CuteLine
Gas Mixer Control AF1000LS

Manual

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Revision History

The changes and additions are added here every time a new revision of the document is made.

Rev	Description	Date	Author
0.1	Preliminary Version	08.10.2012	IF
0.2	Initial Version	15.01.2013	UM
0.3	Rename of the manual – HT-CL-AF1000LS	04.03.2014	UM
1.0	First official release	01.04.2014	UM
1.3	Correction of wiring	14.07.2014	IF
1.4	MiniMix added in Mixer Selection	13.04.2015	IF
1.5	J 1939 Mode added	01.05.2015	IF
1.6	Wiring for O2 Probe modified	04.03.2016	IF
1.7	MiniMix New Version (from Ser.-No. HT1057)	09.06.2016	IF
1.8	J1939 register added	07.03.2018	RR
1.9	Dip switch2 added	10.01.2019	RR
2.0	R26, R77 trim pot resistor changed to fixed resistor	20.05.2019	RR
2.1	Added instruction for Data Logging function	21.10.2020	JM

Approved:

	Author	R & D	Product Manager
Date & Initials	*08.10.2013*	*15.01.2014*	*16.01.2014*
	IF	*TL*	*UM*

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1   Installation declaration (for an incomplete machine)

Installation declaration
(Directive 2006/42/EC, Appendix II B)

The manufacturer: Huegli Tech Murgenthalstrasse 30 4900 Langenthal Switzerland

hereby declares that the incomplete machinery:

*General description:***HT-CL-AF1000LS**

complies with the basic health and safety requirements of machinery directive 2006/42/EC Appendix I.

The special technical documents in compliance with Appendix VII part B have been produced.

The incomplete machine corresponds with the following other EC directives:
    Low tension directive 2006/95/EC

The following harmonised norms were applied:
    DIN EN ISO 12100:2011 **(consolidation of EN ISO 12100-1; EN ISO 12100-2; EN ISO 14121-1)**

Authorised representative for creation of the technical documents:
    U. Moser Murgenthalstrasse 30 4900 Langenthal

The special technical documents are transmitted in electronic form as required by individual state offices.

Operating the incomplete machine is not permitted until the incomplete machine is built into a machine that conforms to the provisions of the machinery directive and an EC conformity declaration in compliance with Appendix II A is provided.

Langenthal 26.09.2013   Huegli Tech AG,

Moser Ulrich
Senior Product Manager

2 About this document

2.1 Information about the Manual

2.1.1 Contents

This Manual contain important details and information about the CuteLine AF1000LS Module

2.1.2 Product affiliation

The Manual describes the finished product at the time of initial delivery.
Supplementary to this manual, there are no special contractual agreements and technical documents needed or available.

2.1.3 This Manual is an integral part of the product

- To ensure trouble-free and safe operation as well as the settlement of any warranty claims, always read this manual first and observe all the information contained herein.
- Keep these Manual close to the product
- Always give the Manual to each subsequent owner or user. Huegli Tech shall not accept liability for any damages or malfunctioning caused by non-adherence to this Manual.
- Please contact Huegli Tech Customer Service if you have any further questions after reading these operating instructions.

2.2 Warning signs in this document

The warning signs in this document provide information about dangers which may arise during product operation. The relevant warning signs are displayed in the "safety" section and at the beginning of each chapter.

There are 3 types of warning signs:

Signal word	Meaning	Consequences of non-adherence
⚠ DANGER	Warns of imminent danger	If not avoided will result in death or serious injury.
⚠ WARNING	Warns of a possible danger	If not avoided could result in death or serious injury.
⚠ CAUTION	Warns of a possibly dangerous situation	If not avoided could result in minor or moderate injury.

2.2.1　Warning sign design

⚠	⚠ **DANGER**
	The type and source of the imminent danger is specified here!
	Possible consequences of non-adherence are stated here.
	➢ Protective measures against the danger are listed here

➢ Always read and carefully observe all warning signs.

2.3　Other symbols

i	**NOTICE**
	The sign specifies possible property damages
	➢ Protective measures against property damages are listed here.

⚠　　　　This symbol displays safety instructions

ⓘ　　　　This symbol displays useful and important information.

➢　　　　This symbol refers to an actual task.

3 Safety

3.1 Basic Safety Instructions

> ⚠️ **WARNING**
>
> Some of the CuteLine functions are subjected to changes depending on SW version.
>
> The data in this manual only describes the product and are not warranty of performance or characteristic.

> ℹ️ **NOTICE**
>
> Huegli Tech believes that all information provided herein is correct and reliable and reserves the right to update at any time. Huegli Tech does not assume any responsibility for its use unless otherwise expressly undertaken.

> ⚠️ **CAUTION**
>
> **Dangerous voltage**
>
> In no case touch the *terminals for voltage and current* measurement!
> Always connect grounding terminals!
>
> All parameters are pre-adjusted to their typical values. But the set points in the "**Basic settings**" settings group !!**must!!** be adjusted before the first start-up of the gen-set.
>
> **! WRONG ADJUSTMENT OF BASIC PARAMETERS CAN DESTROY THE GEN-SET !**
>
> **The following instructions are for qualified personnel only. To avoid personal injury do not perform any action not specified in this User guide!!!**

4 General Guidelines

4.1 Introduction

The **HT-CL-AF1000LS** is a Mixer Driver Module which is optimized for use with Huegli Tech Gas Mixer RM814, RM25, RM40 and MiniMix.

This device performs either as a single or dual stepper motor control depending on the mixer type selected for use.

4.2 Safety instructions and Warnings

Before installing and starting the device, please read the operating instructions. These contain important notes for safety and use.

No liability can be accepted for damage arising from failure to follow the instructions or any inappropriate use.

The HT-CL-AF1000LS unit may only be used for the manner of operation prescribed in the operating instructions and only in connection with third-party devices and components recommended or installed by us or software supplied by us. Any other use shall be considered inappropriate use and will result in the voiding of all liability and warranty claims against the manufacturer.

Interventions and alterations that influence the safety technology and the functionality of the Mixer module may be carried out only by the manufacturer.

Fault-free and safe operation is conditional upon competent transport, assembly and installation as well as qualified use and correct maintenance.

All relevant accident prevention regulations and other generally recognized technical safety and health and safety at work rules are to be observed. Fault-free functioning of the machinery and its peripheral components is only guaranteed with original accessory parts and spare parts.

The HT-CL-AF1000LS unit is robust enough to be placed in a control cabinet with other operating control devices.

4.3 Guarantee terms and conditions

4.3.1 Correct use

The device is intended for exclusive use under the conditions described in the "Technical Data" rubric. Other uses are potentially dangerous. Huegli-Tech AG cannot accept liability for damage which results from incorrect use or application other than that for which it was intended.

4.3.2 Use of Accessories

Accessory parts may be installed or added only when they have been explicitly authorized by Huegli Tech AG. Any claims under guarantee, warranty or product liability shall be void if other parts are used.

The general guarantee terms and conditions of Huegli Tech AG shall apply.

5   Purpose and Function

The CuteLine AF1000LS module is a Lambda (O_2) controller which is designed to measure and control the Lambda / O_2 value of stoichiometric and lean burn gas engines. In addition to this unit a BOSCH® LSU 4.2 wide band lambda (O_2) probe and a Gas Mixer RM.. or MiniMix is required. The CuteLine AF1000LS has an integrated power supply for the heating circuit of the probe.

The module can work as a Standalone unit or in connection with a HT Controller or any other Genset Controller with Can Bus (J1939).
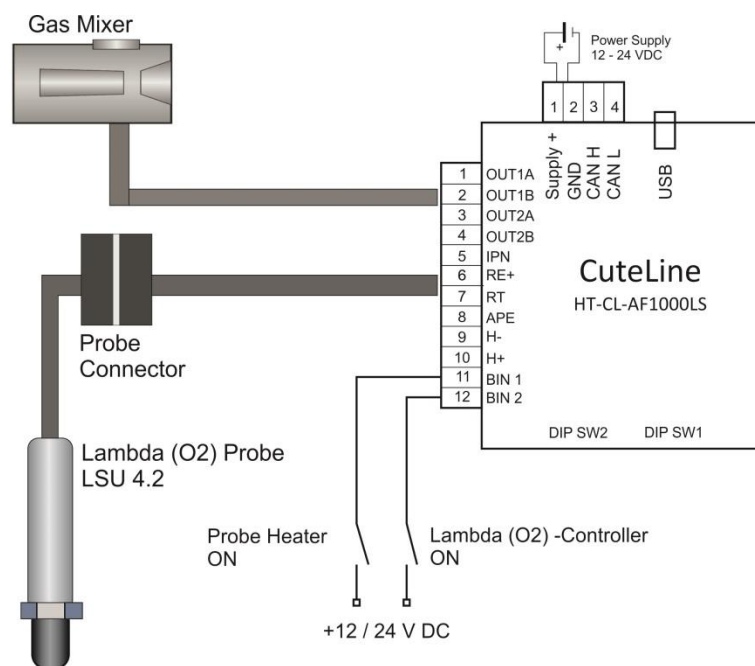
Working Principle

To start the measurement, the probe heater must first be turned on by closing the switch connected to BIN 1. The probe is now heated up by a progressive ramp because fast heating can damage the probe. This could last up to 1 minute. It is recommended to activate the heater together with the prestart command of the engine. To switch on the controller the switch connected to BIN 2 must be closed. This input should be activated when the GCB is closed. Especially on lean burn engines which are working parallel to mains it is not recommended to start the controller while the engine is synchronizing.

Hint

As long as the probe has not reached its working temperature the controller remains switched off. The Mixer remains in its Starting Position

Once the conditions to activate the controller are given it starts to control the gas mixer. This is done by comparing the measured against the requested Lambda / O_2 value.

6   Installation and connection

6.1   Mounting

The CuteLine modules are designed to be mounted on a 35 mm DIN Rail and can be easily attached and detached from the DIN rail.

To mount the module on the DIN rail, attached the upper portion of the module onto the DIN rail and press down the module until the hook clicks itself.
To remove the module from the DIN rail, simply unhook the lower part using a screwdriver and lift the enclosure from the DIN rail.

> **i**
>
> **IMPORTANT**
>
> • Use of inappropriate cables may lead to wrong measured values.

6.2   Electrical Connection

All connectors can be pulled out from the board for easier wiring.

6.3   Power Supply

The nominal supply input for CuteLine AF1000LS Module is 24 VDC but it can also work from a voltage range of 7-30VDC. The green LED on the front is turned on when the device is connected to the power supply. The supply input is reverse polarity protected.
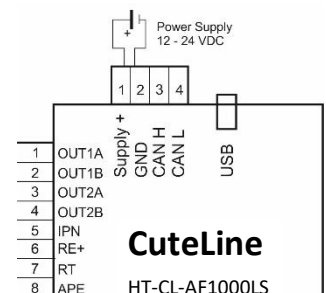
6.4   Wiring Probe and Mixer

The mixer and the probe must be connected according this diagram on the right. The numbers in brackets are the pins in the connector of the Lambda (O2) probe. These numbers correspond to the connector's terminal number as shown in the diagram on the right.

The cables of the harnesses should be only connected to the module when the module is switched off.
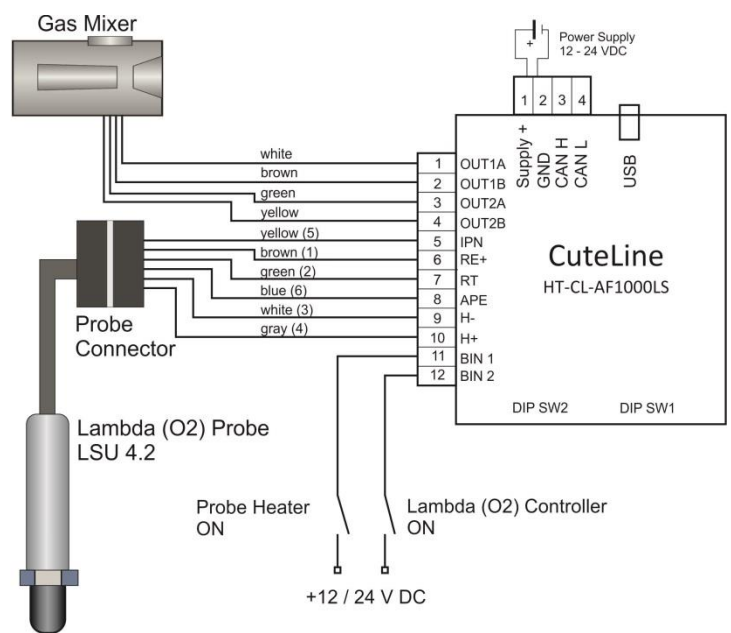
6.5 Dip Switch Settings

Dip SW 1

Pole No.		1	2	3	4	5	6	7	8
State	ON	CAN Bus/ Mod Bus Address Setting				Free	Mixer Type	Mixer Type	CAN 120 Ohm Termination
	OFF					Free	Mixer Type	Mixer Type	No Termination

Mixer Type	SW1:6	SW1:7
RM 814(5)	OFF	OFF
RM25/40(7)	ON	OFF
MiniMix (1.4)* *Ser.-Nr. >= HT1057*	OFF	ON
MiniMix(1.5) *Ser.-Nr. <= HT1056*	ON	ON

* From Software Version 1.11

The Number in brackets shows the number motor revolutions from 0-100%

Address	SW1:1	SW1:2	SW1:3	SW1:4
1	OFF	OFF	OFF	OFF
2	ON	OFF	OFF	OFF
3	OFF	ON	OFF	OFF
4	ON	ON	OFF	OFF
5	OFF	OFF	ON	OFF
6	ON	OFF	ON	OFF
7	OFF	ON	ON	OFF
8	ON	ON	ON	OFF
9	OFF	OFF	OFF	ON
10	ON	OFF	OFF	ON
11	OFF	ON	OFF	ON
12	ON	ON	OFF	ON
13	OFF	OFF	ON	ON
14	ON	OFF	ON	ON
15	OFF	ON	ON	ON
16*	**ON***	**ON***	**ON***	**ON***

*Address Selection 16 (DIP-SW 1:1 to 1:4 ON) is for J1939 Mode, *see Chapter 7.1.4.2*

Dip SW 2

Lambda Probe Type	SW2:1	SW2:2	SW2:3	SW2:4
LSU 4.2	ON	ON	OFF	OFF
LSU 4.9	OFF	OFF	ON	ON

6.6   CAN Bus Connection

Using the CAN Bus connection, the bus cable must be connected to the terminals Can H(igh) and Can L(ow). If the module is the first or the last device in the bus, a termination resistor is required. There is a built-in resistor (120 Ohms) which can be activated by switching DIP SW1:8 to ON position. Shielded cable (for example, HELUKABEL CAN BUS 2x0.22) must be used for the CAN Bus connection.
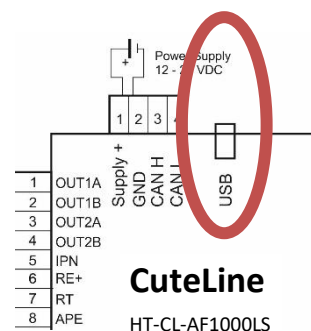
If the device is connected to the controller HT-DST 4602 by Can Bus some settings can be done from the controller. Furthermore actual values (Mixer Position, Lambda Value etc.) are displayed on the controller.

Recommended Wiring
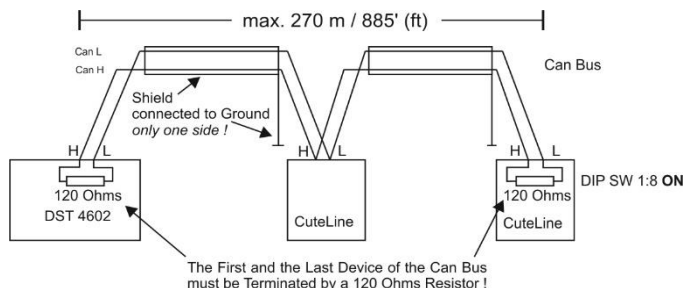
6.7   USB Port

The USB port is used to configure all the settings in the AF1000LS Module. This can be done by the AF1000LS Setup Software.

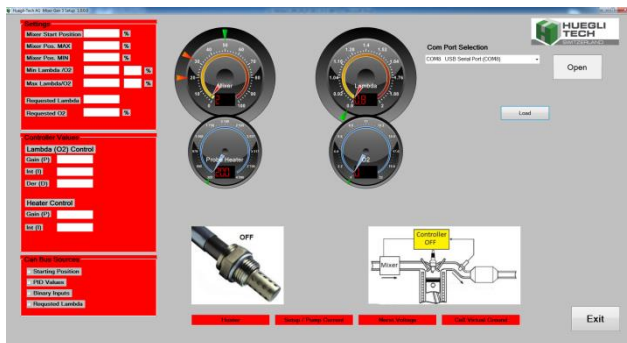# 7   PC Software for AF 1000LS Configuration

7.1   Installation

System Requirements   Windows 7,8,10 (32/64 bit)

Microsoft Framework Extended, can be downloaded here if not installed on you system :
http://www.microsoft.com/en-us/download/details.aspx?id=17718

After the AF1000LS Setup Software is installed and started, the start screen appears:

The next step is to connect the PC and the module by using a USB cable. Next, select the **Com Port** and click on the button **Open** :
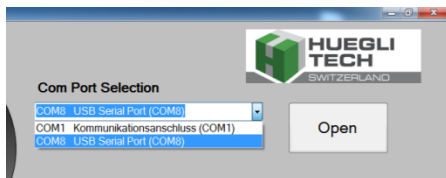
When the communication is active the software indicates the current set points and measured values of the controller.
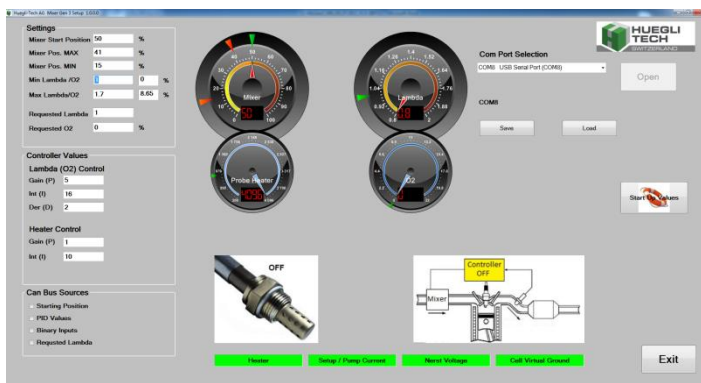
The next chapters describe all required settings of the Mixer module AF1000LS. These set points must be configured if the module is setup for the first time or if changes are necessary.

7.1.2 Settings

The following shows the settings that must be configured in order for the Cuteline AF1000LS to work:

Mixer Starting Position
This determines the position of the Gas Mixer when the engine is started and the control mode is inactive (BIN 2 open).

Mixer Pos. Max. / Mixer Pos. Min.
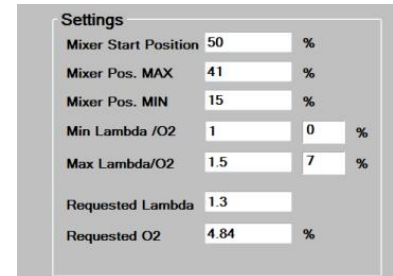This defines a working area of the mixer when the module is in control mode (BIN 2 closed).
This definition depends on the type of engine, type of mixer and the requested Lambda value
If this area is set to 40% for max. position and to 25% for min position the mixer is only allowed to work within this band.
Example:
The Starting Position is at 50% and the working area is set between 25% and 40%, requested Lambda value is 1.3 (= 4.84 % O_2).
Once the device is in control mode, the mixer starts to close and will reach a position of 35% which is within the working area. If the gas quality changes now, the mixer can work only between 25% and 40% as long as BIN 2 is closed.

Min. Lambda /O_2 - Max. Lambda /O_2
These two settings limit the value of the requested Lambda / O_2 to a certain band. If the AF1000LS module is connected to a controller HT-DST 4602, the requested Lambda / O_2 value, sent from the controller, must be within this limitation. Only the Lambda value can be set by the controller. The O2 value is calculated automatically..

Requested Lambda / Requested O_2
Here the requested Lambda or O_2 value for the engine can be set.
The Lambda or O_2 value can be set here. If a new Lambda value is set, the corresponding O_2 value is calculated. In case a new O_2 value is set, the Lambda value is calculated.

7.1.3 Controller Values

The AF1000LS module has two control loops, one for the mixer and one for the probe heater.

Lambda / O_2 Control
The setting of this PID loop determines the reaction of the mixer if the actual measured Lambda O_2 value deviates from the requested value. The PID loop should not be set too fast, because this could influence the Speed / Load governing.
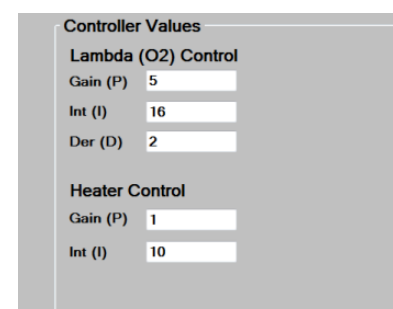Following values are recommended:
Gain (P)   5
Int (I)   15
Der (D)   2
Heater Control
Gain (P)   5
INT (I)   15
The probe should not be heated up too fast once BIN1 is closed

7.1.4 Can Bus Sources

7.1.4.1 Can Bus Connection with HT-DST 4602

As mentioned in earlier chapters, the AF1000LS module can by connected via Can Bus to a controller HT-DST 4602.
Several Set Points and Values can be configured through the controller:

Set Points
Starting Position
Requested Lambda Value
PID Values for Mixer Control

Measured Values
Feedback Mixer Position
Actual Lambda and O_2 value
Requested Lambda Value
Actual Voltage UR (Reference value for probe heater)

Following Set Points can be activated and are configurable on the HT-DST 4602:

Starting Position
Mixer Starting Position is allowed to be changed from the HT-DST 4602
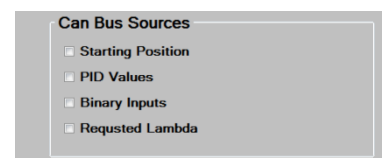
PID Values
The PID loop values can be set from the HT-DST 4602

Binary Inputs
If this check box is activated, the binary inputs BIN1 and BIN2 of the AF1000LS module are un-used. The required signals to activate the probe heater and start the control loop will be sent by Can Bus from the DST 4602

Requested Lambda
It enables the possibility to set the requested Lambda values from the HT-DST 4602

7.1.4.2 J1939 Connection to other Genset Controllers

Furthermore the AF1000LS can be connected to any other control-lers which provide the J1939 protocol for *Volvo EMSI Allspeed*.

Using this ECU following Can Bus Sources can be selected :

Starting Position
Mixer Starting Position is allowed to be changed from the Controller. TSC1" pgn="0x0000"
This value is written on PGN 0000 (TSC1). The value Requested Speed (Byte 1 + 2) is used for it

Binary Inputs
If this check box is activated, the binary inputs BIN1 and BIN2 of the AF1000LS module are un-used. The required signals to activate the probe heater and start the control loop will be sent by Can Bus from the Controller.
For this purpose the PGN FF49 (VP_PRO) is used. The ECU signal *Crank Request* (Byte 2.2) is used for the *Heater ON* signal , for the *Controller ON* signal the ECU value *Stop Request* (Byte 2.4) is used.
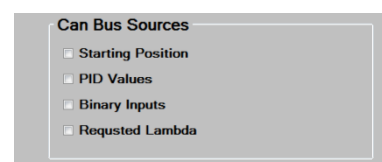
The signal *Crank Request* sent from Controller must be assigned to a function which gives a HIGH signal as soon as the engine is started and must stay HIGH as long as the engine is running.

The *Stop Request* signal can be assigned to the *GCB ON* signal. So the Lambda (O2) controller is switched ON as soon as the engine is loaded.

Requested O2 (Lambda)

It enables the possibility to set the requested O2 (Lambda) values from the Controller.

For this purpose the PGN FF49 (VP_PRO) Byte 0+1 (Throttle Position) is used.

Lambda Sensor Status

PGN FECA

AF1000LS Status Designation: Engine Lambda Sensor ready

J1939 Designation: Oxygen sensor heated

Byte #	Bit Assignment & Description	Value(Dec)	Data Range	Resolution	Unit
1	Bit 8-7 Malfunction indicator lamp status	00			
	Bit 6-5 Red stop lamp status	00			
	Bit 4-3 Amber warning lamp status	00			
	Bit 1-2 Protect lamp status	00			
2	Bits 8-1: Reserved for SAE	00			
3 to 4	SPN (16bit msb)	724	0 – 524287	1	SPN
5	Bits 8-6: SPN(lsb 3 bits)				
	Bits 5-1: FMI	31	0 – 37	1	FMI
6	Bit 7-1 Occurrence count	Variable	0 – 126	1	Count

The PID Settings can be done only by the PC Software

Measured Values indicated on the Controller
Following values can be indicated on the Controller :

Mixer Position   PGN F003 (EEC2) Byte 1   Accelerator Pedal Position
Actual O2   PGN F004 (EEC1) Byte 2   Actual Torque
Requested O2   PGN F004 (EEC1) Byte 1   Demand Torque

7.2 Data Logging

The PC Software must be open and connected to the controller during the logging process.

### 7.2.1 PC Software version 1.12 and above

The Data Logging function saves the data, time and measured values into SCV file.

The SCV files can be opened by Microsoft Excel or other TXT editors.

The measured values being saved: *Lambda, O2, Mixer Position, Heater.*

	A	B	C	D	E	F
1	Date	Time	Lambda	O2	Mixer Pos	Heater
2	2020-10-21	14:09:47	4.08	15.85	50	4092
3	2020-10-21	14:09:57	6.14	17.57	50	1320
4	2020-10-21	14:10:07	6.14	17.57	54	904
5	2020-10-21	14:10:17	6.14	17.57	70.4	985

After connecting to the controller successfully, the Data Logging control box will appear at the right side of the main window.
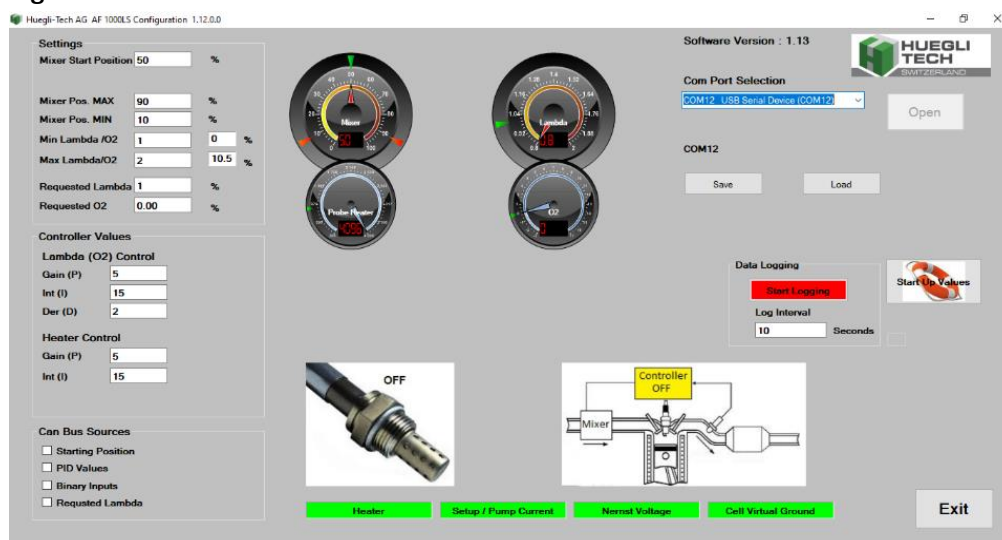
Start Logging (Stop Logging) Button
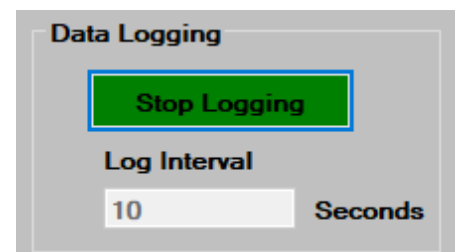Click the button to start or stop logging.
The button in Red colour: Logging stopped
The button in Green colour: Logging in progress

Log Interval
The log interval time in second, default 10 seconds.
Minimum 1 second, Maximum interval: 600 seconds.
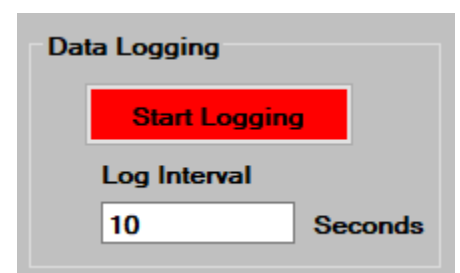
Enter Log Header

After click Start Logging button, the Log Header input box will be popup. Please input any charaters for the identification of current log. The Log Header will be added into the log file name.

Log file location

The log files will be saved inside folder:

[C:\Huegli-Tech\HT_CL_AF1000LS]
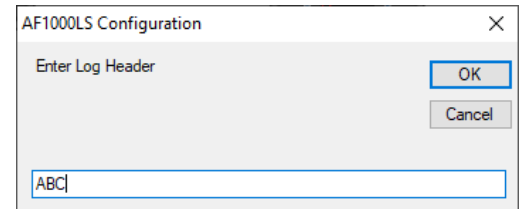
Log file name format

The log file name format is: LOG_[Log Header]_[Date]_[Time].csv

Example: [LOG_ABC_20201021_132045.csv]
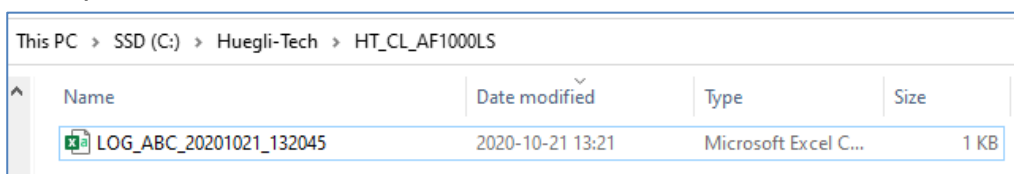
7.2.2 PC Software version 1.11 and below

The Data Logging function saves the data, time and measured values into TXT file.

The TXT files can be opened by any TXT editors.

The measured values being saved: *Lambda, O2, Mixer Position, Heater.*
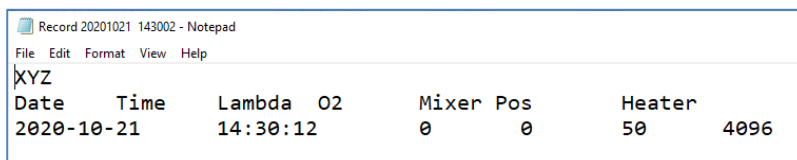
After connecting to the controller successfully, the Recording button and Recording Interval input box will appear at the right side of the main window.

*Recording Button*

Click the button to start or stop logging.

The button in Red colour: Logging stopped

The button in Green colour: Logging in progress

Log Interval

The log interval time in second, default 10 seconds.

Minimum 1 second, Maximum interval: 100 seconds.
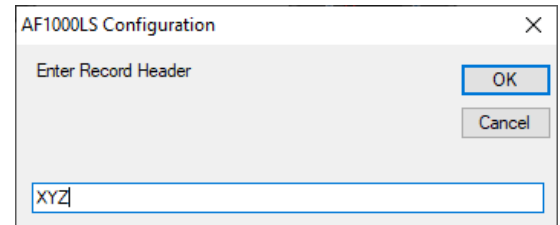
Enter Log Header

After click Start Logging button, the Log Header input box will be popup. Please input any charaters for the identification of current log. The Log Header will be added into the 1st line of the log file.
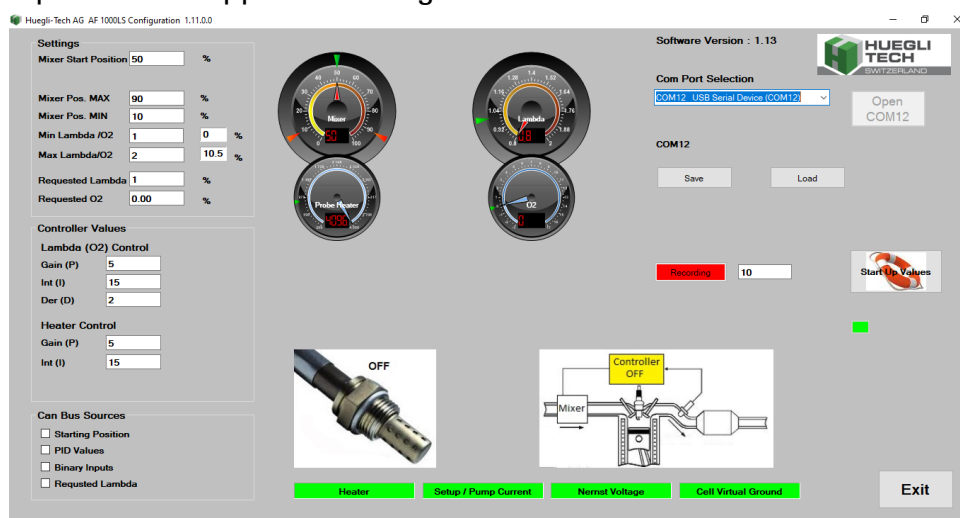
Log file location

The log files will be saved inside folder:

[C:\Users\[WIN USER]\AppData\Local\VirtualStore\Program Files (x86)\AF1000LS Configuration]

Log file name format

The log file name format is: Record [Date] [Time].txt

Example: [Record 20201021 143002.txt]

8   Measured Values and Status

If the PC is connected to the AF1000LS module several values and the status of the device can be read

8.1   Measured Values

8.1.1 Mixer Values

Starting Position
Max. Position
Actual Position
Min. Position

8.1.2 Probe Heater

Requested Value UR
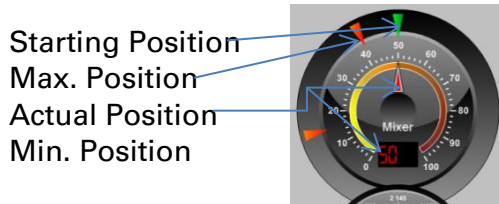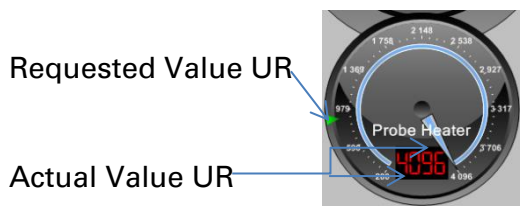
Actual Value UR

The measured value UR is an internal value of the probe which indicated if the temperature of the probe has reached the operation temperature. The value is around 900 depending on the calibration value of the probe.
As long as the probe has not reached its operational temperature, the controller is not switched on!

8.1.3 Lambda / O_2 - values

Requested Lambda

Actual Lambda

Requested O_2

Actual O_2
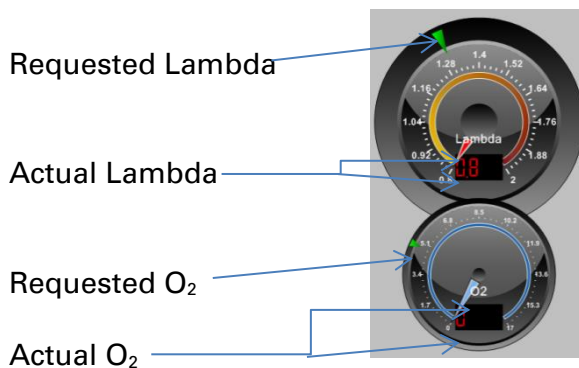
HINT
As long as the probe has not reached its operational temperature, the indicated values are in-valid!

8.1.4 Status Probe Heating

BIN1 open
Probe not heated

BIN1 closed
Probe heating up
operation temperature
not reached

BIN1 closed
Probe heated up
operation temperature
reached

8.1.5 Status Controller
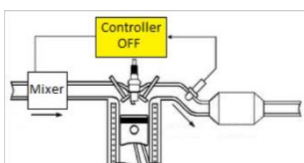
BIN 2 open and /or
operation temperature
not reached
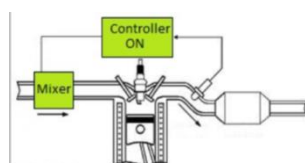
BIN 2 closed and
operation temperature
reached

8.1.6 Status Probe

The Status Bar shows the actual status of the probe.
If any of the indications turn to red the probe is either damaged or there is a problem in the wiring.

9 Technical Data

9.1 Input/output parameters

Power Supply .... 7 - 30VDC, Reverse Polarity Protected

Current Consumption..Lambda Probe On : Maximum 1.2 A with 24VDC Power Supply Input @ 25°C

....Lambda Probe Off: Maximum 0.08A with 24VDC Power Supply Input @ 25°C

Input On State Voltage .... Minimum 3.5V / Maximum 28.8V

Input Off Stage Voltage ....Maximum 1.8V

Number of Inputs .... 2, Binary, Non Isolated

Number of Mixer Control Output..2, Non Isolated

9.2 Performance

Supported Lambda Probe .... LSU4.2 / LSU4.9

9.3 Ambient

Operational Temperature..-40 to 70 ^{o}C (-40 to +158°F)

Storage Temperature ....-40 to +85 ^{o}C (-40 to +185°F)

Relative Humidity .... 5 to 95%, Non-condensing

9.4 Standards / Regulation

Communication Supported Protocols .... Can Bus HT Controller, J1939

.... ModBus through USB (for configuration purpose only)

9.5 Standards / Regulation

Authorizing office ....CE and RoHS requirements

Communication .... CAN Bus SAE J1939, Modbus RTU

9.6 Dimension and weight

Dimension (Including Terminal blocks)..30 x 110 x 94 mm

Weight (Including Terminal blocks)..205g

9.7 Configuration parameters

Wire Size .... 0.5 to 4 mm2 (22 to 12 AWG)

Mounting...DIN Rail 35 mm