The HT Gas-Engine Control System is a comprehensive modular solution, currently suitable for gas engines up to 50 litre displacement.

Four modules complete this system:
- IS-CU InteliSys
- AF-2000 Lambda Controller
- RM-814 or RM-25 Mixer.
- LEF Ignition System

IS-CU InteliSys is a top-end expandable controller for single and multiple generating sets operating in standby or parallel modes.

The AF-2000 is a unique powerful microprocessor and enhanced Lambda Control unit combined with an I/O Module.

The RM 814 & RM 25 Mixers are enhanced, sophisticated Air Gas blenders based on the proven ring gap principle. With an accurate Lambda control tolerance of less than +/- 0.01 is guaranteed.

The LEF Ignition System is a power full and easy to install ignition for industrial engines up to 5 litres per cylinder.

All 3 units communicate with each other via CAN-Bus. Modularity provides an excellent price/performance ratio and allows expansion of I/Os at any time and at reasonable cost.

Contact our gas experts for more information and application detail. www.huegli-tech.com
**Integrated Protection**

Generator
- All standard InteliSys genset and engine protections

**Communication Extension Modules**
- IG-IB
- IG-MU

**Engine**
- Exhaust temperatures
- Turbocharger temperatures
- Mixture temperature
- Gas temperature
- Various pressures

**Software**
- WinEdit
- MultiEdit
- AF-2000-CFG
- Easy Fire

**Extension Features**

InteliSys
- All standard InteliSys extensions
- BCD Ignition communication
The AF-2000 is a unique and enhanced Lambda Control unit combined with an I/O Module. A modern control platform with a powerful microprocessor and a large memory unleashes numerous features and flexibility. It is used in all gas engine application such as stochiometric and lean burn. Mapping power, pressure, temperature and other parameters result in a very precise and fast responding air fuel ratio control. Monitoring combined with logic functions allows the user a wide combination and therefore the AF-2000 can be adapted to any application task. CAN Bus communication to other peripheries facilitate remote access and wiring issues. A powerful graphical display, icons symbols and bar graph for intuitive operation set a new standard for the gas engine controls.

Product Features
- Precise Lambda control
- Can-Bus communication
- Graphical display
- History record (200 events)
- Password protected (3 level)
- Language selection
- Key pad control
- Numerous I/O’s
- Configurable In and Outputs
- Display sealed IP65

Advantage
- Perfect price performance ratio
- O2-Drift compensation
- Remote access via IS-CU
- Automatic set up for commissioning
- Reduced wiring
- Programmable vie key pad

Making the most use out of the AF-2000 is to combine it together with the RM series Mixer. This enables more features and is also cost saving for any application. Additional I/O’s on the Mixer PCB prevent from using costly extensions.

Ask our gas experts for information.
www.huegli-tech.com
Technical Specifications

Control Unit
- Supply Voltage: 24 V DC (+/- 25%)
- Current consumption: <0,6A
- Communication Interface: Can-Bus, RS 232 und RS 485
- Display: Graphical LC-Display, 120 x 16 Dots, Background illuminated
- Keypad: 4 System keys, 10 Function keys
- Housing: electro plated housing 141 x 69 x 32 mm
- Mounting hole: 137 x 65 mm
- Front Display: 144 x 72 mm
- Weight: 0,4 kg

I/O Module
- Supply Voltage: 24 V DC (+/- 25%)
- Interface: Can-Bus
- Digital Input: 8 Input 24 V DC, Low threshold < 5 V, High threshold > 15 V
- Digital Out: 8 Output 24 V DC, max. 0,5 A, Whereas 2 can be used for PWM
- Analogue Input: 4 Input 0..10 V / 0..20 mAmp, 10 Bit
  4 Input for Thermocouple Typ K, max. 900°C, 10 Bit
  1 Input for Pt100, max. 120°C, 10 Bit
  1 Input for Lambda sensor, 10 Bit
- Frequency Input: max. 10 kHz Sine-wave
- Analogue Output: 2 Output 0..20 mAmp (0..10 V with Shunt), 10 Bit
- Dimensions: 183 x 72 mm
- Mounting: 35 mm DIN Rail
An integrated, well protected electronics’ PCB equipped with several Inputs and Outputs provides monitoring features for all important parameter like, gas inlet, air filter clock up, exhaust temperature etc. An analogue output can be used as a drive. CAN Bus communication allows flexibility together with IS-CU and the AF-2000 control system and cost savings for additional I/O’s.

**Product Features**
- Accurate gas metering
- Fast response to load transient
- CAN Communication (combined with AF-200)
- On board I/O’s
- Automatic and Manual drive
- RM-814 (4-14 litre engine displacement)
- RM-25 (14-25 litre engine displacement)
- Status indication

**Technical Specification**
- 12 and 24 VDC
- 6 Analogue Input [VDC, mAmp, Ω]
- 1 Binary Input
- 1 Binary Output
- 1 Analogue Output [VDC]
- IP-67 Protected

The RM Mixer is an enhanced sophisticated Air Gas blender based on the approved ring gap principal. Due to a precise mechanical gear system an accurate Lambda control tolerance smaller than +/- 0.01 is guaranteed. Engineering and design has achieved a level which allows using the mixer for Natural, Bio and other gas application. Robustness and environmental protection makes this mixer unique and extremely user friendly.

A brilliant combination of control units is to use the mixer together with the AF-2000 lambda controller and IS-CU gen-set control system. This unleashes pure control, logic and monitoring power and allows unbounded communication among all peripheries.

Ask us for information and talk to our gas application experts.

**www.huegli-tech.com**
Gas pressure, manifold pressure, exhaust temperature, manifold temperature and other parameters can be connected directly to the mixer.
The BCD Digital Ignition System

1. Description of Control Module

The BCD1-8 is a microprocessor controlled ignition system that combines the advantage of the inductive and the capacitive type ignition in one product.

Each BCD1-8 can supply up to 8 Cylinders. Two units can be configured in a Master/Slave configuration, with the included Easy Fire software, for engines with up to 16 cylinders.

The BCD1-8 produces alternating current (AC) sparks, which reduces the wear of the spark plug. The energy and the spark duration levels can be controlled, for best combustion and longest spark plug life.

Many parameters, e.g. No. of Cylinders, Firing Angle, Strike Mode (Reduced Power, Single- or Double-Strike), Ignition Timing etc. can be set via CAN Bus from the AF-2000 Lambda Controller, eliminating the need for an on-site Laptop.

The timing signal to the BCD is taken either from a ferrous trigger wheel, running at half engine speed (on the camshaft with one peg per cylinder plus one reference pulse), or it gets timing information from the engine’s own ECM.

If a trigger wheel is used, a speed (rpm) related timing curve can be programmed. There is also provision for a fixed or variable timing offset through the RS-232 link.

If more than eight coil outputs are needed, two control modules can be cascaded for up to sixteen (16) coil outputs. The number of outputs is configurable in firmware. The sequence of firings starts when the module receives either the spark reference pulse (ECM) or the additional index pulse from the trigger wheel.

The control module firing order is primary coil 1 followed by coil 2, 3, 4, and up to the configured number of coils. The firing starts when the first trigger pulse following the reference pulse is received. When two modules are used in cascade mode the firing alternates between master (A) and slave (B). The firing order in cascade mode is A1, B1, A2, B2, A3, B3, and up to the configured number of coils.

Note: The combination of the AC spark with plug-mounted coils provides excellent combustion on Natural gas engines up to 5 liter/Cylinder, 2 MW power operation at Lambda 1.6.
2. The BCD features & Specifications

2.1 Features

- Combination of capacitive/inductive
- Alternating current spark (AC)
- User programmable ignition curve
- RS-232 communication link
- Two programmable energy levels
- Up to 8 cylinders. 12, or 16 cylinders are possible in cascade mode
- 2 outputs sinking up to 1Amp. at +25°C and up to 0.5 Amp. at +15°C
- 1 Sensor input 0-5V
- 2 general trigger inputs, VR (passive) or Open collector (active)
- Trigger signals from ½ engine speed disc or from Engine control module
- Overspeed shutdown

2.2 Specifications

Supply Voltage range: 18 - 32 VDC
Power consumption: Max 3.6A RMS
Trigger inputs:
Two separate with automatic detection of type of sensor: Variable reluctance (passive) 0.3-120V p-p or open collector (active) 5V logic, internal pull-up in module
Analog sensor input: One, 0-5 VDC
Output: (Not assigned yet) Two, max. load 30W, 30V, 1 Amp.
Communication port: One, RS 232
Ambient temperature range: -40 °C to +125 °C
Transient Voltage protection: ISO 7637/2 to ISO 7637/3
EMC: CISPR 25-2004/104/EC
Vibration: IEC68-2-35 Fda
Sealing: IP6k9k
Weight: 1.7 kg

3. Dimensions
4. CU2-05 High Tension Coil

Dimensions as per drawing K805 100 05 (last page).

The CU2-05 Coils consist of the upper part, which is the coil itself, plus a screwed on extension that fits right on to the spark plug. Hence, no separate high tension cables are required.

The coil incorporates an integrated connector and two fixations to be screwed to a common bracket.

Unique is the internal insulation, it is a synthetic ester based insulating liquid, which does not restrict internal micro expansions, and which provides a self healing effect.

A feedback signal is available that can be used for combustion information and spark diagnostic.

Secondary voltage
Is defined as the absolute peak value of the voltage during the first negative oscillation during discharge. ($U_{peak}$ in figure A).

Rise time $t_r$
Is defined as the time from that the secondary voltage has reached 10% of $U_{peak}$ to the time that the voltage has reached 90% of $U_{peak}$ without any load.

4.1 Ignition Characteristics

Impedance characteristics

<table>
<thead>
<tr>
<th>Ignition coil parameters</th>
<th>Min</th>
<th>Nom</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (kOhm)</td>
<td>7.5</td>
<td>7.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Secondary inductance (H)</td>
<td>8.5</td>
<td>9.2</td>
<td>10</td>
</tr>
<tr>
<td>Primary inductance (uH)</td>
<td>800</td>
<td>920</td>
<td>1000</td>
</tr>
<tr>
<td>Temp. Range Coil</td>
<td>-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp. Range Plug Boot</td>
<td>-40</td>
<td></td>
<td>+200</td>
</tr>
</tbody>
</table>

Primary current characteristic

Characteristics of primary current with 1.5uF charge capacitor

<table>
<thead>
<tr>
<th>Name</th>
<th>Min</th>
<th>Nom</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak primary current</td>
<td>22</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Coil drive voltage</td>
<td>350</td>
<td>370</td>
<td>400</td>
<td>V</td>
</tr>
</tbody>
</table>
4.2 Spark Characteristic

Spark duration $t_d$

*Is defined as either:*

The time from that the current becomes greater than 1 mA to the time that the current becomes zero after the voltage no longer is limited (see figure B).

*Or*

The time from that the current becomes greater than 1 mA to the first time that the current becomes zero and then no longer reaches 1 mA.

---

Spark characteristics for 370V charge voltage 1.5uF charge capacitor, double strike mode

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Min</th>
<th>Nom</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spark duration</td>
<td>400</td>
<td>430</td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>Spark energy</td>
<td>24</td>
<td>28</td>
<td></td>
<td>mJ</td>
</tr>
<tr>
<td>Secondary voltage (load 500kΩ // 50 pF)</td>
<td>24</td>
<td>26</td>
<td>28</td>
<td>kV</td>
</tr>
<tr>
<td>Secondary voltage rise time (load 500kΩ // 50 pF)</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>μs</td>
</tr>
</tbody>
</table>

---

4.3 Installation

Due to its internal synthetic ester insulation, the coil should always be installed vertically, with the coil portion on top. The maximum inclination from the vertical line is 45° in either direction. See drawing K805 100 05. If the coils had been stored in a horizontal position for sometime, it should be left min 1 hour in its vertical operating position before the engine is started.

---

4.4 Protection

Each coil has a built in over voltage protection in case the spark return connection "C" to the BCD1-8 control is lost.
Product selection guide and application hint

Selection of Mixer by engine parameter:
In order to select the correct ring gap mixer, there are a few issues to watch out for:

- Engine capacity
- Displacement

A basic table helps to select the appropriate mixer:

<table>
<thead>
<tr>
<th>Engine Type Inline [I] or V</th>
<th>Engine Displacement [lt]</th>
<th>Mixer Model</th>
<th>Quantity</th>
<th>Load [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>4-8</td>
<td>RM-814-ZF</td>
<td>1</td>
<td>~80</td>
</tr>
<tr>
<td>I</td>
<td>8-14</td>
<td>RM-814F</td>
<td>1</td>
<td>~200</td>
</tr>
<tr>
<td>I or V</td>
<td>14-25</td>
<td>RM-25F</td>
<td>1</td>
<td>~350</td>
</tr>
<tr>
<td>V (with 2 air filters)</td>
<td>28-50</td>
<td>RM-25F</td>
<td>2</td>
<td>~600</td>
</tr>
<tr>
<td>V (with 1 air filter)</td>
<td>28-60</td>
<td>(RM-45) n.a.y</td>
<td>1</td>
<td>~750</td>
</tr>
<tr>
<td>V (with 2 air filters)</td>
<td>50-85</td>
<td>(RM-45) n.a.y</td>
<td>2</td>
<td>~1100</td>
</tr>
</tbody>
</table>

n.a.y = not available yet

Still there needs to be paid attention to the design between the air filter, mixer and turbo charger.
Restrictions in the design of the piping will cause loss of velocity of the air stream, which will decrease the efficiency of the mixer.
Hence, the suction piping needs to be as straight as possible.
See below drawing recommendation:

Recommendation of piping:

![Recommended array of piping](image)

An inline piping between Airfilter, Mixer and Turbo causes no restrictions.
Not recommended piping:
### Selection of Mixer by engine type:

<table>
<thead>
<tr>
<th>Engine manufacturer</th>
<th>Engine model</th>
<th>N/A or TC</th>
<th>Lambda</th>
<th>Load [kW]</th>
<th>Mixer</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAN</td>
<td>E0834 E 302</td>
<td>NA</td>
<td>Stoichiometric</td>
<td>54</td>
<td>RM-814-ZF</td>
<td>1</td>
</tr>
<tr>
<td>MAN</td>
<td>E0836 E 302</td>
<td>N/A</td>
<td>Stoichiometric</td>
<td>75</td>
<td>RM-814-ZF</td>
<td>1</td>
</tr>
<tr>
<td>MAN</td>
<td>E0836 LE 202</td>
<td>TC</td>
<td>Lean Burn</td>
<td>110</td>
<td>RM-814F</td>
<td>1</td>
</tr>
<tr>
<td>MAN</td>
<td>E2876 E 302</td>
<td>N/A</td>
<td>Stoichiometric</td>
<td>140</td>
<td>RM-814F</td>
<td>1</td>
</tr>
<tr>
<td>MAN</td>
<td>E2876 TE 302</td>
<td>TC</td>
<td>Lean Burn</td>
<td>150</td>
<td>RM-814F</td>
<td>1</td>
</tr>
<tr>
<td>MAN</td>
<td>E2876 LE 302</td>
<td>TC</td>
<td>Lean Burn</td>
<td>210</td>
<td>RM-814F</td>
<td>1</td>
</tr>
<tr>
<td>MAN</td>
<td>E2848</td>
<td>TC</td>
<td>Lean Burn</td>
<td>280</td>
<td>RM-25F</td>
<td>1</td>
</tr>
<tr>
<td>MAN</td>
<td>E2842 E 312</td>
<td>N/A</td>
<td>Stoichiometric</td>
<td>250</td>
<td>RM-25F</td>
<td>1</td>
</tr>
<tr>
<td>Liebherr</td>
<td>G926TI</td>
<td>TC</td>
<td>Lean Burn</td>
<td>170</td>
<td>RM-814F</td>
<td>1</td>
</tr>
<tr>
<td>Jinan</td>
<td>4-190</td>
<td>TC</td>
<td>Lean Burn</td>
<td></td>
<td>RM-25F</td>
<td>1</td>
</tr>
<tr>
<td>Jinan</td>
<td>8V-190</td>
<td>TC</td>
<td>Lean Burn</td>
<td></td>
<td>RM-45F</td>
<td>1</td>
</tr>
<tr>
<td>SCANIA</td>
<td>SGI 12 ST</td>
<td>TC</td>
<td>Lean Burn</td>
<td>200</td>
<td>RM-814F</td>
<td>1</td>
</tr>
</tbody>
</table>

### Possible System Alignments:

**Inline Engine Single Mixer and Single Throttle**

**Sensors to be used:**

- **P Boost** = Pressure Sensor: DMU-01 / 0-2.5 bar absolute (On Huegli Tech supply list)
- **T Mixture** = Manifold Temperature: PT 100
- **T Exhaust Gas** = Exhaust Temperature: T-2472-3000 (On Huegli Tech supply list)
V-Engine Single Mixer and Throttle

V-Engine Single Mixer and Twin-Throttle
V-Engine Twin-Mixer and Single-Throttle

V-Engine Twin-Mixer and Twin-Throttle
Cooperation with adapt engineering

Two companies join competence, experience, dynamics, innovation and their premium products in order to develop together an application and to bring it to functional maturity. The goal is to satisfy and even to exceed the customers operating conditions and high quality expectations.

HUEGLI TECH AG (LTD) supplies customers around the world with components and systems for Diesel- and Gas – engines in off-road, marine & stationary applications since 1929.

HUEGLI TECH AG (LTD) beliefert seit 1929 Kunden weltweit mit Komponenten und System-Lösungen zu Diesel- und Gas-Motoren im Off-Road, Marine & stationären Betrieb.

adapt engineering GmbH, service enterprise for research and development of internal combustion engines, was founded in 1993. Part of it’s core competences are improving combustion processes and exhaust gas emissions of diesel and gas engines, and the application with alternative fuels.


www.huegli-tech.com
www.adapt-engineering.de
### The Project:

<table>
<thead>
<tr>
<th>The Project:</th>
<th>Das Projekt:</th>
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<tbody>
<tr>
<td>Combined heat power (CHP)</td>
<td>Blockheizkraftwerk (BHKW)</td>
</tr>
<tr>
<td>Engine: MAN 2842 V12 340 kW</td>
<td>Motor: MAN 2842 V12 340 kW</td>
</tr>
<tr>
<td>Fuel: Methanol 100%</td>
<td>Kraftstoff: Methanol 100%</td>
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### The team:

<table>
<thead>
<tr>
<th>adapt engineering GmbH</th>
<th>Das Team:</th>
</tr>
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<tbody>
<tr>
<td>Dipl. Ing. Hartmut Pabst</td>
<td>HUEGLI TECH AG (LTD)</td>
</tr>
<tr>
<td>Dr. Ing. Ferdinand Herms</td>
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<table>
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<tr>
<td>Daniel Hügli</td>
<td></td>
</tr>
<tr>
<td>Ingo Fischer</td>
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### The contribution:

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<th>adapt engineering GmbH</th>
<th>HUEGLI TECH AG (LTD)</th>
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</thead>
<tbody>
<tr>
<td>Engine speed controlled by INCON through the common rail injection system</td>
<td>Drehzahlregelung durch Steuerung INCON über die Common-Rail Einspritzung</td>
</tr>
<tr>
<td>Lambda control by AF-2000 through the air-throttle via motor drive</td>
<td>Lambdaregelung durch Steuerung AF-2000 über Luftklappe mit Schritt-Motor</td>
</tr>
</tbody>
</table>

### The result:

<table>
<thead>
<tr>
<th>The result:</th>
<th>Das Resultat:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performant, reliable application</td>
<td>Leistungsfähige, zuverlässige Anlage</td>
</tr>
<tr>
<td>Innovative controls</td>
<td>Innovative Steuerung</td>
</tr>
<tr>
<td>Emission level respected</td>
<td>Emissionen eingehalten</td>
</tr>
<tr>
<td>Optimal fuel consumption</td>
<td>Verbrauch optimiert</td>
</tr>
<tr>
<td>Contributed to a high overall total efficiency</td>
<td>Beitrag zum hohen Gesamt-Wirkungsgrad</td>
</tr>
<tr>
<td>CO₂ - neutral fuel</td>
<td>CO₂ - neutraler Kraftstoff</td>
</tr>
</tbody>
</table>