11.10.2011

ideas make future

MASTER ignition
TCI - CDI
V7.2

Brief Description

The product *MASTER ignition* is a brand new series of ignition units without any direct succession to the previous models. It is the experience in development of industrial and transport safety systems, ignition units and particularly our customers' needs which provided a foundation for the idea and realisation of the new model.

The unit *MASTER ignition* has been functionally designed in order to advance control of spark ignition engines ranging from one to sixteen cylinders (depending on type), with whatever configuration of scanned teeth, types of sensors and features like 3D maps of advance and injection control, sensing manifold depression, temperature, tachometer output, LED strobe, control over charging and revolutions, switching on of fuel pump with either TCI, CDI (or combined) outputs.

The list of features mentioned above determines *MASTER ignition* to be used either for a service or tunning replacement of all conventional motorcycle or automobile ignition units. The integrated redundancy of sensing, together with other key features makes *Master ignition* very suitable for marine and aviation applications, moreover, thanks to the wide range of operating revolutions can be also used for turbines.

The function of *MASTER ignition* relies on *FPGA* technology, which provides digital-analogue conversion of sensor signal, as well as its evaluation and calculation of the mathematical model of the real rotation. Simultaneously, it deals with other operations i.e. redundancy sensing, total control of CDI converter, advanced features and signal records. *FPGA* technology is interesting not only for its high operating performance but particularly for its accuracy, which in principle microprocessor-based systems cannot achieve.

Main Features

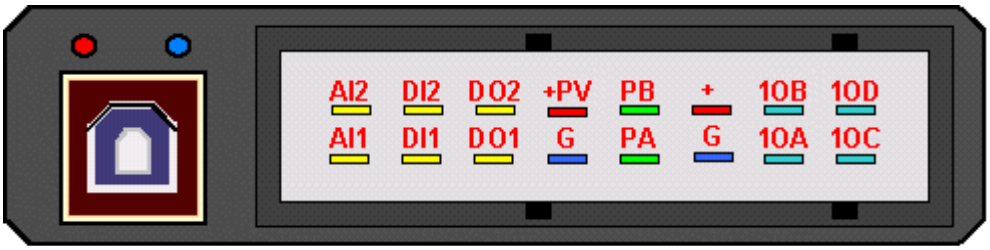
- ✓ The power supply range of 7 to 36 V (depending on type)
- ✓ Working speed from 0 to 120 000 rpm
- ✓ Operating temperature -40 to 85 °C
- ✓ Based on FPGA technology and microprocessor support
- ✓ Mathematical model of the real engine rotation, 64bit
- ✓ Adjustable pick up sensing levels, A/D conversion of signals, ± 25.5 V, 1Msps
- ✓ Angular maps of teeth, the voltage levels for different speeds, filters capture
- ✓ Customizing the input type sensor: Induction, Hall, Opto, Hammer
- ✓ Redundancy of sensing and other integrated elements
- ✓ Advance and Injection control – optional 3D map of ±360° and 0 to 60ms
- ✓ Integrated oscilloscope ± 25.5 V, 1Msps
- ✓ Outputs – MOSFET and IGBT automotive – TCI, CDI or combined
- ✓ Advanced functions – temperature, vacuum, tachometer, stroboscope, charge
- ✓ Integrated and configurable CDI converter 450V with superb performance of 100W
- ✓ User configuration USB – while in operation with possibility of visualization of current status
- ✓ Measurement of voltage, temperature and load of converters
- ✓ Records – long-term and common, engine hours
- ✓ Convenient Firmware Upgrade – regular updates via the website
- ✓ Rapid diagnosis function using LED

Technical Parameters

Parameters	Range
Supply voltage	TCI .... 7-36V CDI (12V).... 7-21V CDI (24V).... 12-36V
Current consumption	TCI.... < 100mA CDI.... 0-8A, dependant on the speed
Working speed rate (range management)	0 - 120 000 rpm (0.1 - 65 000 rpm)
Working temperature	-40 / 85°C
Input mode (PA, PB)	±25.5V, ±0.1V, max ±100V,sampling 1Msps
Maps advance [1]...[8]	±360°, 8 x 1024 pts, (0.1 - 65 000 rpm)
Maps injection [1]...[8]	0..60ms, 8 x 1024 pts, (0.1 - 65 000 rpm)
Coil switching (1OA, 1OB, 1OC ... 1OH) 2x, 4x or 8x, TCI, CDI (depending on type)	TCI.... MOSFET automotive 18A/650V CDI.... IGBT automotive 6A/600V
Digital inputs (DI1, DI2)	0 - 2V = L, 3 - 36V = H (Pull up 1kΩ)
Analogue inputs (AI1, AI2)	0 - 2,5V; 0 - 5V; 0 - 2.5kΩ; > 2.5kΩ
Digital outputs (DO1, DO2)	MOSFET 5A/100V (Pull up 1kΩ)
Measurement of voltage (power supply)	7 to 50V (tol. ±2%)
Measurement of temperature (inside housing)	-40 to +125°C (tol. ±2°C)
CDI converter (voltage, pulse current, efficiency)	100 - 450V, 2 - 24A, efficiency 62 - 75%
Resistance of primary winding coils*	TCI - Inductive, resistance 1.0 - 5.0Ω CDI - Capacitance, resistance 0.1 - 1.5Ω
Memory record	8kB RAM, 8MB FLASH
Status indication by LED	Blue, Red
User configuration - USB	Freeware software MASTER control
Degree of protection	IP65
Package size	105x95x37 mm
Weight	350g

* measured between terminal 1 and G (ground) for capacitive coil or 1 and 15 (supply) induction

Connector plugging



Význam vodičů

MARKING	MEANING	RANGE, ACTIVE LEVEL
+	Voltage supply	7 - 36V
G	Earthing power, sensors	0V
1OA-1OH	Switching coils A-H or user output	TCI - Inductive, resistance 1.0 - 5.0Ω CDI - Capacitance, resistance 0.1 - 1.5Ω
+PV	Power sensors output	+5V, 100mA
PA, PB	Rotation sensor A,B	±25.5V, minimum ±0.1V, sampling 1Msps
AI1, AI2	Analogue input 1,2	0 - 2,5V; 0 - 5V; 0,2 - 2,5kΩ; > 2,5kΩ
DI1, DI2	Digital input 1,2	0 - 1V = L, 3 - 36V = H
DO1, DO2	Digital output 1,2	MOSFET 5A/100V (Pull up 1kΩ)

Common Master units

MASTER ignition 2TCI 2CDI – 12V - 2x output TCI, 2x output CDI, 7 – 21V

MASTER ignition 4CDI – 12V - 4x output CDI, 7 - 21V

MASTER ignition 4TCI - 4x output TCI, 7 - 36V

Optional Master units on request

MASTER ignition 2TCI 2CDI – 24V - 2x output TCI, 2x output CDI, 12 - 36V

MASTER ignition 4CDI – 24V - 4x output CDI, 12 - 36V

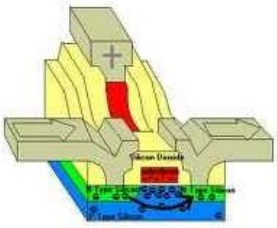
MASTER ignition 8TCI - 8x output TCI, 7 - 36V

MASTER ignition 8CDI – 12V - 8x output CDI, 7 - 21V

MASTER ignition 8CDI – 24V - 8x output CDI, 12 - 36V

MASTER ignition 4TCI 4CDI – 12V - 4x output TCI, 4x output CDI, 7 - 21V

MASTER ignition 4TCI 4CDI – 24V - 4x output TCI, 4x output CDI, 12 - 36V



Output characteristic	TCI - inductive	CDI - capacitance
Energy efficiency	B...D	A...B
Energy of spark	B...C	A...B
Spark slope	A...B	A++
Low coils weight	B...D	A++
Difficulty of construction	A++	C...D
Another use of output*	A++	C...D

* Possibility for other use (switching, injector jets, fuel pump, stroboscope, revolution counter etc.)

Installation

Electronic spark ignition unit *MASTER ignition* is powered by safe voltage up to 36V, however, with variations TCI and CDI there is voltage of thousands of volts on coils. Therefore, it is necessary to pay maximum attention when manipulating. Any changes to the electrical installation of ignition cannot be carried on unless the power is off!!!

Power supply and all ignition inputs are protected against overvoltage and reverse polarity. Neither overvoltage status nor reverse polarity can last permanently, as it can overload the security elements and cause partial or complete damage to the functionality of the ignition.

Ignition outputs are not protected against short circuit and therefore outputs from 1OA up to 1OH, DO1 or DO2 must not be connected to the power terminal (+). Connection to impendence is also forbidden as it would excess the amount of allowed current and result in overload and following destruction of certain switching elements in the ignition.

Spark plug together with cylinder head and engine block must be connected to negative or positive pole of the power. This is necessary to flow of current from secondary winding of ignition coils.

Aluminium housing if ignition is due to own shielding connected to negative pole. Therefore no other conductor apart from negative pole can be connected to the housing.

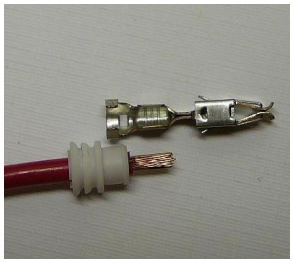
Ignition must never be installed at the places with direct exposure to water, chemicals, extreme temperatures and vibrations. The effect of any of these may cause irreversible damage or destruction of ignition functionality.

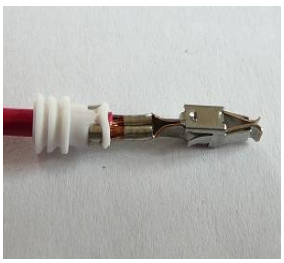
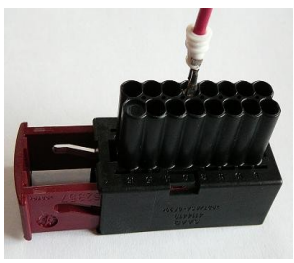
The correct and reliable function of installed equipment is based on its correct power supply. Power wires (+, G) must have a diameter of 2.5 mm, which is ideal for CDI variant. Variant TCI must follow this condition only in case of ground wire (G). Power supply must always be done through circuit breaker (10A melted fuse), which protects ignition in case of reverse polarity, overvoltage or other disorders.

Sparks must be provided with shielding caps. The signal conductor from the rotation sensor cannot be led in parallel way with excitation coil wire (1OA to 1OH), high-voltage conductors or conductors of the alternator excitation. If it is not possible to carry out the wiring in this way it is recommended to lead signal conductor sensors (PA, PA) in shielded or at least in twisted (twisted in pair) conductors in order to eliminate any possible interference of electric-installation.

Connectors crimping

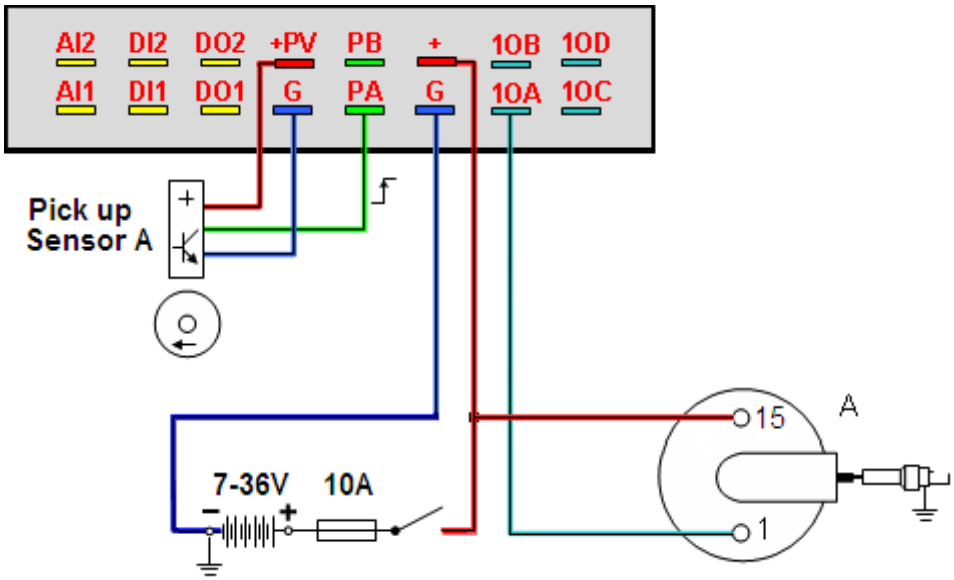
Connector crimping requires a similar procedure as with FASTON connectors, although there is a rubber sealing grommet used here in addition. Regarding tool, it can be done with standard crimping pliers FASTON 1.5mm – 2.5mm. For blocking of unused terminal connectors TYCO it is appropriate to use supplied rubber plugs to comply with IP65 degree of protection.



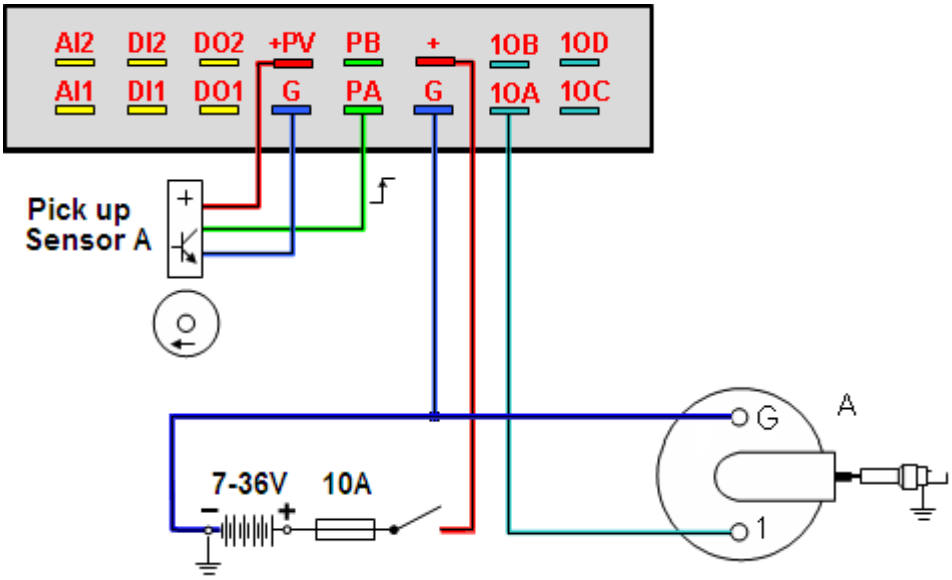
Connection diagram

TCI – model showing connecting of sensor PA and one output 1OA



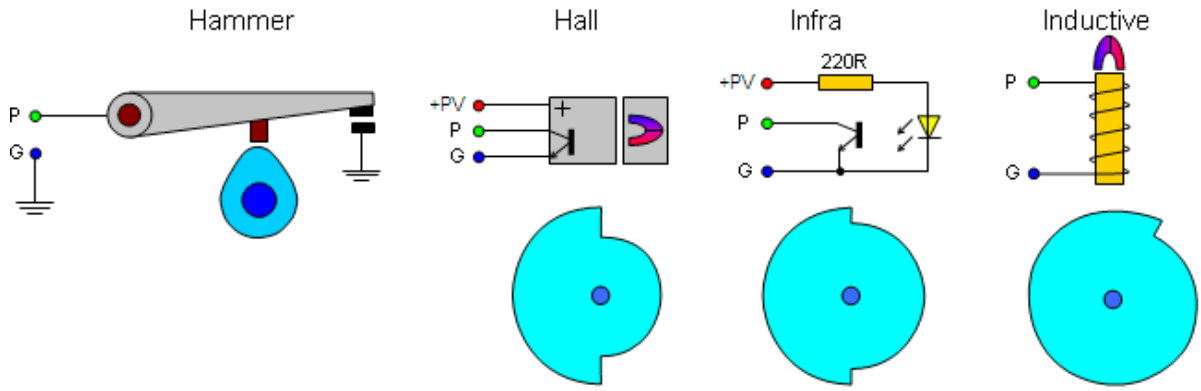
+ ... Positive power supply *+PV ... Sensor power supply* *1OA.... Closing of induction coil*
G ... Negative (Ground) *PA ... Signal sensor A*

CDI – model showing connecting of sensor PA and one output 1OA



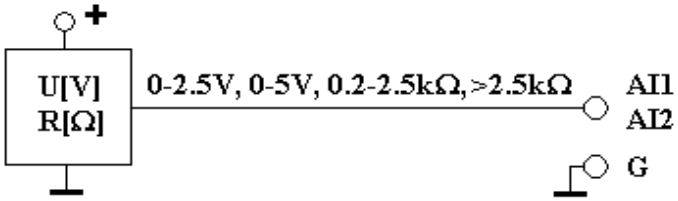
+ ... Positive power supply *+PV ... Sensor power supply* *1OA.... Excitation capacity coil*
G ... Minus (Ground) *PA ... Signal sensor A*

Connecting of Pick up sensors PA, PB



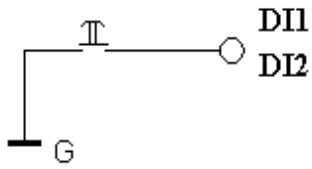
Analogue outputs AI1, AI2

It is possible to connect sensors whose output is either voltage or resistance to analogue outputs AI1 and AI2. Signal from analogue sensors should be led by shielded cable, which helps significantly to eliminate interference.



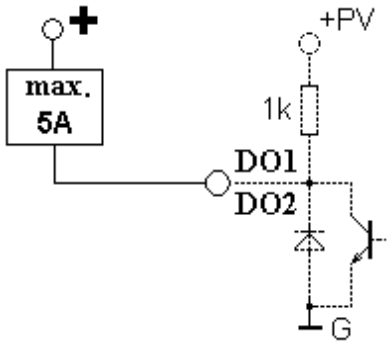
Digital outputs DI1, DI2

Change in input status DI1 and DI2 is easily done by input earthing.



Digital outputs DO1, DO2

Digital outputs can be used for load switching to zero with maximum current load 5A. Therefore it is possible to connect e.g. relay coil, fuel closure coil, indicator of shift revolutions, stroboscope etc.



Configuration software

Unless the configuration for a particular installation has not been done by the manufacturer then it is necessary to adjust the function of the ignition unit. Configuration is done through a personal computer from MASTER-control application via USB connection. The application is compactable with Windows 95 and higher. The installation requires 4MB of free space on your hard disk. Minimum PC configuration is Pentium 166MHz with 32MB RAM.

Making changes to the configuration such as reading and writing of parameters requires installation of application MASTER-control, USB connection and power connection (+, G). When power supply is on it is indicated by flashing blue LED, data transfer is indicated by flashing red LED

Rapid trial changes in the configuration of ignition unit can be made only temporarily by writing them into RAM memory or permanently by storing them in FLASH memory. After starting the application in order to avoid unwanted permanent rewrites is RAM memory selected permanently.

Examples of configurations are part of installation CD.

Function application


Opening configuration


Saving configuration


Information


Help


Online visualisation
Sensor configuration


Maps of advance


Advanced


features


Starting visualisation


Reading configuration


Record configuration


Other settings


Selecting RAM


Selecting FLASH


Local help


Switching In-Out


Selecting Advance


Selecting Injection


Oscilloscope record

Online visualisation

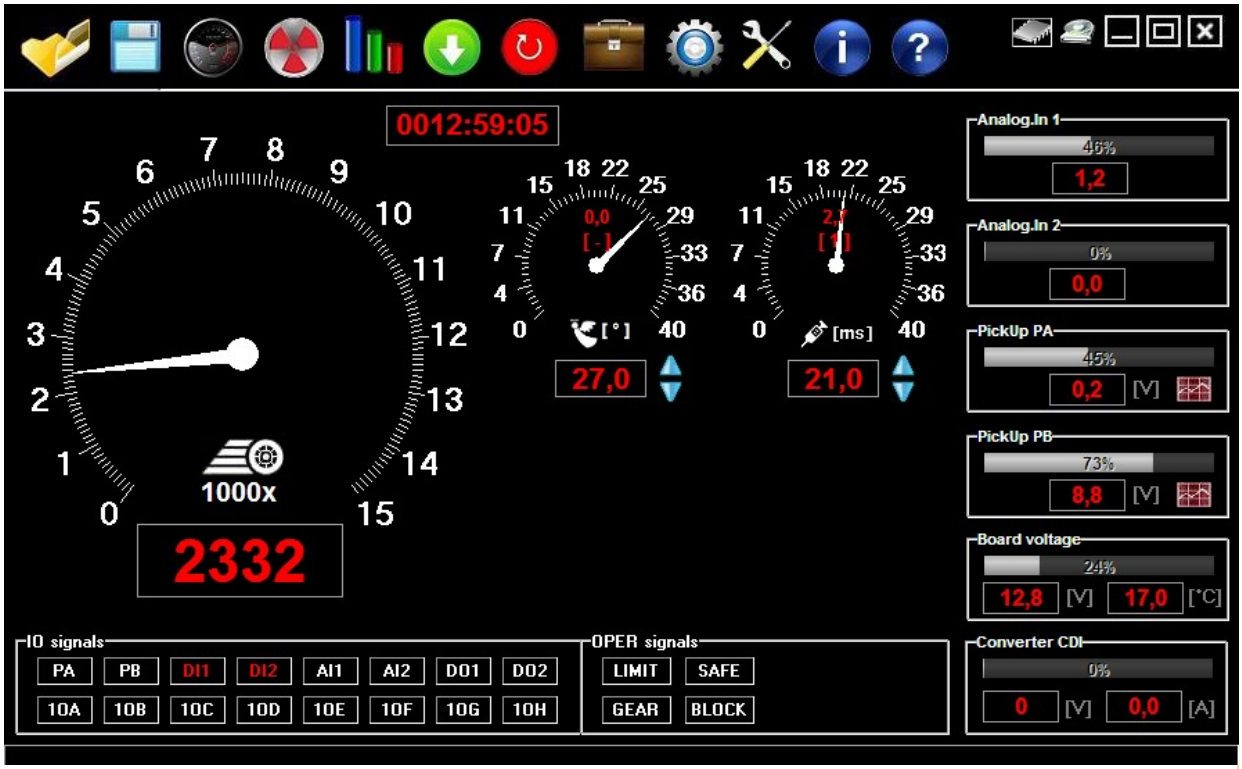
This is an operational display of function and status of ignition unit *MASTER*. In order to have functional display it is necessary to have USB connection and switch power supply on.

Visualised data

- Engine speed (rpm), advance of engine [°], injection time [ms]
- Sensor voltage PA, PB [V]
- Power supply [V] and Temperature [°]
- Converter CDI – Voltage [V], pulsed current [A] and load [%]
- Signals 1OA - 1OH, DI1, DI2, DO1, DO2, AI1, AI2, PA, PB
- Engine work time record [h:m:s]

Starting visualisation

Oscilloscopic record



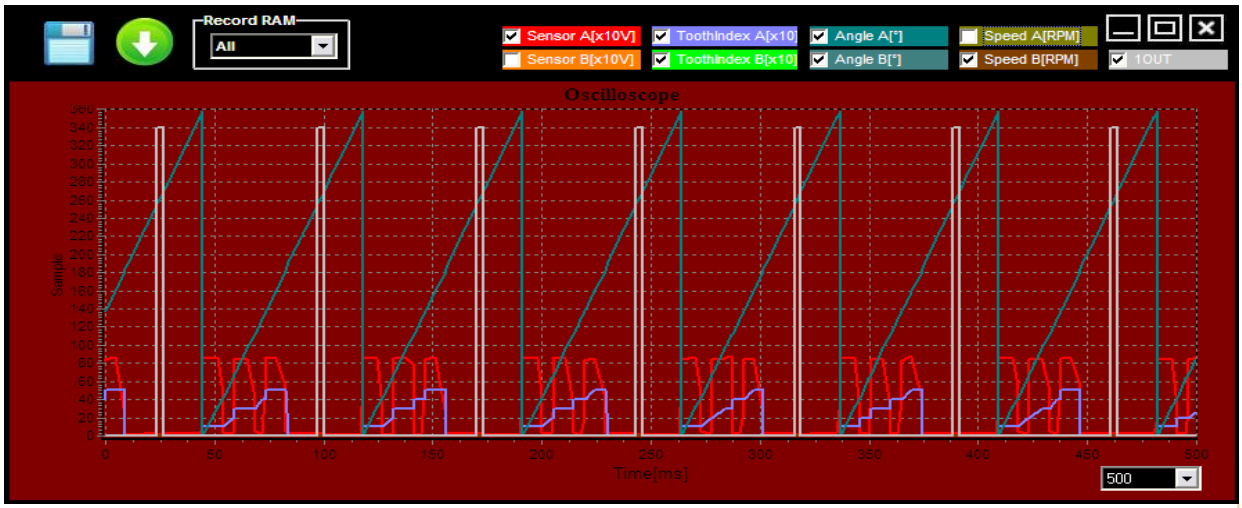
Oscilloscopic record

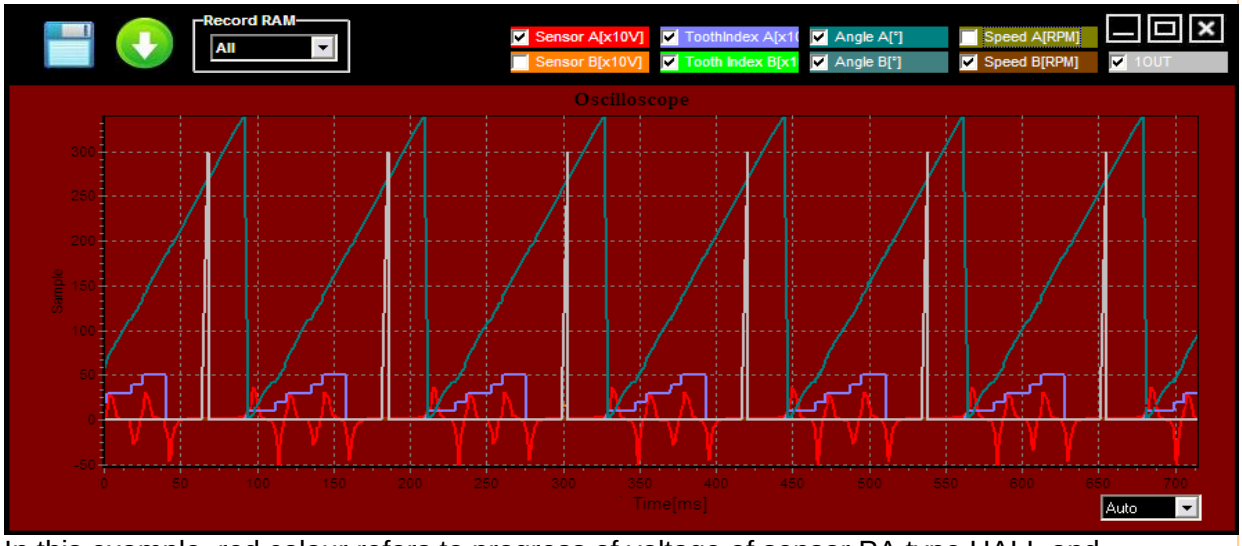
Oscilloscopic record is used in order to graphically visualise measured and calculated data. This helps to quickly evaluate the proper and accurate function of ignition unit *MASTER*. It can thus evaluate the correctness of voltage sensing, counting teeth of mathematic model of the real rotation and angels of closing of output coils.

An example to be given; curve angle of engine angular rotation must be regularly and horizontally increased from 0 to 360°. If there is any change of steepness in the curve or the angle is shorten, the problem is to be found either in wrong angle value set up, number of teeth, the type of synchronisation or unsuitable voltage for sensing.

Visualised data

- Rotation pick up sensor voltage, PA, PB [V]
- Tooth index of pick up rotate plate, Tooth index A-B [-]
- Engine angular rotation, Angle A-B [°]
- Engine speed, Speed A-B [%]
- Outputs switching 1OA-1OH [-]





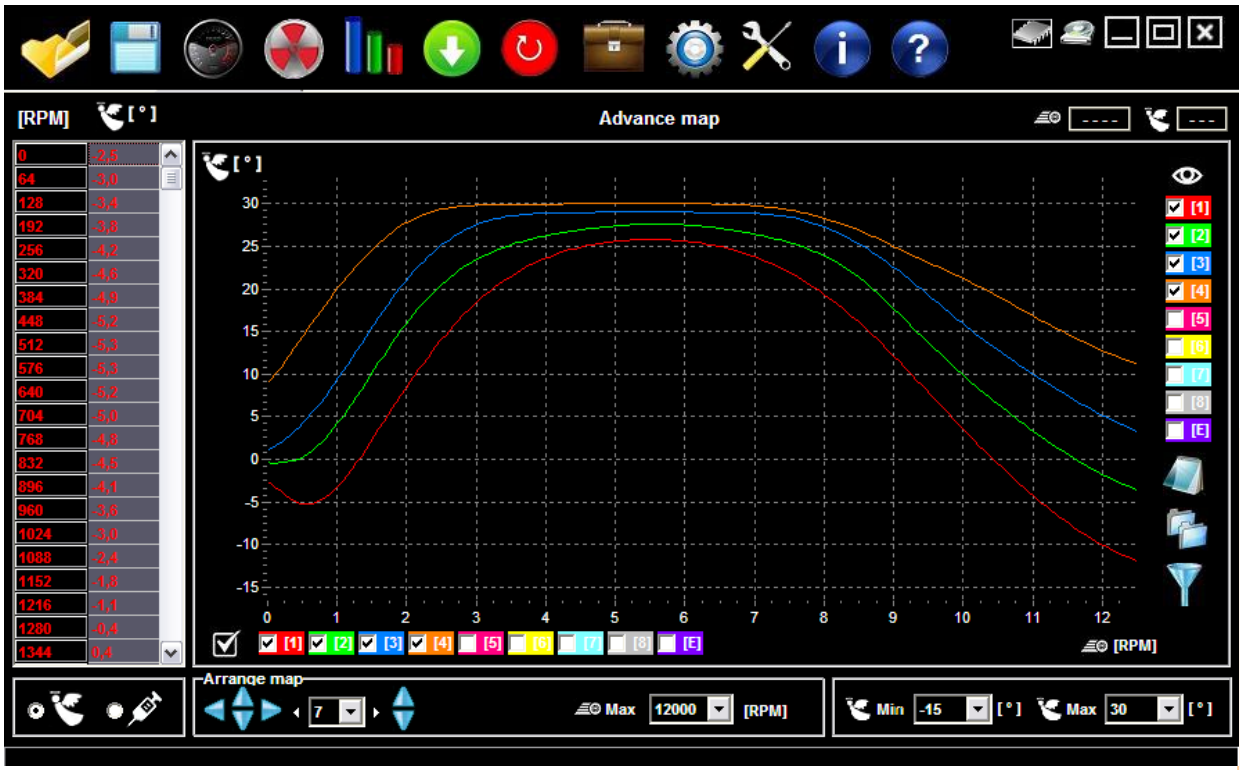
In this example, red colour refers to progress of voltage of sensor PA type HALL and INDUCTIVE, which scans three teeth 0-90-180° and in angle 270° 1OA output is switched – grey curve. Blue colour represents teeth (edge) counting and the last curve refers to spinning of engine within the range of 0-360°.

Maps of Advance and Injection

Maps provide a fast tool to display and model individual curves in advance [1] – [8] in full angle range ±360° (Advance) and 0..60ms (Injection). The given figure influences the moment of output switch from 1OA to 1OH. By using digital (DI1, DI2) or analogue outputs AI1, AI2, PA, PB) it is possible to operationally switch among the maps.

Modelling tools

- Editor maps – quick draw of maps according to specified points
- Mouse modelling – direct editing of maps is possible by mouse movement
- Map shifting – whole map shifting or selected parts only
- Copying – copies of maps one to another of your choice
- Table – direct entry of specific points into table
- Filter – in-progress filtration, rounding the edges of maps

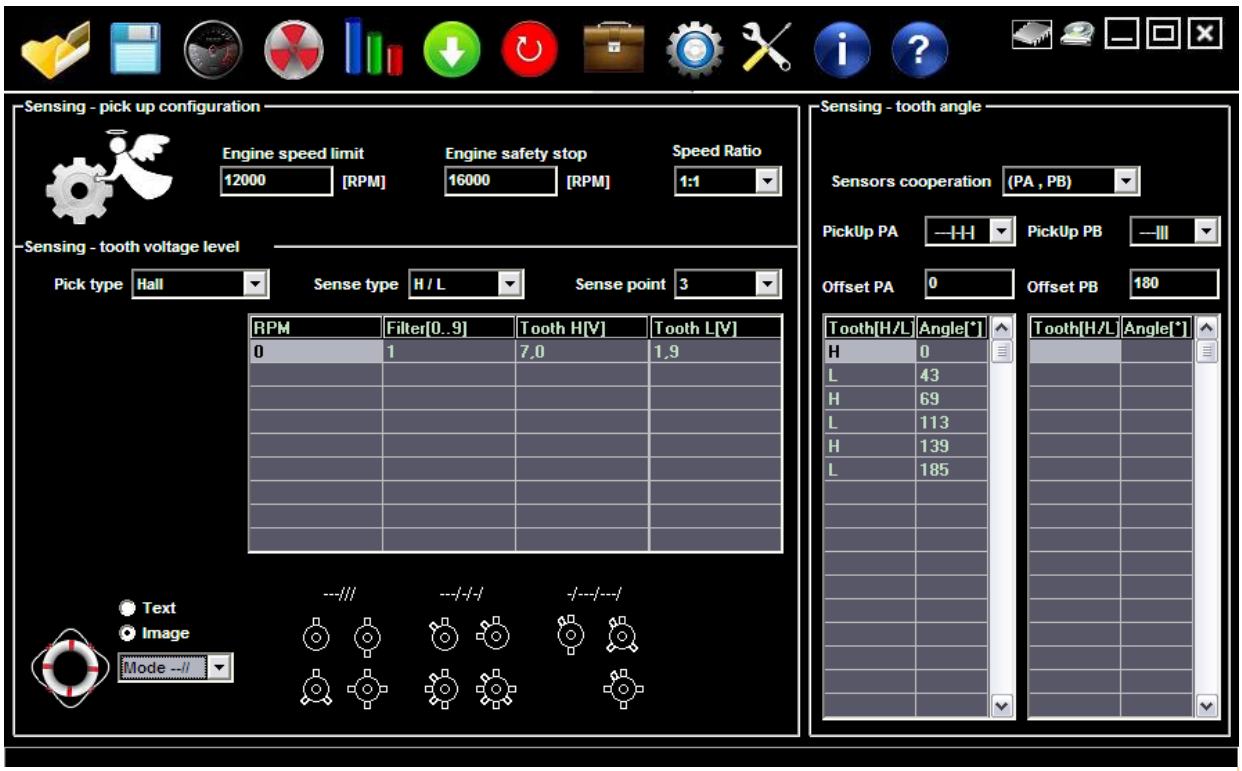


Pick up sensor configuration

Configuring the scanning of engine rotation is the key part of ignition unit *MASTER ignition*. Within its setting it is possible to select voltage level sensing and to change it further on for the chosen range of revolutions. There are other settings to be selected such as filter setting, angles of individual teeth edges or alternatively second level of voltage for synchronisation.

Instructions for scanning

- Sensor type – Induction, Hall, Opto, Hammer
- Speed ratio – entering the Ratio engine speed to pick up rotation plate speed (1:1, 2:1, 1:2)
- Points of scanning – number of samples needed to evaluate the valid edge
- Table of signals – entering the sensor voltage levels depending on the engine revolutions
- Sensors cooperation – dependency of sensing inputs PA and PB, independent - redundant
- Sensor PA, PB – the way of synchronising, i.e. the way of determining the first tooth
- Table of angles PA, PB – entering angles of individual edges and teeth
- Correction PA, PB – Correction of angles entered in the table in range of ±360°



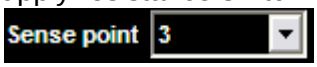
Entering Pick up sensor parameters

A) Choosing type of sensor

Internally it is decided whether to connect signal resistance to ground by Pull Down or Pull Up.

- Induction – signal load resistance switch internally Pull Down to clamp G
- Hall – signal supply resistance switch internally Pull Up to voltage 10V
- Opto – signal supply resistance switch internally Pull Up to voltage 10V
- Hammer – signal supply resistance switch internally Pull Up to voltage 10V

B) Points of sensing



Entering the number of samples allows obtaining valid evaluation of tooth edge. Entering allows filtering off interfering pulse, which prohibits the correct evaluation of teeth. Suitable value is between 2-7.

C) Entering of voltage levels

It is possible to enter one or more levels of voltage sensing depending on engine revolutions.

RPM	Filter[0..9]	Tooth H[V]	Tooth L[V]
0	1	1,0	-1,0
600	1	2,0	-2,0
1200	1	3,2	-3,2
2500	1	5,0	-5,0

- RPM - Entering revolutions from which entered levels of sensing are valid.
- Filter [0..9] -Number of engine revolutions needed to synchronise teeth, recommended [0-2]
- Tooth H[V] - Entering voltage level for tooth H (increasing voltage), range ±25.5V
- Tooth L[V] - Entering voltage level for tooth L (decreasing voltage), range ±25.5V

  Whereas, entered voltage level Tooth H[V] must be higher than Tooth L[V]

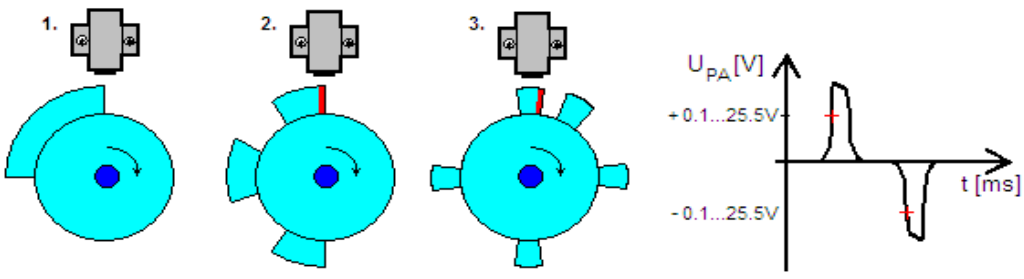
For sensing of HALL or OPTO it is usually sufficient to use one value only for the whole revolution range, thanks to easy switching of Pull Up resistance e.g. Tooth H = 7.0V and Tooth L = 2.0V

For inductive sensing it important to distinguish voltage for starting and basic operational speed e.g. for start choose Tooth H = 1.0V and Tooth L = -1.0V and for idle motion enter values Tooth H = 2.0V and Tooth L = -2.0V, it is also possible to increase the value according to the nature of sensor.

D) Synchronisation of teeth sensing MODE

From the perspective of teeth arrangement it is necessary to choose one from three types of modes of synchronisation:

1. *Without synchronisation* – engine rotation is determined by two edges only or for more edges where it is not necessary to divide pulses to individual outputs 1OA to 1OH.
2. *Long pause* – synchronisation of rotation, thus determining the first tooth (edge) is made on the basis of a long pause.
3. Short pause – synchronisation of rotation, thus determining the first tooth (edge) is made on the basis of a short pause.



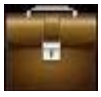
E) Entering angles of teeth edges

Tooth[H/L]	Angle[°]
H	0
L	43
H	69
L	113
H	139
L	185

For a real evaluation of the motor shaft rotation it is necessary to enter a very true map image of teeth in format of edge angles determined by names H, L and their angles. The accuracy of entering can be easily verified by oscilloscope record while engine in rotation, when a linear curve of engine rotation must be drawn within the range 0 - 360°. Common shifting of teeth angle can be done by entering the value correction PA and PB within range ±360°.

F) Entering angles of gripped pistons

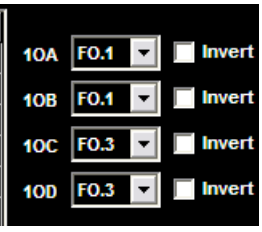
Entering angles of gripped pistons is done in “Advanced features” – “output switching”


Advanced features


Switching to table of output switching

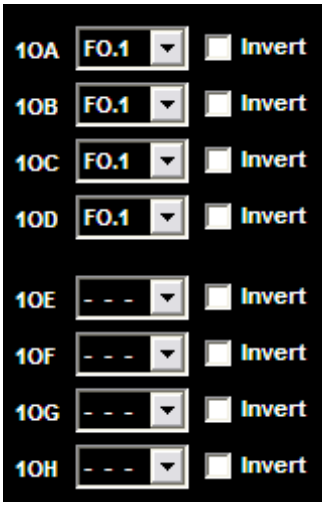
Table of output switching

Index	Function Name	Description	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
FO.1	Capacitive - CDI	X1=spark angle 1OA..X8=1OH,X10=switch[us]	0	180								1000
FO.2	Inductive - TCI	X1=spark angle 1OA..X8=1OH,X10=excit.[ms]										3
FO.3	Injection Coil	X1=injection angle 1OA..X8=1OH			90	270						
FO.4	Fuel pump	X1=mode, X10=switch time[s]										
FO.5	Speed switch	X1=off speed, X10=switch time[s]										
FO.6	Speedometer	X1=speed correction...X10										



For items from X1 to X8 functions FO.1 for CDI and FO.2 for TCI insert angles of gripped pistons from 1OA to 1OH and for items X10 insert period of output switching. Switching time for the CDI is suitable 100us and for TCI from 1 to 5ms depending as the primary coil resistance.

In order to determine the output being used it is necessary to choose output switching function.



Advanced features

Configuration of advanced features gives possibility to sense temperature, pressure and other signals with opportunity to influence operational attributes of ignition unit. Regarding input signals, digital DI1, DI2 can be used or from analogue AI1, AI2, PA or PB can be used.

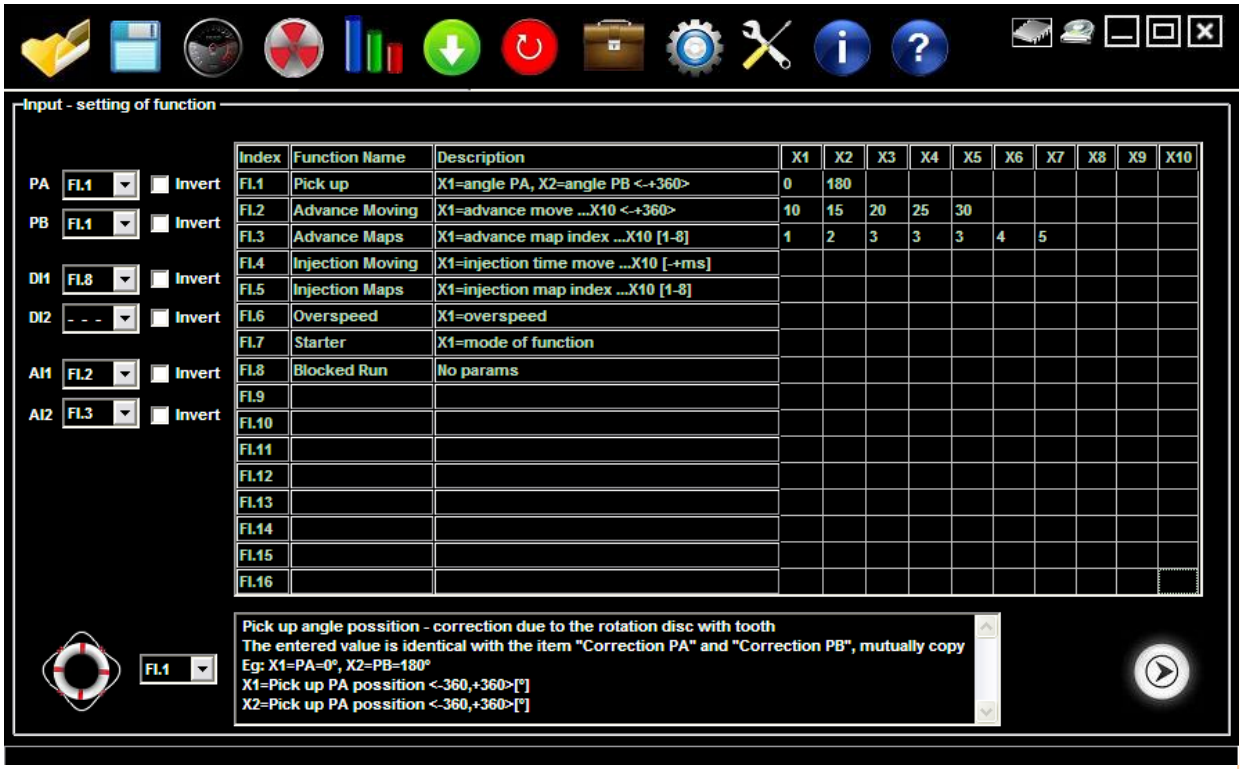
From operational and internal status, depending on selected function, output signals can be switched. Output signals are marked from 1OA to 1OH, DO1 and DO2.

Switching between the table input/output

Local help

Entering functions

- Option input FI.1 – FI.16 or output from FO.1 to FO.2
- Entering parameters of chosen function from X1 to X10
- Choosing of input/output function and inversion of signal
- Description of function parameter is done in application together with local help



Installation Step by Step

1. Install *MASTER control* application on a personal computer with *Windows OS* such as: *95 / 98 / ME / NT / XP / Vista / Win 7*

2. Make a connection to *MASTER ignition* unit by cable *USB A-B*, with a personal computer and install the *USB driver.* Under *Windows 7* is installed automatically.

3. Connect the power wires to the ignition '+' and '*G'* (12V or 24V) only. Once connected, briefly flashes red "SW Boot" and 2 seconds later, the flashing blue LED.

4. Connect the wires of pick up sensor *'PA', 'G' '* and '*+PV' (PB)*

5. Run *Online visualisation* and verify the function of sensing voltage change in *PA (PB).* During the tooth passes around the pick up sensor and display right battery voltage.

6. Open example configuration MASTER ignition according to the application: Example_TCI.ig, Example_CDI.ig, or Example_Injection.ig or another for a particular engine or application.

7. Make adjustment of pick sensor settings teeth according to their actual distribution

8. Make correction or completion of outputs switching angles, but the wires just yet

9. Make correction advance or injection maps

10. Load configuration into the MASTER ignition unit to FLASH or RAM memory, according to the needs of permanent or temporary storage.

11. Run the starter of engine or otherwise run, and let the read oscilloscop record, to verify the function of the rotation pick up sensor and outputs the correct switching angles.

12. Connect the outputs as needed 1OA, 1OB, 1OC, 1OD, 1OE, 1OF, 1OG, 1OH to coil