REPOWER Power Steering Controller Manual

Use

Thank you for purchasing the Inductive Autoworks' REPOWER power steering controller system. This unit is designed to control one of many types of OEM electric power steering units while allowing variable output control through manual input or by connecting with a vehicle speed sensor or another controller.

Currently, we support the following steering systems:

Hydraulic-Electric:

- Volvo
- 2010+ Mazda 3 & Mazda 5
- 2014-18 Nissan Altima
- 2012-20 Dodge Charger & Chrysler 300

Rack:

- 2002-05 Mini Cooper

Column Assist:

- 2012-20 Toyota FRS/GT86 & Subaru BRZ
- 2004-15 Toyota Prius

Hardware Installation

1. Mounting instructions

The PSC's case has 2 holes on the sides designed for M5 or 3/16 Allen head hardware.

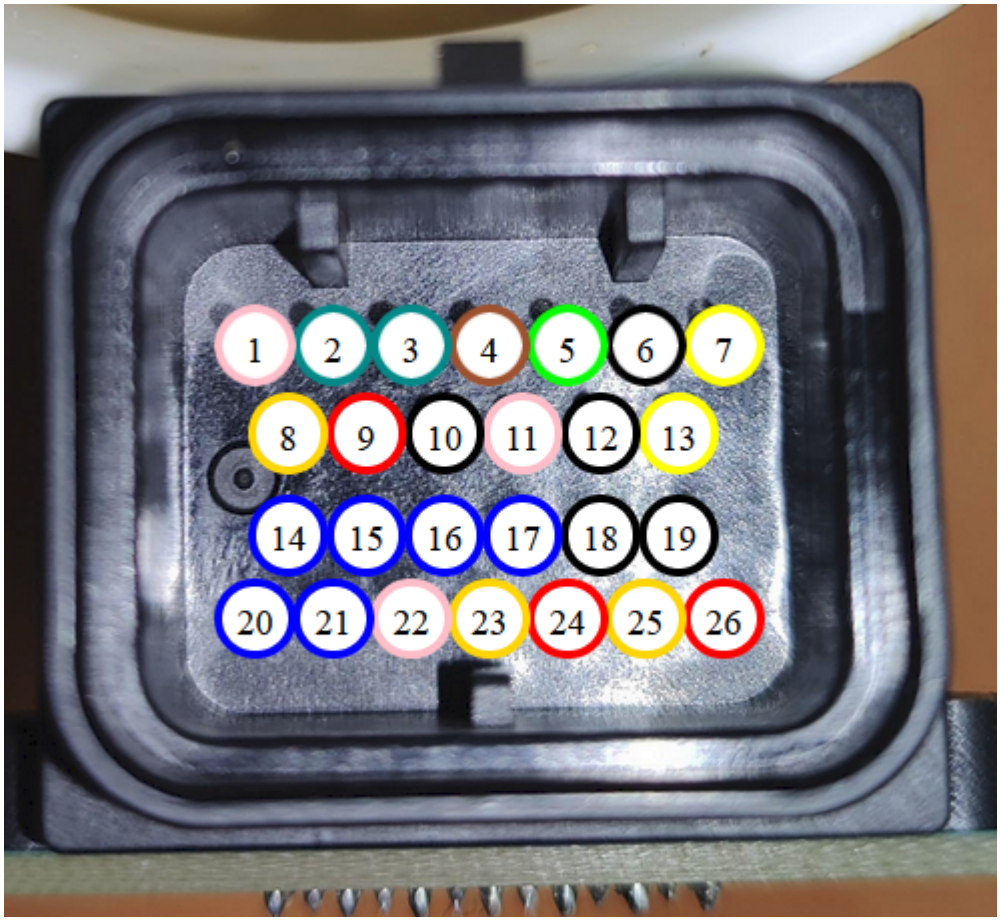
Keep the controller away from heat sources, direct water, submersion in water, and fuel. The case is water and dust resistant but not suitable for the previous conditions. It is strongly recommended to be installed in the cabin of the vehicle.

Due to the internal Wifi antenna the controller must have at least the top or the bottom free of metal covering in order to connect to a programming device such as a smartphone or laptop. It is strongly recommended that the permanent mounting solution remain free of metal on one side to allow easy connection and long life of the antenna.

2. Connector pinout

The PSC uses a 26 pin AMP SuperSeal 1.0 connector. Unused pins are sealed until a terminal is inserted in them, therefore read all the instructions before determining which pins are to be used.

It is important that terminals after being crimped are straight and not bent or bowed. This will prevent pins from being inserted all the way in and possibly result in damage to the connector. If you do not have access to the correct crimp tool please contact your distributor for a flying lead harness.



Pin Number	Type	Function
1	NC	NC
2	OUT	Generic Output 2
3	OUT	Generic Output 1
4	VR	Variable Reluctance Positive

5	DIN	Digital Input (Hall sensor input/ECU PWM input)
6	Ground	Ground
7	Power	Ignition
8	AIN	Pressure sensor signal input
9	5V	5V for Pressure sensor
10	Ground	Ground for Pressure sensor
11	NC	NC
12	Ground	Ground for hall sensor
13	Power	12V Output for hall sensor
14	CAN L	EPS CAN low
15	CAN H	EPS CAN high
16	CAN2 R	120Ohm Termination resistor for CAN 2 (Cut to disable)
17	CAN2 R	120Ohm Termination resistor for CAN 2 (Cut to disable)
18	Ground	Ground for Temperature sensor input
19	GroundL	Ground for Analog Input (Potentiometer)
20	CAN2 L	Vehicle CAN Low
21	CAN2 H	Vehicle CAN High
22	NC	NC
23	AIN	Temperature sensor signal input
24	NC	5V supply for Temperature sensor input
25	AIN	Analog Input (Potentiometer)
26	5v	5V supply for Analog input (Potentiometer)

3. Wiring diagram

[We apologize - this is still a work in progress since there are many variations of how the controller can be used, if you need specific help for your application reach out to inquiry@inductiveauto.com]

Software setup

a. Requirements

Once the unit is wired in and powered up the Wifi is automatically ready to connect. Any device capable of connecting to a Wifi network and accessing a webpage can connect to the PSC.

Wifi requirements: 2.4 GHZ B/G/N

Note, some firewalls and antivirus software do not allow connection to a wifi network with no internet connection. You must disable the firewall features in order to allow the PSC to transmit data to your computer.

b. Connecting to controller

Using your smartphone or laptop, find the network named PSC-XXXXX, where XXXXX is your serial number. The wifi password is provided on a card included with the PSC upon purchase.

Once you are online enter the following URL into your browser:

Http://psc.local

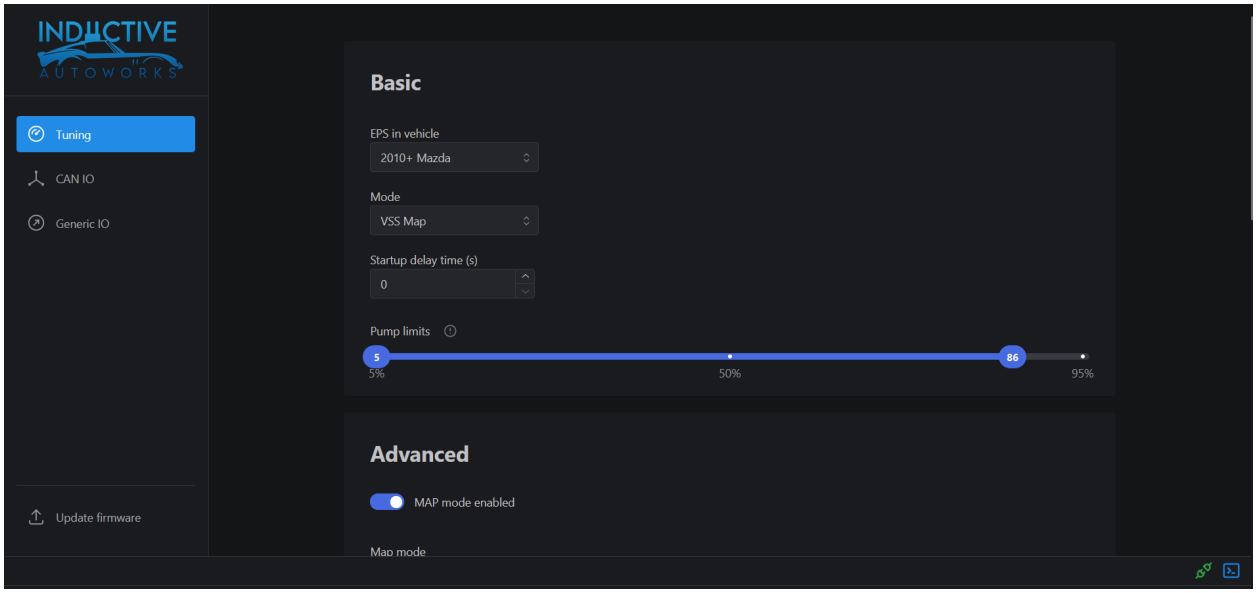
If for some reason that address does not work, please try typing directly into the browser 192.168.1.1

If you are having trouble with the Wifi connection remaining stable on your laptop, please try using a smartphone or tablet.

To prevent unwanted tampering after install each unit has a unique login based on its serial number. No two units share the same login or password. If you ever lose your login please email inqury@inductiveauto.com

c. Basic settings

Once you are online you should see the following screen:



Select your pump type from the drop down menu under “EPS in Vehicle”. This will put the PSC outgoing CAN bus in the mode specific to your pump and what specific CAN messages and behaviors it needs to see to operate the pump correctly.

The drop down menu for “Mode” has the following options for control modes the PSC supports via different inputs:

VSS map - The PSC has 2 onboard inputs for Vehicle Speed Sensors, either hall effect or VR type sensors. It can also receive a VSS signal via CAN BUS.

See the advanced settings section for using speed to change assist effort.

CAN - PSC accepts a CAN message for assist effort. CAN is addressable, please see the Advanced settings section. Ideal for CAN enabled aftermarket ECU’s, or even certain supported OEM ecu’s. Note this requires proper connection of a twisted pair CAN BUS to the Vehicle CAN pins.

PWM - Pulse Width Modulation control input. 5 to 95% operation, user defined table. Ideal for aftermarket ECU’s.

Single value - as long as the unit is powered up the pump will operate at a fixed % of assist effort.

Full manual - 0-5V analogue input controls assist effort. User definable table, see advanced settings. See wiring diagram for correct wiring to use this input.

i. Pump limits bar

Most EPAS are not linear in feel vs assist effort percentage. Especially electro-hydraulic systems are only useful between 40% and 100% assist. Depending on the vehicle and type of use, you will find that limiting the pump from operating below a certain percentage or above a certain percentage allows for the best feel. Many systems are just not effective below a certain % of pump duty cycle. This will take some experimentation, as there are so many variables that can affect feel (tire size, tread wear, suspension design, alignment, tie rod angles, steering wheel size etc etc) the end user must configure this.

Click and drag the circles towards the middle to set limits. The controller will only allow the pump to work within the set limits.

Example 1:

You have the pump limits set from 0-100%. You are using a 5 position potentiometer to control the pump. Pos 1= 0% pos 2 = 25%, pos 3 = 50%, pos 4 = 75%, pos 5 = 100% of actual pump duty cycle.

Example 2:

You have the pump limits set from 50-100%. You are using a 5 position potentiometer to control the pump. Pos 1=50%, pos 2 = 65%, pos 3 = 75%, pos 4 = 87.5%, pos 5 = 100% of actual pump duty cycle.

ii. Save Button

Every time you change a mode or a setting you must press the save button. The change will not take effect until the PSC has written and done a power cycle. Note the power cycle may result in the wifi connected device losing connection and your device connecting to another network. Manually disconnecting from every other network on your device temporarily, is advised.

It is also strongly suggested to ensure the PSC does not lose power during a save or even more importantly a firmware update.

iii. Startup Delay

To prevent the EPAS system operating immediately, you can enter a delay in seconds. Some pumps will default into limp mode if the delay is too long, if this happens cycle power and make the delay shorter.

b. Advanced settings and strategies

i. VSS map

Digital VSS - This setting utilizes a digital signal via pin 3. This can be from a Hall Effect sensor measuring at the transmission output shaft, or on an axle or hub.

Vehicle speed is measured in KM/H. You can calibrate the incoming signal by changing the values in the following boxes;

Pulses per one wheel rotation - number of teeth on trigger wheel

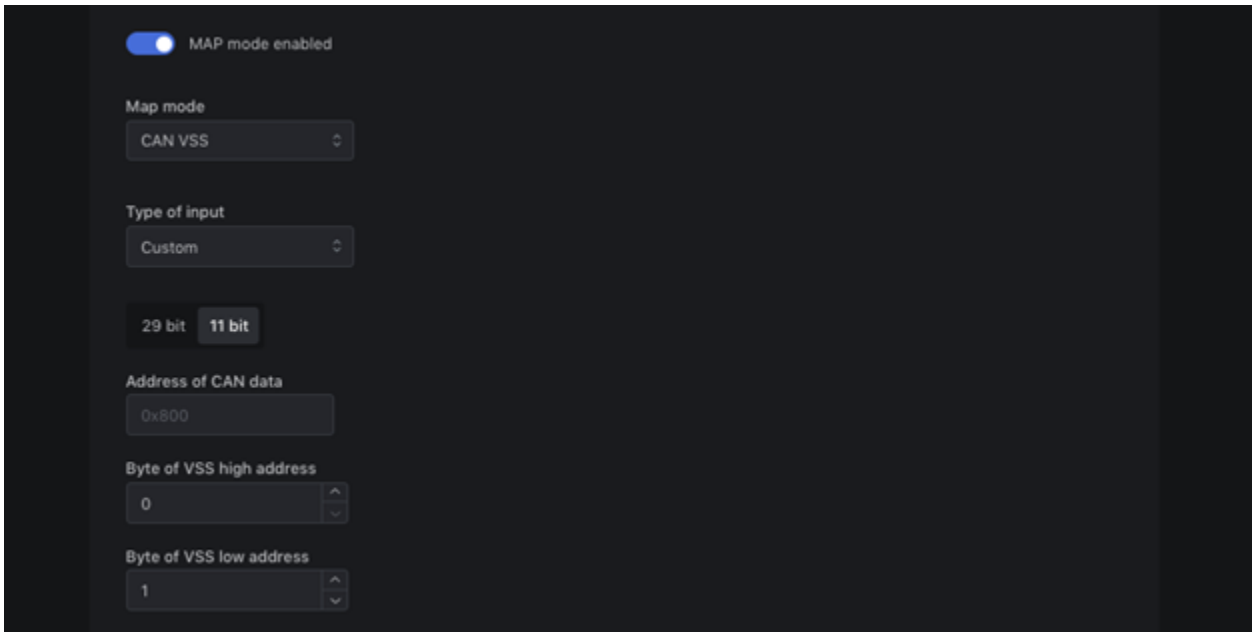
Wheel diameter - overall wheel/tire diameter measured in inches

Note that if you are using a trigger wheel on the output shaft of a transmission you will need to account for the final drive ratio in the differential.

Select the a cell on the “Pump %” row and type in a number to calibrate this table.

This will take some real world testing in order to get the feel to your liking. There is no “one size fits all” math or formula that can be used as setups differ greatly. See calibration tips section.

CAN VSS - From the drop down menu you can select a predefined CAN stream of your vehicle’s ECU or if you select “Custom” to get to the following options;



You can select 11 bit or 29 bit for use on extended address CAN networks.

Enter the address of the CAN message in the format “0x00”

Specify the Byte of the high address or Most Significant Bit

Specify the Byte of the low address or Least Significant Bit

The PSC receives VSS via a common message format: A+ (B / 256)

Set your transmitting CAN device to send in the following format: A+(B x 256

VSS Multiplier is used differently in between protocols. Most common is 0.01

For further assistance regarding this please email inquiry@inductiveauto.com

Table calibration is the same as above in “Digital VSS” mode

WARNING - GPS Speed data is not ideal for PSC control and strongly advised against use to control any power steering system.

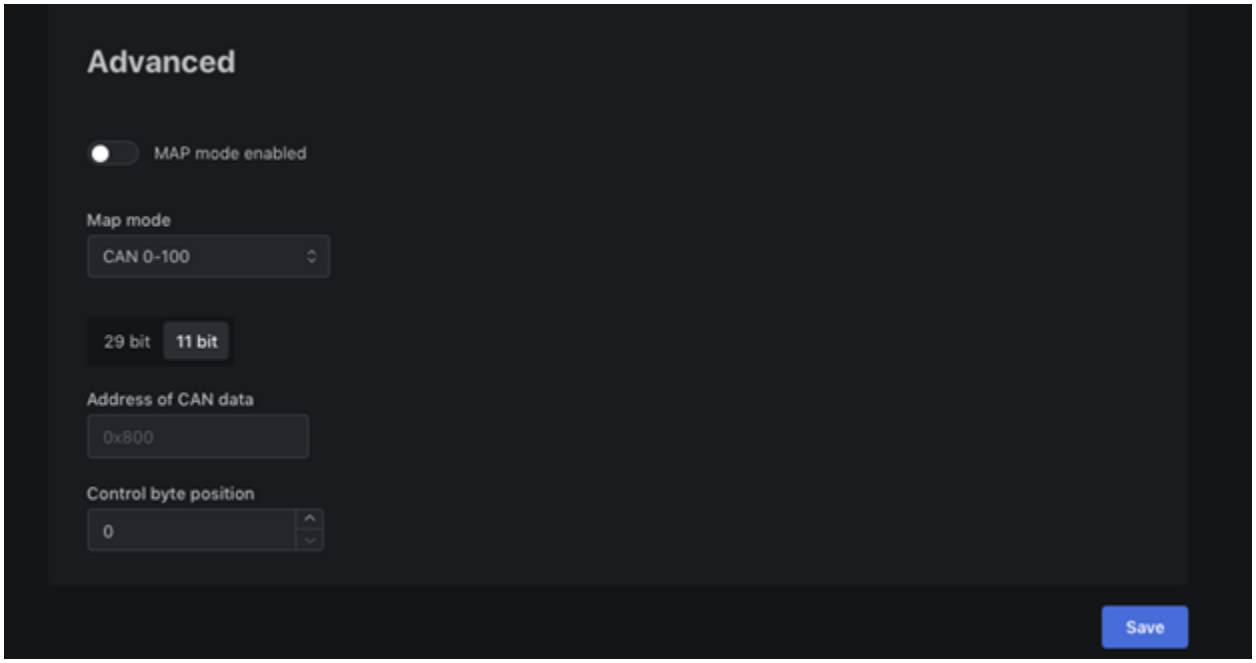
Note CAN Baud rate setting must be correct, this setting is changed in the CAN Table

VR VSS - This mode utilizes a VR sensor connected via Pin 4 and 8. Table calibration is the same as above in “Digital VSS” mode.

ii. CAN

Note that the following menu options are for adjusting the incoming CAN data. Any outgoing CAN Data or general settings such as baud rate need to be adjusted by the CAN I/O tab. Please see Section 4 for more information.

CAN 0-100 - For use with the Vehicle CAN BUS and an ECU or device that can send a CAN message where 00 = % and 64 = 100% of pump duty cycle.



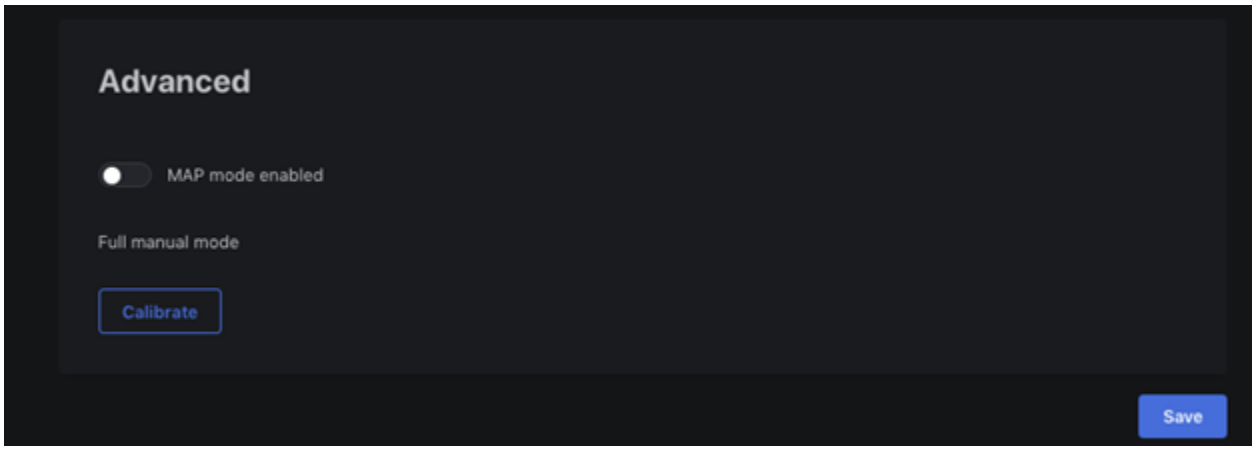
You can select 11 bit or 29 bit for use on extended address CAN networks.

Enter the address of the CAN message in the format “0x00”

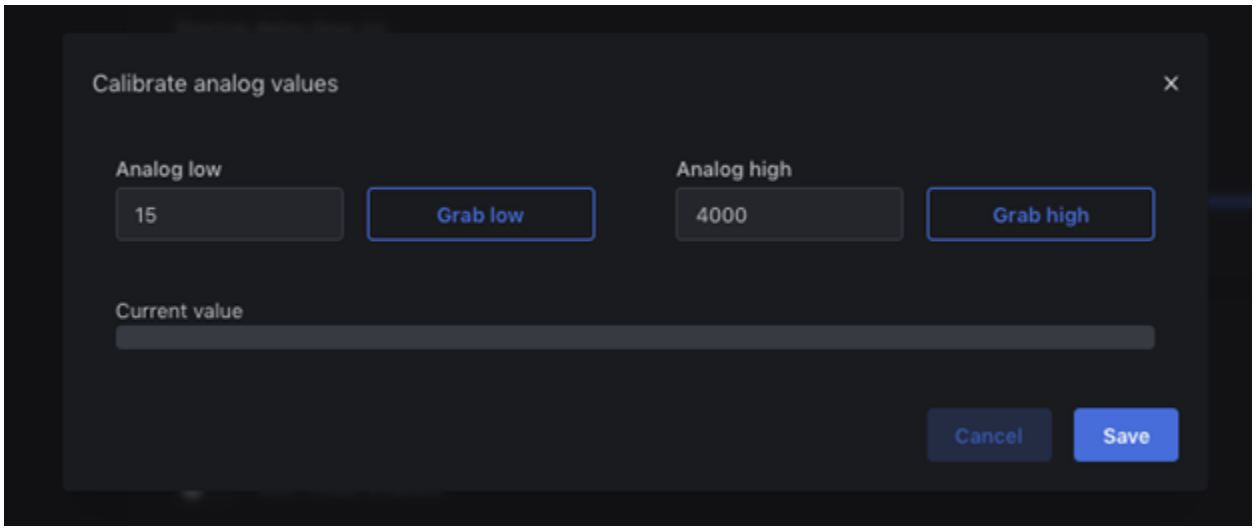
Specify the Byte position of the CAN message.

CAN VSS - See the CAN VSS section above

iii. Full Manual



Using an analog 0-5V input such as a potentiometer, this mode allows you to calibrate the incoming signal.



At the minimum position of your sensor or switch click the “Grab Low” button.

At the maximum position of your sensor or switch click the “Grab High” button

Note; You can calibrate either polarity potentiometer with this tool, the table will be automatically set as linear between the low point and the high point.

Any resistance potentiometer can be used up to 10k ohms, 1K ohms is recommended for maximum resolution.

CAN I/O tab

This Tab is for changing CAN output and general settings. CAN input settings are changed in the Tuning tab options.

The PSC can also transmit the following CAN data:

0	1	2	3	4	5	6	7
Pump duty	VSS msb	VSS lsb	Pressure Sensor MSB	Pressure Sensor LSB	Temp sensor	N/A	Error message
%	Km/H		kPa		C*		
0-64	x10 Multiplier		-.0333 Multiplier (100 multiplier & 3000 divider)		-40 to 200 Signed		**00=** good **30**=overtemp **60**=overpressure **90=** no CAN data from EPAS **FF=** Error

You can select 11 bit or 29 bit for use on extended address CAN networks.

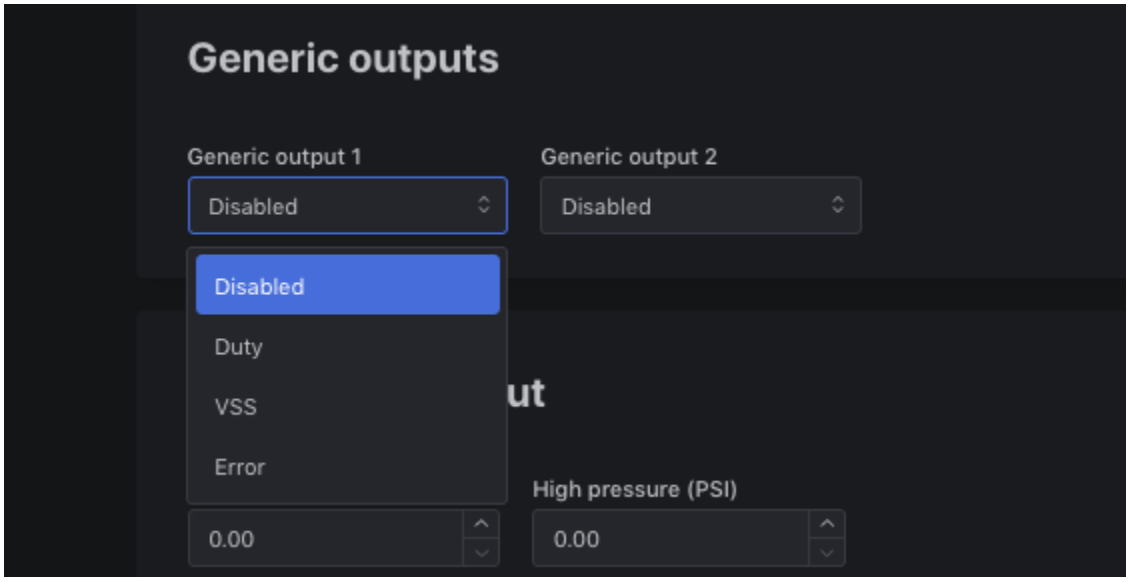
Enter the address of the CAN message in the format “0x00”

Select CAN BUS speed or Baud rate (100, 125, 200, 250, 500, 1000 kbps). This setting must be correct in order to ensure even basic operation of the bus the PSC is connected to as well as the PSC itself.

Broadcast enabled button must be pressed on for PSC to transmit data. Otherwise the PSC will be silent on the bus which can be needed with certain ECU’s.

Generic I/O tab

Generic outputs: (two outputs available, either can be set to the following:)



Duty - Pump duty cycle (pwm signal output; 0=0% pwm, 100=100% pwm)

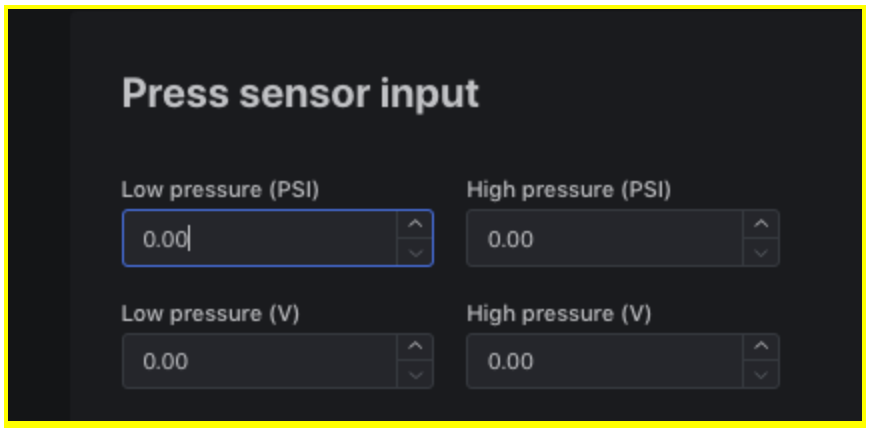
VSS - output can be configured to send a signal to a speedometer or data-logging device. Output is calibratable via multiplier setting.

Error - low side signal, has continuity to ground when PSC is in error state. See “Troubleshooting” for more information.

a. Pressure sensor Input

The PSC has an option for using* a Pressure sensor input, using pins 11, 12 and 13.

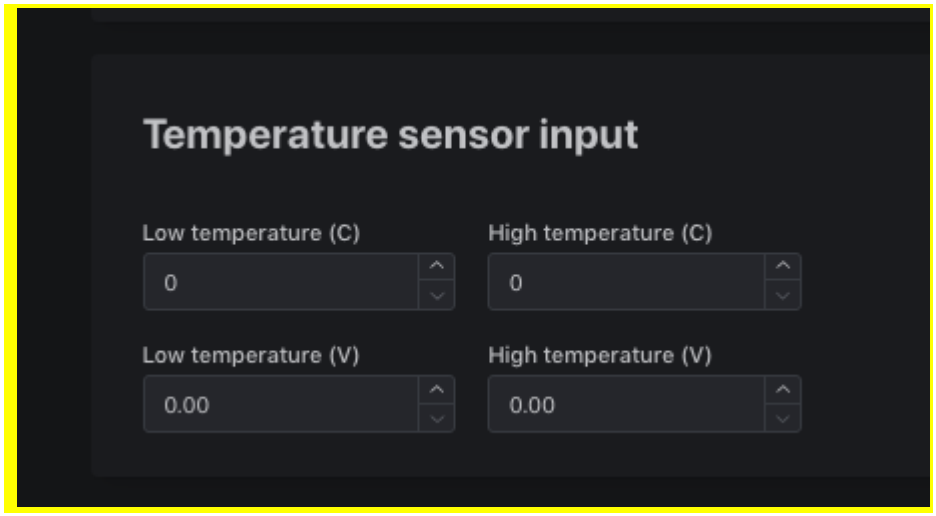
Future versions of the firmware will allow for pump duty cycle compensation based on pressure and temp. The PSC also sends this data out via CAN.



You can calibrate low and high pressure using the boxes pictured. 0-5V pressure transducers are linear calibrations, so only low and high points are needed.

b. Temp sensor input

The PSC has an option for logging a temperature sensor via pins 15, 22, 23. The pinout and wiring diagram sections for more information.



You can calibrate low and high temperature using the boxes pictured.

The PSC has 2.2K pullup resistor built in. The 5V wire is for active temp sensors such as AC Delco PN:12551708 (‘98 Camaro 5L V8).

Troubleshooting

EPAS systems draw a lot of electrical current. It is very important that your vehicle’s battery, alternator and pump wiring be properly sized and in good working order.

Battery terminals need to be clean and tight. Ground connections need to be clean and to bare metal of the chassis, die electric grease is always recommended for connections to bare metal. The number one most common issue in automotive electrical systems, especially aftermarket is grounding.

If you have a smaller amperage dc-dc converter, consider upgrading to a higher amperage version.

Ensure your battery is in good health and is fully charged when setting up and testing your EPAS system. Also considering upgrading to a higher Ah rating if needed.

Ensure use of adequately sized power and ground cables powering the pump. The length of the loop also includes the ground wire. The shorter the loop the less voltage drop likely to occur. A fuse or slow blow type circuit breaker to protect the system in case of a short or overcurrent situation is also required.

The exact needs of your EPAS system depend on many factors, it may require some testing to determine that your electrical system needs improvement. Which EPAS you use, distance to the battery, wheel/tire size, vehicle weight, intended use, etc are all factors in determining what size power cables, dc-dc, and battery may be required for your specific needs.

No CAN bus transmitting from the PSC

Check that the wiring is correct and that the “PSC Broadcast enabled” box is checked in the CAN I/O page

Unit will not power up

Check that you have 12 volts on pin 1 and continuity to battery ground on pin 2

Pump goes into limp mode

Reduce start up delay timer, ensure CAN wiring is correct (high and low are correct)

Additional Information

a. Choosing an EPAS system

Column mount, Electro-hydraulic or rack mount systems are all available to be retro fitted from a number of modern vehicles using OEM parts. There are also aftermarket companies making EPAS systems, but generally they have their own controllers/software. PSC was designed for retrofit solutions.

Electro-Hydraulic will most likely be the simplest to retrofit into a vehicle that had an existing engine driven pump hydraulic system. These systems pressure output is somewhat RPM based, though there are many OEM control solutions, and result in parasitic drag on the engine under all conditions. Overspeeding them can result in cavitation and/or overheating fluid. Electro-hydraulic pumps can bypass all of these problems, as well as offering limitless mounting solutions and depending on what pump you use are very flexible in reservoir and pressure line and return line options. Considerations for reservoir size and design is somewhat case by case but in general starting with the OEM pump's reservoir and improving as needed is a good starting point.

Column mount systems are more common in economy cars but some sports cars such as the BRZ/FRS twins use them as well. They require some careful thought into mounting solutions, either in the cabin or engine bay as space permits. The mounts need to be very strong, flexing will result in lost efficiency and eventually bracket failure. These systems require attention to the mounting angles, similar to a driveshaft would. The U joints used in steering systems have a maximum angle they can be used at, and require the angles cancel each other out. If one angle is greater than the other this will result in strange unpredictable steering due to bind. Heat also needs to be thought about, inside the cabin they don't get much air flow and in the engine bay they would be subjected to high ambient temps. The smaller units can also overheat and many have internal temp sensor(s) to shut down before failure.

Rack mounted EPAS systems are found on some of the best feeling EPAS equipped vehicles such as the Mazda RX8 and Chevrolet Corvette. The motor being directly mounted on the steering rack can cause issues with oil pan or subframe clearance. Modifications to the subframe are often required. Consideration to tie rod angles and clearance will need to be made. Ambient temp in engine bays is also much higher, and even though these systems were designed to be in an engine bay under a hot engine, ensuring adequate airflow to maintain cooling will need to be accounted for.

b. Calibrating tips

There is no "one size fits all" formula or math for setting up one of these systems. Perhaps someone else has a similar setup and can offer settings as a starting point but expect to do some guessing and testing during calibration.

There are so many different factors in a EPAS system, tire size, alignment, amperage draw, voltage drop, steering wheel size, pump/assist type, etc that one just needs to try stuff out and see what feels good. That is the fun part of the install.

Take caution when first starting driving, as you would with any new modification. Ensure that all hardware is tight and electrical connections are tight and secure.

Vehicle speed is not necessary to be calibrated accurately, again this is just to help provide a starting point. Don't worry if your VSS calibration isn't perfect, you can always adjust pump duty cycle or the VSS settings to accommodate as needed.

While stopped, turn the steering wheel and see that everything feels tight and the pump or EPAS is actually assisting. Next try the same at low speeds and see that the system behaves as you expect it to based on the settings entered. Adjust as needed. Increase speed and repeat until satisfied with the settings you have.