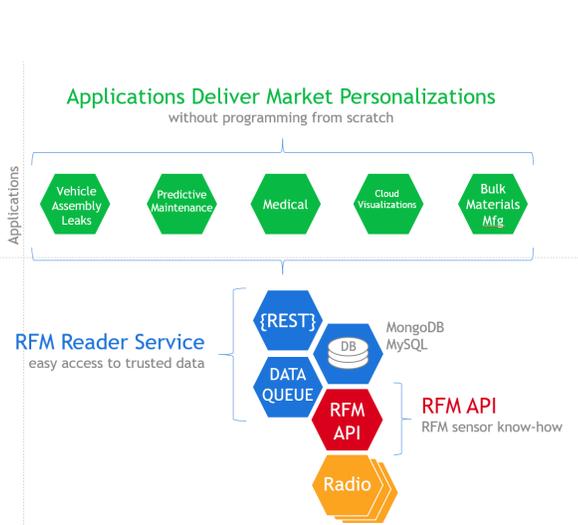




Fixed Reader with ReaderService

Process at the edge to get data faster



```
*RfmApiUsingNordicReaderExample.java SensorT
36 public static void main(String[] args) {
37
38     try {
39         // Create new reader instance
40         Reader reader = new Reader("com.rfmicron
41
42         // Connect to reader
43         String host = "172.16.1.111";
44         int port = 4333;
45         Logger.info("Connecting to the reader IP
46         Future<Boolean> connected = reader.conne
47
48         // Wait for reader connection
```



APPLICATIONS

IoT sensing
Building performance
Factory 4.0 monitoring
Data center monitoring
Cold chain shipping

KEY FEATURES

Reader temperature range
-20 °C to +55 °C
210 x 121 x 31 mm
Smart reader running Linux
16 SMA antenna ports
Smart Passive Sensing™
Java-based RfmApi Software
Aggregates RFM5108 data

What's in the system?

The RFM5109 is a wireless reader system for battery-free Smart Passive Sensing™ devices. The RFM5109 smart reader includes an embedded processor running Linux. The RFM5144 ReaderService is included with the system and runs either on the reader itself for full edge processing, or on a PC/server in a distributed processing configuration.

How is it used?

The system includes several sample programs that employ the built-on REST interface to access data from the integrated data-base. These example programs are a starting point for custom code that can be modified and extended to specific needs.

Sensors sold separately

The system includes a selection of temperature and moisture sensors to facilitate evaluation and software development. Other Axzon sensors can be purchased separately for use with the RFM5109 system.

Part numbers

The RFM5109-B is a system level product that includes the RFM5144-B ReaderService™ interface software. The RFM5144-B is a complete Windows® microservice. The RFM5144 ReaderService™ is able to aggregate data from external RFM5108-B readers. **v0.2.0**

USER GUIDE - RFM5109

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RFM5203-A Wideband antenna

1. Introduction

Thank you for purchasing the RFM5109 Fixed RAIN-UHF Reader system with ReaderService™ microservice for Windows®/Linux/Mac®. The system enables sensor monitoring in various IoT (Internet of Things) applications. The monitoring process employs radio frequency (RF) signals to wirelessly power and communicate with sensors. No wiring is needed for the sensors.

A variety of sensors are available for the RFM5109 reader. Sensors are purchased separately.

1.1. RFM5109-Bx System Components

Industrial fixed reader: The reader is used to communicate with the sensors and retrieve their data and status. The ReaderService microservice can run locally on a smart reader, or on a PC/ server in a distributed processing configuration. Most applications will connect to the reader over Ethernet.



RFM5109-B Fixed Smart Reader

Reader power source: The reader ships with an external power supply. The reader can also be powered over Ethernet, PoE.

Antennas: The system includes one antenna. The reader supports up to 16 antennas, and additional antennas can be purchased separately.

RF cables: Antennas are connected to the reader using the cable provided.

Temperature sensors: The RFM3200, RFM3250 wireless temperature sensors and the RFM2100 moisture sensor are supplied with the system. All sensors employ Axzon Smart Passive Sensing™ technology. These sensors are designed to be mounted directly to monitored objects with their integrated adhesive backings.



RFM3250 Rugged Temperature Sensors



RFM3200 Flexible Temperature Sensors

Software: The RFM5109 ships with the RFM5144 ReaderService software which provides a REST interface into the integrated MySQL database. Standard REST calls are supported. The RFM5144 also includes the RFM5140 RfmApi interface which provides advanced algorithms that convert raw sensor data into trusted information to be managed and processed by the RFM5109.

2. The Reader

The fixed reader is used to communicate with the sensors and retrieve their readings. This wireless reader does not include an integrated antenna; antennas must be connected to the reader using separate cables.



RFM5109-B Fixed Smart Reader front with power and network connections



RFM5109-B Fixed Smart Reader back with 16 antenna ports

2.2. Connecting the reader to a PC

The reader is typically connected to a network using Ethernet. The reader has its own IP address that should be reflected in the software.

The reader's IP address can be modified with the utility software from Nordic-ID. Please see section 5, *Updating the Reader IP Address* for additional details.

2.1. Powering the reader

The reader can operate with a 10 W DC source". The system includes an appropriate connector for the power connection. When power is applied, the PWR LED on the reader unit will illuminate green.

With appropriate PoE hardware the reader can be powered over Ethernet with an 12 W power draw.

3. Using the System

3.1. Identifying and Organizing Sensors

Sensors are typically identified by their EPC or TID numbers. The RFM5144 ReaderService alpha release is able to read EPCs only. The specific value written into the EPC memory area is used to identify individual sensors.

3.2. Sensor Handling and Placement

Axzon sensors can be touched with no worry about affecting their operation.

The RFM3250 temperature sensors are constructed with rugged materials designed to operate in harsh environments. In normal use, the RFM3250 protective backing is peeled from the sensor's adhesive layer before affixing it to a motor or pump for example.

Epoxy mounting of the RFM3250 sensors is allowable. Please see *AN009 RFM3250 Epoxy Recommendations* for more information.

3.3. Software overview

RFM5109 Fixed reader is operated using the RFM5144 ReaderService software. This software includes a complete REST interface, an integrated MySQL database, and support for streaming data modes. The RFM5144 ReaderService uses the RFM5140 RfmApi interface to manage lower-level sensor configuration and raw sensor data. The RFM5140 RfmApi converts raw sensor data into trusted data for the RFM5144 ReaderService to store and process.

Several example programs using the ReaderService are provided.

3.4. Maximum Read Range

The maximum read range for the RFM3250 is approximately 5 to 7.5 meters in a free air environment depending on the antenna used. Near complex mechanical structures, the read range can be reduced to 2-3 meters. Please see the respective sensor product brochure for additional details on each sensor's performance.

Metal enclosures tend to reflect the RF signal throughout the enclosure. It is possible for these reflected signals to combine to create nulls or shadows, where the RF signal cancels itself. These nulls are usually only a few inches or centimeters wide. Moving sensors or antennas in any direction will often correct for any weak signal strength issues.

4. Reader IP Address

The ReaderService demo programs when run from the PC/server require the RF reader's specific IP address to communicate. The RF reader is configured to dynamically set its IP address each time it connects to a network.

Please use the network discovery methods provided in the `RfmApiDemo.java` program from the RfmApi example programs to find IP addresses and configure software dynamically. The RfmApi interface and demo programs are supplied with the ReaderService.

NOTE: Please ignore the remainder of this section if dynamic IP addressing is used.

The format of an IP address is usually xxx.xxx.xxx.xxx, 130.132.xxx.xxx or 128.36.xxx.xxx. IP addresses can be different depending on the network. For instance, when you connect your laptop at home, it has a different IP address than when you connect it at your office.

4.1. Finding your IP address

From within Microsoft Windows 7 or Windows 10, please follow the instructions below to identify your computer's IP address. This will confirm the base IP address range that the reader should use.

1. Click the START button
2. Type `cmd` in the start or search box
3. Select `cmd.exe` or the COMMAND PROMPT when it appears
4. A black command box will appear
5. At the blinking cursor, type `ipconfig /all`
6. Press Enter.
7. Below the heading "Ethernet adapter Local Area Connection:" look for the IP or IPv4 Address entry. The first three numbers are critical: xxx.xxx.xxx....

4.2. Setting a new static IP address

Configuring the reader for a static IP address simplifies evaluation and development tasks. The RFM5109 reader ships configured for a dynamic IP address, which is configured each time the reader is attached to the network. Configuring for a static IP address simplifies the software development task by using a single defined IP address during development.

CAUTION: The IP address you enter should be unique for your organization. Please contact your IT department for additional details.

You can ping your target address using Windows START→COMMAND PROMPT→PING. If the ping returns a reply, then the IP address is occupied, otherwise it times out.

CAUTION: In some cases, the IP address may not reply to your ping if the device is otherwise occupied. Please use an alternate static IP address if you experience erratic reader connection performance. Please consult with your IT department for additional details.

4.3. Optional: Reader Configuration Utility

1. Please connect the reader to your PC using the USB cable
2. Optional: To change the reader's IP address, please open the Nordic Configuration utility supplied with the reader.
3. Please select the Connected button in the upper left of the screen. Enter the IP address and port number of your reader if known. The configuration tool may automatically find your reader.
4. You can confirm that the reader is connected when the right-hand panel is populated with reader-specific information, and address.





Device

Device name	AR52
Device S/N	K172800156
Hardware versi...	PWM00282
Firmware version	5.10 A
FCC ID:	FCC: SCCNUR10W / IC: 5137A-NUR...

Ethernet connection

Ethernet title	AR5x-11009c
Ethernet version	2038
IP address	172.16.1.111
MAC address	00-21-AD-11-00-9C

Utility detailed settings panel

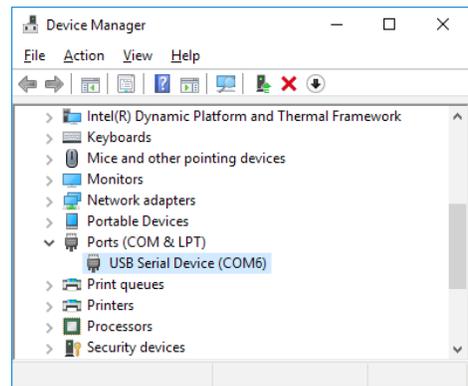
4.4. Optional: Finding the IP address

PuTTY is a download able tool that can be used in place of the reader configuration utility. Both the reader configuration tool and PuTTY are able to configure the reader IP address over USB.

1. Please download PuTTY from:

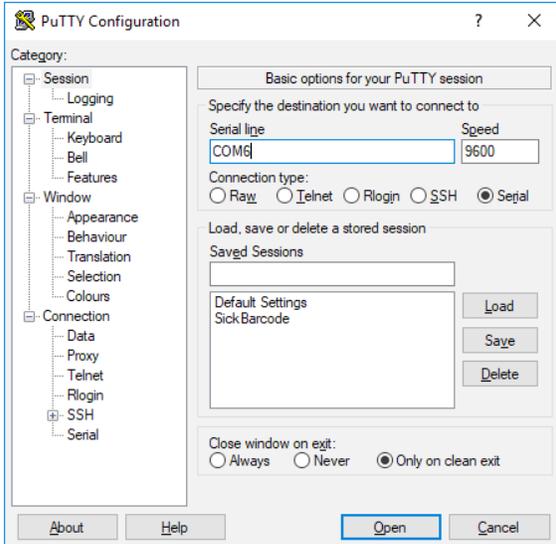
<https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>

2. After installing PuTTY, connect the power, USB, and Ethernet to the RF reader.
3. Open the Windows Device Manager and expand the section Ports (COM & LPT). You should see an entry “NUR Module” or “USB Serial Device” with an assigned COM port (e.g. COM6). You can ensure that you are finding the right COM port by unplugging the RF reader. If Device Manager entry goes away, then you are looking at the correct one.

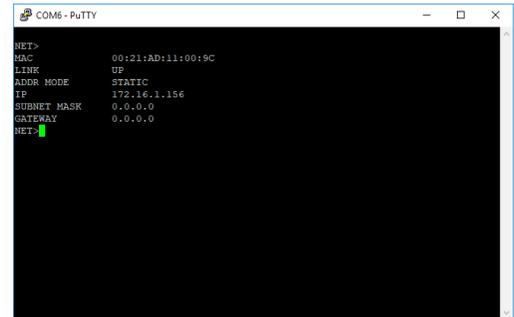


4. Plug the RF reader back in.

5. Open PuTTY, and select the radio button for “serial” in the “Connection type” section. Then enter the COM port under “Serial line”, and set the “Speed” box to 9600.



6. In the PuTTY terminal window type “net” and press enter (note: you will not see any characters on the display). Now the prompt changes to NET >.



7. Please type letter “s” at the command prompt, and press Enter. This will display the IP address and other details of the RF reader. Note the RF reader’s IP address.

5. RFM5144 ReaderService Software

The RFM5144 ReaderService software operates through a REST interface. The software is shipped as a .jar library file along with several example programs. The microservice can be launched directly within Windows.

5.1. Installation Overview

Install and configure the tools in order below:

1. ReaderService
2. MySQL (version 5.7)
3. Apache ActiveMQ (version 5.15)
4. Create a DBA user in the MySQL database
5. Executing the database scripts from the <<reader-service>>/db-script folder.
6. Run the C# demo app to access data.

5.2. Installing the ReaderService

Unzip the Reader Service files into a directory of your choice. Right-click and run <<reader-service>>\bin\install-reader-service.bat as an administrator from the \bin\ folder where you stored your files. In Windows 10, you may receive a warning message when starting new services or tools. Please click the message's more information link to enable the PROCEED button, or right-click the file to "run as administrator".

IMPORTANT: You can confirm the microservice is running by entering and running "services" from the START prompt on Windows. Scroll down the list and right-click Axzon ReaderService to view properties. If the microservice is not running, please right-click and start the service.

IMPORTANT: After starting the service, you can confirm the ReaderService started by reviewing the logs at <<reader-service>>/logs/rfm-reader-service.log.

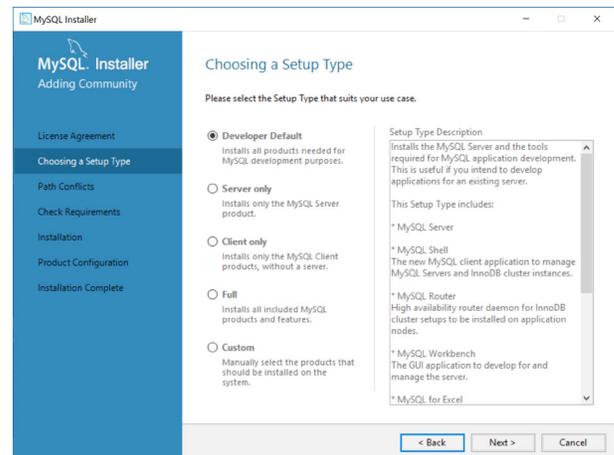
Installing MySQL

Create an account at Oracle to download and install MySQL to your PC from dev.mysql.com.

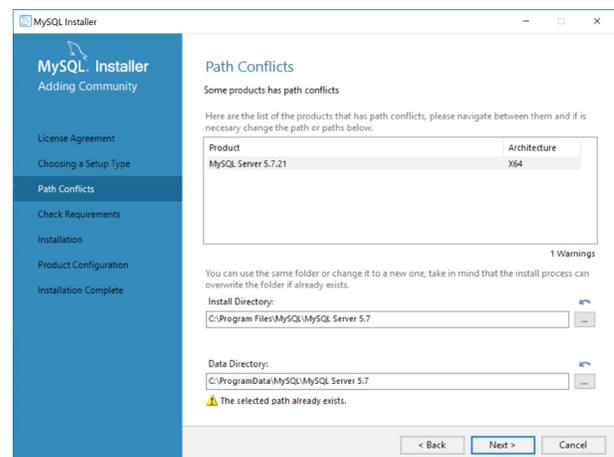
Download the version 5.7 installer for the best match to **MySQL on Windows (installer and Tools)**.

You can download the web-connected installer, or the larger off-line installer.

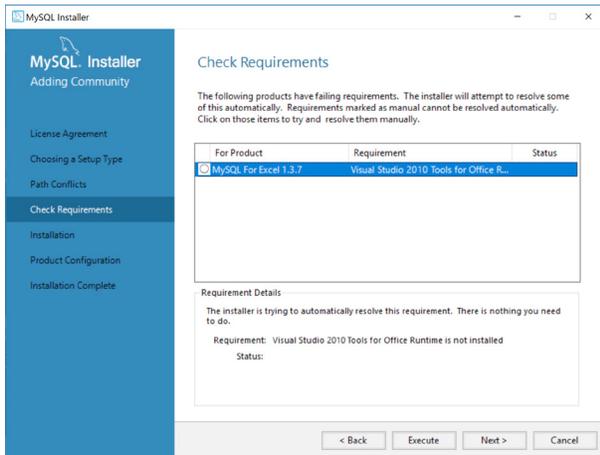
Select the **Developer Default** option.



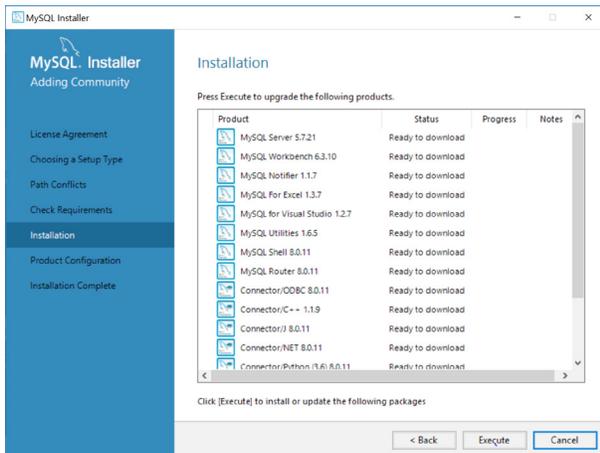
Select the path for the installation.



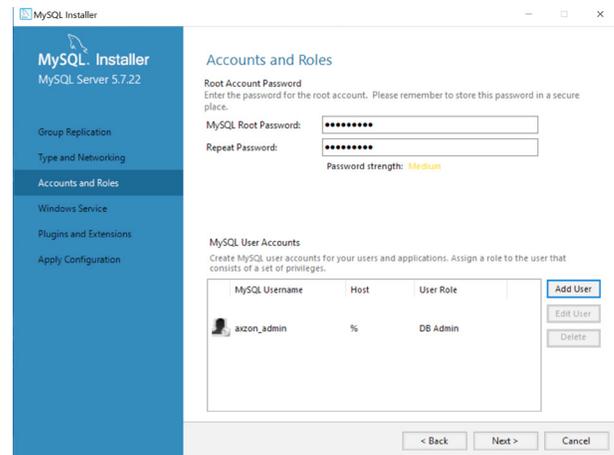
A check is performed to assess if additional components need to be installed.



Components are installed.



Product configuration includes a set of decision, and roles that should be enabled. The root login can be any password that you like.

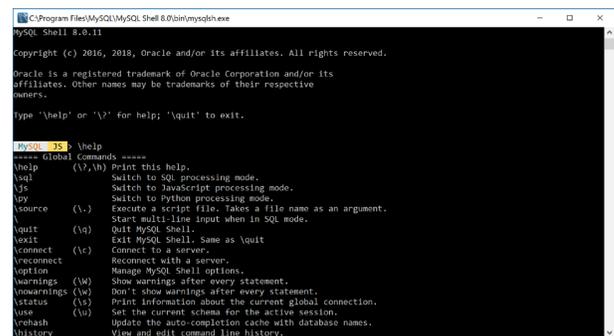


You will need to add a DB admin user with a login/password that matches the login used by the ReaderService.

Role: DBA
Host Matching: %
Login: axzon_admin
Password: axzon_admin

These defaults can be changed in the <<reader-service>>/config/application.properties folder prior to installing the ReaderService.

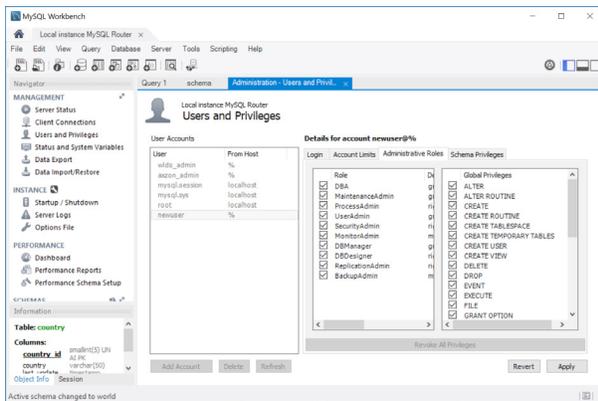
Other setup settings are optional. The installer will open a command prompt window at the completion of the installation.



5.3. Creating a new user

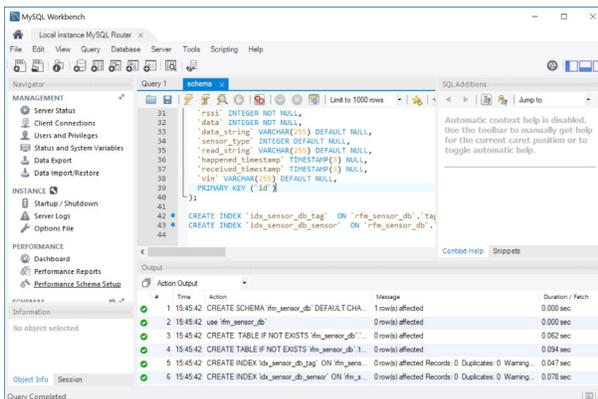
If a new DBA database administrator with all rights was not created during the MySQL installation to match expected database login from the <<reader-service>>/config/application.properties file, then a new DBA role can be configured using the MySQL Workbench.

Role: DBA
 Host Matching: %
 Login: axzon_admin
 Password: axzon_admin



5.4. Creating the Database Schema

Within the MySQL Workbench, load the SQL file <<reader-service>>/db-script/schema.sql. The lightning bolt icon will execute “highlighted or selected” SQL commands. The new rf_sensor_db schema should now be listed in the left workbench window.



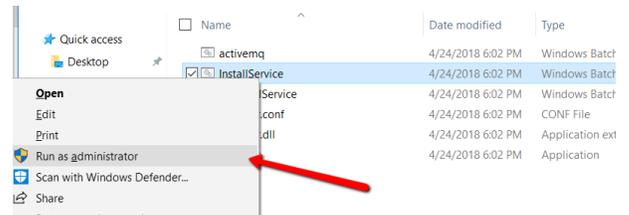
5.5. Installing ActiveMQ

Download ActiveMQ version 5.15 installer. Detailed instructions are also available at <http://activemq.apache.org/getting-started.html>.

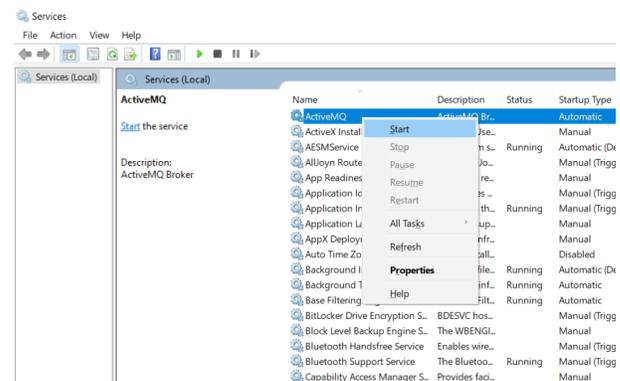
Extract the zip file contents to a program directory of your choice, such as C:\Program Files\activemq.

Name	Date modified	Type
activemq	4/24/2018 6:02 PM	Windows Batc
InstallService	4/24/2018 6:02 PM	Windows Batc
UninstallService	4/24/2018 6:02 PM	Windows Batc
wrapper.conf	4/24/2018 6:02 PM	CONF File
wrapper.dll	4/24/2018 6:02 PM	Application e:
wrapper	4/24/2018 6:02 PM	Application

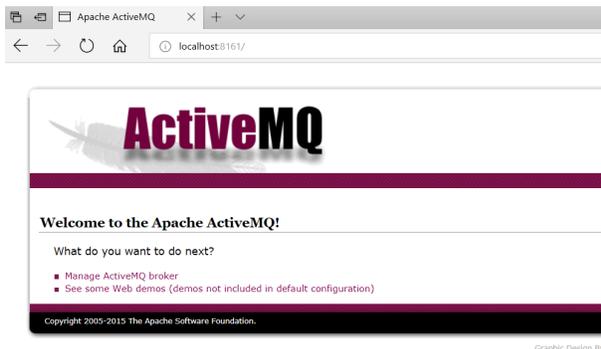
Within the activeMQ/bin directory select and click into the folder that best matches your operating system. Then right-click on InstallService.bat then select “Run as administrator.” Confirm any Windows Defender prompts.



Launch Windows Services by typing “services” at the START menu. Verify that a new service has been added named “ActiveMQ.” If not running already, right click on the service and select start.



Open a browser and navigate to `http://localhost:8161/`. An ActiveMQ page should load indicating installation is finished.

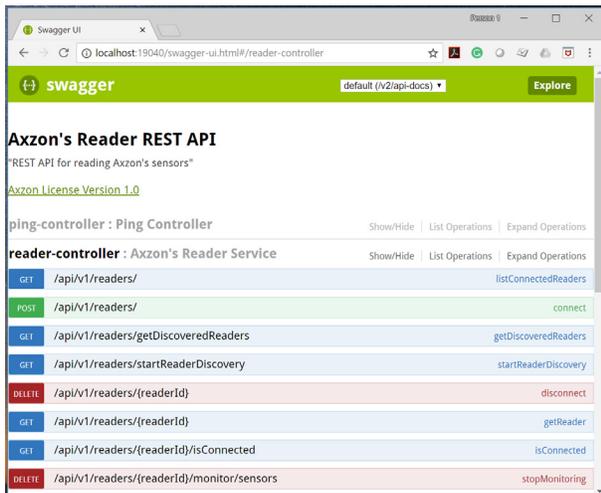


5.6. Access the REST interface with Swagger

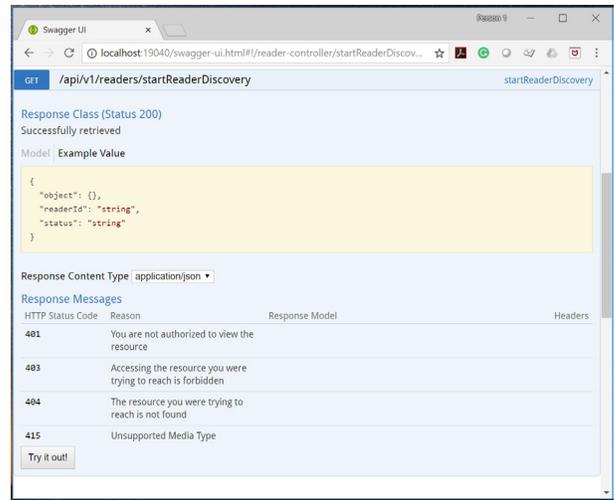
The swagger tool is included with the Reader-Service for easier access the REST commands. Please enable the swagger tool by entering the URL below in a web browser.

`http://localhost:19040/swagger-ui.html`

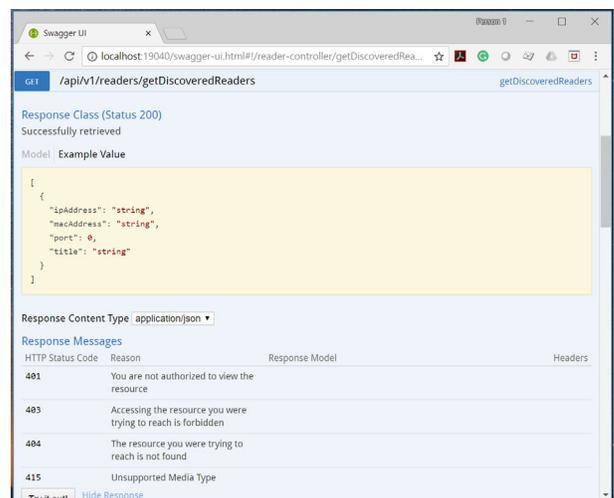
Once the swagger screen opens, you will see several REST commands by clicking the “List Operation”



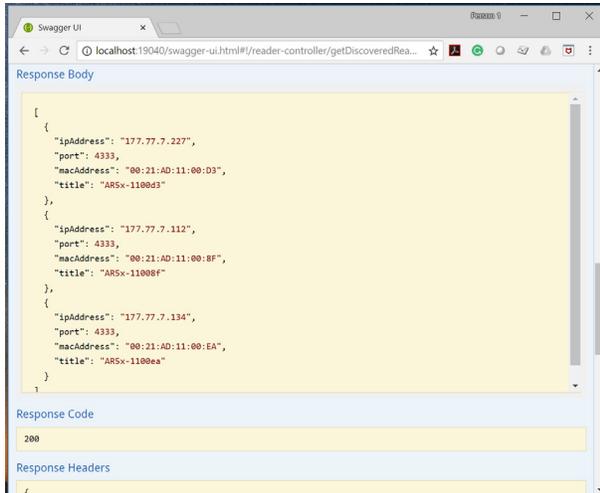
1. **StartReaderDiscovery:** Start the reader discovery process. The reader service can perform an auto discovery of readers connected to the network. Use this endpoint to start the auto-discovery process. Another endpoint is provided for retrieving results of the auto-discovery process (described below). The response should have a property indicating the auto-discovery process has been started.



2. **GetDiscoveredReaders:** Get the list of readers



A list of readers on the network are shown.



NOTE: Get the connected reader details and ID from the connect command response. The RF reader ID is needed for the other commands. In this specific example, the reader ID is **K182100224**.



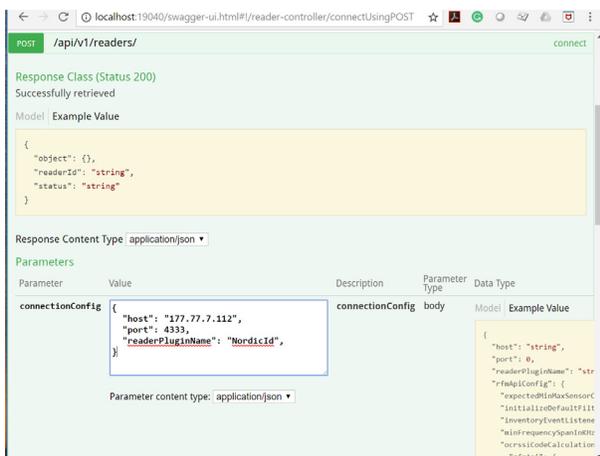
3. Connect: Connect to a specific reader. When the reader is in server mode, it listens for incoming requests on the network. Using this mode, the reader-service must connect to the reader explicitly by using the reader's IP address. The reader's IP address can be obtained through the reader auto-discovery mentioned earlier in this document.

NOTE: The host and port parameters are selected from the list of network connected readers. The reader plug-in name is specific to the model or brand of reader. In this example, the reader is a Nordic-ID RF reader.

```

{
  "host": "177.77.7.112",
  "port": 4333,
  "readerPluginName": "NordicId",
}

```

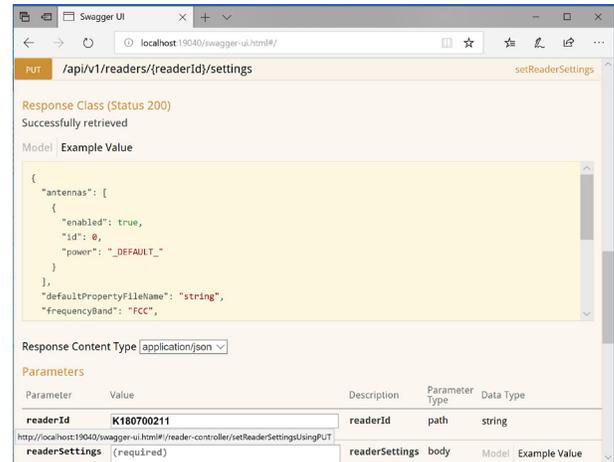


4. **GetReaderSettings:** The reader can be configured to suit your operating needs. To see what configuration options can be modified, the current reader settings can be retrieved. Using this endpoint with a reader's unique identifier, a response is returned containing properties that reflect the current state of the reader, and can be provided in the payload when updating the reader's configuration.

```
{
  "frequencyBand": "FCC",
  "rxDecoding": "Miller_4",
  "linkFrequency": "_256KHz_",
  "modulation": "PRASK",
  "qValue": "_0_",
  "session": "S0",
  "inventoryTarget": "INV_TARGET_A",
  "antennas": [
    {
      "power": "_DEFAULT_",
      "enabled": true,
      "id": 1
    },
    {
      "power": "_DEFAULT_",
      "enabled": false,
      "id": 2
    },
    {
      "power": "_DEFAULT_",
      "enabled": false,
      "id": 3
    }
  ],
}
```

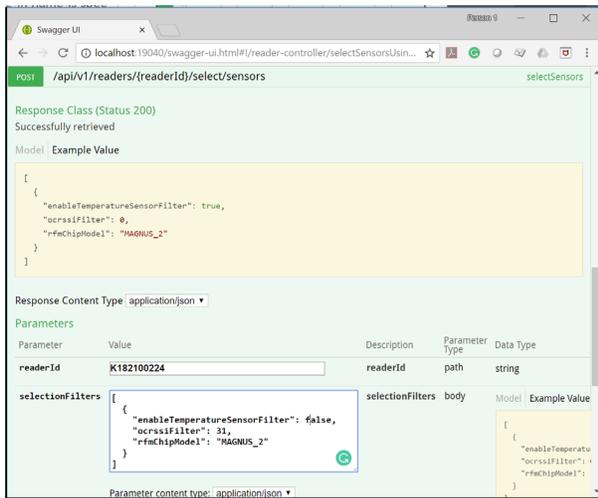
5. **SetReaderSettings:** Specific reader settings can be configured with this endpoint by providing configuration properties in the request payload. This is an important step to ensure the reader is reader sensors adequately. Settings such as link frequency, power level and selected antenna are configured with this endpoint. A common request body used for reading Axzon sensors might look similar the following JSON object.

The response payload is the same shape as the get reader configuration endpoint mentioned earlier.

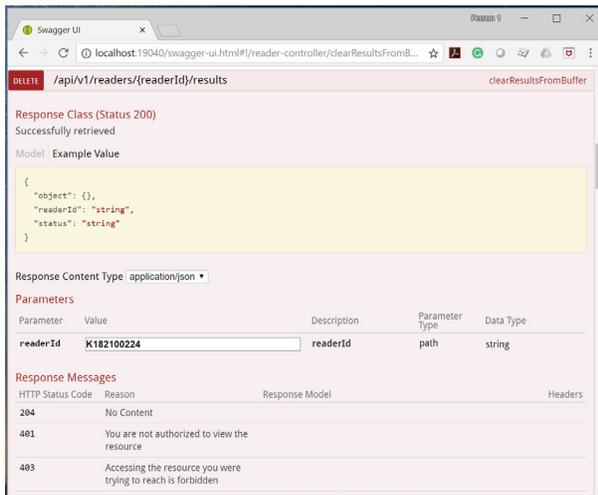


```
{
  "antennas": [
    {
      "enabled": true,
      "id": 0,
      "power": "_DEFAULT_"
    }
  ],
  "defaultPropertyFileName":
"string",
  "frequencyBand": "FCC",
  "inventoryTarget": "INV_TARGET_A",
  "linkFrequency": "_40KHz_",
  "modulation": "ASK",
  "powerLevel": "_DEFAULT_",
  "propertyFileName": "string",
  "qValue": "_0_",
  "readTimeout": 0,
  "rxDecoding": "FM0",
  "selectedAntenna": 0,
  "session": "S0"
}
```

6. **SelectSensors:** Prior to reading sensors, the sensor selection endpoint can be used to specify the desired sensors to be read. For a given chip type, sensor filters can be applied such as an OCRSSI upper or lower bound threshold, and enabling or disabling temperature sensor reads. The temperature filter should be enabled if the temperature sensor is being read.

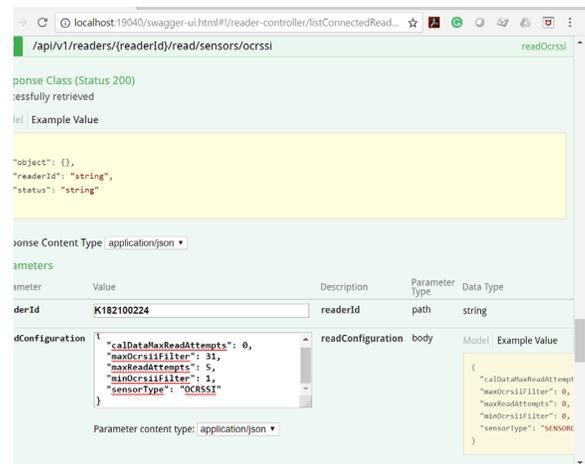


7. **ClearResultsFromBuffer:** Clear previous data from the low-level buffers.



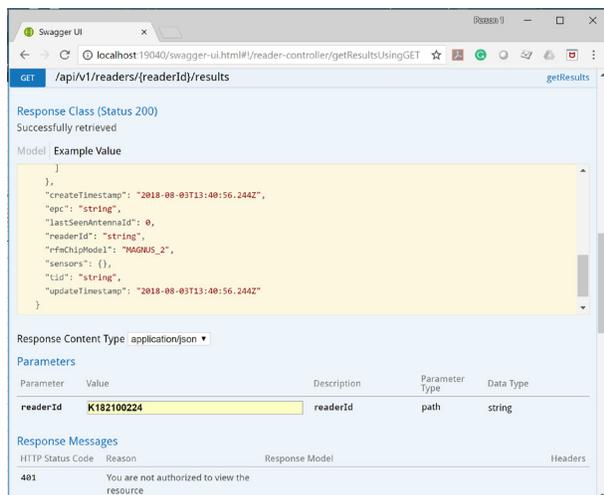
8. **Read a sensor:** After configuring the reader settings and applying filters to select the desired sensors to read, the reading process can be initiated. The calibration data is not needed for the OCRSSI sensor measurement type and is set for zero (0) read attempts. The OCRSSI control can narrow the range of responding sensors and which data is collected. The max/min values from 31 to 1 allow all data to be collected.

```
{
  "calDataMaxReadAttempts": 0,
  "maxOcrssiFilter": 31,
  "maxReadAttempts": 5,
  "minOcrssiFilter": 1,
  "sensorType": "OCRSSI"
}
```



After initiating a read, the reader takes an indeterminate amount of time to finish its read process. The asynchronous nature of the read process causes the results of the read to be retrieved from a different endpoint, described later in this document. Along with a general endpoints to read sensors, there are also endpoints for explicitly reading each sensor type.

9. **GetResults:** After adjusting settings and targeting your desired sensor read type the results are accessed using the `getResults` endpoint.



After a sensor read has been initiated, this endpoint can be used to retrieve the results of the read. The following JSON shows an example response of a successful read.

```

{
  "readerId": "K172800156",
  "lastSeenAntennaId": 1,
  "epc": "0000000000000000000000001933",
  "rfmChipModel": "MAGNUS_3",
  "sensors": {
    "TEMPERATURE_CALIBARATION_PARAMS": {
      "readerId": "K172800156",
      "epc": "0000000000000000000000001933",
      "tagReadMap": {
        "TEMPERATURE_CALIBARATION_PARAMS": [
          {
            "readerId": "K172800156",
            "epc": "0000000000000000000000001933",
            "rssi": -62,
            "antennaId": 1,
            "channelId": 0,
            "frequency": 924750,
            "dataString": "F2D88FB82D547900",
            "updateCount": 1,
            "receivedTimestamp": [ 2018, 8, 3, 13, 36, 47, 187000000 ],
            "happenedTimestamp": [ 2018, 8, 3, 13, 36, 47, 187000000 ],
            "sensorType": "TEMPERATURE_CALIBARATION_PARAMS",
            "rfmChipType": "MAGNUS_3"
          }
        ]
      }
    }
  },
  "firstTagReadTimestamp": [ 2018, 8, 3, 13, 36, 47, 187000000 ],
  "lastTagReadTimestamp": [ 2018, 8, 3, 13, 36, 47, 996000000 ],
  "totalRawReadCount": 0,
  "acceptableRawReadCount": 0,
  "readAttemptCount": 0,
  "totalTagReadCount": 1
},
{
  "updateTimestamp": [ 2018, 8, 3, 13, 38, 56, 978000000 ]
}
}

```

5.7. Troubleshooting

If the application reports errors or does not seem to respond, check the log: `<<reader-service>>/logs/rfm-reader-service.log` to identify any issues.

6. Additional Resources

Please see these additional documents for more information.

System Options:

PB031 RFM5108-B Fixed RAIN/UHF Reader with RfmApi Product Brochure

PB054 RFM5109-B Fixed RAIN/UHF Smart Reader with ReaderService Product Brochure

Software Options:

PB047 RFM5140-B RfmApi Product Brochure

PB048 RFM5144-B ReaderService Product Brochure

Detailed Technical Documents:

IN020 Axzon Sensor EPC Programming Guide

IN023 RFM5108-B Fixed RAIN/UHF Reader User Guide

IN024 RFM5140-B RfmApi Quick Start Guide

IN026 RFM5109-B Fixed RAIN UHF Smart Reader with ReaderService User Guide (this document)

IN027 RFM5140-B Axzon RfmApi Programming Guide

IN028 RFM5144-B Axzon ReaderService Programming Guide



7. Quick Start Process

STEP 1: Connect the System

Please follow the instructions in section 2, *The Reader*.

STEP 2: Load the Reader Configuration Utility (Optional)

If static IP addressing is used for the RF reader, please follow the instructions in section 5.3, *Reader configuration utility*. **NOTE:** Ignore steps 2 and 3 if dynamic IP addressing is managed in the programming code, as with `RfmApiDemo.java` for example.

STEP 3: Find the Reader's IP Address (Optional)

Please follow the instructions in section 4, *Reader IP Address* to find the reader's IP address. Optionally, change the reader IP address if your organization is using static IP addresses.

STEP 4. Install Sensors and Antennas

Please orient the sensors so that they are placed a meter or so in front of the antenna. The antenna should be “pointing at” the sensors for easiest evaluation with the software. Once the system and software are configured with the correct IP address, the antenna and sensors can be used at normal distances. **NOTE:** The RFM3250 sensors included in the kit, are designed for use on-metal surfaces.

STEP 5. Install Software Tools and Launch the ReaderService

Please follow the instructions in section 5, *RFM5144 ReaderService Software*. The software installation instructions cover the ReaderService, as well as its support tools like the ActiveMQ messaging queue and the MySQL data base. **NOTE:** The ReaderService requires a DBA (Data Base Administrator) login to the data base to create needed tables. It is important to carefully follow the suggested logins and passwords in setting up the demo initially. These can be changed to improve security at a time.

CAUTION: Do not try to connect to the RF reader with ReaderService and RfmApi Demo programs at the same time. The ReaderService already manages an instance of the RfmApi internally.

NOTE: Use the `RfmApiDemo.java` program to discover IP addresses for RF readers on your network. Please see RFM5108 and RFM5140 documentation for additional details. Alternatively, you can use the `StartReaderDiscovery` endpoint in the ReaderService REST interface to find available readers on the network.