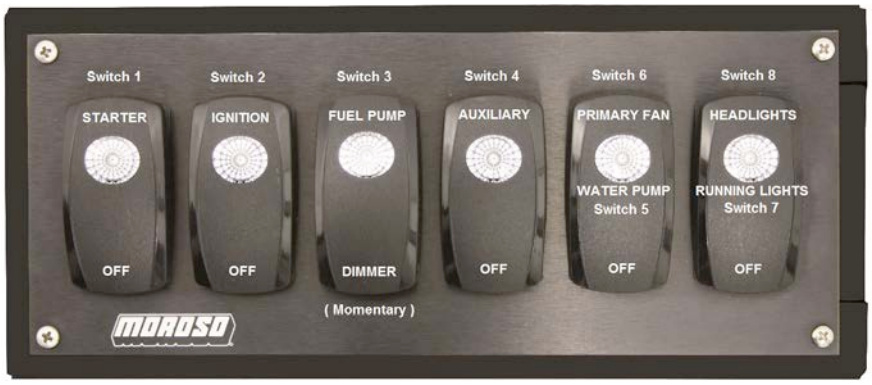
Installation Instructions for Moroso # 76000 and #76050 / #76025
Quick Start Information and Guide

The Main Control Unit (MCU -- #76000) must be connected to a Panel Mount (#76025) or a Roll Bar Mount (#76050) Switch Panel. The Main control unit supplies power as well as communicates to the Switch panel through the standard 10 foot long 9 pin D-Sub Male to 9 Pin D-Sub Female cable provided. The main power cable extending from the MCU must be connected directly to the battery, or a Power Lug. If a Power Lug is used it must have a 1/0 gauge or bigger cable to the battery. The MCU ground must be connected to the battery ground (negative terminal).

Before you begin to wire your vehicle, select an easy access location for the MCU. Suggested mounting locations include under the dash, front floor, rear floor, or trunk of your vehicle. The case is NOT water tight so avoid mounting the MCU in any location that is subject to moisture. Make sure that you allow enough clearance so that the top clear cover can be removed. If you are using the data acquisition feature, the USB port should be kept accessible. Once the MCU is mounted in your vehicle, the power feed from each device should be routed to one of the 10 MCU circuits. We recommend a heavy 12 gauge stranded wire to each device so that there will be little voltage drop even when drawing 20 amps.

The Factory default settings on the Switch Panel are shown below:



Note: Starter Switch will NOT operate without connecting the Neutral Safety Switch input to ground. (Water Pump and Fan) and (Running Lights and Headlights) are 2 position switches. They both operate OFF - ON - ON. Both switches are ON in the UP position. The dimmer switch is momentary and must be held down for 1/2 second to toggle from Day to Night use.

Factory Default Switch / Circuit Settings

Switch 1 --- Circuit 1
Switch 2 --- Circuit 2, Circuit 3, Circuit 4
Switch 3 --- Circuit 5
Switch 4 --- Circuit 6
Switch 5 --- Circuit 7
Switch 6 --- Circuit 8
Switch 7 --- Circuit 9
Switch 8 --- Circuit 10

Circuit 1 -- STARTER
Circuit 2 -- IGNITION

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Additional Instructions for Switch Panel

1. Make sure to mount the MCU away from ignition module to avoid EMI and RFI interference. Recommended minimum distance is 24 inches.

2. Red positive power wire and Black Ground should be connected directly to battery to insure proper voltage. If you want to use a longer positive cable, you should use an appropriate gauge cable for the length of cable that you will run.

3. Before you begin modifying the settings in your switch panel with the software:

A. Identify all of the devices in your vehicle that you will be powering through the switch panel. This includes Starter Solenoid, Ignition Module, Fuel Pump, Computer, Water Pump, Fan, Lights, delay box, throttle stop, etc. etc. Any device that uses more than 30 amps continual must NOT be connected to the MCU. Devices such as Line Locks and Shifter solenoids do not need to be wired through the MCU.

B. Connect to your MCU with the software (if you do not have the MCU mounted in your vehicle, you can power the MCU with a 12 or 16 volt battery by connecting the red wire to positive and the black wire to ground terminals. Name each switch and each circuit. Any switch or circuit not being used should be labeled "Not Used". When you have finished naming the switches and circuits, click on "Download Data to MCU" and make sure that the download is successful. It will prompt you for the circuits that the starter and the ignition are on as well as the Switch that the nitrous circuits are on, if you are not using a nitrous switch then you would enter a "0" as not being used.

C. Go to the parameters page and select the voltage of your vehicle, the max cooling temperature, maximum oil pressure, maximum RPM, and maximum fuel pressure. These are used for the gauges on the Live Amperage Test Page.

4. There is a 2nd CD included with the Switch Panel which is the most current version of the switch panel software (switchpanel.exe - 04/15/13). Load this new version of the software into the C:\moroso folder after you have completely loaded the install CD and have successfully connected to your PC.

5. If you have any questions on installation or using the software, please call Al Smyth at 508-278-2199 ext 508 between 8AM and 5PM EST.

6. After you have installed the Switch Panel, we would like to see photos of your race car with the switch panel installed. We may upload them onto our website.

Thank you,

Portatree Tech Department

Electronic Switch Panel (ESP)
Instructions and Overview of Operation

Parts Required Revision: 121113

Main Control Unit (MCU) in Extruded Aluminum Case (#76000)
- 10 ft 9-pin D-Sub connection cable (MCU to Switch Panel)
- 10 ft USB cable (MCU to PC connection)
- Electronic Switch Panel (ESP) software Level 1

Switch Panel - Panel Mount (#76025) or Roll Bar Mount (#76050)

Overview

Congratulations on your purchase of the Electronic Switch Panel (ESP) power distribution and control system for your race vehicle! The ESP makes wiring a race car easy while also providing safety shut off and other automated functions to improve the race experience.

The ESP is composed of the Main Control Unit (MCU) and Switch Panel, which communicate through a standard 9-pin D-Sub cable that can reach lengths up to 40 ft. In general operation, the ESP can be used as a standard control panel allowing you to turn on and off all systems in the race vehicle. By connecting the ESP to a computer with a standard Type A to B USB cable, its functions can be expanded to allow the system to quickly detect and respond to problems in the race vehicle.

Disclaimer

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If you have a particular concern, please contact Moroso Performance Products Tech Line at (203)-458-0546 for confirmation and/or clarification.

Installation

This section will give a brief overview of installing the Electronic Switch Panel (ESP) in your race vehicle.

Mounting and Mandatory Connections

Before you begin to wire your vehicle, select an easy access location for the MCU. Suggested mounting locations include under the dash, front floor, rear floor, or trunk of your vehicle. The case is NOT water tight so avoid mounting the MCU in any location that is subject to moisture. Make sure that you allow enough clearance so that the top clear cover can be removed. If you are using the data acquisition feature, the USB port should be kept accessible.

Once the MCU is mounted in your vehicle it must be connected to the Panel or Roll Bar mounted Switch Panel. The MCU supplies power as well as communicates to the Switch Panel through the standard 10-foot long 9 pin D-Sub Male to 9 Pin D-Sub Female cable provided.

The main power cable extending from the MCU must be connected directly to the battery or a power lug. If a power lug is used it must have a 1/0 gauge or larger cable to the battery. The MCU ground must be connected to the battery ground (negative terminal).

The power feed from each device should be routed to one of the 10 MCU circuits. We recommend a heavy 12 gauge stranded wire to each device so that there will be little voltage drop even when drawing 20 amps.

Note: Engine RPM is also a mandatory input for correct ESP operation; however, it will be described in the "Engine and Driveshaft RPM Installation" section of this instruction manual.

Sensor Installation

This section will give an overview of connecting Oil Pressure, Fuel Pressure, Water Temperature, and Auxiliary Sensors to the ESP. If you choose to "tee" into existing sensors rather than having designated sensors for the ESP, please contact the sensor manufacturer to make sure that you will not have issues. After connecting new sensor(s) to the ESP, they **MUST** be calibrated using the ESP software for proper operation of the sensor automated ESP functions.

Oil Pressure Sensor(s):

A 3-wire OEM type or industrial pressure sensor can be used for sensing oil pressure in the ESP system, if the 3-wires represent positive (5-volts), signal, and ground. The signal wire of the sensor must be connected to the "OIL 1" or "OIL 2" input of the MCU board. The MCU provides a 5-volt and ground terminal that can be used to power the sensor.

For the best result in obtaining engine oil pressure, it is recommended to have one oil sensor near the filter or pump (typically highest pressure value in the system) and one at the furthest end of the oil galley (typically lowest pressure in the system).

Fuel Pressure Sensor:

A 3-wire sensor with positive, signal, and ground connections must be used for fuel pressure. The signal wire of the sensor must be connected to the "FUEL" input of the MCU board. The positive and ground wires can be connected to the 5-volt and ground terminals, respectively, of the MCU.

Many different types of pressure sensors (i.e. carburetor, nitrous, EFI, and MFI) are available in 3-wire configurations. Although they may seem the same, they differ in accuracy and resolution. Be sure to choose the correct pressure sensor for your application. In general, carburetor and nitrous pressure sensors are of high precision and accuracy. They are capable of reading in tenths of a psi over a small pressure range. EFI and MFI sensors can read over larger ranges (up to 200psi); however, they don't have same resolution as nitrous/carburetor sensors.

Water Temperature Sensor:

A 2-wire OEM temperature sensor can be used for sensing water temperature in the ESP system, if the 2-wires represent signal and positive (5-volts). The signal wire of the sensor must be connected to the "WATER" input of the MCU board. The positive wire can be connected to the 5-volt terminal of the MCU.

Water temperature sensors are generally non-linear, which means it is very important to calibrate them over the expected temperature range of operation before using them for automatic functions in the ESP system. Calibration can be performed with the ESP software.

Auxiliary Sensor:

A 3-wire sensor with positive (5-volt), signal, and ground connections must be used for the auxiliary sensor. As long as these criteria are met, the sensor can be setup to monitor vacuum, temperature, or pressure. The signal wire of the auxiliary sensor must be connected to the "AUX" input of the MCU board. The positive and ground wires can be connected to the 5-volt and ground terminals, respectively.

Engine and Driveshaft RPM Installation

This section will give an overview of connecting the engine and driveshaft RPM inputs to the ESP. Each of these inputs can be either 12, 14, or 16-volt positive signals.

Engine RPM/Tachometer Signal:

Use the standard tachometer output line from your fuel injection or ignition system to connect to the "RPM1" terminal of the MCU. After connecting the engine RPM signal, be sure to setup the ESP to process the input correctly. By default, the ESP will consider an RPM signal to be from an 8-cylinder, 4-stroke engine. This can be changed to any standard combustion engine type on the "Limits and Parameters" page of the ESP software. Setting engine type correctly is important to ensure proper RPM processing. Make sure to download the new engine type to the ESP if it is changed!

Driveshaft RPM:

Two types of sensors can be used for obtaining driveshaft RPM: a Hall-Effect sensor or a Reed Switch. A Hall-Effect sensor is recommended when using 4 or more driveshaft magnets. A Reed Switch should only be used for up to 4 magnets. Note: The ESP system supports up to 8 driveshaft magnets. The more driveshaft magnets used, the better RPM resolution.

The Hall-Effect sensor has 3-wires: signal, positive, and ground. The Reed Switch has 2-wires: signal and positive. The positive input of either sensor can be connected to a 12, 14, or 16-volt power line from the vehicle. The signal wire must be connected to the “RPM2” terminal of the MCU.

Switch and Input Signal Installation

This section will give an overview of connecting the trans-brake, closed throttle, wide open throttle, neutral safety, data acquisition switch, and master kill switch inputs to the ESP. These inputs can be connected through either the MCU or Switch Panel; however, they should **NOT** be connected on both boards.

Trans-Brake Input:

Although this input is labeled trans-brake, any signal that indicates the vehicle has left the starting line can be used (i.e. two-step, trans-brake, or brake off signal). The signal line must be connected to the “TRANS” terminal of the MCU for proper operation. The trans-brake signal must be active high, which means a 12, 14, or 16-volt positive signal is provided to the MCU when the trans-brake is engaged.

Check with your drag racing sanctioning body to determine if connecting to the trans-brake input is acceptable.

Closed Throttle:

Any mechanical single-pole switch can be used for detecting when your vehicle is at closed throttle (idle). Connect one side of the switch to ground and the other side to the “IDLE” terminal of the MCU board.

The closed throttle switch should be mounted to indicate that the blades of the carburetor or throttle body are in the closed position. This means that when the blades JUST begin to open, the closed throttle switch is "OPEN"(not contacted). You can verify this in the "Calibration Diagnostics Registration" section of the software by performing a switch and signal test and actuating the closed throttle (idle) switch to make sure that it is going "ON" and "OFF" properly.

After mounting the switch, it is also recommended to start the vehicle and check the RPM when the closed throttle switch is “ON”. The engine should never be more than 1.25 times the idle RPM when the closed throttle switch is “ON”.

Wide Open Throttle:

Any mechanical single-pole switch can be used for detecting when your vehicle is at wide open throttle. Connect one side of the switch to ground and the other side to the “W.O.T.” terminal of the MCU board.

After the wide open throttle switch is mounted, make sure to test the input in the "Calibration Diagnostics Registration" section of the software by performing a switch and signal test. Actuate the wide open throttle switch with the throttle pedal in your vehicle and verify in the software that the input is going "ON" and "OFF" properly.

Neutral Safety:

The “N.S.” terminal of the MCU must be connected to the neutral safety switch in your race vehicle. When the neutral safety input is brought to ground, the vehicle will be allowed to start. Otherwise, the starter circuit will be prevented from turning on.

Before connecting the neutral safety switch to the ESP, be sure to verify with a voltmeter that it is a grounding (rather than positive) signal. If the switch is currently setup to provide a positive (12, 14, or 16-volt) signal, it must be re-configured to provide a ground signal before being connected to the ESP.

After connecting the neutral safety switch to the ESP, make sure to test the input in the "Calibration Diagnostics Registration" section of the software by performing a switch and signal test. Actuate the neutral safety switch by putting the transmission in and out of park or neutral and verify in the software that the neutral safety input is going "ON" and "OFF" properly.

Data Acquisition Switch:

Any mechanical, normally open, single-pole switch can be used as a data acquisition switch in your race vehicle. Connect one side of the switch to ground and the other side to the “DATA” terminal of the MCU board. When the switch is closed (MCU “DATA” terminal connected to ground), an “ON” signal will be provided to the data acquisition system in the ESP.

After connecting the data acquisition switch to the ESP, be sure to test the input in the "Calibration Diagnostics Registration" section of the software by performing a switch and signal test. Turn the data acquisition switch on and off and verify in the software that "ON" and "OFF" are properly detected.

Note: Data collected in the ESP can only be viewed with Level 3 of the ESP software.

Master Kill Switch:

As with the other switch inputs of the ESP, any mechanical, normally open, single-pole switch can be used for the master kill switch; however, for safety reasons a push/pull switch with normally open contacts is

recommended (i.e. a switch that is pushed to activate and pulled up to deactivate). One side of the switch should be connected to ground and the other side to the “KILL” terminal of the MCU.

To test the master kill switch, enter the "Calibration Diagnostics Registration" section of the software and perform a switch and signal test. Turn the master kill switch on and off and verify in the software that the "ON" and "OFF" signals are properly detected.

General Operation

Both the Switch Panel and Main Control Unit (MCU) are equipped with lights that inform the user about the state of the system. The Switch Panel has 6 lights, one per switch, while the MCU has 10 circuit lights, one per circuit, as well as 4 status lights. The lights on both the Switch Panel and MCU are bi-color meaning they can display as either red or green.

When the Electronic Switch Panel (ESP) is initially powered on, both the Switch Panel and MCU will do a quick test to ensure all systems are functioning properly. During this time, the Switch Panel lights will cycle between all green and then all red. The MCU lights will do the same. After each light sequence is complete, the ESP system will be ready to control the race vehicle.

Default System Setup

The ESP system comes configured such that the 6 switches on the Switch Panel control all 10 circuits on the MCU. The switches are numbered from left to right, making the leftmost switch on the Switch Panel “Switch 1”. The two switches on the right side of the switch panel are dual action, meaning that they have two “on” positions. As such, they are each treated as two separate switches. This results in 8 total switches on the Switch Panel. Please see Figure 1.

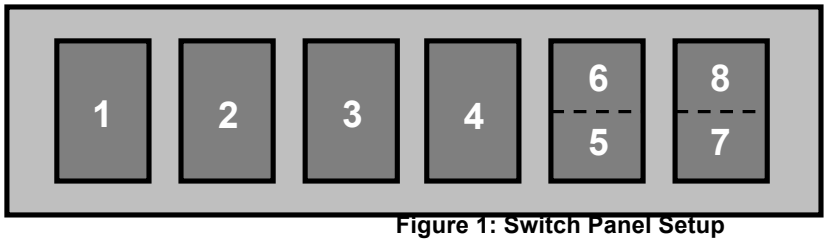

Figure 1: Switch Panel Setup

The initial setup of MCU circuits to Switch Panel switches is as follows:

Switch 1 controls Circuit 1
Switch 2 controls Circuits 2, 3, and 4
Switch 3 controls Circuit 5
Switch 4 controls Circuit 6
Switch 5 controls Circuit 7
Switch 6 controls Circuit 8
Switch 7 controls Circuit 9
Switch 8 controls Circuit 10

In this configuration, the ESP expects the Starter to be on “Circuit 1” and the Ignition System to be on “Circuit 2”. Figure 2 shows the layout of circuits on the MCU board.

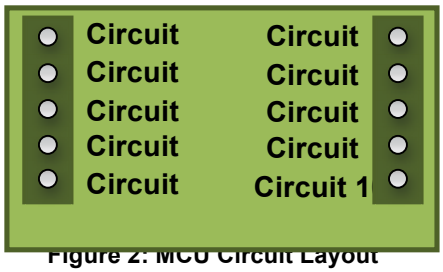

Figure 2: MCU Circuit Layout

With the ESP software, the mapping of circuits to switches can be modified to best suit the needs of the user. The circuit number of the Ignition System and Starter can also be changed using the software.

Switch Panel Lights Red

After startup, if all lights on the Switch Panel turn red, the MCU has detected an “unsafe” startup condition. This occurs if one or more switches on the Switch Panel are in the “on” position during startup. To exit this condition, turn off all switches on the Switch Panel. The MCU will immediately exit the condition and allow the switches to control the circuits.

If communication is lost between the Switch Panel and MCU (e.g. the communication cable between the boards is disconnected), the MCU will become “locked”. All circuits connected to the MCU will shut down and

the MCU circuit lights will turn off. When the Switch Panel is re-connected to the MCU, all the Switch Panel lights may turn red. This occurs if the MCU detected that one or more switches were in the "on" position. By turning off all switches on the Switch Panel, the MCU will exit the "lock" condition and again allow the switches to control the circuits.

Neutral Safety Switch

As with traditional vehicle control systems, the ESP "Neutral Safety" input line ensures a vehicle is in neutral or park before the starter circuit can be turned on. If a ground signal is not received on the "Neutral Safety" input, the ESP will prevent the starter circuit from engaging. The Neutral Safety signal can be connected on either the Switch Panel or MCU.

Master Kill Switch

The ESP system provides the user with the option of wiring a Master Kill Switch into their race vehicle. This switch is intended as a safety device. It allows the user to shut down all circuits in their race vehicle by pressing a single button.

When the Master Kill Switch is enabled (in the "on" position), all lights on the Switch Panel will turn red and all circuit lights on the MCU board will turn off. All circuits connected to the MCU will be shut down.

To exit the Master Kill function, the Master Kill Switch must be disabled (moved to the "off" position) and all switches on the Switch Panel must be turned off. The Master Kill function has successfully been disabled when all lights on the Switch Panel turn off.

Default Amperage Protection

The ESP is initially configured to prevent short circuits and extreme amperage overload conditions. This setup is necessary to ensure the safety of the system, vehicle, and user.

Short Circuit Protection: Each circuit connected to the MCU has 50-amp short circuit protection. If any circuit exceeds 50 amps for greater than 30ms, that circuit will be shut down. The light corresponding to the circuit on the MCU board will flash red fast. The switch mapped to the circuit will also flash red fast.

Constant Current Protection: If a circuit connected to the MCU exceeds 30 amps for more than 10 seconds, that circuit will be shutdown. The light corresponding to the circuit on the MCU board will flash red slow. The switch mapped to the circuit will also flash red slow.

Maximum Amperage Protection: The MCU is designed to handle a total of 120 amps through the board. This amperage must be divided to each side of the board. To ensure equal distribution of amperage draw, each side of the board is limited to 60-amps.

If the total amperage drawn through circuits 1 to 5 or 6 to 10 exceeds 60-amps for more than 30ms, all MCU circuits are turned off and all lights on the Switch Panel turn red. If circuits 1 to 5 caused the over current condition, the MCU lights for these circuits will turn red. If circuits 6 to 10 caused the condition then the MCU lights for these circuits will turn red.

Default Low Voltage Protection

The ESP is setup to monitor the battery voltage of the system and turn off all MCU circuits if an unsafe low voltage condition is detected. An unsafe condition occurs when the system voltage drops below 6 volts for more than 30 ms. After an unsafe voltage condition is detected, the ESP system will enter a low power protection mode where the Switch Panel lights will alternate between all green and all red while the MCU lights will cycle red on and off. To recover from this mode, power to the ESP must be cycled.

Dim Lights on Switch Panel

The switch lights on the Switch Panel can be dimmed for night operation by pressing the momentary contact switch of Switch 3 (press Switch 3 downward for 1/2 second). To undim the lights, again press the momentary contact switch of Switch 3 for 1/2 second.

Limp Mode

When the MCU status light labeled "Limp" is on, an internal system of the ESP has failed and the device has entered Limp Mode. Although the ESP will still operate in this mode, certain functions will be unavailable.

Limp Mode Status Light:

Solid Green – USB or Data Acquisition Failure

When the Limp Status light is solid green, the ESP will not be able to connect to a computer or record data.

Solid Red – Amperage, Voltage, and Sensor Detection Failure

When the Limp Status light is solid red, the ESP will not be able to perform any functions that monitor amperage, voltage, or sensor levels.

Fast Flashing Red – Internal Device Memory Failure

When the Limp Status light is flashing red fast, the ESP will not be able to read or write data to the internal system memory, which could result in a system setup that is different than expected.

If the Limp Mode status light does not turn off after cycling power to the board, contact Tech Support for further assistance.

Switch Panel Lights

In the ESP system, multiple MCU circuits can be controlled by a single switch on the Switch Panel (e.g. Circuits 2, 3, and 4 are controlled by Switch 2 in the default system setup). Although each circuit has a light to display its operational state on the MCU board, the circuits must share a single light on the Switch Panel.

To allow the driver to best respond to events in the race vehicle, the Switch Panel lights will always display the state of the circuit in the worst condition. For example, assume Circuit 2 and Circuit 3 are sharing Switch 2. Circuit 2 is operating normally but Circuit 3 was shut down by the MCU's short circuit protection. Switch 2 would flash red fast: the light condition corresponding to a short circuit.

Features Enabled by Software

Additional features can be enabled and disabled starting with Level 1 of the Electronic Switch Panel (ESP) software. This section will describe each additional feature as well as the software level that is required to use it.

Amperage Warning and Shut Down

Each circuit on the Main Control Unit (MCU) can be setup to warn the user when the amperage draw drops below or rises above a specified level. The circuits can also be setup to automatically shut down when the amperage draw exceeds a specified level for more than 30ms. This feature can be enabled on the "Limits and Parameters" page with Level 1 of the ESP software.

Maximum Circuit Amperage Check: When the "MAX AMPS" field of the "Circuit Amps" section is set to a non-zero value, the MCU will perform a maximum amperage check on the specified circuit. If the circuit exceeds the selected amperage for more than 30ms, it will be shut down. The corresponding circuit and switch light will flash red fast.

If "Slow Blow" is enabled for any circuit, 50-amps will be used as the maximum circuit amperage.

Low Amperage Warnings: Each MCU circuit can be setup to provide a warning to the user when the circuit's amperage drops below a desired level. To enable this feature, set the "Warning Low" field in the "Circuit Amps" section to a non-zero value for the circuit(s) of interest. If the amperage draw of the circuit drops below the selected level, the corresponding circuit and switch lights will flash green slow. The circuit will not be turned off.

High Amperage Warnings: Each MCU circuit can be setup to provide a warning to the user when the circuit's amperage exceeds a desired level. To enable this feature, set the "Warning High" field in the "Circuit Amps" section to a non-zero value for the circuit(s) of interest. If the amperage draw of the circuit exceeds the selected level, the corresponding circuit and switch lights will flash green fast. The circuit will not be turned off.

Limp Mode Off

Although the ESP is able to continue operating in the case of an internal system failure, certain functions (e.g. amperage warnings and safety shutdowns) will be unavailable. If you do not want the system to continue to operate without warnings or safety shutdowns, Limp Mode can be turned off. This option is available on the "Limits and Parameters" page with Level 2 of the ESP software.

To turn off limp mode, un-check the "LIMP MODE ON" box on the "Limits and Parameters" page.

When Limp Mode is turned off and a system failure occurs that prevents the ESP from monitoring amperage, voltage, or sensor levels (i.e. Solid Red Limp Mode status light condition), all MCU circuits will be shut down. The MCU circuit lights will alternate between all red on the left side of the board (Circuits 1-5) and all red on the right side of the board (Circuits 6-10). The Switch Panel lights will alternate between all red on the first 3 switches and all red on the last 3 switches. The error condition will continue to display until all switches on the Switch Panel are turned off.

As suggested in the Limp Mode section of the instructions, if the Limp Mode status light does not turn off after cycling power to the board, contact Tech Support for further assistance.

Circuit Time Outs

Each circuit on the MCU can be setup to automatically shut down after 1 to 30 minutes. This feature can be enabled on the "Limits and Parameters" page with Level 1 of the ESP software.

To enable this feature, set the "Circuit Time Out" field for a circuit to a non-zero value. When the vehicle is not running and not connected to a computer, the selected circuit will shut down after the specified time has elapsed. The MCU and Switch Panel will flash red fast then slow on the corresponding circuit and switch to indicate the circuit has timed out. When time outs are enabled on any circuit, the Switch Panel starter switch light will turn orange. This indicates to the user that time outs are activated.

Starter Shutdown

This feature can be enabled on the "Limits and Parameters" page with Level 1 of the ESP software. When a non-zero value is entered into the "Disable Starter at RPM" field of this page, the starter circuit will be prevented from turning on when engine RPM exceeds the specified level. This feature can be used to prevent the starter from engaging while the vehicle is running.

For the starter shutdown feature to work properly, the correct engine setup must be selected in the "Cylinders" drop down menu of the "Limits and Parameters" page.

Automatic Water Pump and Fan Operation

The ESP can be setup to automatically turn on and/or off up to three circuits in the vehicle based on water temperature. This feature can be enabled on the "Limits and Parameters" page with Level 2 of the ESP software. For this feature to work properly, a temperature sensor must be connected to the ESP. It is strongly suggested that the sensor be calibrated through the ESP software before this feature is enabled (please see "Sensor Calibration" section).

To enable the automatic turn on or automatic turn off feature, the circuit numbers of the water pump and fan circuits to be controlled must be specified in the "Cooling Parameters" section of the "Limits and Parameters" page.

Automatic Water Pump and Fan Turn On: To allow the ESP to automatically turn on the vehicle's water pump as well as up to two fans, the temperature at which each circuit should be turned on must be provided in the "Cooling Parameters" section of the "Limits and Parameters" page. When this feature is enabled, the circuits selected will be turned on when the water temperature rises above the specified level. At this time, the MCU circuit light and Switch Panel switch light will flash green fast then slow to indicate that the circuit has been turned on by a sensor.

If you do not want the water pump and/or fans to remain on despite having this feature enabled, they can be turned off by cycling the switch that controls the circuit. When this occurs, the water pump and/or fan circuits will not automatically turn on again until the water temperature has dropped below and then risen above the "turn on" temperature.

Automatic Water Pump and Fan Turn Off: To allow the ESP to automatically turn off the vehicle's water pump as well as up to two fans, the temperature at which each circuit should be turned off must be provided in the "Cooling Parameters" section of the "Limits and Parameters" page. When this feature is enabled, the circuits selected will be turned off when the temperature drops below the specified level. At this time, the MCU circuit light and Switch Panel switch light will flash red fast then slow to indicate that the circuit has been turned off by a sensor.

If the user does not want the water pump and/or fans to remain off despite having this feature enabled, they can be turned on by cycling the switch that controls the circuits. When this occurs, the water pump and/or fan circuits will not automatically turn off again until the water temperature has risen above and then dropped below the "turn off" temperature.

Oil Pressure Warning and Shut Down

The ESP can be setup to automatically warn the user or shut down up to three circuits in the vehicle based on oil pressure levels. This feature can be enabled on the "Limits and Parameters" page with Level 2 of the ESP software. For this feature to work properly, at least one oil sensor must be connected to the ESP. It is strongly suggested that the sensors be calibrated through the ESP software before this feature is enabled (please see "Sensor Calibration" section).

The oil pressure warning and shut down feature is designed to either warn the user or shut down up to three circuits when the oil pressure in the vehicle drops below a specified level for a selected duration of time (up to 2 seconds). The minimum oil pressure levels can be specified for different RPM ranges, allowing the user to best fit the feature to their vehicle. This feature can be setup to monitor one or two oil pressure sensors.

To enable the oil pressure feature, the circuit numbers of the circuits to shut down or warn in the case of an oil emergency must be specified in the "Oil Pressure Circuit Control" section of the "Limits and Parameters" page. The time duration that the unsafe oil condition is allowed to exist before warning or shutdown must also be specified in this section. In the "Oil Pressure" section on the same page, the oil pressure levels can be entered for RPM ranges from 1000 to 12000 RPM. Finally, the oil sensors to monitor can be selected in the "Oil Sensors" section.

Use Sensor 1: Only oil pressure sensor 1 is monitored for the oil pressure warning and shutdown feature.

Use Sensor 2: Only oil pressure sensor 2 is monitored for the oil pressure warning and shutdown feature.

Use Sensor 1 or 2: Oil pressure sensors 1 and 2 are monitored for the oil pressure warning and shutdown feature. If either sensor drops below the desired oil pressure level, the selected circuits will be shut down or the user will be warned.

Use Sensor 1 and 2: Oil pressure sensors 1 and 2 are monitored for the oil pressure warning and shutdown feature. If both sensors drop below the desired oil pressure level, the selected circuits will be shut down or the user will be warned.

If the system is in "Shut Down Circuits Active" mode (see "Warning Light Only Mode vs. Shut Down Circuits Active Mode" section) and an oil pressure failure occurs, the three specified circuits will be shut down and the circuit lights will flash red fast then slow. All switch panel lights will flash red fast.

If the system is in "Warning Light Only" mode and an oil pressure failure occurs, the three specified circuits will remain on; however, their circuit lights will flash orange fast. All switch panel lights will flash orange fast.

Due to the severity of an oil pressure shutdown, in order to clear the oil pressure failure light codes, the master kill switch must be cycled. If a master kill switch is not connected to the system, power must be cycled to the ESP.

Fuel Pressure Warning and Shut Down

The ESP can be setup to automatically warn the user or shut down up to three circuits in the vehicle based on fuel pressure level. This feature can be enabled on the "Limits and Parameters" page with Level 2 of the ESP software. For this feature to work properly, a fuel pressure sensor must be connected to the ESP. It is strongly suggested that the sensor be calibrated through the ESP software before this feature is enabled (please see "Sensor Calibration" section).

To enable the fuel pressure feature, the circuit numbers of the circuits to shut down or warn in the case of a fuel pressure problem must be specified in the "Fuel Pressure" section of the "Limits and Parameters" page. The fuel pressure at which to shut down the circuits must also be specified in this section.

When the fuel pressure warning and shut down feature is enabled, the ESP will warn the user or shut down up to three circuits when the fuel pressure in the vehicle drops below a specified level for 30ms.

If the system is in "Shut Down Circuits Active" mode (see "Warning Light Only Mode vs. Shut Down Circuits Active Mode" section) and a fuel pressure failure occurs, the three specified circuits will be shut down and the circuit lights will flash red fast then slow. The Switch Panel switch light(s) corresponding to the circuits will also flash red fast then slow.

If the system is in "Warning Light Only" mode and a fuel pressure failure occurs, the three specified circuits will remain on; however, their circuit lights will flash orange fast. The Switch Panel switch light(s) corresponding to the circuits will also flash orange fast.

In order to clear the fuel pressure failure light codes, the switches corresponding to the three fuel pressure circuits must be turned off.

Warning Light Only Mode vs. Shut Down Circuits Active Mode

The ESP has two general modes of operation: Warning Light Only and Shut Down Circuits Active. The user can select the ESP mode of operation on the main page of the software.

Warning Light Only: In Warning Light Only mode, the ESP will only warn the user in the case of an oil pressure failure, fuel pressure failure, or nitrous system failure. No circuits will be shut down.

Shut Down Circuits Active: In Shut Down Circuits Active mode, the ESP will shut down the circuits specified by the user in the case of an oil pressure failure, fuel pressure failure, or nitrous system failure.

When Shut Down Circuits Active mode is selected on the main page of the ESP software, the following warning screen will appear:

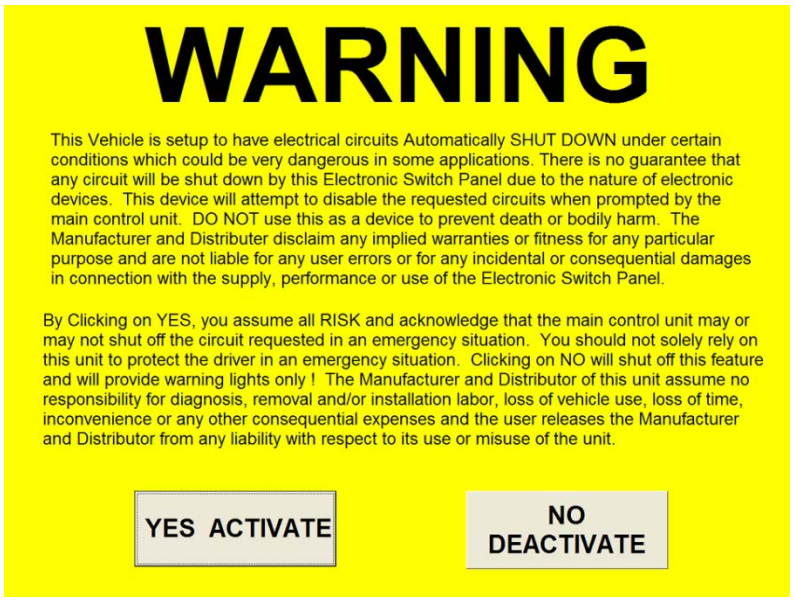

Figure 3: Shut Down Circuits Active Warning

This warning must be accepted by the user, or the ESP will not enter Shut Down Circuits Active Mode.

Closed Throttle Shutdown

Closed throttle shutdown is a safety feature that allows the ESP to automatically shut down all circuits if the vehicle does not return to idle (closed throttle) during a race. This feature can be enabled on the "Custom Circuits" page with Level 1 of the ESP software. For this feature to work properly, the transbrake/two-step and closed throttle inputs must be installed correctly in the race vehicle. Please see the "Installation" section of this manual for further information on setting up these inputs.

To enable this feature, the "ET Safety Shutdown" field on the "Custom Circuits" page must be set to a non-zero value. When closed throttle shutdown is enabled and the vehicle is running, the ESP will monitor for a two-step/transbrake release (transition from high to low on the two-step/transbrake input line). If the vehicle does not return to idle (closed throttle) in the specified time period, all circuits will be shutdown. All MCU circuit lights will turn off and the Switch Panel switch lights will turn red.

To clear the closed throttle safety shutdown condition, all Switch Panel switches must be turned off.

Water Pump and Fan RPM Shutdown

The water pump and fan RPM shutdown feature allows the ESP to automatically turn off the water pump and fan circuits during a race. This feature can be enabled with Level 2 of the ESP software on the "Custom Circuits" page. For this feature to work properly, the transbrake/two-step input must be installed correctly in the race vehicle. Please see the "Installation" section of this manual for further information on setting up this input.

To enable this feature, the user must select at least one circuit (water pump, main fan, or auxiliary fan) to be controlled. The RPM at which the circuits should shut down as well as the time duration for which they should shutdown must also be entered in the "Circuit Shutdown" section of the "Custom Circuits" page. The time duration must be non-zero for the check to be enabled.

When the water pump and fan RPM shutdown feature is enabled, the ESP will monitor for a two-step/transbrake release (transition from high to low on the two-step/transbrake input line). After this point, if the engine RPM exceeds the specified level or is already above this level, the selected circuits, water pump and/or fans, will be shutdown. The corresponding switch and circuit lights will flash red fast then slow to indicate this has occurred.

The circuits selected for this check will turn back on when the time since the two-step release exceeds the time duration for the check. If the race vehicle is turned off while the water pump and fan RPM shutdown feature is in progress, the circuits involved in the check will also automatically turn back on. The corresponding switch and circuit lights will flash green fast then slow to indicate this has occurred.

Nitrous Shutdown

With the nitrous shutdown check, the ESP is able to monitor up to 4 circuits to ensure they stay within selected amperage tolerances. This feature can be enabled on the "Custom Circuits" page with Level 2 of the ESP

software. For this feature to work properly, the wide open throttle input must be installed correctly in the race vehicle. Please see the "Installation" section of this manual for further information on setting up this input.

To use the nitrous shutdown check, all circuits to be monitored must be controlled by a single switch, which will be referred to as the Nitrous Switch. When a Nitrous Switch is selected, the circuits controlled by the switch will only turn on when both the switch is enabled and the vehicle is at wide open throttle. If any of the circuits controlled by the Nitrous Switch are automatically turned off due to a condition in the race vehicle, all remaining circuits controlled by the switch will also turn off.

To enable the amperage monitoring function of the nitrous shutdown check, high and/or low tolerances must be entered for at least one circuit in the "High Amps" and "Low Amps" fields of the "Monitor these Circuits" section of the "Custom Circuits" page. A time must also be entered into the "Time Delay" field of the same page. This represents the maximum time a nitrous circuit can be out of tolerance.

When the nitrous shutdown check is enabled, the ESP monitors the amperage draw of all circuits controlled by the Nitrous Switch. If the amperage draw of any of the circuits rises above or drops below the specified amperage tolerances for the selected time period, the ESP will warn the user or shutdown the circuits depending on the system's mode of operation.

If the system is in "Shut Down Circuits Active" mode (see "Warning Light Only Mode vs. Shut Down Circuits Active Mode" section) and a nitrous shutdown occurs, the four circuits controlled by the Nitrous Switch will be shut down and the circuit lights will flash red fast then slow. The switch light of the Nitrous Switch will also flash red fast then slow.

If the system is in "Warning Light Only" mode and a nitrous shutdown occurs, the four circuits controlled by the Nitrous Switch will remain on; however, their circuit lights will flash orange fast. The switch light of the Nitrous Switch will also flash orange fast.

In order to clear the nitrous shutdown light codes, the Nitrous Switch must be turned off.

Low Voltage Warning

The low voltage warning feature of the ESP allows the system to warn the user when the input voltage drops below 80% of the nominal operating voltage. This feature can be enabled on the "Limits and Parameters" page with Level 1 of the ESP software.

For this feature to work properly, the correct nominal system voltage must be selected in the "System Voltage" box of the "Limits and Parameters" page. To enable the warnings, the "Low Voltage Warning" box must be checked.

When low voltage warnings are enabled and the system voltage of the ESP drops below 80% of the nominal system voltage, the switch light of the designated starter switch on the Switch Panel will turn solid red and flash green slow. The low voltage warning light will only display when at least one circuit or circuit light is on.

Voltage Warning Levels:

12 volt system – Warning at 9.6 volts
14 volt system – Warning at 11.2 volts
16 volt system – Warning at 12.8 volts

PC Connection

The ESP can be connected to a PC through the MCU board with a standard Type A to B USB cable. To communicate with the system, the ESP software is necessary. The following sections will describe how to install and use the ESP software. A PC connection is not necessary for default ESP operation.

Note: The ESP will prevent the vehicle from starting when connected to a PC unless in "Amperage Test Live Connection".

Software Installation

Refer to the "How to Load Software and Connect to P.C." installation instructions included on the software CD in the MCU box.

Link to the PC

Once the ESP and PC are connected via the Type A to B USB cable, open the Switch Panel software so that the main page is displayed. Click "Link to MCU".

If the link is successful, a green box will display "Connected" on the bottom of the screen.

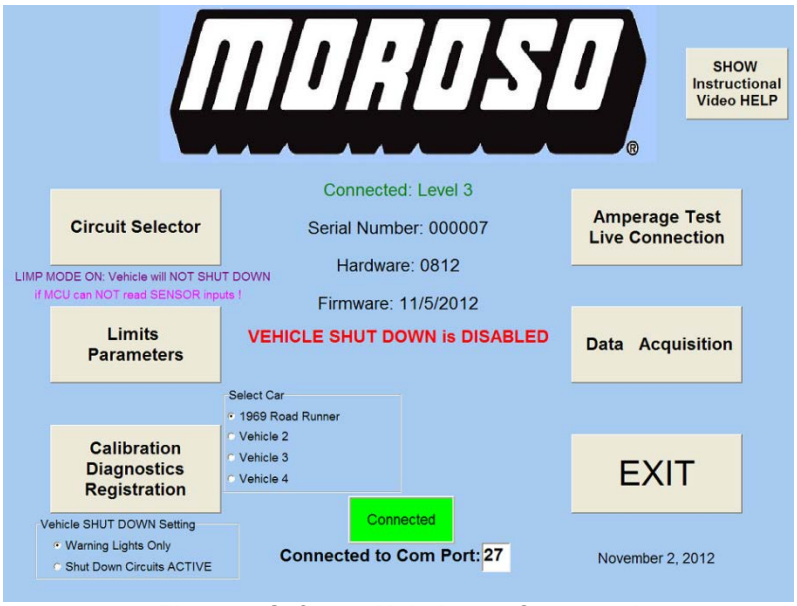

Figure 4: Software Main Page - Connected

If the link is unsuccessful, one of the following conditions may have occurred:

- Red Box with "MAIN CONTROL UNIT Not Connected" displayed
  - ESP is not detected by the PC most likely due to a physical connection problem OR incorrect COM Port being selected
  - Check that the cable connecting to the ESP is fully inserted in the USB connector of the MCU
  - Check that the cable connecting to the PC is fully inserted in the USB jack
  - Check that the ESP is powered
  - Try the "Locate Port" button
- Green Box with "Main Control Unit Not Connected" displayed
  - ESP detected but communication failure occurred
  - Try un-plugging and re-plugging the USB cable to the board
- Orange Box with "Main Control Unit Not Connected" displayed
  - ESP detected but unexpected communication received
  - Try un-plugging and re-plugging the USB cable to the board

To disconnect from the ESP, click the green "Connected" button. It will return to displaying "Link to MCU". The connection can also be ended by exiting the program.

Circuit Selector

The circuit selector feature of the ESP software allows the user to map each circuit to a switch on the Switch Panel. This effectively allows the user to select which switch controls each circuit on the board. "Circuit Selector" can be accessed from the main page of the software (Level 1 ESP software is necessary). In order to modify the circuit to switch mapping on the "Circuit Selector" page, the ESP must be connected to the PC.

Upon entering the "Circuit Selector" page, the software does a compare to determine if the ESP circuit/switch configuration matches the configuration last saved in the software. When a mismatch exists between the saved data and ESP, the user will be asked to select the configuration to display.

The "Circuit Selector" screen is setup to represent the eight switches of the switch panel. Ten circuits are available on the screen and can be moved to any of the eight switches. Switches 1 to 4 can each control up to four circuits, while switches 6 through 8 can only control two.

Steps to move a circuit:

1.) Right-click the circuit of interest
2.) Circuit will highlight in light blue
3.) Left-click the new switch to control the circuit
4.) Circuit will move to the new switch

If a circuit is not being used, it should be disabled. This can be done by left-clicking the circuit. When a circuit is disabled, the check box next to the circuit name will be un-checked. To enable a circuit, simply left-click the circuit. The check box will become checked, indicating the circuit is enabled.

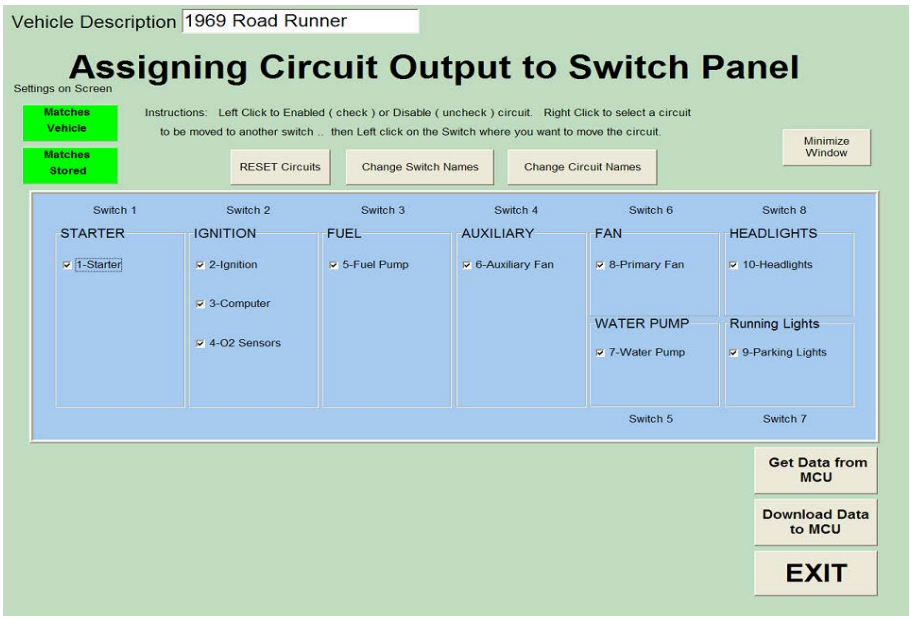

Figure 5: Circuit Selector Screen

After any desired change is made, be sure to send the new configuration to the ESP. To do this, all switches and circuits of the ESP must be off. Click "Download Data to MCU." The software will request that you indicate a new starter and ignition circuit as well as a Nitrous Switch at this time. The starter and ignition circuits are mandatory entries. If a Nitrous Switch does not exist in your system, set this field to 0.

At any time, the "Circuit Selector" screen can be restored to factory defaults by clicking the "RESET Circuits" button. To restore these settings to the ESP, a "Download Data to MCU" must be performed as well. To view the current circuit/switch configuration in the ESP, the "Get Data from MCU" button can be pressed. This will cause the "Circuit Selector" screen to setup to reflect the current state of the ESP.

The "Circuit Selector" screen is very customizable in that each circuit and switch can be re-named to match the function in your race vehicle. "Change Switch Names" allows the user to re-name each switch to match the function in his/her race vehicle while "Change Circuit Names" provides the same function for each circuit.

Note: Changing the circuit/switch setup of the ESP will cause the ESP data acquisition memory to be erased. It is recommended to perform a data acquisition download before re-configuring the ESP circuits and switches.

Amperage Test - Live Connection

The "Amperage Test Live Connection" screen can only be entered from the main page of the ESP software when the ESP is connected to the PC. It is available with Level 1 of ESP software. In this screen, a test of the current draw of each circuit as well as the output of each sensor can be performed.

To begin a live system test, press the "Start" button on the "Amperage Test Live Connection" screen. At this point, any circuit of the ESP system can be turned on and the amperage draw observed. This value is displayed in the center of the screen for each circuit. The maximum and minimum draw of each circuit can be observed at the top and bottom of the screen, respectively. The "Reset Max/Mins" button will reset these values to 0.

If the minimum amperage draw of a circuit is displayed in red, the software is indicating that the value received from the ESP is below the minimum value the circuit can read. When a minimum is displayed in black, it represents the true amperage draw from the system.

To stop a live system test, the "Stop" button or "Exit" button can be pressed. The "Exit" button will also return the user to the main page of the ESP software. If live amperage test is stopped while the vehicle is running, the computer connection will be terminated.

On the left side of the "Amperage Test Live Connection" page, sensor gauges are displayed. The values of these gauges represent readings from the sensors connected to the ESP board. The Auxiliary and Water Temperature sensors share a gauge location. Therefore, to show the auxiliary sensor the "Show Aux" button must be clicked. To return to the water temperature sensor, the "Show WT" button must be clicked.

Oil pressure sensors 1 and 2 also share a gauge location on the live system test screen. To switch from oil sensor 1 to oil sensor 2, "Show OP 2" must be clicked. To switch back to oil sensor 1, "Show OP 1" must be clicked.

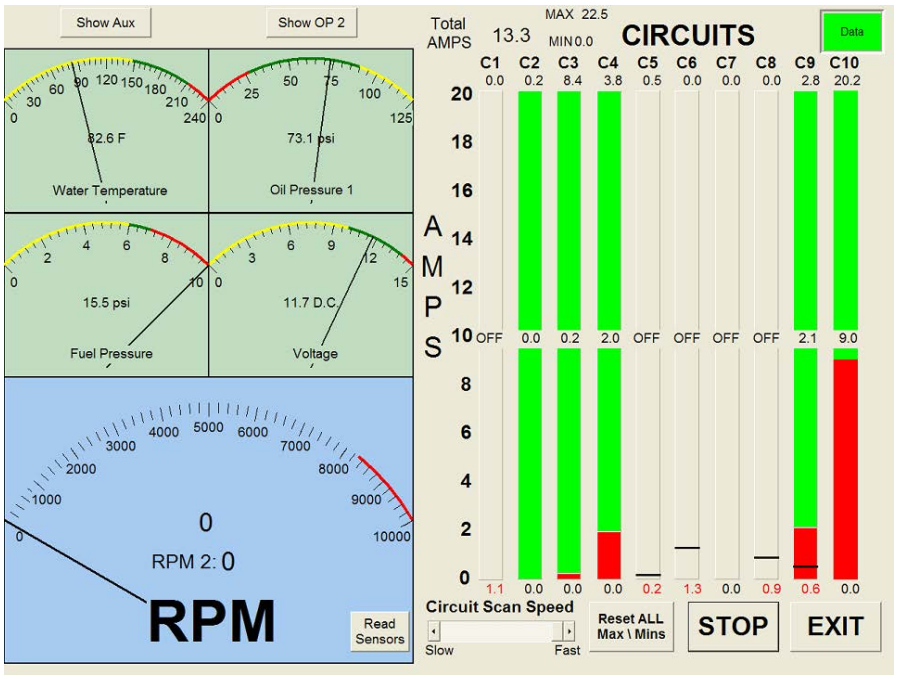

Figure 6: Live System Test Screen

While performing a live system test, a button labeled “Read Sensors” will appear in the lower right corner of the RPM gauge. When clicked, calibration values for each sensor of the ESP will be displayed. These values can be used in combination with actual pressure, temperature, etc values from a trusted sensor in your race vehicle to calibrate the ESP sensors. Further information on calibration can be found in the “Sensor Calibration” section. To close the panel of calibration numbers, the “Hide Panel” button (also in the lower right corner of the RPM gauge) can be pressed.

Switch & Signal Test

With Level 1 of the ESP software, a switch and signal test can be performed to test the setup of the ESP system. Switch test is available by entering the “Calibration, Diagnostics, Registration” screen from the main page of the ESP software.

To begin a switch and signal test, all switches and circuits of the ESP must be turned off. The “Start Test” button must then be pressed. While a switch and signal test is running, the user can turn on and off all Switch Panel switches and observe the circuits controlled. The MCU circuits will not turn on during this test. Instead lights on the software switch test page will indicate the connectivity. Boxes will display in green when a switch/circuit is on, yellow when they are off, and blue when they are not active.

Switch and signal test also allows the user to confirm that system inputs are setup correctly. These inputs include the data acquisition switch and master kill switch as well as the neutral safety, wide open throttle, closed throttle, and two-step/transbrake inputs.

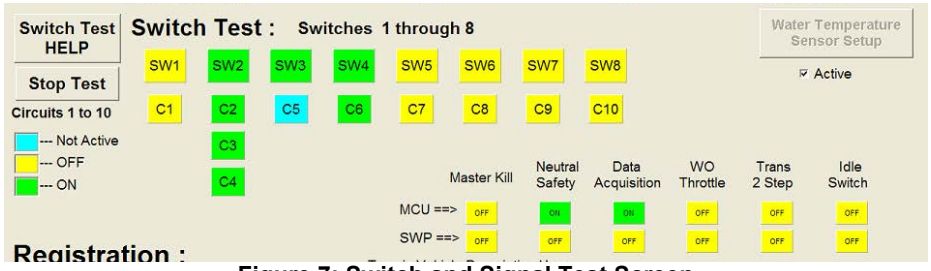

Figure 7: Switch and Signal Test Screen

To end a switch and signal test, all Switch Panel switches must be turned off and the “Stop Test” button must be pressed. If communication between the PC and ESP is lost during a switch and signal test, all Switch Panel lights will flash green slow signaling the error condition. When all switches are turned off, the ESP will return to normal operation.

Limits and Parameters

The “Limits Parameters” page, which can be entered from the main page of the ESP software, can be used to enable additional features in the ESP system. Most features require Level 1 or 2 of the ESP software to be enabled. To learn more about each feature on the “Limits and Parameters” page please see the “Features Enabled by Software” section of this document.

Upon entering the “Limits Parameters” page, the software does a compare to determine if the ESP configuration matches the configuration last saved in the software. When a mismatch exists between the saved data and ESP, the parameters that do not match will be highlighted in yellow.

The limits and parameters page is broken into several sections each of which allows the user to enable a different ESP function. The sections are briefly described below.

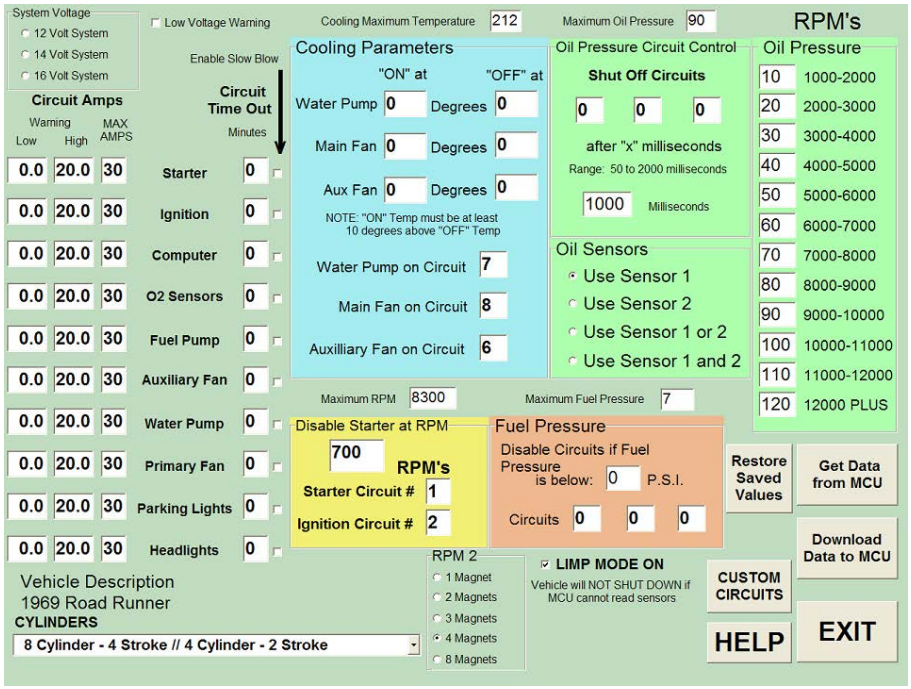

Figure 8: Limits and Parameters Screen

- **Circuit Amps:** Enable/disable high and low amperage warnings as well as maximum amperage shutdowns. In this section, the user can also designate a circuit as “Slow Blow”, which allows it to draw greater amperage on startup.
- **Circuit Time Out:** Enable/disable automatic circuit timed shutdowns that function when the vehicle is off and computer disconnected.
- **System Voltage:** Enable/disable a low voltage warning light that displays when the system voltage drops to 80% of the nominal system level.
- **Cooling Parameters**: Allow/disallow the ESP to automatically turn on/off the water pump and/or fan based on water temperature.
- **Disable Starter at RPM:** Allow/disallow the ESP to disable the starter circuit when the vehicle RPM is over a specified level.
- **Cylinders:** Setup the vehicle engine type to allow the ESP to properly detect engine RPM
- **RPM 2:** Setup the number of magnets on the driveshaft to allow the ESP to properly detect driveshaft RPM
- **Limp Mode On/Off:** When limp mode is on, the ESP will continue to function despite an internal hardware failure. When limp mode is off, the ESP will shut down all circuits in the case of this type of failure
- **Oil Pressure Circuit Control, Oil Pressure, Oil Sensor:** Enable/disable the oil pressure safety shutdown check. This check will monitor one or two oil pressure sensors and shutdown up to 3 circuits if they drop below a minimum pressure level for a set period of time.
- **Fuel Pressure:** Enable/disable the fuel pressure safety shutdown check. This check will monitor the fuel pressure sensor and shutdown up to 3 circuits if the pressure level drops below a minimum set value.

Additional parameters are available on the “Custom Circuits” page which is accessed through the “Limits Parameters” page. The sections on the “Custom Circuits” page are briefly described below.

- **Monitor These Circuits:** Enable/disable the nitrous amperage shutdown. If any of the nitrous circuits fall outside of the amperage tolerance specified, all of the nitrous circuits will be shutdown.
- **Circuit Shutdowns:** Enable/disable the water pump and/or fan shutdown check. This check allows the ESP to temporarily shut down the water pump and/or fan circuits while a race is in progress. The circuits will turn back on after a specified time period.

- **ET Safety Shutdown:** Enable/disable the safety shutdown check that will turn off all circuits on the ESP if closed throttle is not reached after a race.

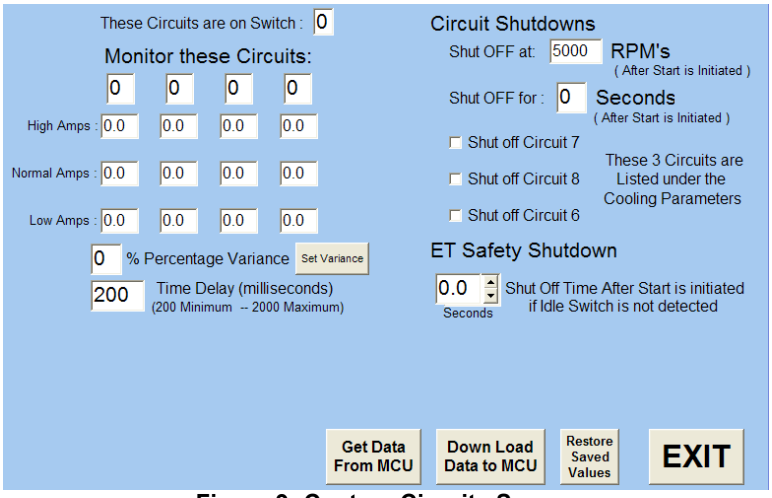

Figure 9: Custom Circuits Screen

Note: On the "Limits Parameters" page, there are several boxes that allow the user to select the maximum RPM, Oil Pressure, Cooling Temperature, and Fuel Pressure of the system. These boxes must be setup correctly for Data Acquisition to process data correctly and for the live system test sensor gauges to display properly.

When any parameter is changed on the "Limits Parameters" page be sure to press the "Download Data to MCU" button to send the changes to the ESP. All switches and circuits must be off for the new setup to download.

To view the current parameters that are in the ESP, click the "Get Data from MCU" button. This will cause the limits and parameters screen to reflect the current state of the ESP. The "Restore Saved Values" button will setup the limits and parameter screen to the values last saved by the user in the software.

Note: Changing the system parameters of the ESP will cause the ESP data acquisition memory to be erased. It is recommended to perform a data acquisition download before sending new parameters to the ESP.

Sensor Calibration

With Level 2 of the ESP software, sensors can be enabled in the ESP system and calibration performed. Sensor calibration is located on the "Calibration, Diagnostics, Registration" screen, which can be accessed off the main page of the ESP software.

The ESP is designed to communicate with two oil pressure sensors, one fuel pressure sensor, one water temperature sensor, and an auxiliary sensor. The auxiliary sensor can be configured to read pressure, vacuum, or temperature. To use a particular sensor in the ESP system, first the sensor must be marked as active in the software. This can be completed by checking the "Active" box for the sensor of interest in the "Calibration" section of the "Calibration, Diagnostics, Registration" page.

After a sensor is marked "Active", it must be calibrated before it will operate properly in the ESP system. If the auxiliary sensor is being used, the sensor type must be correctly selected.

The following are suggested steps for calibrating the oil pressure, fuel pressure, and auxiliary sensors:

1.) Select the range over which to calibrate the sensor (e.g. if you expect oil pressures ranging from 0 to 100 psi then your range is 0 to 100)
2.) Enter the low value of the range (0 in the example) into the bottom calibration box
3.) Enter the high value of the range (100 in the example) into the top calibration box
4.) While the sensor is reading the low value of the selected range (e.g. while the oil pressure of the vehicle is at 0), press "Read Sensor"
    a. Press this button a few times in order to make sure the value is steady
5.) Once the reading is steady, select "Set Low"
6.) Repeat Step 4 for the high value of the selected range (e.g. repeat while the oil pressure of the vehicle is at 100 psi)
7.) Once the reading is steady, select "Set High"

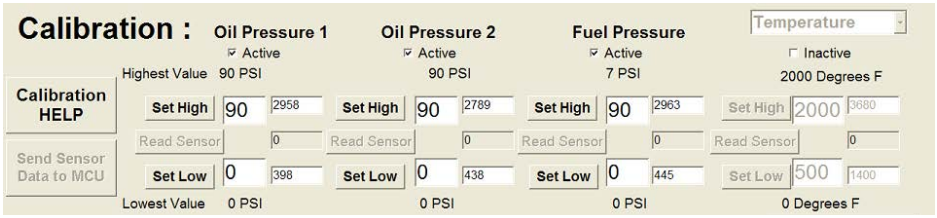

Figure 10: Calibration Screen

Since many temperature sensors are non-linear, the ESP provides a five-point calibration screen to handle temperature sensor calibration. This can be accessed by clicking the "Water Temperature Sensor Setup" button on the "Calibration, Diagnostics, Registration" screen. The steps for temperature, 5-point calibration are as follows:

1.) Select the temperature range over which to calibrate the sensor. These will be the first two calibration points for the temperature sensor
2.) Select 3 intermediate temperature values between the high and low temperature range
    a. Note: All selected values must be separated by at least 10 degrees for correct calibration
3.) While the sensor is reading the value of the first calibration point, press the "Read Sensor" button of the calibration point
    a. Press this button a few times in order to make sure the value is steady
4.) Repeat Step 3 for the remaining 4 calibration points

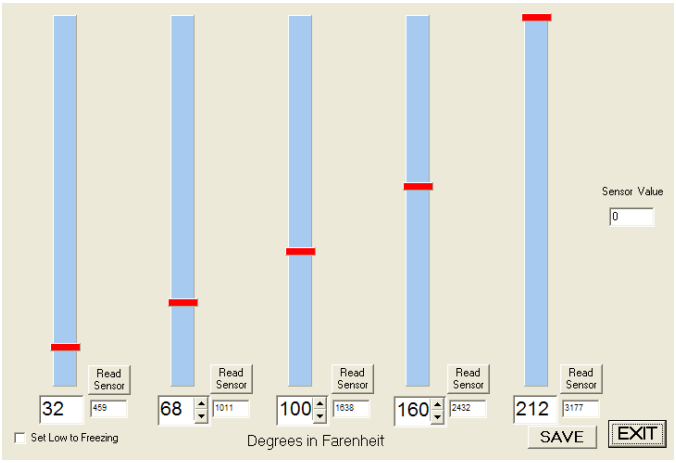

Figure 11: Water Temperature Calibration Screen

During calibration, we suggest using the sensor gauges in the race vehicle or a known calibration tool to ensure that the pressures or temperatures are correct. This is essential for proper calibration and system operation.

After calibrating all active sensors, be sure to send the new calibration values to the MCU by pressing the "Send Sensor Data to MCU" button on the "Calibration, Registration, Diagnostics" page.

Note: Sending sensor calibration data to the ESP will cause the ESP data acquisition memory to be erased. It is recommended to perform a data acquisition download before sending new calibration values to the ESP.

Vehicle Registration

The ESP software is designed to interface with up to four race vehicles. Each race vehicle must have a unique registration code. This code can be obtained by contacting Moroso or Portatree. To activate a new level of the ESP software, a new registration code will be needed.

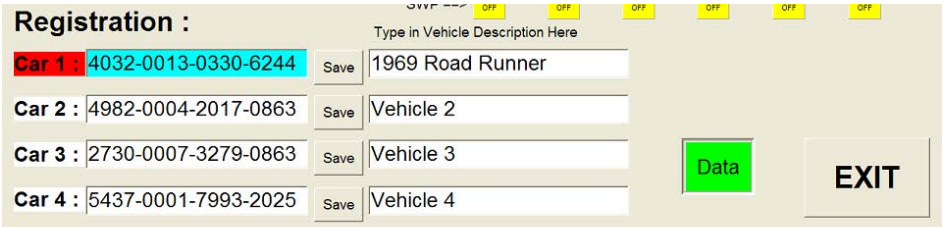

Figure 12: Registration Screen

After obtaining a registration code, enter the "Calibration, Registration, Diagnostics" page from the main page of the ESP software. In the "Registration" section, enter the new code in the box adjacent to the vehicle being updated. A vehicle description can be entered for each registration code to help keep track of the registration information.

The new registration code will take effect on the next link to the vehicle whose code was updated.

Data Acquisition

The ESP can be used as a data acquisition system with Level 3 of the ESP software. For this feature to work properly, a data acquisition switch must be installed in the race vehicle. Please see the "Installation" section of this manual for further information on setting up this input. When using data acquisition, it is recommended that all sensors connected to the system are calibrated. Furthermore, it is important to setup engine type and driveshaft magnet count for RPM to display correctly.

To record data in the ESP system, the data acquisition switch must be turned on while the vehicle is running or while the ESP is in live system test. If the vehicle is off and the PC is not connected, data can also be recorded when the data acquisition switch is turned on and the ignition switch is on. To stop recording data, turn off the data acquisition switch.
If the vehicle and ignition switch are off and the data acquisition switch is turned on, the amount of used memory will display in red across the Switch Panel switches. If all of the Switch Panel lights turn red, the ESP data acquisition memory is full. If all lights are off, the ESP data acquisition memory is empty. All other light combinations represent that some data is recorded in the ESP, but the memory is not yet full. To stop displaying the memory state, perform one of the following: turn off the data acquisition switch, wait 5 seconds for the display to clear, or turn on a Switch Panel switch.

After data has been recorded in the ESP system, it can be downloaded to the PC by clicking the "Download Data from Main Control Unit" button on the "Data Acquisition" page. This page can be accessed from the main screen of the ESP software. While a data download is in progress, the ESP will not allow user input to the system (i.e. it will not allow the user to turn on/off circuits in the system). After the data transfer is complete, you will be prompted to save the data to a file and erase the ESP data acquisition memory.

If you choose to save the data, it will be stored in a .pts file named by date and run number (e.g. YYYYMMDD-## where ## represents the run number). It will be stored in a folder named for the vehicle to which you are connected. If you do not save the data, you will be prompted again to save on exiting the "Data Acquisition" page.

If you choose to erase the ESP data acquisition memory, the recorded data will no longer be able to be accessed from the ESP. It is strongly suggested that you save your data to a file before erasing the ESP memory. If you do not erase the ESP memory following a download, you can click the "Erase" button to clear the memory as well.

After downloading data from the ESP, it will automatically display on the "Data Acquisition" page. To view a different run, click the "Show Files" button or double-click the box displaying the open file's name. This will lead to a file list that will allow you to select a new run to view. After selecting a new run, the file list will automatically disappear. To close the file list without selecting a new data file, click the "Hide Files" button.

Data from the ESP data acquisition system can be viewed in two styles using the ESP software. The default viewing style is as a plot where you can enable and disable the data series to display using the checkboxes on the legend. When the box next to an item in the legend is checked, the data collected for that item will be displayed on the plot. When the box is unchecked, the data for the item will not be displayed.

If the Moroso logo on the data plot makes it difficult to view a particular data series it can be hidden by un-checking the "Logo" checkbox at the bottom of the data plot.

The second style of viewing the data collected is in a data table. To switch to viewing in this style, click the "Show Grid" button on the "Data Acquisition" page. To return to viewing the data as a plot, click the "Hide Grid" button.

The ESP records 19 data series, which include amperage level of the ten MCU circuits, total system amperage draw, oil pressure from oil sensor 1, oil pressure from oil sensor 2, fuel pressure, water temperature, auxiliary sensor output, system voltage, engine RPM, and driveshaft RPM.

After you have selected the data series that you want to view using the legend checkboxes, you can save the setup with the "Save Setups" button. You will be prompted to select a setup number to which the new configuration will be saved (up to 3 setups can be saved). Once this is done, you can change the data series enabled in the legend and then quickly switch back to your preferred setup by clicking the correct setup number.

Every time the ESP data acquisition switch is turned on then off, a "run" is recorded in the data acquisition memory. As a result, when data is downloaded to the computer, it is possible to have multiple runs in a single

data file. To view only one of the runs stored, use the “Select Run to View” dropdown menu. By clicking this menu box, the list of runs stored in the data file will be displayed. Simply select the run to view and it will display on the data plot.

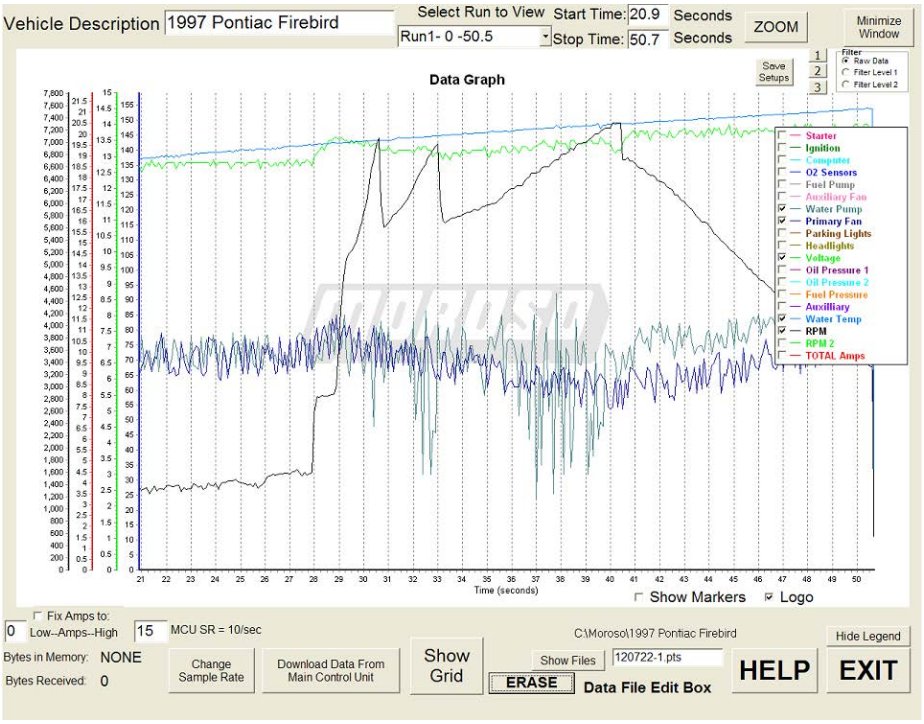

Figure 13: Data Acquisition Screen

Several zoom options can be used when viewing data series as a plot.

Amperage Zoom: This allows the user to select an amperage range to view. The vertical axis of the plot (amperage axis) will be limited to this range; thereby, expanding the amperage values plotted between this range. To use this feature, enter an amperage value into the “Low Amp” and “Amp High” boxes. Then check “Fix Amps to”.

Time Zoom: This allows the user to select a time range over which to view. The horizontal axis of the plot (time axis) will be limited to this range; thereby, expanding the data within it. To use this feature, enter a value into the “Start Time” and “End Time” boxes and click “Zoom”.

Click to Zoom: Zooming can also be performed by left-clicking a location on the data plot and dragging the cursor to the right across the screen. To un-zoom, left-click and move the cursor in the opposite direction.

A time marker is available for aiding in viewing the data. It can be enabled by checking the “Show Markers” checkbox located on the bottom of the data plot. The time marker can be dragged across the data plot using the mouse or moved with the arrow keys.

As the time marker is moved across the screen, it will display the time-axis value at the top of the marker. The value of every data series at that point in time will be displayed on the right-side of the legend. The legend can be hidden to increase the amount of view space available by clicking the “Hide Legend” button. If this is done while “Show Markers” is enabled, the data series values will continue to display. The legend can be unhidden by clicking “Show Legend”.

When “Show Markers” is enabled, an input/output panel will also appear in the upper-left corner of the data plot that shows the on/off state of all circuits and signal inputs in the ESP system. As the time marker is moved across the plot, the input/output panel will update with the state of the circuits and signals at that point of time.

By default, the data displayed in the ESP plots is raw data collected from the system. To view trends in the data, the filter feature of the software may be helpful. In the “Filters” section of the “Data Acquisition” screen, three options are provided: “Raw Data” (default), “Filter Level 1”, and “Filter Level 2”. Filter level 1 provides slight smoothing to the data series while filter level 2 provides heavier smoothing.

The ESP has three sample rates for recording data. The default is 10 samples/second; however, this can be changed by clicking the “Change Sample Rate” button. The options are as follows.

- 10 samples/second (~3.4 minutes of data storage capacity)
- 20 samples/second (~1.7 minutes of data storage capacity)
- 50 samples/second (~40.96 seconds of data storage capacity)

Note: Changing the data acquisition sample rate will cause the ESP data acquisition memory to be erased. It is recommended to perform a data acquisition download before changing the sample rate.

Quick System Specifications

- System voltage: 12 to 16 volts (22 volt absolute maximum)
- Switch Panel and MCU communicate via CAN Bus
    - CAN bus terminated with standard 9-pin DSUB connectors
    - Maximum cable length of 40 ft
- MCU communicates with a PC via USB
    - Connects to PC with a standard Type A to Type B USB cable
    - USB drivers provided with software
- 10 MCU Circuits
    - 30 amp maximum throughput per circuit
    - 120 amp maximum continuous throughput per board
    - Standard wide blade automotive grade fuses
    - Amperage monitoring
    - Heat, short circuit, and over voltage protection
- MCU housed in a black anodized extruded aluminum case with transparent cover
    - Includes mounting brackets
    - Dimensions: 8.5” x 6” x 2”
- Switch Panel has 4 single-position switches and 2 dual-position switches (8 total switches)
- Switch Panel comes in Panel Mount or Roll Bar Mount
    - Panel Mount Dimensions: 8” x 4” x 2”
    - Roll Bar Mount Dimensions (approx): 8” x 3” x 3”
- MCU Only Inputs
    - 2 Oil Pressure
    - 1 Fuel Pressure
    - 1 Water Temperature
    - 1 Auxiliary Sensor
    - 2 RPM Inputs
- MCU and Switch Panel Inputs
    - Master Kill Switch
    - Data Acquisition Switch
    - Neutral Safety Switch
    - Transbrake/Two-Step Connection
    - Wide Open Throttle Switch
    - Idle Throttle Signal

Quick Light Code Guide

The following codes are for MCU circuit lights and Switch Panel switch lights.

- **Solid Green**: Circuit operating properly
- **Slow Flashing Green:** Circuit amperage below warning level
- **Green Flash Fast then Slow:** Circuit has been turned on due to a sensor
- **Fast Flashing Green:** Circuit amperage exceeds warning level
- **Solid Red:** Circuit hardware problem (call factory)
- **Slow Flashing Red:** Circuit amperage exceeds
- **Red Flash Fast then Slow:** Circuit has been turned off due to a sensor
- **Fast Flashing Red:** Circuit has been turned off due to a short circuit
- **Solid Green with Red Flashing Fast:** Oil, fuel, or nitrous failure in warning light only mode

The following codes will only display on the Switch Panel starter switch.

- **Starter Switch solid red with green flashing slow**: Low voltage warning
- **Starter Switch yellow/orange**: Circuit time outs are enabled for at least one circuit

The following are special light codes that are displayed during special shutdowns or emergencies.

- **All Switch Panel solid red (MCU lights off)**
    - Master Kill Switch pressed, all circuits shut down OR
    - Switches on during startup, safety feature OR
    - Switch Panel/MCU communication lost, safety feature OR

    - Race Vehicle did not return to “Closed Throttle” during a run, all circuits shut down
- **All Switch Panel solid red (half MCU lights red)**
    - Left half of MCU lights red – Current draw on left half of board exceeded 60 amps
    - Right half of MCU lights red – Current draw on right half of board exceeded 60 amps
- **Switch Panel and MCU lights alternating between half red and half off:** Limp mode shutdown
- **All Switch Panel slow flashing red (MCU unaffected)**: Oil Pressure shut down
- **All Switch Panel solid green with red flashing fast (MCU unaffected)**: Oil Pressure warning
- **All Switch Panel and MCU lights fast flashing red**: Hardware problem (call factory)
- **All Switch Panel lights alternating green/red and MCU cycling red**: Low voltage shutdown
- **All Switch Panel lights slow flashing green (MCU unaffected)**
    - PC communication lost in switch/signal test, safety feature
- **0 to 6 Switch Panel lights solid red (MCU unaffected):** Used data acquisition memory displayed

The following light codes are for the MCU Status Lights.

- **System Status Light**
    - **Off:** ESP is in lower power mode
    - **Solid Green:** ESP is operating and vehicle is off
    - **Solid Red:** ESP is operating and vehicle is on or attempting to turn on
    - **Fast Flashing Green:** PC is connected to the ESP
    - **Slow Flashing Green:** PC is connected and ESP is performing a switch/signal test
    - **Slow Flashing Red:** PC is connected and ESP is performing a live system test
- **CAN Status Light**
    - **Solid Green:** Switch Panel and MCU are communicating
    - **Solid Red:** Switch Panel and MCU are not communicating
- **Data Status Light**
    - **Off:** ESP is not recording data
    - **Solid Green:** ESP is recording data in data acquisition memory
    - **Solid Red:** ESP data acquisition memory is full
- **Limp Status Light**
    - **Off:** No internal system failures have occurred
    - **Solid Green:** USB or data acquisition failure
    - **Solid Red:** Amperage, voltage, and sensor detection failure
    - **Fast Flashing Red:** Internal device memory failure

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