ANTEC
LEYDEN

INTRO
Service Manual

CE

DECLARATION OF CONFORMITY

We Antec Leyden B.V., Industrieweg 12, Zoeterwoude, The Netherlands, declare that the product

Electrochemical Detector Intro (part number 130.0035)

to which this declaration relates, is in conformity with the following directives:

Safety (73/23/EEC)

Safety requirements for laboratory equipment (Class I, Installation cat. II, Pollution degree 2)	IEC 1010-1

Immunity (89/336/EEC)

Electromagnetic immunity	IEC 801-2/3/4 & ENV 50140
Radio frequency current injection	ENV 50141 & IEC 1000-4-6
Voltage dips and interruptions	IEC 1000-4-11

Emissions (89/336/EEC)

Electromagnetic radiation	EN 55022, Class B (CISPR 22)

Attention

Use shielded cable(s) to connect all I/O's with other devices. Thoroughly connect the shielding to common. Antec Leyden will not accept any liability for damage, direct or indirect, caused by connecting this instrument to devices which do not meet relevant safety standards.

February 27, 2002
H.R. Louw, Manager purchase & production

Important notice

This service manual is designed for use by qualified personnel who are experienced in servicing this type of equipment. Because of the possible hazards to an inexperienced person in servicing this product as well as the risk of damage to the product we strongly recommend that all servicing is performed by our field service representatives.

In addition to improve instrument performance changes may have been made to the instrument by the manufacturer since this service manual was originally printed. Accordingly we make no representations or warranties either express of implied that the information contained in this service manual is complete or accurate. It is understood that the purchaser must assume all risk in the use of this manual for the purpose of performing service upon the instrument it covers.

Components of this instrument which are considered user serviceable are discussed in the manual standard supplied with each instrument.

This instrument contains electrostatic sensitive parts.
Always use proper protection against electrostatic discharges, especially when boards are removed and / or components such as integrated circuits, (MOS)FET opamps etc. are handled.

General safety reminders

The following pages summarise cautionary information basic to the safe operation of this instrument.

It is strongly recommended that the user reads all safety practises as they are posted for his safety!

1. Always take extra care of test equipment. Be sure to use the right equipment for the right job. Measuring high voltages requires a well insulated high voltage probe. Damaged probes and cables are dangerous and should be replaced. Also be cautious around test equipment like an oscilloscope. The oscilloscope housing may become live if the cable is connected to a live circuit! **Avoid dangerous situations at all time!**
2. Avoid standing on damp floors when working on electrical equipment.

Be sure to disconnect the power cord before working on any high voltage circuitry. As power switches more and more disappear from modern equipment, this precaution is very easy to overlook.

3. Please read and heed ALL caution labels! They are posted for your safety.

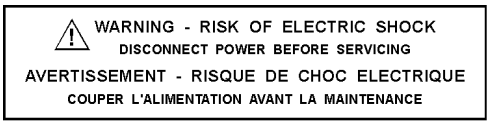
Basic tips regarding to good electrical safety practises are easy to remember. Combined with good common sense they should keep you on the job for a long time to come.

Safety practices

The following safety practices are intended to insure safe operation of the equipment.

Electrical hazards

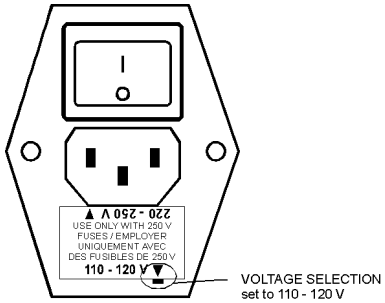
1. Disassembly exposes potentially dangerous voltages. Therefore disconnect the instrument from all power sources before disassembly.



2. Replace blown fuses with size and rating stipulated on the rear panel and in this manual where listed.

WARNING - RISK OF FIRE REPLACE FUSE AS MARKED		
	FUSE RATING	
INPUT VOLTS	UL / CSA	IEC 127
100-120 V 200-240 V	3.2A 250V TL 1.6A 250V TL	T 3.2A 250V T 1.6A 250V

3. Replace faulty or frayed power cords.
4. Check whether the voltage selector is in the correct position. If the triangle with the voltage range is pointing towards the small white block, the system is set to that line voltage. If not correct this insert has to be reversed. Also the fuses are included in the line connector. The correct values are given on the rear panel for the different line sources.



General precautions

1. Perform periodic leak checks on LC tubing and connections.
2. Do not allow flammable and/or toxic solvents to accumulate. Follow a regulated, approved waste disposal program. Never dispose of such products through the municipal sewage system.

Spare parts and service availability

Antec Leyden provides operational spare parts of the instrument and current accessories for a period of five years after shipment of the final production run of the instrument. Spare parts will be available after this five years period on an 'as available' basis.
Antec Leyden provides a variety of services to support her customers after warranty expiration. Repair service can be provided on a time and material basis. Technical support and training can be provided by qualified service personnel on both contractual or as-needed basis.

Table of contents

1 Specifications INTRO

General specifications

Sound pressure level: < 50 dB
Installation category: Category II (IEC 1010)
Pollution degree: Degree II (IEC 1010)
Operating mode: DC
Cell potential: between -1.5 and +1.5 V
Integrator: max./min. range 10 µA/100 nA, max. 10 or 1 V output
Recorder: max./min. range 10 µA/100 pA, max. 10 or 1 V output
Auto zero, maximum compensation:
oxidative mode: 8.5 or 35 nA (att. 1); 850 or 3500 nA (att. 100)
reductive mode: 85 or 120 nA (att. 1); 8500/12000 nA (att. 100)
offset: continuously adjustable between -0.15 and +0.15 V
event marker: 1 or 0.1 V
Resolution display: cell potential (1 mV), output voltage (10 mV), oven temperature (0.1°C) cell current (1, 0.1, 0.01 or 0.001 nA)
Noise: better than 3 pA with load of 0.5 µF (+ 300 MΩ) and 0.1 s filter, with 1 s better than 1 pA

Front panel

Frames
V_{cell}: cell on/off, ox/red indication, cell potential up and down
Display: V_{cell}, V_{out}, °C, I_{cell}, $I_{cell,HR}$
Heater: off, 25 - 47.5°C in 2.5°C increments, on/heating indication
Zero: on/set/off indication, mark
Filter: 0.1 - 5 s in 1, 2, 5 increments
Range: 0.01 - 10 nA/V, or 1 - 1000 nA/V in 1, 2, 5 increments, att. 100 indication

Electrical

Power requirements: 110 VAC, ± 10% ; 50/60 Hz, max. 150 W
220 VAC, ± 10% ; 50/60 Hz, max. 150 W

Ambient environment

Temperature: 5 °C - 40 °C
Humidity: Max. 80% relative humidity, non condensing (5°C - 30°C), linear decreasing to 50% rel. humidity at 40°C

Temperature control
Oven: 100 W, length 40 cm, stable from 5°C above ambient, max. 47.5°C, accuracy better than 0.5°C, stability better than 0.1°C; accommodates flow cell, column and the following options: Rheodyne injector, SSI pulse dampener and bulkhead unions.

Rear panel
Mains
Recorder (adjustable offset)
Integrator
Dip switches
Recorder: max. 10 or 1 V
Zero: low or high
Integrator: max. 10 or 1 V
Mark: 1 or 0.1 V
Communication port (10 pins terminal block)
TTL[1]: Cell on, Cell off, mark, zero on/set, zero off, range x1/x100, load/inject, common
Outputs: T_{oven} (10 mV/°C) (max. load 1 kΩ), common

VT-03 flow cell
Confined wall-jet design, working volume determined by spacer thickness and working electrode (WE) diameter
Spacers: 25, 50 or 120 µm, stackable
WE diameters: 0.5, 0.75, 1.00, 1.90, 2.00, 2.54, **2.74** and 3.00 mm
Cell volumes: 0.005 µl minimum
WE materials: glassy carbon, Pt, Au, Ag and Cu
Reference electrode: long-life Ag/AgCl, fully serviceable
Auxiliary electrode: stainless steel
Wetted materials/parts: Kel-F, FEP, Viton, working, auxiliary and reference electrode

Physical specifications
Dimensions: 44 (L) x 19 (W) x 26 (H) cm = 17.3" x 7.5" x 10.2"
Weight: 10.9 kg (24.0 lb)

[1] TTL: V max. = 5.5 V, logical 1 > 3.5V, logical 0 < 1.0 V

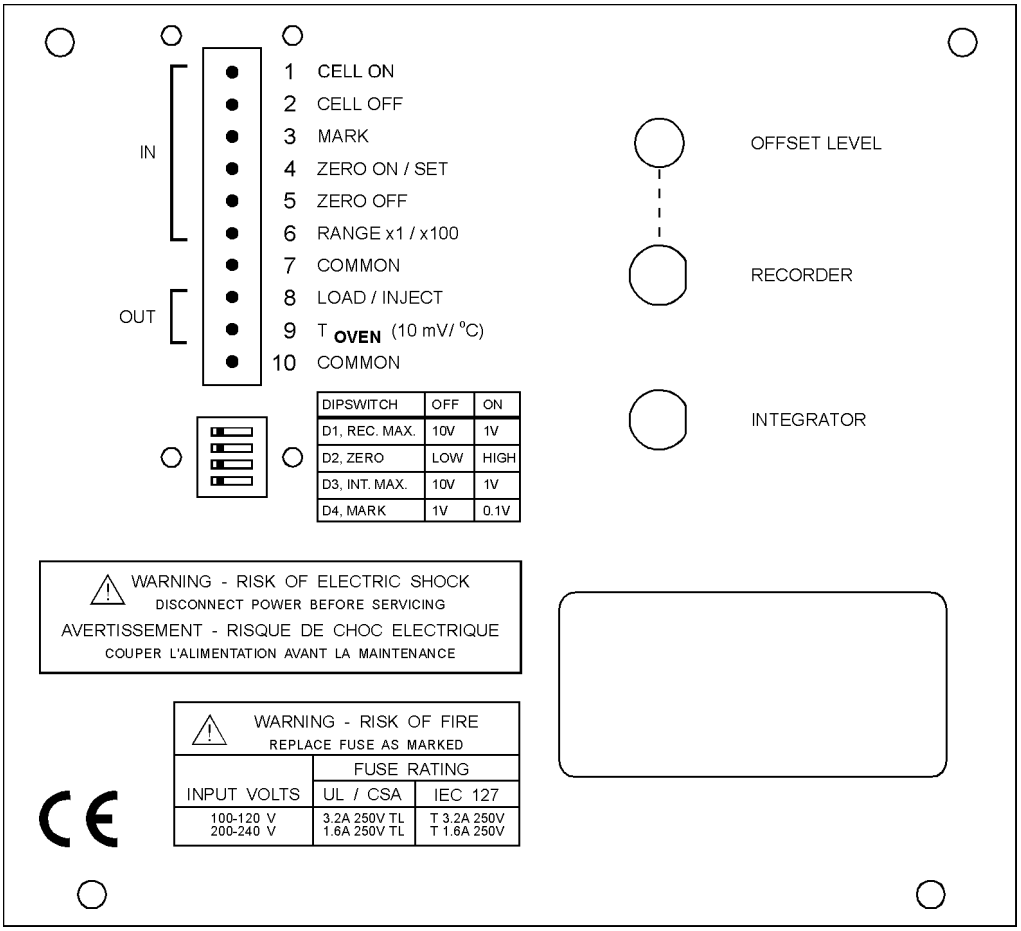


Fig. 1. Rear panel INTRO.

2 Connections

The rear panel consists of a 10 pins I/O connector, four dip-switches, a integrator and recorder output with adjustable offset and the mains inlet (combined mains switch and fuse holder / line voltage selector).

Table 1. 10 pins I/O connector

Pin no.	Description	Activation by	Result
1	Cell on input	TTL low	Switches on the cell
2	Cell off input	TTL low	Switches off the cell
3	Mark input	TTL low	'spike' on recorder output
4	Zero on/set input	TTL low	Forces recorder output to 0 Volt or offset level
5	Zero off input	TTL low	Inactivates zero compensation on recorder output
6	Range x1 / x100 input	TTL low	'toggles' the att. from 100 to 1 and vice versa
7	Common (ground)	-	-
8	Load / inject output	Rheodyne 7725i valve position	Load = TTL high Inject = TTL low
9	T_{oven} output	-	Temperature read-out: 10 mV/°C (max. load 1kOhm)
10	Common (ground)	-	-

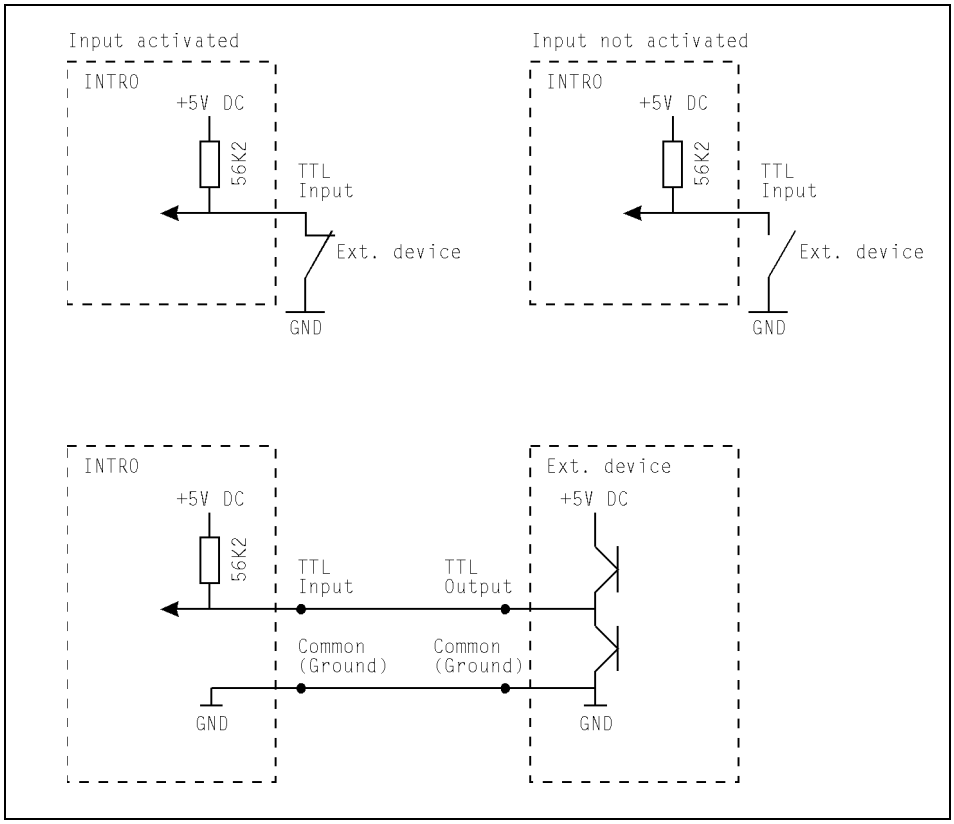


Fig. 2. TTL contacts.

TTL: V max. = 5.5V, logical 1 (TTL high) > 3.5 V, logical 0 (TTL low) < 1.0 V

Recorder output: max. output voltage 12.5 V; max. load 1MOhm
Integrator output: max. output voltage 12.5 V; max. load 1MOhm

Mains inlet and fuses:
For 110 V (AC) ± 10%, use two 3.2 AT fuses (slow, ¼" x 1¼", UL/CSA)
For 220 V (AC) ± 10%, use two 1.6 AT fuses (slow, 5 x 20 mm, IEC127)

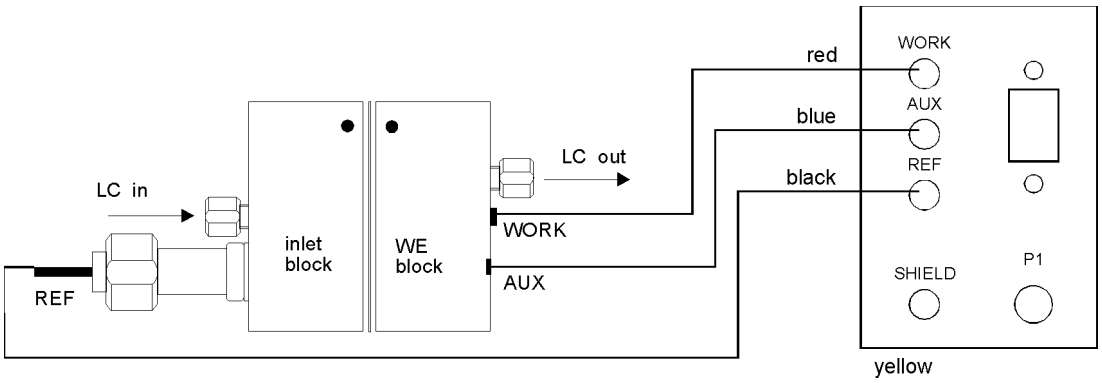


Fig. 3. Connector plate flow cell.

The work (red), aux (blue) and ref (black) connectors may only be used to connect an electrochemical flow cell, with the cell cable supplied, to the corresponding cell connections. See user manual for details on flow cell installation.

NOTE: always switch off the flow cell before touching the connectors because electrostatic discharge may damage the sensitive electronics.

The shield (yellow) connector is used to ground the (Rheodyne) valve (option) via the crocodile clamp included in the cell cable. If the valve is not properly grounded, the Faraday cage effect is not fully functional and the noise will increase.

The P1 (phone jack) connector is used to connect the Rheodyne 7725i internal switch to the INTRO so that the load / inject output at the rear panel becomes functional.

3 The INTRO circuitry

3.1 Introduction

To make servicing easier, in this chapter the different electronic circuits are explained. Service engineers having experience on servicing the INTRO will not need this information and may start with Chapter 4. All block diagrams, wiring diagrams, layouts and circuits are given in Chapter 7.

The INTRO electronics consist of a main board, a front board, a connection board and a power supply.

3.2 Cell control

The working potential is supplied to the flow cell via to the so called 'voltage clamp' (VC) circuit. This circuit is located on the main board, and its schematics are found in main circuit sheet 2.
The reference voltage (REF) is connected via a relay to the minus input of a low-noise FET opamp (U8).
The positive input of this opamp is supplied with the voltage selected via the up- or down key on the front panel. In main circuit sheet 7 the SWUP and SWDN labels correspond with the up- and down key. If for example the up key is pressed one time, one pulse is created (DN). If the up key remains depressed, the circuit will, after a small time, produce fast pulses coming from the oscillator (U11A,R16,C7). These pulses (UP or DN) are fed to the counter circuit in main circuit sheet 6. If BH7 (pin 7, U4) is high, the polarity is reversed and the RED1 label is high, the RED led is on and OXRED is low, causing RL6 on main circuit sheet 2 to close. The effect of RL6 is described in Chapter 3.6 Auto zero.
In main circuit sheet 6 the reference voltage (VOLTCELL) is created via a 12-bits binary counter circuit (U4-6) with two 8-bits DA converters (U1,2), to produce the analog voltage via U3.

The auxiliary voltage (AUX) is connected via RL2 to the output of the VC opamp. This AUX will deliver the necessary current while the high impedance REF will keep its potential. The result is a extremely stable working potential that will remain its potential even when a current is drawn. When the cell is off the relays RL1-3 will fully uncouple the cell from the electronics and the opamp is protected from electrostatic discharge.

The working electrode (WORK) of the cell is connected via a relay to the current to voltage converter circuit (I/E converter). The I/E converter is located on the main-board and the schematics are found in main circuit sheet 2. The minus input of a low noise FET opamp (U12)

is used as the current input, and the positive input is connected to ground. A selectable (att. 1/100) feed-back resistor (R25,26,29 & RL4) provides the desired amplification. The I/E converter output voltage is directly related to the cell current and is used to feed various other circuits.
If the cell potential passes 0 Volt (OXRED), the I/E signal is automatically inverted (RL7, U16). The I/E converter output at the back of the INTRO is connected via a buffer (U20,21) to the (inverted) I/E signal.

3.3 Amplifier & range

The I/E signal is presented to the amplifier circuit. This circuit is located on the main board, and its schematics are found in main circuit sheet 2. The amplifier circuit (U14) is designed to provide the recorder output with a selectable range. The range is selected via the RANGE switch on the front panel (rotary switch). In front circuit sheet 4 the amplifier switch (SW5) circuit is shown. The common of the switch is connected to 3.6 V, and each range position to SAMP01-10. The SAMP01-10 signals are connected to the main board where they are called G01-10. Each range switch position corresponds with G01-10 in main circuit sheet 3. Each signal controls a analog switch (U41-43), and these switches connect the corresponding feed-back resistor over the amplifier opamp (U14). The range dependable signal is inverted to correct its polarity and this signal (AMP) can be measured on TP3 (main).

3.4 Filter

The AMP signal is then presented to the filter circuit in main circuit sheet 4. The filter circuit is selectable via the FILTER switch on the front panel. In front circuit sheet 4 the filter switch (SW2) circuit is shown. The common of the switch is connected to the V+ label coming from the main board, and each filter position to S1-6. The S1-6 signals are connected to the main board. Each filter switch position corresponds with a signal line S1-6 in main circuit sheet 4. Each signal controls an analog switch (U45,46), and these switches connect the corresponding resistor in series with a capacitance to create the corresponding rise time selected. In the .1s position, no resistor is connected so the AMP signal remains unfiltered.

3.5 Marker & output driver

The (filtered) AMP signal (FILTERINT) is presented via jumper J17 to the MARKER, output driver circuit in main circuit sheet 5. Jumper J17 is only used if an optional filter is installed. The marker, output driver is used to include a selectable (1 V / 100 mV via dip 4) marker signal to the recorder output. This marker is controlled either via the front panel or via the mark input on the back of the INTRO. If a mark is given, the MARKERSW signal is low, and Q7 will open causing voltage divider R96,98 to create a short ‘spike’ on the FILTEROUT summator (U37). If dip 4 on the rear panel is off, the DSW4 signal is floating and the mark signal results in a 100

mV 'spike' on the recorder output. If dip 4 is on, the DSW4 signal is low, and the mark signal results in a 1 V 'spike' on the recorder output. Dip 1 on the back of the INTRO is connected to DSW1. If dip 1 is off, the DSW1 signal is floating, if dip 1 is on, the DSW1 signal is low causing voltage divider R104,105 to divide the recorder output signal, including marker, by 10. The FILTEROUT signal combined with the marker and divider is connected to the recorder output via inverter U36 to produce the correct polarity.

3.6 Auto zero

The Auto zero circuit (ZERO) is located on the main board. The circuitry is given in main circuit sheet 9 and 10. The ZERO circuit is based on a 16-bits binary counter circuit (U25-28) with two 8 bit DA converters (U22,23) to produce the analog voltage via U24.
The ZERO ON/SET and OFF switch on the front panel are directly connected to ON/SETSW and OFFSW in main circuit sheet 10. The oscillator circuit (U32B, R83, C24) is used to produce the necessary clock-pulses (CP). The AMP signal coming directly from main circuit sheet 2 is compared via U18 with the offset potential selected on the back of the INTRO (POTM1, POTM2). The result of this comparison is used to determine the count direction (UD) of this circuit with JK flip-flop U31B
When the ON/SET button is pressed, or the ZERO ON/SET contact at the back of the INTRO is made low, the ONLED line is high causing the ON led on the front panel to go on. Also Q5 will close causing the AUTOZONOFF line to become low, RL5 on main circuit sheet 2 will close and the AUTO ZERO signal is connected to the amplifier opamp (U14) via a selectable resistor. When RL5 is closed U14 functions as a summator enabling the AUTO ZERO signal to influence the AMP output and eventually go to 'zero'. How much effect the AUTO ZERO signal has on the output of U14 is determined by the value of resistors R3,42,45. There are two possible choices and combinations of both by means of RL6 and dip-switch 2 at the back of the INTRO (DSW2A, DSW2B). Dip-switch 2 is directly connected to DSW2A and DSW2B, when this dip is on, R3 is used in the summator making the effect about 4 times larger. The largest effect of the AUTO ZERO signal is obtained when RL6 is closed and the (lowest) resistor (R42) is used in the summator. This will happen when the working potential is reductive (see page 13).
When ON/SET is activated, and the count direction is determined, clock-pulses (CP) and either UD or $\overline{UD}$ are active. In main circuit sheet 9, U25-28 will start counting either up or down depending on the desired direction towards 'zero'. The counter status is supplied to DA converters U 22,23, and an analog voltage is created via U24. This analog voltage is called AUTO ZERO, and is connected to RL5 in main circuit sheet 2. While the counter is supplied with clock-pulses (either up or down), the analog AUTO ZERO signal will go up or down causing the AMP signal to go to 'zero' or the offset level selected. When the AMP signal has reached the offset level, the status of comparator U18 will change causing JK flip flop U31B to change its status. This change in status will supply U31A with a clock pulse and OR port U29B will block the clock pulses causing the counter circuit to stop. The result is that any time

ON/SET is activated the ZERO circuit will make the AMP signal go the desired offset level. If the ZERO OFF if is activated either from the front or the back of the INTRO, the ON led will go off, the AUTZONOFF line will open RL5 and uncouple the AUTO ZERO signal from the amplifier, JK flip flop U31A is reset causing the SET led to go off and the clock-pulses are blocked.

3.7 Display

The LCD display and corresponding circuitry is located on the front board (front circuit sheet 2). The LCD is a 3.5 digit type, used to display the values selected via the DISPLAY switch on the front panel. U1 is the driver IC and U3 is used to set the decimal point. VIN is the input voltage which corresponds with the selected value. The display selection is made via SW1 (front circuit sheet 3), if SW5 is in position 1 (V_{cell}), Q7 and Q8 are open, and the working potential can be set. In any other display selection the working potential setting is blocked by Q7 and Q8. Multiplexer IC U4 is used to connect VIN with the selected value i.e. DISPLCELLVOLT, FILTEROUT, TEMP or IEOUT via the position of SW1. Voltage dividers R14-18, 20-23 and 61-64 are used to adapt the potentials to VIN. Also the decimal point is controlled from SW1, the decimal point is correctly positioned for each value selected. To realise this AND port U7 is used. To enable the decimal point to correctly correspond when x100 is active, opto-coupler U5 and schmittrigger U6A are used.

3.8 Oven

The oven circuit is located on the front board (front circuit sheet 4,5). The oven consists of a power unit where high current is transformed to heat via large resistors mounted on a heat sink. The power unit is connected to 24 V AC. A triac is used to switch the high current. The temperature is measured with an LM 35 IC which produces 10 mV/°C. A fan is used to blow the (heated) air through the oven compartment. For details on the oven power unit refer to the wiring diagram on page 34.

In front circuit sheet 4, the TEMPINST line is corresponding with the selected temperature value. The TEMPINST signal is build with precision resistors around SW4. TEMPINST is buffered via U8, and can be measured on TP4 (front). If SW4 is in position HEATER OFF the HEATON line is floating and the heater ON led is off. In any of the selected temperature settings except OFF, the HEATON line is low and the heater ON led is on. The HEAT label is connected to the heater resistors. When a heater current is applied to the heater resistors, opto-coupler U9 will drive Q1 and Q2, and the HEATING led is on.

In front circuit sheet 5 the TEMP line is directly connected with the temperature sensor output in the oven power unit. The TEMPINST line is corresponding with the selected temperature. U13 is used to invert, summate and amplify the selected and actual temperature value. Potentiometer

R39 is used to adjust the zero level of the summator and adjusts the oven set-point. U12 is a integrated circuit for pulse width modulation and control of the triac. The oven circuit is based upon U12 and fed with 24 V AC which is also used to heat the resistors in the power unit.

3.9 Connection board

The connection board is located at the rear panel of the INTRO. The connection board consists of a 10 pins I/O connector, a flat-cable connector, a dip-switch and RC filters on each I/O line. All I/O in- outputs are connected via a flat-cable to the main board, and via the main board to the front board where applicable. See connector board circuit sheet 1 for details.

3.10 Power supply

The power supply located under the main board is covered by a shielding cover. The power supply consist of a combined mains-switch, mains-filter / voltage selector / fuse holder, a power transformer and a power supply board.
The power supply board circuit is given on page 55. Rectifier-bridge B1 is supplied with 24 V AC (3 amps max.). C1 is used to buffer the ripple on the 35 V DC. DC/DC converter V1 produces a stabilised 24 V DC. DC/DC converter V2 is connected to the 24 V DC and produces +15 V DC and -15 V DC. The circuit built around U1 is also a DC/DC converter, which is fed with 35 V DC. This circuit produces +5 V DC. The voltages available are +5 V DC, -15 V DC, +15 V DC, +35 V DC and +24 V DC. In the INTRO the 5 V DC is used for all logical circuits, the + an - 15 V DC for the opamps and the 24 V DC for the heater fan. The 35 V DC is not used. The power supply board has two power cable connectors, JP1 is used to supply the front board and JP2 for the main board. For details see wiring diagram on page 34.

4 Testing and adjustment

4.1 Introduction

In this chapter stepwise test procedures are given for most circuits of the INTRO. When a certain value is out of spec. the adjustment procedure is described. Procedures can be started in a random order.
Each step the 'frame' on the front panel of the INTRO is given, followed by the 'action' within this frame. For example:

1. Vcell: ON

which means: in the 'Vcell frame' on the front panel press the 'ON' button. Only the relevant settings in each procedure are given.

4.2 Voltage clamp test procedure

1. Switch off , and after 5 s, switch on the INTRO via the mains switch at rear panel.
2. Vcell: ON
3. DISPLAY: Vcell
4. x100: ON
5. Connect a voltmeter to the cell connections (see Fig. 4).The readout of the voltmeter must be 0 mV ± 1 mV
6. If this value is out of spec. refer to 'Chapter 4.3 Voltage clamp adjustment procedure', if OK proceed as described below.
7. With the ^ key set the display value to 1.000 V ± 1 mV
8. The readout of the voltmeter must be -1.000 V ± 5 mV
9. If this value is out of spec, refer to 'Chapter 4.3 Voltage clamp adjustment procedure'.

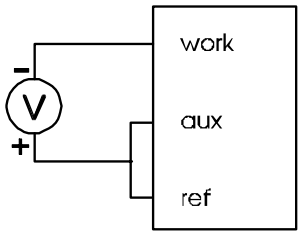


Fig. 4. Connection of the voltmeter.

4.3 Voltage clamp adjustment procedure

1. Disassemble as described in 'Chapter 5.1 General disassembly'.

2. Switch on the INTRO via the mains switch at the rear panel.
3. Connect a voltmeter to the cell connections. (see Fig. 4).
4. Vcell: ON
5. DISPLAY: Vcell
6. x100: ON
7. Adjust with potentiometer R5 (main) the readout of the voltmeter to 0 mV ± 1 mV.
8. With the ^ key set the display value to 1.000 V ± 1 mV
9. The readout of the voltmeter must be 1.000 V ± 5 mV.
10. If this value is out of spec., proceed as described below.
11. Connect the voltmeter with - to TP1 (main), and + to TP2 (main).
12. The readout of the voltmeter must be 1.000 V ± 5 mV
13. If the readout of the voltmeter is not in spec. with step 12, but within 1.000 V± 15 mV, the display needs adjustment. For display adjustment refer to 'Chapter 4.4 Display adjustment procedure'. If the deviation is more than ± 15 mV, the voltage clamp circuitry on the main board (main circuit sheet 2, 6, 7, 8) is faulty.

4.4 Display adjustment procedure

1. Disassemble as described in 'Chapter 5.1 General disassembly'.
2. Switch on the INTRO via the mains switch at the rear panel.
3. Connect a voltmeter with - to TP1 (main), and + to TP2 (main).
4. Vcell: ON
5. DISPLAY: Vcell
6. With the ^ key increase the Vcell value until the readout of the voltmeter is 1.000 V ± 2 mV.
7. Adjust with potentiometer R9 (front) the value in the display to 1.000 V ± 2 mV

4.5 I/E converter offset test procedure

1. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
2. Vcell: ON
3. Check if the OX led switches on, if not switch off the INTRO via the mains switch at the rear panel and go back to step 1. If the OX led still not switches on, the voltage clamp circuitry on the main board (main circuit sheet 2, 6, 7, 8), the keyboard with the integrated leds, or the corresponding wiring is faulty.
4. Vcell: OFF
5. DISPLAY: Icell, HR
6. The value in the display must be .000 nA ± .001 nA, if not in spec. proceed with 'Chapter 4.6 I/E converter offset adjustment procedure'.
7. x100: ON

8. The value in the display must be 00.0 nA ± 00.1 nA, if not in spec. proceed with ‘Chapter 4.6 I/E converter offset adjustment procedure’.
9. x100: OFF
10. DISPLAY: Vcell
11. With the down key select a random negative voltage.
12. Vcell: ON
13. Check if the RED led switches on, if not go back to step 11. If the RED led still not switches on, the voltage clamp circuitry on the main board (main circuit sheet 2, 6, 7, 8), the keyboard with the integrated leds, or the corresponding wiring is faulty.
14. Vcell: OFF
15. DISPLAY: Icell, HR
16. The value in the display must be .000 nA ± .001 nA, if not in spec. proceed with ‘Chapter 4.6 I/E converter offset adjustment procedure’.
17. x100: ON
18. The value in the display must be 00.0 nA ± 00.1 nA, if not in spec. proceed with ‘Chapter 4.6 I/E converter offset adjustment procedure’.

4.6 I/E converter offset adjustment procedure

1. Disassemble as described in ‘Chapter 5.1 General disassembly’.
2. Switch on the INTRO via the mains switch on the rear panel.
3. Vcell: ON
4. Check if the OX led is on, if not, switch off the INTRO via the mains switch at the rear panel and go back to step 2. If the OX led still not switches on, the voltage clamp circuitry on the main board (main circuit sheet 2, 6, 7, 8), the keyboard with the integrated leds, or the corresponding wiring is faulty.
5. Vcell: OFF
6. DISPLAY: Icell, HR
7. Adjust with potentiometer R50 (main) the value in the display to .000 nA ± .001 nA.
8. x100: ON
9. The value in the display must be 00.0 nA ± 00.1 nA.
10. x100: OFF
11. DISPLAY: Vcell
12. With the down key select a random negative voltage.
13. Vcell: ON
14. Check if the RED led is on, if not go back to step 12. If the RED led still not switches on, the voltage clamp circuitry on the main board (main circuit sheet 2, 6, 7, 8), the keyboard with the integrated leds, or the corresponding wiring is faulty.
15. Vcell: OFF
16. DISPLAY: Icell, HR

17. Adjust with potentiometer R48 (main) the value in the display to .000 nA ± .001 nA.
18. x100: ON
19. The value in the display must be 00.0 nA ± 00.1 nA.

4.7 Amplifier offset test procedure

1. Before this test, the I/E converter offset must be correct, refer to 'Chapter 4.5 I/E converter offset test procedure'.
2. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
3. Vcell: ON
4. Check if the OX led is on, if not, switch off the INTRO via the mains switch at the rear panel and go back to step 2. If the OX led still not switches on, the voltage clamp circuitry on the main board (main circuit sheet 2, 6, 7, 8), the keyboard with the integrated leds, or the corresponding wiring is faulty.
5. Vcell: OFF
6. DISPLAY: Vout
7. FILTER: .1 s
8. RANGE: .01 nA/V
9. The value in the display must be 0.00 nA/V ± 0.05 nA/V, if not in spec. proceed with 'Chapter 4.8 Amplifier offset adjustment procedure'.
10. x100: ON
11. The value in the display must be 0.00 nA/V ± 0.10 nA/V, if not in spec. proceed with 'Chapter 4.8 Amplifier offset adjustment procedure'.

4.8 Amplifier offset adjustment procedure

1. Before this adjustment, the I/E converter offset must be correct, refer to 'Chapter 4.5 I/E converter offset test procedure'.
2. Disassemble as described in 'Chapter 5.1 General disassembly'.
3. Switch on the INTRO via the mains switch at the rear panel.
4. Vcell: ON
5. The OX led must be on, if not, switch of the INTRO via the mains switch at the rear panel and go back to step 3. If the OX led still not switches on, the voltage clamp circuitry on the main board (main circuit sheet 2, 6, 7, 8), the keyboard with the integrated leds, or the corresponding wiring is faulty.
6. Vcell: OFF
7. DISPLAY: Vout
8. FILTER: .1 s
9. RANGE: .01 nA/V

10. Adjust with potentiometer R30 (main) the value in the display to 0.00 nA/V ± 0.01 nA/V.
11. x100: ON
12. The value in the display must be 0.00 nA/V ± 0.10 nA/V.

4.9 Rec. and int. output test procedure

1. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
2. Connect a dummy cell (see Fig. 5 on page 27).
3. Vcell: ON
4. DISPLAY: Vcell
5. With the ^ key set the value in the display to .800 V
6. DISPLAY: Icell
7. FILTER: .1 s
8. RANGE: 1 nA/V
9. Dip-switch 1: OFF
10. Dip-switch 3: OFF
11. The value in the display must be 2.67 nA ± 0.05 nA.
12. Connect a voltmeter to the integrator output.
13. The readout of the voltmeter must be 0.267 V ± 5 mV, if not in spec. the integrator output driver on the main board is faulty (main circuit sheet 2).
14. Dip-switch 3: ON
15. The readout of the voltmeter must be 0.027 V ± 2 mV, if not in spec. the integrator output driver on the main board is faulty (main circuit sheet 2).
16. Connect a voltmeter to the recorder output.
17. The readout of the voltmeter must be 2.67 V ± 0.05 V, if not in spec. refer to ‘Chapter 4.10 Recorder output adjustment procedure’.
18. Dip-switch 1: ON
19. The readout of the voltmeter must be 0.267 V ± 10 mV, if not in spec. refer to ‘Chapter 4.10 Recorder output adjustment procedure’.

4.10 Recorder output adjustment procedure

1. Disassemble as described in ‘Chapter 5.1 General disassembly’.
2. Switch on the INTRO via the mains switch at the rear panel.
3. Connect a dummy cell (see page 27).
4. DISPLAY: Vcell
5. With the up key set the value in the display to .800 V.
6. Vcell: ON
7. DISPLAY: Icell
8. FILTER: .1 s

9. RANGE: 1 nA/V
10. Dip-switch 1: OFF
11. The value in the display must be 2.67 nA ± 0.05 nA, note this value.
12. DISPLAY: Vout
13. Adjust with potentiometer R44 (main) the value in the display to exact the same value as noted in step 10.
14. Connect a voltmeter to the recorder output.
15. Adjust with potentiometer R79 (main) the readout of the voltmeter to 2.67 V ± 2 mV.

4.11 Zero circuit test procedure

1. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
2. DISPLAY: Vout
3. FILTER: .1 s
4. RANGE: .01 nA/V
5. Dip-switch 2: OFF
6. ZERO: ON/SET
7. The value in the display must be 0.00 V ± 0.1 V, if not in spec., the zero circuit on the main board is faulty (main circuit sheet 9, 10).
8. x100: ON
9. The value in the display must be 0.00 V ± 0.2 V, if not in spec., the zero circuit on the main board is faulty (main circuit sheet 9, 10).
10. x100: OFF
11. ZERO: OFF
12. Connect a dummy cell (see page 27).
13. DISPLAY: Vcell
14. With the up key set the value in the display to .800 V.
15. RANGE: 1 nA/V
16. Vcell: ON
17. DISPLAY: Icell
18. After stabilisation the value in the display must be 2.67 nA ± 0.05 nA.
19. DISPLAY: Vout
20. ZERO: ON/SET
21. The SET and ON led must go on, and the SET led must go off when the display value is 0.00 V ± 0.05 V, if not in spec. the zero circuit on the main board is faulty (main circuit sheet 9, 10).
22. Vcell: OFF
23. ZERO: OFF

4.12 Mark & offset test procedure

1. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
2. Connect a voltmeter to the recorder output.
3. FILTER: .1 s
4. RANGE: 1 nA/V
5. x100: OFF
6. Dip-switch 1: OFF
7. Dip-switch 4: ON
8. When the mark button on the front panel is pressed, a short 'spike' on the recorder output must result. To measure this 'spike' set the voltmeter in 'auto hold'.
9. MARK: {press button}
10. The voltmeter readout must be 100 mV ± 30 mV.
11. Dip-switch 4: OFF
12. MARK: {press button}
13. The voltmeter readout must be 1 V ± 0.3 V.
14. Turn the OFFSET LEVEL potentiometer at the rear panel fully to one side (about 10 turns).
15. ZERO: ON/SET
16. The voltmeter readout must be 15 mV. ± 3 mV, if not in spec. the offset potentiometer or its corresponding circuit or connections are faulty (main circuit sheet 10).
17. Turn the OFFSET LEVEL potentiometer at the rear panel fully to the other side (about 20 turns).
18. ZERO: ON/SET
19. The voltmeter readout must be 15 mV ± 3 mV, but with reversed polarity as step 14, if not in spec. the offset potentiometer or its corresponding circuit or connections are faulty (main circuit sheet 10).
20. Adjust the OFFSET LEVEL potentiometer at the rear panel while keeping ZERO ON/SET pressed and adjust the voltmeter readout to 0.00 V ± 0.01 V.

4.13 Heater test procedure

1. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
2. For this test the ambient (room) temperature must be below 30 °C.
3. HEATER: 35 °C
4. The heater ON led must be on, if not the heater circuitry on the front board is faulty (front circuit sheet 4, 5).
5. DISPLAY: °C
6. If the value in the display is lower than 35.0 °C, the HEATING led must be on. If the value in the display is higher than 35.0 °C, the HEATING led must be off. If the value in the display is 35.0 °C (stable), the HEATING led must flash.

7. While the oven is heating (HEATING led on or flashing), open the oven compartment and check if the HEATING led goes off, if not the micro switch in the oven compartment is faulty (see 'Chapter 7.2 Wiring diagram').
8. Close the oven compartment and wait until the oven is stable at 35.0 °C ± 0.5 °C, and the HEATING led flashes about 1x per second.
9. If the value in the display is not in spec (± 0.5 °C) with the value selected via the HEATER switch, refer to 'Chapter 4.14 Heater adjustment procedure'.
10. On the 10 pins I/O strip at the rear panel connect a voltmeter with - to pin 10 and + to pin 9.
11. The readout of the voltmeter must correspond with the value in the display (10 mV/°C) ± 5 mV, if not in spec. the output buffer on the main board (main sheet 5), the connector board or its corresponding connections are faulty (connector board circuit sheet 1).

4.14 Heater adjustment procedure

1. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
2. For this test the ambient (room) temperature must be below 30 °C.
3. Disassemble as described in 'Chapter 5.1 General disassembly'.
4. Switch on the INTRO via the mains switch on the rear panel.
5. HEATER: 35 °C
6. DISPLAY: °C
7. If the value in the display is lower than 35.0 °C, the HEATING led must be on. If the value in the display is higher than 35.0 °C, the HEATING led must be off. If the value in the display is 35.0 °C (stable), the HEATING led must flash.
8. Close the oven compartment and wait until the oven is stable, and the HEATING led flashes about 1x per second.
9. Adjust the heater with potentiometer R39 (front) until the temperature is corresponding with the heater switch position (35 °C). **Adjust only 1 turn at a time, and wait for the heater to stable after adjustment**. From the front side seen, turning clockwise will lower the temperature, counter-clockwise will raise the temperature about 0.1 °C/turn.

4.15 I/O test procedure

1. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
2. To test the 10 pins I/O connector at the rear panel, a both side stripped test wire of about 15 cm is needed.
3. Connect one side of the test wire to pin 7, and use the other side to check as described below.
4. Shortly connecting pin 1 must switch the cell on (OX or RED led on).
5. Shortly connecting pin 2 must switch the cell off (OX or RED led off).

6. Shortly connecting pin 3 must produce a marker ‘spike’ on the recorder output. This can be measured either with a flat-bed chart recorder, an integrator or a voltmeter which can ‘auto hold’ the highest voltage.
7. Shortly connecting pin 4 must activate the zero circuit (zero ON led on).
8. NOTE: if the zero on/set input is kept ‘low’, the recorder output stays at 0 V.
9. Shortly connecting pin 5 must deactivate the zero circuit (zero ON led off).
10. Shortly connecting 6 must activate x100 att. (x100 led ON led on). Again connecting pin 6 must deactivate x100 att. (x100 led off).
11. If a Rheodyne 7725i is properly connected to P1 inside the oven cabinet, pin 8 can be tested with an Ohm meter. If the valve is in load position the resistance between pin 7 and 8 must be >10 MOhm in inject < 200Ohm
12. To test pin 10, connect a voltmeter with - to pin 9 and + to pin 10. Check if the voltage corresponds with the °C readout on the display in 10 mV/°C ± 0.5 °C.

4.16 Power-supply voltages test procedure

1. Dissemble as described in ‘Chapter 5.1 General disassembly’.
2. Switch on the INTRO via the mains switch at the rear panel.
3. To measure the power-supply voltages a voltmeter with standard probes is needed.
4. Measure on power supply cable connector J15 (main) the following potentials:
5. Between black and red: +5 V DC ± 0.3 V DC
6. Between black and grey: -15 V DC ± 0.5 V DC
7. Between black and yellow: +15 V DC ± 0.5 V DC.
8. If the heater fan does not turn, check the following potential on the power supply cable connector J3 (front):
9. Between black (pin 10) and blue: +24 V DC ± 0.5 V DC.
10. If no voltages are detected, check the fuses in the mains inlet (combined mains switch and fuse holder / line voltage selector) at the rear panel of the INTRO. See safety practises for details (page 3).
11. If still no voltages are detected, the power supply board is faulty (power supply board circuit sheet 1).

4.17 Noise test

A successful noise test confirms that the controller, including the cell cable, functions properly. If the result of the noise measurement with the dummy cell is within specs, the controller is excluded in a trouble shooting procedure.

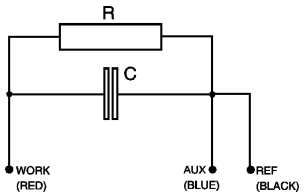


Fig. 5. Dummy cell connection.

The dummy consists of a resistor (R) of 300 MOhm and a capacitor (C) of 0.47 µF in parallel. The current is measured over the resistor according to Ohm's law (V = I x R), hence with a working potential of 800 mV the current drawn will be about 2.67 nA. Slight differences as to this (ideal) value are due to the tolerance of the resistor (± 1%). The capacitor functions as a 'noise generator' and in fact resembles the capacitance of a well-functioning VT-03 flow cell in an ideal HPLC set-up.
The noise generated via the dummy should be less than 3 pA if the filter of the controller is set to 0.1 second, provided that the dummy is within the fully closed Faraday shield at the same position as the flow cell. With a 1s filter the noise should be better than 1 pA.

1. To properly check the noise a flat-bed chart recorder or a similar data acquisition device is needed. **The input voltage of this device must be set to 1 V !**
2. Switch off, and after 5 s, switch on the INTRO via the mains switch at the rear panel.
3. Connect a dummy cell (see Fig. 5).
4. DISPLAY: Vcell
5. With the ^ key set the value in the display to .800 V.
6. Vcell: ON
7. DISPLAY: Icell
8. HEATER: 30 °C (stable, HEATING led flashes)
9. FILTER: .1 s
10. RANGE: .1 nA/V
11. Dip-switch 1: OFF
12. Dip-switch 2: OFF
13. ZERO: ON/SET
14. Wait for 5 min.(stabilisation time).
15. The value in the display must be 2.67 nA ± 0.05 nA.
16. ZERO: ON/SET
17. Now the noise can be measured.

The results of the dummy test must be comparable with the test sheet supplied with your controller. If not the corresponding circuitry on the main board is faulty (man circuit sheet 2).

5 Disassembling

Disassembling is only necessary if values are out of spec. or internal repairs are needed. Disassembling should only be done by qualified service engineers who are experienced in servicing this type of equipment. Always read all notices and safety practises before disassembling electrical equipment (page 2 - 3)!

5.1 General disassembly

1. Switch off the INTRO and remove the mains cable from your local power source.
2. Remove the upper two screws at the rear panel (2xM4x8). Do not remove the four bolts holding the hinges.
3. Open the oven compartment and remove the three screws at the inside front (3xM4x8).To remove these screws use a long screwdriver (PHILLIPS RECESS Gr1, long). Hold the plastic bottom front part while releasing the last screw, and put aside the plastic bottom front part.
4. Lift up the complete upper part and lay it on its left side, at the left hand side of the INTRO. **Take care not to lift too high or too fast, or cable(s) and / or connectors may be damaged**. Use some soft foam underneath the upper part to prevent damage to the fluid drain, and / or the paint. If the upper part is laid down as described, no cable connections have to be released.
5. Now the INTRO is fully functional and can be tested and adjusted if necessary.

5.2 Removing the front panel assembly

1. First disassemble as described in ‘Chapter 5.1 General disassembly’.
2. Do not connect the INTRO to mains power!
3. Remove the (large) flat-cable from J10 (main).
4. Note the position of the coloured wires coming from the upper-part (heater) going to the front board J2,4 (front). Unscrew these wires one by one from the terminal-block.
5. Under the INTRO at the front, remove the two front-panel assembly mounting screws (2xM4x8). To do so position the INTRO on the workbench with the front sticking over the workbench, and unscrew from underneath.
6. Holding the front-panel assembly remove the power connector from J3 (front), and the grounding wire from the bottom of the INTRO lower part.
7. The front-panel assembly is now released from the bottom part, and can be exchanged if necessary.

5.3 Removing the main board

1. First disassemble as described in 'Chapter 5.1 General disassembly'.
2. Do not connect the INTRO to mains power!
3. Remove the (large) flat-cable from J10 (main).
4. Remove the power connector from J15 (main).
5. Remove the cell connector from J11 (main)
6. Remove the output connector from J14 (main).
7. Remove the I/O flat-cable from J12 (main).
8. Remove the load/inject connector from J2 (main).
9. Remove the six main board mounting screws from the long sides of the main board.(6xM3x8).
10. The main board is now released from the bottom part, and can be exchanged if necessary.

5.4 Removing the connector board.

1. First disassemble as described in 'Chapter 5.1 General disassembly'.
2. Do not connect the INTRO to mains power!
3. Remove the I/O flat-cable from J1 (connector board).
4. Remove the four connector board mounting screws in the corners of the connector board (4xM3x5).
5. The connector board is now released from the rear panel, and can be exchanged if necessary.

5.5 Removing the power supply board.

1. First disassemble as described in 'Chapter 5.1 General disassembly'.
2. Do not connect the INTRO to mains power!
3. Remove the main board as described in 'Chapter 5.3 Removing the main board'.
4. Under the main board remove the power supply shielding cover, to do so remove the four power supply shielding cover mounting screws (4xM4x8).
5. Hold the power supply shielding cover, and disconnect the grounding wire from the central ground point. Put aside the power supply shielding cover.
6. Note the location, and remove the power connectors from JP1 and JP2 (power supply).
7. Note the location, and unscrew the green/yellow and two brown wires from terminal block JP3 (power supply).
8. Remove the four power supply board mounting screws in the corners (4xM3x8).
9. The power supply board is now released from the bottom part, and can be exchanged if necessary.

5.6 Removing the heater power unit

1. First disassemble as described in 'Chapter 5.1 General disassembly'.
2. Do not connect the INTRO to mains power!
3. Remove the cell connector from J11 (main).
4. Remove the output connector from J14 (main).
5. Remove the I/O flat-cable from J12 (main).
6. Remove the load/inject connector from J2 (main).
7. Note the position of the coloured wires coming from the upper-part (heater) going to the front board J2,4 (front). Unscrew these wires one by one from the terminal-block.
8. Remove the grounding wire from the side of the bottom part.
9. Now the upper part is completely released from the bottom part, put the upper part on a workbench.
10. Open the cover of the upper part and remove the four screws from the plastic heater cover (4xM3x40). Remove the plastic oven cover together with the metal mazes.
11. Remove the four oven power unit mounting screws (4xM3x8), and put aside the oven power unit.
12. Remove the micro switch at the right side of the oven compartment by unscrewing the two nuts (M2).
13. If necessary cut the black foam to release the green wires coming from the micro switch.
14. Remove the oven power unit together with the micro switch by pulling the wires trough the black feed-trough part.
15. The oven power unit is now released from the upper part, and can be exchanged if necessary.

6 Reassembling

Before reassembling read this carefully!

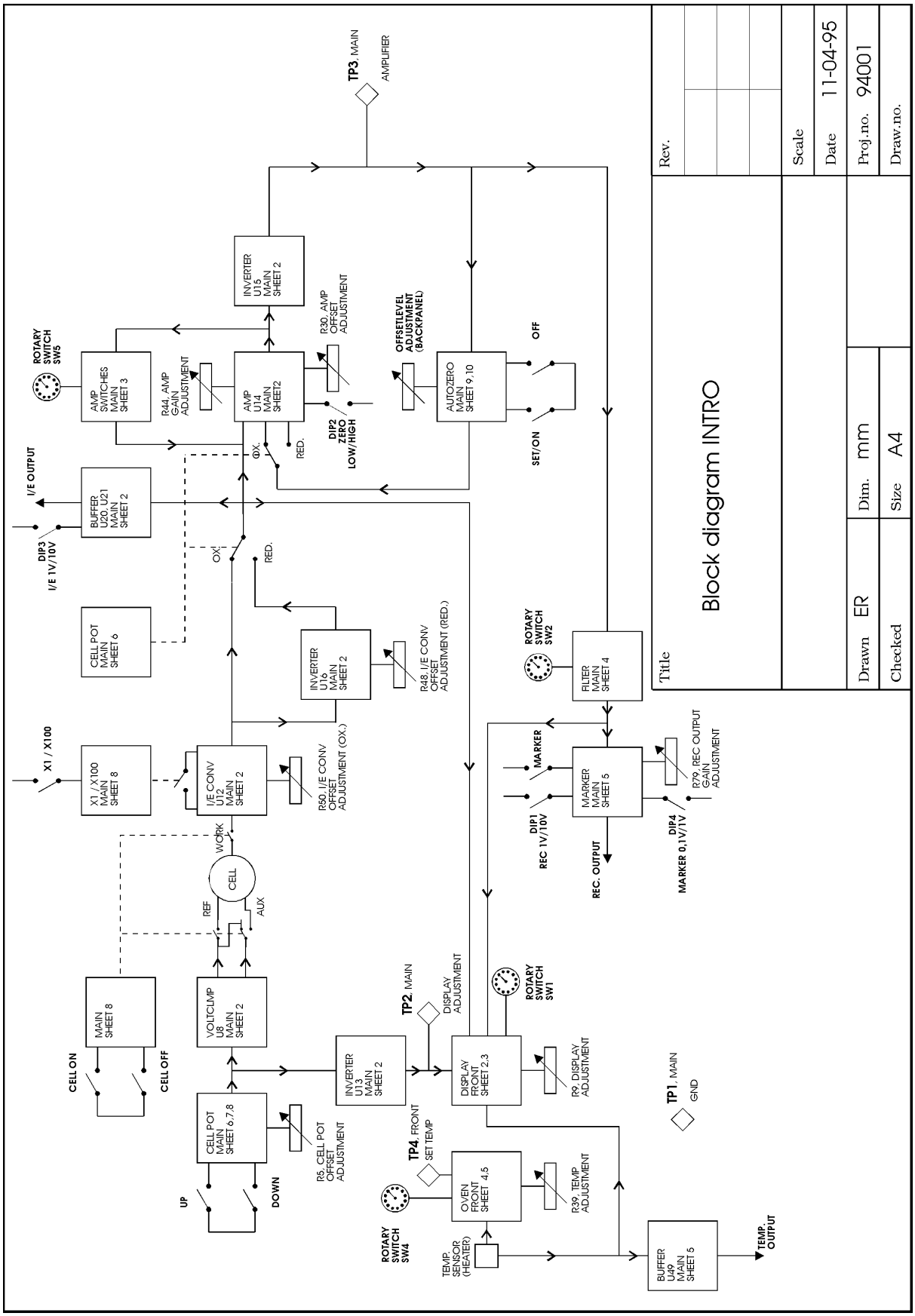
Do not attempt to overtighten, force or wrongly enter a (damaged) screw or the head may turn and the screw will be irremovable. This may also cause permanent damage to the screw thread. Always use the indicated type of screw or the head may turn and the screw will be irremovable.
Always use a correct fitting screwdriver for example PHILLIPS RECESS Gr.1 (long type).

Reassemble as described below:

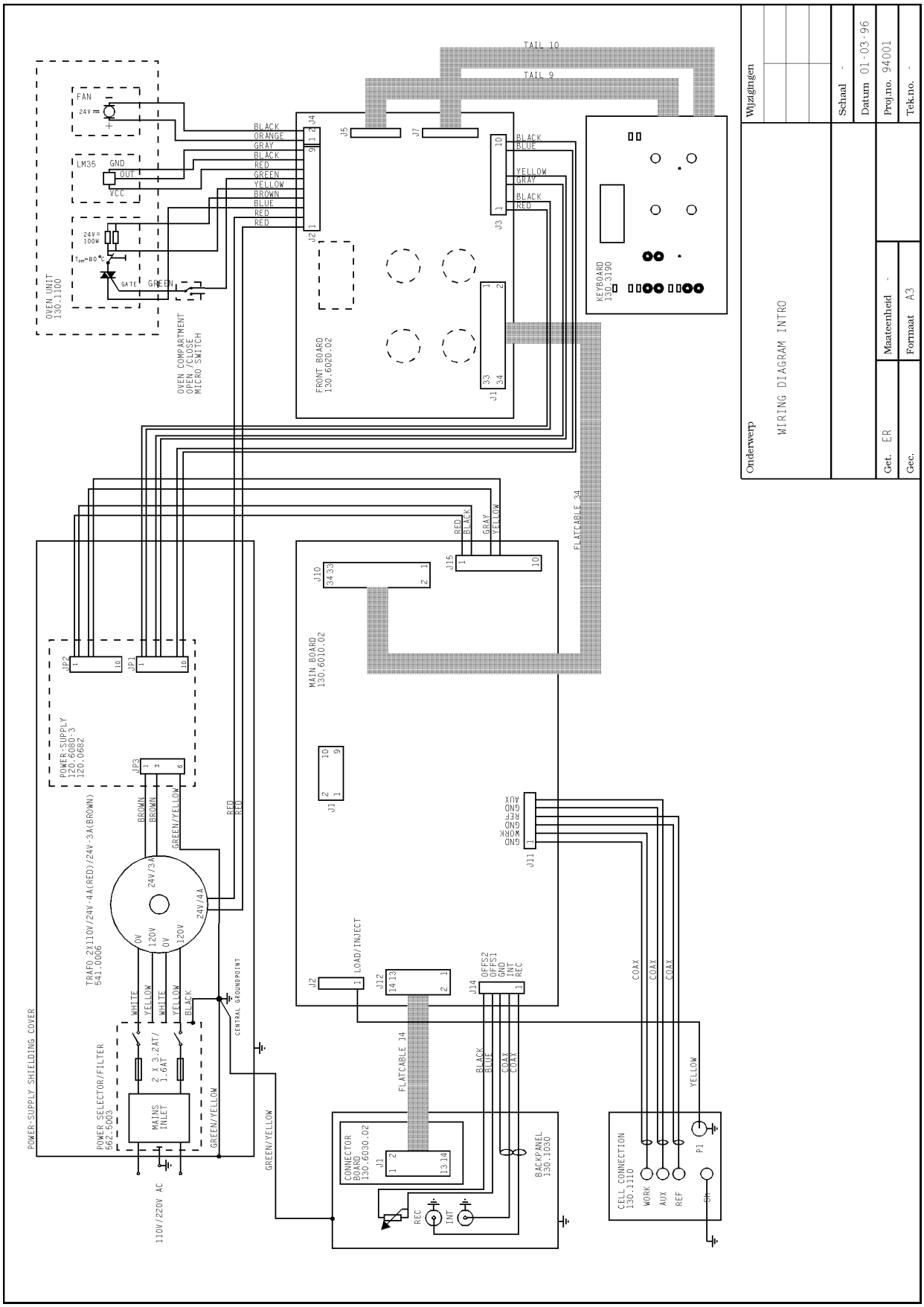
1. Disconnect the INTRO from mains power.
2. Restore all parts, boards, wiring and connectors, in reversed order as disassembling and double check for proper installation.
3. Check the position of the cell connector, the output connector and the load/inject connector (see wiring diagram, page 34). Make sure these connectors are not reversed, the proper direction is indicated with red paint. Make sure all pins fit into the connectors.
4. Slowly lower the upper part onto the bottom part with the metal flaps at the back inside the bottom part, and the front before the metal flaps at the bottom part.
5. When both parts fit correctly, the screw mounting holes at the front and the rear panel correspond such that the screws can be refitted.

7 Drawings

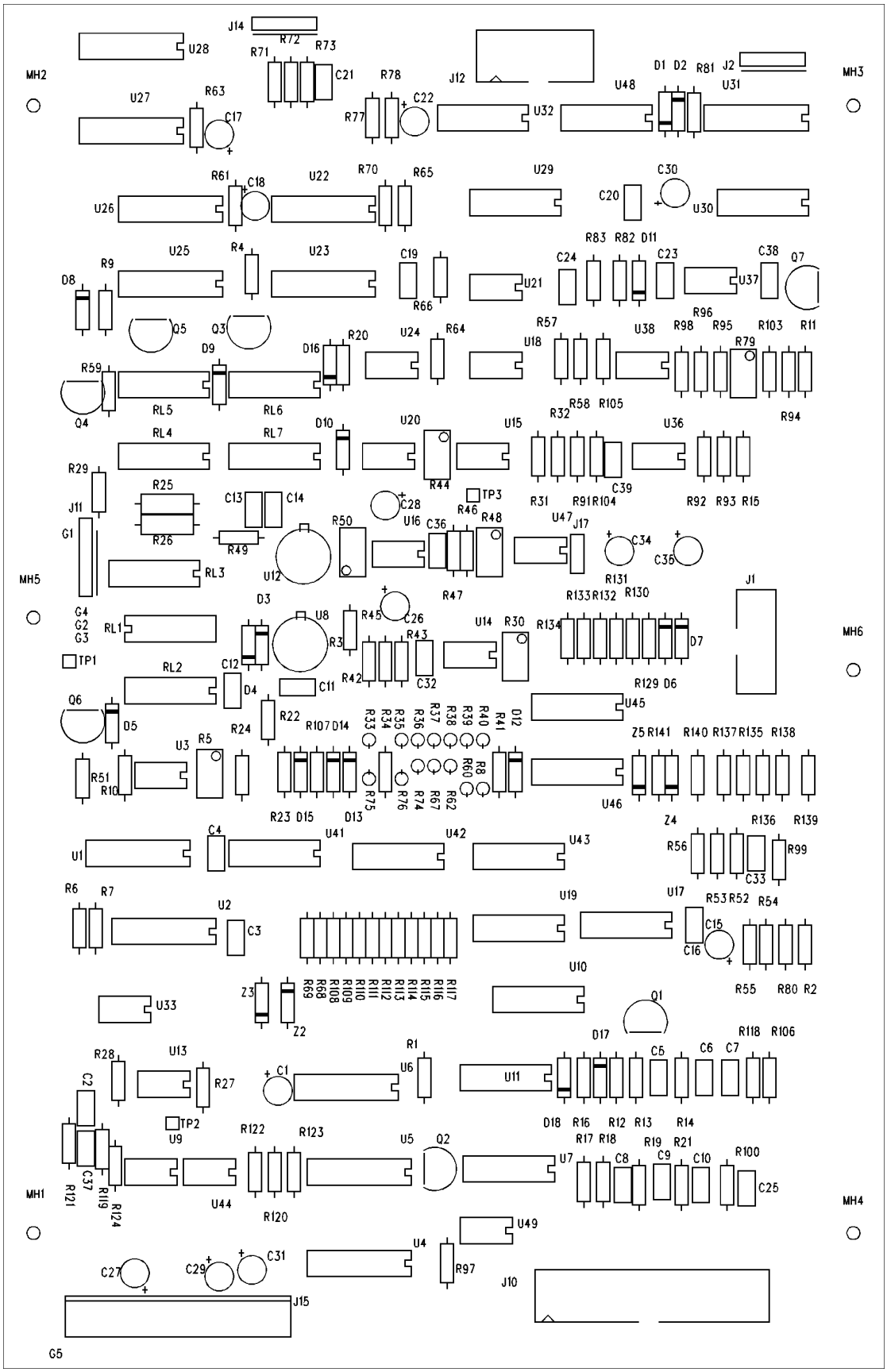
7.1 Block diagram



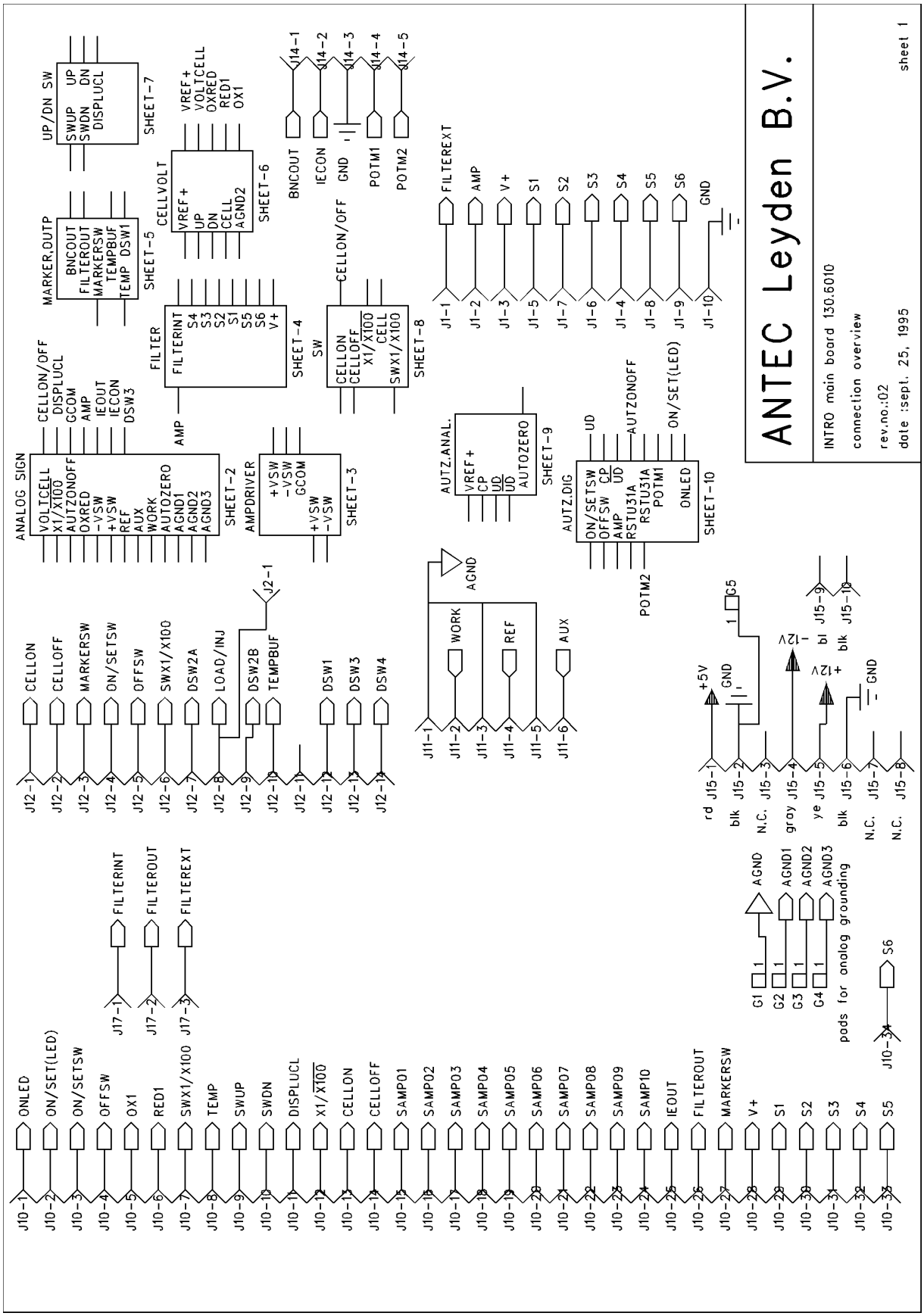
7.2 Wiring diagram



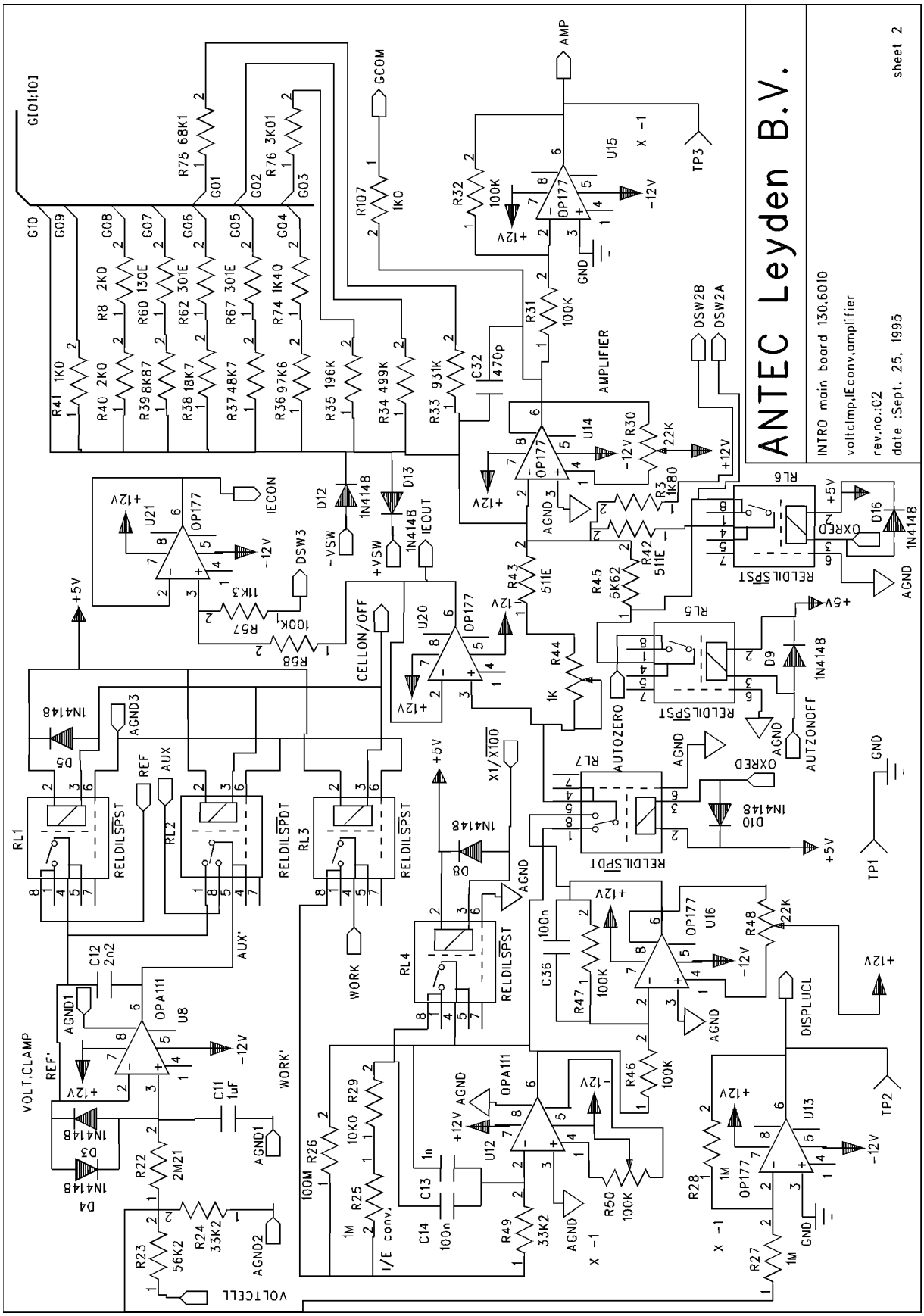
7.3 Layout main board



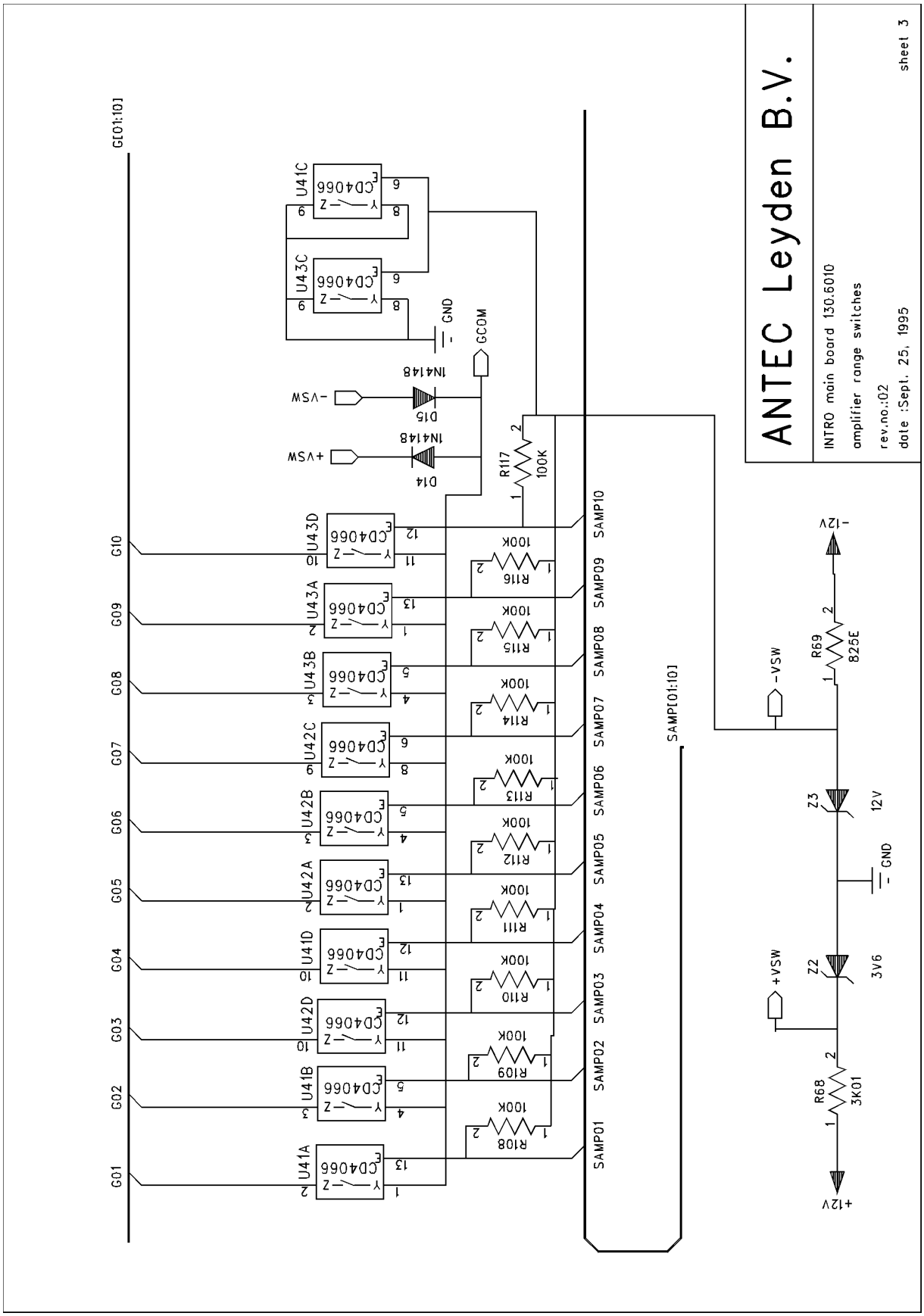
7.4 Main circuit sheet 1



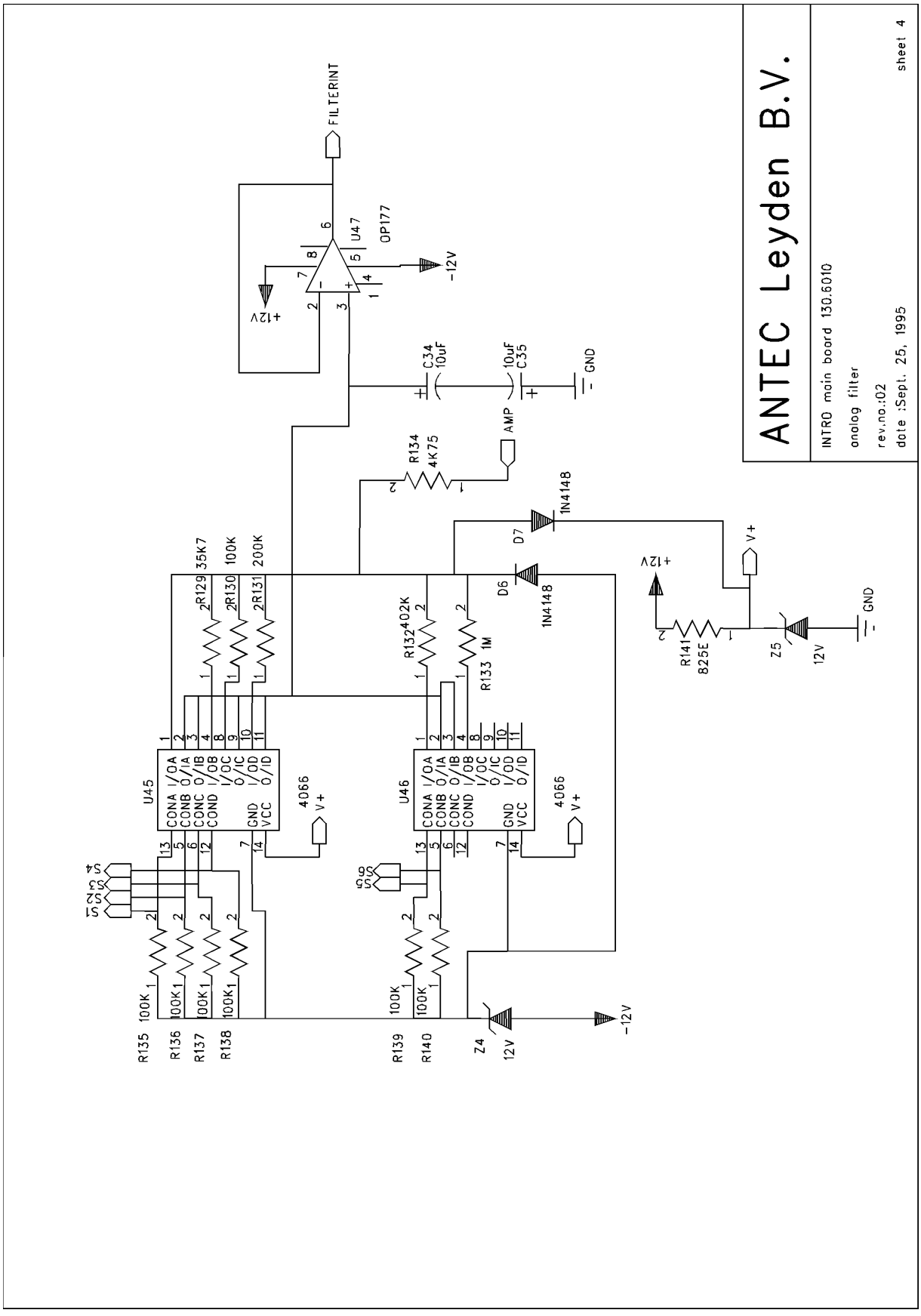
7.5 Main circuit sheet 2



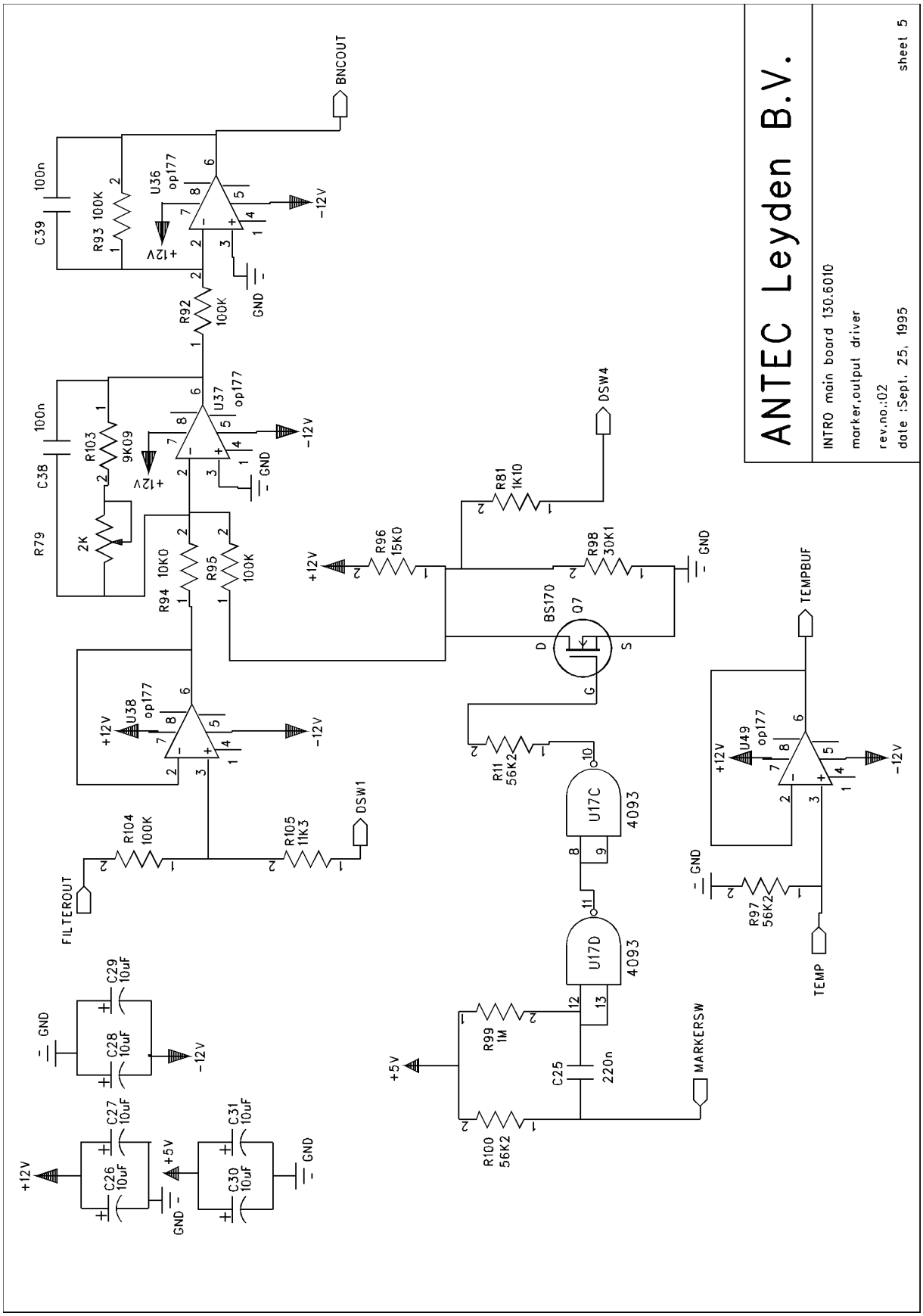
7.6 Main circuit sheet 3



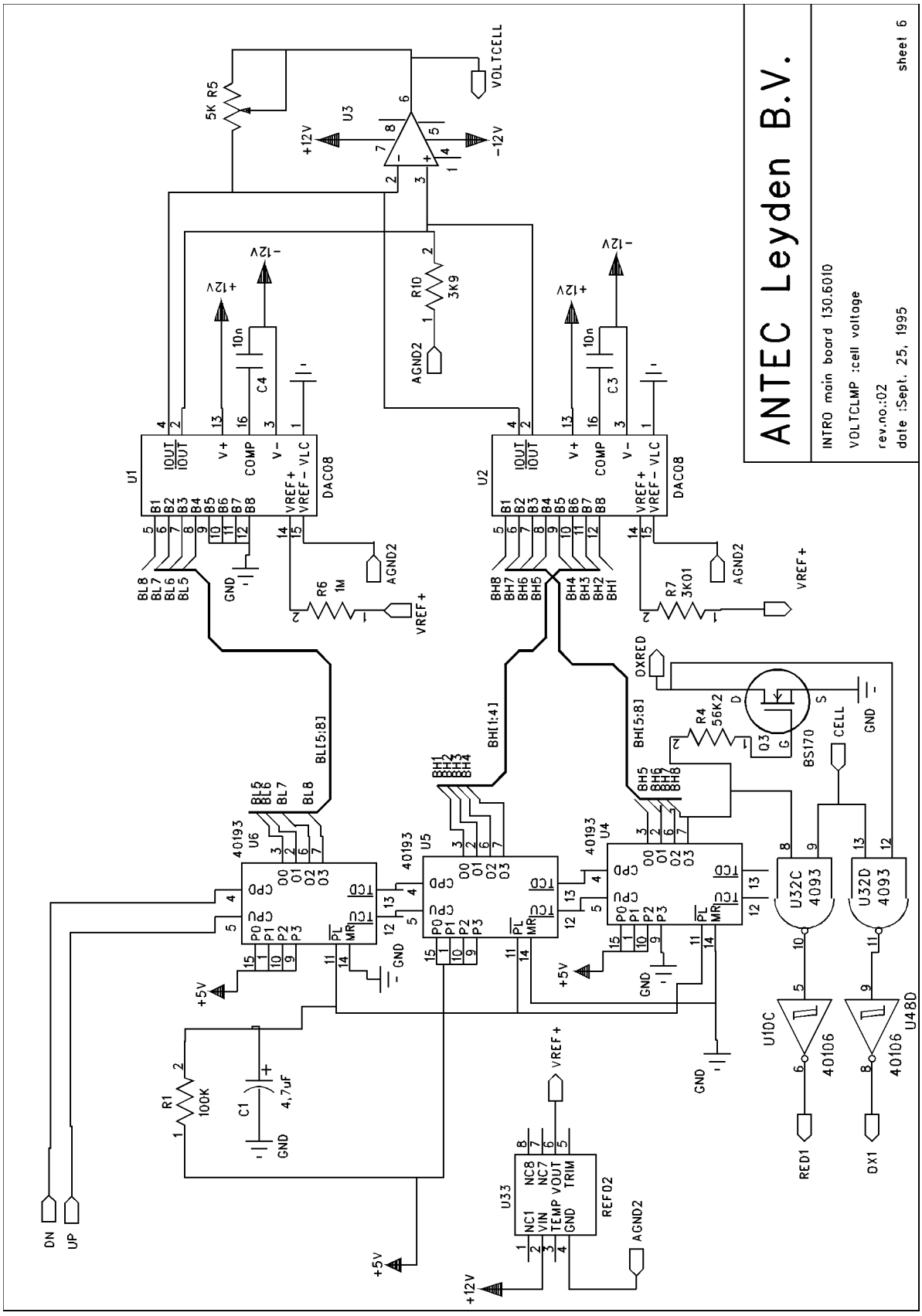
7.7 Main circuit sheet 4



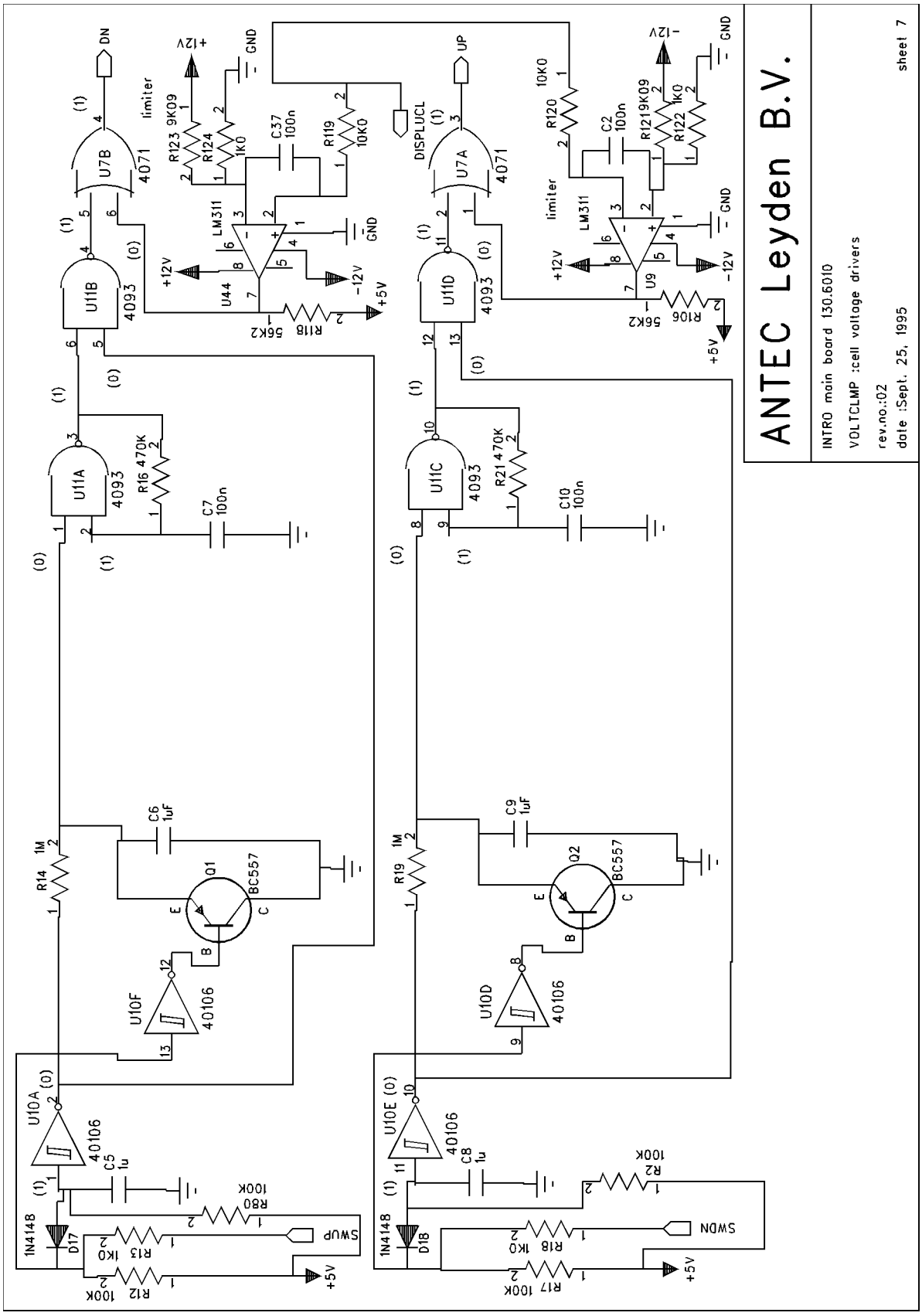
7.8 Main circuit sheet 5



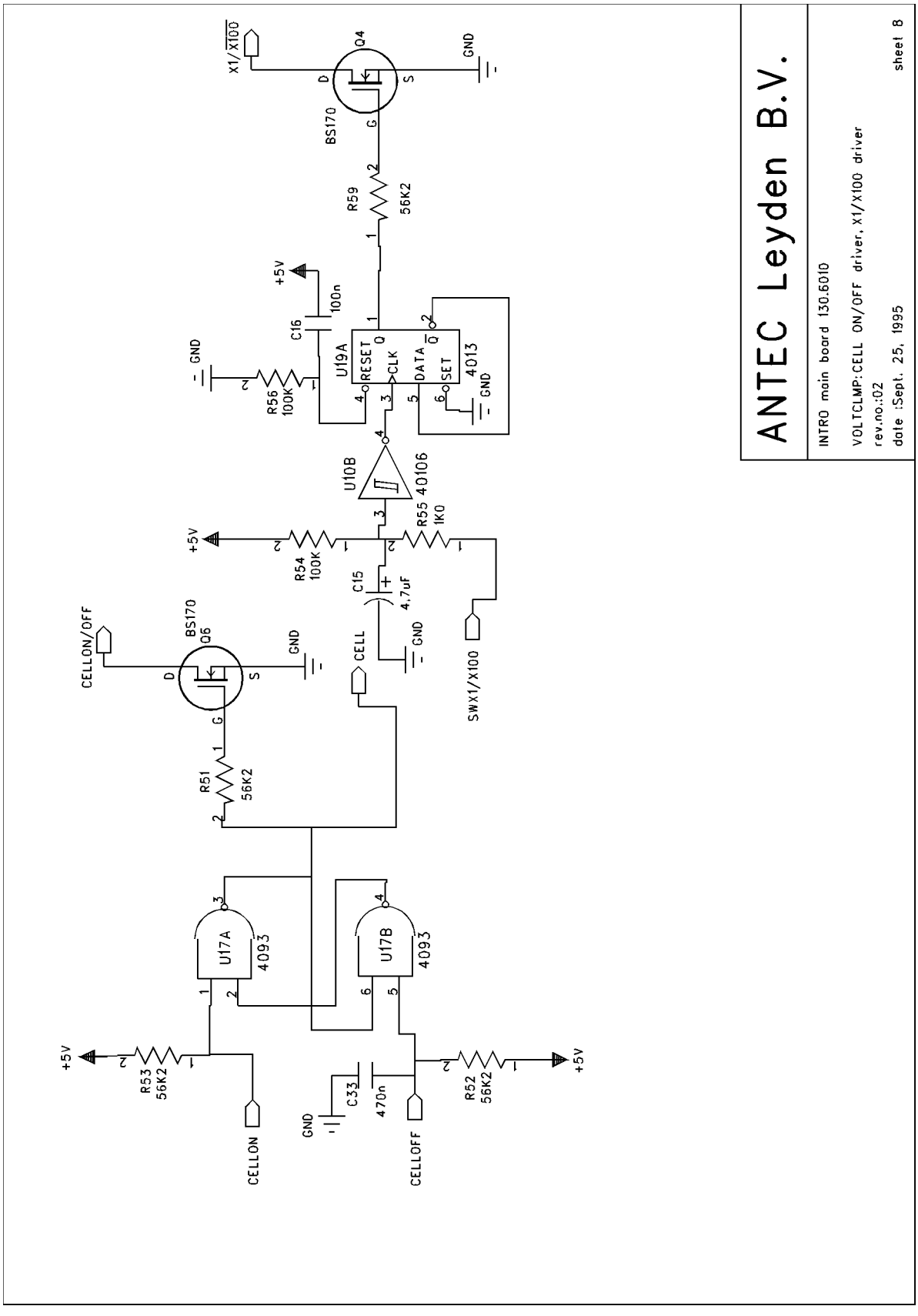
7.9 Main circuit sheet 6



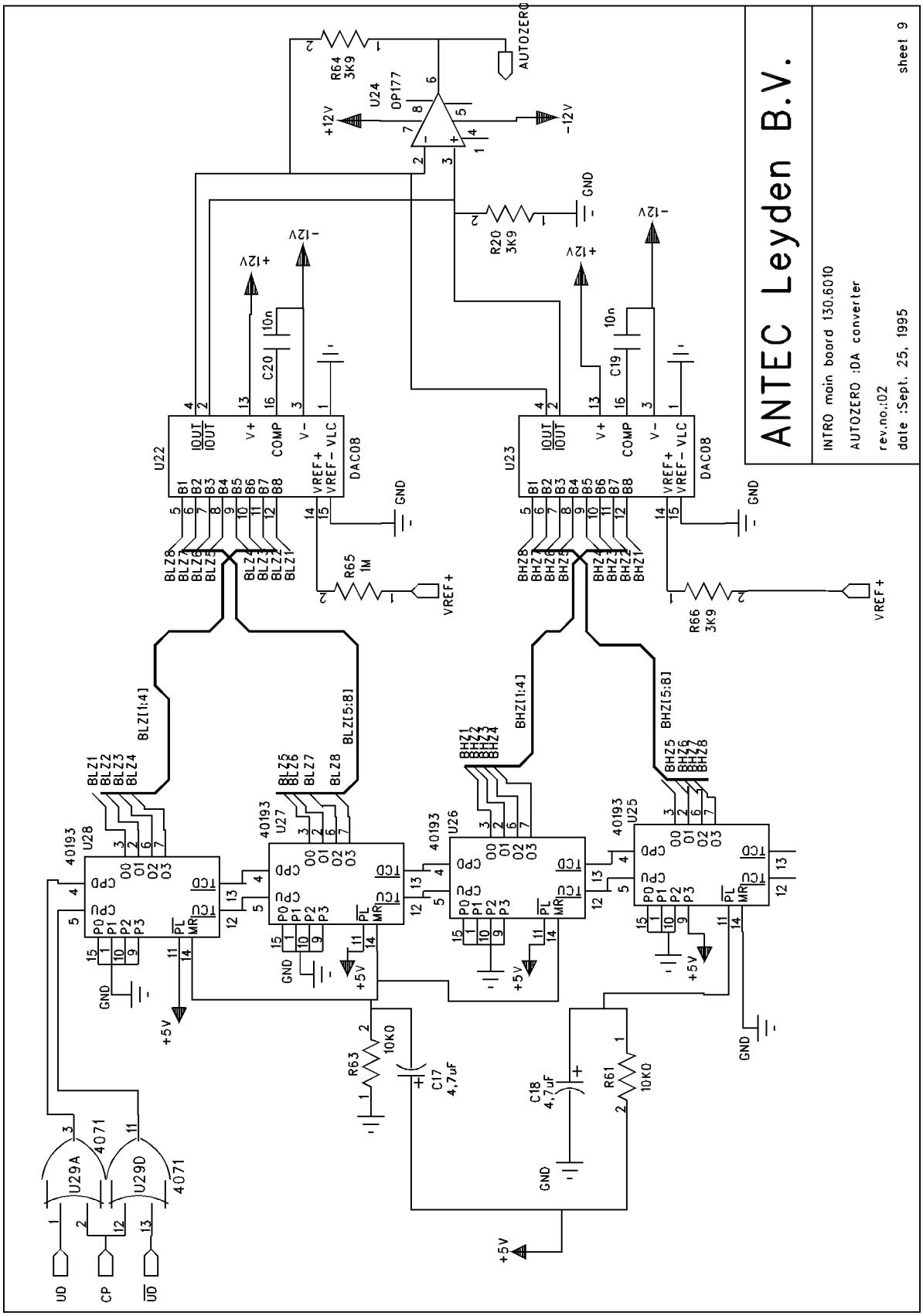
7.10 Main circuit sheet 7



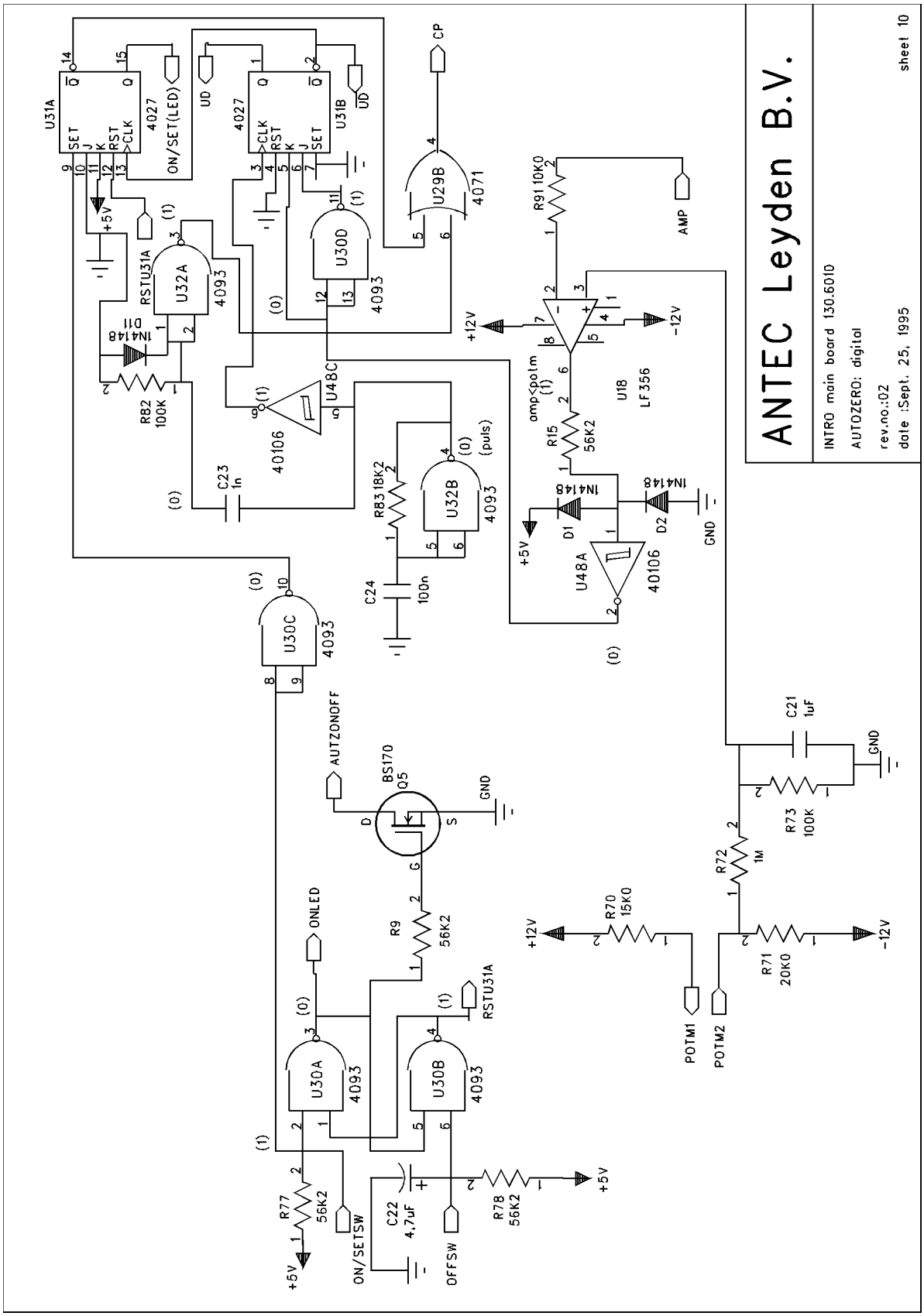
7.11 Main circuit sheet 8



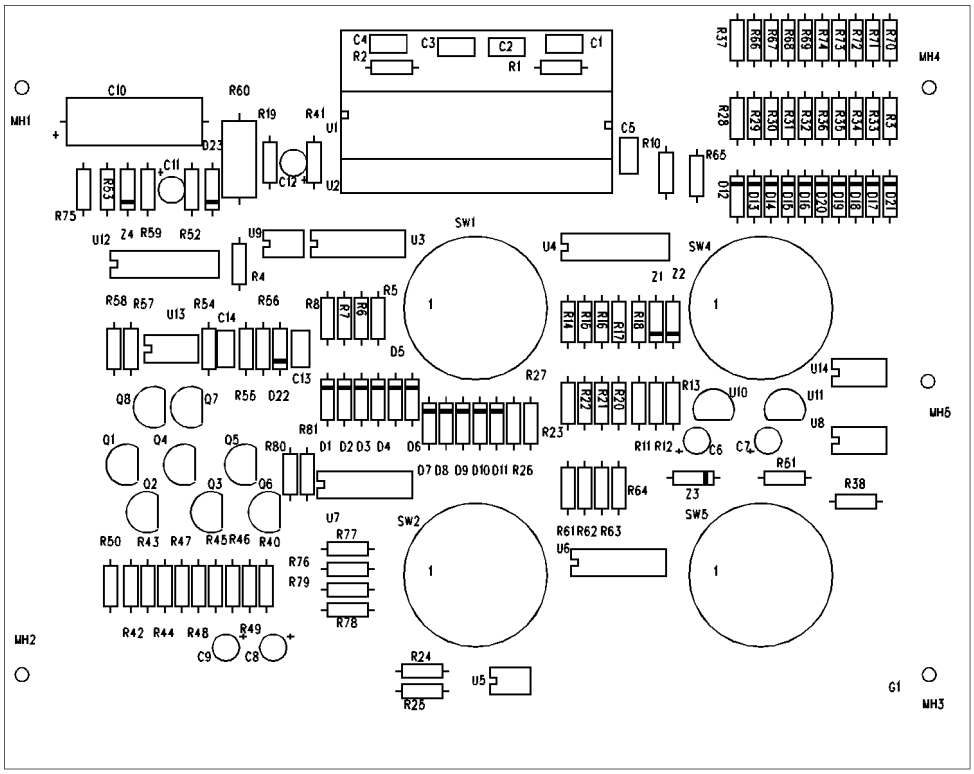
7.12 Main circuit sheet 9

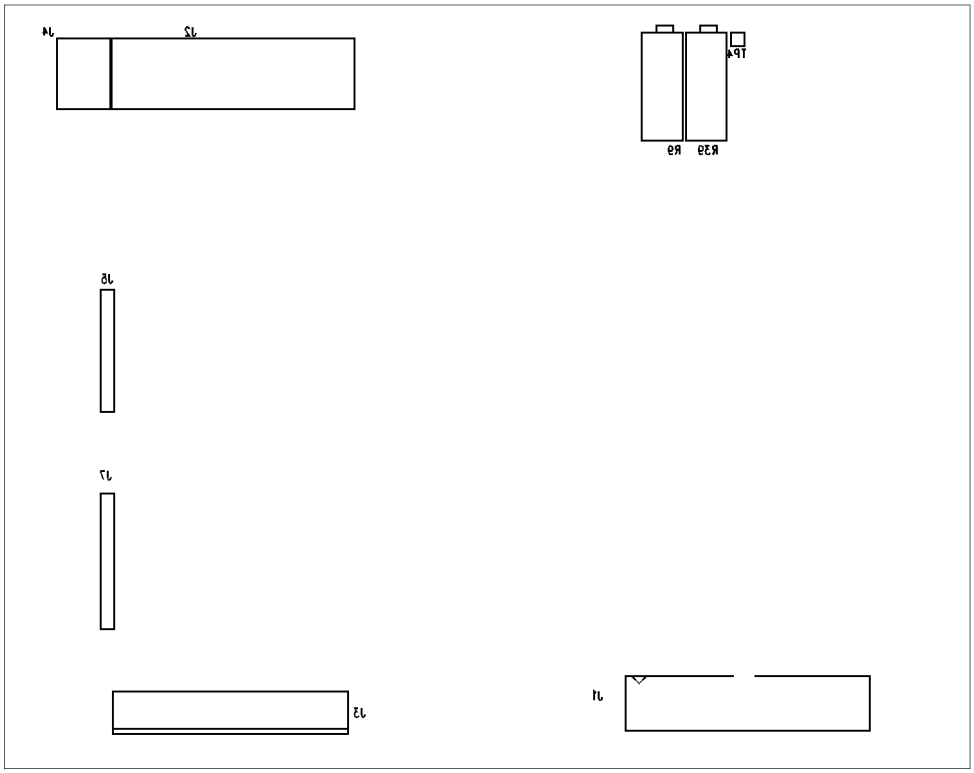


7.13 Main circuit sheet 10

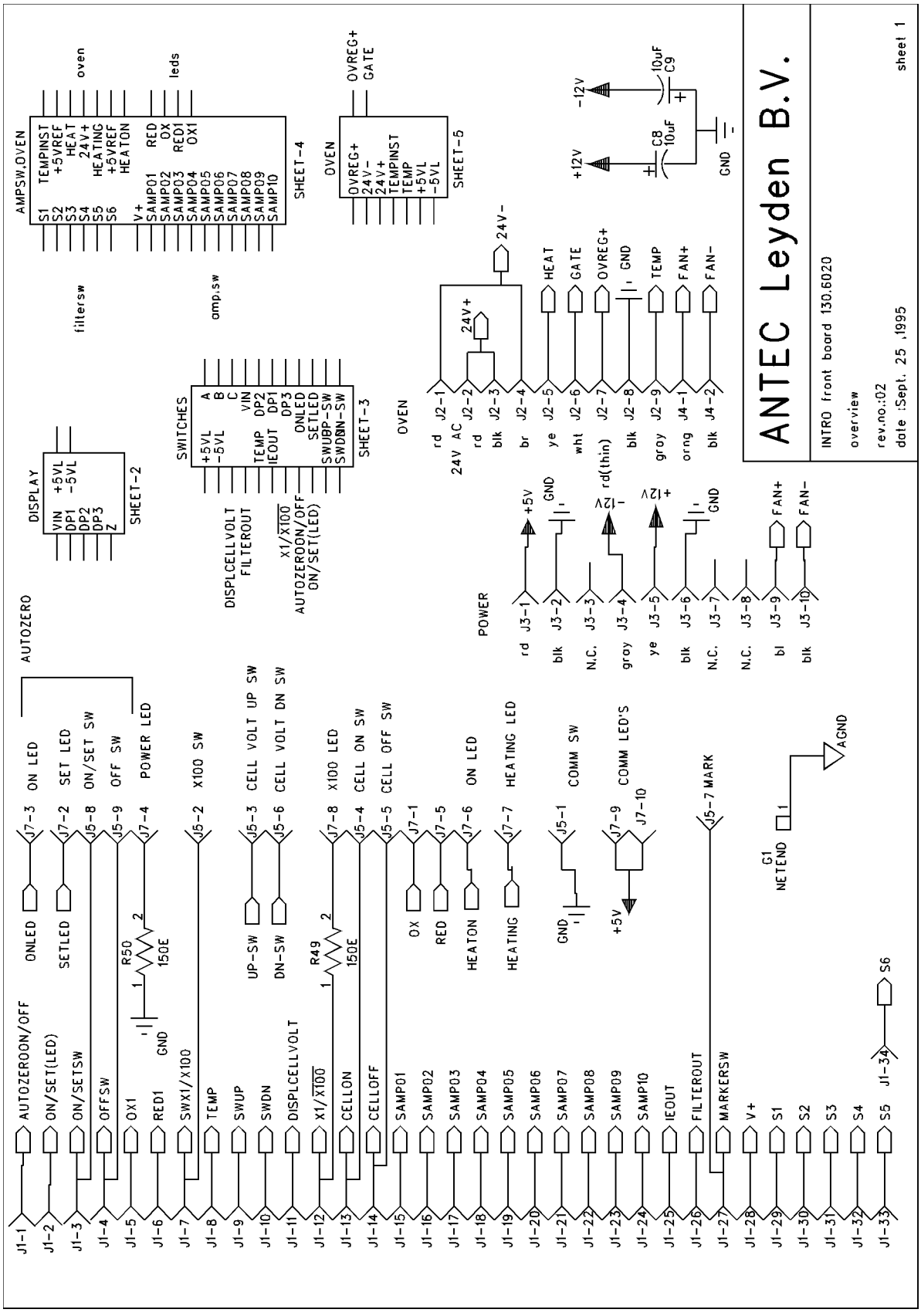


7.14 Layouts front board

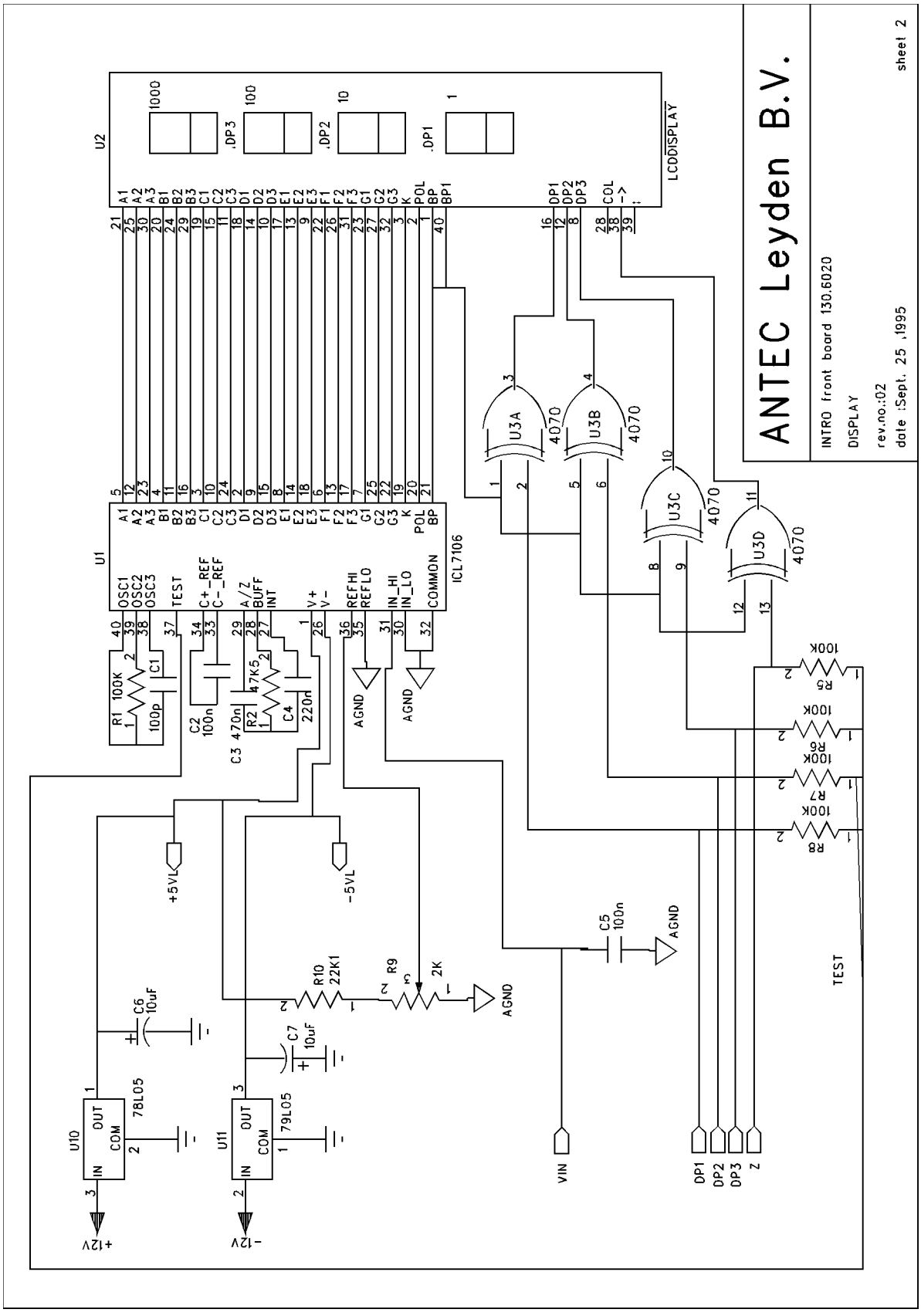




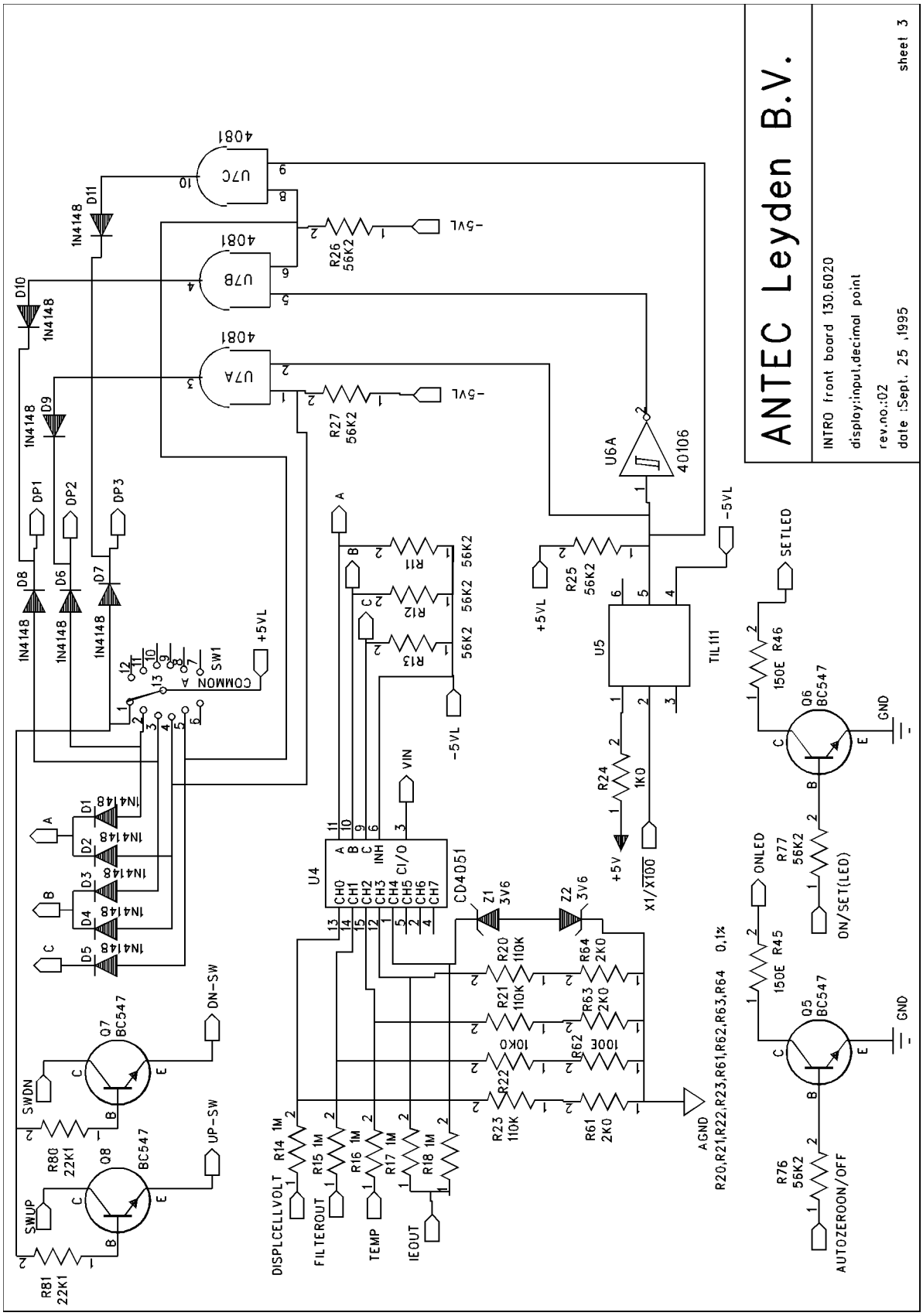
7.15 Front circuit sheet 1



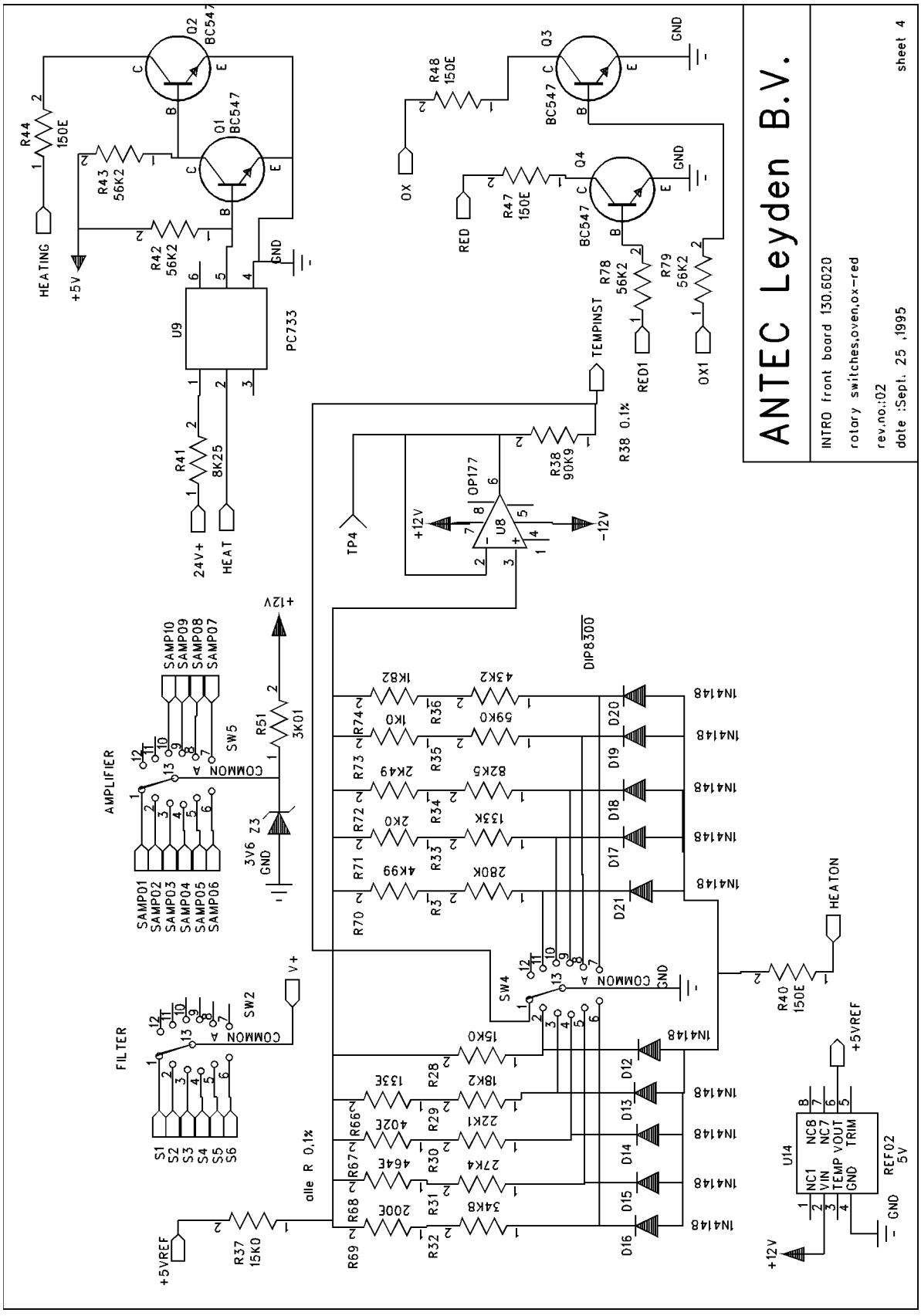
7.16 Front circuit sheet 2



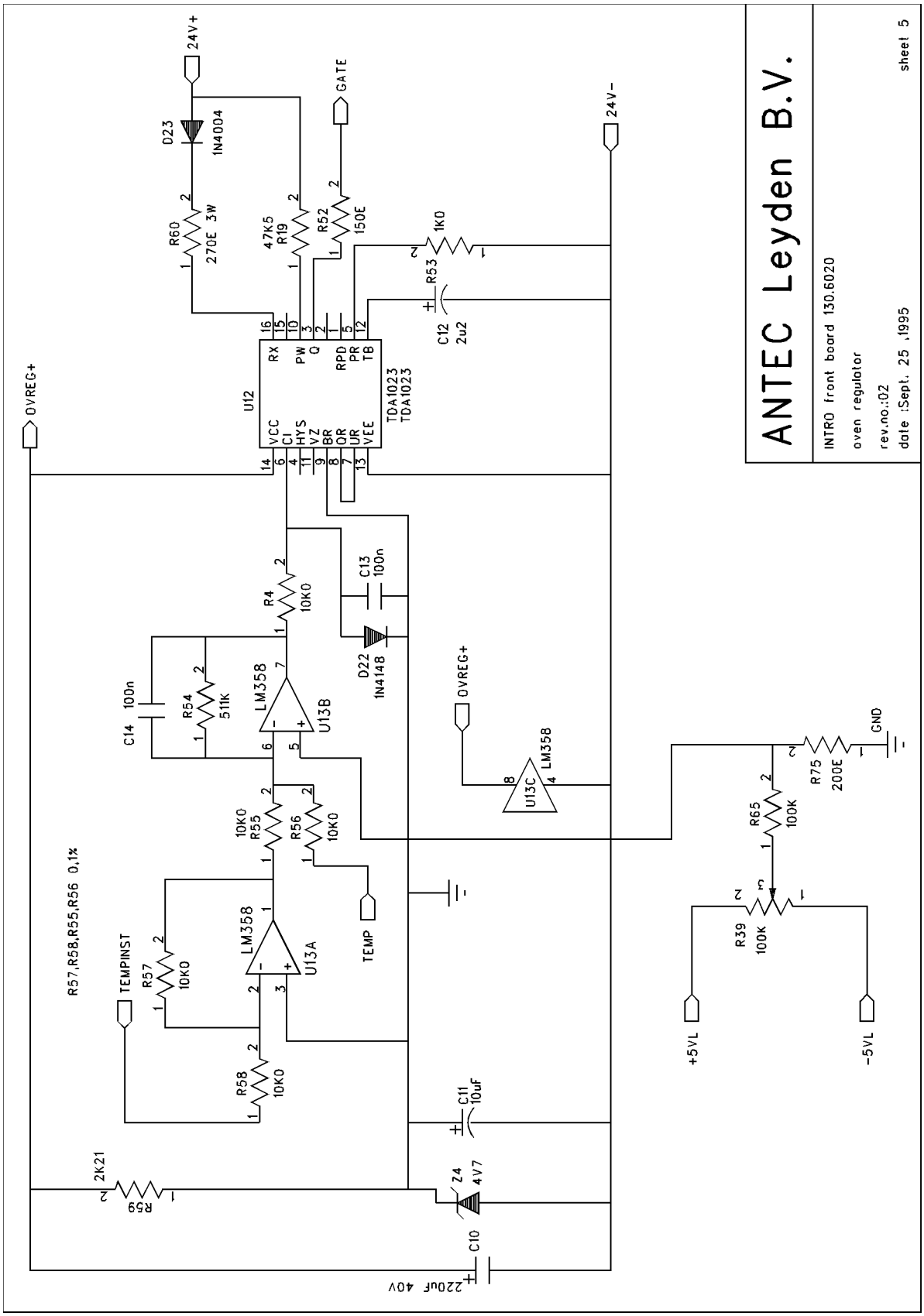
7.17 Front circuit sheet 3



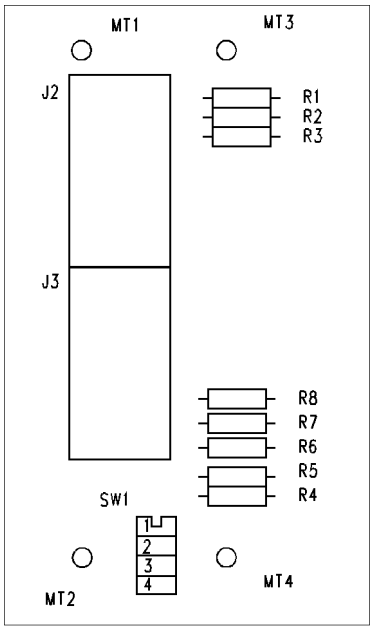
7.18 Front circuit sheet 4

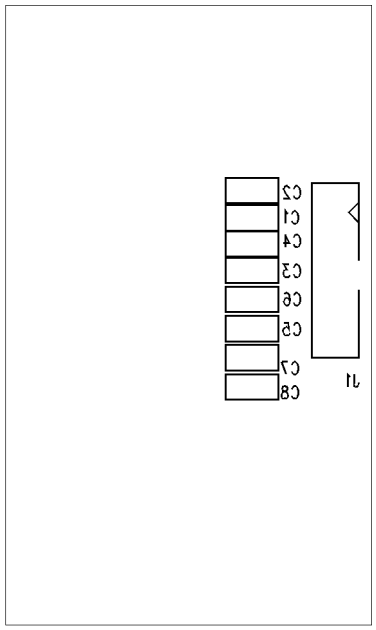


7.19 Front circuit sheet 5

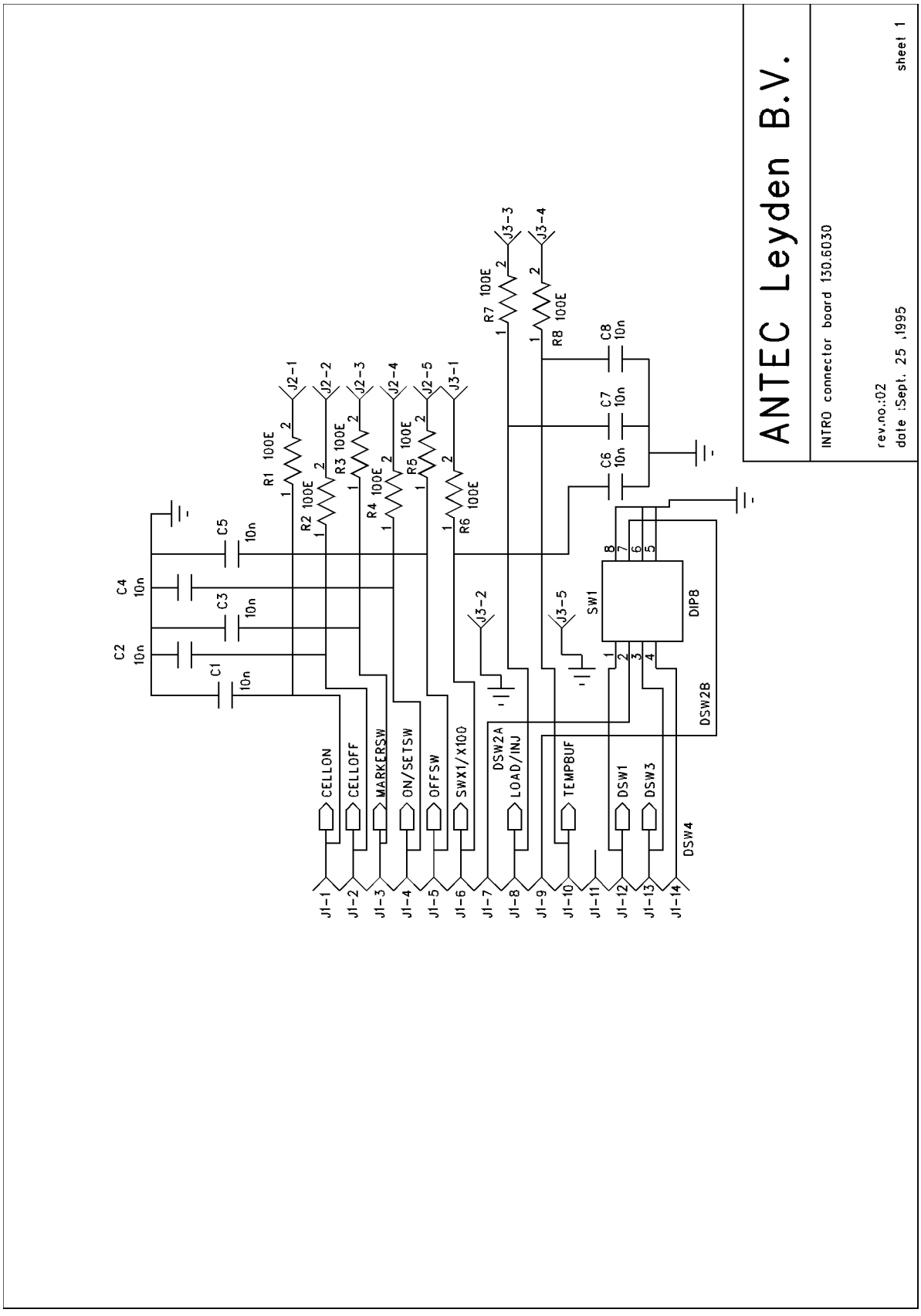


7.20 Layouts connector board

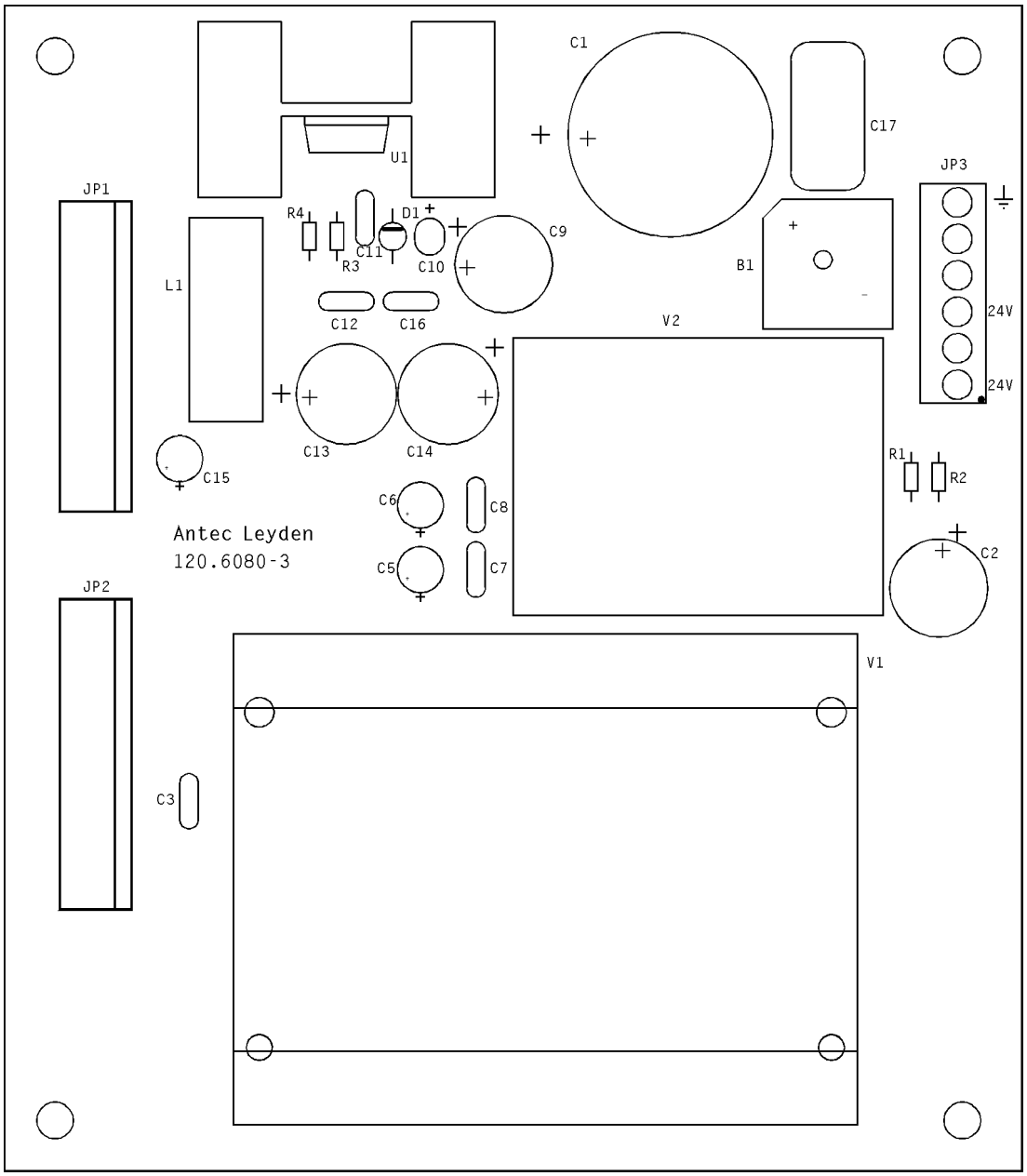




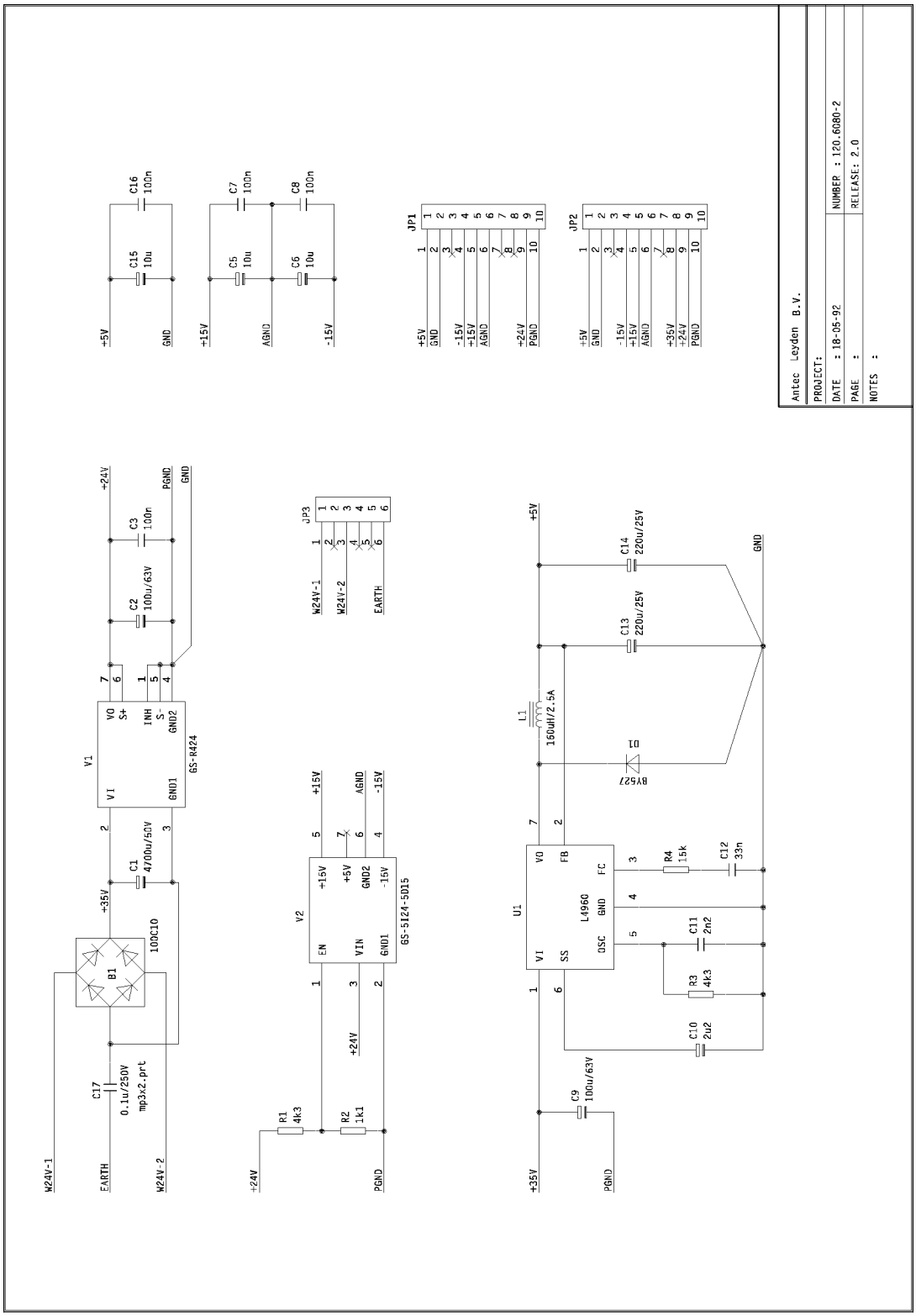
7.21 Connector board circuit sheet 1



7.22 Layout power supply board



7.23 Power supply board circuit sheet 1



8 Trouble shooting

Controller down, power LED off

Possible cause	Remedy
No mains power	Check local power source, plug in power cord
Power switch off	Turn this switch 'on' (at the rear panel)
Faulty fuse	Replace fuse (see page 3)
Divergent mains voltage	Check line voltage (see page 3)
Faulty power supply	See 'Chapter 4.16 Power-supply voltages test procedure'

Icell overload

With DISPLAY switch at Icell, LCD reads:

Possible cause	Remedy
LC related problem	See INTRO manual
Cell current out of range	Switch DISPLAY to Icell (not Icell, HR)
	Switch RANGE to att. x100 (x100 LED on)
Faulty voltage clamp	See 'Chapter 4.2 Voltage clamp test procedure'
Faulty circuitry	See 'Chapter 4 Testing and adjustment'

Vout overload

With DISPLAY switch at Vout, LCD reads a value between 12 V and 13 V, for example:

Possible cause	Remedy
LC related problem	See INTRO manual
Cell current out of range	Switch to a less sensitive range
	Switch RANGE to att. x100 (x100 LED on)
Faulty voltage clamp	See 'Chapter 4.2 Voltage clamp test procedure'
Faulty circuitry	See 'Chapter 4 Testing and adjustment'

Noisy baseline

Possible cause	Remedy
LC related problem	See INTRO manual
Faulty circuitry	See ‘Chapter 4.17 Noise test’

No zero Icell value with Vcell off

Possible cause	Remedy
I/E converter offset not correct	See ‘Chapter 4.5 I/E converter offset test procedure’

No zero Vout value with Vcell off

Possible cause	Remedy
I/E converter offset not correct	See ‘Chapter 4.7 Amplifier offset test procedure’

Malfunctioning ZERO

Possible cause	Remedy
Unable to compensate to 0 V: Compensation to pre-set offset voltage	If required adjust offset voltage at rear panel
Cell current exceeds max. zero compensation (zero SET LED stays on)	Switch on dip switch 2 Switch RANGE to att. x100 (x100 LED on)
Other causes	See ‘Chapter 4.11 Zero circuit test procedure’

Malfunctioning HEATER

Possible cause	Remedy
Heater cabinet not properly closed	Check for obstructions, close cabinet
Faulty heater power unit	Replace heater power unit, see ‘Chapter 5.6 Removing the heater power unit’
Other causes	See ‘Chapter 4.13 Heater test procedure’

Malfunctioning I/O

Possible cause	Remedy
Wiring improperly connected	Check I/O connections between INTRO and external device (see Fig. 2, page 11)
Other causes	See ‘Chapter 4.15 I/O test procedure’