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UBS 2111

User's Manual

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CONTROL AMPLIFIER

UBS 2111

CONTROL AMPLIFIER UBS 2111

1. Introduction
2. Technical Data
3. Power Supplies
4. Inputs
   - 4.1 Analog inputs
   - 4.2 Digital inputs
5. Set Signals
6. Ramp Generator
7. Function Generator
8. Output Stages
9. Measurement Outlets
   Solenoid Current Indicating LEDs
10. Relay Contact and Ramp Indicators
11. General Adivce
12. Starting
13. Circuit Diagrams
14. Optional Equipment
    - 14.1 Position Control of Spring-Return Valve
    - 14.2 Universal PID Regulator
    - 14.3 Regulator Setting Procedure
15. Mechanical Design
    Terminals
16. Order Code
17. Accessories

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1. INTRODUCTION

Control amplifier UBS 2111 lends itself to the control of proportional directional valves, pressure control valves, flow control valves and all other kinds of equipment operated by proportional magnets.

Standardized optional equipment is available for controlling rotational speed with a tachometer sensing device, for position control with a position sensor directly coupled to the proportional magnet, and a variety of other control and regulation purposes.

A wide selection of accessories in the form of printed-circuit cards is available.

Special features:

- compact, low-loss output stages
- differential input for ease of matching external control signals: 0...+/- 10 V or 0...+/- 20 mA
- four digitally polled, individually adjustable control signals, with LED indicators
- digital switching of time ranges for ramp functions
- LED indication of power supply functions
- LED indicators for solenoid output currents, with proportionally controlled light intensity
- outlets at the front panel for measuring solenoid currents and ramp output
- relay output for ramp zero and zero control signal
- compact design, standard 19" rack mounting
- wide range of accessories

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2. TECHNICAL DATA

Supply voltage	Full-wave bridge rectifier, 24 V +/-10% Battery supply 20...36 V Three-phase rectifier 22...32 V
Power consumption	40 VA, approx., at full output
Fuses	2 A/250 V slow, 5 x 20, DIN 41 571
Outputs	Controlled current, 0...1.6 A Pulse-width modulation, 160 Hz
Basic current	0....500 mA, separately adustable
Step current	50...350 mA, separately adjustable
Quiescent current	50...850 mA adjusting range (Quiescent current = basic current + step current)
Maximum current	Quiescent current + 200 mA...1.1 A, max. 1.6 A, separately adustable
Dither signal	Automatic, by 160 Hz chopper signal
Differential input	0...+/-10 V, or 0...+/-20 mA
Rampe time ranges, approx.	1.....10 s for 100 % control signal 0.2....2 s 30...300 ms 20...200 ms
Operating voltage, int.	+/-7.5 V
External load, max.	50 mA, between +7.5 V and -7.5 V 30 mA, between +/-7.5 V and reference zero
Relay output	40 V, max. 10 VA
Measurement outlets	+/-5 V for +/- 100 % control signal current measurement, 1 V equals 1 A
Ambient temperature	-10...+70° C

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3. POWER SUPPLY

Fed by any 24 V dc source, the UBS 2111 produces a +/-7.5 V stabilized voltage to supply the circuits on the card and external command signal sources and additional cards.

The -7.5 V (-Vdd) is identical with input zero potential.

Internal reference zero is at +7.5 V referred to input zero.

The +7.5 V (+Vdd) is +15 V referred to input zero.

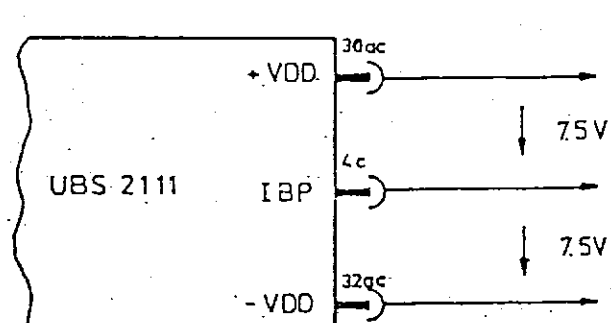
This may cause problems when connecting other equipment, e.g. command signals derived from other electronic units. To overcome such problems, UBS 2111 has a differential input.

The internal power supply of the UBS 2111 is shortcircuit proof.

Supplying external electronic circuits

The UBS 2111 built-in power supply can be used to supply external components, e.g. command signal sources. The total current load imposed on the power supply +/-7.5 V must not exceed the value given in the technical data.

All output terminals are short-circuit proof between them.



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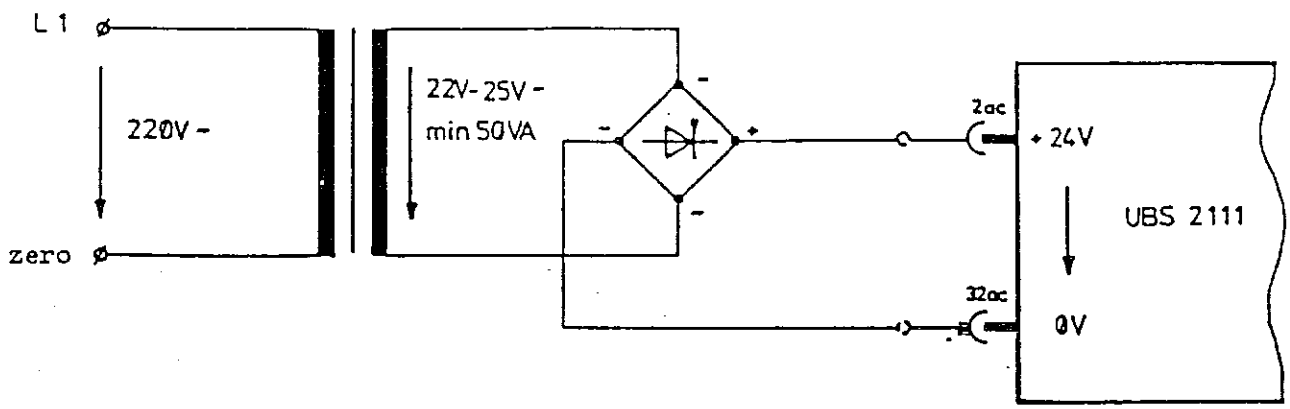
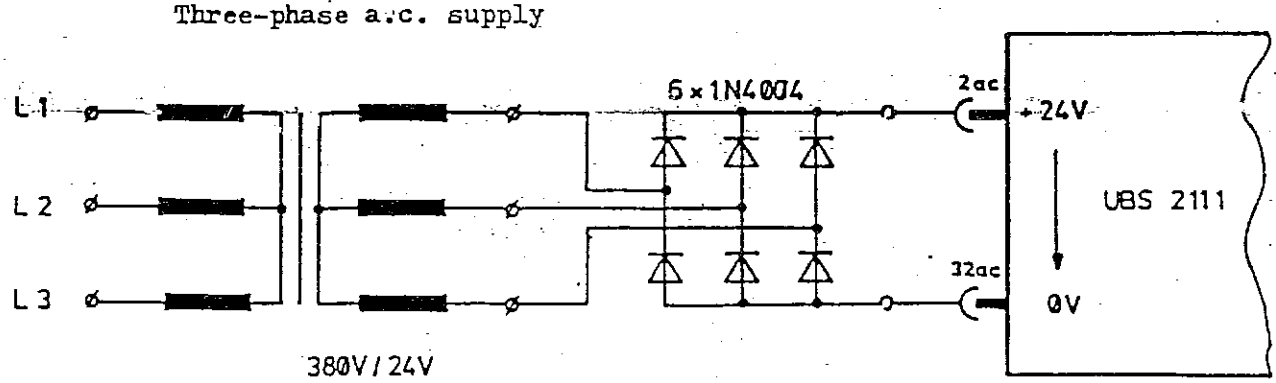
Power Supply Forms

Single-phase a.c.

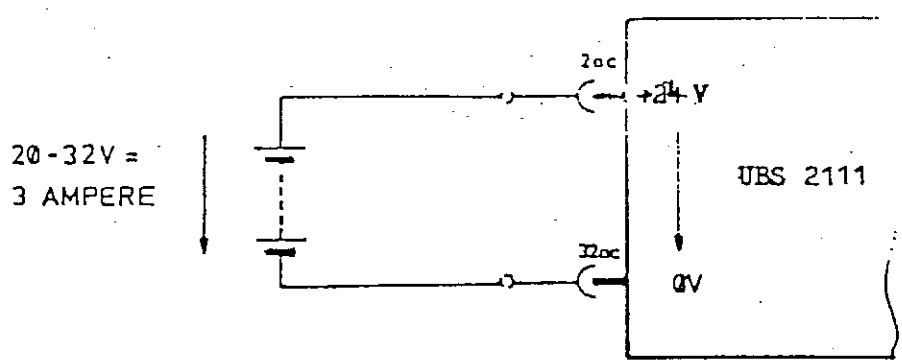
Bridge rectifier B80C3200



Three-phase a.c. supply



D.c., battery or power supply unit



N.B. - Terminals 32ac must not be connected to system earth.

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LED Supervision of Power Supply

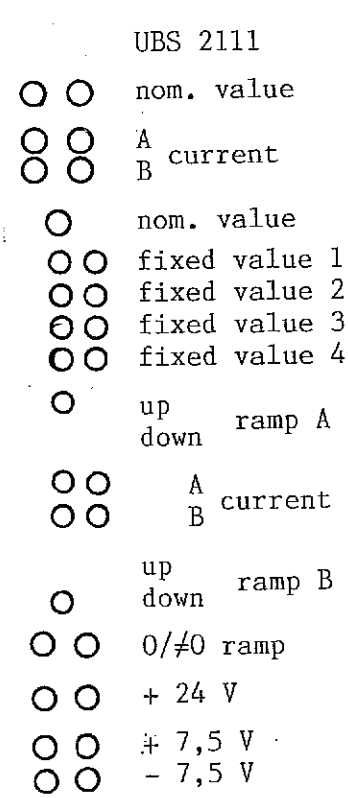
Several control functions are incorporated in the UBS 2111 to supervise the self-contained power supply:

- a green LED indicates correct function of the 24 V supply
- a green LED indicates correct function of the +7.5 V supply
- a green LED indicates correct functions of the -7.5 V supply
- a red LED indicates 24 V supply overload, caused by a wrong connection or an internal fault
- a red LED indicates +7.5 V overload
- a red LED indicates -7.5 V overload

If all three green LEDs are on, there is no fault in the power supply network.

If a red LED is on, some malfunction is present and will have to be traced and corrected.

Picture of unit



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4. INPUTS

4.1 Analog Inputs

UBS 2111 has two analog inputs: a differential input at terminals 18a - 20a, and a single-ended input at terminal 8c.

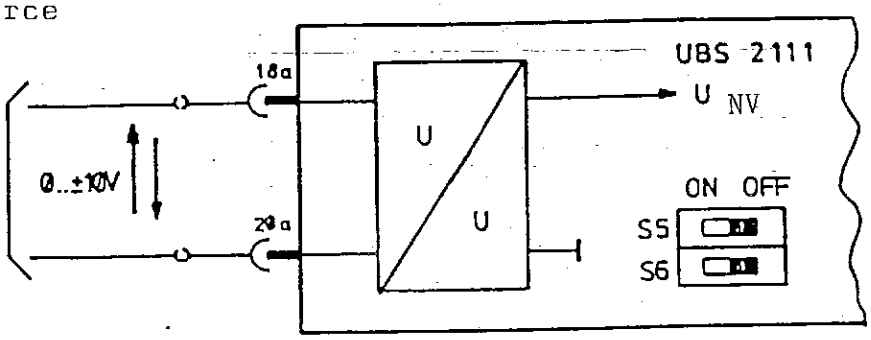
Differential input, 18a-20a

The differential input is used when potential differences between the input signal and the internal supply voltage must be balanced out.

Voltage input, 0...+/-10 V, adjustable as required. The setting range is +/-4...12 V input voltage for full output.

Potential compensating voltage input

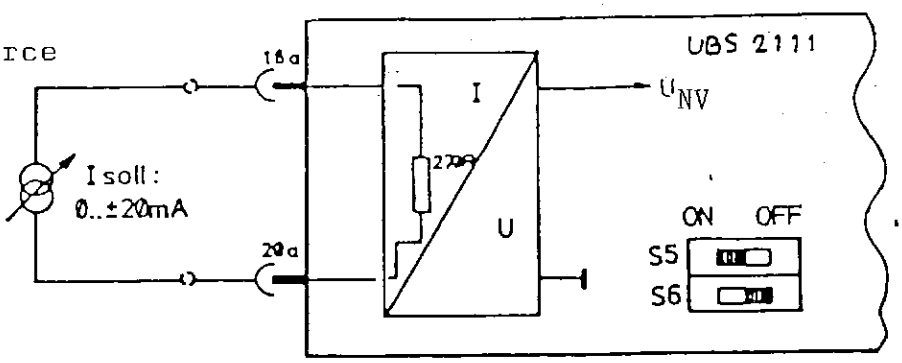
command signal
from external source



The same input may be turned into a current input, 0...+/-20 mA, by moving sliding switch S5 to ON. The setting range for full output is then +/-8...24 mA.

Potential compensating current input

command signal
from external source



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To use the differential input as a potentiometer input, close switch S6, connecting the differential amplifier negative input terminal through a low resistance to internal reference zero.

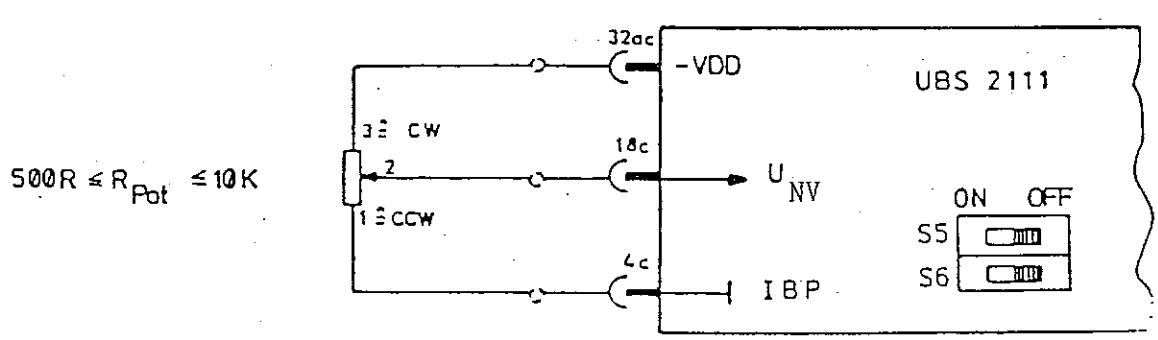
The differential amplifier positive terminal is the potentiometer input leading to the ramp generator.

Terminal 18c is available as potentiometer input with ramp function; it can be used at the same as the differential input and all other inputs.

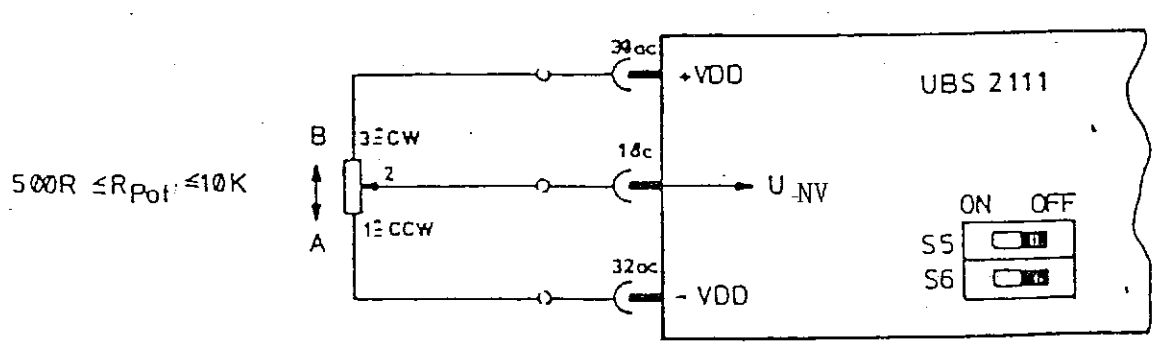
Single-Ended Input, 8c

The analog input at terminal 8c by-passes the ramp generator and supplies the input signal direct to the output stage. +/-7.5 V input voltage, e.g. from a potentiometer, will produce full output to the solenoids.

Potentiometer input with ramp (single-channel)



Potentiometer input with ramp (double-channel)



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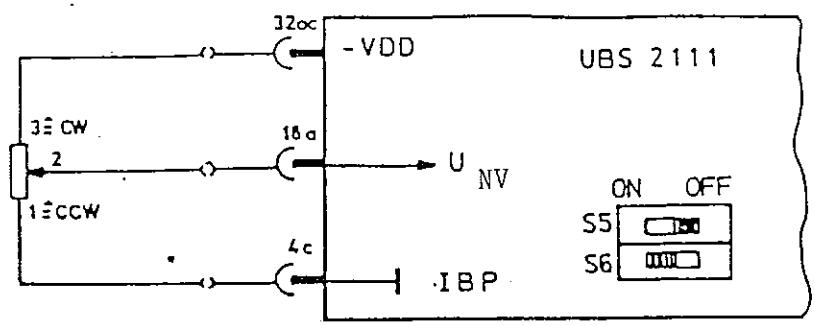
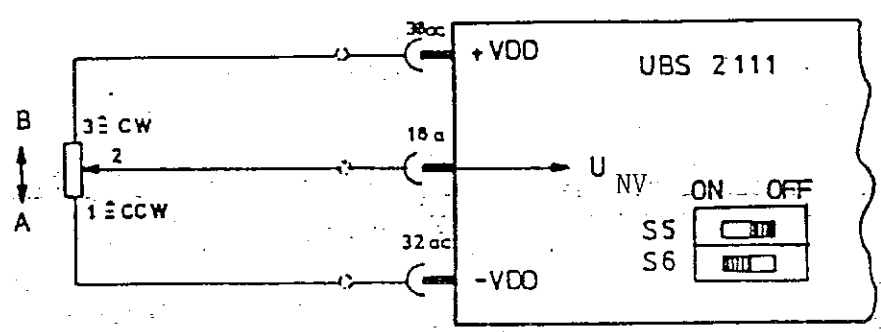
Potentiometer input with ramp (single-channel)

$500R \leq R_{Pot} \leq 10k$



Potentiometer input with ramp (double-channel)

$500R \leq R_{Pot} \leq 10K$



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4.2 Digital Inputs

These inputs are used for digitally polled set-value control signals and ramp time ranges.

The card permits the polling of four defined control signals and two ramp time ranges; the possible combinations are described in Caps. 5 and 6.

The set value control signals are polled thus:

- Polling with 0 V (non input):

  Connect the input to 0 V or to -7.5 V (-Vdd), either galvanically (relay contact, microswitch etc.) or electronically (open collector output etc.).

- Polling with 24 V (pnp input):

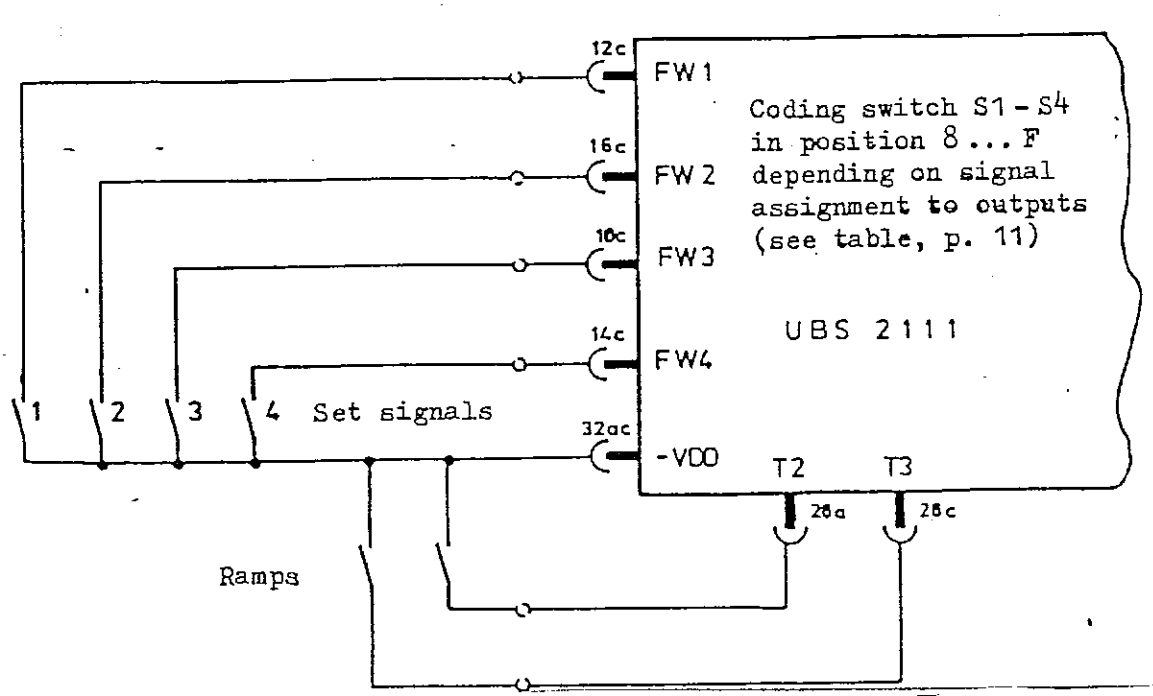
  Connect the input with +24 V, galvanically or by an electronic switch or some other signal source.

Switching between npn and pnp input is automatically effected by the 16-position coding switch S1-S2-S3-S4; see cap. 5.

Rampe time switching is made in the identical manner.

The threshold input voltage is some 6 - 8 V reffered to 0 V.

Polling set signal with 0 V



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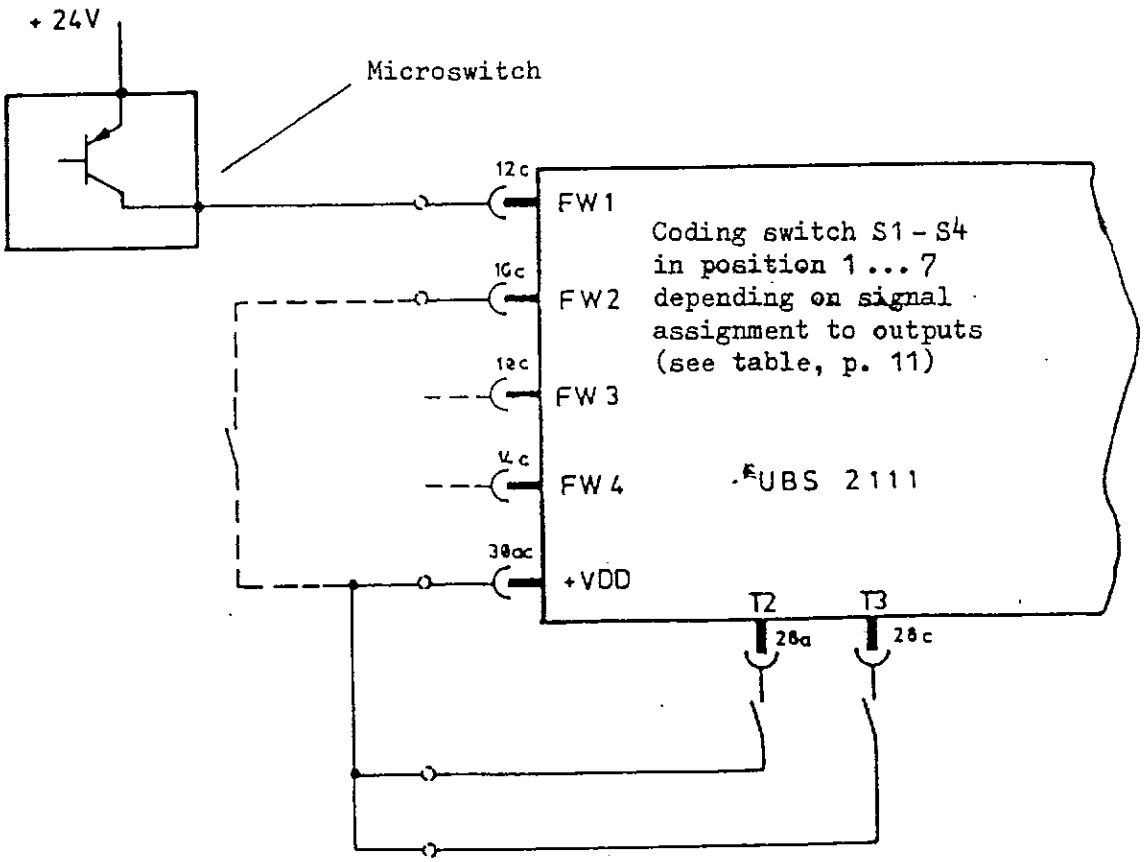
Polling set signal with +24 V



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5. SET-VALUE SIGNALS

The set-value control signals are adjusted to their desired values on the card but polled externally. The UBS 2111 offers four such control signal settings. When one of them is polled, its corresponding indicator LED goes on.

The set control signal can be combined at will, i.e. they may be polled together arbitrarily. The resultant command signal is then the sum of all polled set signals. This combination feature offers many special solution advantages.

Example:

For a pressure control valve, a 4-bit digital/analog converter may be realised with 4 set-value signals:

1st setting corresponds to 10 bar of pressure
2nd " " " 20 bar " "
3rd " " " 40 bar " "
4th " " " 80 bar " "

By combining these signal settings, 16 different pressure settings are available in steps of 10 bar: 0, 10, 20, 30...150 bar, provided that the valve characteristic is linear.

The assignment of the set signals to the solenoid outputs and the type of input (npn or pnp) is controlled by the 16-position coding switch. The possible combinations are shown in the table:

Switch position	Input type	Set signals 1+2	Set signals 3+4
0	pnp (24V)	A	A
1	pnp	B	A
2	pnp	A	B
3	pnp	B	B
4	pnp	B-A	B-A
5	pnp	-(B100%)	B-A
6	pnp	B-A	-(B100%)
7	pnp	-(B100%)	-(B100%)
8	npn (0V)	A	A
9	npn	B	A
A	npn	A	B
B	npn	B	B
C	npn	B-A	B-A
D	npn	-(B100%)	B-A
E	npn	B-A	-(B100%)
F	npn	-(B100%)	-(B100%)

Switch positions marked "-(B100 %)" can not normally be used. In special cases a constant 100 % channel B output is possible.

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Examples

- Switch position 2

  The set signals are applied to a pnp input, signals FW1 and FW2 being assigned to solenoid A, signals FW3 + FW4 to solenoid B.

- Switch position 3

  The set signals are applied to a pnp input, signals FW1 + FW2 and FW3 + FW4 being alternatively assigned to solenoid output B.

- Switch position C

  The set signals are applied to an npn input; signals FW1 + FW2 and FW3 + FW4 can be assigned to solenoid channels A and B in the following manner.

  With the control potentiometer at its extreme CCW end, full output is obtained at solenoid B output. Turning the potentiometer CW will produce a linear reduction of solenoid B output, reaching zero at the potentiometer mid-position. Rotating the potentiometer further CW produces a linear rise of solenoid A output, ending up in full A output at the extreme CW position the potentiometer.

- Switch position D

  The set signals are applied to an npn input. Signals FW1 + FW2 are non-adustable, and provide full signal output to solenoid B. Signals FW3 + FW4 can be assigned to either solenoid output, A or B, in the manner described above for switch position C:

  The left half of the potentiometer range serve solenoid B, the right-hand half serving solenoid A output.

- Switch position F

  No control signal settings are possible, and solenoid B output is at continuous full output.

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6. RAMP GENERATOR

The purpose of a ramp generator is to delay the rise of a solenoid current in a controlled manner. If a step signal is applied to the input, i.e. the input signal rises instantly from zero to full amplitude, the solenoid current will rise linearly from zero to maximum, e.g. 1 A, with a delay determined by the set ramp rise time.

For a controlled hydraulic motor, this means that the increase of rotational speed, i.e. the angular acceleration, is constant up to the prescribed speed. Constant maximum acceleration is generally desirable in all cases where great masses are moved, i.e. where hydraulic drives are used.

The ramp generator is so designed that acceleration and deceleration can be set separately for either direction of movement. The card has four control potentiometers:

- channel A ramp rising - acceleration A direction
- channel A ramp falling - deceleration A direction
- channel B ramp rising - acceleration B direction
- channel B ramp falling - deceleration B direction

Ramp times given always refer to a 100 % change of input signal; for lower signal changes, actual ramp times will be correspondingly shorter.

The standard ramp time range of the card is 1...10 s. The following ramp time ranges are available by polling:

Polling input	Ramp time minimum	Ramp time maximum
-	1.0 s	10 s
T2	0.2 s	2 s
T3	30.0 ms	300 ms
T2+T3	20.0 ms	200 ms

The inputs are polled in the same manner as set signals; coding switch positions 0...7 are pnp input (+24 V polling), positions 8...F, npn input (0 V polling).

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7. FUNCTION GENERATOR

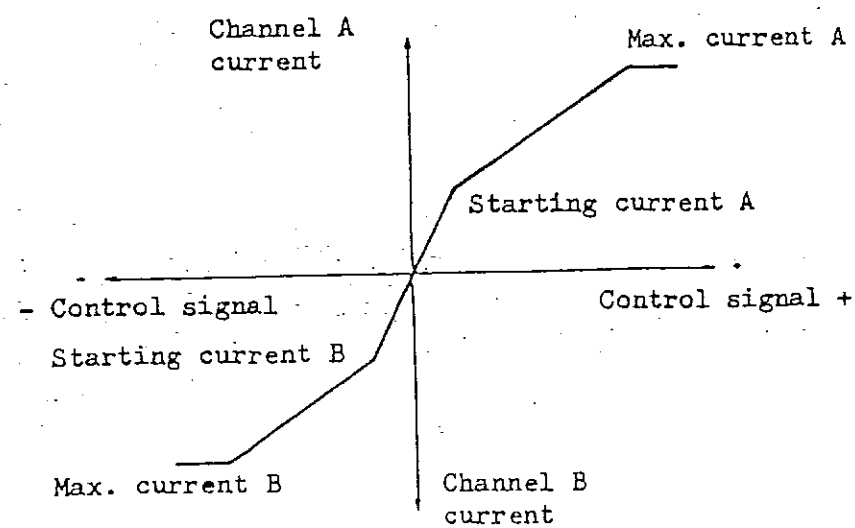
Proportional valves are generally operated by two solenoids, one for each direction of movement. Thus, the control amplifier card must refer a control signal by its sign to the proper solenoid channel.

The solenoids require approx. 20 % of their rated maximum current in order to begin opening the valve. In reversing from one direction of movement to the other, there will always be a pause from the moment when channel A current drops below 20 % of rated maximum, to that when channel B current has risen to approx. 20 % of its rated maximum value; channel B current begins to rise only when channel A current reaches zero.

An ideal transition is achieved when a switch-over from A to B occurs with practically no delay and with no dead-zone. A delay is always present, however, because of the distance that the magnet cores, and valve spool, must travel, and no transition is possible entirely without a dead-zone as a stable neutral position of the valve would the be impossible.

The function generator of UBS 2111 is designed for a nearly ideal transition with a minimal but stable dead-zone.

The step current and the maximum current are set automatically by the function generator for both directions.



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Setting Basic and Step Currents

The basic current is factory-set to approx. 75 mA, the step current to 150 mA.

If these must be changed, the basic current should always be some 40 - 50 % of the step current.

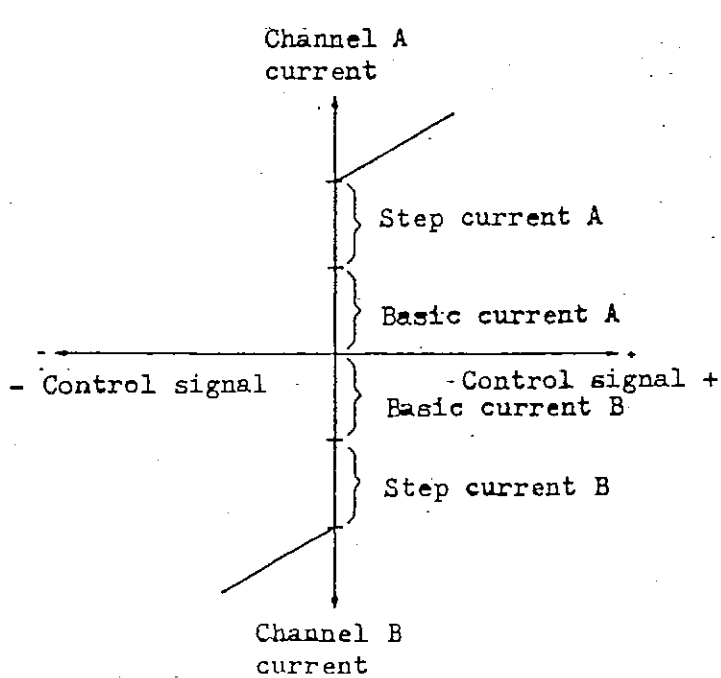
The step current must be adusted so as to make the valve only just begin to open, or to a required minimum value.

The correct setting is achieved when an incremental control signal - approx. 0.3 % - in the proper direction is capable of triggering a valve movement.

As it is generally very difficult to adjust so small a signal, the card is provided with a setting aid in the form of sliding switch S7.

With zero control signal applied, operating S7 in the proper direction will produce a control signal of approx. 0.3 % amplitude.

After adjusting currents, switch S7 shall be returned to neutral position.



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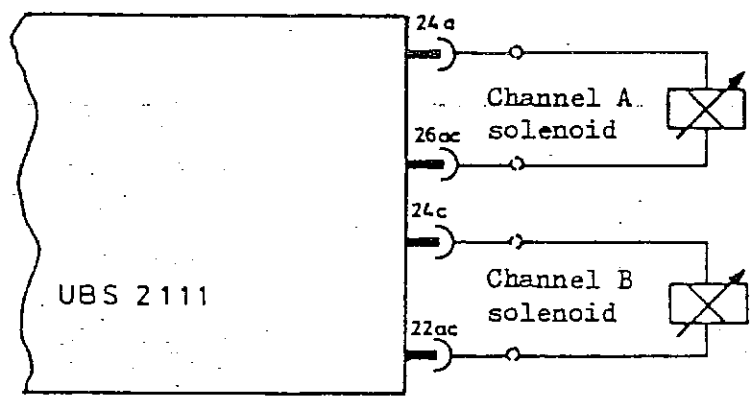
8. OUTPUT STAGES

The output stages operate by the chopper method, i.e. the output signal is a square wave of fixed frequency and variable pulse width. Current control is achieved by varying the timing of the switching pulse, and is largely indepedent of supply voltage, temperature, solenoid resistance, conductor resistance etc.

The advantage of this operating principle is the high efficiency of the output stage. The low heat loss permits the card to be used a relatively high ambient temperatures.

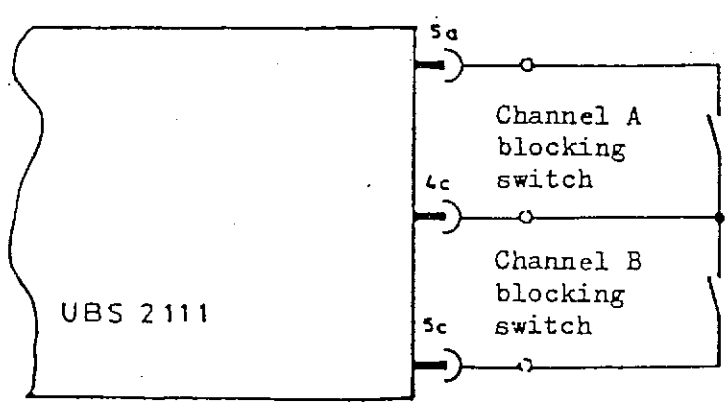
The introduction of a special dither signal is unnecessary, as the selection of a suitable chopper frequency automatically produces a dither effect which largely offsets starting friction and hysteresis.

Solenoid outputs



Power outputs A and B may be blocked by short-circuiting the control signal inputs A and B, respectively, irrespective of actual signal conditions in the card circuit. When blocked, only the basic current is flowing.

Channel blocking



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9. MEASUREMENT OUTLETS; SOLENOID CURRENT INDICATING LEDs

Measurement outlets permit checking of the amplifier function when the card is operating correctly without any malfunctions. The outlets are designed for 2 mm probes.

Control Signal Measurement Outlet

The control signal after the ramp is measured at this outlet, i.e. the signal composed of set signals and differential input voltage or differential input current.

The direct input signal to the output stage (input terminal 8c) cannot be measured here.

The voltage measured is +/- 5 V for 100 % input signal. A positive value means assignment to channel A.

Solenoid Current Measurement Outlets

Solenoid currents can be measured with a simple multimeter without interrupting the circuit.

The voltage registered is 1 V for 1 A solenoid current.

For continuous indication, all three measurement points are also available on the terminal strip:

20 c: control signal
13 a: solenoid A current
13 c: solenoid B current

All three voltmeters should have an internal resistance of at least 2 kiloohm/volt.

Reference zero for measurements is terminal 4c.

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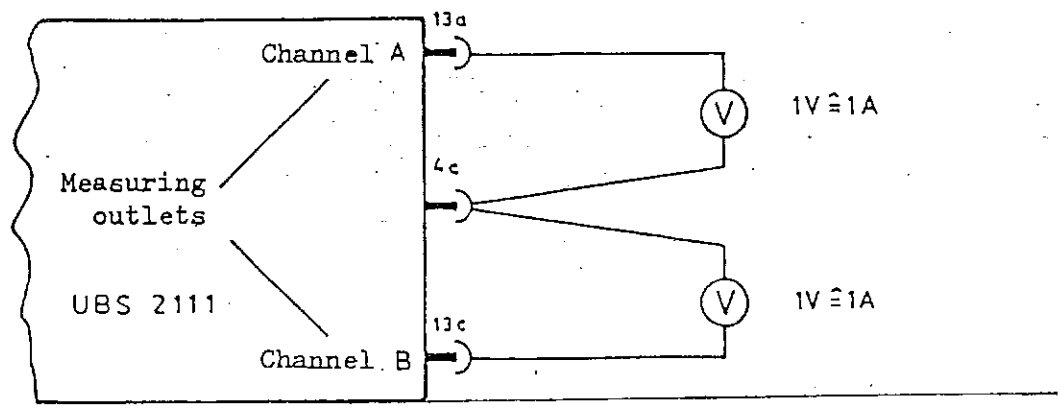
Measuring outlets



Solenoid Current Indicating LEDs

LEDs are connected in parallel with the measurement outlets to indicate which channel is operating. The light intensity of these LEDs is approximately proportional to the solenoid current, making them useful as setting aids when first starting the equipment.

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10. RELAY CONTACT AND "RAMP ZERO" INDICATION

For supervising the starting and operation of the card, LEDs are provided indicating "Control Signal", "Ramp Zero" and "Ramp not Zero".

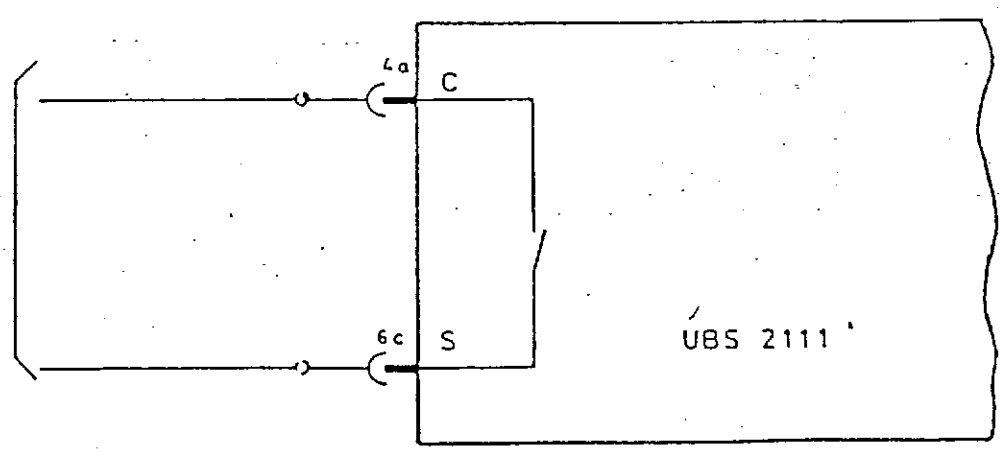
The "Ramp Zero" LED shows that no signal is present; the "Ramp not Zero" LED, that the card circuit is operating.

The "Ramp Zero" condition is also fed to an output terminal by way of a relay contact which closes for "Ramp Zero" and for zero control signal.

This relay contact may be used for a constant check of the function of the card, or for initiating a sequenced operation.

Relay output - Ramp Zero

Maximum
permissible
contact load,
10 VA, 50 V max.



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11. GENERAL ADVICE

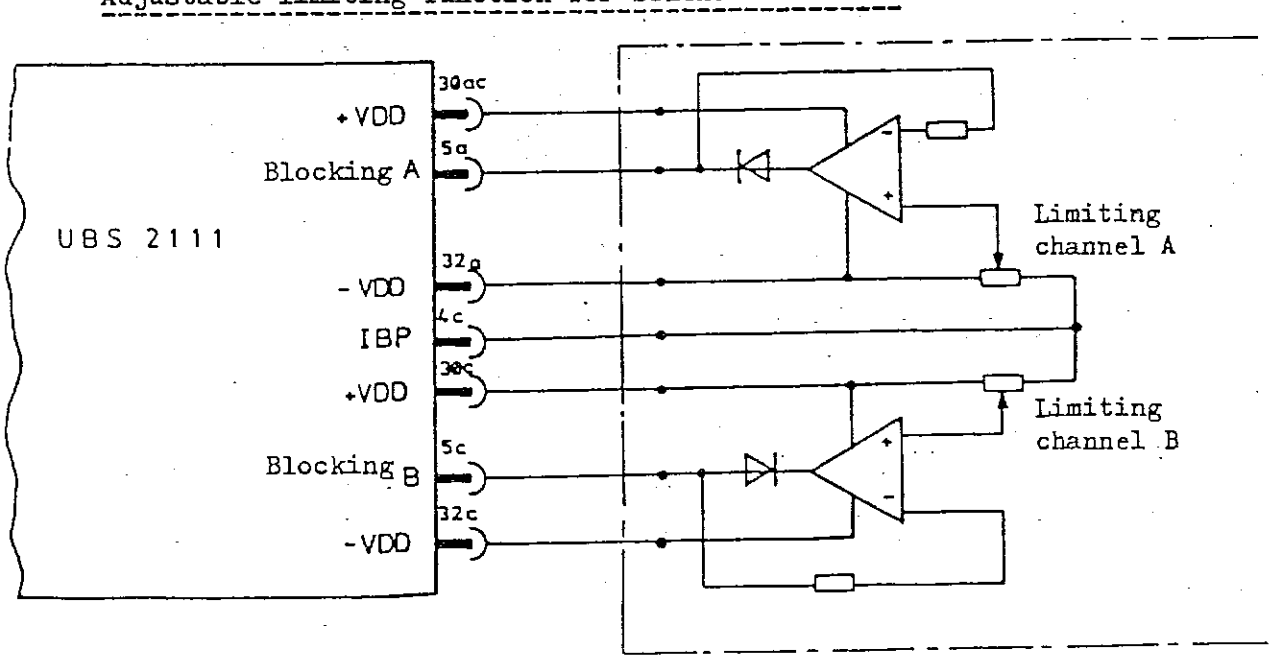
Control amplifier card UBS 2111 is an electronic precision product and must be cared for accordingly. The components on the card lie openly and are easily damaged if proper care is not observed in handling and during transport.

When planning an installation, observe expecially:

- Install the card as far as possible from heat sources, power transformers, large contactors etc.
- Arrange all wiring as far from power-carrying conductors as possible.
- Protect the card against humidity and condensation by enclosing it in a cabinet.
- Observe strictly all technical data when designing circuits.

Besides its standard use, the UBS 2111 is suitable also for many special purposes, e.g. signal limiting via external limiters for safety ciruits and special control measures. In such cases, a fair amount of specialized knowledge of electronics is required. On application, our technical development department is at your service.

Adjustable limiting function for solenoid channels



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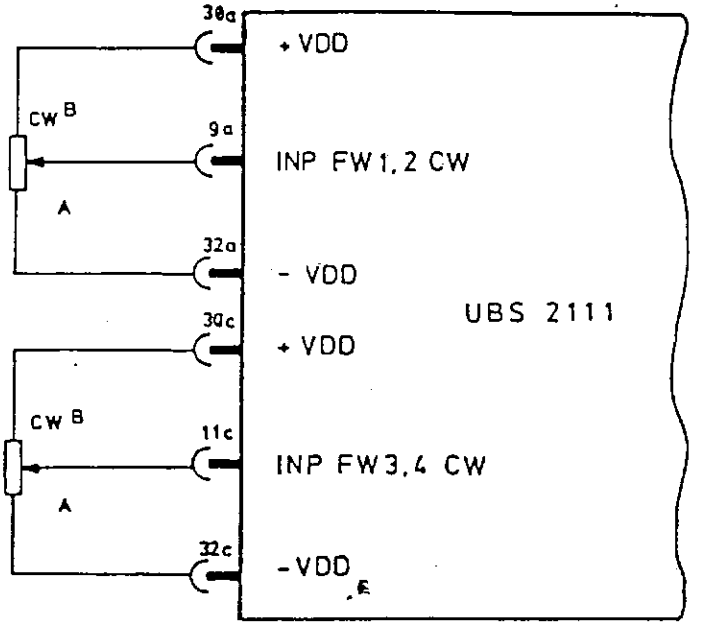
Control signals from potentiometers

100% control signal for set signals 1 + 2

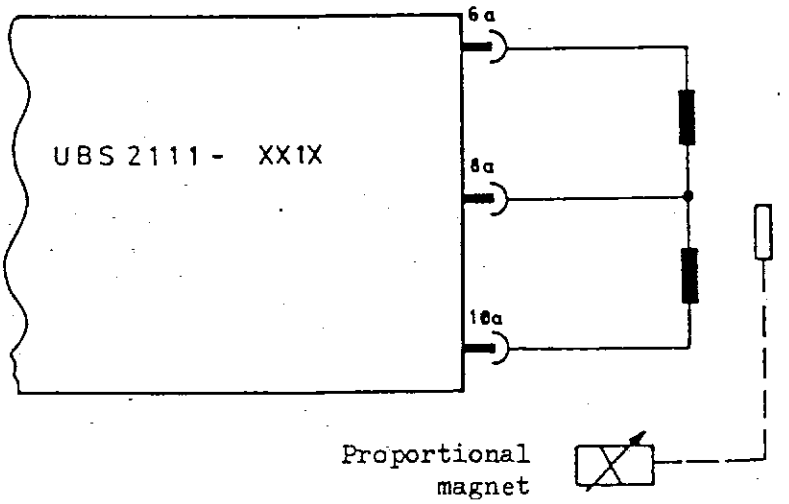
R_{pot} approx. 1 kohm

100% control signal for set signals 3 + 4

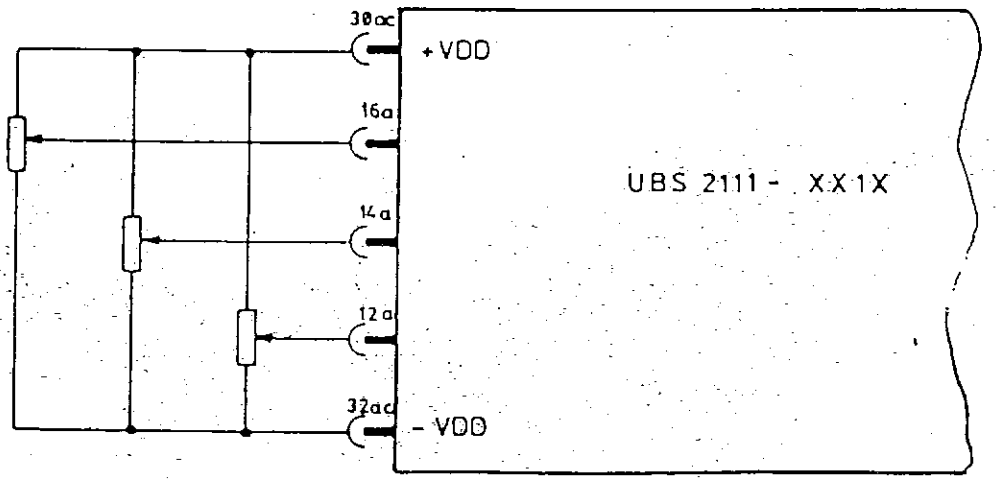


Inductive position sensor

U_{supply} = 8 Vp-p
f = 5 kHz
P_{tot} = 300 mW



Control signal inputs to regulator



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12. STARTING

Before switching on power

Control amplifier card UBS 2111 is virtually proof against damage by wrong connections. Before power is switched on the first time however:

- check the wiring-in of the card against the circuit diagram, also carefully checked
- make sure that external sensors and transducers are correctly connected up
- measure the supply voltage before inserting the card; it must be within the given limits

The requisite adjustments on the card for set-value signals and input selection must be made correctly.

When all connections have been checked and found correct, the card may be inserted.

Switching on power

The hydraulics should be off.

Switch on electric power to the amplifier card, set all control signals to zero.

When switching on, the following green LEDs should come on:

- +24 V - supply voltage available
- +Vdd - +7.5 V available
- -Vdd - -7.5 V available
- Ramp Zero

The power supply is then in order, and the checking may be continued.

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If the LED indication is not in order:

- if the red LED +24 V overload is on and no other LED, there is an overload of the power circuit between +Vdd and -Vdd, or an internal fault;
- if the red LED +Vdd overload is on, there is an external overload between +Vdd and internal reference zero, or an internal fault;
- if the red LED -Vdd overload is on, there is an external overload between -Vdd and internal reference zero, or an internal fault.

Check the connection of external sensors and transducers; a common mistake is confusing the arm of a potentiometer with one of its end terminals.

If LED "Ramp not Zero" comes on instead of "Ramp Zero", a control signal is present. Try polling the set signal, check LEDs, check pnp or npn input characteristic. Check all input voltages, disconnect all input signals if required.

With all these checks completed, all normal card functions can be tested.

Control signals

- Control signal applied by polling set signals; the corresponding LED's shall go on
- Control signal applied via analog inputs

In these cases, the relevant channel indicating LED shall ligth up with an intensity that is proportional to the signal strength, thereby indicating the corresponding solenoid current. If these functions are in order, an exact setting of the control signals can be made; if not, an optimum setting must be sougth.

To avoid problems when switching on the hydraulics, the electronics must be at zero; re-check the setting of the card at the measuring outlets.

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Current settings

After switching on the hydraulics, the quiescent current, the maximum current, the set value signals, and the ramps must be set according to the function desired.

The quiescent current

Is composed of a basic current (operating point) and a step current.

The basic current

Should be adjusted to some 30 - 40 % of the quiescent current; it is factory-set to approx. 75 mA.

The step current

Is so adusted that the addition of a very small control signal will trigger a small movement, e.g. of a hydraulic cylinder, or the beginning of a valve opening.

The incremental trigger signal is obtained by operating switch S7 in the proper direction.

The maximum current

Needs a 100 % control signal to be applied; the I_{max} controls are then adjusted for maximum speed, maximum pressure, etc.

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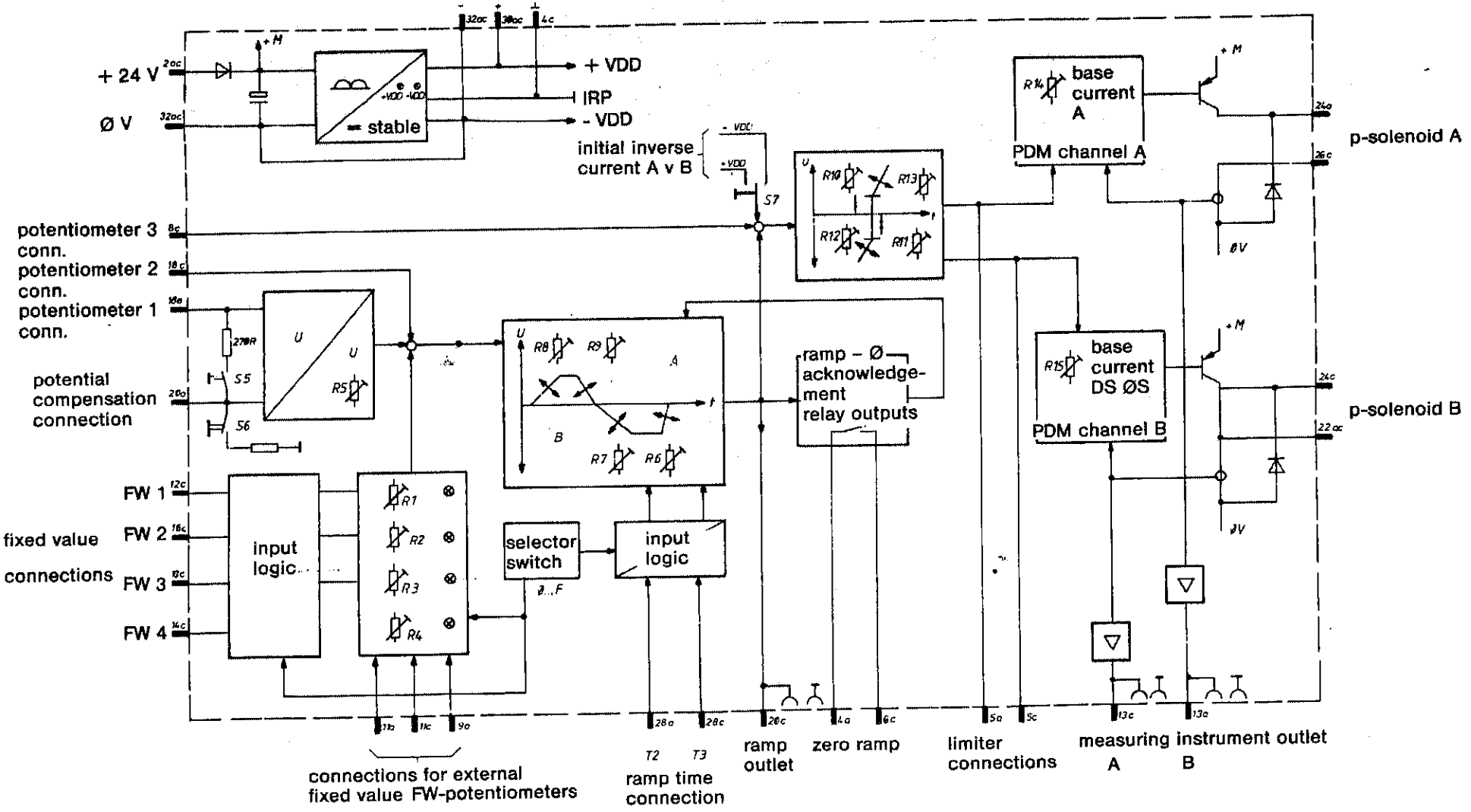
Block circuit diagram UBS 2111:



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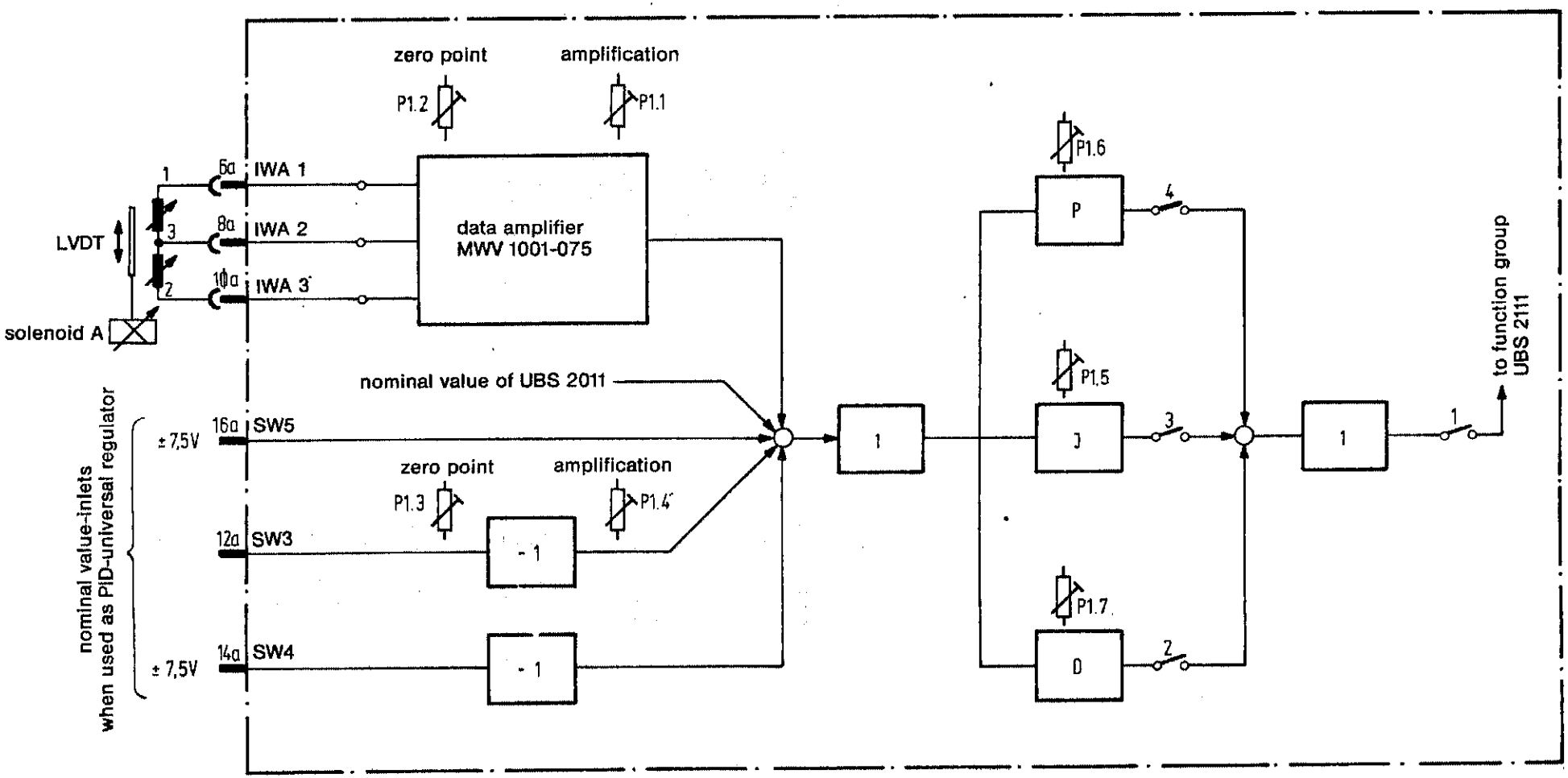
Block circuit diagram UBS 2012:



14. OPTIONAL EQUIPMENT

By adding a regulator card UBS 2012, control amplifier card UBS 2111 can be used for position control and other standard regulation tasks. The UBS 2012 may be equipped with various plug-in modules for processing sensor and transducer signals, e.g. amplifier module MWV 1001 which translate the signal from a position sensor into a control signal for a PID regulator.

The three sections of the regulator can be engaged separately by means of sliding switches to achieve different regulator characteristics, e.g. PD. The setting of the regulator is made with potentiometers having approximately a 1:20 resistance ratio. For standard applications, the range is preset at the factory, but may be changed by inserting extra resistors.

The regulator can be switched off with a sliding switch, e.g. in order to check the setting of the amplifier card.

14.1 Position Control of Spring-Return Valves

Position control is used to reduce hysteresis and overreaction of proportional valves, and to improve their accuracy and dynamics. The actual position of the valve is registered by an inductive position sensor moving with the magnet core or valve spool.

The sensor signal amplifier module in the UBS 2012 translate the signal from the position sensor into a voltage signal to the regulator, which compares it with the command signal and controls the solenoid currents so that the valve assumes its required position as rapidly as possible and is held stable in this position.

The setting of the regulator is described in para. 14.3.

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14.2 Universal PID Regulator

The UBS 2111 with an added UBS 2012 is useful for solving the most diversified regulation problems. Such signal processing as may be necessary, may be achieved by adding a suitable module to the UBS 2012. Various modules for standard problems are available.

The following inputs on the UBS 2111 can be used for control signals from outside the card:

16a	+/-7.5 V	actual or nominal value signals, non-inverting
14a	+/-7.5 V	actual or nominal value signals, inverting
12a	+/- 5 V	actual or nominal value signals, inverting, with zero-setting and gain control

Using these inputs, all conventional industrial regulation tasks - position control, speed control etc. - can be solved.

14.3 Regulator Setting Procedure

The setting of the regulator is carried out in the following manner. An oscilloscope is an advantage during the process, but is not absoluteley necessary.

Before proceeding to the actual setting of the regulator, adjustments on the card should be made as accurately as possible.

Switch the regulator ON.

- Switch on the P section and set it for low gain; turn the gain control potentiometer to its extreme CCW position.

  The I and D sections shall be OFF.

  A control signal, e.g. a set value signal, is applied to the regulator, or card, in step from (ramp generator off). The signal is observed on the oscilloscope or, if not available, the performance of the object to be controlled, is noted.

  The gain is now increased by rotating potentiometer "P-proportional gain" CW until a small oscillation is obtained (low damping) when the step signal is applied.

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- Switch on the D section of the regulator.

  From its extreme CCW position, rotate potentiometer "D-differentiation" CW to set the damping of the oscillation for minimum overshoot.

- Switch on the I section of the regulator.

  Connect the oscilloscope to point L9 on card UBS 2012 near the sensor signal amplifier. Turn potentiometer "I-integration time" CW until the duration of the oscillation is reduced to am minimum.

  If an oscilloscope is not available, set the I control for minimum duration of the oscillation and minimum overshoot.

The selection of regulator characteristic - i.e whether PD, PID or some other form of regulation will give optimum performance - depends on the regulation path.

Examples:

- Position control of a cylinder: choose a PD type regulator. The cylinder has, in itself, an I characteristic, making a PD regulator suitable. A PID regulator would tend to oscillate.

- Speed control of a hydraulic motor: regulator type PID.

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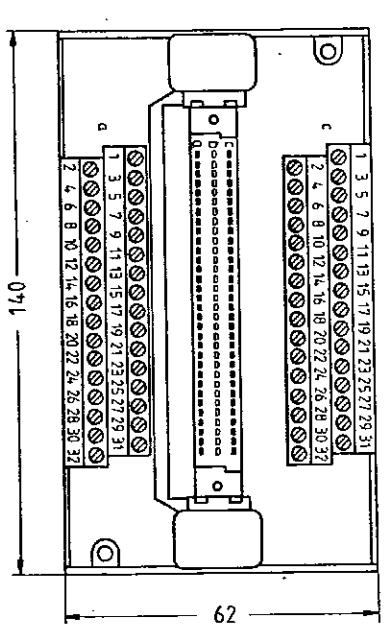
15. MECHANICAL DESIGN

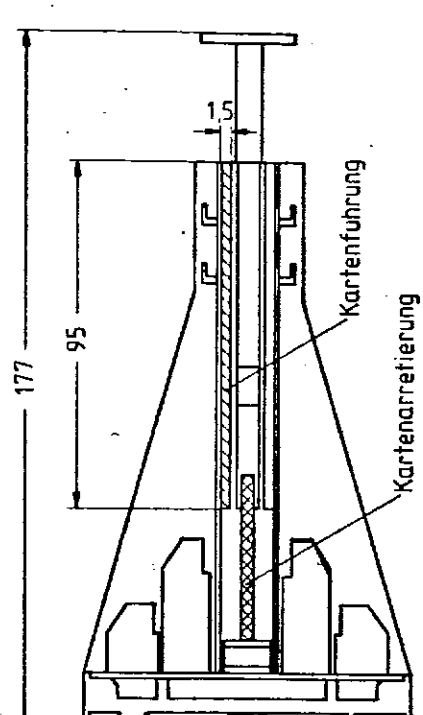
Control amplifier UBS 2111 and its various optional extra equipment form a so-called "Print-Pack". The printed-circuit card, of Europe standard size 100 x 160 mm, the regulator card, back panel etc. form a compact unit, on which the anodized aluminium front panel is mounted.

UBS 2111 fits all 19" standard racks according to DIN 41494 and IEC 297. The panel height is three height units = xx 44.45 = 133.35 mm; the width is ten width units = 50.8 mm.

UBS 2111 has a 64-pin terminal strip according to DIN 41612 Bauform C, with contacts being numbered 1...32, a and c.

For separate mounting of the control amplifier, a card holder with guiding gibs is available.





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Terminals

1ac	NC
2ac	+24 V supply voltage
3ac	NC
4a	Relay contact "Ramp Zero"
4c	Reference zero
5a	Blocking input, channel A
5c	Blocking input, channel B
6a	Position sensor, end terminal
6c	Relay contact "Ramp Zero"
7a	Ramp setting, external
7c	Ramp setting, external
8a	Position sensor mid-point
8c	control signal SW2 input, direct to output stage
9a	Set signal FW1, FW2 control input
9c	NC
10a	Position sensor, end terminal
10c	Set signal FW3 input
11a	Set signals FW1 - 4 control input
11c	Set signal FW3, FW4 control input
12a	Control signal SW3 input to regulator
12c	Set signal FW1 input
13a	Measuring outlet channel A current
13c	Measuring outlet channel B current
14a	Control signal SW4 input to regulator
14c	Set signal FW4 input
15a	NC
15c	Power supply mid-point
16a	Control signal SW5 input to regulator
16c	Set signal FW2 input
17ac	NC
18a	+ differential input
18c	Control signal SW1 input to ramp
19ac	NC
20a	- differential input
20c	Ramp generator output

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21ac	NC
22ac	Proportional magnet B
23ac	NC
24a	Proportional magnet A
24c	Proportional magnet B
25ac	NC
26ac	Proportional magnet A
27ac	NC
28a	Ramp time range control, T2
28c	Ramp time range control, T3
29ac	NC
30ac	-Vdd, +7.5 V stabilized
31ac	NC
32ac	-Vdd, -7.5 V stabilized; 0 V supply

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16. ORDER CODE

Electronic amplifier
for proportional valves

With one power output (A)	-	0
With two power output	-	1
Without ramps and set signals	-	0
With ramps and set signals	-	1
Without position regulator	-	0
With position regulator	-	1
With position regulator, without measuring amplifier	-	2
Without card holder	-	0
With card holder	-	1

Manufacturer's
modification number ----------

Special executions to be ordered in clear.

When UBS 2111 is installed in a card holder, terminals 5ac, 7ac, 9a, 11ac, 13ac and 15ac cannot be used.

If these special functions are requiered, a 64-pole connector must be used.

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17. ACCESSORIES

- UBS 2012 Universal regulator card
- UBS 2013 Measurement adapter, for 19" rack
- UBS 2045 Transformer 220/24 V, plug-in type
- UBS 2071 Ramp card, with 4 additional set signals and ramp generator for extra long ramp times

Precision potentiometers:

- UBS 2501 1-turn, with knob and adhesive scale
- UBS 2502 3-turn, with knob and mounting parts
- UBS 2503 10-turn, with knob and mounting parts
- UBS 2504 Card holder, for installing in cabinet, with 32 terminals, even-numbered, a and c

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