Heinzmann GmbH & Co. KG
Engine & Turbine Management
Am Haselbach 1
D-79677 Schönau / Germany

Phone +49 7673 8208-0
Fax +49 7673 8208-188
E-mail info@heinzmann.com
www.heinzmann.com
V.A.T. No.: DE145551926

HEINZMANN®

Solenoid Valve Technique

Order Information

DARDANOS I

MVC 01-10/20

Manual DG 97 003-e / 02-09

Warning	Read this entire manual and all other publications appertaining to the work to be performed before installing, operating or servicing your equipment. Practice all plant and safety instructions and precautions.
Danger	Failure to follow instructions may result in personal injury and/or damage to property. HEINZMANN will refuse all liability for injury or damage which results from not following instructions
Danger! High Voltage **Danger**	**Please note before commissioning the installation:** Before starting to install any equipment, the installation must have been switched dead! Be sure to use cable shieldings and power supply connections meeting the requirements of the *European Directive concerning EMI*. Check the functionality of the existing protection and monitoring systems.
Danger	**To prevent damages to the equipment and personal injuries, it is imperative that the following monitoring and protection systems have been installed:** Overspeed protection acting independently of the speed governor Overtemperature protection HEINZMANN will refuse all liability for damage which results from missing or insufficiently working overspeed protection **Generator installation will in addition require:** Overcurrent protection Protection against faulty synchronization due to excessive frequency, voltage or phase differences Reverse power protection
	Overspeeding can be caused by: Failure of the voltage supply Failure of the actuator, the control unit or of any accessory device Sluggish and blocking linkage

Warning	**Electronically controlled injection (MVC) will in addition require to observe the following:** With **Common Rail** systems a separate mechanical flow limiter must be provided for each injector pipe. With **Pump-Pipe-Nozzle (PPN)** and **Pump Nozzle (PNE)** systems fuel release may be enabled only by the movement of control piston of the solenoid valve. This is to inhibit fuel from being delivered to the injection nozzle in case of seizure of the control piston.
Warning	The examples, data and any other information in this manual are intended exclusively as instruction aids and should not be used in any particular application without independent testing and verification by the person making the application.
Danger	Independent testing and verification are especially important in any application in which malfunction might result in personal injury or damage to property.
	HEINZMANN make no warranties, express or implied, that the examples, data, or other information in this volume are free of error, that they are consistent with industry standards, or that they will meet the requirements for any particular application.
	HEINZMANN expressly disclaim the implied warranties of merchantability and of fitness for any particular purpose, even if **HEINZMANN** have been advised of a particular purpose and even if a particular purpose is indicated in the manual.
	HEINZMANN also disclaim all liability for direct, indirect, incidental or consequential damages that result from any use of the examples, data, or other information contained in this manual.
	HEINZMANN make no warranties for the conception and engineering of the technical installation as a whole. This is the responsibility of the user and of his planning staff and specialists. It is also their responsibility to verify whether the performance features of our devices will meet the intended purposes. The user is also responsible for correct commissioning of the total installation.

Contents

1 General Information

Customer

Company:

Contact Person:

Phone:

Fax:

E-Mail:

Order-No.

Customer:

HEINZMANN:

Connection Diagram-No.

ESK:

Engine

Type:

Power: kW at rpm

Application

- ☐ Generator
- ☐ Vehicle
- ☐ Locomotive
- ☐ Marine
- ☐ Industrial Engine
- ☐

2 Injection System

2.1 System

☐ PPN (Pump-Pipe-Nozzle)

☐ PNU (Pump-Nozzle-Unit)

☐ CR (Common Rail)

Manufacturer:

Designation:

2.2 Solenoid

☐ HEINZMANN-Solenoid Type:

☐ other Type:

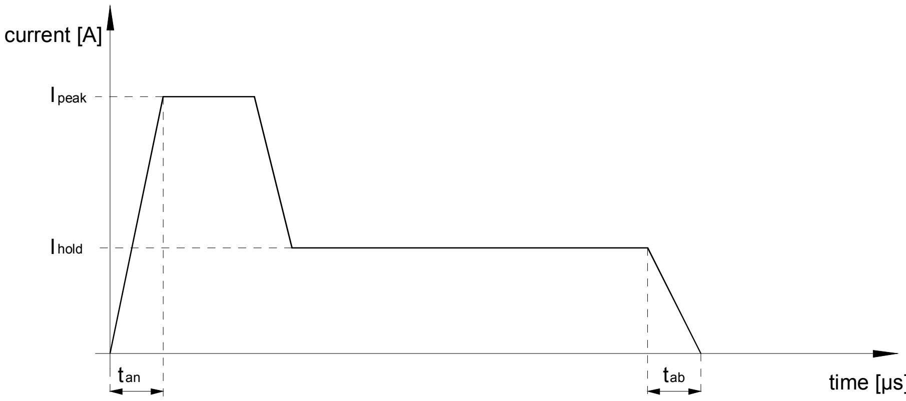


Fig 1: Current Curve

Supply Voltage:	V	=	V
Boost Current:	I_{peak}	=	A
Holding Current:	I_{hold}	=	A
Boost Time:	t_{an}	=	µs
Switch-off Time:	t_{ab}	=	µs
Resistance:	R_{20}	=	Ω
Inductivity:	L	=	mH
Adjusting Force:	F	=	N
Pull-back Spring Force:	F_1	=	N
Moved Mass:	m	=	g

3 Engine Data

Number of Cylinders:

Power per Cylinder: kW/Cyl.

Engine Power: kW at rpm

Firing Table:

For in-line engines, please use the letter 'A' do designate the individual cylinders. For Vee-type engines, use the letter 'A' to designate the first cylinder bank and the letter 'B' to designate the second cylinder bank. Please enter the TDC's specified in degrees crankshaft angle for each cylinder. In doing so, proceed in accordance with the firing order, i.e., the sequence of the TDC angles should be in ascending order.

Firing Order-No.	Cylinder Designation	Top Dead Centre (° CS)
1	A1	0
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

4 Measuring Methods for Determining the Crankshaft Angle

It is the position of the piston that decides on the right injection timing for each cylinder. In order to determine the exact position of the crankshaft and hence of the individual cylinder piston, several different measuring methods based on different mounting locations of the angular sensors are being offered.

4.1 Measuring Accuracy

As accuracy of crankshaft angle determination is crucial for injection accuracy there should be supplied new information on the angle for every 6 degrees crankshaft. This means that at least 60 teeth will be required when the sensor is mounted to the crankshaft, and 120 teeth when mounted to the camshaft. By preference, the teeth should be twice these numbers to obtain an accuracy of 3 degrees crankshaft.

To determine the angular position a specific measuring wheel with rectangular tooth profile should be used if possible.

4.2 Measuring Methods

To determine speed and angular position two speed inputs and one measuring pin input (phase sensor) are provided as a maximum.

The following figure offers an overview of the diverse measuring methods to be considered:

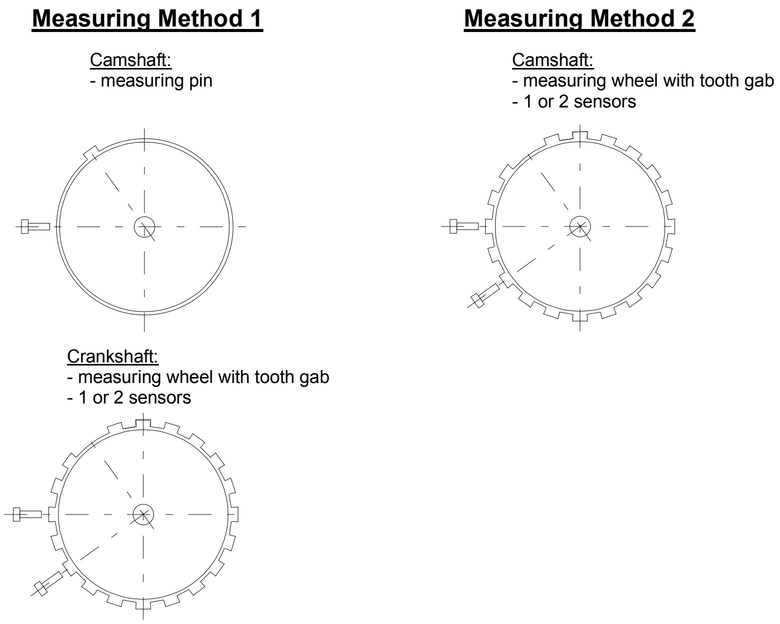
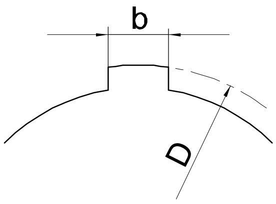


Fig 2: Methode of Measuring

The standard measuring method (measuring method 1) uses one speed sensor on the crankshaft with a tooth gap and a measuring pin on the camshaft serving as a phase sensor. For reasons of redundancy a second crankshaft sensor can be provided.

The speed sensors can be mounted to either the crankshaft or the camshaft. Crankshaft mounting should be preferred since the number of teeth the sensor sees during one revolution will be greater and therefore enhance accuracy of angular measurement.

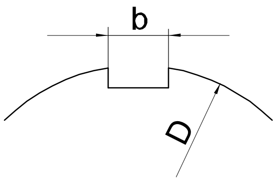
The measuring pin on the camshaft can be designed in various ways:



☐ Single Tooth

b = mm

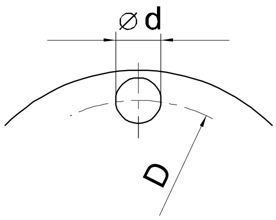
D = mm



☐ Single Gap

b = mm

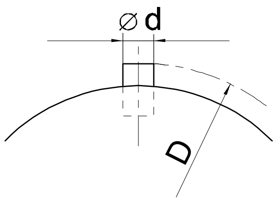
D = mm



☐ Single Pin

d = mm

D = mm



☐ Single Pin

d = mm

D = mm

For the measuring wheel, the following information is needed :

Tooth Breadth: b = mm

Measuring Wheel Diameter: D = mm

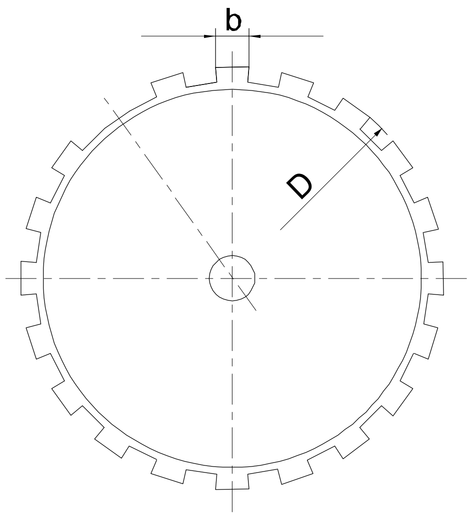


Fig 3: Tooth Gap and Measuring Wheel Diameter

The position of the tooth gap resp. of the measuring pin must be determined exactly. These values are crucial with regard to the angular accuracy of control. The ignition TDC of the cylinder selected first (cylinder A1, TDC is equivalent to 0° crankshaft angle) is to be used as a reference point. All distances (including that of the tooth gap or of the measuring pin on the camshaft) are to be specified in degrees crankshaft angle **before** TDC of cylinder A1.

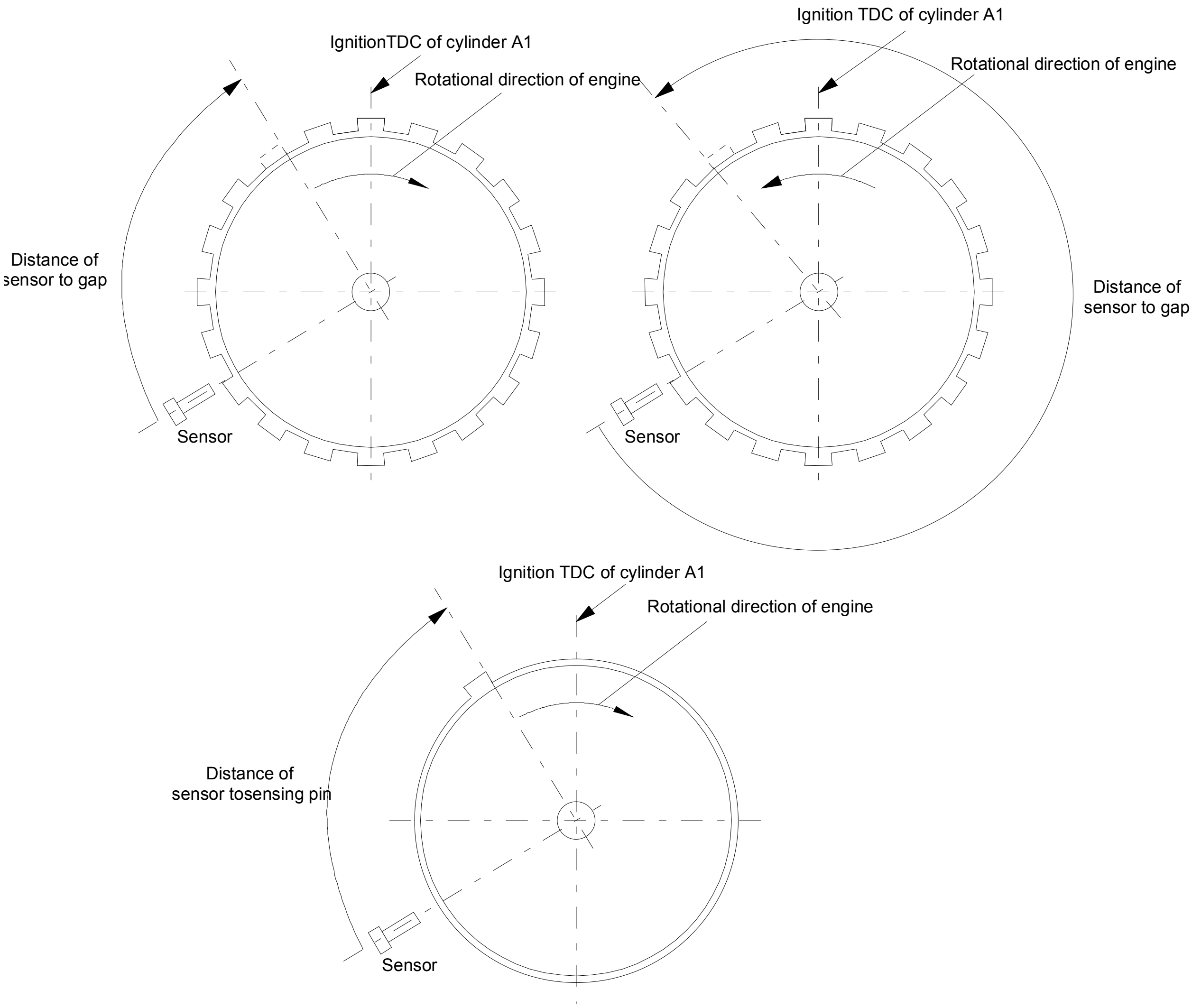


Fig 4: Distance from TDC to Measuring Gap resp. to Measuring Pin

To determine the distance, the crankshaft is rotated into a position where cylinder A1 is exactly at TDC (ignition TDC). With the engine in this position, the distance between the centre of the sensor and the beginning of the gap is measured by degrees crankshaft starting from the sensor in direction of engine rotation. In like manner, the phase sensor distance is to be determined.

☐ **Speed Sensor on Crankshaft**

Number of teeth on crankshaft (gap is counted as one tooth) Teeth

☐ Measuring Method 1: Speed Sensor on Crankshaft, Wheel with Tooth Gap

When using three sensors, this measuring method offers full redundancy in case any of the sensors should fail. If operation is without camshaft measuring pins or in case the pin is at fault, the gap position will be determined during start-up by means of a trial procedure (symbol 224 \f "Wingdings" \s 12 slightly delayed engine start).

☒ Speed Sensor on Meas. Wheel Sensor Centre-Gap Beginning: °Crank

☐ Meas. Pin on Camshaft Sensor Centre-Pin Beginning: °Crank

☐ 2nd Speed Sensor Sensor Centre-Gap Beginning: °Crank

☐ **Speed Sensor on Camshaft**

Number of teeth on crankshaft (gap is counted as one tooth) Teeth

☐ Measuring Method 2: Speed Sensor on Camshaft, Wheel with Tooth Gap

When using two sensors, this measuring method offers full redundancy in case one of the sensors should fail. As sensor location is on the camshaft, accuracy of angular measurment should be ensured by using a measuring wheel with a number of teeth sufficiently large.

☒ Speed Sensor on Meas. Wheel Sensor Centre-Gap Beginning: °Crank

☐ 2nd Speed Sensor Sensor Centre-Gap Beginning: °Crank

As regards other measuring methods arrangements can be made with HEINZMANN any time.

5 Sensors

The below table gives an overview of the numbers and types of sensors that can be connected to the MVC 01-10/20:

Type	Number
Pickups	3
Setpoint Inputs	1 (2)*
Pressure Sensors	3 (2)*
Temperature Sensors	5

*) When using two setpoint inputs, there will be only two pressure sensor inputs available.

All sensors are described in the Manual “DARDANOS“ No. MV 99 002-e.

5.1 Pickups

It is recommended to use Hall sensors by HEINZMANN as angular position sensors. These sensors have been specially developed for precise determination of angular positions.

The suitability of sensors by other manufacturers can be examined on request. For reasons of accuracy, it is not recommenden to use inductive sensors.

Pickup 1:

- ☐ HEINZMANN-Hall Sensor HIA 31 - 46
- ☐ HEINZMANN-Hall Sensor HIA 31 - 76
- ☐ other Type:

Pickup 2:

- ☐ HEINZMANN-Hall Sensor HIA 31 - 46
- ☐ HEINZMANN-Hall Sensor HIA 31 - 76
- ☐ other Type:

Pickup for Measuring Pin:

- ☐ HEINZMANN-Hall Sensor HIA 31 - 46
- ☐ HEINZMANN-Hall Sensor HIA 31 - 76
- ☐ other Type:

5.2 Setpoint Adjuster

There is a maximum of 2 analogue inputs for setpoint adjustement available. These have to be preconfigured by hardware during production in the factory.

- ☐ Setpoint 1
  - ☐ HEINZMANN Setpoint Potentiometer SW 01 - 1 - b
  - ☐ HEINZMANN Setpoint Potentiometer SW 02 - 10 - b
  - ☐ other:
    - ☐ Current Input 4..20 mA
    - ☐ Voltage Input 0..5 V
    - ☐ Range:

- ☐ Setpoint 2
  - ☐ HEINZMANN Setpoint Potentiometer SW 01 - 1 - b
  - ☐ HEINZMANN Setpoint Potentiometer SW 02 - 10 - b
  - ☐ other:
    - ☐ Current Input 4..20 mA
    - ☐ Voltage Input 0..5 V
    - ☐ Range:

5.3 Pressure Sensors

The pressure sensor inputs can be configured for pressure transducers with current signal (4..20 mA) or voltage signal (0..5 V). Hence these inputs have to be preconfigured by hardware during production in the factory.

HEINZMANN sensors provide current signals of 4..20 mA.

- ☐ Boost Pressure
  - ☐ Boost pressure sensor without additional diecast housing
    - ☐ HEINZMANN Sensor DSL 01 - 02 (Range 0..2 bar)
    - ☐ HEINZMANN Sensor DSL 01 - 05 (Range 0..5 bar)
    - ☐ HEINZMANN Sensor DSL 01 - 10 (Range 0..10 bar)
  - ☐ Boost pressure Sensor with additional diecast housing and terminal strip
    - ☐ HEINZMANN Sensor DSG 04 - 02 (Range 0..2 bar)
    - ☐ HEINZMANN Sensor DSG 04 - 05 (Range 0..5 bar)
    - ☐ HEINZMANN Sensor DSG 04 - 10 (Range 0..10 bar)
  - ☐ other:

    Type:

    Manufacturer:

    Range: bar up to bar

    - ☐ Current Input 4..20 mA
    - ☐ Voltage Input 0..5 V
    - ☐ other:

☐ <u>Oil Pressure</u>

- ☐ HEINZMANN Sensor DSO 01 - 06 (Range 0..6 bar)
- ☐ HEINZMANN Sensor DSO 01 - 10 (Range 0..10 bar)
- ☐ other:

  Type:

  Manufacturer:

  Range: bar up to bar

  - ☐ Current Input 4..20 mA
  - ☐ Voltage Input 0..5 V
  - ☐ other:

☐ <u>Rail Pressure Sensor (required for Common Rail)</u>

  Type:

  Manufacturer:

  Range: bar up to bar

  - ☐ Current Input 4..20 mA
  - ☐ Voltage Input 0..5 V
  - ☐ other:

5.4 Temperature Sensors

There are up to 5 temperature sensor inputs configured for using PT 1000, PT 200 or Ni 1000 sensors. These inputs have to be preconfigured by hardware during production in the factory.

☐ Cooling Medium Temperature

- ☐ HEINZMANN Sensor TS 01 - 28 - PT 1000
- ☐ other:

☐ Boost Pressure Temperature

- ☐ HEINZMANN Sensor TS 01 - 28 - PT 1000
- ☐ other:

☐ Oil Temperature

- ☐ HEINZMANN Sensor TS 01 - 28 - PT 1000
- ☐ other:

☐ Fuel Temperature

- ☐ HEINZMANN Sensor TS 01 - 28 - PT 1000
- ☐ other:

☐ Exhaust Temperature

- ☐ HEINZMANN Sensor TS 02 - 60 - PT 200
- ☐ HEINZMANN Sensor TS 02 - 100 - PT 200
- ☐ other:

☐

- ☐ HEINZMANN Sensor TS 01 - 28 - PT 1000
- ☐ other:

☐

- ☐ HEINZMANN Sensor TS 01 - 28 - PT 1000
- ☐ other:

6 Switch Inputs (Digital Inputs)

The functionality of the switch inputs, such as switches for idle speed or fixed speeds, change-over of droop, etc., is discussed in the manual „Basic Information Electronically Controlled Injection Systems, Level 6“ No. MV 99 003-e and should be decided upon in coordination with HEINZMANN.

No.	Activity	Function
1	☐ active with contact closed ☐ active with contact open	Engine Stop
2	☐ active with contact closed ☐ active with contact open	
3	☐ active with contact closed ☐ active with contact open	
4	☐ active with contact closed ☐ active with contact open	
5	☐ active with contact closed ☐ active with contact open	
6	☐ active with contact closed ☐ active with contact open	
7	☐ active with contact closed ☐ active with contact open	
8	☐ active with contact closed ☐ active with contact open	
9	☐ active with contact closed ☐ active with contact open	
10	☐ active with contact closed ☐ active with contact open	
11	☐ active with contact closed ☐ active with contact open	

7 Analogue Outputs

There is a maximum of 2 analogue outputs available. These have to be preconfigured by hardware as current or voltage outputs during production in the factory.

☐ Output 1

Output Range:
- ☐ 4..20 mA
- ☐ 0..5 V
- ☐ other: ....

Output Parameter:
- ☐ Speed
- ☐ Injection Quantity
- ☐ other:

Parameter Range:

Minimum Value:

Maximum Value:

☐ Output 2

Output Range:
- ☐ 4..20 mA
- ☐ 0..5 V
- ☐ other: ....

Output Parameter:
- ☐ Speed
- ☐ Injection Quantity
- ☐ other:

Parameter Range:

Minimum Value:

Maximum Value:

8 Digital Outputs

☐ Output 1

- ☐ high active
- ☐ low active

☐ Output 2

- ☐ Common Alarm
  - ☒ high active
- ☐ other:
  - ☐ high active
  - ☐ low active19

☐ Output 3

- ☐ Emergency Stop
  - ☒ low active
- ☐ other:
  - ☐ high active
  - ☐ low active

☐ Output 4

- ☐ high active
- ☐ low active

9 Configuration Data

The following lists are to specify the most relevant configuration data for first commissioning the installation.

The possibilities of pre-defining setpoints are covered by the manual „Basic Information for Electronically Controlled Injection Systems, Level 6" No. MV 99 003-e and should be coordinated with HEINZMANN.

9.1 Speeds

Minimum Speed (Idle Speed) rpm

Maximum Speed rpm

Overspeed rpm

☐ analogue Speed Setpoint 1

☐ analogue Speed Setpoint 2

☐ Switch Inputs „Increase Speed / Decrease Speed" (Motor Potentiometer)

☐ Fixed Speed

Fixed Speed 1 rpm

Fixed Speed 2 rpm

☐ Temperature dependent Increase of Idle Speed

Idle Speed to Increase to rpm

Temperature for Normal Idle Speed °C....................

Temperature for Increased Idle Speed °C....................

☐ Switch-over to Second Speed Range

Minimun Speed 2 rpm

Maximum Speed 2 rpm

9.2 Speed Ramp

☐ Speed Ramp

Rate of increasing Speed Change rpmps

Rate of decreasing Speed Change rpmps

9.3 Droop

Droop 1

- ☐ Droop 1 = 0 % (isochronous)
- ☐ Droop 1 — %
  - Rated Speed — rpm
  - Zero-load Injection Quantity — mm³/stroke
  - Full-load Injection Quantity — mm³/stroke

- ☐ Switch-over to Droop 2
  - ☐ Droop 2 = 0 % (isochronous)
  - ☐ Droop 2 — %
  - Rated Speed — rpm
  - Zero-load Injection Quantity — mm³/stroke
  - Full-load Injection Quantity — mm³/stroke

9.4 Engine Start

Starter Speed (approx.) — rpm

- ☐ Fixed Starting Quantity Adjustment
  - Starting Quantity — mm³/Hub
- ☐ Variable Starting Quantity Adjustment
  - Starting Quantity 1 — mm³/stroke
  - Starting Quantity 2 — mm³/stroke
  - Time for Starting Quantity 1 — s
  - Ramping Time for Starting Quantity 1 → Starting Quantity 2 — s
- ☐ Temperature dependent Starting Quantity Adjustment
  - Starting Quantity for cold Engine — mm³/stroke
  - Starting Quantity for warm Engine — mm³/stroke
  - Temperature of cold Engine — °C
  - Temperature of warm Engine — °C
- ☐ Start Ramp
  - Start Ramp to begin at — rpm
  - Rate of Increasing Speed Change — rpmps

10 Injection Maps

10.1 Pump-Pipe-Nozzle resp. Pump-Nozzle-Unit

10.1.1 Map of Injection Duration

With these systems, injection pressure is produced by the camshaft via an injection cam. Injection pressure will therefore depend on speed and injection quantity.

On the other hand, the duration of injection will have to be adjusted to obtain equal injection quantities at different speeds. In order to be able to correctly adjust injection duration the characteristic pump map is required.

As start of injection will additionally affect injection duration, the possibility of entering characteristic pump maps for four different injection beginnings has been provided. There is linear interpolation for intermediate map values.

Please, enter in the following characteristic maps the durations of injection specified in degrees crankshaft angle in dependence of engine speed and injection quantity. It is absolutely necessary that the map starts with injection quantity 0 mm³/stroke and that the lowest speed point is provided for engine start.

This map must be entered for four different delivery beginnings. The values for engine speed and injection quantity must be identical for all maps.

Map 1: Start of Delivery: ° crank shaft before top dead centre

Inj. Quantity [mm³/stroke]	Engine Speed [rpm]				
0					

Map 2: Start of Delivery: ° crank shaft before top dead centre

Inj. Quantity [mm³/stroke]	Engine Speed [rpm]				
0					

Map 3: Start of Delivery: ° crank shaft before top dead centre

Inj. Quantity [mm³/stroke]	Engine Speed [rpm]				
0					

Map 4: Start of Delivery: ° crank shaft before top dead centre

Inj. Quantity [mm³/stroke]	Engine Speed [rpm]				
0					

10.2 Common Rail

10.2.1 Map of Injection Duration

Common rail systems offer the possibility of generating the injection pressure independently of engine speed and load. To inject the correct amount of fuel at a certain pressure will require a characteristic map indicating duration of delivery in dependence of injection pressure and injection quantity.
Duration of injection is to be specified in milliseconds. It is absolutely necessary that the map starts with injection quantity 0 mm³/stroke and that the lowest speed point is provided for engine start.

Inj. Quantity [mm³/stroke]	Injection Pressure [bar]					
0						

10.2.2 Map of Injection Pressure

In order to optimally adjust injection pressure for every working point of the engine, a injection pressure map has been provided. This map should list the injection pressures in dependence of engine speed and injection quantity.

Inj. Quantity [mm³/stroke]	Speed [rpm]					

10.3 Map of Start of Delivery

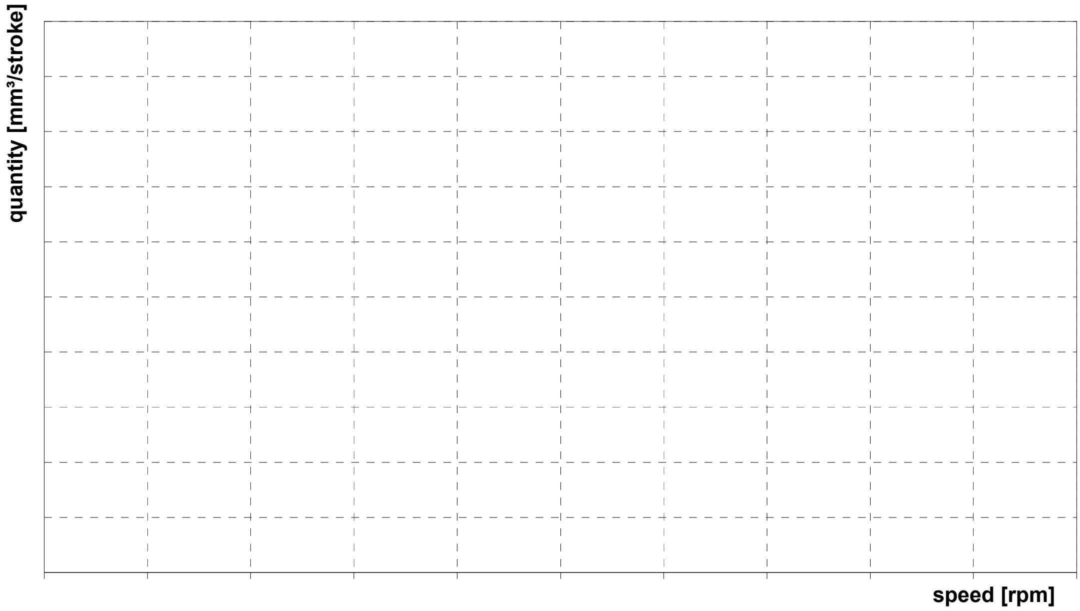
Start of delivery may be varied in dependence of speed and load. By this, it will be possible to tune the engine for optimum consumption and exhaust gas values.

The values to be entered in the start of delivery map are the starts of delivery specified in degrees crankshaft before TDC in dependence of engine speed and injection quantity.

Inj. Quantity [mm³/stroke]	Speed [rpm]							

11 Quantities Limitations

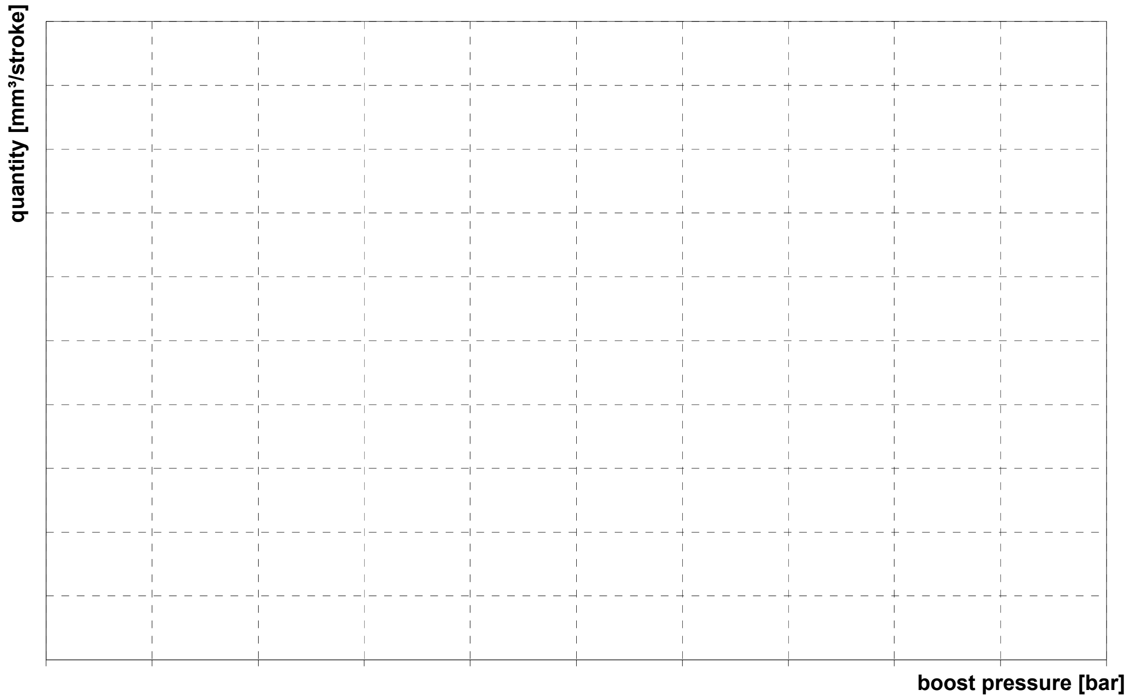
11.1 Speed dependent Quantity Limitation



No.	Speed [rpm]	Quantity [mm³/stroke]
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

No.	Speed [rpm]	Quantity [mm³/stroke]
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

11.2 Boost Pressure dependent Quantity Limitation



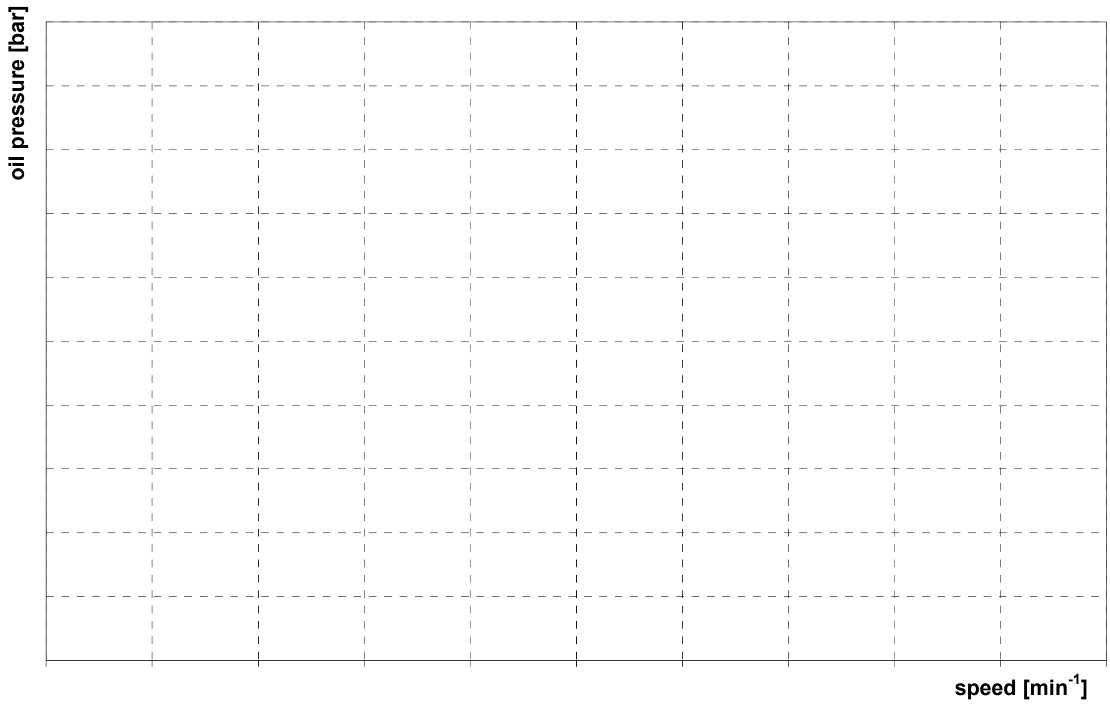
No.	Boost Pressure [bar]	Quantity [mm³/stroke]
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

12 Monitoring Functions

12.1 Speed dependent Oil Pressure Monitoring

☐ Oil Pressure Warning

☐ Oil Pressure Emergency Stop



No.	Speed [rpm]	Warning [bar]
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

No.	Speed [rpm]	Emergency Stop [rpm]
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

13 Harness

To avoid undesirable disturbances during operation, care should be taken that suitable cable materials, sufficient line cross sections and correct cable shielding be used for cabling. It is therefore recommended to order the cable harness together with the other components directly from HEINZMANN. Every cable harness will be manufactured according to the following customer specifications and subsequently tested.

Which cables are required will depend on the type of application and on the number of sensors.

L 1.0	CU - Diagnosis Unit / Programer Unit	.... cm
L 2.1	CU - Speed/Angle Sensor 1	.... cm
L 2.2	CU - Speed/Angle Sensor 2	.... cm
L 2.3	CU - Camshaft Index Sensor	.... cm
L 2.4	CU - Analogue Input Signal 2	.... cm
L 2.5	CU - Analogue Input Signal 3	.... cm
L 2.6	CU - Temperature Sensor 1	.... cm
L 2.7	CU - Temperature Sensor 2	.... cm
L 3.1	CU - Analogue Input Signal 4	.... cm
L 3.2	CU - Temperature Sensor 3	.... cm
L 3.3	CU - Temperature Sensor 4	.... cm
L 3.4	CU - Temperature Sensor 5	.... cm
L 3.5	CU - Digital Input Signal 10	.... cm
L 3.6	CU - Digital Input Signal 11	.... cm
L 3.7	CU - PWM-/Frequency Input Signal	.... cm
L 4.1	CU - Analogue Input Signal 1	.... cm
L 4.2	CU - Analogue Output Signal 1	.... cm
L 4.3	CU - Analogue Output Signal 2	.... cm
L 4.4	CU - PWM-/Frequency Input Signal (only if L 3.7 is not used)	.... cm
L 4.5	CU - CAN- Bus 1	.... cm
L 4.6	CU - CAN- Bus 2	.... cm
L 5.1	CU - Power Supply	.... cm
L 5.2	CU - Digital Input Signal 1	.... cm
L 5.3	CU - Digital Input Signal 2	.... cm

L 5.4	CU - Digital Input Signal 3	.... cm	
L 5.5	CU - Digital Input Signal 4	.... cm	
L 5.6	CU - Digital Input Signal 5	.... cm	
L 5.7	CU - Digital Input Signal 6	.... cm	
L 5.8	CU - Digital Input Signal 7	.... cm	
L 5.9	CU - Digital Input Signal 8	.... cm	
L 5.10	CU - Digital Input Signal 9	.... cm	
L 5.11	CU - Digital Input Signal 1	.... cm	
L 5.12	CU - Digital Output Signal 2	.... cm	
L 5.13	CU - Digital Output Signal 3	.... cm	
L 5.14	CU - Digital Output Signal 4	.... cm	
L 6.1	CU - Bank A Solenoid Valve 1	.... cm	(max. 20 m)
L 6.2	CU - Bank A Solenoid Valve 2	.... cm	(max. 20 m)
L 6.3	CU - Bank A Solenoid Valve 3	.... cm	(max. 20 m)
L 6.4	CU - Bank A Solenoid Valve 4	.... cm	(max. 20 m)
L 6.5	CU - Bank A Solenoid Valve 5	.... cm	(max. 20 m)
L 6.6	CU - Bank A Solenoid Valve 6	.... cm	(max. 20 m)
L 6.7	CU - Bank A Solenoid Valve 7	.... cm	(max. 20 m)
L 6.8	CU - Bank A Solenoid Valve 8	.... cm	(max. 20 m)
L 6.9	CU - Bank A Solenoid Valve 9	.... cm	(max. 20 m)
L 6.10	CU - Bank A Solenoid Valve 10	.... cm	(max. 20 m)
L 6.11	CU - PWM-Output Signal 1	.... cm	
L 7.1	CU - Bank B Solenoid Valve 1	.... cm	(max. 20 m)
L 7.2	CU - Bank B Solenoid Valve 2	.... cm	(max. 20 m)
L 7.3	CU - Bank B Solenoid Valve 3	.... cm	(max. 20 m)
L 7.4	CU - Bank B Solenoid Valve 4	.... cm	(max. 20 m)
L 7.5	CU - Bank B Solenoid Valve 5	.... cm	(max. 20 m)
L 7.6	CU - Bank B Solenoid Valve 6	.... cm	(max. 20 m)
L 7.7	CU - Bank B Solenoid Valve 7	.... cm	(max. 20 m)
L 7.8	CU - Bank B Solenoid Valve 8	.... cm	(max. 20 m)
L 7.9	CU - Bank B Solenoid Valve 9	.... cm	(max. 20 m)
L 7.10	CU - Bank B Solenoid Valve 10	.... cm	(max. 20 m)
L 7.11	CU - PWM-Output Signal 2	.... cm	

14 Further Details