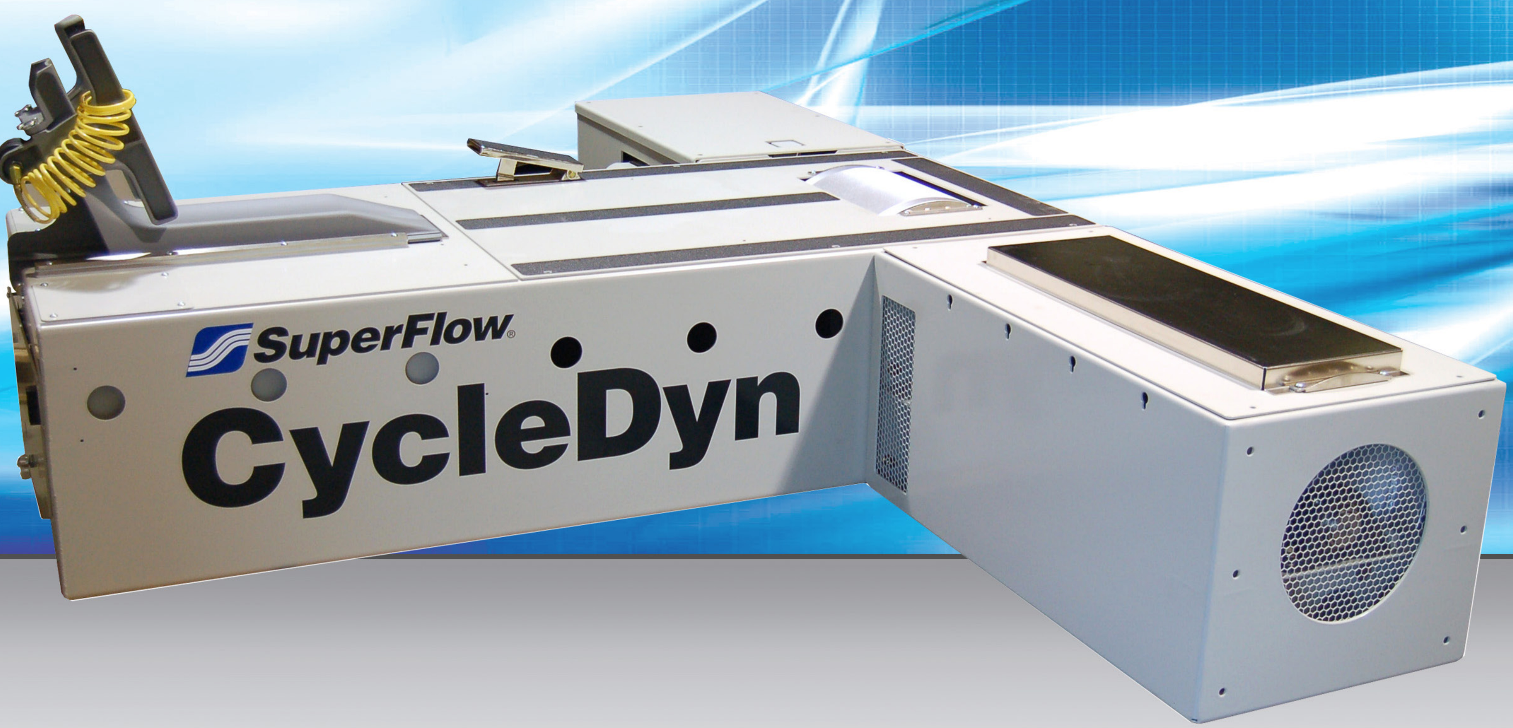
SuperFlow
DYNAMOMETERS & FLOWBENCHES
A Division of Power Test, Inc.

Operator Manual

Pub. No.: 190617 Rev.: 0
June 2019



Original Instructions

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CHASSIS DYNAMOMETER

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

Trademark Notices

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.

Introduction

About This Manual

This manual is provided as a reference to explain the operation of the SuperFlow CycleDyn as used on any engine test system.

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

Target Audience

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

Product Features

The SuperFlow CycleDyn is a motorcycle chassis dynamometer designed to test motorcycles, karts, ATVs (quads), and similar vehicles within a safe, controlled environment. Testing on a dynamometer:

- Reduces road testing liability
- Improves measurement accuracy
- Enhances productivity

How to Use This Manual

This manual is provided as a reference to explain the design, installation, operation, and maintenance of the SuperFlow CycleDyn chassis dynamometer.

- **Chapter 1: Safety**

  Please read this chapter in its entirety before beginning. This chapter addresses safety procedures, warnings, dangers due to non-observance of safety procedures, room requirements, and noise levels.

- **Chapter 2: Product Overview**

  Provides a general overview of the CycleDyn system, including data acquisition, components, specifications, power requirements, the dynamometer, and accessories and options.

- **Chapter 3: Packaging and Handling**

  Describes the product weights and dimensions, shipping and handling information, lifting and handling instructions, unpacking and inspection, and packaging checklists.

- **Chapter 4: Room Requirements**

  Suggests how to design and construct a chassis dynamometer test system with a proper lighting, cooling water, ventilation, exhaust and fire control system. Includes plans and considerations such as safety, sound control, water additives, and equipment sources.

- **Chapter 5: Installation**

  Details the unpacking and installation of a SuperFlow CycleDyn. Includes preliminary checks, sensor box and wheel restraint installation, system cable connections, configuration, calibration, and expansion panels.

  These installation instructions are generic in the description of the system. Some sections may not apply to your system.

- **Chapter 6: System Operation**

  Provides information to help the operator use the CycleDyn for running tests, storing and analyzing test results, and removing the motorcycle. Includes preliminary operation, basic steps to running the CycleDyn, and obtaining engine speed on a chassis dyno.

- **Chapter 7: Handheld Controls**

  Covers the handheld keypad and key functions, startup and main operating screens, dynamometer controls, system controls, and handheld expressions.

- **Chapter 8: Theory**

  Covers test types, test profile descriptions, engine testing errors, and the theory of acceleration effects, correcting power measurements, limit monitoring, and environmental monitoring.

- **Chapter 9: Config File Description**

  Describes the Configuration file used to define the functions of WinDyn and the NGE Data Acquisition System. Includes the channel functions (sensor channels, specification channels, calculated channels, interpolation tables, system channels), control channels, and the display screens.

- **Chapter 10: Service and Calibration**

  Covers CycleDyn inspection and maintenance instructions, maintenance records, calibration instructions, service, and troubleshooting the CycleDyn.

- **Chapter 11: Control Modes**

  This chapter is a parameter adjustment guide intended as a reference for the WinDyn system operator and:

  – Defines the adjustable control parameters in WinDyn.

  – Provides suggestions for tuning the control parameters to provide the best combination for stable, accurate tracking and good step response to set point change.

- **Appendix A: Options and Accessories**

  CycleDyn accessories include the auxiliary roll, high-speed blower module, engine adapter, and second eddy current module. Also includes the CycleDyn parts list for frequently ordered parts.

- **Appendix B: General Testing**

  Provides useful information on torque capacity rating, fuel flow when accelerating, measuring airflow, flowbench correlation, oil temperature control, torque versus speed, fuel injection return flow, cleaning fuel filters, thermocouples, barometric pressure, and noise interference.

- **Appendix C: Parts List and Drawings**

  Provides replacement parts, options, accessories, and mechanical drawings pertaining to the CycleDyn.

- **Appendix D: Exhaust Extraction**

  Provides important information on exhaust extraction systems and provides both good and bad examples.

Manual Conventions

The following conventions indicate items of interest or concern:

WARNING: Failure to take or avoid a specific action could result in physical harm to the user or the hardware.

CAUTION: Failure to take or avoid a specified action could result in loss of data or equipment.

IMPORTANT: Essential operating information.

NOTE: *Helpful information that may provide insight to the user/operator.*

TIP: *Additional information that may provide convenient workarounds or solutions.*

Cross-references refer the reader to additional information in the chapter, manual, or other sources (including Web sites).

Other Manual Information

Add other information the user may need before starting.

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CHAPTER 1

SAFETY

IN THIS CHAPTER

- Safety Warnings
  - Dangers Due to Non-observance of Safety Instructions
- Room Requirements
- General Safety Procedures
- Noise Levels
- Carbon Monoxide Warnings

1.1 Safety Warnings

WARNING: To ensure safe operation, this equipment must only be operated according to the instructions in the *SuperFlow CycleDyn Operator's Manual*. It is also essential that this equipment is installed, maintained, and operated according to local safety requirements.

Any person instructed to carry out installation, maintenance or repair of the equipment must read and understand the *CycleDyn Operator Manual* and in particular the technical safety instructions. Any users of this equipment must operate only the controls of the equipment. Only qualified personnel should remove exterior panels and service equipment.

1.1.1 Dangers Due to Non-observance of Safety Instructions

- Carbon monoxide poisoning
- Hearing damage due to high noise levels
- Electrical shock
- Exposure to rotating parts

1.2 General Safety Procedures

CAUTION: Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around Printed Circuit Boards (PCBs).
- Do not touch the components or conductors on a PCB with your hands or with conductive devices.

CAUTION: To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Always follow basic safety precautions when using this product to reduce risk of injury and/or damage to equipment.

- Only authorized personnel trained in the operation of the dynamometer should have access to the equipment.
- Read and understand all instructions in the user guides.
- Use only the proper electrical sources as prescribed in the installation guide. Ensure circuit breakers are easily accessible and have the proper rating.
- Observe all warnings and instructions marked on the product.
- Ensure proper ventilation of exhaust gases from the vicinity of the dynamometer

- Provide fire extinguishers that are rated for electrical and oils.
- Provide adequate lighting in the test cell and at the operators console.
- Always wear proper protective clothing and eye/ear protection.
- Refer all service questions to qualified personnel.
- Do not remove any safety guards while the machine is in operation and be sure the safety guards are correctly mounted before operating the device.
- Disconnect the external power switch before opening the rear panel of the device.
- Replace the power cable if it is damaged.
- Keep the air inlet grids free of dust or dirt.
- Keep loose material away from the inlet and exhaust air ducts.
- Do not store flammable materials in the vicinity of the dynamometer.
- Keep all personnel, flammable items, and sensitive objects away from any rotating object that can throw debris radially outward.

1.3 Room Requirements

When working in or building a test cell:

- Follow all local construction codes.
- Install a Carbon Monoxide (CO) detector in the test cell.
- Provide fire extinguishers that are rated for gasoline and oils.
- Provide adequate lighting in the test cell and at the operators console.
- Provide a means outside the test cell to turn off the ventilation fans and electrical circuits.

1.4 Noise Levels

SuperFlow Technologies Group always recommends ear protection when operating any product.

Warning Signs of Hazardous Noise[1]

- You must raise your voice to be heard.
- You cannot hear someone two feet away from you.
- Speech around you sounds muffled or dull after leaving a noise area.
- You have pain or ringing on your ears (tinnitus) after exposure to noise.

1. Information in this section was adapted from "Noise and Hearing Loss," American Speech-Language-Hearing Association, 1997–2007, **http://www.asha.org/public/hearing/disorders/noise.htm**, 2007.

Hazardous Noise

Both the amount of noise and the duration of exposure determine the amount of damage to hearing. Noise levels are measured in decibels (dB). The higher the decibel level, the louder the noise. Hair cells of the inner ear and the hearing nerve can be damaged by an intense brief impulse (such as an explosion) or by continuous or repeated exposure to noise.

For sound levels of 85 decibels (dB) or above, use hearing protection. Please follow all safety standards when operating this or any equipment.

1.5 Carbon Monoxide Warnings

When operating fuel-generated equipment in enclosed areas, take the following precautions to protect you and your employees against carbon monoxide exposure.

What is carbon monoxide?[1]

Carbon monoxide (CO) is a poisonous, colorless, odorless, and tasteless gas. Although it has no detectable odor, CO is often mixed with other gases that do have an odor; therefore, you can inhale carbon monoxide right along with gases you can smell and not even know that CO is present.

CO is a common industrial hazard resulting from the incomplete burning of natural gas and any other material containing carbon such as gasoline, kerosene, oil, propane, coal, or wood. One of the most common sources of exposure in the workplace is the internal combustion engine.

How does CO harm you?

Carbon monoxide is harmful when breathed because it displaces oxygen in the blood and deprives the heart, brain, and other vital organs of oxygen. Large amounts of CO can overtake you in minutes without warning—causing you to lose consciousness and suffocate.

Besides tightness across the chest, initial symptoms of CO poisoning may include headache, fatigue, dizziness, drowsiness, or nausea. Sudden chest pain may occur in people with angina. During prolonged or high exposures, symptoms may worsen and include vomiting, confusion, and collapse in addition to loss of consciousness and muscle weakness. Symptoms vary widely from person to person. CO poisoning may occur sooner in those most susceptible: young children, elderly people, people with lung or heart disease, people at high altitudes, or those who already have elevated CO blood levels such as smokers. CO poisoning poses a special risk to fetuses.

Acute poisoning may result in permanent damage to the parts of your body.

1. Information in this section was adapted from the “OSHA Fact Sheet,” U.S. Department of Labor, Occupational Safety and Health Administration, 2002, **http://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf**, 2007.

How can employers help prevent CO poisoning?

To reduce the chances of CO poisoning in your workplace:

- Install an effective ventilation system that will remove CO from work areas.
- Maintain equipment and appliances that can produce CO to ensure they are in good working order, promote their safe operation, and reduce CO formation.
- Consider switching from gasoline-powered equipment to equipment powered by electricity, batteries, or compressed air if it can be used safely.
- Prohibit the use of gasoline-powered engines or tools in poorly ventilated areas.
- Provide personal CO monitors with audible alarms if potential exposure to CO exists.
- Test air regularly in areas where CO may be present, including confined spaces.
- Install CO monitors with audible alarms.
- Use a full-face piece, pressure-demand, Self-Contained Breathing Apparatus (SCBA) certified by the National Institute for Occupational Safety and Health (NIOSH) or a combination full-face piece, pressure demand supplied-air respirator with auxiliary self-contained air supply in areas with high CO concentrations (those immediately dangerous to life and health atmospheres).
- Use respirators with appropriate canisters for short periods under certain circumstances where CO levels are not exceedingly high.
- Educate workers about the sources and conditions that may result in CO poisoning as well as the symptoms and control of CO exposure.
- In addition, if your employees are working in confined spaces where the presence of CO is suspected, you must ensure that workers test for oxygen sufficiency before entering.

What can employees do to help prevent CO poisoning?

To reduce the chances of CO poisoning in the workplace, employees should:

- Report any situation to your employer that might cause CO to accumulate.
- Be alert to ventilation problems—especially in enclosed areas where gases of burning fuels may be released.
- Report promptly complaints of dizziness, drowsiness, or nausea.
- Avoid overexertion if you suspect CO poisoning, and leave the contaminated area.
- Tell your doctor that you may have been exposed to CO if you get sick.
- Avoid the use of gas-powered engines, such as those in powered washers as well as heaters and forklifts, while working in enclosed spaces.

What are the OSHA standards for CO exposure?

The OSHA PEL is 50 parts per million (ppm). OSHA standards prohibit worker exposure to more than 50 parts of the gas per million parts of air averaged during an 8-hour time period.

For more information on carbon monoxide, visit the OSHA Web site at **http://www.osha.gov**.

CHAPTER 2

PRODUCT OVERVIEW

IN THIS CHAPTER

- Introduction
- CycleDyn Models
- Dynamometer
  - Base Enclosure Assembly
  - Eddy Current Power Absorber Assembly
- Data Acquisition
  - Sensor Box
  - Operator Controls
  - Computer System
  - Sensor Box Panels
  - Expansion Panels
- Accessories and Options
  - Temperature and Humidity Probe
  - Engine Speed Sensors
  - Optical Tachometer Sensor
  - Lambda Sensor
  - Volumetric Blow-by
  - Auxiliary Roll (ATV Roll)
  - High-speed Blower Option
  - Drag Pack Extension Kit
  - Second Eddy Current Module
  - Fuel Flow Sensors
  - Airflow Sensors
- Specifications

2.1 Overview

The SuperFlow CycleDyn is a motorcycle chassis dynamometer designed to test motorcycles, karts, ATVs (quads), and similar vehicles within a safe, controlled environment. Testing on a dynamometer reduces road testing liability, improves measurement accuracy, and enhances productivity. Typical applications include:

- Research and Development (R&D)
- Performance testing and tuning
- Diagnostics
- Durability and quality control
- Fuel consumption and emissions testing
- Education
- Vehicle certification

CAUTION: This equipment generates, uses, and can radiate radio frequency energy. If not installed according to the *CycleDyn Operator Manual*, this equipment may cause interference to radio communications. The equipment was designed to provide reasonable protection against such interference when operated in a commercial environment. Operating this equipment in a residential area is likely to cause interference, and the user will be required to correct the interference at the user's own expense.

A CycleDyn system consists primarily of two major components: the dynamometer chassis with its associated equipment, and the Data Acquisition and Control (DAC) system with its associated accessories.

- The vehicle sets on the dynamometer chassis while it is dyno tested. With the vehicle secured to the chassis, the drive wheels spin on a roll while sensors transmit measurements to the DAC system.
- The DAC system comprises 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 dynamometer chassis and the engine. The WinDyn™ software on a stand-alone computer lets users display and analyze the data during and after a test.

2.2 CycleDyn Models

The three basic types of CycleDyn models are inertia only, eddy current, and AC motoring. Added options and accessories expand the variations of each type.

Inertia Only (SF-210)

An inertia-only dynamometer uses the weight of the roll to apply load to the vehicle. When the vehicle accelerates, the engine develops additional power to accelerate the mass weight of the roll and the motorcycle's rotating components. Inertia power is calculated from the base inertia of the dynamometer, the rotating inertia of the motorcycle, rate of acceleration, and the actual road speed the vehicle is traveling at.

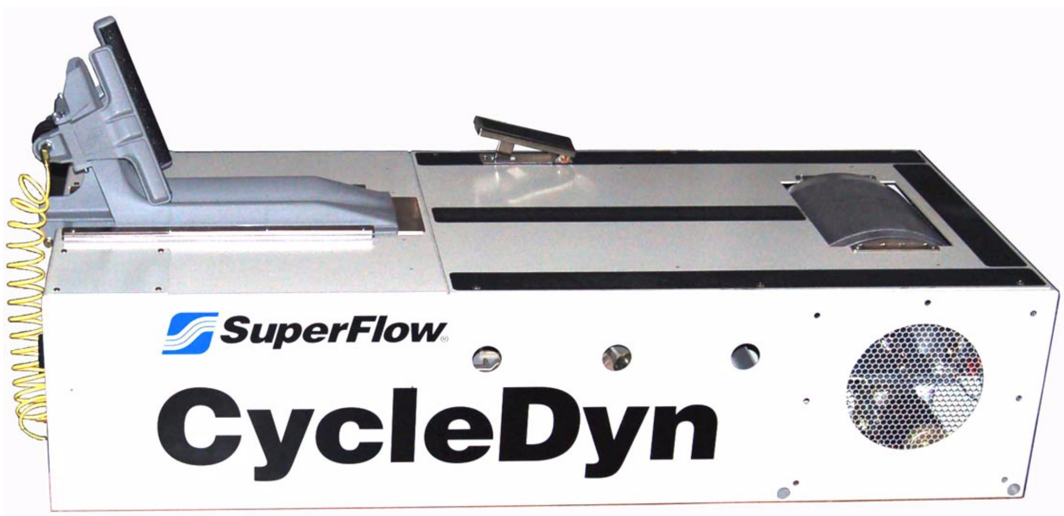


Figure 2-1. Inertia Only

A typical inertia motorcycle dynamometer performs only Wide-Open Throttle (WOT) acceleration tests.

Eddy Current (SF-250)

The eddy current (EC) absorber module attached to the base enclosure applies a variable, computer-controlled load to the roll. With the absorber module, you can perform tests at varying rates of acceleration at steady speeds or at part or full throttle to simulate track, road course, and high-performance street applications. The absorber allows operators to run tests in the safety of a shop environment, yet still test the bike under real-world operating conditions.

SuperFlow's EC module uses a large, air-cooled, eddy current absorber capable of handling the rear-wheel power of most street and racing motorcycles.

Figure 2-2. Eddy Current Module

AC Motoring

This module has an electric motor that will spin the dynamometer roll in controlled conditions. The hardware and software system can then "motor" the test vehicle to perform emissions drive cycles and inertia simulations, evaluate frictional losses, map Engine Control Units (ECUs) and complete numerous other engineering-grade test procedures. Using the AC Motoring option, you can test brakes, drivetrains, and other chassis components. Many tests can even be run without the test vehicle's engine running.

The AC Motor module attaches to the base enclosure but can also be coupled to an eddy current module to provide even greater testing capability.

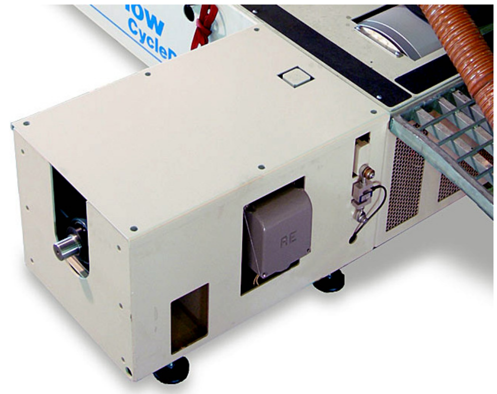


Figure 2-3. AC Motor Module

Plus, the Electronic Inertia Simulation (EIS) software addresses and accounts for parasitic losses of all rotating components through a programmed calibration process.

NOTE: *The EC cube and AC Motoring cube may not be controlled concurrently. While the EC cube can remain attached to the AC Motor cube, the data acquisition and control system cannot control both at the same time. Software is provided to control one or the other.*

2.3 Dynamometer

The SuperFlow CycleDyn chassis dynamometer is a modular system. By selecting the appropriate modules for the chassis, the CycleDyn can be configured to match your test requirements exactly.

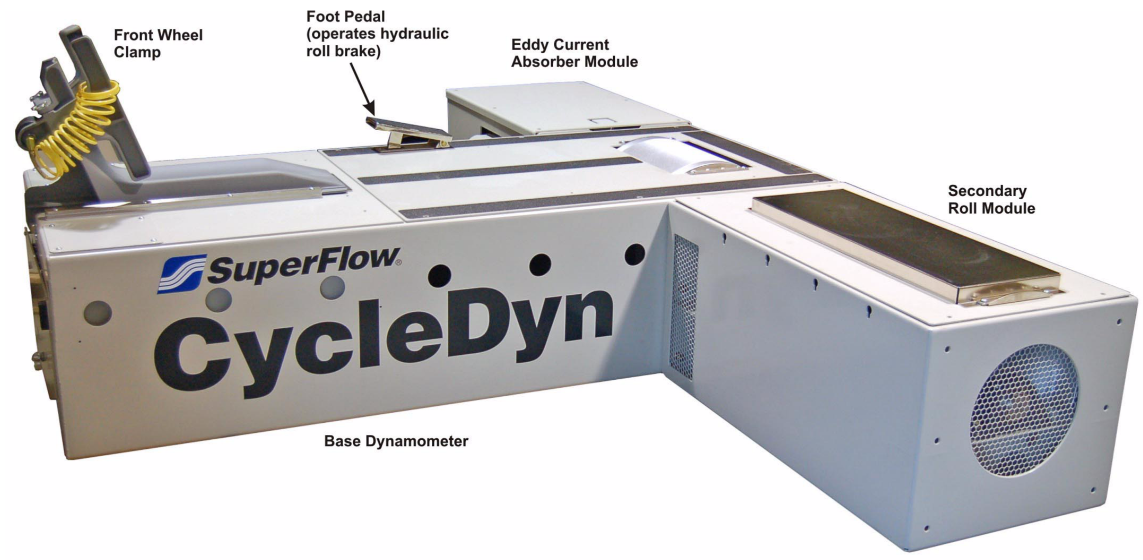


Figure 2-4. Complete CycleDyn System

The core of the system is the base dynamometer enclosure which holds the primary roll, front-wheel clamping assembly, and connections to the sensor box. Some models also include a foot brake, electric starter, battery, and trickle charger. The base dyno and all modules are suitable for above-ground or pit installation. Connections from the chassis to the data acquisition system are provided in one cable.

Depending on the test requirements, modules are added to the base dynamometer.

- To run acceleration or steady-state controlled tests, an eddy current absorber module is attached to either side of the base enclosure, to the secondary roll module, or to an AC motor module.
- A secondary roll module attaches to either side of the base dynamometer and connects directly to the primary roll. The additional roll allows you to test small four-wheel vehicles such as karts, ATVs, and three-wheelers. A side platform is added to support the vehicle.
- To conduct an emissions test or perform drive-cycle simulation, an AC motor module is attached to either side of the base enclosure or to the secondary roll module.

The CycleDyn is capable of performing automatic, computer-controlled acceleration and steady-state tests through the use of inertia, eddy-current power absorption, and AC motor technology.

2.3.1 Base Enclosure Assembly

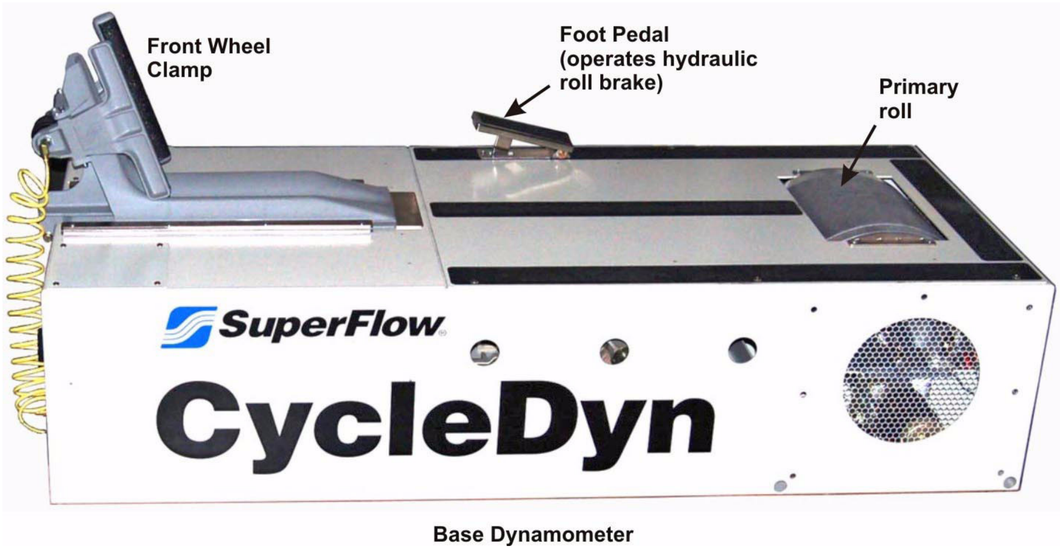


Figure 2-5. Base Enclosure

The frame or base enclosure contains the primary roll, wheel restraint system, foot brake, battery, Interconnect circuit card, starter, and magnetic pickup.

The diameter of the primary roll is 19.875"(505 mm). Two different rolls are available—one with 280 lb.s of equivalent vehicle weight (inertia) and one with 450 lbs. SuperFlow measures the inertia of each roll after it is placed in the chassis to provide an exact calculation of power when the roll is accelerated.

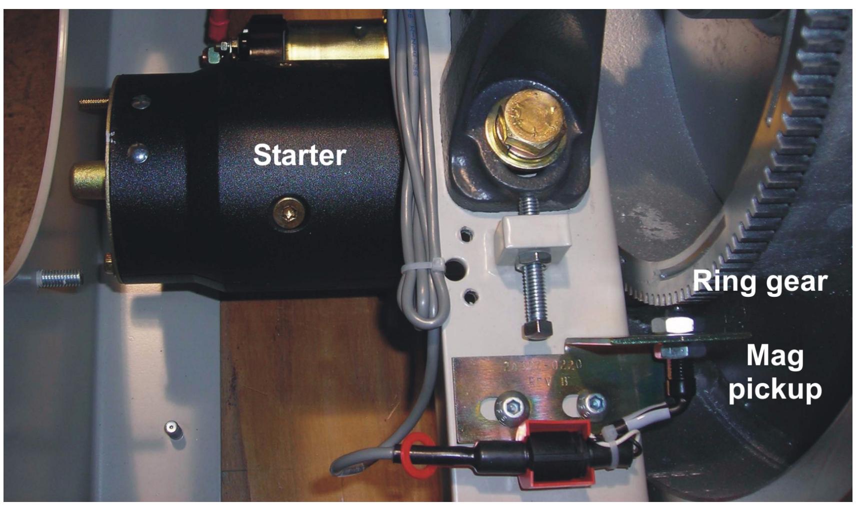


Figure 2-6. Ring Gear

The roll has a 153-tooth ring gear used for the starter and measurement of roll speed. A magnetic pickup detects the teeth on the ring gear and creates a frequency that is then converted to speed through the electronic circuitry and software. The magnetic pickup also creates a signal that interlocks the wheel restraint and starter to prevent accidental engagement while the roll is rotating. The magnetic pickup is nominally set with a 0.015" air gap from the starter ring gear. However, it is important to check for any run-out that may cause the roll gear to hit the pickup and then re-adjust the pickup accordingly.

An electric starter in the dynamometer chassis can be used to center the motorcycle tire on the roll or bump start the engine. The starter is activated by a starter solenoid and engages the roll ring gear. An electronic interlock prevents the starter from engaging while the roll rotates.

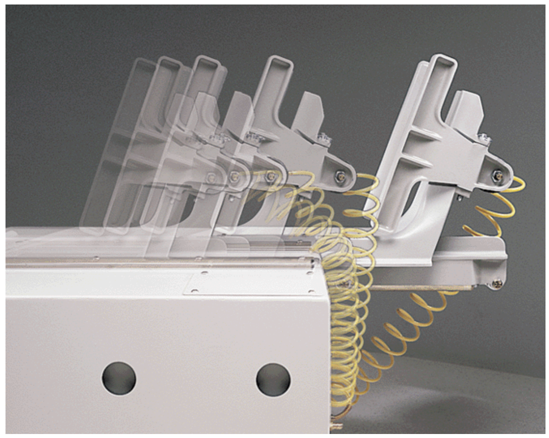


Figure 2-7. Adjustable Wheel Restraint

The motorized, adjustable wheel restraint accepts motorcycle wheelbases from 48” to 72” (1,220 to 1830 mm). The air-actuated clamp firmly grasps the front wheel and holds it in the test position while the vehicle is secured to the dynamometer with straps.

WARNING: Do not operate a vehicle on the dynamometer without securely strapping the vehicle down to the frame assembly. The wheel restraint system is not intended as the sole restraint for the vehicle under test.

The wheel restraint system has a mechanism that consists of a motor which drives the restraint forward or backward. A potentiometer enclosed in the motor assembly provides an analog voltage used by the data acquisition system as a position sensor. Using this sensor, WinDyn displays an index of 0–100 for ease of setup for various wheel bases. An electronic interlock prevents the motor from moving if the roll is rotating.

The wheel restraint clamp is controlled by two solenoids that allow air either in or out of the air bag between the clamp pads. The air pressure is regulated to 90 psi. A check valve located between the air supply and the close solenoid prevents opening of the wheel restraint if the air supply is lost. An electronic interlock prevents it from releasing while the roll is rotating.

The foot brake activates a disc brake on the roll shaft. This brake is intended to hold the roll stationary while moving a vehicle on or off the roll as well as stop the roll from spinning.

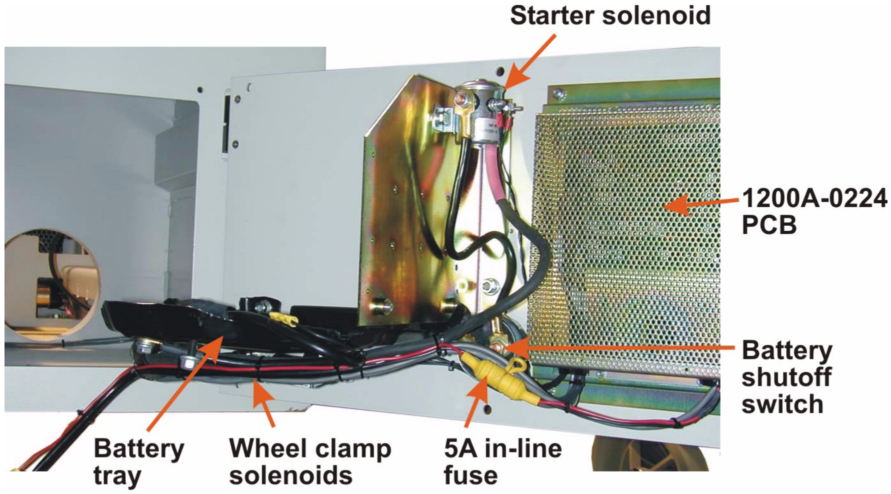


Figure 2-8. Battery Tray and 0224 PCB

A 12-VDC battery located on the front door of the chassis is used to power the starter motor and wheelbase restraint position motor. A 5A in-line fuse protects the battery and the circuitry on the 0224 circuit board from damage. A switch on the access door disconnects the battery power from the starter.

The interconnect circuit card (SuperFlow part number 1200A-0224) is the electronic interface between the chassis and the sensor box. Signals for the roll speed, roll torque, and eddy current control pass through this circuit board. It also contains the circuitry for the wheel restraint system, and starter.

The 0224 dynamometer interconnect card contains a battery trickle charger that has a maximum output of two amps. The charger is intended to maintain a “good” battery and will not charge a dead battery.

2.3.2 Eddy Current Power Absorber Assembly

Figure 2-9. EC Absorber

Depending upon the control mode, the eddy current (EC) absorber produces a load against the motorcycle to simulate additional inertia or apply load to hold the vehicle at a constant speed. The EC absorber requires 220VAC, 20A to operate.

Adding the absorber to a system allows the user to run "steady speed," "steady torque," or "loaded accelerations." SuperFlow technicians measure the bearing and windage (parasitic) losses of each individual absorber when the dynamometer is built and add the losses into the horsepower calculations for the vehicle under test.

An EC controller is mounted on the side of the module where the power connects. A signal from the data acquisition system (sensor box) is routed to the EC controller through the interconnect circuit card to "drive" the absorber and create the load.

A load cell (or torque link) measures the force created from the load and sends an analog voltage to the data acquisition system where it is converted to a roll torque measurement used in the horsepower calculations. The load cell output is calibrated to provide a very accurate measurement.

Figure 2-10. Load Cell

IMPORTANT: The absorber has blades that are a part of the rotor. These provide cooling to the eddy current coil as the absorber rotates. The absorber can be damaged if a load control signal is applied without the absorber spinning.

2.4 Data Acquisition

The SuperFlow data acquisition system consists of at least three components: the sensor system, operator console, and the computer system. The components can be attached to almost any type of chassis dynamometer test stand with or without an absorber.

Additional options and accessories can be added to the system. They are described under "Accessories and Options" on page 2-17.

2.4.1 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 a rolling stand but can be installed on a boom, a wall, or on other support apparatus. All share the same main components. Differences in systems are mainly in the expansion capabilities.

Figure 2-11. Sensor Box

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

The CPU measures and records all data, generates control signals, then broadcasts this data over an Ethernet network to display on the WinDyn™ computer software or use with other SuperFlow test system components.

The sensor box has slots for expansion panels such as thermocouple panels, pressure panels, analog input panels, and so on. The number of panels in the unit depend upon how many panels were purchased.

The box may have up to eight Liquid Crystal Displays (LCDs) on the front door panel for showing user-defined data channels (optional).

The system inputs signals from various sensors and converts those signals into a digital format. Roll speed 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.

In addition to the measured data channels, the user enters data in the form of specification channels. Specifications configure the test system for a particular test device. The specifications, along with the measured data, are used to calculate some of the information the test system displays.

2.4.2 Operator Controls

The handheld controller remote is the main interface with the CycleDyn. Using the handheld controller, operators can perform everything from installing the bike on the dyno to viewing final test results. Using the controller while seated on the motorcycle, an operator can position the wheel restraint, clamp the front wheel, bump the starter to center the rear wheel on the roll, and run a test. The handheld displays user-selected data channels and provides the operator with continuous prompts and choices for running tests.

The handheld controller is available in two styles:

Wired Handheld

Wireless Handheld

Figure 2-12. Handheld Operator Controllers

- **Wired Handheld (1200A-1853-02):** The standard wired handheld controller is encased in a rubberized housing with a Lexon® plastic cover over the backlit, 8-line by 40-character Liquid Crystal Display (LCD) to protect it.

  Two rubber bumpers on the back stabilize the handheld unit when placed on the gas tank, steering wheel, or other surface. The bumpers are removable. A 22-foot cable connects to the sensor box with a color-coded and keyed LEMO connector.

  The wired handheld has 27 hard plastic button keys for entering data and controlling tests. Ten software-defined keys around the display are automatically labeled for a particular function depending upon menu selection or during a scripted automatic test.

  The handheld is sealed for protection from moisture, but the seal is not sufficient for submersion. The cable strain relief protects the cable; however, take care to not wrap the cable tightly around the housing.

  For more information on the wired handheld, refer to Chapter 2, “Product Overview.”

- **Wireless Handheld (1200A-1853-06):** The optional wireless remote handheld controller uses Bluetooth® technology to communicate with the Central Processing Unit (CPU) in the sensor box. It is powered by a rechargeable battery, an AC adapter, or a cigarette lighter adapter. The battery recharges whenever the controller is plugged into an external power source.

  The wireless handheld unit is encased in a rubberized housing with a Lexon plastic cover over the 240x320-pixel monochrome LCD to protect it. Two rubber bumpers on the back stabilize the handheld unit when placed on the gas tank, steering wheel, or other surface. The bumpers are removable.

  The handheld provides control to the system by 15 software-defined keys, a numeric keypad for data entry, three data entry rotary knobs, and the touch-screen display. It is sealed for protection from moisture, but the seal is not sufficient for submersion.

  More information on the wireless handheld is provided in separate documentation.

2.4.3 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.

A computer system is not required to operate the dynamometer, but it significantly enhances the system's capabilities and ease of use. SuperFlow's WinDyn dynamometer software was designed for Microsoft® Windows®-based computers and requires a computer with a Pentium™ or equivalent processor. A printer is connected to the computer.

Figure 2-13. Basic Computer System

The computer communicates with the sensor system through an Ethernet Local Area Network (LAN) cable. Ethernet technology allows users to hook up remote computers throughout the test facility to the test system. Each computer must have WinDyn installed to view data in real time. All computers can analyze recorded data with a special viewer included in WinDyn; the viewer is also available as a free download on the SuperFlow Web site.

The computer installed at the operator's desk is normally configured as the "Master computer." Commands to the test system can only be issued from this computer.

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.

All Windows-supported printers can be used. A color printer is recommended for highest impact and clarity of test graphs.

Refer to the "Computer Requirements" section in chapter 1 of the *WinDyn Users Guide* for the minimum computer requirements, or visit the SuperFlow Web site (**www.superflow.com**) for the current recommendations.

2.4.4 Sensor Box Panels

The system and sensor interconnect panels provide the primary connections between the sensor box and the other parts of the dynamometer system.

2.4.4.1 System Interconnect Panel

Figure 2-14. System Interconnect Panel

- Color-coded and keyed LEMO connectors
- Remote handheld controller serial port
- Air sensor frequency inputs
- Air temperature and humidity sensor inputs
- Auxiliary frequency input
- Engine speed sensor input
- RJ-45 Category 5 (Cat-5)serial connectors

2.4.4.2 Sensor Interconnect Panel

Figure 2-15. Sensor Interconnect Panel

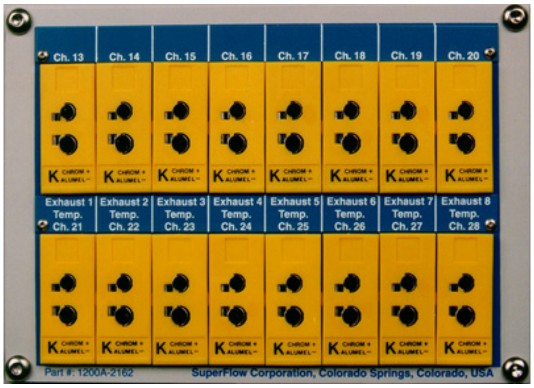
- Absorber speed and torque sensor connections
- Dynamometer interface (chassis dynos)
- Servo valve connection
- Electronic throttle connection
- Auxiliary voltage sensor inputs
- Fuel turbine frequency inputs
- Auxiliary control outputs

2.4.5 Expansion Panels

Expansion panels are mounted onto the side of the sensor box and a cable connects the panel to the CPU circuit board.

2.4.5.1 Thermocouple Input Panel

The thermocouple panel is an optional accessory that provides 16 channels for temperature measurements on the test device.

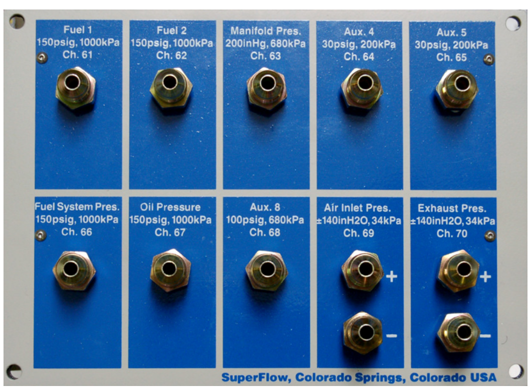


- 16 channels per panel
- Type K, J, or T (ungrounded)
- Type K thermocouple range, 0–2,000°F *(-18° to 1100°C)*, linearized
- Universal panel jacks accept both standard and miniature connectors

Figure 2-16. Thermocouple Input Panel

2.4.5.2 Pressure Input Panel

The pressure panel is an optional accessory that provides up to 10 channels of pressure measurements on the test device. The standard system ships with two channels installed. Other channels are available upon request.



- 10 channels per panel
- Up to six Printed Circuit Board (PCB)-mounted transducers (two can be differential sensors)
- Up to four screw-in, industrial-grade transducers
- 1/8 x #4 male fittings for pressure lines
  - **Oil:** 0–150 psi *(0–1034 kPa)* x 0.1, ± 0.5% fs
  - **Manifold pressure:** –100 to +100 psi *(–690 to +690 kPa)* x 0.1, ± 0.5% fs

Figure 2-17. Pressure Input Panel

2.4.5.3 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.

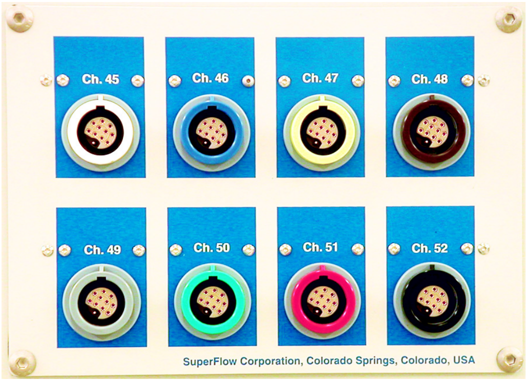


Figure 2-18. Analog Voltage Input Panel

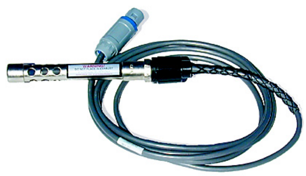
- Eight channels per panel
- 4.096 VDC, 5 VDC, 10 VDC excitation voltages
- +/– 5 VDC and +/– 12 VDC sensor supply voltages
- Adjustable gain and offset accepts any voltage between –100 and +100 VDC
- Color-coded and keyed 10-pin LEMO connectors
- Frequently used for eight channels of Lambda sensor inputs or pressure transducers.

2.5 Accessories and Options

You can select numerous accessories and add various options to the CycleDyn dynamometer system to fit specific testing requirements.

Contact SuperFlow Sales or Customer Service for additional details.

2.5.1 Temperature and Humidity Probe



The temperature and humidity probe supplied with the data acquisition system measures the air inlet temperature and humidity in real time to constantly update the weather readings and calculate correction factors. A variety of cable lengths allows for optimal placement of the probe, including inside an air inlet duct.

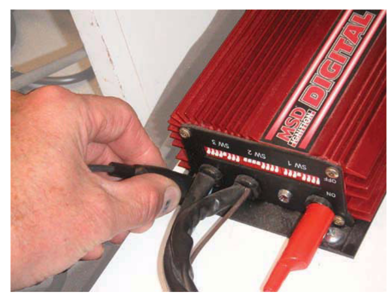
Figure 2-19. Temperature-Humidity Probe

2.5.2 Engine Speed Sensors

SuperFlow provides three different types of pickups to obtain engine speed using the vehicle's ignition system: an inductive pickup, a direct-to-coil connection, and a tachometer wire pickup.

Inductive Pickup

Direct-to-coil Pickup



Tachometer Wire Pickup

NOTE: *Engine speed information is only required to calculate corrected torque and provide a reference for the plots of power to engine rpm. Wheel power and the corrected power calculations are unaffected by engine speed readings or lack thereof.*

See section 6.9, "Obtaining Engine Speed on a Chassis Dyno," on page 6-13 for more information on chassis dynamometer engine speed reading.

2.5.3 Optical Tachometer Sensor

When placed on a rotating component of the engine, the optical tachometer provides another option for measuring engine speed (see section 6.9.1.4, "Optical Tachometer Sensor," on page 6-16). It allows operators to measure the rear wheel speed independently of roll speed, then calculate and display wheel slip. The optical tachometer can also be used on other rotating components such as tires, driveshafts or axles to provide the measurement of slippage or to accurately calculate ratios.

2.5.4 Lambda Sensor

Wideband O2 sensors provide a fast-response air/fuel ratio measurement using an oxygen sensor in the engine exhaust. SuperFlow offers a selection of Lambda meters that can fulfill the needs of most applications.

Gas analyzers are also available.

Figure 2-20. O2 Sensor

2.5.5 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.

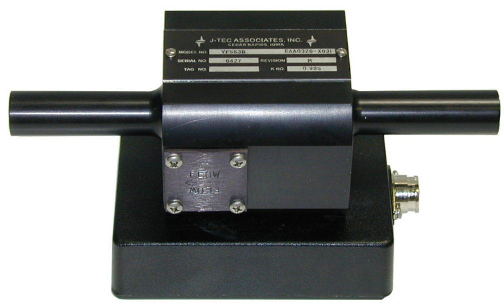


Figure 2-21. Blow-by Sensor

2.5.6 Auxiliary Roll (ATV Roll)

The auxiliary roll can be attached to the main frame of the CycleDyn dynamometer. This roll allows testing of three- or four-wheel vehicles commonly found in motorcycle dealerships and workshops such as ATVs, karts, legend cars, and dwarf cars. A matching platform to support the left front wheel of the ATV is available.

Figure 2-22. CycleDyn ATV Roll

NOTE: *It is possible to use the auxiliary roll and platform by themselves as a simple stand-alone package for a Junior Dragster dynamometer. A small bolt-on EC absorber package is available upon special demand. For details, contact your SuperFlow sales representative.*

2.5.7 High-speed Blower Option

The high-speed blower module consists of a single blower or dual blowers which are belt-driven from the main dynamometer roll. The blowers were designed to produce airflow proportional to road speed through two circular orifices of 8” (20 cm) diameter in the front of the CycleDyn along with cooling air to the exhaust system.

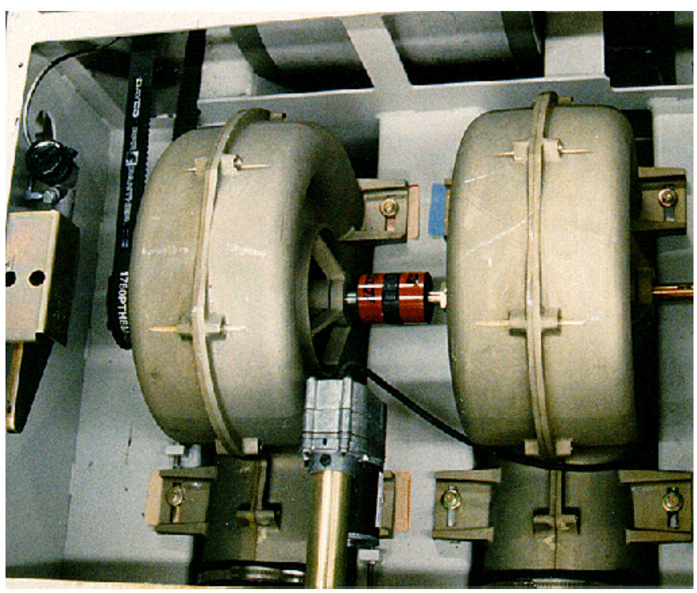


Figure 2-23. Dual Blowers

With dual blowers, air speed is reached up to approximately 180 mph (300 km/h) through an area of 100 in^2 (650 cm^2). The power absorbed by the blower(s) as a function of roll speed is calibrated up to 200 mph (320 km/h) for each system, and the CycleDyn automatically adds this into the vehicle power measurements.

An over-running or "cool down" blower option has an internal AC motor on the blowers that activates when the vehicle speed drops below a preset setting to provide continued airflow over the motorcycle for engine cooling. The blower is shut off after a programmed time, or it can be turned off using WinDyn software features.

IMPORTANT: Because of the complexity of the system, the high-speed blower option should only be installed when the CycleDyn is originally built. If the blowers are added afterward, the CycleDyn must be shipped back to SuperFlow.

2.5.8 Drag Pack Extension Kit

Figure 2-24. Drag Pack Extension

The front wheel restraint extension kit was designed for dragster bikes and custom bikes with extended front forks. It increases the maximum distance between the front edge of the front wheel and the center of the rear wheel to 92″ (234 cm).

2.5.9 Second Eddy Current Module

The complete modularity of the CycleDyn design allows you to add a second eddy current absorber module to the main roll or to the auxiliary roll.

Because of the large capacity of one eddy current absorber module, few applications require a second module. Should you need for additional power absorption capacity, contact your SuperFlow Service representative who will gladly assist you with your project.

IMPORTANT: Tire traction limits the maximum power that can be applied to the CycleDyn roll. Adding downforce to the rear wheel increases traction but also multiplies the measurement error and substantially increases the risk of damaging tires. Keep this in mind when considering installing a second absorber.

2.5.10 Fuel Flow Sensors

Fuel flow sensors or turbines can be added to measure the engine's fuel consumption. The sensor box provides two dedicated channels to connect a turbine. SuperFlow offers two fuel turbine models that can handle up to 800 lbs./hr. total fuel delivery with both channels used. An optional fuel injection canister allows for measuring fuel consumption at higher pressures.

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

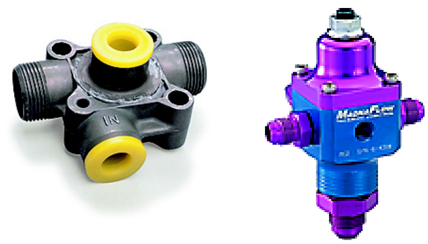


Figure 2-25. Fuel Turbines

2.5.11 Airflow Sensors

Figure 2-26. 9" Air Turbine

SuperFlow airflow turbines are used to measure engine air consumption on the dynamometer. This can provide some very valuable information when evaluating the engine's characteristics such as Volumetric Efficiency (VE), airflow (cfm), Air/Fuel ratio (A/F), and Brake-Specific Air Consumption (BSAC).

Attach these nonrestrictive sensors directly to the engine air inlet, or mount them on the inlet of the engine air supply duct. Two sensors can be used simultaneously.

Choose from the following airflow turbines:

- **4" (10 cm) diameter:** 4–150 cfm (2–70 l/s), 3–100 hp (2–75 kW)
- **6.5" (16.5 cm) diameter:** 10–800 cfm (5–380 l/s), 5–600 hp (3.75–450 kW)
- **9" (23 cm) diameter:** 20–1,200 cfm (10–566 l/s), 30–1,000 hp (22–750 kW)
- **Accuracy:** ± 0.5% fs

2.6 Specifications

2.6.1 Power Requirements

Chassis	
All models	12VDC battery, 75A, side terminals
Inertia only	No AC power required
Eddy current power absorption unit	240 VAC, 20 amps, 1Ph, 50 or 60 hz
Over-running blower option	See note below
AC Motoring module	480 VAC, 200A, 3Ph, 50 or 60 hz

NOTE: *The motor used in the over-running blower option requires 220VAC and uses the same circuit as the eddy current absorber. However, a higher current rating for the circuit is not necessary because the over-running blower motor and eddy current absorber should never be on at the same time.*

Data Acquisition	
All models	120VAC/15A or 240VAC/8A, 50/60hz
Wireless handheld controller (battery charger)	120VAC/0.1A, 60hz (USA model) 90-260VAC/0.8A, 50/60hz (export model)

NOTE: *The SuperFlow instrumentation system requires a dedicated, stable electrical power source for proper operation. SuperFlow recommends using an Uninterruptible Power Supply (UPS) or a high-quality surge suppressor for the sensor box and computer. 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.*

2.6.2 Weights and Dimensions

Item	Weight*	Net Dimensions (approx.)
Base enclosure w/ standard roll	1,200 lbs. *546 Kg*	85” L x 36” W x 20.5” H *216 x 91 x 52 cm*
Base enclosure w/ heavy roll	1,500 lbs. *682 Kg*	85” L x 36” W x 20.5” H *216 x 91 x 52 cm*
Eddy current module	600 lbs. *273 Kg*	31” L x 22.75” W x 21.5” H *79 x 58 x 55 cm*
AC motor module	750 lbs. *341 Kg*	35” L x 20.75” W x 21.5” H *89 x 58 x 55 cm*
Auxiliary roll module	425 lbs. *194 Kg*	40” L x 22.75” W x 20.25” H *102 x 58 x 51 cm*
Sensor box	50 lbs. *23 kg*	22H x 12W x 12D inches *56H x 30.5W x 30.5D cm*
Sensor box on rolling stand	55 lbs. *25 kg*	52H x 24W x 24D inches *132H x 61W x 61D cm*
Wired handheld (with 22-ft. cable)		
Wireless handheld		

* Exact weight depends on the accessories and options purchased. Weight shown is for a standard system configuration and is not the packaged shipping weight.

2.6.3 CycleDyn Chassis

Item	Specifications
Inertia Values (nominal)*	
Light roll	280 lbs. *(127 Kg)*
Standard roll	450 lbs. *(204 Kg)*
Eddy current absorber effective inertia	65 lbs. *(30 Kg)*
Blowers (internal air turbines)	Single blower: 9 lbs. *(4.1 kg)* Dual blowers: 18 lbs. *(8.2 kg)*
Auxiliary roll	200 lbs. *(91 Kg)*
AC motoring module (simulation range)	50–1,250 lbs *(22.7–568.2 kg)*
Rear-wheel Rating	
Inertia only models	500 hp (370 kW)
Eddy current absorber (continuous)	300 hp @ 80 mph (220 kW @ 130 Kph)
AC motoring module (continuous)	75 hp (55.9 kW)
Maximum roll speed	200 mph (320 Kph)
Maximum axle load	1,000 lbs. (455 Kg)

Item	Specifications
Tracks with auxiliary roll module • Roll minimum/maximum tracking width • Roll minimum/maximum tracking width with EC module between rolls	 • 18”–62” (46–157 cm) • 49”–93” (124–236 cm)
Air Requirements (chassis only)	
All models	80 to 100 psi (550 to 700 kPa), clean and dry
Roll Dimensions	
Primary roll	20” diameter x 16” wide (51 x 41 cm)
Auxiliary roll	20” diameter x 28” wide (51 x 71 cm)

* Listed inertia values are nominal. Each system is individually measured and calibrated.

2.6.4 Data Acquisition

SuperFlow’s New Generation Electronics (NGE) provide state-of-the-art data acquisition and control performance:

- Six programmable gain amplifiers
- 8-channel, 12-bit serial interfaced Analog-to-Digital Converter (ADC)

Processors

A Processor (2620 Board)	B Processor (2620 Board)
MC68332 32-bit microcontroller	MC 68332 microcontroller
On-board memory: • 512 Kilobytes (KB) FLASH for application programming • 256 KB battery-backed Static Random-Access Memory (SRAM) • 2 megabytes (MB) SRAM for data recording (5700 lines of data)	On-board memory: • 256 KB system Read-Only Memory (ROM) • 256 KB battery-backed SRAM • 512 KB FLASH
Clock speed 25 MHz	
16K dual-port Random-Access Memory (RAM) interface	

Network Communication

- 10-Mhz Ethernet network controller
- Both 10Base-Tx Ethernet interface connectors:
  - **Normal:** Multi-channel Data Exchange (MDX)
  - **Crossover:** Medium Dependent Interface-X (crossed)—MDI-X
- Network Basic Input/Output System (NetBIOS) Extended User Interface (NetBEUI) protocol
- 16K dual-port RAM interface

Data Acquisition Rate

- Base rate: 1.2 kHz
- Five base channels at 1.2 kHz (TRQ1, TRQ2, CTRL_A1, CTRL_A2, CTRL_A3)
- Eight channels at 150 Hz or 1/8 the base rate (BARO, RPOS, AN23, AN24, AN25, AN26, ADN AN27) analog channels on the 2620
- Eleven frequency channels at 200 Hz (WinDyn limits to six defined channels)
- Two groups of 8 to128 expansion channels, each measured at 1/8 to 1/128 of the base rate depending on how many expansion channels are installed.

Data Filtering

- User-selected
- Eight filter levels

Input/Output

- Sensor inputs
  - Onboard barometric pressure transducer
  - Analog: up to 269 analog voltage channels (WinDyn limit to 70 channels)
  - Frequency: up to 11 magnetic/Transistor-Transistor Logic (mag/TTL) frequency channels (WinDyn limit to 6 channels)
  - Inductive or coil primary spark pickup signal circuit
  - Photo tach input circuit
  - Input for two-channel quadrature encoder or additional TTL frequency channel
- Eight digital inputs (six available on board connectors, all eight available via external connections)
  - TTL/CMOS compatible
  - Internally pulled up to 5 volts
- Outputs
  - Four Digital-to-Analog Converter (DAC) controller outputs
    - Two closed-loop controlled outputs: digital Proportional, Integral, and Derivative (PID) or analog. Available as stepper motor control, eddy current control (PWM), or 0–10Vdc.
    - Two Set-point-only controls (0–10 V or 4–20 mA)
  - Eight relay-capable digital outputs (50 V, 150 mA maximum)

- Six serial outputs
  - **Port A:** XConsole communications (RS-232, 38.4 kBaud)
  - **Port B:** Relay Net (RS-422, 9600 Baud)
  - **Port C:** Wired handheld controller (RS-232, 9600 Baud)
  - **Port D:** Sensor box LCD display with drivers for up to four LCD boards with two six-character LCDs each, daisy-chained (RS-232, 9600 Baud)
  - **Port E:** Bluetooth connection to wireless handheld (115 kBaud)
  - **Port F:** Spare RS-232/422/485, presently used to communicate with VIA J1708/J1939 OBD-II interface (115 KBaud)

Excitation Sources

Several levels of excitation and reference voltages are available for sensors or other devices:

- **+12F:** +12VDC @ 500 mA, individual analog input boards poly-fused at 0.5A
- **+5F:** +5VDC @ 100 mA, individual analog input boards poly-fused at 0.1A
- **-12F:** -12VDC @ 100 mA, individual analog input boards poly-fused at 0.1A
- **-5F:** -5VDC @ 100 mA, individual analog input boards poly-fused at 0.1A
- **10VREFB:** +10VDC Ref @ 40mA, individual analog input boards poly-fused at 0.1A
- **5VREFB:** +5VDC Ref @ 40mA, individual analog input boards poly-fused at 0.1A
- **EX+B:** +4VDC Ref @ 40mA, individual analog input boards poly-fused at 0.1A

Safeties

- Emergency Stop (EMS) command scanned at 150 Hz
- One internal connection to dynamometer panic button
- One input configured for a Normally Closed (NC) external switch
- Serial EMS connection to Relay Net (relay box enclosure)

Power Supply

- Type: ATX
- 115/230 VAC, 6/3 amps, 50/60 Hz

CHAPTER 3

PACKAGING AND HANDLING

IN THIS CHAPTER

- Shipping Weights and Dimensions
- Lifting and Handling Instructions
  - Base Enclosure
  - EC Absorber, AC Motor, or Auxiliary Roll Modules
- Unpacking and Inspection
- Packaging
  - Dynamometer Chassis
  - EC Absorber
  - Sensor Box
  - Cables and Sensors
  - Accessories
  - Computer System
  - Miscellaneous

3.1 Shipping Weights and Dimensions

NOTE: *Weights and dimensions for the individual components are listed in section 2.6, "Specifications," on page 2-22.*

The CycleDyn dynamometer is shipped on one or two wooden pallets (depending on the model). It is shrinkwrapped and covered by a fitted cardboard box secured by plastic or metal straps. In some cases the dynamometer is shipped in a crate.

Table 3-1. CycleDyn Weights and Dimensions

Component	Weight*	Skid or box dimension
Base dynamometer frame	1500~1800 lbs. *685~820 kg*	88 x 42 x 44 inches *225 x 110 x 115 cm*
EC absorber module, sensor box, and accessories	810 lbs *368 kg*	34 x 30 x 45 inches *90 x 80 x 200 cm*
Computer package	140 lbs. *64 kg*	48 x 48 x 31 inches *125 x 125 x 80 cm*
Pit kit	100 lbs. *46 kg*	
Auxiliary roll	500 lbs. *227 kg*	45 x 24 x 27 inches *115 x 65 x 70 cm*
ATV deck	200 lbs. *91 kg*	63 x 28 x 3 inches *160 x 70 x 8 cm*
Legend deck	250 lbs. *114 kg*	98 x 40 x 16 inches *250 x 105 x 45 cm*

* Exact weight depends on the model or configuration

WARNING: The main dynamometer frame and accessory carton have UNEVEN weight distributions.

3.2 Lifting and Handling Instructions

If desired, leave the dynamometer and auxiliary modules on the shipping pallets until ready for installation.

The dynamometer should always be lifted off the shipping pallet with a crane or overhead hoist. Proper lifting instructions and pickup points are indicated below.

Once off the pallet, use a forklift or pallet jack to move the frames or modules. Make sure the forks are completely across the frame and extend out the opposite side. Always use blocks under the frame edges when removing the forklift or pallet jack.

Use an overhead hoist to lower the dynamometer frame and modules to their final position on the floor. Never push the frame off the forklift, pallet jack, or blocks.

WARNING: Failure to use the lift points indicated or improperly using a hoist or forklift may result in damage, severe injury, or death.

TIP: *An alternative method for moving the dynamometer and modules is to use a heavy-duty strap under the frame and lift them with a forklift or hoist. When the dynamometer is in position, slide the strap out from under the frame.*

3.2.1 Base Enclosure

Weight: 1200 lbs. (546 kg)

The roll is the heavy end of the base enclosure.

Figure 3-1. Overhead Hoist Lift Points

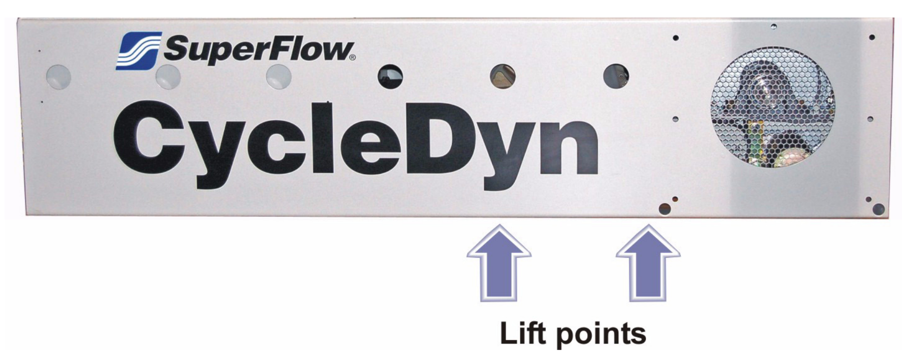
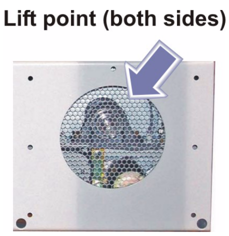


Figure 3-2. Forklift Lift Points

3.2.2 EC Absorber, AC Motor, or Auxiliary Roll Modules



Always use an overhead hoist to lift the modules from the pallet and into their final position next to the base enclosure. Remove the perforated screens from both sides of the module and place hooks on a lifting chain or strap into the openings. Lift the module carefully and place it into position. You can make the final adjustment of the module position by hand.

3.3 Packaging

Use the list below as a general checklist when the system arrives. The list describes a SuperFlow SF-250 Eddy Current CycleDyn. Individual systems may vary; this list is for a standard system and does not include options. Check the order acknowledgement for the exact listing for the particular system.

NOTE: *Some of these parts are shipped in the front compartment of the dynamometer base enclosure. Others are shipped in separate boxes.*

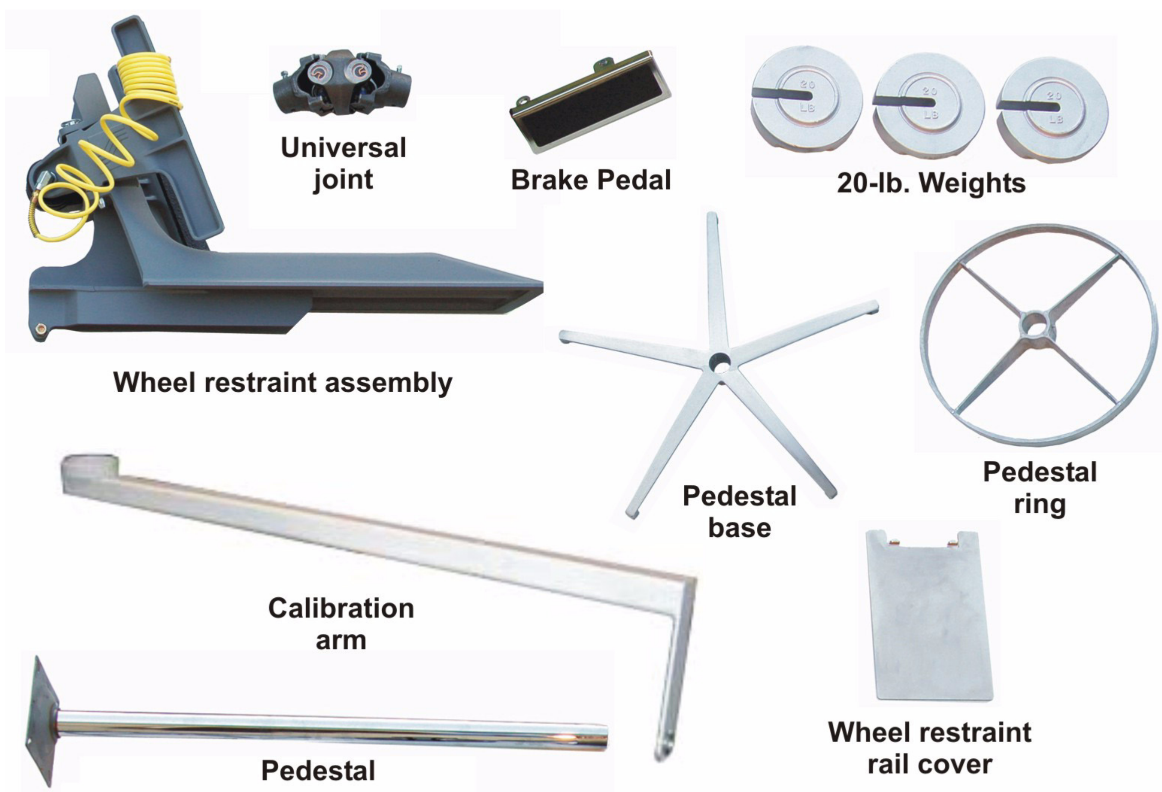
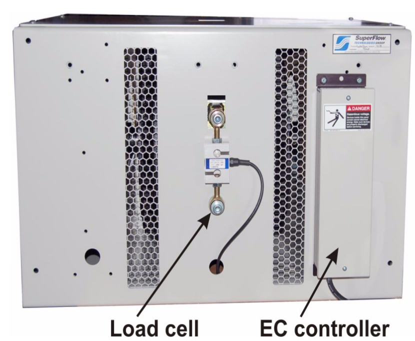


Figure 3-3. CycleDyn Accessories

3.3.1 Dynamometer Chassis

- ❑ Main dynamometer frame with roll
- ❑ Wheel restraint assembly
  - ❍ Base unit
  - ❍ Clamp with air spring
  - ❍ Air hose
- ❑ Wheel restraint rail cover
- ❑ Brake pedal

3.3.2 EC Absorber



- ❑ One eddy current absorber module which includes:
  - ❍ The absorber in the module
  - ❍ The load cell (torque link) with cable (1200A-0219)

> ***NOTE:*** *The load cell is packaged in one of the cardboard boxes inside the base enclosure. A wooden shipping strap secures the load cell mounts.*

  - ❍ The eddy current controller mounted on the module
  - ❍ Power cable for the EC controller
- ❑ 3-foot calibration arm
- ❑ Three each 20-lb. (18-kg) calibration weights
- ❑ Universal joint with 3/8 x 1-3/4 keys (2 ea.) and 3/8-16 x 5/8 square head setscrews (2 ea.)
- ❑ Six each ½-13 x 1-½ bolts to connect the absorber module to the main dynamometer frame

3.3.3 Sensor Box

- ❑ Sensor box with:
  - ❍ 2 or 4 LCD displays on front panel
  - ❍ Cable hanger on back panel
- ❑ Pedestal base, 5 casters, the pole, and a grab ring
- ❑ Power cable
- ❑ Two keys for the door

3.3.4 Cables and Sensors

Cables and sensors typically have the part number printed on a label affixed to one or both ends of the cable.

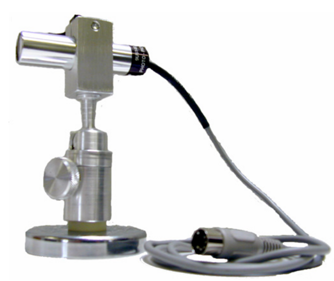
- ❑ Temperature and humidity probe (1200A-0245)
- ❑ Aux 1 and 2 input cable (1200A-2052-01)
- ❑ System interconnect cable (1200A-2274-0x)

NOTE: *The system interconnect cable can be one of two designs. The last digit in the part number indicates which one is included with your system. The installation procedure in chapter 5 details each cable.*

- ❑ Cat-5 LAN Ethernet cable, 10 ft. (E4190P-012540)

3.3.5 Accessories

The following accessories may not be included with all CycleDyn models. Cables and sensors typically have the part number printed on a label affixed to one or both ends of the cable.



- ❑ Optical Tachometer Kit (1200A-0642-1
  - ❍ Cable with yellow LEMO connector (1200A-2271)
  - ❍ Optical sensor (1510P-5140)
  - ❍ Sensor clamp (2400Z-0211)
  - ❍ Clamp knob (3420P-0012)
  - ❍ Magnetic base (3420P-6564)
  - ❍ Reflective tape, 120 inches (5700P-0093)
- ❑ Engine speed cables
  - ❍ Ignition coil sensor (1200A-1939)
  - ❍ Cable, tach leads (1200A-2188)
  - ❍ Cable, coil sensor (1200A-2261)
  - ❍ Cable, tach universal (1200A-2248)
  - ❍ Inductive spark sensor kit (1200A-2450)
    - Δ Inductive spark clip (1200A-2449)
    - Δ Cable, dual probe and gain adjust (1200A-2451)

3.3.6 Computer System

When purchased with the chassis dynamometer system, the computer system includes:

- ❑ Central Processing Unit (CPU) with keyboard and mouse
- ❑ 17” monitor
- ❑ Printer
- ❑ Printer cable (USB)

3.3.7 Miscellaneous

- ❑ SF-1853 wired handheld controller with 22 foot cable
- ❑ *CycleDyn Operator Manual*[1]
- ❑ *WinDyn Users Guide*
- ❑ WinDyn software (CD)
- ❑ System configuration disk (CD)
- ❑ Promotional package (stickers and decals)
- ❑ SuperFlow Test Center banner

1. The operators manual and the WinDyn Users Guide are provided on the WinDyn CD in PDF format. Printed copies can be obtained from SuperFlow Customer Service

CHAPTER 4

ROOM REQUIREMENTS

IN THIS CHAPTER

- Notice
- Safety
- Overview
  - Accuracy of Dynamometer Testing
  - Hazards of Dynamometer Testing
  - Designing a CycleDyn Test Cell
- Test Cell Recommendations
- CycleDyn Installation Options
- General Requirements
  - Room Construction
  - Safety and Environmental Issues
  - Technical Issues
  - System Support Issues
  - Water Drains
- Safety and Environmental Issues
- Convenience Issues
- Further Reading

4.1 Notice

It is imperative that you understand dynamometer testing can be hazardous. A properly designed and built test cell is a prerequisite to providing a safe environment for testing vehicles on a dynamometer.

While SuperFlow provides specific test equipment designed to test motorcycles and ATVs, we have no control over how you build your test cell. These room recommendations are generic and may not be suitable for your particular location or application.

A locally certified engineer or contractor *must* approve your designs and certify they conform to local building codes. Your local governing body regulations and insurance company policies will rule over any questions or uncertainties.

SuperFlow, its employees, or agents do not assume any responsibility or liability for suggestions, applications, or mechanical failure outside of the normal warranty or for issues where negligence, ignorance, or mis-applied technologies are present. Ultimately, you are responsible for ensuring your test cell is safe and conforms to all local codes and regulations.

Read this document in its entirety before beginning construction. Contact SuperFlow Sales or Customer Service if you have any questions or need assistance.

4.2 Safety

1. Follow all local construction codes.
2. Do not locate electric motors in close proximity where fuel is present.
3. Install a carbon monoxide (CO) detector in the test cell and the console area.
4. Provide fire extinguishers rated for gasoline and oils.
5. Provide adequate lighting in the test cell and at the operator's console.
6. Provide a switch outside the test cell to turn off the ventilation fans and high-voltage circuits.
7. Always use hearing and eye protection where applicable.
8. Regularly inspect the cell for fuel, oil, or liquid spills because flammable vapors can ignite.
9. Keep all personnel, flammable items, and sensitive objects away from any rotating or hot items.

4.3 Overview

The CycleDyn makes dynamometer testing affordable and practical for a broad range of users including those who have little or no experience. Although it is very easy to obtain test results with the CycleDyn, it takes some effort to ensure the accuracy of these results. A properly designed and built test cell can help ensure accurate and repeatable test results.

Although the CycleDyn dynamometer can be operated anywhere, it may be difficult to provide sound control or safety in open areas. An enclosed and well-ventilated test room with proper test procedures provides adequate protection against these hazards. Therefore, dynamometer testing should be confined to a restricted area where only the operator is allowed during testing.

Figure 4-1. CycleDyn Test Cell Examples

4.4 Designing a CycleDyn Test Cell

A dynamometer should be installed in a facility with proper lighting and electrical outlets, good ventilation, exhaust extraction, and a fire detection and control system. Make the test cell large enough to easily install and remove the test vehicle. It should allow enough space to work on the vehicle while it is place on the dynamometer, yet small enough to take up minimal space in your building.

Proper airflow through the test cell is critical for engine cooling and room ventilation. Having a larger test cell than necessary makes it difficult to control airflow through the cell and increases the cost because of the need for larger air-handling equipment.

The plans of the following pages provide information on how to design your CycleDyn test cell to achieve the highest possible level of accuracy and safety.

TIP: *Prefabricated rooms are available as an option to building a room.*

4.4.1 Hazards of Dynamometer Testing

Dynamometer testing involves running internal combustion engines. Doing so exposes the operator to rotating parts, fluids under pressure, explosive fuels, high voltages, noise, heat, and exhaust gases. Chassis dynamometer testing has additional risks associated with rotating transmission parts, wheels, and chassis rolls.

IMPORTANT: Safety equipment required to provide maximum protection for the operator must be readily available for dynamometer testing.

Refer to Table 4-1 for a list of hazards and the recommended protection.

Table 4-1. Safety Hazards and Protection

Hazard	Protection
Exhaust gas	Exhaust gas extraction
Fuel (vapors)	Adequate ventilation
Fuel (fire)	• No fuel containers in the test area • No-smoking policy • Fire blanket and fire extinguisher
Rotating parts	Restricted access, no loose clothing, guards and covers on moving machinery
Projections	Guards, safety glasses
Hot parts	Guards, protective equipment (gloves)
Noise	• Hearing protection for the operator • Sound insulation of the test area for other personnel

These risks are associated with the vehicle under test rather than the dynamometer. It is not possible for SuperFlow to protect the operator against all hazards by the design of the dynamometer. The dynamometer must be installed in an environment which is specifically designed for this type of testing and provides maximum protection for the operator.

4.4.2 Accuracy of Dynamometer Testing

Accurate measurement of the output of internal combustion engines is only possible under tightly controlled test conditions. The power output of the engine is directly affected by the quantity and quality of the combustion air, thermal conditions during the test, and atmospheric conditions.

As scientific practice teaches, measurement accuracy is largely determined by the level of control over test conditions during the test. While the system can compensate (to a certain extent) for atmospheric variations, it cannot account for every possible variable in the test environment.

While it is possible to correct the measured power to existing standards, these standards only apply to atmospheric conditions during the test (barometric pressure, air temperature, and vapor pressure). Some factors that the system cannot account for include:

- Exhaust back-pressure
- Oil, water, and fuel temperatures
- Tire pressure and temperature
- Air quality due to contaminates such as exhaust fumes

To keep as many variables as possible under control, the dynamometer needs to be installed in a proper environment. The test cell should have adequate ventilation and exhaust extraction systems, the data acquisition system should allow the operator to measure the various pressures and temperatures of the engine during the test, and the test procedures should be standardized and consistent. For the best results, the test cell should have provisions for maintaining some level of standard environmental conditions.

4.4.3 Installation Options

The CycleDyn was designed to provide a choice of above-ground or in-floor installation.

- Above-ground installations are the standard configuration and need no special requirements.
- For in-floor or pit installations:
  - You must fabricate a suitable pit or construct a platform to enclose the dynamometer.
  - When in a pit or enclosed under covers, the eddy current absorber requires ventilation to prevent it from overheating. Plus, the pit itself may require ventilation according to local codes.
  - You may need to remove the battery and battery charger electronics from the dynamometer and install them on a wall outside the pit. SuperFlow can provide an accessory kit for relocating the electronics.

Drawings detailing the typical configuration for both above-ground and pit installations are available from SuperFlow Sales or Customer Service. Table 4-2 on page 4-7 lists the drawing and installation kit numbers for each possible CycleDyn configuration.Contact your Sales or Customer Service representative to obtain the drawings or for more information.

Table 4-2. CycleDyn Test Cell Documentation Reference

Configuration					Drawing Number U.S.	Drawing Number Metric	Installation Kit
Floor	Inertia	No blower	No ATV roll	no drag kit	5301-0201	5302-0201	N/A
				drag kit	5301-0203	5302-0203	N/A
			ATV roll	no drag kit	5301-0202	5302-0202	N/A
				drag kit	5301-0204	5302-0204	N/A
		Blower	No ATV roll	no drag kit	5301-0201	5302-0201	N/A
				drag kit	5301-0203	5302-0203	N/A
			ATV roll	no drag kit	5301-0202	5302-0202	N/A
				drag kit	5301-0204	5302-0204	N/A
	E/C	No blower	No ATV roll	no drag kit	5301-0205	5302-0205	N/A
				drag kit	5301-0207	5302-0207	N/A
			ATV roll	no drag kit	5301-0206	5302-0206	N/A
				drag kit	5301-0208	5302-0208	N/A
		Blower	No ATV roll	no drag kit	5301-0205	5302-0205	N/A
				drag kit	5301-0207	5302-0207	N/A
			ATV roll	no drag kit	5301-0206	5302-0206	N/A
				drag kit	5301-0208	5302-0208	N/A
Pit	Inertia	No blower	No ATV roll	no drag kit	5301-0209	5302-0209	1200A-0215
				drag kit	5301-0212	5302-0212	1200A-0215
			ATV roll	no drag kit	5301-0211	5302-0211	1200A-0215
				drag kit	5301-0215	5302-0215	1200A-0215
		Blower	No ATV roll	no drag kit	5301-0210	5302-0210	1200A-0215
				drag kit	5301-0214	5302-0214	1200A-0215
			ATV roll	no drag kit	5301-0213	5302-0213	1200A-0215
				drag kit	5301-0216	5302-0216	1200A-0215
	E/C	No blower	No ATV roll	no drag kit	5301-0217	5302-0217	1200A-0216
				drag kit	5301-0219	5302-0219	1200A-0216
			ATV roll	no drag kit	5301-0218	5302-0218	1200A-0217
				drag kit	5301-0220	5302-0220	1200A-0217
		Blower	No ATV roll	no drag kit	5301-0217	5302-0217	1200A-0216
				drag kit	5301-0219	5302-0219	1200A-0216
			ATV roll	no drag kit	5301-0218	5302-0218	1200A-0217
				drag kit	5301-0220	5302-0220	1200A-0217

4.5 General Requirements

Many possible facility and room layouts exist for a motorcycle chassis dynamometer. Testing needs vary from basic power runs to extensive R&D with power levels ranging anywhere from 0 to 500+ hp. It is not possible to recommend a generic design that will fit every customer's needs and budget. These instructions point out issues to be aware of when designing and building your facility. The four general categories are:

- Safety/environmental issues
- Room construction
- Technical issues
- System requirements

In all cases, consult with your architect, contractor, mechanical and electrical engineers, and city planning and regional building offices. Your SuperFlow sales associate or Customer Service representatives are happy to assist you with general design advice; however, they cannot provide detailed engineering services for each facility.

If desired, your SuperFlow Sales representatives can help you obtain a prefabricated room designed to accommodate many of the items discussed below. Contact them at 1-262-252-4301.

The test cell should provide a convenient space for the computer and printer and adequate storage space for the dynamometer accessories (such as sensors, cables, calibration equipment, tie-downs, etc.). The computer system may be located outside the test cell.

The test cell must provide optimum control over test conditions and address safety hazards. Table 4-3 on page 4-9 is a quick reference on what a typical chassis dynamometer room should include.

Table 4-3. Test Room Recommendations

Equipment	Purpose	Requirements
Room	Provide a safe environment for dynamometer testing	• Adequate size for easy and safe access to equipment (see section 4.5, “General Requirements,” on page 4-8) • Adequate lighting • Fire resistance and sound-reducing material used in construction • Doors open outward for emergency evacuation • Wide doors for easy access
Floor	Support dynamometer, vehicle, and operator	Adequate strength, easy maintenance, easy cleaning, anti-slip
Room ventilation	Constant supply of air for combustion, engine cooling, eddy current absorber cooling, and to prevent accumulation of noxious fumes in the test cell	• Sufficient capacity for room size (see section 4.8.1, “Room Ventilation,” on page 4-14) • Maintain a slight negative pressure in the cell, typically 1” (2.5 cm) of H_2O.
Exhaust gas extraction	Evacuate exhaust gas to prevent contamination of engine inlet air and to protect the operator	• Sufficient capacity for maximum expected engine power (see Appendix D, “Exhaust Extraction”) • Hoses must be rated for exhaust temperature with vehicle under load, typically 800–1000°F • CO detectors in the test cell
Fire equipment	First response to a developing fire	• Fire extinguisher suitable for gasoline and electric fires • Fire blanket • Smoke detectors

4.6 Safety and Environmental Issues

Testing vehicles on a dynamometer is hazardous. The room construction, layout, and the proper safety equipment should provide optimal protection to the vehicle operator and to bystanders.

4.6.1 Safety

The first rule for safety is to prevent room access to personnel other than the operator during testing. Install warning lights and signs to this effect. Make sure the room has overall good visibility including sufficient lighting and wide-field mirrors installed so the operator can see all areas of the cell from the driver's seat of the test vehicle.

Because projections from the tires could cause damage or a hazard, you should install adequate shields. Install barriers or guards around the vehicle test area to prevent contact with rotating tires or dynamometer rolls. Avoid placing windows directly behind the rotating tires.

Personnel doors should be escape doors, opening outward from the cell. Proper fire-fighting equipment must be available (fire blanket, extinguishers, etc.). Install battery-backup safety lights in case of power failures.

Install a Carbon Monoxide (CO) detector in the test cell in plain view from all operator positions. Use detectors with a visual and audible alarm.

All electrical wiring must conform to local codes and regulations. Use Ground Fault Circuit Interrupter (GFCI) breakers where required.

WARNING: If your dynamometer is installed in a pit, be aware that poisonous CO gas tends to accumulate in low areas. PROVIDE FORCED AIR VENTILATION IN THE PIT.

4.6.2 Environmental Concerns

The installation of a dynamometer test cell normally requires permits. You must contact local zoning, building, and environmental authorities. Expect to comply with regulations for noise control, pollution (exhaust gas), fire hazards, and employee safety.

Pit drains and floor drains should be routed to a separator because they can contain contaminated fluids.

Coat the floor of the room with a sealant for easy spill cleaning. Epoxy paint mixed with an abrasive material is commonly used.

A chassis dynamometer room can quickly accumulate dirt, oil, and other contaminates from the test vehicles. Consider floor maintenance in the room layout. An appropriate floor drain routed to an oil separator can make cleanups easier.

For pit installations, a drain or sump pump is essential to prevent flooding.

4.7 Room Construction

A motorcycle chassis dynamometer can represent a significant investment. Unless secrecy of your development program is an important issue, it is to your advantage to create a highly visible location for the dynamometer. Position your dyno within view of customers in the reception area of your facility or most visible location from the street to optimize your exposure.

The dynamometer test cell room should be at least 20' (6 m) long, 12' (3.6 m) wide, and 10' (3 m) high. The larger the room, the more expensive the construction, and the more difficult it is to achieve proper ventilation. Your room should only be large enough to comfortably accommodate your motorcycles and conduct your tests.

IMPORTANT: Be aware of special requirements for room construction, including noise abatement, exhaust extraction, and operator safety.

In all cases, it is essential to provide easy vehicle and operator access to the dynamometer area. Many high-performance or racing vehicles have limited ground clearance and turning radius. Short ramps or tight turns cause problems.

The dynamometer area should be well insulated from the rest of the facility to avoid noise issues. Positioning the dynamometer next to an exterior wall could reduce the cost of air- and exhaust-handling system installations.

Wherever possible, position the dynamometer to direct exhaust extraction systems away from other nearby buildings to minimize exhaust gas and noise impact on your neighbors. You can install industrial exhaust silencers to further minimize noise impact as required.

The floor must be able to support the dynamometer, motorcycle or ATV, and a rider. The dynamometer with an eddy current absorber and an auxiliary roll will weigh approximately 3,500 pounds *[1,600 kg].* A 4" to 6" (10 to 15 cm) reinforced concrete slab of 4,000 psi (280 kg/cm2) is generally adequate. In some cases, you may need to reinforce the floor for proper support.

Pit installations require specific design considerations prior to construction or modification to an existing floor. Pit designs must encompass the requirements for the dynamometer and all purchased options such as an eddy current module, auxiliary roll, AC motor module, extended wheelbase, and any other option that will require space in the pit.

The primary door to the test cell should be large enough to accommodate the size of the vehicle and open outwardly for safety. Ideally, the door should be centered on the dynamometer to make it easy to move the vehicle on and off the rolls.

There must be provisions for room ventilation, vehicle cooling blower(s), and exhaust extraction.

Cabinets may be a good idea to store dynamometer accessories and ancillary equipment.

Room Layout

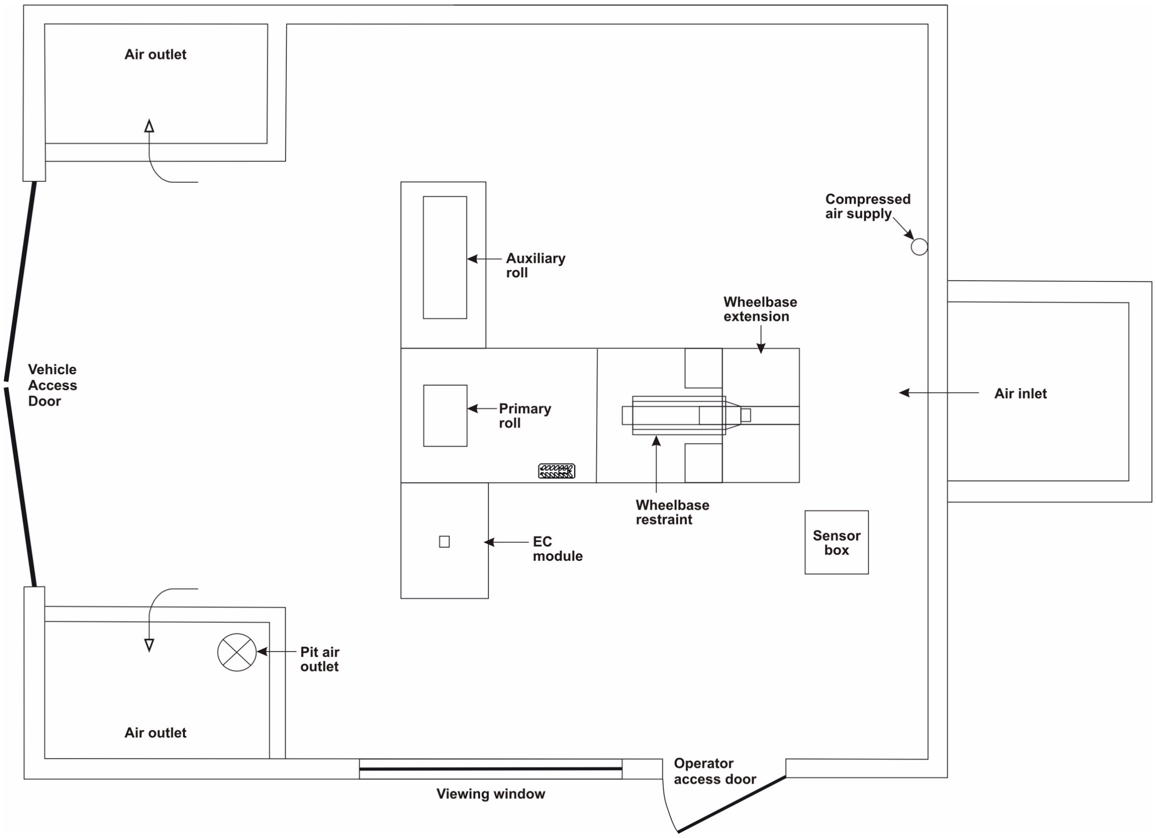


Figure 4-2. CycleDyn Room Layout

The CycleDyn is a modular-design dynamometer. The position of the dynamometer in the room depends on the requirement to test standard motorcycles, ATVs, go-karts, Legend cars, electric cars, or dwarf cars. If using an auxiliary roll, the room should accommodate a wider entry door and floor space.

Above-ground installations also require a ramp to load the vehicle onto the dynamometer. These are typically 4 to 6 feet *[1 to 2 meters]* but can be longer for low-clearance vehicles. The ramps can be removed and reinstalled after each loading/unloading to save space.

The wheelbase extension kit requires more room in front of the dynamometer.

Vehicle Tie-downs

When positioning the dynamometer in the room, you must take tie-down requirements into consideration as well. The CycleDyn has provisions for strap anchor points along the sides of the base enclosure.

Figure 4-3. Tie Down Straps

However, when the dyno is installed below ground, the anchor points are not available. In these situations, tie-down hooks must be installed in the floor next to the dynamometer. Make sure the anchors are positioned to provide tie-down points forward and rearward of the motorcycle on both sides.

Figure 4-4. Floor Anchors

Cored or poured anchors are typically suitable for securing the vehicle. All anchors should be rated for over 5,000 lbs. as a minimum. Discuss with the anchor manufacturer what is available for high-horsepower applications.

Control Room

A separate control room or dedicated viewing area overlooking the dynamometer should be part of the test cell design. This room may be used to house the computer and printer, thus providing a convenient viewing area during testing. For better exposure, enlarge this space or tie it into a showroom. However, avoid positioning the control room where an object thrown from the vehicle may create a hazard. The recommended size of the room is 8x6 feet *[2.5x2m]*.

The control room must allow easy access into the dynamometer room and optimum viewing of the vehicle and operator. A separate outward-opening personnel door directly from the control room to the test cell can be convenient. A large viewing window should be between the control room and the dynamometer area.

DANGER: The potential exists for projectiles to be thrown from the vehicle during testing. Such projectiles typically fly toward the rear and side walls of the test cell. If a projectile impacts a non-reinforced glass window, it could shatter the glass and injure someone.

The viewing window should be installed so a standing person can see all of the vehicle. At a minimum, the window should be 36 inches wide by 30 inches high (101 x 76 cm). The sound isolation provided by the window is much less than the dynamometer test cell walls, so if the window is overly large, it may rattle or transmit excessive noise into the control room.

It is best to use at least two panes of glass in the window with the pane on the dynamometer side wire reinforced. The multiple panes help with sound insulation, and the wire reinforcement helps prevent the glass from shattering. Both panes should be 1/2 to 1/4 inch thick *[6 to 13 mm]*. If a third pane is added, it is best to center the pane at an angle so it is not parallel to the other two panes. The angle helps reduce transmitted sound vibrations. The area directly behind the operator should be a dark or unlit area so the operator cannot see strong reflections in the windows when viewing the vehicle.

TIP: *Prefabricated sound-deadening windows can be purchased from a reputable sound enclosure or window manufacturer.*

4.8 Technical Issues

The two major problems faced in a motorcycle chassis dynamometer test cell are heat evacuation and exhaust gas extraction.

- Power generated by the engine is converted to heat. The engine combustion, cooling system(s), transmission, and exhaust system all generate heat. The dynamometer itself also radiates heat.
- Internal-combustion engines generate carbon monoxide gas (CO) that must be extracted, or the test cell literally becomes a poisonous gas chamber.

4.8.1 Room Ventilation

DANGER: Poisonous carbon monoxide gas is produced as a result of engine operation and may collect inside the building if proper ventilation is not utilized. Always exhaust the air from dynamometer test cells outside and away from other buildings. Always place CO detectors in various locations throughout the building.

Test cell ventilation is one of the most overlooked aspects of a dynamometer test cell room design. Chassis dynamometer testing produces a significant amount of heat that is released into the test room air. Ventilation is required to evacuate this heat from the room. If the room temperature increases during the test or exhaust gas recirculates into the engine inlet, your test results will vary in an unpredictable manner. Both the quantity and direction of airflow are critical for repeatable test results.

Proper room ventilation makes a considerable difference when assessing engine power.

Fundamentally, air is a critical property of the combustion process. Without clean air it is difficult to create power. Figure 4-5 is a graph from a 493.9-hp alcohol circle track motor on an engine dynamometer. Combustion air was taken from inside the test cell, and the exhaust was ventilated outside the building. The first test (MIKE3835) was done with the room fans turned off. Notice the 25.6 hp and 14.63 lb•ft gain that occurred in the second test (MIKE3836) after providing adequate airflow through the room.

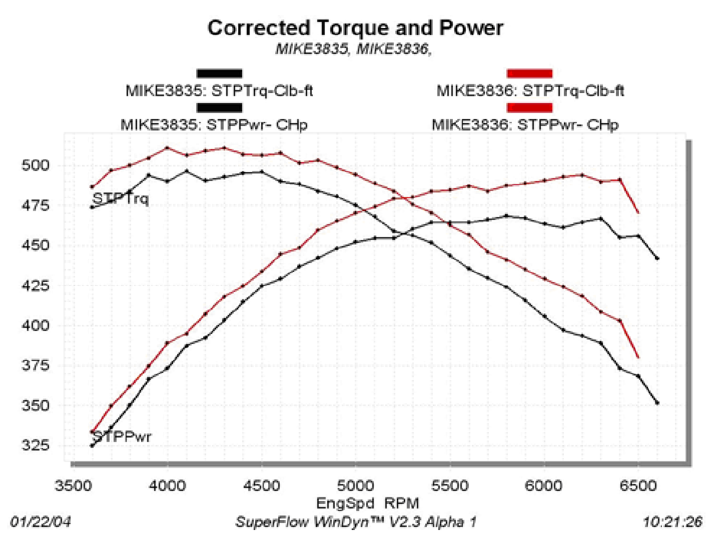


Figure 4-5. The Effects of Air Ventilation

Some racing vehicles require air speed through the radiator or ram air at near road speed. Achieving high flows at high speeds requires tremendous airflow which explains why many high-performance chassis dynamometer rooms resemble wind tunnels with high-volume fans rated at several hundred horsepower.

Proper airflow in a dynamometer test cell is also important for safety. An engine builder almost lost his life because of the excess exhaust fumes he encountered when entering the un-ventilated test cell after only one run. Understandably, ventilation systems can be expensive, but the alternative is inaccurate testing and the risk of injury or death.

Room Design

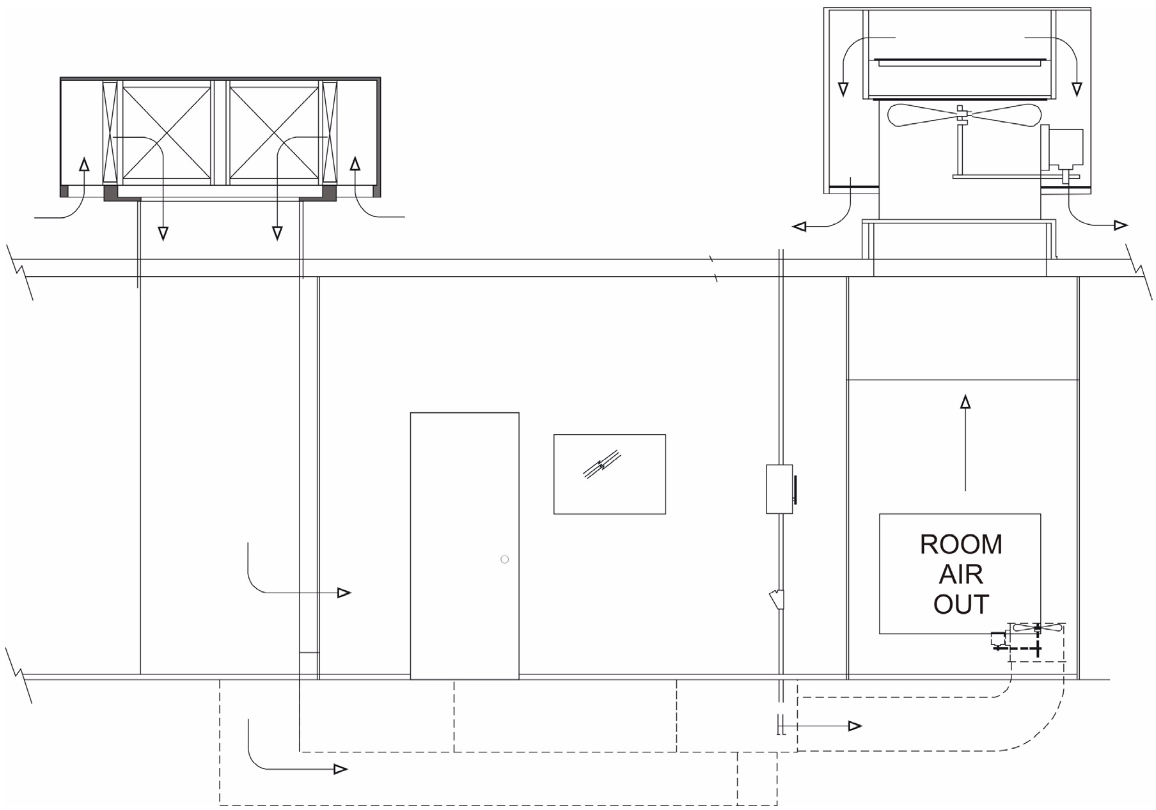


Figure 4-6. CycleDyn Room Ventilation

SuperFlow recommends a cross-flow design for the ventilation system. Position the air inlet duct in the test cell directly in front of the dynamometer with the outlet in the back of the room. The ventilation system should draw fresh air from outside the building and exhaust the air outside the building well away from the inlet to prevent air recycling.

TIP: *Using outside air to ventilate the test cell will reduce building heating and cooling expenses by not wasting conditioned air.*

The large fans required to provide the necessary airflow are noisy. They should be installed in a location where the noise causes minimal disturbance to your employees and neighbors. You may need to take additional protective measures such as enclosing the fans and ducts in sound-dampening material.

The inlet air duct can be fairly large. Place the outlet ducts behind the dynamometer. It is best to have two outlet ducts, one on both sides of the vehicle access door (see Figure 4-2 on page 4-12).

The ventilation system must be able to generate the necessary airflow at the pressure drop caused by your inlet and outlet ducting. Minimizing the length and complexity of ducting greatly reduces the pressure drop and required fan power. The size of the room is critical when choosing the equipment used in the ventilation system. Larger rooms require higher capacity fans. In larger cells it is typically harder to maintain proper airflow while avoiding turbulence and eddy currents. You must consider a cost analysis when airflow requirements escalate.

The vehicle itself plays a part in the room ventilation design. When an engine runs, it radiates heat from all its external surfaces and from its exhaust pipes. The larger the engine, the greater the heat load on the room.

Both the airflow direction and quantity are critical for repeatable test results. Air should enter at the front of the cell and flow across the engine to the rear of the cell. The engine exhaust pipes should be directly in the airflow to propel any leaking exhaust gases out with the main stream of air and prevent it from recirculating to the engine intake.

The room fans should be positioned to extract air from the room even if the access door is open. If the fan is on the inlet side, it will blow the smoke out into the operator area when the door is open and through any natural leaks. Fans should also be placed at the end of the exhaust duct to prevent contaminated air from escaping through leaks or auxiliary ducts into other parts of the building.

Equipment

Realistically, most Heating, Ventilation, and Air Conditioning (HVAC) system designers or contractors do not understand how much air a dynamometer test cell needs and will probably underestimate the amount of airflow required.

SuperFlow recommends an air exchange rate of at least 8 to 10 exchanges per minute. To determine the fan size, multiply the total cubic area of the room by 10. Obtain a fan that will deliver the resultant airflow.

Example:

For a 20 x 12 x 10 foot room, the recommended airflow is 24,000 cfm

20 x 12 x 10 = 2400 cubic feet

2400 x 10 = 24,000 cfm

That might seem like a lot of airflow, but think of a motorcycle going down the road at 80 mph.

TIP: *The airflow through the room should exert enough suction force to make an outward opening door to the test cell difficult to open when the exhaust fans are on.*

Axial fans are most effective for high airflow at low-pressure drops. The fan(s) are best installed on the outlet side. This maintains a negative pressure (about 0.5 to 1 inH_2O or 100 to 200 kPa) in the test room. Most squirrel-cage type blowers of comparable size do not provide an adequate amount of airflow.

Suggested fans are shown in “Ventilation Tube Axial Fans” on page 4-26.

TIP: *Variable-speed controls can be installed to provide adjustable airflow that allows for slow speeds while an operator is working in the test cell and fast speeds while running an engine test. The SuperFlow control system is capable of interfacing with the Variable Speed Drive (VFD) to allow the airflow to coincide with the vehicle road speed.*

Properly connect and ground all electrical items used in the ventilation systems (motors, switches, speed controllers). Explosion-proof motors provide the best safety. Mount the control switch for the fan where it is convenient for the operator. Where applicable, you must use GFCI breakers/ outlets.

Shutters

Shutters can be installed on the intake and exhaust to seal of the room and maintain comfortable working conditions when not running a dyno test.

TIP: *Electrically operated shutters with automatic controls can aid in fire-suppression systems and enhance security for your building*

Screens or grating on the ducts help keep trash and animals out. Grating should have a minimum spacing of 1 inch (2.5 cm) between the bars. If using mesh screening, increase the size of the opening by at least 50% to accommodate the added airflow restriction. Install rain hoods when applicable.

Air Conditioning and Heating

For sophisticated systems, it is possible to heat or cool the incoming air to maintain a constant temperature and humidity in the test cell during tests. For high-powered engines, the flow rates and energy required are very high; therefore, the equipment cost can be much greater than the cost of the rest of the test cell. For most cells, this is not a cost-effective solution.

Airflow Test

After completing the room, check the airflow by attaching a piece of cloth or tissue to a long stick and exploring the airflow direction through the room. The engine intake should be in the area of high flow. Check for swirls to make sure the air behind the vehicle is not recirculating into the engine intake after it passes over the exhaust pipes.

4.8.2 Pit Ventilation

Pit-installed CycleDyn systems require ventilation to remove heat and fumes from the pit. For eddy current packages, proper pit air flow is critical for extracting heat the absorbers create. A dedicated fan for the pit ventilation will ensure proper air flow through the pit. Relying solely on the room ventilation fan will result in a minimal amount of air flow in the pit. Airflow should be directed across the absorbers.

See Figure 4-2 on page 4-12 and refer to the pit design drawing available from SuperFlow Sales or Customer Service.

For CycleDyns equipped with an eddy current absorber or AC motor option, proper airflow through the pit is crucial for extracting heat. Provide a 16" (41 cm) or larger duct with a suitable blower for adequate absorber cooling air supply.

A 6" (15 cm) duct with a small 4” blower suffices for inertia-only systems. If you plan to add an eddy current or AC motor module at a later date, install the a larger fan recommended below.

The best design draws pit air separately from the room air although it is acceptable to route pit air from the room air inlet duct and out the room air outlet. This can be done below surface through a built-in raceway or duct in the floor.

Because fuel vapors can potentially settle in the pit, SuperFlow recommends using an explosion-proof fan or blower for the pit ventilation.

Suggested fans are shown in “Ventilation Tube Axial Fans” on page 4-26.

4.8.3 Exhaust Extraction

IMPORTANT: Consult the local authorities before designing an exhaust system to ensure compliance with environmental restrictions concerning emissions.

Refer to Appendix D, “Exhaust Extraction” for more information.

A proper exhaust extraction system is critical for the safety of your employees and customers inside and outside the test room. In addition to noxious gases, a significant amount of heat releases through the exhaust system. The exhaust extraction system must be able to handle the flow and the exhaust gas temperature.

The two methods to handle exhaust extraction are:

- **Room Ventilation:** If the room ventilation system is designed properly, it can provide exhaust extraction as well. In this design, exhaust gas is diluted with ambient air and removed by the room ventilation fans. However, this rarely works.

  Most ventilation ducts and fans only handle temperatures up to 250°F (110°C), so the air flow volume has to be even higher than normal to achieve total exhaust extraction without damaging the duct or fan. For best results, the dilution ratio of clean air to exhaust should be about 4:1. Therefore, the room ventilation system would need to provide an air exchange rate of 10 to 12 times per minute with special provisions for higher temperatures.
- **Spot Extraction:** The best way to extract exhaust gases is by using temperature-resistant ducting to capture the exhaust gas close to the vehicle tailpipe. Do not seal the duct to the tailpipe. This allows dilution of the exhaust gas with ambient air and reduces any possible influence on engine performance by exhaust back pressure. The open duct on the tailpipe should provide enough free area to achieve the desired dilution ratio.

Install a high-speed, centrifugal-type fan at the outlet end of the exhaust duct to ensure the maximum efficiency of the system. The exhaust duct or hose must be able to withstand exhaust temperatures when the dynamometer is at full load, typically greater than 800°F *[425°C]* at the tailpipe.

To determine the recommended fan size, multiply the maximum potential engine horsepower by 1.4 (cfm per hp), then multiply that by 10 to get the total cfm flow requirement.

Example:

For a motorcycle rated at 100 engine hp:

100 x 1.4 x 10 = 1400 cfm required airflow

A sharp bend in the exhaust ducting will reduce the overall flow in the duct. Take proper care to minimize the number of 90° bends. A gradual arc works much better for maximizing airflow efficiency.

TIP: *Routing an exhaust duct from the tailpipe under a door or through a wall without an extraction fan generally does not work well for dynamometer testing unless you install a very good room ventilation system to back it up.*

Table 4-4 shows the recommended minimum hose diameters for the power level of the engine. However, for maximum efficiency the test cell exhaust system hose should be at least twice the diameter of the engine exhaust pipes. For larger high-powered engines, it is generally best to use two exhaust pipes.

Table 4-4. Exhaust Pipe Diameters

KW/Exhaust	Hose Diameter	HP/Exhaust	Hose Diameter
7.5	7 cm	10	3"
75	10 cm	200	4"
150	13 cm	300	5"
250	16 cm	450	6"
350	20 cm	800	8"
500	23 cm	1000	9"

NOTE: *A good exhaust system with a properly designed room ventilation system will ensure removal of all exhaust gases from the test cell and the building.*

4.9 System Requirements

All dynamometer systems are unique in some way, but they all essentially require the same facility services and provisions.

4.9.1 Electronics and Computers

The SuperFlow chassis dynamometer electronics typically consist of a sensor box and a computer system. Some systems may have additional components such as an electric throttle controller or a relay control box. The sensor box, throttle controller box, and the relay box are all located in the test cell while the computer is usually outside.

Sensor Box

The sensor box houses the Central Processing Unit (CPU) for data acquisition and control along with all the sensor input connections. For chassis dynamometers the sensor is usually mounted on a roll-around pedestal but can be mounted on a wall or support structure.

The data acquisition system has one 35-ft. shielded Category 5 (Cat-5) Local Area Network (LAN) cable that connects the sensor box to the computer. If the computer is outside the test cell, you must route the cable through the test cell wall in a manner that protects them. SuperFlow suggests using 1½- or 2-inch conduit or wireway for this pass-through.

Handheld Controller

The SF-1853 wired or wireless remote handheld controller is used when conducting a test on a SuperFlow chassis dynamometer. The wired handheld connects to the sensor box with a 22-ft. cable (6.7 meters). The wireless handheld uses Bluetooth® technology and has a range of about 30 feet (9 meters) radius. Both units should be protected from damage when the system is not in use.

Figure 4-7. SF1853 Wired Handheld Controller

Computer Systems

A computer with WinDyn™ software installed enhances SuperFlow dynamometer operation. Provide table or console space for the computer and printer. Place the monitor, computer keyboard, and mouse in a location convenient for the operator.

If desired, you can attach a custom support stand for the monitor, keyboard, mouse, handheld controller, and test cell controls to the dynamometer frame or nearby wall. This makes it easy for an operator to conduct a test and review the results without dismounting the motorcyle.

Another option is to install a second monitor for the computer and position it near the dynamometer which allows the operator to view the real-time display on the second monitor but review the test results at a table workstation.

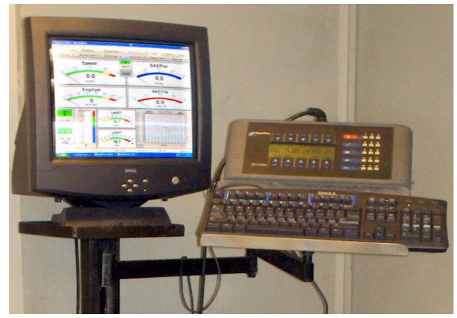


Figure 4-8. Handheld/Keyboard Stand

4.9.2 Electrical Power

Do not underestimate the total amount of electrical power required to supply the test room services. Electrical power is required for:

- Data acquisition electronics and computer system
  – 115/230VAC, 15/8 amps, single phase, 50/60 hz
- The eddy current power absorber (when installed)
  – 208–240VAC, 20 amps, single phase, 50/60 hz (per absorber)
- Lights and accessory outlets for wideband 02, gas analyzer, etc.
- AC Motoring module (when installed)
- Cell ventilation fan(s)
- Exhaust extraction fan(s)
- Spot cooling blower(s); power dependent upon model
- Space heaters and air conditioning units (when needed)

NOTE: *Power requirements for the AC Motor module and test cell ancillary devices is dependent upon the selected models.*

SuperFlow recommends using a separate circuit with surge protection for the computer system and data acquisition electronics. For better protection, use an Uninterruptible Power Supply (UPS).

Remember to install plenty of wall outlets in the room for battery chargers, power tools, and other equipment. A GFCI circuit should protect all electrical outlets in the dynamometer room.

When installing eddy current or AC motor modules, install a dedicated power source for the AC power. Welders and other high-current equipment in use may corrupt non-isolated circuits.

IMPORTANT: Contact your electrician for detailed installation advice.

4.9.3 Compressed Air Supply

Compressed air actuates the dynamometer front wheel restraint clamp. An air supply pressure of 70–90 psi *[483–620 kPa]* is required. Flow is not a factor because it is static pressure.

The optional exhaust tailpipe probe for O2 sensors is also air driven and uses approximately 25 psi *[206 kPa]*. It requires a continuous flow of air while in use.

Keep the air lines clean and dry. Install a filter and water separator on the supply line to the dynamometer. SuperFlow recommends a safety shutoff valve for the air supply and an automatic water purging system accompanied by a quality water separator.

TIP: *For pit installations SuperFlow recommends installing an automatic water purging valve at the air inlet on the dynamometer chassis as this is the lowest point in the air supply line.*

4.9.4 Test Cell Controls and Monitoring

Provide controls for ventilation and exhaust systems, safety shutoff valves, fire warning and protection systems, and basic cell services such as room lights, warning lights, and door controls. Centralize controls on a control panel in or near the test cell. If the controls are inside the test cell, install a main disconnect or emergency stop switch outside the room in case of emergency.

Install a carbon monoxide (CO) detector in the test cell in plain view from all operator positions. Use detectors with a visual and audible alarm.

4.9.5 Vehicle Cooling

The main room ventilation system should evacuate the heat produced by the vehicle cooling system, engine block, transmission, and exhaust. But in many cases, the airflow patterns resulting from the room ventilation system do not provide adequate cooling of certain vehicle components.

The vehicle cooling system, engine compartment, and exhaust system are usually the most troublesome areas. The CycleDyn offers optional integrated blowers, but you may also use spot-cooling fans to handle this deficiency. These fans do not increase the overall airflow through the room. They basically modify the local patterns and speeds of the airflow to accomplish specific cooling goals.

Some racing vehicles require air through the radiator or ram air at near road speed velocities. Achieving these high-speed flows requires tremendous power. This explains why many high-performance dynamometer rooms resemble wind tunnels.

Figure 4-9. Spot Cooling Fan

4.9.6 Water Drains

Water and other liquids may collect in the pit. Locate a drain or sump pump in the pit to keep it clear of liquids.

4.9.7 Sound Control

For most test cell installations, sound control is extremely important if running tests frequently. A properly designed test cell can reduce the sound level by 40 to 50 decibels (dB) between the inside of the cell and outside. The guidelines below are general and applicable to any facility installation.

TIP: *Prefabricated sound-deadening enclosures can be purchased from a reputable sound enclosure manufacturer. Check for local code requirements before installing prefabricated rooms.*

If the walls of the room are constructed properly, the room should provide good sound reduction. However, most of the sound will exit the room through the door, the window, and any leaks through the walls. Caulk all around the window panes during installation and make sure all joints are filled in the gypsum board surrounding the room. Be sure all electrical boxes are caulked all the way around their penetration through the wall, and even caulk all of the small screw holes in the electrical box. Caulk around any wires where they enter the conduit. Sound travels very well down long tubes.

Use special sound-control insulation on the door and a lowering threshold at the bottom of the door. These devices push down against the floor when the door is closed and are available from building suppliers (one manufacturer is Sonitrol). Plug any cable pass-through holes in the walls with blocks of compressible foam. Caulk all around the external switch plates and holes in the test cell wall.

Most rooms are finished with semi-gloss painted walls so they are easy to clean and reflective for better lighting. It is possible to further reduce the sound level in the room by placing absorptive pads on the walls. These are typically one to two inches *[2 to 5 cm]* thick and covered with perforated metal. They are available from various sound-control companies. It is not necessary to cover all the walls to substantially deaden the room. Sound-absorptive pads on 25% of the total surface area will make a significant difference.

Line the inlet and outlet ventilation ducts with a minimum of one-inch thick *[2.5 cm]* duct liner to prevent sound transmission through the ducts. Also line the inside of roof covers. The sound will bounce back and forth across duct liner through several direction changes before exiting at the roof of the building. Make sure the liner is well-adhered to the wall of the duct so the high-velocity air does not blow it loose. Never use duct liner in an area exposed to exhaust gases. The duct liner will collect oil or unburned fuel and become a fire hazard.

4.9.8 Fire Suppression

Engines, fuel, oil, fans, electrical devices, motors, pumps, and all other items inside and outside the test cell can catch fire at any time. When designing your test cell, pay special attention to local fire codes and insurance requirements. This can include sprinkler heads installed inside the test cell (use high-temperature pop-offs due to normal engine heat). Fire extinguishers should conform to local fire codes and be conveniently accessed. If using an automatic fire suppression system, make sure it has safeguards against human contact. Other safeguards such as fire dampers can also be used if allowed in your area.

NOTE: *SuperFlow does not make any specific recommendations related to fire protection or insurance.*

4.10 Convenience Issues

Based on our experience, SuperFlow suggests the following enhancements to your facility:

- Wireless two-way communication link between the driver and system operator.
- Intercom between the test room and control room.
- Digital camera to take pictures of the vehicle while tested. You can download the pictures to the test system computer to display and store with the test data files. Pictures provide a quick method to record the vehicle configuration and the cooling blower arrangement for the test, improving test repeatability.
- Closed-circuit video with monitor in the control room (and/or in the customer viewing area).
- Microphone in the test room, driving speakers in the control room. Due to the test room noise insulation, it may be difficult to hear abnormal engine or driveline sounds from the control room.
- Telephone for communication purposes. A cordless telephone or cell phone is convenient when talking with someone while moving to different areas of the test cell.
- Additional test system computer monitor in the customer viewing area if separate from the control room (e.g., your facility lobby).
- Battery-powered emergency lighting in the test room and control room.
- Space heater and air conditioning, depending upon your climate.
- A secure storage space in the control room for software, manuals, backup disks, and test results. A closed storage space in the test room for sensors, cables, calibration equipment, and personal protective equipment (such as earmuffs and safety glasses).

SuperFlow recommends keeping the test room clean at all times. Dirt from test vehicles tends to accumulate; the powerful room ventilation systems will sweep up and blow around any dirt, rags, papers, etc. Protect your engine, vehicle, and fans by avoiding loose objects. Clean test vehicles before installing them on the dynamometer. Provide a source of water and a garden hose to periodically wash down your test room.

4.11 Equipment Sources

Below are listed some of the common equipment sources for items used in a engine test cell. These are all U.S. companies, but equivalent sources may be available in other parts of the world.

W. W. Grainger
Pumps, fans, ventilation, valves
1-800-473-3473
http://www.grainger.com

American Fan
Room ventilation equipment
1-513-874-2400

Mechtronics E/M Products
Mufflers, exhaust pipe components
1-952-440-9200
http://www.mechtronics.net/catalog

Riker Products
Exhaust pipe components
1-800-292-9744
http://www.rikerprod.com

GTE Industries
Mufflers, exhaust pipe components
1-800-775-2466
http://www.gtexhaust.com

MER Equipment
Exhaust components
http://www.merequipment.com

Soundmaster
Prefabricated test cell enclosures
1-800-472-5952
http://www.dynotestcells.com

Stowe Enterprises — DynoAir
Climate-controlled airflow systems
1-800-315-6751
http://www.stoweenterprises.com

Monoxivent Source Capture Systems
Exhaust pipe components
1-877-608-4383
http://www.monoxivent.com

Nelson Products
Mufflers, exhaust pipe components
1-800-223-4483
http://www.nelsondiv.com

Air Pro
Exhaust collection hoses/systems
1-800-967-0288
http://www.airpro.com

Macurco
Gas detectors and controllers
1-303-781-4062
http://www.macurco.com

Car-Mon Products, Inc.
Exhaust Extraction Systems
1-847-695-9000
http://www.car-mon.com

Plymovent
Exhaust Extraction Systems
1-609-395-3500
http://www.plymovent.com

Intelligent Solutions
Portable CO Monitors
1-503-644-8723
http://www.ueitest.com

4.12 Equipment Recommendations

The equipment listed in the following sections are from the W.W. Graingers online catalog. They are suggestions only. Other brands and models may be suitable for the applications as long as the minimum specifications are met.

Call SuperFlow Sales or Customer Service for suggestions and alternatives.

Fan motors may require special controllers or relays. Consult a local certified electrician to determine the proper equipment for your area.

4.12.1 Tie-down Straps

SuperFlow recommends ratchet-type straps rather than cam buckle locks. You need at least four. You will also need several slings or axle straps for attaching the tie-downs to the vehicle.

Part Number	Size	Rating Capacity	Details
3LLF3	10 ft. x 1 in.		Ratchet strap
1DKX3	27 ft. x 2 in.	3,300 lbs.	Ratchet strap, U-hook
1DMU4	3 ft. x 1 in.	2,000 lbs.	Web sling, eye & eye
2RU88	3 ft. x 2 in.	3,200 lbs.	Web sling, eye & eye
3LLT9	36 in.		Axle strap w/ wear pad

4.12.2 Ventilation Tube Axial Fans

An air exchange rate of 8 to 10 times per minute (minimum) through the test cell (and pit if applicable) is recommended. The flow required depends on the room size (see “Room Ventilation” on page 4-14).

NOTE: *These fan motors are not listed as explosion-proof and therefore should not be located inside the test cell or where fuel or fuel vapors are present. For better protection, request explosion-proof fan motors. Installation must comply with all local and national safety codes.*

Consult SuperFlow Sales, Customer Service, or a qualified air handler contractor for assistance in selecting the proper size.

Room Ventilation

Part Numbers	cfm @ 1”$H_2$0 Static Pressure	Size	Motor*
7F843	13,190	30” diameter fan Belt drive 47H x 34W x 24D	5 hp, 208–230/460 VAC 15–13/7 amps, 3 ph, 60 Hz
7F853	14,445	34” diameter fan Belt drive 50H x 38W x 29D	5 hp, 208–230/460 VAC 15–13/7 amps, 3 ph, 60 Hz
7F862	14,825	36” diameter fan Belt drive 52H x 40W x 29D	5 hp, 208–230/460 VAC 15–13/7 amps, 3 ph, 60 Hz
7F872	21,775	42” diameter fan Belt drive 58H x 46W x 32D	7.5 hp, 208–230/460 VAC 20–18/9 amps, 3 ph, 60 Hz
7F883	28,550	48” diameter fan Belt drive 65H x 52W x 36D	10 hp, 208–230/460 VAC 27–25/12 amps, 3 ph, 60 Hz

* Single-phase motors are also available.

Pit Ventilation

Pit fans should not be physically located in the pit unless it is rated for hazardous locations.

Part Numbers	cfm @ 0.5”$H_2$0 Static Pressure	Size	Motor
7F930	2126	12” diameter fan Belt drive 20H x 15W x 12D	3/4 hp, 115/230 VAC 12/6 amps, 1 ph, 60 Hz
7F942	3238	16” diameter fan Belt drive 29H x 19W x 17D	1 hp, 115/230 VAC 14/7 amps, 1 ph, 60 Hz

4.12.3 Ventilation Air Shutters

When using motorized shutters, SuperFlow highly recommends using a micro switch for fan delay. This ensures the shutters are open before the fan engages.

Part Number			Inlet Size
Inlet Shutter	Exhaust Shutter	Motorized Shutter	
3C242	3C311	3C235	42” X 42”
3C243	3C312	3C132	48” X 48”

4.12.4 Ventilation Air Filters

Eight or more ventilation air filters are required.

Part Number	Size	Rating Capacity	Details
2W237	20"x25"x4"	92%	1740 cfm @ 0.22" H_2O
2W239	24"x24"x4"	92%	2000 cfm @ 0.22" H_2O

4.12.5 Sump Pumps

A sump pump is required if a drain is not available in a pit installation.

Equipment	Part Number	Flow Rating	Size	Details
Sump pump (submersible)	2P547	34 gpm @ 10 ft. of head	10" H 10" diameter	1/3 hp, 115VAC, 9.6A, 1 ph Vertical switch 1½ NPT outlet
Check valve	2P843	4 psi @ 130°F		1¼ or 1½ FNPT
Sump kit	2P778			3/10 hp pump, 4.8-gallon tank, check valve, 1 NPT outlet

4.12.6 Compressed Air

Compressed air is required for the wheel clamp and O2 exhaust tailpipe probe.

Equipment	Part Number	Max Pressure	Size	Details
Filter/regulator	6D756	250 psi	10H x 2.5W	1/4" NPT, 5-micron filter
Auto drain	6B251	250 psi		Use with above filter/regulator
Pressure gauge	5WZ41	0–160 psi	2" diameter	1/4" NPT

4.13 Further Reading

Excellent books on the design of test facilities and dynamometer testing are:

Engine Testing – Theory and Practice, by Michael Plint and Anthony Martyr, Butterworth-Heinemann, Oxford, UK, 1995.
ISBN 0 7506 1668 7

Dyno Testing and Tuning, by H. Bettes and B. Hancock, Cartech Inc., 2008.
ISBN 978-1-932494-49-5

CHAPTER 5

INSTALLATION

IN THIS CHAPTER

- **Overview**
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- **Wheel Restraint Installation**
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- **System Cable Connections**
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- **Configuration**
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5.1 Overview

This chapter details unpacking and installing a CycleDyn chassis dynamometer test system. It is separated into different sections: the base enclosure, wheel clamp assembly, eddy current module, sensor box, and the computer system.

These installation instructions are generic for a typical CycleDyn system. Some sections may not apply to your system, or you may have accessories covered in other documentation.

If components are included with your system and documentation was not provided, contact SuperFlow Customer Service for assistance.

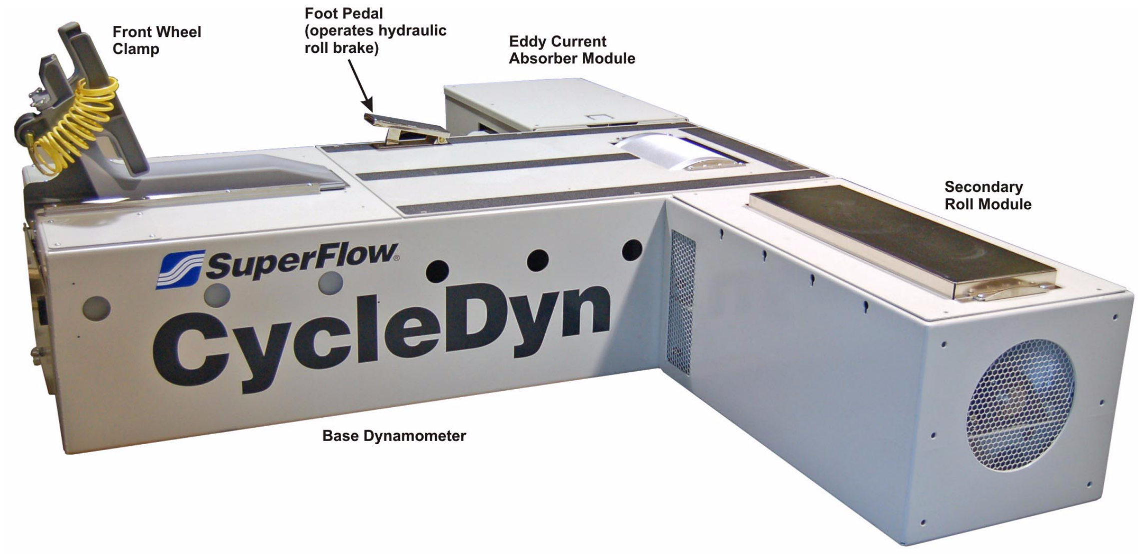


Figure 5-1. CycleDyn with Eddy Current and Auxiliary Roll

IMPORTANT: Read the unpacking and inspection instructions before installing the dynamometer.

Review Chapter 2, “Product Overview.” and Chapter 4, “Room Requirements” before proceeding with the installation.

NOTES:

- *The CycleDyn is shipped partially assembled. Some parts are left off for protection during shipping. Interconnect, power, and sensor cables require installation prior to use.*
- *The wooden platform the CycleDyn is shipped on is intended for shipping only. Do not operate the dynamometer while it is on the shipping platform.*
- *The CycleDyn requires a 12VDC, 75A standard automotive battery with side terminals. SuperFlow does not supply this battery.*

5.2 Unpacking and Inspection

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. Cut the straps securing extra boxes onto the main dynamometer frame and remove them from the frame. Inspect for any external damage.
3. Cut the straps securing the fitted cardboard cover, taking care not to damage the paint underneath the dynamometer cover.
4. Inspect the cardboard cover for external damage or impact. Remove the cardboard box from the dynamometer frame. Remove the shrink wrap.
5. Inspect the dynamometer for any external damage.
6. The front of the CycleDyn has an access panel (door). Remove the six Allen bolts holding this door closed. Open the door.

CAUTION: The front door hinges may exert some spring force on the bolts. Be sure to support the door while removing the bolts, particularly the last one.

Figure 5-2. CycleDyn Chassis Access Door

7. Remove the accessory box, front wheel restraint assembly, pedestal pole, pedestal caster base, the pedestal ring, and any other loose parts from the cavity in the front of the CycleDyn. Also remove all packing material. Verify that no other components or packing materials remain in the plenum.
8. Unwrap all the removed parts and inspect them for any loose parts or damage.

9. Check the inside of the door. The battery bracket and cables should be undamaged. The printed circuit board should be protected by a wire mesh cover. The board and cover should show no evidence of impact nor any damage. Check the air solenoids and plumbing under the battery tray for damage. Check the 5 Amp fuse in the in-line holder.

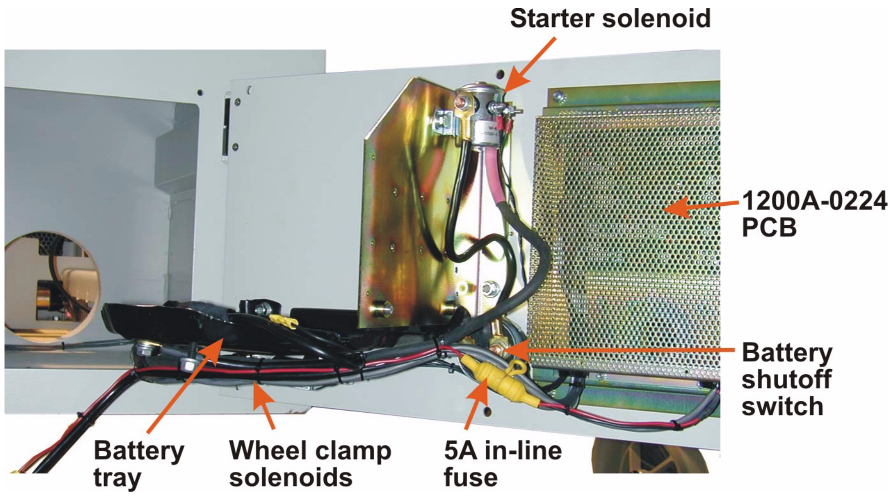


Figure 5-3. Battery Tray and 0224 Circuit Board

10. Close the door and secure it with the Allen head bolts.
11. Remove the plenum cover and the main roll covers.
12. Inspect the roll and the inside of the dynamometer for damage.
13. Inspect the (optional) blowers and ducts for damage. Visually check their alignment.
14. Rotate the roll. It will feel heavy but should rotate freely.
15. Open and unpack the accessary boxes (except for the computer). Lay out the parts and inspect for any damage. Perform an inventory of all parts received.

> Refer to section 3.3, “Packaging,” on page 3-5 and the packing list that accompanied the shipment for a list of parts received for your system. Keep in mind that some loose items are parts of an assembly and may not be listed on the packing list.

16. 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.

5.3 Chassis Installation

WARNING: The CycleDyn is very heavy. Use standard safety procedures when lifting heavy equipment.

5.3.1 Base Enclosure

IMPORTANT: Consider where the dynamometer will be located. The floor must be level and able to support the weight of the dynamometer, motorcycle, and operator. Be sure to think about access to the area and the fact that on above-ground units you will need some sort of ramp to place the motorcycle on the dyno. Ensure approximately 3 feet (1 meter) is behind the eddy current module for the calibration arm to extend outwards.

NOTE: *Do not remove the shipping skids until you are ready to position the dynamometer in its final location.*

1. Remove the four ½″x 3 lag bolts securing the dynamometer to the wooden shipping platform. Two bolts are just inside the access door at the front of the chassis. Access the other two at the rear of the chassis behind the roll.
2. Lift the chassis off the shipping platform and position it in the desired location.

Refer to Chapter 3, section 3.2, "Lifting and Handling Instructions," on page 3-4 for information on moving the dynamometer chassis.

TIP: *For pit installations without enough room in the pit to maneuver the dynamometer, assemble the chassis outside the pit and lower it into the pit when ready.*

5.3.2 Absorber *(EC Models Only)*

If you do not have the EC power absorber option, skip to section 5.4, "Sensor Box Installation," on page 5-12.

The absorber module can connect to either side of the dynamometer frame assembly. The only requirement is that the load cell and EC controller must face toward the front of the dynamometer assembly. Right-side mounting is recommended. (See Figure 5-1 on page 5-3.)

Figure 5-4. Eddy Current Module

WARNING: The absorber module is very heavy—about 700 lbs. (320 kg). Use appropriate lifting means.

1. Remove the four 1/2"x 3 lag bolts restraining the eddy current absorber module to the shipping platform.
2. Lift the absorber housing assembly and carefully set it down on the floor in its final location near the base enclosure. Leave enough room between the absorber and base enclosure to work between them.

Refer to section 3.2, "Lifting and Handling Instructions," on page 3-4 for information on moving the EC absorber module.

3. Remove:
   - The roll cover on the base enclosure
   - The absorber module cover
   - If installed, remove the hexagonally perforated screens on the absorber module and the base enclosure from the sides facing each other (save the parts removed).
4. Locate the universal joint, two 3/8 x 1-3/4 Woodruff keys, and two 3/8-16 x 5/8 set screws.
5. Position one of the Woodruff keys into the slot on the roll shaft (Figure 5-5).

Figure 5-5. Fitting the Key on the Absorber Coupler

6. Install the universal joint on the roll shaft as shown in Figure 5-6. It should have a marking on it that indicates which direction it is installed in the dynamometer. Make sure the key is installed between the slot in the shaft and the universal joint. Insert but do not tighten the set screw.

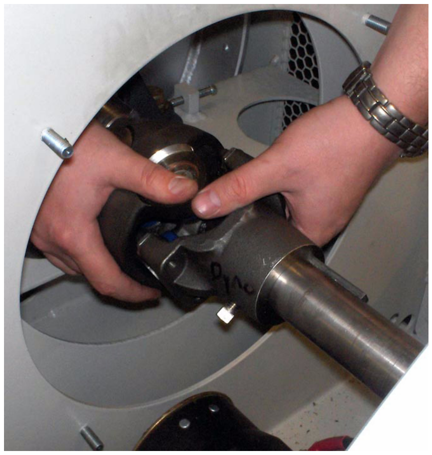


Figure 5-6. Absorber Coupling

7. Slide the absorber module into position and start the other end of the universal joint onto the absorber shaft. Make sure a key is installed between the slot in the shaft and the universal joint. Slide the absorber module next to the base enclosure with the bolt holes lined up. Insert but do not tighten the set screw.
8. Install the six ½ -13 x 1½ bolts between the absorber and dynamometer frame. Tighten in a cross pattern to bring the absorber module evenly together with the base enclosure. Tighten the bolts to 65 lb-ft.
9. Check for some end float on the universal joint assembly. Tighten the set screws on each end of the universal joint to 30 lb-ft.

NOTE: *It is critical to check that the shafts are not bottoming out onto the U-joint or binding in any way. Any binding will result in significant noise in the torque measurement and may also cause damage to the equipment.*

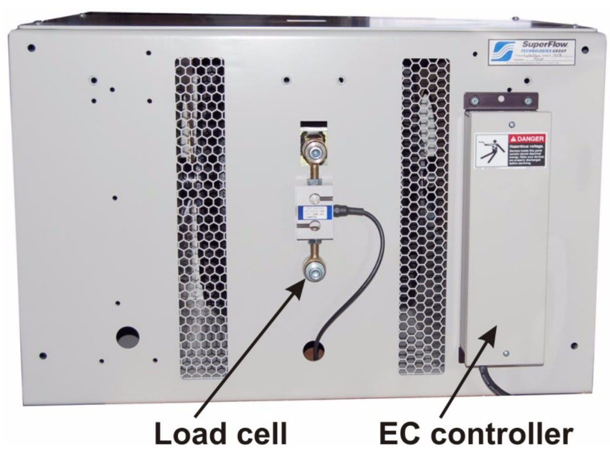


Figure 5-7. Load Cell and Eddy Current Controller

10. Remove the wooden shipping strap from the load cell mount and install the load cell in place (see Figure 5-7). Tighten the bolts on each end to 30 lb-ft.

WARNING: Be extremely careful not to damage any wires or connectors.

11. Route the load cell cable through the hole into the absorber module.
12. Locate the 8-pin Molex® connector on the end of the control cable from the EC controller box on the eddy current absorber module. It should be coiled up inside the housing and labeled 1200A-2377.
13. If the cool-down blower option is installed, locate the 1200A-2356 power cable from the EC controller box. It has an IEC power connection on the end.
14. Route the load cell cable (1200A-0219), the EC control cable (1200A-2377), and if installed, the cool-down blower power cable (1200A-2356) together through the access hole into the base enclosure. This is made easier by using a wire "fish" and pulling the cables through. You can reach the access hole from the bottom side of the absorber frame near the roll.
15. Locate the load cell extension cable (labeled 1200A-2354) in the base enclosure. It has a rectangular 6-pin Molex® connector. Connect the load cell cable (1200A-0219) to the 1200A-2354 extension cable.
16. Locate the eddy current control extension cable (labeled 1200A-2349) in the base enclosure. It has a rectangular 8-pin Molex® connector. Connect the EC control cable (1200A-2377) to the 1200A-2349 extension cable.
17. If the cool-down blower option is installed, locate the power extension cable (labeled 1200A-2355) in the base enclosure. It has an IEC AC power connector. Connect the power cable (1200A-2356) to the 1200A-2355 extension cable.

NOTE: *Refer to Figure 5-8 on the following page for the full wiring diagram.*

18. Connect the 12-gauge, 3-conductor power cable from the eddy current controller box to 220/240VAC, 20-amp, single-phase power. Do not turn on the power until directed.

IMPORTANT: A professional electrician should install all high-voltage wiring. Check your local electrical codes to ensure compliance.

19. If installed, make certain the battery switch on the front door is turned off.

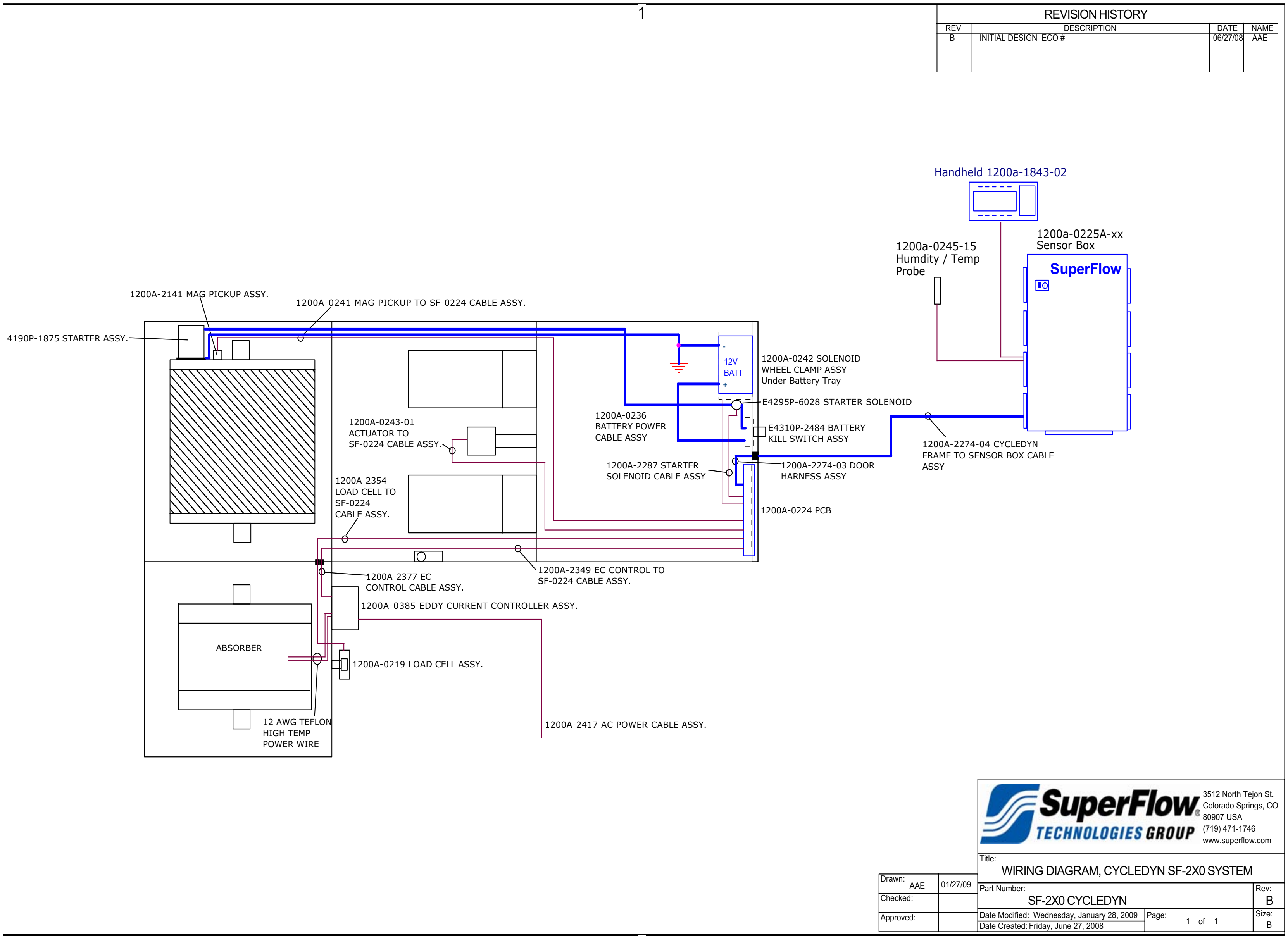


Figure 5-8. CycleDyn Wiring Diagram

20. Open the front door and locate the battery tray.
21. Install the battery and connect the battery cables. Be careful to observe polarity.

NOTE: *The CycleDyn is shipped without a battery. A 12VDC, 75A battery with side terminals is required.*

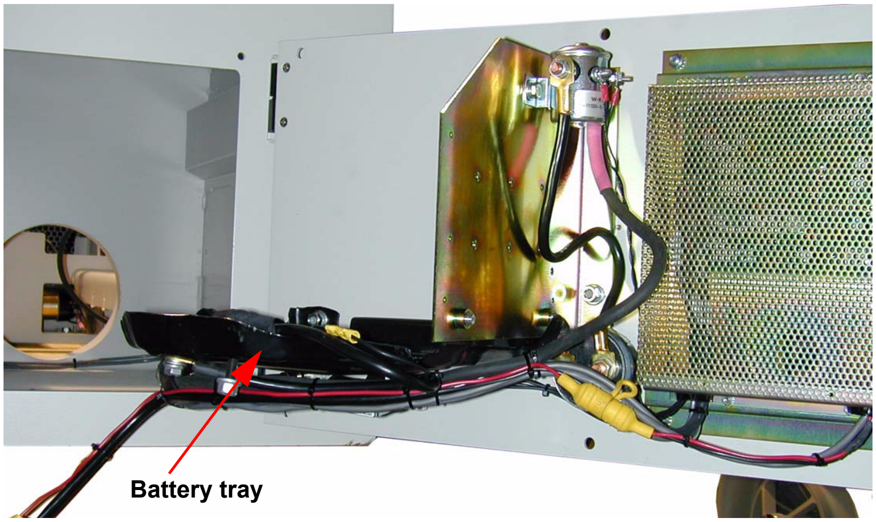


Figure 5-9. Battery Tray and Interconnect Board

5.4 Sensor Box Installation

The sensor box holds the Central Processing Unit (CPU) and associated circuity for the data acquisition system. A rolling pedestal is provided for the sensor box, but it can be mounted on a wall or other support structure if desired.

5.4.1 Pedestal-mounted Sensor Box

1. Locate the sensor box stand which is shipped as four components:
   - Pole
   - Base
   - Five casters
   - Ring
2. Slide the ring onto the pole; the flat side of the ring should go toward the sensor box or upwards. Loosely tighten the ring set screws.
3. Install the five casters on the base by pushing them firmly into the provided holes.
4. Place the sensor box on a table or counter with the bottom accessible.
5. Remove the four bolts from the bottom of the sensor box.
6. Bolt the mounting plate on top of the pole onto the sensor box using the four bolts removed in step 5.
7. Carefully insert the pole with the sensor box into the base.
8. Slide the ring to a comfortable grasping height, typically 4–6 inches (approximately 10–15 cm) below the bottom of the sensor box, and secure the ring with the set screw. Make sure the ring spokes do not interfere with any cables.

Figure 5-10. Pedestal-mount Sensor Box

9. Verify that the cable hooks are installed on the back of the sensor box at the bottom, and make sure the two bolts are tight.
10. Place the sensor box in the test cell where it is convenient for connecting the interconnect cable to the dynamometer and sensor cables to the vehicle but is still out of the way.
11. Do not connect the sensor box power cable until directed.

5.4.2 Cable Connection

The dynamometer interconnect cable connects the sensor box to the dynamometer chassis. Two different cables are used with the CycleDyn. The one used with your system depends on when the system was built.

First, look at the front door of the dynamometer chassis:

- If you see a 1-inch *(25 mm)* access hole at the bottom of the door, use cable 1200A-2274-01.
- If you see a 37-pin amp connector mounted on the door, use cable 1200A-2274-04.

Now look at the cable supplied with the system. The part number is on a white label at each end of the cable.

- 1200A-2274-01 has a plastic 37-pin connector on one end and three white Molex connectors on the other end (one has 17 pins, one has 14 pins, and the other has 2 pins). The 2-pin connector is used for the cool-down blower option and is not used without the option.
- 1200A-2274-04 has a plastic 37-pin connector on both ends.

Based on the above information, determine which cable to use and verify that you have that cable. Contact SuperFlow Customer Service if you have something different or need assistance.

1200A-2274-01

One end of the cable plugs into the connector on the sensor box side panel labeled **dynamometer** and the other end to the circuit card on the inside of the chassis door assembly. Two electrical cable connectors on the sensor box cable plug into the dynamometer interface circuit card (1200A-0224).

1. Open the front door on the CycleDyn chassis and locate the circuit card behind a perforated metal cover. Eight nuts and two screws hold the perforated screen in place. Remove these and the metal screen.

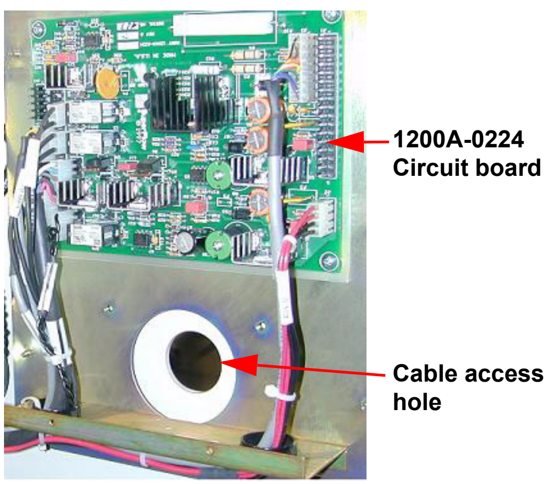


Figure 5-11. CycleDyn Interface Circuit Board

2. Remove the lock nut from the cable conduit pass-through. Slide nut off the cable.

3. Thread the connectors one at a time through the one-inch hole in the bottom center of the front frame door and through the nut.

CAUTION: Be extremely careful not to damage any wires.

4. Insert the cable pass-through into the hole and install the nut. Tighten to secure the cable to the door assembly.
5. Connect the 17-pin connector to the **J1** connector on the 1200A-0224 printed circuit card and the 14-pin connector to the **J12** connector (see Figure 5-11).

IMPORTANT: Notice that the connectors on the printed circuit card have a keying strip behind the pins. The smooth side of the connector must face toward the keying strip and must slide on easily. Be extremely careful when plugging the connector on because it is very easy to get them off-centered. No damage should occur if power is applied, but some functions will not work.

6. If the Cool-Down option is installed, connect the 2-pin connector to the mating connector which should be hanging next to the circuit board.

See section A.5, “Cool-down Blower Option,” on page A-21 for more information.

7. Reinstall the perforated cover and tighten the nut and screws.

   TIP: *SuperFlow recommends covering the top surface of the cover to prevent debris from falling onto the circuit board.*

8. Close the front door and install its retaining screws.
9. Plug the other end of the cable into the sensor box.

1200A-2274-04

One end of the cable plugs into the connector on the sensor box side panel labeled **dynamometer** and the other end to the connector on the front door of the chassis door.

1. Plug the connector on the cable marked **To Sensor Box** into the sensor box.
2. Plug the connector on the cable marked **To CycleDyn** into the connector on the front door of the chassis.
3. Close the front door and install its retaining screws.

5.4.3 Handheld Connections

NOTE: *Instructions on using the wireless handheld unit is contained in separate documentation.*

Be sure the sensor box power is turned **off**. The handheld control unit plugs into the brown receptacle labeled **Handheld** on the connector panel on the sensor box. The handheld connector plug is color coded and keyed for ease of identification.

Figure 5-12. Handheld Controller

See Chapter 7, “Handheld Controls” for more information on using the handheld controller.

5.4.4 Sensor Box Power

NOTE: *Do not connect the sensor box power cord yet.*

The power supply used in the sensor box depends on when it was built.

- Systems built after January 2004 use a standard ATX power supply.
- Early SF-200 through SF-240 systems use a standard computer power ATX supply, also.
- The power supply used in the early SF-250 is a standard AT type computer power supply.

The sensor box power input is selectable for 120VAC or 240VAC. Some power supplies have a switch to select the input voltage while others are compatible with a wide range of input voltages. The frequency can be 50 to 60 hertz.

Open the sensor box using the special key and locate the power supply. Look for a voltage select switch. If you see one, verify that the voltage selection is correct for your location.

On some older systems you must access the power supply voltage selector switch by removing the 4″ hex buttonhead screws attaching the panel with the AC power plug to the sensor box and sliding out the power supply about 1 1/2″ (3 cm) until the red switch is visible. Check the switch setting.

IMPORTANT: If power is interrupted, the sensor box will lose communication with the computer, and any data stored from a test is lost. For this reason SuperFlow recommends using an Uninterrupted Power Supply (UPS) to protect the system during power outages. This also provides enough time to save data to the computer.

The white push-button switch on the sensor box front door is the power switch. Pressing it once turns on the data acquisition system; pressing it again turns it off. On some systems this switch is a "locking" type that will stay depressed when the sensor box power is on. On other systems the power circuit on the CPU is a latching type, so the white switch is a momentary contact push button.

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

Power On Checks

1. Plug the supplied power cable into the sensor box power connection on the bottom of the box and into a convenient outlet.
2. Ensure the handheld controller is plugged in.
3. Press the white push-button switch on the front door. The Liquid Crystal Displays (LCDs) on the door (if installed) should light up, and the heldheld startup screen appears:

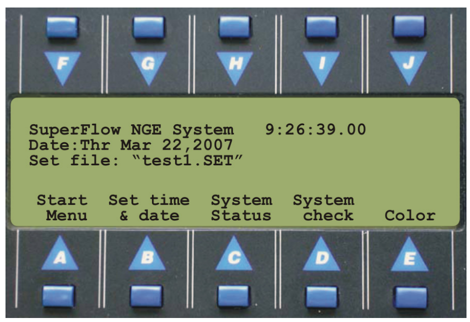


Figure 5-13. Handheld Startup Screen

NOTE: *The time and date may not be correct. These update when the computer and WinDyn are connected to the sensor box.*

4. Press **Start Menu** (the **A** button). The CycleDyn main screen appears:

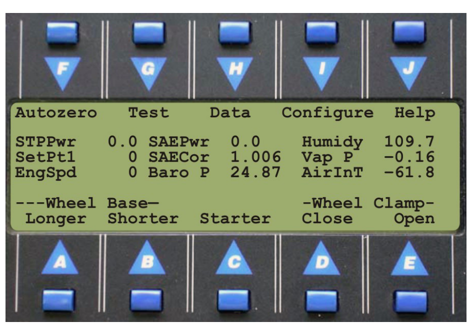


Figure 5-14. CycleDyn Main Screen

If the handheld display does not look like this, do not proceed any further, and contact SuperFlow Customer Service immediately.

5.5 Wheel Restraint Installation

NOTE: *The wheel restraint assembly cannot be installed on the chassis until the data acquisition system (sensor box) is connected to the dynamometer and powered on.*

1. Ensure the battery is installed in the CycleDyn chassis.
2. Turn the battery switch on.
3. Power on the system using the white power switch on the sensor box.
4. The handheld controller should display the Startup screen (Figure 5-13).
5. Press the **Start Menu** key (**A**) or press the red **Stop** key (**red hand** symbol) to access the main menu (Figure 5-14).
6. Press and hold the **—— Wheelbase —— | Longer** key (**A**) until the front wheel restraint actuator rod is fully extended.

NOTE: *If the actuator rod does not move, check all cable connections on the 1200A-0224 circuit board and check the 5A in-line fuse between the battery and the circuit board.*

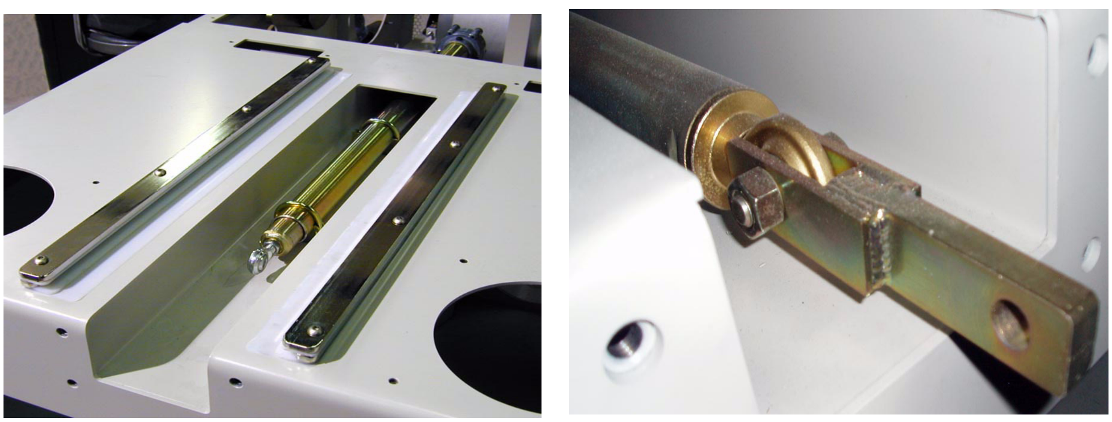


Figure 5-15. Wheelbase Actuator and Wheelbase Extension Rod

7. Slide the stainless-steel cover plate between the two restraint guide rails. The lip on the plate should face toward the front of the dynamometer and point up.

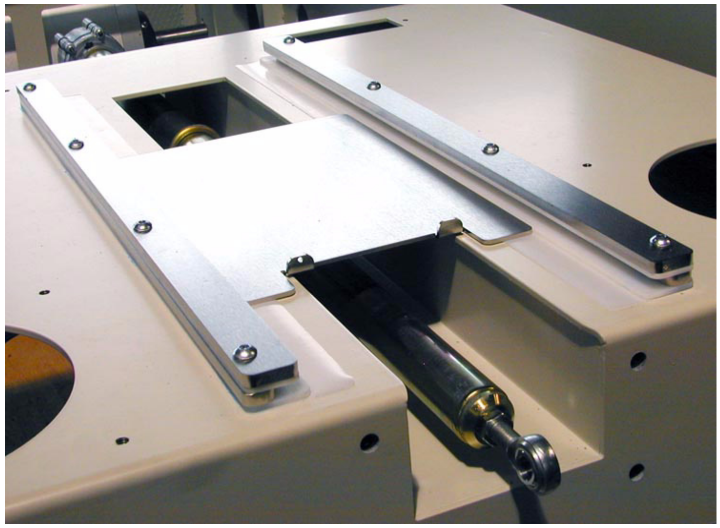


Figure 5-16. Wheelbase Restraint Cover

8. Slide the wheel restraint assembly into the nylon strips between the two restraint guide rails. The lip of the stainless-steel cover plate should catch the underside edge of the restraint (Figure 5-16).

Figure 5-17. Wheelbase Actuator Assembly

9. Fasten the forward edge of the restraint casting to the actuator rod-end with the supplied ½″ bolt or clevis pin.
10. Verify the tightness of all restraint guide bolts.
11. Install the male fitting of the coiled yellow air hose (to the clamp) into the threaded hole closest to the hinge at the bottom of the front door. Use thread sealant on the connection.

12. Install a ¼″ NPT male quick connector for shop air into the other threaded hole in the bottom of the front door. Connect this to clean dry shop air (80 to 100 psi *(550 to 700 kPa)*. Use thread sealant on the connection.

NOTE: *Because of the variety of air line fittings available, SuperFlow does not provide one with the CycleDyn. If desired, the air supply can be directly connected to the dynamometer without using a quick disconnect fitting.*

13. Verify proper restraint operation by using the handheld controller keys (keys **shorter** (**B**) and **longer** (**A**)) to move the restraint from the fully extended to fully retracted position and back to fully extended position (Figure 5-18).

IMPORTANT: Release the button immediately if the wheelbase restraint does not move. Check for binding or restriction of the slides or the motor. Trying to force the motor to move against a restriction can result in damage.

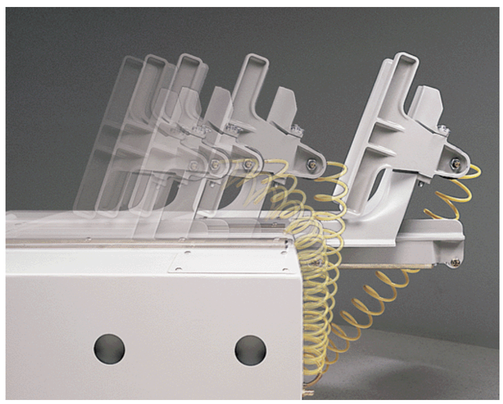


Figure 5-18. Wheelbase Adjustment

WARNING: The front wheel clamp is powerful and can cause injury. Verify that the clamp is clear of all body parts before closing it.

14. Verify proper clamp operation by using the handheld controller soft keys **Close** (**D**) and **Open** (**E**) to close and open the front wheel clamp a few times. Verify that no air leaks exist.

IMPORTANT: Air leaks will cause gradual release of the clamp and loss of motorcycle stability. Never rely solely on the front wheel clamp to hold the motorcycle in position.

5.5.1 Brake Pedal Installation

1. Locate the brake pedal assembly.

Figure 5-19. Brake Pedal

2. Remove the circlip on one side of the pivot pin and remove the pin.
3. Position the brake pedal on the dynamometer cover with the pin holes aligned with the holes of the pedal base. Insert the pin and reinstall the circlip.
4. Verify brake operation by turning the roll by hand and pressing on the brake pedal. The braking action should be firm and immediate. Also verify that the roll turns freely when the pedal is released.

NOTE: *If the brake does not work, remove the chassis roll cover and check the reservoir.*

5.5.2 General Check

See AppendixA, “Options and Accessories” for information on installing accessories such as the blower ducts, auxiliary roll, and wheelbase extension.

1. Check the tightness of the absorber module to inertia roll module hardware and the universal joint set screws.
2. Install the:
   - Roll cover on the dynamometer
   - Screen on the open end of the absorber module
   - Cover on the absorber housing

3. Verify that all fasteners on the dynamometer covers are tight:
   - Roll cover plate
   - Roll edge guides
   - Brake pedal base plate
   - Front air plenum covers (not installed if the dynamometer is equipped with the blower option)

NOTE: *Covers for the 8-inch plenum blower holes are provided on dynamometers without the blower option. Spacer washers are used under the covers to provide ventilation to the plenum. Do not remove the spacers. The plenum is a battery compartment and ventilation must be provided to prevent the accumulation of flammable hydrogen gas. Blocking all air holes could cause an explosion.*

Your CycleDyn dynamometer is now operational. Other sections in this installation chapter address sensor installation and computer setup instruction.

5.6 Computers and Software

A computer system is not required to operate the CycleDyn, but it significantly enhances the system capabilities and makes it easier to use. SuperFlow's WinDyn™ dynamometer software was designed for Microsoft® Windows® and requires a computer with a Pentium™ or equivalent processor. Multiple monitors can be installed, and a printer is connected to the computer.

The primary computer used for the dynamometer should be placed on a table or computer cabinet close to the dynamometer. If desired, it can be placed in an adjoining room. This computer is configured as the "Command Master" computer. Commands to the test system can only be issued from this computer.

Remote computers can be connected to the dyno as "slaves" through a network hub and used as monitors.

All Windows-supported printers can be used. A color printer is recommended for highest impact and clarity of test graphs.

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

5.6.1 Communication

The computer communicates with the sensor system through an Ethernet Local Area Network (LAN) cable. The Ethernet connection requires a network card in the computer. The computer comes from SuperFlow configured for 10Base-T communication.

SuperFlow systems use the NetBIOS Extended User Interface (NetBEUI) network protocol.

5.6.2 Software

SuperFlow provides a computer disk containing the WinDyn operating software. The installation of WinDyn is typical of any program installation; however, the network ***must*** be configured properly. If the network is not running correctly, the computer cannot receive data from the sensor box. The computer must have NetBEUI installed and selected as the default protocol.

Install Adobe® Acrobat® Reader to take advantage of documentation available on the WinDyn CD or from SuperFlow. Acrobat Reader is provided on the WinDyn CD, but you can download the newest version from **www.adobe.com**.

5.6.3 Setup and Connections

1. Install WinDyn according to Chapter 2, “Getting Started” in the *WinDyn Users Guide*.

NOTE: *If purchased from or configured by SuperFlow, the computer will arrive with the WinDyn software installed and configured for the appropriate system.*

2. Connect the Category 5 (Cat-5) network cable from the computer network port to the RJ-45 connector located on the side of the sensor box labeled **Computer Network**.

Refer to Chapter 3, “Testing With WinDyn” in the *WinDyn Users Guide* for information on using the software.

5.7 System Cable Connections

Dynamometer and sensor cables are connected to the data acquisition system on two panels on the side of the sensor box.

5.7.1 System Interconnect Panel

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

Figure 5-20. System Interconnect Panel

Handheld Controller

The SF-1853 wired handheld is connected to the **Handheld** connector. The handheld is typically used on all SuperFlow chassis dynamometers and some engine dynamometers. The handheld controller allows the operator to control the dynamometer from within the confines of the length of the cable.

See Chapter 7, “Handheld Controls” for more information on using the handheld controller.

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 channel definition of channel 7.

See Chapter 9, "Config File Description" for details on the channel definitions in the configuration file.

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 airstream 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.

Be sure the sensor box power is turned **off** when plugging in the probe.

Figure 5-21. Humidity and Temperature Probe

Tach/Freq

An optical tachometer is connected to the yellow receptacle labeled **Tach/Freq**. This sensor allows measurement of the rear wheel speed independently of roll speed. Wheel slip can then be calculated and displayed. The optical tachometer comes with a magnetic base and a roll of reflective tape.

Be sure the sensor box power is turned **off** when plugging in the sensor.

Other TTL or mag frequency devices can be connected here as well but require modification to the channel 12 definition.

See section A.2, "Wheel Speed Optical Sensor," on page A-13 for more information on the optical tachometer sensor and Chapter 9, "Config File Description" for details on the channel definitions in the configuration file.

Engine Speed

Use this optional sensor to obtain an engine speed signal directly from the engine spark circuits when the absorber speed does not match the engine speed (requires a software configuration change). The speed sensor plugs into the green receptacle on the sensor box system interconnect panel marked **Engine Speed**. Four types of sensors are available—a spark probe, direct coil pickup, optical sensor, and a direct electronic tachometer pickup. Other TTL or MAG frequency devices can be connected here as well but require modification to the channel 11 definition.

See section 6.9, "Obtaining Engine Speed on a Chassis Dyno," on page 6-13 and section A.2, "Wheel Speed Optical Sensor," on page A-13 for more information on the engine speed sensors.

XConsole Serial 1/Serial 2

These connections are used with an operator's console (SF-902 Classic, XConsole Pro, or XConsole Compact). Cables connected between the console and this panel carry signals to the console to operate the system. These connections are generally not used on a chassis dynamometer.

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

This is used to connect a Cat-5 shielded Ethernet LAN cable (supplied) from the sensor box to the network connection on the computer for communication with WinDyn.

For details on Ethernet LAN connections (particularly if a network hub or router is used), see Chapter 8, "WComNet" in the *WinDyn Users Guide*.

5.7.2 Sensor Interconnect Panel

The sensor interconnect panel (Figure 5-22) provides connections to the primary sensors and controllers on the dynamometer.

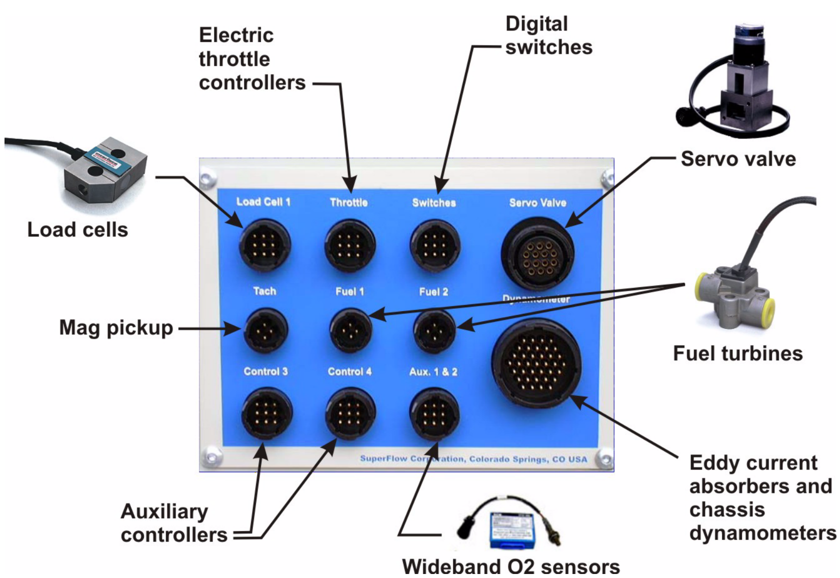


Figure 5-22. Sensor Connection Panel

Dynamometer

This connection is used to connect the sensor box to the chassis dynamometer. It provides the inputs for two load cells, a speed sensor (mag pickup), and the switching controls for the dynamometer (wheel clamp, wheelbase adjust, starter, and blower motor). It also provides one digital input, two auxiliary voltages, and one auxiliary frequency.

Be sure the sensor box power is turned **off** when plugging in the sensor.

Load Cell 1, Tach, Servo Valve

These connections are generally only used on engine dynamometers.

Fuel 1 and Fuel 2

Fuel flow measurement turbines or meters are connected to the sensor box sensor interconnect panel. Connect the 1200A-2046 cable to **Fuel 1** and the 1200A-2047 cable to **Fuel 2**. Be certain to plug it into the correct turbine to ensure the calibration matches the turbine. Calibration tables for each flow turbine is entered in the configuration file.

The SuperFlow low-flow fuel turbine (1200A-FF110) requires either a special converter (1200A-1129) or a jumper moved on the interconnect panel circuit board.

To use a low-flow turbine without the converter, first turn the power off to the sensor box and disconnect the power cord. Open the sensor box and locate the circuit board on the back of the interconnect panel. The part number on the board is 1200A-2621.

TIP: *SuperFlow suggests removing the panel from the box to gain easy access to the jumper.*

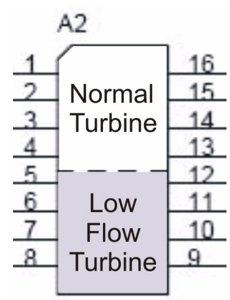


Figure 5-23. 2620 A2 Jumper

Locate the four-pin jumper block labeled **A1** for fuel channel 1 or **A2** for channel 2 (Figure 5-23) on the interconnect panel circuit board. For the standard SuperFlow fuel turbines and all other fuel flow measuring devices, the jumper is in the **Normal Turbine** position. To use the low-flow turbine, move the jumper to the **Low Flow Turbine** position.

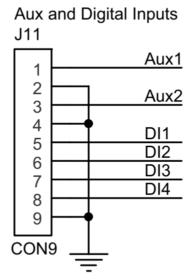
NOTE: *You must return this jumper to the* ***Normal Turbine*** *position any time you wish to return to using the standard 100CS flow turbine or other flow measuring devices.*

Aux 1 and 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 1200A-2252-01 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 1200A-2252-01 cable.

NOTE: *Depending upon the type of sensor used on these inputs, modifications to channels 4 and 5 in the system configuration may be required.*

This connector is also used to input digital signals for WinDyn off/on indicators from external switches. A cable (1200A-2052-02) is available that has the connections for **Auxiliary #1** and **Auxiliary #2** plus two digital input connections (DI-1 and DI-2).



Throttle

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. The electric throttle allows for total automation of testing on the dynamometer.

Switches

The **Switches** connector on the sensor interconnect panel provides eight digital output signals that are used in a variety of ways. Some of the outputs are used for the chassis functions on the dynamometer. These signals are controlled by switch buttons on the handheld controller but can also be controlled with WinDyn display buttons or through automatic test profiles.

These digital outputs will draw to within 0.5 volts to ground while sinking up to 150 mA per output. Static voltage with no device connected is +5 volts. Maximum applied voltage on the outputs is 50 VDC. Recommended use is with +12 VDC relays and an external power supply.

IMPORTANT: These outputs will not "drive" a relay because power is not available on the connector. They control the external relay by providing a switched ground path. Power for the relay must be provided externally to the sensor box.

Controls 3 and 4

The **Control 3** and **Control 4** outputs on the sensor interconnect panel provide automatic controls for external devices such as temperature coolers, heaters, variable speed fans, etc. These outputs have set point control only and provide either 0–10VDC or 4–20mA control signals. The output is programmed through the WinDyn software and can be linked to a direct input from a defined channel in the system configuration file (CFA).

TIP: *If a 4–20mA closed-loop control signal is required for load or throttle control, these outputs can be "mapped" in the software (hardware file) to the controller 1 or controller 2 outputs.*

5.8 Expansion Panels

Optional expansion panels are available to add sensor capability to the data acquisition system. These panels are installed on the sides of the sensor box.

5.8.1 Thermocouple Connections

The sensor box temperature panel has inputs for up to 16 type K thermocouples (Figure 5-24.). 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 the extension cable (if needed) or directly into the thermocouple panel. The panel will accept standard or miniature plugs.

CAUTION: The standard probe type thermocouples are designed so they can be bent into awkward situations. However, once they are bent in one direction, they cannot be straightened without damaging the internal wiring, rendering them inoperative.

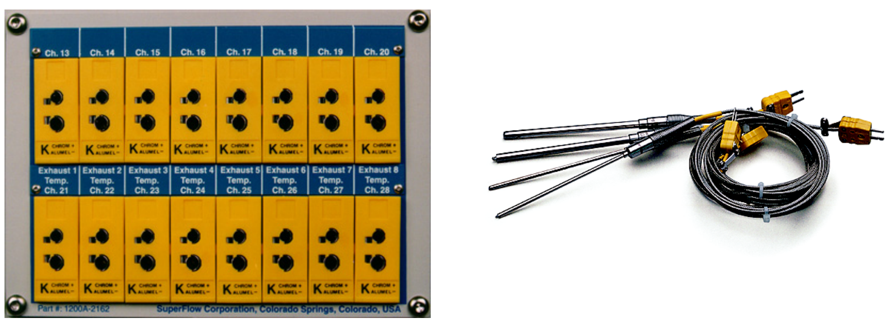


Figure 5-24. Thermocouples

5.8.2 Analog Voltage Expansion

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. Negative ranges can also be accommodated. Frequency-to-voltage converters are available in 1 Khz or 5 Khz ranges.

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

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.

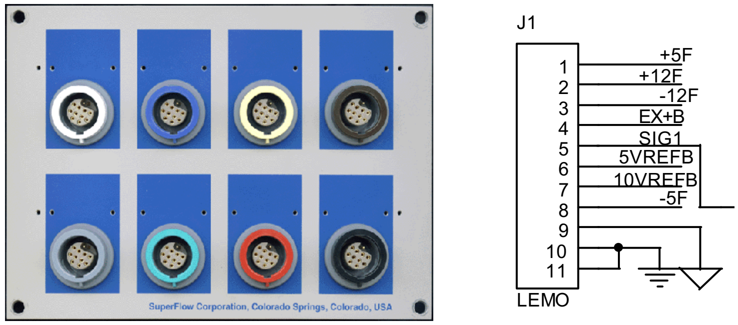


Figure 5-25. Analog Expansion

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:** Unterminated 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 +4.096VDC excitation voltage, x=color
- **1200A-2431-01:** Frequency to voltage adapter, 1Khz maximum
- **1200A-2431-05:** Frequency to voltage adapter, 5Khz maximum

IMPORTANT: Use of custom sensors requires special modification to the software system configuration.

5.8.3 Pressure Connections

Up to 10 pressure sensors (depending on installed options) can be installed in a pressure panel. Connect the #4 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.

Figure 5-26. Pressure

5.9 Configuration

The software completely configures the CycleDyn. The configuration files WinDyn creates and manages will contain channel definitions in the language and unit system of your choice. These files are then installed in the main system directories.

SuperFlow maintains a selection of configuration files based on the most common combinations of English and metric units. Languages other than English applied to the channel definitions is left up to the user.

Configuration files can be based solely on an English or metric unit or a combination of the two. Simply loading the appropriate test group changes from one unit system to the other or from one language to another. This test group will load configurations and screens as appropriate.

NOTE: *The system configuration files are essential to the operation of the system, and most of the other files (such as display files, test files, limits files, etc.) are linked to specific configuration files. To avoid selecting incompatible files, SuperFlow recommends using the* ***Test Group*** *function which automatically loads compatible files. If you have saved a modified configuration file under a new name, you must rebuild those links for the screen, specifications, and test files to work with the new configuration file.*

Refer to the “Test Group” section in the WinDyn Users Guide for more details.

For specific measurements, some customers may wish to use different units than the ones defined in the standard configurations. Select the standard configuration file that most closely fits your requirements and then modify where desired, using the channel configuration editor.

Refer to the “Configuration Editor” chapter of the *WinDyn Users Guide* for detailed instructions.

5.10 Calibration

Prior to first use of the CycleDyn, calibrate the eddy current absorber torque measurement system. Although the system was pre-calibrated at the factory, SuperFlow always recommends verifying the calibration after installation.

Refer to section 10.2.2, “Torque Sensor (Load Cell),” on page 10-7

CHAPTER 6

SYSTEM OPERATION

IN THIS CHAPTER

- **Overview**
- **Safety**
- **Preliminary Operation**
- **Vehicle Installation**
- **Basic Steps to Running the CycleDyn**
- **Analyzing the Test Results**
- **Removing the Vehicle**
- **Obtaining Engine Speed on a Chassis Dyno**

6.1 Overview

This chapter provides instructions for setting up and running a test on the SuperFlow CycleDyn system.

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

6.2 Safety

A dynamometer test cell is a dangerous environment. The operator is exposed to a number of hazards. Risks are associated with the vehicle under test rather than with the dynamometer. It is thus not possible for SuperFlow to protect the operator against all hazards by the dynamometer instrumentation system design.

A proper test cell environment eliminates or reduces the risks associated with dynamometer testing.

Refer to Chapter 4, “Room Requirements” for information on a proper test cell environment.

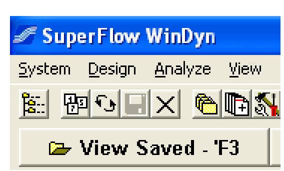
Examples of risks are:

- Engine noise
- Risk of fire
- Risk of burns
- Exposure to rotating parts
- Exposure to parts being projected from the vehicle during operation
- Poisonous exhaust gas

6.2.1 Safety Procedures

- Do not use the brakes of the vehicle.
- Clear the area behind the vehicle before starting any test.
- Always strap down the vehicle. The wheel clamp alone cannot hold the vehicle in a full load test.
- Wear ear and eye protection at all times when testing.
- Take care at all times not to block any of the dynamometer vent openings.

6.3 Quick-Start Checklist

Step	Action	Location	Purpose
	Preliminary checks	• Air pressure @ 80–100 psi • Tie-down straps • Vehicle loading ramp • Handheld controller	Ensure the dynamometer is ready and safe to operate
1	Power on computer system	Power switch on computer	Turns on computer in preparation to load WinDyn software
2	Power on dyno sensor box and eddy current	Sensor box power switch and breakers for EC module	Turns on sensor box and provides voltage to eddy current absorber
3	Load WinDyn software	WinDyn icon on computer screen	Loads the WinDyn software into the sensor box
4	Open desired test group	**F2** function key on computer keyboard	Installs the selected files from the computer to the sensor box
5	Check torque and weather conditions	**2** key on computer keyboard to select screen 2	• Verify the torque system is at or near zero • Verify weather conditions are current
6	Prepare the vehicle for testing	• Load vehicle. • **1** key on computer keyboard to re-select screen 1	• Connect all desired sensors, warm up engine • Go back to screen 1 for normal viewing
7	Use **Eng_Spd** test to assist with selecting an engine speed method	**G** key on handheld, then **A** key to select test.	Use ignition, optical, or calculated methods.
8	Perform system setup	**S** key on computer keyboard to alter setup	• Set correct specifications. • Set the file storage location (folder) in the computer for data files. • Set the name to use for data files; set the beginning sequence number. • Enter any test notes to be appended to the data files. • Memorize setup for future use.
9	Select test to perform	**G** key on handheld, then **A** key to select test.	• Ramp tests, steady state, roadload, etc. • **Use ProFilter *ONLY* IF getting perfect rpm signal.**
10	Start test	**B** key on handheld	• Begins executing the test profile. • Follow prompts on handheld.
11	Perform test	Follow commands on handheld	Perform actions as directed
12	Test complete	Follow commands on handheld displays	• Repeat test or stop • Return throttle to idle
13	Analyze data	**View Saved** icon on WinDyn **Analysis>>Saved** toolbar	Select a data file to analyze, print, or plot: 

6.4 Preliminary Checks and Setup

1. Check that the front wheel clamp has air pressure. The air pressure should be at least 80 psi *[550 kPa]* for adequate clamping force and should not exceed 100 psi *[650 kPa]*. ***Never rely solely on the wheel clamp to support the vehicle.***
2. Check the availability and condition of the tie-down straps. They should be ready for use and within reach of the operator when holding the vehicle on the dynamometer. Do not use frayed or damaged tie-down straps.

   SuperFlow recommends ratchet-type straps rather than cam buckle locks. You need at least four. You will also need several short slings or straps for attaching the tie-downs to the vehicle. You may want to attach the tie-downs to the dynamometer.

1” Tie-down strap

2” Tie-down strap

Axle tie-down strap

Sling tie-down strap

Figure 6-1. Tie-down Strap Types

For tie-down strap part numbers, refer to section 4.12.1, “Tie-down Straps,” on page 4-26.

3. Verify the availability of the handheld controller. The controller should be within reach when sitting on the vehicle while mounted on the dynamometer.
4. Verify that the loading ramp is in position and properly secured to the dynamometer. The ramp should be clear and free of grease or loose material.

IMPORTANT: Slippery ramps may cause accidents.

5. Power on the sensor box and eddy current (if applicable).
6. Power on the computer system and double-click the desktop icon to load WinDyn.
7. Open the front clamp so it is ready to accept the vehicle.

6.5 Vehicle Installation

1. Ride the vehicle onto the dyno. Make sure the front wheel of the vehicle is properly aligned in the restraint groove and is fully inserted into the front wheel chock. If the front wheel does not fit the front wheel chock securely, the clamp may not provide sufficient support to hold the vehicle in position, and it can fall over.
2. Use the handheld controller to close the front clamp.
3. Put the vehicle in neutral and stop the engine.
4. Use the handheld controller keys to adjust the restraint position until the rear wheel is centered on the roll.

CAUTION: Do not operate the wheelbase adjustment with a vehicle strapped down and the wheel clamp engaged as this can damage the wheelbase motor circuit.

5. If equipped with a starter, press the **Starter** key on the handheld controller to spin the rear wheel of the vehicle to center it on the roll. Do not operate the starter motor for more than 10 seconds.
6. Install the tie-down straps front and back to secure the vehicle. Tie-down straps should prevent front, back, and side-to-side movement of the vehicle. Position tie-down straps so they do not interfere with operation of the controls (gear selector, rear brake, throttle, clutch). Route the tie-down straps away from any hot or rotating parts. If desired, the front tire can be strapped to the clamp for added security.

Figure 6-2. Tie-down Straps

WARNING: Improperly installing tie-down straps may cause accidents. The front wheel clamp is for initial positioning only. Do not operate the vehicle without tie-down straps.

7. Connect an exhaust extraction duct to the exhaust system.

Figure 6-3. Exhaust Extraction

6.6 Basic Steps to Running the CycleDyn

WARNING: When a test is not running on the dynamometer, the eddy current (EC) control should be set to 0%. This ensures that no current is applied to the absorbers. Otherwise, they can overheat and be damaged. To reset the load control to 0%, either:

- **Press the red hand button on the handheld before leaving the dyno unattended or**
- **Go to the manual control mode on the handheld and set the load control to 0%.**

Turning off the 240VAC power to the EC absorbers removes any chance of current flow, but use this method only when the dyno will sit idle for long periods.

Running a test on a SuperFlow chassis dynamometer involves two steps. First prepare WinDyn for the test, and second, execute the test itself using the handheld controller. Post-test analysis is performed with the WinDyn Stored Data Viewer.

6.6.1 Test Setup

Installing the correct test group gets the system ready for a test. Preparing WinDyn to accept data and store it in a specific location with a file name helps identify the stored data files. Test Description Notes help operators recognize the customer, engine, and purpose for the test.

1. Load the proper test group file by one of the following methods:
   - Double-click the **Install Test Group** icon on the WinDyn toolbar .
   - Press the **F2** function key on the computer keyboard.
   - Select **System>>Install>>Test Group** on the WinDyn menu.

   Select the desired Test Group file (TPG) from the displayed list and click **Open**.

   NOTE: *This procedure assumes a configuration file and a calibration file are included in the test group design. If not, manually install a configuration file using the* ***System>>Install>>System Configuration*** *menu option. This procedure also assumes the test group includes a calibration file. Otherwise, you need to re-calibrate the dyno or manually load a saved calibration file using the* ***System>>Install>>System Calibration*** *menu option.* ***Loading a CFA without following it with a Calibration file (CAL) always returns your dyno's calibration to a default (uncalibrated) state.***

   Refer to the Test Group section in Chapter 3 of the *WinDyn Users Guide* for more information.

2. Press **2** on the computer keyboard to display the **Dyno Check** WinDyn screen.
   - Check for the correct **Mem4** inertia value for the system (it should never change).
   - Also verify that the correct **Barometer**, **Air Temp**, and **Humidity** readings display.
   - For eddy current equipped systems, check the **Trq1** channel to see if it indicates **0.0, ± 1.5 lb•ft** with no vehicle on the rolls.

   If any of these are incorrect, the dyno is not calibrated.

   You must perform a calibration (see section 10.2, "Calibration," on page 10-6) or install a calibration file that contains the correct calibration coefficients (see Appendix A in the *WinDyn Users Guide* for more information).

3. Press **S** on the computer keyboard to access the **WinDyn Test Setup** dialog box. Use this dialog box to set all the preferences for WinDyn to ensure proper test results.

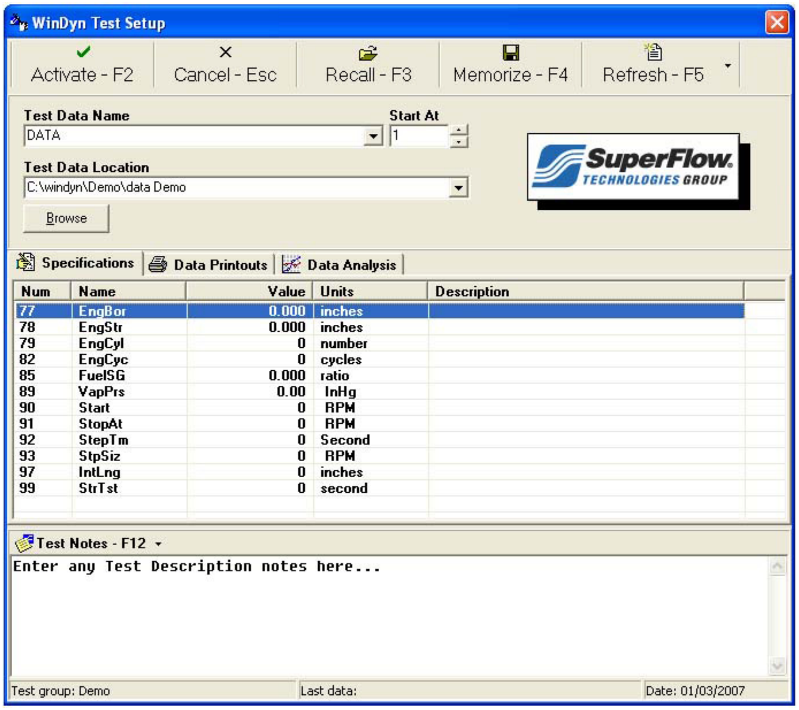


Figure 6-4. WinDyn Test Setup

4. To set up the file name sequence for this series of tests, type a file name in the **Test Data Name** text box. Use a name that identifies the vehicle. Do not end the name with a number because WinDyn automatically assigns a test number to the name. If desired, you can insert a hyphen (-) at the end of the name to separate it from the test number.

5. Set the **Start At** number to **1** (or any desired number). WinDyn cannot use a number higher than 9999. This will be the first test number. Each time a new test is saved, WinDyn automatically increments the test number.

NOTE: *If the **Start At** number is set to **1** and saved tests with the same name are in the same folder, WinDyn automatically increments to the next available number in the folder and adds it to the file name. WinDyn never overwrites an existing file.*

6. Set up the correct folder to store the data files by entering a file path in the **Test Data Location** drop-down list. Use a folder name that identifies the vehicle owner or customer. The drop-down list shows the previous 10 folders used. Click the **Browse** button to search for a folder. The folder location can be anywhere on the computer hard drive, but it is best to keep the data files together with other WinDyn files.

7. Check for the correct vehicle and test specifications. If the specifications are wrong, select the channel and press **ENTER** (or double-click the channel name). Specifications can also be saved and installed with a saved specification file.

Chapter 9, "Config File Description" provides specific details on each specification system and how it is used by the system. See Chapter 3 in the *WinDyn Users Guide* for more information on specifications.

8. In the **Test Notes** area, enter test vehicle details, owner contact information, reasons for testing the vehicle, test results, and anything else that explains why the vehicle is on the dynamometer. The entered information is saved with the stored test data files (*.SFD) and can be viewed or printed with the data. After storing the data, press **F10** to add more information using the Stored Data Viewer program.

> See Chapter 4 in the *WinDyn Users Guide* for more information on test description notes and data analysis.

9. Memorize the setup for future use, and then press **F2** or click the **Activate** button (top left) to install the new test settings.

6.6.2 Test Execution

1. Load the vehicle onto the dynamometer.

> See "Vehicle Installation" on page 6-6 instructions.

IMPORTANT: If using nylon straps, make sure none of them are near any hot surfaces or they may melt. Also, make sure they are not near any rotating parts or near the dyno blowers.

2. Select a method for obtaining engine speed.

> See "Obtaining Engine Speed on a Chassis Dyno" on page 6-13.

3. Connect any additional sensors to the vehicle.
4. Place the temp/humidity probe in the airstream of the air intake or in its normal location (to obtain repeatable results, the probe should be in the same location for every test).

***NOTE:** Instructions for using the SF-1853 Wireless handheld controller is contained in the handheld operators manual.*

5. Press **Test** (**G**) on the handheld controller main operation screen to access the Test menu.

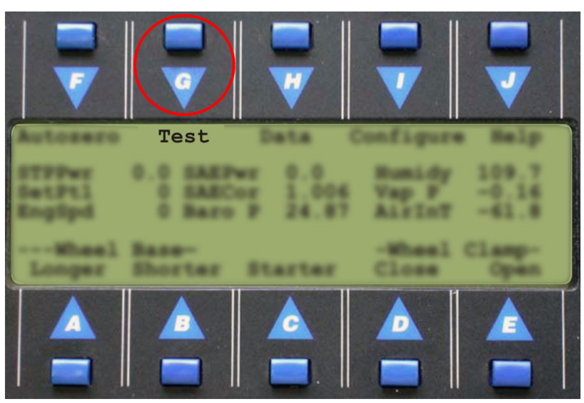


Figure 6-5. CycleDyn Handheld Main Menu

6. Select and perform the desired test using the handheld test menu shown below.

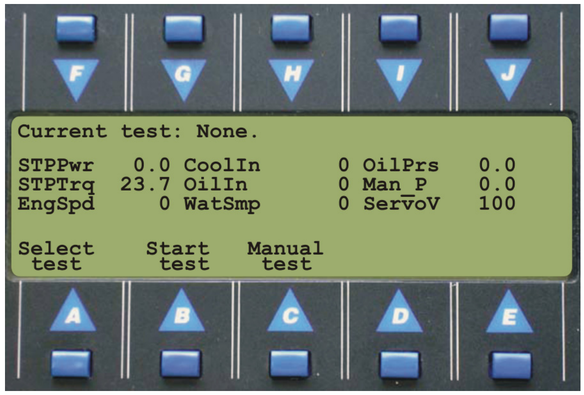


Figure 6-6. Handheld Test Menu

- Press **Select test** (**A**).
- Press the number button corresponding to the test.
- Press **Start test** (**B**).

Refer to section 8.7, “Test Profile Descriptions,” on page 8-14 for test type details.

7. Follow the prompts to run the test. Data from the test is automatically stored to the computer at the end of the test. Repeat the test if desired.

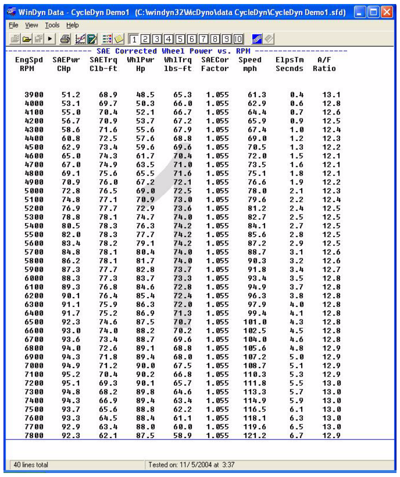
   The test will prompt for the use of ProFilter™. If using ProFilter, you must have a good engine speed signal for it to operate properly, and the test will automatically set the correct parameters based on the selected engine speed signal source. If a perfect engine speed signal is not possible, do not use ProFilter.

ProFilter is a special WinDyn feature that post-processes high-speed recorded data to provide smoother data with even increments of engine rpm on the data printout. See Chapter 4 in the *WinDyn Users Guide* for more information on ProFilter and how to use it.

8. Upon test completion, let the vehicle coast to a stop (the roll brake may be used if your dynamometer is so equipped), and let it cool down as necessary before shutting off the engine. Wait for the roll to stop before getting off the vehicle.
9. Remove the vehicle from the dynamometer when all testing is complete.

See “Removing the Vehicle” on page 6-12 for details.

6.7 Analyzing the Test Results



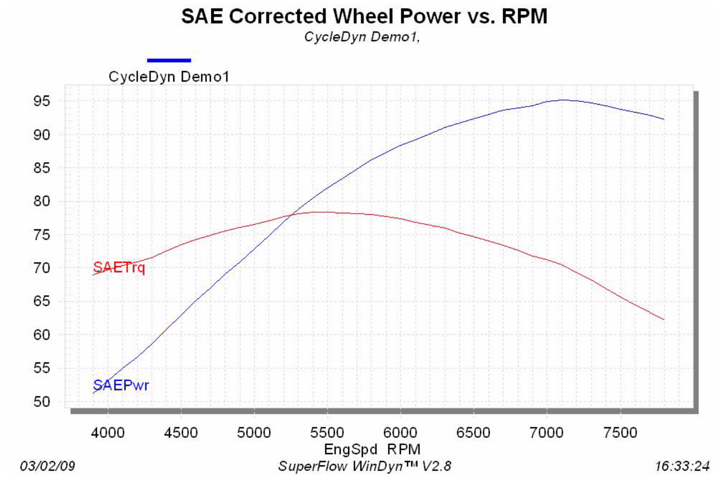
WinDyn Data - CycleDyn Demo1 (C:\windyn32\McDyno\data CycleDyn\CycleDyn Demo1.sfd)

File View Tools Help

SAE Corrected Wheel Power vs. RPM

EngSpd RPM	SAEPwr CHp	SAETrq Clb-ft	WhlPwr Hp	WhlTrq lbs-ft	SAECor Factor	Speed mph	ElpsTm Secnds	A/F Ratio
3900	51.2	68.9	48.5	65.3	1.055	61.3	0.4	13.1
4000	53.1	69.7	50.3	66.0	1.055	62.9	0.6	12.8
4100	55.0	70.4	52.1	66.7	1.055	64.4	0.7	12.6
4200	56.7	70.9	53.7	67.2	1.055	65.9	0.9	12.5
4300	58.6	71.6	55.6	67.9	1.055	67.4	1.0	12.4
4400	60.8	72.5	57.6	68.8	1.055	69.0	1.2	12.3
4500	62.9	73.4	59.6	69.6	1.055	70.5	1.3	12.2
4600	65.0	74.3	61.7	70.4	1.055	72.0	1.5	12.1
4700	67.0	74.9	63.5	71.0	1.055	73.5	1.6	12.1
4800	69.1	75.6	65.5	71.6	1.055	75.1	1.8	12.1
4900	70.9	76.0	67.2	72.1	1.055	76.6	1.9	12.2
5000	72.8	76.5	69.0	72.5	1.055	78.0	2.1	12.3
5100	74.8	77.1	70.9	73.0	1.055	79.6	2.2	12.4
5200	76.9	77.7	72.9	73.6	1.055	81.2	2.4	12.5
5300	78.8	78.1	74.7	74.0	1.055	82.7	2.5	12.5
5400	80.5	78.3	76.3	74.2	1.055	84.1	2.7	12.5
5500	82.0	78.3	77.7	74.2	1.055	85.6	2.8	12.5
5600	83.4	78.2	79.1	74.2	1.055	87.2	2.9	12.5
5700	84.8	78.1	80.4	74.0	1.055	88.7	3.1	12.6
5800	86.2	78.1	81.7	74.0	1.055	90.3	3.2	12.6
5900	87.3	77.7	82.8	73.7	1.055	91.8	3.4	12.7
6000	88.3	77.3	83.7	73.3	1.055	93.4	3.5	12.8
6100	89.3	76.8	84.6	72.8	1.055	94.9	3.7	12.8
6200	90.1	76.4	85.4	72.4	1.055	96.3	3.8	12.8
6300	91.1	75.9	86.3	72.0	1.055	97.9	4.0	12.8
6400	91.7	75.2	86.9	71.3	1.055	99.4	4.1	12.8
6500	92.3	74.6	87.5	70.7	1.055	101.0	4.3	12.8
6600	93.0	74.0	88.2	70.2	1.055	102.5	4.5	12.8
6700	93.6	73.4	88.7	69.6	1.055	104.0	4.6	12.8
6800	94.0	72.6	89.1	68.8	1.055	105.6	4.8	12.9
6900	94.3	71.8	89.4	68.0	1.055	107.2	5.0	12.9
7000	94.9	71.2	90.0	67.5	1.055	108.7	5.1	12.9
7100	95.2	70.4	90.2	66.8	1.055	110.3	5.3	12.9
7200	95.1	69.3	90.1	65.7	1.055	111.8	5.5	13.0
7300	94.8	68.2	89.8	64.6	1.055	113.3	5.7	13.0
7400	94.3	66.9	89.4	63.4	1.055	114.9	5.9	13.0
7500	93.7	65.6	88.8	62.2	1.055	116.5	6.1	13.0
7600	93.3	64.5	88.4	61.1	1.055	118.1	6.3	13.0
7700	92.9	63.4	88.0	60.0	1.055	119.6	6.5	13.0
7800	92.3	62.1	87.5	58.9	1.055	121.2	6.7	12.9

40 lines total | Tested on: 11/ 5/2004 at 3:37



All automated tests will save the test data automatically onto the computer. Use the WinDyn **Stored Data Viewer** to view, plot, and print recorded data.

A **SuperFlow Explorer** utility program is available on the WinDyn Tools menu to help you locate data files.

- Select **Analyze>>Saved Test>>View** on the WinDyn main menu to start the Stored Data Analysis program and display the test results. Use the numeric keys or the mouse to select any of 10 available pages.
- Click the **Plot Test** button or select **View>>Plot** to display the results in graphical format. Use the numeric keys or the mouse to select any of 10 available pages.
- Click the **Print Test** button (printer icon) to print the tabular data or select **File>>Print Plot** to print the graph.

Refer to the WinDyn Help screens or Chapter 4 of the *WinDyn Users Guide* for more information on how to use the test analysis features of the WinDyn Stored Data Viewer.

6.8 Removing the Vehicle

WARNING: Some vehicle parts may still be hot and may cause burns. Be careful when removing cables, sensors, and tie-down straps.

1. Disconnect all sensors and cables.
2. Verify the ramp is clear and secure.
3. Verify the front clamp is closed and secure.
4. Remove tie-down straps slowly while holding the vehicle in an upright position. Do not allow one strap to pull the vehicle over to one side, or it may fall. Sit on the vehicle to control it.
5. Use the handheld controller to release the front clamp.
6. Move the handheld controller out of the way.
7. Slowly back the vehicle off the dyno. Use the vehicle's hand-operated brake to slow the movement of the vehicle.

6.9 Obtaining Engine Speed on a Chassis Dyno

One of the more challenging aspects of running vehicles on a chassis dynamometer is obtaining noise-free engine speed readings (rpm). This section provides tips on how to accomplish that goal successfully. Some of the problems associated with obtaining a good, clean rpm signal are:

- Noisy ignition components: wires, plugs, ignition modules
- Noisy electrical components on or near the test vehicle: alternators, generators, welding equipment, electric motors for compressors, high-voltage equipment, etc.
- No plug wires (coil over cap systems, Diesels, etc.)
- Inaccessible plug wires

All of the above issues (and more) contribute to erratic or no rpm readings. Basically, it is not an easy job. However, power calculations on a SuperFlow chassis dyno do not require an engine rpm signal. This is because all the power calculations are derived from the roll and not the engine.

On an engine dynamometer, flywheel speed and torque are measured. Therefore, the formula for engine horsepower is:

$$\text{EngineHorsepower} = \frac{\text{EngineTorque} \times \text{EngineSpeed}}{5252.113}$$

In the above equation, engine rpm is a requirement to compute engine horsepower.

But on a SuperFlow chassis dynamometer, wheel power (the power at the point where the vehicle wheels contacts the dynamometer roll) is calculated using the following formula:

$$\text{WheelHorsepower} = \text{InertiaPower} + \text{DynoLosses} + \text{RollPower}$$

- **Inertia power** is derived from the known inertia mass of the roll being accelerated during the test. We measure the rate of acceleration from the roll speed pickup.
- **Dyno losses** are computed at the factory and are embedded in the system configuration.
- **Roll power** is generated by an eddy current absorber and calculated from the strain gauge torque multiplied by roll rpm divided by 5252.113.

Thus, no part of the wheel power equation requires engine rpm.

You can literally dyno all day and never need engine speed. SuperFlow even provides a default printout page (number 9) that is defined with roll speed on the X-axis for convenient plotting of power when engine speed is erratic or nonexistent. So if you only need some quick horsepower numbers, do not worry about engine rpm.

Of course, having engine speed is still important, particularly for graphing power numbers vs. rpm and for deriving the **WhlTrq** numbers that come from the wheel power number. Thus, a good engine rpm reading is desirable even if it isn’t needed for the power calculations.

6.9.1 Engine Speed Sensors

NOTE: *Older versions of WinDyn and its associated configuration files may not be set up for all the various sensors. These require a hardware modification and changes to several channels in the software.*

SuperFlow offers three different types of ignition pickups to obtain engine speed using the vehicle's ignition system, and an optical tachometer sensor. All connect to the Engine Speed connector on the sensor box. In addition to the sensors, engine rpm can be back-calculated from roll speed.

See section A.1, "Engine Speed Sensors," on page A-3 for detailed information on these sensors.

6.9.1.1 Inductive Pickup

This pickup may be used on any pulsing electrical signal wire that has a relationship to engine speed. The spring-loaded clip fits around a spark plug wire, coil wire, or fuel injection wire. The sensor will have either a manually set gain adjustment dial or an automatic gain adjustment (depending on the model).

The pickup can be placed in different positions on the signal wire to get the best signal; it is polarity sensitive, so its orientation on the signal wire may require reversing to work properly. In some cases, two clips can be used together to "boost" the spark signal.

See section A.1.1.2, "Inductive Clip," on page A-7 for more information on this device.

When using this pickup, adjust the pulse-per-revolution factor through the **Pul/Rv** channel in the WinDyn specifications. The frequency from the pickup is divided by the **Pul/Rv** factor to calculate revolutions per second. That is then multiplied by 60 to get revolutions per minute. The following table helps explain how the channel is used with a four-cycle engine.

Table 1. Inductive Pickup Pulse per Revolution

IGNITION PULSES				
Specification	**Wasted spark**	**Wasted Spark**	**No Wasted Spark**	**No Wasted Spark**
Frequency from the pickup (Hz)	50	25	25	12.5
Divided by pulses per rev factor	1	1	0.5	0.5
Multiplied by time factor (seconds in a minute)	60	60	60	60
Resultant rpm	3000	1500	3000	1500

6.9.1.2 Direct Coil Pickup

This pickup may be used by connecting its clips directly to the primary wires +/– on an ignition coil. Although the pickup implies correct polarity by the red and black lead colors, it may work better with the leads reversed. Try it. A green LED flashing on the device will confirm a good signal is present.

This device generally works with signal levels of at least 10–12 VDC. Lower levels will not work successfully; thus, it cannot be used on a 0–5VDC pulse wire.

When using this method, the pulse-per-revolution factor is adjusted through the **Pul/Rv** (SparkP on some systems) channel in the WinDyn specifications.

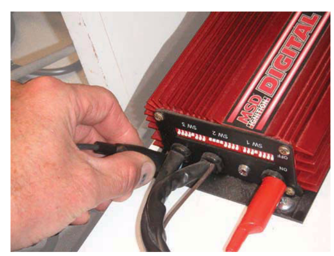
The resultant engine speed is calculated as shown in Table 1 on page 6-14.

Many customers report highly successful results with this pickup. Several have grafted different connectors onto it and simply splice into the vehicle ignition system wiring harnesses to get a good signal. Obviously, this takes some time and effort and is usually done on repeat customer vehicles instead of on the single-dyno-session user.

An isolation circuit is built into this sensor to protect the data acquisition system from damage caused by ignition spikes or ungrounded circuits. However, the device can be damaged if used on high voltage such as the type coming from an MDS ignition system.

See section A.1.1.3, “Direct Coil Pickup,” on page A-10 for more information on this device.

6.9.1.3 Tach Wire Pickup



This pickup may be directly connected to any pulsing signal source with an amplitude of 5 to 16 volts DC. For instance, if the vehicle has an ignition module with a tachometer output tap, you can connect one lead of this pickup to the signal source and the other lead to chassis ground.

Because this sensor is connected directly between the vehicle and the data acquisition system input, it is very important that a good earth ground connection exists on the vehicle. Otherwise, this sensor provides an excellent path for static discharge and causes damage to the system electronics.

See section A.1.1.4, “Tach Wire Pickup,” on page A-10 for more information on this device.

When using this method, the pulse-per-revolution factor is adjusted through the **Pul/Rv** (SparkP on some systems) in the WinDyn specifications. To determine the Pul/Rv factor, you may need to consult the ignition module manufacturer’s documentation. If no documentation is available, adjust the factor until the WinDyn engine speed display matches the vehicle’s tachometer reading.

TIP: *On some ignitions, you may need to disconnect the tach to obtain a signal for WinDyn.*

6.9.1.4 Optical Tachometer Sensor

This pickup was originally designed by Caterpillar Corporation for obtaining engine speed on Diesel engines, which do not have ignition systems. This pickup may be used to measure the rpm of any rotating object on the test vehicle. It does this by reading its reflected beam from a piece of reflective tape you attach to the rotating object. It works quite well as long as a rotating object associated with engine speed is available on the engine or drivetrain. This method of obtaining engine speed is often preferred since it is generally not susceptible to noise interference.

See section A.1.2, “Optical Sensor,” on page A-11 for more information on this device.

Use of this sensor requires the exact ratio between the frequency output of the optical sensor and the actual engine speed. This value is set into the **RpmRat** specification channel and used to convert the signal from the sensor to engine rpm. If the sensor is placed on the harmonic balancer or crankshaft flywheel, the ratio will be **1.00**. If the sensor is placed on anything else, you need to determine the ratio and enter it into the channel.

6.9.1.5 Calculated Method

A final method SuperFlow offers to obtain engine speed relies on no pickups at all. Instead, we derive the engine speed from the dyno roll speed using the following calculations:

WhRvPm = (Speed/60)*(5280/(TirDia*0.2618))

Calculates the wheel revolutions per minute using the roll speed and tire diameter. The constant 0.2618 equals Pi divided by 12 and is used to simplify the equation for WinDyn.

EngSpd =WhRvPm*RpmRat

Calculates engine speed in a specific transmission gear ratio as a function of roll speed.

The only requirements for this method to work are to know the tire diameter and the vehicle's overall ratio for the transmission gear chosen to perform the test. The tire diameter value is entered into the TirDia specification channel, and the overall ratio is entered into the RpmRat channel.

Although this method may be the least accurate (usually to within +/– 1%), it is a viable method to use when the others do not work or are not feasible. When using the method with the ProFilter™ feature, the resultant rpm increments may not be exactly even.

Keep in mind, this method does not work with vehicles equipped with an automatic transmission or CVT, nor can you obtain an accurate engine speed reading if you change transmission gears during the test.

TIP: *The test profiles included with the system provides an easy and automatic way of calculating the TirDia and RpmRat channel values. Run the test and follow the instructions. Once the correct value is determined, we suggest saving a setup file for that vehicle to expedite setup for future tests.*

6.9.2 Engine Speed Setup

SuperFlow provides several methods for obtaining engine speed. One or another will work. However, you may need to experiment with each one before you decide which one works best for the test vehicle. The system configuration files provided with WinDyn are pre-configured for multiple engine speed selection methods.

Select the desired method through the following specifications channels:

- **IgnPck** **Default Value 1**

  This channel enables the input signal from the inductive spark pickup, coil pickup, or the direct tach wire connection and uses it in the engine speed calculation. It is the desired method for calculating engine speed. A **1** in this channel enables this input. A **0** in this channel disables this input to the calculation.

- **OpTach** **Default Value 0**

  Use this channel to select the optical sensor method for calculating engine speed. A **1** in this channel enables input signals from the optical sensor. A **0** in this channel disables the optical sensor input to the calculation.

- **CalTac** **Default Value 0**

  Use this channel to select the calculated method for calculating engine speed. A **1** in this channel enables engine speed calculations with no signal input device, instead using roll speed in mph, tire diameter, and overall ratio. A **0** in this channel disables these inputs in the engine speed calculation.

To use a specific method, enable the appropriate method by setting the proper specification channel to a value of **1** and turning off the other methods by setting their specification values to a **0**. To do this, double-click the **WinDyn Specifications** toolbar icon, press the **S** key on the computer keyboard, or on the handheld unit select the **Configure>>Specs>>Edit** menu.

*TIP: A utility test profile, **Eng_Spd.tpf**, is provided to help you select and configure your system for a specific rpm method. SuperFlow strongly encourages you to run this test profile any time you set up engine speed measurements on a test vehicle.*

See section 8.7.4, "Other Tests," on page 8-19 for details on the Eng_Spd test.

To manually set up the system for obtaining engine speed:

Ignition Pickups

1. Connect the sensor.
2. Set the **IgnPck** specification channel to **1**, set **OptTac** and **CalTac** to **0**.
3. Set the **Pul/Rv** specification channel to the appropriate pulses-per-revolution factor.

Optical Tachometer Sensor

1. Connect the sensor.
2. Set the **OptTac** specification channel to **1**, set **IgnPck** and **CalTac** to **0**.
3. Set the **RpmRat** specification channel to the appropriate pulses-per-revolution factor.

Calculated Method

1. Connect the sensor.
2. Set the **CalTac** specification channel to **1**, set **IgnPck** and **OptTac** to **0**.
3. Set the **RpmRat** specification channel to the appropriate pulses-per-revolution factor.

CHAPTER 7

HANDHELD CONTROLS

IN THIS CHAPTER

- Handheld Controls
- Keypad
- System Power-up Screen
- Main Operating Screen
- Dynamometer Controls
- System Controls
  - Autozero
  - Test
  - Data
  - Configure
- Handheld Expressions
- Error Messages

7.1 Handheld Controls

NOTE: *This chapter covers the use of the wired handheld controller. The description and operation of the wireless handheld unit is covered in a separate document.*

The SF-1853 remote handheld controller is the main operator interface when conducting a test on a SuperFlow chassis dynamometer. Current data and other status information also displays on the handheld.

Figure 7-1. SF1853 Wired Handheld Controller

The SF-1853 is encased in a rubberized housing with a Lexon® plastic cover over the Liquid Crystal Display (LCD) to protect it. Two rubber bumpers on the back allow operators to place the handheld on the steering wheel without it falling off. The bumpers can be removed if desired. The buttons are hard plastic. The LEMO connector for the sensor box is color-coded and keyed.

The handheld is sealed for protection from moisture, but the seal is not sufficient for submersion. The cable strain relief protects the cable; however, take care not to wrap the cable tightly around the housing, and do not suspend the handheld with the cable.

IMPORTANT: Do **NOT** not leave the handheld unit in or on the vehicle while driving it off the dynamometer.

7.2 Keypad

The handheld panel is divided into three areas: the hard keys (numerical) on the right, the display, and the soft keys surrounding the display. The hard keys are labeled such because their function is always the same. The software determines the function of the soft keys.

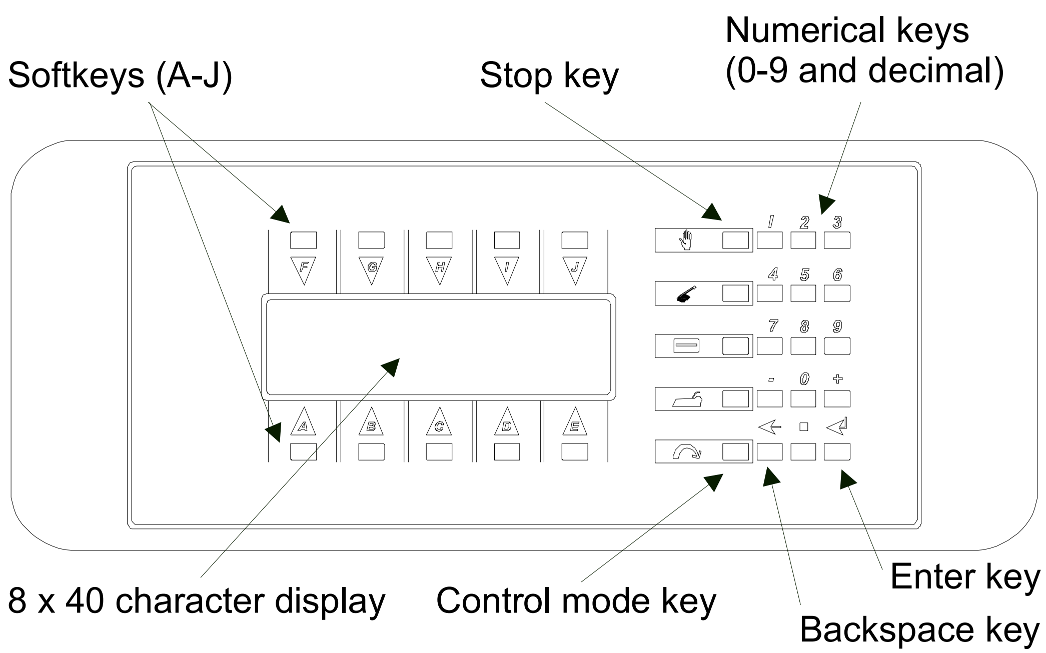
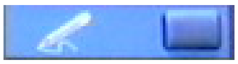
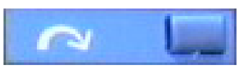
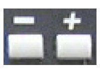
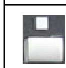


Figure 7-2. Handheld Keypad

The numeric keypad is used to switch between display screens (1–9) and to enter numerical values into the system.

The other hard keys perform the functions listed in Table 7-1.

Table 7-1. Handheld Key Functions

Graphic	Key	Function	Description
	**Red Hand**	**Stop**	Returns to the main menu, stops running tests, removes load from the absorber, and aborts the current action without saving any data.
	**Pencil**	**Record**	Records one data line each time it is pressed.
	**123...**	**Display**	Alternates the current data screen's display of units, channel number, measured values.
	**Printer**	**Print**	Sends a print command to the computer to print current data as specified in the WinDyn Print Setup dialog box. If the Prompt for Print option is not selected, the system will print directly. Otherwise, the Print Setup dialog box appears on WinDyn.
	**Curved Arrow**	**Toggle**	Cycles between normal operation and the load control command line.
	**+ / – Keys**	**Polarity**	Enters the respective polarity (+ sign normally not required).
	**Back Arrow**	**Clear**	Backspaces and clears the last entered digit.
	**Box**	**Decimal**	Enters a decimal point at the cursor.
	**Bent Arrow**	**Return**	Installs the entered value into the system.

7.3 System Power-up Screen

Figure 7-3 shows the system at power-up. The displays show the current date and time. This screen also displays whenever the soft key sequence F, A, D, E is pressed.

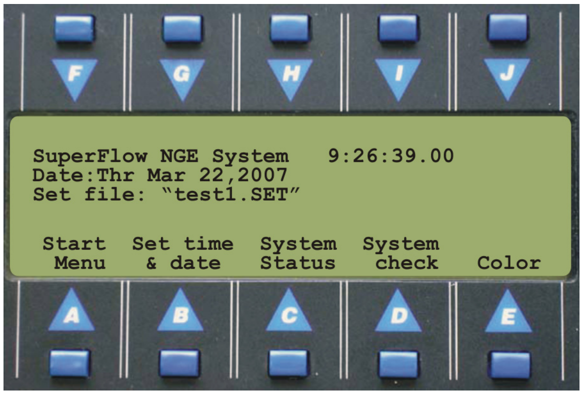


Figure 7-3. Power-up Display

- **Start Menu:** Displays the main operation screen for the system.
- **Set Time and Date:** Displays the time/date entry screen and makes changes if necessary. The time and date are normally downloaded from the computer when communication is established. Changing the time or date here is rarely necessary.
- **System Status:** Provides information pertaining to the system such as the system type, installed hardware file, Operating System (OS) version, program versions, and number of nodes connected to the system network. Submenus display the B-processor version, the names of the connected nodes, and information on the control system types.
- **System Check:** Performs quick diagnostics on the Random Access Memory (RAM) and displays the amount of memory available. The screen also displays the installed OS version and program code (PRG or PGM) versions.
  - **Reset System:** Performs a complete system restart. Make sure the system is in a safe mode prior to performing this restart (no engine, vehicle, or other devices running).
  - **Node Names:** Displays the list of network node names connected to the system.
- **Screen color:** Select normal or reverse mode for the operator interface (black on white or white on black).

7.4 Main Operating Screen

The operating screen (Figure 7-4) displays when the **Start Menu** button on the Power Up screen or the red hand **Stop** key is pressed.

TIP: *Press the Red Hand button at any time to return to the Main start screen.*

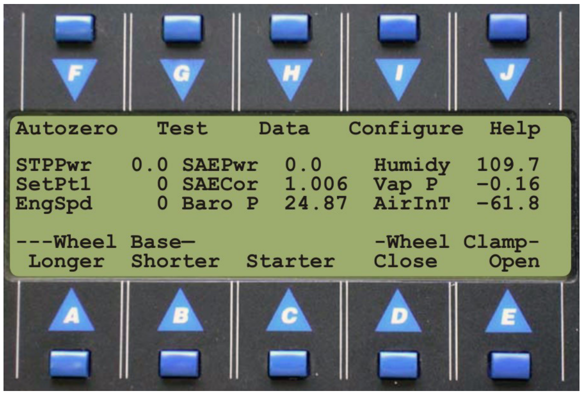


Figure 7-4. Main Operation Display

The buttons along the top of the display perform functions described in “System Controls” starting on page 7-9. The buttons along the bottom of the display perform functions described in “Dynamometer Controls” on page 7-8.

The center section of the handheld display serves two functions:

- In normal operation the screen displays nine channels that are defined in the system configuration file (CFA). Nine different screens are available, each with nine channels. The channel selection for the screens is also defined in the configuration file.

  Press any of the number keys on the right side of the handheld to select the corresponding screen. The channel name and the current data for that channel display.

  Press the display button located between the display and the numeric buttons to change the units of measurement display for each channel. Press the button again to show the channel number. Press it again to return to the real-time display.

- When running an automated test, the display will show messages scripted in the test. These messages range from operator prompts, to selected channel readouts, to test status information, to whatever the test author scripts. At the end of a test, the display reverts to the normal data display.

  Also during an autotest, the buttons on the bottom (A–E) can be reconfigured in the test for specific functions.

7.5 Dynamometer Controls

The lower row of buttons beneath the display (A–E) control certain function on the dynamometer.

7.5.1 Wheel Base

The position of the front wheel restraint can be varied by pressing and holding these keys. The softkey label will flash to indicate movement. Pressing **Longer** will extend the front wheel clamp assembly further away from the roll. Pressing **Shorter** will bring the wheel clamp closer to the roll.

A data channel (**WhlRst**) available in WinDyn is used to measure the position of the wheel restraint. It is calibrated to read zero at the shortest length and 100 at the greatest length. For any particular motorcycle, a specific number between 1 and 100 should be appropriate for tests. After the motorcycle is installed, note the restraint position index. You can then use that value to pre-set the wheelbase position before testing the next motorcycle of the same model.

IMPORTANT: Release the button immediately if the wheelbase restraint does not move. Check for binding or restriction of the slides or the motor. Trying to force the motor to move against a restriction can result in damage.

7.5.2 Starter

The electric starter (optional on some models) is used for centering the motorcycle on the roll without having to start the engine. It is also used to “jump start” motorcycles that do not have an electric starter. Press and hold the Starter button to engage the starter motor. The softkey label will flash to indicate movement.

Do not operate the starter motor for more than 10 seconds each minute, or it may be damaged by overheating.

7.5.3 Wheel Clamp

The front wheel clamp can be opened or closed by pressing these keys. A timed message displays to indicate the position of the clamp as a result of the command. When opening the clamp, a message displays on the handheld, prompting the operator to confirm the operation. The clamp will not open if the system detects that the roll is spinning.

7.6 System Controls

This section describes the functions of the top row of buttons on the handheld display. he display changes, and a menu displays on the handheld after each button is pressed. Further action of the display buttons is dictated by the label above or below the display.

7.6.1 Autozero

The Autozero function zeros all configured sensors to zero by command.

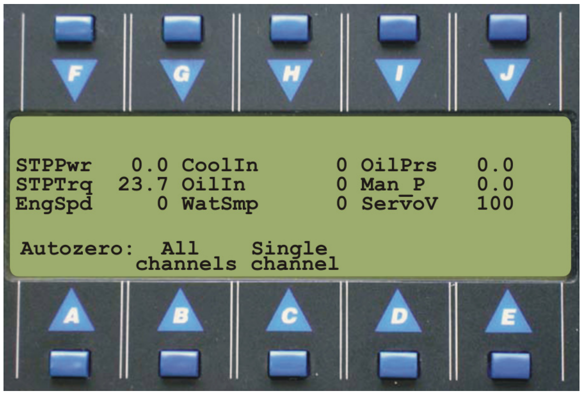


Figure 7-5. Autozero Screen

- **Autozero all channels (timed message):** Pressing **All channels** (**B**) zeros each channel defined in the configuration file (CFA) to zero by command. After the action is complete (which may take several seconds), the display returns to the main operation screen (Figure 7-5).
- **Autozero single channel screen:** A single channel can be zeroed without affecting the others. Press **Select**, then press the channel number on the number keypad to select the desired channel. Pressing **ENTER** will zero that channel only.

NOTE: *You do not have to use the* ***Select*** *command to access the channel number entry. Pressing the channel number directly will select the channel. This applies to all functions that use the Select key.*

7.6.2 Test

This screen shows the name of the test that is currently loaded into the system and ready for execution. If no test is installed, the display shows **None**. The buttons on the bottom of the screen prompt the operation for an action.

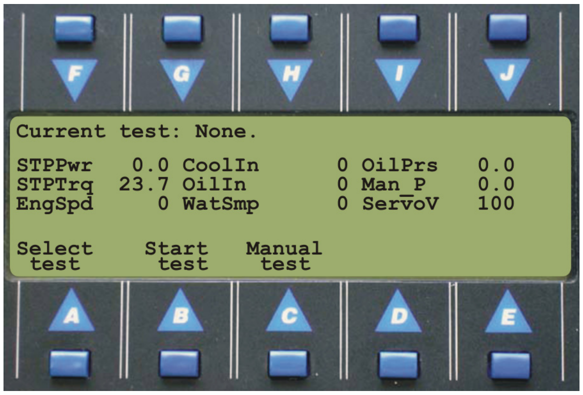


Figure 7-6. Test Screen

- **Select Test:** Press **Select Test** (***A***) to display the available test profiles. If more tests are available that cannot fit on the screen, use Page Up or Page Down to scroll through the tests. Test names shown between [brackets] indicate a test loaded into the system within a Set file. Test names shown between <brackets> indicate a test available in a designated location on the dynamometer computer.

  Press **Select**, then press the test number on the number keypad to select a test. Press **ENTER** to load that test into the system. The test name appears at the top of the screen. If for some reason the test profiles are not available, an error message appears (see section 7.8, “Error Messages,” on page 7-20).

- **Start Test:** Pressing **Start Test** (**B**) begin the test. A typical test displays instructions and information on the screen. Pressing Start Test with no test loaded in system displays an error message (see section 7.8, “Error Messages,” on page 7-20).

NOTE: *Test messages may overwrite data displays, and soft keys A–E are labeled by the test to perform specific functions within the test script.*

- **Manual Test:** Pressing the Manual Test button (C) displays the mode select screen. The B key shows the current selected mode. Press the **A** or **B** soft key to scroll through the control modes. Press **Done** to activate the mode or **Exit** to cancel and return to the previous screen. After selecting the control mode, the Manual Control screen displays.

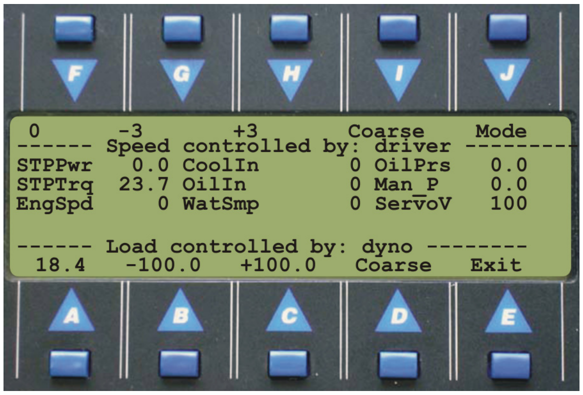


Figure 7-7. Manual Control Screen

- Press the **A** key to enter a direct control value (set point) with the number keys and the **ENTER** key.
- Press the **B** or **C** keys to increment or decrement the set point by the value indicated.
- Press the **D** key to change the step values on the B and C keys. Three choices are available: Coarse, Medium, and Fine. These step values can be changed through the Configure menu (see section 7.6.4, “Configure,” on page 7-13).
- Press **Exit** (**E**) to return the controllers to zero state (no load/no throttle) and return to the previous screen.
- Press **Modes** (**J**) to display the Mode Select screen.

7.6.3 Data

Pressing the data command button (**H**) displays data recorded in the data acquisition system memory (Figure 7-8). This data is referred to as current data and can be analyzed on the handheld before looking at it on the computer.

Figure 7-8. Data Screen

- **First/Last:** Displays the first/last recorded line of data.
- **Up/Down:** Displays the next/previous line of recorded data.
- **Screen:** Press the **J** key to scroll through data display screens 1–9 or press a direct keypad number entry to access a screen.
- **Save Data:** Sends data to the computer where WinDyn saves it to a SuperFlow Data (SFD) file. The data is saved under a file name as specified in the Auto Increment File name dialog box as an **Autotest Saves Data** entry.
- **Erase Data:** Clears the memory in the data acquisition system of any recorded data. It will prompt to confirm the action before erasing the data.
- **Records:** Displays total lines of data in test. This button does not have a command function.
- **Number:** Displays the current line number.
- **Exit:** Returns to the main operating screen or the previous command screen.

7.6.4 Configure

The Configure screen provides access to system functions. Most of these functions are handled by the WinDyn software automatically or with operator interface. Some functions are easier to use with the WinDyn software and are provided on the handheld as a secondary access method.

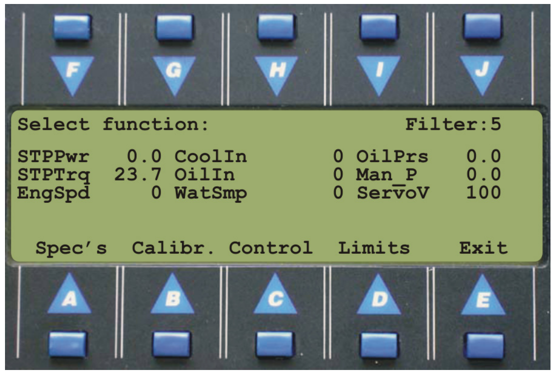


Figure 7-9. Configure Screen

Filter

It is possible to select “automatic filtering” for individual data channels when building a configuration file. In that case, the system filter setting determines what filter to apply to those data channels. Press the **J** button to change the data filter rate on those channels.

For more information, see chapter 7, “Configuration Utility,” in the *WinDyn Users Guide*.

To change the filter rate, enter a value from 0–7 (0 is no filter, and 7 is maximum filter). Press **Exit** to return to the main operator screen.

Table 7-2. Data Filter Rates

Filter Value	Frequency	Recommended for...
Auto	Variable	Changing conditions*
0	No filter	Not recommended
1	20 hz/50 ms	2000 rpm/sec acceleration tests
2	10 hz/100 ms	1000 rpm/sec acceleration tests
3	5 hz/200 ms	600 rpm/sec acceleration tests step changes during step tests
4	2.5 hz/400 ms	300 rpm/sec acceleration tests
5	1.25 hz/800 ms	100 rpm/sec acceleration tests (system default setting for most sensors) or for sensors with a slow response time
6	0.625 hz/1600 ms	Steady-state tests wait time during step tests
7	0.3125 hz/3200 ms	Steady-state tests wait time during step tests (system default setting for weather sensors) or for sensors with readings that do not typically change

* Automatic filtering is selected on individual data channels when building a configuration file. The filter applied to these data channels is determined by the system filter setting. The system filter is set during an autotest.

When designing automated tests, it is possible to modify the system filter at any time during the test. SuperFlow recommends selecting the suggested filter rate for each type of test or for each test section.

Use the following screen to select the system filter:

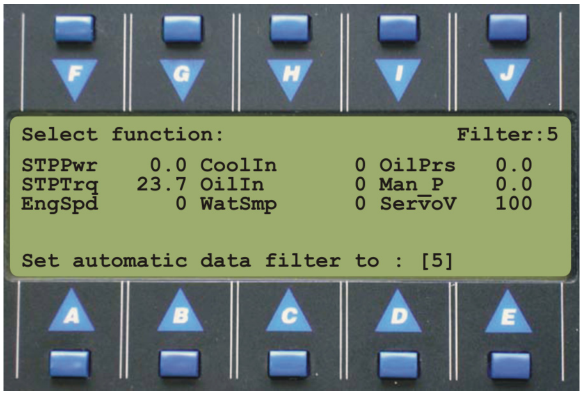


Figure 7-10. System Filter Screen

Specifications

Specification channels (constants) are used to define values that will remain constant throughout a test. These values are typically associated with a particular engine, vehicle, or test setup. The specification channels are defined in the configuration file but can be easily modified in WinDyn or on the handheld.

You can also store values specific to a vehicle or test a specification (CST) file on the computer and load it into the system when required. It usually is easier and quicker to change the specification values on the WinDyn Test Setup screen, but sometimes (especially on a chassis dyno) it helps to have access through the handheld.

Press the **A** button to display the Specifications screen.

Figure 7-11. Specifications Screen

- **Select New File:** Accesses the stored specification files. If specification files are stored on the computer, they will display on the screen. To select a specification file, enter the number.

NOTE: *It is not necessary to use the Select command first. Press **Exit** to return to the main operator screen. An error message appears if no files are available or if the computer is not communicating with the handheld unit.*

- **Save File:** Sends the new values to WinDyn where they will be stored in a specification file (CST) using the file name of the currently installed file (the original file is overwritten). If a CST file was not installed, the file is given the same name as the installed Configuration file (CFA). An existing CST file with that name will be overwritten.
- **Edit:** Press to display a list of the defined specification channels. Enter the channel number to modify the channel value.
  - **Edit specification channel:** ChName (the defined name of the specification channel)
  - **Current value: xxxx.xx** (Current Value is the existing number entered in the channel)
  - **Enter new value:** [xxxx.xx] Changes the number in the channel—use the numeric keypad to enter a new value.
- **Exit:** Press to return to the previous command screen.
- **Calibration:** Sensors (measured channels) can be calibrated on the handheld or directly from WinDyn. Press **Calib** (**B**) on the Configure screen to access the calibration screen.

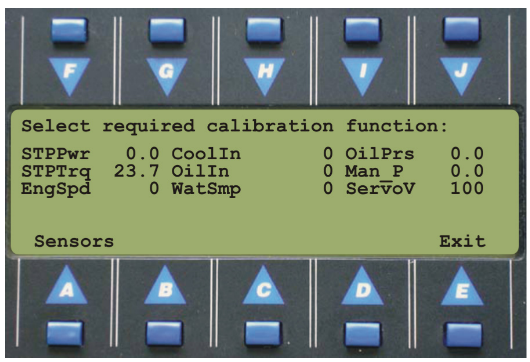


Figure 7-12. Calibration Function Screen

Press **Sensors** (**A**) to select the sensor calibration function.

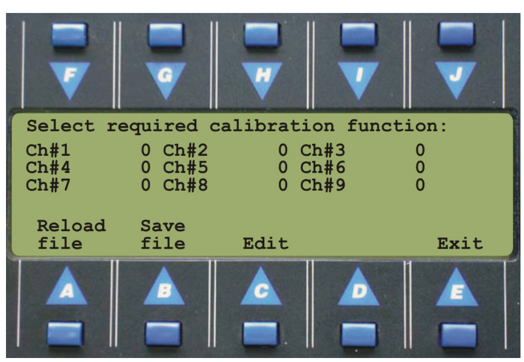


Figure 7-13. Select Calibration Function Screen

Select from the following options:

– **Reload file:** Press the **A** button to load the calibration file last saved on the computer into the test system.

– **Save file:** Press the **B** button to save the current calibration data of the system onto the computer. It will save with the same name as the currently installed configuration file (CFA) and overwrite an existing calibration file (CAL) with that name.

– **Edit:** Press the **C** button to display the channels available for calibration as defined in the configuration file.

Press **Select** to calibrate the channel to calibrate, then enter the channel number using the numeric keypad and **ENTER** button. The channel method selection screen will appear.

Enter Channel Number: [0]

Calibrate by:

Default CurrVal. Coeff. Exit

– **Default:** Resets the sensor calibration to the default values specified in the configuration (CFA) file.

– **CurrVal:** Calibration by Current Value requires a known, accurate input to the sensor. For example, a pressure channel needs a pressure applied, or the torque channel needs a load. Zero (0) is not a valid calibration value and will corrupt the system, causing it to stop operating.

– **Coef:** Press this button to display the calibration coefficient for the sensor channel. The coefficient is the conversion factor to change the output voltage or frequency from the sensor into the desired reading. Knowing this value can be beneficial in tracking the stability of the sensor over a long period time.

PID Control System

The control screen allows you to access various features.

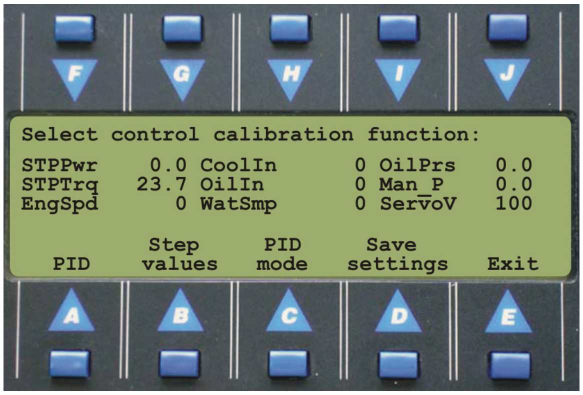


Figure 7-14. Control Screen

- **PID:** Accesses the control parameter. SuperFlow suggests avoiding this function unless properly trained in tuning closed-loop servo control parameters.
- **Step Values**: Change the Coarse, Medium, and Fine step values for each control mode defined in the configuration.

- **Save Settings:** Saves the current PID setting to a control file in the designated WinDyn directory. It saves under the same file name as the configuration (CFA) file but with a CCP extension.
- **Exit:** Returns to the previous displayed screen.

Limits

Use the Limits Setup screen to select from the available limits files and to turn Limits on or off. Limit files are created with the Limits Profile editor and embedded into a Set file which then stores the Limits files in flash memory, making them available in this screen. You can install Limits files through a test group or directly using the **WinDyn System>>Install** menu.

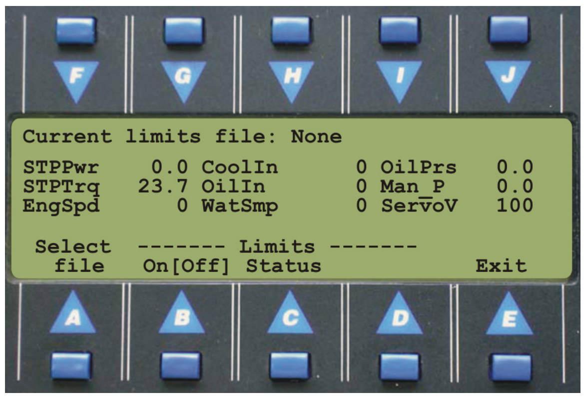


Figure 7-15. Limits Screen

The current installed Limits file displays at the top of the screen. If a Limits file is not installed, the display shows **None**.

Select from the following options:

- **Select File:** Accesses the stored Limits files. If files are stored on the computer or in a Set file, they will display on the screen. Press **Select** and enter the number of the file to select it. Press **Exit** to return to the main operator screen. An error message appears no files are available or if the computer is not communicating with the handheld unit.
- **On[Off]:** Press the **B** button to toggle the Limits on and off. The brackets show the current state.
- **Status:** Press the **C** button to display a screen showing the current status of the Limits protection.
- **Exit:** Returns to the previous command screen.

7.7 Handheld Expressions

This section describes the symbols and expressions used on the handheld display.

- **( ) round brackets:** Round brackets with a file name indicate the file was found in the default specified WinDyn directory in the computer.
- **< > angle brackets:** Angle brackets with a file name indicate the file was found in the RAM memory of the test system.
- *** (asterisk):** An asterisk behind a test file name indicates a Hill Simulation test type is loaded. No asterisk indicates a normal advanced test profile.
- **Abort:** Stops the current action and cancels any selections, calibrations, or configurations that were not previously saved.
- **All channels:** The selected operation (such as Autozero) is performed on all measured (sensor) channels
- **Autozero:** Calibrates the zero point on the selected measured (sensor) channels. All sensor inputs must be in a zero state prior to performing this function.
- **BProc:** Displays the software versions for the second (B) microprocessor on the CPU (only used on 1942/2060 board sets)
- **Cal/Calibrate/Calibr.:** Accesses the calibration functions
- **Calibrate by default:** Calibrates the selected measured (sensor) channel to the default value provided in the configuration file (*.cfa)
- **Coeff.:** Coefficient used for calibration, in engineering units per electrical units. Calibrate by coefficient if the sensor has a known output for a given input.
- **Configure:** Accesses common system configurations such as the specification file used, the calibration, and the control system settings.
- **Continue:** Displayed during an autotest, this command resumes a test that was paused using the Pause command.
- **Control:** Accesses the control system settings.
- **CTRL Setup:** Accesses the controller scaling configurations.
- **CTRLSys:** Provides a list of the controller board configuration installed in the sensor box.
- **Current Test:** Displays the current automated test loaded in the system.
- **Current value:** Displays the current value measured by the selected sensor channel (prior to performing the new calibration).
- **CurrVal.:** Accesses sensor calibration by current value.
- **Data:** Accesses the screens displaying the data recorded in the test system.
- **Default:** Selects default configuration or calibration information for the displayed function.
- **Done:** Confirms control mode selections, exits the selection screen, and activates the controller(s).
- **Down:** Scrolls down recorded data lines.
- **Dyno:** Refers to the dynamometer.
- **Edit:** Accesses an editing screen for the selected function.
- **Edit channel:** Accesses an editing screen for the selected channel.

- **Engine:** Refers to the engine controller—usually the throttle control actuator.
- **Enter new value:** Enters a new value for calibration of a sensor or specification channel.
- **Erase data:** Erases all recorded data from test system memory. A warning and request for confirmation will display.
- **Exit:** Returns to the previous screen.
- **Filter:** Displays the current system filter setting (0–7). This setting will affect the filtering of all sensor channels defined as auto filter in the configuration file (*.cfa).
- **First:** Returns to the first data line of the recorded data file.
- **Last:** Returns to the last data line of the recorded data file.
- **Manual test:** Accesses the control mode selection for manual control of the test system.
- **Next chan.:** Scrolls down the list of available channels.
- **Node:** A device communicating over the Ethernet network. Every node has its unique identifier.
- **Number X:** Displays the line number (X) of the recorded data line currently displayed. Press this key to enter a data line number to display the corresponding recorded data line.
- **PageDn:** Scrolls down the list of channels by page (screen).
- **PageUp:** Scrolls up the list of channels by page (screen).
- **Parms:** Refers to parameters, as in control system parameters.
- **Pause:** Displayed during an autotest, this command temporarily halts the test and maintains the current control set points until Continue is pressed.
- **Perform calibr.:** Edit the calibration of the channel displayed.
- **PID:** Accesses the settings for Proportional, Integrative, and Derivative (PID) control parameters used by the control system software.
- **Prev. chan:** Scrolls up the list of available channels.
- **Records X:** Displays the total number of data lines (X) in the recorded data file.
- **Reload file:** Loads the last saved calibration file from the computer into the test system. Use this function if the calibration data presently in the test system is erroneous, damaged, or corrupted.
- **Remote:** Refers to the computer system where the WinDyn files used by the test system reside.
- **Reset system:** A system restart command equivalent to power-up. Must be executed after system type configurations. No engine, vehicle, or other device may be controlled by the test system when activating a reset.
- **Return to list:** Displays the channel list.
- **Save data:** Saves the recorded data on the WinDyn computer system, using the automatic (sequential) file name defined in WinDyn.
- **Save file:** Saves a modified calibration, limits, or specification file to the WinDyn computer, overwriting the existing file.
- **Save settings:** Saves the modified configuration settings to the WinDyn computer and in the test system memory.
- **ScreenX:** Scrolls between the 1–9 data display screens defined by the configuration file (*.cfa).

- **Select channel:** Selects a channel from the displayed list.
- **Select new file:** Selects a file from the displayed list.
- **Sensors:** Any measured sensor channel.
- **Single channel:** Autozeroes a single channel. The sensor input must be in a zero state prior to performing this function.
- **SortList:** Sorts the displayed list of channels or files alphabetically or numerically (alternating)
- **Spec's:** Accesses the specifications selection and editing functions.
- **Start menu:** The main system menu. Pressing the Stop key (red hand symbol) on the operator interface returns the system to the Start menu.
- **Start test:** Starts executing the automated test loaded in the test system.
- **Step values:** Determines the incremental steps for coarse, medium, and fine adjustment of the set point controllers.
- **Stop:** Displayed during an autotest, this command stops the test in progress and returns the system to the start menu.
- **Test:** Provides access to the test command menus.
- **Up:** Scrolls up recorded data lines.

7.8 Error Messages

This section describes some of the error messages that might appear on the handheld display.

Warning! no computer nodes connected. The system cannot perform the requested function.

The sensor box and computer are not communicating. Check the network cables and make sure WinDyn is running. If necessary, restart the system.

No Files Found

No files were found in the specified directory on the computer. Check the system file path in the WinDyn Preferences to make sure the proper path is designated.

Warning! No Valid Test profile found. Cannot perform requested function.

No test profile is loaded. Press **Select Test** and load a test.

CHAPTER 8

THEORY

IN THIS CHAPTER

- Overview
- Tire-Roll Interface
- Chassis Dynamometer Accuracy
- Interpreting Power Measurements
- Power Correction Factors
- Aerodynamic Power
- Test Profile Descriptions

8.1 Overview

Essentially two types of testing methods are used on a chassis dynamometer: inertia only and controlled load. SuperFlow chassis dynos have the ability to do both. However, the wheel power readings obtained from either type of test are calculated the same way for both:

$$\text{WheelHorsepower} = \text{InertiaPower} + \text{DynoLosses} + \text{RollPower}$$

- Inertia power is derived from the known inertia mass of the roll being accelerated during the test. The rate of acceleration is measured using the signal from the roll speed pickup. The inertia mass of the roll is measured at the factory and embedded in the system configuration. In addition, the inertia mass of any attached accessories (eddy current absorber, AC motor, auxiliary roll, or blowers) is added to the inertia power calculation.
- Dyno or aerodynamic losses occur as the rolls encounter wind resistance as they spin. Even though these are very small values, the losses are measured at the factory and embedded in the system configuration.
- Roll power is derived from the strain gauge (load cell) torque measurement multiplied by roll rpm, divided by the standard constant: 5252.113. Even in inertia-only testing when the eddy current absorber is not used, the load cell measures a small amount of friction that still occurs in the bearings. In controlled acceleration and steady-state testing, roll power is the primary source of the power measurement.

NOTE: *On inertia-only dynamometers without an eddy current absorber, the roll power calculation is omitted in the total power formula.*

8.1.1 Inertia Testing

Mechanical power is defined as the ability to accomplish a certain amount of work in a certain amount of time. On an inertia chassis dynamometer, the work is accomplished by accelerating a roll of known mass and inertia. If time and rate of acceleration are recorded, it is possible to derive power. Inertia dynamometers provide a fast, cost effective, and reasonably accurate means to determine the maximum power output of an engine or vehicle.

IMPORTANT: There is frequent confusion over the terminology and interpretation of the specifications of inertia dynamometers. Inertia is the resistance of a mass to linear or angular acceleration and is normally expressed in lbs.in^2 [kg.m^2] or lbs.in.sec^2. “Roll inertia” on SuperFlow dynamometers is provided in “lbs. [kg] of equivalent vehicle weight” which is easier to relate to real-world situations. This number actually means that the roll simulates the inertial resistance to acceleration of a vehicle of this weight. For convenience, the documentation generally uses the term “XXX lbs. roll”. Once again, this should not be interpreted as the actual mass of the roll but as the equivalent vehicle weight. For example: the inertial resistance of the roll to acceleration of a 450 lbs. (205 kg) roll as used in our inertia-only CycleDyn dynamometer models is similar to that of a motorcycle of 450 lbs. (205 kg) total weight, including the rider.

Ideally, the inertia (equivalent vehicle weight) of the roll should match the actual weight of the vehicle under test for perfect simulation of on-road performance. Because the weight of the vehicle under test varies considerably, this is only possible with variable inertia dynamometers. Some variable inertia dynamometers use a series of flywheels which can be individually engaged or disengaged to achieve close approximation of equivalent vehicle weight (**M**echanical **I**nertia **S**imulation or MIS dynamometers). Other dynamometers use electric motors capable of electrically simulating inertia (**E**lectrical **I**nertia **S**imulation or EIS dynamometers). These variable inertia dynamometers are considerably more complex and expensive to build and install and are typically only required for accurate emissions drive cycle simulation. SuperFlow has developed and installed several hundred of such MIS and EIS dynamometers for government-mandated emissions test programs throughout the world.

For performance testing and diagnostic purposes, the inertia (equivalent vehicle weight) of the dynamometer must not necessarily simulate vehicle weight accurately. Differences will show up as slower (if the actual vehicle weight is lower than the dyno simulates) or faster (if the vehicle weight is higher than the dyno simulates) rates of acceleration than would occur on the road. The difference in the rate of acceleration between the dynamometer and the road will not have any influence on the actual power measurement as long as the air and fuel flow are not significantly affected. Air and fuel flow will be affected only if the rate of acceleration differs substantially. This is an important consideration when tuning A/F ratios on an Inertia only dyno.

Developing a good inertia chassis dynamometer with a fixed inertia thus requires a carefully determined compromise between the extremes of vehicle weights to be expected on the system. SuperFlow has selected a roll with an equivalent vehicle weight to produce accurate test results for the widest possible range of vehicles.

It should be noted that the inertia of the rotating parts of the vehicle should also be factored into the inertial power measurements because power produced by the engine will be used to accelerate the engine, transmission, driveline components, and the wheel itself, in addition to the roll. In other words, if the engine's power output is fixed, then the power available to accelerate the rollset is the power remaining after drivetrain parasitic losses and power consumed to accelerate the vehicle's drivetrain, since it, too, has some inertia.

SuperFlow accounts for this inertia with a constant (defaulted to 0) in the inertia power equation. This constant is only an estimate, since measurement of each vehicle's drivetrain inertia would be quite difficult and cumbersome to perform. However, since the constant remains unchanged from vehicle to vehicle, any error induced, is still repeatable, and allows assessment of lighter drivetrain components and their affect on measured wheel power. Please note, that when comparing wheel power to engine power from an engine dyno, without knowing precise drivetrain inertia values for the vehicle, parasitic loss values may be incorrectly assessed. The constants may be changed via the configuration editor if desired.

8.1.2 Controlled Testing

On an inertia-only dynamometer, power measurements are only repeatable, and thus useful, under wide-open throttle (WOT) conditions. This limits applications for this type of dynamometer. Any problems which occur at constant speed, at partial throttle or during throttle transition will be difficult or impossible to detect or troubleshoot. ***Due to their dynamic nature, inertia dynamometers are not suitable for engine run-in programs or fuel mapping.***

An eddy current absorber allows for steady speed and part throttle testing. SuperFlow chassis dynamometers with an eddy current absorber can perform a variety of automated tests including acceleration, steady state, and cycle simulation. During steady state testing, the inertia of the drivetrain (and our rollset) will be nulled out, since it will not be accelerating. Thus, steady state testing will produce the most accurate results. Steady state testing also provides more stable measurements for run-in programs and fuel mapping.

On SuperFlow chassis dynamometers, the equivalent vehicle weight values of the rollset are added into the power calculations along with the eddy current power measurements. With the added capabilities of the eddy current absorber, it is possible to add any amount of additional electrical inertia simulation to control the rate of acceleration for any heavier vehicle weight within the design parameters of the system.

8.2 Tire-Roll Interface

One of the main drawbacks to chassis dynamometer testing is the tire-to-roll interface. On an engine dynamometer, the engine output is directly measured at the flywheel. On a chassis dynamometer the driveline, wheel and tire will have an influence on the measurement results.

None of these mechanical components has an efficiency of 100%, so each of them will sap some engine power and convert it to heat. Some of the net power produced by the engine will be lost in the gearbox, some in the clutch, some in the chain, belt, or drive shaft, some in the bearings, and some will be lost in the tire. Most of these mechanical losses are fairly predictable. The tire losses are the biggest variable.

When a tire rolls on a surface, the deformation of the carcass and rubber in and around the contact patch requires some energy which is converted into heat. The source of this energy is the engine power, so some of this power will be lost as heat. It is unfortunately not possible to easily measure this power loss.

Following variables have an impact on the magnitude of this loss:

- Relative radius of the contact surface to the tire radius. On a flat road, the radius of curvature of the road is infinite and the tire deformation is determined by load, tire structure and tire pressure. On a chassis dyno, the smaller the diameter of the dynamometer roll, the greater the deformation and thus losses in the tire. This explains why a large roll is better than a small one and a single roll is better than a cradle roll system (which results in two successive deformations per revolution).
- Downforce on the tire. The greater the weight on the tire, the greater the tire deformation and thus the power losses. There is a common misconception that the vehicle should be weighted or pulled down to avoid tire slip on the roll. While it is true that there is a traction limit, beyond which loss of traction may result, our testing shows that this is not a problem on any motorcycle under 200hp wheel horsepower or any automobile under 500hp wheel horsepower. The knurl of the SuperFlow roll has been selected to provide greatest traction with negligible tire wear. Pulling the vehicle down ***excessively*** with rear tie-down straps will greatly increase the tire losses, increase the risk of tire damage (due to the build-up of heat in the carcass), and reduce the accuracy of the power measurement.
- Tire pressure and temperature. The tire pressure will have an effect on the deformation, and the tire temperature will have an effect on the rate of increase of the heat build-up. For best results, the tire should be inflated to its highest nominal pressure (as for high speed road use) and the tire temperature should be kept constant. The tire pressure will have a more significant effect on the accuracy and repeatability of the power measurement than the tire temperature.

You must also consider tire slippage. A common misconception is that slip must be avoided at all costs to obtain accurate power measurements. This is not true. Power losses due to slip are usually negligible compared to power losses incurred by adding down force to the tire to avoid slip.

The design of the dynamometer roll should keep slip at a minimum. SuperFlow has experimented with and tested with many different roll surface finishes. The knurl used on the CycleDyn has proven to be the best compromise between traction and tire wear.

See section A.2, “Wheel Speed Optical Sensor,” on page A-13 for information on how to measure tire slippage.

8.3 Chassis Dynamometer Accuracy

The power measurement of the inertia dynamometer is based on the inertia of the roll and the measured acceleration rate. A highly accurate result can only be obtained if the inertia value and the acceleration are measured with high precision. The eddy current dynamometer uses both the inertia power calculation and the eddy current power calculated by roll torque calibration, added together for the total power measurement. Power consumed by the dynamometer itself is also factored in on both types as parasitic losses.

SuperFlow has developed highly accurate electrical measuring technology for its EIS emissions dynamometers used in government-mandated programs. This sophisticated technology allows us to determine the equivalent vehicle inertia values to the nearest pound.

Every SuperFlow chassis dynamometer is calibrated for inertia of the roll, of the eddy current absorber, and of the blowers where applicable. These calibrated values are stored in the electronics of each individual system.

The same technology also allows us to measure parasitic losses (bearing losses, windage, aerodynamic losses) of every rotating part down to the nearest 1/100 of one horsepower. Again, each roll, absorber, and blower is calibrated and the values are stored in the electronics. Aerodynamic losses are adjusted as a function of air density for greatest accuracy.

Acceleration is calculated from speed measurements obtained with a tooth gear and magnetic pick-up. The roll speed measurement is referenced, filtered, and processed to result in several acceleration calculations per revolution of the roll. This results in a much higher resolution than any other system on the market.

The sophisticated technology used in the calibration and in the electronic circuits guarantees the most accurate power measurements possible.

8.4 Interpreting Power Measurements

The SuperFlow Data Acquisition system displays several power calculations. The most important are Wheel Power and Corrected Wheel Power.

See Chapter 9, "Config File Description" for details on the actual calculation formulas used in the system.

8.4.1 Wheel Power

Wheel power is the power that the vehicle puts to the ground in the conditions prevailing on the day of the test. All corrected power and wheel torque numbers are derived from this measurement.

Wheel power is the power actually measured at the tire contact patch in the atmospheric conditions of the test. It is the sum of the inertia power measurement plus the power applied by the eddy current absorber plus the parasitic power losses of the dynamometer. No corrections are applied.

This number should be the same as the uncorrected wheel power number of comparable dynamometer systems in similar conditions, provided these systems also take the parasitic losses in the dynamometer itself into consideration and are properly calibrated.

8.4.2 Corrected Wheel Power

Corrected wheel power is the measured wheel power corrected to standard atmospheric conditions. This is the power that the vehicle would put to the ground when tested in standard atmospheric conditions. The correction is only valid for full throttle tests.

A variety of power correction factors exist. They are available from the Society of Automotive Engineers (SAE, STP), the European Community (ECE), the German Industry Standards (DIN), the Japanese Industry Standards (JIS), the International Organization for Standardization (ISO), etc. SuperFlow has selected the SAE and STP standards for the default configuration files supplied with the dynamometers (ECE and DIN in the metric version). Because WinDyn can be completely user configured, the correction type may be changed to any standard of choice at any time.

See section 8.5, “Power Correction Factors,” on page 8-8 for more details.

8.4.3 Ground Torque

Ground torque is calculated from wheel power and roll speed corrected to standard conditions using the power correction factors (SAE for CycleDyn and STP for AutoDyns). This is the torque which the vehicle would deliver to the ground when tested in standard conditions.

8.4.4 Wheel Torque

Wheel torque is calculated from wheel power and engine speed. No corrections are applied. The calculation is relative to the conditions prevailing on the day of the test. Although this is not the actual measured torque applied to the ground, it is a common value used in marketing and advertising to represent torque of the vehicle under test.

8.4.5 Corrected Wheel Torque

Corrected wheel torque is the calculated wheel torque corrected to standard atmospheric conditions using the power correction factors outlined above. This is the torque of the vehicle when tested in standard conditions. Corrected torque is only valid for full throttle tests.

8.5 Power Correction Factors

SuperFlow Customer Service receives many questions about power correction. A typical question is, “I tested this engine on one day and got 500hp corrected and the next day I tested it at 30 degrees cooler air temperature, and my horsepower was 485 corrected. Shouldn't I get the same answer both times?” The answer is: “Probably not.”

The reason is that the power “correction” factor is actually misnamed. It is really an estimate of what the power would be under different conditions. The power correction procedure for use in dynamometers was not developed by SuperFlow, but rather by the SAE (Society of Automotive Engineers), so test data under varying conditions can be compared. It was intended for use with normal automotive engines and for only pressure and temperature differences of 7% or less. It is, at best, only an approximation of what the power would be if you actually tested under those conditions.

The problems arise from the fact that “power correction” fails to address anything except the change in density of air. For example, on a cold and a hot day the engine may have the same cylinder block temperature. This means that air entering through the head will be heated more on a cold day than it will on a hot day. The correction factor does not take this into consideration. It also ignores coolant temperature and oil temperature, which have been shown time and again to have a substantial effect on the measured power. Humidity also has a variable effect on power because it affects the rate of combustion and the point at which detonation occurs. It also affects the speed of combustion, as well as displaces air that could normally be ingested by the engine.

In addition, the engine's state of tune must be optimized for each day's atmospheric conditions, just as you would do if at the track. The correction factor can only make up the power difference if the engine is in its best state of tune for the atmospheric conditions during the test.

While corrected power will probably give you better numbers than uncorrected power, there is still no substitute for testing under the same conditions when you have to make close comparisons. For the best results, you should try to maintain constant air temperature, fuel temperature, oil temperature, coolant temperature, humidity, and barometric pressure. For many reasons, this cannot be accomplished completely, but sometimes you can design your test cycle to minimize the change.

8.5.1 Power Output

The power output of an internal combustion engine is significantly influenced by barometric pressure, ambient air temperature, and air humidity.

- Lower ambient barometric pressure reduces the density of the air, thus reduces the amount of oxygen filling the cylinder for each cycle, resulting in lower power output. Conversely, higher barometric pressure increases power.
- Lower ambient air temperature results in increased density of the air, thus increases the amount of oxygen filling the cylinder for each cycle, resulting in higher power output. Conversely, higher air temperature reduces power output.
- Lower air humidity (less water vapor) leaves more room for oxygen per cubic foot of air, thus increases the amount of oxygen filling the cylinder for each cycle, resulting in higher power output. Conversely, higher air humidity reduces power output. Higher humidity may also reduce the burn-rate in the cylinders.

There are power correction standards for gasoline and diesel engines, for applications in road vehicles, stationary engines, or marine engines, etc. For a SuperFlow chassis dynamometer, relevant standards are those generally intended for gasoline engines in road vehicles.

Power correction standards try to estimate what the vehicle power would be under reference conditions. They cannot calculate ***exactly*** what that power output would be. The greater the difference between the ambient conditions during the test and the reference conditions, the greater the error in the estimate. Most correction standards include limits on their applicability. This limit is typically +/- 7%. This means if the correction factor is greater than (>) 1.07 or less than (<) 0.93, the corrected power numbers are not considered to be acceptable, and the test should be performed again under conditions which are closer to the reference conditions.

For most applications this is less of a problem, and the corrected power numbers are still the best basis for comparisons. However, keep this into consideration when comparing test results obtained under considerably different test conditions. At a single location, the correction factor will usually vary less than 5% through the year.

Power corrections are only valid for Wide Open Throttle (WOT) tests. ***Corrected power numbers for any test performed under partial throttle conditions should be disregarded.***

8.5.2 Correction Standards

Several Standards organizations have determined methods for estimating power under reference conditions. The best-known organizations are:

- SAE (Society of Automotive Engineers), USA
- ECE (European Community), Europe
- DIN (Deutsche Industrie Norm), Germany
- ISO (International Standards Organization), worldwide
- JIS (Japanese Institute for Standardization), Japan

The default configurations supplied with the SuperFlow chassis dynamometer include power corrections to the following standards: SAE, STP, ECE, DIN. Because WinDyn can be completely user configured, the correction type may be changed to any standard of choice at any time.

NOTE: *There is a tendency for all these standards to converge. The only worldwide power correction standards at this time are the ones determined by ISO. For internal combustion engines in road vehicles, this is the ISO 1585 standard. The current SAE J 1349 and ECE standards are nearly identical to the ISO 1585 standard.*

SAE (Standard J1349)

The SAE standard applied is a modified version of the SAE J1349 standard of June 1990. Power is corrected to reference conditions of 29.23 inHg *[99 kPa]* of dry air and 77^{0}F *[25 ^{0}C]*. This is the default correction used on CycleDyn.

STP (Standard J607)

The STP (also called STD) standard is another power correction standard determined by the SAE. This standard has been stable for a long time and is widely used in the performance industry. Power is corrected to reference conditions of 29.92 inHg *[101.3 kPa]* of dry air and 60 ^{0}F *[15.5 ^{0}C]*. Because the reference conditions include higher pressure and cooler air than the SAE standard, these corrected power numbers will always be about 4% higher than the SAE power numbers. This is the default correction used on AutoDyns.

ECE

The ECE standard is based on the European Directives. Power is corrected to reference conditions of 99 kPa [*29.23 InHg*] and 25 ^{0}C [*77 ^{0}F*].

DIN

The DIN standard is determined by the German automotive industry. Power is corrected to reference conditions of 101.3 kPa [*29.91 InHg*] of dry air and 20 ^{0}C [68 ^{0}F]. With the advent of European legislation and standards, national standards such as the DIN (formerly widely used) are now less significant.

8.6 Aerodynamic Power

FAxCd (Frontal Area x Coefficient of Drag, Channel 78) of the standard CycleDyn and AutoDyn configuration files is used in the Road Load automated test to simulate aerodynamic drag at any road speed up to the maximum speed of the vehicle. The charts below are provided to help you determine the proper value to enter in this Specification channel. There is a chart for US units and one for Metric units.

The easiest way to use the chart is to have a maximum corrected wheel power number for your vehicle.

Wheel power can of course be obtained easily by performing a power run on the dynamometer. The maximum speed the vehicle can reach on the road can be estimated or assumed (for unmodified vehicles, the manufacturer's rated top speed can be used).

On the chart, power is on the Y-axis (left), and speed is on the X-axis (bottom). The graphs themselves represent the power needed to reach a given speed for a given aerodynamic drag (FAxCd).

Trace straight lines for the maximum corrected wheel power and maximum speed of your bike; then find the FAxCd graph closest to where both lines intersect. The value for this FAxCd line can then be used as input for channel 78.

Example:

Assume a Honda CBR1100XX Blackbird has 133 Corrected HP at the rear wheel, and rated at 181 mph. The intersection of the lines indicates a FAxCd about halfway between 2.5 and 3.0, or 2.75. Entering this value provided a good starting point for the Road Load test. Some more fine-tuning of the value resulted in a top speed of 181 mph at a FAxCd of 2.6 on the dyno.

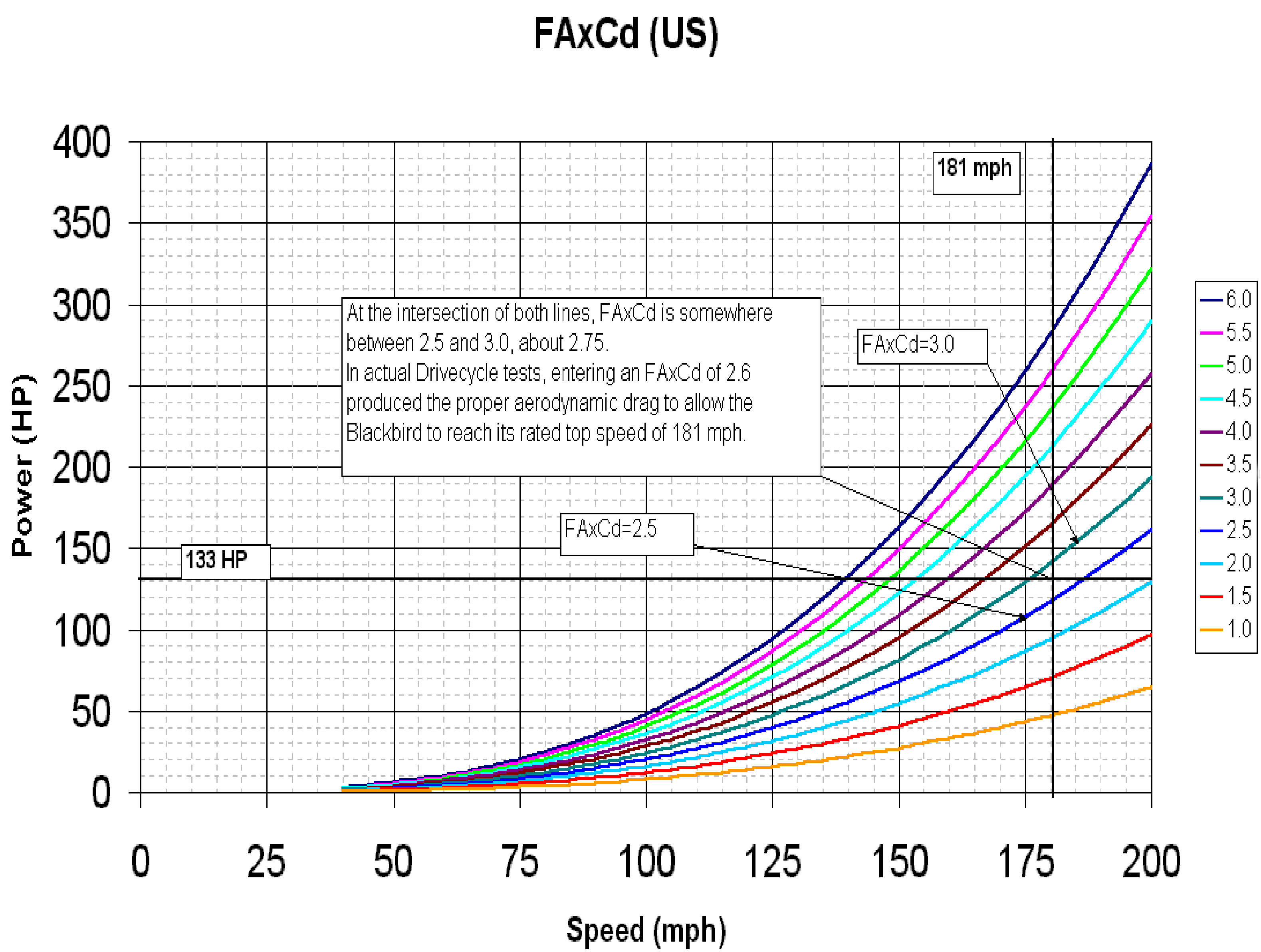


Figure 8-1. Frontal Area Coefficient of Drag, US

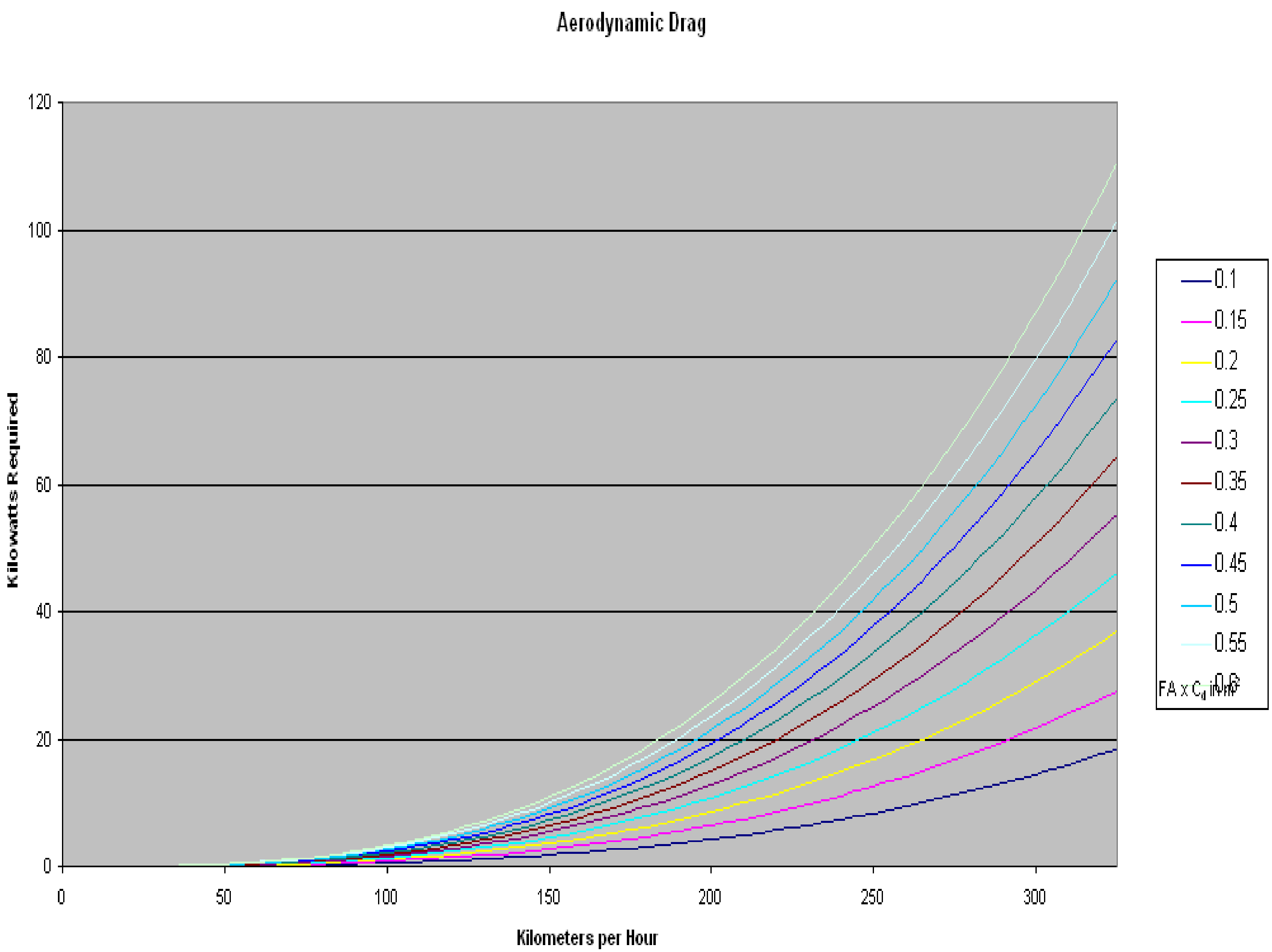


Figure 8-2. Frontal Area Coefficient of Drag, Metric

8.7 Test Profile Descriptions

The following tests are provided with SuperFlow chassis dynamometer products:

8.7.1 Acceleration Test

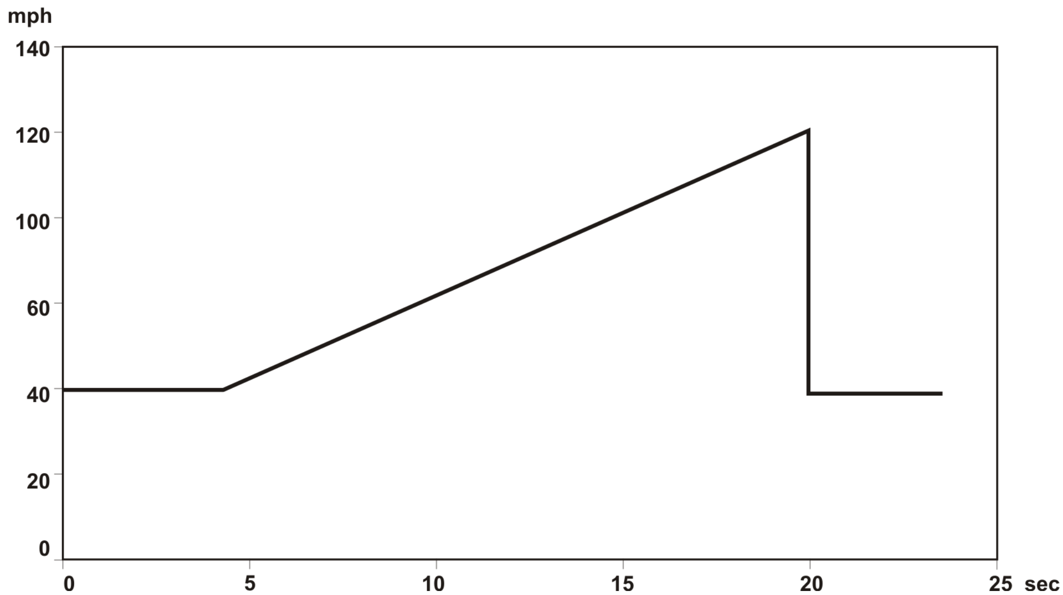


Figure 8-3. Automated Acceleration Test

The standard type of test typically executed on a chassis dyno is an acceleration test. This type of test ramps the engine from one speed to another. For instance, one might run a test from a start speed of 40 mph to an upper speed of 100 mph. During the test, the operator holds the vehicle throttle position constant, usually at Wide Open Throttle (WOT) from the starting test speed to the ending test speed. These tests are usually performed in a single drive gear, without allowing the transmission to shift.

Power is calculated from the rate of acceleration of the dyno system inertia mass, the dyno system parasitic losses, and from any torque measured by the absorber strain gauge.

Whenever possible, the rate of acceleration should be chosen to closely match the vehicle's typical usage rate of acceleration. This is particularly important for calibrating air/fuel ratios. Choosing an acceleration rate that is different than the vehicle's common usage may result in a too rich or too lean air/fuel ratio during normal vehicle operation off the dyno.

Data is recorded in time intervals during accelerations tests. When a stable engine speed signal is available, data is recorded 100 times per second during the test, and a special WinDyn feature called ProFilter™ is used to produce data in even rpm increments. When ProFilter is not selected, data is recorded at a rate of 10 times per second and is also presented that way in the printout.

The ProFilter feature is only available on ramp type tests. If the vehicle shifts gears during the test, the ProFilter feature will not function correctly. If this happens or if a stable engine speed signal is not available, disable ProFilter feature and re-run the test.

Data recording is typically triggered by a specific mph. During initial test setup, the operator is prompted to select a START speed in mph. That speed becomes the recording trigger to begin data recording during the ramp. When the START speed is crossed, data recording begins. Data recording ends when an upper speed in mph is crossed or if the system detects a negative acceleration, as would happen if the operator backs off the throttle.

All tests are generally performed at wide open throttle but may be performed at a fixed throttle position. Data is automatically saved at the end of each test run to an SFD file on the computer hard drive. If ProFilter is enabled, it will post process the data file as it is saved to produce even rpm increment results. On some systems, the test will prompt the operator to enter the ProFilter parameters. On older systems, ProFilter must be set manually from the appropriate WinDyn menu.

NOTE: *SuperFlow chassis dynamometers built before July 2005 had four separate selections for acceleration tests: ProInrt (inertia only), ProAccel (timed or controlled acceleration), ProAero, and ProLoad. After July 2005, these tests were combined into one test selection: AcclRamp. Within the one test were options for each of the four different types of acceleration tests.*

INERTIA (ProInrt)

This is the most commonly used test profile for chassis dynos. This test does not engage the load system during the acceleration ramp, thus allowing the vehicle to accelerate only against the system inertia. This type of test is good for a quick assessment of vehicle power, but since the test does not provide any load on the vehicle, is not the best choice for tuning purposes. The rate of acceleration is determined by the power and gear ratio of the vehicle along with the inertia of the dyno system, thus, the rate achieved may be too fast for best tuning purposes.

This test prompts the operator for an initial test speed in mph at which the data acquisition system will begin recording data. An ending speed in mph is then requested and is used by the test profile to terminate recording of data. The test profile also checks for a negative rate of acceleration which will also terminate recording of test data, in the event the test is aborted before the upper test speed is achieved.

Once all parameters are entered, the operator is prompted to proceed. The operator should select the gear for the test and accelerate the vehicle to the starting mph.

At the end of the test, the eddy current absorber is engaged to return the vehicle to the starting speed. To perform another identical test, press the **New Run** selection, or stop the test by pressing the **Stop** selection. When New Run is pressed, the operator can reload the test parameters or quickly **Bypass** them and use the previous test's parameters.

When **Stop** is pressed, the eddy current absorber will engage to bring the vehicle speed to 0 mph. If you do not wish to return the vehicle speed to 0 mph, press the big red hand (reset) function on the handheld to end the test.

TIMED (ProAccel)

This test is also referred to as a **controlled acceleration** test and is only available on eddy current equipped dynamometers. This test is similar to the inertia style test in that the operator accelerates the vehicle from a starting speed to an ending speed. The difference from an inertia test is the eddy current absorber controls the rate of acceleration during the entire test. The tests should be run in a single gear, typically at wide open throttle.

Timed tests are similar to the type commonly used on SuperFlow engine dynamometers. The engine accelerates at the same rate throughout the test. This test is far more accurate than inertia-only tests for tuning the engine, especially when observing air/fuel ratio data. It is a very good test for supercharged or turbocharged applications because boost is stable throughout the test ramp.

Power numbers for this type of test may differ slightly from those observed under inertia only conditions. However, these numbers are a more accurate representation of the actual power available to propel the vehicle than those presented by the inertia-only style test.

The rate of acceleration can be chosen to closely match the vehicle's typical usage rate of acceleration. This is particularly important for calibrating air/fuel ratios. Choosing an acceleration rate that is different than the vehicle's common usage may result in a too rich or too lean air/fuel ratio during normal vehicle operation off the dyno.

All tests are generally performed at wide open throttle, but may be performed at any fixed throttle position. The Controlled Acceleration test prompts the operator for an initial test speed in mph at which the data acquisition system will begin recording data. An ending speed in mph is then requested and is used by the test profile to terminate recording of data.

A time interval in seconds for the duration of the test is also requested. The time interval for these tests must exceed that which it takes to complete a basic inertia-only test in the same speed range. Otherwise, the eddy current absorber is turned off during the test, resulting in an inertia style test (this method can be used when you want to run an inertia style test, but need to “load” the engine before beginning the ramp).

Once all parameters are entered, the operator is prompted to proceed. The operator should select the gear for the test and accelerate the vehicle to the starting mph. The eddy current absorber will engage and hold the vehicle. The operator should maintain wide open throttle, allowing vehicle speed to stabilize for a few seconds at the starting speed. Once stabilized, press the **Accel** selection on the handheld to begin the acceleration ramp. The vehicle will accelerate at a constant rate toward the upper test speed.

At the end of the test, the eddy current absorber is engaged to return the vehicle to the starting speed. To perform another identical test, press the **New Run** selection, or stop the test by pressing the **Stop** selection. When New Run is pressed, the operator can reload the test parameters or quickly **Bypass** them and use the previous test’s parameters.

When **Stop** is pressed, the eddy current absorber will engage to bring the vehicle speed to 0 mph. If you do not wish to return the vehicle speed to 0 mph, press the big red hand (reset) function on the handheld to end the test.

AERO (ProAero) and LOADED (ProLoad)

These tests are variations to the standard inertia test. The **AERO** test factors vehicle weight and frontal area to provide a more realistic load scenario during the acceleration ramp. As vehicle speed increases, so does the load from the load system. Thus, the ramp more realistically simulates the “on-the-road” load experience. Since vehicle weight and frontal area can be varied to achieve different rates of acceleration, you may find this test to be more useful for tuning purposes than the standard inertia test.

The **LOADED** test is also a simple variation of the inertia test. It functions exactly the same but allows the operator to apply a fixed percentage of load to the rollset for the entire ramp. Fundamentally, this makes the rolls feel “heavier” to the vehicle and slows the overall rate of acceleration. Again, this type of test may be more useful for tuning purposes than the standard inertia test since you can adjust the rate of acceleration by increasing or decreasing the percentage of load applied during the test.

8.7.2 Steady State Test

Steady-state tests are only available on eddy current equipped dynamometers. This type of test uses the eddy current absorber to hold the vehicle at a constant speed for a certain length of time and samples data at various points depending on the test settings. This test should be run in a single gear and may be run at any throttle setting.

Power is calculated from the power absorbed by the eddy current absorber strain gauge during the test. Dyno parasitic values are also added to the wheel power calculation, as in the inertia style tests. Inertia values are not used (though it is still in the total power calculation) since the roll is not accelerating thereby resulting in an inertia power reading of zero.

These tests are similar to those used on engine dynamometers in that the engine is allowed to stabilize at a speed point before collecting data. They are the most accurate test for tuning the engine, especially when observing air/fuel ratio, temperature, and pressure data. This type test is also very good for engines that are not normally aspirated, such as turbocharged or supercharged.

Power numbers for this type test may differ slightly from those observed under inertia or controlled acceleration conditions. However, these numbers are perhaps the most accurate representation of the actual power at a specific engine speed under fully loaded conditions.

Step Test

These tests prompt the operator for an initial test speed in mph at which the data acquisition system will begin recording data. An ending speed in mph is then requested and is used by the test profile to terminate recording of data.

A step increment in mph is requested next, followed by a time interval in ***seconds*** for each step. The time interval for these tests is used to hold the vehicle at each mph step for a length of time prior to sampling data.

This test does not use ProFilter™ so it is turned off for the test (on older systems you must use the appropriate WinDyn menu to ensure the ProFilter feature is turned). Data recording during the test can be switched from a single data point to 100 data points per second for each step. The latter method can be utilized if you need to see how rapidly the vehicle speed stabilizes or if you are interested in an "average" of the data for each step point. The recording rate is selected by the operator via the handheld test prompts during initial test setup.

Once all parameters are entered, the operator should select the gear for the test and accelerate the vehicle to the starting mph. The eddy current absorber will engage and hold the vehicle. The operator is then prompted to start the test by pressing **Step** on the handheld. The test will then begin, holding the vehicle speed constant, sampling a data point, then moving to the next speed set point determined by the speed increment size and time interval.

At the end of the test, the eddy current absorber is engaged to return the vehicle to the starting speed. To perform another identical test, press the **New Run** selection, or stop the test by pressing the **Stop** selection. When New Run is pressed, the operator can reload the test parameters or quickly **Bypass** them and use the previous test's parameters.

When **Stop** is pressed, the eddy current absorber will engage to bring the vehicle speed to 0 mph. If you do not wish to return the vehicle speed to 0 mph, simply press the big red hand (reset) function on the handheld to end the test.

Data is automatically saved at the end of each test run to an SFD file on the computer disk drive.

STEADYST

This test functions similarly to the step test, without the step increments. Basically, the test holds the vehicle at any selected speed and allows data recording at either 1, 10, or 100 times per second. The operator uses the handheld to select the vehicle speed and recording rate during initial test setup. This test does not use ProFilter, so it is turned off in the test (on older systems you must use the appropriate WinDyn menu to ensure the ProFilter feature is turned).

This test can be very useful when performing fuel injection mapping or other tune-up functions. During test operation, the operator may vary throttle position while the system records data. If a different speed is desired, press the **Newmph** button to enter another speed setting.

Presses the **Stop** selection on the handheld to end each recording session.

To perform another identical test, press the **New Run** selection, or stop the test by pressing the **Stop** selection. When New Run is pressed, the operator can reload the test parameters.

When the **Stop** is pressed, the eddy current absorber will engage to bring the vehicle speed to 0 mph. If you do not wish to return the vehicle speed to 0 mph, simply press the big red hand (reset) function on the handheld to end the test.

Data is automatically saved at the end of each test run to an SFD file on the computer disk drive.

8.7.3 Road Load Simulation Tests

Road Load Simulation tests are only available on eddy current equipped dynamometers.

RoadLoad

This test can be used to perform vehicle diagnostic checks under load conditions similar to those experienced on the road. You can run the tests in any gear; shifting during the test is permitted. You may use any throttle position during the test. Basically, it is like driving down the road but not actually going anywhere.

Power is calculated from dyno system inertia mass rate of acceleration and the power absorbed by the eddy current absorber during the test. Since data recording is not determined by any preset parameters, it may be more difficult to perform recorded data analysis. SuperFlow suggests using line number or a test timer as the X-axis on any plotting performed on the test data.

The Road Load test uses an estimated vehicle weight (with operator) and an estimated frontal area in equivalent square feet to calculate the load applied to the vehicle as vehicle speed increases. ProFilter is not used, so it is turned off in the test (on older systems you must use the appropriate WinDyn menu to ensure the ProFilter feature is turned).

Once the test starts, recording is enabled and you may operate the vehicle in any manner desired. The eddy current absorber applies varying amounts of load as vehicle speed varies. The test basically records data at a predetermined rate of time (the default is ten data lines per second).

The factors influencing the amount of load are total vehicle weight (TotlWt, channel 77) and the frontal area entered for the vehicle (FAxCd, channel 78). The operator is prompted to enter these values during initial test setup.

The test terminates when the operator presses **Stop** on the handheld selection. Since there is no “starting speed” to return to, the eddy current is ***not*** engaged to return the vehicle to any given speed. To perform another identical test, press the **New Run** selection, or stop the test by pressing the **Stop** selection. When New Run is pressed, the operator can reload the test parameters.

When **Stop** is pressed, the eddy current absorber will engage to bring the vehicle speed to 0 mph. If you do not wish to return the vehicle speed to 0 mph, press the big red hand (reset) function on the handheld to end the test.

Data is automatically saved at the end of each test run to an SFD file on the computer disk drive.

8.7.4 Other Tests

Automated tests can be designed to perform functions other than measuring the performance of a vehicle. The following are examples of such tests:

TirDia

This test can be used to determine the actual tire diameter for channel 84, TirDia, in the vehicle specifications. Simply set up the optical tachometer to observe wheel revolutions on the rear wheel. Accelerate the vehicle to a desired speed and hold the speed constant. Run the test and it will automatically calculate the correct tire diameter for channel 84. A WinDyn screen is provided in the standard display file to allow you to observe the test changing the tire diameter.

When the test is complete, manually save the new tire diameter in the vehicle specification file using the handheld or WinDyn option. You may observe the new tire diameter in channel 84 via the handheld or WinDyn screen 3 on the standard display file.

Eng_Spd

This test provides a convenient method for setting up the engine speed pickup on the vehicle you are testing. We strongly suggest using this test for all RPM selection setup. It prompts the operator through several optional engine speed methods, and provides input screens for selecting and configuring each RPM method. Although this can be done via the specifications editor function within WinDyn, this test profile greatly speeds up the process and can be done while on or in the vehicle. It also insures the correct settings are made to each specification channel used by channel 125, EngSpd.

At the end of the test, be sure to save your new settings to a specification file for the vehicle you are testing. By doing so, you may load the specifications file the next time that vehicle is tested, foregoing the lengthy rpm setup process.

BreakIn

This test is used to warm the engine in preparation for other tests or to help seat the seals after an overhaul. The test runs for approximately 30 minutes with gradual amounts of load. It requires no external sensors connected to the engine or vehicle and does not record data. The test can be run in any gear and at any speed. It runs for 5 minutes at 0% load, 10 minutes at 3% load, 10 minutes at 7% load, and finishes with 5 minutes at 0% load. The handheld displays the distance traveled during the test.

Fan_Off

On CycleDyn systems with the over-running blower option, the blowers automatically turn on at the end of a test when the vehicle's speed drops below 3 miles per hour. The blowers run for a predetermined amount of time with no way for the operator to turn them off. This test provides an easy way to turn the blowers off. Simply select and run the test.

CHAPTER 9

CONFIG FILE DESCRIPTION

IN THIS CHAPTER

- Overview
- Channel Types
- Channel Functions
  - Measured Channels
  - Specification Channels
  - Calculated Channels
  - Interpolation Tables
  - System Channels
- Control Channels
- Data Display Screens

9.1 Overview

The Configuration file is used to define the functions of WinDyn™ and the SuperFlow Data Acquisition System. The channel functions, control functions, and console display are all set in the Configuration file. Once established, the file is stored on the computer hard drive and downloaded to the Data Acquisition System (memory). The Configuration file defines the WinDyn basic elements and is required for proper operation.

Refer to chapter 11 in the *WinDyn Users Guide* for more information on the configuration file and how to modify it.

9.2 Channel Types

Five general channel types are available in the WinDyn system:

- **Sensor Channels:** Receive data from sensors
- **Calculated Channels:** Perform calculations using inputs from other channels
- **Specifications:** Store constants associated with a particular engine, vehicle, or test
- **Interpolation Tables:** Store nonlinear functions for calibration and calculation purposes
- **System Channels:** Contain timers and special system memories

9.3 Channel Functions

The channels listed in this section are in the standard default configuration file for a CycleDyn dynamometer system. Actual configurations may vary based on the product and customer application. Gaps in the numbering are undefined channels or are sensor channels used as calculated channels.

9.3.1 Measured Channels

Sensor channels 1 through 76 input measured data and convert it to a reading. In some cases the reading is a direct reflection of the input such as volts in to volts out. In other cases the input is converted to a different value such as volts in to air/fuel (A/F) ratio out or frequency to rpm. The type of thermocouple used determines temperature channel values.

Channel Types

Four types of measured data channels are available in the SuperFlow Data Acquisition system for sensor inputs:

- **Strain gauge (load cell) channels** accept the differential voltage output signal from a strain gauge or load cell.
- **Frequency channels** can read any sensor device that provides a magnetic (mag) or Transistor-Transistor Logic (TTL) output. These channels are typically used for fuel, air, and fluid flow meters. Six frequency channels are available directly on the data acquisition, but others can be added with a frequency-to-voltage converter on an analog voltage expansion panel.
- **Analog voltage channels** may be used to measure any sensor device outputting analog voltage. These inputs are most commonly used for pressure transducers or other auxiliary devices. Ten channels are located directly on the data acquisition system. Others are available on expansion panels (pressure and voltage).
- **Thermocouple channels** can be configured for several different types of thermocouples (K, J, T, or E) and can be read in either Fahrenheit or Celsius degrees.

Any of these channels may be used for any display function, in a calculated channel, as a control channel, or in a test profile.

Filters

Sensor channels have filters applied to the raw data. Table 9-1 shows the filter choices, their corresponding corner frequencies, and the recommended applications.

Table 9-1. Data Filter Rates

Filter Value	Frequency	Recommended for...
Auto	Variable	Changing conditions*
0	No filter	Not recommended
1	20 Hz/50 ms	2000 rpm/sec acceleration tests
2	10 Hz/100 ms	1000 rpm/sec acceleration tests
3	5 Hz/200 ms	600 rpm/sec acceleration tests or for the step changes during step tests
4	2.5 Hz/400 ms	300 rpm/sec acceleration tests
5	1.25 Hz/800 ms	100 rpm/sec acceleration tests (system default setting for most sensors) or for sensors with a slow response time
6	0.625 Hz/1600 ms	Steady-state tests wait time during step tests
7	0.3125 Hz/3200 ms	Steady-state tests wait time during step tests (system default setting for weather sensors) or for sensors with readings that do not typically change

* Automatic filtering is selected on individual data channels when building a configuration file. The filter applied to these data channels is determined by the system filter setting. The system filter is set during an autotest.

The standard filter rate settings for the various types of inputs are:

- Torque, engine speed, and vehicle speed – automatic
- Thermocouples – 5
- Air and fuel turbines – automatic
- Wideband O2 sensors – 5
- Air temperature, humidity, and barometric pressure – 7

Channel Definitions

On the following channel definitions, the first line after the channel description is the input minimum and maximum values followed by the displayed values.

Table 9-2. Sensor Channels

Channel	Input	Output (English)	Output (Metric)
1 – AirSen	**0.000 1.000 volts**	**0.000 1.000 volts**	
Channel 1 is used to measure the voltage from the ambient air temperature sensor. The voltage is used by Channel 74 to determine the air temperature. This channel has a default coefficient of 1.000, no auto zero, and is filtered at 7. Calibrating this channel alters the air temperature readings displayed by channel 74.			
2 – Trq1	**0.000 4.096 volts**	**0.000 1925.5 lb-ft**	***0.000 2610.6 N-m***
Channel 2 is used to measure the torque from the eddy current (EC) power absorber. It senses the voltage from the strain gauge and converts it to torque for calculations and power measurements. The default EC strain gauge calibration coefficient is approximately 470.093 lb-ft *[637.361 Nm]* per volt. This coefficient may be changed through calibration. The channel is set up for zeroing by command and is set for an automatic filter (which allows changes through test profiles). This channel is defined as a control channel (for the road load simulation test) and has a minimum value set at –2000 and maximum value set at +2000.			
3 – Not Used			
Channel 3 is not used. It may be used as a calculated channel if desired.			
4 – LambVt	**0.000 10.000 volts**	**0.000 10.000 volts**	
Channel 4 is used for a analog voltage input. It may be used for 0–5 VDC sensors on 2242 board sensor boxes or 0–10 VDC sensors on 1942/2060-01 and 2620 board sensor boxes. The channel has a default coefficient of 1.000 and can be calibrated if necessary. Filtering is set to 5 and no zeroing (zeroing is not recommended for this channel when using the 2242 board). The maximum voltage on 2242 boards is 4.096 VDC. The channel may be zeroed on 2242 boards if a sensor is connected or if the signal source, pin 5, is grounded.			
5 – AuxVt2	**0.000 4.096 volts**	**0.000 4.096 volts**	
Channel 5 is used for analog voltages input. It may be used for 0–5 VDC sensors on 2242 board sensor boxes or 0–10 VDC sensors on 1942/2060-01 and 2620 board sensor boxes. The channel has a default coefficient of 1.000 and can be calibrated if necessary. Filtering is set to 5 and no zeroing (zeroing is not recommended for this channel when using the 2242 board). The maximum voltage on 2242 boards is 4.096 VDC. The channel may be zeroed on 2242 boards if a sensor is connected or if the signal source, pin 5, is grounded.			
6 – HumSen	**0.000 1.000 volts**	**0.000 1.000 volts**	
Channel 6 is the input for the humidity sensor used to measure the humidity of the air. It is used by Channel 120 to calculate relative humidity. This channel has a coefficient of 1.000, no auto zero, and is filtered at 7. Calibrating this channel is alters the humidity readings displayed by channel 120.			

Table 9-2. Sensor Channels

<table>
<tr><th>Channel</th><th>Input</th><th>Output (English)</th><th>Output (Metric)</th></tr>
<tr><td>7 – Freq 1</td><td>0.000 5000 hz</td><td>0.000 5000 hz</td><td></td></tr>
<tr><td colspan="4">Channel 7 is used to measure the frequency from auxiliary sensors such as airflow or fuel flow measurement turbines. The coefficient for this channel is 1.000, with a maximum input frequency of 5000 hz. It is set for automatic filtering to allow changes through a test profile and is set for no zeroing. Changing the coefficient will alter the values displayed.</td></tr>
<tr><td>8 – Freq 2</td><td>0.000 5000 hz</td><td>0.000 5000 hz</td><td></td></tr>
<tr><td colspan="4">Channel 8 is used to measure the frequency from auxiliary sensors such as airflow or fuel flow measurement turbines. The coefficient for this channel is 1.000, with a maximum input frequency of 5000 hz. It is set for automatic filtering to allow changes through a test profile and is set for no zeroing. Changing the coefficient will alter the values displayed.</td></tr>
<tr><td>9 – Freq 3</td><td>0.000 5000 hz</td><td>0.000 5000 hz</td><td></td></tr>
<tr><td colspan="4">Channel 9 is used to measure the frequency from auxiliary sensors such as airflow or fuel flow measurement turbines. On 2242 and 1942/1060-01 systems this channel is used to input an engine speed signal from an optical tach or direct tach sensor. The coefficient for this channel is 1.000, with a maximum input frequency of 5000 hz. It is set for automatic filtering to allow changes through a test profile and is set for no zeroing. Changing the coefficient will alter the values displayed.</td></tr>
<tr><td>10 – Speed</td><td>0.000 43.181 Hz</td><td>0.000 1,000 mph</td><td>0.000 1,609 km/h</td></tr>
<tr><td colspan="4">Channel 10 is used to measure the frequency of the roll from a magnetic pickup attached to the starter gear on the chassis dynamometer roll. This channel is scaled to directly produce a mile-per-hour reading from the frequency received. It is set for automatic filtering to allow changes through a test profile and is set for no zeroing. Changing the coefficient will alter the values displayed and severely alter the dynamometer calibration. Changing the values for this channel is not recommended. This channel is also defined as a control channel. It has a minimum value set at 0 and a maximum value set at 200.</td></tr>
<tr><td>11 – EngFrq</td><td>0.000 5000.0 Hz</td><td>0.000 5000.0 Hz</td><td></td></tr>
<tr><td colspan="4">Channel 11 is used to measure the frequency from an engine speed sensor. Inductive clips, direct connection pickups, or optical sensors may be used. The coefficient for this channel is 1.000, with a maximum input frequency of 5000 hz. It is set for automatic filtering to allow changes through a test profile and is set for no zeroing. Changing the coefficient alters the values displayed. The frequency output is combined with channel 83, Pulses per Revolution, to calculate the engine speed in channel 125.</td></tr>
<tr><td>12 – OptTac</td><td>0.000 5000.0 Hz</td><td>0.000 5000.0 Hz</td><td>0.000 40.000 km/h</td></tr>
<tr><td colspan="4">Channel 12 is used to measure the frequency output from an optical tachometer sensor. The optical tachometer shines a light onto a surface such as the rear wheel of the vehicle and measures the pulse for each revolution from a piece of reflective tape placed on the rim. The coefficient for this channel is 1.000 with a maximum input frequency of 5000 Hz. It is set for automatic filtering to allow changes through a test profile and is set for no zeroing. Changing the coefficient will alter the values displayed. The optical tachometer is used by channel 56 and then 57 to determine wheel revolutions. It is then used with channel 53 for determination of wheel slip.</td></tr>
</table>

Table 9-2. Sensor Channels

<table>
<tr><th>Channel</th><th>Input</th><th>Output (English)</th><th>Output (Metric)</th></tr>
<tr><td colspan="4">13 to 20 – Thermocouple Inputs 1 through 8</td></tr>
<tr><td colspan="4">Channels 13 through 20 are for standard thermocouple inputs. These may be renamed to fit specific functions by using the Configuration Editor Program. These channels are normally set up for Type K thermocouples. No other type of thermocouple can be used without a hardware modification. The maximum range is 2000°F [1100°C]. These channels require no zeroing and are set with a filter rate of 5.</td></tr>
<tr><td colspan="4">21 to 28 – Exhaust Temperatures 1 through 8</td></tr>
<tr><td colspan="4">Channels 21 through 28 are used for measuring exhaust gas temperature thermocouples. They may also be used for other temperature measurements if required. They are designed for Type K thermocouples, and no other type of thermocouple can be used without a hardware modification. The maximum range is 2,000°F [1100°C]. These channels require no zeroing and are set with a filter rate of 5.</td></tr>
<tr><td rowspan="2">29 to 36 – Analog Voltages 1 through 8</td><td>Channels 29–35
0.000 10.00 VDC</td><td>Channels 29–35
0.000 10.00 VDC</td><td></td></tr>
<tr><td>Channel 36
0.000 20.00 VDC</td><td>Channel 36
0.000 20.00 VDC</td><td></td></tr>
<tr><td colspan="4">Channels 29 through 36 are used for measuring DC voltage inputs. They are currently defined for 0—10 VDC inputs on channels 29–35. Channel 36 is normally defined for 0–20 VDC. Each channel may be configured through hardware modifications for 0–1, 0–5, 0–10, or 0–20 VDC. These channels are set for zeroing by command and are set with a filter rate of 5. The channel is set for a coefficient of 1.000 and does not require calibration.</td></tr>
<tr><td colspan="4">37 to 49, 51, and 52 – Unused</td></tr>
<tr><td colspan="4">Channels 37 through 49, 51 and 52 are not currently used in the standard version of the motorcycle dynamometer. Eight expansion sensors may be added in this channel slot with optional, additional hardware. The additional inputs could be thermocouples, pressures, or analog voltages and may be renamed to fit specific functions by using the Configuration Editor Program. They may also be used for additional calculated channel definitions.</td></tr>
<tr><td>61 – OilP</td><td>0.000 3.636 volts</td><td>0.000 150 psi</td><td>0.000 1034 kPa</td></tr>
<tr><td colspan="4">Channel 61 is for measuring oil pressure. The transducer has a range of 0–150 psi [1034 kPa]. It may be re-calibrated, if required, through the calibration menu or through changes in the Configuration File. Filtering is set to 5 and zeroing is by command.</td></tr>
<tr><td>62, 64, 65, 67, 68 – AxPrs1 to AxPrs5</td><td>Channel 62
0.000 3.636 volts
Channel 64, 67, 68
0.000 3.636 volts
Channel 65
0.000 3.636 volts</td><td>Channel 62
0.000 100.00 psi
Channel 64, 67, 68
0.000 150.00 psi
Channel 65
0.000 200.00 psi</td><td>Channel 62
0.000 689.5 kPa
Channel 64, 67, 68
0.000 1034.25 kPa
Channel 65
0.000 3879 kPa</td></tr>
<tr><td colspan="4">These channels are expansion channels for pressure measurement. They may be implemented by buying additional pressure transducers. Filtering is set to 5 and zeroing is by command.</td></tr>
</table>

Table 9-2. Sensor Channels

<table>
<tr><th>Channel</th><th>Input</th><th>Output (English)</th><th>Output (Metric)</th></tr>
<tr><td>63 – Man.P</td><td>0.000 3.636 volts</td><td>0.000 407 in/Hg</td><td>0.000 1397 kPa</td></tr>
<tr><td colspan="4">Channel 63 is used to measure the manifold inlet pressure or vacuum in inches of mercury (in/hg). It has a range of –30 to +173 in/hg [–103 to +586 kPa]. Filtering is set to 5 and zeroing is by command.</td></tr>
<tr><td>64 – OilRtP</td><td>0.000 3.636 volts</td><td>0.000 60 psi</td><td>0.000 413.7 kPa</td></tr>
<tr><td colspan="4">Channel 64 is for measuring oil return pressure. The transducer has a range of 0-30 psi [206.8 kPa]. This is typically a plastic board mount type differential transducer with one side blocked off. Thus, even though the full range of the transducer is 407 inHg, it will only provide a reading up to 173 inHg and its resolution will be based on the full scale value. It should not be used with liquids. It may be recalibrated if required, through the calibration menu, or through changes in the Configuration File. Filtering is set to 5 and zeroing is by command. The default coefficient for the channel should be 16.5016.</td></tr>
<tr><td>66 – Fuel P</td><td>0.000 3.636 volts</td><td>0.000 300.00 psi</td><td>0.000 2068 kPa</td></tr>
<tr><td colspan="4">Channel 66 is used to measure fuel pressure. It has a range of 0–300 psi (2068 kPa). Filtering is set to 5 and zeroing is by command.</td></tr>
<tr><td>69, 70 – Air1 P, Air2P</td><td>0.000 3.636 volts</td><td>0.000 276.00 inH_20</td><td>0.000 70 kPa</td></tr>
<tr><td colspan="4">Channels 69 and 70 measure air inlet pressure (air box) at the engine. Filtering is set to 5 and zeroing is by command.</td></tr>
<tr><td>71, 72, 73 – CtrlV1, CtrlV2, CtrlV3</td><td>0.000 10.000 volts</td><td>0.000 10.000 volts</td><td></td></tr>
<tr><td colspan="4">Channels 71, 72 and 73 display control voltages 1, 2, and 3 from the WinDyn sensor system. They are used primarily for diagnostics to track the behavior of the control system or other parameters that may be mapped to these channels. They are not normally used for any test applications. Filtering is set to automatic and no zeroing is required. Coefficients are set to 1.000 and should not be altered.</td></tr>
<tr><td>75 – WhlRst</td><td>0.300 4.096 volts</td><td>0.000 100.00%</td><td></td></tr>
<tr><td colspan="4">Channel 75 is used to measure the position of the wheel restraint. It is calibrated to read zero at the shortest length and 100 at the greatest length. For any particular motorcycle, a specific number between 1 and 100 should be appropriate for tests. After the motorcycle is installed, note the restraint position index; you can then use that value before testing the next motorcycle of the same model. Filtering is set to 7 and no zeroing is required. Coefficients should not be altered.</td></tr>
<tr><td>76 – BaroP</td><td>0.000 3.698 volts</td><td>0.000 29.920 inHg</td><td>0.000 101.3 kPa</td></tr>
<tr><td colspan="4">Channel 76 is used to measure barometric pressure. The barometric pressure transducer is located on the circuit board installed in the sensor box. If an accurate mercury barometer is available, SuperFlow recommends calibrating the barometric pressure sensor to exactly agree with the mercury barometer. If an accurate barometric pressure measurement device is not available, use the default calibration or obtain an absolute barometric pressure reading locally. Filtering is set to 7 and no zeroing is required. Coefficients should not be altered.</td></tr>
</table>

9.3.2 Specification Channels

Channels 77 through 99 are all specifications or constants. The values shown here are defaults, and many will change for each variety of test engine. SuperFlow recommends that after you determine a set of specifications for a particular test, save the data to a file. Before beginning the next test, load the previously recorded set of specifications, and the test system is automatically configured for the test. You normally do not need to manually change these specifications if they were entered correctly the first time and stored under the name of the engine.

Table 9-3. Specification Channels

Channel	Default Value (English)	Default Value (Metric)
77 – TotlWt	**600.00**	***272.16***
Channel 77 is used for entering the total weight of the test vehicle with the driver. Channel 77 is used by channel 106 to determine the actual power required to simulate road load power.		
78 – FAxCd	**5.000**	***.465***
Channel 78 is used to enter the estimated effective frontal area of the test vehicle in square feet [m^2] times the drag coefficient. Channel 107 uses channel 78 to calculate the estimated air drag power of the vehicle at each speed. Typical values for motorcycles vary from 2.0 to 6.0 ft^2 [*0.2 to 0.6* m^2].		
79 – EngRat	**1.000**	
Channel 79 is used to enter the ratio between the engine crankshaft speed and the transmission speed. Typical values are between 1.5 and 3.0. Channel 79 is used with channels 80 and 81 to calculate the overall gear ratio in channel 55.		
80 – TrnRat	**1.000**	
Channel 80 is used to enter the ratio of the transmission gear used during the test. Channel 80 is used with channel 79 and 81 to calculate the overall gear ratio in channel 55.		
81 – DrvRat	**1.000**	
Channel 81 is used to input the drive ratio between the transmission output and the rear wheel. Typical values are between 2 and 4. Channel 80 is used with channel 79 and 81 to calculate the overall gear ratio in channel 55.		
82 – DJCorF	**1.100**	
Channel 82 is used as an additional multiplier for creating SAEPwr comparisons to uncalibrated dynamometers in your marketing area. The factor is used in channel 114 to add 10% more power to channel 112. Numbers created using this factor are for speculation only and should not be used as any kind of standard. The factor can be changed to provide any percentage increase value desired.		
83 – Pul/Rv	**0.500**	
Channel 83 is typically used to enter the number of spark pulses per revolution (PPR) for the engine rpm measurement. If the engine speed appears to be off by a factor of 2, change the number of pulses per revolution to make the rpm read correctly. The engine frequency, channel 11 (or channel 9 on 2242 and 1942/2060-01 systems), is combined with the PPR number in channel 83 to make the appropriate engine speed calculation in channel 125.		

Table 9-3. Specification Channels

<table>
<tr><th>Channel</th><th>Default Value (English)</th><th>Default Value (Metric)</th></tr>
<tr><td>84 – TirDia</td><td>24.000</td><td>61</td></tr>
<tr><td colspan="3">Channel 84 is used to enter the tire diameter. This information is used for calculating the wheel slip in channel 53. The tire diameter information is combined with the wheel revolutions in channel 56 to determine a wheel speed, channel 57 which derived from the optical tach input—channel 12. If wheel slip is apparent under no load, it may be necessary to adjust the effective tire diameter to reduce the slip to zero at light loads. Motorcycle tires tend to change their effective rolling diameter under high rates of acceleration or deceleration; this is an interesting result to view on plots during a test. If the average number is not zero, change the entered tire diameter in this channel to change the average value to zero. The average effective rolling diameter is usually about 1” [25 mm] less than the measured diameter. A test profile is provided (Tire_Dia) that automatically calculates the correct tire diameter value when the test is run using the optical tach.</td></tr>
<tr><td>85 – IgnPck</td><td>1</td><td></td></tr>
<tr><td colspan="3">Channel 85 is used to select the engine speed calculation method desired for channel 125. A 1 in this channel enables the input signal from inductive spark pickup, coil pickup, or direct tach wire sensors into the rpm calculation in channel 125. A 0 in this channel disables the signal from these devices to.</td></tr>
<tr><td>86 – OpTach</td><td>0</td><td></td></tr>
<tr><td colspan="3">Channel 86 is used to select the engine speed calculation method desired for channel 125. A 1 in this channel enables the optical tach input into the rpm calculation in channel 125. A 0 in this channel disables the signal from this device.</td></tr>
<tr><td>87 – CalTac</td><td>0</td><td></td></tr>
<tr><td colspan="3">Channel 87 is used to select the engine speed calculation method for channel 125. A 1 in this channel enables engine speed calculations with no signal input device, instead using roll speed in mph, tire diameter, and overall drive ratio. A 0 in this channel disables this rpm calculation in channel 125. This method cannot be used with any type of automatic transmission because of torque converter slippage varying the overall drive ratio.</td></tr>
<tr><td>93 – Recpcl</td><td>1.000</td><td></td></tr>
<tr><td colspan="3">Channel 93 is a reciprocal value used by the ProFilter™ feature to properly calculate engine speed increments when using the optical tach or calculated rpm methods. This value is controlled by the test profile. Channel 93 is used when setting up the ProFilter rev counter channel. It should not be altered by the user.</td></tr>
<tr><td>94 – RpmRat</td><td>1.000</td><td></td></tr>
<tr><td colspan="3">Channel 94 is the ratio used by channel 125 for calculating engine speed when using the optical tach or calculated engine speed methods. This ratio is computed automatically when the EngSpd.tpf test profile is run to select the engine speed method. Unless the exact ratio is known, SuperFlow recommends running the EngSpd.tpf test profile and allowing the system to set this ratio.</td></tr>
<tr><td>95 – Start</td><td>40.000</td><td>60</td></tr>
<tr><td colspan="3">Channel 95 is for entering the start speed to use in various automated tests. It may be changed from the handheld controller before starting the automated test as required. It is then be restored in channel 95 by the automated test.</td></tr>
</table>

Table 9-3. Specification Channels

Channel	Default Value (English)	Default Value (Metric)
96 – StopAt	**100.0**	***160***
Channel 96 is for entering the speed for stopping an automatic test. When the test is run, it may be altered from the handheld controller. The new value is re-entered in Channel 96.		
97 – StepTm	**20.000**	
Channel 97 is used to enter the step time in seconds for the various automated tests. The step time may be modified from the handheld controller during most autotests as required. The new value is then entered into channel 97 automatically.		
98 – StepSiz	**10.000**	
Channel 98 is used to enter the requested step size for step changes in automated test profiles. The step size may be modified from the handheld controller before the test begins, and the new value is entered into channel 98 automatically.		

9.3.3 Calculated Channels

The calculated channel is one of the most powerful features of the WinDyn software. Sensor data, specifications, interpolation tables, other calculations, or any direct constant value can be combined into a mathematical calculation to produce real-time data that displays and records along with the rest of the test data. Channels 100 through 129 are dedicated calculated channels. Additionally, any unused measured channel may be configured as a calculated channel, although SuperFlow does not recommend creating them in channel blocks used for installed measured channels.

For instance, if a thermocouple module is installed in channels 13–28, do not make channel 25 a calculated channel. However, if the thermocouple module was not installed, any or all of channels 13–28 could be used for additional calculated channels. Any predefined calculated channel may easily be modified using the configuration editor supplied with WinDyn.

The calculation formula as it is in the configuration is shown next to the channel name in Table 9-4. The top line is the English value and the bottom line is metric. If only one line displays, no metric version is available.

Table 9-4. Calculated Channels

Channel	Calculation Formula	Metric Formula
50 – CWhlPw	**C112**	
Channel 50 is the old corrected wheel power channel used with previous CycleDyn configuration files. It is made available for direct comparison with old saved data files. The value is the same as the value displayed in channel 112, SAEPwr.		
53 – WhlSlp	**% = (C57-C10)/C10*100**	
Channel 53 is used to estimate the wheel slip that occurs during a test. It takes the difference between the wheel speed measured by the optical tachometer in channel 57 and the roll speed in channel 10 and converts it into a percent slip number. The slip value is usually low at low rates of acceleration or at constant speed. Under high acceleration or deceleration, some slip will appear. If the slip is greater than zero at low loads, it is possible that the tire diameter information used by channel 57 is incorrect for the motorcycle. The tire diameter information comes from the specifications in channel 84. Change the tire diameter until the average slip is zero at constant speed and no load. This is the effective rolling diameter of the tire.		
54 – Rv/mph	**C125/C10**	***Rv/kmh***
Channel 54 calculates the ratio of the engine speed to the roll speed during a test. This ratio is useful for observing potential wheel slip, clutch slip, or tire slippage during changes in speed. During fast transients, you can also introduce some change in the ratio if different data filtration rates are on the engine tachometer versus the roll speed.		
55 – OvrRat	**C79*C80*81**	
Channel 55 calculates the overall ratio of all gears from crankshaft to the driven wheel of the vehicle under test. Engine ratio, transmission ratio, and final drive ratio are multiplied together to obtain the overall ratio. This calculation is useful when using the optical tach, channel 12, to calculate engine speed, channel 125. It is also used when calculating engine speed (channel 125) using tire diameter and roll speed.		

Table 9-4. Calculated Channels

Channel	Calculation Formula	Metric Formula
56 – WhelRv	**rpm = C12*60**	
Channel 56 is used to calculate the wheel rpm based on the optical tachometer signal from channel 12. Channel 57 uses channel 56 to calculate the actual wheel speed in miles per hour [*km/h*] from the optical tachometer input.		
57 – WhlSpd	**mph = C56*C84/12*3.1416*50/5280**	***kp/h = C56*C8483.1416*60/100000***
Channel 57 is used to calculate the wheel speed in miles per hour [*km/h*] from the optical tachometer input on channel 12 and calculations in channel 56. Channel 84, the tire diameter, is used to convert the wheel rpm to miles per hour [*km/h*].		
58 – WhRvPm	**(C10/60)*(5280/(C84*0.2618))**	
Channel 58 calculates the wheel revolutions per minute using the roll speed (C10) and tire diameter (C84). The constant **0.2618 equals Pi divided by 12** is used to simplify the equation for WinDyn. Channel 58 can then be used to derive engine speed in channel 125 without using any type of sensor.		
59 – OptRmp	**C9*60**	
Channel 59 is used to calculate optical rpm when using the 1200A-2448-1 optical cable for engine speed calculations. The cable is used in the channel 11 jack, but the signal appears on the channel 9 frequency channel. Since the frequency is in hertz, it must be multiplied by 60 to get pulses per minute instead of pulses per second.		
74 – AirInT	**C1T136**	
Channel 74 displays the air inlet temperature from the thermistor used for measuring ambient air temperature. The thermistor is located inside the humidity probe and should be positioned near the intake air for the engine. The voltage from channel 1 is interpolated using table 136 to produce a temperature value. Fahrenheit or Celsius readings are determined by the values entered into interpolation table 136. The air temperature data is used to determine power correction factors and air density.		
100 – WhlPwr	**C108+C105+C126**	
Channel 100 is used to calculate the measured rear wheel power delivered to the dynamometer roll. Channel 126, the eddy current absorber power, is added to Channel 108, the inertia power due to acceleration, and Channel 105, the dynamometer parasitic power loss. Some **inertia only** dynamometers use only the inertia power, leading to measurement errors. All corrected power and wheel torque numbers are derived from this channel.		
101 – SAECor *k ECE*	**((459.7+C74)/536.7)^0.5*(29.23/ (C76–C118))**	***(99/(C76–))^((C74+273)/298)^0.6***
Channel 101 is used to calculate the Society of Automotive Engineers [ECE] power correction factor for the engine under test. It combines the ambient air temperature from channel 74 and the barometric pressure from channel 76 with the vapor pressure of the air moisture from channel 118. The factor corrects the power to the estimated power at 77°Fahrenheit [25°C] and 29.23 inches of mercury *[99 kPa]* air pressure. The SAE [ECE] correction factor is used by channel 112, SAE Power [ECE Power], to correct the wheel power in channel 100. This is the default correction factor used in the CycleDyn system.		

Table 9-4. Calculated Channels

<table>
<tr><th>Channel</th><th>Calculation Formula</th><th>Metric Formula</th></tr>
<tr><td>102 – STPCork DIN</td><td>((459.7+C74)/519.7^0.5*(29.97/C76–C118))</td><td>(101.3/C76–C118)*((C74+276/293)^0.5</td></tr>
<tr><td colspan="3">Channel 102 is used to calculate the power correction factor for standard temperature and pressure. It uses the ambient air temperature from channel 74, the barometric pressure from channel 76, and the vapor pressure from channel 118 to calculate a power correction factor. The factor corrects the power to the estimated power at 60°Fahrenheit and 29.92 inHg barometric pressure [15.56°C and 101.3 kPa]. Channel 113, STP Power [DIN Power], uses channel 102 to correct the wheel power in channel 100.</td></tr>
<tr><td>103 – Unused</td><td></td><td></td></tr>
<tr><td colspan="3">Channel 103 is unused and is available to develop your own calculated channel.</td></tr>
<tr><td>104 – Unused</td><td></td><td></td></tr>
<tr><td colspan="3">Channel 103 is unused and is available to develop your own calculated channel.</td></tr>
<tr><td>105 – DynLos</td><td>hp = (C10T131)+(C10T132)*(C119/0.0763)</td><td>kW = ((C10T131)+(C10T132)*C119/1.293)*0.746</td></tr>
<tr><td colspan="3">Channel 105 is used to calculate the parasitic losses inherent in the dynamometer due to bearing friction, aerodynamic drag, and blower options. This channel uses the roll speed and then refers to interpolation table 131, where the actual test data for the dynamometer was entered as a function of speed. This calculation returns the actual power for each speed that represents the internal losses in the dynamometer. Interpolation table 132 contains power loss data for the eddy current (EC) absorber, auxiliary roll, and the blower when these options are enabled. SuperFlow measures these losses at the factory by motoring the dynamometer at all speeds up to 200 miles per hour [320 km/h] and recording the loss information. Channel C119 adjusts the absorber and blower losses for air density. The value 0.0763 is a constant relating to standard air density. This channel is combined with channels 126 and 108 in channel 100 to calculate wheel power.</td></tr>
<tr><td>106 – TirLos</td><td>hp = (C77/2)*0.010*C10/375</td><td>hp = (C77/2)*0.010*9.81*C10/3600</td></tr>
<tr><td colspan="3">Channel 106 is used to calculate the estimated rolling power losses of the non-driven tire. Rolling losses are a function of the weight on the tire and the tire loss coefficient of 0.010. Channel 129 then uses Channel 106 to calculate the required absorber torque to apply during the Road Load simulation tests. The constant 375 comes from the standard horsepower equation constant that uses 33,000 lbs-ft/min. Dividing 33,000 by 5280 and then multiplying by 60 equals 375. This converts to lbs-miles/hour, which works with the mph value from channel 10.</td></tr>
<tr><td>107 – AirDrg</td><td>hp = (1.055*C78)*(C10^3)*C119/10000</td><td>kw = (1.29)*(C10^3)*C119*C78/100000</td></tr>
<tr><td colspan="3">Channel 107 is used to calculate the air drag power for the vehicle. This channel uses channel 78 for vehicle frontal area times the coefficient of drag and uses channel 119 for air density. These are all multiplied by the cube of the vehicle speed, channel 10, to determine the air drag power at any speed during a test. Channel 129 uses these figures to determine the correct road load power for Road Load test simulations.</td></tr>
</table>

Table 9-4. Calculated Channels

<table>
<tr><th>Channel</th><th>Calculation Formula</th><th>Metric Formula</th></tr>
<tr><td>108 – InrPwr</td><td>hp = (C224_40)*C122*C10/375</td><td>kw = ((C224*0.454)+40)*9.81*C122* C10/3600</td></tr>
<tr><td colspan="3">Channel 108 is used to calculate the inertia power during a transient test. When the vehicle is accelerating or decelerating, the engine develops additional power to accelerate the inertia of the roll, the absorber, and the rotating components of the motorcycle. Inertia power is calculated from the base inertia of the dynamometer (channel 224 or Mem4), the rotating inertia of the motorcycle (defaulted to a value of 40, but may be changed if desired), the rate of acceleration in G's from channel 122, and the actual road speed from channel 10. Channel 100 uses the inertia power to determine the total wheel power. The constant 375 comes from the standard horsepower equation constant that uses 33,000 lbs-ft/min. Dividing 33,000 by 5280 and then multiplying by 60 equals 375. This converts to lbs-miles/hour, which works with the mph value from channel 10.</td></tr>
<tr><td>109 – DstncF</td><td>feet = C225*5280</td><td></td></tr>
<tr><td colspan="3">Channel 109 calculates distance traveled in feet. Memory channel 5 (C225) is a system channel that continually calculates distance in miles. This channel is used in the Road Load simulation test. You may also use it in any other test profile by adding a command to preset Memory 5 to zero prior to starting the test. All current test profiles reset memory channel 5 at the beginning of each test.</td></tr>
<tr><td>110 – DstncM</td><td>miles = C225</td><td></td></tr>
<tr><td colspan="3">Channel 110 calculates distance traveled in miles. Memory channel 5 (C225) is a system channel that continually calculates distance in miles. However, you cannot change the decimal units displayed on channel 225. Channel 110 allows the number of decimal points to be changed. This channel is used in the Road Load simulation test, and you may also use it in any other test profile by adding a command to preset Memory 5 to zero prior to starting the test. All current test profiles reset memory channel 5 at the beginning of each test.</td></tr>
<tr><td>112 – SAEPwr</td><td>CHp = C100*C101</td><td></td></tr>
<tr><td colspan="3">Channel 112 is used to calculate the "corrected" rear wheel power for the test vehicle. Channel 100, the rear wheel power, is multiplied times channel 101, the SAE (ECE) temperature and pressure correction factor. The SAECor (kECE) correction factor, channel 101, is for estimating what the power would be at 77°F (25°C) air temperature and 29.23 inHg (99 kPa) barometric pressure in dry air.</td></tr>
<tr><td>113 – STPPwr</td><td>CHp = C100*C1012</td><td></td></tr>
<tr><td colspan="3">Channel 113 is used to calculate the "corrected" rear wheel power for the test vehicle. Channel 100, the rear wheel power, is multiplied times channel 102, the STP (DIN) temperature and pressure correction factor. The STPCor (DIN) correction factor, channel 102, is for estimating what the power would be at 60°F (15.56° C) air temperature and 29.92 inHg (101.3 kPa) barometric pressure in dry air.</td></tr>
<tr><td>114 – DJWhPw</td><td>CHp = C112*C82</td><td></td></tr>
<tr><td colspan="3">Channel 114 is used to calculate a "comparison" rear wheel power for the test vehicle. Channel 112, the SAE corrected rear wheel power, is multiplied times channel 82, DJCorF, the dyno comparison factor. Channel 114 is for estimating what the power would be on a competitor's dyno at 77°F (25°C) air temperature and 29.23 inHg (99 kPa) barometric pressure in dry air. This channel is an estimate only; it is used for comparisons with another dyno and should not be used for marketing or development purposes.</td></tr>
</table>

Table 9-4. Calculated Channels

Channel	Calculation Formula	Metric Formula
115 – SAETrq	**Cft = C112*5252.113/C125**	
Channel 115 derives a corrected torque value in lbs-ft from the SAE corrected power calculated at the rear wheel in channel 112, using engine speed from channel 125. Although this is not the actual torque applied to the ground, it is a common value used in marketing and advertising to represent corrected torque of the vehicle under test.		
116 – STPTrq	**C113*5252.113/C125**	
Channel 116 derives a corrected torque value in lbs-ft from the STP corrected power calculated at the rear wheel in channel 113, using engine speed from channel 125. Although this is not the actual torque applied to the ground, it is a common value used in marketing and advertising to represent corrected torque of the vehicle under test.		
117 – DJWhTq	**C114*5252.113/C125**	
Channel 117 derives a corrected torque value in lbs-ft from the dyno comparison corrected wheel power calculated at the rear wheel in channel 114, using engine speed from channel 125. Although this is not the actual torque applied to the ground, it is a common value used in marketing and advertising to represent torque of the vehicle under test. This channel is an estimate only; it is used for comparisons with another dyno and should not be used for marketing or development purposes.		
118 – VapP	**InHg = C74T137*C120/100**	
Channel 118 is used to calculate the vapor pressure of the water in the air under the test conditions. The percent humidity calculated in channel 120 is combined with the 100% humidity data generated by channel 74, the air temperature, and T137, the interpolation table Channel T137 contains the vapor pressure for 100% relative humidity at each temperature. Then channel 120, the percent relative humidity, is multiplied times that number to determine the actual vapor pressure. The vapor pressure is then subtracted from the barometric pressure to determine the net barometric pressure to use in the power correction factors in channels 101 and 102. Vapor pressure is the true measure of water vapor content of the air. Relative humidity cannot be used directly because it varies with air temperature.		
119 – AirDen	**lb/cft = 0.0763*C76/29.92*520/ (460+C74)**	***g/l = 1.293*C76/101.3*273/(273+C74)***
Channel 119 is used to calculate the air density under the test conditions. Air density is measured in pounds per cubic feet (gram per liter) of air. The constant 0.0763 is the lbs/cubic feet of air at sea level. Channel 119 uses the barometric pressure from channel 76 and the air temperature from channel 74 to calculate the actual air density under test conditions.		
120 – Humidy	**(C6–0.655)/2.54*100)/ 1.093–(0.0012*C74)**	***((C6–0.655)*39.37)/ 1.93–(0.00216*C74+0.0384))***
Channel 120 takes the humidity sensor voltage input from channel 6 and combines it with the air temperature to determine the percent relative humidity of the air during the test. Channel 118 then uses this data to determine the vapor pressure in the air for power correction.		
121 – WhlTrq	**lb-ft = C100*5252.113/C125**	***N-m = C100*9549/C125***
Channel 121 derives an uncorrected torque value in lbs-ft *[nm]* from the wheel power measured at the rear wheel in channel 100, using engine speed from channel 125. Although this is not the actual torque applied to the ground, it is a common value used in marketing and advertising to represent torque of the vehicle under test.		

Table 9-4. Calculated Channels

Channel	Calculation Formula	Metric Formula
122 – Accel	**g = C220/21.937**	
Channel 122 calculates the actual acceleration or deceleration of the test vehicle in G's. It uses channel 220 which calculates the acceleration in miles per hour per second and converts it to G's by dividing by 21.937. One G is equal to an acceleration rate of 21.937 miles per hour per second [*9,807 meters per second per second*].		
123 – RolRPM	**rpm - C10*5280/60/19.85/3.1416*12**	***rpm = C100*1000/60/0.4/3.1416*100***
Channel 123 is used to calculate the roll rpm during a test. It determines the roll rpm from the roll speed from channel 10 by calculating the circumference of the roll and dividing it into the distance traveled per revolution at that speed.		
125 – EngSpd	**(C85*(C11+C9)/C83*60) +((C86*C59)+C58)*C94)**	
Channel 125 is used to calculate the engine speed. It uses several methods to do this, determined by the settings of channels 85, 86, and 87. Whichever of those channels is set to a value of 1 (with the other two set to zero) determines which calculation to use. The first portion uses the frequency input from channel 11, the ignition pickups (or channel 9 in 2242 or 1942/ 2060-01 systems), divided by the pulses per revolution of the engine, channel 83. Multiply these by 60 to convert the pulses per second to pulses per minute for rpm. The second portion of the equation uses the frequency from the optical tach pickup, channel 59, along with an rpm ratio, channel 94, of the rotating device to the engine's rotation. The optical tach could be receiving a signal from the rear wheel; thus, the overall ratio would be the drivetrain ratio. However, the optical tach could be used on any rotating device on the engine, and the ratio should then be the ratio of that device to the engine crankspeed. The third portion of the equation calculates engine speed in a specific transmission gear ratio as a function of roll speed. It requires no specific pickups.		
126 – AbsPwr	**hp = C2*C123/5252.113**	**kw = C2*C123/9549**
Channel 126 is used to calculate the power absorbed by the eddy current (EC) power absorber. It uses the power absorber torque from channel 2 times the roll speed from channel 123 and divides by a constant to determine the power absorbed. This value is combined with channels 108 and 105 in channel 100 to calculate wheel power. When the EC absorber is loaded during a test, this channel contributes a larger portion to the wheel power calculation in channel 100.		
127 – CsDnLs	**hp = C108+C105**	
Channel 127 is used to calculate the estimated power losses or coast-down losses for the vehicle under test. It should only be used for the results of an automated coast-down test to determine the vehicle losses at various speeds. It uses channel 108, the inertia power for the test, and adds on the internal dyno losses. The result is the total power being removed from the vehicle as it coasts-down at each speed. This is not equal to the total power loss of the vehicle when it is actually running under power because the transmitted power is less during coast-down.		
128 – GrndTq	**Cft = C112*5252.113/C123/19.85*C84**	
Channel 128 is used to calculate the corrected wheel torque actually applied to the ground, derived from the SAE corrected wheel power in channel 112. This value changes based on the vehicle gear ratio or tire diameter used during the test. Lower numbered gears will produce higher values.		

Table 9-4. Calculated Channels

Channel	Calculation Formula	Metric Formula
129 – CEcTq1	lb-ft = (C106+C107–C105)*5252.113/ C123	N-m = (C106+C107–C105)*9549/ C123
Channel 129 is used to calculate the compensated EC torque required to provide different inertia simulations for different weight vehicles. This signal is used to provide control for road power simulations that will duplicate the normal road loads for aerodynamic drag, channel 107, and tire rolling resistance, channel 106. Channel 105 is dyno parasitic power loss; channel 123 is roll rpm. This channel is used exclusively in the Road Load test profile.		

9.3.4 Interpolation Tables

Interpolation tables store non-linear functions for calibration and calculation purposes. They are typically used as calibration tables for air and fuel turbines, parasitic inertia tables for chassis dyno rolls, and correction factor tables. This feature is used to linearize a sensor, or basically perform calculations from a set of arbitrary data. Tables can be defined with interval or variable interval input values. The interpolation tables are located in channels 130 through 139.

Interpolation Channel 131 – DynLsT

Channel 131 is an interpolation look-up table for the actual parasitic losses of the dynamometer roll. These losses are measured at the factory at all speeds up to 200 miles per hour [*320 km/h*]. The actual measured losses are entered into the table for each ten miles per hour [*16,09 km/h*] increment. As a test is run, this data may be accessed as a function of miles per hour [*km/h*] and delivers the actual power loss at that speed. Although numbers are provided in this table, the actual values used by the CycleDyn come from low-level configuration tables programmed into the sensor box during factory testing. Changing the values in the table will not effect the calculations in channel 105, DynLos.

Interpolation Channel 132 –BlwLsT

Channel 132 is an interpolation look-up table for the eddy current, auxiliary rolls and blower losses, if these options are installed on the dyno. If speed is delivered to this table, it will return the power loss at that speed. Although numbers are provided in this table, the actual values used by the CycleDyn come from low-level configuration tables programmed into the sensor box during factory testing. Changing the values in the table will not effect the calculations in channel 105, DynLos.

Interpolation Channel 136 — AirTpT

Channel 136 is an interpolation look-up table to convert the voltage from the air temperature sensor in channel 1 into actual temperature for channel 74. Do not modify this table unless you have good calibration data.

Name: AirTpT
Type: Variable

In (x):	0.033	0.086	0.114	0.152	0.206	0.282	0.364
Out f(x):	300.20	230.00	212.00	194.00	176.00	158.00	144.80
In (x):	0.459	0.582	0.738	0.935	1.178	1.471	1.808
Out f(x):	131.60	118.40	105.20	92.002	78.801	65.594	52.400
In (x):	2.178	2.558	2.922	3.245	3.510	3.712	3.857
Out f(x):	39.200	26.000	12.800	-0.400	-13.60	-26.80	-40.00

Figure 9-1. Channel 136 U.S. Values

Name: AirTpT
Type: Variable

In (x):	0.033	0.086	0.114	0.152	0.206	0.282	0.364
Out f(x):	149.00	110.00	100.00	90.001	80.001	70.001	62.667
In (x):	0.459	0.582	0.738	0.935	1.178	1.471	1.808
Out f(x):	55.333	48.000	40.667	33.334	26.000	18.663	11.333
In (x):	2.178	2.558	2.922	3.245	3.510	3.712	3.857
Out f(x):	4.000	-3.333	-10.66	-18.00	-25.33	-32.66	-40.00

Figure 9-2. Channel 136 Metric Values

Interpolation Channel 137 — VapPrT

Channel 137 is an interpolation look-up table to determine the vapor pressure at 100% relative humidity (saturation vapor pressure) for the dry bulb temperature.

Name: VaporT Type: Fixed Fixed Interval (n): 10.000

In (x):	0.000	10.000	20.000	30.000	40.000	50.000	60.000
Out f(x):	0.040	0.070	0.110	0.160	0.250	0.360	0.520
In (x):	70.000	80.000	90.000	100.00	110.00	120.00	130.00
Out f(x):	0.740	1.030	1.420	1.930	2.590	3.440	4.520
In (x):	140.00	150.00	160.00	170.00	180.00	190.00	200.00
Out f(x):	5.870	7.550	9.630	12.180	15.270	18.990	23.450

Figure 9-3. Channel 137 U.S. Values

Name: VaporT Type: Variable

In (x):	-5.000	-10.00	-15.00	-20.00	0.000	5.000	10.000
Out f(x):	0.750	0.520	0.370	0.320	0.930	1.110	1.350
In (x):	15.000	20.000	25.000	30.000	35.000	40.000	45.000
Out f(x):	1.720	2.270	3.070	4.180	5.640	7.530	9.910
In (x):	50.000	55.000	60.000	65.000	70.001	75.001	80.001
Out f(x):	12.830	16.360	20.550	25.460	31.160	37.700	45.150

Figure 9-4. Channel 137 Metric Values

Interpolation Channel 139 — CstDwn

This table is only used when the advanced NGE coastdown feature is enabled through a test profile. Data will be filled in by the coastdown test profile and used temporarily to produce drivetrain parasitic loss data. Default table values will be:

- Input = 0-200
- Output = all zeros or erratic data

9.3.5 System Channels

System channels are pre-programmed channels that supply important information to WinDyn. The following descriptions lists the system channels and their functions. System channels can be read and displayed in the same manner as data channels and can be used as operators in calculated channels. System channels cannot be modified or used for closed-loop control.

Table 9-5. System Channels

Channel	Name	Description
200	**Time-H**	Displays the current hour from the system clock*
201	**Time-M**	Displays the current minute from the system clock
202	**Time-S**	Displays the current second from the system clock
203	**SecDay**	Displays the number of seconds since midnight
204	**TsTime**	Displays the number of seconds of an autotest. Resets to zero when an autotest starts
205	**RnTime**	Display total number of seconds since data acquisition system was first turned on.
206	**Fuel-M**	Not used in current SuperFlow systems
207	**SetPt1**	Channel 207 is the load set point used by the absorber control system. A value is this channel indicates the control set point being used. The value changes depending upon the control channel being used. If control is manual, then the value represents a percentage of load from 0-100%. If the control is to Engine Speed, then the value indicates an rpm control point from 0–20,000 rpm. If the control is to Trq1, then the value represents a control point from 0 to 2500 lb-ft on the strain gauge.
208	**SetPt2**	Channel 208 is the throttle set point used by the optional electronic throttle control system. A value is this channel indicates the control set point being used. The value changes depending upon the control channel being used. If control is manual, then the value represents a percentage of throttle from 0-100%. If the control is to Engine Speed, then the value indicates an rpm control point from 0-20,000 rpm. If the control is to Trq1, then the value represents a control point from 0 to 2500 lb-ft on the strain gauge.
209	**SpcGv1**	Not used in current SuperFlow systems
210	**Timer 1**	Channel 210 is a system timer channel. This channel is typically used in test profiles to indicate the total time a test is running. It uses tenths precision.
211	**Timer 2**	Channel 211 is a system timer channel. This channel is typically used in test profiles to indicate ramp time or the time during which the data is collected during a test. It uses thousandths precision.

Table 9-5. System Channels

Channel	Name	Description
212–218	Timer 3 to Timer 9	Used by the autotest to monitor timing functions. The timers are not user accessible. See the Test Profile editor in the WinDyn Users Guide for details
219	SpcGv2	Not used in current SuperFlow systems
220–222	Memory 0 to Memory 2	These channels are acceleration in mph/second. Channel 220 is used to calculate acceleration in G's.
223	Memory 3	Channel 223 is used to hold the total number of data lines recorded.
224	Memory 4	Channel 224 contains the dyno inertia in equivalent vehicle mass in pounds. This value changes when different equipment options are selected in the handheld controller setup menu.
225	Memory 5	Channel 225 is distance traveled in miles since the last counter reset.
226–227	Memory 6 to Memory 7	Not used in current SuperFlow engine dynamometer systems
228	Memory 8	Channel 228 is recommended for use as the system revolution counter (this is defined by the user via the system console configuration settings). It may be used to track the amount of engine revolutions on a specific engine for rebuild or break-in purposes. It is reset via the console or via a test profile command.
229	Memory 9	Channel 229 is used by the automated tests to trigger the starting and stopping of the real-time graphs in WinDyn. Do not use this channel for other purposes or this triggering function will be lost.
230	Memory 10	Not used in current SuperFlow engine dynamometer systems
231	LineNo	Channel 231 is a system channel which indicates the line number of the data line recorded in a test data file (.sfd). It can also be used when recording raw data at 100 times per second as a 1/100th second timer channel.
232	Year (yyyy)	This channel specifies the year when the first data line is recorded in a test. This information is a permanent record of the test execution date and cannot be changed.
233	Month (mm)	This channel specifies the month when the first data line is recorded in a test. This information is a permanent record of the test execution date and cannot be changed.
234	Day (dd)	This channel specifies the date when the first data line is recorded in a test. This information is a permanent record of the test execution date and cannot be changed.
235	DayWk Day of week (0-7 = Sun-Sat)	This channel specifies the day of the week when the first data line is recorded in a test. This information is a permanent record of the test execution date and cannot be changed.

* WinDyn will synchronize the computer clock with the clock in the data acquisition system. The system time/date channels (200-203 & 232-235) are linked to the computer clock when WinDyn connects with the system.

9.4 Control Channels

Control channels are data channels that can function as closed loop feedback channels. Closed loop feedback channels allow the CycleDyn to servo (adjust) a control device, such as control on a dynamometer to produce a desired value, such as 50mph or 100 lb-ft of torque. The control system uses the control channel to "see" the current value, for example the current torque value, and compares the current value to the desired value. The control system continues to servo the controller (up or down depending on whether the current value is higher or lower than the desired value) until the current value (the value of the control channel) matches the desired value. This process of "read current value", "compare to desired value" and "adjust" continues until the control system is placed into manual mode.

Five control channels are available for use by up to two controlled devices, such as dynamometer load and throttle controllers. This allows five different controlled values to be defined for closed loop control. In other words, one or both controllers could be used to execute closed loop control of up to two of ten possible values simultaneously. The combination of a controller controlling a specific value is called a mode. Up to ten different control modes can be used by combining the five control channel values with the two available controllers.

It is not necessary to define all five channels. At a minimum, only one channel must be defined if closed loop control is required. Many testing applications use two control channels, one for torque and one for speed. This allows tests to be conducted that control closed loop speed or closed loop torque. The standard SuperFlow CycleDyn chassis dynamometers uses one controller (load) and two control channels, vehicle speed (Channel 10) and roll torque (Channel 2). A second controller can be installed for closed-loop servo control on an electronic throttle or other device. Testing requirements vary considerably in terms of control requirements.

WARNING: Adding control channels require PID parameters to be created and "tuned." This process is very complicated and should not be attempted by anyone without experience and understanding of PID closed-loop servo control methods.

See Chapter 11, "Control Modes" for more information on closed-loop control and how it works on SuperFlow dynamometers.

9.5 Data Display Screens

The main display of the remote handheld controller shows measured, specification, calculated, and system data channels. The display channels are grouped onto nine separate screens for convenience. Each screen is accessed by pressing a numeric key (1–9) on the control panel.

See the chapter on the Configuration Editor in the *WinDyn Users Guide* for more information on changing the selected channels on the screens or designing new screens.

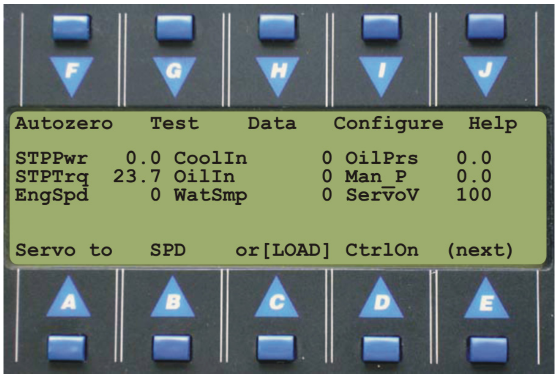


Figure 9-5. Handheld Data Screen

CHAPTER 10

SERVICE AND CALIBRATION

IN THIS CHAPTER

- Inspection and Maintenance
- Calibration
  - Calibration Coefficients
  - Torque Sensor (Load Cell)
  - Barometric Pressure Sensor
  - Pressure Transducers
  - Temperature Channels
  - Air Temperature and Humidity
  - Optical Tachometer
  - Ignition Spark Pickup
  - Air and Fuel Flow Sensors
- Service
  - Lubrication
  - Wheel Clamp Operation
  - Blower Maintenance
- Troubleshooting the CycleDyn

10.1 Inspection and Maintenance

The CycleDyn should be periodically serviced according to the and maintenance schedule below.

Depending on your location, maintenance contracts may be available from SuperFlow Technologies Group. Contact SuperFlow Customer Service for details.

The following tables allow you to keep track of inspections and monthly and quarterly service.

Log sheets are provided at the end of this chapter for keeping a record of the maintenance performed on the system. Remove the originals from this manual and make copies for your use. Knowing what maintenance was done and when can be very beneficial to prolonging the life of your dynamometer.

Table 10-1. CycleDyn Dynamometer Maintenance Chart

Components	Inspection Interval	What to do ...	Repair or replace when/if ...*
Handheld controller cable	Each use	Inspect for wear, damage	Worn or damaged
Pressure fittings	Each use	Inspect for wear, damage	Worn or damaged
Pressure hoses	Each use	Inspect for wear, damage	Worn or damaged
Thermocouples	Each use	Inspect for wear, damage	Worn or damaged
All electrical cables and sensor cables	Each use	Inspect for wear, damage	Worn or damaged
Battery	Weekly	Check electrolyte level	Does not hold charge
Sensor box wheels	Weekly	Inspect for wear or damage, clean out debris and dust	Worn or damaged
Universal joint nuts	Every 1 month	Tighten to: 20-24 ft-lb (27–32 N-m)	Stripped or damaged
Universal joint set screws	Every 1 month	Tighten to: 30 ft-lb (40 N-m)	Stripped or damaged
Blower drive belt	Every 1 month	Inspect for fraying; check tracking on pulleys and deflection X” at mid span	Frayed or damaged
Blower intermediate coupling	Every 1 month	Check for extrusion of elastomer spider	Worn or damaged
Blower intermediate coupling set screws	Every 1 month	Tighten to: 6 ft-lb (8 N-m)	Stripped or damaged
Dynamometer chassis, Sensor Box, Handheld Computer, Computer Monitor, etc.	Every 1 month	Clean	As needed
Absorber torque sensor (load cell)	Every 3 months	Calibrate	Cannot be calibrated
Load cell bolt (upper)	Every 3 months	Tighten to: 35 ft-lb (47 N-m)	Stripped or damaged
Load cell bolt (lower)	Every 3 months	Tighten to: 35 ft-lb (47 N-m)	Stripped or damaged
Disc brake mounting screws	Every 3 months	Tighten to: 30 ft-lb (40 N-m)	Stripped or damaged
Disc brake pads	Every 3 months	Check for wear	Thickness < 0.06” (1.5 mm) if even wear
Brake fluid, master cylinder (DOT3)	Every 3 months	Inspect level	Every 2 years
Roll speed magnetic pickup	Every 3 months	Check for clearance, adjust to 0.005” (0.13 mm) at tightest point	Damaged
Air hose to clamp	Every 3 months	Inspect for leaks, damage	Leaking or damaged
Air bag on clamp	Every 3 months	Inspect for leaks, damage	Leaking or damaged
Restraint guide bolts	Every 3 months	Tighten to: 15–18 ft-lb (20–24 N-m)	Stripped or damaged
Linear actuator clamps	Every 3 months	Tighten to: 15–18 ft-lb (20–24 N-m)	Stripped or damaged
Battery	Every 3 months	Clean top and terminals	Does not hold charge
Inertia Roll P.B. bearings	Every 6 months	See section 10.3.1, “Lubrication,” on page 10-19	Noisy or rough running
Inertia roll P.B. bearing bolts	Every 3 months	Tighten to: 90 ft-lb (120 N-m)	Stripped or damaged
Blower pulleys	Every 6 months	Tighten evenly to 9 ft-lb (12 N-m) for 1/4” bolts, 30 ft-lb (40 N-m) for 3/8” bolts	Stripped or damaged
Universal joint coupling	Every 6 month	See section 10.3.1, “Lubrication,” on page 10-19	Worn or damaged
EC absorber stub shaft bolts	Every 6 months	Tighten to: 30 ft-lb (40 N-m)	Stripped or damaged
EC absorber internal bearings	Every 6 months	See section 10.3.1, “Lubrication,” on page 10-19	Noisy or rough running
EC absorber P.B. bearing bolts	Every 6 months	Tighten to: 90 ft-lb (40 N-m)	Stripped or damaged
EC absorber P.B. bearings	Every 6 months	See section 10.3.1, “Lubrication,” on page 10-19	noisy or rough running
Fasteners, general	Every 6 months	Tighten as necessary	Stripped or damaged
Battery	Every 2 years	Replace	Every 2 years

* See Appendix C, “Parts List & Drawings” for a list of part numbers.

Monthly Maintenance Check List				
Component	**What to do ...**	**Replace when/if ...**	**OK**	**Notes**
Universal joint nuts	Tighten to: 20-24 ft-lb (27–32 N-m)	Stripped or damaged		
Universal joint set screws	Inspect level	Stripped or damaged)		
Blower drive belt	Inspect for fraying; check tracking on pulleys and deflection X” at mid span	Frayed or damaged)		
Blower intermediate coupling	Grease at lower fitting; use Supertelmaco or equivalent (1)	Worn or damaged)		
Blower intermediate coupling set screws	Tighten to: 6 ft-lb (8 N-m)	Stripped or damaged)		

Date:	**Technician:**

3-Month Maintenance Check List				
Component	**What to do ...**	**Replace when/if ...**	**OK**	**Notes**
Universal joint coupling	1 pump with hand grease gun*	Excessive play		
Absorber torque sensor (load cell)	Calibrate the sensor	Cannot be calibrated		
Load cell bolt (upper)	Tighten to: 35 ft-lb (47 N-m)	Stripped or damaged		
Load cell bolt (lower)	Tighten to: 35 ft-lb (47 N-m)	Stripped or damaged		
Disc brake mounting screws	Tighten to: 30 ft-lb (40 N-m)	Stripped or damaged		
Disc brake pads	Check for wear	Thickness < 0.06” (1.5 mm) if even wear		
Brake fluid, master cylinder (DOT3)	Inspect level	Every 2 years		
Roll speed magnetic pickup	Check for clearance, adjust to 0.005” (0.13 mm) at tightest point	Damaged		
Air hose to clamp	Inspect for leaks, damage	Leaking or damaged		
Air bag on clamp	Inspect for leaks, damage	Leaking or damaged		
Restraint guide bolts	Tighten to: 15–18 ft-lb (20–24 N-m)	Stripped or damaged		
Linear actuator clamps	Tighten to: 15–18 ft-lb (20–24 N-m)	Stripped or damaged		
Inertia roll P.B. bearing bolts	Tighten to: 90 ft-lb (120 N-m)	Stripped or damaged		
Inertia Roll P.B. bearings	2 pumps with hand grease gun*	Noisy or rough running		
Battery	Clean top and terminals	Does not hold charge		
Blower pulleys	Tighten evenly to 9 ft-lb (12 N-m) for 1/4” bolts, 30 ft-lb (40 N-m) for 3/8” bolts	Stripped or damaged		
EC absorber stub shaft bolts	Tighten to: 90 ft-lb (40 N-m)	Stripped or damaged		
EC absorber internal bearings	Grease until grease appears at overflow*	Noisy or rough running		
EC absorber P.B. bearing bolts	Tighten to: 30 ft-lb (40 N-m)	Stripped or damaged		
EC absorber P.B. bearings	Tighten to: 90 ft-lb (120 N-m)	noisy or rough running		
Fasteners, general	Tighten as necessary	Stripped or damaged		

Date:	**Technician:**

* See section 10.3.1, “Lubrication,” on page 10-19.

10.2 Calibration

The sensors used with the CycleDyn should be periodically calibrated for highest measurement accuracy. The calibration assigns coefficient values for the channels defined in the configuration file (CFA/CFD) as calibrated channels. The coefficients are determined by the default values set in the channel configuration or by the values entered during a calibration procedure.

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

Technical specifications for some sensors are available in data sheets that can be obtained from SuperFlow Customer Service or Sales.

Because calibration standards or known values are the basis for accurate test results, never guess at the value of the standard. 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%.

To avoid accidental mis-calibration, the calibration editor has a built-in safeguard. Calibration entries exceeding ±10% change from the defined calibration value will trigger an alert message. If, for any reason, the real error exceeds this 10% and the calibration must be adjusted by a greater value, the safeguard can be overridden. Apparent calibration drifts of more than 10% should be investigated because they may point to a defective sensor or a problem with the electronics.

Carefully follow these procedures to accurately calibrate the SuperFlow data acquisition system.

10.2.1 Calibration Coefficients

When the calibration is saved as a file on the computer, the coefficient for each sensor channel with its zero offset is saved in the file. WinDyn can automatically reload this calibration file each time a test group is installed, ensuring an accurate calibration.

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.

For more information on calibration coefficients and how they affect the data acquisition, see Appendix A, "WinDyn Calibration Files," in the *WinDyn Users Guide*.

10.2.2 Torque Sensor (Load Cell)

NOTE: *This sensor is only present in CycleDyn systems equipped with the eddy current absorber option or AC Motor option.*

Common SuperFlow technical support questions involve low torque readings and power numbers obtained from the dynamometer. In many cases, proper attention to torque calibration will solve the problem.

The torque sensor measures the force created from the absorber load and sends an analog voltage signal to the CPU for measurement and conversion to a digital readout. The force measured is only as accurate as the calibration that is performed on the unit. If the calibration is off by five percent, then the measured torque will be off by five percent as well and will also affect the power readings. The absorber is pre-calibrated at the factory, but it is wise to check the calibration periodically.

SuperFlow recommends doing this according to the schedule in Table 10-1, “CycleDyn Dynamometer Maintenance Chart,” on page 10-4.

Basic calibration of the torque system is an important part of dyno repeatability. It should be a regular part of the operational routine and you ***must*** performed it any time you replace a load cell or the main CPU circuit card. This section provides a step-by-step procedure for calibrating the SuperFlow data acquisition system.

NOTE: *Torque is referred to in units of lb-ft as well as ft-lb. The two are interchangeable, although the correct term is lb-ft. Metric units are treated the same way (Nm or N-m).*

For questions about this procedure, contact SuperFlow Customer Service.

Some important notes about calibration are:

- It is absolutely imperative that the weights used for torque calibration be accurate to one decimal place (20.5 lbs., not 20 lbs. 8 oz.). Realize that the weight at the end of the calibration arm will be multiplied by a factor of the arm length in feet, so any error in the measurement of the weights will also be amplified by that factor.
- Use enough weight to equate to a torque reading in the range of the vehicles tested on the dyno. To figure the amount of calibration weight required, use this equation:

  Expected wheel torque ÷ 3 = Calibration weight required

  (where 3 is the effective length of the calibration arm)
- Use multiple weights that can be removed individually during calibration. This allows you to check the system calibration at different torque values and check linearity throughout the torque circuit range.

On all CycleDyn systems, three 50-pound weights were provided when the system was shipped from the factory. Replacements or additional weights can be obtained from SuperFlow Customer Service.

IMPORTANT: It is a known fact that the accuracy of horsepower measurements is a direct result of the accuracy of the torque calibration which is dependent on the value of the calibration weights. **Know your weights**.

Calibration Procedure

1. The data acquisition system and the test room should be at normal operating temperature. Leave the system power on for at least 15 minutes prior to performing a torque calibration.
2. Start WinDyn.
3. Load the standard test group and ensure the screen displays are active.
4. Cycle through the WinDyn screens (press buttons numbered 0 through 9 on the computer keyboard) until the channel representing **Torque** displays. On most CycleDyn systems it is on screen number 2. The channel number is 2 and is usually named **Trq1**.

   This is the actual torque indication as measured by the load cell. Do not use any of the corrected torque channels for calibration (SAETrq, STPTrq, GndTrq, ECETrq, etc.).
5. Locate the calibration arm.

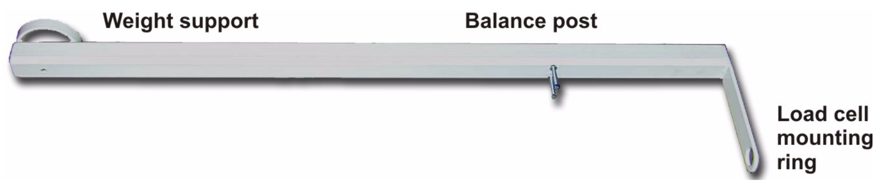


Figure 10-1. CycleDyn Calibration Arm

6. Place the calibration arm on the dynamometer load cell with the balance posts in the center of the absorber housing (an access hole is in the top of the absorber box for this). Ensure the end ring is seated in the groove on the load cell post.

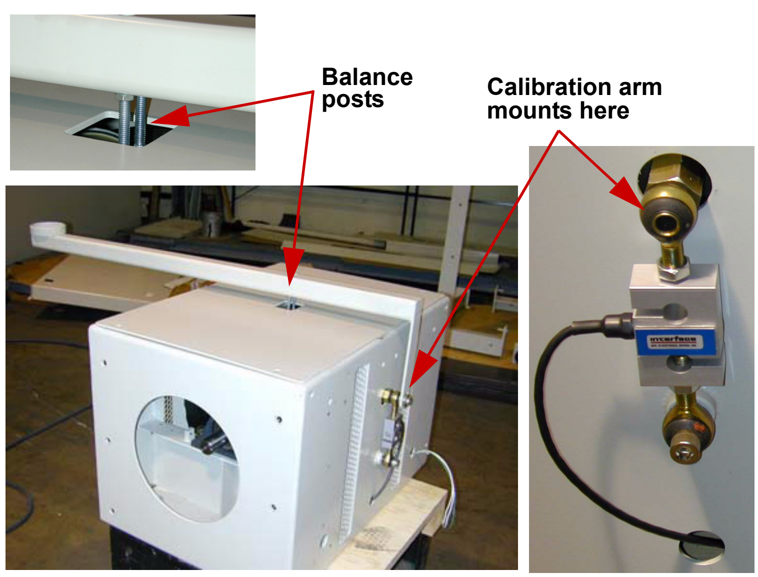


Figure 10-2. Calibration Arm – Mounted

7. Do not put any weights on the calibration arm at this time.

8. Calculate the torque value of the weight by multiplying the weight value times the effective length of the calibration arm. The CycleDyn calibration arm is 3 feet long.

Example:

Weight = 60 lbs. [*27.2 kg*]   Arm Length = 3 ft. [*0.9144 m*]

Torque is calculated by: 60 x 3 = 180 lb•ft

27.2 x 9.81 x 0.9144 = 244 N-m

**9.81 is the conversion from Kg to KgF*

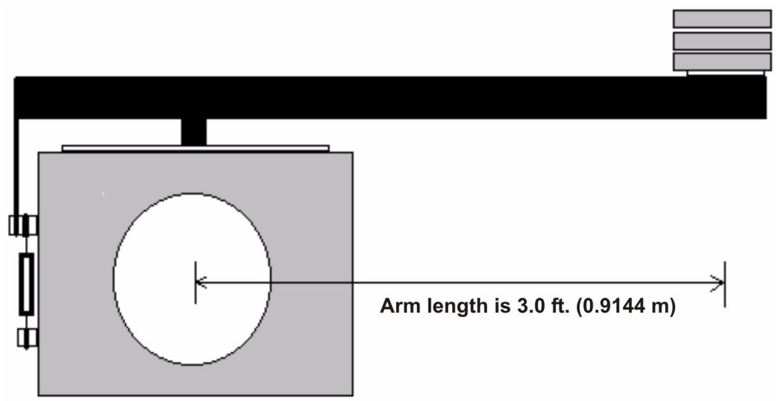


Figure 10-3. Eddy Current Calibration

With the standard 20-pound weights supplied by SuperFlow, the calculated torque values are:

- Three weights: 180 lb•ft (244 N-m)
- Two weights: 120 lb•ft (163 N-m)
- One weight: 60 lb•ft (81 N-m)

Acceptable tolerance at maximum weight is ±2 lb•ft [*1.36 N-m*]. Linearity should be better than ±2 lb.ft [*2.7 Nm*] of torque.

From WinDyn

1. From the main **WinDyn** menu, select **System>>Calibrate**, or press the letter **C**. The **Calibrate** dialog box appears.

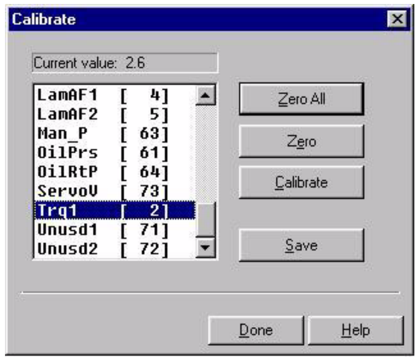


Figure 10-4. Calibrate – Torque

2. Scroll down the list and find **Channel 2, Trq1** (it may have a different name). Click this channel, and a small torque value displays because of the weight of the arm.
3. Click **Zero**. This zeros the torque, removing the weight of the bar from the process.

> ***NOTE:*** *The strain gauge (load cell) is a voltage output device. In the calibration procedure, the torque is zeroed with the calibration arm on the absorber. This effectively removes the weight of the arm in the calibration calculation. Calibrating with a known weight creates a coefficient for converting the voltage to torque. After calibrating, the arm is removed and the torque channel zeroed again. The zero offset factor does not affect the coefficient because the conversion factor remains the same anywhere on the voltage scale.*

4. A **Confirm** dialog box appears. Click **OK**.
5. Place the calibration weights onto the end of the calibration arm as shown in Figure 10-3. Make sure they are secure and steady.
6. Check the torque reading on the display against the calculated value. If it is within acceptable limits, skip to step 16. Additional calibration is unnecessary.
7. Click **Calibrate**. A **Channel Calibrate** dialog box appears. In the **Enter new value for channel ___ in lb-ft** text box, type the calibration torque value calculated in step 8 on page 10-9.

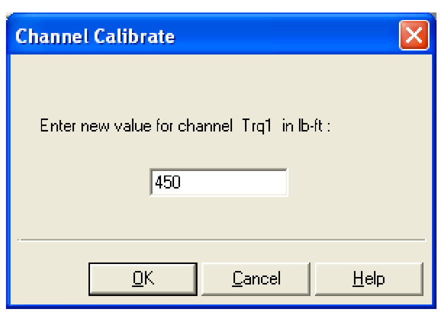


Figure 10-5. Channel Calibrate

8. Press the **ENTER** key on the keyboard, or click **OK**.
9. If using multiple weights, remove them one at a time. Re-calculate the torque value, and verify the reading on the screen display. Linearity should be better than ±2 lb•ft [*2.7 N-m*] of torque. If they are not within acceptable limits, recheck the zero reading and repeat the calibration. When all weights are off, the torque reading should be zero. If not, re-zero and repeat the calibration.
10. Remove all of the weights and the calibration arm. The display will show a negative torque value which is the offset registered by the calibration arm.
11. Click the **Zero All** button and then **OK**.
12. To save the calibration, click **Save**. The calibration file is saved with the same name as the currently loaded configuration (CFA). WinDyn prompts with this information.
13. Click **OK**. If a calibration file already exists, a dialog box appears asking whether to overwrite the file. Always overwrite the file when a new calibration is created.
14. Click **Yes**. A dialog box appears stating **File received and saved OK**.
15. Click **OK**.
16. Click **Done** to exit the 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.

From the Handheld Controller

Figure 10-6. SF-1853 Handheld Controller

1. Zero the Torque channel from the handheld controller:
   - Select **Autozero** (**F** key) followed by **Single channel** (**C** key)
   - Select channel **2** (**Trq1**) by pressing **Select** followed by **2** and **ENTER**
   - Press **Exit** (**E** key) to return to the main menu
2. Place the calibration weights onto the end of the calibration arm as shown in Figure 10-3. Make sure they are secure and steady.

3. From the handheld controller:
   - Press **Configure** (**I** key) followed by **Calibrate** (**B** key)
   - Press **Sensors** (**A** key)
   - Press **Edit** (**C** key)
   - Select the torque channel (**Trq1**) by pressing **Select** followed by **2** and **ENTER**.
   - Press **Current value** (**C** key) and enter the calculated torque value.
   - Verify that your entry is correct and confirm by pressing **Yes** (**A** key).
   - Press **Exit** (the **E** key) twice.

     A message appears asking to save the changes in the calibration file on the computer hard drive. Do **NOT** save the changes at this time: press **No** (**E** key).
   - Press **Exit** (the **E** key) to exit the Configuration mode.
4. The calibrated value should appear on the handheld and Windyn displays. If it is not correct, something may be binding or broken in the eddy current absorber or the load cell. Check for a problem and try the calibration again.
5. If using multiple weights, remove them one at a time. Re-calculate the torque value, and verify the reading on the screen display. If they are not within acceptable limits, recheck the zero reading and repeat the calibration. When all weights are off, the torque reading should be zero. If not, re-zero and repeat the calibration.
6. Remove all of the weights and the calibration arm. The display will show a negative torque value which is the offset registered by the calibration arm.
7. Autozero the torque channel as described in step 1.
8. Save the new calibration:
   - From the handheld controller:
     - Select **Configure** (**I** key) followed by **Calibrate** (**B** key).
     - Press **Save file** (**B** key).
     - Press **Exit** (**E** key).
   - From WinDyn:
     - Select **System>>Save >>Sensor Calibration** from the main menu. The calibration file is saved with the same name as the currently loaded configuration (CFA). WinDyn prompts with this information.
     - Click **OK**. If a calibration file already exists, a dialog box appears asking whether to overwrite the file. Always overwrite the file when a new calibration is created.
     - A message appears to confirm that the file-saving operation completed successfully. Click **OK**.

10.2.3 Barometric Pressure Sensor

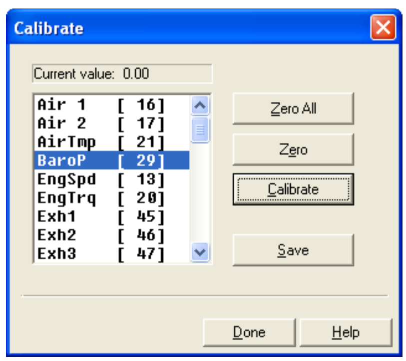
The barometric pressure sensor is installed on the Printed Circuit Board (PCB) inside the sensor box. The configuration channel for Baro P has calibration values entered according to the manufacturer's specifications, but it can be calibrated to provide more accurate readings for the dyno location.

Obtain an accurate, uncorrected barometric pressure reading in inHg (for U.S. unit systems) or kPa (for metric unit systems) from a mercury barometer. If a mercury barometer is not available, contact a local airport or weather service and ask for the "station or uncorrected pressure." The barometric pressure reading from a television station is corrected for local elevation and therefore is not acceptable for calibrating the sensor.

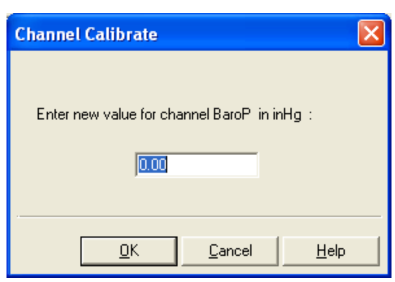
You can perform calibration from the computer using WinDyn or from the handheld controller. Both methods are provided below.

From WinDyn

1. From the **WinDyn** main menu, select **System>>Calibrate** or press the letter **C**. The **Calibrate** dialog box appears.



2. Scroll down the list and find **Channel 76 (Baro)**. Click this channel and the current barometric reading displays.
3. Click **Calibrate**. A dialog box appears with the message **Enter new value for channel ____ in in/Hg**. The value displayed is the current Baro value based on the existing calibration.



4. Enter the correct value obtained from a mercury barometer or weather service.
5. Press the keyboard **ENTER** key or click **OK**.
6. Click the **Save** button. The calibration file is saved with the same name as the currently loaded configuration (CFA). WinDyn prompts with this information.

7. Click **OK**. If a calibration file already exists, a dialog box appears asking whether to overwrite the file. Always overwrite the file when a new calibration is created.
8. Click **Yes**. A dialog box appears stating **File received and saved OK**.
9. Click **OK**. The calibration is now complete.
10. Click **Done** to exit the calibration dialog box.

From the Handheld Controller

1. Press **Configure** (**I** key) followed by **Calibrate** (**B** key).
2. Press **Sensors** (**A** key), then press **Edit** (**C** key).
3. Select the Baro channel by pressing **Select** followed by **76** and **ENTER**.
4. Choose from the following options:
   - Press **Default** (**A**) to reset the calibration to the factory settings.
   - Press **Coef** (**D**) to view the calibration coefficient.
   - Press **Current Value** (**C**) to calibrate the channel.
     - Enter the correct barometric pressure value and press **ENTER** (**0**)
     - Verify that your entry was correct and, if so, press **Yes** (**A**).
     - Press **Exit** (the **E** key) twice.
5. If a computer is connected, answer **Yes** (**D**) to the **Save changes…** question.
6. Select **Exit** (**E**) to return to the **Start** menu.
7. The calibrated value should appear on the handheld and WinDyn displays. If it is not correct, check for a problem and try the calibration again.

10.2.4 Pressure Transducers

NOTE: *The standard configuration files were designed with the default CycleDyn pressure transducer configurations. If different sensor ranges are used, first change the configuration files using the DEF Configuration Editor before calibrating the sensors using the method described below.*

Pressure transducers normally use the calibration provided by the transducer manufacturer. This calibration is programmed in the DEF Configuration Editor program for each pressure channel and provides an accuracy of better than 1% of full scale. If you modify the channel definition for the transducer range or the units of measurement, you must adjust the calibration accordingly.

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 below, ***or*** you can default the calibration to the range defined in the channel definition.

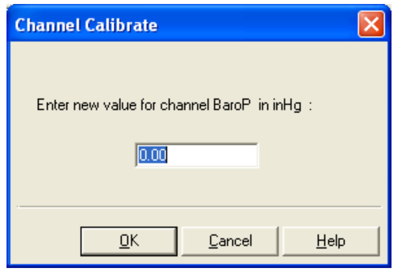
IMPORTANT: Any time you add a new transducer where one wasn't before or replace an existing transducer with one of a different range, you must generate new calibration.

From WinDyn

1. From the **WinDyn** main menu, select **System>>Calibrate** or press the letter **C**. The **Calibrate** dialog box appears.

2. Scroll down the list and find a channel to select. Click the channel to display a current reading.
3. With no pressure applied, click **Zero** to zero the pressure channel.
4. A **Confirm** dialog box appears. Click **OK**.
5. Apply a known pressure to the pressure sensor using a controlled (constant) pressure source. Measure this pressure with an accurate device.

6. Click **Calibrate**. A dialog box appears with the message **Enter new value for channel ____ in in/Hg**. The value displayed is the current reading based on the existing calibration.



7. Type the correct value in the text box.
8. Press the keyboard **ENTER** key or click **OK**.
9. Click the **Save** button. The calibration file is saved with the same name as the currently loaded configuration (CFA). WinDyn prompts with this information.
10. Click **OK**. If a calibration file already exists, a dialog box appears asking whether to overwrite the file. Always overwrite the file when a new calibration is created.
11. Click **Yes**. A dialog box appears stating **File received and saved OK**.
12. Click **OK**. The calibration is now complete.
13. Click **Done** to exit the calibration dialog box.

From the Handheld Controller

1. Zero the selected channel from the handheld controller:
   - Select **Autozero** (**F** key) followed by **Single channel** (**C** key)
   - Select channel by pressing **Select** followed by the channel number and **ENTER**
   - Press **Exit** (**E** key) to return to the main menu
2. Apply a known pressure to the pressure sensor using a controlled (constant) pressure source. Measure this pressure with an accurate device.
3. Select **Configure** (**I**), then **Calibrate** (**B**), then **Edit** (**C**).
4. Select the pressure channel to which the pressure is being applied.
5. Choose from the following options:
   - Press **Default** (**A**) to reset the calibration to the factory settings.
   - Press **Coef** (**D**) to view the calibration coefficient.
   - Press **Current Value** (**C**) to calibrate the channel.
     – Enter the correct barometric pressure value and press **ENTER** (**0**)
     – Verify that your entry was correct and, if so, press **Yes** (**A**).
     – Press **Exit** (the **E** key) twice.
6. If a computer is connected, answer **Yes** (**D**) to the **Save changes…** question.
7. Select **Exit** (**E**) to return to the **Start** menu.

10.2.5 Temperature Channels

The standard XConsole data acquisition uses type K thermocouples. The temperature channels do not normally require field calibration. If temperatures appear to be incorrect, compare the temperature readings of the XConsole to an accurate calibrated thermometer. If calibration is necessary:

1. Obtain an accurate thermocouple calibrator (this is an instrument capable of simulating the thermocouple sensor signal for a specific temperature).
2. Remove the thermocouple panel from the box, but keep the ribbon cable plugged into it.

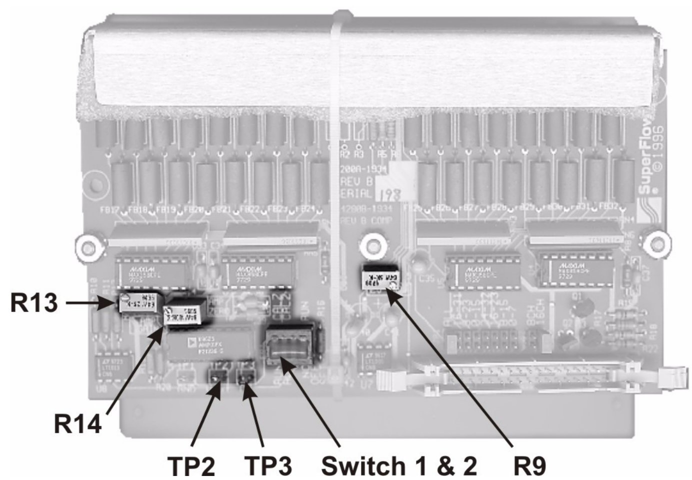


Figure 10-7. Thermocouple Panel Calibration Adjustments

3. Set switches **1** and **2** to the **CALZ** position
4. Using a precision Digital Multi Meter (DMM), measure amplifier output voltage between **TP2** and **TP3**. Adjust **R14** until the voltage reads zero.
5. Set the switches to **RUN**.
6. Set the thermocouple calibrator to room temperature, and plug it into one of the thermocouple inputs. Adjust **R9** until the temperature readout for this channel on the test console matches the temperature on the calibrator.
7. Set the thermocouple calibrator to 1800°F (US units) or to 1000°C (metric units). Adjust **R13** until the temperature readout for this channel on the test console matches the temperature on the calibrator.
8. Set the thermocouple calibrator back to room temperature and verify that the room temperature input reads correctly.

10.2.6 Air Temperature and Humidity

The air temperature and humidity sensors are built into a single probe. The sensors output a voltage which is converted in WinDyn to air temperature and humidity readings. If necessary, you can calibrate by adjusting the voltage output of each sensor using the Calibration menu.

Calibrate air temperature first because its reading is also used in the humidity calculation. Obtain an accurate air temperature reading from a thermometer or other temperature reading device located near the air temperature/humidity probe. Make sure you keep this device readily available for future use because it is now your reference device for calibrating your system.

At the same time obtain a relative humidity reading from an accurate source such as a hygrometer or psychrometer. Take the reading close to the air temperature/humidity probe. Again, keep this device available for future use.

Perform calibration from the computer using WinDyn or from the XConsole operator's panel. Use the same procedure as with the Barometric Pressure calibration. The air temperature sensor is channel number 1 (AirSen) and the humidity sensor is channel number is 6 (HumSen).

The value displayed as the current value is the voltage reading from the sensor. While monitoring the temperature or humidity readings on a WinDyn screen, change this voltage until the reading matches the source device reading. You may need to increase or decrease the voltage reading and may need to repeat the process several times to obtain the desired final result.

When calibration is complete, save a new calibration file.

10.2.7 Optical Tachometer

The optical tachometer does not require calibration.

10.2.8 Ignition Spark Pickup

The ignition spark pickup does not require calibration other than entering the correct number of pulses per revolution in the Specifications file.

For the ignition spark pickup, use Specifications channel 83. The default value is 0.5 pulse per revolution.

10.2.9 Air and Fuel Flow Sensors

Air turbines and fuel turbines are not normally used with chassis dynamometers; therefore, the default configurations do not include them. If adding air turbines, you must modify the configuration.

These turbines are individually calibrated and linearized at SuperFlow. The calibration is tracked by a serial number engraved on the side of the turbine.

The calibration values supplied with the turbine consist of a table with multiple points of frequency output verses a cfm or gph flow. The values are entered into an Interpolation table.

Contact SuperFlow Customer Service for assistance with adding air and fuel flow sensors to a chassis dynamometer system.

10.3 Service

10.3.1 Lubrication

***NOTE:** Roll bearings and absorber bearings which are subject to dusty or high-moisture environments should be maintained according to the more stringent schedule outlined below.*

The rollset and absorber bearings are pre-lubricated with grease but must be periodically re-lubricated. The manufacturer's recommendation is based on environmental conditions. The bearing operational temperature is from –20°F to +275°F. SuperFlow has observed normal operating temperatures of 130°F. The required re-lubrication cycle is dependent upon the operating conditions, speed, temperature, dust, moisture, and other environmental conditions. To prevent catastrophic bearing failures, you must follow the following lubrication guide:

Conditions	Minimum Re-lubrication Interval
Normal	Every 400 hours of operation or 6 months, whichever occurs first
High usage (more than 4 hours per day average)	Every 200 hours of operation or 3 months, whichever occurs first
Dusty environment	Every 200 hours of operation or 3 months, whichever occurs first
High-moisture environment	Every 200 hours of operation or 3 months, whichever occurs first

Use high-performance synthetic grease with an NLGI2 rating for all rotating bearings. Synthetic grease normally has a lower viscosity index (meaning it changes its properties less with temperature) so it works better for high dynamometer speeds.

Roll Bearings

Service roll bearings after 400 hours of operation or every 6 months, whichever comes first. For heavy usage (more than 4 hours of use per day), this should be every 200 hours or about 3 months. It is preferable to lubricate the system often with small amounts of grease rather than going for long periods and then lubricating heavily. Frequent, light lubrication prolongs bearing life.

Add grease slowly while the shaft is rotated, until a slight bead of grease forms at the seals. In harsh environments, re-lubricate as often as necessary to maintain a slight grease leakage at the seals. The quantity of lubrication for each pillow bearing is 0.40 ounces (an approximate equivalent volume is 1 inch x 1 inch x ¾ inch volume of grease) or one squirt from a hand pump.

CAUTION: Do not over-lubricate the bearings. This causes the bearings to run at too high an operating temperature and reduces bearing life.

Driveshaft U-joint

If the drive joint between the power absorber and the primary roll has grease fittings, lubricate it after every 400 hours of operation or every 6 months (more frequent for heavy usage). Lubricate with a lithium-based grease or the same grease used for the roll bearings.

Eddy Current Absorbers

The absorber bearings should be lubricated after every 400 hours of operation or six months (whichever comes first). For heavy usage or when the absorber is likely to get very hot in use (constant high speed or close proximity to hot areas), lubrication of the absorber bearings should be every 100 hours or once a month.

These instructions are in accordance with the manufacturer recommendations.

1. Lubricate the absorber with specially formulated grease for high heat application (EP-2) using a hand operated grease gun.

IMPORTANT: DO NOT use pressurized greasing systems which could damage grease seals in the retarder. Damage resulting from the use of pressurized lubricating systems is not covered by warranty.

2. Pump grease into the fitting until it comes out the vent fitting.

Load Cell (Strain Gauge)

If the load cell rod ends have grease fittings, lubricate them on the same schedule as the roll bearings with a lightweight Moly or Lithium-base grease.

10.3.2 Wheel Clamp Operation

Operation of the wheel clamp mechanism is as follows:

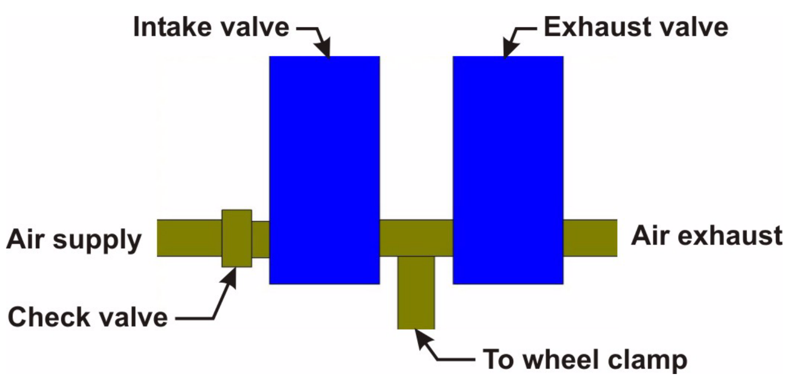


Figure 10-8. Wheel Clamp Air Valve Assembly

When the **Close Wheel** clamp button on the handheld is pressed, the intake valve solenoid is energized (opened) and the exhaust valve solenoid closes (de-energizes). This causes the air spring bag to fill and close the clamp.

When the **Open Wheel** clamp button on the handheld is pressed, the intake valve solenoid is de-energized (closed) and the exhaust valve solenoid opens (energizes). This releases air from the air spring bag and opens the clamp.

If the wheel clamp is closed and shop air is removed, the check valve will hold air in the system and keep the clamp closed. If power to the system is turned off, both valves will close, again keeping air in the system and the clamp closed. This only works if the system is airtight. Many units are not. For this reason SuperFlow does not advise leaving a vehicle on the unit if the vehicle is not strapped down.

10.3.3 Blower Maintenance

The CycleDyn blowers are installed and adjusted at the factory. It is very unlikely the drive belt will require adjusting unless it is removed. In that case, use the following procedure which assumes the dyno came with the blower assembly already installed and you only need to check and adjust belt tension.

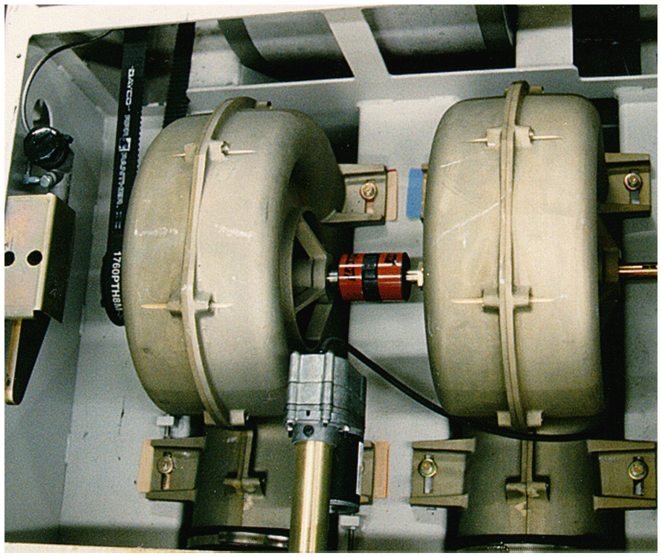


Figure 10-9. Dual Blower Assembly, Top View

10.3.3.1 Blower Bearings

No maintenance is required. The service life of the blower bearings was selected to cover the full average useful life of the dynamometer. To detect accidental damage, SuperFlow always recommends checking the bearings for noise or excessive resistance by spinning the shaft manually whenever the blower drive belt is removed.

10.3.3.2 Drive Belt Alignment

Visually inspect the belt for alignment whenever removing the cover for other service purposes. Rotate the roll and blowers and check for proper belt tracking. If the belt has a tendency to move toward the edge of a drive gear, you must realign the belt by adjusting the blower position in the frame. If you have the dual blower option, you must align the outer blower must with the inner blower after properly adjusting the belt drive system. It is best to move the outer blower until the spider coupling between the blowers slides freely over both shafts.

10.3.3.3 Checking Belt Tension

1. Remove the top cover from the chassis. This allows you to see the blower assembly and the belt drive.

NOTE: *You need a spring scale capable of measuring at least 25 lbs. of tension. These are found at most hardware stores or the fishing department of sporting goods stores.*

2. Attach the spring scale to the center of the toothed belt span, halfway between the drive pulley on the drum roll shaft and the pulley on the blower assembly.
3. Lay a straight edge along the belt from the drum roll pulley to the pulley on the blower assembly. Pull upward on the spring scale and apply tension as noted in Table 10-2. The belt should deflect 3/8" ±1/16" (0.373”). If it does not, adjust it.

Table 10-2. Blower Belt Tension

Blower	Tension		Deflection	Span Length
	Minimum	Maximum		
Single Blower	11.38 lbs	12.26 lbs	0.373 ±0.0625 in	23.87 in
Dual Blower	16.19 lbs	17.93 lbs	0.373 ±0.0625 in	23.87 in

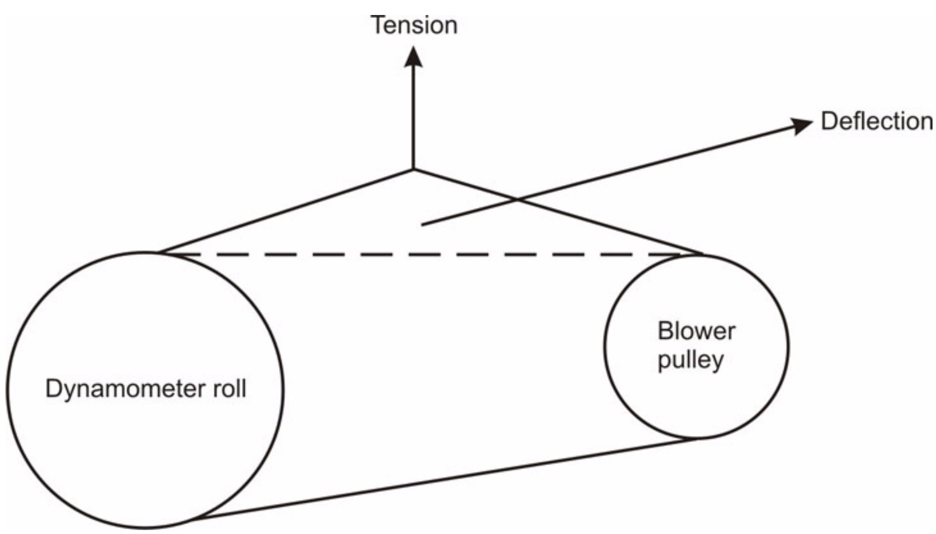


Figure 10-10. Blower Belt Tension

4. If tension is correct, reinstall the chassis top cover. The procedure is complete.

10.3.3.4 Drive Belt Adjustment Procedure

To adjust the belt tension: either adjust the drum roll fore/aft (minor adjustments), or adjust the blower assembly fore/aft (preferred method). Each choice has its pros and cons.

Drum Roll Adjustment Method

For minor tensioning of the blower belt, loosen the pillow block bearing mounting bolts on the drum roll shaft. Fore/aft adjustments allow movement of the drum to tension the belt.

Moving the drum subsequently causes the starter engagement mesh to change which could affect the starter's engagement. If that occurs, you can loosen the two bolts on the starter mounting bracket and then the adjust the starter up/down using an adjustment bolt for proper engagement.

You must also check clearance on the brake rotor/caliper assembly. The caliper assembly has no adjustments, so you may be limited on belt tensioning adjustment due to interference with the brake caliper.

Pros to this method: You do not affect the dual-blower center shaft coupling alignment which is very critical and difficult to measure. Also, fore/aft adjustment screws on both sides of the drum make it relatively easy to keep the drum aligned properly.

Cons to this method: Starter engagement can be very time consuming to adjust properly. Brake caliper mounting may restrict your ability to adjust belt tension to the correct specifications.

Blower Assembly Adjustment Method (Preferred Method)

For gross adjustment to blower belt tension, move the blower assembly fore/aft. On a single blower unit this is very simple because you have no center shaft coupling to contend with as you do with the dual-blower assembly.

To adjust belt tension, loosen the four blower assembly mounting bolts where the assembly mounts to the chassis. Then loosen the hose clamp coupling to the blower plenum hose. Then make fore and aft adjustment using bolts provided for that purpose on each side of the right-hand blower assembly. It is important to keep the belt pulley aligned so the belt does not walk off either pulley. Several adjustment iterations are necessary to verify tension and alignment. To check alignment, run the starter to spin the roll. Once tension is set, tighten the blower assembly mounting bolts; if you have a single blower unit, you are finished.

If you have a dual-blower assembly, next check the alignment of the center shafts and coupling to verify the left-hand blower is aligned correctly with the right-hand blower. You can do this using a straight edge.

- Remove three coupling guard screws and slide the cover to one side.
- Remove the elastomer band.
- Place a 4" straight edge across the two coupling halves in two positions, 90 degrees from one another.
- With the straight edge in place, try to place a 0.005" feeler gauge under the straight edge. Do this in both positions. If the feeler gauge will fit under the straight edge, you must make adjustments to the left-hand blower assembly fore/aft to eliminate the misalignment. If the 0.005" feeler gauge will not fit under the straight edge, no misalignment exists.

Pros to this method: Greater belt tensioning adjustment than with the drum roll. This is the preferred method to tension the belt.

Cons to this method: The biggest problem is adjusting the second blower for zero misalignment on the center shaft coupling. It is important to zero this alignment error.

10.3.4 Wheel Restraint Motor Replacement

Calibrating the Wheel Position Reading

1. Position the shaft 5 turns out from fully retracted.
2. Remove the position potentiometer from the gear.
3. Adjust the potentiometer for a 0% reading on the WinDyn wheel restraint position channel (WhlRst).
4. Re-install the potentiometer on the gear.

10.3.5 Handheld Screens and Computer Monitors

Always consult your computer monitor manufacturer's recommendations for use and cleaning instructions first.

Dirt, dust, and fingerprints can make displays difficult to read. Liquid Crystal Displays (LCDs) and computer monitors are not made of glass; therefore, do not use typical glass treatment agents, which have abrasive ingredients such as ammonia, on your LCDs or flat-screen monitor.

If you need to point out text or image details to others, be sure to never touch the screen. When possible, use a stylus or the mouse pointer. You may alternately add a screen protector over the surface which helps prevent accidental contact.

IMPORTANT: When cleaning the LCD screen or monitor, do not spray any liquids onto the LCD directly. Do not use paper towels or tissues because their texture can scratch the surface. Do not use ordinary household glass cleaner on computer monitor screens (especially cleaners with ammonia). They can remove anti-glare protection

LCD Screens

The SF-1853 handheld controller LCD screens can accumulate dirt and oil from fingertips.

To clean the LCD screen, use a soft cotton cloth. If a dry cloth does not completely clean the screen, you can apply rubbing alcohol to the cloth and wipe the screen with the damp cloth or use alcohol-based cleaning wipes.

Computer Monitors

Dust can quickly accumulate on computer monitor which can cause reading strain and distort clarity. Clean the monitor regularly as needed.

IMPORTANT: Flat-panel computer monitors are not designed for touch. Be careful when handling and cleaning your monitor. The tiny dots that make up images on the screen are separate transistors/crystals. Pressure can easily crack pixels which become black spots on the monitor when damaged. Pressing and poking with a dull object (including fingers) or a sharp object damages far more than one individual pixel. Extensive damage will obliterate entire areas of imaging.

1. Turn power off or unplug the monitor before cleaning.
2. Be sure to use the correct materials when dusting your monitor. Use a soft cloth such as soft, untreated eyeglass cloths or microfiber cleaning cloths. Make certain that any commercial computer monitor cleanser you purchase specifically states it is safe for cleaning computer monitors or screens. Some people make their own solution using 50% isopropyl alcohol and 50% distilled water (tap water can leave mineral spots).
3. Spray the cloth, not the monitor. Dampen the cloth slightly with the cleanser, then gently wipe your screen in a consistent motion, such as counterclockwise, rather than haphazard motions. Use cleaner sparingly.

TIP: *Placing a glare filter over your computer monitor provides added protection against dirt buildup and against damage from touching the monitor. Many types of filters are available.*

10.4 Troubleshooting the CycleDyn

Problem	Solution
The wheelbase adjustment actuator moves very slowly or jerks like the motor shuts on and off.	The battery is low or the drive circuits on the battery board have a problem.
The wheel base adjustment does not work.	• The 5A in-line fuse on the cable from the battery to the 0224 circuit board is blown. • Verify that the Molex connectors on the 0224 circuit board on installed correctly. • The 0224 PCB circuit has been damaged.
The wheel clamp does not operate.	• No air pressure. • Verify that the Molex connectors on the 0224 circuit board on installed correctly. • One or both air solenoid valves are defective.
The chassis has a clunking or banging noise as the roll decelerates.	Most likely the Love Joy coupling between the dual blowers is out of alignment. It is non-evasive and will not affect the dyno readings. Do not attempt adjusting or replacing the coupling because it could result in other problems with the blowers.
Overrunning blowers do not function.	Refer to Figure C-4, “CycleDyn Running Blower Wiring Diagram,” on page C-13.

10.5 Maintenance Log Sheets

Use the log sheets on the following pages for keeping a record of the maintenance performed on the system. Remove the originals from this manual and make copies for your use.

Monthly Maintenance Check List				
Component	What to do ...	Replace when/if ...	OK	Notes

Date:	Technician:

3-Month Maintenance Check List				
Component	What to do ...	Replace when/if ...	OK	Notes

Date:	Technician:

CHAPTER 11

CONTROL MODES

IN THIS CHAPTER

- Introduction
- Control Modes
  - Manual (Position) Control Mode
  - Servo Control Mode
- Digital Encoders
- PID Control Setup
- Control Mode Parameters
  - Actuator Phase
  - Controller Phase
  - Open and Close Rate
  - P-Gain
  - I-Gain
  - P-Threshold
  - I-Time
  - D-Gain
  - D-Time
  - Filter
  - Delay
- Adjusting Control Mode Parameters
- WinDyn Control File

11.1 Overview

This chapter defines the adjustable control parameters in WinDyn and provides suggestions for tuning the control parameters to provide the best combination for stable, accurate tracking and good step response to set point change.

Because the optimal set of control parameters may vary with engine types or vehicle types, it is useful for the operator to have a good general understanding of how to quickly and effectively tune the control parameters. However, keep in mind that no "auto-tuning" function is built into the software. The best way to tune is through sustained trial and error methods.

The SuperFlow chassis dynamometer systems use digital Proportional, Integral, and Derivative (PID) control parameters to provide electrical control signals to the eddy current absorber or AC motor. Default parameters are provided with the system to handle the majority of vehicle applications. You may adjust these parameters as necessary to adapt to a specific application.

Contact SuperFlow Customer Service for assistance.

11.2 Control Modes

A control mode refers to the output signal the system is controlling to. This could be the position of a load control valve or throttle actuator, or it could be measured dynamometer speed or torque. Even calculated values such as engine power can be used as a control mode.

The System Configuration Editor defines control modes. Up to five control modes are available for each controller. Up to four controllers are currently supported by the system—two primary and two secondary. Only the primary controllers are closed-loop controlled. However, any two of the four controllers can be selected as primary. When activating both primary controllers simultaneously, each must be assigned a different control mode (e.g., both throttle and load cannot control to dynamometer speed at the same time).

Typical combinations are:

- Throttle controlling ***torque*** and Dyno (servo valve) controlling ***speed***
- Throttle controlling ***speed*** and Dyno (servo valve) controlling ***torque***

In control theory, the following terms are commonly used:

- **Set point:** The value of the desired control through a channel to, for example, engine speed
- **Feedback signal:** The actual measured value of that channel
- **Error:** The difference between the set point and the feedback signal

The two general types of control modes are **manual** and **servo**. The control system software was designed to provide seamless mode switching. This means it is possible to switch from manual to servo control mode or from one servo control mode to another while the engine is running. The system will automatically determine the set point of the new control mode during the transition to avoid abrupt changes in load or throttle position. This is a very effective way to troubleshoot a control mode problem versus a water (or eddy current) system problem.

11.2.1 Manual (Position) Control Mode

Also called "open loop" control mode, this mode only sends a position signal to the corresponding actuator (the load controller or the throttle controller). It does not take the feedback signal into consideration and thus has no self-correcting effect. The manual (position) control mode is used whenever the control signal is only determined as a "% of full range" of the controller actuator.

With the dynamometer load controller in the manual control mode, the load on the dynamometer is determined by the position of the load control valve (or the electric current in the dynamometer eddy current coils). The operator determines a "% of load" value which sets the valve (or current) to a particular percentage of its full operating range. The resulting load on the dynamometer is purely a function of water flow through the valve (or current through the coils) at that position, which combines with the rotational speed of the absorber to create a resisting torque. The valve position (or electric current) is not affected by any feedback signals.

The % of load setting does not correspond to any specific torque value but rather to a torque curve as a function of speed. In this mode the operator can easily stall the engine by applying excessive load.

The manual mode is typically used for diagnostic purposes or to warm up the engine (this is only practical if the appropriate position is approximately known by experience).

If a throttle control option is installed, when it is in the manual control mode, the system will control the engine throttle to a given percentage (%) of full travel. No actual throttle position feedback is provided; the percentage of full travel indicated by the control system corresponds to the value at the throttle actuator, not the actual throttle position of the engine. If the linkage between the throttle actuator and the throttle valve is not adjusted properly for end stops and travel (or if it is nonlinear), it causes a difference between actuator position and actual throttle position.

11.2.2 Servo Control Mode

Also called "closed loop" control mode, this mode sends a position signal to the corresponding actuator (the load controller or the throttle controller), measures the resulting change in the controlled variable, calculates the error, and refines the position signal until the desired set point is reached and maintained. The servo control mode is used whenever the control signal is tied to a measured variable.

Speed Control Mode

This is the most common dynamometer control mode used during automated tests. Speed control mode is an excellent example of a closed-loop control system because the feedback signal and the error signal influence the control output. The load control valve or eddy current is controlled by the system to maintain a desired dynamometer speed (the set point). The load position will be modulated so the load applied by the absorber matches the speed output of the dynamometer to the desired operating point.

Speed control is used in all automated tests that step through the engine rpm band while recording data. Speed control can also be used to maintain the vehicle at a constant speed while the throttle is varied. However, if the throttle is not opened sufficiently for the vehicle to reach the desired set point, load control will never activate. Only when the vehicle speed is at or above the set point will the load controller start to vary the load on the dynamometer to bring the feedback signal to the set point. This means a transition phase usually occurs where the set point is exceeded before the feedback signal settles to the desired value. This is called "overshoot" and is a normal phenomenon. The control parameters can be adjusted for faster or slower system response and more or less overshoot.

A throttle controller can also be used in speed control mode. The throttle is then modulated to reach the desired dynamometer speed independently of the dynamometer load applied. This test mode can be used to simulate cruise control operation.

Torque Control Mode

This is the most common throttle control mode used during automated tests. The throttle actuator is controlled by the system to maintain a specific dynamometer torque (the set point). The throttle position modulates so the torque produced by the engine matches the set point. This typically results in torque control to better than ±1 lb•ft (N-m) of the set point.

A typical application for a combination of throttle controlling torque and load controlling speed is the mapping of an engine. By stepping through the torque range for each speed point, the complete engine map can be covered in the shortest possible time.

WARNING: Always turn the dynamometer load control on (in speed mode) before you switch the throttle to torque mode. If no load is applied by the dynamometer, the throttle controller will immediately open the throttle fully in an attempt to achieve the desired torque. This will result in an immediate engine overspeed condition.

The load (servo valve) controller can also be used in torque control mode. The dynamometer load then modulates to reach the desired torque independently of the throttle position. This test mode is used to apply a constant torque to accessory belts or chain drives.

Other Control Modes

Additional control modes may have been defined for systems used in special applications. It is also possible for dyno operators to define their own control modes. Examples are:

- Horsepower
- Throttle position
- Manifold (boost) pressure
- Engine speed (for engine dynamometers)

11.3 Selective Control

When system power is switched on, it defaults to the manual control mode (also called position control mode). The operator can then select servo control mode for either controller in any available control mode.

In each control mode, it is possible to modify the control output signal using the handheld controller. The ranges for each control mode of the encoder can also be changed to suit the user's needs.

The handheld controls allow continuous adjustment of the set point. Three sensitivity selections are available for each control mode (fine, medium, coarse). The sensitivity selection determines how many button pushes (or turns of the encoder knob on a wireless handheld) are required for a given set point change. The selection from coarse to medium changes the encoder sensitivity by a factor of 2. A change from coarse to fine changes the controller sensitivity by a factor of 10.

Figure 11-1. Handheld Controller

Example:

If the total control output range is 0–100, then each click stop on the encoder will change the set point output as a function of sensitivity selection:

Table 11-1. Control Step Values

Control Mode	Range	Coarse	Medium	Fine
Manual	100%	10%	5%	1%
VehSpd	200 mph	10 mph	5 mph	1 mph
VehTrq	2500 lb•ft	100 lb•ft	50 lb•ftt	10 lb•ft

11.4 PID Control Setup

The WinDyn control system requires operator interaction in two separate portions of the software. First you must assign and define the desired control channels in the WinDyn Configuration file (CFA). Then tune PID using the operator control console or handheld interface.

Current hardware limits the number of closed-loop control outputs to two controllers. Each controller is given a name in the configuration file. Typically, names such as Load, Servo, Dyno, or Throttle are used. However, you can change the name through the WinDyn Configuration file (CFA). Typically, if Load or Servo is selected, the dynamometer load will control vehicle speed or torque. If Throttle is selected, the engine throttle controls vehicle speed or torque. However, the naming of the controller in the software is arbitrary, so misnaming is very possible.

Each controller can be assigned up to five control channels. Any measured or calculated channel may be assigned as a control channel through the Configuration file (CFA). Typically, on chassis dynamometers, dyno speed in mph and a calculated wheel torque is used. On an engine dyno, engine speed in rpm and measured engine torque is used. After assigning a channel, you must allocate minimum and maximum values to the channel to enable the control outputs.

11.5 Control Mode Parameters

SuperFlow systems utilize a Proportional, Integral, and Derivative (PID) gain method, hence the term PID control. SuperFlow provides each system with an initial set of optimized control mode parameters to provide adequate control for a wide variety of testing applications. The parameters are:

- Actuator phase
- Controller phase
- Open rate
- Close rate
- P-Gain
- I-Gain
- I-Threshold
- I-Time
- D-Gain
- D-Time
- Filter
- Delay

11.5.1 Actuator Phase

The actuator phase (allowed values: 0 or 1) determines the actuator direction of travel as a response to the controller output signal. A "1" inverts the signal. If the actuator phase is 0, the actuator goes from 0 to 100% when the controller output signal goes from 0 to 100%. If the actuator phase is 1, the actuator goes from 100 to 0% when the controller output signal goes from 0 to 100%. The actuator phase must be correctly selected to properly drive the control mechanism on the dyno system.

Table 11-2. Actuator Phase

Actuator Type	Actuator Phase	0%	100%
Throttle	0	Idle	WOT
Eddy current	0	No load	Full load
Control valve on water brake outlet	1	No load	Full load
Control valve on water brake inlet	0	No load	Full load

Examples

- **Throttle Control with Electric Actuator**

  If the actuator phase is 0, and the manual throttle position control is varied from 0 to 100% on the controller, the throttle actuator will move the throttle from fully closed (idle) to fully opened (WOT) position.

  If the actuator phase is 1, and the manual throttle position control is varied from 0 to 100% on the controller, the throttle actuator will move the throttle from fully opened (WOT) to fully closed (idle) position.

  The throttle controller typically requires an actuator phase of 0.

  In some situations, such as when the throttle actuator is mounted on the reverse side of the throttle lever, the actuator phase will be 1. Take care in these situations because the throttle actuator will be at its 100% position for engine idle. When power is turned off, the throttle actuator will return to its 0% position, or WOT, on the engine.

- **Eddy Current Dynamometer Load Control**

  If the actuator phase is 0, and the manual load control is varied from 0 to 100% on the controller, the coil excitation current will increase from 0 to 100% and the dynamometer load will increase from zero load to full load.

  If the actuator phase is 1, and the manual load control is varied from 0 to 100% on the controller, the coil excitation current will decrease from 100 to 0% and the dynamometer load will decrease from full load to zero load.

  Eddy current dynamometer load controllers typically require an actuator phase of 0.

- **SuperFlow Water Brake Load Control**

  The SuperFlow water brake is an outlet-controlled device. If the actuator phase is 0 and the manual load control is varied from 0 to 100% on the controller, the servo valve position will change from 100% (fully closed) to 0% (fully open), and the dynamometer load will decrease from full load to no load.

  If the actuator phase is 1, and the manual load control is varied from 0 to 100% on the controller, the servo valve position will change from 0% (fully open) to 100% (fully closed), and the dynamometer load will increase from no load to full load.

  Water brake dynamometers with the load controller on the outlet typically require an actuator phase of 1. The phase will be 0 when the load controller is on the inlet.

11.5.2 Controller Phase

The controller phase (allowed values: 0 or 1) determines closed-loop control polarity, i.e., the direction of movement of the controller output as a response to a change in the feedback signal (the controlled parameter). If the controller phase is 1, when the feedback signal increases, the controller output signal will increase. If the controller phase is 0, when the feedback signal increases the controller output signal will decrease.

NOTE: *The actuator phase must be properly determined before the controller phase is set because the actuator phase also has an impact on the aggregate polarity of the closed-loop control system.*

Example 1:

A typical throttle actuator controlling to ***engine speed*** (with **actuator** phase = 0):

If the **controller** phase is 1 and measured engine speed increases, the controller output will increase, and the throttle actuator will open the throttle more, allowing the speed to increase further still.

If the **controller** phase is 0 and measured engine speed increases, the controller output will decrease, and the throttle actuator will close the throttle more, maintaining the desired engine speed.

In this application, the **controller** phase should be **0**.

Example 2:

A typical throttle actuator controlling to ***engine torque*** (with **actuator** phase = 0):

If the **controller** phase is 1 and measured engine torque increases, the controller output will increase, and the throttle actuator will open the throttle more, allowing the torque to increase further still.

If the **controller** phase is 0 and measured engine torque increases, the controller output will decrease, and the throttle actuator will close the throttle more, maintaining the desired torque.

In this application, the **controller** phase should be **0**.

Example 3:

An Eddy current dynamometer controlling ***engine speed*** (with **actuator** phase = 0):

If the **controller** phase is 1 and measured engine speed increases, the controller output will increase, and the load will increase, maintaining the desired speed.

If the **controller** phase is 0 and measured engine speed increases, the controller output will decrease, and the load will decrease, allowing the speed to increase even more.

In this application, the **controller** phase should be **1**.

Example 4:

An Eddy current dynamometer controlling ***engine torque*** (with **actuator** phase = 0):

If the **controller** phase is 1 and measured engine or roll torque increases, the controller output will increase, and the load will increase, allowing the torque to increase even more.

If the **controller** phase is 0 and measured engine or roll torque increases, the controller output will decrease, and the load will decrease, maintaining the desired torque.

In this application, the **controller** phase should be **0**.

Example 5:

A SuperFlow water brake controlling to ***engine speed*** (with **actuator** phase = 1):

If the **controller** phase is 1 and measured engine speed increases, the controller output will increase, and the load will increase, maintaining the desired speed.

If the **controller** phase is 0 and measured engine speed increases, the controller output will decrease, and the load will decrease, allowing the speed to increase even more.

In this application, the **controller** phase should be **1**.

Example 6:

A SuperFlow water brake controlling to engine torque (with **actuator** phase = 1):

If the **controller** phase is 1 and measured engine torque increases, the controller output will increase, and the load will increase, allowing the torque to increase even more.

If the **controller** phase is 0 and measured engine torque increases, the controller output will decrease, and the load will decrease, maintaining the desired torque.

In this application, the **controller** phase should be **0**.

Table 11-3. Controller Phase

Control Device	Actuator Phase	Control Channel	Controller Phase
Throttle	0	Engine Speed	0
	0	Engine Torque	0
Eddy Current	0	Engine or Roll Speed	1
	0	Engine or Roll Torque	0
Servo Valve	1	Engine Speed	1
	1	Engine Torque	0

11.5.3 Open and Close Rate

Allowed Values: 0–7

These parameters apply a filter to the control system output signal to the control mechanism. Suggested values: 0 (they are not generally used on anything except diesel engine dynos)

What it Does

The Open and Close Rate parameters provide the capability to control the valve open-versus-close rate to compensate for a controller that acts differently while opening versus closing (unloading versus loading). Because nearly all SuperFlow systems have these parameters set to zero, this feature is not currently used.

11.5.4 P-Gain

$P_{term} = (Error * P_{gain\_value} * Phase)$ ***where Phase = ±1***

Allowed values: Any floating point value

Suggested Value Range

- 0.4 to 2 for engine dynos controlling to engine speed
- 350 to 450 for CycleDyn controlling to vehicle speed
- 500 to 600 for AutoDyn controlling to vehicle speed

What it Does

Proportional Gain determines how rapidly error influences the control to the dyno or to the throttle. The P-Gain is proportional to the difference between the desired set point valve and the actual current value. Its effect is greatest when the actual reading is far away from the set point. If the P-Gain is too high, the system could overshoot the set point. The system shows instability by oscillating (alternately overshooting and undershooting the set point) or surging. The oscillation (or surging) may slowly subside over time. If the P-Gain is too low, the system will never be within the range where the I-Gain will start working (I-Gain threshold). Consequently, the set point is never reached. When setting up the control system, it is better to start on the low side (enter smaller gain numbers) and then increase the values slowly.

Suggested Adjustment Technique

First adjust the P-Gain parameter. When initially adjusting the P-Gain, SuperFlow recommends setting all other parameters to 0. With the I-Gain at zero, the system will never reach its set point, but the control channel (engine speed, throttle, vehicle speed, etc.) will move toward the set point. The purpose of adjusting the P-Gain with the other parameters at zero is to adjust the P-Gain so the system reacts reasonably quickly without exhibiting instability. Observe the (engine or wheel) speed and the control valve position indicator (where available) while the system is seeking the set point. Note how quickly the controller responds and whether it overshoots and undershoots as it seeks to control to the set point.

The control system will not pull the engine (or wheel speed) all the way down to the selected speed because the I-Gain and I-Threshold are not set up yet. On an engine dynamometer, the engine speed may stabilize at 300 to 500 rpm above the set point.

Try a minimal value of P-Gain. Successively double it until step response improves. If you notice high frequency (1-10 Hz) steady-state instability as a result of increasing P-Gain, use half the current value of P-Gain. Since P-Gain may have other undesired effects on step response, use the minimal amount necessary to improve step response.

Check for stability at a minimum of four different speed set points. If the system surges for 30 seconds or less and then settles down, that’s okay. This is corrected when D-Gain is adjusted.

11.5.5 I-Gain

I_{term} = (Error * I_{gain_value})
Allowed values: any floating point value

Suggested Value Range

- 0.01 to 0.08 for engine dynos
- 0.01 to 1 for CycleDyn controlling to vehicle speed
- 0 to 2 for AutoDyn controlling to vehicle speed
- Suggested setup prior to adjustment: 0.01

What it Does

The purpose of the integrator is to integrate the error to zero. The I-Gain (Integrator Gain) keeps increasing controller output until the desired set point is reached. It sets the gain applied to the integrated error and controls how fast the system responds to set point changes. This process is much like the operator of a manual dyno who observes the current speed and keeps adding load, a little at a time, until the set point is reached. It helps minimize time-average deadband errors. If the I-Gain is too low, the engine or vehicle speed will take a long time to achieve its set point. If the I-Gain is too high, the system may overshoot excessively and take a long time to settle down or may never stabilize at the set point.

Suggested Adjustment Technique

Start with the minimal suggested value of I-Gain. Increase I-Gain by successively doubling it until the rise time of the closed-loop step response of speed or torque is approximately 1 to 3 seconds. Since the I-term is an integrated value, integrator wind-up can occur if the I-term is "turned on" over too wide a bandwidth. The I-Threshold parameter is used to adjust this bandwidth and prevent the integration from creating too much gain due to a large error signal. The I-Time parameter allows the system to integrate the error signal over a longer period of time to create a smoother gain signal. You could use this parameter to force the system to smooth through a random, erratic change in the error signal.

Usually it is easiest to start the PID adjustment with the integrator turned off (value = 0). After refining the P- and D-Term, the system should respond properly and stabilize properly. However, it may not actually reach the desired set point.

11.5.6 I-Threshold

Allowed values: Any floating point value

This value is associated with the control channel, i.e., rpm or mph.

Determines bandwidth for integration of the error signal.

Suggested Value Range

- At least large enough to capture the control channel offset due to the P-Term for engine dynos (usually around 1000 rpm or less)
- At least large enough to capture the control channel offset due to the P-Term for chassis dynos controlling to vehicle speed (usually 5-10 mph)
- Suggested setup prior to adjustment: must be some value other than zero, as a zero will turn off the integrator completely.

What it Does

The I-Threshold parameter specifies the range from the set point where the I-Gain will function. For example, with an I-Threshold of 300 rpm and a set point of 1500 rpm, the I-Gain would be active from 1200 to 1800 rpm (the magnitude of the error must be 300). Further, if the P-Gain does not bring the speed within this range, the I-Gain will not become active and the speed will never reach the set point. In other words, the Integrator Threshold determines the window within which the Integrator takes effect. This means the I-Term will only become operational when the actual value enters a window of "set point ± I-Threshold."

The integrator should take effect when the P-term and the D-term lower the error term as much as possible. This is very useful for limiting the integrator output while the control system is in a major transitional phase, i.e., a transition from no load to the first set point. Furthermore, if the I-Threshold were set to zero, then in essence, the integrator would always be turned off.

The integrator term tends to slow down the system response by stabilizing the control algorithm as the set point approaches. On systems with lots of system inertia (slower response) such as a chassis dynamometer, the integrator should only become active when the control channel value is relatively close to the desired set point.

Suggested Adjustment Technique

To set the I-Threshold, observe the difference between set point and engine/vehicle speed during the above P-Gain adjustment. Double this rpm (or mph) value and enter it as the I-Threshold. This is not a critical adjustment; if this number is too small, all that happens is the engine does not load down the final portion of the way to the desired rpm, and the system will never reach its set point.

11.5.7 I-Time

Allowed Values: 0–256

Determines the number of control system cyclic loops to use to determine the I-Term.

Suggested Value Range

Typically a 0 or low value (less than 10) for all system types.

Increasing the value will cause the I-Term to delay its effect.

Suggested Setup Prior to Adjustment: 0

What it Does

The I-Time parameter determines the time base within which the error integrates. It is used to define the rate in which the integrator is processed. This time determines how often the integrator is operated during the controller update. For example, a setting of 5 would cause the integrator to be updated every 5th time. This parameter is used to slow down the integrator. The wider this time base, the slower the system response will be, making the system more stable but also increasing overcompensation of the error. On systems with lots of system inertia (= slower response) such as chassis dynamometer, the integrator should work within a fairly narrow time band.

11.5.8 D-Gain

$$D_{term} = ((Error_{Current} - Error_{A\_While\_Ago}) * D_{gain\_value})$$

Allowed values: Any floating point value

Suggested Value Range

- 4 to 20 for engine dynos controlling to engine speed
- 0.025 to 5000 for a CycleDyn controlling to vehicle speed
- 0 to 5000 for an AutoDyn controlling to vehicle speed

Suggested Setup Prior to Adjustment

- Engine Dyno controlling to engine speed D-Gain = 1
- Chassis Dyno controlling vehicle speed D-Gain = 5000
- Chassis Dyno controlling roll torque D-Gain = 0.01

What it Does

The D-Gain helps stabilize the control channel to the set point. It helps reduce the ringing, oscillations and instability associated with high P-Gain and high I-Gain. The D-Gain is proportional to the rate of change of the engine rpm or wheel speed. The D-Gain determines to what extent error rate of change influences control to the dyno or to the throttle. If the D-Gain is too low, the control system will have excessive overshoot and will surge for a long time before settling down. If D-Gain is too high, the system will take too long to reach the set point and may be oversensitive to changing speed, thus making the system unstable.

Suggested Adjustment Technique

Use the minimum D-Gain possible to reach an acceptable reduction in ringing. Gradually increase D-gain to damp oscillations and reduce overshoot. With a smaller I-Gain, the overshoot of the set point will be minimal and can possibly can be eliminated. To check the D-Gain adjustment, set the engine speed to midrange, then set the engine speed 100 rpm higher (or set the wheel speed 5 mph higher). Check for surging, overshoot, and ringing at the control valve position indicator (for a water brake).

11.5.9 D-Time

Allowed Values: 0-256

Determines the number of control system cyclic loops to use to determine the D-Term (effectively creates a cumulative error based on control system cyclic time).

Suggested Value Range

Typically a 0 or low value (less than 10) for all system types.

Increasing the value will cause the D-Term to delay its effect.

Suggested Setup Prior to Adjustment: 0

What it Does

The D-Time parameter is used to control the size of the window over which the derivative is measured. Since increasing or decreasing the window size also adjusts the resolution and scale of the measurement, the D-Time cannot be adjusted without also affecting the D-Gain.

11.5.10 Filter

Allowed values: 0–7

Suggested Value Range: Usually set to zero

What it Does

This term is the filter rate applied to the feedback signal. If the feedback signal in the control loop is noisy, set this value fairly high. However, the filter adds delay to the feedback, so it will slow down the system response. The filter algorithm is the same as those used for the Open and Close rate parameters. The larger the number, the more filtering and delay.

Suggested Adjustment Technique

Leave the filter at zero unless a noise problem is apparent and cannot be corrected. In that case, start with the lowest filter value for that channel and gradually increase the filter until the problem does not affect control stability. The step response performance may be affected.

11.5.11 Delay

Allowed Values: Any integer value

Suggested Value Range: Usually set to zero

What it Does

This term applies a delay to the controller output signal. It provides a method in which a delay can be introduced between the control system and the actual output of the control valve. In essence, this parameter indicates the number of passes (cycles) that will occur through the control system before the controller output signal will be updated.

Suggested Adjustment Technique

Leave the delay at zero for most applications. If you want to delay controller response to smooth through sudden changes in the device under control, then increase the delay value until the control system responds smoothly.

11.6 Adjusting Control Mode Parameters

It is useful to set up two speed set points or two torque set points that the operator may manually toggle between to observe closed-loop system step response for the purpose of tuning the control parameters. Determine these set points to prevent the engine from reaching excessive speed and to ensure the engine throttle remains above idle.

It is helpful to create a strip chart display object on a WinDyn screen to allow real-time observation of the control system while performing adjustments. WinDyn uses the channels named SETPT1 and SETPT2 as its control channels. By displaying either of these channels and the desired control channel on a strip chart at the same time, you can observe control system response in real time.

It is best to tune by individually adjusting the control parameters in each of the control loop modes. If you encounter a problem while running dual-mode, closed-loop control, the easiest approach is to go back and individually tune each of the two single-mode control loops that would otherwise be operating simultaneously.

For best results, in engine dynamometer applications, SuperFlow recommends using the load controller to control the engine rpm. The engine controller (throttle) can be used in throttle position (manual mode) or to control the engine torque (close-loop mode). In chassis dynamometer applications, SuperFlow recommends using the absorber unit to control the vehicle speed.

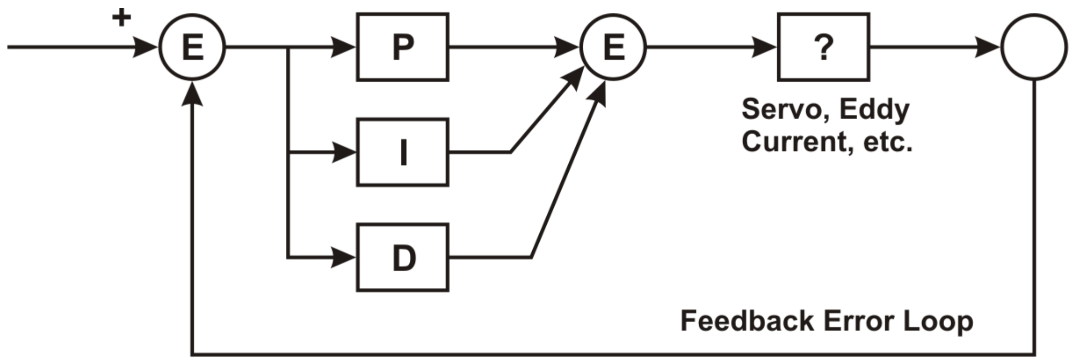


Figure 11-2. Closed-Loop Control

The SuperFlow control system functions shown in Figure 11-3 produces a cumulative gain (P+I+D) to the control mechanism based on the error signal feedback. The control systems cycle at a 400-hz (2.5-ms) rate.

This PID adjustment procedure assumes the test system and engine/vehicle are operating properly and that the electrical or hydraulic supply to the test system is sufficient.

On the SuperFlow water brake it is necessary to determine whether the boost valve will be used and the position of the capacity valve before making any adjustments on the control parameters.

Parameters not listed in this section are best left at the original value or zero.

Preliminary Steps

1. Turn off the I-Gain and the D-Gain by setting them to zero.
2. Start with a P-Gain term at the lower end of the suggested value range for your system.

Begin Adjustment

1. Successively double P-Gain until you reach satisfactory step response. If the P-Gain results in continuous high-frequency, steady-state instability, lower it by half again.
2. Gradually increase P-Gain until instability reappears, then lower it by 20%.
3. Start with a D-Gain term at the lower end of the suggested value range for your system. Gradually increase D-Gain (in small increments) until the overshoot is acceptable and steady-state stability is good.
4. Note the difference between the set point and the actual value. Add 50% to this difference. Set the I-threshold at this calculated number.
5. Start with an I-Gain term at the lower end of the suggested value range for your system. Successively double I-Gain until the system settles onto the set point within 3–5 seconds. If instability occurs, lower I-Gain by half again.
6. Gradually increase I-Gain until instability reappears, then lower it by 20%.
7. Continue adjustment until satisfied. You may need to alter the other parameters (I-Time, D-Time, Filter, Delay, etc.) to achieve reach exact response desired.

Figure 11-3 illustrates the influence of various parameters on the system response. The (exaggerated) example shows the effect of entering a new set point (of 2500 rpm) for engine speed on the actual system response.

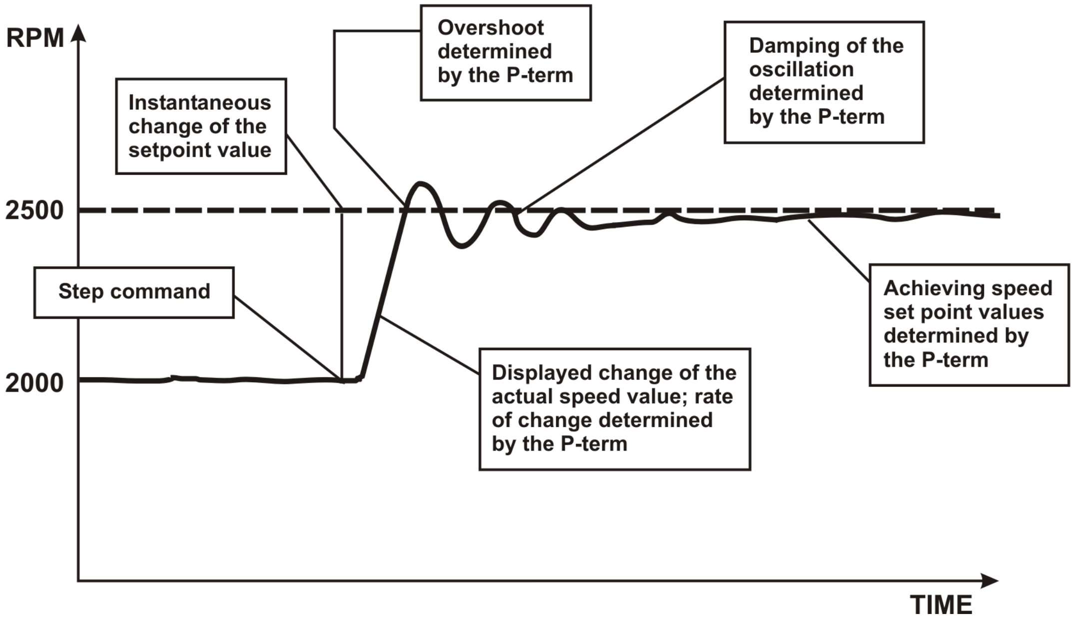


Figure 11-3. System Response Parameters

11.7 WinDyn Control File

The control parameter information is stored in a file with a *.CCP file name. When a CCP file is saved from the handheld controller or console it is always saved to a file with the same name as the currently installed configuration file but with a CCP extension. The existing file is overwritten without warning.

To save a CCP file to a different or new file name, from the WinDyn main menu, select **System>>Save>> Control Parameters**. A dialog box appears where you can select or enter the name of the file to save the current control parameters to.

You may load control parameters using the WinDyn Test Group function if the file is designated when designing the test group.

APPENDIX A

OPTIONS AND ACCESSORIES

IN THIS APPENDIX

- Engine Speed Sensors
  - Ignition-based Sensors
  - Optical Sensor
- Wheel Speed Optical Sensor
- Auxiliary Roll (ATV Roll)
- High-speed Blower Option
- Cool-down Blower Option
- Wheel Restraint Extension Kit
  - Installation
  - Operation

A.1 Engine Speed Sensors

Engine speed information is only required to calculate the torque values used in the data readouts Wheel power and all the corrected power calculations are unaffected by engine speed readings or lack thereof. The only real reason to use engine speed on a chassis dynamometer is to correlate the power and torque against engine rpm.

To use engine speed in the data analysis, you must install an engine speed sensor. SuperFlow supplies three ignition-based engine speed sensors and one optical sensor for the CycleDyn as standard.

All engine speed sensors plug into the green LEMO connector on the sensor box system connection panel labeled **Engine Speed**. The connection is keyed so no other cable can be used for that connection.

For detailed information on engine speed, see Section 6.9, “Obtaining Engine Speed on a Chassis Dyno,” on page 6-13.

To Engine Speed Sensor

Figure A-1. Engine Speed Connection

A.1.1 Ignition-based Sensors

NOTE: *Ignition systems using solid core spark plug wiring and/or non-resistive spark plugs produce high levels of electrical interference. On these systems it may be impossible to obtain a good engine speed signal. If problems persist despite trying the different clips, replace the wires and/or spark plugs by resistive (noise-suppressed) parts to perform the test.*

Engine speed is generally derived from the number of pulses received by a sensor per second and converted to revolutions per minute (rpm). The pulse-per-revolution factor is adjusted through the Pul/Rv channel (pulses per revolution) in the WinDyn specifications. You can use WinDyn or the handheld controller to set the pulses/rev. Typically, this setting is 0.5, 1.0, or 2.0 on most engines.

A.1.1.1 SF-2445 Spark Probe Assembly

The 1200A-2445 spark probe assembly is designed to plug into any SuperFlow NGE-based sensor box with an engine speed connector. The sensor can measure engine speed with an array of signal input sensors by analyzing both the energy and frequency of the input signal when making decisions on the real spark signal. The output of the SF-2445 is a simple TTL frequency, which when processed by the data acquisition system is converted to an engine rpm readout.

The spark probe assembly contains:

- Sensor interconnect enclosure with mode select switch and LEMO cable
- One inductive spark clip assembly (part number 1200A-2443)
- One capacitive spark clip assembly (part number 1200A-2444)

The SF-2445 can be programmed for several different modes to handle most engine speed situations. Input signal sources can vary from spark plugs, fuel injectors, tachometers, and alternators. Signal detection and conditioning is done automatically to provide the correct frequency to the data acquisition system. To convert to rpm in WinDyn, first set a ratio of pulses-to-engine revolutions, then multiply the frequency of the pulses from the sensor (in Hertz) by that ratio.

Features

- Motorola-based Central Processing Unit (CPU)
- Input signal
  - 1–100,000 Hertz
  - 0.5–100 Volts
- Output signal
  - 3.3V TTL pulse frequency
- Frequency and amplitude signal conditioning
- Handles both single and wasted spark ignition systems
- Operates on 8–20 VDC power provided by the data acquisition system
- Easily upgradable with new features as they become available
- SF-2444 spark clip assembly
  - Compact antenna/capacitive type probe
  - Clips onto any wire (spark plug, injector, ECM, etc.)
- SF-2443 inductive spark clamp assembly
  - Small and compact design
  - Clamps onto any wire (spark plug, injector, ECM, etc.)

Connection

[

1. Select the desired type of signal input device (inductive clamp, capacitive clip, etc.) and connect it to the signal conditioner.
2. Attach the clamp or clip to a spark plug wire or other engine speed signal source.
3. Plug the green LEMO cable to the engine speed (channel 11) connector on the sensor box.
4. Select the desired mode on the selector switch (currently only Mode 0 is available).

Pulses per Revolution

Engine revolutions per minute (rpm) is derived from the number of pulses received from the probe per second and converted to revolutions per minute in the data acquisition processor by a pulses-to-revolution ratio. The ratio is entered with the **Pul/Rv** or **SparkP** channel in the WinDyn specifications file. You can set the pulses/rev ratio on the WinDyn Test Setup screen or with the handheld controller. Typically, this setting is 0.5, 1.0, or 2.0 depending on the number of cylinders on the engine.

Alternative Signal Sources

The SF-2445 can also detect the speed signal from a spark ignition's primary (12-volt) circuit or from a fuel injection wire.

To sense speed from a primary ignition circuit, place the inductive clamp onto the +12-volt wire that supplies power to the ignition unit. Use this method when the spark plug wires are not easily accessible. This setup can also be used to limit the amount of interference the spark noise may have on system operation when using very-high-energy ignition systems that emit large amounts of electromagnetic energy.

To connect to a fuel injection wire, the probe must be inserted between the two wires of an injector. Placing the probe around both wires will only cancel the signal.

Service

No maintenance or service is required on the SF-2445 other than to keep it clean and safe from damage.

Use the form on the following page to submit comments or issues with the SF-2445 spark probe assembly. Fill out the form with as much detail as possible. Fax the form to (719) 578-1792, or scan it and e-mail to **service@superflow.com**.

Contact SuperFlow Customer Service at **service@superflow.com** or call 719-471-2972 with any comments or questions.

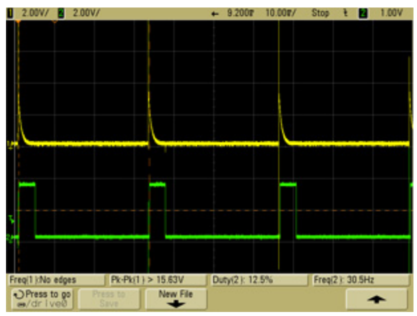
SF-2445 Spark Probe Problem Report Procedure

Overall Goal: Report information issues about the SF-2445 assembly

Step 1. SF-2636 Scope Data Collection

Using an oscilloscope (the USB style will work):

- Probe 1 (top – yellow): SF-2636 test point TP9 is the input signal from the probe
- Probe 2 (bottom – green): SF-2636 test point TP11 is the signal pass to the sensor box



Spark Signal Capture Example (3,600 rpm)

NOTE: *Step 1 data collection shows what part of the system is the cause of the problem. The data collected will help the SF-2445 development.*

Step 2. Service Technician: ______________________________ Date:______________

Testing Description

Ignition Description

Problem Description

A.1.1.2 Inductive Clip

The 1200A-2450 dual spark probe assembly is designed to plug into any SuperFlow NGE-based sensor box with a spark engine speed connector. The spark probe assembly contains:

- One inductive spark clip assembly (part number 1200A-2449)
- One spark sensor assembly (spark-sensitivity adjustment control box and sensor cable, part number 1200A-2451)

Figure A-2. Inductive Speed Sensor

This probe is an inductive pickup with adjustable gain. It may be used on a spark plug wire, coil wire, fuel injection wire, or almost any pulsing electrical signal wire that has a relationship to engine speed.

- The control box on the spark sensor assembly contains a special circuit to isolate and detect spark signals. It has a 10-position (0–9) push-button switch and two twist-lock connectors the spark clip assembly attaches to. The switch is used to adjust the spark clip's sensitivity.
- The sensitivity (gain) is variable from 0–9 (0 is the least amount of sensitivity and 9 is the most). Always try your first attempt with the gain set at 5, then work from there to clean up a bad signal. Dropouts require more gain; spikes require less. Do not rely on a good signal at idle as the correct gain setting to use for the dyno test. Typically, the gain used for good idle rpm does not work well for the loaded full throttle test. Ignition pulses are usually stronger at idle than under load; thus, a setting that works for idle rpm results in loss of signal during an actual test (due to insufficient gain).
- This pickup is polarity sensitive, so you may need to turn over the clamp on the signal wire to get it to work properly. Most ignitions with two plugs and one coil fire one plug positive and one plug negative. This means there is no way to initially tell which way to orient the clamp for best response.
- The clamp must remain completely closed during a test or else the signal will be lost. Use a rubber band to hold it closed.
- The pickup does not work well on low-voltage pulses (under 5 VDC) if used on a primary coil wire.
- The inductive pickup can also receive unwanted ignition noise from adjacent cylinder spark plugs and their wires. Try to isolate the pickup from adjacent wires if possible.

A second pickup may be attached to the control box to enhance the strength of weak signals or to cancel out a wasted spark pulse. We have used this successfully on multiple-cylinder engines where a single probe set on the highest gain setting continues to get signal dropouts.

Since the pickup may work on low-voltage wires (~8-16VDC), you may be able to obtain a signal using a fuel injection wire or ignition primary wire. Another option is to install a “test loop” by replacing the ignition fuse with a loop of appropriately sized wire and clamping over that loop. You must change the pulses per rev if you use this method.

If connecting this style pickup on late-model production vehicles, you may not have a spark plug wire to connect to. In that case you can improvise: remove the coil-over-cap connection, fabricate a plug wire to extend to the plug, and connect the coil-over-cap connection to the other end of the fabricated plug wire extension. Then place the inductive pickup around the extension. We have also used this pickup successfully on injector wires and the primary coil wires if they are accessible and produce a strong enough signal.

Adjusting the Spark Sensitivity

Because of the wide variety of ignition systems currently in use, it is necessary to adjust the sensitivity of the spark clip's sensor for best performance. Some ignition systems generate a stronger spark signal than others. The control box contains a push-button adjustment switch to adjust the spark signal to a level usable by the SuperFlow data acquisition system. With the adjustment switch, the probe can:

- Amplify a weak spark signal
- Limit the amount of noise present in the spark signal that may be misinterpreted by the system as a weak spark signal

In some ignition systems, the amount of noise emitted from an adjacent spark plug wire may be stronger than the spark signal emitted in a quiet ignition system. In most cases, a setting near the middle (4 or 5) provides satisfactory results. If you suspect the spark probe assembly is picking up noise from one or more adjacent spark plug wires, adjust the sensitivity to a smaller number. If the spark signal is dropping out completely, adjust the sensitivity to a larger number.

Always set the gain at 5 on the first attempt and then work from there to clean up a bad signal. Drop-outs require more gain; spikes require less. Do not rely on a good signal at idle as the correct gain setting to use for the dyno test. Typically, the gain used for good idle rpm does not work well for the loaded full-throttle test.

Using Two Spark Clips

One inductive spark clip is included with each spark probe assembly. The spark clip assemblies are interchangeable and can be connected to either twist lock connector on the spark sensor assembly control box.

To purchase additional clips, call SuperFlow Customer Service at (800) 471-7701.

The black connectors on the end of each spark clip assembly are identical. When using two spark clip assemblies, each connector on the end of the spark clip assembly will plug into either twist-lock connector on the control box. Likewise, each spark clip assembly can be used independently in a single spark clip system and can be plugged into to either twist-lock connector.

Why Use Two Spark Clips? In most cases, only one spark clip is required to detect a strong engine-speed signal. However, two spark clips are sometimes required to measure the speed of engines with a wasted-spark ignition. If a single spark clip does not produce a reliable signal, using two spark clips may provide a better speed signal. In general, the only two situations where two spark clips may be needed are:

- When testing a wasted-spark ignition system
- When a single spark clip does not produce a reliable signal

Wasted-spark Ignition Systems

In wasted-spark ignition systems, a spark is produced with every rotation of the crankshaft—in other words, a spark is produced on the exhaust stroke and on the compression stroke. The spark produced on the exhaust stroke is wasted.

Because the wasted spark occurs during the exhaust stroke, a number of conditions exist in the cylinder when the spark occurs, resulting in a wide range of spark signals. Depending on the ignition system being tested, the signal detected during an exhaust spark can be as large as the signal detected during a compression spark or too small to be detected by the sensor at all.

In the wasted spark ignition system (Figure A-3), one coil provides a spark to two cylinders.

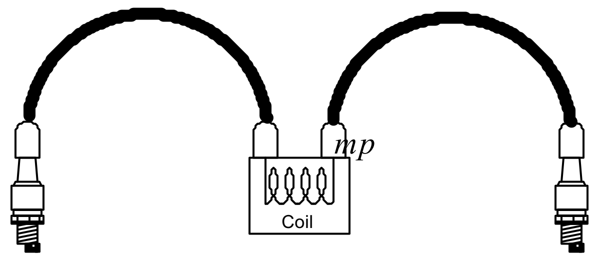


Figure A-3. Wasted Spark Connection

To detect a signal in a wasted-spark ignition system, it is necessary to connect two spark clips to the spark sensor assembly—one spark clip fastens to each spark plug wire coming from the ignition coil. A special circuit inside the control box combines the two signals and sends a single resulting signal back to the SuperFlow sensor box.

Figure A-4 shows the proper way to orient the spark clips relative to each other in a wasted-spark system. It is not important which direction the current flows through the spark clips. However, the electrical current flowing through each spark plug wire must flow through each spark clip in the same direction. If either spark clip is reversed, the detected signal will be weak and erratic.

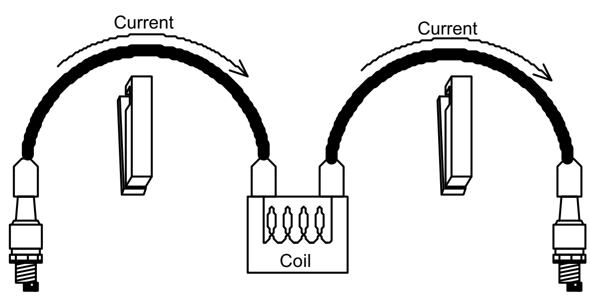


Figure A-4. Connecting Two Spark Clips

If the spark signal seems erratic, reverse the position of one of the spark clips. If the signal improves, leave the reversed spark clip in its new position.

Alternative Signal Sources

The spark clip can also detect the speed signal from a spark ignition's primary (12-volt) circuit or from a fuel-injection wire.

To sense speed from a primary ignition circuit, clamp one spark clip onto the 12-volt wire that supplies power to the ignition unit. Use this method when the spark plug wires are not easily accessible. This setup can also be used to limit the amount of interference the spark noise may have on system operation when using very-high-energy ignition systems that emit large amounts of electromagnetic energy.

To connect to a fuel injection wire, the probe must be inserted between the two wires of an injector. Placing the probe around both wires only cancels the signal.

Troubleshooting the Spark Clip

If you have difficulty obtaining a reliable speed signal using the spark clip, use the following table to help you solve the problem:

Problem	Possible Cause	Solution
Speed signal drops out	• Control box sensitivity is set too low • Spark clip jaws are not closing completely • Ignition is wasted-spark type	• Increase sensitivity • Make sure the spark clip jaws are clean and close with no gap (use rubber bands or tape if necessary) • Use two spark clip assemblies
Speed signal is erratic	• Control box sensitivity is set too high • Ignition signal is very noisy	• Decrease sensitivity • Locate all cables as far as possible away from ignition components

A.1.1.3 Direct Coil Pickup

P/N 1200A-1939 (with cable assembly 1200A-2261)

The coil pickup is used to detect the signal directly at the coil. It consists of a pair of alligator clips and processing electronics. It works on standard or capacitive discharge ignition systems. This is a very sound way to measure engine speed, but it is often difficult to reach the coil(s). Most motorcycle coils are hidden under the fuel tank or buried deep in the frame. Some vehicles have the coil built into the distributor or spark plug housing.

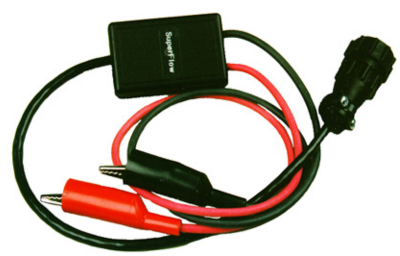


Figure A-5. Direct Coil Pickup

To use the direct-coil pickup, connect its clips directly to the primary wires +/– on an ignition coil. Although the pickup implies correct polarity by the red and black lead colors, it may work better with the leads reversed. A green LED flashing on the device will confirm a good signal is present.

A.1.1.4 Tach Wire Pickup

P/N 1200A-2188 (with cable assembly 1200A-2448)

This pickup may be directly connected to any pulsing signal source with an amplitude of 5 to 16 volts. For instance, if the vehicle has an ignition module with a electronic (not spark pulse) tachometer output tap, you can connect the positive lead of this pickup to the signal source and the other lead to chassis ground.

Figure A-6. Direct Tach Connection

When using this method, adjust the pulse-per-revolution factor through the **Pul/Rv** in the WinDyn specifications. For Pul/Rv tach output factors, you may need to consult the ignition module manufacturer's documentation. In the event no documentation is available, adjust the factor until the WinDyn engine speed display matches the vehicle's tachometer reading (on some ignitions, the tach may need disconnecting to obtain a signal for WinDyn).

Because this sensor is connected directly between the vehicle and the data acquisition system input, it is very important that a good earth ground connection exists on the vehicle. Otherwise, this sensor provides an excellent path for static discharge. Isolation circuits are built into the other ignition sensors.

A.1.2 Optical Sensor

IFR Optical Tach, P/N 1200A-0642-1 (with cable assembly 1200A-2448-1)

This sensor can measure the rpm of any rotating object on the test vehicle by reading its reflected beam from a piece of reflective tape you attach to the rotating object. It works quite well as long as a rotating object associated with engine speed is available on the engine or drivetrain. This method of obtaining engine speed is often preferred, since it is generally not susceptible to noise interference.

Figure A-7. Optical Speed Sensor

WARNING: Always turn power off to the sensor box prior to connecting or disconnecting the optical sensor to prevent damage to the sensor or to the data acquisition electronics.

IMPORTANT: This sensor is also used for detecting a speed signal from sources other than the engine—most commonly off a tire or driveshaft—and used to detect slippage (see Section A.2, “Wheel Speed Optical Sensor,” on page A-13). When used for engine speed, always use the green LEMO 1200A-2448-1 cable and the Engine Speed port on the sensor box interconnect panel—not the yellow LEMO, Tach/Freq.

Other than keeping the optics of the sensor clean, no maintenance is required on the optical tachometer.

The optical tachometer comes with a magnetic base and a roll of reflective tape. Place a single piece of tape on the rotating part, and position the sensor so the infrared light reflects off the tape. Using more than one piece of tape means spacing each piece exactly at equal distance on the rotating part, or the system will not interpret the signal correctly. The sensor will work up to about 4-6 feet away from the reflective surface.

TIP: *Many engine compartments are primarily lined with plastic, so a metal surface for the magnetic base is difficult to find. For these situations, a small metal plate (such as a metal light switch cover) can be fastened to an appropriate place in the engine compartment.*

If using the harmonic balancer on the engine or any other rotating device attached directly to the crankshaft, the direct readout from the optical tach will be in engine revolutions per second. Thus, the ratio of frequency to engine speed is 1.000 and the **RpmRat** specification channel is set accordingly.

However, if you are using a pulley on the engine running at a different ratio than crankshaft speed, you must enter that ratio into the **RpmRat** specification channel. The ratio is used to convert the optical tach frequency from pulley revolutions per second to engine revolutions per minute.

If you are using the optical sensor on the vehicle rear wheel assembly or driveshaft, you'll need to know the correct ratio between the wheel and the engine. Several specification channels are provided (**EngRat**, **TrnRat**, and **DrvRat**) to enter specific ratio values which are then used to calculate an overall ratio in channel **OvrRat**. If you know the overall ratio for the gear you are testing in, enter it into the **RpmRat** channel. If you know the individual ratios, enter them into the drivetrain ratio channels leaving any that don’t apply to 1.000. Then take the value from the **OvrRat** channel and enter it into the **RpmRat** channel.

If you are attempting to obtain engine speed from the wheel or driveshaft, keep in mind this method does not work with vehicles equipped with an automatic transmission. Nor can you obtain an accurate rpm reading if you change transmission gears during the test or CVT.

TIP: *The **ENG_SPD** test profile provides an easy and automatic way of calculating the **RpmRat** channel value. Run the test and follow the instructions. After determining the correct value, SuperFlow suggests saving a setup file for that vehicle to expedite setup for future tests.*

Any loss of signal results in erratic behavior. We have found the system needs several revolutions of the reflective surface before the signal will stabilize. As with the ignition pickups, some issues are associated with using the optical tach pickups:

- It does not take much to trigger the sensor, but sometimes a larger reflective surface will help to ensure a good signal. If possible, join small pieces of the reflective tape together to make a 1-inch-by-1-inch square to ensure no loss of signal. Observe sensor or vehicle movement during the test to see if that is causing loss of signal (the aiming point is changing).
- When mounted close (less than 12 inches) to the reflective tape, the signal will sometimes increase (randomly) by a factor of ~10 (2500 now equals 25000). We don't know why, but this has become apparent when using the device for engine speed off pulleys or harmonic balancers on an engine. To alleviate the problem, aim the sensor so it contacts the reflective surface at a slight angle instead of directly (90 degrees) at the reflective tape. Or move the sensor farther away from the reflective surface.
- Erratic signal may also be related to vibration, where mounting the sensor on a surface off the vehicle or dyno solves the problem. Unfortunately, when using it for engine speed inside the engine compartment, this can be difficult to do.
- When using the device on the engine pulleys or harmonic balancer, the line of sight to the reflective surface must not become impaired when the engine moves under torque. It may take several positioning alignments to get the reflective surface to stay in line when the engine is under load vice simply idling.
- The signal is infrared. The sensor saturates in direct or even indirect sunlight. Shadow tubes don’t help. You simply cannot use the device outdoors. The sensor also doesn't work well in incandescent lighting. The same frequency that saturates it in sunlight is also present with incandescent lighting.
- Aluminized tape won't work. However, shiny surfaces near the sensor such as chrome parts can affect the reading.
- The unit is affected by RFI and other electronic noise. We’ve also seen it go crazy when rev limiters are hit. The sensor cable can act as an antenna and couples noise interference into the sensor box electronics. When this happens, try isolating the cable away from the engine.

A.2 Wheel Speed Optical Sensor

IFR Optical Tach, P/N 1200A-0642-1 (with cable assembly 1200A-2272 cable)

The same optical sensor used for engine speed (Figure A-7 on page A-11) can be used measure the rear wheel speed independently of roll speed. Wheel slip can then be calculated and displayed.

With the optical tachometer properly set up, it displays real tire slip during testing. Knowing this can be critical as excessive tire slip can result in apparent power losses on the dynamometer.

Place the magnetic base on the dynamometer platform with the sensor at a distance of 8″ to 25″ (20 to 65 cm) from the rear wheel. Attach one piece of reflective tape to the rim or tire, and aim the optical tachometer to this piece. Shield the tape from bright ambient light.

TIP: *Vibration affects the unit. Sometimes you cannot achieve a good signal when it is sitting on the dynamometer chassis. Move it off the dyno onto a stool, jack stand, etc., and you may get a stable signal. Bear in mind, if the vehicle wheel is severely out of balance, it may be causing you signal loss.*

See Section 8.2, “Tire-Roll Interface,” on page 8-5 for information on the tire-to-roll relationship and how it affects power measurements.

WARNING: Always turn power off to the sensor box prior to connecting or disconnecting the optical sensor to prevent damage to the sensor or to the data acquisition electronics.

Plug the optical tachometer cable into the 1200A-2272 extension cable. Then plug the yellow LEMO connector into the yellow receptacle labeled **Tach/Freq** on the sensor box system interconnect panel (Figure A-8). Be sure to turn the power OFF before plugging in the connector. Power the sensor box on, and start WinDyn on the computer.

Rotate the wheel slowly back and forth, or run the vehicle in low gear at a slow speed. The LED indicator on the optical tachometer should light up when the tape is in view. Using the LED as the reference, adjust the position of the optical tachometer until it sees the tape for each pass.

Figure A-8. Optical Tach Connection

Accurate wheel speed measurement with the optical tachometer requires the effective rolling diameter of the tire entered into the system. A specification channel (**TirDia**) is provided for this purpose. Measuring the diameter with a tape measure does not provide the rolling diameter because the effective rolling diameter of the tire on the dynamometer roll is approximately 1″ (2.5 cm) less than the measured outside diameter of the tire on a flat surface. Therefore, the tire diameter must be measured electronically and entered into the specification channel.

Manually Entering the Tire Diameter

Select a WinDyn display screen showing wheel slip (**WhlSlp**). This screen should also show tire diameter (**TirDia**), wheel speed from the optical tachometer (**WhlSpd**), and roll speed (**Speed**).

Enter the estimated tire diameter before proceeding. You can access the TirDia specification channel through the WinDyn Test Setup dialog box or through the Specifications configuration menu on the handheld.

See Section 6.6, "Basic Steps to Running the CycleDyn," on page 6-7 for information on the Test Setup feature and "Specifications" on page 7-14 for details on using the handheld controller.

Start the vehicle and bring it to a constant speed at about 60 mph (100 kph) or somewhere in the middle range of the vehicle. Do not accelerate, and do not apply any absorber load, but hold the speed constant with the throttle. After a few seconds, the roll speed should match the wheel speed. Verify the wheel slip reading. Ideally, it should be zero.

- If the wheel slip is positive, the wheel speed reading exceeds the roll speed. Decrease the tire diameter in the TirDia Specifications channel until you obtain a near-zero slip reading of less than ±0.5%.
- If the wheel slip is negative, the roll speed exceeds the wheel speed reading. Increase the diameter in the TirDia Specifications channel until you obtain a near-zero slip reading of less than ±0.5%.

TIP: *You can quickly determine the correction required by multiplying the percentage of wheel slip displayed by the tire diameter value in the TirDia specifications channel.*

When the final tire diameter is known, save the specifications file for future reference.

Using a Scripted Test

The **TIR_DIA** test profile provides an easy and automatic way of calculating the tire diameter and setting the specification channel value. Run the test and follow the instructions. When the correct value is determined, SuperFlow suggests saving a specification file for that vehicle to expedite setup for future tests.

A.3 Auxiliary Roll (ATV Roll)

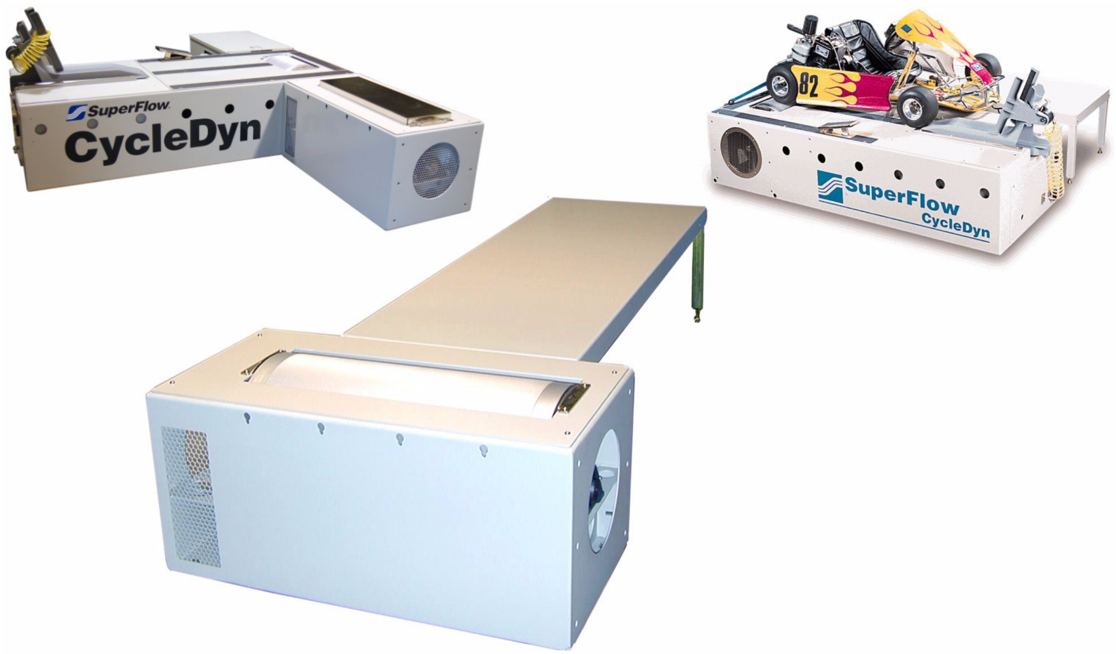


Figure A-9. Auxiliary Roll with Platform

You can attach the auxiliary roll to the main frame of the CycleDyn dynamometer. This roll allows testing of three- or four-wheel vehicles commonly found in motorcycle dealerships and workshops such as ATVs, karts, legend cars, and dwarf cars. A matching platform to support the left front wheel of the ATV is also available.

It is possible to use the auxiliary roll and platform by themselves as a simple stand-alone package for a Junior Dragster dynamometer. A small, bolt-on eddy current absorber package is available on special demand. Contact your SuperFlow Sales representative for details.

Specifications

- **Roll length:** 28″ (71 cm)
- **Roll diameter:** 19.875″ (50.5 cm)
- **Module dimensions:** 40″L x 22.75″W x 20.25″H (102 x 58 x 51 cm)
- **Module weight:** 425 lbs. (194 kg)
- **Minimum inside track dimension:** 18″ (46 cm)
- **Maximum outside track dimension:** 62″ (157 cm)
- **Maximum weight on roll:** 1,000 lbs. (455 kg)
- **Auxiliary platform size:**
  - **Standard Quad:** 28″ x 62.75″ (71 x 160 cm)
  - **Legend Deck:** 28″ x 82.75″ (71 x 210 cm)
- **Auxiliary platform maximum weight capability:** 700 lbs. (320 kg)

Installation

WARNING: The auxiliary roll weights about 700 lbs. (320 kg) and is very heavy. Use appropriate lifting means.

The auxiliary roll is preferably installed on the left side of the main frame to maintain sufficient access to the roll brake pedal when running.

1. Install the universal joint on the main roll shaft. Make sure the key is installed between the slots in the shaft and the universal joint. Do not tighten the setscrew.

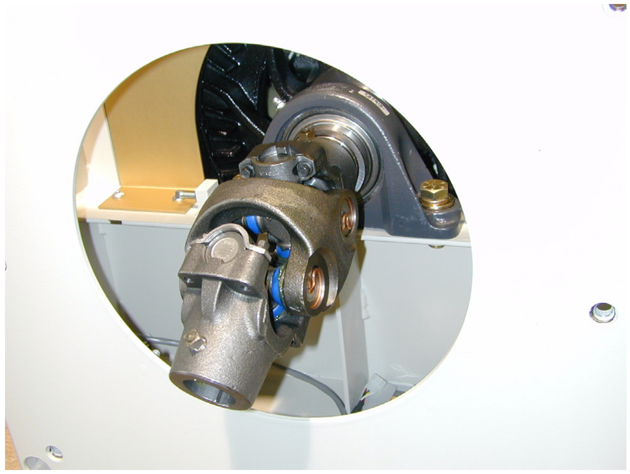


Figure A-10. Coupler on Main Shaft

2. Move the auxiliary roll module into position and start sliding the other end of the universal joint onto the auxiliary roll shaft. Make sure a key is installed between the slots in the shaft and the universal joint.

Figure A-11. Aligning the Coupler

3. Install the six ½ -13 bolts between the auxiliary roll and the dynamometer frame and tighten to 65 lb•ft to bring the module together with the main frame.

4. Check that the universal joint assembly has some end-float. Tighten the set-screws on each end of the universal joint to 30 lb•ft.
5. Verify that both rolls now rotate smoothly together.

The auxiliary roll is now permanently connected to the main roll and will rotate whenever the main roll is driven. Dynamometer operation is identical with or without the auxiliary roll.

WARNING: Vehicle tie-downs must prevent front-to-back and lateral movement of the vehicle at all times. When a motorcycle is tested on the dynamometer, access to the auxiliary roll must be blocked.

Configuration

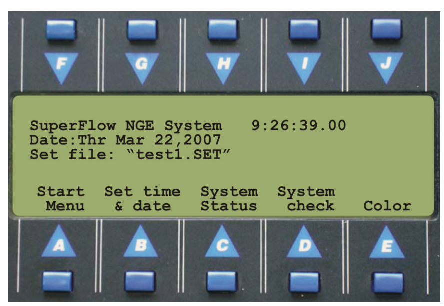
After the roll is mechanically connected to the CycleDyn dynamometer (or if it is being removed), it is necessary to configure the data acquisition system electronics for the additional hardware. This way the electronics consider the additional inertia (equivalent vehicle weight) and parasitic losses of the auxiliary roll.

If the rollset is a new addition to an existing system, contact SuperFlow Customer Service for assistance in entering the rollset and parasitic loss values into your system configuration.

The data acquisition system contains a hidden menu where users can select the options installed on their system. To access this menu and select the auxiliary roll, follow these steps:

WARNING: The configuration you are about to perform will have a significant impact on the operation and measurement results of your CycleDyn. If you have any doubts while performing these steps or if you accidentally go into other areas of the configuration screens, press EXIT until you return to the Start Menu, and contact your Service representative for step-by-step assistance.

1. Turn the CycleDyn sensor box off, wait for 5 seconds, and turn it back on.
2. The system power-up menu appears on the handheld controller (see image at right).



3. If you do not see this screen, press the red **Stop** key (**hand** symbol) on the handheld controller and press the soft key sequence **F, A,D, E**. This takes you to the power-up screen.
4. Now press the soft key sequence **G, I, F, J**. The **System Configuration** screen appears.
5. Select **Change Options** (**A**)
6. Use the **Prev.** (**A**) and **Next** (**B**) keys to position the blinking cursor next to the **Auxiliary Roll #1** selection (**Auxiliary roll #2** if you are installing a second auxiliary roll). Use the **Toggle** (**C**) key to check this option.
7. Press **Exit** (**E**), **Save Settings** (**D**), and **Exit** (**E**) again.
8. Press **Yes** to reset the system and return to the system power-up menu.
9. Observe screen 2 on WinDyn for the new system inertia value. Record this number for future reference.

Installing the Auxiliary Platform

If you have the auxiliary platform, position it in front of the auxiliary roll. The platform is supported by two legs on the front and attaches to four keyholes in the auxiliary roll at the rear. Because the keyholes are evenly spaced, it is possible to attach the platform in the best location for your application.

Service

The auxiliary roll uses the same bearings as the main roll.

> Refer to Section 10.3.1, “Lubrication,” on page 10-19 for details on bearing lubrication. No other maintenance is required.

A.4 High-speed Blower Option

The high speed blower option consists of single or dual blowers belt-driven from the main dynamometer roll. The blower option is typically installed at the factory and requires careful alignment and calibration. If adding this option to an existing system, you must send the base enclosure to SuperFlow.

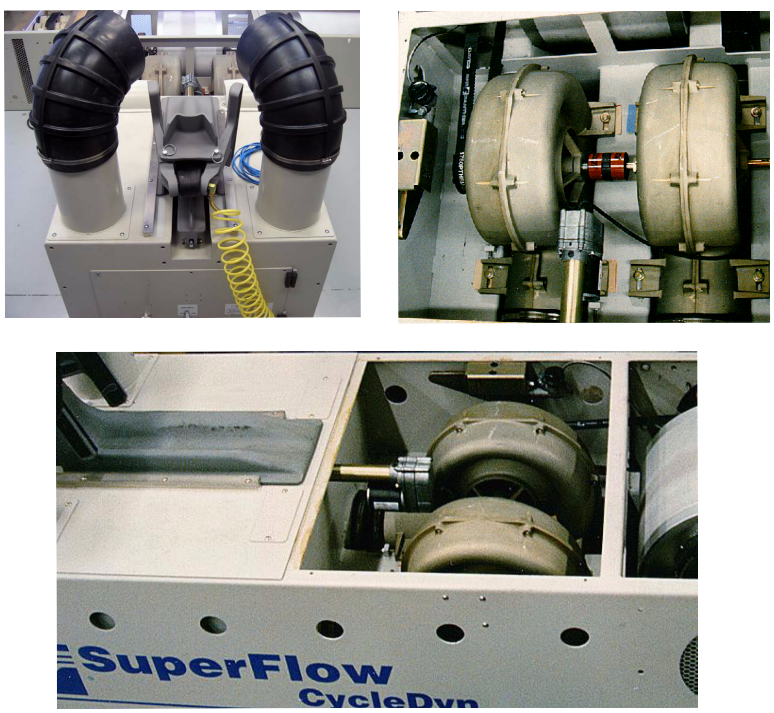


Figure A-12. Dual High-speed Blowers

The blowers are designed to produce airflow of approximately road speed through two circular orifices of 8” (20 cm) diameter in the front of the CycleDyn along with some cooling air to the exhaust system.

- With dual blowers, air speed is proportional to roll speed up to approximately 180 mph (300 km/h) through an area of 100 in^2 (650 cm^2).
- The power absorbed by the blower(s) is individually recorded as a function of roll speed and calibrated up to 200 mph (320 km/h) for each system. The CycleDyn automatically compensates for the power losses to the blowers. The correction is continuously adjusted for air density.
- For a given air pressure in the main plenum and small back-pressure changes, air velocity is inversely proportional to duct size.

Installation

Parts

Part	Description	Qty
Elbow	8” pipe	2 ea.
Tube	Flanged air duct	2 ea.
Tube	Slider air duct	2 ea.
Hose	8”	2 ea.
Hose clamps		6 ea.

1. Remove the covers from the access holes at the front corners of the base enclosure.
2. Install the flange piping over the access holes using the same bolts from the covers.
3. Use the piping, tubes, and hose to position the ducts in the desired location.
4. Secure with hose clamps.

Operation

WARNING: Before first use, it is important to thoroughly vacuum the area under the CycleDyn and the front plenum in the main dynamometer frame to prevent dust or debris projection that can damage the blower turbines.

The blowers produce air at very high speed. The inlet air reaches the blowers though the bottom and side of the dynamometer. Dust or debris in the area may be sucked up and thrown at high velocity to the motorcycle or the operator. The CycleDyn is equipped with a debris screen which stops debris larger than 0.5″ (1.3 cm) only. Smaller particles may still be projected and cause a safety hazard.

It is important to:

- Keep the dynamometer area clean.
- Wear eye protection at all times when testing.
- Always use air filters for the engine air inlet, particularly when directing the airstream into ram air systems.
- Verify proper fastening of any ducts and covers before testing. Loose parts could be projected because of the air pressure.

The blowers pressurize the main plenum in the front of the CycleDyn (this is the compartment accessed through the front door). From the main plenum, air exits through two round 8″ (20 cm) orifices in the front of the plenum. These are used for engine cooling and ram air supply. Install ducting as required.

NOTE: *SuperFlow does not supply ducts as standard. Basic duct adapters are available as an option.*

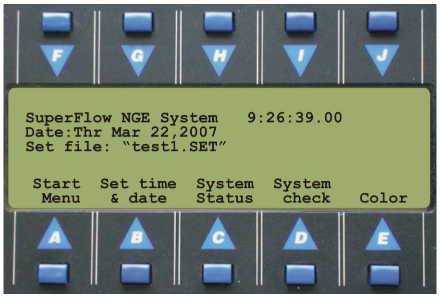
Configuration

If the blowers are disconnected from the primary roll (or if they are re-connected), you must configure the data acquisition system electronics for the additional hardware. This way the electronics consider the additional inertia (equivalent vehicle weight) of the bowlers.

The data acquisition system contains a hidden menu where users can select the options installed on their system. To access this menu and select the auxiliary roll, follow these steps:

WARNING: The configuration you are about to perform will have a significant impact on the operation and measurement results of your CycleDyn. If you have any doubts while performing these steps or if you accidentally get into other areas of the configuration screens, press Exit until you return to the Start Menu and contact your Service representative for step-by-step assistance.

1. Turn the CycleDyn sensor box off, wait for 5 seconds, and turn it back on.
2. The system power-up menu appears on the handheld controller (see image at right).



3. If you do not see this screen, press the red **Stop** key (**hand** symbol) on the handheld controller and press the soft key sequence **F, A,D, E**. This takes you to the power-up screen.
4. Now press the soft key sequence **G, I, F, J**. The **System Configuration** screen appears.
5. Select **Change Options** (**A**).
6. Use the **Prev.** (**A**) and **Next** (**B**) keys to position the blinking cursor next to the **single blower** or **dual blower** selection depending on your configuration. Use the **Toggle** (**C**) key to check this option.
7. Press **Exit** (**E**), **Save Settings** (**D**), and **Exit** (**E**) again.
8. Press **Yes** to reset the system and return to the system power-up menu.

A.5 Cool-down Blower Option

The cool-down blower (or overrunning blower) is an add-on option for the single- or dual-blower modules. An internal AC Motor attached to the blower turbine(s) keeps the blowers operating when the primary roll has stopped to provide continued airflow over the motorcycle for engine cooling. A clutch mechanism detaches the motor when it is not running.

The electric motor automatically activates when the motorcycle speed exceeds and then drops below a pre-set amount and runs for a predetermined length of time. You can manually turn it off using a WinDyn push-button switch display set to control Digital Output #7 or by running the **Fan_off** test profile.

No service is required other than checking and adjusting the belt tension.

For more information, refer to Figure C-4, “CycleDyn Running Blower Wiring Diagram,” on page C-13.

A.6 Wheel Restraint Extension Kit

The front wheel restraint extension kit was designed for dragster bikes and custom bikes with extended front forks. It extends the front restraint an additional 20″ (51 cm) or 36″ (91 cm) depending on which option is selected.

- 1200A-0251-20 accommodates wheel bases from 66″ (168 cm) to 104″ (264 cm).
- 1200A-0251-36 accommodates wheel bases from 66″ (168 cm) to 120″ (305 cm).

Both kits include extension platforms, actuator rod extension, rail covers, and longer guide rails.

Figure A-13. Wheelbase Extension

A.6.1 Installation

Refer to figure Figure A-15 for an illustration of the wheel base extension. The drawing is specific for the 36” extension but applies to the 20” kit as well.

1. If adding the extension kit to an existing system, remove the wheel restraint, the short extension bar, the rail assembly, and the cover plate.
   - The wheel restraint is secured to the actuator arm extension with a ½” bolt or clevis pin. After removing the bolt or pin, pull the wheel restraint toward the front, and it will slide out of the rail assembly. Set it aside. There should be enough air line to allow the assembly to stay connected. If not, disconnect the air line.
   - After removing the restraint, slide the Way Cover Plate out (the bright silver piece that covers the trough behind the wheel restraint). This part id replaced with a longer one.
   - If installed, remove the short extension arm (save the bolt and nut—they will be used later).
   - Remove the 8 button-head bolts that secure the rail assembly to the top deck of the dyno and remove all the pieces. These parts are all replaced.
2. Bolt the deck extensions onto the front of the dyno using the 3/8-16 x 1 Hex Head bolts (see Figure A-13). Note the left and right side extensions and be certain to put them on correctly.
3. Refer to Figures Figure A-14. and Figure A-15. to see how the rail is assembled. The parts are identical between left and right, but position them so the bolt holes are closer toward the outside of the dynamometer frame.
   - The thin plastic sheets (#8) go on first (2 on each side)
   - Then the wide plastic rail (#7)
   - Then the narrow metal rail (#4)
   - Then the narrow plastic rail (#6)
   - Finally, cap it off with the wide metal rail (#5).

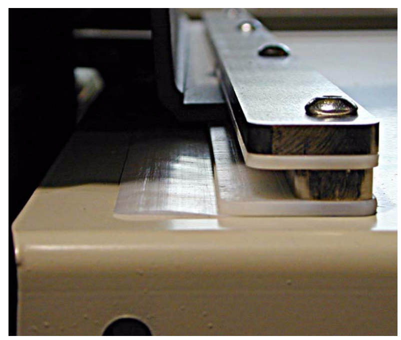


Figure A-14. Slide Restraint Rail Detail

4. Line up all the pieces and secure the assembly to the deck using the supplied 5/16-18 x 1¼ Allen head bolts (12 ea). Apply some blue Loctite® thread locker or equivalent to keep the bolts from vibrating out over time.
5. Install the extension bar (#3) onto the rod end of the linear actuator arm in the trough. Secure with the ½” bolt and nylon lock nut. Ensure that the bolt is horizontal.
6. Verify that the jam nut on the rod end has not loosened. Tighten if necessary.
7. Place the Extended Way cover (#1) on top of the thin plastic sheets with the two metal tabs pointing up and toward the front of the dynamometer.
8. Install the wheel restraint back on top of the way cover so the tabs on the cover are inside the cavity at the back of the restraint. Make sure the tabs engage the restraint so the way cover is dragged forward when the restraint moves forward.
9. Press the restraint back into position, and place the free end of the extension bar in the channel on the bottom of the restraint.

10. Line up the holes in the wheel restraint with one of the holes in the extension arm and secure with the clevis pin. The extension bar has several holes for easily adjusting the length of the extension depending on the motorcycle being tested.
11. Install the Rue clip into the clevis pin to secure it. The clip is similar to a trailer hitch pin and usually goes on easier one way than the other. If it is difficult to get it on, try flipping it over.

A.6.2 Operation

The wheelbase extension can be adjusted for several lengths. Before placing a motorcycle on the dynamometer, estimate the approximate length required and set the wheel restraint accordingly.

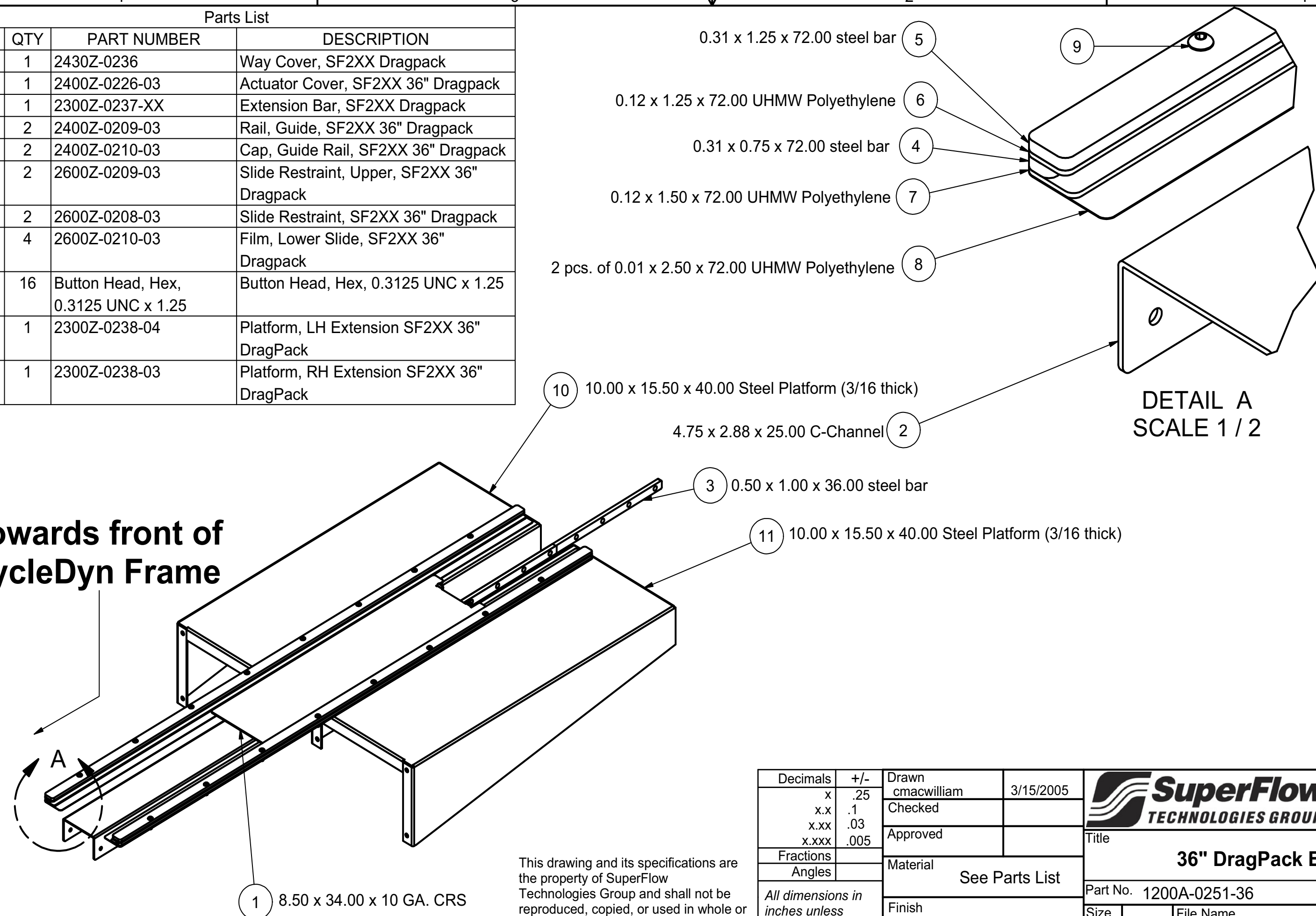
- Remove the clevis pin from the front of the restraint assembly
- Slide the restraint forward or back as needed.
- Line up the restraint holes with a hole in the extension arm.
- Secure with the clevis pin.

If the restraint is far enough forward to leave a large gap between the roll and the restraint assembly, place the provided cover in the trough to fill the gap. Remove the cover before moving the restraint back because it will block the assembly from moving to the rearward position.

WARNING: Damage may occur if the handheld wheelbase button is held down and the restraint assembly is stuck or blocked.

Figure A-15. 36" Dragpack Extension

Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	2430Z-0236	Way Cover, SF2XX Dragpack
2	1	2400Z-0226-03	Actuator Cover, SF2XX 36" Dragpack
3	1	2300Z-0237-XX	Extension Bar, SF2XX Dragpack
4	2	2400Z-0209-03	Rail, Guide, SF2XX 36" Dragpack
5	2	2400Z-0210-03	Cap, Guide Rail, SF2XX 36" Dragpack
6	2	2600Z-0209-03	Slide Restraint, Upper, SF2XX 36" Dragpack
7	2	2600Z-0208-03	Slide Restraint, SF2XX 36" Dragpack
8	4	2600Z-0210-03	Film, Lower Slide, SF2XX 36" Dragpack
9	16	Button Head, Hex, 0.3125 UNC x 1.25	Button Head, Hex, 0.3125 UNC x 1.25
10	1	2300Z-0238-04	Platform, LH Extension SF2XX 36" DragPack
11	1	2300Z-0238-03	Platform, RH Extension SF2XX 36" DragPack



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Decimals	+/-
x	.25
x.x	.1
x.xx	.03
x.xxx	.005
Fractions	
Angles	

All dimensions in inches unless otherwise specified.

Drawn: cmacwilliam 3/15/2005
Checked
Approved
Material: See Parts List
Finish
Do not scale drawing

SuperFlow TECHNOLOGIES GROUP
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Title: **36" DragPack Extension**
Part No. 1200A-0251-36
Size: B
File Name: 1200A-0251-36.iam
Rev: A
Scale: 1:10
Weight: 171.124 lbmass
Sheet 1 of 1

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APPENDIX B

GENERAL TESTING

IN THIS APPENDIX

- Static Electricity
- Barometric Pressure
- Noise Interference
- Fuel Flow When Accelerating
- Airflow Measurement
- Flowbench Correlation
- Oil Temperature Control
- Torque versus Speed
- Thermocouples

B.1 Static Electricity

An ungrounded vehicle on a chassis dynamometer will create a very high static charge as the tires turn. This charge normally dissipates in a short time after the vehicle is stopped if an alternative ground path is not provided.

The alternative ground path can then be the handheld controller (wired model) and/or the operator while stepping down from the vehicle. The back plate of the handheld is metal and is connected to earth ground through the sensor box. If the handheld backing plate is laid on a metal part of the vehicle or the operator is in contact with the backing plate and touches a metal part of the vehicle, a discharge occurs. In some circumstances a discharge can also occur when the operator steps down from the vehicle and contacts the ground. Such a discharge can cause severe damage to the system electronics and give the operator an electric shock.

The best way to prevent any static buildup and subsequent discharge is to provide a positive ground path. The easiest and most efficient method is to connect a ground strap from the vehicle frame to a positive earth ground. This strap can be flat metal braid, welding cable, battery jumper cables, or a length a thick, solid copper wire. With one end permanently attached to an earth ground point and a alligator-style clip on the other, it only takes a few seconds to ground the vehicle and prevent damage or injury.

B.2 Barometric Pressure

A very critical aspect of your dyno test procedure is barometric pressure readings. Remember that the barometric pressure figure you work with must be the uncorrected barometric pressure. This is different than the relative barometer reading given by a weather station. You must get the barometric pressure for the local altitude, temperature, and gravity.

SuperFlow dynamometer systems are equipped with a barometric pressure transducer and will keep track of current barometric pressure conditions. However, just as you must calibrate the torque system occasionally, you must also check and calibrate the barometric pressure transducer. The first step is to obtain a valid barometric pressure reading.

If calling an airport or weather station for barometric pressure, be sure to ask them for an "uncorrected station barometric pressure reading in inches of mercury." Keep in mind as a rule of thumb that for every 1000 foot elevation above sea level, the barometric pressure will drop approximately 1 inch of mercury. So, if they give you a barometric pressure reading of 30.01 inHg and you are at an elevation of 2,000 feet, they have given you the "relative" barometer and not the actual station pressure. Ask again. The reading should be closer to 28.01 inHg.

The best solution is to buy your own wall-mounted mercury column barometer or one of the new electronic weather stations used by racing teams that give the station pressure. Be sure to correct the readings for temperature and gravity as described in the instructions included with the barometer.

Several sources are available for these instruments. One good source is PRINCO instruments (see **www.princoinstruments.com**).

B.3 Noise Interference

Radio Frequency Interference (RMI) and Electromagnetic Interference (EMI) are always a problem with electronics around high-output ignition systems and other high-energy devices. Both can occur simultaneously. The radiated energy from a high-frequency section on a TIG welding machine can even cause interference. The way we isolate our electronics and suggest our customers address the phenomena specifically apply to our equipment. SuperFlow has had very good success with these applications, and our customers typically work with all the various high-output ignitions, including the high-energy, high-frequency plasma units.

- Carefully separate all sensors and cables from close proximity with the ignition wires.
- Do not run a sensor cable parallel with an ignition wire.
- If a sensor must cross the path of an ignition wire, cross it at 90 degrees if possible (and with space between).
- Consider putting a Faraday cage (device for shielding electronic noise) around your ignition amplifier.
- The amplifier (ignition) case should probably be grounded (check with manufacturer of ignition).
- Keep the coil wire (when used) to less than 18" in length.
- Verify ground paths from spark return to battery (a very good filter in itself).
- Do not leave a timing light connected while running tests.
- Check all the above often.

B.4 Fuel Flow when Accelerating

After running a few tests on an accelerating engine with your SuperFlow dynamometer system, you will discover that the power output and the air/fuel ratio change with the speed of acceleration. An understanding of fuel flow within the engine can shed light on these changes. What happens to fuel delivery when the engine is accelerating? How does fuel flow differ when the engine is running at a steady speed?

When an engine is running at a steady speed, fuel is mixed with air and travels down the port as spray flow. Some of the fuel is vaporized and behaves exactly like air. Other fuel remains in droplet form. These unvaporized fuel droplets partially coat the walls of the ports with a film of liquid fuel as a result of turns and general turbulence. This film creates a slow-moving flow along the wall which ranges from 0.010" to 0.020" (1.2 to 2.5 mm) thick. Moving much more slowly than the spray flow, this fuel moves down the port and breaks off at the valve where it enters the cylinder as additional spray droplets. When the engine is running at a steady speed, the wall flow and spray flow reach a point of equilibrium, delivering the desired air/fuel ratio to the cylinder.

When the engine speed changes suddenly, as during acceleration from 4,000 rpm to 5,000 rpm, the spray flow rushes to the new equilibrium point almost immediately, but the slow-moving wall flow requires almost 100 engine cycles before it reaches the higher flow level. The net result is that the engine cylinder receives insufficient fuel at the increased speed operating point for the first 100 cycles. The engine runs lean and may stumble and miss. The traditional solution is to add an accelerator pump that delivers extra fuel during the transition. The additional fuel travels down the port primarily as spray flow and overcomes the momentary lag in the wall flow fuel delivery.

When the engine is already running at full throttle under rapid acceleration, the accelerator pump has no effect. In this case the normal solution is to increase the jet size so the engine will run richer. Unfortunately, the engine then always operates rich during full throttle, and the richness is greater than necessary if the engine was running at a constant speed. That is why the engine may stutter with a rich air/fuel ratio.

On the dynamometer, the engine should generally be one or two steps richer to achieve maximum power under acceleration tests than during steady-state tests at the same speed.

In a race car application, engines frequently accelerate at different speeds, rates, and times. First-gear acceleration might exceed 2,000 rpm a second, while fifth gear acceleration may be less than 100 rpm per second as a vehicle reaches top speed. The same air/fuel delivery ratio will not be correct in both situations. Currently, mechanical carburetor systems do not compensate for this problem. Some fuel injection Engine Control Modules (ECMs) modules can be tuned to compensate for this effect.

To determine how much enrichment your particular engine requires, it is necessary to run a series of tests at progressively richer settings at each of the acceleration rates your engine will experience in its normal application. The richest setting is usually required for the highest rate of acceleration and the leanest setting for the best steady-speed power. You cannot determine the correct mixture by the air/fuel ratio, but only by the net power produced. For a performance engine application, select the mixture for the acceleration rate that will be used the greatest portion of the time.

To determine how quickly air and fuel flow systems respond during acceleration testing, perform a simple manual test: run the engine at a constant speed such as 3,000 rpm at full throttle. Manually record data by rapidly pushing the record button.

After 3 seconds, continue to record data rapidly and increase the engine speed rapidly by advancing the engine speed control knob upward approximately 500 rpm. Let the engine run another 10 seconds at this point while continuing to record data manually as rapidly as possible.

When viewing this set of test data, you will see the actual air and fuel flow delivery readings: first at 3,000 rpm and then at the higher test speed. By comparing the data changes over time, you can determine how long it takes to reach a stable reading. Also examine the power. Power stabilizes sooner than the fuel flow due to delays in fuel flow measurement.

This test should be the worst possible combination because you are making the most rapid step change possible. It requires approximately 5 to 7 seconds to reach a stable data point.

Production engines experience this problem to a lesser degree because of increased manifold heat and the higher vapor pressure of typical pump gasoline. The extra manifold heat evaporates the wall flow back into the airstream and promotes vaporization of the fuel droplets and spray flow. Unfortunately, manifold heat also increases the air charge temperature and reduces the volumetric efficiency at maximum power.

B.5 Airflow Measurement

The SuperFlow airflow turbines used to measure air consumption of the engine on your dyno can provide some very valuable information when evaluating the engine's characteristics. You will miss some crucial information if you do not measure airflow: volumetric efficiency, airflow, air/fuel ratio, and brake-specific air consumption become critical missing links in your engine test program.

The airflow turbine fan spins at a speed that is directly proportional to the volume flow rate. SuperFlow air turbines are calibrated at 6 test points by comparison to standard orifices. This test is actually performed on a flowbench, but the flowbench only compares the air turbine readings to the standard orifice flows. A special mathematical formula correlates the orifice flow reading in cfm to the airflow turbine frequency. The six flow orifice test data points are entered into the WinDyn computer program.

The airflow volume is measured and transmitted to the data acquisition system. The data is processed and calculated with the local barometer, vapor pressure and carburetor air temperature to provide the displayed data in standard cubic feet per minute (scfm) or normalized liters per second (Nl/s). Scfm is what the airflow would be if the atmospheric conditions were measured at reference conditions, e.g., a barometric pressure of 29.92 inches of mercury, 60 degrees F, and no water in the air (dry vapor pressure).

As a rule, an engine consumes approximately 1.25 scfm of air per horsepower (0.8 l/s per kW) at peak torque while using approximately 1.4 scfm (0.9 l/s) at peak power.

Look at the Volumetric Efficiency (VE) and the Brake-Specific Air Consumption (BSAC) columns. If the VE percent is very high (>100%) and the BSAC is substantial (>6.0 lbs./hp per hour or 3,700 g/kWh), some of the air and fuel that could have helped create more power probably went right through the engine and was wasted. Therefore, check for a poor valve sealing or faulty camshaft design.

If the flowbench investigation indicates you have parts that should create strong power but the dyno results are lower than expected, start looking at the air-related information the dyno provides for the solution.

When measuring airflow, be aware that pulsations in the airflow or in the fuel flow will cause errors in the reading. Each engine induction cycle causes a pulse in airflow. Because the fan blades are not symmetrical to airflow for forward direction versus backward, pulsating airflow will cause the turbine to read consistently high or low, depending on its design and the frequency. At higher pulsation rates, the result tends to be very small. When running at lower speeds, pulsations can cause significant errors.

For instance, a four cylinder engine running at full throttle at 1500 rpm will have substantial airflow pulsations. The frequency is low enough that the flow rate can be in error by as much as 15%. The solution is to add a dampening drum between the engine and the airflow sensor. The damping drum should have a volume of 30 to 100 times the volume of the engine displacement. You can hang a 50-gallon (200l) barrel from the ceiling and connected it to the engine with a 12-inch (30cm) diameter flex tube. The air turbine is attached to the end of the damping drum to minimize the pulsation problem. This solution works well on a 4, 6, or 8-cylinder engine.

NOTE: *Readings from SuperFlow flowbenches cannot be used to directly calibrate airflow turbines. The flowbench compares the flow through an orifice to the flow through the test item. At sea level temperature and pressure, the air turbine and flowbench readings are the same. At all other air densities, the flowbench flow differs from the air turbine flow by the square-root of air density. Therefore, we recommend sending your air turbines to SuperFlow at least annually for re-calibration.*

B.6 Flowbench Correlation

The internal combustion engine is an air pump; therefore, modifying an engine design to maximize its airflow will generate more power. Using your SuperFlow flowbench and dynamometer in tandem will produce a reliable testing team in your ongoing search for power.

When placing a cylinder head, intake manifold, or head and manifold together on the flowbench for evaluation, resist the temptation to automatically make all the holes larger for one important reason: airflow is more dependent on the shape than on size. Airflow testing becomes mandatory to precisely gauge the airflow capability of the components. What "looks about right" usually is not.

The *complete intake system* can be evaluated on the flowbench to indicate the level of power that the system will produce. The maximum airflow at a test pressure of 25 inches of water multiplied by 0.27 will estimate the horsepower (per cylinder) the components can make. (When a test pressure of 10 inches of water is used, the formula becomes the flowbench reading multiplied by 0.43). This number may shift slightly if the engine is not matched with the components or if the engine is extremely efficient. This estimated power versus airflow number is a reliable indicator of predicted performance.

Your flowbench can also produce a close estimate of the speed at which peak power will occur. Divide 1,266 by the displacement of one cylinder, then multiply the result by the maximum airflow measured at a test pressure of 25 inches of water. This leads to one final calculation regarding torque: peak torque is reached at approximately 75 to 76 percent of the engine speed for peak power.

For these estimates to be accurate, consider several factors: a key factor is the assumption that the engine's components are matched or will be "tuned" correctly for maximum airflow. If an engine has components to effectively operate mechanically at 7,500 rpm but has airflow capacity to turn 10,000 rpm for peak power, it may never make the trip to the finish line.

In addition, these formulas were derived for typical automotive 4-cycle, V8 type, gasoline powered, normally aspirated engines. The formulas may not predict reasonable values for engines of different configuration.

For additional information, refer to the SuperFlow Flowbench Operator Manuals.

B.7 Oil Temperature Control

Every experienced dynamometer operator understands that oil temperature affects engine power. For any extended testing, ***an oil cooler is mandatory***. It is important to note that the cooler can only control the temperature of the oil entering the engine. The temperature of the oil exiting the engine is a function of the oil flow rate and engine heat rejection.

The typical flow rate for an automotive engine is approximately 1 gallon (4 liters) of oil per minute for each 1,000 rpm of engine speed. As oil passes through the engine, the oil temperature will rise 20 to 60°F (11 to 33°C), depending on power and speed. Consider a rise of 60°F the maximum for engine operation. A greater temperature difference means the oil is either too thick or too thin at some point in the engine lubrication cycle. Industrial and race engine designers try to limit the oil temperature difference through the engine to approximately 20°F (11°C) for minimum wear and block thermal distortions.

Keep the oil temperature constant during an engine test. A variation of 10°F (6°C) can change measured power by 1%. SuperFlow's optional oil cooling system works with both wet and dry sump oil systems. It is important for the engine oil to pass through a filter before entering the oil cooler. If your engine fails during testing, it can contaminate the oil cooler, making it difficult to clean.

B.8 Torque versus Speed

All four-cycle engines running on gasoline without supercharging tend to develop approximately the same maximum torque per cubic inch of displacement. This number is approximately 1.35 to 1.55 lb•ft of torque per cubic inch of displacement. This can also be expressed as a BMEP of 200 to 230 psi.

Despite the best efforts of engine builders over the years, nothing has improved this number appreciably. (Again, this number is valid only for 4-cycle engines without supercharging running on gasoline, no matter what the size.)

Engine stroke is a more important determinate of power. The stroke usually determines the speed at which an engine develops its power. Typically, maximum power is developed when the average piston speed is between 4,000 and 4,500 ft./minute (20 to 23 meters/second.)

Because power is equal to torque multiplied by speed divided by a constant ($\mathrm{HP} = \frac{\mathrm{Torque} \times \mathrm{Speed}}{5,252.113}$) and because the maximum torque for a given displacement is constant, the power per cubic inch is directly proportional to engine speed. Since engine maximum speed is inversely proportional to engine stroke, the shorter the stroke, the more power per cubic inch the engine can develop.

For example, an engine with a 3-inch stroke will develop maximum power at approximately 8,000 rpm, while an average engine with a 1.5-inch stroke will develop maximum power at approximately 16,000 rpm. The maximum torque per cubic inch will be exactly the same for both engines, but the maximum power per cubic inch will be twice as great for the shorter stroke engine.

B.9 Thermocouples

SuperFlow utilizes four kinds of type K thermocouples (yellow connector blocks, temperature range from 0–1,800 degrees F). Each one utilizes two wires to relay the temperature signal.

Table B-1. Thermocouple Specifications

Use	Diameter	Length	Wire Gauge	Time Constant
Air, Exhaust	0.25", 6.35 mm	5", 127 mm	20#, 0.028"dia	< 0.3 sec
Fluids	0.25", 6.35 mm	5", 127 mm	20#, 0.028"dia	<10 sec
Air, Exhaust	0.125", 3.17 mm	5", 127 mm	28#, 0.020"dia	< 0.18 sec
Fluids	0.125", 3.17 mm	5", 127 mm	28#, 0.020"dia	< 4 sec

SuperFlow switched to 0.125” thermocouples for the SF-902 systems. These provide faster response times for improved data acquisition. Two types of 0.125" diameter thermocouples in a 5" tube length feature either a closed or open end; 28-gauge wire (0.020" diameter) is used in both. If using the open-end version for measuring air temperatures, expect a response time of less than 0.18 seconds; the closed-end thermocouple requires a 10-second reaction time in an airstream. In liquids, their response time is less than 4 seconds.

Keep in mind the trade-off for faster response times is less longevity. The 0.125” open-tip probes require more frequent replacement if used for exhaust gas temperature measurement.

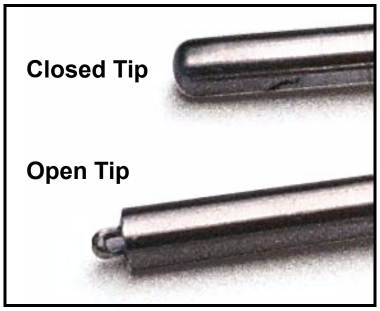


Figure B-1. Thermocouple Tips

A 0.25" diameter thermocouple tube is available in a 5" length with an open thermocouple end. Utilizing 20-gauge wire (0.0285" diameter), it is ideally suited for measuring temperatures of air or exhaust gases. Its response time to a step change in temperature is approximately 0.3 seconds. This response time is a function of the thermocouple and not a software limitation.

A second 0.25" diameter thermocouple tube also has a 5" length and uses a closed end. Fitted with 20-gauge wire (0.0285" diameter), the closed-end model is specifically designed for measuring fluid temperatures. The response time for temperature changes in fluid is approximately 10 seconds. (While this closed-end version could be used to measure air temperatures, the air response time is much greater).

Proper placement of the thermocouples is critical to proper exhaust gas measurement. The thermocouple must be placed in the high-velocity flow area of the exhaust pipe to obtain uniform readings. As a rule, a protrusion of at least 0.31" (8 mm) into the gas stream is a minimum placement figure. Most users report good results at 0.37" (9 mm) protrusion.

IMPORTANT: Index the open end of the tip so gases flow evenly across both types of wire and through the opening.

Thermocouple readings are affected by the radiation of heat from the surrounding pipe. Cast iron exhaust headers, for example, run hotter on the interior surface and radiate heat back to the thermocouple. As a result, the thermocouple can read up to 150°F (80°C) hotter than with a thin-walled steel header pipe. Conversely, pipes cooled with an air blower will register a lower temperature reading than uncooled pipes even though the gas temperature is actually the same. Stainless pipes have a different heat reflection than mild steel.

Because the exhaust gases are only flowing over the thermocouples for about 40% of each engine cycle, the temperature readings average 150 to 200°F (80 to 110°C) less than the true average exhaust gas temperature.

Two final factors which induce fluctuations in thermocouple readings are contamination and vibration.

Proper maintenance procedures for these thermocouples should include cleaning the plug contacts periodically. If you encounter erratic thermocouple readings at any time during a test, first unplug and plug the thermocouples back in to regain contact possibly lost by vibration. You can normally spot a loose contact by lower-than-normal temperature readings. On the other side of the spectrum, an erratically high temperature reading is often the result of ignition noise.

If you require specialty thermocouples for other categories of temperature measurements the only SuperFlow dynamometer system requirement is that the thermocouples are type K (you can use other types if the system is configured for those types with the proper electronic module).

SuperFlow recommends using ungrounded type thermocouples because they induce less RFI noise into the data acquisition and control system. A grounded thermocouple will respond faster but will also introduce ignition noise into the system. Any thermocouple should have a shielded wire cable if applying it to a spark ignition engine. You may also use an ohm meter to check if the thermocouple is shorted to ground or open.

APPENDIX C

PARTS LIST & DRAWINGS

IN THIS APPENDIX

- Critical Spares
- Frequently Ordered Parts
  - Chassis
  - Blower Option
  - Eddy Current Module
  - Auxiliary Roll Module
  - Wheelbase Extension (Drag Pack)
  - Cables
  - Sensor Box
  - Sensors
  - Lambda
  - Pressures
  - Temperatures
  - Analog Voltage Panel
- Drawings

C.1 Critical Spares

Description	Part Number	Qty*	Application
Power supply, ATX switcher	E4190P-0235	1	Sensor box
Roll speed magnetic pickup	1200A-2141	1	
Circuit Board, Battery/Wheelbase	1200A-0224	1	On chassis door
SF-1853 Handheld Controller	1200A-1853-02	1	Wired remote
Fuse, 5A/3AG SLO-BLO	E4320P-313005	1	From battery to PCB

* Quantities listed are the recommended number to have on hand. They may not reflect the actual number of pieces used in the system.

C.2 Frequently Ordered Parts

This list contains a portion of CycleDyn frequently ordered parts and accessory parts.

C.2.1 Chassis

Description	Part Number	Application
Battery	User purchased	75A, side terminals
Roll speed magnetic pickup	1200A-2141	
Fuse, 5A/3AG SLO-BLO	E4320P-313005	From battery to PCB
Air bag on clamp	4300P-0201	
Air hose to clamp	3600P-1510	
Solenoid assembly, wheel clamp	1200A-0242	2 required
Check valve, modified	4100Z-010	Wheel clamp assembly
Starter, Electric 12VDC	4190P-1875	
Starter solenoid	E4295P-6028	Electric starter option
Cable, battery positive	4330P-2054	
Cable, battery negative	4330P-3054	
Set, Disc Brake Pads,	3420P-53667	
Kit, Brake Caliper with O-rings	1200A-0229-OR	
Brake Rotor	3420P-6524	Modified disk
Brake fluid, master cylinder (DOT3)	T5600P-5032	
Actuator, Linear	E4190P-5652	Wheelbase adjustment (requires 1200A-0243-01 cable installed)
Linear actuator clamps	3600P-35406	2ea required
Bracket, Linear Actuator	2300Z-0237-04	Actuator to wheel restraint assy
Way Cover	2430Z-0219	Wheel restraint
Slide, Restraint Lower	2600Z-0201	2ea required
Slide, Restraint Upper	2600Z-0202	2ea required
Slide, Restraint, Film	2600Z-0205	4ea required
Restraint guide bolts	05UNC114X938	8ea required
HHCS, 5/8-11 x 2, GR 8 PLTD	10UNC200X015	Inertia roll bearings, 4 ea required Use with 5/8 flat and lock washer
Bearings, 2-3/16 Pillow Block	3100P-2316	Inertia roll, 2 ea required

C.2.2 Blower Option

Description	Part Number	Application
Blower Duct Kit	1200A-0250	
Belt, Blower drive	3900P-176835	Primary drive from roll
Blower intermediate coupling	3300P-6851	Dual blower option
Motor, 1B46SDS	3900P-0146	Overrunning blower option
Belt, Drive	3900P-0035	Overrunning blower option
Relay, SSR 224/280VAC 25A	E4295P-24025	Overrunning blower option

C.2.3 Eddy Current Module

Description	Part Number	Application
Torque sensor (load cell)	1200A-0219	
SHCS, 1/2-20 x 1-1/2, GR 8	9-42-1.75-08B	Load cell bolt, upper
SHCS, 1/2-20 x 1-1/2, GR 8	T9-42-1.50-08B	Load cell bolt (lower)
Calibration Arm	2300Z-0255	Requires 2ea, 5/16-18 x 3, SQ Head balance posts (9-35-3.00-12B)
Calibration Weights, 20lb	4000P-2813	
Eddy Current Controller	1200A-0235	IGBT (new systems only)
Eddy Current Controller	1200A-0260	SCR (old style)
Bearings, 2-3/16 Pillow Block	3100P-2316	2ea required
HHCS, 5/8-11 x 2, GR 8	9-45-2.00-10G	Pillow block bearings, 4ea required
Universal joint coupling	3900P-0201	Modified Yoke assembly
Set Screw, 3/8-16 x 5/8	9-32-.625-12B	Universal Joint, 2ea required

C.2.4 Auxiliary Roll Module

Description	Part Number	Application
Bearing, 2-3/16 Pillow Block	3100P-2316	
HHCS, 5/8-11 X 2 GR 8	10UNC200X015	Pillow block bearings, 4ea required Use with 5/8 flat and lock washers
Shaft Coupler	3900Z-0201	Modified Yoke
Key, Woodruff, 3/8 x 1-3/4	2400Z-0208	Coupler, 2ea required
Set Screw, 3/8-16 x 5/8	06UNC058X128	Coupler, 2ea required
Kit, ATV Platform	1200A-0246	63” x 28”
Kit. Legend Platform	1200A-0254	83” x 28”

C.2.5 Wheelbase Extension (Drag Pack)

Description	Part Number	Application
Bar, 20” Actuator Extension	2300Z-0237-01	
Bar, 36” Actuator Extension	2300Z-0237-03	
Pin, 1/2 x 1-1/5 Clevis	2300Z-0290	Extension bar to restraint
Pin, Rue	3420P-0022	Extension bar to restraint
HHCS, 1/2-13 x 2, G8	08UNC200X928	Actuator arm to extension bar
Nut, 1/2-13 NYLOK	08UNC000C043	Actuator arm to extension bar
Way Cover, Drag Pack	2430Z-0236	
Actuator Cover, 20”	2400Z-0226-01	
Actuator Cover, 36”	2400Z-0226-03	

C.2.6 Cables

Description	Length	Part Number	Application
Cable, Cat-5	10-ft	E4190P-12540	Sensor box to computer
Cable, Cat-5 Shielded	35-ft	E4330P-04504	
Cable, Cat-5 Shielded	50-ft	E4330P-04505	
Cable, sensor box to dynamometer		1200A-2274-01	w/ Molex connections
Cable, sensor box to dynamometer		1200A-2274-04	w/ Amp connections
Cable, Sensor Box to AC Motor		1200A-2274-02	
Cable, Aux 1 & Aux 2	1-ft	1200A-2052-01	Lambda or voltage input
Cable, universal battery voltage	15-ft	1200A-2861	Connects to 1200A-2052-01
Cable, Blowby meter	15-ft	1200A-2045-902	Connects to Tach/Freq channel

C.2.7 Sensor Box

Description	Part Number	Application
SF1853 handheld controller	1200A-1853-02	Wired remote
Handheld controller cable	1200A-1867	22ft
Key, sensor box	3430P-3515	
LCD display (2 displays per panel)	1200A-2470-x	X indicates # of displays
Power supply, ATX switcher	E4190P-0235	Console and sensor box
Power supply, AT switcher	E4190P-4145	Old style sensor box
Fuse, 2A, 5x20 mm, slow blow	E4320P-213002	115/120VAC
Fuse. 4A, 5x20 mm, slow blow	E4320P-213004	208/240VAC
Cable assembly, power switch	1200A-2260-01	
Pedestal casters	3430P-0014	
Kit, pedestal mount	1200A-2471	
Kit, wall mount	1200A-2472	Cables not included
Kit, ceiling mount	1200A-2948	Cables not included

C.2.8 Sensors

Description	Part Number	Application
Temp/humidity probe, 15-ft cable	1200A-0245-15	
Temp/humidity probe, 40-ft cable	1200A-0245-40	
Temp/humidity probe, 50-ft cable	1200A-0245-50	
Tachometer Kit, Optical IFR • Cable, IR Tach • Cable, IR Tach • Optical Pickup • Clamp, Optical Sensor • Knob, base clamp • Base, Magnetic • Reflective tape	1200A-0642-1 1200A-2272 1200A-2448-1 1510P-5140 2400Z-0211 3420P-0012 3420P-6564 5700P-0093	 Engine speed Wheel speed Sold by the inch
Direct Coil, engine speed sensor	1200A-1939	requires 1200A-2261 cable
Cable, spark input	1200A-2261	use with 1200A-1939 sensor
Cable, Direct Tach	1200A-2188	requires 1200A-2448 cable
Cable, Universal Tach	1200A-2448	use with 1200A-2188
Dual Probe Inductive engine speed sensor	1200A-2450	
• Spark Clip, Inductive • Spark Adjusting Assembly w/ Cable	1200A-2449 1200A-2451	

C.2.9 Lambda

Description	Part Number	Application
Lambda, Air/Fuel ratio,O2 sensor	1200A-NGE1000-021	ECM model AFM1000
Cable, AFM1000 analog input	1200A-2826	To Aux1/Aux2
Cable, AFM1000 analog input	1200A-2462-01-X	LEMO (X indicates color)
O2 sensor, AFM1000	4000P-1000A-2	Replacement sensor
Kit, FAST O2 Sensor • Power Supply, 12VDC • FAST O2 Sensor • DC Power Plug	1200A-FAST02-A 4000P-16146 4000P-170579 E4230P0762	Connects to Aux1/2
Kit, FAST O2 Sensor • Power Supply, 12VDC • FAST O2 Sensor • DC Power Plug • Lemo Plug	1200A-FAST02-L 4000P-16146 4000P-170579 E4230P0762	Connects to LEMO panel Choose color
Cable, FAST AMP extension	1200A-EXT-AMP	Extension cable for Aux1/2, 15ft
Cable, FAST LEMO extension	1200A-EXT-LEMO	
Probe, Exhaust Tailpipe	1200A-EXH01	
Weld-in bung, oxygen sensor	1400P-0063	Exhaust gas analyzers

C.2.10 Pressures

Description	Part Number	Application
Hose, –3x-3 10ft SST	3600P-623120	
Hose, –4x-4 10ft SST	3600P-641120	
Adapter, 1/8 X # 3 fitting	3500P-20210203	
Adapter, 1/8 X # 4 fitting	3500P-20210204	
Kit, transducer, 5 psi, board mount	1200A-PS0505	Gases
Kit, transducer, 100 psi, board mount	1200A-PS0100	Gases
Kit, transducer, 150 psi, board mount	1200A-PS0150	Gases
Kit, transducer, -5/+5 psi, board mount	1200A-PS5005	Gases
Kit, transducer, -30/+30 psi, board mount	1200A-PS3030	Gases
Kit, transducer, -100/+100 psi, board mount	1200A-PS100100	Gases
Kit, transducer, 150psi, metal can	1200A-PR0150	Liquids
Kit, transducer, 300psi, metal can	1200A-PR0300	Liquids
Replacement transducers, use 1200A-Pxxxxx pressure kits for adding transducers		
Transducer, –5/+5 psi, board mount	E1510P-40021	Inlet air, exhaust
Transducer, 5 psi, board mount	E1510P-4005	
Transducer, –30/+30 psi, board mount	E1510P-40151	Aux 4, Aux 5
Transducer, –100/+100 psi, board mount	E1510P-41001	Manifold, Aux 8
Transducer, 150 psi, board mount	E1510P-4150	
Transducer, 150 psi, metal can	E1510P-5150	Oil, fuel
Transducer, 300 psi, metal can	E1510P-5300	

C.2.11 Temperatures

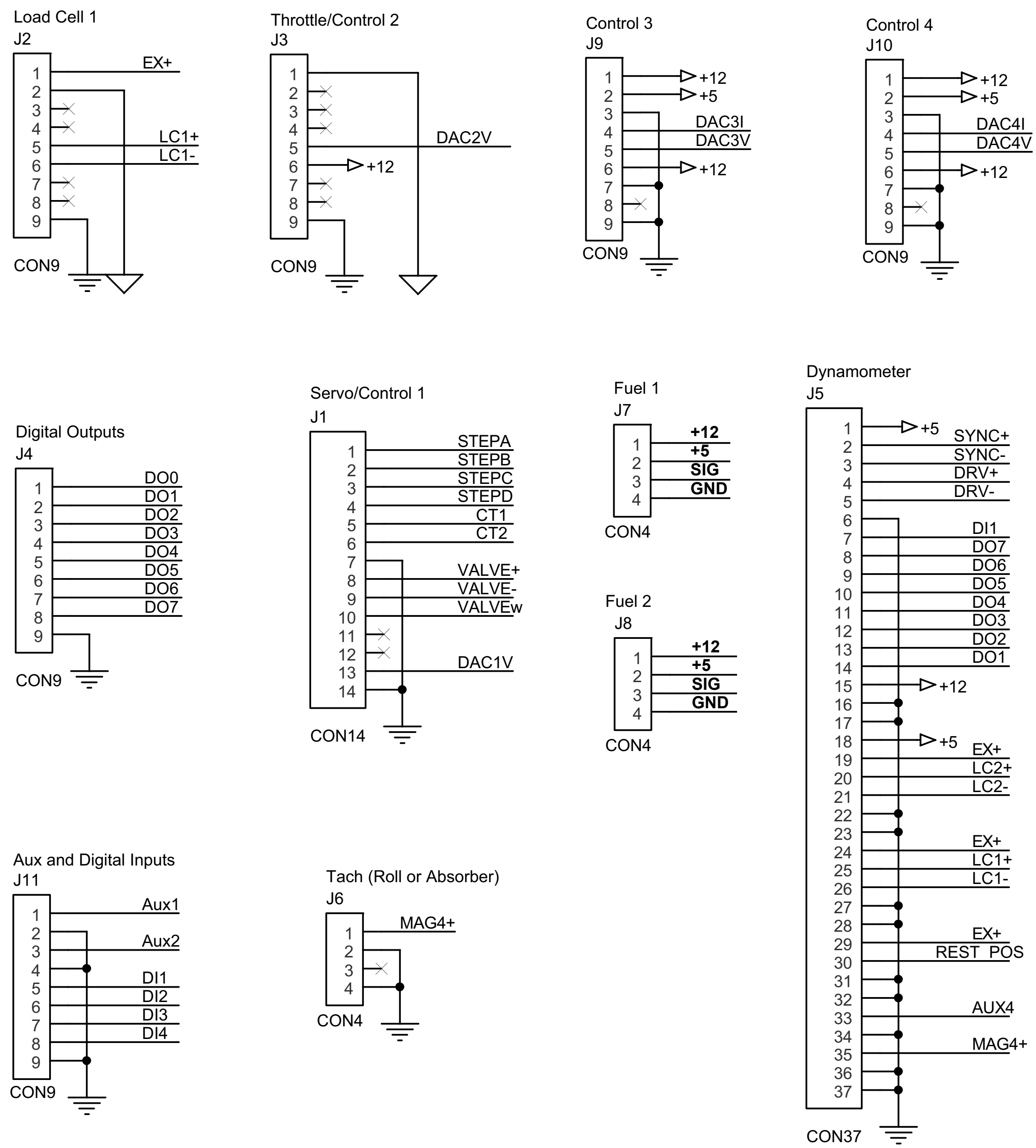
Description	Part Number	Application
Temp/humidity probe, 15-ft cable	1200A-0245-15	
Temp/humidity probe, 40-ft cable	1200A-0245-40	
Temp/humidity probe, 50-ft cable	1200A-0245-50	
TC, 1/8 X 2”, closed tip	1510P-1202	Oil and coolant systems
TC, 1/8 X 4”, open tip	1510P-1800	Gases
TC, 1/8 X 4”, closed tip	1510P-1801	Liquids
TC, 1/4 X 4”, open tip	1510P-2500	Gases
TC, 1/4 X 4”, closed tip	1510P-2501	Liquids
Cable, type K TC extension	1200A-1591-x	X indicates length (5, 10, 15, & 35 feet)
Collar, 1/4 shaft	F3110P-0250	Weld on
Fitting, 1/8t X 1/8 MPT thermocouple	3500P-2012	Swaglok compression
Fitting, 1/4t X 1/4 MPT thermocouple	3500P-2013	Swaglok compression
Psychrometer	5100P-1330	Wet/dry temperature

C.2.12Analog Voltage Panel

Description	Part Number	Application
Cable, analog input, BNC	1200A-2462-01-x	25-ft cable (X indicates LEMO color)
Cable, analog input, unterminated	1200A-2462-x	25-ft cable (X indicates LEMO color)
Kit, analog cables, unterminated	1200A-2462-KIT	Eight cables, 25-ft, all LEMO colors
Freq to volt adapter, mag 1 Khz	1200A-2431-01	15-ft cable (specify connector type and LEMO color)
Freq to volt adapter, mag 5 Khz	1200A-2431-05	15-ft cable (specify connector type and LEMO color)
Cable, battery input	1200A-2860 1200A-2188	Requires both cables, used with 20V input channel, black LEMO, 15-ft
Cable, remote pressure transducer	1200A-2469-0x	15-ft cable (X indicates LEMO color); use with metal can transducers
Transducer, 30 psi, metal can	E1510P-5030	
Transducer, 50 psi, metal can	E1510P-5050	
Transducer, 150 psi, metal can	E1510P-5150	
Transducer, 300 psi, metal can	E1510P-5300	
Transducer, 2000 psi, metal can	E1510P-5320	

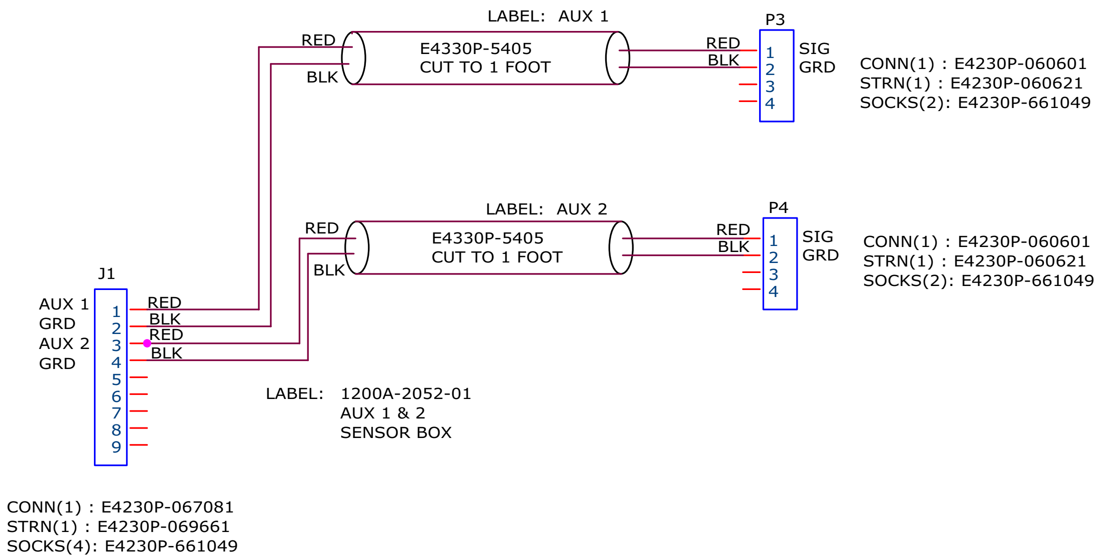
C.3 Drawings

C.3.1 2621 Amp Connector Panel



REVISION HISTORY

REV	DESCRIPTION	DATE	NAME
A	Production release	9-16-04	AAE



NOTES:

1. ALL DIMENSIONS IN INCHES UNLESS NOTED.
2. CUT SHIELD WIRE FLUSH
3. CUT ALL UNUSED WIRES AT CABLE JACKET
4. HEAT SHRINK CABLE JACKET AT BOTH ENDS
5. HEAT SHRINK ALL TWO CABLES TOGETER ON J1 END
6. CONNECT BOTH BLK WIRES TO PIN 2 ON J1

SuperFlow

SuperFlow Corporation

Title: CABLE ASSY,AUX 1 & 2 INPUT CHASSIS INPUT

Size: A | Document Number: 1201-2052-01 | Rev: B

Date: Wednesday, January 12, 2005 | Sheet 1 of 1

Figure C-1. Cable, Aux 1 & 2

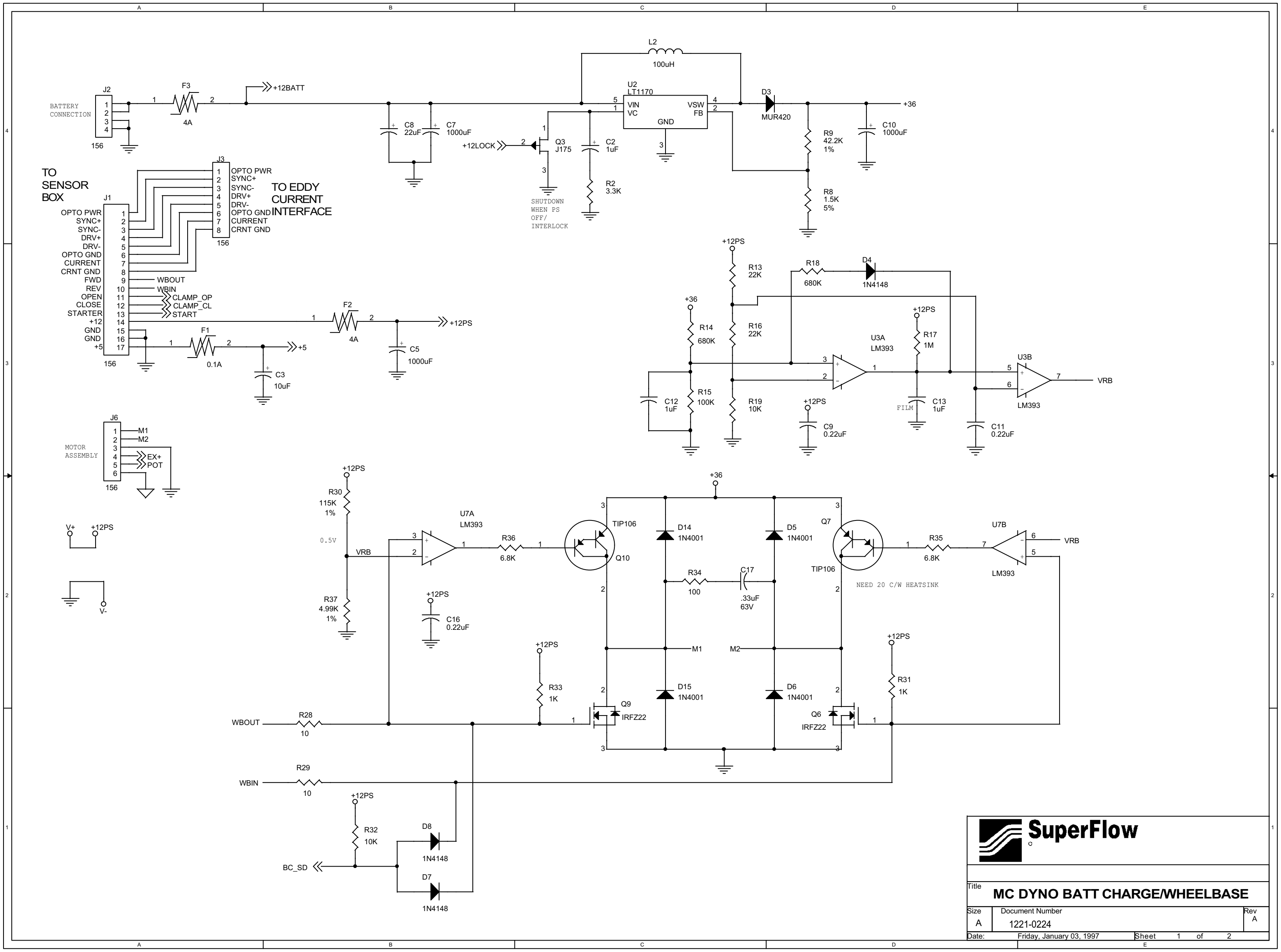


Figure C-2. Battery Charge/Wheel Base

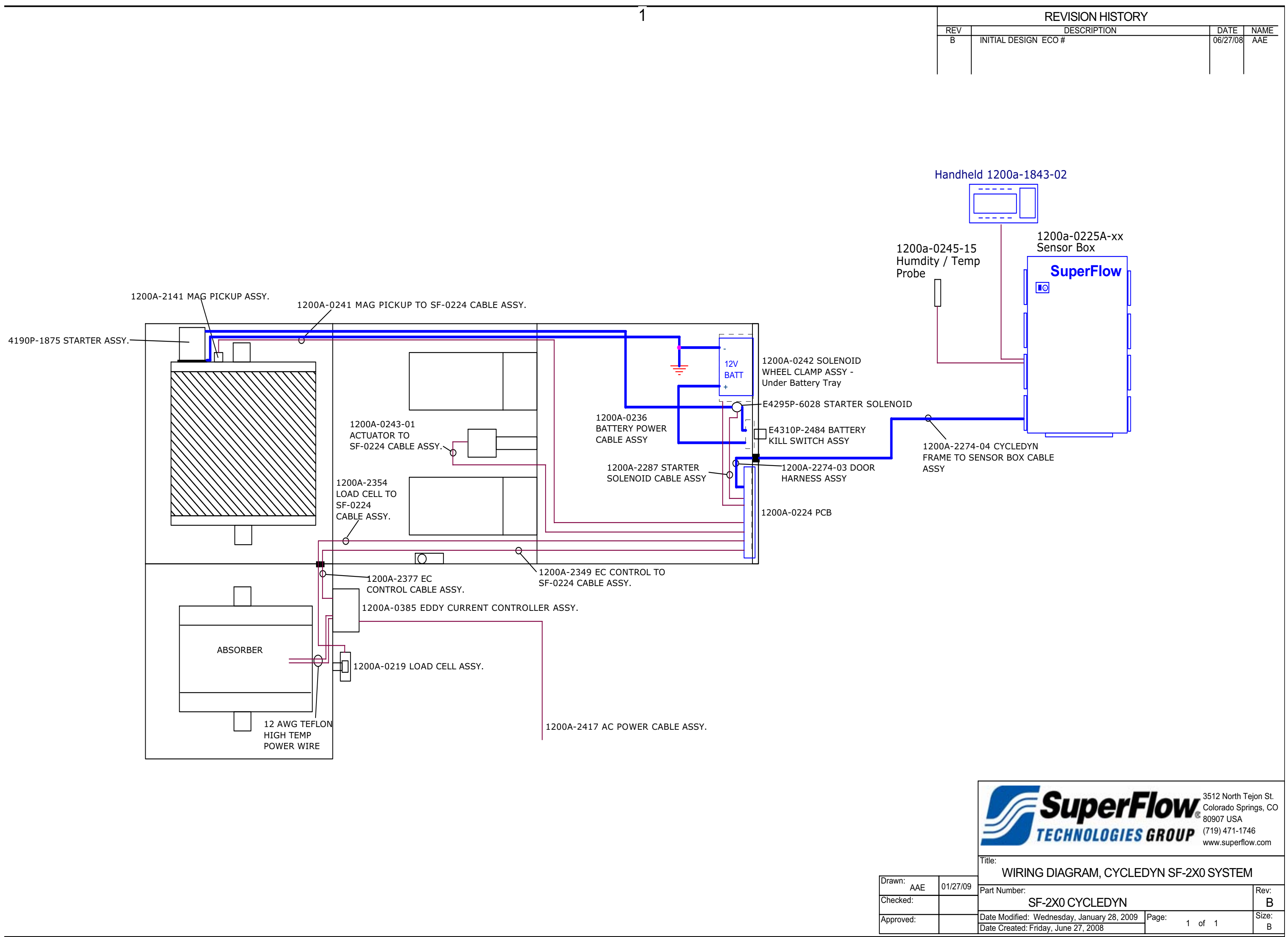


Figure C-3. CycleDyn Wiring Diagram

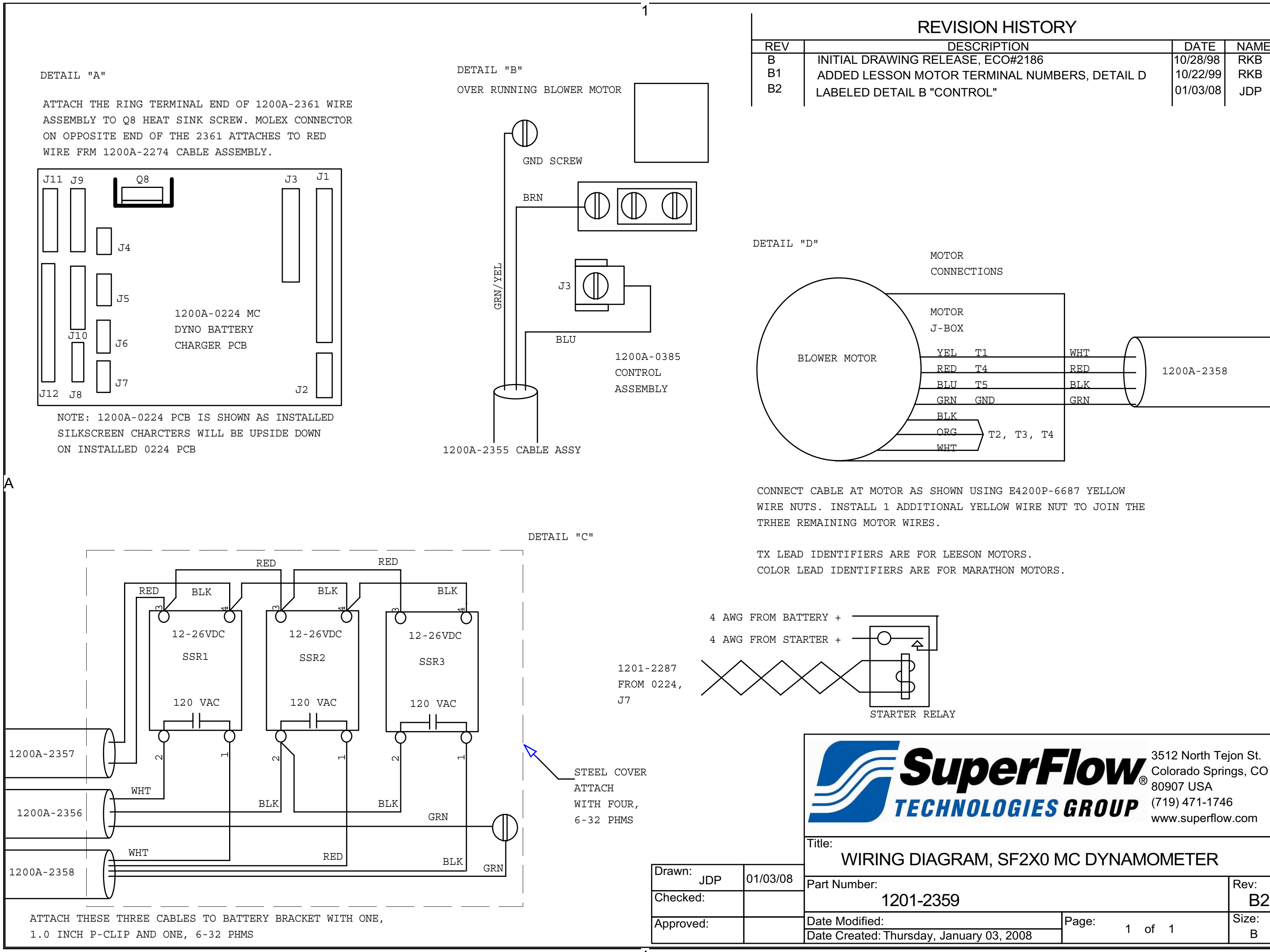


Figure C-4. CycleDyn Running Blower Wiring Diagram

APPENDIX D

EXHAUST EXTRACTION

IN THIS APPENDIX

- **Safety Warning**
  - **Carbon Monoxide Warnings**
- **Chassis Dyno Applications**
- **Vehicle Maintenance Facility CO Exhaust System Design Criteria**
- **References**

D.1 Safety Warning

Although SuperFlow has had many years' experience with dynamometer test facilities, we are by no means the experts in designing effective exhaust extraction systems for each customer or application. We suggest you rely on professionals in the industry such as Car-Mon, Plymovent, Monoxivent, and others. Please contact them during your initial design process for your test cell, and get professional recommendations for your specific application.

For contact information, refer to section 4.11, "Equipment Sources," on page 4-25.

Obtain a portable CO monitor for your dyno operators and insist they wear it at all times. For added safety, install a fixed-mounted CO detector in the test cell and one just outside the door to the test cell.

D.1.1 Carbon Monoxide Warnings

When operating fuel-generated equipment in enclosed areas, take the following precautions to protect you and your employees against carbon monoxide exposure.

What is carbon monoxide?[1]

Carbon monoxide (CO) is a poisonous, colorless, odorless, and tasteless gas. Although it has no detectable odor, CO is often mixed with other gases that do have an odor; therefore, you can inhale carbon monoxide right along with gases you can smell and not even know that CO is present.

CO is a common industrial hazard resulting from the incomplete burning of natural gas and any other material containing carbon such as gasoline, kerosene, oil, propane, coal, or wood. One of the most common sources of exposure in the workplace is the internal combustion engine.

How does CO harm you?

Carbon monoxide is harmful when breathed because it displaces oxygen in the blood and deprives the heart, brain, and other vital organs of oxygen. Large amounts of CO can overtake you in minutes without warning—causing you to lose consciousness and suffocate.

Besides tightness across the chest, initial symptoms of CO poisoning may include headache, fatigue, dizziness, drowsiness, or nausea. Sudden chest pain may occur in people with angina. During prolonged or high exposures, symptoms may worsen and include vomiting, confusion, and collapse in addition to loss of consciousness and muscle weakness. Symptoms vary widely from person to person. CO poisoning may occur sooner in those most susceptible: young children, elderly people, people with lung or heart disease, people at high altitudes, or those who already have elevated CO blood levels such as smokers. CO poisoning poses a special risk to fetuses.

Acute poisoning may result in permanent damage to the parts of your body.

1. Information in this section was adapted from the "OSHA Fact Sheet," U.S. Department of Labor, Occupational Safety and Health Administration, 2002, **http://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf**, 2007.

How can employers help prevent CO poisoning?

To reduce the chances of CO poisoning in your workplace:

- Install an effective ventilation system that will remove CO from work areas.
- Maintain equipment and appliances that can produce CO to ensure they are in good working order, promote their safe operation, and reduce CO formation.
- Consider switching from gasoline-powered equipment to equipment powered by electricity, batteries, or compressed air if it can be used safely.
- Prohibit the use of gasoline-powered engines or tools in poorly ventilated areas.
- Provide personal CO monitors with audible alarms if potential exposure to CO exists.
- Test air regularly in areas where CO may be present, including confined spaces.
- Install CO monitors with audible alarms.
- Use a full-face piece, pressure-demand, Self-Contained Breathing Apparatus (SCBA) certified by the National Institute for Occupational Safety and Health (NIOSH) or a combination full-face piece, pressure demand supplied-air respirator with auxiliary self-contained air supply in areas with high CO concentrations (those immediately dangerous to life and health atmospheres).
- Use respirators with appropriate canisters for short periods under certain circumstances where CO levels are not exceedingly high.
- Educate workers about the sources and conditions that may result in CO poisoning as well as the symptoms and control of CO exposure.
- In addition, if your employees are working in confined spaces where the presence of CO is suspected, you must ensure that workers test for oxygen sufficiency before entering.

What can employees do to help prevent CO poisoning?

To reduce the chances of CO poisoning in the workplace, employees should:

- Report any situation to your employer that might cause CO to accumulate.
- Be alert to ventilation problems—especially in enclosed areas where gases of burning fuels may be released.
- Report promptly complaints of dizziness, drowsiness, or nausea.
- Avoid overexertion if you suspect CO poisoning, and leave the contaminated area.
- Tell your doctor that you may have been exposed to CO if you get sick.
- Avoid the use of gas-powered engines, such as those in powered washers as well as heaters and forklifts, while working in enclosed spaces.

What are the OSHA standards for CO exposure?

The OSHA PEL is 50 parts per million (ppm). OSHA standards prohibit worker exposure to more than 50 parts of the gas per million parts of air averaged during an 8-hour time period.

For more information on carbon monoxide, visit the OSHA Web site at **http://www.osha.gov**.

D.2 Chassis Dyno Applications

Nearly every chassis dyno installation SuperFlow Technical Support Engineers commission has exhaust extraction problems. Many have such poor exhaust extraction systems, it would be suicidal to run a vehicle in the test cell for more than a few minutes. The next few pages will provide some "Do's and Don'ts" for the new chassis dyno facility operator. We'll use photos to illustrate some ineffective and effective techniques.

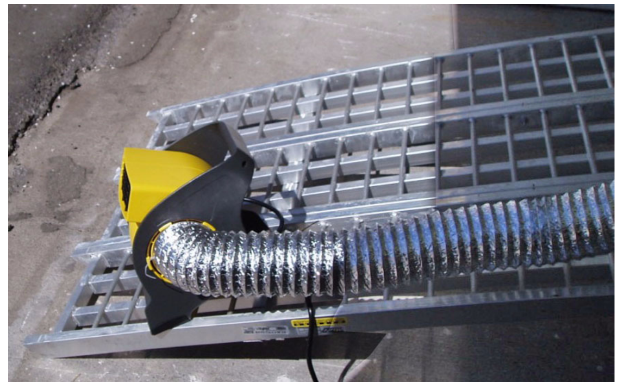
First, let's look at some photos of installations that weren't quite successful at achieving their goal of efficient exhaust extraction. These photos show the effects of exhaust heat when applied to vinyl hose. As you can see, vinyl simply doesn't stand up to the heat generated by a vehicle on a chassis dynamometer. Some of these hoses were ruined while the vehicle was idling. Plastic hose will suffer the same demise. Rubber hose will get so hot that it may self combust; it also emits an awful smell as it heats up.

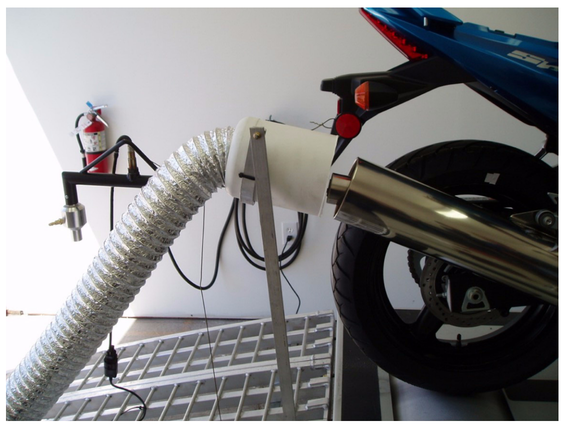




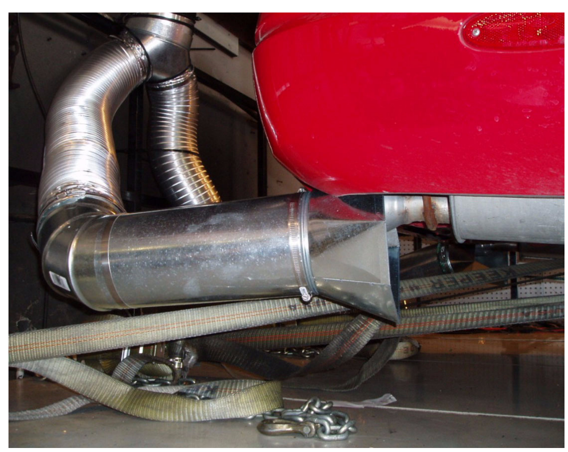
ZECA
673
V 230 Hz 50
Kw 0,37 A 3

The next choice for many dyno operators after a bad experience with vinyl, rubber or plastic hose, is to try dryer duct or stovepipe from the local hardware store. Here are some examples we've encountered in the field. Although this may work, it is only good as a temporary solution, as it certainly doesn't convey a professional appearance to your customers.





The one below is our favorite, using roof spouting to route the exhaust back to the front of the garage and out of the building, a “McGyver” application if there ever was one!



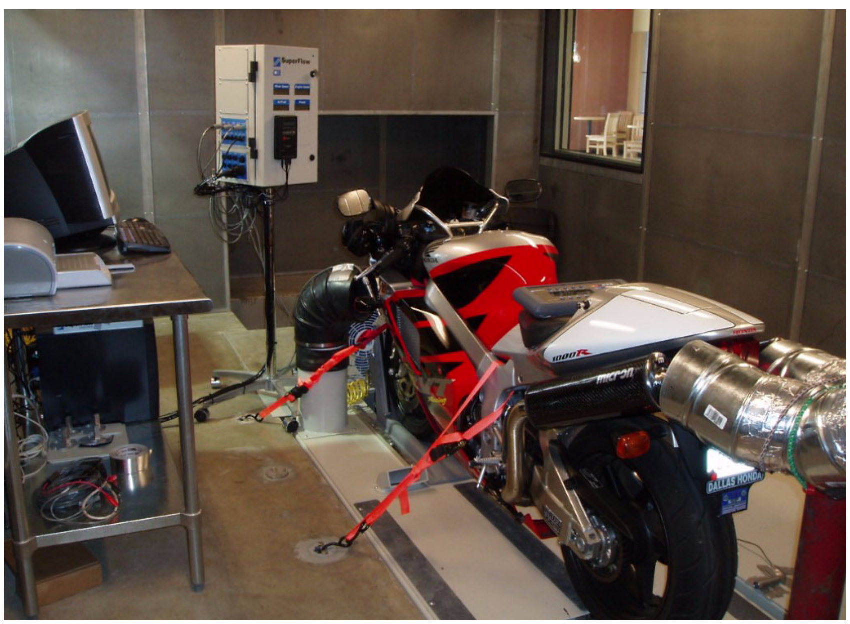
We see many test cells designed with the idea they will have enough airflow to extract the exhaust without any help from duct work or auxiliary fans. If the cell is small and the airflow is huge (many thousands of cfm flow, exchanging all air in the room at least 10–12 times per minute), this is possible. However, very few test cells achieve this goal, even those “pre-fab” units sold by reputable dynamometer room manufacturers.

Our suggestion, when considering such a cell, is to get a money-back guarantee from the manufacturer. Then, when the cell is complete, run a typical vehicle you plan to test at wide open throttle (WOT) for at least 1 minute with the cell doors closed and the fans on. CO levels should not exceed 30 ppm where the operator will sit when operating the vehicle. Most manufacturers of these rooms will not give you such a guarantee. That doesn't mean their test cell is bad; it just means you must do more to get rid of the poisonous gas than simply close some doors and turn on some fans.

One of the worst things you can do is subcontract your test cell airflow and exhaust design to a local HVAC contractor. Few of them have ever had to deal with the amount of airflow required in a dyno cell or the task of extracting 800–1000°F expanding high-velocity gases from a vehicle running wide open throttle on a dynamometer. They will try to convince you that our recommendations for fans and exhaust hose are unnecessary, and they will build you something for less money. You will be disappointed and end up spending a lot more money to solve the problem.

Here are some examples of test cells that fail the above check and disappointed their owners tremendously.

The two photos below are a pre-fab cell, with a 40,000-cfm fan. Exhaust gas would swirl around in the room. The problem was solved after adding ducting from the vehicle exhaust to the fan to get the exhaust moving towards the big fan.



This room had a huge fan, but the exit air was restricted by the room air outlet ducts at the back of the room even though there was one on each side wall. The velocity of the air in the room was very low due to the large-entry air opening in the front of the room. Exhaust would hit the wall in the back of the cell when the door was closed and swirl back to the front, then back past the operator as if he were sitting with his nose on the exhaust of the bike.

Note fan size below

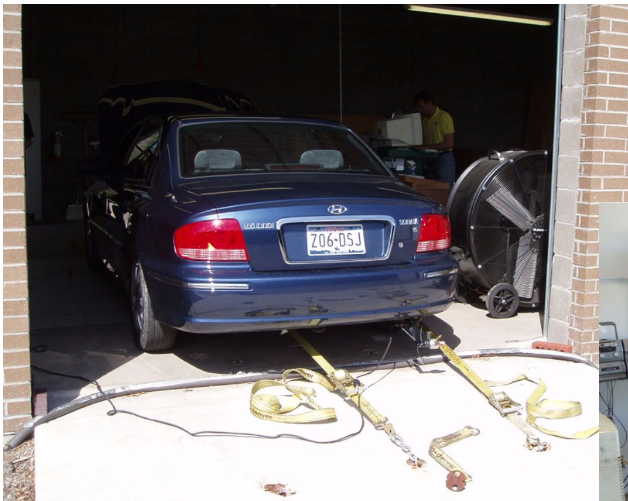
Exhaust column openings were raised about 5' off the ground

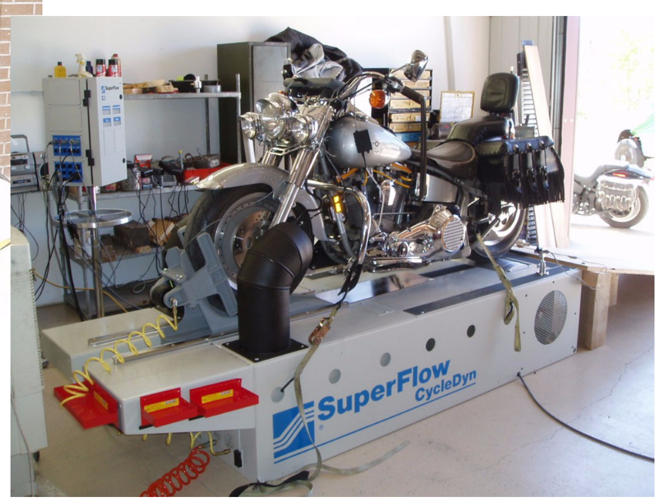
A solution was effected by raising the openings of the air outlet columns in the back corners of the room to about 5 feet off the ground. We also found that opening the door in the front left of the room helped airflow as well. This indicates the air entry to the room is restricted, perhaps by air filters or too small ducting.

Note the size of the fan sitting on top of the cell. It was more than capable of flowing enough air in the cell once they sorted out the restricted inlet problem.

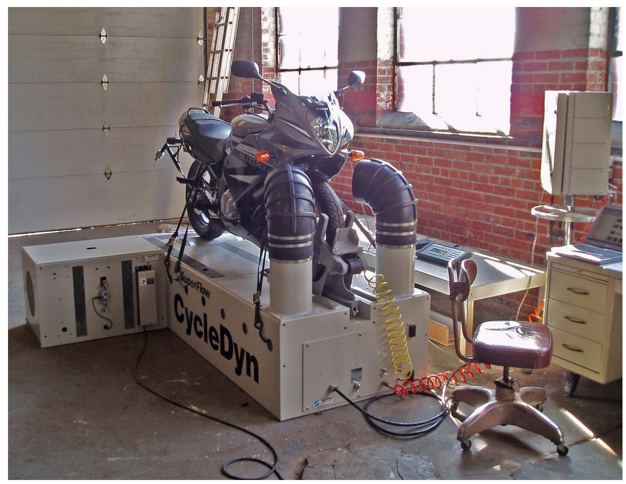
The worst offenders are people who believe the exhaust will just naturally see an open door in the garage or even a small open window, and it will just naturally say, "Hey, look over there—a path to the outside world. Let's go outside and play." Rarely, if ever, does this method work. Even if the dyno is close to that door, your chances of being exposed to severe CO poisoning is quite high.

Some "bad" examples:





Prevailing winds often blow the exhaust back into the building or trailer.

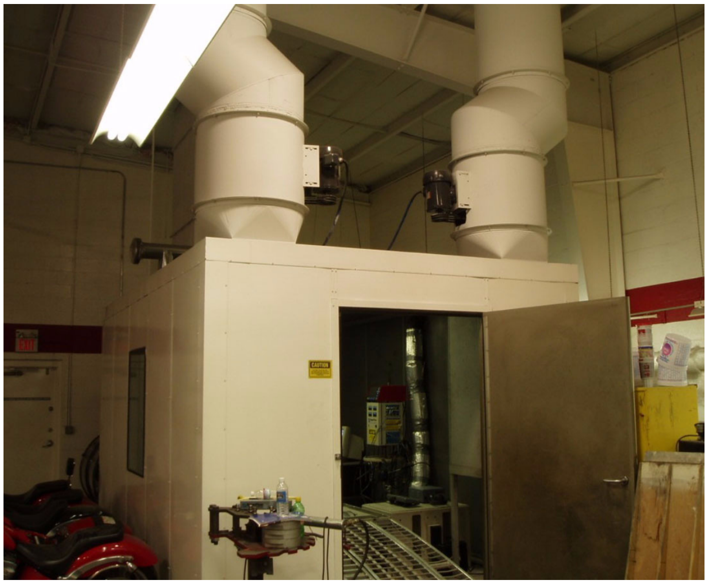


Each of the photos above are examples of very bad installations for extracting exhaust. The AutoDyn customer actually did diesel trucks on the dyno in the back of that long room. There was no exhaust extraction whatsoever.

It looked like they had tried some dryer ducting, but that stuff was simply not capable of handling the pressure of 500-hp diesel truck exhaust systems, so they just gave up on it. During our visit, we could not run a vehicle on the dyno simply because it was too dangerous!

Okay, we've shown several examples of what not to do, so, let's take a look at some examples of what works.

The picture below left shows a pre-fab test cell with two huge fans. Air velocity in the room is very high, and exhaust extraction is excellent.



The picture above right shows an AutoDyn cell with an absolutely huge, albeit dangerous, fan. It was like standing in front of an airplane propeller in this cell, but there was no problem with exhaust.

The above example is an AutoDyn test cell with a very large fan directing air to the front of the vehicle and the open door at the back. This one has an adjustable nozzle, making the room a virtual wind tunnel.

Here are several more good examples:


The test cell above had good-sized fans and moved a bunch of air, but they still used exhaust hoses to direct the exhaust to the fan ducts inside the cell. This ensures all exhaust is extracted.


The above setup was unique. They had a 5000-cfm fan outside the cell and built a capture unit to fit on the ramp behind the bike. The ramp actually acted as a plenum for the exhaust extraction unit.

If you can't afford huge fans for huge airflow, the next best solution is to provide hoses that won't be destroyed by exhaust heat and pressure, and place a fan on the other end to suck out the exhaust. Here are several good examples:

D.3 Vehicle Maintenance Facility CO Exhaust System Design Criteria

NOTE: *This section is adapted from Car-Mon Products, Inc., a company that specializes in installing vehicle exhaust extraction systems.*

It is important to understand that this contaminant is a known and lethal health hazard. Before attempting to design a system, it is imperative that you gather sufficient information about the application so the designed system will provide the end user with a safe work environment. Make sure the largest engine to be tested is identified. It is essential to provide this information at the start of the design process. For the installed system to function correctly, you must determine the sizing of the connecting hose, ducting, and fan based on the type of vehicle and engine, cubic inch displacement, and testing requirements.

Vehicle exhaust systems differ from other types of air-handling applications in several ways. First, the air being conveyed contains a high concentration of health-related hazardous materials including carcinogenic contaminants. They frequently enter the system in a super-heated state, under pressure and at high velocity, creating a rapidly expanding gaseous compound. The exhaust system design must have sufficient airflow capability to overcome the flow rate as well as the expansion rate of the exhaust gases with a negative pressure system. In addition, it must not affect the performance of the engine being tested by creating either a back pressure or vacuum condition which can alter the readings on the testing instruments. For this reason, the selection of connecting components to the exhaust pipe, hose size, and airflow rate are critical.

It is essential to discuss with the end user the type and location of the exhaust pipes, along with engine information and testing requirements when reviewing prospective exhaust system manufacturers as the basis of specification. Design professionals in the vehicle exhaust industry are available and typically willing to provide assistance. They should be consulted regarding application requirements and current product information.

ACRONYMS & ABBREVIATIONS

4WD

Four-Wheel Drive

A

acfm

actual cubic feet per minute

ADC

Analog-to-Digital Converter

ATX

Advanced Technology Extended

AWD

All-Wheel Drive

B

BDC

Bottom Dead Center

BMEP

Brake Mean Effective Pressure

BPS

bits per second

BSAC

Brake Specific Air Consumption

BSFC

Brake Specific Fuel Consumption

BTDC

Before Top Dead Center (TDC)

BTU

British Thermal Unit

C

C

Celsius

Cat-5

Category 5

cfm

cubic feet per minute

CID

Cubic Inch Displacement

cm

centimeter (cm)

cmH_2O

centimeter of water

CPU

Central Processing Unit

CSV

Comma-Separated Value

D

D

diameter

DAC

- Data Acquisition and Control
- Digital-to-Analog Converter

DACS

Data Acquisition Control System

DBMS

Database Management System

DIN

Deutsches Institut für Normung

DLL
Data Link Library

DPDT
Double-Pole, Double-Throw

DRAM
Dynamic Random Access Memory

E

EC
eddy current

ECE
Economic Commission for Europe

e.g.
for example

EMS
Emergency Stop

EPROM
Erasable Programmable Read-Only Memory

etc.
and so on

F

F
Fahrenheit

fax
facsimile

ft-lb
foot-pound

ft^3/sec
cubic feet per second (also cfs and ft^3/s)

G

GB
gigabyte

GPF
General Protection Fault

gpm
gallons per minute

GUI
Graphical User Interface

H

H_2O
Water (Hydrogen/Oxygen)

hp
horsepower

HTML
HyperText Markup Language

I

icfm
inlet cubic feet per minute

ID
identification or identifier

IDE
Integrated Drive Electronics

i.e.
that is; meaning

IIS
Internet Information Server

inH_2O
: inches of water

in/Hg)
: inches of mercury

ISA
: Industry Standard Architecture

K

KB
: kilobyte

KBps
: kilobytes per second

KHz
: kilohertz

km
: kilometer

kPa
: Kilo Pascal

kW
: kilowatt

L

LAN
: Local Area Network

lb-ft
: pound-foot

LCD
: Liquid Crystal Display

L/D ratio
: Length-to-diameter ratio

LED
: Light-Emitting Diode

l/s
: liters per second

lpm
: liters per minute

M

m
: meter

m^3/sec
: cubic meters per second

mag/TTL
: magnetic/Transistor-Transistor Logic

MB
: megabytes

Mbps
: megabits per second

MDI-X
: Medium Dependent Interface-X (crossed)

MDX
: Multi-channel Data Exchange

MHz
: megahertz

mm
: millimeter

m/s
: milliliters per second

N

N-m

Newton-meter

NetBEUI

Network Basic Input/Output System (NetBIOS) Extended User Interface

NetBIOS

Network Basic Input/Output System

NGE

New Generation Electronics

NIC

Network Interface Card

O

O.D.

Outside Diameter

OEM

Original Equipment Manufacturer

P

Pa

Pascal

PC

personal computer

PCB

Printed Circuit Boards

PCI

Peripheral Component Interconnect

PDF

Portable Document Format

PID

Proportional, Integral, and Derivative

psi

pounds per square inch

R

RAM

Random Access Memory

RJ-45

Registered Jack-45

ROM

Read-Only Memory

rpm

revolutions per minute.

S

SAE

Society of Automotive Engineers

SIMM

Single In-line Memory Module

SRAM

Static Random-Access Memory

STP

Standard Temperature and Pressure (STP) ; sometimes called STD

SWED

SWitch EDitor

T

TCP/IP

Transmission Control Protocol/Internet Protocol

TDC

Top Dead Center

TPF

Test Profile (also referred to as an autotest)

TPS

Throttle Position Sensor

TTL

Transistor-Transistor Logic

U

UI

User Interface

URL

Uniform Resource Locator (URL), formerly known as Universal Resource Locator

USB

Universal Serial Bus

UPS

Uninterruptible Power Supply

V

VAC

Volts Alternating Current

VDC

Volts Direct Current

VFD

Vacuum Fluorescent Display

W

WAN

Wide Area Network

WYSIWYG

What You See Is What You Get

GLOSSARY

Num/Sym

10-Base-TX Ethernet Converter

The TC3105 UTP-to-Fiber Optic Converter replaces or extends 10Base-T segments with multimode (850/1300nm) or single mode (1300/1550nm) fiber-optic cable and is frequently used to link Ethernet switches or workstations. Typical applications include extending full duplex LAN segments up to 80km or connecting two Ethernet segments through fiber optic cable.

A

acfm

actual cubic feet per minute (*see* "cfm" on page 5)

acceleration

In physics or physical science, acceleration (a) is defined as the rate of change (or derivative with respect to time) of velocity. It is thus a vector quantity with dimension length/time.

accuracy

A measurement that is referenced to a known standard.

ADC

An Analog-to-Digital Converter (abbreviated ADC, A/D or A to D) is an electronic circuit that converts continuous signals to discrete digital numbers. The reverse operation is performed by a digital-to-analog converter (DAC).

See also: "DAC" on page 6.

airflow

The amount of air used at each data point. Typically displays as cubic feet per minute (cfm) or standard cubic feet per minute (scfm).

ATX

Advanced Technology Extended (ATX) refers to a computer-industry standard for a type of power supply.

auto-install

Install a file automatically on a specific condition (for example, install a test group upon launching WinDyn).

autotest

A scripted procedure or sequence of steps instructing the SuperFlow dynamometer to perform various commands. Usually executed and controlled automatically by the test system. Also known as a *test profile*.

average

The sum of a data set divided by the number of items in the set (also know as *Mean*).

AWD

Four-Wheel Drive (4WD, 4x4, four by four) and All-Wheel Drive (AWD) is a four-wheeled vehicle with a drivetrain that allows all four wheels to receive power from the engine simultaneously.

B

barometric pressure

The local barometric pressure at the time of the test or at the data point. Mercury barometers are preferable for a local reference.

BDC

Bottom Dead Center (BDC) is the position of a piston where it is closest to the crankshaft.

See also: "BTDC" on page 4 and "TDC" on page 15.

bell housing

The bell housing is part of the transmission system on a gasoline (also known as petrol) or diesel powered vehicle. It is bolted to the engine block and contains the flywheel and torque converter or clutch of the transmission. A starter motor is usually mounted on the bell housing using a ring gear on the flywheel.

best fit line

The closest straight line fit to a given set of data points. Calculated from a least-squares approximation of the data set.

blow-by

A mechanical or electric sensor that measures the volumetric gas flow by means of vortex sensing. This is used to verify ring and system sealing.

BMEP

The Mean Effective Pressure (MEP) is an estimate of the pressure exerted into the combustion chamber of an internal combustion engine. Brake MEP (BMEP) denotes dynamometer testing.

It is calculated by taking the torque exerted by the engine over one revolution for a two-stroke engine and two revolutions for a four-stroke engine and dividing it by its displacement.

BMEP is a useful comparison tool between different engines and is a good indicator of engine performance. It is important to remember that the values produced by the formula are for theoretical analysis only and do not reflect the actual pressures inside an individual combustion chamber.

BSAC

Brake-Specific Air Consumption (BSAC) is an efficiency rating showing the amount of air consumed in pounds per horsepower hour.

BSFC

Brake-Specific Fuel Consumption (BSFC) is an efficiency rating showing the amount of fuel consumed in pounds per horsepower hour.

BTDC

Before Top Dead Center. Top Dead Center (TDC) is the datum point from which engine timing measurements are made. For example, ignition system timing is normally specified as degrees Before Top Dead Center (BTDC), although a very few small and fast-burning engines require a spark just After Top Dead Center (ATDC) such as the Nissan MA engine with hemispherical combustion chambers or hydrogen engines.

See also: “TDC” on page 15.

BTU

A British Thermal Unit (BTU) is a unit used to measure quantity of heat, defined as the quantity of energy necessary to raise the temperature of 1 lb. of water 1° Fahrenheit.

C

calibration

Calibration refers to the process of determining the relation between the output (or response) of a measuring instrument and the value of the input quantity or attribute—a measurement standard. In non-specialized use, calibration is often regarded as including the process of adjusting the output or indication on a measurement instrument to agree with the value of the applied standard within a specified accuracy.

CAN

A Controller Area Network (CAN) is a broadcast, differential serial bus standard for connecting Electronic Control Units (ECUs). Specifically designed to be robust in electromagnetically noisy environments such as automotive, but is now used in industrial environments that may be subject to noise.

See also: “LAN” on page 10 and “WAN” on page 16.

Cat-5

Category 5 Unshielded Twisted Pair (UTP) cabling used for connecting computer networks.

CBT

Corrected Brake Torque, meaning, corrected to a condition other than what conditions were at the time of testing.

CBHp

Corrected Brake Horsepower, meaning, corrected to a condition other than what conditions were at the time of testing.

Celsius (C)

Celsius: Of or relating to a temperature scale that registers the freezing point of water as 0° and the boiling point as 100° under normal atmospheric pressure.

See also: “F (Fahrenheit)” on page 8.

CFA/CFD configuration file

WinDyn software configuration file. The .cfa file is the binary file that is sent to the data acquisition for use; the .cfd file is the editable (non-compiled) file.

See also: “configuration file” on page 5 and “DEFTool” on page 6.

cfm

When manufacturers list performance for blowers and compressors, it is stated as “Capacity” in cfm (cubic feet per minute). This refers to the volume of air at the inlet to the unit; therefore, it is often referred to as inlet cfm (icfm) or actual cfm (acfm). The terms cfm, acfm, and icfm are used interchangeably and mean basically the same thing.

channel order

Defines which data channels (out of all available channels) WinDyn will display and plot when viewing stored test data.

chassis dynamometer

A test system which uses a set of rolls (that are driven by the wheels of a vehicle under test), connected to a type of power absorber capable of controlling the load applied to the rolls.

These dyno’s do not account for power losses in the drivetrain such as the gearbox, transmission, or differential, etc.

See also: “dynamometer” on page 7 and “engine dynamometer” on page 7.

CID

Cubic Inch Displacement. Engine displacement is defined as the total volume of air/fuel mixture an engine can draw in during one complete engine cycle; it is normally stated in cubic centimeters, liters or cubic inches. In a piston engine, this is the volume that is swept as the pistons are moved from Top Dead Center (TDC) to Bottom Dead Center (BDC).

cm

A centimeter (cm) is a unit of length equal to one hundredth of a meter, the current International System of Units (SI) base unit of length.

See also: “m (meter)” on page 10 and “mm” on page 11.

cmH_2O

A centimeter of water or cmH_2O is used to determine pressures during mechanical ventilation.

It is defined as the pressure exerted by a column of water of 1 cm in height at 4 °C (temperature of maximum density) at the standard acceleration of gravity.

$$1\ \mathrm{cmH_2O} = 98.0638\ \text{pascals}$$

See also: “H2O” on page 8, “inH2O” on page 9, and “Pascal” on page 12.

Column Averages

A WinDyn window that shows the column averages, minimums, or maximums for a particular data range. The information shown is for the currently displayed page of test data. The values can be printed by selecting the appropriate item in the Print Setup dialog box.

configuration file

The configuration file is the master file for all SuperFlow data acquisition systems which utilize the WinDyn™ program.

The configuration file exists in two formats: *.CFD and *.CFA. The CFD format is the editing format used as data is entered and modified. The CFA format is the “absolute” compiled version of the CFD format and is the actual file installed in the data acquisition system.

See also: “CFA/CFD configuration file” on page 5.

Control

Configures the Proportional, Integral, and Derivative (PID) closed-loop control system for SuperFlow data acquisition systems. The file extension is .ccp.

See also: “PID” on page 13.

conversion factor

A number used to convert units to a different reference of units such as converting inches to feet, feet to miles, or hours to seconds.

correction factor

A number used to arithmetically correct data to a recognized and defined standard.

CPU

The Central Processing Unit (CPU) is the component in a digital computer that interprets computer program instructions and processes data. Sometimes referred to as the processor or central processor, the CPU is where most calculations take place. In terms of computing power, the CPU is the most important element of a computer system.

On large machines, CPUs require one or more printed circuit boards. On personal computers and small workstations, the CPU is housed in a single chip called a microprocessor.

CSV

The Comma-Separated Value (CSV) file is a common file format that stores tabular data (like in a Microsoft® Excel® spreadsheet). The format is old, dating back to the days of mainframe computing. For this reason, CSV files are common on all computer platforms. For more information, refer to Microsoft online Help.

CT

Corrected Torque is used for chassis dynos. Corrected Wheel Power is the torque at the tire patch corrected to conditions other than test conditions.

current test

Test data currently recorded in the data acquisition system's memory. Data is temporary and is erased when a new test is started or when power is turned off.

See also: "saved test" on page 13.

D

D (diameter)

In geometry, a diameter (D) of a circle is any straight line segment that passes through the center and whose endpoints are on the circular boundary, or, in more modern usage, the length of such a line segment.

DAC

- **Data Acquisition and Control:** Gathering and analyzing information, making a decision based upon that analysis, and then acting accordingly (*See also:* "DACS" on page 6).
- **Digital-to-Analog Converter:** In electronics, a DAC is a device for converting a digital (usually binary) code to an analog signal (current, voltage or electric charge). Digital-to-analog converters are interfaces between the abstract digital world and analog real life.

  The reverse operation is performed by an analog-to-digital converter (ADC).

See also: "ADC" on page 3.

DACS

A Data Acquisition Control System is a network of sensors and actuators governed by a controlling application. On SuperFlow systems, this application is often referred to as the "sensor box."

decibel (dB)

A dimensionless, logarithmic unit of measurement used for expressing ratios. Decibels are useful for measurements in acoustics, physics, electronics, and other disciplines. A decibel is one tenth of a bel (B).

DEF

A SuperFlow WinDyn™ configuration (channel DEFinition).

DEFTool

The SuperFlow WinDyn Configuration Utility program used to view the CFD file.

See also: "CFA/CFD configuration file" on page 5.

DIN

Deutsches Institut für Normung (DIN; in English, the German Institute for Standardization) is the German national organization for standardization.

DIN and mini-DIN connectors, as well as DIN rails, are several examples of older DIN standards used around the world today.

displacement

A change of position.

See also: "CID" on page 5 and "VE%" on page 16.

display file

A WinDyn file that configures real-time current data displays on the computer monitor. Each display consists of one or more screens; each screen consists of one or more instruments.

See also: "screen group" on page 14.

DPDT/DPST

Double-Pole, Double-Throw (DPDT) or Double-Pole, Single-Throw (DPST) describes a switch or relay that can throw or make electrical contact with two separate stationary contacts.

DRAM

Dynamic Random Access Memory (DRAM) is a type of memory used in most computers.

See also: "EPROM" on page 7, "RAM" on page 13, "ROM" on page 13, and "SRAM" on page 14.

dynamometer

A dynamometer (dyno) is a machine used to measure torque and rotational speed (rpm) from which power produced by an engine, motor, or other rotating prime mover can be calculated.

See also: "chassis dynamometer" on page 5 and "engine dynamometer" on page 7.

E

EC (eddy current)

An eddy current is caused by a moving magnetic field intersecting a conductor or vice-versa.

ECE

The Economic Commission for Europe (ECE) was established to encourage economic cooperation among its member States.

EGT

Exhaust Gas Temperature. EGT numbers are a good way to diagnose intake manifold distribution problems.

EMS

Emergency Stop (EMS) is a SuperFlow feature that disables an engine from running.

engine dynamometer

An engine dynamometer measures power and torque directly from the engine's crankshaft (or flywheel), when the engine is removed from the vehicle.

See also: "dynamometer" on page 7 and "chassis dynamometer" on page 5.

EPROM

An Erasable Programmable Read-Only Memory (EPROM) is a type of nonvolatile computer memory chip that retains its data when its power supply is switched off. It is an array of floating gate transistors individually programmed by an electronic device that supplies higher voltages than those normally used in electronic circuits.

See also: "DRAM" on page 7, "RAM" on page 13 and "ROM" on page 13, and "SRAM" on page 14.

Ethernet

Ethernet is a large and diverse family of frame-based computer networking technologies for Local Area Networks (LANs). It defines a number of wiring and signaling standards for the physical layer, two means of network access at the Media Access Control (MAC)/Data Link Layer, and a common addressing format.

See also: "LAN" on page 10.

F

F (Fahrenheit)

Fahrenheit (measured in degrees) is a temperature scale where the freezing point of water is 32 degrees Fahrenheit (32°F) and the boiling point is 212 degrees, placing the boiling and freezing points of water exactly 180 degrees apart. Negative 40 degrees Fahrenheit (-40 °F) is equal to negative 40 degrees Celsius (-40 °C).

See also: “calibration” on page 4.

force

In physics, force is an influence that may cause a body to accelerate. Force may be experienced as a lift, a push, or a pull and has a magnitude and a direction. The actual acceleration of the body is determined by the vector sum of all forces acting on it (known as net force or resultant force). In an extended body, it may also cause rotation or deformation of the body. Rotational effects and deformation are determined respectively by the torques and stresses that the forces create.

See also: “torque” on page 15, and “work” on page 17.

friction power

The horsepower it takes to spin all the engine parts to a particular rpm. Data can come from motoring the engine or from a look-up table in the software.

ft-lb

The foot-pound force (ft-lb_f) is an English unit of work or energy (frequently abbreviated to foot-pounds). Foot-pound force is the name given as the unit of measure for “kinetic energy” equation.

When using torque setting for a torque wrench, such as a specification for tightening a fastener, use the engineering units of ft-lb.

See also: “torque” on page 15 *and* “lb-ft” on page 10.

ft^3/sec

A cubic feet per second (also cfs and ft^3/s) is an Imperial unit/U.S. customary unit volumetric flow rate, which is equivalent to a volume of 1 cubic foot flowing every second.

fuel flow

The amount of fuel used at each data point. Typically measured as pounds per hour (lbs./hr.).

G

gpm

gallons per minute

group name

Network name used to designate several devices on the network as part of a common group. Each device that shares the common name is part of the same group.

See also: “node name” on page 12.

H

H_2O

Water (Hydrogen and Oxygen)

Freezing point 0°C (32°F); boiling point 100°C (212°F); specific gravity (4°C) 1.0000; weight per gallon (15°C) 8.338 pounds (3.782 kilograms).

H_2O temp

The water temperature that flows in and out of the engine.

hardware

Hardware is the general term that is used to describe physical artifacts of a technology.

It can be equipment such as fasteners, keys, locks, hinges, latches, corners, handles, wire, chains, plumbing supplies, tools, utensils, cutlery and machine parts.

In the computer industry, hardware refers to computer equipment such as Central Processing Units (CPUs), disks, disk drives, display screens, keyboards, printers, boards, and chips.

See also: “software” on page 14.

Help file

Instructions and other information accessed on a computer. The file extension is .hlp.

Many programs come with the instruction manual or a portion of the manual integrated into the program. To access online documentation in most programs using Microsoft Windows®, press the **F1** function key.

hill simulation

A special autotest used to simulate hill conditions while driving on a flat test track. Typically used in towing dynamometer applications.

horsepower

Horsepower (hp) is a non-metric unit of power listing the maximum rate of power application of internal-combustion engines.

The English horsepower is defined in terms of ft-pound force.

1 watt (W) = ˜ 44.253 728 96 ft·lbf/min

1 horsepower (hp) (Imperial mechanical) = 33000 ft·lbf/min = 550 ft·lbf/s

See also: “lb-ft” on page 10.

I

icfm

inlet cubic feet per minute

See also: “cfm” on page 5.

IDE

An Integrated Drive Electronics (IDE) interface is an interface for mass storage devices in which the controller is integrated into the disk or CD-ROM drive.

in/Hg)

Inches of mercury (inHg, in/Hg, or Hg) is a unit for pressure. It is defined as the pressure exerted by a column of mercury of 1 inch in height at 32 °F (0 °C) at the standard acceleration of gravity.

1 inHg = 3,386.389 pascals at 0°C

See also: “calibration” on page 4 and “Pascal” on page 12.

inertia

The property of matter which requires a force to be exerted upon it to change either its position or motion.

inH$_2$O

Inches of water is a unit of measurement for pressure. It is expressed as the pressure required to displace a quantity of liquid in a fixed or given area, i.e., a tube or manometer.

See also: “H2O” on page 8 and “inH2O” on page 9.

inlet air temperature

The CAT or carburetor air temperature.

install

Load a file into the test system to use.

install, save, exit

Install a file into the test system, save changes, and exit the current program editor.

instrument

A virtual measurement device (such as an analog meter or bar graph) that displays on the computer monitor and shows data in real-time. Also called a *screen object*.

ISA

Industry Standard Architecture (ISA) was a computer bus standard for IBM®-compatible computers.

K

km

A kilometer (km) is a unit of length that is equal to 1,000 meters, the current International System of Units (SI) base unit of length.

kPa

Kilo Pascal is a unit of pressure: 1 kPa is approximately the pressure exerted by a 10-g mass resting on a 1-cm^2 area. 101.3 kPa = 1 atm. There are 1000 pascals in 1 kilo pascal.

See also: “Pascal” on page 12.

kW

A kilowatt (kW) is a unit of power equal to 1,000 watts. A watt (W) is the International System of Units (SI) derived unit of power, equal to one joule per second. One joule is the work done or energy required to exert a force of one newton for a distance of one meter.

See also: "N-m" on page 11 and "newton" on page 12.

L

lambda

A sensor that measures air-fuel (A/F) ratio.

LAN

A Local Area Network (LAN) is a computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings and connect workstations and computers. However, one LAN can be connected to other LANs over any distance through telephone lines and radio waves. A system of LANs connected in this way is called a Wide-Area Network (WAN).

See also: "Ethernet" on page 7, "NetBEUI" on page 11, "NetBIOS" on page 11, "CAN" on page 4, and "WAN" on page 16.

lb-ft

When torque is generated by an engine *and* absorbed and measured by SuperFlow dynamometer systems, the engineering units are in lb-ft (pound-feet).

See also: "force" on page 8, "ft-lb" on page 8, and "N-m" on page 11.

LCD

A Liquid Crystal Display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector.

L/D ratio

Length-to-diameter (L/D) ratio is a frequently used engineering relationship.

In aerodynamics, the **lift-to-drag (L/D) ratio** is the amount of lift generated by a wing, compared to the drag it creates by moving through the air.

Both concepts can be applied when referring to lift-to-valve-diameter ratio.

LED

A Light-Emitting Diode (LED) is a semiconductor device that emits incoherent narrow-spectrum light when electrically biased in the forward direction.

l/s

Liters per second is a type of flow measurement used to quantify bulk fluid or gas movement.

Limits or Safety Limits

A WinDyn program that monitors selected channels and reacts to trip values on those channels.

linearize

To associate a non-linear function (such as temperature) with a measured linear parameter (such as voltage).

lpm

Liters per minute is a type of flow measurement used to quantify bulk fluid or gas movement.

M

m (meter)

The meter (m) is a measure of length. It is the basic unit of length in the metric system and in the International System of Units (SI) used around the world for general and scientific purposes. This is approximately the distance from floor to hip on the average barefoot man.

See also: "cm" on page 5 and "mm" on page 11.

m^3/sec

A cubic meter per second (m3/sec, m3 ·s-1, m3/s) is a derived International System of Units (SI) unit of flow rate equal to that of a cube with sides of one meter (1000 mm; 39.37 in) in length exchanged or moving each second. It is popularly used for water flow, especially in rivers and streams, and fractions for Heating, Ventilation, Air Conditioning (HVAC) values measuring air flow.

mag/TTL

The term magnetic/Transistor-Transistor Logic (mag/TTL) refers to a low-level signal typical of magnetic sensors. The TTL signal is optimum 0–5 VDC. Mag and TTL are two different types of low-level signals.

manifold pressure

Manifold pressure is typically for reading the pressure inside the intake manifold.

margin of error

A specific index that is beyond or less than the minimum acceptable number.

MDI-X

Medium Dependent Interface-X (crossed): crossover 10Base-Tx Ethernet interface connector.

MDX

Multi-channel Data Exchange: normal 10Base-Tx Ethernet interface connector.

ME%

Mechanical Efficiency. To calculate, divide the brake horsepower by the indicated horsepower (IHp).

mean

The sum of a data set divided by the number of items in the set (also know as *average*).

micron or micrometer (µm)

One millionth of a meter

mm

A millimeter (mm) is one thousandth of a meter, the International System of Units (SI) base unit of length.

See also: “cm” on page 5, “m (meter)” on page 10, and “micron or micrometer (mm)” on page 11.

m/s

Milliliters per second is a type of flow measurement used to quantify bulk fluid or gas movement.

N

N-m

A Newton-meter (N-m) is a compound unit of torque corresponding to the torque from a force of one newton applied over a distance arm of one meter.

(A newton is the amount of force required to accelerate a body with a mass of one kilogram at a rate of one meter per second squared).

See also: “lb-ft” on page 10.

NetBEUI

Pronounced *net-boo'-ee*, NetBIOS Extended User Interface (NetBEUI) is an enhanced version of the NetBios protocol used by Microsoft Windows networking.

It is a non-routable protocol, which means computers not located on the same network segment or subnet cannot communicate.

See also: “Ethernet” on page 7, “LAN” on page 10, and “NetBIOS” on page 11.

NetBIOS

Network Basic Input/Output System. An application-programming interface used to implement data exchange between computer nodes usually connected through a Local Area Network (LAN.

See also: “Ethernet” on page 7, “LAN” on page 10, and “NetBEUI” on page 11.

newton

A newton (N) is the amount of force required to accelerate a mass of one kilogram (Kg) at a rate of one meter per second squared.

1 N = 1 Kg X m/s^2

See also: "N-m" on page 11 and "Pascal" on page 12.

NGE

New Generation Electronics: a SuperFlow data acquisition and control system for dynamometers.

See also: "chassis dynamometer" on page 5, "dynamometer" on page 7, and "engine dynamometer" on page 7.

NIC

Network Interface Card. Provides the required hardware support for network communications. Typically inserted into one of the computer card slots or CCAlptop slots.

node name

Network name of an individual device.

See also: "group name" on page 8.

O

O.D.

Outside Diameter

OEM

Original Equipment Manufacturer

ohm

The ohm (symbol: Ω) is the SI unit of electrical impedance or, in the direct current case, electrical resistance.

oil temp

Temperature of the oil that flows in and out of the engine.

oil pressure

Typically shown in psi, oil pressure indicates the pressure in the oiling system just prior to lubricating the engine bearings.

overlay

Graphically compare two or more sets of test data.

P

Pascal

The Pascal (Pa) is the International System of Units (SI) derived unit of pressure or stress. It is equivalent to one newton per square meter.

See also: "newton" on page 12.

PCB

In electronics, Printed Circuit Boards (PCBs) are used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive substrate.

Alternative names are printed wiring board (PWB), etched wiring board, and switchboard. After populating the board with electronic components, a printed circuit assembly (PCA) is formed.

PCI

The Peripheral Component Interconnect, or PCI Standard, specifies a computer bus for attaching peripheral devices to a computer motherboard. These devices can take any of the following forms:

- An *integrated circuit* fitted onto the motherboard itself, called a *planar device* in the PCI specification.
- An *expansion card* that fits in sockets.

The PCI bus is common in modern computers, where it has displaced ISA and VESA Local Bus as the standard expansion bus, but it also appears in many other computer types. The bus will eventually be succeeded by PCI Express, which is standard in most new computers and other technologies.

percentage of error

The theoretical value minus the actual value divided by the actual value times 100.

PID

A Proportional, Integral, and Derivative (PID) controller is a common feedback loop component in industrial control systems.

See also: "Control" on page 5.

probable error

A term that can be defined with mathematics and is directly related to the number of samples taken.

psi

The pound-force per square inch (lbf/in^2) is a unit of pressure based on avoirdupois units. In casual English language use, it is rendered as "pounds per square inch" (psi) with little distinction between "mass" and "force."

R

RAM

Random Access Memory (RAM) is a type of volatile computer memory in the form of integrated circuits that can be accessed randomly in any order. RAM is the most common type of memory found in computers and other devices such as printers.

See also: "DRAM" on page 7, "EPROM" on page 7, "ROM" on page 13, and "SRAM" on page 14.

receive

Retrieve (download) a file from the test system and save it to a computer disk.

real-time data

Data displayed as it occurs.

repeatability

A test that readily duplicates another test under the same conditions.

RJ-45

Registered Jack-45. An eight-wire connector used in networking) when Cat-5 (Category 5) Unshielded Twisted Pair (UTP) cables are used.

ROM

Read-Only Memory (ROM) is prerecorded nonvolatile computer memory. Once data is written onto a ROM chip, it cannot be removed and can only be read.

Unlike RAM, ROM retains its contents even when the computer is turned off.

See also: "DRAM" on page 7, "EPROM" on page 7, "RAM" on page 13, and "SRAM" on page 14.

rpm

Revolutions per minute (rpm) is a unit of frequency commonly used to measure rotational speed—particularly in the case of rotation around a fixed axis. It represents the number of full rotations an object makes in one minute.

S

SAE

SAE International is the Society of Automotive Engineers (SAE), a professional organization for mobility engineering professionals in aerospace, automotive, and the commercial vehicle industries. The Society is a standards development organization for engineering powered vehicles of all kinds, including cars, trucks, boats, aircraft, and others.

saved test

Test data saved in a file on a computer disk.

See also: "current test" on page 6.

scfm

standard cubic feet per minute (*see* "cfm" on page 5)

screen

One of the available windows in a single WinDyn screen group.

screen group

A WinDyn file that configures real-time current data displays on the computer monitor. Each screen group consists of one to ten screens; each screen consists of one or more instruments. Screen groups have a CDF extension.

screen object

A virtual measurement indicator (for example, meter, bar graph, strip chart, etc.) located on a WinDyn screen. Also called an instrument.

serial port

In computing, a serial port is a serial communication physical interface through which information transfers in or out one bit at a time (contrast parallel port).

While such interfaces as Ethernet, FireWire, and USB all send data as a serial stream, the term "serial port" usually identifies hardware more or less compliant to the RS-232 standard, intended to interface with a modem or with a similar communication device.

For the most part, the USB interface has replaced the serial port.

See also: "USB" on page 16.

servo

A servomechanism, usually shortened to servo, is a power-driven mechanism that automatically controls the performance of a machine.

set point

A value to which a controller attempts to maintain.

SIMM

Single In-line Memory Module is a small circuit board that can hold a group of memory chips. Typically, SIMMs hold up to eight (MacIntosh) or nine (PC) RAM chips. SIMMs are measured in bytes rather than bits.

See also: "DRAM" on page 7, "EPROM" on page 7, "RAM" on page 13, "ROM" on page 13, and "SRAM" on page 14.

software

Software (or a software program) enables a computer to perform specific tasks, as opposed to the physical components of the system (hardware). This includes application software such as a word processor, which enables a user to perform a task, and system software, such as an operating system, which enables other software to run properly by interfacing with hardware and with other software or custom software made to user specifications.

See also: "hardware" on page 8.

specification

- Specifications (also known as constants) are set values associated with a particular engine, vehicle, or test. For example, engine bore and stroke are parameters associated with an engine and are used to calculate other values. Another example are Lower and Upper speeds used in an automated test. A specification file is used to enter all the specifications simultaneously. Specification files have a .cst extension.
- A technical description of the construction or requirements for a product or device. In general, specifications are in the form of written descriptions, drawings, prints, commercial designations, industry standards, and other descriptive references.

SRAM

Static Random-Access Memory (SRAM) is a type of memory that is faster and more reliable than the more common DRAM (Dynamic RAM). The term static is derived from the fact that it doesn't need to be refreshed like DRAM.

See also: "DRAM" on page 7, "EPROM" on page 7, "RAM" on page 13, and "ROM" on page 13.

STP

The Standard Temperature and Pressure (STP) standard (sometimes called STD) is a power correction standard considered by the SAE to be obsolete but is still widely used in the performance industry.

SWED

The SWitch EDitor (SWED) file configures the front panel switches for SuperFlow data acquisition systems that include a relay box.

switch configuration

Specifies the function of a system's switches, relays, and digital input/output (I/O). Switch files have .sca (editable) and .scf (compiled) file name extensions. The program that defines a switch configuration is called SWED.

T

T/in3

Torque per cubic inch is a way to rate engine efficiency. Torque is the brake torque divided by the displacement in cubic inches.

TCP/IP

TCP/IP (Transmission Control Protocol/Internet Protocol) is the basic communication language or protocol of the Internet. It can also be used as a communications protocol in a private network (either an intranet or an extranet).

TDC

Top Dead Center (TDC) is the position of a piston where it is furthest from the crankshaft.

See also: "BDC" on page 3 and "BTDC" on page 4.

test averaging

WinDyn can mathematically average the data from multiple tests into a single data file. The averaged data may then be displayed, plotted, and printed like any other data file.

test data

The recorded information from an AutoTest saved to memory or a computer disk.

test description

User notes describing a test and saved with the test data.

test group

Comprises a set of system files including a configuration, screen group, channel order, etc. Used to quickly configure the system for a specific application or series of tests. Test group files have a .tgp extension.

test system

A test system normally consists of a data acquisition and control system, a dynamometer, and a number of sensors. The test system is responsible for controlling and measuring the vehicle or engine under test.

thermocouple

A thermocouple is a sensor for measuring temperature. It consists of two dissimilar metals, joined together at one end. When the junction of the two metals is heated or cooled, a voltage is produced that can be correlated to the temperature. Thermocouple alloys are commonly available as wire.

torque

A twisting force, expressed in pounds-feet (lbs-ft). In physics, torque (or often called a moment) can informally be thought of as "rotational force" or "angular force" which causes a change in rotational motion.

See also: "force" on page 8 and "work" on page 17.

towing dynamometer

A trailer- type test system towed behind a vehicle. The dynamometer installed in the trailer loads the engine by applying a measured pulling force to the draw bar of the vehicle. The draw bar pull is often programmed as a hill simulation while driving on a flat test track.

TPF

Test Profile. Also referred to as an autotest.

TPS

A Throttle Position Sensor (TPS) is a sensor used to monitor the position of the throttle in an internal combustion engine. The sensor is usually located on the butterfly spindle so it can directly monitor the position of the butterfly throttle valve.

The sensor is usually a potentiometer and therefore provides a variable resistance dependent upon the position of the butterfly valve (and hence throttle position).

TTL

Transistor-Transistor Logic (TTL) is a class of digital circuits built from Bipolar Junction Transistors (BJTs) and resistors. It is called transistor-transistor logic because both the logic gating function (e.g., AND) and the amplifying function are performed by transistors.

U

μm (micron or micrometer)

One millionth of a meter

undefined channel

A configuration channel that has not been assigned a purpose. Initially, all configuration channels are "undefined." Deleting any channel from a configuration causes it to become undefined.

unique name

A network name that uniquely identifies a device on the network.

See also: "node name" on page 12.

USB

Universal Serial Bus (USB) is an external bus standard that supports data transfer rates of 12 Mbps. A single USB can be used to connect up to 127 peripheral devices such as mice, modems, and keyboards. USB also supports plug-and-play installation and hot plugging.

See also: "serial port" on page 14.

UPS

Uninterruptible Power Supply. A UPS (sometimes called a battery backup) is a device which maintains a continuous supply of electric power to connected equipment by supplying power from a separate source when utility power is not available

V

vapor pressure

The pressure exerted by water vapor in the atmosphere. Vapor pressure is typically listed in inches of mercury (Hg). A system data sensor normally provides the vapor pressure reading.

VDC/VAC

VDC is a three-letter abbreviation with multiple meanings; the most common is Volts (V) of continuous current (Direct Current—DC). VAC stands for Volts of Alternating Current.

VE%

Volumetric Efficiency. It is normally calculated from the swept volume of the engine versus the amount of airflow the engine has consumed.

velocity

The velocity of an object is its speed in a particular direction. Velocity can also be defined as rate of change of displacement or just as the rate of displacement. It is a vector physical quantity with dimension $LT^{(-1)}$.

See also: "displacement" on page 7.

VFD

A Vacuum Fluorescent Display (VFD) is a type of display used primarily on consumer-electronics equipment such as video cassette recorders and microwave ovens. Unlike Liquid Crystal Displays (LCDs), a VFD emits a very bright light with clear contrast and can easily support display elements of various colors.

W

WAN

A Wide Area Network (WAN) is used to connect Local Area Networks (LANs) and other types of networks together so users and computers in one location can communicate with users and computers in other locations.

See also: "LAN" on page 10 and "CAN" on page 4.

WinDyn™

SuperFlow Technologies Group's dynamometer software package.

work

Work is the quantity of energy transferred from one system to another. In a typical measurement system, work is gauged in joules. The rate at which work is performed is power.

See also: "force" on page 8 and "torque" on page 15.

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