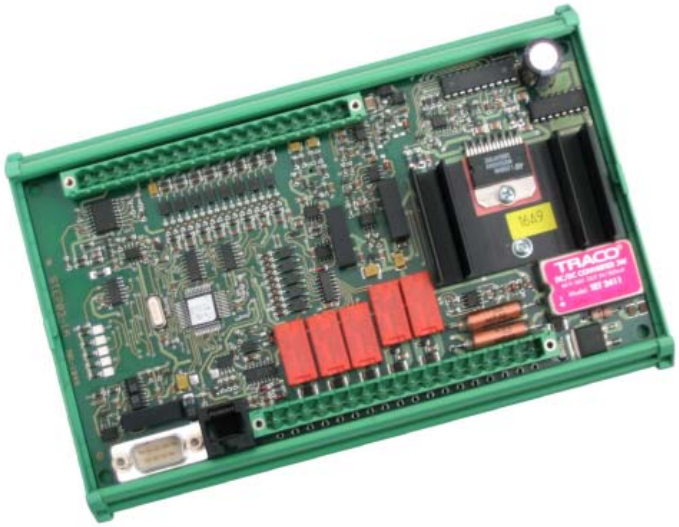
37112C

WOODWARD

ST 3
Lambda Controller



Operation Manual
Software Version 2.1xxx

Manual 37112C

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

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Important definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment.

NOTE

Provides other helpful information that does not fall under the warning or caution categories.

Revision History

Rev.	Date	Edit.	Changes
NEW	04-06-02	Tr	Release
A	05-07-06	TP	New format, minor corrections, updated wiring diagram
B	05-11-23	TP	Minor corrections, reference test description updated (lock function)
C	06-06-29	TP	Minor corrections, lambda probe wiring diagram added

Table of Contents

Figures and Tables

Figures

Chapter 1.
General Information

Introduction

Additional Documents and General Information

The specification as well as the wiring diagram of the Lambda probe LSU4 manufactured by the company of "Robert Bosch GmbH" is described in the following documents (dated 26.07.2002) and can be ordered directly at the manufacturer:

- A258400004 Wiring diagram of the probe
- Y258K01005d Technical brochure for customers

ATTENTION

Do not at any time attach or separate the LSU4 during operation of the ST 3. This can destroy the Lambda probe.

NOTE

The connector plug module includes a trimming resistor, which assigns the characteristics of the Lambda probe and is necessary for the function of the probe.

Please note the details of the probe manufacturer for the cable length between the Lambda probe and the ST 3.

Lambda Probe Heating

The Lambda probe must be heated according to the specification. If the Lambda probe is not to be heated continuously the probe can be activated by a relay of the ST 3 shortly before enabling of the control.

Intended use: The device must only be used for those applications which are described in these manual. The prerequisite for a proper and safe operation of the product is correct transportation, storage, and installation as well as careful operation and maintenance.

NOTE

This manual has been developed for a unit fitted with all available options. Inputs/outputs, functions, configuration screens, and other details described, which do not exist on your unit, may be ignored.

The present manual has been prepared to enable the installation and commissioning of the unit. Due to the large variety of parameter settings, it is not possible to cover every combination. The manual is therefore only a guide. In case of incorrect entries or a total loss of functions, the default settings may be taken from the list of parameters in the appendix of this manual.

Chapter 2.
Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as easily as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, etc.) away from the control, modules, and work area as much as possible.

4. **Opening the control cover may void the unit warranty.**
   Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

   - Ensure that the device is completely voltage-free (all connectors have to be disconnected).
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, connectors, or components with conductive devices or with bare hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Chapter 3.
Connecting the Unit

Wiring Diagram

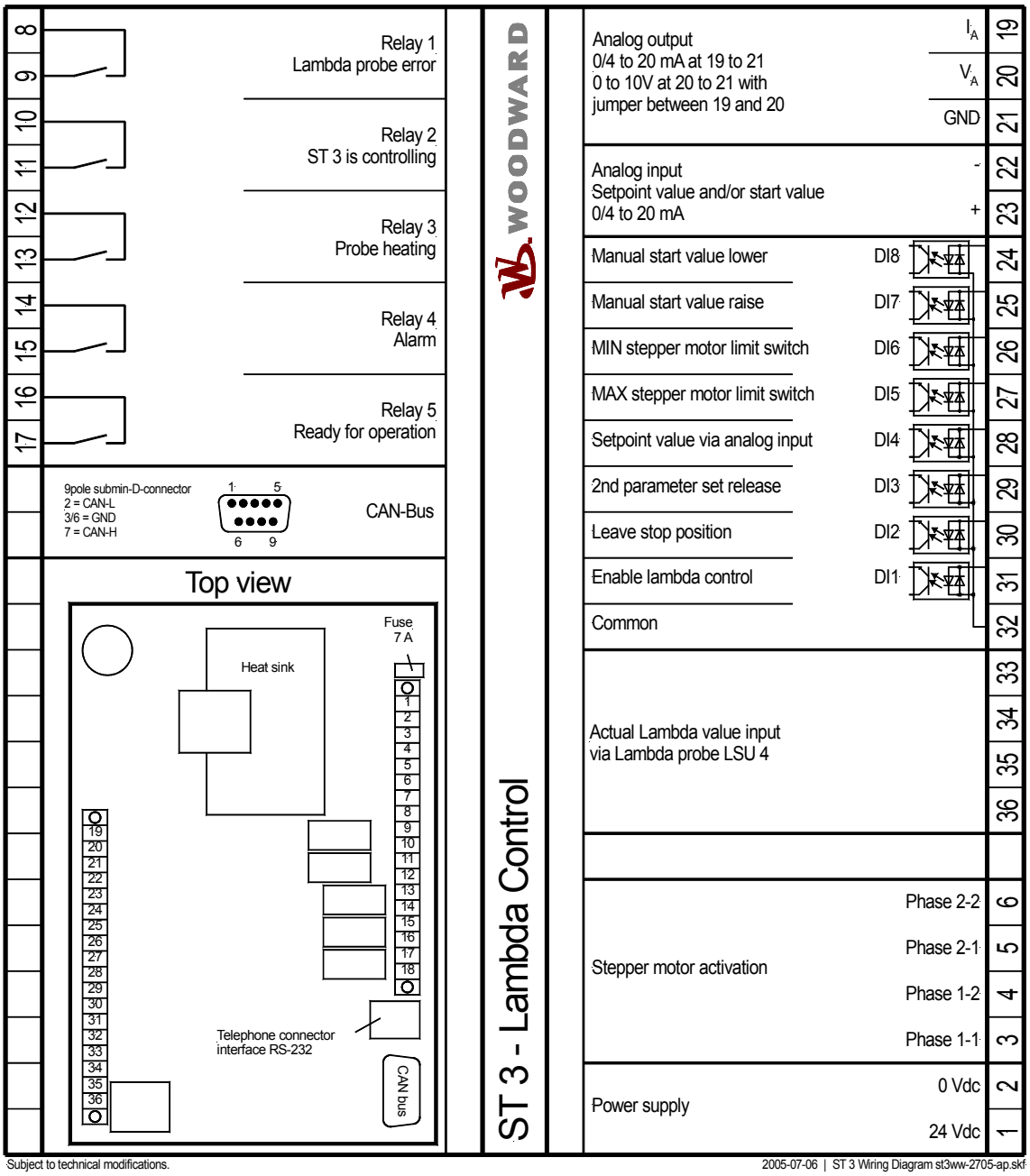


Figure 3-1: Wiring diagram

Connection Terminals

Power Supply

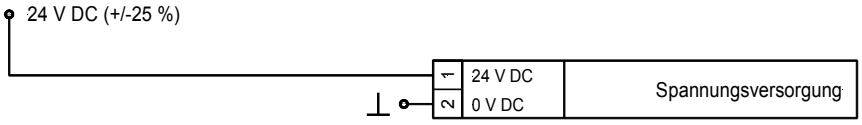


Figure 3-2: Power supply

Terminal	Description	A_{max}
1	24 Vdc (in normal operation)	2.5 mm²
1	0 V refernce point	2.5 mm²

Measuring Input for the Lambda Probe

Terminal	Description	A_{max}
33	RT	2.5 mm²
34	APE	2.5 mm²
35	IPN	2.5 mm²
36	RE+	2.5 mm²

These descriptions can be found on the wiring diagram of the LSU 4, too.

ATTENTION

Do not at any time attach or separate the LSU4 during operation of the ST 3. This can destroy the Lambda probe.

NOTE

The connector plug module includes a trimming resistor, which assigns the characteristics of the Lambda probe and is necessary for the function of the probe.

Please note the details of the probe manufacturer for the cable length between the Lambda probe and the ST 3.

Analog Inputs

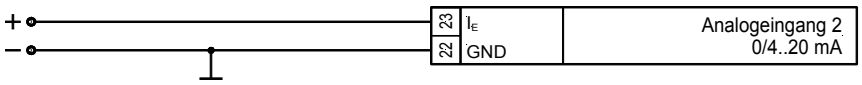


Figure 3-3: Analog inputs

I_E	0 V	Description	A_{max}
23	22	Analog input Set point value and/or starting value	2.5 mm²

Discrete Inputs

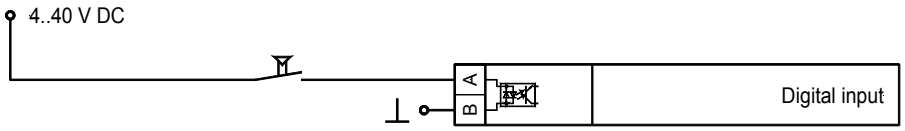


Figure 3-4: Discrete inputs

Terminal	Associated common	Description (according to DIN 40 719 Part 3, 5.8.3)	A_{max}
31	32	Discrete input 1 - Enable Lambda control	2.5 mm²
30		Discrete input 2 - Leave stop position	2.5 mm²
29		Discrete input 3 - Parameter set #2	2.5 mm²
28		Discrete input 4 - Analog set point value	2.5 mm²
27		Discrete input 5 - Stepper motor limit switch MAX	2.5 mm²
26		Discrete input 6 - Stepper motor limit switch MIN	2.5 mm²
25		Discrete input 7 - Manual set point value - raise	2.5 mm²
24		Discrete input 8 - Manual set point value - lower	2.5 mm²

Stepper Motor Actuation

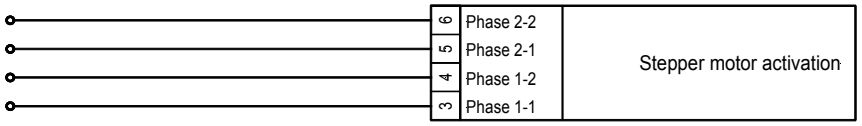


Figure 3-5: Stepper motor actuation

Terminal	Description	A_{max}
3	Phase 1-1	2.5 mm²
4	Phase 1-2	2.5 mm²
5	Phase 2-1	2.5 mm²
6	Phase 2-2	2.5 mm²

Analog Output

Analog output 0/4 to 20 mA at 19 to 21, 0 to 10V at 20/21 with 19 and 20 interconnected.

Terminal	Description	A_{max}
19	I_A	2.5 mm²
20	V_A	2.5 mm²
21	GND	2.5 mm²

Relay Outputs

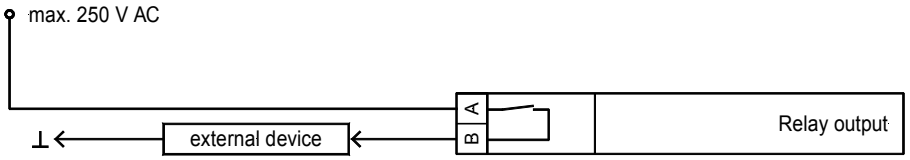


Figure 3-6: Relay outputs

		Description	
make contact			
common ***A***	closing ***B***		A_{max}
9	8	Relay 1 - Lambda probe failure	2.5 mm²
11	10	Relay 2 - ST 3 is controlling	2.5 mm²
13	12	Relay 3 - Heat Lambda probe	2.5 mm²
15	14	Relay 4 - Alarm	2.5 mm²
17	16	Relay 5 - Ready for operation	2.5 mm²

Interface

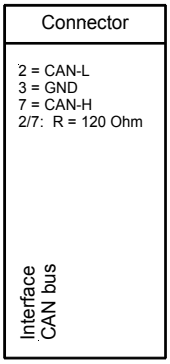


Figure 3-7: Interface

Terminal					Description
2	**3**	**7**			
CAN-L	GND	CAN-H			CAN bus

NOTE

Please note that the CAN bus must be terminated with an impedance which corresponds to the wave impedance of the cable (e.g. 120 Ohm). The terminating resistor is positioned between CAN-H and CAN-L on the engine CAN bus.

Shielding

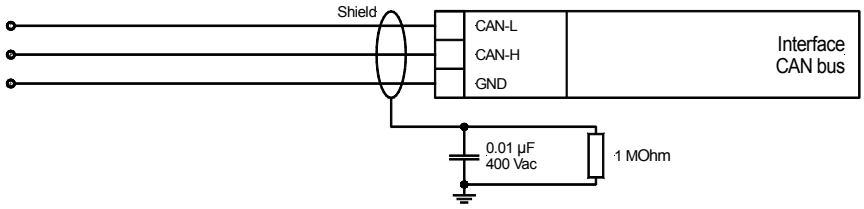
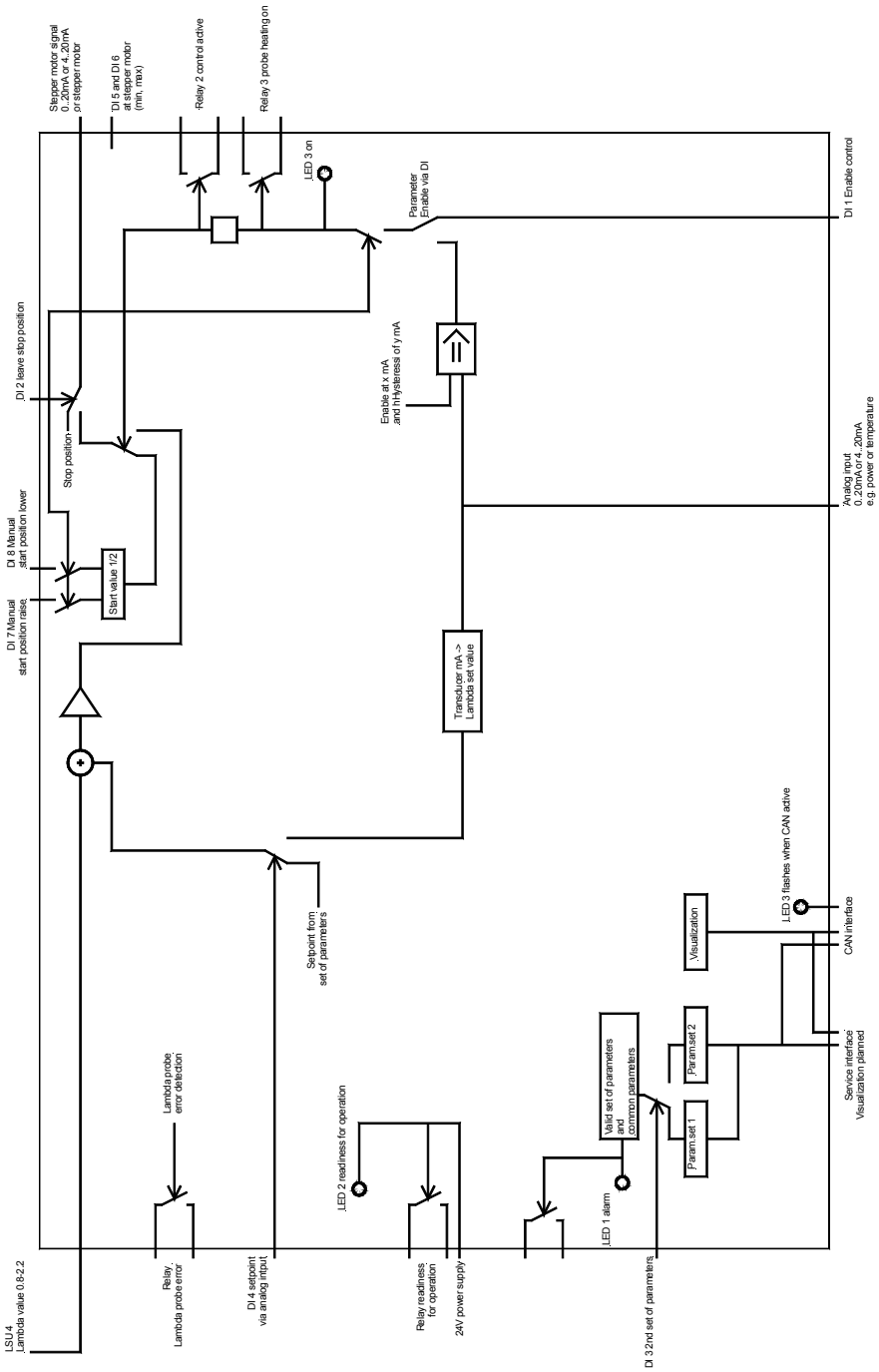


Figure 3-8: Shielding

Chapter 4.
Functional Description

Operational Overview of the ST 3



LEDs

LED No.	Color	Meaning
1	Red	Alarm
2	Green	Ready for operation
3	Yellow	CAN bus changes status with every successful transmitted message
4	Yellow	Lambda control active (same as relay 2)
5	Yellow	Monitoring of the control pulses of the stepper

Function

Starting the ST 3

Power supply is applied to the ST 3. No discrete input is set.

- Output of the control signal for the stop position if the analog output is selected.
- If the stepper motor driver was selected as the actuator, the stepper signal starts into minimum limit switch direction to the stop position.

Starting the Engine

Enabling the discrete input 3 "Set of parameter #2" the second parameter set can be selected. With the second set of parameters the values for actuator start position, some control parameters, the Lambda set point value and the operating mode of the enable can be changed.

The discrete input 2 "Leave stop position" is set.

- The actuator goes to the starting position (according to the configuration).

Starting the Control

If "Enable via discrete input" is configured, the control starts after setting the discrete input 1 "Enable control". If "Enable via analog input" is configured, the control starts after the adjusted value (applied through the analog input) is exceeded.

- Relay 3 energizes (turns on the external Lambda probe heating).
- The ST 3 starts to control the configured Lambda set point value after the time, set in "Time for heating up the lambda probe", is expired. This is signaled by the LED 4 and the relay 2.
- The probe operation is monitored.

Probe Monitoring

A probe error is displayed

- if the control is active and the preheating time of the probe (parameter "Time for heating up the lambda probe") is expired.
- for lambda values above 2.4 or below 0.8.

If the parameter "Monitoring probe" is set to Yes, a probe error is displayed if the lambda value is between 0.98 and 1.04 for at least a duration, which is set in the parameter "Lambda probe error delay", and is only changing slightly.

External Set Point Value for Control

Discrete input 4 "Analog set point value" is set:

- The current, measured at the analog input, is converted using a characteristic curve into a Lambda set point value.
- The characteristic curve is defined in a parameter of the ST3 set with 9 bases.
- If the discrete input 4 is set prior to the enabling of the Lambda control, the Lambda value is controlled immediately to the external set point value.
- If the discrete input 4 is set as well as enable via analog input is configured the analog signal is used for both functions accordingly.

Stopping the Control

If "Enable via discrete input" is configured, the control stops after resetting the discrete input 1 "Enable Lambda control". If "Enable via analog input" is configured, the control stops if the adjusted current value is fallen below the starting value for more than the hysteresis.

- Relay 2 and relay 3 de-energize.
- The actuator goes into starting position.

Drive to Stop Position

Reset of the discrete input 2 "Leave stop position".

- The actuator drives into stop position.

De-energizing the ST 3

The ST 3 may now be de-energized.

Stepper Motors

Compatible Models

The circuitry used is designed for the control of 2-phase bipolar stepper motors. Stepper motor actuation enables both full and half step modes (please note the connection diagram below) and operation takes place in phase chopping mode. The maximum current on the stepper motor can be configured to a value of up to 2.0 A. It must be noted that the stepper motor may be overloaded if the maximum current is set too high.

In half step mode, the torque is kept constant by reducing the current by the factor of √2 in the half step (if current is flowing in two windings).

Although the use of unipolar stepper motors is possible, it is not the best solution. The center tap on the motor must not be connected up; the outputs on the driver modules are connected to the ends of the winding. The unipolar stepper motor is operated in the same way as a bipolar stepper motor. Unlike bipolar control, current is applied to two windings simultaneously so the same torque is achieved with a single weaker current. It is not possible to connect the center tap with the L298 driver module (or any other H-bridge driver) because the winding current restriction would no longer function.

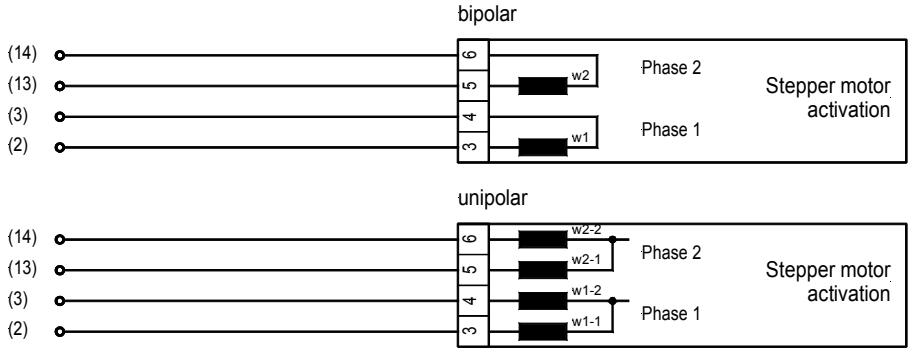


Figure 4-1: Schrittmotortypen

NOTE

Please observe the technical specifications of the stepper motors when setting the parameters.

Control Principle

A stepper motor cannot start up with the maximum frequency. Similarly it must be braked before stopping so that it does not overshoot the starting point. This yields the following typical acceleration/deceleration profile:

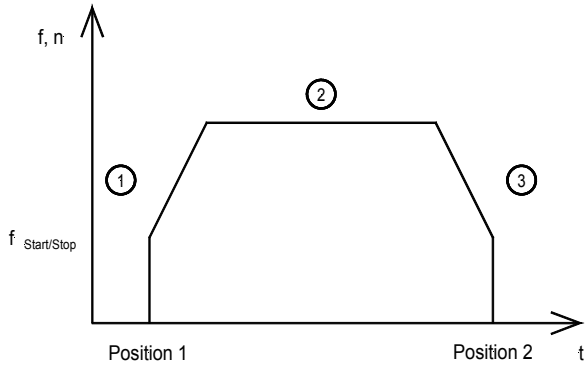


Figure 4-2: Control principle

The acceleration/deceleration profile may be divided into three phases:

- Phase 1: acceleration phase with linear ramp
- Phase 2: phase with constant or velocity
- Phase 3: braking phase with linear ramp

Constant acceleration of the engine and load can be achieved thanks to the linear ramp on condition that the torque is independent of the speed.

The start-up frequency and the maximum constant velocity are dependent on the stepper motor and can be configured. The acceleration ramp can be configured in Hz/s; the braking ramp results is obtained from the algorithm for converting the control variable.

NOTE

After changing from stop to a start position or between two start positions, you have to give the stepper motor some time that it is able to reach the position.

If you change between the positions too fast, it may happen that the position of the stepper motor is not detected correctly. Remedy: executing a reset.

Analog Output

The analog output is a current output for 0 to 20 mA. It can be changed into 4 to 20 mA by a parameter. Using a jumper across the terminals 19 and 20, you can generate a voltage of 0.10V between the terminals 20 and 21 (see wiring diagram).

Chapter 5.
Configuration

The configuration may be performed by the user directly using a PCs and the program LeoPC1 via the serial configuration interface. The following baud rates are possible:

- Direct configuration 1.200 Baud (8 Bit, no parity, 1 stop bit)

WARNING

Do not configure the unit during plant operation.

NOTE

Please note the parameter list at the end of this manual.

Direct Configuration

NOTE

Zur Parametrierung über den Seitenstecker (Direktparametrierung) benötigen Sie ein Direktparametrierkabel (Bestellcode "DPC", P/N: 5417-557), das Programm LeoPC1 (wird mit dem Kabel geliefert) und die entsprechenden Konfigurationsdateien. Die Beschreibung des PC-Programmes LeoPC1 sowie dessen Einrichtung entnehmen Sie bitte der Online-Hilfe, die bei der Installation des Programmes ebenfalls installiert wird.

Über die Parametrierschnittstelle kann das Gerät parametriert werden. Dazu ist ein Direktparametrierkabel notwendig, welches auf der einen Seite am PC/Laptop und auf der anderen Seite am Gerät angeschlossen wird.

Für die direkte Parametrierung gibt es eine Datei, die mittels des Programms LeoPC1 geöffnet werden kann. Die Parameter, die im Abschnitt "Parameter" ab der Seite 18 beschrieben sind, können mittels dieser Datei identifiziert und geändert werden.

Parameter

The parameters may be configured using the PC program LeoPC1 (refer to the external manual for a description).

Software Version — **Software version**

Version number of the software.

Dynamic Parameter

General Settings

Stop position of the actuator — **Stop position of the actuator** — **0,00 to 100,00 %**

Input of the stop position of the actuator in percent of the total actuator's range.

Start position — **Start position of the actuator** — **0,00 to 100,00 %**

Input of the start position of the actuator in percent of the total actuator's range.

Control Parameters

Gain Kp — **Gain factor K_{PR}** — **0 to 300,00**

The closed-loop control system gain is indicated by the proportional-action coefficient K_{PR}. The variable to be controlled is achieved more rapidly by increasing the P-gain.

Reset time Tn — **Reset time T_N** — **0 to 99,99 s**

The reset time T_n represents the I-component of the PID controller. The I-component results in permanent control deviation being eliminated in the controlled state.

Deriv.act. Tv — **Derivative action time T_V** — **0 to 99,99 s**

The derivative-action time T_V represents the D-component of the PID controller. An increase in the phase reserve (stability) and the attenuation results from increasing this parameter.

Set Point Values

Fixed setpoint value

Fixed Lambda setpoint value **0,8 to 2,20**

If the controller is used as a stand-alone device, this value is used as the set-point value for Lambda control.

Base Points for Set Points of the Analog Input

Fixed setp. of Lambda at yy.y %

[yy,y = 0 % / 12,5 % / 25,0 % / 37,5 % / 50,0 % / 62,5 % / 75,0 % / 87,5 % / 100,0 %]

Assignment of analog value to set point value **0,8 to 2,20**

The set point value can be assigned via an analog input. In this table the base for the Lambda set point value is entered as function of the analog input. The change from 0 to 20 mA to 4 to 20 mA has no consequence.

Start of the Control

Release control via

Enable Lambda control via analog input **Analog input / DI 1**

It is possible to select whether control is enbabled by a discrete input or by an analog input.

Time for heating up

Time for heating up the lambda probe **0 to 99s**

Time, during which the relay 3 lambda probe heating is picked up and the control is not yet active.

Monitoring probe

Monitoring probe **YES / NO**

The probe is monitored whether it displays a constant value between Lambda 0.98 and 1.04.

Probe error delay

Lambda probe error delay **0 to 9.9min**

Time, during which a probe error in the range between 0.98 and 1.04 has to be present until it is indicated.

Release control at

Starting value for the control **0 to 100%**

Starting the control by an analog input this value is the starting value.

Release control Hysteresis

Hysteresis **0 bis 100%**

The control will be determined if the signal at the analog input is smaller than the value "Starting the control – hysteresis".

System Parameters

General Settings

Analog input

Analog input	YES / NO / 20 to 100% / 0 to 100%

With this parameter a selection between a 20 to 100% and a 0 to 100% input is made. If the input has been configured to 20 to 100%, a wire break detection is monitored. Values between 0% and 100% are considered according to a 0 to 100% setting.

NOTE

The stepper motor turns during starting (during connection of the power supply) always into the direction of the min limit switch.

ATTENTION

If you change the direction of the rotation the description of the limit switches change, too. Please mark prior to changes of the direction of the rotation the stop and start position of the stepper motor and the analog outputs. Please check them additionally following the changes.

Direction of rotation invert

Invert rotation direction	YES / NO

The direction of the rotation of the actuator is inverted. If this parameter is changed the wiring of the min and the max connection of the limit switches have to be inverted.

Step motor piloting

Step motor piloting	YES / NO

This parameter defines the type of the output.

YES..... The actuator will be activated by the stepper motor, an activation by the analog output is not possible.

NO..... The actuator will be activated by the analog output.

DIs Operating Current / Closed Current

The DIs may be switched between operating current and closed current. If the parameter "Control over CAN" is set (YES), the following is valid

- a 1 in the respective bit
  for operating current – DI energized
  for closed current – DI not energized
- a 0 in the respective bit
  for operating current – DI not energized
  for closed current – DI energized

When sending the DI states, a 1 means always "set", regardless, whether this takes place with operating or closed current.

DI 1 release

DI 1 release set **OPERATING/CLOSED CURRENT**

Enables Lambda control.

DI 2 drop out of stop position

DI 2 drop out of stop poition set **OPERATING/CLOSED CURRENT**

The actuator moves from stop to starting position (according to parameter set).

DI 3 2. parameter list

DI 3 parameter list 2 set **OPERATING/CLOSED CURRENT**

Selection between parameter set 1 and 2.

DI 4 Set value from analog input

DI 4 set value from analog input set **OPERATING/CLOSED CURRENT**

The set value is taken over from the analog input instead of the parameter set.

DI 5 End switch of stepper motor MAX

DI 5 limit switch MAX set **OPERATING/CLOSED CURRENT**

Activates the limit switch MAX for the stepper motor.

DI 6 End switch of stepper motor MIN

DI 6 limit switch MIN set **OPERATING/CLOSED CURRENT**

Activates the limit switch MIN for the stepper motor.

DI 7 Manually start position high

DI 7 manual start position set higher **OPERATING/CLOSED CURRENT**

Increases the manual value of the start position.

DI 8 Manually start position low

DI 8 manual start position set lower **OPERATING/CLOSED CURRENT**

Decreases the manual value of the start position.

Analog Output

Analog output

Analog output **20 to 100% / 0 to 100%**

This parameter defines the range of the analog output.
20 to 100%.. The output range is 4 to 20 mA.
0 to 100%.... The output range is 0 to 20 mA.

NOTE

If the analog output is not used, it has to be configured to 0 to 100%. Otherwise, a wire break failure is detected and the control does not start.

Stepper Motor

At stop position retain moment

At stop position retaining moment — **HOLD / CUT OFF**

HOLD ..... Retaining force is maintained in stop position.
CUT OFF ..... Retaining force is not maintained in stop position.

Number of end limit

Number of limit switches — **MIN+MAX / MIN**

MIN+MAX.. Two limit switches are available (MIN+MAX).
MIN ..... One limit switches is available (MIN).

NOTE

In case of one limit switch, this should be moveable (upper / lower limit). The parameter Direction of rotation invert affects this.

Control variable output in

Stepper mode — **HALF STEP MODE/FULL STEP MODE**

HALF..... The stepper motor is driven in half step mode.
FULL ..... The stepper motor is driven in full step mode.

ATTENTION

If this parameter is changed, a reference drive has to be executed.

Phase chopping mode

Chopping Modus — **YES/NO**

YES.....Phase chopping modus.
NO.....Inhibit chopping modus.

MAX PWM freq. stepper motor

Maximum PWM frequency — **20 to 1.000 Hz**

Maximum control frequency for the stepper motor. This frequency is never exceeded.

MIN PWM freq. stepper motor

Minimum PWM frequency — **20 to 1.000 Hz**

Minimum control frequency for the stepper motor. The frequency never falls below this value. This frequency is used for the start/stop process.

MAX active current fro step motor

Maximum stepper motor current — **0 to 2.000 mA**

Maximum operating current for the stepper motor.

Ramp stepper motor

Set point value ramp for stepper motors — **50 to 5.000 Hz/s**

The set point value for the stepper motor is modified via a ramp. The slope of the ramp is used to alter the rate at which the controller modifies the set point value. The more rapidly the change in the set point is to be carried out, the greater the value input here must be.

PWM-freq. zero set

PWM frequency for the search for zero setting **20 to 1.000 Hz**

This value specifies the frequency to be used by the stepper motor for the search for zero setting. There is neither an acceleration ramp nor a braking ramp. This should be chosen as low as possible to ensure a safe recognition of the limit switches.

Carry out reference test

Reference test carry out **YES/NO**

Entering YES will start the reference test.

The step number determined during the reference drive differs, depending on the setting of the parameter Stepper Mode (half/full step mode).
The controller enabling may not be set. The command is cancelled automatically after the reference test or in case of set control release. During the reference test the stepper changes between both limit switches to determine the number of steps.
This number of steps will be taken over under certain preconditions (refer to the following note!). It is possible to check the successful takeover by reading in the parameter "Number of steps f.the stepper m." again. Additionally, the actual step number is displayed in the display "Pos. of actuator" of LeoPC1.

Number of steps f.the stepper m.

Step count of the stepper motor **0 to 65.535**

The number of (internal) steps from flap setting = 0 to flap setting = MAX. This value is determined with the reference test (refer to the following note!). If only one limit switch is present, this value must be entered manually.

NOTE

The automatic takeover of the number of steps has a lock function.

In order to take over the number of steps after performing a reference test by the ST 3, the following proceeding must be followed:

1. **Configure parameter "Step motor piloting" to NO**
2. **Disconnect the power supply from the ST 3 for at least 5 seconds**
3. **Connect the power supply to the ST 3 again**
4. **Configure parameter "Step motor piloting" to YES**
5. **Perform reference test as described above**
6. **Check takeover of the determined number of steps by reading in the parameter "Number of steps f.the stepper m." again**

CAN Interface

These parameters exist only for direct configuration.

Baud rate

Baud rate — **20/50/100/125/250 kBaud**

This Baud rate is used for CAN bus communication (the communication with the controller device takes place with 250 kBaud.)

CAN-Node-ID

ID of the transmitting address for data transmission — **0 to 31**

Data is sent on this ID address via the CAN bus (e.g. measuring values).

Control over CAN

Empfang von Stopposition / DI / AI über den CAN-Bus — **YES / NO**

YES..... The start/stop position, the states of the discrete inputs (except stepper motor MIN/MAX), and the value of the analog input are received via the CAN bus.

NO..... The stop position is evaluated out of the discrete inputs. The status of the discrete inputs is evaluated locally. The value of the analog signal is evaluated via the local analog input (wired to the ST 3). Values received via the CAN bus are ignored.

CAN ID receive data

ID for receiving data — **read only**

On this ID address the unit will receive data via the CAN bus.

CAN ID send data

ID for sending data — **read only**

On this ID address the unit will send data via the CAN bus.

CAN ID receive para

ID for receiving parameter — **read only**

On this ID address the unit will receive parameters via the CAN bus.

CAN ID send para

ID for sending parameter — **read only**

On this ID address the unit will send parameters via the CAN bus.

CAN ID receive upload

ID for receiving display screens — **read only**

On this ID address the unit will receive screens from the higher level unit via the CAN bus.

CAN ID send upload

ID for sending display screens — **read only**

On this ID address the unit will send screens from the higher level unit via the CAN bus.

Diagnosis

Test of Lambda input

Test of Lambda input **YES / NO**

The actual Lambda value will be set to approx. 1 for test purposes. Measuring of the actual value is disabled.

Manual handling mode

Manual adjustment **YES / NO**

The actuator can be adjusted by the discrete inputs "manual start position higher" and "manual start position lower". The adjusted value expires if the actuator goes into stop position or if the control is released.

Set param. to delivery conditions

Reset to factory values **0 to 65.535**

Please enter the software version of the unit here to reset all parameters to factory values.

Displaying Current Values

Start position

Current start position

The current activated start position in % is indicated.

active setpoint Lambda

Lambda set point

The current valid Lambda setpoint is indicated for checking.

actual value Lambda

Lambda actual value

The measured Lambda value is indicated.

Remote Control with GCP-30

The following settings have to be made for remote controlling the ST 3 with the control device GCP-30:

Parameter	Setting
Node ID:	6
Baud rate	Same setting as for GCP
Control over CAN	Yes
Release control via	DI1

The DI input states received from the ST 3 via CAN can be read out with the parameters DI1 to DI (exception: limit switch MIN/MAX of the stepper motor.)

Values received from the ST 3 can be read out using the parameters Data1, Data2, and Data.

If the ST 3 is controlled via CA, a reset has to be executed before driving into start position that the ST3 is able to determine the position of the stepper motor.

Status of the Discrete Inputs

ATTENTION

If the parameter Control over CAN is set (YES), the states of the discrete inputs (except stepper motor MIN/MAX) are received via the CAN bus!

`DI 1 Lambda control rel.` **Discrete input 1 "Enable Lambda control" is set**

If this discrete input is energized, "YES" is displayed.

`DI 2 leave stop position active` **Discrete input 2 "Leave stop position" is set**

If this discrete input is energized, "YES" is displayed.

`DI 3 2nd parameter set release` **Discrete input 3 "Parameter set 2" is set**

If this discrete input is energized, "YES" is displayed.

`DI 4 fixed of Lambda from an. in.` **Discrete input 4 "Set value of the analog input" is set**

If this discrete input is energized, "YES" is displayed.

`DI 5 MAX stepper motor limit` **Discrete input 5 "MAX stepper motor limit" is set**

If this discrete input is energized, "YES" is displayed.

`DI 6 MIN stepper motor limit` **Discrete input 6 "MIN stepper motor limit" is set**

If this discrete input is energized, "YES" is displayed.

`DI 7 Manual start position higher` **Discrete input 7 "Manual start position raise" is set**

If this discrete input is energized, "YES" is displayed.

`DI 8 Manual start position lower` **Discrete input 7 "Manual start position lower" is set**

If this discrete input is energized, "YES" is displayed.

Current Operating Mode

`Operational status` **Operational status**

The operational status of the device can be viewed here. The operational statuses are coded as follows:

02 ZERO SETTING operational status
04 INITIAL STATE / NO CONTROL ACTIVE operational status
08 CONTROLLING operational status.

The state of the relays 1 to 5 may be displayed:

Relay 1	Probe error	energized yes/no
Relay 2	Controlling	energized yes/no
Relay 3	Probe heating	energized yes/no
Relay 4	Error	energized yes/no
Relay 5	Ready	energized yes/no

The values determined via CAN may be displayed:
Value 1 Stop/start position
Value 2 Low byte analog input
Value 3 According to the DIs

Chapter 6.
Commissioning

DANGER - HIGH VOLTAGE

When commissioning the control, please observe all safety rules that apply to the handling of live equipment. Ensure that you know how to provide first aid in the event of an uncontrolled release of energy and that you know where the first aid kit and the nearest telephone are. Never touch any live components of the system or on the back of the system:

LIFE THREATENING

CAUTION

Only a qualified technician may commission unit. The "EMERGENCY-STOP" function must be operational prior to commissioning of the system, and must not depend on the unit for its operation.

Commissioning the Stepper Motor

If the stepper motor is selected as actuator the following is valid:

- After connecting to the power supply the stepper is moving into the direction of the limit switch MIN.
- If a stepper with two limit switches is used, a reference test can be carried out to determine the number of steps (refer to parameter "Carry out reference test" on page 23). If the position of the limit switches is moved, a rerun is necessary.
- Is only one limit switch available this hast to be the limit switch MIN. To determine the number of steps, the stop position is set to 0 % and the start position is set to 100 %. If discrete input 2 “Leave stop position” is set now, the stepper runs up to 100 %. This value corresponds to the number of steps. Now the number of steps can be increased until the stepper has run up to the correct end point.

Regardless whether the step number has been determined manually or executing a reference drive, the step number has to be checked for correctness.
To do this, you can increase the stop position from 0% to 50% for example. If the step number has been determined correctly, the actuator is in the middle then.

The average current of the stepper motor can be adjusted using the chop operation. Therefore the switch-off level is configured. The average current is overtaken depending on the connected stepper motor (with reference to the superposed ripple of the current).

ATTENTION

During commissioning the adjusted current must be checked. Is the current too high the stepper motor can be damaged by an overload.

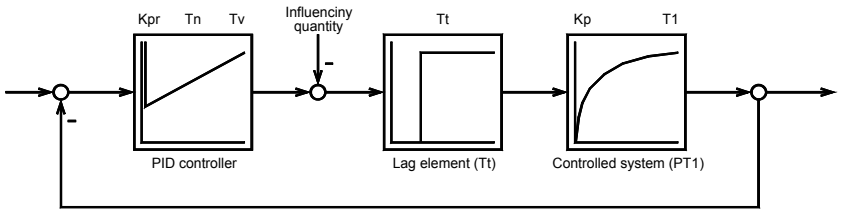
Defining the Start Position

The adjustment of the start position can proceeded as follows: A wide-pitch setting is made by setting the configuration value "start position". For fine adjustment the parameter "manual" can be set to YES and the actuator can be adjusted manually with the discrete input 7 "Manual start position higher" and the discrete input 8 "Manual start position lower". After the correct position is adjusted, this value is read out via the parameter "Current start position" and entered into the corresponding parameter "start position".

Controller Output

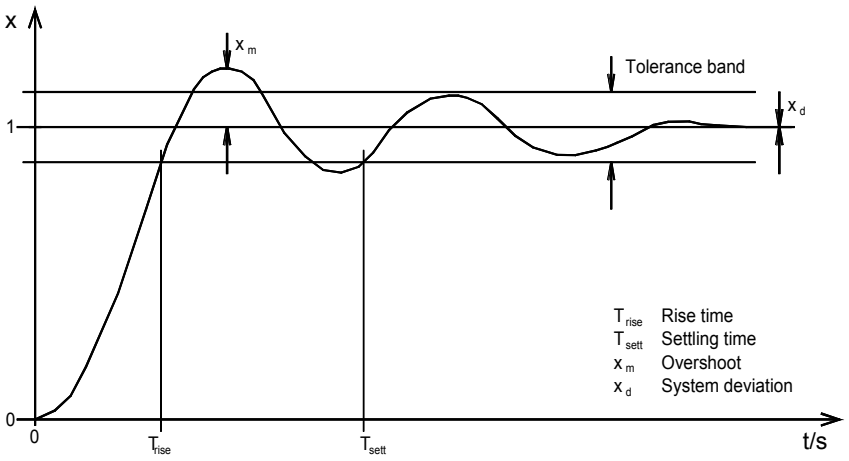
The analog PID controller forms a closed-loop control loop together with the controlled system (usually a first-order lag element). The parameters of the PID controller (proportional-action coefficient K_{PR}, derivative-action time T_V and reset time T_n) can be modified individually. The configuration screens are used for this purpose.

Control loop



In the event that an abrupt disturbance variable is applied to the control loop, the reaction of the controlled system can be recorded at the output as a function of the time (step response).

Step response (example)



Various values can be obtained from the step response; these are required for adjusting the controller to its optimum setting:

Rise time T_{rise}
Period starting when the value of the control variable leaves a predefined tolerance range for the control variable following a step in the disturbance variable or reference input variable and ending the first time the value re-enters this range.

Settling time T_{sett}
Period starting when the value of the control variable leaves a predefined tolerance range for the control variable following a step in the disturbance variable or reference input variable and ending when the value re-enters this range permanently.

Overshoot x_m
Highest transient setpoint value deviation during the transition from one steady-state condition to a new steady-state condition following modification of the disturbance variable or reference input variable ($x_{m\ optimum} \leq 10$ %).

System deviation x_d
Permanent deviation from the final value (PID controller: $x_d = 0$).
The values K_{PR}, T_n and T_V can be determined from these values by applying various conversion factors. It is also possible to determine the optimum controller setting by performing various calculations, such as compensation or adaptation of the time constant, the T-sum Rule, Symmetrical Optimum, Bode diagram. Other setting procedures and information may be obtained from current literature.

Controller Setting

Controller Setting, Possibility 1 (Ziegler and Nichols)

ATTENTION

The following must be observed regarding the controller setting:

- **Ensure that the emergency shut-down system is ready for use.**
- **Note the amplitude and frequency during the determination of the critical frequency.**
- **If the two values alter uncontrollably:**

→ S H U T D O W N

The setting rule described below only serves as an example. Whether this method is suitable for setting your particular controlled system has not been and cannot be taken into account as each controlled system behaves uniquely.

There are various possibilities of setting a controller. The setting rules according to Ziegler and Nichols are explained below (determination for abrupt disturbances on the system input); this setting method assumes a pure lag element connected in series with a first-order lag system.

1. Controller operated as a P-only controller
   (where $T_n = \infty$ [screen setting: T_n =0], $T_V = 0$).
2. Increase gain K_{PR} (P-gain) until the control loop oscillates continuously at $K_P = K_{Pcrit}$.

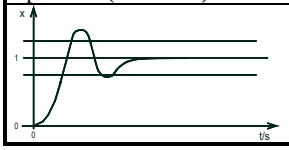
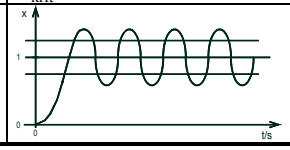
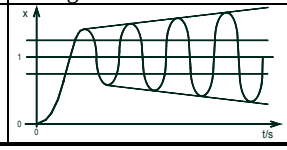
ATTENTION

If the unit starts to oscillate uncontrollably, carry out an emergency shut-down and alter the screen setting accordingly.

3. At the same time: measure the critical cycle duration T_{crit} of the continuous oscillation.
4. Set the parameters:

PID controller					**PI controller**				
K_{PR}	=	0,6	×	K_{Pkrit}	K_{PR}	=	0,45	×	K_{Pkrit}
T_n	=	0,5	×	T_{krit}	T_n	=	0,83	×	T_{krit}
T_V	=	0,125	×	T_{krit}					

Step response

Controller setting optimum ($x_m \leq 10$ %)	Controller setting T_{krit}	Controller setting wrong
		

Controller Setting, Possibility 2

ATTENTION

The following must be observed regarding the controller setting:

- **Ensure that the emergency shut-down system is ready for use.**
- **If the engine gets into a dangerous condition:**

→ S H U T D O W N

Presetting for both parameter sets

Kp = 5
Tn = 2 s
Tv = 0 s

Lambda set point value

For parameter set 1 e.g. 1,0.
For parameter set 2 e.g. 1,4.
The engine must operate safely for both Lambda values.

Proceeding

Start engine and run the engine up to about 3/4 of the rated engine power. Carry out set value jump by changing the parameter set. Notice the Lambda actual value.

The change is executed too fast.	Reduce Kp.
The change is executed too slow.	Increase Kp, reduce carefully Tn.
A oscillation occurs but was not expected	Increase Tn.

Tv is set to 0 (PI controller).

Appendix A.
Dimensions

Housing	Extrusion profile Um 108 Vibration dampers M4×6
Dimensions	184 × 130 × 58 mm 174 × 108 × 26 mm
Connection	1.5 mm² or 2.5 mm² screw terminals depending on the plug connector
Protection type	IP 00
Weight	aprox. 300 g

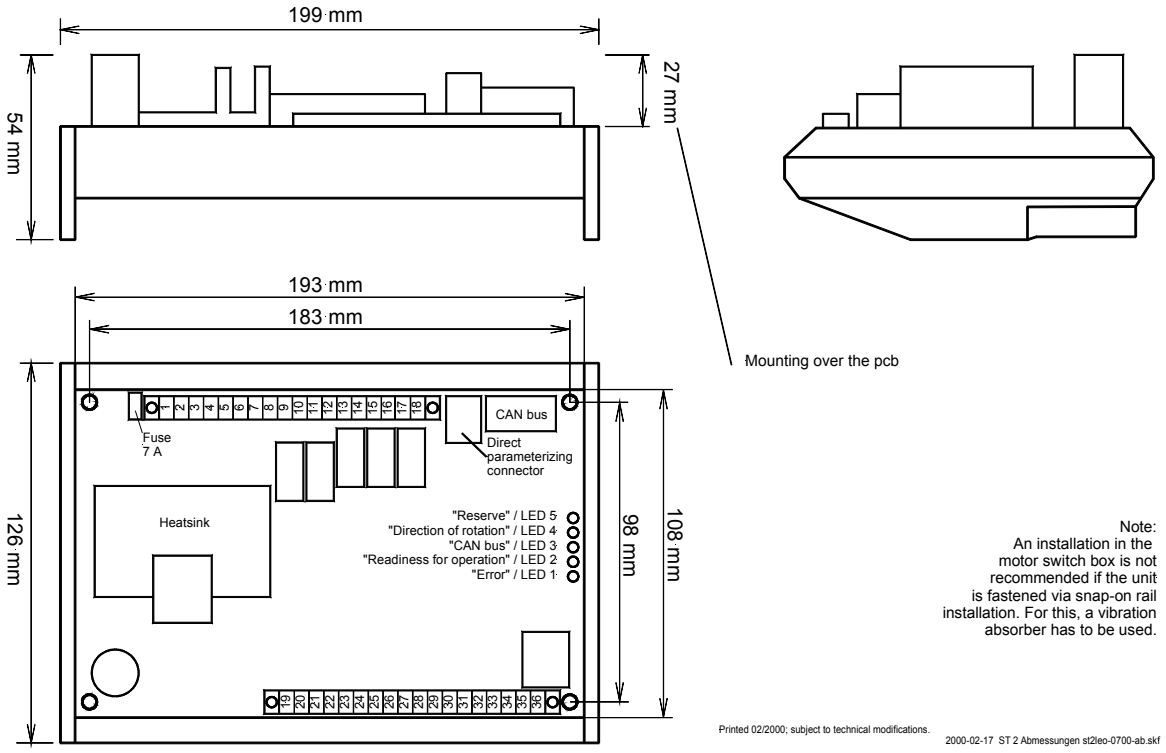


Figure 6-1: Dimensions

Appendix B.
Technical Data

Measured variables----- Connection for Lambda probe LSU4 (manuf. Robert Bosch GmbH)

Environment variables ----------
- Power supply ..... 24 Vdc (±25 %)
- Intrinsic consumption (without stepper motor) .....max. 4 W
- Ambient temperature .....-20 to 70 °C
- Ambient humidty..... 95 %, non-condensing

Discrete inputs----------isolated
- Input range.....4 to 40 Vac/dc
- Input resistance..... approx. 6.7 kΩ

Relay outputs ----------potential free
- Version ..... make contact
- Load.....maximum 2 A at 24 Vdc
- Maximum switching capacity (DC)..... 45 W

Interface ----------isolated
- Isolation voltage.....1.000 Vdc
- Version.....CAN

Housing ----------
- Extrusion profile for fastening on DIN rail / C profile ..... Um 108
- Dimensions.....184 × 130 × 58 mm
- Vibration dampers..... M4×6
- Dimensions.....174 × 108 × 26 mm
- Connection..... 1.5 mm² or 2.5 mm² screw terminals depending on the plug connector
- Weight ..... approx. 300 g

Protection ----------
- Protection class.....IP 00
- EMV Test (CE)..... tested according to the applicable EN guidelines

Appendix C.
CAN Interface

Description

Communication via the CAN bus serves the purpose of data exchange with other subscribers which are connected to the CAN bus. The cyclical output of internal measured value and configuration via the CAN bus are possible.

Identifier (ID)

The IDs are configurable. Please note that parameters specific to the CAN bus can only be modified by direct configuration via the RS-232 interface.

Four transmission and reception boxes are provided, the IDs of which are fixed depending on the Node-ID:

- Receiving data
- Sending data
- Receiving a configuration message
- Sending a response to a configuration

Furthermore the device reacts to a start/stop telegram on ID 0.

Cyclically Transmitted Data

A multiplex signal is transmitted every 120 to 130 ms. The length of data per telegram sent is 7 bytes. The following formula is used:

MUX	Word 1		Word 2		Word 3	
8 Bit	16 Bit		16 Bit		16 Bit	
	8 Bit High	8 Bit Low	8 Bit High	8 Bit Low	8 Bit High	8 Bit Low

Receiving Data

The length of data per telegram received is 7 bytes. The following formula is used:

MUX	Word 1		Word 2		Word 3	
8 Bit	16 Bit		16 Bit		16 Bit	
	8 Bit High	8 Bit Low	8 Bit High	8 Bit Low	8 Bit High	8 Bit Low

If the parameter Control over CAN is set, the DIs (except min/max of the stepper motor) and the analog output are transferred over the CAN bus.

CAN Bus Protocol

	WORD 1	WORD 2	WORD 3
MUX 1	Value 1	Value 2	Value 3
MUX 2	Value 1	Value 2	Value 3

Refer to the appendix for the complete protocol.

Start/Stop of the Cyclically Sending of Data via the CAN Bus

The telegram length is 2 bytes.

Byte 1 "1" for start
"2" for stop
Byte 2 Node ID of the unit
or "0" (general command for all devices on the bus)

Transmitting Protocol

MUX	WORD	Value	Unit/comment
1	Word 1	Protocol ID	30001
1	Word 2	Set point value	in Lambda * 100
1	Word 3	Actual value	in Lambda * 100
2	Word 1 bit 15	Zero setting activated	
	Word 1 bit 14	No control active	
	Word 1 bit 13	Control active	
	Word 1 bit 12	Relay 5	Ready
	Word 1 bit 11	Relay 4	Error
	Word 1 bit 10	Relay 3	Probe heating
	Word 1 bit 9	Relay 2	Controlling
	Word 1 bit 8	Relay 1	Probe error
	Word 1 bit 7	Discrete input 8	Manually start position low
	Word 1 bit 6	Discrete input 7	Manually start position high
	Word 1 bit 5	Discrete input 6	End switch of stepper motor MIN
	Word 1 bit 4	Discrete input 5	End switch of stepper motor MAX
	Word 1 bit 3	Discrete input 4	Set value from analog input
	Word 1 bit 2	Discrete input 3	2. parameter list
	Word 1 bit 1	Discrete input 2	Drop out of stop position
	Word 1 bit 0	Discrete input 1	Release
2	Word 2 high	Free	For later use
	Word 2 low	Analog input	Analog input in steps (0 to FF Hex)
2	Word 3	Actuator position	(0 to 10000)

Receiving Protocol

MUX	WORD	Value	Unit/comment
1	Word 1	Stop/start position	Stop position / start position (0 to 10000)
1	Word 2 high byte	free, always set to 0	
	Word 2 low byte	Analog input	Values lower than 30 for the analog input (0 to 255) are considered as wire break if the analog input is configured to 4 to 20 mA
1	Word 3 bit 15	Manual start position lower	like for DI
	Word 3 bit 14	Manual start position higher	like for DI
	Word 3 bit 13	free, always set to 0	
	Word 3 bit 12	free, always set to 0	
	Word 3 bit 11	fixed Lambda from analog input	like for DI
	Word 3 bit 10	2nd parameter set release	like for DI
	Word 3 bit 9	leave stop position active	like for DI
	Word 3 bit 8	Lambda control release	like for DI
	Word 3 bit 7, 6	Manual operating mode	If bit 7 = 0 and bit 6 = 1, then like for set parameter manual operating mode
	Word 3 bit 5, 4	use data 1 as start position	If bit 5 = 0 and bit 4 = 1, then use value in word 1 as start position. If bit 5 = 1 and bit 4 = 0, then use value in word 1 as stop position. Else use parameter.
	Word 3 bit 3, 2, 1, 0	reset the position of the stepper motor	If bit 3 = 0, bit 2 = 1, bit 1 = 0, and bit 0 = 1, then the ST3 resets the position of the stepper motor.

Example to remote control the stepper motor via the CAN bus:

- Configure the stepper motor according to this manual
- Configure "Stop position via CAN"
- Configure "DIs via CAN bus"

- Send the following data via the CAN bus to MUX 1, Word 1

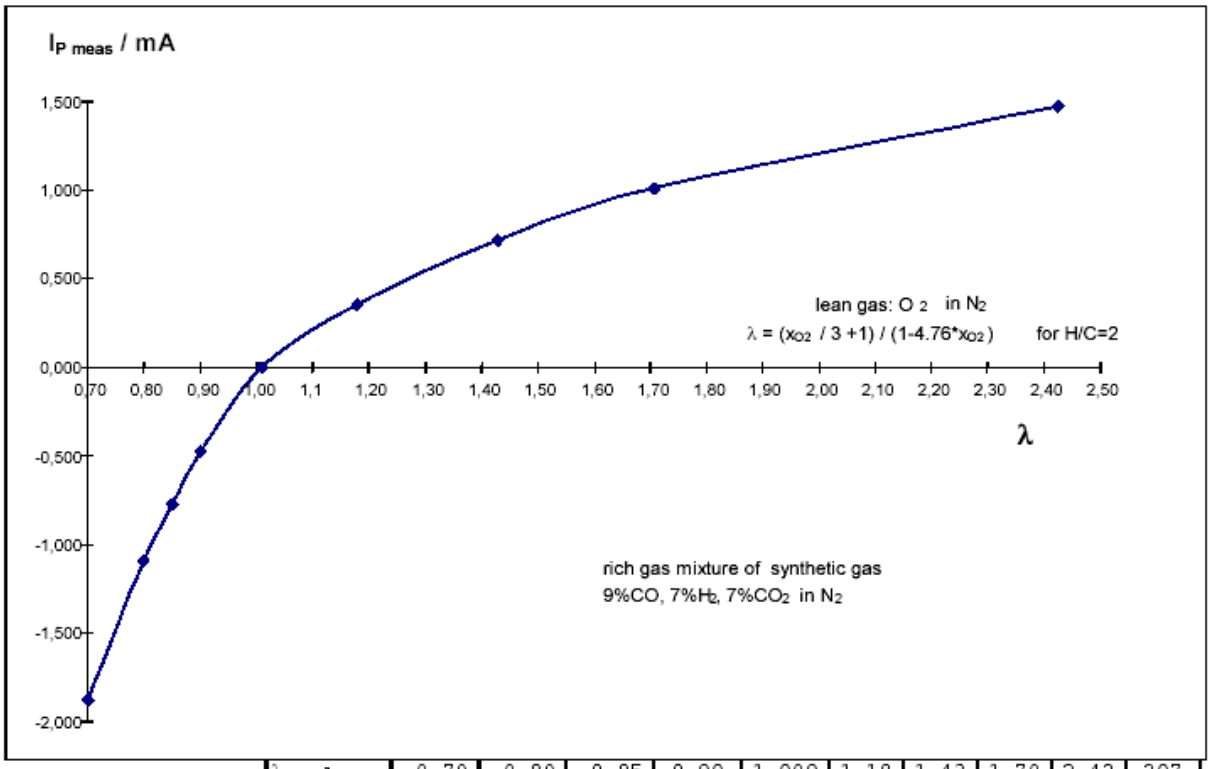
0 % = 0x01 0x00 0x00 0x00 0x00 0x00 0x20
100 % = 0x01 0x27 0x10 0x00 0x00 0x00 0x20

First send a 100 % value followed from a 0 % value. The stepper motor position is reset to 0 % then

Appendix D.
Lambda Probe LSU 4

Please note the Technical Customer Information (Y 258 K01 005-000e) of the probe manufacturer.

The Lambda probe LSU 4 will be manufactured with various different housing and connectors. Please send your request to the probe manufacturer for details.



λ-value	0,70	0,80	0,85	0,90	1,009	1,18	1,43	1,70	2,42	207
$I_{p,meas}$/mA	-1,85	-1,08	-0,76	-0,47	0,00	0,34	0,68	0,95	1,40	2,55

Figure 6-2: Lambda probe characteristic

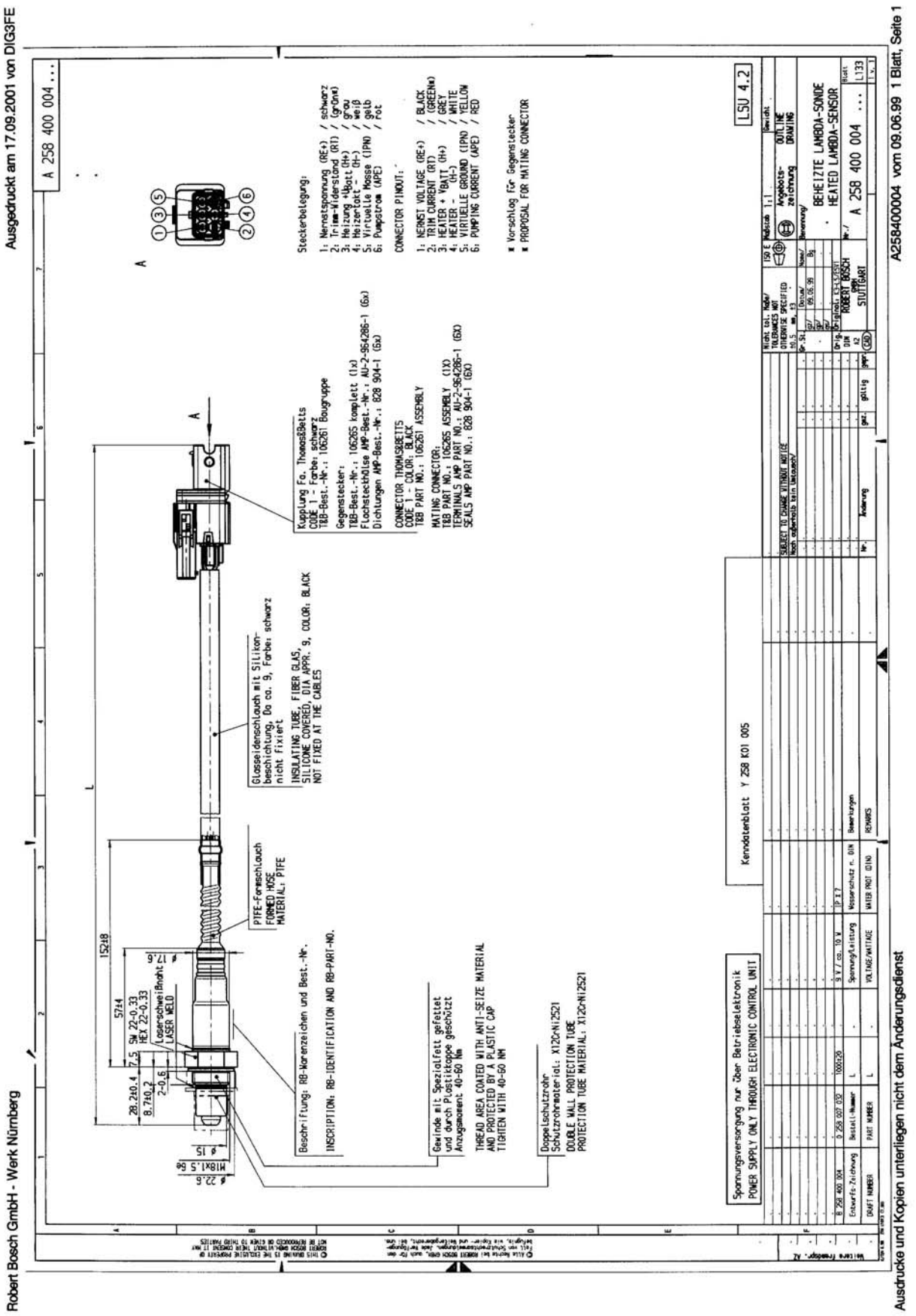


Figure 6-3: Lambda probe connection

Appendix E.
Troubleshooting

The actuator moves into wrong direction

The controller leans an already lean mixture instead of enriching it.

- Test whether the controller oscillates. YES: Slow down the control.
- Change rotation of direction, if the actuator runs into the wrong direction.

ATTENTION

If you change the direction of the rotation the description of the limit switches change, too. Please mark prior to changes of the direction of the rotation the stop and start position of the stepper motor and the analog outputs. Please check them additionally following the changes..

Appendix F.
Parameter List

Product number P/N _____ Rev _____

Type ST 3 _____

Project _____

Serial number S/N _____ Date _____

Option	Parameter	Setting range	Default setting	Customer settings	
	Software version	-			
	Stop position of the actuator	0.00 to 100.00 %	000.00%		
Set 1	**PARAMETER "DYNAMIC"** - SET OF PARAMETERS 1				
..	Start position	0.00 to 100.00 %	050.00%		
..	Gain Kp	0.00 to 300.00	012.00		
..	Reset time Tn	0.00 to 99.99 s	001.50		
..	Deriv.act Tv	0.00 to 99.99 s	000.00		
..	Fixed setpoint of Lambda	0.8 to 2.20	001.00		
..	Fixed setpoint of Lambda 0,0 mA	0.8 to 2.20	000.78		
..	Fixed setpoint of Lambda 2,5 mA	0.8 to 2.20	000.79		
..	Fixed setpoint of Lambda 5,0 mA	0.8 to 2.20	000.80		
..	Fixed setpoint of Lambda 7,5 mA	0.8 to 2.20	000.85		
..	Fixed setpoint of Lambda10,0 mA	0.8 to 2.20	000.90		
..	Fixed setpoint of Lambda12,5 mA	0.8 to 2.20	000.95		
..	Fixed setpoint of Lambda15,0 mA	0.8 to 2.20	001.00		
..	Fixed setpoint of Lambda17,5 mA	0.8 to 2.20	001.05		
..	Fixed setpoint of Lambda20,0 mA	0.8 to 2.20	001.10		
..	Release of control	Analog value / DI1	DI 1		
..	Time for heating up the lambda probe	0 to 99s	15s		
..	Monitoring probe	YES/NO	YES		
..	Lambda probe error delay	0 to 9.9min	0.1min		
..	Release of control via	0.00 to 100.00 %	050%		
Set 1	Release of control Hysteresis	0.00 to 100.00 %	010%		
Set 2	**PARAMETER "DYNAMIC"** - SET OF PARAMETERS 2				
..	Start position	0.00 to 100.00 %	075.00 %		
..	Gain Kp	0.00 to 300.00	012.00		
..	Reset time Tn	0.00 to 99.99 s	001.50		
..	Deriv.act Tv	0.00 to 99.99 s	000.00		
..	Fixed setpoint of Lambda	0.8 to 2.20	001.60		
..	Fixed setpoint of Lambda 0,0 mA	0.8 to 2.20	001.20		
..	Fixed setpoint of Lambda 2,5 mA	0.8 to 2.20	001.25		
..	Fixed setpoint of Lambda 5,0 mA	0.8 to 2.20	001.30		
..	Fixed setpoint of Lambda 7,5 mA	0.8 to 2.20	001.35		
..	Fixed setpoint of Lambda10,0 mA	0.8 to 2.20	001.40		
..	Fixed setpoint of Lambda12,5 mA	0.8 to 2.20	001.45		
..	Fixed setpoint of Lambda15,0 mA	0.8 to 2.20	001.50		
..	Fixed setpoint of Lambda17,5 mA	0.8 to 2.20	001.55		
..	Fixed setpoint of Lambda20,0 mA	0.8 to 2.20	001.60		
..	Release of control	Analog value / DI1	DI 1		
..	Time for heating up the lambda probe	0 to 99s	15s		
..	Monitoring probe	YES/NO	YES		
..	Lambda probe error delay	0 to 9.9min	0.1min		
..	Release of control via	0.00 to 100.00 %	050%		
Set 2	Release of control Hysteresis	0.00 to 100.00 %	010%		

Op-tion	Parameter	Setting range	Default setting	Customer settings	
	PARAMETER "SYSTEM"				
	Analog input	0 to 100%/20 to 100%	0 to 100%		
	Direction of rotation invert	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Step motor piloting	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	DI 1 Release	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	DI 2 Drop out of stop position	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	DI 3 2nd parameter set	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	DI 4 Set value from analog input	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	DI 5 End switch of stepper motor MAX	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	DI 6 End switch of stepper motor MIN	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	DI 7 Manually start position higher	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	DI 8 Manually start position lower	OPER./CLOS. CUR.	OPER. CURRENT	☐ O ☐ C	☐ O ☐ C
	Analog output	0 to 20/4 to 20 mA	0 to 20 mA		
	PARAMETER "STEPPER MOTOR"				
	At stop position retaining moment	switch off/non release	switch off	☐ o ☐ n	☐ o ☐ n
	Number of end limit	two/one	two	☐ 2 ☐ 1	☐ 2 ☐ 1
	Control variable output in	Half step/full step	full step	☐ h ☐ f	☐ h ☐ f
	Phase chopping mode	Phase/Inhabit	Phase	☐ p ☐ i	☐ p ☐ i
	MAX PWM-Freq. stepper motor	20 to 1,000 Hz	0800Hz		
	MIN PWM-Freq. stepper motor	20 to 1,000 Hz	0100Hz		
	MAX active current for step motor	0 to 2,500 mA	00500mA		
	Ramp stepper motor	50 to 5,000 Hz/s	01000Hz/s		
	PWM-freq. zero set	20 to 1,000 Hz	00100Hz		
	Zero setting activated	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Number of steps from the stepper motor	0 to 65,535	00800		
	PARAMETER "CAN BUS"				
	Baud rate	125/250 kBaud	00250		
	CAN-Node-ID	0 to 255	00006		
	Control via CAN	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	CAN ID receive data	0 to 65,535	00230		
	CAN ID send data	0 to 65,535	00262		
	CAN ID receive para	0 to 65,535	00742		
	CAN ID send para	0 to 65,535	00774		
	CAN ID receive upload	0 to 65,535	00806		
	CAN ID send upload	0 to 65,535	00838		
	PARAMETER "DIAGNOSIS"				
	Test of Lambda input	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Manual handing mode	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Set parameters to delivery conditions	0 to 65535	19235		
	Start position		read only		
	Active setpoint lambda		read only		
	Actual value lambda		read only		
	DI 1 Lambda control release		read only		
	DI 2 Leave stop position active		read only		
	DI 3 2nd parameter set release		read only		
	DI 4 Fixed of lambda from analog input		read only		
	DI 5 MAX stepper motor limit		read only		
	DI 6 MIN stepper motor limit		read only		
	DI 7 Manual start position higher		read only		
	DI 8 Manual start position lower		read only		
	CURRENT OPERATING STATUS				
	* 2 Zero setting		read only		
	* 4 No control active		read only		
	* 8 Controlling		read only		
	Relay 1 Probe error		read only		
	Relay 2 Controlling		read only		
	Relay 3 Probe heating		read only		
	Relay 4 Error		read only		
	Relay 5 Ready		read only		
	Data 1 Stop/Start position		read only		
	Data 2 Low Byte Analog Input		read only		
	Data 3 like the DIs		read only		

Appendix G.
Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed. If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Returning Equipment For Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the unit(s), attach a tag with the following information:

- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part numbers (P/N) and serial number (S/N);
- description of the problem;
- instructions describing the desired repair.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors
- antistatic protective bags on all electronic modules
- packing materials that will not damage the surface of the unit
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material
- a packing carton with double walls
- a strong tape around the outside of the carton for increased strength

Return Authorization Number RAN

When returning equipment to Woodward, please telephone and ask for the Customer Service Department in Stuttgart [+49 (0) 711 789 54-0]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the unit(s) to be repaired. No work can be started until a purchase order is received.

NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at +49 (0) 711 789 54-0 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part numbers P/N (XXXX-XXX) that is on the enclosure nameplate
- the unit serial number S/N, which is also on the nameplate

How To Contact Woodward

Please contact following address if you have questions or if you want to send a product for repair:

Woodward Governor Company
Leonhard-Reglerbau GmbH
Handwerkstrasse 29
70565 Stuttgart - Germany

Phone: +49 (0) 711 789 54-0 (8:00 - 16:30 German time)
Fax: +49 (0) 711 789 54-100
e-mail: sales-stuttgart@woodward.com

For assistance outside Germany, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone number
USA	+1 (970) 482 5811
India	+91 (129) 230 7111
Brazil	+55 (19) 3708 4800
Japan	+81 (476) 93 4661
The Netherlands	+31 (23) 566 1111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, go to **www.woodward.com/ic/locations**.]

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by e-mail, or through the Woodward website.

- Technical support
- Product training
- Field service during commissioning

Technical Support is available through our many worldwide locations, through our authorized distributors, or through GE Global Controls Services, depending on the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical engineering support, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference technical support.

Product Training is available on-site from several of our worldwide facilities, at your location, or from GE Global Controls Services, depending on the product. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***customer training***.

Field Service engineering on-site support is available, depending on the product and location, from our facility in Colorado, or from one of many worldwide Woodward offices or authorized distributors. Field engineers are experienced on both Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***field service***.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Contact

Your company _____

Your name _____

Phone number _____

Fax number _____

Control (see name plate)

Unit no. and revision: P/N: _____ REV: _____

Unit type ST 3 _____

Serial number S/N _____

Description of your problem

_____

_____

_____

_____

_____

_____

Please be sure you have a list of all parameters available. You can print this using LeoPC1. Additionally you can save the complete set of parameters (standard values) and send them to our Service department via e-mail.

We appreciate your comments about the content of our publications.

Please send comments to: stgt-documentation@woodward.com

Please include the manual number from the front cover of this publication.

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Homepage

http://www.woodward.com/power

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address/phone/fax/e-mail information for all locations is available on our website (www.woodward.com).

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