



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

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Abbreviations

BMS	–	Building Management System
DB	–	Distribution Board
SANS	–	South African National Standards
PV	–	Photovoltaic
kWh	–	Kilowatt Hour
kWp	–	Kilowatt Peak
AC	–	Alternating Current
GUI	–	Graphical User Interface
DC	–	Direct Current
LV	–	Low Voltage
SLA	–	Service Level Agreement
OHS	–	Occupational Health and Safety

1. EXECUTIVE SUMMARY

The purpose of this document is to describe the scope of works required for the Building Management System (BMS) installation at the Albert Wessels and Donald Gordon building within the university facilities at the Business School Campus. The scope of works will be completed with a phased approach which each respective building being a separate phase.

This document must be read in conjunction with the bill of quantities and concept drawings.

The successful contractor must ensure that they are able to meet the program dates of the university including commissioning and hand-over timelines.

2. SCOPE OF WORKS

This section of the enquiry document covers what is required in terms of the Electrical installation and the exclusions

2.1. Project Objective

The main objective of this project is to integrate the existing electrical and mechanical building services with a system that will allow appointed operators to monitor, regulate and generate reports on these devices.

This system should be able to provide monitoring and optimizing the use and efficiency of its supervised subsystems to allow more efficient operation within the building.

The system shall provide for the safety and comfort of personnel in the building while allowing for a more energy efficient and ecofriendly solution, thereby promoting a more sustainable environment.

Any system that is implemented must be modular and upgradeable at a later date, to allow for the University to expand its capacity and/or capability in the future.

2.2. Project Scope

2.2.1. In Scope

The scope of this project shall include the following:

- Design of BMS system to monitor and regulate the following building services:
 - Power Metering
 - Lighting
 - HVAC Metering
 - Water Metering
 - Storage Water Tank Monitoring
 - Venue Scheduling System
 -
- Installation and configuration of controllers and gateways.
- Installation of BMS software in workstations. Workstations to be supplied, installed and configured for use.
- Design of user interface, widgets, graphs, trends, alarms, and reports
- Testing and commissioning of system
- Training of maintenance staff

2.2.2. Scope Exclusions

The following area are excluded as part of the project scope:

- Installation of building services accessories (access controls, fire alarm system, lighting, etc.)
- CCTV and Access Control, though this would be suitable to include in the BMS System. The University has stated that an outside contractor cannot interface with the existing security systems as this poses a security risk.

2.3. Site Location

This project will be designed for and implemented at two separate buildings namely the Albert Wessels Building and the Donald Gordon Building, located at the WITS Business School Campus. the physical address is as follows:

2 St Davids Place & Saint Andrews Road Parktown 2193, Johannesburg



Figure 1 – WITS Business School

Equipment to be installed shall be suitable for continuous operations under the local conditions indicated in table 1 below.

Altitude	1 723m
Minimum temperature	-5°C
Maximum temperature	35°C
Humidity	60%
Lightning	Severe

Table 1 - Site Conditions

3. CODES AND STANDARDS

- The Occupational Health and Safety Act no. 85 of 1993, as revised
- The Local Government Ordinance 1939 (Ordinance 17 of 1939) as amended and the municipal by-laws and any special requirements of the local supply, authority, as revised
- Electrical Wiring Code – SANS 10142-2, as revised
- Electrical Wiring Code – SANS 10142-1, as revised
- IEC62271-200
- IEC 62271-100

4. QUALITY OF MATERIALS AND WORKMANSHIP

- All materials and equipment for this Contract shall be new and undamaged.
- Where so directed by the specification or by the Engineer, the Contractor shall provide samples and test certificates of materials for approval.
- The labour used by the Contractor shall always be adequately qualified and experienced for the task.
- All work shall be completed in the presence of a site supervisor whose qualifications and experience to supervise this work must be acceptable to the The University.
- The final installation must meet the functional requirements of the project.
- Trained maintenance personnel must be able to operate the system independently.

5. DELIVERY AND STORAGE OF EQUIPMENT

- The tenderer should include in the pricing as part of this contract for delivery, storage and final positioning of equipment.
- The delivery and offloading of equipment shall be arranged with and approved by the University, all work shall be in accordance with The University s' requirements.
- The tenderer shall at their own expense arrange for storage facilities onsite or offsite.
- The tenderer shall be solely responsible for the protection and security of all equipment during storage and installation. The University shall only take responsibility for the site and all equipment after handover.

6. DESIGN CONSTRAINTS

The current state of the building presents several limitations that impede the implementation of comprehensive energy monitoring and automation through a Building Management System these aspects had to be taken into consideration when the design was formulated.

6.1.1. Electrical

- The entire electrical load is supplied via a single main feed. This configuration does not allow for disaggregated measurement of individual end-users such as HVAC systems, lighting, and general-purpose outlets.
- Multiple load types (e.g., lighting, plug points, and HVAC equipment) are connected to the same circuit breakers. This lack of segregation complicates targeted monitoring and control.
- Certain DB Boards have no spare capacity; therefore, additional breakers cannot be added without upgrading the board.

6.1.2. Mechanical

- The HVAC infrastructure consists of equipment of varying types and ages, most of which lack remote monitoring or control capabilities.
- This heterogeneity, coupled with aging assets, poses a challenge for centralized energy management and fault detection.
- A single, aging mechanical water meter serves the entire building. The accuracy of the readings is questionable due to wear and the potential influence of entrapped air in the system.
- There are no sub-meters installed to monitor water consumption in individual ablution facilities, hindering effective water usage analysis and leak detection.

6.2. Assumptions

The following assumptions have been made:

- Building services (Lighting, HVAC, etc) are assumed to not be readily available and functioning accordingly for BMS system integration as the building is old and most existing infrastructure lacks BMS capabilities.
- All the building services required to be integrated to the BMS system can communicate via Modbus protocol
- Fire alarm panels are assumed to be existent
- Sufficient capacity is available on the existing IT infrastructure to accommodate the BMS.
- Sufficient funds will be available for the procurement of components and accomplishment of project.
- The final solution is tender agnostic. However, the functional requirements shall not be compromised.

6.3. Working Times

Due to the Business School offering part-time courses, seminars and webinars to local and international students, the facilities are typically in use every day of the week. The successful contractor will be expected to work with The University to schedule all disruptive work at the beginning of the project.

7. SYSTEM DESIGN OVERVIEW

7.1. System Requirements

The optimal operation of the system is mainly dependent on the following components:

7.1.1. Automation Server

The Automation Server serves as the central backbone of the Building Management System (BMS). It hosts and executes BMS applications, manages system-wide configurations, collects and logs data, and manages communications between system components.

Each building requires one Automation Server, which must be integrated into the Wits network to enable remote access and centralized monitoring.

7.1.2. Workstations and software application

BMS workstations are the computers with restricted access that run the BMS system software application. The application is designed to allow the operator to visually interact with the building services. The operator can monitor and control all building services that are part of the system from the workstation. From the workstations the operators can see trends, set alarms, and generate reports.

7.1.3. System Communication network

This is required to ensure communication between the BMS system and the subsystems, also called building services. The building service controllers should be cascade via RS485 and connected to the LAN via Ethernet connection or BACnet connection.

7.1.4. Field Controller

The Field Controllers act as distributed field-level devices directly interfacing with building equipment. Operating under the AS-P Server, they execute control logic for HVAC, lighting, and other building systems.

Each BMS control panel—installed adjacent to the distribution boards (DBs) in every building—must include one RP-C.

These controllers will manage outputs such as contactors and will serve as the input point for sensors installed throughout the facility.

7.2. System network design

The system diagram is shown in the Figure 1 below.

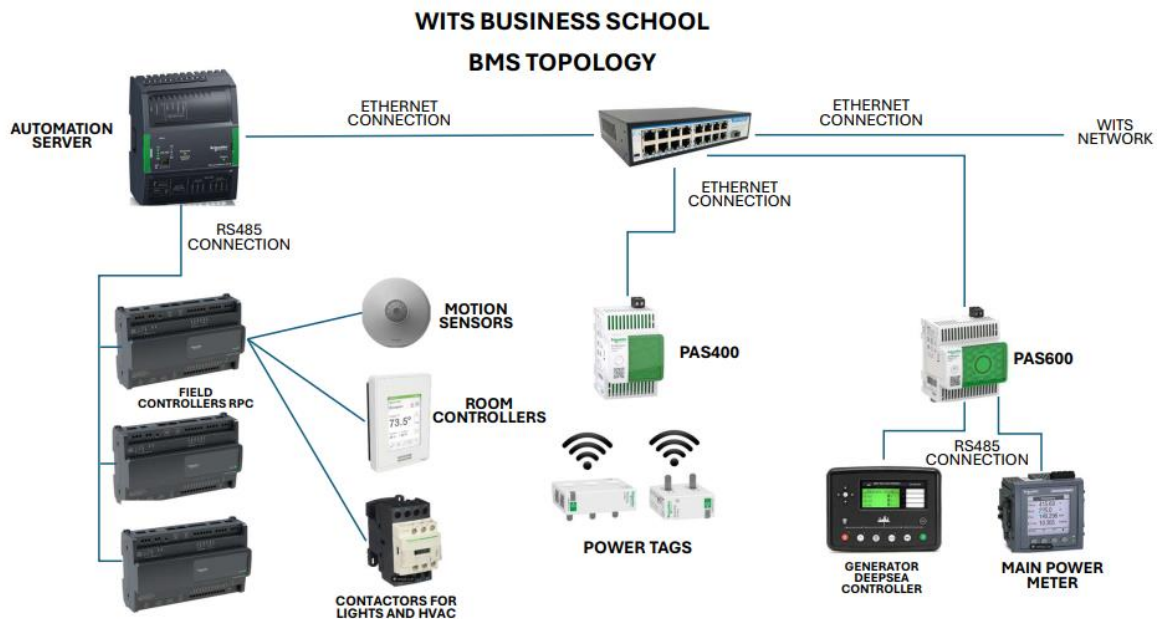


Figure 2 – BMS Topology

The line diagram shown in the figure above depicts the system network topology. All components of the system – workstations, servers, controllers, and the controlled components shall communicate using the Modbus and/or BACnet protocol. The controllers of each building service will be cascaded via RS485 interface and connected to the LAN via Ethernet connection. The Ethernet devices such as Wi-Fi will be directly connected to the building LAN.

7.3. Electrical Metering Systems

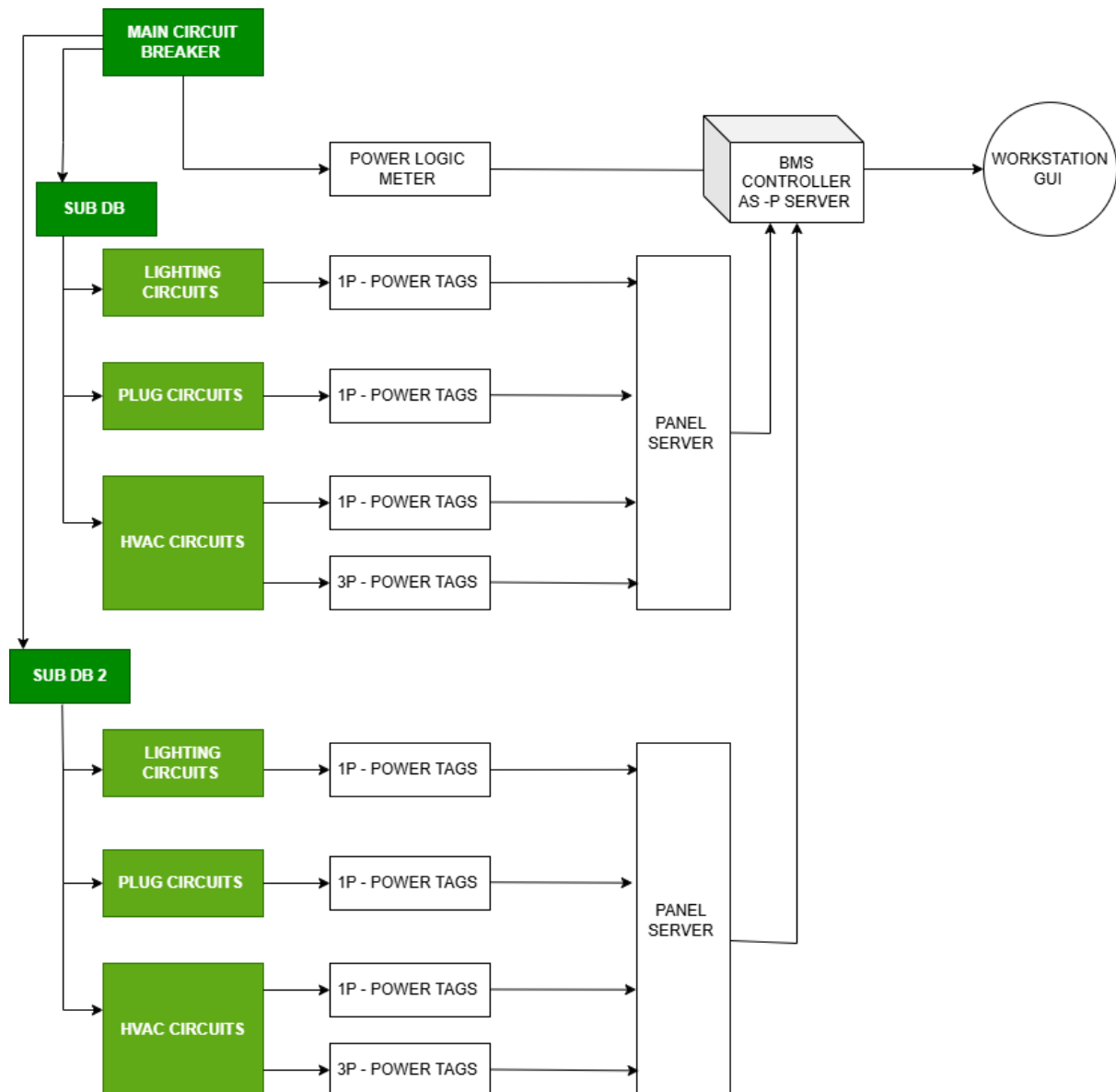


Figure 3 – Electrical Distribution to BMS Block Diagram

The figure above depicts a typical electrical distribution architecture throughout the building. The building's total energy usage will be metered by a Power logic meter directly installed onto the Main DB Board. The individual breakers thereafter will be monitored by Power Tags. These will transfer data wirelessly in M-Bus Format, thereafter the RPC Controller that will transfer the data to the BMS Controller/server in BACnet format to be displayed on a workstation or Graphical User Interface.

7.3.1. Power Logic Meters

The Power Logic Power Quality Meters will be installed in each building's main electrical room, positioned near the primary incoming supply.

These devices will monitor energy consumption and power quality parameters, supporting energy efficiency and electrical health monitoring strategies.

7.3.2. Power Tags

Power Tag Energy sensors—either single-phase (1Ph) or three-phase (3Ph), depending on load requirements—will be mounted on each circuit breaker feeding HVAC equipment. Power Tag Energy can be connected to Eco Struxure solutions or to any other building monitoring systems (BMS) or SCADA systems.

These wireless energy sensors enable circuit-level energy monitoring and asset-level power management via integration into the BMS. They are a simple and easy to install method of metering and fault finding on electrical circuits.

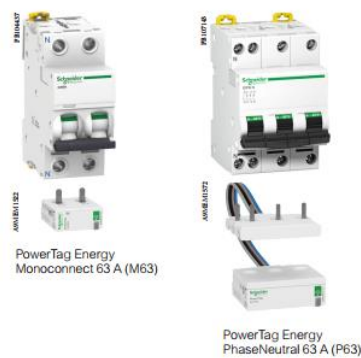


Figure 4 – Power Tags

7.3.3. Generator Monitoring Integration

The existing Deep-Sea Controllers of the backup generators can be interfaced with the BMS using the Modbus protocol. This will facilitate real-time remote monitoring of operational parameters and automatic fault alarms.



Figure 5 – Deep-Sea Controller can be integrated onto the BMS System

7.4. Electrical Lighting Control

With the implementation of Field Controllers with Occupancy Sensors, this will allow The University to integrate all the existing lighting for the building on the BMS System to allow them to be remotely controlled and with the addition of Power tags Energy usage can also be monitored.

7.4.1. Occupancy Sensors

Occupancy sensors will be strategically deployed in offices, and shared spaces to detect motion and presence. Contactors in series with PIR Occupancy Sensors (3 Per Lecture room) hardwired into the lighting circuit

Manual override functionality must be integrated via local override switches in each BMS control panel to accommodate user preferences.

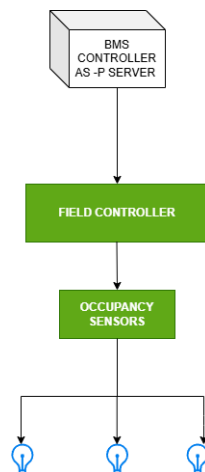


Figure 6 – Occupancy Sensor Control

7.4.2. DALI Controllers

Lecture Room Lighting will be controlled through a DALI gateway, DALI controllers and light drivers. The DALI controllers will be cascaded via RS485 and connected to the LAN via Ethernet connection or BACnet connection.

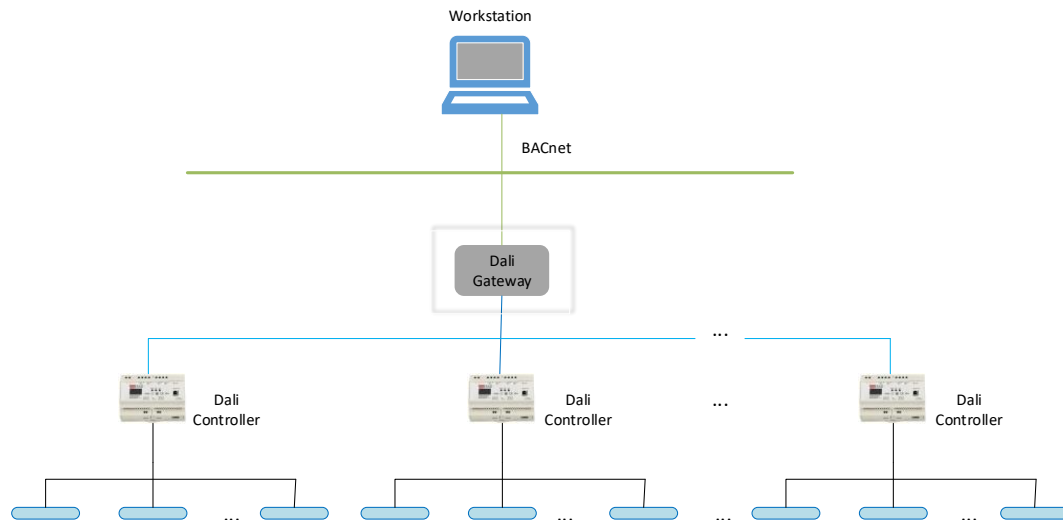


Figure 7 – DALI Lighting Control Line Diagram

7.5. Mechanical Water Metering

BMS Systems is to also monitor water usage for the buildings by providing a real time analyses on water consumption. The buildings are fed directly from a municipal supply point. The water usage can be captured at this point directly from the water meter and communicated to the BMS System via a gateway.

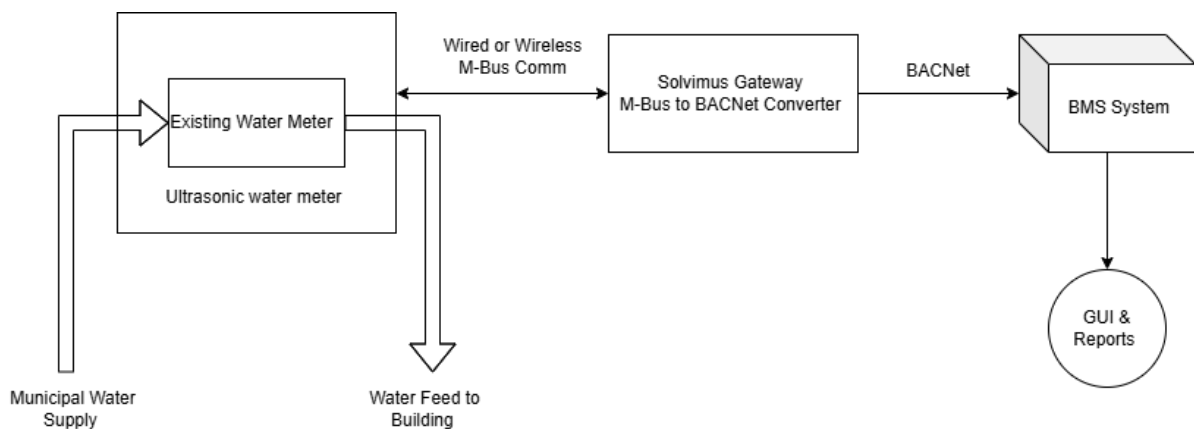


Figure 8 – Water Metering Control Block Diagram

Figure 4 above depicts the line diagram for communication from the sensors to our BMS system. The components listed below form part of this

7.5.1. Ultrasonic Water meters

A digital ultrasonic water meter will be installed on each building's main water supply line to enable consumption tracking and resource efficiency. These ultrasonic meters can provide data to the gateway located in the BMS controller in M-Bus format.



Figure 9 – Ultrasonic Water Meter

7.5.2. Solvimus Gateway

This will serve as the protocol interface to seamlessly integrate water meter data into the BMS, ensuring full visibility of utility usage across all monitored buildings. This device converts data from M-Bus to BACnet which can be interpreted by the BMS controller.



Figure 10 – Solvimus Gateway MBus to BACNet converter

7.6. Mechanical HVAC

The HVAC metering and control within the Building Management System (BMS) uses field controllers, occupancy sensors, and room controllers to deliver energy-efficient and automated climate control. Occupancy sensors detect presence to activate or reduce HVAC operations, while room controllers adjust settings based on temperature and user input. Field controllers manage equipment like VAVs, FCUs, or AHUs, and energy meters track consumption for optimization and cost control. All data is fed into the BMS for monitoring, scheduling, and analytics, ensuring comfort, reduced energy waste, and intelligent facility management.

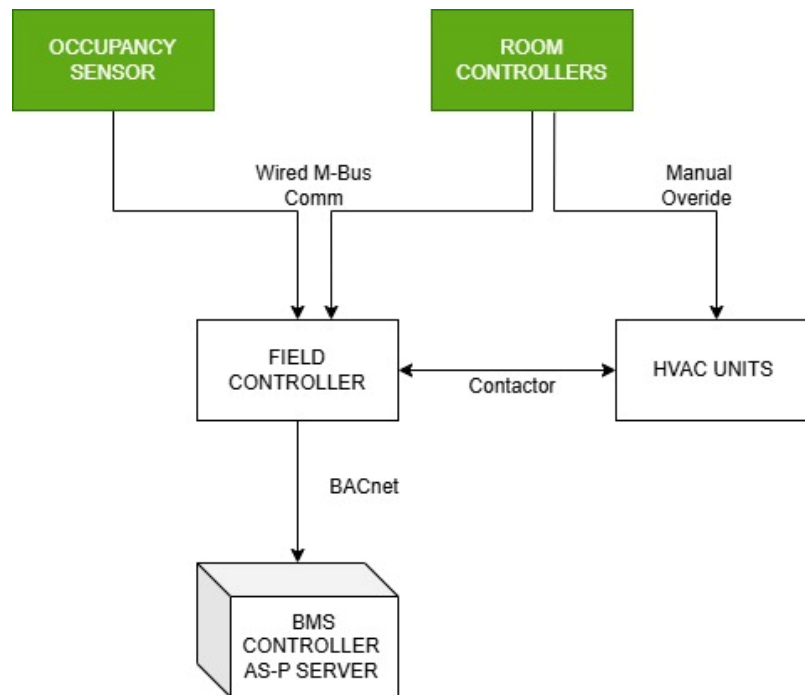


Figure 11 – BMS implementation on HVAC Systems

7.6.1. Room Controllers

Each lecture room will be equipped with a Room Controller to display real-time environmental parameters such as temperature, humidity, and CO₂ levels.

These devices will interface with the local Field Controller to facilitate intelligent environmental control based on occupancy and indoor air quality metrics. The Room Controllers will also allow for manual override of the HVAC units.



Figure 12 – Room Controller

7.7. Mechanical Storage Water Tank Infrastructure

The University has installed Water Storage tanks for water security. These tank systems are to be integrated into the BMS in the following way:

7.7.1. BMS Controller

Power Tags can be installed on the breakers used to feed the Pumps, these pumps can be monitored and controlled by the field controllers to enable switching.

7.7.2. Level Sensors

These can be ultrasonic or pressure-based sensors for accurately determining the amount of water remaining in the tanks and represent these in a suitable manner on our BMS software.

Over and above the remote monitoring, we propose installing a physical level indicator on the side of the tank so that readings can be monitored on site.

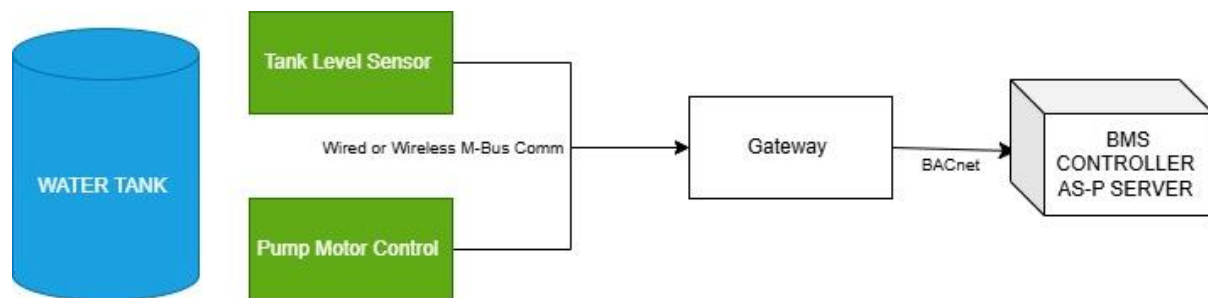


Figure 13 – Tank Implementation and Control

7.8. Wi-Fi

The Wi-Fi will be assigned a fixed IP and will be integrated to the BMS via Ethernet connection to the LAN, this is show in the BMS system line diagram

7.9. System software

The software will be designed to allow the user to interact with the building services that are integrated to the BMS system.

This will include the design of the user interface, widgets, trends, alarms, and reports.

7.10. BMS control panel

The control panel will house the subsystem controllers and gateways, and a power supply unit. A touch screen HMI will be mounted on the panel door to allow users access to the basic system setting and diagrams.

8. DESIGN BREAKDOWN FOR ALBERT WESSELS BUILDING

Generator Integration

via Modbus MSTP – Deep Sea Generator Controller.

Substation DB Board

via Modbus MSTP – Supply and install Power Quality Power Meter.

DB-LG Lower Ground Floor Distribution Board

Supply and install 5 x Power Tags for Aircon Power Monitoring.

Supply and install 5 x Contactors for switching of the Aircons

Supply and install 12 x Contactors for switching of the Lights

Supply and install 6 x Contactors for switching of the Underfloor Heating

Supply and install 6 x Power Tags for Underfloor Heating Power Monitoring.

DB-G Ground Floor Distribution Board

Supply and install 3 x Power Tags for Aircon Power Monitoring.

Supply and install 3 x Contactors for switching of the Aircons

Supply and install 8 x Contactors for switching of the Lights

Supply and install 7 x Contactors for switching of the Underfloor Heating

Supply and install 7 x Power Tags for Underfloor Heating Power Monitoring.

DB-1 First Floor Distribution Board

Supply and install 13 x Power Tags for Aircon Power Monitoring.

Supply and install 13 x Contactors for switching of the Aircons

Supply and install 9 x Contactors for switching of the Lights

DB-1A First Floor Distribution Board

Supply and install 2 x Power Tags for Aircon Power Monitoring.

Supply and install 2 x Contactors for switching of the Aircon.

Supply and install 2 x Contactors for switching of the Underfloor Heating.

Supply and install 2 x Power Tags for Underfloor Heating Power Monitoring.

DB-1B First Floor Distribution Board

Supply and install 22 x Power Tags for Aircon Power Monitoring.

Supply and install 22 x Contactors for switching of the Aircons

Supply and install 18 x Contactors for switching of the Lights

DB-1C First Floor Distribution Board

No data as the board is unmarked.

DB-Plant-O-M-SCW

No Data as no access to DB board.

SUB DB-2 Second Floor Distribution Board

Supply and install 3 x Power Tags for Aircon Power Monitoring.

Supply and install 3 x Contactors for the switching of the Aircon.

Supply and install 1 x Contactors for switching of the Underfloor Heating.

Supply and install 1 x Power Tags for Underfloor Heating Power Monitoring.

Supply and install 2 x Contactors for switching of the Geysers.

Supply and install 2 x Power Tags for Geyser Power Monitoring.

Supply and install 7 x Contactors for switching of the Lights

Main Incoming Water Meter via M-Bus

Hard wired connection to M-Bus/Modbus Gateway.

Lecture Theatres Room Controllers via BACnet MSTP

Supply and install 1 x Room Controller with LCD Display and buttons for triggering Occupancy and Temperature Setpoint with Temperature / Humidity/ CO2 Air Quality readings.

Lower Ground Floor 1 x Lecture Room

Ground Floor 6 x Lecture Rooms

1st Floor 5 x Lecture Rooms

Lighting control

Contactors in series with PIR Occupancy Sensors (3 Per Lecture room) hardwired into lighting circuit.

Lower Ground Floor 1 x Lecture Room

Ground Floor 6 x Lecture Rooms

1st Floor 5 x Lecture Rooms

Lighting control Contactors

Lower Ground Floor Multiple Offices x 4

Lower Ground Floor Dining Area x 1

Lower Ground Floor Computer Laboratory x 1

Lower Ground Toilets x 1

Ground Floor Multiple Offices x 20

Ground Floor Dining Area x 1

Ground Floor Toilets x 1

1st Floor Multiple Offices x 33

1st Floor Boardrooms x 2 (This could also be done with PIR Occupancy Sensors)

1st Floor Toilets x 1

9. DESIGN BREAKDOWN FOR DONALD GORDON BUILDING

Generator Integration

via Modbus MSTP – Deep Sea Generator Controller.

Substation DB Board

via Modbus MSTP – Supply and install Power Quality Power Meter.

DB-SMDB-GA Ground Floor Distribution Board -

Supply and install 20 x Power Tags for Aircon Power Monitoring.

Supply and install 20 x Contactors for switching of the Aircons

Supply and install 23 x Contactors for switching of the Lights

SMDB-GC Ground Floor Distribution Board -

Supply and install 6 x Power Tags for Aircon Power Monitoring.

Supply and install 6 x Contactors for switching of the Aircons

DB-SMDB-1A First Floor Distribution Board -

Supply and install 1 x Power Tags for Extractor Fan Power Monitoring.

Supply and install 11 x Contactors for switching of the Aircons

Supply and install 6 x Contactors for switching of the Lights

SMDB-2A Second Floor Distribution Board -

Supply and install 16 x Power Tags for Aircon Power Monitoring.

Supply and install 16 x Contactors for switching of the Aircons

Supply and install 20 x Contactors for switching of the Lights

Main Incoming Water Meter

via M-Bus - Hard wired connection to M-Bus/Modbus Gateway.

Lecture Theatres Room Controllers via BACnet MSTP -

Supply and install 1 x Room Controller with LCD Display and buttons for triggering Occupancy and Temperature Setpoint with Temperature / Humidity/ CO2 Air Quality readings.

Ground Floor 1 x Auditorium

1st Floor 5 x Lecture Rooms

Lighting control

Contactors in series with PIR Occupancy Sensors (3 Per Lecture room) hardwired into lighting circuit –

Ground Floor 1 x Auditorium

1st Floor 5 x Lecture Rooms

Lighting control Contactors

Ground Floor Multiple Offices x 3

Ground Floor Dining Area x 2

Ground Floor Library x 1

Ground Floor Kitchen x 1

Ground Floor Toilets x 1

1st Floor Multiple Offices x 10

1st Floor Lecture Rooms x 5

1st Floor Toilets

2nd Floor Multiple Offices x 25

2nd Floor Toilets x 1

10. TECHNICAL SPECIFICATION REQUIREMENTS

This system is engineered to operate according to standards and within operating specification, this includes:

10.1.1. Server and workstations

The **minimum requirement** for the servers or workstations is the following:

- 1.5 GHz processor with 4GB of RAM
- Microsoft Windows 11 operating system
- Serial port, parallel port, USB port, and Ethernet port
- 10/100MBPS Ethernet NIC
- 100 GB hard disk
- CD-RW drive
- High resolution (minimum 1280 x 1024), 17" flat panel display
- Optical mouse and full function keyboard
- Audio sound card and speakers
- License agreement for all applicable software.

10.1.2. Electrical

- This specifies the type and the size of electrical cable used to power the building services that are integrated into the BMS system, the specifications of the relays or standalone controllers used, and the panel wire size and colour.
- The BMS control panel shall be powered from a 220V single phase supply
- The type and the colour of the electrical cable should be the same as the one used in the building electrical wiring. The size of the electrical should not be less than 6mm.
- The relays and standalone controller should be capable of switching 220V and handle the maximum current drawn at full load condition
- The control panel shall be wired with 2.5mm coloured wires that will be neatly run into cable trays. The control panel shall be protected by an isolator located outside the panels and another inside the panel.

10.1.3. System communication network

- The system component shall communicate via shielded communication cables.
- Communication cables shall not be run in parallel to power cables in proximity.

Please see complete list of Specification Documents in appendix A.

11. INSPECTION TESTING AND COMMISSIONING

Below inspections and testing shall be conducted and provided to the engineer and The University .

- **Type tests, Routine Tests & Special Tests**

To be performed and provided by manufacturer.

- **Factory Inspections**

Switchgear and DB boards shall be inspected at the manufacture's premises in the presence of the engineer to ensure compliance with specification

- **FAT**

Factory acceptance testing – FAT shall be done on the fully functional equipment in the factory before delivery. The Contractor must fully complete the programming and final settings of all relevant parameters as provided by engineer.

- **SAT**

Site acceptance testing – SAT shall be performed upon delivery to site. The Service Provider shall first perform a visual inspection to determine any impact disturbance thereafter testing of equipment as required to prove same condition as on FAT completion.

- **Commissioning**

The equipment shall be commissioned after the Service provider has completed all required installations

- **Maintenance**

The Service Provider is to provide maintenance and post implementation support for the BMS Workstation including all necessary BMS Software and Licence for a period of 3 years

12. TRAINING

On-site training shall be provided to owner's representative and maintenance personnel.

The training shall include hands-on instructions involving the operation and maintenance of the system.

The curriculum should include:

- System overview
- System operation
- Software features overview
- Design graphs and trends
- Display graphs
- Design and run reports

13. Annexure A -Specification Documents