Service Manual

Technical
Description and
Service Instructions

for

XENON NOVA® 175
MODEL 20 1315 20

Order No. SV3367

Contents

0. General

Thank you for your expression of confidence in the KARL STORZ brand name. Like all of our other products, this product is the result of years of experience and great care in manufacture. You and your organization have decided in favor of a modern, high-quality piece of equipment from KARL STORZ.
KARL STORZ instruments and equipment are for use only by qualified medical personnel who are trained in their use. All electrical installations at the location of use should meet applicable national and local electrical codes.
Refer servicing to duly authorized KARL STORZ service personnel. Always use genuine replacement parts from KARL STORZ. To determine which replacement parts are required please refer to the enclosed replacement parts list. Repair and calibration of this device requires special tools and gauges; certain internal adjustments must not be altered.
For further information, please consult this service manual or contact:

KARL STORZ GmbH & Co. KG
Mittelstrasse 8, 78532 Tuttlingen
PO Box 230, 78503 Tuttlingen
Germany
Phone: +49 (0)7461 708-980
Fax: +49 (0)7461 708-75500
E-Mail: technicalsupport@karlstorz.de
Web: www.karlstorz.com

KARL STORZ Endoscopy-America, Inc.
2151 East Grand Avenue
El Segundo, CA 90245-5017
USA
Phone: +1 424 218-8100
+1 800 421-0837
Fax: +1 424 218-8526

Warranty

All KARL STORZ instruments and equipment are warranted to be free from defects in workmanship and materials for **two (2) years** from date of sale, unless otherwise specified; any instruments or equipment with such defects during the applicable warranty period will be promptly repaired or replaced at no charge to the customer.

KARL STORZ shall not be liable, expressly or implicitly, for:

- Any damages which might arise or be caused, whether by the customer or by any of the users of the instrument or equipment, as a result of:
  - misuse, mishandling, and/or improper operation,
  - repairs, modifications and/or alterations performed other than by KARL STORZ or a KARL STORZ authorized repair facility, or
  - use in combination with adaptors and/or equipment, or use in any manner or medical procedure, other than those for which it is designed; and
- Any special, indirect and/or consequential damages of any kind and however caused arising from the sale or use of the instrument and/or equipment.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED, AND/OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF MERCHANTABILITY, FITNESS, AND/OR OF SUITABILITY FOR A PARTICULAR PURPOSE, AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON KARL STORZ'S PART.
KARL STORZ neither assumes nor authorizes any person to assume for it any other liabilities in connection with the sale of said instrument and equipment. To ensure proper use, handling, and care of instruments and equipment, consult the applicable product literature, catalog, brochure, instruction manual, teaching film and other materials which are included with the product and/or otherwise available from KARL STORZ, at no charge, upon request.

Maintenance and Repair

KARL STORZ recommends that all equipment be checked and inspected once a year by KARL STORZ, or by an authorized agent. All services such as modifications, repairs, calibrations, and/or readjustments may only be performed by KARL STORZ or by an authorized agent.

***CAUTION:** Repairs may only be performed by qualified technicians trained in electrical or electronic engineering, in compliance with the relevant occupational, safety and accident prevention regulations.*
Always unplug the equipment before performing any repairs.
Safety Testing based on IEC EN 62353, IEC / UL 60601-1, whichever may apply, must be performed after servicing has been completed.

By making the enclosed technical information available, KARL STORZ does not authorize any service or repair by unauthorized service personnel. Tampering with the instruments or equipment, or unauthorized service or repair of the device nullifies and voids the warranty.

Reservation of Rights

Section 1.

Instruction Manual

Direction Sign:

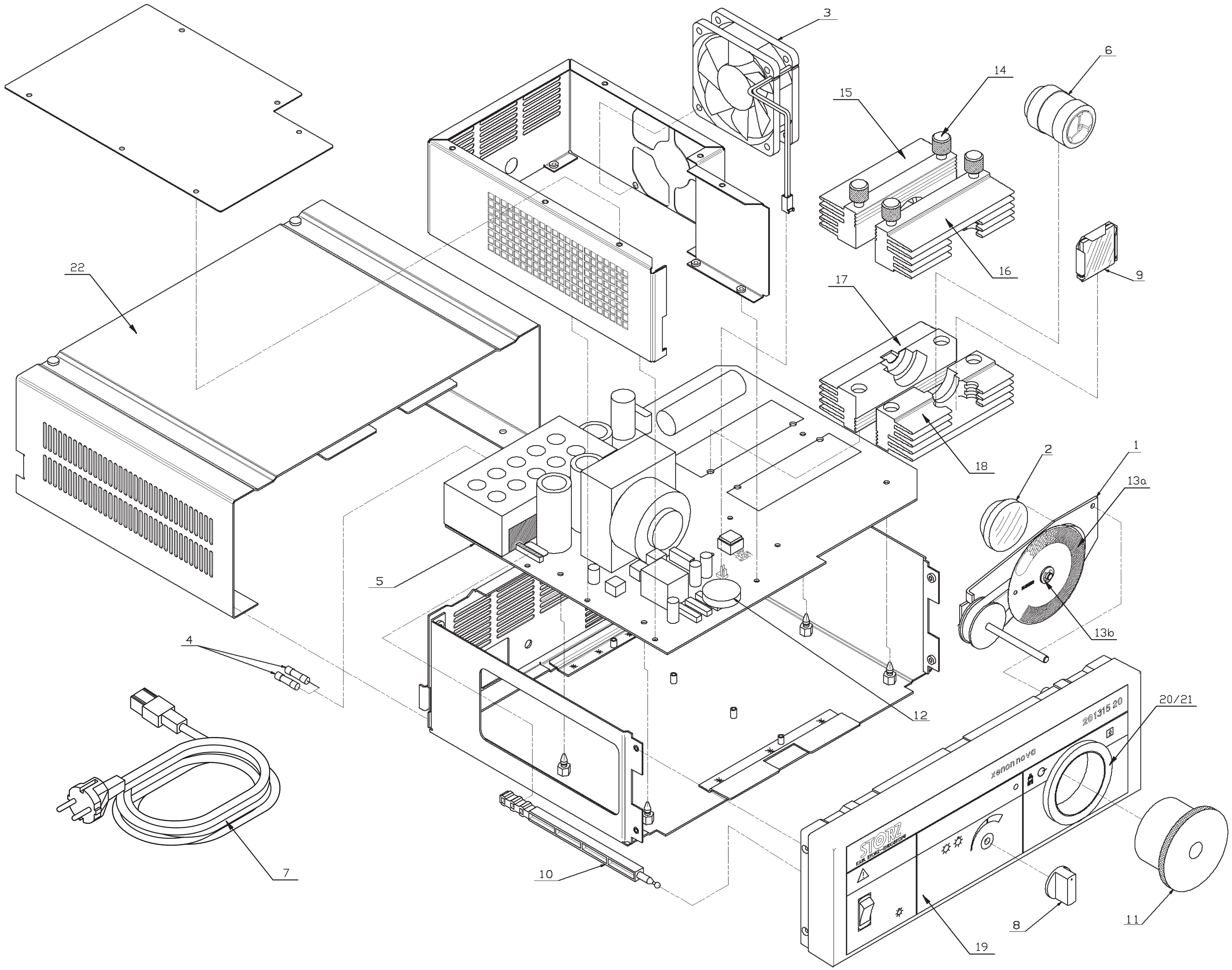
Section 2.

Physical Design

Contents 2. Physical Design

2.1 Exploded views of the XENON NOVA® 175

2.1.1. Exploded view of the XENON NOVA® 175 (up to serial no. LF0611830)



2.1.2. Spare parts of the XENON NOVA® 175 (up to serial no. LF0611830)

Position	Item description	Order no.
1	Attenuator assembly, without attenuator disc M19288	20131586
2	Condenser lens	20131581
3	Fan assembly (with connector and mounting rivets)	20131585
4	Power fuse 2 x T 3.15 AL / 250 V (220 VAC … 240 VAC)	1069600
	Power fuse 2 x T 6.3 AL / 250 V (100 VAC … 125 VAC)	2027890
5	Power supply (without lamp heat sinks and chassis)	no longer available*)
6	Lamp	20132026
7	Power cord (with ground lead)	400A
	Power cord “hospital grade” (USA)	400B
8	Brightness control knob (with screw)	20131582
9	Hot mirror assembly (in holder)	20131583
–	Filter holder	M19283
–	Hot mirror	M19603
10	Switch actuator rod	no longer available*)
11	Light cable adaptor	20134080
12	Battery, timer	20131587
13a	Attenuator disc, only, without axle	M19288
13b	Fixation ring to fix attenuator disc M19288 at axle	M19431
14	Screw M4 x 75 to fix heat sink	M19418
15	Heat sink, top, anode	M19281
16	Heat sink, top, cathode	M19279
17	Heat sink, bottom, anode	M19282
18	Heat sink, bottom, cathode	M19280
19	Faceplate, finished	no longer available*)
20	Optic adaptor ring	M18202
21	Thread ring to fix optic adaptor ring M18202	M18203
22	Housing cover	no longer available*)
–	Power switch on power supply	no longer available*)

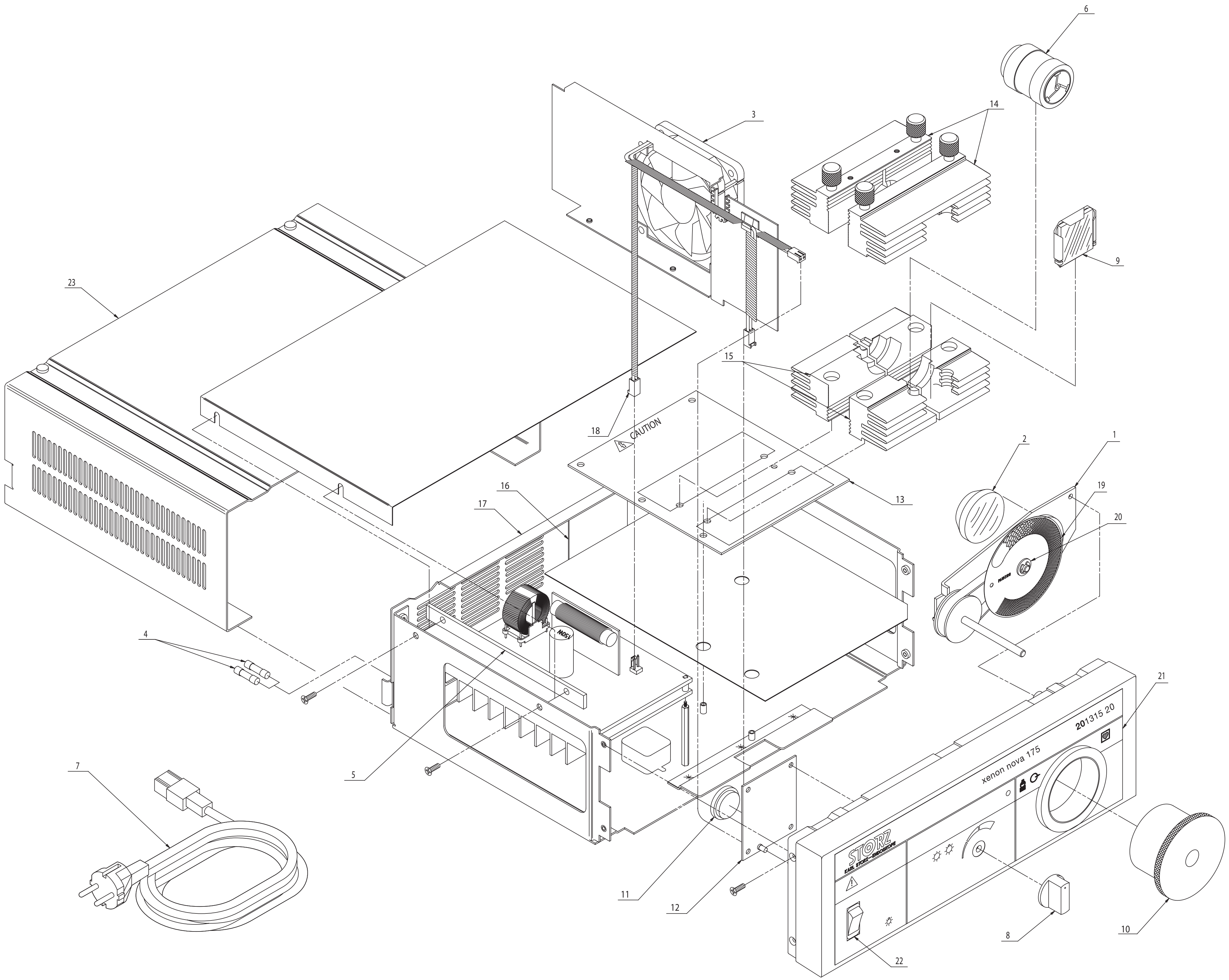
Important note:

When ordering replacement parts always provide the following data

Item description **Order no.**

*) *Please contact your Global Sales Manager.*

2.1.3. Exploded view of the XENON NOVA® 175 (as from serial no. LF0611831)



2.1.4. Spare parts of the XENON NOVA® 175 (as from serial no. LF0611831)

Position	Item description	Order no.
1	Attenuator assembly, without attenuator disc M19288	20131586
2	Condenser lens	20131581
3	Fan assembly (with connector and mounting rivets)	20131585
4	Power fuse 2 x T 3.15 AL / 250 V (220 VAC … 240 VAC)[1]	1069600
	Power fuse 2 x T 6.3 AL / 250 V (100 VAC … 125 VAC)[1]	2027890
	Power fuse 2 x T 1.6 AL / 250 V (220 VAC … 240 VAC)[2]	1069500
	Power fuse 2 x T 3.15 AL / 250 V (100 VAC … 125 VAC)[2]	1069600
5	Power supply	Z07558
6	Lamp	20132026
7	Power cord (with ground lead)	400A
	Power cord “hospital grade” (USA)	400B
8	Brightness control knob (with screw)	20131582
9	Hot mirror assembly (in holder)	20131583
–	Filter holder	M19283
–	Hot mirror	M19603
10	Light cable adaptor	20134080
11	Battery, timer	20131587
12	Timer PCB	20134091
13	Lamp PCB	20134092
14	Heat sink, top, front	M19281
	Heat sink, top, rear	M19279
15	Heat sink, bottom, front	M19282
	Heat sink, bottom, rear	M19280
16	Nomex barrier	20134093
17	Rear panel assembly	ET12-201315-17
18	Jumper cable p.s. to timer PCB	20134089
19	Attenuator disc, only, without axle	M19288
20	Fixation ring to fix attenuator disc M19288 at axle	M19431
21	Faceplate assembly, finished	Z07612
22	Power switch	1163890
23	Housing cover	M13283

Important note:

When ordering replacement parts always provide the following data

Item description **Order no.**

1) Valid up to serial no. BC0627483.
2) Valid as from serial no. BC0627729.

Section 3.

Descriptions of Operation and Circuit Diagrams

Contents 3. Descriptions of Operation and Circuit Diagrams

3.1 Description of operation of the XENON NOVA® 175

3.1.1. General description

The 201315 20 XENON NOVA® 175 is a 175 W Xenon light source designed for use in general endoscopic surgery, especially where high light levels may be needed, and where cine, video, or still photographic documentation may be required.

The Xenon lamp color temperature approximates bright sunlight and is considered unmatched for visual and photographic color rendition. Full intensity is reached almost immediately without a warm-up period.

The XENON NOVA® 175 operates at a constant power level (about 175 W) while the brightness is manually adjusted by an opto-mechanical attenuator. This assures the greatest range of light-to-dark without arc instability problems.

Note: *Refer to Section 1 Instruction Manual for operating warnings and cautions.*

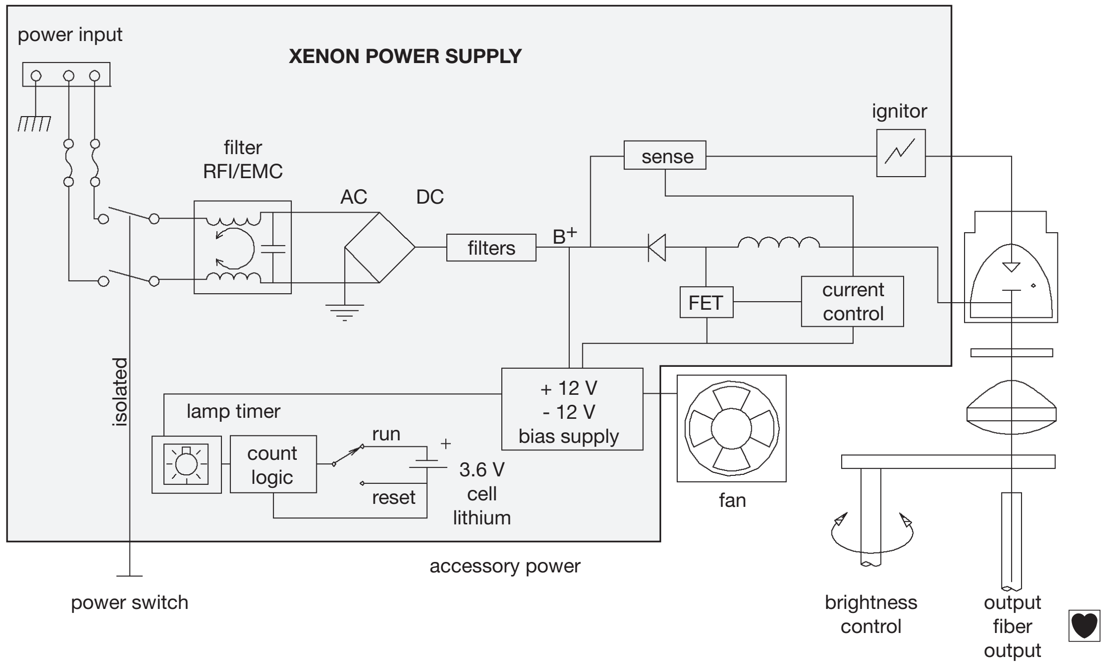
3.1.2. Basic features

3.1.2.1. Manual brightness control

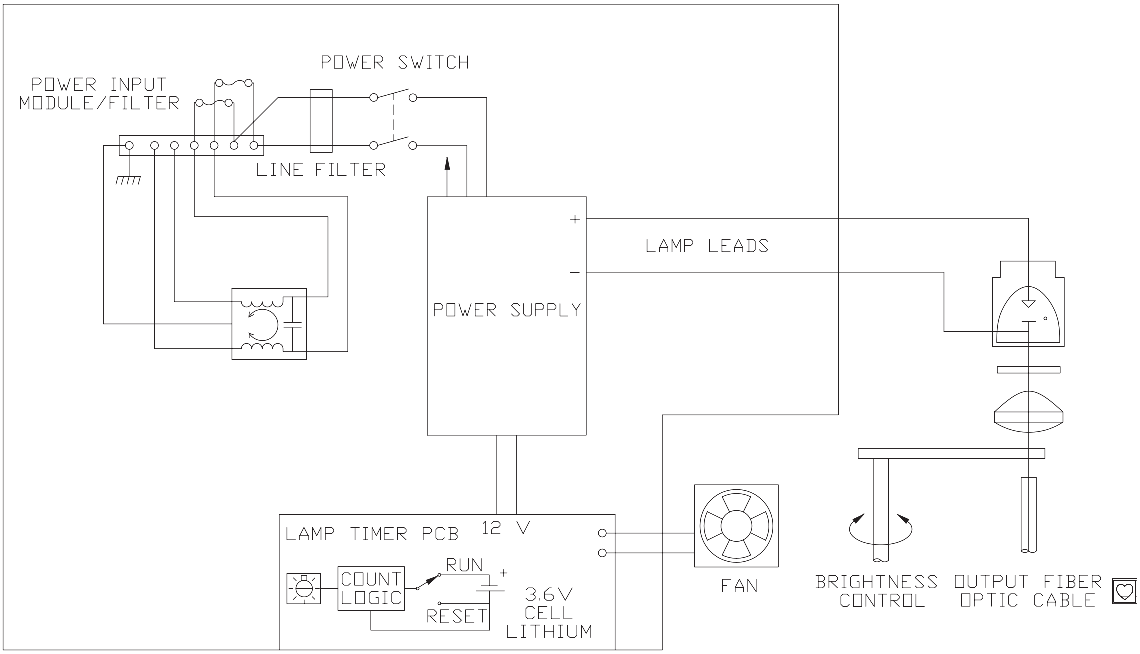
The brightness can be manually adjusted using a brightness control knob.

3.1.3. Block diagrams of the XENON NOVA® 175

3.1.3.1. Block diagram of the XENON NOVA® 175 (up to serial no. LF0611830)



3.1.3.2. Block diagram of the XENON NOVA® 175 (as from serial no. LF0611831)



3.2 Detailed description of operation

3.2.1. Fan

The fan is a 12 VDC fan, with power supplied by the power supply.

3.2.2. General information on power supplies

The power supply delivers constant power to the Xenon lamp and fan, and contains the high voltage ignition module. Power supplies from two different vendors are used in this light source. These may be identified as follows:

- Carsan Engineering – serial number marked on right front corner of power supply PCB (example : 326-8F-4351)
- Warner Power – serial number on top of heat sink on left side of power supply
- Warner Power – serial number on bottom label and on top of CI by input terminal J1, J2 and J3 (for devices as from serial no. LF0611831)

These will be referred to as Carsan or Warner in subsequent section.

For light sources with a serial number under 1050, use Section 3.2.3.2 Circuit diagram of the Carsan power supply (as from serial no. 0001 up to 1050) for information.

For light sources with a serial number over 1050 and a Carsan power supply, use Section 3.2.3.4 Circuit diagram of the Carsan power supply (as from serial no. 1051 up to 3863).

For light sources with a serial number over 1050 and a Warner power supply, use Section 3.2.4.2 Circuit diagram of the Warner power supply (as from serial no. 3864 up to LF0611830) for information.

For light sources with a serial number over LF0611831 and a Warner power supply, use Section 3.2.4.4 Circuit diagram of the Warner power supply (as from serial no. LF0611831) for information.

3.2.3. Carsan power supply (as from serial no. 0001 up to 3863)

3.2.3.1. Description of Carsan power supply operation

AC rectifier

The power entry module (located on the rear panel) contains two power fuses, one for each side of the AC line. The C100 capacitor provides line filtering, and the R102 bleeder resistor prevents the possibility of an electrical shock if the power cord plug conductors or the power entry module pins are touched after removal of the power cord.

Both sides of the line are switched with the S100 power switch, and the RV100 metal oxide varistor protects the circuitry from power surges. The T100 transformer, L100 choke, C101, C106, and C107 capacitors provide additional filtering and prevent EMI/RFI noise from feeding backward onto the line.

The D100 bridge rectifier (in conjunction with the C102 and C103 filter capacitors) converts the AC line voltage to DC and provides the B+ supply voltage for the entire power supply. The B+ supply voltage can range from 127 V (at 90 VAC), to 378 V (at 264 VAC). R100 and R101 are swamping/bleeder resistors for the C102 and C103 filter capacitors, and the C104 and C105 capacitors prevent switching-frequency transients generated by the power supply from getting back onto the AC line.

ⓘ ***Note:*** *All the electrical components from the power entry module to the D100 bridge rectifier are shielded by a conductive box soldered to the circuit board which must be temporarily removed if access to these components becomes necessary. The conductive box must be reinstalled after servicing.*

Bias supply circuit (low voltage section)

The bias supply circuit is powered by the rectified AC line voltage B+, see Section AC rectifier for AC rectifier description. The B+12, B-12, and +12 V output voltages are generated by the T400 flyback transformer, which is driven by the U400 pulse width modulator IC and the Q400 FET driver.

In order to start the PWM chip (U400), several milliamperes of current are drawn from the B+ supply through the R407 current-limiting resistor. This charges up the C405 capacitor to approximately 16 V, causing the PWM chip to turn on. Since the PWM chip draws more current than the R407 current limiting resistor can deliver, the PWM chip then draws current from the C405 capacitor until the voltage drops to 11 V, causing the PWM chip to turn off. This on and off action produces an 16 V – 11 V sawtooth waveform at U400-7 and occurs only during start-up.

Pin 7 of U400 produces an internally generated 5.1 V reference voltage when the PWM chip is on. However, during start-up, the signal will appear as a 5.1 V square wave that corresponds to the on and off action of the 16 V – 11 V sawtooth waveform on U400-7. The 5.1 V reference voltage drives a relaxation oscillator at U400-4. The signal at U400-4 will be a square wave with the ON TIME modulated at 50 kHz. R401 and C401 provide the RC time constant for the 50 kHz switching rate. The PWM output at U400-6 is initially a square wave with the ON TIME modulated at 50 kHz. This signal drives the gate of the Q400 FET.

During the ON TIME, the Q400 FET conducts and provides a current path to ground for pin 3 of the T400 transformer, causing the core of the transformer to begin charging up. During the OFF TIME, the magnetic field of the transformer collapses and causes a polarity reversal on all transformer windings. This polarity reversal allows current to flow from the transformer through the D406–D408 diodes and begins to charge up the C407, C409, and C411 output filter capacitors. Current also flows through the D402 and D403 diodes and begins to charge up the C405 capacitor, ultimately supplying power to the PWM chip once running. After a few cycles, all capacitors are charged up, and the PWM chip runs from power supplied by the T400 transformer. At this point the circuit is self-sustaining with a stable voltage of about 12 V at pin 7.

The PWM chip varies its duty cycle according to the load. The PWM supply voltage at U400-7 is constantly monitored at U400-2 through the R405/R406 voltage divider. The voltage at U400-2 is then compared to an internally generated reference voltage of 2.5 V. If pin 2 senses that the supply voltage at U400-7 is dropping, it increases the duty cycle (up to a maximum of 50%) in order to supply more energy to the circuit. The duty cycle will be less than 50% for lighter loads.

The PWM chip has a safety feature protecting the Q400 FET from overcurrent. The ISEN input at U400-3 monitors the current through the FET by comparing the voltage at R403 to an internal reference voltage. If the FET current should rise to 1 A, 1 V will be present at U400-3, and the PWM chip will shorten the duty cycle to avoid over-driving the FET.

The PWM chip also protects itself from overvoltage at pin 7 using an internal zener diode. The zener diode clamps the pin 7 supply voltage to a maximum of about 33 V.

Lamp timer circuit

The lamp timer circuit keeps track of lamp usage in hours, and warns the operator that a scheduled lamp change is approaching or overdue. The red LED (D902) on the faceplate will light at approximately 450 hours (90% of the lamp's expected life) and start blinking at around 500 hours to indicate a lamp change is imperative. Upon changing the lamp, the user must manually reset the timer by pressing the green reset switch (S900) located inside the light source next to the fan. The circuit power is maintained by the BT900 lithium battery when the light source is not in use. The battery must be replaced every 10 years to insure continued operation.

The first stage of the lamp timer circuit consists of a CD4060 binary counter (U900) driven by a 20 kHz crystal (Y900). The CD4060 counter divides the 20 kHz crystal frequency down to a 1.22 Hz square wave at U900-3, which provides clocking for the next stage of the counter. When the light source is in use, the yellow LED (D903) will blink to indicate the circuit is running. A test jumper (J900) is also provided to reduce the overall 500 hour count to about 30 minutes for testing purposes. This section of the circuitry is powered by the +12 V bias supply output and is only active when the light source is in use.

The second stage of the lamp timer circuit consists of two CD4020 binary counters, a CD4017 decade counter, a lithium battery (BT900) and a reset switch (S900). These counters are driven by the 1.22 Hz square wave from the first stage of the counter circuit and keep track of lamp usage hours. Pins 9 and 11 of the CD4017 decade counter (U903) provide the logic signals that activate the FET's that control the REPLACE LAMP LED (D902). The lithium battery powers this section of the circuitry at all times, whether the light source is on or not. When pressed, the reset switch sets all three counters back to zero.

The final stage of the lamp timer circuit consists of 3 FET's (Q901–Q903), the REPLACE LAMP LED (D902), and the LED current-limiting resistor (R906). At approximately 450 hours U903-9 goes high and activates the Q901 FET which turns on the REPLACE LAMP LED (D902). At approximately 500 hours U903-9 goes low and U903-11 goes high, activating Q902. Since Q902 is in series with Q903, and Q903 is continuously clocked by U900-3 at a 1.22 Hz rate, the REPLACE LAMP LED will start to blink. In addition, when U903-11 goes high, it disables pin 13 of the CD4017 which is the count-enable pin, preventing any additional counting of the CD4017 counter (U903). This holds the count at 500 hours until the S900 reset switch is pressed. Since this stage of the circuit is powered by the +12 V bias supply output, the REPLACE LAMP LED and associated circuitry do not draw power from the lithium battery.

Power supply

During normal operation, if the main switching FET Q200 has just turned off, current is being supplied to the lamp by the magnetic field collapsing in inductor L200. The current flows through inductor L201, flywheel diode D200, current sense resistor R206, inductor L601, and through the lamp anode to the cathode. It returns from the L601 back to the L200 inductor. Since the inductor L200 supplies power to the lamp circuit, the current output is reduced from an initial value of 15 A to about 13 A when the switching transistor Q200 is turned on by the control circuitry. Since the diode D200 prevents current flow through it, current is routed from the B+ supply (127 VDC – 378 VDC) through the Xenon lamp and then through the L200 inductor and the FET and a single turn winding of T200 to ground. This charges the L200 inductor so that the current again becomes 15 A and the switching transistor is turned off by the control circuitry.

Since the AC component of the ripple current is quite high (higher than the Xenon lamp would tolerate) most of the ripple current is routed through C214, specially rated for high ripple current. This protects the lamp from the ripple.

The snubber consists of L201, D202, and R205. It acts to dissipate energy which would otherwise heat up the FET junction.

The main current control loop PWM controller of the supply reads the current sampled from T200 through resistor R308. This loop is a pulse-by-pulse regulator to prevent overcurrent through the Q200 FET.

The current through the lamp is sampled by the current sense resistor R206 which develops a voltage of 10 mV/A (so at 14 A nominal, we would measure 140 mV). This small voltage is amplified by op-amp U300B to about 1.4 V before being fed to U301 pin 1. Inside the regulator chip is another op-amp which generates an error signal (EOUT) proportional to the difference between the voltage developed by the lamp-current sense voltage and the voltage from the current adjustment potentiometer.

The PWM regulator feeds the final pulse-width-modulated drive signal to optoisolator U200 in the FET drive circuit. Since the FET Q200 must turn on and off quickly, a special FET driver circuit drives the gate pin of FET Q200. The FET driver has its own dedicated 5 V regulator derived from the +12 VDC bias supply.

Ignition circuit

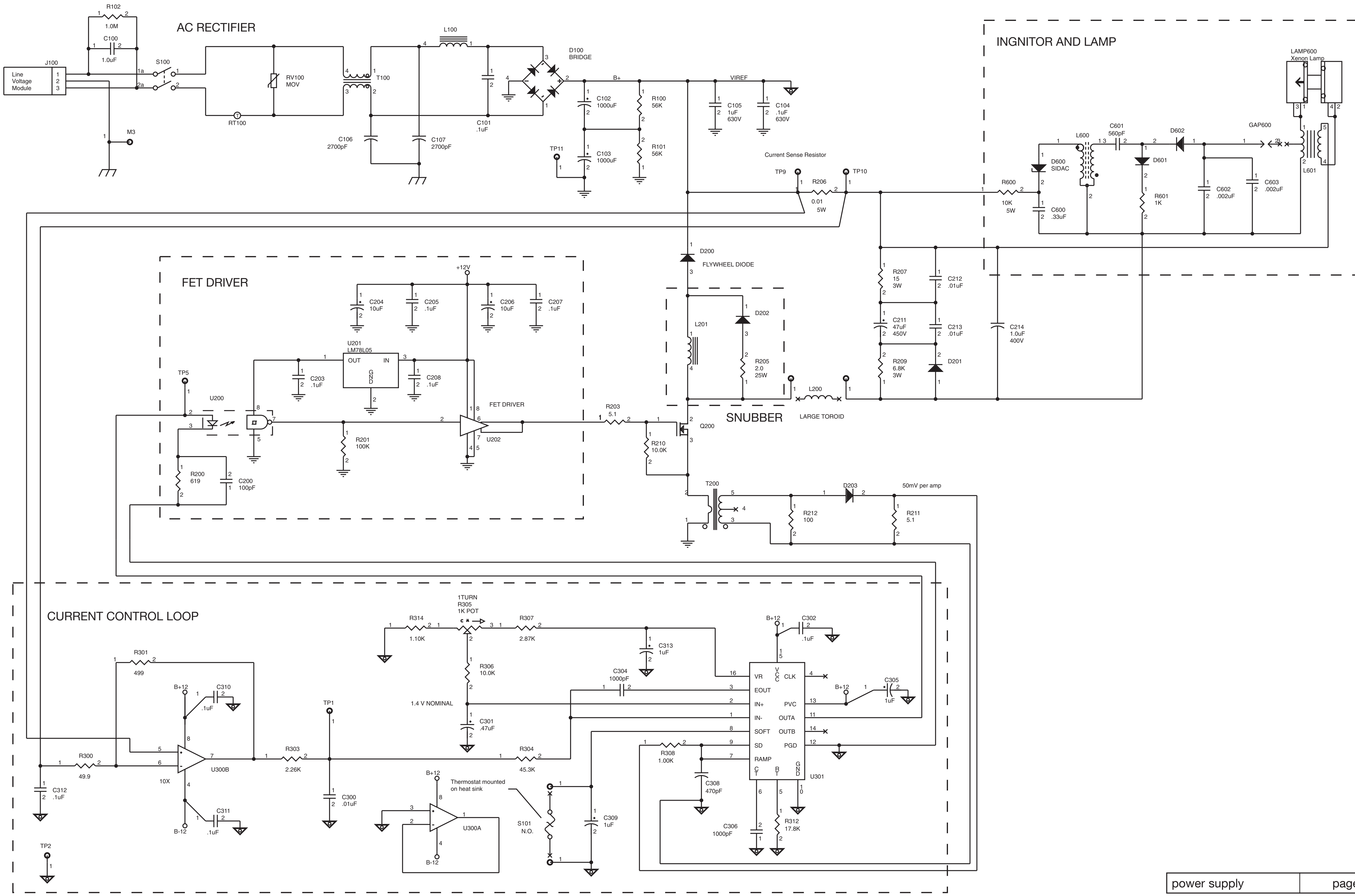
When the lamp is off, the full B+ voltage through R600 is across the sidac D600 and capacitor C600. When the sidac reaches 95 V, it discharges the capacitor through the L600 inductor (a high-voltage transformer), which through C601, D601, and D602 successively pump charge into capacitors C602 and C603. When the voltage across C602 and C603 reaches 7500 V (the breakdown voltage of the sparkgap GAP600), the capacitors discharge through the sparkgap and put a high-current pulse into the center tap of transformer L601. This current develops 15 kV across each lamp heat sink (for 30 kV total). This causes the lamp-electrode gap to break down and conduct an arc streamer which acts as a conducting path.

The lamp might start at this point since it is provided with approximately 14 V and the arc gap has broken down, but it would have difficulty. A boost voltage is needed to reliably heat the lamp electrodes into thermionic emission. This “boost” energy is stored in capacitor C211 and discharges across the lamp when the lamp begins to conduct.

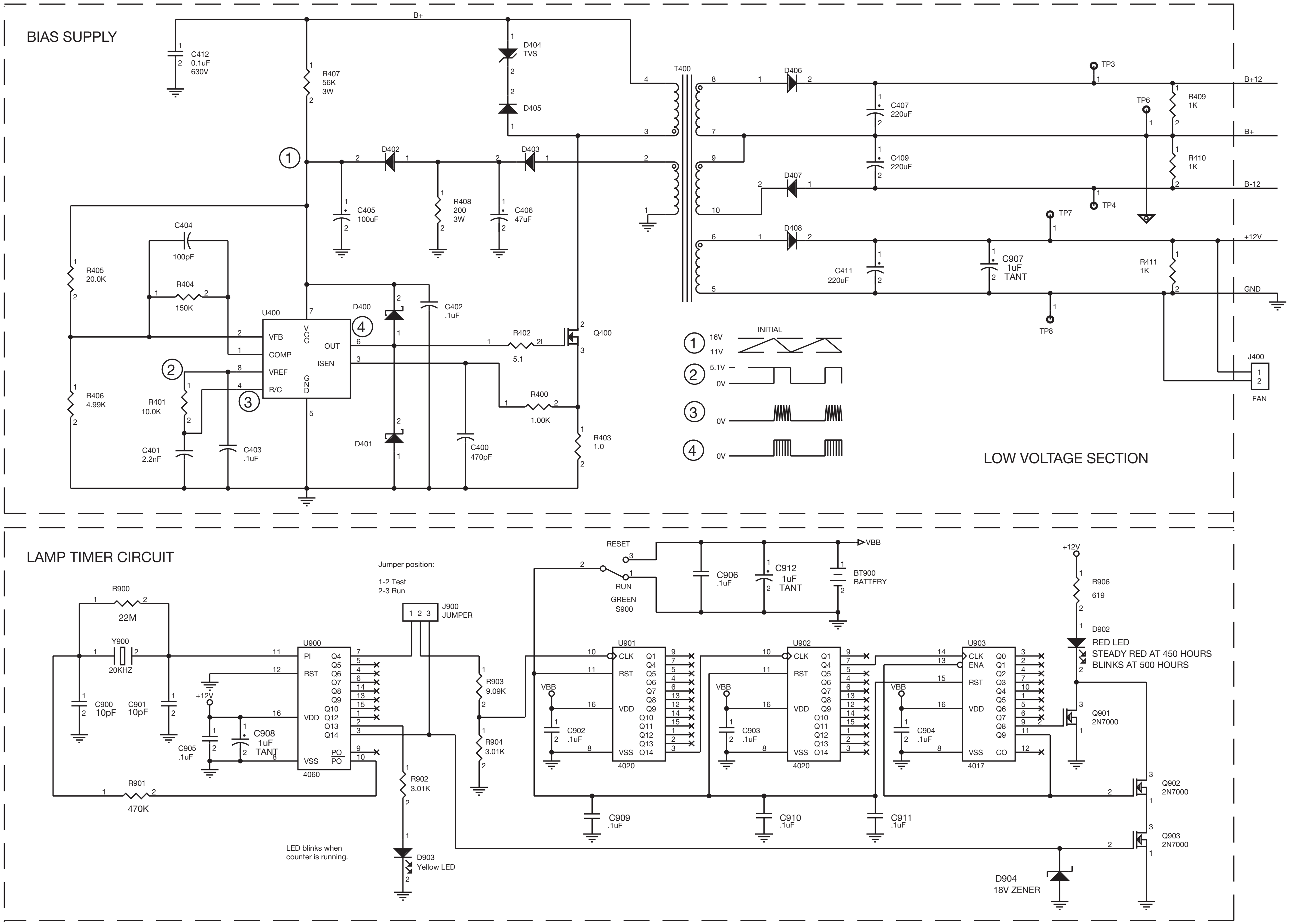
Measurements

The sidac waveform is sawtooth with a minimum close to ground and a peak of 95 V. The capacitor C211 should reach B+ voltage before the arc breaks down. Beyond this point measurements are best taken with the device turned off. Measure the associated high-voltage components for shorts or opens.

3.2.3.2. Circuit diagram of the Carsan power supply (as from serial no. 0001 up to 1050)

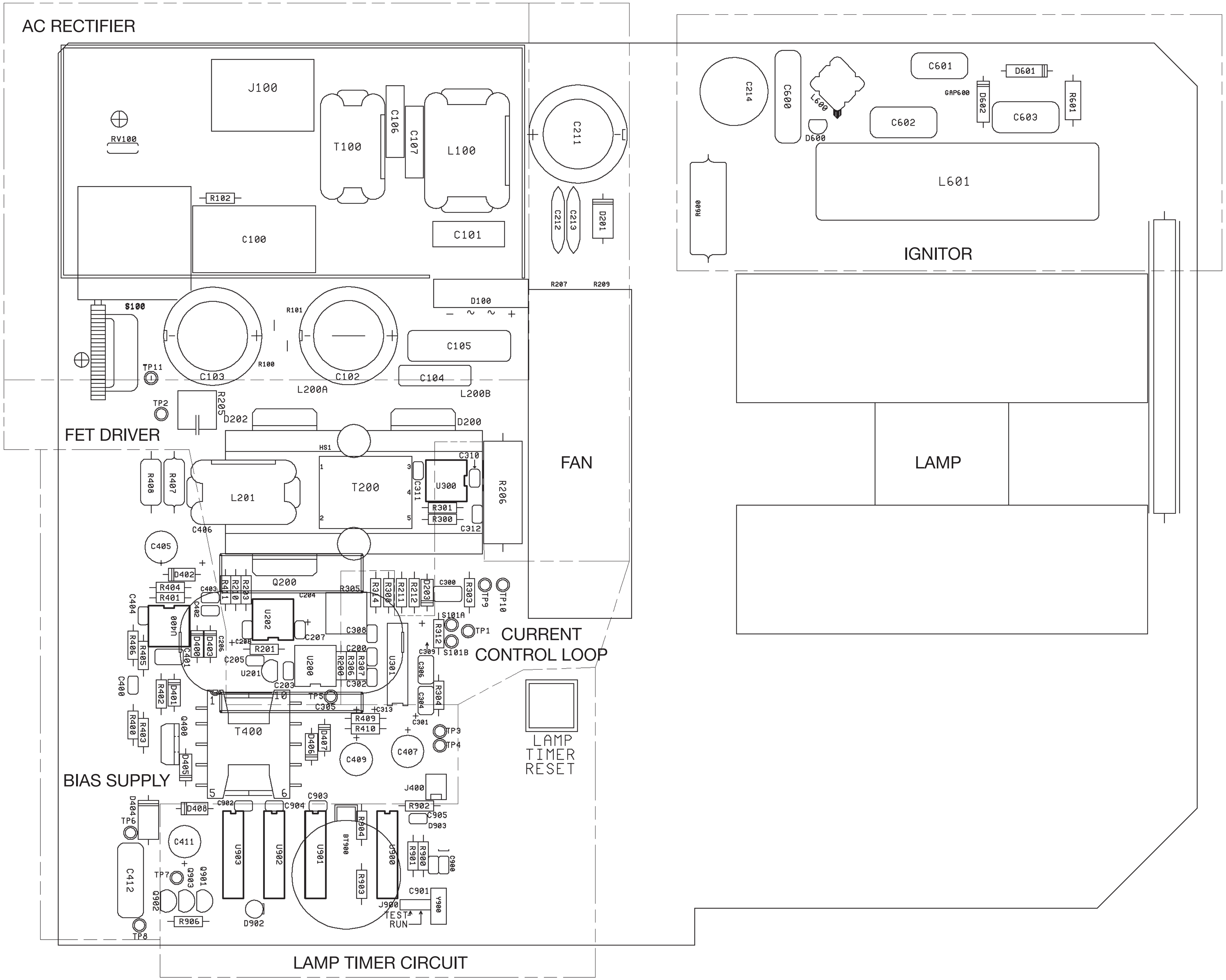


power supply	page 1 of 2

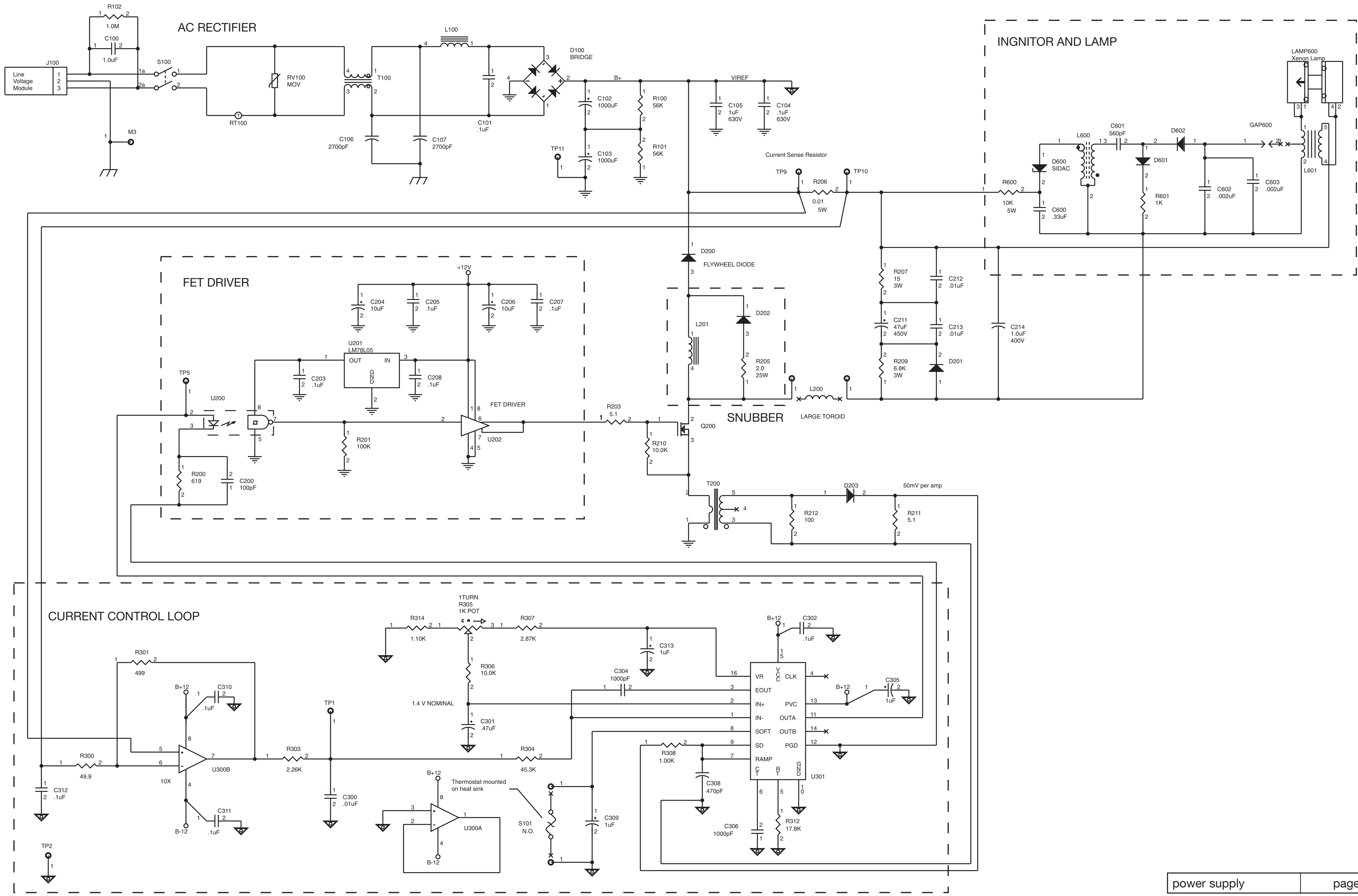


power supply	page 2 of 2

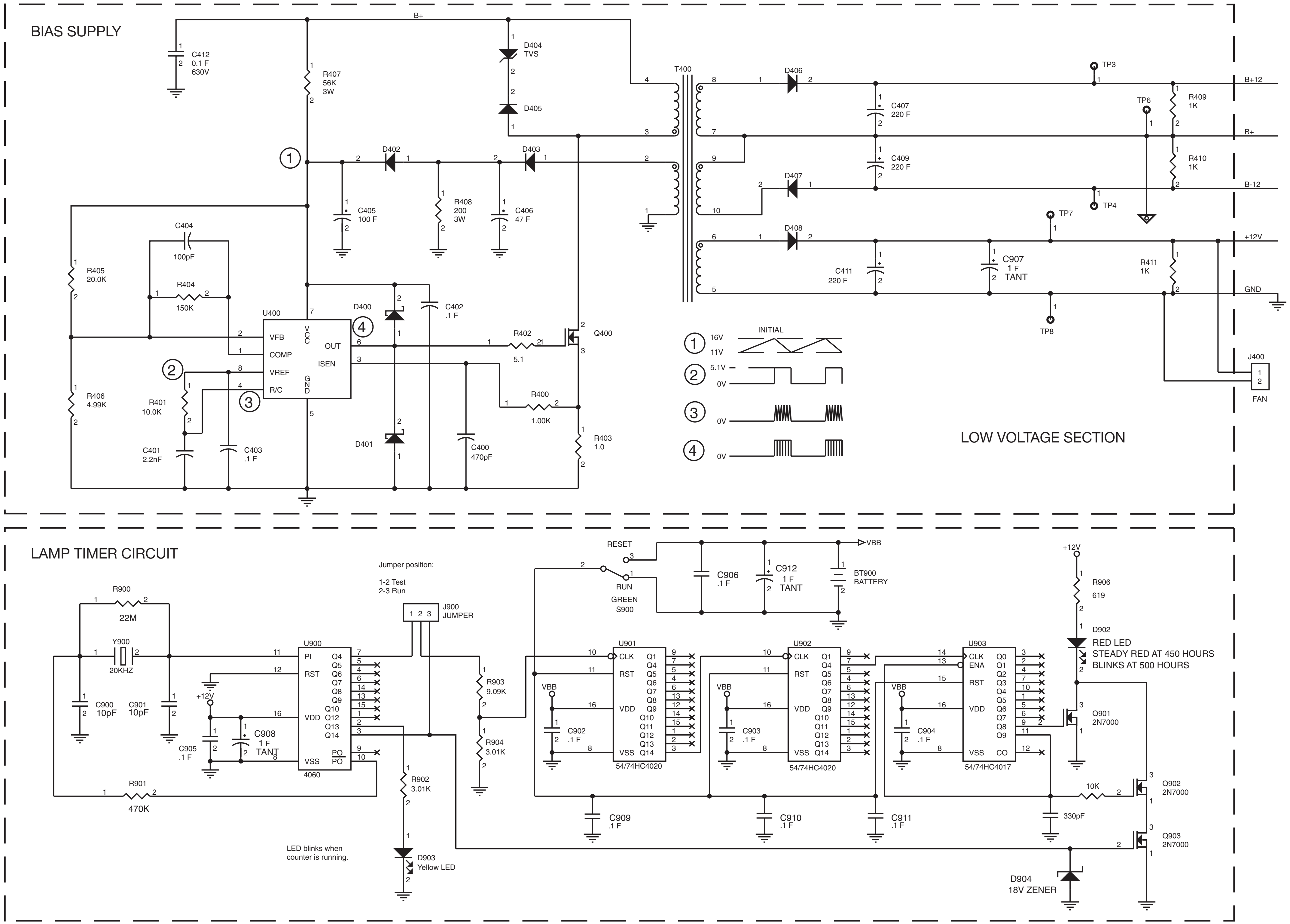
3.2.3.3. Component diagram of the Carsan power supply (as from serial no. 0001 up to 1050)



3.2.3.4. Circuit diagram of the Carsan power supply (as from serial no. 1051 up to 3863)

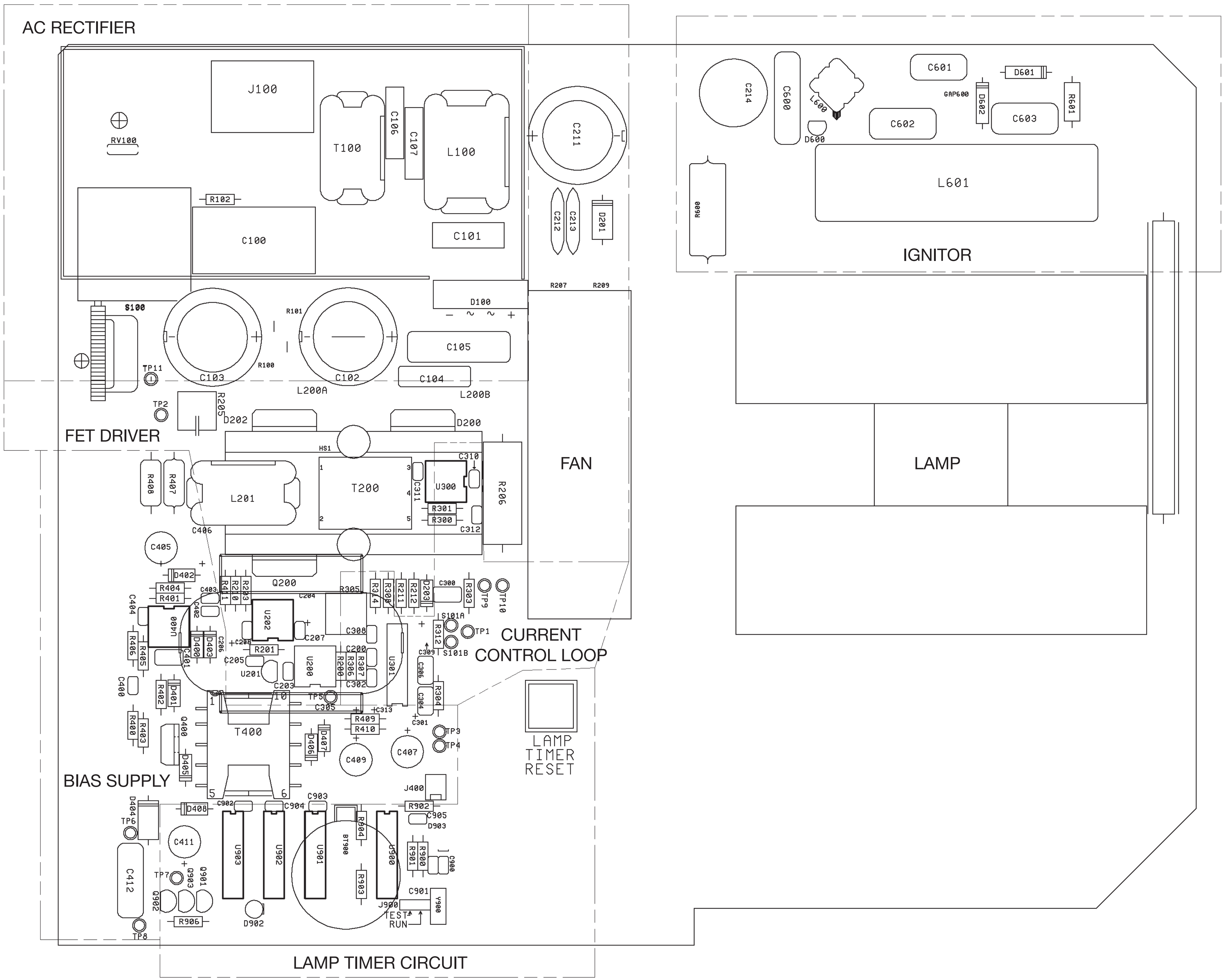


power supply	page 1 of 2



power supply	page 2 of 2

3.2.3.5. Component diagram of the Carsan power supply (as from serial no. 1051 up to 3863)



3.2.4. Warner power supply (as from serial no. 3864)

3.2.4.1. Description of Warner power supply operation

The Warner power supply consists of input filtering, AC rectifier, dual buck regulators, auxiliary 12 V supply, a timing circuit, and a differential lamp igniter.

Warner power supply input

The input power entry starts with two 6.3 A, 250 V fuses (F1 and F2), one on the neutral (“N”) line and the other on the live (“L”) line. Power switch, SW1, a single-throw double-pole switch, is connected in series with the AC lines. The inrush current is limited by R14, a 10 h NTC thermistor. The input EMI filtering consists of two X-capacitors, C9 and C10, four Y-capacitors, C17, C18, C43, and C44, and a common-mode inductor, T4.

The power supply is protected from high input voltages by a 390 V varistor, RV1. The AC line is rectified through an 8 A, 800 V bridge rectifier BR1. The rectified voltage is filtered through C1, C20, and L4 to eliminate the 50/60 Hz ripple. This is supply voltage Vbulk1.

Vbulk1 is supplied to the first of two stages of buck regulators and also to the circuitry that is used to make the maintenance and the auxiliary supplies.

Warner power supply maintenance / auxiliary supplies

Using the Vbulk1 as its supply, U1, a three-terminal pulse-width modulated IC, and T5, a flyback transformer, work together with other external circuitry to maintain the supply used as the 12 V auxiliary for the fan, and for the control circuitry for the ballast.

Vbulk1 connected to pin 1 of T5 and the solid state switch TOP224 connected to pin 3 delivers the excitation required to induce the power on pins 5 and 8 of T5. This power is rectified through D17 and filtered by C12. The auxiliary voltage for the fan can be picked up at J4. The control circuitry power input is connected after TS1, a thermal switch that provides the thermal protection for the ballast. When the ballast is thermally overloaded, this switch will open, cutting power from the control circuitry and shutting down the ballast. The voltage for the supply is determined by feedback to the TOP224 switch at pin 4. A third winding on T5, pins 5 and 6, provides pin 4 with the voltage information. This feedback winding is rectified by D14 and filtered by C11 and C7. D13, a zener diode allows further manipulation of the feedback should it be necessary to change the supply voltage. D16 and D3 on the primary side of T5 provide a discharge path for the energy stored in the transformer.

Warner power supply control circuitry regulator

The regulation of this power supply uses a two-stage buck converter configuration found on the power board. The first stage of the buck converter drops the Vbulk1 voltage down to the Vbulk2 voltage. Q1, an IRFP450, working with L1, a 1.8 mH inductor, is capable of dropping Vbulk1 down to approximately 165 V. Q2, an IRFP260, working with L2, a 300 mH inductor, regulates the output power.

The control circuitry for both stages is located on the control board. The control circuitry for the first stage uses UC3525, a pulse-width modulating integrated circuit, U1. The components C9, a 0.01 μF cap, and R2, a 2.94 kh resistor determine the frequency of the regulator. The frequency of this buck stage is approximately 50 kHz. C1, C2, C5, C6, and C7 prevent noise. D1 and D2, added to the output of U1, prevent high voltages from damaging the IC. R3 and R4 are a voltage divider used as reference voltage for the error amplifier. This error amplifier works with the feedback from the regulated supply at Vbulk2 to determine changes in the output of the regulator. It will adjust the duty cycle of Q1 on the power board to keep the level of Vbulk2 within the specified range. R5, R7A, and R13, on the power board, establish the feedback from Vbulk2 to the error amplifier in U1. R1, in the error amplifier circuit, determines the gain of the error amplifier. C29, a 0.1 μF capacitor, is used in the soft-start feature of the IC.

The signal from the regulator circuitry to the buck FET, Q1, has to be transformed to a different voltage reference, since the regulator circuit is referenced to RETURN and the buck FET, Q1, is referenced to Vbulk2. A coupling transformer T1, and D9, D10, and R19 function together to change the reference of the signal from the regulation circuit to the regulating buck FET, Q1. D5, a 15 V zener diode, protect the gate of Q1 from over-voltage damage. Q3, D7, and R15 assist in the turning on and off Q1 to decrease the losses during switching. At the higher power end of this first stage is Q1, D1, a 15 A commutating diode, and C15 and R20, the first stage snubber. The storage of Vbulk2 is accomplished with C4, a 390 μF, 200 V capacitor.

The second stage, powered by the first stage at Vbulk2, is similar. At the control board, the heart of the second stage regulator is U2, a UC3525 pulse-width modulator integrated circuit, the same as the first stage. C12, a 0.01 µF capacitor, and R10, a 2.37 kh resistor, determine the frequency of the second stage. The frequency of the second stage is approximately 60 kHz. R9, C3, C4, C8, C11, C13 and C14 reduce noise. D3 and D4 protect U2 from high voltages, similar to D1 and D2 in the first stage. The shutdown function of the IC is disabled by being tied to RETURN, through R35.

R16, a 2 kh five-turn potentiometer, along with R14 and R12 set the reference for the error amplifier in U2. This potentiometer is used to adjust the output current. The output current can be set at some predetermined output voltage. This set reference level works with feedback from a current sense signal and will change the duty cycle of Q2 on the power board.

The feedback and the reference set level are compared and – depending on the current adjustment setting – the duty cycle is adjusted to send more or less current to the Xenon lamp. The voltage across R4, a 0.015 h current sense resistor on the power board, through R17 a 1 kh resistor, is fed back to the error amplifier in U2. R11 determines the gain of the error amplifier.

A circuit designed to avoid overpowering the lamp. Q1, R13 and R18 will sense the lamp voltage with help from R12 on the power board and when the lamp voltage reaches a predetermined level, Q1 will begin to turn on, sending current to the error amplifier in U2. The regulator will begin to decease the current to the lamp.

There is a different reference between the power board devices and the control circuitry. This is handled the same as it is handled in the first stage, with a transformer and supporting circuitry. In this case T2, D11, D12 and R18 function to change the reference of the control signal to the regulating buck FET, Q2.

A 15 V zener diode D4 protects the gate of the buck FET, Q2, from high voltages. D8, Q4, and R16 function to speed up the turn-on and turn-off time of the power device to decrease switching losses. D2, a 15 A 200 V diode, is the commutating diode for the second stage regulator circuit. C16 and R17 is the snubber circuit across D2 commutating diode. Following the second stage, L5, a common mode choke, and C5, a 0.022 µF capacitor, have been incorporated to reduce the noise returning to the power supply.

C8 and R5 work together to provide the necessary energy required to sustain the arc in the lamp once the arc has been created. They supply a discharge current through the lamp that enables the lamp to stay on until the ballast is able to take over.

Warner power supply ignition

The basic operation of the igniter is to increase the voltage across the lamp to start an arc across the electrodes of the lamp. C21, R24, R25, Q5 and T6 are the first stage. C21 is charged up until the potential across Q5, a 105 V SIDAC, triggers the SIDAC. When Q5 fires, a large amount of current is sent through the primary of T6. This energy is transformed to the secondary of T6 where it will begin to pump up the C23 and C24 through D18 of the next stage. As the SIDAC, Q5, fires, C21 is discharged but then is charged up through R24 and R25. As C21 is discharged, the potential across Q5 increases again until it is great enough to fire the SIDAC again. This oscillating process is repeated. C23 and C24 are charged through D18 from the first stage oscillator to about 5 kV. At this point a 5 kV spark gap, SG1, discharges through the primary of a step-up differential transformer, T7. The secondary of T7 is connected directly to the output of the ballast across the lamp. The igniter portion of the ballast will operate until the lamp conducts. The above sequence will continue as long as the ballast is in its open-circuit mode. The output voltage remains high until the lamp ignites.

Warner power supply lamp timer circuit (as from serial no. 3864 up to LF0611830)

Four stages of counters are incorporated in the timer design. The start of the counting mechanism for the design is U2, a MC14060B a 14-bit binary counter, along with C28, C29, R28, R29, and Y1, that create the 20 kHz oscillator. The output of U2 is fed to the next IC, U3, a MC14020B, a 14-bit binary counter.

For test purposes the timing circuitry can be clocked faster by shorting J1 pin 1 to pin 2 at J7. For normal operation the jumper is set to position J1 pin 2 to pin 3. The clocks from U2 to U3 in the test mode are about 800 µs apart while in the normal mode the clock pulses to U3 are approximately 820 ms apart.

U3 divides the transitions by 16,384 before sending the clock pulses to U4, another MC14020B 14-bit binary counter. For test mode the pulses are approximately 13.1 s apart. In normal operating mode the pulses are approximately 13,386 s (3.7 h) apart. U4 further increases the time of the transitions of the clock by a factor of 16. This increase changes the test mode transitions to 210 s and the normal operation transitions to 214,170 s (59.5 h) apart. These clock transitions will reach the final counter stage U5, an MC14017 decade counter. From the last counter two events are tracked.

A red warning indicator lamp, D21, will light when the lamp is about to reach end of life and will start flashing when the lamp has reached the end of life. U5 controls the circuitry, which includes Q6, Q7, Q8, R26, and D21, for this function. U5 will count 7.5 transitions from U4 before turning on Q6 to light LED D21.

Note: *The half transition comes into play because U5 is positive edge triggered where the other counters are negative edge triggered.*

In one more pulse from U4, Q6 will turn off and Q8 will turn on. Q8 is in series with Q7, that is being turned on and off at a frequency of 1.2 Hz by a tap off U2. This causes the flashing of D21 to indicate the end of life.

C25, C26, C27, C30, C31, C32, C33, C34, C35, C36, C37, C39, and C41 have been added to the design to minimize the effect of noise on the circuit. D19, a 15 V zener diode, protects from high voltages. D20, a yellow LED, along with R27 indicates if the oscillator is working by flashing at a frequency of 2.4 Hz tapped off U2.

A battery, BAT1, has been incorporated to allow the running time of the lamp to be stored when the ballast has been turned off. SW2 will reset the timer circuit. The timer should be reset whenever the lamp is changed.

Warner power supply lamp timer circuit (as from serial no. LF0611831)

Note: *See also Section 3.2.4.6 Circuit diagram of the timer PCB (as from serial no. LF0611831).*

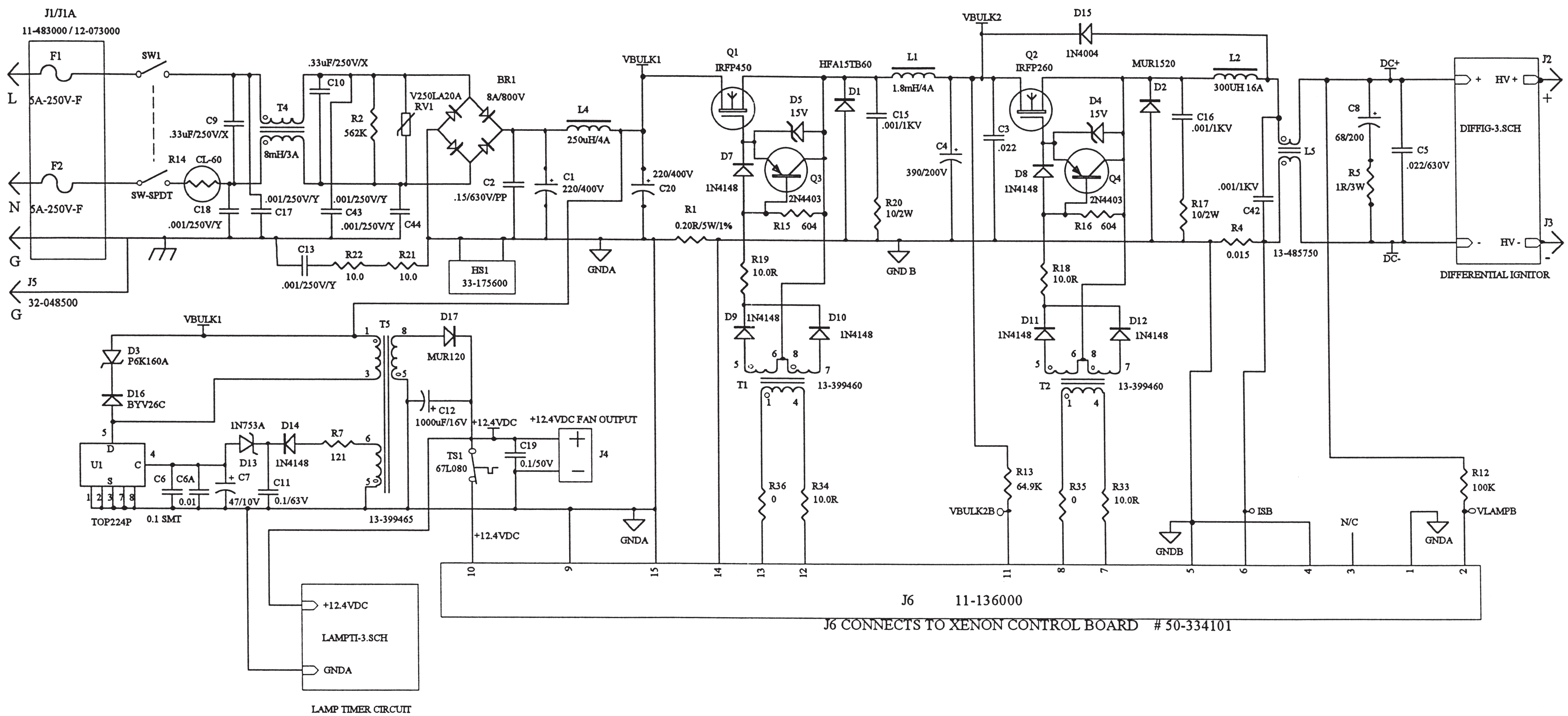
The lamp timer circuit keeps track of lamp usage in hours, and warns the operator that a scheduled lamp change is approaching or overdue. The red LED (D902) on the faceplate will light at approximately 450 h (90% of the lamp's expected life) and start blinking at around 500 h to indicate a lamp change is imperative. Upon changing the lamp, the user must manually reset the timer by pressing the reset switch located inside the light source on the faceplate. The circuit power is maintained by a lithium battery when the light source is not in use. The battery must be replaced every 10 years to insure continued operation.

The first stage of the lamp timer circuit consists of a CD4060 binary counter (U1) driven by a 20 kHz crystal (Y1). The CD4060 counter divides the 20 kHz crystal frequency down to a 1.22 Hz square wave at U1-3, which provides clocking for the next stage of the counter. When the light source is in use, the yellow LED (D1) will blink to indicate the circuit is running. A test jumper is also provided to reduce the overall 500 h count to about 30 min. for testing purposes. This section of the circuitry is powered by the +12 V bias supply output and is only active when the light source is in use.

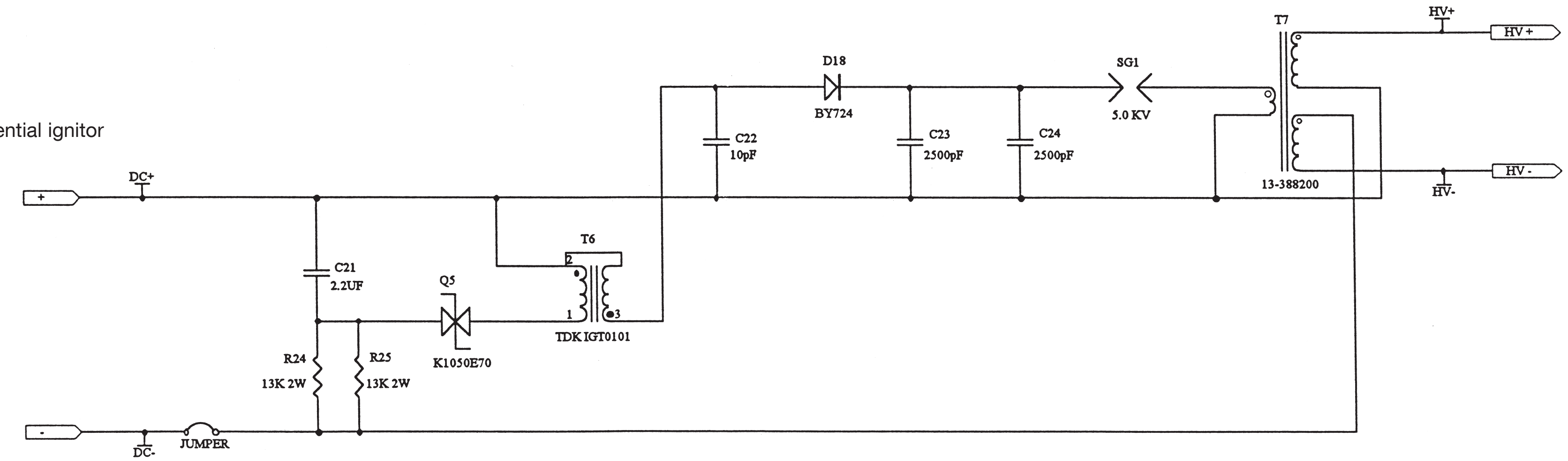
The second stage of the lamp timer circuit consists of two CD4020 binary counters, a CD4017 decade counter, a lithium battery (BAT) and a reset switch (SW). These counters are driven by the 1.22 Hz square wave from the first stage of the counter circuit and keep track of lamp usage hours. Pins 9 and 11 of the CD4017 decade counter (U4) provide the logic signals that activate the FET's that control the REPLACE LAMP LED (D3). The lithium battery powers this section of the circuitry at all times, whether the light source is on or not. When pressed, the reset switch sets all three counters back to zero.

The final stage of the lamp timer circuit consists of 3 FET's (Q1 – Q3), the REPLACE LAMP LED (D3), and the LED current-limiting resistor (R7). At approximately 450 h U4-9 goes high and activates the Q2 FET which turns on the REPLACE LAMP LED (D902). At approximately 500 h U903-9 goes low and U903-11 goes high, activating Q3. Since Q3 is in series with Q1, and Q1 is continuously clocked by U1-3 at a 1.22 Hz rate, the REPLACE LAMP LED will start to blink. In addition, when U4-11 goes high, it disables pin 13 of the CD4017 which is the count-enable pin, preventing any additional counting of the CD4017 counter (U4). This holds the count at 500 h until the SW RESET switch is pressed. Since this stage of the circuit is powered by the +12 V bias supply output, the REPLACE LAMP LED and associated circuitry do not draw power from the lithium battery.

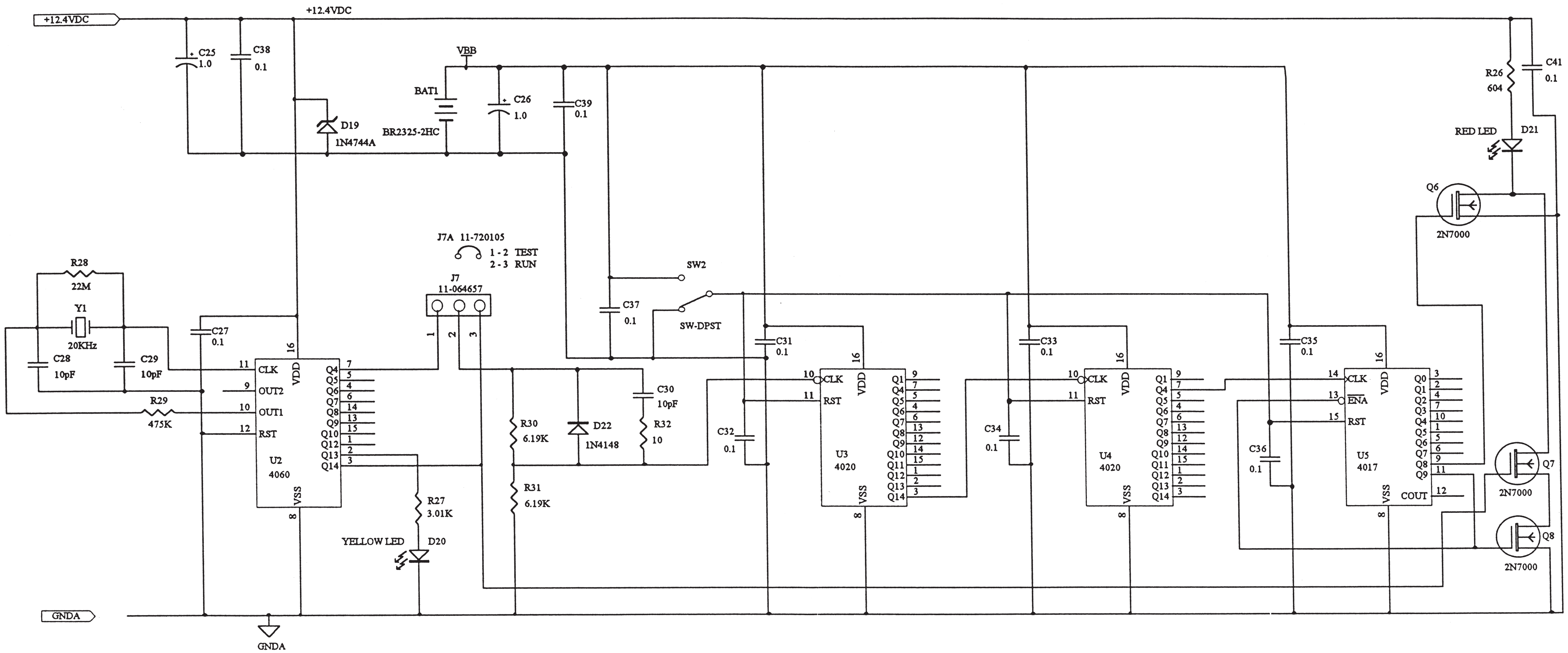
3.2.4.2. Circuit diagram of the Warner power supply (as from serial no. 3864 up to LF0611830)



differential ignitor

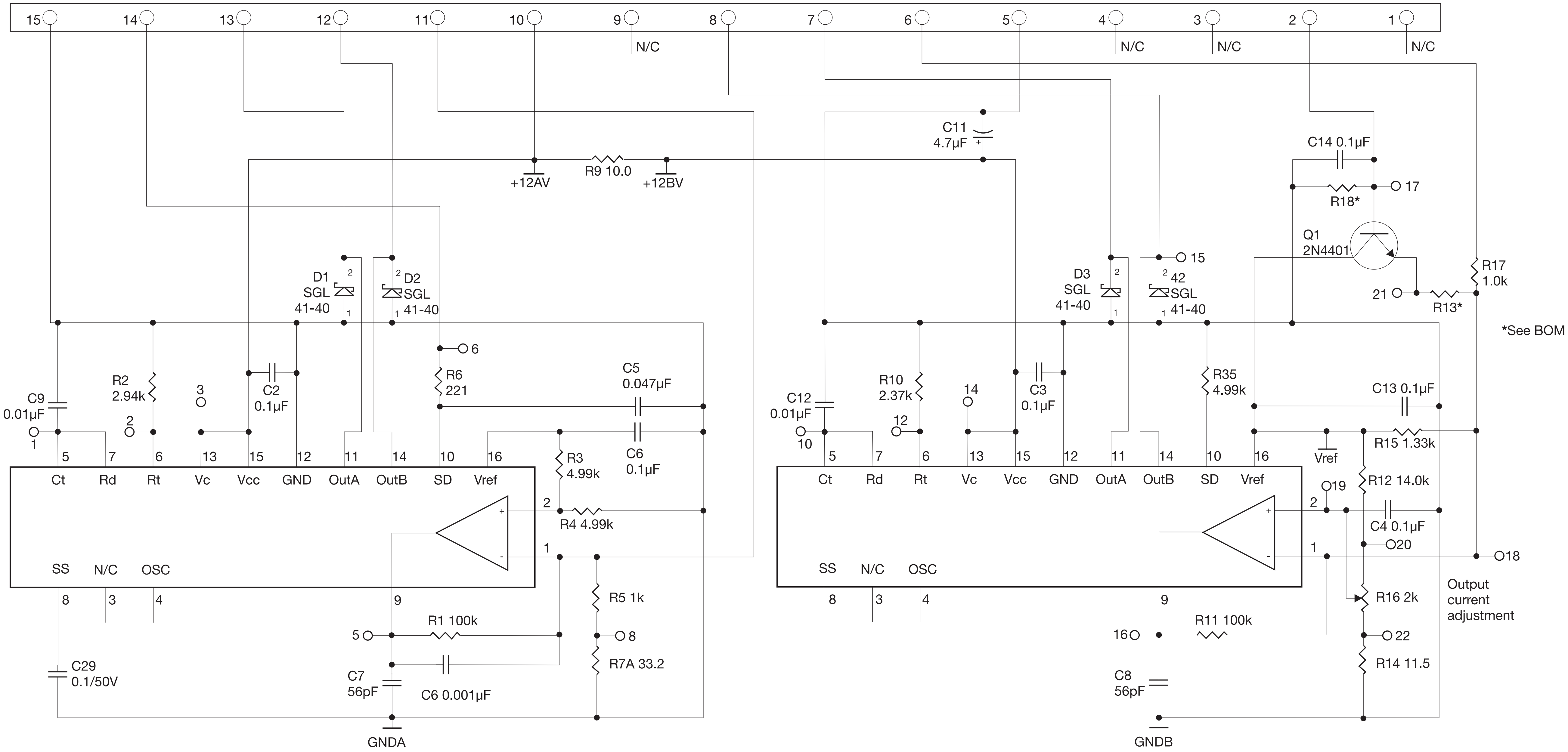


lamp timer circuit



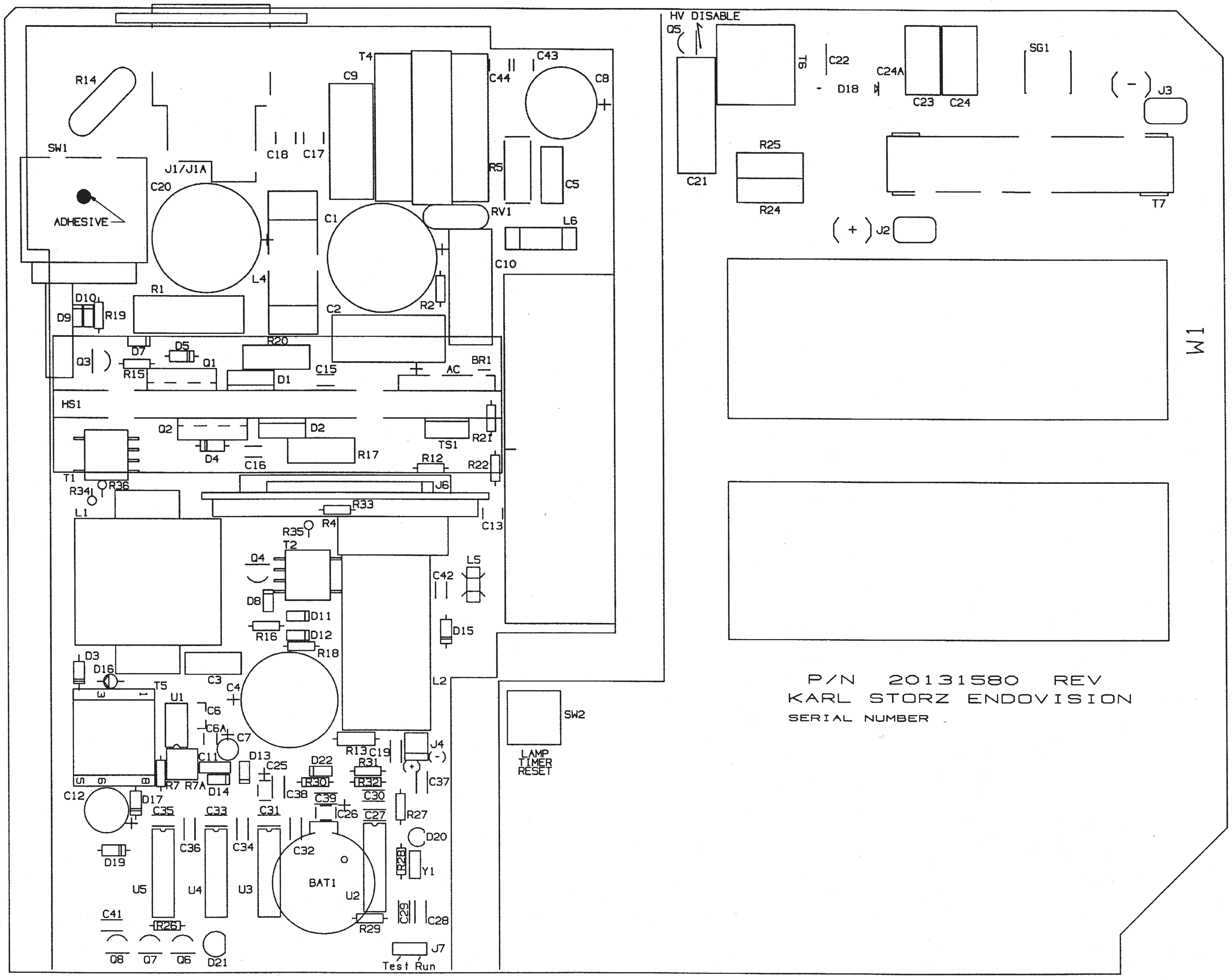
power supply	page 2 of 3

control board no. 50-334101

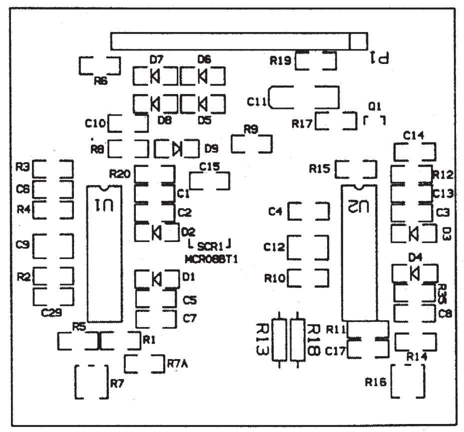


power supply	page 3 of 3

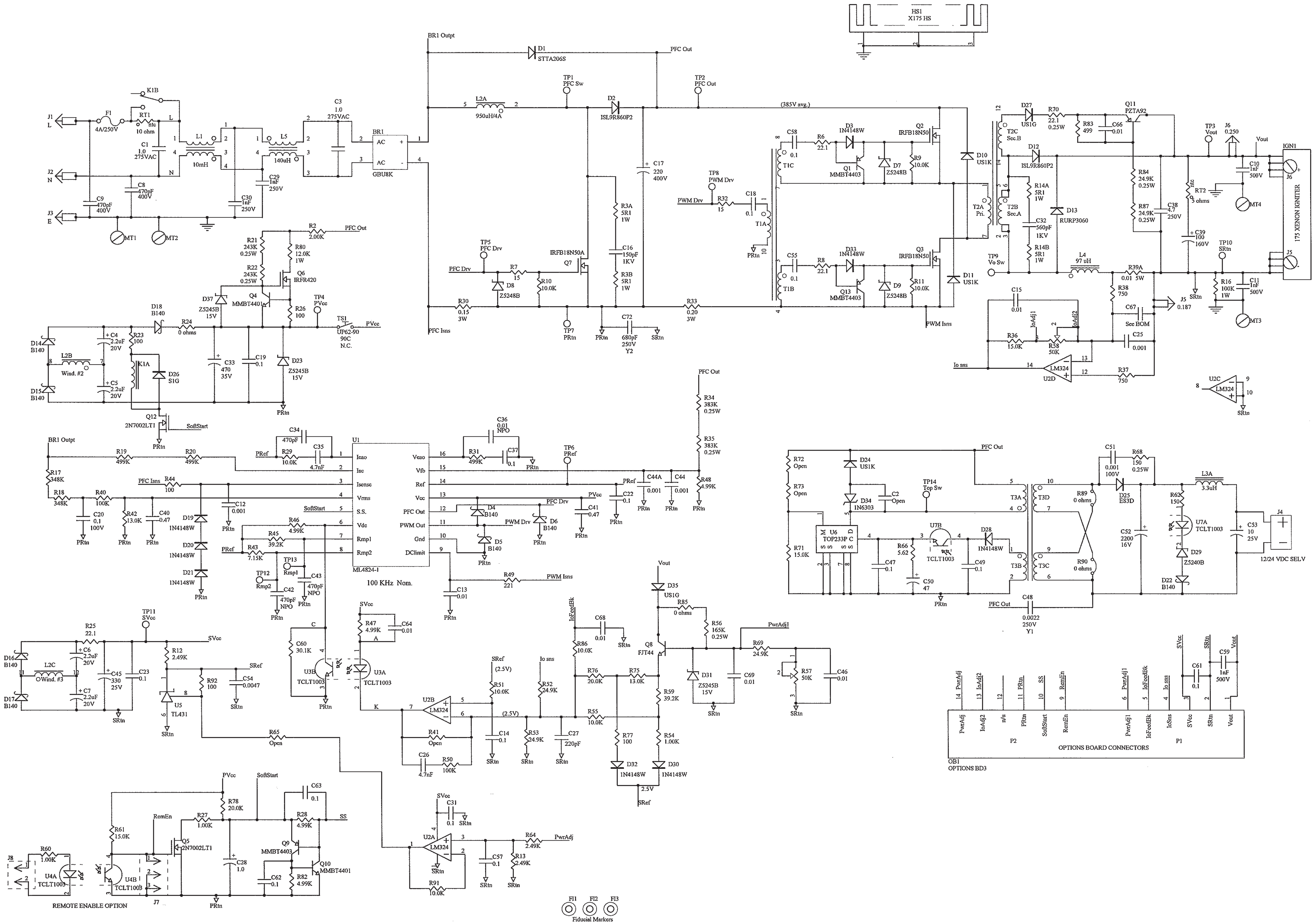
3.2.4.3. Component diagram of the Warner power supply (as from serial no. 3864 up to LF0611830)



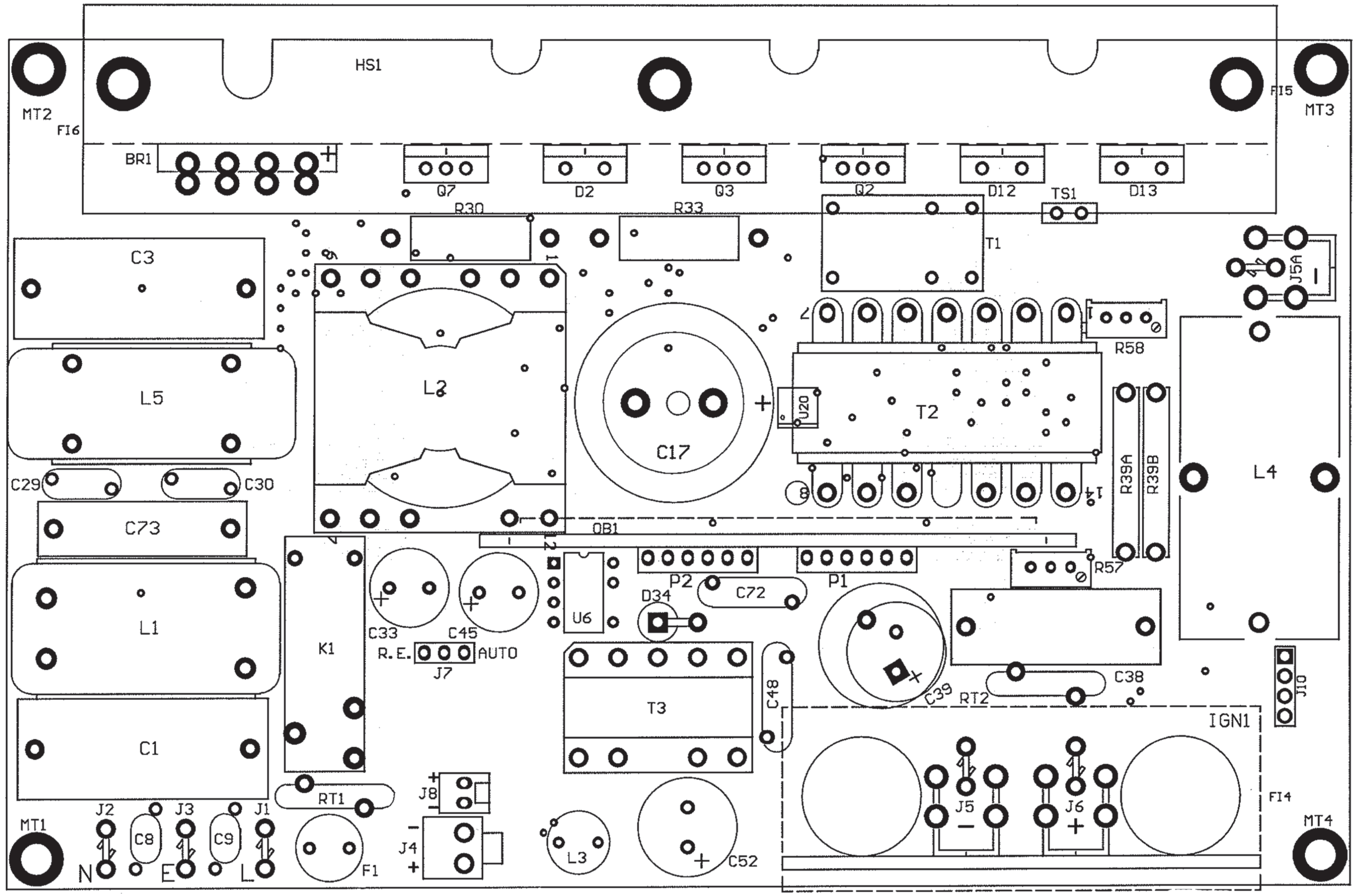
CONTROL BOARD #50-3341101



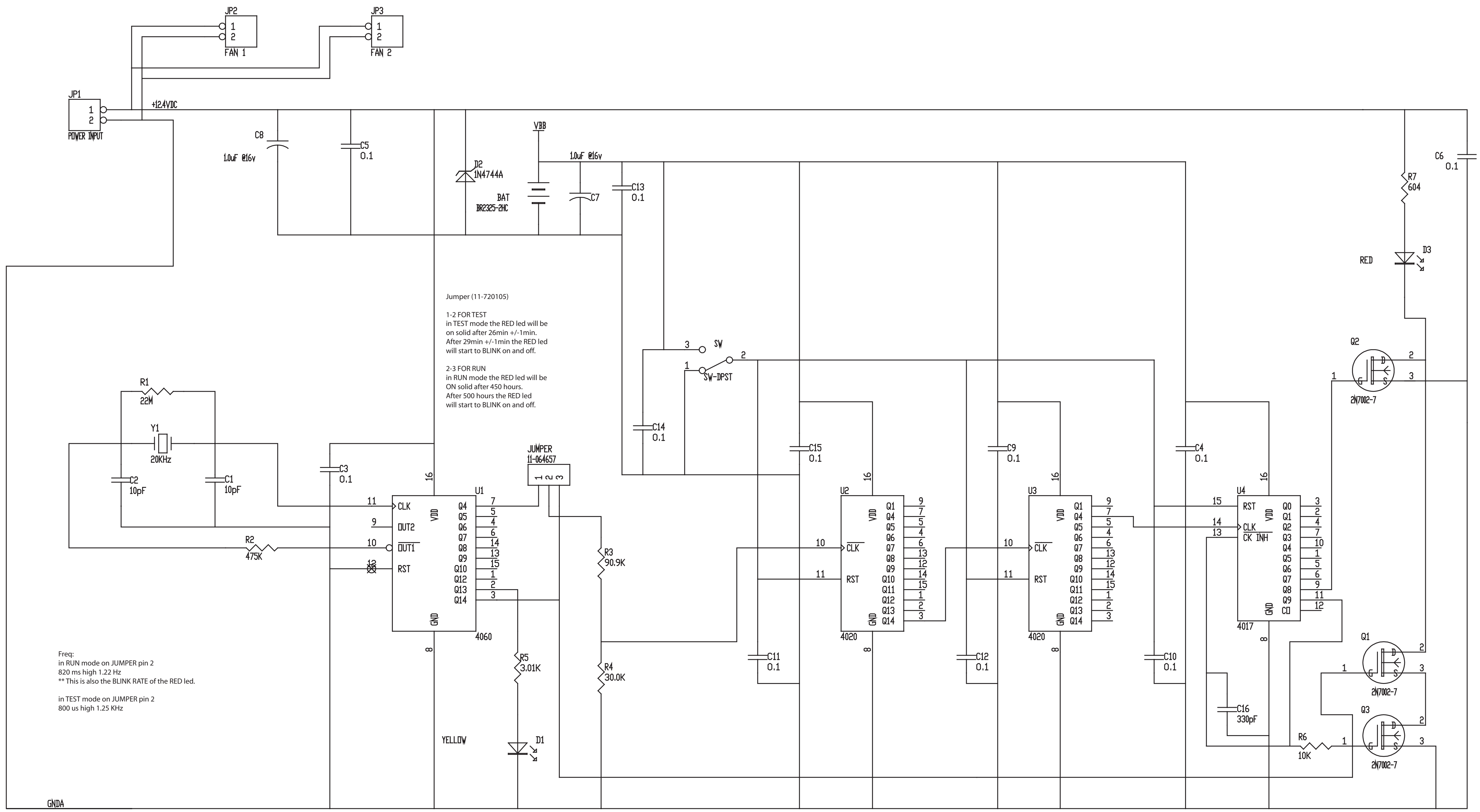
3.2.4.4. Circuit diagram of the Warner power supply (as from serial no. LF0611831)



3.2.4.5. Component diagram of the Warner power supply (as from serial no. LF0611831)



3.2.4.6. Circuit diagram of the timer PCB (as from serial no. LF0611831)



3.2.5. Light attenuator

This device attenuates the light output.

3.2.6. 175 W Xenon lamp

The lamp always runs at the same power. Turning the brightness control knob does not affect the lamp output; therefore, the lamp lifetime is the same at any brightness level.

If the lamp has run for more than 450 h (90% of the lamp's warranted life of 500 h), the REPLACE LAMP indicator will light while the light source is on. If the lamp has run for more than 500 h, the REPLACE LAMP indicator will blink continuously while the light source is on, until the lamp hours RESET switch is depressed.

THE LIGHT OUTPUT OF THE LAMP IS EXTREMELY HIGH. The exact focal point has been determined by experience to cause minimum problems (such as light cable destruction) while still providing maximum light output.

3.3 Troubleshooting

3.3.1. Troubleshooting the XENON NOVA® 175

Device won't power up

– Check the power cord and connections. Replace if necessary.
– Check for blown power fuse. See Power fuse blown.
– Check power source. See Power source.

Device suddenly shut down

– Make sure the fan is working and vents are unobstructed. If the fan is not working, see Fan will not run.
– Measure the lamp wattage, see General complaint of low brightness. If it is above 183 W (normal), readjust to 175 W.

Power fuse blown

– Indication of a power supply component failure (probably the FETS), see Section 3.2.3 Carsan power supply (as from serial no. 0001 up to 3863) and Section 3.2.4 Warner power supply (as from serial no. 3864).

Fan will not run

– Check the fan itself. Replace if necessary.
– Check the 12 VDC output from the power supply and all connections, see Section 3.2.3 Carsan power supply (as from serial no. 0001 up to 3863) and Section 3.2.4 Warner power supply (as from serial no. 3864).

Lamp will not start or stay lit

– Replace the lamp with a known good one.

ⓘ ***Note:*** *There is not necessarily a visible indication of age or noticeable difference between a Xenon lamp that is new and one with thousands of hours on it. It is good practice to discard old Xenon lamps rather than to keep them around as spares. Old lamps may cause erratic starting, flickering, and generally poor operation.*

– Check for blown power fuse. See Power fuse blown.
– Check the power supply, see Section 3.2.3 Carsan power supply (as from serial no. 0001 up to 3863) and Section 3.2.4 Warner power supply (as from serial no. 3864).

Light cannot be dimmed properly

– Check the light attenuator mechanism for jammed or broken parts. Replace if necessary.

General complaint of low brightness

- Examine all other parts in the optical system, including the light guide cable, the endoscope, the video camera and lenses.
- Measure the power (in W) required by the lamp.
  Measure the voltage across the R206 resistor and multiply the value by 100. Measure the voltage across the lamp. Multiply these two values together to find the lamp power. The power requirement should be at least 166 W, but not more than 184 W. If the lamp power is between 166 W and 184 W and the light output is too low, replace the lamp.

! ***CAUTION:*** *Lamps are high pressure vessels and must be handled with care. When handling the lamp wear safety glasses and face shields to protect the face and gloves to prevent skin oil transfer. Never touch the porcelain insulator on the lamp with bare hands. When working with an operating lamp, wear eye and face protection to prevent blindness or UV damage.*

! ***CAUTION:*** *Connect the voltmeter only when the lamp is already started; otherwise, the high-voltage starting pulse will damage or destroy the voltmeter. Do not restart the device when making measurements.*

Replace lamp indicator lights before 450 hours have elapsed

- Check to see if the counters have been updated, see Section 3.2.4 Warner power supply (as from serial no. 3864), section Warner power supply lamp timer circuit (as from serial no. 3864 up to LF0611830).

Light-cable input-end burning

- Check for inadequate cleaning of the cable, or use of a previously burned cable.
- Unsuitable light-guide; that is, a light-guide only suitable for low power use.

3.3.2. Component courses of action

Lamp

- If the lamp fails before 500 hours, look for the following items to ensure no other problems were responsible. Replace the lamp.
  - Check for marked discoloration inside the lamp (usually caused by a seal leak).
  - Check for a cracked window (caused by thermal shock).
  - Check for a crazed or burned reflector. This can be caused by overheating or overcurrent, and is indicative of problems elsewhere.

Light attenuator

- Check for a jammed attenuator wheel or a broken part. Replace if necessary.

Power supply (up to serial no. LF0611830)

- If possible, check the power supply by using a lamp known to be good.
- Check all connections.
- AC Rectifier
  If there is no B+ voltage present when the light source is switched on, ensure there is power at the outlet where the light source is plugged in.
  Remove the power cord from the light source and check the power fuses in the power entry module.
  - If both fuses are good, it is likely that the S100 power switch or the D100 bridge rectifier is defective.
  - If one or both of the power fuses are blown, check the Q200 FET that drives the Xenon lamp. It is also possible that one of the electrical components in the AC rectifier circuit is shorted. Check the capacitors on both sides of the D100 bridge rectifier and the bridge rectifier as well.

  If the B+ voltage is extremely low, check to see if one of the circuits connected to B+ is loading down the voltage. It is also possible that one of the filter capacitors in the circuit is defective.

- Bias Supply
  Measure the three output voltages (B+12, B-12 and +12V) with a digital voltage meter. If one of the supply voltages is missing, but the other two are present, it is likely that either one of the T400 secondary windings has opened or the corresponding rectifier diode for that supply line (D406, D407 or D408) is open.
  If all three output voltages are missing or extremely low, it is possible that one of the outputs is severely loaded down by a shorted component. When this occurs, the loaded output will rob energy from the T400 transformer, causing all the outputs to be low.
  Make sure that the B+ supply voltage is present. If B+ is not present, the problem probably lies in the AC rectifier section of the power supply.
  Make sure the Q400 FET is functioning by examining the gate and drain with an oscilloscope. You should observe a square wave with the ON TIME modulated at 50 kHz. If not, the problem probably lies in the PWM circuit (U400 and related components).
  Lift one end of each rectifier diode (D406, D407 and D408) from the PC board one at a time, to see if the other two output voltages return to normal. If this happens, the circuitry connected to the output with the lifted diode is defective or the filter capacitor next to that diode is shorted. Trace out the suspected circuit looking for shorted components or other problems. If all three diodes have been lifted and the Q400 FET appears to be working, but still no voltages appear at the outputs, the primary windings of the T400 transformer are probably open.
  If the PWM circuit is not working, begin by checking the supply voltage at U400-7. If there is no voltage at pin 7, either R407 is open, one of the components connected to U400-7 is shorted to ground, or the PWM chip itself is defective. If there is a 16 V – 11 V sawtooth waveform at U400-7, the PWM chip is trying to start but cannot stay running. The T400 transformer or the Q400 FET may be defective. If there is no square wave at U400-6, the PWM chip may be defective. If there is a square wave at U400-6 but no 50 kHz modulation during the ON TIME, the components connected to pins 4 and 8 of the PWM chip may be defective or the PWM chip itself may be defective.
- Lamp Timer Circuit
  A problem may be evident either through the non-operation of the faceplate LED or a gross error in the timing (e.g., the REPLACE LAMP indicator comes on in a few days).
  - If the replace lamp indicator lights before 450 hours have elapsed, inspect U903.
  - If U903 is not 54/74HC4017, call KARL STORZ customer service and order a lamp power supply upgrade kit (order no. 201315 80). Install the kit as directed.

  Visually observe the D903 yellow LED located inside the power supply area next to the battery. With the light source running, the D903 LED should blink at a rate of 2.44 times per second (37 pulses in 15 seconds).
  - If the D903 LED blinks correctly, the first stage of the circuit is probably working.
  - If the D903 LED is blinking much faster than 2.44 times per second or is on continuously, check the Y900 crystal for 20 kHz operation, the C900 and C901 capacitors, or the U900 counter chip itself.
  - If the D903 LED does not come on at all, the problem could be no +12 V at U900-16, a defective counter (U900) or crystal, or a defective LED.

  If the first stage of the circuit is working, place the J900 jumper in test mode, turn on the light source, and press the green reset switch (S900) next to the fan. The red REPLACE LAMP LED should come on solid in 26 minutes and 13 seconds. The LED should start blinking 29 minutes and 43 seconds after the reset switch was pressed.
  If this doesn’t happen, check that U901-10 is being clocked by a 1.25 kHz square wave. If so, the problem could be a defective counter (U901-U903), a defective FET (Q901-Q903), a defective LED (D902), or a dead battery (BT900).

3.4 Technical data

XENON NOVA® 175 **20** 1315 20		
Supply voltage	100 VAC … 125 VAC / 220 VAC … 240 VAC, ±10%	
Power frequency	50 Hz / 60 Hz	
Power consumption	400 VA[3] / 350 VA[4]	
Power fuses[3]	2 x T 3.15 AL / 250 V	(220 VAC … 240 VAC)
	2 x T 6.3 AL / 250 V	(100 VAC … 125 VAC)
Power fuses[4]	2 x T 1.6 AL / 250 V	(220 VAC … 240 VAC)
	2 x T 3.15 AL / 250 V	(100 VAC … 125 VAC)
Lamp type	Xenon lamp, 175 W	
Lamp voltage	12.5 VDC (nominal)	
Lamp current	14 A, ±2 A	
Wattage	175 W (nominal)	
Color temperature	5600 K (initial)	
Operating temperature	10 °C … 40 °C	(50 °F … 104 °F)
Dimensions (w x h x d)	305 mm x 101 mm x 240 mm	
Weight	4.0 kg	
Storage and transport conditions:		
Storage temperature	0 °C … 60 °C	(32 °F … 140 °F)
Humidity	0% … 95%, rel. humidity, non-condensing	
Atmospheric pressure	+500 hPa … +1080 hPa	

Standard compliance

According to IEC 60601-1, UL 2601, CSA 601.1:

Type of protection against electric shocks: Protection Class I

Degree of protection against electric shocks: Applied part of type BF[5] / CF[6]

Please read the Electromagnetic Compatibility Information in the appendix of the instruction manual.

According to IEC 60601-1-2:2001:

Directive compliance

According to Medical Device Directive (MDD):

Medical device in Class I

This medical device bears the CE mark according to MDD 93/42/EEC. A code number after the CE mark indicates the responsible notified body.

ETL LISTED
CONFORMS TO
UL-544
UL-2601.1
104988
CERTIFIED TO
CAN/CSA C22.2 NO. 601.1
ETL TESTING LABORATORIES INC.
CORTLAND, NEW YORK 13045

3) *Valid up to serial no. BC0627483.*
4) *Valid as from serial no. BC0627729.*
5) *Older versions of the XENON NOVA® 175.*
6) *Newer versions of the XENON NOVA® 175.*

Section 4.

Replacement of Individual Assemblies

Direction Sign:

Contents 4. Replacement of Individual Assemblies

4.1 Information about replacements

The device is fully adjusted and tested before it leaves the manufacturers. If the device fails, a test of the assemblies should be carried out by authorized KARL STORZ technical staff.

4.2 Tools required for replacing the individual assemblies

- Power supply
  Phillips screwdriver, medium
  Needle nose pliers
  Conductive work mat, wristband, ground cable

- Fan assembly
  Phillips screwdriver
  Needle nose pliers
  Standard screwdriver
  Conductive work mat, wristband, ground cable

- Lamp
  Torx driver and assorted bits
  Thermal compound
  Conductive work mat, wristband, ground cable

- Attenuator assembly
  Torx driver and assorted bits
  Phillips screwdriver
  Needle nose pliers
  Standard screwdriver
  M3 hex wrench
  Conductive work mat, wristband, ground cable

- Condenser lens
  Torx driver and assorted bits
  Phillips screwdriver
  Needle nose pliers
  Standard screwdriver
  M3 hex wrench
  Conductive work mat, wristband, ground cable

- Hot mirror assembly
  Torx driver and assorted bits
  Conductive work mat, wristband, ground cable

! ***CAUTION:*** *Repairs may only be performed by qualified technicians trained in electrical or electronic engineering, in compliance with the relevant occupational, safety and accident prevention regulations.*
Always unplug the equipment before performing any repairs.
Safety Testing based on IEC EN62353, IEC / UL 60601-1, whichever may apply, must be performed after servicing has been completed.

4.3 Replacement of the power supply Z07558 (as from serial no. LF0611831)

Refer to Section 4.9 Figures for replacements, Figures 1 and 2.

a. Disconnect the light source from its power source.
b. Remove the outer cover by sliding the interlock slide to the right, removing the four screws on the bottom of the case, and sliding the cover back.
c. Remove the power supply cover by loosen the screws holding it in place.
d. Remove the faceplate assembly by removing the four screws and pulling the faceplate assembly forward.
e. Disconnect the input wires and the lamp leads.
f. Remove the screws holding the power supply on the bottom of the device.
g. Unplug the timer PCB.
h. Carefully lift the power supply out of the case.
i. Unplug the fan connector from the power supply.
j. Transfer the standoffs from the power supply to the replacement power supply.
k. Replace the power supply and reassemble in reverse order of disassembly.

! ***CAUTION:*** *Make sure that the top and bottom halves of the heat sink are aligned so that the lamp can be fitted free of distortion. Replacement of the fan assembly*

4.4 Replacement of the fan assembly

Refer to Section 4.9 Figures for replacements, Figure 1.

a. Disconnect the lamp leads from the power supply.
b. Unplug the fan wires from the timer PCB.
c. Remove the two screws at the bottom of the device holding the fan assembly.
d. Remove the screws holding the rear panel and pull the panel back slightly from the device.
e. Remove the fan assembly.
f. Replace the fan and reassemble in reverse order of disassembly.

4.5 Replacement of the lamp

Refer to Section 4.9 Figures for replacements, Figures 1 and 2.

a. Disconnect the light source from its power source.
b. Remove the outer cover by sliding the interlock slide to the right, removing the four screws on the bottom of the case, and sliding the cover back.
c. Lift the lamp insulator and fold it back.
d. Unscrew the four heat sink thumbscrews.
e. Carefully remove the upper half of each heat sink. Remove the old lamp.

! ***CAUTION:*** *Lamps are high pressure vessels and must be handled with care. When handling the lamp wear safety glasses and face shields to protect the face and gloves to prevent skin oil transfer. Never touch the porcelain insulator on the lamp with bare hands.*

f. Apply a thin coating of thermal joint compound around the inside circumference of the heat sinks (both anode and cathode) as well as on the anode end surface.
g. Reassemble in reverse order of disassembly.

4.6 Replacement of the attenuator assembly

Refer to Section 4.9 Figures for replacements, Figures 1 and 3.

a. Disconnect the light source from its power source.
b. Remove the outer cover by sliding the interlock slide to the right, removing the four screws on the bottom of the case, and sliding the cover back.
c. Remove the power supply cover by removing the screws holding it in place.
d. Disengage the power switch actuator bar by holding the tab with pliers and pushing the bar down.
e. Remove the faceplate assembly by removing the four screws and pulling the faceplate forward.
f. Remove the brightness control knob by removing the set screw with an M3 hex wrench.
g. Remove the two retaining screws holding the attenuator assembly to the posts and remove the assembly, sliding the post for the knob out of its hole.
h. Replace the attenuator assembly and reassemble in reverse order of disassembly.

4.7 Replacement of condenser lens

Refer to Section 4.9 Figures for replacements, Figures 1 and 3.

a. Remove the attenuator assembly as described in Section 4.6 Replacement of the attenuator assembly.
b. Remove the three retaining screws holding the lens.
c. Replace the condenser lens and reassemble in reverse order of disassembly. Tighten the retaining screws a little at a time, moving in a circular pattern in order to keep the correct orientation of the lens. Avoid overtightening the screws.

4.8 Replacement of the hot mirror assembly

Refer to Section 4.9 Figures for replacements, Figures 1 and 2.

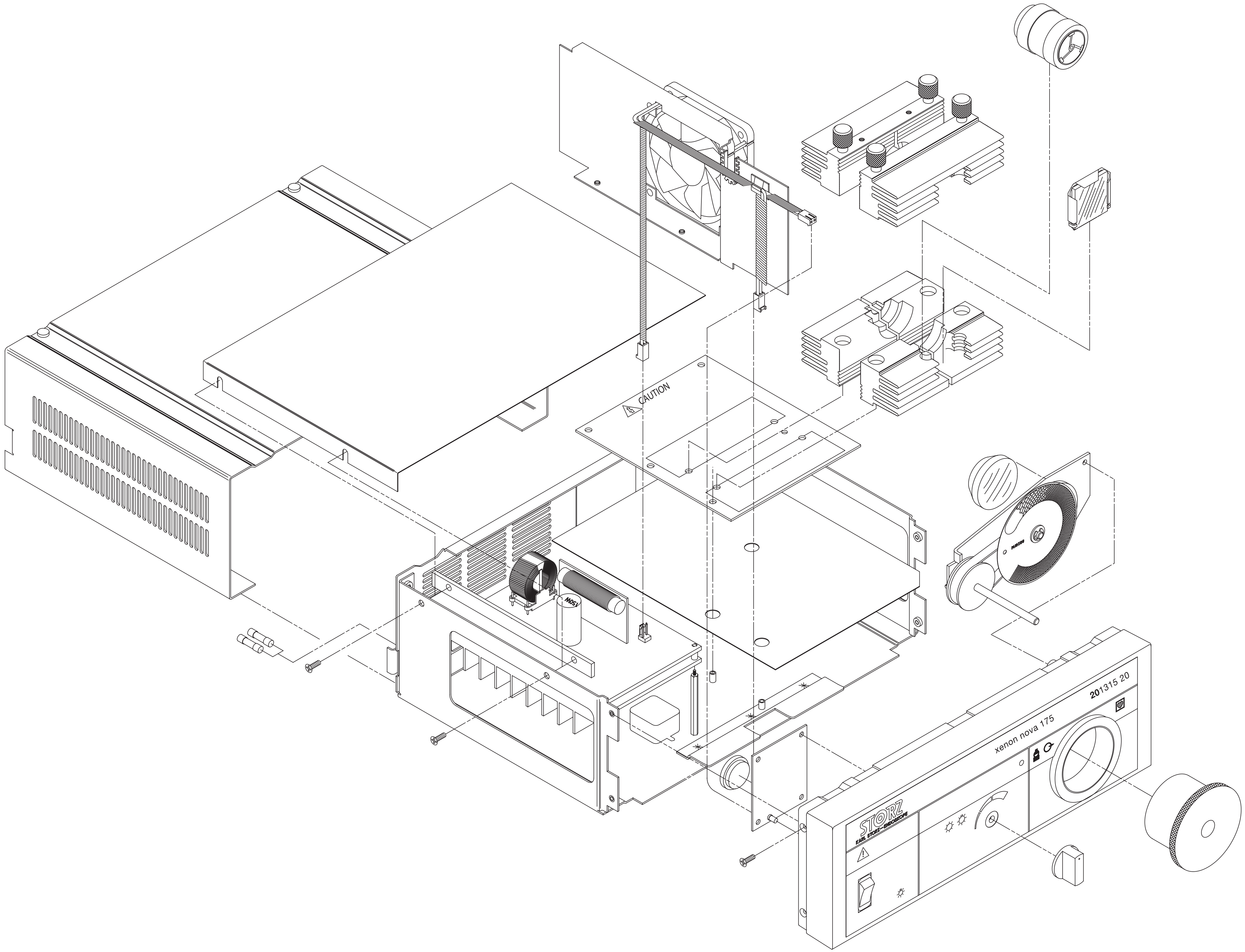
a. Disconnect the light source from its power source.
b. Remove the outer cover by sliding the interlock slide to the right, removing the four screws on the bottom of the case, and sliding the cover back.
c. Remove the power supply cover by removing the screws holding it in place.
d. Disengage the power switch actuator bar by holding the tab with pliers and pushing the bar down.
e. Remove the faceplate assembly by removing the four screws and pulling the faceplate forward.
f. Lift the lamp insulator and fold it back.
g. Unscrew the thumbscrews on the front heat sink.
h. Carefully remove the upper half of the heat sink.
i. Lift the hot mirror assembly out of the lower heat sink slot and replace with the new hot mirror assembly.

! ***CAUTION:*** *The hot mirror assembly is secured against falling out by two retaining clips in the bottom part of the heat sink. Bend back the retaining clips at the front and remove the filter.*

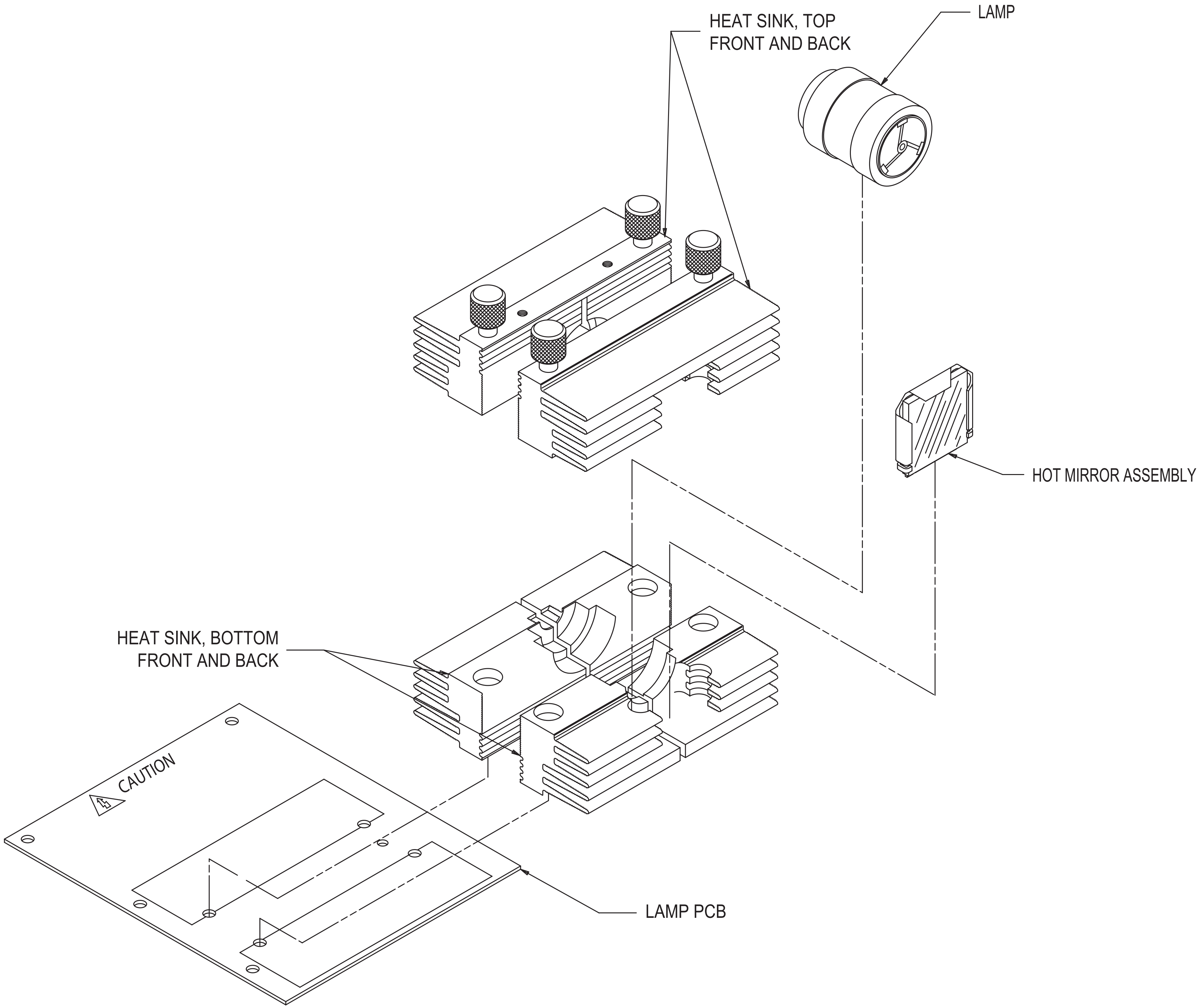
j. Reassemble in reverse order of disassembly.

4.9 Figures for replacements

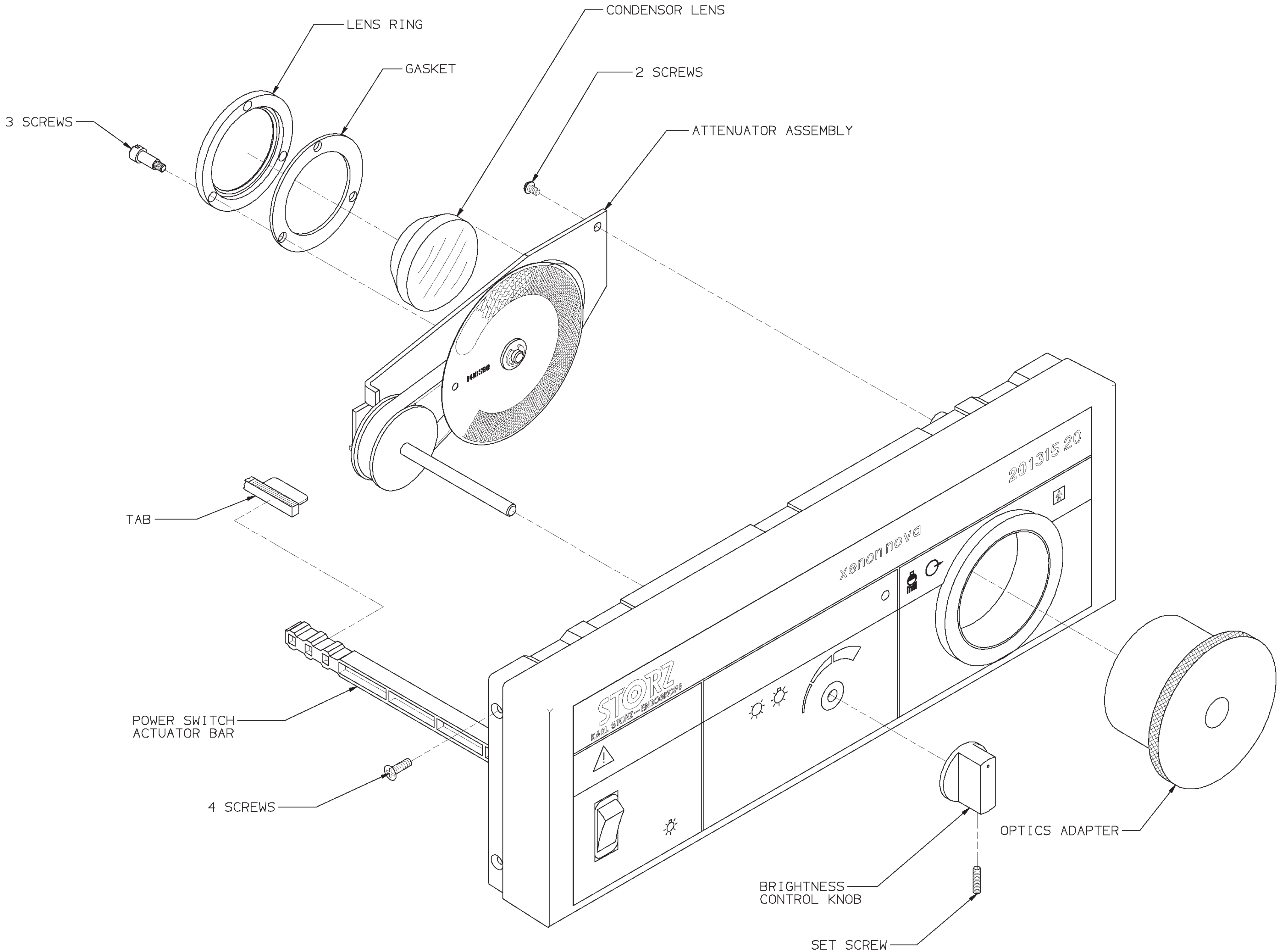
4.9.1. Figure 1 (as from serial no. LF0611831)



4.9.2. Figure 2 (as from serial no. LF0611831)



4.9.3. Figure 3


LENS RING
CONDENSOR LENS
GASKET
2 SCREWS
3 SCREWS
ATTENUATOR ASSEMBLY
TAB
POWER SWITCH
ACTUATOR BAR
4 SCREWS
OPTICS ADAPTER
BRIGHTNESS
CONTROL KNOB
SET SCREW
xenon nova
201315 20

Section 5.

Testing and Adjustments

Direction Sign:

Contents 5. Testing and Adjustments

5.1 Equipment required for the individual settings

ⓘ ***Note:*** *The device is fully adjusted and tested by the manufacturer. Readjustments should be performed by qualified personnel only. Opening the equipment or performance of any repairs or modifications of the equipment by unauthorized persons shall relieve KARL STORZ GmbH & Co. KG of any liability for its performance. Any such opening, repair, or modification performed during the warranty period shall void all warranty.*

5.2 Test instruments required for the individual adjustment procedures

– Digital voltmeter (DVM)
– Small flat blade screwdriver
– Torx screwdriver with assorted bits
– Current probe

5.3 Testing and adjusting the lamp current (up to serial no. LF0611830)

a. Disconnect the power cord from the light source.

b. Remove the outer cover by sliding the interlock slide to the right, removing the four screws on the bottom of the case, and sliding the cover back.

c. Remove the power supply cover by removing the screws holding it in place.

d. Lift the lamp insulator and fold it back.

e. Reconnect the power cord and turn the device power on.

CAUTION: *Do not look into the lamp or light cable. Do not allow light from either the light source or the light-cable to shine directly on hands or other areas of the body; burns may occur.*

CAUTION: *Lamps are high pressure vessels and must be handled with care. When handling the lamp wear safety glasses and face shields to protect the face and gloves to prevent skin oil transfer. Never touch the porcelain insulator on the lamp with bare hands. When working with an operating lamp, wear eye and face protection to prevent blindness or UV damage.*

f. If the Carsan power supply is installed measure the voltage across R206 and multiply this value by 100. This is the lamp current and should be about 14 A.

If the Warner power supply is installed measure the voltage across the R4 (a 0.015 h resistor) and multiply this value by 67.

CAUTION: *Connect the voltmeter only when the lamp is already started; otherwise, the high-voltage starting pulse will damage or destroy the voltmeter. Do not restart the device when making measurements.*

g. Connect the DVM across the lamp. Measure and record the lamp voltage.

h. Lamp power (the product of current and voltage) should be around 175 W. Adjust the lamp current as required, using the R305 current adjustment potentiometer on the power supply for a Carsan power supply or the R16 current adjustment potentiometer on the power supply for a Warner power supply to adjust the lamp power to 175 W.

CAUTION: *Repairs may only be performed by qualified technicians trained in electrical or electronic engineering, in compliance with the relevant occupational, safety and accident prevention regulations.*
Always unplug the equipment before performing any repairs.
Safety Testing based on IEC EN62353, IEC / UL 60601-1, whichever may apply, must be performed after servicing has been completed.
To prevent damage to the components caused by the build-up of electrostatic charges, we recommend that you connect yourself to ground via the wristband throughout servicing.

i. Remove the DVM from the circuit and turn off the power. Reassemble in reverse order of disassembly.

5.4 Testing and adjusting the lamp current (as from serial no. LF0611831)

a. Disconnect the power cord from the light source.
b. Remove the outer cover by sliding the interlock slide to the right, removing the four screws on the bottom of the case, and sliding the cover back.
c. Lift the lamp insulator and fold it back.
d. Reconnect the power cord and turn the device power on.

! ***CAUTION:*** *Do not look into the lamp or light cable. Do not allow light from either the light source or the light-cable to shine directly on hands or other areas of the body; burns may occur.*

! ***CAUTION:*** *Lamps are high pressure vessels and must be handled with care. When handling the lamp wear safety glasses and face shields to protect the face and gloves to prevent skin oil transfer. Never touch the porcelain insulator on the lamp with bare hands. When working with an operating lamp, wear eye and face protection to prevent blindness or UV damage.*

! ***CAUTION:*** *Connect the voltmeter only when the lamp is already started; otherwise, the high-voltage starting pulse will damage or destroy the voltmeter. Do not restart the device when making measurements.*

e. Connect the DVM across the lamp. Measure and record the lamp voltage.
f. Lamp power (the product of current and voltage) should be around 175 W. Set the current probe to 10 mV/A, place current probe on lamp return (-) wire and adjust the lamp current to 0.140 V or to a value that would result the 175 W power requirement. The current adjustment potentiometer is R58 on the power supply.
g. Remove the DVM from the circuit and turn off the power. Reassemble in reverse order of disassembly.

5.5 Disabling the lamp ignitor

a. Remove the power supply as described in Section 4.3.1 Replacement of the power supply 201315 80 (up to serial no. LF0611830), steps a-i or Section 4.3.2 Replacement of the power supply Z07558 (as from serial no. LF0611831), steps a-i.
b. For devices up to serial no. 3863 locate and remove the R600 (or lift one end off the PCB) resistor on the power supply to disable the ignitor.

   For devices as from serial no. 3864 set a jumper on the power supply at position “HV DISABLE” to disable the ignitor.
c. Reassemble (as needed) in reverse order of disassembly.

Section 6.

Maintenance and Safety Checks

Direction Sign:

Contents 6. Maintenance and Safety Checks

6.1 Safety checks

We recommend carrying out safety checks at least once a year.

Work to be carried out	Remark
Visual inspection	
– Housing and accessories	no external damage
– Inscriptions, manufacturer's identification plate data	correct, legible, clean, wipeable, securely attached fixed to the housing
– CE mark, KARL STORZ inspection label	present
– Instruction manual	correct ratings, undamaged, securely positioned
– Power fuses[7]	clean, free of grease, securely attached
	free from visible faults
– Lamp and lens system	
– Internal parts of the device	
Test for proper operation	
– Power switch	
– Power supply	functions perfectly within the stated voltage range (100 VAC … 125 VAC / 220 VAC … 240 VAC)
– Lamp replacement	easy to perform
– Light cable	can be inserted easily into the corresponding socket, engages easily into detented position
– Manual intensity control	brightness adjustment knob
– Fan	
Electric safety measurements[8] (IEC EN 62353)	
– Protective ground resistance: (with power cord) $\leq$ 0.3 Ω	
– Earth leakage current: $\leq$ 1.0 mA	
– Touch current: $\leq$ 0.5 mA	
– Patient leakage current: $\leq$ 0.5 mA	
– Patient leakage current: $\leq$ 5.0 mA (line voltage on the applied part)	

CAUTION: *Repairs may only be performed by qualified technicians trained in electrical or electronic engineering, in compliance with the relevant occupational, safety and accident prevention regulations.*
Always unplug the equipment before performing any repairs.
Safety Testing based on IEC EN 62353, IEC / UL 60601-1, whichever may apply, must be performed after servicing has been completed.

7) For correct power fuse ratings see Section 3.4 Technical data.
8) Valid for devices with applied part type BF.

Work to be carried out	Remark
■ **Electric safety measurements[9]) (IEC EN 62353)** – Protective ground resistance: (with power cord) ≤ 0.3 Ω – Earth leakage current: ≤ 1.00 mA – Touch current: ≤ 0.50 mA – Patient leakage current: ≤ 0.05 mA (line voltage on the applied part)	

N.C. = Normal condition S.F.C. = Single fault condition

6.2 Safety devices

For further information about safety devices and instructions please see instruction manual.

6.3 Maintenance operations

Performance of preventive maintenance is not essential. Regular maintenance can, however, contribute to identifying potential problems before they become serious, thus enhancing the instrument's reliability and extending its useful operating life.

Maintenance services can be obtained from your local representative or from the manufacturer.

Regardless of the accident prevention regulations or testing intervals for medical instruments prescribed in different countries, we recommend a safety check of the device at least once a year.

6.3.1. Lamp replacement

When the lamp has operated for 450 hours (90% of the warranted life of 500 hours) a red lamp warning indicator will light on the faceplate. At 500 hours, the lamp warning indicator will blink continuously until the lamp hours counter is reset. For lamp replacement instructions, see Section 4.5 Replacement of the lamp. It is recommended that new lamps purchased from a source other than KARL STORZ should be operated for eight hours in the light source prior to clinical use.

9) Valid for devices with applied part type CF.

6.3.2. Battery replacement

Carsan power supply

Disassemble the light source as necessary, until the battery may be accessed, refer to Section 4.6 Replacement of the attenuator assembly. Lift the battery clip with needle nose pliers and remove the battery from the holder. Replace the battery and reassemble in the reverse order.

Warner power supply – up to serial no. LF0611830

The power supply must be removed from the light source. The battery connections are soldered in place and must be unsoldered to be replaced.

Warner power supply – as from serial no. LF0611831

The battery location is on the timer PCB.

6.3.3. Interior cleaning

Depending on the cleanliness of the operating environment, removal of dust from the interior of the device may be required periodically. Remove the outer cover and power supply cover as described in Section 4.3.1 Replacement of the power supply 201315 80 (up to serial no. LF0611830) or Section 4.3.2 Replacement of the power supply Z07558 (as from serial no. LF0611831). Blow dust from the device using compressed air, taking care not to direct air at the fan blades or the attenuator screen. Reinstall the covers.

6.4 Servicing and repair

Defective equipment should be serviced and repaired by factory trained technicians and replacement parts must be ordered from KARL STORZ.

Third party substitutions may result in noncompliance of this product with its original specifications.

KARL STORZ maintains a repair and replacement warehouse which is normally adequate to ensure prompt replacement of damaged telescopes and instruments. Under the repair and replacement plan, you receive an identical as-new instrument and are only charged the repair costs for the defective instrument. For telescopes, you receive a guarantee of 1 year, and for instruments 6 months.

For fiberscopes and equipment, individual repair is necessary. Usually to bridge the repair period, you will receive a device on loan which you then return to KARL STORZ as soon as you receive the repaired device.

In Germany you can refer repairs direct to

Phone: +49 (0)7461 708-980
Fax: +49 (0)7461 708-75500

or

KARL STORZ GmbH & Co. KG
Repair Service Dept.
Dr. Karl-Storz-Str. 34
D-78532 Tuttlingen

In other countries please contact your local KARL STORZ branch or authorized dealer.

6.5 Power fuse replacement

For detailed information please see instruction manual.

6.6 Cleaning and disinfection

For detailed information please see instruction manual.

Section 7.

Modifications and Supplements

Contents 7. Modifications and Supplements

7.1 Warner power supply information (as from serial no. 3864 up to LF0611830)

The Warner power supply consists of input filtering, AC rectifier, dual buck regulators, auxiliary 12 V supply, a timing circuit, and a differential lamp igniter.

Warner power supply input

The input power entry starts with two 6.3 A, 250 V fuses (F1 and F2), one on the neutral (“N”) line and the other on the live (“L”) line. Power switch, SW1, a single-throw double-pole switch, is connected in series with the AC lines. The inrush current is limited by R14, a 10 h NTC thermistor. The input EMI filtering consists of two X-capacitors, C9 and C10, four Y-capacitors, C17, C18, C43, and C44, and a common-mode inductor, T4.

The power supply is protected from high input voltages by a 390 V varistor, RV1. The AC line is rectified through an 8 A, 800 V bridge rectifier BR1. The rectified voltage is filtered through C1, C20, and L4 to eliminate the 50/60 Hz ripple. This is supply voltage Vbulk1.

Vbulk1 is supplied to the first of two stages of buck regulators and also to the circuitry that is used to make the maintenance and the auxiliary supplies.

Warner power supply maintenance / auxiliary supplies

Using the Vbulk1 as its supply, U1, a three-terminal pulse-width modulated IC, and T5, a flyback transformer, work together with other external circuitry to maintain the supply used as the 12 V auxiliary for the fan, and for the control circuitry for the ballast.

Vbulk1 connected to pin 1 of T5 and the solid state switch TOP224 connected to pin 3 delivers the excitation required to induce the power on pins 5 and 8 of T5. This power is rectified through D17 and filtered by C12. The auxiliary voltage for the fan can be picked up at J4. The control circuitry power input is connected after TS1, a thermal switch that provides the thermal protection for the ballast. When the ballast is thermally overloaded, this switch will open, cutting power from the control circuitry and shutting down the ballast. The voltage for the supply is determined by feedback to the TOP224 switch at pin 4. A third winding on T5, pins 5 and 6, provides pin 4 with the voltage information. This feedback winding is rectified by D14 and filtered by C11 and C7. D13, a zener diode allows further manipulation of the feedback should it be necessary to change the supply voltage. D16 and D3 on the primary side of T5 provide a discharge path for the energy stored in the transformer.

Warner power supply control circuitry regulator

The regulation of this power supply uses a two-stage buck converter configuration found on the power board. The first stage of the buck converter drops the Vbulk1 voltage down to the Vbulk2 voltage. Q1, an IRFP450, working with L1, a 1.8 mH inductor, is capable of dropping Vbulk1 down to approximately 165 V. Q2, an IRFP260, working with L2, a 300 mH inductor, regulates the output power.

The control circuitry for both stages is located on the control board. The control circuitry for the first stage uses UC3525, a pulse-width modulating integrated circuit, U1. The components C9, a 0.01 µF cap, and R2, a 2.94 kh resistor determine the frequency of the regulator. The frequency of this buck stage is approximately 50 kHz. C1, C2, C5, C6, and C7 prevent noise. D1 and D2, added to the output of U1, prevent high voltages from damaging the IC. R3 and R4 are a voltage divider used as reference voltage for the error amplifier. This error amplifier works with the feedback from the regulated supply at Vbulk2 to determine changes in the output of the regulator. It will adjust the duty cycle of Q1 on the power board to keep the level of Vbulk2 within the specified range. R5, R7A, and R13, on the power board, establish the feedback from Vbulk2 to the error amplifier in U1. R1, in the error amplifier circuit, determines the gain of the error amplifier. C29, a 0.1 µF capacitor, is used in the soft-start feature of the IC.

The signal from the regulator circuitry to the buck FET, Q1, has to be transformed to a different voltage reference, since the regulator circuit is referenced to RETURN and the buck FET, Q1, is referenced to Vbulk2. A coupling transformer T1, and D9, D10, and R19 function together to change the reference of the signal from the regulation circuit to the regulating buck FET, Q1. D5, a 15 V zener diode, protect the gate of Q1 from over-voltage damage. Q3, D7, and R15 assist in the turning on and off Q1 to decrease the losses during switching. At the higher power end of this first stage is Q1, D1, a 15 A commutating diode, and C15 and R20, the first stage snubber. The storage of Vbulk2 is accomplished with C4, a 390 µF, 200 V capacitor.

The second stage, powered by the first stage at Vbulk2, is similar. At the control board, the heart of the second stage regulator is U2, a UC3525 pulse-width modulator integrated circuit, the same as the first stage. C12, a 0.01 μF capacitor, and R10, a 2.37 kh resistor, determine the frequency of the second stage. The frequency of the second stage is approximately 60 kHz. R9, C3, C4, C8, C11, C13 and C14 reduce noise. D3 and D4 protect U2 from high voltages, similar to D1 and D2 in the first stage. The shutdown function of the IC is disabled by being tied to RETURN, through R35.

R16, a 2 kh five-turn potentiometer, along with R14 and R12 set the reference for the error amplifier in U2. This potentiometer is used to adjust the output current. The output current can be set at some predetermined output voltage. This set reference level works with feedback from a current sense signal and will change the duty cycle of Q2 on the power board.

The feedback and the reference set level are compared and – depending on the current adjustment setting – the duty cycle is adjusted to send more or less current to the Xenon lamp. The voltage across R4, a 0.015 h current sense resistor on the power board, through R17 a 1 kh resistor, is fed back to the error amplifier in U2. R11 determines the gain of the error amplifier.

A circuit designed to avoid overpowering the lamp. Q1, R13 and R18 will sense the lamp voltage with help from R12 on the power board and when the lamp voltage reaches a predetermined level, Q1 will begin to turn on, sending current to the error amplifier in U2. The regulator will begin to decease the current to the lamp.

There is a different reference between the power board devices and the control circuitry. This is handled the same as it is handled in the first stage, with a transformer and supporting circuitry. In this case T2, D11, D12 and R18 function to change the reference of the control signal to the regulating buck FET, Q2.

A 15 V zener diode D4 protects the gate of the buck FET, Q2, from high voltages. D8, Q4, and R16 function to speed up the turn-on and turn-off time of the power device to decrease switching losses. D2, a 15 A 200 V diode, is the commutating diode for the second stage regulator circuit. C16 and R17 is the snubber circuit across D2 commutating diode. Following the second stage, L5, a common mode choke, and C5, a 0.022 μF capacitor, have been incorporated to reduce the noise returning to the power supply.

C8 and R5 work together to provide the necessary energy required to sustain the arc in the lamp once the arc has been created. They supply a discharge current through the lamp that enables the lamp to stay on until the ballast is able to take over.

Warner power supply ignition

The basic operation of the igniter is to increase the voltage across the lamp to start an arc across the electrodes of the lamp. C21, R24, R25, Q5 and T6 are the first stage. C21 is charged up until the potential across Q5, a 105 V SIDAC, triggers the SIDAC. When Q5 fires, a large amount of current is sent through the primary of T6. This energy is transformed to the secondary of T6 where it will begin to pump up the C23 and C24 through D18 of the next stage. As the SIDAC, Q5, fires, C21 is discharged but then is charged up through R24 and R25. As C21 is discharged, the potential across Q5 increases again until it is great enough to fire the SIDAC again. This oscillating process is repeated. C23 and C24 are charged through D18 from the first stage oscillator to about 5 kV. At this point a 5 kV spark gap, SG1, discharges through the primary of a step-up differential transformer, T7. The secondary of T7 is connected directly to the output of the ballast across the lamp. The igniter portion of the ballast will operate until the lamp conducts. The above sequence will continue as long as the ballast is in its open-circuit mode. The output voltage remains high until the lamp ignites.

Warner power supply lamp timer

Four stages of counters are incorporated in the timer design. The start of the counting mechanism for the design is U2, a MC14060B a 14-bit binary counter, along with C28, C29, R28, R29, and Y1, that create the 20 kHz oscillator. The output of U2 is fed to the next IC, U3, a MC14020B, a 14-bit binary counter.

For test purposes the timing circuitry can be clocked faster by shorting J1 pin 1 to pin 2 at J7. For normal operation the jumper is set to position J1 pin 2 to pin 3. The clocks from U2 to U3 in the test mode are about 800 μs apart while in the normal mode the clock pulses to U3 are approximately 820 ms apart.

U3 divides the transitions by 16,384 before sending the clock pulses to U4, another MC14020B 14-bit binary counter. For test mode the pulses are approximately 13.1 s apart. In normal operating mode the pulses are approximately 13,386 s (3.7 h) apart. U4 further increases the time of the transitions of the clock by a factor of 16. This increase changes the test mode transitions to 210 s and the normal operation transitions to 214,170 seconds (59.5 h) apart. These clock transitions will reach the final counter stage U5, an MC14017 decade counter. From the last counter two events are tracked.

A red warning indicator lamp, D21, will light when the lamp is about to reach end of life and will start flashing when the lamp has reached the end of life. U5 controls the circuitry, which includes Q6, Q7, Q8, R26, and D21, for this function. U5 will count 7.5 transitions from U4 before turning on Q6 to light LED D21.

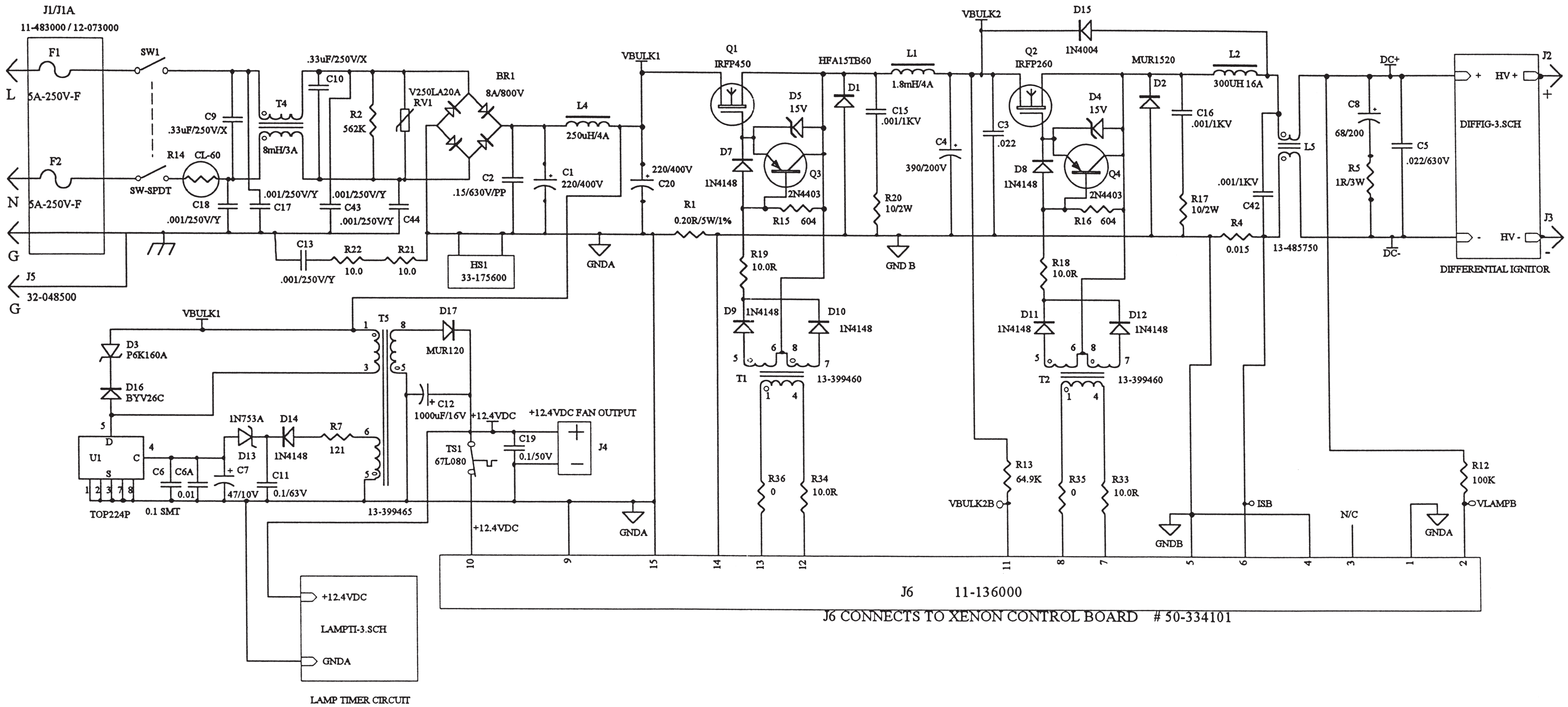
Note: *The half transition comes into play because U5 is positive edge triggered where the other counters are negative edge triggered.*

In one more pulse from U4, Q6 will turn off and Q8 will turn on. Q8 is in series with Q7, that is being turned on and off at a frequency of 1.2 Hz by a tap off U2. This causes the flashing of D21 to indicate the end of life.

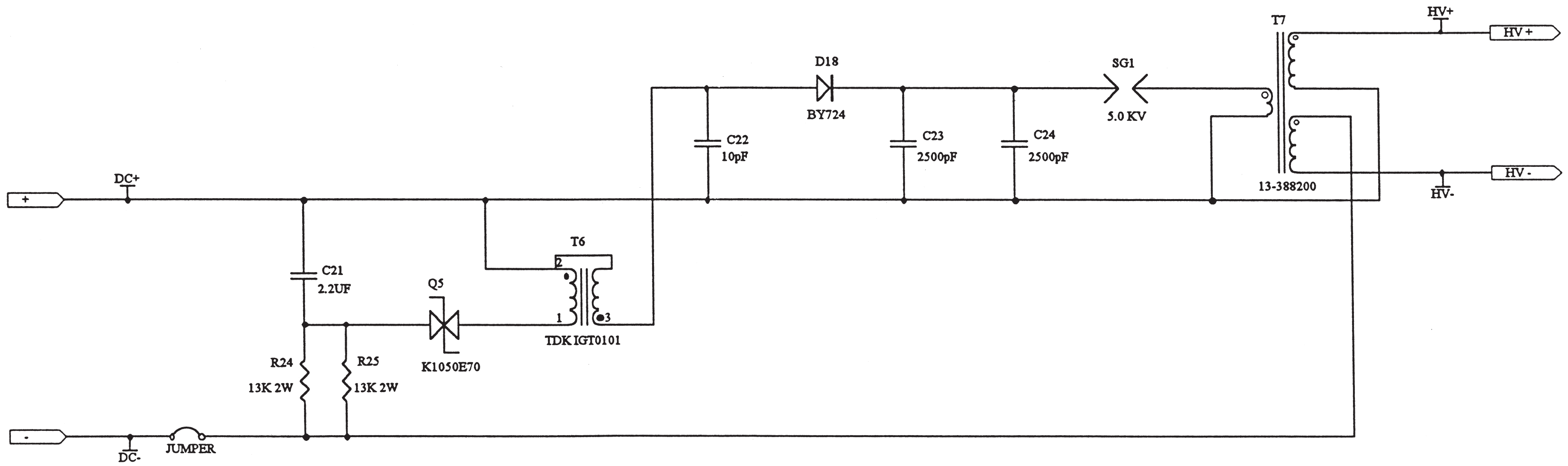
C25, C26, C27, C30, C31, C32, C33, C34, C35, C36, C37, C39, and C41 have been added to the design to minimize the effect of noise on the circuit. D19, a 15 V zener diode, protects from high voltages. D20, a yellow LED, along with R27 indicates if the oscillator is working by flashing at a frequency of 2.4 Hz tapped off U2.

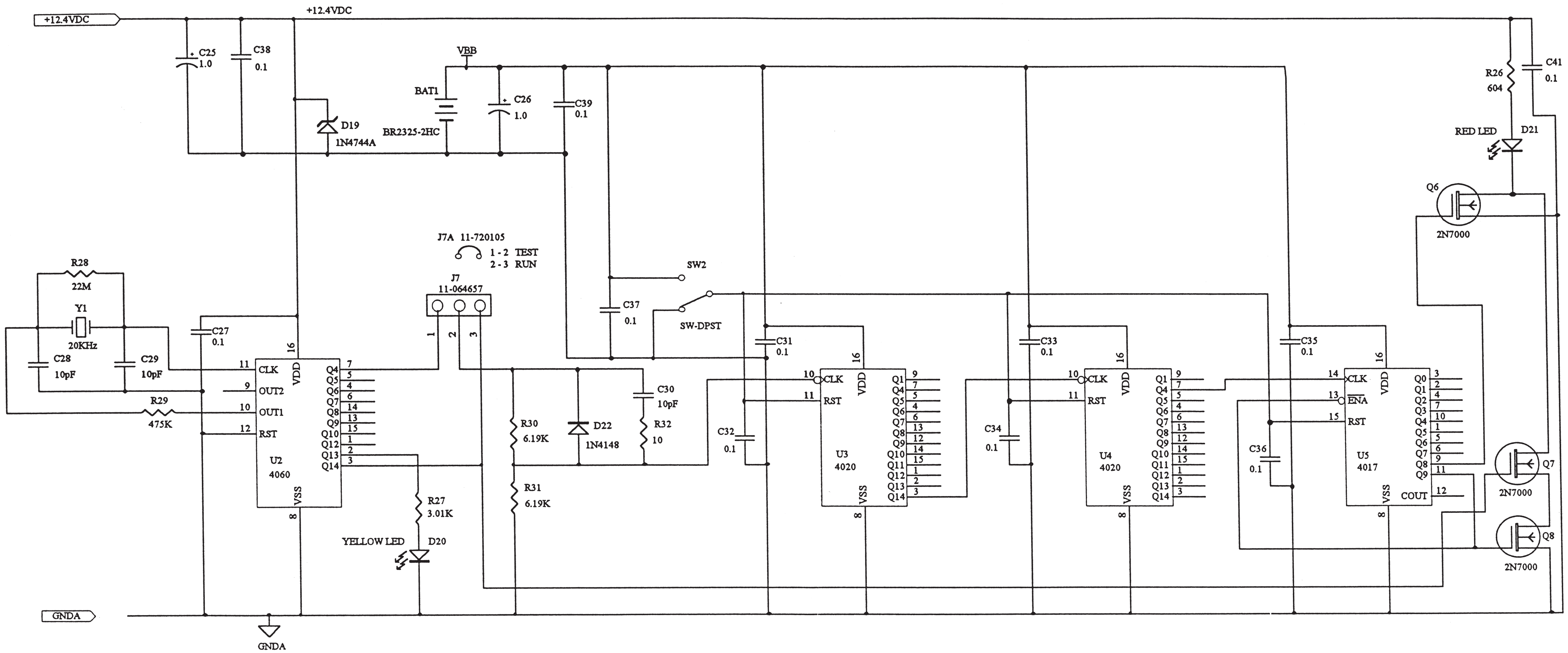
A battery, BAT1, has been incorporated to allow the running time of the lamp to be stored when the ballast has been turned off. SW2 will reset the timer circuit. The timer should be reset whenever the lamp is changed.

7.1.1. Circuit diagram of the Warner power supply



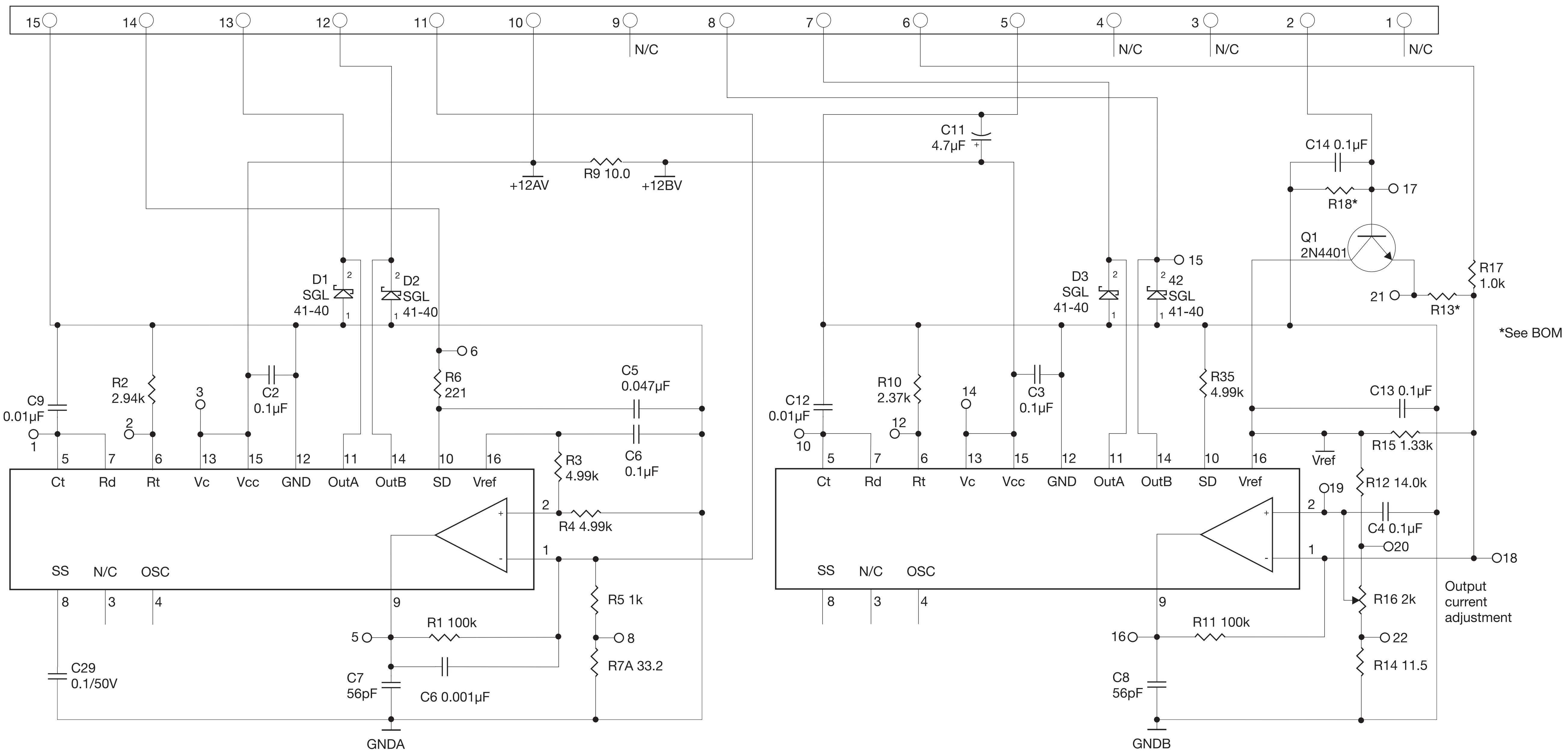
power supply	page 1 of 3





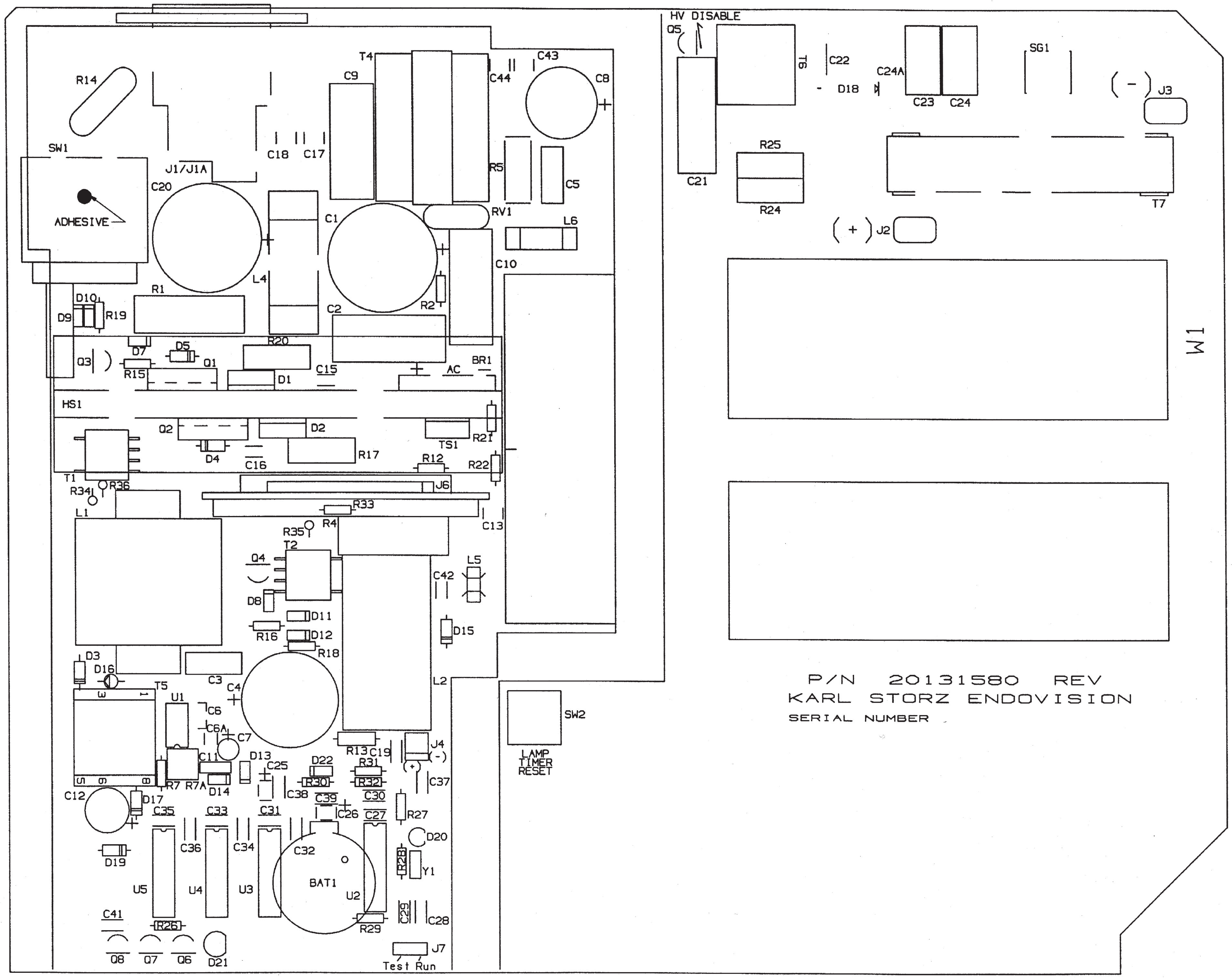
power supply	page 2 of 3

control board no. 50-334101

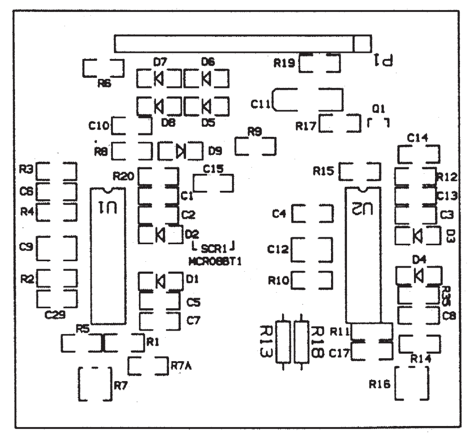


power supply	page 3 of 3

7.1.2. Component diagram of the Warner power supply



CONTROL BOARD #50-3341101



Section 8.

Appendix

Direction Sign:

1 ⇦ Instruction Manual

2 ⇦ Physical Design

3 ⇦ Descriptions of Operation and Circuit Diagrams

4 ⇦ Replacement of Individual Assemblies

5 ⇦ Testing and Adjustments

6 ⇦ Maintenance and Safety Checks

7 ⇦ Modifications and Supplements

KARL STORZ GmbH & Co. KG
Mittelstraße 8, 78532 Tuttlingen/Germany
Postfach 230, 78503 Tuttlingen/Germany
Phone: +49 (0)7461 708-0
Fax: +49 (0)7461 708-105
E-Mail: info@karlstorz.de
Web: www.karlstorz.com

KARL STORZ Endoscopy-America, Inc.
2151 East Grand Avenue
El Segundo, CA 90245-5017, USA
Phone: +1 424 218-8100,
+1 800 421-0837
Fax: +1 424 218-8526

KARL STORZ Endoscopy Canada Ltd.
2345 Argentia Road, Suite 100
Mississauga, Ontario L5N 8K4 Canada
Phone: +1 905 816-8100
+1 800 268-4880
Fax: +1 905 858-0933

KARL STORZ Endoscopia Latino-America, Inc.
815 N. W. 57th Avenue, Suite 480
Miami, FL 33126-2042, USA
Phone: +1 305 262-8980
Fax: +1 305 262-8986

STORZ
KARL STORZ—ENDOSKOPE