LIVE SPARK

Flame Effect System

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Important Safety Information

The FirePixel flame effect is designed for operation by experienced special effect professionals only. It is required that installers and operators follow all local codes, laws and regulations and consult with relevant local authorities having jurisdiction before use in any private or public environment. Possible codes and standards that may apply in your jurisdiction of use include NFPA 160, "Standard for Flame Effects Before an Audience," NFPA 58, "Liquified Petroleum Gas Code," or others.

Prior to installation or use, carefully consult the LiveSpark Flame Effect and Operation Document for details that will aid in obtaining operating permits in your area.

Introduction

Congratulations on purchasing your new LiveSpark flame effect system. This guide will introduce you to its safe operation, the FirePixel's and AfterBurner's unique features, and provide pointers on how you can get the most out of your system for your installations, stage shows, and other productions.

Together, the FirePixel, AfterBurner and LiveSpark Controller offer a flame effect system unlike any other, delivering visualization capabilities in fire previously only found in the world of lighting. FirePixels produce a highly luminous, smoke-free, soot-free, wind-resistant flame that can be integrated, synchronized, and digitally controlled into any theatrical performance.

The FirePixel offers precision-level control over flame height: ranging from a one-inch candle up to a 4 foot flame. The AfterBurner extends the FirePixel's flame height capabilities up to 12 feet. The FirePixel and Controller are compliant with NFPA 160 and have been permitted for use in many jurisdictions and circumstances. The system offers an array of features to ensure performer and audience safety, including relight, flame sensing, water and obstruction detection, auto-calibration, a physical shutoff/ignition key, and three layers of emergency stop protection.

System Components

Component	Purpose
FirePixel	Variable height flame effect
AfterBurner	Flame effect accessory that boosts FirePixel's flame output
Controller	Powers and controls flame effect devices
Cable	Delivers power and data to FirePixels, AfterBurners & Controller
Regulator	Regulates propane fuel to usable pressure
Fuel Hose	LPG-rated hose that conducts propane vapor from source to destination
Accumulator	Propane fuel tank that supplies high peak vapor flow rates
FirePixel Clamp	Attaches FirePixel to U-bracket and supports up to two AfterBurners
Power Supply	Powers longer chains of devices where additional power is needed

The following items are not included with LiveSpark systems but may be necessary for your applications.

- Propane gas canisters
- DMX / MIDI cables
- Lighting controller
- MIDI controller
- Computer

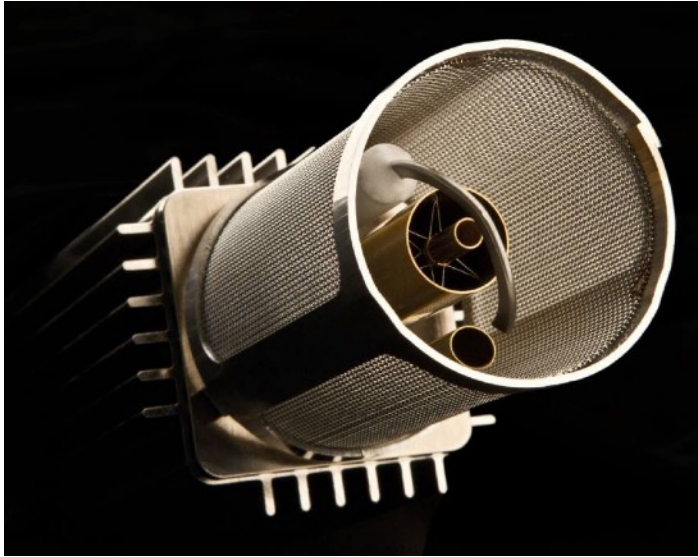# Photos of typical equipment included in a LiveSpark system

LiveSpark Controller

LiveSpark Cable

FirePixel

Propane Fuel Regulator

Description of Components

1. FirePixel Flame Effect: Propane-fueled, self-igniting, auto-calibrating flame effects that produce a highly luminous, virtually smoke-free, soot-free and wind resistant flame. The FirePixel's low latency flame reactivity and variable flame height can deliver a wide range of visual effects.

The FirePixel is a specialized flame effect that receives data from the LiveSpark Controller and creates a single column of flame, up to 4 feet in height. Up to twenty-five LiveSpark FirePixels can be daisy-chained together (up to 127 with external power), from the Controller via the **LiveSpark Cable,** to create a visualization performance.

Fuel is supplied from any propane gas canister (not included) with a compatible "disposable propane adapter", through **Propane Fuel Regulators**, and is ignited when signaled. It is also possible to fuel FirePixels via a hose and manifold system. The FirePixel offers several key features to support special effects applications and performances:

- **Fuel Efficiency:** The FirePixel burns fuel at an efficient rate with a maximum fuel flow rate of 15 LPM at full flame height.

- **Auto-Calibration:** The FirePixel automatically calibrates the height of the flame based on the wind conditions and relights if it blows out.

- **Rapid Response:** The FirePixel responds quickly to commands (eg. ignite, adjust flame height, extinguish) — within 6 milliseconds.

- **Monitor & Control:** The FirePixel can be controlled and monitored in conjunction with the LiveSpark Controller and Stage3D iPad app, indicating ignition, water condition, physical obstruction on the burner, and network connectivity issues.

2. **Stage 3D:** A complete visual rendering and monitoring software app that visualizes the expected behavior of a FirePixel installation. The 3D environment presents a virtual stage to the user, allowing you to accurately position and identify each FirePixel in your performance system.

   The address and real-time status of each FirePixel is displayed in 3D against the backdrop of any user-created photo. Nominal performance visualization are represented graphically as 3D blocks, or fire particle system simulation.

   Any FirePixel error condition that may occur such as Failure to Ignite, Water Condition, Obstruction is highlighted graphically and textually on the display as it occurs. Visual error indication lets you quickly spot which FirePixel is having a problem, so easily identify where to direct attention.

3. **LiveSpark Controller:** The Controller is a 2U 19" rack mount equipment powered by a standard 110VAC connection. FirePixels may be directly powered and controlled by the LiveSpark Controller.

   The LiveSpark Controller also accept inputs from other industry standard performance control systems such as DMX light boards, midi devices, and music production software such as Ableton Live.

   The LiveSpark Controller communicates with and receives status from each FirePixel via a dedicated bi-directional command protocol. To further increase safety, the Controller features four levels of shutoff including nominal operation off button, data key lock, operator presence control, and an emergency stop (E-Stop) switch.

   The 3-pin DMX port accepts signals from any standard DMX interface such as a light board or DMX console.

   The Midi port accepts signals from any standard Midi interface such as a Midi controller, keyboard, drum trigger, drum machine, touch pad, wind controller, Midi guitar, etc.

   An Ethernet port accepts control commands from any external network broadcaster, such as the Ableton Live FirePixel plugin provided by LiveSpark. Additional application plugins to extend the range of authoring environments is planned for future release by LiveSpark and partners.

System Diagram
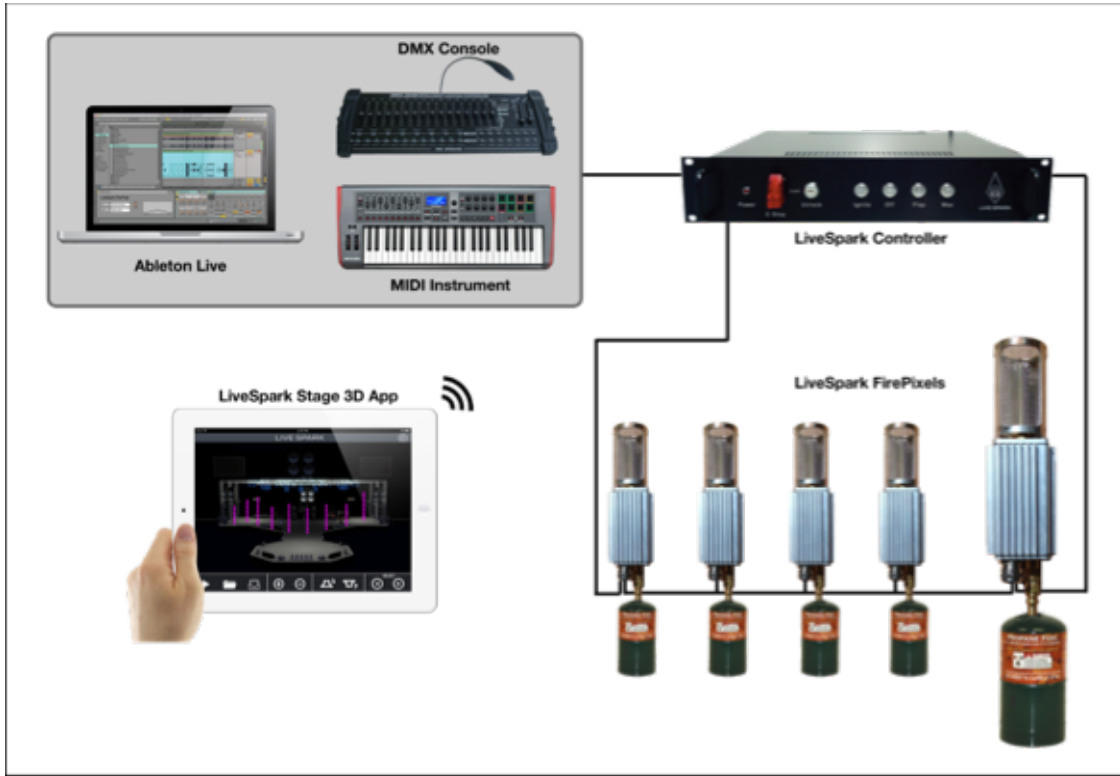
Fuel Requirements

FirePixels are compatible with propane fuel only. Propane may be delivered to the FirePixel from any UL, CSA or other certified storage tank. Propane supplied may contain some portion of butane and up to 5% propylene, per the ASTM's and GPA's HD-5 standard. Most US suppliers provide HD-5 propane under the name "propane," which is compatible with FirePixels.

FirePixels are not compatible with natural gas, methane, pure butane or any other flammable or non-flammable fuel. FirePixels are not compatible with any liquid fuel. Using a non-compatible fuel may damage FirePixels and void their warranty. Propane must be fully vaporized prior to conveyance into the FirePixel fuel inlet. Do not supply FirePixels from a propane tank designed to distribute propane in liquid form, such as tanks with bottom- or side-outlet valves. Do not supply additional fuel to the FirePixel flame output.

Operating Pressure

FirePixels are designed to operate with propane fuel regulated to a pressure of 30PSI +/- 3PSI at the fuel inlet. It is important to use an appropriate regulator that can deliver fuel at the correct operating pressure. A +/- 3PSI variation of pressure inlet pressure is acceptable.

WARNING! Exceeding regulated fuel supply pressure above 30PSI may cause fuel to leak and damage FirePixel hardware. never SET REGULATED PRESSURE TO exceed 30PSI.

FirePixels are factory-calibrated to operate at 30PSI. Exceeding this pressure may cause the FirePixels internal valve to leak and create a dangerous condition. Supplying FirePixels with fuel at pressures below 30PSI is also not recommended. FirePixels operated at lower pressures may fail to ignite, may not create desirable flame perceptual effects, and may release small amounts of uncombusted fuel to the atmosphere due to repeated attempts to ignite, though the FirePixel will enter the Locked state if ignition fails repeatedly (see Stage3D documentation for monitoring errors).

Because propane cools as it expands from its liquid pressure (120PSI at 72F) to its vaporized usage pressure, it is possible for the output pressure of the propane supply tank to fall below 30PSI. During this condition FirePixels should be extinguished and

no further fuel should be supplied until a suitable operating pressure can be obtained, either after absorbing sufficient heat from the atmosphere, via a propane heating or vaporization system certified for such use, or by replacing the fuel supply.

Fuel Consumption

The maximum fuel flow rate at 30 PSI of a FirePixel at maximum flame value is 15 LPM. Fuel consumption at maximum setting is 1 G per hour. Setting the FirePixel to lower average flame heights will consume considerably less fuel, especially if flame height is varied. In common practice, a FirePixel varying its height continuously should be expected to perform for 1-2 hours on a 1LB LPGas cylinder.

FirePixel Setup Instructions

** **NOTE:** The LiveSpark FirePixel and Controller must be installed and operated by experienced and licensed professionals only. Improper installation or operation of flame effects can result in property damage, physical injury, or death. **Follow all local codes and ordinances.**

Install in a suitable location

Identify the location of the LiveSpark FirePixels per your stage or environment requirements. Exercise caution when installing LiveSpark FirePixels – consult the Flame Effect Compliance and Operation document for minimum distances to flammable and other materials. Refer to mounting instructions if mounting the LiveSpark FirePixels to truss, pipe or other fixtures.
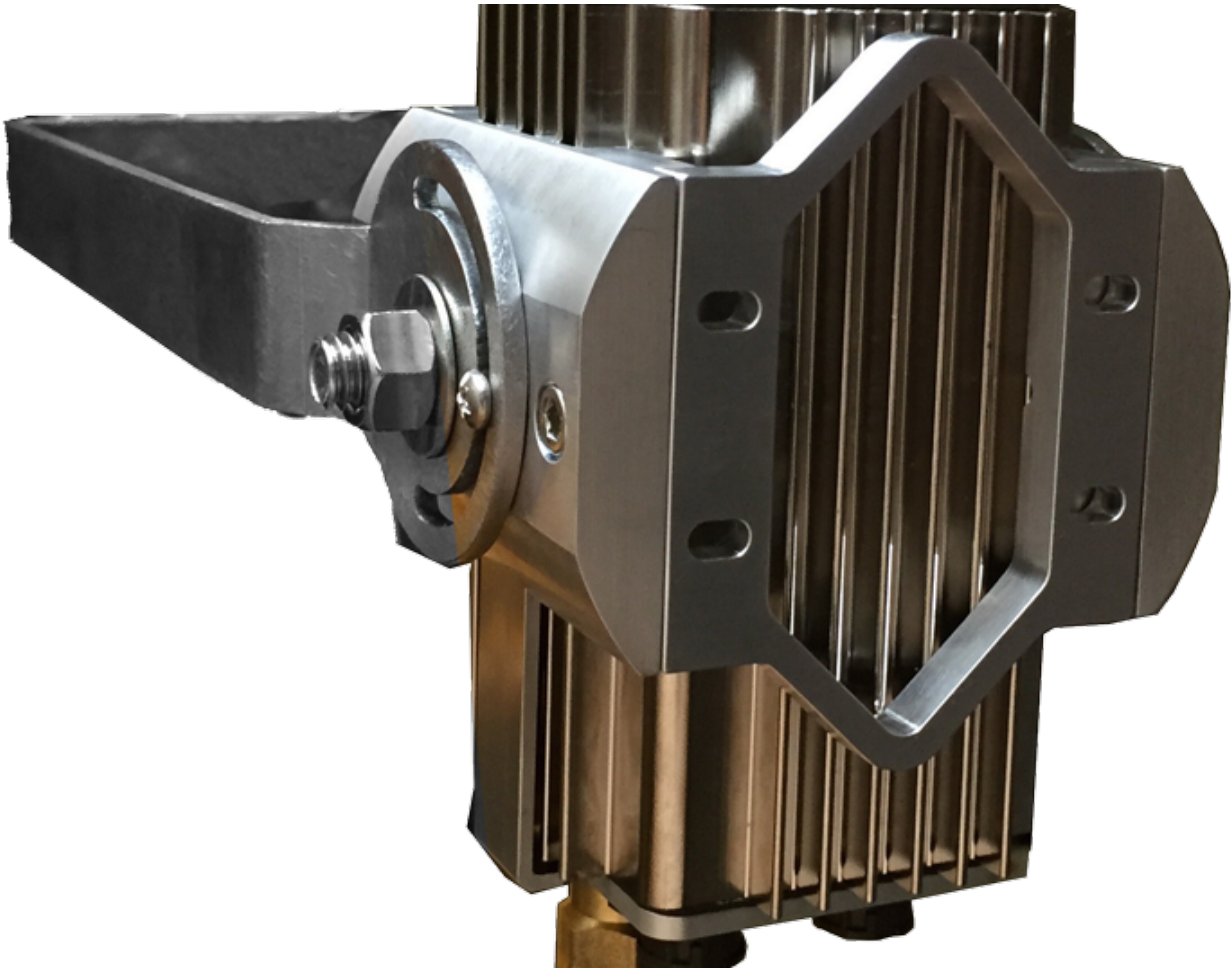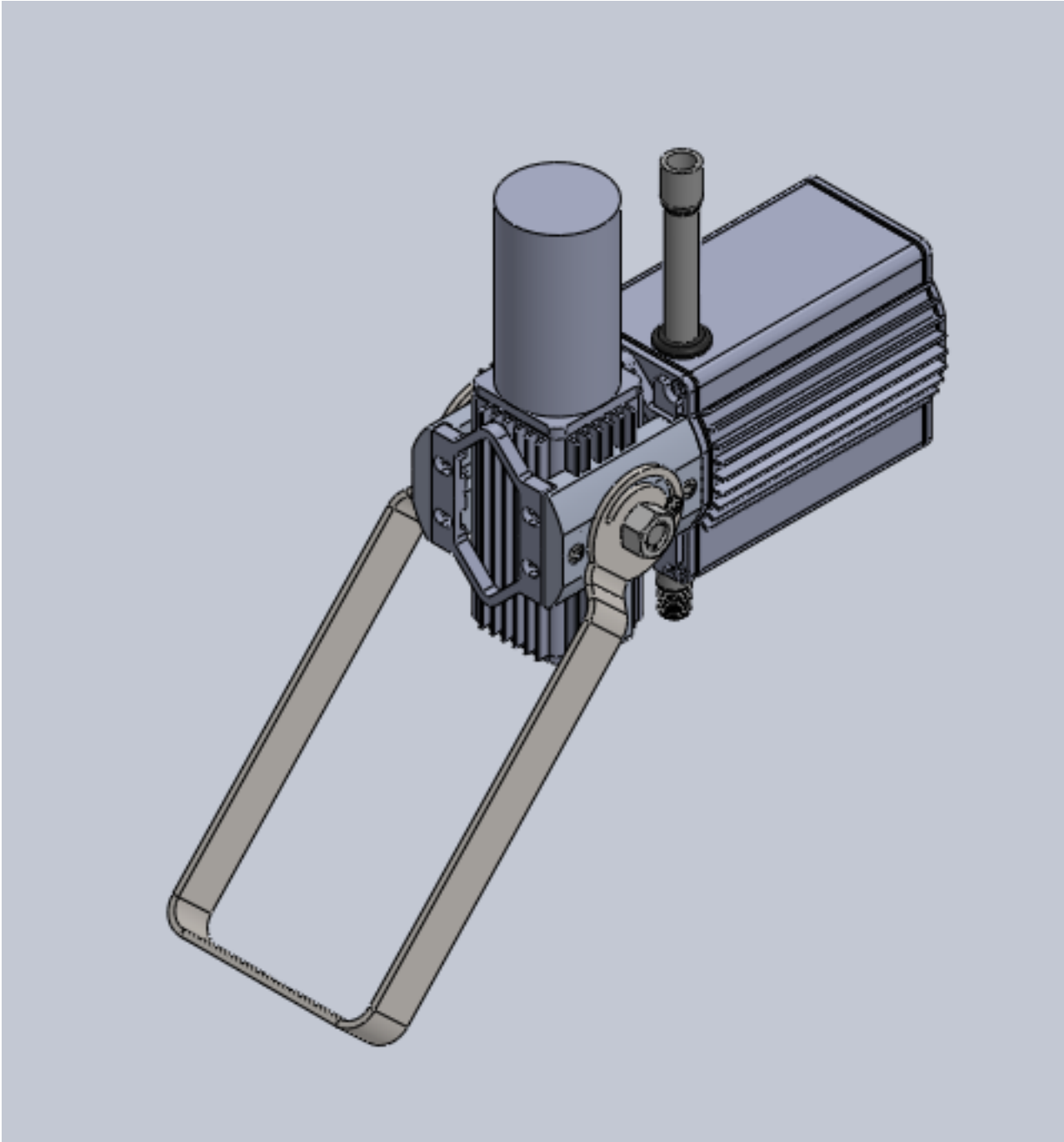
Mounting

FirePixels and AfterBurners may be mounted with LiveSpark's clamping system. The LiveSpark Clamp supports the FirePixel, attaches to a standard lighting U-Bracket, and allows attachment of up to two AfterBurners.

FirePixels are designed to be perform optimally at angles of up to 45° from vertical. In still air environments the FirePixel may be mounted as low as horizontally, but no lower. Even though a FirePixel may appear to operate acceptably at lower angles, air currents or convection may direct flame into the FirePixel, causing overheating or other damage to burner components or wiring and is not recommended.
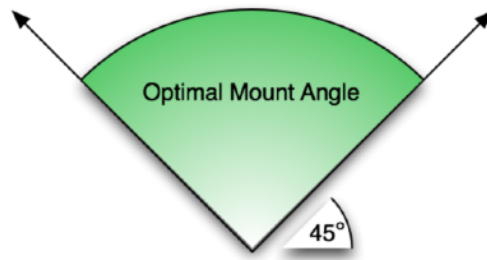
Recommended Mounting Angle

Fuel Connection

1. Attach a regulated propane supply to each FirePixel set for 30PSI.

Electrical Connection

The LiveSpark Cable contains a total of four 18awg conductors consisting of 2 conductors for power and 2 for data. FirePixels operate at 24VDC and consume a maximum of 8W each. The power supply included in the LiveSpark Controller is capable of supplying up to 12 FirePixels directly. Additional FirePixels may be powered by attaching external power supplies.

Each FirePixel base has two circular connectors, one female, and one male. The male connector is the one with male contacts, and is the data transmitter. The female connector is the one with female contacts, and is the data receiver.

Be sure to plan your FirePixel system layout so that each output connects to the next FirePixel's input, forming a daisy chain pattern. The order of connection is important, since that is the order in which your FirePixels will be numerically addressed.

The LiveSpark Controller's FirePixel input and output connectors are of the same type as the FirePixel itself.

1. Connect the male connector of the LiveSpark cable to the female connector at the bottom of the first FirePixel in your FirePixel daisy chain. Ensure the connection is properly fastened by aligning the connector notches and applying even pressure on both connectors until they fit together. Connect the other side of the cable to the LiveSpark Controller's adapter cable.

2. Continue the connections by daisy-chaining another LiveSpark Cable to the next FirePixel in your device chain. Repeat this step for all remaining FirePixels. Attach no more than 12 FirePixels directly to the Controller power supply (if more FirePixels are to be used in a single chain, external power is required).

3. The final FirePixel in the daisy chain should be connected to the Controller. The male connector on the FirePixel sends its output via the adapter cable to the Controller. This connection is important so the Controller can receive the number of FirePixels as well as any errors they may transmit along the chain. T**he flame effect system will not operate properly without this return connection from the final FirePixel in the chain to the Controller,**

Connect Controller Power and Accessories

To complete the set up of the LiveSpark Controller, connect its power cord and accessories.

1. Connect the Controller power cord to a standard 110VAC outlet and turn on the power switch on the rear panel. The LED light located at the front of the Controller will illuminate to indicate the unit is powered on. In about 30 seconds, the Controller is ready for use when the IGNITE button illuminates.

2. Attach the Wi-Fi antenna (optionally included on some Controllers) on to the Wi-Fi mounting screw on the rear panel of the Controller

3. If using a compatible Operator Presence Control (OPC) device such as a dead-man switch, attach it to the OPC XLR connection on the rear panel of the Controller.

    *** **NOTE**: If not using an Operator Presence Control device, you **must** then attach the provided OPC Bypass to the XLR socket. FirePixel power flows through the OPC XLR connector via pins 2 & 3. Without this connection your FirePixels will not operate.

4. Insert the key (provided) into the key lock switch on the front panel of the Controller.

AfterBurner

The AfterBurner is a FirePixel accessory that creates a variable-height flame up to 12 feet tall. An AfterBurner is intended to operate only as an attachment to a FirePixel, using the LiveSpark Clamp. Each AfterBurner is managed by its "parent" FirePixel. The FirePixel must be lit, and at least have a flame height value of 10 or greater in order for the AfterBurner to fire. The Controller may send commands to the AfterBurner, but it is the parent FirePixel that decides if flame conditions are within acceptable limits to allow the AfterBurner to release fuel to the atmosphere.

Setup Instructions

1. Attach the AfterBurner to a parent FirePixel using the two side screws provided on the FirePixel Clamp.

2. Attach a regulated propane set to 60PSI.

3. Attach a LiveSpark Cable from the parent FirePixel's output (male) connector to the AfterBurner's input connector (female).

4. Attach a LiveSpark Cable from the AfterBurner to the next FirePixel in the daisy-chain.

FirePixel Operation

Ignition

Once the LiveSpark system is properly configured and all local codes and requirements have been met, ignite the FirePixels by following this procedure.

1. Power on the LiveSpark Controller and wait until the Ignite switch is illuminated.

2. Be sure a compatible Operator Presence Control (dead-man switch) or the provided OPC Bypass is connected.

3. Insert the Controller key and twist it to the Unlock position.

4. Flip the E-Stop switch cover up.

5. Turn the E-Stop switch to the UP / ON position.

6. Press the IGNITE button.

THIS WILL CAUSE THE CONNECTED CHAIN OF FIREPIXELS TO IGNITE.

Extinguishing Flames

IN AN EMERGENCY Flip the E-Stop switch DOWN / OFF.

To turn flames off in a non-emergency situation, press the OFF button on the Controller.

You may also turn the flames off by twisting the key lock switch to the LOCK position or by disconnecting / deactivating an attached Operator Presence Control.

FirePixels operate using "Normally Closed" valves, which stops the flow of fuel to the burner when power is disconnected.

Automatic Calibration

After powering up and ignition the FirePixels begin automatic calibration which takes 2-10 seconds in normal conditions. During calibration flame heights will vary based on factory settings and operating environmental conditions. FirePixels should reach their minimum flame height in 2-10 seconds at which point they can be turned off by pressing the OFF button. Calibration is retained as long as the FirePixels are powered.

FirePixel Demo

After you have installed your hardware and configured Stage3D, you can test the FirePixels using the on-board Demo.

*** Note: The on-board demo is a pre-programmed flame sequence that demonstrates some of the unique features of the FirePixel flame effect.

1. Follow the ignition procedure above to ignite the connected FirePixel chain.
2. To play the demo, press the DEMO button.
3. During or after the demo you can press and hold the MAX button to set all connected FirePixels to their maximum flame height.

LiveSpark Controller Feature Summary

Action	Function	Steps
Power On	Boots up the LiveSpark Controller and FirePixels into a Standby state.	1. Connect LiveSpark Controller Power Adapter to the Controller 2. Lift E-Stop switch cover 3. Flip Ignition Switch into the ON position 4. Wait 30 seconds for LED light to indicate Controller is in Standby
Power Off	Cut off power to LiveSpark Controller and FirePixels	1. Flip E-Stop to OFF position or 2. Turn off Controller or 3. De-activate Operator Presence Controller
Ignite FirePixels	Ignites FirePixels, calibrates to minimum flame height, FirePixels ready to receive data.	1. Ensure the LiveSpark Controller is powered on. 2. Turn Key Lock Switch into the Unlock position. 3. Ensure OPC or OPC Bypass is connected. 4. Wait for IGNITE button to illuminate. 5. Press the IGNITE button. 6. Wait 10-30 seconds to complete calibration (minimum flame height)
Off Button	Extinguishes all flame on FirePixel. Locks functionality to other buttons on the Controller	1. Press the OFF button. FirePixels extinguish.
Play / Stop Demo Mode	Initializes onboard demo sequence	1. Ignite FirePixels 2. Press the PLAY button. Ensure it is lit 3. Demo plays for 2-3 minutes or until Demo button is pressed again
Max	Overrides existing DMX / MIDI / Ethernet data stream and raises flame height to 100%	1. Press and hold the MAX button to set all FirePixels to 100% 2. Release the blast button to return flame to 0% or previous control state.

DMX Control

Any standard DMX equipment such as a DMX light board, console, or other device that complies with the DMX protocol may be used with the LiveSpark Controller to author and control a FirePixel flame performance.

A single DMX channel controls one FirePixel. If an AfterBurner is attached, the DMX channel directly following the parent FirePixel controls the AfterBurner. If two AfterBurners are attached, two DMX channels following the parent FirePixel control each of the attached AfterBurners.

The first DMX channel in the connected DMX Universe controls the first FirePixel in the chain, the second channel controls the second FirePixel and so on. To change the DMX start address of the FirePixel chain, enter the Controller configuration web page and set the start address parameter.

1. Connect the DMX device's output to the DMX input (5-pin XLR) connection on the rear panel of the LiveSpark Controller using a DMX cable and 5-pin to 3-pin adapter if necessary (not provided). **Do not connect your DMX device to the Controller's OPC Bypass XLR input, which may cause damage by applying power to the device.**

2. Follow the ignition procedure above to ignite the connected FirePixel chain.

3. Operate your DMX device to control the flame heights of the connected FirePixel chain.

4. When finished press the OFF button on the Controller or follow the appropriate procedure in the "Extinguishing Flames" section above.

MIDI Control

Any standard MIDI device such as a Midi controller, keyboard, drum trigger, drum machine, touch pad, wind controller, MIDI guitar, or other MIDI -compatible interface may be used with the LiveSpark Controller to author and control a FirePixel flame performance.

Because the MIDI protocol has a narrower communication bandwidth, it is recommended that no more than 6 FirePixel values be continuously modified at one time. For faster control, use the Ethernet port as described in the "Ethernet Control" section below.

One MIDI pitch corresponds to the address of one FirePixel, starting with MIDI not zero, which in MIDI terminology is commonly referred to as C-2 (the note 'C' 2 octaves below middle 'C'). The MIDI velocity controls flame height. The MIDI velocity range is 0-127: so a velocity of 0 produces a minimum flame height, a velocity of 64 produces a medium flame height and a velocity of 127 produces a maximum flame height.

Playing a MIDI note C-2 at a velocity of 64 sets the first FirePixel in the chain to a middle flame height.

Ethernet Control via Ableton Live

Because FirePixels are capable of a high dynamic range of flame heights that can each be rapidly addressed, you can create incredibly rich visual experiences with this system. To author these performances, a system capable of precise timing, synchronization with music, and powerful sequencing, looping and triggering features is essential. Ableton Live provides such an authoring environment, and LiveSpark offers a Live plugin to easily transmit this data to the LiveSpark Controller via Ethernet.

Requirements

Live is a music production studio software produced by Ableton and available online at: www.ableton.com. To control FirePixels using this software, Max 6 must also be installed, and is available from: www.cycling74.com. Follow instructions accompanying Ableton Live 9 Suite and Max 6 to correctly install, authorize and configure these packages on your computer. Both software packages are available for Mac OS and Windows operating systems.

Plugin Installation

Once Ableton Live 9 Suite and Max 6 are installed and configured, download the LiveSpark Plugin for Ableton Live from:

www.livesparkfire.com/downloads

Drag and drop the firepixelableton.amxd into the MIDI instruments section of any Live MIDI track. This enables your MIDI track to send data to the LiveSpark Controller and control your FirePixel chain.

For a demonstration of how to author rich performances using Live, download a FirePixel demonstration Live project from:

www.livesparkfire.com/downloads

Similar to MIDI control (see "MIDI Control" section of this Guide), note C-2 in the Live MIDI track corresponds to the first FirePixel in your connected FirePixel chain. Each MIDI note and its associated velocity tells a FirePixel how high to adjust its flame and for how long.

The overall Gain may be adjusted by dragging up or down on the Gain knob in the FirePixel plugin pane, and this adjustment can be recorded and automated just like any other Live Automated Parameter.
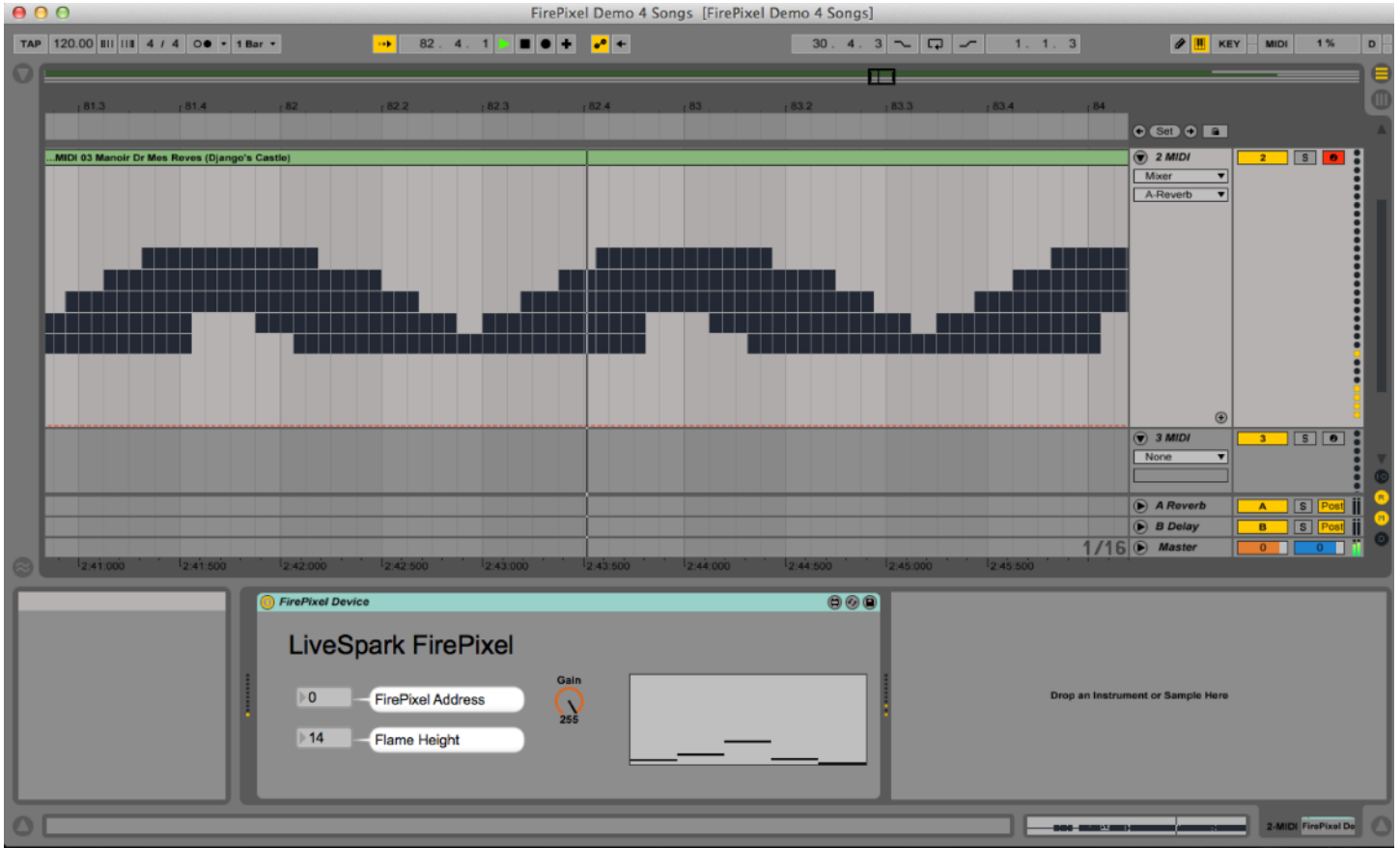
A FirePixel simulation is also displayed to show the flame heights your Live project will create as it plays.

Many other Ableton Live features may be used in conjunction with your FirePixel system and are beyond the

scope of this Guide. Please consult the Ableton Live manual and online tutorials to get the most from this powerful authoring software.
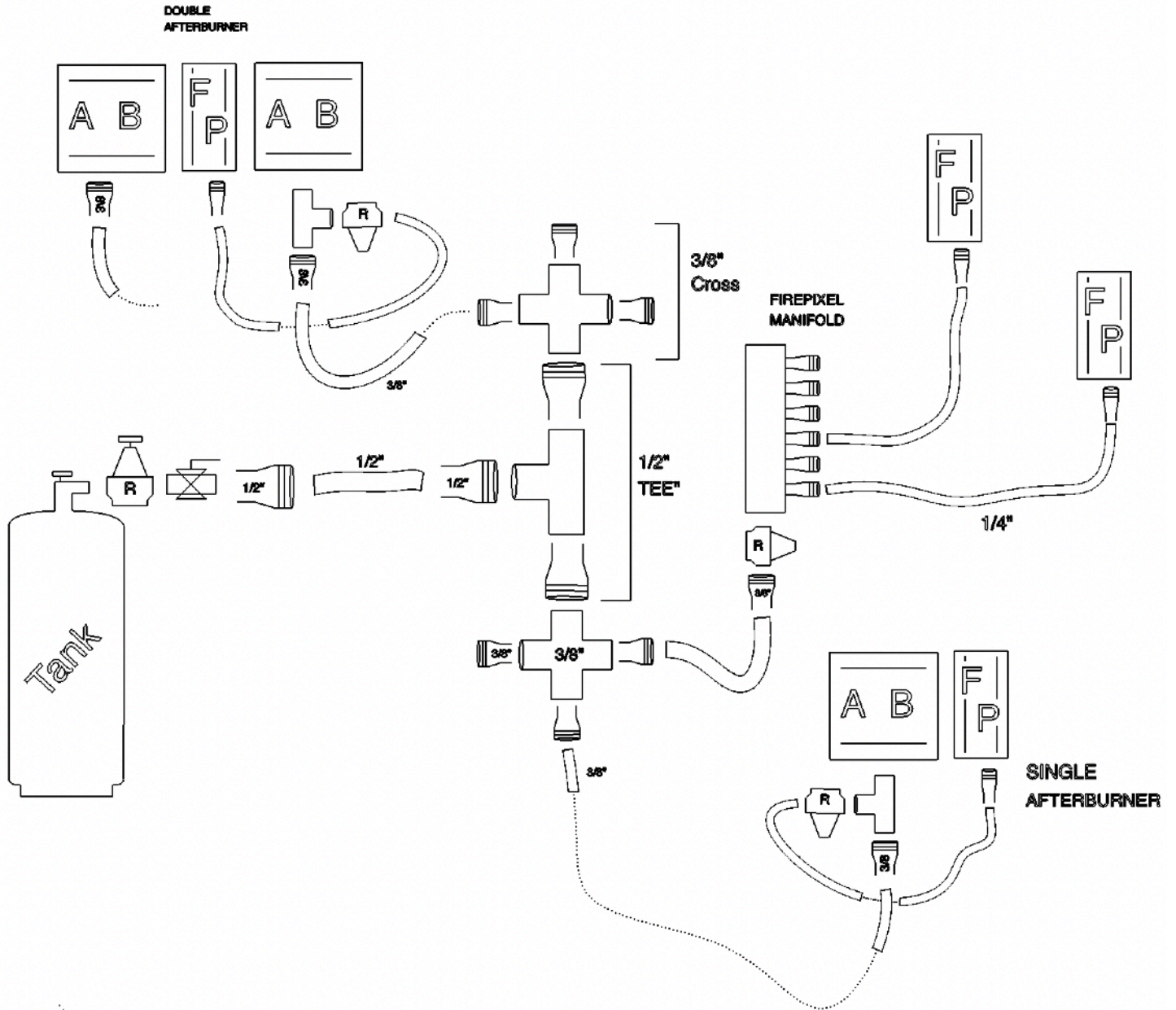

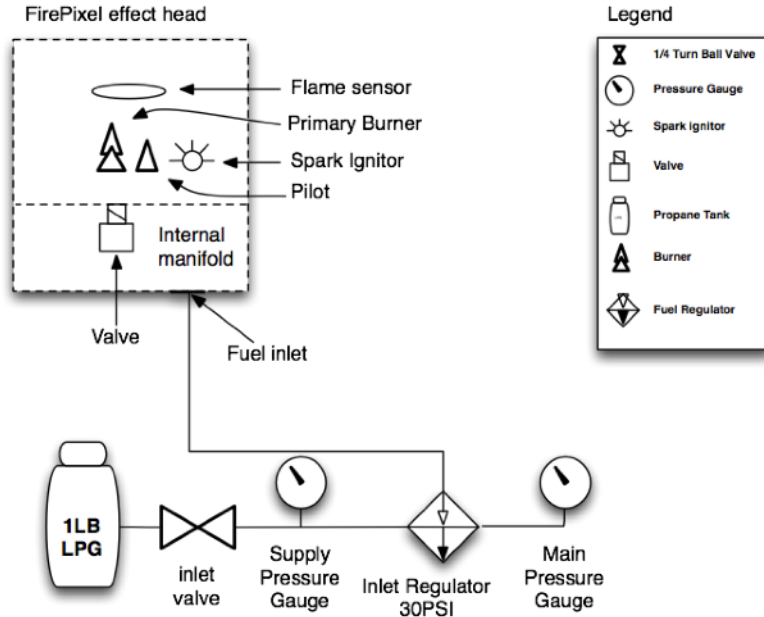
Ableton Live with FirePixel Plugin

Plumbing Diagrams

FirePixels may be fueled individually using propane regulators and propane fuel cylinder adapters, or via hose, an accumulator and manifolds as shown in these example diagrams.

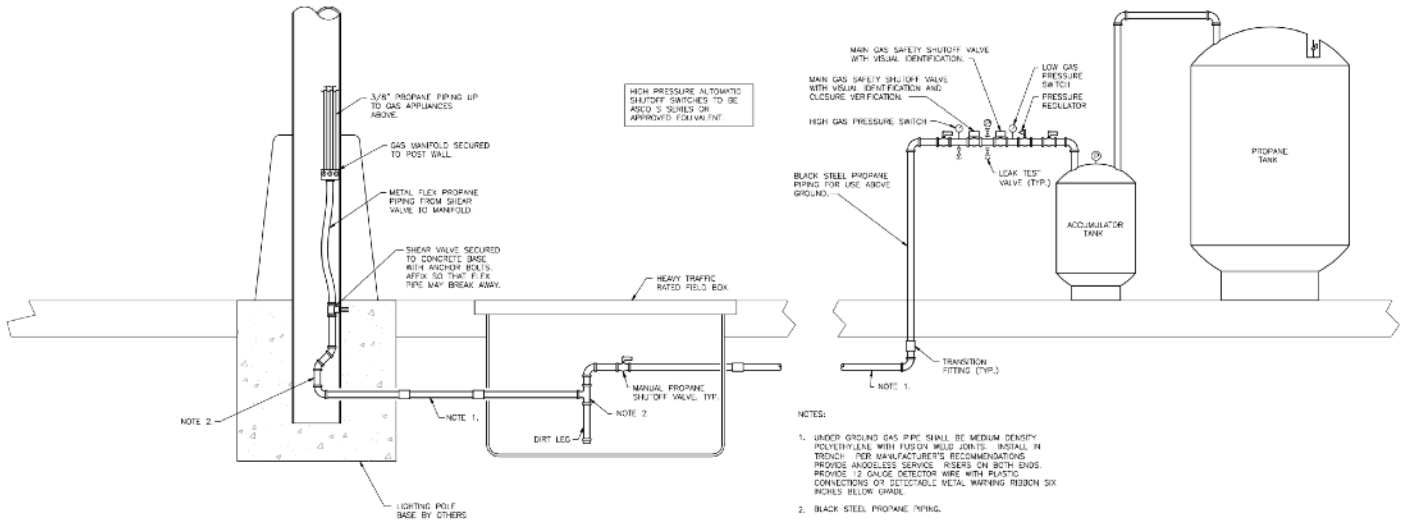## Example of single LPG supply tank and manifold layout

Example of individually regulated 1LB LPG supply
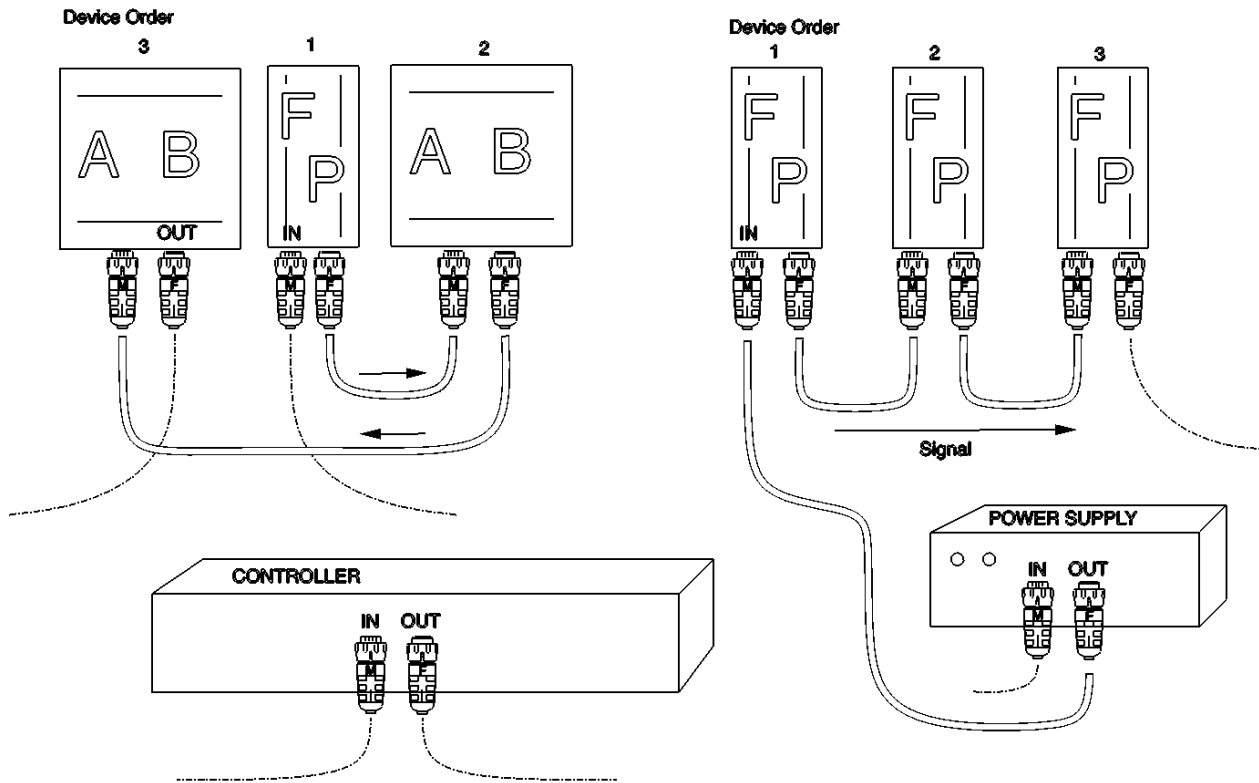

Example of permanent plumbing installation with underground piping.

Wiring Diagram

Firmware Upgrade

There are two methods to upgrade device firmware. The first requires physical access to the FirePixel or AfterBurner that will receive the upgrade. The second method allows upgrading the firmware using the same cables as are used to control your system.

Updating the firmware using a PICKit 3 and device programming connector

What you'll need:

- **Microchip PICKit3 programmer**

- **6-pin LiveSpark programming cable**

- **USB cable**

- **Microchip MPLAB IPE Software**

- **Firmware HEX file**

1. Connect your FirePixel system to the LiveSpark Controller as you normally would.
2. Flip the E-Stop switch up, and be sure the FirePixel device chain is powered.
3. Connect the LiveSpark programming cable to the FirePixel or AfterBurner you intend to program by attaching the 5-pin male connector on the cable to the 5-pin female connector on the base of the FirePixel. Note: Do not attempt to connect this cable to either of the larger 4-pin connectors used by the Controller.
4. Connect the other end of the LiveSpark programming cable to the programmer, making sure to align pin 1 with the white arrow on the PICKit3 programmer.
5. Connect the USB cable to the PICKit3 programmer and to your computer.
6. Open the MPLab IPE (Integrated Programming Environment) software. Version 3.15 was available as of this writing.
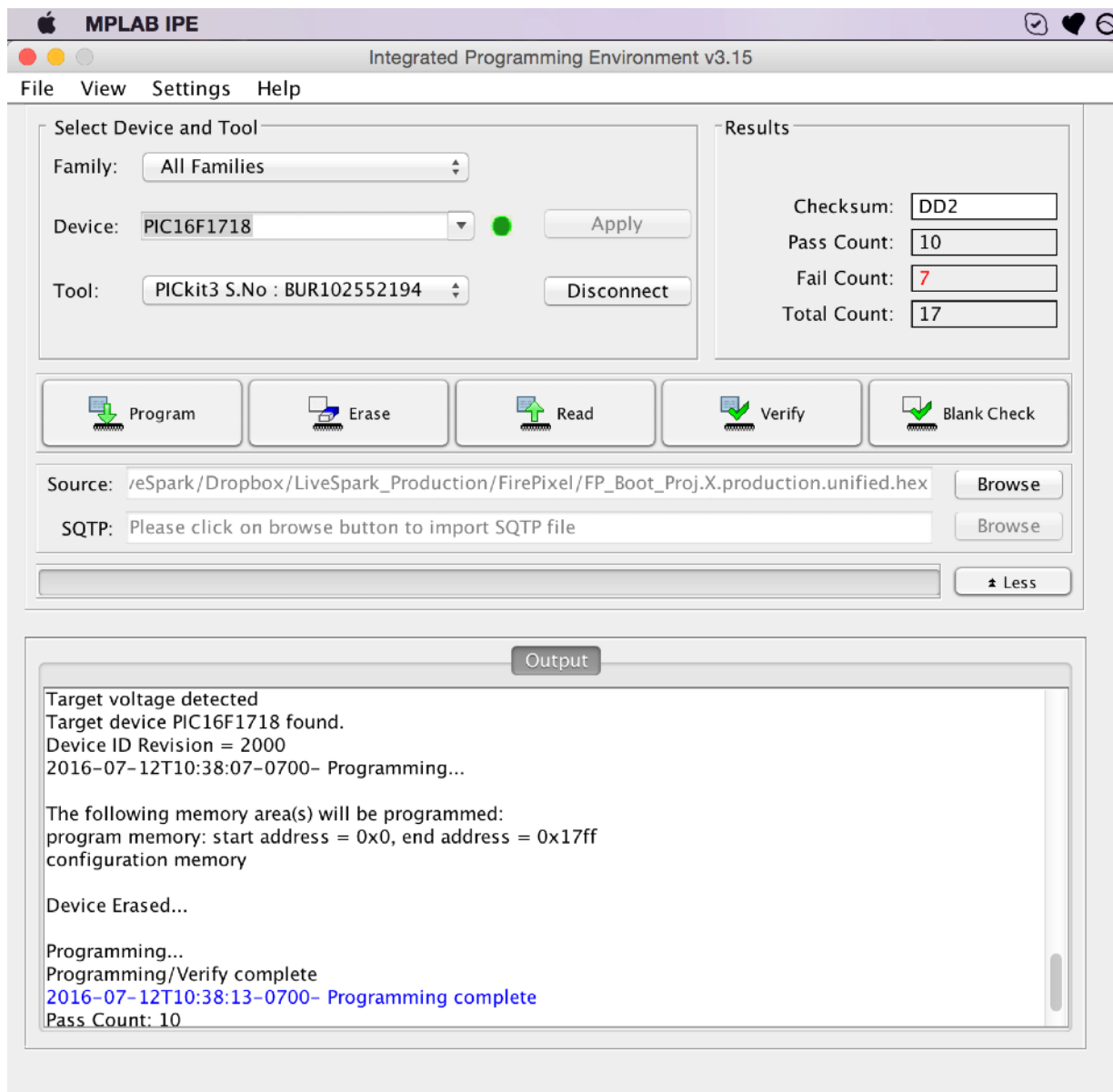
7. Enter PIC16F1718 into the **Device** field, or select it from the drop-down list, then click Apply.
8. In the **Tool** drop-down, a single option for your PICKit3 should appear along with its Serial #, which will differ for your device from the one used in this documentation.
9. Press the Connect button.
10. If a warning dialog appears describing the selection of 3V versus 5V devices, dismiss it. No change is needed.
11. From the File menu, select Import->Hex.
12. Using the file browser that appears, navigate to the location of the FirePixel or AfterBurner firmware HEX file you wish to use for this upgrade. Note: Be sure to use the HEX file for the appropriate device.

13. You are now ready to program the FirePixel or AfterBurner with the new firmware. Press the Program button. A message with the word "Programming" should appear in the IPE Output window. Programming will continue for approximately 10 seconds. After programming completes, a message "Programming/Verify complete" should appear in the output window.
14. Disconnect the programming cable from the FirePixel or AfterBurner device.
15. Using the E-Stop on the Controller, power cycle the device chain by flipping the switch down, waiting a few seconds, then flipping the switch back up.
16. Your device is now upgraded.

Updating the firmware using the LiveSpark Controller

It is also possible to update the firmware using the LiveSpark Controller and the same LiveSpark cables normally connected to your device chain. This method is easier than connecting a programming cable to each device you want to upgrade. In some instances this method may be less reliable, so if this method fails, it may be necessary to use the programming cable and procedure listed above.

What you'll need:

- **Ethernet Cable**

- **Web browser**

- **Firmware HEX file**

1. Connect an ethernet cable to your computer and to the Ethernet port on the back of the LiveSpark Controller.
2. Open a web browser and navigate to http://10.37.13.1
3. Select Upgrade Firmware.
4. Follow the instructions on the upgrade webpage to complete the firmware upgrade for the devices you wish to upgrade.