ALMACO

INNOVATING SEED RESEARCH

BEYOND THE FIELD

D1 App API

Developer's Manual

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DEVELOPER'S MANUAL

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Introduction

Read this manual carefully to comprehend all modes of operation and levels of integration for the D1 App. It is vital to your operation and the integrity of your data collection to understand the capabilities and tools the D1 App provides. This manual contains descriptions and specifications of the operation of this software that will enable you to operate and integrate at optimal capacity. This manual contains installation instructions, a troubleshooting guide, and detailed explanations on all pages and modes of integration and operation.

The D1 App is the D1 Connection Software that fully integrates with ALMACO's VantageHD Harvest software and additional software that implements the API functionality. The D1 App has been designed to be a low-maintenance, user-friendly, data collection tool. The software is written to run on any Windows 10 computer and has been optimally designed for the Mobile Demand xTablet 7200.

All specifications, diagrams, and tables in this manual are based on the latest information at printing time. ALMACO reserves the right to make changes at any time without notice. Please contact an ALMACO representative if you have any questions about:

- Material in this manual

- Function and operation of the D1 App

- Integration with the D1 App API

- Troubleshooting, service, or other topics

TO THE PURCHASER:

We at ALMACO wish to extend to each customer our thanks and congratulations for your selection of the D1 App to be included in your agricultural software tool suite for field production.

We believe that our D1 App offers the best performance and value to the D1 harvest hardware. We ensure that the user interface and controls of the software have been specially designed for your ease of use. The data captured through this software has been tested to ensure optimal results for your precision research operation.

Our skilled workforce has engineered the ALMACO D1 App software at our USA headquarters to meet your performance, quality, and reliability expectations.

You and your company have joined the ever-growing group of agricultural researchers using ALMACO products. The ALMACO family is thankful for the opportunity to earn your business and we will continue to strive to meet your after-sale service needs with our 24/7/365 customer support.

Please read the information contained within the operator's manual carefully before operating **your** software.

Respectfully,

Patrick Clem, CEO

Contents

5 SAFETY

5.1 General Safety

Every year, many accidents occur which could have been avoided with a few seconds of thought and a safer approach to handling agricultural machinery and implements.

Designers build in as many safety features as possible, such as safety shields for belts, chains, sprockets, etc., but the designer cannot guarantee safety.

It is an end user's responsibility to ensure no hazards are occurred by operators.

Do not place fingers into open moving parts; injury may occur.

Do not climb, sit, or stand on the equipment.

Do not allow foreign objects into the equipment.

Do not use equipment in an unintended manner.

Do not use it in potentially explosive atmospheres.

These general safety precautions and the safety decals on the machine are intended to help avoid accidents and create a safe working environment.

5.1.1.1 Personal Protective Equipment

The following Personal Protective Equipment is to be worn while working around the D1 Unit:

Proper PPE for normal operation

 • Safety glasses

Proper PPE to be worn during service to D1 Unit

 • Safety glasses

5.1.1.2 Recognize Safety Information

This is the safety alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

Follow recommended precautions and safe operating practices.

5.1.1.3 Follow Safety Instructions

Carefully read all safety messages in this manual and the safety decals on your machine. Keep all decals in good condition and replace any that are missing or damaged. New decals are available from ALMACO. Refer to **Safety Decal Locations** later in this section for ordering information. Be sure new equipment, components, and repair parts display all required safety decals.

5.1.1.4 Service Safety

Disconnect D1 before performing any electrical work or service on the machine.

5.1.1.5 Handle Chemical Products Safely

Direct exposure to hazardous chemicals can cause serious injury.

A Safety Data Sheet (SDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques.

Check the SDS before you start any job using hazardous chemicals, so you will know the risks and how to handle chemicals safely. Follow the procedures and use the recommended equipment.

5.1.1.6   Observe Environmental Protection Regulations

Before disposing of chemically treated seed, know the correct method of disposal. Observe relevant environmental protection regulations when disposing of seeds and cartridges.
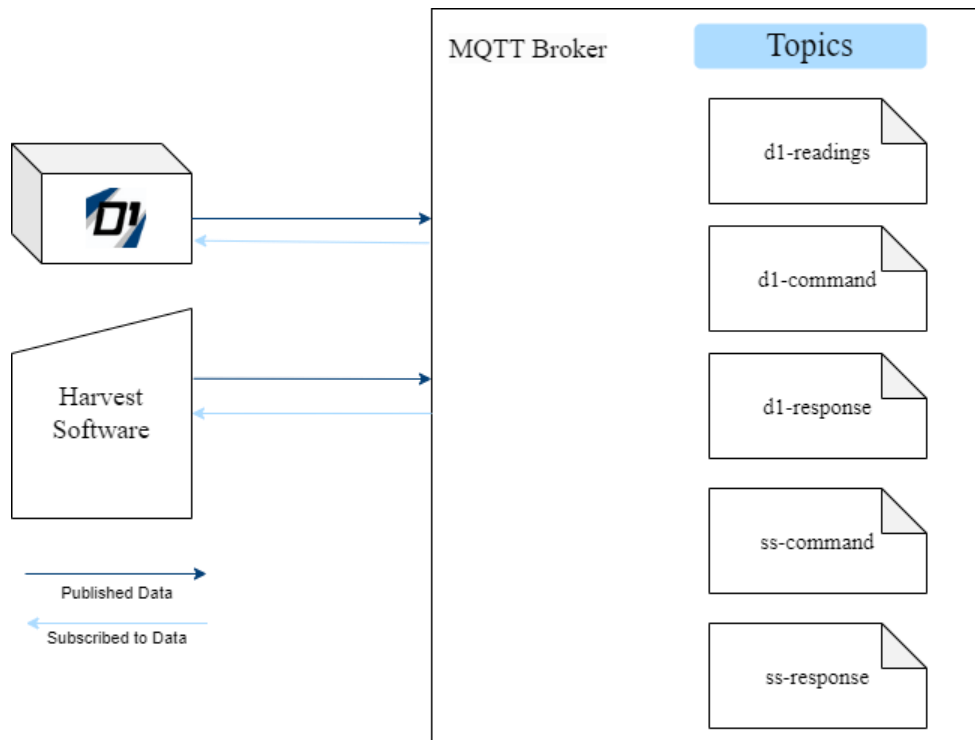
6 INTEGRATION

6.1 Programming Conventions

This manual has been written for developers to enable them to connect to our software and build onto our technology. Our API (Application Programming Interface) enables the consistent transfer of data from our system to yours. Our MQTT API implements the standard MQTT architectural pattern and protocol of clients publishing and subscribing to predetermined topics.

MQTT stands for Message Queuing Telemetry Transport and is a lightweight publish-subscribe messaging protocol. In standard MQTT architecture, there is one MQTT broker with a set of topics. Clients are external components communicating with the broker. A client can publish data to topics and subscribe to receive data from topics. Once a client is subscribed to a topic, the broker will ensure that the client will receive all published content on that topic.

6.2 How to Use Our MQTT API

The D1 Application uses an MQTT broker architecture to transfer information via JSON messages. Within the D1 App, there are 5 topics that an integrating software can publish and subscribe to.

6.3 How to Establish a Connection

As with all coding solutions, there are many clever methods to how this can be done but the following is one solution for connection done in C#. For additional solutions in other coding languages, there is much documentation online on MQTT connections. We recommend you take the information on the topics, information structure, and coding logic flow and write your code based on MQTTs language-specific documentation.

Connection with any MQTT broker starts through setting up a client and subscribing to the necessary topics.

```
    private IManagedMqttClient managedMqttClient = new MqttFactory().CreateManagedMqttClient();
```

```
var tlsOptions = new MqttClientTlsOptions
{
    UseTls = false,
    IgnoreCertificateChainErrors = true,
    IgnoreCertificateRevocationErrors = true,
    AllowUntrustedCertificates = true
};
```

MQTT requires that there are configurations for MQTT TLS (Transport Layer Security).
Our system does not require TLS as it is an internal communication on localhost. More
important configurations for your implementation of our API are below. Your ClientId
can be a string of your choice but ensure that you select port 1883, server of localhost,
and that the rest of the options are configured correctly. The details of the
configurations are essential for connection.

```
var options = new MqttClientOptions
{
    CleanSession = true,
    ClientId = "HarvestClient",
    KeepAlivePeriod = TimeSpan.FromSeconds(5),
    ProtocolVersion = MqttProtocolVersion.V500,
    ChannelOptions = new MqttClientTcpOptions
    {
        Server = "localhost",
        Port = 1883,
        TlsOptions = tlsOptions
    }
};
```

```
await managedMqttClient.StartAsync(
    new ManagedMqttClientOptions
    {
        ClientOptions = options
    });
```

6.4 Subscribing to Topics

Once you have identified what topics you would like to subscribe to, you must internally code the subscribing connection.

```
await managedMqttClient.SubscribeAsync("d1-readings", MqttQualityOfServiceLevel.AtLeastOnce);
```

After you have set up the connection and you have subscribed to the correct topics, it is necessary to handle the MQTT-received messages. Depending on the topic received, you can implement functionality accordingly.

```
/// <summary>
/// Handles the received application message using the specified event args.
/// </summary>
/// <param name="eventArgs">Event arguments passed into the method.</param>
/// <returns></returns>
public Task HandleReceivedApplicationMessage(MqttApplicationMessageReceivedEventArgs eventArgs)
{
    var thisTopic = eventArgs.ApplicationMessage?.Topic;
    var thisPayload = eventArgs.ApplicationMessage.ConvertPayloadToString();

    var errors = new List<string>();

    try
    {
        switch (thisTopic)
        {
```

6.5 Publishing To Topics

To publish to any topic, one must create a JSON object, serialize the object, and publish it to the desired topic.

```
JSON_Response thisResponse = new JSON_Response
{
    timestamp = DateTime.Now,
    command_string = command,
    response_string = response
};
```

```
var output = JsonConvert.SerializeObject(thisResponse, Formatting.Indented);
```
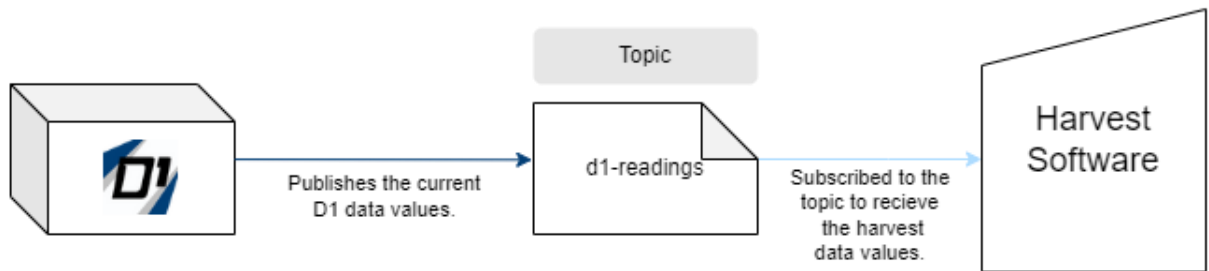
```
MqttPublish("d1-commmand", output);
```

Depending on the topic, the input, and output will look different. All will be serialized JSON objects with a time stamp, but the format of each topic is specific to the data being transferred. Continue to the topics section to see the format information.

6.6 D1 App Topics

D1 Readings

The 'd1-readings' topic is where the D1 App publishes all data information pertaining to weight, test weight, moisture, and temperature. These messages will be posted frequently while D1 App is connected to a D1 Unit.

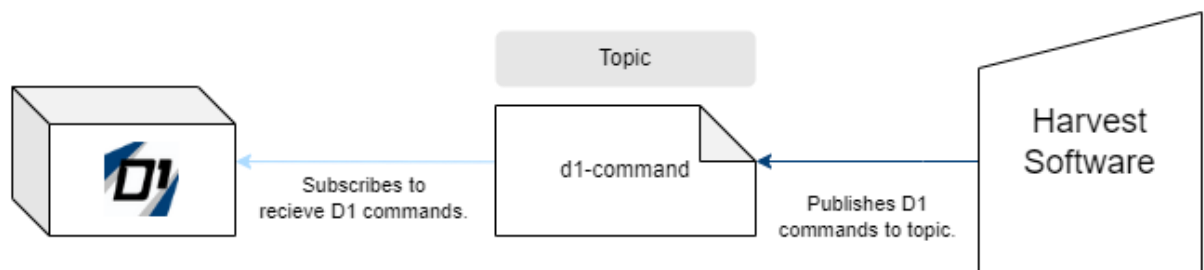The format of the 'd1-readings' JSON is:

```json
{
    "timestamp":"2023-05-04T10:00:58.9234876-05:00",
    "left_weight": 10.114106178283691,
    "left_test_weight":"NaN",
    "left_moisture":"NaN",
    "left_temperature":"NaN",
    "right_weight":"NaN",
    "right_test_weight":10.114106178283691,
    "right_moisture":10.114106178283691,
    "right_temperature":10.114106178283691,
    "left_weight_raw":10.114106178283691,
    "left_test_weight_raw":10.114106178283691,
    "left_moisture_raw":10.114106178283691,
    "left_temperature_raw":10.114106178283691,
    "right_weight_raw":10.114106178283691,
    "right_test_weight_raw":10.114106178283691,
    "right_moisture_raw":10.114106178283691,
    "right_temperature_raw":10.114106178283691
}
```

The values on the right side will vary based on the configurations of the machine, the implemented calibration curve, and the date-time. If the combine is not a dual plot machine, it will not have both left and right values. If the machine is not giving a value for a parameter, the JSON will contain a "NaN" as a place holder. The first 8 values of the JSON (not the timestamp) are the raw uncalibrated voltages relating to the left-hand value. The next 8 are the fully calibrated value based on the current calibration curve implemented in the D1 App Calibration tab.

Within the code, we recommend creating a readings object and serializing and deserializing the object using the System.Text.Json namespace in .NET.

D1 Command

The 'd1-commands' topic is where the D1 App subscribes to all commands that can be published by external components of software. There are 2 commands an external software can publish to the 'd1-commands' topic with positive result, these being "hide" and "show".
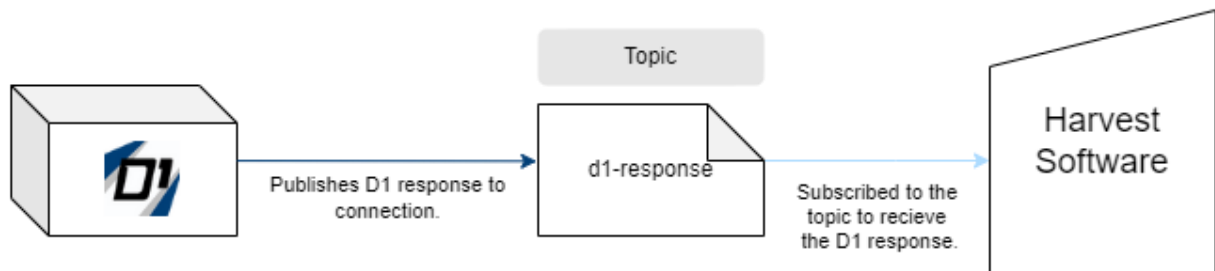

The format of the 'd1-commands' JSON is:

```json
{
    "timestamp": "2023-05-04T10:00:38.987654-5:00",
    "command_string": "show"
}
```

```json
{
    "timestamp": "2023-05-04T10:00:38.987654-5:00",
    "command_string": "hide"
}
```

The command to hide will minimize the D1 App to the service tray of the windows device that the D1 App is running on. The command to show the D1 App will bring the App the foreground of the windows machine.

D1 Response

The 'd1-response' topic is the location of connection updates. The D1 App will post to the 'd1-response' updates the command of connected and the response of true or false. If the Connection was a success, then the response is true. If the D1 App failed to connect to the D1 unit, then the response is false.

Topic

Publishes D1 response to connection.

d1-response

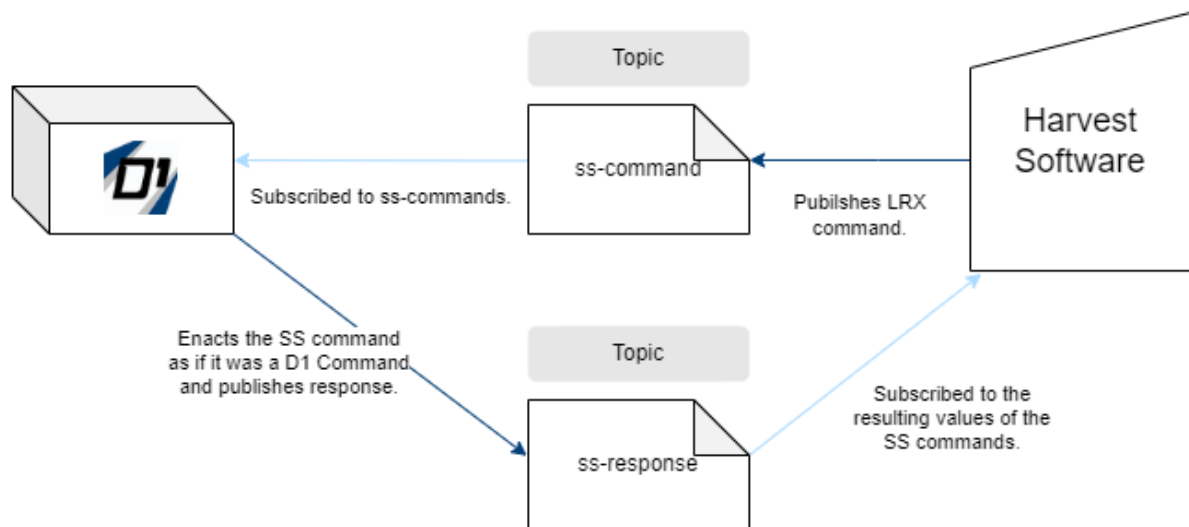Subscribed to the topic to recieve the D1 response.

Harvest Software

The format of the 'd1-response' JSON is:

```json
{
  "timestamp": "2023-05-04T10:00:38.987654-5:00",
  "command_string": "Connected",
  "response_string": "true"
}
```

SS Commands

To create a backwards compatibility with harvest software that previously interfaced with the Seed Spector LRX, the D1 App supports the 'ss-command' and 'ss-response' topics. The D1 App will emulate the SS in that it will accept the exact same command strings and respond with a Seed Spector result.

An example of a 'ss-command' JSON is:

```json
{
    "timestamp": "2023-05-02T10:13:17.5846009-05:00",
    "command_string": "$Z14W020Z6"
}
```

The D1 App will process the command string as if it was an SS LRX and respond with publishing to the 'ss-response' with both the command and the response to the command.

An example of a 'ss-response' JSON is:

```
{
    "timestamp": "2023-05-02T10:13:13.8266056-05:00",
    "command_string": "R012345",
    "response_string": "17.57\r\n9.92\r\n13.94\r\n16.24\r\n9.83\r\n9.72"
}
```

In this example the command string is: R012345. The value R is the request for the calibrated readings and the numbers refer to which readings are requested. In this case:

0: left_moisture = 17.75

1: left_weight = 9.92

2: right_weight = 13.94

3: right_moisture = 16.24

4: left_temperature = 9.83

5: right_temperature = 9.72

To know more about the command strings and responses, refer to the LRX manual.

6.7 Helpful Libraries and Tools

Libraries that we use to perform the MQTT operations:

- MQTTnet version 4.1.3.436
- MQTTnet.Extensions.ManagedClient 4.1.3.436

    https://github.com/dotnet/MQTTnet

A helpful for tool for working with MQTT that we recommend is MQTT Explorer.

    https://apps.microsoft.com/store/detail/mqttexplorer/9PP8SFM082WD?hl=en-us&gl=us

7 TROUBLESHOOTING

8 ADDITIONAL RESOURCES

8.1 Warranty

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