Bioquant

Service Manual

DECLARATION OF CONFORMITY

Manufacturer declares that the product

Electrochemical Detector **Bioquant**
part number 160.0035

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 61010-1

Immunity (89/336/EEC)

Electromagnetic immunity	EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-4-11

Emissions (89/336/EEC)

Electromagnetic emission	EN55022 (Class B), EN61000-3-2, EN61000-3-3

Attention

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

June 20, 2003

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 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 is 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 are handled.

Spare parts and service availability

Manufacturer 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.
Manufacturer 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.

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 the safety practises as they are posted for his safety!** Always take extra care of your 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!**
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.

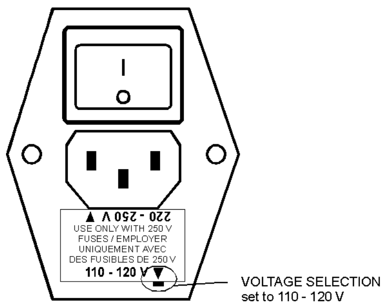
⚠ WARNING - RISK OF ELECTRIC SHOCK
DISCONNECT POWER BEFORE SERVICING
AVERTISSEMENT - RISQUE DE CHOC ELECTRIQUE
COUPER L'ALIMENTATION AVANT LA MAINTENANCE

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

INPUT VOLTS	FUSE RATING	
	UL / CSA	IEC 127
100-120 V	3.2A 250V TL	T 3.2A 250V
200-240 V	1.6A 250V TL	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.

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1 Specifications

1.1 General specifications

Power	110-120/220-240 VAC, 50/60 Hz
Operating modes	DC, Pulse and Scan
Potential range	between +2.00 and - 2.00 V in 10 mV increments
Recorder output	between +0.1 and - 0.1 or between +1.0 and -1.0 V
Current ranges integrator	1 nA, 10 nA and 1 µA/V
Integrator output	between +10.0 and -10.0 V
Offset	between +50% and - 50% of recorder output, 10% steps
Drift monitor	0.1 - 10 nA/min (Pulse), 0.1 pA/min - 10 nA/min (DC)
Event marker	10% of recorder output
Autozero	range determined by integrator setting, in µA range: 16 µA, in nA range: 160 nA, in pA range: 16 nA; triggered by keyboard, rear panel contact closure, or RS232C control
RS232C	full parametric instrument control (option)
Injector sensor	starts system clock if Load → Inject
Oven	length 40 cm, from 5°C above ambient to 45°C, accuracy 0.5°C, stability 0.1°C; accommodates injector, column, pulse dampener and flowcell

1.2 DC mode

Current ranges recorder	10 pA - 5 µA in 1, 2, 5 steps
Filter (time constants)	0.1 - 5 s in 1, 2, 5 steps
Noise	< 2 pA with a dummy cell (load of 300 MΩ and 0.5 µF) with 0.1 s filter; with 2 s filter the noise is < 1 pA

1.3 PULSE mode

Range	10 nA - 5 µA in 1, 2, 5 steps
Pulse times	t1: 100 - 2000 ms; t2: 100 - 2000 ms; t3: 0 (off) - 2000 ms in 10 ms steps
Sample times	20, 40, 60, 80 and 100 ms

1.4 SCAN mode

Range	10 nA - 5 µA in 1, 2, 5 steps
Scan rate	1 - 50 mV/s in 1, 2, 5 steps
Cycle	half, full or continuous
	Start/Stop, Hold and Autozero, Starting potential (E1), End potential (E2)

1.5 AUTO mode

DC mode (5 files) and pulse mode (4 files), master/slave mode, cycle time, number of cycles, drift monitor
Time-based control of 20 time points as to sensitivity, filter settings, output contacts (2 open collector, 2 relays), autozero, offset, inject/load position of electrically actuated VALCO injector (option) and E-cell (DC only). Switching time electrically actuated VALCO injector: 80 ms

1.6 Rear panel I/O connections

Mains, Recorder (12 bits) and Integrator (analog)
2 open collector outputs (AUX 1 and 2) I max. 250mA, U max. 28V and 2 relay outputs I max. 500mA, U max. 28V, cell on, cell off, + 24 V output I max. 500mA, Common, Hold/Busy, Start, Reset, Autozero, Overload, Inject marker, Electrically actuated injector control, position of manual injector, RS232C connector (option)

1.7 Physical specifications

Dimensions
Weight

2 Disassembling

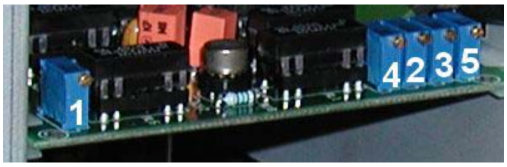
Disassembling is only necessary if values are out of spec. or internal repairs are required. The SERVICE MODE guides you through all settings, values and specs. and advises you when to disassemble for adjustment.

Before disassembling read this carefully! Never remove boards while mains power is on this may cause serious damage to electronic parts.

2.1 Opening the Bioquant for service

Disconnect the Bioquant from mains power. Open the top panel by removing the 4 screws. Let the back panel rest on the connectors so that you have both hands free to remove the metal strip that secures the PCB's (arrow).	
Take out the metal strip that secures the PCB's. Be careful not to drop the stainless steel screws.	
Carefully move out the CPU board a little bit, keep the back panel in your other hand.	

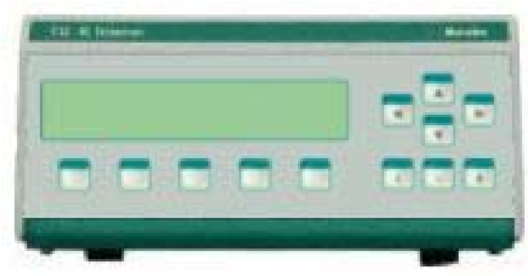
<table>
<tr><td>Disconnect the flat cable connectors from the CPU board. Do not remove the other wires. Put the back panel on the table.</td><td></td></tr>
<tr><td>Now you can access all relevant parts for service. Boards:
1. electrode board
2. CPU board
3. oven board
4. IO board
5. power supply board

The blue parts P1…5 and X1 are adjustable resistors. These numbers refer to text in the service manual.
</td><td></td></tr>
<tr><td>The 2 openings in the rear panel enable adjustments without disassembly.</td><td></td></tr>
</table>

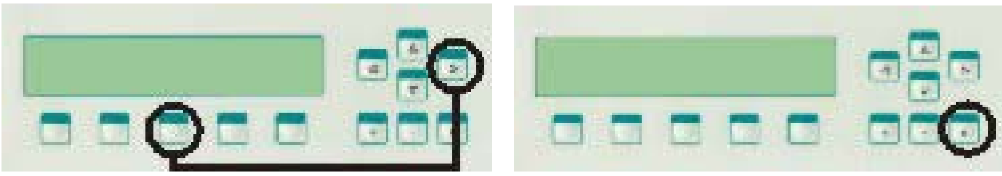
To take out the electrode board, first remove the cell connector. Then pull out the board.	
If for some reason the lower part has to be opened, this can be done by removing the 4 screws.	

Some boards include cable connections. Gently remove these before board removal. A small screwdriver may be used to gently loosen the connectors. **The connectors are all unique, note the fitting directions to prevent errors.**

3 Service mode



The service mode can be accessed using the Bioquant control unit by switching on the Bio-quant while keeping the accept button (#) depressed. The Service mode main screen will be displayed. To leave the service mode, switch off the Bioquant.

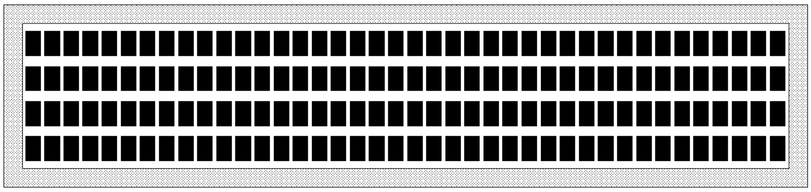


Resetting the Bioquant (left) immediately followed by keeping the # button pressed continuously (right), will also enter the service mode. Always wait at least 10 seconds between switching off and on the Bioquant.

```
                Service mode
DISPL    KEYB     I/O     ADJ    RS232
```

Main screen of the service mode is showing the 5 service menus.

3.1 Display test (DISPL)



This screen enables you to check if all pixels on the LCD display are fully functional.
The LCD display is built up of 4 lines of 40 characters. Each character block has 5 x 7 pixels.
If all pixels are fully functional the display is black. If one or more pixels are missing the display control on the CPU board, the flat cable or the corresponding connections are faulty.

If necessary the display contrast can be adjusted as described below.

1. Disassemble the Bioquant as described.
2. Switch on the Bioquant in any screen.
3. Adjust the display contrast to your convenience with potentiometer X1 on the CPU-board (see layout).
4. Reassemble as described.

3.2 Keyboard test (KEYB)

This screen enables you to test all keyboard keys.
After entering this screen the display will reveal F1. If the corresponding key is pressed the screen will show F2 etc. This test will step through all keys ending with the # key after which the Service mode main screen is displayed.
This test requires that the keys are activated in the order displayed.
If it is impossible to pass a certain key the keyboard control on the CPU board, the flat cable (see wiring diagram) or the corresponding connections are faulty.

3.3 I/O tests (I/O)

```
            i/o test
PREV     IN     OUT
```

This screen enables you to select between an I/O in- or output test. Pressing F2 (IN) will bring you to the input test screen F3 (OUT) to the output test screen. Pressing F1 (PREV) brings you back to the Service mode main screen.

3.3.1 Input test (IN)

```
        inputs are: 0111111111
PREV
```

This screen enables you to test all relevant input functions. Pressing F2 will display ten characters inputs are 0111111111. After pressing F1 (PREV) the i/o test screen is displayed. The ten characters displayed correspond with input signals on the rear panel or other input functions.
An input signal given on the rear panel strip must be a low (common) pulse with a minimal pulse length of 110 ms.
To easily check inputs on the rear panel use a custom made short circuit wire between common (pin no. 12 on the upper- or lower rear panel strip) and the input to be tested.

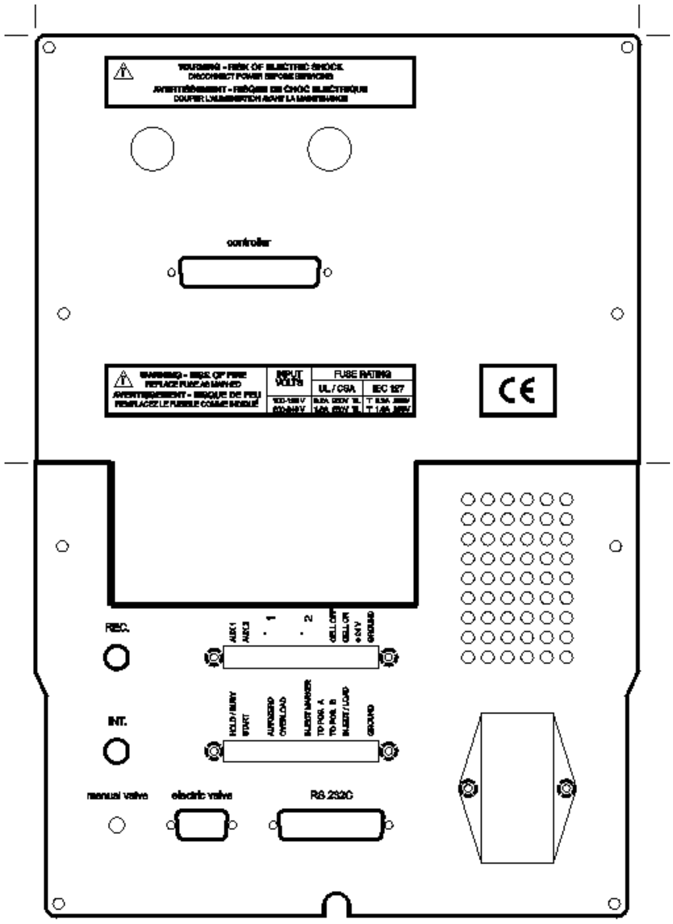


Fig. 1. Rear panel of the Bioquant

From left to right the ten characters displayed correspond with the following functions and are tested as described below.

1. Open / close sensor for oven compartment (located on the inside of the oven compartment cover). Check this function by opening and closing the oven cover, or by manual interruption of the sensor. The status for open is 1 closed is 0.
2+3. Control signals from internal electrically actuated injector. Check this function by giving a low (common) input on either pin no. 8 or 9 on the lower rear panel strip. The status of the actuator changes from LOAD (01) to INJECT (10) or vice versa. For more information about the electrically actuated injector refer to the corresponding manual.
4. Inject/load in-output. Corresponds with “manual valve” and pin no. 10 on lower rear panel strip. Check this function by giving a low (common) input, short-circuit “manual valve” or by switching the manual injector. A low (common) input, a short-circuit on “manual valve”, or switching the manual injector to INJECT produces a 0 on screen.
5. Autozero input. Corresponds with pin no. 4 on lower rear panel strip. Check this function by giving a low (common) input. A low (common) input produces a 0 on screen.
6. Not connected
7. Start input. Corresponds with pin no. 2 on lower rear panel strip. Check this function by giving a low input. A low (common) input produces a 0 on screen.

8. Hold/busy in-output. Corresponds with pin no. 1 on lower rear panel strip. Check this function by giving a low (common) input. A low (common) input produces a zero on screen.
9. Cell off input. Corresponds with pin no. 9 on upper rear panel strip. Check this function by giving a low (common) input. A low (common) input produces a 0 on screen.
10. Cell on input. Corresponds with pin no. 10 on upper rear panel strip. Check this function by giving a low (common) input. A low (common) input produces a 0 on screen.

If any input fails the I/O input control on the I/O board, the wiring or the corresponding connections are faulty.

3.3.2 Output test (OUT)

```
        outputs are: inactive

 PREV    ACT     INACT
```

This screen enables you to select the i/o output status. Pressing F2 (ACT) will force the outputs to a active status. F3 (INACT) forces them to the inactive status. F1 (PREV) brings you back to the i/o test screen. How to test one or more outputs is described in method A-C.

A. TTL outputs are tested with a voltmeter. Connect the minus of the voltmeter to common (pin no.12 on the lower- or upper rear panel strip) and the plus of the voltmeter the TTL output that needs to be tested. **In an active status the voltmeter will display 5V ± 0.5V, inactive 0V ± 0.5V.**

B. Open collector outputs are tested with a voltmeter. Connect the voltmeter with the plus to the 24V output (pin no.11 on the upper rear panel strip) and the minus of the voltmeter to the open collector output that needs to be tested. **In an active status the voltmeter will display 24V ± 0.5V, inactive 0V ± 0.5V.**

C. Switching relays are tested with an Ohmmeter (contacts open or closed measurement). Connect the Ohmmeter to the relay pins that need to be tested. The situation drawn on the rear panel is the inactive status.

To check all outputs proceed as described below.

1. Press F3 (INACT):	Outputs are: inactive
2. Connect a voltmeter as described in method A.	
3. Pin no.7 rear panel lower strip (INJECT MARKER):	5V ± 0.5V
4. Pin no.5 rear panel lower strip (OVERLOAD):	5V ± 0.5V
5. Pin no.1 rear panel lower strip (HOLD/BUSY):	5V ± 0.5V
6. Connect a voltmeter as described in method B.	
7. Pin no.1 rear panel upper strip (AUX 1):	0V ± 1V
8. Pin no.2 rear panel upper strip (AUX 2):	0V ± 1V
9. Connect an Ohmmeter as described in method C.	
10. Between pin no.4 and 5 rear panel upper strip:	0Ω ± 2Ω
11. Between pin no.3 and 5 rear panel upper strip:	>10MΩ

12.Between pin no.7 and 8 rear panel upper strip:	$0\Omega \pm 2\Omega$
13.Between pin no.6 and 8 rear panel upper strip:	$>10M\Omega$
14.Press F2 (ACT):	Outputs are: active
15.Connect a voltmeter as described in method A.	
16.Pin no.7 rear panel lower strip (INJECT MARKER):	0V ± 1V
17.Pin no.5 rear panel lower strip (OVERLOAD):	0V ± 1V
18.Pin no.1 rear panel lower strip (HOLD/BUSY):	0V ± 1V
19.Connect a voltmeter as described in method B.	
20.Pin no.1 rear panel upper strip (AUX 1):	24V ± 1V
21.Pin no.2 rear panel upper strip (AUX 2):	24V ± 1V
22.Connect an Ohmmeter as described in method C.	
23.Between pin no.3 and 5 rear panel upper strip:	$0\Omega \pm 2\Omega$
24.Between pin no.4 and 5 rear panel upper strip:	$>10M\Omega$
25.Between pin no.6 and 8 rear panel upper strip:	$0\Omega \pm 2\Omega$
26.Between pin no.7 and 8 rear panel upper strip:	$>10M\Omega$

If one or more of these checks fail the I/O control on the I/O-board or its corresponding connections (see wiring diagram) are faulty.

3.4 Adjustments (ADJ)

```
            adjustments
 PREV   VLTCL   ZER.IE   AZERO    OUTP
```

This screen enables you to select between certain functions in which tests and if necessary adjustments are made.
Pressing F1 (PREV) brings you back to the Service mode main screen.

- F2 (VLTCL) the voltage clamp circuitry test/adjustment
- F3 (ZER.IE) the current to voltage converter circuitry test/adjustment
- F4 (AZERO) the autozero circuitry test/adjustment
- F5 (OUTP) the output voltages test/adjustment

These levels are all factory set and under normal circumstances do not need adjustment.

If necessary adjustment is made with one or more potentiometers situated on the electrode-board (see layout). If any of these test/adjustments fail the source of the problem is most likely on the electrode-board (or its corresponding connections).

Prior to pressing F2 (VLTCL) connect a voltmeter as illustrated in Fig. 2.

This voltmeter must have an internal resistance of 10MΩ or higher.

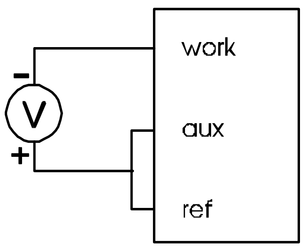


Fig. 2. Connection of the voltmeter for the VLTCL test.

3.4.1 Reference voltage (VLTCL)

```
            Ecell =  0.00 V

PREV   +2.00    0.00    -2.00
```

This screen enables you to select between the two outer and intermediate voltage levels of the voltage clamp circuitry. F2 (+2.00) forces the voltage clamp circuitry to +2.00V, F3 (0.00) to 0.00V and F4 (-2.00) to -2.00V. Pressing F1 (PREV) brings you back to the adjustments main screen.

Check the specs. as described below:

1. Press F2 (+2.00)	U meter:	+2.00V ± 1mV
2. Press F3 (0.00)	U meter:	0.00V ± 0.1mV
3. Press F4 (-2.00)	U meter:	-2.00V ± 1mV

If these values are within spec. the voltmeter can be disconnected **after leaving this screen i.e. pressing F1 (PREV).**
When no voltage, or a voltage >2.5V is detected the voltage clamp circuitry on the electrode-board or its corresponding connections are faulty.
For adjustment see description below.

1. Disassemble as described.
2. Press F2 (+2.00)
3. With P3 (see layout) adjust the voltmeter readout to 2.00V ± 1.00mV
4. Press F3 (0.00)
5. With P2 (see layout) adjust the voltmeter readout to 0.00V ± 0.10mV
6. Go back to step 2 until the values are in specs.
7. Press F1 (PREV) and disconnect the voltmeter.
8. Reassemble as described.

3.4.2 Current/voltage converter (ZER.IE)

```
          Temp = 30 Range = nA
          Gain = 1  Value = +0001

  PREV    READ     1       10    RANGE
```

This screen enables you to select different amplifications and displays the zero status setting of the I/E converter for these selections. Whilst entering this screen the oven temperature is automatically set to 30 °C to ensure proper check/adjustment temperature.
The Temp = xx displays the actual oven temperature and will be stable after warm a warm-up period. If your room temperature is above 30 °C the specs. may not be reached!
F3 (1) and F4 (10) changes the internal amplification. F5 (RANGE) toggles between pA, nA and µA range. F1 (PREV) returns you to the adjustments main screen.
The zero level can only be READ into the system RAM when the range is nA and the amplification level is 1 in all other settings the READ function disappears.
Because of the extremely high amplifications of the circuitry this value should only be READ or adjusted only under some specific circumstances.
To check this values the Bioquant must be on in the above screen for at least 30 min.
The READ and / or adjustment is performed in the nA range at amplification level 1 at a temperature of 30 °C (Temp = 30). The value readout is hexadecimal.

To check for proper adjustment proceed as described below.

1. Press F5 (RANGE) until Range = nA
2. Press F3 (1): Value = ±0000 ± 0005
3. Press F4 (10): Value = ±0000 ± 0010
4. Press F5 (RANGE) until Range = pA
5. Press F3 (1): Value = ±0000 ± 0010
6. Press F4 (10): Value = ±0000 ± 0030
7. Press F5 (RANGE) until Range = µA
8. Press F3 (1): Value = ±0000 ± 0005
9. Press F4 (10): Value = ±0000 ± 0010

If values are out of specs. proceed as follows:

1. Press F5 (RANGE) until Range = nA
2. Press F3 (1): Gain = 1
3. Press F2 (READ): Value = ±0000 ± 0001

Now re-check all ZER.IE values if not in spec. adjustment is required proceed as described below.

1. Disassemble as described.
2. Switch on the Bioquant in the Service mode as soon as possible after disassembling and got to the ZER.IE screen.

3. **Adjustments are automatically done at 30°C. The system temperature is very important.**
4. Press F5 (RANGE) until Range = nA
5. Press F3 (1): Gain = 1
6. Press F2 (READ): Value = ±0000 ± 0001
7. Press F4 (10)
8. Adjust the value with P4 (see layout) to ±0000 ± 0001
9. Repeat step 6 to 8 until values are in specs.
10. Reassemble as described.

If the ZER.IE values are still out of specs. the I/E converter circuit on the electrode-board is faulty.

3.4.3 Autozero level (AZERO)

```
Setting = 0000 Value = +0000

PREV    0000    4800
```

This screen enables you to select between a zero and intermediate AZERO value. The AZERO value is the compensation signal presented to the amplifier circuit to enable the output to become 0.00V. This signal is used to autozero and / or produce offset in the output signals. Pressing F2 (0000) produces a zero level, F3 (4800) an intermediate level. F1 (PREV) brings you back to the adjustments main screen. The Value readout is hexadecimal.
To check this values the Bioquant must be on in the above screen for at least 30 min.

1. Press F2 (0000)   Value = ±0000 ± 0005
2. If this Value is out of spec. refer to ZER.IE check/adjustment.
3. Press F3 (4800)   Value = +4800 ± 0010
4. If this value is out of spec. adjustment is required proceed as described below.

1. Disassemble as described.
2. Switch on the Bioquant in the Service mode as soon as possible after disassembling and got to the AZERO screen.
3. **The system temperature is very important.**
4. Adjust to +4800 ± 0010 with P1 (see layout).
5. Reassemble as described.

If the AZERO values are still out of specs. the I/E converter or the zero circuit on the electrode-board is faulty.

3.4.4 Outputs test and adjustments (OUTP)

```
PREV    REC     INT
```

This screen enables you to select between a check / adjustment on the recorder- and / or the integrator output. F2 (REC) brings you to the recorder output check screen, F3 (INT) to the integrator output screen. F1 (PREV) brings you back to the adjustments main screen.

3.4.4.1 Recorder output check and adjustment (REC)

```
          Rec. Outp. =  0.00 V
PREV   +full    0.00    -full
```

This screen enables you to select between the two outer and intermediate voltage levels of the recorder output circuitry.
F2 (+full) forces this output to max. (+1.00V), F3 (0.00) to zero voltage (0.00V) and F4 (-full) to max. neg. (-1.00V). F1 (PREV) brings you back to the output main screen.
To check connect a voltmeter to the recorder output at the back panel of the Bioquant.
Checks are performed as described below.

1. Press F3 (0.00)	U meter:	0.00V ± 0.05V
2. Press F4 (-full)	U meter:	-1.00V ± 0.05V
3. Press F2 (+full)	U meter:	+1.00V ± 0.05V

If these values are within spec. the voltmeter can be disconnected.
When no voltage at all or a voltage >1.5V is detected the recorder output circuitry on the electrode-board or its corresponding connections (see wiring diagram) are faulty.
The recorder output circuit only requires adjustment for the +full (+1.00V) setting.
For adjustment see description below.

1. Disassemble as described.
2. Switch on the Bioquant in the Service mode and got to the Recorder output check and adjustment screen.
3. Press F2 (+full) Rec. Outp. = +1.00V
4. Adjust the voltmeter readout with P5 (see layout) to +1.00V ± 0.05V

If the values are still out of specs. the recorder output circuit on the electrode board is faulty.

The recorder output can be set from 1.00V max. to 0.1 V max. by changing the jumper position from JP8 (1.00V) to JP9 (0.1V). This jumper is located on the right hand side of the MOTHER-board (see layout).

3.4.4.2 Integrator output test

```
          Int. Outp. =  0.00 V

PREV   +full    0.00    -full
```

This screen enables you to select between the two outer and intermediate voltage levels of the integrator output circuitry.
F2 (+full) forces this output to max. (+10.00V), F3 (0.00) to zero voltage (0.00V) and F4 (-full) to max. neg. (-10.00V). F1 (PREV) brings you back to the output main screen.
To check connect a voltmeter to the integrator output at the back panel of the Bioquant.
Checks are performed as described below.

- Press F3 (0.00)	U meter:	0.00V ± 0.05V
- Press F4 (-full)	U meter:	-10.00V ± 0.50V
- Press F2 (+full)	U meter:	+10.00V ± 0.50V

If these values are within spec. the voltmeter can be disconnected.
If these values are out of specs. check the AZERO adjustment, since this values are electronically related to the AZERO adjustment.
When no voltage or a voltage > 10.5V is detected the integrator output circuitry on the electrode-board ore its corresponding connections (see wiring diagram) are faulty.

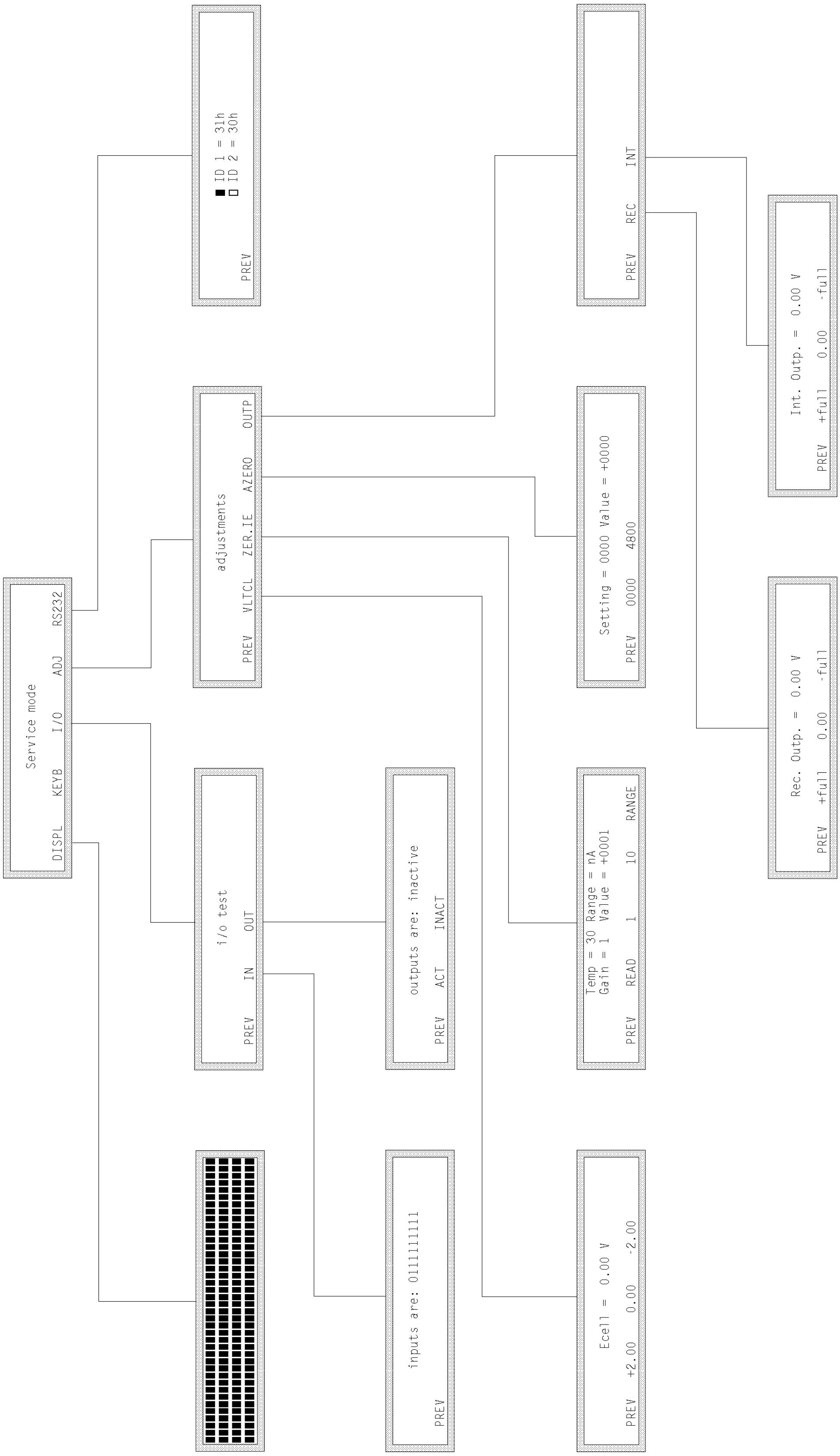
3.5 RS232

```
              ■ ID 1 = 31h
              □ ID 2 = 30h
PREV
```

In this screen the device identifier i.e. ID 1, ID 2, can be user defined.

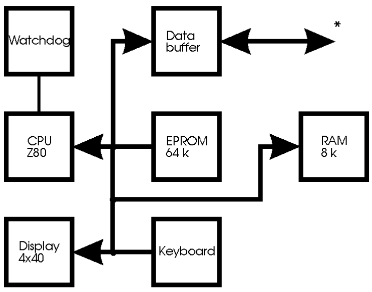
Default values are: ID 1=31, ID 2=30 (both hexadicimal). For any necessary testing on the RS232C communication port refer to the normal mode or the RS232C communications protocol. The electronic schematics for the RS232C port driver are included in the I/O-board circuit.

4 Overview of service mode screens

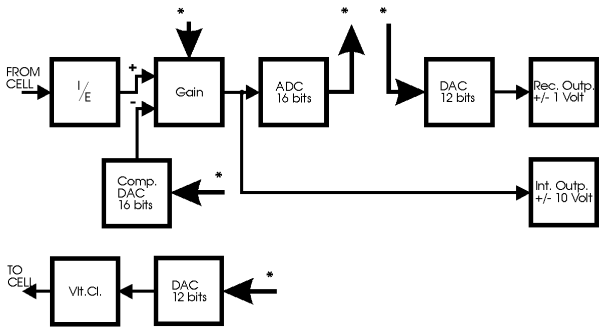


5 Block diagrams

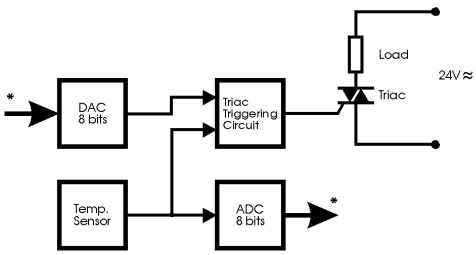
CPU-board



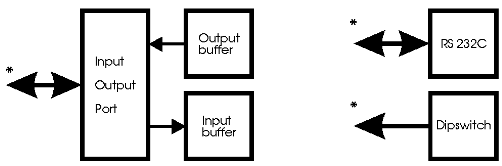
Electrode-board



Ovencontrol-board



I/O-board



6 The Bioquant controller

6.1 Introduction

The Bioquant has been designed for maximum functionality and ease of use. The control of ECD parameters is such that without reading this chapter, it should be possible to operate the detector. This chapter is intended as a reference guide in case questions arise during operation. The information shown in the numerous screens is presented in alphabetical order. For each item an explanation is given, together with the item's nature and the screen(s) of appearance. The nature of an item can be:

- Control: parameters with a cursor box ('☐') can be attained via cursor buttons and changed by the '+' and '-' button.
- Status: without a cursor box a parameter reflects the current status.
- Functions: parameters in CAPITALS are commands accessible via function buttons.

The ENTER button ('#') is only used to accept changes in cell potential. In the top right corner of each screen the name of the present screen is displayed. If available, the most left function button displays a previous screen, and the most right one the next screen.

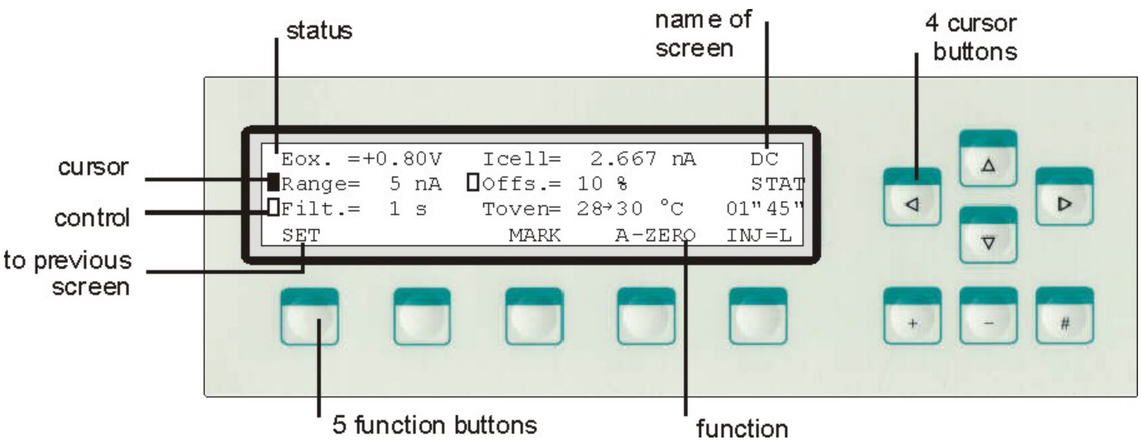
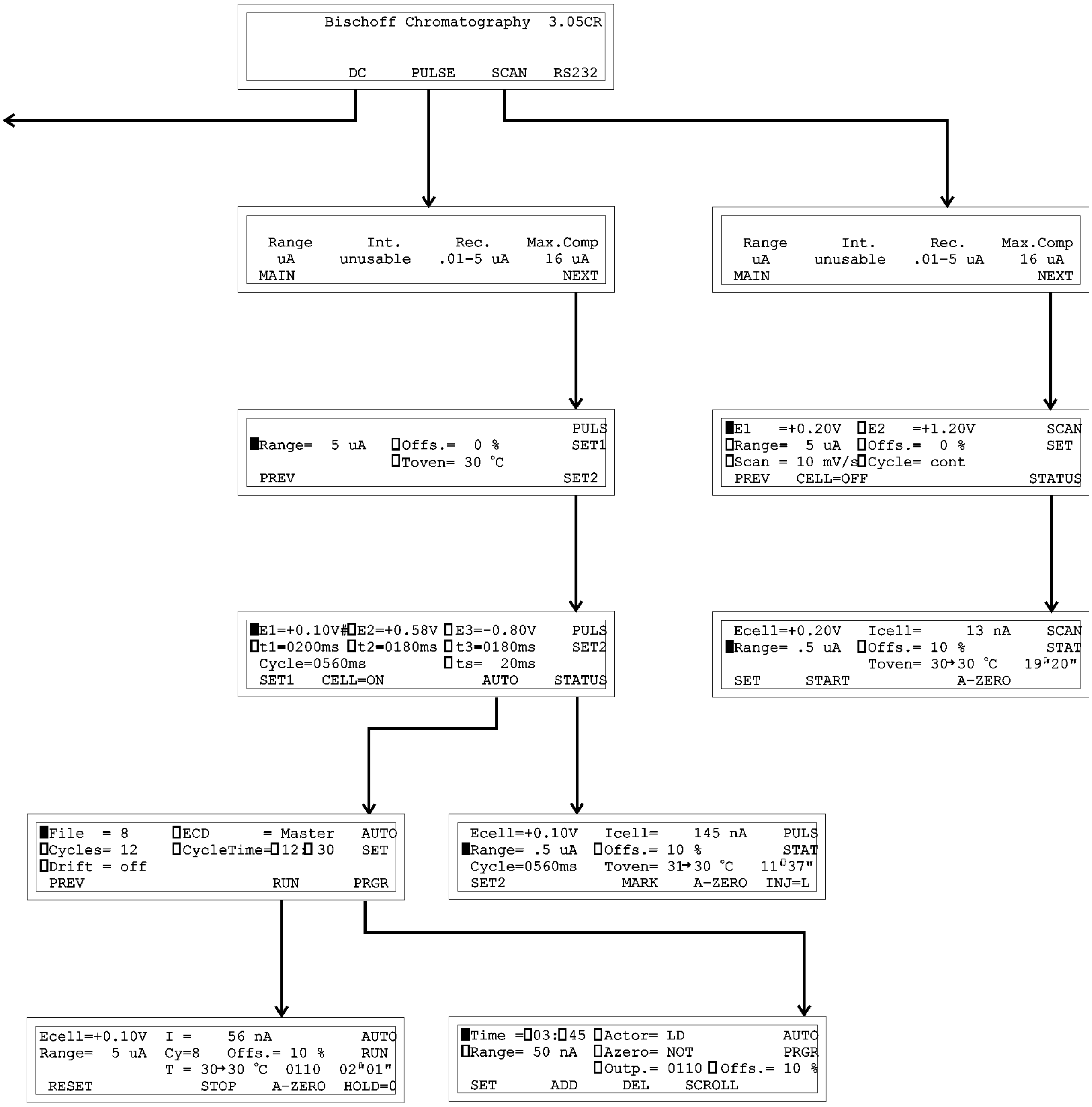


Fig. 3. Bioquant keyboard. The cursor is on 'Range' which allows changes using the '-' and '+' button.

6.2 Overview of Bioquant control unit screens


Bischoff Chromatography 3.05CR
DC PULSE SCAN RS232
Range Int. Rec. Max.Comp
uA unusable .01-5 uA 16 uA
MAIN NEXT
Range Int. Rec. Max.Comp
uA unusable .01-5 uA 16 uA
MAIN NEXT
PULS
■Range= 5 uA □Offs.= 0 % SET1
□Toven= 30 °C
PREV SET2
■E1 =+0.20V □E2 =+1.20V SCAN
□Range= 5 uA □Offs.= 0 % SET
□Scan = 10 mV/s□Cycle= cont
PREV CELL=OFF STATUS
■E1=+0.10V#□E2=+0.58V □E3=-0.80V PULS
□t1=0200ms □t2=0180ms □t3=0180ms SET2
Cycle=0560ms □ts= 20ms
SET1 CELL=ON AUTO STATUS
Ecell=+0.20V Icell= 13 nA SCAN
■Range= .5 uA □Offs.= 10 % STAT
Toven= 30→30 °C 19'20"
SET START A-ZERO
■File = 8 □ECD = Master AUTO
□Cycles= 12 □CycleTime=□12:□30 SET
□Drift = off
PREV RUN PRGR
Ecell=+0.10V Icell= 145 nA PULS
■Range= .5 uA □Offs.= 10 % STAT
Cycle=0560ms Toven= 31→30 °C 11'37"
SET2 MARK A-ZERO INJ=L
Ecell=+0.10V I = 56 nA AUTO
Range= 5 uA Cy=8 Offs.= 10 % RUN
T = 30→30 °C 0110 02'01"
RESET STOP A-ZERO HOLD=0
■Time =□03:□45 □Actor= LD AUTO
□Range= 50 nA □Azero= NOT PRGR
□Outp.= 0110 □Offs.= 10 %
SET ADD DEL SCROLL

6.3 Parameters

Actor

(AUTO) PRGR	control

Controls the electrically actuated injector (VALCO option), during execution of a TimeFile. Forces this valve to load ('LD') or inject ('INJ') (see page 42).

ADD

(AUTO) PRGR	function

Adds the current data line to the TimeFile. Confirmation is asked for if an existing time is overwritten. As time 00' 00" always exists, changing this time results in an overwrite warning (see page 42).

AUTO

DC SET, PULS SET2	function

Enters the auto mode ('AUTO SET' screen) for editing and running a TimeFile.

A-ZERO

DC STAT, AUTO RUN, PULS STAT, SCAN STAT	function

Sets the recorder and integrator output voltage to 0 V, or to the offset voltage (see page 36).

Azero

(AUTO) PRGR	control

Controls the autozero, which can be programmed in a TimeFile (see page 42).

CELL=ON/OFF

DC SET, PULS SET2, SCAN SET	function

Toggles between cell 'ON' and 'OFF'. If the cell is switched ON in the pulse mode only E1 is applied, the pulsation starts when PULS STAT screen is entered. In the DC or scan mode, Eox./Ered. or Ecell is applied.
pulse mode: pulsation occurs as long as the cell is on, irrespective which screen is selected.

Cy

AUTO RUN	status

Displays the cycle counter. In the master mode, if a TimeFile has to be executed more than once ('Cycles'>1), this is the number of times a TimeFile is started (see page 42).

Cycle

PULS SET2, PULS STAT	status

Displays the total duration of one pulse (t1 + t2 + t3). As from each cycle only one data point is sent to the recorder output, this duration determines the frequency of the recorder output.

Cycle

SCAN SET	control

Controls the nature of the cycle: half, full and continuous. 'Half' means that the cell potential runs from E1 to E2 and stops at E2. 'Full' means that the cell potential runs from E1 to E2, and back to E1, and then stops. 'Cont' means that the cell potential runs from E1 to E2 and back to E1 continuously.

Cycles

AUTO SET	control (master)

Controls the number of times a TimeFile has to be repeated. If the Bioquant is master this number can be 1 - 99 or continuous. If the Bioquant is slave the number of cycles is 1 (see page 42).

CycleTime

AUTO SET	control

Controls the duration of a TimeFile (max. 99' 59"). When this time is reached the execution of the TimeFile stops. If programmed, the next run is started (see page 42).

DEL

(AUTO) PRGR	function

Deletes the current data line from the TimeFile. Confirmation is asked for. Time 00' 00" can not be deleted (see page 42).

Drift

AUTO SET	control

Controls the driftmonitor in the auto mode, which intermits the execution of a TimeFile when the baseline is drifting. The available drift monitor settings depend on the range selected at time 00:00 in the TimeFile (see page 42). Can be set between 0.1 pA/min and 10 nA/min.

E1, E2, E3

PULS SET2	control

Controls the cell potential settings of the pulse. A change in E1 has to be confirmed with the '#'-button.

Ec

(AUTO) PRGR (DC only)	control

Controls the cell potential in a TimeFile (see page 42).

ECD

AUTO SET	control

Controls the status of the system, toggles between 'Master' and 'Slave'. If 'Master' other parts of the HPLC system can be controlled by the Bioquant (see page 42).

Ecell

PULS STAT, AUTO RUN (Pulse only), SCAN STAT	status

Displays the cell potential during 't1' in the pulse mode.
Displays the actual cell potential in the scan mode.

Eox. or Ered.

DC SET	control

Controls the oxidative or reductive cell potential. Can only be set or changed after confirmation with the '#' button. Passing the 0.00 V value automatically changes the readout from 'ox' to 'red' and in reverse.

Eox. or Ered.

DC STAT, AUTO RUN (DC only)	status

Displays the oxidative or reductive cell potential.

File

AUTO SET	control

Controls the number of the TimeFile to be edited or activated. In the DC mode file numbers 1 - 5 are available, in the pulse mode file numbers 6 - 9 can be selected. The TimeFiles remain stored in RAM, also after switching off the Bioquant (see page 42).

Filt.

DC SET, DC STAT, (AUTO) PRGR (DC ONLY)	control

Controls the rise time filter settings for the recorder output, which are: 0.1, 0.2, 0.5, 1, 2 or 5 seconds (see page 36).

HOLD=0/1

AUTO RUN, SCAN STAT	function

Interrupts the execution of a TimeFile or scan. Toggles between 1 and 0. Pressing the hold button again continues the TimeFile or scan were it was stopped (see page 42).

Icell

DC STAT, PULS STAT, SCAN STAT	status

Displays the true, non-compensated cell current, i.e. unaffected by zero or offset. The cell current is one of the most important parameters in ECD.

INJ=I/L

DC STAT, PULS STAT	function/status

Displays or switches the position of the injection valve, toggles between inject (I) and load (L). If a manual injector with position sensor (e.g. the Rheodyne 7725i) is applied, it echoes the position of the injector. If an electrically actuated injector is used (optional) it is possible to switch the injector with this function button.

MAIN

RANGE screen	function

Returns to the ‘MAIN’ screen.

MARK

DC STAT, PULS STAT	function

Triggers a marker signal on the recorder output.

NEXT

RANGE screen	function

Enters the next (xx SET) screen

Offs.

DC SET, DC STAT, (AUTO) PRGR, PULS SET1, PULS STAT, SCAN SET, SCAN STAT	control

Controls the percentage offset, can be set between -50 and 50%. The offset % on *both* outputs relates to the recorder range setting (see page 36).

Offs.

AUTO RUN	status

Displays the percentage offset during execution of a TimeFile.

Outp.

(AUTO) PRGR	control

Controls the four output functions in the auto mode. The notation of the output ‘0000’ corresponds to the four output controls at the rear panel of the controller (from left to right: relay 2, relay 1, aux 2, aux 1). The position indicated on rear panel refers to the ‘0000’ setting (see page 42).

PREV

DC SET, AUTO SET, PULS SET1, SCAN SET	function

Returns to previous screen.

PRGR

AUTO SET	function

Enters the (AUTO) PRGR screen

Range

DC SET, DC STAT, (AUTO) PRGR, PULS SET1, PULS STAT, SCAN SET, SCAN STAT	control

Controls the recorder range setting, varying from 10 pA to 5 µA full scale, divided in 1, 2 and 5 steps. In the DC mode, selectable recorder ranges depend on the pre-selection of the integration range in the ‘Range select’ screen. In the pulse and scan mode only the µA range can be used (see page 36).

RESET

AUTO RUN	function

Aborts the TimeFile and returns to the ‘AUTO SET’ screen. The cycle counter (‘Cy’) is reset to 1 (see page 42).
Outputs Aux 1 and 2, and Relays 1 and 2 are deactivated (status: 0000).

RUN

AUTO SET	function

Starts the execution of a TimeFile (master/slave). If the Bioquant is slave, the system waits for the ‘START’ input trigger to start the next run (see page 42).
In the slave mode the RUN command initialises the AUTO RUN screen, the system waits for the ‘START’ input trigger to start a TimeFile.

Scan

SCAN SET	control

Controls the scan speed, can be set from 1 - 50 mV/s in 1, 2, 5 steps.

SCROLL

(AUTO) PRGR	function

Scrolls through a TimeFile (see page 42).

SET

DC STAT, AUTO RUN, PULS STAT, SCAN STAT)	function

Returns to the previous (xx SET) screen.

SET1, SET2

PULS SET2, PULS STAT	function

Returns to PULSE SET screen 1 or 2

START

AUTO RUN, SCAN STAT	function

In the DC and pulse mode (master if cycles >1): toggles between STOP and START to control the execution of a TimeFile. In the scan mode START starts a scan.

STATUS

DC SET, PULS SET2, SCAN SET	function

Enters the next (xx STAT) screen.

STOP

AUTO RUN, SCAN STAT	function

In the scan mode, STOP aborts the scan and resets the cell potential to E1.
In the DC and pulse mode (master, cycles >1): toggles between STOP and START to control the execution of a TimeFile. Pressing ‘STOP’ aborts this run, cycle counter (Cy) is not reset. By pressing the same button (‘START’) again, the next cycle is started (Cy = Cy +1) (see page 42).
STOP also deactivates the outputs Aux 1 and 2, and Relays 1 and 2 (status: 0000). This toggle is also active in the slave mode.

t1, t2

PULS SET2	control

Controls the duration of a corresponding step in the pulse mode. The time can be set between 100 and 2000 ms in 10 ms increments.

t3

PULS SET2	control

Controls the duration of a corresponding step in the pulse mode. The time can be set between 0 (=off) and 2000 ms in 10 ms increments.

Time

(AUTO) PRGR	control

Controls the time to execute a data line in a TimeFile, can be set with one second resolution. Maximum time is 999 min and 59 s. The time to stop the execution of a TimeFile must be programmed by the CycleTime in the AUTO SET screen (see page 42).

Toven

DC STAT, PULS STAT	status

Displays the actual (left value) and the pre-set oven temperature (right value, set in ‘xxSET’).

Toven

DC SET, PULS SET1	control

Controls the temperature of the oven. Range: off, 15 - 60°C, selectable in 1°C steps. The oven is stable from 5 °C above ambient.

ts

PULS SET2	control

Controls the duration of the sampling time in the pulse mode. The time can be set between 20 and 100 ms in 20 ms increments.

7 Data acquisition

7.1 Introduction

One of the characteristics of electrochemical detection is its tremendous dynamic range. In amperometric detection peak heights may vary from micro-amperes down to the pico-ampere range. The Bioquant covers such a wide range from 5 µA down to 10 pA full scale, without being limited by electronic noise.
The Bioquant is equipped with three output connections for data acquisition, the recorder ('REC'), the integrator output ('INT') and the RS232 port. The *integrator* output has been designed to supply a non-manipulated, analog signal from the I/E converter which is as close as practically possible to the working electrode (WE). The *recorder* signal is manipulated by the CPU of the Bioquant. The RS232 output supplies the cell current immediately after DA conversion. No additional AD-DA conversion is applied. The details on data acquisition in the various ranges will be discussed for the output channels.

7.2 Internal organisation

At the working electrode (WE) in the electrochemical flow cell the electron transfer takes place due to an oxidation or reduction reaction. The resulting electrical current is amplified by the current-potential (I/E) converter (Fig. 4).

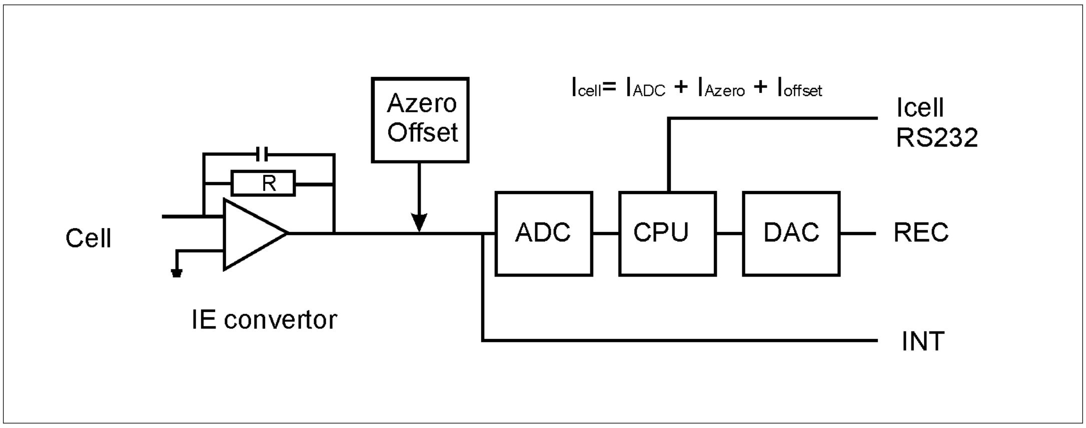


Fig. 4. Bioquant signal processing from electrochemical flow cell to REC, IN, RS232 output. R is a selectable resistor of 100, 10 or 0.1 MΩ, corresponding to the pA, nA and µA range respectively.

In the I/E converter a range of 10, 100 or 10000 nA full scale (FS) can be selected, which corresponds to the so-called pA, nA and the µA range, respectively. These are the three Bioquant integrator ranges that can be set in the 'Range select' screen.

```
              Range select
  Range      Int.       Rec.     Max.Comp
■  nA      10 nA/V   .1-50 nA    160 nA
 MAIN                               NEXT
```

Fig. 5. The Bioquant 'Range select' screen. The 10 nA/V corresponds to 100 nA full scale on the integrator output (=10V).

The integrator range selection is the first step in the signal pathway (Fig. 4). It affects both the integrator and the recorder output and has several important consequences for data acquisition (Table I).

Table I. Parameters affected by the integrator range setting.

Parameter	output	comment
signal output	INT/REC	gain increases with more sensitive range
available REC ranges	REC	see Table V
max. compensation	REC/INT	decreases with more sensitive range
I-cell display	screen	resolution increases with more sensitive range

The next step is the autozero and offset compensation. Then the signal is further manipulated for the recorder output or sent to the integrator output without manipulation.

Table II, different output characteristics.

	RS232	INT	REC
output signal	+/- 21 µA (with comp.)	+/- 10 V	+/- 1V
Max. range	5 nA, 50 nA, 5 µA *	10 nA, 100 nA, 10 µA	5 nA, 50 nA, 5 µA
Max. comp.	16 nA, 160 nA, 16 µA	idem	idem
Max. signal	21 nA, 210 nA, 21 µA	26 nA, 260 nA, 26 µA	21 nA, 210 nA, 21 µA
Resolution	1 pA, 10 pA, 1 nA	Unlimited, purely analogue (only limited by acquisition software)	12 bits (0.5 mV)
Auto zero	Resets zero point of full scale window**	Set to 0 V	Set to 0 V
Offset	Resets full scale window to % of full scale range***	Set relatively to subrange setting	Set as % of full scale output
Filter (DC only)	Y	N	Y

* In RS232 data acquisition use always the maximum range setting. Minor range settings do not amplify the signal, however they limit the full scale. Minor range settings affect (amplify) the REC output only.
** If a 5 µA range setting is used, the full scale window is –5..+5 µA. After auto zero at a background current of 1 µA and, this full scale window is –4..+6 µA.
*** If a 5 µA range setting is used, the full scale window is –5..+5 µA. Applying -50% offset, results in a full scale window of –2.5..+7.5 µA.

7.3 Integrator output

The integrator output has been designed to supply a clean, purely analog signal from the I/E converter. Except for the autozero and offset compensation, no further manipulation of the signal occurs. If required, manipulation of a chromatogram (i.e. noise filtering) can be done by integration software. Thus a clean chromatogram will always be available for re-integration.

Table III. Integrator range and maximum zero compensation.

range	current, full scale	max. zero comp.	max. current
µA	10 µA	16 µA	26 µA
nA	100 nA	160 nA	260 nA

pA	10 nA	16 nA	26 nA

When data are obtained from the integrator output, it is obvious that the pA range allows the highest sensitivity. Each range has a different maximum zero compensation (Table III). For example, in the nA range a current of 100 nA full scale can be managed. Together with a zero compensation of 160 nA, the maximum current that can be handled is 260 nA.
Due to the nature of data generation the integrator output is unusable in the pulse and scan mode.

7.4 Recorder output

Several steps occur before sending the signal to the recorder output. After analog-to-digital conversion (ADC), a number of recorder range settings can be selected in the central processing unit (CPU). This selection occurs in the ‘DC SET’ or ‘DC STAT’ screen.

```
 Eox. =+0.80V   Icell=  2.667 nA    DC
■Range=  5 nA  □Offs.= 10 %         STAT
□Filt.=  1 s    Toven= 28→30 °C   01'45"
 SET              MARK    A-ZERO  INJ=L
```

Fig. 6. Selection of the recorder output range in the ‘DC SET’ or ‘DC STAT’ screen.

After digital to analog conversion (DAC) the signal is sent to the REC output. The recorder range selection has several consequences for the data acquisition (Table IV).

Table IV. Parameters affected by the recorder range setting.

parameter	Output	comment
signal output	REC	gain increases with more sensitive range
offset	REC/INT	see Table VI
marker	REC	10% of full scale REC output

In the DC mode the signal can be smoothened by a rise time filter. In addition, more complex signal manipulation, needed for pulse and scan is possible. Although the name of this output suggests otherwise, it is often used in connection with an integrator.
The recorder output ranges between +1 and -1 V with 12 bits resolution, which means that the output resolution is 0.5 mV (2 V/2^{12}). The best way to exploit this output resolution is to set the range as sensitive as possible.

Table V. Recorder ranges and maximum zero compensation.

	Range		
pA	nA	µA	
10			
20			
50			
100	0.1		
200	0.2		
500	0.5		range
1000	1.0		overlap
2000	2.0		

5000	5.0	
	10.0	0.01
	20.0	0.02
	50.0	0.05
		0.10
		0.20
		0.50
		1.00
		2.00
		5.00

maximum zero compensation (nA)		
16	160	16000

There is much overlap in the recorder range settings offering flexibility as to maximum zero compensation (Table V). For example, if a chromatogram is acquired at 10 nA, the nA or µA range can be selected (Table V). With a high background current the µA is chosen (max. 16 µA compensation), at a low background the nA range is preferred (max. 160 nA compensation).
The resolution of the zero compensation is 16 bits per selected integrator range. At a high maximum compensation, the compensation circuit uses larger steps to reach a 0 V output, hence the resolution of the zero compensation decreases. Therefore, a compromise is made between maximum zero compensation and resolution. To maintain a high autozero resolution with accurate zero settings, the maximum compensation is decreased with the integrator range. In certain cases, when a small peak is 'blown up' with integration software, a typical stepwise (0.5 mV = 1 bit) peak profile is seen (Fig. 7). In that case the recorder output resolution is not sufficient, and the detector should be set at a more sensitive recorder range.

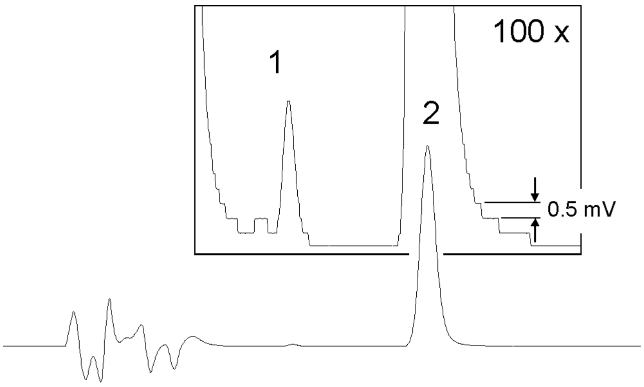


Fig. 7. A 'stepwise' pattern after magnification of a chromatogram.

This phenomenon will not occur at the *integrator* output because this output is purely analog and therefore, in principle, with infinite resolution.

7.5 Integrator vs. recorder output

In the pulse and the scan mode, only the recorder output is suitable for data acquisition. In the DC mode both outputs can be used, in that case a choice has to be made.

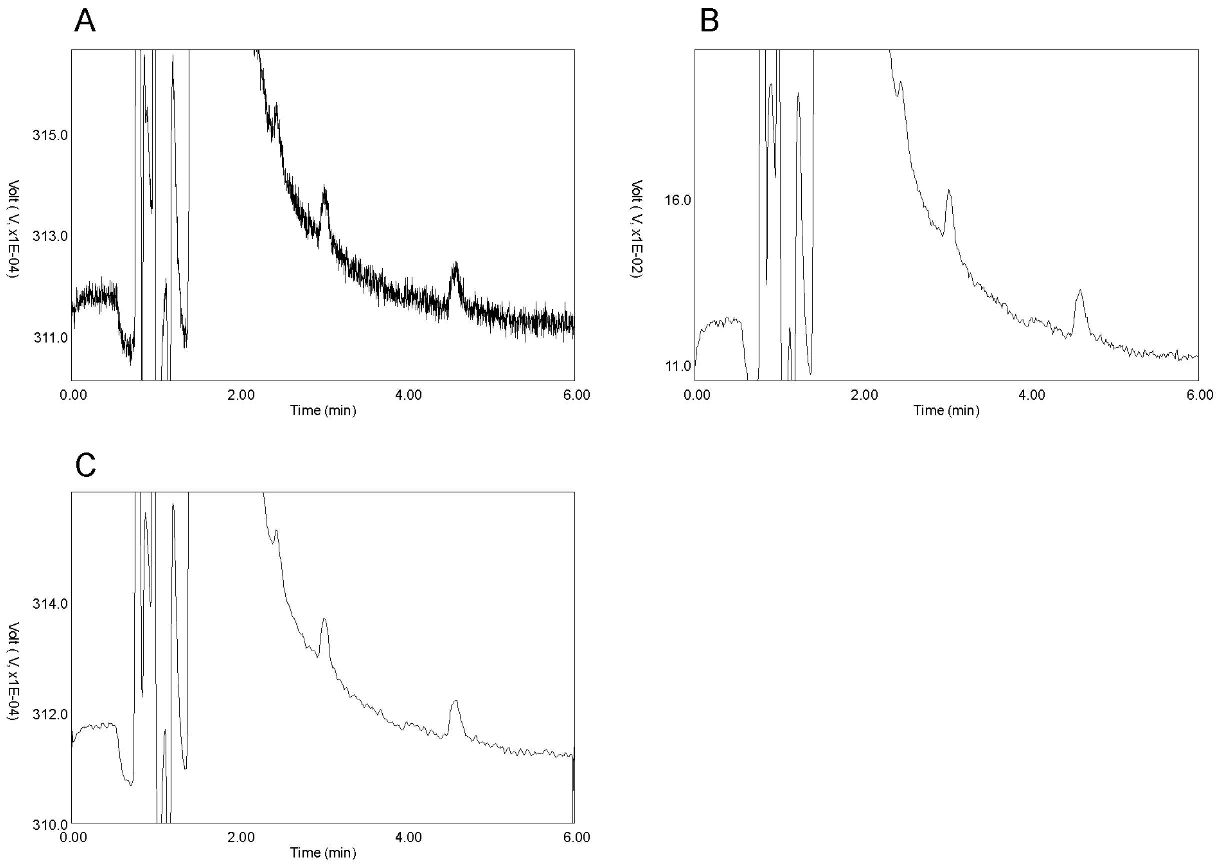


Fig. 8. The clean signal from the integrator output (A) is smoothened by integrator software using a running average filtering (C). This results in a similar chromatogram as obtained from the recorder output using a rise time filter of 1 s (B).

A specific advantage of the integrator output is the large dynamic range and infinite resolution. It is an analog output which means that the resolution is only limited by the integrator that is used. In most integrators this is approximately 1 μV. The 12 bits recorder output has a maximum output resolution of 500 μV.

Often, the *recorder* output is chosen for data acquisition thus offering the possibility of smoothening by means of rise time filters (Fig. 8). The advantage of having a clean signal from the *integrator* output is not always recognised, or the possibility for smoothening data is not implemented in the integration software.

7.6 Offset

A maximum offset of +50% and - 50% in 10% steps can be achieved, active on both the integrator and the recorder output. On the recorder output the offset is given as the percentage of the recorder range setting. For example, a 20% offset at 5.0 nA full scale setting will give a 1.0 nA offset. This is a 200 mV offset when the maximum recorder output is 1.0 Volt.

For the integrator output the situation is more complicated because the offset percentage relates to the recorder range setting. The integrator offset (in mV) is given in Table VI for a 10 V integrator output.

Table VI. Effect of recorder range on the offset of the 10 V integrator output.

Range			Offset (mV)				
pA	nA	μA	10%	20%	30%	40%	50%
10	0.1	0.01	1	2	3	4	5

20	0.2	0.02	2	4	6	8	10
50	0.5	0.05	5	10	15	20	25
100	1.0	0.10	10	20	30	40	50
200	2.0	0.20	20	40	60	80	100
500	5.0	0.50	50	100	150	200	250
1000	10.0	1.00	100	200	300	400	500
2000	20.0	2.00	200	400	600	800	1000
5000	50.0	5.00	500	1000	1500	2000	2500
1	10	1000	Integrator output (nA/V)				

Although this may seem a complex way of compensating the background current, in practise it gives the best possible flexibility and optimum resolution of the 16 bits compensation in each operating range. By simply changing the percentage offset or the recorder range, almost any offset compensation can be set between 1 and 2500 mV on the integrator output.

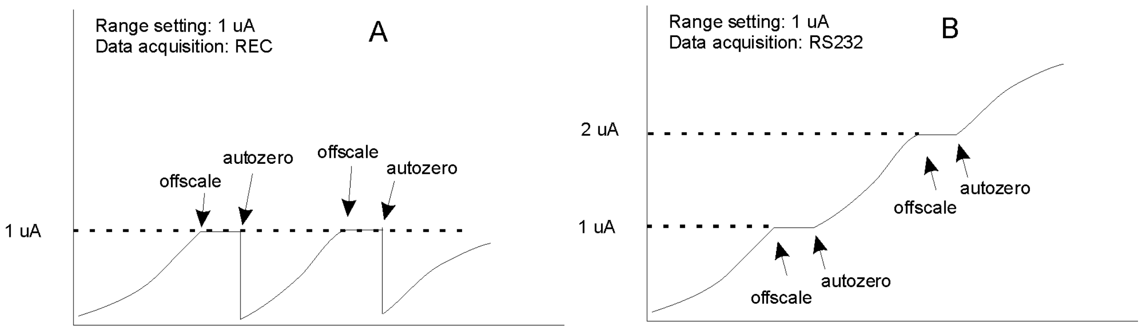


Fig. 9. Auto zero resets the full scale window in RS232 (B), while the REC and INT output (A) are set to zero Volt.

8 AUTO mode and TimeFiles

8.1 Introduction

The AUTO mode of the Bioquant enables a time-based, automated and full parametric control of electrochemical detection (ECD). This is particularly useful when during a run or between runs settings have to be changed such as the sensitivity, autozero or control of external equipment (i.e. trigger to start integration software etc.). A TimeFile contains a series of data lines in which the settings of the Bioquant can be changed with 1 second time resolution. A TimeFile is executed only in the AUTO mode.

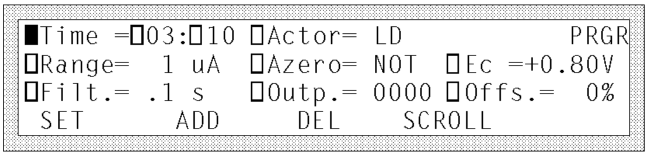


Fig. 10. Programming a TimeFile using the '(AUTO) PRGR' screen.

The file is made using the ‘(AUTO) PRGR’ screen on the Bioquant (Fig. 10) or, when the Bioquant is equipped with the RS232 option, by using the TimeFile editor in ‘Bioquant Dialogue for Windows’. Programmable parameters comprise cell potential, range, autozero, offset, rise time, electrically actuated injector (if present) and the Bioquant output contacts to control the status of external equipment.

8.2 Range programming

In certain analyses large differences in analyte concentration (and peak height) occur. If the analyte with the highest concentration is on scale, another analyte may be recorded at a low output resolution. When the small peak is magnified with integration software a typical stepwise peak profile is seen (Fig. 7). In such a case a chromatogram can be obtained using a TimeFile to switch the sensitivity of the controller to another range during the run (Fig. 11).
In Table VII an example is given of a TimeFile for sensitivity switching between 2 peaks. In this example the system is equipped with an internal VALCO valve, which means that programming the switching of the valve is possible (Fig. 10, ‘Actor’). At time 00:00 the valve is switched to ‘inject’, the trigger to start the integrator is connected to the ‘INJECT MARKER’. At time 00:10 the valve is switched back to ‘load’ to enable continuous refilling of the injection loop. At time 1:26 the sensitivity is increased by a factor of 100 from 50 nA/V to 0.5 nA/V, together with an autozero command. After passage of the small peak, the range is switched back to 50 nA/V. At t=3:05 the end of the chromatographic run is programmed in the ‘AUTO SET’ screen, using the ‘CycleTime’ parameter.
If the *integrator* range is switched between µA, nA or pA, simultaneously with an autozero command this may result in an inappropriate baseline setting. Setting the range first is recommended in such case.

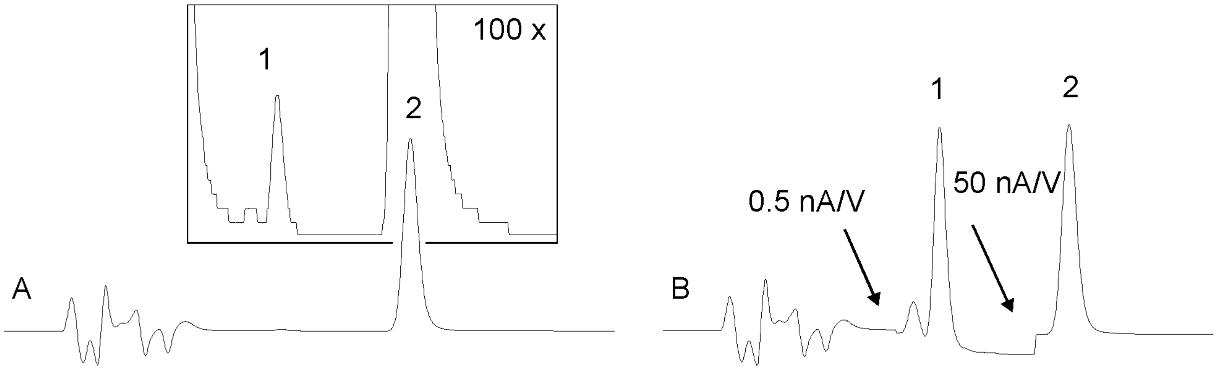


Fig. 11. Example of range programming to maintain the recorder resolution. In chromatogram (A) a range setting of 50 nA/V is used, in chromatogram (B) the output range is automatically switched during the run resulting in a considerable improvement of the output resolution of peak 1.

Table VII. TimeFile used for output resolution programming.

time	int. range	rec. range	rise time	valve	auto zero	offset	output	E cell
00:00	nA	50 nA	1 s	inject	set	00%	0000	0.80 V
00:10	nA	50 nA	1 s	load	not	00%	0000	0.80 V
01:26	nA	0.5 nA	1 s	load	set	00%	0000	0.80 V
01:55	nA	50 nA	1 s	load	set	00%	0000	0.80 V
03:05	Cycle Time (end of run)							

8.3 Drift monitor

The AUTO mode of the Bioquant is equipped with a drift monitor, which puts the detector on 'hold' when the baseline is drifting. The drift monitor is only active at the beginning of a Time-File, both in the master and slave mode. After starting a TimeFile the baseline is monitored during one minute and the 'wait..' message is displayed. When the baseline is not within the pre-set limit, the drift monitor remains active. When the drifting baseline is within the pre-set limit the drift monitor is deactivated, and the run continues.
The drift monitor is useful when, for example, after each run a cleaning pulse is programmed to reduce fouling of the working electrode. A cleaning pulse consists of e.g. a 10 seconds potential step at -1V.

```
■File  = 2     □ECD     = Master   AUTO
□Cycles= 12    □CycleTime=□12:□30   SET
□Drift = 5 pA/min
 PREV                     RUN      PRGR
```

Fig. 12. Programming the drift monitor in the 'AUTO SET' screen.

After this cleaning pulse it takes some time to get a stable baseline again. The drift monitor can be used to ensure a user-definable stable baseline before the start of the next run.
However, the duration of each run will always be at least one minute longer. In this minute the drift in the baseline is monitored.

8.4 Step by step programming of the AUTO mode (ECD = Master)

In this step-by-step guide the example from Table VII will be programmed. In this example the system consists of an HPLC system, a Bioquant with VALCO option (automated injection valve), an integrator, and an on-line microdialysis set-up.
The Bioquant is *master* which means that the Bioquant starts a run, and controls the number of automated runs.

Hardware connections:

1. Connect the hardware trigger of the integrator to the 'Inject marker' on the rear panel of the Bioquant as indicated in (Fig. 13).

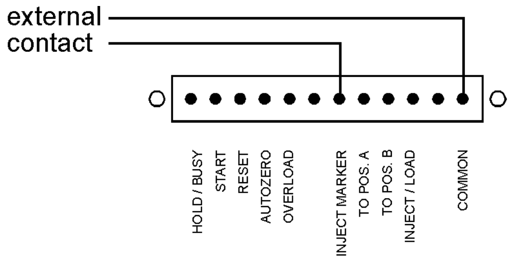


Fig. 13. External contact to start the integrator by switching the automated (built-in) VALCO valve.

2. Connect the dialysis tubing to the automated VALCO injection valve.
3. In this example the integrator is connected to the REC output at the rear panel of the Bioquant.
4. Prepare the LC-EC system for analysis.

Programming the AUTO mode:

5. From the Bioquant 'Main' screen, choose DC, and in the 'Range select' choose NEXT. In the 'DC SET' screen, set the temperature at the desired value (or choose 'off') and choose AUTO. You are now in the 'AUTO SET' screen in the AUTO mode.
6. In the 'AUTO SET' screen select the TimeFile that you want to edit with 'File'. When it is your first file, select nr. 1. There are 5 TimeFiles available in the DC mode (and 4 in the Pulse mode). The number of times you want to repeat this TimeFile is set with 'Cycles'. Because the Bioquant will give the integrator and switching valve the starting signals, it is set at 'Master'. The duration of one run is set with 'CycleTime'. A step programmed at a time similar to or larger than the cycle time (i.e. t ≥ 3:05), will not be executed!

```
█File   = 1     ▯ECD      = Master   AUTO
▯Cycles= 12     ▯CycleTime=▯03:▯05    SET
▯Drift = off
 PREV                      RUN       PRGR
```

Before the drift monitor can be set (if required), the first line in the TimeFile has to be programmed. The drift monitor is linked to the range setting of the first line in the TimeFile (at t = 0:00).

7. Press 'PRGR' to go into the edit mode of the TimeFile. The 'PRGR' screen appears:

```
█Time =□00:□00 □Actor= INJ        PRGR
□Range= 50 nA  □Azero= SET  □Ec =+0.80V
□Filt.=  1 s   □Outp.= 0000 □Offs.= 0 %
 SET      ADD      DEL     SCROLL
```

When all settings are correct, this line in the TimeFile can be saved by choosing ‘ADD’. When the time already exists, the question ‘Do you want to overwrite time?’ appears. As each new TimeFile contains a t = 0:00, this question will always appear after editing this line.
In our example, after editing t=0:00 an additional screen will appear, asking you in which range you want to operate at the 50 nA/V setting. You may choose between the nA and the µA range. See ‘Chpt. Data acquisition’, page 36, for specific details on differences between both modes.
In our example the nA range is chosen, and confirmed with ‘ACCEPT’. The message ‘New time is saved’ is displayed.

```
  Range      Int.       Rec.    Max.Comp
█  nA     10 nA/V    .1-50 nA   160 nA
□  uA      1 uA/V    .01-5 uA    16 uA
                                 ACCEPT
```

Choosing ‘SCROLL’ allows you to scroll through your TimeFile. With ‘DEL’ an existing line in your TimeFile can be deleted (after confirmation).

8. Step 7 is repeated for each line in the TimeFile. When a line is edited and saved, without changing the time, the original line is overwritten (after confirmation). When the time of an existing line is changed and saved, it is saved as a new line without overwriting the original line. Each TimeFile can contain a maximum of 20 data lines.
9. The last line *in the TimeFile* is at t = 1:55. By choosing ‘SET’ you may return to the ‘AUTO SET’ screen.
10. In the ‘AUTO SET’ screen ‘CycleTime’ is set at 3:05. If required, the drift monitor can be programmed. In the nA range a choice can be made between ‘off’, 1 pA/min - 0.1 nA/min in 1, 2, 5 steps.
11. Your system is now ready for automated operation. A TimeFile is started by choosing ‘RUN’ in the ‘AUTO SET’ screen. The ‘AUTO RUN’ screen will appear.

```
Eox. =+0.80V  I =  1.26 nA         AUTO
Range=  50 nA  Cy=1   Offs.=  0 %   RUN
Filt.=  1 s   T = 30→30 °C  0000  00’01"
 RESET            STOP    A-ZERO  HOLD=0
```

This is the status screen of the AUTO mode. Current settings are displayed, including the actual cycle number (‘Cy’) that is executed.
The autozero command (‘A-ZERO’) is always accessible during operation in the AUTO mode.
When the drift monitor is programmed and the drift is beyond the pre-set value, the ‘wait...’ message is displayed in stead of the time.

```
Eox. =+0.80V  I =  1.26 nA         AUTO
Range=  50 nA  Cy=1   Offs.=  0 %   RUN
Filt.=  1 s   T = 30→30 °C  0000  wait..
 RESET            STOP    A-ZERO  HOLD=0
```

Important note when using the drift monitor:

If an injection or an external event is programmed at t = 0:00, these events are executed immediately while the drift monitor is putting the system on hold. This can be prevented by programming these events at t = 0:01.

Furthermore, the duration of each run will always be at least one minute longer. In this minute the drift in the baseline is monitored.

Interrupting a TimeFile:

12. When ‘HOLD’ is chosen, the timer is stopped, the message ‘HOLD=1’ appears in the corner of the ‘AUTO RUN’ screen. After pressing ‘HOLD’ again, the timer continues (‘HOLD=0’).
13. When ‘STOP’ is chosen, the execution of the TimeFile is interrupted. Starting the next run at t = 0:00 is possible by choosing ‘START’ (if cycles >1). The cycle counter (‘Cy’) is increased.
    STOP also deactivates the outputs Aux 1 and 2, and Relays 1 and 2 (status: 0000).
14. When ‘RESET’ is chosen, the execution of the TimeFile is interrupted and the ‘AUTO SET’ screen appears. The cycle counter is reset to 0 (‘Cy = 0’).
    RESET also deactivates the outputs Aux 1 and 2, and Relays 1 and 2 (status: 0000).

Note: In the *master* mode the HOLD, STOP, START and RESET functions are accessible only from the keyboard. In the *slave* mode these inputs are accessible via the rear panel of the Bioquant. Accessible keyboard functions in the *slave* mode are: RUN, STOP, RESET and A-ZERO.

8.5 Step by step programming of the AUTO mode (ECD = Slave)

For the same example as given above, a TimeFile will be programmed. The system consists of an HPLC system with autosampler, a Bioquant and an integrator.

The Bioquant is *slave* which means that a run is started by an external contact (i.e. from autosampler). Also the number of automated runs is controlled externally.

Hardware connections:

1. Connect a hardware trigger of the autosampler to ‘START’ on the rear panel of the Bioquant as indicated in Fig. 14. A contact closure is required between ‘COMMON’ and ‘START’ to start a TimeFile. Consult your autosampler manual for details on connecting the external contact to a relay.
2. Connect your integrator to the REC output at the rear panel of the Bioquant.

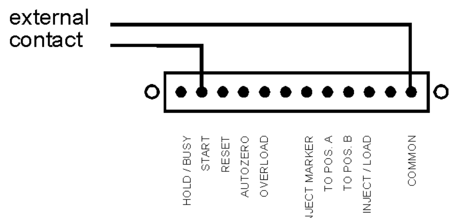


Fig. 14. Input contacts needed for external control of the Bioquant (slave mode).

3. Prepare the LC-EC system for analysis.

Programming the AUTO mode:

The programming of the TimeFile is done in the same way as described for the master mode. In the following steps the differences with the master mode are given.

3 In the ‘AUTO SET’ screen choose ‘ECD = Slave’. The number of cycles is controlled by the autosampler, in the Bioquant ‘Cy’ is automatically set at 1 and can not be changed.

```
█File   = 1     □ECD      = Slave   AUTO
 Cycles= 1     □CycleTime=□03:□05    SET
□Drift = off
 PREV                     RUN      PRGR
```

4 Choose ‘PRGR’ to go in the edit mode of the TimeFile and continue programming the TimeFile as described above.

5 By pressing RUN the system is ready for automated operation. The TimeFile is started by an external contact closure from the autosampler (Fig. 14). The duration of this contact closure must be at least 100 ms. Each time a run is started the ‘AUTO RUN’ screen appears. After the ‘RESET’ command (via relay1), the ‘AUTO SET’ screen is displayed.

The autozero command (‘A-ZERO’) is accessible during operation in the AUTO mode as long as ‘I-Cell’ is displayed.
Accessible keyboard commands in the *slave* mode are: RUN, STOP, RESET and A-ZERO. This means that you can also start (and stop) the TimeFile from the keyboard.

Interrupting a TimeFile:
In the slave mode the Bioquant does not respond to a ‘HOLD’ command from the keyboard. You can stop the timer by making an external contact closure between ‘HOLD’ and ‘COMMON’. As soon as the contact closure is released, the TimeFile continues.

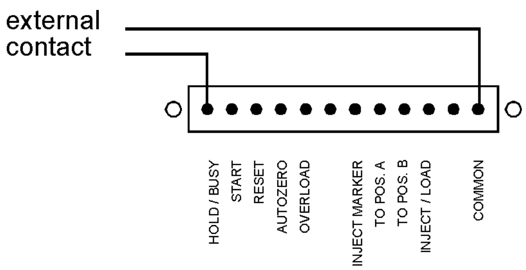


Fig. 15. External contact to give a ‘HOLD’ command during execution of a TimeFile in the slave mode.

4. If ‘STOP’ is chosen from the keyboard, the execution of the TimeFile is interrupted. STOP command toggles between STOP and START to control the execution of a TimeFile. STOP also deactivates the outputs Aux 1 and 2, and Relays 1 and 2 (status: 0000).
5. When ‘RESET’ is chosen from the keyboard, the execution of the TimeFile is interrupted and the ‘AUTO SET’ screen appears. RESET also deactivates the outputs Aux 1 and 2, and Relays 1 and 2 (status: 0000).

Note: In the *master* mode the HOLD, STOP, START and RESET commands are accessible only from the keyboard. In the *slave* mode these inputs are accessible via the rear panel of the Bioquant. Accessible keyboard commands in the *slave* mode are: RUN, STOP, RESET and A-ZERO.

8.6 Other events

Inject/load and inject marker:
A frequently used function is the inject/load (or inject marker) as a trigger for starting the integration software. This trigger is always accessible, not only in the AUTO mode.

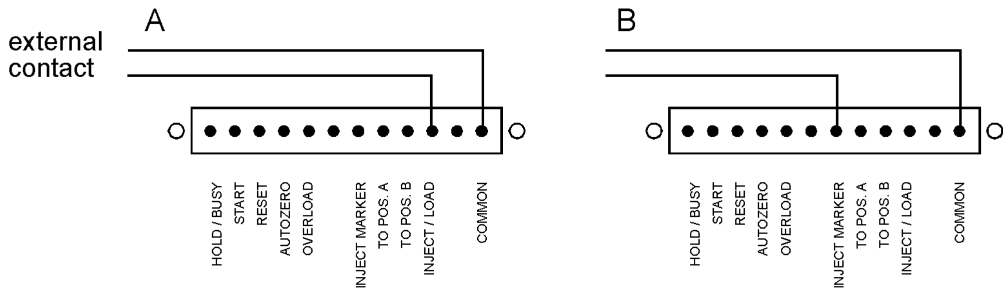


Fig. 16. Output contact needed to start the integrator by switching the Rheodyne 7725i (A) or an automated (built-in) VALCO valve (B).

The Rheodyne 7725i has an internal relay and must be connected by a cable to “manual valve” on the rear panel. If properly connected, the status of inject/load is ‘high’ when the valve is in ‘load’ position, the status is ‘low’ when the valve is switched to ‘inject’.
The ‘INJECT MARKER’ is only active when an electrically actuated VALCO injector is present (VALCO option). This output is high when the injector is in ‘load’ position and low in the ‘inject’ position.

Hold/busy:
The hold/busy is a double function.
Input: when a TimeFile is executed in the *slave mode*, the timer can be stopped externally by connecting 'HOLD' and 'COMMON' as described above (Fig. 15). The timer continues after disconnection.
Output: the 'BUSY' output is active (low) when during operation in the *master* or *slave mode* the Bioquant is put on 'hold' by the drift monitor. The 'HOLD' command from the keyboard does not affect the status of the 'BUSY' output!

Overload:
Activated when a recorder overload occurs.

Autozero:
Enables external activation of the autozero command. This function is active only when the 'I-Cell' is displayed.

To pos A, B:
Forces the VALCO electrically actuated injector to position A (load) or B (inject).

Cell on (off)
Switches on (off) the flow cell. This input command can be used for example to switch on and stabilise the flow cell early in the morning by means of a timer.

Programming output functions:
Four output functions can be programmed at each time. The notation of the output '0000' corresponds to the four output controls at the back panel of the controller. These are from left to right: relay 2, relay 1, AUX2, AUX1 (Fig. 17).
For example, if AUX1 has to be activated, the output is set to '0001'. If a contact closure has to be made using relay 1, the output is set to '0100'. The contact is made between pin 3 and 5 at the 12 pins connector of the upper I/O connector. At the same time the contact between 4 and 5 is interrupted. The relay position indicated on the rear panel refers to the '0' setting (see Fig. 17).
In
Table VIII the output commands and the corresponding external contacts are given. Combinations of commands enable control of multiple external contacts at the same time. For example, the command '0101' activates AUX1 and relay 1 at the same time.

Table VIII. Outputs and commands, combinations are possible.

output	command
AUX1	0001
AUX2	0010
relay 1	0100
relay 2	1000

8.6.1 TTL contacts

The Bioquant uses TTL input contacts for START, RESET, AUTOZERO, TO POS. A and TO POS. B. These contacts require a minimum TTL-low pulse duration of 100 ms to be activated. If multiple activations are required the next pulse must be given after 100 ms TTL-high. If the input is kept low, only one activation will occur.

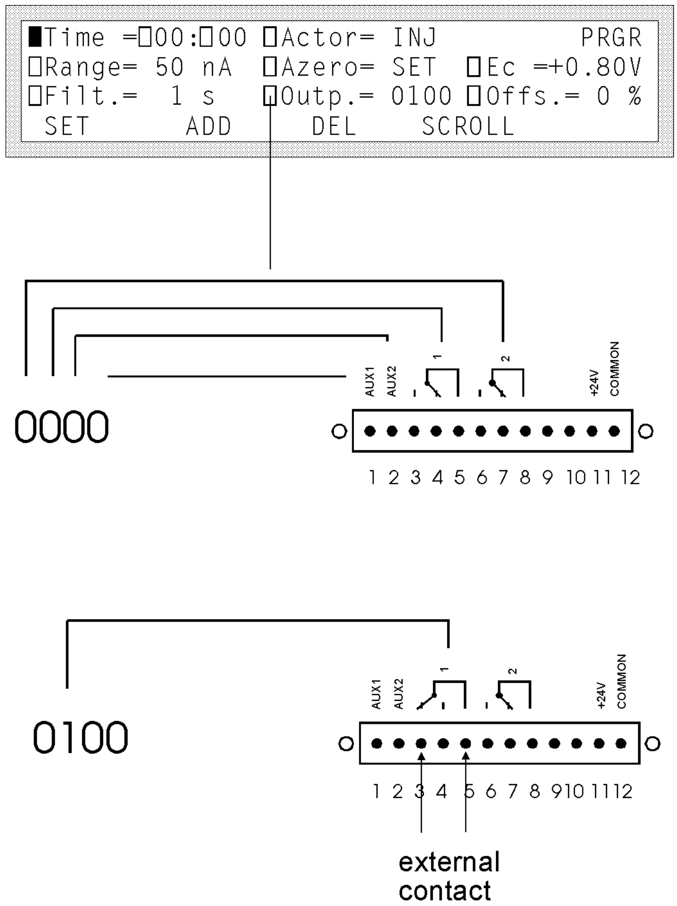


Fig. 17. Programming an external contact closure using the 'Outp.' command in a TimeFile.

There are at least two ways to activate a contact by TTL-low. This can be done by making a contact closure of the input with common (see Fig. 14, 'START' command) or by using an external TTL contact which is made low (see Fig. 14, 'RESET' command). In the latter case it is important that the status of the external contact is known, and that the apparatus is connected to the same ground (by the mains power supply) as the Bioquant.

Table IX. I/O contacts, upper 12 pins connector. Default status of output connections is low (0 V). The connections 1-8 are only accessible in the AUTO mode (master and slave mode).

No.	Name	Function
1	AUX1	open collector output, I max. 250 mA, U max. 28 V
2	AUX2	open collector output, I max. 250 mA, U max. 28 V
3, 4, 5	relay 1	contact between 5 (common) and 4 (default) or 3, I max. 500 mA, U max. 28 V
6, 7, 8	relay 2	contact between 8 (common) and 7 (default) or 6, I max. 500 mA, U max. 28 V
9	Cell off	trigger to switch off the cell (level triggered)
10	Cell on	trigger to switch on the cell (level triggered)
11	+24 V	+24 V output, I max. 500 mA
12	common	ground

Table X. I/O contacts, lower 12 pins connector. Default status is high (5 V).

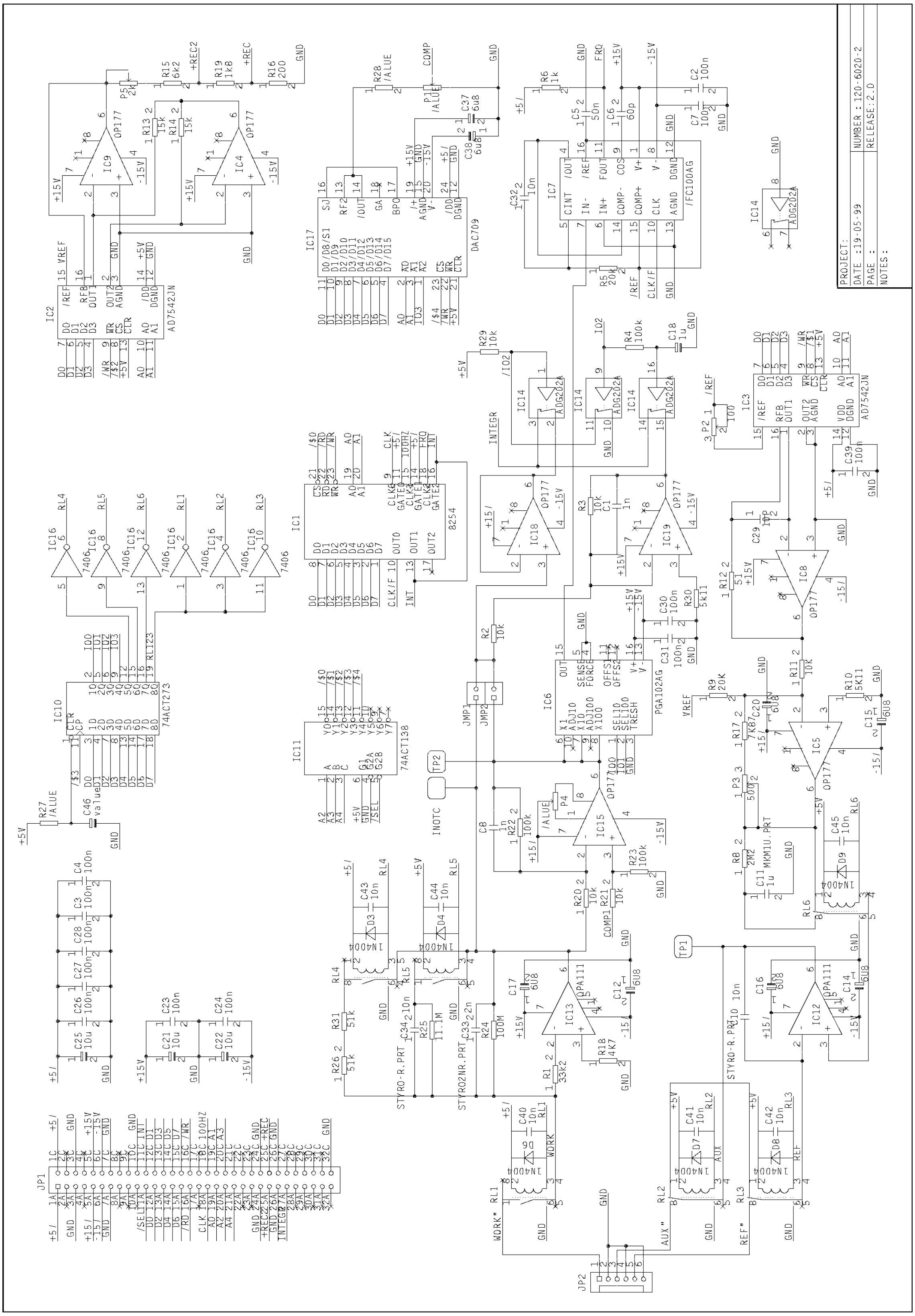
No.	Name	Ac-cess	Activ(at)e	Function
1	Hold/Busy	slave, master	status: low	Output: active if drift monitor 'holds' the run (master + slave). Input: active as 'HOLD' command (slave mode).
2	Start	slave	level triggered	Starts a TimeFile
3	Reset	slave	level triggered	Resets the AUTO mode
4	Autozero	always	level triggered	Autozero command, always accessible when 'I-Cell' is in Bioquant display
5	Overload	always	status: low	Active when recorder overload occurs ('REC OVLD')
6	not conn.			
7	Inject marker	always	status: low	In combination with VALCO, high: 'load', low: 'inject'.
8	to pos. A	always	level triggered	In combination with VALCO, forces injector to 'load'
9	to pos. B	always	level triggered	In combination with VALCO, forces injector to 'inject'
10	inject/load	always	status: low	In combination with Rheodyne 7725i, high: 'load', low: 'inject'.
11	not conn.			
12	common	always		Ground

Some contacts are *level triggered*, they are activated by making an external contact closure for at least 100 ms with common (= low). Releasing the external contact does not affect the I/O contact function. Other contacts are *status sensitive*. They are active only when the status is low, releasing the external contact closure deactivates (status = high).
Lower contact 1 is only accessible in the AUTO mode (master and slave). Lower contact 2 and 3 are only accessible in the slave mode (AUTO mode). Lower contact 4 is always accessible when 'I-Cell' is displayed. Other lower contacts are always accessible.

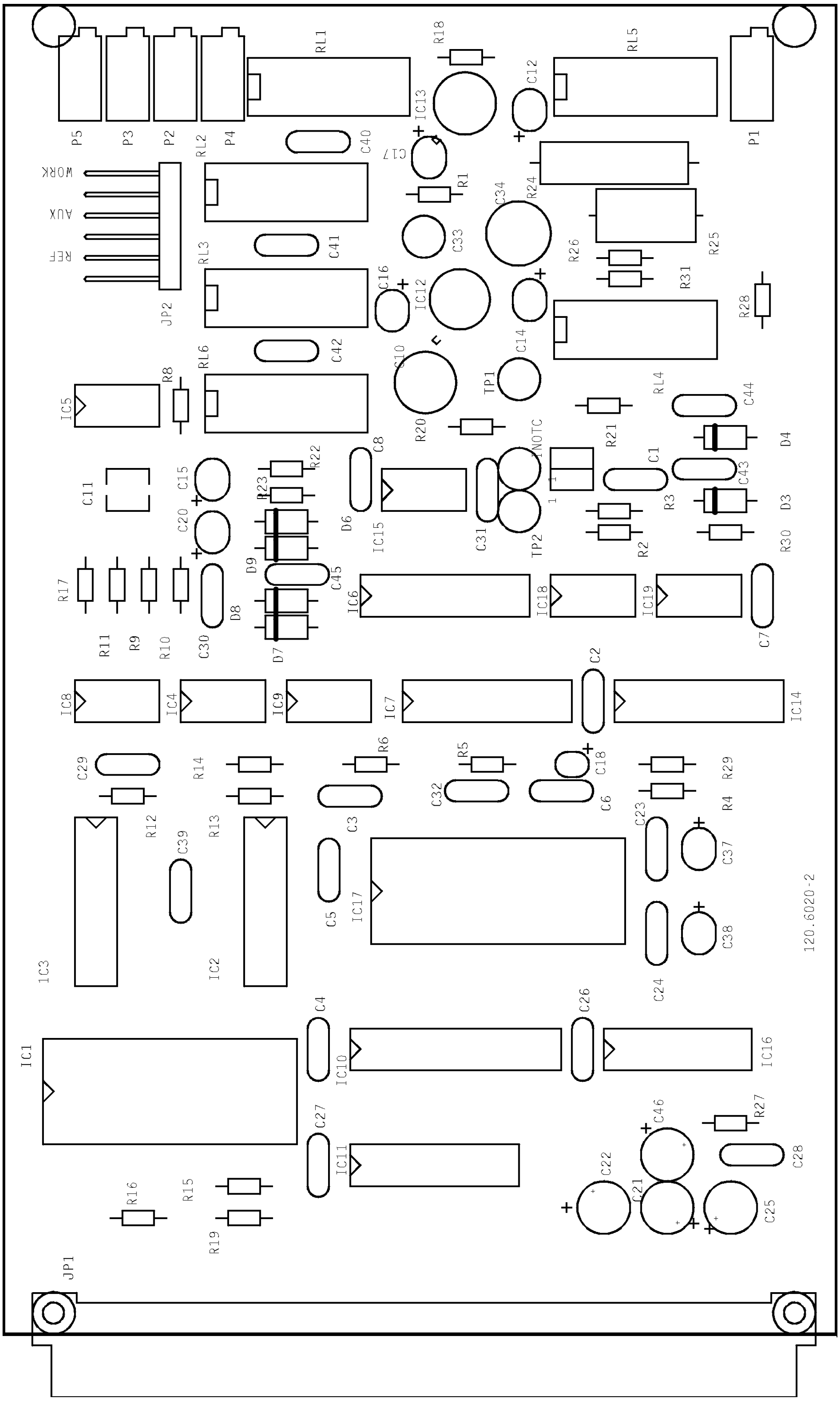
Service Manual

Part II
Board layout and circuitry

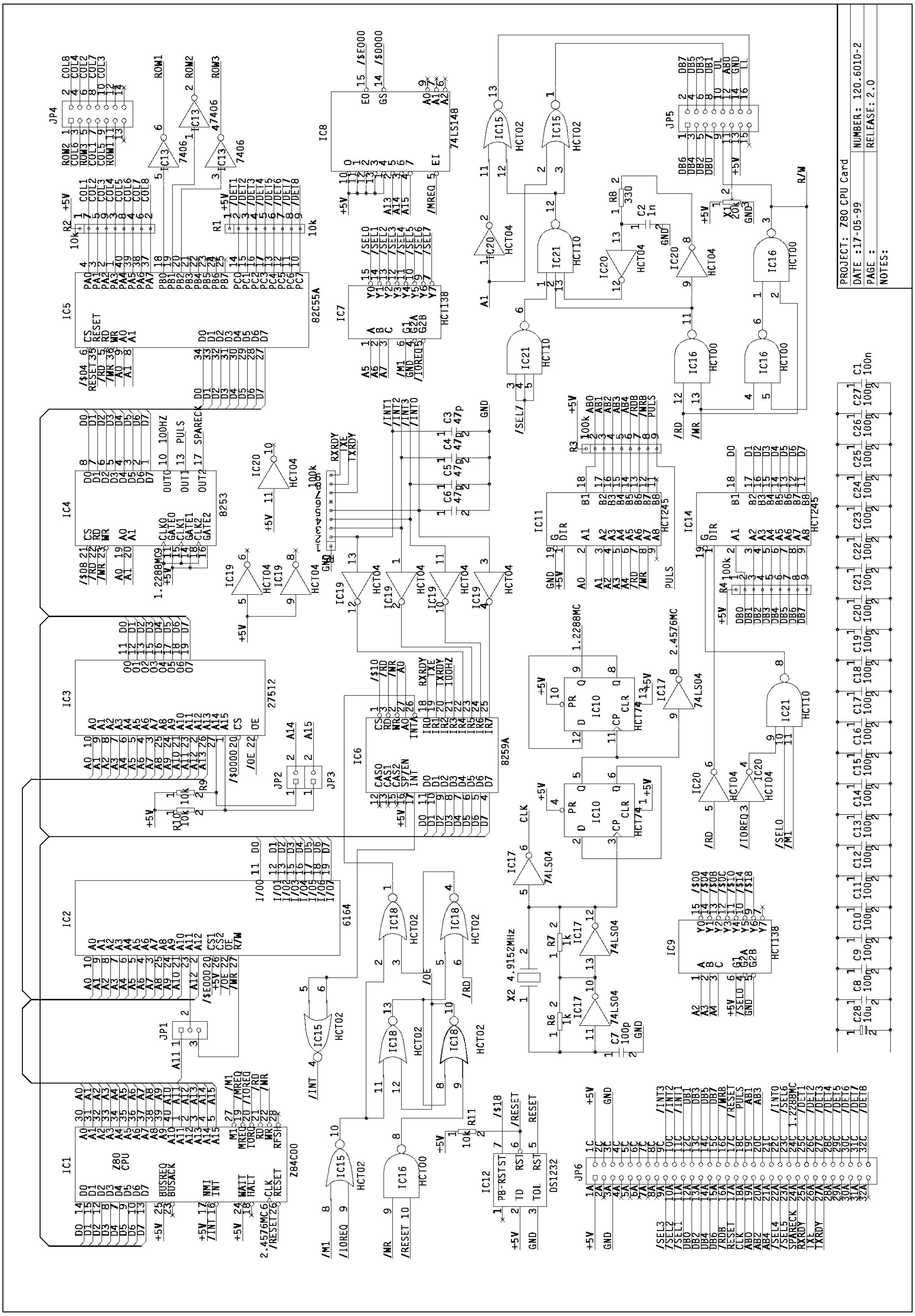
9 Electrode board circuit



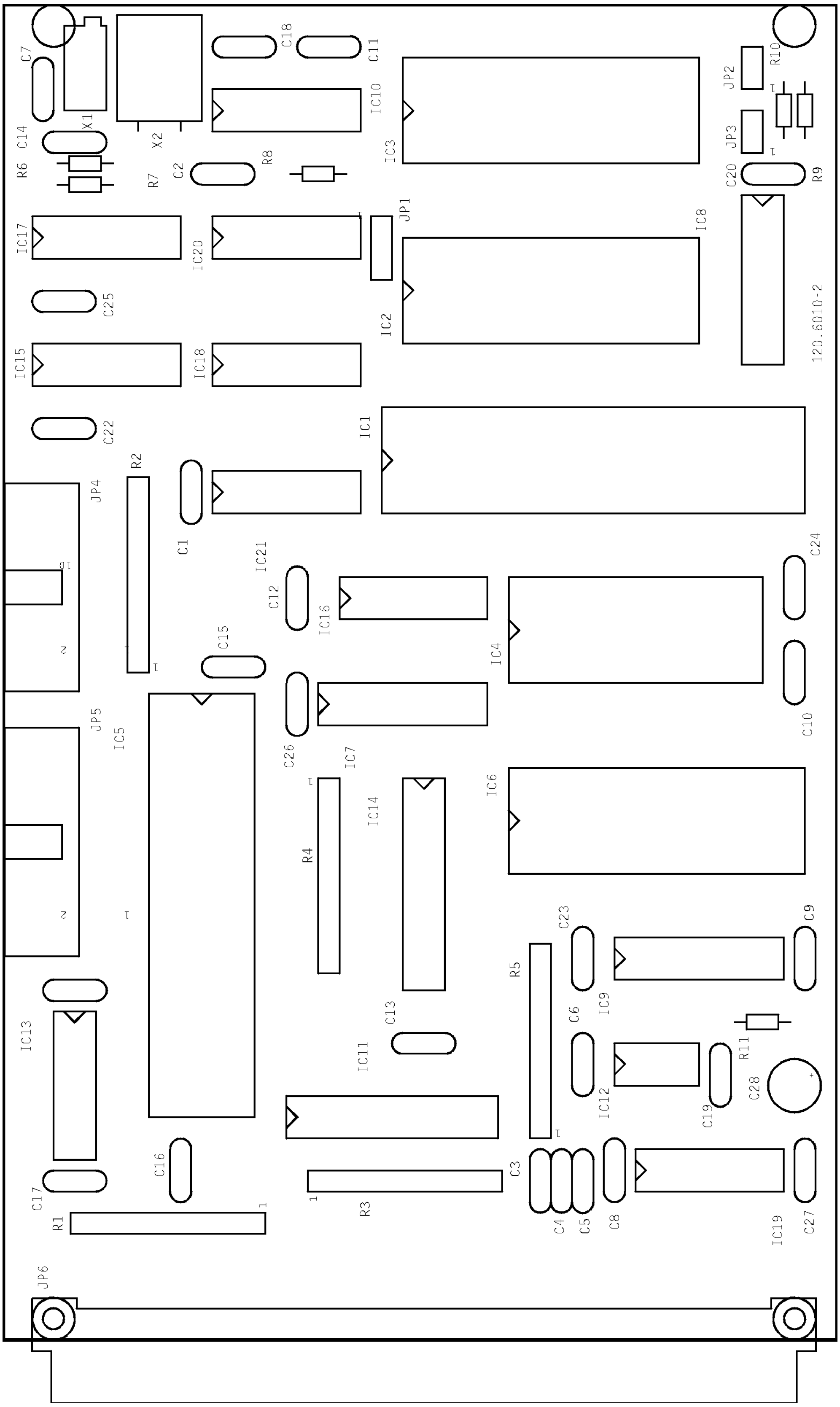
10 Electrode board layout



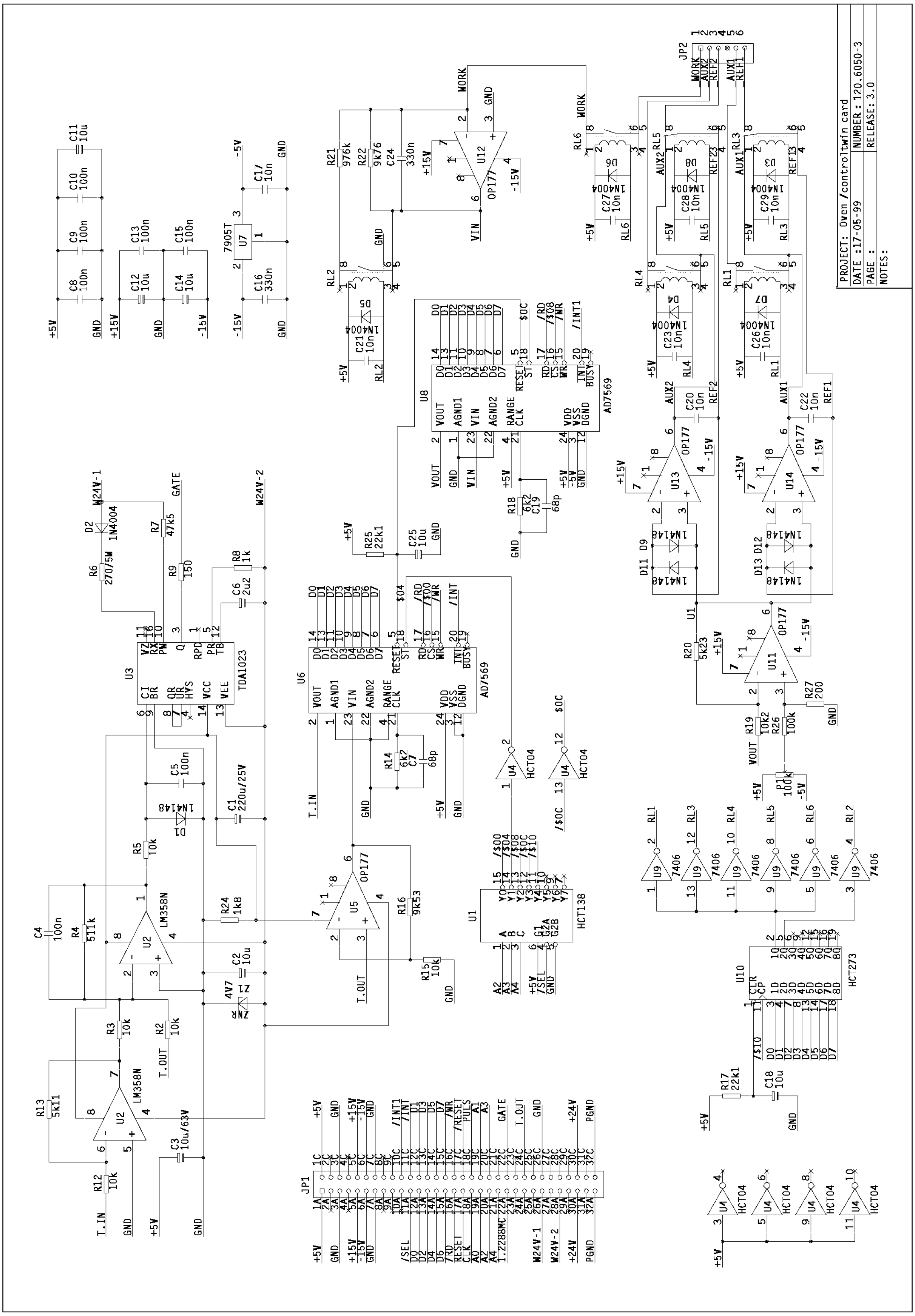
11 CPU-board circuit



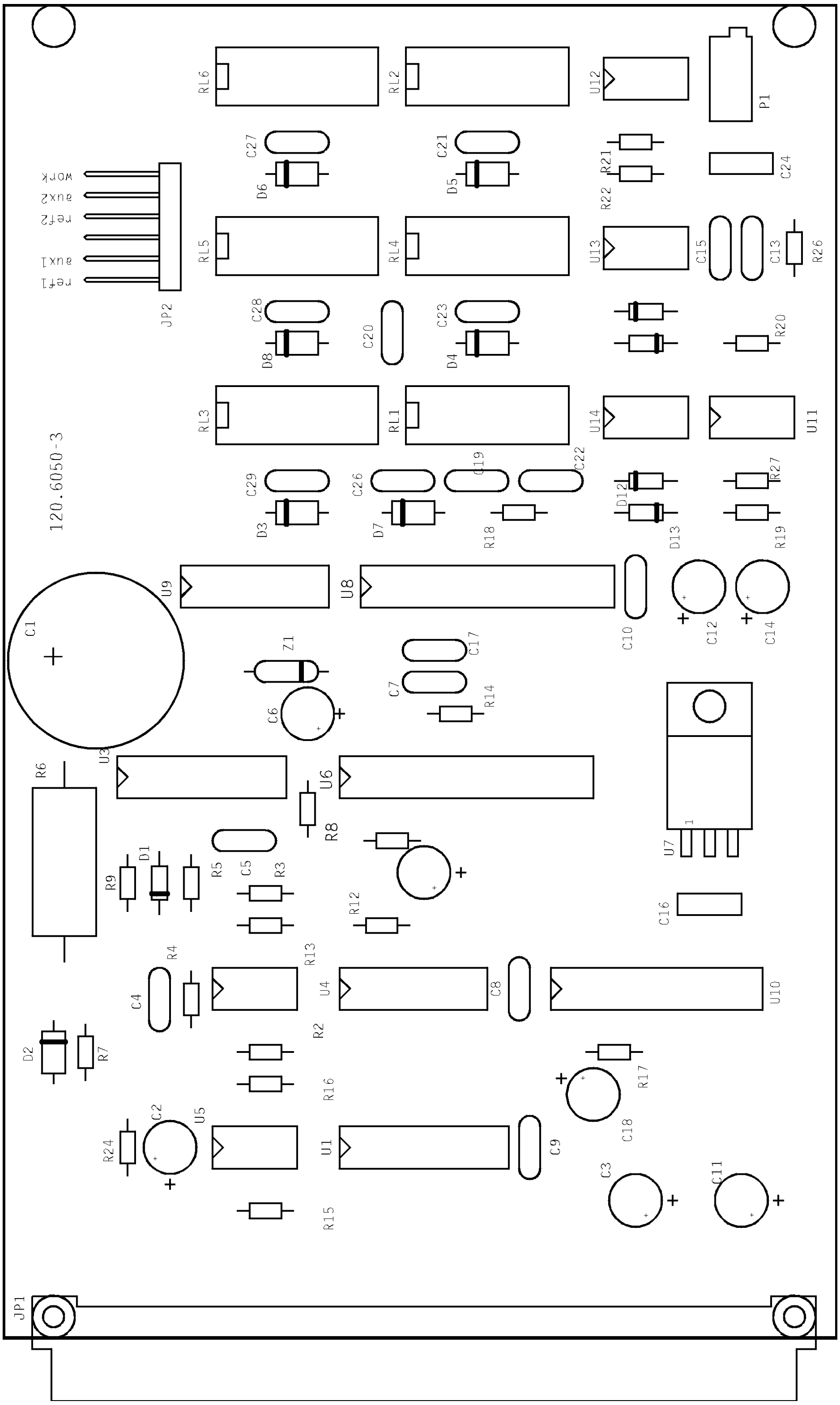
12 CPU-board layout



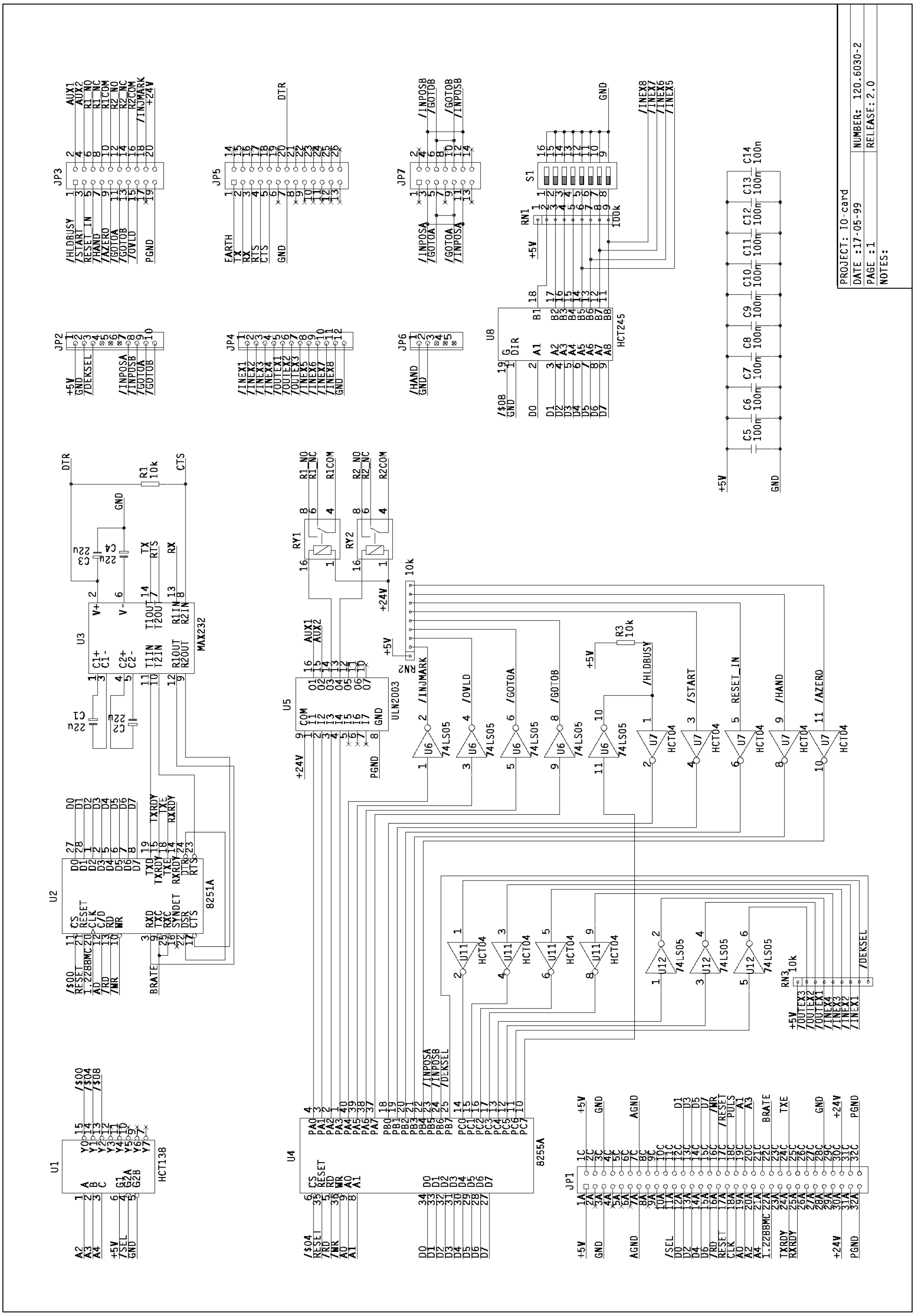
13 Oven control board circuit



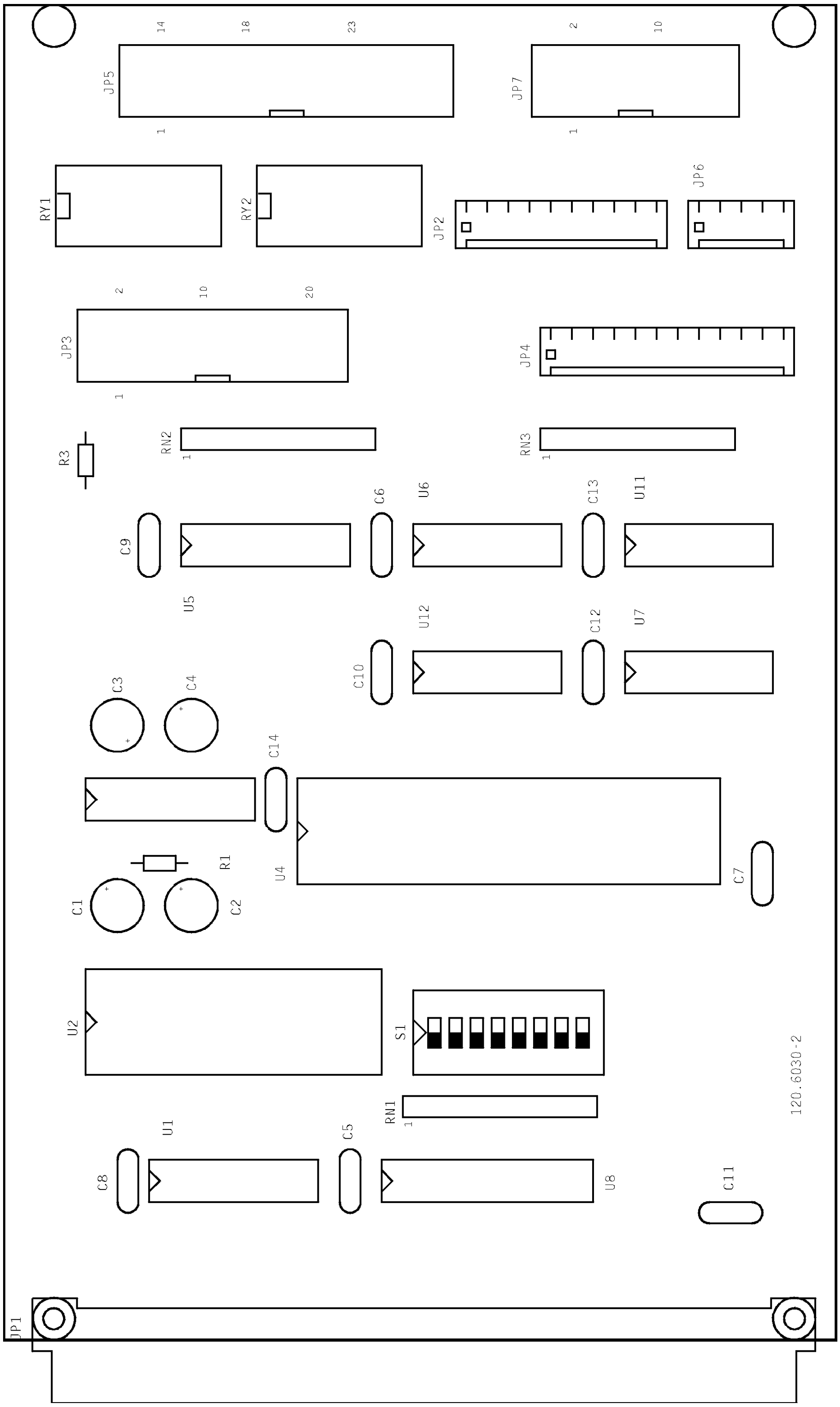
14 Oven control board layout



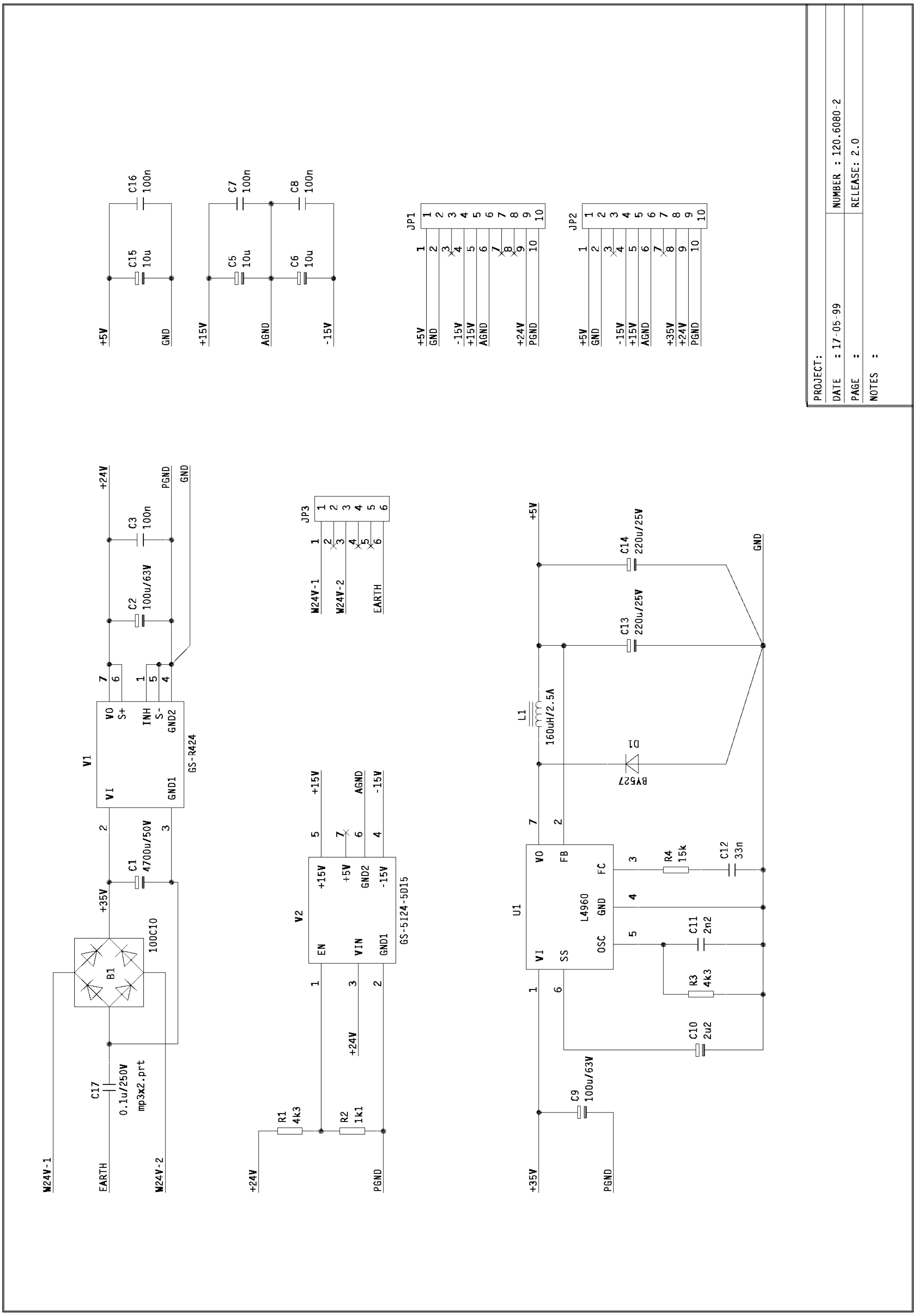
15 I/O-board circuit



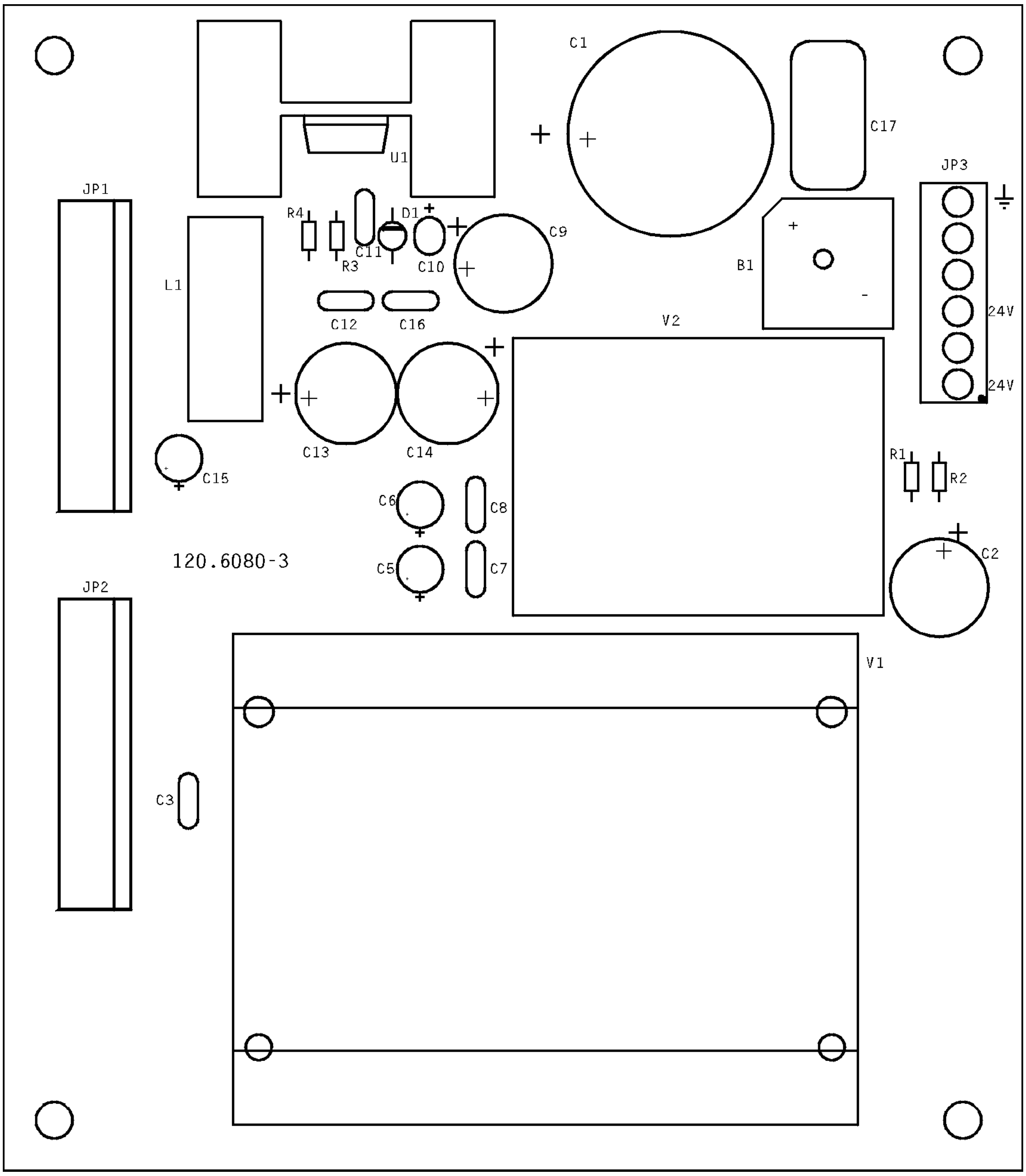
16 I/O-board layout



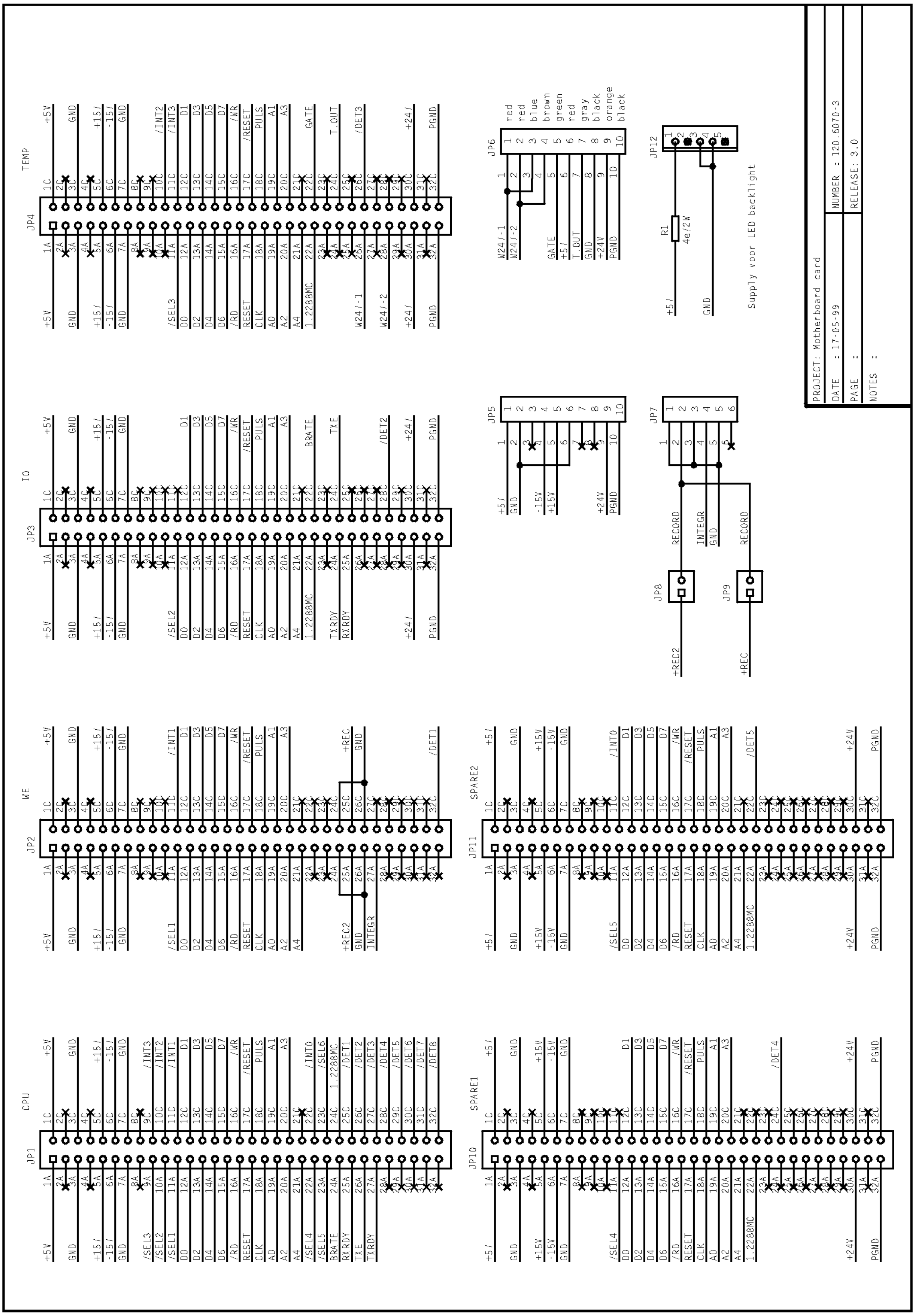
17 Power supply board circuit



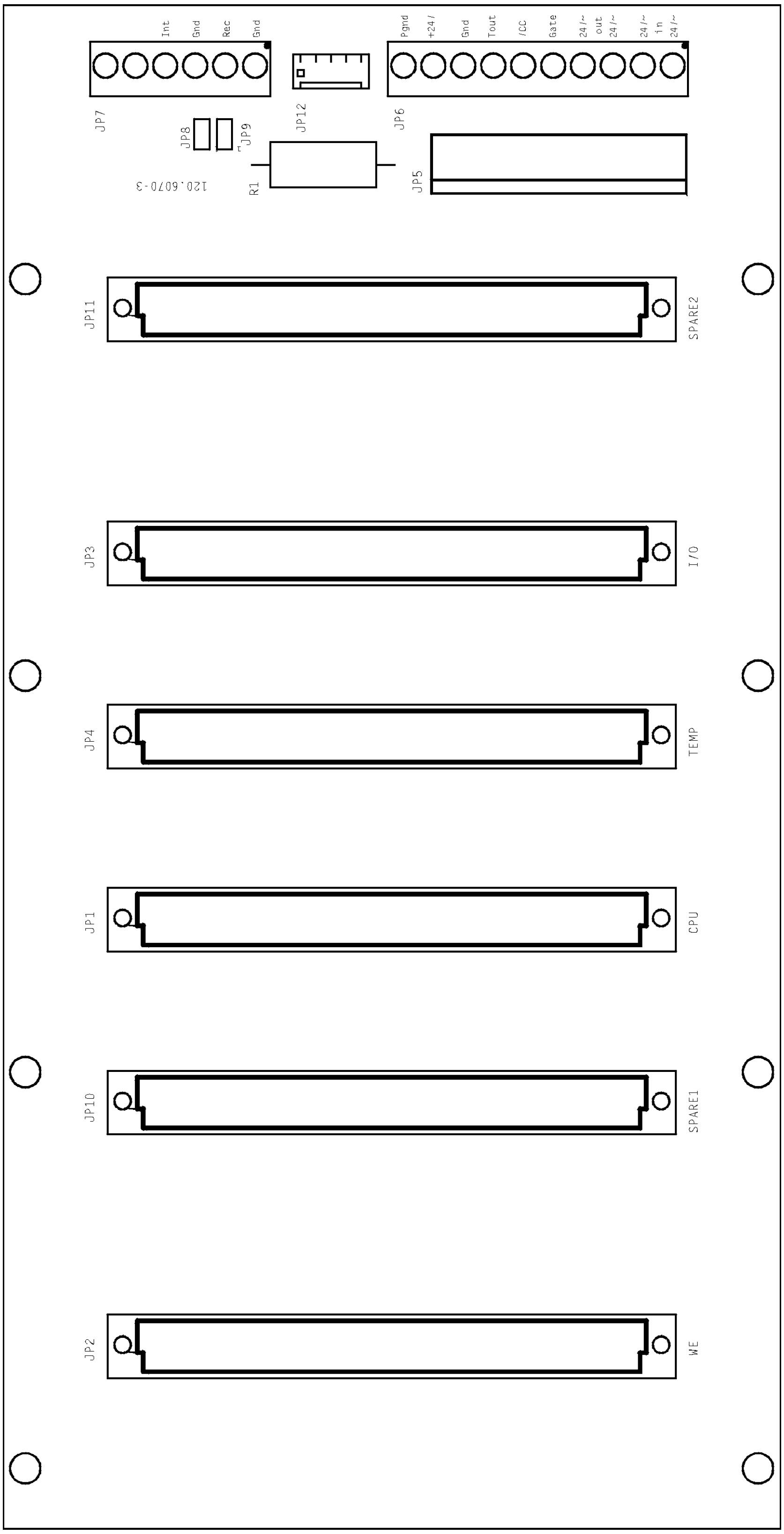
18 Power supply board layout



19 Motherboard circuit



20 Motherboard layout



21 Wiring diagram