SuperFlow
DYNAMOMETERS & FLOWBENCHES
A Division of Power Test, Inc.

Operator Manual

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Original Instructions

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SF- Black Widow Engine Dynamometer

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Please keep this manual for future reference.

This manual is intended to assist operating personnel in becoming familiar with the product and as guidance in ordering necessary parts inclusive of SuperFlow's warranty requirements. Maximum operating efficiency and life of any SuperFlow product will be attained through complete understanding of the instructions and recommendations contained within this manual.

⚠ WARNING

Services performed beyond preventive maintenance by personnel other than SuperFlow Service Technicians on any SuperFlow products during the warranty period may void the warranty.

IMPORTANT

When available, please include the model number and serial number of the product in any correspondence.

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1.0 Introduction

1.1 About This Manual

This manual is provided as a reference to explain the operation of the SuperFlow dynamometer system as used on any engine test system and also covers the operation and maintenance of the SuperFlow engine test stand.

An electronic PDF copy of this manual is provided on the system configuration thumb-drive sent with the SuperFlow system.

IMPORTANT
Please read the complete manual in detail, prior to operating the dynamometer. Contact SuperFlow immediately if you experience problems to avoid any warranty issues.

1.2 Target Audience

This manual is intended to be used by skilled operators trained in the operation of the equipment by a SuperFlow representative.

1.3 Product Features

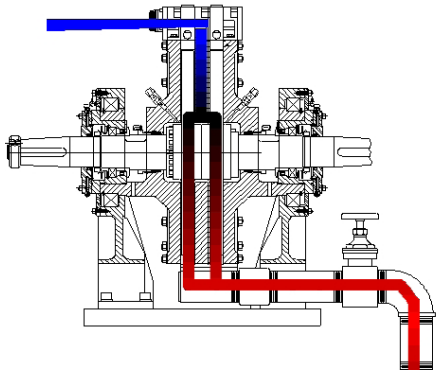
- A system consists of two major components:
  - Dynamometer stand with a Power Absorption Unit (PAU)
  - Data Acquisition and Control (DAC) system – Computer system with WinDyn software.

1.0 Introduction

1.4 Principles of Water Brake Dynamometer Operation

An engine dynamometer is a service tool that allows the operator to safely place a controlled load on an engine. A loaded engine test is the only method of verifying engine capability. With the use of a dyno, an engine can be properly operated throughout its power range without being placed into service. Assembly deficiencies may be detected before the engine is installed into a chassis and an actual evaluation of an engine's operating condition may be performed. The dynamometer is the final quality test before an engine is installed.

A dynamometer has two major components: the absorption unit and the torque indication system. A water brake dynamometer uses an absorption unit (absorber) to absorb power through momentum exchange; using water as the working fluid. A water brake absorber consists of one or more shaft mounted rotors and at least two stators (or end bells). The rotors spin freely inside the absorber housing in the absence of water. When water is introduced into the absorber, the spinning rotor accelerates the water and "throws" it into the stators. If the stators weren't restrained, they would also begin to rotate, similar to a torque converter. But the stators are restrained using a torque arm that is connected to a load cell.



The load cell measures the force with which the stators are trying to rotate. By knowing the distance from the axis of the absorber to the torque arm, torque can be measured by: T = F x d

If we measure speed, horsepower can then be found by the relationship: HP = (T x rpm)/5252
The amount of load absorbed is proportional to the volume of water inside the absorber housing. The water is ultimately absorbing all of the horsepower in the form of heat, therefore the warm water must be exhausted and replenished with cool water to avoid boiling. By restricting the exhaust and controlling the flow of water through the absorber, the volume of water inside, and therefore the load, can be precisely controlled.

2.0 Safety Guidelines

Safety is the most important consideration when operating any dynamometer system. Operators and service personnel should read this manual and become familiar with its content before attempting to operate this machine or to perform service or maintenance to it. Familiarization with this manual will minimize the possibility of accidents or injuries. Although the procedures covered in this manual have proven safe in use, Power Test assumes no responsibility for personal injury or damage to equipment resulting from its applications. All operators must be aware that there are several hazards present to anyone in the test cell. Some of these hazards are:

- Objects rotating at high speeds
- Electrical shock
- Noise
- Pressurized hoses
- Flammable liquids
- Hot solids or liquids
- Exhaust emissions

Certain precautions must be exercised. They are:

- DO NOT operate without ALL shields, guards, and emergency cutoffs in place and operating.
- DO NOT enter the test cell during an engine test unless necessary.
- DO NOT wear loose fitting clothing in the test cell.
- Warning decals are located near areas of potential danger. Replace damaged or lost decals.
- DO NOT make any connections while power is applied to the system.
- DO NOT open any panels while power is applied to the system.
- DO NOT make any plumbing connections without shutting down all water supplies and pumps.
- DO bleed air pressure from all lines before connecting or disconnecting any air hoses.
- ALWAYS wear eye protection.
- ALWAYS wear eye and hearing protection whenever the engine is operating.
- ALWAYS keep work area clean. If a spill occurs, eliminate the hazard immediately.
- NO smoking or open flame in the test area.

These are general guidelines for working with a dynamometer system. It is often helpful to prepare a safety checklist that is distributed to all personnel who enter the test cell. Proper safety is achieved through reinforcement and discipline.

This manual places safety concerns into four categories, they are:

⚠ DANGER

This is the highest level statement. Failure to follow the listed instructions will most likely result in severe injury or death.

⚠ CAUTION

The statements used with this level of warning deal with a safe operating procedure. If they are ignored the possibility of equipment damage or personal injury may exist.

⚠ WARNING

This is a statement of serious hazard. Failure to follow the listed instructions could place the individual at risk of serious injury or death.

IMPORTANT

IMPORTANT indicates precautions relating to operation or usage of the machine or highlights important information on a page.

2.0 Safety Guidelines

The following universal warning decals can be found in the appropriate locations on your equipment. A description of each warning decal is provided below. In addition, these symbols will appear throughout the manual in sections where these hazards may be encountered.

Refer to Manual
- Read and understand manual before operation.
- Failure to understand manual may result in personal injury and/or death.

Wear Eye and Hearing Protection
- Rotating components could cause flying debris.
- Noise levels can reach up to 85 decibels (dB) during maching operation.

Warning
- General warning label.
- Indicates an imminent hazard.

Entanglement Hazard
- Keep hands and arms free of rotating shaft.
- Ensure system has stopped and starting has been disabled prior to servicing.
- Do not operate without all guards and covers in place.

Automatic Starting Hazard
- Equipment can be started remotely.
- Ensure dynamometer system starting has been disabled prior to servicing.

Burn Hazard
- Hot components, water and/or oil.
- Do not touch during operation or while cooling.
- Allow to cool before disconnecting.

Electric Shock
- Exercise caution when working on or nearby. Make certain that power has been disconnected and all residual voltage has been taken under consideration. Unqualified personnel should never attempt electrical work.

Electrostatic Discharge
- Printed Circuit Boards (PCBs) and other electronic devices contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.
- Discharge body static before handling electronic devices.
- Use wrist or ankle straps to contact a grounded surface and maintain contact while handling electronic devices.
- Turn power to the device OFF before disconnecting or connecting cables or wires.
- Do not touch the components or conductors on a PCB with your hands or with conductive devices

Carbon Monoxide (CO) Hazard
- Engine exhaust contains carbon monoxide fumes, be sure test cell is properly ventilated
- If anyone shows signs of carbon monoxide poisoning, get them to fresh air. Fumes can cause headache, dizziness, lack of consciousness and/or death.

Contact Power Test if you have any questions about the safe operations of our equipment and for service and advice.

2.0 Safety Guidelines

2.1 At Installation

⚠ WARNING

- **Do NOT lift the dynamometer by the input shaft. This may damage the dynamometer and void its warranty.**
- **ONLY lift the dynamometer between the absorber and pillow block assemblies with cloth slings. See Figure 4.3**

⚠ CAUTION

- **Take care that the dynamometer is not dropped or set down sharply. This could cause damage to the bearing races and brinelling of the bearings.**
- **The load cell should be handled with equal care. Distortion of this cell will hinder its proper operation.**

2.2 During Operation

⚠ DANGER

- **Extreme care should be taken in the area of the drive shaft that connects the engine to the dynamometer.**
- **All rotating parts must have their guards secured in place.**
- **A drive shaft is considered the fuse in the test setup. In the event of a failure in the engine or dynamometer, the shaft may break. This will save on costly repairs to an engine or dynamometer. However, because of this possible failure, the machine should NEVER be operated without a shaft guard.**

⚠ DANGER

- **Engine exhaust contains carbon monoxide fumes, be sure test cell is properly ventilated**
- **If anyone shows signs of carbon monoxide poisoning, get them to fresh air. Fumes can cause headache, dizziness, lack of consciousness and/or death.**

⚠ WARNING

WEAR EYE and HEARING PROTECTION. Proper eye and hearing protection should be worn at all times when the equipment is operating.

⚠ WARNING

AUTOMATIC STARTING HAZARD.
The dynamometer could be started remotely if equipped with an Air Starter. Ensure starting has been disabled prior to servicing.

⚠ WARNING

BURN HAZARD.
During operation water temperature inside the dynamometer can reach over 125° F. Do NOT touch discharge water, piping or the dynamometer surface during operation. Allow to cool before servicing.

2.0 Safety Guidelines

⚠ WARNING

- **Inspect the equipment monthly to ensure that there are no broken or worn parts which could cause injury to personnel or damage to the equipment.**
- **Only qualified operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ CAUTION

- **Personnel should NOT be in the test cell during operation and observation areas MUST be constructed to protected personnel.**
- **Personnel and other equipment should be kept clear of the drive shaft guard area and NEVER cause an obstruction or block doorways.**

IMPORTANT

The dynamometer is a tool. All personnel should be kept clear of the area and only be in the test area on a "need to be" basis.

2.3 Lockout/Tagout Procedures

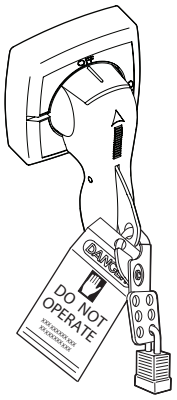


Figure 2.1: Lockout/Tagout

⚠ WARNING

When working with electrical or electronic controls, make sure that the power source has been locked out and tagged out according to OSHA regulations and approved local electrical codes.

The Occupational Safety and Health Administration (OSHA) requires, in addition to posting safety warnings and barricading the work area (including, but not limited to, control room and testing bay), that the power supply has been locked in the OFF position or disconnected. It is mandatory that an approved lockout device is utilized. An example of a lockout device is illustrated in figure 2.1. The proper lockout procedure requires that the person responsible for the repairs is the only person who has the ability to remove the lockout device.

In addition to the lockout device, it is also a requirement to tag the power control in a manner that will clearly note that repairs are under way and state who is responsible for the lockout condition. Tagout devices have to be constructed and printed so that exposure to weather conditions, or wet and damp locations, will not cause the tag to deteriorate or become unreadable.

Power Test does not recommend any particular lockout device, but recommends the utilization of an OSHA approved device (refer to OSHA regulation 1910.147). Power Test also recommends the review and implementation of an entire safety program for the Control of Hazardous Energy (Lockout/Tagout). These regulations are available through OSHA publication 3120.

3.0 System Overview

3.1 Overview

The WinDyn dynamometer system is an instrumentation package designed for complete test control and data acquisition of an engine or chassis dynamometer. Typical applications include:

- Research and development (R&D)
- Performance testing
- Durability and quality control testing
- Fuel consumption and emissions testing
- Education
- Certification testing

You can configure WinDyn for your specific testing needs and can expand it with additional data acquisition capabilities and interfaces as needed. For highest productivity, you can share test data over a facility computer network.

A dynamometer system consists primarily of two major components: the Power Absorption Unit (PAU) on a stand with its associated equipment, and the Data Acquisition and Control (DAC) system with its associated accessories.

- The PAU (or absorber) can be a SuperFlow water brake or a water brake absorber from a different manufacturer, or it can be an electric eddy current (EC) absorber. The absorber stand also holds auxiliary equipment such as a fuel delivery and flow measurement system, a water supply and drain tank, an engine cooling system, a battery or other power source, and a throttle control actuator.
- The DAC system is made of the Central Processing Unit (CPU), an operator control interface, a device to control the load applied to the absorber, and a network of sensors to collect data from the absorber and the engine. The WinDyn software on a stand-alone Personal Computer (PC) allows users to display and analyze the data during and after a test.

The purpose of using a dynamometer is to test the load capability of an engine prior to putting it back in service. It allows for the break-in of a new or newly rebuilt engine in a controllable environment. Typically the SF-Black Widow system is distributed to racing engine manufactures or rebuilders. They have proven this type of break-in procedure through many years of experience. Properly run-in engines last longer, run better and cost less to maintain.

3.0 System Overview

3.2 Dynamometer

The dynamometer stand provides all of the connections from the sensors to the data acquisition system and the mount for the power absorber.

SF-Black Widow

The SF-Black Widow system utilizes a floor-mounted absorber stand and a roll-around engine docking cart to maximize test efficiency in high-volume environments. The versatile docking engine carts are used to pre-stage and dress the engines before they are installed in the test cell. The dynamometer stays in the test cell connected to all its supply lines and support systems. Roll the engine into the cell, dock the cart to the dyno, and attach the fuel supply, airflow turbine, oil and coolant lines, and sensors. The cart is clamped to the absorber stand for testing.

The boom provides clean routing of cables, fuel lines, and cooling pipes. It keeps all the accessories and engine support lines close and available when needed.

The docking cart and boom system keep the test cell safe, organized, and attractive while allowing rapid engine changes. Additional mounts for ignition boxes and work tools can be added if desired. Optional features include cooling flow measurement, and temperature control on oil and engine coolant.

Specifications

- Absorber Type: Water brake
- Maximum Absorber Speed: 11,000 rpm
- Horespower Capacity: 3,000 hp (2,237 kW)
- Torque Capacity: 2,500 lb.-ft. (3,390 Nm)

Water Quality

The quality of the water used in a dynamometer affects absorber and water pump operation. Contamination, salt water, or water with a high mineral count can reduce their life and increase maintenance costs. The load control valve and water seals in the absorber can quickly deteriorate with bad water. Provisions should be made to prevent the growth of algae and bacteria, as well as corrosion or scale formation within the equipment. Water system maintenance is essential to efficient operation, consult a water system specialist to create the proper program to monitor your system.

Filters:

For both open water and recirculating systems, install a filter to clean the water before it enters the dynamometer and engine cooling tower. Install a differential pressure gauge across the filter to determine when the filter needs cleaning. The water should be filtered to remove 0.004- inch diameter particles [100 microns]. In recirculating systems, a filter installed on the return water line back to the supply tank helps keep particles from the engine and dynamometer from getting into the supply water system.

3.0 System Overview

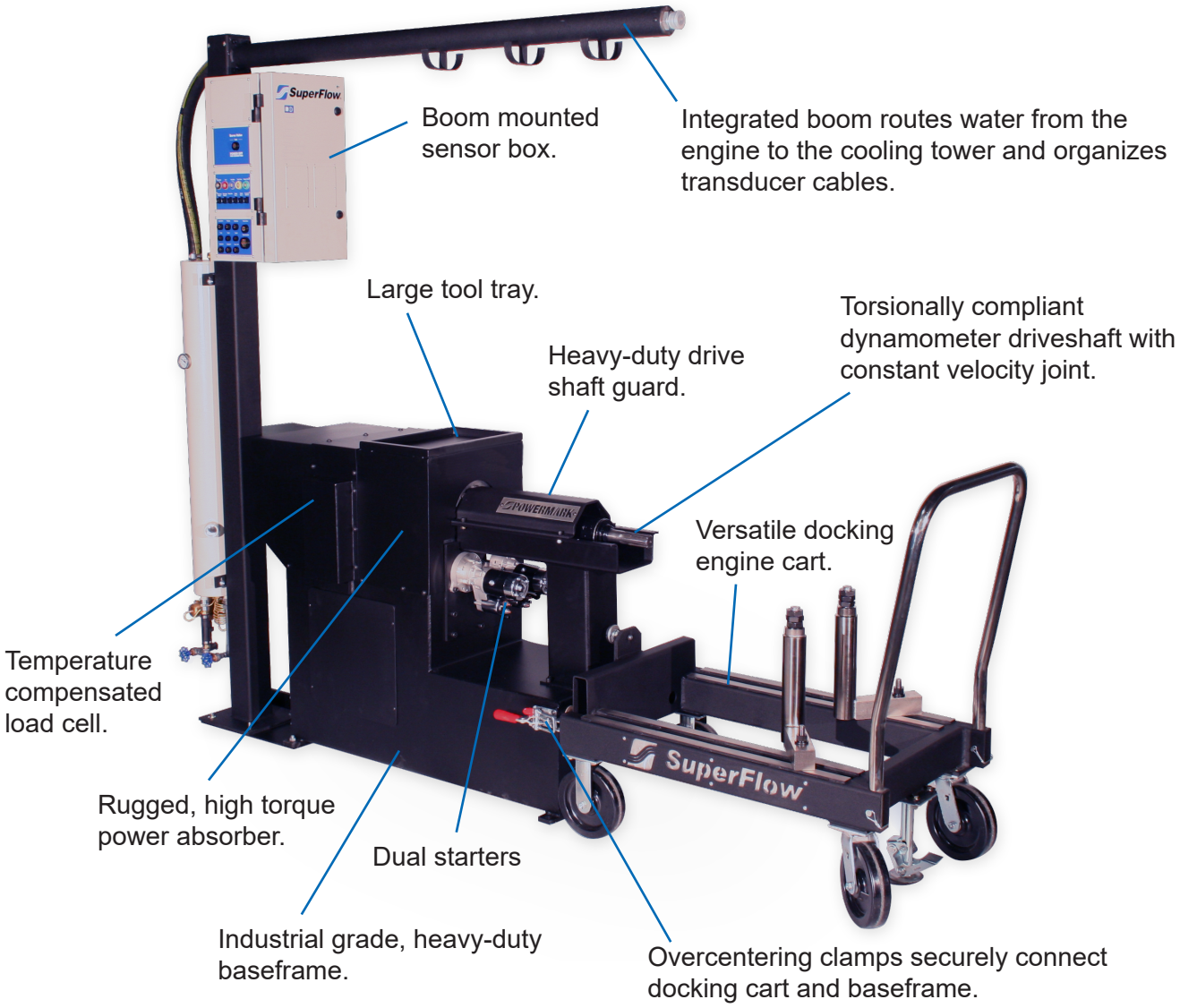


Figure 3.1:SF-Black Widow Engine / Absorber Stand

3.0 System Overview

3.3 Date Acquisition

Components

A WinDyn data acquisition system consists of at least two components. They are the sensor system and the computer system.

NOTE: Additional options and accessories that can be added to the system are described later in this chapter.

The Sensor Box

The sensor box consists of a set of data acquisition and control electronics mounted inside a sheet metal sensor box and is the central core of data acquisition. The box is normally mounted on the absorber stand but can be installed on a boom, the wall, a rolling stand, or on other support apparatus.

The sensor box contains the CPU circuit card, sensor panels, and system interconnect panels.

The CPU measures and records all data and generates control signals, then broadcasts this data over an Ethernet network to display on the WinDyn computer software.

The sensor box has slots for expansion panels such as thermocouple panels, pressure panels, analog inputs panels, and so on.

The system inputs signals from various sensors and converts those signals into a digital format. Airflow, fuel flow, and engine speed are measured as frequencies. A load cell measures torque as an analog voltage. Pressures and temperatures are also measured as analog voltage. A barometric pressure transducer is mounted on the CPU to measure atmospheric conditions during the test. Other sensors can be added as needed.

Figure 3.2: The Sensor Box

IMPORTANT
Do NOT adjust any of the potentiometers on the 2640 board. Contact your representative if you have any questions about the safe operations of our equipment and for service and advice.

3.0 System Overview

The Computer System

The computer system consists of a standard computer with up to three monitors installed, a color printer, and WinDyn dynamometer software. Other than the network connection and minimum performance specifications, no special requirements must be met.

SuperFlow's WinDyn dynamometer software was designed for Microsoft® Windows®-based computers.

The computer communicates with the sensor system through an Ethernet Local Area Network (LAN) cable. Commands to the test system can only be issued from this computer.

All printers supported by Windows can be used. A color printer is recommended for highest impact and clarity of test graphs. The printer is connected to the computer.

Figure 3.3: Operator Console

IMPORTANT

SuperFlow recommends dedicating the computer connected to the dynamometer for dynamometer use only and not utilizing it for other purposes. Multiple programs and Internet access could possibly slow down the computer and affect the dynamometer operation.

Electrical Requirements

The WinDyn instrumentation system requires a dedicated, stable electrical power source for proper operation. SuperFlow recommends using an Uninterruptible Power Supply (UPS) that has a minimum rating of 750 VA or a high-quality surge suppressor for the sensor box and computer. This may protect the electronics from damage in the event of a power surge and keep the engine running if the power goes out. It is best to connect all instrumentation devices to the same circuit to minimize ground loop noise. Adding devices such as battery chargers and fan motors to the same circuit can cause noise problems.

The total power requirement for a basic instrumentation system is 120V/15A or 240V/8A.

TIP: Your electrician can wire the electrical circuits in your test cell with outlets for the sensor box and computer wired to a special protected circuit.

3.0 System Overview

Sensor Panel Modules

System Interconnect Panel (LEMO)

The system interconnect panel provides the primary connection between the sensor box and the peripheral devices (computer, relay box, etc.). The panel also provides connections for some sensor inputs.

- Color-coded and keyed LEMO connectors
- Brown - Remote handheld controller serial port
- Red - Air sensor frequency inputs
- Blue - Air temperature and humidity sensor inputs
- Yellow - Auxiliary frequency input (Tach./Freq.)
- Green - Engine speed sensor input (May also be used for frequency type devices)
- RJ-45 Category 5 (Cat-5) serial connectors

Figure 3.4: System Interconnect Panel

Sensor Interconnect Panel (AMP)

The sensor interconnect panel provides the primary connections between the sensor box and the dynamometer sensors.

- Absorber speed and torque sensor connections (engine dynos)
- Dynamometer interface (chassis dynos)
- Servo valve connection (engine dynos)
- Electronic throttle connection
- Auxiliary voltage sensor inputs
- Fuel turbine frequency inputs
- Auxiliary control outputs
- Digital input and output connections

Figure 3.5: Sensor Interconnect Panel

NOTE: SuperFlow recommends capping or covering any unused AMP connector.

3.0 System Overview

Thermocouple Input Panel

The thermocouple panel provides 16 channels for temperature measurements on the test device.

- 16 channels per panel
- Type K, (grounded or ungrounded)
- Type K thermocouple range, -454° to 2,300°F (–270° to 1260°C), linearized
- Universal panel jacks accept both standard and miniature connectors

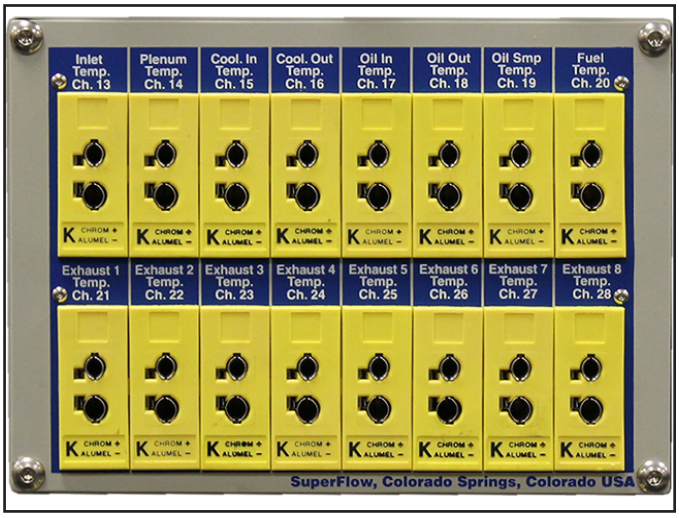


Figure 3.6: Thermocouple Input Panel

Pressure Input Panel

The pressure panel provides up to 10 channels of pressure measurements on the test device. The standard system ships with three channels installed. These are:

- Channels 63, 67 & 68: 0–150 psi [0–1034 kPa]

  63 = Man_P

  67 = Oil_P

  68 = DynWTP

Figure 3.7: Pressure Input Panel

3.0 System Overview

Engine Control Panel

The engine control panel has five outputs electrically controlled by console switches or by programmed test profiles. Four outputs provide 12V switched DC power for ignition, starter, fuel pump, and auxiliary control.

- Internal, automatic reset, 50A thermal breaker on input source, automatic reset, 10-amp polyfuse on ignition output; 14 amps on the starter and fuel pump outputs and 5 amps on the auxiliary output
- Emergency stop functions when used with WinDyn limits or emergency stop switches
- Provides one unswitched, 10-amp, fused 12V connection for external devices
- Connection for remote starter switch

Figure 3.8: Engine Control Panel

⚠ CAUTION

DO NOT use the Magneto Kill Ground connection.

Servo Valve Panels

These panels provide connection plugs for the servo control valve inlet and outlet cables.

Figure 3.9: Servo Valve Input Panel

Figure 3.10: Servo Valve Outlet Panel

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3.0 System Overview

3.4 Accessories and Options

A wide selection of additional sensors, adapters, and engine accessories are available. Contact SuperFlow Sales or Customer Service for additional details.

Analog Voltage Input Panel

The analog voltage panel is an optional accessory that provides up to eight channels of voltage measurements on the test device.

- Eight channels per panel
- Adjustable gain and offset accepts any voltage between –100 and +100 VDC
- Color-coded and keyed 11-pin LEMO connectors

Recommended levels of excitation and reference voltages available on each of the front panel connections for sensors or other devices.

- +5F: +5VDC @ 100 mA, poly-fused at 0.1A
- +12F: +12VDC @ 500 mA, poly-fused at 0.5A
-

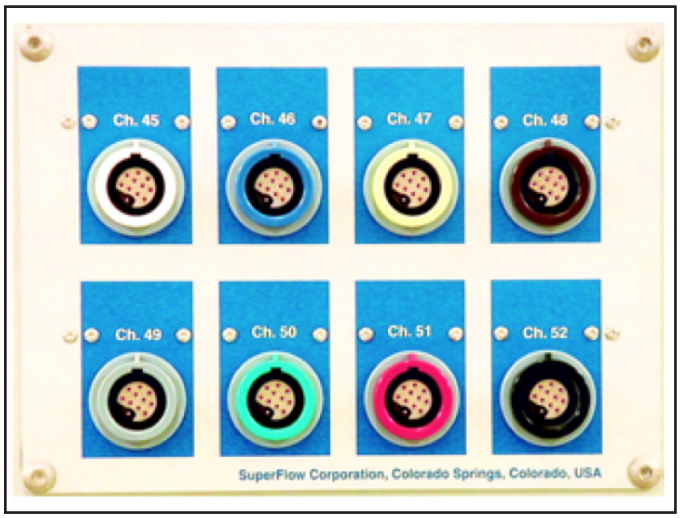


Figure 3.11: Analog Voltage Input Panel

Air Fuel Kit

AEM's 4-Channel Wideband UEGO Controller allows users to simultaneously monitor individual cylinder Air/Fuel Ratios (AFR) on up to four cylinders. Pair multiple units together for use on 6, 8, 10 or 12 cylinders.

- Allows for monitoring of individual cylinder AFRs for maximum engine power and safety
- Two status lights per sensor for error detection and operating status
- Compact (4.8" x 4.55" x 1.44"), weather & shock proof enclosure
- Accurate to 0.1 AFR
- Refer to the AEM Performance Electronics Wideband UEGO Controller instruction manual for detailed information.

Figure 3.12: Air/Fuel Monitor

3.0 System Overview

Fuel System

The fuel system consists of a high performance fuel pump and fuel regulators to provide two measured and regulated engine fuel channels. The system is rated up to 800 lbs/hr total delivery with both channels used.

- Range per channel @ 7psi: 0–400 lb/hr (100 g/s) x 0.1 ± 0.5% fs
- Specific gravity range: 0.40–1.40

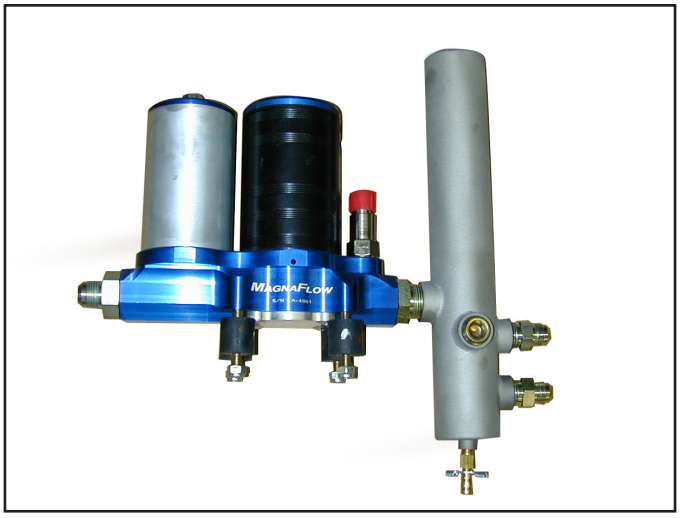


Figure 3.13: Fuel System

Fuel Canister

Designed to measure fuel consumption of fuel injected engines.

- Mid flow unit available in 20 – 720 lb./hr.
- High flow unit available in 30 -1070 lb./hr.
- Available for gas and alcohol.

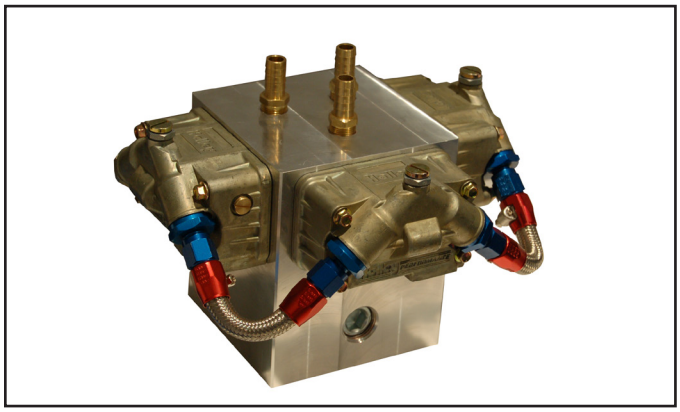


Figure 3.14: Fuel Canister

3.0 System Overview

Oil Coolers

A constant engine temperature is vital in dynamometer testing, especially during endurance tests. Figure 3.15 shows a multi-pass heat exchanger with the water inlet controlled by a mechanical thermostat valve. It can be mounted on the absorber stand, the engine cart, or in an alternative convenient location.

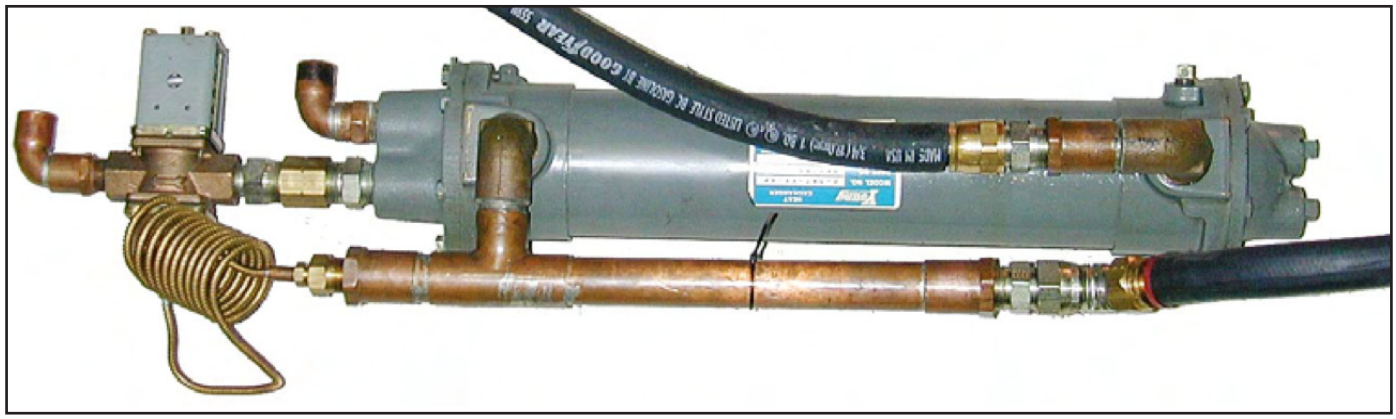
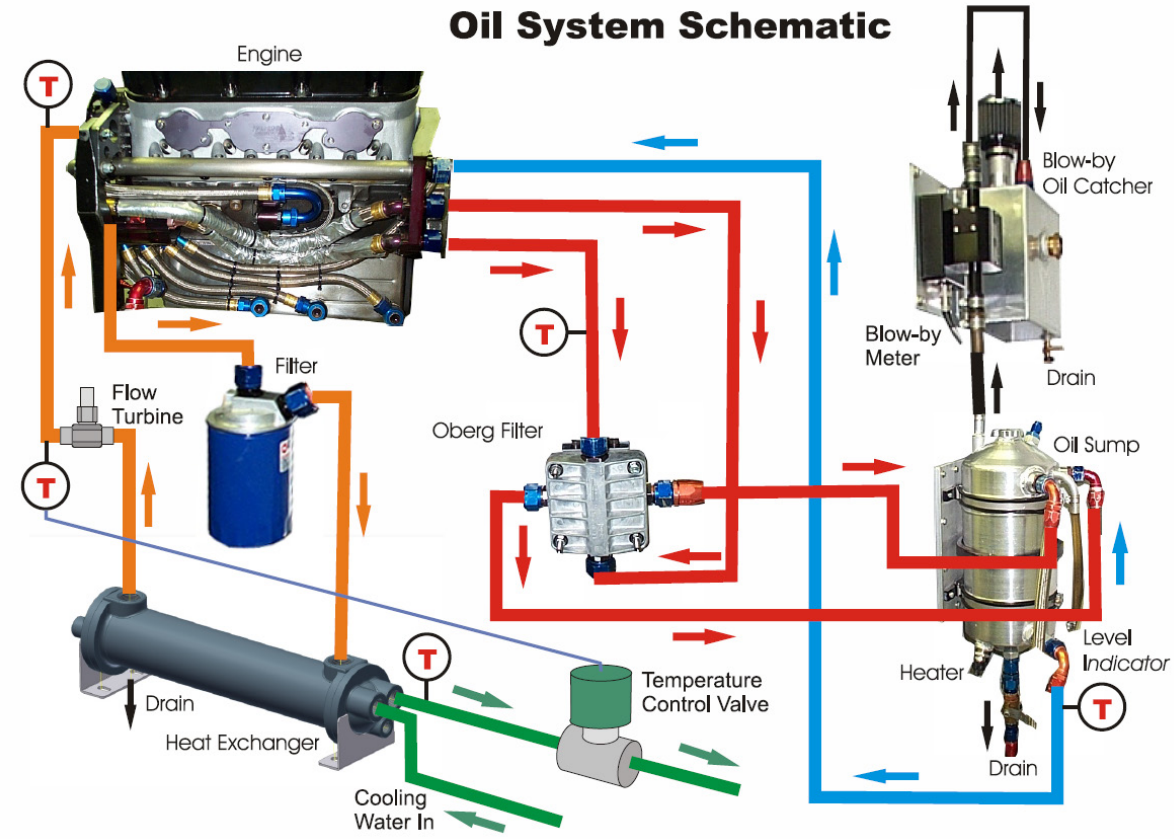


Figure 3.15: Oil Cooler



3.0 System Overview

Engine Cooling Towers

The cooling tower replaces the radiator for water-cooled engines (see Figures 3.16 and 3.17). The thermostat on the cooling tower can be set to control the engine water temperature to a specific setting. The CT700-NOP cooling tower is mounted on the boom support assembly.

The standard CT700-NOP cooling tower controls the engine coolant temperature to between 115° and 185°F (46° and 85°C) and is non-pressurized. It is easy to operate and maintain because it uses the same water for both the engine and the absorber.

Use the optional pressurized CT300P, CT700, or CT1001 cooling towers for higher temperatures (160/ 230°F, 71/110°C) or with antifreeze mixtures. Pressurized cooling towers have separate chambers for engine cooling water and heat exchanger cooling water so you can use Glycol solutions in the engine without having to add Glycol to the dyno water supply. A pressurized cooling tower makes it easier to detect head gasket leaks and provides better temperature stability.

A temperature gauge on the cooling tower monitors the cooling tower conditions. The CT300, CT700, and CT1001 also have a pressure gauge. The temperature and pressure measurements for all four cooling towers can be integrated into the data acquisition system.

Figure 3.16: CT700-NOP Boom Mounted Engine Cooling Tower

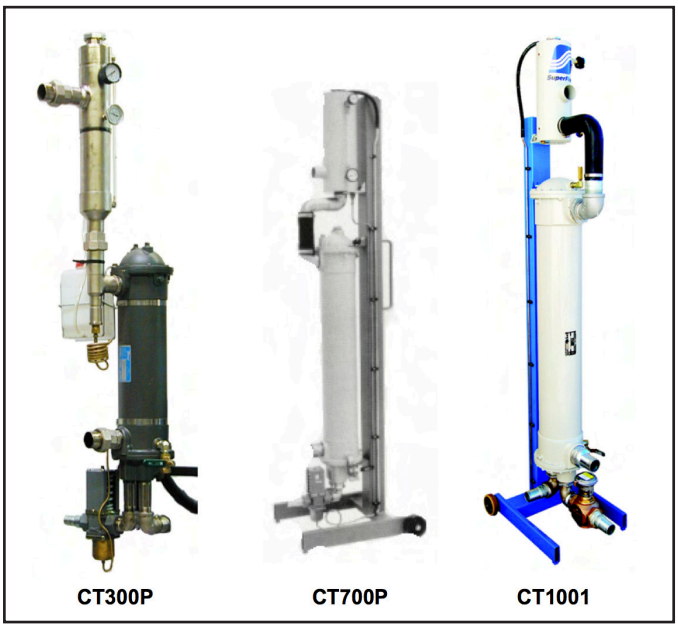
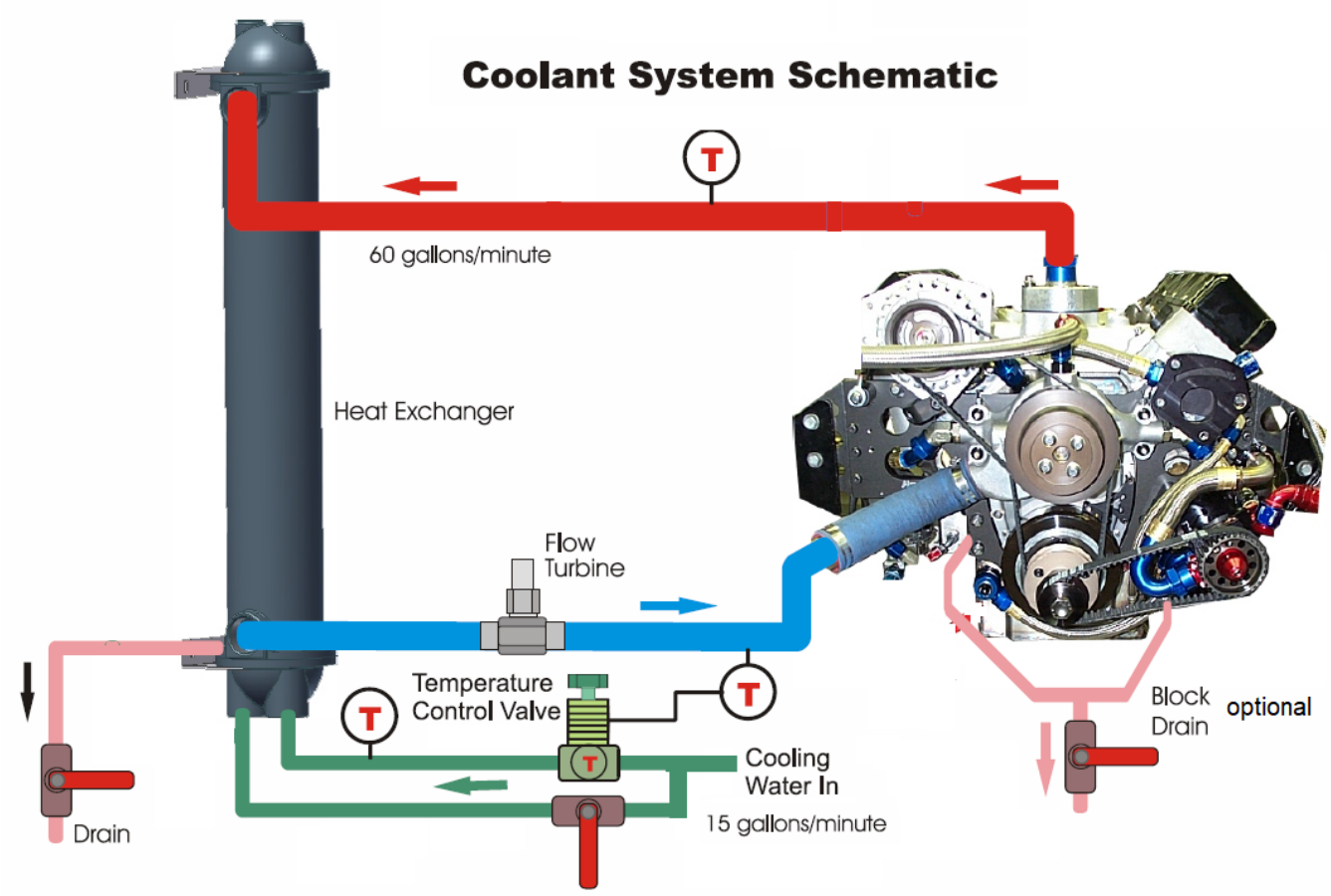


Figure 3.17: Engine Cooling Towers

3.0 System Overview



Volumetric Blow-by

The JTEC VF563 series flow meter provides exceptional accuracy. The sensor measures the volumetric gas flow by means of vortex sensing. A small strut inside the flow tube creates Karman vortices which are measured by an ultrasonic beam directly across the tube. Because the vortex frequency is only a function of the gas velocity, the detected rate is a direct measure of gas velocity and therefore volume flow. Each device is individually calibrated with National Institute of Standards and Technology (NIST) traceable nozzles.

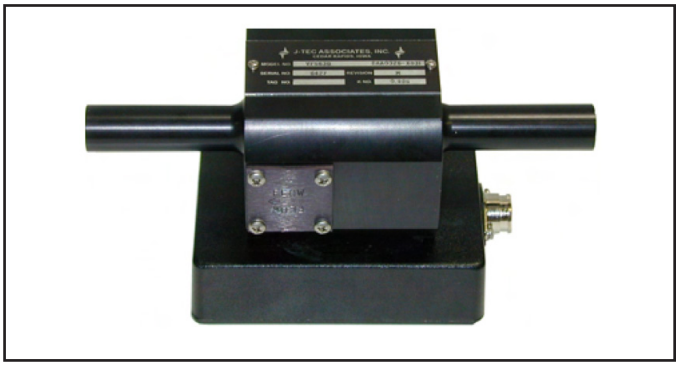


Figure 3.18: Blow-by Sensor

Additional Docking Cart

An extra docking cart to save time between engine tests. Pre-stage one engine while another is being tested.

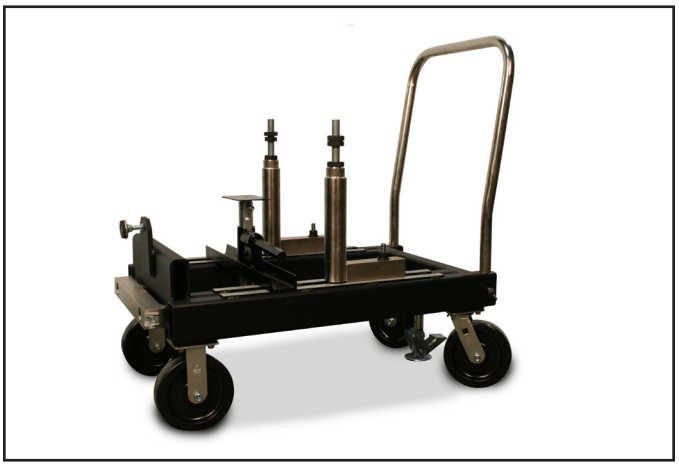


Figure 3.19: Docking Cart

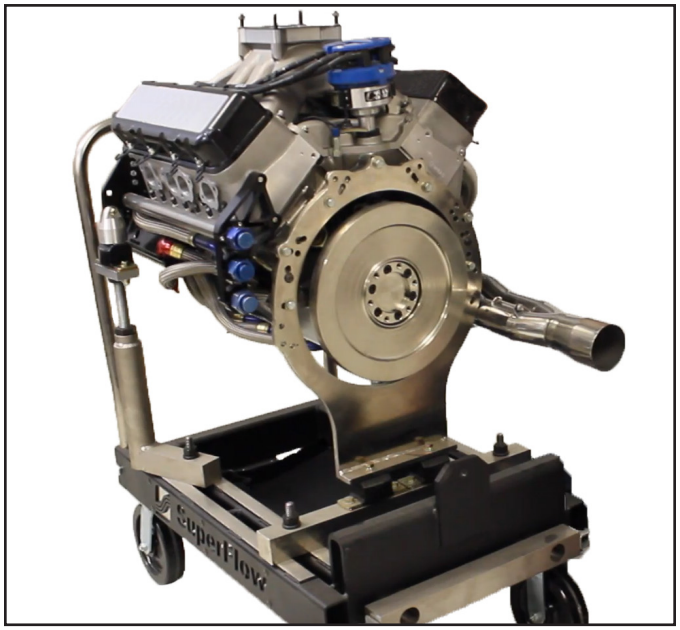


Figure 3.20: Engine On Docking Cart

4.0 Installation

4.1 Location

Location and positioning of the dynamometer is an important factor in creating a functional, easy-to-use test cell. The following guidelines have been provided to assist in positioning your dynamometer:

- The engine dynamometer test cell should be located in an area that is easily accessible from the rebuild area.
- The dynamometer should be located in an area where the noise generated by its operation will not interfere with other processes.
- The electrical and mechanical requirements must be mechanically feasible to install.
- Adequate space must be provided for testing operations.

The following is only a suggested room layout. If conflicts arise, local building codes must be followed. Consult your specific room layout drawings for additional details. Contact your Power Test representative should any questions arise concerning the location or installation of your equipment. Dimensions shown are subject to change.

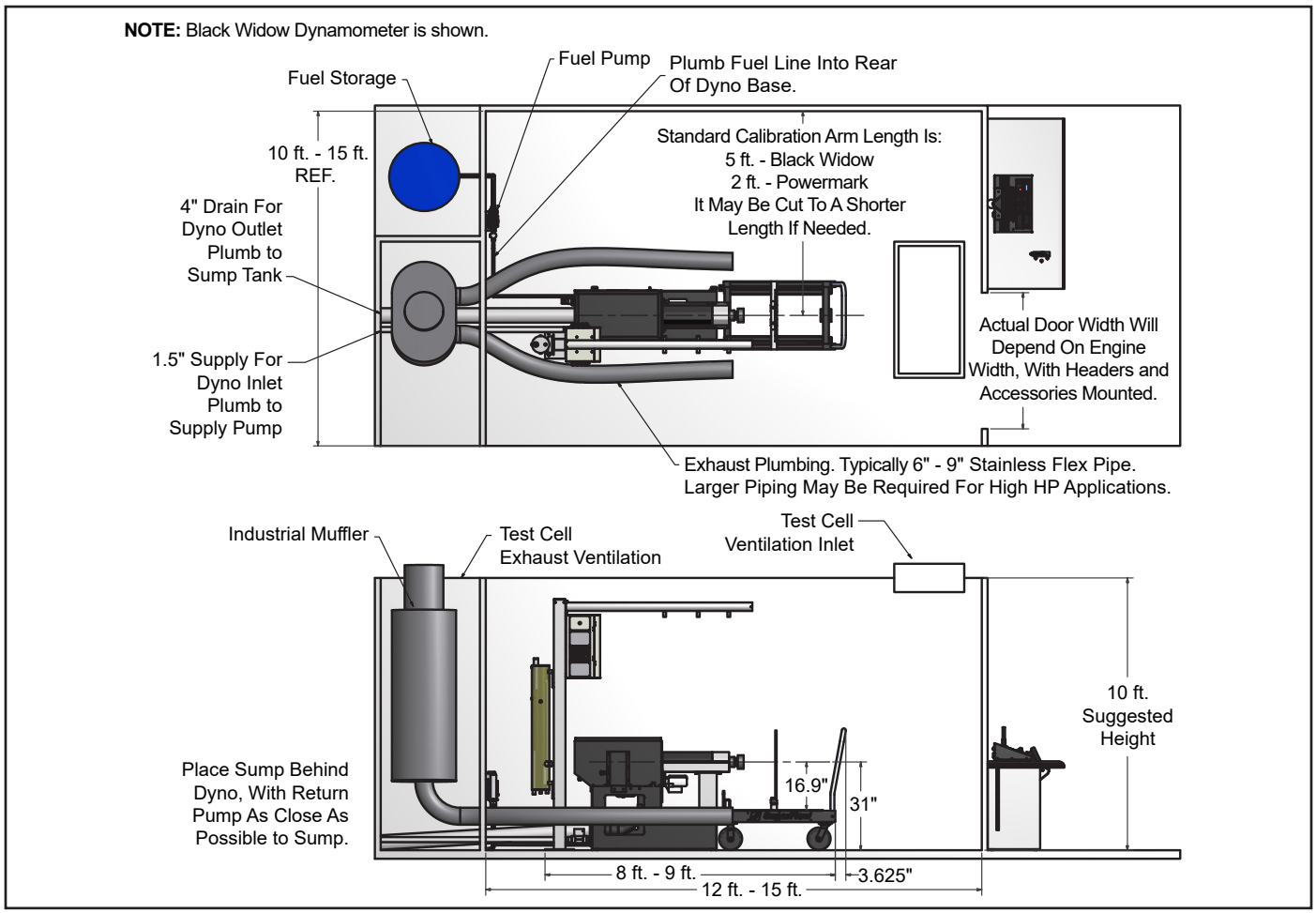


Figure 4.1: Recommended Test Cell Layout

4.0 Installation

4.2 Plumbing Diagram

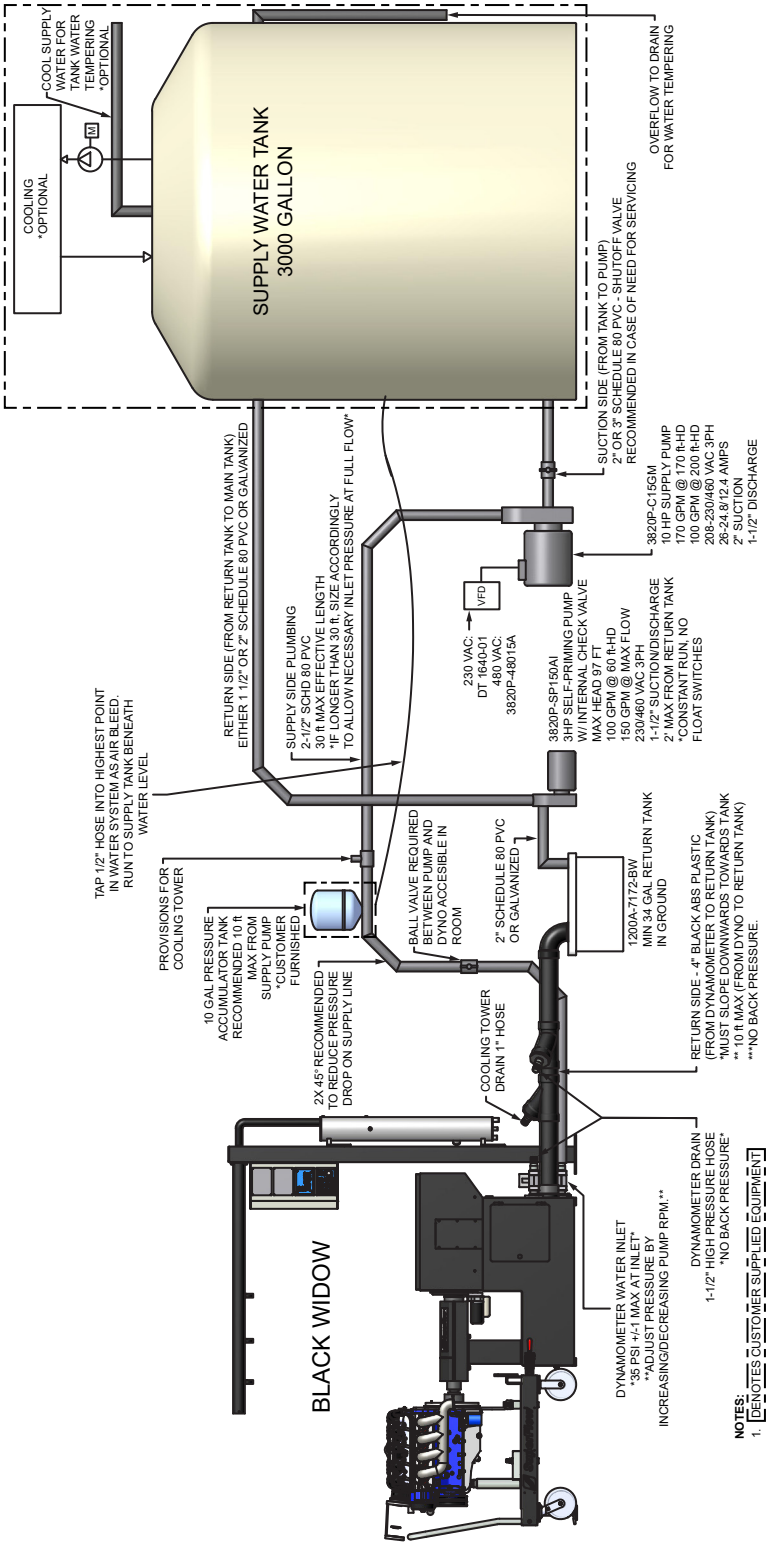


Figure 4.2 SF-Black Widow Plumbing Diagram

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4.0 Installation

4.3 Unpacking

The SF-Black Widow system is shipped partially assembled. Some parts are left off for protection during shipping. Interconnect and sensor cables require installation prior to use.

1. Inspect the crates and boxes for external damage. Be sure to check underneath the crate for possible forklift damage. Report any damage to the shipping company and SuperFlow Customer Service.
2. Remove all components and accessories from the crates or boxes.
3. Inspect all components for loose parts or any damage.
4. Open the rear panel of the operator's console and inspect for loose parts or damage. Ensure that all circuit cards are secure and cables are properly seated in their connectors.
5. Position the sensor box on a stable surface. Locate the sensor box door key. Carefully open the sensor box door, and inspect the inside of the sensor box for any loose parts or visible damage. Ensure all circuit cards are secure and cables are properly seated in their connectors.

⚠ WARNING

HEAVY OBJECTS.
Use lifting aids and proper lifting techniques.

4.4 Engine Docking Cart

The engine cart comes fully assembled except for the support posts and engine mounts.

1. Set the jack post cross-member in place toward the rear (absorber end) of the cart.
2. Install the two engine mount posts, one on each side, toward the front of the cart. Install extension tubes into the posts.

Figure 4.3 Engine Docking Cart

4.0 Installation

4.5 Absorber Stand

The SF-Black Widow stand is designed as a docking system with a boom support frame. The boom system keeps all the accessories and engine support lines close and available when needed. The system keeps the test cell safe, organized, and attractive while allowing rapid engine changes.

1. Position the absorber baseframe and boom stand in a suitable location in the test cell leaving enough space at the front of the baseframe for the engine docking cart, the rear of the boom stand for the exhaust system, and the sides for access to the engine. Position according to Room Layout Drawing (Refer to page 21).
2. Secure the baseframe and boom stand to the floor using floor anchors or other suitable fasteners.

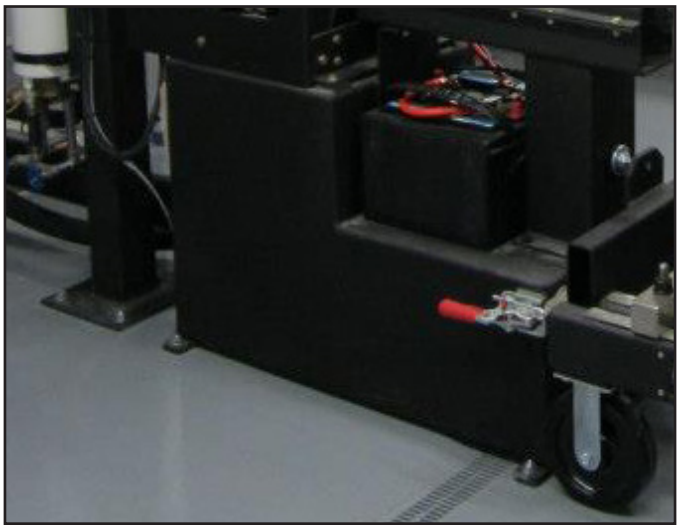


Figure 4.4 Floor Anchors

4.6 Sensor Box

Mount the sensor box on the absorber stand boom. The absorber stand mount makes the sensor connections to the engine easy.

A power cord attaches to the bottom of the box. Electrical power for the sensor box should come from a dedicated, protected line. If desired, a long power cord can be routed into the control room and plugged into the same outlet (UPS or surge suppressor) as the console and computer. Refer to "Electrical Requirements" on page 11.

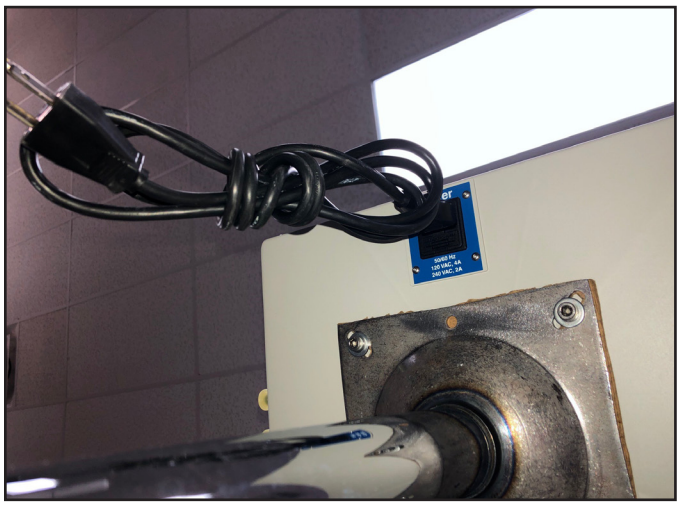


Figure 4.5 Sensor Box Power Cord Connection

4.0 Installation

4.7 Cooling Towers

The engine cooling tower is mounted on the boom support. The two water hoses (supply and drain) must be connected as shown in Figure 4.6.

A thermocouple should be installed on the cooling tower and connected to the Data Acquisition System to monitor and record the cooling temperature with WinDyn. Use the Cool IN channel. A second thermocouple should be installed in the engine water jacket, typically on the intake manifold. Use the Cool OUT channel.

⚠ WARNING

Improper connection of the water inlet and outlet hoses to the CT700-NOP cooling tower can pressurize the system and blow the hoses off the engine which can result in serious equipment damage or bodily injury.

Both the CT300P and CT700P have the cooling water outlet on the thermostat valve which is different than the CT700-NOP. The arrow imprinted on the valve housing indicates the water flow direction.

NOTE: Basic operation instructions for cooling towers is provided in Chapter 5.6.

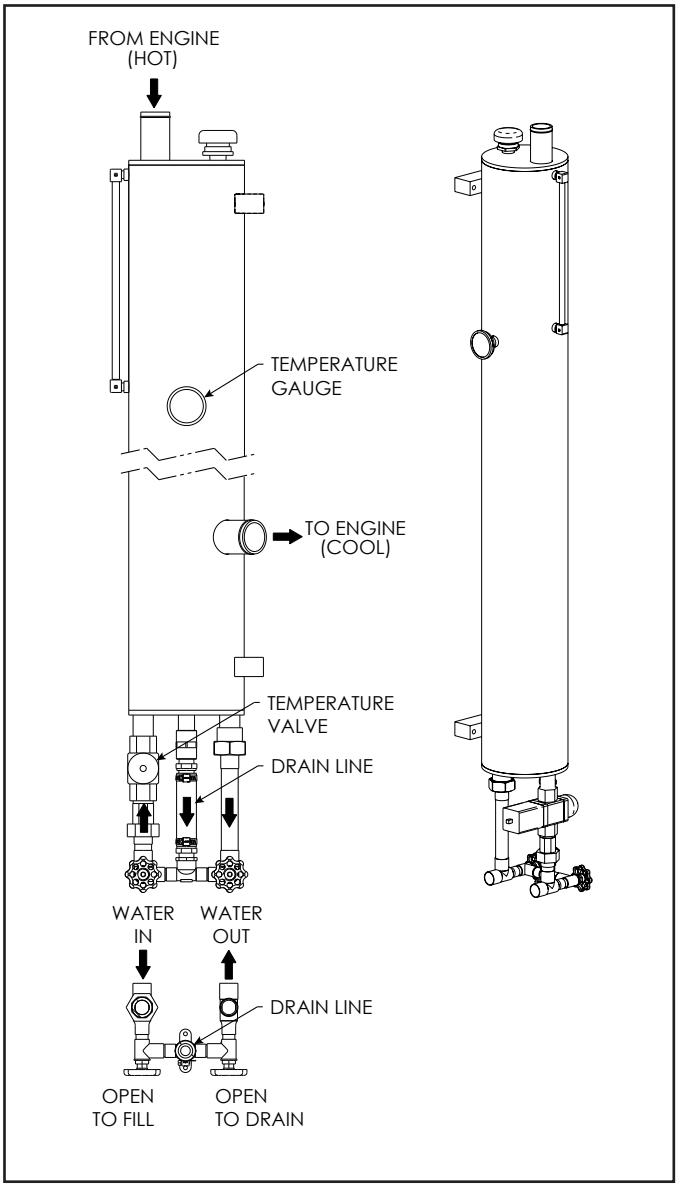


Figure 4.6 CT700-NOP Unpressurized Cooling Tower

4.0 Installation

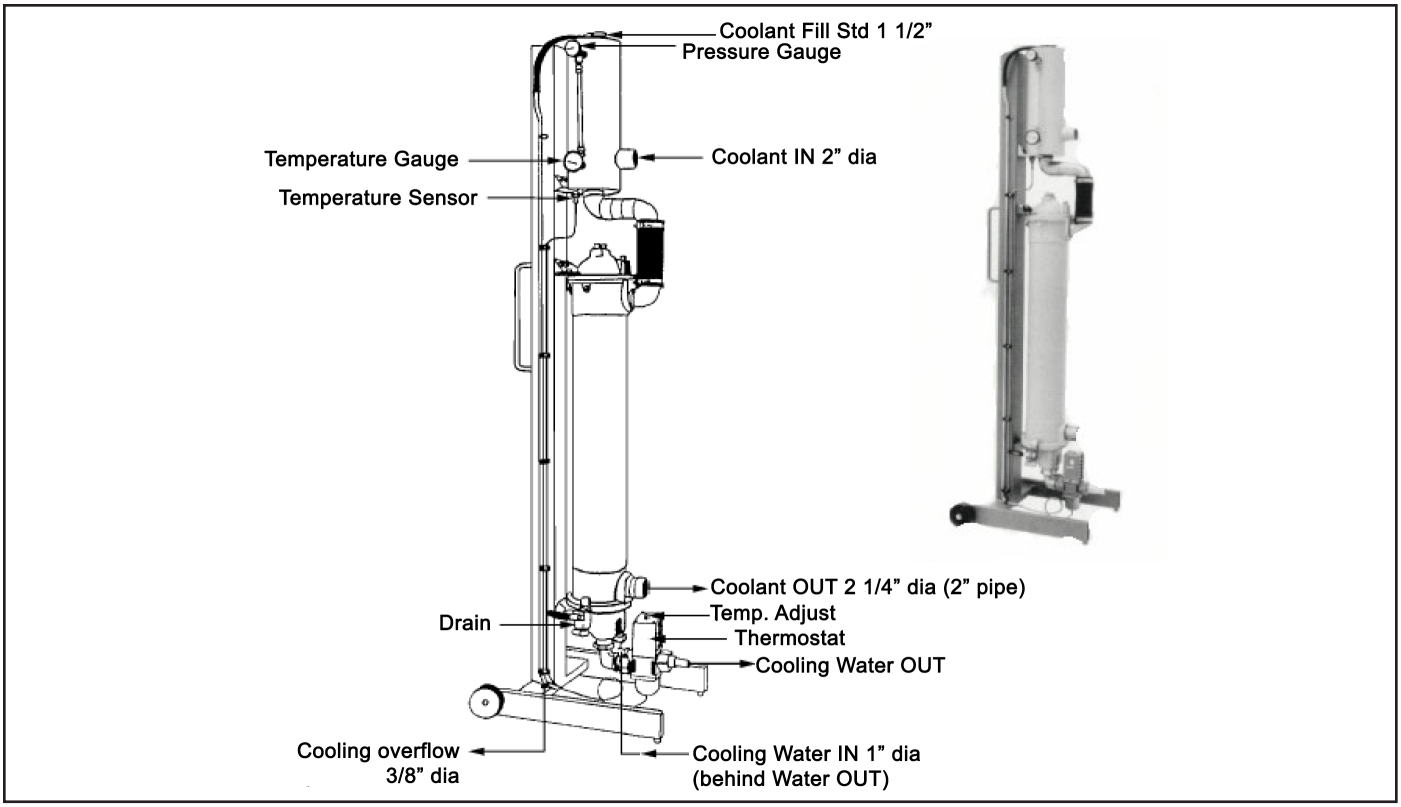
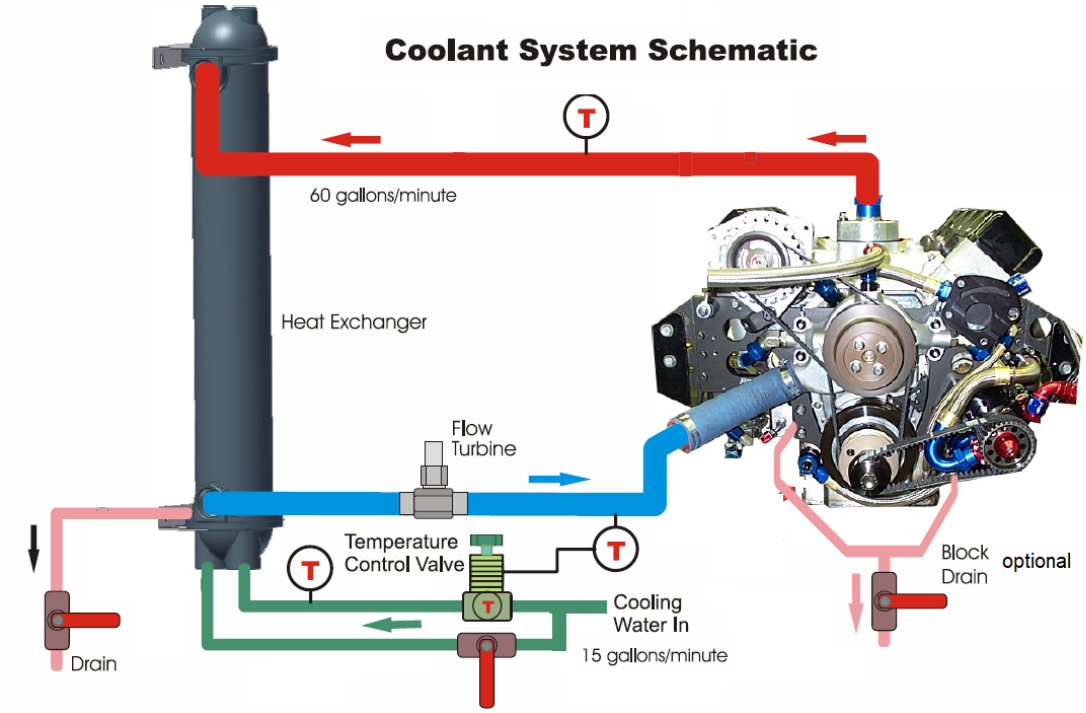


Figure 4.6 CT700P Pressurized Cooling Tower



4.0 Installation

4.8 Computer System

Communication

The computer communicates with the sensor system through an Ethernet Local Area Network (LAN) cable. Connect the Category 5 (Cat-5) network cable from the computer network switch to the RJ-45 connector located on the side of the sensor box labeled Computer Network.

SuperFlow WinDyn 4.0 systems use TCP/IP network protocol. WinDyn 3.2.R2 uses NetBEUI protocol.

Figure 4.7 Network Router

Software

SuperFlow provides a USB thumb-drive containing the WinDyn software. The WinDyn software was installed and configured on your computer system by factory personnel. The thumb-drive is only necessary if you must recover or reinstall the Windyn software. Windyn software is also installed in a SuperFlow System Recovery folder on the computers hard drive, along with manuals and other pertinent documentation.

4.9 System Cable Connections

Open the sensor box. Verify all cables are firmly seated and connected. Close the box, lock it, and put the keys in a safe place.

NOTE: The power supply used in the sensor box and the console is 12 volt switching power supply. Voltage checkpoints for both power supplies are provided on labels affixed to their case. Both use universal input power supplies 100 - 240 VAC.

NOTE: All system cables and their connection ports on the sensor box are labled. The cables are labeled on each end to match the connection port they are to be connected to.

Power

Plug the computer and sensor box power cables into a convenient outlet. The power connection for the sensor box is on the bottom. SuperFlow recommends plugging both units into a suitable surge suppression circuit and using an Uninterruptible Power Supply (UPS) or other power backup for power outages. Refer to "Electrical Requirements" on page 11. There is a 2 amp fuse for current overload protection in the power plug receptacle on the sensor box.

⚠ WARNING

Always turn the power off to the system when plugging or unplugging devices into the sensor box and console.

4.0 Installation

System Interconnect Panel

The system interconnect panel has connections for several different types of sensors and features plus provides the connections to the console and the computer (Figure 4.8).

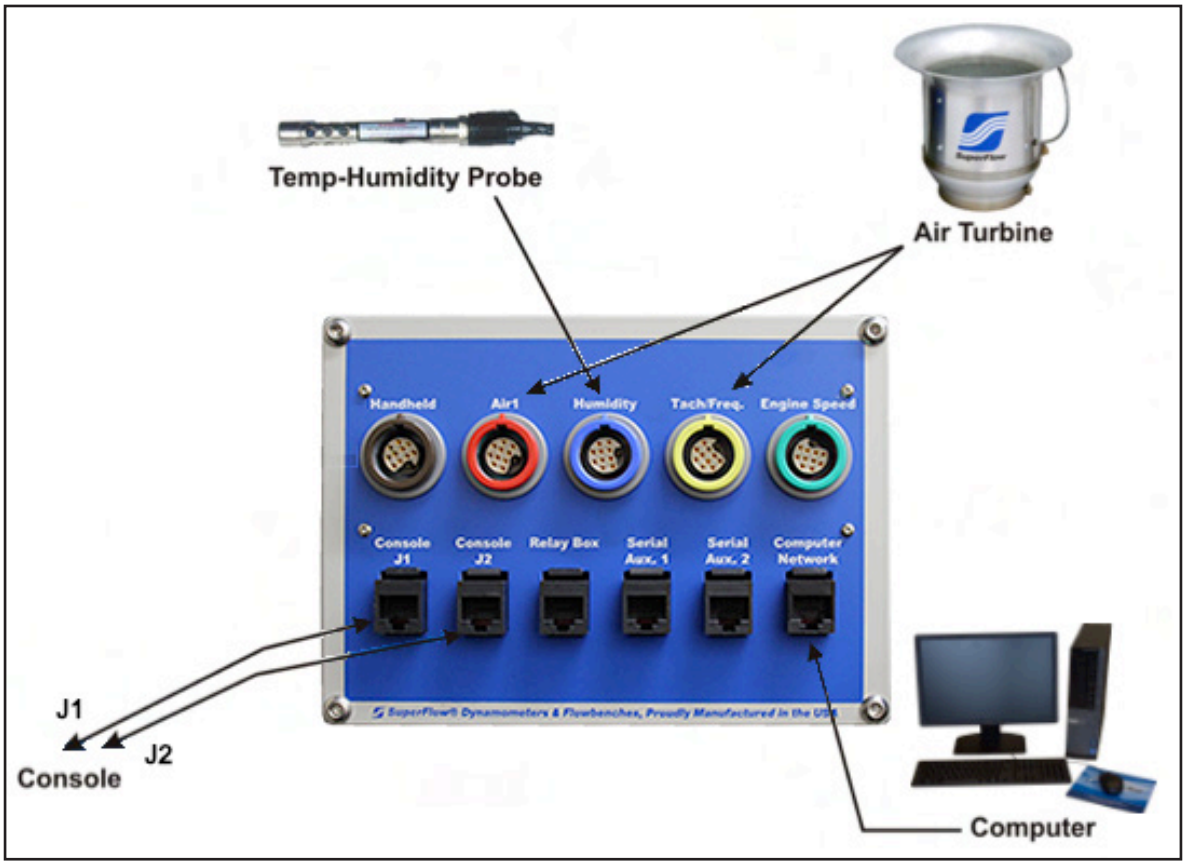


Figure 4.8 System Interconnect Panel

Air 1

SuperFlow airflow measurement turbines are connected to the sensor box system interconnect panel. Use cable 1200A-2044 to connect to the red receptacle labeled Air 1. Calibration tables for each flow turbine are entered in the configuration file. Other TTL or MAG frequency devices can be connected here as well but require modification to the definition of channel 7.

Humidity

The humidity and air temperature probe plugs into the blue receptacle on the sensor box system interconnect panel labeled Humidity. The humidity sensor is sensitive to contamination, so place it in a fresh air stream for the engine intake system and away from potential engine oil, gasoline, and exhaust spray. It is also sensitive to sunlight, so keep it out of direct sunlight.

4.0 Installation

Tach/Freq

A second SuperFlow air turbine can be connected to the yellow receptacle labeled Tach/Freq if desired. Calibration tables for each flow turbine are entered in the configuration file. Other TTL or MAG frequency devices can be connected here as well but require modification to the definition of channel 12.

Engine Speed

Other TTL or MAG frequency devices can be connected here as well but require modification to the definition of channel 11.

Console J1/J2

These connections are used with an operator's console. Cables connected between the console and this panel carry several signals:

⚠ CAUTION

All serial cables should be routed away from any other cables or devices that may produce Radio Frequency (RF) interference such as ignition wires or power cables.

- Serial data: Transmit and receive signals allowing the console to display real-time data from the CPU and control the system from the console.
- Power-on: When the power switch on the console is turned on, the sensor box is also turned on. The push-button power switch on the sensor box should never be used when a console is connected.
- Emergency Stop: When the ES button on the console is pressed, a system ES action initiates.

1. Connect a Cat-5 serial cable (supplied) from the RJ-45 connector J2 on the back of the console to the Console J2 connector on the sensor box system interconnect panel. Make sure the cable is properly secured and protected.
2. Connect a second Cat-5 cable (supplied) from the RJ-45 connector J1 on the back of the console to the Console J1 connector on the sensor box interconnect panel.

Relay Box

A Cat-5 cable connects to the optional SF-1843 relay control enclosure.

Serial Aux 1 & 2

These are for optional serial interface connections.

Computer Network

Connect a Cat-5 shielded Ethernet LAN cable (supplied) from the RJ-45 connector sensor box interconnect labeled Computer Network (Figure 4.8) to the Ethernet router. Connect a cable from the router to the computer network connection port. Do not use the WAN connection on the router.

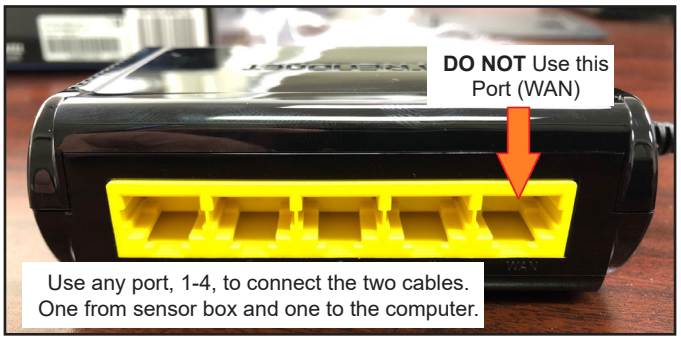
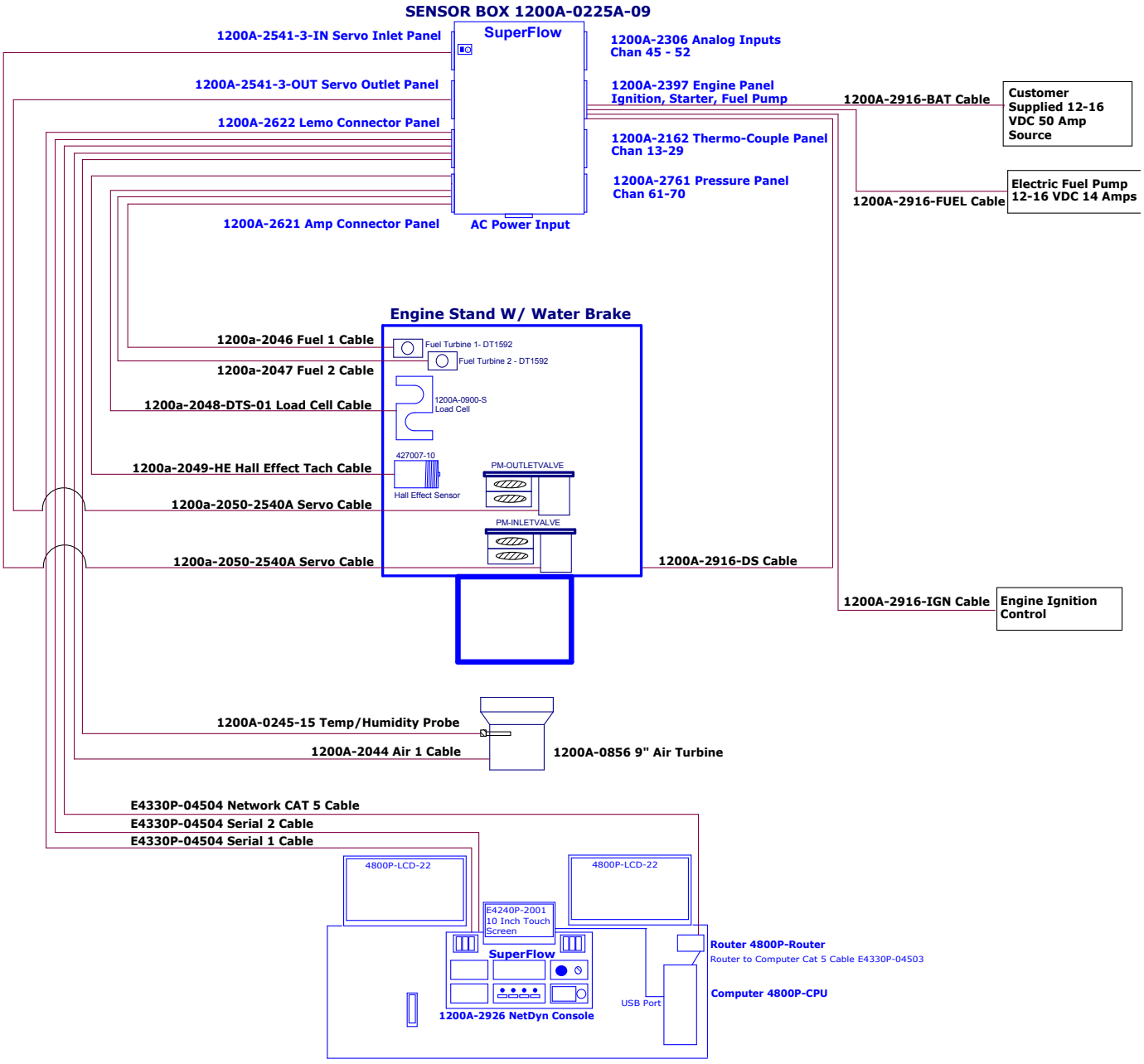


Figure 4.9 Router Connections

4.0 Installation

Electrical Diagram



SuperFlow DYNAMOMETERS & FLOWBENCHES A Division of Power Test, Inc.

4.0 Installation

Sensor Interconnect Panel

The sensor interconnect panel (Figure 4.10) provides connections to the primary sensors and controllers on the dynamometer.

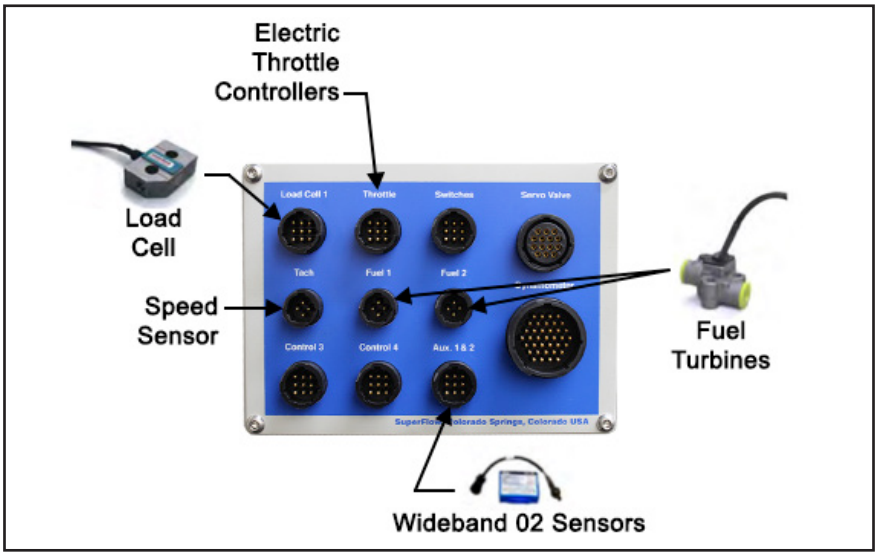


Figure 4.10 Sensor Interconnect Panel

Load Cell 1

Plug the load cell (strain gauge) cable into panel connector marked Load Cell 1.

Tach

Plug the tach sensor cable into the connector labeled Tach. The other end plugs into the absorber speed sensor.

Fuel 1 & Fuel 2

Fuel flow measurement turbines or meters are connected to the sensor box sensor interconnect panel. Connect the cable to Fuel 1 and the cable to Fuel 2. Be certain to plug it into the correct turbine to ensure the calibration matches the turbine. Calibration values for each flow turbine are entered in the configuration file.

Aux 1 & Aux 2

The Auxiliary #1 and Auxiliary #2 inputs are direct (not multiplexed) analog voltage inputs. These inputs are designed for a 0–10 VDC signal and configured for the sensor type in the software. A common application for these inputs is Air/Fuel or lambda sensors. Insert the auxiliary input cable into the connection labeled Aux 1 & 2 on the sensor interconnect panel. This cable splits into multiple connections. Connect other extension cables required for the sensor type used to the other ends of the auxiliary input cable.

NOTE: If your system is utilizing the AEM wideband option, you will not need to use this cable.

This connector is also used to input digital signals for WinDyn off/on indicators from external switches. A cable is available that has the connections for Auxiliary #1 and Auxiliary #2 plus two digital input connections (DI-1 and DI-2).

4.0 Installation

Throttle
If you have the optional electronic actuator, the throttle connector on the sensor interconnect panel connects to an SF-1805 electric throttle controller or other device using a 0–10VDC control signal.

4.11 Expansion Panels

Pressure Connections

Connect the hose to the appropriate pressure source. SuperFlow recommends using reinforced rubber. Stainless steel hoses can be used but have the potential to conduct Radio Frequency Interference (RFI) noise. If used isolate them from the sensor box with short rubber hoses. The standard system comes with #4 AN fittings for channel 63 - Man_P, Channel 67 - Oil_P, and Channel 68 - Dyno WtP.

Figure 4.11 Pressures

4.0 Installation

Thermocouple Connections

The sensor box temperature panel has inputs for up to 16 type K thermocouples. Open-tip thermocouples have a faster response time because of the smaller mass. These are typically used for exhaust gas temperature measurement. Closed-tip thermocouples are typically used for fluid measurement. Plug the thermocouple into an extension cable (if needed) or directly into the thermocouple panel. The panel will accept standard or miniature plugs. The system is typically supplied with 12 closed tip 1/8" thermocouples.

⚠ CAUTION

The standard probe type thermocouples are designed so they can be bent. However, once they are bent in one direction they cannot be straightened without damaging the internal wiring rendering them inoperative. Use a tubing bender to create a smooth radius curve.

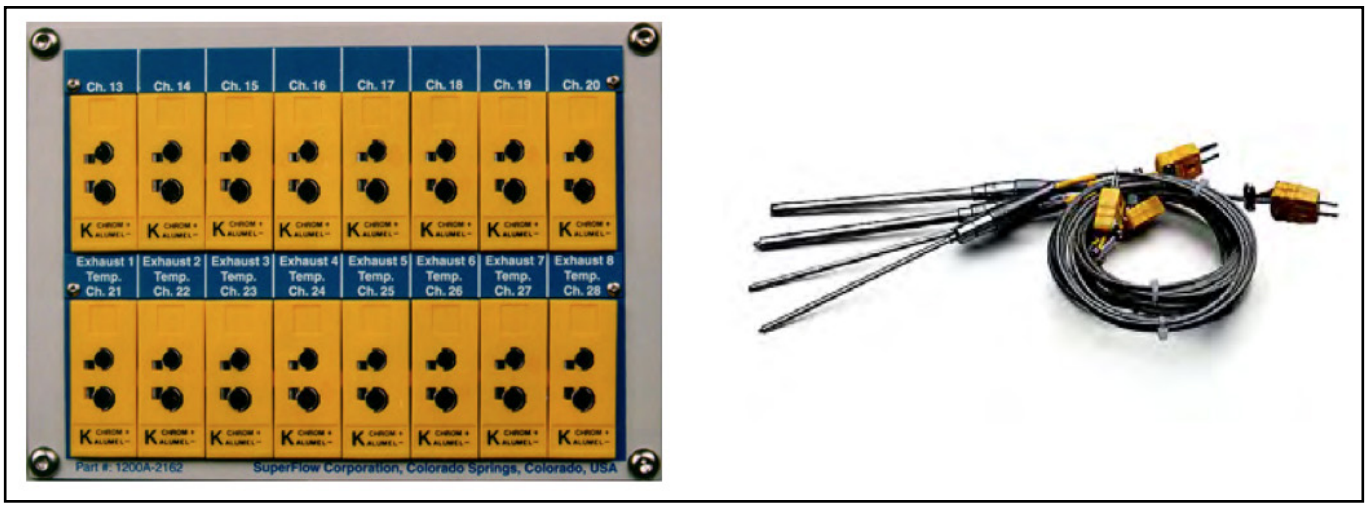


Figure 4.12 Thermocouples

4.0 Installation

Analog Voltage Expansion

⚠ CAUTION

The input circuitry can be damaged if more voltage is applied by the sensor than what the channel is designed for.

This is an eight-channel analog DC voltage input panel used to integrate exhaust gas analyzers, multi-channel Lambda sensors, O2 sensors, pressure transducers, and other voltage output devices. The standard configuration is seven 0–10 VDC channels (45 to 51) and one 0–20 VDC channel (52). Other configurations are available upon request including 0–1 V, 0–5 V, and 0–30 V in any combination.

Excitation and reference voltages are available if needed. The +12F excitation voltage is limited to 500 mA output. All others are limited to 100 mA.

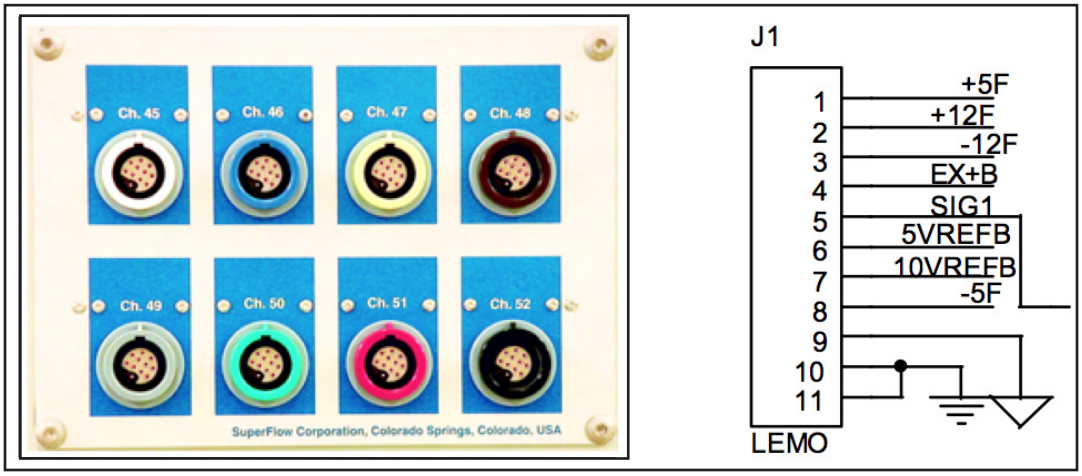


Figure 4.13 Analog Expansion

Receptacles are color coded. All are keyed the same and use the same pin out. The channels are configured in the software as to the type of sensor used. Prefabricated cables are available to connect to this panel:

- 1200A-2462-x: Un-terminated cable for input only, x=color
- 1200A-2462-01-x: BNC terminated cable for input only, x=color
- 1200A-2860 w/1200A-2188: Battery voltage input cable for 20 V channel only
- 1200A-2469-x: For pressure transducers or other devices requiring a +5.00VDC excitation voltage, x=color

IMPORTANT

Use of custom sensors requires special modification to the system configuration file.

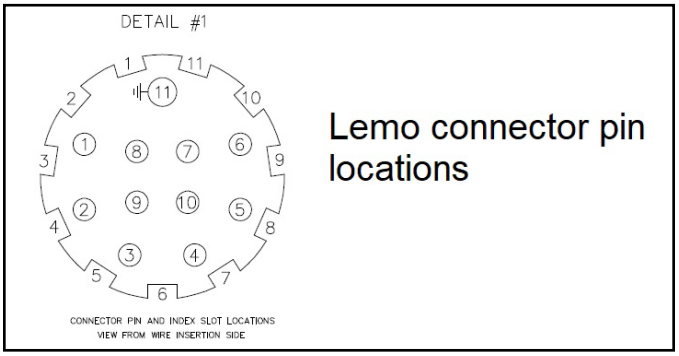
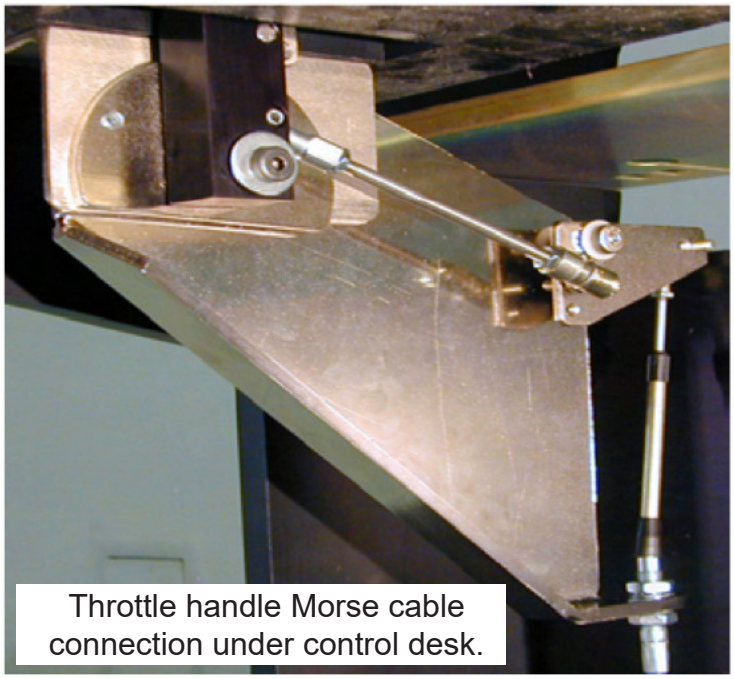


Figure 4.14 Lemo Connector

4.0 Installation

4.11 Throttle System

Several styles of throttle control systems are available. The standard system uses a Morse cable. Electric throttle actuators are also available. Due to the variety of fuel supply systems used on today's engines, you may be required to fabricate special adapters to work with throttle systems. Consult the documentation that accompanied the throttle system on your order.



Throttle handle Morse cable connection under control desk.

Example of Morse cable connection on engine.

Figure 4.15 Morse Cable Throttle System

4.0 Installation

4.12 Initial Check-out

After the sensor box is secured and all the cables are connected, the system can be tested for operation.

1. Ensure the power cables for the sensor box are plugged into a suitable power source.
2. Turn console key switch ON to power ON to the sensor box.
   - Notice that a small green light in the upper right corner on the front of the sensor box illuminates.

   NOTE: The white power button on the sensor box is disabled; do not use it.
3. Turn the computer ON and start the WinDyn and NetDyn programs from desktop.

IMPORTANT
Prior to first using the dynamometer, SuperFlow recommends calibrating the systems torque measurement sensor. Refer to "Calibrating the Sensors" on page 56 in Chapter 6.

IMPORTANT
Sensor calibration is a critical function of accurate measurements. Do not attempt to calibrate any of the sensors in a SuperFlow Data Acquisition System without the proper calibration equipment.

The system is now ready for use. Proceed to Chapter 5 for operation instructions. Consult the WinDyn Operators Manual for detailed information on how to use the software.

NOTE: Refer to Chapter 6 for instructions on calibrating the various sensors in the system. If you experience any problems in getting the system operational, or if the system fails to communicate with the console or with WinDyn, contact SuperFlow Customer Service for assistance.

5.0 Operation

5.1 Introduction

This section describes setting up and running a test on the SuperFlow dynamometer system.

5.2 Safety

⚠ DANGER

- **Extreme care should be taken in the area of the drive shaft that connects the engine to the dynamometer.**
- **All rotating parts must have their guards secured in place.**
- **A drive shaft is considered the fuse in the test setup. In the event of a failure in the engine or dynamometer, the shaft may break. This will save on costly repairs to an engine or dynamometer. However, because of this possible failure, the machine should NEVER be operated without a shaft guard.**

⚠ DANGER

- **Engine exhaust contains carbon monoxide fumes, be sure test cell is properly ventilated**
- **If anyone shows signs of carbon monoxide poisoning, get them to fresh air. Fumes can cause headache, dizziness, lack of consciousness and/or death.**

⚠ WARNING

WEAR EYE and HEARING PROTECTION. Proper eye and hearing protection should be worn at all times when the equipment is operating.

⚠ WARNING

Do not attempt to use the dynamometer without proper training from SuperFlow. Severe injury or property damage may result from improper use.

⚠ WARNING

- **Inspect the equipment monthly to ensure that there are no broken or worn parts which could cause injury to personnel or damage to the equipment.**
- **Only qualified operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ WARNING

BURN HAZARD.
During operation water temperature inside the dynamometer can reach over 125° F. Do NOT touch discharge water, piping or the dynamometer surface during operation. Allow to cool before servicing.

⚠ CAUTION

- **Personnel should NOT be in the test cell during operation and observation areas MUST be constructed to protected personnel.**
- **Personnel and other equipment should be kept clear of the drive shaft guard area and NEVER cause an obstruction or block doorways.**

IMPORTANT

The dynamometer is a tool. All personnel should be kept clear of the area and only be in the test area on a "need to be" basis.

5.0 Operation

An engine test cell can be a dangerous environment. The dynamometer operator will be exposed to a number of hazards. These risks are generally associated with the engine under test rather than with the dynamometer itself and it is thus not possible for SuperFlow to protect the operator against all these hazards by the design of the dynamometer instrumentation system.

A proper test cell environment eliminates or reduces the risks associated with dynamometer testing as much as possible. Examples of risks are:

- Excessive noise
- Risk of fire due to the fuel used
- Risk of burns due to hot engine and exhaust system parts
- Exposure to rotating parts
- Exposure to parts being projected from the engine during operation
- Excessive exhaust gas concentrations

NOTE: WinDyn is capable of automating test cell controls and integrating certain safety features in these controls. Contact a SuperFlow Customer Service or Sales representative for more information or advice.

Emergency Stop

An Emergency Stop switch is mounted near the computer system. Additional emergency stop switches can be installed in the test cell and control room. In the event of an emergency, press the nearest emergency stop switch. The emergency stop command will trigger a shutdown of the dynamometer system and return it to a safe mode.

When the emergency condition has been resolved, turn the switch clockwise to release it, or pull the switch back out depending on switch type. Then clear E-stop in the NetDyn pop-up window to reset the system. If the emergency stop condition was not cleared (the push-button released), the condition will remain active.

Electrical Safety

The sensor box and electric throttle control (if equipped) require 110/230 VAC power. They each have internal power supplies. Opening, adjusting, and repairing the power supplies should not be attempted. Defective power supplies should be replaced.

IMPORTANT
Repairs to the sensor box, console, or throttle controller should only be performed by a qualified Customer Service technician.

Fuses

All SuperFlow equipment is electrically protected by appropriate fuses. If a fuse blows, the cause must be found and removed. Do not replace fuses with a different type. This may result in a severe hazard for the user and/or damage to the equipment.

5.0 Operation

Safety Procedures

The WinDyn instrumentation system controls the engine and the dynamometer. As a result, there is a possibility that a certain function or equipment is activated at a time when this creates a hazard to a person in the area. Avoid such hazards by strictly enforcing the following policies:

- Only authorized personnel, trained in the operation of the complete test system, should have access to the dynamometer area.
- Never allow anyone in the test cell during a test. Access during warm-up periods and when the engine is idling is permissible.
- Power OFF the system during periods when the dynamometer is not in use.
- Ensure good visibility of the complete test cell area from the operator position.
- Ensure circuit breakers are easily accessible and have the proper rating.
- Ensure fuel and water shut-off valves are easily accessible.
- Ensure fire extinguishers are available and certified.
- Allow only authorized personnel to perform maintenance and repairs on electrical and mechanical equipment.
- Always turn power OFF to the system before plugging in cables and sensors to the Data Acquisition sensor box.
- Always turn power OFF to the system when changing engines.

5.0 Operation

5.3 Test Preparation

Prior to the start of dynamometer testing, the entire system should be checked to ensure everything is ready. Some of the items to check are:

- Ensure:
  - – The water supply and cooling systems are operational. Top off the water supply tank if necessary .
  - – The water pressure to the system is set between 60-90psi when deadheaded.
  - – You have an adequate supply of fuel.
  - – You have an adequate supply of engine oil.
- Verify the computer is communicating with the system.

Mounting the Front of the Engine

Mount the engine to the cart. If the carts front mounts do not mate with your engine, you must fabricate your own mounting attachments. SuperFlow does not supply such devices. The engine should be level (parallel to the floor) once mounted.

IMPORTANT

For detailed information, please take a look at Mounting an Engine to the SuperFlow Black Widow Dynamometer video by clicking the following link; *https://youtu.be/Vs5G8wIaQNQ*

Mounting the Engine

It is usually easier to mount the engine on the stand before the headers are installed. Refer to figure 5.1 when following this procedure.

1. Support the engine from a lift at the angle it will be mounted on the Docking Cart. Rotate the front engine mounting pedestals out to each side of the stand.
2. Position the rear of the engine about 4” (10cm) from the rear of the Docking Cart.
3. Raise the rear support post to contact the bottom of the oil pan and position the rear engine center line at the same height of the dyno drive shaft.
4. Attach the front engine mounts and carefully position the engine center line with the Docking Cart center line as the engine is lowered from the hoist.
5. Tighten the front engine mount bolts at the frame.
6. Install the appropriate rear engine mount to support the engine.

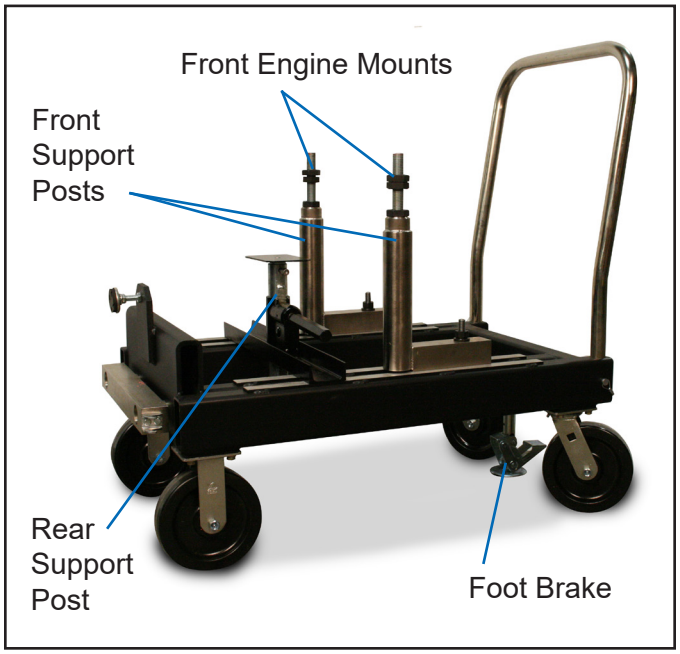


Figure 5.1: Docking Cart

5.0 Operation

7. Roll the Docking Cart into the test cell and dock it with the dynamometer absorber stand. Use the docking clamps and foot brake to secure the cart.
8. Once docked and secured, you may lower the rear support post and remove it if you wish.

Dyno Shaft Connection

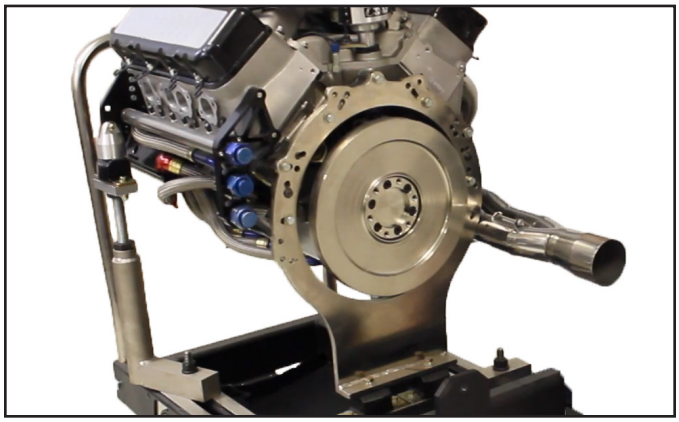


Figure 5.2 Engine Mounted On Cart

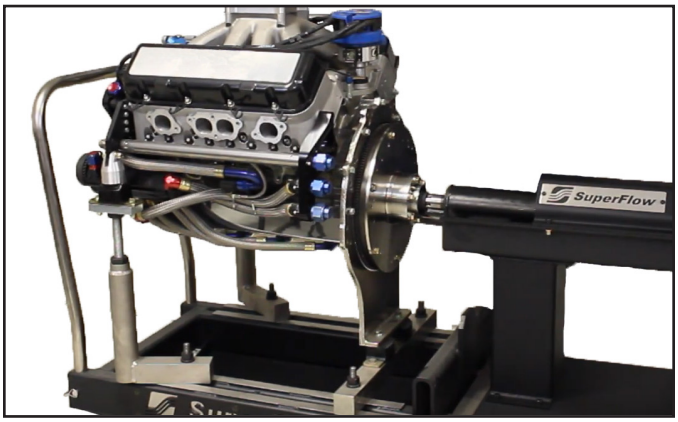


Figure 5.3 Drive Shaft Connected

The dynamometer absorption unit is driven by a torsionally compliant driveshaft with constant velocity joint. The shaft is driven by the engine in the same manner that a standard shift transmission connects to the engine.

First install an adapter plate to the flywheel or flex plate. Engine Adapter Plates for many engines are available from SuperFlow.

IMPORTANT

For detailed information, please take a look at Mounting an Engine to the SuperFlow Black Widow Dynamometer video by clicking the following link; *https://youtu.be/Vs5G8wIaQNQ*

It is very important that the adapter plate be perfectly centered on the flywheel to minimize vibration and damage to the engine and absorber.

5.0 Operation

5.4 Engine Water Cooling System

1. The thermostat or any flow restrictions should be removed from the engine. The thermostat on the cooling tower will perform the temperature control function.
2. Connect the tower supply hoses to the engine (Figure 5.3). Coolant is supplied to the engine from the lower connection on the CT700-NOP cooling tower. Coolant from the engine enters the CT700-NOP cooling tower at the top connection (other cooling towers may vary).
3. Close the drain valve and open the inlet valve to fill the system. Air is purged automatically. Observe the sight tube to determine the cooling tower fill level. Close the inlet valve when the tower is full. After the engine is started it may be required to open the inlet valve and let in more water to compensate for air purging out of the engine. Both valves must be closed for normal operation.
   - **SuperFlow CT300P, CT700P, and CT1001 pressurized cooling towers.**

     The coolant chamber is filled through the radiator type cap at the top of the tower. Once the engine is started and the air purged, replace the cap to pressurize the system.
4. Once the engine and cooling tower are full, the engine can be started and warmed up. Adjustment for temperature control can be made on the control valve located at the bottom of the tower.
5. When the test is completed and before disconnecting the hoses, open the outlet valve to drain the water from the tower and the engine.

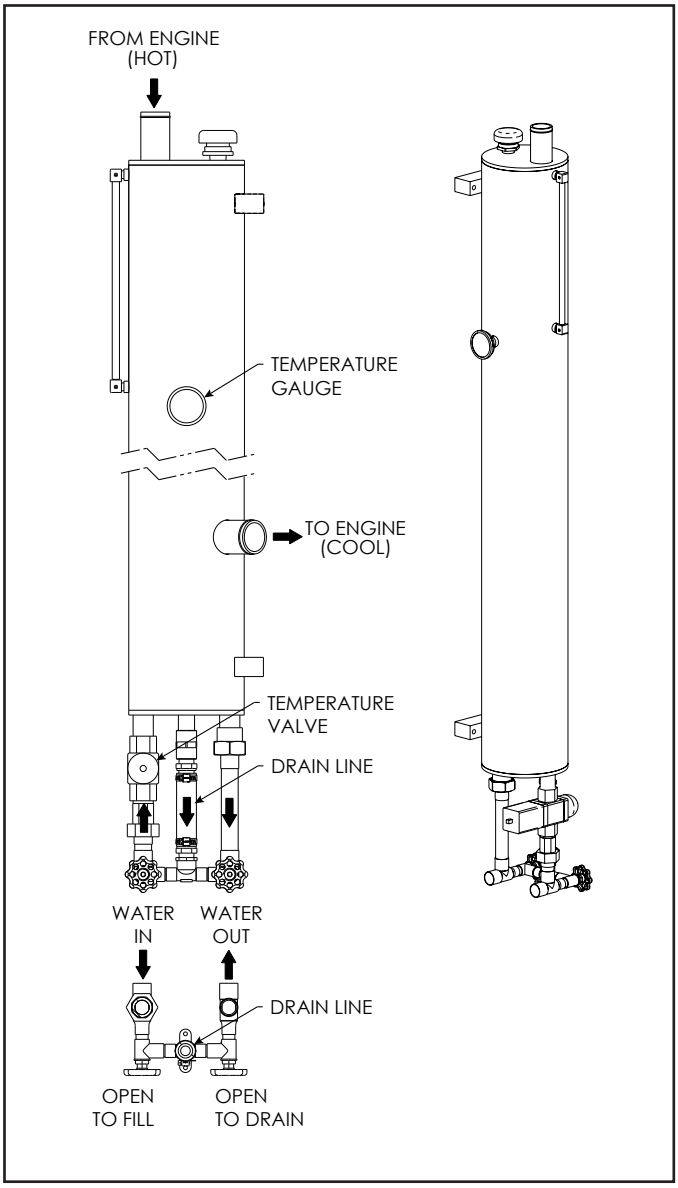
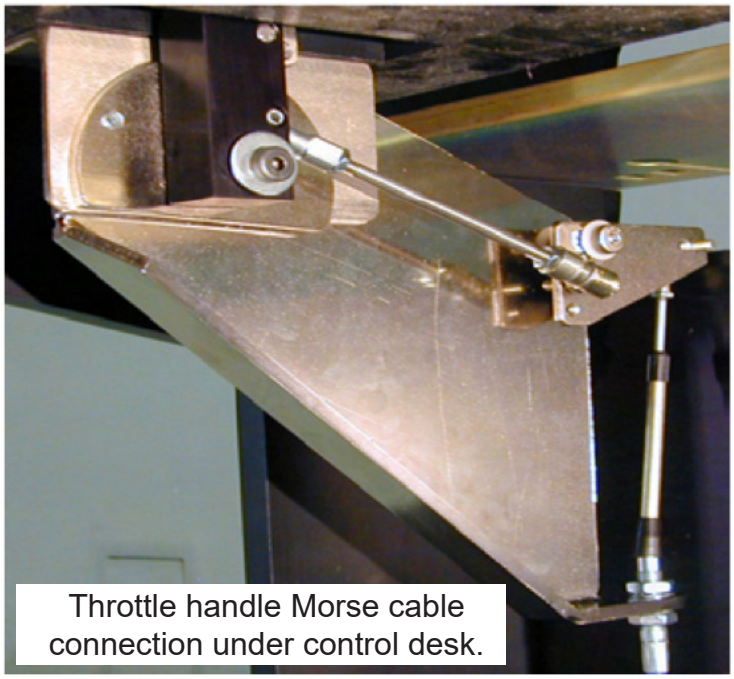


Figure 5.4 CT700-NOP Unpressurized Cooling Tower

5.0 Operation

5.5 Throttle System

Several styles of throttle control systems are available. The standard system uses a Morse cable. Electric throttle actuators are also available. Due to the variety of fuel supply systems used on today's engines, you may be required to fabricate special adapters to work with throttle systems. Consult the documentation that accompanied the throttle system on your order.



Throttle handle Morse cable connection under control desk.

Example of Morse cable connection on engine.

Figure 5.5 Morse Cable Throttle System

5.0 Operation

5.6 Sensor Connections

Stand Connections

1. Place the Air Temperature and Humidity sensor in a location close to or in the airflow to the engine air intake. Do not put too close to the engine as heat from the engine could affect the readings or a backfire from the engine air inlet could damage it. As a rule, put the sensor in the same general location for every test. The data from this sensor is used to apply power correction factors, so its repeatability is critical to your dyno testing results.

⚠ WARNING

Always turn the power OFF to the sensor box when plugging or unplugging devices.

2. Connect the DC Power In cable to the connector labeled DC Input on the engine control panel. The other end of the cable is connected to the 12VDC battery or power supply source.

Engine Connections

1. Attach thermocouples to the engine and connect them to the proper plugs on the sensor box temperature panel.
2. Attach pressure lines to the engine and connect them to the proper transducers on the sensor box pressure panel.
3. Install an air turbine(s) on the engine air intake and connect it to the proper plug on the sensor box interconnect panel.

   NOTE: To prevent damage to the air turbine propeller due to engine backfire, SuperFlow suggests performing initial start and ignition timing without the air turbine mounted to the intake.

4. Connect the ignition, starter, and fuel power cables to the proper plugs on the sensor box engine control panel.

⚠ CAUTION

DO NOT use the Magneto Kill Ground connection.

Figure 5.6: Engine Control Panel

5.0 Operation

5.7 Running an Automated Test

Follow this procedure for running each test. Repeatable and accurate test results are obtained by consistent test methods. Quick reference instructions are provided with this manual as a stand alone document that can be placed near the console for easy viewing.

Infrastructure and Engine Setup

1. Verify the engine installation and all connections to the engine.
2. Ensure:
   - That the connection between engine and dynamometer is aligned and secure and that all guards are properly installed.
   - No tools are left on the engine or dynamometer.
3. Verify:
   - Oil and water levels in the engine and heat exchanger(s).
   - Fuel connections.
   - Electrical connections to the engine.
   - Battery hook-ups and battery charge condition.
   - Throttle connections and adjust throttle end stops, insure you have idle and WOT.
   - Sensors are connected as required for the test.

⚠ CAUTION

DO NOT use the Magneto Kill Ground connection on the Sensor Boxes Engine Control Panel.

4. Ensure no sensor cables, electrical wires, or pressure lines interfere with the engine exhaust system or other hot or rotating parts.
5. Verify that dyno water supply valves are in the correct position.
6. Secure all objects that might move due to air flow in the test cell.
7. Verify:
   - The fuel supply is adequate for the test.
   - The power is on at the console, sensor box, computer, printer, and any additional control equipment.
8. Open ventilation air shutters in the test cell.
9. Open fuel supply valves.
10. Turn ON water pumps and ventilation fans.

⚠ CAUTION

ALWAYS turn ON water pumps and ventilation fans BEFORE starting engine. Damage to the absorber seals may occur if the engine is run without water supplied to the absorber.

5.0 Operation

Quick Start Checklist for SF-BW Engine Dynos With NetDyn

Step	Action	Location	Purpose
Preliminary Steps	Water System Exhaust System Airflow System Mount Engine	Dyno cell	Insure all infrastructure systems are functional Insure all necessary engine mounting functions are completed
1	Power on computer system	Power switch on Dyno Computer	Turns on computer to prepare to load WinDyn software
2	Power on Dyno Console	Key switch on Console	Turns on sensor box and console
3	Launch NetDyn application	NetDyn Icon on left computer desktop	Starts the NetDyn application for the center monitor; NetDyn should automatically connect to the sensor box
4	Launch WinDyn Software	WinDyn Icon on left computer desktop	Establishes comm to sensor box, runs WinDyn application on dyno computer
5	Open desired Test Group	**'F2'** function key on computer keyboard	Installs the selected files from the computer to the sensor box
6	Check Torque and Weather	**'2'** key on dyno computer keyboard	Verify the torque system is at or near zero (+/-2), verify weather conditions are current
7	System setup	**'S'** key on dyno computer keyboard	Set the data file name and beginning sequence number Set the file storage location (folder) for test data files Select test profile to perform (Normal test is **Accel**) Set correct engine specifications Set test parameters Set ValPos channel for engine power (under 1000Hp, use .80) Enter test notes to be appended to the data files Memorize settings for future use
8	Activate Test Setup	**'F2'** function key on computer keyboard	Installs and activates test setup into sensor box.
9	Return to main viewing screen	**'1'** key on dyno computer keyboard	Normal viewing screen when running tests
10	Prepare the engine for testing	Engine and test cell control switches	Connect all desired sensors, warm engine up
11	Start test	**'START'** button on NetDyn application	Begins execution of the selected test type, stops at ramp command; Bring throttle to WOT, servo should hold engine at LOWER RPM setting; allow engine time to stabilize
12	Run Test	**'D'** key on NetDyn application interface	Executes ramp (accelerates engine); when ramp completes, return throttle to IDLE
13	Analyze data	**VIEW SAVED** icon on WinDyn "Analysis - Saved" Toolbar	Select desired data file to analyze, print, or plot

5.0 Operation

Operator Console and Computer

Figure 5.7: Operator Console Controls

Figure 5.8: Dyno Computer Desktop

Use the power switch on the Dyno Computer and the power key switch on the Operator Console to turn both systems ON. The Dyno Computer desktop will show on all screens once the computer operating system has properly loaded.

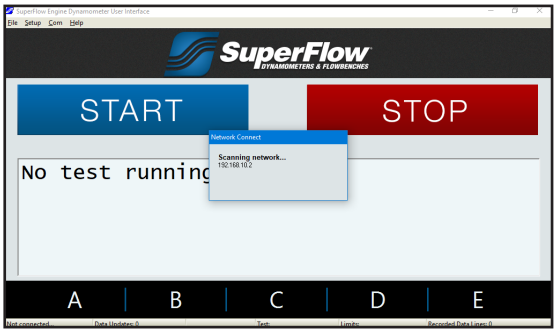


Figure 5.9: NetDyn Loading

Figure 5.10: WinDyn Loading

Load Software

1. Locate the SuperFlow NetDyn program icon on the desktop and **double-click** the icon to load the program.
2. Once NetDyn has been loaded, locate the SuperFlow WinDyn program icon on the desktop and **double-click** the icon to load the program.
   a. The WinDyn initialization screen will show and automatically close once the program has been initialized. WinDyn will require additional load time once the initialization screen closes, wait approximately 15 to 30 seconds for WinDyn to load completely.

IMPORTANT
DO NOT attempt to reload the WinDyn software once the initialization screen closes, wait an additional 30 to 45 seconds before attempting to reload the software.

5.0 Operation

Test Group Dialog

When WinDyn is loaded, operators will be presented with a blank WinDyn desktop. To begin preparing the system for testing, select and load the appropriate Test Group file. Press the **F2** function key to open the **Install Test Group** window. Select the **Test Group** file and press **Open** button to load the associated files.

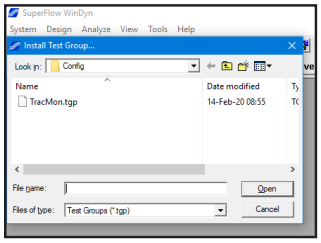


Figure 5.11: Install Test Group Window

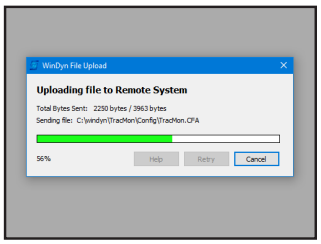


Figure 5.12: Test Group Loading Dialog

WinDyn Prep

Prior to testing, press the '**2**' key on the dyno computer keyboard to load **screen two**. Once the screen is loaded, verify the torque system is at or near zero (± 2) and the weather conditions are current. It is also good practice to verify other sensors appear to be reading correctly. See section "6.2 Calibration" on page 56 if you feel calibration should be performed before testing.

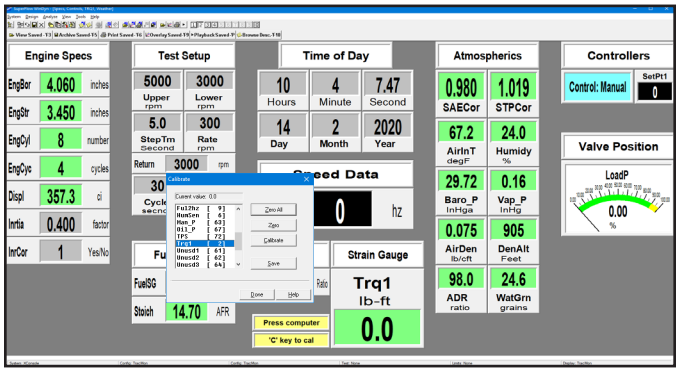
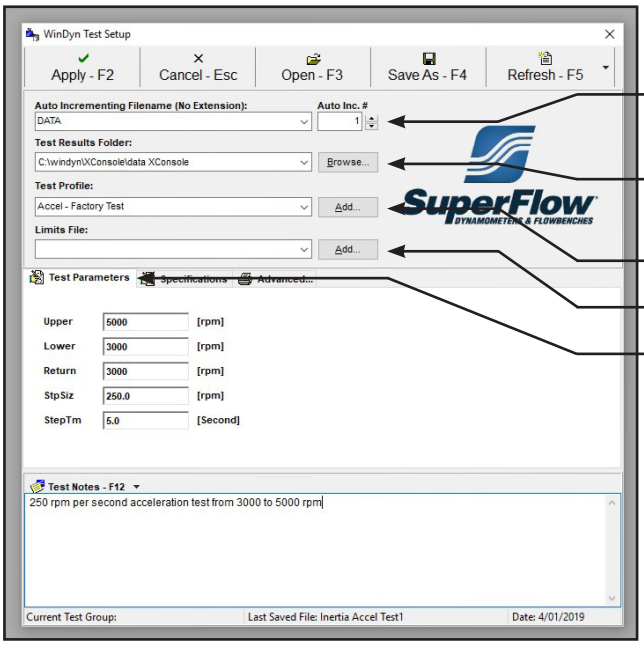


Figure 5.13 Test Setup - Test Parameters

WinDyn Setup Dialog

WinDyn preferences can be set up to quickly prepare the system for testing. To bring up the **Test Setup** window **LEFT-CLICK** anywhere on the main WinDyn display and then type the letter **s** from the computer keyboard and enter the following information:



1. Enter a name you wish to use for the data file and set the increment.
2. Specify the location where the data file will be saved.
3. Select the Test Profile you want to run.
4. Specify a safety limits file if desired.
5. Set the test parameters.

Figure 5.14 Test Setup - Test Parameters

5.0 Operation

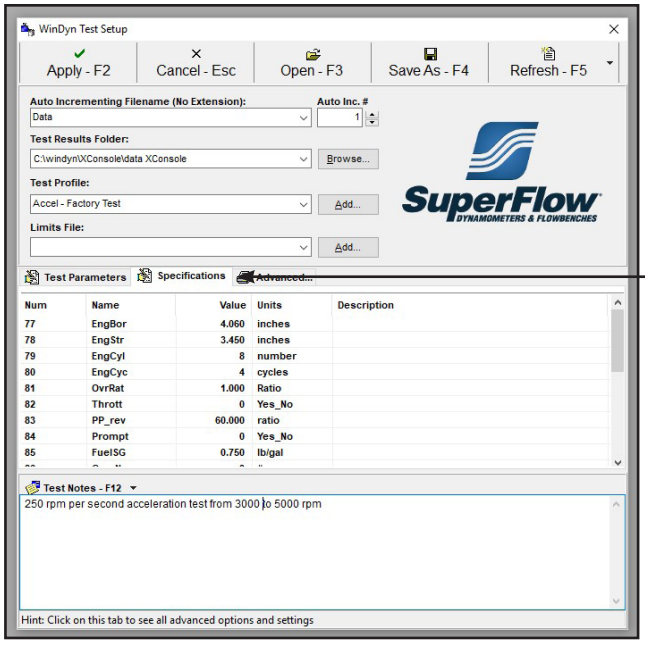


Figure 5.15 Test Setup - Specifications

6. Click the **Specifications** tab and enter the engine specs.
7. Adjust the **Valpos** setting as necessary.
8. Adjust the **fuel specific gravity** as necessary.
9. Verify all other specification settings.

ValPos Adjustment

ValPos Adjustment – WinDyn channel 88

The **ValPos** adjustment allows the user to tune the dyno to the engine being tested. The key is to observe outlet water temps from the absorber. SuperFlow prefers to see temps no higher than 160 deg F. Optimally, use a **ValPos** and **water pressure** setting that gives best control and low outlet water temps.

The **ValPos** channel will range in value from .40 – 1.10 (default is .80).

Recommended settings are as follows:

- .40 = Power levels from 0-300 Hp
- .60 = Power levels from 300-700 Hp
- .80 = Power levels from 700-1200 Hp
- 1.00 = Power levels from 1200-1700 Hp
- 1.10 = Power levels > 1700Hp

IMPORTANT
The water inlet pressure should be no higher than 35 psi.

5.0 Operation

Running a Test

Automated tests are executed from the operator console touch screen or computer keyboard and mouse. The steps below show how to run an Accel Test using the operator console. The following steps assume the Accel Test has been select, WinDyn Software is properly setup, Engine is properly connected to dyno, warmed up and running.

1. Press the **START** button to begin.

Figure 5.16: NetDyn Loading

2. Follow the on screen prompt and increase throttle setting and stabilize speed at 3,000 RPM.

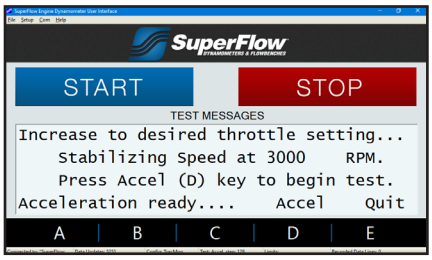


Figure 5.17: Start Accel

3. Once stabilized, begin test by pressing the (**D**) button on the operator console and accelerate speed to upper limit.

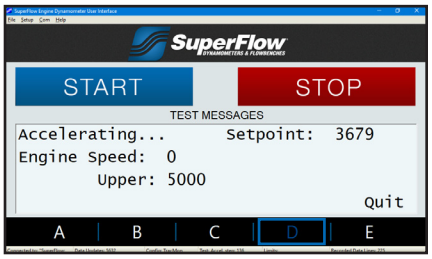


Figure 5.18: Ramping

4. Once test has been completed, return throttle to idle.

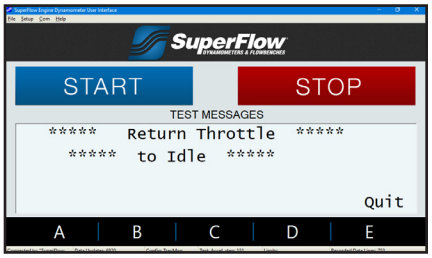


Figure 5.19: Return to Idle

5. At the conclusion of the test, data will be saved.

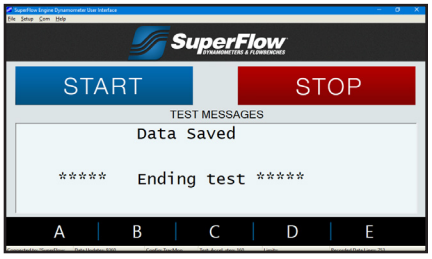


Figure 5.20: Data Saved

5.0 Operation

Post Test

Each test can be viewed after it is saved. Current data is stored in memory in the Data Acquisition sensor box. Saved data is on the computer in the location and with the filename specified in the Test Setup screen. Press “Shift + F3” to select and view the saved test data.

Shutdown

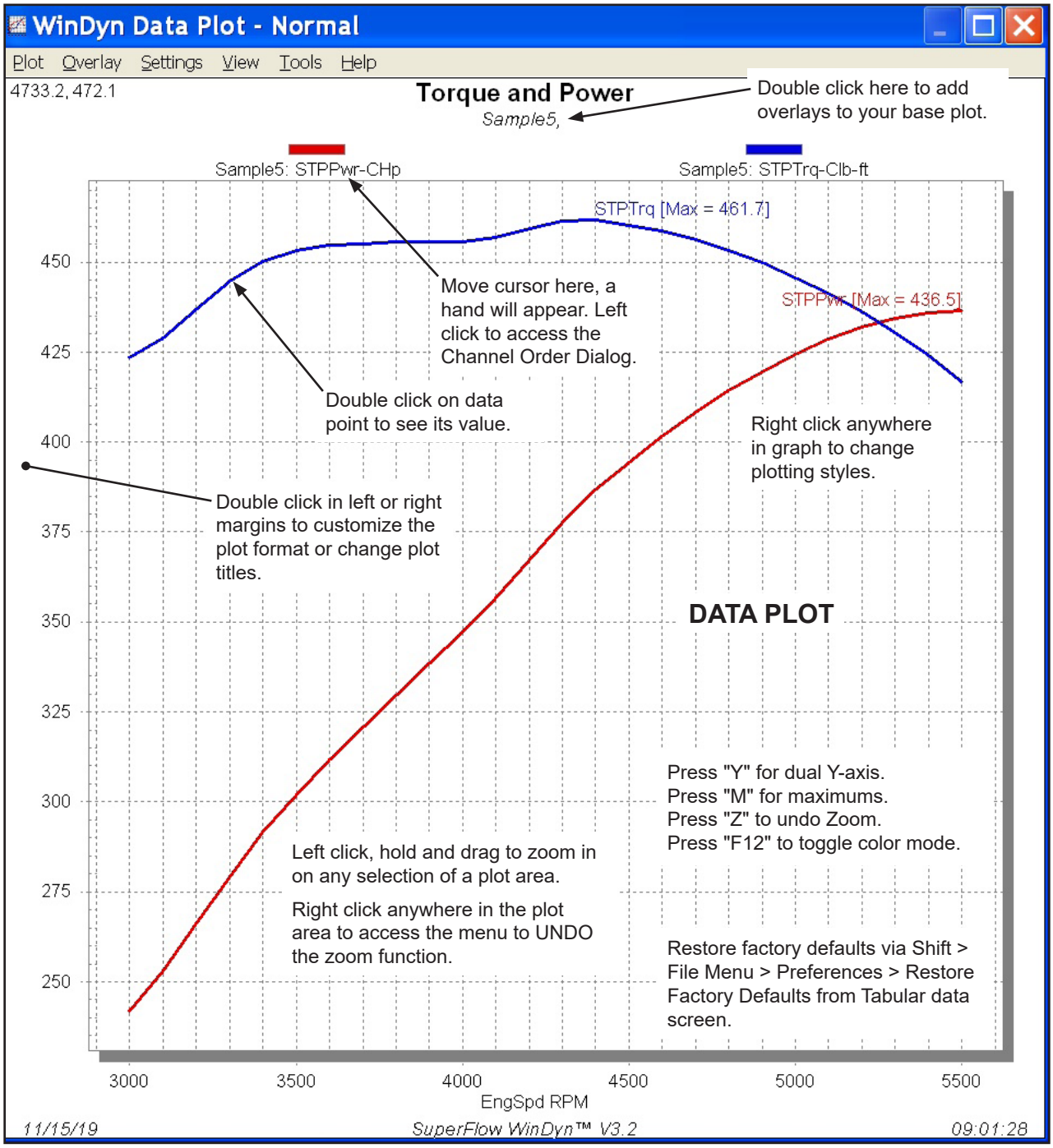
Let the engine cool down as necessary in idle mode, then turn off fuel and ignition. When the test cell ambient temperature and the engine coolant temperature are normal, shut down the test cell pumps and fans.

5.0 Operation

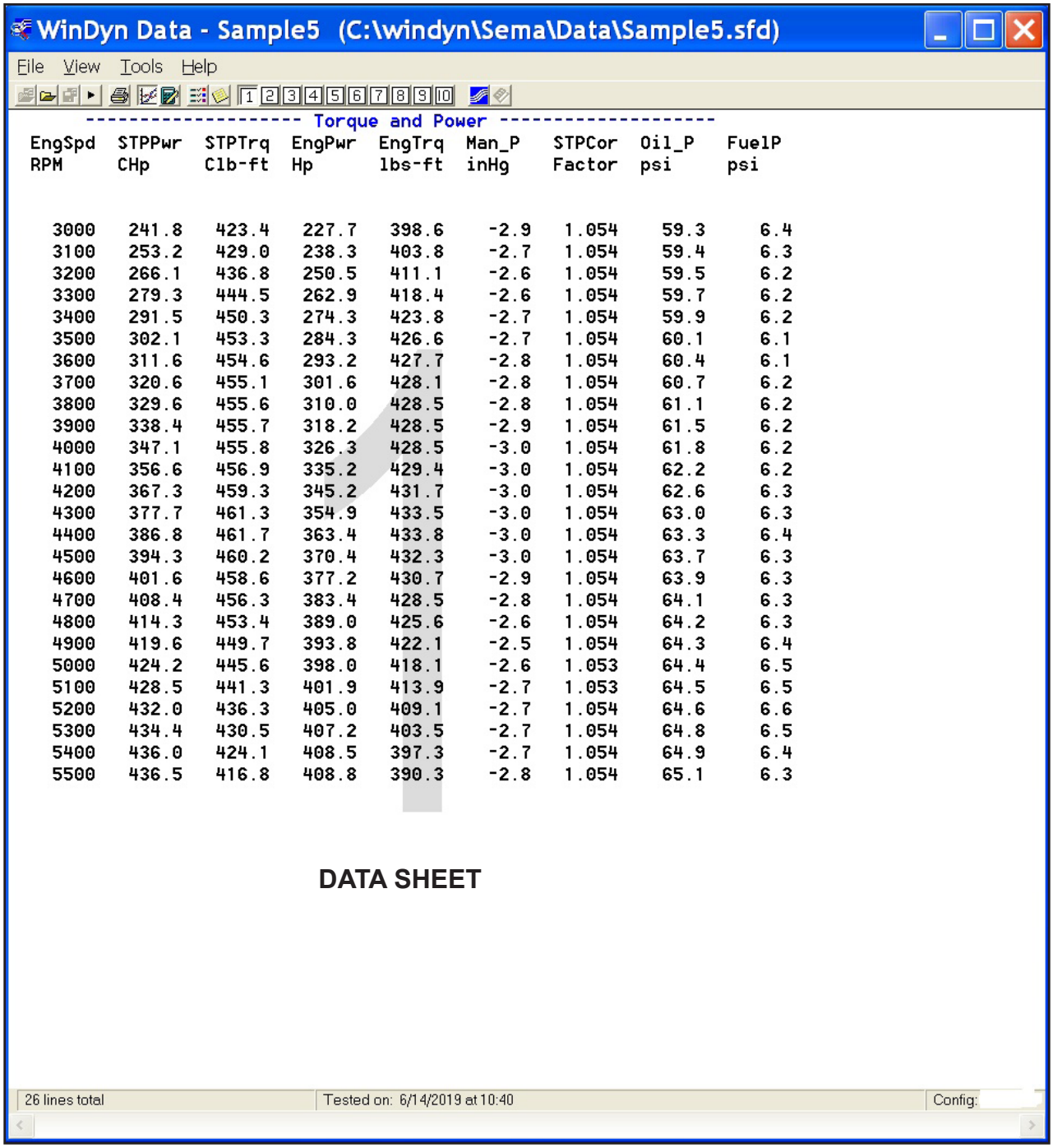
5.8 Analyzing the Test Results

All automated tests will save the test data automatically on the computer. The recorded data can be viewed, plotted, and printed using the WinDyn Stored Data Viewer.

NOTE: Refer to the WinDyn operators manual for more information on how to use the Stored Data Viewer.



5.0 Operation



DATA SHEET

6.0 Maintenance

This product is designed to provide years of trouble free service with a minimum amount of regular maintenance. The system should be periodically serviced according to the maintenance schedule below.

6.1 Maintenance Schedule

If necessary, the dynamometer can be cleaned using an all-purpose cleaning detergent and water. Pay special attention that the load cell is not “soaked” during the cleaning process. The load cell can become wet but should be dried without delay.

⚠ CAUTION

Do not use more than the defined amount of grease as over filled bearings are liable to over heat.

Table 6-1. Maintenance Chart

Maintenance Schedule		
Component	**Interval**	**Action**
System cables	Each Use	Inspect for wear or damage
Pressure hoses & fittings		Inspect for wear or damage
Other sensors		Inspect for wear or damage
Absorber bearing lubrication	See Absorber Manual	Refer to SF-Black Widow Absorber manual provided.
CV Joint lubrication	Every 4-5 Engines	Lubricate drive shaft CV joint with 1-2 pumps of Red Line CV-2 or equivalent grease.
Water Filter/Strainers	Every 3 months	Inspect and clean
Water System		Add 1 gallon of chlorine bleach per 1,000 gallons of water.
Load cell calibration		Calibrate per software manual
Servo valves		Inspect for water leaks
Absorber		Inspect for water leaks
Speed pickup		Inspect for debris or grease
Engine cart		Lubricate castors
Connected sensor calibration		Calibrate
Emergency stop		Verify proper operation
Computer, absorber, stand, and sensor box		Clean
Battery on the Sensor Boxes 2640 Circuit Board	Every Year	Check and replace battery if less then 2.9 VDC

6.0 Maintenance

⚠ WARNING

- **Post safety warnings and barricade work area to prevent unauthorized use of the dynamometer before maintenance has been completed.**
- **Only qualified machine operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ WARNING

AUTOMATIC STARTING HAZARD. An engine connected to dynamometer could be started remotely if dynamometer is equipped with an Air Starter. Ensure starting has been disabled prior to servicing.

Preventative Maintenance

The absorber requires very little maintenance. Follow the suggestions below to increase the life and reliability of your absorber.

Water Supply

High inlet temperatures increase the occurrence of cavitation, which destroys the internal components of the absorber. High water inlet temperatures increase the possibility of unloading because the water inside the absorber turns to steam. Keeping the inlet water temperature as cool as possible greatly reduces these risks. Ensure inlet water temperature remains below 100 degrees F.

Water Quality

Contaminated or hard water can reduce the life of an absorber and increase maintenance cost. Ensure that any filters or strainers incorporated in the system are inspected regularly. Strainers should be cleaned and if necessary filters serviced.

Leaks

Water leaks indicate problems that may lead to failure if left unattended. Check for leaks frequently, and repair as necessary.

6.0 Maintenance

6.2 Calibration

The sensors used with the SF-Black Widow should be periodically calibrated for highest measurement accuracy.

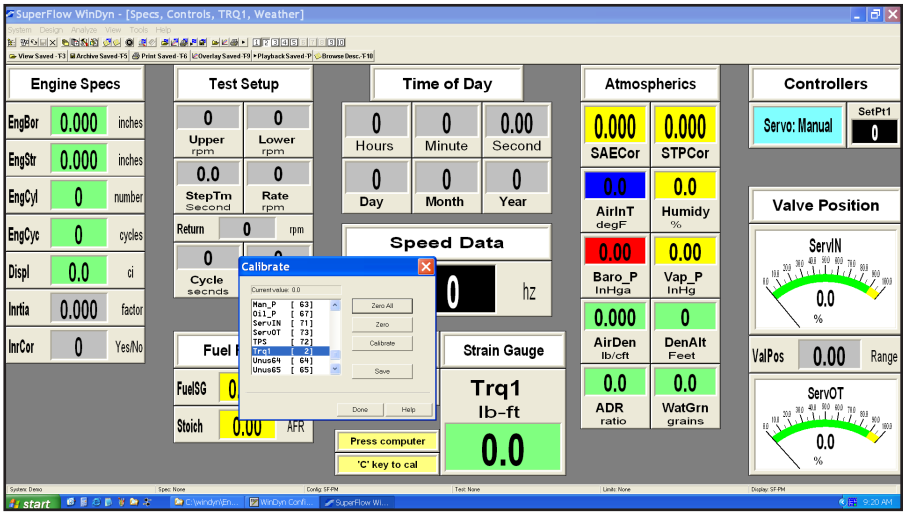
Not all sensor channels require calibration. Some, such as thermocouples, are calibrated at the factory and normally do not need re-calibration. Pressure transducers and analog voltages, have the calibration set in the configuration file based on the manufacturer's specifications.

As a rule, the source used to calibrate a sensor should be 10% more accurate than the sensor being calibrated. For example, if a sensor has an accuracy of +/–1%, the standard used to calibrate it should have an accuracy of +/–0.1%.

Calibrating the Sensors

NOTE: The following procedures are performed using the WinDyn Data Acquisition and Control Software, please refer to the software manual for additional calibration details.

Torque:



1. Power on computer system.
2. Power on dyno system.
3. Launch WinDyn application.
4. Use **System | Install | Test Group** menu option (or **F2** key) to load your specific test group (.tgp) file.
5. Select **SCREEN 2** to observe **Trq1** channel (2).
6. Press '**C**' key on computer keyboard.
7. Calibration dialog box should appear on computer screen.
8. Scroll down in channel dialog and highlight '**Trq1**' channel.
9. Mount cal arm and weight pallet to absorber.
10. Click '**ZERO**' button.
11. Hang cal weights on weight pallet.
12. Observe '**Current value = ????**' in Calibrate dialog box.
13. Click '**Calibrate**' button.
14. Enter computed torque value of hanging weights (**Weight x effective length of arm**) in calibrate dialog box. Click **OK**. The SF-BW uses a 3 foot arm. There are two holes in the arm, use the outer most hole to mount the pallet.

15. Remove weights and calibration arm
16. Click '**ZERO**' button again.
17. Click '**SAVE**' and overwrite existing calibration file by continuing to click '**OK**' as dialogs appear.
18. Click '**DONE**' to exit calibration dialog box.

Torque calibration is now complete. If the readings do not correspond with the procedure or are not within acceptable limits, contact SuperFlow Customer Service.

Pressure Transducers:

If you have pressure sources and calibrated pressure measurement equipment with a higher accuracy than the transducer, it is possible to calibrate the pressure sensors using the procedures similar to those used to calibrate the torque sensor. However, scroll and locate the desired pressure channel and apply a known pressure to the sensor within range to verify calibration.

⚠ WARNING

An abrupt change in pressure may result in damage to the sensor being calibrated. Make certain that the regulated air supply is set to zero before introducing pressure at a slow pace. When finished calibrating, slowly bleed off the air supply before removing from the sensor being tested.

Atmospheric Transducers:

Check the calibration of the weather channels, **AirInt**, **Humidy**, and **BaroP** using a weather station of your choice.

- **AirInt** is calibrated via the AirSen channel 1.
- **Humidy** is calibrated via the HumSen channel 6.

Raise or lower the voltage values in either channel to perform calibration. SuperFlow uses a Kestrel 3500 pocket weather station to calibrate these channels. Any similar device will suffice.

Temperature:

There is no adjustment for the calibration of the temperature sensors. If a temperature is reading incorrectly, try using a different probe. If available, the temperature may be verified with a thermocouple simulator. If that does not work, contact your SuperFlow representative.

Speed:

There is no adjustment for the calibration of the speed sensor. If the speed is reading incorrectly, check the cables, connectors, and, if possible, the gap between the pickup and the gear. If it is still reading incorrectly, repair parts or service may be required. If available, the speed may be verified with a hand tachometer.

Speed pickup gap .015"-.020"

6.0 Maintenance

Calibration Coefficients:

A calibration printout with the coefficient values can be obtained and kept in a log which is useful for documentation and tracking any drift trends in the sensors or changes in the channel definitions.

Performing a current value calibration creates a new coefficient number for that channel or channels. All other channel coefficients should remain the same. The offset value changes every time the system is zeroed.

1. From the main ***WinDyn*** menu, select **Tools>>View Sensor Calibration**.
2. Using the Tutorial at the bottom of the window, follow the steps to open the file and print the calibration values.

6.3 2640 Circuit Board LEDs

1. Both LEDs should be ON when powered up.
2. Active LED should be blinking when powered up.
3. Both LEDs should be ON when connected to the computer network. The top LED will be flashing when WinDyn or NetDyn are active.

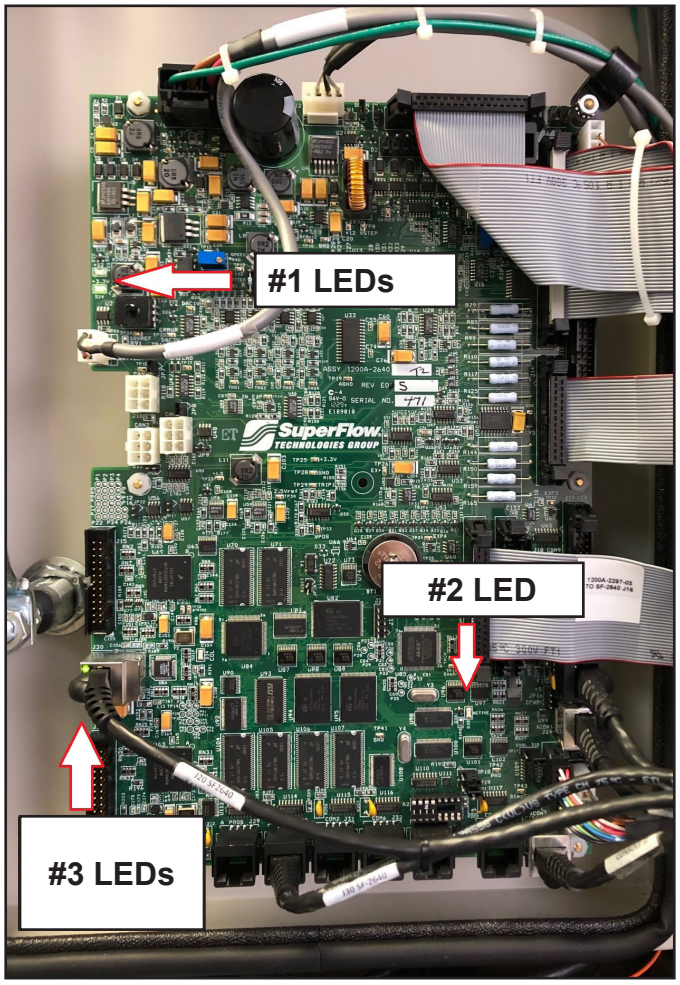


Figure 6.1 2640 Circuit Board LEDs

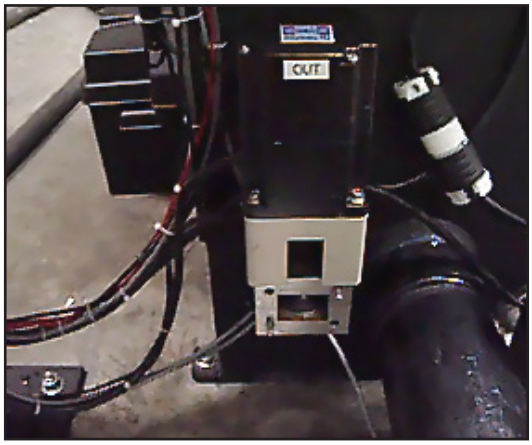
6.0 Maintenance

6.4 Servo Valve Indexing

The following procedure will describe the correct way to index the servo valves (inlet and outlet) on the SF-Black Widow model dynamometer. This process is required anytime you replace or repair either servo valve or their associated servo controller circuit board.

1. To remove the valves, power OFF the sensor box. Disconnect the cables from the valves. Remove the water lines and the four bolts that mount the valves to the absorber.

INLET VALVE

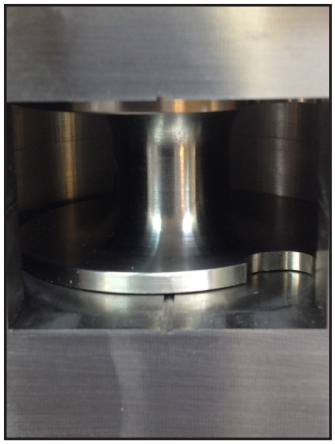


OUTLET VALVE

Figure 6.2 Servo Valves

2. Remove the valves and note their orientation. They must go back on the same way. Also note the inlet valve spool is different from the outlet valve spool.

INLET VALVE SPOOL



OUTLET VALVE SPOOL

Figure 6.3 Servo Valve Spools

6.0 Maintenance

3. Position the valves on the tool tray on the engine stand so you can observe the movement of the valves. Reconnect each valve's cable.
4. Power up the system. Load the Diag_BW test group. Set the console LOAD control mode to MANUAL and 0%. Observe the ServIn and ServOt objects on screen 1 or 2. They should both be reading 0%. This sets both valves at the fully open position.

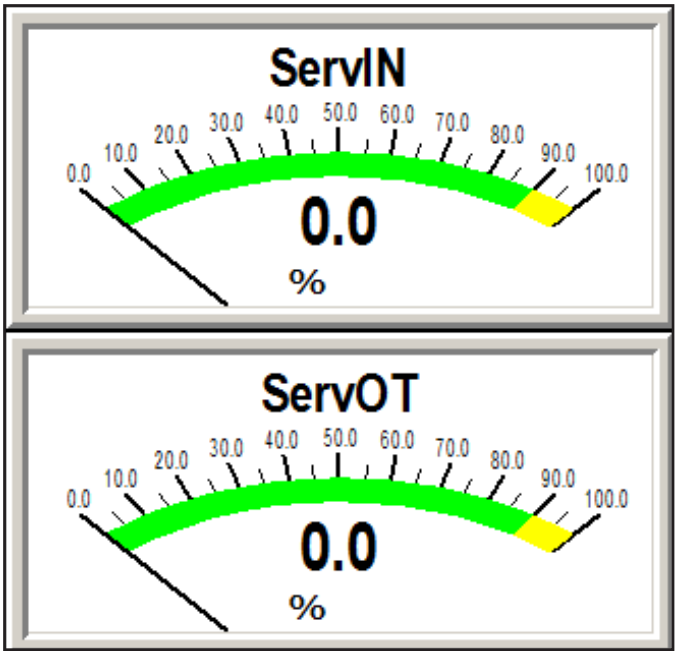
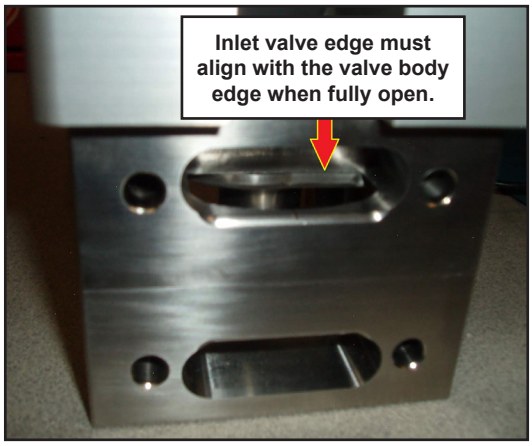
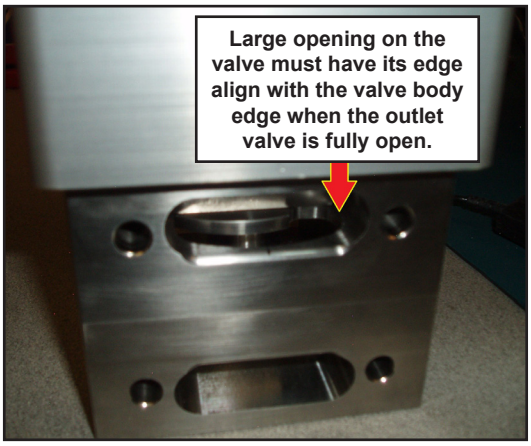


Figure 6.4 WinDyn Servo Gauges

5. Observe the oval opening on the valves. The photos below depict how the valves should look if fully open (0%).



INLET VALVE



OUTLET VALVE

Figure 6.5 Servo Valves Fully Open

6. If the edge is not flush with the opening, you need to perform the indexing adjustment. There is a gross adjustment and a fine adjustment. If you have replaced components in either valve or the valves themselves, you may have to perform the gross adjustment. If alignment is off by more than 3/8 inch to either side of the window, you will need to perform the gross adjustment. Otherwise, skip to the fine adjustment process.

6.0 Maintenance

7. **GROSS ADJUSTMENT PROCESS:** Loosen the set screws on the valve. Confirm that the valve you are indexing is at 0% on the screen. Rotate the valve slowly independent of the shaft until the sharp edge of the valve spool is lined up on the very edge of the window. Dap the set screws with Loctite 242 and snug them down. Repeat as necessary on the other valve (again, make sure that valve is at 0% on the screen).
8. **FINE ADJUSTMENT PROCESS:** The fine adjustments are found on the 1200A-2540 boards inside the sensor box.

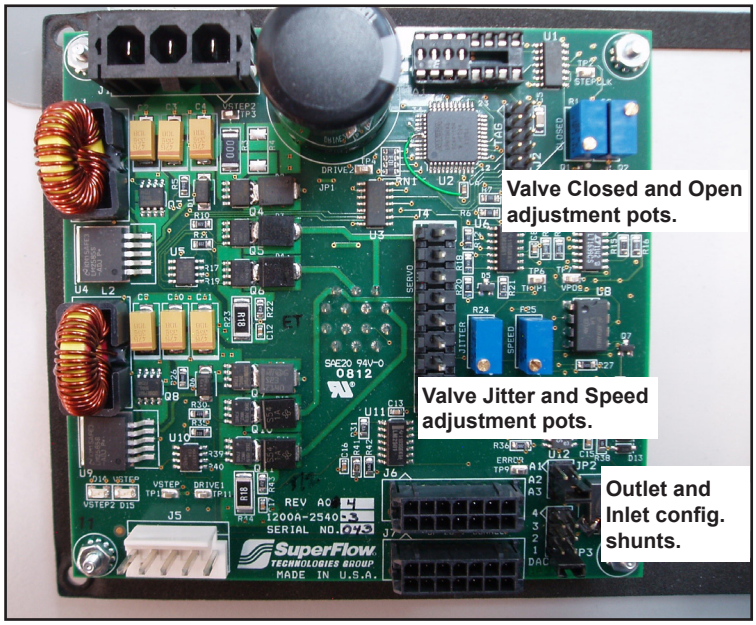
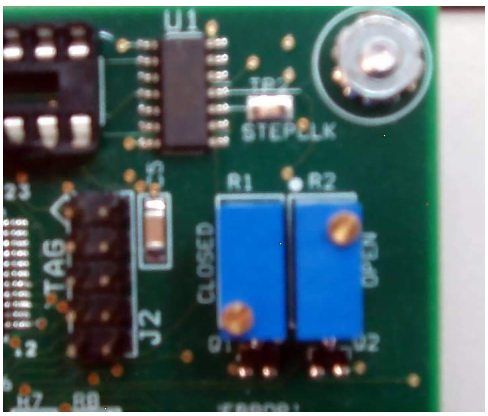


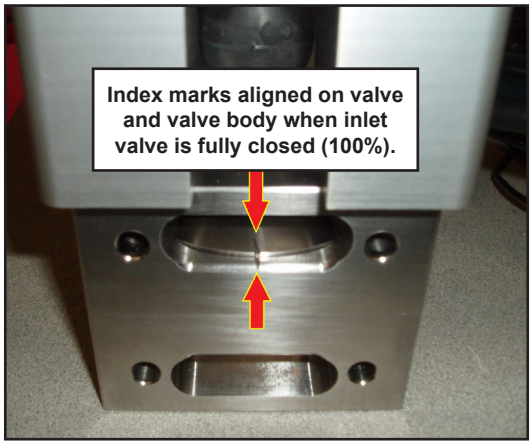
Figure 6.6 Circuit Board

You are initially setting the fully open position. Observe the oval opening in the valve body as described above. Adjust the OPEN pot to align the valve edge flush with the valve body. Do this on each 1200A-2540 board for each valve.

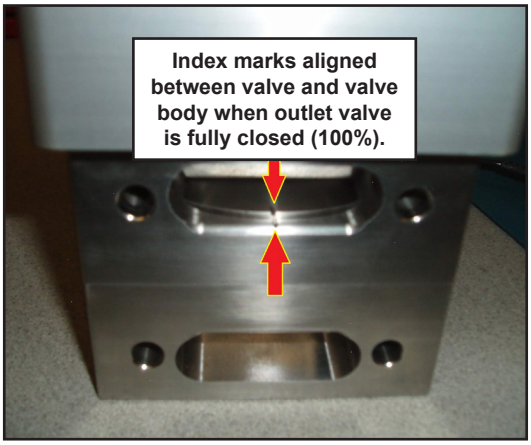


6.0 Maintenance

9. You have now completed the valve opened position adjustment. Now perform the valve closed adjustment.
10. At the console, turn the load knob to 100%; confirm ServIn and ServOt are at the 100% position on the screen.
11. At 100%, both valves should have turned 270 degrees from their original position (3/4 of a complete revolution). The valves should have their index marks lined up as in the photos below.



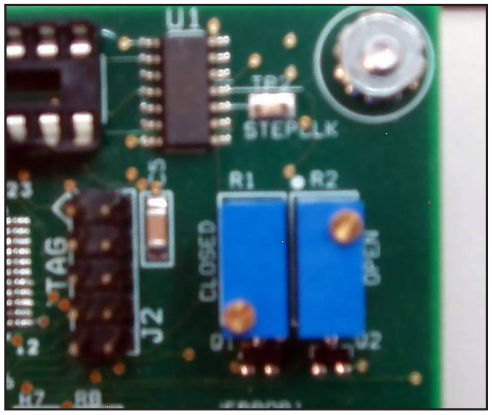
INLET VALVE



OUTLET VALVE

Figure 6.7 Servo Valves Fully Closed

12. If the index marks are not aligned, then an adjustment will need to be made to the “Closed” end-stop potentiometer on the corresponding servo control board (1200A-2540). Adjust until the index marks are as close to being aligned as possible.
13. After adjusting the 100% position, return the load to 0%, and confirm that the opening edges are lined up in their original position again.
14. This completes the indexing process.
15. Power down the system and disconnect the valve cables.
16. Reinstall each valve. We recommend using new gaskets on the mounting blocks. Use Blue Loctite 242 on the bolts.
17. Reconnect the water lines.
18. Reconnect the valve cables.
19. Power up the system and launch WinDyn.
20. Install your normal test group. Do not reinstall the Diag_BW test group
21. This completes the valve indexing process. If you have any questions or concerns, please contact SuperFlow Technical Support.



6.0 Maintenance

7.0 Troubleshooting

This section outlines basic procedures to follow if the component or instruments do not function properly. Contact SuperFlow Technical Support if you have any questions about the safe operation of the equipment or for service and advice.

⚠ WARNING

- **Post safety warnings and barricade work area to prevent unauthorized use of the dynamometer before maintenance has been completed.**
- **Only qualified machine operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ WARNING

AUTOMATIC STARTING HAZARD. The dynamometer could be started remotely. Ensure starting has been disabled prior to servicing.

7.1 Servo Valve

The following procedure can be used to diagnose whether the servo valves can be controlled by the control system. These tests function without any closed loop feedback from the electronics. Thus, PID control parameters are not in play.

Manual test mode:

1. Load the **Diag_BW.tgp** test group into your system. If you do not have this test group, contact SuperFlow Customer Service for a copy.
   a. This contains a config file (.cfa) that changes the inlet valve control mode to always copy the outlet valve.
   b. Thus, it will allow you to control both inlet and outlet control valves in manual mode control without the engine running. Normally, the inlet valve will not move until engine RPM exceeds 500.
   c. If you don't have the **Diag_BW.tgp**, but you have the WinDyn Config editor enabled on your system, you may edit the **SetIn** channel (103) as follows to enable the inlet valve to copy the outlet valve: **return(system(1,1,0,0)/40.96);**
   d. If you do edit your config file, don't forget to return the channel to the original setting when you are finished diagnosing your servo valves. Write down that setting before you edit the file in step C above.
2. Observe WinDyn screen objects showing the servo in and servo out percentage (objects are typically on screen 2 or 6; if not add the objects by editing your screen)

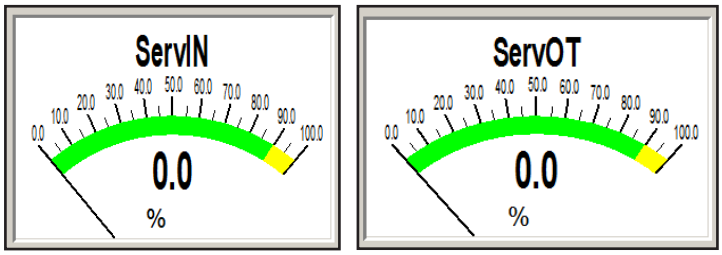


Figure 7.1 Servo IN and OUT Percentage

7.0 Troubleshooting

3. Select **MANUAL** control mode on the small touch screen on your console.
4. Turn the load control knob up and down, from 0% to 100% and observe those screen objects move from 0-100%
5. Now have someone else turn the knob and go into your dyno cell and observe the valves themselves inside the engine stand and see if they are indeed moving when the operator turns the knob.
6. If the valves check out, then you know they are at least capable of moving. That checks out most of the electronics.
7. Your valves still may not be indexed properly. Indexing SF-Black Widow servo valves is addressed in a separate procedure that can be obtained from SuperFlow Customer Service.

Automated test mode:

1. Load the **Diag_BW.tgp** test group into your system. If you do not have this test group, contact SuperFlow Customer Service for a copy.
   a. This contains a config file (.cfa) that changes the inlet valve control mode to always copy the outlet valve.
   b. Thus, it will allow you to control both inlet and outlet control valves in manual mode control without the engine running. Normally, the inlet valve will not move until engine RPM exceeds 500.
   c. If you don't have the **Diag_BW.tgp**, but have the WinDyn Config editor enabled on your system, you may edit the **SetIn** channel (103) as follows to enable the inlet valve to copy the outlet valve: **return(system(1,1,0,0)/40.96);**
   d. If you do edit your config file, don't forget to return the channel to the original setting when you are finished diagnosing your servo valves. Write down that setting before you edit the file in step C above.
2. Observe WinDyn screen objects showing the servo in and servo out percentage (objects are typically on screen 2 or 6; if not add the objects by editing your screen).

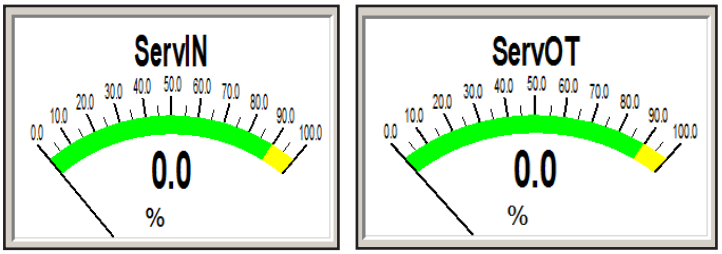


Figure 7.2 Servo IN and OUT Percentage

3. Install the **DiagTest.tpf** test profile. If you do not have this test, contact SuperFlow Customer Service for a copy.
4. Start the test profile and follow its on screen instructions to perform the **RAMP** test.
5. Observe those screen objects move from 0-100% and back automatically.
6. Observe your inlet and outlet valve inside the engine stand cabinet to see if the valves are ramping open and closed.

7.0 Troubleshooting

7. Quit the test.
8. If the valves check out, then you know they are at least capable of moving. That checks out most of the electronics.
9. Your valves still may not be indexed properly. Indexing SF-Black Widow servo valves is addressed in a separate procedure that can be obtained from SuperFlow Customer Service.

The above tests verify that the servos can sweep and are not jammed. They also verify that servo valve voltages are present and can move the valves through their entire rotation.

If the above tests show that one valve or the other or both are not behaving correctly, the problem is most likely with the servo valve, cabling, or associated electronics in the sensor box. The valves are electrically interchangeable and may be swapped from inlet to outlet to see if the valve is the issue or the electronics in the sensor box are the culprit. When swapping the valves, *if they use an extension cable*, be sure to use the extension cable when connecting the valve to the sensor box port. *Newer valves will not have the extension cable*, but their cable will be 10 feet in length and pinned properly to allow direct connection to the port on the box. ***DO NOT USE the extension cables with the newer valves*** that have the longer cables attached to the valves.

Control Electronics:

The 1200A-2540 servo control boards inside the sensor box have in-line fuses in their cabling. It is always a good idea to check those fuses with an Ohmmeter if one of your valves is not moving. The fuses are 5 amp slo-blo type, so a visual check is not sufficient. Use a meter to check them. The SuperFlow part number for those fuses is E4320P-313005.

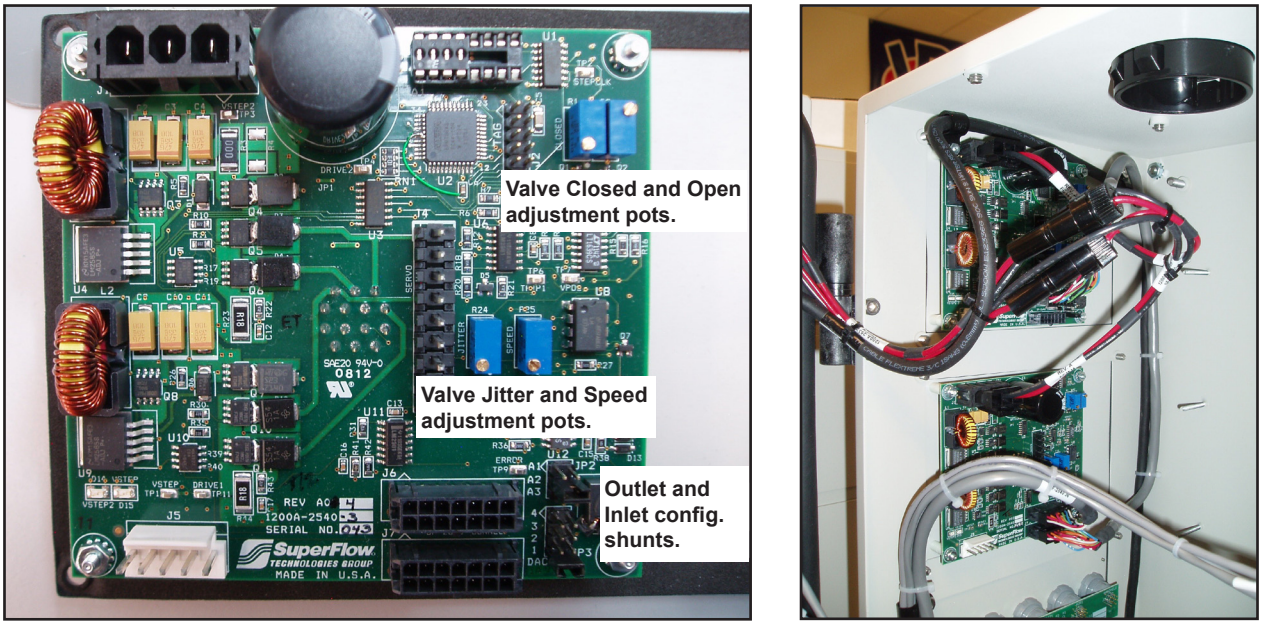


Figure 7.3 Check Fuses

The 1200A-2540 controller boards are basically the same, except for jumpers that are installed on each

7.0 Troubleshooting

board to determine whether the board is for an inlet or an outlet valve. If you receive a replacement board from SuperFlow, you must insure the jumpers are installed correctly for the location where you plan to use the board (inlet or outlet valve). You must also check you valve's fully open and fully closed indexing and adjust as necessary. There is a separate procedure documenting how to perform those adjustments.

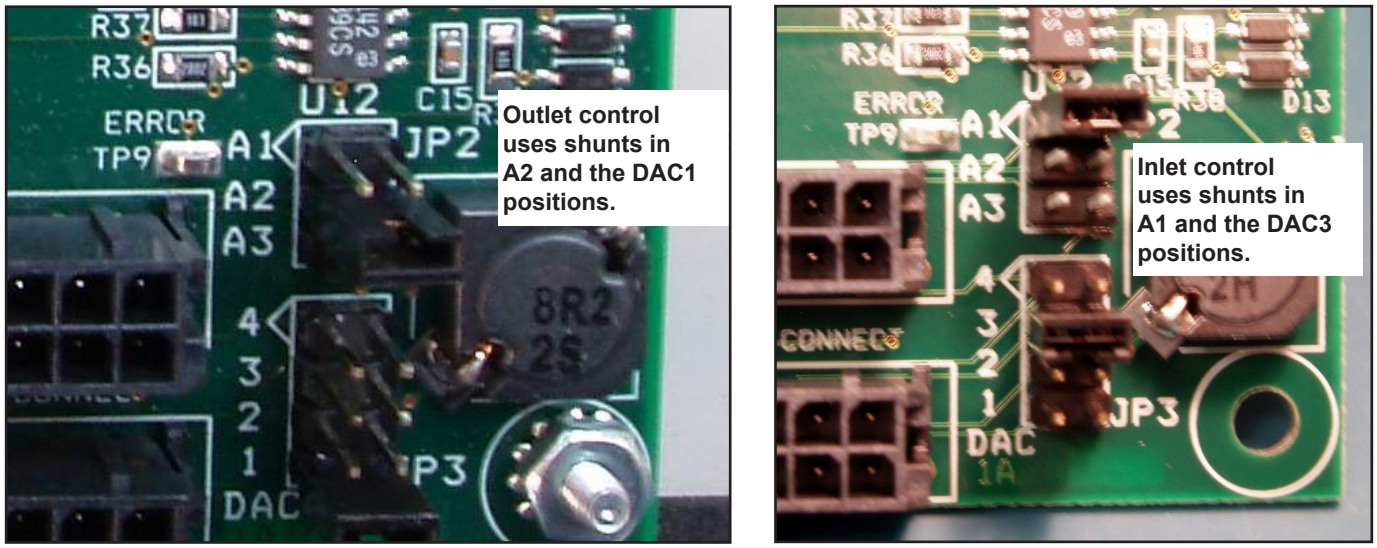


Figure 7.4 Check Jumpers

Another important checkpoint on the 1200A-2540 controller boards is to observe the two LEDs on those boards, VSTEP and VSTEP2. They both must be lit for the board to work properly. If one or both of the LEDs is not lit, the control circuitry will not function properly. If you do find the LEDs not lit, the board will have to be sent to SuperFlow for repair. See photo below for the location of the LEDs on the boards.

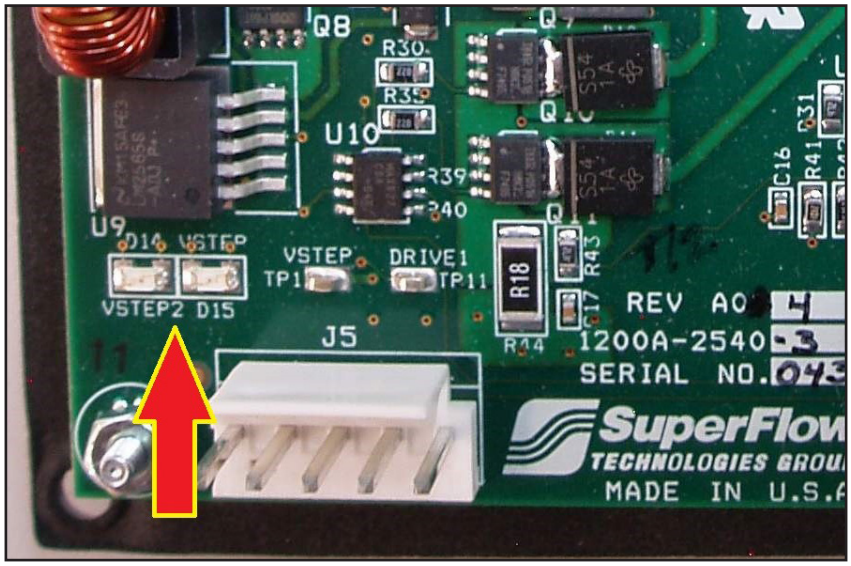


Figure 7.5 Check LEDs

7.0 Troubleshooting

Servo Valve Diagnosis:

During the manual sweep test, not only should the valve sweep evenly, but it is sometimes helpful to put your hand on the servo and feel the little ticks as it rotates.

The ticks should be even without any stutter. If the stutter happens at even increments, like every 4th one, then it is likely that it is a motor problem, or every 16th one, then it is likely an electronics problem. If the stutter is random, it's probably a pot signal issue. Also, we've included a table of the resistance values that should apply to a good servo motor assembly. It is a quick way to see if there is truly a physical problem with the servo. The most common problems are high resistance where there should be open circuits in the motor, which can indicate water in the motor. Any open circuits in pins 1-6 that have a value in the table (other than ∞) are a sign of a burned out coil or damaged cable.

The following resistance checks can be performed on the SF-Black Widow servo valves using the cable connector and its pins. If your valves use an extension cable, then the values below will be correct ONLY if you are measuring with the extension cable connected to the valve. Basically, you want to perform these measurements at the cable end that plugs into the port on the outside of your sensor box.

Servo Valve Connector Resistance Check in ohms (Ω)											
Description	**Pin #**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**11**
Coil C	1		∞	∞	∞	1.5	∞	2.8	∞	∞	∞
Coil B	2			2.8	∞	∞	1.5	∞	∞	∞	∞
Coil A	3				∞	∞	1.5	∞	∞	∞	∞
Shield	4					∞	∞	∞	∞	∞	∞
Center Coil A-B	5						∞	1.5	∞	∞	∞
Center Coil C-D	6							∞	∞	∞	∞
Coil D	7								∞	∞	∞
Potentiometer Signal (wiper)	9									X	Y
Potentiometer + (servo CCW)	10										Z
Potentiometer – (Servo CW)	11										

Notes:

1. All measured values should be within 10% of values indicated in table.
2. ∞ indicates infinite resistance, e.g. open circuit.
3. Pin 8 is not used
4. X should be ~3400 Ω when servo valve is fully open (and properly indexed), at 0% on controller
5. Y should be ~2300 Ω when servo valve is fully open (and properly indexed), at 0% on controller
6. Z should total ~5600 Ω, no matter where the valve is positioned
7. Table connections taken from 1200A-0814-3A-120 schematic

7.0 Troubleshooting

7.2 Absorber

The SuperFlow SF-Black Widow absorber is a very robust and durable piece and rarely fails mechanically. If your servo valves check out good mechanically and electrically, then the next step is to have a look at your absorber. With the engine disconnected from the absorber driveshaft, grasp the driveshaft and try to rotate it by hand. You should be able to rotate the shaft and the absorber impeller relatively easily. If not, then you may have seized a bearing or have other damage inside the absorber.

7.0 Troubleshooting

The troubleshooting tips in the following table may also help diagnose a servo valve or absorber problems.

Troubleshooting Chart	
Symptom	**Possible Cause**
Absorber does not load	• Insufficient water supply
	• Servo Valve spool loose or incorrectly indexed
	• Absorber rotor or stator bad
	• Normal condition: No water will flow through the PM absorber in NORMAL configuration, unless the engine RPM >500
Control unstable (manual mode)	• Engine not running smoothly
	• Severe ignition noise
	• Insufficient water supply
	• Capacity of absorber exceeded
	• Servo Valve spool loose or incorrectly indexed
	• Too much water flowing through the absorber
	○ Check **ValPos** value and **ServIn** position when controlling to EngSpd. Typical **ValPos** range is from .4 to 1.10.
	○ Optimum **ServIn** position is 60-80% for start RPM setpoint
	▪ Too low = **ValPos** too high, decrease **ValPos**
	▪ Too high = **ValPos** too low, increase **ValPos**
	• Water pressure too high or low
	○ Optimum pressure setting is 35 psig
	• Water backing up in outlet port of absorber or horn-of-plenty
	○ This creates backpressure on the system and affects control
	• Check inlet/outlet water temp delta T; optimum delta T is 60-100 degrees F
Control unstable (EngSpd mode); RPM rate inconsistent with selected rate	• Check in Manual mode for control problems
	• PID control parameters incorrect; load correct file (.ccp)
	• Too much water flowing through the absorber
	○ Check **ValPos** value and **ServIn** position when controlling to EngSpd. Typical **ValPos** range is from .4 to 1.10.
	○ Optimum **ServIn** position is 60-80% for start RPM setpoint
	▪ Too low = **ValPos** too high, decrease **ValPos**
	▪ Too high = **ValPos** too low, increase **ValPos**
	• Water pressure too high or low
	○ Optimum pressure setting is 35 psig
	• Water backing up in outlet port of absorber or horn-of-plenty
	○ This creates backpressure on the system and affects control
	• Electronics failure in sensor box

7.0 Troubleshooting

Troubleshooting Chart	
Symptom	**Possible Cause**
Control unstable (EngSpd mode); RPM rate inconsistent with selected rate - continued	• Bad RPM signal
	• Servo Valve spool loose or incorrectly indexed
	• Check inlet/outlet water temp delta T; optimum delta T is 60-100 degrees F
Absorber loses load while testing	• Insufficient water supply
	• Inlet temperature too high (above 90 degrees F)
No load cell reading (no torque measurement)	• Perform Torque Cal procedure
	• Broken wires on load cell
	• Load cell bad
Servo valve does not move (manual mode)	• Cable disconnected
	• Motor failure on valve
	• Debris in valve jamming spool
	• Electronics failure in sensor box
	• Fuse blown
	• 1200A-2540 board bad; check VSTEP and VSTEP2 LEDs

7.3 Water System

You should have a thermocouple installed to measure inlet and outlet water temperature on your system. We typically like to see inlet water temperature no higher than 90 degrees F.

The amount of water flowing through your absorber is determined by your inlet water pressure and the **ValPos** setting you are using. Higher water pressure will cause faster fill rates and push more water through the absorber for a given servo valve opening. We recommend no higher than 35 psig inlet water pressures. You should monitor this pressure via one of the pressure transducer ports on the pressure panel in your sensor box. If you do not have a transducer to use in your panel for this, but have an open port, contact SuperFlow Customer Service to purchase a transducer and have your system configured to read it.

The **ValPos** setting determines how much you are opening the inlet valve. A larger **ValPos** setting will subsequently flow more water. The volume of water flowing through the absorber will have an effect on the outlet water temperature. High flow rates will have lower outlet temps, and a low delta T between inlet and outlet temperatures.

It is not uncommon to have outlet water temps in the high 150's. We would prefer to see a **ValPos** setting that would lower that temp, if control is still acceptable. As we said earlier, the brake itself is very robust and durable, but if internal water temp gets too high, it can flash to steam, and then load control is totally lost, allowing the engine to run away.

It is also very important to insure your outlet water has a "free run" to the sump tank, without any restrictions such as several 90 degree elbows. If water backs up against the absorber outlet, it creates back pressure on the system, and this causes load control instability.

8.0 Appendix

The following pages contain information specific to the SuperFlow SF-Black Widow dynamometer. As specifications and part numbers change, these documents will be updated to reflect the equipment and requirements for your machine at the time of shipment. Contact your sales representative for further information.