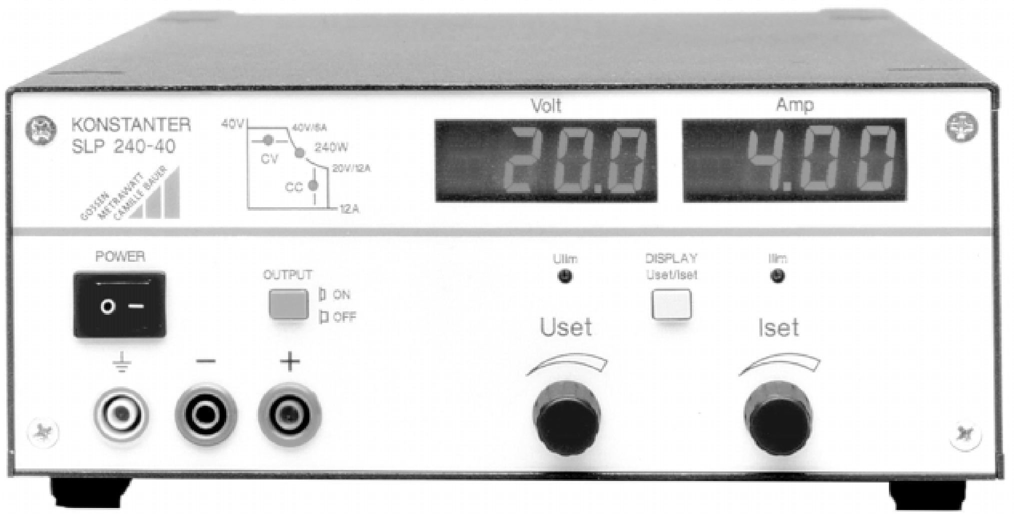
Operating instructions

SLP KONSTANTER series SLP 120 / SLP 240
Laboratory power supply

13025
3/6.97



First inspection

Please unpack the KONSTANTER and its accessory immediately on receipt and check the package for its completeness and any signs of damage incurred in transit.

Unpacking

- ☞ Unpack the Konstanter with the care obligatory for handling electronic equipment.
- ☞ The KONSTANTER is delivered in a packaging suitable for recycling, which is tried and tested to reliably protect the the device in transit. Please take this or an equivalent packaging if repacking the instrument.

Visual inspection

- ☞ Please compare P/O number / type description on the carton and/or label on the device with the indications on the shipping documents.
- ☞ Make sure that all accessory items have been included (→ 1.3 Options and Accessory).
- ☞ Check the packaging and exterior of the instrument and accessory for any signs of damage incurred in transit.

Complaints

If you find any damages, please do not hesitate to complain to the forwarder (keep carton!). Any other deficiencies or the requirement for repair have to be reported to our corresponding representation or directly to the address listed on the back cover.

Warnings and safety instructions

The KONSTANTER has been built and tested in accordance with the electrical safety regulations as listed in the specification and left the factory in perfect condition, in particular with regard to protection class I-requirements. To maintain this condition and to ensure safe operation, the user must follow the instructions and warnings in this Operating Manual. They are emphasized by either of the following titles:

CAUTION!

An operating instruction, the practical application, aso. which must be strictly followed to avoid a possible damage of the KONSTANTER, and to guarantee the correct operation.

WARNING!

An operating instruction, a practical application, aso. which must be strictly followed to maintain the safety protection of the KONSTANTER and to avoid personal injury.

The indispensable warnings are listed below. Each corresponding passage will be referred to throughout the operating instructions.

Indispensable warnings

WARNING I – Non-fused earthing

The KONSTANTER may only been operated with a connected non-fused earthed conductor. Each interruption of this non-fused earthed conductor if inside or outside the KONSTANTER may to lead to the KONSTANTER becoming a danger. Any intentional interruptions are prohibited.

The line connection is made by a 3-wired cable with line connector plug which may only be plugged into a corresponding socket with an earthing contact. This protection effect must not be eliminated by an extension cable without a non-fused earthed conductor.

WARNING II – impacted safety protection

If there are any signs that a safe operating might no longer be possible, switch off the KONSTANTER immediately and save the instrument against unintentional operation. Signs that a safe operating might no longer be possible may be as follows:

- if the KONSTANTER shows visible damages,
- if the KONSTANTER stops working,
- after a long-term storage disregarding the specific storage conditions,
- after heavy demands in transit.

WARNING III – opening of case covers

When opening case covers, voltage leading parts might be laid bare as long as the KONSTANTER is connected.

Do not touch these voltage leading parts laid bare since this is highly dangerous.

Thus, case covers may only be opened or removed by an expert being familiar with these dangers.

WARNING IV – repairs only by an expert

When opening case covers, voltage leading parts might be laid bare as long as the KONSTANTER is connected.

Maintenance and repair works as well as instrument internal alignments may only be made by an expert being familiar with these dangers.

If any possible the KONSTANTER has to be separated from all external voltage sources before these works begin. Then please wait 5 minutes so that the internal condensators can be discharged to harmless voltage values.

WARNING V – replacement of fuses

When replacing faulty fuses please do not use other fuses than those being of the indicated type and the given nominal current strength (see specification resp. label indication).

Any manipulation at the fuses or fuse holders (“mending“ fuses, short-circuiting of the fuse holder, etc.) is inadmissible.

Contents

1 Specifications

1.1 Facilities and applications

The SLP KONSTANTERs (Single-Output Laboratory Power Supplies) are one-channel laboratory power supplies to be used in Research, Development, Production, Education and Service.

The KONSTANTERs maintain either voltage or current constantly and thus they can cover a wide range with their nominal power of 120 W respectively 240 W by their „auto-ranging“ output.

The manual adjustment of voltage and current effects precisely by 10-turn-potentiometers the adjustment range of which can be reduced by aligning tools to avoid an erroneous adjustment of unrequiredly high values.

Two big 3.5-digit LED digital displays show the output voltage respectively the output current and may be switched to setting value indication which is advantageous in particular for current adjustment. Control status indications are signalizing each corresponding operating status.

The earth-free, front and back output can be switched on or off at the standardly provided analog interface either by pressing the key or by signal. When the sensors are connected, the instrument automatically switches to remote-sensing.

The solid metal case has a firm frame as well on its top as also on its base. Moreover, it contains stand-position legs and a stand-position protection at its rear.

In next to no time several cases can be linked firmly and thus construct a multi-channel unit. Furthermore the case is provided with a line output socket so that the unit needs only one feeding line which will be passed on by the Jumper power cable (accessory). Even the mounting into 19“ racks is possible with the corresponding adapters.

1.2 Functional features

Adjustable functions

- ❑ Voltage and current setting value
- ❑ Limit value for voltage and current adjustment range
- ❑ Switching the output On/Off

Indicative functions

- ❑ Voltage / current measuring value
- ❑ Voltage / current setting value
- ❑ Present regulation mode (CC / CV)

Protective and additional functions

- ❑ Pole-confusion protected sensor connectors with automatical activation (auto-sensing)
- ❑ Overtemperature protection
- ❑ Reverse-voltage protection of the output
- ❑ Inrush current limiting
- ❑ Temperature-controlled fan
- ❑ Master-slave coupling

1.3 Options and accessory

Options

The KONSTANTER is well equipped and therefore offers no further options.

Standard accessory:

The consignment of the KONSTANTER contains the following accessories:

- ❑ this operating manual
- ❑ 1 line connection cable (approx. 1.5 m) with an earthing contact plug

Additionally available accessory:

(please see list on last page)

- ❑ 19“ adapter 1x32N for the mounting of a single KONSTANTER of series SLP into a 19“ rack
- ❑ 19“ adapter 2x32N for the mounting of two KONSTANTERs of series SLP into a 19“ rack
- ❑ Jumper power cable, 0.4 m
  ”bridging“ the line supply with one 10 A appliance plug and one 10 A appliance coupling each.

1.4 Technical data

1.4.1 General data

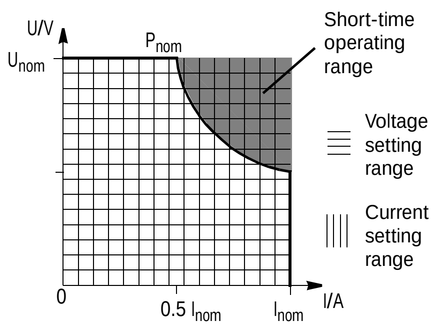
Supply

Connection	Input: 10 A IEC appliance plug Output: 10 A IEC appliance coupling, unswitched, non-fused
Line voltage	230 V AC; +10/–15%; 47…63 Hz;
Power consumption	See section 1.4.3
Inrush current	max. 50 A_{peak}
Line fusing	1x T4A/250V (6.3 x 32 mm, UL) Internal: 1 x T5 A/250 V (5 x 20 mm)

Output

Connection	
Output	At the front, 2 x 4 mm safety sockets At the rear, 6-pins terminal block (pluggable)
Sensor	At the rear, in the output connector plug
Regulator principle	Primary switch-mode regulator with BET technology
Operating modes	Adjustable constant voltage/current source with auto-crossover
Output isolation	Floating output with "safe electrical isolation" to the line input; max. admissible potential output to earth: 120 V; capacity output to earth (case): 60 nF

Output operating range



Short-time operating range:
if operating for a longer time within the short time operating range, the overtemperature protection might react by switching off the output (compare with section 1.4.3: short-term power)

Analog interface

Connection	11-pins terminal block (pluggable)
Ref. potential	Output negative terminal TRG input floating

Connection setting:

Pin	Description	Function
1	SIG1 OUT	Status signal output for output on/off
2	SIG2 OUT	Status signal output for regulation mode CV/CC (open collector, max. 30 V–/20 mA)
3	TRG IN +	Digital control input for output on/off
4	TRG IN –	(low: <1 V; high: 4 ... 26 V); floating
5	+15 V	Auxiliary voltage +15 V/max. 50 mA
6	AGND	Point of reference, conntected to –output by reversible fuse
7	U_{set} –	Analog, inverting voltage control input (0 ... –5 V corresp. 0 ... U_{nom}; R_i = 10 kΩ)
8	U_{set}+	Analog voltage control input (0 ... +5 V corresp. 0 ... U_{nom}; R_i = 10 kΩ)
9	I_{set}+	Analog current control input (0 ... +5 V corresp. 0 ... I_{nom}; R_i = 10 kΩ)
10	U-MON	Monitoring output of the output voltage (0 ... 10 V corresp. 0 ... U_{nom}; R_i = 9.8 kΩ)
11	I-MON	Monitoring output of the output current (0 ... 10 V corresp. 0 ... I_{nom}; R_i = 9.4 kΩ)

Electrical safety

IEC 1010-1 +A1 ('92) EN 61010-1 ('93) VDE 0411-1 ('94)	Safety regulations for electrical measuring, control, regulating and lab instruments; (protection class I; overvoltage category: II for line input, I for output and interfaces; pollution degree 2; earth leakage current typ. 2.5 mA;)
IEC 950+A1+A2 ('93) EN 60950+A1+A2('93) VDE 0805+A2 ('94)	Safety of information technology equipment including electrical business equipment
IEC 529 ('89) EN 60529 ('91) VDE 0470-1 ('92)	Framing protective systems; IP 20 for cases and connectors for line, output, analog interface;
Potential isolation	Test voltage
Line/output – PE	1.35 kV AC
Line – output	2.7 kV AC (type test 3.7 kV AC)

Electromagnetic compatibility

Interference emission

EN 50081-2 ('94) VDE 0839-81-2 ('94)	Generic emission standard industrial environment
CISPR 11 ('90) EN 55011 ('91) VDE 0875-11 ('92)	Limit values and measuring procedures for radio interferences of ISM equipment

Interference immunity

EN 50082-2 ('96) VDE 0839-82-2 ('96)	Generic emission standard industrial environment
IEC 1000-4-2 ('95) EN 61000-4-2 ('95) VDE 0847-4-2 ('96)	Electrostatic discharge (severity level 2 for contact discharge, severity level 3 for atmospheric discharge)
IEC 1000-4-3 ('95) ENV 50140 ('95) VDE 0847-3 ('95)	Electromagnetic HF field (10 V/m, no influence)
IEC 1000-4-4 ('95) EN 61000-4-4 ('95) VDE 0847-4-4 ('96)	Transient interference quantities – Burst (severity level 3)

Ambient conditions

IEC 68-2-6 ('90)	Vibration resisting strength (10-55 Hz; 0.3 mm; 1 oct/min; 3x30 min)
IEC 68-2-27 ('89)	Impact strength (15g; 11ms; semi-sine, 3x6 shocks)
Temperature range	Operation: 0 to 50 °C at > 40 °C current derating (see 1.4.3.) Storage: –25 to +75 °C
Humidity	Operation: ≤ 75% RH; no dewing
Cooling	By integrated fan Air intake: side panels Air outlet: rear panels

1.4.2 Mechanical data

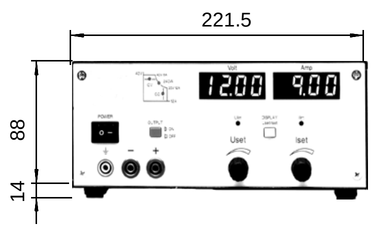
Construction type	Desktop instrument, suitable for rack mounting
Dimensions (B x H x T) for 19" rack	See also dimensional drawing 22.15 x 10.2 x 39.75 cm 1/2 19" x 2 HE x 40 cm
Weight	approx. 2.8 kg
Dimensional drawing	See page 6

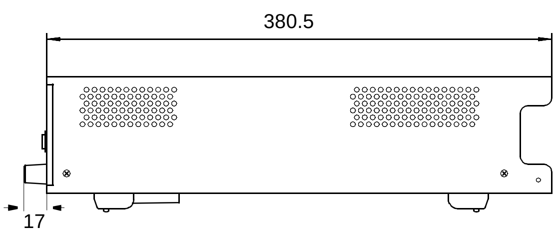
1.4.3 Technical data series 120 W

- Unless otherwise stated, all data are maximum values and are valid on the operating temperature range from 0 ... 50 °C, nominal power range and line voltage range 230 V ±10 % after a warmup time of 30 minutes.
- The indications in % refer to the respective adjustment or measured values

Short designation **Type designation**		**SLP 120-20** **32 N 20 R 10**	**SLP 120-40** **32 N 40 R 6**	**SLP 120-80** **32 N 80 R 3**
Nominal output data	Voltage setting range	**0 ... 20 V**	**0 ... 40 V**	**0 ... 80 V**
	Current setting range	**0 ... 10 A**	**0 ... 6 A**	**0 ... 3 A**
	Continuous power at $T_u \le 40$ °C	**max. 120 W**	**max. 120 W**	**max. 120 W**
	Short-term power for t < 90 s / $T_u \le 25$ °C	**max. 200 W**	**max. 240 W**	**max. 240 W**
	Current derating at $T_u > 40$ °C	**–0.25 A/K**	**–0.15 A/K**	**–0.07 A/K**
Output performance				
Total setting accuracy (at 23 ± 5 °C)	Voltage	0.2 % + 50 mV	0.2 % + 150 mV	0.2 % + 250 mV
referred to 3½-digit set point display	Current	0.5 % + 45 mA	0.5 % + 35 mA	0.5 % + 20 mA
Incl. deviation load/line				
Load effect [1]	Voltage	15 mV	10 mV	10 mV
at 100 % load change [1]	Current	20 mA	10 mA	10 mA
Line effect [1]	Voltage	5 mV	5 mV	5 mV
at 10 % line voltage variation [1]	Current	8 mA	5 mA	5 mA
Residual ripple [1]	Voltage (10 Hz ... 10 MHz)	10 mV_{rms}	10 mV_{rms}	10 mV_{rms}
	Current (10 Hz ... 1 MHz)	25 mA_{rms}	20 mA_{rms}	10 mA_{rms}
Common-mode noise (10 Hz ... 1 MHz)		0.5 mA_{rms}	0.5 mA_{rms}	0.5 mA_{rms}
Settling time (voltage)	Tolerance	40 mV	80 mV	80 mV
at a load change 10 ... 90% Inom	Δ I = 80 %	200 µs	200 µs	200 µs
Undershoot / overshoot voltage at load step 50 A/ms	Δ I = 80 %	400 mV	400 mV	800 mV
Response time (voltage)	Tolerance	40 mV	80 mV	160 mV
at step change in set point 0 → 100 %	No load/nominal load	1 ms / 1 ms	1 ms / 1 ms	4 ms / 4 ms
at step change in set point 100 % → 0	No load/nominal load	1 ms / 1 ms	1 ms / 1 ms	4 ms / 4 ms
Response time (current)	Tolerance	100 mA	60 mA	30 mA
at step change in set point 0 → 100 %	Short circuit/nominal load	< 5 ms / < 5 ms	< 5 ms / < 5 ms	< 10 ms / < 10 ms
at step change in set point 100 % → 0	Short circuit/nominal load	< 5 ms / < 5 ms	< 5 ms / < 5 ms	< 10 ms / < 10 ms
Meter performance (3½-digit)				
Resolution	Voltage	10 mV	100 mV	100 mV
	Current	10 mA	10 mA	10 mA
Accuracy (at 23 ± 5 °C)	Voltage	0.15 % + 25 mV	0.2 % + 120 mV	0.2 % + 150 mV
Referred to the measured value at a time	Current	0.5 % + 30 mA	0.5 % + 25 mA	0.5 % + 20 mA
Protection features				
Output overvoltage protection	Response value	25 ± 1 V	50 ± 2 V	100 ± 4 V
Loading of pole confusion protection	Continuously	10 A	6 A	3 A
Feedback withstand voltage	Continuously	40 V	80 V	100 V
General				
Power supply [1]	Line voltage	230 V~ +10/–15 %	230 V~ +10/–15 %	230 V~ +10/–15 %
		47 ... 63 Hz	47 ... 63 Hz	47 ... 63 Hz
Power consumption	At nominal load	280 VA; 180 W	280 VA; 170 W	280 VA; 170 W
	In standby mode	45 VA; 15 W	45 VA; 15 W	45 VA; 15 W
	At maximum short-term power	550 VA	550 VA	550 VA
Efficiency	At nominal load	> 67 %	> 70 %	> 70 %
Switching frequency	Typically	200 kHz	200 kHz	200 kHz
Ordering No.		K220A	K221A	K222A

1) The regulation data increases by the factor of 1.2 on the function range of the line input voltage from –10 % to –15 %.





Technical data series 240 W

- Unless otherwise stated, all data are maximum values and are valid on the operating temperature range from 0 ... 50 °C, nominal power range and line voltage 230 V ±10 % after a warmup time of 30 minutes.
- The indications in % refer to the respective adjustment or measured values

SLP 240-20 32 N 20 R 20	**SLP 240-40 32 N 40 R 12**	**SLP 240-80 32 N 80 R 6**	**SLP 320-32 32 N 32 RU 18**
0 ... 20 V 0 ... 20 A max. 240 W max. 400 W –0.5 A/K	**0 ... 40 V 0 ... 12 A max. 240 W max. 480 W –0.3 A/K**	**0 ... 80 V 0 ... 6 A max. 240 W max. 480 W –0.15 A/K**	**0 ... 32 V 0 ... 18 A max. 320 W max. 480 W –0.5 A/K**
0.2 % + 100 mV 0.5 % + 55 mA	0.2 % + 150 mV 0.5 % + 45 mA	0.2 % + 250 mV 0.5 % + 35 mA	0.2 % + 150 mV 0.5 % + 50 mA
25 mV 30 mA	18 mV 30 mA	18 mV 15 mA	30 mV 40 mA
5 mV 8 mA	5 mV 8 mA	5 mV 5 mA	10 mV 20 mA
15 mV_{rms} 60 mA_{rms}	15 mV_{rms} 25 mA_{rms}	15 mV_{rms} 20 mA_{rms}	30 mV_{rms} 50 mA_{rms}
0.5 mA_{rms}	0.5 mA_{rms}	0.5 mA_{rms}	0.5 mA_{rms}
40 mV 400 µs	80 mV 200 µs	160 mV 200 µs	64 mV 200 µs
400 mV	400 mV	800 mV	400 mV
40 mV 1 ms / 1 ms 1 ms / 1 ms	80 mV 1 ms / 1 ms 1 ms / 1 ms	160 mV 4 ms / 4 ms 4 ms / 4 ms	64 mV 1 ms / 1 ms 1 ms / 1 ms
200 mA < 5 ms / < 5 ms < 5 ms / < 5 ms	120 mA < 5 ms / < 5 ms < 5 ms / < 5 ms	60 mA < 10 ms / < 10 ms < 10 ms / < 10 ms	180 mA < 5 ms / < 5 ms < 5 ms / < 5 ms
10 mV 10 mA	100 mV 10 mA	100 mV 10 mA	100 mV 10 mA
0.2 % + 50 mV 0.5 % + 25 mA	0.2 % + 120 mV 0.5 % + 30 mA	0.2 % + 120 mV 0.5 % + 25 mA	0.2 % + 120 mV 0.5 % + 40 mA
25 ± 1 V	50 ± 2 V	100 ± 4 V	40 ± 1 V
20 A	12 A	6 A	20 A
40 V	80 V	100 V	64 V
230 V~ +10/–15 % 47 ... 63 Hz	230 V~ +10/–15 % 47 ... 63 Hz	230 V~ +10/–15 % 47 ... 63 Hz	230 V~ +10/–15 % 47 ... 63 Hz
550 VA; 360 W 45 VA; 15 W 1050 VA	550 VA; 340 W 45 VA; 15 W 1050 VA	550 VA; 340 W 45 VA; 15 W 1050 VA	660 VA; 460 W 50 VA; 15 W 1050 VA
> 67 %	> 70 %	> 70 %	> 70 %
200 kHz	200 kHz	200 kHz	200 kHz
K230A	K231A	K232A	K234A

1) The regulation data increases by the factor of 1.2 on the function range of the line input voltage from –10 % to –15 %

2 Preparation and operation

2.1 Line connection

WARNING I to be considered!

CAUTION!
Before switching the KONSTANTER on, please make sure that the line voltage is in accordance with the operation voltage indicated at the rear's line connector.

The KONSTANTER needs 230 V AC supply voltage. Please connect the line connector at the rear to a line plug socket with a non-fused earthed conductor by the supplied cable.
The ratings regarding power consumption of the KONSTANTER are stated on the label at the bottom side of the instrument.

Above the line input plug, the KONSTANTER is provided with a line output socket to "bridge" the line voltage to further instruments. This line output socket is neither switched nor fused.

WARNING!
When bridging the line voltage, please consider that the total current consumption at the line feeding point is not exceeding 10 A!

Suitable "Jumper Power Cables" are availabe as accessory (see list at the last page).

2.2 Load connection

The load lines are connected either by 4 mm safety laboratory plugs to the safety sockets „+“ and „–“ at the front side or to the 6-pins terminal block, outputs „+“ and „–“ at the rear.
The rear load connection is equipped with two pins each for „+“ and „–“.
If the load current is higher than 10 A, both pins must be connected due to the contact load capacity.

Care for a sufficient line cross section and for the polarity. It is recommended to twist the load lines and to mark them at both ends with their polarity.

When loads are connected as well at the front as also at the rear, the constant voltage regulation refers to the connection pins at the rear. This kind of connection is prohibited for parallel outputs since otherwise there would be danger of overload for the internal link.

The yellow-green safety socket at the front side is connected to PE (earth/case) and serves the possible connection of earthing lines, cable shields or as earthing point of one of the output terminals.

2.3 Remote sensing

Take advantage of the high voltage constance of the output even for longer load lines. Compensate the voltage drop of the load lines by additional sensor lines.

Function

- Sensor terminals +SENSE / –SENSE detect the output voltage decisive for the voltage measuring and regulating circuits directly at the load (instead of the output pins).
- This sensor operation (remote sensing) offers the following advantages:
  + At constant voltage operation the voltage at the load remains largely uninfluenced of the current-depending voltage drops on the load lines.
    These voltage drops are compensated by the automatical corresponding increase in voltage at the output sockets.
  + At constant current operation the voltage limit at the load is also independent from the output current.
  + The voltage value delivered from the measuring function refers to the voltage detected by the sensor lines.
    Thus, load parameters as well as power input or load resistance can be calculated more precisely.
- For remote sensing, the parameters and limit values shown in figure 2.3 are applicable.

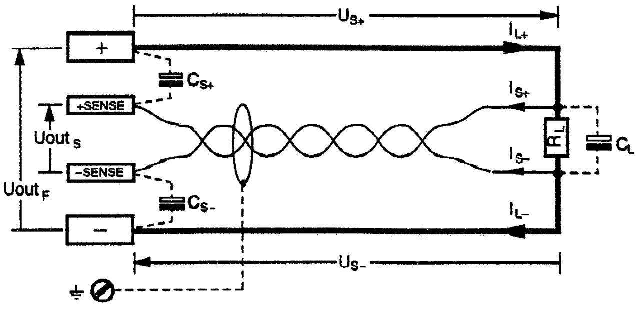


Figure 2.3 Load connection with remote sensing

- C_{S+}, C_{S-} typical ... 220 µF
- U_{S+}, U_{S-} ≤ 1 V
- I_{S+} ≈ $Uout_S$ / 150 kΩ – U_{S+} / 81 Ω
- I_{S-} ≈ 70 µA · $Uout_S$ / Uout nom – U_{S-} / 81 Ω

Connection

- Connect the two sensor lines +SENSE and –SENSE at the rear's output plug conductor as near as possible to the load with the corresponding output terminal.
- Interference couplings can be held lower by:
  ☞ Twisting the sensor lines and / or
  ☞ Shielding the sensor lines
  (shield to earth/case or output negative terminal)
- The impedance of long load and sensor lines may lead to oscillations of the output voltage. Load capacities are supporting this.
- By one capacitor each (C_{S+}, C_{S-}) between SENSE and output pin (see figure 2.3), you can counteract to the regulator oscillation.
- Moreover, twisting the load lines reduces their impedance.
- An erroneous connection of the sensors has no damaging effects on the KONSTANTER, but leads to the following reversible events:
  + Confusing the poles of the sensor or interruption of a load line:
    If the output voltage at the KONSTANTER is not limited by the current regulation, it will exceed the set value. Then the overvoltage protection reacts at once and deactivates the output.
  + Interruption of a SENSE line:
    Automatical switching back to local sensing for the corresponding output terminal.
- If the sensors are connected erroneously, the voltmeter display will not show the voltage at the output pins / load.

Switching on

- The switching to remote sensing effects automatically by linking the SENSE terminal connection to its output terminal.
- Switching it off is made by opening this link.

2.4 Rack mounting

The case of the KONSTANTERs is designed to permit use both as a desktop instrument and also for mounting into a 19" rack. You can mount either two KONSTANTERs in side-by-side or a single KONSTANTER with an additional cover plate into the rack. In next to no time you can change the desktop instrument into a rack mounting device.

Preparing a single KONSTANTER for rack mounting

Please use our accessory 19" adapter 1x32N which includes a 19" stop and a ½19“ cover plate.

① Remove the 4 screws at the front of the KONSTANTER.

② Remove the two filler strips at the front, left and right side.

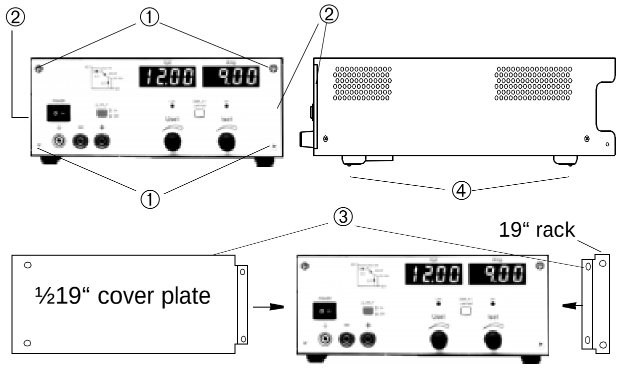


Figure 2.4 a Preparing a single instrument for rack mounting

③ Replace them by the 19" stop on one side and and the ½19“ cover plate on the other side and fasten them again with the 4 screws.

④ Unscrew the stand-position legs by removing the rubber inlet under which you will find the screws.

⑤ Now mount the KONSTANTER into the rack. Please keep all dismounted parts just in case you want to refix them in the rack.

⑥ The KONSTANTER must be laid on one side on rails which are, together with the front plate fastening screws required for the fixing of the KONSTANTER, rack-specific and to be supplied from your 19" rack supplier.

Preparing two KONSTANTERs for rack mounting

Please use our accessory 19" adapter 2x32N which includes two 19" stops and one 19" link.

① Remove the 8 screws at the front of the KONSTANTERs.

② Remove the two filler strips at each front, left and right side.

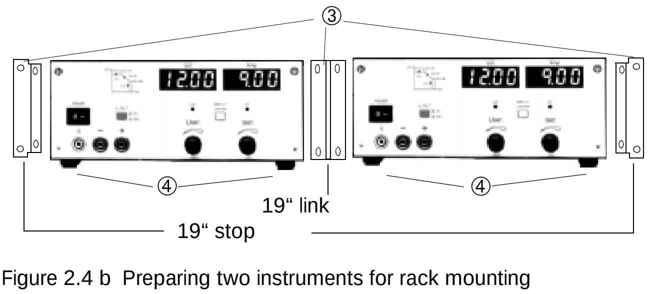


Figure 2.4 b Preparing two instruments for rack mounting

③ Replace them by the 19" stops on the left and right side, mount the 19" link into the middle and fasten them again with the 8 screws.
Now bolt the two cases at bore-hole and thread in the stand-position protection at the rear.

④ Unscrew the stand-position legs by removing the rubber inlet under which you will find the screws.

⑤ If you wish to connect both KONSTANTERs electrically, please use our accessory "Jumper Power Cable".

⑥ Now mount the KONSTANTERs into the rack. Please keep all dismounted parts just in case you want to refix them in the rack.

⑦ The KONSTANTERs must be laid on two sides on rails which are, together with the front plate fastening screws required for the fixing of the KONSTANTER, rack-specific and to be supplied from your 19" rack supplier.

2.5 Combination to a multi-channel desktop instrument

You may combine up to 3 KONSTANTERs to a multi-channel desktop instrument (see also section 5 for the electrical coupling possibilities via analog interface).

① Unscrew the stand-position legs by removing the rubber inlet under which you will find the collar screws.
At the bottom side you will now see four enlargened oblong holes.

② Screw these 4 collar screws into the 4 threads on the top of the other instrument case. Please keep the 4 washers and the stand-position legs.

③ Set the KONSTANTER without stand-position legs on top of the other KONSTANTER. The screws of the underneath device must be introduced into the enlargened oblong holes of the upper instrument. Now please push the upper instrument slightly until the screws are locked in position.

④ Bolt the two instruments together by the bore-holes and threads at the rear stand-position protection. Thus a possible sliding of the corresponding upper instrument can be avoided.

⑤ If you wish to connect both KONSTANTER electrically, please use our accessory „Jumper Power Cable“.

3 Control, indicators and connectors

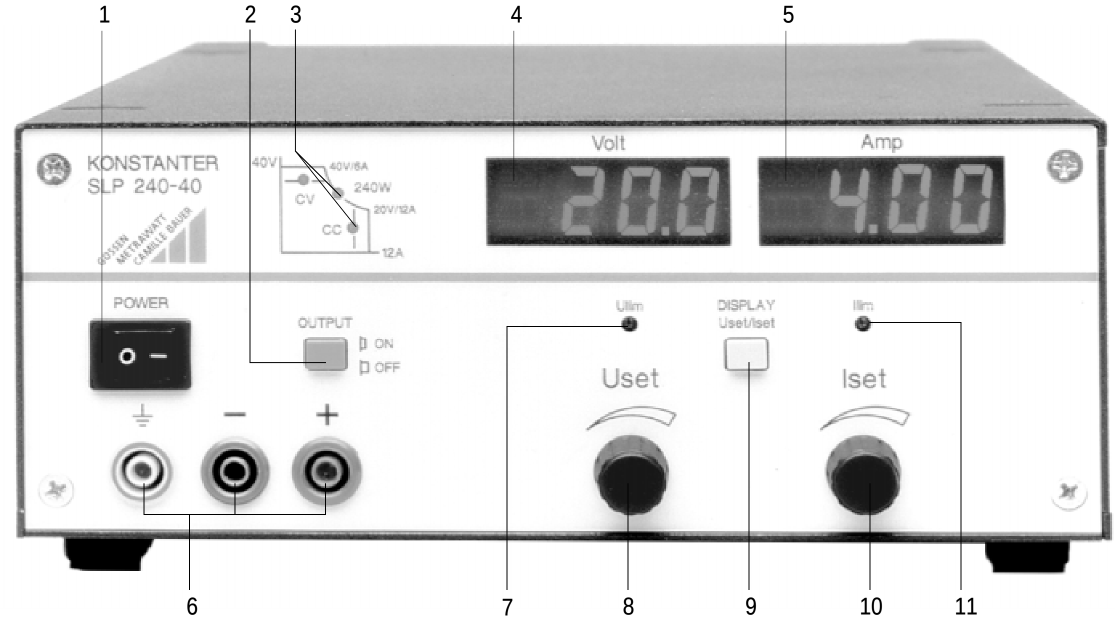


Figure 3.1 Control, indicators and connectors at the front

[1] Line switch <POWER>
Switching the KONSTANTER on/off.
After having been switched on, the KONSTANTER adjusts to all values given by the setting of the control elements or by the control signals at the analog interface. Then the instrument is ready for further operation.
When switching off, the KONSTANTER is disconnected from the line and the output will be deactivated.

CAUTION!
Please do not switch on/off too often within short periods. Otherwise, the efficiency of the inrush current limitation might be reduced and as a consequence, the line fuse might react!

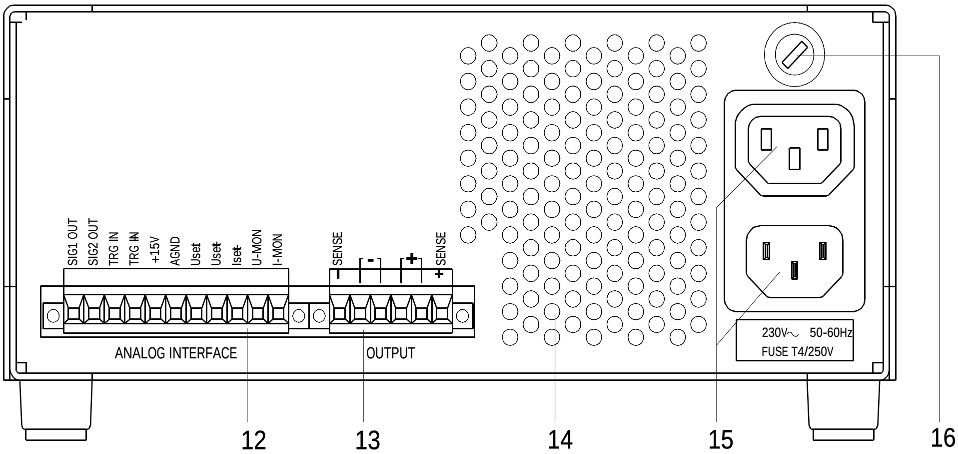
[2] <OUTPUT> key
Pressing the button <OUTPUT> activates respectively deactivates the power output.
If the output is activated, one of the regulation mode indicators illuminates CV or CC [3].
Switching the output on/off produces no considerable over-/ undershoot of the output voltage.
When switching the output off, an electronic "sink" will be activated for approx. 300 ms. This circuit discharges the output capacitors rapidly and afterwards the output will be "high-resistive" (R_i > 50 kΩ II 250 µF).

☞ Further description in section 4.3

CAUTION!
The output connections are not galvanically insulated by switching the output off.

[3] Regulation mode indicators
The three LED indicators signalize the present operation status (regulation mode) of the output.

”CV“ illuminates	constant voltage mode (Uout = Uset)
”CC“ illuminates	constant current mode (Iout = Iset)
”Pmax” illuminates	overtemperature protection has reacted; output is not activated;



[4] Left display
The left digital display shows the measured value of the output voltage Uout in Volts as standard indication.
As long as the key [9] <DISPLAY Uset/Iset> is pressed, the display shows the manually set voltage setpoint value Uset.

Type/nominal voltage	Measuring resolution / range
20 V	0.01 (max. 19.99)
32/40/80 V	0.1 (xx.x)

[5] Right display
The right digital display shows the measured value of the output current Iout in Amperes as standard indication.
As long as the key [9] <DISPLAY Uset/Iset> is pressed down, the display shows the manually set current setpoint value Iset.
Measuring resolution / range 0.01 (max. 19.99)

☞ Further description in section 4.3

[6] Output at the front
The set constant voltage resp. the constant current can be taken from the safety sockets at the front or from the connector at the rear [13].

– (blue)	Negative output terminal
+ (red)	Positive output terminal
⏚ (yellow-green)	Earthing feature for the output or shield connections provided that shielded load lines are used. The earthing terminal is linked with the case and the PE contact of the line connector.

☞ Further description in section 2.2

Figure 3.2 Operation and connection elements at the rear

[7] Voltage setting limit adjustment <Ulim>
The upper limit value Ulim for the voltage setting value Uset is adjusted on this trimmer potentiometer. Please use exclusively a screw driver of size 3.

☞ Further description in section 4.1.2

[8] Knob for voltage setting <Uset>
This knob adjusts the output voltage. This adjuster is made as a 10-turn-potentiometer and enables you to adjust the voltage setting value Uset very precisely in the range defined by Ulim [7].
Press key [9] to monitor the setting value Uset.

☞ Further description in section 4.1.3

[9] Display switch key <Uset/Iset>
Pressing key [9] switches both displays [4/5] from Uout/Iout to Uset/Iset.
Keep this key pressed down if you want to control every change of Uset/Iset or Ulim/Ilim during this processing.

[10] Knob for current setting <Iset>
With regard to the current setting, this knob has the same principle as the voltage setting knob [8].
Press key [9] <DISPLAY Uset/Iset> to monitor the present current setting value.

☞ Further description in section 4.2.3

[11] Current setting limit adjustment <Ilim>
The upper limit value Ilim for the current setting value Iset is adjusted on this trimmer potentiometer. Please use exclusively a screw driver of size 3.

☞ Further description in section 4.2.2

[12] Analog interface

CAUTION!
The contacts of the analog interface are connected to electronic components which might be damaged by electrostatic discharges. Before touching the contacts, please balance the potential difference between you and the KONSTANTER by touching the case!

The analog interface offers possibilities to
- remotely set the output voltage und current by analog control voltages 0 ... 5 V or 0 ... –5 V

  ☞ Further description in section 5.4 / 5.5
- externally measure or record output voltage and current via monitor signals 0 – 10 V

  ☞ Further description in section 5.6 / 5.7

- supply the TRIGGER input or external regulation devices with an auxiliary voltage of approx. +15 V
- couple several KONSTANTERs in master/slave operation

  ☞ Further description in section 5.8.2 / 5.9.2
- vary the output’s inner resistance

  ☞ Further description in section 5.10
- activate/deactivate the output via the potential-free TRIGGER input

  ☞ Further description in section 5.3

[13] Rear output

The OUTPUT interface offers two possibilities

- Tapping the constant voltage resp. current at the rear of the KONSTANTER by connection block
- Connecting the sensor lines (SENSE) to compensate voltage drops on the load feeding lines

  ☞ Further description in section 2.2 and 2.3

[14] Air outlet

The air outlet at the rear and at the side serve to regulate the temperature in the KONSTANTER. Through this ventile supported by a temperature controlled fan, the heat generated in the KONSTANTER is blown away.

CAUTION!
The air ventile must not be closed, e.g. the outgoing warm air must not be stopped through blocking the outlet holes. If this instruction has not been followed, the overtemperature protection will react and deactivate the output (see section 4.3).

[15] Line input

Line input with bridged line socket for appliance plugs. These bridged line sockets enable you to connect up to 3 KONSTANTERs directly via two short line cables with appliance plugs. Thus, no more than one feeding line is necessary.

☞ Further description in section 2.1

[16] Line fusing

Fusing the line voltage input

All device types: T 4.0 A / 250 V (6.3 x 32 mm)

The second line input terminal is fused internally by
T 5.0 A / 250 V (5 x 20 mm)

WARNING!
When replacing faulty fuses please do not use other fuses than those being of the indicated type and the given nominal current strength (see specification resp. label indication. Any manipulation at the fuses or fuse holders („mending“ fuses, short-circuiting of the fuse holder, etc.) is inadmissible.

4 Adjusting the output values

4.1 Output voltage

4.1.1 Uout – Actual voltage measuring value

- The left digital instrument [4] <Volt> shows the actual measured value Uout which is the value of the voltage being at the output terminals.
- With remote sensing, the shown measured value refers to the voltage, which is taken by the sensors at the load.
- The 3½ digit display is updated approximatly three times per second; overflow indication if values exceed 19.99 V on 20 V devices.
- When the output voltage is superposed with AC signals, the display shows the arithmetic average value.

☞ Regarding measuring range, measuring resolution and measuring accuracy see section 1.4.3 Electrical data

4.1.2 Ulim – Limit value for Uset

Function

- Upper limit value for voltage setting range of <Uset> [8]
- Protection against unintentional too high adjustment of the voltage setting value Uset
- When inserting Ulim = 0 V (left strike), the voltage control <Uset> is unefficient (e.g. when setting the output voltage via the analog interface).

Adjustment of Ulim

- Adjust Ulim at the left trimmer potentiometer [7] <Ulim>
- Use exclusively a screwdriver of size 3 to avoid any damages at the potentiometer
- Deactivate the output: <OUTPUT> ”OFF”
- At first, set Uset on maximum value (turn potentiometer [8] <Uset> clockwise to the strike)
- Press key [9] <DISPLAY Uset/Iset>
- The left display [4] <Volt> switches from the actual voltage measuring value Uout to the manually adjusted voltage setting value Uset
- Keep pressing this key down
- Screw simultaneously <Ulim> [7] with the screwdriver until the left display [4] <Volt> shows the voltage to be set for Ulim.
- Increase in voltage: screw clockwise (increment)
- Decrease in voltage: screw counter-clockwise (decrement)
- This voltage now is the maximum value to which Uset can be adjusted manually.

Adjustment range

- The 270° rotation angle of <Ulim> corresponds to an adjustment range 0 V ≤ Ulim ≤ Unom.
- The 10 possible turns at the <Uset> knob [8] always correspond to the range 0 V to Ulim.

4.1.3 Uset – Voltage setting value

Function

- Setting value of the output voltage.

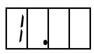
Adjustment of Uset

- Adjust Uset at the left knob [8] <Uset>
- At first, press key [9] <DISPLAY Uset/Iset>
- The left display [4] <Volt> switches from the actual voltage measuring value Uout to the manually adjusted voltage setting value Uset
- Keep pressing this key down
- Turn at the same time knob [8] <Uset>
- Increase in voltage: screw clockwise (increment)
- Decrease in voltage: screw counter-clockwise (decrement)
- Provided that output is activated <OUTPUT> ”ON”, the output voltage changes directly with the setting of the knob.
- If deactivated output <OUTPUT> ”OFF”, no voltage is at the output, not even during the adjustment. The voltage is only brought to the output after activating <OUTPUT> ”ON”.
- After releasing key [9] <DISPLAY Uset/Iset> the display [4] switches back to the indication of the measuring value of the output voltage Uout.

CAUTION!
The value for Uset can also be changed if the KONSTANTER is not activated.

Adjustment range

- This knob permits 10 rotations.
- The 10 possible turns at the multi-turn-potentiometer [8] <Uset> always correspond to the range 0 V to Ulim
- The lower Ulim is set, the ”finer“ can low values be adjusted for Uset.
  The setting accuracy specified in section 1.4.3 refers to each setting value shown.
- The indication of the voltages Uout and Uset ends at 19.99 for 20 V devices.
  For exceedingly adjusted values, the AD converter produces an overflow indication:



4.2 Output current

4.2.1 Iout – Actual current measuring value

- The right digital instrument [5] <Amp> shows the actual measured value Iout which is the value of the flowing output current.
- When the output current is superposed with AC signals, the display shows the arithmetic average value.
- The 3½ digit display is updated approximatly three times per second; overflow indication if values exceed 19.99 A on 20 A devices.

☞ Regarding measuring range, measuring resolution and measuring accuracy see section 1.4.3 Electrical Data.

4.2.2 Ilim – Limit value for Iset

Function

- Upper limit value for current setting range of <Iset> [10].
- Protection against unintentional too high adjustment of the current setting value Iset.
- When inserting Ilim = 0 A (left strike), the current control <Iset> is unefficient (e.g. when setting the output current via the analog interface).

Adjustment of Ilim

- Setting the limit value for Iset is the same procedure as for setting the limit value for Uset (4.1.2)
- Only the following adjustment and indication elements are changing:
  Left trimmer [7] <Ulim> → Right trimmer <Ilim> [11]
  Left knob [8] <Uset> → Right knob <Iset> [10]
  Left display [4] <Volt> → Right display <Amp> [5]

Adjustment range

- The 270° rotation angle of <Ilim> corresponds to an adjustment range 0 A ≤ Ilim ≤ Inom.
- The 10 possible turns at the <Iset> knob [10] always correspond to the range 0 A to Ilim.

4.2.3 Iset – Current setting value

Function

- Setting value of the output current (limiting).

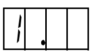
Adjustment of Iset

- Setting the setting value for Iset is the same procedure as for setting the setting value for Uset (4.1.3)
- Only the following adjustment and indication elements are changing:
  Left knob [8] <Uset> → Right knob <Iset> [10]
  Left display [4] <Volt> → Right display <Amp> [5]

CAUTION!
The value for Iset can also be changed if the KONSTANTER is not activated.

Adjustment range

- The 10 possible turns at the <Iset> knob [10] always correspond to the range 0 A to Ilim.
- The lower Ilim is set, the ”finer“ can low values be adjuseted for Iset.
  The setting accuracy specified in section 1.4.3 refers to each setting value shown.
- The indication of the voltages Iout and Iset ends at 19.99 for 20 V devices.
  For exceedingly adjusted values, the AD converter produces an overflow indication:



4.3 OUTPUT – Switching on/off of the power output

- The power output is switched on/off by the red <OUTPUT> key [9].
- Pressing this key activates resp. deactivates the power output.
  OUTPUT OFF → OUTPUT ON
  OUTPUT ON → OUTPUT OFF
- During adjustment of Uset/Ulim/Iset/Ilim, you can switch the power output off to avoid damages at the connected load by unintentionally setting the values exceedingly high.
- If the power output is deactivated ”OUTPUT OFF”, the regulation mode indicators are switched off.
- If the output was deactivated by the overtemperature protection, the yellow LED “Pmax“ [3] illuminates. The output cannot be reactivated before the KONSTANTER has reached its normal operation temperature.
- Further functions which may deactivate the power output:

✗ External control signal to TRG IN at the analog interface (see Section 5.1 and 5.3)

✗ Overvoltage protection will react as soon as the voltage at the output terminals exceeds 125 % of Unom
Cause:
- Output voltage is set too high by the Uset control signal at the analog interface
- Voltage transients when switching inductive consumers
- Homopolar voltage feedback of connected consumers (for instance DC motors) or of parallel-connected voltage sources
- Remote sensing: sensor lines are reverse connected or a load line is/has been interrupted.

In this case the indication “CV“ for constant voltage operation continues to illuminate whereas the displayed measured output voltage drops to zero. The analog interface SIG1OUT signalizes „OUTPUT OFF“.

The output can be reactivated after the cause for overvoltage has been eliminated.

✗ Overtemperature protection reacts
Cause:
- Obstructed cooling, for instance by covering the air intake or outlet holes.
- Ambient temperature or load is too high; the instrument is able to give its nominal power in a permanent operation up to 40 °C (measured at the air inlet).
- The integrated fan is defective.

After having cooled down sufficiently, the output is re-activated automatically.

CAUTION!
The output terminals are not galvanically insulated by switching the output off.

5 Control via analog interface

5.1 Pin assignment

SIG1 OUT, SIG2 OUT (output)
- Digital status signal outputs referred to AGND
- SIG1 OUT signalizes the status of the power output
- SIG2 OUT signalizes the actual regulation mode
- Kind of signal 	Open Collector
- Max. OFF voltage 	30 V DC
- Max ON current 	20 mA

☞ Detailed description in section 5.2

TRG IN+, TRG IN– (input)
- Floating digital control input to switch the power output ON/OFF
- Low signal: $-26\ V \leq U_S \leq +1\ V$
- High signal: $+4\ V \leq U_S \leq +26\ V$
  $I_S = (U_S - 2\ V) / 1.5\ k\Omega$

☞ Detailed description in section 5.3

+15 V (output)
- This auxiliary voltage output (14 ... 17.5 V DC referred to AGND) can be used for either to feed the TRIGGER input or also for the supply of external components (for instance reference element to produce control voltages).
- This output is electronically current-limited to approx. 60 mA and short-circuit protected against AGND.

AGND (Analog Ground = Reference point)
- Point of reference for all analog control inputs and outputs.
- By an auto-reversible fuse (rating 110 mA) this connection is internally linked with the negative terminal of the power output.

Uset–, Uset+ (input)
- Analog (differential) voltage input referred to AGND to control the output voltage. For activated output the following issues apply:
- $Uout = USET + U_{su} \cdot k_{su}$
  Uout: output voltage at constant voltage mode
  USET: voltage setting value, manually adjusted
  U_{su}: external control voltage ($0 ... 5\ V \triangleq 0 ... Uout_{nom}$)
  k_{su}: voltage control coefficient = $Uout_{nom}$ / 5 V
  R_{su}: input resistance Uset+: 10 kΩ
  Uset–: 15 kΩ

☞ Detailed description in section 5.4

Iset+ (input)
- Analog voltage input referred to AGND to control the output current. For activated output the following issues apply:
- $Iout = ISET + U_{si} \cdot k_{si}$
  Iout: output current at constant voltage operation
  ISET: current setting value, manually adjusted with <Iset> knob
  U_{si}: external control voltage ($0 ... 5\ V \triangleq 0 ... Iout_{nom}$)
  k_{si}: current control coefficient = $Iout_{nom}$ / 5 V
  R_{si}: input resistance: 10 kΩ

☞ Detailed description in section 5.5

U-MON (output)
- Analog voltage output, proportional to the output voltage Uout measured by the sensor lines ($0 ... 10\ V \triangleq 0 ... Uout_{nom}$).
- The output referred to AGND has an output resistance of 9.8 kΩ and is protected against short-circuiting.

☞ Detailed description in section 5.6

I-MON (output)
- Analog voltage output, proportional to the flowing output current Iout ($0 ... 10\ V \triangleq 0 ... Iout_{nom}$).
- The output referred to AGND has an output resistance of 9.4 kΩ and is protected against short-circuiting.

☞ Detailed description in section 5.7.

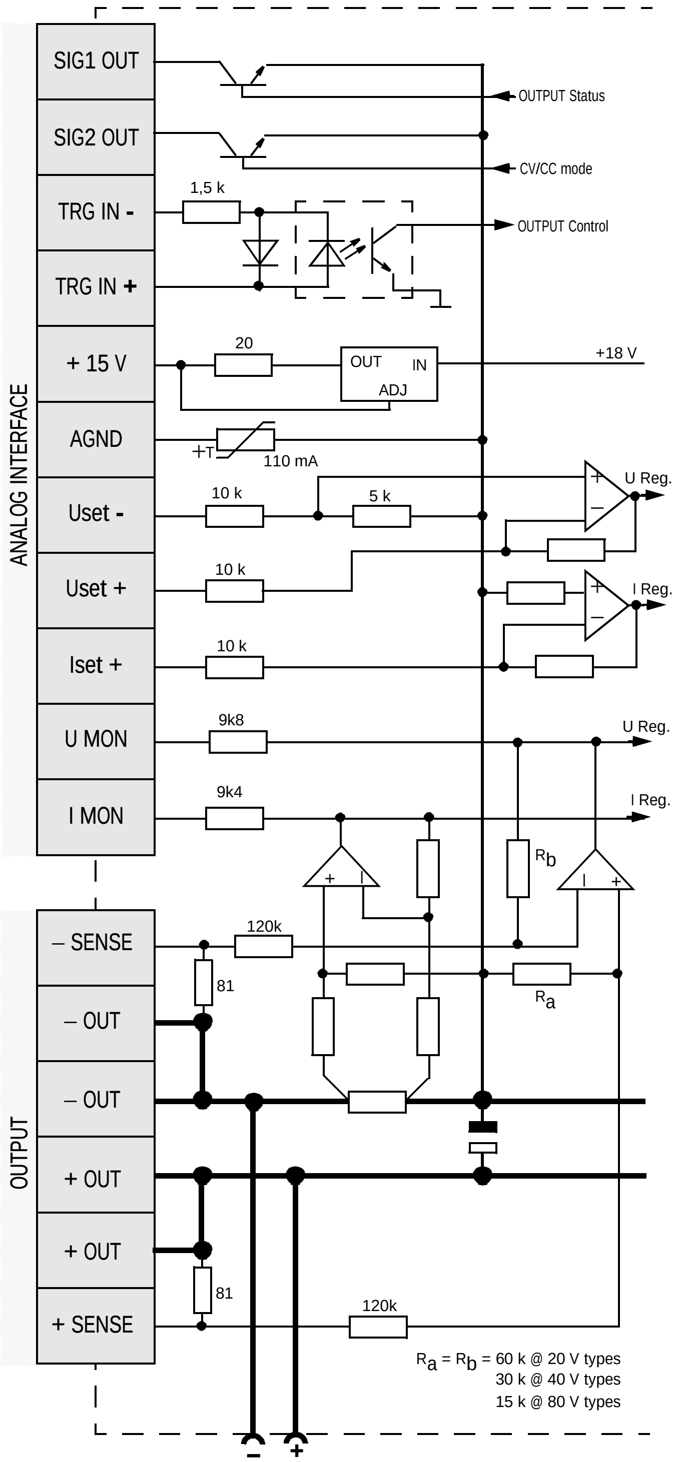


Figure 5.1 Internal circuitry of analog interface and output (simplified schematic)

5.2 Status signal outputs

Function

- The KONSTANTER is equipped with two digital open collector outputs which are referred to AGND and are designed for the status signalization.
- SIG1 OUT – signalizes activation status of the power output:
  OUTPUT ON = passive high (=OFF)
  OUTPUT OFF = active low (=ON)
  - Coupling this output with the TRIGGER input of another KONSTANTER offers the possibility to simultaneously activate resp. deactivate both KONSTANTER outputs (see section 5.8.2 and 5.9.2).
  - Being a report signal to surveillance equipment.
  - Controlling an external output relay.
    Since the output voltage drops very rapidly (< 1 ms) if OUTPUT ON → OFF , the relay can switch off-load with passive consumers.
- SIG2 OUT – signalizes the actual regulation mode of the power output
  - Const. current (CC) or overload (Pmax) = active low (=ON)
  - Const. voltage (CV) or OUTPUT OFF = passive high (=OFF)
  - Being a report signal to surveillance equipment.

Connection

- Operating values
  Max. OFF voltage 30 V DC
  Max. ON current 20 mA
  Low level < 1 V at $I_S \leq 20$ mA
- To produce an "active high" signal of +15 V, the status signal outputs can be linked to the +15 V terminal via the pull-up-resistor R_{PU} (minimum 1 kΩ).

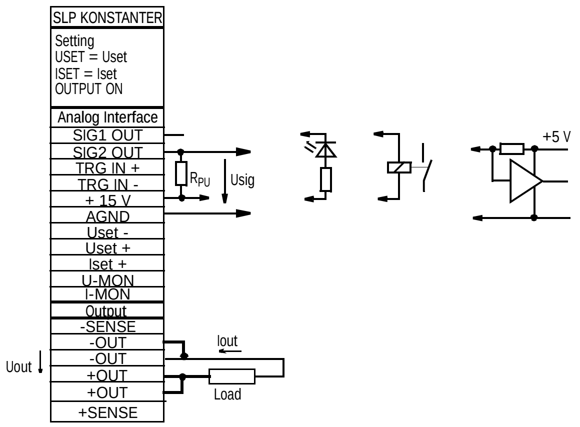


Figure 5.2 Example for connecting the status signal outputs

5.3 TRIGGER input

Function

- The floating optocoupler input TRG IN permits the remote control of the OUTPUT function by a binary control signal.
- The TRIGGER input cannot be efficient unless OUTPUT key has been pressed down (ON).
- Coupling this input with the signal output SIG1OUT of another KONSTANTER offers the possibility to simultaneously activate resp. deactivate both KONSTANTER outputs (see section 5.8.2 and 5.9.2)
- In automatic test systems, the OUTPUT status can be controlled by application-specific signals at the TRIGGER input.

Connection

- Connect the control signal between TRG IN + and TRG IN –.
  For signal levels see table.

Signal	U_S	I_S	Output
High	4 ... 26 V DC	(U_S – 2 V) / 1.5 kΩ	OFF
Low	0 ... 1 V DC	0 mA	ON

- The + 15 V output of the analog interface can be used to feed the TRIGGER input (see figure 5.3 a).

WARNING!
The TRIGGER input TRG IN is floating and functionally isolated against the output circuit.
This functional isolation is no "safe electric separation" according to the electrical safety regulations.

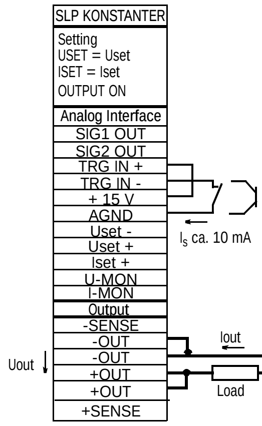


Figure 5.3 a Control of the TRIGGER input by a switching element

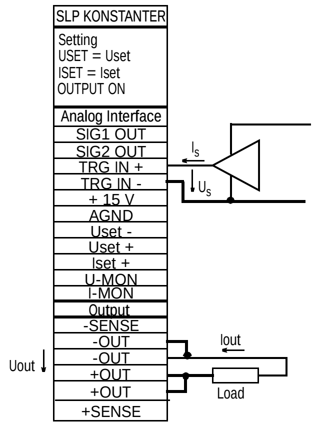


Figure 5.3 b Control of the TRIGGER input by an external signal

5.4 Remote control of the output voltage

Function

- You can set the output voltage Uout by an external control voltage U_{su} via the control inputs Uset+ (non-inverting) and Uset– (inverting).
- The following formula is applicable for constant voltage operation:
  $Uout = USET + U_{su} \cdot k_{su}$
  USET: manually adjusted voltage setting value
  k_{su}: voltage control coefficient = $Uout_{nom}/5$ V
  Max. setting error: ± 0.05 % of U_{nom} ± 2 % of the setting value
- The voltage control input is constructed as differential voltage input:
  Uset+: Non-inverting input:
  U_{su} = 0 ... +5 V for Uout = 0 V ... $Uout_{nom}$;
  input resistance 10 kΩ
  Uset–: Inverting input:
  U_{su} = 0 ... –5 V for Uout = 0 V ... $Uout_{nom}$;
  input resistance 15 kΩ

Notes

- The control inputs are not isolated; their point of reference AGND is linked with the negative terminal of the power output.
- Connecting earthed circuits to the control input can lead to setting errors by leakage currents or current loops.
- If the control voltage U_{su} is referred to the output negative terminal at load side, the inverting input will have to be linked with this point (link b in figure 5.4 a).
  This reduces the influence produced by the voltage drop on the negative load line.
- If the control voltage is isolated against the output, please connect Uset– with AGND (link a in figure 5.4 a).
- If the output voltage is controlled by a remote potentiometer, please apply the wiring according to figure 5.4 b.
- U_{su} can also be applied as an alternating voltage, for instance to superpose interference signals upon the set continuous voltage USET.
  The limit frequency of the modulated output voltage depends on the voltage amplitude.
  A special regulator principle enables the limit frequency to be largely independent from the load altitude and the set current limitation.

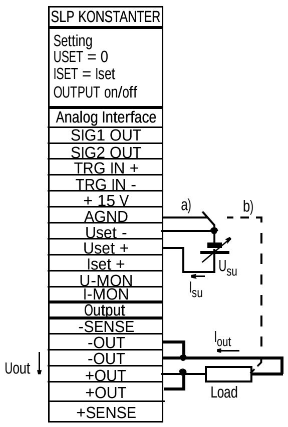


Figure 5.4 a Wiring for control of the output voltage by external voltage

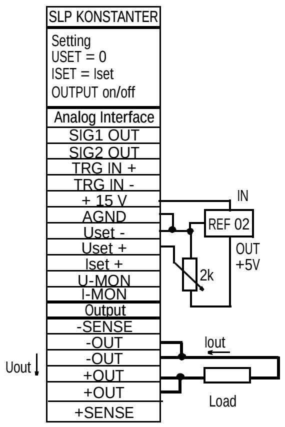


Figure 5.4 b Wiring for control of the output voltage by external potentiometer

5.5 Remote control of the output current

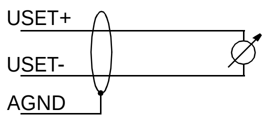
Function

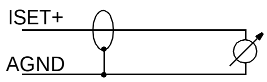
- You can set the output current Iout by an external control current I_{si} via the control inputs Iset+ and Iset–.
- The following formula is applicable for constant current operation:
  $Iout = ISET + U_{si} \cdot k_{si}$
  ISET: manually adjusted current setting value
  k_{si}: current control coefficient = $Iout_{nom}$ / 5 V
  Max. setting error: ±0.1 % of I_{nom} + 2 % of the setting value
- Current control input
  Iset+: Non-inverting input:
  U_{si} = 0 ... +5 V for Iout = 0 A ... $Iout_{nom}$;
- The input resistance is 10 kΩ.

Notes

- The control input is not isolated; its point of reference AGND is linked with the negative terminal of the power output.
- Connecting earthed circuits to the control input can lead to setting errors by leakage currents or current loops.
- The control voltage U_{si} must not be linked at load side with the output negative terminal (figure 5.5 a).
- If the output current is controlled by a potentiometer, please apply the wiring according to figure 5.5 b.
- U_{si} can also be applied as an alternating voltage, for instance to superpose interference signals upon the set continuous current ISET.
  The limit frequency of the modulated output current depends on the voltage amplitude due to the load resistance.

CAUTION!
The control inputs Uset+, Uset– and Iset+ should always be wired with a shielded cable.
Connect this shield to the point of reference AGND.





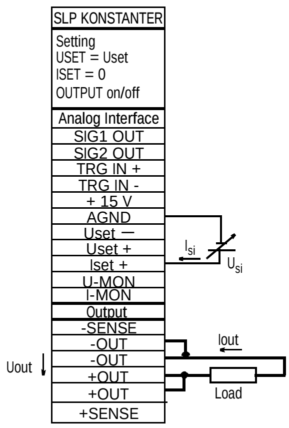


Figure 5.5 a Wiring for control of the output current by external voltage

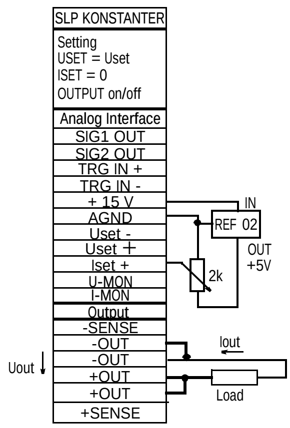


Figure 5.5 b Wiring for control of the output current by external potentiometer

5.6 Voltage monitor output

Function

- Referring to AGND, the U-MON terminal delivers a voltage U_{MU} proportional to the output voltage Uout.
- U-MON is the slave control voltage for the master-slave series operation (see 5.9.2).
- U-MON may also be used for measuring, surveillance or recording purposes.
- The following formula applies
  $U_{MU} = Uout \cdot k_{MU} \cdot k_{load} = 0 \ldots 10\ V$
  $k_{MU} = 10\ V / Uout_{nom}$; U monitor coefficient
  $R_{i\ (U\ monitor)} = 9.8\ k\Omega$; U monitor output resistance

  Load coefficient

$$k_{load} = \frac{R_{load}}{R_{load} + 9.8\ k\Omega}$$

  R_{load} = Load resistance
  Max. error of U_{MU}: ± 5 mV ± 2 % of reading (for R_{load} > 10 MΩ)

Notes

- U-MON is not isolated; its point of reference AGND is linked with the negative terminal of the power output.
- Connecting the earthed circuits to the monitor outputs can lead to reading errors due to leakage currents or current loops.
- With remote sensing the voltage monitor output refers to the output voltage measured by the sensor lines (see. 2.3).
- The monitor output is protected against short-circuit.
  – The output resistance is 9.8 kΩ.

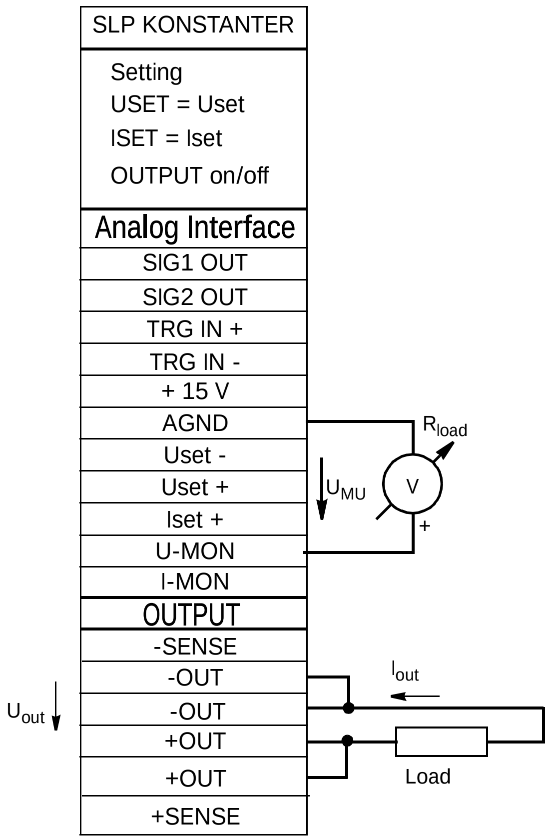


Figure 5.6 Wiring voltage monitor

5.7 Current monitor output

Function

- Referring to AGND, the I-MON terminal delivers a voltage U_{MI} proportional to the output current Iout.
- I-MON is the slave control voltage for the master-slave parallel operation (see 5.8.2).
- I-MON may also be used for measuring, surveillance or recording purposes.
- The following formula applies
  $U_{MI} = Iout \cdot k_{MI} \cdot k_{load} = 0 \ldots 10\ V$
  $k_{MI} = 10\ V / Iout_{nom}$; I monitor coefficient
  $R_{i\ (I\ monitor)} = 9.4\ k\Omega$; I monitor output resistance

  Load coefficient

$$k_{load} = \frac{R_{load}}{R_{load} + 9.4\ k\Omega}$$

  R_{load} = Load resistance
  Max. error of U_{MI}: ± 5 mV ± 2 % of reading (for R_{load} > 10 MΩ)

Notes

- I-MON is not isolated; its point of reference AGND is linked with the negative terminal of the power output.
- Connecting the earthed circuits to the monitor outputs can lead to reading errors due to leakage currents or current loops.
- The monitor output is protected against short-circuit.
  – The ouput resistance is 9.4 kΩ.

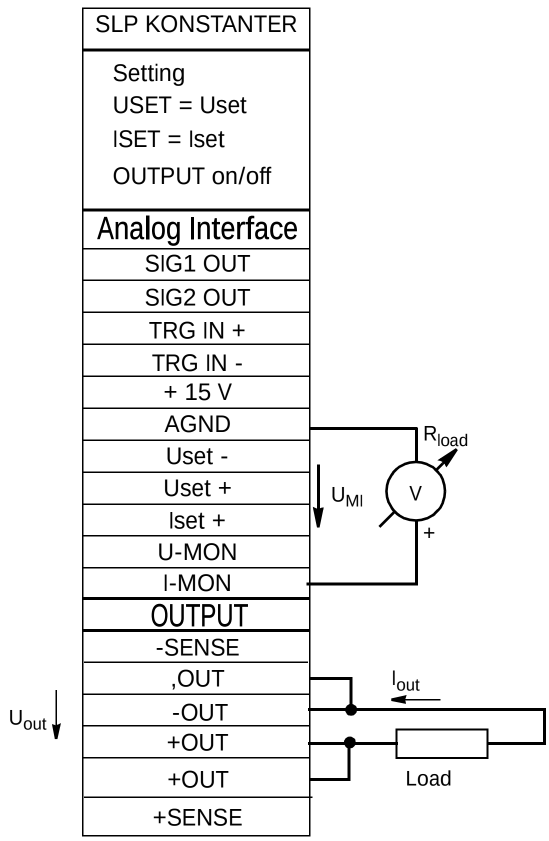


Figure 5.7 Wiring current monitor

5.8 Parallel operation

If the output current of a single KONSTANTER is not sufficient for your application requirements, you may connect as many KONSTANTERs parallel as required.

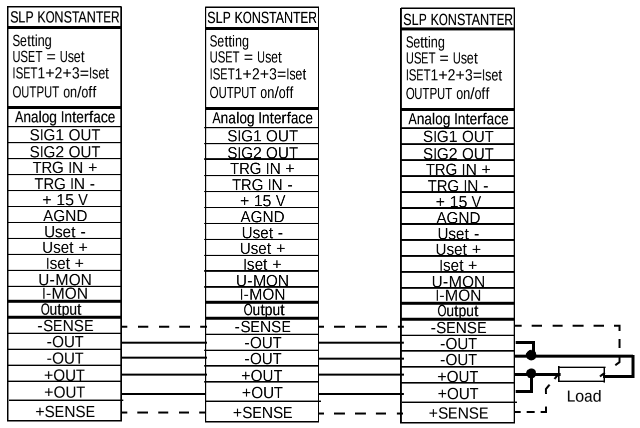
CAUTION
When switching parallelly any outputs with different nominal voltages, all outputs must be limited to the lowest nominal voltage value involved. This adjustment is made by Ulim.

5.8.1 Direct parallel operation

Function

- This is the easiest possibility to supply a higher current for the load than one single KONSTANTER can deliver.
- You may use KONSTANTERs with different output ratings. However, all voltage setting values must be adjusted resp. limited to the same value.
- Not suitable for the constant voltage operation.

Wiring



– – – – = only for remote sensing

Figure 5.8.1 a Wiring for parallel operation

Adjustment

- Deactivate each output.
- Set the voltage setting values Uset of all KONSTANTERs involved in this parallel operation at approximately the same value.
  Uset = USET1 = USET2 = USET3 = USETn
- Set the current setting values Iset in a way that all KONSTANTERs involved in this parallel operation have approximately the same value.
  IsetI = ISET1 + ISET2 + ISET3 + ... + ISETn
- Activate the outputs.

Operating principle

- Having been switched on, the KONSTANTER with the highest voltage setting supplies at first the load current.
- The more the load resistance is continuously decreased, the more the load current is steadily increased.
- As soon as the load current reaches the set value Iset for the presently loaded output, the current regulation is activated for this output.
- Reducing the load resistance further decreases the output voltage down to the point where the voltage value coincide with the next output which is set lower.
- Starting from this point, the KONSTANTER supplies a part of the load current.
- This procedure continues as long as the output with the lowest voltage setting will be reached.
- Then, this output keeps the voltage at the load constant. Should even this output lead into current regulation, the load current will be the sum current of all parallel devices and remains constant until short-circuit.

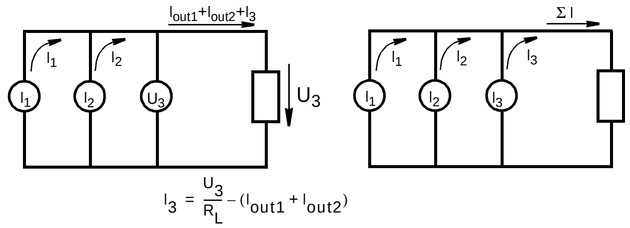


Figure 5.8.1 b Operating principle of direct parallel operation in ideal operating range for voltage regulation at the load

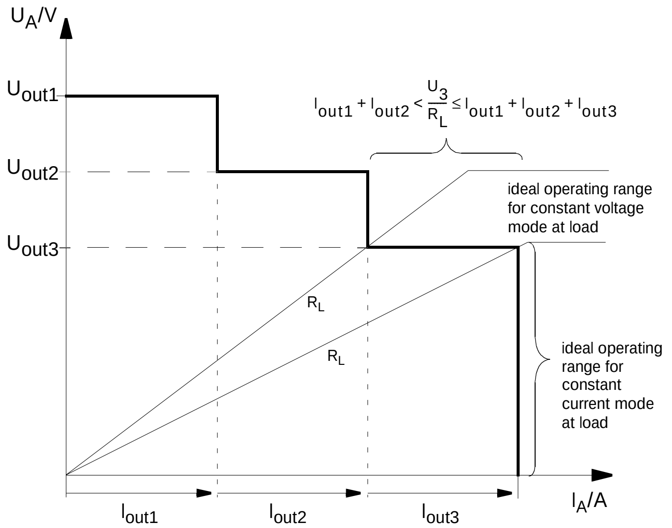


Figure 5.8.1 c U/I diagram at direct parallel operation

Notes

- Each output has a slightly different voltage due to the corresponding setting tolerances.
  In case of larger voltage differences, an electronic sink will be activated for outputs with lower voltage settings.
  This sink tries to reach – possibly pulsating – the lower voltage value which does neither damage the KONSTANTER nor the load.
  However, if problems with the load current measuring might arise, please couple the instruments in master-slave parallel operation (see section 5.8.2).
- Coupling the SIG1 outputs to the TRG inputs enables you to switch the outputs altogether on/off (see section 5.8.2)

5.8.2 Master-slave parallel operation

Function

The master-slave parallel operation offers essential advantages compared with the direct parallel operation:

- Suitable as well for constant voltage as also for constant current regulation.
- The output parameters (total output voltage, current limitation, output on/off) are completely adjusted by the leading instrument (master).
- All KONSTANTERs involved are loaded equally.

Wiring

- Define one of the KONSTANTER as master instrument.
- Couple master and slave instrument(s) as shown in figure 5.8.2.
- Connect the load lines (see section 2.2).
- To reach a good current symmetry keep the load lines as short and as strong as possible. Then please balance with R_{sym}.

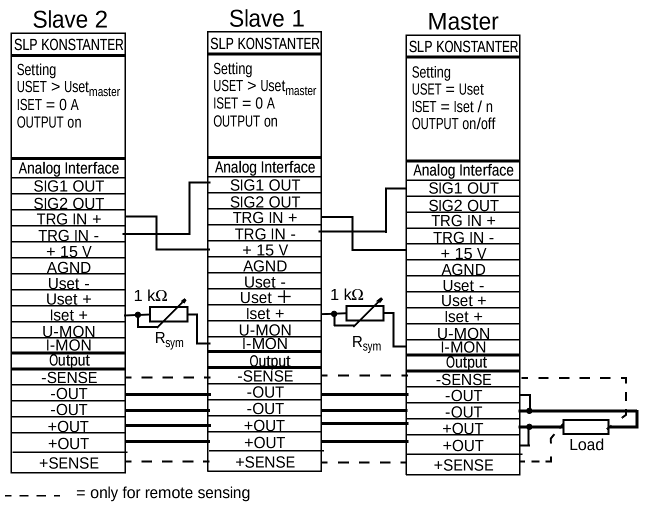


Figure 5.8.2 Wiring for master-slave parallel operation

Adjustment

Switching on for the very first-time:

- Short-circuit load
- Switch on master instrument (line) and set:
  OUTPUT off
  USET= Uset; required output voltage
  ISET= Iset/n; Iset: required sum output current;
  n: number of KONSTANTERs
  only applicable if all n instruments have the same nominal ratings; see Notes
- Switch on Slave 1 (line) and set:
  OUTPUT on despite pressed OUTPUT key, the output at first remains inactive since it is still disabled by the master instrument via its TRG input
  USET > $USET_{master}$ The voltage setting value of the slave instruments must be set at least 2 % higher than that of the master instrument, e.g. on maximum
  ISET = 0 A You can deactivate Iset knob by adjusting Ilim = 0 A
- Same procedure for all further slave instruments.
- Pressing OUTPUT ON on the master instrument automatically switches on and controls all slave outputs.
- Check the flowing output current on the displays of the KONSTANTER.
- By adjusting R_{sym} you can balance the output current of each slave instrument accurately to the output current of the master device. The change can immediately been seen at each corresponding display.
- Eliminate load short-circuit.
- From now on adjustment and regulation of the (total) output parameters effect completely by the master instrument.

Switching on repeatedly:

- Any order of sequence may be selected for off-switching the line and restart later on.

Operating principle

- The leading instrument (master) controls, with its current monitor signal, the output current of the next device (slave 1) via the devices' current control input.
- Slave 1 uses the same procedure as its master device for the following Slave 2, etc.
  The sum output current thus is always proportional to the master's output current.
  The leading instrument controls the OUTPUT on/off status of the slave devices by coupling the MASTER SIG1 output with the Slave TRG input.

Notes

Instruments with different output ratings

- Use the instrument with the lowest nominal voltage as master device.
- The voltage setting range of the other instruments must be limited to this lowest nominal value by Ulim.
- $Iout_{Slave}$ corresponds only percentially to $Iout_{master}$ referred to I_{nom}

Example:

Master:	SLP 120-20	U_{nom}:	20 V	I_{nom}:	10 A	
	Setting:	USET:	12 V	ISET:	3 A	(30 %)
Slave 1:	SLP 120-20	U_{nom}:	20 V	I_{nom}:	10 A	
	result:	Uout:	12 V	Iout:	3 A	(30 %)
Slave 2:	SLP 120-40	U_{nom}:	40 V	I_{nom}:	6 A	
	result:	Uout:	12 V	Iout:	2 A	(30 %)

General

- You can insert a wire link instead of R_{sym} if you require no exact current symmetry. By doing so, each Slave device generally supplies a little more current than the master instrument.
- If the connections of the analog interface and the sensor lines are longer than 1 m, please use shielded cables.
  Link the shield with earth/case or AGND.
- The measuring function of the master instrument senses the commonly produced output voltage of all instruments involved but only its own output current.
  In order to get the total output current, add the current measuring values of all instruments involved.

5.9 Series operation

If the output voltage of a single device is not sufficient for your application requirements or if you wish to produce a ± voltage, you may switch several instruments in series.

WARNING!
The maximum admissible total output voltage of the series connection is 120 V (resp. 240 V with earthed centre).

5.9.1 Direct series operation

CAUTION!
When connecting any outputs with different ratings in series, the highest current adjusted will flow through all outputs in case of a short-circuit. The internal reverse voltage protection diode, however, is only dimensioned for its own nominal current (see reverse voltage protection data section Electrical data). Therefore all current setting values must be limited to the lowest nominal current value involved. This adjustment is made by Ilim. If there are outputs with a lower nominal value, you may also connect a diode reverse- biased (D_e figure 5.9.1a) between the output terminals. This diode must be able to lead the current with the strongest output.

Function

- This is the easiest possibility to supply a higher voltage for the load than one device can deliver.
- Low time waste for the wiring.
- Not suitable for constant current operation.

Wiring

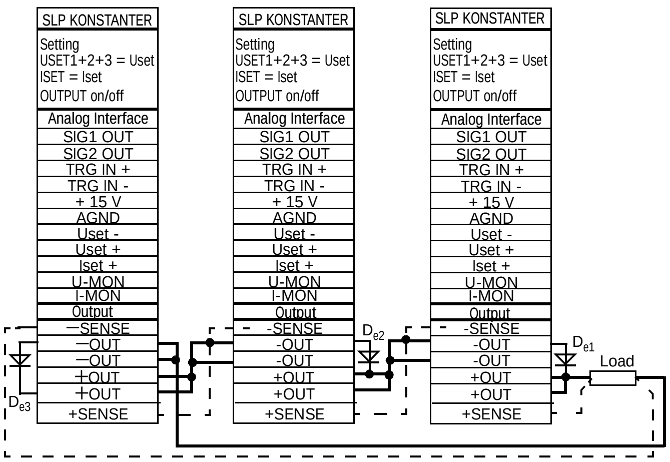


Figure 5.9.1 a Wiring for the direct series operation

Adjustment

- Deactivate each output.
- Set the current setting values ISET of all devices involved at approximately the same value:
  Iset = ISET1 = ISET2 = ISET3 = ISETn
- Set the voltage setting values USET of all devices involved in parallel switching at approximately the same value:
  Uset = USET1 + USET2 + USET3 + ... + USETn
- Activate the outputs.

Operating principle

- The sum of all output voltages is offered to the consumer.
- If the connected load resistance is steadily reduced, all outputs deliver at first the same load current.
- As soon as the load current reaches the lowest set current value, the corresponding output begins to regulate the current.
- With further reduced load resistance this output keeps the load current as long constantly as its output voltage has dropped to 0 V.
- Further reducing the load resistance forces this output to take a negative voltage by the other outputs.
- Its internal reverse voltage protection diode will start to lead at approx. –0.5 V.
- Now the load current can rise again until the output with the next higher current setting switches to current regulation.
- This procedure will continue as long as the load current finally forces the output with the highest current setting into the current regulation.
- From this last output the current will be kept constantly until short-circuit.

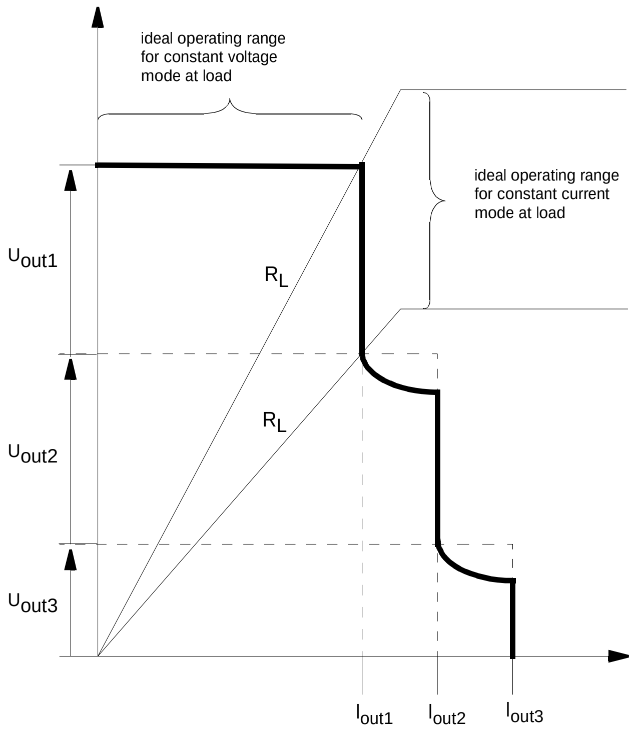


Figure 5.9.1 b U/I diagram at direct series operation

Note

- Coupling the SIG1 outputs to the TRG inputs enables you to switch the outputs altogether on/off (see section 5.9.2)

5.9.2 Master slave series operation

Function

The master-slave series operation offers essential advantages compared with the direct series operation:

- Suitable as well for constant voltage as also for constant current regulation.
- The output parameters (total output voltage, current limitation, output on/off) are completely adjusted at the leading instrument (master).
- All KONSTANTERs involved are loaded equally.

Wiring

- Define one of the devices as master instrument.
- Couple master and slave instrument(s) as shown in figure 5.9.2.
- Connect the load lines at the outer points of the series connection.
- Symmetrize each one of the output voltages with R_{sym}.

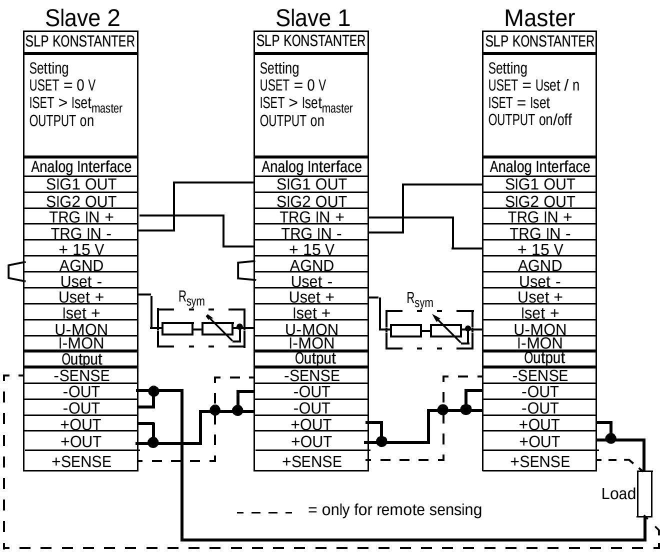


Figure 5.9.2 Wiring for the master-slave series operation

- You can simplify and optimate the symmetrization by a combination of trimmer potentiometer and fixed resistor (metal film, $T_k \leq 50$ ppm/K) for R_{sym} .

Slave nominal voltage	R_{sym} nominal value	R_{sym} combination
20 V	40 kΩ / 0.2 W	36 kΩ +10 kΩ – trimpot
32 V	64 kΩ / 0.2 W	60 kΩ +10 kΩ – trimpot
40 V	80 kΩ / 0.2 W	75 kΩ + 10 kΩ – trimpot
80 V	160 kΩ / 0.2 W	150 kΩ + 20 kΩ – trimpot

Adjustment

Switching on for the very first-time:

- Do not load output (idling)
- Switch on master instrument (line) and set:
  OUTPUT off
  USET = Uset/n — Uset: required total output voltage; n: number of KONSTANTERs; only applicable if all n instruments have the the same nominal ratings; see Notes
  ISET = Iset — required output current
- Switch on slave 1 instrument (line) and set:
  OUTPUT on — despite pressed OUTPUT key, the output at first remains inactive since it is still disabled by the master instrument via its TRG input
  USET = 0 V — You can deactivate Uset knob by adjusting ULIM = 0 V
  ISET > $ISET_{master}$ — The current setting value of the slave instruments must be set at least 2 % higher than that of the master instrument, for instance on maximum.
- Same procedure for all further slave instruments.
- Pressing OUTPUT ON on the master instrument automatically switches on and controls all slave outputs.
- Check the output voltages on the displays of the KONSTANTERs.
- Adjusting R_{sym} you can balance the output voltage of each slave accurately to the output voltage of the master device. The change can immediately been seen at each corresponding display.
- Connect load.
- From now on adjustment and regulation of the (total) output parameters effect completely by the master instrument.

Switching on repeatedly

- Any order of sequence may be selected for off-switching the line and restart later on.

Operating principle

- The leading instrument (master) controls, with its voltage monitor signal, the output voltage of the next device (slave 1) via the devices voltage control input.
- Slave 1 uses the same procedure as its master device for the following Slave 2, etc.
  The sum output voltage thus is always proportional to the master's output voltage.
  The leading instrument controls the OUTPUT on/off status of the slave devices by coupling the MASTER SIG1 output with the Slave TRG input.

Notes

KONSTANTER with different output ratings

- Use the KONSTANTER with the lowest nominal current as master device.
- The current setting range of the other KONSTANTERs must be limited to this lowest nominal value by ILIM.
- $Uout_{Slave}$ corresponds only percentially to $Uout_{Master}$ referred to U_{nom}

Example:

Master:	SLP 120-40	U_{nom}:	40 V		I_{nom}:	6 A
	Setting:	USET:	12 V	(30%)	ISET:	3 A
Slave 1:	SLP 120-20	U_{nom}:	20 V		I_{nom}:	10 A
	result:	Uout:	6 V	(30%)	Iout:	3 A
Slave 2:	SLP 120-20	U_{nom}:	20 V		I_{nom}:	10 A
	result:	Uout:	6 V	(30%)	Iout:	3 A

General

- If the connections of the analog interface and the sensor lines are longer than 1 m, please use shielded cables.
  Link the shield with earth/case or AGND.
- The same current is flowing through all KONSTANTER.
  Therefore the current measuring value of the master instrument suffices for the measuring of the load current.
  In order to get the sum output voltage, add the voltage measuring values of all KONSTANTERs involved.

5.10 Variation of the output resistance

Function

- The output resistance of the output is nearly 0 Ω in constant voltage mode.
- For some applications, for instance the simulation of long load lines or weak car batteries, you may increase the output resistance of the output.
  The set (no load) output voltage is then decreasing proportionnally to the increasing load current (figure 5.10 a).

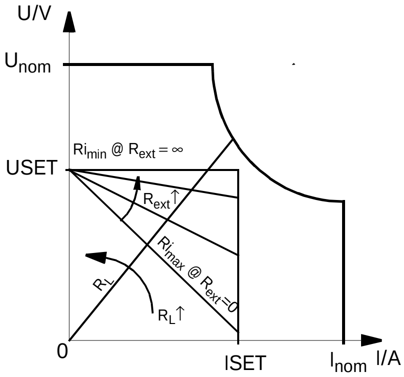


Figure 5.10 a Dependence of the output voltage on the load

Standardization

- The standard-scaled curve, figure 5.10 b, is applicable for all types of this series.
- From this diagram you can see very quickly and easily which output resistance R_i will be set by which control resistance R_{ext}.
  $R_i = R_{imax}$ · indicated value

Wiring

- Wire the analog interface according to figure 5.10 c.
- Thus, the output resistance R_i depends on the external control resistance R_{ext} as follows:

$$R_{ext} = \frac{30\,k\Omega \times U_{nom}}{R_i \times I_{nom}} - 24{,}4\,k\Omega$$

Example: U_{nom} = 40 V, I_{nom} = 6 A, R_i = 0.5 Ω
===> R_{ext} = 376 kΩ

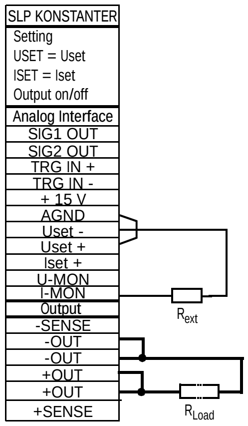


Figure 5.10 c Wiring to vary the output resistance

- Table of the R_{imax} values for each device type

Device type	120-20	120-40	120-80	
R_{imax}/Ω	2.46	8.2	32.8	
Device type	240-20	240-40	240-80	320-32
R_{imax}/Ω	1.23	4.1	16.4	2.19

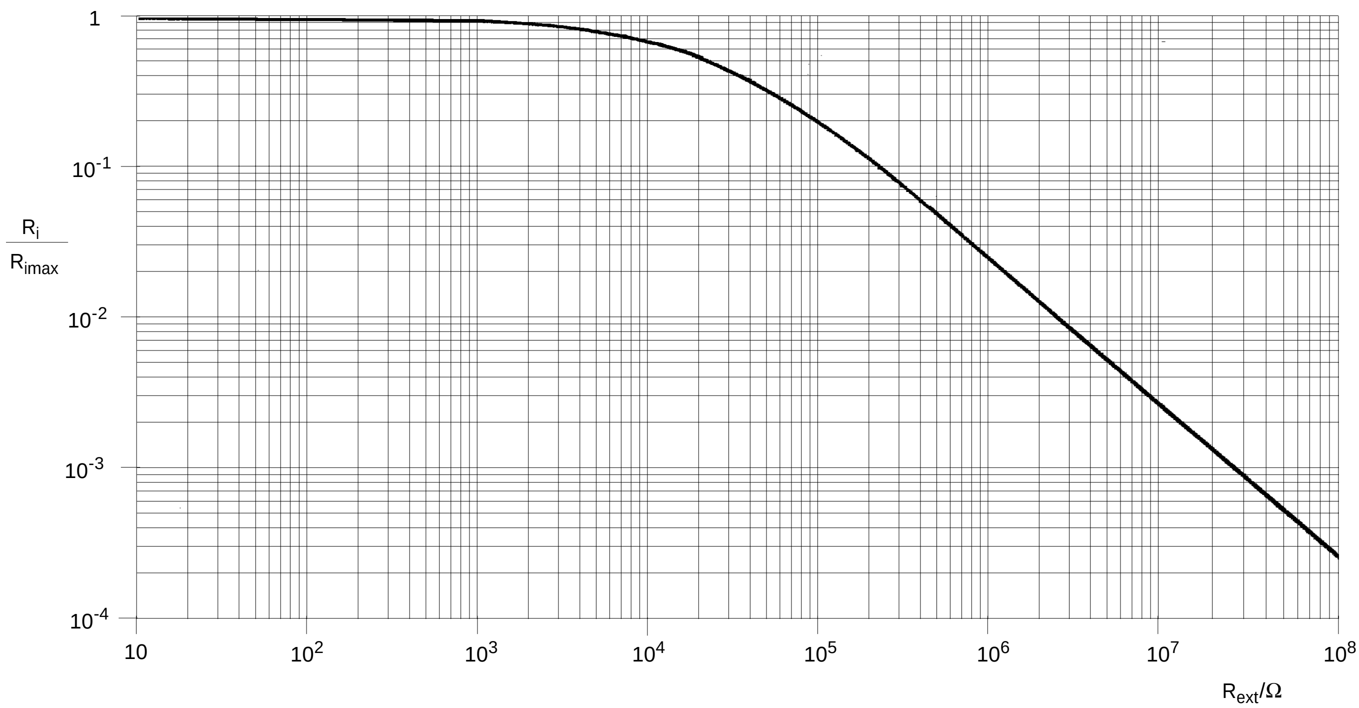


Figure 5.10 b Standarized diagram to fix the output resistance if provided control resistance

Ordering informations

Designation	Nom. data	Ordering no.
SLP KONSTANTER 32 N 20 R 10	20 V / 10 A / 120 W	K220A
SLP KONSTANTER 32 N 40 R 6	40 V / 6 A / 120 W	K221A
SLP KONSTANTER 32 N 80 R 3	80 V / 3 A / 120 W	K222A
SLP KONSTANTER 32 N 80 R 3	20 V / 20 A / 240 W	K222A
SLP KONSTANTER 32 N 40 R 12	40 V / 12 A / 240 W	K231A
SLP KONSTANTER 32 N 80 R 6	80 V / 6 A / 240 W	K232A
SLP KONSTANTER 32 N 32 R 18	80 V / 6 A / 240 W	K234A
SLP KONSTANTER 32 N 32 R 18	80 V / 6 A / 320 W	K234A

Accessories

Designation	Ordering no.
19“ adapter 1x32N required to mount a single unit of the SSP 32 N / SLP 32 N series into a 19“ rack	K990A
19“ adapter 2x32N required to mount two units of the SSP 32 N / SLP 32 N series into a 19“ rack	K990B
Jumper power cable, 0.4 m The cable is fitted with one 10 A appliance plug and one 10 A appliance coupling each. This cable might be used as a “jumper“ of the power supply between various devices if the latter are connected mechanically to a multi-channel-unit. Thus, the combined unit requires only one power cable.	K991A

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