uv-technik

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Solid State AC-Power supply for uv-lamps

up to 5000 watts

ALP 51-U

UL/CSA certified

solid state power supply ALP 51-U

Contents

1 General

1.1 UL-Certification

This unit is certified in accordance with UL 60950 / CSA C22,2 No. 60950, Information Technology Equipment, 3rd edition, Dec. 2000

Certifying No.: E222015, 01NK 43395A

1.2 How does it work

The ALP 51-U is a full electronic, controllable AC power supply for uv-lamps from about 1000 to 5000 watts nominal power and designed for applications in accordance to UL 60950. It is tuned especially to operate with mercury discharge uv-lamps. The lamps are driven with square-wave current, through this the obscuring period during the zero-axis crossing of current, occurring at sinus-shaped supply (standard power supply), is dropped.

Principle of function is a controllable constant current source. The lamp current may be in a large range between 1.5 and 15A. In practice an integrated interface unit controls **lamp power** to a constant value, depending to an extern DC 0...10V signal. Within a range of about 100 to 450V of nominal lamp voltages a power range of about 500 to 5000W is possible, but depending from the lamp data. Usually a power range for a specific lamp from 10 to 100% power is possible, but also depending from lamp type, operation voltage and lamp cooling. The maximum power, driven with DC 10V could be adjusted to lower values.

So all lamps with electrical data's in the mentioned area could be connected to the same power supply!

The power supply ensures a good galvanic isolation between mains and control voltage levels, and gives interface to the electric control unit, e.g. a PLC. This interface is designed for controlling lamp power constantly. It is adjusted by an analogous voltage of DC 0....10V.

With the analogous input the lamp will be switched ON/OFF and adjusted for power.

Since there switch semiconductors, there is no reliable shut off in sense of VDE or IEC, as it is necessary in case of service works! An additional mains contactor or mains switch therefore is recommended.

An analogues output (DC 0...10V) transmits the lamp voltage outwards for monitoring the lamp, and, together with one separate contact, for monitoring some special faults. To this output could be connected e.g. a voltmeter with colored scale (yellow, green, red = burn-in, good operation, fault) for optical control or the analogous input of a PLC for automatic monitoring the lamp.

The ALP is designed to be mounted in a cabinet but also without any cover into a rack or e.g. in a printing machine nearby the uv-lamp.

Air cooling of this units is be ensured by a factory side equipped fan.

1.3 Special advantages of this solid state power supply

Step less controlling of lamp power
different lamps could be connected at the same power supply
very quick lamp power pulsing possible
automatic constant lamp power
3-phase symmetrical mains connection
easy to built in and less wiring
no ignitor needed
less heavy according to a standard 5 kW power supply
UL-sign
designed in accordance with EN 60950 / UL60950 and other European and world wide standards

2 Technical Data

2.1 General

Can operate mercury and metal halide lamps without any changes to the power supply.
Lamp power remote control
Lamp voltage monitor
Up-to-date FET technology
Air cooling

Efficiency	typical 92%
Ambient temperature range:	+5 to +40° C, see Derating Curve in *2.5*, too
Storage temperature range:	-10 to +70° C
Built-in position:	right up, connectors down side
Dimensions over all:	520 x 128 x 325 [1)] mm, [1)] add ≥ 25mm for undisturbed airflow
Weight:	approx. 15 kg

2.2 Mains Input

Mains voltage and frequency: nominal:	3x 400 to 480V ±6% / 50 and 60Hz
Mains current:	3x 13A at 3x 400V, 3x 11A at 3x 480V
Mains connection:	3 phases plus Protective Earth (PE)

CAUTION: If connected to an IT-mains network (network with Neutral NOT connected to PE) please contact your supplier. According to principle function of the missing phase protection, the ALP could be switched off without a real missing phase.

Power factor	about 0,6
Fuse protection needed:	15A circuit breaker [1)]

1) z.B. von eta (http://www.e-t-a.com/at/produkte/mechanik/kap02.shtml)
Schurter (http://www.schurter.ch) oder
Willbureger (http://www.willburger.de/schalterdatenblatt.htm)

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Typical inrush current when connected to mains:	typical 240A (0,01ms), 100A (0,3ms)
Remark:	This values are important for the right choice of a mains contactor, otherwise the contacts could be destroyed in the long run (contacts melt together).
Inrush current when starting the uv-lamp:	No
EMC	EN 55011, group I, class A (industrial areas)
Cooling fan	must be supplied separately by DC 24V

2.3 Output for UV lamps

Lamp current about 1.5 to 15A continuos
(the lowest lamp current depends on the lamp and its cooling conditions, possibly a lamp switches off at approx. 3 or 4 A)

Suitable for nominal lamp voltage from	100 to 450 V
Continuous power output	up to 5000 W; good air cooling is recommended.

With a small trimming potentiometer nearby the green connector it is possible to reduce max. power to < 3kW. This allows to use the full range of DC control voltage 1...10V all over the power range of a specific uv-lamp. Reduce power = turn right.

It is possible to pulse lamp power between min. and max. values within very short times, e.g. 500 W and up to 5000W.

Pulse operation:	lamp current rise up time	≤ 2 ms
(10-100%)	lamp current fall down time	≤ 3 ms
Integrated ignition unit	Us = approx. 2x 2000V symmetric	

Power Supply is protected against short circuit on the output circuit

Power Supply is protected against ground fault on the output circuit

Power Supply is protected against open circuit (no lamp connected or cable disconnection)

Recommended maximum cable length (distance between power supply and uv-lamp):

for Hg lamps	max. 15 m
for doped lamps:	max. 10 m

(this values depends from cable capacitance and lamp igniting behavior)

Cable should be shielded, due to the EMC-Standards. Shield must be grounded only on 1 side !!

2.4 Controlling and Indications

The interface to the external custom side control is due to security recommendations of UL 60950 totally separated to the ALP internal mains and control circuits. Consequently the interface has to be supplied by custom side DC 24V / 100mA .

Mains ON delay time	After applying mains to the ALP the unit needs a delay time of ≤ 5 sec. to be clear to operate. **Notice:** while this ON delay time, the fault monitoring contact may cause short and irregular switching!
analogous input for lamp power control:	DC 0...10V, $R_i \geq 5$ kΩ (input resistance) DC 0...0.5V = OFF DC 1...10V = ON and lamp power 10...100% within limits 1.5...15A
analogous output for lamp voltage monitoring:	DC 0...10V, 3mA, (short circuit protected) DC 0...8V = AC 0...500V lamp voltage DC 8,0...8,5V = ALP ready, input OFF DC 8,0...10V = ALP ignites and/or lamp OFF
in case of a fault (fault monitoring contact closed)	DC 0…< 0,2V = mains blackout to ALP DC 0.2...1.5V = ALP overtemperature DC 2.0...4.0V = ground fault in lamp circuit DC 5.0...7.0V = missed phase on mains (t > 1 sec.)

digital output for fault monitoring contact data	potential free contact, closes when fault is monitored voltage max. DC 48 V current max. DC 0,2 A insulation voltage against PE max. AC 60 V / DC 100 V

Notice: in case of a fault do not switch off mains immediately, otherwise you get no monitoring from the ALP.

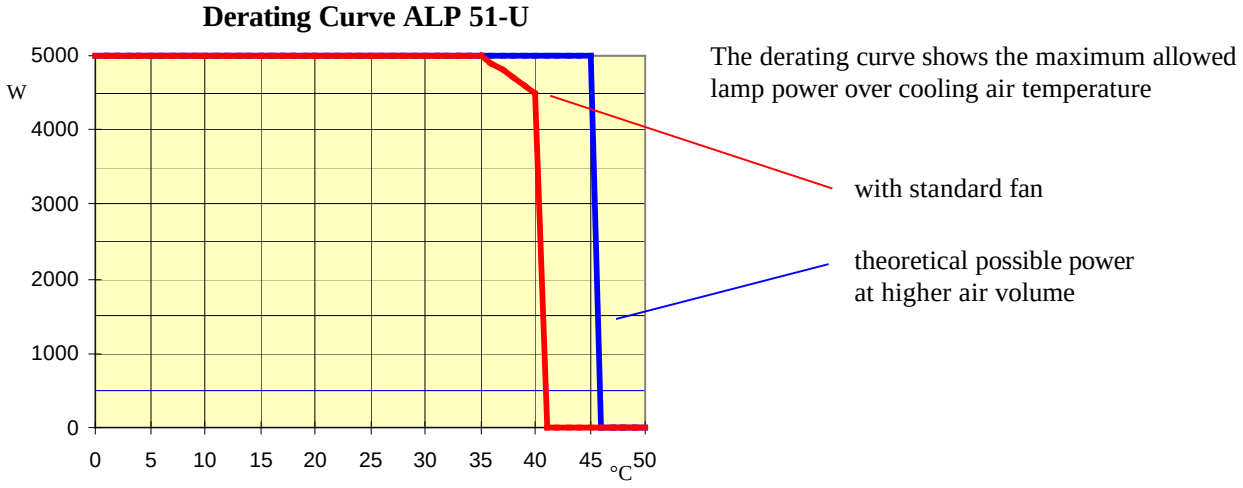
Reset: Overtemperature and Missing Phase faults will be reseted automatically if fault disappears. In case of Ground Fault mains have to be disconnected to the ALP for at least 20 seconds.

General Notice: generally external control circuits are recommended to be slowed down and provided with filtered inputs, as it is state of the art for industrial rough electrical ambience (disturbances) to avoid unexpected behavior of the EPS or the ambient control units. Eventually software filter e.g. by calculating an average value about several measurements on an analogous input are applicable.

2.5 Cooling

An efficient cooling of the ALP 51-U is important for the maximum possible output power. Cooling depends from the amount of airflow through the rips of the cooling unit and the temperature of air.

ALP 51-U is equipped with a fan mounted in the middle on the rips of the cooling unit. The fan allows to reach 4500W lamp power at max. 40°C. To reach 5000W a maximum cooling air temperature of 35°C is allowed.
At lower power than 4500W nevertheless a maximum air temperature of 40°C is recommended.

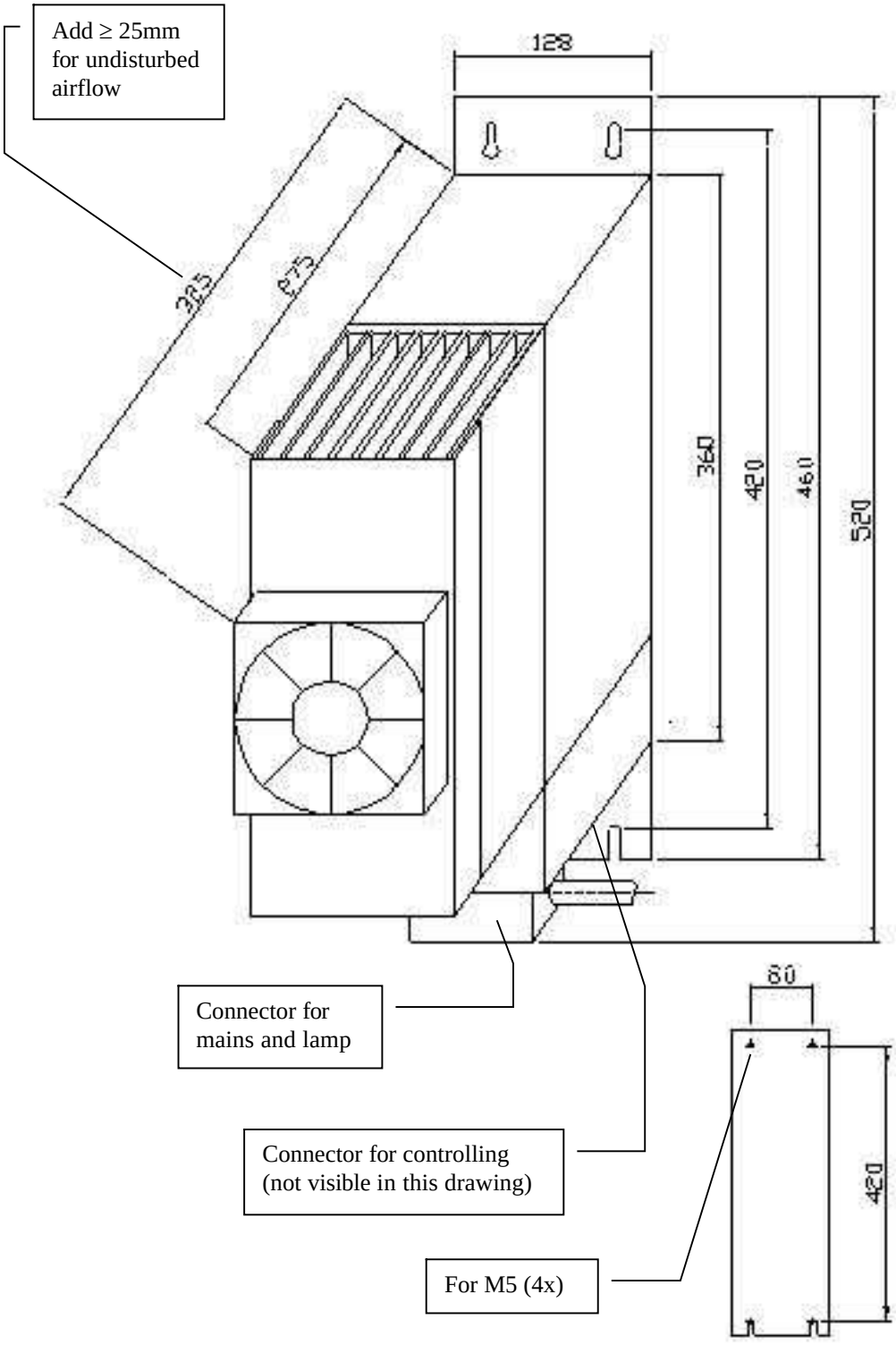


Cooling fan:	Fan is integrated as a standard, see derating curve. The fan needs custom side supply, standard is DC 24V in accordance with UL.

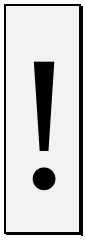
2.6 Repair of ALP 51-U

Practice has shown, that the ALP 51 series is a high reliable electronic power supply. Equipped with ground fault protection there should be nearly no extern fault, which could destroy the unit. But if it happens, it could be repaired by the manufacturer, because of its modular inner design.
A customer repair is not possible. There are no exchangeable fuses or similar easy to replace parts inside.

2.7 Dimensions ALP 51-U



3 Safety Requirements:



To minimize the risk of electric shock while e.g. make service at the uv-lamp connected to the output of the power supply, it is important to switch off mains with a main switch or mains contactor in accordance with the national standards, before working at the parts connected to the power supply.

Reason: The uv-lamp is switched off by semiconductors, which have a high but not infinite resistance. So electric shock may occur, if mains is not disconnected.

3.1 Instructions for Instrument Safety concerning Protective Earth Conductor Connection

3.1.1 General:

For noise elimination, there are installed three-phase current line filters in the electronic power supplies. For these line filters, which are necessary in these power categories, it is impossible to manage with discharge currents, which are smaller than 3.5 mA. Therefore, in accordance to the current Standards, appropriate precautionary measures have to be carried out.
We start the following contemplations from the assumption that our instruments operate in plants, which are solid connected with mains.
In accordance to EN 50176 (VDE0160) April 1998 Section 5.3.2.1 "Discharge Current via the Protective Earth Conductor" one of the following measures has to be taken:

a) Cross section of the protective earth conductor has to be at least 10 mm^2 Cu.
   NOTE: This minimum cross section was established out of consideration for its mechanical strength.
b) Monitoring of protective earth conductor by a facility, which leads to independent switching-off of the electronic equipment in case of failure.
c) Wiring of a second conductor, electrical parallel to the protective earth conductor, via separate terminals. This conductor by itself has to comply with the demands for the protective conductor.

3.1.2 Fault-Current Circuit Breaker

Above mentioned “b)” is complied with this. Additionally the following should be taken into consideration: Our electronic equipment can carry a DC leakage in case of failure. Therefore a special fault-current circuit breaker has to be used, which releases at DC fault.
Also attention has to be paid to a peculiarity of the three-phase line filter:
In normal case, when all three phases are applied to, the discharge current is typically under 30 mA. In case of missing phase or phases or in the moment of switching on, there can occur asymmetries, in consequence of which the current values can be between 180 mA (ALP 51 series) and 270 mA (ALP 90 series).
If several power supplies are installed in the machine, it is impossible to use a fault-current circuit breaker. The Standard speaks here about incompatibility of protective measures.

Therefore one of the following measures has to be applied:

3.1.3 Connection of Protective Earth Conductor with at least 10 mm^2 Cu

Our units ALP 51-U and ALP 60 have a separate M6-screw at their case for connection of protective earth conductor. Via this screw the demanded 10 mm^2 Cu-wire has to be contacted safely with the unit and has to be routed to the electric distribution.

3.1.4 Double Routing of Protective earth conductor

ALP 51-U is equipped with a plug, which is internally prepared for the double wiring of the protective earth conductor, so that there can be made a connection in accordance to the Standard.

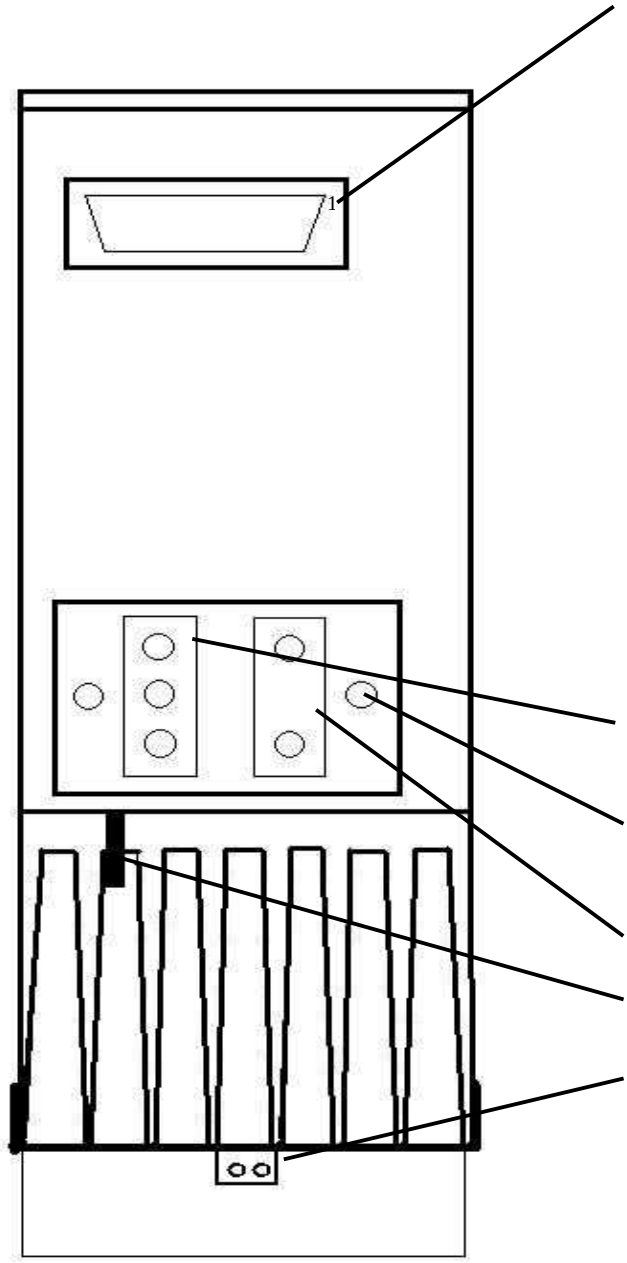
With the above mentioned notes we want to give support to the user. In the end the user himself is responsible for the compliance with the relevant Standards and their realization.

4 Trouble shooting ALP 51-U

fault	measuring/indication	reason	elimination
ALP 51-U or lamp could not be switched on auto turning off while running	fault monitoring contact not closed and DC-output voltage about ≥ 8.0 V	reignition after switch off will not run because of still too hot uv-lamp uv-lamp switched off itself, is destroyed or a too long mains short cut occurred lamp too cold and shut off when running in stand by a longer time	wait for cooling down lamp check uv-lamp check terminations and wiring to the lamp Check cooling of lamp
same	fault monitoring contact closed and DC-output voltage 5.0...7.0 V	missed phase in main (t > 1 sec.)	check mains fuses etc. check terminations and mains contactor (1 contact burned out ?) automatic RESET when all 3 phases are reconnected
same	fault monitoring contact closed and DC-output voltage 2.0...4.0 V	ground fault in lamp circuit	check terminations and wiring to the lamp RESET by switching OFF-ON mains for at least 20 sec. OFF
same	fault monitoring contact closed and DC-output voltage 0.2...1.5 V	thermal switch off, ALP too hot because of overload, bad cooling or too high ambient and/or cooling air temperature .	air stream impeded ? air filters polluted ? Measuring: at the right or left side at middle height of cooling unit near housing of ALP 51-U: ≤ 50°C recommended, 60°C max automatic RESET after cooling down ALP 51-U
same	fault monitoring contact closed and DC-output voltage ≤ 0,2V	Mains fault to ALP short circuit in lamp circuit ALP 51-U defective.	check mains voltages check terminations and wiring to the lamp check connectors replace ALP 51-U
same	fault monitoring contact not closed and DC-output voltage ≤ 0,2V	Extern DC24V supply fault short circuit in lamp circuit ALP 51-U defective.	check DC24V voltage check terminations and wiring to the lamp check connectors replace ALP 51-U
asymmetrical mains phase currents	current L1, L2, L3 is different	A difference of about 1A is normal. Asymmetrical mains voltage	Nothing to do. check mains and fuses

5 Installation

5.1 Electrical connections ALP 51-U



Control connections (15pole D-Sub):

1	n.c.
2	n.c.
3	n.c.
4	+ DC 0...10V input (power controlling)
5	fault monitoring contact
6	n.c.
7	fault monitoring contact
8	external + DC 24V/100 mA supply
9	GND
10	GND
11	n.c.
12	+ DC 0...10V output (lamp voltage)
13	n.c.
14	n.c.
15	n.c.

main- and lamp connections

1	L1
2	L2 (not depending from rotary field)
3	L3
PE	
1	UV lamp
2	UV lamp
PE	thread bolt M5

Voltage supply of cooling fan separately.

View from bottom (connector side)

More Details to the connectors see chapter 5.1.1

5.1.1 Connectors

5.1.1.1 Main and lamp connection

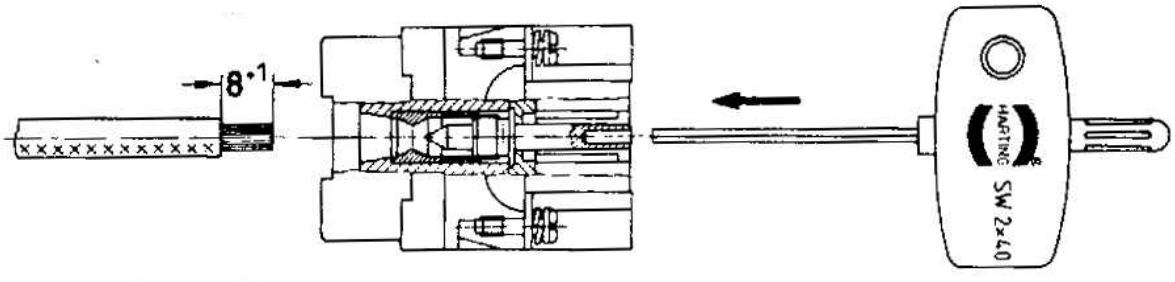
For main and lamp connections to ALP 51-U a HARTING (Espelkamp, Germany) connector is used.

3 pole + PE	mains, up to 480V female module (F), HAN C-module, contacts (female), 2,5 mm²/AWG 14 termination by crimping or soldering; length of stripped conductor 9,0mm	 HARTING no.: 09 14 003 3101 HARTING no.: 09 32 000 6205
2 pole	uv-lamp 2 pole male module Han-axial screw module-40 termination by an axial screwing terminal, see picture down on this page	 HARTING Nr.: 09 14 002 2601
Mounting frame for 2 modules, printed with „A“ ...“F“		HARTING Nr.: 09 14 006 0301
Housing (cable side) PG29		HARTING Nr.: 09 30 006 0543
connecting cycles	≥ 500	
Crimping tool	type BUCHANAN, accessories position jacket for HAN C gauge 0,5-1mm² + 2,5mm²	HARTING no.: 09 99 000 0001 HARTING no.: 09 99 000 0308 HARTING no.: 09 99 000 0007
tool for removing contacts:		
	HAN C (mains contacts)	HARTING no.: 09 99 000 0305

Axial Screwing connection for uv-lamp:

for stranded wire 2,5 ... 10 mm² (AWG 13 ... 7)
(thin stranded wire 2,5 ... 6 mm²)
Do not drill the stranded wire!

example: male contact HAN K 6/12



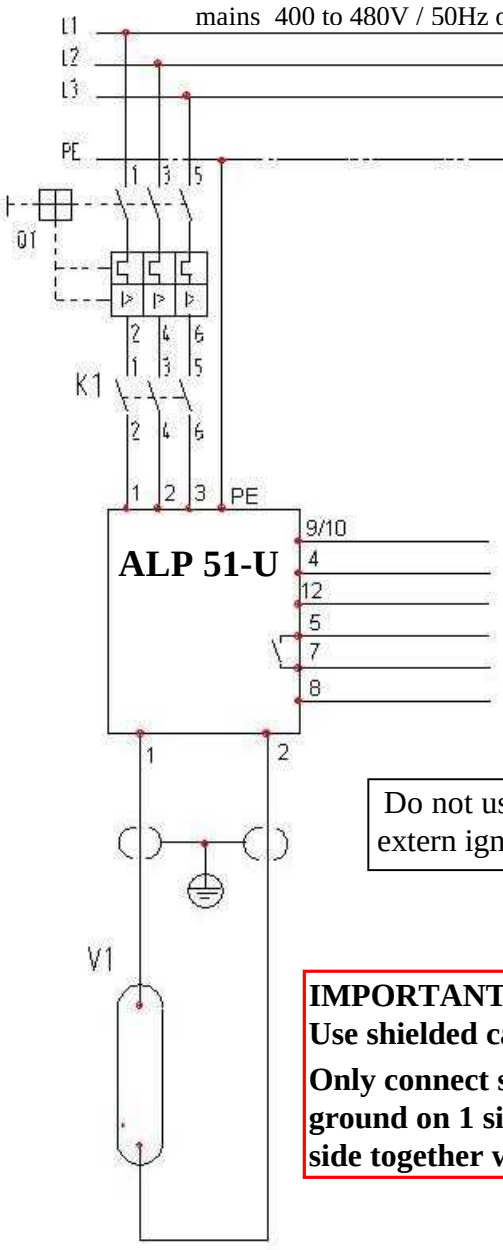
connecting:	insert uninsulated end of wire completely into the connecting box	Inbus tool
	when tightening the screw hold wire in position.	SW 2 mm torque: 1Nm max.

5.1.1.2 control connections

The control connector is on cable side without contacts, to enable the customer to use a customary 15 pole D-sub connector of his own. So he can choose a termination technique as screwing, insulation piercing, crimping or soldering etc.
The housing has 2 cable inlets of PG11 size, one is closed by a removable dummy.
Two small screws to fit the contact housing are included.

Manufacturer	PHÖNIX, Germany
Connector type	Vario Sub 15
Article No.	1688 052
Type	VS-15-T-2 PG11
Protection grade	IP 67

5.2 Electrical wiring diagram ALP 51-U



ALP51-U Anschlussplan.jpg

3x 15A circuit breaker
(more details see 2.2 *Mains Input*)

mains contactor [1)]
(When choosing the mains contactor be aware of the mains inrush current of ALP 51-U, see 2.2 *Mains Input*)

GND
+ DC 0...10V input [2)]
+ DC 0...10V output [3)]
fault monitoring contact
fault monitoring contact
external supply +DC24V/100mA

Do not use an extern ignitor !

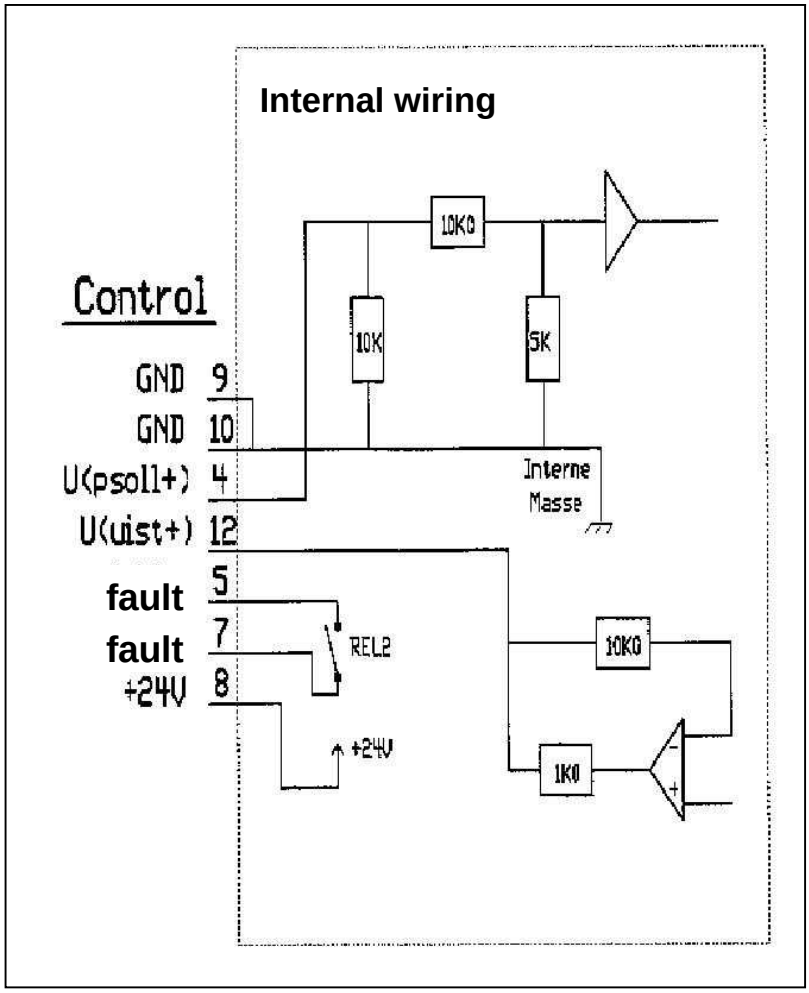
IMPORTANT :
Use shielded cable only!
Only connect shield to ground on 1 side at ALP side together with ALP !!

CAUTION
When working at the lamp terminations switch off main switch before !
Residual voltage may occur !

1) Main contactor recommended to have reliable switch OFF and no residual voltages at the output t the lamp.
Otherwise electric shock may occur while working at the uv-lamp etc. e.g. for service !
2) ON/OFF and power control
3) lamp voltage monitor and, in case of fault, fault monitor

5.3 Internal wiring of control interface

(For information only)



5.4 Installation according to EMC rules

5.4.1 Protection against voltage strikes on mains (lightning strike protection)

Practice has shown, that electrical providing installations worldwide often are not or not sufficient protected against disturbances on mains resulting of e.g. lightning strikes. This sometimes leads to flash-overs and following destruction inside the power supplies, because those strikes are more energy intensive, than Standard strikes, the units are designed to.

Problem is less with strikes between phases, but more with strikes between phases and earth (PE). These strikes overload mostly the EMC filter and the main current components in the ALP.
While further development and upgrading of the ALP, the EMC-filter are changed to reach lower currents to earth in regard to use GFI (ground fault interrupter) with lower setting currents..
Therefore impedance between PE and phases is higher. This is an advantage for using GFI, but at same time a disadvantage against strikes.
Purpose of the so called Y-capacitors inside the EMC filter, which influence the effect of protection incidentally, is not to protect against lightning strikes, but to fulfill RFI rules.

We therefore recommend, if the protection grade at customers installation is unknown or bad, to add to the ALP installation (e.g. inside the electrical cabinet) components for strike suppression.

Useful professional components may be found e.g. at PHOENIX CONTACT (www.phoenixcontact.com). Their brochure "TRABTECH" includes a lot of technical hints, as well as data for the needed components.

5.4.2 Shielding of lamp cables

Due to the rectangular current, the lamps are driven (approx. 255Hz), harmonics occur. According to EMC rules, those cables have to be shielded between ALP 51-U and lamp housing.

IMPORTANT: connection of shield to ground:

1. Shield have to be grounded to the central grounding point (PE) of the cabinet by a 4, better 6 mm² lead, as well as the ALP have to be grounded to that point. Use 6, better 10 mm² lead in this case.

2. **Shielding must be grounded only on 1 side of cable !!**
   Otherwise the Ground Fault Protection of ALP 51-U detects a fault.
   The shield MUST NOT connected on the lamp side additionally and it MUST NOT used as PE for grounding the lamp housing.

   Using connectors between ALP and lamp housing, the shield of the first part of the cable (= between ALP und connector) have to be grounded as usual to the ALP or to the central PE point in the cabinet. Do NOT connect shield on the other cable side to the connectors PE terminal.

   The second cable section (from connector to the lamp) also have to be grounded only on 1 side, primarily at the connectors side. Connectors PE should not only be grounded to the eventually surrounding metal sheets it is mounted on, but additionally connected by a 4, better 6 mm² lead to the central PE point in the cabinet!
   For grounding the lamp housing (PE) a 2,5 mm² lead from connectors PE to the lamp head is ok.

   If using terminals (e.g. ceramic terminals) at the edge of the cabinet for connection of lamp heads, it is proven to ground shield of both cables (one to ALP, one to lamp) together near the terminal with special shield connection clamps (e.g. clamping on a common copper rail). Do NOT ground the shield on the other side of both cables.
   It is important, that this copper rail AND the ALP is additional grounded by a 6, better 10 mm² lead to the central PE point of the cabinet.

3. Grounding of shield should be done by special shield connection clamps, to realize a good connection all over the surrounding surface of the shield.

4. If an Ampere meter is used, it is proven to NOT cut the shield of the wire to and from the meter. Ground the shield as described above.

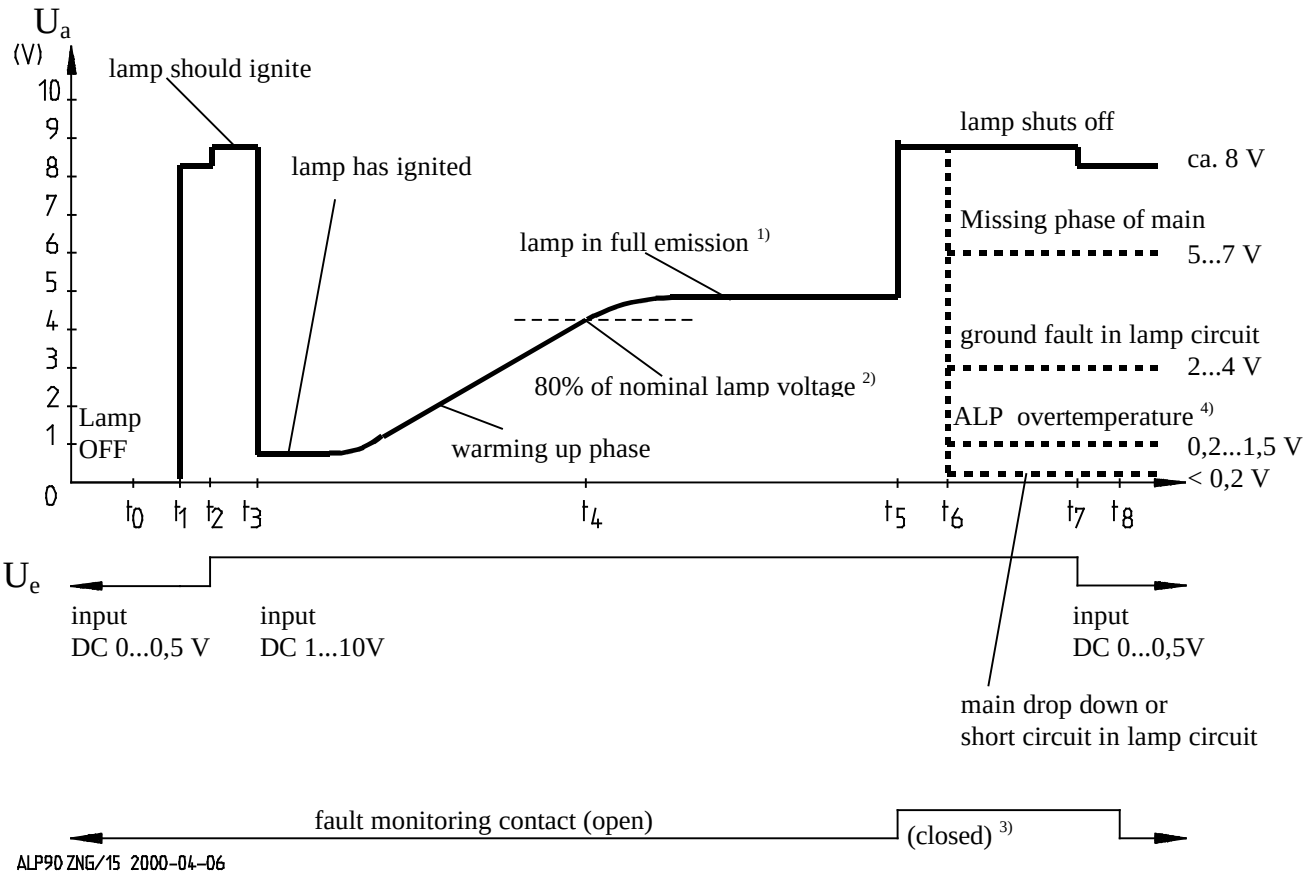
5.4.3 Laying cables

As usual with laying cables according to EMC rules, the lamp cables should not be laid in parallel to cables for analogous or other low level signals, to avoid disturbances to these signals.
If it should not be possible to avoid parallel laying, all concerned cables have to be shielded carefully.
Additionally an intensive test of all functions of these low level and analogous signals have to be taken out in several conditions, the lamp could run, e.g. while ignition (disturbance by the igniting pulses), while full power running, etc.

For connect Protective Earth (PE) see more in paragraph 3.1

5.5 Help for programming PLC

Behavior of lamp voltage when ALP 51-U is switched on and when a fault occurs



Legend:

U_a DC output voltage, shows lamp voltage or, in case of faults, monitors the fault (see *2.4*).

U_e DC input voltage, ON/OFF of ALP and adjusting lamp power (see *2.4*).

t_0 switch mains ON

t_1 = t_0 + 5 sec (inner switch on delay of ALP)

t_2 ALP ON + ignite (max. 10 sec. if lamp does not ignite, controlled by extern switch OFF by DC voltage U_e)

t_3 lamp ignites (now should U_e = 10V in order to shorten warm up phase)

t_4 lamp has warmed up ($U_a \geq$ 80% of nominal lamp voltage); now is the first moment power adjustment should be used by U_e = DC 1...10V

t_5 a fault occur

t_6 = t_5 + 1 sec

t_7 = t_5 + 5...10 sec; switch OFF ALP by $U_e \leq$ 0,5 V

t_8 mains OFF for at least 20 sec for a Reset (necessary only when Ground Fault has occur)

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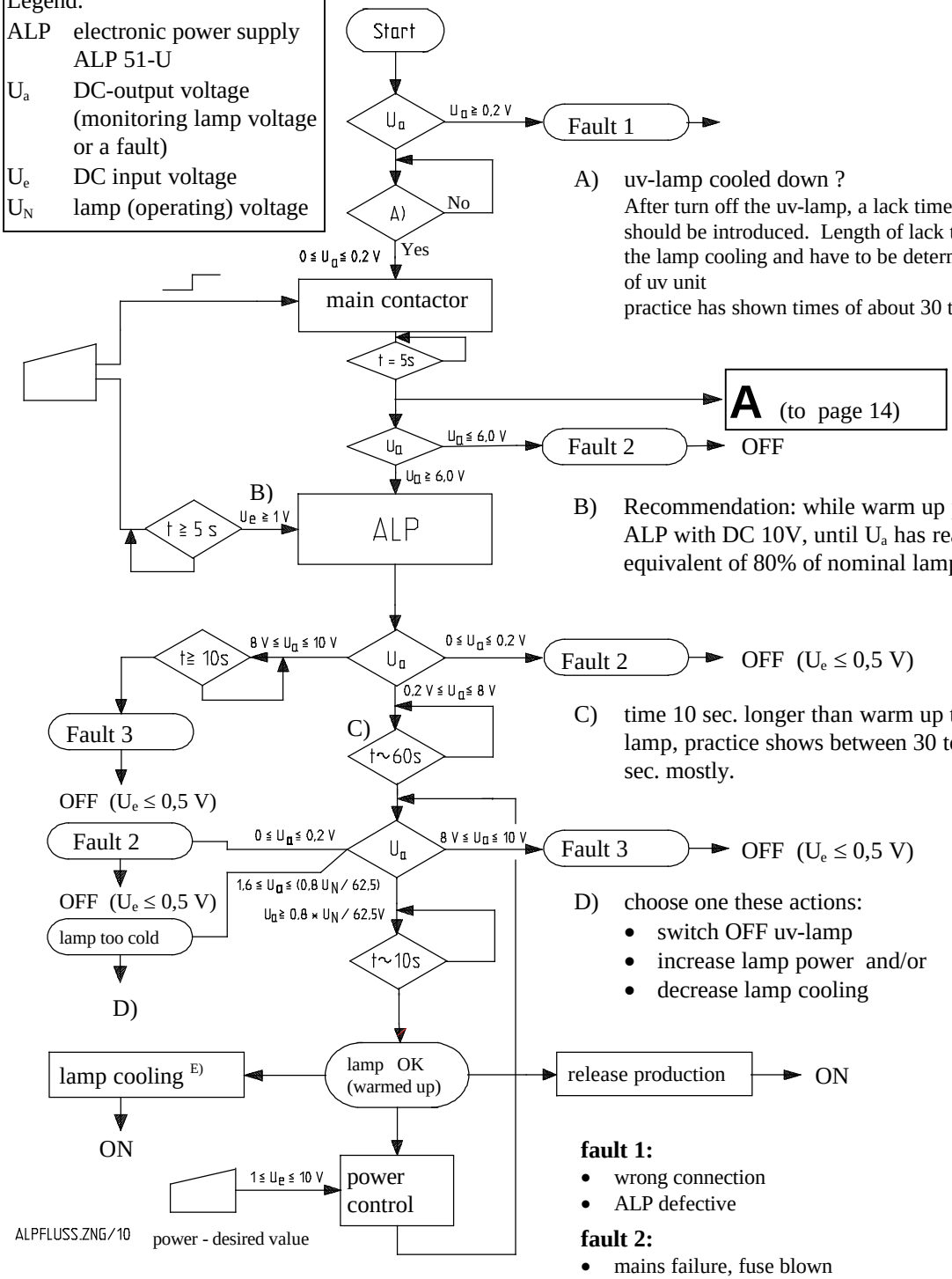
1) voltage U_a depend of nominal lamp voltage (operating voltage)
2) lamp cooling have to be active over 80% lamp voltage, reduce cooling when lower than 80%.
3) only in case of fault monitoring: Missed Phase, mains fault, Ground Fault and ALP Overtemperature
4) automatically Reset when fault is eliminated

Help for programming PLC (continued)

Flow diagram for controlling ALP 51-U together with UV-lamp

Legend:

ALP	electronic power supply ALP 51-U
U_a	DC-output voltage (monitoring lamp voltage or a fault)
U_e	DC input voltage
U_N	lamp (operating) voltage



A) uv-lamp cooled down ?
After turn off the uv-lamp, a lack time before turning on again should be introduced. Length of lack time depends mostly of the lamp cooling and have to be determined for each type of uv unit
practice has shown times of about 30 to 600 sec.

B) Recommendation: while warm up phase run ALP with DC 10V, until U_a has reached the equivalent of 80% of nominal lamp voltage.

C) time 10 sec. longer than warm up time of lamp, practice shows between 30 to 120 sec. mostly.

D) choose one these actions:
- switch OFF uv-lamp
- increase lamp power and/or
- decrease lamp cooling

E) switch ON lamp cooling, when lamp voltage has reached 80% of nominal lamp voltage.

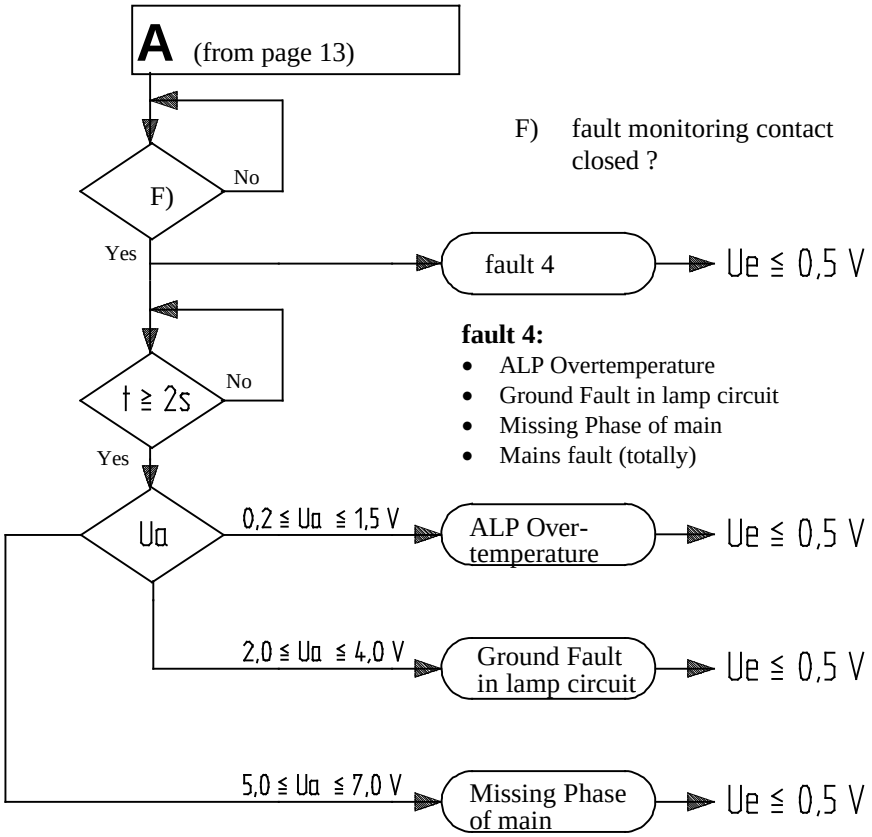
fault 1:
- wrong connection
- ALP defective

fault 2:
- mains failure, fuse blown
- short circuit in lamp circuit
- ALP defective

fault 3:
- uv-lamp shut OFF / do not ignite
- disconnection to the lamp

Help for programming PLC (continued)

Flow diagram for controlling ALP 51-U together with UV-lamp (continued)



In case of Ground Fault:
switch OFF mains
(= Reset, approx. 20 sec)

Reset after fault 4:

- ALP Overtemperature, mains total fault and Missing Phase of mains are reseted automatically when fault is eliminated.
- Ground Fault in lamp circuit: mains have to be switched OFF for at least 20 sec.