Application Note

BRTSYS_AN_050

IoTPortal Greenhouse Application

Version 1.0

Issue Date: 15-08-2025

Greenhouse environment monitoring and plant growth control using the IoTPortal.

BRT Systems Pte Ltd (BRTSys)
1 Tai Seng Avenue, Tower A #03-07, Singapore 536464
Tel: +65 6547 4827
Web Site: http://brtsys.com

Table of Contents

1 Overview

BRTSys IoTPortal is a flexible monitoring, sensing and control system which leverages IoT to increase efficiency and optimize resource usage across a wide variety of processes and applications. Designed to be quickly and easily deployed, simple to configure and use, the IoTPortal is ideal for managing an agricultural Greenhouse application.

To achieve consistent crop quality and yield, agricultural applications must consider not only the soil conditions but a whole range of other conditions including the irrigation and surrounding environment. Despite the widely acknowledged benefits of introducing automation into agricultural systems, this can be challenging. The diverse range of parameters involved means that systems which monitor and/or control only soil, environmental or irrigation do not fulfil the full potential that automation can bring to the farm.

IoTPortal, with its wide range of sensors/actuators covers all areas of the grow environment, offers an effective solution for monitoring, controlling and maintaining areas such as:

- Soil moisture and nutrient level
- Nutrient tank levels and nutrient mix
- Irrigation
- Ventilation and air quality

This application note will cover how the IoTPortal can address the challenges of greenhouse operation via automation and simplify greenhouse environments for users.

1.1 Greenhouse Challenges

As the world's population continues to grow, farming has become an increasingly important industry as food security is crucial for future generations. Maintaining high crop yields is essential to provide food required to sustain growing populations, while the utilization of greenhouses within the farming environment is one approach used to ensure higher crop yields. Traditional greenhouse applications allow farmers greater control over environmental factors necessary to produce good quality and high yield crops.

Farmers who employ greenhouse technology to grow crops must first decide which crops they will be investing in, as crop choice affects the environmental conditions required within the greenhouse. A farmer may choose to grow Romain Lettuce within the greenhouse, this crop would require different parametric ranges to that of other crops the farmer may choose to grow. To ensure the maximum crop yield for the chosen crop, there are several factors which must be monitored and controlled:

- **Nutrient Mixing** - Crops require a nutrient mixture to promote healthy growth and feed the plants as they grow. Typically, this is a mix of two nutrients (A and B), and this mix must be precisely controlled to ensure that desired pH and EC (Electrical Conductivity) levels are reached for optimal yield.
- **Irrigation & Watering** - Systems are required to deliver nutrient mixes and to maintain the soil moisture and soil temperature levels to promote growth.
- **Greenhouse Temperature & Humidity** - Vital to ensure yields, temperature must be controlled precisely within the grow environment including leaf temperature control
    - **Misting** - Helps to reduce air and leaf temperature and increases greenhouse humidity
    - **Ventilation** - natural ventilation and forced ventilation (using fans) helps to ventilate and exchange air between the greenhouse and external environment to control humidity & temperature.
- **Lighting & Shades** - Crops require defined levels of light during the growth process, control of light also aids temperature and humidity control for the greenhouse.
- **CO2 control** – Levels of CO_2 within the greenhouse can affect growth cycles, supplementation and reduction techniques can be considered to increase crop yield.

An example of typical environmental ranges for ensuring the maximum crop yield for Romain Lettuce can be found in Table 1 below:

Parameters\Range	MIN	Typical	Maximum
Soil Moisture	65%	75%	85%
PH	6.0	6.2	6.8
EC	1.2	1.5	2.5
Temperature	15°C	18-22°C	28°C
CO2	600ppm	800ppm	1000
Humidity	50%	60%-70%	85%
Watering	-	Between 6:00AM and 3:00PM when soil moisture drops below 50%	-
Tank Circulation	-	Between 5:30AM and 6:00PM	-

Table 1 - Greenhouse System Specification for Romain Lettuce

Manual measurement and control of the important environmental values is a time consuming and labor-intensive process, leading to reduced efficiency within the farming environment. For example, to ensure appropriate nutrient levels pH and EC readings must be taken directly from the soil. This leads to higher costs and lower yields due to poor variable control within the greenhouse.

Farmers are increasingly embracing automation to resolve the challenges associated with greenhouse crop growth, including more accurate and regular environmental measurements, automatic control of parameters such as temperature and humidity, and enabling precision control of nutrient mixes. The benefits received by farmers when scaling over multiple greenhouses or farms increase even further when automating these processes and is an important step for ensuring food security in the future.

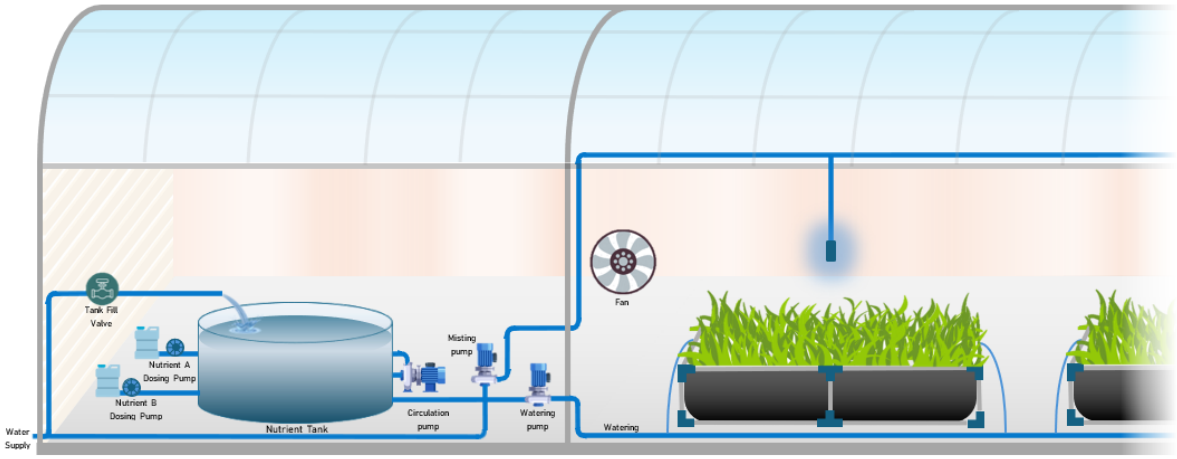

Figure 1 - Greenhouse Environment

2 Hardware – Sensors & Actuators

To increase efficiency within a farming environment sensors and actuators can be installed within the greenhouse to monitor variables important to crop yield (such as pH and EC levels in the soil), and to control devices important to the crop growth cycle (such as irrigation, misting, and nutrient pumps). This section will discuss how farmers can leverage BRTSys LDSBus Sensors & Actuators to monitor and control key factors within their greenhouse environments.

Figure 2 illustrates the LDSBus hardware, sensors, and actuators that can be added to the greenhouse environment to monitor crop parameters and control greenhouse equipment:

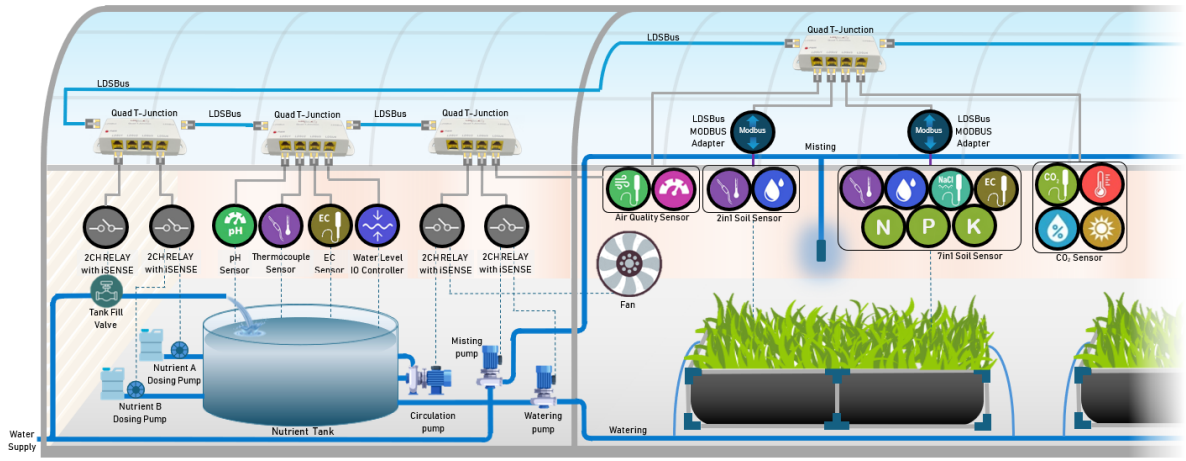

Figure 2 - Greenhouse System with added Sensors & Actuators

Error! Reference source not found. Table 2 below contains a list of the hardware components included within the Greenhouse example for a unit grow area between 100m^2 ~ 120m^2:

Device Description	Quantity
LDSBus 2CH Relay + iSENSE	2
LDSBus 2CH Relay	2
LDSBus Isolated IO Controller	1
Water Level Probe	1
LDSBus Electrical Conductivity Sensor Adapter	1
Electrical Conductivity Probe	1
LDSBus pH Sensor Adapter	1
pH Probe	1
LDSBus Thermocouple Sensor Adapter	1
Thermocouple Probe	1
LDSBus Air Quality Sensor	1
LDSBus CO2 Sensor	2
LDSBus Modbus/SDI-12 Adapter	6
Modbus 2in1 Soil Sensor	3
Modbus 7in1 Soil Sensor	3
LDSBus Quad T-Junction	4
Watering Pump	1
Misting Pump	1
Tank Circulation Pump	1
Fan	1
Dosing Pump	2

Table 2 - Hardware Components

2.1 Monitoring & Control

This section describes how the LDSBus hardware, sensors, and actuators are used to effectively sense, monitor and control key factors within the greenhouse environment.

Soil Condition Monitoring

2-in-1 and 7-in-1 soil sensors measure parameters such as NPK (Nitrogen, Phosphorous, Potassium) values, Electrical Conductivity, Sodium Chloride (salinity), moisture and soil temperature. These allow the temperature, moisture and nutrient levels to be determined. As these 3rd party sensors have Modbus interfaces, the BRT Systems LDSBus to Modbus/SDI-12 adapter allows them to be connected to the LDSBus network.

Nutrient Tank Mixing

Sensor adapters monitor various parameters via external 3rd party probes. This includes the pH, water temperature (thermocouple), Electrical Conductivity (indication of water quality and nutrient levels). Additionally, the water level is monitored via a water level probe connected to the LDSBus Isolated IO Controller. Relay actuators control a circulation pump which ensures the solution is well mixed. Finally, the nutrient mix is achieved by dosing and mixing pumps connected to LDSBus 2CH Relays with current sensing.

Irrigation & Misting

Irrigation and misting control are provided by pumps connected to 2CH relays with current sensing. The current sense feature allows power consumption monitoring as well as any power disruption to the pumps.

Greenhouse Temperature & Humidity

Greenhouse temperature is controlled by a fan connected to a 2CH relay with current sensing, while greenhouse temperature and humidity can be regulated via the misting pumps connected to a 2CH relay with current sensing.

CO_2 Monitoring

CO_2 and environmental conditions are monitored by the LDSBus CO_2 sensor. The LDSBus Carbon Dioxide sensor measures CO_2, Temperature, Humidity and Ambient Light.

3 The IoTPortal Solution

Now that the various sensors and actuators are identified and selected, it is time to connect them to the IoTPortal, and this is achieved via the IoTPortal Gateway. The gateway collects sensor data and transfers these to the IoTPortal and automation routines in the IoTPortal continuously monitor the incoming sensor data and when grow parameters deviate, these routines act to re-establish equilibrium by sending commands to the actuators via the gateway.

3.1 IoTPortal Topology

In this application, a single IoTPortal gateway is utilized along with several sensors and actuators to monitor and control the grow parameters within the greenhouse. The sensors and actuators can be connected to any of the three available LDSBus ports on the gateway and are daisy chained through LDSBus Quad T-Junctions. All three LDSBus ports on the gateway are utilized in this example. This helps maximize the range of the system as each LDSBus (up to 200m long) can be routed in different directions to different parts of the farm. The system topology can be seen in Figure 3 below:

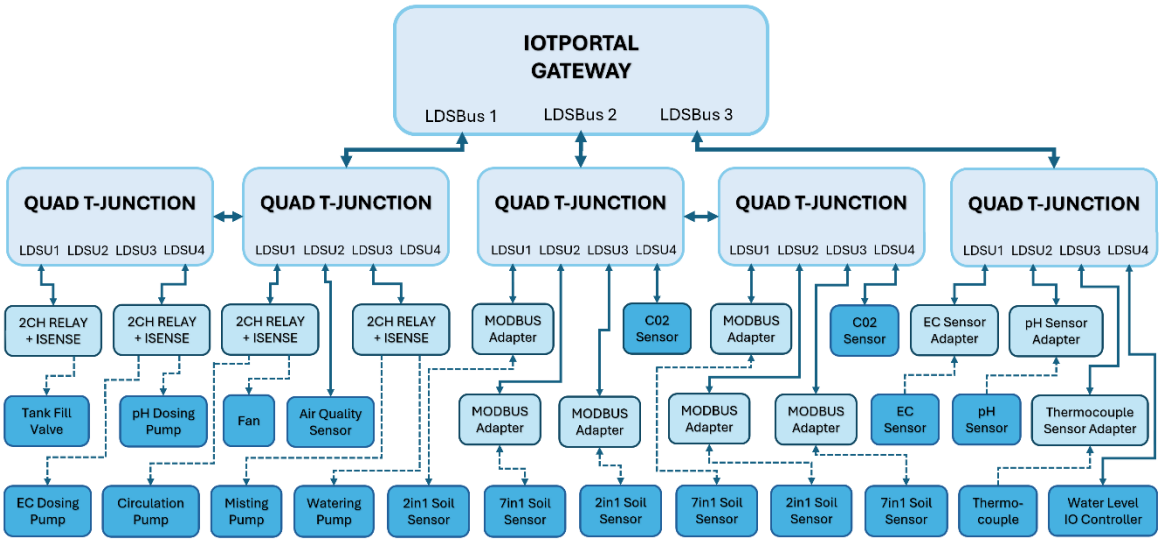

Figure 3 - System Topology

3.2 Automation

This section discusses how the IoTPortal System can be used to automatically control greenhouse parameters based upon the LDSBus sensor inputs, and how the actuators can be leveraged to maintain ideal growth conditions within the greenhouse.

The IoTPortal Gateway provides the ability to sense a wide variety of parameters through its three LDSBus ports and associated LDSBus Sensors and acts as the gateway between the LDSBus and the IoTPortal Cloud platform. The modular design of the LDSBus allows large numbers of sensors and actuators to be added, whilst multiple gateways provide for even bigger systems. The gateway provides power to all the connected sensors avoiding the need for power outlets around the greenhouse.

Figure 4 below shows the greenhouse with the IoTPortal incorporated to provide automation and increase system efficiency:

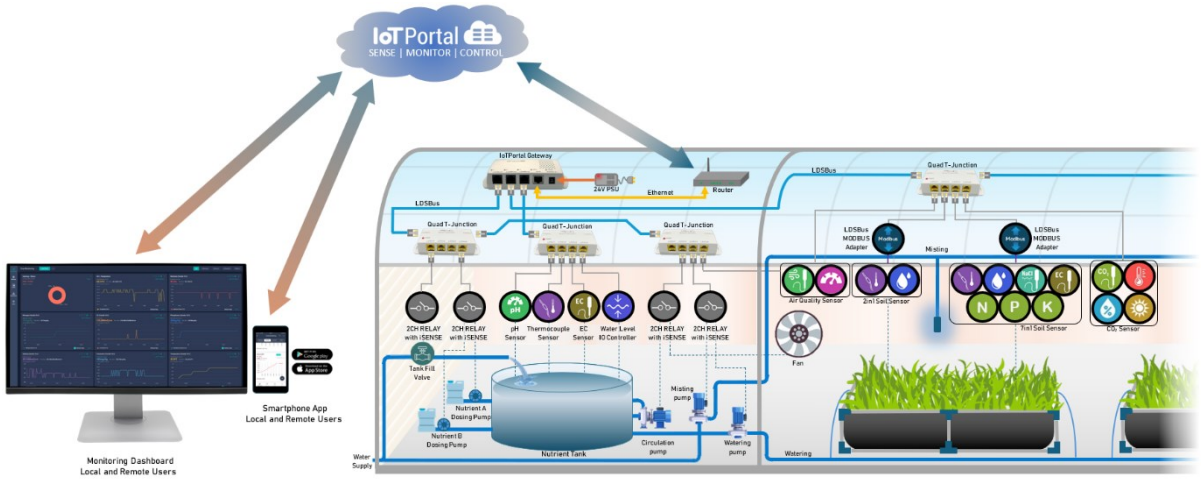

Figure 4 - Greenhouse with IoTPortal System

Nutrient Tank

At the start of the day, nutrients are mixed in the nutrient tank. A water valve is turned on to fill the nutrient tank to the desired depth and is cut off when the water level probe reports the target level has been reached. The irrigation pump and irrigation valves are cut off during the fill process. Next the dosing pumps add Nutrient A and B to the mix according to the desired ratio. This is done in small steps, and the water circulation pump is turned on to mix the nutrients. pH and EC are also monitored and when the desired pH and EC values are reached, the dosing and mixing are stopped. The automated events controls the pumps and valves via 2CH Relays, avoiding the need for manual addition of doses to adjust these parameters.

Irrigation

The irrigation pump and valve are turned on via 2CH Relays and the nutrient mix from the water tank flows to the vegetation beds. Soil sensors monitor the soil moisture, pH and EC levels and when the target levels are reached, the irrigation stops. This process is broken into multiple steps that run in a loop to allow for the nutrient and water to settle into the soil and be ready for uptake by the plant roots.

Misting

With an array of sensors such as the CO_2 sensor monitoring humidity and temperature around the greenhouse, we can automatically activate the misting pumps connected to a 2CH relay with current sensing to increase humidity or decrease temperature when required.

CO_2 Monitoring

CO2 is absorbed during photosynthesis, and this can lead to a drop in CO2 during the day. When the drop is below the limit (e.g. 600ppm) CO2 generators (kerosene, propane or natural gas) can be turned on to restore CO2 levels. This can be achieved via LDSBus 2CH Relays which handle loads up to 16A. Air Quality Sensors such as the LDSBus Gas and TrueVOC sensors can determine if any incomplete burning took place and if the air quality is safe for humans and plants and issue alerts when levels are unsafe.

4 Monitor – Web Console and Smartphone App

This section details how staff can utilize the IoTPortal Web Management Console (WMC) and Smartphone Apps to monitor the entire greenhouse. Both iOS and Android apps are available.

Sensor data from all the gateways on the systems is stored and processed on the IoTPortal Cloud. This centralized processing and storage allows access to data for authorized users from anywhere in the world via their smartphone or a desktop web browser. Staff and management can monitor the greenhouses regardless of whether they are on-site, at home or even away in another country.

The IoTPortal offers a zero-code environment for automation settings and all the afore described greenhouse automations can be configured using the Apps and Web Management Console, with no programming required whatsoever. This includes sensor thresholds, chart setup, and setting of user notifications and automated events.

4.1 Web Management Console

High frequency sampling of sensor and actuator data (at 5 second intervals) combined with visualization of the data via the apps and WMC dashboarding feature provides comprehensive real-time monitoring. The mobile apps are convenient for quick lookup of sensor data or chart once an alert has been received (push/SMS/email). However, the WMC is designed for large desktops and offers a more convenient high resolution charting feature for deeper data analysis.

Charts can be re-sized and rearranged so that the key parameters can be viewed briefly, with even more charts available by scrolling up and down the dashboard. An example of some of the charts for this greenhouse application are shown in Figure 5 below. Charts shown include ambient light and humidity from the 4in1 sensor, and EC, Moisture, Nitrogen and Phosphorous from the 7in1 soil sensor.

The Web Console has a wide range of other features, refer to the user guide for more details.

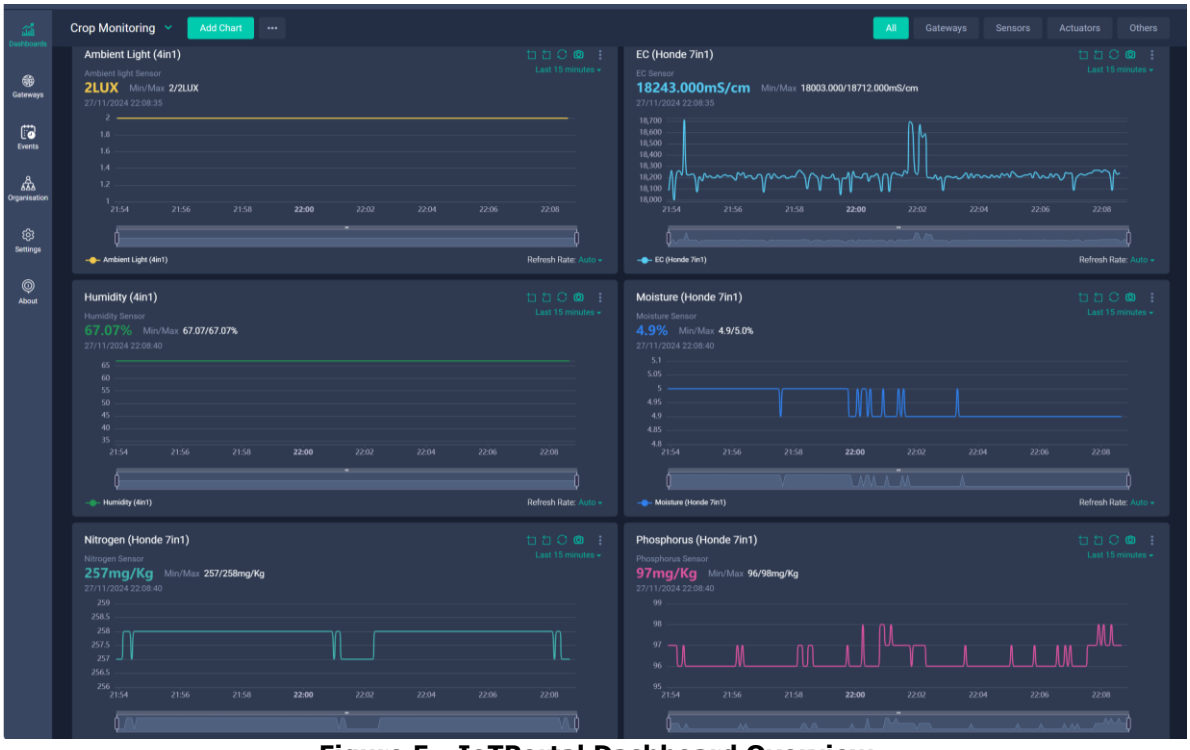

Figure 5 - IoTPortal Dashboard Overview

The charts include several key features including:

- Sampling and reporting of readings 5 second intervals
- View the latest reading, and historical max/min readings
- Drag the chart using the mouse via the top bar (containing the sensor name) to reposition within the dashboard
- Re-size the width of the chart by clicking on the edge and dragging. Wider charts up to the full screen width allow more detailed viewing of trends in the data
- Hover over the chart line to see a pop-up with the value of that data point
- Set the time interval (for example 15 minutes is shown here)
- Save the chart as an image
- Drag the handles on the summary bar at the bottom to adjust the time range.

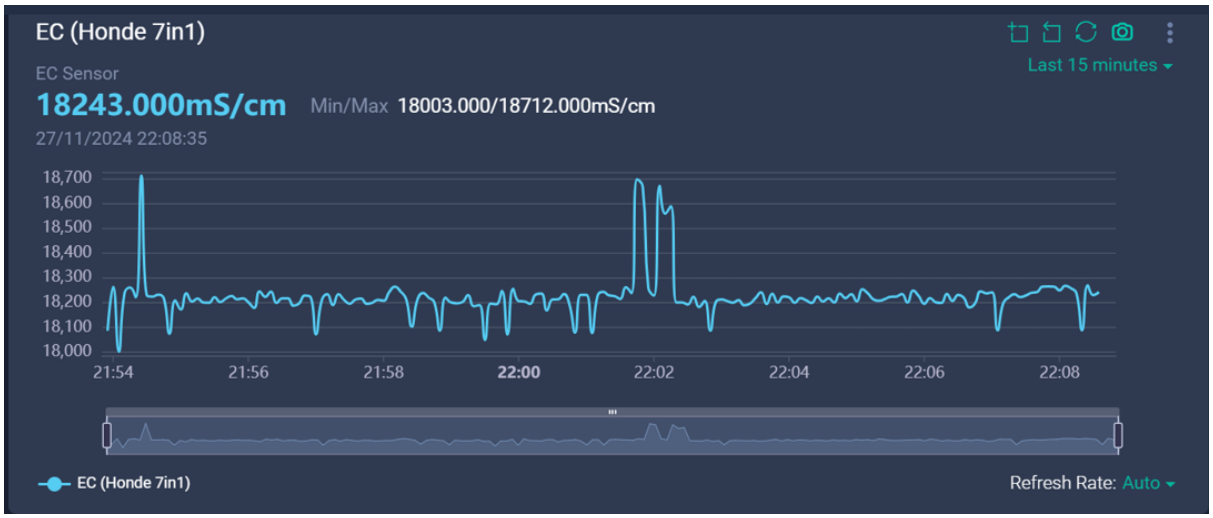

Figure 6 - IoTPortal Dashboard EC Chart

For this greenhouse application the following graphs have been configured to view on the dashboard for the sensors connected to the system:

- Environmental:
    - Ambient Light
    - Humidity
    - CO_2
    - Temperature
- Soil
    - Nitrogen, Phosphorous, Potassium values (NPK)
    - Electrical Conductivity
    - Sodium Chloride (salinity)
    - Moisture
    - Soil temperature
- Nutrient mix
    - pH
    - Electrical Conductivity
    - Temperature (Thermocouple)
    - Fluid level

There are also several actuators included in the system which control the various pumps. Other devices such as grow lights can also be controlled. These lights and pumps are controlled using a 2CH relay which also has current sensing functionality, thus current draw for a given actuator can also be graphed and included on the dashboard. Differences in current consumption compared to normal levels can help indicate degradation or failure of the pump motor.

The actuator graphs included are as follows:

- Watering Pump state + current
- Misting Pump state + current
- Air Circulation Fan state + current
- Tank Circulation pump state + current
- pH Dosing Pump state + current
- EC Dosing Pump + current
- Tank Fill Valve state

In case of reading drifting or change in the probe, sensors may be calibrated.

Sensors can be calibrated using the BRTSys LDSBus Configuration Utility Tool. Please refer to LDSBus Configuration Utility Guide for the calibration procedure. BRTSys also have a series of calibration videos which give further details.

4.2 IoTPortal Smartphone App

The IoTPortal smartphone app for Apple and Android phones provides similar functionality to the Web Application but from the employee's smartphone, allowing easy access and control whilst on the move.

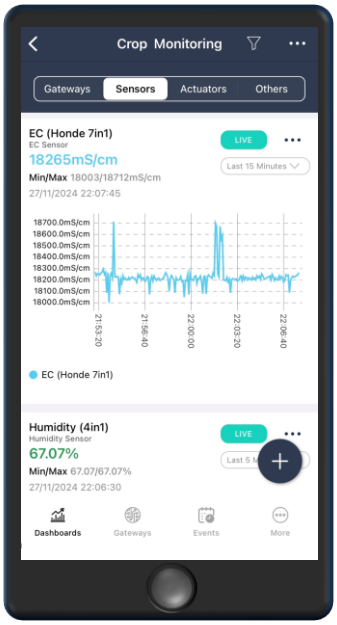

Figure 7 - IoTPortal Smartphone App

4.3 Events, Alerts and Automation

In addition to the sensing and monitoring features, IoTPortal can control parameters via the automation features (Events and Alerts) as shown in section 3.2.Table 3 shows examples of some of the events and alerts which can be configured for the greenhouse.

Event Name	Event Condition	Event Action	Alert
Watering Pump	1) Daily Recurrence Between: 6:00 AM – 3:00 PM **AND** 2) 7in1 Soil Sensor-Moisture Falls below 50 % and remains for 60 sec(s)	1) Activate Relay Channel for Watering Pump 2) Delay for 3 Mins 3) Deactivate Relay Channel for Watering Pump	Send Push Alert/SMS if (7in1 Soil Sensor – Moisture) Falls below 20%
Tank Circulation Pump	Daily Recurrence @ 05:30AM	1) Activate Relay Channel for Tank Circulation Pump 2) Delay for 30 Mins 3) Deactivate Relay Channel for Tank Circulation Pump	Send Push Alert/SMS
Misting Pump	1) Daily Recurrence Between: 10:30 AM – 2:30 PM **AND** 2) $C0_2$ Sensor - Temperature Rises above 35 °C and remains for 300 sec(s)	1) Activate Relay Channel for Misting Pump 2) Delay for 10 Mins 3) Deactivate Relay Channel for Misting Pump 4) Delay for 10 Mins	Send Push Alert/SMS
Air Circulation Fan	1) Daily Recurrence Between: 10:30 AM – 2:30 PM **AND** 2) $C0_2$ Sensor - Temperature Rises above 35 °C and remains for 300 sec(s)	1) Activate Relay Channel for Air Circulation Fan 2) Delay for 10 Mins 3) Deactivate Relay Channel for Air Circulation Fan 4) Delay for 10 Mins	Send Push Notification if Temperature Rises above 45 °C
EC Dosing Pump	1) Daily Recurrence Between: 5:30 AM – 6:00 PM **AND** 2) EC Sensor - Falls below 2.5	1) Activate Relay Channel for EC Dosing Pump 2) Delay for 1 Mins 3) Deactivate Relay Channel for EC Dosing Pump	Send Push Alert/SMS if EC Sensor - Falls below 1
pH Dosing Pump	1) Daily Recurrence Between: 5:30 AM – 6:00 PM **AND**	1) Activate Relay Channel for pH Dosing Pump 2) Delay for 1 Mins	Send Push Alert/SMS

	2) pH Sensor - Raises above 7.0	3) Deactivate Relay Channel for pH Dosing Pump	
Fill Tank Pump (On)	1) Daily Recurrence Between: 8:30 PM – 5:30 AM **AND** 2) Water Level IO Controller - Falls below 100cm and remains for 60 sec(s)	1) Activate Relay Channel for Fill Tank Pump	Send Push Notification if Water Level IO Controller - Falls below 50cm
Fill Tank Pump (Off)	2) Water Level IO Controller - Rises above 120cm	1) Deactivate Relay Channel for Fill Tank Pump	N/A

Table 3 - System Events

5 Future Improvements

Adopting IoTPortal with its unified architecture opens the door to other benefits which were not covered in detail in this application note, allowing farmers to optimize the business even further,
Aside from achieving good and consistent crop yields, businesses can suffer from hidden costs which reduce profitability but can be difficult to track down. One example is energy usage, which can significantly impact profit margins. Visibility of energy usage allows the use of devices such as fans, lighting, and pumps to be monitored and optimized to reduce energy wastage as well as in many cases wear and tear of equipment.

The highly flexible IoT Portal platform and LDSBus connectivity allow easy extension of the system with different types of sensors and actuators. For example, adding grow lighting, shades and rain curtains can be easily incorporated to provide further control overgrowth parameters.

Grow recipes can be implemented to optimize crop growing conditions at different stages of the grow cycle and for the crop type. Whilst some systems allow recipes for soil or nutrient conditions, with IoTPortal your recipe can facilitate maintenance of all key parameters leading to better results. The recipe can be easily created and modified via the IoTPortal's zero-code interface allowing the farm to optimize it based on data gathered from previous crop cycles and to adapt to changes in crop type.

With IoTPortal, BRT Systems also recognizes the importance that data analysis and ongoing improvement can make to a business. Extract data and carry out analysis over the entire crop grow cycle to optimize conditions for future grow cycles, and to produce reports for farm management.

6 Conclusion

In this application note we have shown how the IoTPortal works synergistically with farmers to support greenhouses whether they be based on soil or hydroponics.

We have also shown that by using a combination of BRTSys LDSBus sensors and actuators and 3rd party sensor probes, the system can monitor a wide range of key parameters, not only in the soil but also in the nutrient mix and the surrounding air quality and environment and automate the daily tasks of growing. IoTPortal brings a significant advantage over discrete monitoring systems by bringing all these parameters into one unified system, easing the process of monitoring the entire farm via one application. Wastage of energy, water and nutrients can be minimized through precise delivery of water and nutrients to the plants and running pumps, fans and burners only when required.

The sensor, actuator and energy and water consumption data collected by the IoTPortal coupled with crop data (weight, height, leaf width, color, yield) of crop can be analysed together to gain additional insights into the grow process.

Automation frees up human resources to focus on exceptions and they can be redeployed to serve a larger farm area and in the maintenance of the grow beds and burner equipment and during harvests.

7 Contact Information

Refer to https://brtsys.com/contact-us/ for contact information.

Appendix A – References

Document References

LDSBus_Configuration_Utility_Guide

LDSBus Quad T-Junction Usage for IoTPortal

Portal Web Application (WMC) User Guide

Android Mobile Application User Guide

iOS Mobile Application User Guide

Acronyms and Descriptions

Terms	Description
CO2	Carbon dioxide
EC Sensor	Electrical Conductivity
IoT	Internet of Things
LDSBus	Long Distance Sensor Bus
LDSU	Long Distance Sensor Unit
WMC	Web Management Console
2CH Relay	2 Channel Relay + iSENSE
pH	Potential of Hydrogen
ppm	Parts Per Million

Appendix B – List of Figures and Tables

List of Figures

List of Tables

Appendix C – Revision History

Document Title: BRTSYS_AN_050IoTPortal Greenhouse Application

Document Reference No.: BRTSYS_000122

Clearance No.: BRTSYS#128

Product Page: https://brtsys.com/

Document Feedback: Send Feedback

Revision	Changes	Date
Version 1.0	Initial Release	15-08-2025