SharpShooter® with Rate Sync®

Turf Sprayer Edition

Operator and Maintenance Manual

CAPSTAN
SINCE 1893 AG SYSTEMS, INC.
APPLICATION SYSTEMS FOR PROFESSIONALS

P/N 118556-002 | Revised 06-2016

SERVICE CONTACT INFORMATION

If a problem arises with the SSRS Turf System that cannot be corrected with the information in this manual, please contact your dealer for service and technical assistance. If further assistance is needed, contact Capstan Ag Systems, Inc.

Dealer: _____

Contact: _____

Phone: _____

Address: _____

City / State / Zip: _____

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FIGURES

1.0 INTRODUCTION

SharpShooter® with Rate Sync® with Blended Pulse™ is an innovative Capstan Ag patented process that combines a tip-management system with rate control technology to solve the greatest limitation of modern sprayer technology - ***spraying from one tip size at a time***.

As an aftermarket retro fit, SharpShooter® with Rate Sync® uses patented Blended Pulse-Width Modulation technology providing a simple solution of having exactly the right effective tip size to maintain both a set rate and a set pressure throughout the entire sprayer speed range.

SharpShooter® with Rate Sync® permits independent operator control over pressure, droplet size, rate and speed without ever changing tips. It may seem magical but the impact on operational efficiency, application quality, drift control and chemical savings is profound.

Since the spray function is controlled at the tip, spray shut off is instantaneous. The flow and pressure are retained in the boom at the tips so when the boom is turned on there is instant flow at the proper rate and pressure.

SharpShooter® with Rate Sync® enhances the physics of spraying to provide a foundation for today's advanced GPS rate controllers with 10 section nozzle spray control and mapping features to truly provide a Total Turf Application System.

SharpShooter® with Rate Sync® provides the right tip size at the right time automatically and instantaneously.

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2.0 - SAFETY

2.1 - Hazard Communications

This manual contains important information on how to safely, efficiently and correctly install, operate and maintain **SharpShooter Turf System**. Following these instructions will help keep personnel safe, reduce downtime and increase the reliability and life of the equipment, its components and related systems.

- Review the Safety Information in the Original Equipment Manufacturer (OEM) sprayer equipment manual(s).
- Follow the instructions (in this manual) for each step thoroughly to ensure safe work conditions in and around OEM sprayer equipment.
- It is important for all individuals working with chemicals to understand the potential risks, necessary safety precautions, and proper response in the event of accidental contact.
- Review the OEM sprayer equipment manual(s) for chemical safety information.
- Review, understand and read procedures and use Safety Data Sheets (SDS) and the required Personal Protective Equipment (PPE) for hazardous chemicals.

Make certain that all personnel have read this manual and thoroughly understand safe and correct operation and maintenance procedures.

Please keep this manual and all enclosed documentation in an accessible location known to all operators, installation, and maintenance personnel.

If you do not understand the Capstan Ag Systems, Inc. equipment after reading this manual, please obtain the proper training before working with equipment to ensure your own safety and well as your co-workers' safety.

- Do not attempt to operate any equipment or system until you completely understand why, when and how it operates. If you are uncertain after studying this manual, please contact Capstan Ag Systems, Inc.

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2.2 - Signal Words

Signal Words used in product safety messages (found in this manual) are based upon these standards:

- American National Standards Institute (ANSI) Z535.1-6
- American Society of Agricultural and Biological Engineers (ASABE) MS-23/14

2.3 - Definitions

The **DANGER** symbol indicates a hazardous situation, which if not avoided, will result in death or serious injury. This signal word is limited to extreme situations.

The **WARNING** symbol indicates a hazardous situation, which if not avoided, could result in serious injury or equipment damage.

NOTE: DANGER or WARNING signal words are not used for property damage accidents unless personal injury risk is appropriate to a specific hazardous situation level.

The ***NOTICE*** symbol addresses practices not related to personal injury and safety practices.

The **SAFETY INSTRUCTION** symbol explains safety practices and hazardous situations in detail, above what the **DANGER** and **WARNING** symbols can provide.

2.4 - Conformance

Safety Messages in this Capstan Ag manual conforms to the ANSI Z535 Standard:

- **Safety Color Code: (WARNING)**
- **Signal Word:** WARNING!
- **Hazard Statement:** Chemical Residues may be present in the OEM equipment.
- **Instructions Statement:** Release pressure on the liquid application system before servicing. Rinse the system with clean water prior to installing or servicing fittings, hoses, valves, or nozzles.
- **Consequences Statement:** Use proper PPE at all times to avoid personal injury.

2.5 - HCS Pictograms and GHS Safety Labels

OSHA's Hazard Communication Standard (HCS) places pictograms on labels to alert users of chemical hazard exposure **[Figure 1]**. You many find these pictograms on OEM sprayer equipment. Review the OEM sprayer manuals for further explanations on these pictograms.

Figure 1: HCS Pictograms

The HCS aligned its provisions with the United Nations' Globally Harmonized System (GHS) Classification and Labeling of Chemicals in 2012. **[Figure 2]** displays a GHS Safety Label example for a chemical hazard.

Figure 2: GHS Safety Label Example

Capstan Ag Systems, Inc. add-on spraying systems for OEM and retrofit sprayer equipment (Booms and Toolbars) may contain (where applicable) HCS pictograms and GHS safety labels (on our equipment) and safety "signal word" messages (in this manual) **[Figure 3]**.

These labels and safety messages warn all personnel about hazardous chemicals or potentially unsafe chemical conditions that may exist while working around sprayer equipment.

Figure 3: GHS Safety Warning Example

2.6 - Hazardous Energy

People working around OEM sprayer equipment may be exposed to hazardous energy in several forms and combinations during installation, operation or maintenance, of Capstan Ag equipment, such as:

- Kinetic (mechanical) - energy in the moving parts of mechanical systems (springs or spring-loaded).
- Potential (residual) - energy stored in pressure vessels, such as liquid application systems and hydraulic cylinders and hoses.
- Electrical energy - generated electrical power, static sources, or electrical storage devices (such as batteries or capacitors).
- Thermal (high or low temperature) - energy resulting from mechanical work, radiation, chemical reaction, or electrical resistance.

2.7 - Chemical Safety

Following these common handling practices for working safely around hazardous chemicals:

- Always have an ample water supply nearby.
- Never smoke or eat while working around chemical spraying equipment.
- Have qualified technicians that are familiar with all local, State or Province, and Country-specific laws install and service the equipment.
- Operate the equipment according to the Product, Operation or Maintenance Manual.
- Avoid chemical exposure by using the proper PPE. Remove contaminated clothing immediately and wash skin (and clothing) thoroughly with soap and water. Wash contaminated clothing after every use.
- Bleed off pressurized sprayer equipment and flush the chemical residue with clean water before servicing.
- If symptoms of illness occur during or shortly after working on or around spraying equipment, immediately call a physician or go to a hospital.

2.8 - Unsafe Equipment Use

- The use of the Capstan Ag equipment by non-qualified personnel.
- The use of unsuitable tools or replacing components or spare parts with ones other than those specified in this manual or by Capstan Ag personnel.
- Re-engineering Capstan's operating software so it changes the intended use of the Capstan Ag equipment without FIRST consulting Capstan Ag Systems, Inc.

2.9 - Battery Safety

Use the procedure in the appropriate sprayer equipment manual for connecting, disconnecting and jump-starting the machine's battery.

- Keep sparks and flames away from the battery. Battery gas can explode and cause serious injury. Do not smoke in battery charging area.
- Remove jewelry, which might make electrical contact and create sparks.
- Avoid chemical burns by not rubbing eyes or skin while working with the battery.
- Wash your hands immediately after completing the job.

2.10 - Extinguishing Fires

Fire extinguishing systems must meet the applicable OSHA requirements and all users of Portable/Fixed Fire Suppression Equipment must know the types, limitations, and proper uses of this equipment; including hazards involved with incipient stage firefighting.

Know where fire extinguishers and first aid kits are located and how to use them.

- Inspect the fire extinguisher and service the fire extinguisher regularly.
- Follow the recommendations on the instructions plate.
- Very small fires can be put out (extinguished) with a fire extinguisher. Use an appropriate method to extinguish a fire (water for paper fires, and chemical extinguishers for electrical or chemical fires.

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3.0 - PARTS IDENTIFICATION

3.1 - SharpShooter with Rate Sync (SSRS Display)

[Figure 4] - The SSRS Display is located at the operator station.

The SSRS Display contains a user interface screen and several keypad buttons:

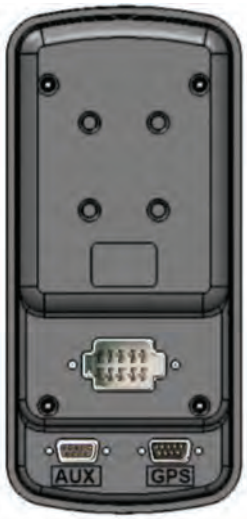
- Power button
- Menu button
- Auto/Manual button
- Increase button
- Decrease button

Figure 4: SSRS Display

118500-110

[Figure 5] - Connections on the back of the SSRS Display include the main connection port, a GPS connection point and diagnostic connection (AUX).

Figure 5: SSRS Display Connection Ports



3.2 - Extension Harness, SSRS Display

[Figure 6] - The Extension Harness routes from the Power Hub to the SSRS Display.

PART NO.	DESCRIPTION
118600-110	Extension Harness, 14’ for SmithCo / Toro
118600-106	Extension Harness, 18’ for Jacobsen

Figure 6: Extension Harness, SSRS Display

118600-110

3.3 - Power Hub

[Figure 7] - The Power Hub can usually be located at the center of the boom mast.

The Power Hub is a junction block where the battery power is routed to the Valve Drivers. The Power Hub also routes Pressure Sensor signals and Valve Driver signals to the SSRS Display.

PART NO.	DESCRIPTION
118600-250	Power Hub, 9-Nozzle, 15’
118600-253	Power Hub, 11-Nozzle, 18’
118600-256	Power Hub, 12-Nozzle, 20’
118600-101	Power Hub,13-Nozzle, Universal

The power hubs listed above replace the following power hub part numbers:

PART NO.	DESCRIPTION
118600-104	Power Hub, 9-Nozzle, SmithCo
118600-105	Power Hub, 11-Nozzle, Universal
118600-103	Power Hub,12-Nozzle, SmithCo

NOTICE

Left and right boom harnesses, power extension, display extension and pressure sensor extensions will also be required if replacing the older style power hubs.

Figure 7: Power Hub

118600-253

118600-102

3.4 - Left Boom Harness

[Figure 8] - Left Boom Harness (Driver's left-hand side) from the Power Hub.

PART NO.	DESCRIPTION
118600-251	Left Boom Harness, 3 Section, 9-Nozzle, 1-3, 15’
118600-254	Left Boom Harness, 3 Section, 11-Nozzle, 8-11, 18’
118600-257	Left Boom Harness, 3 Section, 12-Nozzle, 9-12, 20’

NOTICE Not needed for the Universal 13 nozzle 118600-101 Power Hub.

Figure 8: Left Boom Harness

118600-254

3.5 - Right Boom Harness

[Figure 9] - Right Boom Harness (Driver's right-hand side) from the Power Hub.

PART NO.	DESCRIPTION
118600-252	Right Boom Harness, 3 Section, 9-Nozzle, 7-9, 15’
118600-255	Right Boom Harness, 3 Section, 11-Nozzle, 8-11, 18’
118600-258	Right Boom Harness, 3 Section, 12-Nozzle, 9-12, 20’

NOTICE Not needed for the Universal 13 nozzle 118600-101 Power Hub.

Figure 9: Right Boom Harness

118600-255

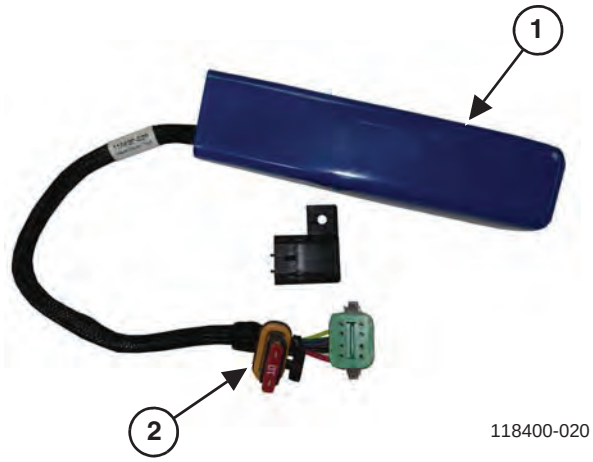
3.6 - Valve Driver Module

[Figure 10] - The ① Valve Driver Module(s) are usually located next to the Power Hub. Two are required. One is for the BOOST row of nozzles and one is for the non-boosted nozzles.

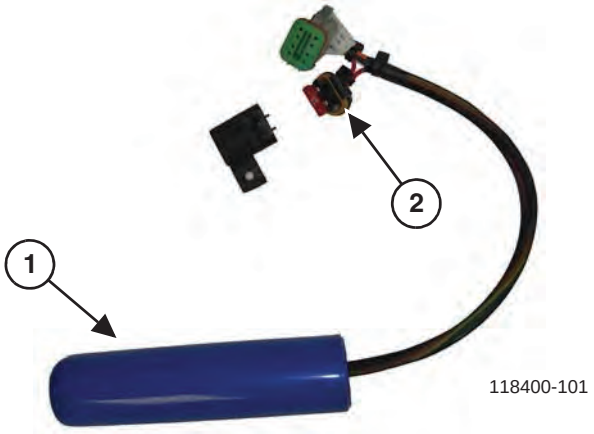
Each Valve Driver has a single connector that connects to the Power Hub. Each Valve Driver is equipped with a ② 10A fuse.

NOTICE 118400-020 replaces 118400-101.

Figure 10: Valve Driver Module



118400-020



118400-101

3.7- Pressure Sensor

[Figure 11] - On most models the Pressure Sensor is located near the center section of the rear boom. On SmithCo models the Pressure Sensor is located at the machine center behind the seat.

NOTICE The Pressure Sensor must be installed in a vertical upright position. It should be located so product flow aways flows past it to avoid plugging. It must also be installed at a location that will allow an accurate reading when all, or only one boom section, is turned on.

The Pressure Sensor provides pressure signals to the SSRS Display.

Figure 11: Pressure Sensor

116301-001

3.8 - Extension Harness, Pressure Sensor

[Figure 12] - The Pressure Sensor Extension Harness connects the Pressure Sensor to the Power Hub.

NOTICE Pressure Sensor Extension Harness is used on SmithCo Sprayers only.

Figure 12: Extension Harness, Pressure Sensor

118600-108

3.9 - Power Harness

[Figure 13] - The Power Harness connects the Power Hub directly to the battery.

PART NO.	DESCRIPTION
118600-107	Power Harness, 14’ SmithCo / Toro
118600-109	Power Harness, 18’ Jacobsen (with 5A fuse)

Figure 13: Power Harness

118600-107

118600-109

3.10 - Boom Shutoff Adapter

Several Boom Shutoff Adapters are available depending on the sprayer model and boom configuration.

[Figure 14] - This style Boom Shutoff Adapter with the Deutsch connector services the following power hubs:

PART NO.	DESCRIPTION
118600-250	Power Hub, 9-Nozzle 15’
118600-253	Power Hub, 11-Nozzle 18’
118600-256	Power Hub, 12-Nozzle 20’

The boom shutoff adapter intercepts the signals from the rate controller section signals that open and close the boom section shutoff valves. Typically the machine boom section shutoff on SmithCo machines are removed and the Boom Section Adapters connect directly to the controller harness.

SharpShooter uses this signal to turn on and off the nozzle valve assemblies located on the boom nozzle bodies. These assemblies are located on the boom section spray tubes. When the signal wire is powered up, 12V, the nozzle valves open. When the signal wire has no power, the nozzle valves close.

Applicable Shutoff Adapter service parts include the following part numbers:

Figure 14: Boom Shutoff Adapters

118602-124

118602-120

118602-127

9 and 10 Section Configurations		
118602-129	SmithCo / Toro	9-Section Raven Envizio; 9-Noozle Boom
118602-118	Jacobsen	
118602-127	SmithCo / Toro	10-Section Raven Envizio; 11-Nozzle Boom
118602-120	Jacobsen	
118602-128	SmithCo / Toro	10-Section Raven Envzio; 12-Nozzle Boom
118602-122	Jacobsen	

3 Section Configurations		
118602-125	SmithCo / Toro	3-Section Raven 440; 9-Nozzle Boom (spade terminals)
118602-119	Jacobsen	3-Section Raven 440; 9-Nozzle Boom
118602-124	SmithCo / Toro / Deere	3-Section Raven 440; 11-Nozzle Boom (spade terminals)
118602-121	Jacobsen	3-Section Raven 440; 11-Nozzle Boom
118602-126	SmithCo / Toro	3-Section Raven 440; 12-Nozzle Boom (spade terminals)
118602-123	Jacobsen	3-Section Raven 440; 12-Nozzle Boom

[Figure 15] - This style of Boom Shutoff Adapter with the large round connector services the following older Power Hubs.

NOTICE These Hubs do NOT have separate boom and power harnesses.

PART NO.	DESCRIPTION
118600-104	Power Hub, 9-Nozzle Boom, SmithCo
118600-105	Power Hub, 11-Nozzle, Universal
118600-103	Power Hub,12-Nozzle, SmithCo
118600-101	Power Hub, 13-Nozzle, Universal, 21’

Figure 15: Boom Shutoff Adapter

118602-111

Replacements for this style of adapter includes the following part numbers:

10 Section Configurations	
118602-111	10-Section Raven Envizio; 11-Nozzle Boom (Packard weather-pack terminals)
118602-112	10-Section Raven Envizio; 12-Nozzle Boom (Packard weather-pack terminals)
118602-110	10-Section Raven Envizio; 13-Nozzle Boom (Packard weather-pack terminals)

3 Section Configurations	
118602-117	3-Section Raven 440; 9-Nozzle Boom (spade terminals)
118602-115	3-Section Raven 440; 11-Nozzle Boom (spade terminals)
118602-104	3-Section Raven 440; 11-Nozzle Boom (Packard weather-pack terminals)
118602-116	3-Section Raven 440; 12-Nozzle Boom (spade terminals)
118602-103	3-Section Raven 440; 13-Nozzle Boom (Packard weather-pack terminals)

3.11 - Y-Adapter

[Figure 16] - The Y-Adapter connects to the Boom Shutoff Adapter and allows two nozzle locations to be a single section.

Figure 16: Y-Adapter

118602-102

3.12 - Battery Power Cable

[Figure 17] - The Battery Power Cable (Envizio Pro) is required for aftermarket installations of advanced rated controllers. This 30A fused harness connects the battery to an aftermarket switch that controls an aftermarket fuse panel for the rate controller power and ground wires.

Figure 17: Battery Power Cable

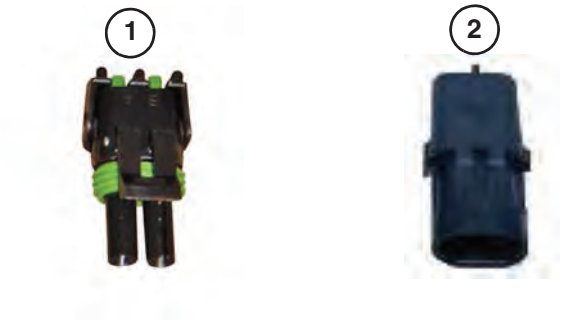
118600-120

3.13 - Electrical Connector Dust Plugs

[Figure 18] - The Packard ① 2-pin Tower and ② 2-pin Shroud may be used as plugs to weather proof any unused connectors or for modifying the pump PWM valve signal wire to the rate controller harness.

ITEM	PART NO.	DESCRIPTION
1	706500-502	WP Plug 2-Pin tower
2	706510-502	WP Plug 2-Pin shroud

Figure 18: Electrical Connector Dust Plugs



3.14 - Nozzle Valve Assembly

[Figure 19] - The SharpShooter pulses the Nozzle Valve Assembly to maintain a constant boom and tip pressure.

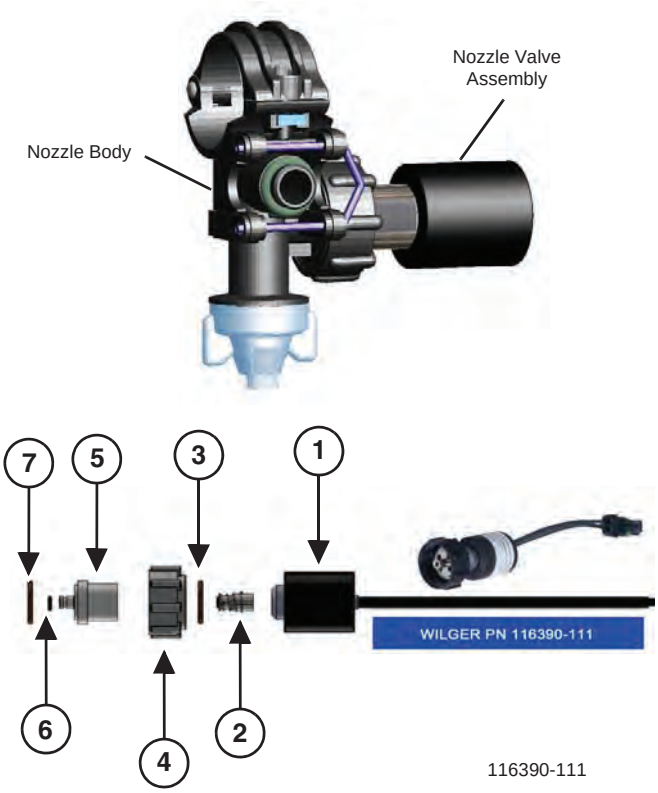
The Nozzle Valve Assembly screws onto the nozzle bodies replacing the standard diaphragm check valve. The 2 pin Packard connector plugs into boom harness from the Power Hub.

NOTICE

This part requires a Wilger brand nozzle body. Do not replace broken nozzle bodies with a brand other than Wilger as significant leaking will occur.

ITEM	PART NO.	DESCRIPTION
1	116189-111	Coil
2	716009-111	Plunger
3	715022-204, Size-015	O-ring
4	717101-007	Flynut
5	116188-111	Valve Body
6	715022-201, Size-008	O-ring
7	715022-206, Size-016	O-ring

Figure 19: Nozzle Valve Assembly



3.15 - Tips

[Figure 20] - Capstan offers Wilger pre-orifice drift reduction tips.

Depending on the top spraying speed desired, Capstan offers:

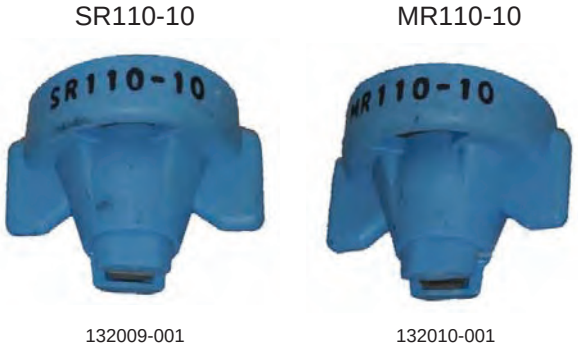
- SR110-10 - inside nozzle bodies.
- MR110-10 - outer BOOST nozzle bodies.

NOTICE

These tips have the same inlet orifice that determines the maximum flow. But the two tips have different exit orifices to allow a broader droplet spectrum.

- MR110-125 tips are used to replace the MR110-10 tips when application rates exceeding 2.0 gal/1000sf are consistently used. Additional tips may be ordered as necessary.
- SR110-06 tips are used to replace the SR110-10 tips when application rates less than 1.0 gal/1000sf are consistently used.

Figure 20: Tips



3.16 - Wilger Nozzle Bodies

[Figure 21] - Wilger Nozzle Bodies.

Figure 21: Wilger Nozzle Bodies

132017-001

132002-001

3.17 - Hypro Dry Boom Adapters

[Figure 22] - Hypro Dry Boom Adapters.

Figure 22: Hypro Dry Boom Adapters

132025-001

132026-001

3.18 - Pressure Sensor Breakout Harness

[Figure 23] - The Pressure Sensor Breakout Harness is a service tool used to evaluate the Pressure Sensor.

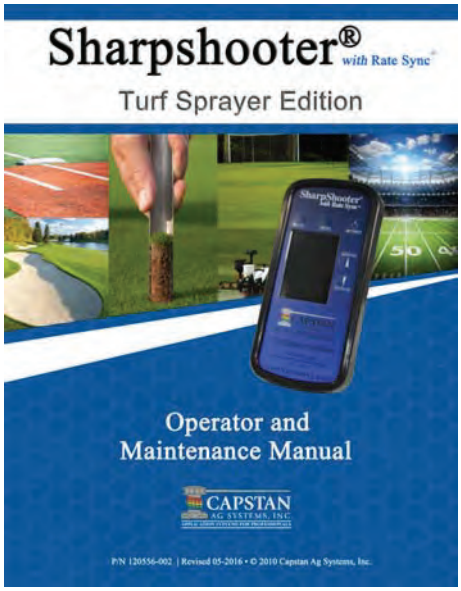
Figure 23: Pressure Sensor Breakout Harness

620185-001

3.19 - SharpShooter with Rate Sync Turf Sprayer Edition Operator and Maintenance Manual

[Figure 24] - The SharpShooter with Rate Sync Turf Sprayer Edition Operator and Maintenance Manual is supplied to aid the owner/operator in safety, operation, maintenance and troubleshooting of the SharpShooter with Rate Sync system.

Figure 24: SSRS Turf Manual



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3.20 - Original Equipment Manufacturer Kits

KIT NO.	SMITHCO KITS FOR SHARPSHOOTER WITH RATE SYNC TURF EDITION	QTY.	OEM Factory Installed	Retro-fit Aftermarket Customization
118600-230	Kit, SmithCo 9-Nozzle, 9-Section,15' Boom, Turf SS		Jacobsen Kit (made by SmithCo for Jacobsen)	
118600-226	Kit, SmithCo 11-Nozzle, 10-Section, 18' Boom, Turf SS		Jacobsen Kit (made by SmithCo for Jacobsen)	
118600-228	Kit, SmithCo 12-Nozzle, 3 & 10-Section, 20' Boom, Turf SS		Jacobsen Kit (made by SmithCo for Jacobsen)	
	Core Components			
118500-110	SSRS Display		ALL	
118400-020	Module, Valve Driver		ALL	
118600-101	Power Hub, Turf, 13-Nozzle, Turf SS		Retro-fit	John Deere/SDI
118600-107	Power Harness, Turf, 14'		SmithCo	
118600-108	Extension Harness, Pressure Sensor		SmithCo	
118600-109	Power Harness, Turf, 18'			All except SmithCo
118600-250	Power Hub, 9-Nozzle, Turf		ALL	
118600-251	LH Boom Harness, 3-Section, 9-Nozzle, 1, 2, 3		ALL	
118600-252	RH Boom Harness, 3-Section, 9-Nozzle, 7-9		ALL	
118600-253	Power Hub, 11-Nozzle, Turf		ALL	
118600-254	LH Boom Harness, 3-Section, 11-Nozzle, 1, 2, 3, 4		ALL	
118600-255	RH Boom Harness, 3-Section, 11-Nozzle, 8, 9, 10, 11		ALL	
118600-256	Power Hub, 12-Nozzle, Turf		ALL	
118600-257	LH Boom Harness, 3-Section, 12-Nozzle, 1, 2, 3, 4		ALL	
118600-258	RH Boom Harness, 3-Section, 12-Nozzle, 9, 10, 11, 12		ALL	
116301-001	Pressure Sensor Assy, 100 PSI, 0.5-5 VDC, 1/4" MNPT, WP		ALL	
118600-125	Extension, Turf SS, 8 cond x 25', 18 ga, Universal, DT			All except SmithCo
116390-111	Valve Assy, Wilger OM Coil w/Grip Body, PFE		All	

KIT NO.	SHUTOFF HARNESSES	QTY.	OEM Factory Installed	Retro-fit Aftermarket Customization
118602-102	Harness, Shutoff, Y Adapter, Turf		ALL Sprayers using advanced Rate Controllers with more than 9 nozzles	
118602-129	Harness, Shutoff, Turf, 9-Section Turf			John Deere/SDI
118602-127	Harness, Shutoff, Turf, 10-Section Turf			Toro, John Deere/ SDI
118602-128	Harness, Shutoff, 12-Nozzle, 10 Section Turf			Toro, John Deere/ SDI
118602-110	Harness, Shutoff, Turf, 10-Section, 13 Pigtails, Universal			John Deere/SDI

KIT NO.	ACCESSORIES and SERVICE PARTS	QTY.	OEM Factory Installed	Retro-fit Aftermarket Customization
116188-111	Valve Body, Wilger w/Grip		ALL	
116189-111	Valve, Coil Assy, 7W, OM		ALL	
706500-502	Harness, Dust Plug, 2-Pin Tower, WP		ALL	
706510-502	Harness, Dust Plug, 2-Pin Shroud, WP		ALL	
118600-120	Harness, Power, Turf, 2 cond x 12', 12ga		ALL	
118603-101	Ram Mount, Ball		ALL	
118703-001	Kit, Installation, SS		ALL	
132031-001	Harness, Power, Turf, 2 cond x 12ga, battery lugs x bare ends		Retro-fit only	Retro-fit Raven Epro
620185-001	Harness, Breakout, 3-Pin, WP		ALL	
706500-502	Packard Tower, 2-Pin		ALL	
706510-502	Packard Shroud, 2-Pin		ALL	
715022-201	O-Ring, Viton, -008		ALL	
715022-204	O-Ring, Viton, -015		ALL	
715022-206	O-Ring, Viton, -116, Wilger		ALL	
716009-111	Plunger Assy, PFE		ALL	
717101-007	Valve, Fly Nut, Wilger		ALL	

KIT NO.	ACCESSORIES and SERVICE PARTS	QTY.	OEM Factory Installed	Retro-fit Aftermarket Customization
	Wilger Nozzle Bodies and Tips			
132002-001	Wilger ComboRate Nozzle Body, End Body		All sprayers, all customers	
132009-001	Wilger Combojet Tip, SR110-10		All sprayers, all customers	
132009-006	Wilger Combojet Tip, SR110-06		Parts service for lower rates (optional)	
132010-001	Wilger Combojet Tip, MR110-10		All sprayers, all customers	
132017-001	Wilger C/R II Saddle/Body 1” 1-Way 3/8” Inlet BP, BM		All sprayers, all customers	
132025-001	Dry Boom Adapter, Single, 1” x 3/4”		All sprayers, all customers	
132026-001	Dry Boom Adapter, Double, 1” x 3/4”		All sprayers, all customers	
132030-001	Wilger Combojet Tip, MR110-125		Parts service for higher rates (optional)	

3.21 - Capstan Parts Support - Non Kit Parts

PART NO.	DESCRIPTION	QTY.	SmithCo, Jacobsen, John Deere/SDI
132009-006	Combojet Tip, SR110-06 (replaces 132009-001 for low rates)		ALL
132030-001	Combojet Tip, MR110-125 (order with 132029-001)		ALL
132009-001	Combojet Tip, SR110-10 (order with 132010-001)		ALL
132010-001	Combojet Tip, MR110-10 (order with 132009-001)		ALL
716009-111	Plunger Assembly, PFE		ALL
717101-007	Fly Nut, Wilger		ALL
116188-111	Valve Body, Wilger w/Grip		ALL
715022-206	O-Ring Wilger, -116, Viton (Between Body and Nozzle)		ALL
715022-204	O-Ring, -015, Viton (Between Coil and Body, All Valves)		ALL
715022-201	O-Ring, -.008, Viton, Small		ALL
116189-111	Coil Assembly, 7-Watt, Overmolded		ALL
132020-001	Wilger Boom Clamp, High Reach C/R II 3/4” - 1 1/4”		Old Toro and John Deere Models

4.0 - OPERATION

4.1 - SSRS Operation Objectives

The SharpShooter with Rate Sync system is especially useful in solving three basic spraying challenges that result from conventional rate controller spraying:

1. Performance limitations of single tip selection applications related to speed (slower and faster) and rate (smaller and larger) ranges.

2. Inability to independently control pressure that can contribute to excessive drift and/or lower speed spray pattern collapse.

3. Quality challenges on consistent and correct rates due to the inherent limitations of a basic rate controller applications.

Solving Challenge 1: Single tip spraying

As an example, using Wilger SR110-10 on the Non-Boost solenoids, the SharpShooter with Rate Sync system can automatically select a tip size anywhere between 0.2 to 1.0 GPM according the rate, speed and pressure values. With the BOOST feature, using the MR110-10 tips on the BOOST solenoids, the SharpShooter with Rate Sync system can select tips anywhere between 0.2 to 2.0 GPM. This allows the SharpShooter with Rate Sync system to select the appropriate tip to maintain a pressure set point regardless of speed or rate.

NOTICE The sprayer can operate at a constant pressure and rate anywhere from 2 to 10 MPH at 1.0 gallons/thousand sf for fairway applications. For greens and tees, the sprayer can spray up from 0.5 to 4.0 gallons/thousand sf with typical green speeds.

Solving Challenge 2:

If winds pick up, the operator can lower the pressure set point and the SharpShooter with Rate Sync system will elect a larger effective tip size to achieve that pressure. The larger tip and lower pressure has the effect of reducing driftable fines. This drift control can be done “on-the-go” while maintaining rate and speed.

Solving Challenge 3:

Consistent and accurate applications from “dead stop” spraying, low-speed and hill-climbing applications, and effects of boom section changes are minimized by the SharpShooter with Rate Sync systems quick ability to change the effective tips sizes.

4.2 - SSRS Display Controls

[Figure 25] - The SSRS Display has five buttons to navigate and control the system. A screen on the SSRS Display interface provides immediate information and easy access to the menu items.

Icon	Description
	Press the <*Power*> button to turn the SSRS Display ON, the light behind the power button will illuminate.
NOTICE	The system defaults to Manual Mode each time the SSRS Display is powered up.
	**[Figure 26]** - Press the <*Menu*> button to enter the main menu list.
NOTICE	The Menu button doubles as enter/ exit through all the menu items.
NOTICE	Main menu screen, two pages, shows all the menu items on the left and the current value of each on the right.
	Press the <*Increase/Decrease*> buttons to navigate the menu items highlighting the desired field. Manually select duty cycle percentage, or effective tips size in Manual Mode, or Set target pressure in Auto Mode letting the SSRS Display determine the duty cycle, or in other terms, the “effective tip” size required.

Figure 25: SSRS Display Controls

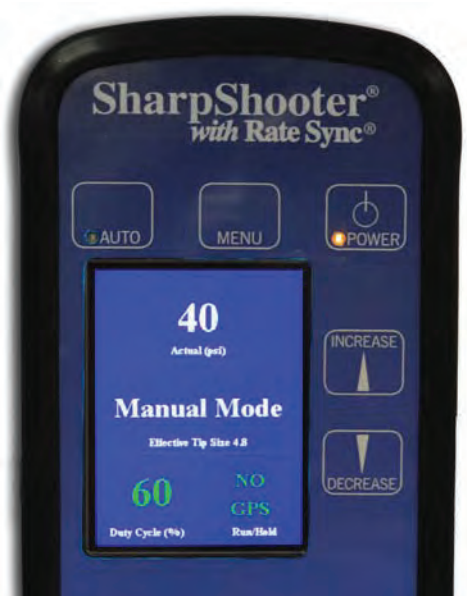
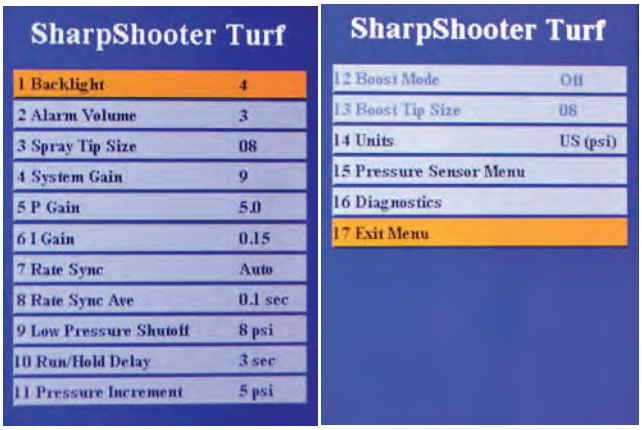


Figure 26: Main Menu Items



Press the <menu> button to enter desired selection.

To exit the main menu, scroll up/ down with the arrow buttons to highlight line 17 Exit Menu, then press the <*menu*> button.

Auto/Manual Button - Manual Mode is the default mode at power up. Manual Mode will pulse nozzle valves at the duty cycle percentage selected by the increase/decrease buttons. The Manual Mode is known as the Rate Controller Only Mode used in the event that the SSRS Display fails to automatically control pressure. It is not necessary to change tips.

Manual Mode can also be used to close all nozzle valves by toggling down to 10% duty cycle, then pressing decrease once more. This will close all solenoids and the diagnostic readout will show "OFF".

NOTICE

In the Manual Mode the increase/decrease buttons act like an electronic rotary nozzle body with an "infinite" number of tips that can be selected by the operator.

The Automatic Mode is the standard operating mode for SharpShooter with Rate Sync. Press the <*Auto*> mode button, the LED light behind auto/manual button will illuminate. The SSRS Display will automatically work to maintain an operator set target pressure. It does this by pulsing the nozzle valves at a duty cycle percentage controlled by the target pressure.

NOTICE

Upon powering up the SharpShooter with Rate Sync system and pressing the <**Auto**> mode button, the SharpShooter with Rate Sync will begin pulsing at 50% duty cycle. It will remain at 50% until the run-hold delay time has elapsed. At that time the SSRS Display will begin to adjust the duty cycle to achieve the set pressure. This allows the flow control system to establish itself on initial power up before the SSRS Display will regulate the pressure.

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4.2.1 - SSRS Display Screen

[Figure 27] - The SSRS Display screen shows a real time readout of the SharpShooter with Rate Sync system operation.

Actual pressure, effective tip size, and duty cycle are displayed in the Manual Mode. Actual pressure, target pressure and duty cycle appear in the AUTO Mode. A diagnostics readout area appears in both modes.

Indicator Lights and Sounds - The SSRS Display indicator lights are located behind the Power button and Auto/Manual button.

When the SSRS Display is powered on, the indicator light behind the ① power button will appear constant. This signals a properly operating system.

The indicator light behind the Auto/Manual button will be off when in ② Manual Mode (also read out in center of screen). When ③ Auto Mode is selected, the indicator light will turn on and screen readout will change to show target pressure.

The SSRS Display includes audible and visual alarms. The audible alarms are an accessible menu item. Visual alarms include a readout area in the lower right hand portion of the screen and a flashing light behind power button.

The alarm readout will appear and the power button light will flash once per second when the following appear:

1. **Pressure Sensor Error** - Present when there is no pressure acting on the sensor. Could also be pressure above or below the limits of the pressure sensor.
2. **Minimum Duty Cycle** - Appears when the minimum duty cycle value is experienced.
3. **Maximum Duty Cycle** - Appears when the maximum duty cycle value is experienced.
4. **No GPS** - Will appear when the Rate Sync is functioning and no GPS values are being received by the SSRS Display. This error will not appear when the Rate Sync is set to off.
5. **No GPS VTG** - Shows that the SSRS Display is receiving some GPS signals but not the necessary VTG signal.
6. **Low Pressure Shutoff** - When the Low Pressure Shutoff menu setting is 8 PSI, this readout will appear when the pressure drops below 8 PSI. At this point nozzle valves will close. Nozzle valves will open and the readout will clear when pressure increases to at least 12 PSI.
7. **Boost** - Appears when the Boost nozzles are on.

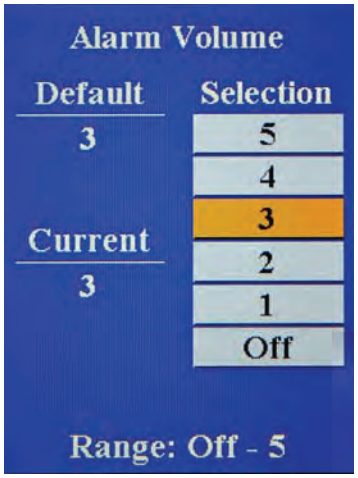
Figure 27: SSRS Display Screen

[Figure 28] - In each specific menu selection item screen, a default value and current value are both listed on left side of screen.

Range of selection parameters is called out on bottom of screen and selection choices are locate on the right.

To choose a new parameter in any menu, scroll up/ down with the arrow keys highlighting the desired selection, then press the menu button to exit that screen. Your selection will now be the value on the right side of the main menu screen.

Figure 28: Menu Example



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5.0 - CONTROL FEATURES

5.1 - Specific Menu Items

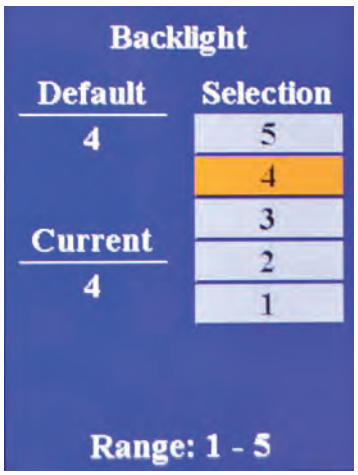
Line 1 - Backlight

[Figure 29] - Backlight allows choices of LCD screen brightness and backlight behind the keypad for low light conditions.

Range: 1 - 5 (Dimmest to Brightest)

When selections 1 and 2 are active (low ambient light conditions) the keypad buttons become back-lit.

Figure 29: Line 1 -Backlight

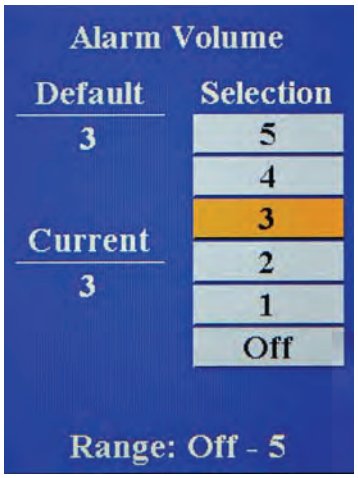


Line 2 - Alarm Volume

[Figure 30] - Alarm volume menu offers personalization of the alarm function. One can choose to deactivate the alarm or select a variety of volumes.

Range: 1 - 5 (Quiet to Loudest)

Figure 30: Line 2 - Alarm Volume



Line 3 - Spray Tip Size

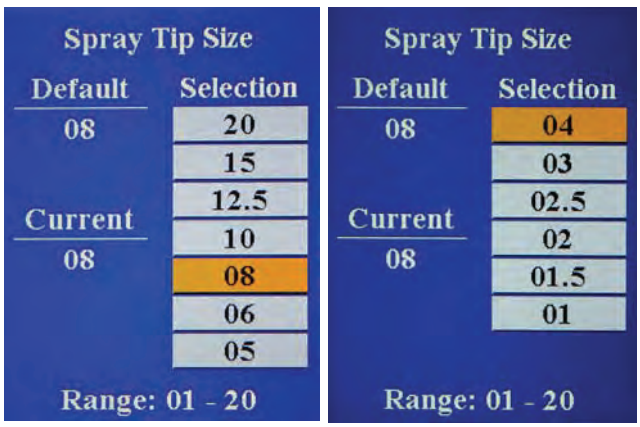
NOTICE

This defines the tips for the NON-BOOST row of nozzles toward the front of the machine.

[Figure 31] - It is important to choose your Spray Tip Size in the SSRS Display menu (2 pages) for the Rate Sync to function properly.

Range: 01 - 20

Figure 31: Line 3 - Spray Tip Size



Line 4 - System Gain

[Figure 32] - System Gain is the first pressure control parameter in the SSRS Display menu system. System Gain changes the total response of system according to the same ratio between the individual P Gain and I Gain values. It is the first menu item to utilize when tuning the pressure control.

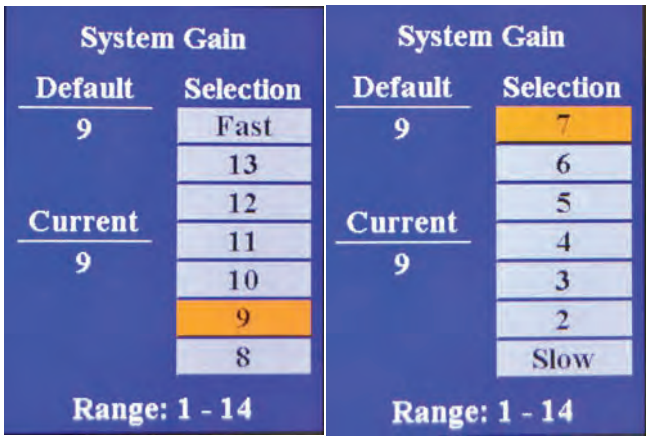
Increasing the System Gain makes the SharpShooter with Rate Sync system react faster to pressure changes.

Decreasing System Gain makes SharpShooter with Rate Sync system react slower to pressure changes.

Range: 1 – 14 (slow to fast)

Recommended Starting Value = 9

Figure 32: Line 4 - System Gain



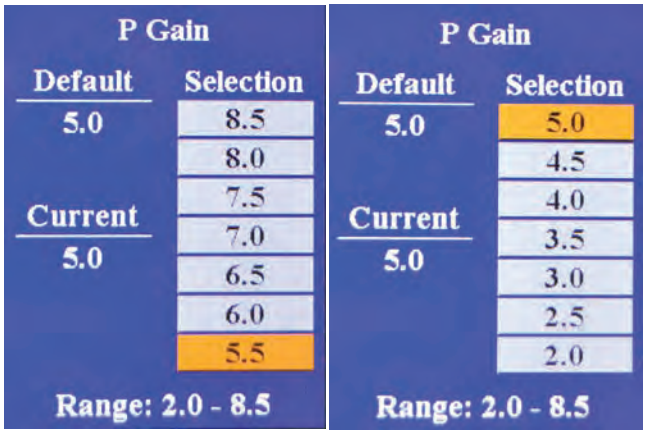
Line 5 - P Gain

[Figure 33] - P (Proportional) gain is the second pressure tuning parameter in the SSRS Display menu. Proportional gain determines the initial speed at which SSRS Display drives the duty cycle toward the target value. Stabilize an oscillating system by selecting a lower number. Speed up a sluggish system by selecting a higher number **[Figure 33]**.

Range: 2.0 – 8.5 (slow to fast)

Recommended Starting Value = 5

Figure 33: Line 5 - P Gain



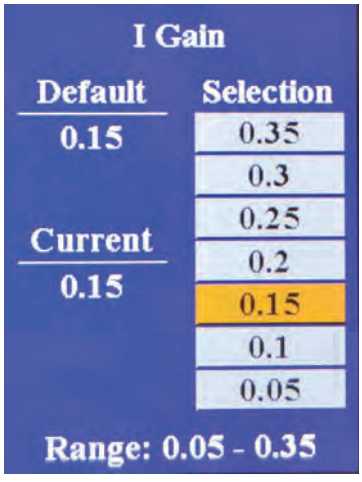
Line 6 - I Gain

[Figure 34] - I (Integral) Gain, the third pressure tuning parameter in the SSRS Display, determines the acceleration driving duty cycle to the target value. To stabilize an oscillating system, use a lower number. To speed up a sluggish system, use a higher number.

Range: 0.05 – 0.35 (slow to fast)

Recommended Starting Value = 0.15

Figure 34: Line 6 - I Gain



Line 7 - Rate Sync

[Figure 35] - Rate Sync uses real time speed change to determine the proper duty cycle for the appropriate nozzle. It is used to make the SharpShooter with Rate Sync system react faster to speed changes.

10hz is optimal, but Rate Sync Ave being selectable, a receiver running 5hz can be used

NOTICE A 10 Hz NMEA GPS connection and VTG signal is required for Rate Sync to operate properly.

NOTICE If no 10 Hz NMEA GPS signal is available, the Rate Sync Menu option should be set to OFF.

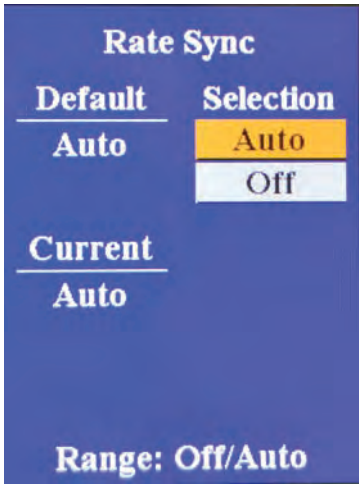
NOTICE Rate sync turned off disables speed change corrections. GPS connection is not needed with rate sync off.

Range: Off/Auto

Recommended Value = Auto

- Rate Sync auto allows the SharpShooter with Rate Sync system to correct the pressure quicker during speed changes based on GPS data and automatically calculating the max speed based on tip size.

Figure 35: Line 7 - Rate Sync

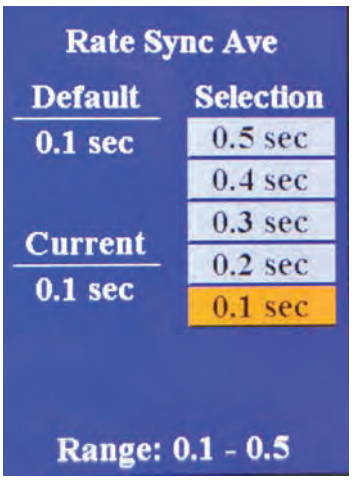


Line 8 - Rate Sync Ave

[Figure 36] - Rate Sync Ave is the time parameter used in rate sync calculations. Default setting of 0.1 second is recommended, higher settings cause rate sync to react slower.

Range: 0.1 - 0.5

Figure 36: Line 8 - Rate Sync Ave



Line 9 - Low Pressure Shutoff

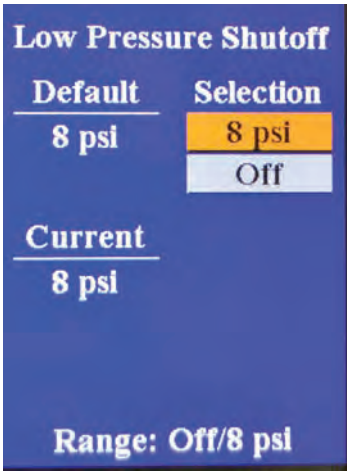
[Figure 37] - Low Pressure Shutoff allows the SSRS Display to turn off the nozzle valves when the pressure decreases below 8 PSI. Thus this feature is intended to duplicate the effect of the nozzle drip checks found on sprayers. To alert the operator that the low pressure shutoff feature has been activated, low PSI shutoff will appear in the diagnostic readout area.

When the pressure rises above 12 PSI again, the SSRS Display will pulse at 50% duty cycle for the start-up delay period and then will resume pressure control.

When set to the OFF position, the SSRS Display will maintain a minimum duty cycle percentage, equal to the pulse frequency, regardless of either low or zero pressure.

Range: Off/8 PSI

Figure 37: Line 9 - Low Pressure Shutoff



Line 10 - Run/Hold Delay

[Figure 38] - Run/Hold Delay is the delay at startup when SSRS Display begins at a preset value (50% duty cycle) allowing for the rate controller to stabilize before making larger pressure control changes.

In **AUTO** Mode, whenever the boom or all sections are toggled off, the SSRS Display will store the duty cycle effective at that moment.

When the boom is turned on and the run / hold signal is returned, the SSRS Display will begin to control pressure by first resuming the pulsing at the previous duty cycle before the boom was shutoff.

The “Hold” readout will appear in the Diagnostics area, to alert the operator that the initialization delay has been activated. The start-Up delay time is equal to the Run / Hold delay time.

This allows the flow control system to resume control and attain rate stability.

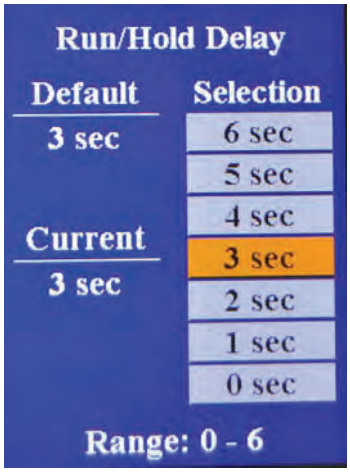
Once the delay period has elapsed, the SSRS Display will resume pressure control.

The diagnostic readout area will read Hold and count down the seconds to alert the operator that the run / hold delay has been activated. When Hold count down is finished, the SSRS Display will read Run in diagnostics area. At this Run point the SSRS Display is controlling pressure once again.

Range: 0 - 6

While a value of 3 is the default value, **for TURF applications a 0 or 1 is recommended.** Increasing the value allows more time for the rate to stabilize before the SharpShooter with Rate Sync pressure control activates.

Figure 38: Line 10 - Run/Hold Delay

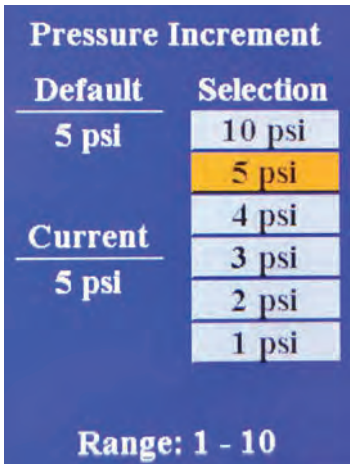


Line 11 - Pressure Increment

[Figure 39] - Pressure Increment allows the operator to choose the pressure increment per toggle of the increase/decrease button.

Range: 1 - 10

Figure 39: Pressure Increment

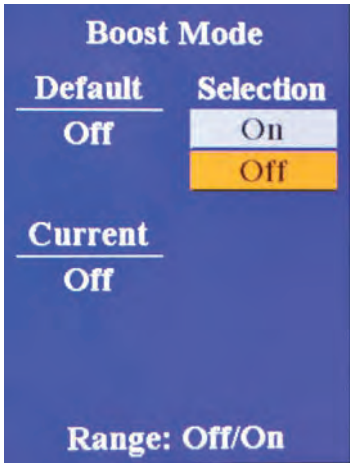


Line 12 - Boost Mode

[Figure 40] - Turning ON the Boost Mode activates a second row of nozzle tips to spray. The effect is to expand the range of effective tip sizes to fully utilize the product pump for a greater range of speeds and rates.

Range: Off/On

Figure 40: Line 12 - Boost Mode



Line 13 - Boost Tip Size

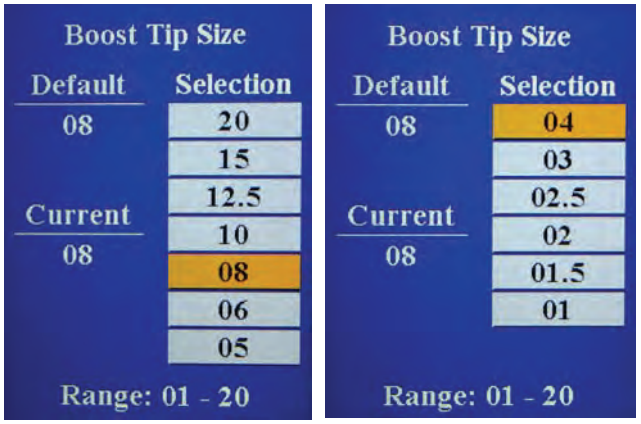
NOTICE This defines the tips for the BOOST row of nozzles toward the rear of the machine.

[Figure 41] - It is important to change your Boost Tip Size in the SSRS Display menu (2 pages) for Rate Sync to function properly.

Range: 01 to - 20

NOTICE Capstan SSRS comes with size 10 tips.

Figure 41: Line 13 - Boost Tip Size



Line 14 - Units

[Figure 42] - The Units Menu consists of three choices for the SSRS Display pressure units to be displayed in.

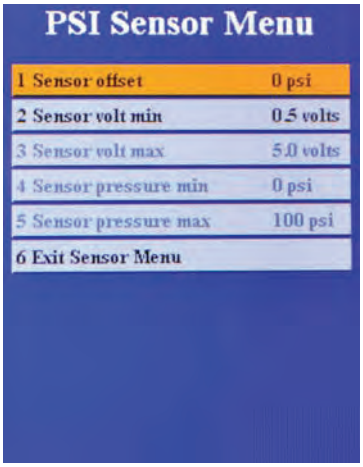
Range: US, SI

Figure 42: Line 14 - Units

Line 15 - Pressure Sensor Menu

[Figure 43] - PSI Sensor Menu consists of pressure sensor specific parameters. Entering the Sensor PSI offset and the Sensor volt min allows one to select appropriate equipment settings. Sensor volt max, sensor volt min and sensor PSI max are readouts for diagnostic purposes.

Figure 43: Line 15 - Pressure Sensor Menu



Sensor Offset

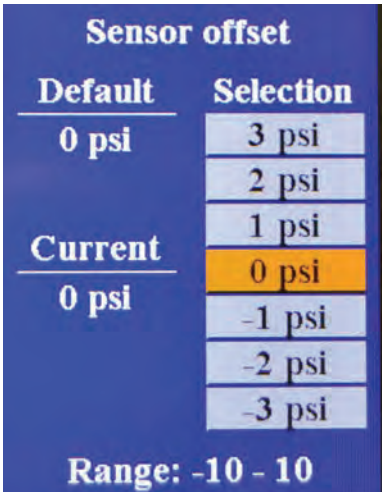
[Figure 44] - Manipulate this setting if a difference in the pressure is noticed across separate pressure sensors, such as between the SSRS Display pressure reading and the rate controller pressure display from a secondary pressure sensor.

NOTICE

SharpShooter with Rate Sync system requires a greater quality pressure sensor relative to pressure sensors which just report a screen value. So in most cases the adjustment will be correcting the value to the least accurate sensor.

Range: 10 to -10

Figure 44: Sensor Offset

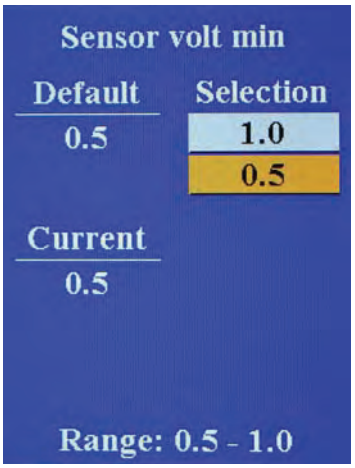


Sensor Volt Min

[Figure 45] - Capstan PSI Sensors need no change from default value of 0.5. Set appropriately if using a 1.0 - 5.0 volt PSI sensor.

Range: 0.5 to -1.0

Figure 45: Sensor Volt Min

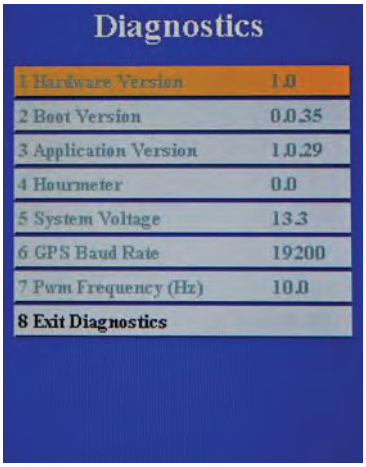


Line 16 - Diagnostics

[Figure 46] - Diagnostics menu is a readout for set parameters in the SharpShooter with Rate Sync system. These may be useful in troubleshooting and/or diagnostic purposes.

NOTICE These parameters cannot be changed.

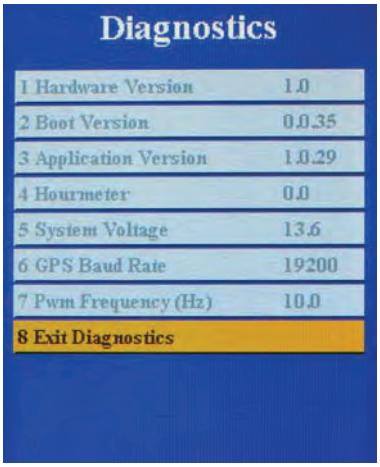
Figure 46: Line 16 - Diagnostics



Line 17 - Exit Menu

[Figure 47] - Use this line item to exit the main menu structure. Toggle the increase/decrease buttons highlighting the Exit Menu field, then press Menu button. This is necessary since the Menu button doubles as enter and exit functions.

Figure 47: Line 17 - Exit Menu



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6.0 - EMERGENCY SPRAYING

6.1 - Emergency Modes of Spraying

The SharpShooter with Rate Sync system has been designed with several features that allow the operator to continue spraying in the event of a SharpShooter with Rate Sync or Rate Controller component failure.

When the SSRS Display will not automatically control pressure but still pulses:

- With the pulsing still functioning, turning the SSRS Display to the Manual Mode returns the operator to traditional rate controller functionality.

- In this case the Manual Mode acts like an “electronic” rotary nozzle body, but with an unlimited number of tips choices. Instead of rotating a 3-way or 5-way nozzle body on the back of the boom, the operator manually arrows the duty cycle up or down to change the “effective” tip size as displayed on the screen. If the pressure goes to high, the operator arrows up to a larger tip. If the pressure is too low, the operator arrows down to a smaller tip.

- The Manual Mode is typically used in the event of a SharpShooter with Rate Sync pressure sensor failure. The Manual Mode will allow the operator to adjust the pressure range in which the Rate Controller operates. This pressure range can be changed on-the-go for varying spray conditions.

When the SSRS Display does not automatically control pressure and does not pulse:

- Turning the SSRS Display OFF also returns the operator to the traditional rate controller mode.

The Close selection allows the operator to disable the pulsing of the valves for maintenance, troubleshooting, or in event of system failure.

The Open selection locks the solenoids open.

- A conventional tip chart will be needed to select a proper tip based on pressure and rate. The SharpShooter with Rate Sync nozzle solenoids are still powered and will act as electronic “drip checks” and work with the boom section On/Off switches. This feature will allow the operator to continue spraying until repairs can be made.

- In this situation the BOOST feature will need to be turned OFF and the non-BOOST tips (SR110-10) will likely be sufficient. However, it may be necessary to re-size these tips based on speeds and rates applied.

When the Rate Controller or flow meter fails, and the SharpShooter with Rate Sync continues to pulse:

- Put the Rate Controller in the Manual Mode. This locks the flow control valve to a single position and eliminates the need for the flow meter and control valve.

- Put the SSRS Display in the Manual Mode. This locks in a tip size chosen by the operator. The tip size can be manually changed to select the tip needed.

NOTICE This option allows the operator to easily revert back to a Speed and Pressure mode of application without having to change the exiting tips installed on the sprayer.

- Referencing conventional tip charts, the operator selects a single speed (typically 3 MPH) and an operating pressure (typically 40 PSI). He then would select a tip size that would deliver the desired rate at 3 MPH and 40 PSI.

- To select the right tip, start spraying at 3 MPH. Arrow the SSRS Displays duty cycle up or down until the machine is spraying at 40 PSI. This duty cycle is then the effective tip size needed to achieve the desire rate at 40 PSI and 3 MPH.

- The operator must continue to spray only at 3 MPH to maintain the target rate.
- The operator will need to do a test run, checking the volume and area applied. Dividing the volume by the area will serve to verify the rate. It may be necessary to modify the tip size or speed to achieve the desired rate.

7.0 - TIP SELECTION

7.1 - Tip Selection and Capacities

It is important to adhere to the following rules:

1. Always use 110° spray angle tips, maintain a minimum boom height of 21”, with 24” the preferred height above the grass. However if 80° spray angle tips are used, maintain the boom height at 36” or greater.

2. Never use Air Induction (AI) spray tips.

- The SharpShooter with Rate Sync pulsing tends to squirt liquid out the air holes of the AI tips.

- While AI tips are a good solution to the drift control challenges of rate controller spraying, the need for them is offset by the advancement of SharpShooter with Rate Sync and non-AI pre-orifice tips.

3. For turf spraying with rates between 1.0 and 2.5 gal/1000sf, Wilger SR110-10 and MR110-10 tips are provided. The SR tips are installed on the non-boosted row of nozzles. The MR tips are installed on the boosted row of nozzles (toward the rear of the machine).

4. For turf spraying where rates are consistently less than 1.0 gal/1000sf (43 GPA), it is recommended that the Wilger SR110-06 tips should replace the SR110-10 tips. This allows for a larger number of droplets for the same rate for a more thorough coverage.

5. For turf spraying where rates are consistently more than 2.0 gal/1000sf (86 GPA), it is recommended that Wilger MR110-125 replace the MR110-10 tips on the boosted row of nozzles. This allows a larger combined effective orifice to better utilize the full pump capacity of the machine at the top end speeds.

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8.0 - MAINTENANCE

8.1 - Strainers and Screens

NOTICE Factory-built sprayers typically come with 50-mesh strainers. These will need to be changed to the 80-mesh strainers.

Check the mesh size of the strainers and replace the screens if they are too coarse.

[Figure 48] - Most sprayers are built with strainers to filter debris from the spray. An 80-mesh screen is required to *prevent nozzles from plugging*. When selecting a strainer DO NOT rely on the color coding. Check with the strainer manufacturer to be sure and select the 80-mesh strainer.

Plugged strainers will cause a reduction in system operating pressure.

When replacing the mesh screen on TeeJet strainers, first install and set the mesh screen in the strainer head. Then install the strainer cap. Failure to do this will likely result in a damaged mesh screen and overall strainer failure.

Figure 48: Strainers and Screens

NOTICE Clean the strainers on a regular basis.

NOTICE Use 80-mesh or finer strainer screens. The filter manufacturer is specified only on the strainer housing. Only a color code identifies the strainer mesh size which is not consistent between filter suppliers.

NOTE: The following chart has been typical, but check with your local supplier for any changes or updates.

MESH	TEEJET	HYPRO	ARAG	BANJO
30	Yellow	Red	Red	Yellow
50	Red	Blue	Blue	Red
80	Blue	Yellow	Yellow	Blue
100	Green	Green	Green	Green

8.2 - Jump-Starting/Welding/Charging

- If jump-starting or charging the batteries on the sprayer, disconnect the rate controller and the SharpShooter power wires to prevent damage to the SharpShooter system.
- If welding on the equipment, disconnect the rate controller and the SharpShooter power wires to prevent damage to the SharpShooter system.

8.3 - Servicing the Spray System

- Before servicing the spray system or spray components, the spray tank and system should be emptied of chemical mixture and flushed with clean water. Clean the machine of all chemical residue.

8.4 - Inspecting the Spray System

- Inspect spray system hoses for cuts, nicks or abrasions before each use. Replace any damaged hoses immediately.
- Check for loose hoses, mounting hardware and components. Tighten if necessary.
- Verify all hoses and wiring are secure.
- Make sure boom strainers are clean.
- Check for damaged or missing decals. Replace decals if damaged or missing.

8.5 - Cleaning the Spray System

- Thoroughly clean the spray system with clean water after each use.
- Avoid high pressure spray when cleaning the spray system components, valves and wiring connectors.

8.6 - Product Tank and Boom Line Rinsing

At the end of the day and/or between chemical changes the following rinse procedure must be performed.

- Drain excess chemical from the tank according to standard safety practices of disposing of chemical.
- Using a hose or a tank rinse system integrated on the machine, rinse the product tank thoroughly with clean water and drain according to standard safety practices.
- Fill the turf product tank with 25 gallons of clean, fresh water. Spray the fresh water out the tank through the entire boom length making sure both nozzles at each location spray.

NOTICE Failure to do a proper rinse at the end of the day can cause unnecessary plugging/ dripping. Failure to rinse between chemical changes could leave residual chemical that could damage the turf in next application.

8.7 - Winterizing for Storage

DO NOT USE FERTILIZER TO WINTERIZE! The use of fertilizer for winterization will cause internal damage to the nozzle valves.

- Thoroughly clean the spray system before winter storage.
- Flush the spray system with clean water.
- Winterize the spray system with RV antifreeze for winter storage. Proper winterizing of the sprayer with a Capstan system installed on it is essential. Make sure the booms are completely full of antifreeze at 100% strength and that the solenoids are pulsed (sprayed) for a few minutes to ensure the antifreeze remaining in the solenoids is at full strength.

NOTICE Improper winterizing procedure could result in damage to the internal components of the solenoids.

9.0 - TROUBLESHOOTING

9.1 - Setup

9.1.1 - SharpShooter with Rate Sync (SSRS Display) Data Logging Procedure

The tools required are:

- A computer.
- A nine pin pigtail (male pins) to USB serial cable purchased at a local electronics store.
- Capstan diagnostic software tool. See instructions below to acquire this software.

Capstan Diagnostic Software Tool

This software tool may be downloaded from the Capstan website at www.capstanag.com

- Log in at the dealer log-in.
- Look for the Capstan Diagnostic Tool, and double click to download.
- Elect the “Save As” option to store at a desired location on your computer.
- When the save is complete, select the “Open Folder” option.
- In the folder, double click the Capstan Diagnostic file to “unzip” and save it as an icon on the computer’s main screen.

Connect the serial cable into both the 9-pin pigtail on the SSRS Display and the USB port to the computer.

Locate which computer communication port the USB cable is using, by viewing the “Devices.” Typically, you can use the “Control Panel” selection on your computer to view “Devices.” From here, you should be able to see the computer COM Port that the USB cable is using.

Click on the Capstan Diagnostic Tool and enter the proper COM port number from the drop-down menu. The Baud Rate should be set at 19200.

You are now able to run the programming diagnostics.

NOTICE This data may be useful when assistance is required for diagnostic reasons.

9.1.2- SharpShooter with Rate Sync (SSRS Display) Programming

NOTICE This should be performed only by a qualified service technician.

Required Items:

- Capstan Can Commander.
- Translator Box and USB Cable.
- Programming Cable.

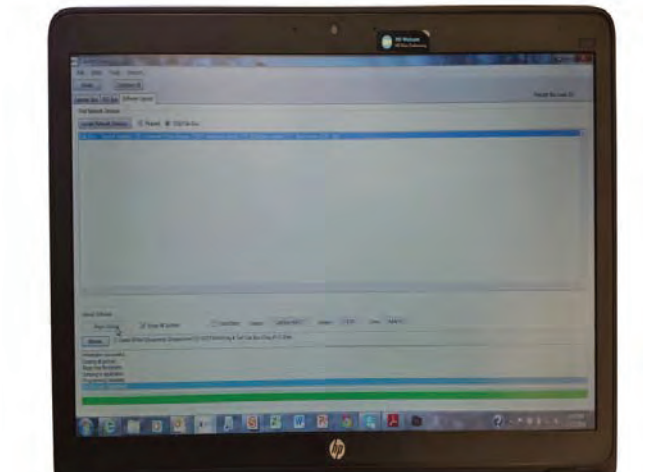
[Figure 49] - Connect the programming cable to the SSRS Display ① auxiliary port and to Can 1 port of ② translator.

Figure 49: SSRS Display Programming

Programming:

1. Power up the SSRS Display
2. Plug in Translator and Programming Cable
3. **[Figure 50]** - *Open Capstan Can Commander
   - Choose ‘Software Upload’ tab
   - Select ‘SSQ/Cab Box (SSRS Display)
   - Click ‘Locate Network Devices’ (hardware info appears)
   - Select ‘Erase All Sectors’
   - Click Browse and choose code to upload
   - Click hardware info above, it will be highlighted in blue
   - Click ‘Begin Upload’ progress bar will appear (wait for ‘programming complete’)
   - Disconnect programming cable
   - Power Up the SSRS Display

Figure 50: Capstan Can Commander



9.2 - SYSTEM TESTING AND TUNING

For system testing, know that the SharpShooter and the rate controller can be isolated from each for evaluation purposes.

By putting the SharpShooter in the Manual Mode, the rate controller can be evaluated independently. The Manual Mode removes the automatic tip function and “locks in” a specific tip size (Duty Cycle).

Likewise putting the rate controller in the MANUAL Mode removes the automatic rate control by locking the flow control valve. The SharpShooter can then be evaluated independently.

9.2.1 - Recommended Guidelines

NOTICE While necessary maintenance or repairs on the Capstan Ag. System, Inc. product can be performed by any company, we recommend only authorized Capstan Ag. System, Inc. dealers, as improper or incorrect maintenance or repairs voids this warranty.

When servicing a SSRS System, Capstan recommends the following three step troubleshooting process:

1. Perform baseline service checks and verify the original SSRS setup values in this manual.
2. Identify individual performance problems. Evaluate possible causes and corrections for performance issues.
3. Troubleshoot individual components and replace if needed.

NOTICE The primary service tool will be a simple multi-meter that can measure voltage and resistance (ohms).

9.2.2 - Baseline Evaluation Protocol

1. Verify voltage readings. See pages 65 thru 74 for individual component testing.
2. Visually check all wire connections, harnesses, and connectors for loose, broken, or damaged wires.
3. Visually check all hoses for wear or damage.
4. Check the “Most Common” issues.
    a. Strainer and Filter:
        - Verify the strainer and filter are clean and the flow direction arrow on the filter head is orientated correctly.
        - Verify the strainer is an 80 mesh strainer.
        - Verify that the strainer has not been crimped by improper installation. On a TeeJet filter, the strainer must first be installed and seated in the filter head. Then the filter cap is installed. If the strainer is installed in the cap first, it will not seat properly in the filter head.
    b. Solenoid Assembly:
        - If the solenoids are stuck open or closed, then there has been either a filter failure or an incomplete cleansing after an application. Disassembly the solenoid and clean. Check the solenoid plastic for damage or an excessive wear groove and replace if necessary. Check the coil to 19-23 ohms specification.
        - If the solenoids are dripping, then either the filter has failed and debris is preventing the solenoid to completely close, or there is an O-ring failure, particularly the small O-ring on the tip of the solenoid.

c. Check for incorrect or damaged tips. The SR110 tips should be on the front row of solenoids. The MR110 tips should be on the rear or Boosted solenoids. There may be situations when an SR110-06 replaces the SR110-10 tips and a MR110-125 tips replaces the MR110-10. See Tip Selection and Capacities on page 43.

d. Using the Pressure Breakout Harness, check the input voltage (12V) and the output signal (2.5V), when the SharpShooter is in the Manual Mode and adjusted to attain a boom pressure of 50 PSI (2.5V).

5. Follow instructions on pages 47 thru 48 to verity the SharpShooter setup parameters.

6. Power up the Rate Controller. Verify the setup parameters.

7. Do a “Like Component Swap” to see if the failure follows the component.

8. Perform dry and wet tests, see 9.2 - SYSTEM TESTING AND TUNING.

9. If necessary contact your “OEM Dealer Service” so the Capstan diagnostic tools can be used to conduct the SSRS Display Data Logging Procedure on page 47.

9.3 - TROUBLESHOOTING TESTS

9.3.1 - SharpShooter with Rate Sync Dry Test

***Verify Power to the SSRS Display*:**

1. **[Figure 51]** - Turn on the SSRS Display. It will default to the Manual Mode. A red light in the lower left corner of the power button will illuminate showing a properly working display.

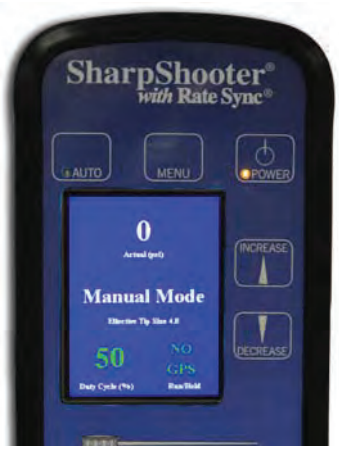
2. Observe that the SSRS Display screen reads Manual Mode and a 50% duty cycle.

NOTICE This confirms that the SSRS Display pigtail harness fuse is functioning and that power is being received.

Service Actions:

If the SSRS Display does not power on, check the fuse and/or trace the power from the battery. Check pins, connectors and wires for proper contact and/or damage.

Figure 51: Verify Display Power



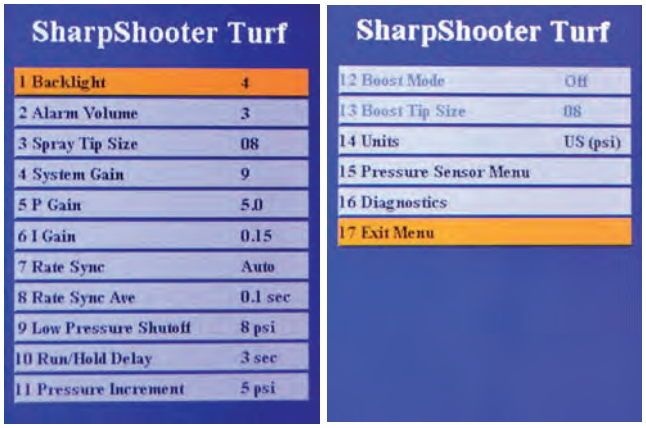
9.3.2 - SSRS Menu Items

Verify that the SSRS Display and Rate Controller programming parameters are set up correctly:

1. **[Figure 52]** - Power up the SSRS Display, and press Menu. Do a check of the SSRS Display parameters to verify correct settings. Reset if necessary. Reset to default valves.

2. Power up the Rate Controller. Verify the setup parameters.

Figure 52: SSRS Menu Items



9.3.3 - Boom Section Control Test

Verify SharpShooter with Rate Sync solenoids match the rate controller section switches:

1. Turn the SSRS Display ON and leave in the Manual Mode at a 50% duty cycle,
2. Turn the Rate Controller ON. An advanced rate controller will require starting a job. Verify the rate controller is in the AUTO Mode.
3. Toggle ON all the section switches.
4. Toggle the Master Switch ON.
5. All solenoid valves on the boom should start clicking.

Service Actions - If all the solenoids do not start clicking.

   a. Verify that the SSRS Shutoff Adapter is connected to the Rate Controller Harness boom section signal wires and to the SSRS Power Hub.
      1. Verify the boom section signal of 12 volts is coming from the rate controller. Unplug the boom section adapter and the check rate controller harness signal for each section switch.
      2. If 12V is present with the boom section when the switches are turned on (and 0.0 v. when off), check that the boom section adapter pins match the controller boom signal pins. Re-pin if necessary.
   b. Check the fuses on the valve drivers.
   c. Swap the valve drivers. If the solenoids start pulsing replace the bad valve driver.
   d. Otherwise, trace the pulse signal from the SSRS Display through Power hub to the Valve Driver and Solenoids by checking pins, connectors and wires. Pulse voltage should read about 6V on a DC scale. (See 9.5.11 - Pulse Circuit Test on Page 70.) Fix or replace the failed component.

6. Toggle OFF all rate controller boom sections.
7. Toggle boom section 1 ON.

NOTICE A solenoid valve on boom section 1 should start clicking. Some boom sections may have more than 1 solenoid assigned to it.

8. Repeat steps 6 and 7 for each boom section.

Service Actions:

If solenoid valves on a different boom section click on instead, the shutoff adapter is not properly connected to the appropriate rate controller harness boom section wires. Redo the connections until the proper section clicks.

9.3.4 - Wet Test 1 Flow Control

This test evaluates the rate controller flow control independent of the SharpShooter with Rate Sync system. It tests the SharpShooter with Rate Sync system BOOST function, pump, flow control valve and flow meter functions.

Fill the sprayer with at least 100 gallons of water for these tests

Perform the following steps:

1. Power up the SSRS Display and remain in the Manual Mode at 50% duty cycle. (This locks in a particular duty cycle or tip and removes the SSRS Display impact on flow).
2. Power up the rate controller to the AUTOMATIC Mode. Start job with all section switches ON and the Master switch OFF.
3. Set a test speed of 5.0 MPH and set the emergency brake to prevent movement that might reset the test speed to 0.0 MPH.
4. Switch Master Switch to ON. Both rows of nozzles should begin to pulse and spray.
5. Check the rate controller on the UNITS selection. If TURF UNITS, using the INC/DEC toggle, set a rate of 1.5 gallons/thousand. If US UNITS, set a rate of 64 GPA.
6. Turn on the sprayer product pump. Throttle the sprayer to maximum throttle.
7. Once the spray stabilizes, note the resulting boom pressure. Increase or decrease the duty cycle (effective tip size) until the pressure is near 50 PSI.
8. Increase the rate to 2.0 gal/thousand or 84 GPA.
    a. Observe that the rate controller should achieve that rate.
    b. Observe that the pressure will drop increase and stabilize.
9. Decrease the rate to 1.0 gal/thousand or 42 GPA.
    a. Observe that the rate controller should achieve that rate.
    b. Observe that the pressure will decrease and stabilize.
10. Return the rate to 1.5 gal/thousand.
    a. Observe that the rate controller should return to 1.5 gal/thousand.
    b. Observe that the pressure should return to the original value.
11. If all performs as stated, proceed to (9.3.5 - Wet Test Pressure Control page 55).

Service Actions:

If the rate does not stabilize or achieve the target rate:

1. Verify that the rate controller speed calibration is set correctly and not to zero.
2. Verify that rate controller is getting a speed signal.
    a. If doing a static test verify that the test speed did not go to 0.0 MPH. If so, reset the test speed.
    b. If moving, verify that there is a GPS signal of adequate signal strength. You may need to move the sprayer away from buildings or from under trees. If the issue persists, contact your GPS dealer support.
3. Verify that the pump is ON, the machine is at full throttle and valves for a Chem Loader attachment are closed.
4. If using a Test Speed, verify that the boom section switches are switched to manual ON and not to AUTOMATIC CONTROL.
5. You may have reached the pump output limit, if a newer pump or if the pump is older and its performance is decreasing.
    a. Lower the speed so see if the applied rate matches the target rate. You may need to change the duty cycle (effective tip size) to maintain your pressure.
    b. Alternatively, lower the rate and check again.
6. The BOOST feature may not be working. Verify that both rows of nozzles are spraying. If only one row is spraying, check the duty cycle. Increase either your speed or rate toward 80% duty cycle. At 80% duty cycle the BOOST nozzles should start spraying. Then decrease the duty cycle toward 20%. At 20% duty cycle the BOOST nozzle should stop spraying and the duty cycle should jump to 40% and then settle in at the appropriate duty cycle for that rate and speed.

If the rate still does not stabilize or achieve the target rate:

1. Evaluate for defective flow meter, pump impeller or pump bearing components.
    a. Locate the rate controller screen with which you can observe the GPM rate reading as the machine sprays in the rate controller AUTOMATIC Mode.
    b. If the GPM reading is unstable, switch the rate controller to the MANUAL Mode. This locks for flow control valve or PWM pump valve and isolates the flow meter.
    c. If the GPM stabilizes, the flow control valve or PUMP PWM control valve is likely defective.
2. With the rate controller in MANUAL Mode, if the GPM reading DOES NOT stabilize, then either the flow meter, pump impeller, or pump bearings are worn.
    a. If the sprayer rate is unstable at ALL rates, speeds and pressure, the issue is likely the flow meter.
    b. Set the SSRS to 40 PSI and compare the GPM reading from the rate controller to a calculated GPM using the unit appropriate formula below:

        GPM = (GPA x Speed (mph) x Nozzle Spacing (inches) x Number of Nozzles)/5940

        GPM = (GPT x Speed (mph) x Nozzle Spacing (inches) x Number of Nozzles)/136

        LPM = (L/Hex x Speed (km/hr) x Nozzle Spacing (cm) x Number of Nozzles)/60,000

NOTE: A test speed is not always accurate, so the calculated GPM number could be slightly off.

If the actual flow does not come close to the calculated flow, then either the flow meter calibration is incorrect, or the flow meter is failing and needs to be replaced. **Recheck for the meter calibration number as noted on the flow meter.**

c. If the sprayer rate is unstable at the low ends of the rate, speed and pressure ranges, AND/OR it can not achieve normal maximum rate, speed or pressure, the issue is possibly a worn or damaged pump impeller or bearings.

Flow Control Valve and Rate Controller:

1. For a centrifugal pump: With the engine off and rate controller ON and in MANUAL Mode, toggle the manual INC/DEC switch.

   a. Note if you can see or hear the flow control valve respond, then at least a voltage signal is getting to the valve from the rate controller.

2. Disconnect the flow control valve harness from the rate controller harness.

   a. Using a Volt Meter, this test should yield a +12/-12 volt reading. If the voltage is not correct, the INC/DEC switch, Raven harness and connections should be evaluated. If no defect is found, then the rate controller itself needs to be repaired.

3. A rate controller may work in MANUAL Mode, but not under load in the AUTOMATIC Mode. Using a test speed, set the sprayer up to begin spraying. In the AUTOMATIC Mode toggle the INC/DEC switch. Tap into the signal wire and again measure voltage to the control valve. If inadequate voltage, repair or replace the rate controller.

4. For PWM driven diaphragm pump:

   a. With the rate controller in the MANUAL Mode check the harness to the PWM valve for a 0 to 12V signal. If no voltage occurs, check rate controller harness, and connectors for issues. Ultimately it could be an issue with the rate controller.

   b. With the rate controller in AUTOMATIC Mode with a test speed and spraying, toggle the INC/DEC switch. Observe the pump shaft for related change in RPM. If shaft doesn't spin, then the issue is likely with the rate controller. If the shaft spins, but doesn't change in rpm with the INC/DEC, the issue could be either the PWM valve or the rate controller.

9.3.5 - Wet Test Pressure Control

This test evaluates the pressure side control of the SharpShooter with Rate Sync system with the flow control held constant.

Perform the following steps:

1. If not already, power up the SSRS Display and put in the AUTO Mode at 40 PSI.

2. If not already, power up the rate controller and put in the MANUAL Mode. This locks for flow control to a constant position.

3. Set a test speed of 4.0 MPH, turn on the pump and section switches. Toggle the master switch to initiate boom spraying. Using the INC/DEC switch adjust the rate to some acceptable value. Allow the sprayer to get to rate and pressure. The SharpShooter with Rate Sync system should be pulsing. Note the SSRS Display duty cycle reading.

4. Use the INC/DEC switch on the rate controller to increase the rate. The pressure should increase. The SSRS Display duty cycle should change and return the pressure to 40 PSI.

5. Decrease the rate. The pressure should decrease. The SSRS Display duty cycle should change and return the pressure to 40 PSI.

Service Actions:

If the pressure does not return to 40 PSI:

a. Verify that the pump is on and the machine is at full rpm.

b. Verify that the solenoids are not plugged.

c. Using the TEST SPEED mode, verify that the boom section switches are set Manual ON and not set to automatic section controls.

d. Verify that the SSRS Display duty cycle is changing. If the SSRS Display duty cycle is not changing:

i. Test the Pressure Sensor for proper input and output signal voltages. (See pressure sensor tests on pages 68 and 69). Replace the pressure sensor if bad.

ii. Trace the pulse signal back from the solenoid pigtail harness back through the valve drivers and power hub back to the operator display. (See Component Testing on pages 65-74).

9.3.6 - Wet Test 3 Integrated Pressure and Flow Control

This test evaluates if the rate controller and SSRS Display are working together to achieve both flow and pressure control.

If Tests 1 and 2 Pressure Control were successful, this test should most likely pass as well.

NOTICE TEST 3 and 4 can also be used as the SharpShooter with Rate Sync DEMO. In this case use a TEST SPEED instead for actual speed.

Perform the following steps:

1. Fill the sprayer tank with about 100 gallons or more of water.

2. Start the sprayer and achieve a speed (TEST SPEED or ACTUAL SPEED) of 5.0 MPH If using a TEST SPEED, set the emergency brake.

3. Power up the SSRS Display and select AUTO Mode at 40 PSI.

4. Power up the rate controller in the AUTOMATIC Mode with all section switches in the MANUAL ON position and the Master Boom switch OFF.

5. Set a rate of 1.0 gallons/thousand if the rate controller is set to TURF UNITS or 42 GPA if the rate controller is set to US UNITS.

6. Turn on the sprayer pump and switch the rate controller switch to ON. Watch the SSRS Display duty cycle as the sprayer achieves the target rate and pressure.

a. If the SSRS Display duty cycle doesn't reach 80%, only one row of nozzles will be spraying.

b. If the SSRS Display duty cycle passes 80%, then the BOOST nozzles will spray and the SSRS Display duty cycle will initially drop to 40% and then settle at the value needed for rate and speed to maintain the 40 PSI.

7. BOOST TEST:

   a. If both sets of nozzles are spraying, decrease the speed and rate until the SSRS Display duty cycle approaches 20%. When you pass 20% the BOOST nozzles will stop spraying and the SSRS Display duty cycle will initially climb to 40% and then settle at the value needed for rate and speed to maintain the pressure set point.

   b. If only one row of nozzles is spraying, observe the SSRS Display duty cycle. Increase the speed and/or rate and watch the SSRS Display duty cycle. Once the duty cycle reaches 80% the BOOST nozzles should spray.

   c. In both cases the rate controller will be working to maintain the target rate and the SharpShooter with Rate Sync system will be working to maintain the set pressure.

      If the BOOST is not working, trace the BOOST signal back through the valve driver and power hub to the operator display. (See Component Testing on pages 65-74).

8. FLOW INTEGRATION TEST:

   a. Set the sprayer to 1.5 gallon/thousand or 64 GPA, 5.0 MPH and 50 PSI.

   b. Using the INC/DEC rate controller toggle increase the target rate to 2.0 gallons/thousand. As the rate controller changes the applied rate to match the target rate, observe the pressure and the SSRS Display duty cycle. The pressure will increase. The SSRS Display duty cycle will also increase to create a large effective tip size and consequently bring the pressure back to 50 PSI.

   c. Using the INC/DEC rate controller toggle decrease the target rate to 1.0 gallons/thousand. As the rate controller changes the applied rate to match the target rate, observe the pressure and the SSRS Display duty cycle. The pressure will decrease. The SSRS Display duty cycle will also decrease to create a smaller effective tip size and consequently bring the pressure back to 50 PSI.

   d. Return to 1.5 gallons/thousand or 64 GPA and go to the next test.

      If the applied rate doesn't stabilize or meet the target rate, return to TEST 1.

      If the pressure does not stabilize or return to the target pressure, return to TEST 2.

9. SPEED TEST:

   a. Set the sprayer to 1.5 gallon/thousand or 64 GPA, 5.0 MPH and 50 PSI and start spraying.

   b. Increase speed to 9.0 MPH. Note that the applied rate changes and the rate controller works to match the target rate. Note that the pressure decreases and the SSRS Display duty cycle increases to create a larger effective tip size to return the pressure to 50 PSI.

   c. In the rate controller, decrease the test speed to 3.0 MPH. Note that the applied rate changes and the rate controller works to match the target rate. Note that the pressure increases and the SSRS Display duty cycle decreases to create a smaller effective tip size to return the pressure to 50 PSI.

10. PRESSURE TEST:

    a. Set the sprayer to 1.5 gallon/thousand or 64 GPA, 5.0 MPH and 50 PSI and start spraying.

    b. Decrease the pressure to 20 PSI, but don't change the speed. Observe the rate controller working to maintain the target rate as the SSRS Display duty cycle increases to a larger effective tip size to drop the pressure. This is the DRIFT CONTROL feature of SharpShooter with Rate Sync system. NOTE the larger droplets size and reduced drift.

    c. Increase the pressure to 60 PSI, but again do not change the speed. Observe the rate controller working to maintain the target rate as the SSRS Display duty cycle decreases to a smaller effective tip size to increase the pressure. NOTE the smaller droplet sizes and increased drift.

    d. During a DEMO you might want to raise the boom to further illustrate the drift impact of the SharpShooter with Rate Sync system.

Service Actions:

    a. During a DEMO, if the rate completely falls off, verify that the test speed did not go to zero. Bumping the machine can fool the rate controller that the machine is moving and will override the TEST SPEED.

    b. At the top speed, if the applied rate cannot achieve the target rate, the pump capacity may have been exceeded. Decrease the speed until the applied rate matches the target rate.

    c. At the top speed the applied rate achieves the target rate, but the pressure exceeds the pressure set point the duty cycle will read 100%. The tips will have reached their limit and further speed will cause the pressure to increase. Unless there are drift concerns, it is still OK to spray.

9.3.7 - Wet Test 4 Immediate ON/OFF

This test evaluates the solenoids ON/OFF response over the whole boom and by boom sections.

Perform the following steps:

1. Start the sprayer with about 100 gallons of water.
2. Power up the SSRS Display and select AUTO Mode at 50 PSI.
3. Power up the rate controller to 1.0 gallons/thousand or 42 GPA with the boom section switch ON and the Master boom switch OFF.
4. Turn on the pump and increase the engine to full rpm.
5. Achieve a speed (Actual or TEST) of 4 MPH.
6. Allow the booms to charge and the machine to settle in on the target rate and pressure.

TOTAL BOOM ON/OFF:

7. Turn the Master Switch OFF. Note that the nozzle solenoids stop spraying immediate. The pressure climbs to either the preset agitation value (typically 60-70 PSI), or the pump dead-head pressure depending on the particular sprayer.

8. Turn the Master Switch ON. Note the nozzles start spraying immediately. The SSRS Display duty cycle works to return the pressure to the target value. The rate controller works to return the rate to its target value.

INDIVIDUAL NOZZLES:

9. Repeat this test with one section at a time.

10. You will notice that the speed by which individual nozzles achieve rate when turned OFF or ON will affect the applied rate recovery to the target rate.

NOTE: The flow control valve is the limiting factor to the applied rate achieving and maintaining the target rate. Depending on how large the target rate is, the boom can be quickly depleted of liquid before the flow control valve can open far enough. To optimize its response proceed to the Rate Optimization Test.

11. If all performs well, proceed to (9.3.8 - Wet Test 5 Rate Optimization page 59).

Service Actions:

a. Check for any nozzles that are dripping.

   i. Check for debris keeping the plunger open.

   ii. Check for a damaged O-ring at the tip of the solenoid.

b. Check for plugged or damaged filter.

c. Slow flow recovery could also be systematic of a damaged flow control valve. See Test 1: Flow Control of the Integration Testing.

d. Proceed to Wet Test 5 Rate Optimization.

9.3.8 - Wet Test 5 Rate Optimization

This tests tunes the rate controller and SSRS Display operating parameters for optimum performance.

NOTICE Most of the 300 gallon sprayers have pumps and performance is optimized at 50 PSI. Different units may have a different optimum pressure.

NOTICE The sprayer must be running and spraying to effect this test protocol.

Perform the following steps:

For a PWM Drive Pump with 2 PWM Settings:

1. In the rate controller you will most likely find a MAX PWM value of 253 and a Minimum PWM value of 1.

2. The minimum PWM value needs to be set near 60, OR the value that makes the pump to rotate.

3. Typically there is also a choice of two Valve Types:

   a. PWM Valve: In this case when the boom is shut off the pump operating PWM value drops to the minimum PWM value. This valve type creates an issue for diaphragm pumps if there is no pressure relief circuit to limit the pressure build up past 70 PSI or so.

b. PWM Close Valve: In this case when the boom is shut off, the pump stops. This creates a large issue for consistent spraying and from spraying from a dead stop. It is done to prevent a diaphragm pump from continually building pressure that could ultimately burst hoses, etc. This is overcome by continually using an agitation circuit as a pressure relief circuit. Therefore the rate controller will have a Preset Agitation PWM setting to maintain a 60-70 pis agitation pressure when the booms are off. Often users think the Preset Agitation is a pressure and set it too low. That PWM value is typically around 100 to achieve a 60-70 agitation pressure.

For Advanced Rate Controllers with 3 PWM values:

1. The 3 PWM values are: Maximum (253), Minimum (~60) and PreSet which is a value you may want to change depending on a green/tee or fairway application. In general this is the value the PWM goes to when the booms stops spraying. The smaller the difference between the operating PWM value and the Preset Value is, the more optimum is the sprayer response and performance. However the Preset PWM value by the pump “boom off” pressure that results from the PWM value.

To determine the Preset PWM value:

1. Find the location in the rate controller where you can monitor the PWM value while spraying.

   a. On fairways, using the maximum speed (typically 8-9 MPH) and your rate determine the operating PWM value that will determine the Preset Value you want to use. With any Preset Value you use, check the “boom-off” pressure. It should not exceed 100 PSI. If the pressure is too high, the Preset PWM will have to be lowered.

   b. Do the same with the greens and tees. Given that the rates are higher and speeds are lower for greens, it would not be unusual for the two PWM values to be close.

   c. If these two values are different, you consider editing the Preset Value for the two applications.

      The object is to keep the minimize the recovery time of the pump to resupply the boom when changes to speed, boom section or rate occurs.

      In both cases above, it is then possible to adjust the rate controller valve calibration for a faster response, but yet stable response.

For an engine driven centrifugal pump with an inline flow control valve:

1. Tune the valve calibration from 2123.
2. Try varying the second digit from the right “2” (deceleration timing). The larger lengthens time and is more stable. Try 2133, or 2143.
3. Then increase the third digit from the right “1” (velocity of change) one number at a time. Increasing the number makes the valve respond faster. For example: Change to 2143 to 2243, or 2343.
4. Test each setting the balance of speed and stability. Typically when you increase the speed, you also need to increase the deceleration time.

SharpShooter with Rate Sync Performance Optimization:

Timing and speed of control helps reduce issues with dead stop spraying, boom section changes and dramatic speed changes, that can affect application quality.

There are generally 3 parameters that are effective in tuning the SSRS Display control relative to a rate controller. All three are accessible via the MENU toggle:

1. Run/Hold Parameter: This value was to allow the rate controller to stabilize before the SSRS Display would begin to control pressure. This delay (Hold) period prevented instability as the rate controller and SSRS Display worked to control rate and pressure, respectively.

    a. The default value is 3 seconds.

    b. Decreasing that time allows the SharpShooter with Rate Sync to start controlling the pressure sooner;

    c. In most cases this value can be dropped to either 0 or 1 second.

    d. The new setting should be tested to make sure it does not cause the rate controller to become unstable.

2. System Gain: The value affects the response time of SSRS Display to changes in pressure. The system gain change two values (P gain and I gain) proportionally. The higher the number the quicker the response. Again any change to this value should be tested to avoid rate instability.

3. P gain: This value is addressed after the System Gain is optimized.

General Spray Operation Strategies:

Spray performance is more consistent the less the flow control valve has to move in response to a change.

1. If the “Entry Speed” of a spray pass can be kept the same an the “Exit Speed” of the previous pass, the flow control valve does not need to move. Result: Less under or over application.

    a. Determine a comfortable “Turning Speed” as you target exit and entry speed between passes. Typically this is 5-6 MPH. Fairway speeds can be as high a 7-12 MPH. So the strategy is to slow down to the comfortable turning speed as you exit a pass and maintain that turning speed as you start the next pass.

2. Smaller areas are more challenging than larger areas. So to minimize flow control changes, it is best to spray greens and tees at a constant speed around of 3-4 MPH.

3. The SSRS Display provides the option to turn the BOOST OFF if the operating duty cycle does not exceed 100%. This may be desirable when spraying greens or tees.

4. Boom section changes work the flow control valve. The largest challenge is going from a full boom to one nozzle spraying and vis versa. To the experienced operator he may be able to manage these large swings in the number of sections spraying.

5. Dramatic speed changes work the flow control valve. Smooth speed changes are best to eliminate under or over applications. The Rate Sync feature of the SharpShooter with Rate Sync system allows more aggressive speed changes.

9.4 - SWAPPING COMPONENTS

SharpShooter Turf systems are comprised of a number of components. Some of these components are used in multiples. Components with multiple usage are:

- Nozzle Valves.
- Valve Drivers.

When troubleshooting failed components, it can be helpful to swap the failed part with a working part at another location. If the problem follows the failed part to the new location, repair or replace the failed part.

If the problem does not follow the failed part, then the problem is likely elsewhere in the system and other troubleshooting means may be followed.

NOTICE Use caution when swapping failed components as in rare cases the failed component may cause other components to fail at the new location.

9.5 - COMPONENT EVALUATION

9.5.1 - Fuses

Blown fuses are indicators of a short or overload condition. Therefore, never replace a fuse with a larger fuse. Larger fuses may result in costly component failures.

9.5.1.1 - OEM Turf SharpShooter System Fuse Location

FUSE LOCATION	RATING	TYPE	COLOR
Power Harness	5A	ATO/ATC	Tan
Valve Drivers	10A	ATO/ATC	Red

NOTICE On OEM ***factory-installed*** units, the battery wire fuse may be located in a sprayer fuse bus instead of in the wire itself. See page 17 to view the factory-installed Power Harnesses.

9.5.1.2 - Turf Aftermarket Systems (Outside of SharpShooter) Fuse Location

FUSE LOCATION	RATING	TYPE	COLOR
Battery Power Cable	30A	ATO/ATC	Green

NOTICE On ***Aftermarket-installed*** units, the battery power cable with 30A fuse is required for aftermarket installations of advanced rate controllers and does not plug directly into the SharpShooter System. (See page 20 to view the aftermarket-installed Battery Power Harnesses).

9.5.2 - Nozzle Valves

Plugged nozzle valves can be classified into two categories:

- Plunger blockage.
- Plunger stuck.

[Figure 53] - Plunger blockage results when larger debris catches between the ① orifice and ② plunger seal. This is the smallest flow passage within the nozzle valve.

Stuck plungers result when smaller debris collects around the ③ plunger barrel and binds the plunger in place.

Symptoms of a blocked or stuck plunger are:

- No spray.
- Constant spray.
- Dripping when the nozzle is shut off.

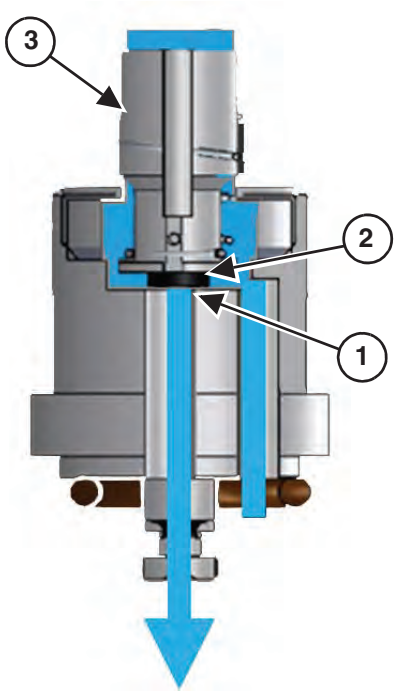
NOTICE Pinched or split O-rings will also cause nozzles to drip when shutoff.

NOTICE Operating a plugged nozzle valve for extended periods of time may result in a nozzle valve coil failure. Clean any plugged nozzle valves immediately.

NOTICE If plugged nozzles are a frequent problem in a particular boom section, inspect the machine's boom filter screens for plugged or damaged screens. An 80-mesh screen is recommended to prevent nozzles from plugging. Check the mesh size of the strainers and replace strainers if they are too coarse.

NOTICE Before removal or installation of the nozzle valves, make sure that the pressure has been released from the boom tubes.

Figure 53: Nozzle Valve Debris



9.5.3 - Nozzle Valve Cleaning

WARNING

CHEMICAL RESIDUES MAY BE PRESENT IN THE EQUIPMENT. RELEASE PRESSURE ON THE BOOMS BEFORE SERVICING. RINSE THE SYSTEM WITH CLEAN WATER PRIOR TO INSTALLING OR SERVICING FITTINGS, HOSES, VALVES, OR NOZZLE VALVES. USE PROPER PPE AT ALL TIMES TO AVOID PERSONAL INJURY.

[Figure 54] - Rotate the ① coil CCW to remove it from the ⑤ valve body. Remove the ② plunger from the coil. Inspect the ③ O-ring on the coil and inspect the ⑥ O-ring and ⑦ O-ring on the valve body.

NOTICE Remove debris from the nozzle valve components items 2 thru 7 by washing with clean water.

Inspect the plunger for wear or damage, see page 65. Replace the plunger if it is worn or damaged.

Inspect the valve body. Make sure the orifice is not plugged with debris, worn or damaged. If orifice is worn or damaged replace valve body.

NOTICE Apply 40 in-lbs of torque to the ① coil when it threads into ⑤ valve body to properly seat the O-ring (Item 3).

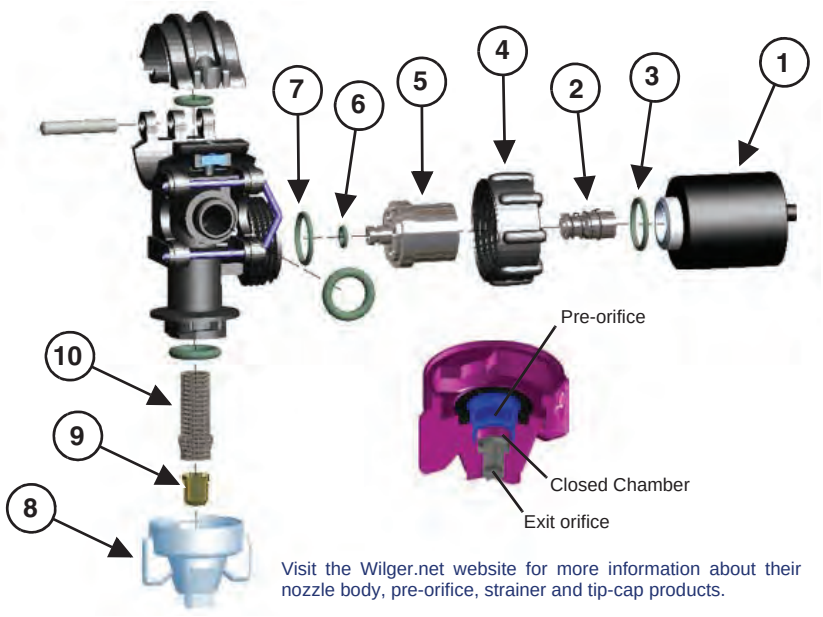
[Figure 54] - Remove the ⑧ tip-cap, ⑨ pre-orifice and ⑩ strainer.

NOTICE Remove debris from the Wilger nozzle body components items 8 thru 10 by washing with clean water. Replace any worn or damaged parts. (See Wilger.net for items 9 and 10).

Figure 54: Nozzle Valve Cleaning

ITEM	DESCRIPTION
1	Coil
2	Plunger
3	O-ring, Viton, -015
4	Flynut
5	Valve Body
6	O-ring, Viton, -008
7	O-ring, Viton, -016
8	Tip-cap, see page 21.
9	Pre-Orifice, see Wilger.net
10	Strainer, see Wilger.net

NOTE: See 3.14 - Nozzle Valve Assembly on page 21 for part numbers.



Visit the Wilger.net website for more information about their nozzle body, pre-orifice, strainer and tip-cap products.

9.5.4 - Plunger Seal Inspection

[Figure 55] - After extended use the soft plunger seal will wear a groove where the seal impacts the hard orifice seat. Replace plunger if worn or damaged.

As the groove deepens the pressure capacity of the valve will decrease, until the pressure capacity interferes with the operating pressure of the SharpShooter system. The result is erratic pulsing, often described as “flickering”.

The SharpShooter system will operate normally at lower pressures until replacement parts can be acquired. High operating pressures and abrasive chemicals will accelerate the wear of the plunger seal material.

Figure 55: Plunger Seal Inspection

9.5.5 - Coil Failure Test

Coil failures are often the result of two factors:

1. Extended valve use with a plugged nozzle.
2. Extended use in corrosive environments.

NOTICE

Capstan recommends cleaning any plugged nozzle valves immediately. Capstan also recommends rinsing the inside of the Turf system with clean water and washing the outside of the coils with clean water as often as practical.

Disconnect the nozzle valve from the nozzle harness pigtail (connector) by unplugging the 2-pin Packard connector which is located on the spray boom.

[Figure 56] - Use a voltmeter to measure the ohms of resistance across pins A and B on the nozzle valve connector.

- 7 watt valve resistance of 21-23.5 ohms.

If proper resistance is not found:

- Clean the connector terminals.
- Replace the coil.

Figure 56: Voltmeter Coil Check

9.5.6 - Battery Voltage Check

Disconnect the SSRS Display from the Power Hub harness by disconnecting the 8-pin Deutsch connector. The connector is generally located in the cab.

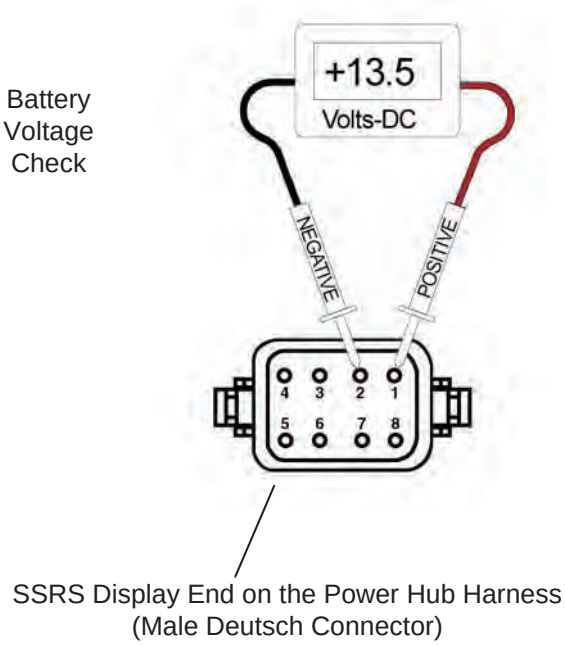
[Figure 57] - Use a voltmeter to observe that there is 13.5 VDC between pins 1 and 2 with the engine running, or 12.0 VDC without the engine running.

Be sure that the polarity is accurate by observing the positive voltage when the red (positive) probe is connected to pin 1 and the black (negative) probe is connected to pin 2.

If no voltage is present:

- Check the 30A fuse located at the sprayer fuse panel.
- Check the Power Hub battery connections.
- Check the condition of the battery.
- Check the condition of the alternator.

Figure 57: Battery Voltage Check



9.5.7 - System Load Capacity Check

Disconnect the desired nozzle valve 2-pin connector that is located on the spray boom farthest from the battery.

Turn OFF the SSRS Display, and then turn ON all boom sections.

Start the engine and turn ON all electrical loads including air conditioning, foam markers, monitors, etc.

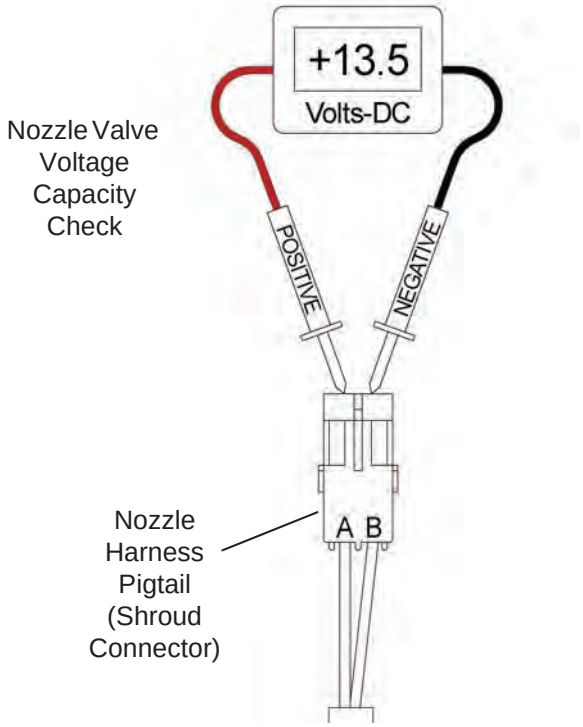
[Figure 58] - Use a voltmeter to observe the system voltage between pins A and B.

The SharpShooter with Rate Sync nozzle valves operate best at 12 VDC or higher. Using less than 12 VDC will result in reduced pressure capacity. This will often result in erratic nozzle pulsing, sometimes described as “flickering”. Also, check nozzle valves for worn plunger seals. See 9.5.4 - Plunger Seal Inspection on page 65.

If low voltage is observed:

- Check and clean the battery terminals.
- Check the battery condition.
- Check the alternator condition.
- Check the condition of connections.

Figure 58: System Load Capacity Check



9.5.8 - Valve Driver Voltage Check

Disconnect the Valve Driver from the Power Hub harness by disconnecting the 8-pin Deutsch connector. The connector is generally located at each boom section.

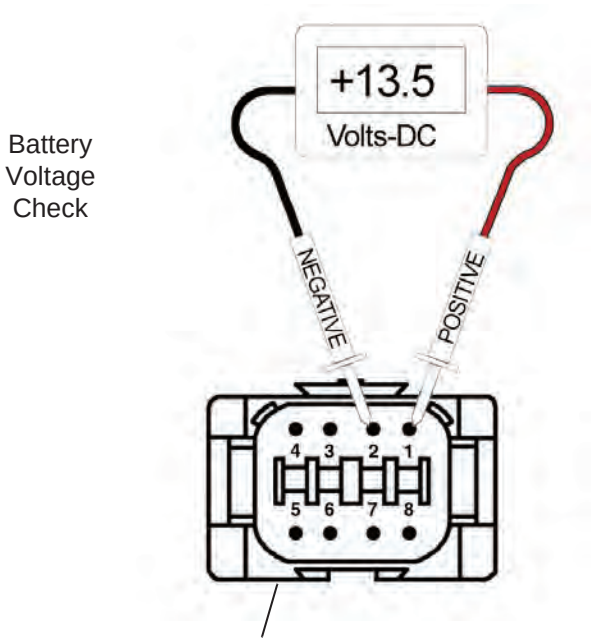
[Figure 59] - Use a voltmeter to observe that there is 13.5 VDC between pins 1 and 2 with the engine running or 12.0 VDC without the engine running.

Be sure the polarity is accurate by observing the positive voltage when the red (positive) probe is connected to pin 1 and the black (negative) probe is connected to pin 2.

If no voltage is present:

- Check the 30A fuse located at the sprayer fuse panel.
- Check the Power Hub battery connections.
- Check the Power Hub Valve Driver extension connection.
- Check the condition of the battery.

Figure 59: Valve driver Voltage Check



9.5.9 - Pressure Sensor Signal Test

Disconnect the pressure sensor from the pressure sensor harness. Connect one end of the pressure sensor breakout harness diagnostic tool into the pressure sensor shroud connector. Connect the other end into the pressure sensor harness tower connector.

NOTICE Make sure the Breakout Harness Diagnostic Tool is properly connected between the Pressure Sensor shroud connector and the Pressure Sensor harness tower connector. (See Figure 60).

NOTICE A poorly connected diagnostic tool is a frequent issue when trying to obtain voltage readings.

With the engine running and the pump turned on, use the rate controller to establish 40 PSI on the pressure gauge.

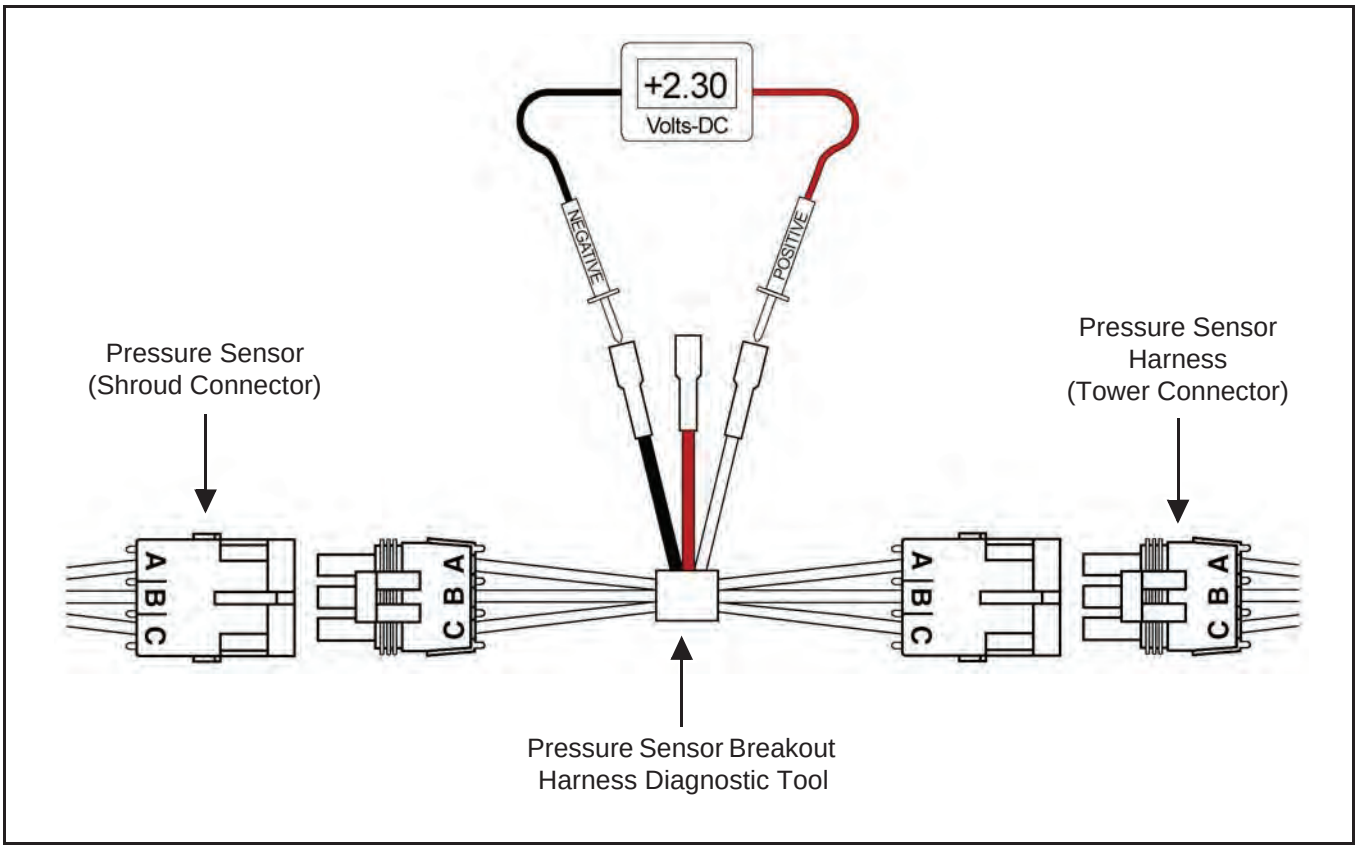
[Figure 61] - Use a voltmeter to observe that there is 2.30 VDC between the Black and White wire on the pressure sensor breakout harness.

Using the rate controller, adjust the pressure. Increasing the pressure should result into a higher output signal on the voltmeter (up to 5.0 VDC at 100 PSI). Decreasing the pressure should result in a lower output signal (down to 0.5 at 0 PSI).

If accurate voltage is not present:

- Verify the accuracy of the pressure gauge.
- Check for power to the pressure sensor. See 9.5.10 - Pressure Sensor Input Power Check on page 69.
- Replace the pressure sensor.

Figure 60: Pressure Sensor Signal Test



9.5.10 - Pressure Sensor Input Power Check

Disconnect the pressure sensor from the pressure sensor harness. Connect one end of the pressure sensor breakout harness diagnostic tool into the pressure sensor shroud connector. Connect the other end into the pressure sensor harness tower connector.

NOTICE Make sure the Breakout Harness Diagnostic Tool is properly connected between the Pressure Sensor shroud connector and the Pressure Sensor harness tower connector. (See Figure 61).

NOTICE A poorly connected diagnostic tool is a frequent issue when trying to obtain voltage readings.

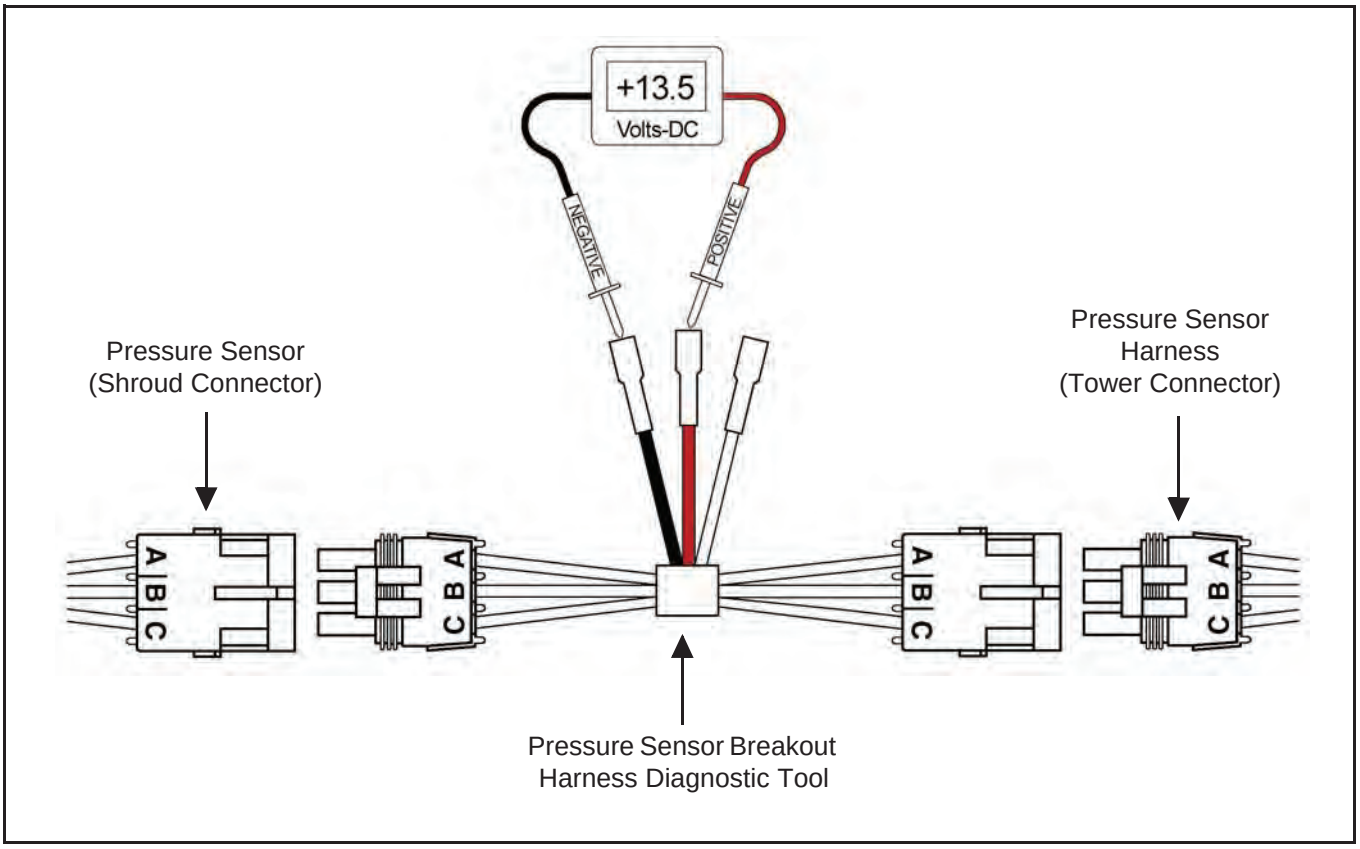
[Figure 61] - Use a voltmeter to observe that there is 13.5 VDC between the Red and Black wire on the pressure sensor breakout harness with the engine running, or 12.0 VDC without the engine running.

Be sure the polarity is accurate by observing that there is positive voltage when the Red (positive) probe is connected to Red pressure sensor breakout harness wire and the Black (negative) probe is connected to Black pressure sensor breakout harness wire.

If no voltage is present:

- Check the fuse located at the battery.
- Check the battery connections.
- Check the condition of the battery.
- Check the condition of the alternator.

Figure 61: Pressure Sensor Input Power Check



9.5.11 - Pulse Circuit Test

SSRS Display Output Check

Disconnect the Valve Driver from the extension harness that routes to the power hub by disconnecting the 8-pin Deutch connector.

Place the SSRS Display in the Manual (PWM) Mode and then select 70% duty cycle with the increase/ decrease keys.

[Figure 62] - Use a voltmeter to observe that there is 4.05 VDC between pins 1 and 4.

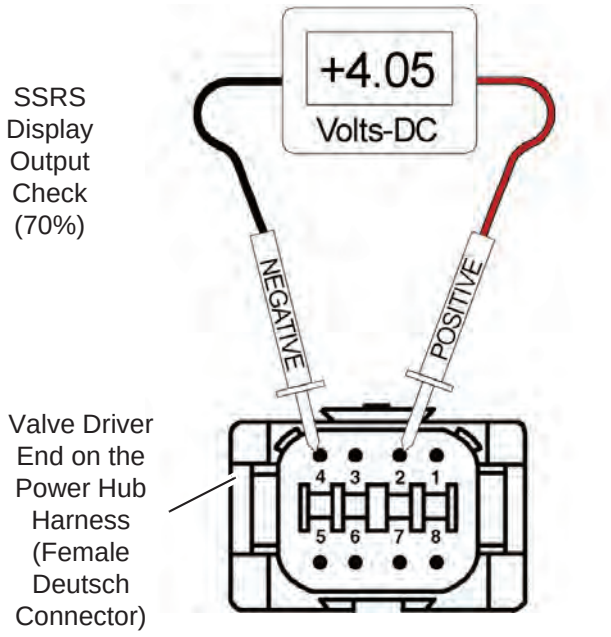
Most voltmeters measure signal as 12 VDC 10 Hz square wave which is a low voltage. In addition, the signal is inverted, so the 70% duty cycle selected on SSRS Display will actually be a 30% duty signal at the Valve Driver. Measurements may vary depending on the voltmeter used. This tests the even pulse.

Make the same measurement between pins 2 and 5. This tests the odd pulse.

If accurate voltage is not found:

- Check the Valve Driver extension connections.
- Check the SSRS Display extension connections.
- Check the SSRS Display serial diagnostics.

Figure 62: Pulse Circuit Test



9.5.12 - Valve Driver Output Check

Disconnect the desired nozzle valve 2-pin connector from the nozzle harness pigtail (connector) located on the spray boom.

Place the SSRS Display in the Manual Mode and then select 70% duty cycle with the increase/decrease keys. Turn ON the boom section, corresponding to the nozzle harness pigtail (connector) being tested.

[Figure 63] - Use a voltmeter to observe that there is 9.5 VDC between pins A and B.

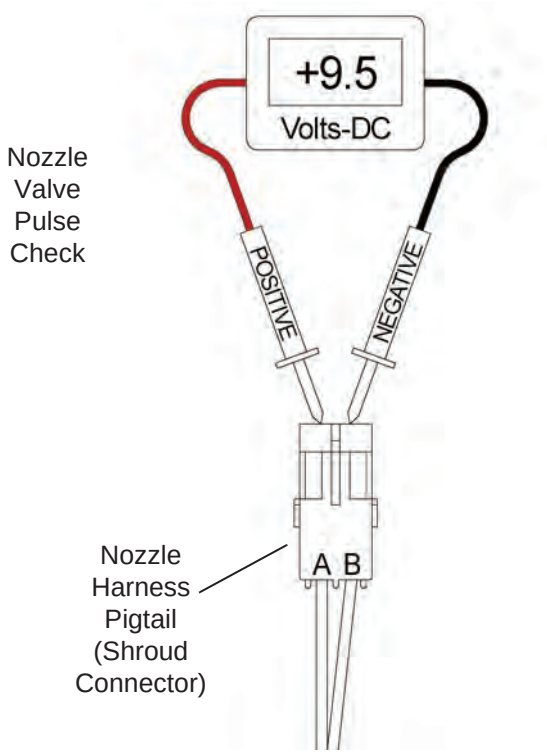
Most voltmeters measure signal as 12 VDC 10 Hz square wave which is a low voltage. Measurements may vary depending on the voltmeter used. Note the color of the wire in position B as either White or Green.

Make the same measurement on an adjacent nozzle harness pigtail (connector). The wire color in position B should change from White to Green or from Green to White.

If accurate voltage is not found:

- Check the nozzle harness extension connections.
- Check the Valve Driver extension connections.
- Check the SSRS Display extension connections.

Figure 63: Valve Driver Output Check



9.5.13 - Valve Driver Input Check

Disconnect the SSRS Display from the SSRS Pigtail harness by disconnecting the 8-pin Deutsch connector located on the SSRS Display.

Start the engine, turn ON the pump and boom, then use the spray rate controller to establish 40 PSI on the pressure gauge. The boom should now be spraying.

[Figure 64] - Tap a jumper wire, several times per second, between pins 1 and 4 on the Power Hub harness 8-pin Deutsch connector. Observe that every even nozzle valve turns off as the jumper connects and turn on as the jumper disconnects.

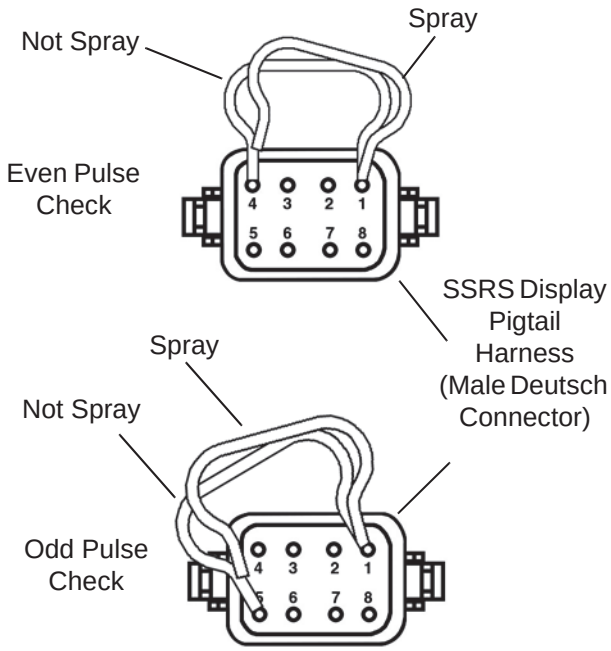
Tap a jumper wire, several times per second, between pins 1 and 5 on the extension harness connector. Observe that every odd nozzle valve turn on as the jumper connects and turn off as the jumper disconnects.

Observe the nozzle pulsing on each boom section.

If the boom sprays, but does not pulse, when the jumper wire is tapped:

- Check the Power Hub SSRS Display extension connection.
- Check the Valve Driver extension connections.

Figure 64: Valve Driver Input Check



9.5.14 - Boom Section Run / Hold Signal Test

Disconnect the SSRS Display from the SSRS Pigtail harness by disconnecting the 8-pin Deutsch connector located on the SSRS Display.

With water in the product, start the engine, turn on the pump with the boom OFF. Put the rate controller in the Manual Mode (now running speed and pressure). Set a test speed. Toggle the increase/decrease switch to establish 40 PSI on the pressure gauge. The boom should not be spraying.

The rate controller should be sending a 13.5 VDC (engine running) or a 12.0 VDC (engine off) run/hold signal through the Shutoff Adapter and Power Hub to the SSRS Display.

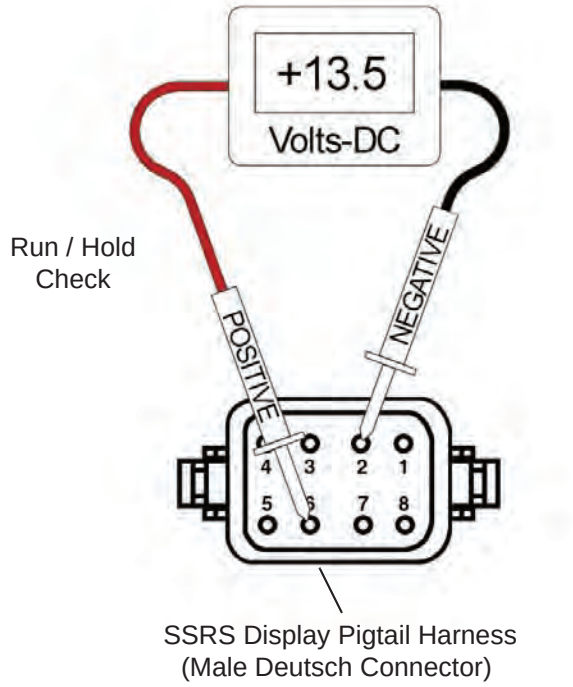
[Figure 65] - Turn ON boom section one to observe that the nozzle valves open and spray fully open. Use a voltmeter to check that signal between pins 2 and 6.

Turn OFF boom section number one and then observe the spray and voltage disappear. Repeat the test on remaining boom sections.

If no spray or voltage is observed:

1. Check the boom shutoff adapter connections.
2. Check the run/hold signal from the rate controller harness.
3. Check for continuity in the cable, and then check the rate controller section switches.
4. Send in the rate controller.

Figure 65: Boom Section Run / Hold Signal Test



9.5.15 - Boom Section Shutoff Signal Test

Disconnect the Valve Driver from the Power Hub harness by disconnecting the 8-pin Deutsch connector.

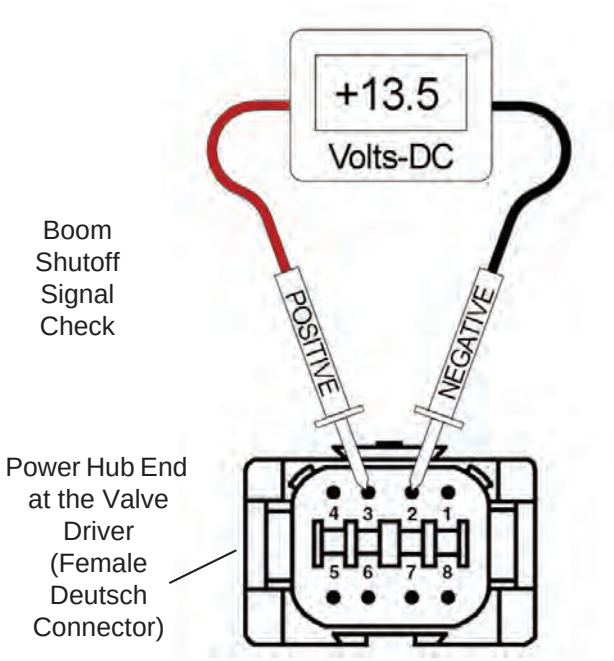
Turn ON the rate controller Master Switch and all Section Switches.

[Figure 66] - The rate controller should be sending a 13.5 VDC (engine running) or a 12.0 VDC shutoff signal through the Shutoff Adapter and then the Power Hub. Use a voltmeter to check that signal between pins 2 and 3. Check each power hub harness to the Non-Boost and the BOOST valve drivers.

Turn OFF the boom shutoff switch to observe the voltage disappear.

- If no spray or voltage is observed, trace the voltage signal from the rate controller harness (each section wire) through the Capstan Boom Shutoff adapter to the Power Hub.

Figure 66: Boom Section Shutoff Signal Test



9.6 - SYMPTOM ANALYSIS

⚠ WARNING

Before operating or servicing system: Read and understand the machine's Operator Manual and the SharpShooter with Rate Sync Turf Sprayer Edition Operation and Maintenance Manual. Follow the warnings and instructions in the manuals when making repairs, adjustments, or servicing. Check for correct function after adjustments, repairs or service. Untrained operators and failure to follow instructions can cause injury or death.

Use the following chart to locate and correct the problems which most often occur with the SharpShooter with Rate Sync System.

PROBLEM	CAUSE	CORRECTION
Under application.	Tips too small.	Check for proper tip size.
	Plugged tips.	Clean or replace tips.
	Plugged filter(s).	Clean or replace filter(s).
	Filter(s) not installed correctly.	Check all filters for correct installation.
	Plugged, kinked or collapsed hoses.	Check all hoses and replace as needed.
	Pump not turned on.	Turn pump on.
	Outrunning sprayer liquid system capability.	Slow down.
		Run at optimum pressure (not too low, not too high).
	Incorrect rate settings.	Check and adjust rate settings.
	Incorrect calibration settings.	Check and adjust settings.
	Faulty radar.	Replace radar.
	Poor GPS satellite signal.	Verify that the GPS is working correctly.
	Faulty rate controller switch.	Locate bad switch(s) and replace switch.
	Servo valve not working correctly.	Check servo valve and replace if needed.
	Boost not working.	Check for broken wires.
		Check Valve Driver(s) and replace if needed.
Over application.	Tips too large.	Check for proper tip size.
	Worn tips.	Replace tips.
	Speed too slow.	Increase speed.
	Incorrect rate settings.	Check and adjust rate settings.
	Incorrect calibration settings.	Check and adjust settings.
	Servo valve not working correctly.	Check servo valve; replace if needed.

PROBLEM	CAUSE	CORRECTION
Rate instability.	Low voltage to rate controller.	Test voltage and repair as needed.
	Faulty flow meter.	Repair or replace flow meter if needed.
	Faulty pressure dampener on diaphragm pump(s).	Replace pressure dampener(s).
	Faulty speed sensor reading.	Check radar and replace if needed.
	Collapsed suction hose.	Replace suction hose.
	Inlet plugged.	Check and clean inlet if needed.
	Incorrect valve calibration settings.	Check and adjust settings. See the rate controller's manual.
	Incorrect SSRS Display PID parameters.	Check SSRS Display PID Parameters and adjust as needed.
	SSRS Display Run / Hold Parameter too short.	Adjust SSRS Display Run / Hold Parameter.
	Faulty rate controller.	Replace rate controller.
Pressure instability.	Faulty rate controller.	Replace rate controller.
	Worn or sticky poppets.	Check and replace poppets as needed.
	Incorrect SSRS Display PID parameters.	Check SSRS Display PID parameters and adjust as needed.
	Faulty pressure sensor.	Replace pressure sensor.
Single nozzle valve drips when shutoff.	Plunger is lodged with debris.	Clean nozzle valve. See 9.5.3 - Nozzle Valve Cleaning on page 64.
	Plunger is worn.	Replace plunger. See 9.5.4 - Plunger Seal Inspection on page 65.
Single nozzle valve sprays erratically.	Plunger is worn.	Replace plunger. See 9.5.4 - Plunger Seal Inspection on page 65.
Single nozzle valve will not shut off.	Plunger is lodged with debris.	Clean nozzle valve. See 9.5.3 - Nozzle Valve Cleaning on page 64.
Section will not spray.	Blown fuse on Valve Driver.	Replace fuse on Valve Driver.
	Faulty Valve Driver.	Replace Valve Driver.
SSRS Display not functioning properly.	Low voltage at SSRS Display.	Perform system voltage checks.
Every other nozzle pulses.	Faulty Valve Driver.	Replace Valve Driver.
	Faulty Harness.	Replace Harness.
	Faulty harness.	Replace harness.
No pulse - Auto Mode (Manual Mode: Pulses).	Incorrect pressure sensor input and output settings.	Check and adjust settings.
No pulse - Auto Mode (Manual Mode: No pulse).	Faulty SSRS Display.	Replace the SSRS Display.

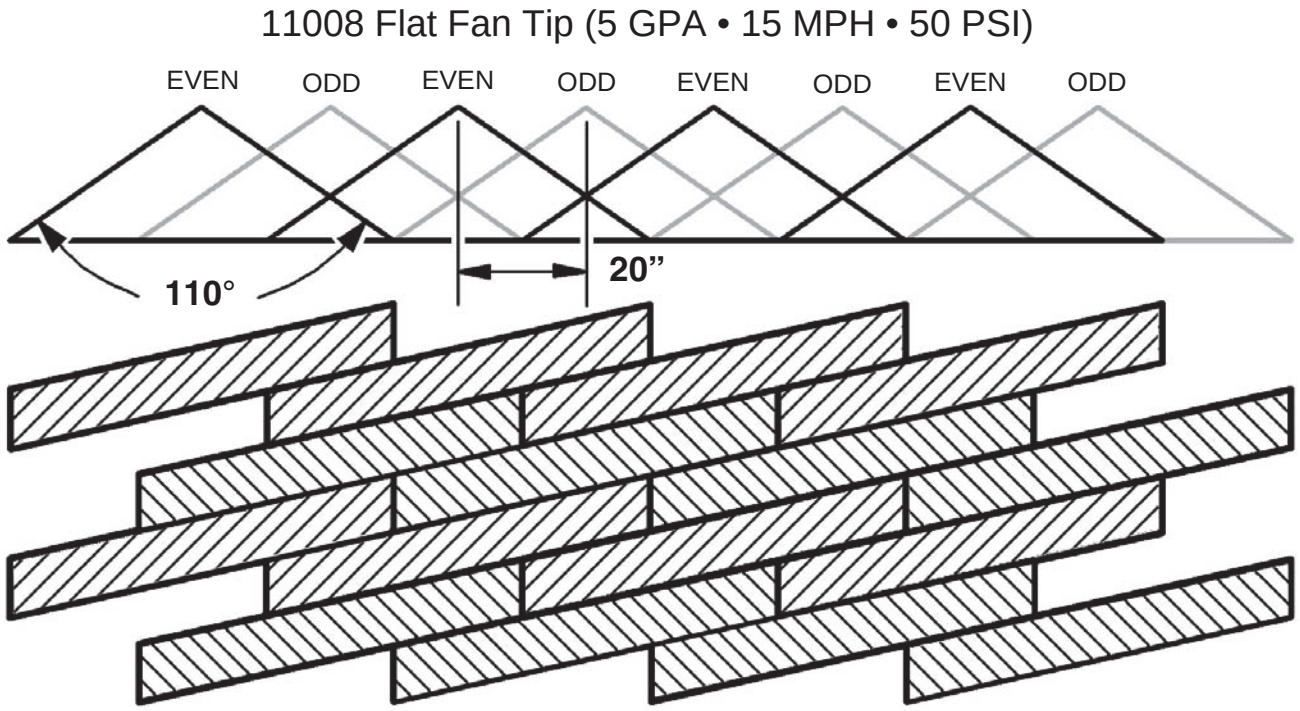
9.7 - TECHNICAL BULLETIN - JULY 11, 2001 (REVISED APRIL 12, 2006)

Spray Skips from Poor Pulse Blending

Over the years, Capstan's field engineers have received many questions about blended pulse spraying and its potential for causing skips in the field. In rare instances, skipping has been documented in the field. This technical bulletin is intended to explain pulse blending, and the techniques used to provide optimum spray coverage and to prevent skipping.

What is blended pulse spraying? Each nozzle in a blended pulse spray system emits 19 spray pulses per second. Adjacent nozzles have alternate timing. The alternating pulses, the overlapping spray patterns and the natural dispersing of droplets, blend together to provide consistent coverage of the target.

What makes the pulses blend? Below is an illustration of what a blended pulse spray pattern might look like if it were sprayed upon a flat surface. This spray pattern is similar to a #8 size flat fan spray tip (with a 110° fan angle) that is spraying 5 GPA at 15 MPH with a 50 PSI boom pressure. The nozzles are 20" apart. Each tip is rotated 12.5° to prevent pattern interference between nozzles. The minimum boom height is 21" above the spray target.

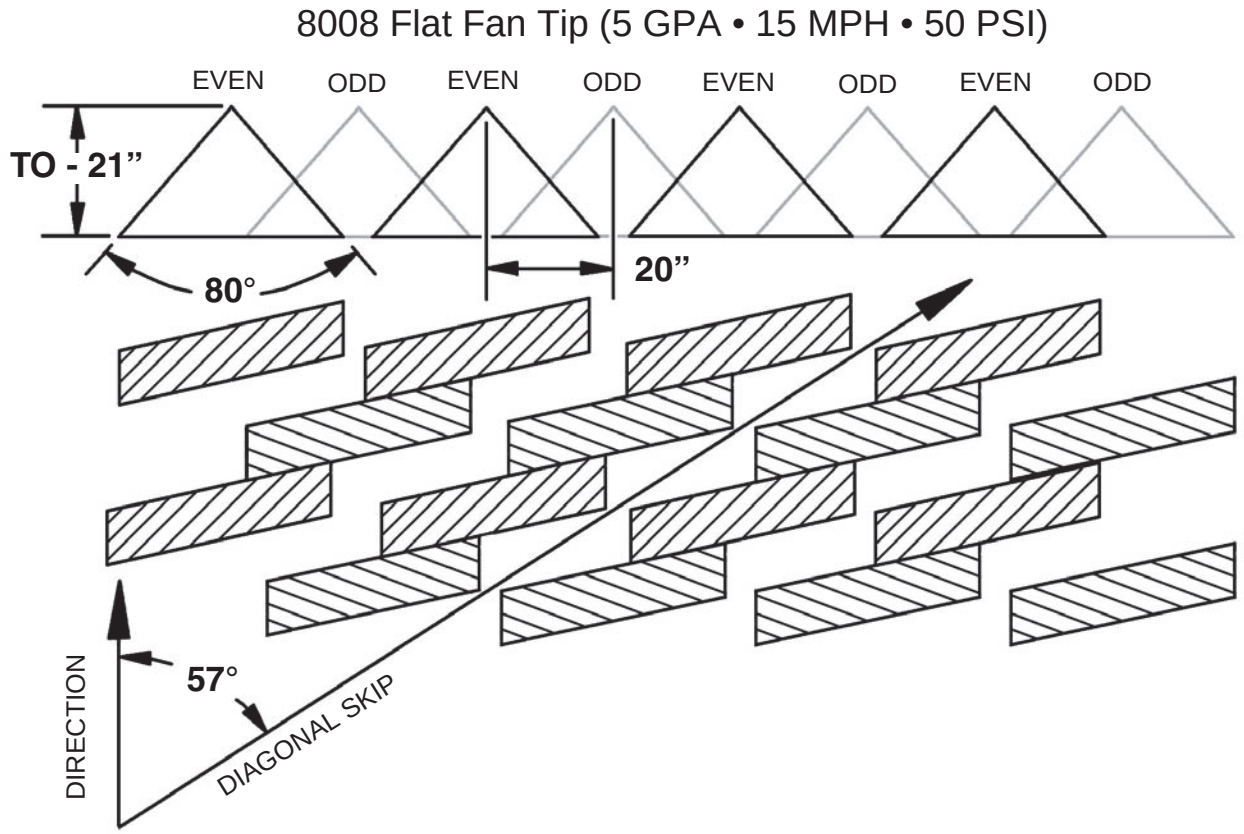


In this example, each nozzle sprays 1/3 of the time, but adjacent nozzles alternate and overlap to fill in areas between the nozzles. As the sprayer increases speed, rate, or boom height, the pulses become wider, this provides additional overlap, better pulse blending, and increased spray coverage.

As the sprayer decreases speed or rate, skips may begin to appear. For this example, a smaller tip size would be recommended if slower speeds are desired.

Pattern width and natural droplet dispersion are not shown in the diagram. These factors help to smooth out the pulses and fill in skips. The amount of droplet dispersion depends upon the style of tip being used. For example, low-drift tips typically emit large droplets and provide minimal droplet dispersion.

What causes skipping? Below is the same illustration from the previous page except that 80° fan angle tips are used rather than 110° tips. In this case, the 21" boom height doesn't provide adequate nozzle overlap and skips can be seen. Tips emitting small droplets, with plenty of droplet dispersion, will fill in large skips. Large droplet tips may not fill in the skips, and this may result in poor coverage. The skips appear as diagonal lines in the direction of travel. The angle of the diagonal depends upon the speed of the sprayer.



To Prevent Skipping:

1. Use wide-angle spray tips and appropriate boom heights to provide 150% nozzle overlap.
   - For 80 degree tips, use 36" or greater boom height.
   - For 110 degree tips, use 24" or greater boom height.
   - Use pressures which fully develop the intended fan angle.
2. Avoid pulse Duty Cycles below 33%.
   - Use appropriately sized spray tips for the desired speed, rate, and pressure ranges.
   - Avoid speeds in the lower 1/3 of the speed range.
   - Avoid rates in the lower 1/3 of the rate range.
3. Use additional caution when using drift control tips or drift control additives which increase droplet size and reduce droplet dispersion. Carefully observe the boom height, duty cycle, and tip selection recommendations to ensure adequate spray coverage.
4. **Always read and follow chemical label instructions!** Agronomic and environmental factors significantly affect efficiency of the chemicals, and will magnify the adverse effects of poor coverage. Carefully observe boom height, duty cycle and tip selection recommendations for hot and dry field conditions, large / mature weed pressures, etc.
5. **Always apply blended pulse broadcast sprays using a 19 Hz or greater pulse frequency!** Capstan's "Commander" module and SSRS Display allow the pulse frequency to be reduced for non-sprayer applications, when uniform coverage is not required.

10.0 - WARRANTY POLICY

LIMITED WARRANTY

Rev Date: 7/15/2014

A. What does the Limited Warranty cover?

The ultimate purchaser/user (“you”), by acceptance of seller Capstan Ag Systems, Inc.’s, (“our,” “we,” or “us”) product, assume all risk and liability of the consequences of any use or misuse by you, your employees, or others.

All replacement components furnished under this warranty, but shipped before the failed component is returned for evaluation, will be invoiced in the usual manner and warranty adjustments will be made after the component claimed to be defective has been returned to and inspected and deemed defective by us at our factory.

Upon determining that a component has failed under warranty, the repaired component or replacement component, furnished under this warranty, will be shipped at our expense, to your location. We will credit you an amount equal to the incoming freight you paid. We shall not be responsible for installation costs. (You shall be responsible for all customs and brokerage fees for all international transactions.)

If the component does not prove to be defective, you shall be liable for all freight, inspection and handling costs. In no event will any claim for labor or incidental or consequential damages be allowed for removing or replacing a defective product. Warranty will be denied on any component which has been subject to misuse, abuse, accidents, or alterations, or to improper or negligent use, maintenance, storage or transportation and handling.

Our liability under this warranty, or for any loss or damage to the components whether the claim is based on contract or negligence, shall not in any case exceed the purchase price of the components and upon the expiration of the warranty period all such liability shall terminate. The foregoing shall constitute your exclusive remedy and our exclusive liability.

The terms of this warranty do not in any way extend to any product which was not manufactured by us or one of our affiliates.

While necessary maintenance or repairs on your Capstan Ag Systems, Inc. product can be performed by any company, we recommend that you use only authorized Capstan Ag Systems, Inc. dealers. Improper or incorrectly performed maintenance or repair voids this warranty.

The foregoing warranty is exclusive and is in lieu of all other warranties expressed or implied. We shall not be liable for any incidental or consequential damages resulting from any breach of warranty.

Your exclusive remedy for breach of warranty shall be repair or replacement of defective component(s): Provided, if the component(s) are incapable of being repaired or replaced, your exclusive remedy shall be credit issued, but such credit shall not exceed the purchase price of the components.

On any claim of any kind, including negligence, our liability for any loss or damage arising out of, or from the design, manufacture, sale, delivery, resale, installation, technical direction of installation, inspection, repair, operation of use of any products shall in no case exceed the purchase price allocable to the components.

In no event, whether as a result of breach of contract or warranty or alleged negligence, shall we be liable for incidental or consequential damages, including, but not limited to: personal injury, loss of profits or revenue, loss of use of equipment or any associated equipment, cost of capital, cost of substitute equipment, facilities or services, downtime costs, environmental damage, crop losses, or claims of customers of you for such damages.

B. What is the period of coverage?

We warrant to you, that our products are free from defects in material and workmanship in normal use and service for a period of one year from date of purchase.

C. How do you get service?

Our obligation under this warranty shall be limited to the repairing or replacing at our option, the component which our inspection discloses to be defective, free of charge, return freight paid by us, provided you: (i) Notify us of defect within thirty (30) days of failure; (ii) Return the defective component to us, freight prepaid; (iii) Complete the Owner Registration Form and returned it to us; and (iv) Establish that the product has been properly installed, maintained and operated in accordance with our instructions or instructions contained in our operations or maintenance manuals and within the limits of normal usage.

Any claim for breach of our warranty must be in writing addressed to us and must set forth the alleged defect in sufficient detail to permit its easy identification by us. All breach of warranty claims must be made within thirty (30) days after expiration of the warranty period which is applicable to the defective product. Any breach of warranty claim not timely made will not be honored by us and will be of no force and effect.Any component that needs to be repaired or evaluated for warranty has to be authorized before return. Contact the factory (785-232-4477) to get a Return Materials Authorization (RMA #). This helps to track the part coming into the factory for repair or replacement.

Before returning any component to the factory, clean the component as well as possible to remove any dirt or chemical residue. Components received at the factory that are not clean, will be returned and warranty denied.

After receiving your RMA #, package the part, making sure to include the RMA #, your name, customer's name, your address and phone number and description of problems or failure. Then ship to:

Capstan Ag Systems, Inc.
Attn: Warranty/Repair
4225 SW Kirklawn Ave.
Topeka, KS 66609

Phone: (785) 232-4477
Fax: (785) 232-7799
Hours: 8:00 a.m. - 4:00 p.m. CST

D. How does state law relate to this Limited Warranty?

Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

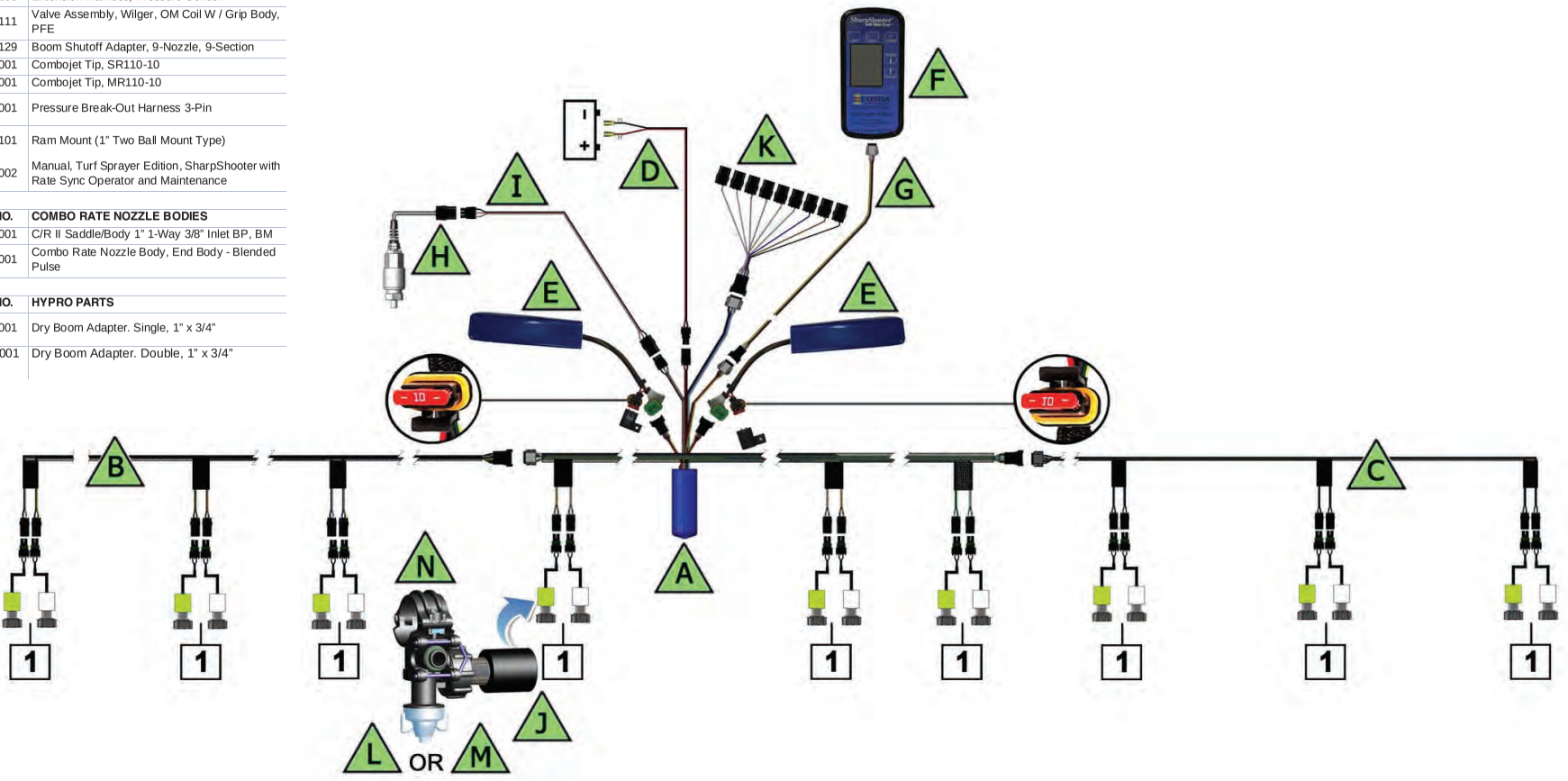
This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

11.0 - KIT SMITHCO 118600-230, 9-NOZZLE, 9-SECTION, (1-1-1-1-1-1-1-1-1), 15’ BOOM, TURF SSRS

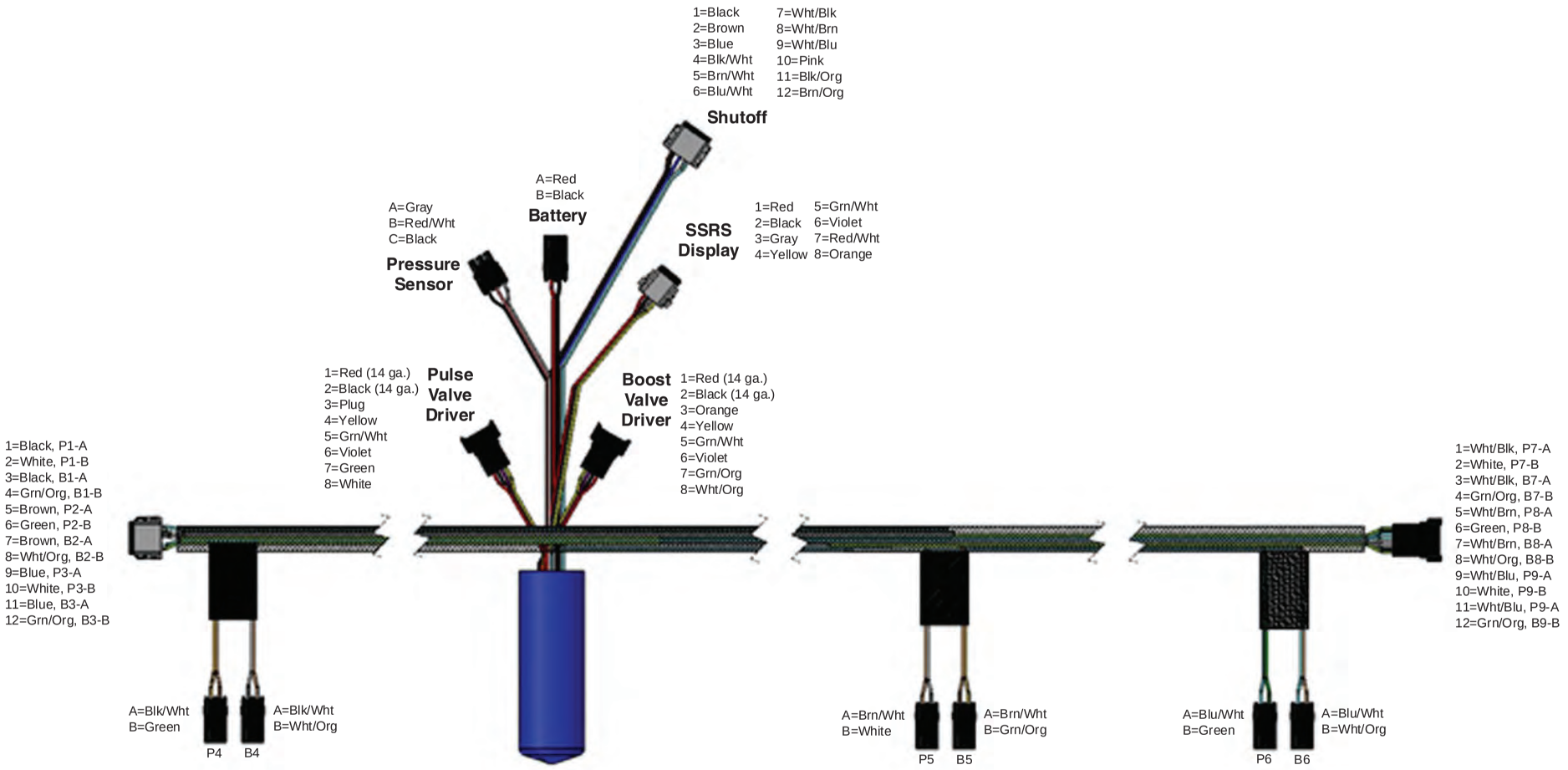
ITEM	QTY.	PART NO.	CAPSTAN SHARPSHOOTER PARTS
A	1	118600-250	Power Hub, Turf, SmithCo 9-Nozzle, Center
B	1	118600-251	LH Boom Harness, (12 wire) Sections 1-3
C	1	118600-252	RH Boom Harness, (12 wire) Sections 7-9
D	1	118600-107	Power Harness (14')
E	2	118400-020	Valve, Driver Module
F	1	118500-110	SSRS Display
G	1	118600-110	Extension Harness, SSRS Display (14')
H	1	116301-001	Pressure Sensor Assy, 100 PSI, 1/4" MNPT, Packard
I	1	118600-108	Extension Harness, Pressure Sensor
J	18	116390-111	Valve Assembly, Wilger, OM Coil W / Grip Body, PFE
K	1	118602-129	Boom Shutoff Adapter, 9-Nozzle, 9-Section
L	9	132009-001	Combojet Tip, SR110-10
M	9	132010-001	Combojet Tip, MR110-10
Not Shown	1	620185-001	Pressure Break-Out Harness 3-Pin
Not Shown	1	118603-101	Ram Mount (1" Two Ball Mount Type)
Not Shown	1	118556-002	Manual, Turf Sprayer Edition, SharpShooter with Rate Sync Operator and Maintenance

ITEM		PART NO.	COMBO RATE NOZZLE BODIES
N	9	132017-001	C/R II Saddle/Body 1" 1-Way 3/8" Inlet BP, BM
Not Shown	9	132002-001	Combo Rate Nozzle Body, End Body - Blended Pulse

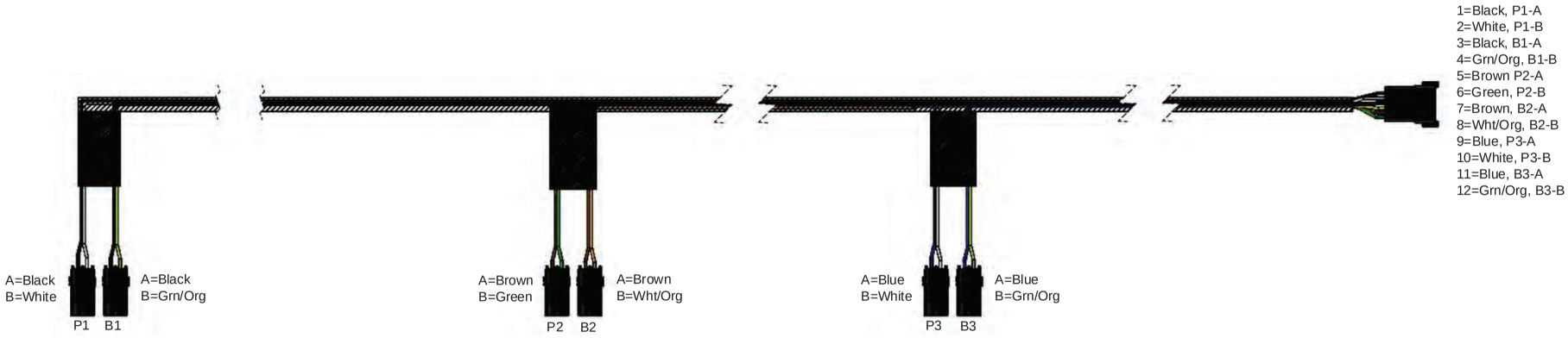
ITEM		PART NO.	HYPRO PARTS
Not Shown	4	132025-001	Dry Boom Adapter. Single, 1" x 3/4"
Not Shown	5	132026-001	Dry Boom Adapter. Double, 1" x 3/4"



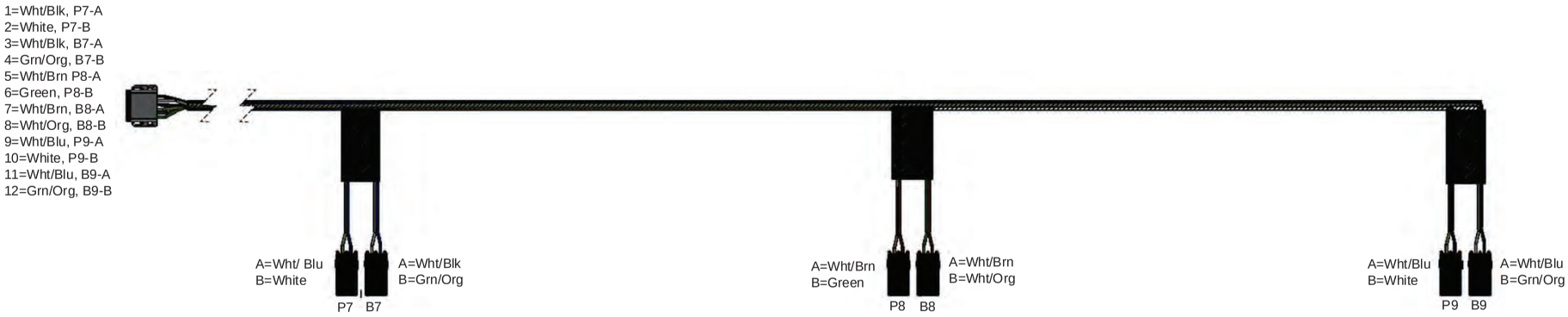
11.1 - Power Hub, 9-Nozzle, 3-Section, Boom 4, 5, 6 - P/N118600-250



11.2- LH Boom Harness, 9-Nozzle, 3-Section, Boom 1, 2, 3 - P/N118600-251



11.3 - RH Boom Harness, 9-Nozzle, 3-Section, Boom 7, 8, 9 - P/N118600-252

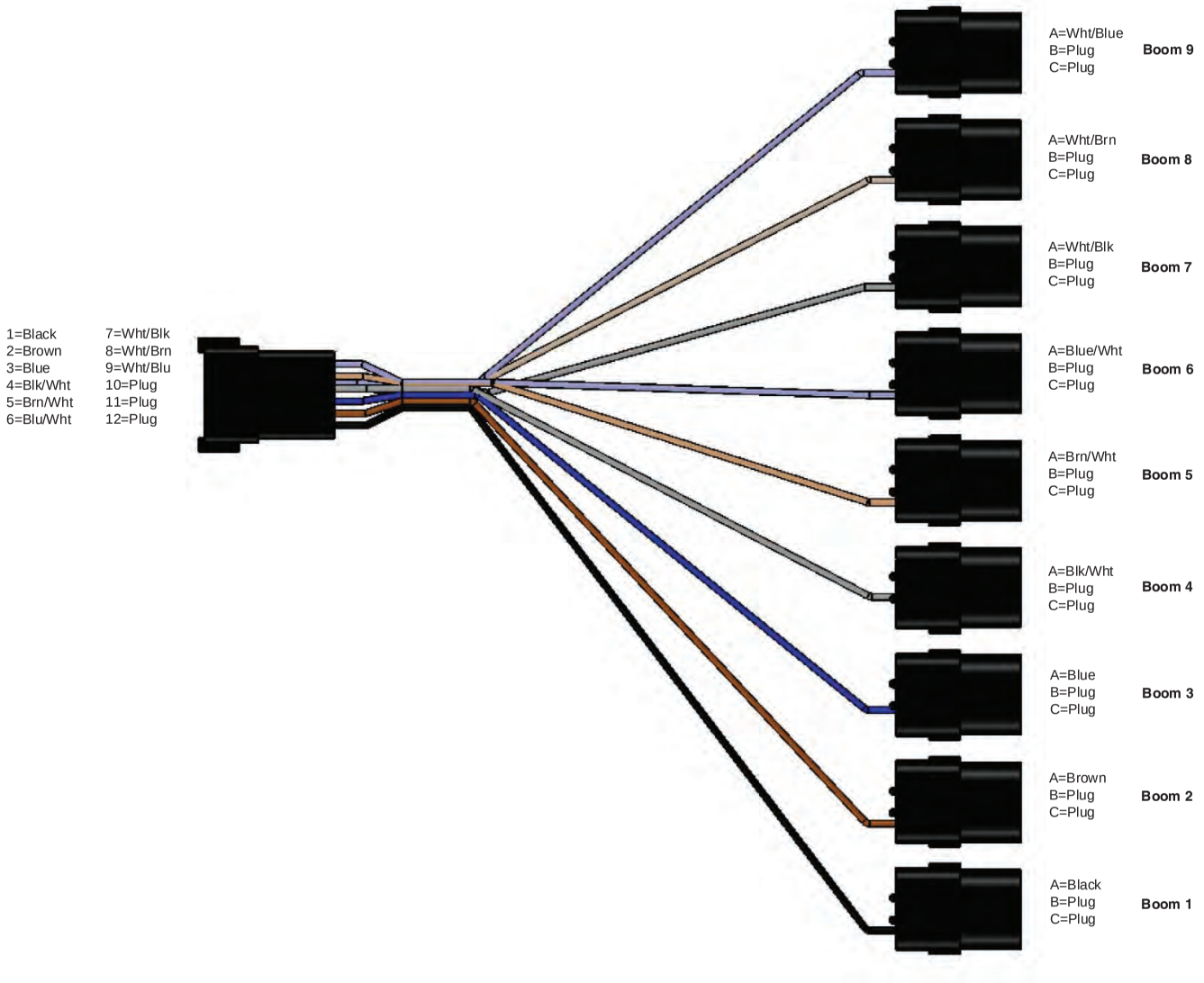


11.4 - Extension Harness, SSRS Display, PN118600-110

11.5 - Power Harness, PN118600-107

11.6 - Extension Harness, Pressure Sensor, PN118600-108

11.7 - Boom Shutoff Adapter, 9-Nozzle, 9-Section, PN118602-129



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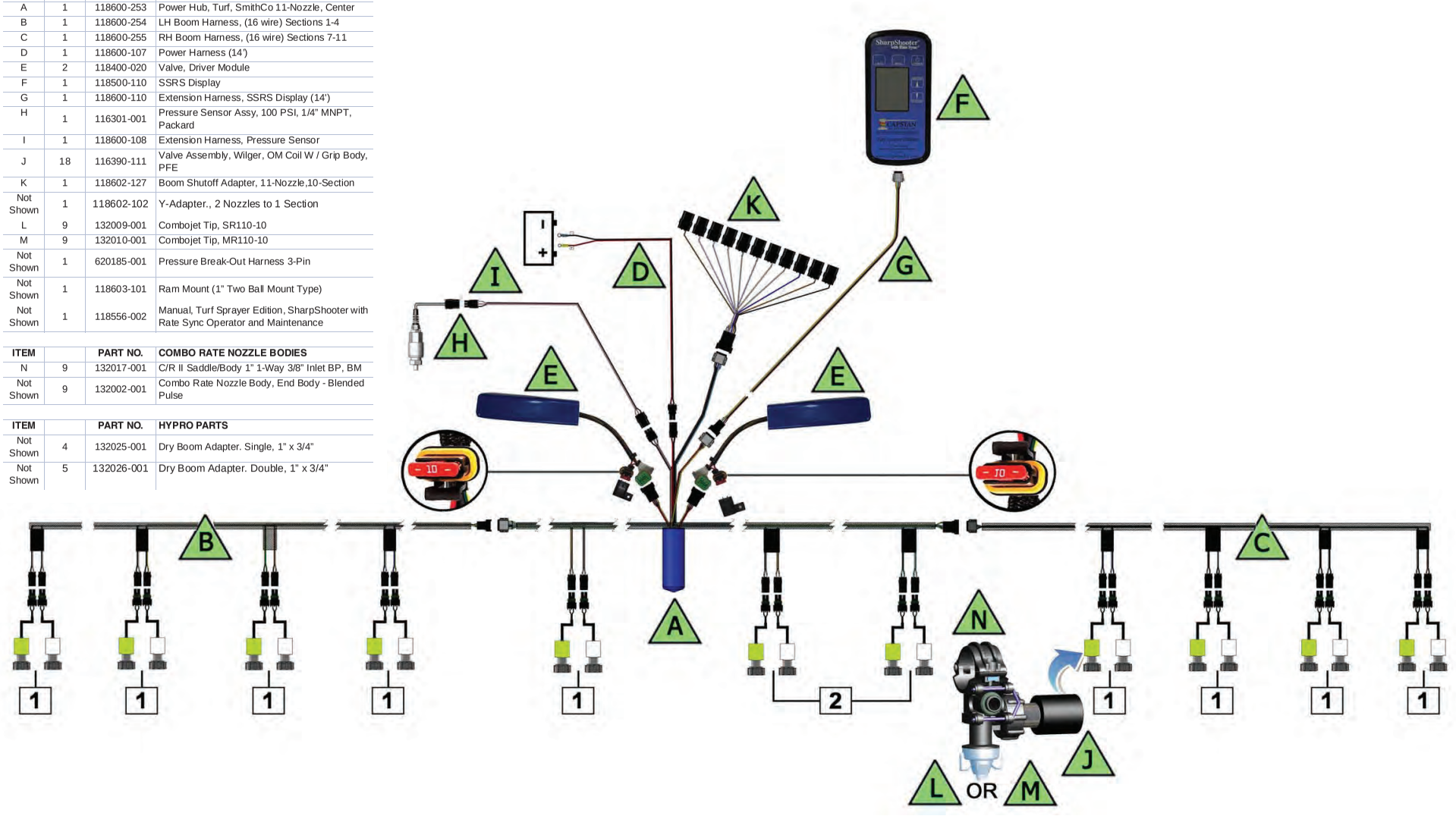
12.0 - KIT SMITHCO 118600-226, 11-NOZZLE, 10-SECTION, (1-1-1-1-1-2-1-1-1-1), 18' BOOM, TURF SSRS

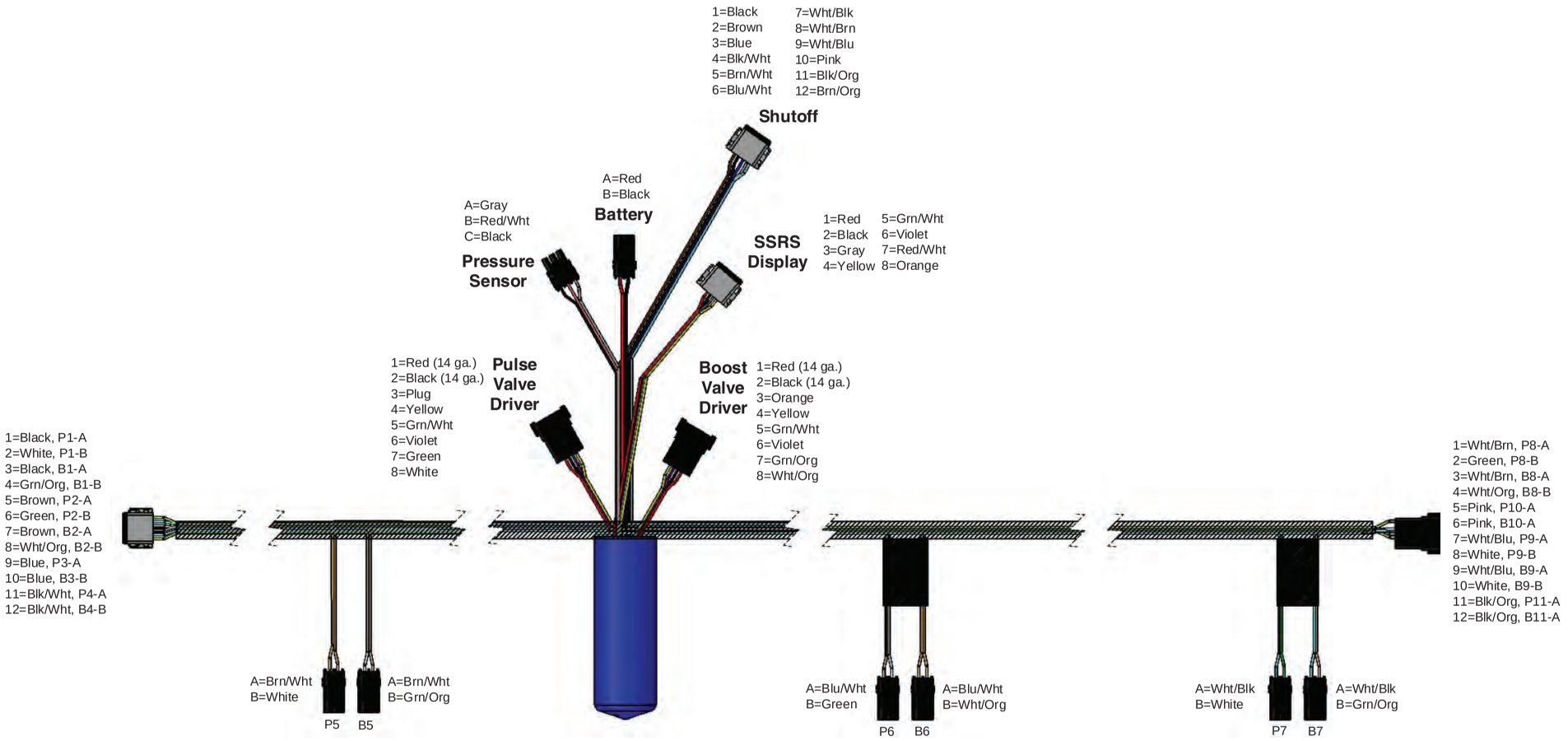
ITEM	QTY.	PART NO.	CAPSTAN SHARPSHOOTER PARTS
A	1	118600-253	Power Hub, Turf, SmithCo 11-Nozzle, Center
B	1	118600-254	LH Boom Harness, (16 wire) Sections 1-4
C	1	118600-255	RH Boom Harness, (16 wire) Sections 7-11
D	1	118600-107	Power Harness (14')
E	2	118400-020	Valve, Driver Module
F	1	118500-110	SSRS Display
G	1	118600-110	Extension Harness, SSRS Display (14')
H	1	116301-001	Pressure Sensor Assy, 100 PSI, 1/4" MNPT, Packard
I	1	118600-108	Extension Harness, Pressure Sensor
J	18	116390-111	Valve Assembly, Wilger, OM Coil W / Grip Body, PFE
K	1	118602-127	Boom Shutoff Adapter, 11-Nozzle,10-Section
Not Shown	1	118602-102	Y-Adapter., 2 Nozzles to 1 Section
L	9	132009-001	Combojet Tip, SR110-10
M	9	132010-001	Combojet Tip, MR110-10
Not Shown	1	620185-001	Pressure Break-Out Harness 3-Pin
Not Shown	1	118603-101	Ram Mount (1" Two Ball Mount Type)
Not Shown	1	118556-002	Manual, Turf Sprayer Edition, SharpShooter with Rate Sync Operator and Maintenance

ITEM		PART NO.	COMBO RATE NOZZLE BODIES
N	9	132017-001	C/R II Saddle/Body 1" 1-Way 3/8" Inlet BP, BM
Not Shown	9	132002-001	Combo Rate Nozzle Body, End Body - Blended Pulse

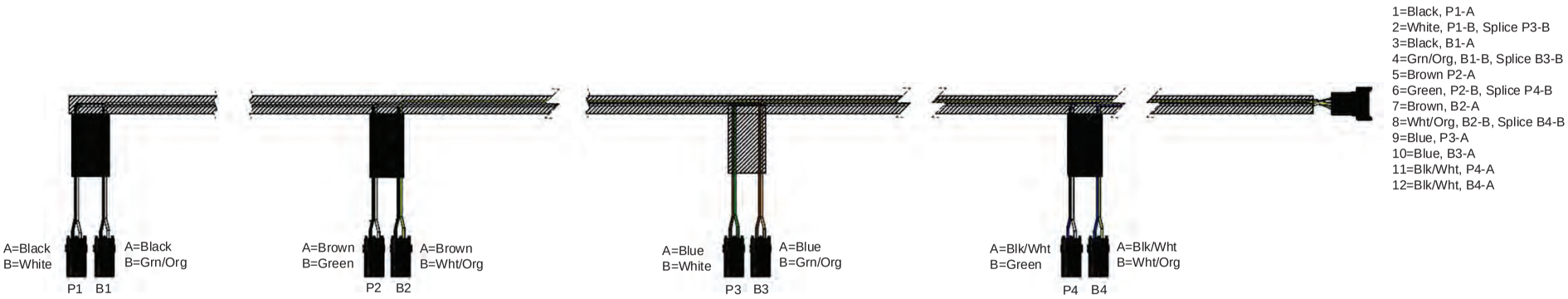
ITEM		PART NO.	HYPRO PARTS
Not Shown	4	132025-001	Dry Boom Adapter. Single, 1" x 3/4"
Not Shown	5	132026-001	Dry Boom Adapter. Double, 1" x 3/4"



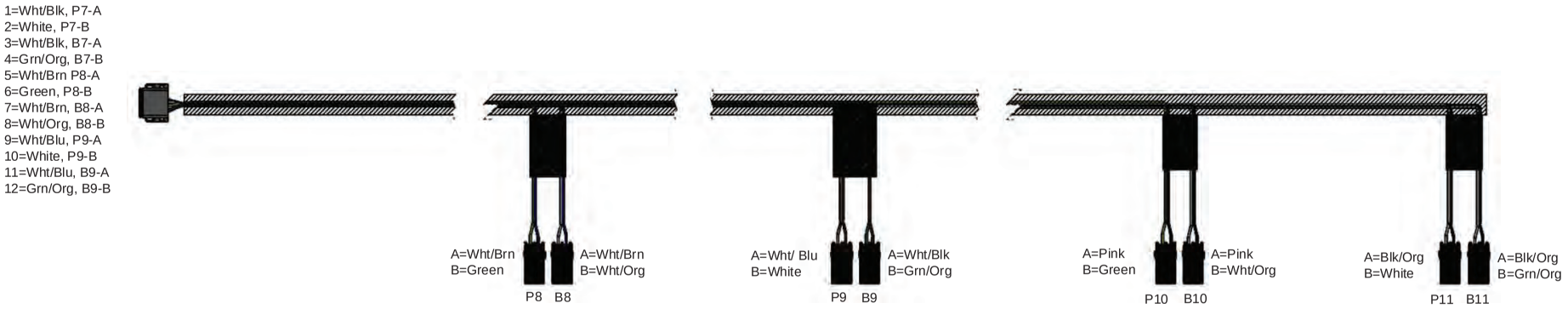
12.1 - Power Hub, 11-Nozzle, 3-Section, Boom 5, 6, 7 - P/N118600-253



12.2 - LH Boom Harness, 11-Nozzle, 3-Section, Boom 1, 2, 3, 4 - P/N118600-254



12.3 - RH Boom Harness, 11-Nozzle, 3-Section, Boom 8, 9, 10, 11 - P/N118600-255

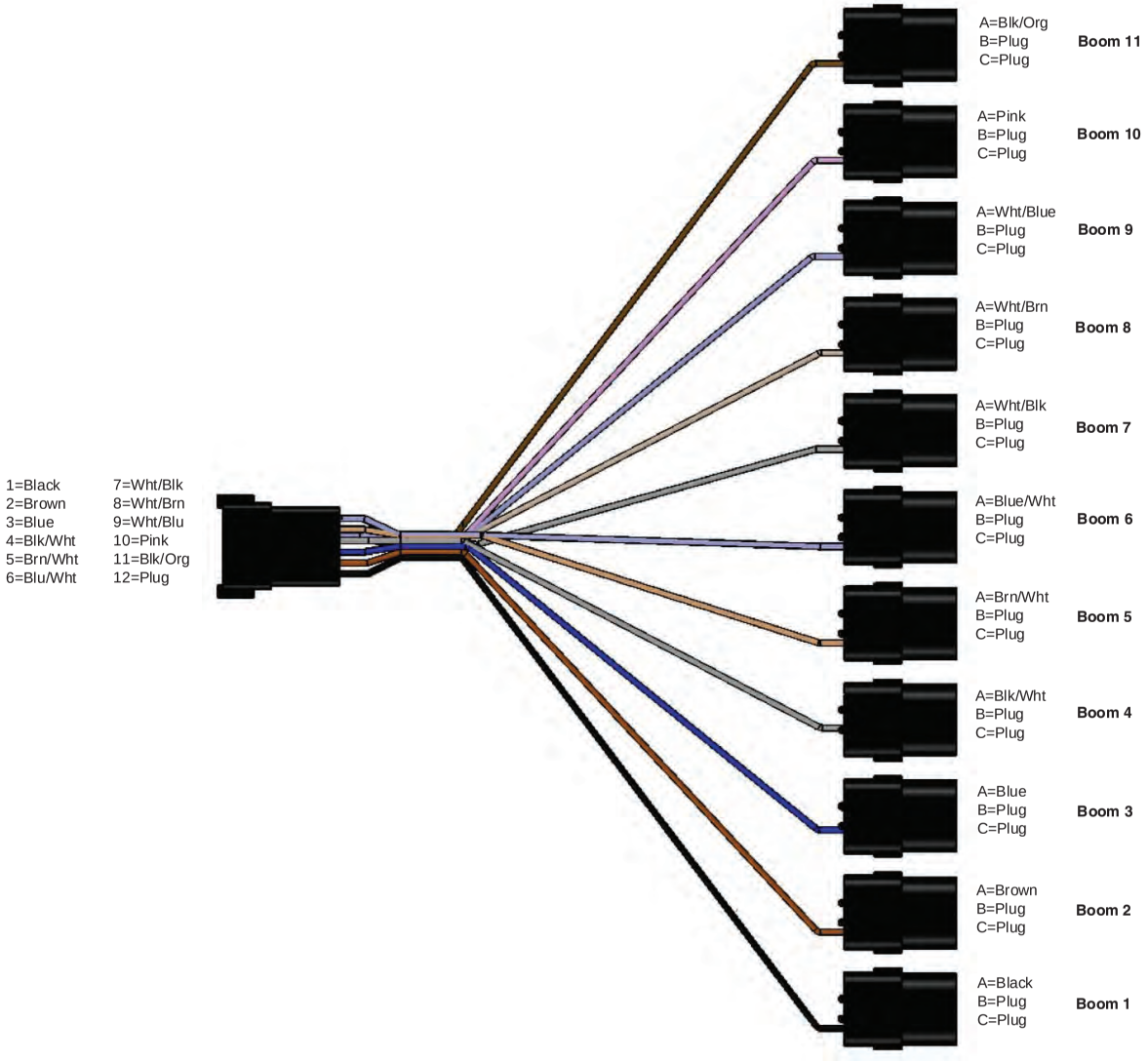


12.4 - Extension Harness, SSRS Display, PN118600-110

12.5 - Power Harness, PN118600-107

12.6 - Extension Harness, Pressure Sensor, PN118600-108

12.7 - Boom Shutoff Adapter, 11-Nozzle, 10-Section, PN118602-127



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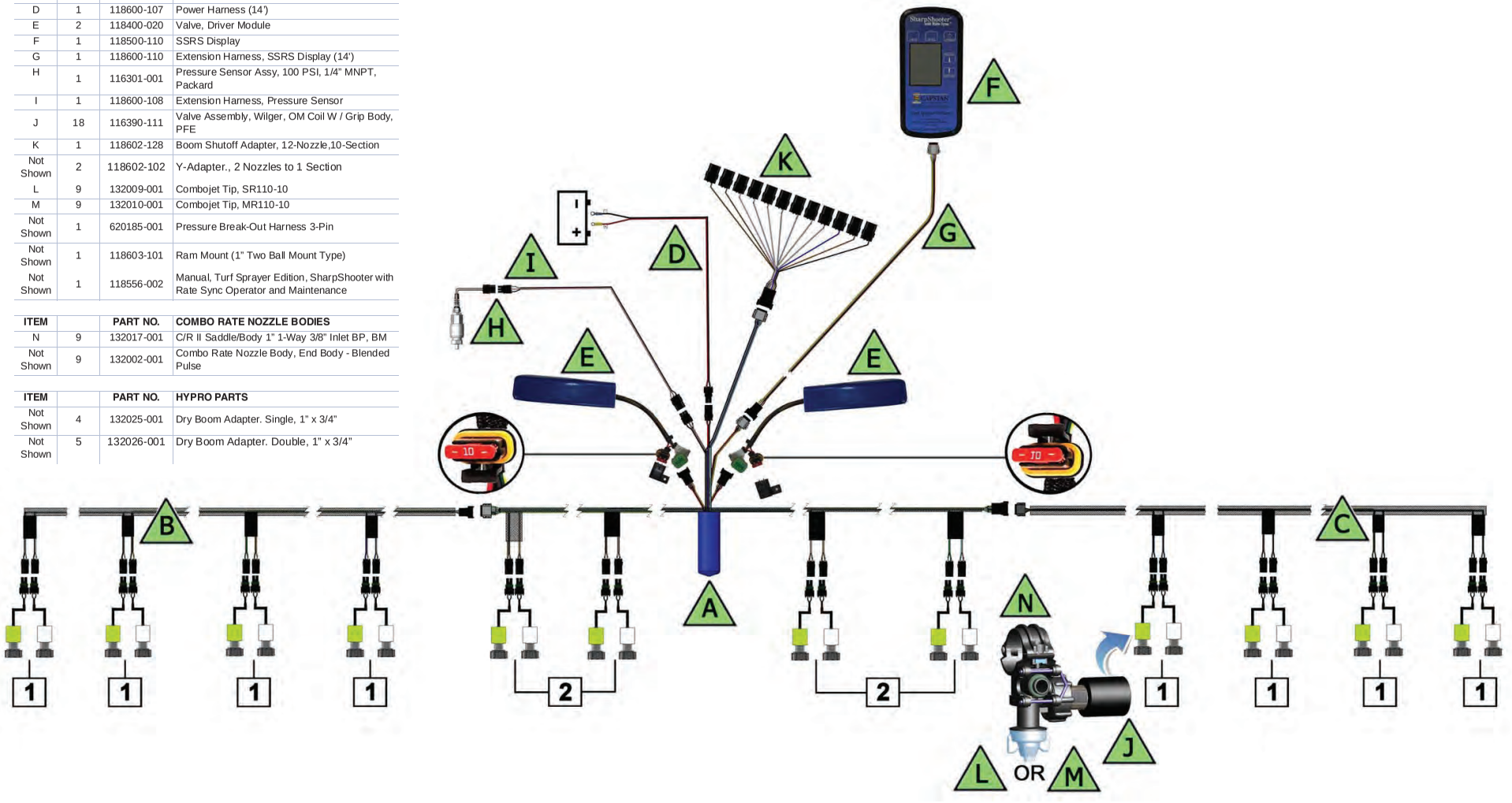
13.0 - KIT SMITHCO 118600-228, 12-NOZZLE, 10-SECTION, (1-1-1-1-1-2-1-1-1-1), 20' BOOM, TURF SSRS

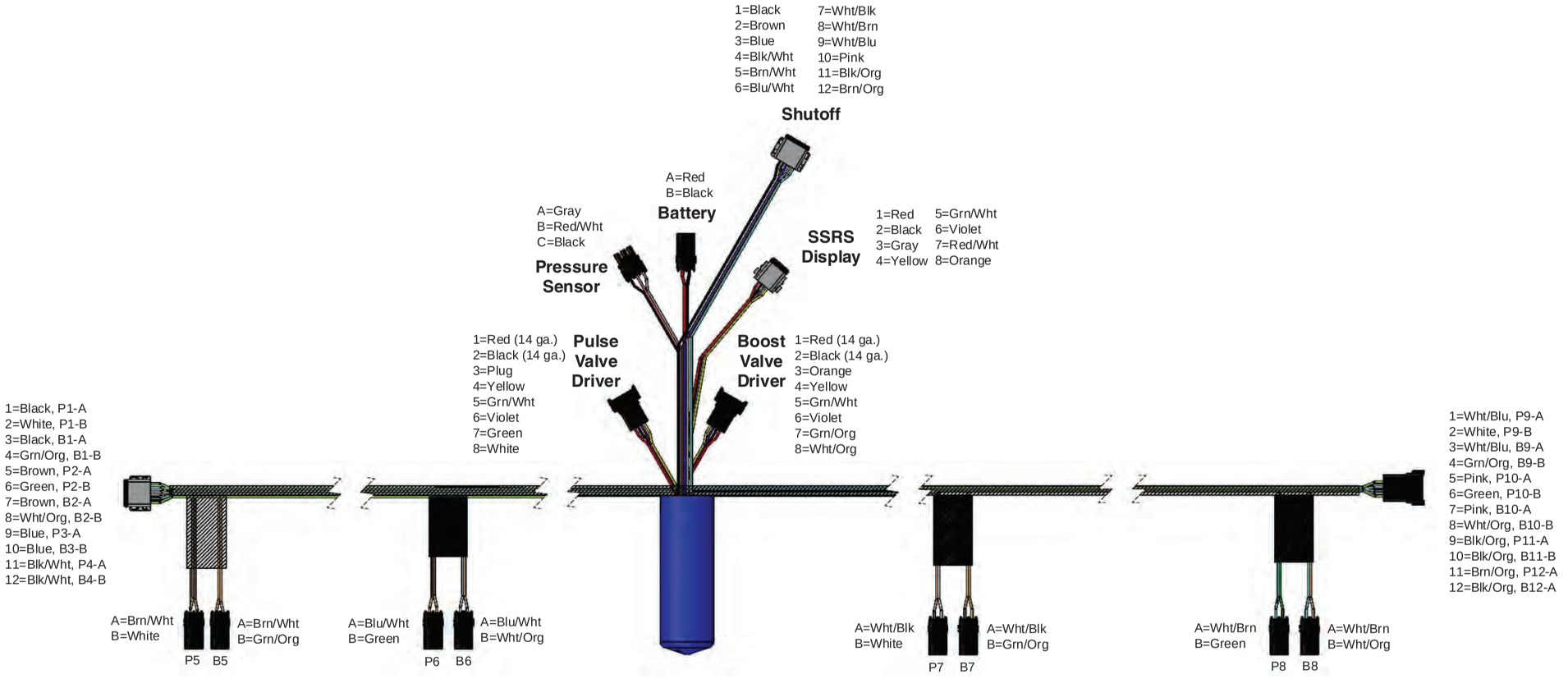
ITEM	QTY.	PART NO.	CAPSTAN SHARPSHOOTER PARTS
A	1	118600-256	Power Hub, Turf, SmithCo 9-Nozzle, Center
B	1	118600-257	LH Boom Harness, (16 wire) Sections 1-4
C	1	118600-258	RH Boom Harness, (12 wire) Sections 7-11
D	1	118600-107	Power Harness (14')
E	2	118400-020	Valve, Driver Module
F	1	118500-110	SSRS Display
G	1	118600-110	Extension Harness, SSRS Display (14')
H	1	116301-001	Pressure Sensor Assy, 100 PSI, 1/4" MNPT, Packard
I	1	118600-108	Extension Harness, Pressure Sensor
J	18	116390-111	Valve Assembly, Wilger, OM Coil W / Grip Body, PFE
K	1	118602-128	Boom Shutoff Adapter, 12-Nozzle,10-Section
Not Shown	2	118602-102	Y-Adapter., 2 Nozzles to 1 Section
L	9	132009-001	Combojet Tip, SR110-10
M	9	132010-001	Combojet Tip, MR110-10
Not Shown	1	620185-001	Pressure Break-Out Harness 3-Pin
Not Shown	1	118603-101	Ram Mount (1" Two Ball Mount Type)
Not Shown	1	118556-002	Manual, Turf Sprayer Edition, SharpShooter with Rate Sync Operator and Maintenance

ITEM		PART NO.	COMBO RATE NOZZLE BODIES
N	9	132017-001	C/R II Saddle/Body 1" 1-Way 3/8" Inlet BP, BM
Not Shown	9	132002-001	Combo Rate Nozzle Body, End Body - Blended Pulse

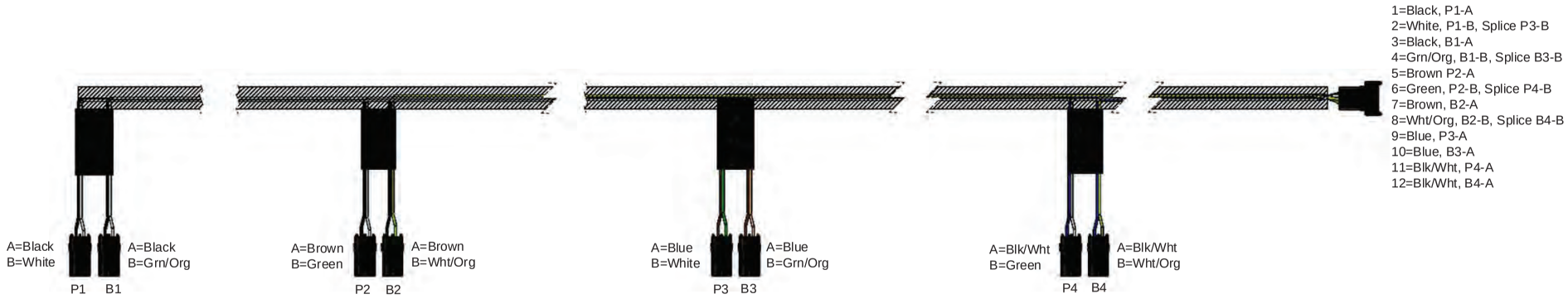
ITEM		PART NO.	HYPRO PARTS
Not Shown	4	132025-001	Dry Boom Adapter. Single, 1" x 3/4"
Not Shown	5	132026-001	Dry Boom Adapter. Double, 1" x 3/4"



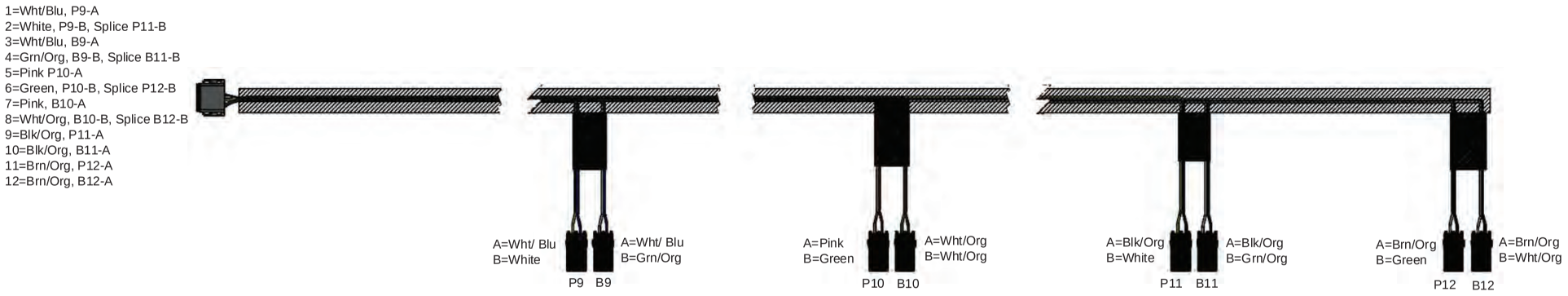
13.1 - Power Hub, 12-Nozzle, 3-Section, Boom 5, 6, 7, 8 - P/N118600-256



13.2 - LH Boom Harness, 12-Nozzle, 3-Section, Boom 1, 2, 3, 4 - P/N118600-257



13.3 - RH Boom Harness, 12-Nozzle, 3-Section, Boom 9, 10, 11, 12 - P/N118600-258

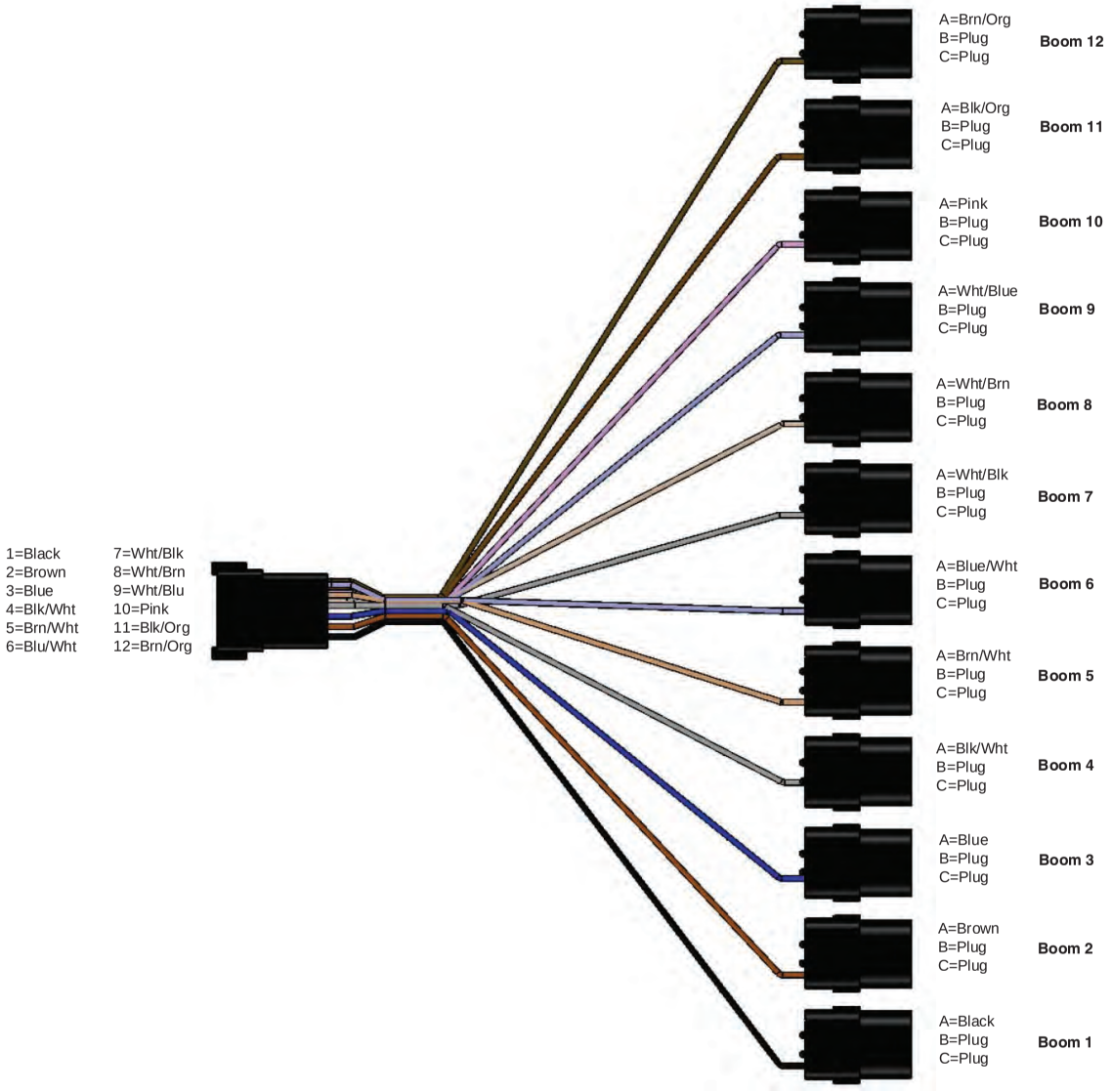


13.4 - Extension Harness, SSRS Display, PN118600-110

13.5 - Power Harness, PN118600-107

13.6 - Extension Harness, Pressure Sensor, PN118600-108

13.7 - Boom Shutoff Adapter, 12-Nozzle, 10-Section, PN118602-128



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SharpShooter® - Turf Sprayer Edition

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SINCE 1893 AG SYSTEMS, INC.
APPLICATION SYSTEMS FOR PROFESSIONALS

P/N 118556-001
Revised 06-2016