SP6 INSTALLATION AND SETUP MANUAL

Contents

1 SportDevices End User Software License & Warranty Disclaimer

DISCLAIMERS

Limitations of warranties and liability: This Software, including the embedded SPx DAQ firmware, is provided and licensed by SportDevices on an "as is" basis, without any other warranties or conditions, express or implied, including, but not limited to, warranties of merchantable quality, satisfactory quality, merchantability or fitness for a particular purpose or non-infringement, or those arising by law, statute, usage of trade, course of dealing or otherwise. The entire risk as to the results and performance of the software is assumed by you. To the maximum extent permitted by applicable law, neither SportDevices, its dealers or suppliers shall have any liability to you or any other person or entity for any indirect, incidental, special, or consequential damages whatsoever, including, but not limited to, loss of revenue or profit, lost or damaged data or other commercial or economic loss, even if SportDevices. has been advised of the possibility of such damages, or they are foreseeable. SportDevices is also not responsible for claims by a third party. Other possible damages INCLUDE VEHICLE OR ENGINE DAMAGES, DYNAMOMETER DAMAGES, AND PERSONAL INJURIES. The limitations set forth herein shall apply whether or not the alleged breach or default is a breach of a fundamental condition or term or a fundamental breach.

If you are downloading this Software, the following applies:

All risk of damage to the Software during transmission and download is assumed by you.

All “Software” products, including standard and beta release versions of SportDyno Software and SportDevices’s Firmware are licensed on a (non-transferable) as-is, without warranty, basis only. There are no warranties which extend beyond those stated here. The purchase price of any SPx kit (SP1, SP3, SP4, SP6) includes an implicit software license. This software license does not include any setup, training, calibration, or other consulting services.

By installing and/or using the Software you certify that you have read, understood and agreed to comply with and be bound by the following terms and conditions. If you do not agree with these terms and conditions do not install and/or use the Software.

The only exception to the above is that the “Software’s media” will be replaced (if found to be unreadable) for a duration of 30-days from the original invoice ship date from SportDevices or authorized distributor. Any implied warranty determined to be applicable to the “Software’s media” is limited in duration to the duration of this warranty.

In the event of a media defect in material or workmanship, SportDevices’s sole responsibility is to repair (or at its option - replace or refund) the defective media. Final warranty determination will be the decision of SportDevices.

SportDevices shall not be responsible for (a) labor, transportation or other incidental charges or (b) consequential or other damages incurred by use of SportDevices Software media.
Media replacement performance will be initiated by returning the alleged defective media freight prepaid to SportDevices with dated purchase invoice.

Any disputes arising between the parties over any products, services, warranties, terms, agreements, etc. shall be governed under the laws of Valencia (Spain) and in an appropriate court within its jurisdiction.

This Software License Warranty Disclaimer supersedes all prior warranty statements. Inquiries concerning this Software License Warranty Disclaimer should be directed to:

SportDevices
Cami del Port 145, 46470 Catarroja, Spain

2 General Safety Instructions

Use the following safety guidelines to help ensure your own personal safety and to help protect your equipment and working environment from potential damage.

SAFETY: General Safety

When setting up the equipment for use:

- Place the equipment on a hard, level surface. If the equipment is installed in a closed-in wall unit, ensure that there is enough ventilation.
- Avoid placing objects on top of this equipment to permit the airflow required for proper ventilation. Restricting airflow can damage the equipment.
- Keep your device away from radiators and heat sources.
- Keep your equipment away from extremely hot or cold temperatures to ensure that it is used within the specified operating range. (check technical parameters section)
- Keep your equipment away from Electromagnetic emitting devices like CDI ignition, or electric motors / VFD (Variable Frequency Drive)
- Do not push any objects into the air vents or openings of your equipment. Doing so can cause fire or electric shock by shorting out interior components.
- Ensure that nothing rests on your equipment's cables and that the cables are not located where they can be stepped on or tripped over.

When operating your equipment:

- Do not use your equipment in a wet environment, for example, in a wet basement.
- Do not use AC powered equipment during an electrical storm.
- Do not spill food or liquids on your equipment.
- Before you clean your equipment, disconnect it from the electrical outlet. Clean your device with a soft cloth dampened with water. Do not use liquids or aerosol cleaners, which may contain flammable substances.
- Clean the display with a soft, clean cloth and water. Apply the water to the cloth, then stroke the cloth across the display in one direction, moving from the top of the display to the bottom. Remove moisture from the display quickly and keep the display dry.
- Long-term exposure to moisture can damage the display. Do not use a commercial window cleaner to clean your display.

⚠ **CAUTION: Do not operate your equipment with any cover(s) removed.**

- If your equipment does not operate normally - in particular, if there are any unusual sounds or smells coming from it - unplug it immediately and contact an authorized dealer or service center.

⚠ **WARNING: To prevent the spread of fire, keep open flames away from this product at all times.**

2.1 SAFETY: When Working Inside Your Device

Do not attempt to service the equipment yourself, except as explained in your documentation or in instructions otherwise provided to you by SportDevices. Always follow installation and service instructions closely.

2.2 SAFETY: General Power Safety

 By default, if other values are not specified all SportDevices equipment are rated for **230 VAC / 50 Hz.** (115 VAC units will have a specific label for that)

Observe the following guidelines when connecting your equipment to a power source:

- Check the voltage rating before you connect the equipment to an electrical outlet to ensure that the required voltage and frequency match the available power source.
- Do not plug the equipment power cables into an electrical outlet if the power cable is damaged.
- To prevent electric shock, plug the equipment power cables into properly grounded electrical outlets. If the equipment is provided with a 3-prong power cable, do not use adapter plugs that bypass the grounding feature, or remove the grounding feature from the plug or adapter.
- If you use an extension power cable, ensure that the total ampere rating of the products plugged in to the extension power cable does not exceed the ampere rating of the extension cable.
- If you must use an extension cable or power strip, ensure the extension cable or power strip is connected to a wall power outlet and not to another extension cable or power strip. The extension cable or power strip must be designed for grounded plugs and plugged into a grounded wall outlet.
- If you are using a multiple-outlet power strip, use caution when plugging the power cable into the power strip. Some power strips may allow you to insert a plug incorrectly. Incorrect insertion of the power plug could result in permanent damage to your equipment, as well as risk of electric shock and/or fire. Ensure that the ground prong of the power plug is inserted into the mating ground contact of the power strip.
- Be sure to grasp the plug, not the cable, when disconnecting equipment from an electric socket.

2.3 SAFETY: If Your Device Gets Wet

⚠ **CAUTION: Before you begin any of the procedures in this section, see the SAFETY: General Safety section of this document.**

⚠ **CAUTION: Perform this procedure only after you are certain that it is safe to do so. If the device is connected to an electrical outlet, turn off the AC power at the circuit breaker, if possible, before attempting to remove the power cables from the electrical outlet. Use the utmost caution when removing wet cables from a live power source.**

1. Disconnect the AC cord from the electrical outlet, and then, if possible, disconnect the AC cord from the device.
2. Turn off any attached external devices, then disconnect them from their power sources, and then from the device.
3. Contact SportDevices support (info@sportdevices.com)

⚠ **Limited Warranties:** warranty is limited to normal usage of the device, any fault caused by inappropriate usage or accident will not be covered

2.4 SAFETY: If You Drop or Damage Your Equipment

⚠ **CAUTION: Before you begin any of the procedures in this section, see the SAFETY: General Safety and Power Safety sections of this document.**

4. **CAUTION: If any internal components can be seen through damaged portions, or if smoke or unusual odors are detected, disconnect the device from the electrical outlet and contact SportDevices support** (info@sportdevices.com)

1. Save and close any open files, exit any open programs, and shut down the computer.
2. Turn off the device and disconnect from the power source, and then disconnect from the computer.
3. Turn off any attached external devices, and disconnect them from their power sources and then from the computer.
4. Connect the device to the power source and turn on the device.
5. If the device does not start, or if and smoke or unusual odors are detected, or you cannot identify the damaged components, contact SportDevices support.

2.5 Protecting Against Electrostatic Discharge

⚠ **CAUTION: Disconnect product from mains power source in accordance with product specific safety information located on the "Safety Information" section of this website.**

Electrostatic discharge (ESD) events can harm electronic components inside your device. Under certain conditions, ESD may build up on your body or an object, such as a peripheral, and then discharge into another object, such as your device. To prevent ESD damage, you should discharge static electricity from your body before you interact with any of your device's internal electronic components, like the Bluetooth plug-in.

You can protect against ESD and discharge static electricity from your body by touching a metal grounded object (such as an unpainted metal surface on your device) before you interact with anything electronic.
You can also take the following steps to prevent damage from electrostatic discharge:

- When unpacking a static-sensitive component from its shipping carton, do not remove the component from the antistatic packing material until you are ready to install the component. Just before unwrapping the antistatic package, be sure to discharge static electricity from your body.
- When transporting a sensitive component, first place it in an antistatic container or packaging.
- Handle all electrostatic sensitive components in a static-safe area. If possible, use antistatic floor pads and work bench pads.

2.6 Dynamometer Important Safety Tips

- Securely fasten test vehicle using all available restraining ratchet straps. The more straps the better. Secure both front to back and side to side. Never move the steering wheel for front wheel drive vehicles while under test.
- Always inspect vehicles for fuel or oil leaks before testing as dyno electrical system can ignite fuel
- Always perform low speed test run to confirm vehicle is adequately secured and operational before doing extensive testing.
- Keep people away from the dyno test area and NEVER have people stand behind the rear of the vehicle. Debris may be stuck in the tires tread and may become projectiles during testing.
- When operating around rotating parts do not wear loose fitting clothing as they may get caught up in rotating pulleys or mechanical components
- Keep dyno area clean from all loose objects
- Keep all hands, feet, and other objects away from moving rolls during tests
- Always wear approved safety equipment such as eye protection and steel tow boots around dyno area
- The dynamometer rollers and power absorption units can become very hot during testing. Avoid contact with them as serious burns or injury can occur.
- The dynamometer power absorption units require high voltage DC current to operate.
- Contact with the high power electrical wires and boxes may be fatal. Disconnect all power to the electrical system before inspecting or servicing.
- During extended testing vehicle cooling system and engine may become very hot.
- Extreme caution is necessary when working near these components.
- Always inspect vehicle tires for wear or damage before testing and only operate with tires that are in good condition and at the proper tire pressure. FOR ALL TIRES TIRE PRESSURE SHOULD BE BETWEEN 1.8 to 2.5 bar (25-35 PSI)
- Never let untrained personal operate the vehicle during dyno testing
- Exhaust gasses are poisonous and may be fatal.

2.7 Technical Specs

- Supply Voltage 100-240 Vac
- Power Consumption: max 40 W
- Working Conditions: Temperature: -10ºC to 40ºC, humidity < 90%
- Storage Conditions: Temperature: -20ºC to 80ºC, humidity < 80%
- Provided supplies:
  - 5 V-sensors (max 100 ma)
  - 5V-load cells (max 50 ma / each)
  - 12 V-relays (max 1.2A)

2.7.1 Input Specs

- 4 x **Roller speed input**. TTL input. Max 150 pulses/rev in single roller mode (without prescaler), **Prescaler settings**: 1:1, 2:1, 4:1, 8:1, 16:1 to allow usage of encoders.
- 1 x Engine Rpm Speed input (TTL levels). Capacitive and Inductive clamps available with TTL output.
- 8 x Analog inputs (0-5v) (14 bit)
- 8 x Thermocouple (type-k) Inputs (16 bit)
- 2 x Load Cell input (sampling > 30K SPS, 24 bit accuracy and digital zero/gain), includes a **digital filter.**
- 1 x Low frequency Pulse Counter Input (Ex. detonation counter), max freq is 1000 Hz
- 1 x Run/Stop Button (same as SP1)
- 1 x Panic Button (Emergency Stop)

Notes:

- Sampling frequency is > 30K SPS for load cells and 50 Hz for the rest of channels.

- SportDyno Software allows the usage on an **External analog card** (through CANBUS or MODBUS), for example DEIF CIO308 (CANBUS) provides 8 extra channels that can be configured in several scales for voltage, current or resistance measurement.

2.7.2 Output Specs

- 4 x PWM Brake Control Signal (0-5V, 2.4 KHz fixed, 10 bit, 0 to 100% duty cycle)
- 8 x Digital Outputs (12V Relays) (max 0.5 A sink, max recommended 100 ma)
- 1 x Air Speed Output (PWM 0-5v) (2.4 KHz fixed, 10 bit, 0 to 100% duty cycle)
- 1 x Servo output / Throttle. Selectable from: PWM 0-5v (10 bit), or RC pulse type (PPM, 50 Hz, 0.5 to 2.5 ms pulse)

2.7.3 Connectivity Specifications

- 2 x RS232 DB9 Connector (Computer and provision for serial Console)
- 1 x Ethernet RJ45 Connector (100 Mbps)
- 2 x CANBUS (CAN power supplies, and user data)
- 1 x Internal Bluetooth (available under request)

3 SP6 Installation

3.1 Introduction

The SP6 System consists of a Data Acquisition unit (DAQ) with up to four complete Roller control channels.
There are two hardware versions: AWD/HUB-2 (up to 2 brakes and cells) and HUB-4 version (up to 4 brakes and cells). Each Roller Control Channel consists of:

- Roller speed measurement (hall effect sensor),
- Load Cell channel (brake torque measurement),
- Brake Control output channel

SP6 can be used to automate most functions on a dyno room (engine test bed) or to control a vehicle dynamometer (rolling road or hub dyno).
It has several inputs and outputs to acquire data from the engine and to control the brake(s) and other parts of the installation.

SP6 Kit includes:

- SP6 DAQ unit
- Hall effect sensor(s) to read speed from one roller or from brake
- Capacitive and Inductive clamps, for reading Engine RPM
- Load cell(s) for acquiring brake torque (several models available)
- Brake Power Supply: Input 230 Vac, Output: 200 Vdc, 21 Amp control based on current (40A model available optionally).
- USB to Serial adapter. Note that serial COM still has more immunity against electric noise than USB (specially with 2 stroke engines / CDIs), for this reason we prefer to have the serial cable as long as possible, and USB part close to the computer.
- Installation Cables
- Software CD / Pendrive

3.1.1 Connection with the PWS

PWS should use only one connection at a time: PWM or CAM, please check section 3.4.2.9

3.2 Dynamometer Installation.

Two basic types of dynamometers can be controlled with SP6:

- On **vehicle dynamometers** (roller or hub), SP6 performs basically data acquisition and speed control on the dynamometer roller(s). Normally SP6 is not used to control the vehicle operation, as the operator can actuate directly over the starter motor, throttle, clutch, etc. In some cases SP6 is often used to control certain dynamometer actuators: lifts, motors, etc.

- On **engine test bed dynamometers**, SP6 in addition of Data Acquisition and speed control, can also perform control over several parameters of the engine as engine start, fans, throttle, etc. And the installation can be splitted in a dyno room and a control room to allow the user to operate the engine in a safer and more comfortably way.

3.2.1 Vehicle Dynamometers

Both SP6 AWD and SP6-HUB-4 can be used on several types of vehicle dynamometers:

- Motorcycle dyno (single roller)
- **2WD Car dyno, 1 axle, single roller / twin roller**. Twin roller: Single sensor or double sensor
- **AWD Car Dyno: 2 axles**, single/twin roller. Twin roller: Single or double sensor (total 4 sensors)

- **HUB-2 dynamometer, 2 brakes**, one to each car hub (left / right) for 2WD cars
- **HUB-4 dynamometer: 4 brakes**, one to each car hub for 2WD or AWD cars. This configuration is only available with **SP6-HUB-4 version**
- Other dynos based on rollers, with a maximum of 4 speed sensors

Most sensors/devices are connected typically to SP6:

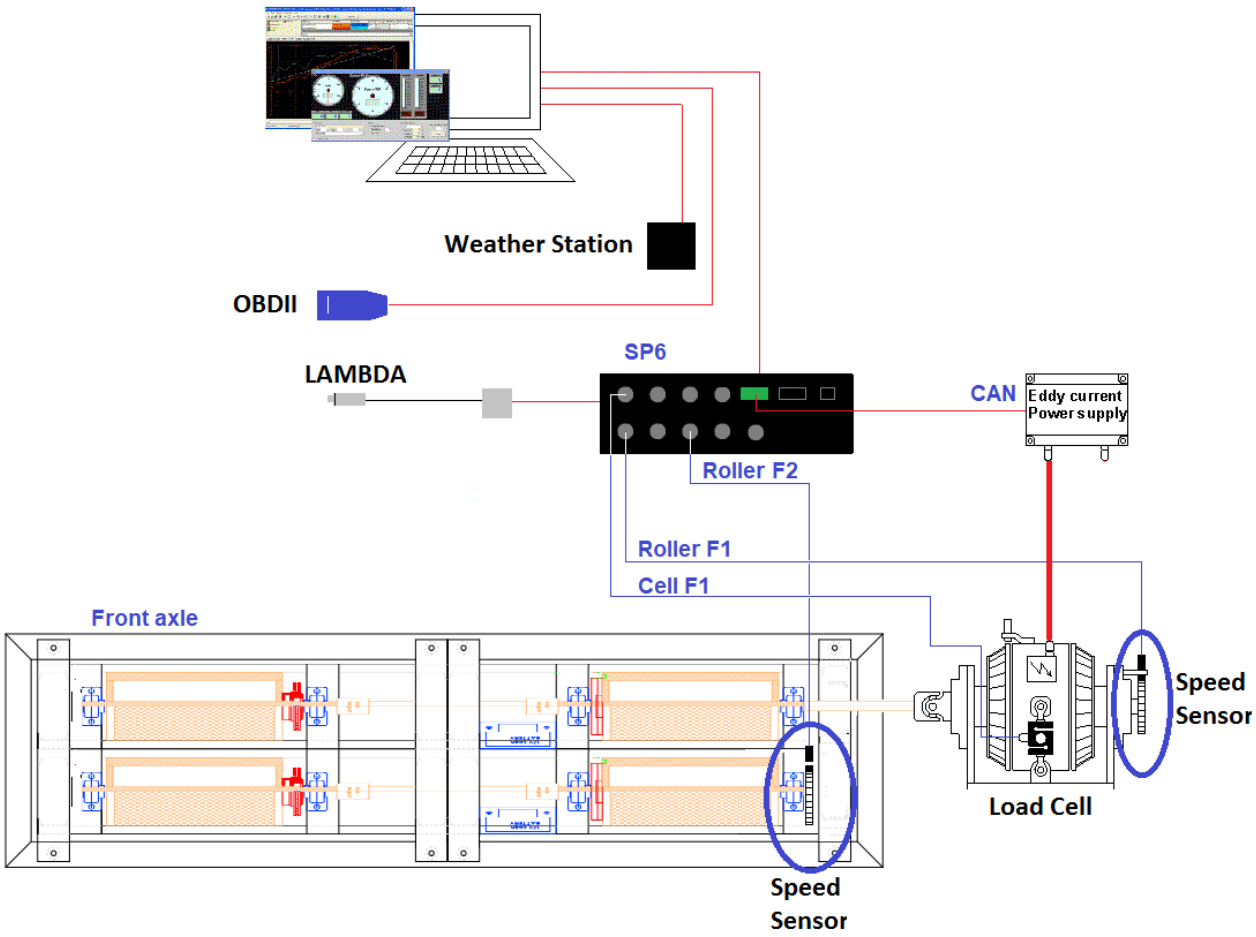
- Lambda (with external controller)
- Thermocouples (water, exhaust, etc) (up to 8)
- Other analog signals (up to 8)
- Remote control

But other devices are connected directly to Computer:

- USB Weather Station
- USB OBDII Interface
- xDS interface
- CAN Adapters
- Serial Exhaust Gas Analyzer

3.2.2 2WD Single / Twin Roller Dynamometer

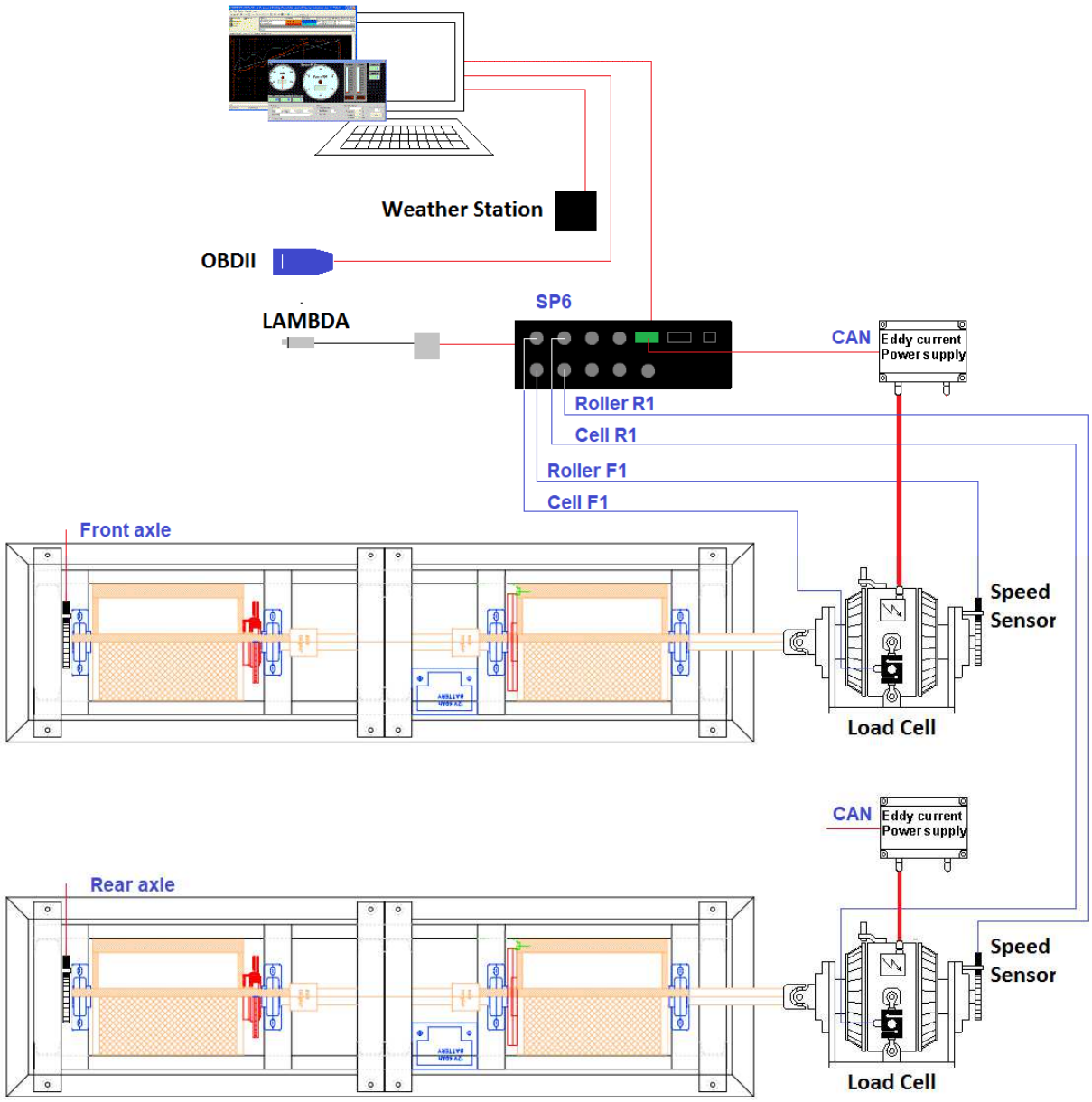
In 2WD dynamometers the main speed sensor (F1) is recommended to be installed at the brake side.
For **single roller dynamometers** there is obviously only one sensor (F1), one load cell (F1) and one power supply + brake, while for **twin roller dynamometers** the rear sub-axle could have its own auxiliary speed sensor connected to channel F2 if the dynamometer does not have a link between front and rear sub-axles in order to measure slippage or tire deformation effects.



Note: auxiliary sensor (F2) is optional

3.2.3 Single Roller AWD Dynamometer:

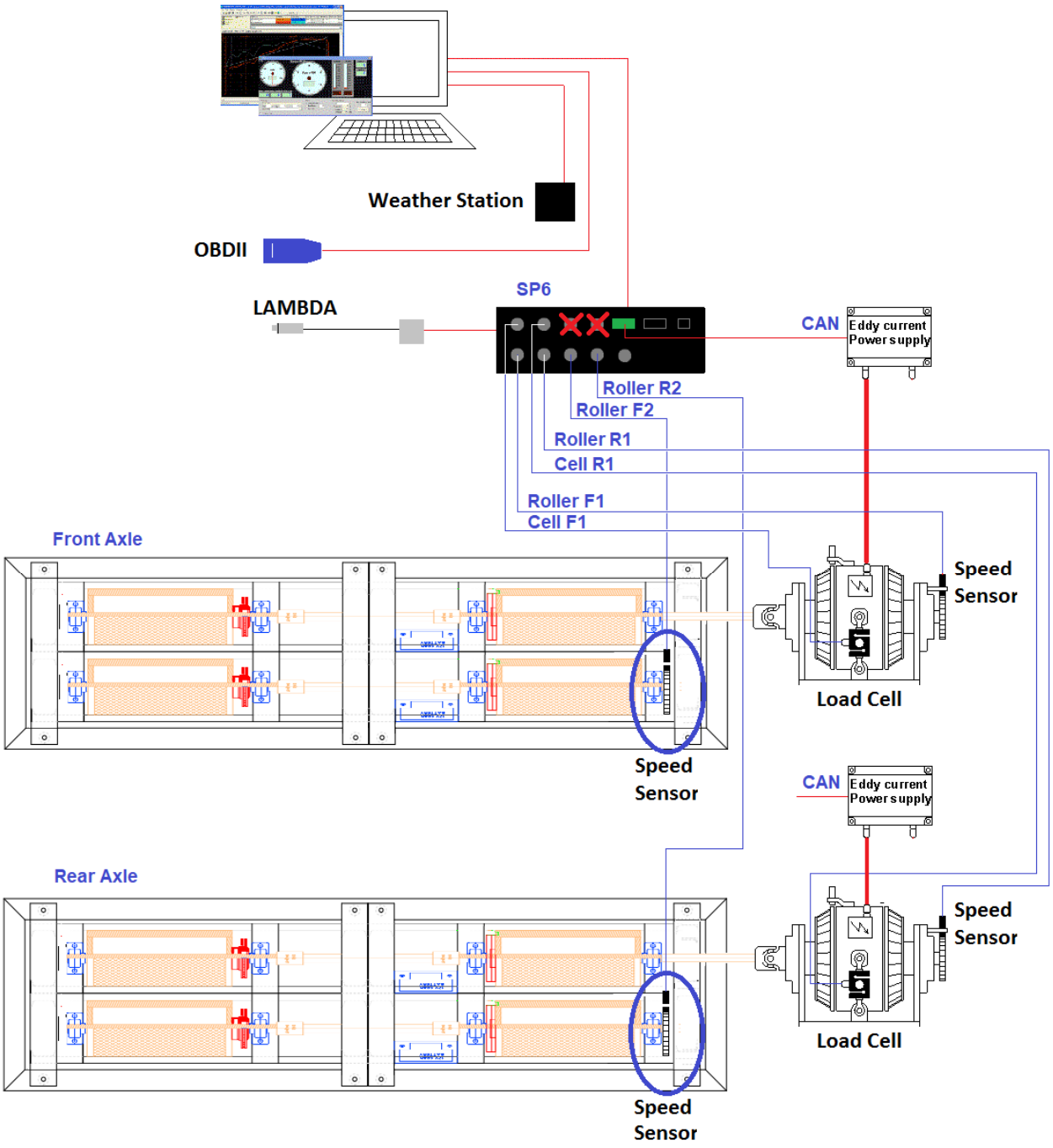
In **single roller AWD dynamometers** each axle has its own hall sensor, load cell, and power supply + brake using F1 and R1 channels, as shown in the picture.



Note: **speed sensor** is recommended to be mounted at **brake side** to avoid the oscillations caused by the elastic couplers

3.2.4 Twin roller AWD Dynamometer:

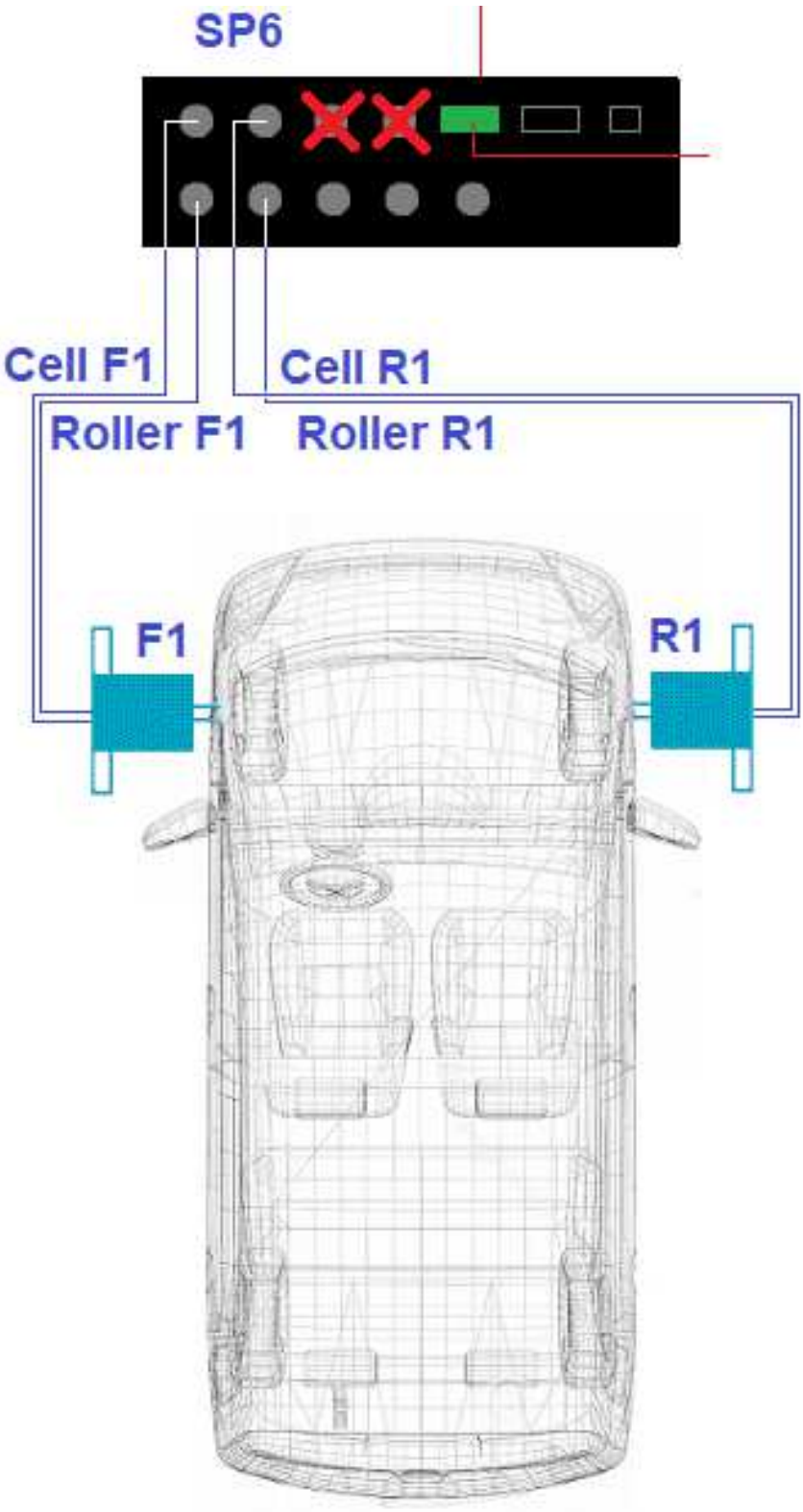
In **twin roller AWD dynamometers F1 and R1 channels** are used (roller and cell). Optionally SP6 could use the same configuration as 2WD twin roller dynamometers (**roller channels F2 and R2**) in order to measure speed at rear-subaxes (not braked), even with the **SP6 AWD version** (2 load cells), since the rear sub-axles are not braked and do not need a load cell.



Note: auxiliary sensors (F2 and R2) are optional

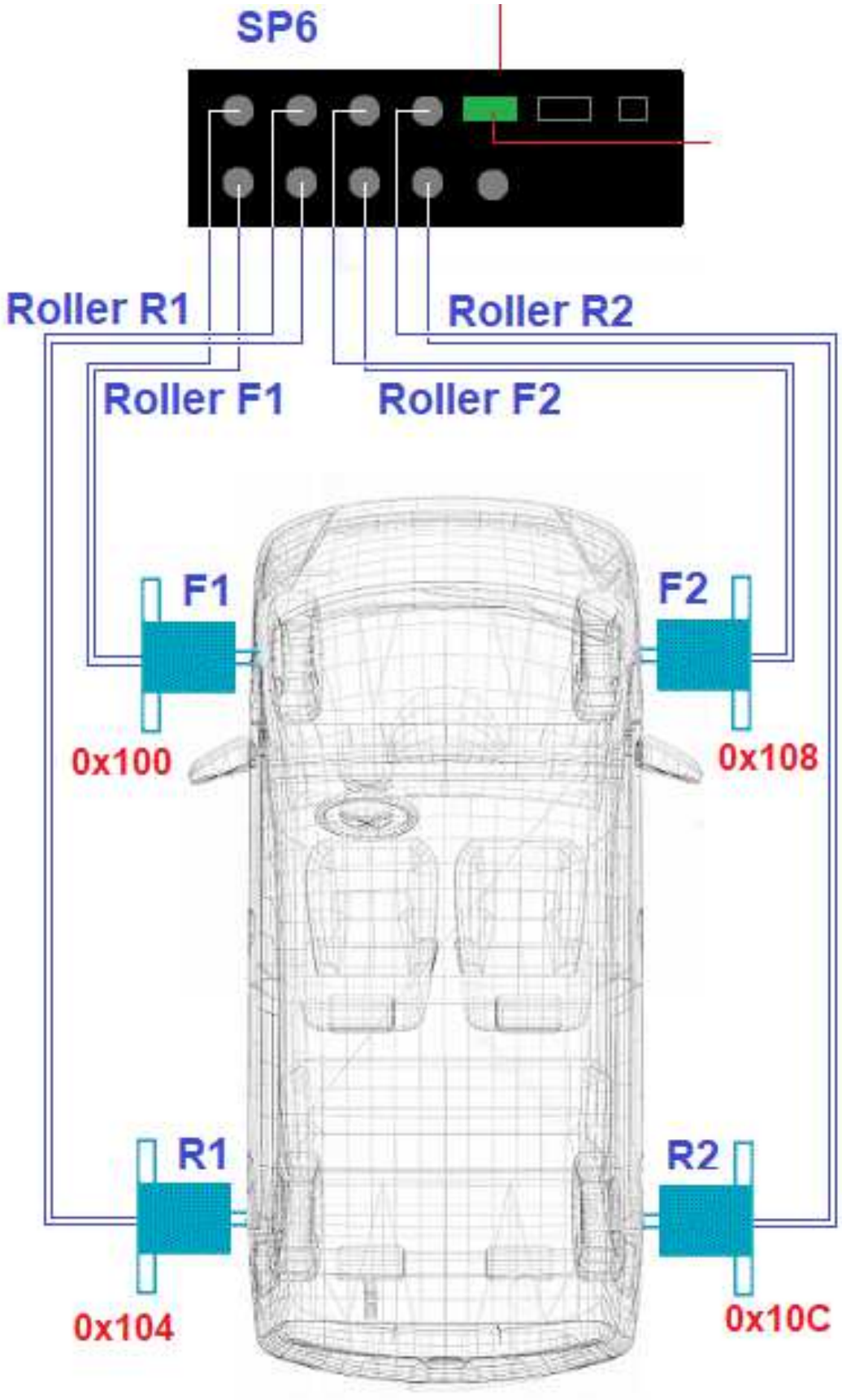
3.2.5 HUB-2 Dynamometer

When using **SP6 AWD/HUB-2** version for a HUB-2 dyno it is important to realize that **only channels F1 and R1 are complete:** rollers F2 and R2 can be used for auxiliary rollers, but **cells F2 and R2 do not exist**. Thus when using the DAQ with a HUB-2 dynamometer only "front" and "rear" channels can be used, then it is proposed to use Front (1) for left side, and Rear (1) for right side. This also happens with **SP5 AWD.**
Actually, left and right channels are swappable.



3.2.6 HUB-4 Dynamometer

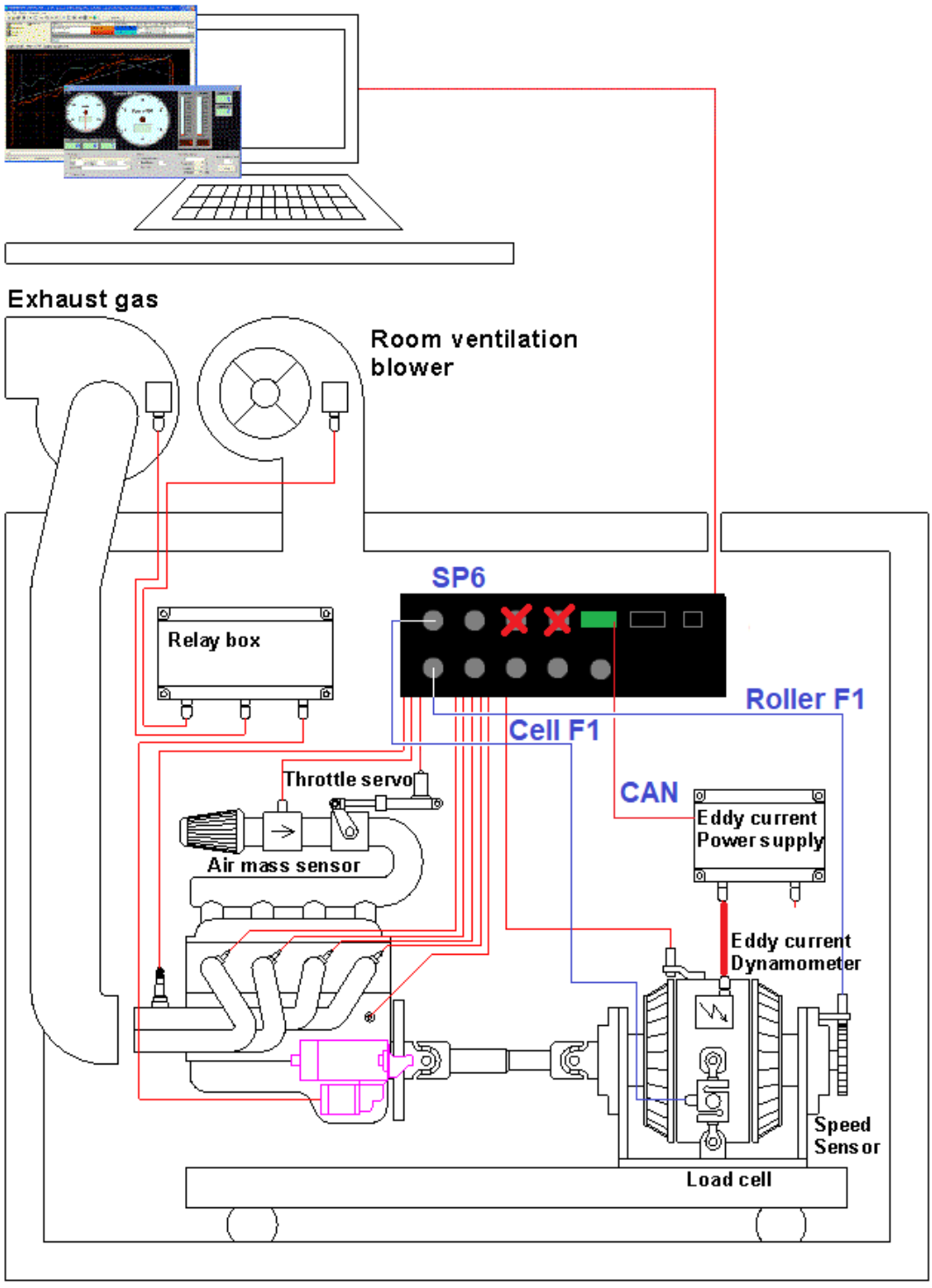
HUB-4 Dynamometer can only be implemented using **SP6-HUB-4 version** since it is the only one that implements the 4 load cells and has the 4 brakes sync active (HUB-2 version will not have it active). In the next picture **CAN IDs** are shown to ease the PWS connections.



3.2.7 Engine Test bed dyno installation

Below is shown a typical dyno room controlled with SP6. Typically a **SP6 2WD** version will be used, which is same HW version as **SP6-AWD** (with 2 load cells) without AWD activation.
Typically only **channels F1 (roller F1 and cell F1)** will be used.

As **SP6 2WD still have two load cell inputs,** this feature can be used to control 2 dynamometers with a single DAQ using two SportDyno profiles. For instance a 2WD dynamometer with channels F1, and engine dynamometer with channels R1, but not at same time!



Note: SP6 can be installed close to the dyno / engine to shorten all data and control cables, and then only the serial cable will have to go through the wall to the computer. All control tasks will be performed

from the computer, although for safety critical actions (as turning the engine ignition OFF) it is recommended to have an extra switch in series, at the control room.
Nevertheless **it is not recommended to install either SP6 or power supplies directly over the chassis** as they are not rated for strong vibrations

3.3 Proposed installation parts.

- **SP6 DAQ module.** This unit provides both Data Acquisition and Speed Control functions.
- **Computer.** Any modern computer with Win7 - 10 will work.
- **USB-Serial adapter**, it is included with the kit
- **Hall Effect Sensor(s).** This sensor(s) is used to read the roller speed (rolling road dynamomer) or brake speed (engine test bed)
- **Gear Tooth.** Installed on the roller or at the eddy current brake to read its speed. Minimum recommended is 16 teeth and maximum 150 (for single brake, 80 for two brakes). Encoders can be used when the internal hardware prescaler is setup correctly.
- **Load Cell.** Reads the brake force / torque. Typical values are 300 kg for motorcycle dynos 500 - 1000 kg for car dynos, but it is recommended to do the math for each dyno.
- **Eddy Current Brake.** 192 volt rated. Normally brakes are rated in the range of 16 to 21 Amps
  Brake Power supply: Current models PWS3.2 and HS-PWS implement the brake control by controlling the brake current.
- **Throttle Servo [optional].** A high torque RC servo can be used to drive the throttle.
- **Ignition and Starter Relays [engine test bed].** 12 volt relays to control the engine. Additional relays can be controlled with the SP6 to control the fans on the room.
- **Fans / Turbines.** Some type of fans or turbines may be necessary for the following functions:
  - Feeding fresh air intake with from outdoor (air inside the room gets hot quickly) this turbine should be very high power (>2 KW, or >5KW) and high speed to simulate on-track conditions, a variable speed driver is recommended + frequency to voltage converter to use the air speed. SP6 has a PWM output called “air-speed” that can control the speed of the air turbine as a function of roller/engine speed.
  - Exhaust extraction, first segment of this tube should be made with iron or steel because the high temperature of exhaust gas.
  - Engine cooling, engine should by cooled by a fan, a car's fan or a truck's fan can be used with a thermostat to ensure the coolant will be at a right temperature all time. A heat interchanger may be also used to increase cooling efficiency.
  - Engine and exhaust pipes cooling, when running on the track the exhaust pipes are being cooled as the vehicle runs, but when working on the dyno they may get too hot and can be damaged. For instance titanium exhaust pipes cannot work at high temperatures.
- **(VFD) Variable Frequency Drive [optional].** It is recommended to control air-intake turbine.

3.4 SP6 Connections

3.4.1 SP6 Front Panel

Front panel has the following Connectors:

9 x Round Connectors:

- 4 x 4-pin **Load Cell** Connectors (HUB-4 version, 2 connectors in AWD/HUB-2 version)
- 4 x 5-pin Connectors for **Roller, Brake Output** and Start/Stop Switch
- 1 x TTL Ignition RPM input (3-pin) the inductive clamp (black)

1 x CANBUS: PWS CAN and user data (250 Kbaud default)

2 x RS232 Serial connector

- COM0: Computer (115200 baud, no parity, 1 stop bit)
- COM1: provision for serial Console

1 x Ethernet Connector (100 Mbit)

1 x Mains 230 VAC / 36W Power Input

SP6 also provides **two leds:**

- Red led, normally OFF. If ON it means that there is some error at initialization. If blinking it may mean that 12V power supply is faulty.
- Green led: normally shows the SP6 activity blinking at different speeds

3.4.1.1 Roller / Brake Front1, Front2, Rear1, Rear2 Connectors

1 – **5V**
2 - GND
3 – Start / Stop Switch (active LOW)
4 – Brake output (PWM 0 to 5 volt, 2.4 KHz)
5 – Roller input (0 to 5 volt pulses)

3.4.1.2 Cell Front1, Front2, Rear1, Rear2 Connectors

1 – Cell (-), SP6 uses up to four 24-bit ADCs with built-in amplifier (in the HUB-4 version)
2 - GND
3 – **5V** (max 50 ma total)
4 – Cell (+)

3.4.1.3 PWS CANBUS

This connector is used for the **Power Supply Communications** (commands and feedback). It can also acquire user data (for instance from an ECU). Default speed is 250 Kbaud, it is not recommended to be changed (it will cause to lose communications with power supplies)

1 – GND
2 - CANL
3- Shield
4- CANH
3 – **5V** (max 100 ma)

3.4.1.4 Engine RPM Input

1 – GND
2 – Engine RPM pulses (0-5 V)
3- **5V** (max 100 ma)

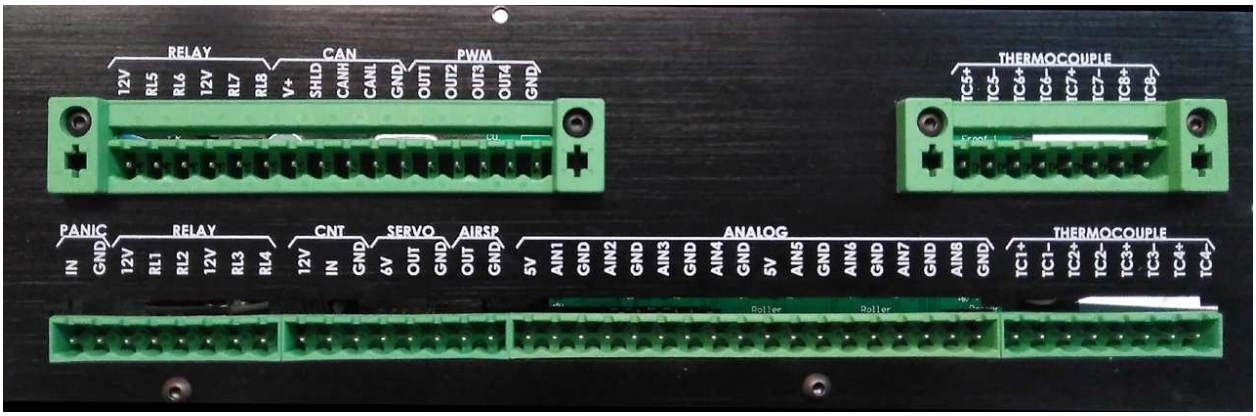
3.4.1.5 USER CANBUS

This CANBUS allows the user to acquire data from ECUs or other CAN devices at a different speed than PWS BUS (250 Kbaud). Please note that pinout does not match the PWS CANBUS pinout

1 – GND
2- Shield
3- CANH
4 - CANL
3 – **5V** (max 100 ma)

3.4.2 SP6 Rear Panel

Rear Panel has the following Connectors:



- 8 x Relays: Relays 1-4 at bottom row, Relays 5-8 at top row
- 1 x CANBUS (extra CANBUS for user data, default 250 Kbit, configurable)
- 4 x PWM outputs (same signal as for the front round connectors)
- 8 x Type K Thermocouples. Bottom Row: sensors 1 to 4. Top Row: sensors 5 to 8
- 1 x "Panic" Input (Emergency Stop)
- 1 x Low Speed counter CNT (typically for detonation counter)
- 1 x Servo Output: internally configurable to RC pulse (PPM) or PWM / analog
- 1 x Airspeed output: PWM 0-5 volt as a function of roller speed
- 8 x Analog inputs, 0 to 5 Volt (lambda, etc)

3.4.2.1 Relays

There are 8 Relay Outputs. Each relay output consists of an Open Collector line (-) and a 12 Volt Positive line which are intended to drive low power 12 volt relays / 100 ohm approx.
The maximum power deliverable by the SP6 is **1.5A**, this means that low consumption relays should be used, but they can be operated all at a time (while SP5 had restrictions with the max number of relays)

Normally the terminals Normally Open and Common are used on the relays for some of the following functions:

- Power the engine ECU/CDI (ignition output)
- Operate the starter Relay (the small relay operates a bigger relay, not the starter motor)
- Cooling Fans
- Other actuators such as an elevator to ease the vehicle to entering/going out from twin rollers

Function	SP6	Sequencer
IGN / Ignition	RL1	7
Starter relay	RL2	6
FAN1 (user)	RL3	5
FAN2 (user)	RL4	4
F1 / Func (user)	RL5	3
F2 / Lift	RL6	2
F3 / Bed (in)	RL7	1
F4 / Bed (out)	RL8	0

3.4.2.2 Panic Button

Panic Button / Emergency Stop is a Normally Open Switch that can be connected to the “panic” terminals. Polarity does not matter. When pressed the SP6 will apply a pre-defined brake torque to the rollers until they are stopped (switch can be released before the rollers are stopped)

3.4.2.3 PWM outputs

PWM signals are replicated at back side to ease the installation of SP6 and PWS, in order to avoid using the “T-cables” that split the signal from 5-pin connectors between hall sensor and PWS (as in SP5)
1 – OUT1 (F1)
2– OUT (R1)
3– OUT3 (F2)
4 – OUT4 (R2)
5 – GND

3.4.2.4 Counter Input

Low Speed counter CNT (typically for detonation counter)

1 – 12V (100 ma max)
2– Input (0-5V, max 1000 Hz)
3– GND

3.4.2.5 Servo Output

Servo Output is internally configurable to RC pulse (PPM) or PWM / analog
1 –6V (4A max)
2– Output. Configurable to PPM, PWM, analog (0-5V)
3– GND

3.4.2.6 Air Speed

Airspeed output: PWM 0-5 volt / 2.4 KHz as a function of roller speed
1 –Output (0-5V), configurable as PWM or analog
2– GND

3.4.2.7 Analog inputs

SP6 provides up to 8 analog inputs with a 12-bit converter

1-5V	10-5V
2-AIN1 / LAMBDA1	11-AIN5
3-GND	12-GND
4-AIN2 / LAMBDA2	13-AIN6
5-GND	14-GND
6-AIN3	15-AIN7
7-GND	16-GND
8-AIN4	17-AIN8
9-GND	18-GND

3.4.2.8 Thermocouple Inputs

SP6 includes 8 differential inputs with cold-juntion compensation to read thermocouples type K

Bottom Row	**Top Row**
1 – TC1+	1 – TC5+
2 – TC1-	2 – TC5-
3 – TC2+	3 – TC6+
4 – TC2-	4 – TC6-
5 – TC3+	5 – TC7+
6 – TC3-	6 – TC7-
7 – TC4+	7 – TC8+
8 – TC4-	8 – TC8-

3.4.2.9 Power Supply

Please refer to Power Supply Installation and setup manual.

Installation of Power Supply (all models) consists of connecting the following lines:

- **Input power lines**: 230 volt 50/60 Hz.
- **Output power lines**: 200 Vdc max, 21 / 40 Amp max (depending on models)
- **Control cable**, a "Y" split cable is provided to get the brake control signal from the **5-pin Roller Connector**. Connect this cable if CAN is not available or not being used.
- **Installation is recommended to be performed at the wall** or at other "stable" surface (no vibrations)

Power Supply can be connected through EITHER:

- **PWM signal (from each roller connector),** using the "Y" cable provided at each PWS unit, or using the rear PWM1-PWM4 pins, although this is less common. For PWS1.5 only PWM is available.

- **CAN BUS:** using the front SP6 CAN connector to all PWS. As CAN is a bus and SP6 already has the "Terminator" resistor in, the last of the PWS needs to have the Terminator Jumper set. Also, the CAN IDs need to be configured to 0x200, 0x204, 0x208 and 0x20C (check below)

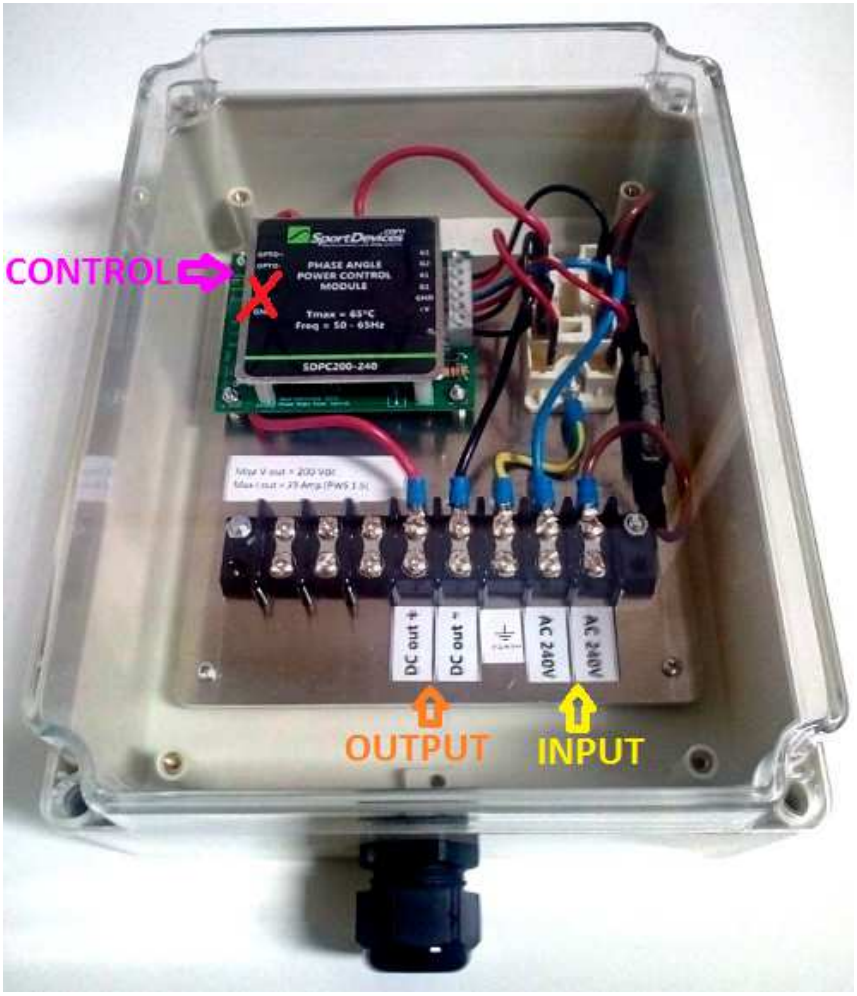
PWS3.x and HS-PWS:
Recently we have added **CANBUS** to PWS3.x and HS-PWS: connect this to SP5/SP6 PWS CANBUS. In case of several PWS (AWD dyno or HUB-4) the last PWS in the bus must have the **terminator ON**, the rest terminator OFF / jumper removed. It will **be shown a "C"** in the LCD close to the temperature value when **CAN connection is established**, for instance 25º"C" (it is not referred to Celsius degrees)

PWS	CAN ID
Front 1	0x100 & 0x200
Rear 1	0x104 & 0x204
Front 2	0x108 & 0x208
Rear 2	0x10C & 0x20C

CAN IDs. Check the PWS documentation.

PWS1.5:

IMPORTANT: **Do not use 5V, I/P and GND lines,** these lines are **not isolated from the grid** and may cause severe damage to SP6 or computer. They are only used for testing purposes (non isolated potentiometer)



4 SportDyno Quick Setup Guide

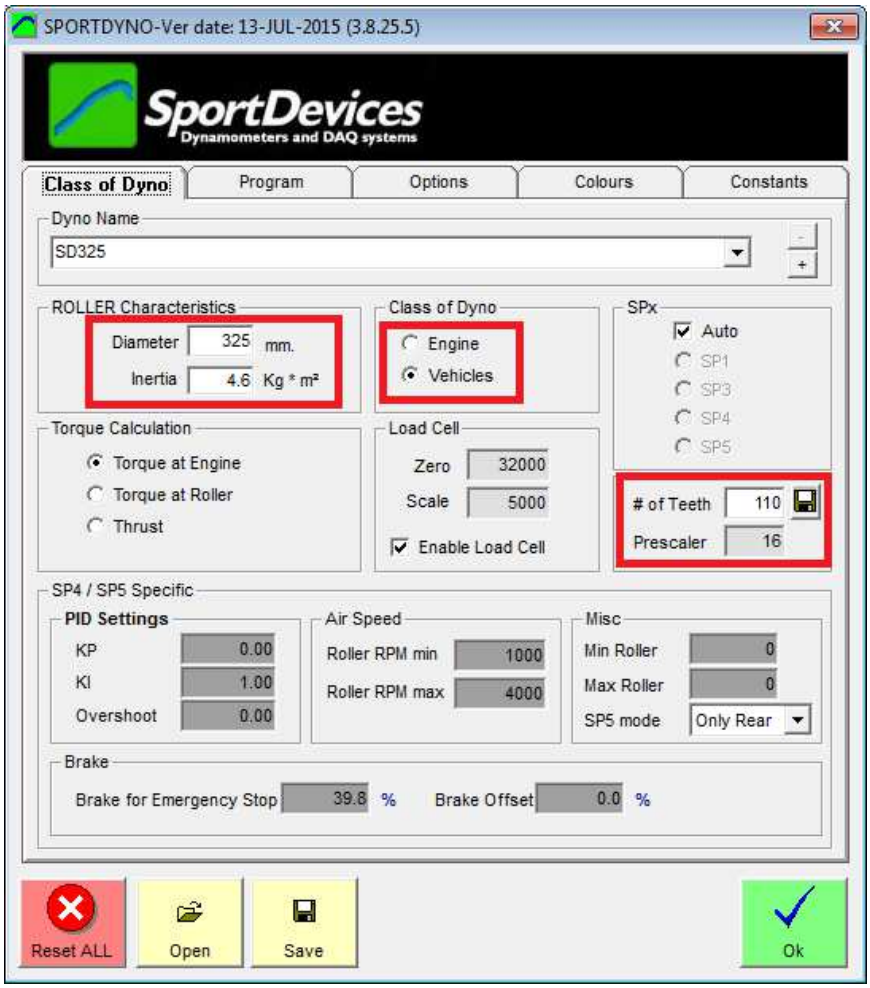
Configuration can be divided into 4 phases:

- Inertial configuration: roller(s) and pulses
- Ratio configuration, for manual modes this step may be necessary to be repeated for each vehicle, engine, or gear used.
- Load Cell configuration, this process can be performed at the end
- Speed Control Configuration

4.1 Inertial Configuration: Roller / Flywheel

Setup all roller / dyno data at “Config / Class of Dyno” Window

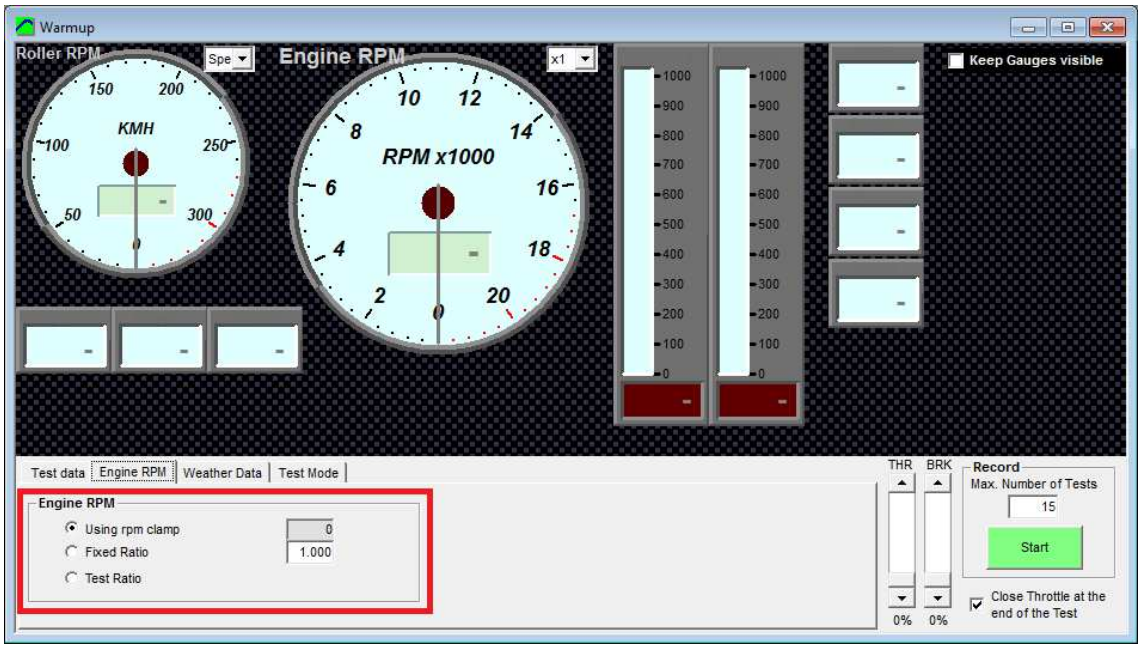
- Dynamometer **type**: Vehicle Dyno or Engine testbed
- **Roller Diameter**
- **Roller Inertia**
- Number of **Teeth** for gear tooth. Note: recommended from 80 to 150 teeth
- **Prescaler**: always 1 for SP6 (please note that SP6 can internally have a HW prescaler from 1 to 16 to allow the usage of encoders)
- Set “SP6 mode” to “Only Front” by default.



4.2 Ratio Configuration

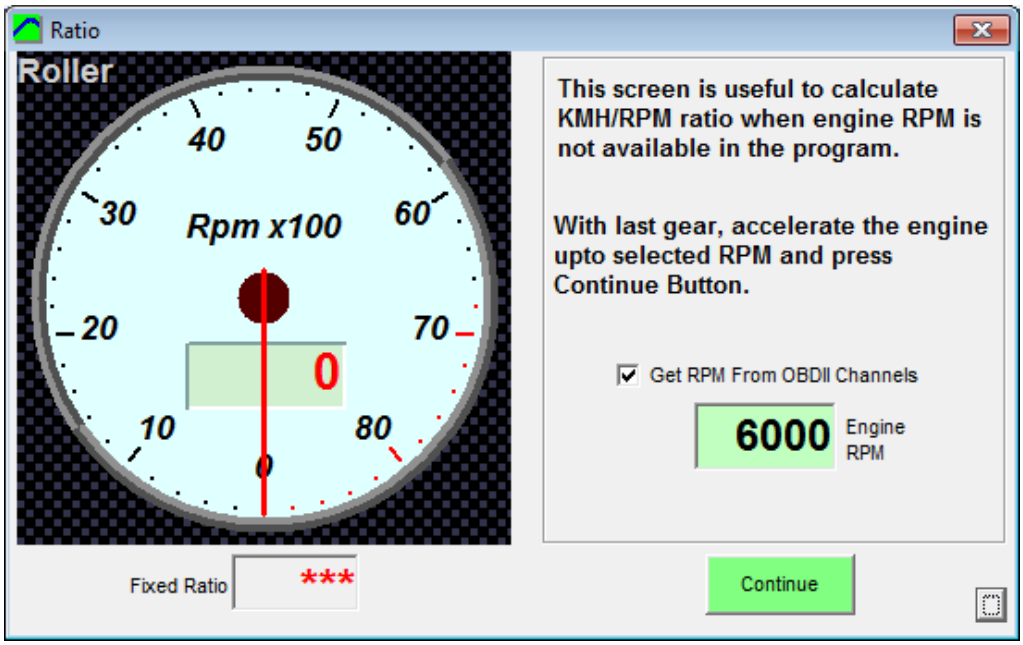
Ratio is a **key** parameter which is used on several processes of Sportdyno, and also on SP6 for speed control:

- It is used to convert Roller Torque to Engine Torque. Due to the gearbox torque conversion, normally torque at roller will be higher than at engine.
- It is used for drawing the Engine RPM axis, and as reference for the torque and power peak values.
- On SP4 and SP6, it is used to calculate an estimation of engine RPM (from roller RPM), since only roller RPM is used for speed control, but all target values are referred to engine speed.



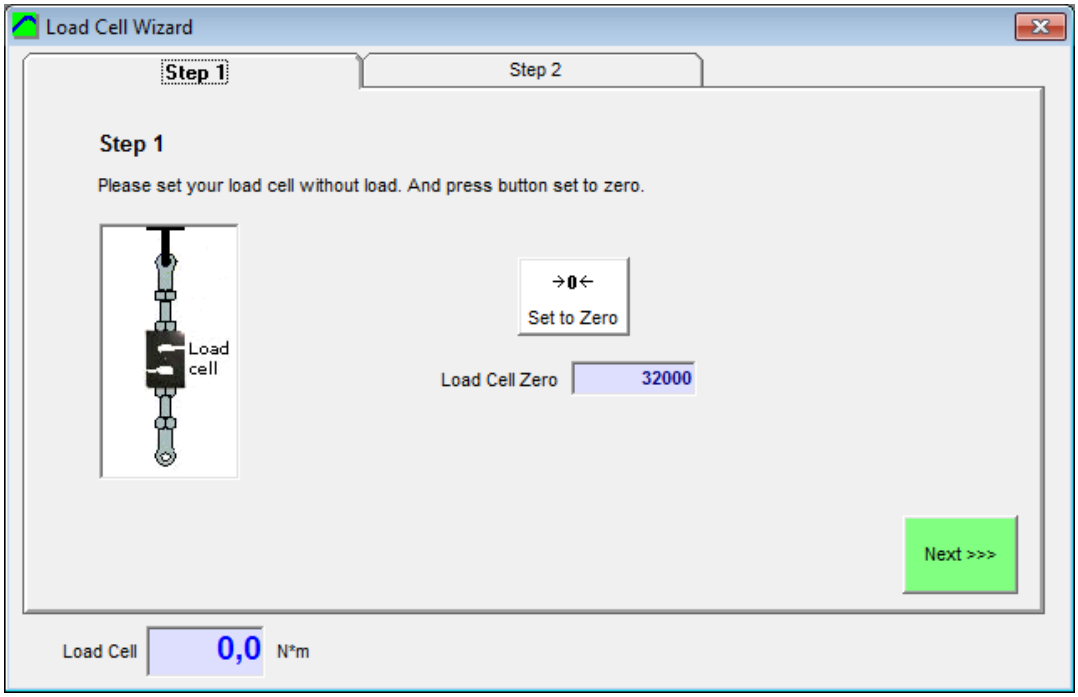
There are three ways to provide ratio to Sportdyno:

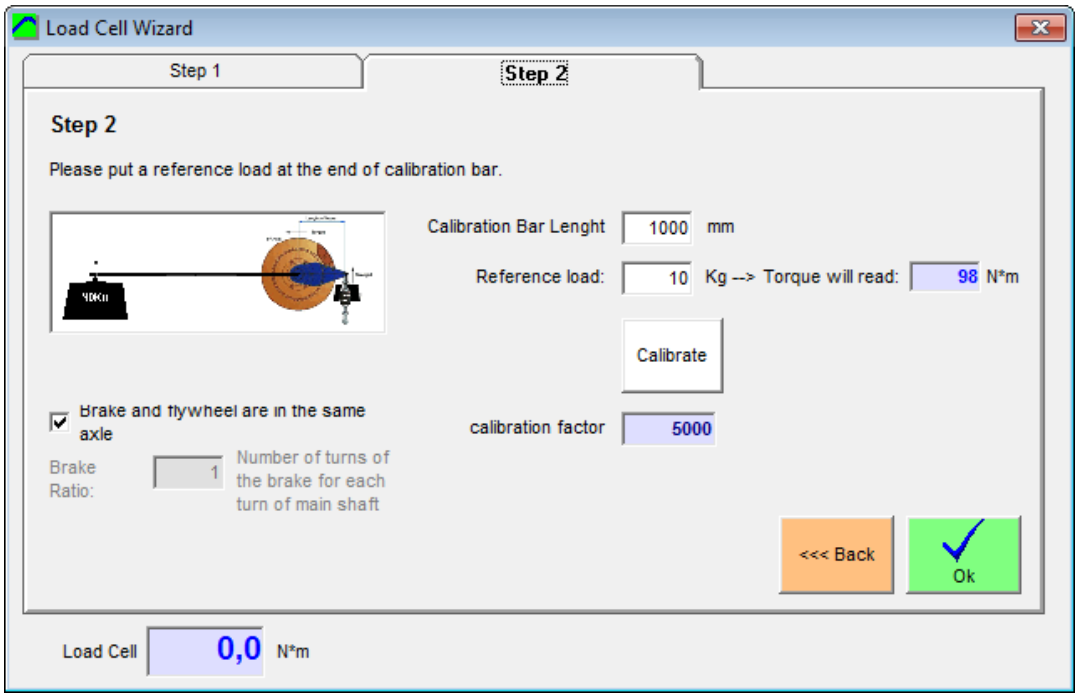
- **Using capacitive or inductive clamp:** Although Engine RPM Channel is not directly used for the three functions described below, Sportdyno will perform an histogram from engine rpm and roller rpm channels to get the Ratio value before starting the test, and (by default) after the test is finished
- **Fixed ratio**: in certain cases when Ratio value is known ratio can be setup directly (for instance engine test bed when there is a fixed transmission from engine to flywheel / brakes)
- **Test Ratio**: this option will open the "Test Ratio" window. Based on the vehicle's Engine RPM gauge this tool will determine the ratio value from Roller channel and the entered value for Engine RPM. The main disadvantage of this method is that normally all vehicle's Engine RPM gauges have an error between 10% and 20%, thus Ratio value will have this error too.
  NOTE: When using **OBDII** Interface Engine RPM can easily be acquired from the vehicle's ECU for the Ratio calculation.



4.3 Load Cell Calibration

Load cell calibration consists of applying a known weight on a calibration arm at the brake. But first of all, the cell has to be “zeroed” when it has no weight. Then the program is able to use the difference from the digital reading between the no-load condition and the loaded condition to perform the calibration.



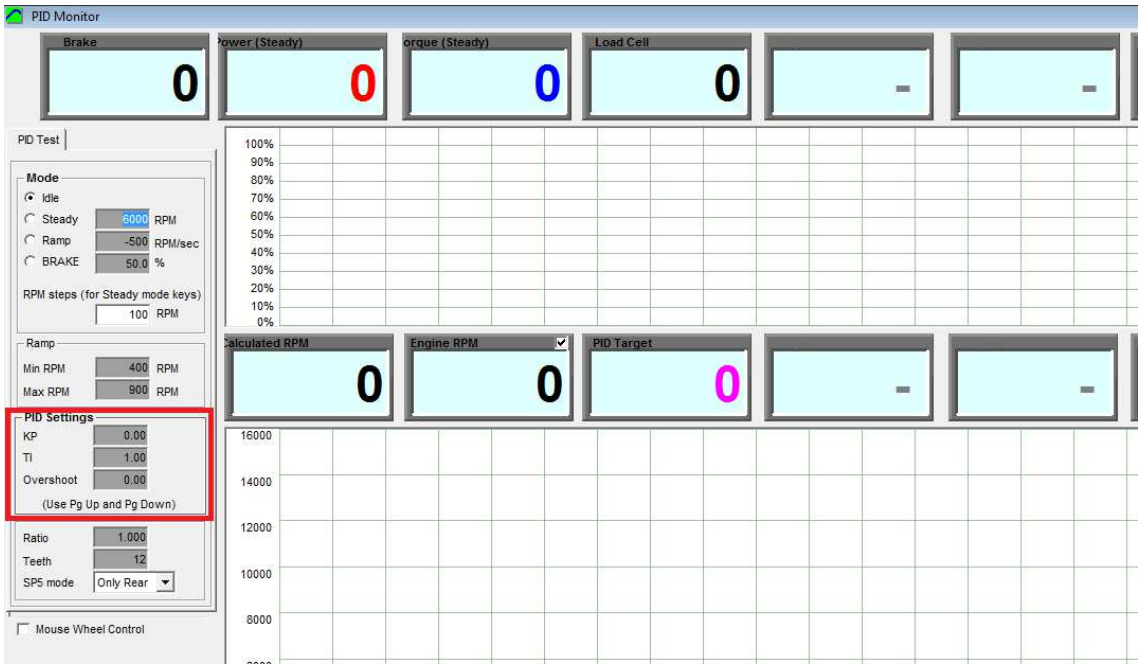


Note: if no calibration arm is available, **calibration can be performed directly over the cell** with the following considerations:

- Calibration arm length is the load cell arm length (distance from brake axle to cell)
- If cell works in pulling mode, then fill the reference load with a negative weight (for instance -20 kg for a 20 kg weight)

4.4 Speed Control Configuration (SP1+, SP4, SP5, SP6)

P.I.D. coefficients determine the brake response to the difference between the desired speed (target) and the current speed (this difference is called error).
SP6 implements a standard PID, with I constant proportionally to P (Kp) → Ti, this allows changing only Kp constant and SP6 will modify Ki to keep the same dynamic behavior. (Ki = Kp * 1 / Ti)
SP6 does not implement a Kd derivative constant, but it implements a more sophisticated overshoot control.



A good starting point for PID setup is:

Kp = 1 (1 to 2 for motorcycles, or 10-15 for car dyno, it may be higher)
Ti = 0.5-1 (max recommended 0.3 to 1.0)
Overshoot = 0 (Td / derivative control)

Kp basically controls the speed control reaction time. Control can be made faster increasing Kp, but excessively high values will cause fast oscillations on the system, thus a balance has to be found between speed response and stability
Kp by itself cannot make the speed control to reach the exact target speed, for this reason the integral control (I) is used.
Ti is (normally) modified in a narrow interval (typically 0.5 to 1.5) to get a faster approaching / drift to the target (low values), but fast approaching / drift also cause to decrease the reaction speed.

Td: With high inertia dynos, some overshoot will be present in the control operation, but normally a small overshoot is preferred as it ensures faster control than when the acceleration is so dampened so the overshoot does not happen.
Nevertheless, with lightweight dynos overshoot can be excessive and then the Overshoot coefficient has to be used to decrease overshoot to a safer value.

Note: **Power Supply Version 3.x (and PWS1.5)** is strongly recommended as they provide faster and more accurate response.

Document changes:

V0.92 General Review
V0.91 Software functions vs relay numbers, CAN IDs listed.
V0.9 initial Version