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.de
www.heinzmann.com

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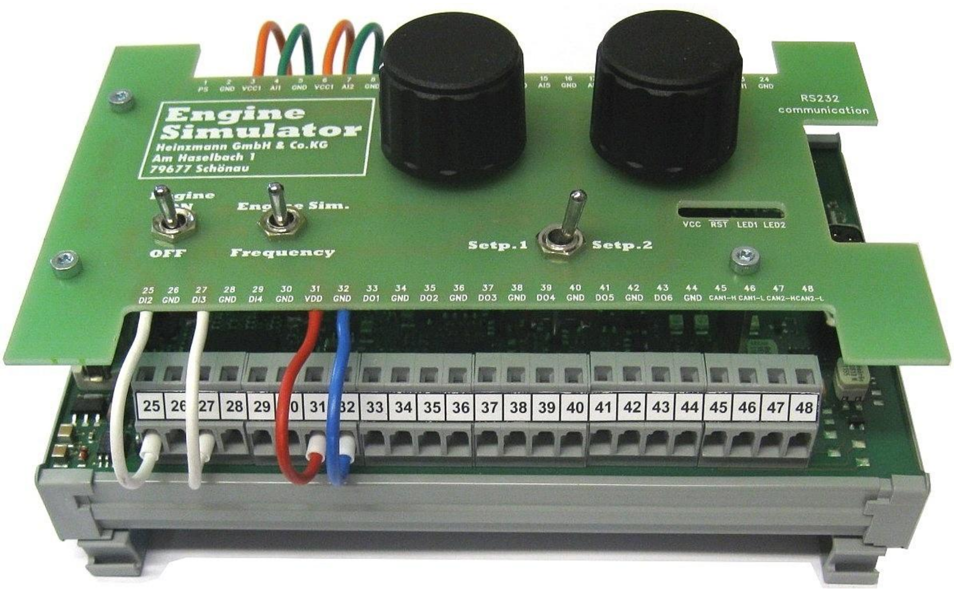
HEINZMANN®

Engine & Turbine Management

Engine Simulator



Version information

Version	Description of changes	Date	Edited by
1.00	Created	11.04.11	R. Zeller
1.01	Section ↑*2.6* Multiple gap wheel and ↑*2.7 Misfire* signal generation created	13.05.11	R. Zeller
1.02	Section ↑*2.8 Signal* pattern generation created	05.07.11	R. Zeller
1.03	Section ↑*2.2.4* Generating interference signals on the crankshaft and ↑*2.5 Engine* speed signal development created	04.08.11	R. Zeller
1.04	Section ↑ *2.2.5* Generating interference signals on the camshaft created	09.09.11	R. Zeller
1.05	Frequency range added in section ↑*2.1* General	22.12.11	R. Zeller
1.06	Section ↑ *2.2.4* Generating interference signals on the crankshaft revised	12.04.12	R. Zeller
1.07	Section ↑*2.9* Output signal generation added	27.07.12	R. Zeller

DANGER

The appropriate manuals must be thoroughly studied before installation, initial start-up and maintenance.

All instructions pertaining to the system and safety must be followed in full. Non-observance of the instructions may lead to injury to persons and/or material damage.

HEINZMANN shall not be held liable for any damage caused through non-observance of instructions.

Independent tests and inspections are of particular importance for all applications in which a malfunction could result in injury to persons or material damage.

All examples and data, as well as all other information in this manual are there solely for the purpose of instruction and they may not be used for special application without the operator running independent tests and inspections beforehand.

HEINZMANN does not guarantee, neither expressly nor tacitly, that the examples, data or other information in this manual is free from error, complies with industrial standards or fulfils the requirements of any special application.

WARNING

To avoid any injury to persons and damage to systems, the following monitoring and protective systems must be provided:

– Overspeed protection independent of the rpm controller

HEINZMANN shall not be held liable for any damage caused through missing or insufficiently rated overspeed protection.

– thermal overload protection

The following must also be provided for alternator systems:

– Overcurrent protection
– Protection against faulty synchronisation for excessively-large frequency, voltage or phase difference
– Directional contactor

The reasons for overspeeding may be:

– Failure of positioning device, control unit or its auxiliary devices
– Linkage sluggishness and jamming

WARNING

The following must be observed before an installation:

– Always disconnect the electrical mains supply before any interventions to the system.
– Only use cable screening and mains supply connections that correspond with the *European Union EMC Directive*
– Check the function of all installed protection and monitoring systems

	**Please observe the following for electronically controlled injection (MVC):** – For **common rail** systems each injector line must be equipped with a separate mechanical flow-rate limiter – For **unit pump** (PLD) and **pump-injector unit** (PDE) systems, the fuel enable is first made possible by the solenoid valve’s control plunger motion. This means that in the event of the control plunger sticking, the fuel supply to the injection valve is stopped.
	As soon as the positioning device receives power, it can actuate the controller output shaft automatically at any given time. The range of the controller shaft or control linkage must therefore be secured against unauthorised access.
	HEINZMANN expressly rejects any implied guarantee pertaining to any marketability or suitability for a special purpose, including in the event that **HEINZMANN** was notified of such a special purpose or the manual contains a reference to such a special purpose.
	HEINZMANN shall not be held liable for any indirect and direct damage nor for any incidental and consequential damage that results from application of any of the examples, data or miscellaneous information as given in this manual.
	HEINZMANN shall not provide any guarantee for the design and planning of the overall technical system. This is a matter of the operator its planners and its specialist engineers. They are also responsible for checking whether the performances of our devices match the intended purpose. The operator is also responsible for a correct initial start-up of the overall system.

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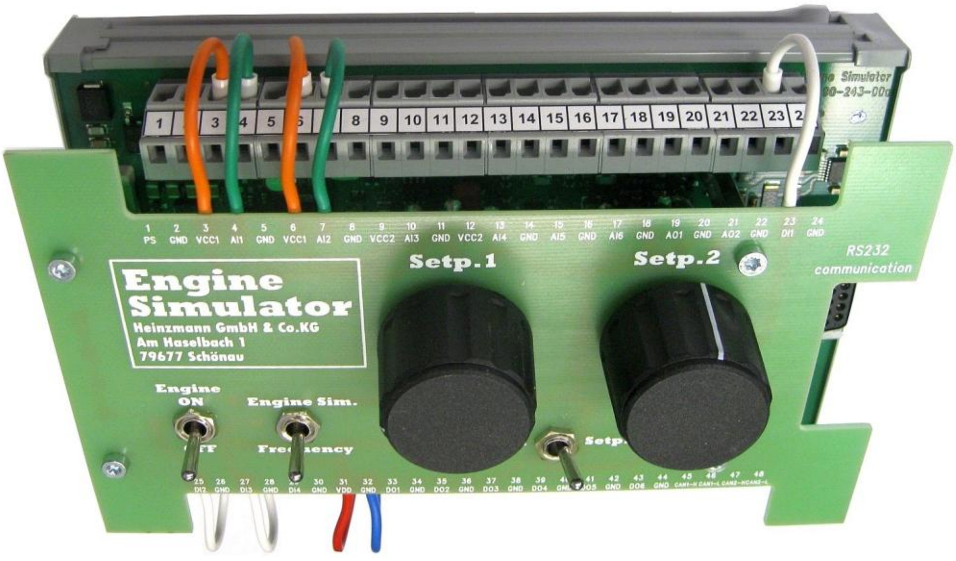
1 General

The engine simulator hardware is equipped with the following inputs and outputs:

- 6 x frequency/PWM/digital outputs
- 4 x frequency/PWM/digital inputs
- 6 x analogue inputs
    - 4 x 0..5 V
    - 2 x 0..25 mA
- 2 x analogue outputs
    - 1 x 0..5 V
    - 1 x 0..25 mA
- 2 x CAN BUS
- 1 x RS232
- 48-pin extension plug



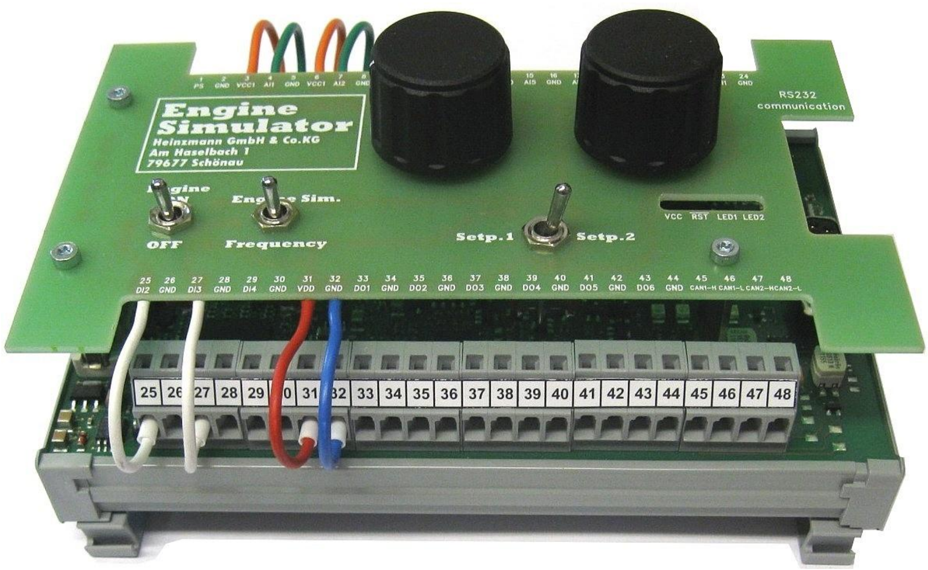


Fig. 1 Views of engine simulator

2 Standard simulator

2.1 General

The engine simulator can be used as a simulator for frequency or the engine, i.e. also in engine-speed-controlled operation. It generates the signals of two crankshaft sensors and one camshaft sensor via three frequency outputs. The configuration of these signals can be freely selected.

The start condition can also be defined to ensure the engine is always started at the identical point. This is required if there are investigations into synchronisation.

The minimum frequency of the simulator is 5 Hz. The maximum frequency is set to 10000 Hz by default. Theoretically it is possible to have higher frequencies. This could be implemented by request.

2.2 Signal generation

The signals from PickUp1 and PickUp2 are generated independently from each other, i.e. they are in no way connected. This means that it is possible that the PickUp2 crankshaft gap position may shift relatively towards that of PickUp1. Insofar as PickUp1 and PickUp2 have the same number of teeth, this shift is barely or not at all visible.

However, the camshaft signal is produced directly by PickUp1, i.e. this signal is exactly synchronous with the PickUp1 signal. The signal width of the camshaft signal corresponds to a PickUp1 tooth.

An internal tooth counter is used to generate the signal. This tooth counter runs from 1 to double the number of teeth (i.e. for 60 teeth from 1 to 120). The PickUp1 gap position is always generated at tooth no. 1 and the number of teeth set in the parameters. The PickUp2 gap position and the camshaft positions are entered relative to tooth number 1 by PickUp1.

The frequency creation always relates to PickUp1. The signals from PickUp2 and CamIndex are generated from this frequency.

2.2.1 Configuration of the PickUp1 signals

1	TeethPickUp1	Number of teeth from PickUp1
2	NumberOfGapPickUp1	Number of gaps
3	ToothRatioPickUp1	Tooth ratio for PickUp1 signal
4	StartToothNo	Tooth number at which the signal generation starts upon engine start (see also 4110)
5	FrequencyRampPickUp1	Speed at which the frequency changes
4001	PickUp1GapHighOrLow	Polarity of the signal in the gap (taken over only at zero speed)

4005	PU1FrequencyRampOn	Activation of the frequency ramp
4110	ResetToothNoAtStop	Reset tooth counter at engine stop. This will start each engine start in the same position

2.2.2 Configuration of the PickUp2 signal

11	TeethPickUp2	Number of teeth from PickUp2
12	NumberOfGapPickUp2	Number of gaps
13	ToothRatioPickUp2	Tooth ratio for PickUp2 signal
14	TeethOffsetForGapPU2	Tooth offset of the PickUp2 gap relative to the PickUp1 tooth counter (taken over only at zero speed)
15	FrequencyRampPickUp2	Speed at which the frequency changes
4011	PickUp2GapHighOrLow	Polarity of the signal in the gap (taken over only at zero speed)
4015	PU1FrequencyRampOn	Activation of the frequency ramp

2.2.3 Configuration of the CamIndex signal

21	CamSimulationMode	Selection of the camshaft signal 0 = deactivated 1 = single pulse 2 = freely configurable 3 = trigger disc with 4+1 teeth 4 = trigger disc with 6+1 teeth 5 = trigger disc with 8+1 teeth
22	NoOfCamPositions	Number of camshaft signals when the signal is freely configured
24	CamOffset	Tooth offset of the first camshaft signal relative to the PickUp1 tooth counter
2250	CamPositions()	Display of the number of teeth at which a camshaft pulse is created (regarding the PickUp1 tooth counter)
4021	CamIndexHighOrLow	Polarity of the signal (taken over only at zero speed)
6000	CamPositions()	Number of teeth from the camshaft signals if configured freely (regarding the PickUp1 tooth counter)

2.2.3.1 Calculating the CamOffset

In parameter 24, CamOffset, the tooth offset of the first camshaft signal relative to the tooth counter of PickUp1 must be entered. This is the distance used by the MVC control unit as a synchronising criterion. The CamOffset is calculated from the MVC control unit parameters 3 SensorToGapPickUp1 and 5 SensorToCamIndex as follows:

For 3 SensorToGapPickUp1 < 5 SensorToCamIndex the following applies:

24 CamOffset = (720° + 3 SensorToGapPickUp1 - 5 SensorToCamIndex) / 360° * 1 TeethPickUp1

For 3 SensorToGapPickUp1 > 5 SensorToCamIndex the following applies:

24 CamOffset = (3 SensorToGapPickUp1 - 5 SensorToCamIndex) / 360° * 1 TeethPickUp1

2.2.4 Generating interference signals on the crankshaft

A signal failure of PickUp1 or PickUp2 can be simulated by setting the tooth ratio 3 ToothRatioPickUp1 or 13 ToothRatioPickUp2 to 0% or 100%.

To generate a synchronising fault, you can manually briefly change the number of gaps 2 NumberOfGapPickUp1 or 12 NumberOfGapPickUp2 to an incorrect value and immediately back to the correct value.

However, this may cause synchronising faults to apply during one or several revolutions. For this reason, there is also the option to generate a single synchronising fault. It is possible to generate the two faults “gap detected, but tooth expected” and “tooth detected, but gap expected”.

When activating parameter 4002 PU1SyncToothInGap or 4012 PU2SyncToothInGap the gap is one time given as a tooth. An additional synchronising fault can be generated by activating the parameter again.

Via parameter 4003 PU1SyncErrGapInTooth or 4013 PU2SyncErrGapInTooth on the other hand the synchronising fault is generated by inserting one-time a gap instead of a tooth at an arbitrary position. An additional synchronising fault can be generated by activating the parameter again.

2.2.5 Generating interference signals on the camshaft

You can create a signal failure by setting parameter 21 CamSimulationMode to 0 (disabled).

A different configuration than that expected by the control unit may be entered in parameter 21 CamSimulationMode to generate an interference signal.

Insofar as free mode has been selected (21 CamSimulationMode = 2), this can also be performed by varying the number of pulses to be generated in parameter 22 NoOfCam-Positions.

However, this may cause synchronising faults to apply during one or several revolutions. For this reason, there is also the option to generate an individual synchronising fault using parameter 4022 CamIndexSyncErrorOn. Upon activation, a pulse is suppressed once. The pulse to be suppressed can be selected in parameter 25 CamSyncErrorIndex. Enter the index of field 2250 CamPositions() here. It shows the tooth number at which the camshaft pulse is created.

Activating parameter 4022 again will create another synchronising fault.

2.3 Frequency simulation

Switch 2812 SwSimEngineOrFreq must be set to 'Freq' for frequency simulation. Frequency simulation can be (de)activated using switch 2810 SwEngineOn.

The frequency specification can either be specified directly using DcDesk 2000 or using two sensor values (usually potentiometers). Use 4100 FrequencyPotOrPC to select. If the parameter is set to 'PC', the frequency specification is set using parameter 100 FrequencySetpPC.

If they are specified using sensor values, both sensors, 2900 Setpoint1 and 2901 Setpoint2, are used. They are selected using switch 2811 SwSetpoint2Or1.

The frequency generated from these sensors is shown in parameter 2101 FrequencySetp1 and/or 2102 FrequencySetp2.

Parameter 5 FrequencyRampPickUp1 and/or 15 FrequencyRampPickUp2 specify the change speed of the frequency specification.

2.4 Engine simulation

Switch 2812 SwSimEngineOrFreq must be set to 'Engine' to trigger an engine simulation. The engine simulation can be (de)activated using switch 2810 SwEngineOn.

Information on the current torque is required for engine simulation. It is connected in 2902 TorqueInput.

The target torque specification can be specified either directly using DcDesk 2000 or using two sensor values (usually potentiometers). It is selected using 4150 TorquePotOrPC. If the parameter is set to 'PC', the frequency specification is set using parameter 150 TorqueSetpPC.

If they are specified using sensor values, both sensors, 2900 Setpoint1 and 2901 Setpoint2, are used. They are selected using switch 2811 SwSetpoint2Or1.

The torque generated from these sensors is shown in parameters 2201 TorqueSetp1 and/or 2202 TorqueSetp2.

The target torque value the simulator operates with is shown in 2051 EngineTorqueSetp.

Parameter 5 FrequencyRampPickUp1 and/or 15 FrequencyRampPickUp2 specify the change speed of the frequency specification.

The engine's moment of inertia is specified in parameter 200 MomentOfInertia. Smaller values result in a faster engine.

Parameters 6100..6250 are used to specify characteristic maps for the minimum and maximum engine torque. No additional torque is generated above the maximum torque, i.e. if more torque is requested, the engine is overloaded and the engine speed drops.

The percentage value of the current engine torque is defined by 2902 TorqueInput, with regard to these characteristic maps. This torque is shown in 2050 EngineTorque.

The starter speed is specified in parameter 250 StarterSpeed. This starter speed is generated if the engine is off and switch 2810 SwEngineOn goes to 'On'. Insofar as the target torque is smaller than that required for engine start (from characteristic curve), the engine starts.

The starter speed is overlaid by a sine-shaped oscillation to simulate the starter action.

2.5 Engine speed signal development

Instead of simulating an engine, the engine speed signal can also be created using a reproducible specification in which you can define parameters.

For this purpose, switch 2812 SwSimEngineOrFreq must be set to 'Engine'. In function 4101 SpeedCurvOrEngineSim you must also select 'SpeedCurve'.

The engine speed signal can be (de)activated using switch 2810 SwEngineOn.

The engine speed signal must be entered in the following parameters:

7000 SpeedSim:t()	Time for engine speed signal
7300 SpeedSim:n()	Associated engine speed values

As soon as switch input 2810 SwEngineOn is activated, engine speed signal generation begins as per the procedure defined in the parameters. Once the signal has run completely, the last engine speed signal value is maintained.

Deactivation followed by a reactivation of 2810 SwEngineOn generates the same signal sequence.

The frequency ramp is valid also when generating the signal. Deactivate the frequency ramp if the exact procedure as defined in the parameters is to be generated.

2.5.1 Running DcDesk record files

This function therefore also enables DcDesk record files to be played. For this purpose, first save the parameters of both characteristic curves as hzm files and then open this hzm file and the desired rec file in CodeWright. There you can mark the two columns for the time axis and the engine speed value one after the other and transfer them to the hzm file.

It might be advisable to perform this using Excel to compensate for an offset of the time axis and to round off the engine speed values.

2.6 Multiple gap wheel

Some special applications require a multiple gap wheel. In the process, there are several gaps on the measuring wheel and the number of teeth between the individual gaps varies. This enables very fast synchronising as only the number of teeth between the gaps must be counted.

The engine simulator supports the generation of such signals on PickUp1 and PickUp2. Both PickUps create the signal of the same gear wheel (if required, different wheels may also be implemented).

i *In a multiple gap wheel, displacement of the PickUp2 signal using parameter 14 TeethOffsetForGapPU2 upon engine start generates an incorrect PU2 signal and the offset is also incorrect – for this reason, leave parameter 14 at 0 (item for the to-do list).*

In the process, take into account the following parameters:

6	NumberOfMultiGaps	Number of gaps on the gear wheel
2020	MultiGapIndexPickUp1	Displays the gap index PickUp1
2021	MultiGapIndexPickUp2	Displays the gap index PickUp2
4006	PU1MultiGapWheelOn	Activates the multiple gap signal PickUp1
4016	PU2MultiGapWheelOn	Activates the multiple gap signal PickUp2
6050	MultiGapPositions()	Setting parameters of the gap positions

Enter the tooth numbers of the gap positions in field 6050 MultiGapPositions(), i.e. a gap is generated instead of a tooth for each figure. Please ensure that the numbers are entered in ascending order. The last gap position must also exactly correspond to the number of teeth from parameter 1.

For example: MAN special gear wheel with 240 teeth and 8 gaps

1	TeethPickUp1	= 240

5	NumberOfMultiGaps	= 8
4003	PU1MultiGapWheelOn	= 1
6050	MultiGapPositions(0)	= 21
6051	MultiGapPositions(1)	= 63
6052	MultiGapPositions(2)	= 91
6053	MultiGapPositions(3)	= 117
6054	MultiGapPositions(4)	= 149
6055	MultiGapPositions(5)	= 179
6056	MultiGapPositions(6)	= 215
6057	MultiGapPositions(7)	= 240

2.7 Misfire signal generation

The engine simulator can create a misfire signal. However, this is not within the scope of the standard simulator software. This process requires variant 2.

Misfire signal generation stores a table with engine speed values in the control unit. The values can be run on request. This process enables the creation of a reproducible misfire engine speed signal.

4200 MisfireSignalOn   Activating the misfire signal generation

Setting this parameter to 1 will generate the signal. The table stored in the control unit is run once, then the signal is generated "normally" again. Generating the signal can be interrupted by setting the parameter to 0.

This may also be performed using switch function 2814 SwMisfireSignalOn. In the process, switch flank 0 → 1 is evaluated and simulation activated if it is not yet running and would otherwise deactivate.

To ensure that the signal analysis of the connected engine speed sensor operates correctly, it is required to set the correct parameters for the number of teeth and the simulation frequency in the engine simulator and the speed governor.

The engine simulator currently contains the misfire signal of a Guascor 16-cylinder gas-powered engine. In this engine, 12 different cylinders were briefly connected so that the corresponding cylinder did not fire. The engine speed sequence was recorded and can be reproduced using the engine simulator.

The engine had 165 teeth and was operated at 1500 rpm. For the engine simulator this means that a frequency of 4125 Hz must be set.

As a rule, the recorded signal may also be modulated to other signals. However, this no longer corresponds to a real signal sequence.

With the above signal, the recorded signal has a duration of 144 seconds and requires around 600 kB of memory in the control unit.

2.8 Signal pattern generation

The outputs may also be used to output a signal pattern. For this purpose, the standard simulator has three outputs; others may have up to six.

The signal has a resolution of 1 ms (if required, a more precise output signal generation may be implemented) and a maximum duration of 65.535 s.

The signal pattern of all outputs is started at the same time, i.e. the signal pattern of all outputs is synchronous. The start of the signal pattern can either be performed using function 4300 SignalPatternOn or switch function 2815 SwSignalPatternOn. The signal pattern is generated until both requests have been reset or the entire signal generation time has expired. Restarting the signal pattern initially requires resetting the signal.

The parameters of the signal pattern are set via the following parameters

16000	Pattern1:Time	Time frame for signal pattern
16100	Pattern1:Level	Output level for signal pattern

and the following parameters for additional signals. Setting the parameter to 0 ms in an element greater than Index 0 in Pattern1:Time() indicates the end of signal generation. The signal level of the last element is maintained until the signal generation time has expired.

The signal patterns created are shown on parameter

2301	Pattern1	the current output level for signal patterns

and the following. These output levels can be assigned to the desired output via the normal parameter settings of the digital outputs (parameter 8800ff). In the process, the outputs must be set to binary outputs (parameter 4800ff).

2.9 Output signal generation

There is also the possibility to generate an arbitrary signal which may be used for output via an analogue or PWM output.

The parameters of the signal generation are set via the following parameters

1700	SignalGenSetpoint	setpoint of the signal
1701	SignalGenAmplitude	amplitude of the signal
1702	SignalGenFrequency	frequency of the signal
3700	SigGenOutput	generated signal
5701	SignalGenMode	mode of the signal:

0 = straight
1 = square wave
2 = triangular wave
3 = sine wave

The generated signal 3700 SigGenOutput may be assigned to any analogue or PWM output. If using an analogue output, please note on high frequencies the output signal may be damped by the hardware filter circuit on the board.

3 Pin assignment

Pin	Name	Meaning	Use in standard simulator
1	PS	Power supply	
2	GND	Earth	
3	VCC1	Supply of analogue input 1 (5V)	
4	AI1	Analogue input 1 (0..5V)	Target value 1
5	GND	Earth of analogue input 1	
6	VCC1	Supply of analogue input 2 (5V)	
7	AI2	Analogue input 2 (0..5V)	Target value 2
8	GND	Earth of analogue input 2	
9	VCC2	Supply of analogue input 3 (5V)	
10	AI3	Analogue input 3 (0..5V)	Filling signal (analogue)
11	GND	Earth of analogue input 3	
12	VCC2	Supply of analogue input 4 (5V)	
13	AI4	Analogue input 4 (0..5V)	
14	GND	Earth of analogue input 4	
15	AI5	Analogue input 5 (0..25mA)	
16	GND	Earth of analogue input 5	
17	AI6	Analogue input 6 (0..25mA)	
18	GND	Earth of analogue input 6	
19	AO1	Analogue output 1 (0..25 mA)	
20	GND	Earth of analogue output 1	
21	AO2	Analogue output 2 (0..5V)	
22	GND	Earth of analogue output 2	
23	DI1	Digital/PWM input 1	Signal on/off
24	GND	Earth of digital/PWM input 1	
25	DI2	Digital/PWM input 2	Target value 2 or 1
26	GND	Earth of digital/PWM input 2	
27	DI3	Digital/PWM input 3	Select frequency or engine simulation
28	GND	Earth of digital/PWM input 3	
29	DI4	Digital/PWM input 4	Filling signal (PWM)
30	GND	Earth of digital/PWM input 4	
31	VDD	Supply 5V	
32	GND	Earth	
33	DO1	Frequency/PWM output 1	PickUp1 signal
34	GND	Earth of frequency/PWM output 1	
35	DO2	Frequency/PWM output 2	PickUp2 signal

36	GND	Earth of frequency/PWM output 2	
37	DO3	Frequency/PWM output 3	CamIndex signal
38	GND	Earth of frequency/PWM output 3	
39	DO4	Frequency/PWM output 4	
40	GND	Earth of frequency/PWM output 4	
41	DO5	Frequency/PWM output 5	
42	GND	Earth of frequency/PWM output 5	
43	DO6	Frequency/PWM output 6	
44	GND	Earth of frequency/PWM output 6	
45	CAN1-H	CAN bus 1 high	
46	CAN1-L	CAN bus 1 low	
47	CAN2-H	CAN bus 2 high	
48	CAN2-L	CAN bus 2 low	