

E M K 11

Emission Current Regulator
for directly heated Electron Beam Guns

1	Summary.....	3
1.1	Application.....	3
1.2	Function	3
1.3	Design.....	3
2	Warranties	3
3	Technical Data	4
3.1	Electrical	4
3.1.1	Power Supply	4
3.1.2	Input Signals	4
3.1.3	Output Signals.....	4
3.2	Connector assignment	5
3.2.1	X1 AI-EMR1 Regulator Board.....	5
3.3	Elements of the Front Panel	6
3.3.1	LED's	6
3.3.2	Test jacks, Trimmer, Switches	6
3.4	Elements on the Board.....	7
3.4.1	Regulator Board	7
3.4.2	SCR-Board.....	7
4	Service Instructions.....	8
4.1	Analog inputs	8
4.1.1	Emission Current Setpoint, local	8
4.1.2	Emission Current Setpoint computer/rate regulator	8
4.1.3	Filament Current Offset IHO.....	8
4.1.4	Emission Current Actual Value.....	8
4.2	Emission Current Regulator	9
4.3	Filament Current Offset IHO.....	9
4.4	Filament Current Regulator	9
4.5	Actual Value Outputs.....	9
4.5.1	Emission current	9
4.5.2	Filament current	9
4.6	Reference Voltage Source	10
4.7	Fault Monitor	10
4.8	Regulator Blocking	10
4.9	Mode Select	10
4.10	Firing Pulses	11
4.10.1	Generator IC	11
4.10.2	Long Pulses	12
4.11	Power section /actuator.....	12
5	Test Procedure.....	13
6	Commissioning.....	13
7	Trouble shooting	13
8	Drawing Numbers	14
9	Revision	14

1 Summary

1.1 Application

The EMK11 regulates the emission current of a directly heated electron beam gun by varying the filament current.

1.2 Function

The EMK11 features emission current -regulator and filament current-regulator in cascaded sequence. Superposition of an external (rate-) regulator is optional. Every nested regulator receives its setpoint from the superimposed regulator or from the setpoint-input. The externally supplied actual values are fed to the corresponding regulator via buffers. The last regulator feeds the firing-pulse-generator.

The EMK11 features the following modules:

- differential inputs of setpoints,
some with ramp generators
- emission regulator with inhibit
- filament regulator with inhibit
- actual value of filament current
- true RMS converter of filament current
- firing pulse generator (integrated circuit)
- floating circuitry by means of synchronisation voltage
transformer, firing pulse transformers, current transformer, opto isolator, relais
- single phase SCR module with overvoltage protection
- fault monitor
- reference voltage source
- buffered outputs for actual values

1.3 Design

The regulators and all corresponding parts are mounted on the - front view - right board A1 EMK, the power section, consisting of firing pulse generator, synchronisation voltage transformer, firing pulse transformers, current transformer, power relays and SCR module, on the „left“ board A2 1 (the SCR module is in fact mounted on a heat sink and connected to the board).

2 Warranties

Under this Agreement the sole obligation of Leybold AG with respect to the information in this document shall be to exercise due care and diligence in transmitting such information with reasonable promptitude and adequate completeness to the other party and to correct any errors in such documentation without delay, at its own cost.

Any other warranty whatsoever of Leybold AG is excluded. Leybold AG, for example, without limiting the generality of them foregoing, is not responsible for the ability of the other party to use the information provided with the manual.

Furtheron LH AG makes no commitment to up-date nor to keep current the information contained in this document. No part of this document may be copied or reproduced in any form or by no means without the prior written consent of Leybold AG.

3. Technical Data

3.1 Electrical

3.1.1 Power Supply

Regulator

+ 15 V, + 400 mA, - 100 mA

isolation class A acc to DIN 0110

SCR

127/230 V, 50/60 A, max. 2 A

isolation class C acc to DIN 0110

3.1.2 Input Signals

Set Points

input type: differential amplifiers (ref. 4.1)

input resistance > 1 M Ohm (overload: 10 K Ohm)

0 ... 10 V eq. 0 ... 100%

unused inputs must be connected to 0 V

Actual Values

input type: differential amplifiers (ref. 4.1)

input resistance > 1 M Ohm (overload: 10 K Ohm)

0 ... 10 V eq. 0 ... 100%

amplification x 1/2/4/8/20/40/80 selectable

Digital

- power on, regulators on, emission/rate regulation

24 V, 10 mA

3.1.3 Output Signals

Reference Voltage

10 V max. 5 mA

(for external setpoint potentiometer)

Actual Values

emiss3-on current XE1, -amplified XE2,

filament current Xeff

0 .. + 10 V, Rload min 10 K Ohm

Contact "Fault Monitor"

floating

rating 10 W, AC 30 V / DC 36 V, 0,5 A

opens for fault or missing regulator supply

3.2. Connector assignment

For identification purposes in the circuit diagram the main connector of the regulator board (right handed) is referenced to as X1 and as X11 of the power board (left handed) though both are marked as X1 on the individual board. X2 connects both boards. Text in brackets "(+ 15 V regulator supply)" refers to internally used signals accessible on connector pins.

3.2.1 X1 AI-EMR1 Regulator Board

Connector type: F48 indirect on to DIN 41612

d2	(+ 15V regulator supply)	(IA02) *
d4	+ 10 V output reference voltage	1A02
z4	0 V	1C02
d6	+ input setpoint I (from potentiometer)	1B02 **
b6	- input setpoint I (from potentiometer)	1B02 **
d8	+ input setpoint II (from computer)	1C02 **
b8	-input setpoint II (from computer)	1C02 **
d10	+ input setpoint III (from rate regulator)	1D02 **
b10	- Input setpoint III (from rate regulator)	1D02 **
d12	+ input setpoint IH0 (.from computer)	2A02 **
b12	- input IH0 (.from computer)	2B02 **
d14	+ input actual value emission current	1E02
b14	- input actual value emission current	1E02
d16	(output of filament current regulator YJ)	3B16
d18	analog output XE1 emission current	3E05
d20	analog output XE1 emission current	3E11
d22	analog output XE1 emission current	2D15
z22	0 V /analog-outputs	2E15
d24	digital input, "activate regulators" IRMS	4B02
d26	digital input, "activate regulators	4B02
d28	digital input, "activate regulators	4C02
d30	(-15 V regulator supply)	1A02
d32	0 V regulator supply	1A02
b32	0 V.1.filter capacitors of analog inputs	1E02
z32	0 V.digital inputs	4C02

* 1A02 refers to page 1, row A, column 02 of circuit diagram 5.842-003273

**not used inputs must be connected to 0 V

3.3. Elements of the Front Panel

3.3.1 LED's

Regulator Board

H1	regulating emission current	4E13
H2	regulating deposition rate	4E13
H3	regulator activated	4BO6
H4	not u,d	

SCR Board

H1	power on	5D14
H2	fault monitor	5DO5

3.3.2 Test jacks, Trimmer, Switches (regulator board only)

WE	X3	setpoint of emission current	1B15	
	X4	filament current offset IHO	3DO9	
XE	X5	actual value of emission current	1E16	
XJ	X6	filament current, filtered	3B11	
YE	X7	output of emission current regulator	3B15	
YJ	X8	output of filament current regulator	3A15	
xi	X9	filament current, real	2DO3	
	X10	filament current, RMS	2D14	
	X11	w - x difference	2CO8	
M	X12	0 V, analog reference	1B15	
	R6	filament current offset	2BO9	
	S1	amplification of emission current actual value		1D12
		S2	select emission/rate	4EO3

3.4 Elements on the Board

3.4.1 Regulator Board

C14	I-response of emission regulator	3A03
R24	P-response of emission regulator	3A04
C8	I-response of filament regulator	3A13
R9	P-response of of filament regulator	3A15

R27, 29, 30 (1 ...) and R15, 31 (2 ...) are offset trimmers; By means of R13 (2D10) analog output IRMS is set to 10 V eq. 2A.

3.4.2 SCR-Board

The test jacks at the upper edge of the board are accessible only by using extender boards.

X3	synchronisation voltage max. ± 1 V	5A08
X4	saw teeth of firing pulse generator (10 M Ohm probe required)	5C05
X5	pulse generator, 10 KHz synchronised to firing pulses	5A06
X6	firing pulses	5A06
X7	filament current, real, rectified	5D13
X8	0 V	5D13
LB60	modification for 60 Hz	5C03

4. Service Instructions

The operating principles of an inverting regulator, an amplifier, a comparator and offset compensation are considered known and therefore not discussed further.

The components of the EMK11 are mounted on two printed circuit boards, both double-lined through-contacted, made of epoxy-resin glass fabric.

AI-EMR1 provides the complete analog signal processing (regulators, input amplifiers a.s.o). A2-EML1 provides the firing pulse generator and all components connected to the mains. The boards are connected one to the other by means of X2 and a flat cable.

The numbering of the components is alphanumeric in correspondence to the circuit diagram. It begins in the top left corner and proceeds to the right downwards, anew on each board.

Thus AI and A2 both have an R1....

4.1 Analog inputs

The setpoint inputs (local, computer/rate regulator, minimum filament current) and the input of the actual value of the emission current consist of differential/instrumentation amplifiers.

Thus it's mandatory to run both wires (+/-) to the signal source. The signal sources must be ground-referenced once and connected to X-/4 (1C02) or Xld32 (1A02). The inputs are filtered by means of C-L-C (C21, L2, C19, 1AB..) and protected against overvoltage by means of resistor-diodemodules (zIVIB06).

Unused inputs must be connected to ground (0 V)!

4.1.1 Emission Current Setpoint, local

The differential amplifier N8 (1B08) with offset trimmer R27 (1C08) is followed by a ramp generator N5A (1B13) which prevents steps in the value setting.

4.1.2 Emission Current Setpoint computer/rate regulator

The setpoint source is selected by means of reed-relay K3 (1C03/4C11) and fed to the differential amplifier N9 (1D08) with offset trimmer R29 (1D08). The ramp generator is bypassed because on one hand the computer can be programmed not to output fast changes and on the other the output signal of the rate regulator must not be affected.

4.1.3 Filament Current Offset IHO

The differential amplifier N11 (2A07) w/ offset trimmer R31 (2B07) or-, in local mode - the trimmer R6 (2B04) is followed by a ramp generator N3B (3C05) which prevents steps in the value setting.

4.1.4 Emission Current Actual Value

The differential amplifier N10 (1E08) with offset trimmer R30 (1E08) is followed by amplifier N5B (1E13). The amplification factor is settable to x 1, 2, 4, 8, 20, 40, 80 by means of S1 (1D12)

4.2 Emission Current Regulator

The PI-response of regulator N6B (3A03) is set by C14 (3A03) and R24 (3A04). Because C14 and R24 are located on solder posts, it is easy to adapt the response to other applications. Documentation of a modification is essential.

The setpoint source (manual or computer/rate) is selected via K2B (1B14); the actual value is provided via N5B (X4, ref. 4.1.4).

4.3 Filament Current Offset IHO

It is a feature of all electron beam guns -even of TV- and amplifier-tubes, which are operated with constant filament current - that even for the slightest emission current a relatively high filament current (IHO) is necessary. A 100% change of emission current is effected by e.g. a 20% change of filament current.

In order to use the full 10 V swing of the emission current regulator (YE), IHO and YE are processed by means of N3A (3A10), N3C (3C07) and multiplier N2 (3A07) to get the filament current setpoint W according to the equation:

$$W = (10 \text{ V} - \text{JHO}) * \text{YE} / 10 + \text{JHO}$$

In local mode JHO is set by means of R6 (2B09) and in remote mode by the setpoint input (ref. 4.1.3), selected by K1B (2A10) according to the table given in 4.9.

4.4 Filament Current Regulator

The PI-response of regulator N3D (3A14) is set by C6 (3A13) and R9 (3A15). Because C6 and R9 are located on solder posts, it is easy to adapt the response to other applications. Documentation of a modification is essential.

Protection of the SCR module requests a very fast response of the regulator. Therefore the - by means of R7G, C6, C7 (3B11) - averaged actual value is chosen and not the slower RMS value.

For higher firing angles the difference between averaged and RMS value is considerable. -But it doesn't matter since the current regulator is the innermost one.

4.5 Actual Value Outputs

4.5.1 Emission current

The actual value of the emission current XE1 is available at the card connector buffered and protected against shorting and transients by means of N6C (3E02), Z5, Z6 (3E02/04). XE2, the amplified value, is processed the same way [N6D (3E09), Z3, Z4 (3E10)].

4.5.2 Filament current

It is measured on EML1 by means of the current transformer T3 (5C15), rectified by V9 (5C13) and converted to nom. 10 V by R12 (5C12). UR12 is fed to the current regulator (ref. 4.4) and to the true-RMS-converter N1 (2E07).

C4, R3, C5 (2E09) and internal circuitry of N1 provide a second-order active filter. The settling time is approx. 50 ms.

The output of the RMS-converter is amplified in N6A (2D12) and available at the card connector ' protected against shorting and transients by means of Z1 and Z2 (2CD13).

4.6 Reference Voltage Source

The reference voltage of 10 V (N7, 1A05, internally L1+) is available externally eg. for feeding a set point potentiometer.

4.7 Fault Monitor

If setpoint and actual-value differ, except for transients, something-is wrong in the regulated loop. The difference of setpoint and actual-value is amplified and filtered in N5C (2CO7) (PT1-response) and fed to a window-comparator N5D 82C12), whose window is ± 5 V.

A fault is indicated by means of an opening contact of K2 (5DO7) and flashing LED "A" (5D02) on the power board.

4.8 Regulator Blocking

Power is switched on by means of K1 (5AD13), filamentcurrent regulator and IHO-ramp generator are activated by means of U1E/4B1O, U1C/3A14, U1D/3CO4.

Emission current regulator and ramp generator must be activated through a separate signal "activate regulator" (opto isolator U2A/4BO7, analog switches U1E/4B1O, U1A/3AO2, U1B/1B13).

4.9 Mode Select

Selection of the operating mode is possible by means of switch S2 (2EO3) in the front panel or the overriding inputs "emission" and "rate".

	IHO internal	IHO external	WE I remote control	WE II emission	WE III rate
S2 emission	X		X		
S2 'rate'		X			X
externa lemission'		X		X	
external 'rate'		X			X

4.10 Firing Pulses

The "firing angle" α as referenced in this manual is the angle in degrees electrical between the positive zero-crossing of the mains/synchronisation voltage and the firing pulse:

$$\alpha = 90^\circ \text{el} = \pi/2 \quad 50 \text{ Hz: } 5 \text{ ms} \quad 60 \text{ Hz: } 4.167 \text{ ms}$$

4.10.1 Generator IC

The firing pulses are generated in U2 (5C05), an integrated circuit type UAA 146 with the following features:

- zero crossing detector for synchronization voltage on pin 9
- saw tooth generator with R10 and C12 for 50 Hz, R10//R11 and C12 for 60 Hz (close LB60 for 60 Hz)
- firing angle comparator (saw tooth at pin 7 - control voltage at pin 8)
- flip-flop to prevent double pulses; it is set by the comparator and reset by the zero crossing of the synchronisation voltage
- pulse length discriminator with R15 and C13 (max. 180° el)
- drivers which separate the pulses according to the polarity of the synchronization voltage (pin 10, 14)

A tap of the synchronisation voltage transformer is wired to the connector, allowing for a 127 V 60 Hz mains.

The sawtooth is adjusted to be "flat" only very shortly before the rising edge (it allows adjustment of the minimum firing angle).

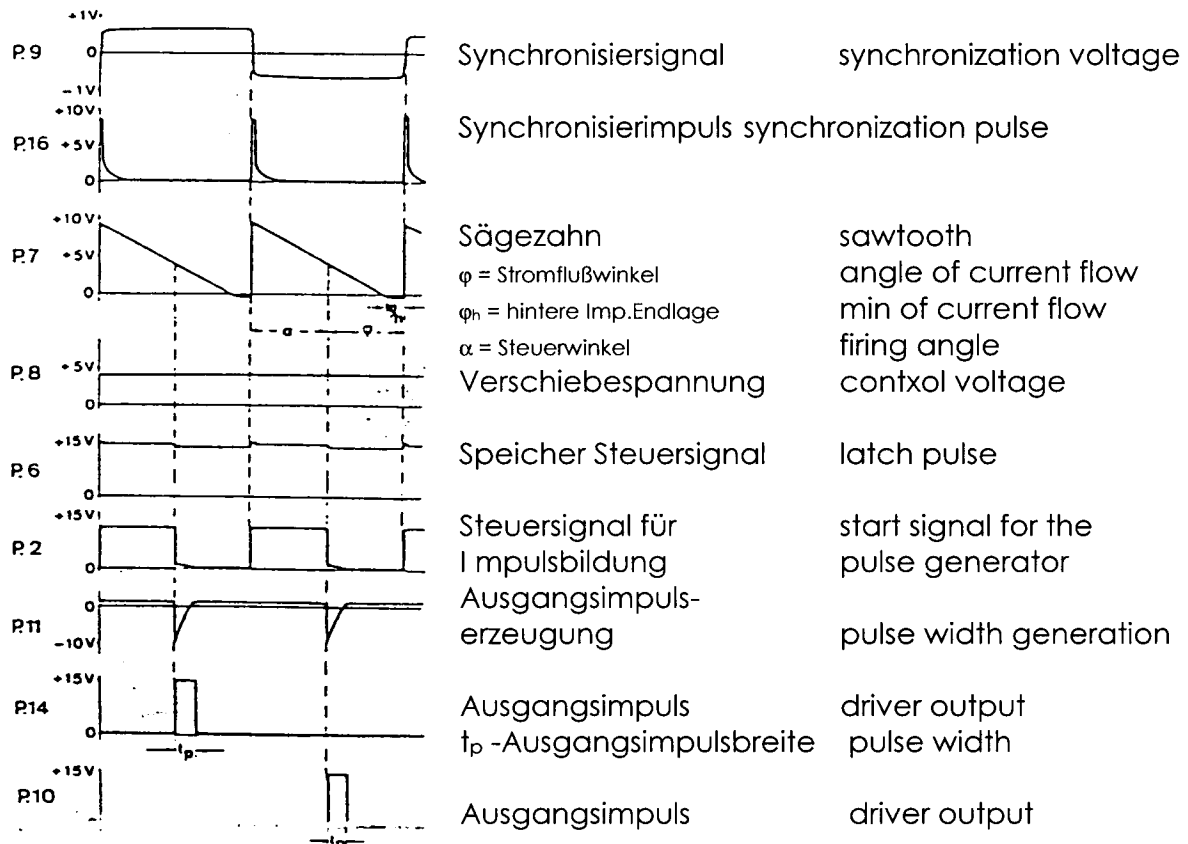
For measurements at pin 7 a 10 MOhm (10:1) probe is mandatory.

The maximum pulse length is set by means of R15, C13 to exceed 180° el., but the pulse will be terminated by the synchronisation voltage. Long pulses are necessary because of the inductive load in case of broken filament.

* The driver transistors open during the pulse; so V3, V4 5CD07 close!!

Pin 6 cannot be loaded.

Source: manufacturer's data



4.10.2 Long Pulses

On one hand, the firing pulse generator has to supply long pulses because of the inductive load caused by a broken filament, on the other, the compact design denies the use of appropriate transformers. Only chopped pulses allow the use of small transformers T1, T2 (5B09). The timer/oscillator 1/2 NE 556 (5A03) is synchronised to the firing pulses by means of V5 (5B05). Rectification of the 10 KHz carrier with V6 and V7 provides the long firing pulses.

The firing pulse current may be measured as a voltage drop of appr. 150 mV across the 1.5 Ohm resistors R7 and R16 (5B12).

Danger "Life wire!!"

4.11 Power section /actuator

Two SCR's in one module V12 (5B13), wired antiparallely, control the flow of current. Varistor Z1 (85B16) clips overvoltages. The SCR's are "fat"-dimensioned to allow fuseless application, though the circuit breaker must have an I^2t of $< 390 \text{ A}^2\text{S}$.

Current transformer T3 with load R12 (3C13) are discussed in 4.5.2, fault monitor relay K2 (5D07) and LED in 4.7, and relay K1 (5D18) in 4.8.

5 Test Procedure

(test rig is necessary)

- check components for type, placement, polarity, values
- connect all inputs to 0 V and compensate offset in the sequence R27, R29, R30, R14, R31, R15
- $R6 = 0$
- activate K1 (5D14)
- adjust rectifier limit to 18'el by means of R8 on A2 (5C02)
- verify programming of D2 (4D05) according to table 4.9.

6 Commissioning

Necessary tools:

- manual, extender boards for F48 and M24+7
- two-channel-digital-scope w/ roll-mode (or chart-recorder)
- check external connections for shorts (outputs), polarity (+/-), amplitude and type (AC/DC)
- check response of filament current controller and emission current controller.

Documentation of modifications in essential

7 Trouble shooting

The following tools are necessary

- manual
- extender boards for F48 and M24+7
- two-channel-digital-scope with analog and roll mode (or analog scope and chart recorder)
- solid knowledge of analog and digital circuits
- check the function of the modules acc. to the manual

8 Drawing Numbers

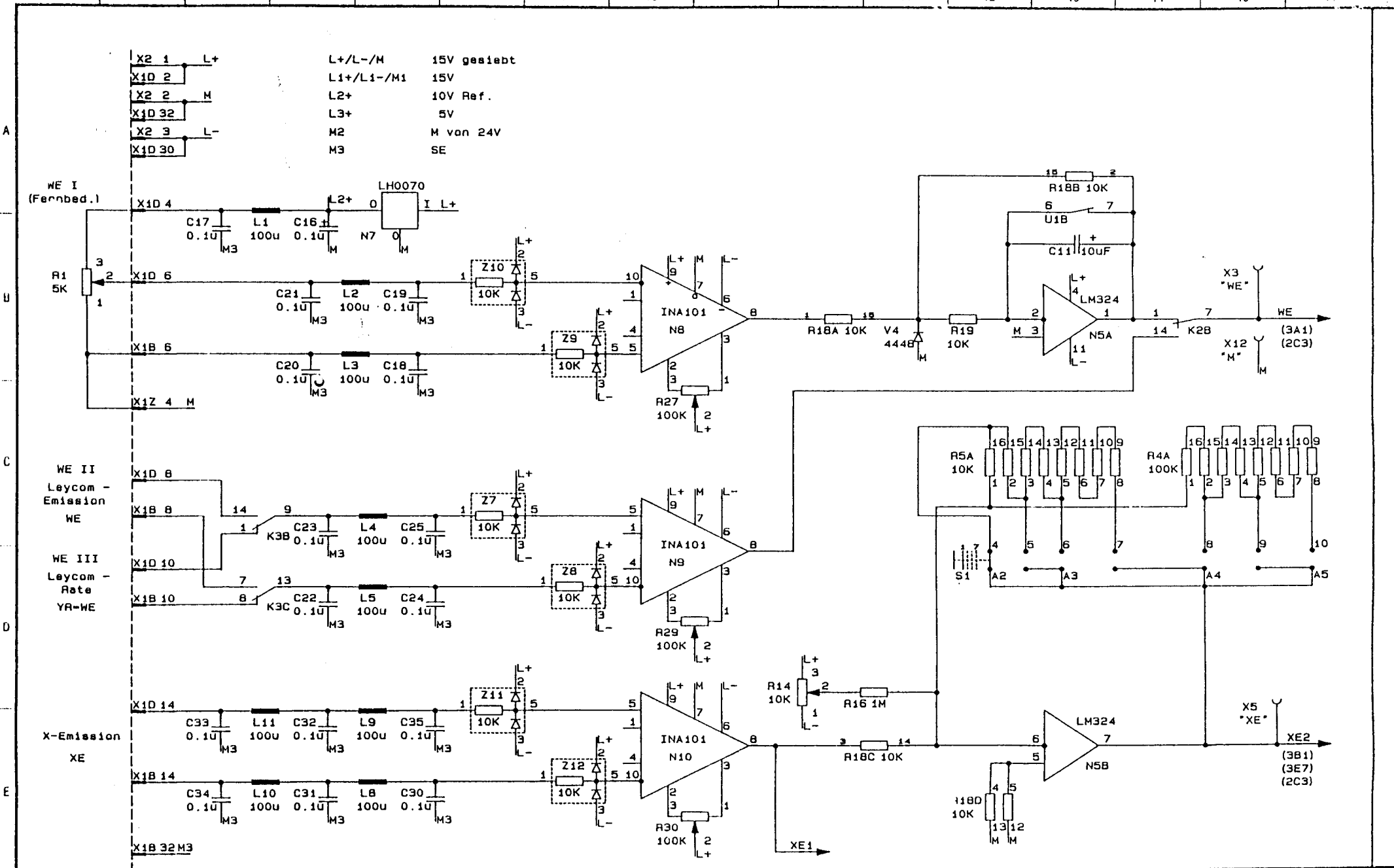
circuit diagram	5.842-0032/3
list of material	5.847-0233/2
manual german	5.840-0012/4
manual englisch	5.840-0013/4

9 Revision

Manual	8/90
--------	------

The use or communication of the contents thereof, are only allowed with our agreement. All rights are reserved.

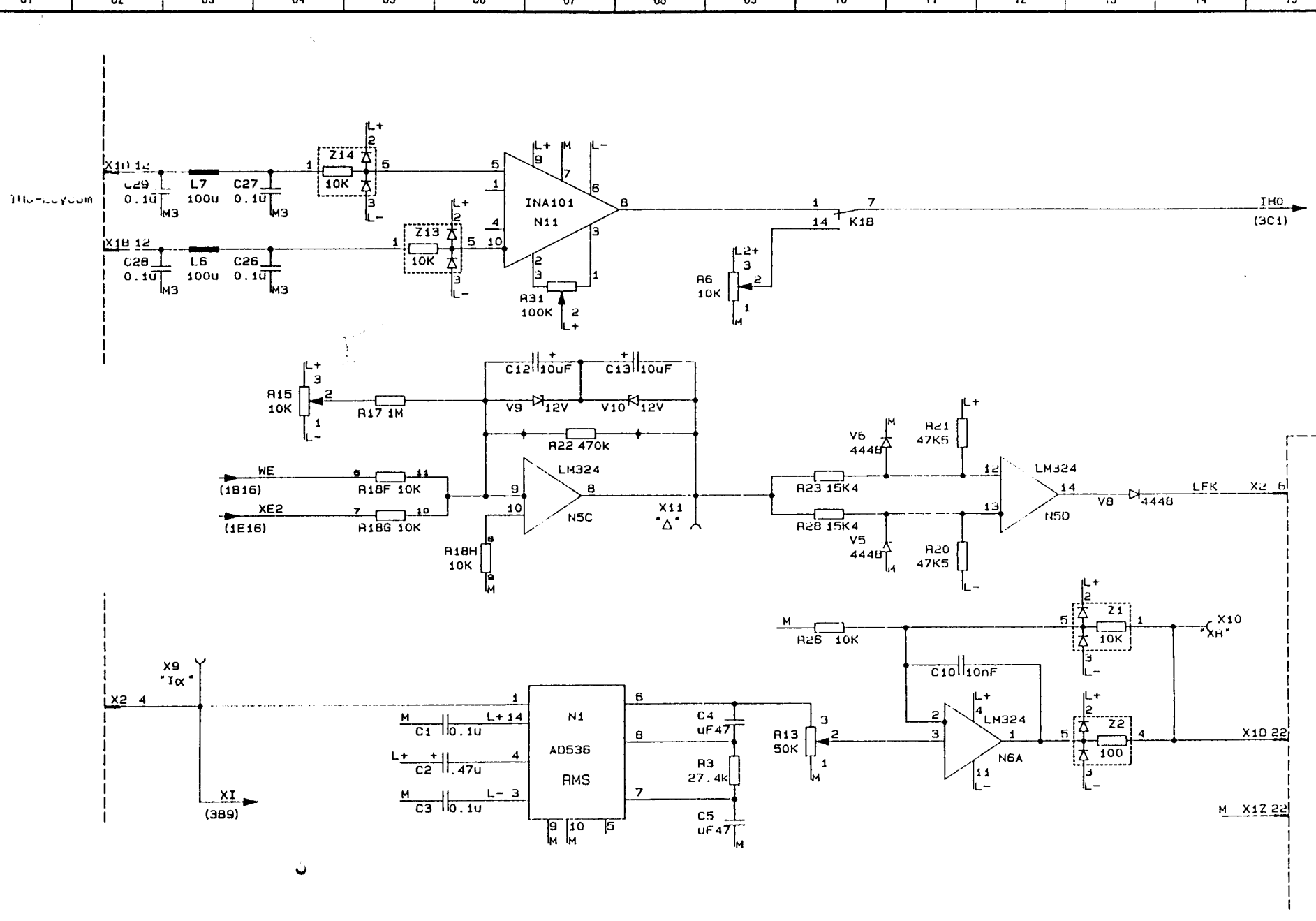
Unsere Mitteilung dieses Inhalts sind nur mit unserer Zustimmung gestattet. Alle Rechte vorbehalten.



Ref. Spannungsquelle / REFERENCE VOLTAGE SOURCE	Differenzverstärker / DIFFERENTIAL AMPLIFIER	Hochlaufintegrator / SETPOINT RAMPING	
Sollwerteingang I / SETPOINT INPUT I			
Sollwerteingang II/III / SETPOINT INPUT II/III		Istwertanpassung / ACTUAL VALUE SCALING	Auftrags-Nr.
Istwerteingang 'Emissionsstrom' / ACTUAL VALUE INPUT 'EMISSION CURRENT'			

Anderungen Revision	Bearb.	020387	ZIPP	Beschreibung Description	EMK 11	Emissionskonstanter		Zeichnung Nr. Drawing No. 5.842-0032/3	von of 5	Blatt Sheet 1
	Geprüft	080290	<i>Zipp</i>							

Kopieren dieses Dokumentes und Abgeben an Dritte ist ohne schriftliche Genehmigung des Herstellers nicht zulässig.
 Copying of this document and giving it to others and the use or communication of the contents thereof, are only allowed with our agreement. All rights are reserved.
 Alle Rechte vorbehalten.
 C LEYBOLD AG 15

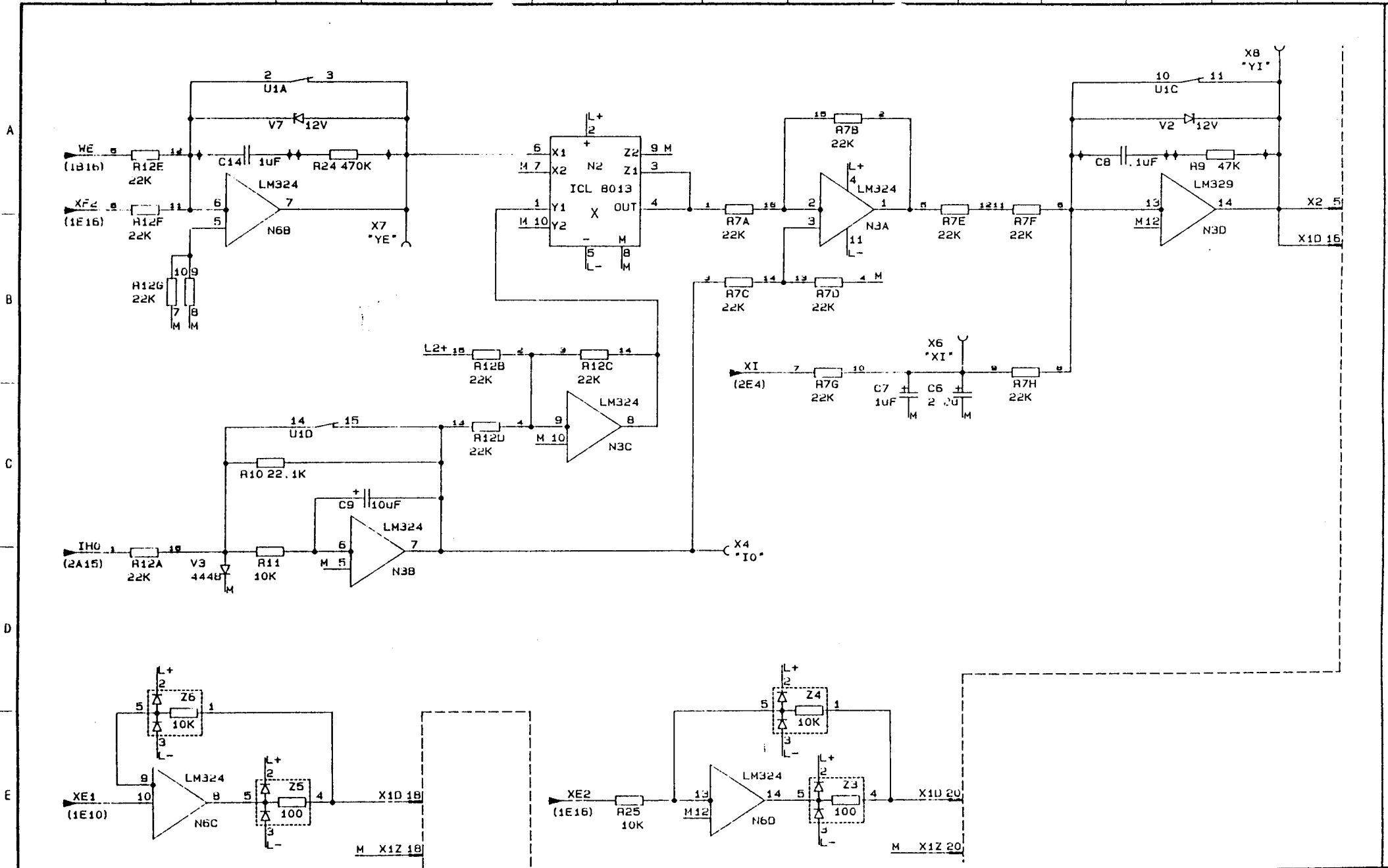


Eingang IHO extern / INPUT IHO EXTERN
 Lastkreisfehlererkennung / FAULT MONITOR
 Effektivwertbildung / TRUE RMS CONVERTER
 Fensterkomparator / WINDOW COMPARATOR
 Ausgangsverstärker Ieff. / AMPLIFIER IRMS

Auftrags-Nr.
 von 5
 Blatt Sheet 2

Änderungen Revision 1 2 3	Bearb. 020387 ZIPP Geprüft 000290 <i>ZIPP</i> Datum Name	Beschreibung Description FMK 11 EMISSION CURRENT REGULATOR Emissionskonstanter	LEYBOLD AG WERK HANAU	Zeichnung Nr. Drawing No. 5.842-0032/3	von 5 Blatt Sheet 2
------------------------------------	--	---	--------------------------	---	------------------------

Kopieren, Drucken, Weitergeben und Gehen ist zu untersagen und die
 Verwendung ohne Erlaubnis ist mit unserer Zustimmung verbunden. Alle Rechte vorbehalten.
 LEYBOLD AG 15



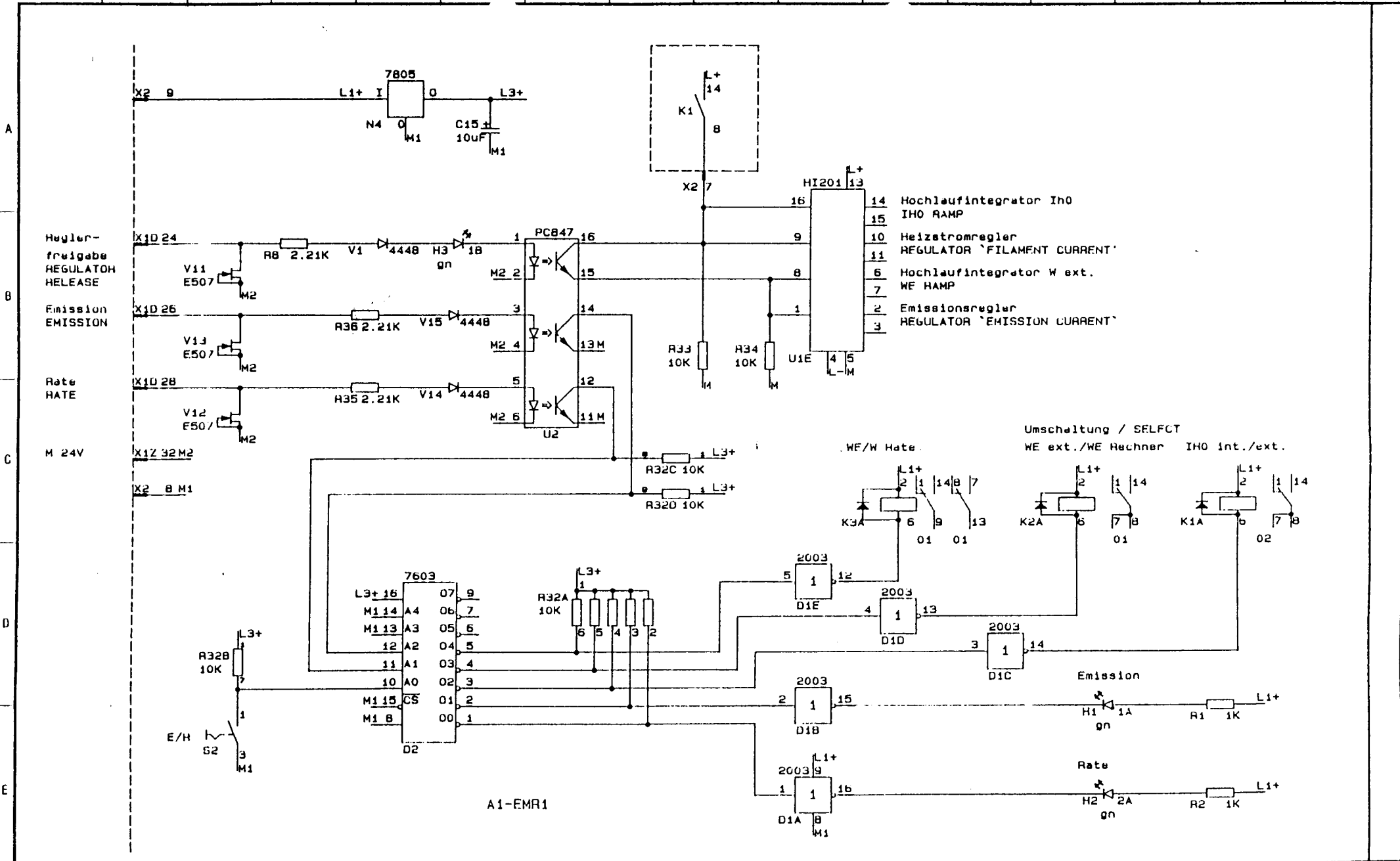
Emissionsregler / REGULATOR 'EMISSION CURRENT' IH0 Verarbeitung / IH0 PROCESSING Stromregler / REGULATOR 'FILAMENT CURRENT'
 IH0 Hochlaufintegrator / IH0 RAMP
 Ausgangsverstärker XE1 / OUTPUT BUFFER XE1 Ausgangsverstärker XE2 / OUTPUT BUFFER XE2

Bearb. 020367 ZIPF Geprüf. 000290 Datum Name	Beschreibung Description EMK 11 EMISSION CURRENT REGULATOR Emissionskonstanter	Zeichnung Nr. Drawing No. 5.842-0032/3	von of 5	Blatt Sheet 3	Auftrags-Nr.
					LEYBOLD AG 15



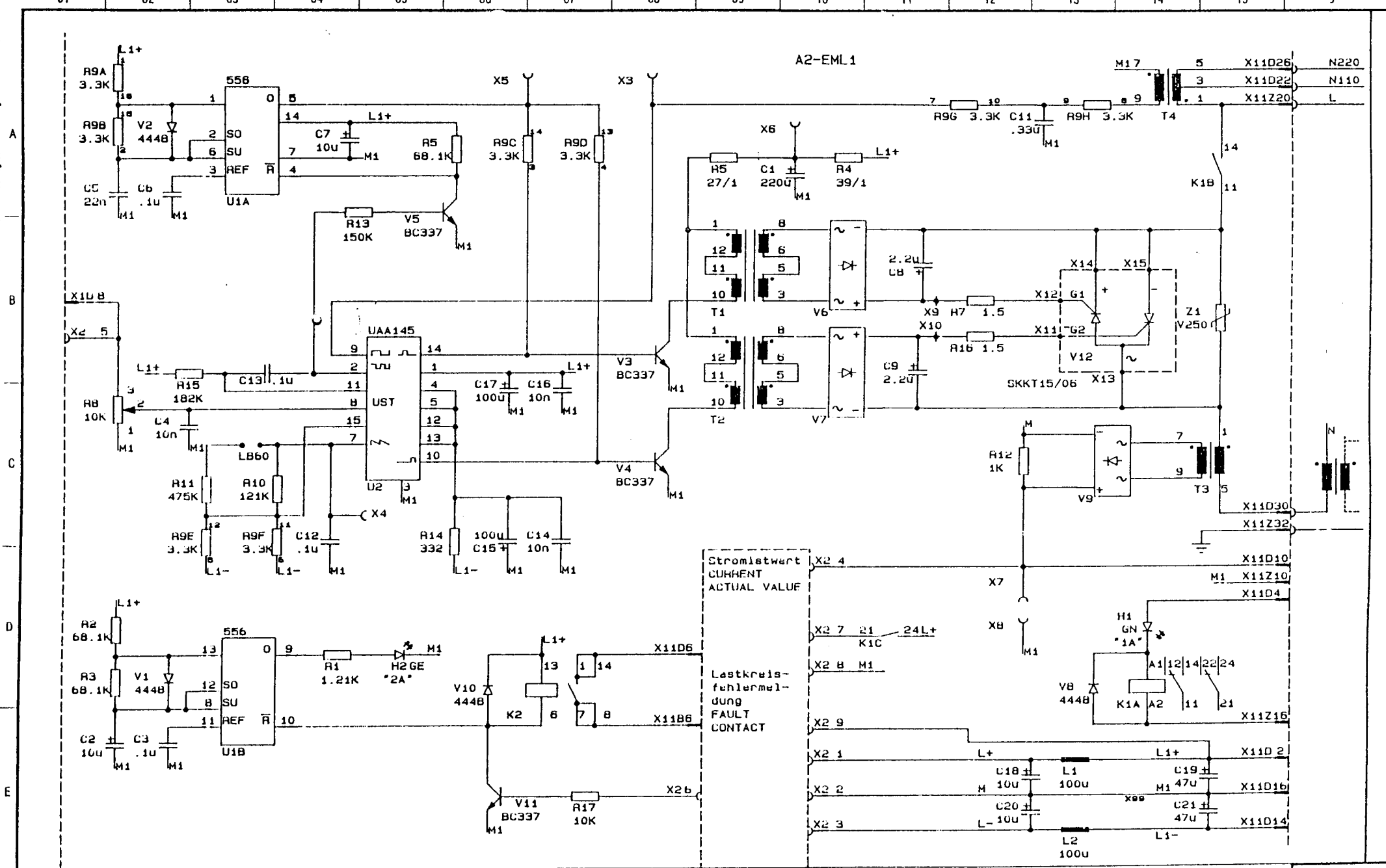
The use or communication of the contents thereof, are only allowed with our agreement. All rights are reserved.
 Die Mitteilung ihres Inhalts sind nur mit unserer Zustimmung gestattet. Alle Rechte vorbehalten.
 LEYBOLD AG 19

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16



Auswahl Sollwertquelle / SETPOINT SOURCE SELECTION				Reglerspannen / REGULATOR INHIBITS		-	
Auftrags-Nr.						+	
A1-EMR1				EMMISSION CURRENT REGULATOR		von Blatt	
EMK 11				Emissionskonstanten		Sheet	
Bearb. 020307 ZIPP Geprüft 020202 Datum Name				LEYBOLD AG WERK HANAU		Zeichnung Nr. Drawing No. 5.842-0032/3	
Änderungen Revision				5		4	

Copying of this document, and giving it to others and the use or communication of the contents thereof, are only allowed with our agreement. All rights are reserved.



Zündimpulsgenerator / FIRING PULSE GENERATOR	Synchronisationstransformator / SYNCHRONISATIONS TRANSFORMATOR
Zündübertrager / FIRING PULSE TRANSFORMER	Thyristormodul / SCR MODUL
Blinkoszillator / FLASHER	Stromwandler / CURRENT TRANSFORMER

Bearb. 280187 SPERZEL Geprüft. 080280 [Signature] Datum _____ Name _____	Beschreibung/Description EMK 11 EMISSION CURRENT REGULATOR Emissionskonstanter	LEYBOLD AG WERK HANAU	Zeichnung Nr. Drawing No. 5.842-0032/3	von of 5	Blatt Sheet 5
--	--	--------------------------	--	-------------	------------------

LEYBOLD AG 15