Crank Simulator

User's Guide

Version 1.3

15/04/2015

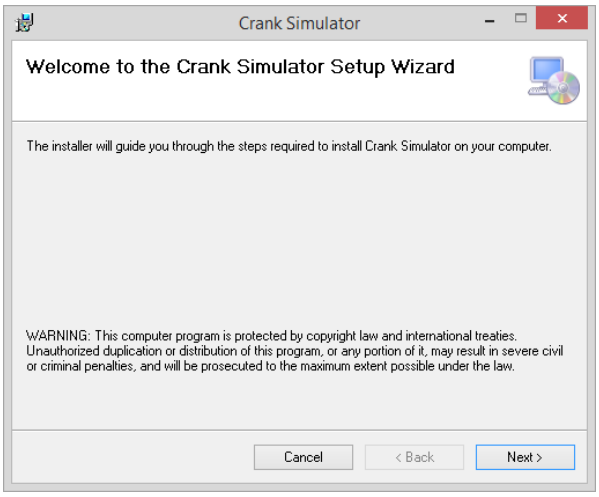
Table of content:

1 Overview

TODO

2 PC Software installation

This software has been successfully tested on Microsoft Windows 7, 8.0 and 8.1. Installation on other Windows versions has to be attempted with care.
To install the software, login as administrator or as a user having administrator permissions. Locate and run the file named *CrankSimSetup.msi*, which will launch the installation wizard. Follow the instructions until installation completes.



Crank Simulator Setup welcome message

If a previous version of the Crank Simulator is installed, it is required to uninstall the previous version (typically through Control Panel/Program and Features/) before the new version can be installed.
After successful installation, a new program shortcut called Crank Sim will appear in the Start Menu under Programs/EmTroniX/Crank sim.

3 CAN Interface Device Drivers Installation

The PC software communicates with the simulator box using the CAN bus (the Ethernet and USB connectors present on the box are for the time being not operative)

The simulator box can receive commands from a CAN interface of any brand, but the PC software was designed to work solely with a PCAN-USB driver of manufacturer Peak-System which can be purchased at http://www.peak-system.com.

The driver's references can be found here: http://www.peak-system.com/PCAN-USB.199.0.html?&L=1

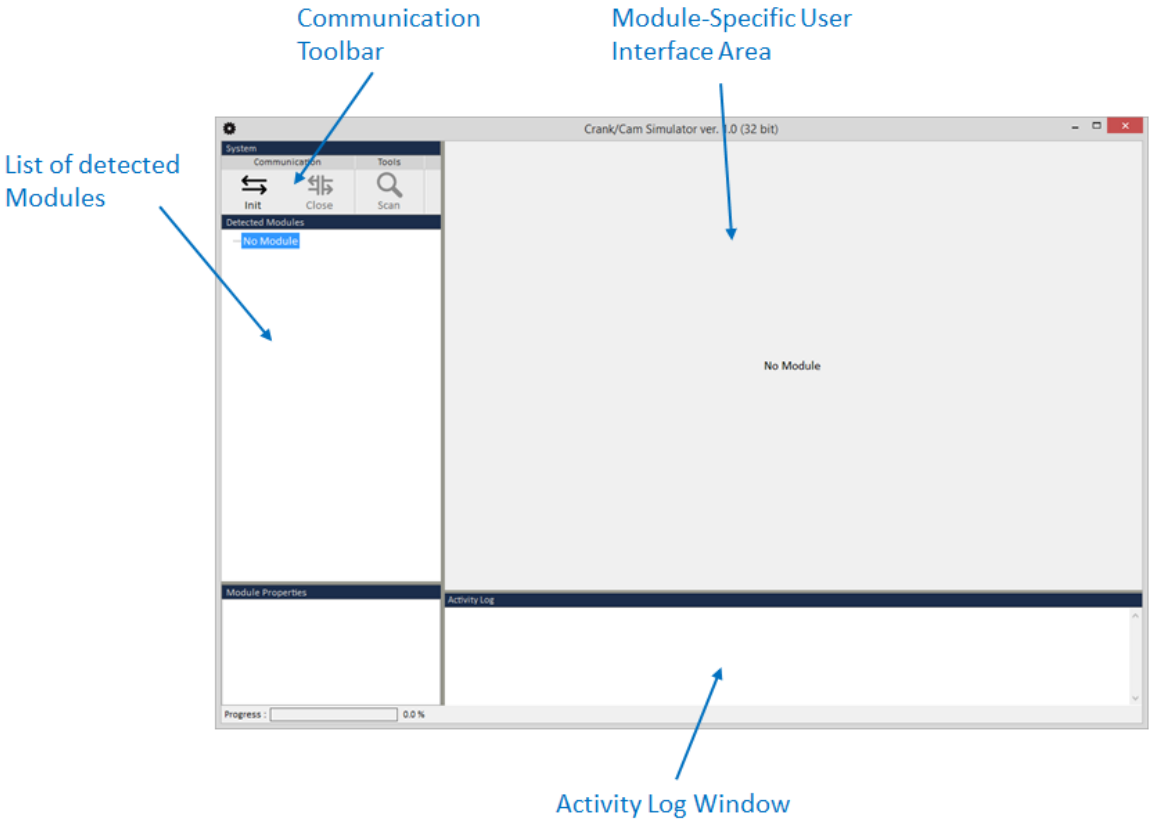
The Peak-CAN USB drivers have to be installed on the host computer before any attempt can be made to communicate with the simulator box.

The PCAN USB drivers can be downloaded here: http://www.peak-system.com/Support.55.0.html?&L=1

4 User interface

4.1 Establishing communication with the Crank Simulator

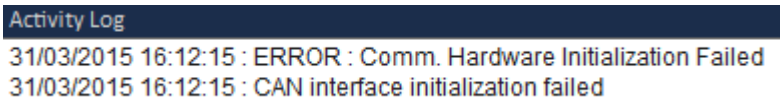
If the PC software and CAN Drivers have been installed successfully, when launching the Crank Simulator application, the following window should appear:



Main window

The first step to initiate a communication with one or more simulator boxes is to start the CAN Interface. Use the "INIT" button located in the communication toolbar to attempt to initialize the CAN Interface. If the device drivers for the CAN interface we properly installed and the interface is plugged-in, the following message should appear in the activity log window:

The "INIT" would then become disabled and the "CLOSE" and "SCAN" button become enabled. The following message would appear if the CAN interface was not properly plugged-in or if there was a problem with the CAN device drivers:



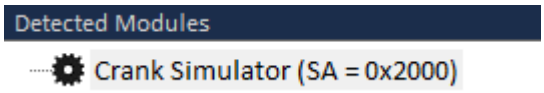
Use the "CLOSE" button to terminate the CAN communication and release access to the CAN Driver.

Once the CAN interface has been initiated successfully, press the "SCAN" button. By doing so, the PC software sends out a broadcast CAN connection message with will be received and answered by all the Crank Simulator modules present on the CAN bus.

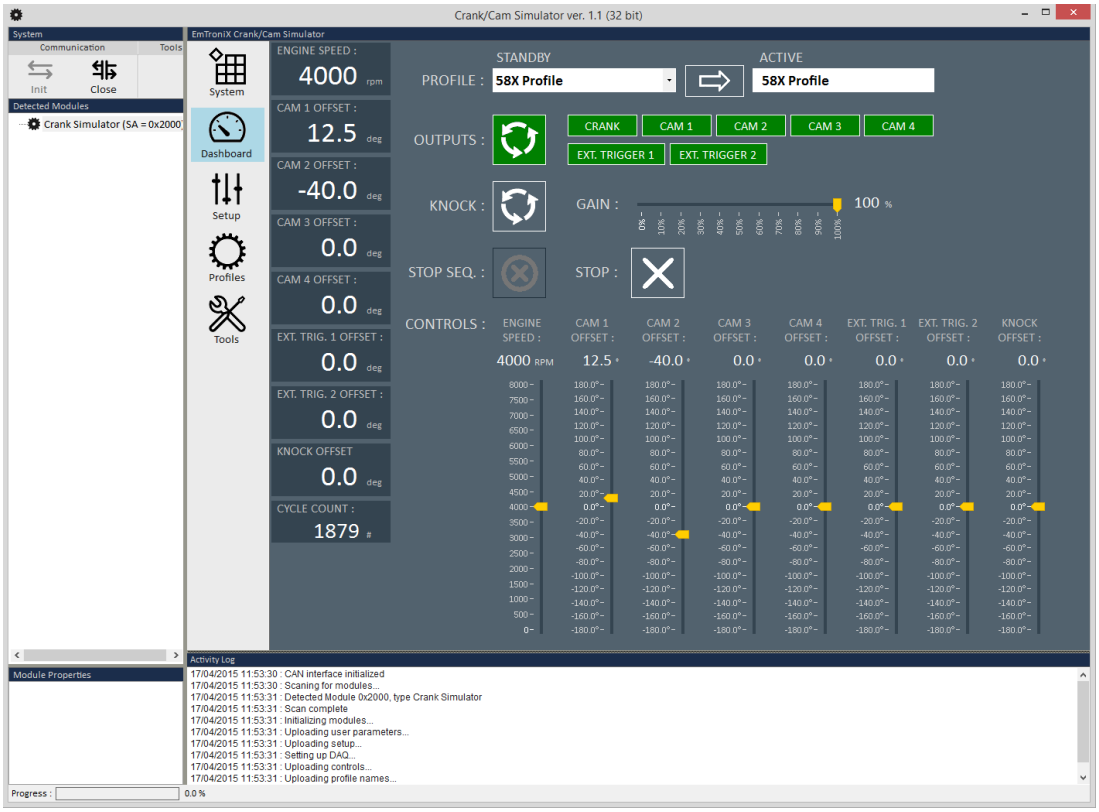
WARNING: this version of the PC software is not able to handle communication with more than one module at a time. Therefore, please make sure only one Crank Simulator is connected to the CAN bus when using the PC software to avoid unpredictable behaviors.

WARNING: the crank simulator box doesn't filter incoming CAN messages, so installation on a heavily loaded CAN bus (such as vehicle or engine bus) should be prevented to avoid unnecessarily high communication handling load for the CPU (which could affect the software operation).

If the communication is set-up properly and at least one module is powered and ready on the CAN bus, a new reference to this module will appear in the detected modules list:

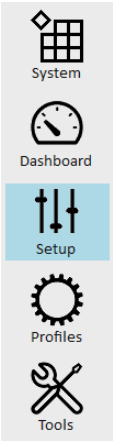


And the crank simulator user-interface will show-up in the module area:



4.2 Crank Simulator GUI overall description

The crank simulator GUI is made of a series of five panels having each specific functions:



SYSTEM Panel: Contains general system parameters which can be modified by the user.

DASHBOARD Panel: Allows the user to visualize and modify all the control parameters of the simulator

SETUP panel: Allows the user to modify all the calibration/setup parameters of the system

PROFILES panel: Allows the user to edit the wheels, analog crank and knock profiles.

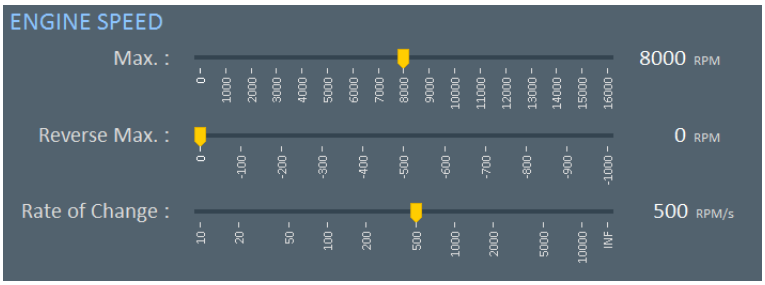
TOOLS panel: Contains accessory system tools.

4.3 Setup Panel description

The panel contains all the system calibration/setup parameters which are stored in the non-volatile memory of the simulator box and are re-called at each power up. Limitations defined in the setup (Max. Engine Speed, Min./Max. offsets, …) always apply regardless of the command source (Interface Knob, PC software dashboard or CAN command).

The setup panel is made of a series of eleven sub-panels containing each all the parameters related to a specific aspect of the system.

a. <u>ENGINE SPEED Sub-panel</u>

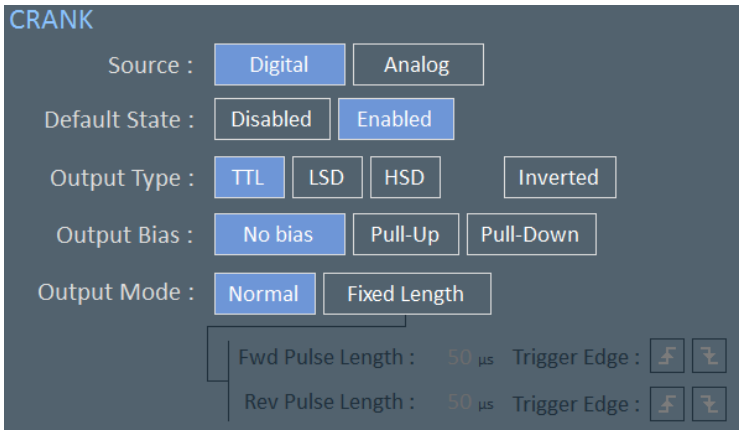


This sub-panel contains the following calibration parameters:

- **Maximum Engine Speed**: Max. value of the engine speed which can be commanded (in RPM) in the regular direction
- **Maximum Reverse Engine Speed**: Max. negative value of the engine speed which can be commanded (in RPM) in the reverse direction
- **Engine Speed Rate of Change** : Rate at which the engine speed changes from one set point to another (in RPM/seconds)

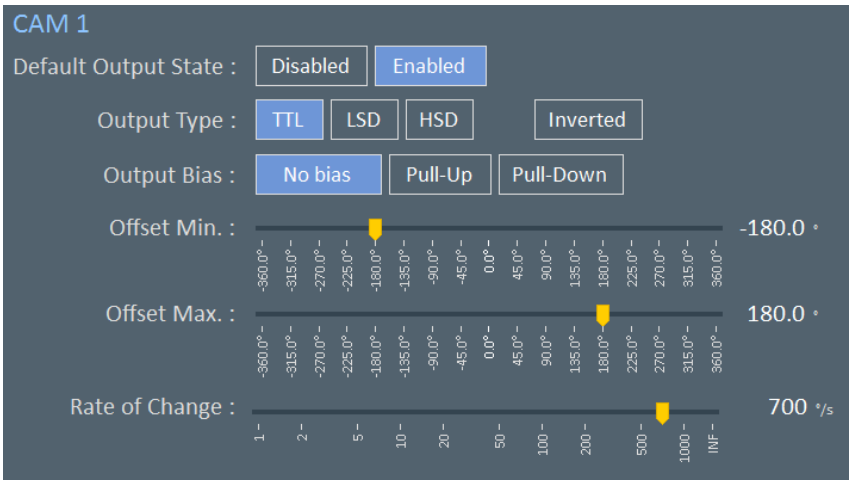
b. CRANK Sub-panel

This panel contains all the parameters related to the Crank output.



- **Crank Source**: The cranks signal can come either from the digital pattern generator (the output is then the Crank signal of the selected Profile) or from the analog crank generator (which must be defined in the Analog Crank Sub-Panel of the Profiles Panel)
- **Default State**: On/Off state applied to the crank output at start-up
- **Output Type/Output Bias** : Crank output driver configuration (TODO: describe each param)
- **Output Mode**: Normal or Fixed Length mode selection.

c. CAM 1/CAM 2/ CAM 3/ CAM 4/ EXT. TRIGGER 1 Sub-panel

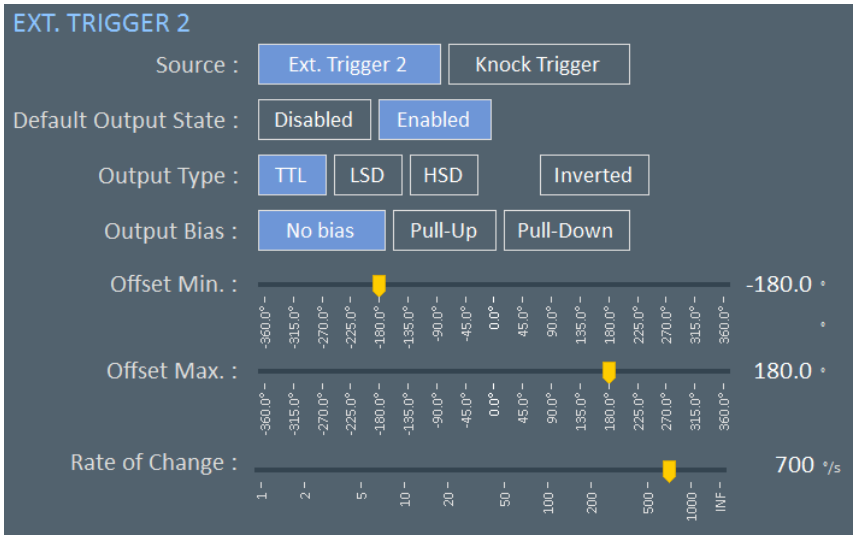


Sub-panels CAM 1, CAM 2, CAM 3, CAM 4 and EXT TRIGGER 1 contain identical parameters related to their respective outputs. These parameters are:

- **Default State**: On/Off state applied to the selected output at start-up

- **Output Type/Output Bias** : Crank output driver configuration (TODO: describe each param)
- **Offset Min. :** Min. value of the offset which can be commended for this output
- **Offset Zero :** Not used
- **Offset Max. :** Max. value of the offset which can be commended for this output
- **Offset Rate of Change** : Rate at which the offset changes from one set point to another (in RPM/seconds)

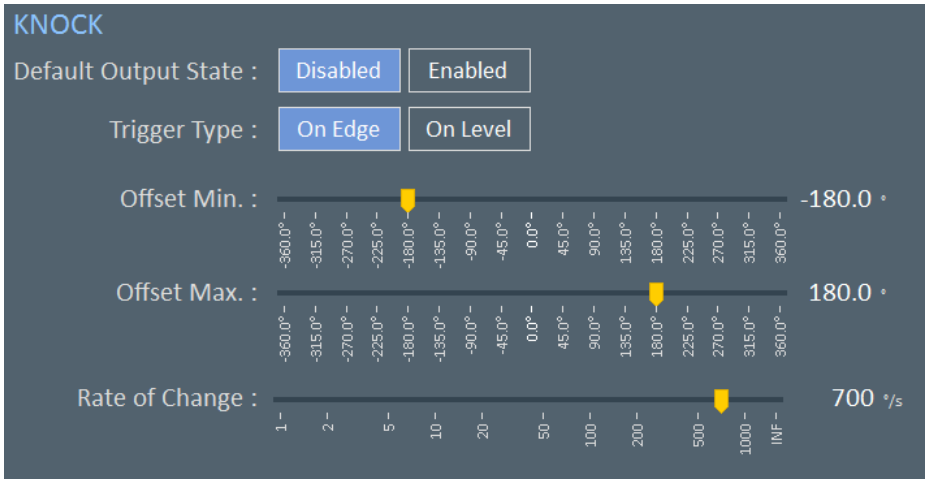
d. EXT. TRIGGER 2 Sub-panel



Sub-panel EXT TRIGGER 2 contains an additional parameter compared to the previous ones:

- **Source :** Select if the ext. trigger 2 output will generate the ext. trigger 2 signal or the knock trigger signal defined in the selected profile
- **Default State**: On/Off state applied to the selected output at start-up
- **Output Type/Output Bias** : Crank output driver configuration (TODO: describe each param)
- **Offset Min. :** Min. value of the offset which can be commended for this output
- **Offset Zero :** Not used
- **Offset Max. :** Max. value of the offset which can be commended for this output
- **Offset Rate of Change** : Rate at which the offset changes from one set point to another (in RPM/seconds)

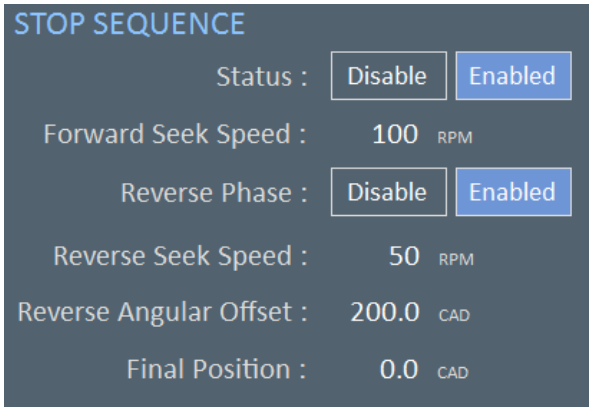
e. KNOCK TRIGGER Sub-panel



Sub-panels KNOCK TRIGGER contains the following parameters:

- **Default State**: On/Off state applied to the selected output at start-up
- **Trigger Type**: To select if the knock signal has to be launched when a rising edge is detected on the knock profile element (the knock signal will then be generated entirely), or if the knock signal should be generated (starting always from zero) when the level of the knock profile element is high. In this later case, the knock signal will be generated as long as the level stays high (returning to zero when the end is reached).
- **Offset Min. :** Min. value of the offset which can be commended for this output
- **Offset Zero :** Not used
- **Offset Max. :** Max. value of the offset which can be commended for this output
- **Offset Rate of Change** : Rate at which the offset changes from one set point to another (in RPM/seconds)

f. STOP SEQUENCE Sub-panel



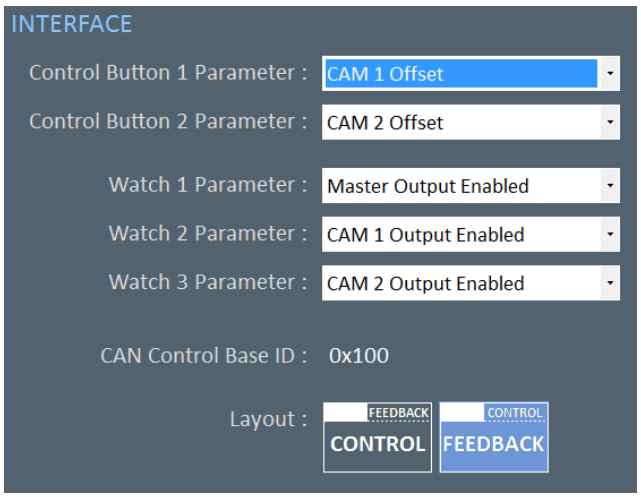
This sub-panel contains all the parameters related to the stop sequence:

- **Status**: Enable/disable state of the stop sequence
- **Forward seek speed:** Speed at which it will start seeking for the final or reverse (= final – reverse angular offset) position.
- **Reverse Phase:** Enable/disable state of the reverse phase.
- **Reverse seek speed :** Speed at which it will start seeking for the final position in the reverse direction (if reverse phase enabled)
- **Final position**: Angular position where the speed will be set to zero.

g. INTERFACE Sub-panel

This sub-panel contains all the parameters related to the setup of the physical interface.

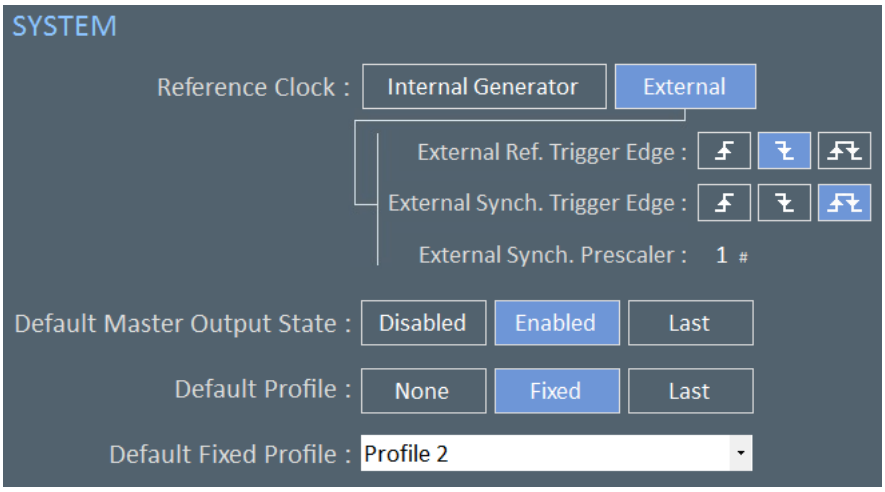
The user can select from a list of predefined parameters, which ones he wants to assign to the two control knobs of the physical interface. The user can further select three of these parameters as watches displayed on the interface's LCD screen.



- **Control Button 1/2 parameter :** Control parameter assigned to the control button 1 or 2
- **Watch 1/2/3 parameter :** Parameter (for display only) assigned to watches 1, 2 or 3
- **CAN Control Base ID :** Lower CAN message ID of the CAN Commands (see CAN Commands Description)
- **Layout :** The user can select to have either the control parameter or the feedback parameter displayed in large characters in the interface.

h. SYSTEM Sub-panel

This sub-panel contains some general system parameters.



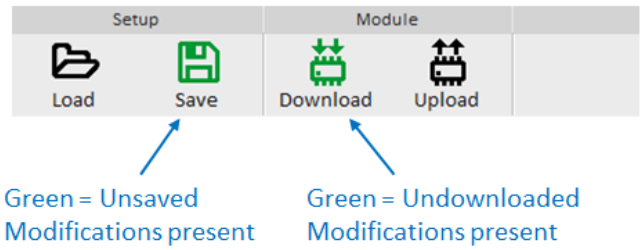
- **Reference clock**: The simulator box can use either its internal system clock to generate the output signals, or a combination of an external reference and a synchro. signal to trigger the output signals generation.

  The following parameters have to adjusted when the external reference clock option is selected:

  - **External Ref. Trigger Edge**: The generator increases the virtual engine angle by 0.1 deg. each time an electric edge is detected at the external reference input. This option allows selection of the edge type to be considered (Rising, Falling or Both) and the reference signal.
  - **External Synch. Trigger Edge:** A second synchronization input can be used to indicate the position of the virtual angle zero (once or periodically). This option allows selection of the edge type to be considered (Rising, Falling or Both) on the synchronization signal
  - **External Synch. Prescaler**: this parameter should be used to set the synchro. edge counter division factor (0 to 16). If the value set is none zero, the simulator needs to see at least one edge of the selected type before the output signals are generated (for signal consistency reasons). Furthermore, after an idle period of more than 4 seconds, the synchronization is considered lost and a new edge has to be detected again before output signals generation is re-enabled. If the value is set to zero, the synchronization function is disabled.

- **Default Master Output State:** This options controls the start-up state of the master output :
  - Disabled: the master output is set to disables at startup
  - Enabled: the master output is set to enabled at startup
  - Last : the last master output state selected during the previous session is recalled at startup
- **Default Profile:** This options controls the profile automatically selected at startup :
  - None: no profile is selected at startup, the user has to selected a profile manually
  - Fixed: the profile indicated in the default profile drop-box is automatically selected at startup, regardless of the profile selected during the last session.
  - Last : the last profile selected during the previous session is recalled at startup

NOTE: Value changes made to the setup parameters will remain ineffective and local to the PC until they are downloaded and applied to the simulator box. This is done by pressing the download button in the setup panel toolbar. The download button will remain highlighted as long as modified setup parameters haven't been downloaded to remind the user to do so.

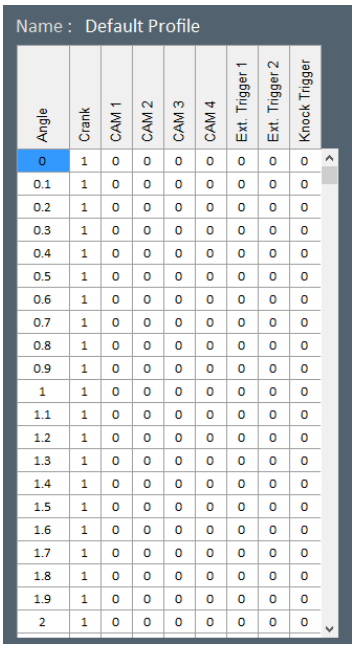


4.4 Profiles Panel description

The panel contains a series of sub-panels describing the eight wheel profiles, the analog crank and the knock shapes.

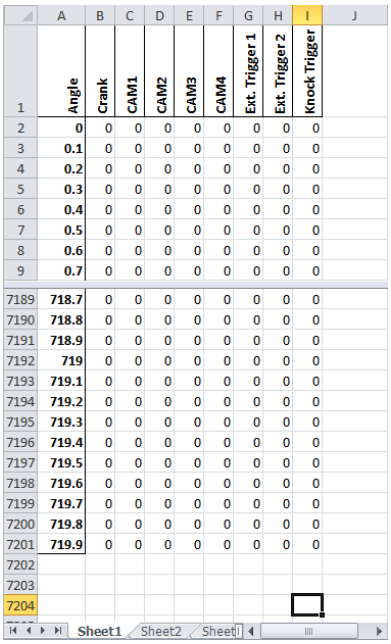
a. Profile 1/2/3/4/5/6/7/ 8 Sub-panel

This sub panels contain a description of the corresponding wheel profiles in a tabular format (from angle 0 to 719.9 per steps of 0.1 degree) with a binary representation of each element of the profile (CAM1, 2, 3, 4, Ext Trigger 1, 2, Knock Trigger) per column.



Name : Default Profile

Angle	Crank	CAM 1	CAM 2	CAM 3	CAM 4	Ext. Trigger 1	Ext. Trigger 2	Knock Trigger
0	1	0	0	0	0	0	0	0
0.1	1	0	0	0	0	0	0	0
0.2	1	0	0	0	0	0	0	0
0.3	1	0	0	0	0	0	0	0
0.4	1	0	0	0	0	0	0	0
0.5	1	0	0	0	0	0	0	0
0.6	1	0	0	0	0	0	0	0
0.7	1	0	0	0	0	0	0	0
0.8	1	0	0	0	0	0	0	0
0.9	1	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0
1.1	1	0	0	0	0	0	0	0
1.2	1	0	0	0	0	0	0	0
1.3	1	0	0	0	0	0	0	0
1.4	1	0	0	0	0	0	0	0
1.5	1	0	0	0	0	0	0	0
1.6	1	0	0	0	0	0	0	0
1.7	1	0	0	0	0	0	0	0
1.8	1	0	0	0	0	0	0	0
1.9	1	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0



	A	B	C	D	E	F	G	H	I
1	Angle	Crank	CAM1	CAM2	CAM3	CAM4	Ext. Trigger 1	Ext. Trigger 2	Knock Trigger
2	0	0	0	0	0	0	0	0	0
3	0.1	0	0	0	0	0	0	0	0
4	0.2	0	0	0	0	0	0	0	0
5	0.3	0	0	0	0	0	0	0	0
6	0.4	0	0	0	0	0	0	0	0
7	0.5	0	0	0	0	0	0	0	0
8	0.6	0	0	0	0	0	0	0	0
9	0.7	0	0	0	0	0	0	0	0
7189	718.7	0	0	0	0	0	0	0	0
7190	718.8	0	0	0	0	0	0	0	0
7191	718.9	0	0	0	0	0	0	0	0
7192	719	0	0	0	0	0	0	0	0
7193	719.1	0	0	0	0	0	0	0	0
7194	719.2	0	0	0	0	0	0	0	0
7195	719.3	0	0	0	0	0	0	0	0
7196	719.4	0	0	0	0	0	0	0	0
7197	719.5	0	0	0	0	0	0	0	0
7198	719.6	0	0	0	0	0	0	0	0
7199	719.7	0	0	0	0	0	0	0	0
7200	719.8	0	0	0	0	0	0	0	0
7201	719.9	0	0	0	0	0	0	0	0
7202									
7203									
7204									

Sheet1 Sheet2 Sheet3

Profiles can be uploaded automatically from the simulator box when a connection is established if the appropriate option has been enabled from the System Panel ("Upload Wheel Profiles at Startup" option). If this option is not selected, the user has to manually upload the profile from the simulator box to allow edition.

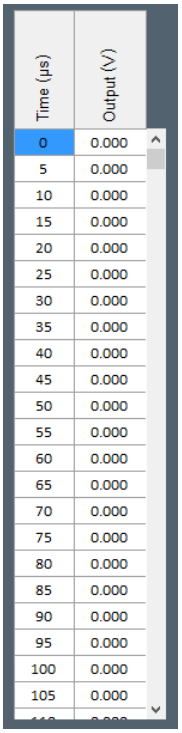
Profiles can be edited manually by modifying the values directly into the table. They can be saved to and loaded from a file, or imported from an Excel document.

Excel documents which can be used as import for profiles need to have a specific format. A profile template file is therefore provided with the PC Software and can be found in :

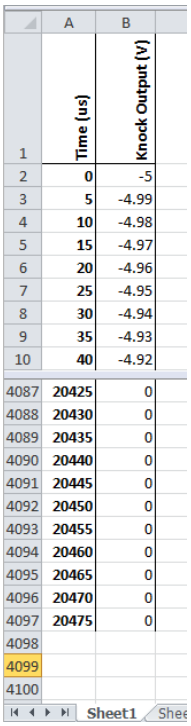
/Program Files (x86)/EmTroniX/Crank Simulator/Templates

b. Knock Sub-panel

This sub panels contain a description of the knock signal shape in a tabular format (from 0 to 20475 us by steps of 5us) with the corresponding output voltage in the second column.



Time (µs)	Output (V)
0	0.000
5	0.000
10	0.000
15	0.000
20	0.000
25	0.000
30	0.000
35	0.000
40	0.000
45	0.000
50	0.000
55	0.000
60	0.000
65	0.000
70	0.000
75	0.000
80	0.000
85	0.000
90	0.000
95	0.000
100	0.000
105	0.000



	A	B
1	Time (us)	Knock Output (V)
2	0	-5
3	5	-4.99
4	10	-4.98
5	15	-4.97
6	20	-4.96
7	25	-4.95
8	30	-4.94
9	35	-4.93
10	40	-4.92
4087	20425	0
4088	20430	0
4089	20435	0
4090	20440	0
4091	20445	0
4092	20450	0
4093	20455	0
4094	20460	0
4095	20465	0
4096	20470	0
4097	20475	0
4098		
4099		
4100		

Sheet1 Shee

The knock signal shape can be uploaded automatically from the simulator box when a connection is established if the appropriate option has been enabled from the System Panel ("Upload Knock Profile at Startup" option). If this option is not selected, the user has to manually upload the knock shape from the simulator box to allow edition.

Knock shapes can be edited manually by modifying the voltage values directly into the table. They can be saved to and loaded from a file, or imported from an Excel document.

Excel documents which can be used as import for knock shapes need to have a specific format. A profile template file is therefore provided with the PC Software and can be found in:

/Program Files (x86)/EmTroniX/Crank Simulator/Templates

c. Analog Crank Sub-panel

This sub panels contain a description of the Analog Crank signal shape in a tabular format (from 0 to 719.9 by steps of 0.1 degree) with the corresponding output voltage per 0.1 degree in the second column.

Time (µs)	Output (V)
0	0.000
0.1	0.000
0.2	0.000
0.3	0.000
0.4	0.000
0.5	0.000
0.6	0.000
0.7	0.000
0.8	0.000
0.9	0.000
1	0.000
1.1	0.000
1.2	0.000
1.3	0.000
1.4	0.000
1.5	0.000
1.6	0.000
1.7	0.000
1.8	0.000
1.9	0.000
2	0.000
2.1	0.000

	A	B
1	Angle	Analog Crank (V)
2	0	0
3	0.1	0.02618
4	0.2	0.05236
5	0.3	0.07854
6	0.4	0.10472
7	0.5	0.1309
8	0.6	0.15708
9	0.7	0.18326
10	0.8	0.20943
11	0.9	0.23561
12	1	0.26179
7193	719.1	-0.23561
7194	719.2	-0.20943
7195	719.3	-0.18326
7196	719.4	-0.15708
7197	719.5	-0.1309
7198	719.6	-0.10472
7199	719.7	-0.07854
7200	719.8	-0.05236
7201	719.9	-0.02618
7202		
7203		
7204		

Sheet1 She

The analog crank signal shape can be uploaded automatically from the simulator box when a connection is established if the appropriate option has been enabled from the System Panel ("Upload Analog Crank Profile at Startup" option). If this option is not selected, the user has to manually upload the analog crank shape from the simulator box to allow edition.

Analog crank shapes can be edited manually by modifying the voltage values directly into the table. They can be saved to and loaded from a file, or imported from an Excel document.

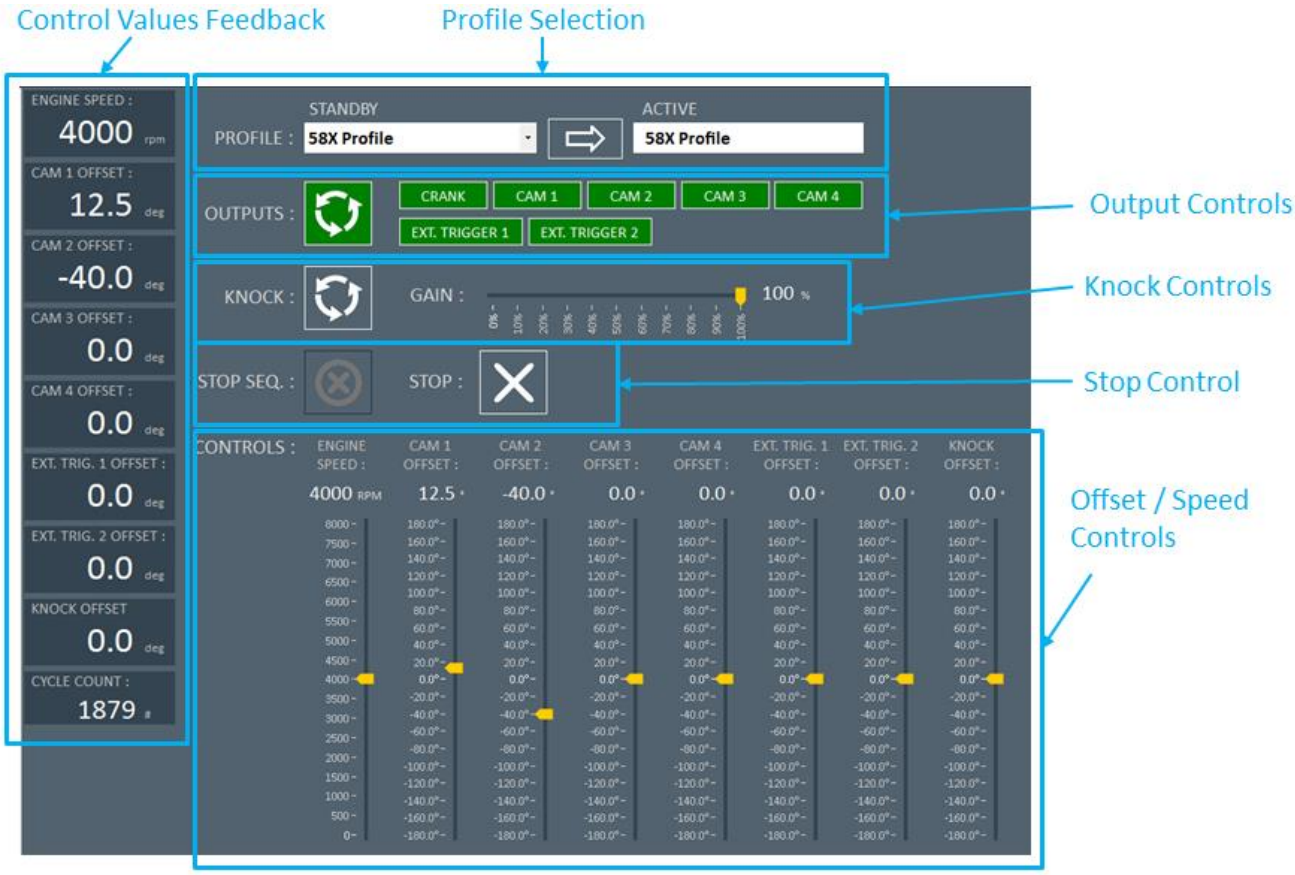
Excel documents which can be used as import for analog crank shapes need to have a specific format. A profile template file is therefore provided with the PC Software and can be found in:

/Program Files (x86)/EmTroniX/Crank Simulator/Templates

NOTE: Value changes made to the Profile will remain ineffective and local to the PC until they are downloaded and applied to the simulator box. This is done by pressing the download button in the corresponding sub-panel toolbar. The download button will remain highlighted as long as modified profiles data haven't been downloaded to remind the user to do so.

4.5 Dashboard Panel description

The panel contains visual displays of the feedback values of the important system control parameters. It also allows the user to modify these control parameters.



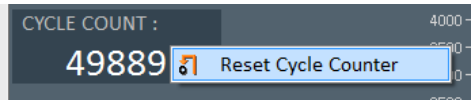
a. <u>Control Values Feedback</u>

On the left side of the panel is a series of displays showing the value of the control parameters which are effectively applied inside the crank simulator box (Control Values Feedback). The values are periodically streamed by the module at a rate of 150 ms.

As control command can come from different sources (CAN command, PC software or Interface Knobs), the feedback value might not always be those commanded by the user in the PC software.

WARNING: the data streaming is initiated by the PC software when the crank simulator is detected at the end of the Scanning procedure. If for some reason the power to the crank simulator was turned off and on, data streaming would be inhibited and feedback values thereby frozen without warning to the user. A new Scan procedure has then to be launched to re-initialize the data streaming process.

The cycle count can be reset by right-clicking on the cycle-count panel and select "Reset cycle count" menu item.



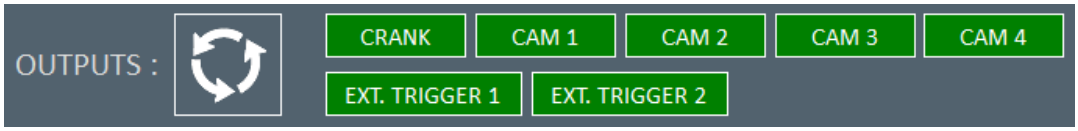
b. Active Profile Selection

At the top of the panel is located a profile drop-down box containing the list of the eight profiles defined and a text box indicating which is the current active profile (the symbol "-----" indicates that no profile has yet been selected)

To activate a new profile, the user has to select it from the profile list and press the white arrow button located to the right to make it become the active profile.

The active profile indicator always shows the name of the profile which is effectively used inside the simulator box (this information is part of the streamed data)

c. Output Controls



The individual output state (enabled/disabled) of the Crank, CAM 1, 2, 3, 4, Ext. Trigger 1 and 2 are indicated by the state of the corresponding buttons in the outputs control area. The large button to the left is the master output state button (state overriding all the individual output states)

These states are periodically streamed by the simulator box and indicate the effective state of these outputs inside the box. They can be controlled by the user by pressing on the corresponding button.

d. Knock Controls

The gain of the analog knock output can be adjusted by the user using the slider located in the knock control area. The position of the slider does not reflect the effective knock gain used by the simulator box. The large button to the left is the knock output state button, which is periodically updated to indicate the effective state of the knock output state used by the simulator box.

e. Stop Control

The stop control area contains two buttons: the left one which can be used to activate or deactivate the stop sequence. This button is disabled if the stop sequence is disabled in the system setup. The state of the stop sequence is periodically streamed by the simulator box. The state of the button thereby reflects the stop sequence state effectively used by the simulator box.

WARNING: as long as the stop sequence is active, no speed command will be accepted by the simulator box.

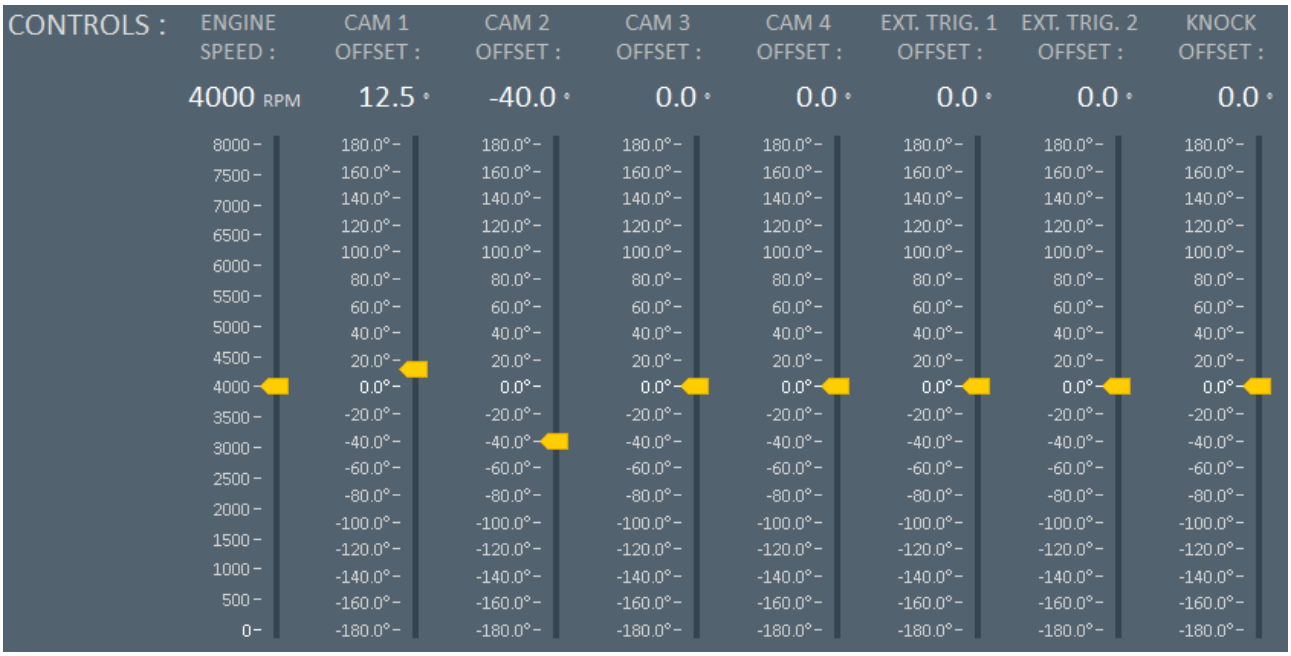

Disabled


Enabled


Active

The second button should be used to stop the simulator with immediate action (no engine speed rate of change is applied)

f. Engine Speed/ Output Offset controls



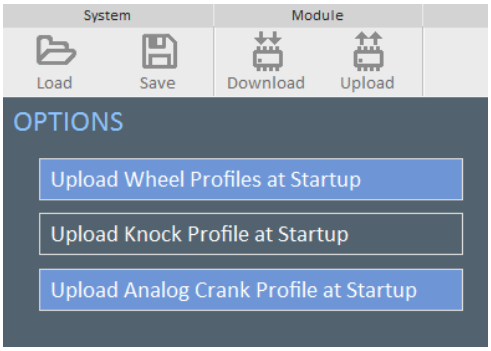
A series of eight sliders can be found in the controls area. The range of these sliders is automatically adjusted to reflect the min./max. range defined in the system setup for a given parameter. The Engine Speed, CAM 1, 2, 3, 4, Ext. Trigger 1, 2 and Knock offset can be adjusted either by moving the slider to the desired values or by entering the value in the edit box located right above the corresponding slider.

The positions of the sliders do not reflect the effective values used by the simulator box, they are only used to issue commands to the box. Effective values are indicated in the corresponding display feedback area.

4.6 System Panel description

The system panel contains for the time being only a few user options which are stored in non-volatile memory of the simulator box.

- **"Upload Wheel Profiles at Startup"** : Option to select if all eight wheel profiles should be uploaded automatically from the simulator box when a connection is established
- **"Upload Knock Profile at Startup"** : Option to select if all Knock Profile should be uploaded automatically from the simulator box when a connection is established
- **"Upload Analog Crank Profile at Startup"** : Option to select if the analog crank profile should be uploaded automatically from the simulator box when a connection is established



The options were added to reduce the time taken to connect to the crank simulator as these different profile uploads can be quite time consuming.

WARNING: the toolbar buttons present in this panel were designed to be used to load/save/upload and download entire system configurations (setup, profiles, …). These buttons are however disabled in this version of the software as these features are not implemented yet.

4.7 Tools Panel description

The tools panel contains two buttons:

- **Flash New Firmware**: tool to be use to reprogram the crank simulator processor software. The tool will prompt for an .elf file containing the processor executable code which needs to be provided by the user.
- **Flash New FPGA Code**: tool to be use to reprogram the crank simulator FPGA code. The tool will prompt fort a .bin file containing the FPGA code which needs to be provided by the user.

WARNING: make sure the system is in safe conditions before starting the programming procedure. Main power supply to the simulator box should not be turned off and the communication not interrupted while programming is in progress.

5 CAN Commands Description

The following CAN bus parameters should be used to communicate with the Crank Simulator:

Baud rate: **250 Kb**
CAN ID Length: **Normal (11bit)**
Message length: **Always 8 bytes**

The module's main CPU has a CAN reception FIFO of 64 messages. It is however recommended to avoid sending command messages at a rate higher than 100 per second to avoid overloading the CPU with communication handling tasks.

The command type depends on the CAN message ID as follow:

Command	Message ID
SET TARGET ENGINE SPEED	Base + 0
SET OUTPUT OFFSET AND STATE	Base + 1
SET KNOCK GAIN	Base + 2
SELECT PROFILE	Base + 3
ENABLE STOP SEQUENCE	Base + 4
ENABLE MASTER OUTPUT	Base + 5
SET ENGINE SPEED ROC	Base + 6
SET STOP SEQ PARAMS	Base + 7
EDIT PROFILE	Base + 8
TEST PROFILE CONTROL	Base + 9
DATA STREAMING CONTROL	Base + 10

The base message ID has to be adjusted using the PC Software (default 0x100) in the *Setup panel-> Interface*. Multiple modules located on a single CAN bus should each have a unique base ID so they can be individually addressed.

5.1 Command: SET TARGET ENGINE SPEED

FUNCTION: To control the simulated engine speed.

Command parameter(s):

Data	Type	Description
Target Engine Speed	S16	Target engine speed in RPM

Command message format :

	Value
ID	**Base + 0**
B0	**Target Engine Speed MSB**
B1	**Target Engine Speed LSB**
B2..B7	**Not Used**

Even if an engine speed ranging from -32768 to +32767 RPM can theoretically be commanded, the controller will limit the engine to the min./max. range defined in the system setup. The engine speed will increase at a rate as defined in the system setup.

No answer will be sent by the module to this command

Example: Base ID set to 256 (=0x100) in the system setup. To engine request an engine speed of 2000 (=0x7D0) RPM, the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x100	**8**	**0x07**	**0xD0**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**

XX = don't care

5.2 Command: SET OUTPUT OFFSET AND STATE

FUNCTION: To control the CAM 1, CAM 2, CAM 3, CAM 4, Ext. Trigger 1, Ext. Trigger 2 and Knock trigger output angular offset and state (On/Off).

Command parameter(s):

Data	Type	Description
Output ID	U8	Index of the output : 0 = CAM1 OFFSET 1 = CAM2 OFFSET 2 = CAM3 OFFSET 3 = CAM4 OFFSET 4 = EXT TRIGGER 1 OFFSET

		5 = EXT TRIGGER 2 OFFSET 6 = KNOCK OFFSET
Angular Offset Target	S16	Angular offset to be applied to this output (in degree **x 10**)
Output State	U8	0 = Off, 1 = On

Command message format:

	Value
ID	**Base + 1**
B0	**Output ID**
B1	**Angular Offset Target MSB**
B2	**Angular Offset Target LSB**
B3	**Output State**
B4..B7	**Unused**

Even if an angular offset ranging from -32768 to +32767 degree can theoretically be commanded, the controller will limit the offset to the min./max. range defined in the system setup. The angular offset will increase at a rate as defined in the system setup.

No answer will be sent by the module to this command

Example 1: Base ID set to 256 (=0x100) in the system setup. To request a CAM 4 output offset of 34.2° with the output enabled, multiply the offset angle by 10 (=342 or 0x156) and set the CAN message content like this:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x101	**8**	**0x03**	**0x01**	**0x56**	**0x01**	**XX**	**XX**	**XX**	**XX**

Example 2: Base ID set to 256 (=0x100) in the system setup. To request a Knock Trigger output offset of -18.2° with the output enabled, multiply the offset angle by 10 (=-182 or 0xFF4A) and set the CAN message content like this:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x101	**8**	**0x06**	**0xFF**	**0x4A**	**0x01**	**XX**	**XX**	**XX**	**XX**

XX = don't care

5.3 Command: SET KNOCK GAIN

FUNCTION: To control the gain of the knock analog output.

Command parameter(s):

Data	Type	Description
Knock Gain	U8	Gain in percent

Command message format:

	Value
ID	**Base + 2**
B0	**Knock Gain**
B1..B7	**Not Used**

No answer will be sent by the module to this command

Example: Base ID set to 256 (=0x100) in the system setup. To set the knock gain to 90% (=0x5A), the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x102	**8**	**0x5A**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**

XX = don't care

5.4 Command: SELECT PROFILE ID

FUNCTION: To select the active profile.

Command parameter(s):

Data	Type	Description
Profile ID	U8	Active profile index from 1 to 8

Command message format:

	Value
ID	**Base + 3**
B0	**Profile ID**
B1..B7	**Not Used**

No answer will be sent by the module to this command

Example: Base ID set to 256 (=0x100) in the system setup. To select the profile number 4, the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x103	**8**	**0x04**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**

XX = don't care

5.5 Command: ENABLE STOP SEQUENCE

FUNCTION: To enable or disable the stop sequence.

Command parameter(s):

Data	Type	Description
Stop Sequence State	U8	0 = Off, 1 = On

Command message format:

	Value
ID	**Base + 4**
B0	**Stop Sequence State**
B1..B7	**Not Used**

WARNING: once a stop sequence has been launched using an Enable Stop Sequence command, a Disable Stop Sequence command must imperatively be sent to re-enable normal operation of the simulator.

No answer will be sent by the module to this command

Example: Base ID set to 256 (=0x100) in the system setup. To enable a stop sequence, the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x104	**8**	**0x01**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**

XX = don't care

5.6 Command: ENABLE MASTER OUTPUT

FUNCTION: To set or clear the master output state.

Command parameter(s):

Data	Type	Description
Master Output State	U8	0 = Off, 1 = On

Command message format:

	Value
ID	**Base + 5**
B0	**Master Output State**
B1..B7	**Not Used**

No answer will be sent by the module to this command

Example: Base ID set to 256 (=0x100) in the system setup. To set the master output state to ON, the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x105	**8**	**0x01**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**

XX = don't care

5.7 Command: SET ENGINE SPEED ROC

FUNCTION: To set the engine speed rate of change, overriding the value defined in the system setup structure. The value changes made are not stored in non-volatile memory.

Command parameter(s):

Data	Type	Description
Target Engine Speed	U16	Engine speed rate of change (RPM/s) ranging from 0 to 20000, or 65535 for infinite.

Command message format:

	Value
ID	**Base + 6**
B0	**Engine Speed ROC MSB**
B1	**Engine Speed ROC LSB**
B2..B7	**Not Used**

No answer will be sent by the module to this command

Example 1: Base ID set to 256 (=0x100) in the system setup. To set the engine speed ROC to 2000 RPM/s (=0x7D0), the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x106	**8**	**0x07**	**0xD0**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**

Example 2: Base ID set to 256 (=0x100) in the system setup. To set the engine speed ROC to infinite, the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x106	**8**	**0xFF**	**0xFF**	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**

XX = don't care

5.8 Command: SET STOP SEQ PARAMS

FUNCTION: To set the stop sequence parameters, overriding the value defined in the system setup structure. The value changes made are not stored in non-volatile memory.

Command parameter(s):

Data	Type	Description
Stop seq. control	U8	Bit 0 : Stop sequence enabled Bit 1 : Stop sequence reverse phase enabled Bit 2..7 : unused
Forward seek speed	U16	Engine speed (RPM) at which the final or reverse angle will be sought for.
Final angle	S16	Angle (in degree **x 10**) where engine speed will be set to zero.
Reverse offset	U16	Angular offset (in degree **x 10**) in the reverse direction. This parameter is not used if reverse phase is disabled.
Reverse seek speed	U8	Negative engine speed (RPM) at which the final angle will be sought for. Value provided will be negated and is limited to -255 RPM. This parameter is not used if reverse phase is disabled.

Command message format:

	Value
ID	**Base + 7**
B0	**Stop seq. control**
B1	**Forward seek speed MSB**
B2	**Forward seek speed LSB**
B3	**Final angle MSB**
B4	**Final angle LSB**
B5	**Reverse Offset MSB**
B6	**Reverse Offset LSB**
B7	**Reverse seek speed**

No answer will be sent by the module to this command

Example 1: Base ID set to 256 (=0x100) in the system setup. To configure the stop sequence to have forward and reverse phases, forward seek speed of 200 RPM (=0xC8), final angle of 176.5° (x 10 = 1765, or 0x6E5), reverse offset of 89.2° (x 10 = 892, or 0x37C) and reverse seek speed of -50 RPM (= 0x32), the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x107	**8**	**0x03**	**0x00**	**0xC8**	**0x06**	**0xE5**	**0x03**	**0x7C**	**0x32**

Example 2: Base ID set to 256 (=0x100) in the system setup. To configure the stop sequence to have only a forward phases, forward seek speed of 200 RPM (=0xC8), final angle of 176.5° (x 10 = 1765, or 0x6E5), the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x107	**8**	**0x01**	**0x00**	**0xC8**	**0x06**	**0xE5**	**XX**	**XX**	**XX**

XX = don't care

5.9 Command: EDIT PROFILE

FUNCTION: To modify the content of a wheel profile. The changes made are not stored in non-volatile memory.

Command parameter(s):

Data	Type	Description
Profile ID	U8	Index of the profile (1 to 8)
Output ID	U8	Index of the output to modify : 0 = CRANK 1 = CAM1 2 = CAM2 3 = CAM3 4 = CAM4 5 = EXT TRIGGER 1 6 = EXT TRIGGER 2 7 = KNOCK
Start Angle	S16	Edition start angle (in degree **x 10**)
Length	U16	Edition angular length (in degree **x 10**)
Value	U8	Value to apply (0 or 1)

Command message format:

	Value
ID	**Base + 8**
B0	**Profile ID**
B1	**Output ID**
B2	**Start Angle MSB**
B3	**Start Angle LSB**
B4	**Length MSB**
B5	**Length LSB**
B6	**Value**
B7	**Not used**

No answer will be sent by the module to this command

Example: Base ID set to 256 (=0x100) in the system setup. To edit the profile number 3, output CAM 1, to set ones in the range of -36.0° (x 10 = -360 or 0xFE98) to +24.0° (so length is 60.0°, x10 = 600 or 0x0258), the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x108	**8**	**0x03**	**0x01**	**0xFE**	**0x98**	**0x02**	**0x58**	**0x01**	**XX**

XX = don't care

WARNING: after one or more edition commands have been sent, the profile has to be selected (using command SELECT PROFILE ID) even if it is the active profile for the modifications to take effect.

5.10 Command: TEST PROFILE CONTROL

FUNCTION: The simulator contains an integrated function that allows temporary switching to a secondary 'test' profile which runs for a given number of cycles and after which the original profile is restored. This command controls the execution of this procedure.

Command parameter(s):

Data	Type	Description
Start/Abort	U8	Start = 1, Abort = 0
Test Profile ID	U8	Index of the test profile (1 to 8)
Number of cycles	U32	Number of test cycles to run

Command message format:

	Value
ID	**Base + 9**
B0	**Start/Abort**
B1	**Test Profile ID**
B2	**Number of cycles (Byte 3, most significant)**
B3	**Number of cycles (Byte 2)**
B4	**Number of cycles (Byte 1)**
B5	**Number of cycles (Byte 0, least significant)**
B6..B7	**Not used**

WARNING: The test profile will run as long as the number of cycles hasn't been reached and an abort command hasn't been received (there is no other way to switch back to the original profile)

WARNING: Changing the original or the test profile while a test is running MUST be avoided

No answer will be sent by the module to this command

Example: Base ID set to 256 (=0x100) in the system setup. To temporarily switch to profile number 3 and run it to 1000 cycles, the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x109	**8**	**0x01**	**0x03**	**0x00**	**0x00**	**0x03**	**0xE8**	**XX**	**XX**

XX = don't care

5.11 Command: DATA STREAMING CONTROL

FUNCTION: To enable/disable the periodic transmission of data over the CAN bus.

Command parameter(s):

Data	Type	Description
TX Interval	U16	The data transmission period (must be >=10ms, 0 = disabled)
Streaming CAN Base ID	U16	Data streaming messages base CAN ID (not allowed : 0, 0x410, 0x411, 0x412, 0x413, 0x414, 0x415, and must be <=0x7FD)

Command message format:

	Value
ID	**Base + 10**
B0	**TX Interval MSB (milliseconds)**
B1	**TX Interval LSB (milliseconds)**
B2	**Streaming CAN Base ID MSB**
B3	**Streaming CAN Base ID LSB**
B4..B7	**Not used**

Example: Base ID set to 256 (=0x100) in the system setup. To enable data streaming with a period of 300ms and with a base CAN ID of 0x400, the CAN message content should be:

ID	Len	B0	B1	B2	B3	B4	B5	B6	B7
0x10A	**8**	**0x01**	**0x2C**	**0x04**	**0x00**	**XX**	**XX**	**XX**	**XX**

XX = don't care

The following messages will be sent periodically (if selected TX interval is not zero):

	Value
ID	**Streaming CAN Base ID**
B0	**Engine speed MSB (RPM)**
B1	**Engine speed LSB (RPM)**
B2	**System status MSB (see below)**
B3	**System status LSB (see below)**
B4	**CAM 1 Offset MSB (degree x 10)**
B5	**CAM 1 Offset LSB (degree x 10)**
B6	**CAM 2 Offset MSB (degree x 10)**
B7	**CAM 2 Offset LSB (degree x 10)**

	Value
ID	**Streaming CAN Base ID + 1**
B0	**CAM 3 Offset MSB (degree x 10)**
B1	**CAM 3 Offset LSB (degree x 10)**
B2	**CAM 4 Offset MSB (degree x 10)**

B3	**CAM 4 Offset LSB (degree x 10)**
B4	**Ext. Trigger 1 Offset MSB (degree x 10)**
B5	**Ext. Trigger 1 Offset LSB (degree x 10)**
B6	**Ext. Trigger 2 Offset MSB (degree x 10)**
B7	**Ext. Trigger 2 Offset LSB (degree x 10)**

	Value
ID	**Streaming CAN Base ID + 2**
B0	**Knock Trigger Offset MSB (degree x 10)**
B1	**Knock Trigger Offset LSB (degree x 10)**
B2	**Cycle Count (Byte 3, most significant)**
B3	**Cycle Count (Byte 2)**
B4	**Cycle Count (Byte 1)**
B5	**Cycle Count (Byte 0, least significant)**
B6	**0**
B7	**0**

System status is a bitfield defined as follow:

Bit 0 : Master output enabled state
Bit 1 : Crank output enabled state
Bit 2 : CAM1 output enabled state
Bit 3 : CAM2 output enabled state
Bit 4 : CAM3 output enabled state
Bit 5 : CAM4 output enabled state
Bit 6 : External Trigger1 output enabled state
Bit 7 : External Trigger2 output enabled state
Bit 8 : Knock Trigger output enabled state
Bit 9 : Stop Sequence in progress
Bit 10..14 : Active Profile Index (zero-based)

6 Crank Simulator box

6.1 User interface

a. Front panel elements

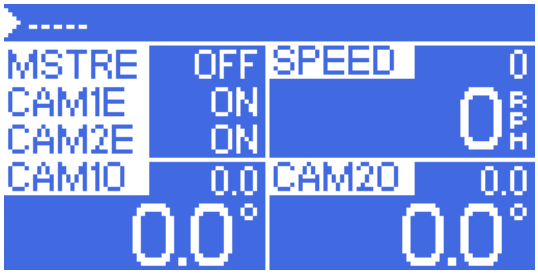
The front panel of the crank simulator box contains the following elements:

- A multi-purpose LCD display
- A large rotary and push switch labelled 'navigation' should be used to adjust the simulator speed, to scroll through the menu items and confirm a selection in a menu.

NOTE : This button has also a secondary emergency function: by pressing the button for more than 2 seconds, the simulator engine speed is immediately set to zero.

- Two small rotary control switches labelled Control A and B which should be used to adjust the value of the selected control parameter.

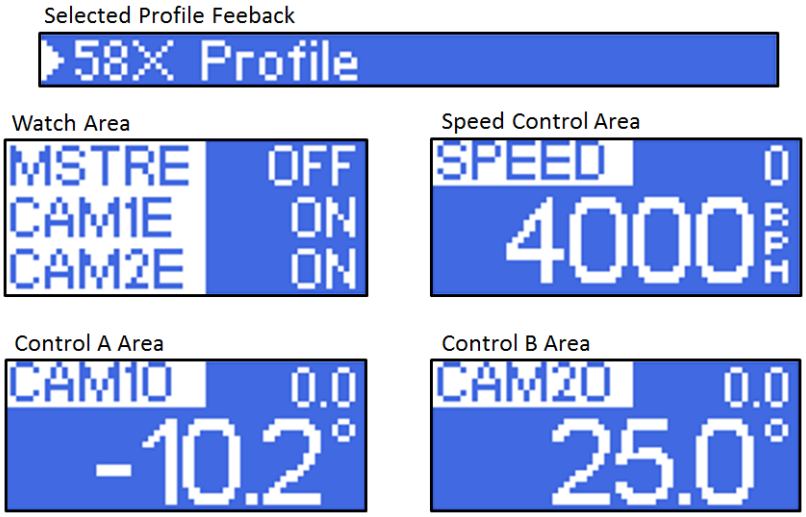
After a few second of boot time, the LCD will turn on, display some temporarily system informations (software and FPGA code versions) and finally display the default application screen.



Default main-screen

b. Main Screen

The main screen is split in five different control and display areas:



- **Selected Profile Feedback:** This area indicates the name of the currently active profile (regardless of the origin of the selection: PC or Simulator Box). A series a dashes "-----" indicate that no profile is currently selected and thereby not signal is generated at the output.

- **Watch area:** In this area are displayed the values/states of three watch parameters which can be individually selected via the PC interface (->Setup->Interface)

- **Speed Control Area**: This area is exclusively intended for simulator speed control. Depending on the control layout selected via the PC application (->Setup->Interface), the commanded value of the simulator speed will be displayed either in large characters in the center of the area, or in small characters in the top-right of the area. Identically, the instant feedback value of the simulator speed will be displayed in the opposite spot. The commanded value indicated is the one that has been selected by the user via the simulator box. It does not show the value commanded from the PC or using CAN commands, so there can be a mismatch between the commanded value and the feedback (i.e. if the last command was sent via the PC). The simulator speed can be adjusted using the rotary switch located at the right of the top panel.

- **Control A/B Areas:** These areas are intended to display and control specific control parameters which can be selected via the PC interface (->Setup->Interface). Depending on the parameter selected the mnemonic indicated in the top left side of the area will be :

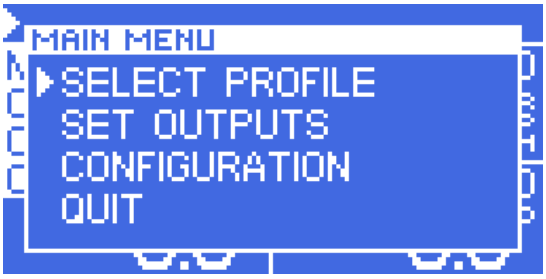
Parameter	Mnemonic

Crank Output Enabled	CRNKE
CAM 1 Offset	CAM1O
CAM 1 Output Enabled	CAM1E
CAM 2 Offset	CAM2O
CAM 2 Output Enabled	CAM2E
CAM 3 Offset	CAM3O
CAM 3 Output Enabled	CAM3E
CAM 4 Offset	CAM4O
CAM 4 Output Enabled	CAM4E
Ext. Trigger 1 Offset	EXT1O
Ext. Trigger 1 Output Enabled	EXT1E
Ext. Trigger 2 Offset	EXT2O
Ext. Trigger 2 Output Enabled	EXT2E
Knock Offset	KNOKO
Knock Output Enabled	KNOKE
Knock Gain	KGAIN
Profile Select	PROID
Stop Sequence Enabled	SSEQE
Master Output Enabled	MSTRE

As for the simulator speed, the commanded value for the selected parameter will be displayed either in large characters in the center of the area, or in small characters in the top-right of the area depending on the selected display layout (->Setup->Interface). The instant feedback value of the parameter will be displayed in the opposite spot. Again, the commanded values indicated are those that have been selected by the user via the simulator box (not those coming from CAN commands or the PC interface). The value of a parameter can be adjusted using the rotary switch located right below its control area.

c. Main Menu

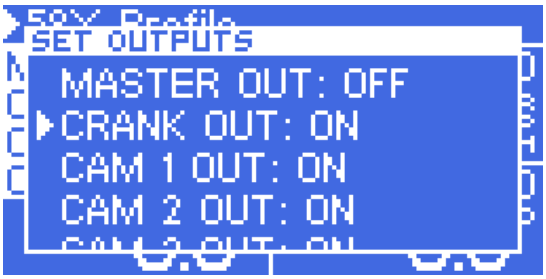
Press the main navigation switch to display the main menu and rotate the switch to scroll through the menu items.



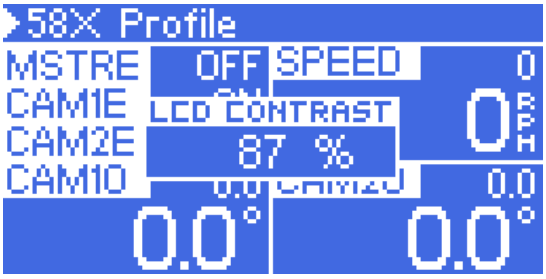
To confirm a selection, press the main navigation switch again (select QUIT to hide the main menu).

- **Select Profile Sub-Menu**: In this menu are listed the names of the eight different profiles. An asterisk (*) in front of a profile name indicated the currently active profile. Scroll up and down this sub-menu and press the main navigation button to select a new active profile (or QUIT to leave this sub-menu).

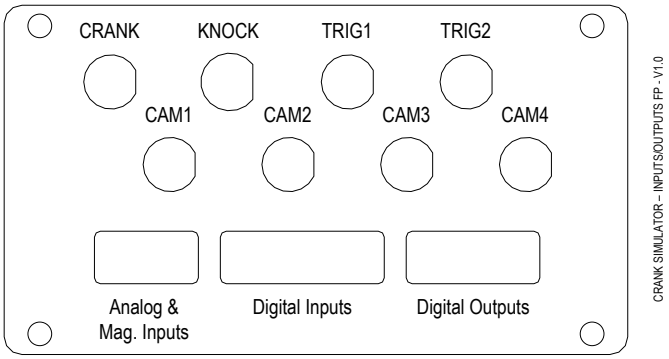
- **Set Outputs Sub-Menu**: In the menu are listed the master output state and all the different channel-individual outputs state. To modify the state of any of these outputs, move the pointer in front of the output item and press the main navigation button to toggle its state. When done, move to the very bottom of the menu and select QUIT.



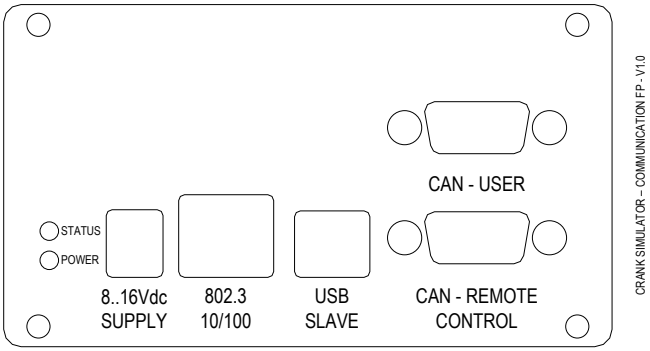
- **Configuration Sub-Menu**: This menu contains for now only the LCD contrast adjustment. Select this item to adjust the LCD contrast by rotating the master navigation switch up or down. Press the master switch to leave the menu. The selected contrast is automatically saved in non-volatile memory and will be recall at startup.



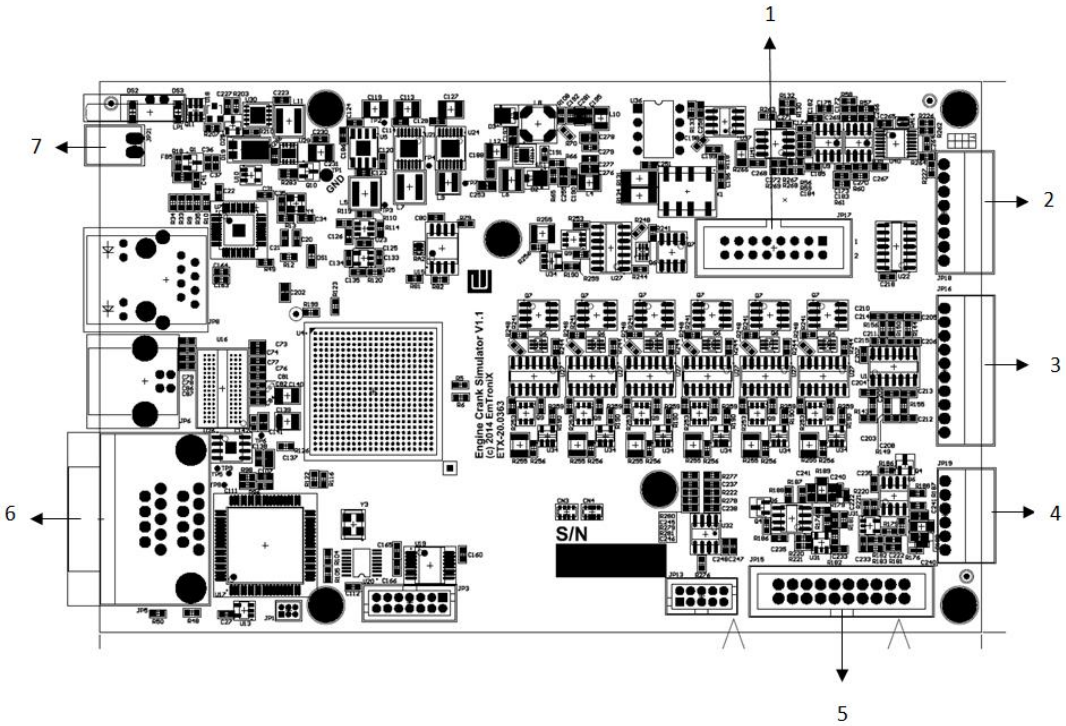
6.2 Inputs/Outputs



IO Panel

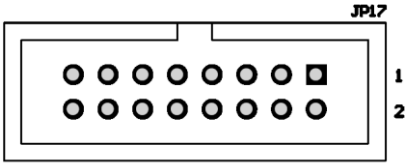


Communication Panel



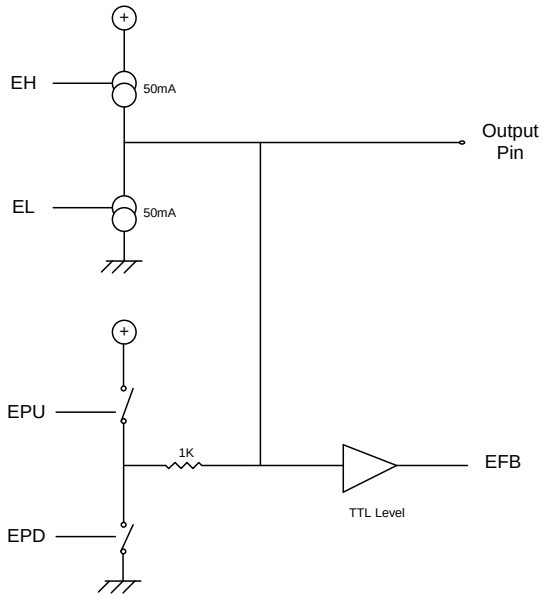
Internal connections

1. Crank/CAM/TRIG I/O



15. CRANK	13. KNOCK	11.CAM1	9.CAM2	7. CAM3	5.CAM4	3.Trigger1	1. Trigger2
16. GND	14. AGND	12. GND	10. GND	8. GND	6. GND	4. GND	2. GND

Output stage:



Digital outputs:

Level: Low Level : < 0.8V

High Level : > 3V

Crank: HSD/LSD open collector with Bias – Pull-Up – Pull-Down

CAM1: HSD/LSD open collector with Bias – Pull-Up – Pull-Down

CAM2: HSD/LSD open collector with Bias – Pull-Up – Pull-Down

CAM3: HSD/LSD open collector with Bias – Pull-Up – Pull-Down

CAM4: HSD/LSD open collector with Bias – Pull-Up – Pull-Down

Trig1: HSD/LSD open collector with Bias – Pull-Up – Pull-Down

Trig2: HSD/LSD open collector with Bias – Pull-Up – Pull-Down

Digital inputs:

Level: Low Level : < 1.3V

High Level : > 2.8V

Trig_1: Pull-Up – Pull-Down

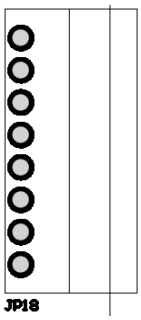
Trig_2: Pull-Up – Pull-Down

Analog outputs:

Crank output voltage: +/- 15V, 50 Ohms, Max. current +/-150mA

Knock output voltage: +/- 2.5V (200MSPS), 600 Ohms, Max. current +/-30mA

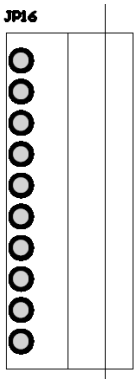
2. Digital Outputs



8. GND
7.GND
6. Dig_Out_6
5. Dig_Out_5
4. Dig_Out_4
3. Dig_Out_3
2. Dig_Out_2
1. Dig_Out_1

Output Voltage : 0-5V, Impedance 600 Ohms, Maximum Output Current +/-25mA

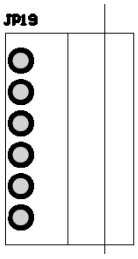
3. Digital Inputs



10. GND
9. GND
8. GND
7. GND
6. Dig_In_6
5. Dig_In_5
4. Dig_In_4
3. Dig_In_3
2. Dig_In_2
1. Dig_In_1

Input Voltage: 0-5V, Input Pull-Up 1.5K Ohms, Maximum Input Current 3.5mA

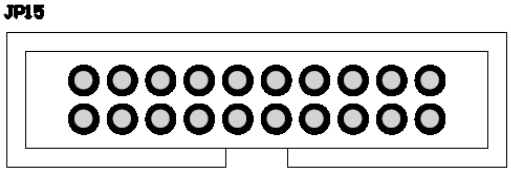
4. Analog & Mag. Inputs



6. ADC_2
5. ADC_1
4. GNDA
3. Mag_In_Hi_2
2. Mag_In_Lo_1
1. Mag_In_Hi_1

ADC input range : 0 - 10V, Impedance : 15k Ohms
Mag. input range : 0 - 50V, Impedance : 10k Ohms

5. LCD connector

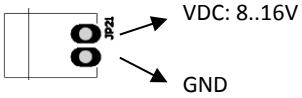


2. +5V	4. RS	6.Ena	8. DB1	10. DB3	12. DB5	14. DB7	16. CS2 #	18. VEE	20. LED-
1. GND	3. VO	5.RW	7. DB0	9. DB2	11. DB4	13.DB6	15. CS1 #	17. RST #	19.+5V

All Digital signals are in 5V.
Signals extension # are with low logic.

6. Can connector

7. Power supply



Nominal: 12Vdc –Max 2A (8 to 16 VDC)