1. Installation and connection instructions

Supply voltage: 9...36 V
Smooth DC voltage with residual ripple ≤ 5 %.
If bridge-rectified supply voltage is applied, the size of the capacitors used for voltage smoothing has to be adjusted to the selected maximum current.

A separate grounding wire is to be used for the setpoint signal. The grounding wire is to be connected directly to the GND terminal.
If the connecting cable is over 3 m long, a shielded cable is to be used for the signal cords.
The cables must not be laid parallel to power cables.

The setpoint voltage must not be outside of the selected setpoint range for long times. The current controller may be damaged by prolonged application of setpoint voltages being outside of that range.

2. Use of buttons

The upper display line shows the parameter name. The lower line indicates the corresponding parameter value.
Provided that the cursor is positioned in the upper line, a different parameter can be selected by pressing one of the two buttons. Press the upper button (+) to proceed to the next parameter or the lower button (-) to select the previous parameter. If the cursor is positioned in the lower display line, the value of the parameter currently identified in the upper line can be changed by pressing one of the buttons. Press the upper button (+) to increase the value or the lower button (-) to reduce the value. Press both buttons at the same time to change between parameter selection and value selection (i.e. change between names line and values line).
Note: The selected values are immediately taken over by the current controller. However, the changed value is not saved until the user changes from value selection to parameter selection by pressing both buttons at the same time. The selected value is also saved when the display returns to standby mode (when no button has been pressed for about 5 minutes). In case of a power failure, the value setting is lost.

3. Standard starting procedure

3.1 Overview

- Start the current controller (set 1 enabled).
- Select the setpoint range.
- Select the setpoint dead range.
- Select the maximum current.
- Select the minimum current.
- Select the ramp up time.
- Select the ramp down time.

Note: The dither frequency and dither amplitude cannot be selected!

3.2 Description of Settings

After installation and correct connection of the current controller, the operating voltage has to be switched on (preferably at a nominal value of 0 mA).
When the current controller is started, parameter set 1 is enabled with the factory settings listed in section 5.1.
The settings should be changed in the following order:

- To select the setpoint signal: Select the "Input" menu. Press both buttons at the same time. Select the desired setpoint range. Press both buttons at the same time to save the selected setpoint range.
- To select a setpoint dead range: Select the "Inputoff" menu. Press both buttons at the same time. Select the desired setpoint dead range. Press both buttons at the same time to save the selected setpoint dead range.

**Note: The setpoint dead range parameter causes the setpoint signal to be ignored up to the selected threshold value.
If a minimum current has been selected, this current is not set until the threshold value has been reached.**

- To select the maximum current: Select the "Imax" menu. Press both buttons at the same time. Select the desired maximum current. Press both buttons at the same time to save the selected maximum current.

Attention: If the setpoint signal is not 0 and the current controller has been enabled on the ENABLE input, the controller starts to tune the setpoint.

- To select the minimum current: Select the "Imin" menu. Press both buttons at the same time. Select the desired minimum current. Press both buttons at the same time to save the selected minimum current.

Note: The selected maximum current setting cannot be lower than the minimum current. Likewise, the selected minimum current setting cannot be higher than the maximum current.

- To select the ramp up time: Select the "Ton" menu. Press both buttons at the same time. Select the desired ramp up time. Press both buttons at the same time to save the selected ramp up time.

Attention: If the voltage supplied to the RL input is 2 V ... 36 V, the ramp parameters are ignored. In this case, the shortest possible ramp is used.

- To select the ramp down time: Select the "Toff" menu. Press both buttons at the same time. Select the desired ramp down time. Press both buttons at the same time to save the selected ramp down time.

**Note: Select the "Current" menu to view the current value measured by the A/D converter of the current controller and to check whether the controller works correctly. No offset correction of this value has been performed by the micro-controller, which means that the accuracy is about ±10 %.
If the controller cannot adjust the selected setpoint, the message "NO CONT." will be displayed.**

4. Extended settings

4.1 Possible configurations of the digital current controller

a) Copying factory settings from set 2 to set 1 and changing parameters (see section 4.2)

- Start the current controller (set 1 enabled).
- Select the "Paramet." menu pressing the lower button (-).
- Briefly press both buttons at the same time.
- Select "P 2 -> P 1" pressing the upper button.
- Briefly press both buttons at the same time. The settings in set 2 are now copied to set 1.
- Change the setpoint range, if necessary.
- Change the setpoint dead range, if necessary.
- Change the maximum current, if necessary.
- Change the minimum current, if necessary.
- Change the ramp up time, if necessary.
- Change the ramp down time, if necessary.

Note: A dither is only used if it was configured in set 2 by the system supplier. The current controller provided by Kendrion Binder Magnete is delivered with a 40 % dither (≈ 280 mAp-p).

b.) Complete settings (see section 4.3)

- Start the current controller (set 1 enabled).
- Select the "Paramet." menu pressing the lower button (-).
- Briefly press both buttons at the same time.
- Select "Edit P 2" pressing the upper button.
- Briefly press both buttons at the same time. Set 2 is now enabled (cursor blinks).
- Select the setpoint range.
- Select the setpoint dead range.
- Select the maximum current.
- Select the minimum current.
- Select the ramp up time.
- Select the ramp down time.
- Select the dither amplitude.
- Select the dither frequency.
- Select the "Paramet." menu and choose "Edit P 1" (set 1 is enabled, the cursor disappears).
- Select the "Paramet." menu and copy set 2 to set 1 ("P 2 -> P1").

Note: All parameters can be configured.

4.2 Copying factory settings from parameter set 2

By selecting the "Paramet." menu, parameter set 2 configured by the hydraulic system supplier can be copied to parameter set 1 to allow this configuration to be enabled as soon as the current controller is started. The controller is delivered by Kendrion Binder Magnete with the configuration detailed in section 5.1.
Proceed as follows:

- After installation and correct connection of the current controller, the operating voltage has to be switched on. If possible, a 0 mA nominal voltage should be applied to avoid any undesired impact on the hydraulic system during parameterization.
- When the current controller is started, parameter set 1 is enabled with the factory settings listed in section 2.1.
- Select the "Paramet." menu. Select "P 2 -> P1" to copy the values from parameter set 2 to set 1.

4.3 Complete settings

Attention: The following settings are only to be made by suitably qualified personnel!

Select the "Paramet." menu and choose "Edit P 2" to allow parameter set 2 to be configured. The settings should be made in the order detailed in section 3. The dither frequency and dither amplitude should be selected last:

- Select the "Dither" menu. Press both buttons at the same time. Select the desired dither amplitude. Press both buttons at the same time to save the selected dither amplitude.

Note: The dither is a sinusoidal oscillation modulated on the setpoint signal. When the dither amplitude is too high, the controller can no longer correct the oscillation. This means that the modulated sinusoidal signal will no longer change even if the dither amplitude increases. Low setpoints will automatically reduce the dither amplitude.
If the values to be selected are unknown, the dither should be set to a mean current value.

- Select the "fdither" menu. Press both buttons at the same time. Select the desired dither frequency. Press both buttons at the same time to save the selected dither frequency.

Note: Select a dither frequency at which the valve slide performs only minor oscillations without affecting the hydraulic system.

The values are immediately taken over by the controller. However, the changed values are not saved until both buttons are pressed at the same time (see section 2).
If the values included in parameter set 2 are to be enabled whenever the current controller is started, the set 2 values have to be copied to parameter set 1 by selecting the "Paramet." menu (see section 4.2).

4.4 Delete status

The delete status can be assigned to both parameter sets (see section 5.1):

- Select the "Paramet." menu.
- Press both buttons at the same time.
- Select "Delete".
- Press both buttons at the same time. The new values are copied to the corresponding parameter set and the current controller is initialized.

5. Parameters

5.1 Parameter sets

The current controller features 2 parameter sets: P 1 and P 2. **Parameter set 1 is the default parameter set loaded when supply voltage is applied**. Set 1 includes the actual operating parameters. The current controller is delivered with set 1 in delete status.

Delete status	
Setpoint signal (Input):	0...5 V
Setpoint dead range (Inputoff):	0 %
Maximum current (Imax):	0 mA
Minimum current (Imin):	0 mA
Ramp up time (Ton):	50 ms
Ramp down time (Toff):	50 ms
Dither amplitude (Dither):	0 %
Dither frequency (fdither):	83 Hz

Parameter set 2 can be used to store factory settings.
The Kendrion Binder Magnete factory settings of parameter set 2 are suitable for a variety of standard proportional solenoids.

Set 2	
Setpoint signal (Input):	0..5 V
Setpoint dead range (Inputoff):	0 %
Maximum current (Imax):	2100 mA
Minimum current (Imin):	0 mA
Ramp up time (Ton):	50 ms
Ramp down time (Toff):	50 ms
Dither amplitude (Dither):	40 %
Dither frequency (fdither):	83 Hz

5.2 Change of parameter sets

Set 1 is enabled automatically as soon as the current controller is switched on. To enable parameter set 2, select the "Paramet." menu and choose "Edit P 2". **When set 2 is enabled, the cursor will blink.** To disable set 2, select the "Paramet." menu and choose "Edit P 1". For details how to select the settings of the individual parameters, please refer to section 2.
The individual parameters of the enabled parameter set can be changed independently of each other and in any desired order. However, the change sequence detailed in sections 3 and 4.3 should be adhered to as any changes will immediately be taken over by the current controller.
The delete status described in section 5.1 can be enabled for both parameter sets (see section 4.4). It is also possible to copy the parameters from set 2 to set 1 (see section 4.2) and vice versa. However, this can only be done if the parameter set to be changed has been enabled.

5.3 Parameter administration

Fig. 1 shows the parameter administration setup. The two parameter sets with which the current controller can be initialized are stored in the EEPROM. Changeover between the two parameter sets is done via the "Paramet." menu. When parameter set 2 is enabled, the cursor will blink. Parameters cannot be changed unless the corresponding parameter set has been enabled. Apart from the setpoint signal, setpoint dead range, maximum current, minimum current, ramp up time and ramp down time, it is also possible for the dither amplitude and dither frequency to be changed when parameter set 2 is selected. The dither parameters are also included in parameter set 1. However, they cannot be changed and they are not enabled when the current controller is delivered by Kendrion Binder Magnete. These two parameters should only be configured by suitably qualified personnel.
The "Paramet." menu allows the entire parameter set to be changed and the values included in set 1 to be copied to set 2 and vice versa (see section 4.2). This menu can also be used to assign a delete status to the parameter set (see section 4.4). By pressing both buttons at the same time, the original parameters stored in the EEPROM are overwritten with the new parameters and the new parameters are transmitted to the current controller.

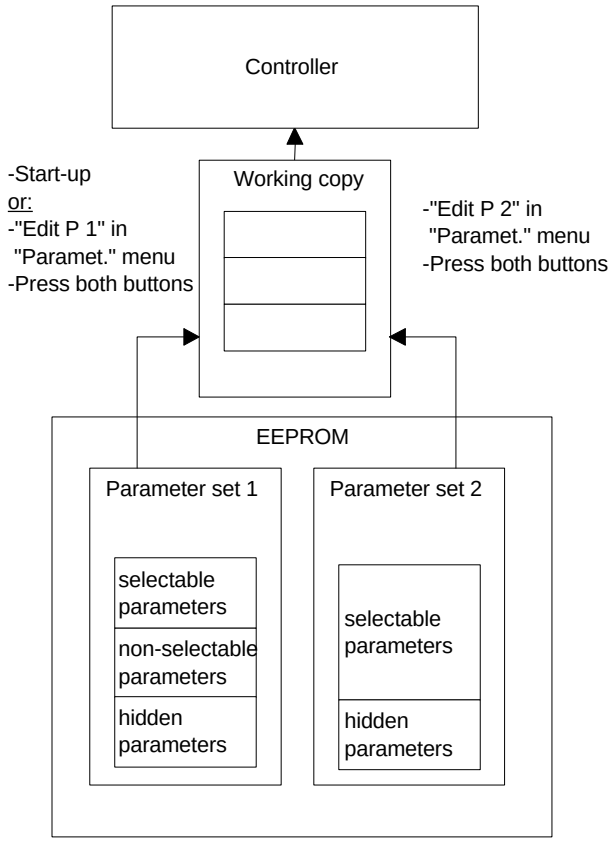

Fig. 1: Parameter administration block diagram

6. Messages

The current controller recognizes faults and specific operating statuses and displays corresponding messages on the controller display:

- DISABLE: 0 V ... 0.5 V on the "ENABLE" control input. Controller switched off
- SHORT CIRCUIT: short circuit on the output
- NO CONT.: controller has reached the maximum control limit; the supply voltage is too low for the selected nominal current to flow through the solenoid.
- In case a serious fault occurs, the "Error" message is displayed along with the corresponding error code. In this case, the current controller has to be assigned the delete status (see section 4.4) before any new parameterization can be started. The last 10 error codes are stored in consecutive order for diagnostic purposes and can be read out in parameter set 2 via the "Error" menu. (Error code 255 means that the corresponding memory location is unoccupied and that no error has occurred.)

Error codes and meanings:

1:	IIC bus error
3:	implausible parameters during initialization
4:	wrong control byte during initialization
5:	error during parameter storage
6:	wrong control byte during parameter storage
7:	error during storage of a parameter set
8:	wrong control byte during storage of a parameter set
10:	overflow on serial interface
12:	transmission error on serial interface
13:	message processing error
14:	message transmission error
15:	unknown message type
16:	implausible message
17:	controller not calibrated

7. Examples

Fig. 2 shows the operating behaviour of the current controller.

Parameter settings:

Setpoint signal (Input):	0..5 V
Setpoint dead range (Inputoff):	0 %
Maximum current (Imax):	2100 mA
Minimum current (Imin):	700 mA
Ramp up time (Ton):	2.0 s
Ramp down time (Toff):	4.0 s
Dither amplitude (Dither):	0 %
Dither frequency (fdither):	250 Hz

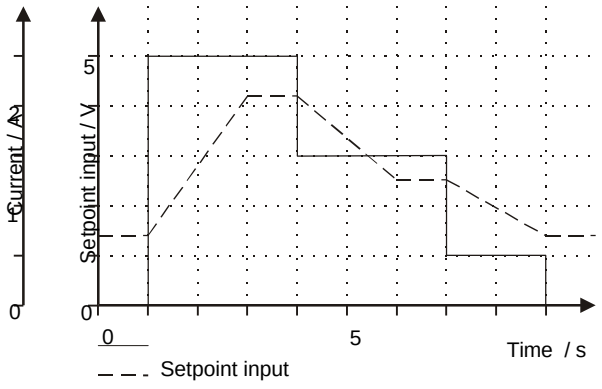

Fig. 2: Operating behaviour

Fig. 3 shows the operating behaviour of the current controller at a 10 % setpoint dead range.

Parameter settings:

Setpoint signal (Input):	0..5 V
Setpoint dead range (Inputoff):	10 %
Maximum current (Imax):	2100 mA
Minimum current (Imin):	700 mA
Ramp up time (Ton):	2.0 s
Ramp down time (Toff):	3.0 s
Dither amplitude (Dither):	0 %
Dither frequency (fdither):	250 Hz

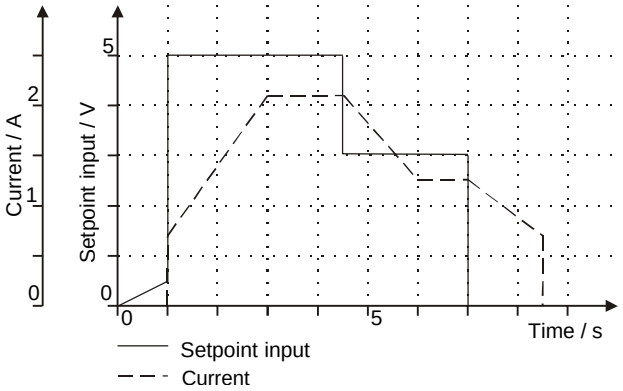

Fig. 3: Operating behaviour with 10 % setpoint dead range

Fig. 4 shows the actual current path during operation of a proportional solenoid with dither.

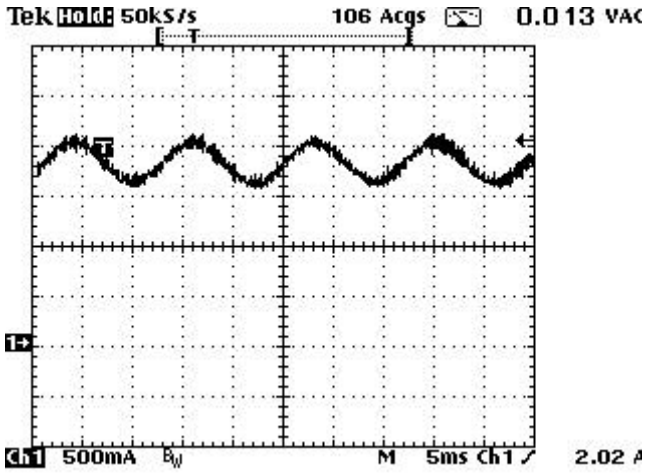

Fig. 4: Current path with dither

8. Serial interface

The current controller is equipped with a serial interface. An optional programming kit (33 43603A00) can be used for configuration over the PC via the RS232 port.

9. Definition of terms

Dither: alternating signal which is superimposed on the setpoint to reduce static friction and the hysteresis associated with it. The digital current controller adjusts the dither amplitude to the setpoint signal to avoid control deviations generally encountered with analog current controllers.

Delete status: parameter set ensuring a safe controller status. The maximum current is set to 0 mA to disable solenoid control.

Parameter: selectable values to determine the controller behaviour (e.g. minimum current, maximum current, etc.).

Parameter set: all parameters of the current controller.

Setpoint dead range: percentage of setpoint range ignored by the current controller. The output current is kept at 0 mA as long as the setpoint remains below the dead range threshold value. When the threshold value is reached the current is increased to the selected minimum current value.

Ramp: limitation of the setpoint rise and fall speed.

Ramp down time: time it takes for the current to fall from maximum current to minimum current at a maximum negative setpoint jump.

Ramp up time: time it takes for the current to rise from minimum current to maximum current at a maximum positive setpoint jump.

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