UNIMA-KS

Development & production of control equipment
Visualization, measurement and regulation SW
WWW.UNIMA-KS.CZ unima-ks@unima-ks.cz

Ing. Z.Královský
Petr 457
675 22 STAŘEČ
Tel.: 568 870982
Fax: 568 870982
e-mail: kralovsky@unima-ks.cz

Ing. Petr Štol
Okrajová 1356
674 01 TŘEBÍČ
Tel.: 568 848179
Cell: 777 753753
e-mail: stol@unima-ks.cz

Electronic ignition circuit specification

TMCI1+ (OEZ)

15.02.2005
SW version: V 3.02

CONTENTS:

1. Device purpose

The electronic ignition circuit (hereinafter referred to as TMCI1+) is designed to control ignition in two- to eight-cylinder combustion engines. Ignition may be controlled optionally by one or two sensors, the number of teeth per gear ring may be selected regardless of the number of engine cylinders.

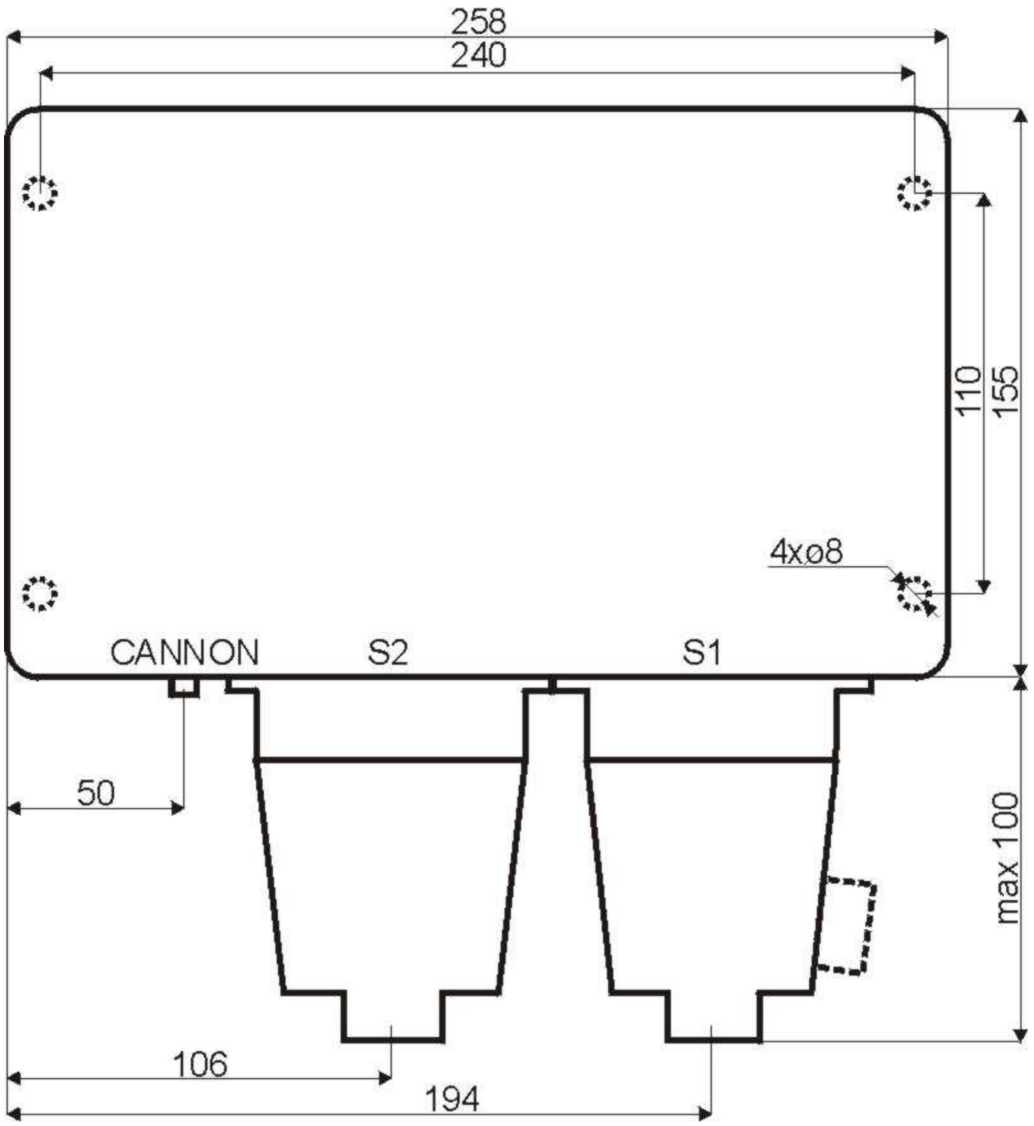
2. Operating conditions

For proper operation of TMCI1+, it is necessary to maintain the basic operating conditions defined in the following chapters:

a) correct connection of input-output connectors
b) power supply within the given tolerance
c) correct setting of parameters
d) keeping operating temperature of environment within the range 0-60°C

3. Mechanical structure

TMCI+ is placed in a hermetically-sealed metal box of dimensions 258x155x92mm. Four mounting holes placed at the bottom at a distance of 110x240mm and with 8mm thread serve the purpose of mounting on the engine. There are two connectors of the Amphenol type on the side serving the purpose of connecting coils and signals and the CANNON connector (for preliminary dimensioning of connector positions, see fig.).

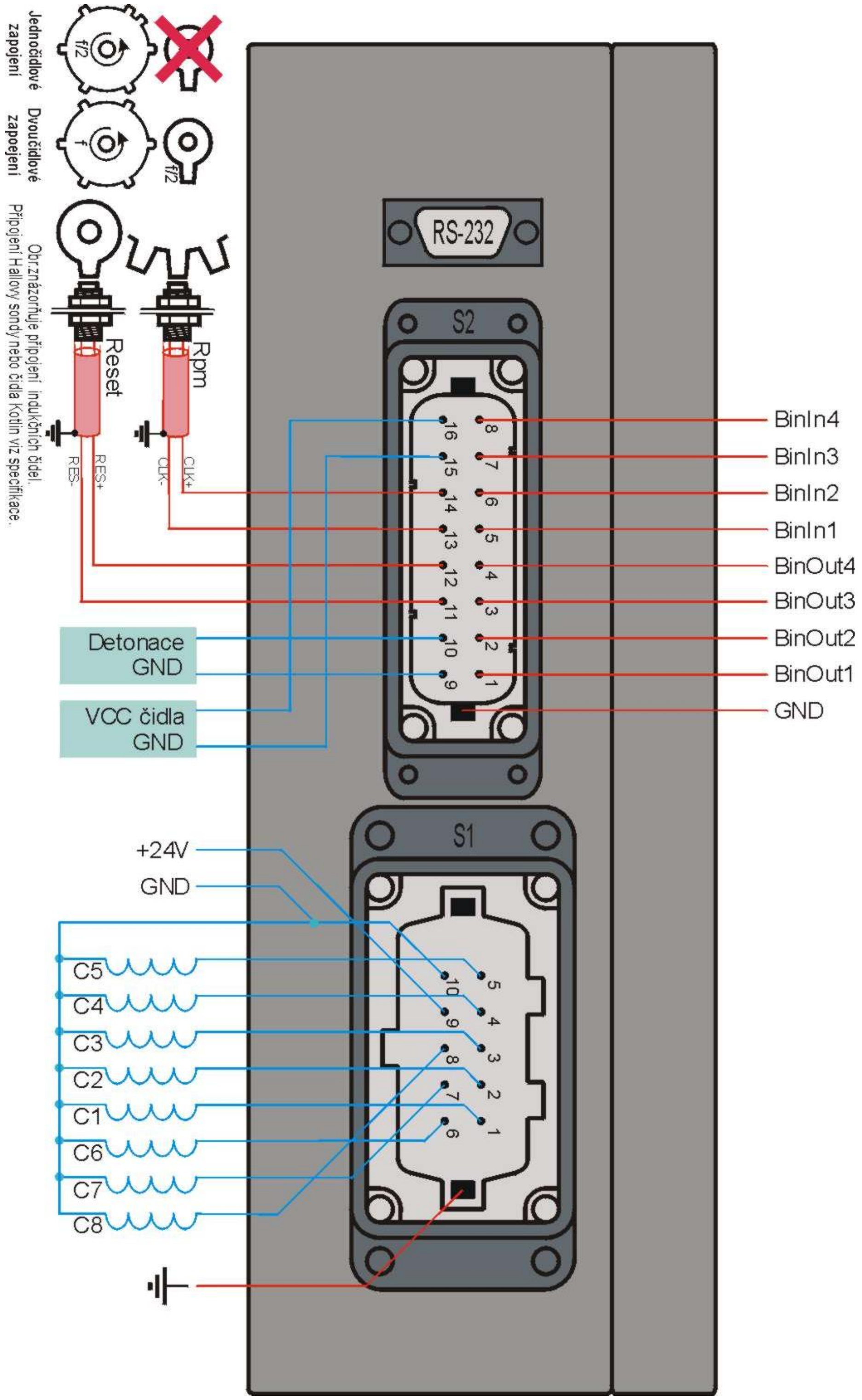


4. Electrical structure

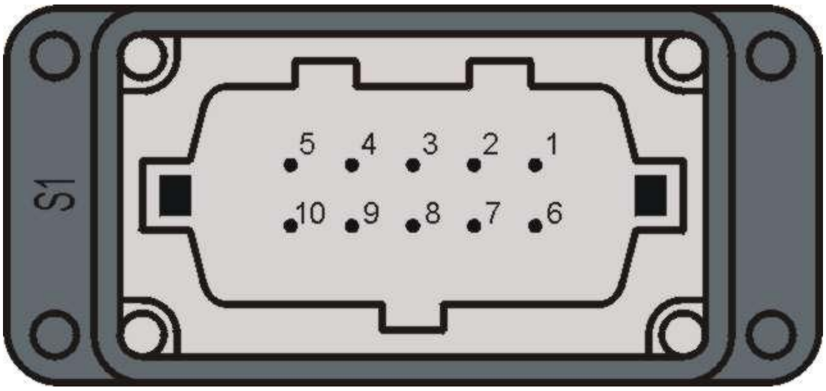
Two connectors of the Amphenol S1 type (power connector – power supply and outputs for coils) and an S2 connector (input signals, logic inputs and outputs) ensure the connection of TMCI1+ inputs and outputs.

The CANNON connector ensures the connection of SP to PC (monitoring, diagnostics setting).

Connector layout:



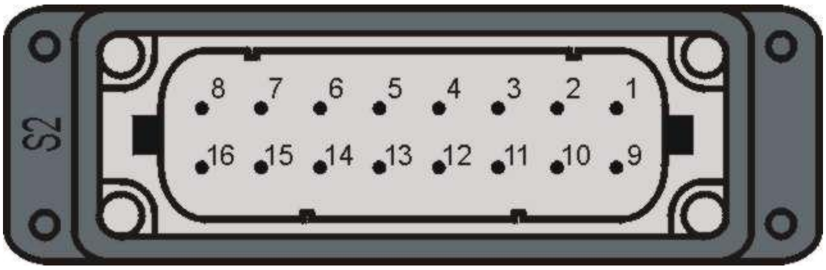
4.1 S1 connector



	Title	Meaning	Working values
S1-1	C1	Switching output for induction coil	Uout=250-330V Imax= 40A/10us
S1-2	C2	Switching output for induction coil	
S1-3	C3	Switching output for induction coil	
S1-4	C4	Switching output for induction coil	
S1-5	C5	Switching output for induction coil	
S1-6	C6	Switching output for induction coil	
S1-7	C7	Switching output for induction coil	
S1-8	C8	Switching output for induction coil	
S1-9	+24V	Power supply	(18-28)V Icc=0.25A/24V at standstill Icc=1.25A/24V at 8-cyl./1500rpm
S1-10	GND		

Output voltage (i.e. supplied energy) on outputs for coils is given by the "*PWM Energy*" parameter setting. If the parameter equals 0, the output voltage is 250V (energy 0.0938J); if the parameter is set to maximum value 127, the output voltage is 330V (energy 0.154J).

4.2 S2 connector



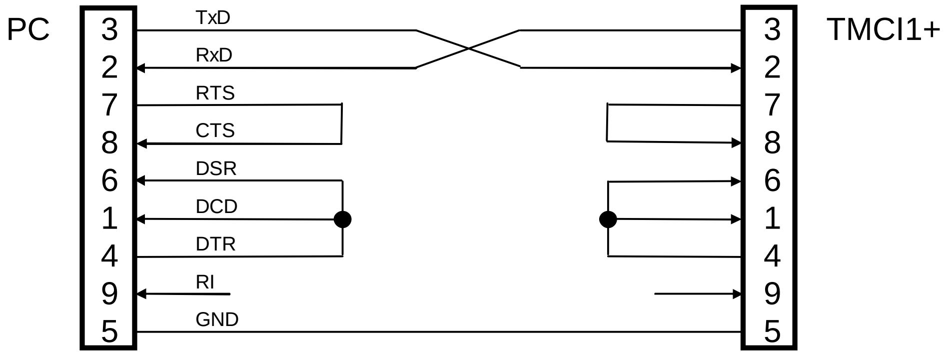
	Title	Meaning	Working values
GND	GNDD	Common earth for binary inputs and outputs	
S2-1	BinOut1	Program-configurable binary outputs	Outputs are realized by switching transistors against earth. Output transistor is switched at active output. Maximum switched voltage is 80V, switched current 50mA (max 100mA)
S2-2	BinOut2		
S2-3	BinOut3		
S2-4	BinOut4		
S2-5	BinIn1	Program-configurable binary inputs	Binary inputs are activated by short-circuiting of the respective terminals against earth
S2-6	BinIn2		
S2-7	BinIn3		
S2-8	BinIn4		
S2-9	GND	Connection of detonation sensor	
S2-10	DET		
S2-11	RES-	Differential input of reset sensor, RES+ may be used as open collector sensor input	Voltage ~(1-30V) Input impedance 1.5kohm
S2-12	RES+		
S2-13	CLK-	Differential input of crank sensor, CLK+ may be used as open collector sensor input	Voltage ~(1-30)V Input impedance 1.5kohm
S2-14	CLK+		
S2-15	GND	Supply voltage for sensor	Voltage optionally (5/24)V I=20mA permanently I=100mA at peak
S2-16	+5/24V		

4.3 Connection of TMCI1+ to PC

TMCI1+ and PC communication is realized through the RS-232 serial interface. The CANNON 9-pin connector is used for connection to this interface.

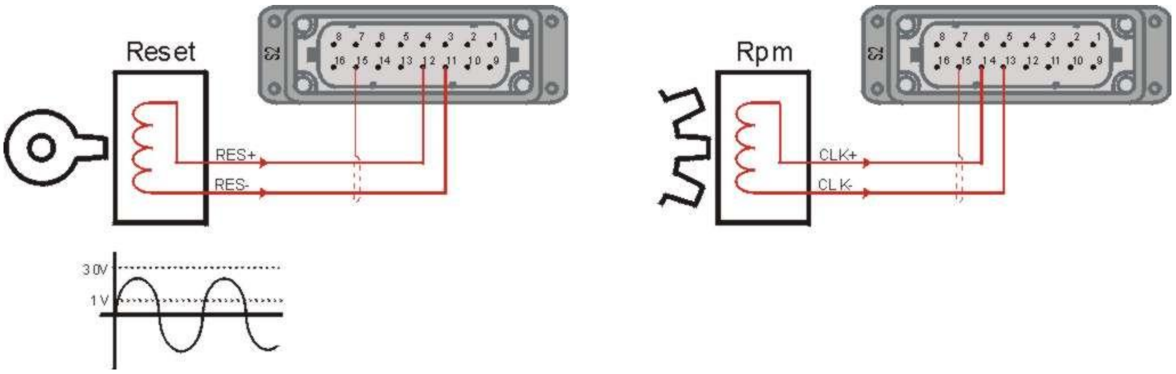
By connecting the TMCI1+ to a PC using the serial cable and by launching the “MONITOR.EXE” program, the operation may be monitored and TMCI+ parameters may be set.

Connection of cable for connection of TMCI+ to a PC:



4.4 Connection using induction sensor

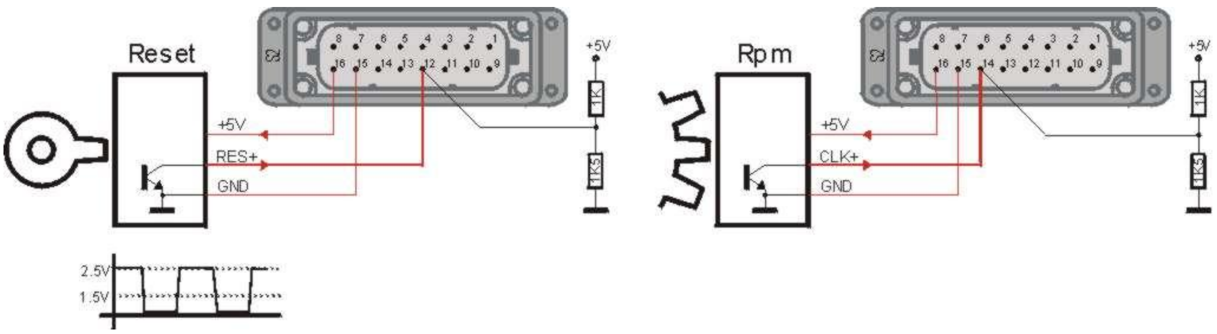
Reset and speed induction sensor connection (reset signal is not used in one-sensor connection):



If one induction sensor is used in a two-sensor connection, the second sensor can be optional (also induction sensor, Hall probe, Kotlin)

4.5 Connection using Hall probe

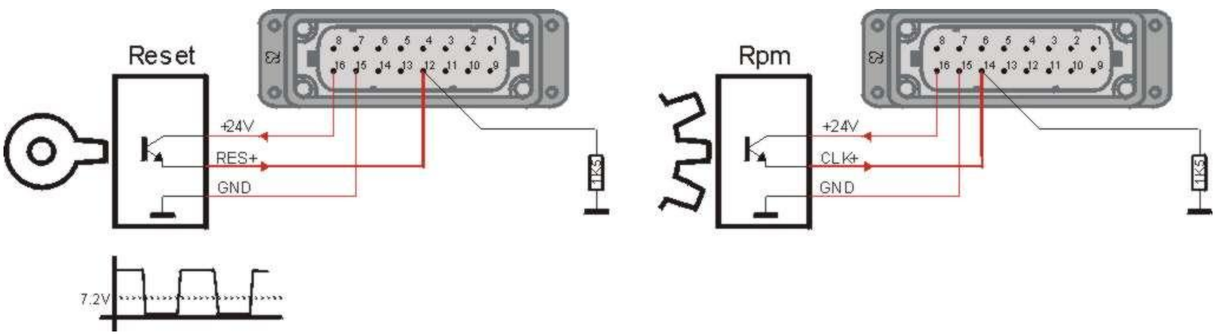
Reset and speed Hall probe connection (reset signal is not used in one-sensor connection):



If the Hall probe is used in a two-sensor connection, the second sensor cannot be Kotlin (only a Hall probe or induction sensor). Resistances in the above figure define the internal connection of the input in TMCI1+ (do not connect).

4.6 Connection using Kotlin sensor

Reset and speed Kotlin sensor connection (reset signal is not used in one-sensor connection):

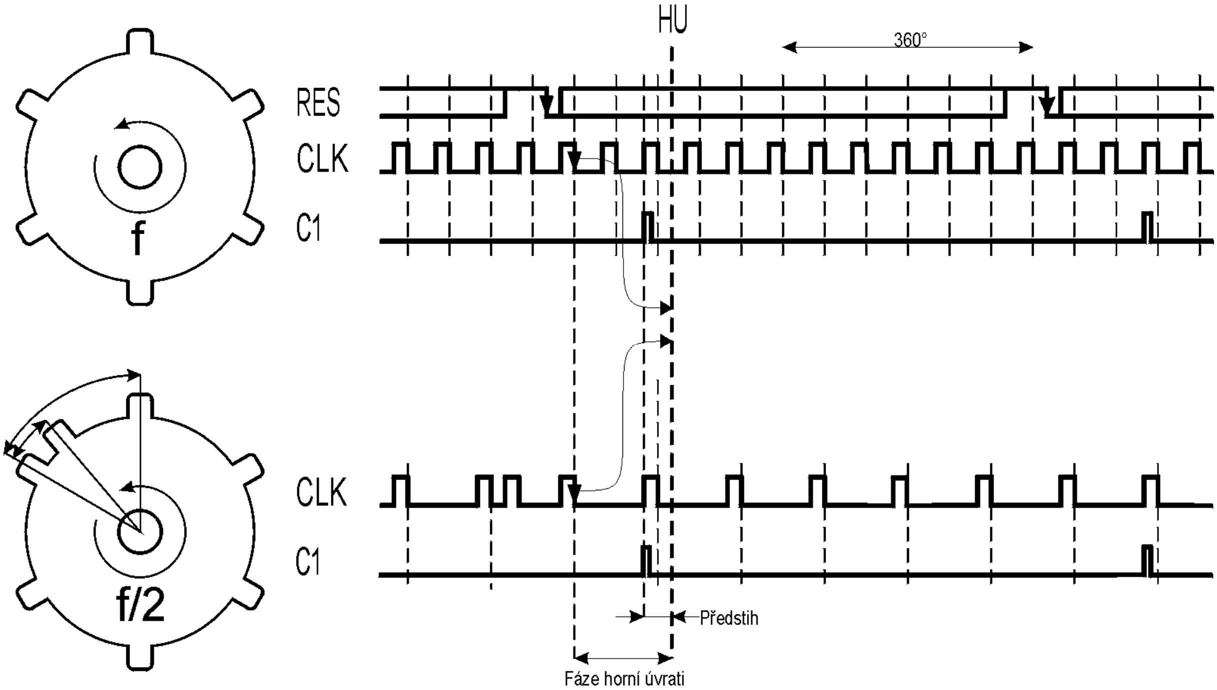


If a Kotlin sensor is used in a two-sensor connection, the second sensor cannot be a Hall probe (only a Kotlin or induction sensor). Resistance in the above figure defines the internal connection of the input in TMCI1+ (do not connect).

5. Functional description

5.1 RES and CLK control signals

Generating coil signals is given by RES and CLK input signals, and setting TMCI1+ parameters. The starting point of the firing cycle is given by the set number of sensors, see fig.: (figures shown correspond to number of teeth = 6)



In the case of double-sensor reading (RES+CLK signals), the starting point of the firing cycle is the first descending edge of the CLK signal along the descending edge of the RES signal. In this case, the gear wheel is directly on the engine shaft and its speed is the same as the engine speed.

In the case of single-sensor reading (only CLK signal), the starting point is the descending edge of the CLK signal following the CLK impulses less than 1/2 of the CLK signal period distant from each other. In this case, the gear wheel rotates at 1/2 the speed of the engine.

Top dead center of the first cylinder is given by the basic parameter *“Angle between the starting point of the firing cycle and the top dead center of the first cylinder”*. This parameter (angle) may be set manually by means of the mechanical element on TMCI1+. At the rated speed, the first cylinder fires by the *“Desired pre-ignition at rated speed”* parameter value before top dead center.

Other cylinders fire gradually at angles 720°/number of cylinders regardless of the number of teeth of the gear ring. During the cycle, the CLK signal (descending edges of the CLK signal) serves the purpose of only correcting the current values of the engine speed and therefore the current angle at dynamic changes; the number of teeth of the used gear ring is thus independent of the number of engine cylinders.

In addition, the sequence of coil firing (connection of outputs) may be set by means of the parameters. The first one (first cylinder) fires the “A coil” output, the next one fires the “B coil” output…, where A, B,…. =<1..8>.

5.2 Pre-ignition control

Basic pre-ignition is given by parameter setting. During the operation, this starting value for pre-ignition can decrease (by the effect of binary input, detonations, speed size).

5.2.1 Decrease of pre-ignition from speed

The ignition system fires with basic pre-ignition at the speed given by the *“Rated speed”* parameter and higher speed. If the speed is lower than the rated speed, the pre-ignition is linearly decreased with decreasing speed by the *“Decrease of pre-ignition at starting speed”* value at the speed given by the *“Starting speed”* parameter. If the speed is lower than the starting speed, the pre-ignition is not further decreased.

5.2.2 Decrease of pre-ignition in detonations

If the ignition system detects detonations, the pre-ignition decreases gradually at the defined rate *“Pre-ignition decreasing rate in detonations”* by the maximum value *“Maximum decrease of pre-ignition in detonations”*.

If there is no effect of detonation and the pre-ignition was decreased by the effect of detonations, it returns to its original value at the defined rate *“Pre-ignition increasing rate after detonations”*.

6. Binary inputs

6.1 Physical binary inputs

TMCI1+ disposes of 4 physical binary inputs. The status of every binary input corresponds to the state of short-circuiting (disconnection) of the relevant terminal on the S-DI TMCI terminal board.

6.2 Logic binary inputs

TMCI1+ disposes of 8 logic binary inputs. Logic binary inputs are double-value quantities controlled according to the setting of parameters by physical inputs affecting the TMCI1+ function. Every logic input is assigned a value specifying the physical input controlled by it, or the logic input is permanently set as inactive (unconnected) or active (unconnected and inverted). One physical input can control more logic inputs.

Logic input	**Purpose**
TEST mode	Bringing TMCI into testing mode
Pre-ignition decrease	Decreases pre-ignition by defined value
Enable firing	Enable firing
5 inputs unused	

6.2.1 TEST mode

Activation of the input “TEST mode” of TMCI fires on all outputs regardless of the courses of the RES and CLK input signals.

6.2.2 Pre-ignition decrease

By activating this input, the size of the pre-ignition may be decreased by the value given by the “Pre-ignition decrease binary input” parameter.

6.2.3 Enable firing

Activation of this input (together with the speed signal) is a prerequisite for ignition system activation. By deactivating the input, firing may be disabled, even though the ignition system evaluates engine run on the basis of information produced by the speed sensor.

If this input is not connected, it is necessary to set the input in the parameters as “Unconnected (permanently inactive)” and invert the input polarity to make it permanently active.

The input is functional with TMCI1+ (TMCI1) from version 3.02. The input is permanently active on ignition systems with the older version of firmware regardless of input setting or status.

7. Binary outputs

7.1 Logic binary outputs

Operation of TMCI1+ and evaluation of input signals and binary inputs are affected by the status of 8 double-value quantities.

Logic output	Description
STOP	TMCI1+ zero speed of engine evaluated
LO speed	TMCI1+ speed less than rated speed (start) evaluated
Detonations	TMCI1+ detonations evaluated
Firing error	Firing on a certain cylinder is lower than defined limit
PWM pre-ignition	Generation of PWM signal that is proportional to pre-ignition decrease
3 x *Unused*	

7.1.1 STOP

The logic output “STOP” is active in case TMCI1+ speed is lower than the minimum speed to be evaluated. TMCI1+ evaluates speed when the CLK signal period is less than 21.8ms (i.e. engine speed in single-sensor connection and 6 teeth is more than 230rpm).

7.1.2 LO speed

Engine speed is lower than the rated speed (given by the *“Rated speed of engine”* parameter), TMCI1+ according to speed and parameter setting decreases ignition.

7.1.3 Detonations

The detonation sensor signal exceeded the limit defined by the *“Level of detonations for pre-ignition decreasing”* parameter, or 10s has not elapsed from exceeding this limit.

If this logic output is active, the pre-ignition is decreased at the rate defined by the parameter (due to detonations, the pre-ignition may be decreased from the rated value of pre-ignition by the maximum value given by the *“Maximum decrease of pre-ignition in detonations by [°]”* parameter).

If the output is inactive, the pre-ignition increases gradually at the defined rate to the original value rated pre-ignition.

7.1.4 Firing error

If proper ignition fails to occur in any of the cylinders in the last 256 firings of each cylinder, TMCI1+ activates this logic output if the success rate of firing is lower than the set parameter *“Firing-evaluation”*.

7.1.5 PWM pre-ignition

The PWM signal is generated on output, whose interval corresponds to pre-ignition decrease. If the signal is permanently in log.0, decrease of pre-ignition advance equals zero; if the signal is permanently in log.1, pre-ignition advance was decreased by 20°, 50% interval corresponds to a decrease of pre-ignition advance of 10°.

7.2 Physical binary outputs

The status of physical outputs (connection/disconnection of output transistor on the S-DO terminal board) is given according to the setting of parameters by the status of the logic outputs. Polarity may be set for each physical output (in activation, the output transistor is connected/disconnected).

8. Actual pre-ignition set-up procedure

a) Setting of correct parameters for firing sequence of coils, type and number of sensors, starting and rated speed, detonation limits …
b) *“Manual correction of top dead center angle [0.1°]”* parameter reset.
c) *“Desired pre-ignition at rated speed (firing angle before top dead center [0.1°]”* parameter adjustment to desired value of pre-ignition at rated speed.
d) *“Decrease of pre-ignition at starting speed”* parameter setting to zero value.
e) Turning the motor using the starter (without gas) and measurement of actual pre-ignition using the stroboscope.
f) Entering measured value of actual pre-ignition into program (pushbutton “Actual pre-ignition” on tab “Basic” in parameters. Based on the measured value, the program corrects the parameter *“Angle between the starting point of the firing cycle and the top dead center of the first cylinder [°]”* so that the actual engine pre-ignition corresponds to the specified requirement.
g) If necessary, items e) and f) may be repeated until the difference between the desired and the actual pre-ignition advance is less than approximately 5°.
h) *“Decrease of pre-ignition at starting speed”* parameter setting to desired value.
i) Start of engine (with gas); after start and attainment of rated speed at low power (logic outputs “LO speed“ and “Detonations” are inactive), fine tuning of the top dead center phase (by *“Manual correction of top dead center angle [0.1°]”* parameter or by turning element on TMCI1+) so that the actual pre-ignition measured by the stroboscope corresponds to the set parameter (if the pre-ignition is higher, turn in the “+“direction or increase the parameter; if the pre-ignition is lower, turn in the “-“direction or decrease the parameter.