

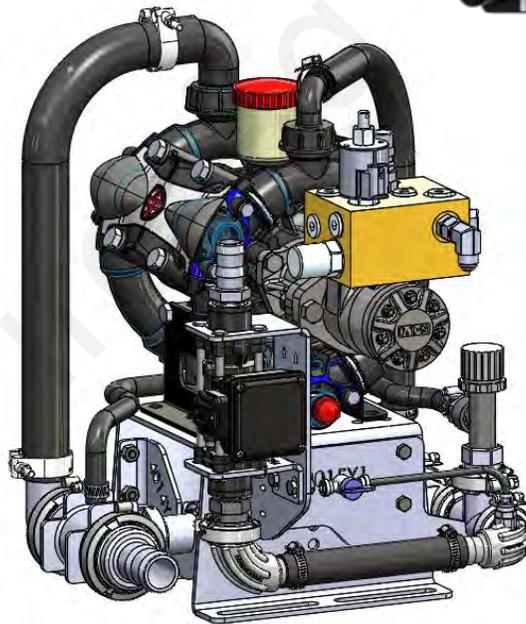
396-3815Y1



SureFire
Ag Systems

PumpRight Fertilizer System for Raven Rate Control Module (RCM)

PUMPRIGHT
HYDRAULIC DRIVE DIAPHRAGM PUMPS



NOTICE

Operator should read this manual before operating the system.

Maximum Pump Flow and Application Rates

	Number of Diaphragms	Max Flow GPM	Max GPA on 40' at 6 MPH	Max GPA on 60' at 6 MPH
PR17	3	17	35	23.5
PR30	3	30	62	41
PR40	4	40	82	55
D250	6	55		75

SureFire Ag Systems



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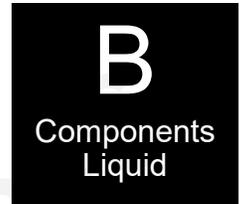
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QuickStart Setup Sheet See the sheet for your harness, profile, and product setup

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Safety

TAKE NOTE! THIS SAFETY ALERT SYMBOL FOUND THROUGHOUT THIS MANUAL IS USED TO CALL YOUR ATTENTION TO INSTRUCTIONS INVOLVING YOUR PERSONAL SAFETY AND THE SAFETY OF OTHERS. FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN INJURY OR DEATH.



**THIS SYMBOL MEANS
ATTENTION!**

BECOME ALERT!

YOUR SAFETY IS INVOLVED!

Note the use of the signal words DANGER, WARNING and CAUTION with the safety messages. The appropriate signal word for each has been selected using the following guidelines:



DANGER: Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations typically for machine components which, for functional purposes, cannot be guarded.



WARNING: Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and includes hazards that are exposed when guards are removed. It may also be used to alert against unsafe practices.



CAUTION: Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE is used to address safety practices not related to personal safety.





Hydraulic Fluid and Equipment Safety

This system uses hydraulic equipment with hydraulic fluid under extremely high pressure.

Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin causing serious injury. Keep all hoses and connections in good serviceable condition. Failure to heed may result in serious personal injury or death. Avoid the hazard by relieving the pressure before disconnecting lines or performing work on the system.

Make sure hydraulic fluid connections are tight and all hydraulic hoses and lines are in good condition before applying pressure to the system. Use a piece of paper or cardboard, NOT BODY PARTS, to check for suspected leaks. Wear protective gloves and safety glasses or goggles when working with hydraulic systems. DO NOT DELAY!

Check hydraulic hoses and fittings frequently. Loose, broken, and missing hardware can cause equipment to not perform properly and can result in serious injury or death. Hydraulic systems can be hot and cause burns. Before working on any system, wait until the fluid has cooled.

If an accident occurs, see a doctor familiar with this type of injury immediately. Any fluid injected into the skin or eyes must be treated within a few hours or gangrene may result.



A Word to the Operator

SAFETY IS YOUR RESPONSIBILITY.

YOU are the key to safety.

It is YOUR responsibility to read and understand the safety messages in this manual.

This system may be used to apply many different kinds of agricultural liquid products. Read and follow all label information and instructions related to the handling, storage, and application of the product you are using.

All electrical harnessing should be checked regularly and should be routed and secured so it will not be pinched, cut, or stretched.

SureFire Ag Systems



General Description

A

Introduction

You have purchased a SureFire fertilizer system for your equipment. This system will be controlled by your in-cab display and Raven Rate Control Module (RCM). The RCM will adjust the speed of the SureFire PumpRight hydraulic pump based on feedback from the flowmeter and vehicle speed. The system is capable of using optional section valves to minimize overlap.

The RCM is capable of controlling up to 5 products depending on the exact situation. So, the same RCM that controls this PumpRight system could control additional liquid, dry or anhydrous ammonia products on your equipment.

You will need a SureFire RCM adapter harness to connect the RCM to the product harness(es). Setup instructions will be furnished with the adapter harness so all the products controlled with a single RCM controller will work properly.

You will use the Virtual Terminal (VT) or Universal Terminal (UT) software on your display to view the RCM on your screen.

To do Section Control, presor mapping you will need a Task Controller unlock for your display.

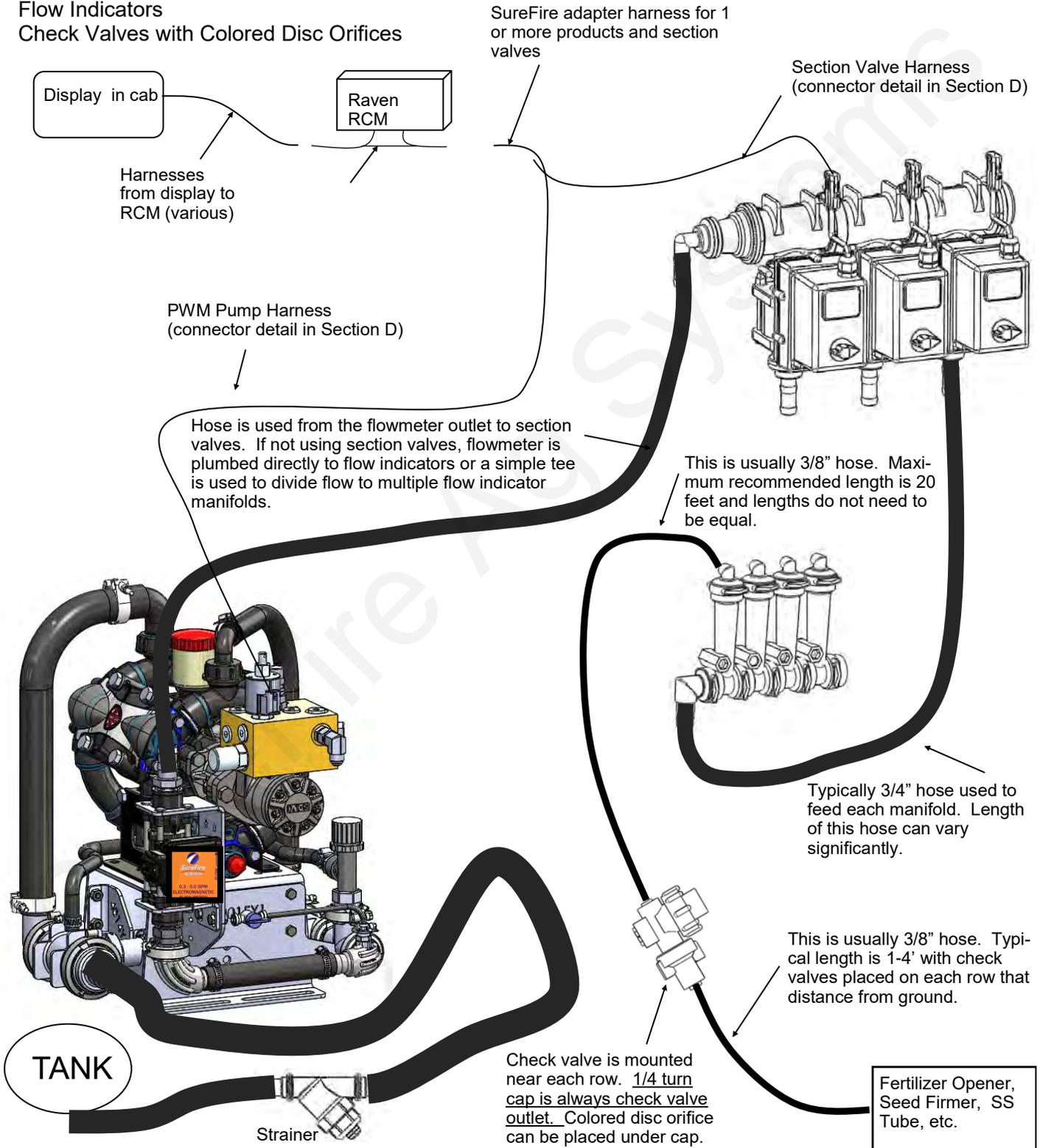
Basic Installation Steps

1. Mount the Raven RCM and connect it to the Implement ISOBUS.
2. Open the packages and familiarize yourself with the components. See the System Overview Example on the following page to see the big picture of how SureFire Fertilizer Systems are installed. Refer to manual sections B & D for component information.
3. Mount the PumpRight pump and make hydraulic connections. See section E for hydraulic plumbing information.
4. Plumb the tank to the PumpRight inlet. See section E for details.
5. Install the plumbing kit including section valves, flow indicator columns / manifolds, check valves, plumbing to each row unit delivery point. See section B for information on these components.
6. Attach the flowmeter outlet to section valve, manifold inlet, or LiquiShift inlet. Attach section valve outlets to flow indicator inlets.
7. Attach harnesses as shown in Section D.
8. Set up RCM for SureFire fertilizer system as shown in Section F or in the setup instructions sent with the RCM adapter harness.
9. Fill system with water, conduct initial operation and tests per Section F or in the QuickStart instructions.
10. Winterize system with RV Antifreeze if freezing temperatures are expected.
11. Do pre-season service each year as described at end of manual.

System Overview Example

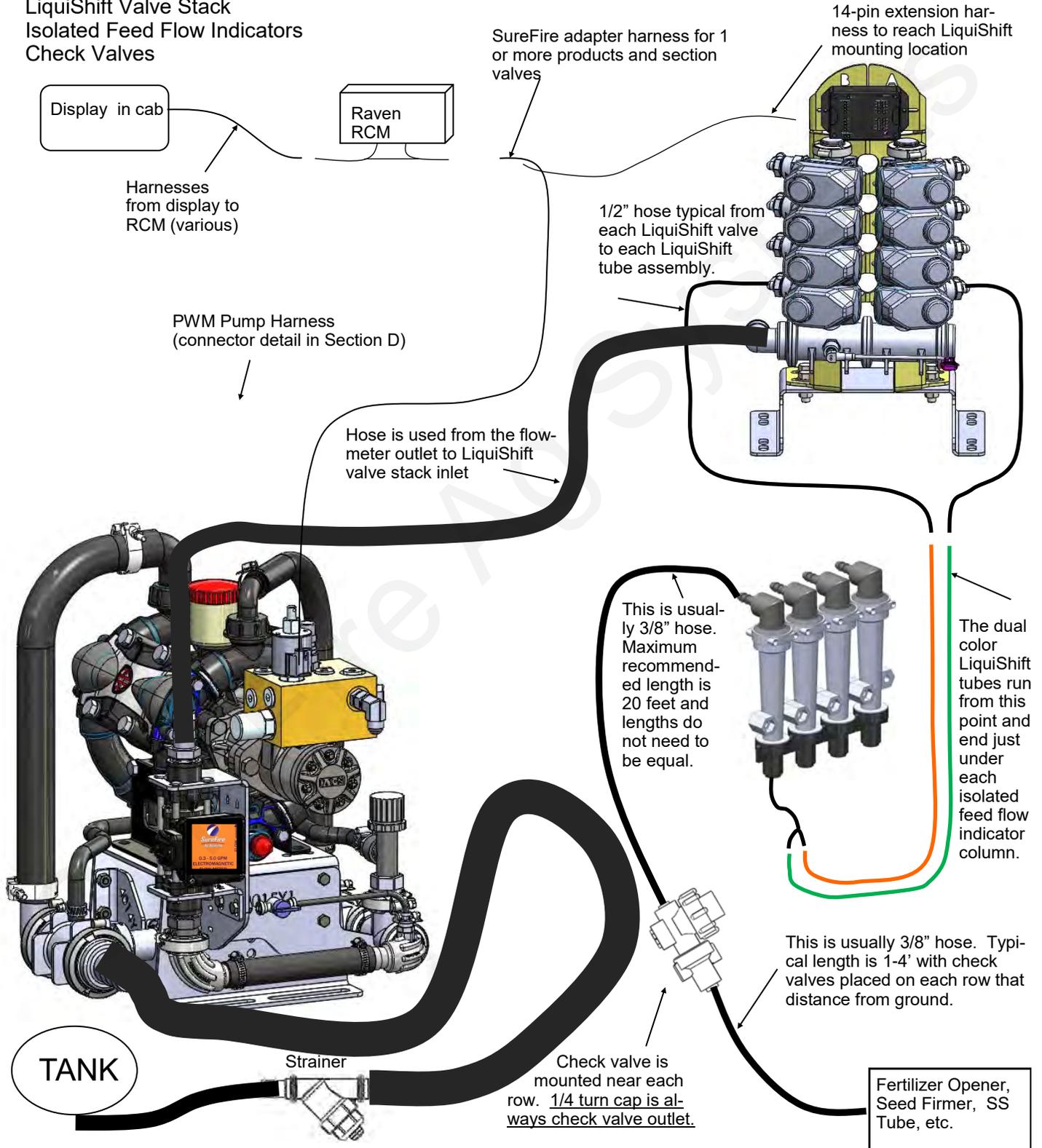
The following gives an example of a complete SureFire Fertilizer system with these components:

- In-cab Display
- Raven RCM
- PumpRight PR17
- Section Valves
- Flow Indicators
- Check Valves with Colored Disc Orifices



The following gives an example of a complete SureFire Fertilizer system with LiquiShift and these components:

- In-cab Display
- Raven RCM
- PumpRight PR17
- LiquiShift Valve Stack
- Isolated Feed Flow Indicators
- Check Valves



PR17 & PR30 Electromagnetic Flowmeter Kits

0.13 - 2.6 GPM Item Number 500-02-2082 (PR17)

0.3 - 5 GPM Item Number 500-02-2085 (PR17)

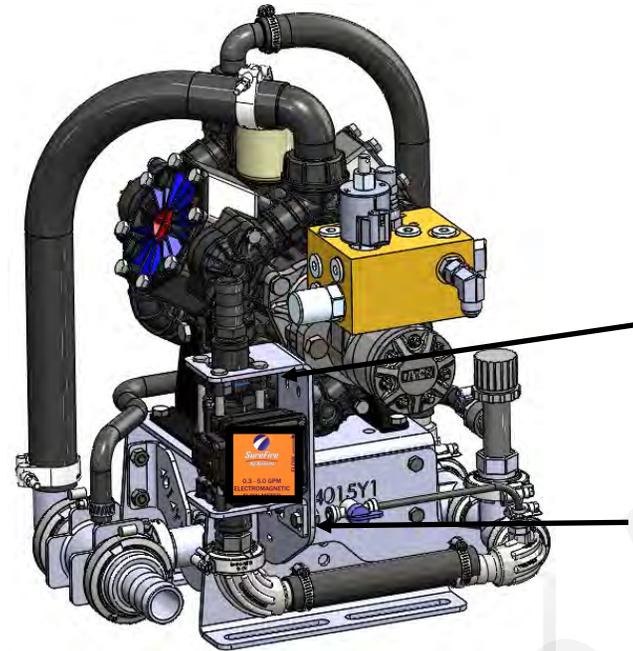
0.6 - 13 GPM Item Number 500-02-2090 (PR17 & PR30)

1.3 - 26 GPM Item Number 500-02-2095 (PR30)

Kits include flowmeter, adapter harness, mounting bracket, hose barb fittings & hose clamps.

-Before doing any arc welding on the implement, unplug the cable to the flowmeter, or damage to the flowmeter may result.

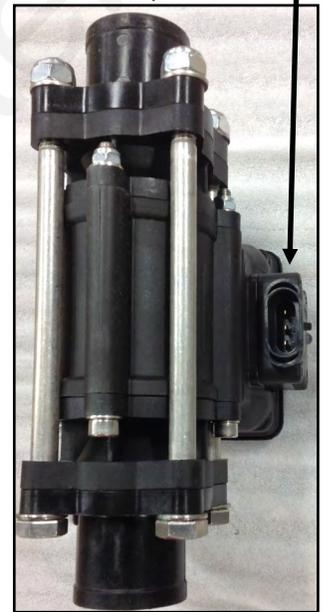
-Do not power wash the flowmeter. High pressure spray directed at the back edge of the face plate or at the wire connector may allow water into the flowmeter electronics.



Mounting Bracket, 410-4015Y1 (QTY 1) (not used for PR40 and D250 Pump)

Mounting Bracket, 400-3826Y1 (QTY 1) (not used for PR40 and D250 Pump)

Amp SuperSeal 3-pin connector
Use adapter 201-17842 to connect to 3-pin MP harness



Troubleshooting Tip:



Remove red guard to reach pins. Be careful so you don't break red side keepers.

3-pin MP Tower A- Signal B- 12V Power C- Ground (See the next page for more flowmeter tips)
3-pin AMP SuperSeal 1- Ground 2- 12V Power 3- Signal

Electromagnetic flowmeters are superior to traditional turbine flowmeters in two basic ways. First, they have no moving parts. There are no wear items or potential for contaminants to jam a spinning turbine.

Second, electromagnetic flowmeters detect the flow by electrically measuring the velocity of the liquid, which makes them independent of viscosity or density of the fluid measured. They are extremely accurate using the standard calibration number. **SureFire still recommends you perform a catch test to verify the system is properly installed and configured.**

Flowmeter Model (black meter with orange label)	JD GRC Flow Calibration	FPT Size	Hose Barb In kit
0.13 - 2.6 GPM	3000	3/4"	1"
0.3 - 5 GPM	3000	3/4"	1"
0.6 - 13 GPM	2000	3/4"	1"
1.3 - 26 GPM	2000	1"	1"

Earlier model flowmeters (meters with white labels with black text) have different calibration numbers. See the documentation for those meters to find the calibration numbers.

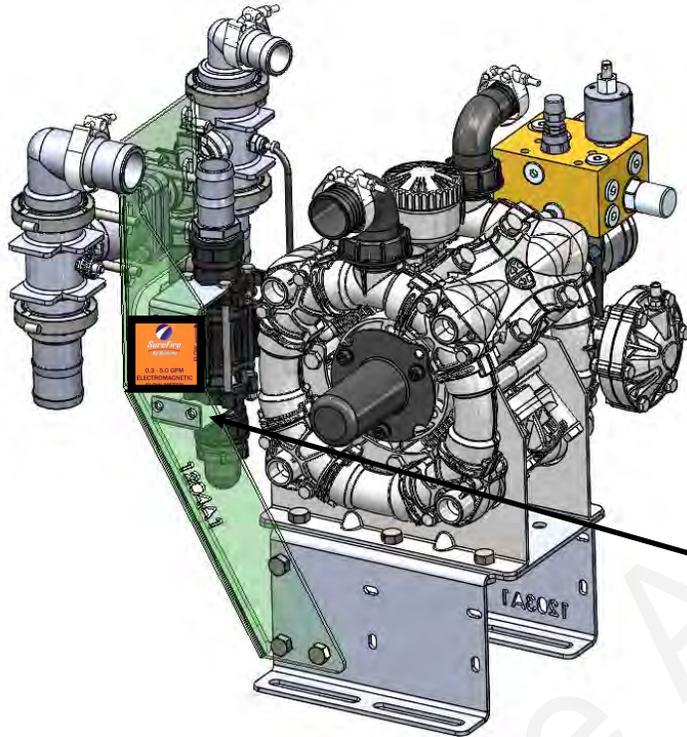
PR40 & D250 Electromagnetic Flowmeter Kit

2.6 - 53 GPM Item Number 500-02-2080

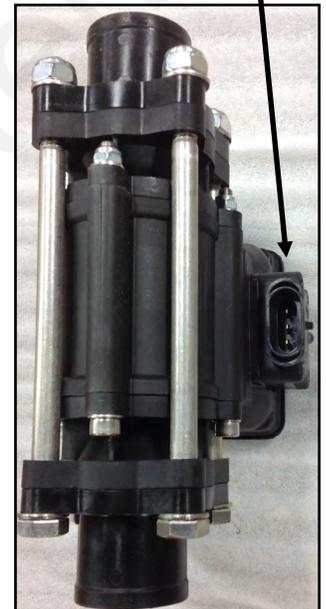
Kits include flowmeter, adapter harness, mounting bracket, hose barb fittings & hose clamps.

B
 Components
 Liquid

- Before doing any arc welding on the implement, unplug the cable to the flowmeter, or damage to the flowmeter may result.
- Do not power wash the flowmeter. High pressure spray directed at the back edge of the face plate or at the wire connector may allow water into the flowmeter electronics.



Amp SuperSeal 3-pin connector
 Use adapter 201-17842
 to connect to 3-pin MP harness



Mounting Bracket,
 400-3335Y1 (QTY 2)
 (used for PR40 and D250
 Pump only)



Remove red guard to reach pins. Be careful so you don't break red side keepers.

Troubleshooting Tip:

3-pin AMP SuperSeal 1- Ground 2- 12V Power 3- Signal

Power to Ground should be 12 volts.

Signal to Ground should be 4.5 to 5 volts

Do Tap Test between Signal and Ground to test harnessing.

3-pin MP Tower A- Signal B- 12V Power C- Ground

Additional Tip:

If flowmeter is not reading and the harnessing has checked out OK with voltage readings and tap test, try cleaning the inside tube of flowmeter with warm soapy water and a soft brush. Sometimes, a film builds up on the electrodes.

Flowmeter Model (black meter with orange label)	JDRC 2000 Flow Calibration	FPT Size	Hose Barb In kit
2.6—53 GPM	2000	1-1/4"	1-1/2"
1.3—26 GPM	2000	1"	1"

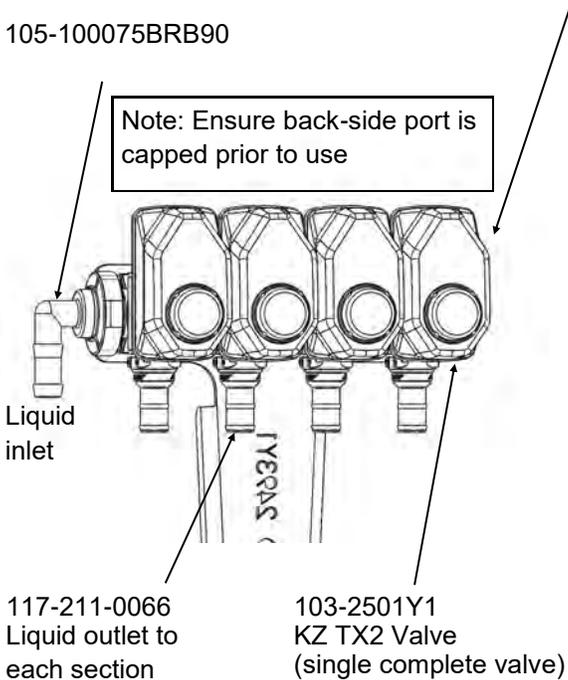
Earlier model flowmeters (meters with white labels with black text) have different calibration numbers. See the documentation for those meters to find the calibration numbers.

Section Valves and LiquiShift Valves

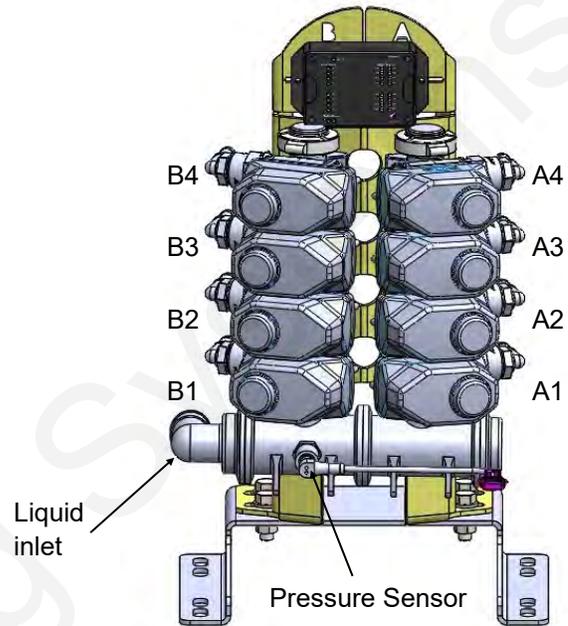
B
Components
Liquid

105-100PLG (alternate
105-100PLG025 includes 1/4" pipe
thread for gauge)

105-100075BRB90



LIQUISHIFT
Variable Rate Technology



Additional Parts:

- 1" Gasket 105-100G-H
- 1" Clamp 105-FC100

How section valves work

Section valves can be assembled into groups with a common inlet to control flow to each section. Common assemblies use up to 5-6 valves, however, more can be used where practical. Many alternate fittings can be used to accommodate different hose sizes and configurations.

The valves have a 3-pin weather pack electrical connector. This has a power, ground, and switched wire. The power measured to ground should have 12 volts when the controller is on. The switched wire will have 12 volts to turn the valve on, and 0 volts to turn the valve off.

Wiring Connector: Pin A—Red, 12 Volts + Pin B—Black, Ground - Pin C—White, Signal 12V=on ; 0V=off	Mounting Hardware: 2 Valve Bolt Kit 384-1100 Mounting Bracket 400-2493Y1
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How LiquiShift Works

LiquiShift is a section valve manifold specifically built and controlled to provide the operator a very wide flow range for variable rate application. It is valuable for variable rate prescription application or variable rate between different fields. Each section has an A and B valve that are opened based on the section status, current rate and system pressure. Therefore, a 4- section LiquiShift (shown above) will have 8 total valves.

The valves themselves are identical to a regular section valve (KX TX2) and have a 3-pin weather pack electrical connector.

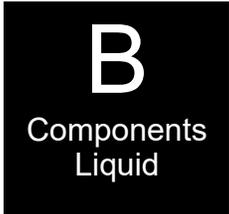
LiquiShift systems are available with systems from 1-8 sections.

On the RCM, LiquiShift systems connect to the RCM Adapter Harness with a 14-pin round connector. Typically this connector would be for Sections 1-6 (product 1) or Sections 7-12 (product 2). Your system may vary so check the specific instructions with our RCM adapter harness.

Pressure Sensor

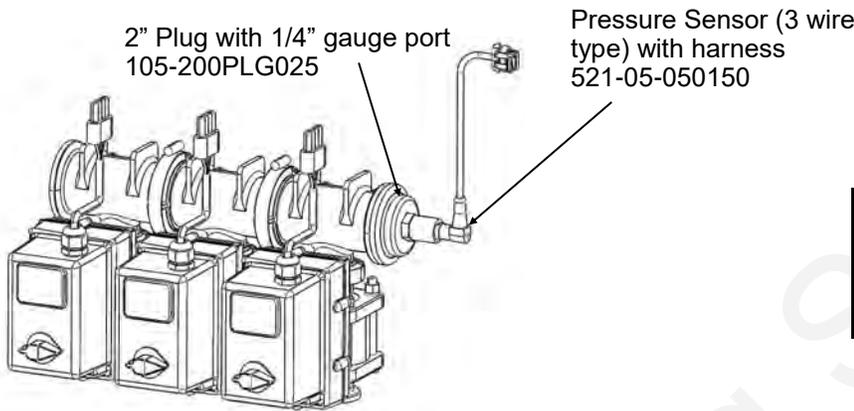
3 Wire Sensor with 2" Manifold x 1/4" MPT Fitting

Item Number 520-00-055100

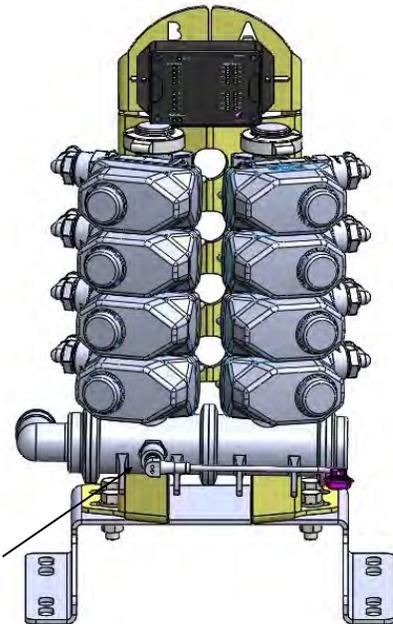
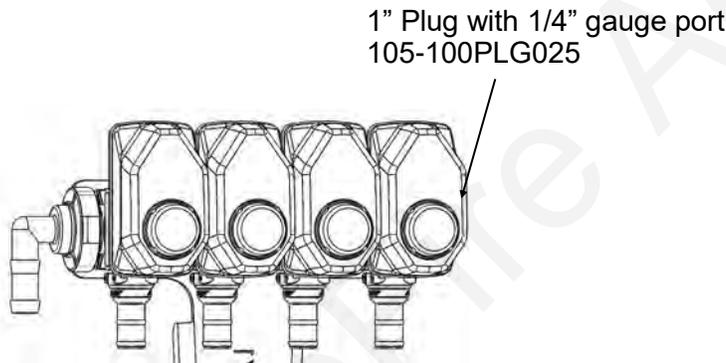


The RCM has the ability to show fertilizer system pressure on the display. The pressure sensor is most often mounted on electric section valves when used in PumpRight systems. The pressure sensor is a 100 psi, 0-5 v, 3-wire type sensor for compatibility with the RCM. The sensor has a 1/4" MPT fitting.

The user can select to display the pressure on the in-cab display. The pressure sensor is very helpful to optimize system performance and troubleshoot any issues. Pressure alarms or limits can be set on the display in the cab.



RCM Setup:
 Pressure Sensor Type: Custom
 Pressure Calibration: 50 mv/psi



Pressure Sensor for LiquiShift is mounted at the base of the valve stack. The same sensor is used for LiquiShift and displayed on the display.

Pressure Sensor Hose Tap Kits

When electric section valves or LiquiShift is **not** used in the fertilizer system, the best location to install the pressure sensor is in the hose after it leaves the flowmeter. To use these kits, order the correct kit for your hose size. Then also order the kit above that includes the 2" Manifold x 1/4" MPT fitting.

- | | |
|--------------------------|---------------|
| 3/4" Hose Pressure Tap | 520-00-055800 |
| 1" Hose Pressure Tap | 520-00-055850 |
| 1 1/2" Hose Pressure Tap | 520-00-055900 |

Pump Priming and Air Bleed Valve

An air bleed valve is included with each pump to aid in system priming. It is shipped in the pump accessories bag and must be installed during system installation.

B

Components
Liquid

Why use an air bleed valve:

Most fertilizer systems are equipped with a 4 lb or 10 lb check valve on the end of each hose delivering fertilizer to the ground. These valves do not let air escape from the system, unless it is pressurized. PumpRight liquid pumps are not good air compressors. Therefore, the pump can struggle to prime due to air trapped on the outlet side of the pump.

The air bleed valve is a small 1/4" valve that when opened lets air escape from the pump outlet at zero pressure. Open until liquid comes out and then close the valve.

Be sure the air bleed valve tube does not become plugged with dirt or it will not allow air to bleed.

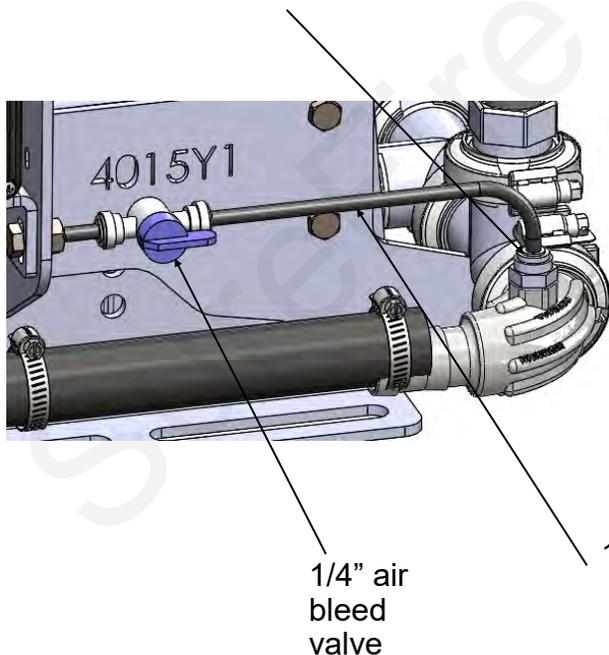
How to install the air bleed valve:

Remove the 1/4" plug from the quick connect fitting on the pump outlet side (see pictures below). Next, insert the 1/4" tubing in the quick connect fitting. Run the 1/4" tubing to an easily accessible spot on your equipment. Next, cut the tubing and push the 1/4" valve onto the tubing. Finally, run the tubing to a low location where any fertilizer that escapes will run on the ground.

Be sure the air bleed valve tube does not become plugged with dirt or it will not allow air to bleed.

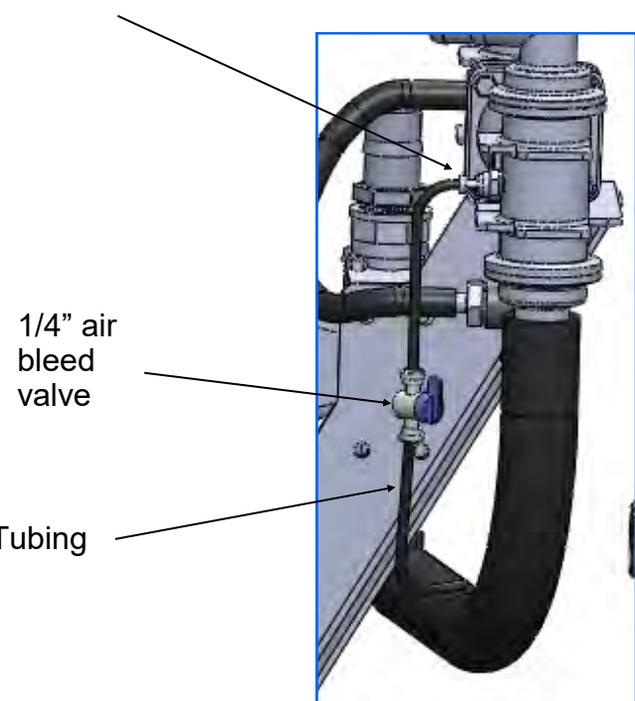
PR17 & PR30

Attach 1/4" tubing to 1/4" QC on the 90 deg HB sweep gauge port



PR40 & D250

Attach 1/4" tubing to 1/4" QC on back side of 1" x 2" tee on outlet side of pump



Recirculation & Agitation

A recirculation valve is standard on all 4 PumpRight models outlet plumbing assemblies.

B

Components
Liquid

How Recirculation Works:

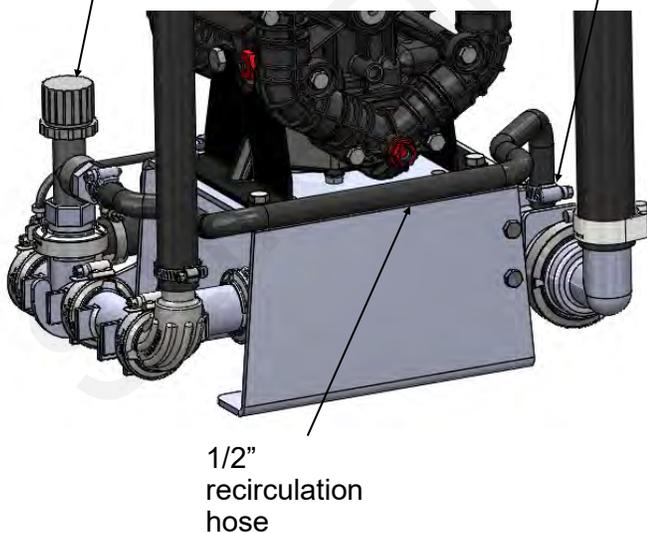
When running a PumpRight pump at less than 20% of its maximum flow, it sometimes improves system stability to allow the pump to run faster. Opening the recirculation valve diverts some pump flow before the flowmeter, causing the pump to run faster. The application rate is still measured by the flowmeter and everything that passes through the flowmeter is applied to the ground. If the pump is surging at a low flow rate, open the recirculation regulation valve until the pump runs smoothly. *Start with a quarter to a half turn.* OPENING THE VALVE LOWERS THE MAXIMUM RATE THAT CAN BE APPLIED TO THE GROUND. Close the valve if a higher rate is required.

How to modify for tank agitation:

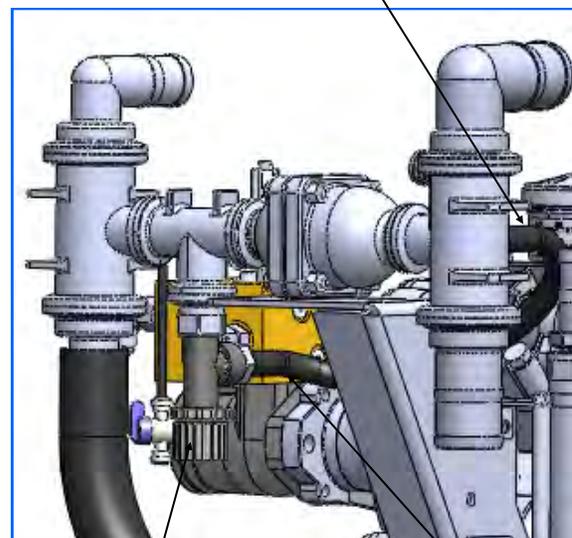
If tank agitation is required, the recirculation valve can be re-plumbed to divert flow to the tank. All that is required is to remove the 1/2" recirculation hose from the pump. Then replace the 3/8" MPT x 1/2" HB on the inlet side of the pump with a 3/8" plug which is included in your PumpRight accessories bag. Finally, install a longer 1/2" hose from the recirculation valve back to the tank.

PR17 & PR30

Recirculation Regulation Valve,
102-23520-3/4
Start with a quarter to a half turn.



PR40 & D250



Product Distribution

To assure proper and even distribution to each row, the product being applied must be metered to each individual row. This metering is done by one of the 3 following methods which create back pressure so an equal amount of liquid is applied to each row:



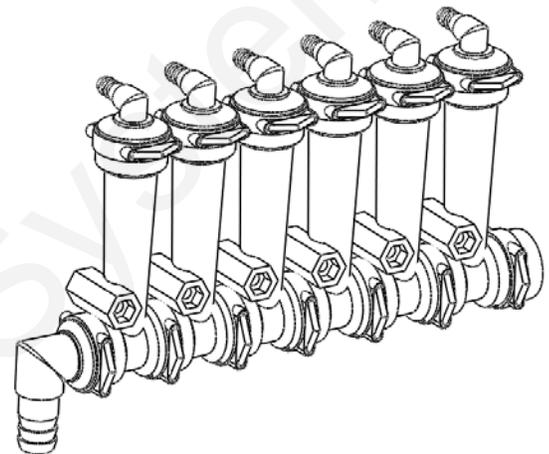
1. A metering orifice may be placed in the check valve cap in the line that leads to each row. (See photo on page 13)
2. A dual metering tube kit with dual check valves may be used. (See pages 18-21)
3. A LiquiShift valve stack may be used that automatically selects which metering tube to use based on system pressure.

Floating Ball Flow Indicator & Manifold System

Flow indicators give a clear visual signal that a fertilizer system is working. These indicators use an o-ring and wire clip connection to snap together in any configuration necessary.

SureFire has simple tee brackets and U-bolts that will mount these to a variety of bar sizes.

Two main types of flow indicators are used. On 30" row spacing, the low flow column with 1/4" push to connect outlet is recommended for rates under 10 GPA. For rates over 10 GPA the full flow column with 3/8" hose barb outlet is preferred.



Parts List

Complete Columns

701-20460-950	Single Full Flow Column with 3/8" HB - 90 Degree Outlet
701-20460-940	Single Full Flow Column with 3/8" QC - 90 Degree Outlet
701-20460-960	Single Full Flow Column with 1/2" HB - 90 Degree Outlet
701-20460-935	Single Low Flow Column with 3/8" QC - 90 Degree Outlet
701-20460-920	Single Low Flow Column with 1/4" QC - 90 Degree Outlet

Fittings

701-20503-00	ORS x 3/4" HB - Straight
701-20511-00	ORS x 3/8" HB - 90 Degree
701-20512-00	ORS x 1/2" HB - 90 Degree
701-20513-00	ORS x 3/4" HB - 90 Degree
701-20516-00	ORS x 1/4" QC - 90 Degree
701-20517-00	ORS x 3/8" QC - 90 Degree
701-20518-00	ORS x 1/4" FPT - 90 Degree
701-20519-00	ORS x 1/4" FPT - Straight
701-20520-00	ORS Male x ORS Female - 90 degree
701-20521-00	Wilger End Cap
701-20523-00	ORS Male x ORS Female x 3/8" FPT - Isolator
701-20525-00	ORS Male x ORS Male x 1" FPT - Tee

Service Parts Only

701-20460-02	Wilger Flow Indicator Ball Retainer
701-20460-03	FKM O-Ring for indicator body & fittings
701-20460-04	Wilger Lock U-clip
701-20460-05	Flow Indicator Ball - 1/2" SS Ball
701-20460-06	Flow Indicator Ball - Maroon Glass
701-20460-07	Flow Indicator Ball - Red Celcon
701-20460-08	Flow Indicator Ball - Green Poly
701-20460-09	Flow Indicator Ball - Black Poly
701-20460-15	Viton O-Ring for column & fittings
701-40225-05	Viton O-Ring for Orifice

Brackets & U-Bolts

400-1037A1	3-6 Row Bracket
400-3155Y1	7-12 Row Bracket
400-2011A1	White Backer Plate for 3-6 Row Bracket
400-2010A1	White Backer Plate for 7-12 Row Bracket
400-1315A2	Flow Indicator Bracket, 6-8 in wide hitch mount

Floating Ball Flow Indicators- Full Flow Column (mostly 3/8" HB)

The full flow column is typically used with rates over 10 GPA on 30" rows. For rates less than 10 GPA SureFire recommends the low flow columns with 1/4" push to connect outlet fittings.

The full flow columns are most often assembled with 3/8" hose barb outlets. See the low flow info below for the difference between full and low flow columns.

Full Flow Indicators w/ 3/8" Hose Barb Outlet

Column Flow (GPM):	.05-2.70 GPM
Equivalent Application Rate On 30" Rows at 6 MPH:	2-70 GPA

Ball Selection for 30" Rows

GPM	GPA	Ball
.05-.18	2-6	Green Plastic*
.09-.30	3-10	Red Plastic*
.31-.72	10-20	Maroon Glass
.40-2.1	13-70	Stainless Steel (1/2")

*Plastic balls may float on heavier fertilizers, such as 10-34-0. SureFire recommends using the low flow column for these flow rates.

400-2010A1
12-Row White Visi-
bility Backer Plate

701-20460-950
Full Flow Column
w/ 3/8" HB Outlet

701-20521-00
End Cap

701-20525-00
Center Fed Tee
with Gauge Port

101-100075BRB
1" MPT x 3/4" HB

1/4" x 2"
Bolt

400-3155Y1
7-12 Row
Bracket

380-1001
Fits 7"x7" Tube



B

Components
Liquid

Low Flow Column (mostly 1/4" QC)

The low flow column has a smaller internal diameter. This means a heavier ball can be used to monitor a smaller flow.

SureFire uses the low flow columns with 1/4" push to connect outlet fittings. The flow capability of 1/4" tubing and the low flow column are a great pair for rates on 30" rows under 10 GPA.

Externally, the low flow column can only be identified by "Low Flow" molded into one side of the column. All the same fittings work with low flow and full flow columns.

Low Flow Indicators w/ 1/4" Push to Connect Outlet

Column Flow (GPM):	.03-.30 GPM
*** Low Flow Column with 3/8" hose barb	.03 - .70 GPM
Equivalent Application Rate On 30" Rows at 6 MPH (1/4" QC):	1-10 GPA

Ball Selection for 30" Rows

GPM	GPA	Ball
.03-.09	1-3	Green Plastic*
.05-.14	2-4	Red Plastic*
.10-.18	3-6	Maroon Glass
.15-.70	5-10	Stainless Steel (1/2")

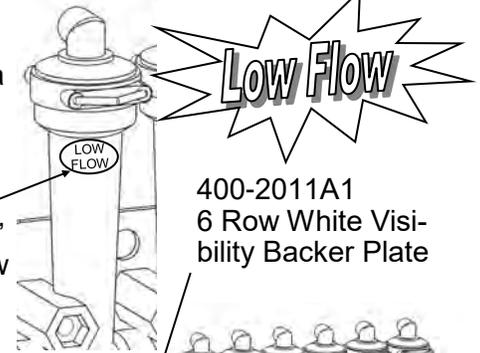
*These balls may float on heavier fertilizers, such as 10-34-0. Use Maroon Glass in this case.

Low Flow

400-2011A1
6 Row White Visi-
bility Backer Plate

701-20513-
00 3/4" HB
90 degree
inlet

400-1037A1
3-6 Row
Bracket

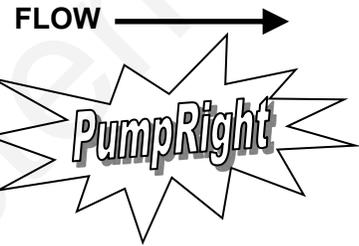
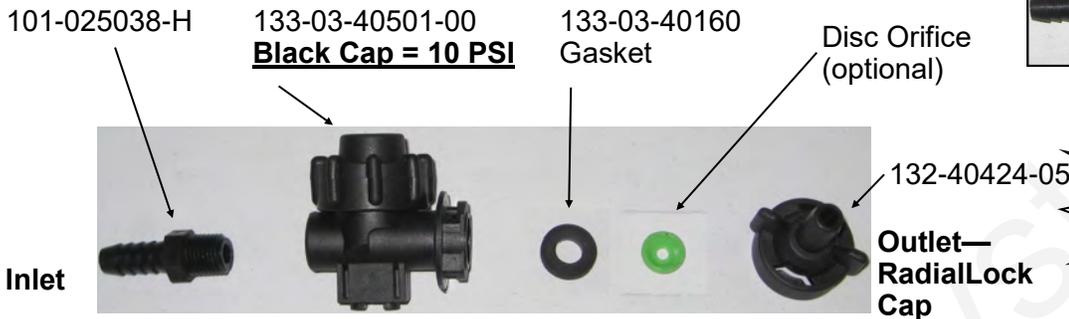


Check Valves

10 lb check valve with 3/8" hose barbs

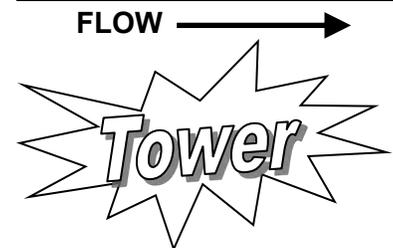
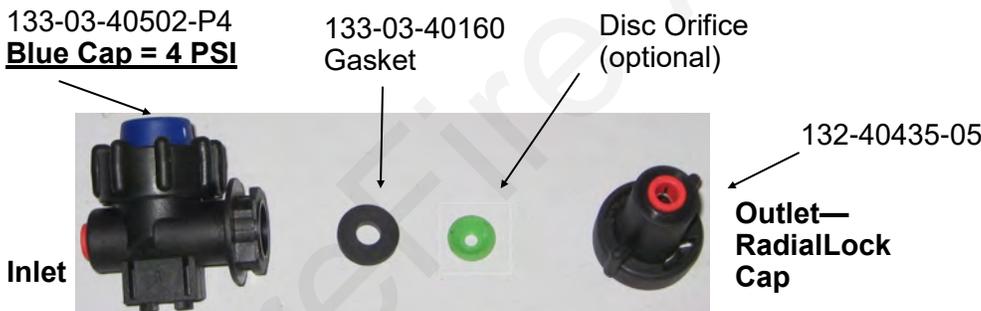
B
Components
Liquid

The recommended check valve for most **PumpRight** installations is the 10 lb check with 3/8" hose barbs. This works with 3/8" rubber hose which SureFire recommends for most applications over 10 GPA on 30" rows. The recommended minimum system operating pressure for this check is 20 psi, to ensure all checks open fully.



4 lb check valve with 1/4" quick connect fittings

4 lb check valves are typically used with **electric pump systems**. SureFire recommends this valve for use with 1/4" tubing applying up to 10 GPA on 30" rows. The recommended minimum system operating pressure for this check is 10 psi, to ensure all checks open fully.



Special Purpose Check Valve Assemblies

Assembly Part Number	Description	Suggested Uses (30" rows)
136-10-04QC04QC	1/4" QC x 1/4" QC 10 lb	< 10 GPA with PumpRight & 1/4" Tubing
136-10-06QC06QC	3/8" QC x 3/8" QC 10 lb	With 3/8" tubing plumbing
136-04-06HB06HB	3/8" HB x 3/8" HB 4 lb	> 10 GPA with Electric Pumps
136-04-08HB08HB	1/2" HB x 1/2" HB 4 lb	> 50 GPA with PumpRight
136-10-08HB08HB	1/2" HB x 1/2" HB 10 lb	> 50 GPA with PumpRight

Colored Disc Orifice Chart for 30" rows

B

Components
Liquid

30" Spacing

Orifice Color (Approx Size)	PSI	Gal/Min 28-0-0	MPH						
			4.0	4.5	5.0	5.5	6.0	6.5	7.0
Pink (24)	10	0.033	1.62	1.44	1.30	1.18	1.08	1.00	0.93
	20	0.046	2.28	2.02	1.82	1.66	1.52	1.40	1.30
	30	0.057	2.80	2.49	2.24	2.04	1.87	1.73	1.60
	40	0.065	3.24	2.88	2.59	2.36	2.16	1.99	1.85
	50	0.073	3.64	3.23	2.91	2.64	2.42	2.24	2.08
	60	0.081	3.99	3.54	3.19	2.90	2.66	2.45	2.28
Gray (30)	10	0.050	2.50	2.22	2.00	1.82	1.66	1.54	1.43
	20	0.072	3.55	3.15	2.84	2.58	2.37	2.18	2.03
	30	0.088	4.34	3.85	3.47	3.15	2.89	2.67	2.48
	40	0.101	4.99	4.44	4.00	3.63	3.33	3.07	2.85
	50	0.112	5.56	4.95	4.45	4.05	3.71	3.42	3.18
	60	0.124	6.13	5.45	4.91	4.46	4.09	3.77	3.50
Black (35)	10	0.070	3.46	3.08	2.77	2.52	2.31	2.13	1.98
	20	0.098	4.86	4.32	3.89	3.54	3.24	2.99	2.78
	30	0.120	5.96	5.30	4.77	4.33	3.97	3.67	3.40
	40	0.139	6.88	6.11	5.50	5.00	4.58	4.23	3.93
	50	0.156	7.71	6.85	6.17	5.61	5.14	4.74	4.41
	60	0.170	8.41	7.48	6.73	6.12	5.61	5.18	4.81
Brown (41)	10	0.094	4.64	4.13	3.71	3.38	3.10	2.86	2.65
	20	0.132	6.53	5.80	5.22	4.75	4.35	4.02	3.73
	30	0.162	8.02	7.13	6.41	5.83	5.34	4.93	4.58
	40	0.187	9.24	8.22	7.39	6.72	6.16	5.69	5.28
	50	0.209	10.34	9.19	8.27	7.52	6.89	6.36	5.91
	60	0.228	11.30	10.05	9.04	8.22	7.53	6.95	6.46
Orange (46)	10	0.119	5.91	5.26	4.73	4.30	3.94	3.64	3.38
	20	0.169	8.37	7.44	6.69	6.08	5.58	5.15	4.78
	30	0.207	10.25	9.11	8.20	7.45	6.83	6.31	5.86
	40	0.239	11.83	10.51	9.46	8.60	7.88	7.28	6.76
	50	0.267	13.23	11.76	10.58	9.62	8.82	8.14	7.56
	60	0.293	14.50	12.89	11.60	10.55	9.67	8.92	8.29
Maroon (52)	10	0.149	7.36	6.54	5.89	5.35	4.91	4.53	4.21
	20	0.210	10.38	9.23	8.31	7.55	6.92	6.39	5.93
	30	0.257	12.70	11.29	10.16	9.24	8.47	7.82	7.26
	40	0.296	14.67	13.04	11.74	10.67	9.78	9.03	8.39
	50	0.332	16.43	14.60	13.14	11.95	10.95	10.11	9.39
	60	0.363	17.96	15.96	14.37	13.06	11.97	11.05	10.26
Red (63)	10	0.218	10.78	9.58	8.62	7.84	7.18	6.63	6.16
	20	0.307	15.20	13.51	12.16	11.05	10.13	9.35	8.69
	30	0.376	18.62	16.55	14.89	13.54	12.41	11.46	10.64
	40	0.435	21.51	19.12	17.21	15.64	14.34	13.24	12.29
	50	0.486	24.05	21.38	19.24	17.49	16.03	14.80	13.74
	60	0.532	26.33	23.40	21.06	19.15	17.55	16.20	15.04
Blue (80)	10	0.351	17.39	15.46	13.91	12.65	11.59	10.70	9.94
	20	0.496	24.57	21.84	19.66	17.87	16.38	15.12	14.04
	30	0.608	30.09	26.75	24.08	21.89	20.06	18.52	17.20
	40	0.702	34.74	30.88	27.79	25.26	23.16	21.38	19.85
	50	0.785	38.86	34.54	31.08	28.26	25.90	23.91	22.20
	60	0.859	42.53	37.81	34.03	30.93	28.36	26.18	24.31
Yellow (95)	10	0.506	25.06	22.27	20.05	18.22	16.70	15.42	14.32
	20	0.715	35.39	31.46	28.32	25.74	23.60	21.78	20.23
	30	0.876	43.37	38.55	34.69	31.54	28.91	26.69	24.78
	40	1.009	49.94	44.39	39.95	36.32	33.29	30.73	28.54
	50	1.133	56.07	49.84	44.86	40.78	37.38	34.51	32.04
	60	1.239	61.33	54.51	49.06	44.60	40.88	37.74	35.04
Green (110)	10	0.686	33.95	30.18	27.16	24.69	22.63	20.89	19.40
	20	0.973	48.19	42.83	38.55	35.04	32.12	29.65	27.53
	30	1.186	58.70	52.18	46.96	42.69	39.13	36.12	33.54
	40	1.372	67.90	60.35	54.32	49.38	45.27	41.78	38.80
	50	1.531	75.78	67.36	60.63	55.12	50.52	46.64	43.30
	60	1.681	83.23	73.98	66.58	60.53	55.49	51.22	47.56

PumpRight Pressure Recommendations (with 10 lb check valves):

- Minimum 20 PSI
- Maximum 80 PSI

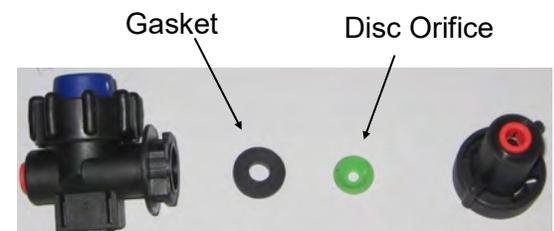
Tower Electric Pump Pressure Recommendations (with 4 lb check valves):

- Minimum 10 PSI
- Maximum 30 PSI

Chart is for 28-0-0 Fertilizer @ 70°

- Heavier fertilizers (like 10-34-0) will have 5-15% less flow than chart indicates for a certain pressure
- Cold fertilizers will cause system pressure to increase at a given application rate.
- Tower Electric Pump Systems will have reduced flow and increased electrical current draw due to cold fertilizer increasing operating pressure. **Use the largest orifice possible for cold weather operation.**

Colored Disc Orifice assemblies under the check valve cap in most cases. (Drop the orifice with the hole down into the cap, then put the gasket on top of it.) The orifice can also be installed in a manifold (common on grain drills).



FLOW → 1/4 Turn Cap is Outlet

Colored Disc Orifice Chart Common Grain Drill Row Spacings



7.5" Spacing

Orifice Color (Approx Size)	PSI	Gal/Min 28-0-0	MPH						
			4.0	4.5	5.0	5.5	6.0	6.5	7.0
Pink (24)	10	0.033	6.5	5.8	5.2	4.7	4.3	4.0	3.7
	20	0.046	9.1	8.1	7.3	6.6	6.1	5.6	5.2
	30	0.057	11.2	10.0	9.0	8.2	7.5	6.9	6.4
	40	0.065	13.0	11.5	10.4	9.4	8.6	8.0	7.4
	50	0.073	14.5	12.9	11.6	10.6	9.7	8.9	8.3
	60	0.081	15.9	14.2	12.8	11.6	10.6	9.8	9.1
Gray (30)	10	0.050	10.0	8.9	8.0	7.3	6.7	6.1	5.7
	20	0.072	14.2	12.6	11.4	10.3	9.5	8.7	8.1
	30	0.088	17.3	15.4	13.9	12.6	11.6	10.7	9.9
	40	0.101	20.0	17.8	16.0	14.5	13.3	12.3	11.4
	50	0.112	22.3	19.8	17.8	16.2	14.8	13.7	12.7
	60	0.124	24.5	21.8	19.6	17.8	16.4	15.1	14.0
Black (35)	10	0.070	13.8	12.3	11.1	10.1	9.2	8.5	7.9
	20	0.098	19.4	17.3	15.6	14.1	13.0	12.0	11.1
	30	0.120	23.8	21.2	19.1	17.3	15.9	14.7	13.6
	40	0.139	27.5	24.5	22.0	20.0	18.3	16.9	15.7
	50	0.156	30.8	27.4	24.7	22.4	20.6	19.0	17.6
	60	0.170	33.6	29.9	26.9	24.5	22.4	20.7	19.2
Brown (41)	10	0.094	19	17	15	14	12	11	11
	20	0.132	26	23	21	19	17	16	15
	30	0.162	32	29	26	23	21	20	18
	40	0.187	37	33	30	27	25	23	21
	50	0.209	41	37	33	30	28	25	24
	60	0.228	45	40	36	33	30	28	26
Orange (46)	10	0.119	24	21	19	17	16	15	14
	20	0.169	33	30	27	24	22	21	19
	30	0.207	41	36	33	30	27	25	23
	40	0.239	47	42	38	34	32	29	27
	50	0.267	53	47	42	38	35	33	30
	60	0.293	58	52	46	42	39	36	33
Maroon (52)	10	0.149	29	26	24	21	20	18	17
	20	0.210	42	37	33	30	28	26	24
	30	0.257	51	45	41	37	34	31	29
	40	0.296	59	52	47	43	39	36	34
	50	0.332	66	58	53	48	44	40	38
	60	0.363	72	64	57	52	48	44	41
Red (63)	10	0.218	43	38	34	31	29	27	25
	20	0.307	61	54	49	44	41	37	35
	30	0.376	74	66	60	54	50	46	43
	40	0.435	86	76	69	63	57	53	49
	50	0.486	96	86	77	70	64	59	55
	60	0.532	105	94	84	77	70	65	60
Blue (80)	10	0.351	70	62	56	51	46	43	40
	20	0.496	98	87	79	71	66	60	56
	30	0.608	120	107	96	88	80	74	69
	40	0.702	139	124	111	101	93	86	79
	50	0.785	155	138	124	113	104	96	89
	60	0.859	170	151	136	124	113	105	97
Yellow (95)	10	0.506	100	89	80	73	67	62	57
	20	0.715	142	126	113	103	94	87	81
	30	0.876	173	154	139	126	116	107	99
	40	1.009	200	178	160	145	133	123	114
	50	1.133	224	199	179	163	150	138	128
	60	1.239	245	218	196	178	164	151	140

10" Spacing

Orifice Color (Approx Size)	PSI	Gal/Min 28-0-0	MPH						
			4.0	4.5	5.0	5.5	6.0	6.5	7.0
Pink (24)	10	0.033	4.9	4.3	3.9	3.5	3.2	3.0	2.8
	20	0.046	6.8	6.1	5.5	5.0	4.6	4.2	3.9
	30	0.057	8.4	7.5	6.7	6.1	5.6	5.2	4.8
	40	0.065	9.7	8.6	7.8	7.1	6.5	6.0	5.6
	50	0.073	10.9	9.7	8.7	7.9	7.3	6.7	6.2
	60	0.081	12.0	10.6	9.6	8.7	8.0	7.4	6.8
Gray (30)	10	0.050	7.5	6.7	6.0	5.4	5.0	4.6	4.3
	20	0.072	10.6	9.5	8.5	7.7	7.1	6.6	6.1
	30	0.088	13.0	11.6	10.4	9.5	8.7	8.0	7.4
	40	0.101	15.0	13.3	12.0	10.9	10.0	9.2	8.6
	50	0.112	16.7	14.8	13.4	12.1	11.1	10.3	9.5
	60	0.124	18.4	16.4	14.7	13.4	12.3	11.3	10.5
Black (35)	10	0.070	10.4	9.2	8.3	7.6	6.9	6.4	5.9
	20	0.098	14.6	13.0	11.7	10.6	9.7	9.0	8.3
	30	0.120	17.9	15.9	14.3	13.0	11.9	11.0	10.2
	40	0.139	20.6	18.3	16.5	15.0	13.8	12.7	11.8
	50	0.156	23.1	20.6	18.5	16.8	15.4	14.2	13.2
	60	0.170	25.2	22.4	20.2	18.4	16.8	15.5	14.4
Brown (41)	10	0.094	14	12	11	10	9	9	8
	20	0.132	20	17	16	14	13	12	11
	30	0.162	24	21	19	17	16	15	14
	40	0.187	28	25	22	20	18	17	16
	50	0.209	31	28	25	23	21	19	18
	60	0.228	34	30	27	25	23	21	19
Orange (46)	10	0.119	18	16	14	13	12	11	10
	20	0.169	25	22	20	18	17	15	14
	30	0.207	31	27	25	22	21	19	18
	40	0.239	35	32	28	26	24	22	20
	50	0.267	40	35	32	29	26	24	23
	60	0.293	43	39	35	32	29	27	25
Maroon (52)	10	0.149	22	20	18	16	15	14	13
	20	0.210	31	28	25	23	21	19	18
	30	0.257	38	34	30	28	25	23	22
	40	0.296	44	39	35	32	29	27	25
	50	0.332	49	44	39	36	33	30	28
	60	0.363	54	48	43	39	36	33	31
Red (63)	10	0.218	32	29	26	24	22	20	18
	20	0.307	46	41	36	33	30	28	26
	30	0.376	56	50	45	41	37	34	32
	40	0.435	65	57	52	47	43	40	37
	50	0.486	72	64	58	52	48	44	41
	60	0.532	79	70	63	57	53	49	45
Blue (80)	10	0.351	52	46	42	38	35	32	30
	20	0.496	74	66	59	54	49	45	42
	30	0.608	90	80	72	66	60	56	52
	40	0.702	104	93	83	76	69	64	60
	50	0.785	117	104	93	85	78	72	67
	60	0.859	128	113	102	93	85	79	73
Yellow (95)	10	0.506	75	67	60	55	50	46	43
	20	0.715	106	94	85	77	71	65	61
	30	0.876	130	116	104	95	87	80	74
	40	1.009	150	133	120	109	100	92	86
	50	1.133	168	150	135	122	112	104	96
	60	1.239	184	164	147	134	123	113	105

All application rates (gallons/acres) are estimates based on 0-28-0 (10.65 lbs/gallon) at 70 degrees F

All application rates (gallons/acres) are estimates based on 0-28-0 (10.65 lbs/gallon) at 70 degrees F

Colored Disc Orifice Chart

B
Components
Liquid

15" Spacing

Orifice Color (Approx Size)	PSI	Gal/Min 28-0-0	MPH						
			4.0	4.5	5.0	5.5	6.0	6.5	7.0
Pink (24)	10	0.033	3.2	2.9	2.6	2.4	2.2	2.0	1.9
	20	0.046	4.6	4.0	3.6	3.3	3.0	2.8	2.6
	30	0.057	5.6	5.0	4.5	4.1	3.7	3.5	3.2
	40	0.065	6.5	5.8	5.2	4.7	4.3	4.0	3.7
	50	0.073	7.3	6.5	5.8	5.3	4.8	4.5	4.2
60	0.081	8.0	7.1	6.4	5.8	5.3	4.9	4.6	
Gray (30)	10	0.050	5.0	4.4	4.0	3.6	3.3	3.1	2.9
	20	0.072	7.1	6.3	5.7	5.2	4.7	4.4	4.1
	30	0.088	8.7	7.7	6.9	6.3	5.8	5.3	5.0
	40	0.101	10.0	8.9	8.0	7.3	6.7	6.1	5.7
	50	0.112	11.1	9.9	8.9	8.1	7.4	6.8	6.4
60	0.124	12.3	10.9	9.8	8.9	8.2	7.5	7.0	
Black (35)	10	0.070	6.9	6.2	5.5	5.0	4.6	4.3	4.0
	20	0.098	9.7	8.6	7.8	7.1	6.5	6.0	5.6
	30	0.120	11.9	10.6	9.5	8.7	7.9	7.3	6.8
	40	0.139	13.8	12.2	11.0	10.0	9.2	8.5	7.9
	50	0.156	15.4	13.7	12.3	11.2	10.3	9.5	8.8
60	0.170	16.8	15.0	13.5	12.2	11.2	10.4	9.6	
Brown (41)	10	0.094	9.3	8.3	7.4	6.8	6.2	5.7	5.3
	20	0.132	13.1	11.6	10.4	9.5	8.7	8.0	7.5
	30	0.162	16.0	14.3	12.8	11.7	10.7	9.9	9.2
	40	0.187	18.5	16.4	14.8	13.4	12.3	11.4	10.6
	50	0.209	20.7	18.4	16.5	15.0	13.8	12.7	11.8
60	0.228	22.6	20.1	18.1	16.4	15.1	13.9	12.9	
Orange (46)	10	0.119	11.8	10.5	9.5	8.6	7.9	7.3	6.8
	20	0.169	16.7	14.9	13.4	12.2	11.2	10.3	9.6
	30	0.207	20.5	18.2	16.4	14.9	13.7	12.6	11.7
	40	0.239	23.7	21.0	18.9	17.2	15.8	14.6	13.5
	50	0.267	26.5	23.5	21.2	19.2	17.6	16.3	15.1
60	0.293	29.0	25.8	23.2	21.1	19.3	17.8	16.6	
Maroon (52)	10	0.149	15	13	12	11	10	9	8
	20	0.210	21	18	17	15	14	13	12
	30	0.257	25	23	20	18	17	16	15
	40	0.296	29	26	23	21	20	18	17
	50	0.332	33	29	26	24	22	20	19
60	0.363	36	32	29	26	24	22	21	
Red (63)	10	0.218	22	19	17	16	14	13	12
	20	0.307	30	27	24	22	20	19	17
	30	0.376	37	33	30	27	25	23	21
	40	0.435	43	38	34	31	29	26	25
	50	0.486	48	43	38	35	32	30	27
60	0.532	53	47	42	38	35	32	30	
Blue (80)	10	0.351	35	31	28	25	23	21	20
	20	0.496	49	44	39	36	33	30	28
	30	0.608	60	54	48	44	40	37	34
	40	0.702	69	62	56	51	46	43	40
	50	0.785	78	69	62	57	52	48	44
60	0.859	85	76	68	62	57	52	49	
Yellow (95)	10	0.506	50	45	40	36	33	31	29
	20	0.715	71	63	57	51	47	44	40
	30	0.876	87	77	69	63	58	53	50
	40	1.009	100	89	80	73	67	61	57
	50	1.133	112	100	90	82	75	69	64
60	1.239	123	109	98	89	82	75	70	
Green (110)	10	0.686	68	60	54	49	45	42	39
	20	0.973	96	86	77	70	64	59	55
	30	1.186	117	104	94	85	78	72	67
	40	1.372	136	121	109	99	91	84	78
	50	1.531	152	135	121	110	101	93	87
60	1.681	166	148	133	121	111	102	95	
White (125)	10	0.867	86	76	69	62	57	53	49
	20	1.230	122	108	97	89	81	75	70
	30	1.504	149	132	119	108	99	92	85
	40	1.735	172	153	137	125	114	106	98
	50	1.938	192	171	153	140	128	118	110
60	2.124	210	187	168	153	140	129	120	
Lime Green (156)	10	1.372	136	121	109	99	91	84	78
	20	1.947	193	171	154	140	128	119	110
	30	2.381	236	209	189	171	157	145	135
	40	2.752	272	242	218	198	182	168	156
	50	3.071	304	270	243	221	203	187	174
60	3.363	333	296	266	242	222	205	190	

All application rates (gallons/acres) are estimates based on 0-28-0 (10.65 lbs/gallon) at 70 degrees F.

20" Spacing

Orifice Color (Approx Size)	PSI	Gal/Min 28-0-0	MPH						
			4.0	4.5	5.0	5.5	6.0	6.5	7.0
Pink (24)	10	0.033	2.4	2.2	1.9	1.8	1.6	1.5	1.4
	20	0.046	3.4	3.0	2.7	2.5	2.3	2.1	2.0
	30	0.057	4.2	3.7	3.4	3.1	2.8	2.6	2.4
	40	0.065	4.9	4.3	3.9	3.5	3.2	3.0	2.8
	50	0.073	5.5	4.8	4.4	4.0	3.6	3.4	3.1
60	0.081	6.0	5.3	4.8	4.3	4.0	3.7	3.4	
Gray (30)	10	0.050	3.7	3.3	3.0	2.7	2.5	2.3	2.1
	20	0.072	5.3	4.7	4.3	3.9	3.5	3.3	3.0
	30	0.088	6.5	5.8	5.2	4.7	4.3	4.0	3.7
	40	0.101	7.5	6.7	6.0	5.4	5.0	4.6	4.3
	50	0.112	8.3	7.4	6.7	6.1	5.6	5.1	4.8
60	0.124	9.2	8.2	7.4	6.7	6.1	5.7	5.3	
Black (35)	10	0.070	5.2	4.6	4.2	3.8	3.5	3.2	3.0
	20	0.098	7.3	6.5	5.8	5.3	4.9	4.5	4.2
	30	0.120	8.9	7.9	7.1	6.5	6.0	5.5	5.1
	40	0.139	10.3	9.2	8.3	7.5	6.9	6.3	5.9
	50	0.156	11.6	10.3	9.3	8.4	7.7	7.1	6.6
60	0.170	12.6	11.2	10.1	9.2	8.4	7.8	7.2	
Brown (41)	10	0.094	7.0	6.2	5.6	5.1	4.6	4.3	4.0
	20	0.132	9.8	8.7	7.8	7.1	6.5	6.0	5.6
	30	0.162	12.0	10.7	9.6	8.7	8.0	7.4	6.9
	40	0.187	13.9	12.3	11.1	10.1	9.2	8.5	7.9
	50	0.209	15.5	13.8	12.4	11.3	10.3	9.5	8.9
60	0.228	17.0	15.1	13.6	12.3	11.3	10.4	9.7	
Orange (46)	10	0.119	8.9	7.9	7.1	6.5	5.9	5.5	5.1
	20	0.169	12.6	11.2	10.0	9.1	8.4	7.7	7.2
	30	0.207	15.4	13.7	12.3	11.2	10.3	9.5	8.8
	40	0.239	17.7	15.8	14.2	12.9	11.8	10.9	10.1
	50	0.267	19.8	17.6	15.9	14.4	13.2	12.2	11.3
60	0.293	21.7	19.3	17.4	15.8	14.5	13.4	12.4	
Maroon (52)	10	0.149	11	10	9	8	7	7	6
	20	0.210	16	14	12	11	10	10	9
	30	0.257	19	17	15	14	13	12	11
	40	0.296	22	20	18	16	15	14	13
	50	0.332	25	22	20	18	16	15	14
60	0.363	27	24	22	20	18	17	15	
Red (63)	10	0.218	16	14	13	12	11	10	9
	20	0.307	23	20	18	17	15	14	13
	30	0.376	28	25	22	20	19	17	16
	40	0.435	32	29	26	23	22	20	18
	50	0.486	36	32	29	26	24	22	21
60	0.532	39	35	32	29	26	24	23	
Blue (80)	10	0.351	26	23	21	19	17	16	15
	20	0.496	37	33	29	27	25	23	21
	30	0.608	45	40	36	33	30	28	26
	40	0.702	52	46	42	38	35	32	30
	50	0.785	58	52	47	42	39	36	33
60	0.859	64	57	51	46	43	39	36	
Yellow (95)	10	0.506	38	33	30	27	25	23	21
	20	0.715	53	47	42	39	35	33	30
	30	0.876	65	58	52	47	43	40	37
	40	1.009	75	67	60	54	50	46	43
	50	1.133	84	75	67	61	56	52	48
60	1.239	92	82	74	67	61	57	53	
Green (110)	10	0.686	51	45	41	37	34	31	29
	20	0.973	72	64	58	53	48	44	41
	30	1.186	88	78	70	64	59	54	50
	40	1.372	102	91	81	74	68	63	58
	50	1.531	114	101	91	83	76	70	65
60	1.681	125	111	100	91	83	77	71	
White (125)	10	0.867	64	57	52	47	43	40	37
	20	1.230	91	81	73	66	61	56	52
	30	1.504	112	99	89	81	74	69	64
	40	1.735	129	114	103	94	86	79	74
	50	1.938	144	128	115	105	96	89	82
60	2.124	158	140	126	115	105	97	90	
Lime Green (156)	10	1.372	102	91	81	74	68	63	58
	20	1.947	145	128	116	105	96	89	83
	30	2.381	177	157	141	129	118	109	101
	40	2.752	204	182	163	149	136	126	117
	50	3.071	228	203	182	166	152	140	130
60	3.363	250	222	200	182	166	154	143	

All application rates (gallons/acres) are estimates based on 0-28-0 (10.65 lbs/gallon) at 70 degrees F.

Colored Disc Orifice Chart

B
Components
Liquid

22" Spacing

Orifice Color (Approx Size)	PSI	Gal/Min 28-0-0	MPH						
			4.0	4.5	5.0	5.5	6.0	6.5	7.0
			10	0.033	2.2	2.0	1.8	1.6	1.5
20	0.046	3.1	2.8	2.5	2.3	2.1	1.9	1.8	
30	0.057	3.8	3.4	3.1	2.8	2.5	2.4	2.2	
40	0.065	4.4	3.9	3.5	3.2	2.9	2.7	2.5	
50	0.073	5.0	4.4	4.0	3.6	3.3	3.1	2.8	
60	0.081	5.4	4.8	4.3	4.0	3.6	3.3	3.1	
Gray (30)									
10	0.050	3.4	3.0	2.7	2.5	2.3	2.1	1.9	
20	0.072	4.8	4.3	3.9	3.5	3.2	3.0	2.8	
30	0.088	5.9	5.3	4.7	4.3	3.9	3.6	3.4	
40	0.101	6.8	6.1	5.4	5.0	4.5	4.2	3.9	
50	0.112	7.6	6.7	6.1	5.5	5.1	4.7	4.3	
60	0.124	8.4	7.4	6.7	6.1	5.6	5.1	4.8	
Black (35)									
10	0.070	4.7	4.2	3.8	3.4	3.1	2.9	2.7	
20	0.098	6.6	5.9	5.3	4.8	4.4	4.1	3.8	
30	0.120	8.1	7.2	6.5	5.9	5.4	5.0	4.6	
40	0.139	9.4	8.3	7.5	6.8	6.3	5.8	5.4	
50	0.156	10.5	9.3	8.4	7.6	7.0	6.5	6.0	
60	0.170	11.5	10.2	9.2	8.3	7.6	7.1	6.6	
Brown (41)									
10	0.094	6.3	5.6	5.1	4.6	4.2	3.9	3.6	
20	0.132	8.9	7.9	7.1	6.5	5.9	5.5	5.1	
30	0.162	10.9	9.7	8.7	8.0	7.3	6.7	6.2	
40	0.187	12.6	11.2	10.1	9.2	8.4	7.8	7.2	
50	0.209	14.1	12.5	11.3	10.3	9.4	8.7	8.1	
60	0.228	15.4	13.7	12.3	11.2	10.3	9.5	8.8	
Orange (46)									
10	0.119	8.1	7.2	6.5	5.9	5.4	5.0	4.6	
20	0.169	11.4	10.1	9.1	8.3	7.6	7.0	6.5	
30	0.207	14.0	12.4	11.2	10.2	9.3	8.6	8.0	
40	0.239	16.1	14.3	12.9	11.7	10.8	9.9	9.2	
50	0.267	18.0	16.0	14.4	13.1	12.0	11.1	10.3	
60	0.293	19.8	17.6	15.8	14.4	13.2	12.2	11.3	
Maroon (52)									
10	0.149	10	9	8	7	7	6	6	
20	0.210	14	13	11	10	9	9	8	
30	0.257	17	15	14	13	12	11	10	
40	0.296	20	18	16	15	13	12	11	
50	0.332	22	20	18	16	15	14	13	
60	0.363	24	22	20	18	16	15	14	
Red (63)									
10	0.218	15	13	12	11	10	9	8	
20	0.307	21	18	17	15	14	13	12	
30	0.376	25	23	20	18	17	16	15	
40	0.435	29	26	23	21	20	18	17	
50	0.486	33	29	26	24	22	20	19	
60	0.532	36	32	29	26	24	22	21	
Blue (80)									
10	0.351	24	21	19	17	16	15	14	
20	0.496	34	30	27	24	22	21	19	
30	0.608	41	36	33	30	27	25	23	
40	0.702	47	42	38	34	32	29	27	
50	0.785	53	47	42	39	35	33	30	
60	0.859	58	52	46	42	39	36	33	
Yellow (95)									
10	0.506	34	30	27	25	23	21	20	
20	0.715	48	43	39	35	32	30	28	
30	0.876	59	53	47	43	39	36	34	
40	1.009	68	61	54	50	45	42	39	
50	1.133	76	68	61	56	51	47	44	
60	1.239	84	74	67	61	56	51	48	
Green (110)									
10	0.686	46	41	37	34	31	28	26	
20	0.973	66	58	53	48	44	40	38	
30	1.186	80	71	64	58	53	49	46	
40	1.372	93	82	74	67	62	57	53	
50	1.531	103	92	83	75	69	64	59	
60	1.681	113	101	91	83	76	70	65	
White (125)									
10	0.867	59	52	47	43	39	36	33	
20	1.230	83	74	66	60	55	51	47	
30	1.504	102	90	81	74	68	62	58	
40	1.735	117	104	94	85	78	72	67	
50	1.938	131	116	105	95	87	81	75	
60	2.124	143	127	115	104	96	88	82	
Lime Green (156)									
10	1.372	93	82	74	67	62	57	53	
20	1.947	131	117	105	96	88	81	75	
30	2.381	161	143	129	117	107	99	92	
40	2.752	186	165	149	135	124	114	106	
50	3.071	207	184	166	151	138	128	118	
60	3.363	227	202	182	165	151	140	130	

All application rates (gallons/acres) are estimates based on 0-28-0 (10.65 lbs/gallon) at 70 degrees F.

36" Spacing

Orifice Color (Approx Size)	PSI	Gal/Min 28-0-0	MPH						
			4.0	4.5	5.0	5.5	6.0	6.5	7.0
			10	0.033	1.4	1.2	1.1	1.0	0.9
20	0.046	1.9	1.7	1.5	1.4	1.3	1.2	1.1	
30	0.057	2.3	2.1	1.9	1.7	1.6	1.4	1.3	
40	0.065	2.7	2.4	2.2	2.0	1.8	1.7	1.5	
50	0.073	3.0	2.7	2.4	2.2	2.0	1.9	1.7	
60	0.081	3.3	3.0	2.7	2.4	2.2	2.0	1.9	
Gray (30)									
10	0.050	2.1	1.8	1.7	1.5	1.4	1.3	1.2	
20	0.072	3.0	2.6	2.4	2.2	2.0	1.8	1.7	
30	0.088	3.6	3.2	2.9	2.6	2.4	2.2	2.1	
40	0.101	4.2	3.7	3.3	3.0	2.8	2.6	2.4	
50	0.112	4.6	4.1	3.7	3.4	3.1	2.9	2.6	
60	0.124	5.1	4.5	4.1	3.7	3.4	3.1	2.9	
Black (35)									
10	0.070	2.9	2.6	2.3	2.1	1.9	1.8	1.6	
20	0.098	4.1	3.6	3.2	2.9	2.7	2.5	2.3	
30	0.120	5.0	4.4	4.0	3.6	3.3	3.1	2.8	
40	0.139	5.7	5.1	4.6	4.2	3.8	3.5	3.3	
50	0.156	6.4	5.7	5.1	4.7	4.3	4.0	3.7	
60	0.170	7.0	6.2	5.6	5.1	4.7	4.3	4.0	
Brown (41)									
10	0.094	3.9	3.4	3.1	2.8	2.6	2.4	2.2	
20	0.132	5.4	4.8	4.4	4.0	3.6	3.3	3.1	
30	0.162	6.7	5.9	5.3	4.9	4.5	4.1	3.8	
40	0.187	7.7	6.8	6.2	5.6	5.1	4.7	4.4	
50	0.209	8.6	7.7	6.9	6.3	5.7	5.3	4.9	
60	0.228	9.4	8.4	7.5	6.8	6.3	5.8	5.4	
Orange (46)									
10	0.119	4.9	4.4	3.9	3.6	3.3	3.0	2.8	
20	0.169	7.0	6.2	5.6	5.1	4.6	4.3	4.0	
30	0.207	8.5	7.6	6.8	6.2	5.7	5.3	4.9	
40	0.239	9.9	8.8	7.9	7.2	6.6	6.1	5.6	
50	0.267	11.0	9.8	8.8	8.0	7.3	6.8	6.3	
60	0.293	12.1	10.7	9.7	8.8	8.1	7.4	6.9	
Maroon (52)									
10	0.149	6	5	5	4	4	4	4	
20	0.210	9	8	7	6	6	5	5	
30	0.257	11	9	8	8	7	7	6	
40	0.296	12	11	10	9	8	8	7	
50	0.332	14	12	11	10	9	8	8	
60	0.363	15	13	12	11	10	9	9	
Red (63)									
10	0.218	9	8	7	7	6	6	5	
20	0.307	13	11	10	9	8	8	7	
30	0.376	16	14	12	11	10	10	9	
40	0.435	18	16	14	13	12	11	10	
50	0.486	20	18	16	15	13	12	11	
60	0.532	22	20	18	16	15	14	13	
Blue (80)									
10	0.351	14	13	12	11	10	9	8	
20	0.496	20	18	16	15	14	13	12	
30	0.608	25	22	20	18	17	15	14	
40	0.702	29	26	23	21	19	18	17	
50	0.785	32	29	26	24	22	20	19	
60	0.859	35	32	28	26	24	22	20	
Yellow (95)									
10	0.506	21	19	17	15	14	13	12	
20	0.715	29	26	24	21	20	18	17	
30	0.876	36	32	29	26	24	22	21	
40	1.009	42	37	33	30	28	26	24	
50	1.133	47	42	37	34	31	29	27	
60	1.239	51	45	41	37	34	31	29	
Green (110)									
10	0.686	28	25	23	21	19	17	16	
20	0.973	40	36	32	29	27	25	23	
30	1.186	49	43	39	36	33	30	28	
40	1.372	57	50	45	41	38	35	32	
50	1.531	63	56	51	46	42	39	36	
60	1.681	69	62	55	50	46	43	40	
White (125)									
10	0.867	36	32	29	26	24	22	20	
20	1.230	51	45	41	37	34	31	29	
30	1.504	62	55	50	45	41	38	35	
40	1.735	72	64	57	52	48	44	41	
50	1.938	80	71	64	58	53	49	46	
60	2.124	88	78	70	64	58	54	50	
Lime Green (156)									
10	1.372	57	50	45	41	38	35	32	
20	1.947	80	71	64	58	54	49	46	
30	2.381	98	87	79	71	65	60	56	
40	2.752	114	101	91	83	76	70	65	
50	3.071	127	113	101	92	84	78	72	
60	3.363	139	123	111	101	92	85	79	

All application rates (gallons/acres) are estimates based on 0-28-0 (10.65 lbs/gallon) at 70 degrees F.



Dual Metering Tube Plumbing Kits with Dual Check Valve

For more information, read [Navigating the Metering Tube Maze](#) or [Metering Tube / LiquiShiftTube Charts](#).



SureFire dual metering tube plumbing kits are a great way to apply fertilizer.

These plumbing kits will contain everything you need to distribute fertilizer from the flowmeter outlet down to the ground application device of your choice (not included).

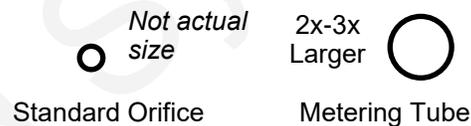
These instructions will show you where all the pieces go. It will provide guidance on how much metering tube to use. There are some optional fittings included in each plumbing kit. These instructions will show you where and why you'd want to use the optional pieces.

The dual check valve assembly is a key piece in the dual metering tube design. In addition to a check valve to stop fertilizer from draining when the system is shut off, **each check valve has an on/off valve on top of it. These on / off valves allow the operator to turn on only tube 1, only tube 2, or both tube 1 and 2.** This provides for three different application ranges, which is especially helpful when using a fertilizer which has a highly variable viscosity based on temperature changes or when changing rates from field to field.

Dual Advantage of Dual Metering Tube

Metering tube provides a larger passage way diameter than a comparable orifice. For a 5 GPA rate on 30" rows, a size 0.046" orifice would be used. For the same rate a 0.110" meter tube that is 8' long would be used. This 8' tube with more than twice the diameter creates a fertilizer system resistant to plugging while providing excellent row to row distribution.

By using two metering tubes, the fertilizer system can handle a wider range of rates and provide the proper system pressure as the fertilizer properties change due to temperature, mixtures and other factors.



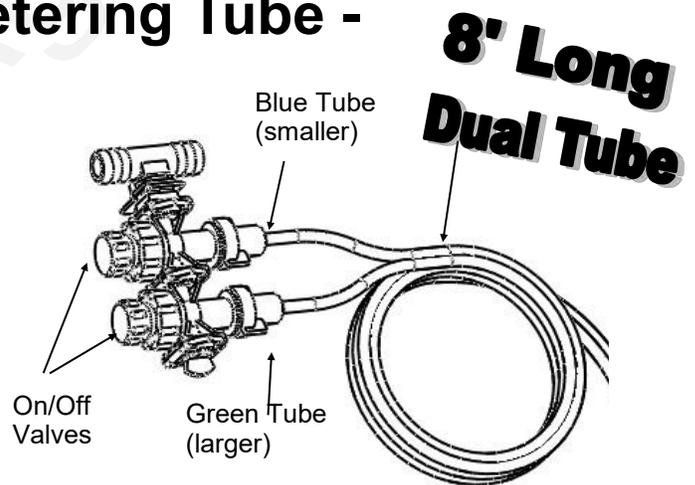
Field Operation of Dual Metering Tube - Dual Check Valve System

The dual metering tube allows for three application rate ranges. Some fertilizers have a widely variable viscosity. Therefore, based on temperature, tank mixing and fertilizer batch, the best tube to use will change.

SureFire recommends you start with the larger tube ON only. This is the middle size and is a good starting point. Conduct a test using the Nozzle Flow Check with fertilizer to determine your system pressure. If pressure is below 15 psi, some check valves may not open and row to row distribution will be uneven.

Start with larger tube ON, smaller tube OFF:

- **Pressure below 15 PSI: Turn larger tube OFF and smaller tube ON.**
- **Pressure over 50 PSI: Turn BOTH tubes ON.**



	GPA on 30" rows (approx, will vary)
Blue Tube	1.5 - 3
Green Tube	3 - 6
Blue & Green Tube	6 - 10
Minimum Recommended flow for Blue Tube (8 ft)	4 - 5 oz/min

Other tubes are available if needed for different application rates.

** Ultra Low Rate Application –For rates from 2-5 oz/min/row use a 12 foot length of metering tube. To calculate oz/min/row: $Oz/min/row = (GPA \times MPH \times spacing \text{ (inches)}) \div 46.4$

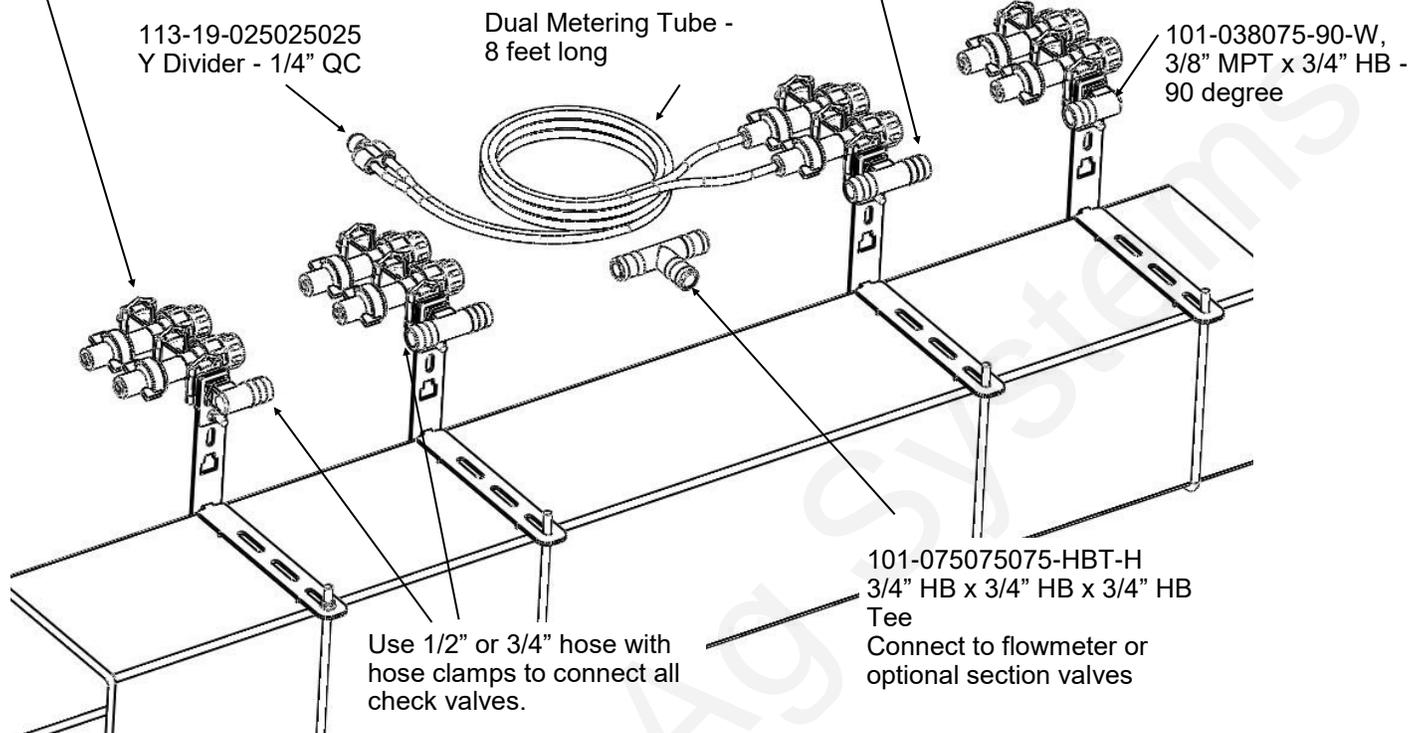


Dual Check Valve Plumbing Diagram

4 Row Planter Shown, add rows as necessary

136-04-200400, Dual 4 PSI check valve with 1/4" QC caps and 3/8" FPT inlet

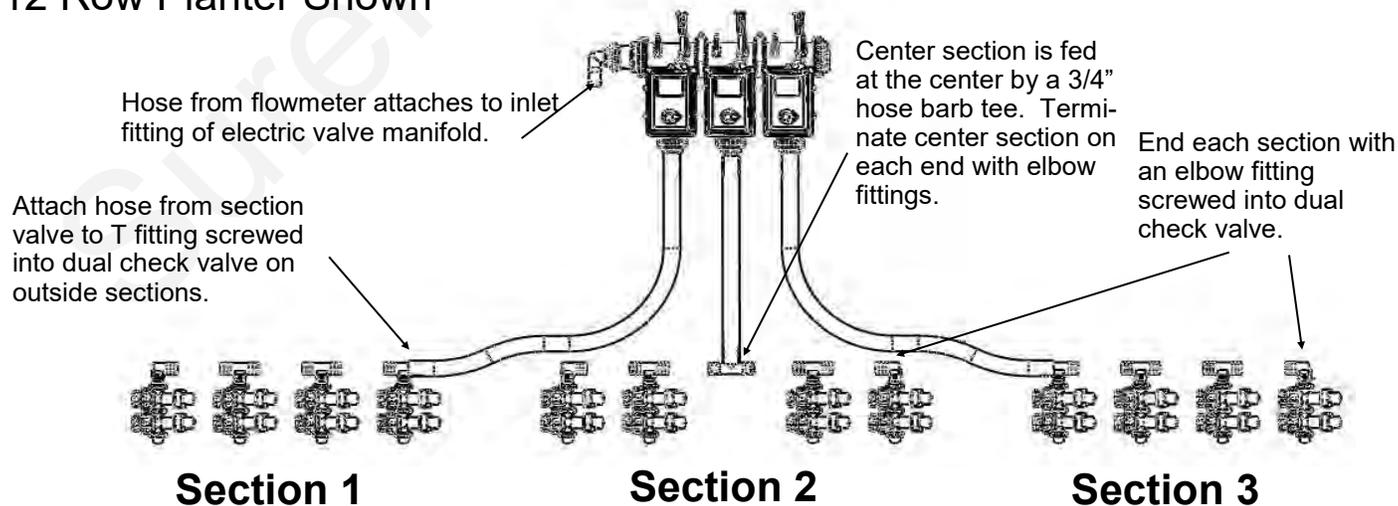
101-075075038-HBT-M-W 3/4" HB x 3/4" HB x 3/8" MPT Tee



This is a general diagram showing the dual check valve assembly mounted on a planter toolbar. The check valve and bracket are very flexible in their mounting. The check valve can mount behind, directly over, or in front of the toolbar. The check valve can be put in the bracket facing up & down or sideways (shown). In addition the steel bracket could be rotated 90 degrees and clamp around the bar. The multiple slots in the bracket are used to mount to any tube 7x7 inches or smaller.

Sectional Plumbing Diagram with Dual Check Valves

12 Row Planter Shown



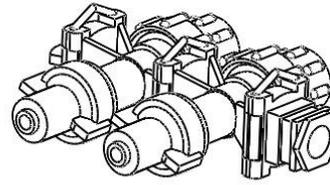
For a **2 section plumbing system**, omit the center section and plumb similar to the outside 2 sections.

Dual Check Valve Assembly Steps

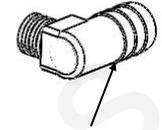
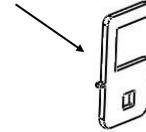
B
Components
Liquid

Follow these steps to mount each check valve to the steel bracket.

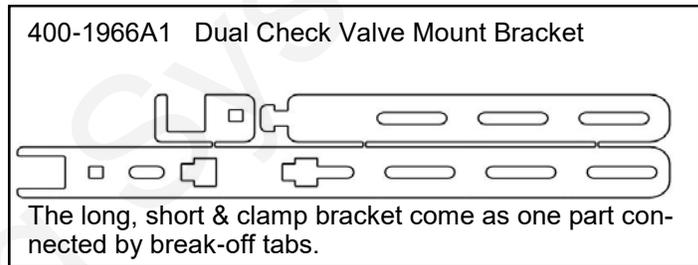
1. Screw the 3/8" MPT x 3/4" HB tee or elbow into the check valve using blue thread sealer. Orient the hose barb to run the 3/4" hose down the planter toolbar.
2. Insert the check valve into the "C" notch in the end of the bracket, according to how you want the check valve to be mounted on your planter. Orient the wire clips up or to the side for easiest access.
3. Slide the small "C" clamp bracket around the check valve to lock it in place.
4. Install the 1/4" carriage bolt and flange nut to secure the "C" clamp plate around the check valve.
5. Now, mount the check valve on the bar. Hold the check valve and long bracket assembly on the toolbar. Slide the tab on the front of the short bracket into the upper or lower notch on the long bracket.
6. Slide the L bolt into the appropriate slots on the brackets for your tube size. Tighten the 1/4" flange nuts to hold the bracket in place.



Clamp Bracket



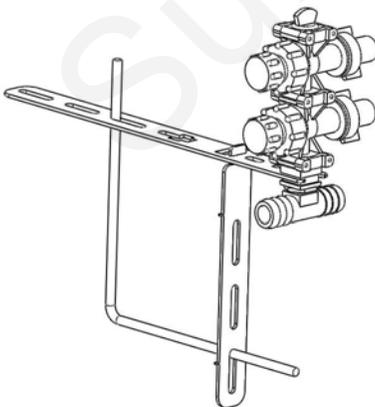
Elbow at end of section, Tee in mid-locations.



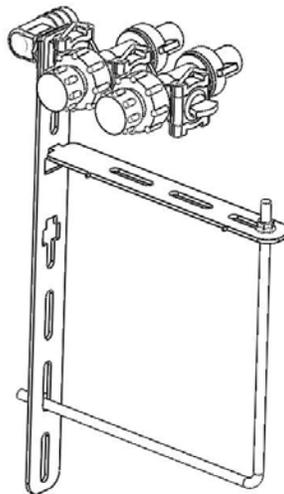
Check Valve Mounting Options

The dual check valve mounting bracket is very flexible to fit many different planter configurations. Three options are shown here to illustrate some of the possibilities.

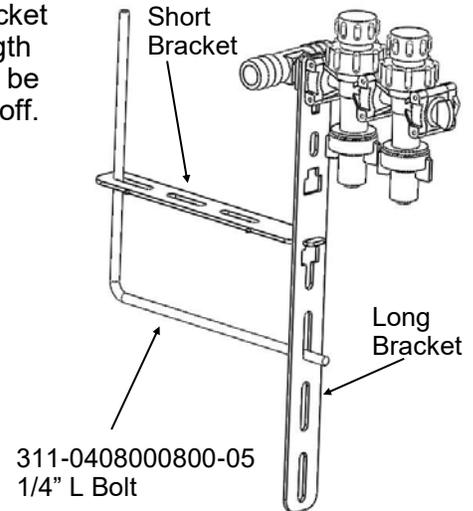
Example 1. Use the long bracket on the top of a bar. The check valve is mounted vertically. The liquid supply hose is ran directly on the front side of the bar. The U-bolt is placed in slots to clamp on a 4x6 inch tube.



Example 2. Use the long bracket on the rear of a bar. The check valve is mounted over the top of the bar. The supply line would run above and behind the bar. The short bracket is placed in the notch to mount the check valve closer to the bar.



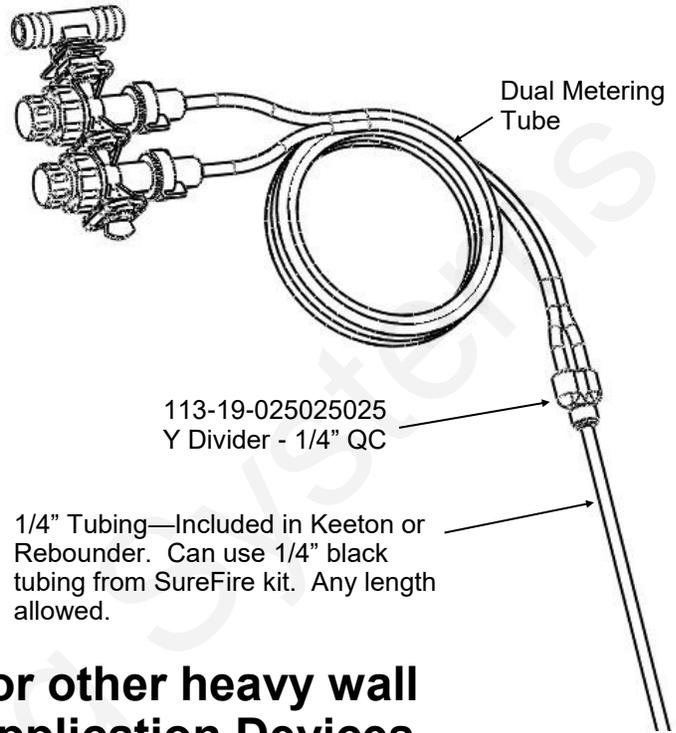
Example 3. Use the long bracket on the front of a 3x7 bar (vacuum tube on some planters). Mount the check valve hanging forward of the bar. The supply line will run directly over the bar. The excess bolt and bracket length can be cut off.



Connection to Keeton Seed Firmer, Rebounder Seed Covers or through thin wall stainless steel tubes

1. Mount the Keeton Seed Firmer or Rebounder Seed Cover.
2. Route the tube included in the above kit as instructed.
3. Attach the 1/4" tube to the 1/4" QC Y divider fitting.
4. Zip all tubing to the planter and row unit in as many locations as possible.

For thin wall stainless steel tubes, you can push the 1/4" black tubing all the way through the stainless steel tube so fertilizer will run directly from the tubing onto the ground.

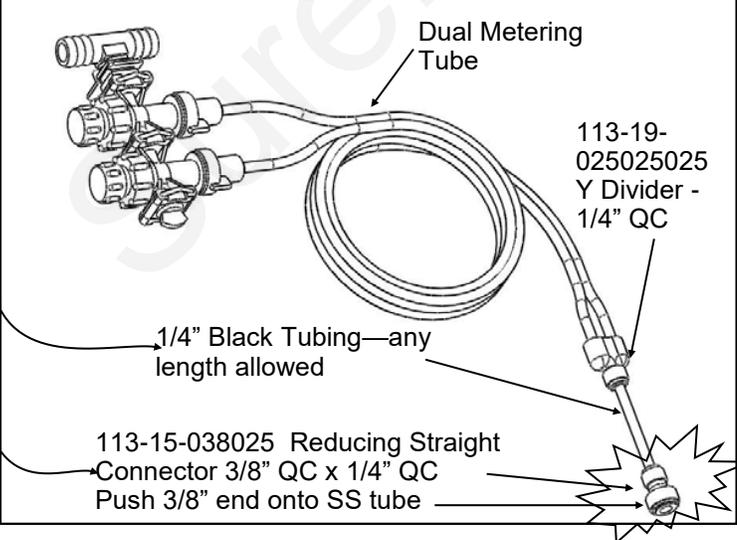


Connection to Totally Tubular or other heavy wall Stainless Steel Tube Ground Application Devices

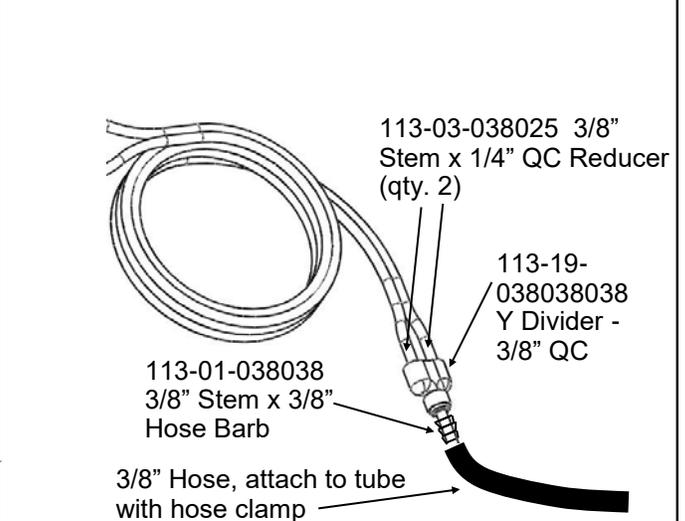
When using a 3/8" OD stainless steel tube to apply fertilizer to the ground, there are two options for the delivery tube plumbing. If the tube ID is less than 1/4" (tubing will not fit inside tube) this attachment method must be used. The description following is for Option 1. See bottom right picture for Option 2.

1. Use the 1/4" x 3/8" QC fitting shown. Push the 3/8" end onto the stainless steel tube. (Hint: if the fitting slips off the stainless steel tube, use sandpaper or a file to roughen the end of the tube slightly)
2. Use a short piece of 1/4" black tubing to connect the Y fitting to the reducer fitting on the stainless steel tube.
3. Zip all tubing to the planter and row unit in as many locations as possible.

Option 1: QC Fitting attaches to SS Tube



Option 2: 3/8" Hose attaches to SS Tube



396-4116Y1 Metering Tube (8'), LiquiShift, and Split Flow Tube Charts

Low Viscosity (28-0-0 approx 10.7 lb/gal)				Medium-Low Viscosity (32-0-0 approx 11.0 lb/gal)			
	oz/min	mL/min	gal/min		oz/min	mL/min	gal/min
Tube Color	Flow Range	Flow Range	Flow Range	Tube Color	Flow Range	Flow Range	Flow Range
Gray	3.5-10	105-295	0.03 - 0.08	Gray	2.5-7.5	74-222	0.02-0.06
Purple	6-20	180-590	0.05 - 0.16	Purple	4.1-15.7	121-464	0.03-0.12
Brown	8-25	235-750	0.06 - 0.20	Brown	5.7-20	170-590	0.04-0.16
Blue	10-31	295-915	0.08 - 0.24	Blue	7.5-25	220-740	0.06-0.20
Green	18-55	530-1600	0.14 - 0.43	Green	14-46	415-1360	0.11-0.36
Tan	25-75	740-2220	0.19 - 0.59	Tan	20-64	590-1890	0.16-0.50
Orange	44-126	1300-3725	0.34 - 0.98	Orange	36-114	1065-3370	0.28-0.89
Yellow	55-154	1625-4555	0.43 - 1.20	Yellow	44-137	1300-4050	0.34-1.07
Black	72-205	2130-6060	0.56 - 1.60	Black	60-175	1775-5175	0.47-1.37
5' Tan	33-100	975-2960	0.26 - 0.78	5' Tan	27-85	800-2515	0.21-0.66
5' Orange	57-165	1685-4880	0.45 - 1.29	5' Orange	49-155	1450-4585	0.38-1.21
5' Yellow	70-200	2070-5915	0.55 - 1.56	5' Yellow	59-185	1745-5470	0.46-1.45
5' Black	95-260	2810-7690	0.74 - 2.03	5' Black	80-235	2365-6950	0.63-1.84

10-60 PSI 60°F

Medium Viscosity (Starter, N-P Blend, approx 11.2 lb/gal)				High Viscosity (10-34-0 approx 11.6 lb/gal) For 11-37-0, find the flow range here, and use next larger tube.			
	oz/min	mL/min	gal/min		oz/min	mL/min	gal/min
Tube Color	Flow Range	Flow Range	Flow Range	Tube Color	Flow Range	Flow Range	Flow Range
Gray	1.5-5.0	45-150	0.01-0.04	Gray			
Purple	2.2-11.5	65-340	0.02-0.09	Purple	1-4	30-118	0.008-0.03
Brown	3.5-15	105-445	0.03-0.12	Brown	1.4-6	41-177	0.011-0.05
Blue	5-19.5	150-575	0.04-0.15	Blue	1.8-8	53-237	0.014-0.06
Green	9.5-37	280-1095	0.07-0.29	Green	2.6-14	77-414	0.02-0.11
Tan	14-53	415-1565	0.11-0.41	Tan	4-22	120-650	0.03-0.17
Orange	27-102	800-3015	0.21-0.80	Orange	9-44	265-1300	0.07-0.34
Yellow	33-120	975-3550	0.26-0.94	Yellow	13-61	385-1805	0.10-0.48
Black	48-145	1420-4290	0.38-1.13	Black	18-80	530-2365	0.14-0.63
5' Tan	20-75	590-2220	0.16-0.59	5' Tan	6-31	165-910	0.04-0.24
5' Orange	38-140	1125-4140	0.30-1.09	5' Orange	13-62	375-1820	0.10-0.48
5' Yellow	46-170	1360-5030	0.36-1.33	5' Yellow	18-85	540-2525	0.14-0.67
5' Black	67-200	1980-5915	0.52-1.56	5' Black	25-112	745-3310	0.20-0.88

10-60 PSI 60°F--For 10-34-0 select a tube with additional capacity for cold weather.

Water (8.34 lb/gal)			
	oz/min	mL/min	gal/min
Tube Color	Flow Range	Flow Range	Flow Range
White	2.5-7.5	75-220	0.02-0.06
Gray	5.8-15.5	170-460	0.045-0.12
Purple	10-26	295-770	0.08-0.20
Brown	12.5-34	370-1005	0.10-0.27
Blue	17.5-45	520-1330	0.14-0.35
Green	26-70	770-2070	0.20-0.55
Tan	34-93	1005-2750	0.27-0.73
Orange	60-159	1775-4700	0.47-1.24
Yellow	75-196	2220-5800	0.59-1.53

These charts are typical flow rates from 10 to 60 PSI.

Electric pumps typically won't operate at 60 psi. See charts on next page for 10 to 40 PSI for typical electric pump operating range.

These charts are designed for typical N-P fertilizers. Suspension, granular, and/or clay-based products may not follow these charts.

These charts are for product at 60° F. Products will be thicker and pressure will be higher at lower temperatures (esp 10-34-0). MAW

LiquiShift Dual Tube Combinations

Low Viscosity Product (28-0-0) (10.6 lb/gal)		
ML	OZ	20-70 PSI
Flow Range	Flow Range	Tubes
180-1475	6-50	Purple/Blue
240-2365	8-80	Brown/Green
295-2510	10-85	Blue/Green
295-3105	10-105	Blue/Tan
535-5025	18-170	Green/Orange
535-5765	18-195	Green/Yellow
740-6210	25-210	Tan/Yellow
740-7390	25-250	Tan/Black
1035-8870	35-300	5' Tan/Yellow
1300-9165	44-310	Orange/Black
1035-9610	35-325	5' Tan/Black
1625-10350	55-350	Yellow/Black
1685-11830	57-400	5' Orange/Black
2070-13600	70-460	5' Yellow/Black

Medium-Low Viscosity (32-0-0) (11.0 lb/gal)		
ML	OZ	20-70 PSI
Flow Range	Flow Range	Tubes
135-1180	4.5-40	Purple/Blue
165-1920	5.7-65	Brown/Green
220-2070	7.5-70	Blue/Green
220-2570	7.5-87	Blue/Tan
415-4495	14-152	Green/Orange
415-5175	14-175	Green/Yellow
590-5620	20-190	Tan/Yellow
590-6210	20-210	Tan/Black
830-7985	28-270	5' Tan/Yellow
1035-8030	35-275	Orange/Black
830-9020	28-305	5' Tan/Black
1300-9020	44-305	Yellow/Black
1420-10795	48-365	5' Orange/Black
1775-12125	60-410	5' Yellow/Black

To calculate Flow (oz/min/row): **Speed (mph) X Rate (gpa) X Row Spacing (in) divided by 46.4**

Calculate Minimum flow using Minimum Speed and Minimum Rate.

Calculate Maximum flow using Maximum Speed and Maximum Rate.

Find the Tube Combination that best covers the Flow Range needed.

10-34-0 gets thicker and harder to push when cold. **Use a larger tube combination when possible for 10-34-0** so it will flow OK when it is cold.

Medium Viscosity (N-P-K Blend, ProGerm-11.2 lb/gal)		
ML	OZ	20-70 PSI
Flow Range	Flow Range	Tubes
75-885	2.5-30	Purple/Blue
105-1475	3.5-50	Brown/Green
150-1625	5-55	Blue/Green
150-2070	5-70	Blue/Tan
295-3990	10-135	Green/Orange
295-4435	10-150	Green/Yellow
415-5025	14-170	Tan/Yellow
415-5765	14-195	Tan/Black
590-7245	20-245	5' Tan/Yellow
800-7100	27-240	Orange/Black
590-7985	20-270	5' Tan/Black
975-7690	33-260	Yellow/Black
1125-9760	38-330	5' Orange/Black
1360-10795	46-365	5' Yellow/Black

High Viscosity (10-34-0 at 60 deg) (11.65 lb/gal)		
ML	OZ	20-70 PSI
Flow Range	Flow Range	Tubes
30-325	1-11	Purple/Blue
44-530	1.5-18	Brown/Green
53-590	1.8-20	Blue/Green
53-830	1.8-28	Blue/Tan
75-1480	2.6-50	Green/Orange
75-1920	2.6-65	Green/Yellow
118-2220	4-75	Tan/Yellow
118-2960	4-100	Tan/Black
180-3400	6-115	5' Tan/Yellow
265-3400	9-115	Orange/Black
180-4230	6-143	5' Tan/Black
385-3850	13-130	Yellow/Black
415-4730	14-160	5' Orange/Black
530-5765	18-195	5' Yellow/Black

Tubes may need to be adjusted for best operation with a particular product.

If necessary, system can be operated at 70-90 PSI to achieve high flow rates.

Green/Yellow combination should only be used when maximum range is needed.

LiquiShift Mode Selection should be set at 20-80 PSI for Green/Yellow tubes.

7/14/2020

Metering Tubes to use to split the flow to both sides of the row:

(Numbers indicate the **flow range through each tube** in oz/min with a pressure drop from 4 to 15 psi)

LOW VISC	2'	32"	4'
Purple	7-20	6-15	5-11
Blue	12-32	11-25	9-20
Green	24-55	20-47	18-36
Tan	31-73	27-64	24-48
Orange	56-125	47-110	41-83
Yellow	71-153	60-135	53-104
Black	91-205	76-175	68-133
MID VISC	2'	32"	4'
Purple	4-11	3-9	2-6
Blue	7-20	5-15	4-11
Green	14-36	10-30	8-23
Tan	20-55	15-44	12-31
Orange	37-100	30-84	26-62
Yellow	46-120	36-102	30-75
Black	65-145	52-130	45-100
HIGH VISC	2'	32'	4'
Purple	1-4	0.9-3	0.6-2
Blue	2-8	1.8-6	1.6-4
Green	4-14	3-11	2.5-9
Tan	6-22	4.5-17	3.8-11.5
Orange	14-44	10.5-36	8-25
Yellow	19-61	15-49	12-34
Black	27-80	21-65	16-49
WATER	2'	32'	4'
White	3.5-7.5	3-5.8	2.5-5
Gray	7-15	6-13	5-11
Purple	13-26	11-23	9-18
Blue	22-40	19-39	16-31
Green	33-70	28-60	25-48
Tan	43-93	37-80	32-64

(32" tube is an 8' tube cut into 3 pieces)

VISC	EX	LB/ GAL	SP GR
LOW	28-0-0	10.7	1.29
MID	9-24-3	11.2	1.34
HIGH	10-34-0	11.6	1.39

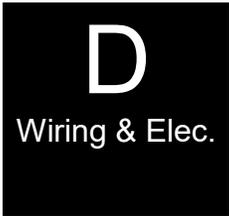
As with all metering tube recommendations, these charts should provide a starting point, but adjustments may need to be made in the field.

When doing a split at the row, we are trying to provide paths of equal resistance (and equal flow) to each side of the row, while keeping the pressure drop in this step as small as possible.

In general, use as large a tube (and / or as short a tube) as possible to minimize the pressure drop caused by splitting the flow. In other words, if possible, use the tube that matches up best at the low end of the range on the chart, rather than at the high end.

A compromise may need to be made in LiquiShift systems that have a wide flow range that extends beyond a selection on the chart.

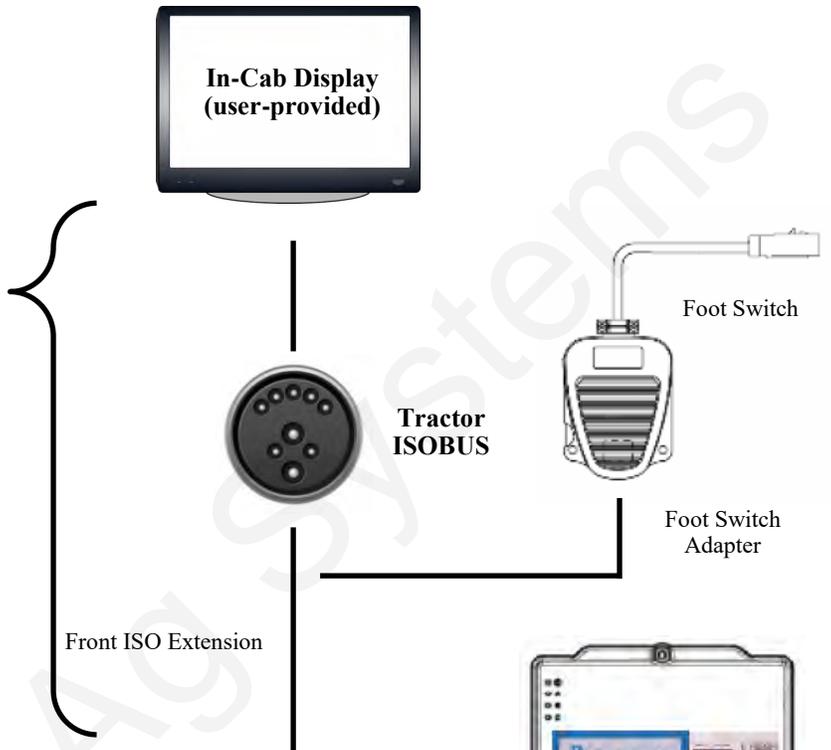
SureFire Harness Layout for RAVEN RCM



SureFire recommends buying a Raven RCM Adapter Harness from SureFire that will connect directly to the three connectors on the Raven RCM Controller.

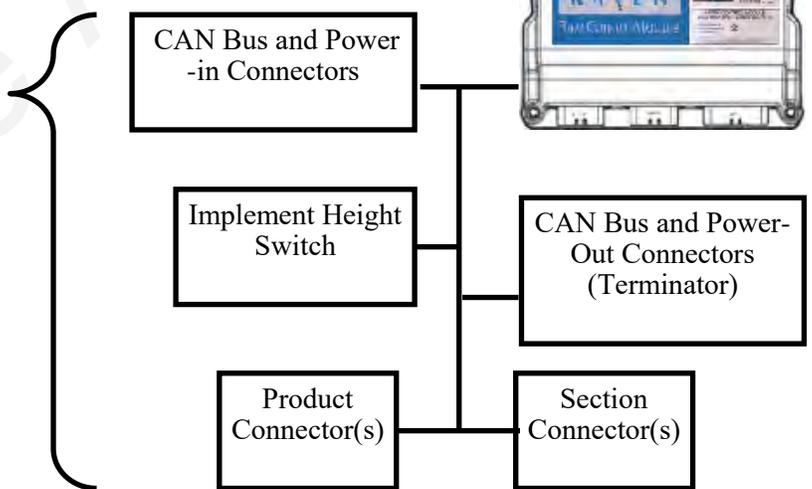
Footswitch & ISO Extensions (Purchase from SureFire)

Designed to integrate with many ISOBUS virtual terminals, The Raven RCM's connection starts at the tractor's ISOBUS connection. Power and information is relayed to the Raven RCM using a SureFire Front ISO Extension which includes a foot switch and CAN bus connections. Already using the tractor ISOBUS? No Problem. SureFire has an ISOBUS Y harness that can be used in that instance.



Raven RCM & Adapter Harness (purchase from SureFire)

These harnesses connect the CAN bus to the Raven RCM. Each harness will go directly to 12-pin product connectors and 14-pin section connectors. SureFire offers many different Raven RCM Adapter Harnesses built for a specific single-product or multi-product systems.



Final Harnesses (purchase from SureFire)

Final Harnesses connect the Raven RCM Adapter Harness to pump drivers, flowmeters, hydraulic motors, speed sensors, pressure sensors, valves and any other components in a liquid, dry or NH3 application system.

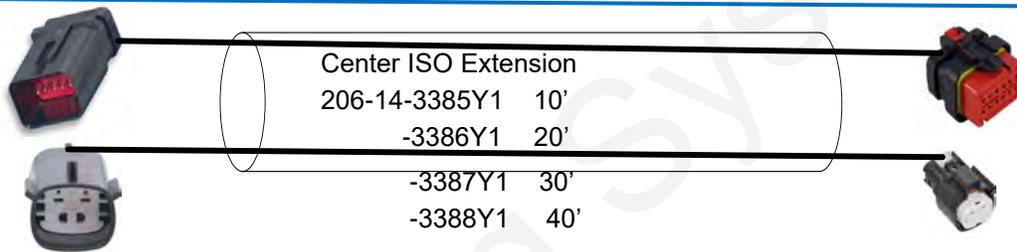
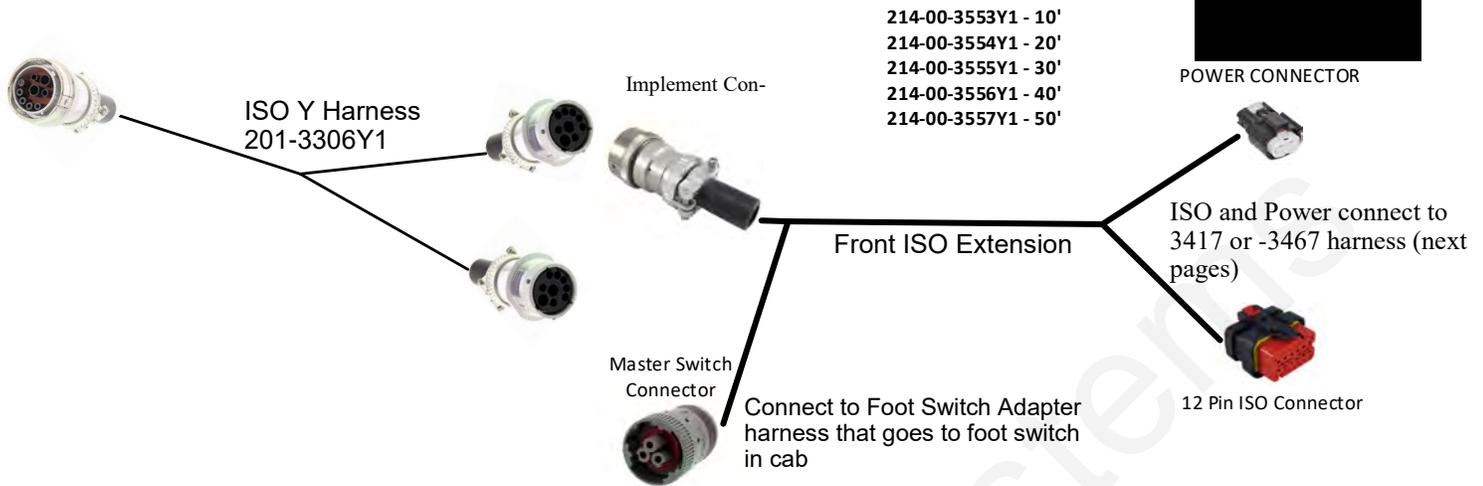
Product Harnesses

One is required for each product being applied. They start with a 12-pin connector and are unique to Liquid, Dry or NH3 application.

Section Harnesses

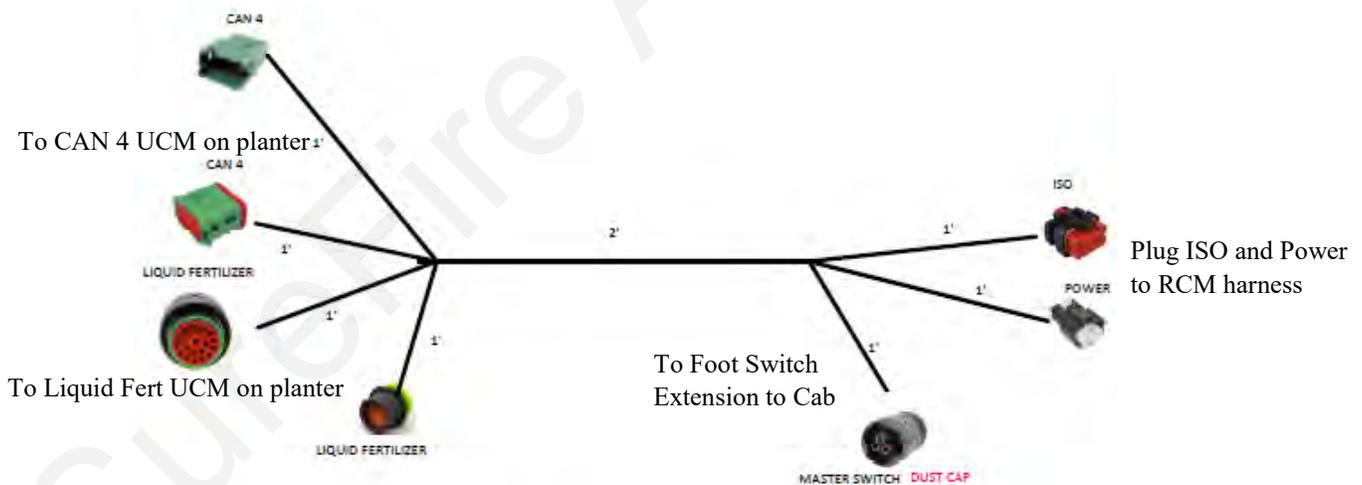
Each section harness starts with a 14-pin connector that allows up to 6 sections to be controlled.

Harness Layout Below and on the next page are the harnesses in a typical setup. Your layout may vary. A layout could begin with a Center ISO Extension if there is a connection for that on the implement.



Harness Option for Case 2000 Series Planter to Raven RCM

213-05-3873Y3

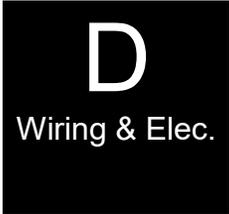


Plugging in the Raven RCM:

1. Plug the 35-pin and 23-pin connectors from the SureFire adapter harness (213-00-3467Y_) into the RCM.
2. Plug the 12-pin ISO and 2-pin Power connector on the long leads of the 213-00-3467Y_ harness into the ISO and Power connectors shown above. Plug in an ISO terminator to the short ISO lead, or connect next ISO module.
3. The RCM must have a foot switch in the cab. Make the necessary connections to connect the foot switch.
4. Plug in the Implement Height Switch if it is being used.
5. Plug in the final Product and Section harnesses.

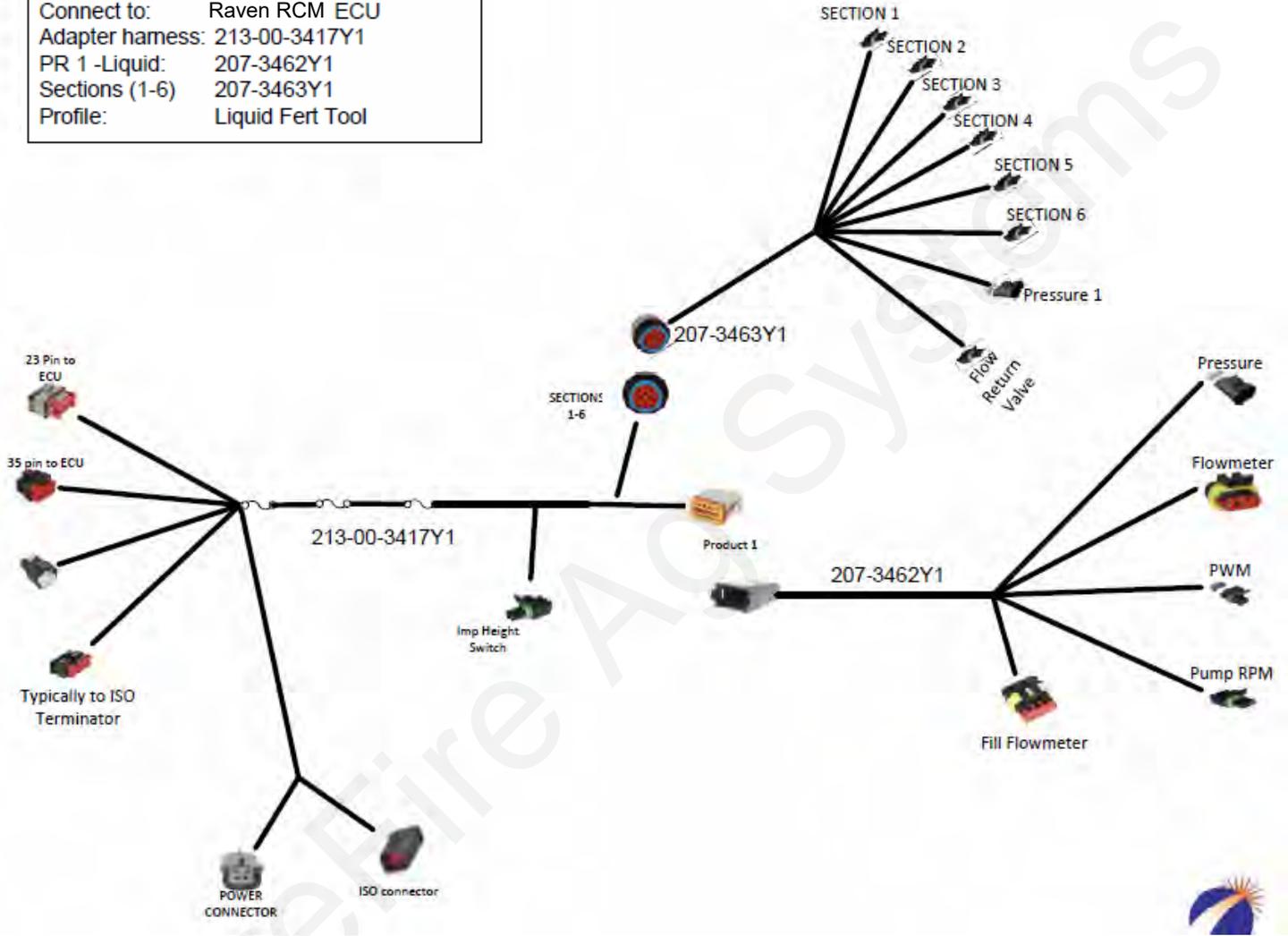
Example PumpRight & RCM Layout

The harnessing shown below would be used to connect a SureFire PumpRight system with up to 6 section valves to the Raven RCM.



Using SureFire Direct to RCM ECU

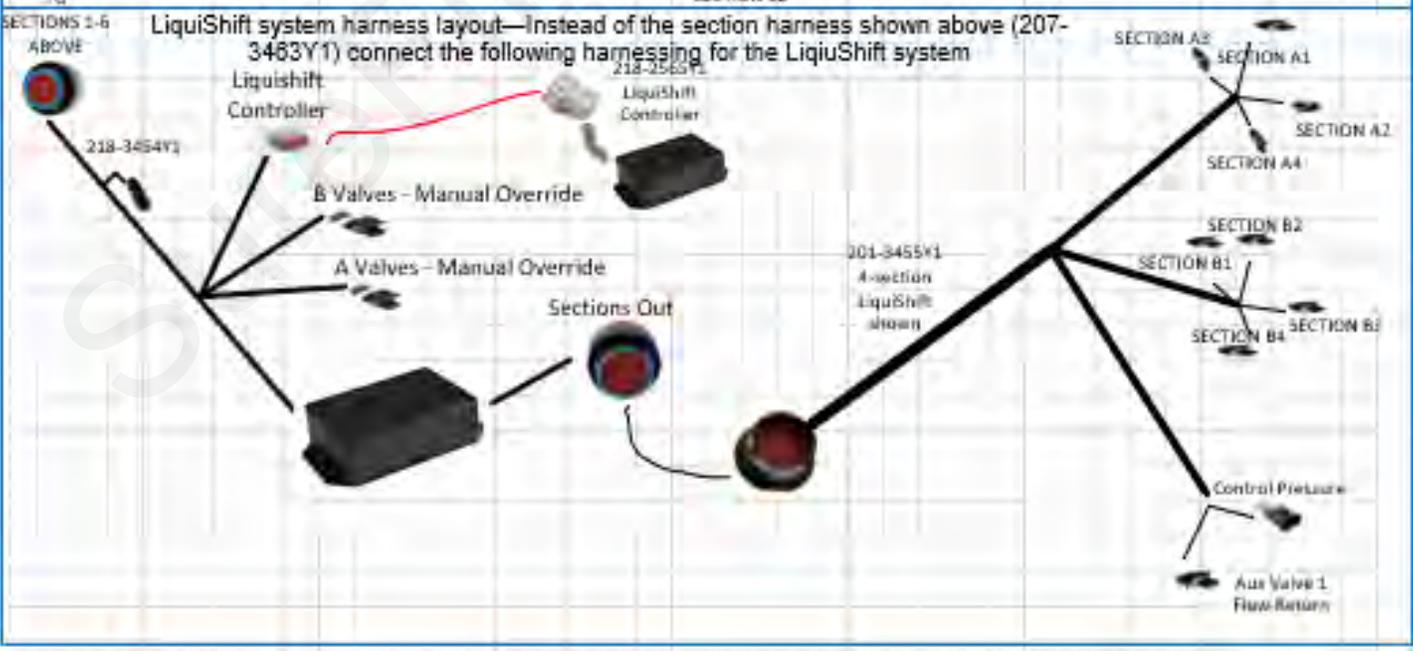
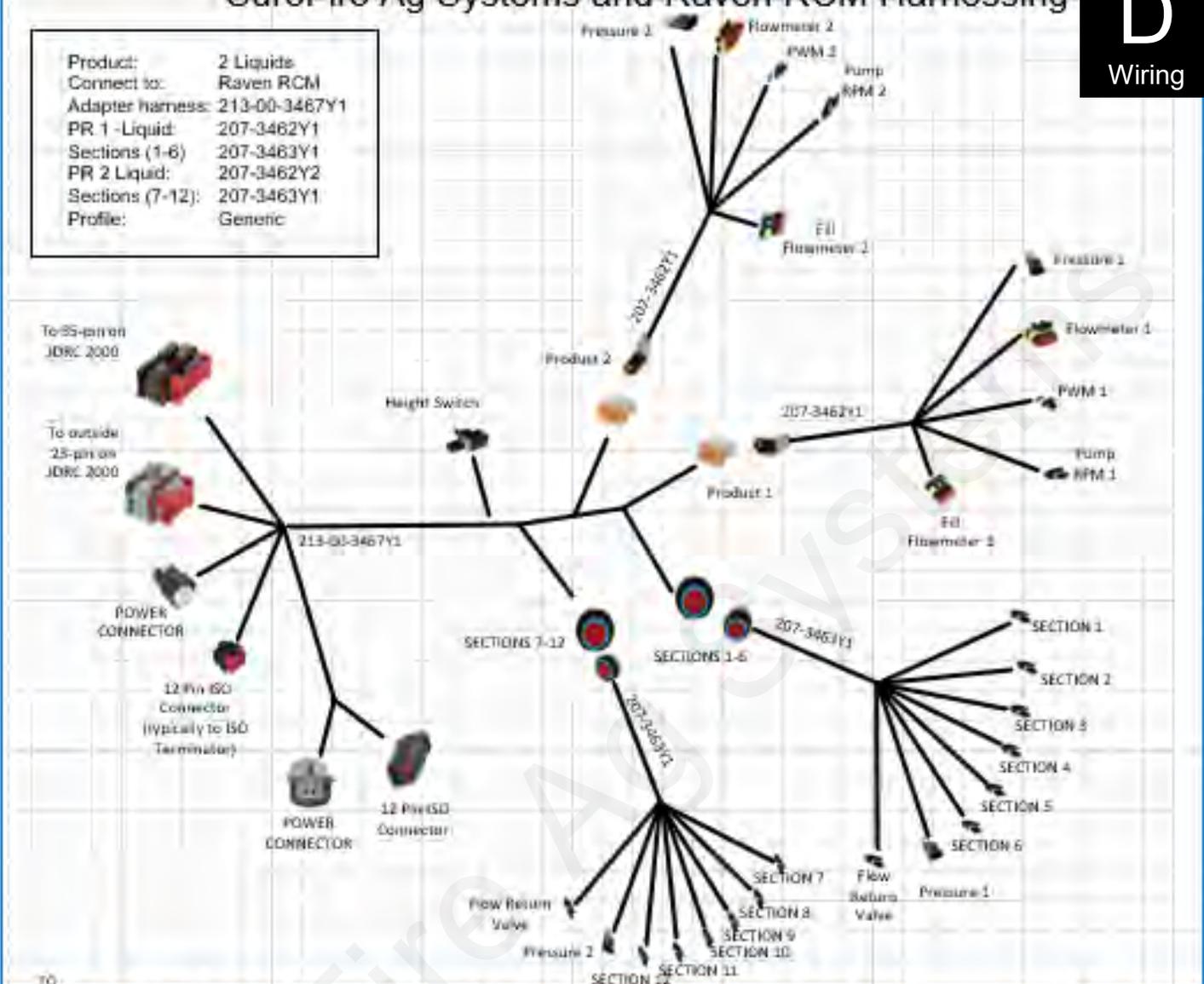
Product:	1 Liquid (up to 6 Sections)
Connect to:	Raven RCM ECU
Adapter harness:	213-00-3417Y1
PR 1 -Liquid:	207-3462Y1
Sections (1-6)	207-3463Y1
Profile:	Liquid Fert Tool



SureFire Ag Systems and Raven RCM Harnessing

D
Wiring

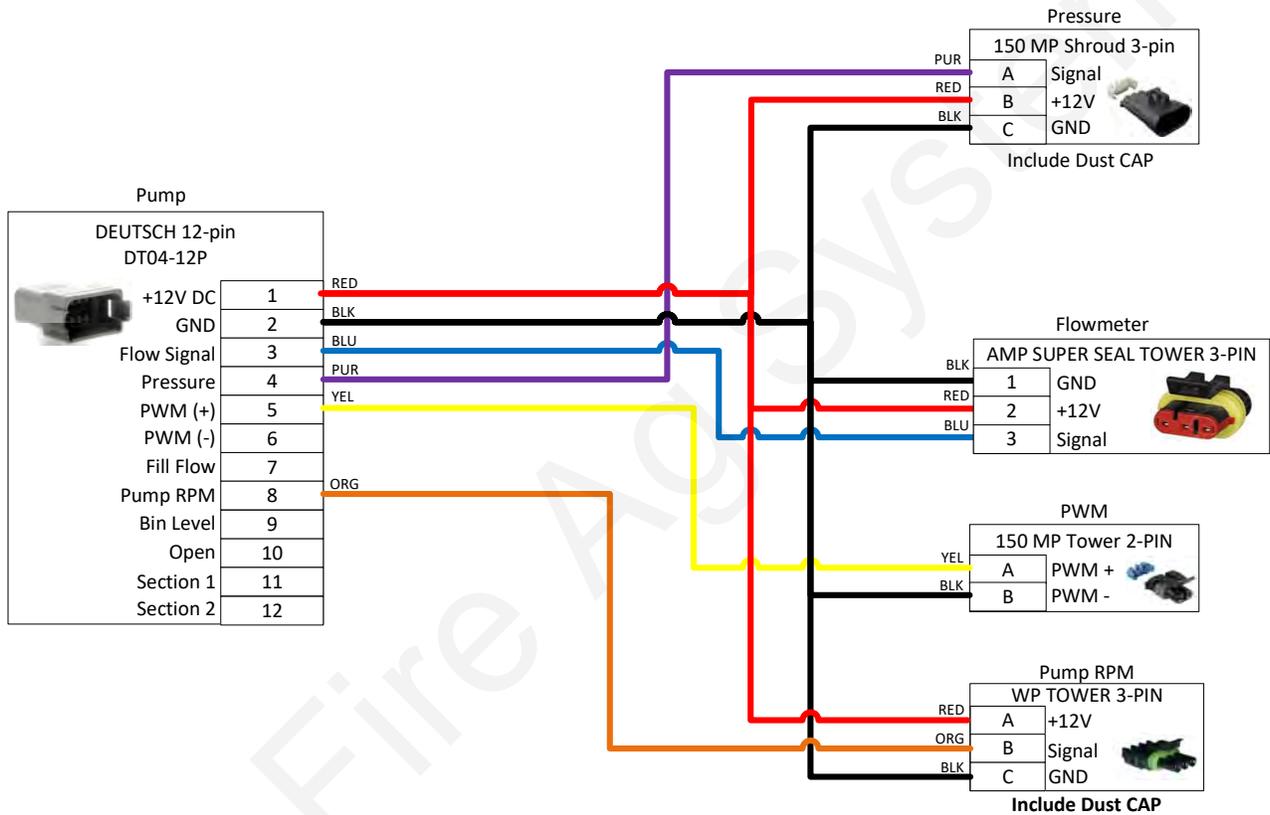
Product:	2 Liquids
Connect to:	Raven RCM
Adapter harness:	213-00-3467Y1
PR 1 -Liquid:	207-3462Y1
Sections (1-6):	207-3463Y1
PR 2 Liquid:	207-3462Y2
Sections (7-12):	207-3463Y1
Profile:	Generic



207-3462Y2

Final Cable for SureFire Liquid Pump System (pwm, flow, pres., pump rpm)

Wire 18AWG
unless otherwise
specified

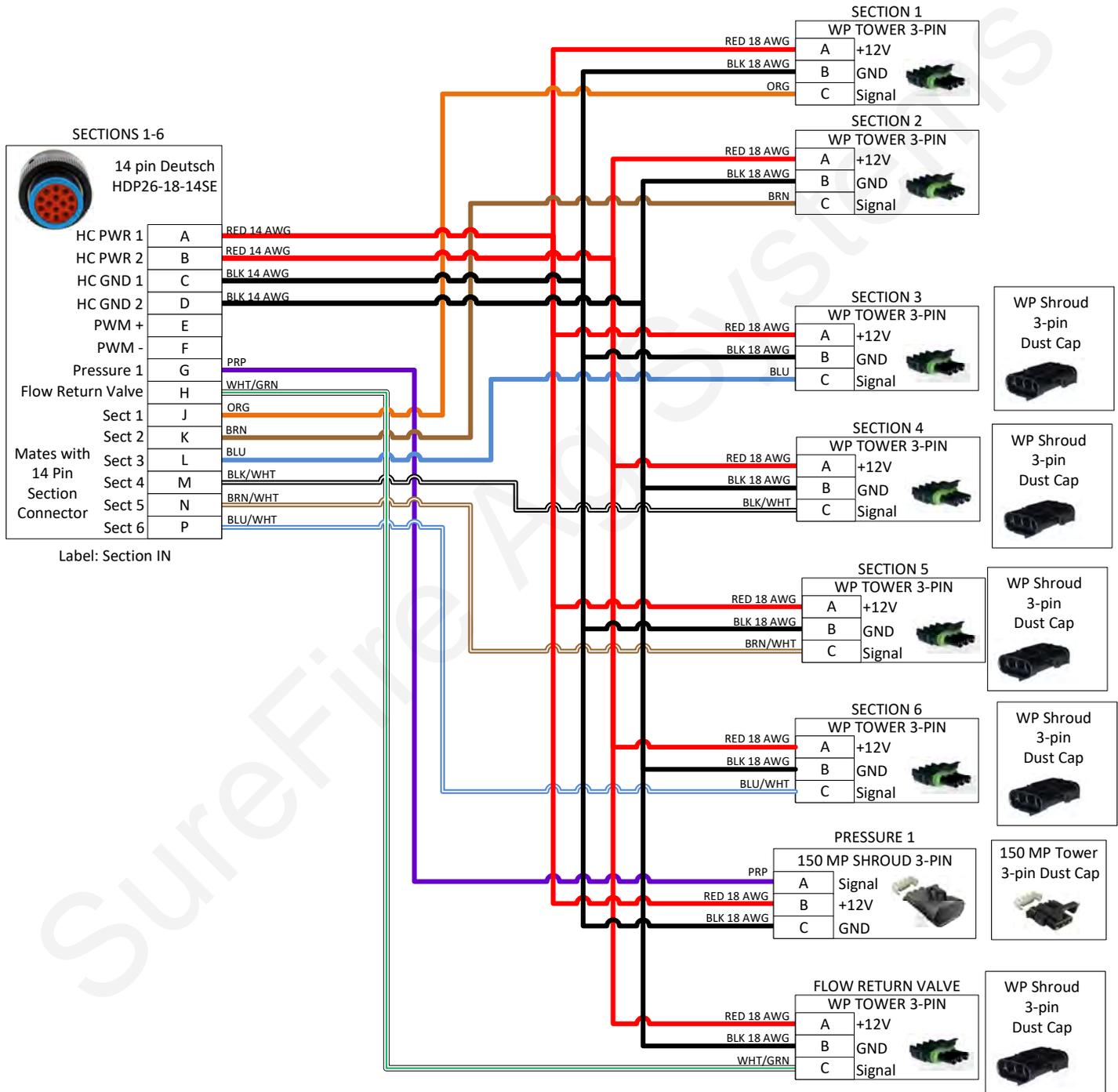


Part No:	207-3462Y2	Drawn By:	Brandon Cavenee		
Description:	Final Cable for SureFire Liquid Pump System (pwm, flow, pres., pump rpm)	Last Edit Date:	6/4/2021	Revision	A-03
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207-3463Y1

14-Pin 6 Section Final Cable (6 sections, flow return, pressure)

**Wire 18AWG
unless otherwise
specified**

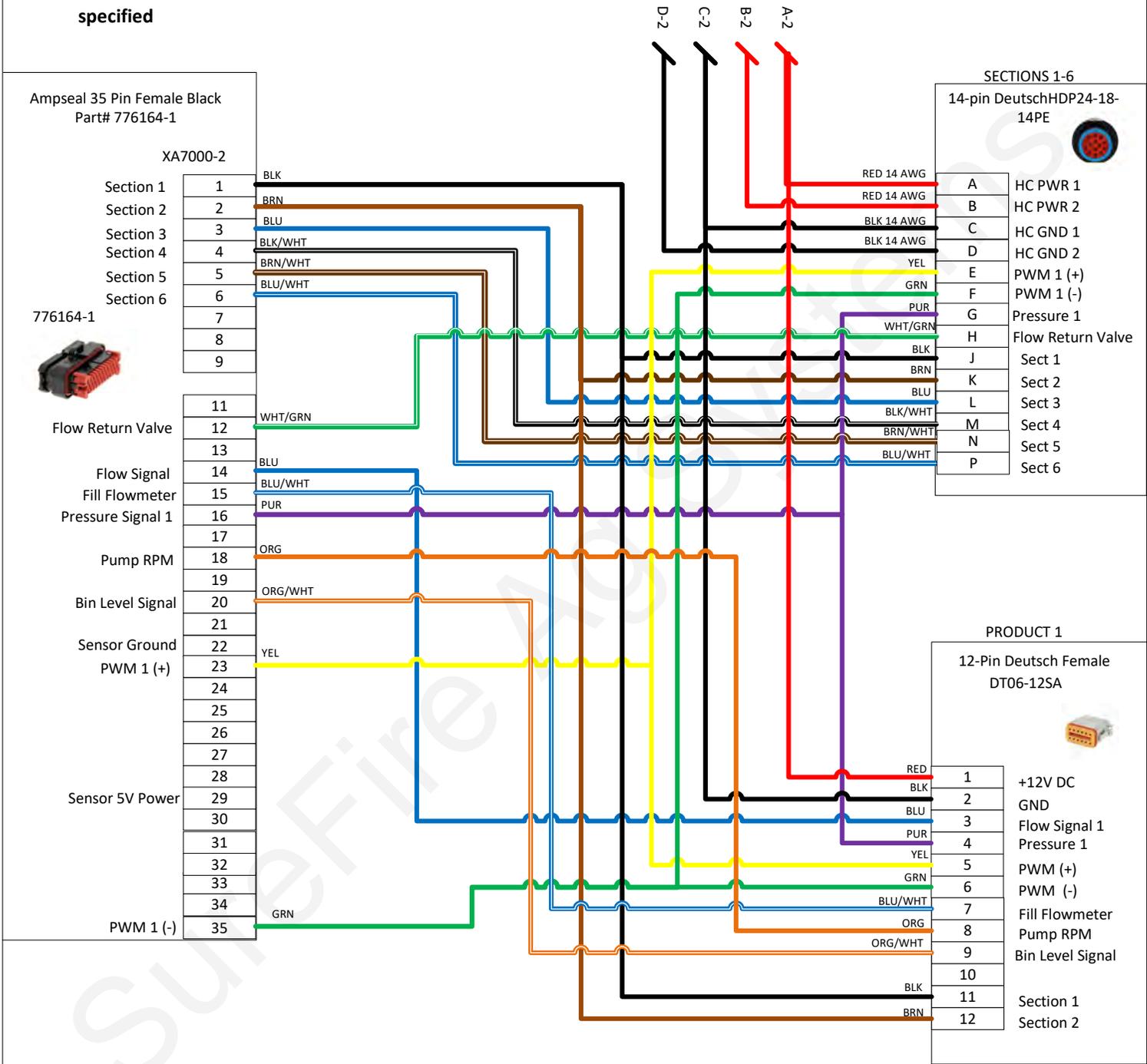


	Part No:	207-3463Y1	Drawn By:	Brandon Cavenee		
	Description:	14-Pin 6 Section Final Cable (6 sections, flow return, pressure)	Last Edit Date:	6/4/2021	Revision	A-02
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213-00-3417Y4

ECU to Liquid Single Product_6 sections

Wire 18AWG
unless otherwise
specified



Part No:	213-00-3417Y4	Drawn By:	Mark Wolters		
Description:	ECU to Liquid Single Product_6 sections	Last Edit Date:	9/4/2018	Revision	A-06
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213-00-3417Y4 ECU to Liquid Single Product_6 sections

**Wire 18AWG
unless otherwise
specified**

**Ampseal 23 Pin
Female Gray
Part# 770680-4**



XA7000-1

Hi Power15A	1	RED 14 AWG
Hi Power 15A	2	RED 14AWG
Hi Power 15A	3	RED 14 AWG
Hi GND	4	BLK 14 AWG
Hi GND	5	BLK 14 AWG
Hi GND	6	BLK 14 AWG
	7	
	8	
ECU Power	9	RED 14 AWG
	10	
Master Switch	11	BLU
Imp Height Switch	12	GRN
Sensor Return (Gnd)	13	BLK
+5VDC	14	RED
ECU Ground	15	BLK 14 AWG
	16	
ISO CAN LO	17	GRN
ISO CAN HI	18	YEL
	19	
	20	
	21	
	22	
+12V Sensor	23	

**12 Pin ISO Connector
Ampseal 16 (Male)
12 Pin, Part# 776438-1**

1	BLK 14 AWG	ECU GND
2	RED 14 AWG	ECU Power
3	BLK	GND
4	YEL	ISO CAN Hi
5		
6	BLU	Master Switch
7		
8	RED 14 AWG	12 V Batt Power
9	RED	
10	GRN	ISO CAN Lo
11		
12		



**POWER CONNECTOR
Molex MX (Male), 2 PIN
Part# 19433-0014**

1	BLK 8 AWG	HC GND
2	RED 8 AWG	HC PWR



**12 Pin ISO Connector
Ampseal 16 (Female)
12 Pin, Part# 776437-1**

1	BLK 14 AWG	ECU GND
2	RED 14 AWG	ECU Power
3	BLK	GND
4	YEL	ISO CAN Hi
5		
6	BLU	Master Switch
7		
8	RED 14 AWG	12 V Batt Power
9	RED	
10	GRN	ISO CAN Lo
11		
12		



**POWER CONNECTOR
Molex MX (Female), 2 PIN
Part# 19432-0014**

1	BLK 8 AWG	HC GND
2	RED 8 AWG	HC PWR

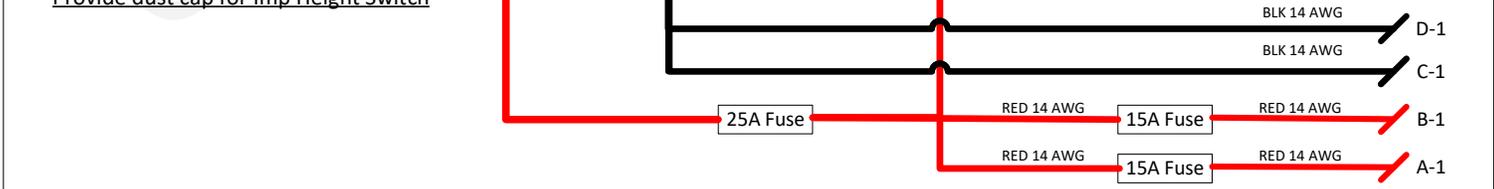


**Imp Height Switch
WP TOWER 3-PIN**

A	BLK	GND
B	GRN	Imp Sw
C	RED	+5VDC

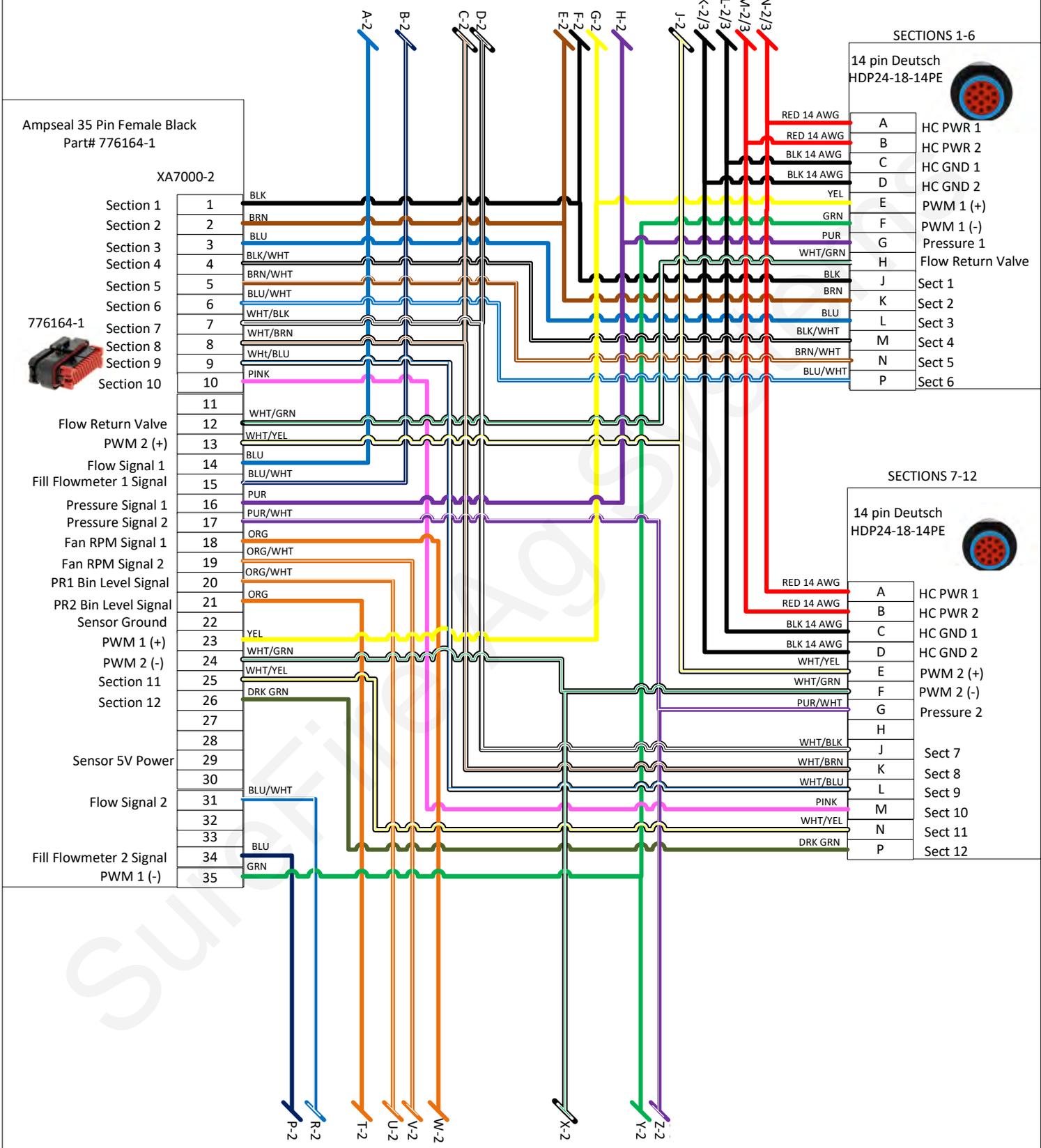


Provide dust cap for Imp Height Switch



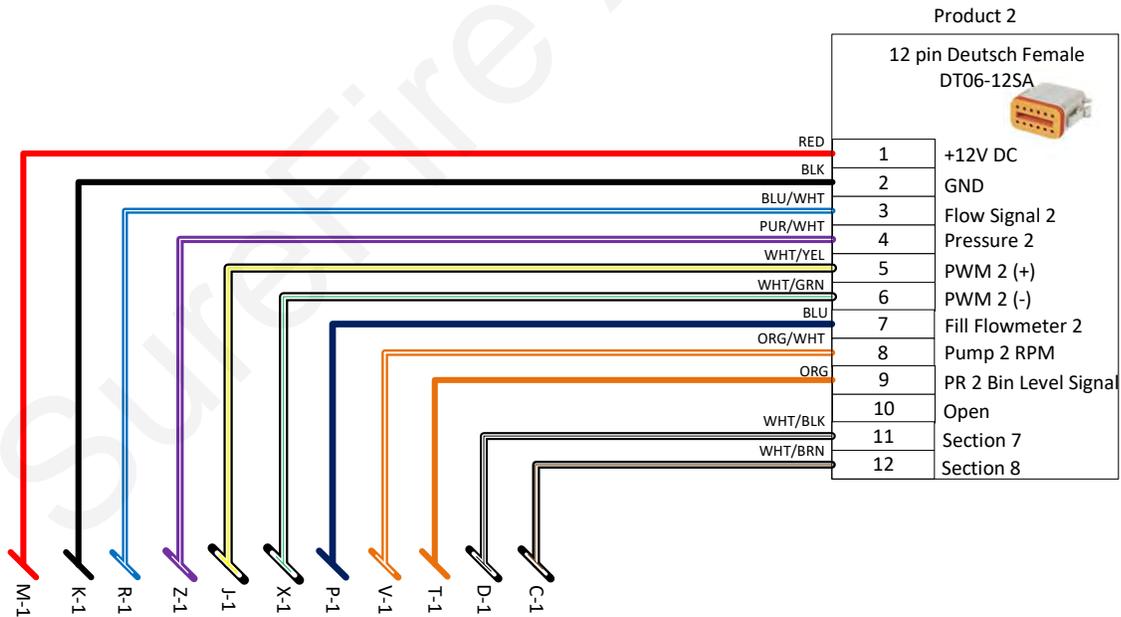
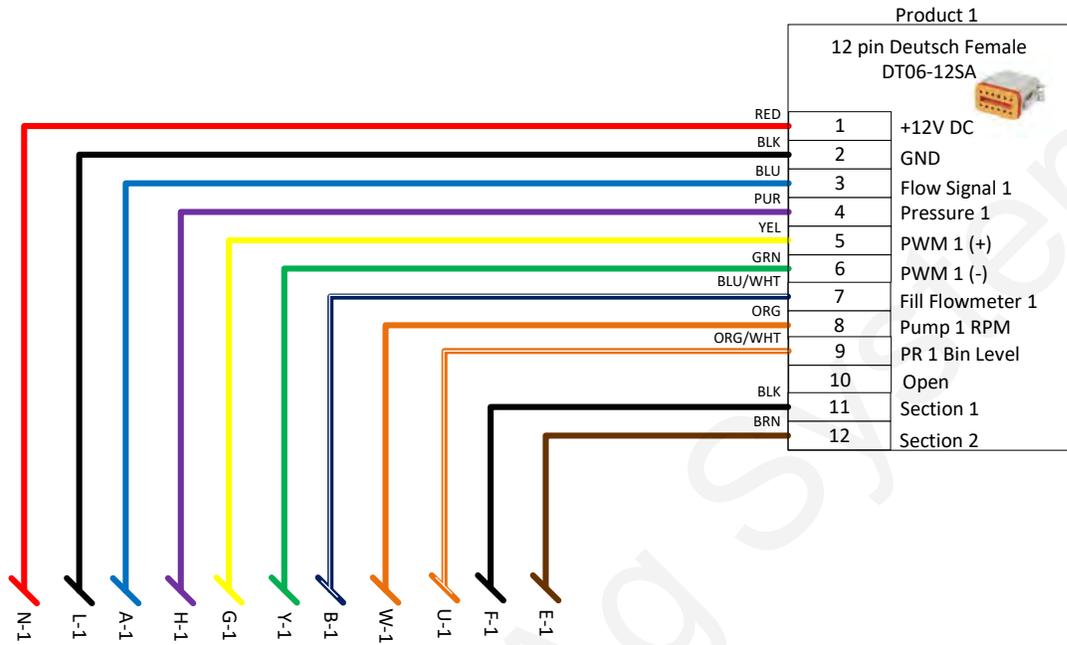
	Part No:	213-00-3417Y4	Drawn By:	Mark Wolters		
	Description:	ECU to Liquid Single Product_6 sections	Last Edit Date:	9/4/2018	Revision	A-06
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ECU Direct to Liquid 2 product and 12 sections adapter harness



213-00-3467Y4

ECU Direct to Liquid 2 product and 12 sections adapter harness



	Part No:	213-00-3467Y4	Drawn By:	Mark Wolters		
	Description:	ECU Direct to Liquid 2 product and 12 sections adapter harness	Last Edit Date:	9/4/2018	Revision	A-06
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213-00-3467Y4

ECU Direct to Liquid 2 product and 12 sections adapter harness

Wire 18AWG unless otherwise specified

Ampseal 23 Pin Female Gray
Part# 770680-4



XA7000-1

Hi Power15A	1	RED 14 AWG
Hi Power 15A	2	RED 14AWG
Hi Power 15A	3	RED 14 AWG
Hi GND	4	BLK 14 AWG
Hi GND	5	BLK 14 AWG
Hi GND	6	BLK 14 AWG
	7	
ECU Power	9	RED 14 AWG
	10	
Master Switch	12	BLU
Imp Height Switch	13	GRN
Sensor Ground	14	BLK
+5VDC	15	RED
ECU Ground	16	BLK 14 AWG
	17	
ISO CAN LO	18	GRN
ISO CAN HI	19	YEL
	20	
	21	
	22	
+12V Sensor	23	

ISO
Ampseal 16 (Male)
12 Pin, Part# 776438-1

1	BLK 14 AWG	ECU GND
2	RED 14 AWG	ECU Power
3	BLK	GND
4	YEL	ISO CAN Hi
5		
6	BLU	Master Switch
7		
8	RED 14 AWG	12 V Batt Power
9	RED	
10	GRN	ISO CAN Lo
11		
12		



POWER CONNECTOR
Molex MX (Male), 2 PIN
Part# 19433-0014

1	BLK 10 AWG	HC GND
2	RED 10 AWG	HC PWR



12 Pin ISO Connector
Ampseal 16 (Female)
12 Pin, Part# 776437-1

1	BLK 14 AWG	ECU GND
2	RED 14 AWG	ECU Power
3	BLK	GND
4	YEL	ISO CAN Hi
5		
6	BLU	Master Switch
7		
8	RED 14 AWG	12 V Batt Power
9	RED	
10	GRN	ISO CAN Lo
11		
12		



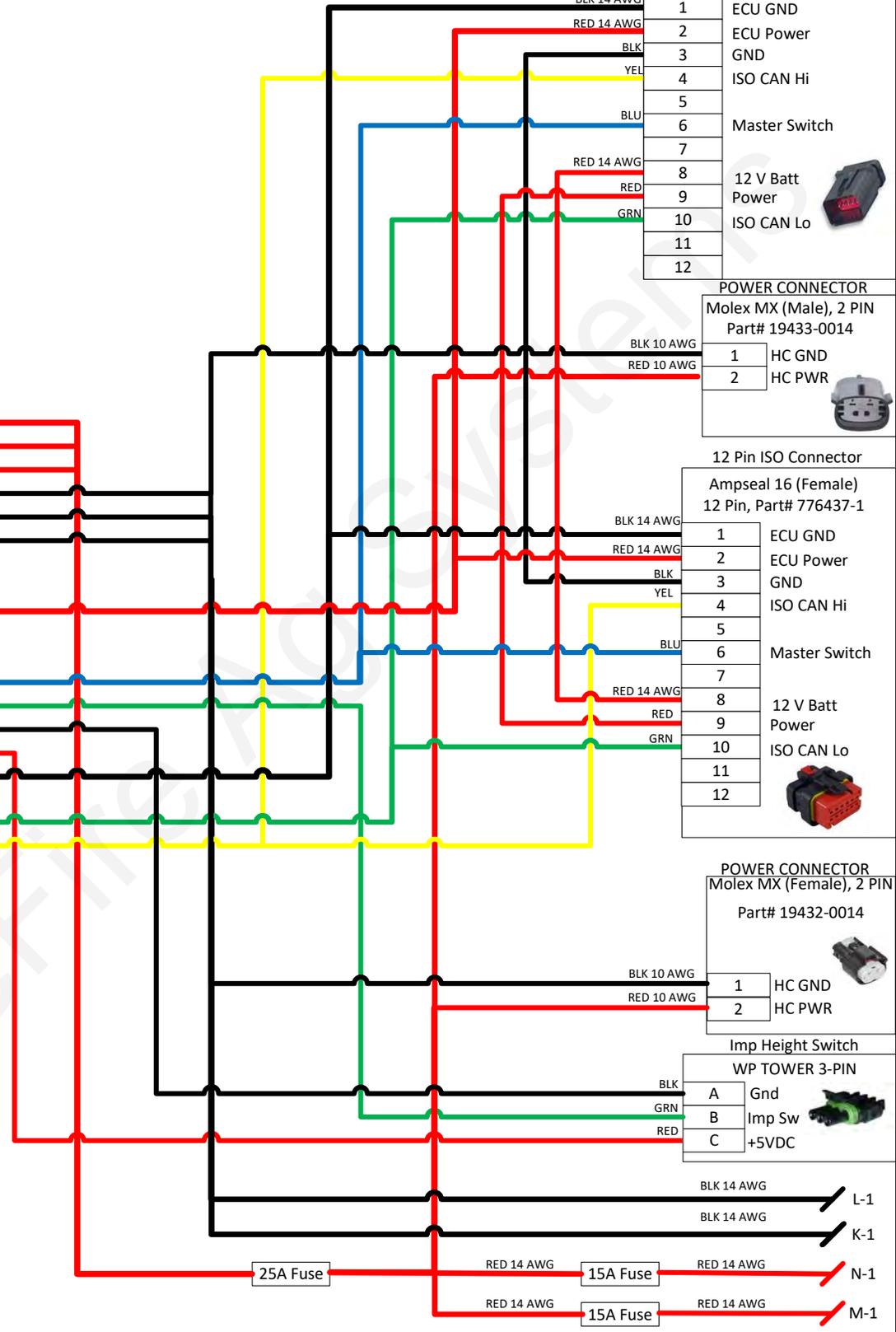
POWER CONNECTOR
Molex MX (Female), 2 PIN
Part# 19432-0014

1	BLK 10 AWG	HC GND
2	RED 10 AWG	HC PWR



Imp Height Switch
WP TOWER 3-PIN

A	BLK	Gnd
B	GRN	Imp Sw
C	RED	+5VDC

Part No:	213-00-3467Y4	Drawn By:	Mark Wolters		
Description:	ECU Direct to Liquid 2 product and 12 sections adapter harness	Last Edit Date:	9/4/2018	Revision	A-06
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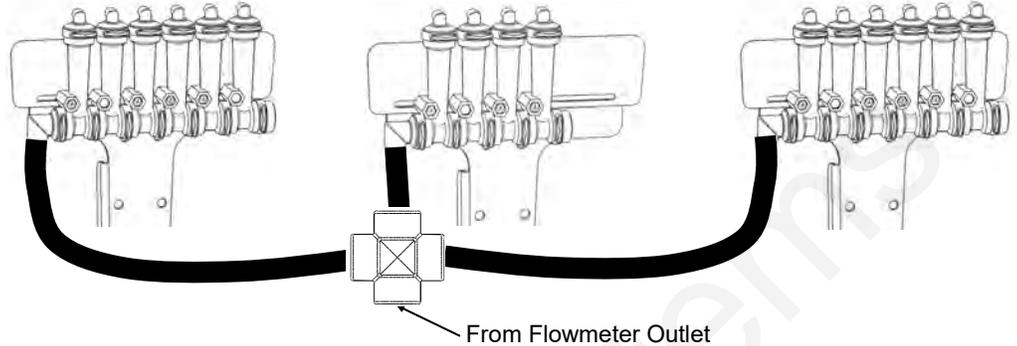
Floating Ball Flow Indicators

E Installation Overview

Flow Indicators are extremely flexible and can be mounted in hundreds of different configurations on various types of liquid application equipment. This page is to give you some ideas and let you customize the installation for what works best on your equipment.

16 Row Split 6 - 4 - 6

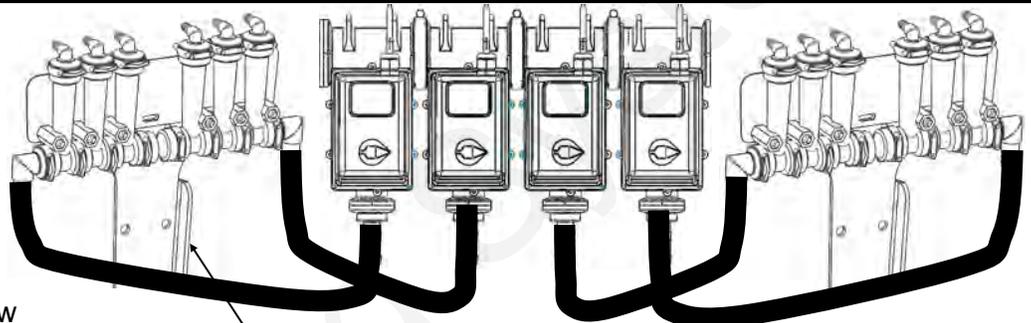
This configuration works well on a 16 row front fold planter. Each flow indicator manifold is shown fed by a cross in a single section installation. Each manifold could be fed by a section valve if desired.



12 Row Split 3 - 3 - 3 - 3

Shown here is a 12 row with four 3 row sections controlled by four section valves. Note each 6 row T-Bracket can hold two separate 3 row manifolds.

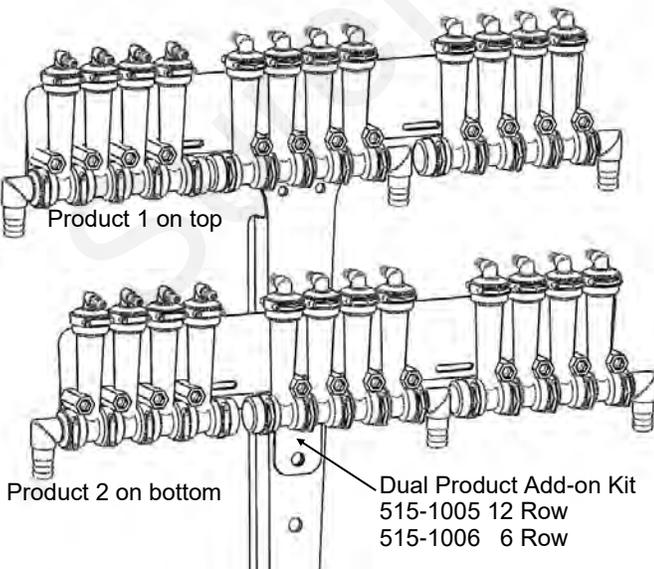
A 4 section 24 row could be similar with four 6 row manifolds on two large T-Brackets.



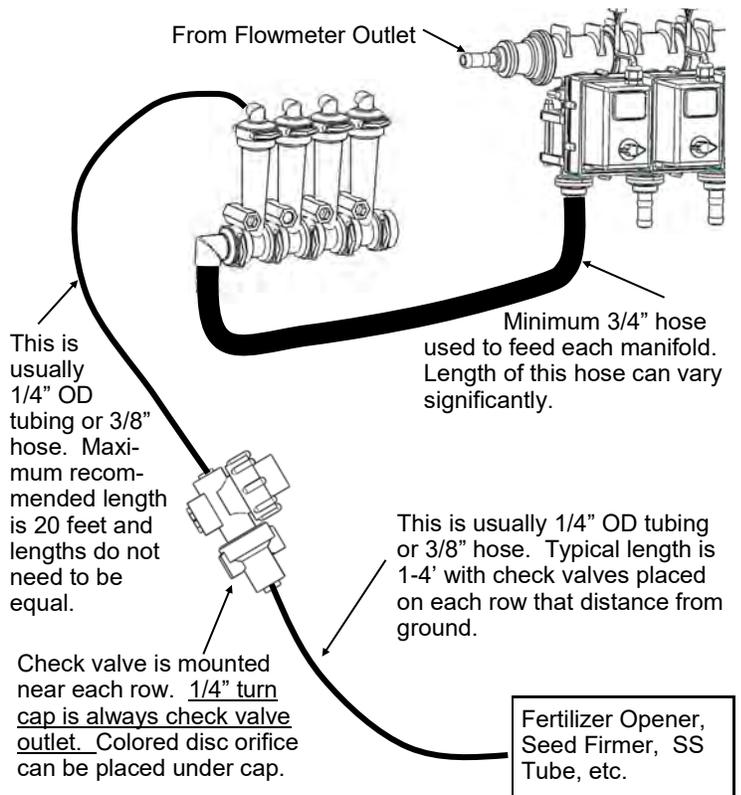
NOTE: Another option is the flange can face forward so the T-Bracket could be mounted on the front side of a bar.

12 Row Dual Product Product 1 Split 4 - 4 - 4 / Product 2 Split 4 - 4 - 4

In this case each manifold would be fed by a section valve. There would be 6 total section valves (3 sections X 2 products). Most often one set (top) of flow indicators would be Full Flow for high rate fertilizer and 2nd set (bottom) would be Low Flow for starter.

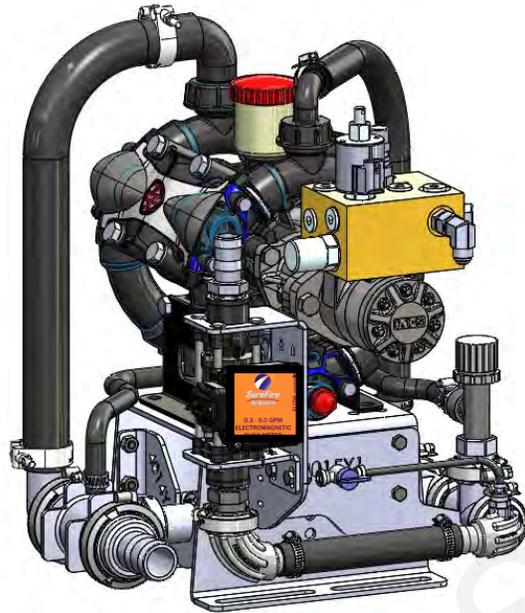


General Plumbing Guidelines



PumpRight Installation

PR17 Pump Shown. Other PumpRight sizes function identically, but will require slightly different mounting due to the different physical size of the pump.



Mounting

1. Mount pump in your preferred location. The PumpRight pump has excellent suction and priming ability, so it can be mounted away from or above fertilizer tanks.
2. SureFire has pump mounting brackets available for many models of planters and for mounting in different locations to fit your system setup.
3. SureFire has U-Bolts available to mount the pump directly to multiple bar sizes shown below. If the U-Bolts will not work, order the universal backer plate, number 400-1973A1 which allows use of 1/2" bolts to clamp to any size tube up to 8" wide.

Mounting Bar Size	Item Number	Item Description
3" x 3"	380-1022	1/2" U-bolt Kit - 1/2", fits 3" x 3" tube - (3" opening)
4" x 4"	380-1023	1/2" U-bolt Kit - 1/2", fits 4" x 4" tube - (4" opening)
4" x 6"	380-1015	1/2" U-bolt Kit - 1/2", fits 4" x 6" tube - (4" opening)
5" x 7"	380-1017	1/2" U-bolt Kit - 1/2", fits 6" x 4" tube - (6" opening)
6" x 7"	380-1014	1/2" U-bolt Kit - 1/2", fits 5" x 7" tube - (5" opening)
7" x 7"	380-1016	1/2" U-bolt Kit - 1/2", fits 7" x 5" tube - (7" opening)
6" x 10"	380-1018	1/2" U-bolt Kit - 1/2", fits 7" x 6" tube - (7" opening)
7" x 7"	380-1001	1/2" U-bolt Kit - 1/2", fits 7" x 7" tube - (7" opening)
6" x 10"	380-1021	1/2" U-bolt Kit - 1/2", fits 6" x 10" tube - (6" opening)
8" x 12"	380-1019	1/2" U-bolt Kit - 1/2", fits 8" x 12" tube - (8" opening)
8" x 16"	380-1020	1/2" U-bolt Kit - 1/2", fits 8" x 16" tube - (8" opening)

PumpRight Hydraulic Connections PWM Valve

E

Installation Overview

Manual Override - Push down and turn 1/2 turn CCW to lift the valve for manual override to check for proper hydraulic operation. **Override will completely open valve, so limit tractor hydraulic flow to valve.**

(May need to clean packed dirt to allow movement of override knob.)

Push down and turn 1/2 turn CW to return to operating position.

Load Sense Port—For power beyond hydraulic use only.

Bypass Valve—Remove the cap to access a bypass needle valve. This valve is shipped from the factory closed. **The only case when valve should be open is when running in series with other hydraulic motors.**

Depending on your tractor and exact hydraulic plumbing scenario your pump may turn very slowly when it should stop. To stop the pump completely, open the bypass valve slightly.

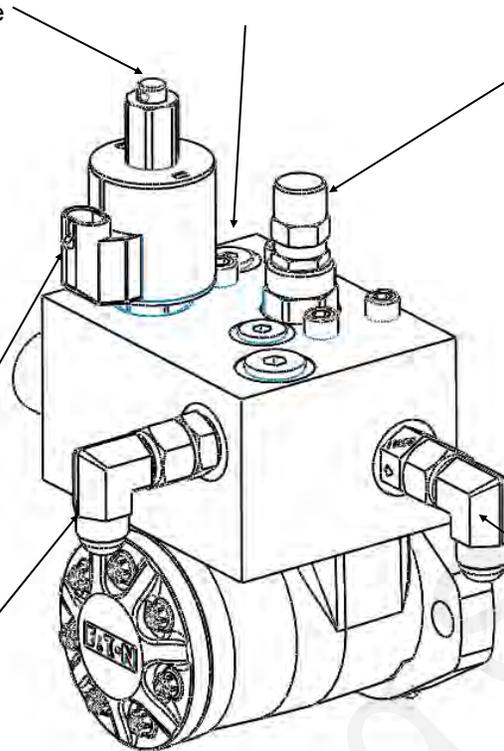
To adjust the Bypass Needle Valve, first loosen the lock nut. Do not overtighten the needle valve.

PWM Valve Connector -2 Pin MP Shroud

Troubleshooting Tip:
To check coil, an ohmmeter placed on the two pins should show 7-9 ohms.

Pressure line from Tractor

Return oil to Tank - Check valve included on return port



▲ DANGER

Hydraulic oil under extremely high pressure. Do not use hand or any other skin to check for or to stop hydraulic leaks. Be sure pressure is relieved before loosening hydraulic fittings. Replace worn hoses immediately. Seek medical care immediately if hydraulic oil is shot into the eye or the skin.

Pump Rotation Check Valve

A check valve is included on the outlet port of the hydraulic valve. This prevents the pump from running in the wrong direction. If ran in the wrong direction, liquid will be pumped, however the hydraulic valve will not be able to control the flow. The check valve can be identified by the Part Number 1108R stamped on it and a flow direction arrow.

How it Works with Power Beyond Hydraulics

This valve is designed to work with power beyond hydraulics. This configuration will not require a standard tractor remote hydraulic valve. The load sense port and hose described next will typically not be needed if other hydraulic ports are in use. If the load sense is needed, do this: First, remove the load sense plug and install a #6 male boss x #6 JIC adapter fitting, SureFire PN 161-01-6MB-6MJ. Then run a 3/8" or 1/4" hydraulic hose back to the tractor. This hose will connect to the load sense port on the tractor. The load sense line will signal the tractor hydraulic system to supply the flow needed by the pump to meet your application rate. The SureFire valve has an internal load sense check valve, which is required for power beyond hydraulics.. The bypass valve (see above) must be closed to use power beyond hydraulics or else an unlimited amount of oil will be continuously circulated.

PumpRight Hydraulic Connections

E

Installation
Overview

Hydraulic Hose

SureFire recommends 1/2" hydraulic hose for both pump inlet and outlet. The hoses will need #8 JIC female swivel fittings.

Where do I get hydraulic flow for my PumpRight?

This question is often asked as many implements use up all the hydraulic connections on a tractor. SureFire has some recommendations as to what works best.

Best Option - Dedicated PumpRight Circuit

If you have a tractor remote available, attach the tractor remote valve directly to the PumpRight pressure and return ports. DO NOT try to avoid this method simply to save another set of hydraulic hoses running to the tractor. Operating the PumpRight on it's own circuit is the simplest for installation and operation. It guarantees the PumpRight won't negatively affect any other hydraulic components on your equipment.

Preferred

Alternate Option - In Series with John Deere CCS Fan or Bulk Fill Seed Fan

If you do not have a tractor remote valve available, this may be your best method. You can plumb the PumpRight after the seed distribution fan in series. If using this method, the SureFire PWM bypass valve must be open (see previous page for instruction & picture). If bypass is left closed, the SureFire valve will limit the speed of the seed distribution fan.

For example, the John Deere CCS fan uses around 7 GPM of oil. This will limit the PumpRight maximum flow (9 GPM oil necessary for maximum flow). See the charts on the next page for adjusted maximum pump flow. See section G for flow charts to determine your necessary flow rate.

DO NOT plumb the PumpRight in series with a vacuum fan. The vacuum fan uses just a few GPM of oil. Also, problems will be caused by excessive pressure at the vacuum fan motor

Two PumpRights

The preferred method is to plumb the two pumps in series. DO NOT plumb two pumps after the CCS fan. Excessive pressures may damage the CCS fan motor. Run the pressure line from tractor to first pump inlet. Plumb from the outlet of Pump 1 to the Inlet of Pump 2, then from Pump 2 outlet back to the tractor. Open the bypass needle valve on both pumps so each valve controls motor speed independently. Run the flow setting procedure on the next page to minimize the hydraulic flow based on the pump that requires more hydraulic motor flow.



DANGER

Hydraulic oil under extremely high pressure. Do not use hand or any other skin to check for or to stop hydraulic leaks. Be sure pressure is relieved before loosening hydraulic fittings. Replace worn hoses immediately. Seek medical care immediately if hydraulic oil is shot into the eye or the skin.

PumpRight Hydraulic Oil Flow Requirements

(Requirements for 4.0 CID Motor—standard SureFire motor beginning in 2016—
Earlier motor was 4.9 CID which uses 20% more oil)

E

Installation
Overview

Setting Tractor Hydraulic Remote Speed

PumpRight pumps require a constant hydraulic oil flow from the tractor. The amount of oil needed varies with pump size and speed. The chart at right shows the necessary oil flow for each pump model at varying fertilizer flows.

Use this procedure to determine the correct setting on your tractor hydraulic flow.

1. Run the fertilizer system in the field at the maximum rate and ground speed.
2. Turn down the hydraulic flow slowly while watching the pump flow (Volume / Minute).
3. Observe when the Volume / Minute begins to drop.
4. Turn the hydraulic flow back up slightly.

This setting will provide the Pump Right pump just enough oil for your application rate.

If running with the bypass open (only recommended when 2 motors are operated in series) this process will minimize the oil circulated in the bypass loop, leaving more oil flow for other hydraulic functions.



The pump is rated at a maximum of 550 RPM. Spinning the pump over 550 RPM may cause pump failure.

The system will spin the pump faster than that if precautions are not taken to limit the speed. This could happen if the strainer becomes plugged or blocked and the controller attempts to speed the pump up to achieve the desired Rate. It could also happen if a high pressure situation occurs that opens the Pressure Relief Valve (PRV) and the pump speeds up to try to achieve the Rate.

Monitor the pump RPM. If the pump begins to speed up, check for a blocked strainer or other issue.

Set the Pump RPM High Limit and Maximum Pressure Alarm as shown in Section F.

Another way to limit the maximum pump speed is to set the High PWM Limit just above what is needed for regular operation. If the pump tries to speed up above that, check for blocked strainer or other issue.

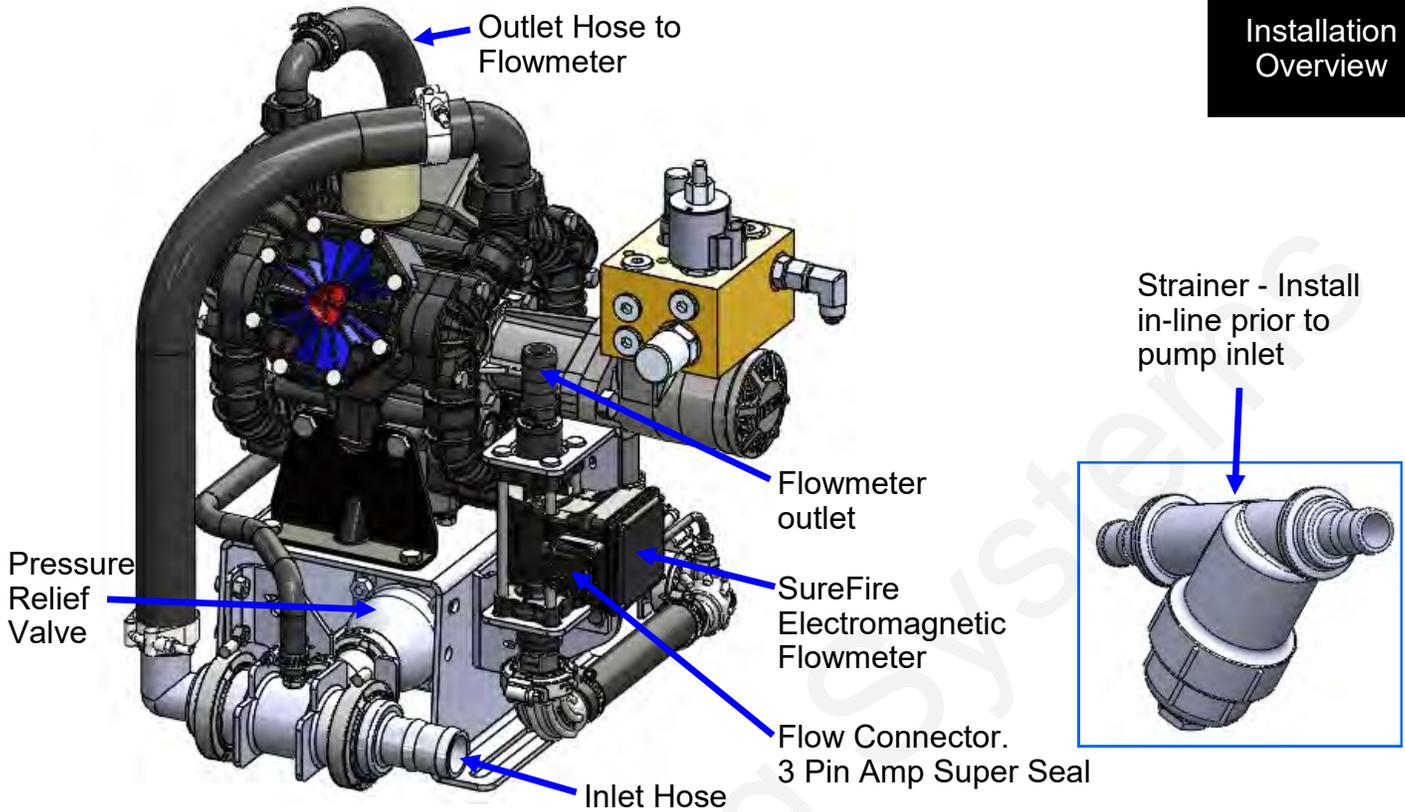
Model PR17 - 3 Diaphragms		
Fertilizer Flow (GPM)	Pump Speed (RPM)	Hydraulic Oil Flow (GPM)
5	137	2.4
10	275	4.8
15	412	7.1
17	467	8.1
Model PR30 - 3 Diaphragms		
Fertilizer Flow (GPM)	Pump Speed (RPM)	Hydraulic Oil Flow (GPM)
5	85	1.5
10	170	2.9
15	255	4.4
20	340	5.9
25	425	7.4
30	510	8.8
Model PR40 - 4 Diaphragms		
Fertilizer Flow (GPM)	Pump Speed (RPM)	Hydraulic Oil Flow (GPM)
10	115	2.0
20	229	4.0
30	344	6.0
40	458	7.9
Model D250 - 6 Diaphragms		
Fertilizer Flow (GPM)	Pump Speed (RPM)	Hydraulic Oil Flow (GPM)
10	86	1.6
20	172	3.2
30	258	4.8
40	343	6.4
50	429	8.0
55	472	8.6



PR17 & PR30 Liquid Plumbing Connections

E

Installation
Overview

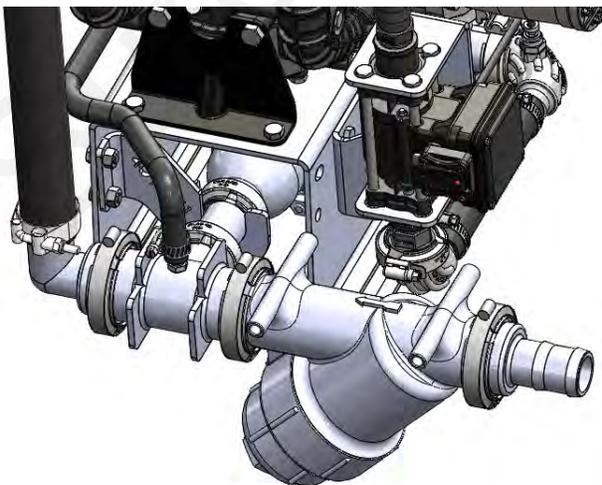


Inlet: The PR17 and PR30 PumpRight are shipped with a 1 1/2" inlet hose barb. Attach this to the hose from your supply tank and strainer. A 1 1/2" 90 degree hose barb is included and can be substituted.

Inlet Strainer: A 20 mesh strainer is included in the pump kit. The manifold strainer includes two hose barbs so it can be mounted anywhere in the inlet line. If space allows, the strainer can be mounted directly to the inlet plumbing assembly as shown below.

Outlet: The outlet is plumbed directly to the flowmeter with 1" hose. As shown above, the flowmeter may be mounted directly to the PumpRight pump. The flowmeter outlet is a 1" hose barb. The outlet hose should be a minimum of 24" long with a gentle curve prior to any fittings for optimum flowmeter performance. The flowmeter outlet will attach to your manifold(s) or section valves. A 3/4" hose barb is included in the bag of parts and can be substituted on the flowmeter outlet.

Pressure Relief Valve (PRV): The PRV is a 100 psi relief. If there is a restriction that creates over 100 psi in the system, the PRV will open allowing the excess flow to pass back to the inlet side of the pump. This protects the pump and fertilizer system from damage.



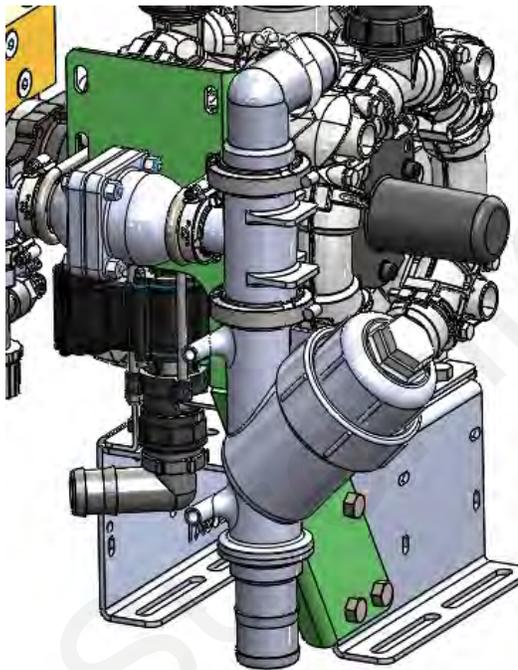
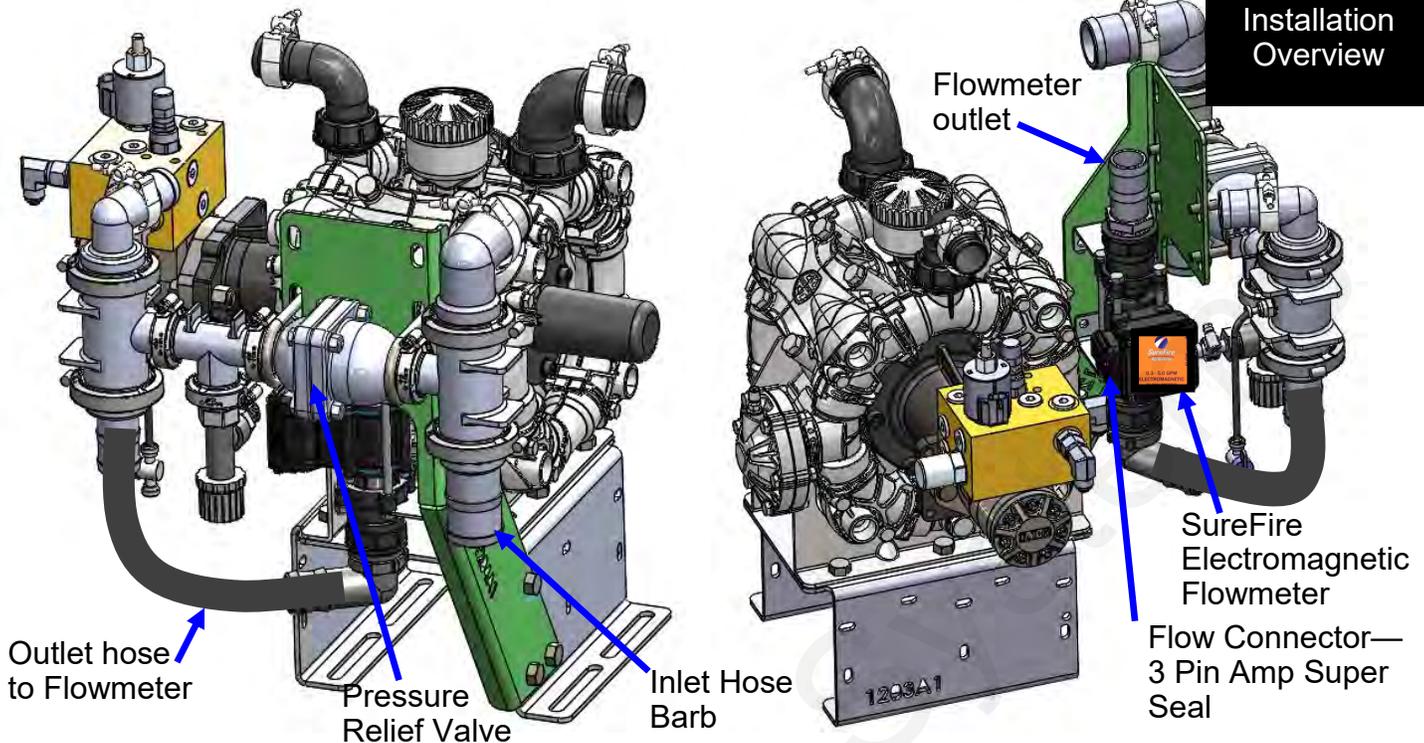
CAUTION

These pumps can deliver liquid at high pressure (290 PSI). Be sure the 100 PSI Pressure Relief Valve (PRV) is installed and functioning so system pressure will be kept under 100 PSI. Check hoses, hose clamps, and liquid fittings regularly and repair or replace loose connections.

PR40 & D250 Liquid Plumbing Connections

E

Installation Overview



Inlet: The PR40 and D250 PumpRight are shipped with a 2" inlet hose barb. Attach this to the hose from your supply tank and strainer. A 2" 90 degree hose barb is included and can be substituted.

Inlet Strainer: A 20 mesh strainer is included in the pump kit. The manifold strainer includes two hose barbs so it can be mounted anywhere in the inlet line. If space allows, the strainer can be mounted directly to the inlet plumbing assembly as shown in image to the left.

Outlet: The outlet is plumbed directly to the flowmeter with 1 1/2" hose. As shown above, the flowmeter may be mounted directly to the PumpRight pump. The flowmeter outlet is a 1 1/2" hose barb. The outlet hose should be a minimum of 24" long with a gentle curve prior to any fittings for optimum flowmeter performance. The flowmeter outlet will attach to your manifold(s) or section valves.

Pressure Relief Valve (PRV): The PRV is a 100 psi relief. If there is a restriction that creates over 100 psi in the system, the PRV will open allowing the excess flow to pass back to the inlet side of the pump. This protects the pump and fertilizer system from damage.



CAUTION

These pumps can deliver liquid at high pressure (290 PSI). Be sure the 100 PSI Pressure Relief Valve (PRV) is installed and functioning so system pressure will be kept under 100 PSI. Check hoses, hose clamps, and liquid fittings regularly and repair or replace loose connections.

Rate Control Module (RCM) Setup

Following are screen shots typical of a Raven RCM setup. Your setup and screens may vary since the RCM is capable of running many different application scenarios.

To access the RCM, push this button. If this button is not present the rate controller is not communicating with the display.

This button will take you to the Main Run Screen below.



Main Run Screen

Actual Rate (gal/ac) 5.0
Target Rate (gal/ac) 5.0
Tractor Speed (mph) 5.0

Navigation Buttons:
 Raven RCM Run Screen (Home icon)
 Setup (Gear icon)
 Totals (1 2 3 icon)
 Diagnostics (Waveform icon)

Estimated Volume Remaining / Tank Refill Button (press to refill tank)
 Implement Height Switch Indicator, Arrow will point up or down to indicate implement position if height switch is used.



Menu Structure



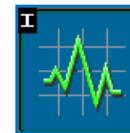
Setup

- **Applicator Setup** > Profile > Height Switch > Test Speed
- **System Settings** > Control Valve Setup
 - Rate Sensor Setup
 - Tank Fill Settings
 - Display Setup Menu
 - Pressure Sensor Setup
 - Auxiliary Functions Setup (Advanced Tuning)
- **Alarm Settings**
- **Rates Setup**/ Display Smoothing / Decimal Shift



Totals

- Current
- Job Summaries
- Lifetime Totals



Diagnostics

- System Information Menu
- Tests
- System Summary
- Product Summary

See the [Raven RCM Operation Manual](#) for safety information and additional setup/operating information.



The operator is responsible for knowing and understanding the safe operation of this equipment. Systems with hydraulic equipment require additional safety precautions to prevent serious injury and/or death.

Rate Control Module (RCM) Setup

Following are screen shots typical of a Raven RCM 2-product setup. Your setup and screens may vary since the RCM is capable of running many different application scenarios.

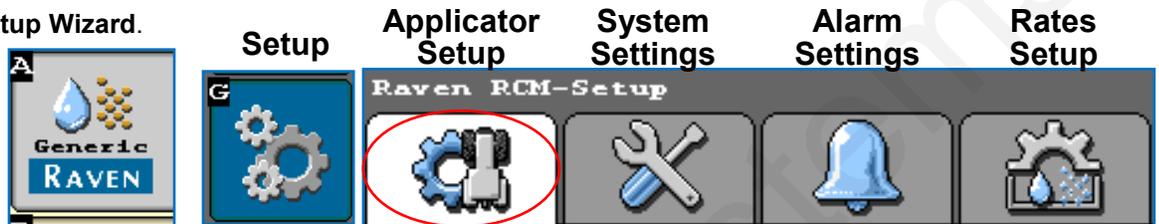
To access the RCM, push this button. If this button is not present the rate controller is not communicating with the display.

This button will take you to the Main Run Screen below.



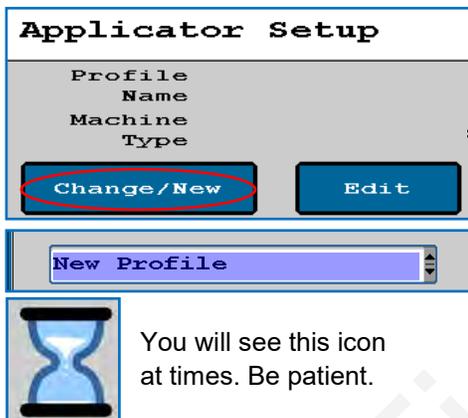
For a single-product setup, use a **Liquid Fert Tool** profile. For two or more products (without NH3), use a **Generic** profile. If using NH3, set up an **NH3** profile.

1. Navigate to the **Setup Wizard**.

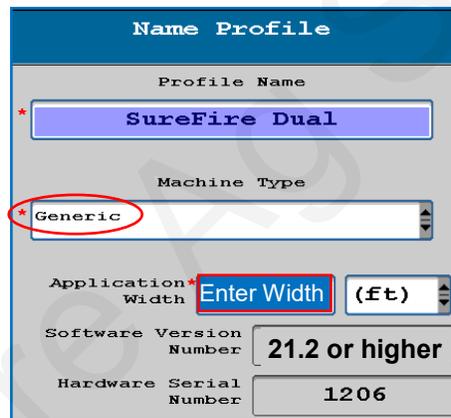


For the initial setup, start a new profile. The Raven RCM allows you to store 8 profiles. Be prepared to wait during this phase of the setup process. The following screens are for a typical 2-product setup. Your setup may vary.

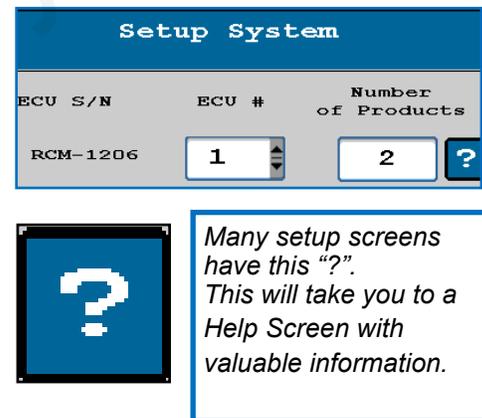
2. Start a **New Profile**.



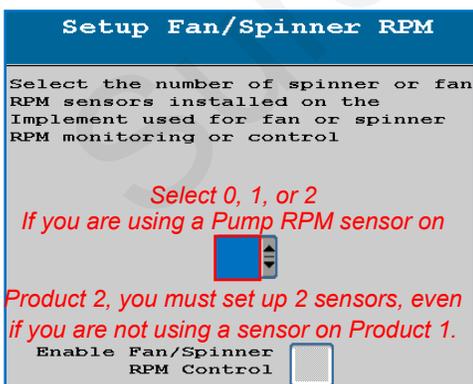
3. Enter a **Profile Name**. **Machine Type > Generic**



4. **Number of Products = 2**



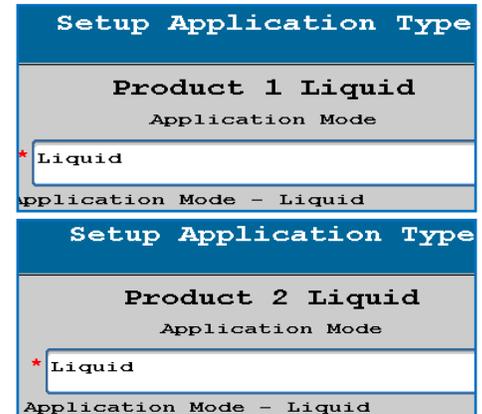
5. **Fan/Spinner RPM**-Use for pump RPM sensor on hydraulic pump. Product 2 uses RPM Sensor # 2 on the SureFire harness.



6. Select **Application Type & Mode**



If you are applying a Dry product, one or both products could be set up as Granular Fertilizer, with an appropriate Application Mode for that setup.



See the [Raven RCM Operation Manual](#) for safety information and additional setup/operating information.

Setup instructions for Raven RCM and SureFire: 2 Liquid Products



7. Section Group Setup—Typical setup—Product 1 is Sections 1-6. Product 2 is Sections 7-12. Can have up to 12 sections. Many other setups are possible. For a typical dual product setup, you will say **NO** to sharing section drivers. However, when using a Spartan injection pump that is going into a mixing chamber, say **YES** to sharing section drivers with the main product.

Setup Section Groups

Are section drivers shared between all products in product harness? ?

Yes No

60.00ft 60.00ft

Product 1 Sections: 15.00 15.00 15.00 15.00

Product 2 Sections: 15.00 15.00 15.00 15.00

See note above on YES or NO

No

Setup Section Harnessing

Section Group	Starting Section Number	Number Of Sections	Equal Section Widths
1	1	4	<input checked="" type="checkbox"/>
2	7	4	<input checked="" type="checkbox"/>

Setup Section Width

Enter the width of the sections

1*	10.000 (ft)	7	10.000 (ft)
2*	10.000 (ft)	8	10.000 (ft)
3*	10.000 (ft)	9	10.000 (ft)
4*	10.000 (ft)	10	10.000 (ft)
5*	0.000 (ft)		
6*	0.000 (ft)		

Setup Section Group Assignment

Product	Section Groups
1	Section Group 1
2	Section Group 2

Setup Section Groups

Number of Section Groups:

Typical setup shown. Many different section setup combinations are possible. The SureFire harness has Sections 1-6 on one connector and Sections 7-12 on another connector. You could set up each product with 12 sections and share section drivers. You do NOT have to have the same number of sections on each product.

8. SureFire Pressure Sensors will be CUSTOM.

Setup Pressure Sensors

Pressure Sensor 1: Custom

Pressure Sensor 2: Custom

Setup Pressure Assignment

Pressure Sensor 1

Product 1:

Product 2:

Pressure Sensor 2

Product 1:

Product 2:

Setup Pressure Alarms

	Min	Max	Alarm?
Pressure 1 (PSI)	0	85	<input checked="" type="checkbox"/>
Pressure 2 (PSI)	0	85	<input checked="" type="checkbox"/>

For additional protection, set the Max Pressure at 85 PSI (can be higher if needed). PRV is set for 100 PSI.

9. Pump RPM setup-for hydraulic

Setup Fan/Spinner RPM Calibration

RPM 1 Calibration (Pulse/Revolution)	15	Alarm?	<input type="checkbox"/>
RPM 1 Low Limit (RPM)	0		<input type="checkbox"/>
RPM 1 High Limit (RPM)	500		<input checked="" type="checkbox"/>
RPM 2 Calibration (Pulse/Revolution)	15		
RPM 2 Low Limit (RPM)	0		<input type="checkbox"/>
RPM 2 High Limit (RPM)	500		<input checked="" type="checkbox"/>

Setup RPM Sensor Assignment

RPM Sensor 1

Product 1:

Product 2:

RPM Sensor 2

Product 1:

Product 2:

RPM Calibration for SureFire Pump RPM sensor is 15 pulses/rev. Set up as needed for your system. Product 2 will be RPM Sensor 2 on the SureFire harness. If using a Pump RPM sensor, you will set up a *Display Setting* on the Run Screen with the Pump RPM readout (described later).

Set the **RPM High Limit at 500** for a SureFire PumpRight hydraulic pump, and **check the Alarm box**. If maximum pump capacity is needed, this may be increased to 550. (Generally, if the pump tries to go over 500 RPM, there is probably another issue such as a plugged strainer or too much recirculation or other problem.)

Read the [Raven RCM Operation Manual](#) for safety information and additional setup/operating information.

Setup instructions for Raven RCM and SureFire: 2 Liquid Products



10. Control Valve Setup (start with the numbers indicated for your system)

Valve Response Rate: (Adjust as needed)

- PumpRight (hydraulic) 1-2
- Tower (electric) 20
- Catalyst and Spartan 1-5

Control Deadband: Start at 2

If pump is slow responding to rate or speed changes, increase **Valve Response Rate**. If product oscillates around rate going across the field, reduce **Valve Response Rate**.

Could set **PWM High Limit** less than 100 to limit pump speed.

Low Limit (Adjust in field as needed)

- PumpRight (hydraulic) 25-30
- Tower (electric) 8-15
- Catalyst and Spartan 5-10

PWM Startup (Adjust in field as needed)

- PumpRight (hydraulic) 35-40
- Tower (electric) 15-25
- Catalyst and Spartan 5-15

Setup PWM

Product 1 Liquid

Coil Frequency (Hz)

PWM High Limit (%)

PWM Low Limit (%)

PWM Startup (%)

Fine-tune PWM Low Limit at Diagnostics > Tests > Calibrate PWM Limits

Setup Control Valve

Product 1 Liquid

Control Valve Type

Valve Response Rate (1-100)

Control Deadband (%)

11. Enter appropriate Flowmeter Cal.

Setup Rate Sensor

Product 1 Liquid

Flowmeter Calibration

Flowmeter Pulse/Units

Flowmeter Size (GPM)	Pulses/Gal	Spartan model #	Puls/fl oz
0.08-1.6	22710		
0.13-2.6	3000		
0.3-5.0	3000	115	1700
0.6-13	2000	125	890
1.3-26	2000	135	450
2.6-53	2000	145	220

SureFire Electromagnetic Flowmeters. Verify pls/gal on Serial Number label.

13. Set Rates as desired.

You must enter at least one rate.

Check **Display Smoothing**

Set the **Decimal Shift** box at 1.

Set **Decimal Shift** at 2 for rates such as 0.25 gal/ac.

Set **Decimal Shift** at 0 for high rates.

12(a). Tank and Fill Flowmeter setup

Setup Tank/Bin

Product 1 Liquid

Tank Capacity (gal)

Current Tank Level (gal)

OPTIONAL: Use as desired

Low Tank Level (gal) Alarm?

Tank Fill Monitor

Check **Tank Fill Monitor** box if using a fill flowmeter.

12(b). Fill Flowmeter Cal setup

Setup Tank Fill

Product 1 Liquid

Tank Fill Flowmeter Calibration

Tank Fill Flowmeter Pulse/Units

Then enter **Tank Fill Flowmeter Calibration**

SFA 3" Fill Flowmeter 130

SFA 2" Fill Flowmeter 300

(Units are 10 gal on SureFire Tank Fill flowmeters.)

Setup Rates

Product 1 Liquid

Preset Rate Values (gal/ac)

Rate Bump (gal/ac)

Rate Selection

Display Smoothing

Decimal Shift

For high rates, decimal shift can be set at 0, if desired.

14. Set Off-Rate Alarm as desired.

Setup Alarms

Product 1 Liquid

Off Rate Alarm (% off target rate) Alarm?

If Pressure Sensor 1 has a minimum pressure alarm enabled the system will not drop below that pressure to maintain spray pattern.

Set up Product 2 in a similar fashion to the Product 1 setup.

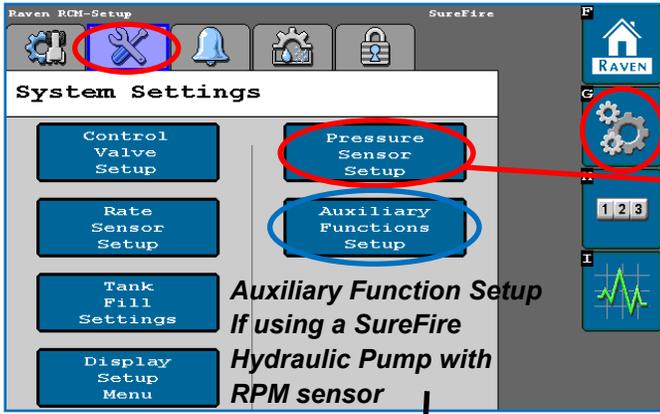
Read the [Raven RCM Operation Manual](#) for safety information and additional setup/operating information.



Setup instructions for Raven RCM and SureFire: 2 Liquid Products

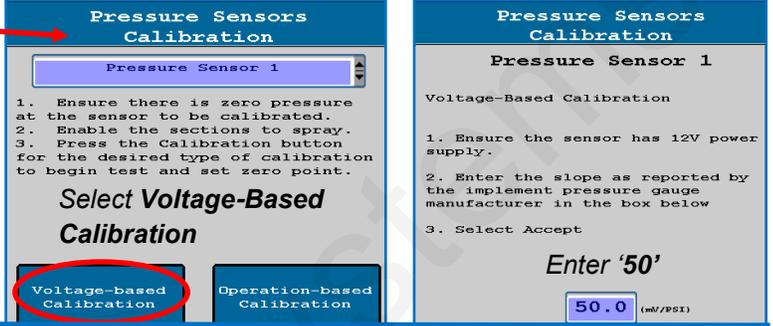


15. Pressure Sensors must be calibrated. See the boxes below for the procedure. Enter **50.0 mv/PSI** for SureFire 0 to 5 volt, 0-100 PSI sensor. *If you have 2 sensors, both must be calibrated. Be sure there is no pressure against the sensor when calibrating. Unplug the sensor during the calibration process.*

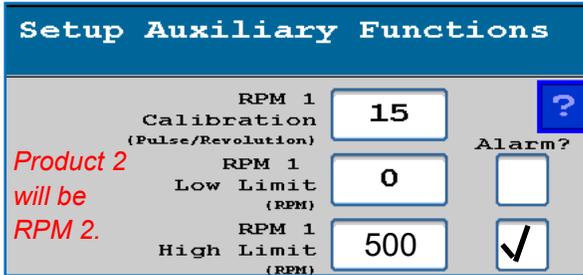


*Auxiliary Function Setup
If using a SureFire
Hydraulic Pump with
RPM sensor*

SureFire recommends putting the Pressure Sensor reading in your **Display Settings** on the Run Screen (see next page). For complete information on how the sensor is operating, go to **Diagnostics > System Information > Pressure Sensors**.



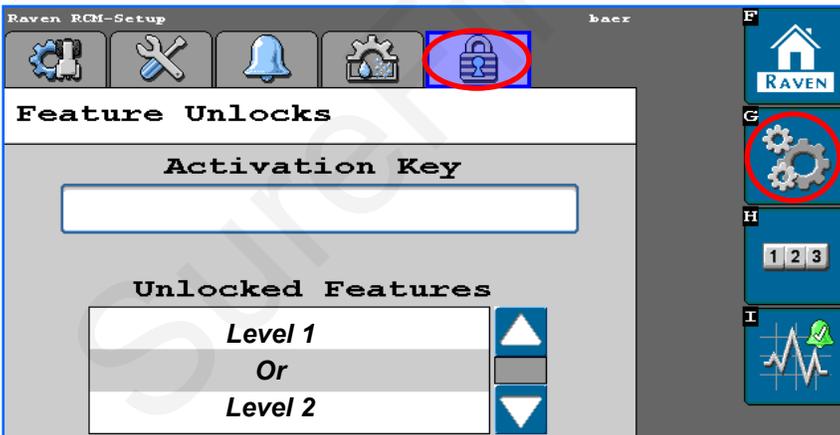
16. If using a Pump RPM sensor on a SureFire PumpRight Hydraulic Pump



*Product 2
will be
RPM 2.*

(The SureFire hydraulic pump with an RPM Sensor is 15 pulses/rev as shown above.)

These instructions do not cover every possible setup. Your setup may be different. See the [Raven RCM Operation Manual](#) for safety information and complete setup and operating instructions. SureFire harnesses for the Raven RCM are designed for specific operating setups. Pinouts on the Raven RCM change depending on the Profile Setup and the number of products. See the wiring harness diagram for your harness. More information is available at support.surefireag.com



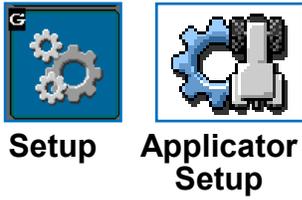
If Profile Setup will not allow you to select a Control Valve Type, check the Unlock Screen. If Level 1 or Level 2 is not shown, contact SureFire to get an Activation Key for the unlock.

This requires knowing the RCM Serial Number (on the RCM or at **Diagnostics > System Information > Hardware/Software > Hardware Serial Number**).

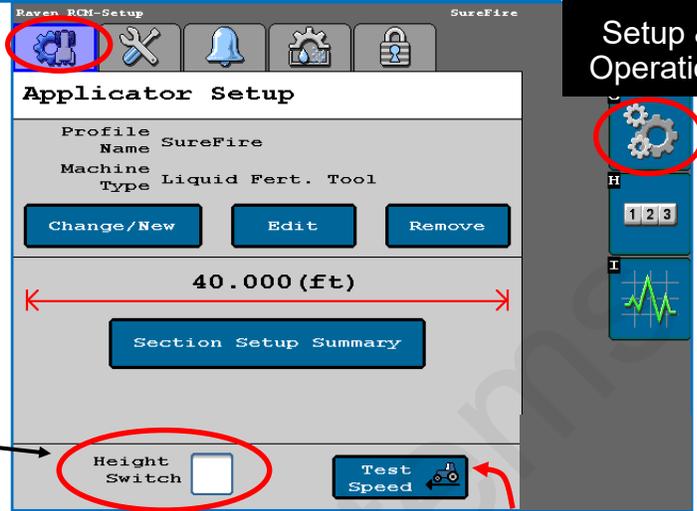
Setup instructions for Raven RCM and SureFire: 2 Liquid Products



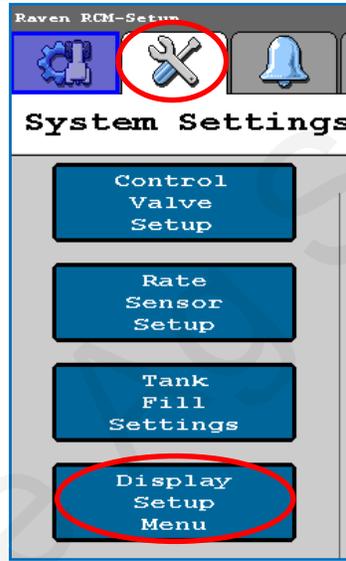
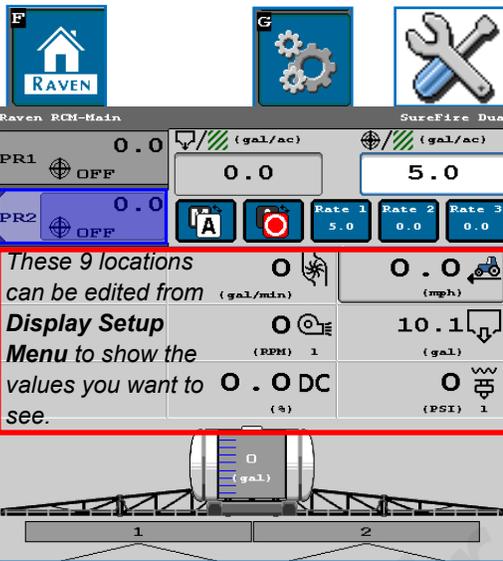
Implement Height Indicator Setup



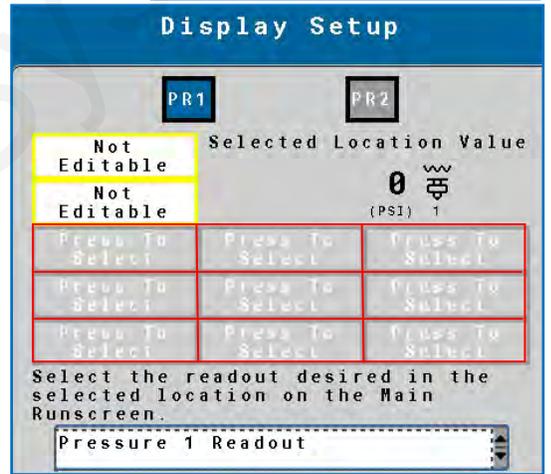
Check the **Height Switch** box if you are using a Mercury Switch or Finger Style Switch for Implement Height Indication.



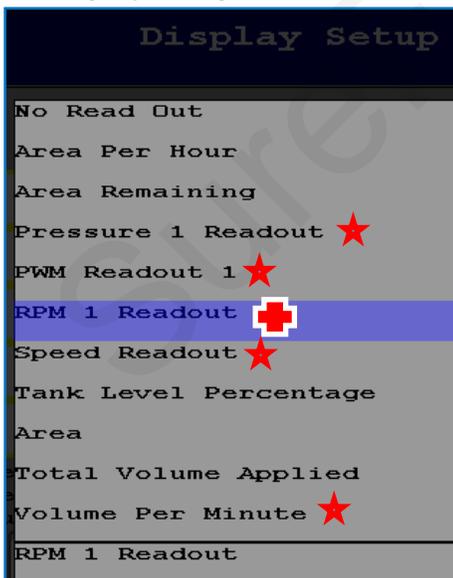
Run Screen Display Setup



Test Speed will be used later when testing the system.



Display Setup Menu



Control Valve Setup Menu

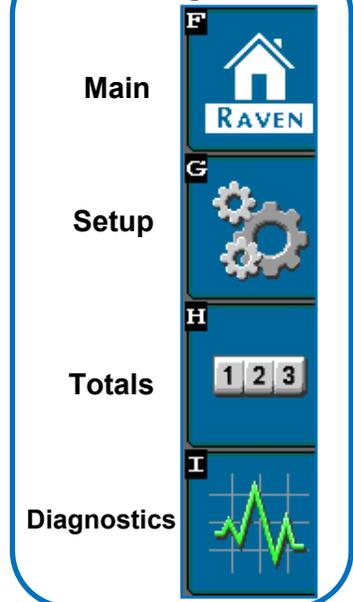
- Valve Response Rate
- Control Deadband
- PWM Setup (Coil Frequency, High Limit, Low Limit, PWM Standby)

Auxiliary Features Setup Menu

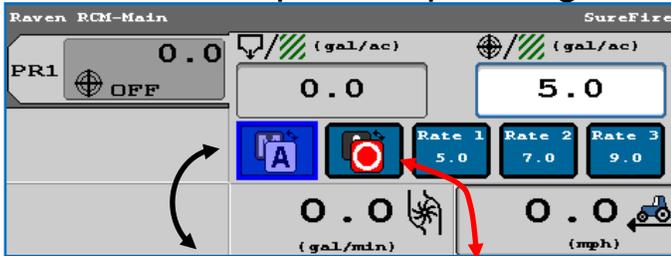
- PPM Calibration Pulse/Rev
- RPM Low Limit
- RPM High Limit
- RPM Sensor Assignment

- ★ Recommended for all systems
- ✚ Recommended for hydraulic pump systems with Pump RPM sensor

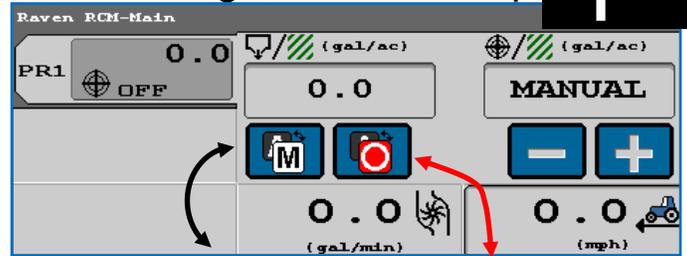
Navigation



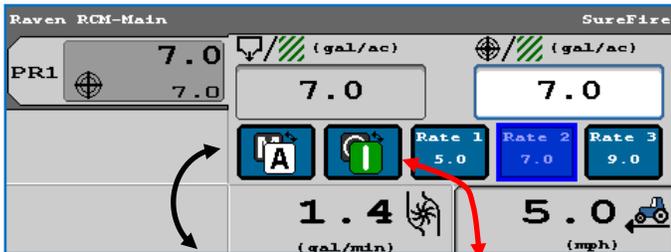
Read the [Raven RCM Operation Manual](#) for safety information and additional setup/operating information.



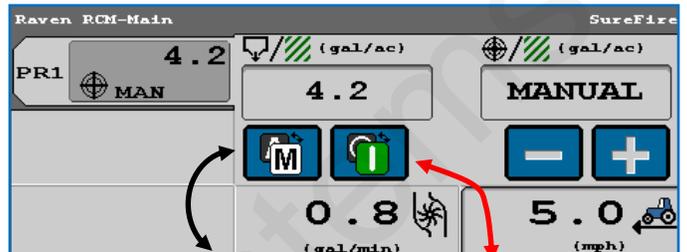
AUTO MODE / DISABLED



MANUAL MODE / DISABLED



AUTO MODE / ENABLED



MANUAL MODE / ENABLED

CRITICAL

Solution Pump Dry

Product 1 Liquid

The solution pump is dry. Turn pump off immediately!

If flow or pressure is not immediately detected, the **Solution Pump Dry** warning will come up and the system will shut down.

Solution Pump Dry is NOT a problem for SureFire electric pumps or for SureFire PumpRight hydraulic diaphragm pumps. It is a problem for centrifugal pumps.

Solution Pump Dry will not come up in **Diagnostics > Tests > Calibrate PWM Limits**.

- Initial Operation in MANUAL mode: (See Optional Manual Pump Operation below)**
1. Fill the system with water. For first time startup, open air bleed valve until a steady stream comes out.
 2. Enter a **Test Speed** by pressing on the **Speed (mph)** window or at **Setup > Applicator Setup**.
 3. Navigate to **MANUAL MODE** as shown above (toggle between Auto and Manual with the Auto/Manual button).
 4. **ENABLE** system (toggle between Enable / Disable with the Enable / Disable button).
 5. Height switch must be **DOWN** (or uncheck Height Switch box).
 6. Turn on **Master Switch**. Press and hold + to increase flow.
 7. Monitor Flow (gal/min), PSI, DC, Pump RPM (if using Hydraulic pump with RPM sensor).
 8. Go to **Switch Box**. Turn Sections OFF and ON.
 9. Turn Master Switch OFF.
-

OPTIONAL MANUAL PUMP OPERATION:

Go to **Diagnostics > Tests > Calibrate PWM LIMITS**. Here you can manually run the pump without the system shutting down if it doesn't read flow immediately. Turn on Master Switch, Start the test, hold + button to increase pump speed.

- Initial Operation in AUTO mode: (Could also do Nozzle Flow Check).**
1. Enter a **Test Speed** by pressing on the **Speed (mph)** window or at **Setup > Applicator Setup**.
 2. Toggle system to **AUTO / ENABLED**. Select a Rate.
 3. Height switch must be **DOWN** (or uncheck Height Switch box).
 4. Turn on **Master Switch**.
 5. Monitor Actual Rate (gal/ac), Flow (gal/min), PSI, DC, Pump RPM.
 6. Go to **Switch Box** (above). Turn Sections OFF and ON.
 7. Turn Master Switch OFF. (NOTE: Pressure will be much less with water than with heavier, thicker fertilizer.)

Read the [Raven RCM Operator's Manual](#) for safety information and additional setup/operating information.

Main Screen / Run Page

The Main Screen / Run Page displays several key operational metrics:

- PR1:** 7.0 (gal/ac)
- PR2:** 0.0 (OFF)
- Rate 1:** 5.0 (gal/ac)
- Rate 2:** 7.0 (gal/ac)
- Rate 3:** 9.0 (gal/ac)
- Flow Rate:** 1.4 (gal/min)
- Speed:** 5.1 (mph)
- RPM:** 73 (RPM)
- Application Rate:** 40.0 DC (gal/ac)
- Pressure:** 26 (PSI)

Navigation icons include Home (RAVEN), Settings, and a numeric keypad (1, 2, 3). A status bar at the bottom shows Master ON, Switch Box, and Quick Start buttons.

Diagnostics

The Diagnostics menu is divided into two main sections:

- System Information Menu:**
 - Hardware / Software
 - Switchbox
 - Delivery System
 - Section Status
 - System Voltages
 - Working Parameters
 - Switches / Status
 - Pressure Sensors
 - Bin Level Sensors
 - RPM Sensors
 - Tank Fill Monitor
- Tests Menu:**
 - Nozzle Flow Check
 - Rinse Cycle
 - Control / Section Test
 - Calibrate PWM Limits

Additional options include System Summary and Product Summary.

Frequently Used System Information Screens

Pressure Sensor Information
System Information

Pressure Sensors

Pressure Sensor 1

- Pressure Voltage (V): 0.00 (Should be 0.0)
- Pressure Sensor (V): 0.0
- Pressure (PSI): 0
- Slope (mV/PSI): 50.0

Delivery System Information
System Information

Delivery System

- Application Width (ft): 40.000
- Flow Meter (Hz): 55.0
- Flow Rate (gal/min): 1.1
- Application Rate (gal/ac): 5.0
- PWM Duty Cycle (%): 29.7

Annotation: Tap Test look here (pointing to the Flow Meter value)

Set PWM Limits
Tests > Calibrate PWM Limits

- Turn Master Switch ON.
- Press the Start button.
- Adjust setting until minimum acceptable flow/pressure is achieved, and press Set Low Limit.
- Adjust setting until maximum acceptable flow/pressure is achieved, and press Set High Limit.

Note: Turn the Master Switch off to stop product application.

Current values: 1.2 (gal/min) High Limit, 31.0 DC (PSI) Low Limit.

These tests can be run at initial system startup or for troubleshooting. Similar tests can also be run from the Run Page using Manual and Auto Mode with a Test Speed.

Section Test
Tests > Control / Section Test

- Select the section outputs to be activated.
- Turn the Master Switch on.
- Press the Start button.
- Toggle Sections using the buttons.

Note: Turn the Master Switch off to stop product application.

Buttons: 1, 2, 3, 4, Start, Master OFF

Instruction: Press and hold the - or + button to operate the control valve.

When testing with water, the system pressure will be much less than it will be with a fertilizer product.

Nozzle Flow Check
Tests > Nozzle Flow Check

- Enter test speed and rate.
- Turn Master Switch ON.
- Press the Start button.

Note: Turn the Master Switch off to stop product application.

Test Speed (mph): 4.0
Rate (gal/ac): 6.0
Current Flow: 1.9 (gal/min)

Read the [Raven RCM Operator's Manual](#) for safety information and additional setup/operating information.

TROUBLESHOOTING TIPS:

1. Pump Won't Run—Start the Calibrate PWM Limits Test. Press (+) to run the PWM Duty Cycle (DC) to 100%. With a voltmeter check voltage at the 2-pin PWM connector at the EPD or hydraulic valve solenoid. You should have 12-13 volts. If there is voltage here, but the pump won't run, check the pump using the following tests:

Electric Pump—Start Calibrate PWM Limits Test to open Section Valves. Unplug the two big connectors that plug into the black EPD module on the pump tower. Plug these together. This will take power from the battery directly to the pump(s). The pump(s) should run full speed.

Hydraulic Pump—On the hydraulic valve block, pop up the Manual Override button (red knob on top of solenoid). If unit has been in the field, you may need to loosen the dirt to move the knob. In cab, turn hydraulic flow to very low. Start Calibrate PWM Limits Test to open Section Valves. Engage hydraulics. Pump should begin turning. Slowly increase hydraulic flow to speed up pump.

2. Pump runs and liquid flows, but display is not reading flow. Unplug the flowmeter. With a voltmeter, check for 12 volts between pins 1 (black) and 2 (red) of the connector that plugs into the flowmeter. (You may have to remove the red keeper to get access to the pins with your voltmeter. Be careful not to break the sides of the red keeper.) You should also have 4-5 volts between pins 1 (black) and 3 (red).

If the voltage is OK, conduct a tap test. Have one person on the display go to Diagnostics > System Information > Delivery System, watching Flow Meter (Hz). The second person will tap repeatedly between pins 1 and 3 on the flowmeter connector with a bent paper clip or short piece of wire. As the person taps, the display should show some numbers on Flow Meter (Hz).

If the voltages are good, and the tap test shows on the display, but the system does not read flow when liquid is flowing, the flowmeter is not working.

3. PWM Startup—For best startup performance, set the PWM Startup at or slightly above the DC% that the system will be running at in the field.

Using the Quick Start button:



Use the Quick Start button to get the system primed and ready to apply when entering a field or starting in a field corner. Turn on the Master Switch, push Quick Start, the system will begin applying as if the Speed is 3 mph. Start driving. The Auto Rate Control will take over when the speed reaches the Minimum Application speed. Quick Start runs for 15 seconds. For additional time, push Quick Start again.

Virtual Terminal (VT), Universal Terminal (UT), and Task Controller (TC)

VT or UT software allows the display to show the ISOBUS Implement (the Raven RCM) on the display screen. This usually comes with the display, but be sure the software is installed if the display has not previously been used as a Virtual Terminal.

Task Controller software is necessary to do Section Control, Variable Rate Application using prescriptions, and/or As-Applied Mapping. Task Controller is typically purchased from the display manufacturer as an Unlock.

See the Task Controller documentation from your display manufacturer for more information on setup and operation.

For more information, see the *SureFire Manual for your Raven RCM system* at www.surefireaq.com/support.

Read the [Raven RCM Operator's Manual](#) for safety information and additional setup/operating information.

Hydraulic Pump Will Not Turn

Turn hydraulics off, go to the **SureFire PWM valve** and use the manual override (red knob) on top of the electric coil to **manually open the valve** (Manual Override UP = valve fully open). There may be dirt in here that needs to be cleaned out before you can turn and raise the override. Turn hydraulics on **at a low flow only** as the valve is 100% open. If pump does not turn, try hydraulic lever in opposite direction. Does the pump turn? If it turns, your problem is electric / electronic. If the pump still does not turn, you have a hydraulic problem.



Electric / Electronic Problem

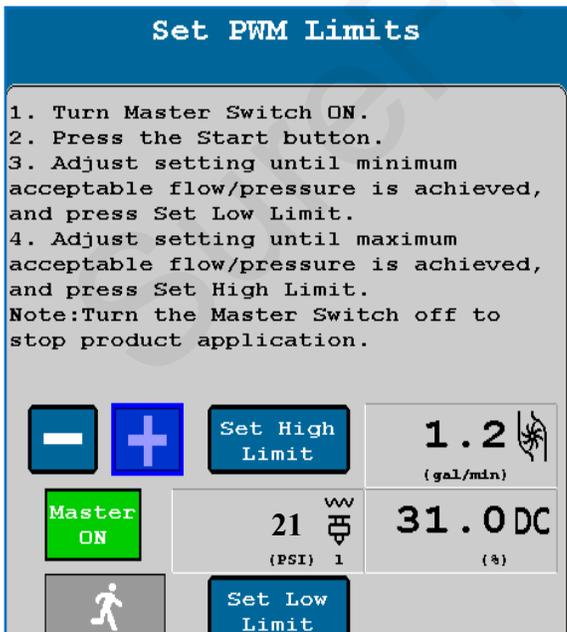
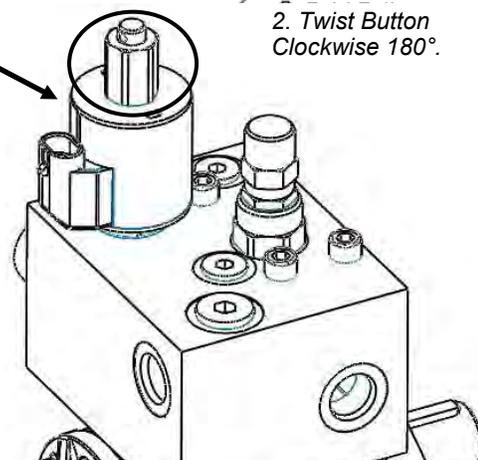
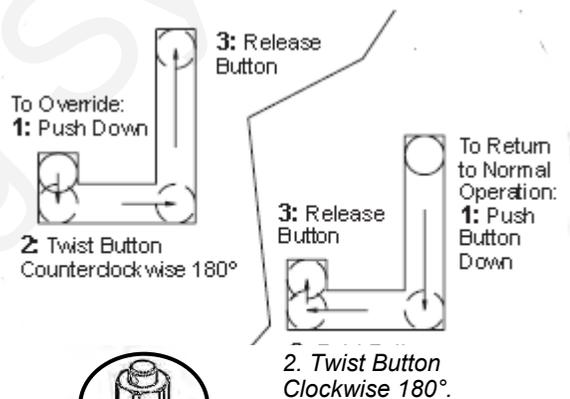
1. Close manual override (lock down)
2. Go to **Diagnostics, Calibrate PWM Limits Test** to investigate this issue (this is a place where you can turn the pump on).
3. Verify hydraulics are on.
4. Start test. Hold down "+" button for a few seconds. A single tap of this button produces a very small change in signal to the valve, so you must hold it.
5. Take a metal object and hold it next to the coil. If the coil is working, you will feel the magnetic pull. The coil should also show 7 to 9 ohms between the two pins on the electrical connector to the coil.
6. If no magnetic force is felt, disconnect the PWM valve connector and check voltage. You will need 6-12 volts to get hydraulic valve to open.
7. If 6-12 volts is not present, check harnesses and review control valve type setup.
8. Go back to the 12-pin connector that plugs into the Pump harness. Check voltage between pins 5 & 6 (or 2).
9. At 35-pin connector on ECU, PR 1 PWM—pins 23 & 35; PR 2 PWM—pins 13 & 24). Contact SureFire for further assistance.
10. You can remove the electromagnetic solenoid with proportional valve to see if the valve moves when a PWM signal is sent to it.

11. Diagnostics > Tests > Calibrate PWM Limits

Hydraulics Problem

1. Leave the manual override open on the SureFire valve.
2. Check the hose routings. The "P" port on the SureFire valve should hook to pressure. The "T" port is the return that should flow back to the tractor.
3. Try hoses in a different hydraulic remote. Inspect hydraulic connectors for damage or restrictions.

Hydraulic Manual Override Down - Normal Operation Up - Override, valve 100% open



The **Section Test** is another place to run the system. Or, enter a Test Speed and run the system in Manual Mode from the Run Screen.

Tests > Nozzle Flow Check is a good screen to try a Speed and Target Rate to see if it will lock on to a rate. *When testing with water, the pressure will be a lot less than it will be when using a fertilizer product.*

You can also enter a Test Speed and run the system in Auto Mode from the Run Screen.

Application Rate Fluctuates

First, you need to determine if the fluctuation is caused by the controller sending fluctuating signals to the valve or because of something else.

1. **Inspect & clean pump inlet strainer.** Strange flow rate fluctuations are very often due to an obstruction to the pump inlet. Inspect plumbing from tank to pump.

OR

1. Run the system in Manual Mode with a Test Speed.
2. Turn the system on. Watch the flow in GPM.
3. Is the flow steady within a very small range? For example, a fluctuation from 12.3 to 12.6 GPM would be considered normal. A fluctuation from 10-14 GPM is a problem. If only a small normal fluctuation is seen in section test, skip steps 4-8 and proceed to "Application Rate Fluctuates in Field " below.
4. If there is a large fluctuation, observe the system flow. Is the discharge a steady stream; are the flow indicator balls floating steady?
5. If visually the flow is steady, but the display reports a fluctuation in GPM, inspect the flowmeter. See section B of manual for flowmeter information. Check connections between tank and pump. A loose connection may not show up as a leak, but it can be a place where air can be sucked in. Air in the system will cause erratic flowmeter operation.
6. If visually the flow is unsteady, the flowmeter is working correctly reporting a flow problem. Is the pump turning steady or surging?
7. If the pump is turning steady, the hydraulic circuit is functioning correctly. Look for any type of obstruction in the pump inlet. Clean the strainer. If continually plugging the strainer investigate fertilizer quality and necessary strainer size.
8. If the pump speed is surging, there is a hydraulic problem.

Application Rate fluctuates in field, but flow in Section Test mode is stable.

This problem indicates the valve calibration needs changed. The system is surging because the Rate Controller is moving the hydraulic valve too much.

1. Go to **Setup - System Settings - Control Valve Setup**.
2. Lower the Valve Response Rate. You can do this on the go and see how the change affects the rate.
3. In extreme cases, it may be necessary to go to Advanced Tuning and adjust some other parameters.

Application Rate is slow to get to the Target Rate

1. To get system to Target Rate faster on startup, go to **Setup - System Settings - Control Valve Setup > PWM Setup > PWM Startup**. Set PWM Startup (%) so that pump starts up at or slightly above the normal PWM Duty Cycle.
2. If system is slow responding to rate or speed changes, you may need to increase the Valve Response Rate. Go to **Setup - System Settings - Control Valve Setup**. Increase Valve Response Rate. You can do this while going across the field and observe the effects of each change. If Valve Response Rate is at 100 and system is still slow getting to Target, go to Advanced Tuning and increase P and S.

Helpful Operating and Troubleshooting Information on the Raven RCM

1. **Flow (gal/min), Pressure (PSI), PWM Duty Cycle (DC%), and Pump RPM** (if equipped on your hydraulic pump) are important indicators of system performance. It is good to know what these values are in normal field operation. They provide good troubleshooting information if there is a problem.
2. These items can be placed on the Run Screen with Display Settings.

1.4 (gal/min)	5.1 (mph)
73 (RPM) 1	11.8 (gal)
40.0 DC (%)	26 (PSI) 1

G

Troubleshooting

No Flow shown on display, but liquid is being pumped

Flowmeter Tap Test

See which flowmeter connector you have



Remove red guard to reach pins. Don't break red side clips.

Flowmeter pinout:

3-pin MP Tower

A- Signal B- 12V Power C- Ground

3-pin AMP SuperSeal

1- Ground 2- 12V Power 3- Signal

1. Unplug the flowmeter. With voltmeter, check for **12 volts between Power & Ground** of flowmeter connector. Should have **4-5 volts between signal and ground**. If voltage is not present, inspect wiring harness and check for voltage at harness connection(s) nearer the Rate Controller (at 12-pin Deutsch connector, Power is 1, Ground is 2, Flow Signal is 3).
2. If 12 volts is present, then conduct a **tap test**. Go to **Setup > Settings > Flow/Rate Sensor Setup** and change the flow cal to 1. Have a second person watch GPM on the 1,2,3 screen while other person taps repeatedly (use a short piece of wire or a paper clip) between signal and ground pins of flowmeter connector. A flow value (gpm) should show up indicating the wiring is not damaged. (If alone, note or reset a volume counter to 0, and start Calibrate PWM Limits Test. Check for increased volume after tapping.)
3. If the flow showed on the display during the tap test, your wiring to that point is good. If tap test did not work, go back to the next harness connection and do a tap test there between signal and ground.
4. If the tap test registers flow on the display, replace flowmeter. (*Sometimes, cleaning the inside tube of the flowmeter with soapy water and a soft brush will remove a film covering the electrodes.*)
5. Change Flow Cal back to appropriate Flow Cal when finished with Tap Test.
6. SureFire has a Speed/Flow Simulator (PN 219-01462) or a Tap Tester (212-03-3912Y1) that can be used to confirm if the wiring is good between the flowmeter and controller.

Field Verification of Flowmeter Calibration

Always verify the flow cal setting by comparing the amount actually applied in the field (from weigh tickets) with the amount shown on the display. Adjust the flow cal as needed to get less than 1% difference between the actual amount applied and the amount shown on the display.

In general:

Increase the Flow Cal number if not enough product is actually being applied. (If you want more, increase the number)

Decrease the Flow Cal number if too much product is being applied. (If you want less, decrease the number)

Formula to Adjust Flow Cal Number

$(\text{Volume shown on display}) / (\text{Volume actually applied}) \times \text{flow cal number in display} = \text{new flow cal}$

Example: Display shows 727 gallons was applied. Weigh ticket shows 750 gallons was actually applied. Flow cal number in display was 3000. (*We applied too much, so we will decrease the flow cal.*)

$$727 / 750 \times 3000 = 2908 \text{ (new flow cal number to set in display)}$$

(Any adjustments to the flow cal number will only be as accurate as the measurements used in figuring it.)

Do not power wash the flowmeter.

Unplug the flowmeter before welding on the implement.

Section Valve(s) will not move

1. Go to **Diagnostics > Tests > Control/Section Test** to investigate this issue. If system shuts off with Solution Pump Dry warning, use the Calibrate PWM Limits Test.
2. Start Section Test. Check and uncheck the boxes. With the box checked the valve should turn on. The valve should be off with the box not checked.
3. If none of the valves are working, or if half of the valves are working, it may be a Power (or Ground) issue. The odd-numbered sections have one power source, the even-numbered sections have another power source. (See harness diagrams)

Pin	Function
A	+ 12 V Constant
B	Ground
C	+ 12 V Signal

4. If a valve does not open, switch the connector that is plugged into that valve with a connector that is plugged into a working valve. Also, plug in the connector to the non-working valve to a valve that is working.

5. Check the harness connection to the non-working valve. It is a 3-Pin Weather Pack connector. Check voltage pin A to Pin B. Must be 12 volts, if not, go back to the next harness connection and check the voltage there. (See harness diagrams for pins)

6. If voltage is present on pins A&B of 3 pin connection to valve, then check Pin C to Pin B. This should be 12 volts when the valve is commanded on or open. This should be zero volts when valve is off or closed.
7. If signal voltage is not present to open valve, use diagrams to check at the 14-pin connector, then the 47-pin for voltage on the proper pin for that section.
8. If harnesses and voltages are good, but valve still will not open, remove the actuator from the valve and see if the actuator will work when it is not connected to the valve. Use a wrench to turn the valve to be sure it is moving freely. Be sure actuator and valve are oriented correctly when you put them back together.
9. If constant voltage (Pins A&B) and switched voltage (Pins C&B) are present, inspect, repair or replace the valve.



This is a 3-way valve. If product will not flow when valve is ON, either move the outlet hose to the other outlet port, or remove actuator and rotate valve ball 180°, and replace actuator. Product should flow through the port closest to the Indicator light when the valve is open (green).

Pressure Sensor is not reading

1. Be sure the Pressure Sensor that is displayed on your screen is the same sensor that is plugged into your harness for that product (Sensor 1 or Sensor 2).
2. Make sure the pins where the harness screws on to the end of the sensor have not been bent.
3. Be sure Pressure Sensor is set up and calibrated in the display. Unplug the pressure harness before doing this.

Setup > Settings > Pressure Sensor Setup. Select the sensor you want. > Calibrate Pressure Sensor > Voltage-based Calibration > 50 mv/PSI.

4. There should be a green LED light on the end of the pressure sensor. This may be difficult to see in daylight. The sensor needs 12 v. Check between pins B&C on the Pressure connector on the harness that connects to the pressure sensor. If there is no voltage here, check the voltage between pins 1 & 2 on the 12-pin connector labeled PUMP.
5. **Testing Pressure Sensor Harnessing:** If the pressure sensor is not reading, you can use a AA or AAA battery to test the harnessing. Connect the (-) end of the battery to pin C and the (+) end to pin A of the pressure connector. The 1.5 v should show up as 30 psi on the screen. You can check this at *Diagnostics > System Information > Pressure Sensors*. (0 PSI should be 0.0v)

Other issues

G

Trouble-
shooting

1. “My rate won’t go low enough. I want 8 gpa, but it won’t put down less than 11 gpa.”

- A. Check **Setup > System Settings > Rates > Minimum Flow Rate**. This can be set at 0.0 or at the low range of your flowmeter. This is **gal / min** not **gal / acre**.
- B. Check **Setup > System Settings > Control Valve Setup > PWM Settings > Low Limit**. Default setting is 10 for electric pumps and 25-30 for hydraulic pumps. If set too high, the pump cannot slow down enough when your speed drops or when sections close.
- C. On a hydraulic pump, be sure the red manual override knob is down and locked on the hydraulic valve.

2. “I can’t get up to my rate. I want 12 gpa, and I can’t get more than 10 gpa.”

- A. How many GPM are required to hit your rate? Is this within the pump's specifications? On an electric pump, the output of the pump decreases as the pressure increases. Keep the pressure under 40 PSI (or lower) on an electric system. Is a recirculation valve open, allowing too much liquid to recirculate?
- B. On a dual electric pump system, check each pump individually to see that each one is working at capacity.
- C. Is the strainer plugged? If too small of a mesh strainer is being used, the fluid can gel up around the screen as the fluid is pulled through.
- D. Does the pump have enough hydraulic oil to hit the desired rate? If the pump is in series behind another pump or motor, the hydraulic oil to this pump may be limited.
- E. Check **Setup > System Settings > Control Valve Setup > PWM Setup > PWM Settings > High Limit**. This should be 100.
- F. Check the PWM DC % (Duty Cycle). This can be placed on the Run Screen.
- G. Check the Pump RPM. Maximum RPM should be 500-550 RPM.
- H. Run the pump with a Test Speed in Manual Mode. Press the + button to increase flow. Observe flow (GPM), PWM DC%, PSI, and Pump RPM (if equipped).
- I. Run a Nozzle Flow Check. See gal/ac, PSI, gal/min, and PWM Duty Cycle.
- J. Is the flow cal correct? Is the width of the implement set correctly?

3. “It’s pretty close to the rate, but it won’t ever lock in to the rate.”

- Go to **Setup > System Settings > Rates > Display Smoothing**. Check the box for Display Smoothing.
- Without Display Smoothing it is normal for the system to show the rate constantly changing small amounts as you go across the field. With Display Smoothing, if the Applied Rate is close to the Target Rate, the display does not show all the small changes.

4. “When I start up, I get a screen that says “Solution Pump Dry”.

This is not unusual on the RCM. If the flowmeter does not show flow immediately when you start, this screen pops up. It is made to protect centrifugal pumps that can be harmed quickly if they are dry. This is not a problem for SureFire diaphragm pumps. To get to Target Rate quicker on startup, set the PWM Startup % so the pump starts at or near where it will be running.

5. “My pressure is too high / too low.”

The pressure will be what it is depending on how hard it has to push to get the amount of liquid you are moving from the pressure sensor to where it leaves the system. This pressure will depend on the product itself, the volume (gal/min) you are moving and how much restriction there is to that flow. The orifice or metering tube will be the primary restriction, but it is possible that other parts of the system may add to the total pressure. The pressure a system develops will be less (possibly much less) with water than it will be with a fertilizer product.

What pressure is “too low”?

You need enough pressure to open the check valves. If the pressure is too low, some check valves will open before others, so that some rows may be flowing while others are not. **With 4 lb check valves, we like at least 8 PSI. With 10 lb check valves, we like 15-20 PSI.**

What pressure is “too high”?

There are a few products that may have flow characteristics that are better at lower rather than higher pressures. With most products that is not a concern.

The plumbing components of a SureFire system are rated at 100 PSI or above. On an electric pump system, the pump capacity decreases as the pressure increases. Our standard Tower pump has an internal 70 PSI bypass. **With an electric pump, we like to see pressures from 10 to 30 PSI.** If the pump has the capacity to hit the rate at higher pressures, there is not a problem with doing that, but for long-term operation it would be best to switch to a larger orifice or metering tube.

The SureFire PumpRight hydraulic pump has the ability to pump up to 290 PSI. SureFire plumbs these with a 100 PSI pressure relief valve (PRV) so that plumbing components will not be damaged if high pressure develops. **Typical operating pressures with hydraulic pumps will be 20-60 PSI,** but the pump will work fine at 80-90 PSI if that is needed. If continually running in that high range, consider a larger orifice or metering tube.

Lower pressure will not necessarily reduce the **velocity of the output stream** at the row. Conversely, higher pressure will not necessarily increase the velocity of the output stream at the row. The velocity of the output stream is determined by the volume of the flow and the size of the opening at the output. Changing the pressure by changing an orifice or metering tube upstream from the outlet will not affect the velocity of the output stream if the flow volume remains the same.

Options if pressure is too high with orifices: Use a bigger orifice. Slow down. If pressure is too low, use a smaller orifice.

With metering tube: Options if pressure is too high: Use a larger diameter tube. Shorten the tubes that are on now. Slow down. (*The pressure in a metering tube is related to the viscosity of the product. Many products change viscosity as the temperature changes. A product will have a higher viscosity (and therefore higher pressure) on a cold morning that it will on a hot afternoon.*)

With metering tube: Options if pressure is too low: Switch to a smaller diameter tube. Use a longer tube.

See SureFire publication “396-3269Y1 Navigating the Metering Tube Maze” for more information on how metering tube works.

See SureFire publication “396-3229Y1 Liquid System Components Overview” for a description of all the system components and additional troubleshooting/service information.

See the system manual for your system for more complete information. Manuals and publications are available for download at www.surefireag.com.

Read the [Raven RCM Operator’s Manual](#) for safety information and additional setup/operating information.

Recommended Care and Maintenance

H

Maintenance
& Parts

Winterization

SureFire recommends flushing your fertilizer pump and complete system with adequate amounts of water first. Next, use RV antifreeze to winterize your system by pumping an adequate amount through all components. At the beginning of the next season, begin with water to verify the system is in working order with no leaks.

Change Pump Oil Annually

PumpRight pumps use an internal oil lubricated crankshaft and connecting rod design. The oil is held in an external reservoir with level indicators. Hypro oil is recommended for the pump. This is a non-detergent SAE30 weight oil. If not available, hydraulic jack oils are a similar non-detergent formulation. Annual oil changes are recommended.

To fill or drain the pump completely, the pump shaft must be turned slowly by hand. The hydraulic motor will have to be removed to do this.

On some pump models, the pump will have to be removed from the mounting bracket and lifted slightly to allow access to the oil plug.

When refilling the pump with oil, the shaft will again have to be rotated to fill the pump to its required oil volume.

CRANKCASE OIL CAPACITIES			
Model	Capacity	Model	Capacity
PR17	13 oz	PR40	56 oz
PR30	28 0z	D250	98 oz

Diaphragm & Valve Replacement

PumpRight pumps are designed to allow very simple replacement of the two main pumping components; the diaphragms and the inlet & outlet valves. It is a good practice to replace these every 2 or 3 years (or every 1000 hours). It is a small job that helps ensure reliable operation during the busy season.

Pre-season Service

(A little time spent here may prevent some downtime when you want to be rolling.)

1. Visually check entire system (hoses, fittings, harnesses, etc.) for any signs of wear or trouble.
2. On the display, recheck all setup screens (see Section F) to verify correct setup.
3. Fill system with water and run in Manual mode (Section Test or Calibrate PWM Limits Test) to verify components and system are in working order. (May need to open air bleed valve to prime pump the first time. Be sure air bleed tube is not plugged.)
4. Clean out the dirt that may be packed in to the manual override knob on the hydraulic valve block. Be sure manual override knob can be operated in case it is needed for troubleshooting. The knob should be pushed down and locked for normal operation.
5. If necessary run pump in manual override mode to check hydraulic setup (see page 37).
6. Tighten all clamps. Loose clamps may be evident by leaks on the output side of the system. Loose clamps from the tank to the pump are not always apparent, but can be sources of air getting into the system which can create issues.
7. Push in tubes at all Quick-Connect fittings so they are seated tightly. Tubes that are not fully seated are not always obvious, but may allow air in, which can cause check valves to leak.
8. Remove the black cap from the top of each check valve. Check the diaphragm to be sure it is intact and not gummed up with residue. Look under the diaphragm for debris. Compress the spring in the cap to be sure it moves freely. Carefully replace diaphragm and tighten cap.
9. Remove and clean the strainer. Be sure strainer is tightened securely so it will not suck air.
10. Be sure all rows are flowing and that all metering tubes/orifices are open. (Note: It will take a higher flow rate with water to create enough pressure to open all the check valves.)
11. Run the Nozzle Flow Check to verify that system will lock on to a Target Rate.

H
Maintenance
& Parts



⚠ DANGER

Hydraulic oil under extremely high pressure. Do not use hand or any other skin to check for or to stop hydraulic leaks. Be sure pressure is relieved before loosening hydraulic fittings. Replace worn hoses immediately. Seek medical care immediately if hydraulic oil is shot into the eye or the skin.



⚠ CAUTION

These pumps can deliver liquid at high pressure (290 PSI). Be sure the 100 PSI Pressure Relief Valve (PRV) is installed and functioning so system pressure will be kept under 100 PSI. Check hoses, hose clamps, and liquid fittings regularly and repair or replace loose connections.

PumpRight Valves & Diaphragms

H

Maintenance
& Parts

Diaphragm Pump Service Kits

1 Kit contains 1 diaphragm and 2 valves to service a single pumping diaphragm.

Order multiple kits to service all the diaphragms in your specific pump per chart below...

Visit support.surefireag.com for [PumpRight Diaphragm Pump Repair and Maintenance Video](#)

QTY in Kit	Part Number	Description
PR17 Pump Service Kit - 3 Diaphragm		
KIT #: 291-13-100100 (pump requires 3 kits)		
1	291-13-1040083	BlueFlex Diaphragm (PR17)
2	291-13-2429051	Valve
2	291-13-3460380	Gasket/O-ring

PR30 Pump Service Kit - 3 Diaphragm		
KIT #: 291-13-100150 (pump requires 3 kits)		
1	291-13-550081	BlueFlex Diaphragm
2	291-13-2429051	Valve
2	291-13-3460380	Gasket/O-ring

PR40 Pump Service Kit - 4 Diaphragm		
KIT #: 291-13-100150 (pump requires 4 kits)		
1	291-13-550081	BlueFlex Diaphragm
2	291-13-2429051	Valve
2	291-13-3460380	Gasket/O-ring

D250 Pump Service Kit - 6 Diaphragm		
KIT #: 291-13-100200 (pump requires 6 kits)		
1	291-13-550081	BlueFlex Diaphragm
2	291-02-9910-759051	Valve
2	291-02-680070	Gasket/O-ring

For other service parts, see individual Pump Part Breakout Diagrams in [396-4034Y1](#), the PumpRight manual that came with your pump.

[Also see the manual and individual pump parts breakouts online here.](#)

PumpRight Valves & Diaphragms

Diaphragm Pump Service Kit Replacement Instructions for PR Pumps



Visit support.surefireag.com for PumpRight Diaphragm Pump Repair and Maintenance Video or support.surefireag.com

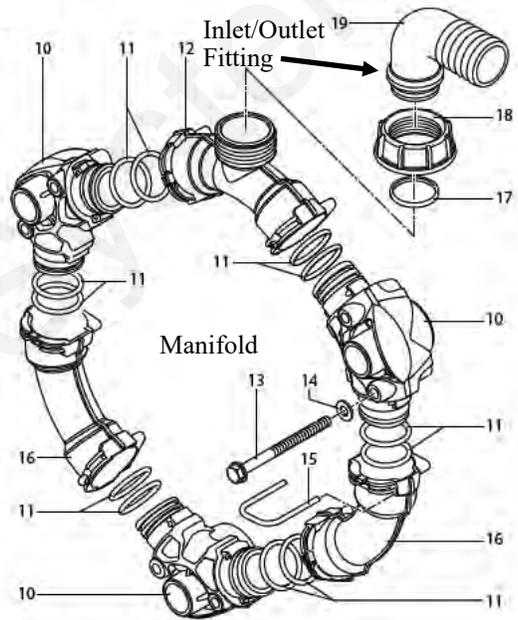
Diaphragm & Valve Service Steps:

1. Remove inlet and outlet plumbing connections by unscrewing ring nut on inlet and outlet fitting.
2. Use extreme caution when removing and replacing drain plug, so that threads are not stripped and o-ring is not damaged. Remove drain plug from bottom of pump to drain oil from pump. Rotate pump shaft to remove all oil. Replace drain plug making sure o-ring is in place. Tighten plug to 180 In.Lbs.
3. Remove pump manifold(s) using a 13 mm wrench.
4. Remove and replace complete valve assembly.
5. Remove the pump head.
6. Remove the diaphragm bolt, support washer and diaphragm. Turn the pump shaft to up stroke to replace diaphragm.
7. Install new diaphragm (LIQUID side up), then replace washer and bolt.
8. Turn pump to downstroke to seat new diaphragm into the sleeve groove.
9. Replace pump head and manifold(s).
10. Refill crankcase with SAE30 non detergent oil (PumpRight Oil or hydraulic jack oil). Turn the pump shaft and top off sight glass.

NOTE: See individual Part Breakout Charts for Bolt/Nut Torque Specs.

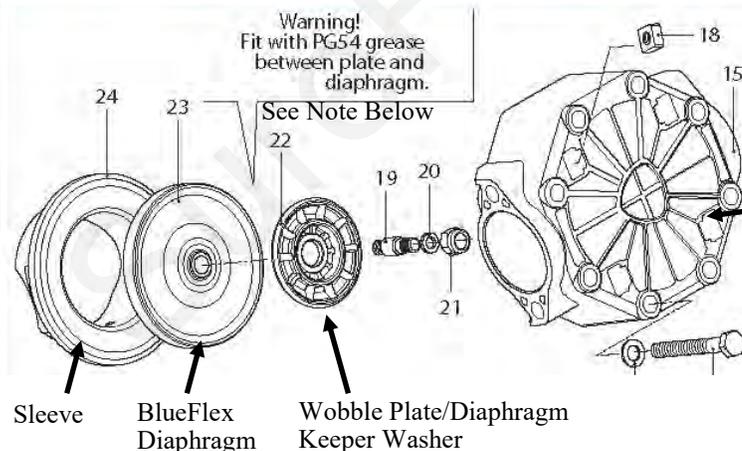
	Number of Diaphragms
PR17	3
PR30	3
PR40	4
D250	6

**Typical Manifold—2 per pump—
inlet and outlet**

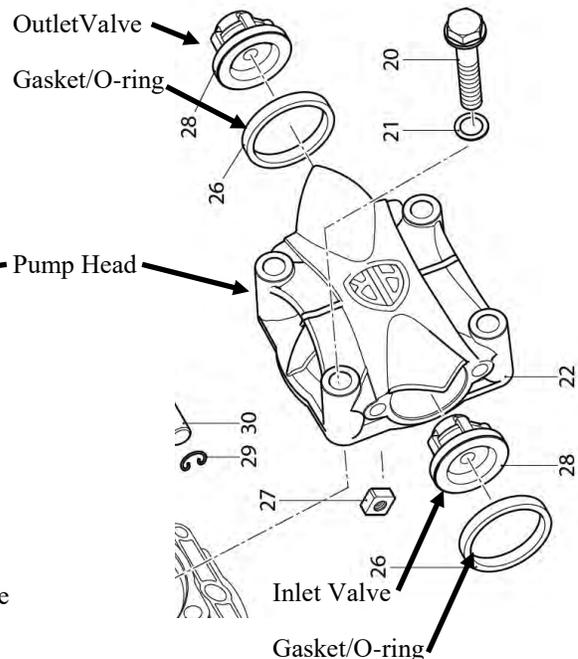


Typical Valve Assembly

Typical Diaphragm Assembly



NOTE: A multipurpose grease is fine to use for applying in between the Diaphragm and Wobble Plate/Washer



For other pump service parts, see individual Pump Part Breakout Diagrams in [396-4034Y1](#), the PumpRight manual that came with your pump.

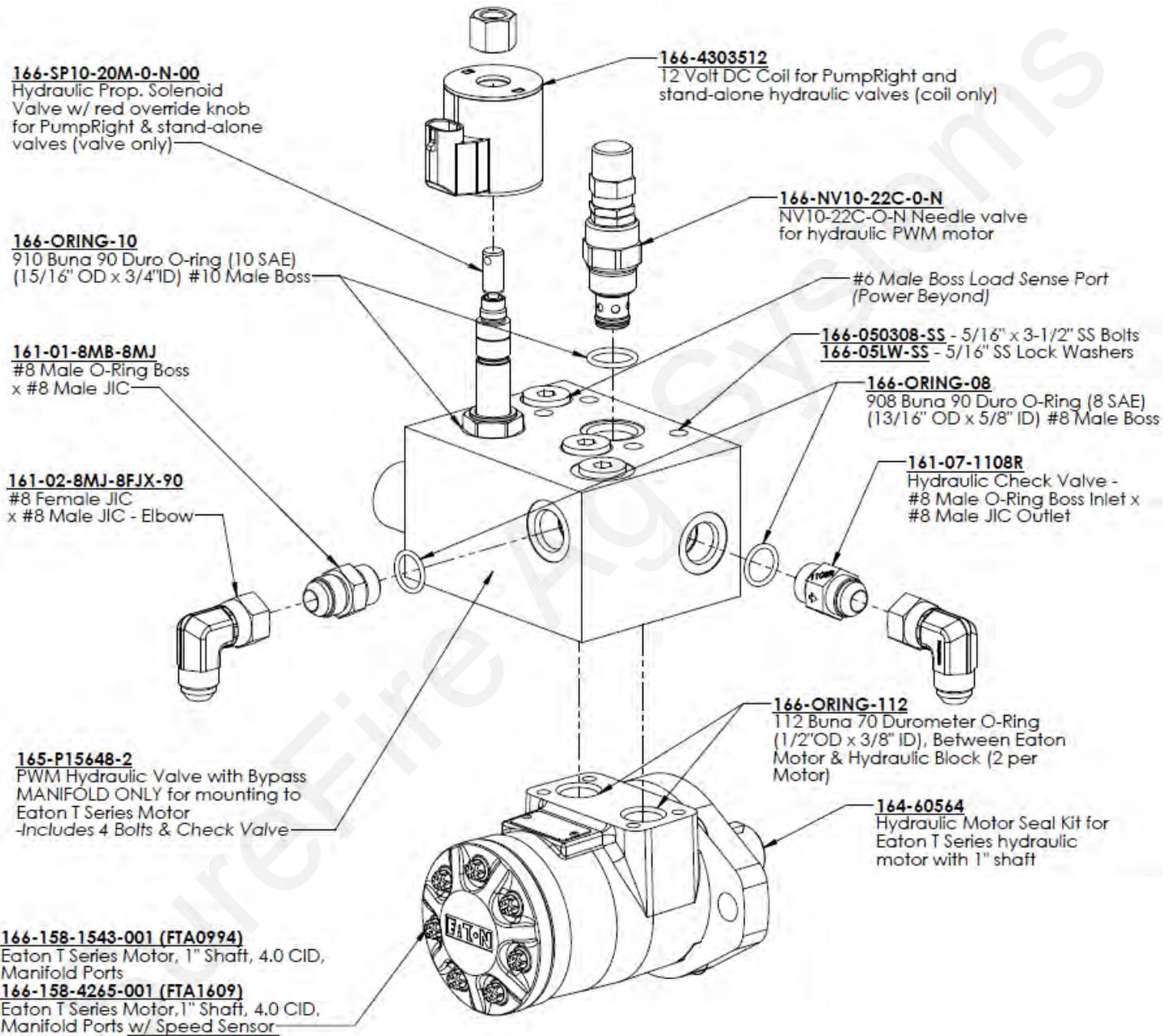
[Also see the manual and individual pump parts breakouts online here. \(store.surefireag.com\)](#)

[Go to support.surefireag.com for pump information and parts breakdowns.](#)

PWM Valve and Motor Parts



- 164-FTA0994 4.0 CID motor (this is the standard motor beginning in 2016)
- 164-FTA1609 Same as 164-FTA0994, but with RPM Speed Sensor-- GRC does not support a Pump RPM sensor.



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