



Installation Instruction for SM400 Standalone Engine Management

This User Manual Only for Rev3 & Rev4 Boards

Warning

The EMS400 allows for total flexibility in engine tuning, misuse of this product will destroy your engine.

SPTRONICS holds no responsibility for any engine damage that may results from the misuse of this product.

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EMS400 Specifications:

Standalone engine management system based on Megasquirt MS3x processor and firmware with enhanced inputs and output ports in aluminum sealed enclosure and sealed automotive grade connector. It can control sequential injection on engines up to 4 cylinders, or semi-sequential up to 8 cylinders, combined with direct fire ignition for engines up to 4 cylinders (active or passive coils) or wasted spark ignition on engines up to 8 cylinders (active only coils). Can be connected as a fully standalone ECU or as piggyback and share the sensor reading with the stock ECU as it has differential trigger inputs, The 4-bar internal MAP sensor can read up to 44psi of boost, 5V ref voltage, and software switches to pull up resistors. It has dedicated inputs (Crank, CLT, IAT, MAP, TPS and O2), 1 programable knocking input. 10 low side outputs to drive injectors or any solenoid valve, 4 of them can be used to drive stepper motor idle. 4 dedicated ignition outputs and to drive both active and passive coils, unused ignition output can be used as auxiliary output to drive any solenoid. 5 digital/frequency. 4 analog/digital inputs. It comes with a mating connector and terminals. CAN bus connectivity, SD card slot and Real Time Clock (RTC) with backup battery for data logging. USB as main connectivity and USB or Wi-Fi for monitoring. Bluetooth/Wi-Fi name and pin are configurable.

Trigger Inputs:	2 x Differential Crank Input (Hall or VR)
Injector Drivers:	4 x Saturated (8-ohm minimum, High Impedance Only)
Ignition Drivers:	4 x Logic level or direct coil (active and passive coils supported)
Outputs:	6 x Low Side Output 2.5A max.
Analog Inputs:	4 x inputs can be used as analog input or as switch input.
Digital/Frequency Input:	5 x Input as switch input or frequency input, only Hall sensor supported.
Knocking Input	1 x Programmable knocking input.
Throttle Position Input	1 x 0-5V analog input.
Internal 4 bar Map sensor	Internal 4 bar map sensor.
Coolant Temperature Sensor	1 x 0-5V analog input.
Inlet Air Temperature Sensor	1 x 0-5V analog input.
O2 Sensor	1 x 0-5V analog input.
USB	1 x PC Communication
5 Volt Reference	1 x 5V output for sensor supplies.
Sensor Ground	1x Ground for sensor supplies.
CAN Bus	1x CAN Bus.
Bluetooth/Wi-Fi	Wireless communication port (Bluetooth or Wi-Fi).

Wiring Diagram:



Looking at PCB connectors

Main Connector:

Pin	Name	Comment
1	GND	
2	Low side output 2	
3	Digital/Frequency 5 Input	
4	Digital/Frequency 4 Input	
5	Digital/Frequency 3 Input	
6	Digital/Frequency 2 Input	
7	Digital/Frequency 1 Input	
8	Low side output 6	
9	Low side output 5	
10	Low side output 4	
11	Low side output 3	
12	Injector 4 output	
13	Injector 3 output	
14	Ignition 4 output	
15	Ignition 3 output	
16	O2 Analog sensor input	
17	Intake Air Temp. Sensor Input	
18	Coolant Temp. Sensor Input	
19	Throttle Position Sensor Input	
20	Knocking 1 Input	
21	Analog/Digital 4 Input	

22	Analog/Digital 3 Input	
23	Analog/Digital 2 Input	
24	Analog/Digital 1 Input	
25	Injector 2 output	
26	Injector 1 output	
27	Ignition 2 output	
28	Ignition 1 output	
29	Sensors Ground Output	
30	Sensors 5V Output	
31	CAN L	
32	CAN H	
33	Cam Negative Input	
34	Cam Positive Input	
35	Crank Negative Input	
36	Crank Positive Input	
37	Switched 12V Input	
38	Low side output 1	
39	GND	

Installation:

Grounding:

The ECU must have an electrically secure ground connection, which means that the battery negative must be properly grounded to the chassis AND engine. The ground wire, whether it is from the battery or to the chassis and engine, must have perfect electrical conductivity. This means that there must not be any paint or rust under the wire terminal. Make sure that when you install the ground wire there is bare metal exposed where the wire contacts the vehicle component. Both of black wires should be connected to secure ground and we also recommend that the ground wire be as short as possible.

It is recommended to connect the main ground directly to the car battery ground and the ignition ground should be connect via separate wire to the chassis.

Separating the ignition ground from the main ground will reduce the noise generating from ignition coil when driving coil directly (passive coil).

2 mm wires are recommended for ground wires, minimum is 1 mm.

Power Requirement:

The EMS400 requires a minimum supply voltage of 10V or greater to run. We recommend that the ECU be supplied with 13.8V nominal operating voltage. Ensure that the vehicle's charging system is in perfect operating condition prior to installation. The Vbatt wire should be connected to ignition switched and fused to the battery source.

Sensors Reference Voltage and Sensor Ground:

The EMS400 has one 5V sensor voltage supply that will be needed during standalone installation. Use the Vref and Sgnd to supply all the sensors with power needed.

The Vref is fused protected by 0.5A resettable fuse.

Trigger Inputs:

EMS400 has two differential trigger input crank input+ and crank input- for the Crank signal. Cam input+ and cam input-. Each one has an option to be connected as differential or as single input.

Mode	Connection
VR Sensor	<ul style="list-style-type: none">• Connect VR Sensor to Input+/Input- for Standalone connection• Connect VR+ Sensor to Input+ and leave Input- unconnected for Piggyback connection.
Hall Input	<ul style="list-style-type: none">• Connect Hall sensor Input+, connect Input- to ground.

For pull up option and set point adjusting please check trigger settings from software part.

Throttle Position Sensor (TPS):

Throttle position sensor work as potentiometer which needs to be supplied with 5v and ground to generate 0-5v signal according to the throttle position. Use the Vref and Sgnd for sensor supply and connect the signal output to TPS input.

Coolant Temp Sensor (CLT):

Coolant temperature sensor works as resistor which changes its resistance with temperature, there is internal resistor inside EMS400 valued at 2.49 Kohm to be connected with coolant sensor to form voltage divider. Use Sgnd for ground supply to sensor and CLT input from EMS400 to second sensor pin.

For pull up option please check pull up settings from software part.

Air Temp Sensor (IAT):

Intake air temperature sensor works as resistor which changes its resistance with temperature, there is internal resistor inside EMS400 valued at 2.49 Kohm to be connected with IAT sensor to form voltage divider. Use Sgnd for ground supply to sensor and IAT input from EMS400 to second sensor pin.

For pull up option please check pull up settings from software part.

O2 Sensor:

Oxygen sensor input can be connected to narrow band sensor 0-1V or wideband controller output 0-5V

Analog/Digital Inputs:

EMS400 has 4 analog/digital inputs, each can be used as analog input or as digital input.

An/Dig input 0-5 can be connected directly to the input to read the analog value or can be used as digital input which need negative voltage to be activated (active low).

There is pull up option through 10kohm resistor to 5v which can be activated from the software pull up options.

Digital/Frequency Inputs:

EMS400 has 5 digital/Frequency input, it can be used as digital input or as frequency counter.

Digital input which needs negative voltage to be activated (active low). Frequency input to count pulses input such as vss sensor or second cam signal. Digital sensor (Hall sensor) is only supported type of input.

There is pull up 10kohm resistor to 5v connected to the input.

Injectors:

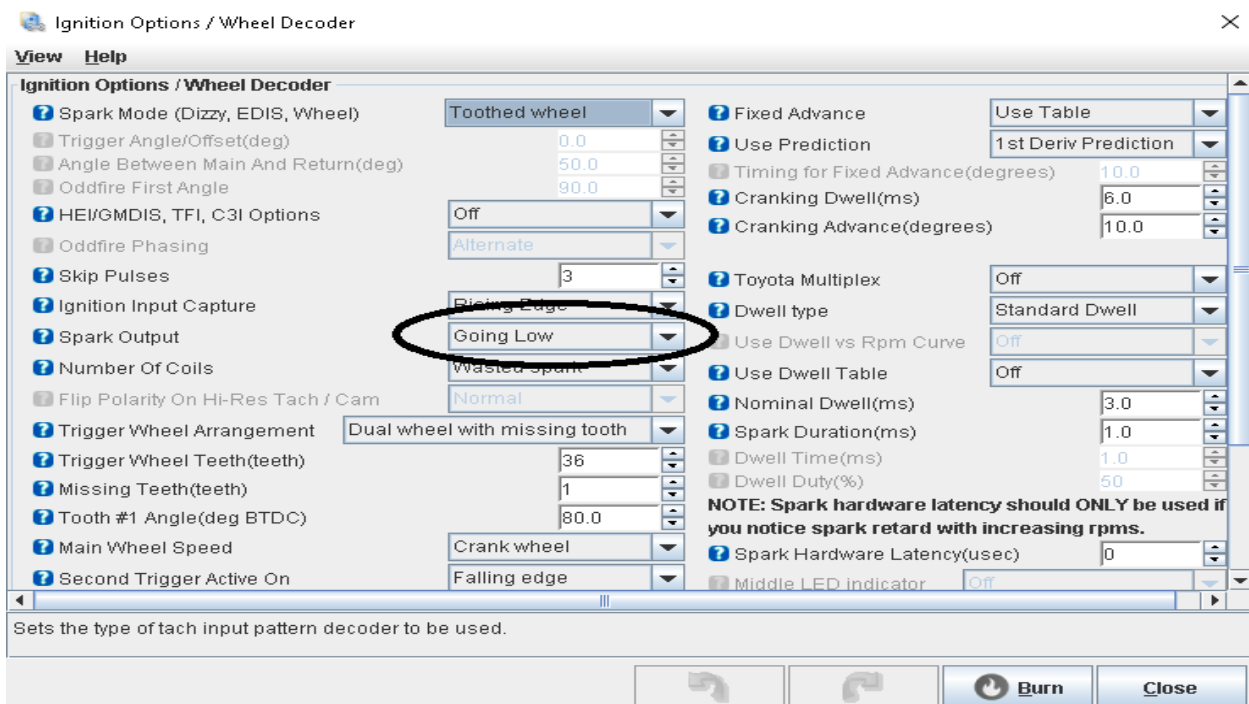
Four low side output each rated at 2.5A (can drive 2 high impedance injectors 12ohm and more), can be connected for 4 cylinder in sequential configuration or to 6, 8 cylinder in semi sequential/batched configuration.

One side of injector to be connected to switched 12v and injector negative signal from EMS400.

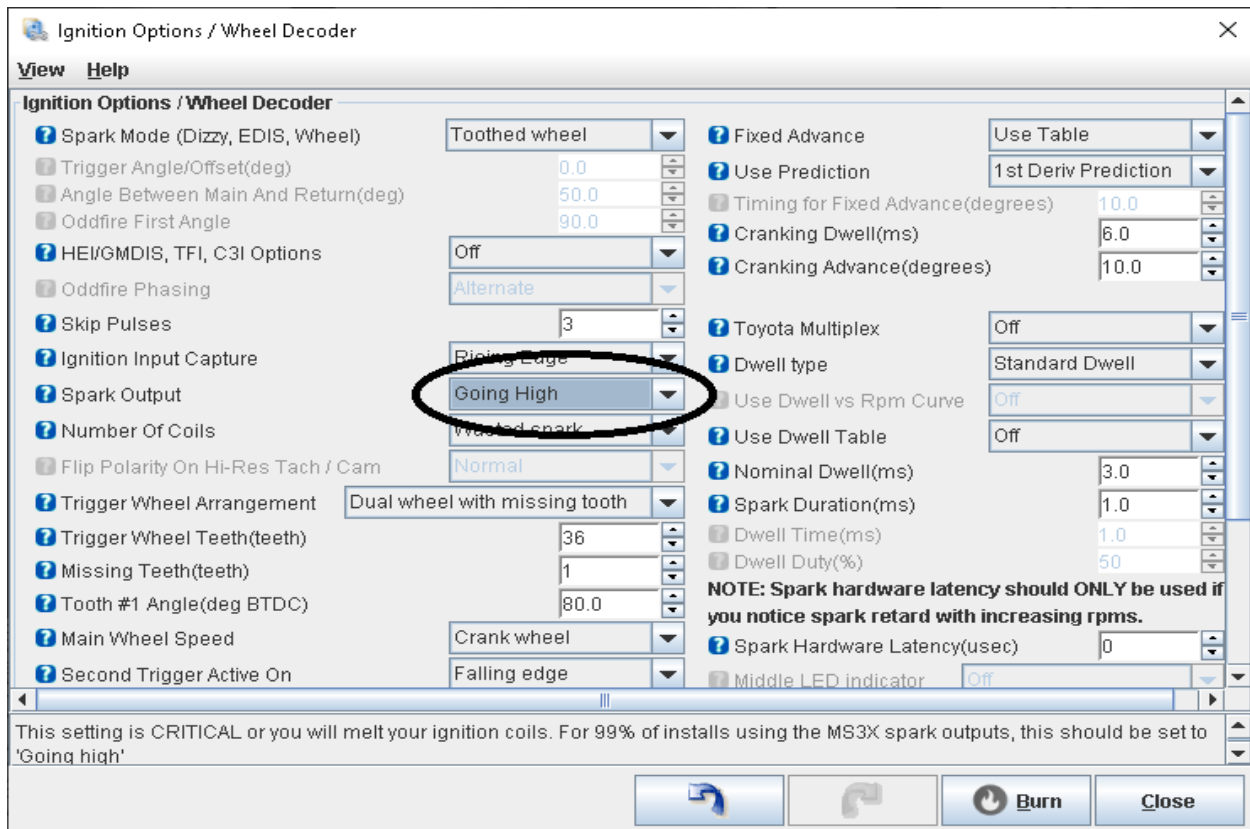
Ignition:

EMS400 has built in igniter to drive passive coils directly plus the ability to drive active (smart) coils.

Four logic level 5V output to drive smart (active) coils, each output can driver up to 2 smart coils. Ignition output to be connected to the signal input in the smart coil and select "Going low" from "Spark Output" under "Ignition Options" in TunerStudio as in picture below.



Each ignition output can drive one passive coil, the signal coming from MES200 is low side (ground signal) the other pin from coil should be connected to switched 12V. "Spark Output" should be changed to "Going High" as in picture below.



General Purpose Outputs:

EMS400 has 6 additional low side outputs, each capable of generation ground signal to drive solenoid vale, relay, etc. max current 2.5A.

Fuel Pump:

Fuel pump relay can be driven by any unused output, here is the setting for TunerStudio.

Fuel Pump and Pressure Control

View Help

Fuel Pump and Pressure Control

Fuel Pump Mode: Open-Loop PWM

Control Interval(ms): 20

Fuel Pump Output: Output 1

Output Frequency: 11.1Hz

Fuel Pump Output Polarity: Normal

Pressure Regulation/Correction: Vac referenced

'Fixed' automatically adjusts fuel PW.

Static/Target Rail Differential Pressure(psi.g): 43.5

Static/Target Rail Differential Pressure(kPa.g): 300.0

Priming Duty(%): 100.0

Off Duty(%): 0.0

Minimum Duty(%): 0.0

Maximum Duty(%): 100.0

Pressure Sensor Input (kPa): Off

Sensor Type: Gauge

Temperature Sensor Input: Off

Temperature Correction: Off

Closed-Loop PID settings

Proportional Gain(%): 10.0

Integral Gain(%): 5.0

Derivative Gain(%): 3.0

100.0	100.0	100.0	100.0	100.0	100.0	100.0
80.0	100.0	100.0	100.0	100.0	100.0	100.0
60.0	100.0	100.0	100.0	100.0	100.0	100.0
40.0	100.0	100.0	100.0	100.0	100.0	100.0
20.0	100.0	100.0	100.0	100.0	100.0	100.0
10.0	100.0	100.0	100.0	100.0	100.0	100.0
↙	0	1000	2000	3000	4000	6000

rpm

The values in the table specify the duty cycle percent of the control output to the pump or controller based on the RPM/load axes.

Buttons: **Burn** **Close**

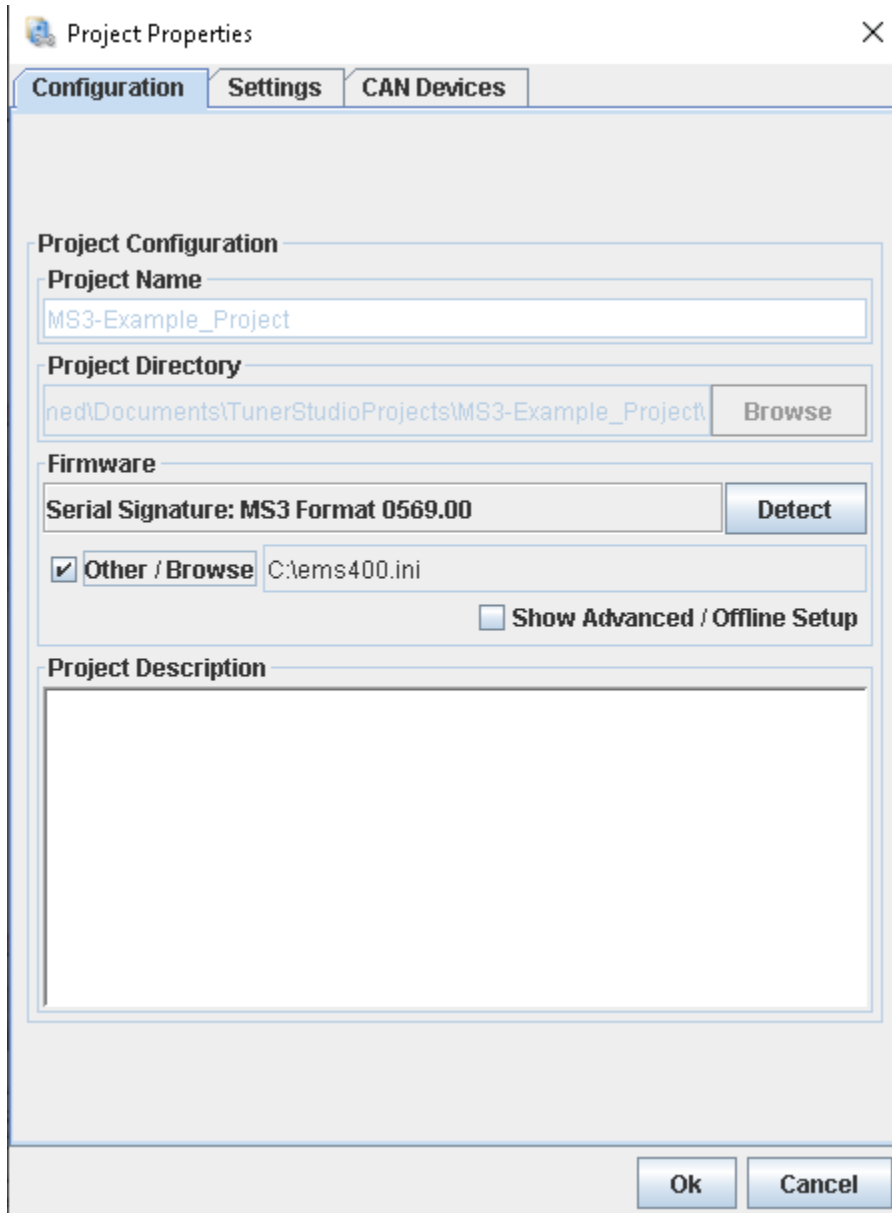
Stepper Valve:

EMS400 support stepper motor as idler, by choosing "Stepper valve (4 or 6 wire)" from "Idle Valve Type" this will enable the internal stepper motor drive and will use Output3, Output4, Output5 and Output6.

Output3 to Output6 will not be usable if stepper valve is chosen.

Installing INI Settings File:

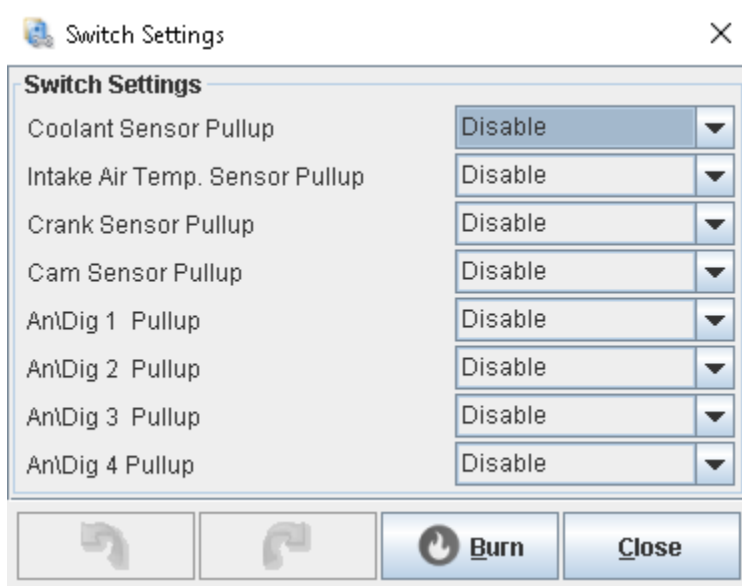
Ini file to be installed with the TunerStudio project, access the project properties from "File" -> "Vehicle Project" -> "Project Properties" then browse to file location



After the project loading again, additional menus are added to TunerStudio.

Pull Up Menu:

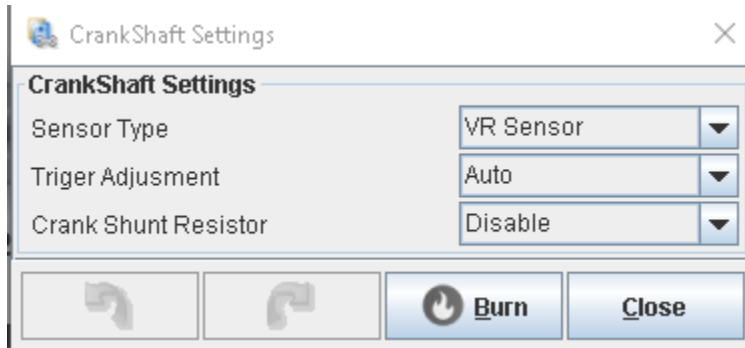
Pull up menu under “Basic/Load Settings” -> “Pull Up Switches Settings”



- Coolant Sensor Pullup: will connect CLT input to 5V through 2.49 Kohm resistor.
- Intake Air Temp. Sensor Pullup: will connect IAT input to 5V through 2.49 Kohm resistor.
- Crank Sensor Pullup: will connect CRK+ input to 5V through 10 Kohm resistor.
- Cam Sensor Pullup: will connect Cam+ input to 5V through 10 Kohm resistor.
- An\Dig 1 Pullup: will connect the input to 5V through 4.7 Kohm resistor.
- An\Dig 2 Pullup: will connect the input to 5V through 4.7 Kohm resistor.
- An\Dig 3 Pullup: will connect the input to 5V through 4.7 Kohm resistor.
- An\Dig 4 Pullup: will connect the input to 5V through 4.7 Kohm resistor.

Crank Trigger Setting:

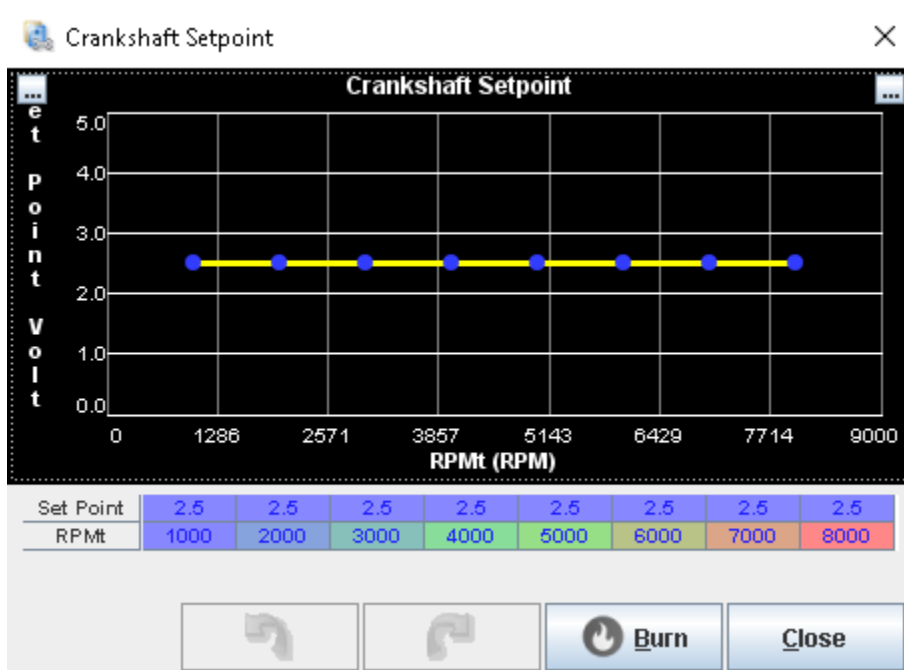
Crank settings menu under “Ignition Settings” -> “Crankshaft Trigger Settings”



- Sensor Type: the type of sensor being used VR or Hall sensor.
- Triger Adjustment: to enable or disable the manual adjustment for set point and hysteresis. "Auto" will adjust these setting automatically according to last signal detection. "Manual" will enable another 2 menus for set point and hysteresis.
- Crank Shunt Resistor: it enable shunt resistor 4.7kohm between Crk+ and Crk-, with some trigger need shunt resistor to reduce the noise.

Crank Setpoint Setting:

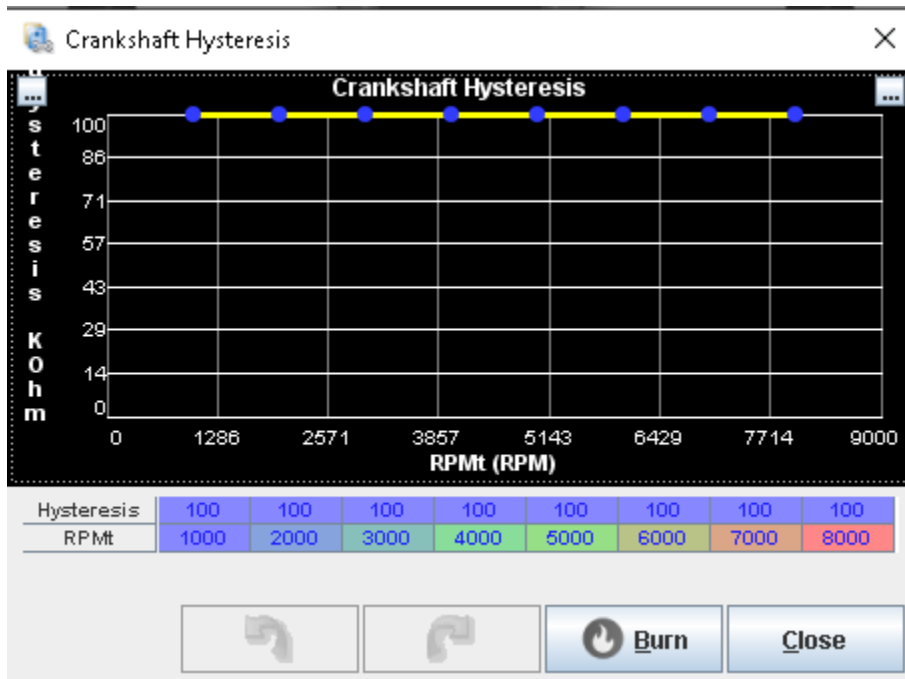
Crank setpoint can be accessed from "Ignition Settings" -> "Crankshaft Setpoint Curve", it will be enabled only if "Trigger Adjustment" is set to "Manual"



- Set Point: it is the minimum voltage which the trigger comparator will accept the input signal as correct trigger signal.
- RPMt: is the engine speed that correspond to the comparator setpoint voltage.

Crank Hysteresis Setting:

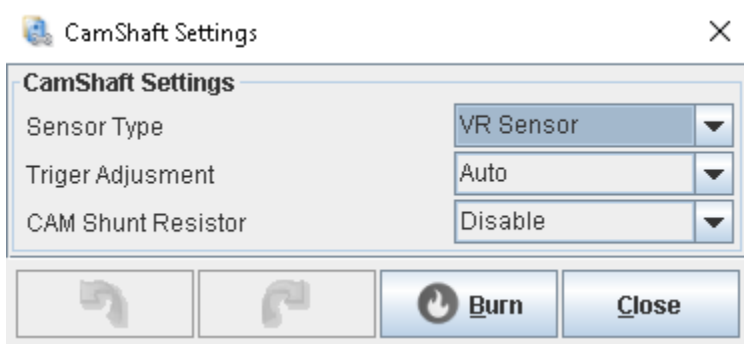
Crank setpoint can be accessed from "Ignition Settings" -> "Crankshaft Hysteresis Curve", it will be enabled only if "Trigger Adjustment" is set to "Manual"



- Hysteresis: is the resistor value in that form the Schmitt trigger input combined with setpoint voltage, value ins Kohm and values from 1 to 100 is acceptable.
- RPMt: is the engine speed that correspond to the comparator hysteresis value.

Cam Trigger Setting:

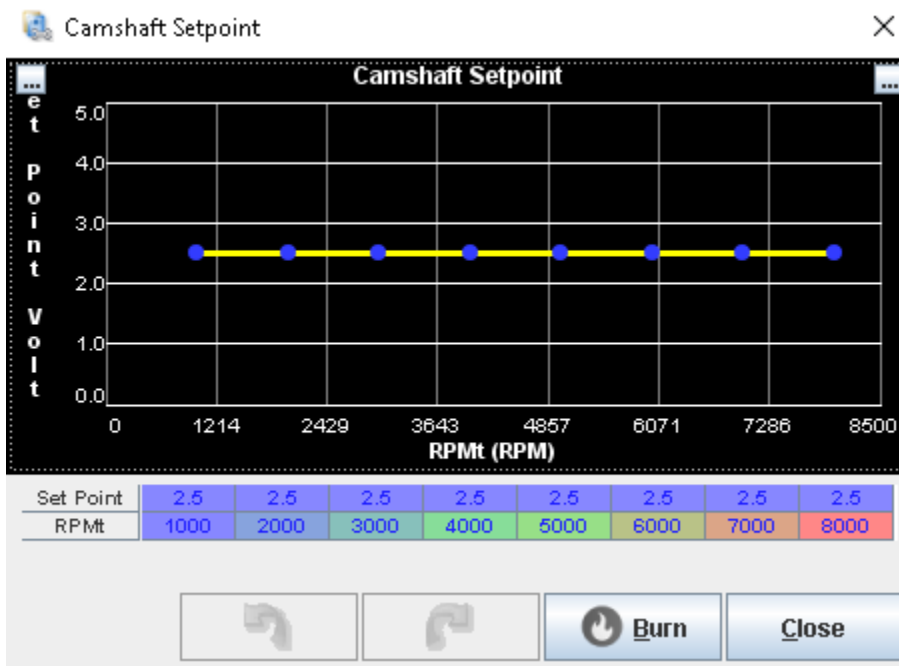
Cam settings menu under "Ignition Settings" -> "Camshaft Trigger Settings"



- Sensor Type: the type of sensor being used VR or Hall sensor.
- Triger Adjustment: to enable or disable the manual adjustment for set point and hysteresis. "Auto" will adjust these setting automatically according to last signal detection. "Manual" will enable another 2 menus for set point and hysteresis.
- Cam Shunt Resistor: it enable shunt resistor 4.7kohm between Cam+ and Cam-, with some trigger need shunt resistor to reduce the noise.

Cam Setpoint Setting:

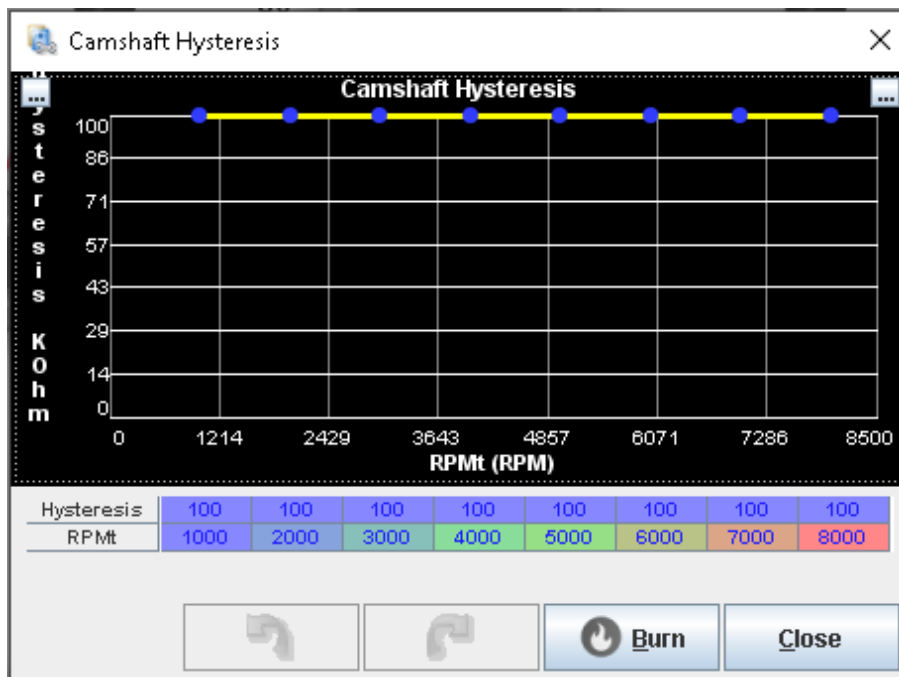
Cam setpoint can be accessed from "Ignition Settings" -> "Camshaft Setpoint Curve", it will be enabled only if "Triger Adjustment" is set to "Manual"



- Set Point: it is the minimum voltage which the trigger comparator will accept the input signal as correct trigger signal.
- RPMt: is the engine speed that correspond to the comparator setpoint voltage.

Cam Hysteresis Setting:

Cam setpoint can be accessed from “Ignition Settings” -> “Camshaft Hysteresis Curve”, it will be enabled only if “Trigger Adjustment” is set to “Manual”



- Hysteresis: is the resistor value in that form the Schmitt trigger input combined with setpoint voltage, value ins Kohm and values from 1 to 100 is acceptable.
- RPMt: is the engine speed that correspond to the comparator hysteresis value.

USB Communication:

There USB port will be configured as virtual serial port (COM port), once the driver installed and the device connected you should find the new COM port in “Device Manger” menu, under “Ports (COM & LPT)” new item will be add named “USB Serial Device (COMx)”, you will use this COM port number when you connect to TunerStudio.

Here is the USB driver:

https://sptronics.com/?attachment_id=4329

Wireless Communication:

There are 2 options to be connected to EMS400 wirelessly: Bluetooth or WIFI, both way can be used with TunerStudio on Windows PC or Msdriod, Shadow Dash on any Android device. The main use for wireless communication is for monitoring or logging and it's not recommended to tune over wireless communication.

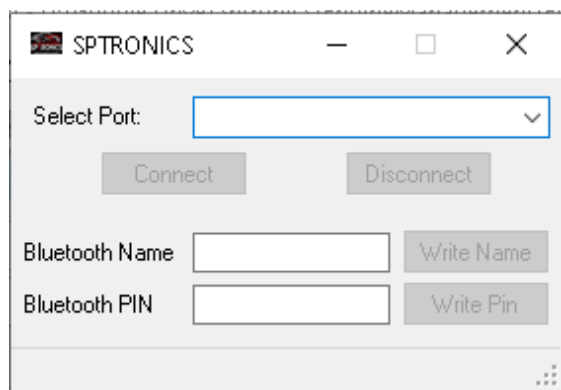
It is not allowed flash any firmware over wireless communication.

Pairing your PC or android device to EMS400 can be done by discovering devices around you and EMS400 will be discovered, just to connect to pair and use "1234" as the pin code.

Changing Bluetooth name or pin can be done using "BT Writer" application, available for download under download tab in the EMS400 web page.

Here is the link for BT Write application.

https://sptronics.com/?attachment_id=4331



Make sure the EMS400 is not connected to TunerStudio then select the Com port connected to EMS400 then click "Connect", after that choose the name and pin required then click on the required button.

WIFI communication can be done through connection to access point named EMS400, your devices will get IP in the range 192.168.1.x. to connect to TunerStudio, MS Droid or Shadow Dash use IP 192.168.4.1 and port 23 as the setting for EMS400.

Changing access point name and adding password can be done by accessing access point configuration page, open any web browser and type 192.168.4.1, the configuration page will appear, from AP Setting you will get the option to change SSID and add password.

Warranty

SPTRONICS warrants to the consumer that all High-Performance products will be free from defects in material and workmanship for a period of twelve (12) months from date of the original purchase. Products that fail within this 12-month warranty period will be repaired or replaced at SPTRONICS's option, when determined by SPTRONICS that the product failed due to defects in material or workmanship.

This warranty is limited to the repair or replacement of the SPTRONICS part. In no event shall this warranty exceed the original purchase price of the SPTRONICS part nor shall SPTRONICS be responsible for special, incidental, or consequential damages or cost incurred due to the failure of this product. Warranty claims to SPTRONICS must be transportation prepaid and accompanied with dated proof of purchase. This warranty applies only to the original purchaser of product and is non-transferable. All implied warranties shall be limited in duration to the said 12-month warranty period. Improper use or installation, accident, abuse, unauthorized repairs or alterations voids this warranty. SPTRONICS disclaims any liability for consequential damages due to breach of any written or implied warranty on all products manufactured by SPTRONICS.

SPTRONICS will not be responsible for electronic products that are installed incorrectly, installed in a non-approved application, misused, or tampered with.

Any SPTRONICS electronics product can be returned for repair if it is out of the warranty period. There is a minimum charge of \$20.00 for inspection and diagnosis of SPTRONICS electronic parts. Parts used in the repair of SPTRONICS electronic components will be extra.

SPTRONICS will provide an estimate of repairs and receive written or electronic authorization before repairs are made to the product.