User's Manual
SECU-3 Manager (v4.3)

Table of contents

Introduction

After installation and connection of SECU-3 unit, it requires configuration. This is done using special manager software (hereinafter Manager). The program allows to: change parameters, tables, upgrade firmware of the unit, perform diagnostics of the unit, display readings, record and playback log files and more. All necessary basic settings can be changed in real time. The unit is communicated with using a USB cable or Bluetooth (if the unit is equipped).

To understand the principle of the unit configuration better, you need to understand the philosophy of the program.

All settings of the SECU-3 unit can be roughly divided into two types:

- **changeable in real time.** These settings can be changed “on the fly” without upgrading the firmware of the unit, they are stored in non-volatile storage of unit (EEPROM). To change them, use the Manager's tab “Parameters and monitor” and partially the “Tuning KS” tab.
- **changeable by firmware upgrade only**. To change these settings, you need to first read the firmware from the unit, then change the required settings and then write (upgrade) the unit with the modified firmware. The Manager's tab “Firmware data” and partially the “Tuning KS” tab is used.

Tables can be in set or separate, in addition there are the ones used for ignition and the ones used for injection. All the tables are listed below, in brackets the dimensions are indicated. Tables in set:

For ignition:

- Start angle map (1x16);
- Idle angle map (1x16);
- Work angle map (16x16);
- Coolant temper. corr. map(1x16)

For injection:

- VE (16x16);
- AFR (16x16);
- Cranking pulse width (1x16);
- Warm up enrichment (1x16);
- Injector dead time (1x16);
- IAC position on run (1x16);
- IAC position on cranking (1x16);
- Acceleration enrichment vs TPS (1x8);
- Acceleration enrichment vs RPM (1x4);
- After start enrichment (1x16).

Tables not included into sets (edited by firmware upgrade only):

- Dwell time map (1x32);
- KS attenuator map(1x128);
- CLT sensor curve map (1x16);
- Choke opening map (1x16);
- IAT sensor curve map (1x16);
- Ignition advance angle correction vs IAT (1x16).

All table sets are also divided in two types:

- **changeable in real time.** This is one set. You can edit table data in real time by clicking the “Edit tables” button on the tab “Parameters and monitor”;
- **changeable by firmware upgrade only.** There are four sets of these tables and they are stored in the firmware (flash). You can only change them by reading the firmware on the “Firmware Data” tab before. After editing the table data, the firmware with the modified tables should be

written in the unit also by using the tab “Firmware Data”.

As already mentioned above, **there are also tables not included in the sets.** They exist in a single copy in the firmware. They are edited on the “Firmware Data” tab by means of upgrading the firmware of the unit.

You should also understand how the ignition advance angle and the injection pulse width is formed (calculated) in various modes of engine operation. The calculation of the ignition advance angle:

- **Start:**

Timing_from_cranking_map + Octane_Corr

- **Idling:**

Timing_from_idling_map + Corr_from_CLT_map + Corr_from_idling_regul + Corr_from_IAT_map + Octane_Corr

- **Operating mode:**

Timing_from_work_map + Corr_from_CLT_map + Corr_from_KS + Octane_Corr + Corr_from_IAT_map

Where:

Timing_from_cranking_map – ignition timing is taken from the cranking map (advance angle vs cranking RPM).
Octane_Corr – octane correction value set at the tab **«2: Angle»** (ignition timing shift value).
Timing_from_idling_map – ignition timing is taken from the idling map (advance angle vs engine speed).
Corr_from_CLT_map – correction of ignition timing taken from CLT map (advance angle vs coolant temperature).
Corr_from_IAT_map – correction of ignition timing taken from IAT map.
Corr_from_idling_regul – correction of ignition timing obtained from idle speed regulator.
Corr_from_KS – correction of ignition timing obtained from the detonation control algorithm.
Timing_from_work_map – ignition timing is taken from the work map which stores advance angle depending upon engine speed and manifold absolute pressure.

At that:
- If CLT sensor is off (at the tab “**5:Temperature**”), then **Corr_from_CLT_map** = 0, which means no correction ignition timing according to CTS is done;
- If KS is off (at the tab **“Tuning KS”**), then **Corr_from_KS** = 0, which means no correction according to KS is performed;
- If idling regulator is on, it starts operating, when the engine is warmed up to the temperature set at the tab “**3: Idling**”;
- The resulting ignition timing (in any mode) is limited on the top and on the bottom with the set values. The speed of ignition timing changing is also limited. See the parameter's tab “**2: Angle**”.

Injection pulse width calculation (if you use only the ignition control functions, you may skip this section):

- **Before start:**

Short single-time opening of injectors (injection before cranking), to form a film on the walls of the intake manifold. The time of the injectors' opening is indicated in the tab “**1: Start**” and depends linearly on the temperature of the engine.

- **Start:**

Cranking_PW + Inj_dead_time

- **Idling:**

(Basic_inj_PW * VE * AFR * Warmup_enrich) + Afterstart_enrich + Lambda_Corr + Accel_enrich + Inj_dead_time

- **Operating mode:**

(Basic|_inj_PW * VE * AFR * Warmup_enrich) + Afterstart_enrich + Lambda_Corr + Accel_enrich + Inj_dead_time

Where:

Cranking_PW – Injection pulse width table depending on engine temperature. Used only during cranking.
Inj_dead_time – Table where the time is specified during which the injector does not inject fuel. The time depends on car-system voltage.
Basic_Inj_PW – Injection pulse width calculated basing on the MAP, IAT and constants specified in the parameters (No. of cylinders, engine volume, injector performance, No. of injections per cycle, injection configuration)
VE - Table in which the volumetric efficiency depending on the absolute pressure (engine load) and RPM (engine speed) is specified.
AFR - Table in which the air/fuel ratio is set depending on the engine load and RPM.
Warmup_enrich - Table in which the enrichment rate is set depending on the temperature of the engine. Used until the engine is warmed up to reach the operating temperature.
Afterstart_enrich - Table which specifies the extent to which the mixture should be enriched after start-up. It is activated after starting the engine and slowly removed in each engine stroke. The number of strokes is indicated in the tab "**1:Start**", the parameter "**Enrichment time after start in strokes**".
Lambda_Corr - Correction of the mixture according to the oxygen sensor. Is only activated if: the temperature of the engine exceeds the specified threshold, after the start time a specified number of strokes have run, and the engine speed is above the specified threshold. Correction is off in transient modes (acceleration/deceleration) and if the current ratio of the air/fuel is not equal to 14.7.

Accel_enrich - Correction which is calculated basing on the two tables with the adjustment according to the so-called normal conditions adjusted according to engine temperature:

Norm_cond_PW * Accel_TPS * Accel_RPM * Accel_CLT_Corr ,

Where:

Norm_cond_PW - injection pulse width at 100 kPa, 20 °C, air/fuel = 14.7,
Accel_TPS - rate from the table "Acceleration enrichment vs TPS",
Accel_RPM - rate from the table "Acceleration enrichment vs RPM",
Accel_CLT_Corr - coefficient linearly dependent on engine temperature, at -30°C equal to value "**Cold accel. multiplier**" (tab "**Acceleration**"), and at 70°C equal to 100% (no correction).

To avoid confusion, please note that some of the parameters, and values in certain tables are coefficients, but expressed in %. For example, to multiply by 100% means to multiply by a coefficient of 1.00. For example, the abovementioned parameter "**Cold accel. multiplier**".

Program Installation

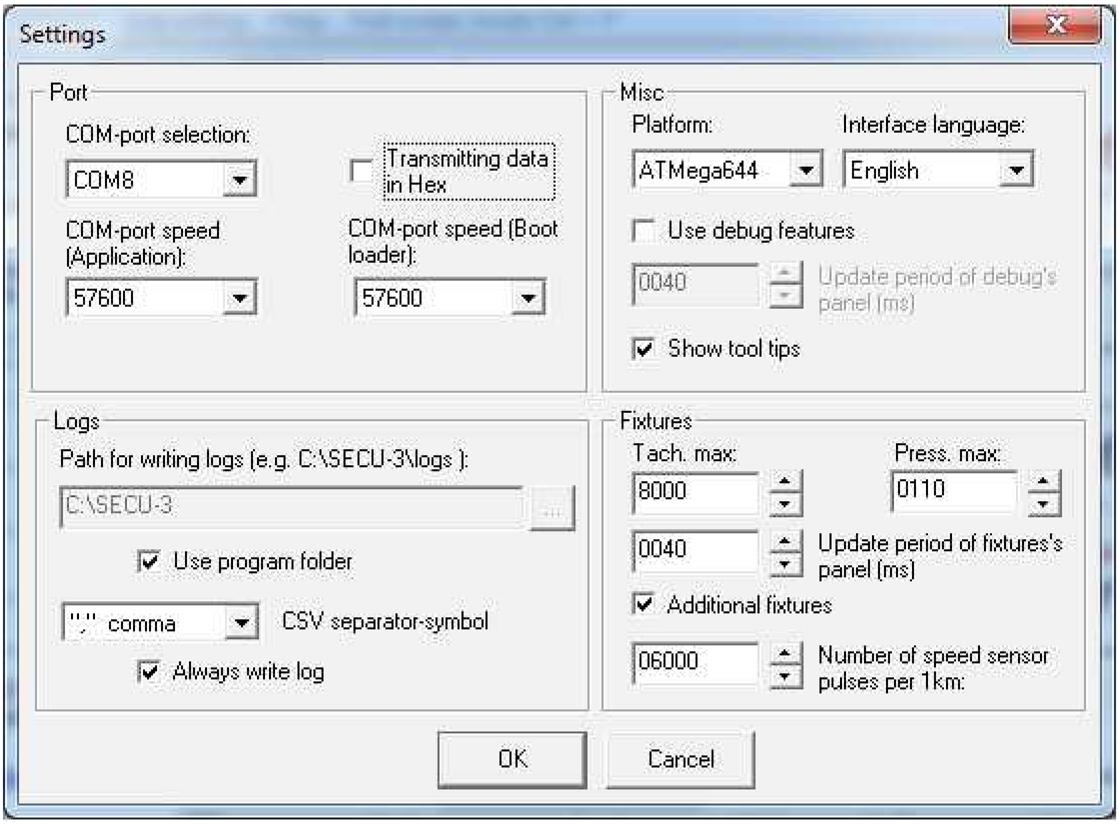
The SECU-3 Manager program does not require installation and is available in two alternate versions: in the form of a single **exe** file and as a **7z** file archive. If you download the 7z archive, you should unpack the data in it (libraries and the exe file) into a separate folder and run it form there.

Libraries should be installed in the same folder as the executable file, otherwise the program will not run.

For the correct program operation the manager and the firmware must be from the same release (must be the same version, e.g. both of v4.3).

SECU-3 Manager Program Settings

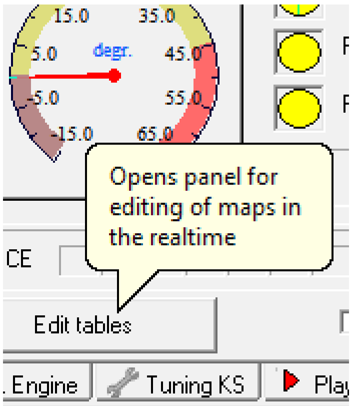
First you should configure the Manager and connect to the unit. This should be done once, after that the program will memorize the settings and use them. Program settings are stored in the ini file, which is located in the same directory as the program. To open the window with the settings, click the “Settings” menu. The Manager settings window appears:



In this window we can:

- set the COM-port parameters for connecting to the unit (port number, speed);
- specify path for saving of files, containing logs of unit operation (log files);
- set constant recording of logs (set by default, useful for initial tuning);
- unit platform (installed processor model). The default installed processor in the units is ATMega644;
- specify the data transmission format (Hex or binary). Binary is default;
- choose the manager's interface language. Russian and English languages are supported (to switch to another language you have to restart the manager). English is default;
- set the showing of debugging toolbar (for developers);
- choose to show or not the pop-up tips when the mouse is over the control elements (helpful for

beginners). For example:



- set maximum values for the virtual instruments “Speed”, “Absolute pressure”;
- set the update period for the instrument's panel. The smaller the value is, the more often the instruments are updated, but the more processor time of the computer is required for this;
- “Additional fixtures” - to display or not the additional instruments in full-screen mode;
- “number speed sensor pulses per 1 km” – if the vehicle speed sensor is connected, set the number of pulses from the speed sensor per 1 km way.

The unit connection speed set by default is 57600 (for units sold since 15-05-2014), and 9600 bits/sec for the other ones. For the number of the COM-port see the Device Manager of your computer. For USB versions of the unit look for a COM-port that contains the line “Silicon Labs CP210x USB to UART Bridge” in the name. For example:

The required port number is COM8. We should set the same value in the manager's settings. If the port number and its speed corresponds to the settings and cable is connected to the unit then after quitting the settings menu, the manager will automatically connect to the unit.

Note: for connecting to the unit having the USB interface you should download and install drivers from our website SECU-3.org (“Downloads” → “USB Drivers”).

You can see if the manager is currently connected to the unit by seeing the icon and the text in the manager status bar:

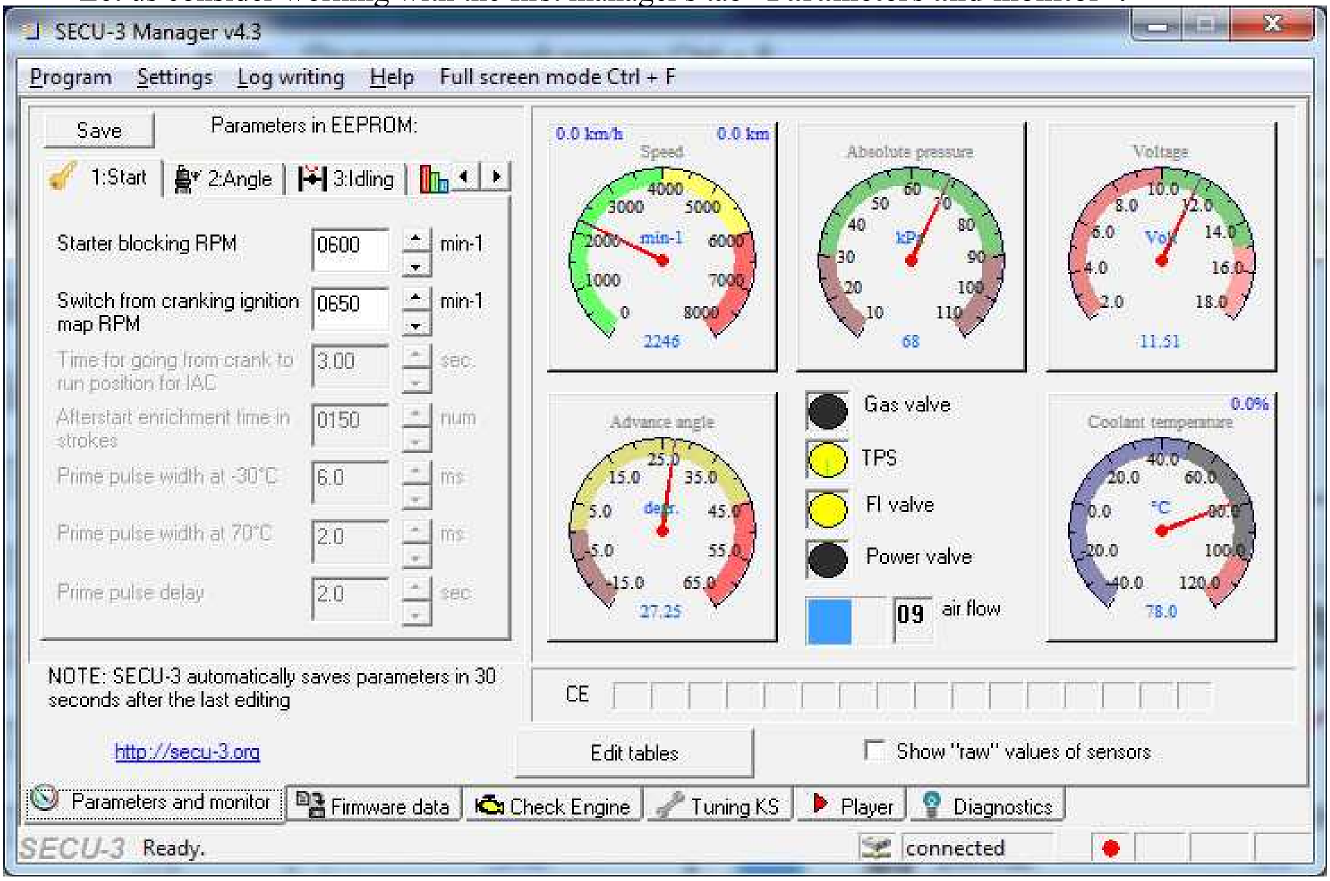
- connected with the unit, 

- no connection with the unit (check the port number and speed, the unit power supply, and the proper connection of the interface cable etc.). If the manager is connected, most of the controls and the instruments bar become active.

The manager automatically (some time after the editing is finished) or when clicking the button “Save” records the parameters into the unit (into EEPROM).

Working with "Parameters and monitor" tab

Let us consider working with the first manager's tab "**Parameters and monitor**".



The right side of the manager's window on this tab displays sensor readings in a graphic form. When necessary, you may activate a digital display of unprocessed (raw) sensor values, putting a checkmark next to "**show "raw" values of sensor**s". This section of the window is only intended to display information.

Between the instruments "Advance Angle" and "Temperature" round detectors that flash with yellow light are located. These are the status of the gas valve (or the GAS_V input), throttle position (yellow shows that the gas pedal is pressed and green shows the throttle position if TPS is used) the status of Idle cut-off valve and Power valve.

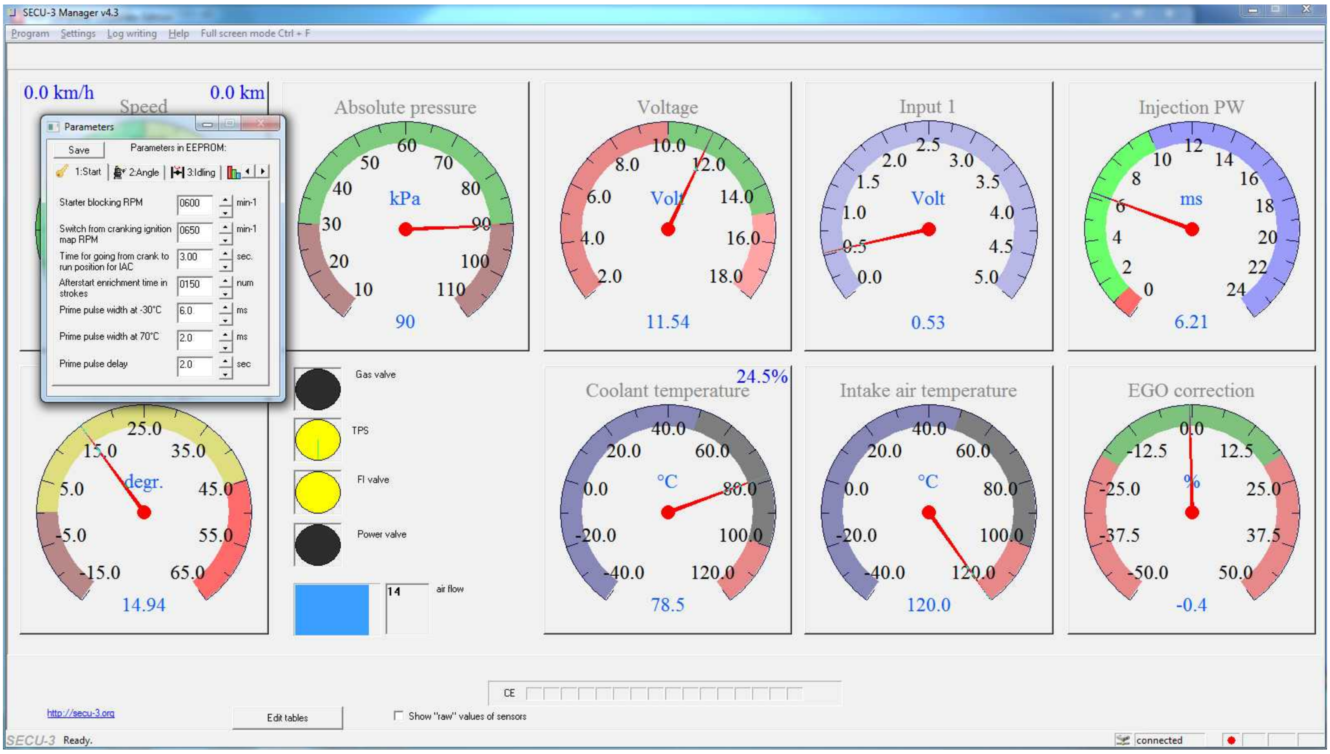
And below is located a small horizontal display showing the current number of the curve along the load axis in tables (along the MAP axis), the so-called "air flow rate".

On this tab and in the tab "Player" the full screen mode may be activated (Menu item "Full screen mode CTRL+F". When this mode is enabled, the manager's window with the fixtures is stretched to full screen, and the tabs with settings and tables (if the "Edit tables" window is open) are opened in separate windows "Parameters" and "Edit tables". In full screen mode four additional instruments are displayed that show voltage on the inputs ADD_I1 and ADD_I2, the injection pulse width and the lambda correction.

Note: universal inputs and outputs ADD_IO1 and ADD_IO2 are by default configured as ignition outputs (IGN_OUT5 and IGN_OUT6), so the voltage in corresponding fixtures is equal to 0. To display the voltage you should activate the inversion of the mentioned outputs in the tab "Firmware Data" (button "I/O remapping").

Below the instrument panel a bar with the error indicators "Check Engine" is located. If any error occurs, a numeric error code appears in the appropriate box.

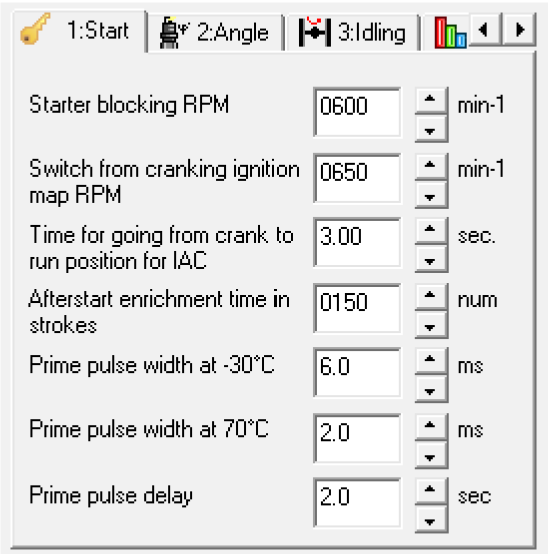
In the lower right corner of the window, a small red circle shows if a log file is recorded or not at the moment.



In the left part of the manager's window in the tab “Parameters and monitor” is a set of tabs with the key parameters of the unit that might be changed “on the fly”. Some tabs may be unavailable, if the firmware does not support the corresponding functions (for example fuel injection control).

Key unit parameters include the following tabs.

1: Start



Here you can set the RPM, which, if exceeded, make the unit output ST_BLOCK intended to lock the starter deactivated, as well as set the RPM exceeding which, firmware will switch to the ignition timing work map or the ignition timing idle map. If RPM is lower than specified threshold, the ignition advance angle from the cranking map will be used.

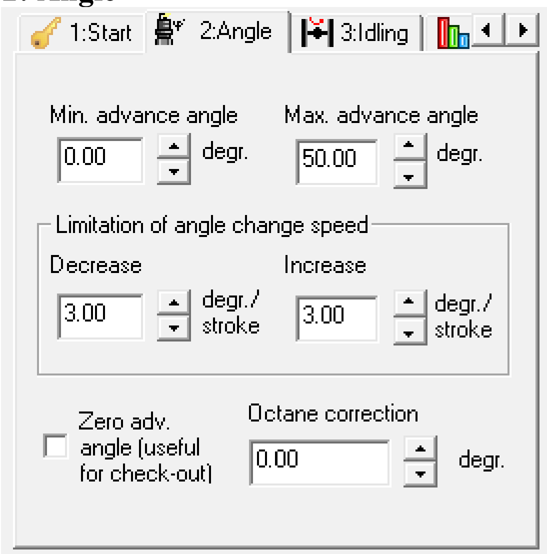
The following parameters are available only for a firmware having the function of fuel injection. Before starting the engine the idle speed regulator position is calculated according to the table “IAC position on cranking”. After starting, the calculation of the idle speed regulator position is initiated according to the “IAC position on run” table after the time period “**Time for going from crank to run position for IAC**”.

The “After start enrichment” table is also applied after the start. It operates throughout the **“Afterstart enrichment in strokes”.**

The following parameters are designed for setting so-called Prime Pulse - injection before starting of ICE. It facilitates engine starting in cold environment. After ignition turn on and prior to ICE starting, a certain portion of fuel is injected into the inlet manifold (by one-time opening of injectors). Such injection is performed with delay "**Prime pulse delay**", so that the petrol pump timely pumps up the necessary pressure. To set the injection duration for various temperatures, two reference points are used, between which the injection time is changed in a linear manner:

- injection duration at -30 °C (in milliseconds);
- injection duration at +70 °C (in milliseconds).

2: Angle



Min. advance angle – irrespective of the advance angle maps, the unit will not form the advance angle lower than this value.

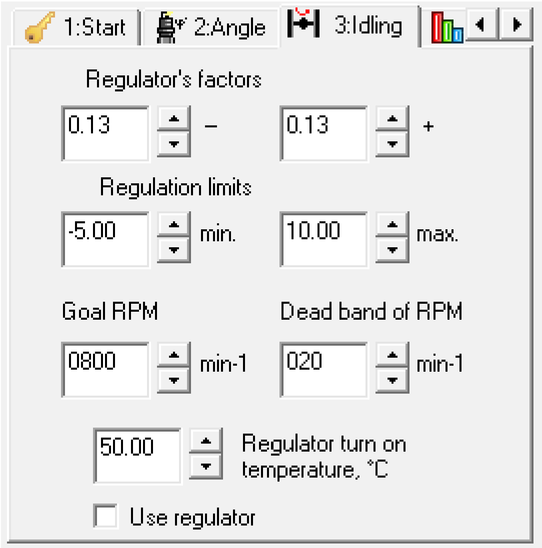
Max. advance angle – accordingly, the upper advance angle limit.

Limitation of angle change speed allows setting the rates of **increasing** or **decreasing** of the advance angle per combustion stroke. It results into smoother advance angle change without sharp transitions.

Zero adv. angle – setting the mandatory zero advance angle. It is usable at setting the stroboscope-based mark or other checkout. You must remember to remove this tick afterwards!

Octane correction – this value is added to the ultimate advance angle and has no effect, if the zero angle check is set. If you have configured the crankshaft position sensor (CKP) not very accurately and would like to adjust the initial ignition timing by this parameter basing on the stroboscope, then temporarily set the zero values in all ignition tables, disable the idling regulator (tab "3: Idling") and detonation control (tab **"Tuning KS")**, and by changing this parameter, achieve the precise coincidence of the strobe marks.

3: Idling



In this tab, only the idling regulator parameters are configured (maintaining the idling RPM by variating of ignition timing). Before using the regulator, configure the carburetor as described in its manual. The same refers to the fuel injection control, i.e. first configure all the injection map properly.

Regulator's factors - set the factor values determining the extent by which the current advance angle will be changed to maintain the target idling RPM. They are selected by trial to achieve maximum stability of the idling RPM (and accuracy).

Regulation limits - set the advance angle variation limits to maintain the target RPM. One should not set too high mentioned limits, as they may case instable idling RPM.

Goal RPM - sets the RPM which the idling speed regulator will aim to maintain.

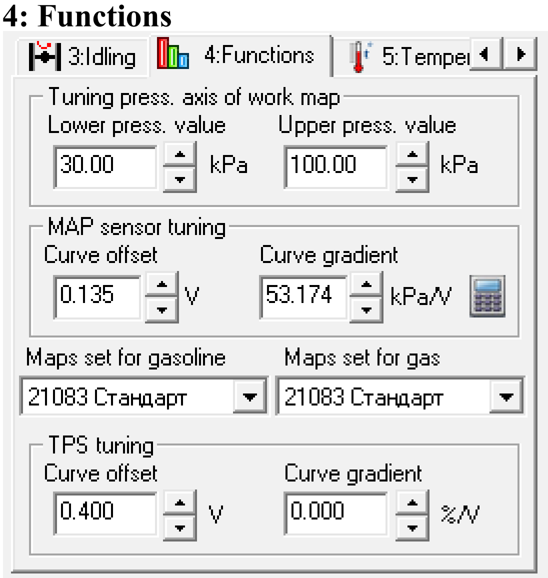
Dead band of RPM - the RPM value within the range of which the regulator will not change the advance angle. If the value is too low, it may lead to unstable idling RPM.

Use regulator - the permission or inhibition of the idling speed regulator. Enable the regulator only after you find out how to configure the ignition timing tables and other basic settings.

Regulator turn on temperature – for the non-warmed up engine, one may not use the idling speed regulator in order not to interfere with the warming up. For this purpose, the idling speed regulator switch temperature is configured depending on the temperature of the coolant.

The automatic choke RPM regulator is disabled after the warming up with the temperature higher than this threshold.

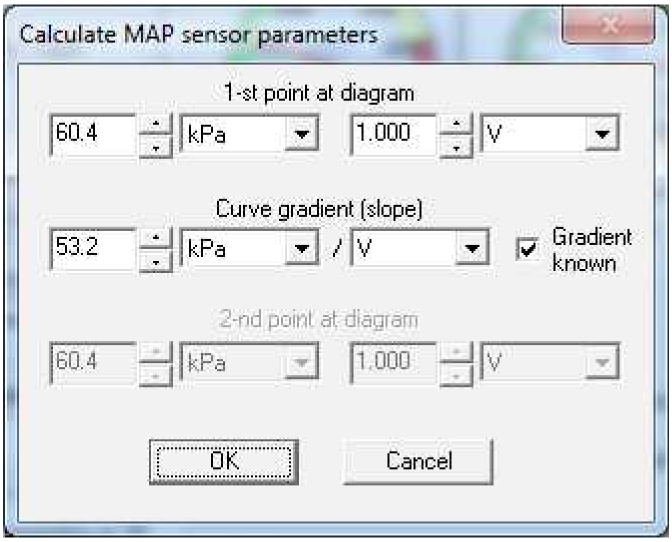
4: Functions



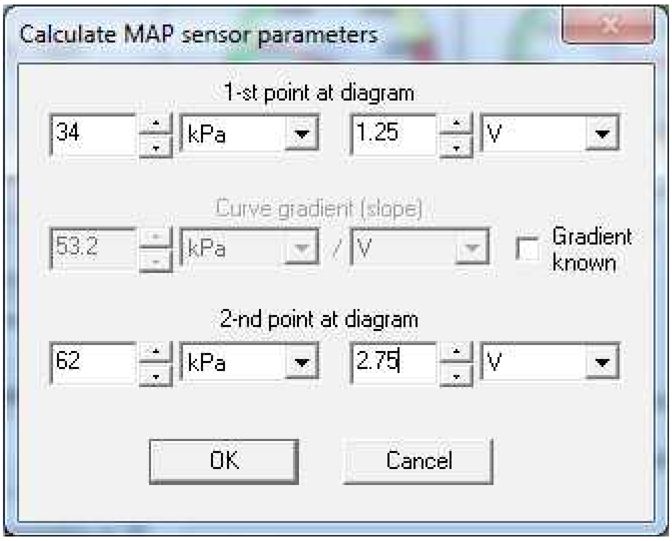
The configuration of the pressure (load) axis in the operation mode is intended for setting the MAP range which will be distributed between 16 curves of table. By these values, the calibration of the MAP axis values is performed in the work advance angle map and injection tables (so-called “air flow”). The “**Upper press. value”** parameter is set as a value displayed by the “Absolute pressure” fixture at the throttle fully opened and maximum load, for instance, in fourth gear at 40 km/h. The **“Lower press. value”** parameter is set as a value displayed by the “Absolute pressure” fixture at the throttle fully closed and maximum RPM, for instance, at forced idling. Generally, it is approximately 95 kPa and 30 kPa, accordingly (for the naturally-aspirated engine).

The **MAP sensor tuning** is intended for setting the specification of the MAP sensor connected to the unit. The default MAP sensor installed in the ECUs is MPX4250AP for which necessary settings in the software are already made default. The firmware supports only the MAP sensor with the linear relation of voltage to pressure (slope can be either positive or negative). The first parameter sets the **curve offset** (the sensor generates voltage starting from not a zero, but rather with a certain shift), the second parameter sets the **curve slope** (gradient or in other words, the extent to which the sensor output voltage is changed upon change in pressure).

On the right from the MAP sensor parameters, the calculator button is situated, by pressing which one may calculate the MAP sensor's parameters in a user-friendly form, basing on the known values.



For instance, the GM 466 039 0134 sensor is available. This is a sensor for 1 Bar, and there is a voltage – pressure table. Select two values in the table, for instance, 1.25V – 34kPa and 2.75V – 62kPa. Insert the points into the calculator:

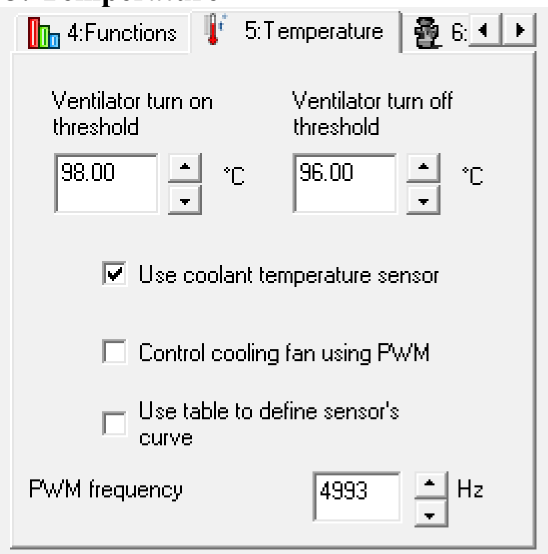


Press OK and the calculated offset and slope values will appear in the corresponding parameters. Now the unit is configured for operation with the sensor. One may check the correctness of the calculation by observing pressure at the non-started engine, it will be equal to the atmospheric pressure (nearly 101 kPa at sea level).

Below the MAP sensor's parameters one should select a set of curves **for petrol** and **for gas.** There are 5 sets in the list, the first four of them are contained in the firmware (in flash memory), the last set is contained in EEPROM and it may be edited in the real-time mode. The switching between the selected modes will be performed according to the voltage at the GAS_V gas valve input of the ECU. If there is no voltage at this input, the set selected for petrol is used.

TPS tuning – setting of the throttle position sensor parameters. Set **offset** so that the TPS characteristic pass through zero, and **slope (gradient)**, the percentage of throttle position change, which falls upon 1 Volt. At using the simple limit switch of the carburetor, set 0% slope, and in this case offset may have any value. At that, in the tab **"6: Fuel cutoff"** one should set the opening % threshold as equal to 0%.

5: Temperature



In this tab, the following parameters can be configured:

Ventilator turn on threshold – if the temperature is equal to or greater than this threshold, then the fan is switched on. This parameter must be greater than the switch-off threshold. If the fan control by PWM is used, then the behavior of these parameters is slightly different (see below).

Ventilator turn off threshold – if the temperature is equal or lower than this threshold, the fan is switched off. This parameter must be lower than the switch-on threshold. If the fan control by PWM is used, than this parameter is not used.

Use coolant temperature sensor – if a check is set, then the advance angle correction (and other related functions) according to the coolant temperature will be used, or not used otherwise. If this check is not set (or CLT sensor is absent), then the control of the fan is impossible.

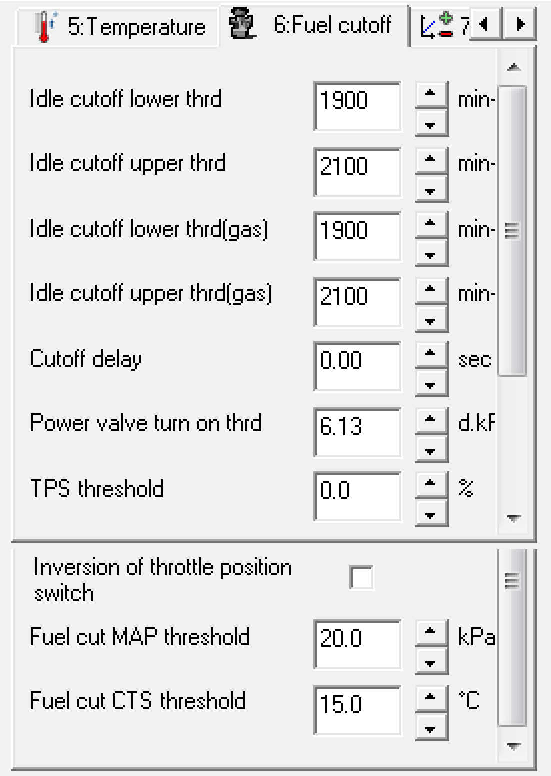
Control cooling fan using PWM – if a check is set, the signal (PWM) regulating the fan RPM will be generated on the ECF unit's output. At that, the fan is connected through the fan speed control unit (SECU-FAN-PWM). The fan will start to rotate at minimum speed 7.75 °C in advance of the fan turn on threshold and with maximum speed at reaching this threshold.

PWM frequency – one may change the frequency of the control PWM signal (5000 Hz as default).

Use table to define sensor's curve – if this check is set, the table (contained in the firmware) which may be changed by reading the firmware from the "Firmware Data" tab and pressing the **"Tune CTS curve"** is used. After changing the table, it is necessary to record the changed firmware into the unit (also in the "Firmware Data" tab). Such configuration is used at connecting the sensors which are different from the recommended to the unit, e.g. resistive sensors (thermistors).

If you are not familiar with the calibration of sensors, then use the recommended sensors with the linear characteristic (LM235 based), for which it is not necessary to configure the lookup table. With such sensors, the unit operates in the default mode without the check **"Use table to define sensor's curve"** set.

6: Fuel cutoff



In this tab, the following parameters are configured:

Lower and **upper idle cut-off valve** thresholds for petrol (used if there is no voltage on the GAS_V input). If the throttle is open, then the valve is always turned on (open). If the throttle is closed, then the delay countdown is started (see below). The valve will remain open, until the delay expires. If the delay has expired and the RPM are higher than the upper threshold, then the valve is turned off. If the RPM falls below the lower threshold or the throttle opens, then the valve is turned on again.

In the injector firmware, the lower and the upper idle cut-off valve thresholds for petrol are used as the fuel cut-off thresholds (“OverRun Fuel Cut”).

Lower and **upper idle cut-off valve** thresholds for gas (used if there is voltage on the GAS_V input). Some users arrange the gas intake control based on the idle cut-off valve output. In the injector firmware, the lower and the upper thresholds of the idle cut-off valve for gas are used for fuel cut-off in order to limit the maximum engine RPM (engine protection).

Cutoff delay is the delay of the idle cut-off valve switch-off. This parameter is also used in injector firmware as fuel cut-off delay.

Power valve turn on thrd is used for setting a discharge level at which the FE unit output will be activated, i.e. the FE unit output is activated at the pressure which is equal (or above) to the “Upper pressure value” (from tab “4: Functions”) minus the “Power valve turn on thrd” (from this tab).

Some carburetors already have this electrically-controlled valve (for instance, carburetors of export VAZ-2108 car). For the carburetors in which such system is arranged in a pneumo-mechanical manner (and they are the majority), one may produce an adapter and control it electrically. More details on http://secu-3.org.

Inversion of throttle position switch – if check is not set, then the throttle pedal is considered released when the unit's CARB input is grounded.

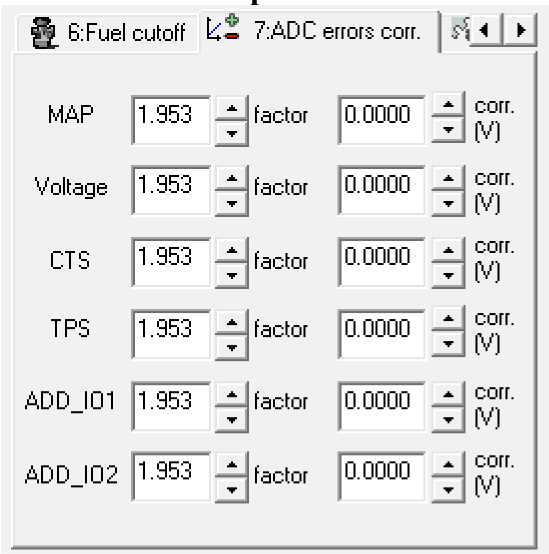
TPS threshold is the threshold as a percentage, and in case of falling short thereof, it is considered that the throttle pedal is released. At using the throttle position sensor, it is recommended to set the threshold of 1-3% for the guaranteed recognition of the released throttle pedal. If the throttle limit switch of the carburetor is used, then this value must be set at 0%.

Fuel cut MAP threshold – is used only in injector firmware, and the value is generally lower than that at idle. If manifold pressure is higher than this threshold, then the cut-off is not active.

Fuel cut CTS threshold – is used only in injector firmware, it is the lowest ICE temperature at which the cut-off is used (so, it does not influence the operating stability of the cold ICE).

Therefore, one may efficiently control the "engine braking" mode and save fuel in the carburetor and at controlling the fuel injection.

7: ADC error compensation



This tab is used for the precise setting of the ADC unit in order to make the sensor readings accurate to the maximum.

The coefficient is multiplied by the current value, and the correction value (in volts) is added to the current value.

By measuring the voltage applied to the unit's analog inputs with a voltmeter, one must reach the same values in the manager, with the "Show "raw" values of sensors" option selected.

Generally, it is necessary to change only the coefficient, and correction will hardly be required. Possibly, all the coefficients with be equal to one another. The reference voltage spread of 5V causes a slight error.

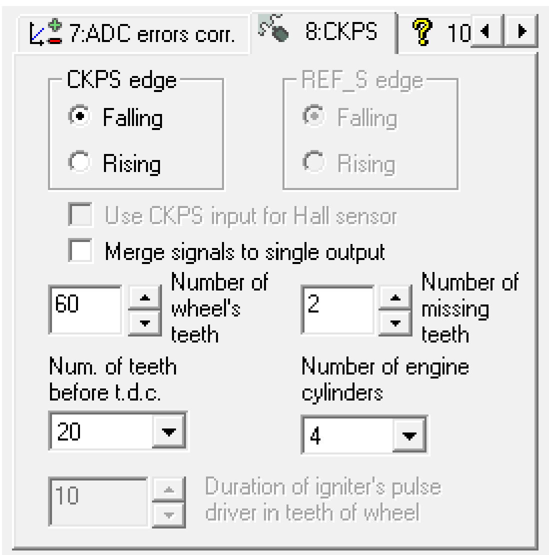
For the new units (since 2014), all coefficients are equal to 1,953 by default.

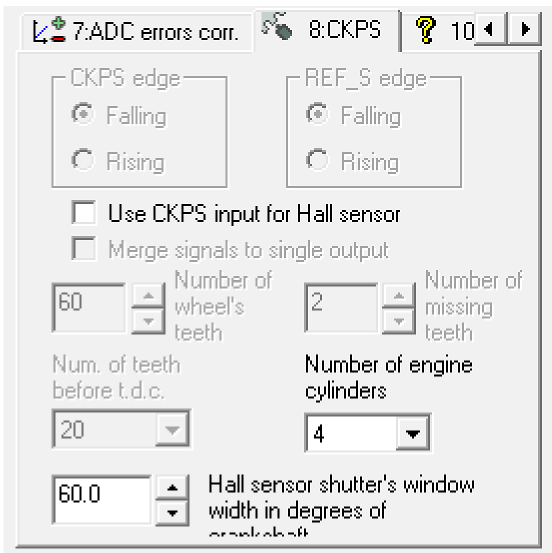
After the adjustment of these parameters, IT IS IMPERATIVE to make sure that the setting based on the two voltage points is correct!

8: CKPS

At CKP sensor-based synchronization, the tab has the following view:

At conventional Hall-based synchronization, the tab has the following view:





In this tab the configuration of the trigger wheel (pulley) installed on the crankshaft, and the configuration of the crankshaft position sensors, ignition distribution between the cylinders, number of engine cylinders and duration of ignition module's start impulse in the teeth of wheel (or window width in the interrupter disc of the hall sensor) are set.

CKPS edge and REF_S edge - in case of occurring synchronization errors, try to select various combinations of these parameters for the error to disappear. The change of the edge (front) is similar to the change of polarity of sensor connection.

Use CKPS input for Hall sensor – in some engines (for instance, scooters and mopeds), the VR sensor is used instead of the hall, and it must be connected only to the CKPS input. At that, the firmware similar to the hall sensor one is used (with HALL_SYNC option).

Merge signals to single output – all ignition signals will be united on one IGN_OUT1 output. The name of this parameter speaks for itself. It is useful when you want to use high tension distributor.

Number of wheel's teeth. Sheaves with different teeth quantity (from 16 to 200) and with different quantity of missing teeth (from 0 to 2) are supported.

At using one crankshaft position sensor, a tooth or two must be missing from the sheave (it is used as a mark). Accordingly, the "**Number of missing teeth**" is equal to 1 or 2, depending on the number of the missing teeth. At using two sensors (angular impulse sensor (CKPS) + reference sensor (REF_S), the number of missing teeth is equal to 0. In such case, the mark is the tooth passing by the second crankshaft position sensor (REF_S), which gives one pulse per crankshaft revolution. Usually, such two sensors are installed on the flywheel (teeth plus rod).

Number of teeth before t.d.c. is the number of teeth between the mark and the CKP sensor in the position of the TDC of the first cylinder. The count must be performed from the mark in the direction opposite to the crankshaft rotation. If the Manager does not allow setting too low number of teeth up to the TDC of the first cylinder, which is what you need, then add a number of teeth between the TDC of the neighboring cylinders. This quantity may be calculated under the following formula:

$$Teeth\_number\_between\_\mathrm{TDC} = \frac{2 * sheave\_teeth\_number}{engine\_cylinders\_number}$$

For instance, you have a 4-cylinder engine, sheave/flywheel with 114 teeth, and the rod passes by the reference sensor with respect to the TDC of the first cylinder 10 teeth in advance. You cannot set 10 teeth in the manager. Add 2*114/4=57 to 10, obtain 10+57=67 teeth and set this value. Another example, you have a 5-cylinder engine, and 60-2 pulley/trigger wheel. The mark passes by the CKP sensor with respect to the TDC of the first cylinder 5 teeth in advance. Accordingly, 5+2*60/5=29 teeth. See recommendations for sheave installation at http://secu-3.org/ustanovka-dpkv/?lang=en.

Duration of igniter's pulse driver in teeth of wheel – this parameter may be selected by trial or calculated with the following formula:

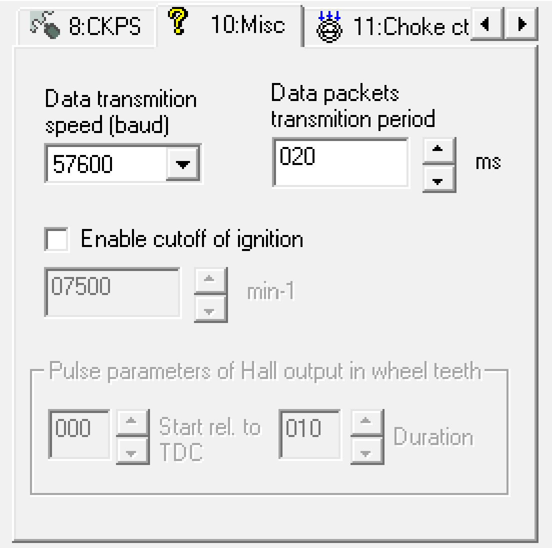
$$Duration = \frac{2 * sheave\_teeth\_number * ignition\_channels\_number}{3 * engine\_cylinders\_number}$$

If the ignition module overheat at low RPM (idling) or the engine operation is instable (ignition skips), increase this value but no more than twofold. This parameter is not used in the firmware supporting the dwell time calculation (see DWELL_CONTROL firmware option).

Hall sensor shutter's window width in degrees of crankshaft – it is used only in the firmware with Hall-based synchronization (see HALL_SYNC firmware option). It is set as 60° by default (the value for the conventional interrupter's window in distributor of 4-cylinder engines). Since the rotation frequency of the distributor shaft is twice as low as that of the crankshaft, this value will always be two times as great as the actual distributor shutter window width in degrees.

One should note a significant property related to this parameter. It is required by the firmware that the signal switching from the Hall sensor (shutter goes out from the sensor) is performed 60° in advance of the TDC. If the window in the shutter is equal to 60° (based on the crankshaft), then it is possible to allow spark generation based not on time, but on the reversion signal switching (shutter inputs into the sensor) at very low RPM. It may be configured in the start ignition timing map (if the value is equal to zero at certain RPM, then spark generation based strictly on the shutter input is allowed). Consequently, it is preclude the possibility of failed engine start due to too early ignition, which is caused by the inconsistence of the crankshaft rotation speed at very low RPM.

10: Misc



In this tab, the following parameters are configured:

Data transmission speed (baud) – defines the transmission speed of one data packets. After saving this setting, the unit must be restarted and the connections settings in the Manager must be changed. The value of this parameter and the corresponding value in the Manager's settings window must coincide.

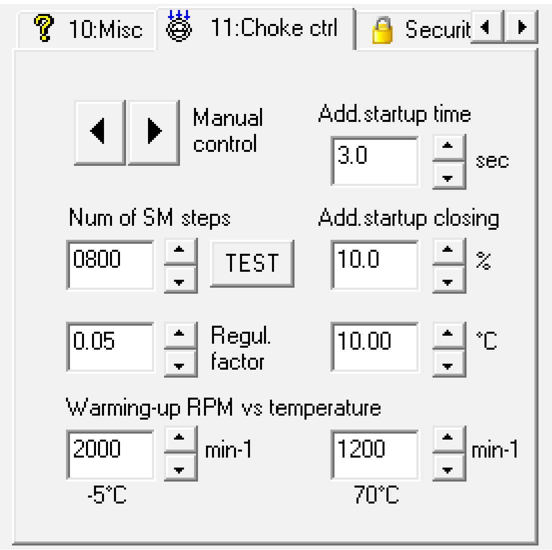
Data packets transmission period – defines the interval for sending the data packets to the Manager, for instance, each 20 ms. Do not set a too low value without specific necessity.

Enable cutoff of ignition – the RPM value at exceeding which the ignition impulse generation is ceased. Ignition cut-off may result into detonations in the silencer. You must be especially careful at using this parameter in case of the gas equipment installed. The best way is to combine the ignition cut-off with the simultaneous fuel cut-off (if the injection control is used).

Pulse parameters of Hall output in wheel teeth – the duration and position of the signal from the unit output which is reassigned as HALL_OUT is configured. “**Start rel. to TDC**” – start of the Hall impulse generation relatively to the TDC in the sheave teeth. **“Duration” -** duration of the Hall emulation impulse in the sheave teeth.

Hall sensor output emulation will be useful for generating a synchronization signal for other ECU (using the distributor with Hall-based synchronization) or for a tachometer connection. If you use this signal only for the tachometer, then the values of the above-referred parameters may be actually random.

11: Choke ctrl



Choke control or stepper IAC setting (if firmware with fuel injection support is used). In the case of stepper IAC, only one parameter is used, the number of SM steps.

Manual control – at the first pressing of any of this horizontal arrows, the firmware is set into the manual mode of the stepper motor control. One may control the choke or IAC valve position with the accuracy of up to one step. Used for testing purposes.

Add.startup time – adds the additional closing time (see “Add.startup closing”) and, at the same time, the pause after start prior to the switch-on of the closed-loop RPM regulator. At the moment of regulator switch-on, the additional closing is disabled.

Num of SM steps – number of the steps of the stepper motor required for the complete closure of the choke from the full opening position, and vice versa. This parameter is also used in the fuel injection-inclusive firmware to preset the IAC valve steps number.

Add.startup closing – prior to the start, it will be added to the current choke position from the table for additional closure of the choke, if the coolant temperature is lower than the closing temperature and higher than zero.

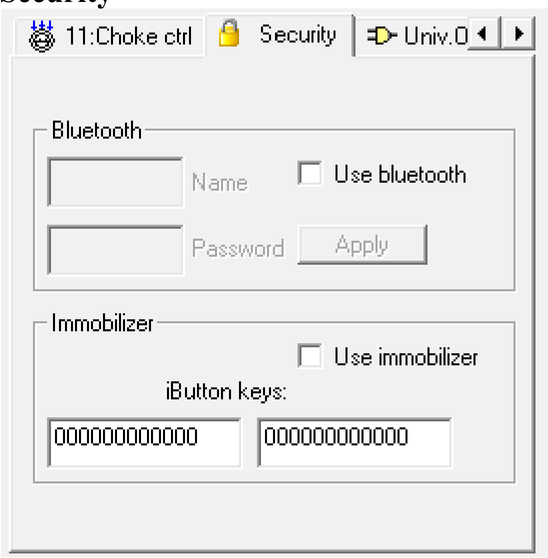
Closing temperature – temperature from zero and up to which the additional closing will be used. The choke is always fully closed, if the temperature is lower than zero.

Regul. factor – regulator coefficient (I-regulator is used). The lower the value, the smoother is the RPM maintenance. If the value is too low, the system will not be able to adjust for the occurring RPM deviations timely. A too high value will result into instability and the resulting RPM fluctuation.

Warming-up RPM vs temperature – the desirable warming-up RPM are set, basing on two points: RPM at -5°C and 70°C. At the temperature lower than -5° C, the RPM will be set for -5°C. Accordingly, if the temperature is higher than 70°C, the RPM will be the same as for 70°C. Within the range from -5 to 70°C, the RPM will smoothly decrease. Please note that the RPM will not fall below idling (the choke will fully open and the idling mode will operate), therefore, at 70°C the RPM may be set as lower than the idling.

In order to disable the closed-loop regulator, it is necessary to set zero RPM for -5°C. See more details about configuring the regulator at http://secu-3.org/forum/viewtopic.php?f=11&t=9

Security



In this tab you can manually set a new name and password for the Bluetooth module as well as insert the iButton key values for the immobilizer.

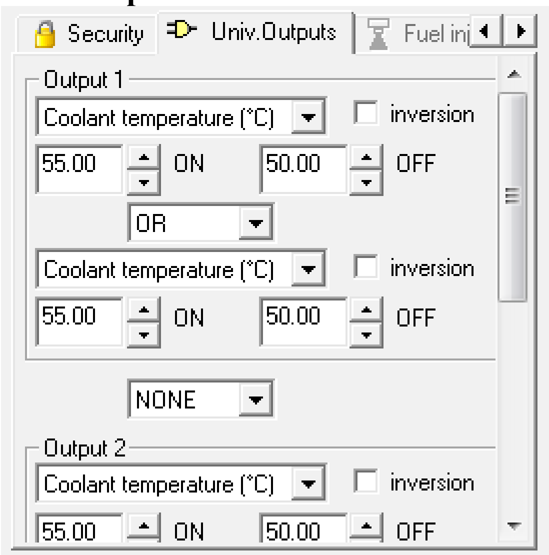
Use Bluetooth – set this check, if Bluetooth is installed in your unit and you want to change the username and password, and that at changing the data transmission speed in the parameters tab **“10: Misc”** the Bluetooth speed be also changed by the firmware in a synchronized way. If the check is not set, then the speed in the Bluetooth module will not change upon changing the baud rate of exchange with the unit! **It is also recommended to insert this check in the reserve parameters of the unit, so that after EEPROM resetting, Bluetooth operates at correct speed.**

Name — is used for entering a new Bluetooth name. **Password** – is used for entering a new Bluetooth password. To change the name and password, enter new values and press the **“Apply”** button. The unit will be restarted and will set new values into the Bluetooth module. This may take a few seconds (wait 15 sec.). **The name and passport of the Bluetooth module must be changed through the USB cable only!**

Use immobilizer – if the check is set, the unit will operate only if the iButton key is connected!

The iButton key looks like a tablet (for instance, DS1990) and is connected to the BL jumper. In new units (since 2014), the white angular connector may be installed on the board instead of the BL jumper. The values of the two keys must be filled in the fields below the check (one of the keys is generally spare). The key values are generally indicated on the front side of the iButton.

Univ. outputs

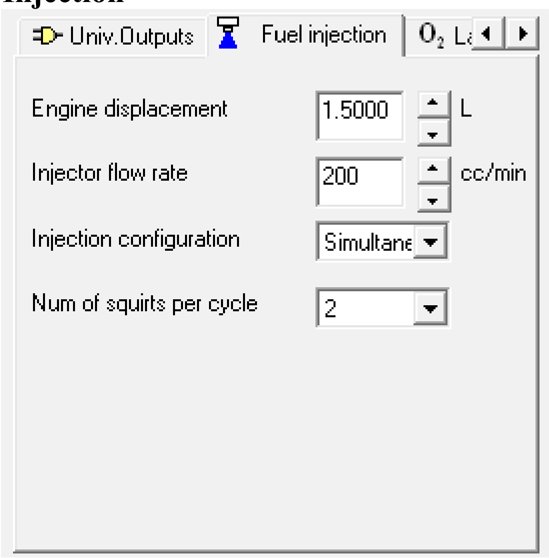


This parameters tab allows setting (programming) the behavior of the so-called universal outputs. Any free unit's output can be reassigned as UNI_OUTx and its behavior may be configured in a very flexible way, depending on various events and conditions (input functions).

Up to three outputs may be configured. Each output has two conditions which are joined by the logic functions (AND, OR, Excl. OR, 2nd condition). Each condition has the input function type selection, two thresholds (on and off) and the optional inversion. If two conditions are insufficient for configuring the output, then two outputs may be joined by the logic function and the condition of the second output may be used. Thus, only the first and the second output may be joined, and up to 4 conditions may be obtained for the setting. The setting result will be generated on the first output (UNI_OUT1).

Advice: while setting, always set the switch-on threshold as higher than the switch-off threshold. In such a way, it is easier to understand the logic of the output operation.

Injection



This tab is only available for the injection-inclusive firmware. Here you can configure the ICE displacement, injector flow rate, injection configuration and number of injections per engine cycle.

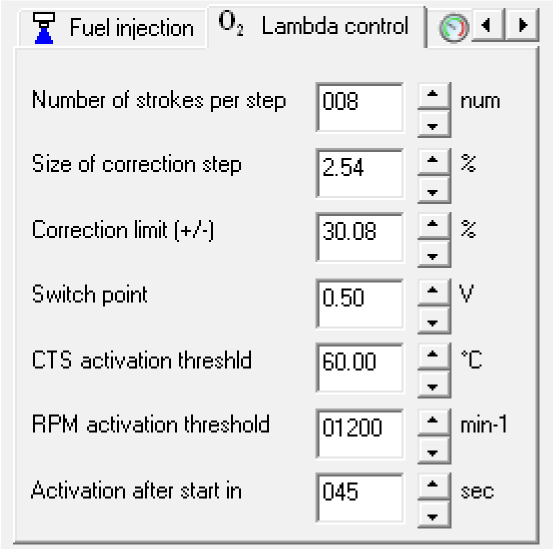
Engine displacement – is the engine volume, you should know it.

Injector flow rate – is the injector flow rate in cubic centimeters per minute. The greater the engine displacement, the higher the injector flow rate with margin should be. If the flow rate is insufficient, then the engine may fall short of fuel in advanced load modes.

Injection configuration – injection configuration may assume two values: Throttle-body and Simultaneous injection. Throttle-body injection means that only one operating injector (instead of a carburetor) is set in the centre. Simultaneous injection means that an injector is set in front of each cylinder, and they are opened simultaneously.

Num of squirts per cycle – it determines how many times per cycle the injector(s) will be opened. This parameter is usually selected by trial. For the high flow rate injectors, you should not use many injections per cycle, as such injectors are usually opened/closed slowly.

Lambda control



In this tab, the parameters of the mixture regulation based on the narrow-band oxygen sensor are configured. Wide-band sensors are also supported, but they processed in a narrow-band manner (threshold only). This tab is only available for the injection-inclusive firmware.

Number of strokes per step – correction will change each referred number of strokes.

Size of correction step – size of correction step as a percentage (the absolute value).

Correction limit (+/-) – is the maximum correction value as a percentage.

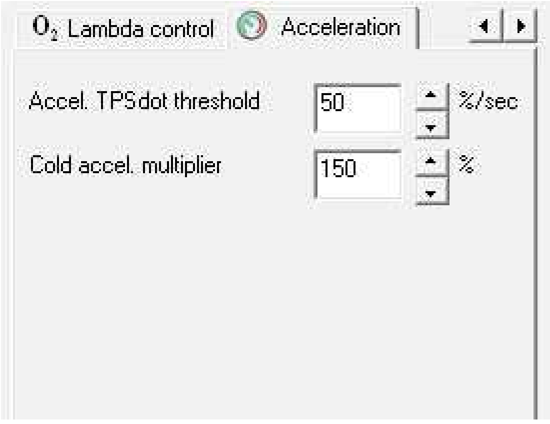
Switch point – is the threshold of oxygen sensor switching. It is the voltage generated by the sensor at stecheometric air-to-fuel ratio. For wide-band sensor this value is usually 2.5V.

CTS activation threshold – the lambda control will be enabled after warming the engine up to this temperature.

RPM activation threshold – the lambda control is used only for the RPM higher than specified.

Activation after start in – lambda regulator switch-on delay which is necessary for oxygen sensor warming up.

Acceleration



In this tab, the enrichment at acceleration is configured, i.e. so-called “acceleration pump”. Such tab is available only for the firmware with fuel injection.

Accel. TPSdot threshold – if the gas pedal is pressed/released with the speed lower than specified, then the acceleration enrichment is not enabled. In particular, the threshold is required for protection against noise (so that the enrichment is not enabled when the throttle does not move).

Cold accel. multiplier – is the enrichment correction factor at -30°C, which decreases linearly and is equal to 100% at +70°C and higher. The lower the engine temperature, the greater the enrichment is required. Factor is expressed in %.

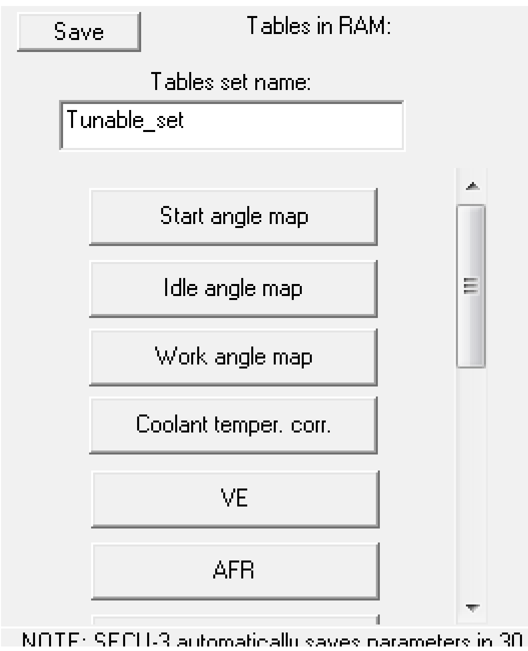
Editing tables in real time

Now the process of table editing in real time (in the online mode) will be observed. The total of 5 table sets are stored in the unit memory. Four of them are stored in the firmware (and are unavailable for editing in the online mode), one is stored in the EEPROM (available for editing in the online mode).

WARNING! At pressing the “Edit tables” button, the set of tables stored in the EEPROM is opened. Therefore, for editing the tables in the online mode, it is required that in the tab “4: Functions” the last set is selected from the list. If other sets are selected, then the table editing will not be applied to the engine!

The “Editing tables” button is used for editing of tables online.

After pressing the button, the list with the tables available for editing will appear:



The copy of the set can be loaded into the editable set from the firmware or EEPROM (at that, unsaved data will be lost). To save the tables in EEPROM, press the “Save” button (do it as frequently as possible).

The title of the table set may be changed. The buttons opening the corresponding maps are available as follows:

For ignition:

- **Start angle map (1x16)** – calculation is based on this ignition timing map, if the RPM are lower than specified in the tab “**1: Start**”. This map represents the ignition timing vs RPM.
- **Idle angle map (1x16)** – this map is used at idling (when the throttle is fully closed and, accordingly, the gas pedal is released). In this map, the ignition timing is related to RPM.
- **Work angle map (16x16)** – is a three-dimensional ignition timing map. Basing on this map, the ignition advance angle is calculated depending on the RPM and air pressure in the intake manifold (according to the number of curve).
- **Coolant temper. corr. (1x16)** – this map contains the ignition timing correction table depending on the coolant temperature (correction vs CLT).

For injection:

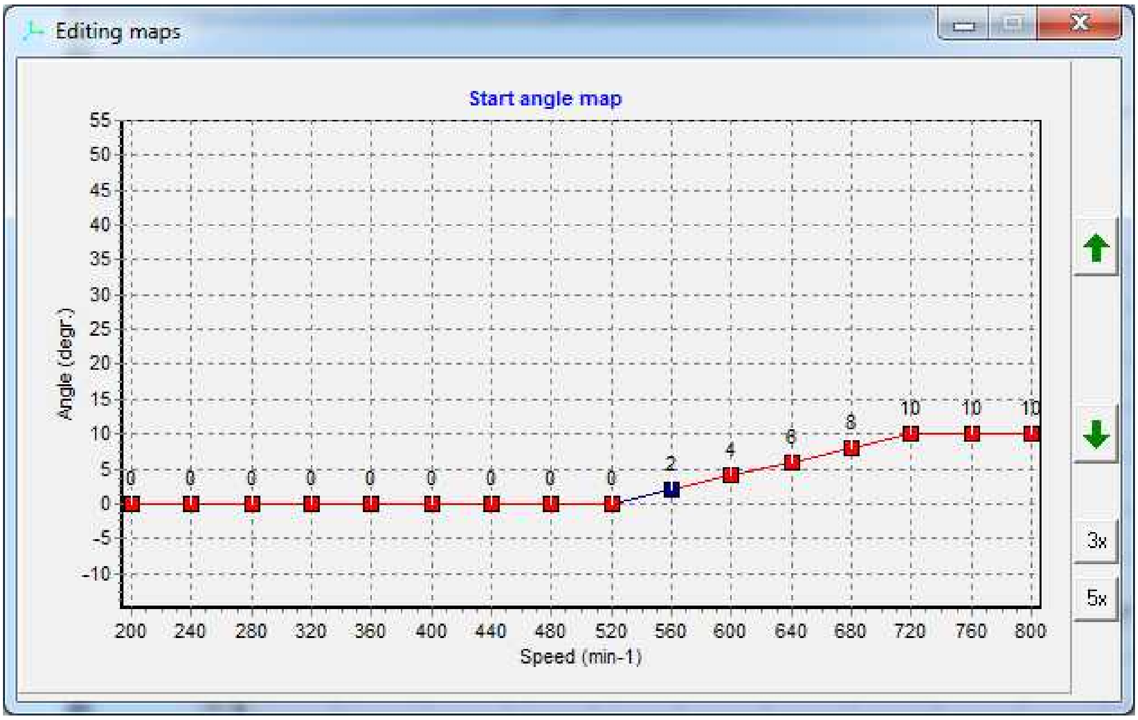
- **VE (16x16)** – is the so-called VE table (volumetric efficiency). It contains coefficients, which specify the relation of actual volume of air entered into the cylinder vs RPM and pressure in the intake manifold;
- **AFR (16x16)** – is the so-called AFR table. It sets the various values of the air/fuel ratio depending on the RPM and pressure in the intake manifold;
- **Cranking PW (1x16)** – this map specifies the injection pulse width, used at engine start (cranking). The injection pulse width depends on the engine temperature;
- **Warming-up enrich. (1x16)** – it is the enrichment coefficient depending on the engine
- temperature;
- **Inj. dead time (1x16)** – the map specifies the time in ms during which the injector does not inject fuel. The period is related to the system voltage. Injector needs some time to open and close, so simply put any value in this table is difference between open and close times;
- **IAC on run (1x16)** – is used for the open-loop control of the idling RPM. The IAC valve position depends on the engine temperature;
- **IAC on cranking (1x16)** – it is the IAC position at engine start, which depends on the engine temperature;
- **Accel. enr. TPS (1x8) –** this map is used at calculating the acceleration enrichment. It sets the coefficients depending on the throttle opening/closing speed**;**
- **Accel. enr. RPM (1x4)** – this map is used at calculating the acceleration enrichment. It sets the coefficients depending on the RPM;
- **Afterstart enr. (1x16)** – this map sets the extent by which the mixture must be enriched after the start. It operates for a limited time after the start.

Lets observe the example of editing the cranking ignition timing map. To do this, press the **“Start angle map”** button.

The graph window will open. The graph points may be moved by the mouse, and keyboard: **“Right”, “Left”** arrows allow to select a point for editing. **“Up”** and **“Down”** arrows change the value of the selected point with the step of 0,5 degrees (each table has its own step).

“Left” and “right” arrows may be used in combination with the SHIFT key for the group selection of points for editing. The left CTRL key may be used in combination with the left mouse clicks on the points for the group selection of points for editing.

On the right from the graph, there are buttons **“Pull-up”** and **“Pull-down”** (green arrows) which are for moving entire curve and buttons smoothing the curve by 3 or 5 neighboring points.



There is also a context menu on the graph editing window:

Zero all curve points
Duplicate value of 1st point
Build curve using 1st and last points

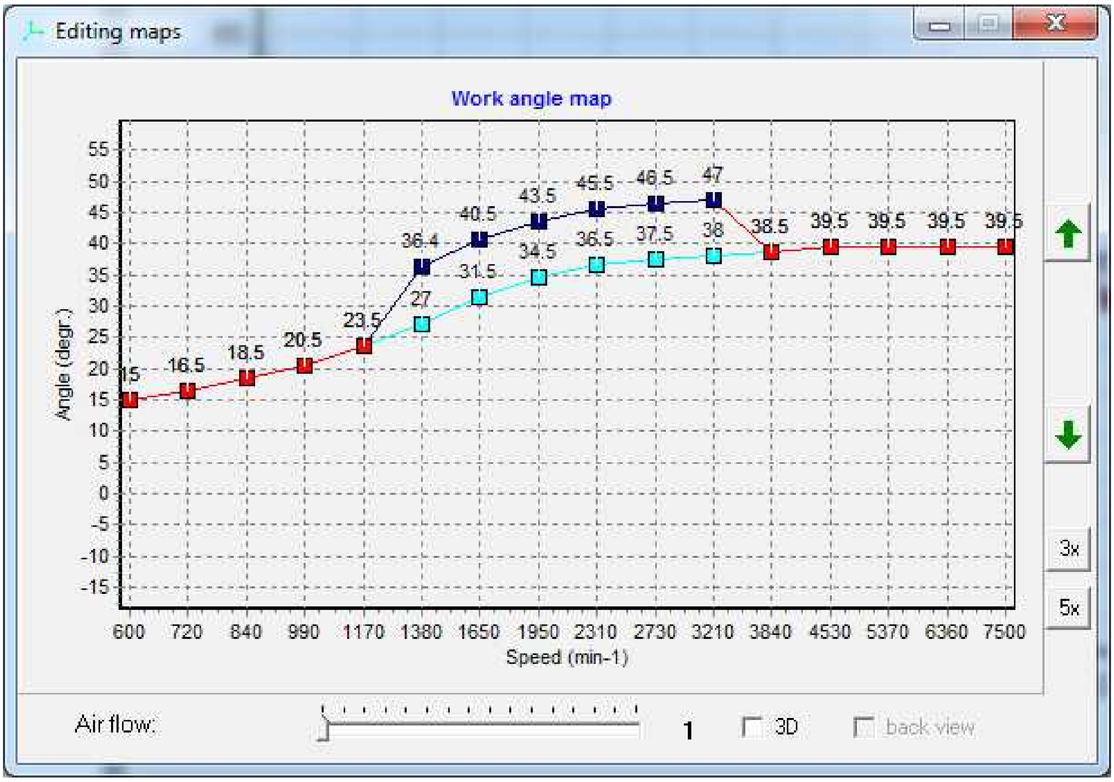
"**Zero all curve points** " – all curve points will be set equal to 0.

"Dublicate value of 1st point" – all curve points will be set equal to the first point value.

"**Build curve using 1st and last points**" – the curve will assume a form of the line connecting the first and the last points.

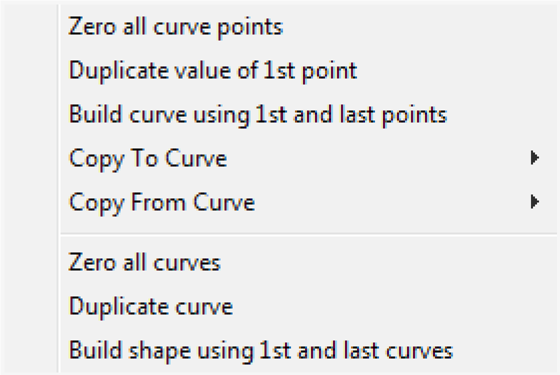
Other two-dimensional tables (which are the majority) have the similar structure.

Three-dimensional tables have a slightly more complex structure. Now the editing of a three-dimensional table, exemplified by the Work angle map, the editing window of which has the following view will be reviewed:



In the bottom of the window, the slider that selects the number of curve ("aif flow") is situated. The current number of curve can be also switched by the "Z" and "X" keys. The editable pints are selected by a deep blue color.

This window has a context menu with the following view:



The effect of the first three items is similar to the previous (two-dimensional) editing windows. The following is additional:

"**Copy to curve**" – one may copy the current curve into the selected one.

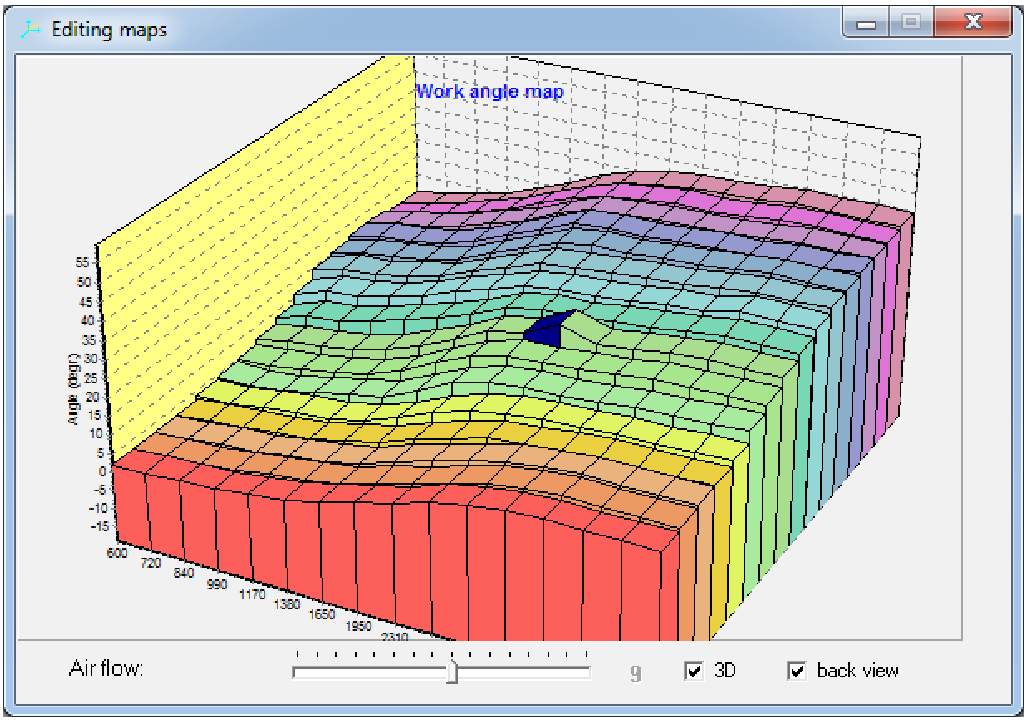
"**Copy from curve"** – one may copy the selected curve into the current curve.

"**Zero all curves"** – values of all 16 curves will be set equal to 0.

"**Dublicate curve"** – the current curve will be copied into the remaining 15 curves.

"Build shape using 1st and last curves" – the whole graph will be built from the 2nd to the 15th curves inclusive, basing on the 1st and 16th curve data by using linear interpolation.

If it is desirable, this map may be reviewed in a three-dimensional (3D) form. To do this, it is necessary to set the "3D" check, and the window will assume the following view:



Editing the graph points is performed in a similar way as in the previous examples. The editing point is selected by a deep blue color. As in the two-dimensional mode, the "Z" and "X" keys switch the curve number. The following shortcuts operate additionally:

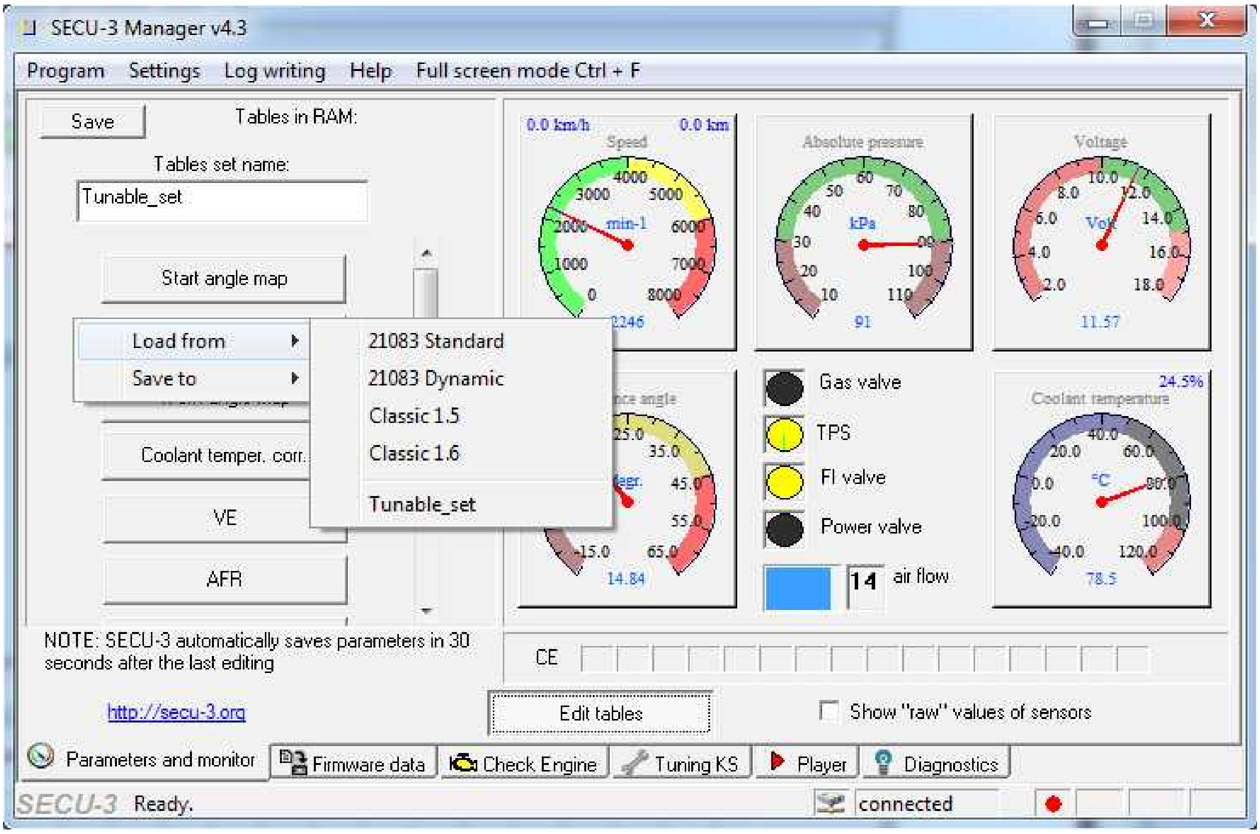
«B» - sets/cancels the "back view" (view from back side)

«Q» - changes the 3D graph view by filling in the space below the points by a color related to the point value.

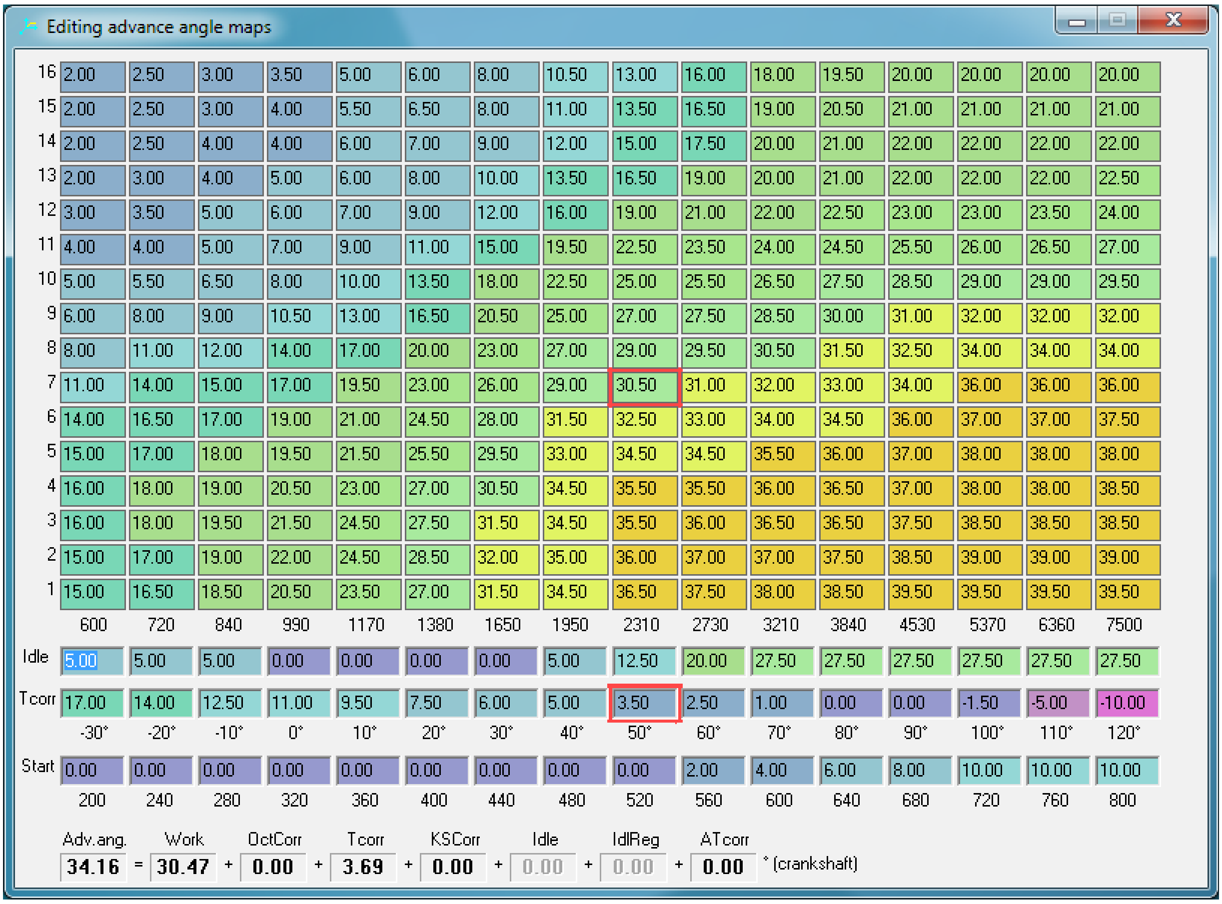
«A», «S», «D», «W» - rotate the camera around the graph in a joystick-like manner.

If you want to load and edit tables stored in the firmware, then first they must be loaded through the menu (see the figure below). Afterwards, the changes should be done and saved into

EEPROM (you can save only into EEPROM). Then (in the tab "Firmware Data") EEPROM may be saved into a file, and the import of tables from the EEPROM file into an opened firmware can be performed (see "Import data" sub-menu). Thus, the edited tables can be transferred into the firmware.



The grid like editing mode is also available (only ignition timing maps currently).



	600	720	840	990	1170	1380	1650	1950	2310	2730	3210	3840	4530	5370	6360	7500
16	2.00	2.50	3.00	3.50	5.00	6.00	8.00	10.50	13.00	16.00	18.00	19.50	20.00	20.00	20.00	20.00
15	2.00	2.50	3.00	4.00	5.50	6.50	8.00	11.00	13.50	16.50	19.00	20.50	21.00	21.00	21.00	21.00
14	2.00	2.50	4.00	4.00	6.00	7.00	9.00	12.00	15.00	17.50	20.00	21.00	22.00	22.00	22.00	22.00
13	2.00	3.00	4.00	5.00	6.00	8.00	10.00	13.50	16.50	19.00	20.00	21.00	22.00	22.00	22.00	22.50
12	3.00	3.50	5.00	6.00	7.00	9.00	12.00	16.00	19.00	21.00	22.00	22.50	23.00	23.00	23.50	24.00
11	4.00	4.00	5.00	7.00	9.00	11.00	15.00	19.50	22.50	23.50	24.00	24.50	25.50	26.00	26.50	27.00
10	5.00	5.50	6.50	8.00	10.00	13.50	18.00	22.50	25.00	25.50	26.50	27.50	28.50	29.00	29.00	29.50
9	6.00	8.00	9.00	10.50	13.00	16.50	20.50	25.00	27.00	27.50	28.50	30.00	31.00	32.00	32.00	32.00
8	8.00	11.00	12.00	14.00	17.00	20.00	23.00	27.00	29.00	29.50	30.50	31.50	32.50	34.00	34.00	34.00
7	11.00	14.00	15.00	17.00	19.50	23.00	26.00	29.00	30.50	31.00	32.00	33.00	34.00	36.00	36.00	36.00
6	14.00	16.50	17.00	19.00	21.00	24.50	28.00	31.50	32.50	33.00	34.00	34.50	36.00	37.00	37.00	37.50
5	15.00	17.00	18.00	19.50	21.50	25.50	29.50	33.00	34.50	34.50	35.50	36.00	37.00	38.00	38.00	38.00
4	16.00	18.00	19.00	20.50	23.00	27.00	30.50	34.50	35.50	35.50	36.00	36.50	37.00	38.00	38.00	38.50
3	16.00	18.00	19.50	21.50	24.50	27.50	31.50	34.50	35.50	36.00	36.50	36.50	37.50	38.50	38.50	38.50
2	15.00	17.00	19.00	22.00	24.50	28.50	32.00	35.00	36.00	37.00	37.00	37.50	38.50	39.00	39.00	39.00
1	15.00	16.50	18.50	20.50	23.50	27.00	31.50	34.50	36.50	37.50	38.00	38.50	39.50	39.50	39.50	39.50

	600	720	840	990	1170	1380	1650	1950	2310	2730	3210	3840	4530	5370	6360	7500
Idle	5.00	5.00	5.00	0.00	0.00	0.00	0.00	5.00	12.50	20.00	27.50	27.50	27.50	27.50	27.50	27.50

	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°
Tcorr	17.00	14.00	12.50	11.00	9.50	7.50	6.00	5.00	3.50	2.50	1.00	0.00	0.00	-1.50	-5.00	-10.00

	200	240	280	320	360	400	440	480	520	560	600	640	680	720	760	800
Start	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	4.00	6.00	8.00	10.00	10.00	10.00

Adv.ang.		Work		OctCorr		Tcorr		KSCorr		Idle		IdlReg		ATcorr	
34.16	=	30.47	+	0.00	+	3.69	+	0.00	+	0.00	+	0.00	+	0.00	° (crankshaft)

In this mode, only the following advance angle maps are simultaneously displayed on this window:

- Work angle map
- Idle angle map
- Coolant temper.corr.
- Start angle map

The current operating point, i.e. those table cells from which the values for the calculation of the advance angle are taken at a particular moment, is displayed in a red frame. If the point is situated between the two values of the table, then the two cells are selected by the red frame.

In addition, for better visual perception, the cells are hued in the color corresponding to the value. The lower the value, the cooler the color, and the greater the value, the warmer the color.

The line with the summands of the total advance angle is displayed in the bottom of the window:

Work map + Octane correction + Temperature correction + Detonation correction + Idling map-based correction + Idling speed regulator correction + Intake air temperature correction (ATS table in the firmware).

If any of the summands is not used in the current engine operation mode, then it is displayed in a grey color. All values are given in degrees, basing on the crankshaft.

For the movement between the cells, use the keyboard arrows. The following shortcuts operate within the window:

"Left", "Right", "Up", "Down" keys are used for jumping between the cells and the tables.

«]» key decreases the value in the cell with the cursor by 0.5.

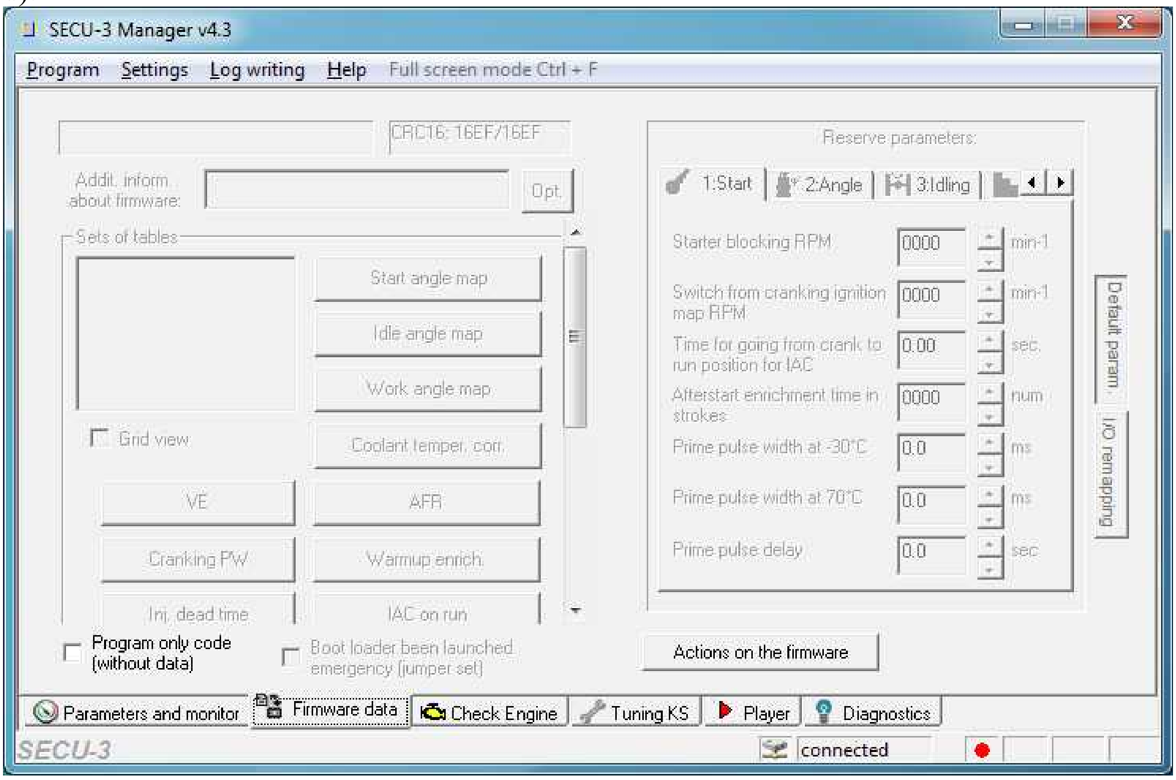
«\» increases the value in the cell with the cursor by 0.5.

You may also simultaneously edit the maps in the grid, graphic and 3D modes, as the data is synchronized automatically.

Working with "Firmware Data" tab

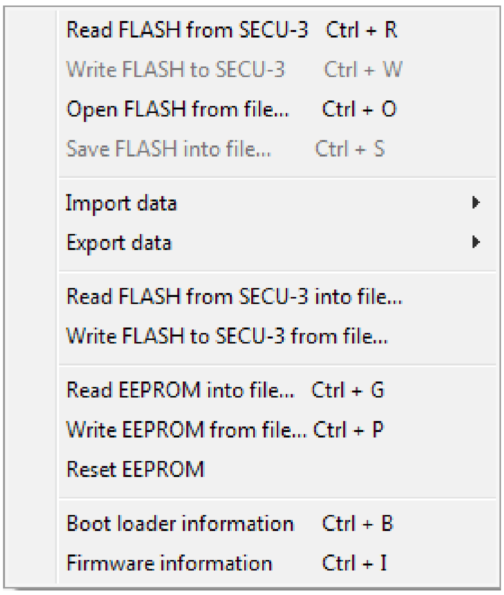
Lets review working with the Manager's tab **"Firmware Data"**. As it was previously noted, in this tab you can change the SECU-3 unit parameters for which the re-flashing of the unit is required (upgrading the firmware).

The tab has inactive control elements by default, i.e. the firmware is not loaded (or not opened).



To start working with this tab, it is required to load a firmware into it (a few ways are available). It can be done by opening a context menu by the right mouse button, or by pressing the "Actions on the firmware" button.

The menu has the following view:



The name of the majority of the menu items speaks for itself. The firmware (flash) can be read from the unit, opened from a file on the disk, or read directly from the unit into a file. Similarly, the firmware can be recorded into the unit, saved into a file on the disc and recorded into the unit directly from the file. You can read EEPROM into a file, or alternately, record it to SECU-3 from a file.

“Reset EEPROM” – the use of this menu item is similar to setting the “Default EEPROM” jumper, except the resetting is performed immediately, but after the power switch-on of the unit. It is recommended that during this process, the ignition coils are disconnected from the ignition modules to prevent the accidental actuation.

“Boot loader information” – the boot loader version information will be read from the unit and displayed in the status bar.

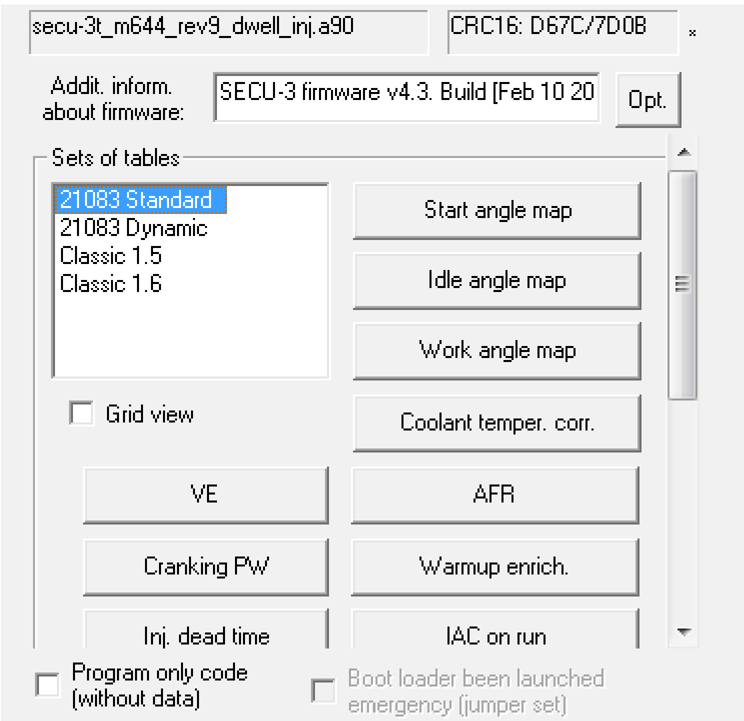
“Firmware information” – the firmware information will be read from the unit (additional text information, list of firmware options, version) and displayed in a separate window.

In order to read the firmware directly from the connected unit, select the menu item “Read FLASH from SECU-3”. The firmware reading process will be started in the Manager's status bar.

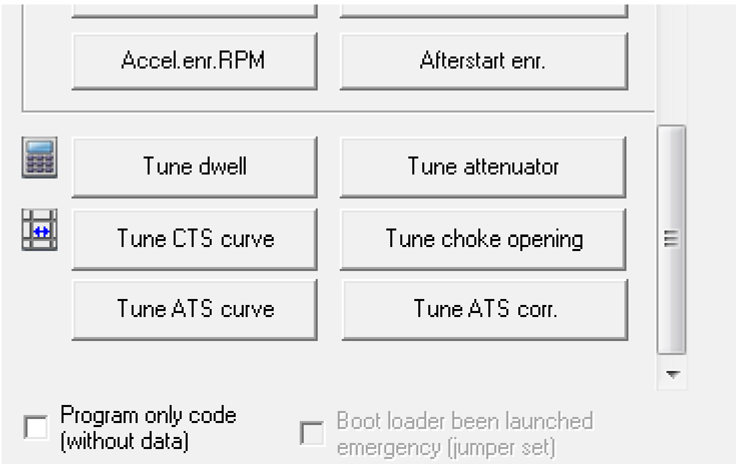
When the firmware is read, its data can be modified.

Now this tab will be reviewed section by section. In the left section, the firmware file name is displayed, and slightly on the right, the check sum (CRC16) is displayed (two values). Slightly downwards, the additional firmware information field is situated (it is stored in the firmware and may be edited, e.g. for saving marks), and the “Options” button which opens the firmware options information and firmware version is situated slightly rightwards.
Here can also edit all the tables contained within the firmware:

Below, in the “Sets of tables” box, the list with the names of the table sets for selection and the buttons opening the corresponding tables from the selected set for editing are situated. The “Grid View” tcheck acts in a way similar to the check situated in the window of editing tables in real time (Parameters and Monitor → Edit tables).



The following box which is located below, contains the buttons that open separate tables (which are not included into the sets) for editing. The description of tables is given below the figure.



- Tune dwell (1x32) – prescribes the relation of the coil dwell time vs board voltage, the dwell time calculator can be used at known coil characteristics (press the calculator icon to the left from the button;
- RPM grid editing (1x16) - an icon to the left from the “Tune CTS curve” button, editing of the RPM grid determining the horizontal axis (RPM axis) step in three-dimensional tables.
- Tune CTS curve (1x16) – setting of the correspondence of the temperature sensor's voltage with its temperature (CTS calibration);
- Tune attenuator (1x128) – the amplification factors table which is used by the detonation detection algorithm;
- Tune choke opening (1x16) – sets the choke position based on the engine temperature;
- Tune ATS curve (1x16) – setting of the correspondence of the voltage of the temperature sensor with its temperature (ATS calibration);
- tune ATS corr. (1x16) – a table specifying the relation of the ignition timing correction to the intake air temperature.

Here also the following checks are situated:

- Program only code (without data) – it may be useful for the quick firmware update with saving the data (only the code will be updated). It is recommended only for the experienced users!
- Boot loader been launched emergency (jumper set). Use this check only if the “Boot loader” jumper is set, so you want to launch loader manually.

In the right part of the tab “**Firmware Data”**, the reserve parameters and input/output reassignment parameters of the unit (two vertical buttons swap the display of the reserve parameters window and outputs reassignment window) are situated.

The reserve parameters are the default unit parameters. They re-record the basic settings at launching the unit with the “Default EEPROM” jumper installed or at selecting the menu item “Reset EEPROM”. This process takes up to 10-15 seconds, and for its duration the “Check Engine” lamp lights up. After successful setting and tuning of the unit, it is recommended to set the reserve parameters of the unit as the basic ones. In such case, you may expeditiously reset the configured settings.

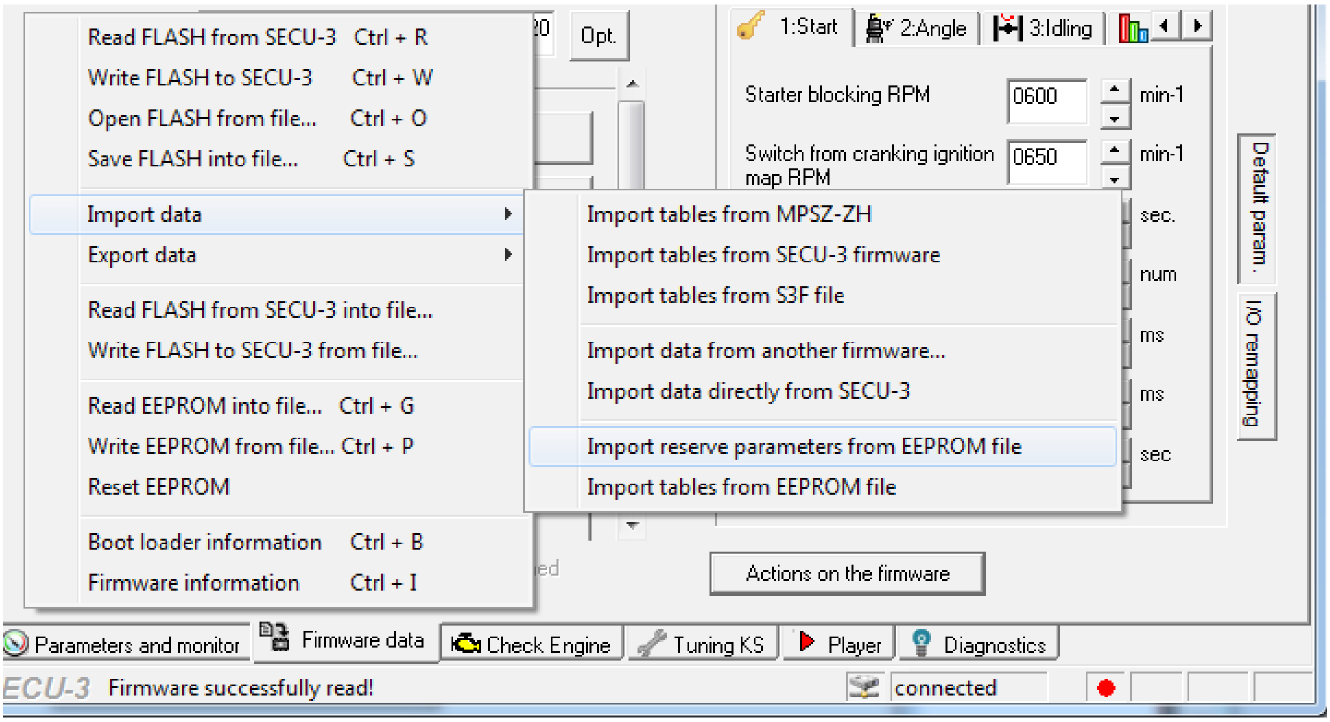
The reserve parameters window has the same view as the parameters window in the tab **“Parameters and Monitor”**. The only exclusion is the presence of the tab “9: Knock”. The latter contains exactly the same parameters as on the tab **“Tuning KS”** (which is described further).

In order not to set the reserve parameters manually, the firmware may be read from the unit, EEPROM parameters may be read into a file, and the reserve parameters may be imported from the EEPROM file (see Import data sub-menu).

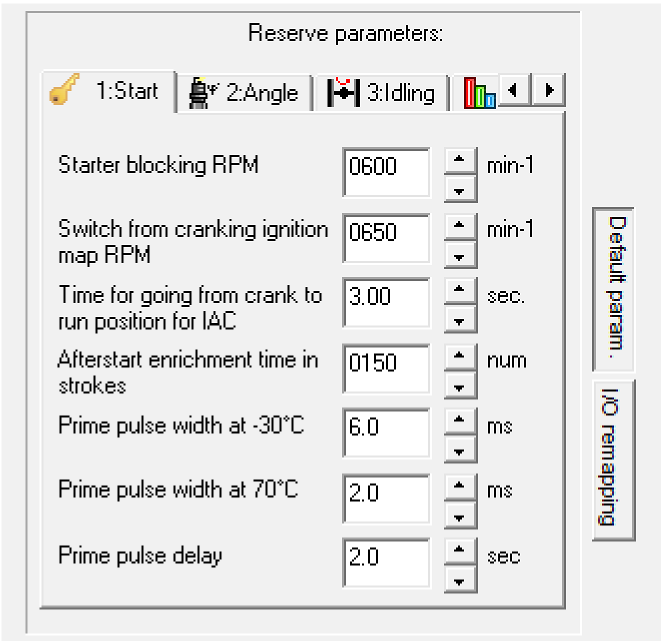
All manipulations shall be made on the tab “Firmware Data” using the context menu items:

1. Read FLASH from SECU-3.
2. Read EEPROM into file (a menu for saving the file appears, select the EEPROM file location).

3. Import data - Import reserve parameters from EEPROM file (a menu for file selection appears, indicate the EEPROM file that has just been saved).



Now the unit reserve (backup) parameters will contain the same parameters as those that were configured at the tab **"Parameters and Monitor"**.



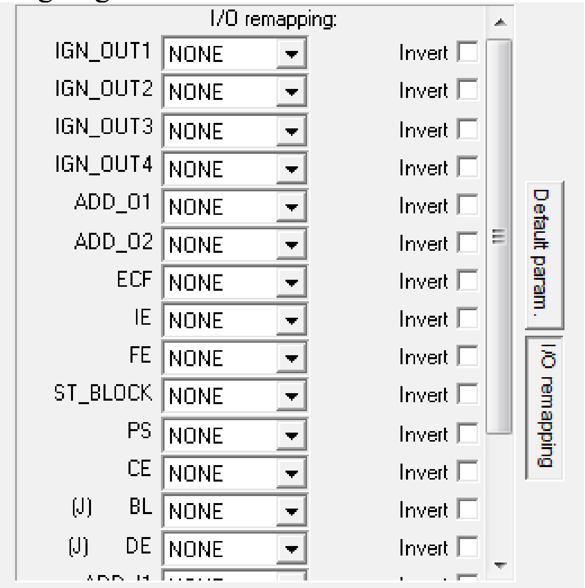
After adjustment of the curves online you can save them into a **s3f** file to use later in new firmware versions or, for example, post at our forum (will be helpful for others). For this you have to do the following steps using the Manager, which is still not updated:

1. Read EEPROM into file;
2. Import tables from EEPROM file into this firmware;
3. Now the tables are incorporated into firmware and they can be exported into s3f.

It is possible to import the selected tables from another SECU-3 firmware, from s3f file and even from MPSZ-ZH. Importing data (as opposed to tables) means that the **reserve parameters and tables** will also be transferred. It is also possible to import data from file of another SECU-3 firmware or directly from the unit.

It is possible to export selected tables to another SECU-3 firmware, to s3f format or to one of the MPSZ-ZH formats.

If you press the button "**I/O remapping**", then instead of reserve parameters a corresponding window appears. Reassignment parameters of inputs and outputs of the unit allow you to reassign inputs and outputs of the unit for performing alternative functions different from the original ones. For example, the output ADD_O1 can be reassigned for the control of the electric fuel pump, stroboscope etc., while by default it is used as a 5th ignition output. A complete list of re-assignable functions is in the table going below.



"NONE" means that no alternative function is selected. Against each reassigned input or output a check mark "Invert" is located, which establishes the inversion of output operation or inversion of input analysis.

Peculiarities of reassigning and connecting to specific inputs/outputs

Lambda sensor (LAMBDA) can be assigned only to ADD_I1. The units released since 2014 have this input connected to the contact KS_2 of the unit. The sensor should be connected to it.

Intake air temperature sensor (AIR_TEMP) can be assigned only to ADD_I2, which is hardware combined with ADD_O2 output and connected to ADD_IO2 unit contact. So the check mark "Invert" should be checked against ADD_O2 output for it not to influence the IAT readings.

Each of the BL and DE jumpers can be reassigned as an output, in which case each of them does not lose its principal function (emergency run of the loader or EEPROM reset). For connecting the iButton tablet the BL jumper should not be reassigned.

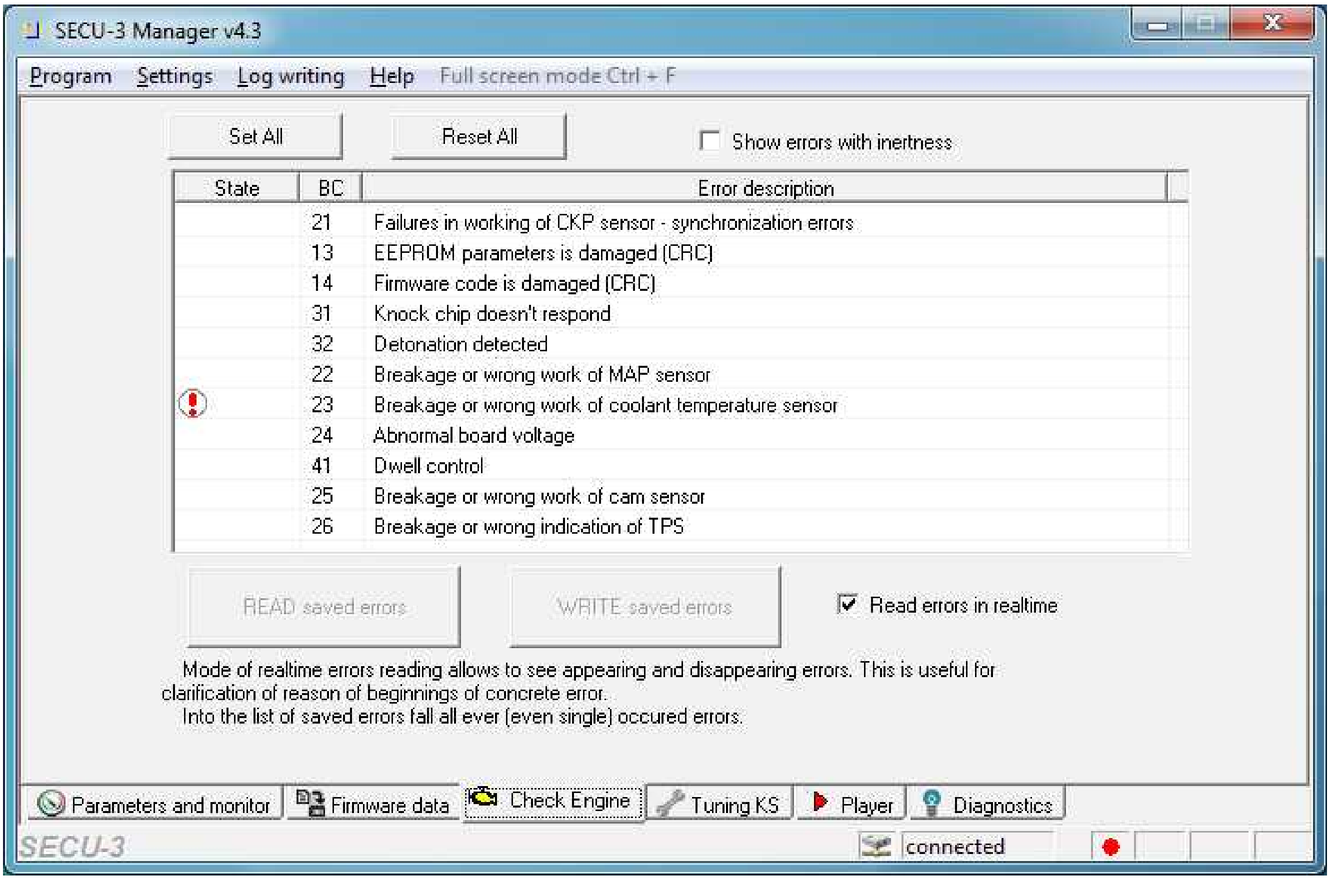
Table of Alternative Functions

Name	Description
FL_PUMP	Electric fuel pump control output. Activated for 5 seconds after the ignition is on when there are engine RPM and for 3 seconds after they disappear.
HALL_OUT	Output emulating the signal from the Hall sensor. Usually used to "deceive" the throttle-body injection ECU or as an output for the low-voltage tachometer
STROBE	Stroboscope output. If you connect high-power LEDs to this output you can use this unit in the strobe mode for adjustment of ignition according to crankshaft marks.
PWRRELAY	Output for control of unit's powering relay (main relay). Used together with one of inputs reassigned as IGN.

<table>
<tr><td>IGN</td><td>Input analyzing the presence of ignition. Used for controlling the unit's power supply when the ignition is switched off. Used together with one of outputs reassigned as PWRRELAY.</td></tr>
<tr><td>SPD_SENS</td><td>Input for impulses from vehicle speed sensor.</td></tr>
<tr><td>BC_INPUT</td><td>Input, the short circuit to ground or to +12V (depending on the checked checkmark “Invert”) of which activates the output of blink codes to CE lamp.
After switching to the mode the CE lamp will slowly blink 4 times and the output of error codes will start. After indicating all errors CE will again slowly blink 4 times and the cycle will start again.
See the list of codes and errors corresponding to them in the column «BC» at the tab «Check Engine» of the Manager.</td></tr>
<tr><td>MAPSEL0</td><td>Input used for switching between the sets of tables.
Used together with the input GAS_V of the unit. The combination of voltages at those inputs allows choosing between 4 sets of tables.
For example two sets for gas and two for petrol.
<table>
<tr><td>GAS_V to ground
MAPSEL0 to ground</td><td>Set of tables selected in the Manager for petrol tab (tab “4:Functions”)</td></tr>
<tr><td>GAS_V to ground
MAPSEL0 to +12V</td><td>First set of tables from the list on the tab of parameters (tab “4:Functions”)</td></tr>
<tr><td>GAS_V to +12V
MAPSEL0 to ground</td><td>Set of tables selected in the Manager for gas (tab “4:Functions”)</td></tr>
<tr><td>GAS_V to +12V
MAPSEL0 to +12V</td><td>Second set of tables from the list on the tab of parameters (tab “4:Functions”)</td></tr>
</table></td></tr>
<tr><td>LAMBDA</td><td>Input for connecting of O2 sensor</td></tr>
<tr><td>AIR_TEMP</td><td>Input for connecting of IAT sensor</td></tr>
<tr><td>IGN_OUT3</td><td>Ignition output 3</td></tr>
<tr><td>IGN_OUT4</td><td>Ignition output 4</td></tr>
<tr><td>IGN_OUT7</td><td>Ignition output 7</td></tr>
<tr><td>IGN_OUT8</td><td>Ignition output 8</td></tr>
<tr><td>SM_DIR</td><td>Output setting the direction for stepper motor motion (control of choke, idle speed regulator or stepper gas valve). Used together with SM_STP</td></tr>
<tr><td>SM_STP</td><td>Output providing steps for stepper motor (control of choke, Idle speed regulator or stepper gas valve). Used together with SM_DIR</td></tr>
<tr><td>INTK_HEAT</td><td>Output for control of input manifold electric heating</td></tr>
<tr><td>INJ_OUT1</td><td>Output to the injector 1</td></tr>
<tr><td>INJ_OUT2</td><td>Output to the injector 2</td></tr>
<tr><td>INJ_OUT3</td><td>Output to the injector 3</td></tr>
<tr><td>INJ_OUT4</td><td>Output to the injector 4</td></tr>
<tr><td>UNI_OUT1</td><td>Universal programmable output N1</td></tr>
<tr><td>UNI_OUT2</td><td>Universal programmable output N2</td></tr>
<tr><td>UNI_OUT3</td><td>Universal programmable output N3</td></tr>
</table>

Working with “Check Engine” tab

This tab contains the error codes table and is active only when there is connection to the SECU-3 unit. When there is an some error, the sign appears in the corresponding line. In the column marked “BC” the blink code of an error is shown.



This tab is designed to view and analyze the errors occurring during operation of the SECU-3 unit. When the unit is adjusted correctly, there should be no errors! If there are errors, you should get rid of them by changing the settings or the correct connection of the sensors.

The buttons **“Set All”** and **“Reset All”** are used to set or reset all errors in the table simultaneously. You can set or reset a specific error by clicking on the icon .

To read the error list recorded in the memory of the unit (which occurred at least once), you should click the button “**READ saved errors”.**

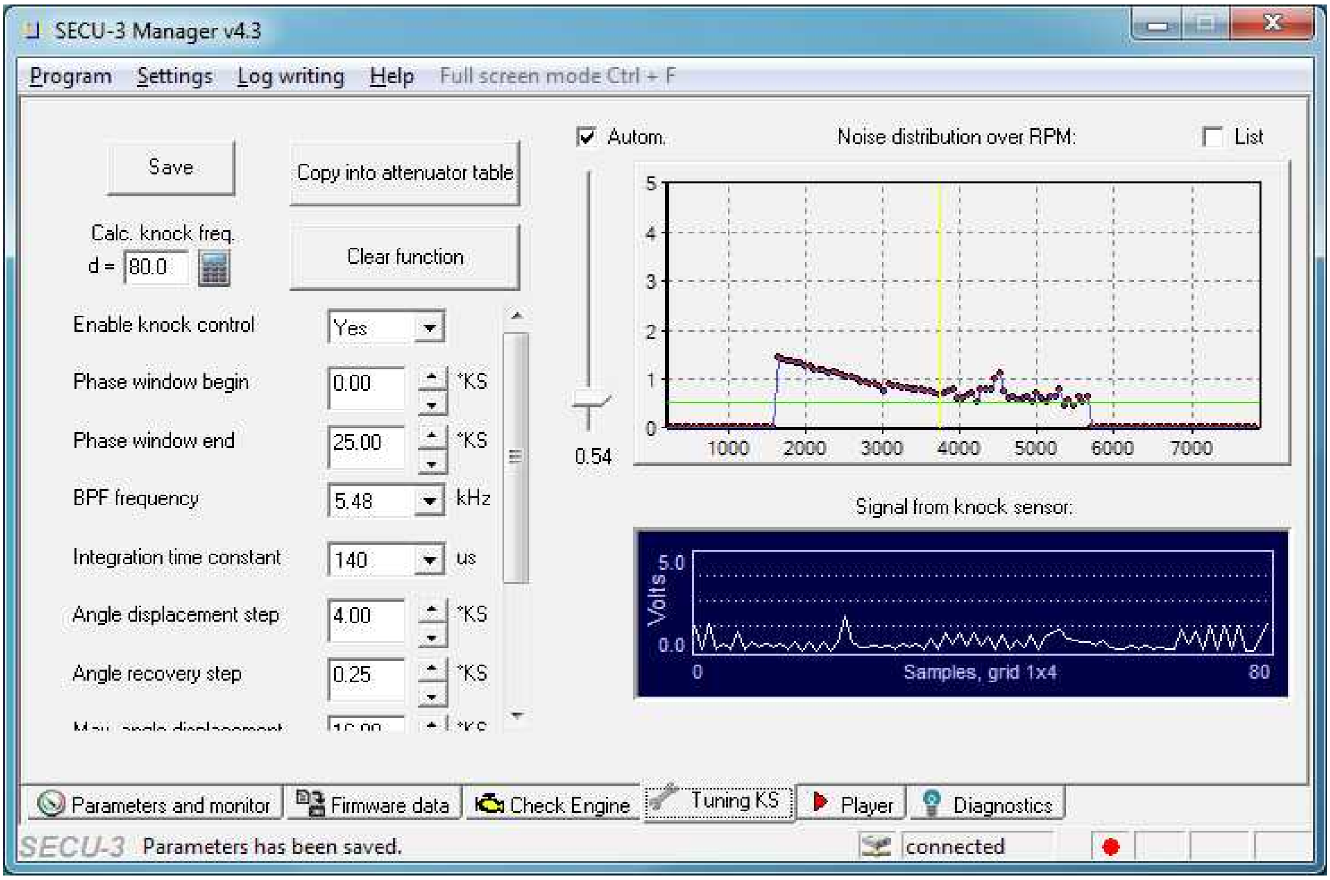
To write the error list from the table back to the unit you should use the button “**WRITE saved srrors”.**

The buttons “READ/WRITE saved errors” become active only when there is no check mark “**Read errors in realtime”.**

To see the appearing and disappearing errors in real time, the checkmark “**Read errors in realtime”** should be checked. Codes of errors will be continuously read from the SECU-3 unit and displayed in the table.

The check mark “**Show errors with inertness**” is designed to fix the display of errors for a short time, so that it is possible to notice them (for example, an error appears for a very short time and is difficult to see it). This checkbox is active only if the box “**Read errors in realtime”** is checked.

Working with "Tuning KS" tab



On this tab you can configure parameters of detonation detection and control. The configuration of detonation control should be made last (after configuring the ignition advance angle tables).

The tab window may be divided into three main sections. In the left part there are parameters that include the "Save" button and a field for entering the cylinder diameter (a rough calculation of detonation frequency). In the right half of the window there is a graph which shows the dependence of the KS signal on the engine speed. Below is an oscilloscope window which shows the signal with KS in real time (updated from right to left).

Let us review the list of parameters. This parameter list is also at the tab "**9: Knock**" in the reserve parameters.

Enable knock control – Switching on/off the detonation detection and control. By default detonation control is off ("No").

Phase window begin – Angular position of crankshaft relative to TDC where the system starts "listening to" detonation (the integration of signal from KS starts).

Phase window end - Angular position of crankshaft relative to TDC where the system stops "listening to" detonation (integration of signal from KS is completed and the result is ready for reading).

Detonation usually starts after TDC and lasts for a few tens of degrees (the value may vary depending on the number of engine cylinders, the shape of the combustion chamber etc.). Thus, these two parameters allow reducing the ingress (integration) of excess noises into the overall result when the crankshaft position makes detonation technically impossible.

BPF frequency - Value of the band-pass filter frequency through which the signal from KS passes. The aim is the extraction of a signal with the specified frequency only (ideally). The value must match the detonation frequency of your engine. The detonation frequency can be roughly calculated using the diameter of the cylinder (in a small field, slightly above the list of parameters, enter the diameter in mm and click on the calculator icon) or by spectrum analysis of the KS signal (by recording the KS signal and performing spectrum analysis).

Integration time constant – The so called integrator time constant, influences the amplitude of the signal (the integration result). The smaller is the value, the higher is the amplitude of the signal in the oscilloscope window.

Advance displacement step - Ignition advance angle retard step. Each time when detonation is detected, the ignition advance angle is reduced ("kicked back") by this value.

Angle recovery step - Ignition advance angle recovery step. When there is no detonation the ignition advance angle is increased by this value with a period equal to the delay of recovery of the ignition advance angle.

Max. angle displacement - Maximum total ignition advance angle displacement at detonation. No matter how many times in succession the detonation is detected, the correction value of ignition advance angle according to KS cannot exceed this value.

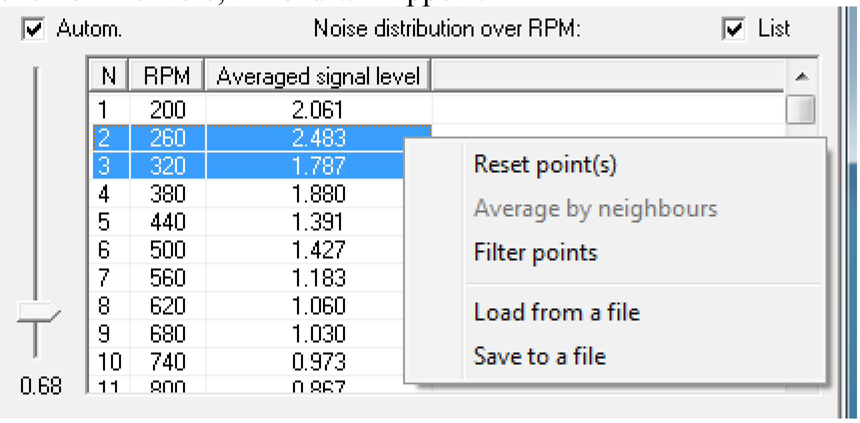
Knock threshold – Detonation threshold. If the integrator output voltage (in the oscilloscope window) exceeds this value, it is assumed that the detonation has occurred.

Angle recovery delay – Dealy of ignition advance angle recovery in engine strokes. Determines the speed of correction reduction of the ignition advance angle according to KS.

The change in the above parameters affects the system behavior in real time. To save them in the nonvolatile unit memory (EEPROM), click the "Save" button.

The graph "Noise distribution over RPM"shows the dependence of the KS signal amplitude on the engine speed with current values in parameters and in the attenuator table (see below the information about the table). The graph also shows two mutually perpendicular lines. The vertical yellow line shows the current RPM (moves left and right). The horizontal red or green line shows the so-called target KS signal level in the absence of detonation (background noise, explained below).

In the upper right corner is the checkbox "List", and when it is checked, a table appears instead of a graph. The table shows the values for all the 128 points that are displayed on the graph. If you right-click on the table, a menu will appear:



Using the menu, you can reset the selected point(s), average the point value according to the values of neighboring points, filter (smooth) points using a statistical algorithm, save the complete list of points to a file, load a previously saved list of points from a file.

To the left of the graph (table), there is a vertical scroll bar, and above it a checkbox **"Autom."**. If the checkbox is checked, then the program itself (automatically) will calculate the target value of the background noise (horizontal line on the graph). If the box is not checked, the position of the line on the graph can be set manually using the vertical scroll bar. The green color of this line means that everything is ok (the system will be able to ensure the background noise level close to a set target value using the attenuator). If the line is red, this means that the dispersion of the KS signal amplitude is too big and the gain control range of the attenuator will be not enough to maintain background noise at the level of the set target value.

The button **"Clear function"** resets all the points on the graph (resets statistics).

The button **"Copy into attenuator table"** is used to calculate the attenuator table (gain values) for normalization of the KS signal. Normalization means the dependence of the signal gain value on the RPM at which the graph of the background noise is close to the horizontal line (specifically, to a target value). The operation of this button requires the firmware at the tab **"Firmware data"** to be open and the statistics of the noise of the engine according to the RPM to be collected.

In general, the sequence of configuration steps can be divided into two stages. The first stage is the statistics collection for the attenuator table configuration and it looks as follows:

1. Using any method (octane correction, ignition timing tables) reduce the ignition advance angle by a few degrees to avoid the occurrence of detonation during configuration;

2. At the tab “Firmware data” read the firmware out of the SECU-3 unit;

3. Go to tab “Tuning KS” and enable the detonation control. It is recommended to use the check “Autom.”;

4. Set the parameters of the BPF frequency, the beginning and end of the phase window, and the integration time constant. Set the maximum value of the detonation threshold;

5. Using idling or in motion collect the statistics of background noise for the widest possible RPM range (the graph will be updated interactively). It is desirable to remove sharp peaks (you can switch to a list of values and manually remove the peaks on the graph or perform filtration);

6. After collecting the statistics of noise vs RPM, check if this statistics is within the range of 0.75 V and more. In this case it will be more accurate. If the signal level is too low, then reduce the integration time constant, clear the graph and collect statistics on RPM again.

7. If after collecting the statistics the horizontal line is red and not green, then first of all check the background noise graph (maybe it has sharp peaks). You can also try narrowing the phase window for signal selection, changing the BPF frequency or changing the integration time constant and repeat the statistics collection process.

Please note that after changing **the BPF frequency, the beginning and the end of the phase window and the integration time constant parameters,** you will have to collect the statistics of background noise (and reconstruct the attenuator table) again!

If you already have statistics on RPM, the level on the graph is not below 0.75 V and it does not run too high on the whole graph, and the automatic scroll bar to the left of the graph shows the green line, do the following:

8. Click the button “Copy into attenuator table”;

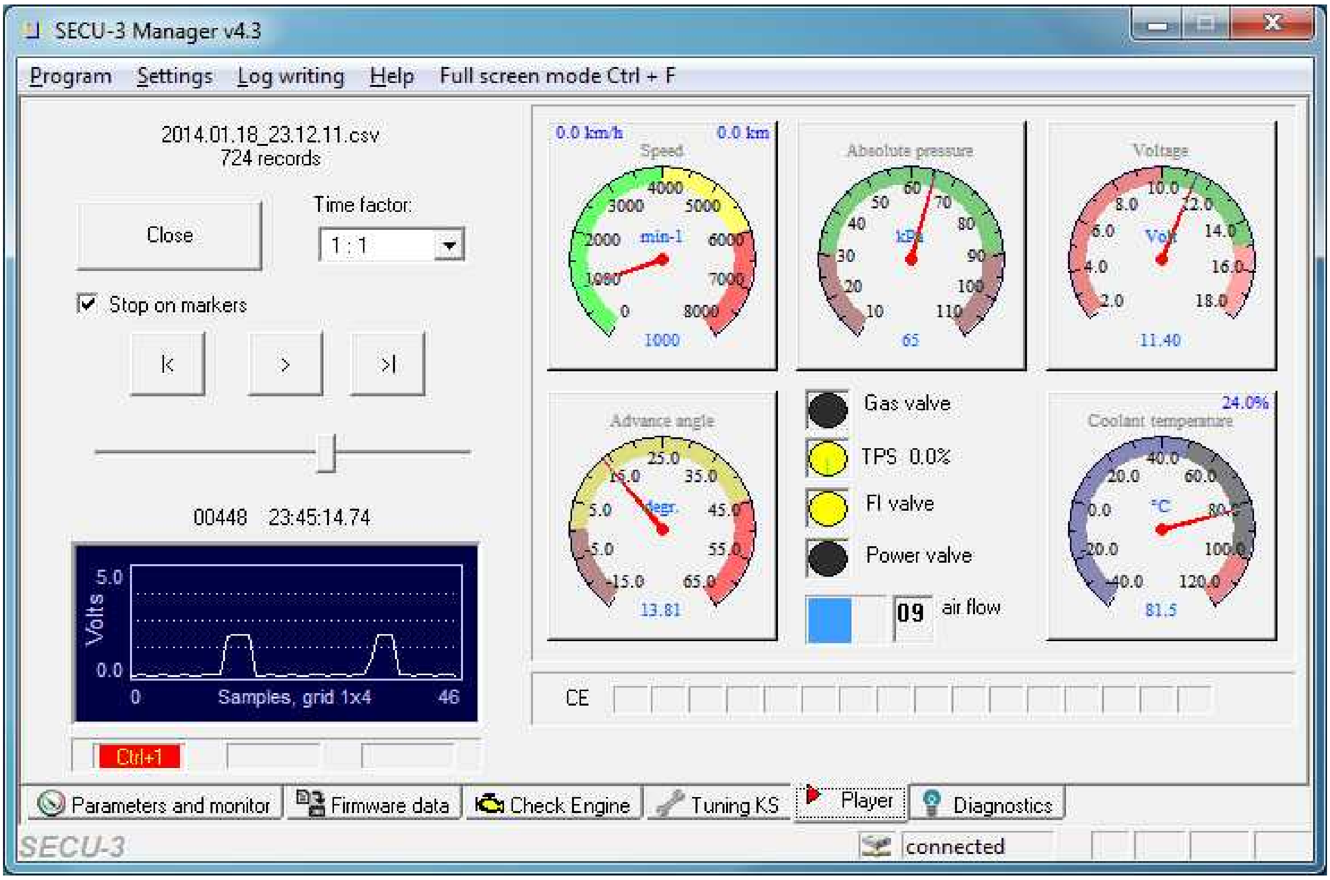
9. Go to the tab “Firmware data” and flash the unit.

The second stage is to adjust the detonation threshold and the parameters of ignition advance angle correction at detonation. After the firmware flashing is complete go back to the tab “Tuning KS”, clear the graph and re-collect the statistics on RPM, now the graph should be approximately smooth throughout the entire RPM range.

Set the value of the detonation threshold so that it is a little higher then the graph of background noise (when you get erroneous registrations of detonation, try to increase the threshold a little and vice versa). Choose the retard and recovery parameters for the ignition advance angle experimentally, you may start with default values.

You may also read about the configuration of the detonation control here: http://secu-3.org/forum/viewtopic.php?f=15&t=218

Working with "Player" tab



This tab serves to playback the previously recorded log files of the SECU-3 unit operation. It is convenient to write a unit operation log after travelling a particular section of a route to analyze later the behavior of the system as a whole. The analysis of logs not only helps in configuration of tables, but also helps to identify problems. A tab of the player window a looks like the tab "Parameters and Monitor" but instead of parameters the playback controls are displayed, and in the lower left part there is an oscilloscope window to display a KS signal and indicators of marks (markers) of the log.

To write a log, in the main menu of the program click the item **"Log writing"** → **"Begin writing"**. To stop writing – click the menu item **"Log writing"** → **"End writing"**. When writing a log, you can insert markers by pressing key combinations. There are only three kinds of markers: "red" (CTRL+1) "green" (CTRL+2) and "blue" (CTRL+3). You can insert them any number of times. With each pressing, one of the time points of the log is marked (a line in the **csv** file). Log files are saved using the path set in the Manager settings. A log file is in the text format and can be opened for analysis using any text processing program as well as imported into MS Excel.

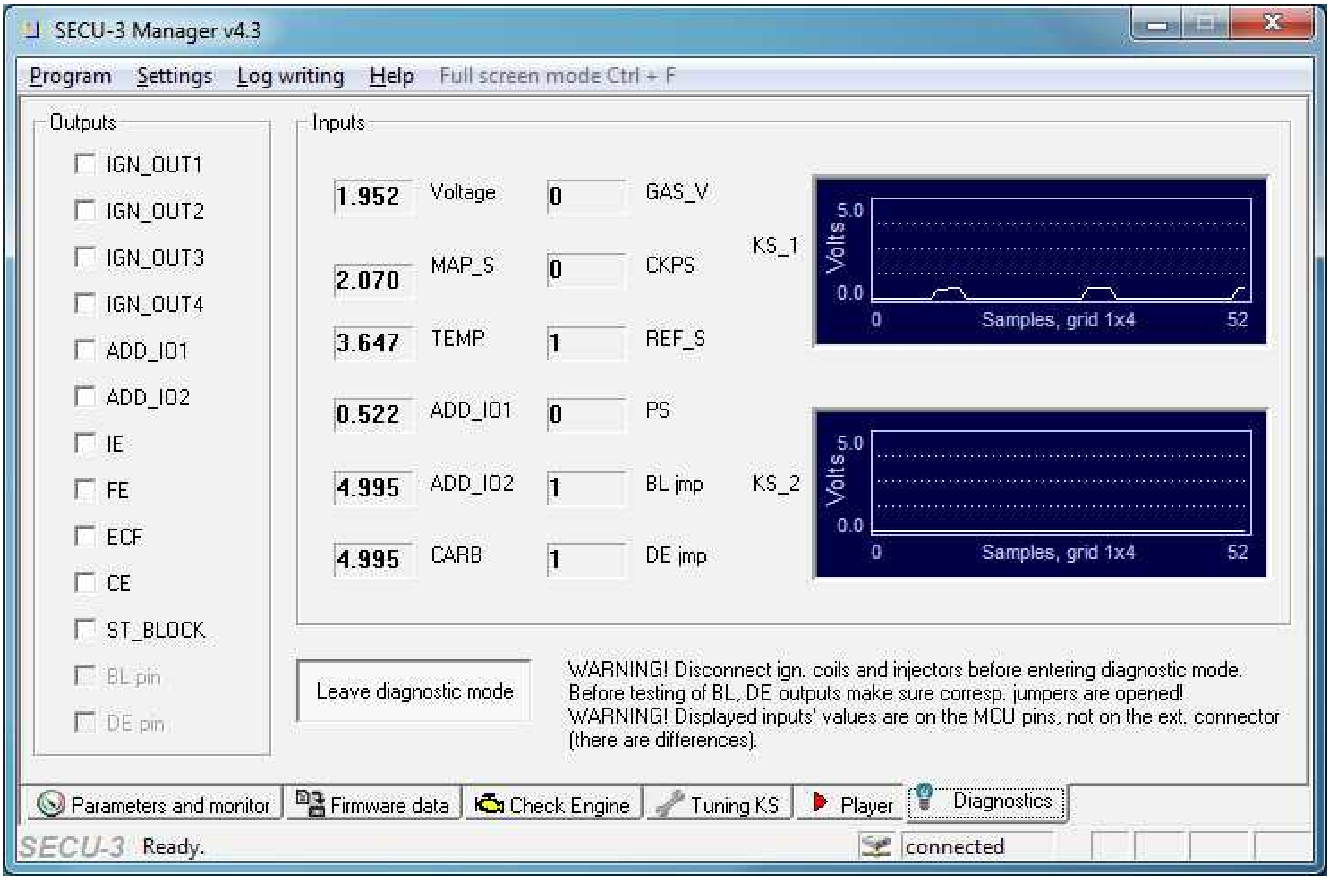
To open a file and start playing log, click a large button titled **"Open file"**.

Time factor is used for speeding up and down the log playback speed (16:1 does not necessarily mean that the record will be played 16 times as fast).

You can check the check box **"Stop on markers"**, then the playback of the log will stop automatically if there is a marker appear. Markers make it easy to mark the trouble spots in the engine operation during the test runs, which greatly simplifies your log analysis.

A horizontal scroll bar allows navigating through the log entries quickly. Above the scroll bar there are three buttons. The left button is used to move one record back, the right one accordingly to move one record forward, and the middle button starts or stops the playback.

Work with Manager Tab “Diagnostics”



This tab is designed for diagnostics of all the inputs and outputs of the SECU-3 unit and the detonation inputs. Here you can switch on/off a certain output, and also see the values of the inputs.

IMPORTANT! Disconnect the ignition coils from the ignition modules before turning to the diagnostic mode so they don't burn! Before testing BL, DE as outputs, make sure that jumpers are removed!

A tab window can be conveniently divided into three parts. In the left part there are check boxes for checking outputs (checking the box switches on the corresponding output). In the center are the status indicators of the inputs. The status of the discrete inputs is described by the values 0 or 1. Please note that the status of the inputs is displayed the way it is at the pins of the microcontroller, and not at the pins of the external connector. To the right there are two oscilloscope windows that display the signal (already processed by the HIP9011 chip) from the two inputs for KS. In this case some parameters from the tab “Tuning KS” are used.

For testing inputs and outputs you require at least basic understanding of what kinds of outputs exist (high side or low side) and what is a pull-up resistor. Not all inputs or outputs have an integral (or soldered by default) pull-up resistor. For better understanding read the installation manual and connection of the corresponding unit or see its electrical schematic diagram.

List of used acronyms

ADC – Analog-to-Digital Converter
AFR – Air-to-fuel ratio
BPF – Band-Pass Filter
BTDC – Before TDC
CE – Check Engine
CKPS – Crankshaft Position Sensor, CKP
CS – Crankshaft
CLT – Coolant Temperature (sensor), CTS
ECU – Engine Control Unit, Electronic Control Unit
EEPROM – Electrically Erasable Programmable Read-Only Memory
EGO – Exhaust Gas Oxygen (sensor), O2 Sensor, Lambda sensor

IAC – Idle Air Control (actuator)

IAT – Intake Air Temperature (sensor), ATS

ICE – Internal Combustion Engine

KS – Knock (Detonation) Sensor

LED – Light-Emitting Diode

MAP – Manifold Absolute Pressure Sensor

MPSZ – Microprocessor Ignition System, Microprocessor Ignition

NBO – Narrow-Band Oxygen (sensor)

PS – Phase Sensor, camshaft sensor, cam sensor

PW – Pulse Width (e.g. injection PW)

PWM – Pulse-Width Modulation

REF_S – Referense Sensor (e.g. using rod on the flywheel)
RPM – Revolutions per minute (min-1)
SM – Stepper Motor
TDC – Top Dead Center
TPS – Throttle Position Sensor

USB – Universal Serial Bus

VE – Volumetric Efficiency

WBO – Wide-Band Oxygen (sensor)

Description of firmware options

The following table shows the list of firmware options displayed in the list of options in the Manager's (tab “Firmware data”, the button “Opt.”).

VPSEM	The starter blocking output is used for indicating the status of idle cutoff valve
DWELL_CONTROL	For direct dwell control in the firmware
COOLINGFAN_PWM	Use PWM to control the fan RPM
REALTIME_TABLES	Enable editing tables in real time
DEBUG_VARIABLES	Enable debug mode, allowing to monitor the status of some variables in the firmware (for developers)
PHASE_SENSOR	Enable the usage of the phase I(cam) sensor
PHASED_IGNITION	Enable phased ignition (full-sequential ignition)
FUEL_PUMP	Electric fuel pump control
THERMISTOR_CS	The coolant temperature sensor of resistive type (thermistor) is used. The characteristic of the sensor is provided by the table
SECU3T	Assembly for the SECU-3T unit. Added extra functionality compared to old SECU-3
REV9_BOARD	Assembly for boards SECU-3T rev. 9 and up (rev.9, A, B, C, D)
DIAGNOSTICS	Enable hardware diagnostics support (tab “Diagnostics” will be active)
HALL_OUTPUT	Enable support for signal emulation such as from the Hall sensor
STROBOSCOPE	Enable support of embedded stroboscope function
SM_CONTROL	Enable functionality for control of choke or IAC stepper motor
VREF_5V	Use 5V reference voltage for ADC
HALL_SYNC	Use synchronization from Hall sensor instead of crankshaft position sensor
CKPS_2CHIGN	Assemble firmware with support of 2-channel ignition modules (controlled by 2 fronts). Forget it if you are not from Russia.
UART_BINARY	Use binary mode when transmitting data via UART instead of ASCII
FUEL_INJECT	Enable fuel injection control support