DESCRIPTION

Uninterruptible DC Power Supply
Type GL 110.1 / LG 110 NC

for ships of the navy

GL 110.1 / LG 110 NC

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2. Fundamentals for the standby power supply on board of ships

2.1 General possibilities

2.1.1 Standby parallel mode of operation (Fig. 2.1).

With this classical mode of operation the battery and the consumer are continuously coupled with each other; a power supply ensures the charging of the battery as well as the supply of the consumers when mains are available.

In any case, inherent to the system the battery voltage is always identical with the voltage of the “secured bar”. The power supply must be so designed on the output side that, for one thing, the batteries are reasonably charged and, for the other thing, the consumer voltage remains within the required tolerance range. As far as the current load is concerned, respective reserves will have to be considered, since the consumer current available is determined by a battery which has to be recharged. If the current available is rated too low, there will be continual charging/discharging cycles between the power supply and the battery, or the battery and the consumer resp.

2.1.2 Standby parallel operation with BCU (battery control unit) (Fig. 2.2):

The standby parallel operation is enlarged by a facility which can cut off charging subject to the battery condition. As compared with the classical standby parallel operation, the continual minor charging/ discharging cycles are prevented. The battery is decoupled via diodes in forward direction to the “secured bar”, so that in the event of load impacts or a mains failure the battery takes over the supply of the consumers without interruption, and a relay contact bridges the diode. Special charging methods such as constant current supply or impressing of a trickle charging current, are neither possible with this system. The maximum charging voltage results from the set voltage from the “secured bar”.

2.1.3 Uninterruptible changeover operation (Fig.2.3.):

This system provides for a charge of the battery and a supply of the “secured bar” independet of each other. The battery and the “bar” are decoupled by diodes. A reset switch bridges the diode path in case of a mains failure of in case of loads which exceed the output current of the rectifier set. With this method the optimum charging methods may be chosen for any type of battery you like.

2.2 Charging technique requirements for nickel-cadmium batteries

2.2.1 Charging flat to full, 10 h.

2.2.2 Trickle charge at a minimum loss of liquid.

2.2.3 Taking into account the differing ambient temperatures.

Acc. to the present state of knowledge this results in the following charging method:

- Charging at I = const. ≥ 30 A to 1.6 V / element = 32.0 V

- Trickle charging at I = const. = 125 mA to U = 1.45 V / element = 29.0 V

- Switching off the charge until U ≤ 1.3 V / element = 26.0 V, then switching on the charge again

- Immediate switching on of the charge after the battery has been under load

2.3 Power supply requirements for the “secured bar”

2.3.1 Uninterruptible operation

2.3.2 Selectable consumer voltage

2.3.2 Constant consumer voltage

2.4 Comparison of systems

2.4.1 With standby parallel operation the charging condition of the battery determines the voltage on the “secured bar”. (Fig. 2.4).

2.4.2 With standby parallel operation a charge of the battery which requires little maintenance and is preserving the battery, is not possible.

2.4.3 With standby parallel operation the battery determines the maximum available consumer current during the charge (Fig. 2.5).

2.4.4 With changeover operation the charge of the battery and the standby power supply of the consumers are independent of each other.

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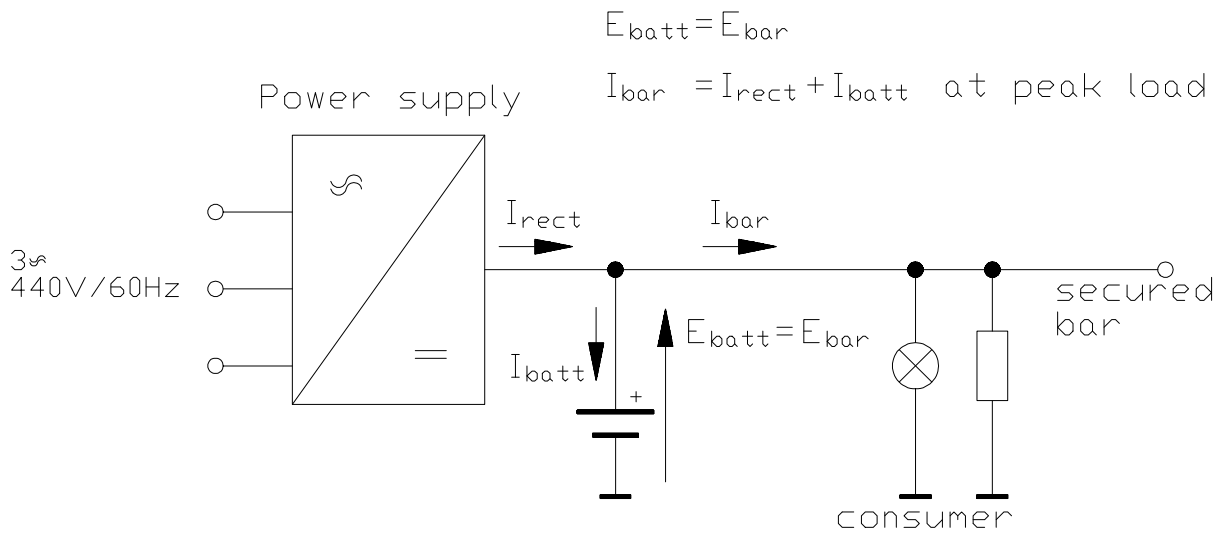

Fig. 2.1 Standby parallel mode of operation

Assets

- one power unit
- minimum of equipment required
- absolutely uninterruptible

Drawbacks

- Equipment voltage = battery voltage, i. e. voltage on the “secured bar” 19..31 V
- only suitable for certain battery types
- no charging current limitation, i. e. breakdown of the “bar” voltage in case of peak loads
- the tolerance of the output voltage must conform to the requirements of the battery

Legend: E_{batt} = battery Voltage
E_{bar} = voltage at the secured bar
I_{batt} = battery current
I_{rect} = rectifier current
I_{bar} = current at the secured bar

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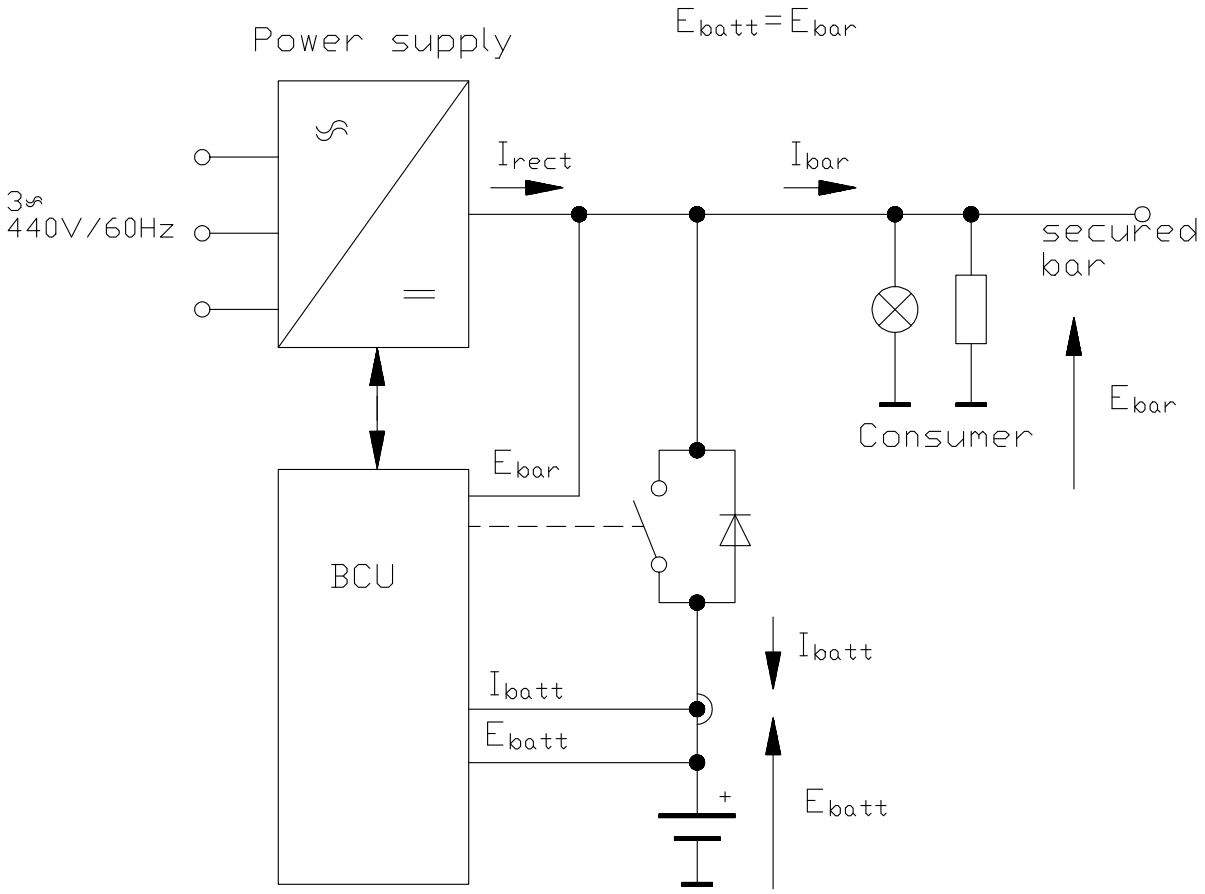

Fig. 2.2 Standby parallel mode of operation with battery control unit (BCU)

Assets

- One power unit
- Freely selectable "bar" voltage with charged battery *
- No continual minor charging/discharging cycles

* only with pilot line of BCU power supply

Drawbacks

- More equipment required
- Equipment voltage = battery voltage during charge
- Max. equipment voltage determines max. charging voltage
- Short voltage drop in case of a mains failure

E_{bar} = 26 ... 29 V freely selectable

Legend : E_{batt} = battery Voltage
E_{bar} = voltage at the secured bar
I_{batt} = battery current
I_{rect} = rectifier current
I_{bar} = current at the secured bar

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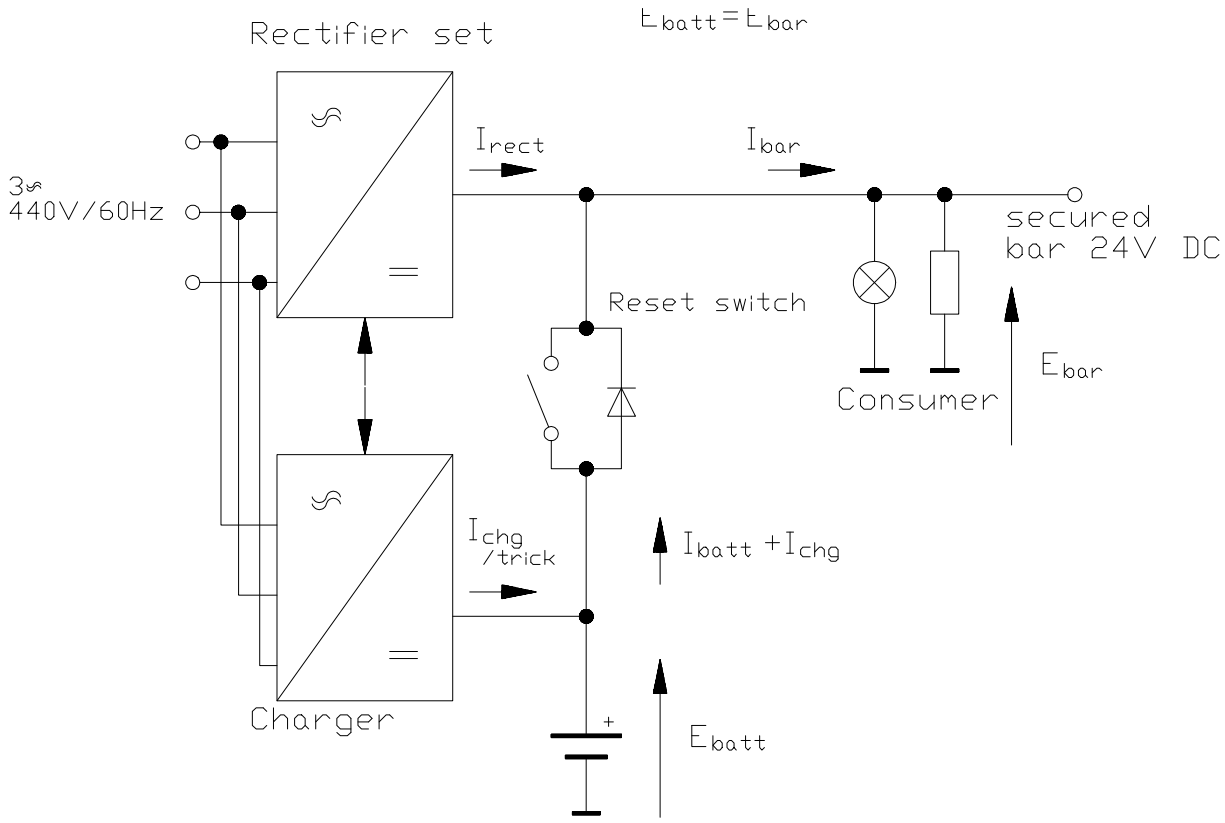
E_{batt} = 19 ... 31 V depending on charging condition
$I_{bar} = I_{rect} + I_{chg} + I_{bat}$ (with charged battery)

Fig. 2.3 Uninterruptible changeover operation



Assets

- Optimum charge of the battery
- Consumer voltage independent of the battery voltage
- No continual minor charging/discharging cycles
- Load reserve $I_{bar} = I_{rect} + I_{chg} + I_{batt}$
- Operation when rectifier fails

Drawbacks

- More equipment required
- Short voltage drop in case of a mains failure

Fig. 2.4 Battery voltage versus voltage of

Legend : E_{batt} = battery Voltage
E_{bar} = voltage at the secured bar
I_{batt} = battery current
I_{rect} = rectifier current
I_{bar} = current at the secured bar
I_{chg} = charging current
I_{trick} = trickle charging current

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secured bar

Battery voltage	Voltage on the "secured bars" E_{bar}			
	Standby parallel mode	Standby parallel mode with BCU		Uninterruptible changeover mode
		Charging	Charging off	GL 110.1 / LG 110 NC
0,0 V	0,0 V	0,0 V	$E_{charge\ max.}$	)
19,0 V	19,0 V	19,0 V	$E_{charge\ max.}$	) freely selectable
26,7 V	26,7 V	26,7 V	$E_{charge\ max.}$	) 26 ... 29 V
28,8 V	28,8 V	28,8 V	$E_{charge\ max.}$	)
31,0 V	31,0 V	31,0 V		If $E_{Batt} = E_{GL} + 4.2$ V $\rightarrow\rightarrow$ $E_{GL} = E_{GL} + 1.8$ V

Fig. 2.5 Comparison of charging and load conditions

	Standby parallel mode	standby parallel mode with BCU	Uninterruptible changeover mode
			GL 110.1 / LG 110 NC
Charging current	$I_{batt} = I_{rect} - I_{bar}$	$I_{bat} = I_{rect} - I_{bar}$	$I_{batt} = I_{chg}$
Trickle charging current	$I_{batt} = f(E_{bar}; \vartheta_{batt})$	$I_{batt} = Ø$ resp. $= f(E_{bar}; \vartheta_{batt})$	$I_{batt} = I_{trick.}$
Load current during charge	$I_{bar} = I_{rect} - I_{batt}$	$I_{bar} = I_{rect} - I_{batt}$	$I_{bar} = I_{rect}$
Load current with charged battery	$I_{bar} = I_{rect}$	$I_{bar} = I_{rect}$	$I_{bar} = I_{chg} + I_{rect}$

3. Description of the system

The uninterruptible DC power supply system GL 110.1 /LG 110 NC is composed of 3 units (Fig. 3.1),

- the GL 110.1 rectifier
- the LG 110 NC charging section
- and the reset switch.

The three functional units are accomodated in 2 19" cabinets having 9 units of height each (Fig. 3.2). With mains beeing available, the GL 110.1 rectifier with its controlled output characteristic supplies the “secured bar”. The max. rectifier current amounts to 80 A, while the output voltage is freely selectable within the range of 26 ... 29 V.

By means of the LG 110 NC charger the battery is being charged when mains are available. The max. charging current is 30 A. The charging characteristic is optimum adjusted to the LS 230 nickel-cadmium batteries and described in detail in section 5.

In case of a mains failure the “secured DC supply bar” including its consumers is directly coupled with the battery by means of diodes so that an uninterruptible reset switch effects the short-circuiting of the diodes after a short period of time. A detailed description is given in section 6.

All operating and display elements are arranged on the front of the instruments, the same as the connections for mains voltage, control lines and the connections to the battery as well as to the “secured bar”. All inputs on the mains side and all ouputs on the DC side are protected via selective circuit breakers.

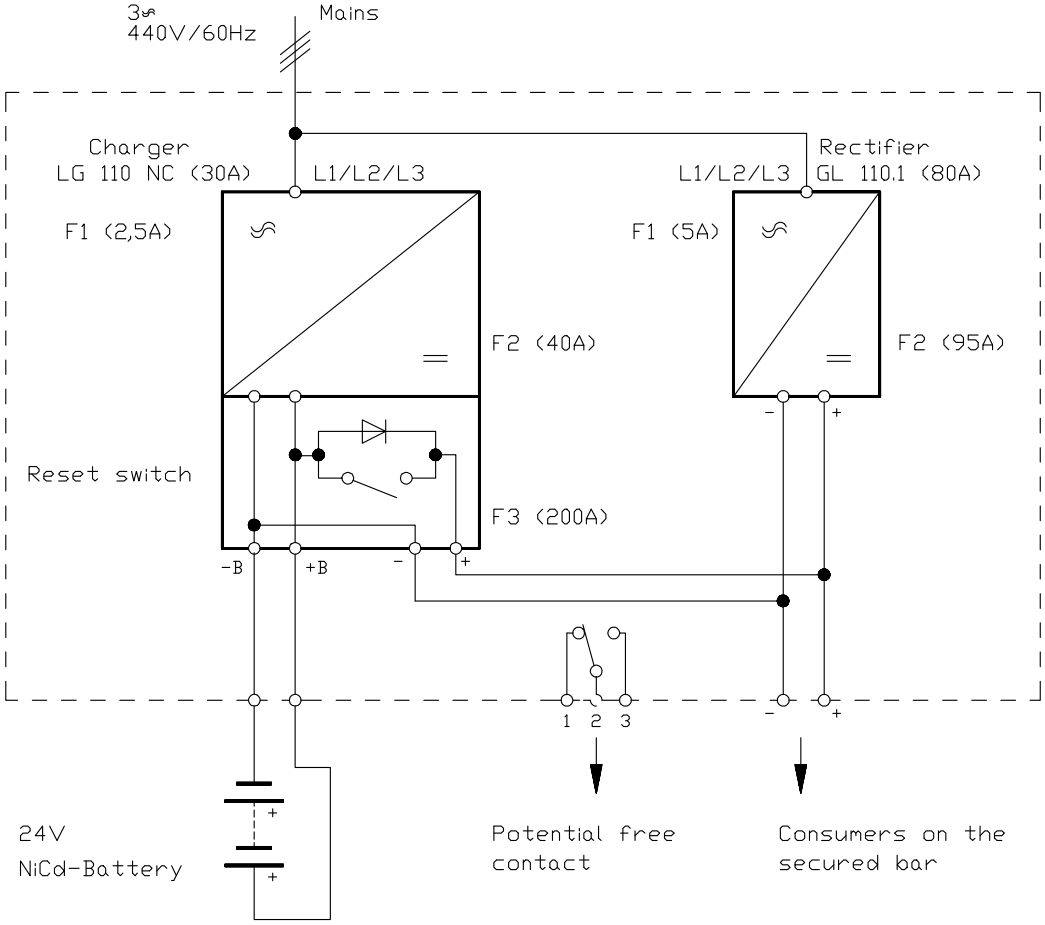

Fig. 3.1 Block diagram, uninterruptible DC power supply GL 110.1 / LG 110 NC

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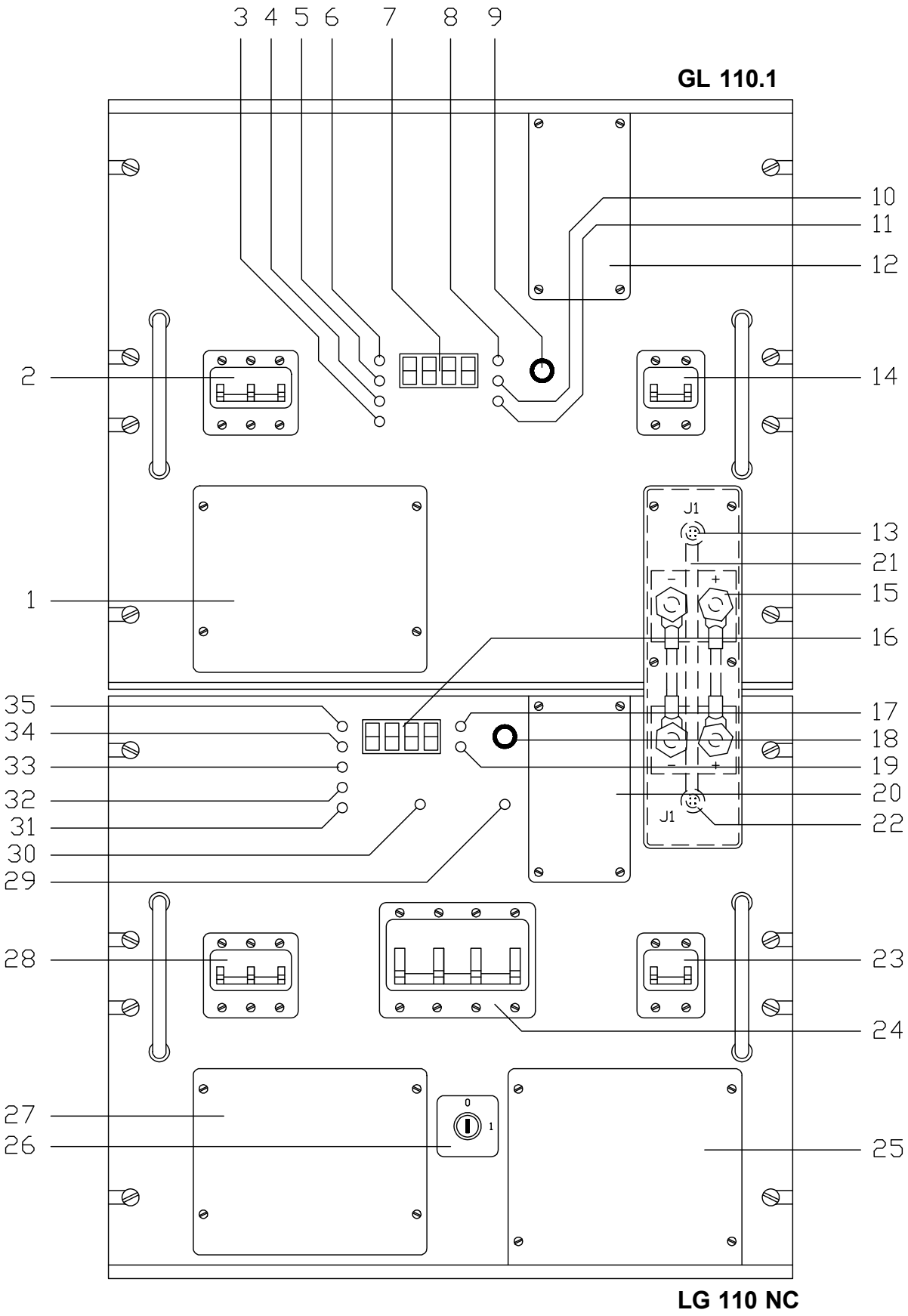

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Fig. 3.2 Front panel

Front panel description

Rectifier GL 110.1

1 Covered AC Connection Terminals MAINS INPUT and MONITORING OUTPUT

2 ACB F1 MAINS INPUT

3 LED - red, Eout < 22 V

4 LED - red, Eout > 32 V

5 LED - green, OPERATION O. K.

5 LED - yellow, MAINS EXISTING

7 4 digit LED Display for Output Voltage or Current

8 LED - yellow, Eout/ V

9 Pushbutton S 1 SELECT SWITCH (E_{out} / I_{out})

10 LED - yellow, Iout / A

11 LED - red, OVERLOAD ($E_{out} \geq 80$ A)

12 Cover with Potentiometer for Setting OUTPUT VOLTAGE with R33

13 Socket J 1 (Connection for Data Transfer)

14 ACB F2 DC OUTPUT

15 Covered DC Connection Bolts DC OUTPUT

Battery Charger LG 110 NC

16 4 digit LED Display for Output Voltage or Current

17 LED - yellow, Eout / V

18 Pushbutton S 1 SELECT SWITCH (E_{out} / I_{out})

19 LED - yellow, Iout / A

20 Cover with Potentiometer for Setting OUTPUT VOLTAGE with R33

21 Flexible cable for Data Transfer

22 Socket J 1 (Connection for Data Transfer)

23 ACB F2 DC OUTPUT

24 ACB F3 RESET SWITCH

25 Covered DC Connection Bolts Battery and SECURED BAR

26 Key Switch ON / OFF for MANUAL CHARGE

27 Covered AC Connection Terminals MAINS INPUT and MONITORING OUTPUT

28 ACB F1 MAINS INPUT

29 LED - red, BATTERY OPERATION

30 LED - green, MAINS OPERATION

31 LED - yellow, MANUAL CHARGE ENDED

32 LED - red, Eout < 18 V

33 LED - red, Eout > 33 V

34 LED - green, OPERATING O. K.

35 LED - yellow, MAINS EXISTING

Legend : ACB = **A**utomatic **C**ircuit **B**reaker

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4. Description of the GL 110.1 rectifier

The rectifier set is designed for the supply of the “secured bar” on board of ships when the mains supply is available. The output voltage is adjustable from 26...29 V. The max. rectifier current is 80 A.

4.1 Connections (Fig. 4.2)

- Connectable and accessible from the front
- Terminals on the mains side (with caps) suitable for through-wiring
- Terminals for potential-free contact in the connection box on the mains side
- Direct voltage output through covered threadet bolt in the front side

Attention:

The threadet bolt nuts of the direct voltage output may only be tightened with a starting torque of a max. of 20 Nm.

4.2 Operating and display elements (Fig. 4.1)

- Four-digit LED display for indication of the output voltage or current.
  (changeover by means of push-button S1, status indicated by LED´s "Volt" or "Amp")

- yellow LED "mains on"
- green LED “operating o.k.” (no failure)
- red LED “overload” (failure)
- red LED “Display “Volt > max” (failure)
- red LED “Display “Volt < min" (failure)
- Circuit breaker input (mains)
- Circuit breaker output (DC)
- Setting of the output voltage with a potentiometer after removal of the control p.c.b. cover

4.3 Monitoring

A potential-free contact is available for monitoring the operation. The contact relay is tightened during trouble-free operation. The following failures are signalled:

- Mains failure
- Overload I > 80 A
- Output voltage > 32 V
- Output voltage < 22 V)

4.4 Perfomance description

4.4.1 GL 110.1

The 3 x 440 V AC mains supply is converted into direct voltage of 26...29 V/80 A max. by the assemblies which are referred to hereafter and described in detail (Fig. 4.3 and 4.4). After being rectified and screened, the supply voltage (3 x 440 V AC) is passed via the AC filter to the power unit.

Triggered by the regulator and control p.c.b., the DC voltage (660 V) is pulse-width modulated and passed to the transformers T4 and T5.

Via T6 as an intermediate storage, and C1 the potentialy isolated low voltage (26...29 V) is available on the output terminals after DC filtering.

The power supply feeds the display, the control p.c.b. and the power unit with its supply voltages. The display unit signals failures, operating status and the values of the output voltage or of the output current. The output characteristic with the alarm levels is illustrated in Fig. 4.5.

4.4.2 AC filter GL 110.1

Mains connection L1, L2, L3, PE, 3 x 440 VAC
Via F1 the three-phase AC voltage reaches a combination of capacitors and chokes. These have the following functions:

- to protect the unit against transient mains interferences and power factor improvements (cos φ)

- to suppress the radio interferences conducted to the mains

Thereafter the three-phase AC voltage is rectified by means of a three-phase bridge rectifier and connected to the mains screening via J3. On the secondary side of the two auxiliarys transformers there are six potentially isolated AC voltages available which are fed via J10 and J11 into the power supply. The auxiliary transformers are fused with the fuses F4 and F5. Via bushing type capacitors the connections of the potential-free contact (1/2 = normally opened, 2/3 = normally closed) are fed into the power supply.

4.4.3 GL 110.1 mains screening

A capacitor bank is available on this unit for screening the three-phase supply voltage after the rectifier.

4.4.4 GL 110.1 voltage supply

On this unit potentially isolated 15 V DC supplies are generated.

Four alternating voltages are fed via J10 into the power supply which generate the stabilized 15 V constant voltages for the driver connections of the switch settings. Via J13 these are fed into the power unit. To generate the 15 V DC supply for the display and the regulator and control p.c.b., an alternating voltage is fed into J11. The regulated 15 V DC voltage applies to J14. Via the KB 1 flat ribbon lead it will be passed into the display and the regulator and control unit. The potential-free contact relais is connected to the terminal strip on the front panel of the set by means of the wire harness KB 9.

4.4.5 GL 110.1 power unit

The GL 110.1 power unit is designed as a double flow converter. The two converter transformers (T3, T4) **alternately** transfer the energy via V1...V6 to the joint output choke T6 at a clock frequency of 40 kHz. Via the electrolytic capacitor C1 the output voltage is led into the DC filter.

The R-C combinations (R-C-1) protect the rectifier and free-running diodes from voltage oscillations. The C-Bg.1 and C-Bg.2 sub-assemlies are components of the radio-interference screening system.

The potentially-isolated pulse-width modulated signals from the regulator and control unit pass through terminal J12 to reach the driver stages which, in turn, drive the power transistors.

4.4.6 GL 110.1 regulator and control unit

The output data (voltage, current) are passed to precision measuring amplifiers and controls via KB5 and J12/J20 on the regulator and control p.c.b. These data are then transformed into pulse width modulated signals and transfered potentially-isolated to the power stage. This sub-assembly is designed as plug-in board, the voltage supply and various analogous signals being passed via KB1 to J21.

After loosening the four fastening screws, the cover on the front panel can be removed. Then the output voltage of the set can be adjusted with R33.

4.4.7 GL 110.1 display

On the display board there are four 7-segment components which effect a 4-digit display of the current and voltage, as well as 7 LEDs which indicate a number of measuring and control operations.

An A/D converter drives the digital display via the toped integrated driver. The voltage supply is fed to the display unit via terminal strip J17. The analogous measuring values of voltage and current are supplied to the display via KB5 and adapted to certain voltage levels by means of resistor combinations. By means of the “select switch” the display of either the current or the voltage can be chosen. According to the change-over either the LED "Volt" or "Amp" lights up.

Change-over is effected by means of a relay which is also accomodated on the board.

The yellow “Mains existing” LED lights up when mains are available. In additon, the green LED “Operation o.k.” indicates orderly operation.

The red LEDs E > 32 V or E < 22 V resp. light up when the permitted voltage range is exceeded.

In case of overload operation the “Overload” LED lights up. The LEDs for the respective disturbance indications and the LED “Operating o.k.” are driven via comparators with transistors switched in sequence.

4.4.8 GL 110.1 DC filter

The transient interferences of the converter output are dampened by L-C combinations in the DC filter acc. to VDE 0871 B. Via a circuit breaker the DC voltage is fed to the output terminals of the set. The pilot line signals are transmitted via J1 and the bushing type capacitors via KB2 through the filter to the display and via J17/J21 to the regulator and control p.c.b..

In the filter also the output data of voltage and current are picked off and transmitted by means of bushing type capacitors and KB5/J41 to the regulator p.c.b. and by means of KB10/J41 to the display.

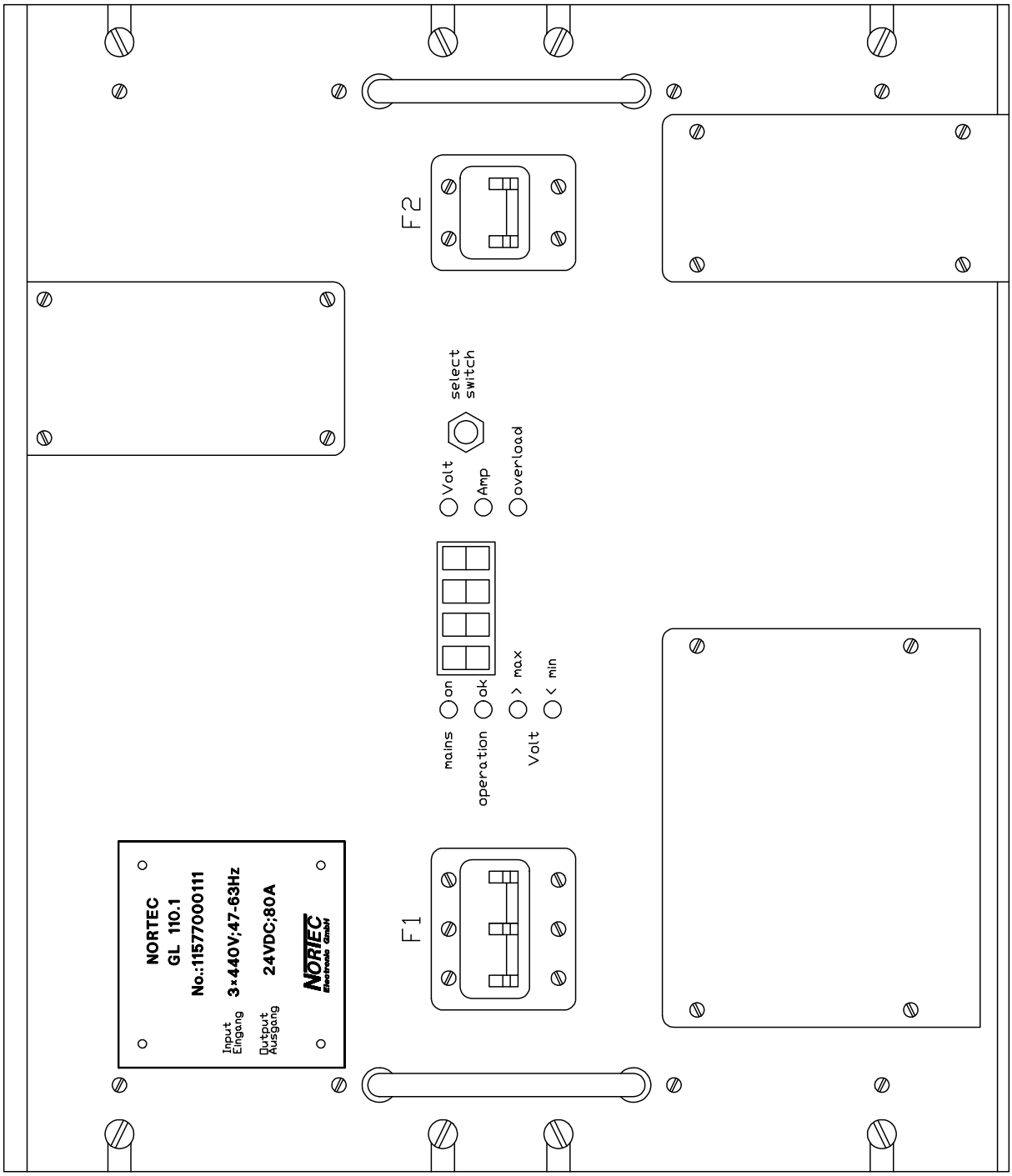

Fig. 4.1 Front panel GL 110.1

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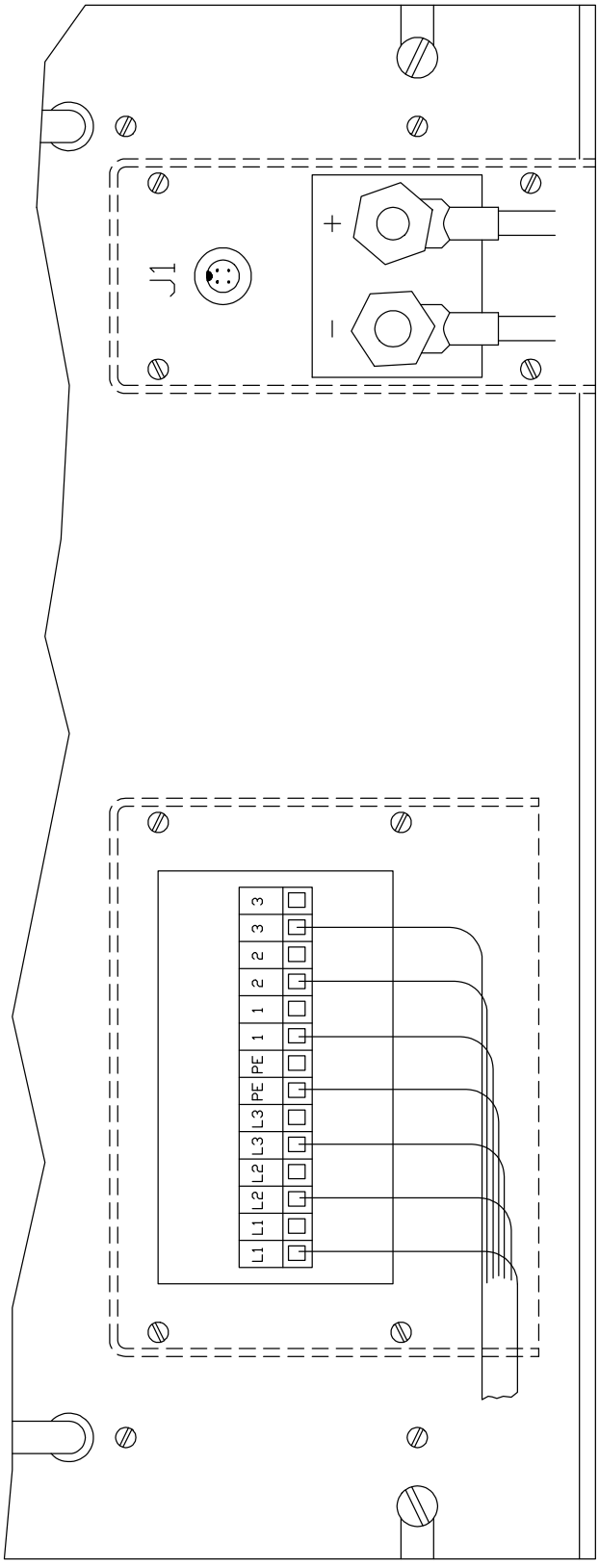

Fig. 4.2 GL 110.1 AC- and DC-connection

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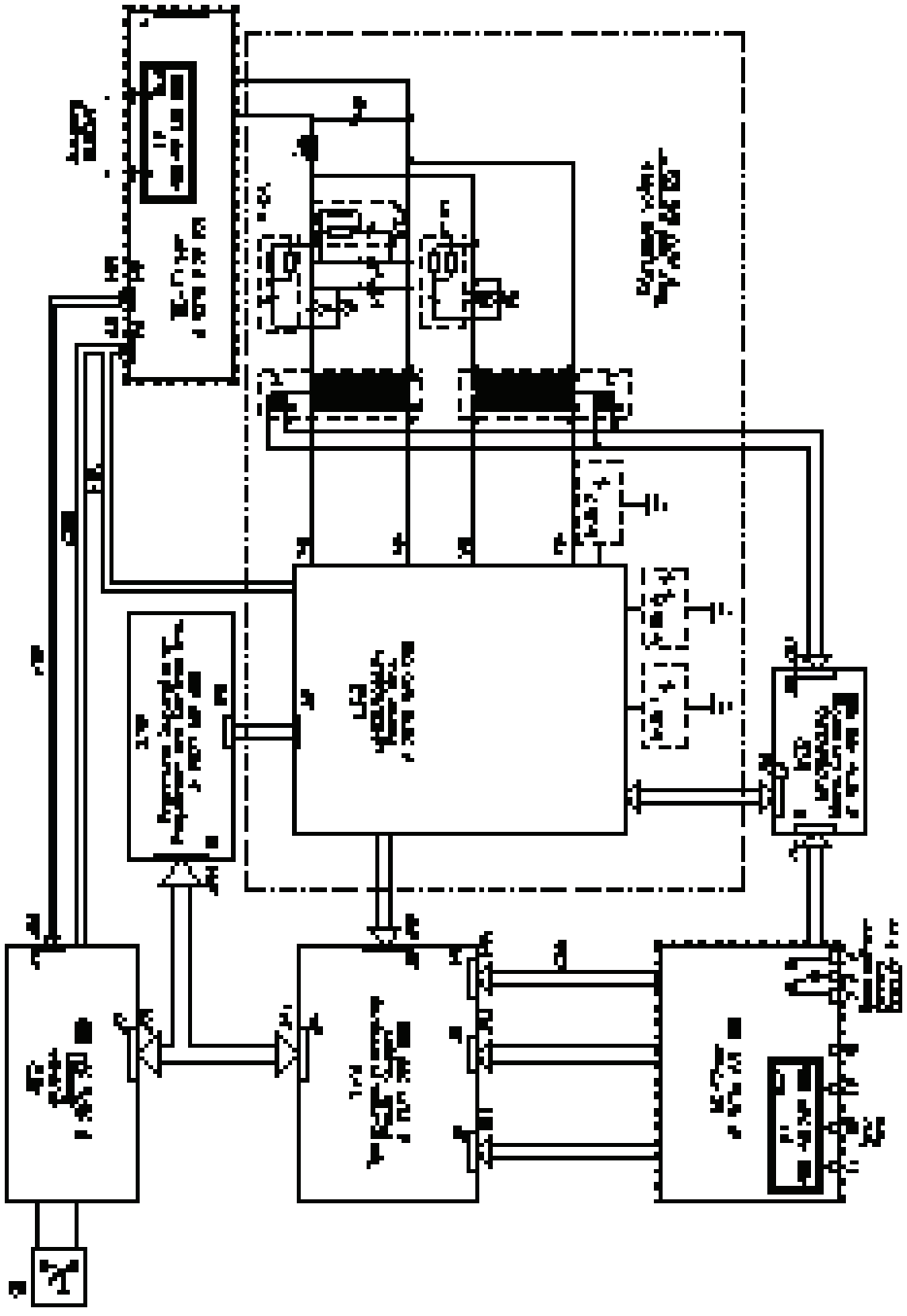

Fig. 4.3 Complete circuit diagram GL 110.1

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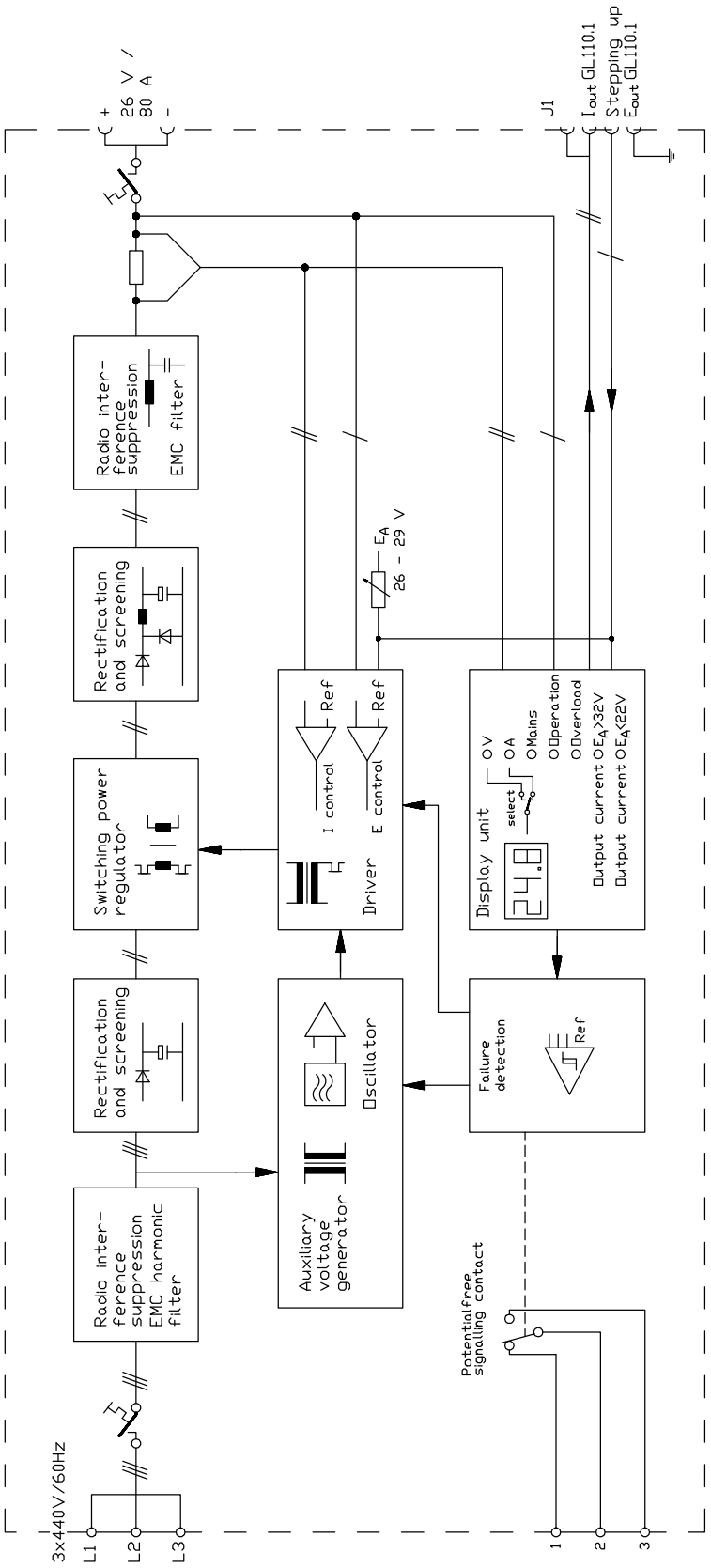

Fig. 4.4 Rectifier set GL.110.1

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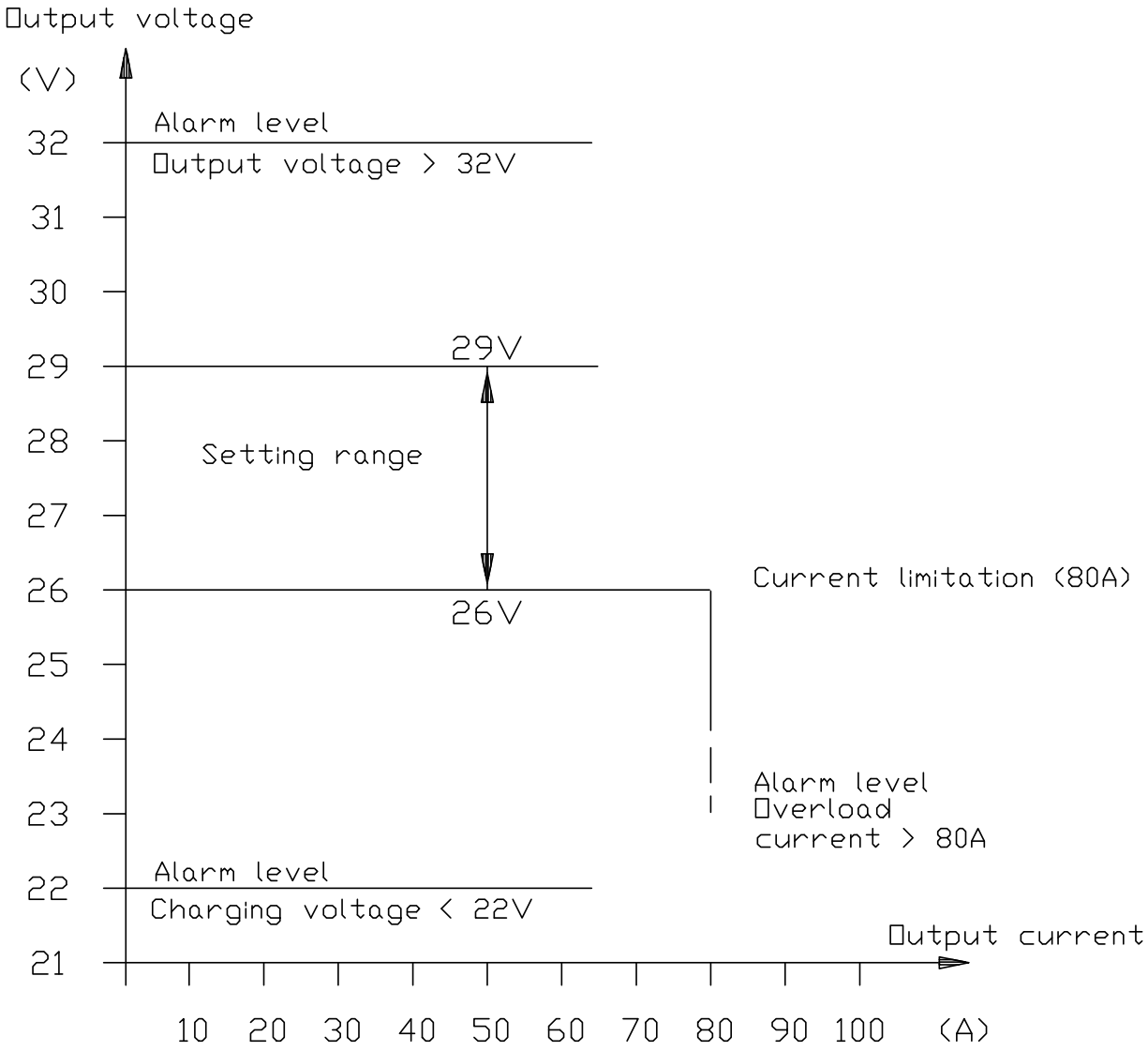

Function diagram GL 110.1

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Fig. 4.5 Rectifier GL 110.1

5. Description of the LG 110 NC charger

The charger is designed for the automatic charge and trickle charge of nickel-cadmium batteries. Charging is effected acc. to an I-characteristic. The charging current is limited to 30 A, the max. output voltage is adjustable.

When the set voltage has been reached, change-over to trickle charge operation at a constant current of 125 mA is effected.

When the battery voltage rises to 31.0 V, the charging current is switched off, until the battery has reached 26.0 V in its no-load condition. At this point the charging current will be switched on again.

After loading the battery due to a mains failure or due to a current consumption which is bigger than the system current (rectifier 80 A + charger 30 A = 110 A), charging will automatically be cut in, i.e. charging at a constant current of 30 A till the upper switching-off setting is reached.

The upper switching-off setting during charge can be adjusted between 29...32 V, normal setting is 31.0 V. the output characteristic of the charger is illustrated in Fig. 5.1, and the typical charging curve in Fig. 5.2.

5.1 Connections (Fig. 5.4)

- Connectible and accessible from the front
- Terminals on the mains side (with cover) suitable for through-wiring
- Terminals for the potential-free contact in the connection box on the mains side
- Charging voltage output via threaded bolt with cover in the front panel
- Connection of the “secured bar” via threaded bolts with cover in the front panel

Attention:

The threaded bolt nuts for the connection to the secured bar may only be tightened with a starting torque of a max. of 20 Nm.

5.2 Operating and display elements (Fig. 5.3)

- Four-digit LED display of output voltage and current. Changeover by means of push button.
- Mains available
- Indication “Operating o.k.” (no disturbance)
- Charging voltage < 18 V
- Charging voltage > 33 V

- “Fast charge period on” with key switch
- Optical and acoustical signal when fast charge period has ended
- Circuit breaker at the charging output (DC)

- Circuit breaker reset switch (DC)
- Adjustment of the switch settings with potentiometers after removal of cover

5.3 Monitoring

A potential-free contact is available for monitoring the operation. The relay of this contact is attracted during undisturbed operation. The following disturbances are signalled:

- Mains failure or missing output voltage GL 110.1
- Charging voltage < 18 V
- Charging voltage > 33 V

5.4 LG 110 NC performance description (Fig. 5.5, 5.6)

The 3 x 440 V, 50/60 Hz supply voltage is fed via the AC filter, the rectifier and the mains screening to the power unit. Here the DC voltage is chopped and potentially isolated transmitted to the low voltage side by means of the transformer T4. This AC voltage is then rectified and flows via a low-pass (T5, C6) to the DC filter. From the DC filter the DC voltage passes via the circuit breaker F2 to the battery terminals. The voltage supply feeds the power unit, the display and the regulator and control board with the corresponding supply voltages. Additionally, the battery is fed with trickle charging current by the SNT of the regulator and control unit.

The charging current and the charging voltage are picked up in the DC filter and passed via shielded wires to the regulator display. The display p.c.b. indicates the output voltage or the output current as well as certain operating conditions and/or disturbances. If necessary, the battery which is fused by means of F3, can be switched on to the “secured bar” with the aid of the reset switch.

5.4.1 LG 110 NC AC filter

(Functions and design are the same as described for the GL 110.1 , para. 4.4.2).

5.4.2 LG 110 NC mains screening

(Functions and design are the same as described for the GL 110.1 , para. 4.4.3).

5.4.3 LG 110 NC voltage supply

This unit generates the potentially isolated 15 V DC supplies and a 43 V DC supply for the trickle charger in the regulator and control unit. AC voltages are fed into J10 from which the stabilized 15 V DC voltages for the driver circuits of the switch setting are drived. These are led via J13 to the power unit. For generating the 15 V DC supply for the display, the regulator and control p.c.b. J11 will be supplied with two potentially isolated AC voltages. Via the flat ribbon cable KB1 these are led to the display and to the regulator and control unit. From the display the trickle charge passes through the DC filter and arrives at the battery terminals. The drive of the potential-free contact is effected by means of J14, pin 12. By means of the wire harness KB9 the potential-free contact is connected to the terminal strip on the front panel of the set.

5.4.4 LG 110 NC power unit

The LG 110 NC power unit is designed as a single-ended flow converter. The power transistors are driven at a clock frequency of 40 kHz. This energy is transmitted to the secondary side of the converter T4. The secondary voltage is rectified and supplies the electrolytic capacitor C6 via the output choke T5.

Via the DC Filter the output voltage arrives at the output terminals of the set. The sub-assemblies C-Bg.1 and C-Bg.2 are components of the interference screening system.

5.4.5 LG 110 NC regulator and control unit

On the regulator and control unit the output data (voltage, current) are led via J20 to the respective measuring amplifiers. The current and voltage regulator changes the pulse-width of the control signals for the power unit, potentially isolated, with the aid of the pulsewidth modulator and the topped driver stage. In addition, the time and control elements for manual fast charge are accomodated on this board. Afer loosening 4 fastening screws, the cover of the front panel can be removed. Then the output voltage of the set can be adjusted by means of R33. For setting the output voltage the safety switch F2 must be cut off. The key switch (pos. 26, fig. 3.2) shall not be in position 1 (manual charging). Where necessary, the pluggable board can also be removed and possibly replaced.

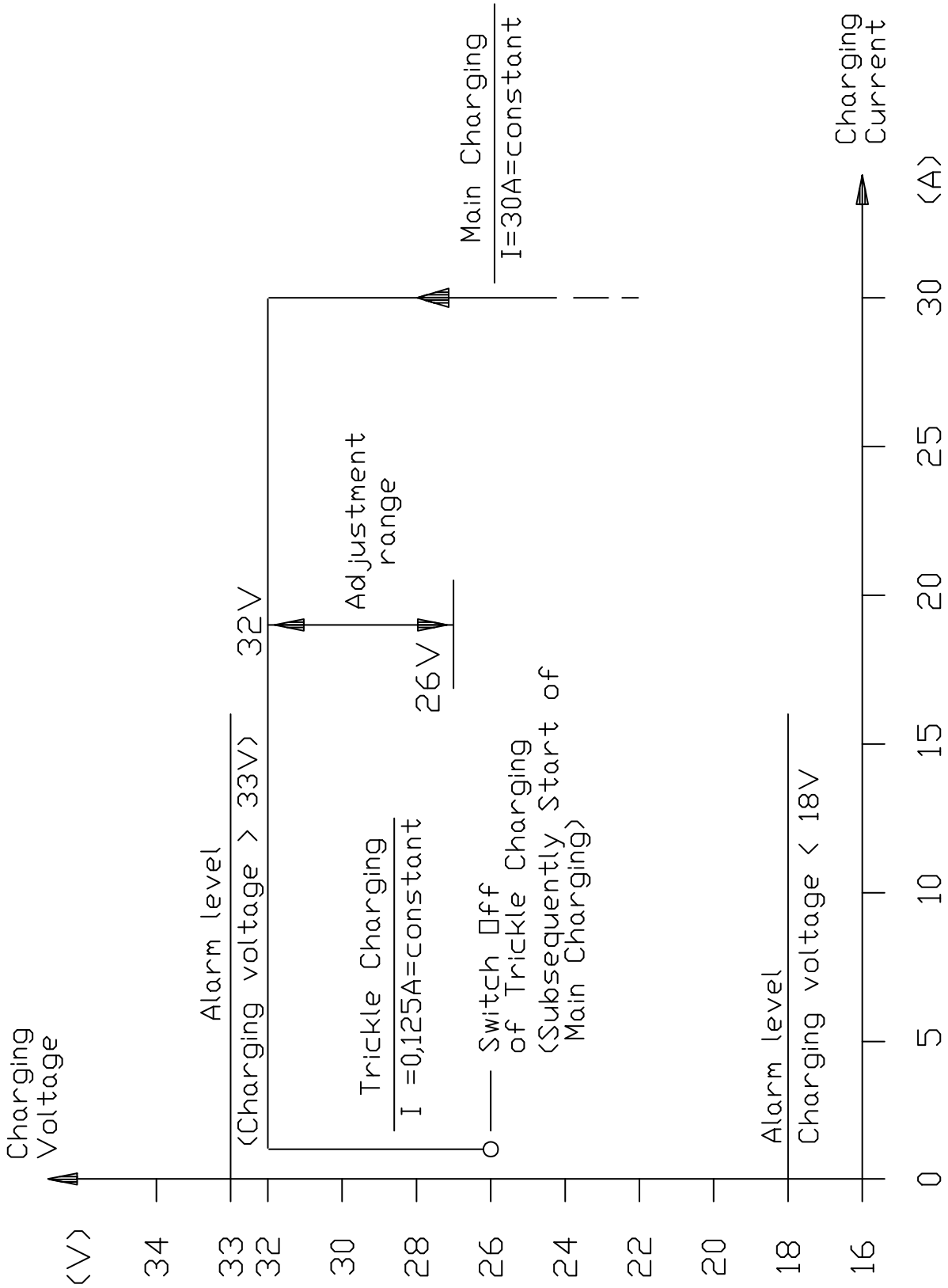
5.4.6 LG 110 NC display

On the display board there are four 7-segment components by means of which a 3-digit display is achieved, as well as 9 LEDs which indicate certain states of operation. With the select switch the user can select either the current or the voltage display. Change-over is effected by means of a relay which is also mounted on the board. The LEDs E/V or I/A resp. will light up accordingly. The analogous current and voltage data available at multiplug J16 are brought to a certain voltage level by means of resistors and passed to an A/D converter. The A/D converter drives the 7-segment components via the topped integrated driver. If the set is connected to the mains supply, this will be indicated by the yellow LED “Mains existing”. Orderly operation is indicated by the green LED “Operating o.k.”.

When the output voltage reaches values 33 V or 18 V, the LED “E > 33 V” or the LED “E < 18 V” lights up. The LEDs “Mains operation” and “Battery operation” indicate whether the reset switch is switched on or off. The “Manual charge ended” LED indicates the end of the manual fast charge. This state of operation is also acoustically signalled by a hooter.

5.4.7 LG 110 NC DC filter

A combination of inductive resistors and capacitors shall shield the output terminals from interferences signalling from the set. The DC filter contains a precision resistor which measures the output current.



The measuring point is connected to the display and to the regulator and control board by means of the wire harnesses KB5 and KB10. The measuring values for voltage measurement and regulation are also

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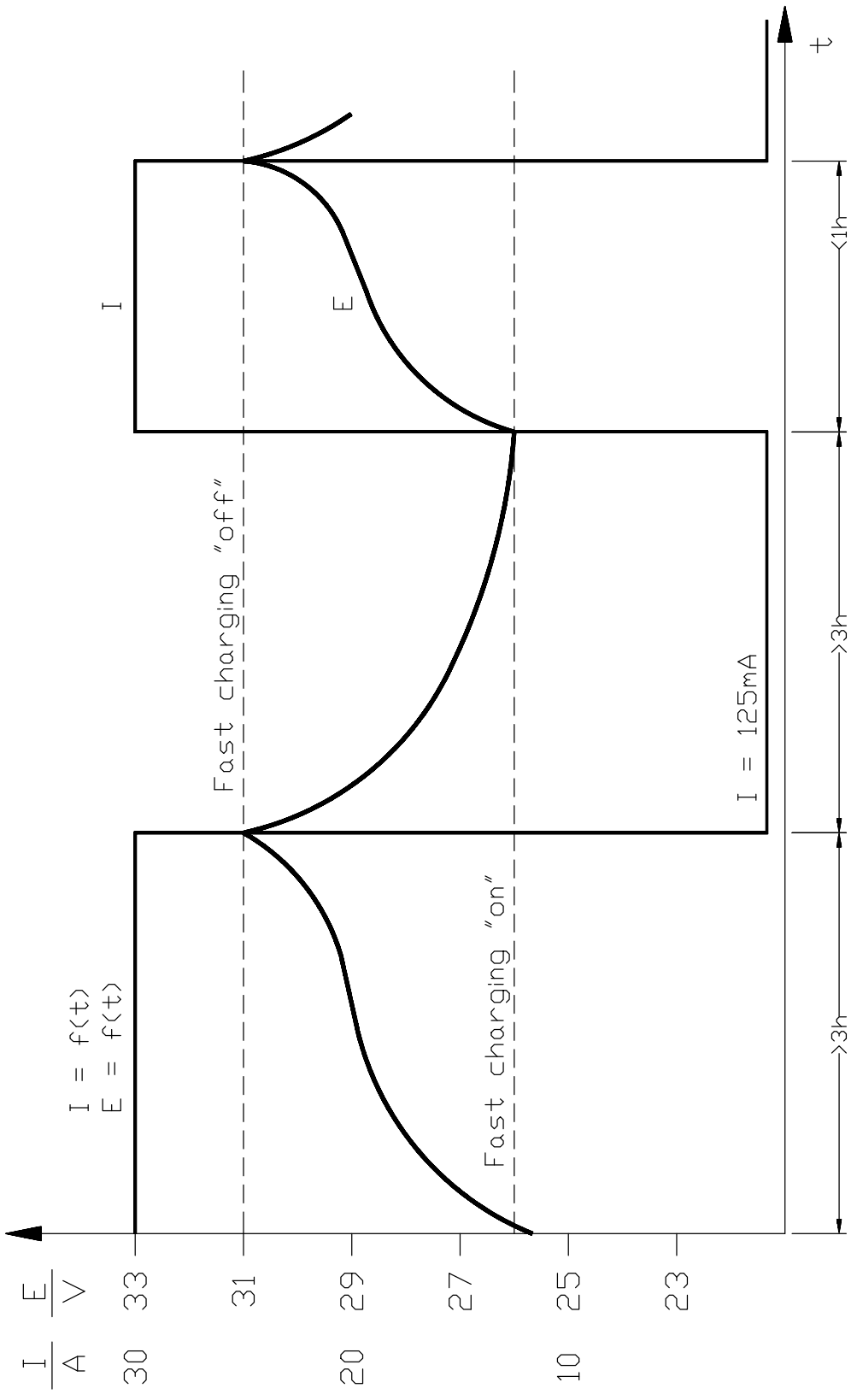

passed through these wire harnesses.

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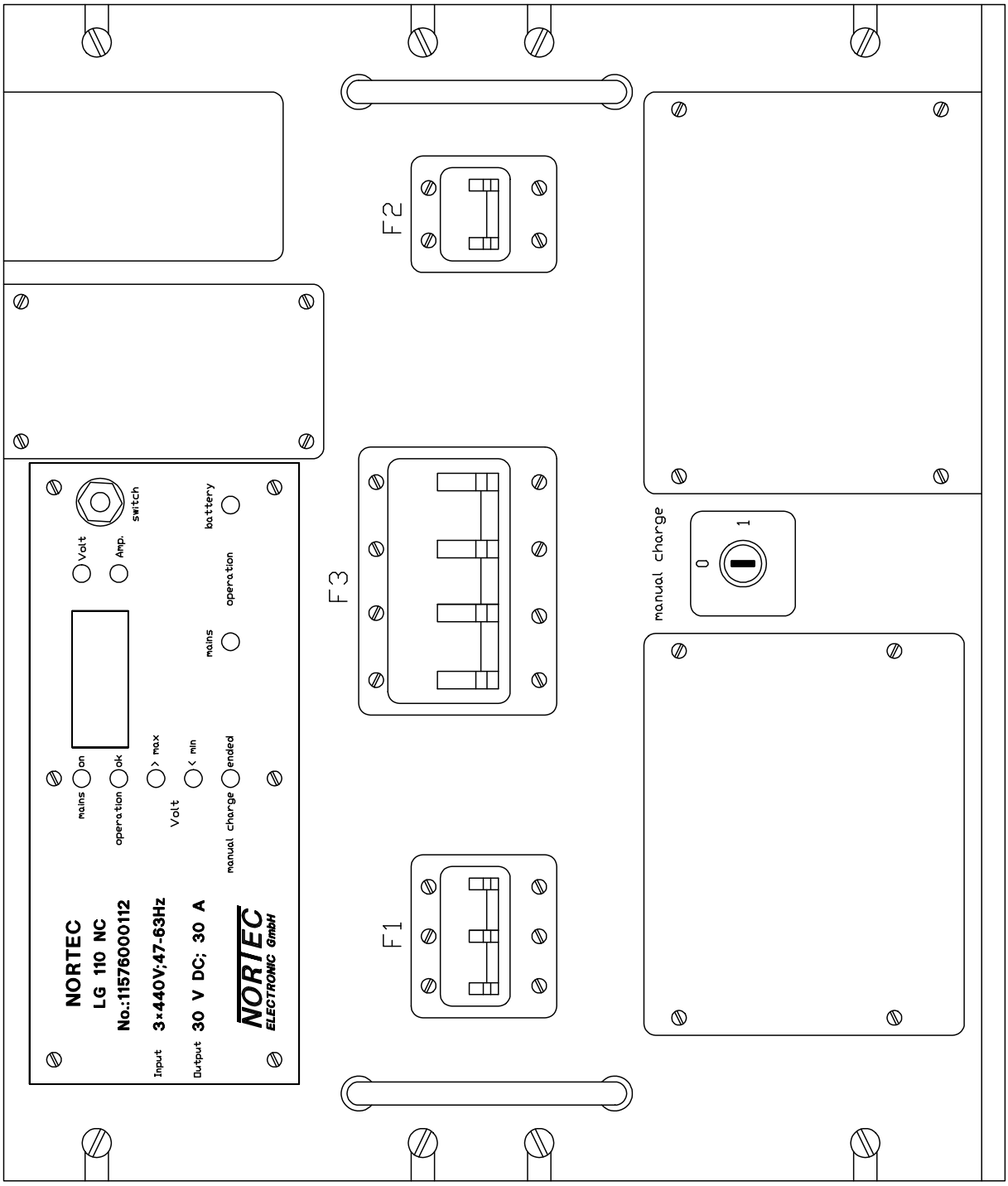

Fig. 5.1 Battery Charger LG 110 NC

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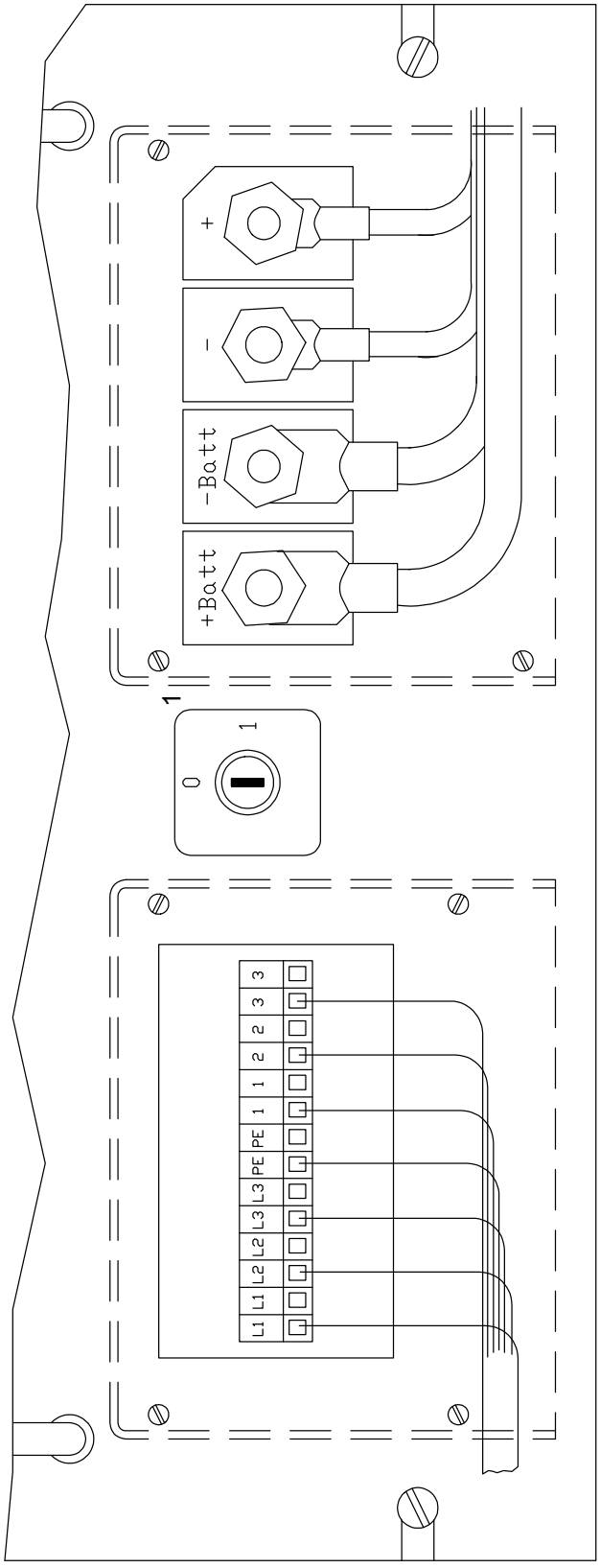

Fig. 5.2 Charging diagram LG 110 NC

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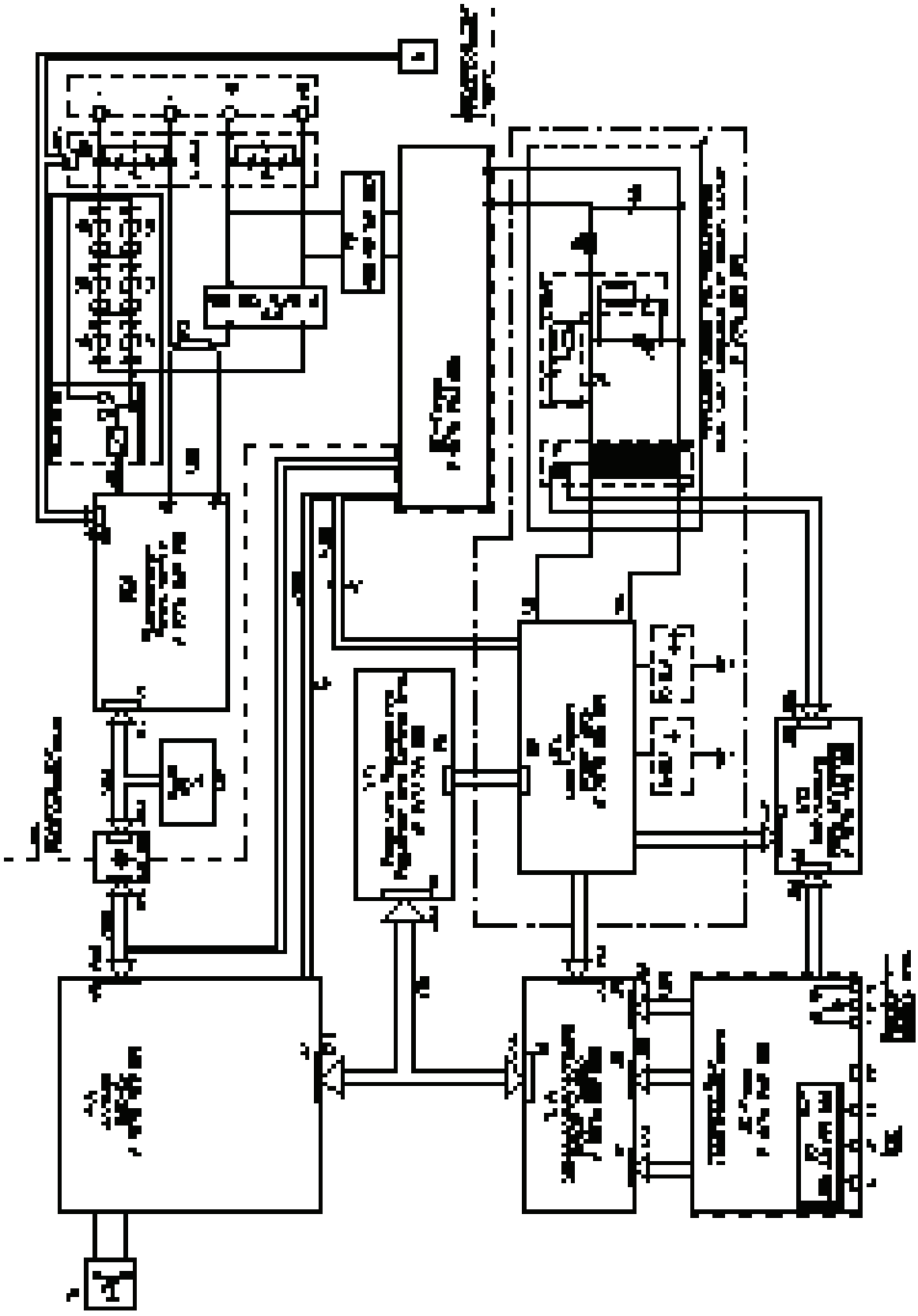

Fig. 5.3 Front panel EG 110 NC

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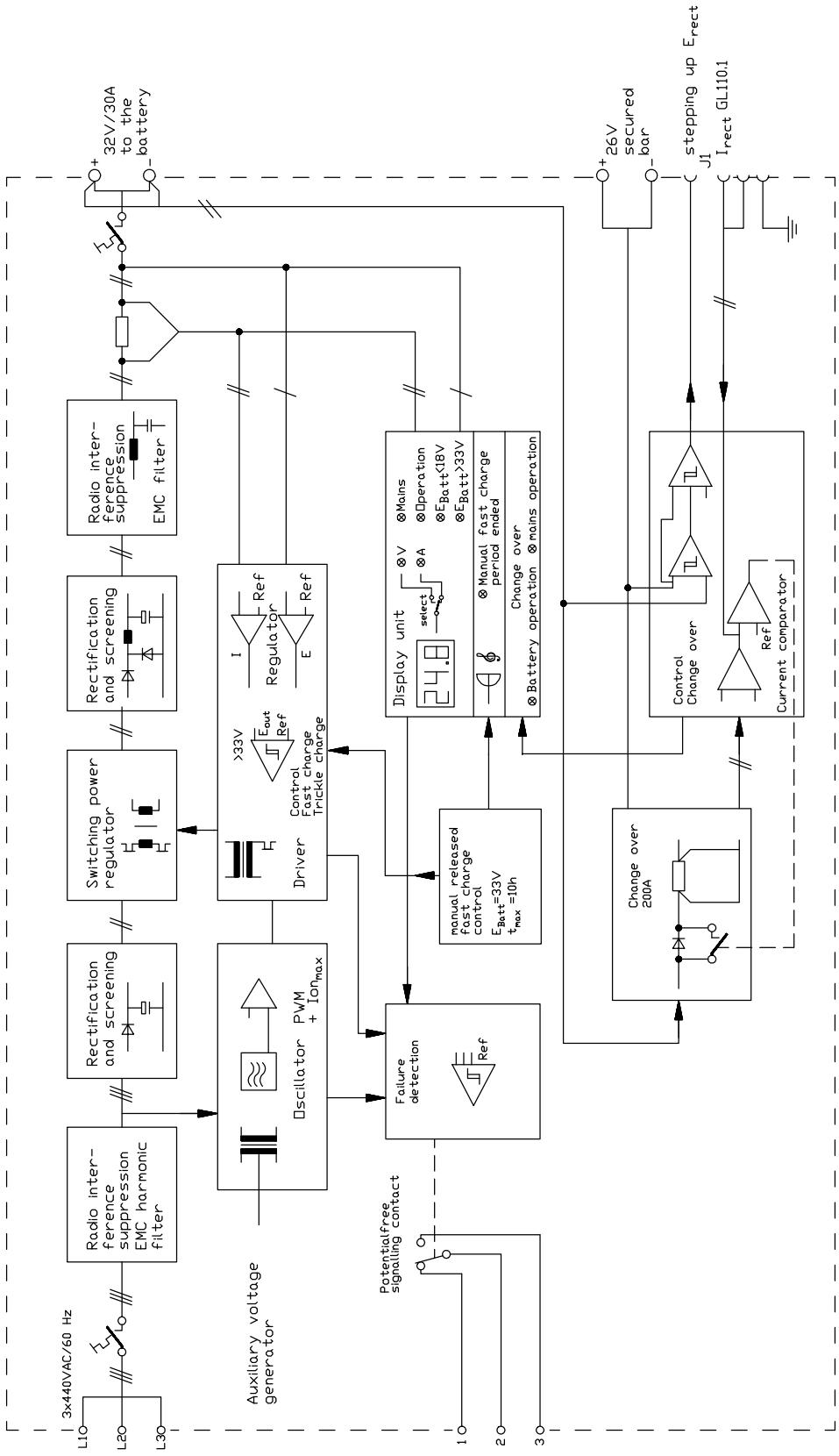

Fig. 5.4 LG 110 NC AC- and DC-connection

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Fig. 5.5 Complete circuit diagram LG 110 NC

Fig. 5.6 LG 110 NC charger with changeover unit

6. LG 110 NC reset switch

The reset switch is accomodated in the LG 110 NC. The functional principle is shown in the Fig. 6.1 and 6.2. The battery is connected via rectifier diodes to the “secured bar” so that the uninterruptible take-over of load is ensured (Fig. 6.3). Afer taking over the load, and dependent on the current, the reset switch closes the relay K1 thereby bridging the diode path. The criteria for switching on and off are shown in Fig. 6.1. Functional characteristics of the reset switch p.c.b.:

This component measures the reset switch current I_R, the voltage of the “bar” E_{bar} and the battery voltage E_{batt}.

Measuring points:

- I_R is measured at the resistor R1 and fed via KB8 to the measuring amplifiers (+ I_R, - I_R).
- E_{bar} and E_{batt} are measured directly via J22/J6 on the output terminals of the LG 110 NC charger.

The following data are transmitted by means of a connecting cable from the GL 110.1 rectifier (J1) to the LG 110 NC charger (J1):

- the rectifier current I_{rect} (1A I_{rect} 32,5 mV)
- transfer of signals from the LG 110 NC to the GL 110.1 in order to raise the output voltage.

In the “reset switch p.c.b.” assembly a summation current is built up ($I_{bar} = I_R + I_{rect}$) by means of which K1 is controlled acc. to the following criteria:

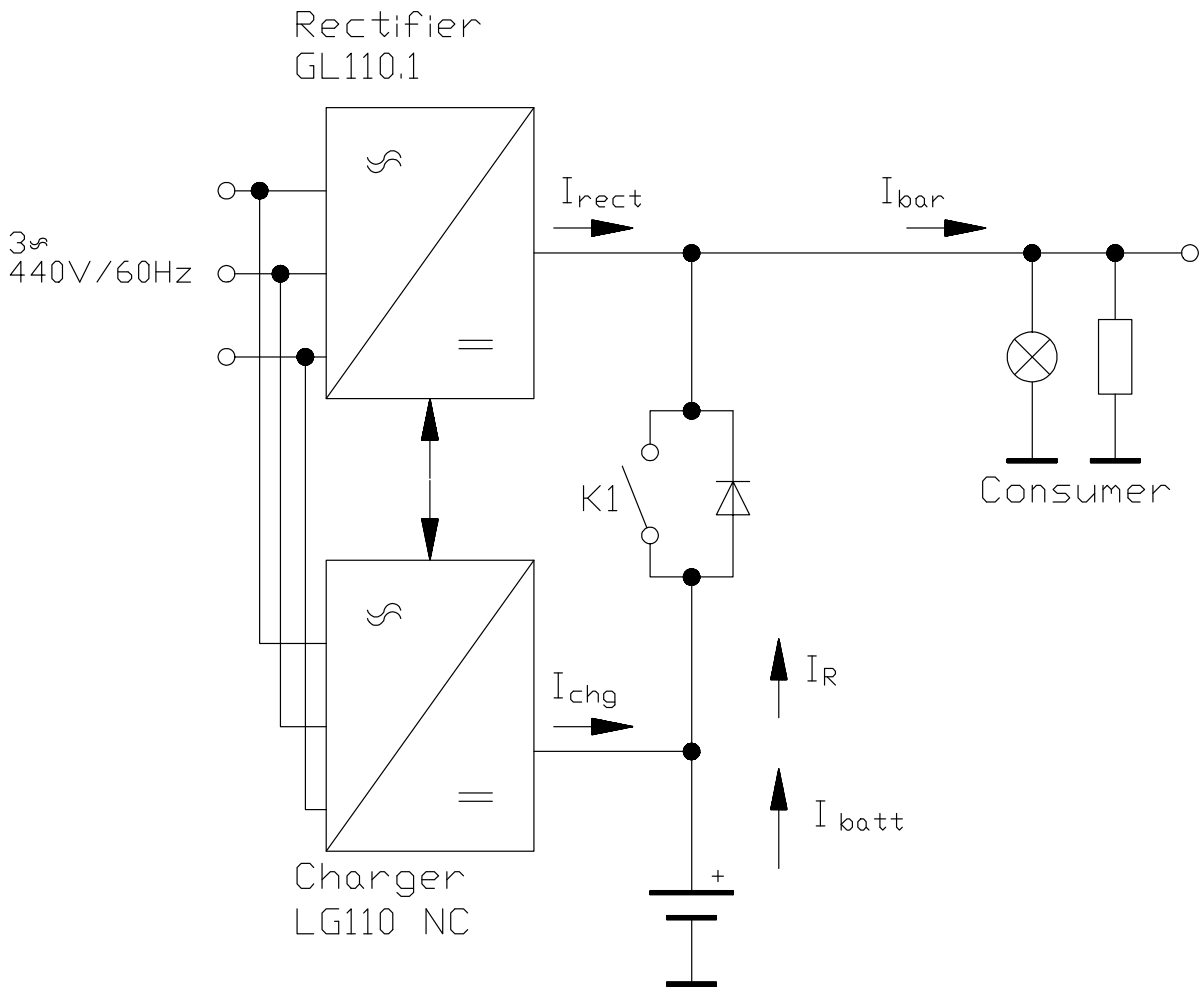
- Current load of the bar $I_{bar} > 80$ A and current in the reset switch $I_R > 50$ A effects an instantaneous cutting of the relay K1.

- Current load of the bar $I_{bar} > 80$ A and reset switch current I_R within the range $10 A < I_R < 50$ A effect cutting in of the relay after 2 minutes.

During a mains failure the reset switch K1 immediately bridges the diode length.

In case of a mains failure or a missing connection of the pilot line J1 the potential-free contact in the LG 110 NC will be activated, and the LED “Operating o.k.” will go out. As soon as the relay K1 is attracted, the display will be switched over to “battery operation”. The relay K1 remains switched on for at least 10 seconds. Opening the relay K1 is principally only possible with mains voltage applying to the rectifier GL 110.1 and a summation current of $I_{bar} < 80$ A.

The dealy and the graded cutting-in of the relay K1 prevents an unnecessary switching to and for during momentary load fluctuations. At a “bar” voltage of low setting and a high charging voltage, a current flow between battery and bar can be produced during the charge from which an uncontrolled charge would



result. To prevent this, the output voltage of the rectifier = bar voltage will be increased by approx. 1.8 V at a battery voltage which exceeds the “bar” voltage by 4.2 V. After decrease of the charging voltage the increased voltage at the rectifier output will also be reduced. Provision has been made for the bar voltage to be kept within STANAG tolerances (Fig. 6.4).

Fig. 6.1 Uninterruptible changeover operation GL 110.1 / LG 110 NC system

Criteria for switching on relay K 1

	Reset switch current IR		
Mains operation $I_R=I_{Chg} + I_{batt}$	< 10 A	10...50A	> 50 A
Emergency operation $I_R = I_{batt}$	remains OFF	2 min. ON	ON immediately

Criteria for switching off relay K 1

Legend:
I_{batt} = battery current
I_{rect} = rectifier current
I_{bar} = current at the secured bar
I_{chg} = charging current
I_R = reset switch current
t_{del} = delay time of relay

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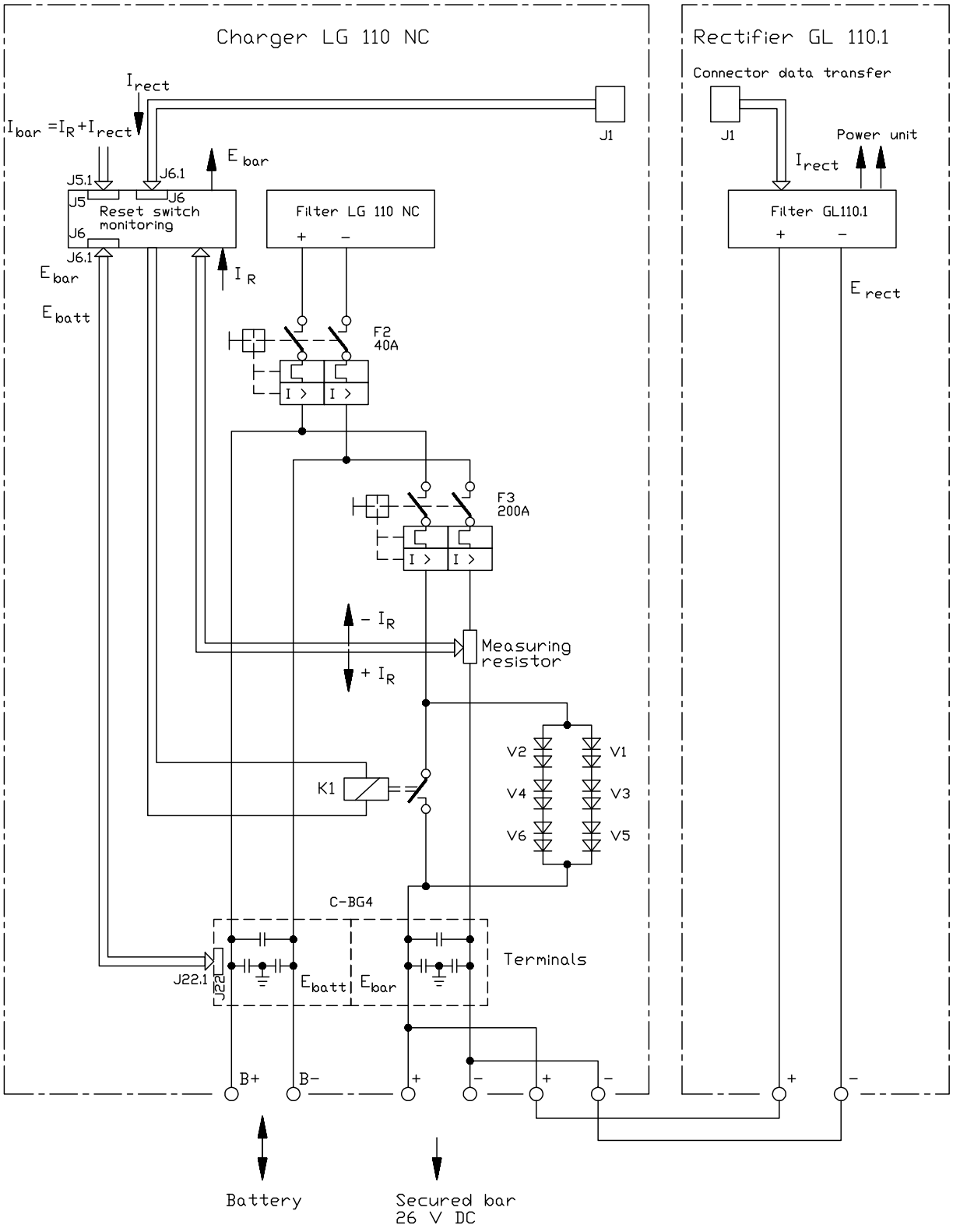

$I_{bar} = I_{rect} + I_R < 80$ A
To $t_{del} = 10$ s

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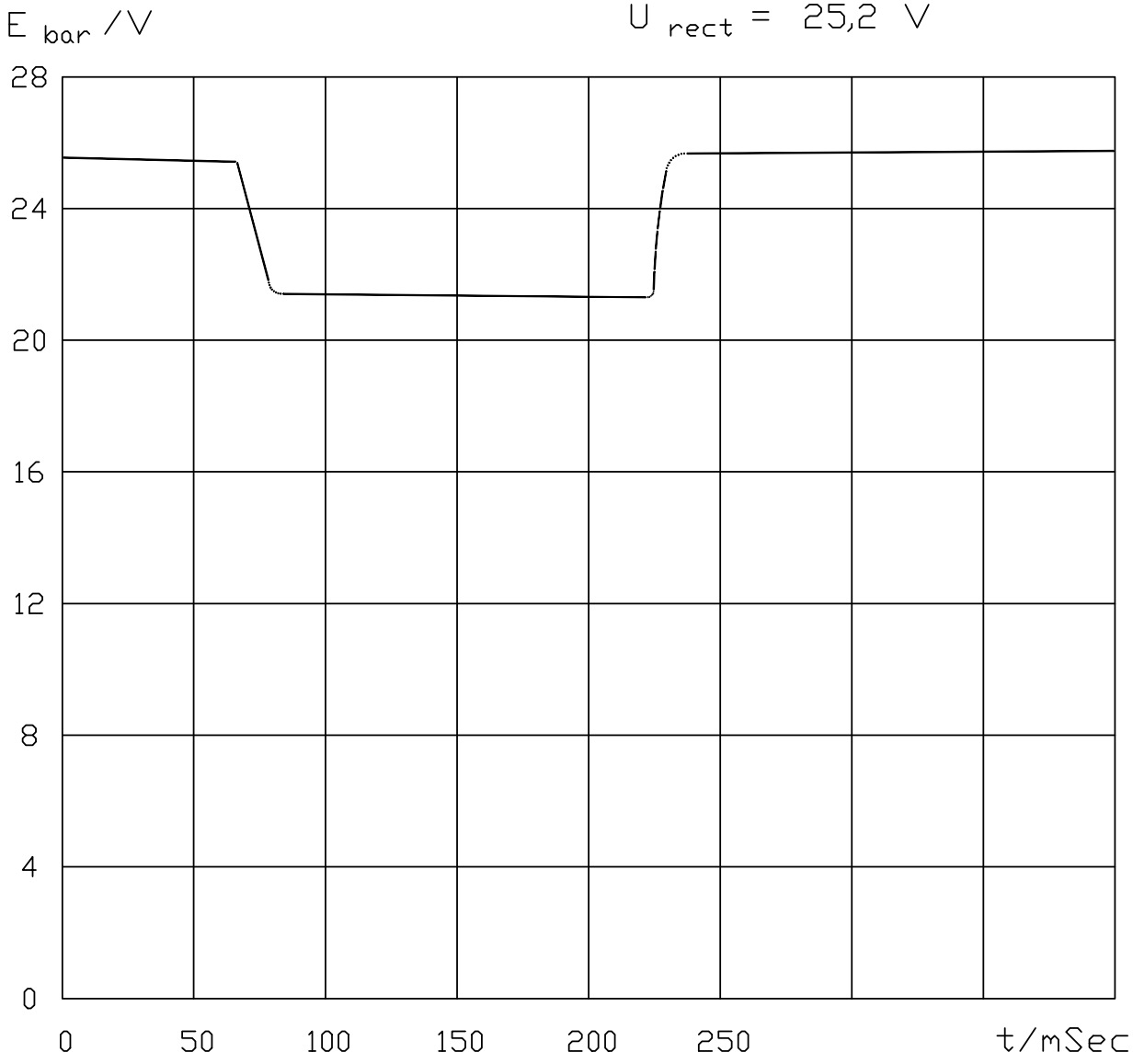
U_E = 440 V AC ± 10%
I_{bar} = 60 A
U_{batt} = 25,7 V
U_{rect} = 25,2 V



The relay K 1 switches Off only in case of mains operation

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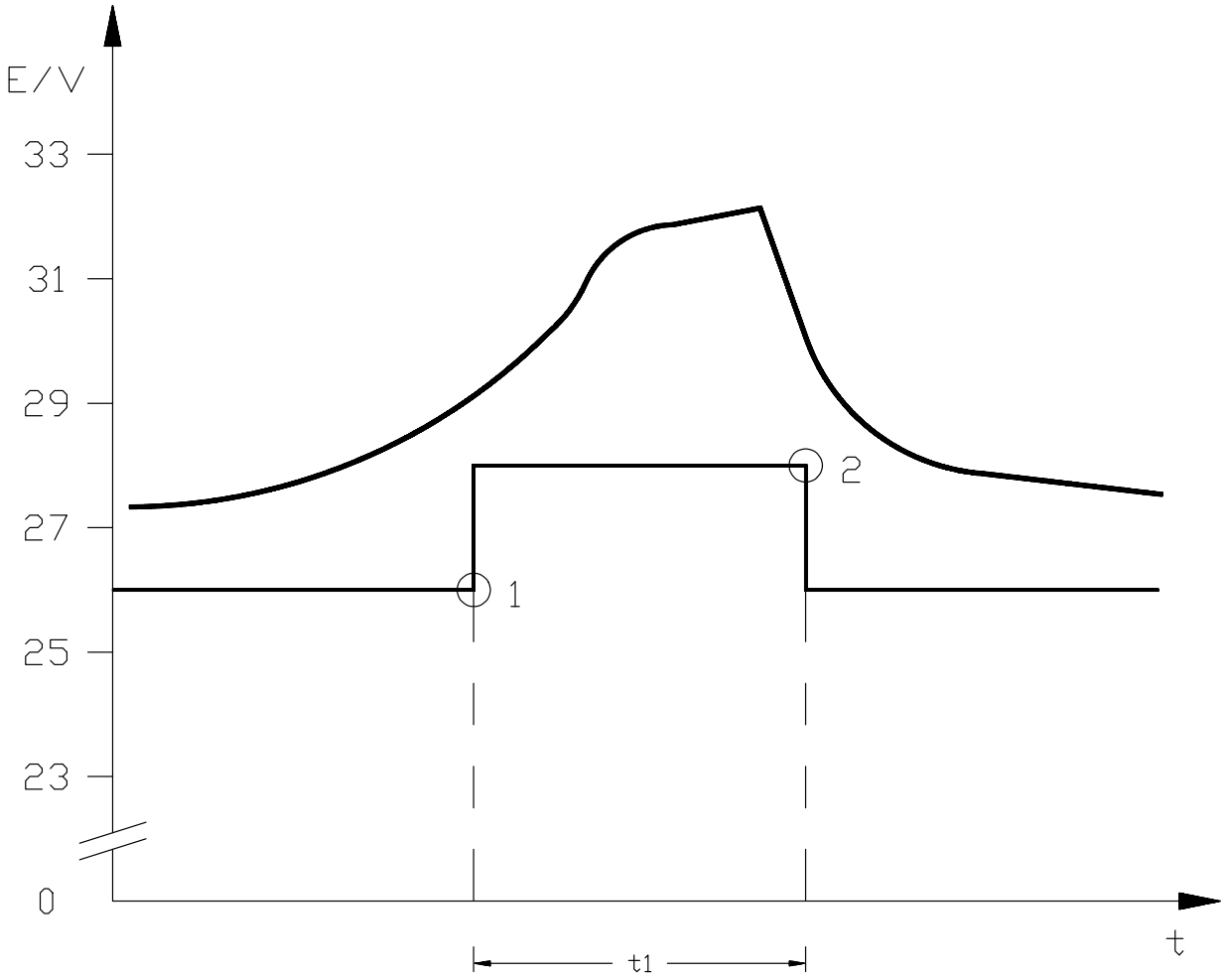

1 = EBatt - ESch > 3 V
2 = EBatt - ESch < 1 V
t1 = 10 - 30 min

Fig. 6.2 Function principle of reset switch

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Fig. 6.3 Changeover from mains to battery operation GL 110.1 / LG 110 NC

Fig. 6.4 Stepping-up of voltage GL 110.1

7. Technical data

7.1 GL 110.1 rectifier

Heigth	: 9 units of height (U)
Depth	: 270 mm as of front panel
Width	: 19 “
Weight (kg)	: approx. 37,5 kg
Protection category	: IP 20 to DIN 40050
Insulation class	: I
Input voltage	: 3 x 440 V ~ ± 10 %, 47...63Hz without neutral conductor
Rated current	: approx. 4.8 A/phase at 3 x 440 V
Active power absorbed	: 2900 W
Power factor	: cos.φ > 0.8
Output voltage	: 26...29 V/± 5 %
Output current	: 80 A max.
Rated power output	: 2320 W
Electrical efficiency	: ≥ 0.8
Output characteristic	: I/E (constant voltage with current limitation)
Circuit breaker at the mains input	: 5 A
Circuit breakter at the mains output	: 95 A

Fault indication by means of a potential-free signalling contact to the respective terminals

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Contact load	: 5 A / 250 V
EMC protection	: acc. to VDE 0871 B
Ambient temperature	: 0...45°C

7.2 LG 110 NC charger

Height	: 9 units of height (U)
Depth	: 270 mm as of front panel
Width	: 19 “
Weight (kg)	: approx. 38,5 kg
Protection category	: IP 20 to DIN 40050
Insulation class	: I
Input voltage	: 3 x 440 V~ ± 10 %, 47...63 Hz without neutral conductor
Rated current	: approx. 2.0 A/phase at 3 x 440 V
Power factor	: cos.φ > 0.8
Active power absorbed	: 1200 W
Charging voltage	: max. 32 V, setting from 27..32 V
Output current	: 30 A max.
Rated power output	: 960 W
Electrical efficiendy	: ≥ 0.8
Output characteristic of NiCd batteries	: Ia I - charging characteristic
Output characteristic of Pb batteries	: I_oE I_a - charging characteristic
Circuit breaker at the mains input	: 2.5 A
Circuit breaker at the output battery	: 40 A
Circuit breaker at the output “bar”	: 200 A

Failure indication via potential-free signalling contact to the outside

Contact load	: 5 A / 250 V
EMC protection	: acc. to VDE 0871 B
Saltwater-proof	
Ambient temperature	: 0...45°C

7.3 Reset switch

The reset switch assemblies are accomodated in the LG 110 NC charging section.

Max. current loadbattery - bar	200 A
Circuit breaker	200 A

Uninterruptible coupling of battery - bar via rectifier diodes.

Bridging of the rectifier diodes depending on current load

Changeover time:	200 ms at I > 50 A and in case of a mains failure

Changeover time:	2 min. at I = 10...50 A
No changeover	at I < 10 A

Opening of the relay contacts only with mains voltage applying to the GL 110.1 rectifier and after a delay of 10 seconds.

8. Taking into operation, operating and display elements

8.1 Taking into operation

- Insert the LG 110 NC and the GL 110.1 in the mounting rack (LG 110 NC at the bottom, GL 110.1 on top).
- Switch off all switches (GL 110.1: F1, F2 / LG 110 NC : F1, F2, F3) (Fig. 8.1, 8.2).
- Plug on the 4-pole connecting lead from GL 110.1 - J1 to LG 110 NC - J1 and screw it down.
- Connect output connector of GL 110.1(+/-) to output connector of LG 110 NC (+/-). (Min. 16 mm², max. 25 mm²) (Fig. 8.4). **(Maximum torque 25 Nm)**
- connect the output connectors (+/-) of the LG 110 NC (Fig. 8.4) to the "secured bar". **Mind the polarity!**

First connect the cable to the LG 110 NC and then to to battery.

- Connect the mains supply (L1, L2, L3, PE, 440 V AC mains supply). Where necessary, also the potential-free contact can be connected.
  Usage: 1-2: NC (normally closed)
  or 2-3: NO (normally opened)

- Switch on F2 on the LG 110 NC. LG 110 NC indicates the battery voltage.

- Set key switch to "0".

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- Switch on F1 on the LG 110 NC and on the GL 110.1 ; by means of the select switch the indication can be switched over so that either the output voltage or the output current will be indicated.

- By means of F2 on the GL 110.1 the voltage can now be switched over to the “secured bar”. Then the reset switch can be activated by means of F3 on the LG 110 NC.

8.2 Operating and display elements (Fig. 3.29

8.2.1 GL 110.1 rectifier

- Mains existing
  The yellow LED lights up when the circuit breaker F1 is closed.

- Operating o.k.
  The green LED lights up when the three red LEDs (overload, E_{out} >32 V and E_{out} < 18V do not light up and when the connecting cable between the LG 110 NC and the GL 110.1 (J1) is properly connected. The potential-free contact is coupled with the LED display.

- Select switch
  By means of this switch the indication can be switched over so that either the output voltage or the output current will be indicated.
  Accordingly, either the LED "Volt" or "Amp" lights up

8.2.2 LG 110 NC charger

- Mains existing
  The yellow LED lights up when the circuit breaker F1 is closed

- Operating o.k.
  The green LED lights up when the two red LED´s (E_{out} > 33 V and E_{out} < 18 V) do not light up and when the connecting cable between the LG 110 NC and the GL110 (J1) is properly connected, and F2 on the GL 110.1 is switched on.
  The potential free contact is coupled with the LED display.

- Select switch
  By means of this switch the indication can be switched over so that either the output voltage or the output current will be indicated.
  Accordingly, either the LED "Volt" or "Amp" lights up

- Mains operation / Battery operation
  The LEDs display the switching state of the reset switch.

  Mains operation:
  The green LED lights up when the “bar” is being supplied by the GL 110.1 rectifier set, the relay K1 is open.

  Battery operation:

The red LED lights up when the “bar” is being supplied by the battery, the relay K1 is closed.

- Manual charge ended
  The yellow LED lights up when the manual charge is finished after 10 h (key-switch "Manual charge" is in position "1").

9. Malfunction analysis

9.1 GL 110.1 malfunction analysis

Fault	Possible cause	Measuring point	Remedy
I. E_{out} too high	1. Setting of wrong rated values	- MP U_{soll} = 2.6 - 2.9 V (Note:If E_{Batt} - E_{rect} > 32 V then U_{soll} = U_{soll} + 0.18 V	- Reduce rated value by means of R 33 on the control p.c.b
	2. Defective control p. c. b.		- Replace control p. c. b.
	3. Defective sense line	KB5/KB10	- Replace sense line
II. E_{out} too low (I_{out} < 80 A)	1. Wrong rated value setting	- MP U_{soll} = 2.6 - 2.9 V	- Increase rated value on control p. c. b. by means of R 33
	2.Defective power unit	- signals at T3/T4, pins 11/12 **ATTENTION: High Voltage**	- Replace p.c.b.
	3. Defective control p. c. b.	-	- Replace control p. c. b.
III. No output voltage	1. F 1 or F 2 switched off	- J4 —> 620 V available (Fig. 9.1)	- Switch on circuit breaker
	2. F 4 of F 5 defective	- J 10 —> 4 x 20 V ~ E1 - E4 J 11 20 V ~/35 V ~ E5 ; E6 (Fig. 9.2)	- Replace fuses F4, F5 (5 x 30, 63 mA)
	3. Defective voltage supply p. c. b.	- J 13 —> 4 x 15 V - (Fig. 9.3) J 14 —> 15 V -	- Replace p.c.b.
	4. Control p. c. b. missing	- J 20 —> Measure output pulses (Fig. 9.4)	- Replace p. c. b.
	5. Power p. c. b. or Power transistors defective	- signals at T3/ T4, pins 11/12 **ATTENTION: High Voltage** **≈ 1400 V**	- Replace p. c. b. and Power transistors
IV. Faulty display	1. Display defective	- displayed values should not deviate from values measured on the outside	- check measuring points - Replace p. c. b.

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by more than 7 %.

Employed measuring instruments: - Oscilloscope for 40 kHz - Multimeter with internal resistance of apx. 1 M Ohm - High Voltage probe			
9.2 LG 110 NC malfunction analyses (NC)			
Fault	Possible cause	Measuring point	Remedy
I. E_{out} too high	1. Setting of wrong rated value	- MP1 = 3.2 V	- Reduce rated value by means of R 33 on the control p. c. b.
	2. Defective control p. c. b		- Replace control p. c. b.
	3. Defective sense line		- Replace sense line
II. E_{out} to low (I_{out} < 30 A)	1. Wrong rated value setting	- MP6 = 0.3 V	- Increase rated value on control p. c. b. by means of R 33
	2. Defective control p. c. b.		- Replace control p. c. b
III. Not output voltage	1. F 1 or F 2 switched off	- J 4 —> 620 V available (Fig. 9.5)	- Switch on circuit breaker
	2. F 4 or F 5	- J 10 —> 2 x 20 V ~ (E1 : E4) J 11 20V ~/ 35 V ~ (E5 : E6) (Fig. 9.7)	- Replace fuses F4 (5 x 30, 63 mA) or F5 (5 x 30, 160 mA)
	4. Control p. c. b. missing	- J 20 —> Measure output pulses (Fig. 9.8)	- Replace p. c. b.
	5. Power p. c. b. or Power transistor defective	- Measure signals at T4	- Replace p. c. b. and Power transistors
IV. No trickle charge	1. Defective fuse on display p. c. b.	- (Fig. 9.9)	- Replace fuse F7 (5 x 20, 0,2 AT) - replace regulator p.c.b.
V. Faulty display	1. Display defective	- displayed values should not deviate from values measured on the outside by more than 7 %.	- check measuring points - replace p. c. b.
VI.			

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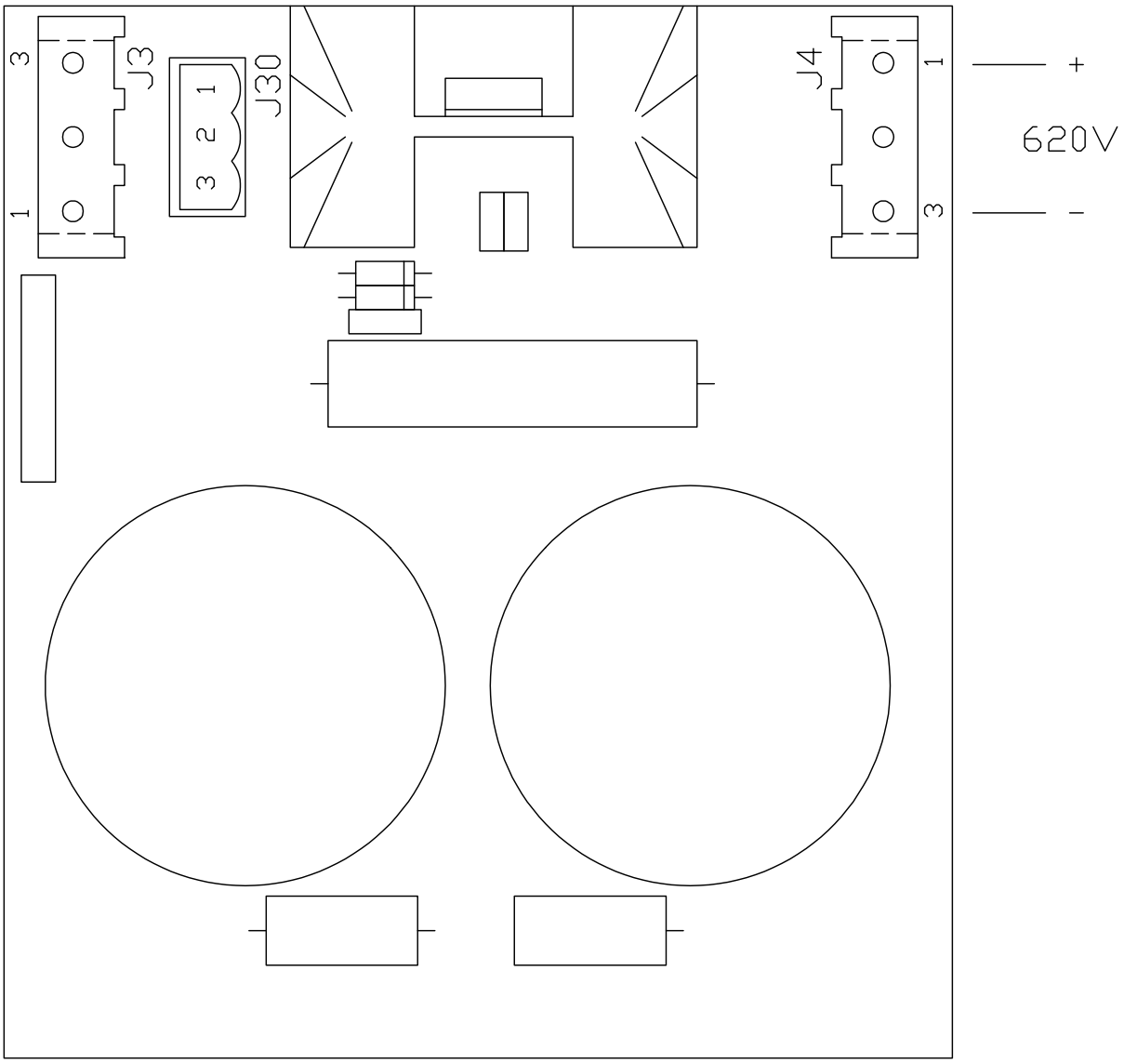

Reset switch fails to switch	1. F 3 switched off	-	- Switch on circuit breaker

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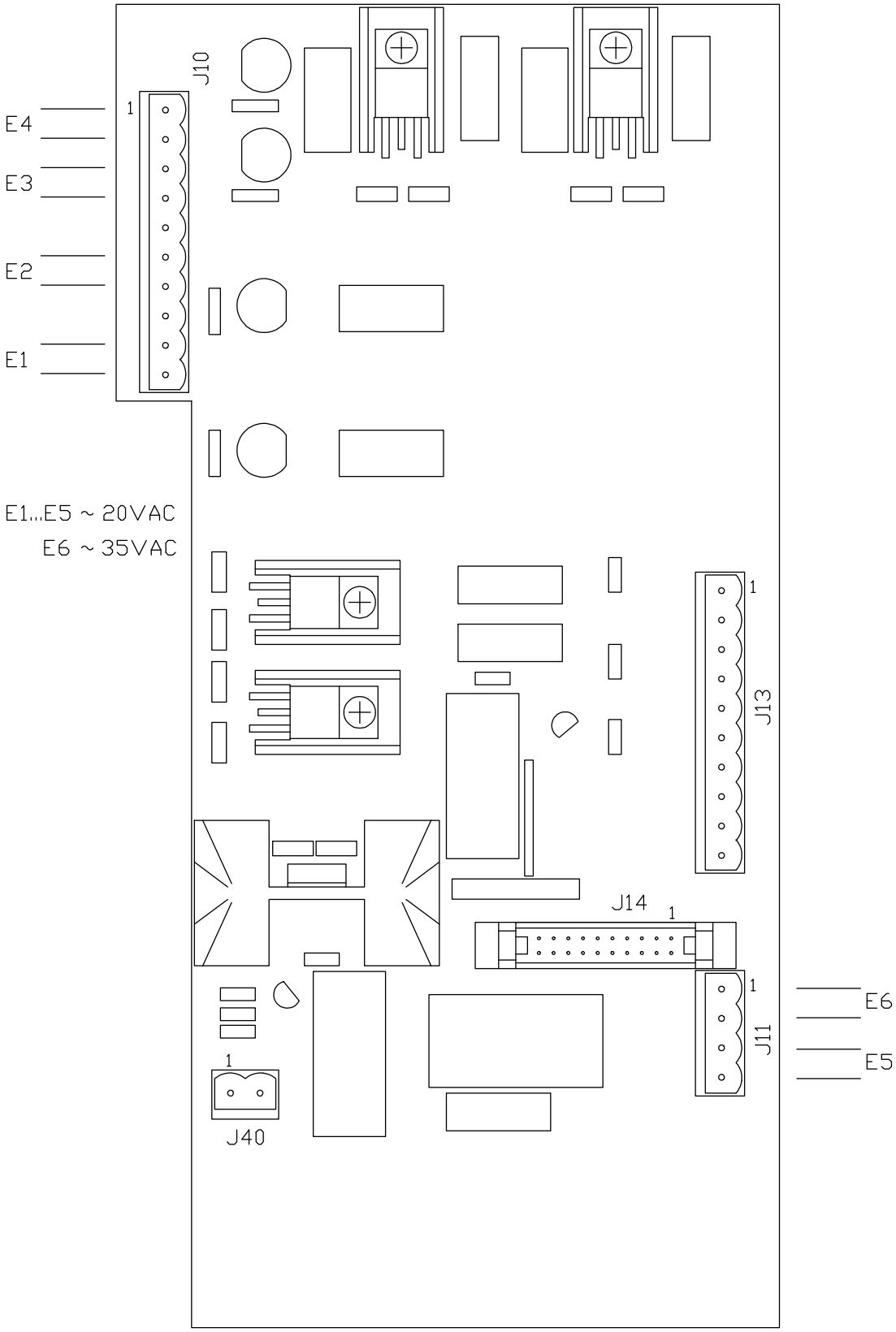

2. F 6 on reset switch - Earth —> Pin 5 - Replace fuse F6

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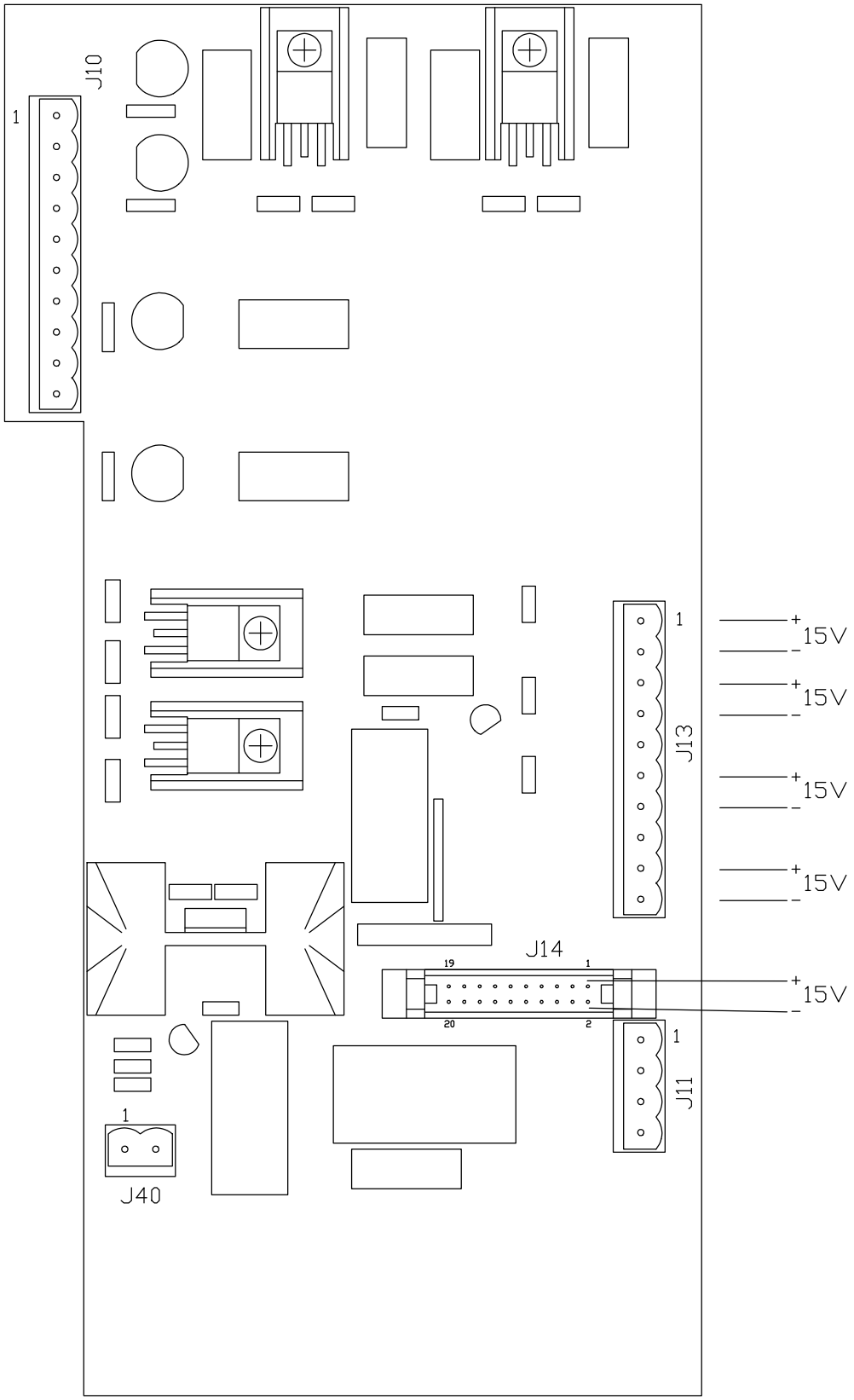

board defective J 6 —> + Ebar (Fig. 9.10) (5 x 15, 2 AT)

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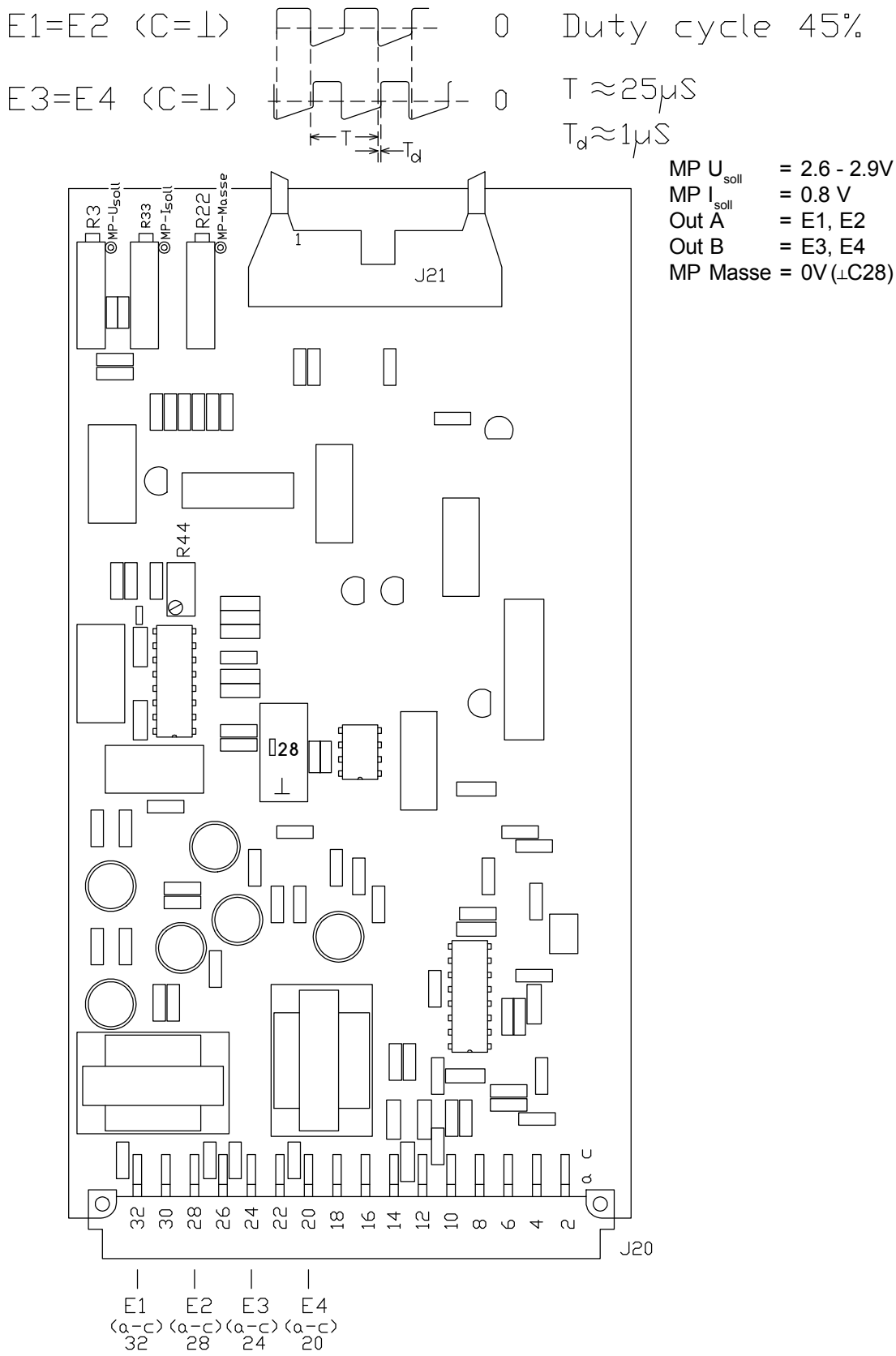

3. Reset switch relay K 1 defective	- Measure voltage on Earth —> Pin 5	- Replace reset switch

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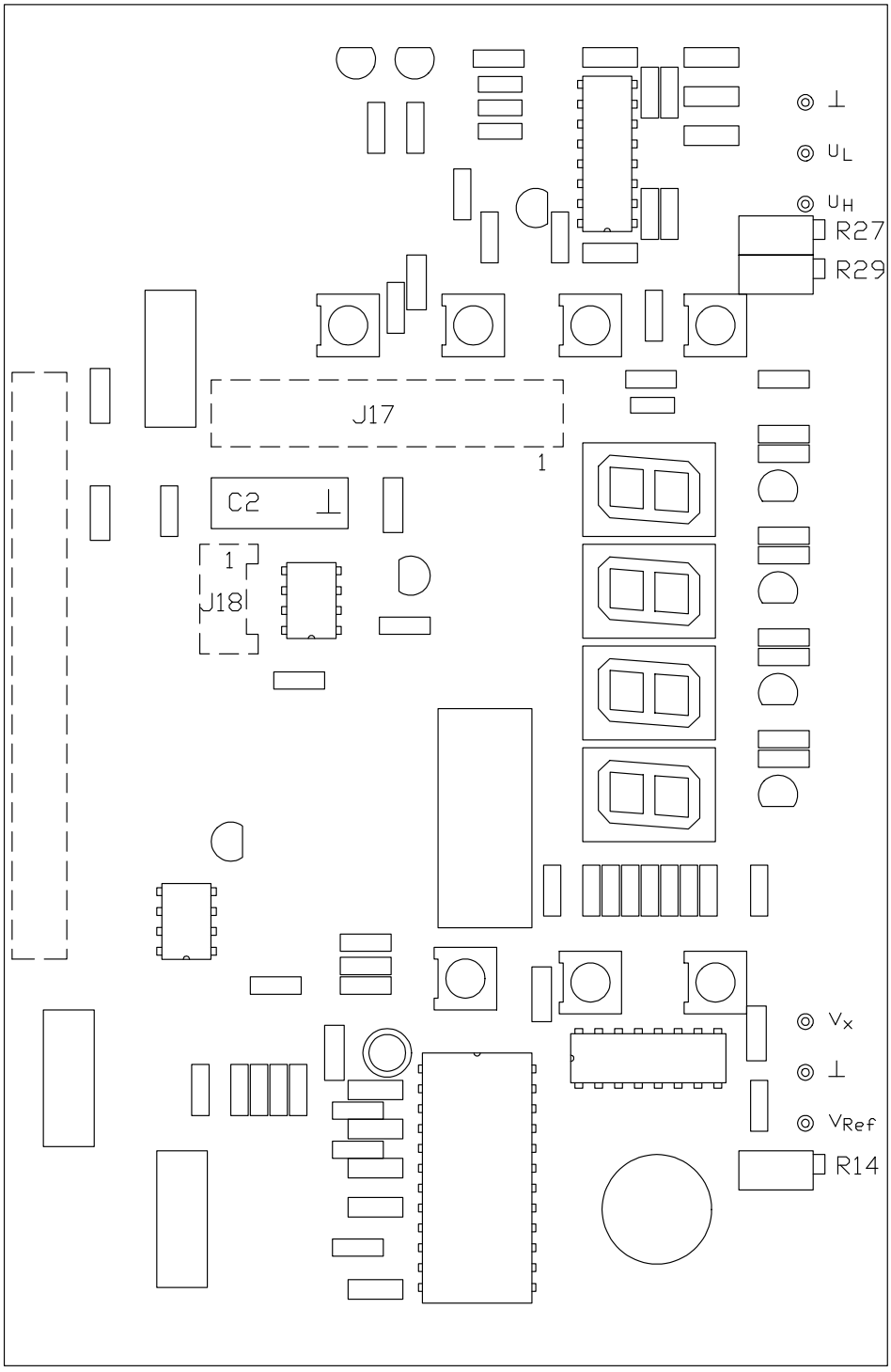

J 6 —>< + Ebar (Fig. 9.10)

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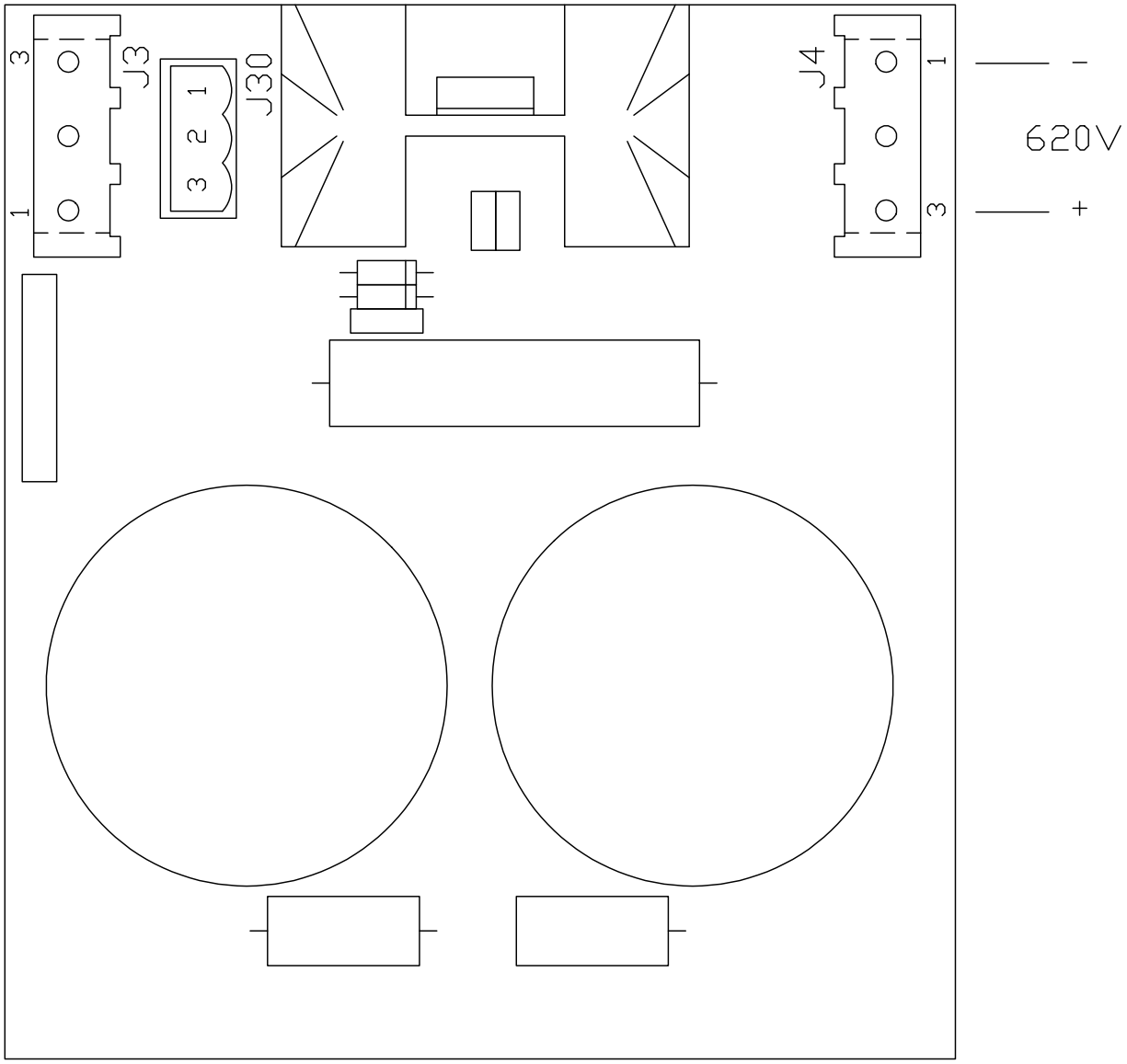

4. Reset switch defective

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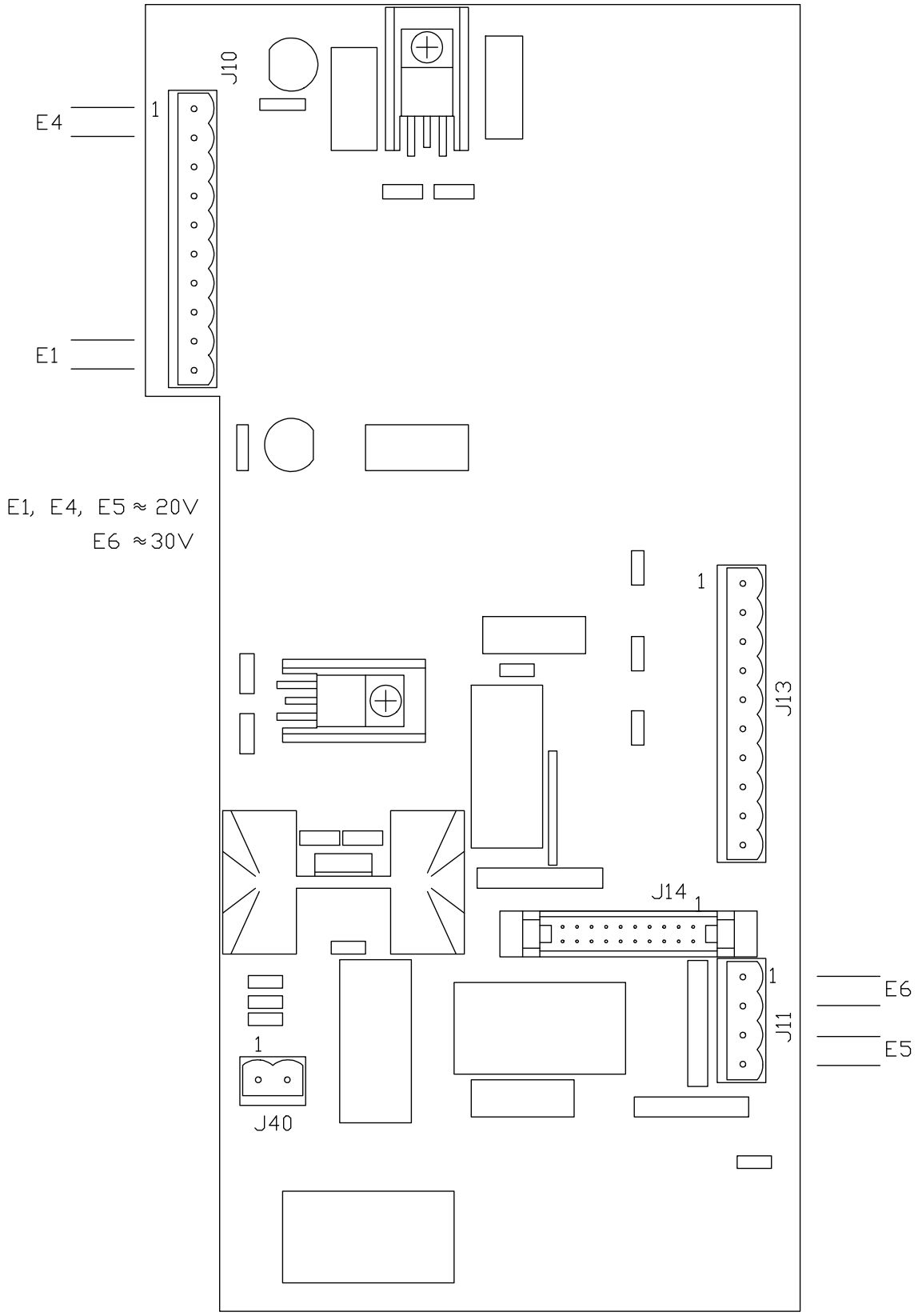

Fig. 9.1 Mains screening GL 110.1
NS2, Order No.:2 1576 428 00

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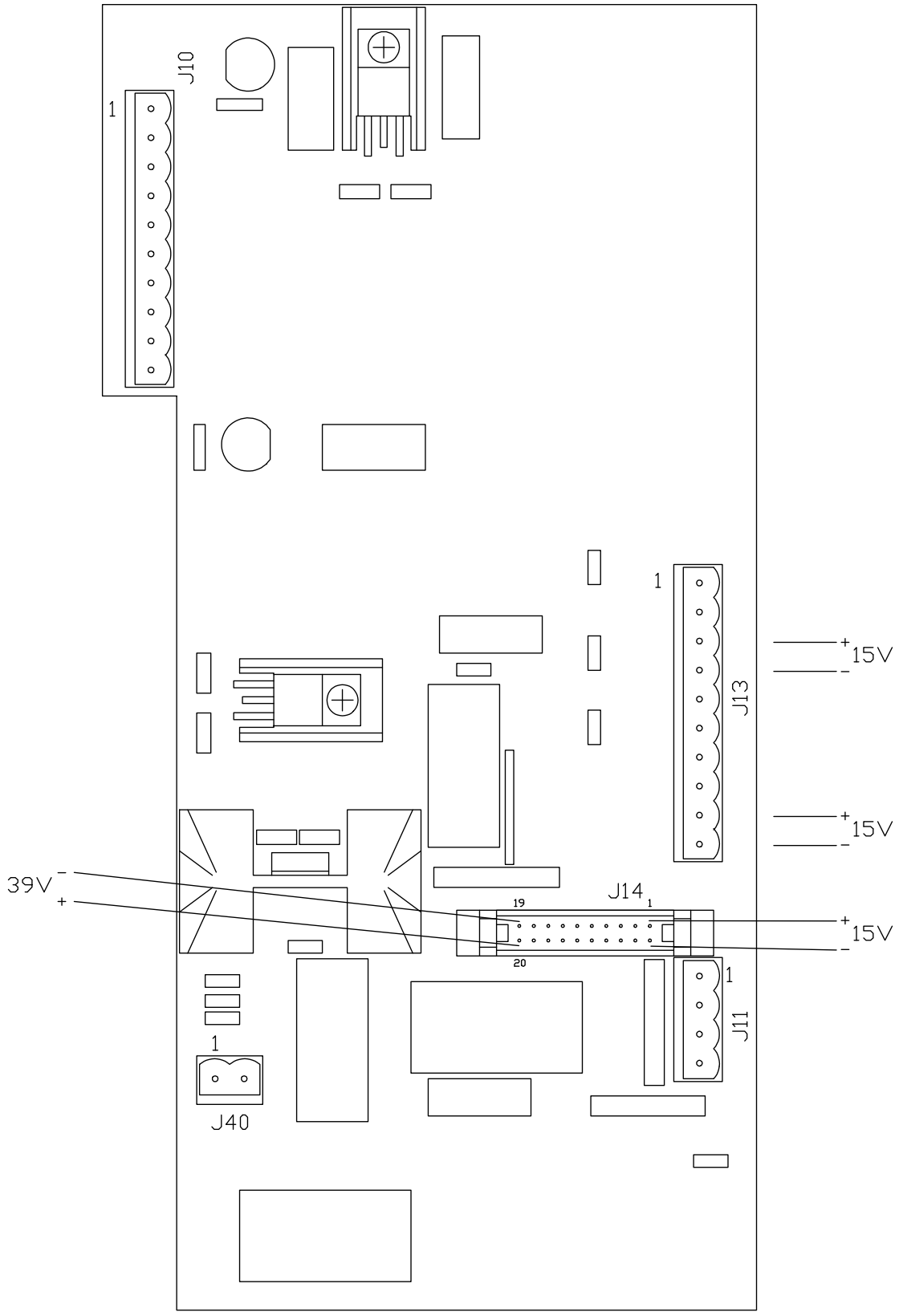

Fig. 9.2 AC Measuring GL 110.1
SV2, Order No.: 2 1577 122 000

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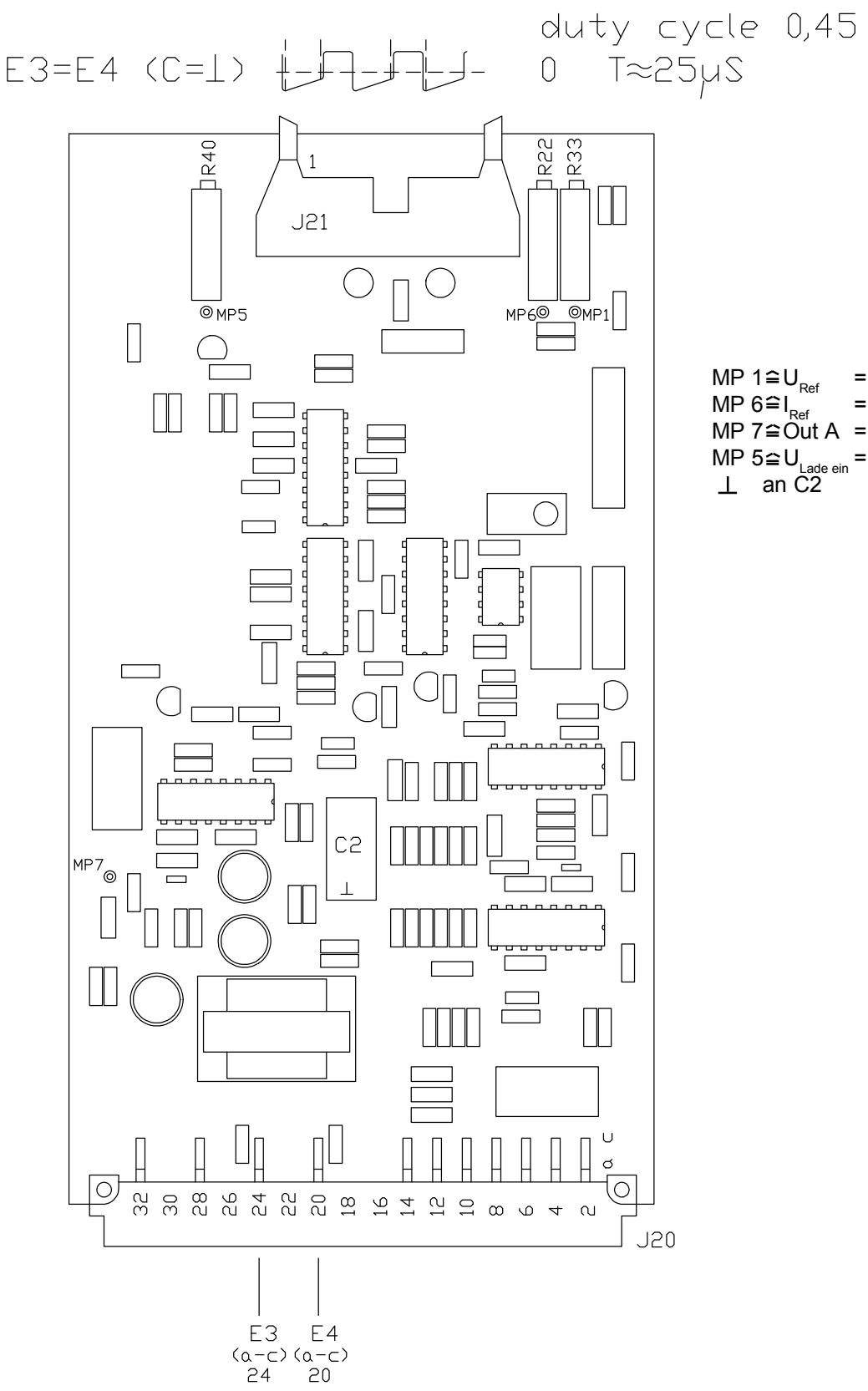

Fig. 9.3 DC Measuring GL 110.1
SV2, Order No.: 2 1577 122 000

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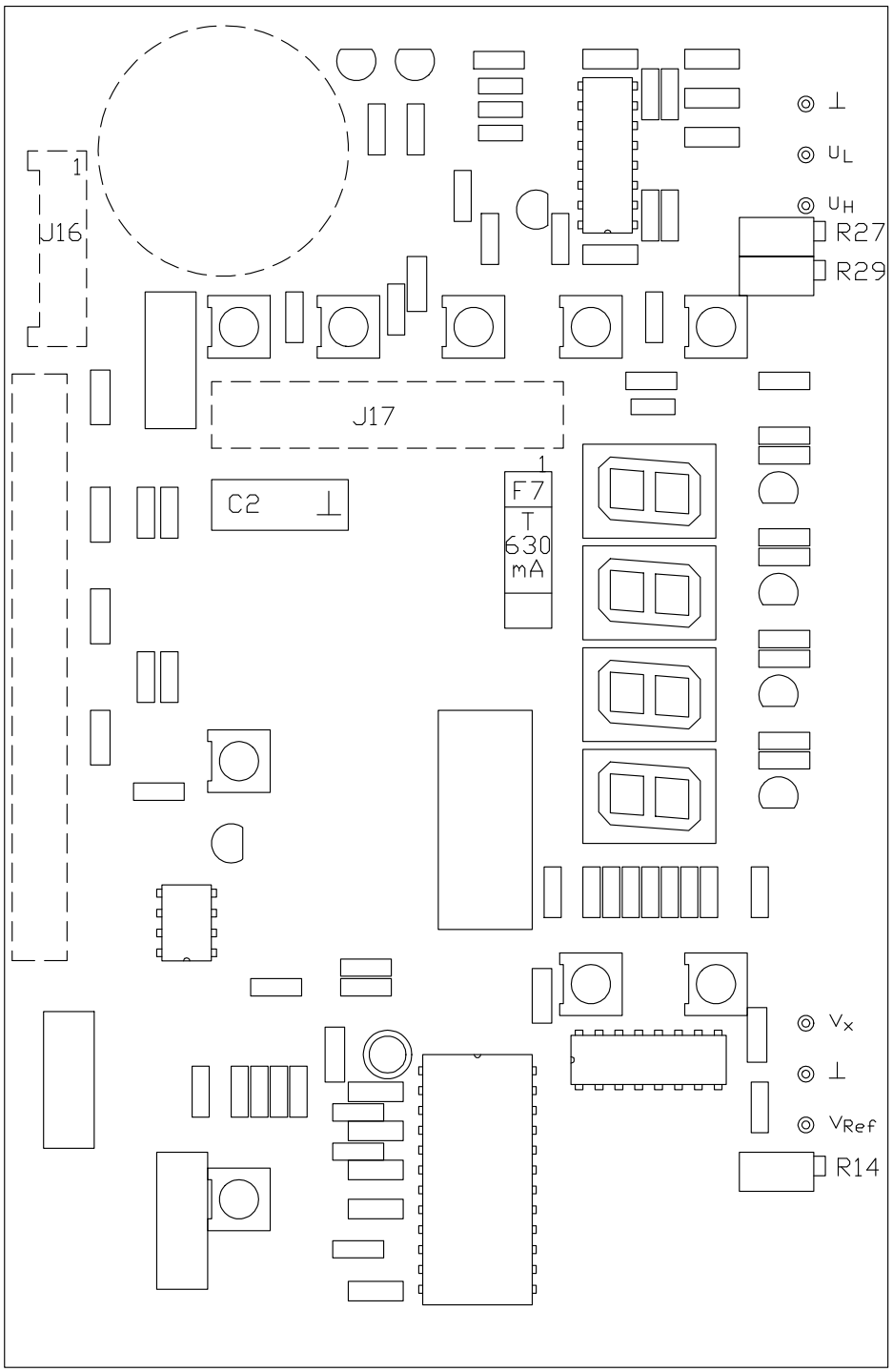

Fig. 9.4 Pulse Measuring GL 110.1
ST2, Order No.: 2 1577 021 000

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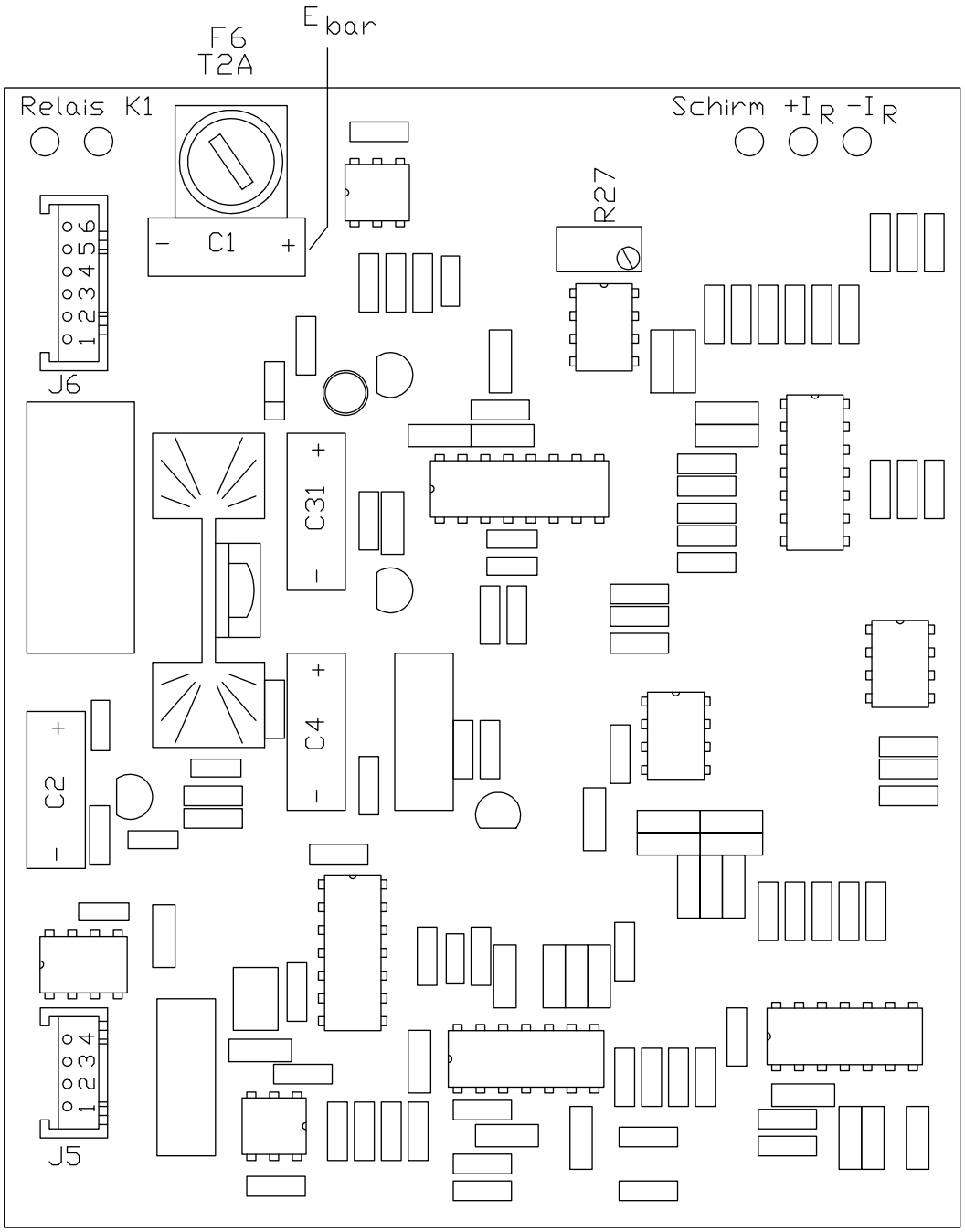

C1- = ⊥
C31+ = U_{Ref} = 2.45 V
C2+ = V_{CC} = 15.00 V
C4- = $-V_{CC}$ = -6.80 V

Fig. 9.5 Display p.c.b. GL 110.1
AZ2, Order No.: 2 1576 124 000

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Fig. 9.6 Mains screening LG 110 NC
NS1, Order No.: 2 1576 428 000
Fig. 9.7 AC Measuring LG 110 NC
SV1, Order No.: 2 1576 122 000
Fig. 9.8 DC Measuring LG 110 NC
SV1, Order No.: 2 1576 122 000
Fig. 9.9 Pulse Measuring LG 110 NC
ST1, Order No.: 2 1576 221 000
Fig. 9.10 Display p.c.b. LG 110 NC
AZ1, Order No.: 2 1576 123 000
Fig. 9.11 Reset switch p.c.b.
RS1, Order No.: 2 1576 029 000

Annex

Schematic Diagrams LG 110 NC
Schematic Diagrams GL 110.1
Dimensional Drawings LG 110 NC
Dimensional Drawings GL 110.1
Spare Parts List LG 110 NC
Spare Parts List GL 110.1

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