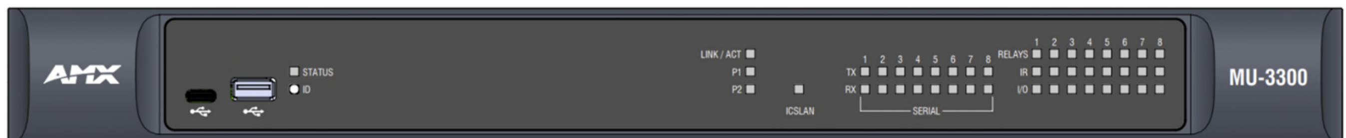
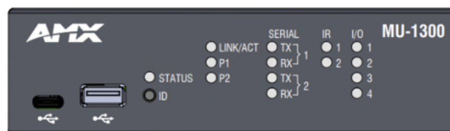
AMX MUSE Programming Guide

Version 1.7





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Revision History

Revision	What's new
1.0	Initial Release

1.1	- Python update to version 3.10
	  - https://docs.python.org/3/whatsnew/3.10.html
	- LDAP integration
	- Platform Service
	  - allows querying for information like FW version, serial number, etc.
	- Auth Session Service
	  - enables scripts to allow basic login credential validation against the current user database
	- I/O Manager Support for CE-COM2 devices for use in Duet Modules
	- ICSLan DNS Lookup support
	  - Allows IP network device name resolution for devices on the ICSLan network
	- Python PIP install supported via *requirements.txt* file
	- Controller to Controller communication
	  - enabled thru a new HControl device type
	- Exposing Scripts as Devices
	  - Allows scripts to expose an API to the MUSE control environment for access and interaction by other scripts or controllers
	- NetLinx Device Driver support
	  - Supports full range of NetLinx control constructs (multiple ports, channels, levels, strings, commands, custom event generation)
	  - Deprecates support for the netlinxClient

1.2	Added details on third-party Python modules support
1.3	- Updated FW & application version information - Added Appendix for Git
1.4	- Updated typos on Events structure table
1.5	- Updated info on 1.4.87 firmware release - Scopes Overview and Working with Scopes sections added - iDevice info added
1.6	- Additional info added to Scopes Overview and Working with Scopes sections
1.7	- Various edits and corrections

Firmware & software versions must be matched for features to function. Please update your devices and software applications to these latest versions:

Device/Application	Initial Release	Previous Release Jan 2025	Latest Jan 2026
MUSE Firmware	1.1.43	1.3.34	1.4.87
MUSE Automator	1.0.54	1.2.4	1.3.17
VS Code Extension	1.2.16	1.5.12	1.5.13
Minimum Required Firmware			
CE Control Extenders		1.2.8	1.2.12
Varia Touch Panels		1.11.42	2.13.25
Minimum Required Software			
Manager		1.03.0.205	1.03.0.205

Note: Attempting to downgrade MUSE firmware may have unexpected results. To downgrade, the user must reset the MUSE to factory firmware, and then (if applicable) load the desired firmware update.

Downgrading firmware will likely require a config-reset.

A unit shipped from the factory with 1.2.x firmware cannot be downgraded to 1.1.x.

Script Versions & Compatibility

MUSE	Python	JavaScript	Groovy	Node-RED
Firmware 1.2.65 VS Code Extension 1.4.7 Automator 1.1.12	3.10	Nashorn	4.0.6	4.0.2
Firmware 1.3.51 VS Code Extension 1.5.12 Automator 1.2.6	3.10	Nashorn	4.0.6	4.1.0
Firmware 1.4.87 VS Code Extension 1.5.13 Automator 1.3.17	3.10	Nashorn	4.0.6	4.1.2

Getting Started

For traditional coding, it's assumed that a user has access to a development environment for Python, JavaScript and/or Groovy. The easiest way to get started is by using the Microsoft® Visual Studio Code (VS Code) development environment with the MUSE Extension for VS Code installed.

Harman created the MUSE Extension for VS Code to facilitate the configuration & programming of the MUSE series of controllers. Using the extension, you can:

- Discover MUSE controllers on the network
- Connect to view Devices and Programs
- Write scripts for MUSE
- Upload scripts
- Attach to the standard output of the scripts for debugging

VS Code and Extension installation

No special version of Microsoft® Visual Studio Code is required for use with MUSE.

The MUSE VS Code Extension is available as a standalone .vsix installation file.

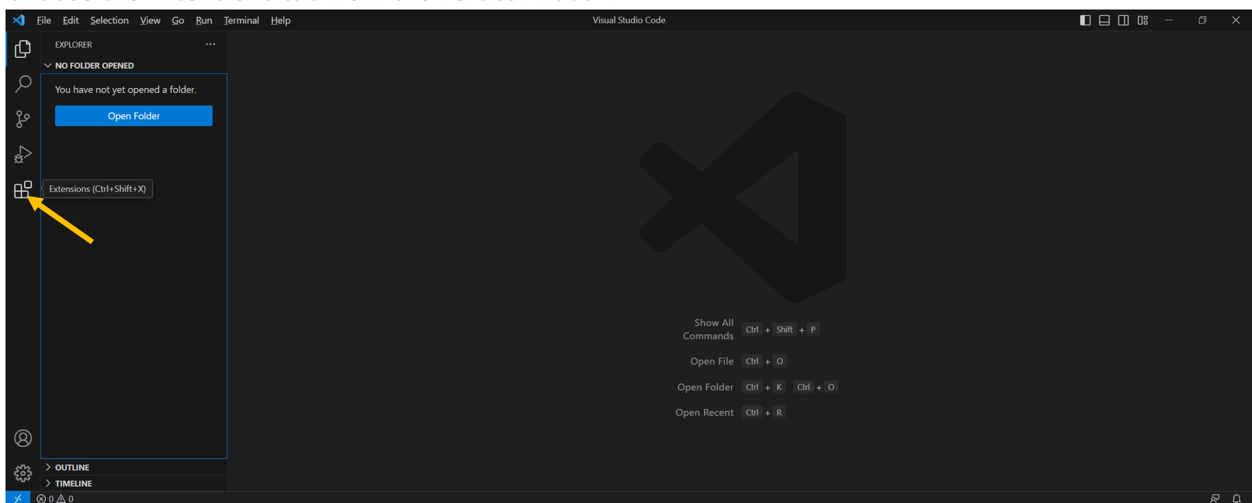
To install VS Code and the MUSE extension:

1. Download and Install the latest version of VS Code from Microsoft: https://code.visualstudio.com/download

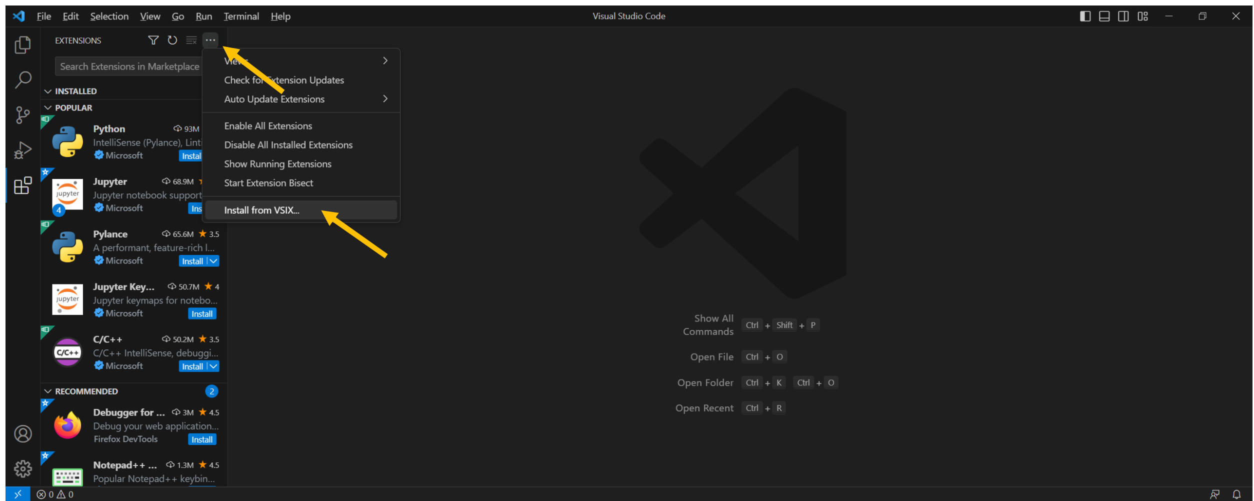
2. Download the VS Code Extension from AMX.com: https://www.amx.com/products/muse-extension-for-vs-code

3. Launch VS Code

4. Choose the Extensions tab from the vertical ribbon.

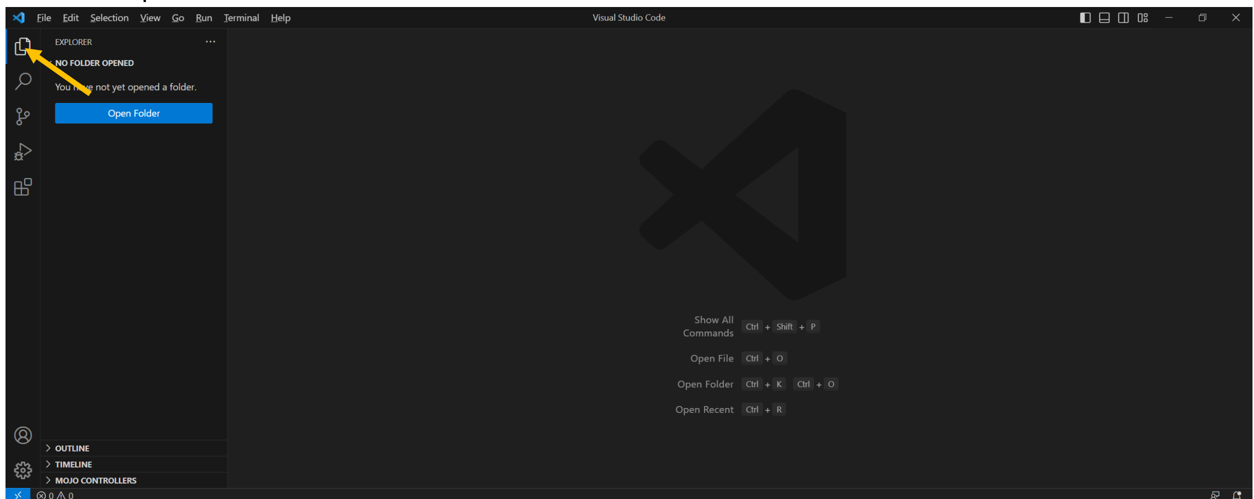


5. Click on the ellipses to show the Extensions context menu and select "Install from VSIX…"



6. Choose the mojo-<version>.vsix file and click Install…

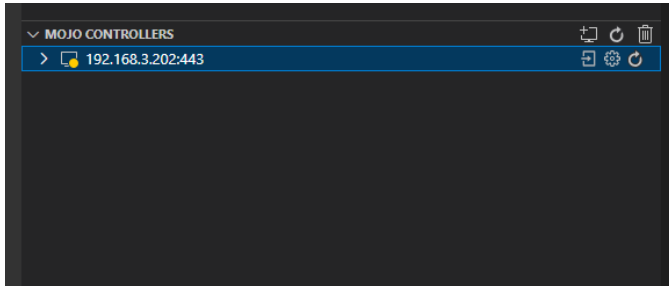
7. Click the Explorer tab on the vertical ribbon.



8. If this is the first time you have run the VS Code application, you will be prompted to open a folder. This folder will contain all the projects you want to group together. Each project will be in a separate folder and can contain any files your project or script needs. Choose a folder to create a place for your projects.

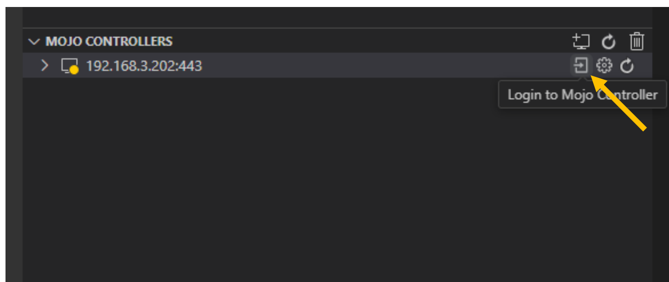
Discovering nearby controllers

In the Explorer there is a node labelled MOJO CONTROLLERS. This tree contains all the controllers you have interacted with recently as well as any controllers that have been discovered nearby. The Mojo VS Code extension sends an HControl discovery broadcast message. Any controllers that respond will appear in the list.

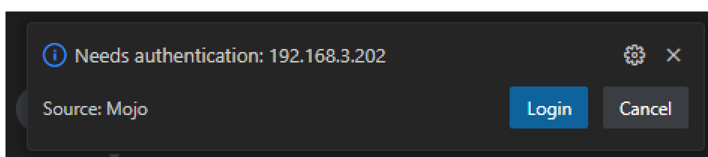


In the above example, a MUSE controller has been discovered at the IP address 192.168.3.202. Note: the yellow pip on the controller icon indicates that it is present but not authorized.

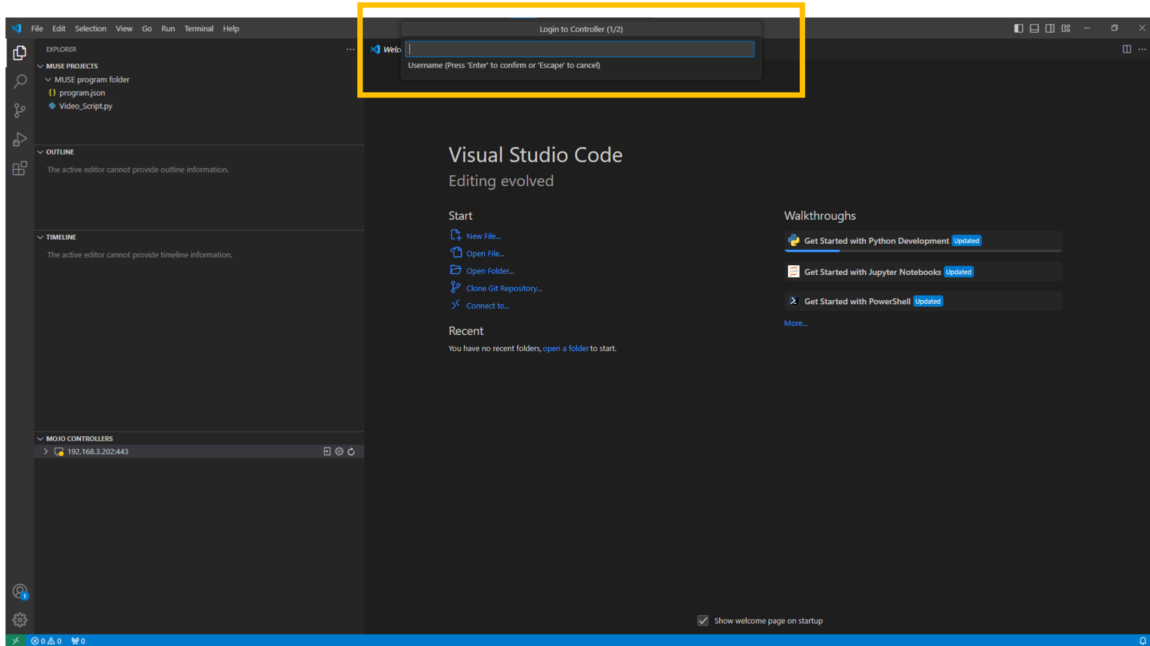
To log in to the controller, click the login icon next to the IP address:



A login prompt will appear at the lower-right portion of the screen:



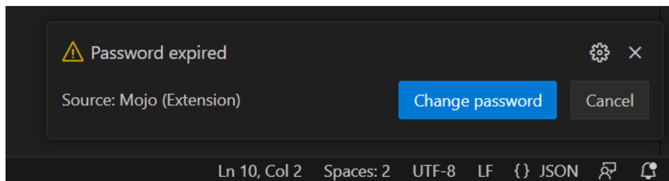
Select 'Login' and follow the prompts at the top of the screen.



The default credentials for a MUSE controller are **admin | password**

If this is the first time you have logged in to this controller, you must choose a new password. By default, password security is set to 'low', so any password besides 'password' is acceptable.

Click 'Change Password' to continue:

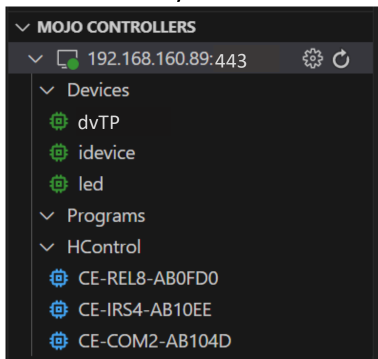


Follow the prompts to change the password and log in.

Mojo Controllers tree view

Once authenticated, the tree view for a Mojo controller contains three nodes:

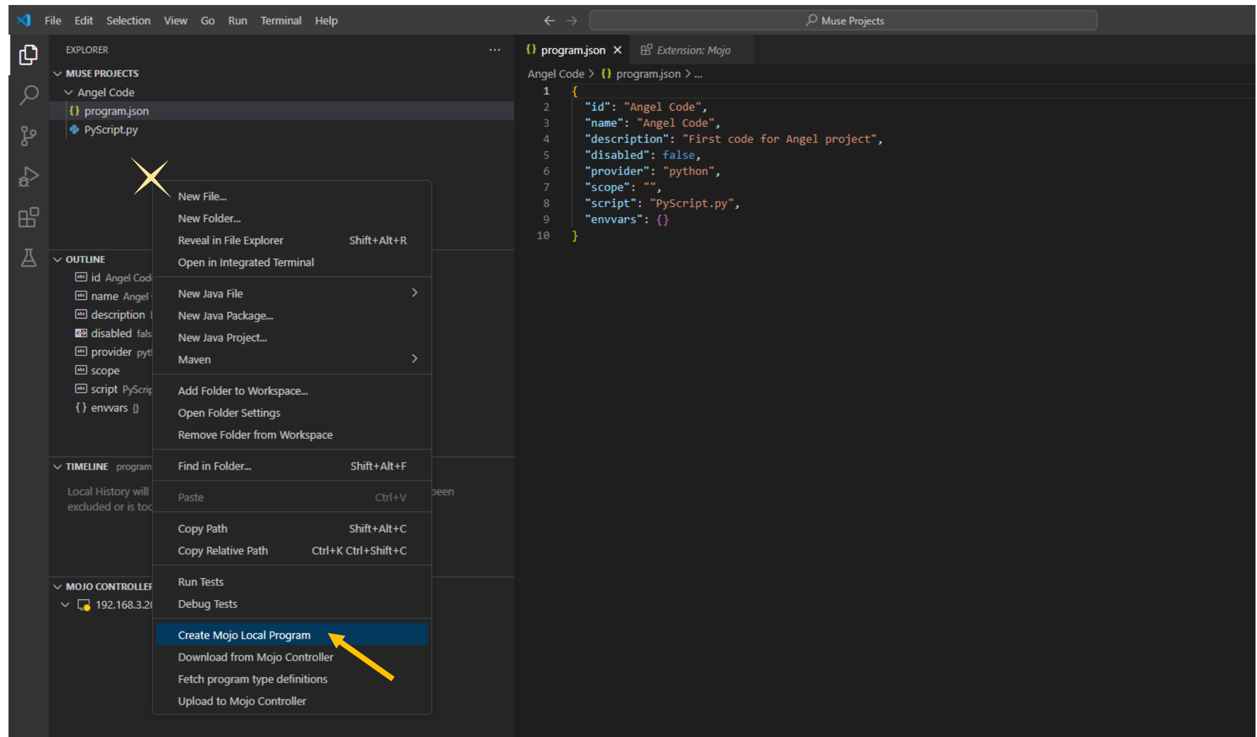
- Devices – Known AMX devices or modules that the script can access
- Programs - Any scripts loaded to the controller, running or disabled
- HControl – Any HARMAN HControl devices that the MUSE controller has discovered



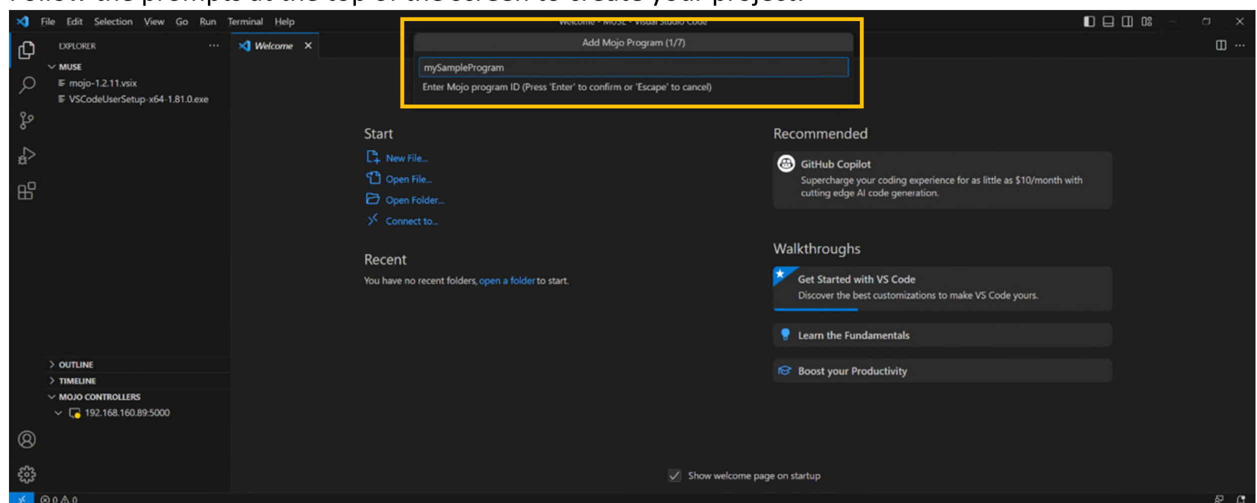
In this example there are three devices; dvTP (a touch panel), idevice (the MUSE controller's built-in control ports), and led (LEDs).
There are no programs currently loaded.
There are three nearby HControl devices. Each of these are the CE family of control extenders.
Note: selecting nearby HControl devices will display their IP address along with other properties.

Creating new scripts

1. To create a new project to contain a script for MUSE to run, right-click on the empty space in the pane and "Create Mojo Local Program" from the menu.



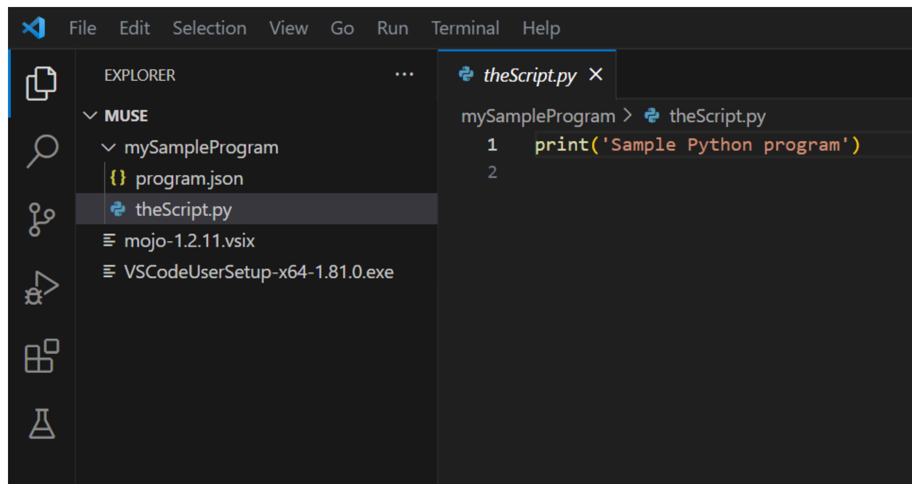
2. Follow the prompts at the top of the screen to create your project:



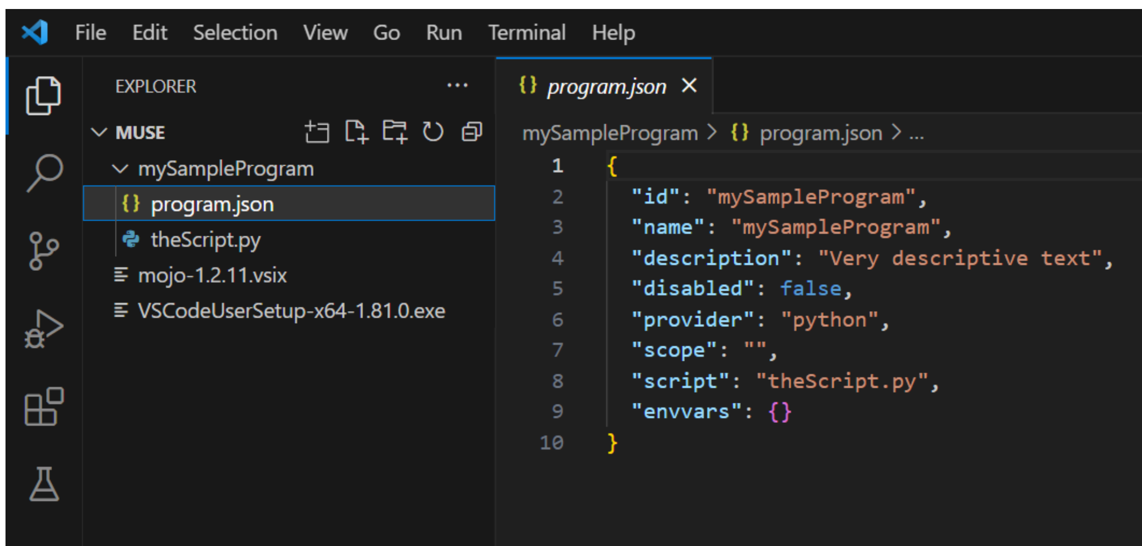
You will be prompted for:

- Mojo Program ID – The friendly name displayed within VS Code for the script
- Program Description – Programmer-provided metadata for the project
- Program Enable/Disable – A flag to determine if the project should run if loaded
- Program Provider – Choose the scripting language for the project
- Program Scope – logically divide devices and scripts into groups
- Program Entry Script – The name of the script to use as a starting point

At this stage a folder and two files have been created for your MUSE script based on your input.



In this example, 'theScript.py' is the Python script that has been created. The *program.json* file contains the MUSE script's target information. If at some later time you create a different Python file in this project and would like to choose it as the starting point, you could edit *program.json* to make it so.



For a basic script that runs at startup, no further intervention is needed.

NOTE: For Python scripts only, the following two lines need to be added to your script to properly use all the available MUSE resources:

At the top:

```
from mojo import context
```

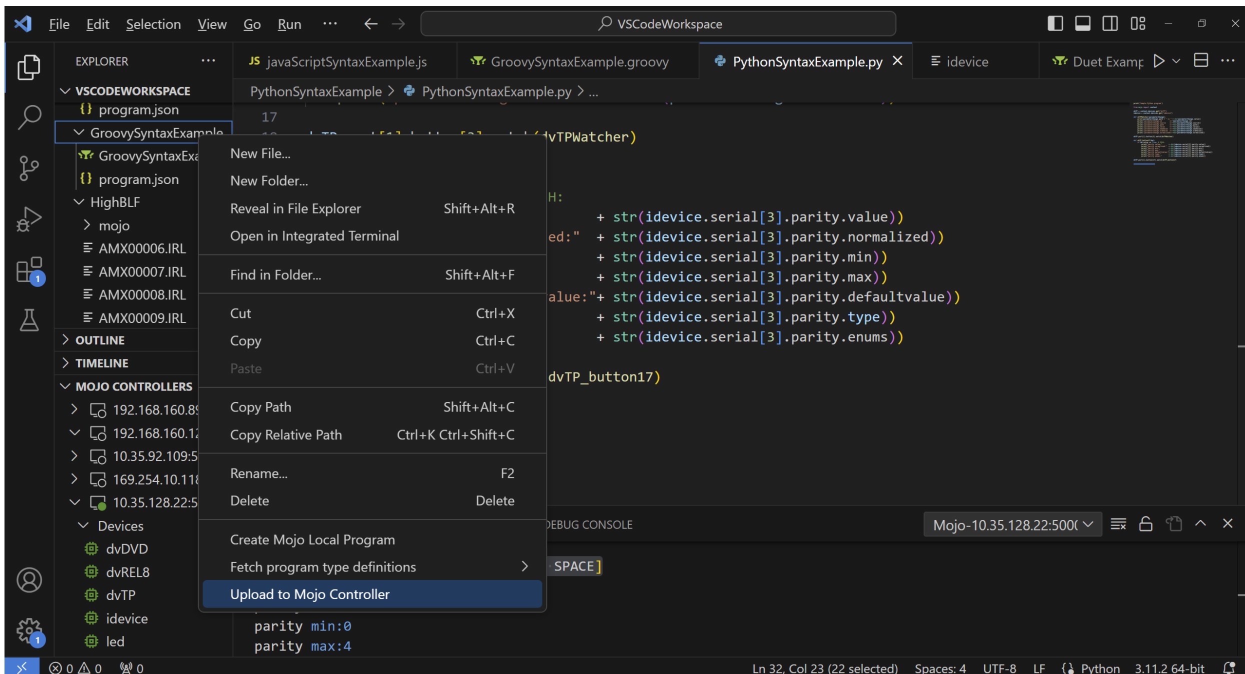
At the bottom:

```
context.run(globals())
```

Loading Scripts

To quickly load a script to a controller, right click on the script's main folder. In the example above, ***mySampleProgram*** is the main folder.

Choose *Upload to Mojo controller*. A dialog will appear at the top center of the VS Code application. First, confirm the script to be loaded. Next, choose any controller you are currently attached to as a target for uploading. Clicking **OK** will upload the script and start it running.



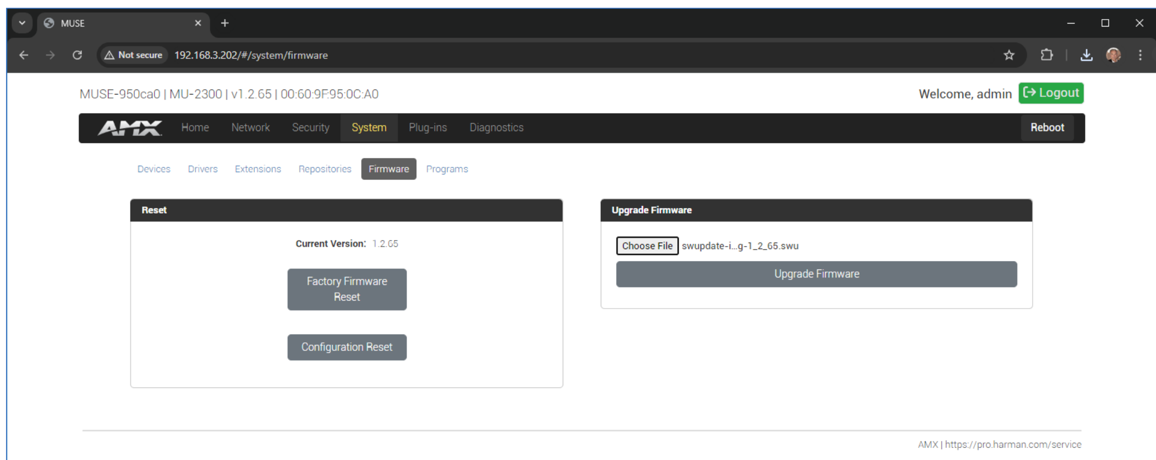
Install MUSE Controller Firmware

To use the latest VS Code Extension with an AMX MUSE controller, you will need to update the MUSE controller firmware available on amx.com. This table shows the required compatible firmware & application versions:

Device/Application	Latest Jan 2026
MUSE Firmware	1.4.87
MUSE Automator	1.3.17
VS Code Extension	1.5.13
Minimum Required Firmware	
CE Control Extenders	1.2.12
Varia Touch Panels	2.13.25
Minimum Required Software	
Manager	1.03.0.205

Firmware can be loaded via the MUSE web interface. Browse to the IP of the MUSE controller and navigate to the *System >> Firmware >> Upgrade Firmware* window. Browse your file system for the firmware .SWU file and select the [Upgrade Firmware] button.

On MUSE, browse to the IP of the MUSE controller and navigate to the *System >> Firmware >> Upgrade Firmware* window. Browse your file system for the firmware .SWU file and select the [Upgrade Firmware] button.



Note: Attempting to downgrade MUSE firmware may have unexpected results. To downgrade, the user must reset the MUSE to factory firmware, and then (if applicable) load the desired firmware update. Downgrading firmware will likely require a config-reset.

A unit shipped from the factory with 1.2.x firmware cannot be downgraded to 1.1.x.

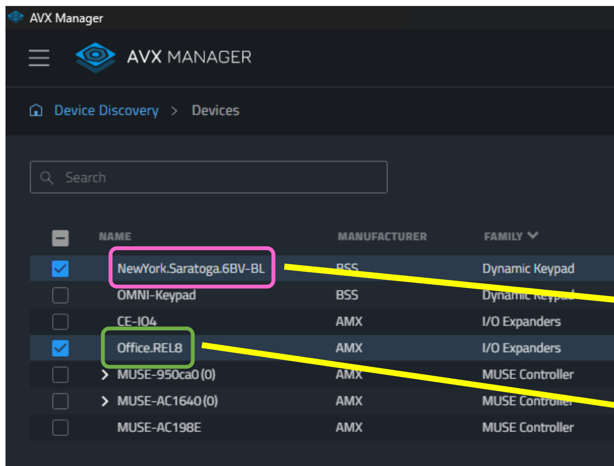
Scopes Overview

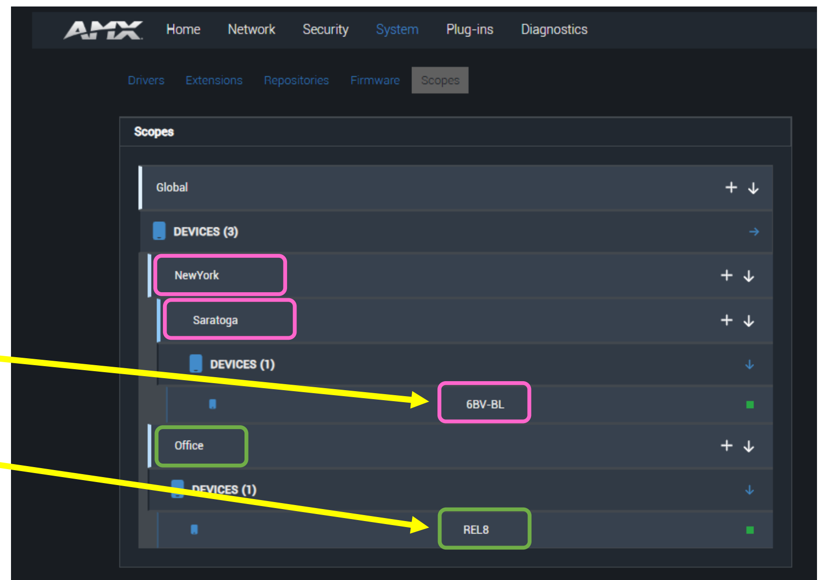
A scope is a naming convention in MUSE where scripts & devices can be organized, loosely translating to a "room." Because MUSE can be used to control multiple spaces, scopes are vital to keep those spaces and the associated devices, scripts and flow organized.

Scopes are part of the HControl device name and use a period/dot character (".") to denote scopes & sub-scopes. Note, the dot character should only be used in an HControl name to denote its scope.

In this example, we have two devices named **REL8** (an AMX CE Control Extender) and **6BV-BL** (a BSS OMNI Dynamic Keypad) in different scopes. See how they are listed in both AVX Manager and in the MUSE web interface:

Device Description	Format	Name
CE relay extender in the office	[scope] **.** [device]	Office.**REL8**
Keypad in Saratoga Springs, NY	[scope] **.** [sub-scope] **.** [device]	NewYork.Saratoga.**6BV-BL**





A script in a scope can refer directly to a device in that same scope without having to use its "fully qualified" (i.e. dot-notated) name. That script can simply refer to the device as **REL8** or **6BV-BL**. Scripts in other scopes should use the full dot-notated name if/when they refer to a device in another scope.

Devices can also be created in the "global" scope, which can be thought of as the root. Please note there is no scope actually named "Global." These devices are simply named the device name, and no additional scope or dot-nation is needed or used.

☑	VariaTouchPanel
☒	Global.VariaTouchPanel

This is useful if scopes are not needed, or if multiple scripts need to refer to a device.

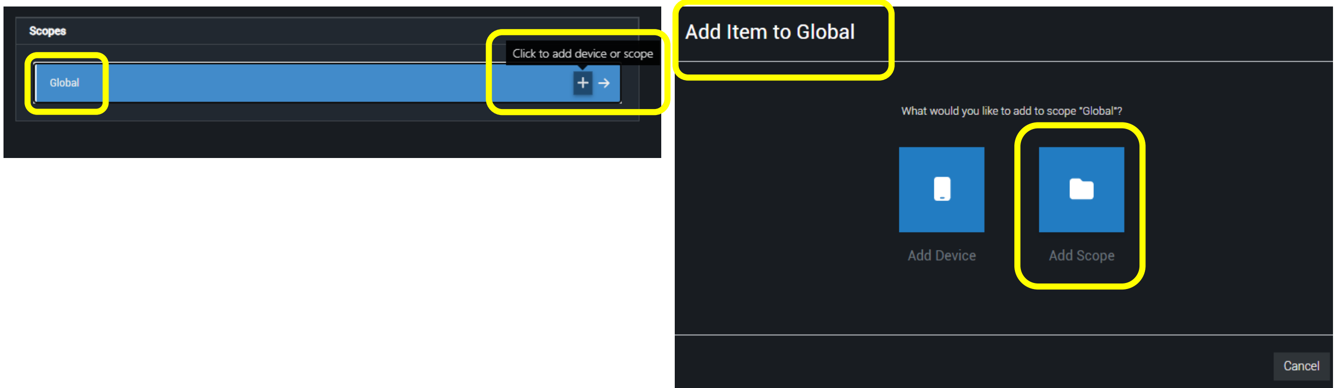
Working with Scopes

Open the MUSE web interface by browsing to the MUSE' IP address. Notice that the *Scopes* tab has replaced the *Devices* tab and the *Programs* tab. The *Scopes* tab gives a convenient view of all devices, scripts & flow organized in their respective scopes.

Please note creating a scope, and organizing scripts & devices into scopes, are optional.

Creating a Scope

To create a scope, press the + on the *Global* scope header, and select the option to **Add Scope**.



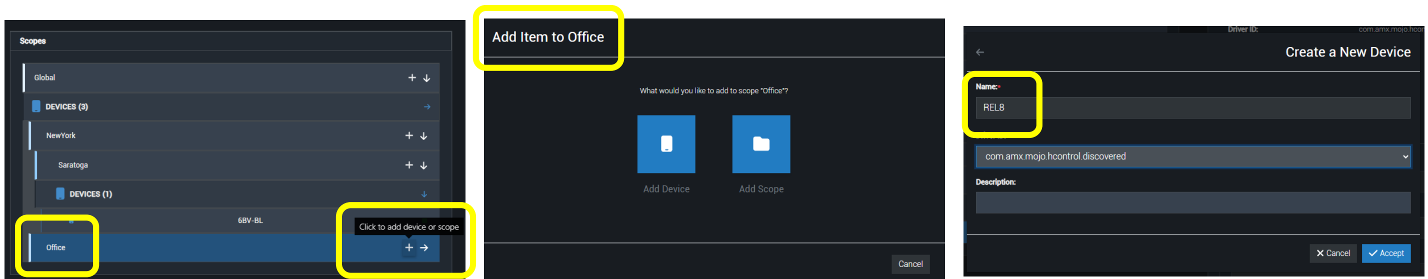
Additional scopes can be added by repeating this step. A sub-scope can be added by pressing the + on the respective scope header.

Creating a Device

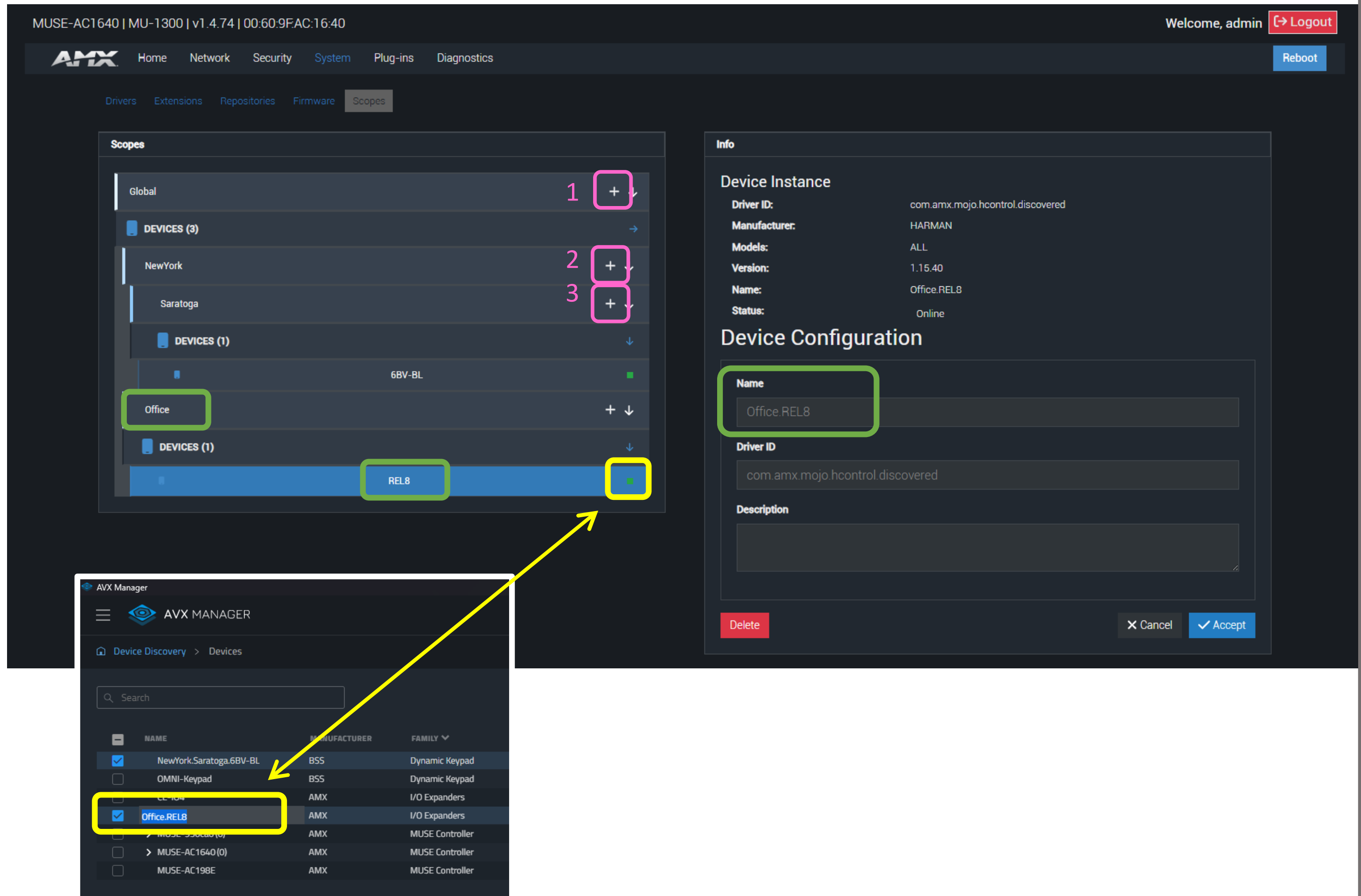
Devices are added similarly to scopes. Devices can be created in the "root" *Global* scope, or in a created scope. See the Device Declarations section for full details on creating devices.

Note that when a device is created in MUSE, the created device name should not contain the scope or any dot notation. The created name is only the desired device name (e.g. **REL8**). Dot notation is added automatically after the device is created, and is based on where the device was created (i.e. where the + was pressed).

In this example below, a relay extender is being added within the *Office* scope (which was created previously). The + is pressed in the *Office* scope header and **Add Device** is selected. The desired device is called **REL8**, and the resulting complete HControl name is **Office.REL8**.



The device name in AVX Manager should (and must) be the fully qualified device name. In this same example, when the device is renamed **Office.REL8** via AVX Manager, the green indicator on the MUSE web interface shows the device is online & matched.

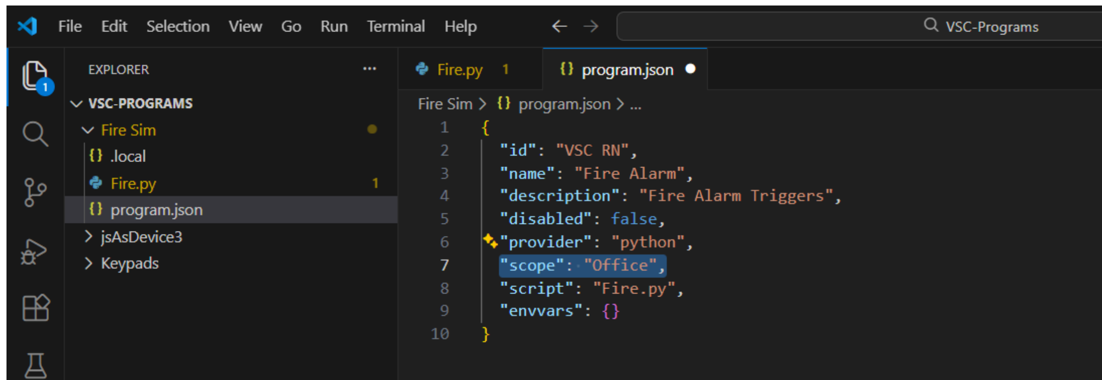


Notice the different + buttons circled in pink, above. Consider these similar situations, and the different end results of each:

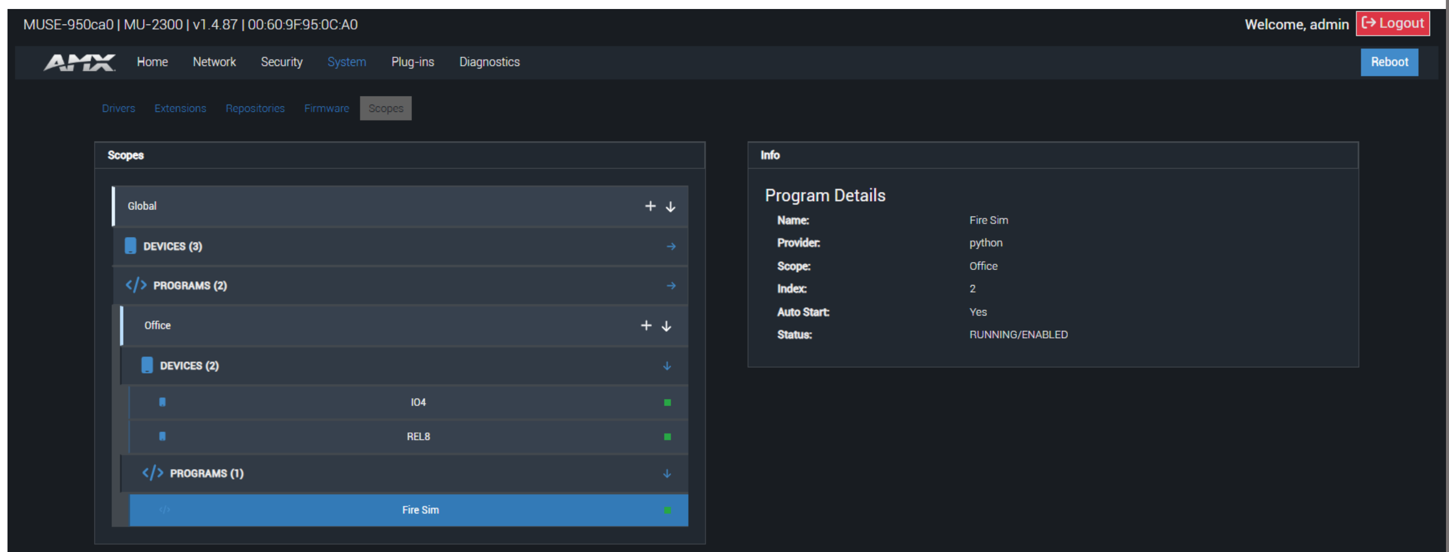
1. If this device was created in the *Global* scope by pressing the + in that header, the resulting complete device name would be **REL8**.
2. If this device was created in the *NewYork* scope by pressing the + in that scope header, the resulting complete device name would be **NewYork.REL8**.
3. If this device was created in the *Saratoga* sub-scope by pressing the + in that sub-scope header, the resulting complete device name would be **NewYork.Saratoga.REL8** because Saratoga is a sub-scope of *NewYork*.

VSC Scripts

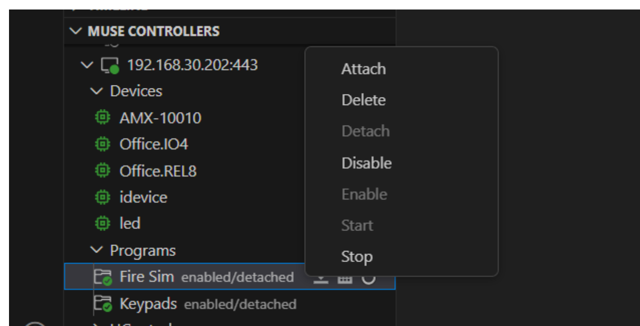
Scripts are still uploaded using the MUSE Extension available for VSC. When intending to transfer a script into a certain scope, that scope name needs to be entered into the *program.json* file that accompanies the script file.



In this example, the *Fire.py* script would be uploaded to the *Office* scope. This can be verified in the MUSE web interface:

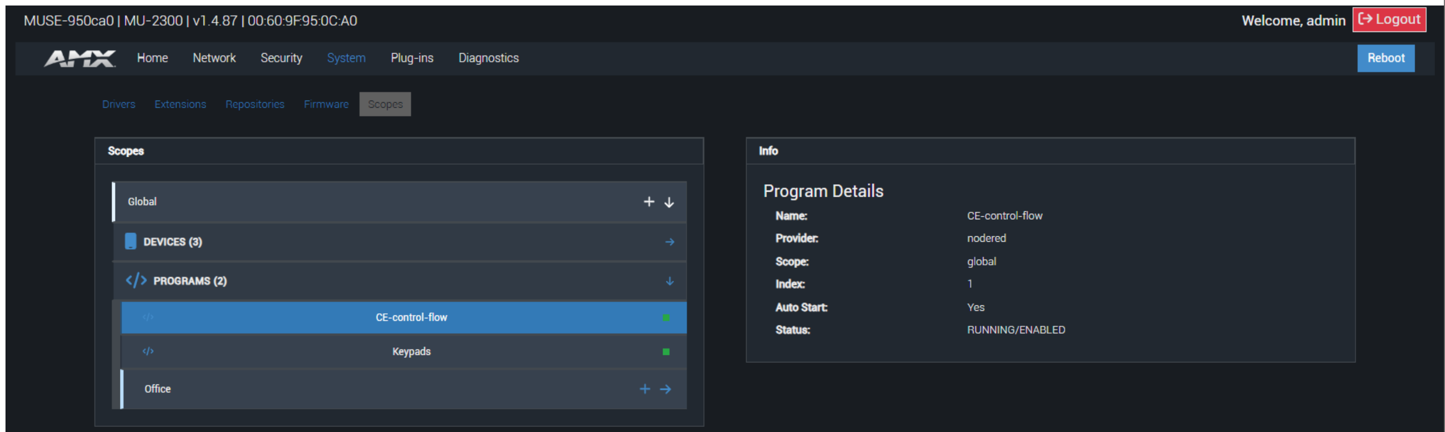


Scripts can still be managed via the VSC MUSE Extension.



Automator Flows

Automator Node-RED flows are pushed to the *Global* scope only, as only one flow is supported per MUSE.



Considerations

Please note that once a device is created, neither its name nor its scope can be changed. This means that, currently, a device cannot be moved from one scope to another. And because a complete device name in AVX Manager contains the scope in dot notation, a device cannot be assigned to multiple scopes.

Upgrading firmware that introduces scopes (i.e. version 1.4.87) may add some example scopes to the *Scopes* list. These can be deleted. A config reset will also remove these example scopes.

Examples

There are a few scopes included as examples. These can be used for testing, as real scopes of a project, or simply ignored. They will not affect the usability of your MUSE. If desired, they can be removed by performing a config reset.

Device Declarations

MUSE uses a dynamic device binding system that allows each running script to access any device that is attached to the MUSE Controller. Touch panels, keypads, modules, and other ICSP, HiQnet, & HControl devices are configured outside of the script.

Devices are acquired by the scripts by name. The naming of the attached devices depends on the connection type. Some are assignable at the time of configuration, and some are automatic.

The primary method to declare a device is through the MUSE Controller's web interface. Depending on the connection type, some devices may auto-register. The following is a description of each device type:

ICSP

ICSP devices are connections to legacy AMX devices that communicate via the ICSP protocol. For example,

- Varia touch panels running the AMX G5 persona
- Modero touch panels
- Metreau keypads
- EXB control extenders

ICSP connections have multiple behaviors that may be supported. URL mode, Listen mode, NDP each behave slightly differently.

URL Mode

The most common connection method is URL mode. The peripheral devices (a touch panel, keypad, etc.) is given the IP address or DNS resolvable hostname of the MUSE Controller as a target to connect. The device reaches out on TCP port 1319 (or 1320 for Secure ICSP) and negotiates a connection with the controller.

Once connected, URL Mode devices will be automatically assigned a unique name based on the device number. If you have a touch panel set to device number 10001, the device name will be AMX-10001. This **Instance ID** is what is used to access the device from a script.

NDP

MUSE supports the NDP method of connection. Devices in NDP mode can be discovered and bound to the controller. The controls are available in the CLI and the controller's web server.

Once created, it will behave as a URL mode device and receive a unique name based on the device number. This **Instance ID** is what is used to access the device from a script.

Listen Mode

ICSP Listen Mode reverses the connection initiation. A device in Listen mode opens a socket to listen to incoming port 1319 connections. It is the controller's responsibility to initiate a connection with the device. To inform the controller of the IP address or DNS resolvable hostname of the target device, a Device needs to be configured. The primary method of configuring the device is on the MUSE Controller's web interface. Point a web browser to the URL of the MUSE Controller and perform the login as prompted.

Next, navigate to the Devices page by choosing the System tab, then selecting Devices. Click the **Create+** button to start configuration of the device.

For each device configuration, a unique name is required. The **Instance ID** is what is used to access the device from a script.

Device Names must consist of only the following characters:

- Upper-case alphabetic characters (A - Z)
- Lower-case alphabetic characters (a - z)
- Numerals (0 - 9)
- Hyphen ("-"), underscore ("_") and space (" ")
- The dot/period (".") Is reserved for scopes and should not be used in an instance name.

Device Names must begin with an alpha-numeric character.
Device Names must not end with a space.

To create an ICSP Listen Mode device definition, use the Driver ID pulldown and choose the *com.amx.thing.ICSP* entry. This will reveal two more fields that are specific to the ICSP driver. The IP address field is used to convey the target IP address for the device in Listen mode. The target port is read-only information containing the default ICSP port.

Create a New Device

Instance Id:

dvTP

Driver ID:

com.amx.thing.icsp

Name:

Varia TP

Description:

Varia SL50

Device Configuration

Port

1319

IP Address

198.18.0.2

✕ Cancel ✓ Accept

Regardless of connection method, **Name** and **Description** are metadata fields reserved for friendly names & other information. They do not affect the functionality of the ICSP device.

HControl

There are three methods to create an HControl device: controller, direct, or discovered. Please note the com.amx.mojo.*hcontrol.generic* device connection has been replaced, and your HControl devices will need to be connected using one of the following more specific connection types:

Controller

Selecting *com.amx.mojo.hcontrol.controller* creates a Controller-to-Controller device where the MUSE controller can control a device bound to a second MUSE controller.

Direct

Selecting *com.amx.mojo.hcontrol.direct* creates a direct connection to an HControl device using its HControl name and IP address. This is useful if a device is not automatically discovered (e.g., if it is on a different subnet).

Discovered

Selecting *com.amx.mojo.hcontrol.discovered* creates a device using just the HControl name of an already-discovered device. All HControl devices on the same subnet as the controller will be automatically discovered as part of the HControl discovery protocol. Discovered devices can be found either in the HControl device list in the Mojo VS Code Extension, or by using Manager software.

Create a New Device

Instance Id:*

dv-REL8

Driver ID:*

com.amx.mojo.hcontrol.direct

Name:

CE-REL8

Description:

CE Series Relay Expansion Box, 8-port

Device Configuration

Port

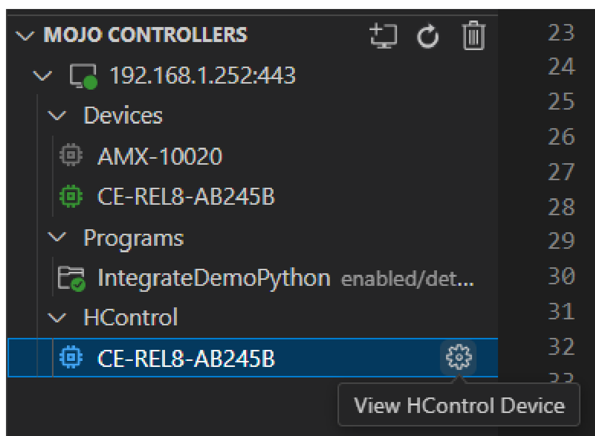
4197

IP Address

192.168.3.115

✕ Cancel ✓ Accept

Instance ID is the HControl name of your intended device and <u>must</u> match the Instance ID assigned to the device to establish an HControl connection. The HControl Instance ID can be found in the HControl device list in the MUSE VS Code Extension.



CE-REL8-AB245B

```
{
    "id": "CE-REL8-AB245B",
    "realIP": "192.168.1.218",
    "name": "CE-REL8-AB245B",
    "location": ""
}
```

Copy and paste this “id” to the Instance id field when creating the device on the MUSE controller. The Instance ID can also be found through the Manager software.

Device Names must consist of only the following characters:

- Upper-case alphabetic characters (A - Z)
- Lower-case alphabetic characters (a - z)
- Numerals (0 - 9)
- Hyphen ("-"), underscore ("_") and space (" ")

Device Names must begin with an alpha-numeric character.
Device Names must not end with a space.

Regardless of connection method, **Name** and **Description** are metadata fields reserved for friendly names & other information. They do not affect the functionality of the ICSP device.

Netlinx

The Netlinx device type allows connection to a Netlinx series controller (eg. NX-2200). Note, this will not work for a secure TLS ICSP connection.

Create a New Device

Instance Id:*

Please fill this out

Driver ID:*

com.amx.thing.netlinx

Name:

Description:

Device Configuration

ICSP Controller IP Address

ICSP Device Number

0

Username

Password

Control Ports

Channel Count	Levels		Max Command Size	Max String Size
	min	max		
255			1024	1024
	0	255		
	0	255		
	0	255		
	0	255		
	0	255		
	0	255		
	0	255		
	0	255		

Add level

Add port

Cancel Accept

For each device configuration, a unique name is required. The **Instance ID** is what is used to access the device from a script.

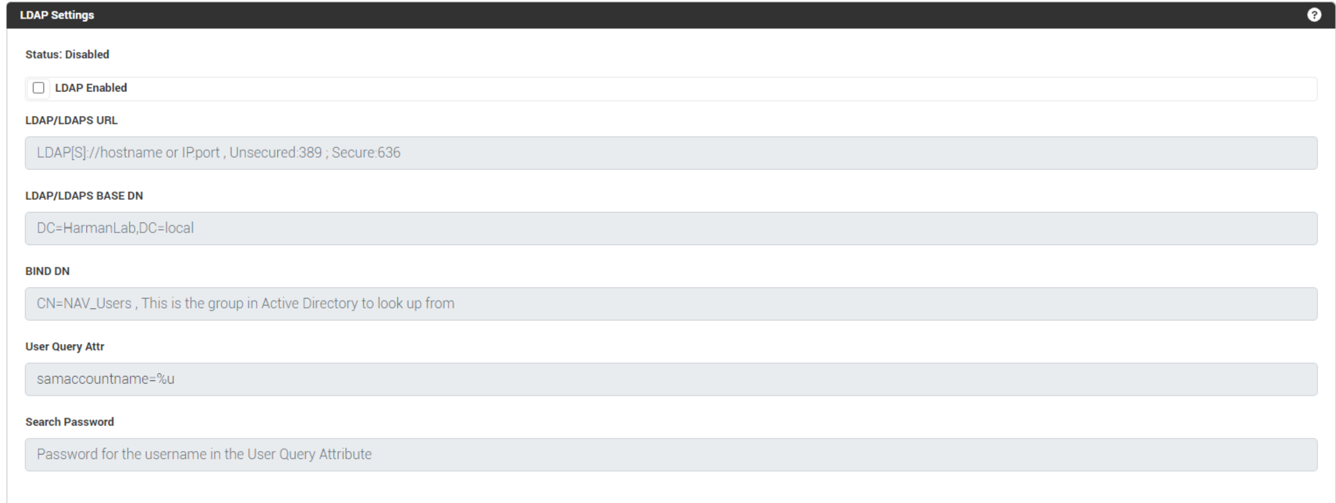
Device Names must consist of only the following characters:

- Upper-case alphabetic characters (A - Z)
- Lower-case alphabetic characters (a - z)
- Numerals (0 - 9)
- Hyphen ("-"), underscore ("_") and space (" ")

Device Names must begin with an alpha-numeric character.
Device Names must not end with a space.

LDAP Integration

The LDAP page provides configuration and tests connection to a remote directory service via LDAPv3. The controller supports the option of an insecure or secure connection. The secure option is supported via the StartTLS command in LDAP and also via "LDAPS", or LDAP over SSL/TLS on port 636. Select the LDAP option on the Security Page to access the LDAP Settings page. The options on this page allow authorized users to enable and modify LDAP security settings.



LDAP Options

Please note that some LDAP parameters are case sensitive and must be entered exactly as they are entered into the LDAP database. You can also perform LDAP Client Configuration via terminal commands to the MUSE controller's Program Port.

LDAP Options

Option	Description
LDAP Enabled	This parameter enables the LDAP configuration parameters described below. **NOTE:** When LDAP is enabled, you can only create device users. If the administrator user has been deleted, you must perform a factory reset of the controller via pushbutton to restore the administrator user.
LDAP.LDAPS URL	This parameter has the syntax **ldap[s]://hostname:port**. • The **ldap:// URL** is used to connect to LDAP servers over unsecured connections. • The **ldaps:// URL** is used to connect to LDAP server over Secure Sockets Layer (SSL) connections. • The **hostname** parameter is the name or IP address, in dotted format, of the LDAP server (for example, *LDAPServer01* or *192.202.185.90*). • The **port** parameter is the port number of the LDAP server (for example, 696).

LDAP Options	
	NOTE: The standard unsecured port number is 389 and the standard secured port number is 636.
LDAP/LDAPS BASE DN	This parameter specifies the Distinguished Name (DN) of an entry in the directory. It identifies the entry that is the starting point of the user search.
BIND DN	This parameter specifies the Distinguished Name (DN) to use to bind to the LDAP server for the initial search for the user's DN.
User Query Attr	This LDAP attribute is used for the AMX equipment user search (e.g. UID). **NOTE:** This attribute MUST be unique in the context of the LDAP BASEDN or the search will fail.
Search Password	This is the password used for the initial bind to the LDAP server - it is the password associated with BIND DN.

Click the **LDAP enabled** check box to make the LDAP options available for selection.

- When LDAP is enabled, users are authenticated using the configuration set up on the LDAP server.
- The "*admin*" user is handled by the local MUSE, and does not connect to the LDAP server for user verification.
- As users log onto a controller, their user name and access privileges are displayed on the User Security Details page (Security >> Users). This information is stored in the controller's RAM but is not written to nonvolatile memory, and is lost after rebooting the controller.
- If a user is removed from the LDAP directory tree & access is denied. If that user name is on the controller's User Security Details web page, it is removed.

Accepting Changes

Click the **Test/Accept** button to save changes on this page. Accepting changes is instantaneous and does not require rebooting the controller.

Testing Connection to the LDAP Server

After entering and accepting the parameters, the Accept/Test button can be used to test the connection to the LDAP server. This test does a bind to the BIND DN using the Search Password entered.

- If connection test successful, displays "LDAP Settings saved and confirmed"
- If connection test fails, displays "LDAP Settings saved but not confirmed. "
    - In this case the admin should check all entries to make sure correct.

Device Online/Offline Behavior

There are two ways to determine the online/offline status of a Device.

The get the current state, you can call the .isOnline() or .isOffline() method.

To be informed of changes to the online/offline status of the Device, use the .online() or .offline() method to register a callback.

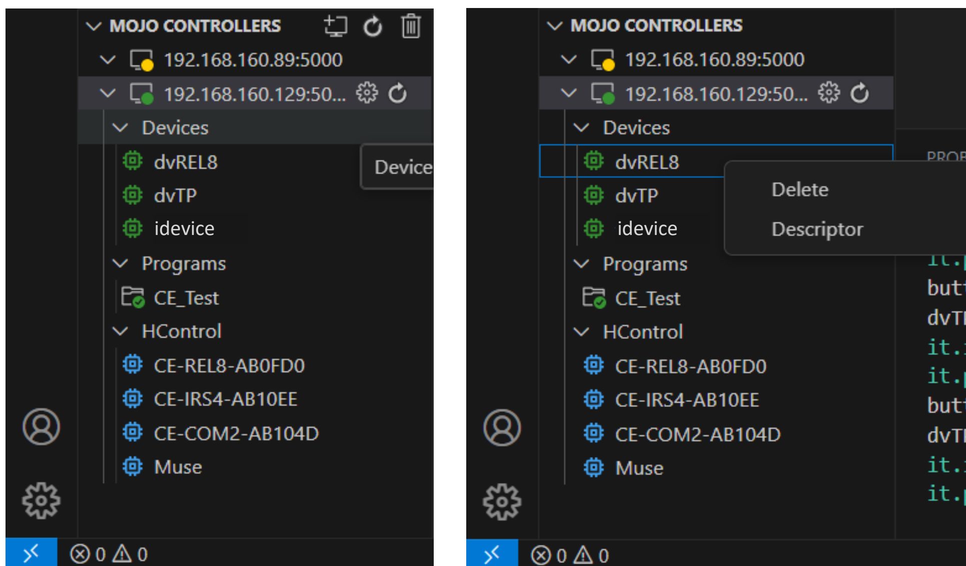
Interpreting Descriptor Files

Any Device in MUSE has its capabilities described in a Descriptor File. This document contains information about the interface you can use to interact with the device. In the case of HControl, this document is provided by the device itself during the connection process. In the case of other communication methods like ICSP and HiQnet the document is dynamically generated based on information provided during the connection process.

The Descriptor File is a .json formatted document. This makes it reasonably human readable and available to parse programmatically.

There are several ways to access this information. The VS Code extension provides a quick way to see an expanded view of the information.

Expand the tree view of the controller to reveal the Devices node:



Right click on the device in question and choose Descriptor from the context menu. A file will open that is an interpretation of the Descriptor file, not the file itself.

JS TascamDVD.js | MojoToNetLinx.py | blf.py | CE-REL8-AB0FD0 | CE.groovy | dvREL8 ×

```
1   |-------------------------------------
2   com.amx.mojo.hcontrol.generic
3   -------------------------------------
4   |
5   +-- id:           com.amx.mojo.hcontrol.generic
6   +-- name:         CE-REL8
7   +-- manufacturer: Harman
8   +-- models:       [ALL]
9   +-- version:      1.11.107
10  +-- description:  HControl based 8 relay expansion box
11  +-- dynamic:      false
12  +-- oneBased:     false
13  |
14  +- PARAMETERS (1)
15  |  +-- version <string> (ro)
16  |      +- [ <string>  min=0
17  |
18  +- COMMANDS (1)
19  |  +-- locate
20  |
21  +-- OBJECTS (1)
22  |   +-- configuration
23  |       +- PARAMETERS (1)
24  |       |  +-- commands <string> (rw)
25  |       |      +- [ <string>  min=0
```

PROBLEMS   OUTPUT   TERMINAL   DEBUG CONSOLE

The file tends to start with configuration information that may not apply to the programming task at hand. The typical control-related information will be in the Arrays portion at that end of the file.

JS TascamDVD.js | MojoToNetLinx.py | blf.py | CE-REL8-AB0FD0 | CE.groovy | CE-REL8-AB0FD0 | dvREL8 ×

```
137  |
138  +- ARRAYS (1)
139  |  +-- relay
140  |       +- ELEMENTS (8)
141  |          +-- [0]
142  |          |   +- PARAMETERS (1)
143  |          |      +-- state <boolean> (rw)
144  |          |          +- [ <boolean>  min=0 max=1
145  |          |          +- [ +- METADATA (1)
146  |          |          +- [    +--- desc = Parameter to set a relay port on/off
147  |          +-- [1]
148  |          |   +- PARAMETERS (1)
149  |          |      +-- state <boolean> (rw)
150  |          |          +- [ <boolean>  min=0 max=1
151  |          |          +- [ +- METADATA (1)
152  |          |          +- [    +--- desc = Parameter to set a relay port on/off
153  |          +-- [2]
154  |          |   +- PARAMETERS (1)
155  |          |      +-- state <boolean> (rw)
156  |          |          +- [ <boolean>  min=0 max=1
157  |          |          +- [ +- METADATA (1)
158  |          |          +- [    +--- desc = Parameter to set a relay port on/off
159  |          +-- [3]
160  |          |   +- PARAMETERS (1)
161  |          |      +-- state <boolean> (rw)
```

PROBLEMS   OUTPUT   TERMINAL   DEBUG CONSOLE

From this example, we can see that the CE-REL8 has an array named ‘relay’ with 8 elements. Each relay has a parameter named ‘state’ that is a Boolean. If we want to engage the relay, we would set the ‘state’ parameter to true.

Here are some syntax examples in the supported languages. In each, assume we have a Device reference held in a variable named dvREL8.

Groovy syntax example:

```
dvREL8.relay[0].state = true
```

Python syntax example:

```
dvREL8.relay[0].state = True
```

JavaScript syntax example

```
dvREL8.relay[0].state = true
```

For this activity, there is very little difference between the syntax in any particular language.

More ways to get the Descriptor and related information

The MUSE controller offers an SSH connection that has many useful CLI commands. To get the same interpretation of the descriptor is available in VS Code, the CLI command is:

```
admin@mojo>driver:describe dvREL8
```

To obtain the actual JSON document, use:

```
admin@mojo>driver:describe -j dvREL8
```

To get the list of commands or parameters that pertain to the device, use:

```
admin@mojo>device:commands
admin@mojo>device:parameters
```

To obtain a list of current devices, use:

```
admin@mojo>device:list
```

Event-based Programming

Adding a watch/listen

One of the most basic requirements of A/V control system programming is reacting to user input from some form of user interface. Typically, touch panels & keypads provide the user the ability to inform the system of their desired functionality.

MUSE has two methods to be notified about changes: **.watch( )** and **.listen( )**

The **.watch( )** method is for parameters. Parameters are attributes that keep their state and can be queried for their value.

The **.listen( )** method is for events. Events, once fired, are gone. You cannot query the value of an event outside of the .**listen( )** callback.

In MUSE, to react to button presses you create a ***watch,*** because buttons are defined as parameters. The watch argument contains a callback function that will be called to process the button event.

Groovy Syntax:

```
dvTP.port[1].button[255].watch( {
    println("button is "+it.value)
    println("dvTP button "+it.id+" "+ ((it.value == true)?"pressed":"released"));
    println("it.id=="+it.id)
    println("it.path=="+it.path)
    })
```

Groovy provides a convenient mechanism for writing complex code within the watch. This Groovy Closure includes the passed parameter containing the event information. If unnamed, the passed parameter is named ***it***. In this example, ***it*** is a Parameter Update Structure that contains everything about the parameter change notification.

For ICSP events, the path contains the port and channel of the button that caused the event in the form port/<p>/button/<b>. So, if button 1 on port 1 was pressed, the event.path value would contain:

`port/1/button/1`

In languages that support regex, this lends itself to a convenient pattern match. For example, in Groovy you can use:

```
  def eventPathPattern = ~"port/[0-9]+/button/[0-9]+"
```

…then extract the event data with:

```
      def eventMatches = it.path =~ eventPortAndChannelPattern
      eventMatches.find()
```

`EventMatches` then becomes a collection with the same port & channel numbers as the two elements.

Python Syntax:

```
dvTP.port[1].button[1].watch(dvTP_port1_button1_watch)
```

…where `dvTP_port1_button1_watch` is a user defined function used as a callback. When the event is processed, this function will be called and passed a parameter update structure containing the parameter change information.

Elsewhere in your code, you need to implement this function:

```
def dvTP_port1_button1_watch(theButtonPress):
    #do stuff with the data in theButtonPress
    print('theButtonPress.path==' +theButtonPress.path)
```

All the event parameters are available in each language. See The Parameter Update Structure for details.

JavaScript syntax:

```
dvTP.port[1].button[4].watch(dvTP_button1_watch)
```

…where dvTP_button1_watch is a user define function used as a callback.

Elsewhere in your code, you need to implement this function:

```
function dvTP_button1_watch(theButtonPress) {
    context.log('dvTP_button_watch(theButtonPress) called')
    context.log(path:'+theButtonPress.path+" is "+theButtonPress.newValue)
```

where theButtonPress is a structure passed into the callback. All the event parameters are available in each language. See The Parameter Update Structure and The Event Structure for details.

Timelines

MUSE provides a centralized timing mechanism to use within the scripts. To ensure that events are processed in the order that they are received, events are processed one at a time. Consequently, invoking a *sleep* method on a thread that is processing an event will delay the processing of the next event until the *sleep* returns. Using a Timeline side-steps this issue by running the delayed code in the centralized timing thread.

To use a Timeline, an instance of a timeline needs to be retrieved from the context.

In Python, the syntax is:

```
tick = context.services.get("timeline")
```

In this case, the variable *tick* will contain the timeline object. To start the timeline, the syntax is:

```
tick.start([1000],True,-1)
```

…where [1000] is an array of times in milliseconds.

The Boolean is the 'relative' flag. If there are multiple times in the array, it determines whether the timings are treated as relative delays between triggers, or as an independent list of times that may trigger out of sequence relative to their order in the list.

The final parameter is the 'repeat' value. A value of -1 indicates that the timeline should run forever. A timeline started with a value of 0 will run once. The value indicates the number of repetitions.

To receive events from the timeline, use this syntax:

```
tick.expired.listen(tickListener)
```

Where *tickListener* is the function that will be called when the timer expires. This is not a fixed name. The script writer creates and names this function:

```
def tickListener(tlEvent):
      # do the timed stuff
```

The *tlEvent* parameter contains information specific to the timeline event that just triggered.

```
def tickListener(tlEvent):
      print("ticklistener expired: sequence=" + tlEvent.arguments["sequence"] +
        ", time=" + tlEvent.arguments["time"] +
        ", repetition=" + tlEvent.arguments["repetition"])
      Repetition = tlEvent.arguments["sequence"]
```

Timelines have the following methods: start(timeArray,relative,repetition), stop(), pause(), restart()

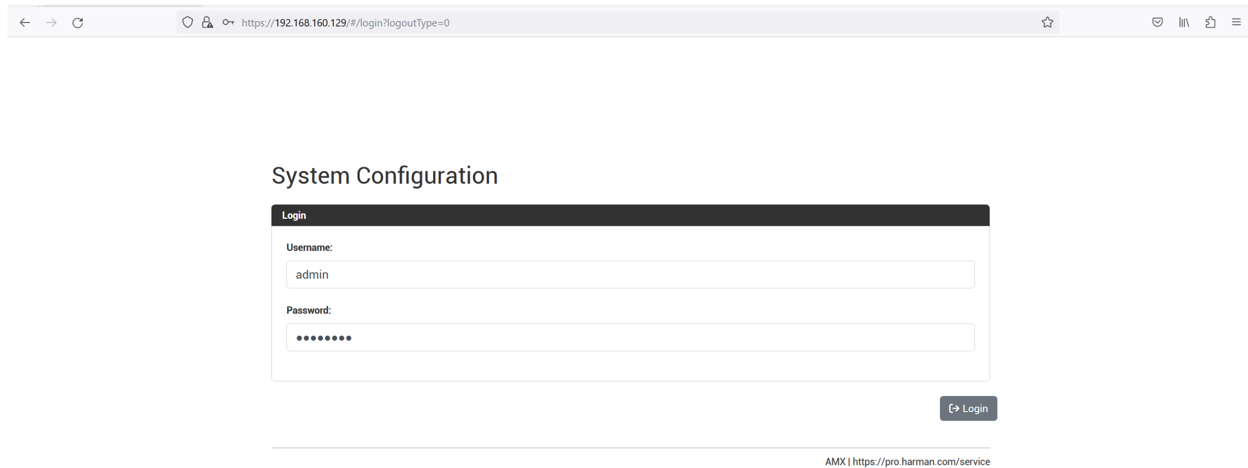
Duet Modules

Initial setup

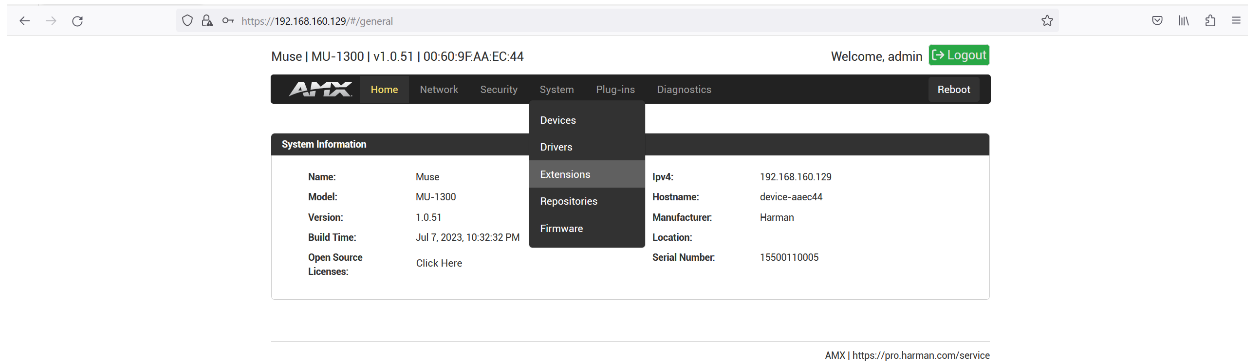
Adding the Duet Extension

By default, the Duet Driver Provider is not installed on the MU-series controller. This Extension must be enabled to load and run Duet-based drivers.

Log in to your MUSE controller's configuration web page:



In the menu bar, choose System -> Extensions



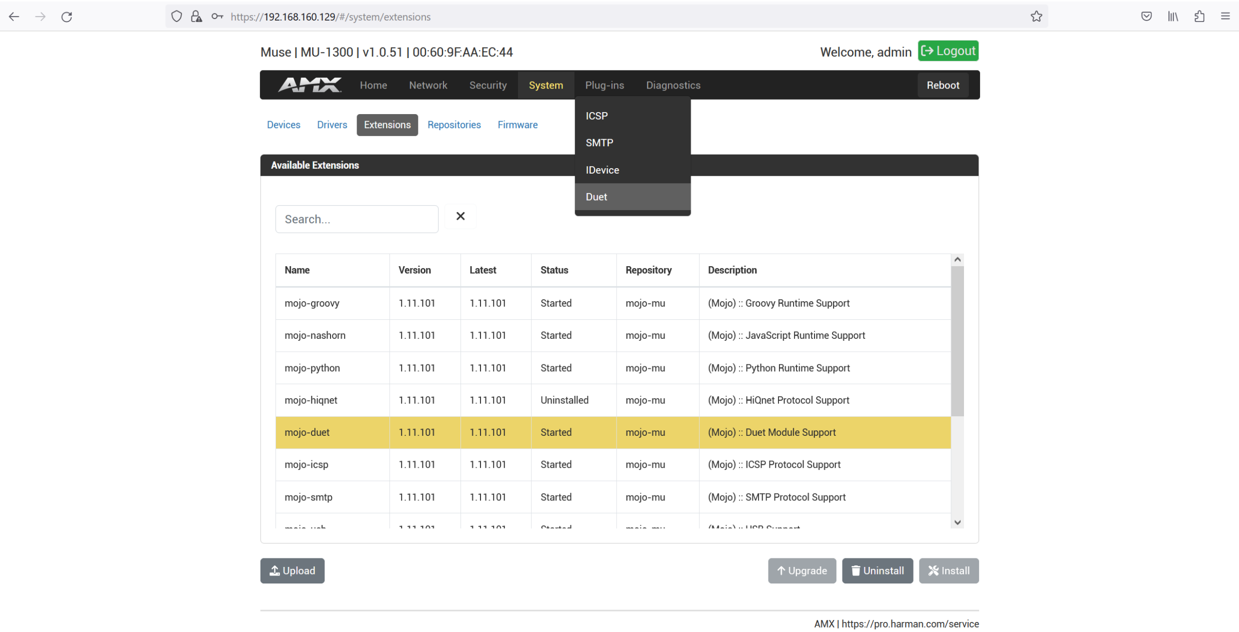
Find **mojo-duet** in the list of available extensions:

We can see that the Extension's status is 'uninstalled'. With **mojo-duet** selected, click **Install**

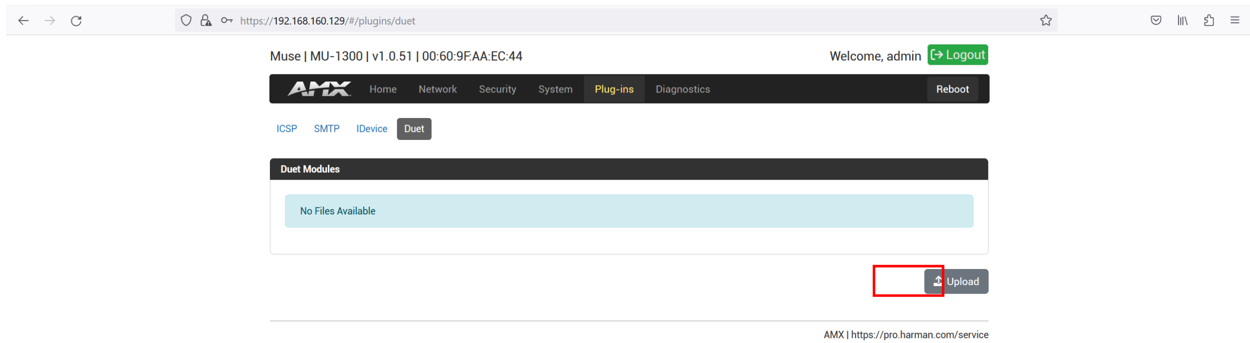
After a few moments, the 'busy' screen will disappear, and the **mojo-duet** extension is enabled.

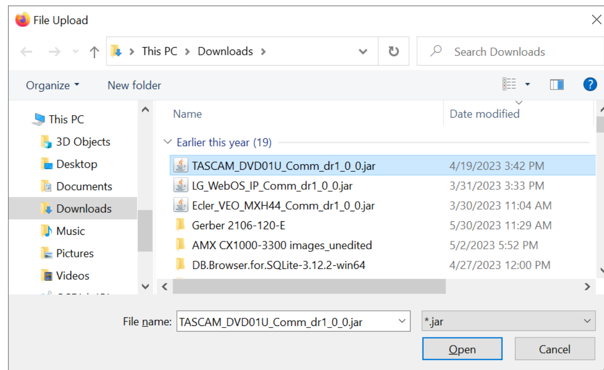
Loading a Duet module's .jar file

Choose Plug-ins -> Duet in the MUSE controller's web configuration menu bar

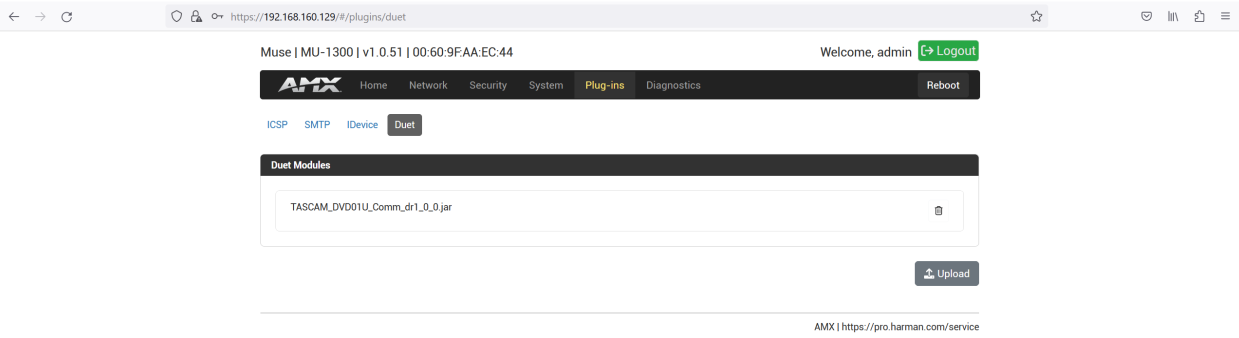


Click Upload to find and load a Duet .jar file



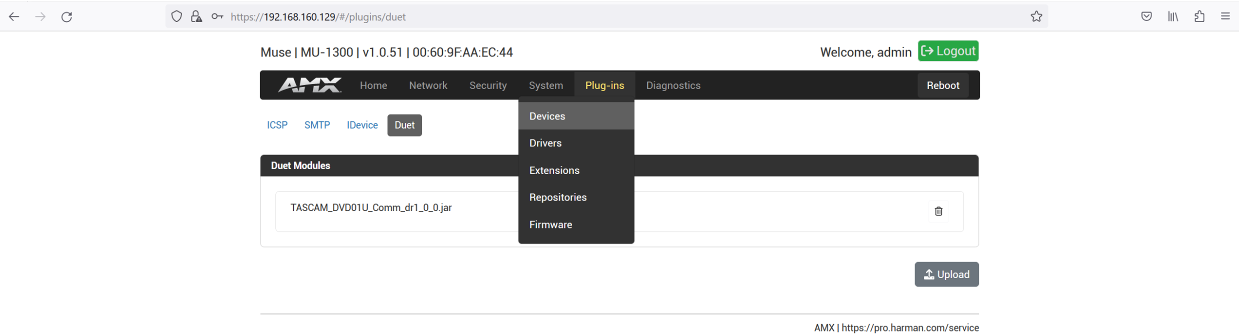


The Duet Driver is now available for use.

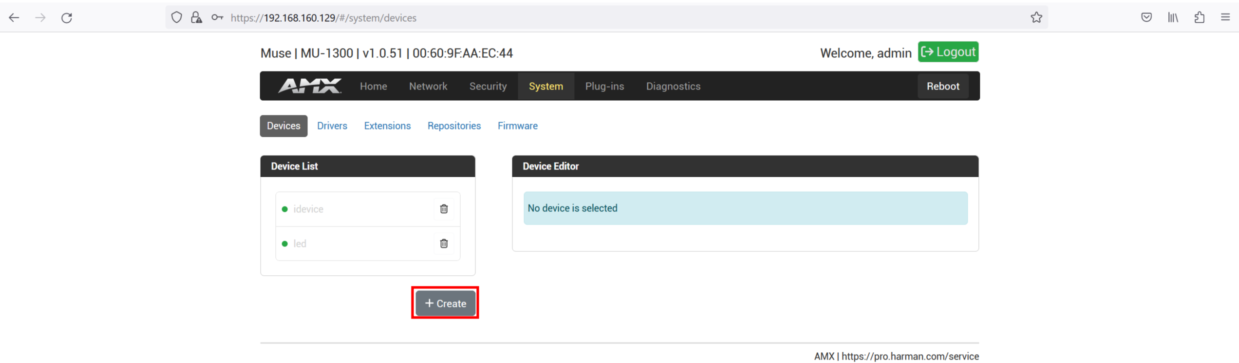


Make a Driver instance

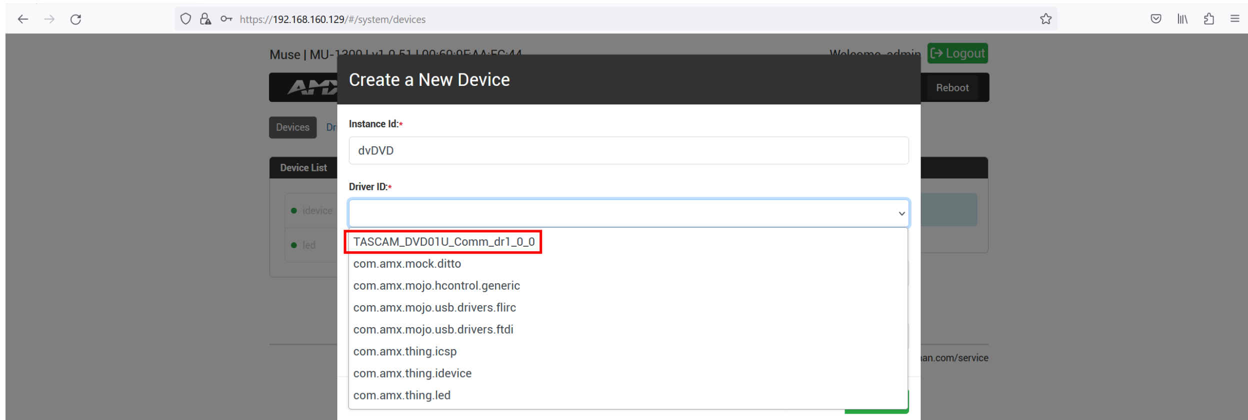
Choose System -> Devices to navigate to the Devices page:



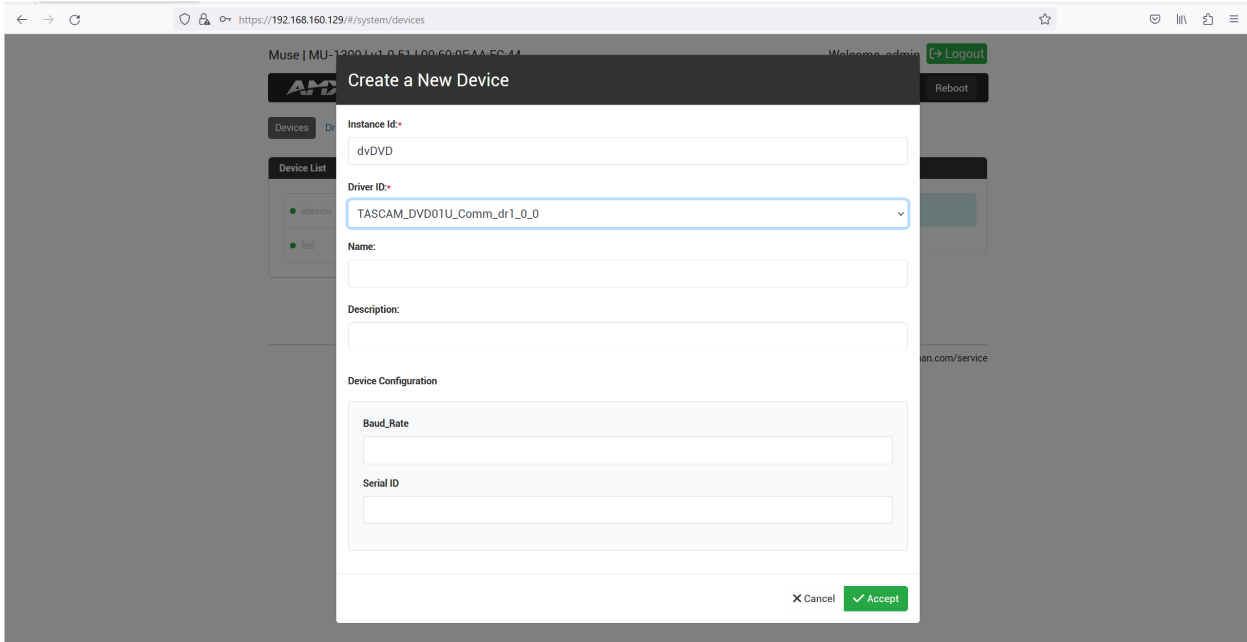
On the Devices page, click the Create button:



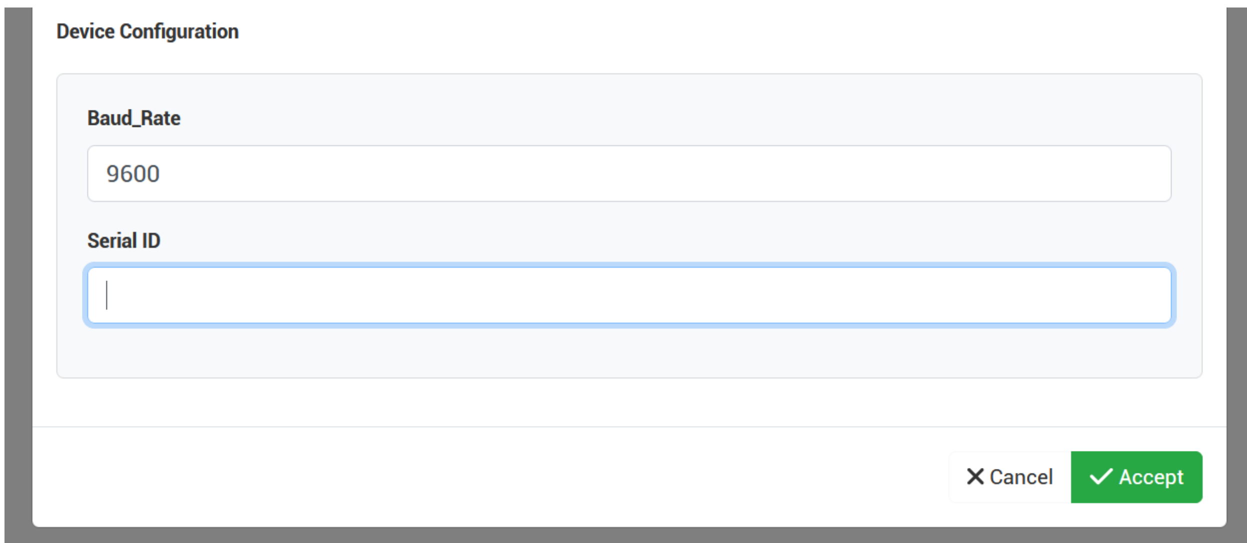
In the resulting dialog box, name the Device and choose the Duet Module to use:



Once selected, the dialog box will now contain new fields relevant to the Duet Module:



Fill out the fields in the Device Configuration section to inform the Duet module about the setup



For the Serial ID, the MUSE controller has a list of all available COM ports on the controller. In future, this will be populated in a pulldown. Until that time, we need to ask the MUSE controller for that list.

In an SSH session with the controller, log in and type the following command:

```
io:list
```

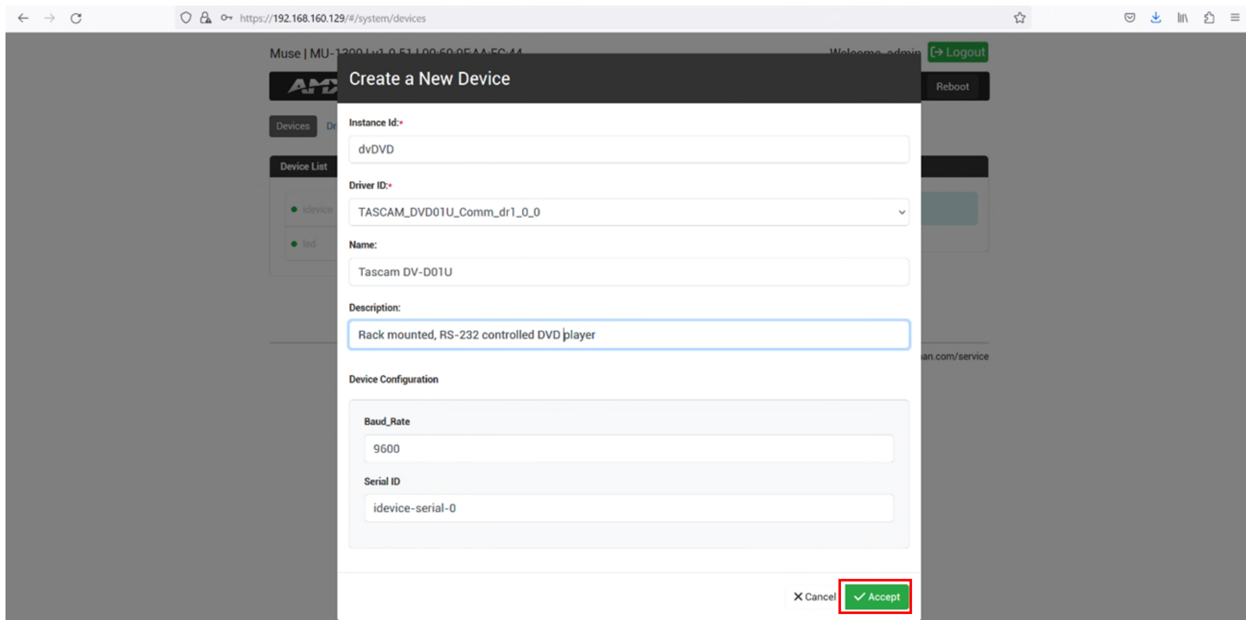
From this list, choose the COM port that the device is physically wired to.

192.168.160.129 - PuTTY

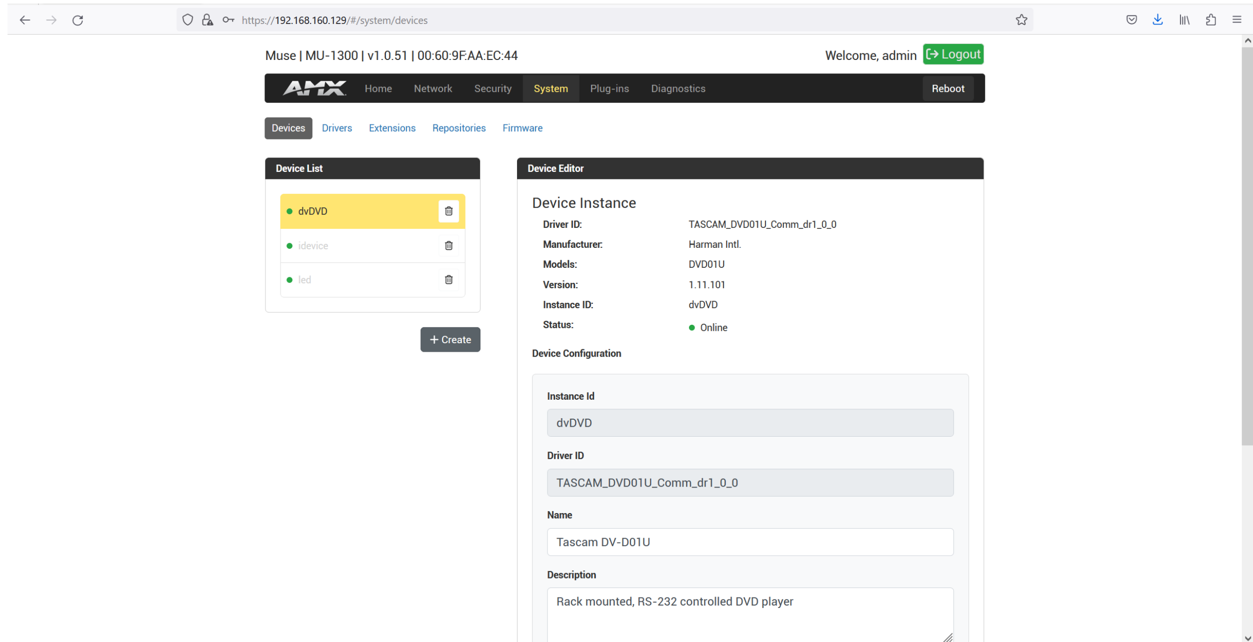
```
End of keyboard-interactive prompts from server

  Mojo Controller  (1.11.101)

Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit '<ctrl-d>' or type 'system:shutdown' or 'logout' to shutdown Karaf.

Password change not required for user admin

admin@mojo()> io:list
ID                | Type
------------------+----------------------------
idevice-serial-0 | com.amx.mojo.api.io.SerialPort
idevice-serial-1 | com.amx.mojo.api.io.SerialPort

admin@mojo()>
```

Note: Mojo keeps the COM ports organized in an array. Consequently, the list is numbered in a zero-based index as most modern programming environments do. Please note this differs from the actual silkscreen on the MUSE unit, which is one-based. In the example above, an MU-1300 is being used. There are two serial ports available on the controller. To use Serial Port 1 as labelled on the controller, choose:

```
idevice-serial-0
```



Click Accept to bind the driver to the COM port.



Using a module instance

Once the module instance is created, the module itself will start. This may include connecting to the device, polling, and other startup behaviors. The module instance will be listed by name in the Device List portion of the MUSE Controller's web server and the device:list CLI command:

```
admin@mojo()> device:list
ID       | Scope    | Status | Driver ID                  | Version
---------+----------+--------+----------------------------+--------
dvDVD    | <GLOBAL> | Online | TASCAM_DVD01U_Comm_dr1_0_0 | 1.12.12
dvTP     | <GLOBAL> | Online | com.amx.thing.icsp         |
idevice  | <GLOBAL> | Online | com.amx.thing.idevice      |
led      | <GLOBAL> | Online | com.amx.thing.led          |

admin@mojo()>
```

The CLI provides some focused insight to the control of the device through the module. Two helpful CLI commands are: device:commands and device:parameters. The essential difference between commands and parameters is persistence. Parameter values stay and can be queried. Commands happen and then are gone.

Asking the CLI what command our DVD player has results in this output:

```
  admin@mojo()> device:commands dvDVD
--------------------------------------------------
DEVICE COMMANDS (dvDVD)
--------------------------------------------------
> "discDevice/0/cycleDiscTray"
> "discDevice/0/cycleRepeat"
> "discDevice/0/queryDiscProperties"
> "discDevice/0/queryDiscProperty" (1 arguments)
```

```
> "discDevice/0/queryTitleProperties"
> "discDevice/0/queryTitleProperty" (1 arguments)
> "discDevice/0/setPlayPosition" (2 arguments)
> "discTransport/0/cycleScanSpeed"
> "discTransport/0/getTrackInfo"
> "discTransport/0/queryTrackProperties"
> "discTransport/0/queryTrackProperty" (1 arguments)
> "menu/0/moveCursor" (1 arguments)
> "menu/0/pressButton" (1 arguments)
> "menu/0/selectItem"
> "module/channel" (3 arguments)
> "module/command" (2 arguments)
> "module/getInstanceProperty" (1 arguments)
> "module/intLevel" (3 arguments)
> "module/passThru" (1 arguments)
> "module/reinitialize"
> "module/setInstanceProperty" (2 arguments)
> "power/0/cycle"
--------------------------------------------------

Use device:invoke to execute a command

admin@mojo()>
```

The commands can be executed through the CLI as stated by this output.

For syntax help with this or any other CLI command, use the **man** or **help** CLI command:

```
admin@mojo()> man device:invoke
DESCRIPTION
        device:invoke

    Invoke a command on a specific runtime device.
 Arguments are presented as name/value pairs separated by '='.  e.g. day=tuesday time=12:00
where day and time are the name of the arguments

SYNTAX
        device:invoke id command [arguments]

ARGUMENTS
        id
                Instance ID
                (required)
        command
                Command Name
                (required)
        arguments
                Command Arguments (name=value format)
```

```
admin@mojo()>
```

So, to toggle the power on this DVD Player, we can say:

```
admin@mojo()> device:invoke dvDVD power/0/cycle
--------------------------------------------------
DEVICE INVOKE COMMAND
--------------------------------------------------
 INSTANCE  : dvDVD
 COMMAND   : power/0/cycle
--------------------------------------------------
Invoked Successfully!


admin@mojo()>
```

For parameters, the device:parameters command lists both the available parameters and their current value.

```
admin@mojo()> device:parameters dvDVD
--------------------------------------------------
DEVICE PARAMETERS (dvDVD)
--------------------------------------------------
> "configuration/device/classname" = com.amx.thing.duet
> "configuration/device/container" =
> "configuration/device/description" = This is a Duet module driver
> "configuration/device/descriptorlocation" = descriptor.json
> "configuration/device/devicestate" = Running
> "configuration/device/manufacturer" = HARMAN Intl.
> "configuration/device/name" = Duet Driver
> "configuration/device/protocolversion" =
> "configuration/device/serialnumber" =
> "configuration/device/softwareversion" =
> "configuration/device/venue" =
> "configuration/device/version" =
> "discDevice/0/discCapacity" = 1
> "discDevice/0/titleCounterNotification" = false
> "discTransport/0/discTransport" = PLAY
> "discTransport/0/trackCounterNotification" = false
> "module/dataInitialized" = true
> "module/debugState" = 2
> "module/deviceDateTime" = Thu Jan 01 00:00:00 UTC 1970
> "module/deviceOnline" = true
> "module/fwVersion" = 1.0.0
> "module/passBack" = false
> "module/version" = 1.0.1
> "power/0/power" = ON
```

```
--------------------------------------------------

admin@mojo()>
```

Parameter values can be set and get individually with the device:set and device:get CLI commands:

```
admin@mojo()> device:set dvDVD discTransport/0/discTransport PLAY
--------------------------------------------------
DEVICE PARAMETER SET
--------------------------------------------------
 INSTANCE : dvDVD
 PARAMETER : discTransport/0/discTransport
--------------------------------------------------
NEW PARAMETER VALUE: PLAY (1)


admin@mojo()>
```

This particular parameter has caused the DVD to start playing. For a full list of values, we can consult the descriptor file for dvDVD. Typing driver:describe dvDVD gives the entire control set for the dvDVD device. The discTransport parameter specifically contains:

```
+- ARRAYS (4)
|  +-- discTransport
|  |    +- ELEMENTS (1)
|  |       +-- [0]
|  |           +- PARAMETERS (2)
|  |           |  +-- discTransport <enum> (rw)
|  |           |  |   +- [ <enum> [ INVALID, PLAY, STOP, PAUSE, PREVIOUS, NEXT, SCAN_FWD,
SCAN_REV, SLOW_FWD ]
```

If we stopped the DVD player and wanted to query the discTransport parameter, we can type:

```
admin@mojo()> device:get dvDVD discTransport/0/discTransport
--------------------------------------------------
DEVICE PARAMETER/METADATA GET
--------------------------------------------------
 INSTANCE           : dvDVD
 PARAMETER/METADATA : discTransport/0/discTransport
--------------------------------------------------
PARAMETER VALUE: STOP (2)


admin@mojo()>
```

These commands and parameters give us insight into how to use our device in control scripts. Duet modules have the concept of Components (typically arrays of Components) and methods/properties. For the above example, the discTransport component array has one element (index 0). This component has a property called discTransport, which is called to set or get the current state of the DVD.

Groovy syntax example:

```
dvDVD.discTransport[0].discTransport = "PLAY"
```

Python syntax example:

```
dvDVD.discTransport[0].discTransport = "PLAY"
```

JavaScript syntax example

```
dvDVD.discTransport[0].discTransport = "PLAY";
```

…as before, the individual bits of Mojo-related syntax barely differ between language.

Exporting Script Functionality

It is possible to expose the functionality of a script to the Mojo system. These exposed (or exported) touch points may then be access from HControl, scripts, or other control modules as a virtual device in the system. When any touch point is exported by the script, a virtual device is created in the system with the same ID as the script.

Note: This implies that scripts and real devices must have unique IDs amongst themselves. These touch points can be modeled as Thing parameters, commands, & events. They can also be contained in objects and arrays just like any other Thing

Script Descriptors

All devices in the Mojo / HControl ecosystem advertise their capability using the descriptor file. To expose the touch points in the script, the programmer must expand the *program.json* file to advertise its parameters, commands, & events.

Full Script Descriptor

```
{
    "$schema": "https://developer.amx.com/schema/amx-mojo-program-1.0.json",
    ".metadata" : {
        "id" : "jstestapp",
        "name" : "JavaScript Driver Program",
        "disabled": false,
        "description" : "JavaScript Driver Program",
        "provider" : "javascript",
        "script": "test.js"
    },

    "led": {
        ".kind": "array",
        ".prototype": {
            ".kind": "param",
            ".type": "enum",
            ".enums": ["OFF", "ON"],
            ".metadata": {
                "setter" : "setLED"
            }
        },
        ".size": 5
    },

    "setAllLeds": {
        ".kind": "command",
        ".arguments": {
            "value": {
                ".type": "enum",
                ".enums": ["OFF", "ON"]
            }
        }
    },

    "power": {
        ".kind": "param",
        ".type": "boolean"
    },
```

```
    "cyclePower": {
        ".kind": "command",
         ".metadata": {
            "method" : "cyclePower"
        }
    },

    "goodbye": {
        ".kind": "event",
        ".arguments": {
            "who": {
                ".type": "string"
            }
        }
    }
}
```

In the above example, there are two parameters and two commands. One of the parameters (led) is actually an array of parameters. This is standard descriptor content with the exception of two new .metadata keys: "setter" and "method". If the .metadata of a parameter contains a "setter" key, the system will look for a top-level function in the script with the same name as the key's value to call whenever a request to set the parameter is received. Likewise, if a "method" key is found in the .metadata of a command, the associated value will be assumed to be a top-level function to call to invoke the command. If a parameter or command doesn't have the "setter" or "method" keys in .metatdata, the function names are assumed to be "set" and "call".

The setter and method functions are required to have the following signatures (as appropriate for each language):

set(path, value) where path is a string denoting the path of the parameter and value is the new value to set. If a custom setter is specified, the function may not need the path argument but it is still required in the signature. Also, the system will guarantee that value is the correct type and value range as described in the descriptor so the script author doesn't need to do type or range checking.

call(path, args) where path is a string denoting the path of the command and args is a map (or specific language equivalent) of named arguments for the command.

So, the outline of a script to handle the *program.json* file above would be (example in JavaScript):

```
function setLED(path, value) {
    // calculate index from path
    // set the LED to new value
    // update the system with the new value
}

function set(path, value) {
    switch (path)
    {
    case "power":
        // set the power to the new value
        // update the system with the new value
        break;
```

```
    }
}

function call(path, args) {
    let value;
    switch (path)
    {
    case "setAllLeds":
        value = args.get("value");
        for (let i=0; i<5; i++) {
            // set led[i] to new value
            // update the system with the new value
        }
        break;
    }
}

// function must have arguments of path and args even though they aren't needed (language
dependent)
function cyclePower(path, args) {
    // cycle the power state
    // update the system with the new value
}
```

Notice that in the example above there is a comment to "update the system with the new value". This requires a mechanism for the script to call into the system. You will also need a similar capability if we want to generate events from script. To facilitate this functionality, a new object has been added to the context global variable in the script called **export**. The export object contains two methods that allow the script act on the virtual device that it has created.

export.update()

The *export.update()* method allows a script to update the value of a parameter. When updated, any listeners to that parameter will automatically be updated with the new value. The update method takes two required arguments and an optional third argument.

1. The first argument is the path of the parameter that is being updated. In the simple case, this is just the name of the parameter. If the device descriptor contains objects and arrays, this path argument is a slash ('/') separated list of nodes in the descriptor tree.
2. The second argument is the new value of the parameter.
3. The third (optional) argument is the normalized value of the parameter. If no normalized value is given, the system will automatically calculate a normalized value using linear interpolation between the minimum and maximum of the parameter.

In JavaScript, our example would read:

```
let export = context.export  // get the export API from context
```

```
function setLED(path, value) {
    // calculate index from path
    // set the LED to new value
    export.update(path, value)  // update the system with the new value
}
```

export.dispatch()

The *export.dispatch()* is similar to the export.update() method except that it generates events instead of parameter changes.

The dispatch method has one required argument which is the path of the event in the descriptor. The dispatch method also takes an optional argument which is a map of name/value pairs representing the arguments of the event that will be generated. The map can be empty, null, or omitted completely for events without arguments.

In Groovy, our example would read:

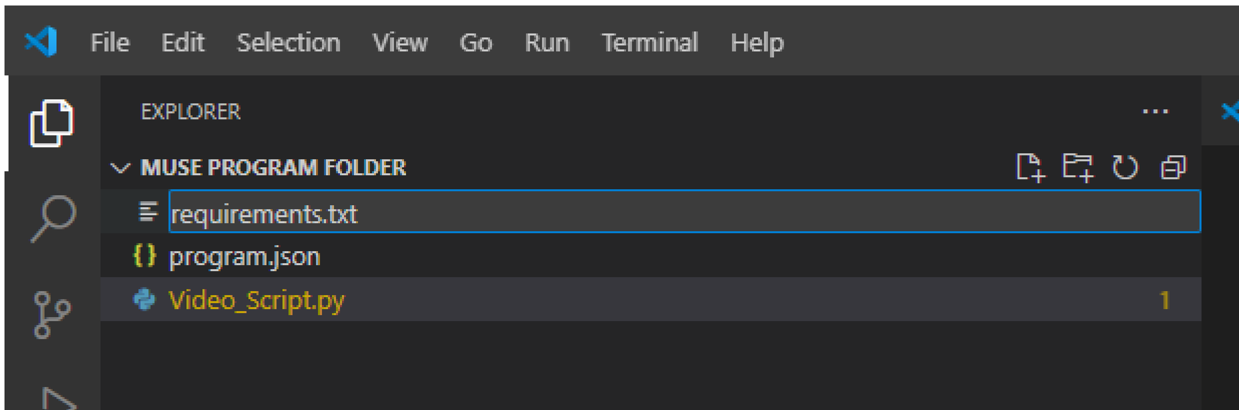
```
export = context.export

function goodbye(name) {
    // generate a goodbye event
    export.dispatch("goodbye", {"who" : name})
}
```

Python Virtualization / PIP Installation

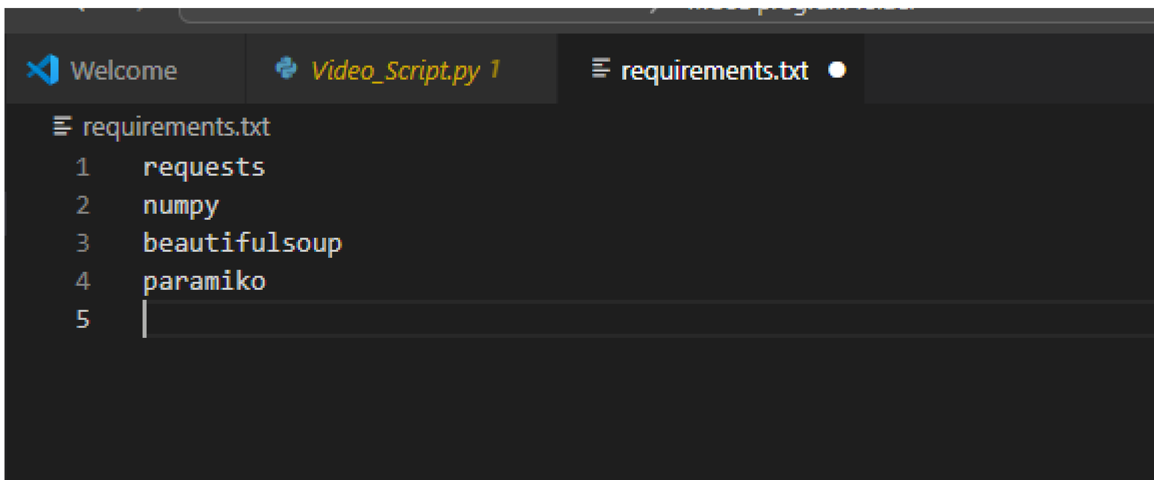
Third-party Python modules can be installed to MUSE using a *requirements.txt* file, which lists out the module (or modules) to download & install. **Note:** MUSE requires Internet access to download modules.

Method 1

In your program, create a text file named *requirements.txt* and enter your list of modules:



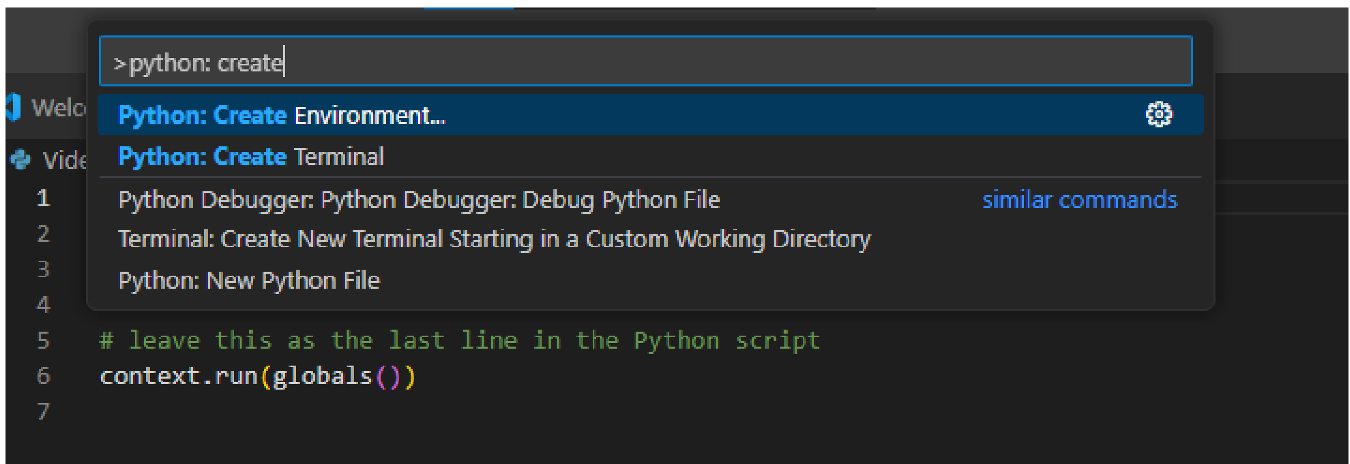
Type in the required module (or modules)



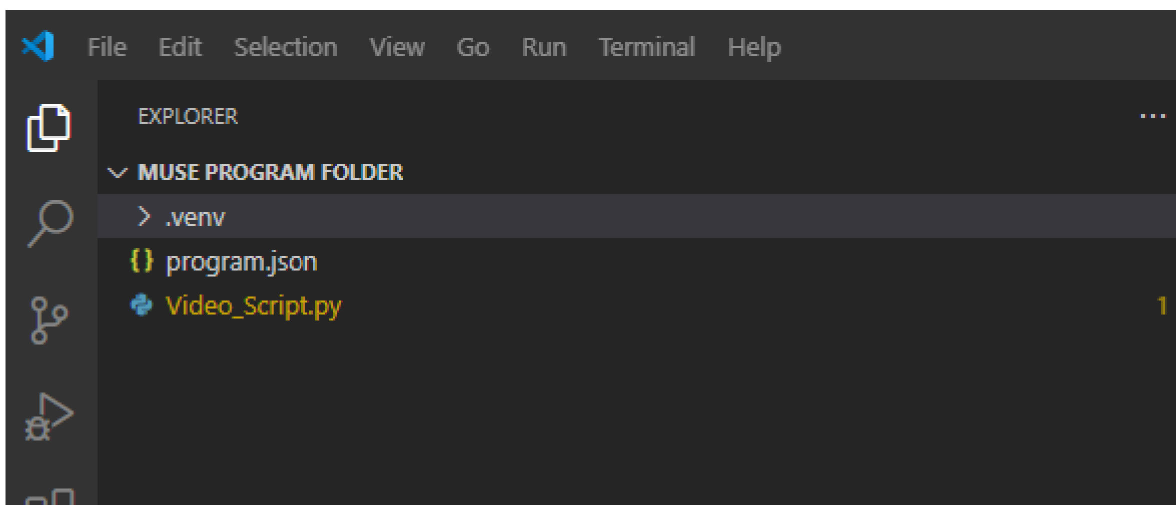
The *requirements.txt* file should then be loaded with your scripts. It will download modules into the code.

Method 2

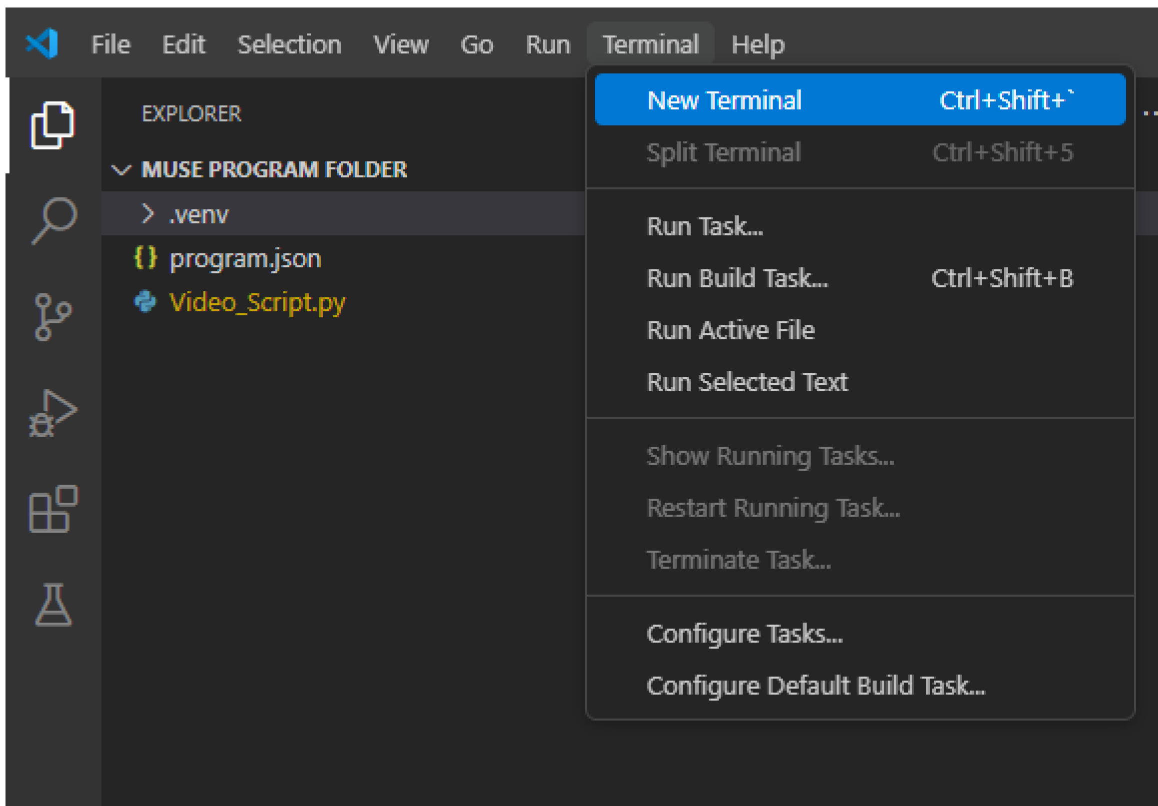
Run a new command named Python: Create Environment.



Select VENV and find your Python executable on your machine. This will create a *.venv* folder within your program.



On the menu, select Terminal >> New Terminal.



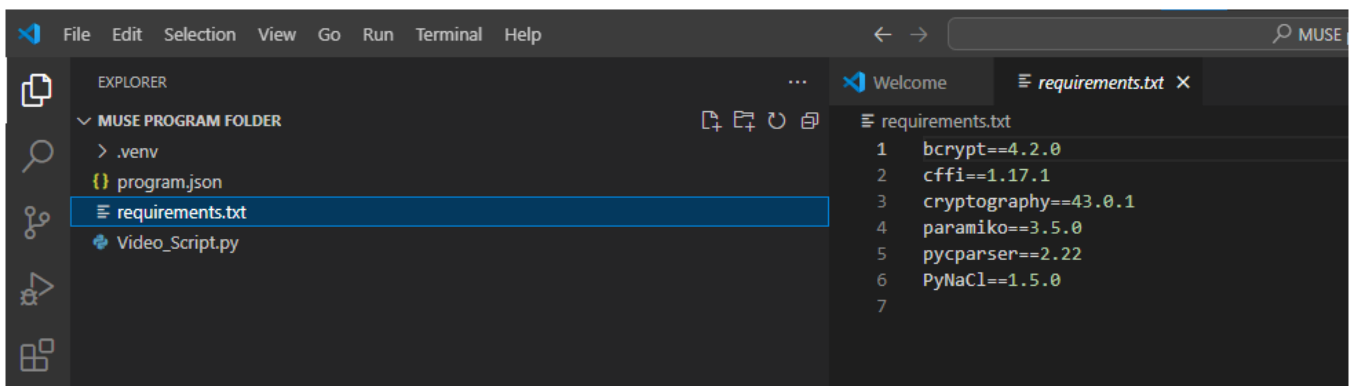
type pip install [module]. Repeat for each required module.

```
pip install paramiko
```

Then freeze the module to a *requirements.txt* file:

```
pip freeze > requirements.txt
```

This will build a *requirements.txt* and list the modules with versions:

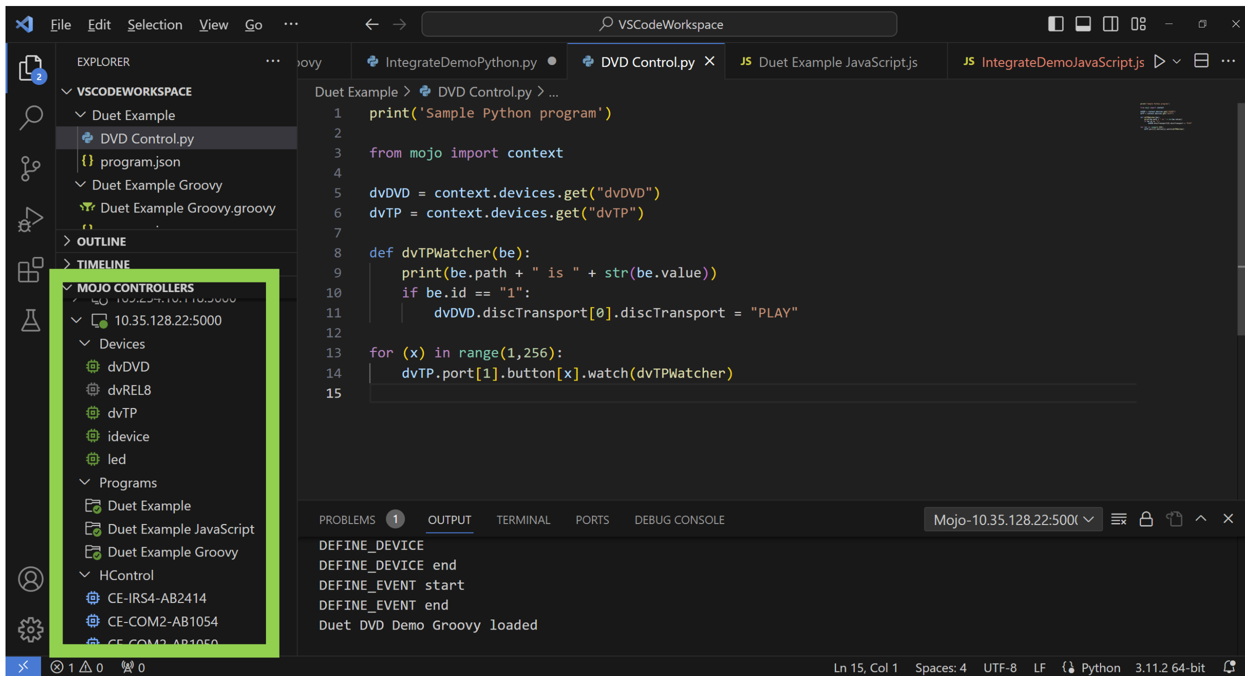


The *requirements.txt* file should then be loaded with your scripts.

Debugging

There are two places that contain substantial debugging information for MUSE. VS Code and the CLI.

VS Code



A great deal of information can be obtained from the MOJO CONTROLLER section that was added by the Mojo VS Code extension.

We can see that we are connected to and authenticated into a controller at 10.35.128.22. The green pip indicates the state of the connection. A yellow pip indicates the controller has been seen on the network, but authentication has not taken place. No pip means the status is unknown. To attempt a connection, use the refresh icon to initiate it. Follow any login prompts or messages that appear.

Once connected, we can see:

- Currently configured devices and their status
- Currently running programs
- HControl devices discovered near the controller

From the Devices portion of the tree, we can remove devices or ask for the descriptor. Each of these activities is available by context menu by right-clicking on the device in question

From the Programs portion of the tree, you can:

- Retrieve the script from the controller
- Restart the script
- Delete the script
- Enable/disable the script
- Attach to / Detach from the standard output of a script (print( ) and log( ) statements go here)

Attaching is the primary means of debugging a particular script. The script author can place print( ) or log( ) statements throughout the code to track the progress and expected code flow. These print statements can contain information about variable states and other helpful information.

Right-click on the running script and choose Attach to see the standard output.

Groovy syntax example:

```
println('DEFINE_DEVICE')

dvTP = context.devices.get("dvTP");
dvDVD = context.devices.get("dvDVD")

println('DEFINE_DEVICE end')

println('DEFINE_EVENT start')

dvTP.port[1].button[17].watch( {
    if(it.value) { //PUSH:
        dvDVD.discTransport[0].discTransport = "PLAY"
    }
    })

dvTP.port[1].button[18].watch( {
    if(it.value) { //PUSH:
        dvDVD.discTransport[0].discTransport = "STOP";
    }
    })

println("Duet DVD Demo Groovy loaded")
```

…would produce the following output when restarted:

```
Program "Duet Example Groovy" attached, you will see outputs here.
DEFINE_DEVICE
DEFINE_DEVICE end
DEFINE_EVENT start
Duet DVD Demo Groovy loaded
```

Python syntax example:

```
print('Duet Example Python')

from mojo import context

print('Grab device objects')
dvDVD = context.devices.get("dvDVD")
dvTP = context.devices.get("dvTP")
```

```
print('Define my button callback')
def dvTPWatcher(be):
    print(be.path + " is " + str(be.value))
    if be.id == "1":
        dvDVD.discTransport[0].discTransport = "PLAY"

print('set a watch for my buttons')
for (x) in range(1,256):
    dvTP.port[1].button[x].watch(dvTPWatcher)

print('Duet Example Python script loaded')
```

…would produce the following output when run.

```
Duet Example Python
Grab device objects
Define my button callback
set a watch for my buttons
Duet Example Python script loaded
```

JavaScript syntax example

```
context.log('JavaScriptDemo START')

context.log('DEFINE_VARIABLE')

var dvTP;
var dvDVD;

function dvTP_button_event(event) {
    context.log('dvTP_button_event(event) called')
    context.log('event:'+event.path+" is "+event.newValue)

    if(event.newValue){ // PUSH:
        var button
        button = parseInt(event.id)
        switch(button) {
            case 9:
              dvDVD.discTransport[0].discTransport = "PLAY";
              break;
            case 10:
                dvDVD.discTransport[0].discTransport = "STOP";
              break;
            default:
              console.log("unhandled button event "+event.id)
          }
```

```
    }
}
context.log('DEFINE_DEVICE')

dvTP    = context.devices.get("dvTP")
dvDVD = context.devices.get("dvDVD")

context.log('DEFINE_EVENT')

for(let i=1;i<=255;i++)
{
   // set watches on all dvTP buttons
   dvTP.port[1].button[i].watch(dvTP_button_event);
}

context.log('Duet Example JavaScript loaded')
```

would produce the following output:

```
Program "Duet Example JavaScript" attached, you will see outputs here.
[INFO] JavaScriptDemo START
[INFO] DEFINE_VARIABLE
[INFO] DEFINE_DEVICE
[INFO] DEFINE_EVENT
[INFO] Duet Example JavaScript loaded
```

CLI (Command Line Interface)

A far more powerful interface for debugging is the CLI.   This is available from SSH, the Virtual COM port available on the USB-C connector, and the Diagnostics → Shell portion of the MUSE web server.

As discussed earlier in this document, device parameters can be retrieved and set, commands sent, devices listed, and dozens of other useful functions performed.

For the entire list of commands, type *help* in the CLI. This will display a document containing all the published commands. Hit CTRL-C to exit this document.

For details on a specific command, use the *man or help* command.   For example:

```
admin@mojo()> man network:ip
DESCRIPTION
        network:ip

    Set and get network config

SYNTAX
        network:ip [options]

OPTIONS
        -e, --ethinterface
                Set ethernet interface specifier [eth0 or eth1] (defaults to eth0)
                (defaults to eth0)
        --help
                Display this help message
        -m, --mode
                Set mode: dhcp: static: ipv6d: ipv6s. {DHCP | Static | Dynamic Ipv6 or
Static Ipv6 [Eth1 can only be static] (defaults to empty)

                (defaults to )
        -s, --subnet
                Set subnet mask [Valid only when mode is static] (defaults to empty)

                (defaults to )
        -g, --gateway
                Set gateway [Valid only when mode is static] (defaults to empty)

                (defaults to )
        -i, --ip
                Set IP address [Valid only when mode is static] (defaults to empty)

                (defaults to )
        -en, --enable
                Enable eth1 [When enabling eth1 ip, subnet, and gateway values must be
entered.]

        -d, --disable
```

```
                Disable eth1


admin@mojo()>
```

…displays all the syntax and option information for retrieving network information about the MUSE controller.

For debugging, the most useful command in the CLI is *log:tail* .   This will show any exceptions that occur, any debug information that has been printed to the log, and other real-time data that is useful.

With our Tascam DVD module running, log:tail will show transactions to and from the serial port attached to the DVD.   This behavior is defined by the Duet module itself.

```
00:11:10.169 WARN  | TimerDaemon | Duet:TASCAMDVD01UDiscDevice | 190 |
TASCAMDVD01UDiscDevice:  Comm ----------> device: BUFFER
'023E504C5963465744202020202020313703'
00:11:10.262 WARN  | Thread-61 | Duet:TASCAMDVD01UDiscDevice | 190 |
TASCAMDVD01UDiscDevice:  Comm <---------- device: INCOMING DATA
'023E504C5973465744202020202020323703'
```

In this case, we can see a transaction that occurred when the module decided to poll the DVD player for status. In this case, the module author decided to print the string, which is a mix of printable and non-printable ASCII characters, as an ASCII stream of the hexadecimal values of each character. Knowing this, we can see that the conversation was:

Controller to DVD: STX>PLYcFWD   17ETX   (please start playing the disc)

DVD to Controller: STX >PLYsFWD   27 ETX   (play command acknowledged)

Appendix A: The HControl API

MUSE contains a framework for communicating with AMX devices, modules, and other AMX specific facilities: the HControl API.

The context variable is the handle for the Mojo engine. It has logging and device access features. The structure of context is:

```
context
•  devices
   •  get(name)      – get a specific device by its name
   •  has(name)      – check if a specific device is defined
   •  ids()          – get the list of defined devices
•  log
   •  level          – set/get the current logging threshold
   •  trace(msg)   – issue a log message at TRACE level
   •  debug(msg)   – issue a log message at DEBUG level
   •  info(msg)    – issue a log message at INFO level
   •  warning(msg) – issue a log message at WARNING level
   •  error(msg)   – issue a log message at ERROR level
•  services
   •  get(serviceName) – get a service by name
•  run(globals())  - a call specific to Python to continue operation once
               the script has reached its end
```

When coding in JavaScript or Groovy, the context variable will be imported and available automatically, but when coding in Python, context must be explicitly imported from the mojo library using the following line of code:

```
from mojo import context
```

Syntax Examples Using Context: (identical for each language unless noted)

Get the device named AMX-10001 and assign it to the script variable dvTP:

```
dvTP = context.devices.get("AMX-10001")
```

Check if a device named dvLighting has been defined:

Python:

```
if context.devices.has("dvLighting"):
      # do something
```

Groovy/JavaScript:

```
if(context.device.has("dvLighting") {
      // do something
```

```
}
```

Send a message to the logger at the WARNING threshold:

```
context.log.warn("dvLighting is not defined")
```

Get Request an instance of the timeline service that triggers 1/second forever:

```
myTimeline = context.services.get("timeline")
mytimeline.start([1000],false,-1)
```

The services available vary based on what is currently installed/enabled.   At the time of this writing, there are three services: timeline, smtp, & platform.

Note: Support for the netlinxClient service has been deprecated and replaced by the Netlinx Driver. It may be removed in the future.

For the syntax and usage of the services, use the following CLI command:

```
doc:list
```

…to obtain the current list of services available and:

```
doc:show serviceName
```

…to show the syntax and usage description.

Accessing Built-In Ports

For MUSE controllers with built in Serial, IR, IO and/or Relay ports, these ports are accessed in code using the "idevice" device name. As mentioned above, the context variable provides access to this device. The following Python code example shows how to create device variables for these ports:

```
iDevice = context.devices.get("idevice")
```

Device Parameters and Commands: Basic Syntax

Coders interact with connected devices using Parameters and Commands. Parameters and Commands are referenced using their device variable and port name. The generic syntax for the path to any parameter or command is:

```
<device>.<port>.<parameter>
```

And

```
<device>.<port>.<command>(<zero or more args>)
```

The <device> is the variable name assigned to the device as retrieved from the MUSE context as shown above. It is common for these variables to be named "dv<device-description>", for example: dvTP, dvCOM2 or dvDisplay.

The <port> is the name of the specific port on the device. The available ports will depend on the specific device and can be found in the HControl device's descriptor file.

The parameters and commands available depend on the specific device and port. These can also be found in the HControl device's descriptor file. See below for examples of using parameters and commands with the built-in control ports available on some MUSE controllers.

Port Arrays and 0-based vs 1-based port numbering

HControl uses a 1-based numbering system for all ports. This means that all ports on products like MUSE Controllers and CE-Series control extenders are numbered starting with 1. You can see this on the silkscreen on these products and when configuring ports from the AVX Manager software.

To simplify programming for products with multiple ports of the same type, the ports are structured as arrays when coding on MUSE. For example, rather than having eight uniquely named COM ports on a MU-3300 from "com1" through "com8", each port is identified by an index into an array.

Because Python, JavaScript and Groovy all use 0-based arrays, you must use array index 0 to access the port numbered "1" on the silkscreen, and array index 7 to access the port numbered "8". In other words, you will always use an array index that is ONE LESS than the port number you wish to access.

All MUSE Serial, IR, IO and Relay ports are arrays, so you must use an array index on the port name. So, the general syntax is:

```
<device>.<port_name>[<0-based index>].<parameter>
```

Or

```
<device>.<port_name>[<0-based index>].<command>(<zero or more args>)
```

Parameters

Parameters are used to set and get individual properties of a device that hold their state, for example the position of a relay on MU-2300 or MU-3300.

All parameters contain the following properties that can be read and (if writable) written.

Property	Data Type	R/W	Description
value	Varies	R/W	The value of the parameter
normalized	Float	R/W	A float value between 0 and 1, inclusive, based on the range of the value
min	Varies	R	The minimum value of a numerical parameter
max	Varies	R	The maximum value of a numerical parameter
defaultvalue	Varies	R	The default value of a parameter
type	Varies	R	The data type of this specific parameter
enums	Array	R	For an enumeration, the specific data points available

Getting and Setting Parameters:

Parameters in HControl can be directly read by setting a variable equal to the parameter value and directly written (if read/write) by setting the parameter value equal to a new value.

For example, you can access the state parameter of relay 1 on an MU-3000 with this code (note the use of the iDevice variable as defined above under Accessing Built-In Ports):

```
Relay1_on = iDevice.relay[0].state.value

iDevice.relay[0].state.value = True
```

The following table lists the contents of each of these parameter properties depending on the data type of the parameter:

Property	Boolean	Integer/Float	Enumeration	String	Byte Array
value	true/false	<number>	<string>**	<string>	byte[]
normalized	0 or 1	0 to 1 inclusive	0 to 1 in steps of 1/(# enums - 1)	Invalid	Invalid
min	0	Min accepted value	0	Min string length	Min array length
max	1	Max accepted value	# enums - 1	Max string length	Max array length
defaultvalue	*	*	*	*	*
type	'boolean'	'integer' or 'float'	'enum'	'string'	'byte_array'
enums	Empty Array	Empty Array	Array of enum strings	Empty Array	Empty Array

* The **defaultValue** field will be the same data type as the Parameter and will contain a valid data entry if there is a default for that parameter, or it will be undefined if there is no default value.

** Reading enumerations will always return a string. Writing/setting can be done with either a string or the zero-based integer that represents the index into the array of enum strings. For example, setting an enum to 0 will set it the value in <parameter>.enums[0].

Watching for Parameter changes:

If you want to trigger a function when a parameter changes, you can set a "watch" on that parameter, passing in the name of the function you want to call when the parameter changes.

Here's an example of using a watch on a relay port:

```
handle_relay_state_change(update):

      print("Relay 1 new state is ", update.value)

iDevice.relay[0].state.watch(handle_relay_state_change)
```

When the watch function is called, it will be passed a **Parameter Update Structure** with details of the parameter and the new value. The contents of the **Parameter Update Structure** (the update variable passed into the example above) is:

Field	Data Type	Description
path	String	The property of the device that this event refers to
id	String	A shortened version path. For ICSP, only the button number is conveyed
value	Varies	The event data. For button events, this would be a boolean
newValue	Varies	Identical to value
oldValue	Varies	The data value before the event was processed
normalized	float	A float value between 0 and 1, inclusive, based on the range of the value

source	Object Ref	The object reference for the specific parameter that was updated

For port arrays, the parameter **path** field will contain a '/' delimited string containing the port name, 0-based port number and parameter name:

```
<port name>/<port number>/<parameter>
```

So in the watch example above, update.path would contain the string "relay/0/state". If watch events are set on multiple ports and/or parameters pointing to the same handler function, you can parse the path string to determine the port and parameter that changed.

The data type of the **value**, **newValue** and **oldValue** fields will always be the same as the data type of the parameter being watched.

Commands

Commands in HControl are called directly using the name of the command with the necessary arguments. Here's an example of using the 'send' command for a Serial port on an MU controller:

```
iDevice.serial[0].send("Hello")
```

Events

Events in HControl are sent from the CE Controller Extender when a stateless device event occurs. Good examples of this are when data is received on a COM2 serial port.

To trigger a function when an event occurs, you can set a "listen" on that event, passing in the name of the function you want to call when the event happens. Here's an example using a listen on a serial port receive event:

```
def handle_received_serial(event):

      # process incoming string found inside the event variable

iDevice.serial[0].receive.listen(handle_received_serial)
```

When the function is called it will be passed an **Event Update Structure** with details on the event. The contents of the **Event Update Structure** (the event variable passed into the example above) are:

Field	Data Type	Description
path	String	The property of the device that this event refers to
id	String	A shortened version path. For ICSP, only the button number is conveyed
arguments	JSON	The data payload of the event, dependent on the specific event
source	Object Ref	The object reference for the specific parameter that was updated

For port arrays, the event **path** field contains a '/' delimited string containing the port name, 0-based port number and the event name:

```
<port name>/<port number>/<event>
```

So in the listen example above, event.path would contain the string "serial/0/receive". If listen events are set on multiple ports and/or events pointing to the same handler function, you can parse the path string to determine the port and event that triggered the function call.

The contents of the **arguments** field contains all the relevant information pertaining to an event and varies depending on the specific device and event. Details on the contents of this field for events on MUSE built-in control ports can be found below.

Specific HControl Details for MUSE Built-In Ports

The examples below are provided in Python. All commands, parameters and general coding structure is the same when coding in JavaScript and Groovy. The only differences are the syntax differences between the languages, like the use of curly braces to identify coding blocks, semi-colons at the end of lines, and (for JavaScript) the use of the "var" keyword to declare variables.

The variable named iDevice is used in all examples to access the built-in ports. This variable name is arbitrary, but for the coding examples below to work, this variable must be defined prior to use as follows:

```
iDevice = context.devices.get("Idevice")
```

This assumes that the controller being used contains built-in-devices. For more robust code, you could verify this as follows:

```
if context.devices.has("idevice"):
    iDevice = context.devices.get("idevice")
else:
    iDevice = None
```

Any future use of the iDevice variable would then first need to verify that it's valid:

```
if iDevice is not None:
    <your iDevice code here>
```

Relay Ports

The relay ports are the simplest, containing only one parameter for control. There are no commands or events.

Parameters

Parameter list:

Parameter Name	Read/Write	Data Type	Description
state	Read/Write	boolean	Engage the relay

Examples:

Turn relay 1 on

```
iDevice.relay[0].state.value = True
```

To watch a relay state, use:

```
handle_relay_state_change(update):
    print("Relay 1 new state is ", update.value)
```

```
iDevice.relay[0].state.watch(handle_relay_state_change)
```

Serial Ports

Unlike the relay ports, the serial ports primarily use commands rather than parameters. The Serial Ports support the following commands:

Command	Arguments	Date Type	Description
send	data	String	Send data out the port
setFlowControl	mode	Enumeration	NONE or HARDWARE
setCommParams	baudRate	Enumeration	1200, 4800, 9600, 19200, 38400, 57600, 115200
	dataBits	Integer	7 or 8
	stopBits	Integer	1 or 2
	parity	Enumeration	NONE, EVEN, ODD
	mode	Enumeration	232, 422, 485
enableReceive	-	-	Listen for message on the port
disableReceive	-	-	Stop listening for messages
flushReceiveBuffer	-	-	Clear incoming buffer

Examples:

To send a string out of Serial Port 1:

```
iDevice.serial[0].send("Hello, world")
```

To send the string: `'This string contains "quoted text" and ° binary data'`

```
iDevice.serial[0].send("This string contains \"quoted text\" and \xB0 binary
data")
```

Notice that the double-quote characters within the string must be escaped and that the degree symbol can be sent as binary using hex code escape sequence `\xB0`

To disable the hardware handshaking available on COM Port 1, send:

```
iDevice.serial[0].setFlowControl("NONE")
```

To clear the receive buffer on COM Port 2, send:

```
iDevice.serial[1].flushReceiveBuffer()
```

To configure COM port 1 to the most common transmission settings, send:

```
iDevice.serial[0].setCommParams("9600", 8, 1, "NONE", "232")
```

Events

Event Name	Argument Keys	Data Type	Description
receive	“data”	UTF-8 encoded String	Received data from a connected device

Examples:

To enable receiving strings that are sent to the COM port from the controlled device it is required to enable receive strings on the port, and then to set a listen event handler for the **receive** event. For example:

```
iDevice.serial[0].enableReceive()

def on_serial1_receive(event):

    received_string = str(event.arguments['data'].decode('utf-8'))

iDevice.serial[0].receive.listen(on_serial1_receive)
```

Note that you must use the **arguments** field of the **Event Update Structure** that’s passed to the event handler function (the event variable above) and access the “data” element of this field to retrieve the UTF-8 encoded data received on the serial port.

Parameters

Parameter	Read/Write	Data Type	Values	Default
baudRate	Read Only	Enumeration	1200, 4800, 9600, 19200, 38400, 57600, 115200	9600
dataBits	Read Only	Integer	7 or 8	8
mode	Read Only	Enumeration	232, 422, 485	232
parity	Read Only	Enumeration	NONE, EVEN, ODD	EVEN
stopBits	Read Only	Integer	1 or 2	1

Examples:

All of the Serial Port parameters are read-only. These parameters are configured using the setCommParams command above.

Here’s an example of reading one of the parameters:

```
data_bits = iDevice.serial[0].dataBits.value
```

To watch for changes on one of these parameters, use:

```
handle_databits_change(update):

       print(“Serial 1 new data bits is “, update.value)

iDevice.serial[0].dataBits.watch(handle_databits_change)
```

IR Ports

Commands

Path	Arguments	Data Type	Description

bufferedSendIr	code	Integer	Queue a timed pulse of IR by index
bufferedSendNamedIr	code	String	Queue a timed pulse invoked by name
clearAndSendIr	code	Integer	Clear the queue, then send the new IR pulse
clearAndSendNamedIr	code	String	Clear the queue, then send the named IR pulse
keypadMacro	code	Integer	Queue digits based on the keypadMode pattern
keypadMode	mode	Integer	Set the pattern for keypad digit transmission
loadIrFile	file	String	The .irl filename to use
offIr	-	-	Turn off IR on the port
onIr	code	Integer	Send IR code continuously by #
onNamedIr	code	String	Send IR code continuously by name
setOffTime	millis	Integer	Set the queue timing interval in ms
setOnTime	millis	Integer	Set the queue active interval in ms
enableFaultDetection	-	-	Alert if no IR LED detected
disableFaultDetection	-	-	Do not alert
setCommParams	baudRate	Enumeration	1200, 4800, 9600, or 19200
	dataBits	Integer	7 or 8
	stopBits	Integer	1 or 2
	parity	Enumeration	NONE, ODD, or EVEN
send	data	String	Use IR as 1-way COM port

Examples:

To send on IR port 3 the IR code in position 1 for a pre-determined pulse time (or add to the queue if there are already bufferedSendIR or bufferedSendNamedIR or keypadMacro commands active) send:

```
iDevice.ir[2].bufferedSendIr(1)
```

To send that same code if it is named 'PLAY' in the .irl file, send:

```
iDevice.ir[2].bufferedSendNamedIr("PLAY")
```

To send the codes on the number pad of the remote for station 345, send:

```
iDevice.ir[2].keypadMacro(345)
```

To change the pattern used to execute keypad macros, use:

```
iDevice.ir[2].keypadMode(2)
```

See the Keypad Mode section of the web server documentation for pattern information.

To load a new IR from the collection of .irl files uploaded to the CE-IRS4 configuration web page, send:

```
iDevice.ir[2].loadIrFile("samsung01.irl")
```

When using buffered (queued) IR, to configure a 1 second interval between IR pulses, send:

```
iDevice.ir[2].setOnTime(1000)
```

When using buffered (queued) IR, to configure the active pulse width to 0.5 second, send:

```
iDevice.ir[2].setOffTime(500)
```

Events

Event	Argument Keys	Data Type	Description
fault	“data”	String	Alerts to missing or reversed IR bud

Examples:

The IRS4 will send a fault event if it detects certain fault conditions like a missing or reversed IR bud when attempting to send an IR message out a port. You must subscribe to this event to receive fault messages.

```
handle_ir_faults(event):
    print(“received fault: “, event.arguments[‘data’])
dvIRS4.ir[3].fault.listen(handle_ir_faults)
```

Parameters

Path	Read/Write	Data Type	Values	Default
carrier	Read/Write	Boolean	true or false	True
mode	Read/Write	Enumeration	IR, SERIAL, or DATA	IR
baudRate	Read Only	Enumeration	1200, 4800, 9600, 19200, 38400, 57600, 115200	9600
dataBits	Read Only	Integer	7 or 8	8
parity	Read Only	Enumeration	NONE, EVEN, ODD	NONE
stopBits	Read Only	Integer	1 or 2	1

Examples:

To set the IR port to use the carrier frequency specified in the .irl file (typically 41Hz modulation of the near infrared signal), send:

```
iDevice.ir[2].carrier.value = True
```

To set the IR port mode to use as a 1-way COM port, send:

```
iDevice.ir[2].mode.value = “DATA”  # turn off carrier to use this mode
```

The COM related parameters are read-only. See the CE-COM2 Parameters for syntax examples.

I/O Ports

Parameters

Parameter	Read/Write	Data Type	Values	Default
debounceTimeMilliseconds	Read/Write	Integer	5-250	75
mode	Read/Write	Enumeration	INPUT or OUTPUT	INPUT
output	Read/Write	Boolean	true or false	false
debounceMinDelta	Read/Write	Float	0.1 - 4.9	0.2
inputMode	Read/Write	Enumeration	DIGITAL, ANALOG, BOTH	BOTH
digitalInputLowMax	Read/Write	Float	0.0 - 9.9	0.8
digitalInput2KPullup	Read/Write	Boolean	true or false	false
analogInput	Read Only	Float	0.0 - 10.0	-
digitalInput	Read Only	Boolean	true or false	-
digitalInputHighMin	Read/Write	Float	0.1 - 10.0	2.7

Examples:

Set the debounce time (minimum time between updates) to 123ms:

```
iDevice.io[0].debounceTimeMilliseconds.value = 123
```

Set the mode for the particular input (input or output):

```
iDevice.io[0].mode.value = "INPUT"

iDevice.io[1].mode.value = "OUTPUT"
```

Set the updates that an IO in input mode will generate:

```
iDevice.io[0].inputMode.value = "DIGITAL"

iDevice.io[0].inputMode.value = "ANALOG"

iDevice.io[0].inputMode.value = "BOTH"
```

Set the state of an IO that is in output mode to output a 'high' or 'low' voltage:

```
iDevice.io[1].output.value = True

iDevice.io[1].output.value = False
```

Get the state of an IO that is in digital input mode (inputMode set to DIGITAL or BOTH):

```
io1_state = iDevice.io[0].digitalInput.value
```

To watch for state changes on this digital input:

```
handle_io_state_change(update)
```

```
        print(“IO state change to: “, update.value)
    iDevice.io[0].digitalInput.watch(handle_io_state_change)
```

Get the state of an IO that is in analog input mode (inputMode set to ANALOG or BOTH):

```
    Io1_level = iDevice.io[0].analogInput.value
```

You can set a watch event on the analog input in a similar fashion as the digital input above. Because the analog input may be constantly changing, you can set the minimum amount of voltage change that will cause a watch to trigger. To set this minimum threshold to 0.5v:

```
    iDevice.io[0].debounceMinDelta.value = 0.5
```

Set the maximum threshold voltage that is considered to be a digital ‘low’:

```
    iDevice.io[0].digitalInputLowMax.value = 0.1
```

Set the minimum threshold voltage that is considered to be a digital ‘high’:

```
    iDevice.io[0].digitalInputHighMin.value =1.1
```

Set the state of the pull-up resistor used in the input configuration:

```
    iDevice.io[0].digitalInput2KPullup.value = True
    iDevice.io[0].digitalInput2KPullup.value = False
```

The Event structure

Any callback or lambda functions for a .listen passed the event structure. This contains the specific information that triggered the event.

Field	Data type	Description
path	String	The property of the device that this event refers to
id	String	A shortened version path. For ICSP, only the button number is conveyed
arguments	array	The data payload of the event, dependent on the specific event
source	Object Ref	The object reference for the specific parameter that was updated

The most commonly encountered event within MUSE is for receiving data from a serial port. Here are some language specific examples.

Python:

```
def dvCOM3_Event(ev):
    print('PY_ev.source    =='+str(ev.source))
    print('PY_ev.path      =='+str(ev.path))
    print('PY_ev.id        =='+str(ev.id))
    print('PY_ev.arguments:')
    print('[\'data\'] =='+str(ev.arguments['data'].decode()))

idevice.serial[3].receive.listen(dvCOM3_Event)
```

…has the following output when a serial message is received:

```
PY_ev.source    ==<mojo.PythonThing object at 0xffff956e9880>
PY_ev.path      ==serial/3/receive
PY_ev.id        ==receive
PY_ev.arguments:
['data'] ==hello from python
```

Groovy:

```
idevice.serial[3].receive.listen({ serialEvent ->
    println("serial data event on COM3")
    println('G_serialEvent.source    =='+serialEvent.source)
    println('G_serialEvent.path      =='+serialEvent.path)
    println("G_serialEvent.id        =="+serialEvent.id)
    println('G_ev.arguments:')
    println('data =='+new String(serialEvent.arguments.get("data"),"UTF-8"))

})
```

…has the following output when a serial message is received:

```
G_serialEvent.source    ==com.amx.mojo.groovy.GroovyThing@1b5a766a
G_serialEvent.path      ==serial/3/receive
G_serialEvent.id        ==receive
G_ev.arguments:
data ==hello from Groovy
```

JavaScript:

```
function dvCOM3_RX(serialEvent){
  context.log("serial data event on COM3")
  context.log('JS_serialEvent.source    =='+serialEvent.source)
  context.log('JS_serialEvent.path      =='+serialEvent.path)
  context.log("JS_serialEvent.id        =="+serialEvent.id)
  context.log('JS_ev.arguments:')
  context.log('data =='+String(serialEvent.arguments.data))
}

idevice.serial[3].receive.listen(dvCOM3_RX)
```

…has the following output when a serial message is received:

```
[INFO] serial data event on COM3
[INFO] JS_serialEvent.source    ==null
[INFO] JS_serialEvent.path      ==serial/3/receive
[INFO] JS_serialEvent.id        ==receive
[INFO] JS_ev.arguments:
[INFO] data ==hello from JavaScript
```

The Parameter Update Structure

Any callback or lambda functions for a .watch( ) attached to a parameter is passed this structure. This contains the specific information that triggered the parameter change event.

Field	Data type	Description
path	String	The specific parameter that has been updated
id	String	The last element of the path
value	variant	The current value of the parameter
newValue	variant	The current value of the parameter
oldValue	variant	The previous value of the parameter
normalized	float	A float value between 0 and 1, inclusive, based on the range of the value
source	Object Ref	The object reference for the specific parameter that was updated

Strangely the most commonly encountered parameter update within the MUSE environment is a button press. Button events can be queried, so are actually parameters.

Groovy:

```
println('Sample Groovy program')

dvTP = context.devices.get("dvTP")

dvTP.port[1].button[2].watch( { parameterChange ->
    println('parameterChange.id        =='+parameterChange.id)
    println('parameterChange.source    =='+parameterChange.source)
    println('parameterChange.path      =='+parameterChange.path)
    println('parameterChange.value     =='+parameterChange.value)
    println('parameterChange.newValue  =='+parameterChange.newValue)
    println('parameterChange.oldValue  =='+parameterChange.oldValue)
    println('parameterChange.normalized=='+parameterChange.normalized)
} )
```

…has the following output when button 2 on port 1 is pressed:

```
parameterChange.id        ==2
parameterChange.source    ==com.amx.mojo.groovy.GroovyThing@36a1b33c
parameterChange.path      ==port/1/button/2
parameterChange.value     ==true
parameterChange.newValue  ==true
parameterChange.oldValue  ==false
parameterChange.normalized==1.0
```

Python:

```python
print('Sample Python program')

from mojo import context

dvTP = context.devices.get("dvTP")

def dvTPWatcher(parameterChange):
    print(parameterChange.path + " is " + str(parameterChange.value))
    print('parameterChange.id        =='+parameterChange.id)
    print('parameterChange.source    =='+str(parameterChange.source))
    print('parameterChange.path      =='+str(parameterChange.path))
    print('parameterChange.value     =='+str(parameterChange.value))
    print('parameterChange.newValue  =='+str(parameterChange.newValue))
    print('parameterChange.oldValue  =='+str(parameterChange.oldValue))
    print('parameterChange.normalized=='+str(parameterChange.normalized))

dvTP.port[1].button[3].watch(dvTPWatcher)

context.run(globals())
```

…has the following output when button 3 on port 1 is pressed:

```
port/1/button/3 is True
parameterChange.id        ==3
parameterChange.source    ==<mojo.PythonThing object at 0xffffb1acc970>
parameterChange.path      ==port/1/button/3
parameterChange.value     ==True
parameterChange.newValue  ==True
parameterChange.oldValue  ==False
parameterChange.normalized==1.0
```

JavaScript:

```
function dvTP_button_change(buttonChange) {
   context.log('dvTP_button_change(buttonChange) called')
   context.log('button:'+buttonChange.path+" is "+ buttonChange.newValue)
   context.log("JS_buttonChange.id        =="+ buttonChange.id)
   context.log('JS_buttonChange.source    =='+ buttonChange.source)
   context.log('JS_buttonChange.path      =='+ buttonChange.path)
   context.log('JS_buttonChange.value     =='+ buttonChange.value)
   context.log('JS_buttonChange.newValue  =='+ buttonChange.newValue)
   context.log('JS_buttonChange.oldValue  =='+ buttonChange.oldValue)
   context.log('JS_buttonChange.normalized=='+ buttonChange.normalized)


idevice.serial[3].receive.listen(dvCOM3_RX)
```

…has the following output when button 1 on port 1 is pressed:

```
[[INFO] dvTP_button_change(buttonChange) called

[INFO] button:port/1/button/1 is true
[INFO] JS_buttonChange.id        ==1
[INFO] JS_buttonChange.source    ==true
[INFO] JS_buttonChange.path      ==port/1/button/1
[INFO] JS_buttonChange.value     ==true
[INFO] JS_buttonChange.newValue  ==true
[INFO] JS_buttonChange.oldValue  ==false
[INFO] JS_buttonChange.normalized==1
```

The Parameter structure – set/get

When manipulating the value of a particular Thing parameter

Field	Data type	Description
value	variant	The new value which cause the parameter change callback
normalized	float	A float value between 0 and 1 inclusive, based on the value's range
min	variant	The minimum value of a numerical parameter
max	variant	The maximum value of a numerical parameter
defaultvalue	variant	The default value of a parameter
type	float	The data type of this specific parameter
enums	enumeration	For an enumeration, the specific data points available

Syntax Examples:

In Python, to retrieve all the properties of the parity setting on COM3:

```
      print("parity value:"       + str(idevice.serial[3].parity.value))
      print("parity normalized:"  + str(idevice.serial[3].parity.normalized))
      print("parity min:"         + str(idevice.serial[3].parity.min))
      print("parity max:"         + str(idevice.serial[3].parity.max))
      print("parity defaultvalue:"+ str(idevice.serial[3].parity.defaultvalue))
      print("parity type:"        + str(idevice.serial[3].parity.type))
      print("parity enums:"       + str(idevice.serial[3].parity.enums))
```

Returns:

```
parity value:NONE
parity normalized:0.0
parity min:0
parity max:4
parity defaultvalue:NONE
parity type:enum
parity enums:['NONE', 'EVEN', 'ODD', 'MARK', 'SPACE']
```

In JavaScript, to retrieve all the properties of the parity setting on COM3:

```
    context.log("parity value:"       + idevice.serial[3].parity.value)
    context.log("parity normalized:"  + idevice.serial[3].parity.normalized)
    context.log("parity min:"         + idevice.serial[3].parity.min)
    context.log("parity max:"         + idevice.serial[3].parity.max)
    context.log("parity defaultvalue:"+ idevice.serial[3].parity.defaultvalue)
    context.log("parity type:"        + idevice.serial[3].parity.type)
    context.log("parity enums:"       + idevice.serial[3].parity.enums)
```

Returns:

```
[INFO] parity value:NONE
[INFO] parity normalized:0
[INFO] parity min:0
[INFO] parity max:4
[INFO] parity defaultvalue:NONE
[INFO] parity type:enum
[INFO] parity enums:[NONE,EVEN,ODD,MARK,SPACE]
```

In Groovy, to retrieve all the properties of the parity setting on COM3:

```
        println("parity value:"       + idevice.serial[3].parity.value)
        println("parity normalized:"  + idevice.serial[3].parity.normalized)
        println("parity min:"         + idevice.serial[3].parity.min)
        println("parity max:"         + idevice.serial[3].parity.max)
        println("parity defaultvalue:"+ idevice.serial[3].parity.defaultvalue)
        println("parity type:"        + idevice.serial[3].parity.type)
        println("parity enums:"       + idevice.serial[3].parity.enums)
```

Returns:

```
parity value:NONE
parity normalized:0.0
parity min:0
parity max:4
parity defaultvalue:NONE
parity type:enum
parity enums:[NONE, EVEN, ODD, MARK, SPACE]
```

Appendix B: LDAP Implementation Details

Overview

The process of verifying credentials and obtaining user authorization is designed to support most organizations requirements for 'least privilege'. The account used to search LDAP to provide user objects for authentication never needs access to user information. Authorization lookups are performed as the authenticated user and as such, no elevated permission is required.

Assumptions and Prerequisites

Assumptions made about the LDAP implementation or environment in which the AMX client will participate include:

1. Must support simple authentication.
2. The account setup for a bind DN must have search capability along with the necessary permissions to read the 'uid', 'cn', 'member' and 'objectclass' attributes.
3. When a search is performed to find a DN with the specified user ID, a search must return one and only one object if the user exists. No object will be returned if an account does not exist for that user ID.
4. An account is considered valid if a user can authenticate/bind. No other attributes are considered during the authentication process.
5. AMX LDAP implementation supports both encrypted and un-encrypted connections using SSL.
6. When a person authenticates, that account must have access to all the attributes defined by RFC 2798 with the following exception:

a. User passwords are not necessarily accessible for anything except to perform a bind to the directory (for example, this attribute may not be directly available to the user).

7. The bind DN must have the ability to search for group membership. (This ability is similar to RMS requirements.)
8. When a person authenticates, that account must have access to "cn" attributes for all groups of which it is a member.
9. Group membership for users is defined by the Role assigned to the user. Use GroupOfNames as the objectClass for group mapping. GroupOfUniqueNames is not supported due to ambiguities associated with implementations which use unique IDs appended to membership DNs.
10. When performing searches for group membership, no restrictions exist which would the restrict returning the full list of objects for which the user is a member with the possible exception of reasonable response timeouts. AMX LDAP implementation does not support paged search results.
11. AMX LDAP implementation does not support following referrals.

Example: Setting a User’s Access Rights

To give AMX equipment users access rights to the Controller, group memberships for administrators and users are defined by the Role Name setting when establishing Roles. Two records need to be created in the database:

- One that represents users with user management administrative privileges. The factory default settings include an administrator user which includes all administrative privileges.
- Another that represents users with user privileges. The factory default settings include a user which includes Device Management, Firmware Update, Network Management, and Security Control privileges.

NOTE: You can create as many groups as necessary according to your policies, but you should create at least two groups to separate administrators from other users.

IMPORTANT: The common name of the LDAP group on the server must match the name of the Role assigned to the user on the controller.

Administrator Access Example

<table>
<tr><th colspan="2">Administrator Access</th></tr>
<tr><th>LDAP Server Configuration</th><th>MUSE Controller Configuration</th></tr>
<tr><td>Example:
dn: cn=administrator,ou=groups,ou=Dallas, dc=example,dc=com
objectClass: groupOfNames
objectClass: top
cn: All_Permissions
member: uid=DallasAdminUser1,ou=people, ou=Dallas,dc=example,dc=com
member: uid=ICSPUser,ou=people, ou=Dallas,dc=example,dc=com</td><td>On the Role Security Details page, create a Role with the Administrator groupOfNames cn, or use the existing administrator role.

Example:
Role Name: All_Permissions</td></tr>
</table>

User Access Example

<table>
<tr><th colspan="2">Administrator Access</th></tr>
<tr><th>LDAP Server Configuration</th><th>MUSE Controller Configuration</th></tr>
<tr><td>Example:
dn: cn=controller01User,ou=groups, ou=Dallas,dc=example,dc=com
objectClass: groupOfNames
objectClass: top
cn: Studio
member: uid=DallasUser1,ou=people, ou=Dallas,dc=example,dc=com
member: uid=DallasUser2,ou=people, ou=Dallas,dc=example,dc=com</td><td>On the Role Security Details page, create a Role with a name which matches the groupOfNames cn.

Example:
Role Name: Studio</td></tr>
</table>

NOTE: If the DN of a user is in both the administrator groupOfNames and the user groupOfNames, the administrative privileges take precedence over user privileges.

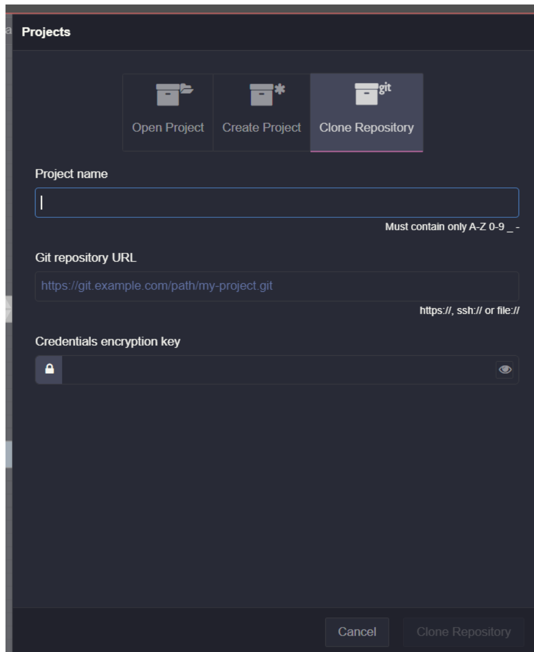
Appendix C: Git

Overview

This section describes how to clone a repository from Github in Automator, add files to a new repository, add Git remote in Automator, commit changes and upload to Git, and how to create a personal access token 9

How to: clone a repository from Github in Automator

1) Projects > New > Clone Repository



Project name : User defined

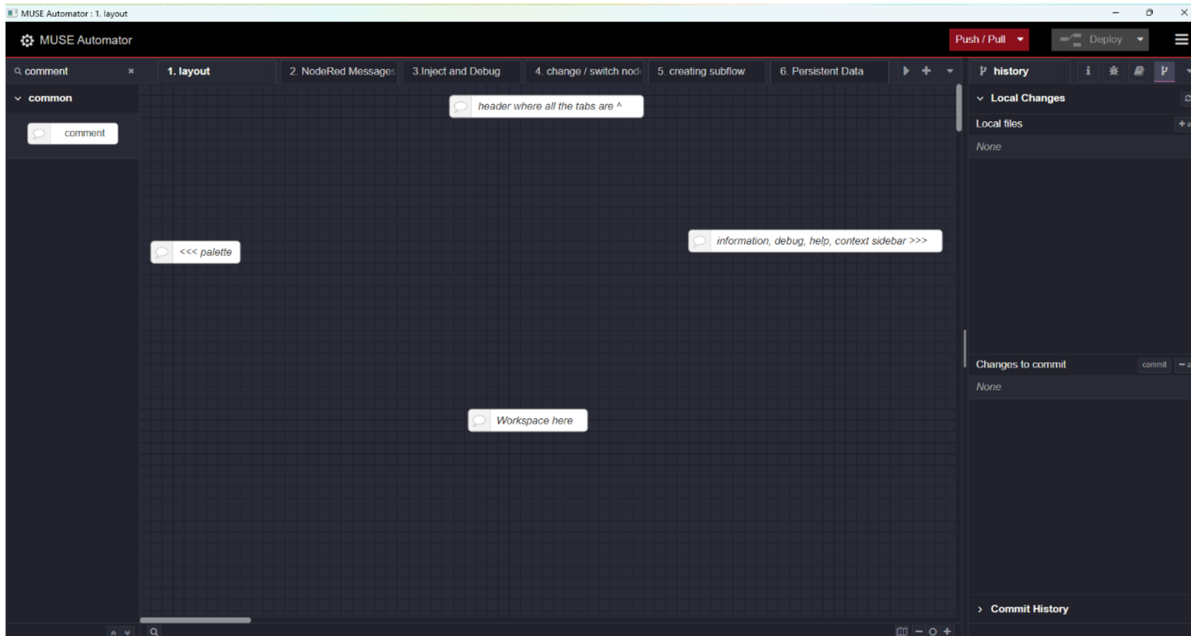
Git repository URL : https://github.com/huntXer3/nodered_lessons.git

Credential's encryption key : leave it empty

Note:

- For project name, only A-Z(uppercase/lower case),0-9, _- are allow. Spaces are not allowed.

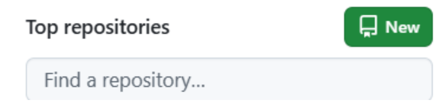
2) Successful cloning of the project.



How to: Adding files to a new repository

1. Login to into your Github account

On the left side, click on New to create a new repository



2. Fill in the detail and create the repository

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? Import a repository.

Required fields are marked with an asterisk (*).

Owner * Repository name *

huntXer3 / testServer

testServer is available.

Great repository names are short and memorable. Need inspiration? How about scaling-octo-robot ?

Description (optional)

Public
Anyone on the internet can see this repository. You choose who can commit.

Private
You choose who can see and commit to this repository.

Initialize this repository with:

Add a README file
This is where you can write a long description for your project. Learn more about READMEs.

Add .gitignore

.gitignore template: None

Choose which files not to track from a list of templates. Learn more about ignoring files.

Choose a license

License: MIT License

A license tells others what they can and can't do with your code. Learn more about licenses.

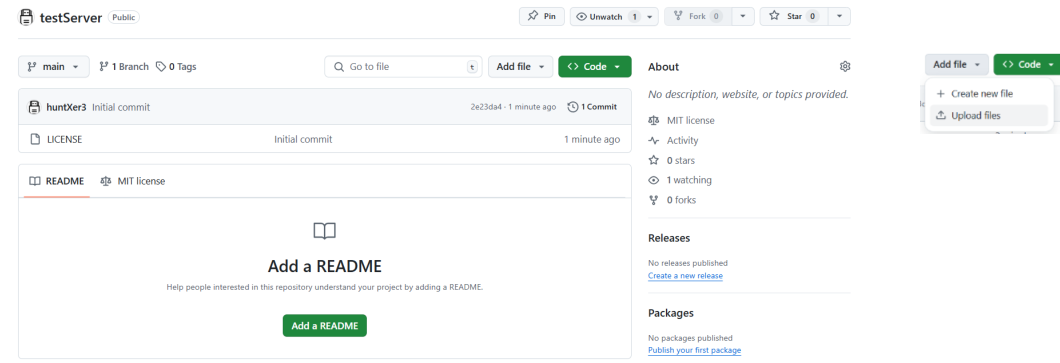
You are creating a public repository in your personal account.

Create repository

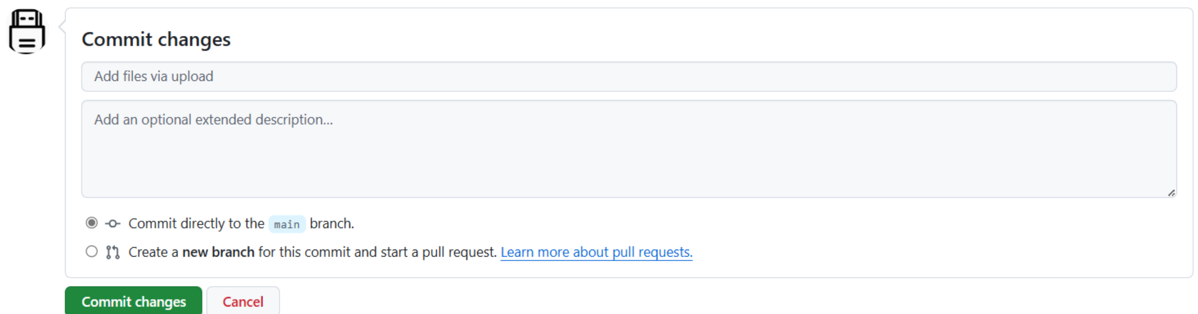
3. Click on Add file to upload file into the repository

The files are in the project directory of automator

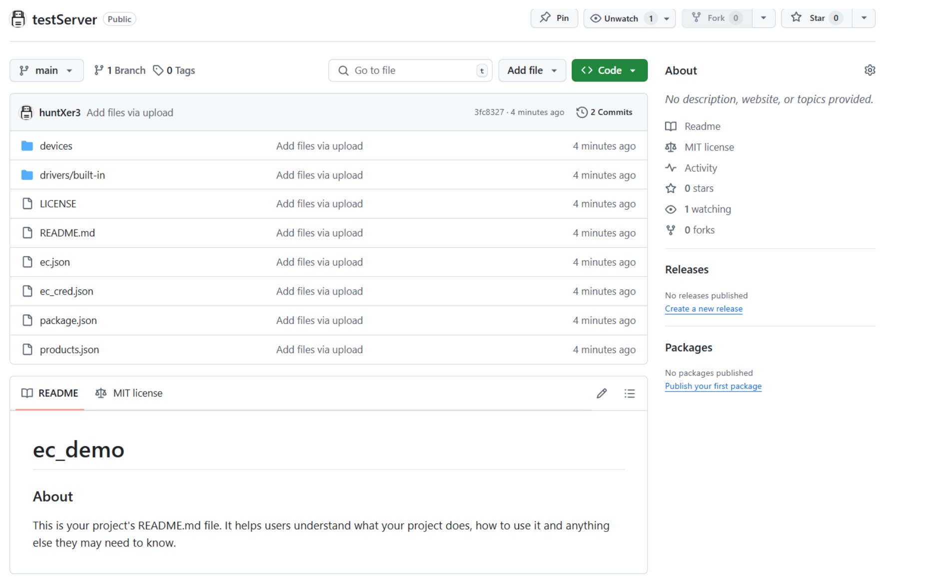
Default directory of the installed directory when installed in Windows 10.
C:\Users*username*\.node-red\projects
Username = current Windows current login user



4. Once the files are uploaded, commit to the changes



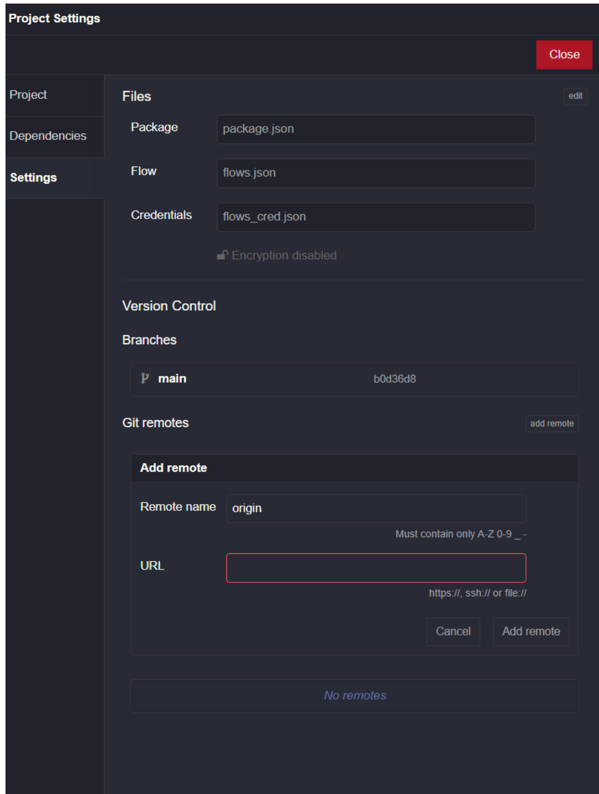
Files successfully uploaded into the new repository.

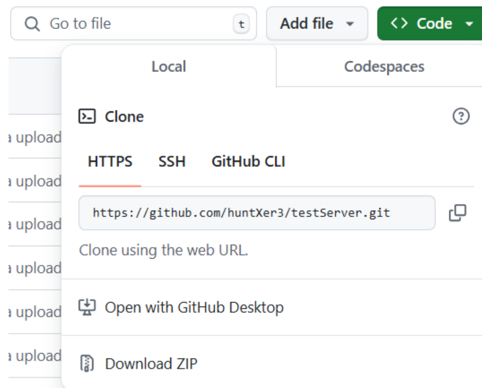


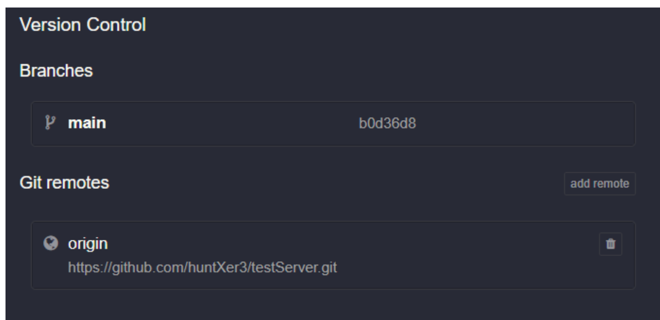
How to: add Git remote in Automator.

1) Project – Project settings – Settings

URL: get the url in Git.



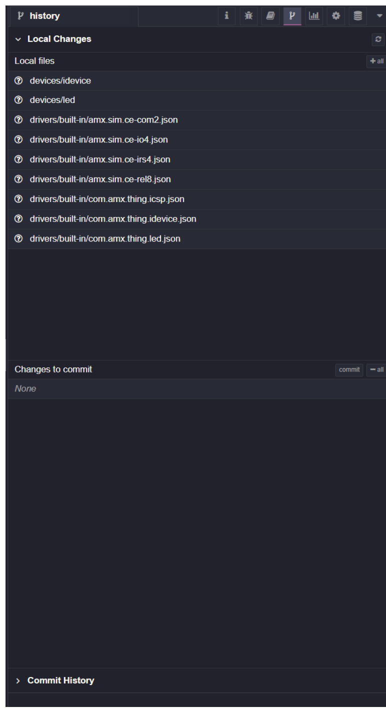




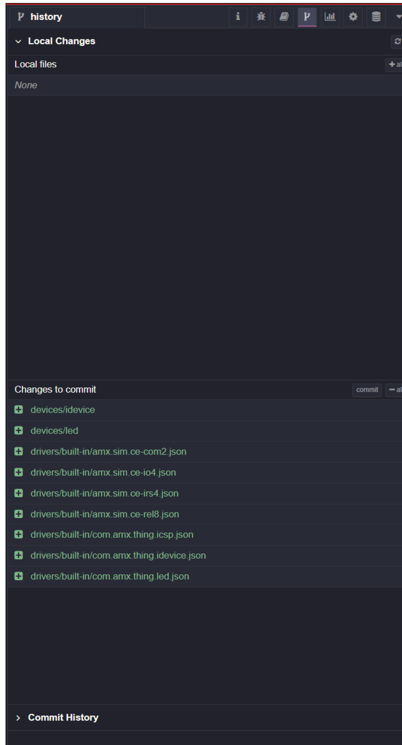
How to: Commit changes and upload to Git

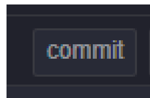
1) After the project is deployed

2) Go to History sidebar click on +all, the changes will be pushed to changes to commit



3) Click on commit to push the changes to the repository.





4) It will prompt for username and password for the first time you commit.

Username : Username you used to log into Github

Password: personal token created.

How to create a personal access token

1) Settings –> developer settings -> tokens (classic)

GitHub Apps
OAuth Apps
Personal access tokens
Fine-grained tokens Preview
Tokens (classic)

Personal access tokens (classic)
Generate new token

Tokens you have generated that can be used to access the GitHub API.

nodered — admin:enterprise, admin:gpg_key, admin:org, admin:org_hook, admin:public_key, admin:repo_hook, admin:ssh_signing_key, audit_log, codespace, copilot, delete:packages, delete_repo, gist, notifications, project, repo, user, workflow, write:discussion, write:packages
Never used
Delete
This token has no expiration date.

ServiceNow Access — repo
Never used
Delete
This token has no expiration date.

Personal access tokens (classic) function like ordinary OAuth access tokens. They can be used instead of a password for Git over HTTPS, or can be used to authenticate to the API over Basic Authentication.

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Last Revised: 2026-03-06