Low Carbon Network Fund Successful Delivery Reward Criteria

9.2 - Confirmation of the SoLa BRISTOL design

September 2012

SoLa BRISTOL (Building, Renewables and Integrated Storage, with Tariffs to Overcome network Limitations)

Version: V 1.0

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Contents

Executive summary

This document provides a detailed overview of the technical solution for the SoLa BRISTOL project. It has been compiled from information provided by the projects partners: Siemens, University of Bath and Western Power Distribution.

The SoLa BRISTOL design contains three key elements; these are the LV Connections Manager, LV Network Manager and Data Concentrator, the three of which provide the intelligence allowing the network to operate flexibly, to overcome potential Network limitations. The remaining components, while key to delivering the solution, respond to the instructions of these elements.

Properties will have four main components, either a single of three Four Quadrant Inverter(s), a DC/DC converter, Battery Enclosure and an LV Connection Manager.
Substations supplying properties with the SoLa BRISTOL solution will have a LV Network Manager installed.

All properties will be linked the connected substation using a VPN over the GPRS network. All substations are linked to the Data Concentrator using a VPN over the GPRS network, recording data from properties and substations.

Project Background

BRISTOL is an alternative method to enable high density photo voltaic solar generation to connect to the low voltage network more efficiently through using an in home battery and variable tariffs.

The project aim is to address the technical constraints that DNOs expect to arise on Low Voltage networks as a result of the adoption of solar PV panels. The trial uses in-home battery storage to provide benefits to customers and aid the DNO with network management. Thirty houses, ten schools and an office will have solar PV and a battery installed. The solar PV will be connected directly to the battery using a DC connection. The AC lighting circuits in the premises will also be converted to DC to enable customers to run small appliances on DC directly from the PV/battery. The battery will be “shared" between the customer and the DNO. The customer will be provided with a variable tariff to encourage electricity use at times of high PV generation and to use electricity stored by the battery when the network is heavily loaded. The DNO will be able to communicate with the battery to charge and discharge it to help with network management.

Document Purpose

The information contained within this document is intended to provide detailed knowledge on:

- The design of individual components,
- The designed capability of the equipment being installed,
- The capability of the DC network and the connection of equipment to it,
- The connection of individual component to create the system,
- The location of equipment in a typical property.

The design has been developed with our partners, Siemens and the University of Bath. It builds upon the Technical Overview outlined in Appendix C of the BRISTOL bid, page 81 of the Design Appendix.

Due to the change incorporated at the project direction stage, requesting Western Power Distribution to incorporate an initial installation before recruiting and surveying properties, the project plan being re-forecasted to account for an initial installation phase. The homes, schools and office will not be selected until after the initial installation in October 2012. Therefore the design will be supplemented after the participant recruitment and re published in December 2012 through the project websites after all locations have been selected and typical designs for homes, schools and the office have been included.

System Design Performance

The University of Bath have broken the SoLa BRISTOL design down into the six main building blocks for the calculation of the system efficiencies: PV panels and associated PV cables, isolation, protection and interconnecting devices, grid site energy import export interface, User load side energy export, energy storage devices and the overall control communication / management devices.

Further details on SoLa Bristol System Efficiencies and losses are included on page 80 of the Design Appendix.

SoLa BRISTOL design

The attached documents have been separated into the following categories:

Design Appendix

Project Specific Descriptions - A description of the functionality and behaviour of the equipment installed and connection of equipment in the loft area.

Component Information – Schematic and wiring diagrams for key components.

Supplementary Information - Supporting documentation relating to the design.

Supplier Documentation – Operating guides, data sheets and user manuals of SoLa BRISTOL components.

Note – All AC cables operating at DC will have Brown sleeves for L+ and Grey sleeved for L-.

Document Provision – Design Appendix

1. Project Specific Descriptions

2. Component Information

3. Supplementary Information

Supplier Documentation – SoLa Bristol Supplier Documentation.pdf

SIEMENS

Transmission and Distribution Ltd.
Infrastructures & Cities Sector

STDL - Smart Grid - Energy Automation

Client – Western Power Distribution

Project Name – So-La BRISTOL

Functional Design Specification Substation, Domestic and Commercial Installations

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0	07/06/2012	First Issue
1	31/05/2012	WPD Distribution
2	11/06/2012	Commercial solution added
3	18/07/2012	Complete Document - Distributed to WPD
4	12/09/2012	Design Review Update

Contents

1 INTRODUCTION

So-La BRISTOL project is an innovative combination of energy storage in customers' premises, coupled with new variable tariffs and integrated network control to overcome generation or load related constraints at key times of the day. It will explore the use of direct current (DC) power in customer premises in conjunction with battery storage shared virtually between the Distribution Network Operator (DNO) and customer, providing benefits to both parties.

Through batteries, the LV network will be operated more actively with additional capacity to manage peak load, control voltage rise and reduce system harmonics. The techniques trialled will, through reduction in constraints and need for network reinforcement, facilitate the connection of low carbon devices at reduced cost over a number locations in a range of premises types including homes, schools and an office space.

2 SCOPE

This document describes the functionality and behaviour of the equipment installed in the homes, schools, an office space, substations and Bath University.

The three key elements to this project are the LV Connections Manager, LV Network Manager and Data Concentrator, the three of which provide the intelligence allowing the network to operate flexibly, to overcome potential Network limitations. The remaining components, while key to delivering the solution, respond to the instructions of these elements.

The LV Network Manager determines when a constraint is reached and determines where response is needed and requests that response.

The LV Connection Manager takes requests for response and turns those into actions by the equipment which is controllable in the premises.

The Data Concentrator logs all of the metering and operational data provided by the LV Network and Connection Managers to be used for system analysis/asset management.

3 REFERENCES

Document Reference	Description
G85221-1B0000-WW9-V000	Outline Hardware Description
MC6-049-2	TM e-mic System Description
MC6-007-2	TM ACP System Description
C79000-G8976-C236-04	EGPRS/GPRS-Router SINAUT MD741-1
E50417-B1076-C340-A4	SIMEAS-P-7KG775x_System Manual
E50417-B1074-C339-A4	SIMEAS_P_OP_Instructions_775x
SA 2012 – V4.1.2	Studer Xtender User manual
	Studer Appendix User manual V4.0.0
	Technical specification - Xtender serial protocol V1.3.1
	Xcom-232i User Manual V1.0.0

4 DEFINITIONS AND ABBREVIATIONS

Abbreviation	Definition / Meaning
CAEx	Logic configuration tool for Siemens Ax 1703 devices
CB	Circuit Breaker
AC	Alternating Current
DC	Direct Current
GPS	Global Positioning System (Satellite)
HMI	Human Machine Interface
kV	Kilovolts (V x 10^3)
LAN	Local Area Network
LED	Light Emitting Diode
MCB	Miniature Circuit Breaker
NTP	Network Time Protocol
NTS	Network Time Server
PSU	Power Supply Unit
Siemens	Manufacturer of Automation and Control equipment
SCALA	Software for configuration of the HMI
SCP	Station Control Point
SCS	Substation Control System
SLC	Station Level Controller
SWGR	Switchgear
LVNM	LV Network Manager
LVCM	LV Connection Manager
DNO	Distribution Network Operator
DR	Demand Response
V	Voltage
CFL	Compact Fluorescent Lamp
LC	Low Carbon
LCT	Low Carbon Tariff
CT	Current Transformer
LV	Low Voltage
LED	Light Emitting Diode

5 FUNCTIONALITY/OPERATION

5.1 Domestic

This section identifies the components which are to be used, their functions and combined interactions.

5.2 Components

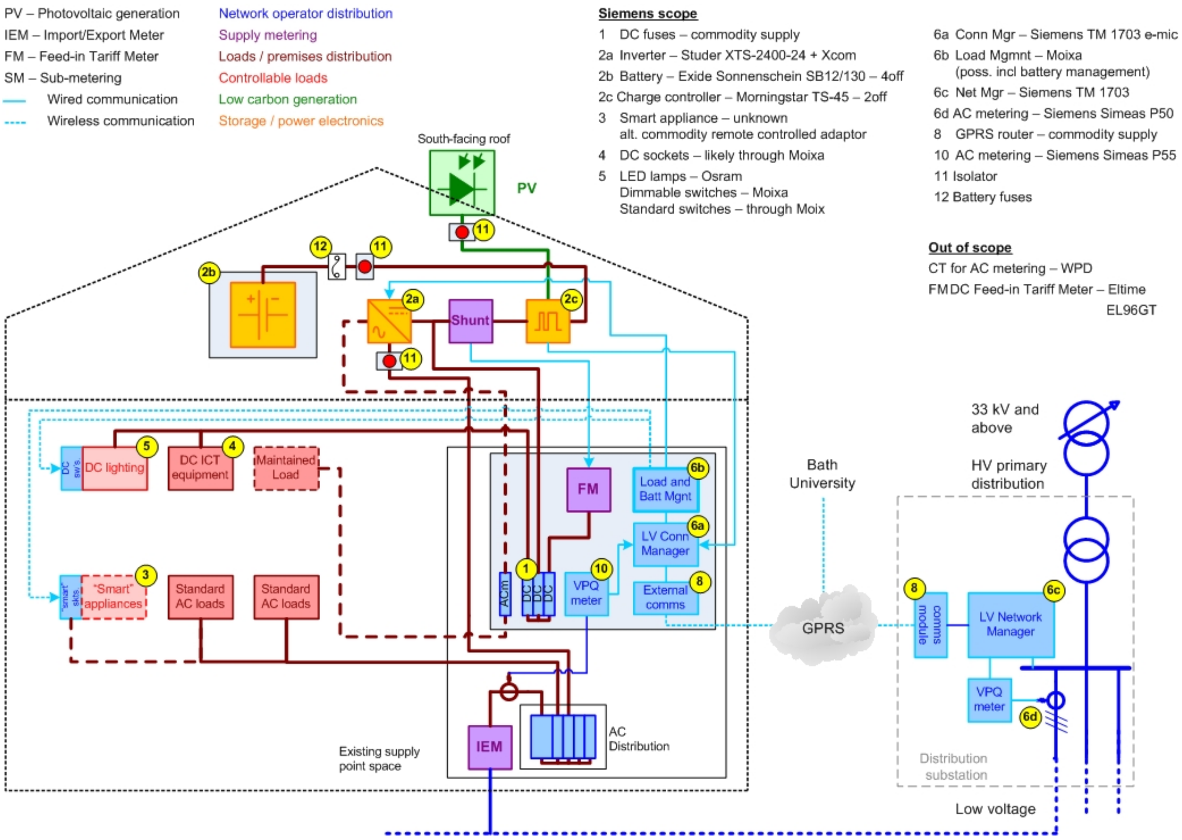


Figure 1 - Substation and Domestic Solution

Equipment/Hardware Description	**Geographic Location**	**Fixing Location**	**Housing type**	
LV Connection Manager	House	To be confirmed after site visit	Consumer Unit	
Load & Battery Management				
GPRS Router				
DC Miniature Circuit Breaker				
AC Meter P55				
Batteries	House	Loft	Cage	
Inverter				
Charge Controller				
Feed In Tariff Meter	House	Wall - Near Existing Electric Meter	N/A	
Photovoltaic Generation	House	Roof	N/A	
DC Switch	House	Replace existing light switches	N/A	
CFL Bulbs	House	Existing Ceiling rose	N/A	
LV Network Manager	Substation	Wall Mounted	Wall Box	
AC Meter/s P50				
GPRS Router				

Table 1 - Equipment / Hardware locations

5.3 Within the House

The system will be configured in accordance with Figure 1 and perform the following functions:

See Figure 2 for the Dataflow and Functions contained within the LV Connection Manager & Load and Battery Manager.

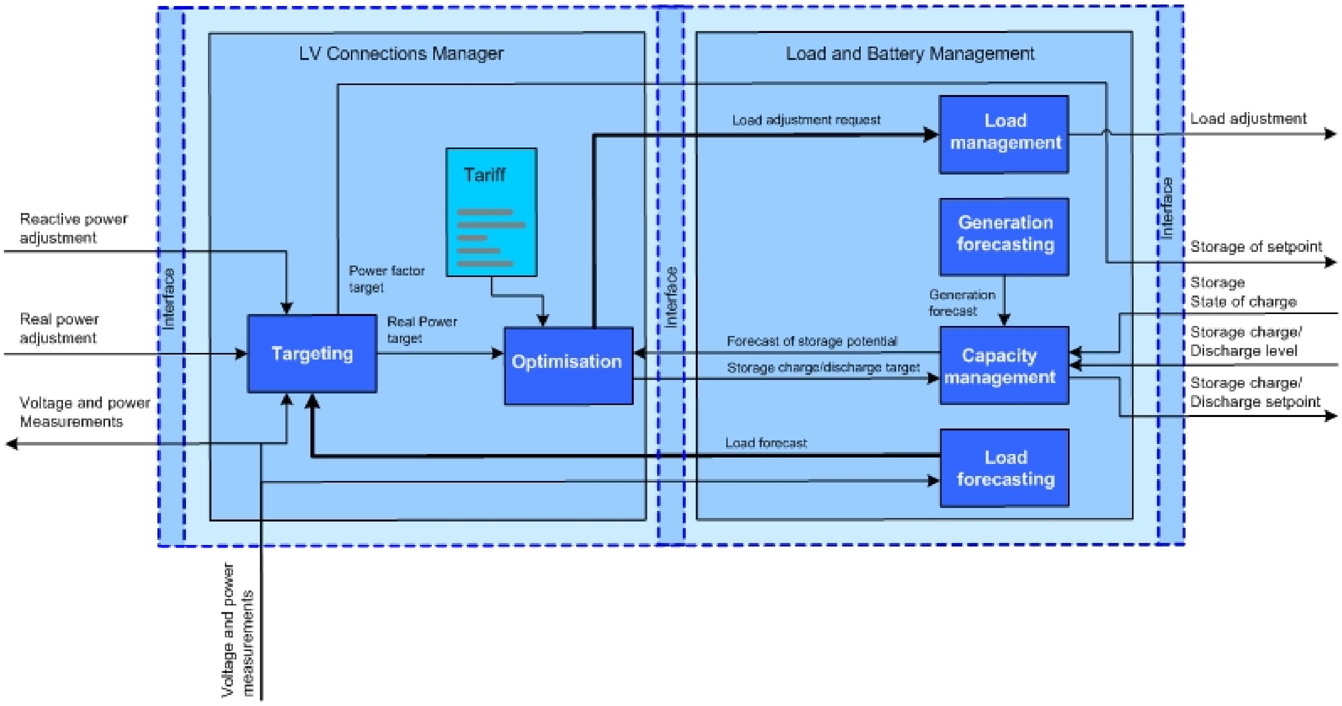


Figure 2 - Dataflow and Functions contain within the LV Connection Manager & Load and Battery Manager

LV Connections Manager

LV Connections Manager covers the following functions:

<u>Targeting</u>
The targeting function takes requests for adjustments to real and reactive power exchange with the premises and, using forecasts of loads as the base line, calculates targets for the inverter to achieve for real power and power factor.

<u>Optimisation</u>
This aspect uses forecasts of potential for load adjustment and storage to determine which adjustments should be applied to optimise the energy supply tariff, taking into account constraints and external requests (for real or reactive power adjustment).

Load and Battery Management

Load and Battery Management focuses on the local availability of energy resources.

Generation forecasting

This determines the level of locally generated energy expected to be available over the next 24 hours, in half-hour periods.

Capacity management

This aspect uses the energy supply tariff to determine whether to charge or discharge the battery, while respecting the battery 'minimum reserve' levels, the requirement to avoid (or at least minimise) any real power export, and minimising the impact on the distribution network.

Load Forecasting

The forecasting aspect determines an aggregated average load forecast for the building in half-hour periods.

Load Management

When the Load management receives a request to increase or decrease load it responds, it sends an increase/decrease load instruction to each controllable load it determined had DR potential for the period.

5.3.1 LV Connections Manager

The LV Connection Manager is part of the home and commercial energy management system and is based o n the Siemens SICAM TM e-mic, performing many functions including control/monitoring/reporting the network voltage profile and battery storage with demand response.

The LV Connection Manager will:

1. Coordinated via the LV Network Manager to maintain network voltage profiles and reduce network peaks locally while taking into account variable tariffs.
2. Coordinating with the Load & Battery Manager to integrate the capabilities of the PV, battery storage and the electrical demand and energy used to actively manage the real power profile to support the distribution network (Demand Response see 5.3.1.1), and provide reactive power support to the network
3. Calculate if customers require any additional battery charging using off peak generation. This will be done via fixed tariffs being programmed into the LV Connection Managers logic.
4. Send data/signals via GPRS to/from the LV Network Manager located in the local substation. The LV Network Manager will then forward this data to the Data Concentrator located in Bath University.

Further detail to be provided regarding the expected information on the logic and functionality.

Energy Monitor App. Information to be displayed	Graphic required Yes/No	Numerical Display Yes/No
PV Power/Volts actual	Yes	Yes
PV Power/Volts over 24hrs	Yes	No
PV Power/Volts over 7 Days	Yes	No
Battery Voltage level	Yes	Yes
Battery Charging/Discharging	Yes	No
Power Usage over 24hrs	Yes	No
Power Usage over 7 Days	Yes	No
AC Meter Power	No	Yes
AC Meter Voltage	No	Yes
Inverter Importing/Exporting	yes	No

The information shown above is the data which the system is expected to collect; the required measurements will be passed from the array of sensing devices to the tablet PC to be displayed in a graphical form.

See Table 2 for network use cases for the LV Connection Manager.

5.3.1.1 Demand Response

While distributed electrical storage is the principal resource for responding to network needs, part of the solution being tested within this project is Demand Response (DR), which is the ability of electrical equipment to modulate its load on the system in response to system needs and requests. The phrase DR allows for not only decreasing the load on the system but to also increase the load in response to the network needs.

Situation		Electrical Demand	Storage	PV
1.Excess generation overload on local network	1a.voltage upper limits exceeded	Increase/ advance load	Charge battery Absorb reactive power	Absorb reactive power Last resort: reduce output
	1b.thermal limits exceeded	Increase/ advance load	Charge battery	Last resort: reduce output
2.High peak load	2a.voltage lower limits exceeded	Decrease/ defer load	Discharge battery Export reactive Power	
	2b.thermal limits exceeded	Decrease/ defer load	Discharge battery	
3.Need to profile match availability of low carbon generation		Adjust load to availability of LC energy	Charge/discharge battery to availability of LC energy	

Table 2 - Network Use for the LV connection Manager

5.3.1.2 Communication interfaces

The LV Connection Manager will communicate to the LV Network Manager via the GPRS router using IEC60870-5-104 protocol. The communications to the Load and Battery Management system, DC/DC convertor and Siemens Simeas P55 AC meter will be via RS485 using MODBUS protocol.

See Chapter 5.3.8 Communications for all Protocols and connection types.

5.3.2 Load and Battery Management

The Load and Battery Manager is part of the home and commercial energy management system and is based on the Moixa Smart Hub, performing many functions including control, monitoring, reporting on the internal DC Voltage system and battery storage.

The Load and Battery Manager will:

1) Coordinated via the LV Connections Manager to perform

    - Capacity Management, taking into account forecasts of storage potential, storage charge/discharge targets. See Figure 2.

    - Load Management, by either charging/discharging the batteries from the PV or to/from the AC Grid network, see DR chapter 5.3.1.1, and monitoring the power used by the secure load i.e. lighting circuits.

2) Using the measured actuals of the PV voltage output create a ‘Generation Forecast’ for the following day/s. It is envisaged that a ‘weekly average’ will be taken; this will provide an idea of the future yield based on recent data which has been provided from the installation. Using a system such as this will provide relatively accurate results for the end user. Gathering readings over a short term will allow the system to be adaptable, rather than providing an expected average the output should show the actual peaks and troughs of the system at different points within the year.

3) Load Forecasting by predicting the electricity demands of the home for the next day, including any Low Carbon Tariff (LCT) demands.

4) Send data/signals to an Energy Monitor App / Web page. to display the DC energy used and generated within various points within the system. The App is to be installed / downloaded on to the IT tablet. *KWMC are working to create the user interface page. Further discussions are required between KWMC, Moixa and Siemens to completely understand how the data will be provided and what the completed output will be.*

5) Any data within the Smart Hub that is being transmitted throughout the system should be stored and transmitted securely recognising that the privacy of customer’s data is of paramount importance, and appropriate authentication mechanisms to access the data are required.

6) Send data/signals via serial communications (MODBUS) to/from the LV Connections Manager that will be passed on to the Data Concentrator at Bath University via the GPRS communications network

7) Be of similar size/design to that of the Siemens ACP TM e-mic whereby it will be DIN-rail mountable with visible power / health / communication LED’s. See document MC6-049-2 TM e-mic System Description chapter 7.1.2 Mechanical Design

8) *Receive data/signals from the Desk Hub (HUB003) and/or USB3-SK001 sockets via Zigbee communications to monitor the DC load profiles located within the commercial properties.*

The Moixa Smart Hub will have the following DC voltage interfaces. *All points listed below are subject to further discussion between WPD and Siemens.*

- 1 x 10-35v DC power socket to power the Smart Hub.

The following lists the types and number of external DC Voltage sockets;

- 3 x SK002 double USB sockets, 5v DC, 1 Amp per socket for charging the IT Tablet/Mobile Phone. Each SK002 to be mounted on a plate to fit and supplied with a UK Standard surface mount back box per SK002
- *1 x SK001 single socket, typically 5-35v DC, 3 Amp socket for charging PC/Laptops. Each SK001 to be mounted on a plate to fit and supplied with a UK Standard surface mount back box.*

See Chapter 5.3.2.1 for communication hardware interfaces.

5.3.2.1 Communication interfaces

The Load and Battery Manager will communicate to the LV Connection Manager via a serial MODBUS protocol using RS485 (9 way Female D-Type). The communications to the Studer Inverter will be via its propriety protocol using RS232 (9 way Female D-Type).

Communication to the IT tablet will be via a separate WI-FI Router/HUB so that a Web page can be updated in real time Chapter 5.3.3.

See Chapter 5.3.8 Communications for all Protocols and connection types.

5.3.3 GPRS Router

A Billion BIPAC 7800GZ GPRS Router (see document BILNJ7800G) will be connected to the LV Connection Manager and used to communicate to the LV Network Manager within the substations (see Figure 1 and Chapter 5.3.8 Communications). This communication channel will allow the LV Network Manager to issue requests for action to alleviate constraints on the power grid system, and to log/report on actions taken in response to these requests.

The signals to be sent between the LV Network Manager and the LV Connection Manager are voltage, current and power.

The GPRS SIM cards are a basic SIM on the Vodafone network. Initially a 5Gb plan has been specified. This in uncapped however, to ensure that no data will be lost regardless of the end user's internet habits. If applicable a more appropriate tariff could be chosen once the data rates and trends have been confirmed.

Further detail on the communications architecture can be found in the 'Communication Topology Notes' and 'Communication Topology Overview'.

5.3.4 Inverter

An inverter primarily converts DC power to AC. Battery inverters are available for 12, 24, and 48 volts DC. On this project the inverter can also be used to convert AC power to DC due to its bi-directional input capabilities.

The inverter for the homes will be rated at 2kW (Continues), 2.4kW for 30 minuets and connected into the 24V DC system (see Figure 1). The inverters for the commercial properties will be rated at 3kW (Continues), 3.5kW for 30 minuets and connected into the 24v DC system while the AC inputs will be connected into the existing 3 phase AC system. The functionality of the inverter allows for islanding capability on loss of grid connection and for DR for import and export of AC power from/to the public distribution network. Please note that the inverter rating is stated at its output rather than input. In this case the 2kW is the power which can be provided down throughout the network / grid connection.

The commercial installations may differ from the initial design, the outcome of the site specific surveys will be vital when identifying any issues with the individual properties. Any adjustment in the design of the system, for example increasing the system voltage to 48vDC, will require a comprehensive property survey review along with an updated design review. Certain components have been specified due to their specific operation at 24vdc. Changing the system operating voltage will have an affect of any universal components therefore costs and timescales could increase. Once the surveys have been completed WPD and SIE will need to make decisions based on the information at hand and review the specific system design.

Figure 3 shows the typical connections to and from an inverter for the homes and Figure 11 shows the typical connections for a 3 phase system for the commercial properties.
See Chapter 5.3.8 Communications for all Protocols and connection types.

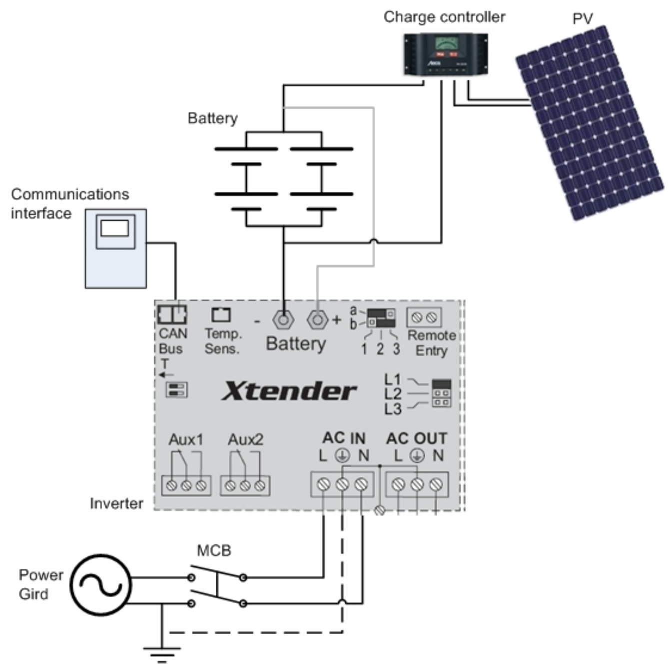


Figure 3 ***- Typical Inverter connections***

Refer to Chapter 5.3.7 DC Network/Connection for integration with the DC system.

5.3.5 Charge Controller (DC / DC Converter)

The Charge Controller or DC / DC Converter is necessary to protect the batteries from overcharging and to supply them with the correct voltage/energy to promote battery life (see Figure 3.)

A Charge Controller is used to maintain the correct charging voltage on the batteries (in this case 24V DC); the brighter the sunlight, the higher the voltage the solar cells produce. This excessive voltage could damage the batteries if it is not regulated and controlled. As the input voltage from the solar array can vary from 0 to ‘hundreds’ of volts (DC) ; the charge controller regulates the input to the batteries to 24V DC to prevent any over charging. The Charge Controller can also set the minimum and maximum charging limits of the batteries as well as open circuit the PV from the DC network to cease charging of the batteries.

The specification of the unit is shown below; the figures are based on the 2kW block designed for use on the domestic properties and will accept a PV array from 1.5-2.5kW.
The commercial systems will aim to utilize a similar design by modularising and duplicating up to achieve higher powers. Though provisions are also in place to design a single unit would be suitable for all commercial installations – the application of either will be lead by the property survey results.

The unit is detailed within drawing 2PE 2630 00 GA.

Refer to Chapter 5.3.7 DC Network/Connection for integration with the DC system within the homes.

Refer to Chapter 6.3.7 DC Network/Connection for integration with the DC system within the commercial properties.

2kW Unit Specification

- Input voltage: Normal DC range for full throughput power 200Vdc to 600Vdc, throughput power being pro-rata reduced below 200V to limit maximum input current to that at 200V.
- Input current: 7.2A @ 600Vdc input, rising to 21.7Adc @ 200Vdc input, at maximum power output (30Vdc @ 130A)
- Output voltage: Regulated 27Vdc to 30Vdc adjustable
- Voltage regulation: <1% over full range of load and line variation
- Voltage ripple: <1% RMS of the dc value
- Output current: 10Adc to 130Adc adjustable (short circuit proof)
- Current regulation: <1% over full range of load and line variation
- Parallel operation with current sharing
- Separate input for battery current control
- Over-temperature protection with automatic reset
- Cooling: Fan assisted

- Efficiency: 90%
- Input protection: Proprietary 25A, 1000V 10 x 38mm ‘Solar’ isolator
- Output protection: to be confirmed; Suggest semiconductor fuse, for reverse battery protection capability
- Input connection: Phoenix plug / socket.
- Output connection: to be confirmed; Bus bar, proprietary DP battery connector (160A rated)
- Operating temperature is based on -25°C to + 50°C ambient. Based on a maximum relative humidity of 90% in an altitude of up to 1000 metres.
- The ambient storage temperature must be between -40°C to + 70°C

5.3.6 Battery/Batteries

The batteries are used to store the energy generated from the 2kW solar array in the homes and 'x'kW in the commercial properties – the size is to be agreed following the completed surveys. They primarily feed the DC distribution system which supplies the DC loads such as IT equipment and Lighting.

The batteries can also be used to respond to the needs of the public distribution network via 'demand response', effectively exporting and importing - for example discharging/charging the batteries to the power grid. The control of these functions will be carried out via the 'Load and Battery Management system' and 'LV Connection Manager'.

For the homes the battery configuration will be as follows 4 x 130Ah 12V DC batteries of which 2 are connected in series and then the pairs connected in parallel to create a nominal 24V DC system see Figure 4.

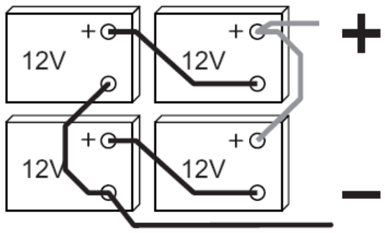


Figure 4 - Battery Connections.

Refer to Chapter 5.3.7 DC Network/Connection for integration with the DC system.

To ensure that the weight of the battery unit has been sufficiently spread over the loft space Bristol City Council require the existing trusses to be cross-beamed. Installing these secondary beams over the existing will spread the load to a greater extent. The battery unit (2PS_2 x 12SMG100F_STSR_00) will be housed within a IP21 enclosure, whereas the Control Unit will be a wall-mounted box (2PE 2630 00 GA).

Any proposed solution will abide by the following points -

- Any installation should have new timber installed and fixed onto the existing timbers.
- This must cover a minimum of 3 joists, (approximately 12 inches apart)
- The installation should sit on top of an appropriate spreading board (plywood / chipboard)

Separate reports will be commissioned for the three trail installations. The outcomes of which will dictate the necessity for any future installations.

5.3.7 DC Network/Connections

The DC network comprises of a number of components, as described throughout the document. The physical connections are detailed below.

- During day-light hours the DC system will be fed directly from the PV array located on the roof of the property. As the output of the array is entirely dependant on the solar irradiance the PV array must be provided with electrical isolation for its DC output, in this instance the existing mechanical isolator will be utilized. (See Figure 5, item 11).

- The charge controller (DC/DC convertor) (see Figure 5, item 2c) fulfils two functions. Firstly they control the amount of power being supplied into the batteries, ultimately stopping the battery bank from being overcharged. Secondly they adjust the voltage, dropping the PV output of 100-150v DC (±40v) to the system voltage of 24v DC. To communicate with this unit a 1 x 5 twisted pair cable (71150BK) will be ran from the loft space to the expected area which the BRISTOL consumer unit will be installed. The communication protocol will be MODBUS over a RS232 connection. Within the consumer unit a connection will be made to the LV Connection Manager, in turn this will transfer data to the ‘Load and Battery Manager’.

- The battery housing is a separate unit from the control panels. Therefore a wired connection links the two, flowing through a fused link on each leg. Three positive and three negative connections are provided as outputs from the unit, these are ran via a disconnect. These stud terminals are the DC outputs for the inverter, consumer unit and G59 Protection Relay.

- In addition to the above the supply is also fed to the inverter (see Figure 5, item 2a), both legs (+ve / -ve) are connected via fused links and installed in a small distribution board. The cable is connected through a DC shunt which takes a signal to the FiT DC generation meter, located within the loft space. The inverter itself has bi-directional AC and DC connections.

- A further isolation point is provided between the batteries and BRISTOL consumer unit. This will be in form of a double pole MCB, rated around 10 Amps.

- A Siemens Simeas P55 AC meter (see Figure 5. item 10) is housed within the new BRISTOL consumer unit which allows for the AC measurements to be taken and passed onto the LV Connection Manager. *Current Transformers (CT’s) will need to be fitted onto the house’s incoming AC cable. The CT’s could be a solid core, split core, Rogowski or optical fibre based current sensor and must be compatible with the meter, refer to SIMEAS-P-7KG775x_System Manual (E50417-B1076-C340-A4) for Current, Voltage input measuring ranges and input connections.*

- The inverter transforms the DC voltage to an AC voltage, as described above, outputting an AC maintained load output along with an AC voltage output back to the public distribution network via the bi-directional AC input.

- From the inverter a DC link is provided to the new ‘BRISTOL’ consumer unit (see Figure 5, item 1). This will be wired in using 3 core twin and earth 4mm (6242Y4) – again this cable will be installed during the initial PV installation phase to cut down works to be completed during the BRISTOL system integration – rather than leave a flying lead the installation team have agreed to terminate the DC connection within a small junction box local to the DB.

- Along with the control units (see Figure 5, item 6a, 6b, 7, 8 & 10) the existing lighting system will be moved onto and powered by this DC network. This will be connected via MCB’s prior to distribution.

    - ERA Technology have produced a report (2012-0479) detailing the “Consideration of the magnitude of the induced voltages in the LVDC circuits” with the findings showing “that these voltages would be measured in millivolts rather than volts and hence they are not a safety issue.”

- The existing AC light circuit connected to the existing AC consumer unit will be moved onto the new BRISTOL consumer unit and connected into the 24v DC system. To do this the light switches will be replaced with rated DC switches (see Figure 6) and the existing pendants will be replaced so that only E27 lamps can be fitted.

- 3 double USB sockets (each 5v @ 1A) will be installed throughout the property, one in the living room, kitchen and master bedroom. These charge points will loop into the existing lighting system and be mounted in a suitable place to run from the trunking. These are installed for the charging of the IT tablet or mobile phone etc. Considerations will have to be given to the wall height at which they are mounted due to the length of lead available on a standard USB charging cable.

- *1 USB socket (5-35v @4A) will be installed in the living room. This socket will loop into the existing system and be mounted in a suitable place to run the trunking. The main use of the socket is for charging a Laptop or PC.*

- The LV Connection Manager communicates with the LV Network Manager (see Figure 1) to control/influence the operating mode (charge/discharge) of the battery via the Load and Battery manager/inverter (see Figure 5, item 2a & 6b) and any loads which it can, including smart appliances (see Figure 5, item 3), controllable AC loads such as intelligent appliances, and any controllable DC lighting.

- The LV Network Manager located in the distribution substation (see Figure 1) communicates with the LV Connection Manager (see Figure 5, item 7) via a separate GPRS communication module (see Figure 5, item 8).

- On the network side of the import/export meter (IEM) sensing equipment (P55) (see Figure 5, item 10) is connected which provides measurements of voltage and power to the LV Connection Manager (see Figure 5, item 6).

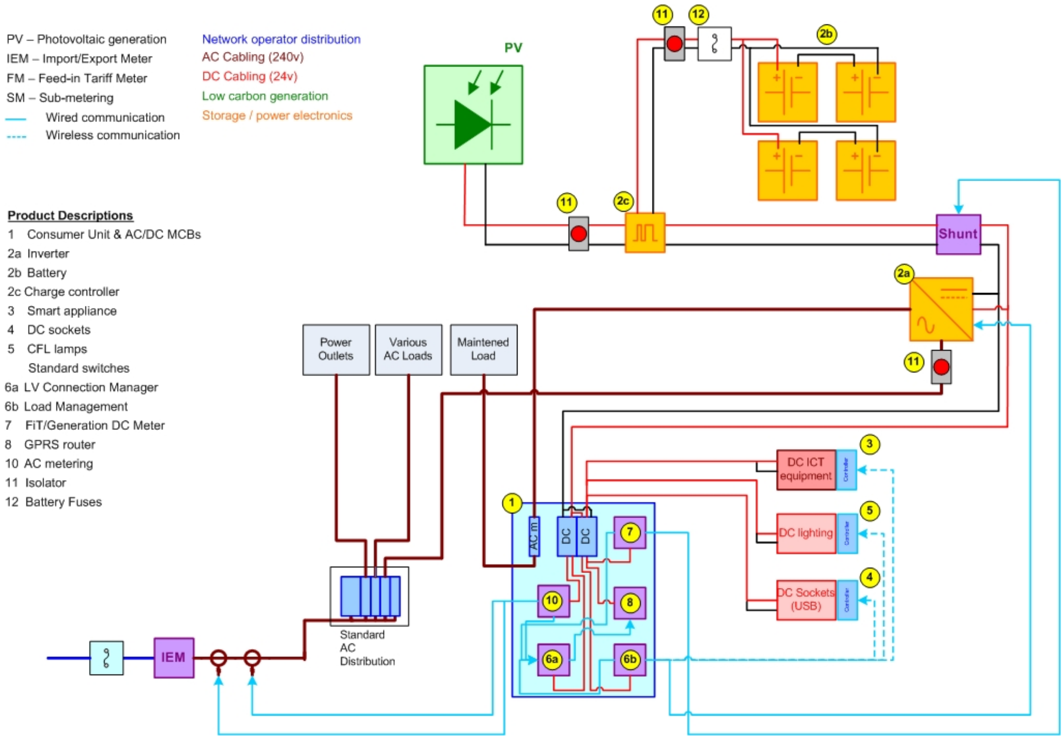


Figure 5 - Typical AC/DC system connections

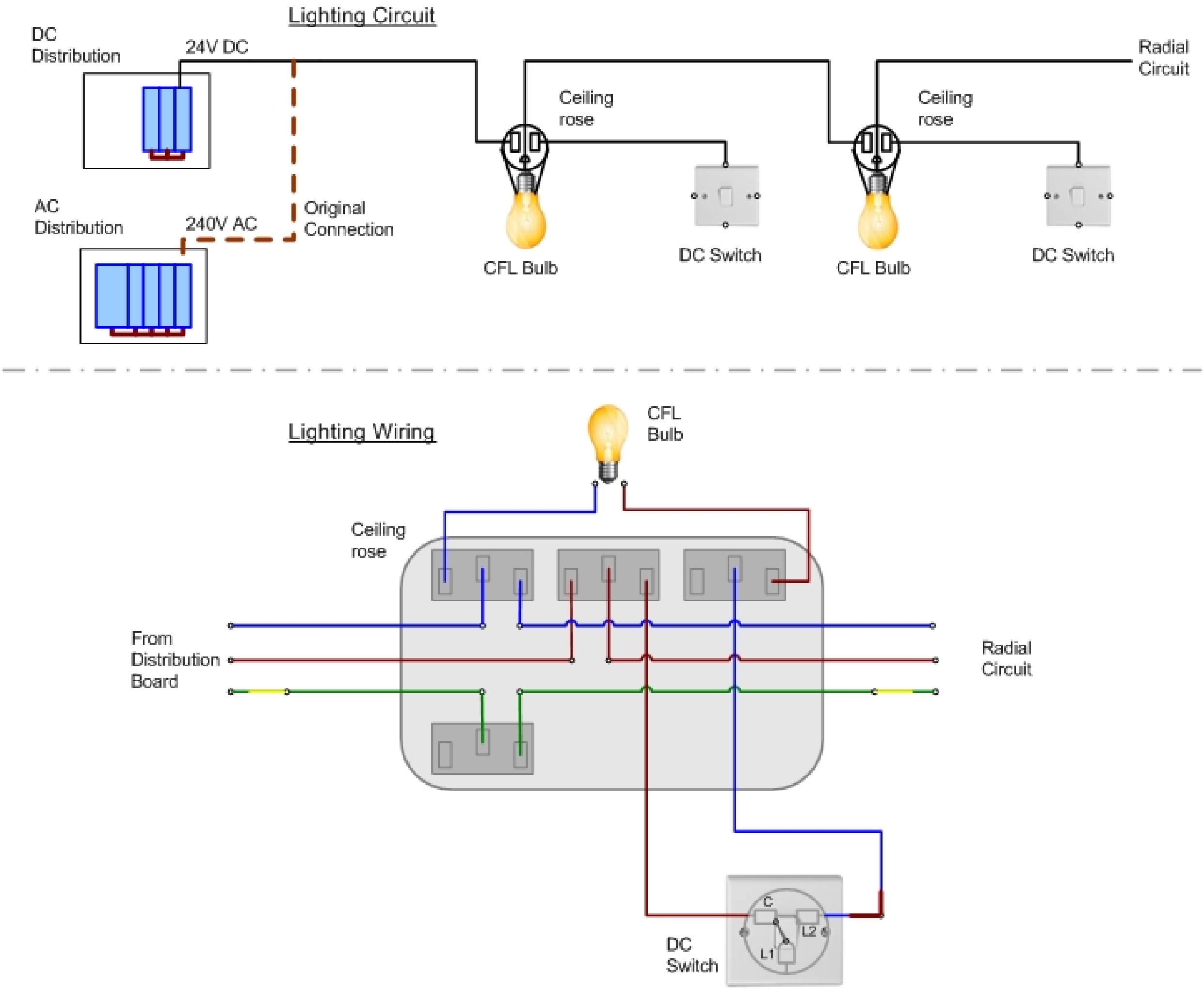


Figure 6 - Lighting system connections

The design of the DC lighting system has allowed for variation – the ideal scenario being the end user has a degree of control over the installation and it can adapted to suit individual requirements. In order to do this safely any proposed bulb / lamp must be factored into the circuit. As detailed in figure …… the issue with retro fitting the system is operating within the current cable specifications of the property. Therefore a maximum of 10A DC has been advised by WPD. Calculations will be completed on the request of each user to ensure their request is suitable.

To allow this adaptation a number of bulbs have been specified as alternatives.

- 3 Watt E27 LED Bulb (E273X1PWW-L)
- 6 Watt E27 LED Bulb (E276X1PCW-L)

In order to safely switch the DC lighting, tests have been successfully completed on two items – a standard 1 gang 2 way single pole plate switch and a 6A 2 way single pole pull switch. It is envisaged that the pull cord will only be used in bathroom applications along with the MEGALUX PD1. The rocker or plate switches will simply replace the existing switches to ensure safe DC operation.

All bulbs specified for general home use (bathroom exempt) have been chosen with a E27 fitting. Due to the popularity of Bayonets or BC fittings within the UK it makes it highly unlikely that the end user will have a suitable AC E27 bulb – therefore reducing the risk of inclusion of a non-standard SoLa BRISTOL light. The pendants are standard E27 units and can handle a current of up to 2.0A.

5.3.8 Communications

Within this project there are many communications links/interfaces located within the Homes/Schools/Offices and Bath University.

The main backbone of the wide area communications will be GPRS (Figure 7) which is required to communicate between the LV Network Manager and the LV Connection Managers. The communication channel will allow the LV Network Manager to issue requests to the LV Connection Managers for action to alleviate constraints, and allow the LV Connection Managers to provide the LV Network Manager with measurements from within the network, and report on actions taken in response to requests from the LV Network Manager. Data/signals within the network/systems will be identified during the course of the project and forwarded onto the Data Concentrator (via GPRS) located at Bath University for analysis.

It is important that when RS232 communications are deployed then the maximum distance of 15 metres must not be exceeded.

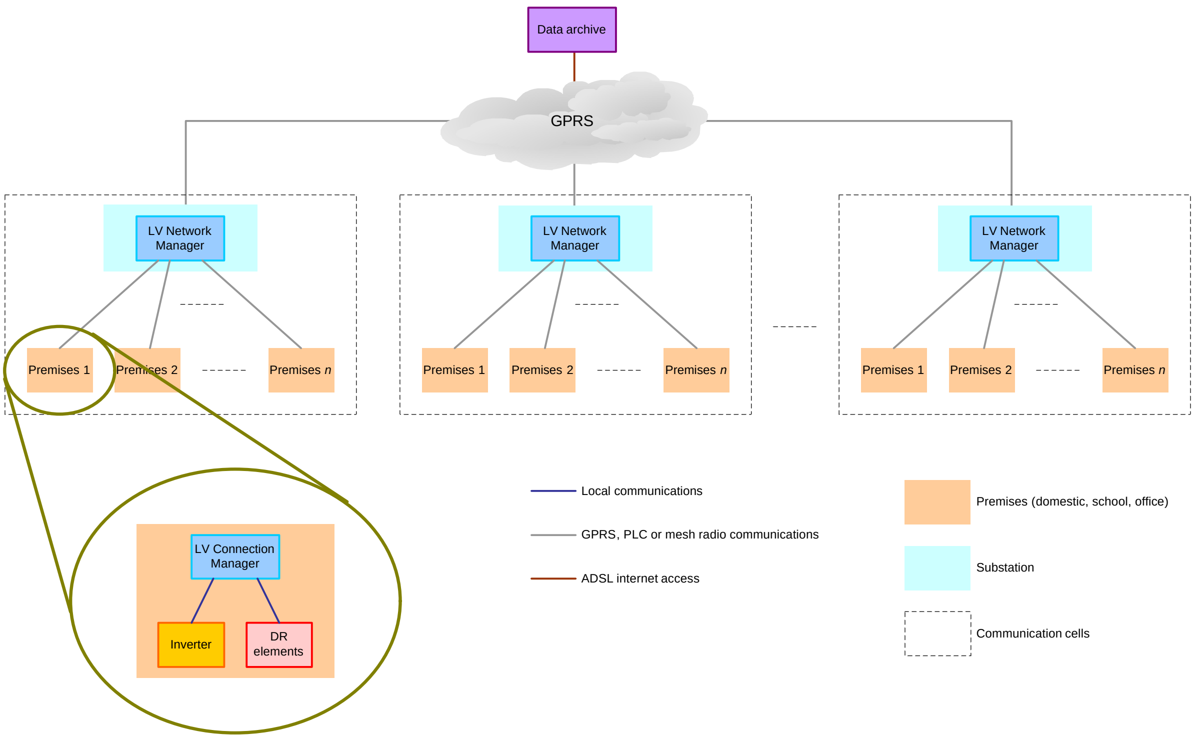


Figure 7 - Overall Communications Architecture

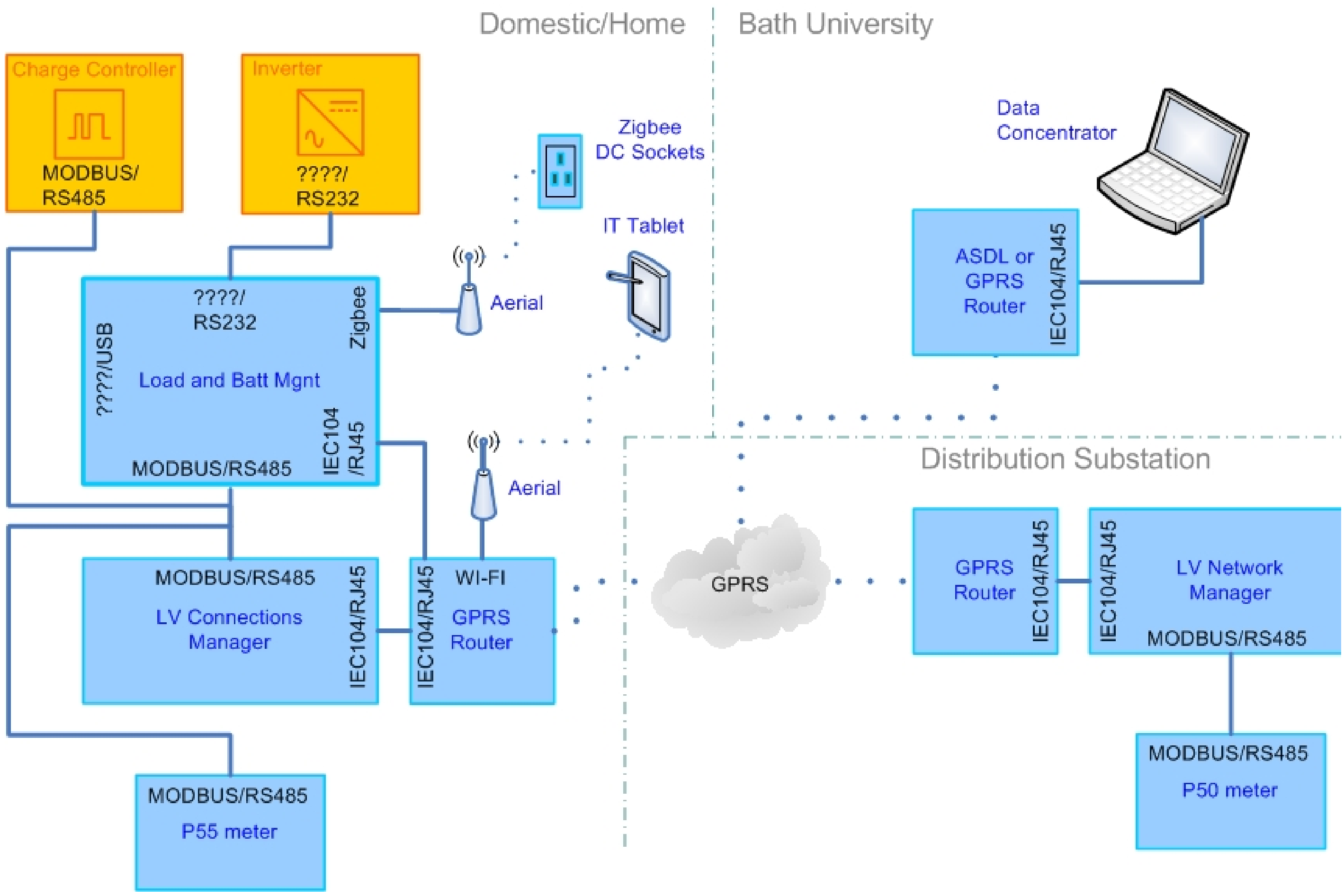


Figure 8 - Domestic Communications Detailed Architecture

Table 3 is a quick reference communications guide listing the different types of devices/hardware, communication interface/s and protocol/s used within this project. It also cross references (columns A-H) the communication connections between each device/hardware type.

Interface / **Hardware**	**RJ45**	**RS485**	**RS232**	**WI-FI**	**USB2**	**Zigbee**	**IEC104**	**IEC103**	**MODBUS**	**Propriety**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
LV Network Manager **(A)**	X (Female)						x							x				
		x							x						x			
LV Connection Manager **(B)**	X (Female)						x							x				
		X (Terminal)							x				x			x		x
Load & Battery Management (Moixa) **(C)**		x (9wD-t F)							x			x						
			x (9wD-t F)							x							x	
						x												
					X (Female)													
GPRS **(D)**	X (Female)						x				x	x						
P50 Power Meter **(E)**		X (9wD-t F)							x		x							
P55 Power Meter **(F)**		x (9wD-t F)							x			x						
Inverter **(G)**			x (9wD-t F)							x			x					
Charge Controller **(H)**		x							x			x						

Table 3 - Communications Interface/Protocol/Hardware

5.3.9 Substation Equipment

The LV Network Manager is part of the substation energy management system and is based on the Siemens SICAM TM, performing many functions including monitoring/reporting on the AC Voltage network. The substation equipment will require an AC/DC single phase converter, 240vAC/24vDC.

This equipment will be fitted indoor at the distribution transformer/substation as follows:

1. Sensing equipment (See Figure 9, item 6d) at the distribution transformer/substation is connected which provides measurements of voltage and power to the LV Network Manager (See Figure 9, item 6c).

2. The LV Network Manager monitors the local measurements it receives, and those received from LV Connection Managers at the premises on the LV network, to identify when the LV network reaches constraint points. These may be voltage and/or thermal constraints, and may be caused by an excess of load or an excess of generation. It then makes requests of the LV Connection Managers to adjust their load position to correct any constraint situations.

3. The technology for the sensing equipment is Siemens Simeas P50 AC meter and will mounted on the front face of a new wall box, to allow for the AC measurements to be viewed and passed onto the LV Network Manger. Current Transformers (CT's) will need to be fitted onto the Feeder outgoing AC cable(s). The CT's could be a solid core, split core, Rogowski or optical fibre based current sensor and must be compatible with the meter, refer to SIMEAS-P-7KG775x_System Manual (E50417-B1076-C340-A4) for Current, Voltage input measuring ranges and input connections. Western Power Distribution are supplying and installing the CT's within the substation. Up to 5 meters can be installed; this is dependent on the number of feeders used for this trial.

4. Send measurements via GPRS to/from the LV connections Manager and to the Data Concentrator located in the local substation and Bath University respectively. Additional requirements will include the measurement of the harmonics since one of the hypotheses is that the use of DC networks can improve power quality.

5.3.9.1 Communication interfaces

The LV Network Manager will communicate to the LV Connections Manager via the GPRS router using IEC60870-5-104 protocol. The communications to the Siemens Simeas P55 AC meters via RS485 using IEC60870-5-103 protocol.

See Chapter 5.3.8 Communications for all Protocols and connection types.

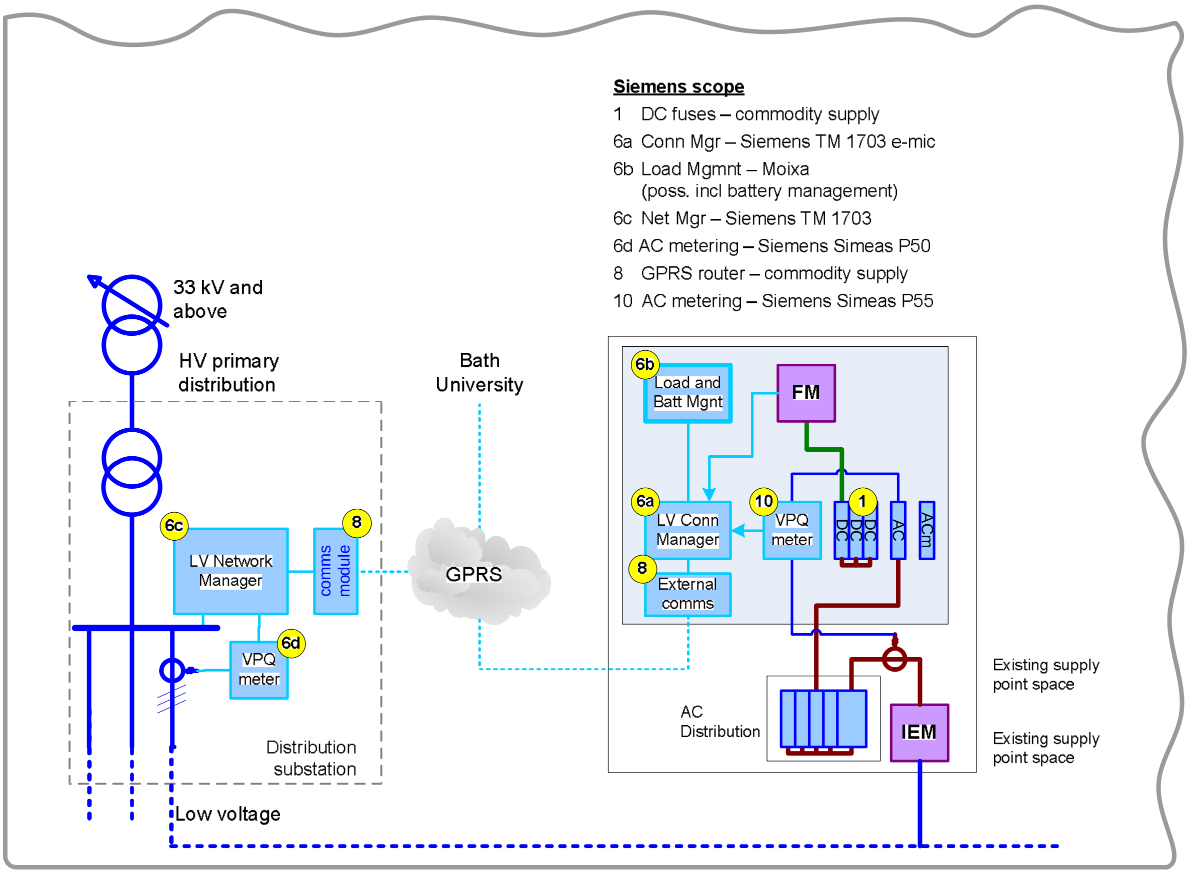


Figure 9 - LV Network Manager Connections

5.3.10 Data Concentrator

The Data Concentrator will form the system for logging metering / operational data and allowing access to this data for trial evaluation purposes. Figure 7 shows the expected location for the data archive and the communication links with the various devices being monitored. The Data Concentrator is based on the Siemens SICAM 230 SCALA software system and will be installed / located on a computer server housed within Bath University.

Requirements
The outline requirements for the solution are as follows:

Essential requirements:

- Able to receive data from all the LV network managers, LV connection managers, LV network instruments and customer premises instruments

- Able to be accessed by the relevant project partners as part of the evaluation of the trial results

- Logged Data will be exported from the SICAM 230 SCALA software in excel or csv format.

- Data should be stored securely recognising that privacy of customer's data is of paramount importance, and appropriate authentication mechanisms to access the data are required

The information listed below is the current specification of the PC which forms the data concentrator. This specification could potentially change, though the machine supplied will be of the quality listed below as a minimum.

Precision T3500: Standard Base
Mid-Tower (Vertical orientation)
Components
1 Processor: One Intel Xeon W3530 (2.80GHz, 4.8GT/s, 8MB, 4C)-Memory runs at 1066MHz
1 Memory: 2GB (2x1GB) 1333MHz DDR3 ECC UDIMM
1 Hard Drive: 250GB 3.5inch Serial ATA (7.200 Rpm) Hard Drive
1 Additional Hard Drive: 250GB 3.5inch Serial ATA (7.200 Rpm) Hard Drive
1 Raid Controller: Not Included SAS Internal Controller Card
1 Raid Controller: C7 All SATA Hard Drives, RAID 1 (Mirroring) for 2 Hard Drive
1 Optical Drive: 16x DVD+/-RW Drive
1 Kensington Clicksafe Notebook Lock
1 Asset Tag - ProSupport (Website, barcode, Onboard Mac Address)
1 Graphics: 256MB NVIDIA Quadro NVS 295 (2DP) (2DP-DVI adapter) (ULGA9)
1 Audio: Integrated sound card
Software
1 Windows Live for Windows 7
1 Optical Software: PowerDVD Software for Vista Home Premium and Ultimate, WIN7 Home Premium, Pro or Ultimate
1 Optical Software: Roxio Starter Software
1 Operating System: English Genuine Windows 7 Professional (32Bit OS)
1 OS Media: MUI Windows 7 Professional (32Bit OS) Resource DVD

6 COMMERCIAL FUNCTIONALITY/OPERATION

6.1 Commercial

This section identifies the components which are to be used within the commercial premises, their functions and combined interactions. Any items which differ to those listed within the Domestic sections are covered in further detail here. .

Throughout the document the term 'Commercial' refers to both the Office and School installations.

6.2 Components

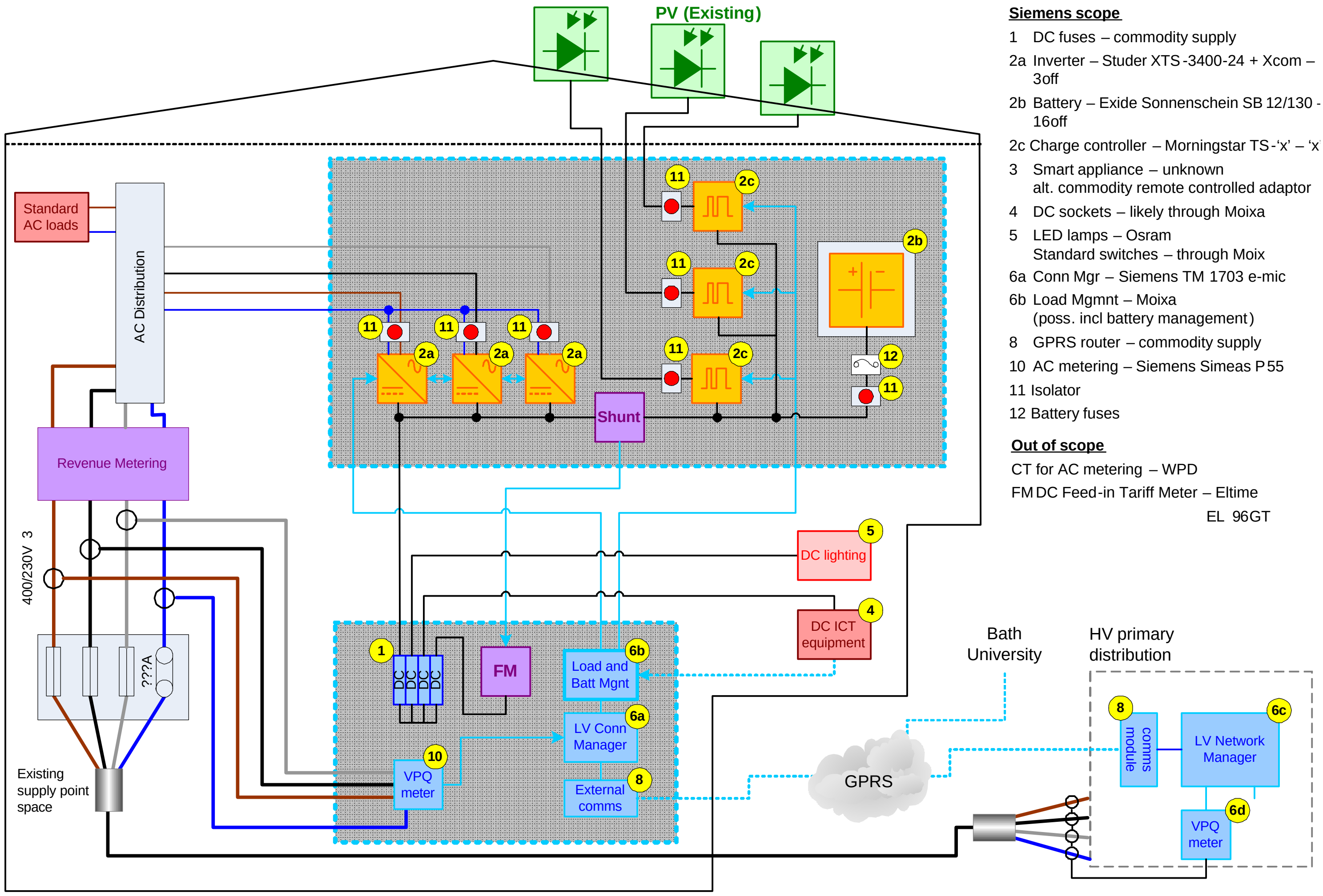


Figure 10 - Substation and Domestic Solution

Equipment/Hardware Description	Geographic Location	Fixing Location	Housing type	
LV Connection Manager	Commercial Property	To be confirmed after site visit	Consumer Unit	
Load & Battery Management				
GPRS Router				
DC Miniature Circuit Breaker				
AC Meter P55				
Batteries	Commercial Property	To be confirmed after site visit	Cage	
Inverter				
Charge Controller				
Feed In Tariff Meter	Commercial Property	To be confirmed after site visit	N/A	
Photovoltaic Generation	Commercial Property	Roof	N/A	
DC Switch	Commercial Property	Replace existing light switches	N/A	
LED T5 Tubes	Commercial Property	Existing Ceiling Modules	N/A	
LV Network Manager	Substation	Wall Mounted	Wall Box	
AC Meter/s P50				
GPRS Router				

Table 4 - Equipment / Hardware locations

6.3 Within the commercial properties

The system will be configured in accordance with Figure 10 and Figure 2. Figure 2 shows the Dataflow and Functions contained within the LV Connection Manager & Load and Battery Manager.

6.3.1 LV Connections Manager

See Chapter 5.3.1.

6.3.1.1 Demand Response

See Chapter 5.3.1.1

6.3.1.2 Communication interfaces

See Chapter 5.3.1.2

6.3.2 Load and Battery Management

The Load and Battery Manager that will be installed into the Schools and Office will be of similar design/functionality/communications as the Load and Battery Manager installed into the homes.

However, for all commercial installations DC / DC power supplies will be provided. 32 will be provided per office and 24 per school. Further investigation will inform of any specific property requirements. A connection will be made from the PC to the LVDC network; these cables will be based around the design of the University of Bath’s DC library.

The Moixa solution, as listed below, may be used, though at this stage all decisions are survey dependant. The option to change the system voltage to 48vdc is described throughout the document, with the final design of the commercial system to be agreed once surveys have been carried out on each property.

The following lists the number of optional DC Desk Hubs per School and per Office;

- *3 x HUB003 – Desk Hub. Each Desk Hub will consist of 8 x USB3 single sockets, typically 5-35v DC, 3 Amp socket for charging PC/Laptops. PIC miro for real time monitoring and Zigbee communication to relay the data to the Load and Battery Manager.*

Also see Chapter 5.3.2 for further information.

6.3.2.1 Communication interfaces

See Chapter 5.3.2.1

6.3.3 GPRS Router

See Chapter 5.3.3

6.3.4 Inverter

See Chapter 5.3.4 for further information on the inverter.

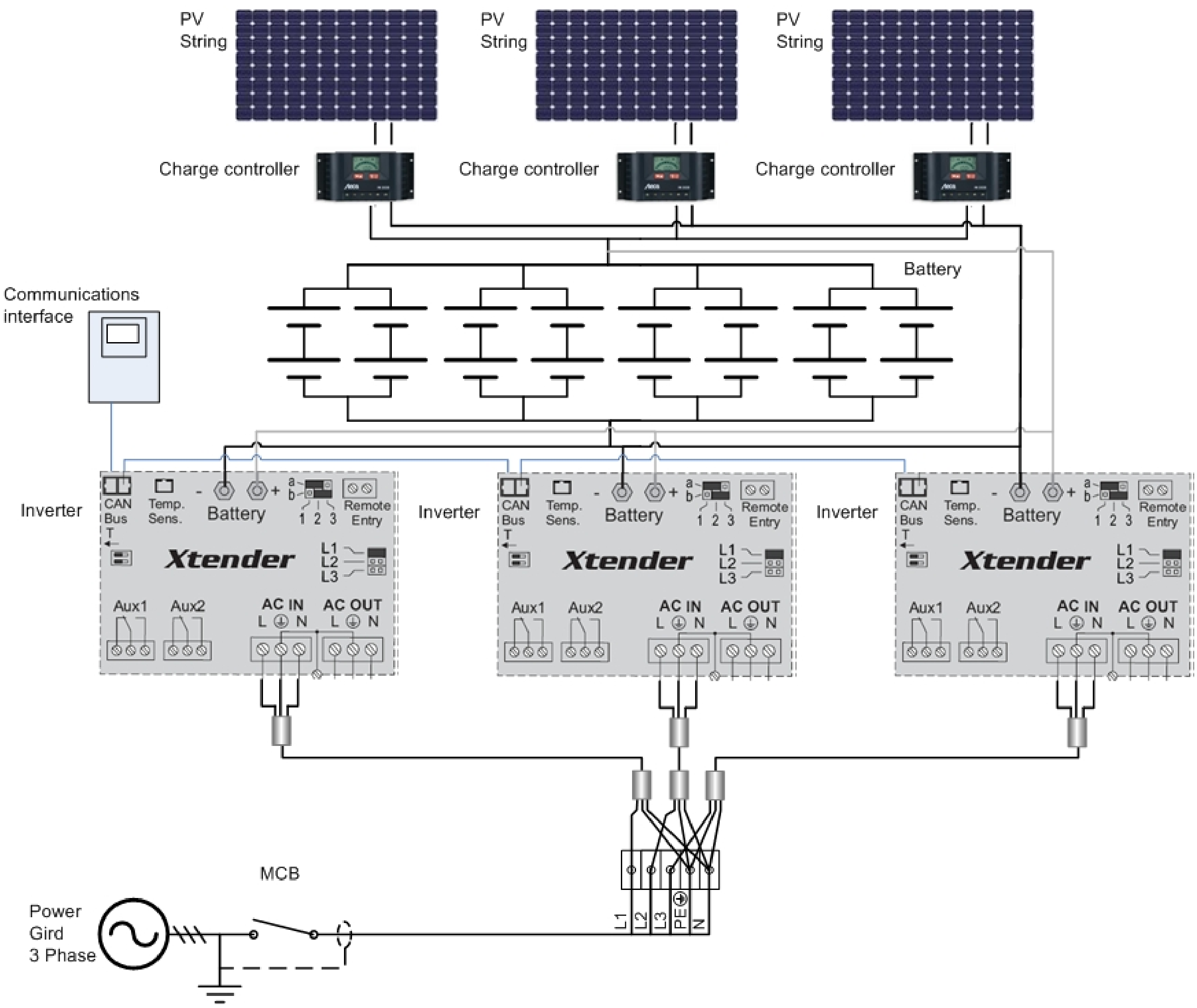


Figure 11 - Typical 3 phase Inverter connections

Refer to Chapter 5.3.7 DC Network/Connection for integration with the DC system.

6.3.5 Charge Controller

See Chapter 5.3.5

6.3.6 Battery/Batteries

The battery configuration to be installed throughout the commercial properties is expected be as follows 16 x 130Ah 12V DC batteries of which two are connected in series and connected to common bus bars to create a nominal 24V DC system, see Figure 4a. The size of the battery bank shown below is dependant on the survey results, in some cases it may not be necessary to install. There is also an option to reconfigure the system as a 48VDC network rather than 24VDC as a worst case. Also, see Chapter 5.3.6 for further information on the battery system.

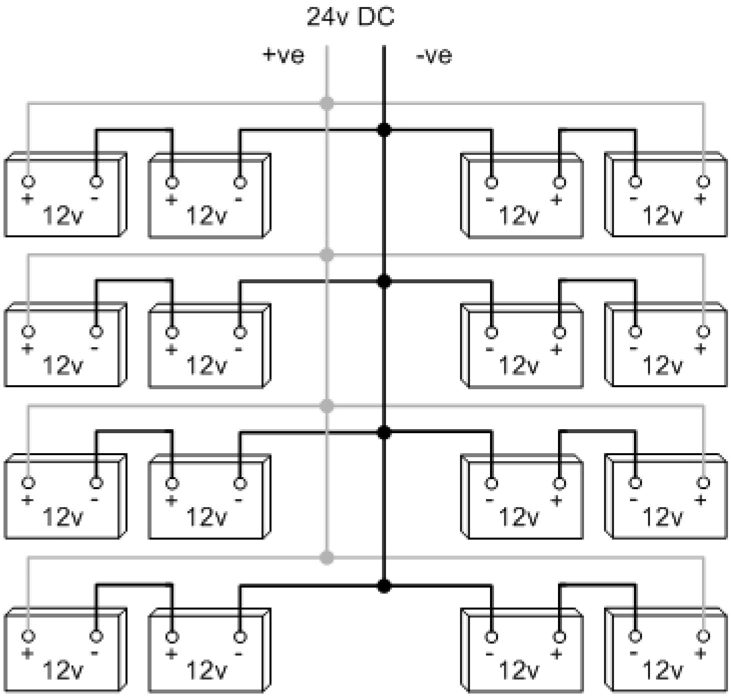


Figure 12 - Battery Connections

Refer to Chapter 5.3.7 DC Network/Connection for integration with the DC system

6.3.7 DC Network/Connections

The DC network comprises of a number of components, as described throughout the document. The physical connections are detailed below

- During day-light hours the DC system will be fed directly from the PV array located on the roof of the property. As the output of the array is entirely dependant on the solar irradiance the PV array must be provided with electrical isolation for its DC output, in this instance the existing mechanical isolator will be utilized. (See Figure 13, item 11).

- The charge controller(s) (DC/DC converter) (see Figure 13, item 2c) fulfils two functions. Firstly controlling the amount of power being supplied into the batteries, ultimately stopping the battery bank from being overcharged. Secondly adjusting the voltage, dropping the PV output of 150v DC (±40v) to the system voltage of 24v DC. The communication protocol will be MODBUS over a RS232 connection. Within the consumer unit a connection will be made to the LV Connection Manager, in turn this will transfer data to the 'Load and Battery Manager'. This unit is yet to be designed; the functionality will represent that of the domestic unit though the size will differ.

- The batteries are connected through a series of fuses. Towards the charge controller fuses will be provided, along with a blocking diode. A fused connection directly between the batteries and the DC Shunt prior to the connection to the BusBar.

- In addition to the above the supply is also fed to the inverter (see Figure 13, item 2a), both legs (+ve / -ve) are connected via fused links and installed in a small distribution board. Initially through a DC shunt which takes a signal to the FiT DC generation meter. The inverter itself has bi-directional AC and DC connections and will be connected into the existing 3 phase system. .

- A Siemens Simeas P55 AC meter (see Figure 13. item 10) is housed within the new BRISTOL consumer unit which allows for the AC measurements to be taken and passed onto the LV Connection Manager. Current Transformers (CT's) will need to be fitted onto the schools and office incoming AC cables. The CT's could be a solid core, split core, Rogowski or optical fibre based current sensor and must be compatible with the meter, refer to SIMEAS-P-7KG775x_System Manual (E50417-B1076-C340-A4) for Current, Voltage input measuring ranges and input connections. Western Power Distribution are supplying and installing the CT's within the home.

- The inverter transforms the DC voltage to an AC voltage, as described above, outputting an AC maintained load output along with an AC voltage output back to the public distribution network via the bi-directional AC input.

- From the inverter a DC link is provided to the new 'BRISTOL' consumer unit (see Figure 13, item 1).

- Along with the control units (see Figure 13, item 6a, 6b, 7, 8 & 10) the existing lighting system will be moved onto and powered by this DC network. This will be connected via MCB’s prior to distribution. The existing lighting circuits are to be assessed before final design can be submitted – feedback is required from each property.

- The existing AC light circuit connected to the existing AC consumer unit will be moved onto the new BRISTOL consumer unit and connected into the 24v DC system. To do this the light switches will be replaced with new DC switches (see Figure 14) and the existing ceiling modules may need to be modified so that only DC LED T5 Tubes can be fitted. Existing lighting circuits to be assessed before final design can be submitted – the use of existing fittings will need to be understood, the current intention is to utilize the existing fittings and removing the choke.

- The provision of DC ICT equipment will be in the form of a plug / socket arrangement along with a DC / DC converter. As an option the below could be implemented.

    - *The DC IT hardware (PC/Laptop/Phones) can by supplied via two methods. Firstly new DC USB3 5-35V sockets (see Figure 10, item 4) connected to the DC system will be mounted within the existing wall/bench trunking. Secondly DC USB Desk Hubs connected to the DC system can be located on top of desks or near a Laptop Charging trolley. The USB sockets/Desk Hubs will be monitored/controlled via the Load and Battery Manager. Existing 240v AC sockets circuits to be assessed before final design can be submitted.*

- The LV Connection Manager communicates with the LV Network Manager (see Figure 10) to control/influence the operating mode (charge/discharge) of the battery via the Load and Battery manager/inverter (see Figure 10, item 2a & 6b) and any loads which it can, including smart appliances (see Figure 10, item 3), controllable AC loads such as intelligent appliances, and any controllable DC lighting.

- The LV Network Manager located in the distribution substation (see Figure 10) communicates with the LV Connection Manager (see Figure 10, item 7) via a separate GPRS communication module (see Figure 10, item 8).

- On the network side of the import/export meter (IEM) sensing equipment (see Figure 11, item 10) is connected which provides measurements of voltage and power to the LV Connection Manager (see Figure 10, item 10).

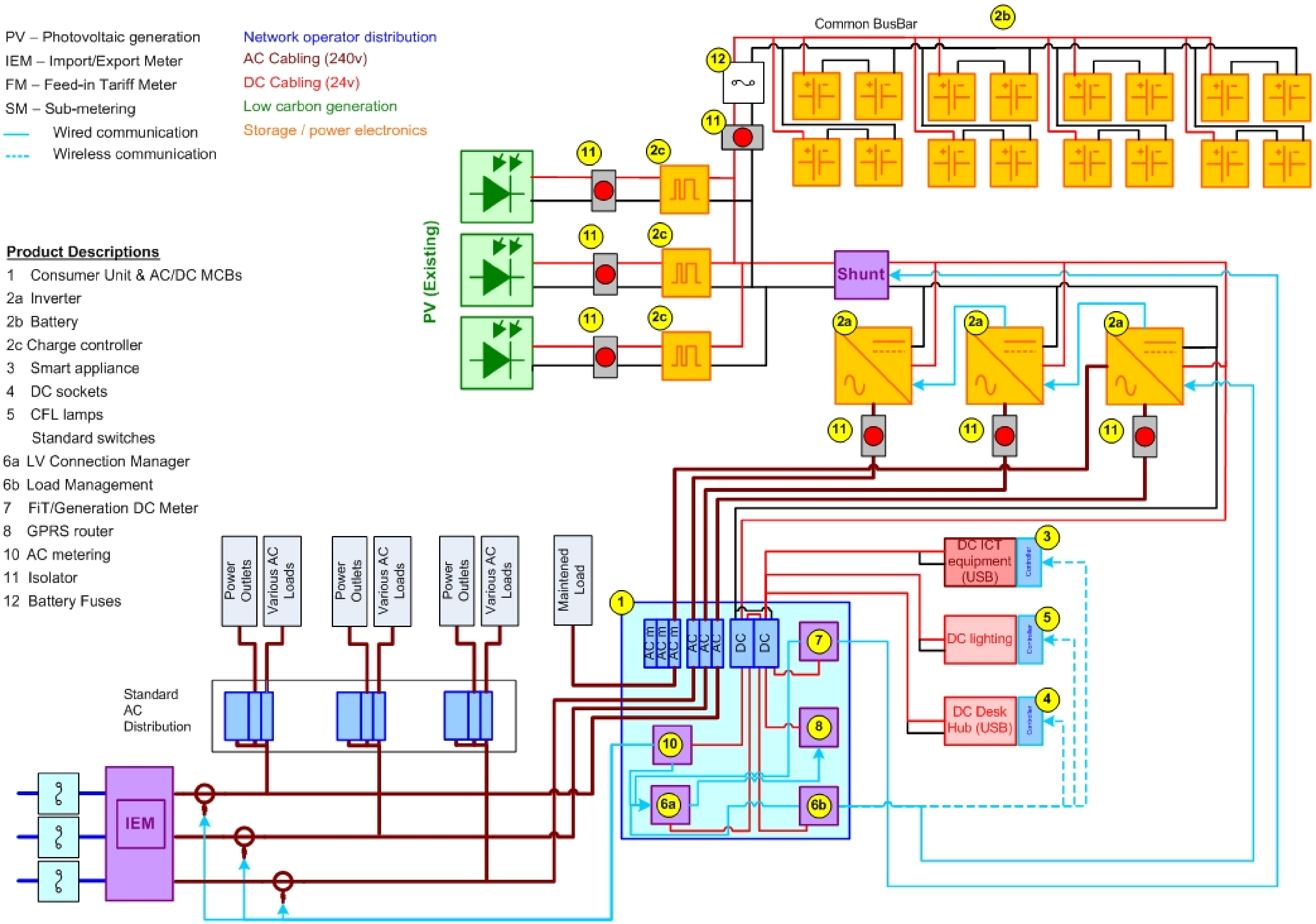


Figure 13 - Typical AC/DC system connections

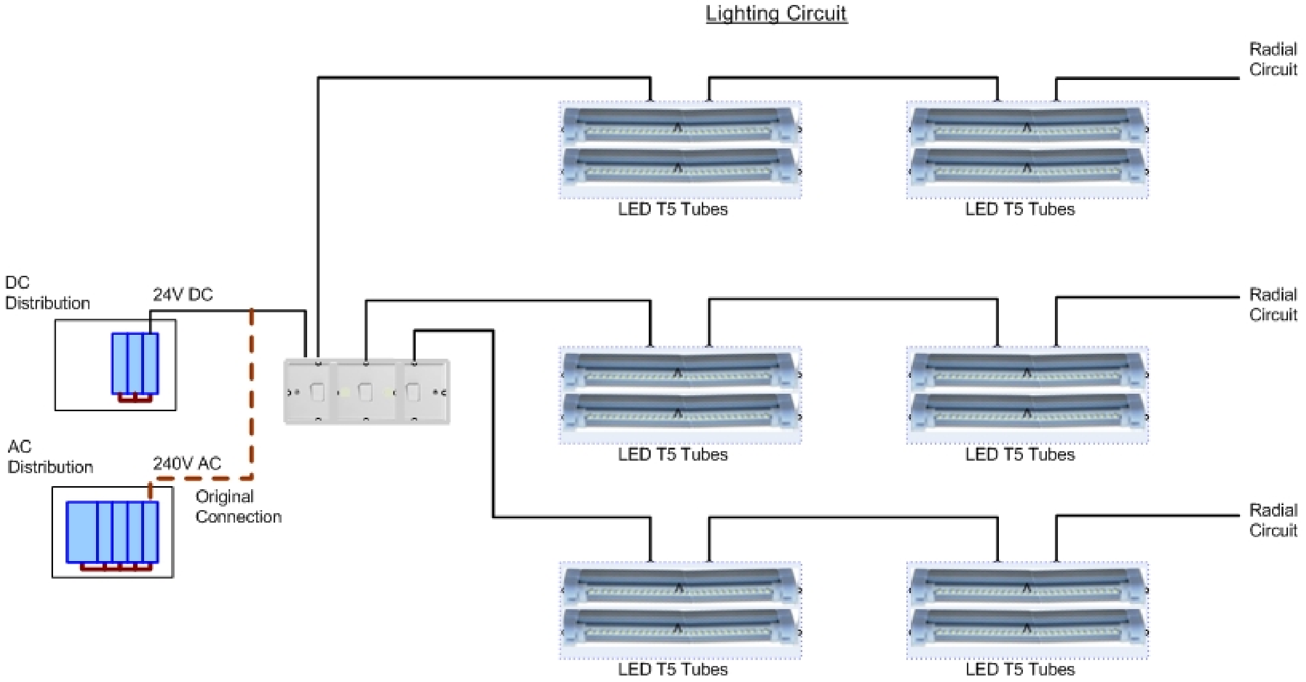


Figure 14 - Lighting system connections

6.3.8 Communications

See Chapter 5.3.8 for further information regarding the system communications.

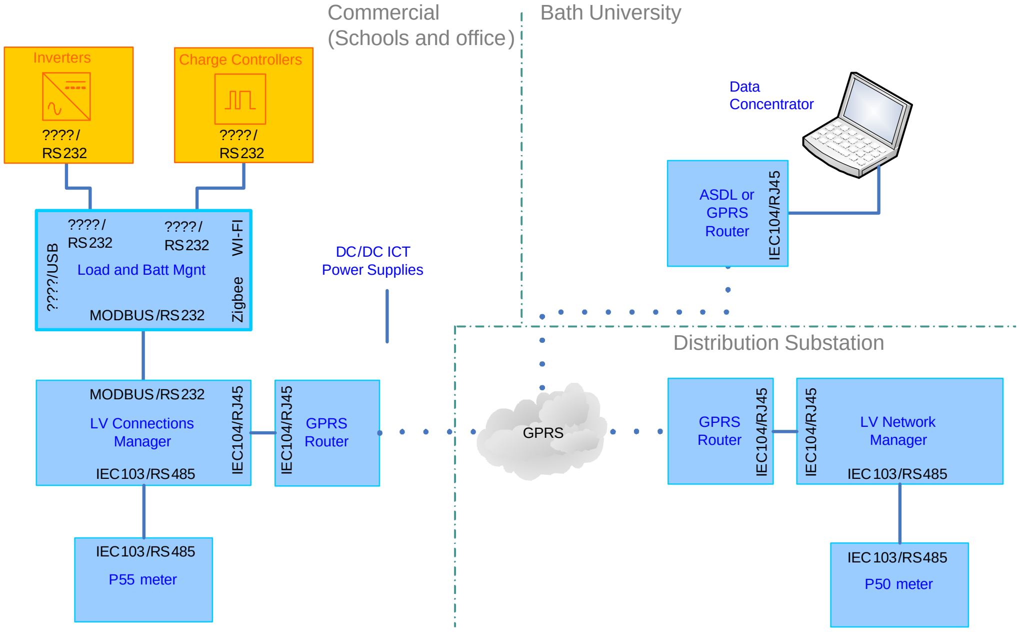
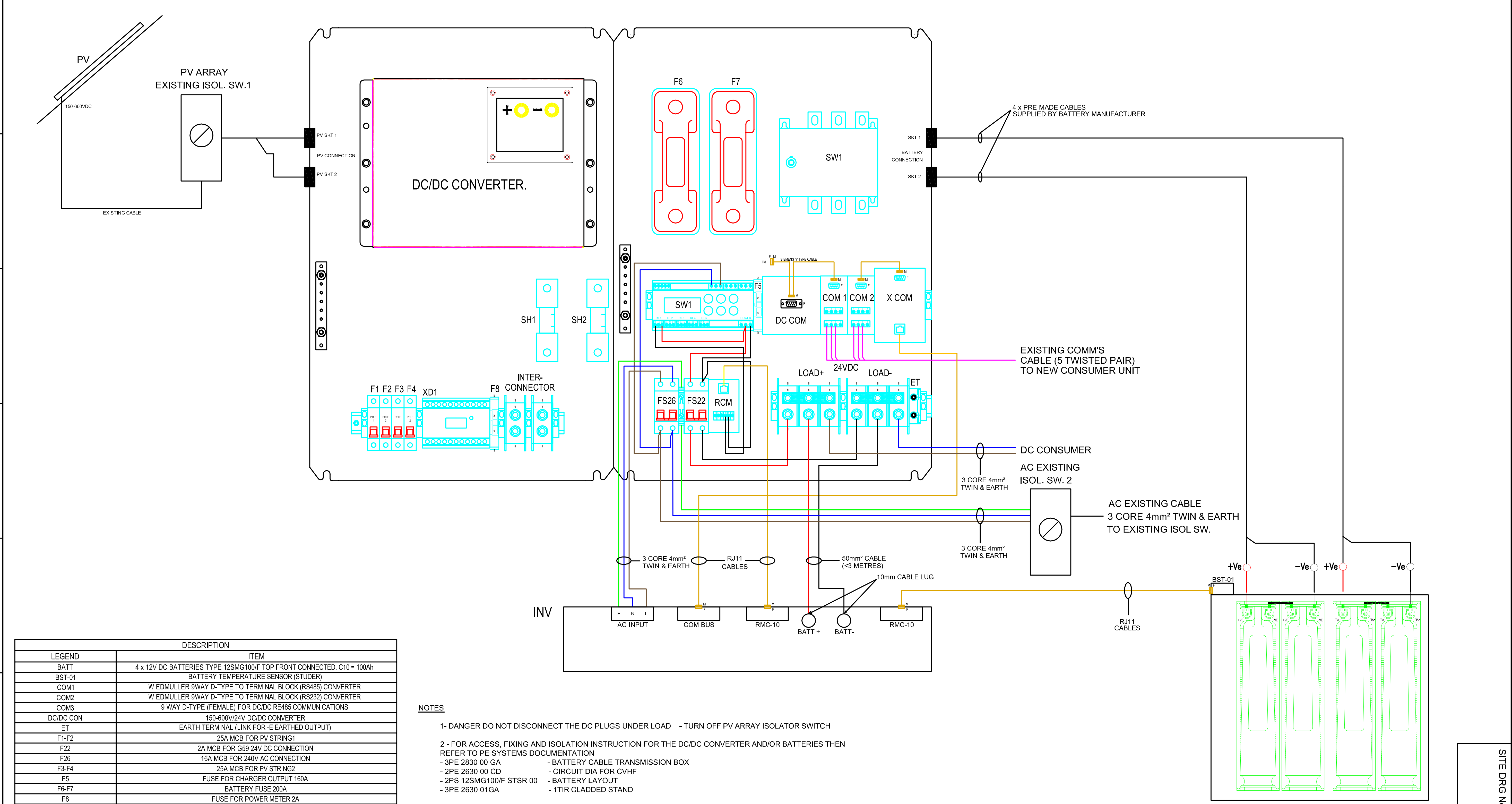


Figure 15 - Commercial properties Communications Detailed Architecture



DESCRIPTION	
LEGEND	ITEM
BATT	4 x 12V DC BATTERIES TYPE 12SMG100/F TOP FRONT CONNECTED. C10 = 100Ah
BST-01	BATTERY TEMPERATURE SENSOR (STUDER)
COM1	WIEDMULLER 9WAY D-TYPE TO TERMINAL BLOCK (RS485) CONVERTER
COM2	WIEDMULLER 9WAY D-TYPE TO TERMINAL BLOCK (RS232) CONVERTER
COM3	9 WAY D-TYPE (FEMALE) FOR DC/DC RE485 COMMUNICATIONS
DC/DC CON	150-600V/24V DC/DC CONVERTER
ET	EARTH TERMINAL (LINK FOR -E EARTHED OUTPUT)
F1-F2	25A MCB FOR PV STRING1
F22	2A MCB FOR G59 24V DC CONNECTION
F26	16A MCB FOR 240V AC CONNECTION
F3-F4	25A MCB FOR PV STRING2
F5	FUSE FOR CHARGER OUTPUT 160A
F6-F7	BATTERY FUSE 200A
F8	FUSE FOR POWER METER 2A
INT	WALL BOX INTERCONNECTING TERMINAL BLOCK
INV	INVERTER (STUDER) 24V DC-240V AC, 2500WATTS
ISOL SW1	PV ARRAY 160-600V DC ISOLATOR SWITCH (EXISTING)
ISOL SW2	240V AC ISOLATOR SWITCH (EXISTING)
LOAD +/-	24V DC LOAD TERMINALS
PV SKT1/2	PLUG/SOCKET PV CONNECTIONS FROM ISOL SW1
RCM-10	REMOTE CONTROL MODULE (STUDER)
RLY1	MAINS PRO G59 PROTECTION RELAY
SH1	SHUNT FOR POWER METER
SH2	SHUNT FOR DC/DC CON
SKT1/SKT2	PLUG/SOCKET BATTERY CONNECTION
SW1	24V DC OUTPUT ISOLATOR SWITCH
TM	SIEMENS RS485 BUS TERMINATING RESISTOR
XCOM	COMMUNICATIONS MODULE (RS232, STUDER)
XD1	POWER METER

NOTES

1- DANGER DO NOT DISCONNECT THE DC PLUGS UNDER LOAD - TURN OFF PV ARRAY ISOLATOR SWITCH

2 - FOR ACCESS, FIXING AND ISOLATION INSTRUCTION FOR THE DC/DC CONVERTER AND/OR BATTERIES THEN REFER TO PE SYSTEMS DOCUMENTATION
- 3PE 2830 00 GA - BATTERY CABLE TRANSMISSION BOX
- 2PE 2630 00 CD - CIRCUIT DIA FOR CVHF
- 2PS 12SMG100/F STSR 00 - BATTERY LAYOUT
- 3PE 2630 01GA - 1TIR CLADDED STAND

3 - FOR INSTALLATION/ISOLATION INFORMATION OF EXISTING PV HARDWARE AND WIRING THEN REFER TO SOUTHERN SOLAR LTD DOCUMENTS.

4 - FOR ACCESS, FIXING AND ISOLATION INSTRUCTION OF THE INVERTER, PLEASE REFER TO STUDER 'EXTENDER, UNIT COMBINING INVERTER BATTERY CHARGER & TRANSFER SYSTEM' DOCUMENT

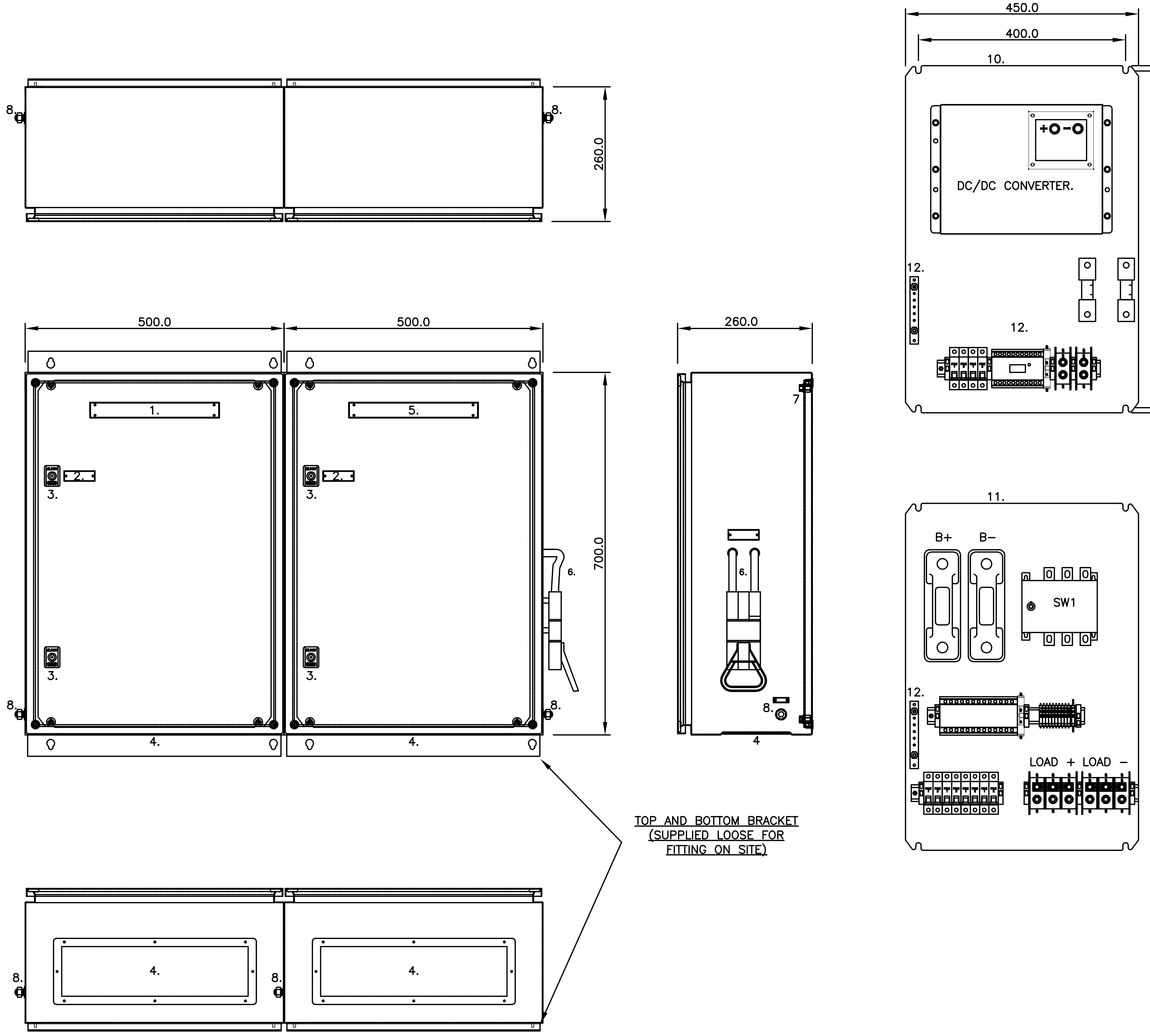
5 - WIRE SIZE/COLOURS
ALL WIRING WILL BE IDENTIFIED WITHIN THE DRAWING
(BN) - BROWN
(BK) - BLACK
(GY) - GREY
(BL) - BLUE
(RD) - RED
(G/Y) - GREEN / YELLOW

6 - ALL CASES OF RELAY OR METAL EQUIPMENT THAT CAN BE TOUCHED ARE TO BE EARTHED USING G/Y 2.5mm

REVISION:	A	FIRST ISSUE
DRAWN:		
CHECKED:		
APPROVED:		

Customer: WPD	Project: WPD BRISTOL So-La Smart Grid
Contractor: SIEMENS Transmission and Distribution Ltd.	Title: WIRING DIAGRAM FOR LOFT HARDWARE INTERFACES
Customer Reference: 8259497	Contractor Drawing No.: G85221-B0232-H1-Q001
Sales Reference: 77PO-03125	Customer Drawing No.:

Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
K.Waite	P.Winton	K.Waite		05.09.12	NTS	A2	004 of 004	A



ITEM No.	DESCRIPTION	LABEL TEXT	CIRCUIT REF.
1	DESIGNATION LABEL	600V PV INPUT & 24V DC/DC CONVERTER BOX	–
2	WARNING LABEL	WARNING 600V & 24V DC LIVE AT ALL TIMES	–
3	DOOR LOCKING MECHANISM	---	–
4	GLAND PLATE (FOR SWA CABLE)	---	–
5	DESIGNATION LABEL	24V DC BATTERY & LOAD OUTPUT BOX	–
6	DP BATTERY CONNECTOR 320A	BATTERY INPUT CONNECTOR	PLG1
7	---	---	PLG2
8	M10 x 30mm BRASS EARTH STUD	---	–
9	---	---	–
10	INTERNAL CHASSIS FOR PV I/P, DC/DC CONVERTED /kWh METER	---	–
11	INTERNAL CHASSIS FOR BATTERY FUSES, LOAD ISOLATION AND MISCELLANEOUS PARTS	---	–
12	EARTH BAR – 130mm LONG (INTERNAL)	---	–
13	INFORMATION LABEL	24V DC BATTERY 1 OUTPUT +VE –VE	CON1
14	INFORMATION LABEL	24V DC BATTERY 2 OUTPUT +VE –VE	CON2
15	INFORMATION LABEL	BATTERY 2 EL SENSE O/P	CON3
16	---	---	–
17	BATTERY 1, BATTERY 2 & BATTERY 2 ELECTROLYTE LEVEL LOW TERMINAL RAIL	---	–
18	---	---	–
19	INFORMATION LABEL	24V DC BATTERY 1 INPUT +VE –VE	CON1
20	INFORMATION LABEL	24V DC BATTERY 2 INPUT +VE –VE	CON2
21	INFORMATION LABEL	BATTERY 2 EL SENSE I/P	CON3
22	---	---	–

NOTES

1. THE CUBICLE IS SECURED TO THE WALL AT THE CENTRES SHOWN VIA FOUR M6 x 6L RAWL BOLTS OR SIMILAR (SUPPLED BY OTHERS); USING THE 'S' SHAPED TOP & BOTTOM BRACKETS (SUPPLIED). THE TWO CUBICLES ARE INTERCONNECTED VIA 50 (75)mm DIAMETER BUSHINGS, WITH ALL INTERCONNECTING CABLES PRE–MADE AND NUMBERED.
2. THE EXTERNAL BATTERY CONNECTOR 'PLG1' MATING HALVES ARE FITED TO THE BATTERY CABLES FOR INTERCONECTION AT SITE.

ASSOCIATED DRAWINGS:
A. SYSTEM INTERCONNECT/WIRING DIAGRAM – 2PE 2830 00CD

ISS	DESCRIPTION	APPD	DATE
0	AS BUILT, NO CHANGES.	A. PIERCE	27/09/11
B	BATTERY 2 WAS 20 CELLS.	A. PIERCE	22/07/11

CUSTOMER: SIEMENS
SITE: BRISTOL HOUSING PROJECT
CONTRACT NUMBER: TBC
COLOUR: RAL 7032
PE W/O No.: 16774/2840
IP RATING: IP21

POWER ELECTRONICS
PE SYSTEMS LIMITED
VICTORIA STREET
LEIGH
WN7 5SE
TEL: (01942)260330
FAX: (01942)261835
Email: sales@pe–systems.co.uk

TITLE
BATTERY CABLE TRANSITION BOX FOR 24V DC SYSTEMS WITH BATTERY CABLES UP TO 50mm SQ SWA

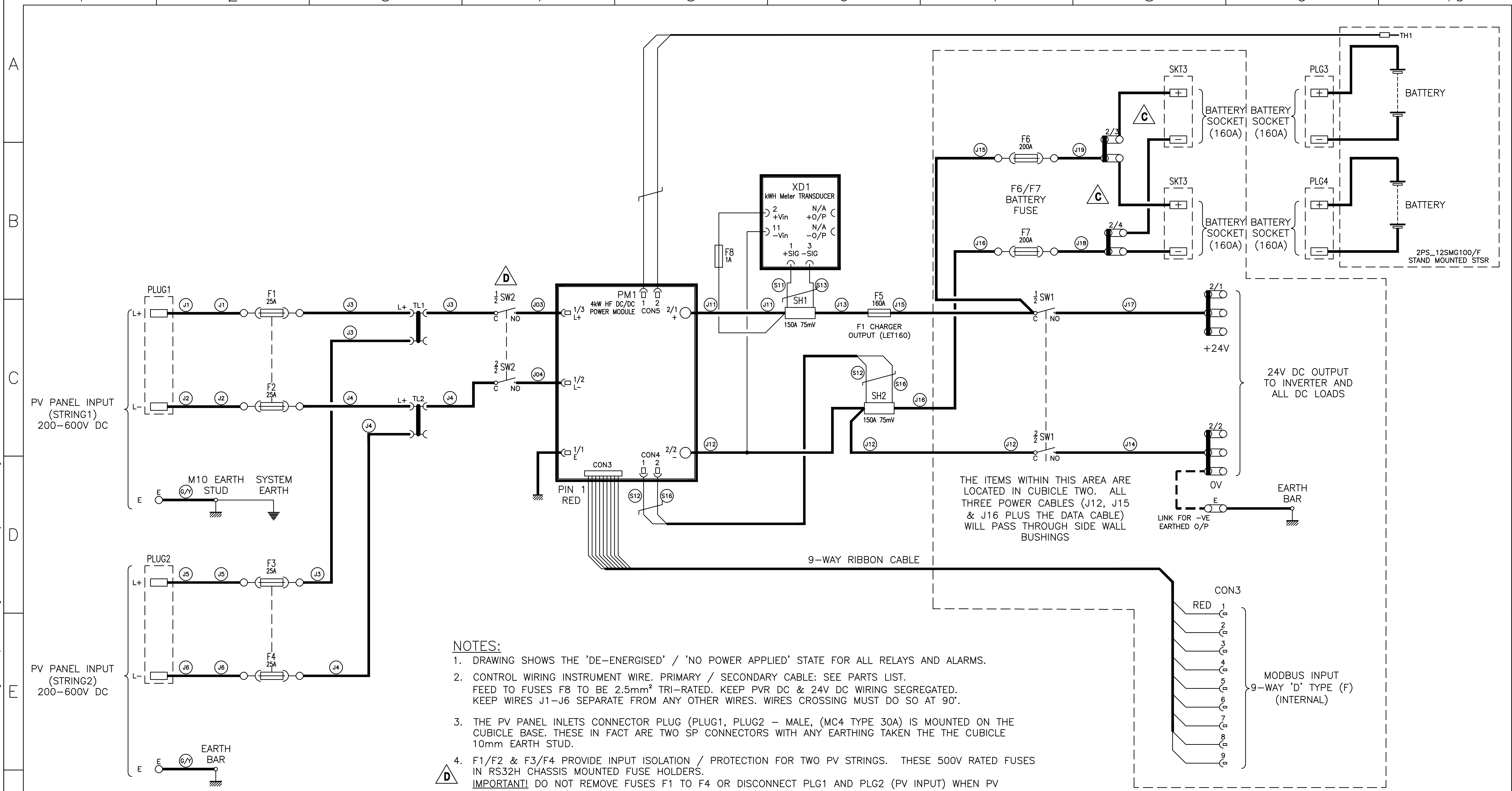
700mm H x 500mm W x 260mm D.

24V DC/DC 4kW SYSTEM

DRAWN	TRACED	CHECKED	APPROVED	DATE
A. PIERCE		M. SMITH	M. SMITH	06/07/11

DRAWING No: 3PE 2830 00 GA

ISSUE: A



NOTES:

1. DRAWING SHOWS THE 'DE–ENERGISED' / 'NO POWER APPLIED' STATE FOR ALL RELAYS AND ALARMS.
2. CONTROL WIRING INSTRUMENT WIRE. PRIMARY / SECONDARY CABLE: SEE PARTS LIST. FEED TO FUSES F8 TO BE 2.5mm² TRI–RATED. KEEP PVR DC & 24V DC WIRING SEGREGATED. KEEP WIRES J1–J6 SEPARATE FROM ANY OTHER WIRES. WIRES CROSSING MUST DO SO AT 90˚.
3. THE PV PANEL INLETS CONNECTOR PLUG (PLUG1, PLUG2 – MALE, (MC4 TYPE 30A) IS MOUNTED ON THE CUBICLE BASE. THESE IN FACT ARE TWO SP CONNECTORS WITH ANY EARTHING TAKEN THE THE CUBICLE 10mm EARTH STUD.
4. D F1/F2 & F3/F4 PROVIDE INPUT ISOLATION / PROTECTION FOR TWO PV STRINGS. THESE 500V RATED FUSES IN RS32H CHASSIS MOUNTED FUSE HOLDERS. <u>IMPORTANT!</u> DO NOT REMOVE FUSES F1 TO F4 OR DISCONNECT PLG1 AND PLG2 (PV INPUT) WHEN PV PANEL/PANELS IS/ARE LIVE. SEY SW2 TO OFF FIRST, THIS MAY BE PADLOCKED OFF.
5. FLOAT VOLTAGE = 27.24V, (BASED ON 12 VRLA CELLS) TEMPERATURE COMPENSATED AT –36mV/˚C BOOST VOLTAGE = N/A, (BASED ON 12 VRLA CELLS) CURRENT LIMIT = 120A
6. THE TEMPERATURE MONITORING THERMISTOR (TH1) WILL BE CONNECTED WITHIN THE BATTERY STAND DIRECT TO THE DC/DC COMVERTER.
7. D THE INPUT CABLES FOR THE BATTERY AND THE LENGTH OF THE TH1 PROBE LENGTHS WILL DEPEND ON THE BATTERY STAND POSITION IN RELATION TO THE THW ENCLOSURES AND A MAXIMUM LENGTH NEEDS TO BE AGREED.

ASSOCIATED DRAWINGS:

A. CUBICLE OUTLINE/TERMINAL LAYOUT – 1PE 2630 00 GA
B. BATTERY STAND LAYOUT – 3PE 2630 01GA
C. BATTERY LAYOUT (VRLA) – 2PS_12SMG100/F_STSR_00

ISS	DESCRIPTION	APPD	DATE
D	PV ISOLATION SWITCH SW2 ADDED AND NOTE 4 AMENDED TO REFLECT REQUIRED OPERATION FOR REMOVAL OF PG1/2 AND F1–F4	M. Smih	21/09/2012
C	BATTERY STRINGS REVISED TO TWO SEPATE STRINGS TERMINALS 2/3 AND 2/4 ADDED WITHIN CUBICLE . (MS)	M. Smith.	10/09/2012
B	REVISED TO MATCH TWO ENCLOSURE CONSTRUCTION. COMMUNICATIONS MODBUSE NOW IN CUBICLE 2, INTERCONNECTING CABLE CLARIFIED. BOTH BATTERY STRINGS AND PROBE ADDED,	A. Pierce	06/09/2012

CUSTOMER: SIEMENS T & D (HEBBURN)
SITE: VARIOUS – SEE ORDER SPEC.
CONTRACT NUMBER: 4505314032
COLOUR: RAL7035
PE W/O No.: F/U 16674/2630
IP RATING: IP21

POWER ELECTRONICS
PE SYSTEMS LIMITED
VICTORIA STREET
LEIGH
WN7 5SE
TEL: (01942)260330
FAX: (01942)261835
Email: sales@pe–systems.co.uk

TITLE: CIRCUIT DIAGRAM FOR CVHF 400/24V 125A DC/DC CONVERTER WITH BATTERY PRUTECTION AND ISOLATION

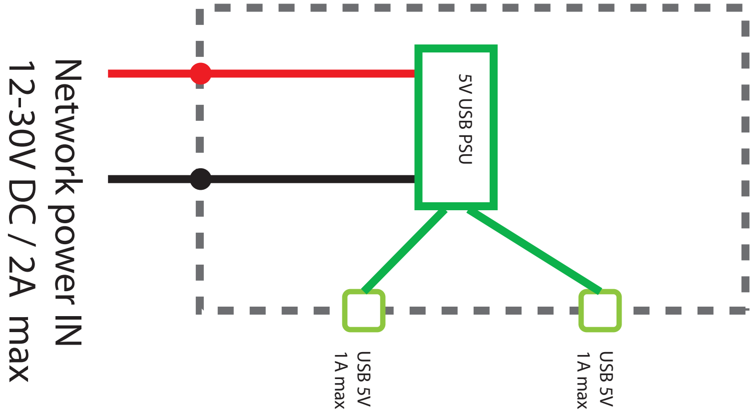
DRAWN	TRACED	CHECKED	APPROVED	DATE
M. Barnes		D. Lewis	M. Smith.	28/08/2012

DRAWING No: 2PE 2630 00 CD
ISSUE: D

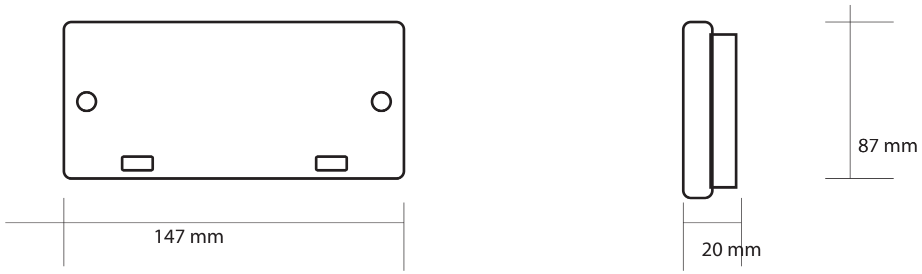
SKU: PSKT004B - USB

USB power socket

INDICATIVE IMAGE



power socket diagram

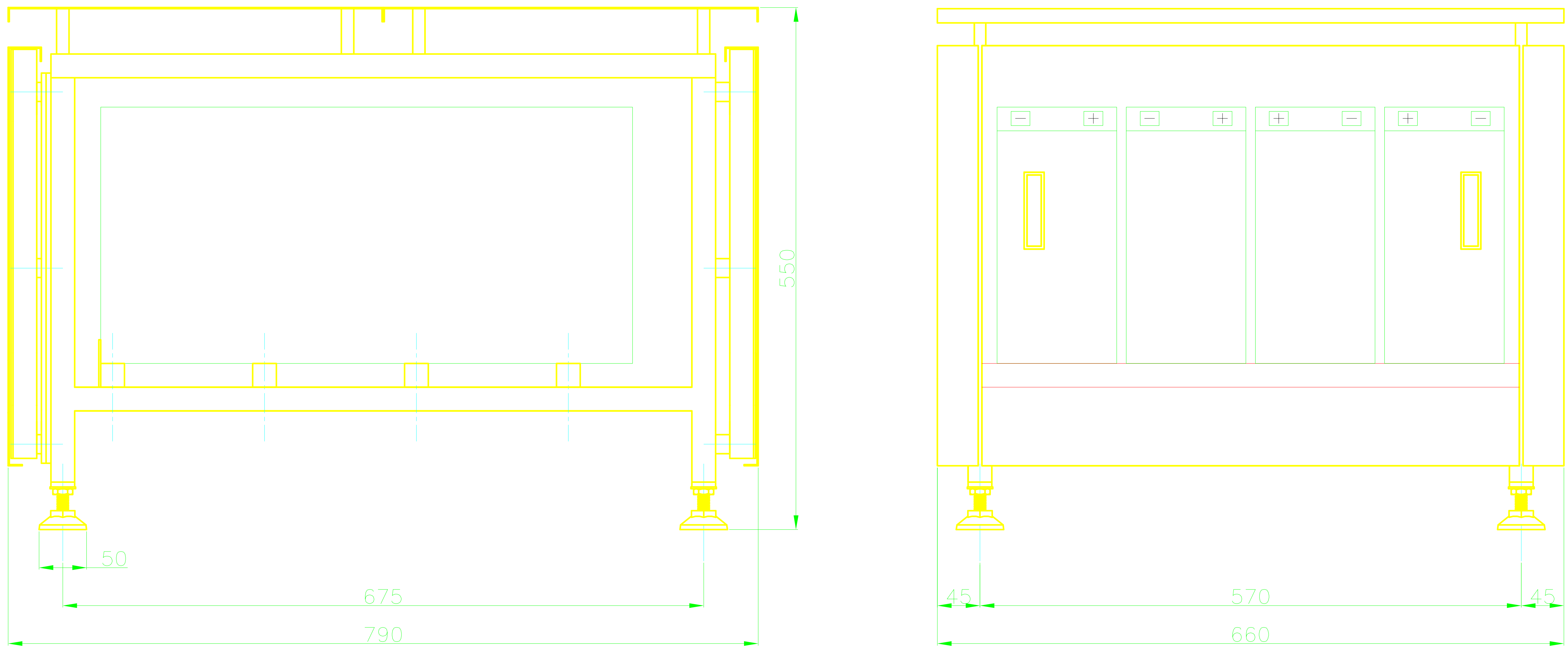


Specification:
Power supply
Power is connected via screw terminals
Input voltage 12-30V DC
Power output
2 x standard USB sockets. Powering DC devices at 5V, max 1A per socket
Form factor
The socket is provided as a standard 147x87mm electrical face plate, and can be attached to a standard back box with standard machine screws

The Moixa power hub is designed to provide efficient DC power to the devices you use every day, powering and charging devices designed to charge from standard USB sockets.
The output USB sockets provide 5V output, at a maximum of 1A per socket, capable of charging iphones / iPads etc. It is designed to fix to UK standard electrical socket back box, and connects to the DC home micronet circuit, or any other DC power supply rated at 12-30V.

Certification/compliance: lab r&d/ trials. Country requirements on request

www.moixatechnology.com
Moixa Technology Ltd, 110 Gloucester Avenue, London, NW1 8HX, UK
Tel. 0207 734 1511 Email. info@moixaenergy.com



LADEN WEIGHT = 229Kg.
MAX FOOT LOAD = 58Kg.

ASSOCIATED DRAWINGS:

A. CIRCUIT DIAGRAM – 1PE 2630 00 GA
B. BATTERY STAND LAYOUT – 3PE 2630 01GA
C. BATTERY LAYOUT (VRLA) – 2PS_12SMG100/F_STSR_00

ISS	DESCRIPTION	APPD	DATE

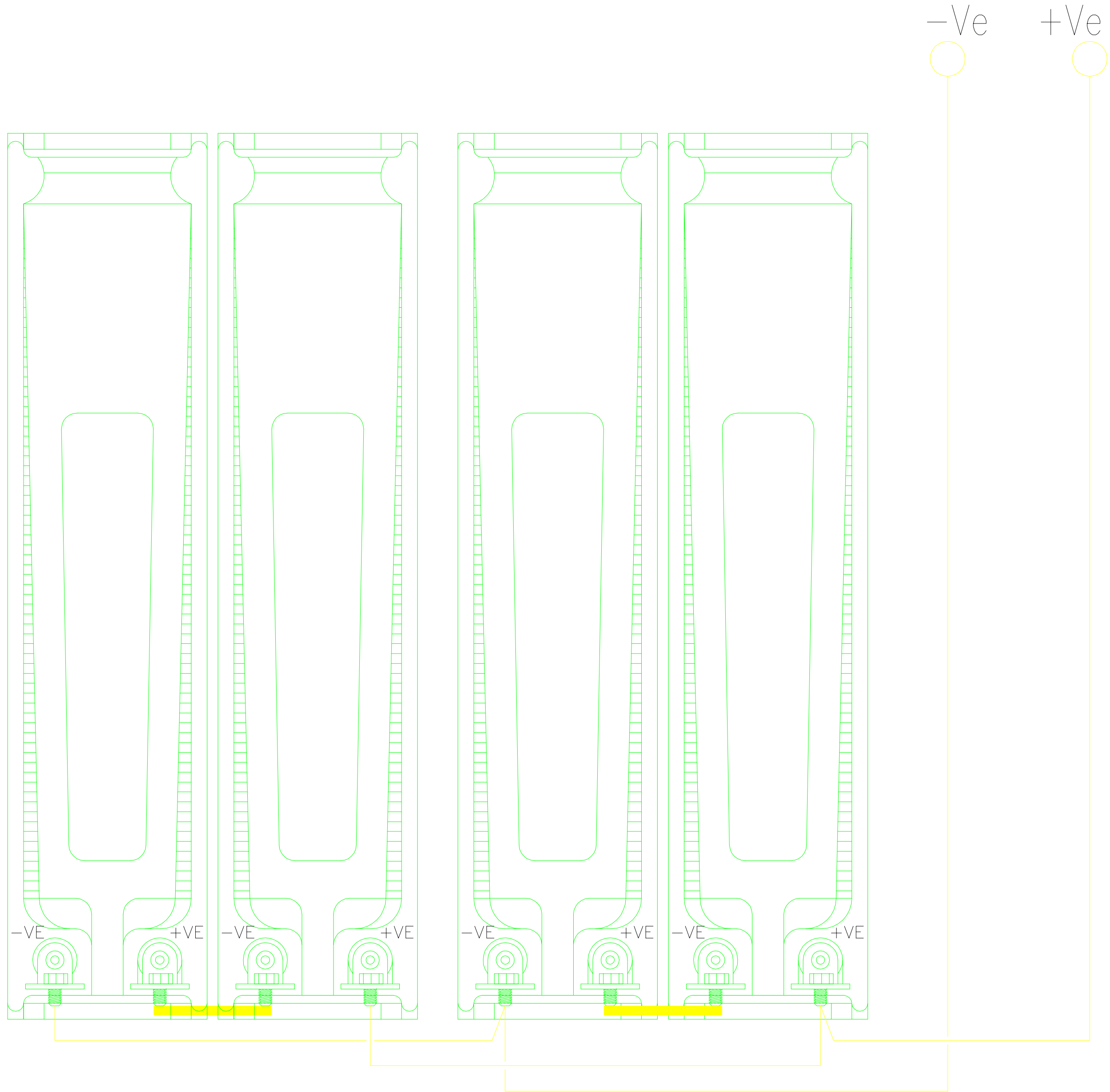
CUSTOMER	SIEMENS T & D (HEBBURN)
SITE	VAROUS – BRISTOL AREA
CONTRACT NUMBER	4505314032
COLOUR	RAL 7032
PE W/O No.	16774/2630
IP RATING	21

POWER ELECTRONICS
PE SYSTEMS LIMITED
VICTORIA STREET
LEIGH
WN7 5SE
TEL: (01942)260330
FAX: (01942)261835
Email: sales@pe-systems.co.uk

TITLE
1T1R CLADDED STAND TO ACCOMODATE 4 x 12SMG100/F SINGLE TIER, SINGLE ROW (STSR) ARRANGEMENT (WITH SPLIT ROOF FOR LOFT ACCESS)

DRAWN	TRACED	CHECKED	APPROVED	DATE
M.BARNES		P. Whiteley	M. Smith.	06/09/2012

DRAWING No	ISSUE
3PE 2630 01GA	A



NOTES

1. SLEEVE ALL CABLE CONNECTIONS ACCORDING TO THE FOLLOWING TABLE:–

EARTHED POLE	POSITIVE	NEGATIVE
NEITHER	BROWN (L+)	GREY (L–)
NEGATIVE	BROWN (L–)	BLUE (M)
POSITIVE	BLUE (M)	GREY (L–)

2. BATTERY TYPE: 12SMG100/F TOP FRONT CONNECTED.
C10 = 100Ah.

3. BATTERY DIMENSIONS:

WIDTH:	560mm.
LENGTH:	126mm.
HEIGHT:	270mm.
WEIGHT:	44.0kg (PER MONOBLOC).
TERMINAL:	M8 (FEMALE)
TORQUE SETTING:	5Nm.

4. THESE CELLS CAN BE SUPPLIED WITH AN ADAPTOR KITS SO THAT THE BATTERY CONNECTION BECOMES M6 AND NOT M8.
THIS BRACKET ROTATES THE CONNECTION THROUGH 90 DEGREES.

5. FOR ASSOCIATED DRAWINGS SEE CUSTOMER SPECIFICATION DETAILS.

ISS	DESCRIPTION	APPD	DATE

CUSTOMER
SEE ORDER SPEC
SITE
SEE ORDER SPEC
CONTRACT NUMBER
SEE ORDER SPEC
COLOUR
SEE SPEC
PE W/O No.
F/U 16774/2630
IP RATING
SEE SPEC

POWER ELECTRONICS
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TEL: (01942)260330
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TITLE
BATTERY LAYOUT FOR 2PS_12SMG100/F_STSR
(GENERIC DRAWING)

DRAWN	TRACED	CHECKED	APPROVED	DATE
M.BARNES		D. Lewis	M. Smith	06/09/2012

DRAWING No
2PS_12SMG100/F_STSR_00
ISSUE
0

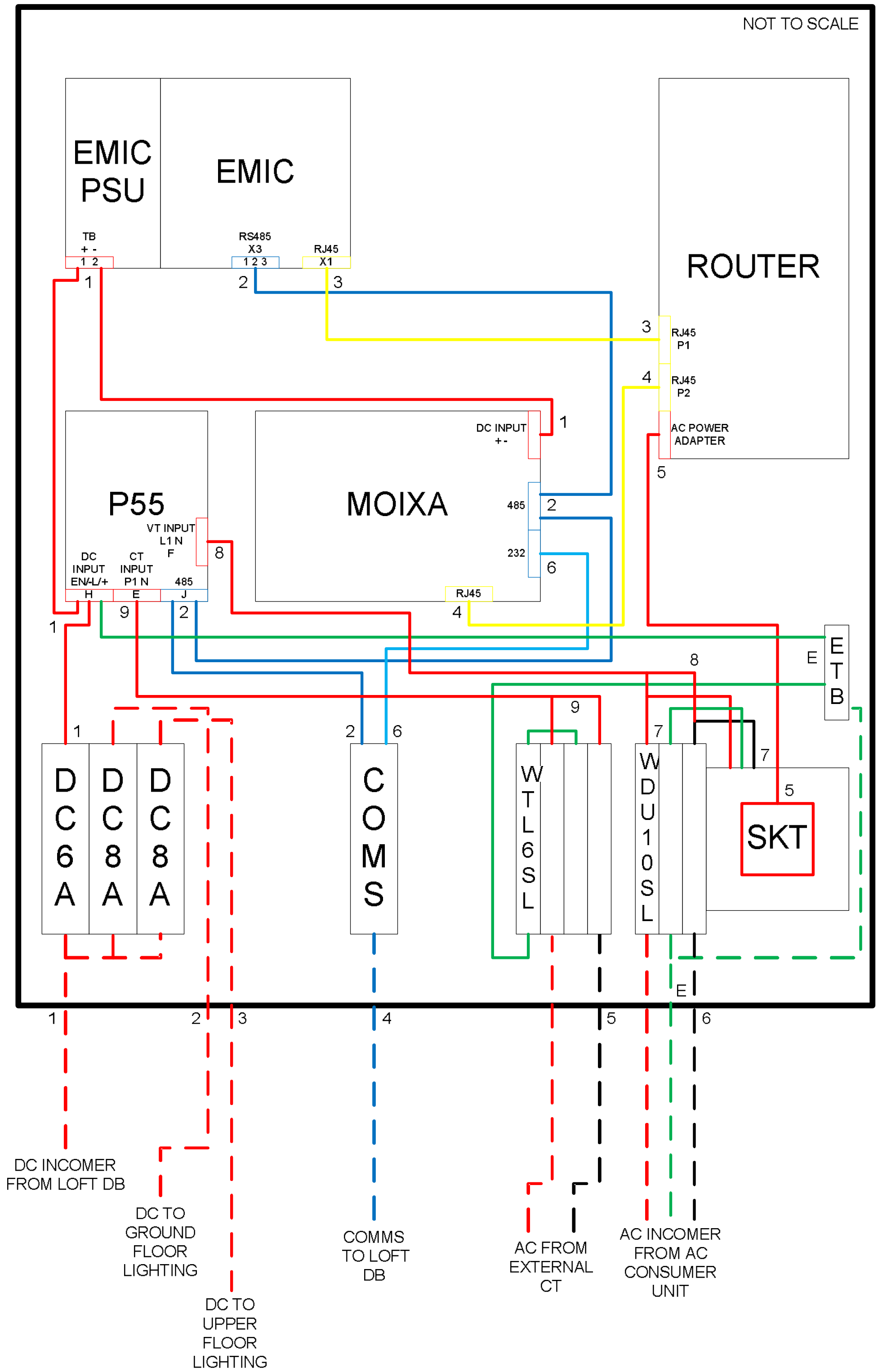
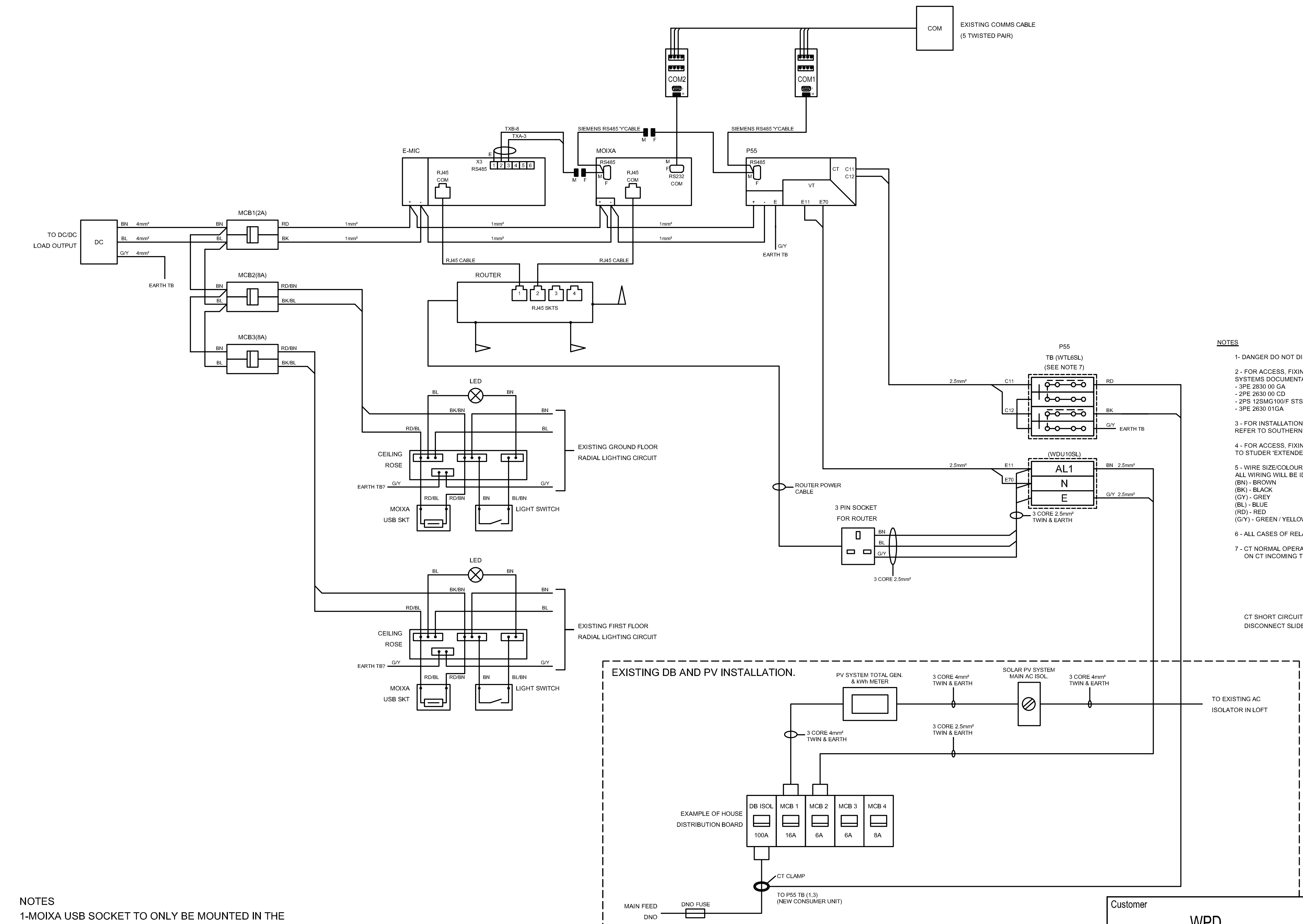


FIGURE 3 – HALLWAY; CABLE CONNECTION REQUIREMENTS

DESCRIPTION	
LEGEND	ITEM
E-MIC	SIEMENS LV CONNECTION MANAGER (SICAM ACP E-MIC)
MOIXA	LOAD AND BATTERY MANAGER
COM1	WIEDMULLER 9WAY D-TYPE TO TERMINAL BLOCK (RS485) CONVERTER
COM2	WIEDMULLER 9WAY D-TYPE TO TERMINAL BLOCK (RS232) CONVERTER
P55	SIEMENS SIMEAS P55 AC METER
MCB1	SIEMENS 2A MCB (5SY5202-7)
MCB2-3	SIEMENS 8A MCB (5SY5208-7)
ROUTER	GPRS/WIFI ROUTER (BILLION)



NOTES

1- DANGER DO NOT DISCONNECT THE DC PLUGS UNDER LOAD - TURN OFF PV ARRAY ISOLATOR SWITCH

2 - FOR ACCESS, FIXING AND ISOLATION INSTRUCTION FOR THE DC/DC CONVERTER AND/OR BATTERIES THEN REFER TO PE SYSTEMS DOCUMENTATION
- 3PE 2830 00 GA - BATTERY CABLE TRANSMISSION BOX
- 2PE 2630 00 CD - CIRCUIT DIA FOR CVHF
- 2PS 12SMG100/F STSR 00 - BATTERY LAYOUT
- 3PE 2630 01GA - 1TIR CLADDED STAND

3 - FOR INSTALLATION/ISOLATION INFORMATION OF EXISTING PV HARDWARE AND WIRING THEN REFER TO SOUTHERN SOLAR LTD DOCUMENTS.

4 - FOR ACCESS, FIXING AND ISOLATION INSTRUCTION OF THE INVERTER, PLEASE REFER TO STUDER 'EXTENDER, UNIT COMBINING INVERTER BATTERY CHARGER & TRANSFER SYSTEM' DOCUMENT

5 - WIRE SIZE/COLOURS
ALL WIRING WILL BE IDENTIFIED WITHIN THE DRAWING
(BN) - BROWN
(BK) - BLACK
(GY) - GREY
(BL) - BLUE
(RD) - RED
(G/Y) - GREEN / YELLOW

6 - ALL CASES OF RELAY OR METAL EQUIPMENT THAT CAN BE TOUCHED ARE TO BE EARTHED USING G/Y 2.5mm

7 - CT NORMAL OPERATION - SHORT CIRCUITING SLIDER BETWEEN TERMINAL BLOCKS TO BE OPEN AND DISCONNECT SLIDE LINK ON CT INCOMING TERMINAL BLOCK CLOSED -

CT SHORT CIRCUIT OPERATION - SHORT CIRCUITING SLIDER BETWEEN TERMINAL BLOCKS TO BE CLOSED AND DISCONNECT DISCONNECT SLIDE LINK ON CT INCOMING TERMINAL BLOCK OPEN -

NOTES

1-MOIXA USB SOCKET TO ONLY BE MOUNTED IN THE LIVING ROOM, KITCHEN AND MASTER BEDROOM.

2-ALL 240 VAC TERMINALS AND P55 TERMINALS TO BE SHROUDED AND LABELED WITH WARNING LABELS.

NOTE

1-MCB 2 WAS USED FOR GROUND FLOOR LIGHTING CIRCUIT. MCB3 WAS USED FOR 1ST FLOOR LIGHTING CIRCUIT.

SITE DRG No.

REVISION:	A	FIRST ISSUE
DRAWN:		
CHECKED:		
APPROVED:		

Customer: WPD	Project: WPD BRISTOL So-La Smart Grid
Contractor: SIEMENS Transmission and Distribution Ltd.	Title: WIRING DIAGRAM OF NEW CONSUMER UNIT
Customer Reference: 8259497	Contractor Drawing No.: G85221-B0232-H1-Q001
Sales Reference: 77PO-03125	Customer Drawing No.

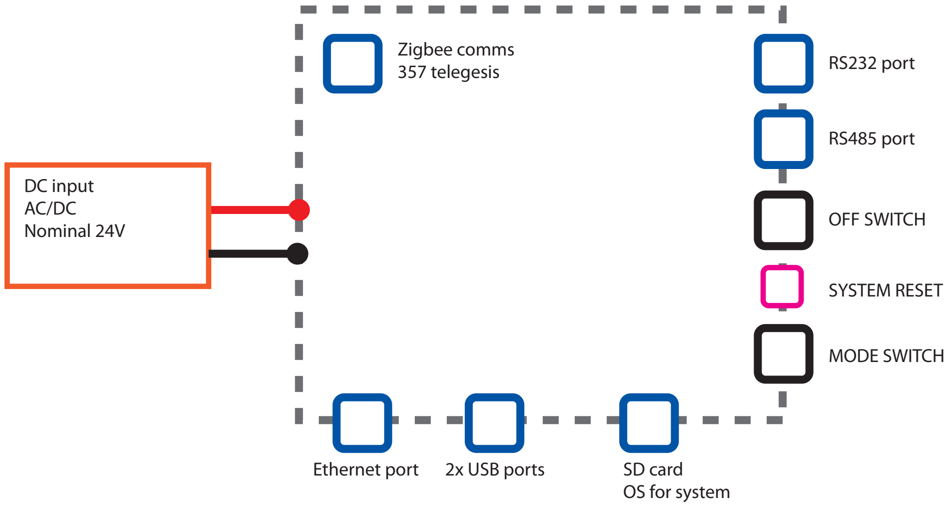
Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
K.Waite	P.Winton	K.Waite		05.09.12	NTS	A2	003 of 004	A

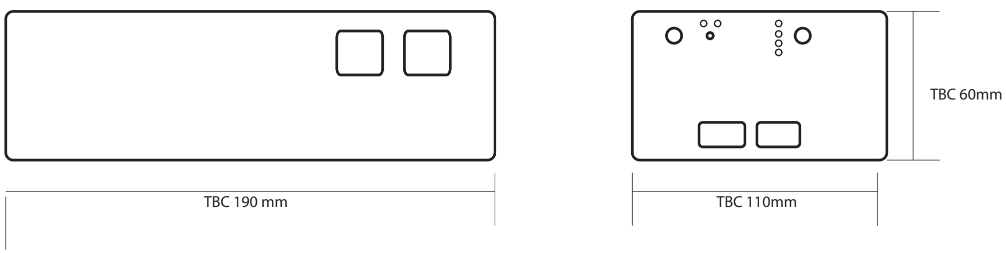
SKU: BMSHUB002

DC Manager unit

DRAFT

DC Manager diagram





indicative image

- Zigbee comms
- Safety BMS unit
- Control of external inverter
- Interface with Modbus
- Ethernet port

Specifications:

Processor/Memory/Storage/OS

ARM9 based linux module running custom distro Open-Embedded, 256MB ram, 4GB SD card used for OS. PIC32 based low level interface board with PSU

I/O interfaces

RS232 interface, configured for Studer inverter unit
RS485 interface, configured as Modbus slave
2x USB ports, 1x ethernet port
Zigbee module, join button (internal), external antenna.
System off switch
Mode select/ multi function input button
Fault LEDs, with reset button (paperclip type)

Power

Input jack for DC power, requires input between 12 and 30V DC
Nominal power requirement 5W

Mounting

The unit is provided with standard 30mm Din rail mounting brackets on the rear

System summary:

Customised version of the standard Moixa BMS / Hub unit designed to control an external inverter unit using an industry standard RS232 port. The Hub has an additional RS485 port to allow connection to an external control unit - the Siemens eMic device.
The hub unit runs customised software package to provide forecasts of load and generation for the local system.
The unit also provides optional functionality: ethernet, USB ports, an SD card is used to host the OS and is externally accessible, and zigbee comms can optionally be included .

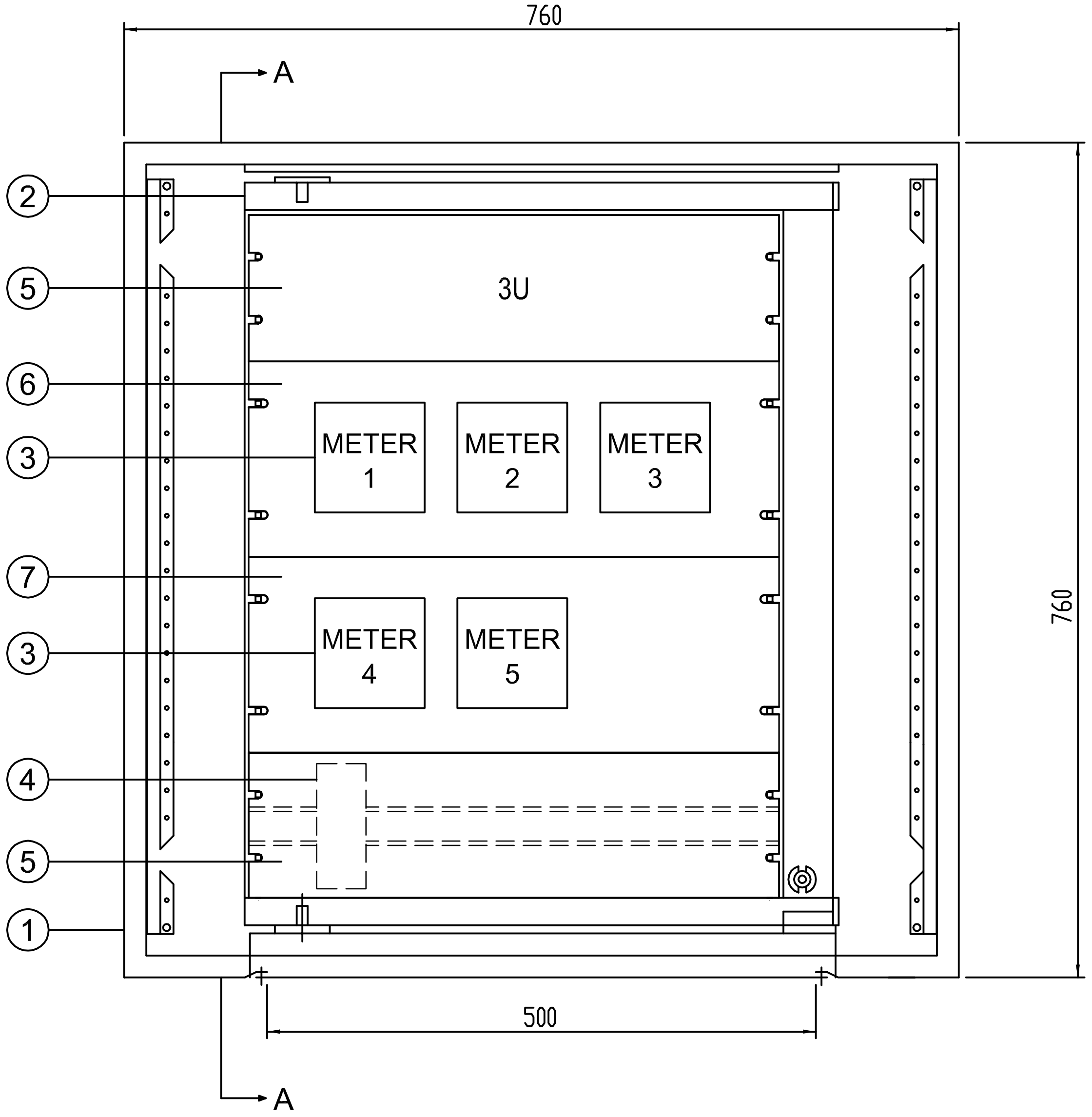
Certification/compliance: lab r&d/ trials. Country requirements on request

www.moixatechnology.com
Moixa Technology Ltd, 110 Gloucester Avenue, London, NW1 8HX, UK
Tel. 0207 734 1511 Email. info@moixaenergy.com

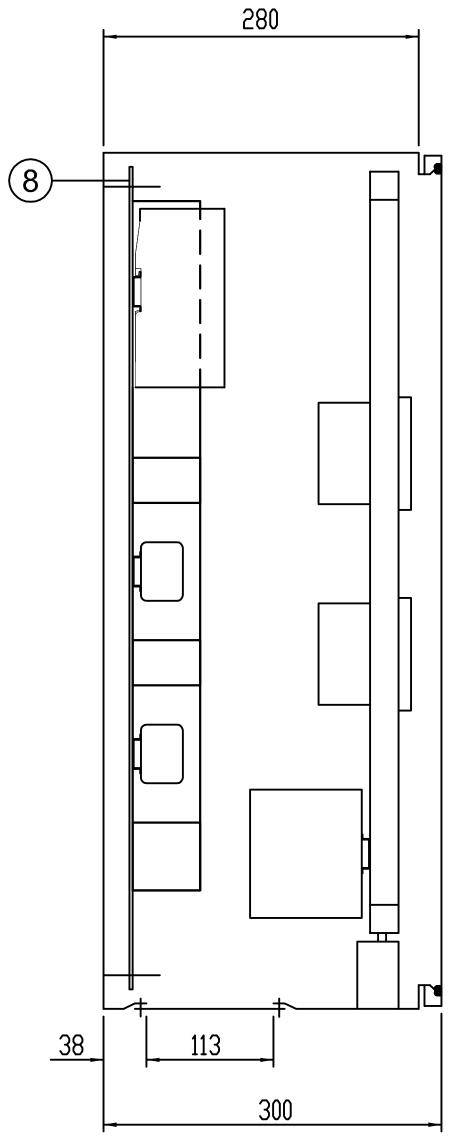
21 TECHNICAL DATA

Inverter model	**XTS 900-12**	**XTS 1200-24**	**XTS 1400-48**	**XTM 1500-12**	**XTM 2000-12**	**XTM 2400-24**	**XTM 2600-48**	**XTM 3500-24**	**XTM 4000-48**	**XTH 3000-12**	**XTH 5000-24**	**XTH 6000-48**	**XTH 8000-48**
Nominal battery voltage	12V	24V	48V	12V		24V	48V	24V	48V	12V	24V	48V	
Input voltage range	9.5-17V	19-34V	38-68V	9.5-17V		19-34V	38 - 68V	19-34V	38-68V	9.5-17V	19-34V	38-68V	
Continous power @ 25°C	650**/500VA	800**/650VA	900**/750VA	1500VA	2000VA			3000VA	3500VA	2500VA	4500VA	5000VA	7000VA
Power 30 min. @ 25°C	900**/700VA	1200**/1000 VA	1400**/120 0VA	1500VA	2000VA	2400VA	2600VA	3500VA	4000VA	3000VA	5000VA	6000VA	8000VA
Power 3 sec. @25°C	2.3kVA	2.5kVA	2.8kVA	3.4kVA	4.8kVA	6kVA	6.5kVA	9kVA	10.5kVA	7.5kVA	12kVA	15kVA	21kVA
Maximum load	Up to short-circuit												
Maximum asymmetric load	Up to Pcont.												
* Load detection (Stand-by)	2 to 25W												
Cos φ	0.1-1												
Maximum efficiency.	93%	93%	93%	93%		94%	96%	94%	96%	93%	94%	96%	
Consumption OFF/Stand-by/ON	1.1W/1.4W/7W	1.2W/1.5W/8W	1.3W/1.6W/8W	1.2W/1.4W/8 W	1.2W/1.4W/10 W	1.4W/1.6W/9W	1.8W/2W/10W	1.4W/1.6W/12 W	1.8W/2.1W/14 W	1.2W/1.4W/14 W	1.4W/1.8W/18 W	1.8W/2.2W/22W	1.8W/2.4W/30W
* Output voltage	Pure sine wave 230Vac (+/- 2%) / 120Vac (1)												
* Output frequency	50Hz / 60Hz(1) +/- 0.05% (crystal controlled)												
Harmonic distortion	<2%												
Overload and short-circuit protection	Automatic disconnection with 3 restart attempts												
Overheat protection	Warning before shut-down – with automatic restart												
Battery charger													
* Charge characteristics	6 steps : bulk - absorption - floating - equalization - reduced floating – periodic absorption												
* Maximum charging current	35A	25A	12A	70A	100A	55A	30A	90A	50A	160A	140A	100A	120A
* Temperature compensation	WithBTS-01 or BSP 500/1200												
Power factor correction (PFC)	EN 61000-3-2												
General data	**XTS 900-12**	**XTS 1200-24**	**XTS 1400-48**	**XTM 1500-12**	**XTM 2000-12**	**XTM 2400-24**	**XTM 2600-48**	**XTM 3500-24**	**XTM 4000-48**	**XTH 3000-12**	**XTH 5000-24**	**XTH 600048**	**XTH 800048**
* Input voltage range	150 to 265Vac / 50 to 140Vac(1)												
Input frequency	45 to 65Hz												
Input current max. (transfer relay) / Output current max.	16A/20A			50A/56A									50A/80A
Transfer time (UPS)	<15ms												
Multifunction contacts	Module ARM-02 with 2 contacts as option			Two independent switchover contacts (potential free,16A-250 Vac / 3A-50Vdc)									
Weight	8.2 kg	9kg	9.3 kg	15 kg	18.5 kg	16.2 kg		21.2 kg	22.9 kg	34 kg	40 kg	42 kg	46 kg
Dimension h x w x l [mm]	110x210x310	110x210x310	110x210x310	133x322x466				133x322x466		230x300x500	230x300x500	230x300x500	
Protection index	IP54			IP20									
Conformity	Directive EMC 2004/108/CE : EN 61000-6-1, EN 61000-6-3, EN 55014, EN 55022, EN 61000-3-2, 62040-2 Low voltage directive : 2006/95/CE : EN 62040-1-1, EN 50091-2, EN 60950-1												
Operating temperature range	-20 to 55°C												
Relative humidity in operation	100%			95% without condensation									
Ventilation	Optional cooling module ECF-01			Forced from 55°C									
Acoustic level	<40dB / <45dB (without / with ventilation)												

* Adjustable value
** value with optional cooling fan module ECF-01
(1) With -01 at the end of the reference (I.e. XTM3500-24-01), means 120V/60Hz. Available for all Xtender except XTH 8000-48



FRONT VIEW
WITH METAL DOOR REMOVED



VIEW ON A-A

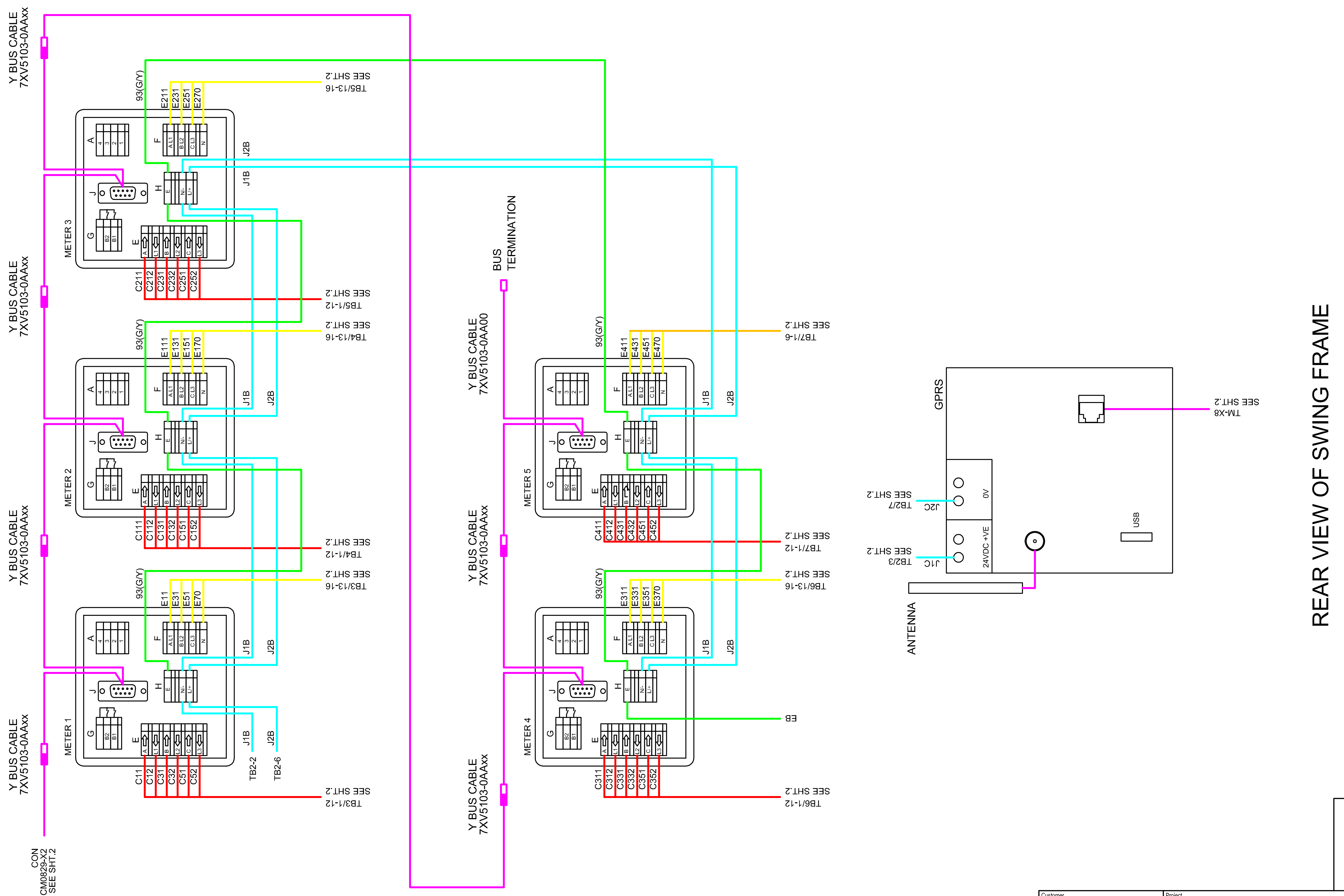
EQUIPMENT SCHEDULE					
ITEM	DESCRIPTION	SUPPLIER	TYPE/PART No.	ORDER REF.	QTY
1	WALLBOX H760xD300xW760	RITTAL	AE1073.600	1010071016	1
2	COMPACT SWING FRAME (14U HIGH)	RITTAL	SR2034.200	1010071016	1
3	METER 1-5	SIEMENS	SIMEAS P 7KG7750	7KG7750-0AA03-0AA1	5
4	GPRS ROUTER + ANTENNA - ANT794-3M	SIEMENS	6NA9870-1AA00	-	1
5	3U BLANKING PLATES	B & B	-	-	2
6	4U MOUNTING PLATE C/W CUT OUT FOR 3 METERS	B & B	-	-	1
7	4U MOUNTING PLATE C/W CUT OUT FOR 2 METERS	B & B	-	-	1
8	REAR BACK PLATE	RITTAL	AE1073.600	1010071016	1

SITE DRG No.

REVISION:	A		FIRST ISSUE
DRAWN:	P.Winton	26.07.12	
CHECKED:	K.Waite	26.07.12	
APPROVED:	K.Waite	26.07.12	

Customer: WPD	Project: WPD BRISTOL So-La Smart Grid
Contractor: SIEMENS Transmission and Distribution Ltd.	Title: GENERAL ARRANGEMENT FOR LV NETWORK MANAGER WALLBOX
Customer Reference: 8259497	Contractor Drawing No.: G85221-B0232-H1-D001
Sales Reference: 77PO-03125	Customer Drawing No.

Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
	P.Winton	K.Waite	K.Waite	25.07.12	NTS	A1	001 of 002	A

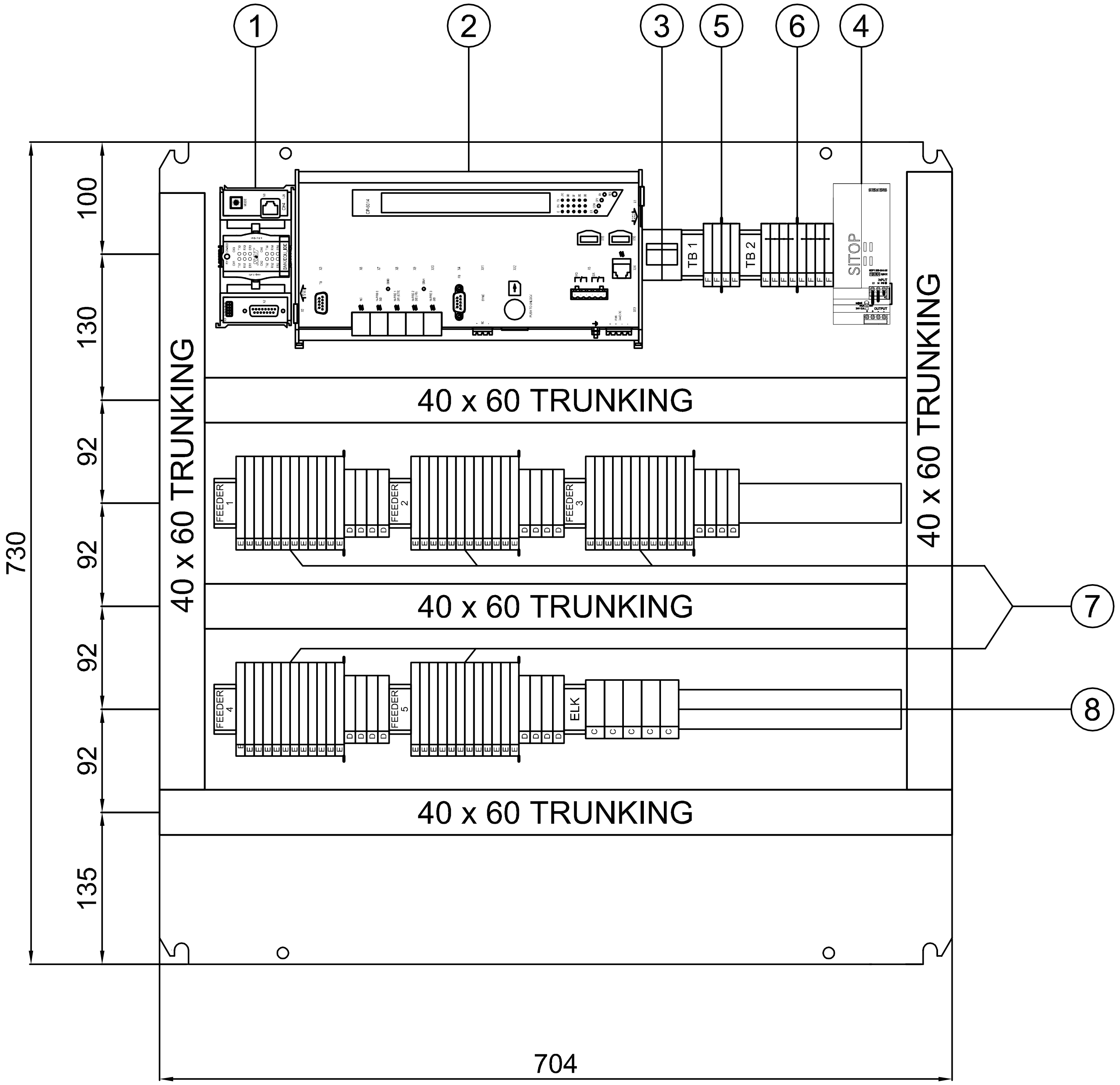


Customer: WPD	Project: WPD BRISTOL So-La Smart Grid
Contractor: SIEMENS Transmission and Distribution Ltd.	Title: WIRING DIAGRAM OF A LV NETWORK MANAGER DOOR EQUIPMENT WALLBOX
Customer Reference: 8259497	Contractor Drawing No.: G85221-B0232-H1-Q001
Sales Reference: 77PO-03125	Customer Drawing No.

Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
	P.Winton	K.Waite	K.Waite	26.07.12		A1	001 of 002	A

REVISION:	A	
DRAWN:	P.Winton	26.07.12
CHECKED:	K.Waite	26.07.12
APPROVED:	K.Waite	26.07.12

FIRST ISSUE



EQUIPMENT SCHEDULE

ITEM	REF	DESCRIPTION	SUPPLIER	TYPE/PART No.	ORDER REF.	QTY
1	CON	RS232/RS485 CONVERTER	SIEMENS	CM-0829	-	1
2	TM	LV NETWORK MANAGER	SIEMENS	CP-6014	-	1
3	MCB	MINITURE CIRCUIT BREAKER	SIEMENS	5SY5 204-7	-	1
4	SITOP	POWER SUPPLY (24VAC/24VDC 5A)	SIEMENS	SITOP 6EP1333-23A01	-	1
5	TB1	240VAC TERMINALS	WEIDMULLER	WDU4SL	-	4
6	TB2	24VDC TERMINALS	WEIDMULLER	WDU4SL	-	8
7	TB3-7	CT & VT TERMINALS	WEIDMULLER	WTL6SL	-	60
8	ELK	EARTH LINKS	WEIDMULLER	STL5	-	5

MCB REFERENCE TABLE

TIER/ LOCN	MCB No.	RATING	SCHEME REF.	LABEL DETAILS		
				1st. LINE	2nd. LINE	3rd. LINE
1	-	4A	MCB1	MAIN	SUPPLY	240VAC

WIRING NOTES:-

1. WHEN WIRE IS CUT TO LENGTH BOTH FERRULES SHOULD BE PUSHED OVER WIRE IN THE SAME ORIENTATION.

   1P1-1/1F1-N3 1P1-1/1F1-N3

   THE PART OF THE FERRULE WHICH INDICATES THE EQUIPMENT REFERENCE MUST BE TERMINATED ADJACENT TO THE EQUIPMENT AND IN SOME CASES WILL BE READ UPSIDE DOWN (INDICATED ON DRAWING BY •)

   EG.

   1F1-N3
   1P1-1/1F1-N3 3 4
   EQUIP REF
   1P1
   1P1-1/1F1-N3 1 2

2: WIRE SIZES/ COLOURS
   ALL WIRING NOT IDENTIFIED TO BE WHITE 1.0mm² PVC.
   ALL OTHER WIRING MARKED * TO BE WHITE 2.5mm² PVC
   OR # TO BE WHITE 4.0mm²
   UNLESS IDENTIFIED BY COLOUR.

   (BN) - BROWN
   (BK) - BLACK
   (GY) - GREY
   (BL) - BLUE
   (GN/YL) - GREEN/YELLOW EARTH CONNECTION.

3: CT WIRING IS IDENTIFIED BY RED FERRULES.
   VT WIRING IS IDENTIFIED BY YELLOW FERRULES.

4: ALL CASES OF RELAYS OR METAL EQUIPMENT THAT CAN BE TOUCHED ARE TO BE EARTHED USING GN/YL 2.5mm²

5: ALL TERMINALS TO BE WDU6SL EXCEPT THOSE MARKED THUS :-

A	WTR4SL	D	WDU10SL
B	SAKC4/35	E	WTL6SL
C	STL5	F	WDU4SL

   WHEN FITTING TYPE A OR B TERMINALS, ENSURE CORRECT ORIENTATION.

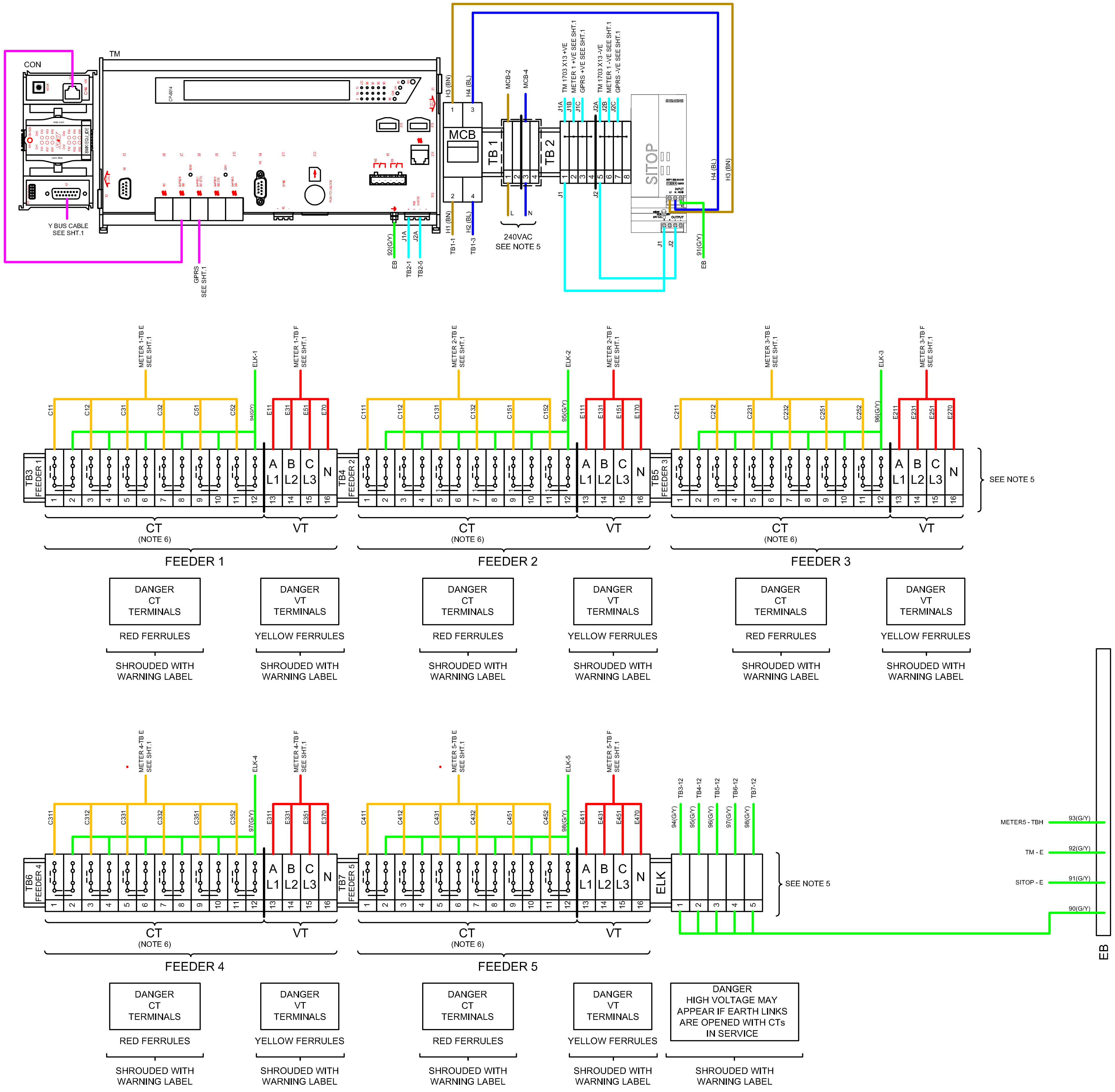
6. THIS WALLBOX HAS BOTTOM ENTRY CABLES.

SITE DRG No.

REVISION:	A		
DRAWN:	P.Winton	26.07.12	FIRST ISSUE
CHECKED:	K.Waite	26.07.12	
APPROVED:	K.Waite	26.07.12	

Customer: WPD	Project: WPD BRISTOL So-La Smart Grid
Contractor: SIEMENS Transmission and Distribution Ltd.	Title: GENERAL ARRANGEMENT OF LV NETWORK MANAGER BACK PLATE LAYOUT
Customer Reference: 8259497	Contractor Drawing No.: G85221-B0232-H1-D001
Sales Reference: 77PO-03125	Customer Drawing No.:

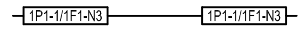
Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
	P.Winton	K.Waite	K.Waite	25.07.12	NTS	A1	002 of 002	A



FRONT VIEW OF BACK PLATE

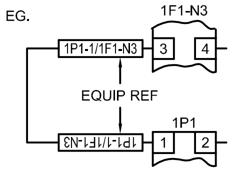
WIRING NOTES:-

1. WHEN WIRE IS CUT TO LENGTH BOTH FERRULES SHOULD BE PUSHED OVER WIRE IN THE SAME ORIENTATION.



THE PART OF THE FERRULE WHICH INDICATES THE EQUIPMENT REFERENCE MUST BE TERMINATED ADJACENT TO THE EQUIPMENT AND IN SOME CASES WILL BE READ UPSIDE DOWN (INDICATED ON DRAWING BY •)

EG.



2: WIRE SIZES/ COLOURS
ALL WIRING NOT IDENTIFIED TO BE WHITE 2.5mm². PVC.
ALL OTHER WIRING MARKED * TO BE WHITE 1.0mm². PVC
OR # TO BE WHITE 4.0mm²
UNLESS IDENTIFIED BY COLOUR.

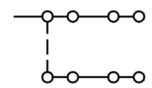
(BN) - BROWN
(BK) - BLACK
(GY) - GREY
(BL) - BLUE
(G/Y) - GREEN/YELLOW EARTH CONNECTION.

3: CT WIRING IS IDENTIFIED BY RED FERRULES.
VT WIRING IS IDENTIFIED BY YELLOW FERRULES.

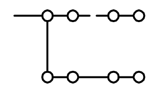
4: ALL CASES OF RELAYS OR METAL EQUIPMENT THAT CAN BE TOUCHED ARE TO BE EARTHED USING G/Y 2.5mm²

5. ALL TERMINAL BLOCKS TO BE AS FOLLOWS:
TB1 & 2 TYPE WDU4 SL.
TB3-7/1-12 TYPE WTL6 SL.
TB3-7/13-16 TYPE WDU10 SL.
ELK TYPE STL5.
ALL 240VAC TERMINALS TO BE FULLY SHROUDED AND DANGER WARNING LABEL APPLIED.

6. CT NORMAL OPERATION - SHORT CIRCUITING SLIDER BETWEEN TERMINAL BLOCKS TO BE OPEN AND DISCONNECT SLIDE LINK ON CT INCOMING TERMINAL BLOCK CLOSED IE



CT SHORT CIRCUIT OPERATION - SHORT CIRCUITING SLIDER BETWEEN TERMINAL BLOCKS TO BE CLOSED AND DISCONNECT SLIDE LINK ON CT INCOMING TERMINAL BLOCK OPEN IE.



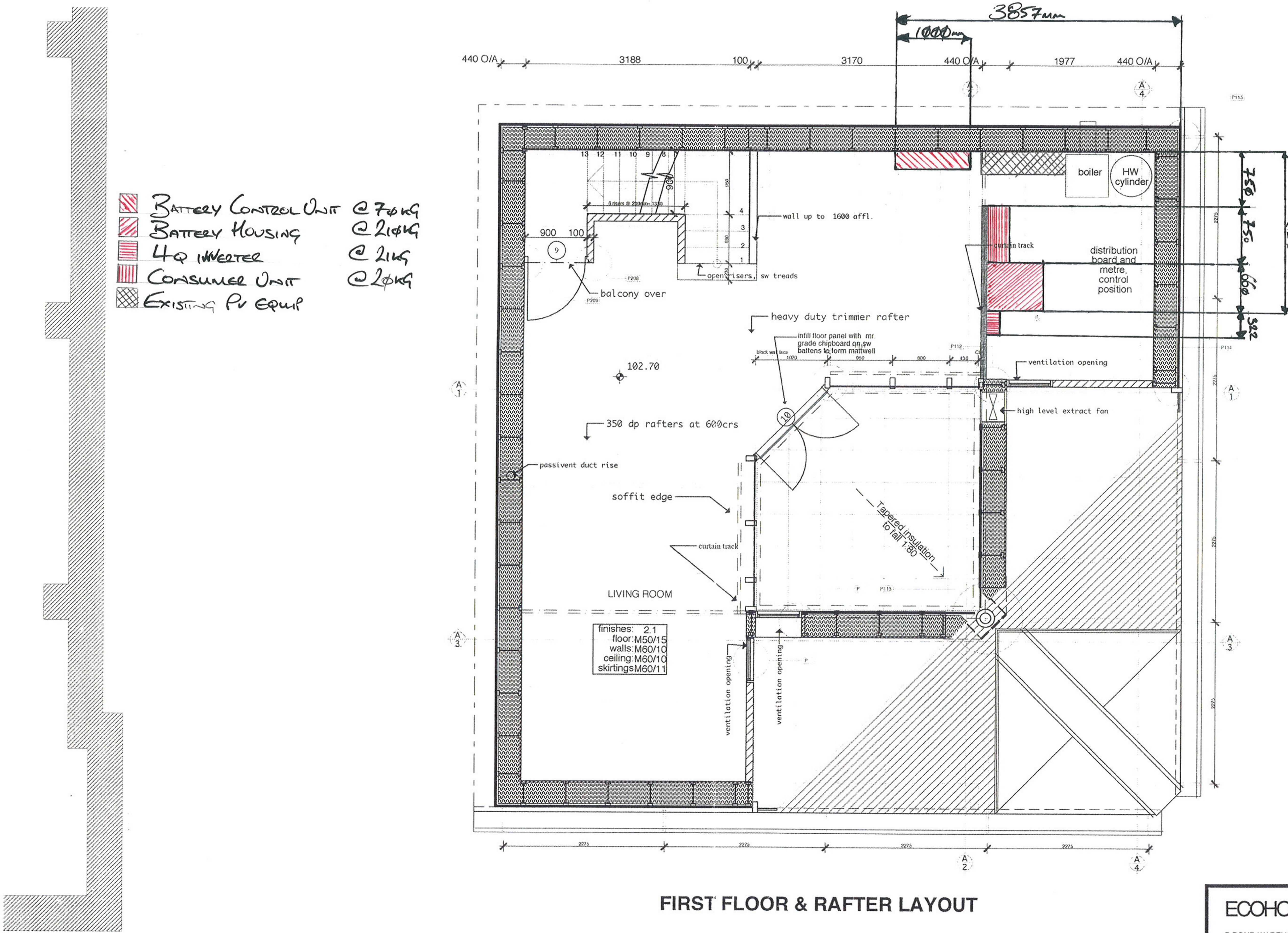
SITE DRG No.

Customer: WPD	Project: WPD BRISTOL So-La Smart Grid
Contractor: SIEMENS Transmission and Distribution Ltd.	Title: WIRING DIAGRAM OF A LV NETWORK MANAGER BACK PLATE
Customer Reference: 8259497	Contractor Drawing No.: G85221-B0232-H1-Q001
Sales Reference: 77PO-03125	Customer Drawing No.:

Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet 002 of 002	Revision
	P.Winton	K.Waite	K.Waite	26.07.12		A1		A

REVISION:	A	
DRAWN:	P.Winton	26.07.12
CHECKED:	K.Waite	26.07.12
APPROVED:	K.Waite	26.07.12

FIRST ISSUE



FIRST FLOOR & RAFTER LAYOUT

ECOHOME	BRUGES TOZER PARTNERSHIP ARCHITECTS
B BOND WAREHOUSE, SMEATON ROAD, BRISTOL.	7, UNITY STREET, BRISTOL BS1 5HH tel: 0117 927 9797 fax: 0117 9279 623
drawing: 770:2A	scale: 1:50 date: september 1995

SIEMENS **Transmission & Distribution Ltd**			
WPD/BRISTOL		**Property Bill Of Materials Version Log**	
Name	Date	Change Description	Version Number
Andrew Smyth	05.09.12	Document Release	V1.0

WPD / BRISTOL - Procurement Schedule

Phase Ref - **EcoHome Trial Installation**

Manufacturer	Part Number	Supplier	Description	No of pc	Total
Siemens	6MF11130GA100AA0BB	Siemens	LV Connection Manager (e-mic)	1	1
Siemens	6MF12131GA050AA0	Siemens	Flash card 2GB	1	1
Siemens	6MF11130GG300AA0GG	Siemens	PS-6630 Power Supply	1	1
Siemens	7KG7755-0AA00-0AA1	Siemens	Property Meter P55	1	1
PE Systems		PE Systems	Battery Cable Transmission Box (x2)	1	1
Fiamm	SMG/F	PE Systems	Batteries	4	4
PE Systems		PE Systems	Collapsable Battery Housing	1	1
Studer	XTM-3500-24	Studer	Studer - Xtender Inverter (Commercial)	1	1
Studer	Xcom-232i	Studer	Studer - Xcom Unit (Domestic)	1	1
Studer	BTS-01	Studer	Studer - Temperature Sensor (Domestic)	1	1
IPU Group	MainsPro	CPS Ltd	G59 Protection Relay	1	1
Moixa	BMS/HUB002	Moixa	MX - DC Manager / Smart HUB	1	1
Moixa	SK002-CM	Moixa	MX - USB DC socket	3	3
Billion	BiPAC 7800GZ		Domestic router	1	1
Crabtree	4170	Crabtree	Light Switch - SPDT	5	5
Crabtree	2141	Crabtree	Light Switch - Pull Cord	3	3
			E27 Light Pendants	14	14
ECS-Marine	12962.000.	Mearns	ECS-Marine - Megalux Bathroom LED Light	1	1
Horizon Star Energy	E273X1PWW-L	Mearns	Horizon Star Energy LED 6W 24vDC E27 fitting	10	10
Horizon Star Energy	E276X1PCW-L	Mearns	Horizon Star Energy LED 3W 24vDC E27 fitting	5	5
LEDLightbulb.net	T5-1FT-60SMD-WW-24V	Mearns	T5 LED Tube (LEDLightbulb.net)	2	2
	SLL18NJ	Mearns	T5 slimline fluorescent fittings	1	1
Rittal	KS1466500	Rittal	Plastic enclosure with metal backplate. 600x600x200	1	1
Rittal	KS1483010	Rittal	Wall mount kit	1	1
Weidmuller	779-598	RS	WDK 2.5 Double Terminals -1021500000	20	20
Weidmuller	131-6700	RS	End Plate -1059100000	4	4
Weidmuller		RS	WPE 4.0 Earth Terminal -1010100000	4	4
Siemens	5TE1201-0DA	Siemens	100A DP Switch Disconnector	1	1
Siemens	8GP1853-0DA20	Siemens	Single Phase Connection Kit	1	1
Siemens	5SU9306-1KK16	Siemens	16A Single Module RCBO - 30mA Sensitivity	1	1
Siemens	5SU9306-1KK06	Siemens	6A Single Module RCBO - 30mA Sensitivity	1	1
Siemens	5SY5216-7	Siemens	16A DC Double Pole MCB	1	1
Siemens	5SY5206-7	Siemens	6A DC Double Pole MCB	1	1
Siemens	5SY5208-7	Siemens	8A DC Double Pole MCB	2	2
Siemens	7XV5103-0AA01	Siemens	Y bus cables RS485	6	6
Siemens	7XV5103-5AA00	Siemens	Bus / RS485 terminator	3	3
RS	556-538	RS	Patch cord Cat 5e UTP PVC 0.5m Green	3	3
RS	116-3001	RS	MONITOR CABLE 316 9MM ST / ST	1	1
RS	116-4228	RS	MONITOR EXTENSION DB9 F-F	1	1
Siemens	7XV5103-2BA00	Siemens	Y-Adapter Cable	1	1
		Lane Plastics	MDF Cover	1	1

WPD / BRISTOL - Procurement Schedule

Phase Ref - **Domestic Trial Installations**

Manufacturer	Part Number	Supplier	Description	No of pc	Total
Siemens	6MF11130GA100AA0BB	Siemens	LV Connection Manager (e-mic)	1	2
Siemens	6MF12131GA050AA0	Siemens	Flash card 2GB	1	2
Siemens	6MF11130GG300AA0GG	Siemens	PS-6630 Power Supply	1	2
Siemens	7KG7755-0AA00-0AA1	Siemens	Property Meter P55	1	2
PE Systems		PE Systems	Battery Cable Transmission Box (x2)	1	2
Fiamm	SMG/F	PE Systems	Batteries	4	8
PE Systems		PE Systems	Collapsable Battery Housing	1	2
Studer	XTM-2400-24	Studer	Studer - Xtender Inverter (Commercial)	1	2
Studer	Xcom-232i	Studer	Studer - Xcom Unit (Domestic)	1	2
Studer	BTS-01	Studer	Studer - Temperature Sensor (Domestic)	1	2
IPU Group	MainsPro	CPS Ltd	G59 Protection Relay	1	2
Moixa	BMS/HUB002	Moixa	MX - DC Manager / Smart HUB	1	2
Moixa	SK002-CM	Moixa	MX - USB DC socket	3	6
Billion	BiPAC 7800GZ		Domestic router	1	2
Crabtree	4170	Crabtree	Light Switch - SPDT	13	26
Crabtree	2141	Crabtree	Light Switch - Pull Cord	1	2
			E27 Light Pendants	14	28
ECS-Marine	12962.000.	Mearns	ECS-Marine - Megalux Bathroom LED Light	1	2
Horizon Star Energy	E273X1PWW-L	Mearns	Horizon Star Energy LED 6W 24vDC E27 fitting	10	20
Horizon Star Energy	E276X1PCW-L	Mearns	Horizon Star Energy LED 3W 24vDC E27 fitting	3	3
Rittal	KS1466500	Rittal	Plastic enclosure with metal backplate. 600x600x200	1	2
Rittal	KS1483010	Rittal	Wall mount kit	1	2
Weidmuller	779-598	RS	WDK 2.5 Double Terminals -1021500000	20	40
Weidmuller	131-6700	RS	End Plate -1059100000	4	8
Weidmuller		RS	WPE 4.0 Earth Terminal -1010100000	4	8
Siemens	5TE1201-0DA	Siemens	100A DP Switch Disconnector	1	2
Siemens	8GP1853-0DA20	Siemens	Single Phase Connection Kit	1	2
Siemens	5SU9306-1KK16	Siemens	16A Single Module RCBO - 30mA Sensitivity	1	2
Siemens	5SU9306-1KK06	Siemens	6A Single Module RCBO - 30mA Sensitivity	1	2
Siemens	5SY5216-7	Siemens	16A DC Double Pole MCB	1	2
Siemens	5SY5206-7	Siemens	6A DC Double Pole MCB	1	2
Siemens	5SY5208-7	Siemens	8A DC Double Pole MCB	2	4
Siemens	7XV5103-0AA01	Siemens	Y bus cables RS485	6	12
Siemens	7XV5103-5AA00	Siemens	Bus / RS485 terminator	3	6
RS	556-538	RS	Patch cord Cat 5e UTP PVC 0.5m Green	3	6
RS	116-3001	RS	MONITOR CABLE 316 9MM ST / ST	1	2
RS	116-4228	RS	MONITOR EXTENSION DB9 F-F	1	2
Siemens	7XV5103-2BA00	Siemens	Y-Adapter Cable	1	2
		Lane Plastics	MDF Cover	1	2

WPD / BRISTOL - Procurement Schedule

Phase Ref - **Substation Installations**

Manufacturer	Part Number	Supplier	Description	No of pc	No of pc
Siemens	6MF11130GA140AA0BB	Siemens	LV Network Manager ™	1	13
Siemens	6MF12131GA050AG0	Siemens	Flash Card 2GB	1	13
Siemens	6MF12110CJ600AA0	Siemens	CM-2860 Patch Plug standard V28,ET,TR	2	26
Siemens	7KG7750-0AA03-0AA1	Siemens	Substation Meter P50	5	65
Siemens	6MF10130CF560AA0BB	Siemens	SM-2556 Network-Interf.Ethernet 10/100TX	1	13
Siemens	6MF10130AF510AA0BB	Siemens	SM-0551 Serial Interface Processor 1 SI	1	13
Siemens	6MF11112AJ200AF0	Siemens	CM-0829 RS232/RS485 Converter	1	13
Siemens	6NH9741-1AA00	Siemens	SINAUT MD741-1 GPRS Router	1	13
Siemens	6NH9870-1AA00	Siemens	Multi Band Flat antenna ANT794-3M	1	13
Siemens	6EP1333-2BA01	Siemens	Power supply 240AC/24DC 5A Power Supply	1	13
Siemens	7XV5103-0AA01	Siemens	Y bus cables RS485	65	65
Siemens	7XV5103-5AA00	Siemens	Bus / RS485 terminator	13	13
Siemens	5SY5204-7	Siemens	4A MCB	1	13
Siemens	6MF1807-0GB02-0AA1	Siemens	SICAM 230 First Licence 2.0	1	1
Siemens	6MF18070GA340AA1	Siemens	DVD	2	2
Siemens	6MF18070GA250AA1	Siemens	Dongle	2	2
Siemens	6MF18070GD570AA1	Siemens	Demo Editor Licence 2.0	1	1
Dell		Splitsec	PC equiped with SCALA data server	1	1
Vodaphone		WPD	GPRS SIM Card	1	13
	See drawing 'meter plates cut out'		3U Blanking Plates	2	26
			4U Blanking Plates cut out for 3 meters	1	13
			4U Blanking Plates cut out for 2 meters	1	13
Rittal	1073500	Rittal	AE ENCLOSURE 760X760X300 RAL 7035	1	13
Rittal	2508010	Rittal	Wall Bracket Kit 10mm (pk of 4)	1	16
Rittal	2519000	Rittal	SZ2519 DOOR STAY FOR AE (pk of 5)	1	15
Rittal	2493000	Rittal	LOCK COVER	1	13
Rittal	2034200	Rittal	SR2034 14U SWING FRAME FOR AE	1	13
Rittal	2514600	Rittal	SZ PLASTIC PLAN HOLDER FOR AE	1	13
RS	528-015	RS	Grey Patch Lead Cat5e (1m)	1	13
RS	556-538	RS	Patch Cord Cat5e (Green, 0.5m)	1	13
Weidmuller	WDU4SL	Weidmuller	240VAC Terminals	4	52
Weidmuller	WDU4SL	Weidmuller	24VDC Terminals	8	104
Weidmuller	WTL6SL	Weidmuller	CT Terminals	20	260
Weidmuller	WDU10SL	Weidmuller	VT Terminals	60	780
Weidmuller	STL5	Weidmuller	Earth Links	5	65
Weidmuller	WTL6/1	Weidmuller	Disconnect Test Terminal Block	30	390
Weidmuller	WTD6/1	Weidmuller	Disconnect Test Terminal Block	30	390
Weidmuller	QVS2	Weidmuller	Cross Connection Slide	30	390
Weidmuller	WAPWTL	Weidmuller	End Plate	5	65
Weidmuller	VH19	Weidmuller	Connection Sleeve	60	780
Weidmuller	BS25	Weidmuller	Fixing Screw	30	390
Weidmuller	S+B35 YELLOW	Weidmuller	Sockets	30	390
Weidmuller	S+B14	Weidmuller	Sockets	30	390
Weidmuller	SSP3	Weidmuller	Disconnect Lock	30	390

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Report Title:	Review of mixed AC and DC wiring
Author:	M W Coates
Client:	Western Power
Client Reference:	LVDC Installations
Report Number:	2012-0479
Project Number:	11WEST003
Report Version:	Final Report Issue 1
Document Control:	Commercial-in-Confidence

Report Checked by:	**Approved by:**
Mr B Knox	Dr A Friday
Principal Engineer	Head of Engineering Design and Performance

September 2012

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Summary

Western Power Distribution is embarking on a project to demonstrate the use of Low Voltage d.c. and battery storage systems in domestic properties, schools and an office. The LVDC system is intended for use in lighting and small power applications and is intended to avoid the need for d.c./a.c. converters.

ERA has been asked to provide consultancy relating to the requirements for separation between a.c. and d.c. circuits and address safety concerns such as induced voltages.

The review of the requirements of BS 7671 has not revealed any regulations that would prevent the wiring of the proposed installations complying with BS 7671. Consideration of the magnitude of the induced voltages in the LVDC circuits has shown that these voltages would be measured in millivolts rather than volts and hence they are not a safety issue.

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1. Introduction

Western Power Distribution is embarking on a project to demonstrate the use of Low Voltage d.c. and battery storage systems in domestic properties, schools and an office. The LVDC system is intended for use in lighting and small power applications and is intended to avoid the need for d.c./a.c. converters. The project is being supported by the Low Carbon Network fund 'BRISTOL'.

ERA has been asked to provide consultancy relating to the requirements for separation between a.c. and d.c. circuits and address safety concerns such as induced voltages.

ERA has been informed that the majority of properties where the concept is to be applied were constructed between 1920 and 1945 and all have been rewired. Most of the rewiring was approximately 15 years ago and it is known that existing lighting and power circuits are run in common conduits or trunking for at least part of the circuit length. The lighting and power circuits are also likely to run through common holes in joints and generally there will be no physical separation between different circuits for at least part of their run.

2. Review

2.1 General

It is intended that the existing lighting circuits will be used to feed the LVDC applications. Provided that the circuits are in good condition and have adequate current carrying capacity and no excessive voltage drop there is considered to be no fundamental reason why these circuits should not be operated at 24 V d.c. Western Power Distribution is aware that accessories such as switches, circuit breakers and other control-gear must be capable of operating safely in DC applications.

2.2 BS7671

Regulation 528.1 of BS 7671 (2011) contains a requirement that a Band I circuit shall not be contained in the same wiring system as a Band II circuit. The LVDC circuits would fall into Band I and the ring main and other 230 V circuits would fall into Band II. This regulation allows a number of exceptions. The first exception is that it is permitted to mix the circuits if every cable or conductor is insulated for the highest voltage present. Thus Regulation 528.1 permits the mixing of LVDC circuits with low voltage power circuits such as ring mains or radial power circuits.

The requirements given in 528.1 have been in existence since at least the 10th edition of the Wiring Regulations (1934). This edition also permitted the circuits to be mixed when the extra low voltage circuits were insulated for the highest voltage present.

It is believed that these requirements were put in place to minimise the risk of mains voltage being transferred to the ELV circuits in the event of a fault. It is considered that these requirements do not relate to any EMC issues that may occur.

Regulation 515.2 of BS 7671 (2011) requires segregation between equipment carrying current of different types or at different voltages to be segregated if they are grouped together in a common assembly. It is noted that this requirement also existed in the 1934 edition of the Wiring Regulations.

It is not anticipated that switchgear or other LVDC equipment will be contained in the same assembly as mains power circuits. Thus this regulation is not considered to be relevant.

Chapter 51 of BS 7671 also contains requirements concerning the identification of circuits and use of warning notices. Although there are no specific requirements for notices identifying the presence of LVDC circuits it is suggested that notices are fixed at both the mains supply point and the d.c. control-gear warning of the presence of mixed a.c. and d.c. circuits. This suggestion is made because the installations will be of an uncommon nature.

Section 444 of BS 7671 contains requirements and recommendations for the avoidance and reduction of electromagnetic disturbances. The requirements of this section are primarily concerned with avoiding disturbances on IT and communications systems as well as equipment containing electronic components or circuits. These requirements are not directly relevant to the type of mixed mains and LVDC circuits that are proposed. However they do highlight the possibility of an interaction between the two types of circuit when they are in close proximity. This interaction is discussed below.

2.3 Electromagnetic effects

When several circuits are run in close proximity to each other there will be an interaction between the circuits. Two forms of interaction have to be considered; capacitive coupling and inductive coupling. Capacitive coupling is a function of the electric field produced by cables or other equipment that are energised but not necessarily carrying current. Inductive coupling is a function of the magnetic field produced by cables or other equipment carrying current.

Capacitively coupled voltages seen on a cable due to its proximity with another circuit will be a function of the voltage of the other circuit and the distance of the victim cable from the line conductor and the neutral or earth conductor. A typical example of such a voltage can be found with traditional twin and earth cables if the line and neutral are connected and the earth is left floating. In such circumstances it has been reported that a voltage of approximately 120 V can be measured between line and cpc and between neutral and cpc. This is to be expected because the cpc is physically positioned at the midpoint of the field generated by the line conductor. In low voltage circuits, in traditional installations, capacitively coupled voltages are very low energy sources and cannot deliver a dangerous current. The voltages can be measured using a digital voltmeter because such meters usually have a high input impedance. If an attempt is made to measure such voltages with a meter such as a Model 8 AVO the current drawn by the meter will be such that the voltage collapses and hence it does not register on the meter. This is because of the lower input impedance of the AVO 8 when compared with that of most DVMs.

Capacitively coupled voltages that may be measured on disconnected lighting circuits that run in the vicinity of energised power circuits are of very low energy and hence are not a cause for concern.

Inductively coupled voltages that can occur on a cable due to its proximity to another circuit are a function of the current carried by the other circuit, the distance over which the two circuits run in parallel and the separation between the source and victim circuits. Induced voltages are due to the magnetic field generated by the current flow in the loaded circuit and are independent of the circuit voltages. Induced voltages are also largely independent of the size of the source and victim cables.

The magnetic field due to the current in the line conductor will be 180° out of phase with that produced by the current in the neutral conductor. This will lead to some cancellation of the magnetic field at the position of the victim cable and hence a reduction in the induced voltage. Theoretically if the line and neutral cables are separated and the victim cable sits at exactly the midpoint between them there will be no induced voltage on the victim cable. This is because the magnetic fields from the line and neutral conductors cancel each other at this point.

The maximum induced voltage will appear on the victim cable if the line and neutral conductors are widely separated and the victim cable is close to one of them. Calculated induced voltages are given below for different separations of the line and neutral conductor with the victim cable touching the line cable, Fig. 1.

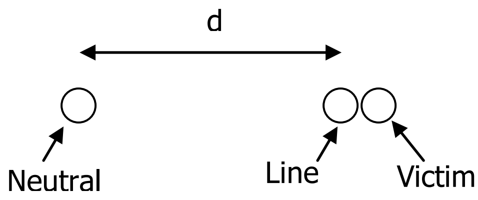

Figure 1 Cable layout for example calculations

The calculated induced voltages given below assume single-core conduit cables having an overall diameter of 3.5 mm so that the centre to centre distance from the line conductor to the victim is 3.5 mm. The load in the source circuit has been taken to be 20 A and the circuits are taken to run in close proximity for 10 m.

Table 1 Induced voltages

Separation, d, mm	Induced voltage, V
5	0.011
10	0.017
25	0.026
50	0.034
100	0.043

The value given for a 5 mm separation can be taken to be an approximation of the voltage that would be induced in a single-core cable running touching a twin and earth cable.

The calculated voltages given in Table 1 are directly proportional to current and the distance over which the circuits run in parallel. So if the load current was increased to 100 A the induced voltage would be increased by a factor of five giving an induced voltage of 0.215 V for a 100 mm separation. Similarly with a current of 100 A and a length in parallel of 100 m the induced voltage would be 2.15 V.

The magnitude of the induced voltages given above show that inductively coupled voltages are not a cause for concern in the proposed installations.

In addition to the points discussed above induced voltages are a function of frequency thus the LVDC circuits will not induce a voltage on the mains circuits.

3. Conclusions

The review of the requirements of BS 7671 has not revealed any regulations that would prevent the wiring of the proposed installations complying with BS 7671. Consideration of the magnitude of the induced voltages in the LVDC circuits has shown that these voltages would be measured in millivolts rather than volts and hence they are not a safety issue.

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Engineering Design and Performance – Assessment of electrical and mechanical components, systems and materials; Third party verification

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ELECTRIUM SALES LIMITED
CERTIFICATE OF COMPLIANCE

Cert Number: 10694

We Electrium Sales Limited of
Leigh Road
Hindley Green
Nr Wigan
Lancashire
England
WN2 4XY

hereby declare that the following products listed on this certificate have been manufactured to the requirements and test(s) of:-

BSEN60669-1:2000 including amendments 1 & 2, corrigendum 1

Product Description:

10AX 1 gang 2 way single pole plate switch
6A 2 way single pole ceiling switch

Ref Number:

4170
2141

BASED ON: CP10679

DATED: 6th September 2012

Such compliance as is detailed is based on the products named having the following prescribed rating(s):-

Rated Voltage: 24V dc

Rated Current: Tested up to 0.8 Amps

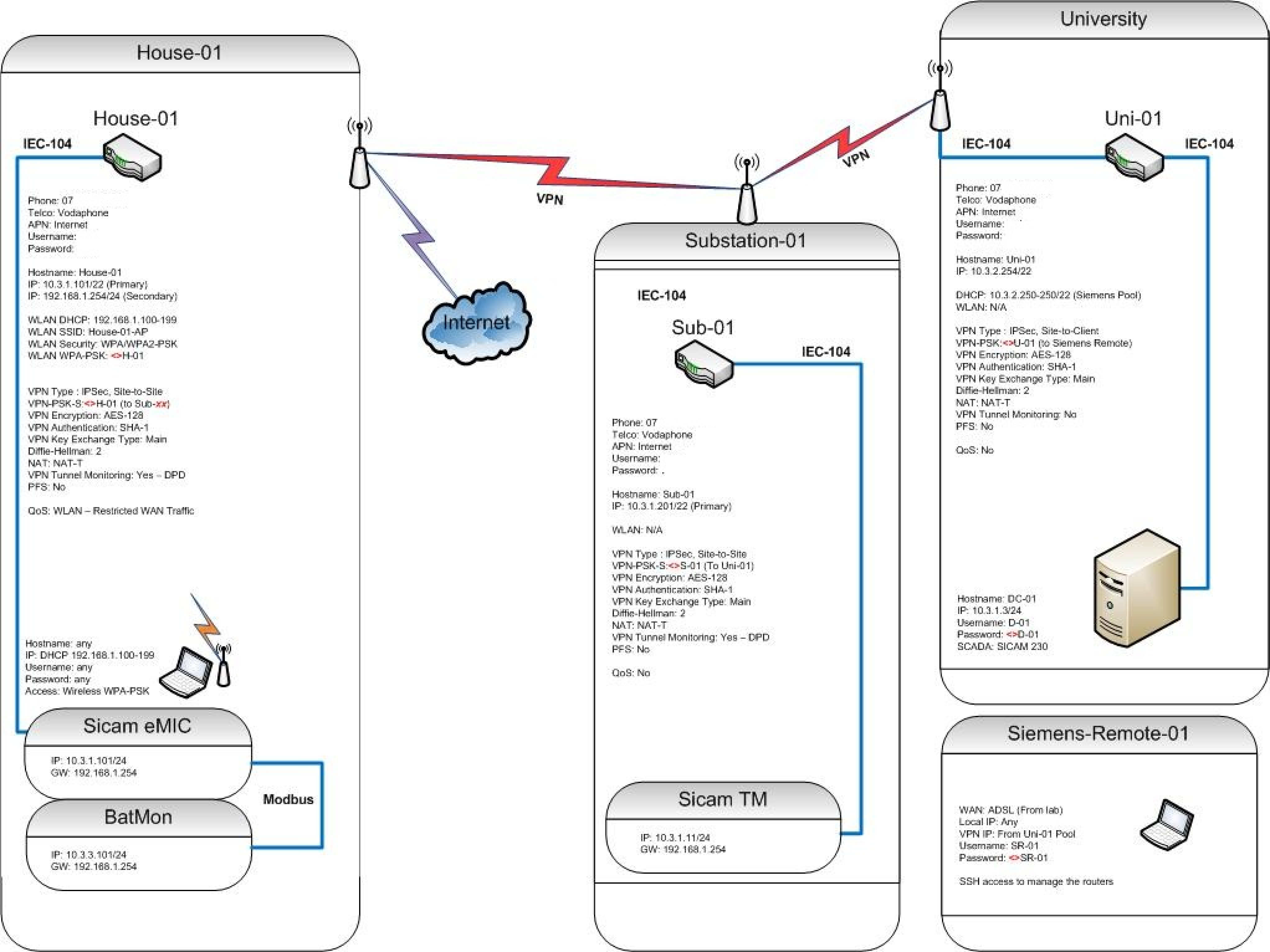
Rated Frequency: 50Hz

....

Signed on behalf of Electrium Sales Limited

POSITION: Laboratory Manager

Date: *07-Sep-2012*


House-01
House-01
IEC-104
Phone: 07
Telco: Vodaphone
APN: Internet
Username:
Password:
Hostname: House-01
IP: 10.3.1.101/22 (Primary)
IP: 192.168.1.254/24 (Secondary)
WLAN DHCP: 192.168.1.100-199
WLAN SSID: House-01-AP
WLAN Security: WPA/WPA2-PSK
WLAN WPA-PSK: <>H-01
VPN Type : IPSec, Site-to-Site
VPN-PSK-S:<>H-01 (to Sub-xx)
VPN Encryption: AES-128
VPN Authentication: SHA-1
VPN Key Exchange Type: Main
Diffie-Hellman: 2
NAT: NAT-T
VPN Tunnel Monitoring: Yes – DPD
PFS: No
QoS: WLAN – Restricted WAN Traffic
Hostname: any
IP: DHCP 192.168.1.100-199
Username: any
Password: any
Access: Wireless WPA-PSK
Sicam eMIC
IP: 10.3.1.101/24
GW: 192.168.1.254
Modbus
BatMon
IP: 10.3.3.101/24
GW: 192.168.1.254
VPN
Internet
VPN
Substation-01
IEC-104
Sub-01
IEC-104
Phone: 07
Telco: Vodaphone
APN: Internet
Username:
Password: .
Hostname: Sub-01
IP: 10.3.1.201/22 (Primary)
WLAN: N/A
VPN Type : IPSec, Site-to-Site
VPN-PSK-S:<>S-01 (To Uni-01)
VPN Encryption: AES-128
VPN Authentication: SHA-1
VPN Key Exchange Type: Main
Diffie-Hellman: 2
NAT: NAT-T
VPN Tunnel Monitoring: Yes – DPD
PFS: No
QoS: No
Sicam TM
IP: 10.3.1.11/24
GW: 192.168.1.254
University
Uni-01
IEC-104
IEC-104
Phone: 07
Telco: Vodaphone
APN: Internet
Username:
Password:
Hostname: Uni-01
IP: 10.3.2.254/22
DHCP: 10.3.2.250-250/22 (Siemens Pool)
WLAN: N/A
VPN Type : IPSec, Site-to-Client
VPN-PSK:<>U-01 (to Siemens Remote)
VPN Encryption: AES-128
VPN Authentication: SHA-1
VPN Key Exchange Type: Main
Diffie-Hellman: 2
NAT: NAT-T
VPN Tunnel Monitoring: No
PFS: No
QoS: No
Hostname: DC-01
IP: 10.3.1.3/24
Username: D-01
Password: <>D-01
SCADA: SICAM 230
Siemens-Remote-01
WAN: ADSL (From lab)
Local IP: Any
VPN IP: From Uni-01 Pool
Username: SR-01
Password: <>SR-01
SSH access to manage the routers

System Efficiencies

By. S.Kaushik E&EE UoB

File: SoLaBristolSystemEfficienciesV0.odt

This document is intended to identify and quantify the system efficiency and losses. Where possible manufacturers claims are taken in the first instance and are to be verified through field collected data over the life time of the project.

The main building blocks of the system to be considered are

a. PV Panels and associated PV Cable

As the PV panels come with different VI ratings for similar panel wattage rating. These two figures are to be provided here. Generally the Si panels can range between 12% to 20% . Above this figure price premium applies. The 60/66 cell panels can have different.

b. Isolation, protection and interconnecting devices

Generally these devices are seen as transparent, though they do contribute to system losses. This device category includes circuit breakers, fuses, connectors and isolating mechanical devices and such like.

c. Grid side Energy import export interface.

The inverter operational, standby and active state power levels have been considered, though these can be configuration and mode of operation dependant.

d. User load side Energy export

The load types and their efficiencies are a major functional element of the system, their efficiencies are to be taken from the manufacturers claims and verified where possible with some experimental data.

e. Energy storage devices.

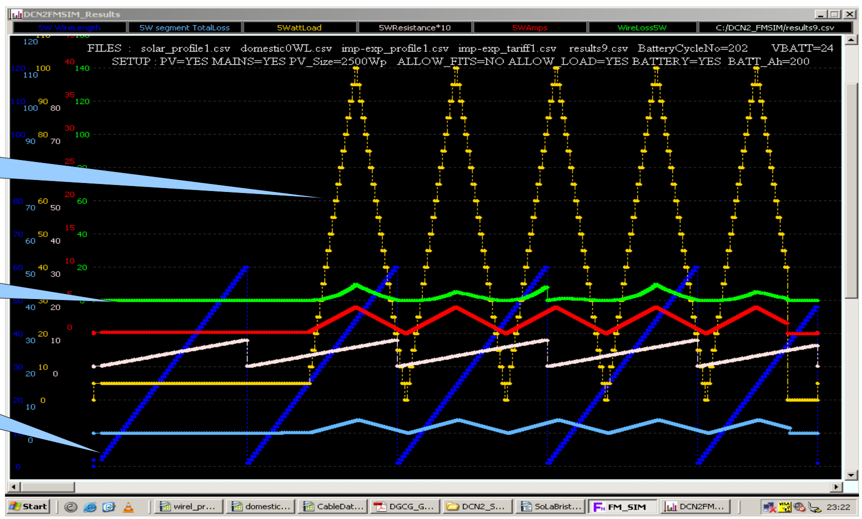
Battery efficiencies are temperature, usage and charging dependant. As the batteries are to be in wide temperature varying environment, and can have major influence on operation thus efficiency. This section is expected to have data both from the field and where possible lab testing.

f. Overall control communication and management devices.

The operational and standby states of these devices and within these

Some of the fixed and known sources of losses have been and can be modelled. In particular, the losses due to wiring can be readily produced, once the installation lengths and wire gauge have been established. The modelling tool used for this is in development phase as part of battery charging discharging simulation tool.

Fig below is one test plot as part of tool development process.



A new concept in loss reduction is Varying wire lengths. This is a new concept for fixed domestic wiring system. This is concept exploration only. The main tool however, can and does provide segment based losses for installation.

This document is considered as living document and is likely to change frequently.

Solution Outline

Product / Function:	**Overall Technical Solution**
Project:	Project BRISTOL (Buildings, Renewables and Integrated Storage, with Tariffs to Overcome network Limitations)
Document status:	Released

The document passes through the following states “Being Processed“, “In Review“ and “Released“

Document for external publication – internal references removed

Revisions

Chapter / Pages changed	Version	Object and Reason of Change/ Reference to Change Requirements	
	V1.00	Issued to client for review	
	V2.00	For publication	

Contents

Figures

Tables

1 Introduction

This document provides an overview of the proposed technical solution for Western Power Distribution's (WPD's) Tier 2 LCNF project: Buildings, Renewables and Integrated Storage, with Tariffs to Overcome network Limitations (BRISTOL). It has been compiled from information and input provided by all the project partners: Western Power Distribution, University of Bath and Siemens.

The information contained in this document is intended to demonstrate the technical feasibility of the project. The technical solution will be the subject of a detailed design phase within the Implementation phase of the project.

2 LV Distribution Network

Section 2 of the submission proforma describes the background to the project. This section seeks to identify the specific network issues that the project will resolve.

WPD's existing tier 2 project, Low Voltage (LV) Network Templates for a Low-carbon Future, seeks to characterise networks by features of customer (load and generation) and the network. Outputs from this project will be a valuable input into this project by forming the basis for network modelling activities.

For the purpose of highlighting the specific issues which the project seeks to solve, a simplistic piece of radial, tapered LV feeder is depicted with distributed loads, which are all assumed to be equal, Figure 1. It is further assumed that some of these properties have generation, which may be active for some of the time. This is shown in the top part of the figure. The second part of the figure represents the distributed load at each property along the network (in red), and the generation (green).

In the third part of the figure the resulting power flows along each section of network is shown – in blue when there is no generation output and in purple with generation. The cable thermal limits are also shown on the diagram. Finally the bottom part of figure shows the resulting voltage profile (in blue without generation output and purple with output) and again operational limits are shown.

As introduced in section 2 of the proforma, the introduction of low carbon technologies are expected to result in two specific cases with impacts on the LV network. These are listed below, along with the resulting effects that this project will address.

1. Excess generation over load on the local network, resulting in
    - 1a. Voltage upper limits exceeded, and/or
    - 1b. Thermal limits exceeded (power import); and
2. High peak load, resulting in
    - 2a. Voltage lower limits exceeded, and/or
    - 2b. Thermal limits exceeded (power export).

Three of these effects are highlighted in the power flow and voltage profile graphs of Figure 1.

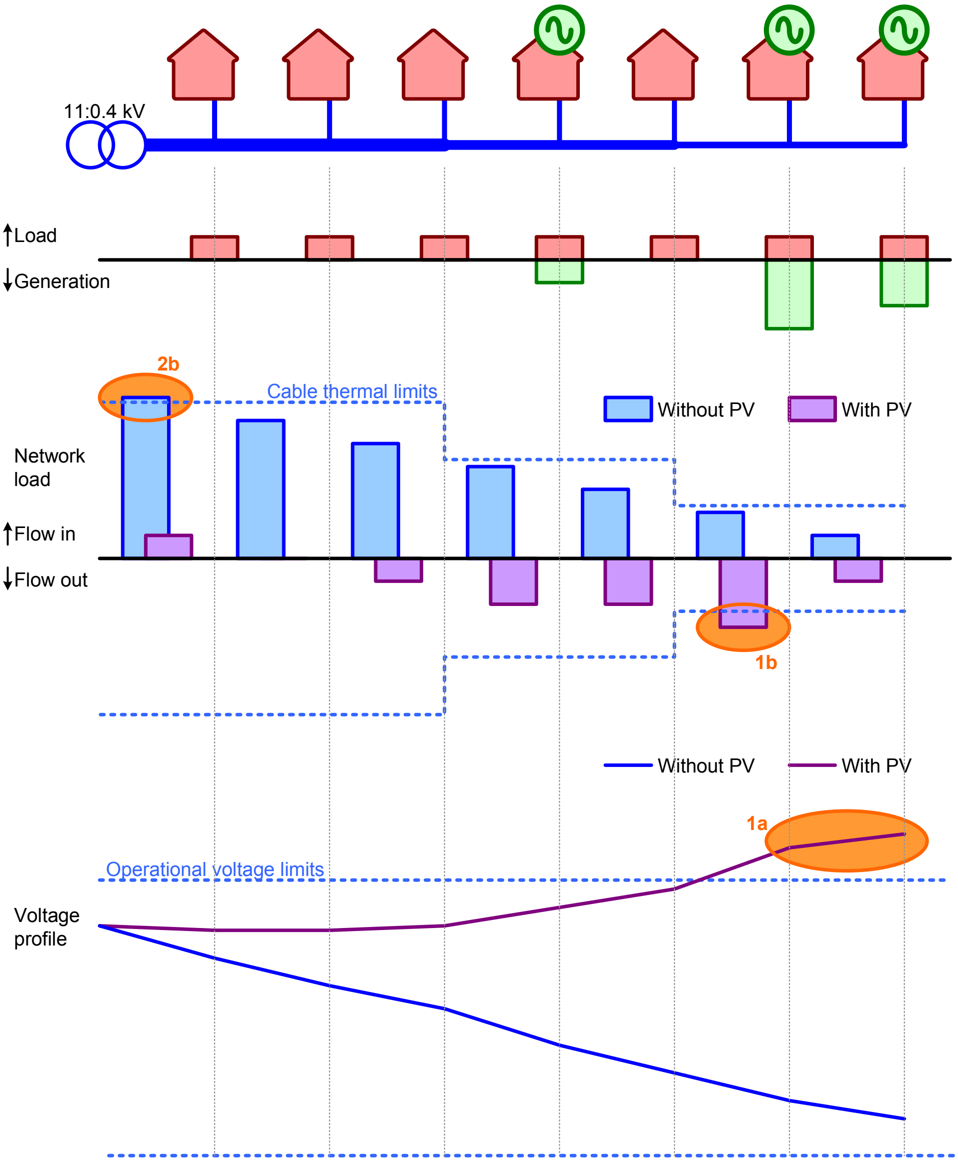


Figure 1 Problem Elaboration

3 Description of Subject Properties

3.1 Domestic Properties

The domestic properties will be selected from Bristol City Council housing stock, for social housing. It is assumed that these will be semi-detached or terraced properties with three bedrooms and two reception rooms, and fitted with double-glazing and loft insulation. While it would be advantageous for some of these properties to be fitted with PV, this is not a criterion for selection.

It is hoped that all the properties in the trial can be on a single distribution transformer, preferably on a single feeder.

These properties will normally be connected single-phase, with a 63 A fuse.

Assumptions

The following assumptions are made about a “standard” property for modelling and budgeting purposes.

- Two DC lighting circuits, with 8 light switches and 14 lamps
- One DC power circuit, with 5 power points
- Properties fitted with PV have 2 kWp installed

3.2 Schools

The schools will be selected from those which have pre-qualified for Bristol City Council’s Solar PV for Bristol Schools scheme. Criteria for selection are that they should have an LV connection and that there should be other properties connected on the same feeder. The connection can be 3-phase or single-phase.

Assumptions

The following assumptions are made about a “standard” property for modelling and budgeting purposes.

- One DC lighting control circuit, with a single control point, and 10 luminaires
- Three DC power circuits, each with 8 power points
- PV typically in the range 3 kWp to 10 kWp, with potential for one school with 50 kWp

3.3 Commercial Office Space

The commercial office space will be one floor of one of Bristol City Council’s office buildings. It will be fitted out with battery storage and IT equipment powered with DC power supplies. Criteria for selection are that they should have an LV connection and that there should be other properties connected on the same feeder. The connection can be 3-phase or single-phase.

Assumptions

The following assumptions are made for modelling and budgeting purposes.

- One DC lighting control circuit, with a single control point or zonal occupancy detection sensor, and 16 luminaires
- Four DC power circuits, each with 8 power points
- A 10 kWp PV panel

4 Solution Overview

This section identifies the components which are to be used, and describes their combined operation, to deliver the Learning Objectives.

4.1 Components

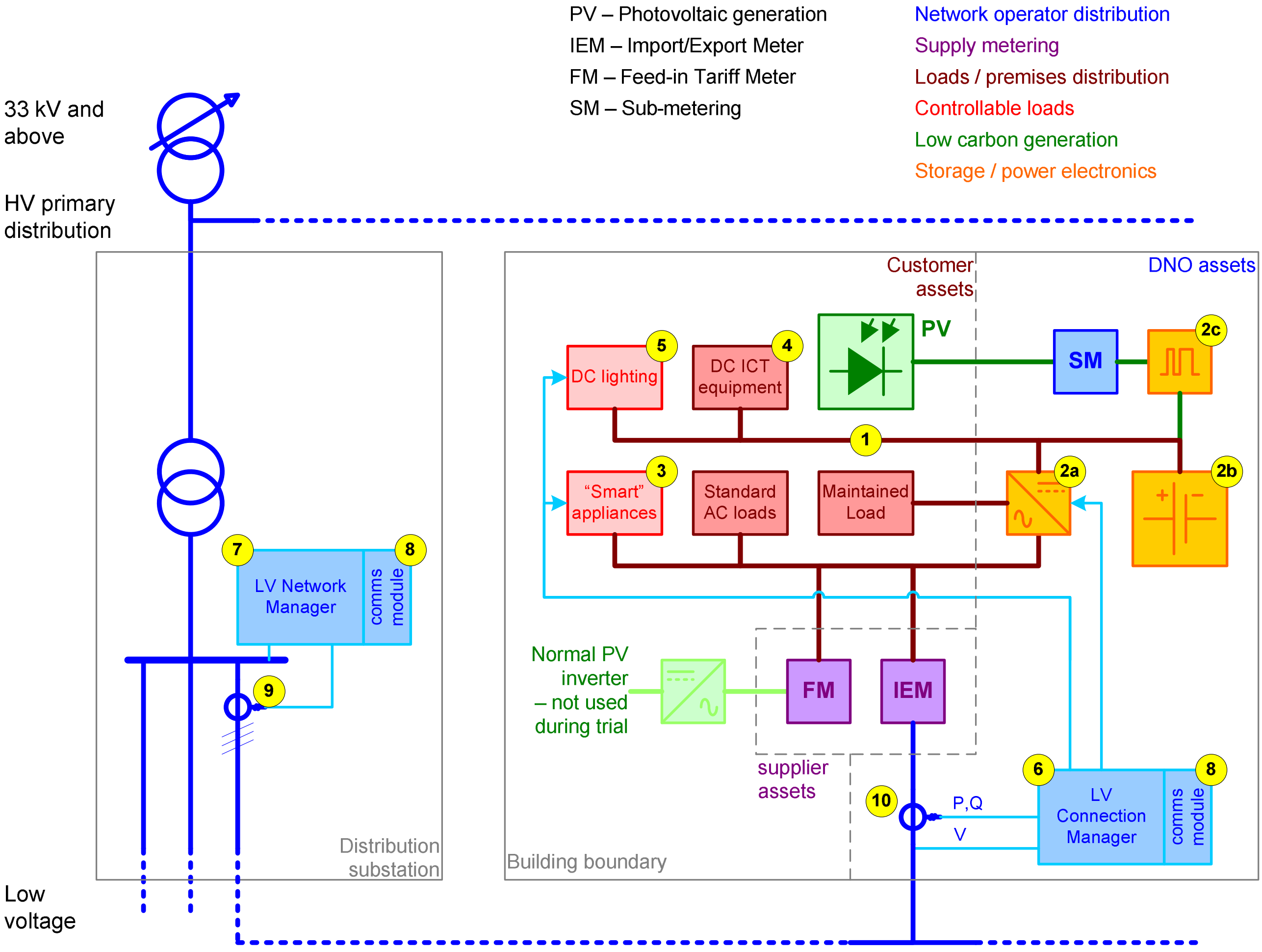


Figure 2 Technical Solution

Within Premises Equipment

Normal electrical distribution arrangements for premises connected at low voltage (LV) are as follows:

- The electrical supply is delivered by the network operator to the point of connection where it is metered. For feed-in tariff purposes this is an import/export meter (IEM in Figure 2).
- Photovoltaic (PV) generation is normally connected to the premises AC distribution through an inverter and feed-in tariff meter (FM).
- Appliances within the premises are supplied by AC distribution.

For the BRISTOL project it is proposed to modify this arrangement as follows:

- On the network side of the import/export meter (IEM) sensing equipment (10) is connected which provides measurements of voltage and power to the LV Connection Manager (6).
- An inverter (2a) connects a battery (2b) to the premises AC distribution.
- The battery also feeds a DC distribution system (1) which supplies DC loads such as IT equipment (4) and lighting (5).
- The PV generation, rather than feeding the AC distribution through its inverter, delivers its power to the battery and DC distribution system through a charge controller (2c).
- The LV Connection Manager is connected to control/influence the operating mode (charge/discharge) of the battery inverter (2a) and any loads which it can, including smart appliances (3), controllable AC loads such as intelligent appliances, and any controllable DC lighting.
- The LV Connection Manager communicates with the LV Network Manager (7) in the distribution substation using attached communication modules (8).

Substation Equipment

For the BRISTOL project equipment will be fitted at the distribution transformer/substation as follows:

- Sensing equipment (9) at the distribution transformer/substation is connected which provides measurements of voltage and power to the LV Network Manager (7).
- The LV Network Manager monitors the local measurements it receives, and those received from LV Connection Managers at premises on the LV network, to identify when the LV network reaches constraint points. These may be voltage and/or thermal constraints, and may be caused by an excess of load or an excess of generation. It then makes requests of the LV Connection Managers to adjust their load position to correct any constraint situations.

4.2 System Operation

The LV Connection Manager and the LV Network Manager provide the intelligence which allows the network to operate flexibly, to overcome the problems under investigation. The remaining components, while key to delivering the solution, respond to the instructions of these elements.

The LV Network Manager determines when a constraint is reached and determines where response is needed and requests that response.

The LV Connection Manager takes requests for response and turns those into actions by the equipment which is controllable in the premises.

4.3 Demand Response

While distributed electrical energy storage is the principle resource for responding to network needs, part of the solution being tested is demand response (DR), which is the ability of electrical equipment to modulate its load on the system in response to system needs and requests. The phrase is often used interchangeably with demand reduction, but DR may also include increasing load in response to system need.

There have been, and are ongoing, other studies[1,2] on the social aspects of DR and the depth of capability which they may offer. This project is not concerned with this, but rather to demonstrate and test the technical feasibility of integrating them within a system for management of the distribution network. This extends to whether the speed and duration demanded for network purposes is compatible with supply quality expectations of load customers.

Network planning activities for low carbon technologies frequently produce planning output with the constraint conditions described in section 1; reinforcements are required for these developments to proceed. Allowing the developments without reinforcement requires alternative methods of ensuring that the constraints do not occur, which is the basis for the technology trials of this project.

When there is low incidence of low carbon technologies, constraints at the planning stage may not necessarily result in actual constraint conditions in practice. However, as the quantity of these premises increases actual constraint conditions will become more prevalent. The frequency, duration and nature of constraint conditions under these scenarios is not yet known and this project will also allow this to be quantified, and hence establish which loads can provide the most appropriate demand response for the constraint.

Table 1 and Table 2 show the types of loads available in domestic properties in the UK, from the perspectives of demand reduction and demand increase respectively. It is not expected that immersion heaters or storage heating will be available within the domestic properties under consideration for this project, therefore these loads are not considered for the project.

[1] Energy Demand Research Project, http://www.ofgem.gov.uk/sustainability/edrp/Pages/EDRP.aspx
[2] Sustainability First project on GB Electricity Demand

Table 1 Loads Appropriate for Demand Reduction

Load	Typical load (domestic) (kW)	DR method	Typical availability *	Potential demand reduction (kW)	
				Peak †	Average †
Immersion heater	3	Interruption	Early morning, early evening	3	1
Storage heating	2	Interruption	Nighttime	2	2
Tumble drier	2.5	Smart appliance (requiring user interaction)	Occasional	2.5	2.5
Dishwasher	1		Occasional	1	1
Washing machine	0.63		Occasional	0.63	0.63
Lighting	0.01 – 0.2	Reduced output	Daytime, early evening and evening (esp. winter)	upto 0.1	upto 0.1

Table 2 Loads Appropriate for Demand Increase

Load	Typical load (domestic) (kW)	DR method	Typical availability *	Potential demand increase (kW)	
				Peak †	Average †
Immersion heater	3	Automatic control	Daytime, nighttime	3	3
Storage heating	2	Automatic control	Daytime, evening (cooler seasons only)	2	2
Tumble drier	2.5	Smart appliance (requiring user interaction)	Occasional	2.5	2.5
Dishwasher	1		Occasional	1	1
Washing machine	0.63		Occasional	0.63	0.63

Notes for Table 1 and Table 2

* Days are split into the following periods: early morning (0500-0700), morning (0700-0900), daytime (0900-1700), early evening (1700-1900), evening (1900-2300), nighttime (2300-0500)

† Peak DR potential is defined as 10 min. Average DR potential is defined as 30 min

5 Solution Technical Details

Each subsection below refers to a numbered element within Figure 2, e.g. section 5.3 refers to the item with a yellow numbered 3 in Figure 2.

5.1 DC Network

Description

While the use of DC networks within domestic and commercial premises is not common, there is wide experience of the use of DC appliances within the truck and leisure vehicle sector. Where possible it is proposed to make use of this learning for the BRISTOL project.

It is expected that 24 VDC will be used as the nominal voltage level for the DC network. This is a compromise between:

- Minimising current flow, and hence losses and switch breaking requirements, and
- Maximising availability of equipment (appliances, lighting, IT equipment, inverters and batteries).

The distribution voltage will be determined by the inverter and battery, but may float between 20 and 30 VDC, depending on battery charge state and mode of operation. Therefore all equipment and appliances will need to be suitable for operation over a wide voltage range.

A prototype DC distribution network has already been installed at University of Bath library, where it is supplying 50 PCs[3].

In the early stages of the project the choice of 24 VDC will be reviewed with regard to equipment cost, energy losses, technical feasibility and safety factors.

Requirements

The proposed requirements and features for the DC network are as follows:

- To be consistent with the requirements of Part P of the Building Regulations, drawing on BS 7671 IEE Wiring Regulations 17th edition as amended, to the extent that it is relevant to this installation;
- A nominal distribution voltage of 24 VDC, with a permissible voltage range of 20 to 30 VDC;
- Use of existing cabling, where safe and practicable (factors will include condition of existing cables and any connection points, cable sizes and required current ratings, ability to segregate DC requirements and proximity to other LVAC cables);
- Use of DC rated switches, contactors and circuit breakers; and
- Rating of the system as Functional Extra Low Voltage (FELV) and application of appropriate protective measures.

[3] http://www.bath.ac.uk/news/2011/03/21/first-dc-network/

Technology Source

To confirm the project feasibility, enable budget costing and reduce technical risk the following sources have been identified for any special or non-standard equipment used for the DC network. (In this context 'non-standard' means not normally used for in-premises electrical distribution.) However, final decisions on the distribution arrangements, socket and switching arrangements and a full procurement exercise will be undertaken during the project.

- Switches for DC lighting – Moixa

5.2 Power Electronics and Energy Storage

Description

The centre of the electrical energy storage solution is the inverter, which takes charge from the battery and delivers it to the AC network. To connect the PV to the battery, and hence the inverter and AC loads, a charge controller is required to prevent overcharging the battery.

If feasible the battery and power electronics will be accommodated close to the consumer unit (a distribution board in the schools or office environment), and the AC connection to the inverter will be via a dedicated way on the consumer unit or distribution board.

Requirements

The outline requirements for the solution are as follows:

For the **Inverter**:

Essential requirements:

- Controllable modes of operation (charging battery, exporting power)
- A nominal voltage of 24 VDC, with a float/boost/fast charge voltage no higher than 30 VDC
- Meets G83/G59 requirements for loss of grid

Desired requirements:

- Islanding capability on loss of grid (to dedicated AC output)
- Controllable reactive power capability

For the **Battery**:

Essential requirements:

- Sealed, maintenance free
- A nominal voltage of 24 VDC, with a safe operating voltage range of 20 to 30 VDC

Desired requirements:

- Appropriate lifetime with high depth of discharge
- Good capacity with fast discharge rate

For the **Charge Controller**:

Requirements:

- A nominal voltage of 24 VDC, with an upper voltage no higher than 30 VDC

Technology Source

To confirm the project feasibility, enable budget costing and reduce technical risk the following technology has been identified that is capable of meeting the essential requirements. However, a full procurement exercise will be undertaken during the project.

- Inverter – Outback GFX and VFX series, SMA Sunny Backup, Studer Xtender series
- Batteries – wide availability
- Charge controller – wide availability

Testing battery technology is not considered an element of this project and the technology chosen should be considered proven, low risk and low cost for the duration of the project.

5.3 Smart Appliances

Description

An important aspect of project BRISTOL is demand response. Smart appliances will provide a method of achieving additional demand response while minimising the effect on lifestyle.

The phrase 'smart appliance' hides a variety of methods for delivering demand response through appliances, which ranges from remotely switched plug adaptors interrupting the supply to the appliance through to full integration of an appliance with ability to receive signals through remote communication.

As discussed in section 4.3 different appliances will have different DR characteristics with regard to size of load, availability periods, utilisation lengths and effect on lifestyle and it is hoped to be able to apply a variety of appliances to explore how they can fit into network needs for DR.

Requirements

The outline requirements for the solution are as follows:

Essential requirements:

- Capable of remote initiation and/or interruption of appliance operation
- Ability for users to override locally

Desired requirements:

- Minimal user interaction needed

Technology Source

To confirm the project feasibility, enable budget costing and reduce technical risk the following technology has been identified that is capable of meeting the essential requirements. However, a full procurement exercise will be undertaken during the project.

- Switched plug adaptors – Green Energy Options, Moixa

5.4 ICT Equipment

Description

The DC powered ICT equipment for the project will generally be in the form of PCs fitted with DC-DC converters.

Requirements

The outline requirements for the solution are as follows:

Essential requirements:

- A nominal distribution voltage of 24 VDC, with a permissible voltage range of 20 to 30 VDC

Desired requirements:

- High efficiency, >95% at 50% load

Technology Source

The technical feasibility of this aspect of the project is proven from the prototype DC distribution network installed by University of Bath, which used the following technology.

- DC-DC converters – Mini-Box 24V DC ATX power supply

5.5 DC Lighting

Description

The voltage of the distributed DC power will be determined by the inverter and battery, and the lighting will need to cope with a variable voltage supply. The DC lighting solution must comprise the lamps or modules, with any required regulating equipment (control modules), and switches or contactors with DC capability for operational switching.

The principal role identified for DC lighting within the project is as a load suitable for supplying from DC, with benefits of reduced transformation losses and harmonic emissions. In some instances lighting could also form a resource for demand response.

Requirements

The outline requirements for the solution are as follows:

For the **lamps**, with any required control module:

Essential requirements:

- Nominal 24 VDC
- High luminous efficiency

Desired requirements:

- Ability to dim

If a **control module** is used, the following is additionally desired of it:

- Safety extra low voltage (SELV) Isolation
- High efficiency
- Remotely controllable dimming

For the **operational switches**:

Essential requirements:

- Capable of switching DC

Desired requirements:

- Fits standard UK pattresses

Technology Source

To confirm the project feasibility, enable budget costing and reduce technical risk the following technology has been identified that is capable of meeting the requirements. However, a full procurement exercise will be undertaken during the project.

LED or DC compact fluorescent lamp (CFL) technology will be sourced

- LED lamps and DC compact fluorescent lamp (CFL) – wide availability
- Dimmable control module – Osram
- Switches for DC lighting (including dimmable control) – Moixa

5.6 LV Connection Manager

Description

The function of the LV Connection Manager is to integrate the capabilities of the PV, battery storage and the electrical demand to:

- minimise the financial cost of energy used,
- minimise the carbon impact of energy used,
- actively manage the real power profile to support the distribution network (demand response), and
- provide reactive power support to the network

to an overall optimal position through the control of the following aspects of their function:

- advancing and deferring load use, and/or reducing load use,
- generation and absorption of reactive power (through the inverter),
- active management of battery charge and discharge.

The following network use cases are defined which the LV Connection Manager should support (see section 5.7 below for details).

Table 3 Network Use Cases for LV Connection Manager

Situation		Electrical demand	Storage	PV
1. Excess generation over load on local network	1a. voltage upper limits exceeded	Increase/ advance load	Charge battery Absorb reactive power	Absorb reactive power Last resort: reduce output
	1b. thermal limits exceeded	Increase/ advance load	Charge battery	Last resort: reduce output
2. High peak load	2a. voltage lower limits exceeded	Decrease/ defer load	Discharge battery Export reactive power	
	2b. thermal limits exceeded	Decrease/ defer load	Discharge battery	
3. Need to profile match availability of low carbon generation		Adjust load to availability of LC energy	Charge/discharge battery to availability of LC energy	

The LV Connection Manager will be housed in each premises in the trial, close to the electrical point of supply. It is anticipated that this will be internal to the premises, although for some supply arrangements an external enclosure may be required.

Requirements

The outline requirements for the solution are as follows:

Essential requirements:

- Able to optimise the factors listed in the above Description
- Able to manage the resources of the premises in support of the Network Use Cases
- Able to communicate with the LV Network Manager
- Able to communicate/integrate with the other components in the premises
- Appropriate for deploying in unmanaged domestic and non-domestic premises

Desired requirements:

- Of a size and form to facilitate deployment at point of connection

Technology Source

The LV Connection Manager will be based on Siemens automation hardware integrating other off the shelf components as necessary to achieve the required functionality.

5.7 LV Network Manager

Description

The function of the LV Network Manager is to identify constraint conditions within the LV network and attempt to resolve them by calling on the capabilities of customers connected to the LV network, managed by LV Connection Managers.

Section 1 describes the specific constraints that the LV Network Manager seeks to highlight and mitigate. These are repeated here:

1. Excess generation over load on local network, resulting in
   - 1a. Voltage upper limits exceeded, and/or
   - 1b. Thermal limits exceeded (power import); and
2. High peak load, resulting in
   - 2a. Voltage lower limits exceeded, and/or
   - 2b. Thermal limits exceeded (power export).

The LV Network Manager will receive measurements locally from the distribution substation/transformer, and from those premises with LV Connection Managers. Additional measurements may also be required from other premises at the ends of feeders. These measurements will be used to determine if any of the constraint conditions (1a, 1b, 2a or 2b) are reached and if so will attempt to redress the associated cause (1 or 2) by changing the power flow from/to premises under control of the scheme via their LV Connection Managers.

The LV Network Manager will be installed at a distribution substation or transformer. It will need to employ components suitable for such deployment and housed in an appropriate enclosure. It is expected that all the substations will be ground-mounted. The project will ideally seek test networks involving indoor substations with space to accommodate the equipment, however, space requirements may dictate that outdoor enclosures are required.

Requirements

The outline requirements for the solution are as follows:

Essential requirements:

- Able to receive measurements from LV Connection Managers and local sensors
- Able to determine when voltage and/or thermal constraints are reached from available measurements
- Able to determine which actions are most beneficial to mitigating the constraint
- Able to communicate requests for those actions to LV Connection Managers
- Able to operate autonomously
- Appropriate for deploying alongside ground-mounted distribution substations

Desired requirements:

- Able to be remotely accessed for supervisory and data collection purposes
- Appropriate for deploying externally

Technology Source

The LV Network Manager will be based on Siemens automation hardware integrating other off the shelf components as necessary to achieve the required functionality.

5.8 LV Communications

Description

The LV Communications (indicated by A in Figure 3) are required to communicate from the LV Network Manager to LV Connection Managers, and vice versa. The communication channel will allow the LV Network Manager to issue requests for action to alleviate constraints to the LV Connection Managers, and allow the LV Connection Managers to provide the LV Network Manager with measurements from within the network, and report on actions taken in response to requests from the LV Network Manager.

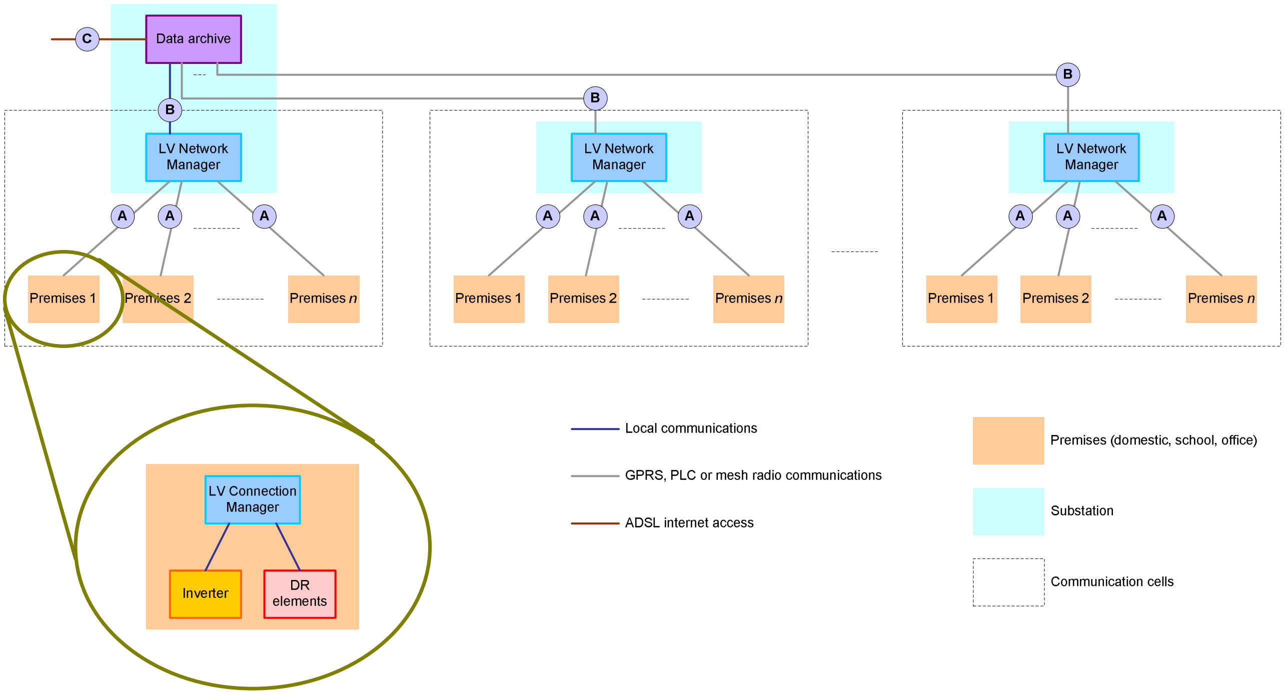


Figure 3 Communications Architecture

Requirements

The outline requirements for the solution are as follows:

Essential requirements:

- Allow an LV Network Manager to communicate with up to 32 LV Connection Managers;
- Support event driven communications (in either direction) with a latency not exceeding 1 second;
- Support periodic communication of measurements from the LV Connection Managers to the LV Network Manager (could be polled), with periods of no less than 1 minute
- Support a total peak payload data rate (total of all stations) of 4 kB per second on the uplinks (to the LV Network Manager) and 0.5 kB per second on the downlinks, with a sustained rate of 3 MB per day on the uplinks and 1 MB per day on the downlinks
- Privacy and security of customer's data is of paramount importance, and appropriate authentication mechanisms to access the communications payloads are required

Desired requirements:

- Communications channel behaves as a bridge, with TCP/IP interfaces at each end (transparent operation)

Technology Source

Testing communications methods is not considered an element of this project and the method chosen should be considered proven and low risk. WPD have existing LCNF projects which are trialling communications for LV networks using power line carrier (PLC). If the PLC communications of these existing projects meet the requirements for Project BRISTOL, and the existing projects indicate sufficient confidence can be placed on these communications, they will be considered for Project BRISTOL.

Other methods under consideration include General Packet Radio Service (GPRS) and, if geography allows, meshed radio such as Zigbee.

5.9 LV Distribution Network Sensors and Instrumentation

Description

The purpose of the LV distribution network sensors and instrumentation is two-fold: firstly, to collect measurements which are used by the LV Network Manager as part of its management of the distribution network; and secondly, as part of the collection of trial data to measure the effectiveness of the intervention methods.

For the LV network management the required data will be voltage of the busbars and real and reactive power flow into each phase of each feeder under management. These measurements will be concerned with RMS values only.

For the collection of trial data the requirements will include measurement of harmonics since one of the hypotheses is that the use of DC networks can improve power quality.

It is possible that the differing requirements, programme timing and cost implications result in separate sets of sensors and instrumentation for each purpose

Requirements

For network management:

Essential requirements:

- Measurement of voltage, real and reactive power, true RMS
- Averaging period maximum 1 second
- Instantaneous values only required
- Capable of fitting without customer interruption

For collection of trial data:

Essential requirements:

- Measurement of voltage, including harmonic content
- Measurement of real and reactive power, true RMS
- Averaging period minimum 1 minute
- All data to be logged continuously and time stamped
- Time stamps within each cell to be synchronised with 20 millisecond accuracy

Desired requirements:

- Measurement of real and reactive power, including harmonic content

Technology Source

To confirm the project feasibility, enable budget costing and reduce technical risk the following technology has been identified that is capable of meeting the essential requirements. However, a full procurement exercise will be undertaken during the project.

- CT – split core, Rogowski coil or optical fibre based current sensors
- Instrument – Siemens Simeas P50

Testing measurement sensors is not considered an element of this project and the method chosen should be considered proven and low risk. WPD have existing LCNF projects which are trialling different measurement sensors. The BRISTOL project will draw on the results of these trials in the selection of appropriate sensors.

- Data should be stored securely recognising that privacy of customer's data is of paramount importance, and appropriate authentication mechanisms to access the data are required

Technology Source

The LV Network Manager will be based on a Siemens data logging system.

5.12 Energy Supplier Tariffs

Description

A number of Variable Tariffs will be will be trialled on the domestic installations to incentivise customers to alter their demand profile, flattening their demand, reducing their peaks using the automated LV connection manager, battery storage, micro generation or lifestyle changes or a mixture of the four. The variable tariff will be coordinated through the LV connection manager.