	
5.1	Voltage / Measuring	Category I
5.2	Temperature	IEC-60068-2-1[3] and IEC-60068-2-2 [3]
5.3	Humidity	IEC 60068-2-56 [3] and IEC 60068-2-56 [3]
5.4	Vibration and Shock	IEC 60068-2-64[3] , IEC 60068-2-6 [3], IEC 60068-2-27 [3]
5.5	Safety Regulation	IEC61010-1[6], IEC62109-2 [13]
5.6	EMC	IEC 61326-1 [9], SANS 61000-6-2, 3 and 4 [17]

**3.3.6.9 Digital Output Module**

No	Item	Specifications
1	<b>Critical</b>	
1.1	Type	Industrial, C Series sourcing digital output
2	<b>Output Characteristics</b>	
2.1	Number of channels	32
2.2	Output type	Sourcing
2.3	Speed	500 µs or better

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No	Item	Specifications
2.4	Output ranges	6 V to 36 V depends on supply power)
2.5	Continuous output current (I <sub>0</sub> ) per channel	250 mA max (6–30 VDC supply voltage)
2.6	Power-on output state	Channels off
2.7	Overvoltage Protection	30 V channel to channel
<b>3</b>	<b>Power Requirements</b>	
3.1	Type	Supplied from external source via I/O connector
3.2	Power consumption active mode	250 mW max
3.3	Thermal dissipation in active mode	1.5 W max
<b>4</b>	<b>General Data</b>	
4.1	Connector type	D-Sub, male, 37 pin
4.2	Operating Temperature	Better than -20 °C to 55 °C
4.3	Operating humidity	10% RH to 90% RH, noncondensing
4.4	Ingress protection	IP40
4.5	Installation Style	Chassis mount
<b>5</b>	<b>Certifications and Standards</b>	
5.1	Voltage / Measuring	Category I
5.2	Temperature	IEC-60068-2-1[3] and IEC-60068-2-2 [3]
5.3	Humidity	IEC 60068-2-56 [3] and IEC 60068-2-56 [3]
5.4	Vibration and Shock	IEC 60068-2-64 [3], IEC 60068-2-6 [3], IEC 60068-2-27 [3]
5.5	Safety Regulation	IEC61010-1[6], IEC62109-2 [13]
5.6	EMC	IEC 61326-1 [9], SANS 61000-6-2, 3 and 4 [17]

**3.3.6.10 IO Cables**

No	Item	Specifications
<b>1</b>	<b>Critical</b>	
1.1	Type	Industrial, I/O cable for custom cabling,
<b>2</b>	<b>Characteristics</b>	
2.1	Connector type	D-Sub. Female, 37 pin
2.2	Cable length	4 m
2.3	Cable type	37 core, 0.128mm <sup>2</sup> with overall foil shield and braided wire protection
2.4	Continuous current per wire	250 mA min

**3.3.6.11 Power Supply 75W ACDC**

No	Item	Specifications
<b>1</b>	<b>Critical</b>	
1.1	Type	Industrial, DIN rail mounted, AC to DC, switch mode.
1.2	Rated Power	75W
1.3	Output voltage	24 Vdc
1.4	Input voltage range	90 - 264 Vac
1.5	Efficiency	88% or better
1.6	Cooling	Free air convection
1.7	Maximum Size (W x H x D)	32 x 126 x 105mm
1.8	Mean Time Before Failure	> 2500 k hrs
<b>2</b>	<b>Input Characteristics</b>	
2.1	Voltage range	90 - 264 Vac
2.2	Frequency range	47 - 63 Hz
2.3	Efficiency	88% or better

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No	Item	Specifications
2.4	Inrush current	<35 A
2.5	Leakage current	< 1 mA at 230 Vac
3	<b>Output Characteristics</b>	
3.1	Voltage	24 Vdc
3.2	Current range	0 - 3.125 A
3.3	Rated Power	75W
3.4	Ripple and Noise	< 120mVp-p
3.5	Voltage adjustment range	23 - 28 Vdc
3.6	Voltage tolerance	± 1.0 %
3.7	Line regulation	± 0.5 %
3.8	Load regulation	± 1.0 %
3.9	Setup, Rise time	1200 ms, 60 ms @ 230 Vac
3.10	Hold up time	60 mS @ 230 Vac
4	<b>Protection</b>	
4.1	Over voltage	29 ~ 33V Shut down output voltage, re-power on to recover
4.2	Overload	105 ~ 130% rated output power Constant current limiting, recovers automatically after fault condition is removed
4.3	Over temperature	Shut down output voltage, re-power on to recover
5	<b>Safety</b>	
5.1	Isolation resistance	I/P - O/P, I/P - PG, O/P - PG: >100 MΩ / 500VDC / 25°C/ 70% RH
5.2	Withstand voltage	I/P - O/P: 3 kV AC, I/P - PG: 2 kV AC, O/P - PG: 0.5 kV AC or better
6	<b>General Data</b>	
6.1	Operating Temperature	-20 °C to 70 °C
6.2	Operating humidity	20% RH to 95% RH, noncondensing
6.3	Temperature coefficient	±0.03%/°C (0 ~ 50°C)
6.4	Cooling	Free air convection
6.5	Ingress protection	IP20
6.6	Installation Style	DIN rail 35Ω x 7.5
6.7	Maximum Size (W x H x D)	32 x 126 x 105mm
6.8	Mean Time Before Failure	> 2500 k hrs
7	<b>Certifications and Standards</b>	
7.1	Voltage / Measuring	Category I
7.2	Temperature	IEC-60068-2-1[3] and IEC-60068-2-2 [3]
7.3	Humidity	IEC 60068-2-56 [3] and IEC 60068-2-56 [3]
7.4	Vibration and Shock	IEC 60068-2-64 [3], IEC 60068-2-6 [3], IEC 60068-2-27 [3]
7.5	Safety Regulation	IEC61010-1[6], IEC62109-2 [13], IEC60204-1[4]
7.6	EMC	IEC 61326-1 [9], SANS 61000-6-2, 3 and 4 [17]

**3.3.6.12 Power Supply 120W ACDC**

No	Item	Specifications
1	<b>Critical</b>	
1.1	Type	Industrial, DIN rail mounted, AC to DC, switch mode.
1.2	Rated Power	120W
1.3	Output voltage	24 Vdc
1.4	Input voltage range	90 - 264 Vac
1.5	Efficiency	88% or better
1.6	Cooling	Free air convection

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No	Item	Specifications
1.7	Maximum Size (W x H x D)	40 x 126 x 115mm
1.8	Mean Time Before Failure	> 2500 k hrs
<b>2</b>	<b>Input Characteristics</b>	
2.1	Voltage range	90 - 264 Vac
2.2	Frequency range	47 - 63 Hz
2.3	Efficiency	88% or better
2.4	Inrush current	<35 A
2.5	Leakage current	< 1 mA at 230 Vac
<b>3</b>	<b>Output Characteristics</b>	
3.1	Voltage	24 Vdc
3.2	Current range	0 - 5 A
3.3	Rated Power	120W
3.4	Ripple and Noise	< 120mVp-p
3.5	Voltage adjustment range	23 - 28 Vdc
3.6	Voltage tolerance	± 1.0 %
3.7	Line regulation	± 0.5 %
3.8	Load regulation	± 1.0 %
3.9	Setup, Rise time	1200 ms, 60 ms @ 230 Vac
3.10	Hold up time	60 mS @ 230 Vac
<b>4</b>	<b>Protection</b>	
4.1	Over voltage	29 ~ 33V Shut down output voltage, re-power on to recover
4.2	Overload	105 ~ 130% rated output power Constant current limiting, recovers automatically after fault condition is removed
4.3	Over temperature	Shut down output voltage, re-power on to recover
<b>5</b>	<b>Safety</b>	
5.1	Isolation resistance	I/P - O/P, I/P - PG, O/P - PG: >100 MΩ / 500VDC / 25°C/ 70% RH
5.2	Withstand voltage	I/P - O/P: 3 kV AC, I/P - PG: 2 kV AC, O/P - PG: 0.5 kV AC or better
<b>6</b>	<b>General Data</b>	
6.1	Operating Temperature	-20 °C to 70 °C
6.2	Operating humidity	20% RH to 95% RH, noncondensing
6.3	Temperature coefficient	±0.03%/°C (0 ~ 50°C)
6.4	Cooling	Free air convection
6.5	Ingress protection	IP20
6.6	Installation Style	DIN rail 35Ω x 7.5
6.7	Maximum Size (W x H x D)	40 x 126 x 115mm
6.8	Mean Time Before Failure	> 2500 k hrs
<b>7</b>	<b>Certifications and Standards</b>	
7.1	Voltage / Measuring	Category I
7.2	Temperature	IEC-60068-2-1 [3] and IEC-60068-2-2 [3]
7.3	Humidity	IEC 60068-2-56 [3] and IEC 60068-2-56 [3]
7.4	Vibration and Shock	IEC 60068-2-64 [3], IEC 60068-2-6 [3], IEC 60068-2-27 [3]
7.5	Safety Regulation	IEC61010-1[6], IEC62109-2 [13], IEC60204-1[4]
7.6	EMC	IEC 61326-1 [9], SANS 61000-6-2, 3 and 4 [17]

**3.3.6.13 Power Supply 120W DCDC**

No	Item	Specifications
1	<b>Critical</b>	

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No	Item	Specifications
1.1	Type	Industrial, DIN rail mounted, DC to DC, switch mode.
1.2	Rated Power	120W
1.3	Output voltage	24 Vdc
1.4	Input voltage range	34 - 67 Vdc
1.5	Efficiency	90% or better
1.6	Cooling	Free air convection
1.7	Maximum Size (W x H x D)	32 x 126 x 105mm
1.8	Mean Time Before Failure	> 1800 k hrs
<b>2</b>	<b>Input Characteristics</b>	
2.1	Voltage range	34 - 67 Vdc
2.2	Efficiency	90% or better
2.3	Inrush current	<5.5 A @ 48 Vdc
2.4	Leakage current	< 1 mA at 230 Vac
<b>3</b>	<b>Output Characteristics</b>	
3.1	Voltage	24 Vdc
3.2	Current range	0 - 5 A
3.3	Rated Power	120W
3.4	Ripple and Noise	< 50mVp-p
3.5	Voltage adjustment range	23 - 28 Vdc
3.6	Voltage tolerance	± 1.0 %
3.7	Line regulation	± 0.5 %
3.8	Load regulation	± 1.0 %
3.9	Setup, Rise time	500 ms, 60 ms @ 48 Vdc
3.10	Hold up time	10 mS
<b>4</b>	<b>Protection</b>	
4.1	Over voltage	29 ~ 33V Shut down output voltage, re-power on to recover
4.2	Overload	105 ~ 130% rated output power Constant current limiting, recovers automatically after fault condition is removed
4.3	Under voltage lockout	Power ON ≥33.6 V DC, OFF ≤33 V DC
4.4	Over temperature	Shut down output voltage, re-power on to recover
<b>5</b>	<b>Safety</b>	
5.1	Isolation resistance	I/P - O/P, I/P - PG, O/P - PG: >100 MΩ / 500V DC / 25°C/ 70% RH
5.2	Withstand voltage	I/P - O/P: 4 kV DC, I/P - PG: 2.5 kV DC, O/P - PG: 2.5 kV DC or better
<b>6</b>	<b>General Data</b>	
6.1	Operating Temperature	-20 °C to 70 °C
6.2	Operating humidity	5% RH to 95% RH, noncondensing
6.3	Temperature coefficient	±0.03%/°C (0 ~ 50°C)
6.4	Cooling	Free air convection
6.5	Ingress protection	IP20
6.6	Installation Style	DIN rail 35Ω x 7.5
6.7	Maximum Size (W x H x D)	32 x 126 x 105mm
6.8	Mean Time Before Failure	> 1800 k hrs
<b>7</b>	<b>Certifications and Standards</b>	
7.1	Voltage / Measuring	Category I
7.2	Temperature	IEC-60068-2-1[3] and IEC-60068-2-2 [3]
7.3	Humidity	IEC 60068-2-56 [3] and IEC 60068-2-56 [3]
7.4	Vibration and Shock	IEC 60068-2-64 [3], IEC 60068-2-6 [3], IEC 60068-2-27 [3]
7.5	Safety Regulation	IEC61010-1[6], IEC62109-2 [13], IEC60204-1[4]

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No	Item	Specifications
7.6	EMC	IEC 61326-1 [9], SANS 61000-6-2, 3 and 4 [17]

**3.3.6.14 Control Enclosure**

No	Item	Specifications
1	Basics	
1.1	Dimensions - Outside	1200mm x 1000mm x 320mm (H x W x D)
1.2	Material	1.6mm Mild steel / 1.6mm 3CR12
1.3	Ingress protection	IP65
1.4	Gland plate	No, solid bottom
1.5	Door	Solid
1.6	Door seal	Polyurethane continuous gasket
1.7	Hinges	4 x Concealed hinges
1.8	Locks	3x 6mm square drive lock
1.9	Coat and 'Colour	Powder coated, Orange (B26)
1.1	Back / Chassis Plate	Yes, 2.0mm mild steel, white

**3.3.6.15 Bill of materials**

No	Item	Qty
1	Wireless Alarm Hub	1
2	Wireless Indoor PIR Detector	2
3	Wireless Magnetic Contact	1
4	Wireless Tag	5
5	Wireless External Siren	2
6	Wireless External Detector	4
7	IoT SIM Card	1
8	Digital Video Recorder (DVR)	1
9	2MP HDCVI IR Bullet Camera, IR, IP67, 12V, BNC port	8
10	1TB 3.5" Surveillance Internal Hard Drive	1
11	Single Channel HD Passive Video Balun	8
12	Male 12V DC Plug with Terminal (5.5mm)	9
13	CCTV 9 Channel 12V 10A PSU power supply 120W	1
14	CAT 5E solid cable (interior use)	40m
15	VESA (100mmx100mm) Mount 1080p 21.5" Monitor with VGA port	1
16	Wireless Keyboard and Mouse Combo (with USB receiver)	1
17	Data Server	1
18	1TB 3.5" SATA - 7200 RPM	1
19	3G/LTE Router with Long Range Antenna:	2
20	24-Port Gigabit Ethernet Managed Switch with IEEE 802.1Q VLAN support	1
21	CAT 5E UV-proof solid cable (exterior use): with drain wire and aluminium shielding	32m
22	Power over Ethernet injector	2
23	RJ45 Surge Protector with PoE support	2
24	DER controller	1
25	DER controller 16ch analog input module	1
26	DER controller 32ch digital input module	1
27	DER controller 32ch digital output module	1
28	DER Controller 37-PIN Shielded D-SUB to Pigtail Cable	3
29	Wireless Weather Station with Console	1
30	Weather station data logger (USB adaptor)	1
31	Weather station solar irradiation sensor	1
32	Enclosure 1000mm (W) x 1200mm (H) x 300mm (D) with back plate, Orange Colour	1

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No	Item	Qty
33	Grey narrow slotted trunking (40mm x 40mm)	6m
34	DIN 35-Ω Passivated* steel slotted rail (35mm x 7.5mm x 1mm)	4m
35	Big head rivets (4mm x 10mm)	60
36	M4 x 10mm Cheese Head Bolt Stainless Steel	4
37	M6 x 10mm Cheese Head Bolt Stainless Steel	12
38	M6 Stainless Steel Hex Nut	4
39	1P+N pole MCB 6A	3
40	DIN rail end stop	14
41	JUK2.5B DIN rail mounted terminal	130
42	JUK5N DIN rail mounted terminal	8
43	JUSLKG3 DIN rail mounted earth terminal	11
44	JUSLKG5 DIN rail mounted earth terminal	7
45	JUK5-HESI DIN rail mounted fuse terminal	2
46	20 x 5mm 5A Glass fuse	2
47	ZMEM/5 DIN rail mounted relay base for E52 type relay	8
48	MEM Relay clip	8
49	E52/S 24V relay with 2 x CO contacts rated 230Vac 5A	7
50	E52/S 12V relay with 2 x CO contacts rated 230Vac 5A	1
51	Power supply (75W, 230Vac/24Vdc AC/DC, DIN Rail mount)	1
52	Power supply (120W, 230Vac/24Vdc AC/DC, DIN Rail mount)	1
53	Power supply (120W, 48Vin/24Vout DC/DC, DIN Rail mount)	1
54	M5 x 10mm Cheese head	4
55	M5 x 10 washers	4
56	Panel Flex cable 1mm <sup>2</sup> Red	8m
57	Panel Flex cable 1mm <sup>2</sup> Brown	5m
58	Panel Flex cable 1mm <sup>2</sup> Black	5m
59	Panel Flex cable 1mm <sup>2</sup> Green/Yellow (earth)	5m
60	Panel Flex cable 1mm <sup>2</sup> Blue	5m
61	Panel Flex cable 0.5mm <sup>2</sup> Grey	5m
62	Panel Flex cable 0.5mm <sup>2</sup> Black	8m
63	Panel Flex cable 0.5mm <sup>2</sup> Red	5m
65	AMB-1.6 Nylon bushing	1m
66	PG-7 -Compression Glands size 00 - 13mm hole size	1
67	RJ45 connector unshielded	10
68	RJ45 boot	10
69	Pad Lock (As per DX standard)	1

**3.3.7 AC Distribution Board**

**3.3.7.1 Bill of materials**

No	Item	Qty
1	Enclosure 1000mm (W) x 1200mm (H) x 300mm (D) Orange Colour, with Back Plate	1
2	Grey narrow slotted trunking 40mm (W) x 40mm (H)	2m
3	Grey slotted trunking 25mm (W) x 25mm (H)	2m
4	Grey slotted trunking 60mm (W) x 40mm (H)	4m
5	DIN 35-Ω Passivated* steel slotted rail (35mm x 7.5mm x 1mm)	4m
6	4 mm x 10mm big head rivets	70
7	DIN rail end stop	16
8	JUK2.5B DIN rail mounted terminal (2.5mm <sup>2</sup> wire)	13
9	JUK5N DIN rail mounted terminal (4mm <sup>2</sup> wire)	8
10	JUK6N DIN rail mounted terminal (6mm <sup>2</sup> wire)	16

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No	Item	Qty
11	JUK35 DIN rail mounted terminal (35mm <sup>2</sup> wire)	4
12	JUSLKG5 DIN rail mounted earth terminal (4mm <sup>2</sup> wire)	6
13	JUSLKG10 DIN rail mounted earth terminal (10mm <sup>2</sup> wire)	8
14	JUSLKG35 DIN rail mounted earth terminal (35mm <sup>2</sup> wire)	3
15	D-JUK2.5 DIN rail mounted terminal end plate (2.5mm <sup>2</sup> )	3
16	D-JUK4/10 DIN rail mounted terminal end plate (4/10mm <sup>2</sup> )	1
17	Single Pole Distribution Blocks Din Rail Mounting 160A: 1 x 10 - 70mm <sup>2</sup> 1 x 6 - 16mm <sup>2</sup> 6 x 2,5 - 16mm <sup>2</sup>	4
18	JUK5-HESI DIN rail mounted fuse terminal (4mm <sup>2</sup> wire)	6
19	ZMEM/5 DIN rail mounted relay base for E52 type relay	3
20	PSF14AE/L DIN rail mounted relay base for E52 type relay	7
21	MEM Relay clip	10
22	E52/S 24V relay with 2 x CO contacts rated 230Vac 5A	8
23	E52/S 230V relay with 2 x CO contacts rated 230Vac 5A	2
24	1P+N pole MCB 6A	4
25	1P MCB 20A	2
26	20 x 5mm 100mA Glass fuse	6
27	Surge protection device (5kA on input, 15kA on output)	12
28	SAM-B1 Copper busbar for 13mm mini rail breakers 750mm long 1 Pole non-insulated	1
29	S125-NN - 125A Isolator MCCB	2
30	A000348 - 1 C/O Auxiliary Switch	4
31	A000744 - 1 C/O Alarm Switch	2
32	S000911 - 200-240VAC Shunt Trip	2
33	MO755620 - 230VAC Motor operator	2
34	A9C70122 - Schneider Remote control actuator or equivalent	6
35	Vigi for Acti9 iC60 - 30mA RCD	2
36	Acti9 iC60 Auxiliary contact, OF + SD, 1NO, 1NC	5
37	A9F79216 - Schneider 16A 2P MCB or equivalent and compatible to item 34	1
38	A9F79232 - Schneider 32A 2P MCB or equivalent and compatible to item 34	2
39	A9F22240 - Schneider 40A 2P MCB or equivalent and compatible to item 34	8
40	220:7.5Vac, 1.5kVA Voltage transformer	3
41	1:500 100A Current transformer	6
42	Panel Flex cable 10mm <sup>2</sup> Green/Yellow (earth)	2m
43	Panel Flex cable 6mm <sup>2</sup> Red	10m
44	Panel Flex cable 6mm <sup>2</sup> Black	10m
45	Panel Flex cable 2.5mm <sup>2</sup> Red	1m
46	Panel Flex cable 2.5mm <sup>2</sup> Black	1m
47	Panel Flex cable 2.5mm <sup>2</sup> Green/Yellow (earth)	2m
48	Panel Flex cable 1.5mm <sup>2</sup> Red	5m
49	Panel Flex cable 1.5mm <sup>2</sup> Black	5m
50	Panel Flex cable 0.5mm <sup>2</sup> Grey	5m
51	Panel Flex cable 0.5mm <sup>2</sup> Black	8m
52	Panel Flex cable 0.5mm <sup>2</sup> Red	5m
53	10mm <sup>2</sup> Boot lace ferrules, non-insulated	12
54	6mm <sup>2</sup> Boot lace ferrules, insulated	40
55	2.5mm <sup>2</sup> Boot lace ferrules, insulated	20
56	1.5mm <sup>2</sup> Boot lace ferrules, insulated	40
57	0.5mm <sup>2</sup> Boot lace ferrules, insulated	50
58	Emergency Stop mushroom button with latch, twist to release	1
59	Contact blocks with support base with NO and NC contact	1

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No	Item	Qty
60	E-stop enclosure (mushroom twist to release) with pushbutton protection	1
61	Add-on contact block 10A NC	1
62	Add-on contact block 10A NO	1
63	PG-7 - Compression Gland size 00 - 13mm hole size	2
64	CG-1 - Compression Gland size 1 - 20mm hole size	11
65	ACG-6 - Compression Gland size 6 - 63mm hole size	2
66	Non insulated ring lug 10-8mm	4
67	Non insulated ring lug 10-10mm	1
68	Rubber grommet fit 8mm hole with 4.8mm throat	22
69	Pratley steel putty quickset clear or equivalent	1
70	Resistors 110Ω, 0.25W, 1%	3
71	Resistors 330Ω, 0.25W, 1%	3
72	SCG6.4 - Heat shrink 6.4mm	2m
73	Pad Lock	1

### 3.3.8 Battery Distribution Board

#### 3.3.8.1 Bill of materials

No	Item	Qty
1	5mm Black Plastic Insulator F-F	6
2	5mm Red Plastic Insulator F-F	6
3	Big head rivets (4mm x 10mm)	4
4	Copper busbar, 10mm x 30mm	1.48m
5	DIN 35-Ω Passivated* steel slotted rail (35mm x 7.5mm x 1mm)	0.1m
6	DIN rail end stop	3
7	Enclosure 450mm (W) x 650mm (H) x 270mm (D)	2
8	Fuse 5x20mm 6.3A	4
9	Fuse Switch Disconnect 2 Pole for 160A Size 00 NH Fuses	5
10	Ultra-fast blowing 160A dc fuse, NH size 00	10
11	JUK5-HESI DIN rail mounted fuse terminal (4mm <sup>2</sup> wire)	4
12	CG-1 - Compression Glands size 1 - 20mm hole size	50
13	Non insulated ring lug 1.5-8mm	2
14	Non insulated ring lug 120-10mm	16
15	Bolt M5 x 10mm Cheese head	12
16	Bolt M5 x 16mm Cheese head	12
17	Bolt M8 x 15mm Hex head (Brass, Copper or Tin Copper) (Not Steel)	24
18	Bolt M10 x 15mm Hex head (Brass, Copper or Tin Copper) (Not Steel)	8
19	M5 x 10 washers	24
20	M6 x 22mm washers (Steel)	30
21	M8 x 10mm washers (Brass, Copper or Tin Copper) (Not Steel)	32
22	M10 x 10mm washers	8
23	M8 spring washer (Brass, Copper or Tin Copper) (Not Steel)	32
24	M10 spring washer (Brass, Copper or Tin Copper) (Not Steel)	8
25	Tek Screws 5.5mm x 16mm (steel)	10
26	Panel Flex cable 0.75mm <sup>2</sup> Red	0.5m
27	Panel Flex cable 0.75 mm <sup>2</sup> Black	0.5m
28	Permoweld Single Flex 120mm <sup>2</sup> Black Double insulated Cable	2m
29	PG-7 -Compression Glands size 00 - 13mm hole size	2
31	AMB-1.2 Nylon bushing	1m
32	0.75 mm <sup>2</sup> Boot lace ferrules, insulated	10

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No	Item	Qty
33	Heatshrink Red 120 mm Diameter	0.5m
34	Heatshrink Black 120 mm Diameter	0.5m
35	Pad Lock	2

### 3.3.9 PV Distribution Board

#### 3.3.9.1 Bill of materials

No	Item	Qty
1	2POLE 40KA PV Surge protector 750VDC I <sub>max</sub> 8-20 A	8
2	Big head rivets (4mm x 10mm)	30
3	DIN 35-Ω Passivated* steel slotted rail (35mm x 7.5mm x 1mm)	1m
4	DIN rail end stop	10
5	Enclosure 550mm (W) x 750mm (H) x 270mm (D) Orange Colour, with back plate	1
6	Fuse Holder Solar PV DC 10 x 38mm 30Amp (No fuses)	16
7	CG-1 - Compression Glands size 1 - 20mm hole size	5
8	PV Fuse 15Amp 1000V 15 Amp DC 10 x 38mm Photovoltaic Fuses	16
9	PV MC4 panel mount Female Coupling Connector 4mm <sup>2</sup> Complete (Housing and terminal)	8
10	PV MC4 panel mount Male Coupling Connector 4mm <sup>2</sup> Complete (Housing and terminal)	8
11	Grey narrow slotted trunking (60mm x 40mm)	1.6m
12	Solar cable 4mm <sup>2</sup> black Rated Voltage 600/1000VAC	4m
13	Solar cable 4mm <sup>2</sup> red Rated Voltage 600/1000VAC	4m
14	Pad Lock	1

### 3.3.10 Metering

Total Energy measurements shall be calculated by the control system using a CT/VT unit

### 3.3.11 Ventilation

No	Item	Specifications
1	Size	12000 Btu/hr Inverter Air Conditioner
2	Gas type	Eco-friendly R410A Gas
3	Energy Efficiency Class (cooling)	A/A++ or better
4	Smart Energy Saver Technology	Yes
5	Filter type	Allergy Care full HD
6	Condenser material	DuraFin+ corrosion resistant
7	Functions	Cooling, Heating with auto setting
8	Modes	Good Sleep Mode Fast Cooling Mode Dehumidification Mode
9	Must include	installation piping and interconnecting cable
10	Standard warranty	12 Month Standard
11	Extended warranty	5 years on all parts and 10 years on the compressor.

#### 1.1.1.1 Bill of materials

No	Item	Qty
1	Aircon	2

**3.3.12 Fire prevention system**

No	Item	Specifications
<b>1</b>	<b>Critical</b>	
1.1	Applicable standards	SANS 10139 SANS 50054
1.1	Extinguishing type	Class A Class B Class C
1.2	Extinguishing Coverage	6m – 10m
1.3	Size	≥ 6 Inches
1.4	Weight	1.3 ± 0.2 kg.
1.5	Alarm Noise Signal	113 – 139 dB (Impact Noise as ACGIH 1999 Standard)
1.6	Installation	Do it yourself
1.7	Maintenance	No
1.8	Replaced (period)	Every 5 years
<b>2</b>	<b>Other</b>	
2.1	Storage temperature	-40°C and 85°C
2.2	Storage conditions	Dry place
2.3	Certificates	ISO9001:2015 SANS

**3.3.12.1 Bill of materials**

No	Item	Qty
1	Passive self-triggered fire extinguishing device or equivalent	8
2	Fire extinguisher	2

**3.3.13 Weather station**

No	Item	Specifications
<b>1</b>	<b>Sensor Suite</b>	
1.1	Operating Temperature	-40° to +150°F (-40° to +65°C)
1.2	Non-operating Temperature	-40° to +158°F (-40° to +70°C)
1.3	Current Draw	(Integrated sensor suite sensor interface module only) 0.14 mA (average), 30 mA (peak) at 4 to 6 VDC
1.4	Solar Power Panel	0.5 Watts (integrated sensor suite sensor interface module), plus 0.75 Watts (Fan-Aspirated)
1.5	Battery	(Integrated sensor suite sensor interface module /Fan-Aspirated) CR-123 3-Volt Lithium cell / 2 - 1.2 Volt NiMH C-cells
1.6	Battery Life	(3-Volt Lithium cell) 8 months without sunlight - greater than 2 years depending on solar charging
1.7	Battery Life	(NiMH C-cells, Fan-Aspirated) Up to 2 years
1.8	Connectors,	Sensor Modular RJ-11
1.9	Cable Type 4-conductor	26 AWG
1.10	Cable Length	Anemometer 40 feet (12 m) (included) 240 feet (73 m) (maximum recommended)
1.11	Wind Speed Sensor	Solid state magnetic sensor
1.12	Wind Direction Sensor	Wind vane with potentiometer
1.13	Rain Collector Type Tipping spoon	0.01" per tip for US versions, 0.2 mm for metric versions, 33.2 in 2 (214 cm 2) collection area
1.14	Temperature Sensor Type	PN Junction Silicon Diode

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No	Item	Specifications
1.15	Relative Humidity Sensor Type	Film capacitor element
1.16	Housing Material	UV-resistant ABS, polypropylene
<b>2</b>	<b>Console</b>	
2.1	Console Operating Temperature	+32° to +140°F (0° to +60°C)
2.2	Non-Operating (Storage) Temperature	+14° to +158°F (-10° to +70°C)
2.3	Current Draw	0.9 mA average, 30 mA peak, (add 120 mA for display lamps, add 0.125 mA for each optional wireless transmitter received by the console) at 4 - 6 VDC
2.4	AC Power Adapter	5 VDC, 1000 mA, regulated
2.5	Batteries	3 C-cells
2.6	Battery Life	up to 9 months
2.7	Connectors	Modular RJ-11
2.8	Housing Material	UV-resistant ABS plastic
2.9	Console Display Type	LCD Transflective
2.10	Display Backlight	LEDs
2.11	Console Dimensions	Console with antenna down (L x H x D) 270 mm x 156 mm x 41 mm Console with antenna extended up (L x H x D) 270 mm x 245 mm x 41 mm Display (L x H) 151 mm x 86 mm
2.12	Weight (with batteries)	0.85 kg
3	Data Logger	Links the weather station to a PC via USB cable.
4	Solar Radiation Sensor	Compatible with included weather station Measures solar radiation

**3.3.14 Aux Equipment**

**3.3.14.1 Bill of materials**

No	Item	Qty
1	T8 LED WEATHERPROOF LINEAR LIGHTS Twin lamp	3
2	22W (5FT) LED Tube	6
3	LED Aluminium Flood Lights (50W)	4
4	CAT 5E solid cable (interior use)	100m
5	Panel Flex cable 10mm <sup>2</sup> Green/Yellow (earth)	30m
6	Panel Flex cable 6mm <sup>2</sup> Green/Yellow (earth)	80m
7	Panel Flex cable 6mm <sup>2</sup> Red	80m
8	Panel Flex cable 6mm <sup>2</sup> Black	80m
9	Surfix Twin Flat & Earth (2+E) 2.5mm <sup>2</sup>	20m
10	Surfix Twin Flat & Earth (2+E) 1mm <sup>2</sup>	40m
11	W207 -4 core cabtyre cable 0.75mm <sup>2</sup>	25m
12	W205 - 2 core cabtyre cable 0.75mm <sup>2</sup>	12m
13	EB44C - Steel Surface Mount 100 x 100mm	2
14	B7403 - Power Socket Duel (1 x 16A +1 x 10A)	2
15	CG-00 - Compression Gland size 00 - 20mm hole size	3
16	CG-0 - Compression Gland size 0- 20mm hole size	2
17	CG- 1 - Compression Gland size 1 - 20mm hole size	2
18	Cable tie 2.5mm x 96mm	200
19	Cable tie 4.8mm x 280mm	400
20	Cable tie 7.6mm x 380mm	200
21	Self-Adhesive Cradles 19mm x 19mm	30
22	Equipment Labelling printer - Brother (once off)	1

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No	Item	Qty
23	Equipment Label Cartridges 6mm white	1
24	Equipment Label Cartridges 12mm white	1
25	Cable Marker EC - 2 (Numbers 0 to 9)	10 x 100
26	Cable Marker Carrier	40
27	RJ45 connector unshielded	40
28	RJ45 connector shielded	6
29	RJ45 boot	46
30	M10 Brass Nut	4
31	M10 Brass Screw Rod / Bolt 60-80 mm	1
32	Non insulated ring lug 10-10 mm	7

**2. Authorization**

This document has been seen and accepted by:

Name and surname	Designation
Aletta Mashao	Senior Manager: PTM&C
Al'Louise Van Deventer	Senior Manager: Maintenance & Operations
Amelia Mtshali	Senior Manager: Design Base and OU Support
Mfundi Songo	Senior Manager: Power Plant
Nick Singh	Middle Manager: Smart Grids Centre of Excellence
Portia Papu	Senior Manager: Customer Service
Pravind Orrie	Senior Manager: Asset Creation Limplanga Cluster
Velaphi Ntuli	General Manager: Distribution Operations & Technology Support

**3. Revisions**

Date	Rev.	Compiler	Remarks
September 2022	Draft	A Bekker	First draft

**4. Development team**

The following people were involved in the development of this document:

1. André Bekker
2. Carl van den Berg
3. Philip Groenewald
4. Renier de Lange
5. Ruan Olwagen

**5. Acknowledgements**

Ficksburg microgrid pilot site development team.

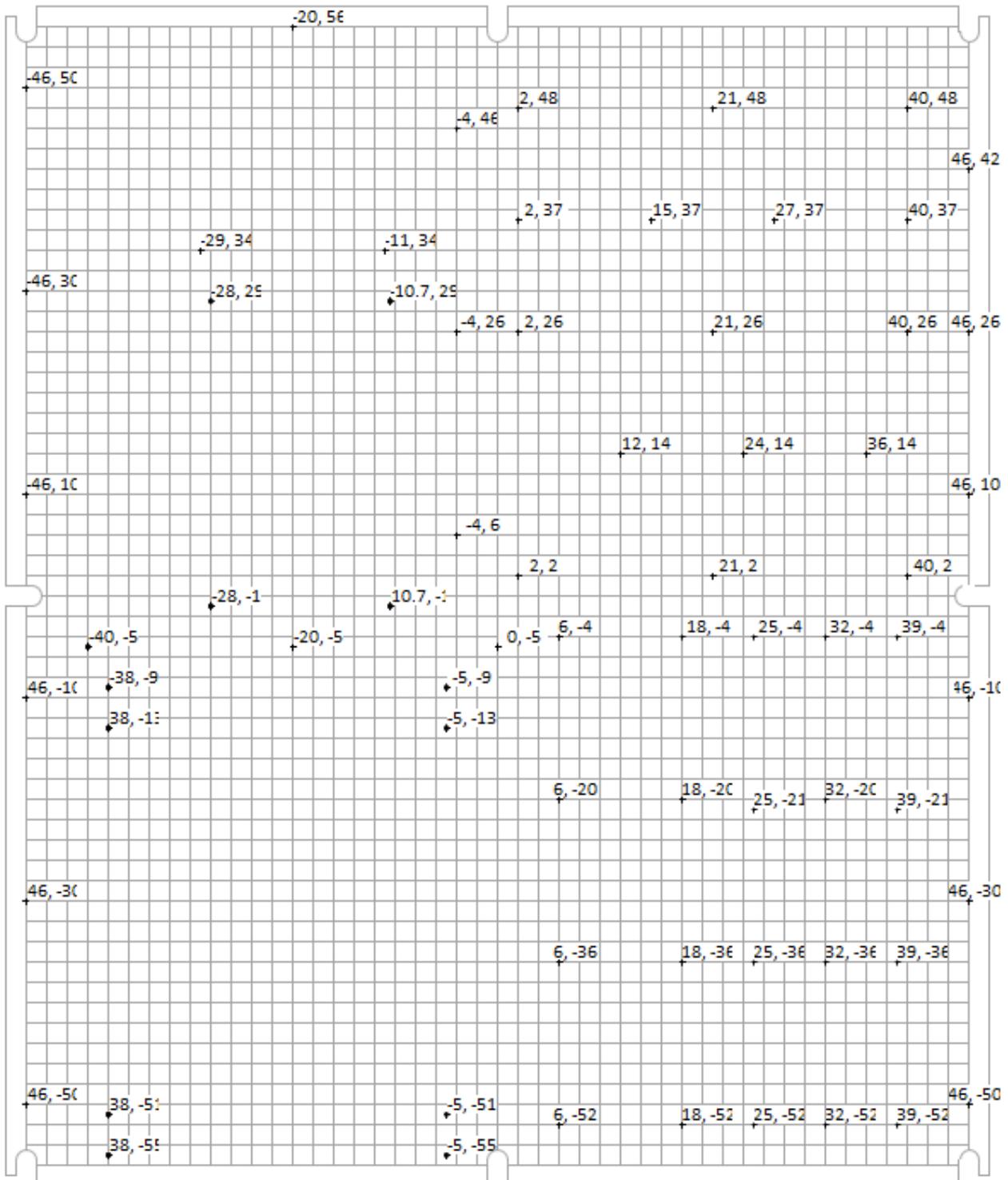
BESS specification development team

RT&D team responsible for the development of the first prototype containerised microgrid generator and energy storage system. C.F. vd Berg, J Rudolph, M. van Zyl, M.S. Cassiem, R. de Lange, R. Olwagen.

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#### 4. Appendix 1: Enclosure modifications

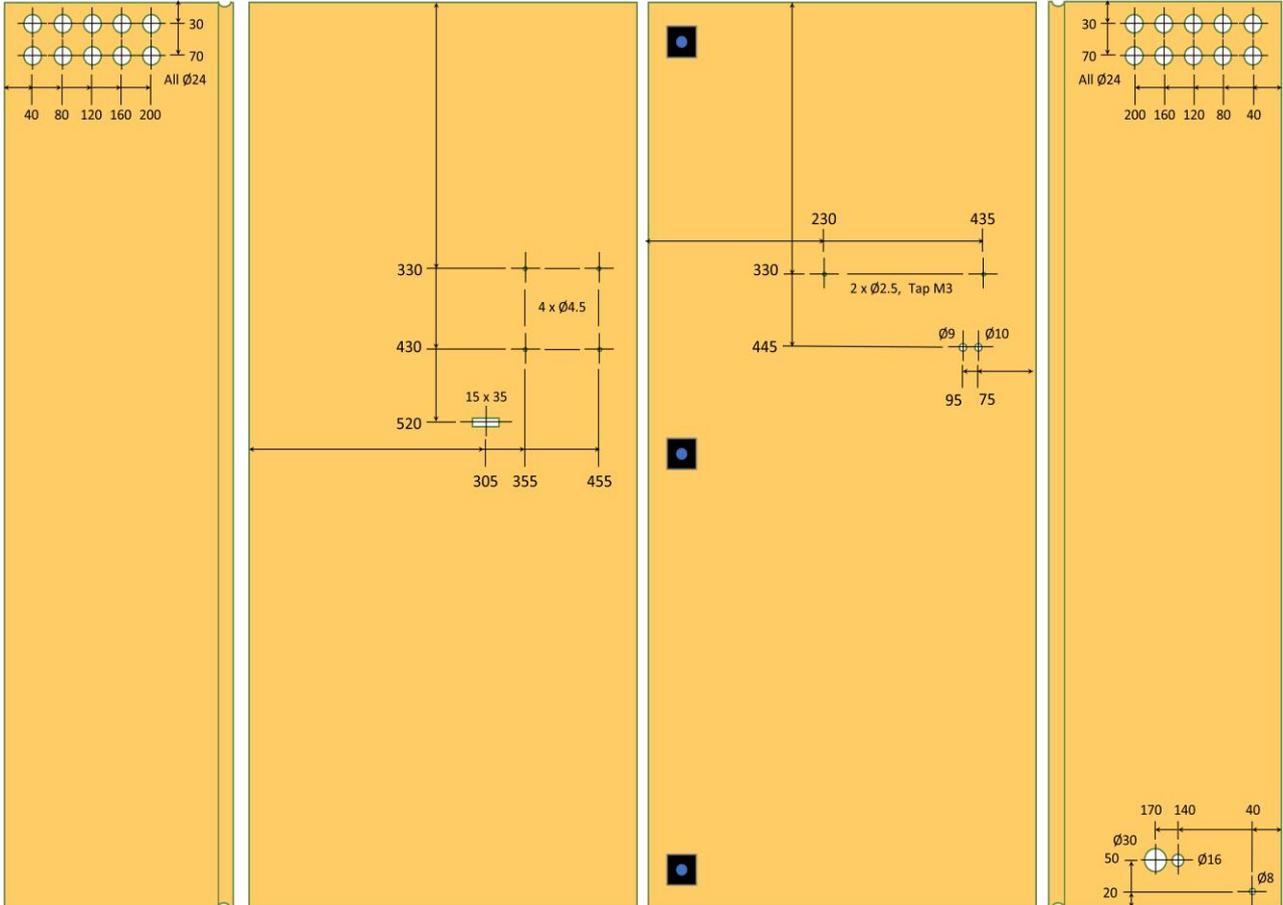
##### 4.1 Control Enclosure Modifications



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Additional holes (drawings - Control Enclosure - Mods 1). All positions are in millimetres and reference to the left bottom (0,0), formatted as (x, y) as from the outside



Ø 4mm	
-46	-50
-46	-30
-46	-10
-46	10
-46	30
-46	50
-40	-5
-29	34
-20	-5
-20	56
-11	34
-4	6
-4	26
-4	46

Ø 6mm	
-38	-55
-38	-51
-38	-13
-38	-9
-28	-1
-28	29
-10.7	-1
-10.7	29
-5	-55
-5	-51
-5	-13
-5	-9

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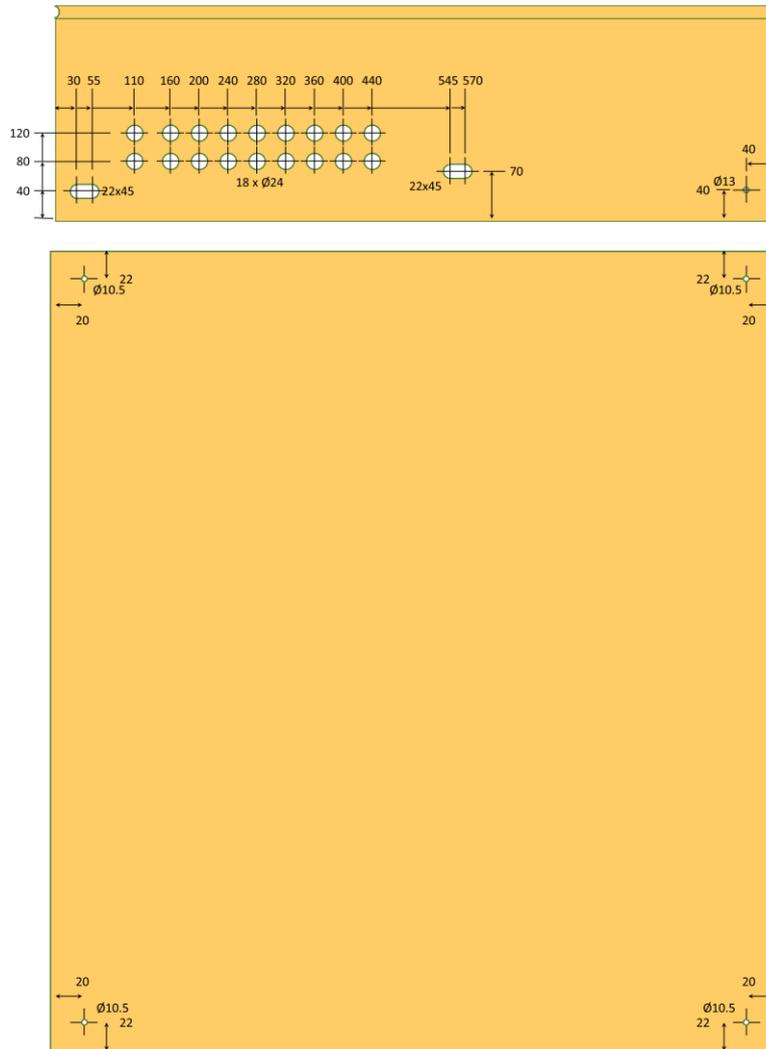
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0	-5
2	2
2	26
2	37
2	48
6	-52
6	-36
6	-20
6	-4
12	14
15	37
18	-52
18	-36
18	-20
18	-4
21	2
21	26
21	48
24	14
25	-52
25	-36
25	-21
25	-4
27	37
32	-52
32	-36
32	-20
32	-4
36	14
39	-52
39	-36
39	-21
39	-4
40	2
40	26
40	37
40	48
46	-50
46	-30
46	-10
46	10
46	26
46	42

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Additional holes (drawing - Control Enclosure - Mods 2). All positions are in millimetres and reference to the center (0,0), formatted as (x, y)

Left side		
x	y	Ø
40	1130	24
40	1170	24
80	1130	24
80	1170	24
120	1130	24
120	1170	24
160	1130	24
160	1170	24
200	1130	24
200	1170	24

Right side		
x	y	Ø
40	20	10
140	50	16
170	50	30
40	1130	24
40	1170	24
80	1130	24
80	1170	24
120	1130	24
120	1170	24
160	1130	24
160	1170	24

Bottom side		
x	y	Ø
30	40	22
55	40	22
110	80	24
110	120	24
160	80	24
160	120	24
200	80	24
200	120	24
240	80	24
240	120	24
280	80	24

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200	1130	24
200	1170	24

280	120	24
320	80	24
320	120	24

Left door		
x	y	Ø
305	680	15 x 35
355	770	4.5
455	870	4.5
355	770	4.5
455	870	4.5

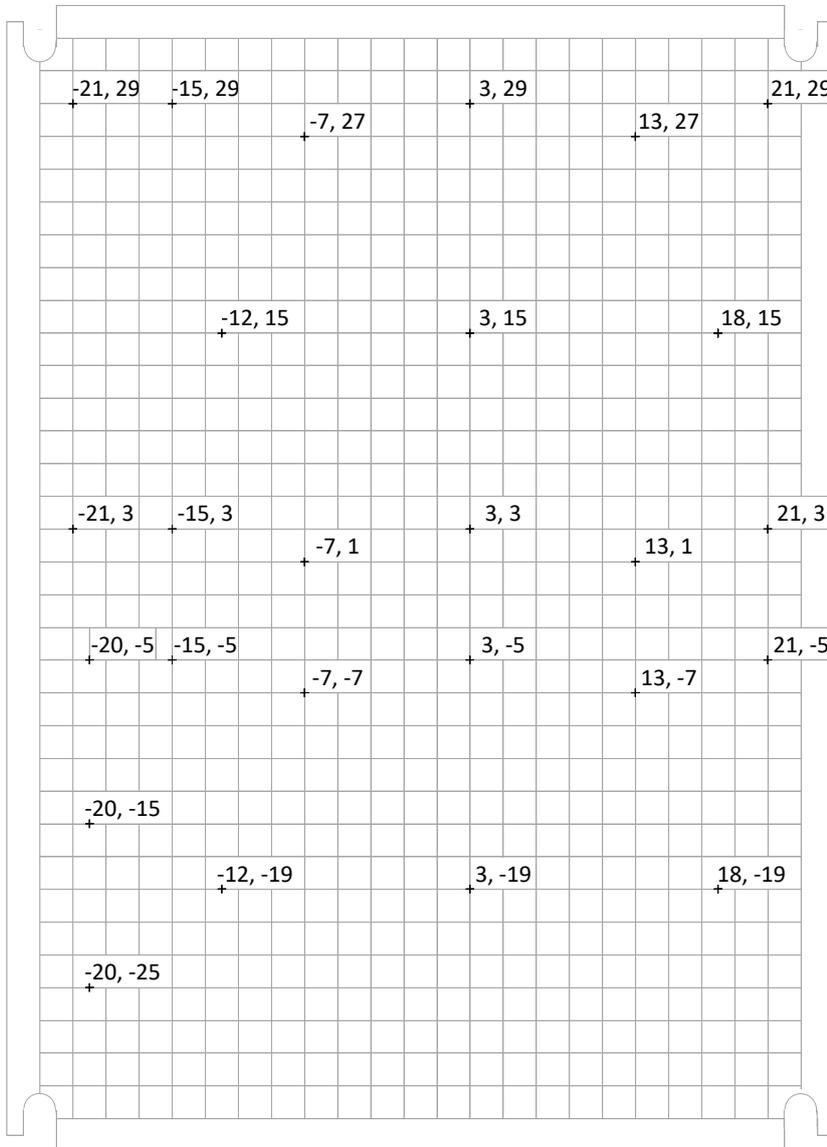
Right door		
x	y	Ø
75	755	10
95	755	9
230	870	2.5
435	870	2.5

360	80	24
360	120	24
400	80	24
400	120	24
440	80	24
440	120	24
545	70	22
570	70	22
960	40	13

Back side		
x	y	Ø
20	22	10.5
20	1178	10.5
980	80	10.5
980	1178	10.5

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4.2 PV Enclosure Modifications



All positions are in millimetres and reference to the centre (0,0), formatted as (x, y)

Ø 4mm	
-21	3
-21	29
-20	-25
-20	-15
-20	-5
-15	-5
-15	3
-15	29
-12	-19
-12	15

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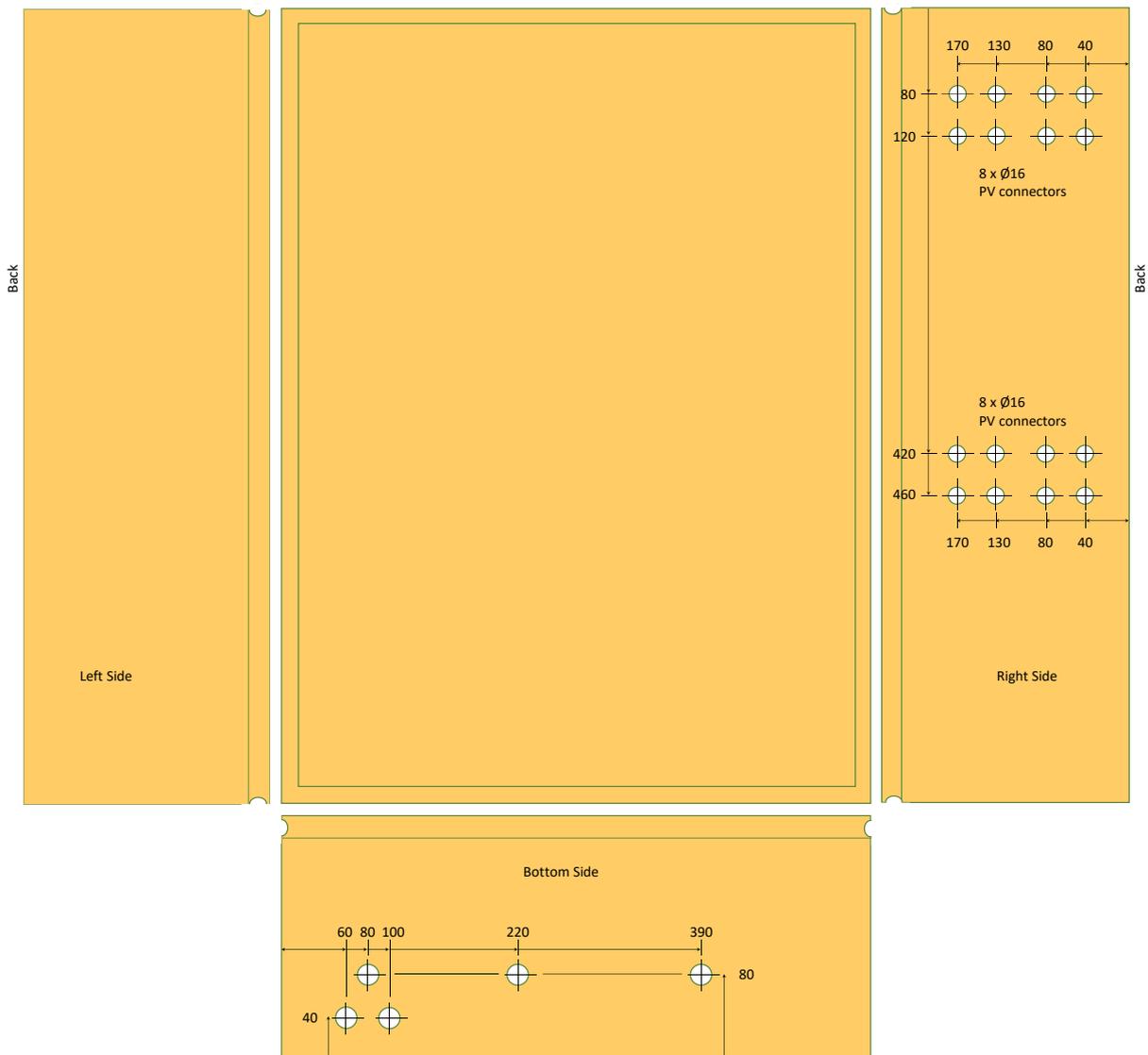
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-7	-7
-7	1
-7	27
3	-19
3	-5
3	3
3	15
3	29
13	-7
13	1
13	27
18	-19
18	15
21	-5
21	3
21	29

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All positions are in millimetres and reference to the left bottom (0,0)

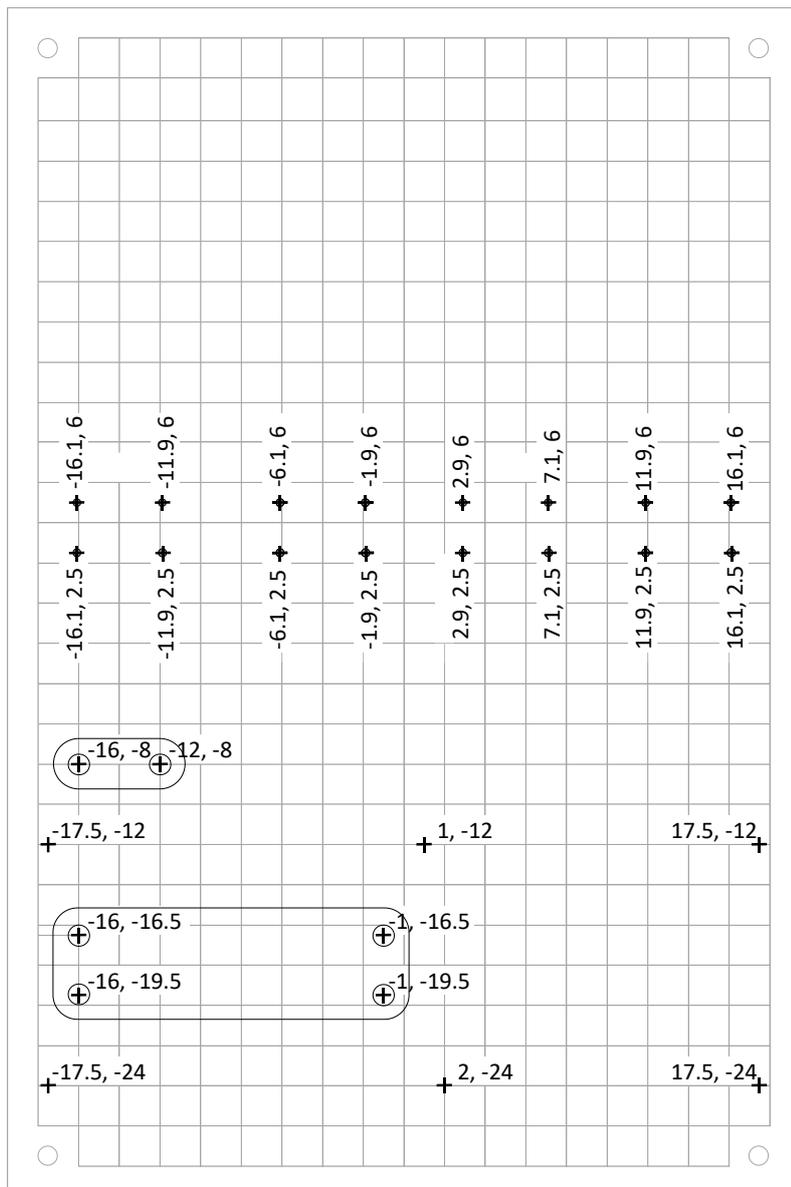
Bottom side		
x	y	Ø
60	40	20
80	80	20
100	40	20
220	80	20
390	80	20

Right side		
x	y	Ø
60	290	16
100	290	16
150	290	16
190	290	16
60	330	16
100	330	16
150	330	16
190	330	16
60	630	16
100	630	16
150	630	16

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190	630	16
60	670	16
100	670	16
150	670	16
190	670	16

### 4.3 Battery Enclosure 1 Modifications



All positions are in millimetres and reference to the centre (0,0), formatted as (x, y)

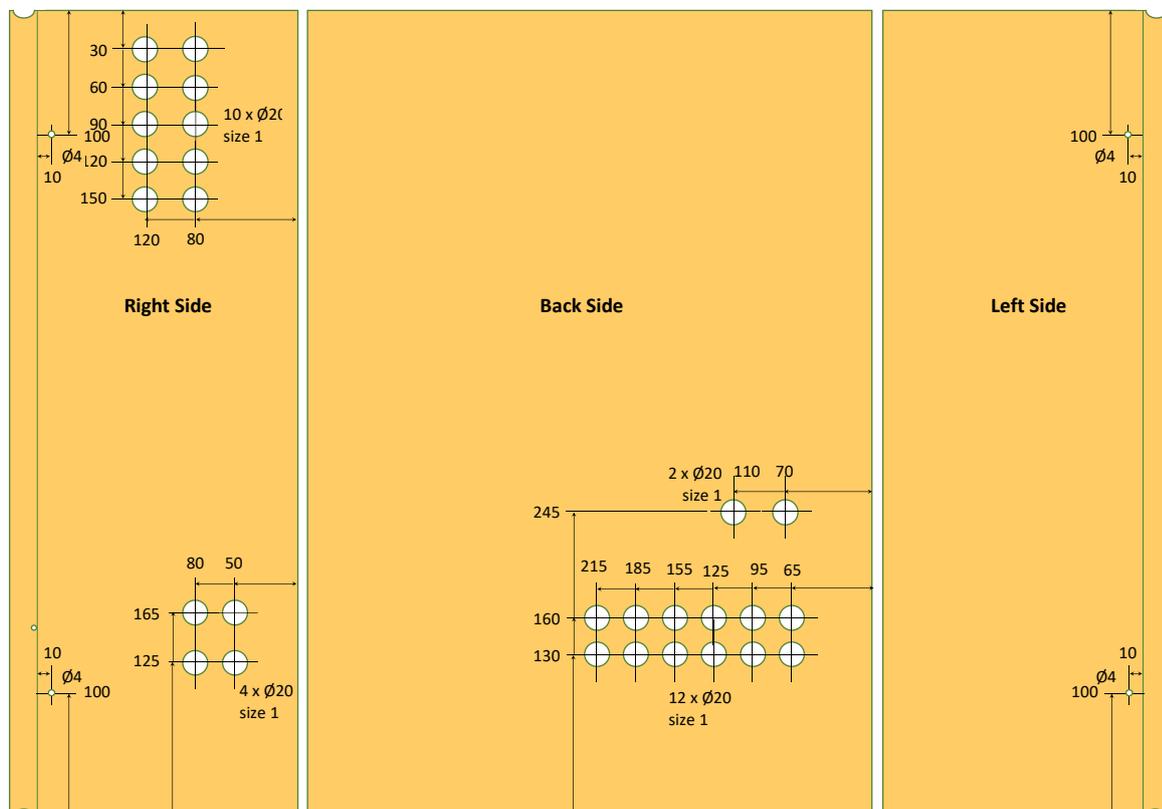
<b>Ø 4mm</b>	
-175	-240

<b>Cut-outs</b>	
Left Bottom	Right Top

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20	-240	<b>x</b>	<b>y</b>	<b>x</b>	<b>y</b>
175	-240	-17.2	-20.7	0.2	-15.3
-175	-120	-17.2	-9.2	-10.8	6.8
10	-120	Corners 12mm radius			
175	-120				
-161	25				
-161	60				
-119	25				
-119	60				
-61	25				
-61	60				
-19	25				
-19	60				
29	25				
29	60				
71	25				
71	60				
119	25				
119	60				
161	25				
161	60				



All positions are in millimetres and reference to the left bottom (0,0) formatted as (x, y) as from the outside.

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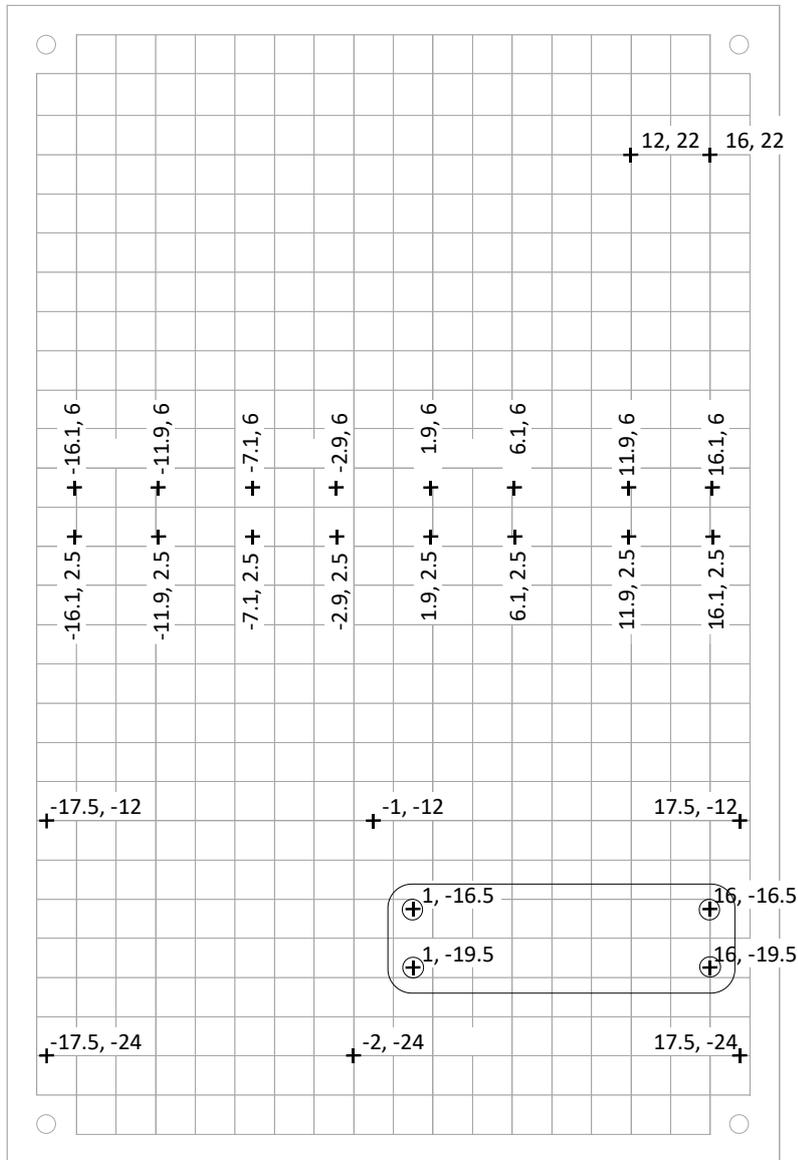
Right side		
x	y	Ø
10	100	4
10	550	4
120	500	20
120	530	20
120	560	20
120	590	20
120	620	20
80	125	20
80	165	20
80	500	20
80	530	20
80	560	20
80	590	20
80	620	20
50	125	20
50	165	20

Back		
x	y	Ø
235	130	20
235	160	20
265	130	20
265	160	20
295	130	20
295	160	20
325	130	20
325	160	20
355	130	20
355	160	20
385	130	20
385	160	20
340	245	20
380	245	20

Left side		
x	y	Ø
10	100	4
10	550	4

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### 4.4 Battery Enclosure 2 Modifications



All positions are in millimetres and reference to the centre (0,0), formatted as (x, y)

Ø 4mm	
-175	-240
-20	-240
175	-240
-175	-120
-10	-120
175	-120
-161	25
-161	60
-119	25

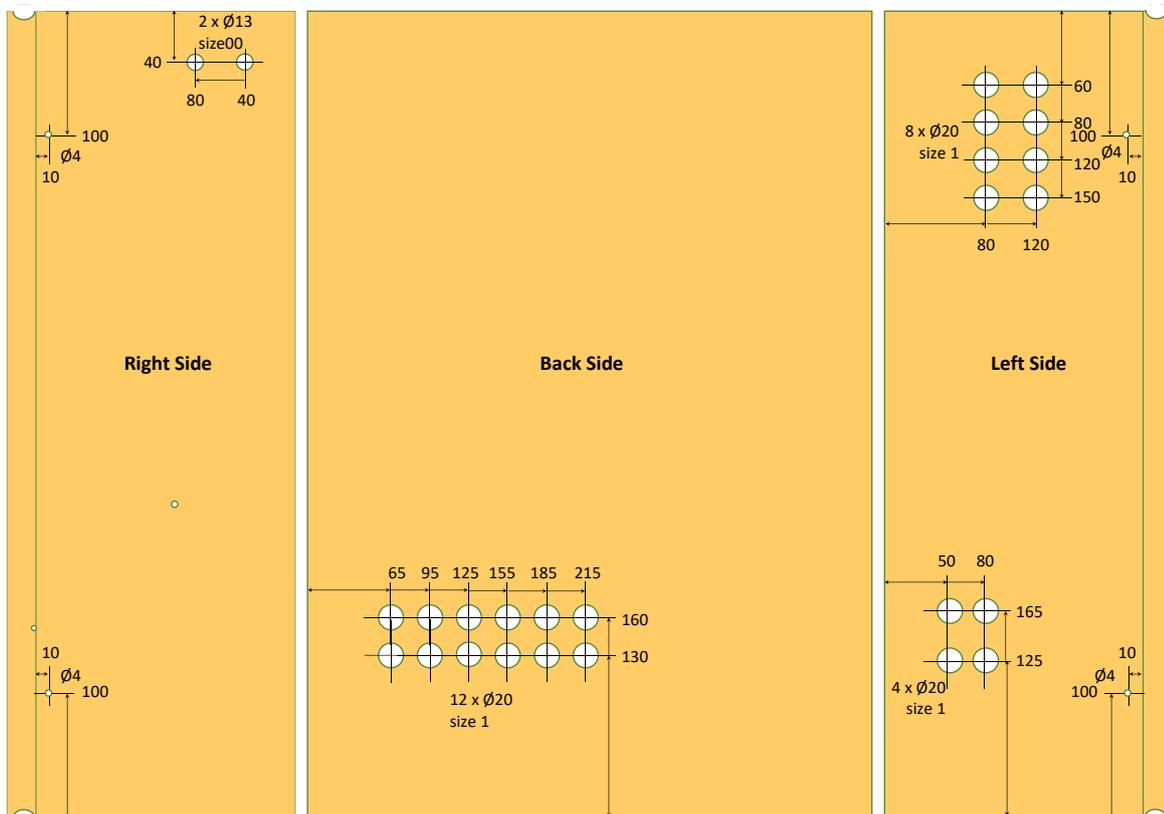
Cut-outs			
Left Bottom		Right Top	
x	y	x	y
-0.2	-20.7	17.2	-15.3

Corners 12mm radius

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-119	60
-71	25
-71	60
-29	25
-29	60
19	25
19	60
61	25
61	60
119	25
119	60
161	25
161	60



All positions are in millimetres and reference to the left bottom (0,0) formatted as (x, y) as from the outside.

Right side		
x	y	Ø
10	100	4
10	550	4
-80	610	13
-40	610	13

Back		
x	y	Ø
65	130	20
65	160	20
95	130	20
95	160	20
125	130	20
125	160	20

Left side		
x	y	Ø
-10	100	4
-10	550	4
50	125	20
50	165	20
80	125	20
80	165	20

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155	130	20	80	500	20
155	160	20	80	530	20
185	130	20	80	560	20
185	160	20	80	590	20
215	130	20	80	620	20
215	160	20	120	500	20
			120	530	20
			120	560	20
			120	590	20
			120	620	20

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