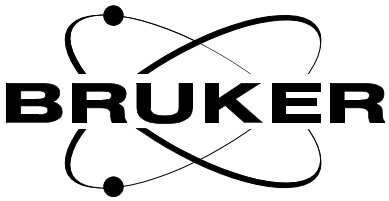

BMPC

Technical Manual

Version 001

BRUKER

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Goto

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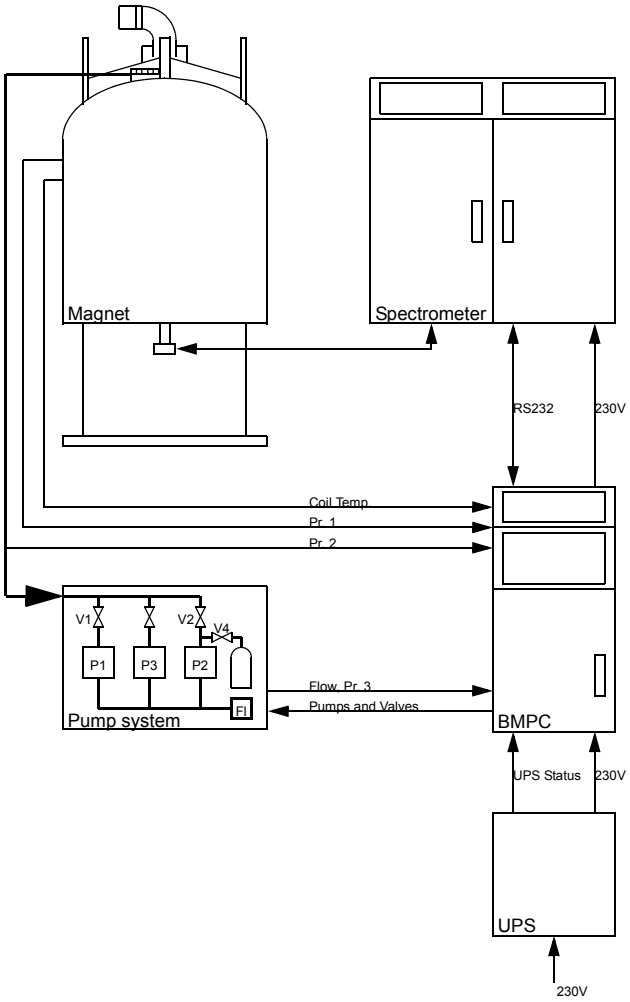
Introduction 1

General 1.1

The BMPC is a microcontroller based unit, used to control and supervise the pumps and valves needed to guarantee a stable condition of pumped Cryogenic High Field Superconducting Magnets. System parameters that are monitored and controlled by this unit include coil temperature, gas pressure and pumped gas flow. The unit carries out the following functions:

- Supervision of the Magnet status and cryogenic parameters
- Control of the Pump system
- Interface between the Magnet, Pump system and user

Figure 1.1. System Block Diagram



Safety Features 1.2

In order to achieve the highest possible level of operational safety, the important units and functions have built in redundancy.

- The pump system consists of three individual vacuum pumps, two of them being automatically controlled, while the third is manually controlled. This last unit provides the most power and is usually in operation during the magnet cool down.
- All pumps and valves can be operated either automatically or manually.
- Helium flow and pressure are measured and displayed by both the Automatic Control Unit and additional measuring instruments.
- To protect against power failures, the system is equipped with an UPS, which can supply power for up to a minimum of 4 hour period of power loss.

The failure of individual systems or extreme changes in the operating parameter values are automatically recognised by the Automatic Control System. If the control system is unable to correct any of these, then alarms are activated.

Monitoring and Automatic Functions 1.3

In order to monitor the magnet, the system parameters such as coil temperature, gas pressure and gas flow are continually measured, displayed on an LC-Display and compared to limit values.

Should any parameter move beyond its allowed limits, action is taken to restabilize or normalize the parameter. For example, should the temperature rise above a certain value, pump 2 would also be turned on, in order to bring the temperature back down.

In addition to these parameters, the controller also monitors the state of the pump system. Abnormalities or error conditions are noted and reported.

Function tests are carried out on Pump 2 at fixed intervals, in order to ensure that it will be available for use when needed.

Errors which do not directly affect the system performance are stored. They can be read via the LC-Display.

Hardware

2

Overview 2.1

The unit is built into a single cabinet and can be divided into 4 functional blocks.

- **BMPC A**utomatic **C**ontrol **U**nit - **BMPC ACU** H5727
  is usedfor the fully automatic control of the pumps and valves
- **BMPC M**anual **C**ontrol **U**nit - **BMPC MCU** H5726
  is used for the manual control of pumps and valves
- **BMPC P**anel **M**eter **U**nit - **BMPC PMU** H5728
  is used to measure pressures and helium flow
- **BMPC L**ine **C**ontrol **U**nit - **BMPC LCU** H5760
  is used as interface between BMPC ACU or BMPC MCU and pumps or valves

Every module is designed as a seperate unit, to allow for an easy exchange of any module.

Figure 2.1. Hardware Blockdiagram

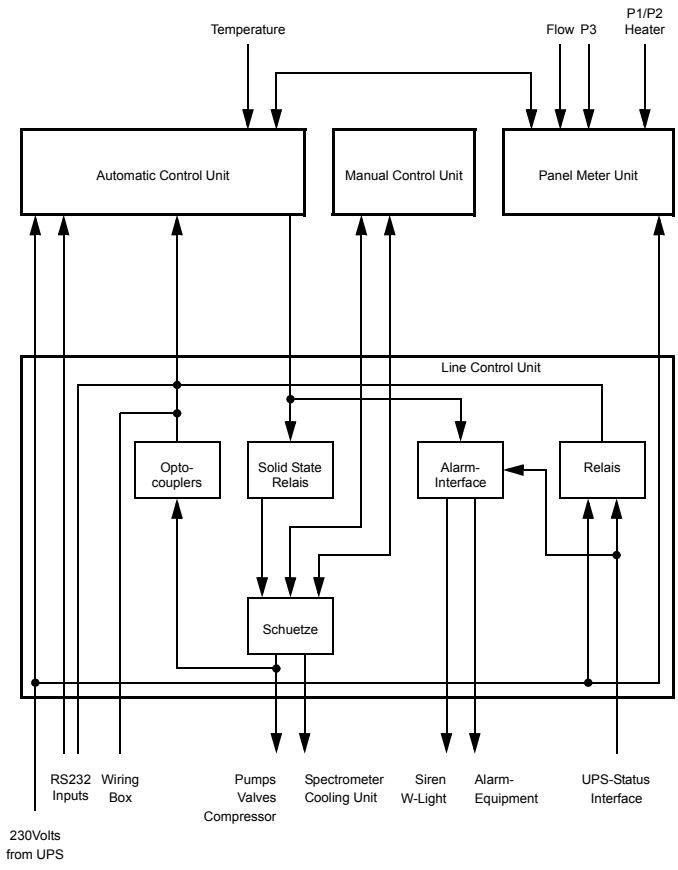
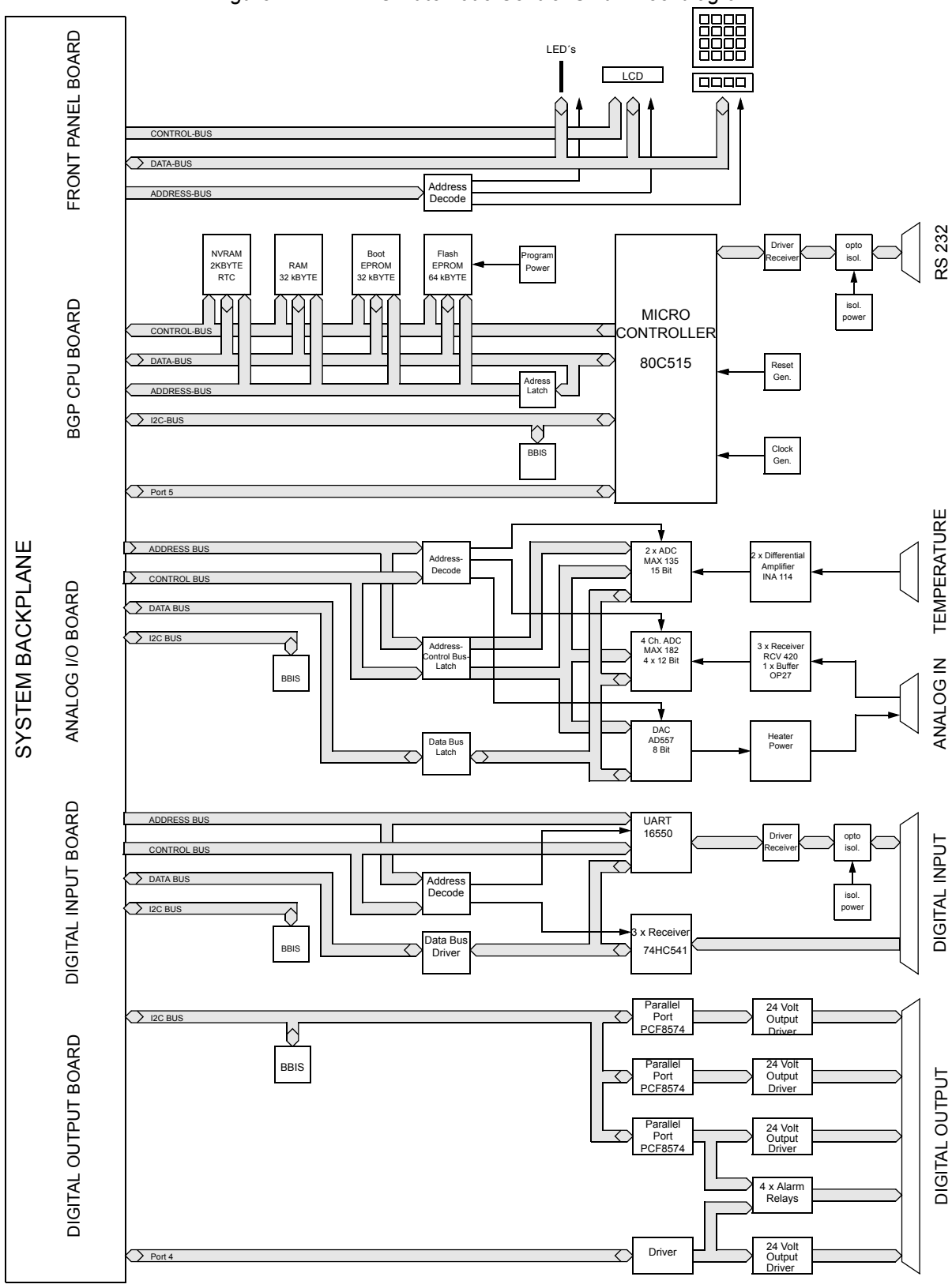


Figure 2.2. BMPC Automatic Control Unit - Blockdiagramm



BMPC Frontpanel Board - H5744 2.2.1

The frontpanel uses a 4 lines by 20 characters LC Display with LED backlight. The LED is switched on or off using the output OUT1 of IC U11 (UART 16550) on the BMPC Digital Input Board. LED on/off controlling is done by software. The 4x4 and 1x4 Keypads are encoded using the keyboard encoder 74C923 (U3). Every keypress forces an Interrupt on INT2 (P1.4) of the 80C515.

BGP 80C536 CPU Board - H5053 2.2.2

This is a general purpose CPU-Board, equipped with different functions.

- Microcontroller µC 80C535 or 80C515 (U15)
- I/O and memory decoder PAL 22V10 (U16) and 74LS138 (U14)
- Memory system:

  Eprom 27256 or 27512 (U3)

  Flash Eprom 28F256 or 28F512 or 29F010 (U2)

  Ram 62256 (U5)

  Ram 62256 or 6116 or NVRam 48TO2B (NVRam with RTC)
- Galvanic isolated RS232 Interface
- BBIS E^2Prom X24022 using I^2CBus Adress 0 (U12)

BMPC Digital Input Board - H5719 2.2.3

The BMPC Digital Input Board is used to sense the 24 Volt outputs of the 230 Volts optocouplers used in BMPC LCU. There are 24 inputs provided. All inputs are clamped to 5 V TTL level. They are read in using bus IC´s 74HC541 (U1, U5, U13). Additionaly there is a fully galvanic isolated RS232 Interface on the board, using UART 16550 (IC U 11).

BBIS E^2Prom X24022 using I^2C Bus Address 2.

BMPC Digital Output Board - H5715 2.2.4

The BMPC Digital Output Board is used to interface between the TTL outputs of the µC80C515 and the 230 Volts Solid State Relais in BMPC LCU. The signals are output using 3 x I^2CBus parallel ports (U3, U6, U9 using I^2CBus address 0, 1 and 2) driving 24 V open collector Outputs L603 (IC U1, U4, U7). There are 4 relays used as galvanic isolated alarm outputs provided on the board. Additionaly there is an interface that serves two switch inputs and 4 x 24 Volt outputs, to drive Buzzers, Relais or Led´s (each output can drive 100mA).

BBIS E^2Prom X24022 using I^2C Bus Address 1.

The BMPC Analog I/O Board is used to interface all sensors used in the system.

1. Temperature Sensors: To measure T1 and T2 there are two current sources driving 10 µA (U4, U3, U9) through the temperature sensor. The voltage (proportional to the temperature) is measured using an instrumentation Amplifier INA114 (U5, U11) and a 15 Bit + Sign ADC MAX135 (U6 and U12).
2. Pressure Sensors: The pressures P1, P2 and P3 are measured using a signal-converter RCV420 (4-20mA to voltage) (U16, U17, U18). The outputs are measured using a 12 Bit ADC with 4 inputs MAX182 (U19) (only 3 inputs are used for pressure measurement).
3. Helium Flow Sensor: The helium flow Fl is measured using the fourth input from MAX182, but driven using an OP27 (U10).

Additionally there is an output to drive the heating resistor of the magnet. It is designed to drive up to 1000 mW with resistors between 50 and 200 ohms. The Output can be switched on/off using a relay (RL1).

The µP Bus interface is designed to be as low noise as possible at the anlog to digital converters. The whole µP Bus is only active, if one of the I/O´s on the Board is selected by firmware.

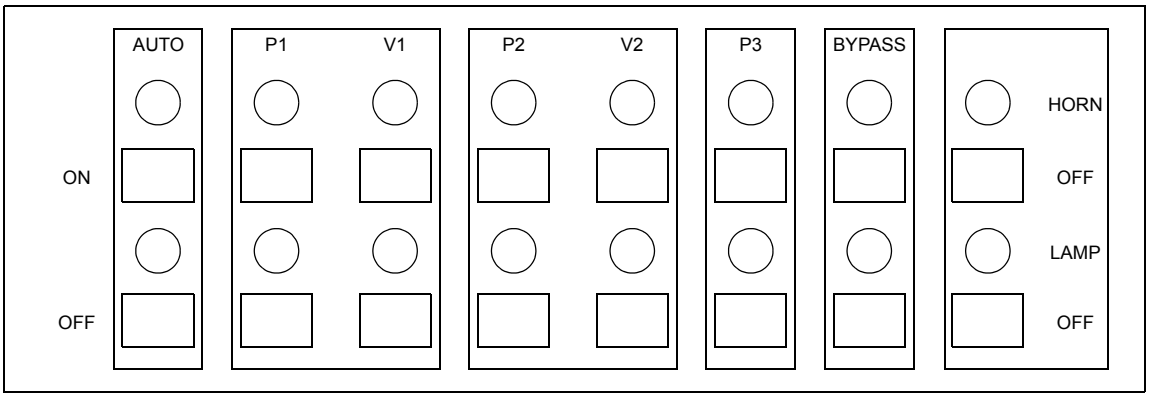
BBIS E^2Prom X24022 (U14) uses I^2CBus address 3.

BMPC Manual Control Unit - BMPC MCU 2.3

The BMPC Manual Control Unit is designed to have full manual control on all pumps and valves except Valve 4, that only can be controlled from BMPC ACU. The BMPC MCU can only be used if the BMPC is in manual mode. In automatic mode all switches from BMPC MCU are disabled (except Horn off, Lamp off, Auto on, Auto off). If a warning or an alarm occurs, one or both of the Leds Horn / Lamp and the corresponding Alarm System (Warning Lamp and / or Alarm Siren) is on. To switch them off, the keys Lamp off and Horn off are used. If the warning or alarm is only switched off, but the reason for the alarm still resides, the alarm outputs are switched on again after a delay from about 20 minutes.

All status leds show the actual status of their corresponding function even if the unit is in automatic mode.

Figure 2.3. BMPC Manual Control Unit Frontpanel



BMPC Panel Meter Unit - BMPC PMU 2.4

The BMPC Panel Meter Unit is the main interface between the pressure sensors P1, P2, P3, the helium flow sensor Fl and the BMPC. To measure the pressures P1, P2 and P3 the Digital Panel Meter 907.15.532 from WIKA is used. To measure the helium flow Fl the flowmeter Enall-P from Hastings or the flowmeter PSR-E from Schäfer is used.

If the BMPC ACU is not used in the system, or disconnected, use the dummy plug (BMPC Analog Dummy Connector HZ04438) at Analog Out. If it is not in place the pressure readouts will be incorrect.

BMPC Line Control Unit - BMPC LCU 2.5

The BMPC LCU is the main interface between BMPC and the pumps and valves. All pumps and valves are switched ON or OFF from BMPC LCU. Therefor a lot of relays, contactors, motor protection switches and fuses are used

While servicing beware of mains voltages!!

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Table 2.1. Protection circuits overview

Pos	Circuit Breaker	Type	Protected Part(s) / Function
1	3F02	S271-K 16A	Main fuse, emergency generator supply (L)
2	3F03	S271-K 16A	Main fuse, emergency generator supply (N)
3	3F04	NEOZED 35A	Main fuse, UPS supply (L)
4	3F04	NEOZED 35A	Main fuse, UPS supply (N)
5	3Q06	PKZM1-2.4 (2A)	Transformer 3TR06 primary side
6	3F07	S271-K 4A	Transformer 3TR06 secondary side
7	3F14	S271-D 20A	Console, Cooling Unit
8	5F13	S271-K 6A	Solenoid Valve V1
9	6F13	S271-K 6A	Solenoid Valve V2
10	7F13	S271-K 6A	Solenoid Valve V3
11	8F13	S271-K 6A	Solenoid Valve V4
12	9Q12	PKZM1-6 (4,5A)	Motor protection circuit breaker P1
13	10Q12	PKZM1-6 (4,5A)	Motor protection circuit breaker P2
14	11Q12	PKZM1-6 (12A)	Motor protection circuit breaker P3
15	12F01	5x20 t 100mA	Transformer 12F01 primary side
16	12F03	5x20 t 1A	Transformer 12F01 secondaryside
17	16F13	5x20 t 200mA	uP interface X1 (optocouplers)
18	18F11	S271-K 6A	Warning lamp, siren (alarm system)
19	19Q12	PKZM1-6 (4A)	Motor protection circuit breaker compressor
20	23F03	S271-K 6A	BMPC ACU, BMPC PMU

Table 2.2. Switches overview

Pos	Switch	Type	Function
1	3S03	4xNC,4xNO	Mains Off, power from UPS or emergency gen.
2	3S11	1xNC,1xNO	Console On (enable)
3	18S11	1xNC,1xNO	Generate Alarm

WARNING Line voltage present at 3S03, 3F02, 3F03, 3F04, 3F05 and X12 even with machine power off!

Software 3

Overview 3.1

The software enables a fully automatic operation of the vacuum pumps used to hold the magnet at its operating temperature. It also supplies many service and test functions. In combination with any alarm equipment (e.g. Bruker Monitoring System) it ensures that the pumped magnet system is extremely safe.

Automatic Mode 3.2

This is the normal operating mode. Only the operation in automatic mode enables the control of pumps and valves by the BMPC Automatic Control Unit. Only in Automatic mode can reactions to bad sensor values be done automatically by the BMPC Automatic Control Unit. In Automatic mode the switches of the BMPC Manual Control Unit are not enabled (except the Horn Off- and Lamp Off switches).

Measuring and Checking 3.2.1

In normal automatic operation, the system measures the following values:

1. Voltage temperature VT1
2. Voltage temperature VT2
3. Pressure P1
4. Pressure P2
5. Pressure P3
6. Helium Flow FI

All sensor values are measured periodically and they are checked against previously set limit values. If a sensor value is higher or lower than the specific limit value the program responds accordingly.

Temperature VT1 or VT2:

- VT1 or VT2 < VT1,VT2 Regulate
  The Bypass Valve[1] is automatically opened. It is closed again if the values are higher then VT1 or VT2 Normal.
- VT1 or VT2 < VT1,VT2 Warning
  Pump 2 is switched on and after a short delay Valve 2 is opened. The Pump is switched off, and the valve closed again if the values are higher then VT1,VT2

1. Bypass Valve is an option

Regulate.
During the warning level condition the warning lamp output is switched on.

- VT1 or VT2 < VT1,VT2 Alarm
  The T1T2 Alarm relays is switched on (Alarm switch closed) and the alarm siren output is switched on.
  The alarm can be reset using the error function on the keyboard

Pressure P1

- P1 > P1 High Warning
  Pump 2 is switched on, the Bypass valve is opened and after a delay of 30 seconds Valve 2 is opened. Additionally the warning lamp output is switched on. The Pump is switched off, and the valves closed again if the value is lower then P1 High Normal.
- P1 > P1 High Alarm
  The P1High Alarm relays and the alarm siren output are switched on (Alarm switch closed).
- P1 < P1 Low Warning
  The warning lamp output is switched on. The warning is reset if the value returns to higher P1 Low Normal.
- P1 < P1 Low Alarm
  The P1Low Alarm relays and the alarm siren output are switched on.
  The alarm can be reset using the error function on the keyboard

Pressure P2

- P2 is used to control the heating if heater regulation is enabled. This function works in both, automatic and manual mode.

Helium Flow

- FI < FI Warning
  Pump2 is switched on, the Bypass valve is opened and after a delay of 30 seconds, Valve 2 is opened. Additionally the warning lamp output is switched on. The Pump is switched off, and the valves closed again when the value becomes higher then FI Normal.
  During the warning level condition the warning lamp output is switched on.
- FI < FI Alarm
  The FI Alarm Relays and the alarm siren output are switched on.
  The alarm can be reset using the error function on the keyboard

All warnings and alarms are combined together with time and date of occurance to the Errorqueue.

Alarm System *3.2.2*

The alarm relays can be used to switch alarm Equipment (24V AC/DC). In connection with the Bruker Monitoring System an alarm forces a telephone based alarm to the personell required to check the magnet system (see also Bruker Monitoring System).

Status Checking 3.2.3

All Input and Output functions are checked periodically by the BMPC Automatic Control Unit.

1. Function of Pump 1
2. Pump 1 Protection switch
3. Valve 1 power
4. Function of Pump 2
5. Pump 2 Protection switch
6. Valve 2 power
7. Function of Pump 3
8. Pump 3 Protection switch
9. Valve 3 power
10. Valve 4 power
11. Automatic Mode
12. Warning Lamp power
13. Warning Siren power
14. Alarm Fuse (Lamp and Siren)
15. Main Switch position (UPS or Emergency System)
16. Line Voltage L1 present
17. UPS Interface
    Load onBypass
    Low Battery
    UPS discharging
    UPS failure

If any of the above functions fails, this will be detected and stored in the error queue

Pump 1 Status 3.2.4

If Pump P1 fails, this will be detected and immediately Pump2 is switched on, Valve V1 is closed and after 30 seconds Valve V2 is opened. This makes sure that no Helium Flow Alarm or P1 High Alarm occurs, as would happen with non working pumps. The Warning Lamp is switched on to sign the Pump 1 failure. Additionally the time at which the pump failed is stored in the Error Queue.

Pump 2 Test 3.2.5

To ensure that Pump 2, which is needed in case of emergency, is operating correctly, there is an automatic test function which is started automatically at fixed times.

To start this test function it has to be initialized once by the user. To initiate the first Pump 2 test the function key RTC is needed (see***"RTC" on page 26***).

Press ESC Key until Point 7 „Enter Year Test P2“, now enter the date and time of the first Pump 2 Test. At point 12 „Enter Test Interval“ enter the number of days between every test of Pump2. If all values are stored the first automatic Pump 2 Test will start at the date and time entered. Each succesive Pump 2 Test will start at the same time, but delayed by the number of days, entered in test interval.

On starting, Pump 2 Test switches on P2. The LCD shows the following text.

Testing Pump 2	Function Name
Ventil 4 closed	Status of Test
P3 = 1024	Pressure P3

After a short delay, V4 will be opened, so that P2 can evacuate the test volume. The LCD shows the following text.

Testing Pump 2	Function Name
Ventil 4 opened	Status of Test
P3 = 234	Pressure P3

The test now runs for about 2 minutes. After 2 minutes the pressure P3 must be lower or equal to the pressure entered with the Limit Key function (see ***"Limits" on page 26***) at point P3 Test. If the test fails, the warning lamp is switched on and an error message is added to the error queue.

If Pump 2 is running at the time the test should run, the test will be delayed for 24 hours.

If, while a running Pump 2 Test the pump P2 is needed to stabilize magnet parameters, the test is aborted and delayed for 24 hours.

Helium fill cycle *3.2.6*

To stabilize temperatures while filling helium, Pump 2 and Valve 2 can be switched on using the switch at BMPC Wiring Box. A keypress starts Pump 2 and after a short delay it opens Valve 2. The running helium fill cycle is indicated by the LED on BMPC Wiring Box. Additionally the Buzzer will beep once an hour.
The helium fill cycle remains until a new keypress or for 48 hours after the first keypress.

Automatic Failure *3.2.7*

If the automatic mode fails, the unit switches to the manual mode, leaving all functions at the last state.

The main difference to operation in automatic mode is, that the Automatic control unit cannot manipulate any pumps or valves while in manual mode (this is hardware protected).

Control of pumps and valves can only be done using the Manual Control Unit.

All functions described in ***"Status Checking" on page 19*** are not enabled in manual mode.

The monitoring- and alarm functions are still enabled, that means that even in manual mode all sensor values are periodically measured and compared to their limit values, alarms are triggered if an alarm condition occurs, but there is no automatic reaction if any failure happens.

The manual mode is mostly used during installation, test and service.

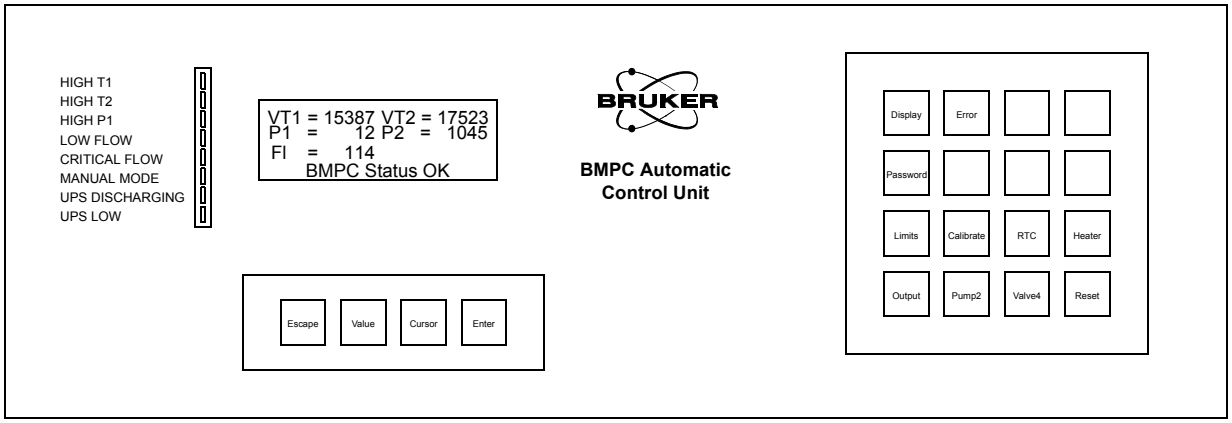
Keypad Functions

4

Overview 4.1

The 4 x 4 Keypad and the 1 x 4 Keypad are used together with the 4 x 20 character LCD to control the automatic functions of the BMPC. Normaly the back light of the LCD is switched off. A keypress on any key switches on the LCD backlight without initiating the key-specific function. If the backlight is already on, a keypress initiates the selected function. If no keypress occurs for about 5 minutes, the backlight will be switched off automatically. If a function is selected after pressing a specific key, the function can be exited using the same key again or by pressing another function key.

Figure 4.1. Front Panel Automatic Control Unit



There are two different kind of key functions available:

- Function Keys: A keypress initiates a specific function (see ***"Function Keys" on page 24***).
- Data Entry Keys: These are used to change or input data used for the selected function (see ***"Data Entry Keys" on page 29***)

Display 4.2.1

A keypress on **Display** toggles between different display layouts of the LCD.

Standard Display

VT1=22175 VT2=19364	Voltage T1 and T2
P1 = 11 P2 = 1036	Pressure 1 and Pressure 2
Fl = 119	Helium Flow
BMPC Status OK	BMBC Status

Extended Display

09:46:54 25.10.94	present Time and Date
VT1=22175 VT2=19364	Voltage T1 and T2
P1 = 11 P2 = 1036	Pressure 1 and Pressure 2
P3 = 1024 Fl = 119	Pressure 3 and Helium Flow

Temperature Control Display - Heater Regulation disabled

Regulation is off	Heater Regulation is off
p3= 1013.7	Pressure 3
P = 300	manual Heater power

Temperature Control Display - Heater Regulation enabled

Cnt 35 Pr= 1200	Timebase counter, Proportional term
p2=1013.2 In= 384	Pressure 2, Integral term
Er= 4.8 Di= 0	Regulation error, Differential term
P = 534 PID= 158	regulated Heater power, PID term

If a special function is selected (e.g. RTC) a keypress on **Display** aborts the selected function and displays the Standard Display. The Extended Display is used to test the RTC for time and date and is used, when serving to calibrate all pressure sensors.

The Temperature Control Display is used to control the Heater section.

Error *4.2.2*

The key **Error** is used to display error messages. If one or more errors occurred during the operation of the BMPC this will be displayed on the status line of the Standard display. Instead of „BMPC Status OK“ the message „xx Errors in Queue“ will appear on the LCD. A keypress on **Error** displays the last stored error.
Example: Alarm function Pressure 1 is too high.

Error Number 4	Queue Index
Alarm P1	Error Text
is too high	
10:20:53 25.10.94	Time and Date of occurrence

Error Number 4 indicates that there are 4 errors in the error queue. Error number 4 was the last stored error and occurred on the 25th of october 94. Use the Key ESC to look through all the error messages until the following message appears.

No more Errors

in Error Queue

The Key **Enter** is used to delete the error displayed. The error can only be deleted if the cause which forced the error is removed. If not, the error message is added again at the end of the error queue. Use the **Enter** key until all errors are deleted. All errors are stored together with time and date of their occurrence This feature can be used to have an exact error protocol.

Password *4.2.3*

Some functions of BMPC are only allowed in supervisor mode (Calibration, RTC...). To enter the password for supervisor mode use the key **Password**. The LCD shows the following text:

Enter Password

New Value = 00000

Use the **Cursor** and **Value** Key to enter the supervisor password. If entered, use the **Enter** key to confirm the password (see***"Data Entry Keys" on page 29***). If the password is OK the following text appears.

Enter Password

New Value = 12345

SupervisorMode

entered

If the password is wrong the text

Enter Password

New Value = 54321

SupervisorMode

left

appears on the LCD. To leave the supervisor mode, simply enter a false password (this should be done if supervisor work is finished).

Limits 4.2.4

To display and change the limit values of the BMPC use the **Limits** key (Supervisor mode required). The following display appears:

VT1 Normal	indicates VT1 Normal to change
New Value = 17000	the new limit value
Old Value = 17000	the old limit value
Max Value = 60000	maximum value allowed

To change a limit use the **Value** and **Cursor** Key to type in a new value and press **Enter** to store the new limit value. The **ESC** Key escapes the selected limit without storing the new value (can be used to look through all stored limit values)(see ***"Data Entry Keys" on page 29***). The order of limit values is as follows

Table 4.1. Limit Value Order

VT1 Normal	VT1 Regulate	VT1 Warning	VT1 Alarm
VT2 Normal	VT2 Regulate	VT2 Warning	VT2 Alarm
P1 Low Normal	P1 Low Warning	P1 Low Alarm	
P1 High Normal	P1 High Warning	P1 High Alarm	
P3 Test			
Flow Normal	Flow Warning	Flow Alarm	

Every value entered is stored in a non volatile *EEPROM*, and the values stored are loaded every time a power on or a reset occurs. To leave the function simply press the **Limit** key again or select another function.

Calibrate 4.2.5

This key is used to calibrate the temperature, the pressure and the helium flow sensors.

WARNING: Use this function with care, wrong calibration can result in bad function of the unit!!

see (***"Calibration" on page 62***)

RTC 4.2.6

The **RTC** key is used to set the internal Real Time Clock (supervisor mode required). After a keypress the following message appears on the LCD:

RTC Setup Menu	Functionname
Enter Year	Value to change
94	Value
11:56:33 25.10.94	actual values

Use the **Value** and **Cursor** keys to change the selected value. The **Enter** key stores the value and the **ESC** key escapes without changing a value (see ***"Data Entry Keys" on page 29***). The order is as follows:

Table 4.2. RTC Value Order

1. Year	7. Year Test P2
2. Month	8. Month Test P2
3. Day	9. Day Test P2
4. Hour	10. Hour Test P2
5. Minute	11. Minute Test P2
6. Seconds	12. Testintervall

Points 7 to12 are to select the first automatic Pump 2 test cycle. If the date and time stored for Pump 2 test is reached, an automatic test of pump P2 will be initiated.

Heater *4.2.7*

The **Heater** Key is used to set the parameters used for the heater regulation. (supervisor mode required). After a keypress the following message appears on the LCD:

Regul. on=1 off=0	Function name
New Value = 1	Value to change
Old Value = 1	Value
Max Value = 1	Maximum value

Use the **Value** and **Cursor** key to change the selected value. The **Enter** key stores the value and the **ESC** key escapes without changing a value (see ***"Data Entry Keys" on page 29***).

The Heater Value order is as follows

Table 4.3. Heater Value order

	Name	Range
0	Regulation On-Off Control	On = 1 / Off = 0
1	P2 Regulate	0 - 11000 in 1/10mBar[a]
2	Proportional Const.	0 - 1000
3	Integral Const	0 - 1000
4	Differential Const.	0 - 1000
5	Regulation Time Base	0 - 21600 in seconds
6	Maximum Heater Power	0 - 1000 in mW
7	Heater Resistor	0 - 200 in Ohms

Table 4.3. Heater Value order

	Name	Range
8	Manual Heater Power	0 - 1000 in mW
9	Integral Start Value	0 - 1000

a. Enter P2 Regulate in 1/10 mBar. For Example 1013 mBar must be entered as 10130.

If the heater regulation is off, the heater power selected in Manual Heater Power is output to the magnet´s heating system (max. 1000 mW). To ensure correct calculation of the heater power the heater resistor must be typed in correctly!
If no magnet heater is required, select regulation **off** and manual heater power = **0;** then the heater output is switched off.

If heater regulation is on, the regulation algorithm tries to hold the pressure difference between P2 and P2 Regulate at 0 mBars (P2 - P2 Regulate = 0 mBars).
To change the regulation characteristic, the values Proportional Const., Integral Const., Differential Const. and Regulation Time Base are used. Do not change any of these values, because it could cause regulation errors.
The maximum allowed power for the automatic regulation can be changed using Maximum Heater Power.

Output *4.2.8*

The **Output** Key is needed to use the settings set in manual Mode for the automatic Mode.

Pump2 *4.2.9*

The **Pump2** Key toggles the status of Pump 2. This function is only enabled during calibration.

Valve4 *4.2.10*

The **Valve4** Key toggles the status of Valve 4. This function is only enabled during calibration.

Reset *4.2.11*

A keypress on **Reset** forces a reset of the application firmware. This is a software reset!

If any function which allows data entry is activ, the key layout for the 1 x 4 keypad is as follows:

ESC

The **Escape** Key escapes from the subfunction displayed without storing a value and switches to next subfunction. This function can be used to look through the whole parameter block selected.

Value

The **Value** Key changes the value indicated by the cursor. The software checks the value against its maximum, so it could be that all values between 0 and 9 are not always allowed.

Example 1: change the value XY Normal from1**4**183 to 1**1**183

XY Normal	
New Value = 1<u>4</u>183	all Values between 0 and 9
Old Value = 14183	are now allowed for the selected digit
Max Value = 45000	because maximum value is 45000
New Value = 1<u>4</u>183	press **Value** Key - Digit changes to 5
New Value = 1<u>5</u>183	press **Value** Key - Digit changes to 6
New Value = 1<u>6</u>183	press **Value** Key - Digit changes to 7
New Value = 1<u>7</u>183	press **Value** Key - Digit changes to 8
New Value = 1<u>8</u>183	press **Value** Key - Digit changes to 9
New Value = 1<u>9</u>183	press **Value** Key - Digit changes to 0
New Value = 1<u>0</u>183	press **Value** Key - Digit changes to 1
New Value = 1<u>1</u>183	new Value - press **Enter** Key to store it
	or **Escape** Key to cancel

Example 2: change the value XY Normal from 4**4**183 to 4**1**183

XY Normal	
New Value = 4<u>4</u>183	only the Values between 0 and 4
Old Value = 44183	are now allowed for the selected digit
Max Value = 45000	because maximum value is 45000
New Value = 4<u>4</u>183	press **Value** Key - Digit changes to 0
New Value = 4<u>0</u>183	press **Value** Key - Digit changes to 1
New Value = 4<u>1</u>183	new Value - press **Enter** Key to store it
	or **Escape** Key to cancel

Goto

Cursor

The **Cursor** Key moves the cursor to the next position allowed. The cursor always moves from the lowest digit to the highest digit allowed and starts again at the lowest digit.

Enter

The **Enter** Key stores the displayed value and switches to next subfunction.

The old value is lost after pressing the Enter Key, therefore, use function with care!

Command List 5

System Commands 5.1

Power Up 5.1.1

MA

Performs a software reset. Replies identification short string (4 characters) of BM-PC.

Reply: M A B M P C

Error Accept 5.1.2

ME

Clears an BMPC error. The BMPC accepts the next command only if all errors are cleared.

Reply:
no more errors: M E
else: M FF_{hex} X1 X2 X3 X4 S1..Sn (next error)

Example:
->M S ;any command
<-M FF_{hex} 2 B M P C S o m e E r r o r 0_{hex} ;Error message
->M E ;Error accept
<-M FF_{hex} 13 B M P C C h e c k S u m E r r o r 0_{hex} ;more errors
->M E ;Error accept
<-M E ;no more errors

Change Accept (Querry) 5.1.3

MQ

With this command all system changes are reported.

Reply: M Q ;if no changes occur

Configuration 5.1.4

MK

Sends system configuration data for service tool.

Reply: M K 1 M ;for BMPC only

Read BBIS (Bruker Board Information System) 5.1.5

M Z ? X1 X2

Read 16 Bytes of the Bruker Board Information System from serial EEPROM.

X1: selects which BBIS to read (0-7)
for BMPC: 00_{hex} -> CPU-Board
01_{hex} -> Digital Output Board
02_{hex} -> Digital Input Board
03_{hex} -> Analog I/O Board

X2: Address of first Byte to read
for BMPC: 00_{hex} - EF_{hex}

Reply : M Z ? X1 X2 D1 .. D16

Write BBIS 5.1.6

M Z ! X1 X2 D1 .. D16

Write 16 Bytes of the Bruker Board Information System to serial EEPROM.

X1: selects which BBIS to write (0-7)
for BMPC: 00_{hex} -> CPU-Board
01_{hex} -> Digital Output Board
02_{hex} -> Digital Input Board
03_{hex} -> Analog I/O Board

X2: Address of first Byte to write
for BMPC: 00_{hex} - EF_{hex}

Reply : M Z ! X1 X2 D1 .. D16

Program download 5.1.7

M Z Z

When sent twice, this command clears the application program on the BMPC´s FLASH-EPROM in order to reprogram it.

Example:
-> M Z Z
<- M Z Z
-> M Z Z ;ATTENTION: After the second M Z Z application program is deleted to allow reprogramming of the FLASH EEPROM !
<- M Z Z
-> M : ;now send first record of source file
<- M O K ;record is programmed error free
repeat last two points until the last record is programmed
-> M : ;now send End-Of-File record
<- M F F ;end of download, BMPC performs reset

Program upload 5.1.8

M Z [X1 X2 X3 X4

This command sends 16 Bytes of programm code from BMPC´s application program.

X1..X4: Address to read 16 Byte of program code

Reply: M Z [X1 X2 X3 X4 D1 .. D16

D1..D16: 16 Bytes of program Code starting at adress X1..X4

Before uploading program code check memory map of BMPC!

Version 5.1.9

M Z V X1

Sends version information of the unit.

X1:
- H = Hardware
- D = First Piggy Board
- L = Second Piggy Board
- B = Boot Software
- A = Application Software
- K = Kernel Software
- C = Checksum Application Firmware
- E = Checksum Boot Firmware

Reply: M Z V X1 X2 X3 X4 X5 X7

if X1 = B or A

- X2: year
- X3: year
- X4: month
- X5: month
- X6: day
- X7: day

Example:

X2	X3	X4	X5	X6	X7		
9	3	0	2	0	8	->	8. Feb. 1993

if X1 = H or D X2: HW-code

if X1 = C or E X2: high byte X3: low byte

Activate Watchdog 5.1.10

M Z Y

Activates watchdog. The watchdog can only be stopped by a hardware reset. This is a dummy function (for compatibilitiy to BSMS), because Watchdog is always activated in the BMPC.

Reply: M Z Y

Check System 5.1.11

M Z C

Checks all parts of the unit. If an error occurs an error message is replied.

Reply:	M Z C	;everything is OK
	M FFhex....	;error message (see error messages)

Processor Sleep 5.1.12

M Z D..X1

X1:	0_{hex}	go to sleep mode
	1_{hex}	leave sleep mode

After this command the processor is in sleep mode (no clock, no access on address- or databus). Waking up is only possible with a Reset or a power down power up sequence.

Reply: M Z D X1

M N X1 X2 D1 D2 D3 D4 Exp Flags

Reads or writes selected Value from/to BMPC (Bruker Magnet Pump Control)

X1: select value (see ***Table 5.1.***)
X2: ´R´ or ´W´
D1,..,D4: Sensor Value

Reply: M N X1 X2 D1 D2 D3 D4 Exp Flags
Flags = 0 if Value was ok
Flags = 1 if Value was out of range

Example:

M N 0 R	Read Temperature T1
M N 0 R 0 0 7D 88 0 0	Temperature T1 is 32136
M N 3 R	Read Pressure P2
M N 3 R 0 0 04 00 0 0	Pressure P2 is 1024 mBar

Cross Reference: all values described can be used instead of X1

Table 5.1. Sensor Value Cross Reference

X1	Value to read	Comment
0	Temperature T1 (mV)	read only
1	Temperature T2 (mV)	read only
2	Pressure P1 (mBar)	read only
3	Pressure P2 (mBar)	read only
4	Pressure P3 (mBar)	read only
5	Helium Flow (SLPM)	read only
6	Helium Level (%)	read / write

M L X1 X2 D1 D2 D3 D4 Exp Flags

Reads or writes Limit Values.

X1: select value (see ***Table 5.2.***)
X2: ´R´or ´W´
D1,..,D4: Limit Value

Reply: M L X1 X2 D1 D2 D3 D4 Exp Flags
Flags = 0 if Value was ok;
Flags = 1 if Value was out of range

Example: M L 0 W 0 0 1B 9C 0 0 Set Limit T1 Normal to 7068
M L 0 W 0 0 1B 9C 0 0 Limit T1 Normal set to 7068

Cross Reference: all values described can be used instead of X1

Table 5.2. Limit Value Cross Reference

X1	Value
0	T1Normal
1	T1Regulate
2	T1Warning
3	T1Alarm
4	T2Normal
5	T2Regulate
6	T2Warning
7	T2Alarm
8	P1LowNormal
9	P1LowWarning
10	P1LowAlarm
11	P1HighNormal
12	P1HighWarning
13	P1HighAlarm
14	P2Normal *
15	P2Heating *
16	P3Test
17	FlowNormal
18	FlowWarning
19	FlowAlarm

M C X1 X2 D1 D2 D3 D4 Exp Flags

Calibrate Gain and Offset from selected Sensor

X1: Sensor to be calibrated (see ***Table 5.3.***)
X2: 0 = Calibrate High Value
1 = Calibrate Low Value
D1,..,D4: Calibration Value

Reply: M C X1 X2 D1 D2 D3 D4 Exp Flags
Flags = 0 if Value was ok
Flags = 1 if Value was out of range

Example: M C 3 1 0 0 2B 48 0 0 Calibrate Low Value
M C 3 1 0 0 2B 48 0 0 Temperature 1 to 11080

➪ ***To calibrate a sensor, the High Value must be transmitted first, and then the Low Value!***

Cross Reference: All Values described can used instead of XI

Table 5.3. Calibration Value Cross Reference

X1	to calibrate
0	Pressure 1
1	Pressure 2
2	Pressure 3
3	Temperature 1
4	Temperature 2
5	Helium Flow

Calibrate Zero Offset T1 and T2 *5.2.4*

M S

Initiates a Zero Offset Calibration of the two ADC´s used to measure Temperature 1 and Temperature 2.

Reply: M S

➪ ***This command writes the offset Values of both channels into the BBIS of BMPC Analog I/O Board to BBIS Block 4 at Address $E9_{hex}$ for T1 and EB_{hex} for T2. This may upset the calibration of Gain and Offset.***

M H X1 X2 D1 D2 D3 D4 Exp Flags

Reads or writes parameter for Heater Regulation

X1: Parameter select (see ***Table 5.4.***)
X2: ´R´ or ´W´
D1,..,D4: Parameter Value

Reply: M H X1 X2 D1 D2 D3 D4 Exp Flags
Flags = 0 if Value was ok;
Flags = 1 if Value was out of range

Example: M H 0 W 0 0 02 EE 0 0 Set maximum Heater Power to 750mW
M H 0 W 0 0 02 EE 0 0 Maximum Heater Power is set to 750mW

Cross Reference: all values described can be used instead of X1

Table 5.4. Heater Regulation Values Cross Reference

X1	Parameter	Range (D1..D4)
0	On-Off Control	On = 1 / Off = 0
1	P2 Regulate	0 - 1000 in mBar
2	Proportional Const.	0 - 1000
3	Integral Const	0 - 1000
4	Differential Const.	0 - 1000
5	Regulation Time Base	0 - 21600 in seconds
6	Maximum Heater Power	0 - 1000 in mW
7	Heater Resistor	0 - 200 in Ohms
8	Manual Heater Power	0 - 1000 inmW
9	Integral Start Value	0 - 1000

Read / Set Real Time Clock RTC 5.2.6

M T X1 D1 D2 D3 D4 D5 D6

This command reads or sets the Real Time Clock on the CPU Board.

X1: ‘R´or ´W´
D1, D2: Year in whole format (eg: 1995)
D3: Month
D4: Day
D5: Hours
D6: Minutes

Example: M T R ;Read RTC
M T R 13 5F 03 1C 0E 04
19 95 03 28 14 04 ;RTC reads 1995 03 28 14 04

Read / Set Time for Pump2 Test *5.2.7*

M M X1 D1 D2 D3 D4 D5 D6

This command reads or sets the Date and Time for the next Test of Pump 2.

X1: 'R´or ´W´
D1, D2: Year in whole format (eg: 1995)
D3: Month
D4: Day
D5: Hours
D6: Minutes

Example: M T R ;Read Time for next Pump2 Test
M T R 13 5F 03 1C 0E 04
19 95 03 28 14 04 ;next Pump2 Test is 1995 03 28 14 05

Diagnostic Commands *5.3*

Enter / Leave Diagnostic Mode *5.3.1*

M D X1

This command enters or leaves Diagnostic Mode

X1: 0 ;leave Diagnostic Mode
1 ;enter Daignostic Mode

Reply: M D X1

In Diagnostic Mode all sensor values are monitored, but not compared to their limit values. No Alarm- or Warning functions are provided.

Output Functions *5.3.2*

M O X1 X2

This command changes the output status of the output selected

X1: output to change (see ***Table 5.5.***)
X2: Output Status
X2 = 0 -> Output off
X2 = 1 -> Output on

WARNING: This function can directly affect system safety. Use with care

Cross Reference: all values described can be used instead of X1

Table 5.5. Output Value Cross Reference

X1	Output
0	Automatic Mode
1	Pump 1
2	Pump 2
3	Valve 1
4	Valve 2
5	Valve 3
6	Valve 4
7	Siren
8	Warning Lamp
9	Console
10	Alarm 1
11	Alarm 2
12	Alarm 3
13	Alarm 4
14	Spare 1
15	Spare 2
16	Spare 3
17	24 Volt SSR
18	Led 1
19	Led 2
20	Buzzer 1
21	Buzzer 2
22	Buzzer 3
23	LCD Led
24	Aux Out

M R A X1 X2

This command sets the Output-Pointer to the Queue.

X1, X2: Pointer to Queue (Value Range 0-1339)

Example: M R A 00 64 ;Set Pointer to actual Pos. -100
M R A 00 64 ;Pointer is set to Pos. -100

M R B D1 D2 D3 D4 D5 D6 D7 .... D24 D25 D26 D27

This command reads the value indexed by pointer from the queue and increments pointer to the next position.

D1:	Date	BYTE
D2:	Hour	BYTE
D3:	Minute	BYTE
D4, D5, D6, D7:	Pressure P2	long
D8, D9, D10, D11:	Proportional term	signed long
D12, D13, D14, D15:	Integral term	signed long
D16, D17, D18. D19:	Differential term	signed long
D20, D21, D22, D23:	PID Sum	signed long
D24, D25, D26, D27:	Heater Power in mWatt	long

Example: M R B ;read Values indexed by Pointer
M R B 02 09 1F 000027D9 00000019 000002D0 00000000 0000004B 00000078
Date is 02
Hour is 09
Minute is 31
P2 is 10201
Proportional therm is 25
Integral therm is 720
Differential therm is 0
PID Sum is 75
Heater Power is 120 mW

M R C X1 X2 D1 D2 D3 D4 D5 D6 D7 .... D24 D25 D26 D27

This command reads the value indexed by the absolute pointer X1, X2 from the queue.

X1, X2: Pointer to Queue absolute

Example: M R C 00 64 ;Set Pointer to Queue Pos. 100

Heater Dac Output *5.3.4*

M P A X1 D1

This command outputs a value to the heater Dac

X1: ´R´ or ´W´
D1: Dac output value - Range 0 to 0xFF

Reply: M P A X1 D1

When using this command the heater regulation must be disabled (see ***"Read / Write Heater Regulation Parameters" on page 38***), and the unit must be set to Diagnostic Mode.

Write I^2C Port *5.3.5*

M P B X1 D1

This command outputs a value to the I^2C parallel port on BMPC Digital Output board.

X1: Address of I2C Port PCF 8574
X1 = 0 -> U3
X1 = 1 -> U6
X1 = 2 -> U9
D1: Output value - Range 0 to 0xFF

Reply:M P B X1 D1

WARNING: This function can directly affect system safety. Use with care

Start Test Cycle Pump 2 Test *5.3.6*

M P C

This command initiates the Pump 2 test cycle

Reply:M P C

Read Digital Input Ports *5.3.7*

M P D X1 D1

Read Digital Input Ports of Digital Input Board

X1: Digital Input Port to read

X1 = 0 -> Port 0
X1 = 1 -> Port 1
X1 = 2 -> Port 2

D1 = Data of Port in Hex

Reply:M P D X1 D1

Front Panel LED Test *5.3.8*

M P E X1

Switch on or off all Front Panel LED´s

X1 = 0 -> Switch off all Front Panel LED´s
X1 = 1 -> Switch on all Front Panel LED´s

Reply:M P E X1

Front Panel Key Test *5.3.9*

M P F

Enable Key Test Function. If enabled, every keypress shows the corresponding keynumber on the LC Display. This function can only be disabled by a hardware reset or a power on sequence.

Reply:M P F

Heater Relais On/Off Control *5.3.10*

M P G X1

Switch on or off the heater relais output

X1 = 0 -> switch of relais output
X1 = 1 -> switch on relais output

Reply:M P G X1

Read internal ADC *5.3.11*

M P H X1 D1

Read ADC Chanells 0 to 7

X1: 0 to 7
D1: result of selected ADC channel

Reply:M P H X1 D1

Read Status of Pump, Valves and Alarms *5.3.12*

M P I D1 D2 D3 D4 D5 D6

Reads Status of Pump1 (D1), Pump2 (D2), Valve1 (D3), Valve2 (D4), Valve3 (D5), Valve4 (D6)

M P J D1 D2 D3 D4 D5 D6 D7 D8

Read Status of Auto/Manual (D1), Siren (D2), Warninglight (D3), Console (D4), Alarm1 (D5), Alarm2 (D6), Alarm3 (D7), Alarm4 (D8)

M P K X1 D1 D2 D3 D4 Exp Flags

Read of write the UPS charge counter

X1: ´R´or ‘W‘

D1..D4: Parameter

Example:
```
M P K R                      ;Read UPS Counter
M P K R 00 00 4D A3 00 00    ;UPS Counter reads 19875
```

In charging Mode the value 915 corresponds to 1 minute, in discharging mode the same value corresponds to 15 seconds.

Error Messages 6

LCD Error Messages 6.1

If any error occurres during work of BMPC, this will be displayed on the LCD in the status line of the standard display mask.

VT1=22175 VT2=19364	Voltage T1 and Vpltage T2
P1 = 11 P2 = 1036	Pressure 1 and Pressure 2
Fl = 119	Helium Flow
1 Errors in Queue	BMBC Status indicates 1 Error occurred

Using the Error Key Functions the error queue can be displayed (see***"Error" on page 25***).

Table 6.1. List of LCD Error Messages

LCD Error Message	possible Errorsources
Pump 1 failed	Pump 1 defective Pump 1 not connected Pump 1 switched off Pump 1 Protection switch 9Q12 switched off
Protection P1 fail	Pump 1 Protection switch 9Q12 switched off Protection level too low pump draws too much current
Valve 1 failed	Fuse 5F13 switched off
Pump 2 failed	Pump 2 defective Pump 2 not connected Pump 2 switched off Pump 2 Protection switch 10Q12 switched off
Protection P2 fail	Pump 2 Protection switch 10Q12 switched off Protection level too low pump draws too much current
Valve 2 failed	Fuse 6F13 switched off

Table 6.1. List of LCD Error Messages

LCD Error Message	possible Errorsources
Pump 3 failed	Pump 3 Protection switch 11Q12 switched off
Valve 3 failed	Fuse 7F13 switched off
Valve 4 failed	Fuse 8F13 switched off
Automatic Mode failed	automatic function failed
Warning Lamp fail	Fuse 18F11 switched off
Siren failed	Fuse 18F11 switched off
System running from Generator	Main Switch 3S03 is in Position UPS
Protection P3 fail	Pump 3 Protection switch 13Q12 switched off
L1 failed	Trafo 3TR06 Protection switch 3Q06 switched off Fuse 3F07 switched off
Alarm Fuse fail	Fuse 18F11 switched off
UPS not present	UPS interface not connected
UPS Load on BYPASS	UPS switched to Bypass (load too high)
UPS Low Battery	UPS Battery is empty
UPS Failure	General failure (see UPS manual)
UPS discharging	UPS is discharging, power from battery
Pump 2 Test failed	BMPC was in manual mode Pump 2 is not working good enough
WARNING T1 is too high	T1 is above Warning level
ALARM T1 is too high	T1 is above Alarm level
WARNING T2 is too high	T2 is above Warning level
ALARM T2 is too high	T2 is above Alarm level
WARNING P1 is too high	P1 is above Warning level
ALARM P1 is too high	P1 is above Alarm level
WARNING P1 is too low	P1 is below Warning level
ALARM P1 is too low	P1 is below Alarm level
WARNING Fl is too low	Flow is below Warning level
ALARM Fl is too low	Flow is below Alarm level
FATAL ERROR	more then 255 errors occurred

Depending on the running firmware the following error messages will be sent in the case of any error.

Table 6.2. Error messages from boot firmware

Error No.	Error message	Description
20	BMPCOrder error	Unknown command or syntax error
2	BMPCCheck sum error	Wrong command string checksum
37	BMPCErase fail	Download: Flash EPROM erase failed or not complete
36	BMPCProgrammer fail	Download: Flash EPROM programming failed or not complete
33	BMPCWrong rec type	Download: record is not Intel hex format
32	BMPCWrong address	Download: address out of valid Flash EPROM address range
34	BMPCWrong checksum	Download: wrong checksum in Intel hex record
38	BMPCWrong transmission check	Download: wrong EOF record
31	BMPCWrong data count	Download: wrong length of Intel hex string
11	BMPCROM error	no valid application software on Flash EPROM
15	BMPCBBIS error	no BBIS available
16	BMPCBBIS checksum error block1	wrong data in BBIS block1
17	BMPCBBIS checksum error block2	wrong data in BBIS block2
18	BMPCBBIS checksum error block3	wrong data in BBIS block3
19	BMPCBBIS checksum error block4	wrong data in BBIS block4

Table 6.3. Error messages from application firmware

Error No.	Error message	Description
20	BMPCOrder error	Unknown command or syntax error
2	BMPCCheck sum error	Wrong command string checksum
16	BMPC??Corrupt data in BBIS ? block1, bus ?	wrong data in BBIS No.?, bus No.?, block1
17	BMPC??Corrupt data in BBIS ? block2, bus ?	wrong data in BBIS No.?, bus No.?, block2
18	BMPC??Corrupt data in BBIS ? block3, bus ?	wrong data in BBIS No.?, bus No.?, block3
19	BMPC??Corrupt data in BBIS ? block4, bus ?	wrong data in BBIS No.?, bus No.?, block4
15	BMPC??BBIS ? bus ? not responding	no BBIS No.?, bus No.? available
70	BMPCI2C Parallel Port Error	I2C Parallel Port is not respomding

Peripheral Connections

7

BMPC Automatic Control Unit 7.1

Temperature 7.1.1

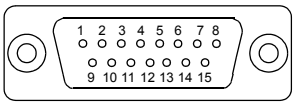


Table 7.1. Pinout - Connector Temperature

Pin	Signal	Pin	Signal
1	Shield	9	T1 Voltage+
2	T1 Current+	10	T1 Voltage-
3	T1 Current-	11	T2 Voltage+
4	T2 Current+	12	T2 Voltage-
5	T2 Current-	13	NC
6	NC	14	NC
7	NC	15	NC
8	NC		

Use P/N HZ3348 CABLE RD 8P25000 BMPC T1/T2 to connect to BMPC Wiring Box.

Analog In 7.1.2

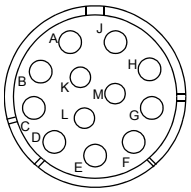
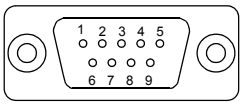


Table 7.2. Pinout - Connector Analog In

Pin	Signal	Comment
A	P1+	4 to 20 mA
B	P1-	return path
C	NC	
D	Heater-	Gnd
E	NC	
F	Flow-	Gnd
G	Flow+	0 to 5 Volts
H	P3+	4 to 20 mA
I	P2+	4 to 20 mA
K	P2-	return path
L	Heater+	0 to 12 Volts
M	P3-	return path

Use Cable HZ03799 BMPC CABLE 10P1300 ANALOG to connect to Analog Out at BMPC Panel Meter Unit.

RS 232 7.1.3



Mini D 9 pin Male

Table 7.3. Pinout Conectot RS232

Pin	Signal	Pin	Signal
1	NC	6	NC
2	RxD	7	RTS
3	TxD	8	CTS
4	DTR	9	NC
5	GND		

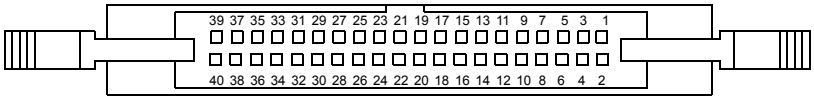


Table 7.4. Pinout - Connector Digital Input to X2

Pin	Signal	Comment	Pin	Signal	Comment
1	L.GND	to LCU - X2	2	L.GND	not used
3	L.GND	not used	4	L.GND	to LCU - X2
5	L.24V	to 24V Relays	6	L.24V	to Optocouplers
7	L.24V	to 24V Relays	8	L.24V	to Optocouplers
9	P1 Status	+ 24V if on	10	P1 Protection Status	+ 24V if ok
11	V1 Status	+ 24V if closed	12	P2 Status	+ 24V if on
13	P2 Protection Status	+ 24V if ok	14	V2 Status	+ 24V if closed
15	P3 Status	+ 24V if on	16	V3 Status	+ 24V if closed
17	V4 Status	+ 24V if closed	18	Auto Status	+ 24V if Auto
19	W-Light Status	+ 24Vif on	20	Siren Status	+ 24Vif on
21	On UPS	+ 24V if from UPS	22	P3 Protection Status	+ 24V if ok
23	L1 present	+ 24V if L1 ok	24	Alarm Fuse Status	+ 24V if Fuse failed
25	UPS Present	+ 24Vif UPS pres.	26	UPS Bypas	0V if Bypass
27	UPS Low Bat	0V if Low Bat	28	In Spare 1	not used
29	UPS Gen Alarm	0 if Failure	30	On AC	+ 24V if 230V ok
31	In Spare 2	not used	32	In Spare 3	not used
33	RS232 - DSR	Data Set Ready	34	RS232 - CTS	Clear to Send
35	RS232 - RxD	Receive Data	36	RS232 - DTR	Data Terminal Rdy
37	RS232 - RTS	Request to send	38	RS232 - TxD	Transmit Data
39	RS232-Gnd	Ground	40	Aux out	not used

Use P/N HZ03634 CABLE RD 40P1500 to connect to X2 of BMPC Line Control Unit

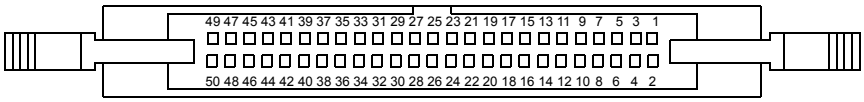


Table 7.5. Pinout Connector Digital Output to X3

Pin	Signal	Comment	Pin	Signal	Comment
1	L.GND	Wiring Box	2	L.GND	Wiring Box
3	L.GND	Wiring Box	4	L.24V_C	Wiring Box
5	L.24V_C	Wiring Box	6	L.24V_C	Wiring Box
7	Switch 1	Wiring Box	8	Switch 2	Wiring Box
9	Led 1	Wiring Box	10	Led 2	Wiring Box
11	Buzzer 1	Wiring Box	12	Buzzer 2	Wiring Box
13	L.GND	SSR	14	L.GND	SSR
15	L.GND	SSR	16	L.GND	not used
17	L.GND	not used	18	L.24V_B	SSR
19	L.24V_B	SSR	20	L.24V_B	SSR
21	L.24V_B	not used	22	Alarm 3B	P1 low
23	Alarm 3A	P1 low	24	Alarm 2B	P1 high
25	Alarm 2A	P1 high	26	Alarm 1B	T1 T2 high
27	Alarm 1A	T1 T2 high	28	Alarm 4B	He Flow low
29	Alarm 4A	He Flow low	30	WD_Ok	+24V if ok
31	Spare 3	not used	32	Spare 2	not used
33	Spare 1	not used	34	Console	+24V if on
35	P2 off	Trigger	36	P2 on	Trigger
37	P1 off	Trigger	38	P1 on	Trigger
39	V4 off	Trigger	40	V4 on	Trigger
41	V3 off	Trigger	42	V3 on	Trigger
43	V2 off	Trigger	44	V2 on	Trigger
45	V1 off	Trigger	46	V1 on	Trigger
47	Warn Light	+24V if on	48	Siren	+24V if on
49	Auto		50	Manu	

Use P/N HZ03636 CABLE RD 50P1500 to connect to X2 of BMPC LCU

P1 / P2 / Heater *7.2.1*

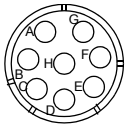


Table 7.6. Pinout - Connector P1 / P2 / Heater

Pin	Signal	Comment
A	P1 +	4 to 20 mA
B	P1 -	return path
C	P2 +	4 to 20 mA
D	P2 -	return path
E	Heater -	Gnd
F	Heater +	0 to 12 Volts
G	NC	
H	NC	

P3 *7.2.2*

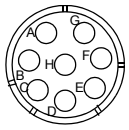


Table 7.7. Pinout - Connector P3

Pin	Signal	Comment
A	P3 +	4 to 20 mA
B	P3 -	return path
C	NC	
D	NC	
E	NC	
F	NC	
G	NC	
H	NC	

Flow Sense *7.2.3*

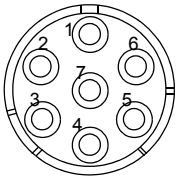


Table 7.8. Pinout - Connector Flow Sense

Pin	Flowmeter Enall	Flowmeter HFM
1	black	-15V
2	white	NC
3	red	+15V
4	green	NC
5	yellow	Flow- (GND)
6	shield	shield
7	NC	Flow+ (0-5V)

Analog Out *7.2.4*

see ***"Analog In" on page 50***

Connector X12 *7.3.1*

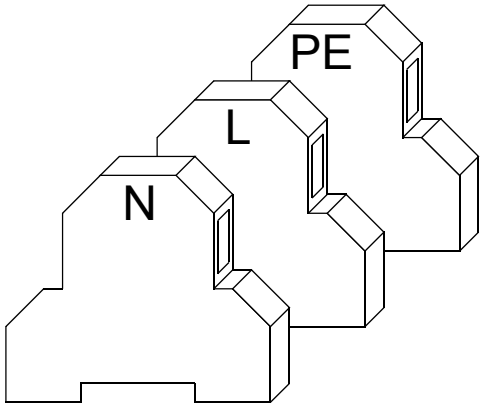


Table 7.9. Pinout - Connectro X12

Name	N	L	PE	Comment
Compressor Pressure Switch	1	2		a
Alarm PC	3	4	5 - gn/ye	1,5 mm^2
Power from UPS	6	7	8 - gn/ye	10 mm^2
Power from Generator	9	10	11 - gn/ye	6 mm^2

a. The compressor switch must be closed when pressure is within limits.
If no pressure switch is used connect Pin 1 and Pin 2 at terminal.

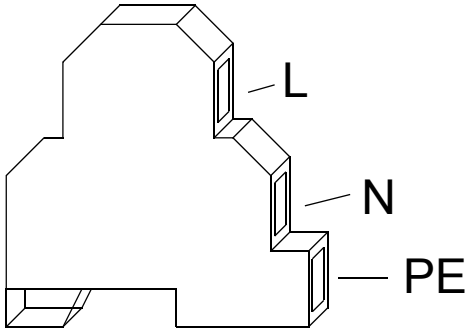


Table 7.10. Pinout - Connector X13

Name	N	L	PE	Comment
Trafo 3TR06 primary side	1	17	gn/yl	factory set don´t alter!
Trafo 3TR06 secondaryside	2	18	gn/yl	factory set don´t alter!
Console	3	19	gn/yl	2,5mm^2
Cooling Unit	4	20	gn/yl	2,5mm^2
Valve V1	5	21	gn/yl	1,5mm^2
Valve V2	6	22	gn/yl	1,5mm^2
Valve V31	7	23	gn/yl	1,5mm^2
Valve V41	8	24	gn/yl	1,5mm^2
Pump P1	9	25	gn/yl	1,5mm^2
Pump P2	10	26	gn/yl	1,5mm^2
Pump P3	11	27	gn/yl	1,5mm^2
Compressor	12	28	gn/yl	1,5mm^2
Siren 1	13	29	gn/yl	1,5mm^2
Siren 2	14	30	gn/yl	1,5mm^2
Warning Lamp 1	15	31	gn/yl	1,5mm^2
Warning Lamp 2	16	32	gn/yl	1,5mm^2

Connector X14 7.3.3

Table 7.11. Pinout - Connector X14

Name	Pin	Pin
T1 or T2 high	1	2
P1 high	3	4
P1 low	5	6
He Flow low	7	8
Auto Fail	9	10
UPS Fail	11	12

All Alarm output signals are wired to this connector. There are 6 different alarm outputs available. Each alarm output is galvanically isolated from all others. Therefore, two connection terminals are provided for any alarm. If an alarm is pending, the switch between the corresponding alarm terminals is closed. If no alarm is pending, the corresponding alarm switch is open. The resistance in this case is 10 kΩ, if no line break ocurs. A line break will cause a resistance of ∞ Ω. The 10 kΩ resistors are located at terminal block X19. They are plugable.

Technical Data of Alarm Outputs

- Maximum switching voltage of Alarm output is 100V DC or 125V AC
- Maximum switching current is 1A.

Alarm Combinations

If neccessary, some alarms can be combined (paralleled). This can easily be done at Connector X19. All alarm output signals, as described above, are located at pins 1..24 of X19 (see BMPC Line Control Unit shematics sheet 20). The pins 25..37 of X19 are reserved for additional alarm(wiring) combinations. If two or more alarms are paralleled, only one 10 kΩ resistor should be mounted.

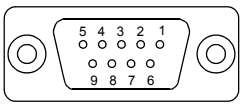
Connector X15 7.3.4

This is the connector from the serial interface (RS232) of ’BMPC Automatic Control Unit H5727 to the spectrometer computer X32. Connect the cable HZ3351 between X15 and the CCU. Software downloads (via PC) are also done via this connector. (see also ***"RS 232" on page 50***)

Connector X16 7.3.5

This is the connector from the additional serial interface (RS232) of ’BMPC Automatic Control Unit’ H5727 to a PC. This PC, if present, can be used for alarm functions. (see also ***"Digital Output" on page 52***)

Connector X17 7.3.6



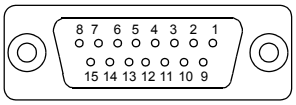
Mini D 9 pin Female

Table 7.12. Pinout - Connector X17

Pin	Signal	Pin	Signal
1	NC	6	Bypass active
2	NC	7	Bettery Low
3	General Alarm	8	NC
4	On common AC	9	NC
5	Common		

Connect the cable HZ03832 between UPS and X17. Status information (errors) from the UPS can be checked via this link. If this cable is not connected, the spectrometer console can not be switched on. Also there will be some errormessages concerning UPS-Errors in the Error Queue

Connector X18 7.3.7



Mini D 15 pin Female

Table 7.13. Pinout - Connecntor X18

Pin	Signal	Pin	Signal
1	L.GND	9	L.24V_C
2	L.GND	10	L.24V_C
3	Switch 1	11	NC
4	Switch 2	12	NC
5	Led 1	13	NC
6	Led 2	14	NC
7	Buzzer 1	15	NC
8	Buzzer 2		

Connect the cable HZ3349 to the BMPC wiring box H5743. This cable connects the switch, the Led and the Buzzer of the BMPC Wiring Box to the BMPC

Installation 8

Hardware 8.1

To ensure good and save operation of the BMPC and the pump system the following installation procedure has to be followed.

After setup of the unit check all internal wiring for loosen screws.

Switch off all fuses and motor protection switches.
Check fuses 3F04, 3F05 (NEOZED 35A), 12F01 (5x20 t 100mA), 12F03 (5x20 t 1A) and 16F13 (5x20 t 200mA).
Connect BMPC connector X12 to the UPS or a wall outlet (50A fused) using cable 4x10mm^2 (P/N 66758). Power on unit using switch 3S03.
Switch on fuse 23F03. Power on BMPC ACU using mains switch on front panel.

Check motor protection switches for setup,
3Q06 must be set to 2A, 9Q12 and 10Q12 must be set to 4,5A, 11Q12 must be set to 12A, 19Q12 must be set to 4A.
Switch on motor protection switch 3Q06 and fuse 3F07. The „OFF“ LED´s from the Manual Control Unit should now be on .
Close all motor protection switches (9Q12, 10Q12, 11Q12 and 19Q12) and Valve fuses (5F13, 6F13, 7F13, 8F13).
Check function of contactors. Pressing P1 On at Manual Control Unit should close Contactor 9K04, pressing P1 Off should open contactor 9K04 (the corresponding LED P1 ON is not iluminated, because the pump is not yet connected).
Check the functions of P2, P3, V1, V2 and V3 with the same procedure.

Connect the pump system to BMPC: P1, P2, P3, Compressor, V1, V2, V3, V4.
Connect the console and cooling system to BMPC only if they are also to be powered via the BMPC and the UPS.
Connect Warning Lamp and Siren if delivered.
Connect UPS Status Interface to BMPC(Cable HZ03832)

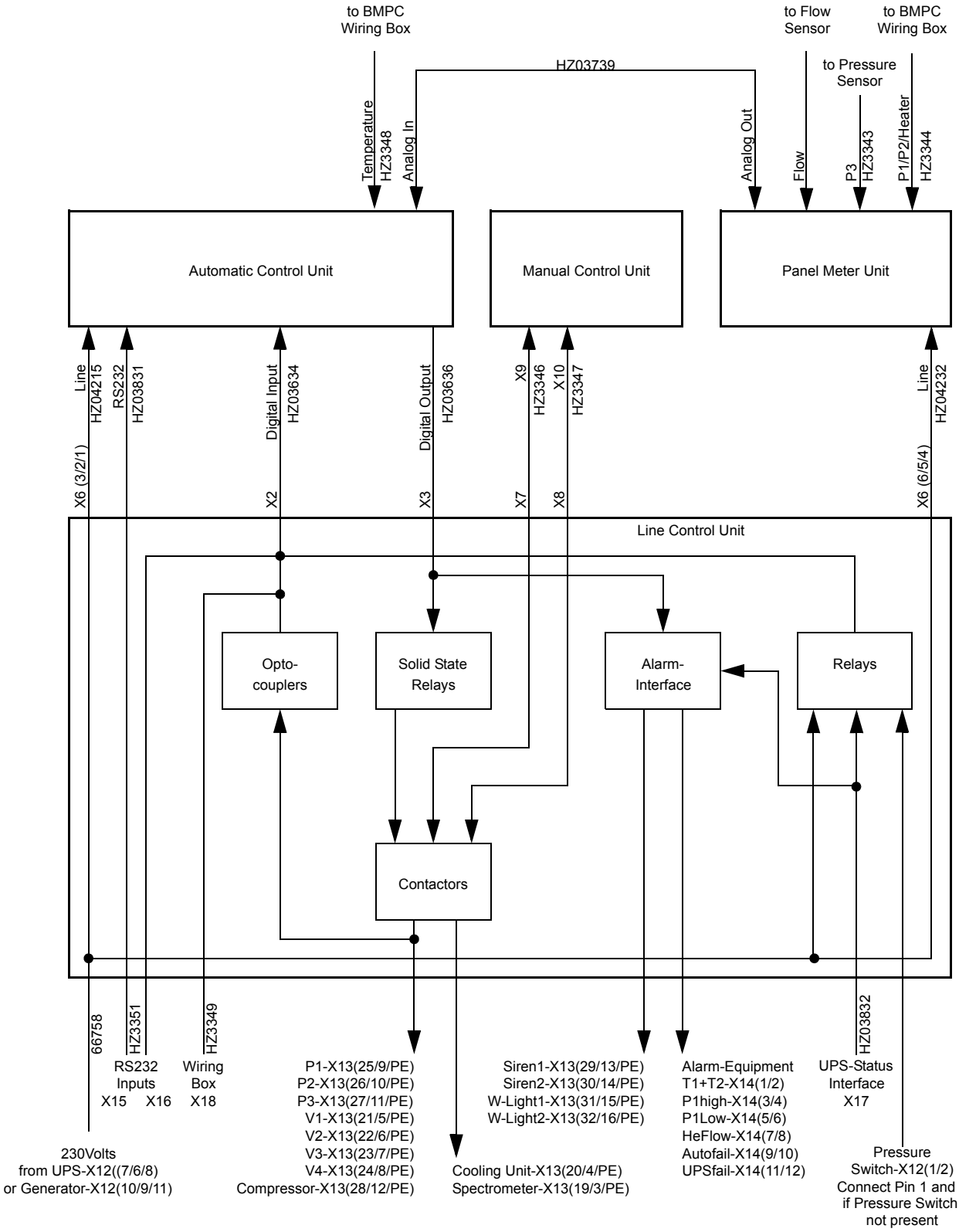
Check function of P1, P2, P3, Compressor, V1, V2 and V3 using Manual Control Unit.
Check Warning Light and Siren pressing switch18S11 of BMPC LCU
Check Console and cooling unit pressing switch 3S11 of BMPC LCU (Console and cooling unit work only if UPS status is ok (Load on inverter)).

Set up timer 3K09 (this function switches off the console and cooling unit 2-3 minutes after a power fail) to 2 - 3 minutes. Check function by removing connector X17. The contactor 3K11 must be switched off 2 - 3 minutes after removing connector X17. Set up timer 18K04 (this function re-enables Warning Light and siren 30 minutes after beeing switched off by the Manual Control Unit if the the alarm is still pending) to 30 minutes.

Connect BMPC Wiring Box to BMPC (P1/P2/Heater to Panel Meter Unit, Temperature to Automatic Control Unit and X18 to Line Control Unit).
Connect Flow Sensor to Flow Sense at Panel Meter Unit and Pressure Sensor P3 to P3 at Panel Meter Unit.

Connect RS232 Interface to console CCU (cable P/N HZ3351).

Figure 8.1. Connections overview



All peripheral line connections use the following Syntax: **FunctionName-ConnectorName(Line/Neutral/ProtectiveEarth)**

Calibration 8.2

For correct operation of BMPC all sensors must be calibrated.
There are two ways to calibrate each sensor

Calibration via Front Panel 8.2.1

To calibrate sensors via the front panel, enter Password and select function **Calibrate**. The LCD shows the following text.

Calibration Menu	indicates Calibration function
Enter high value P1	indicates value to calibrate
996	Calibration value
Actual Value = 2051	ADC readout

Table 8.1. Calibration value order

1. High Value P1	2. Low Value P1
3. High Value P2	4. Low Value P2
5. High Value P3	6. Low Value P3
7. High Value T1	8. Low Value T1
9. High Value T2	10. Low Value T2
11. High Value Fl	12. Low Value Fl

To calibrate a sensor, the high value must be typed in first, then the low value. Type in values only if the ADC readout shows a stable condition. After pressing the **Enter** Key for the low value, gain and offset for the selected sensor is calculated. The gain and offset values are stored in a non volatile E^2Prom. The values are loaded after each reset or power on.

WARNING: Any keypress on the Enter-Key will change the current calibration of the selected item. If you want to calibrate a single item e.g. P2, use the ESC - Key until the specific menue point (e.g. „Enter P2 High Value“) is reached.

Temperature calibration

To calibrate temperatures T1 and T2 use the BMPC T1/T2 Calibration Connector 1 (30kOhm HZ04432) and the BMPC T1/T2 Calibration Connector 2 (4,7kOhm HZ04431). Remove the Temperature connector from the Analog I/O Board of the Automatic Control Unit. Connect the Calibration Connector 1. Enter the high values for T1 and T2 (the values are printed on top of Calibration connectors). Then connect the Calibration Connector 2, enter the low values for T1 and T2. After pressing Enter the sensors T1 and T2 are both calibrated. Reconnect the Temperature connector again to the Analog I/O Board.

Pressure Calibration

To calibrate the pressures, the test volume of the pump system and the pressure transducer P3 is used.
First the high values for all three pressures are entered. Read the pressure meter

P3 of the Panel Meter Unit, and type in the high value P3, then remove the connector P3 on the rear panel of the Panel Meter Unit and connect it to P1/P2/Heater. Read the pressure meter P1 and type in the high value P1, then use an adapter cable to connect the Pressure transducer to the pressure meter P2, read out pressure P2 and type in the high value P2. Reconnect the pressure transducer to P3. Start Pump P2 using the **Pump2** Key. Wait 30 seconds and open Valve V4 using the **Valve4** Key. This will evacuate the test barrel. Wait until P3 is stable, then type in the low value P3. Connect the transducer again to P1 type in low value P1 and low value P2 when connected to pressure meter P2.

The Calibration value for P2 must be typed in in 1/10 mBars. That means the pressure 1013 mBar must be typed in as 10130.

Helium Flow calibration

First enter the high value Fl by switching on P2 using the **Pump2** Key and opening Valve4 using the **Valve4** Key. This increases flow. Type in the high value read from Flow meter of the Panel Meter Unit. Close the Valve, stopp the Pump and type in the Low value.

After calibration check all connections to the Panel Meter Unit.

WARNING:
Don´t leave calibration mode without closing Valve 4.
Don´t switch to manual mode without closing Valve 4.

Calibration via RS232 Interface *8.2.2*

Calibration can also be done using the RS232 Interface. A PC and a special program is needed. (see also ***"Calibrate Gains and Offsets" on page 37***)

Starting BMPC *8.3*

After succesfull installation and calibration, the unit can be started.

To use the automatic mode, all Limit Values (see ***"Limits" on page 26***) and the time for the first automatic Pump 2 test (see ***"RTC" on page 26***
and ***"Pump 2 Test" on page 19***) have to be typed in.

Normally Pump P1 is running and Valve V1 is opened (done in manual mode). Using this settings you can switch to automatic mode. This enables all automatic functions described in ***"Automatic Mode" on page 17***. Switching from Manual Mode to Automatic Mode writes the error message „Automatic Mode failed“ to the Errorqueue. Clear this error message using the erorr functions. (This is not a real error).

If any failure or warning occurs, this will be indicated by the warning Lamp. If the Warning Lamp indicates a malfunction please check the BMPC using the error queue.

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BMPC Wiring Box117

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Tables

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Goto

Shematics BMPC Automatic Control Unit

A

BGP 80C535 CPU BOARD

Figure A.1. BGP 80C535 CPU BOARD Sheet 1 of 3

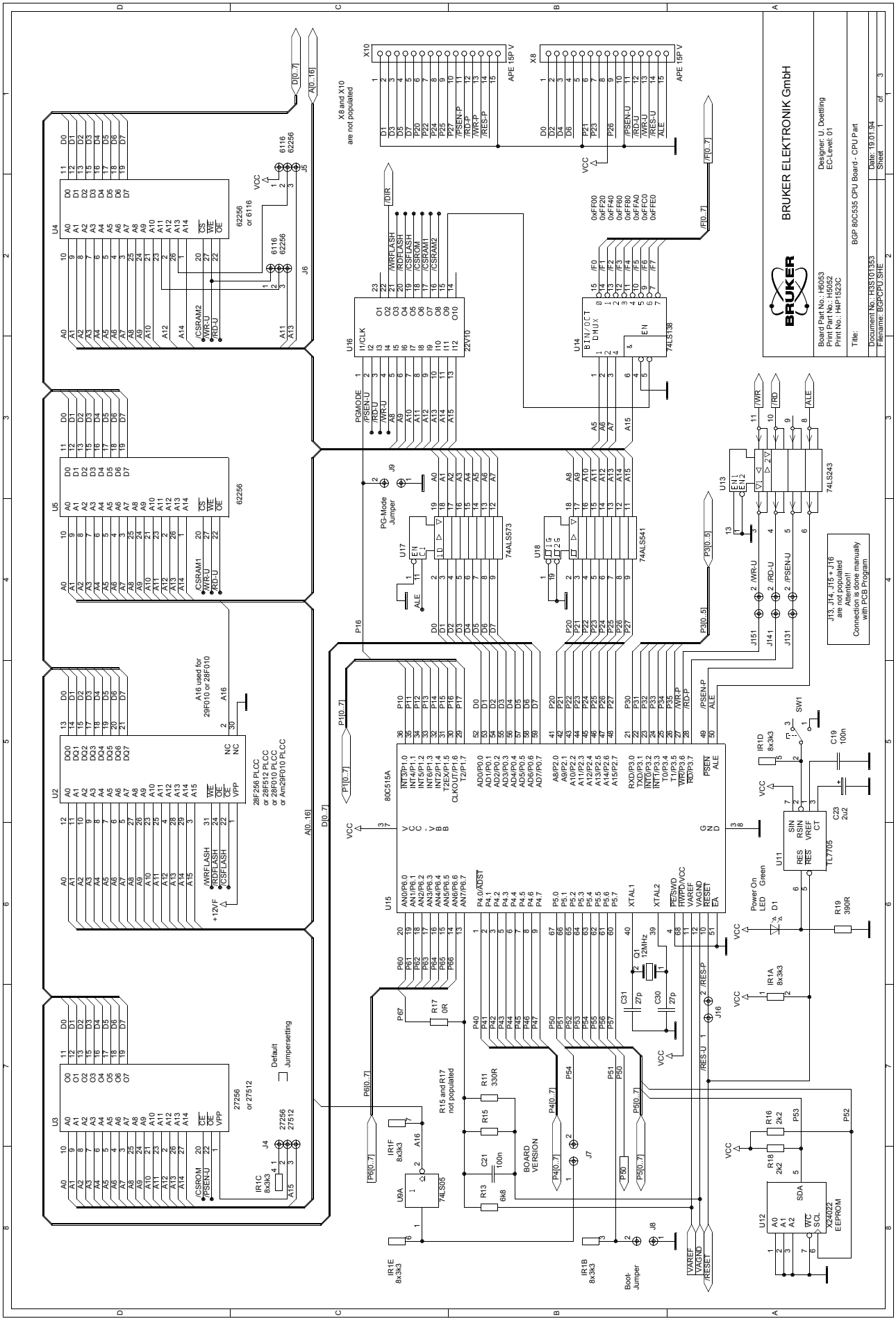


Figure A.2. BGP 80C535 CPU BOARD Sheet 2of 3

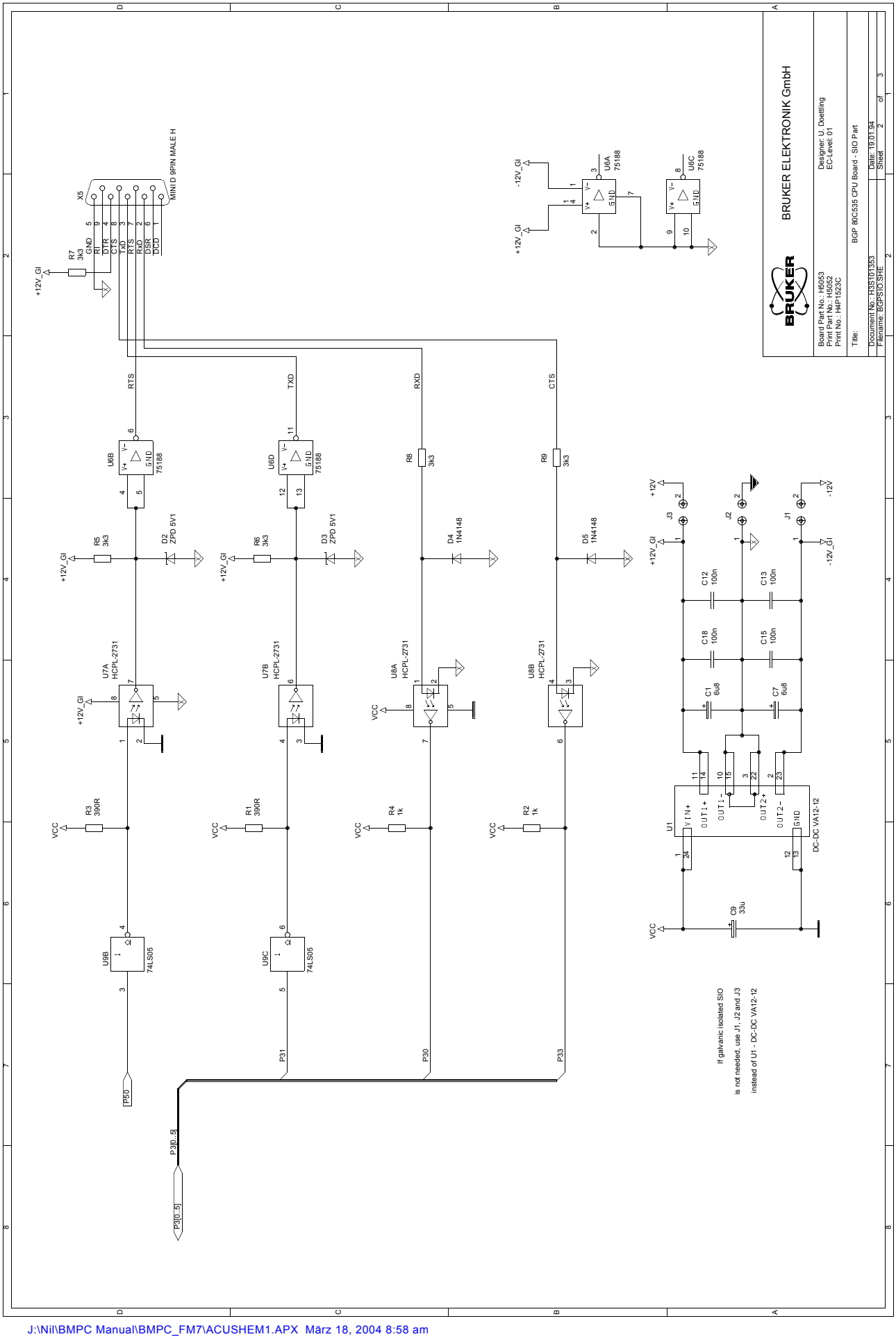


Figure A.3. BGP 80C535 CPU BOARD Sheet 2of 3

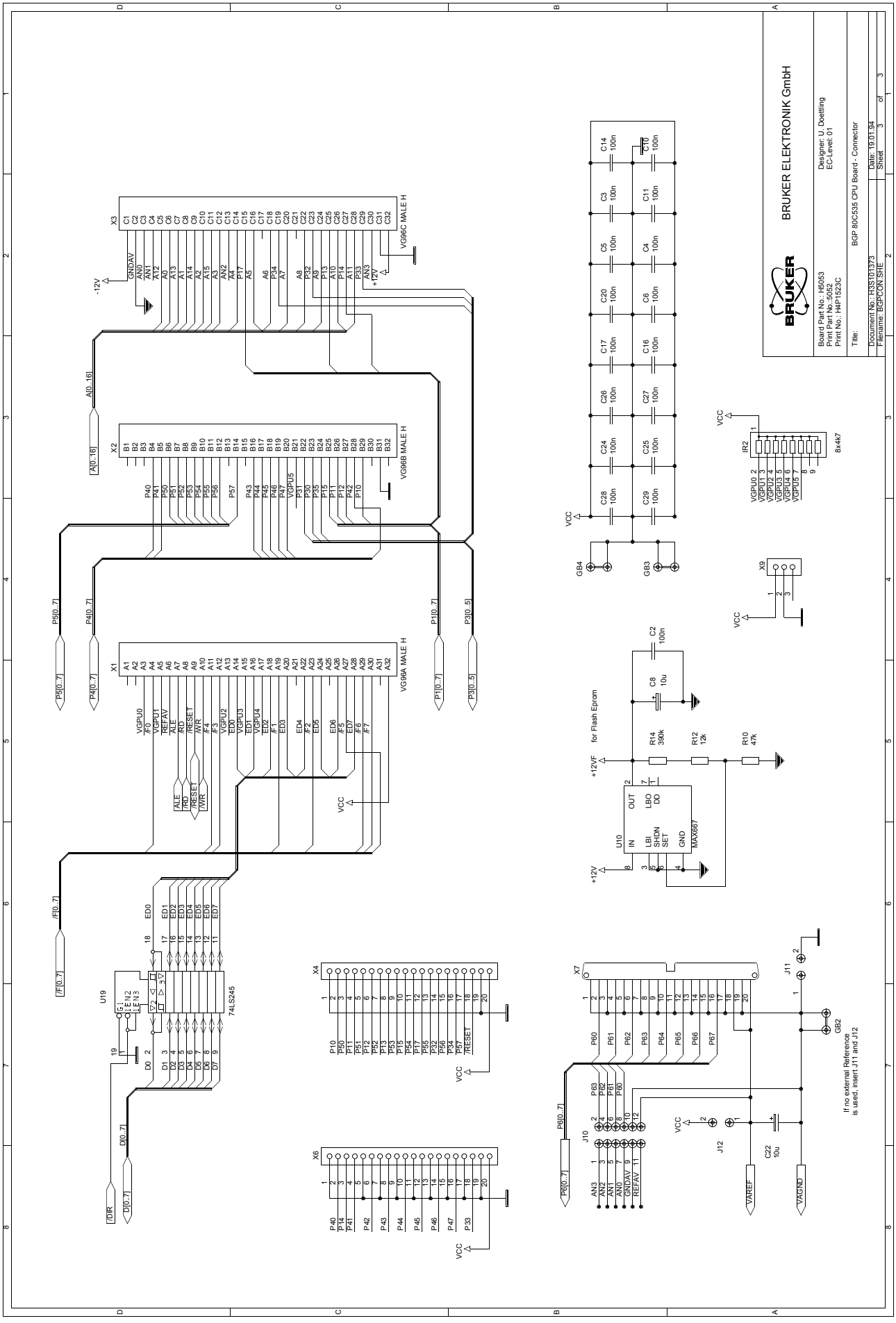


Figure A.4. BMPC Frontpanel Board Sheet 1 of 1

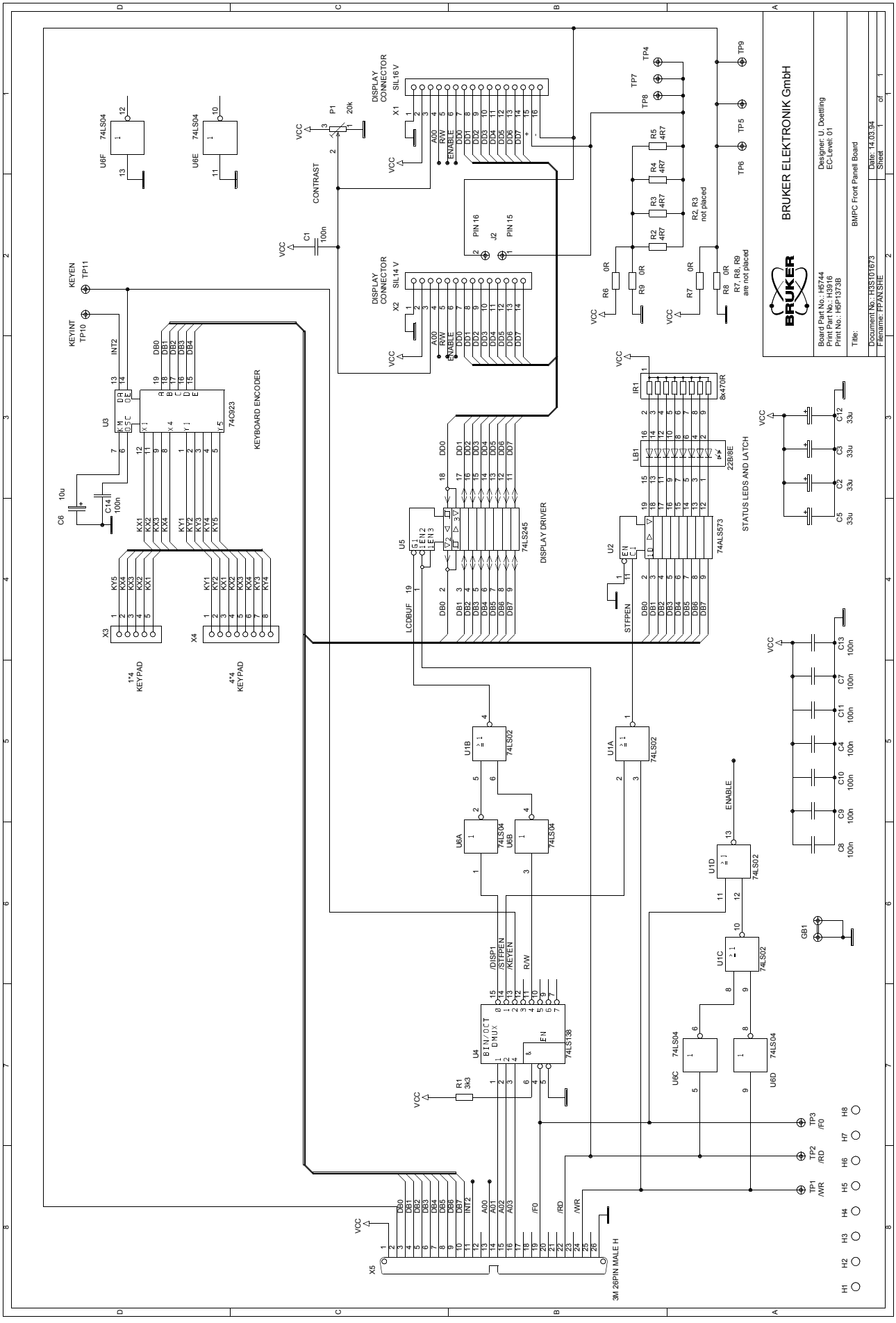


Figure A.5. BMPC Analog I/O Board Page 1 of 3

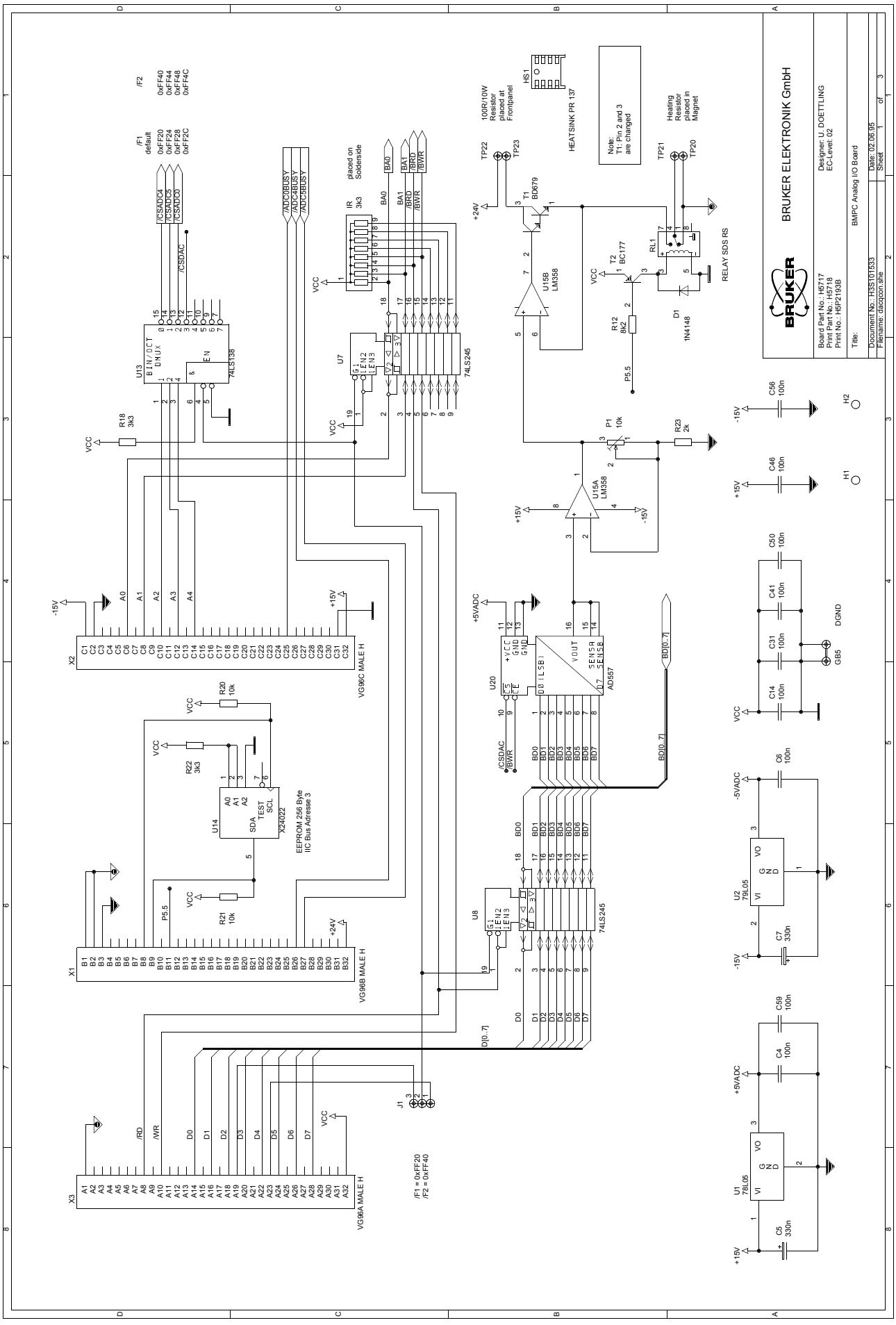


Figure A.6. BMPC Analog I/O Board Page 2 of 3

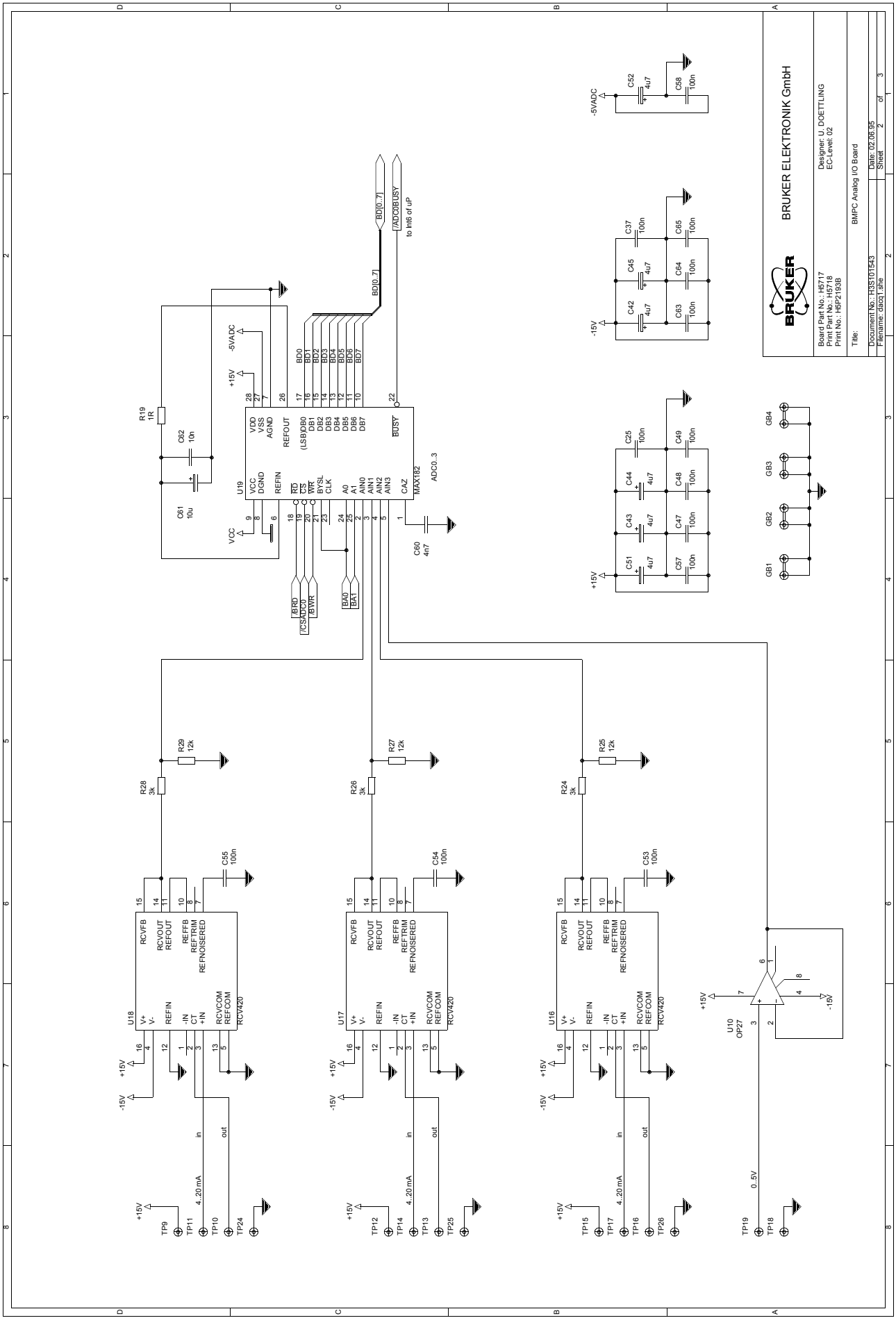


Figure A.7. BMPC Analog I/O Board Page 3 of 3

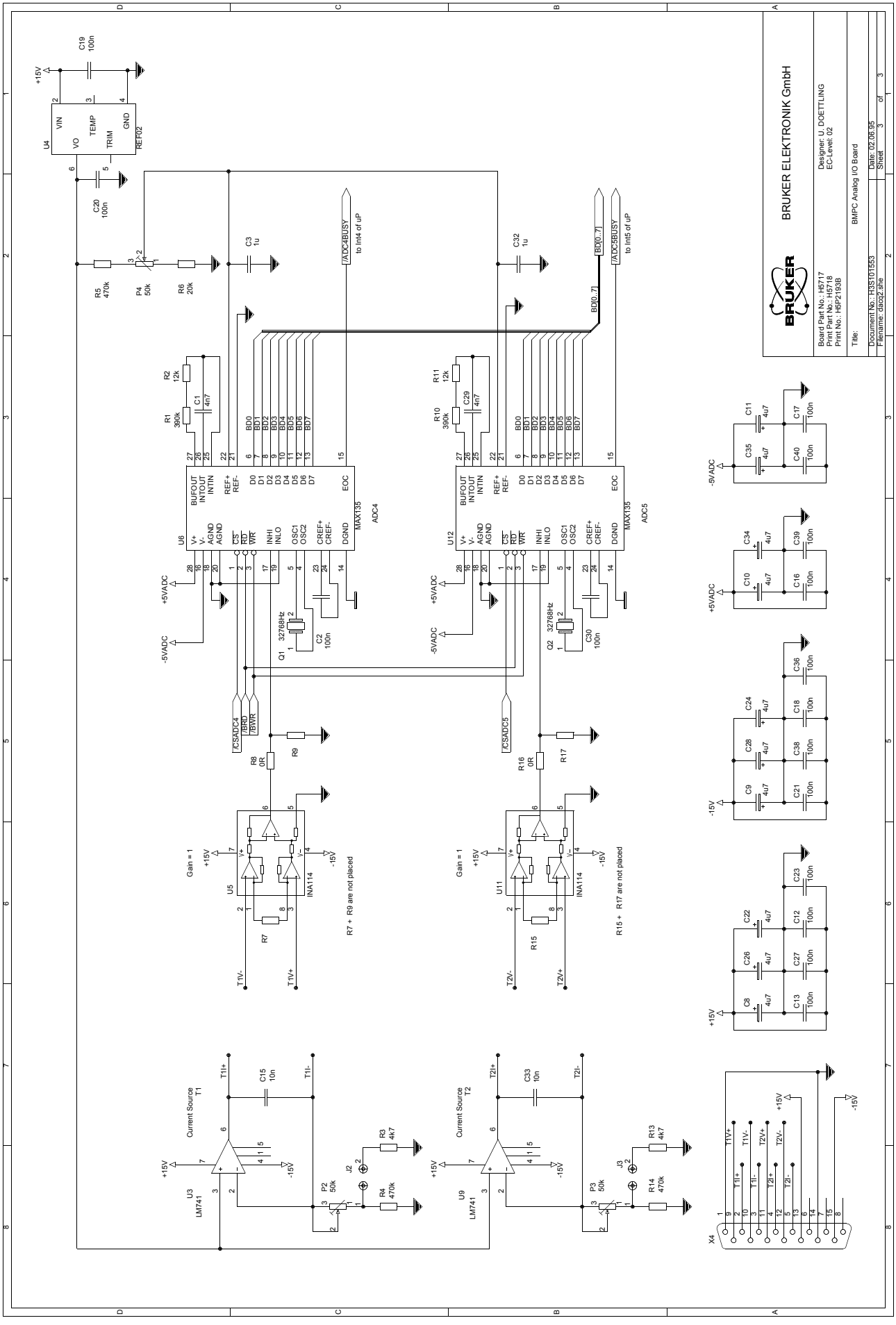


Figure A.8. BMPC Digital Input Board Page 1 of 3

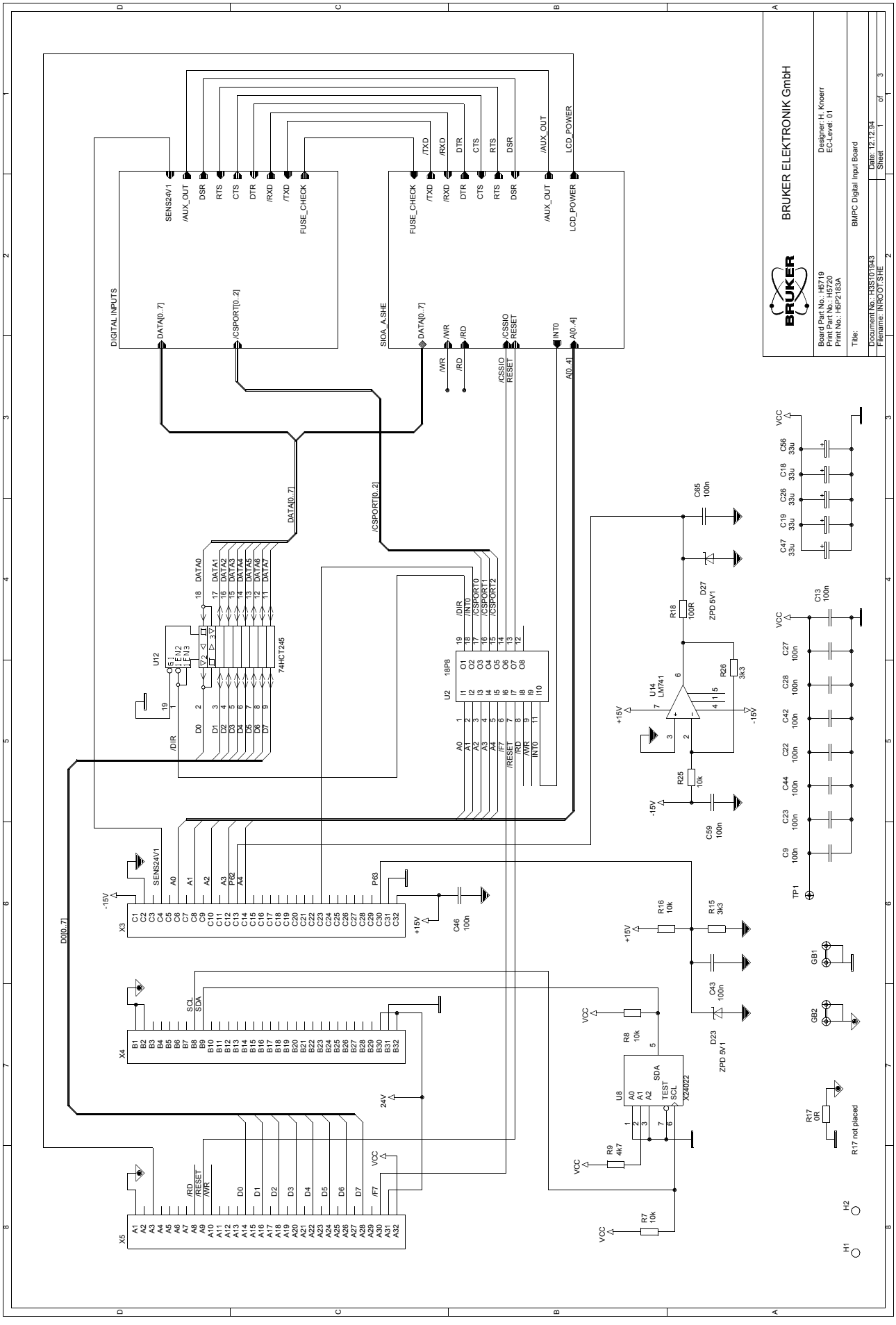


Figure A.9. BMPC Digital Input Board Page 2 of 3

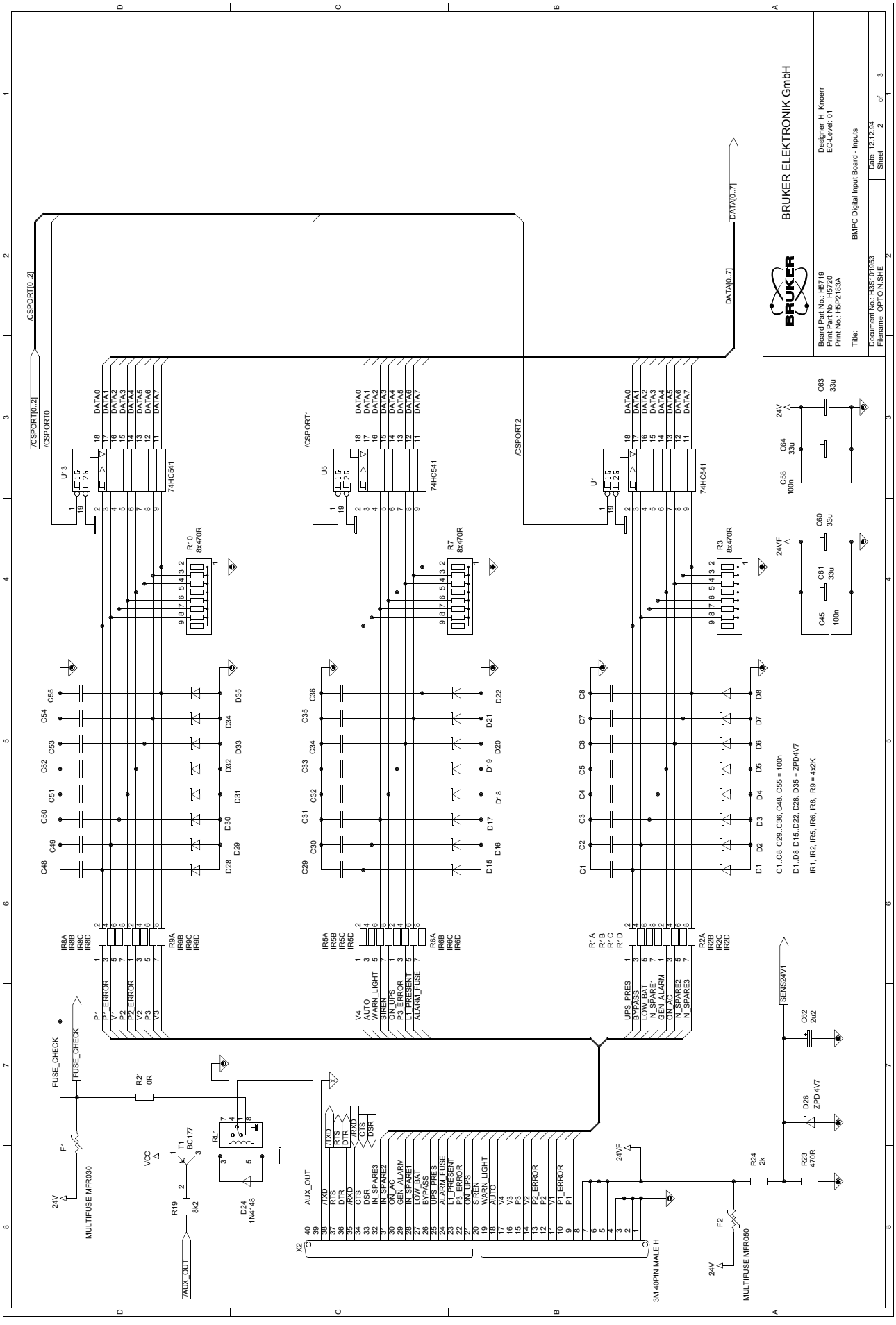


Figure A.10. BMPC Digital Input Board Page 3 of 3

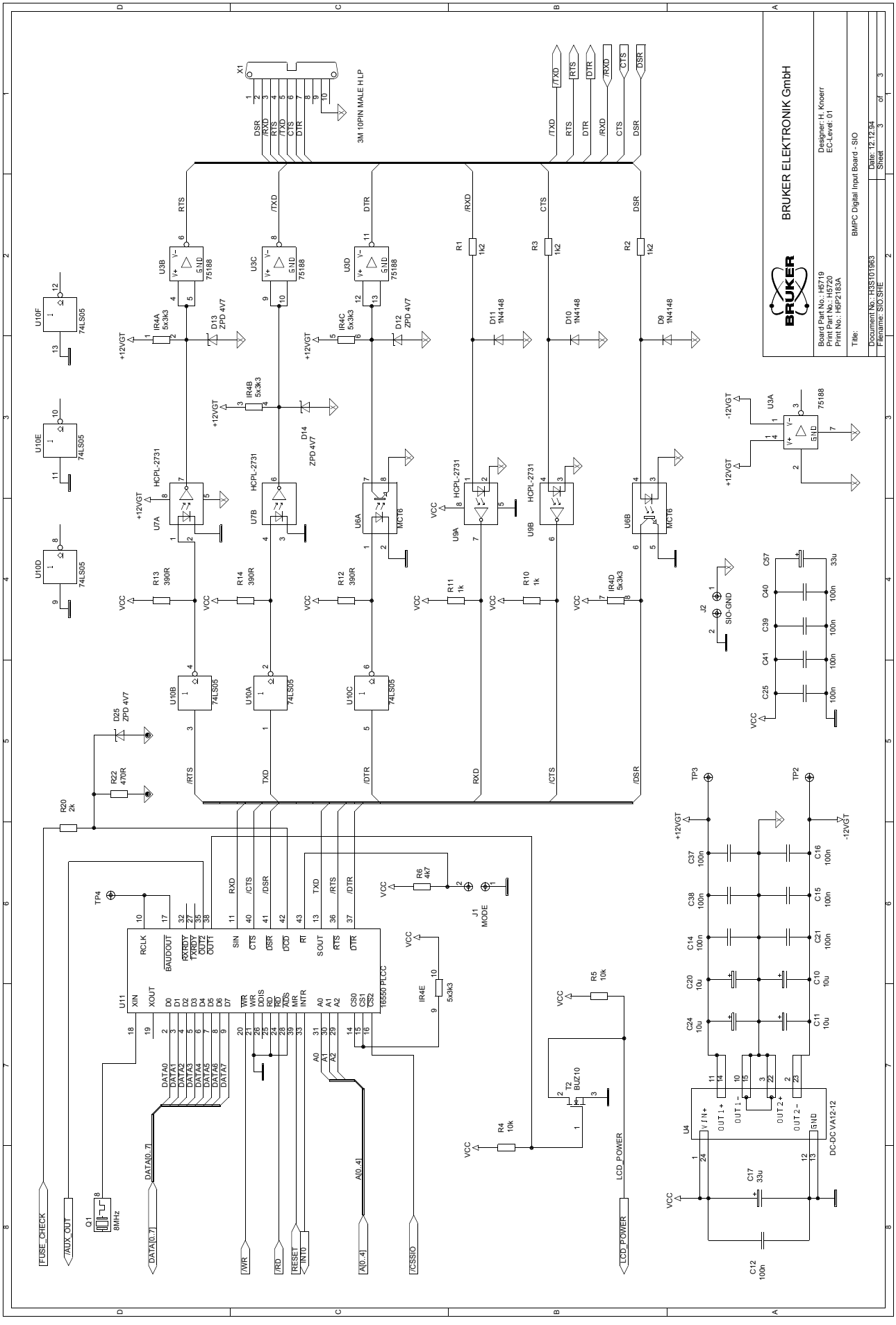


Figure A.11. BMPC Digital Input Board Page 1 of 2

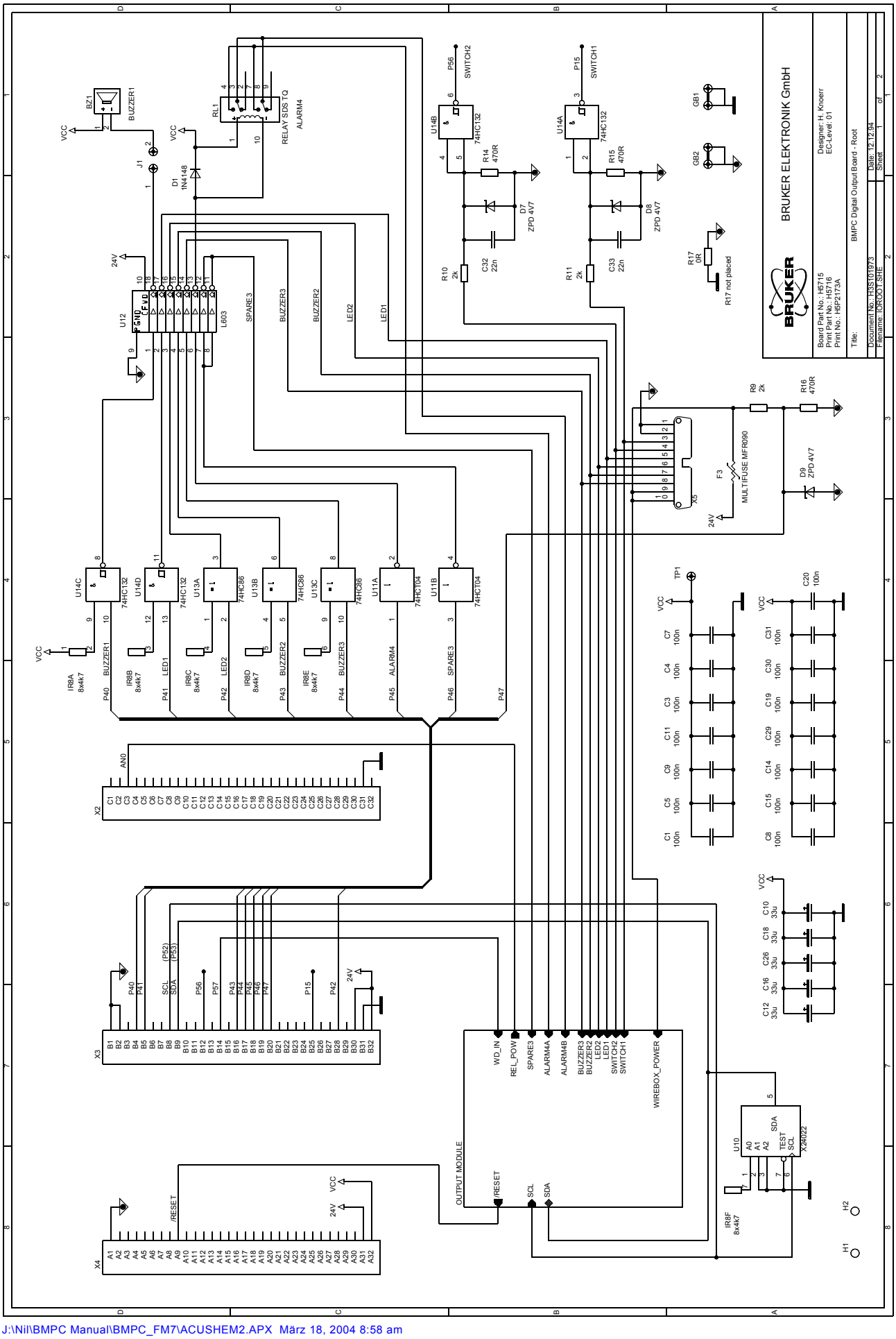
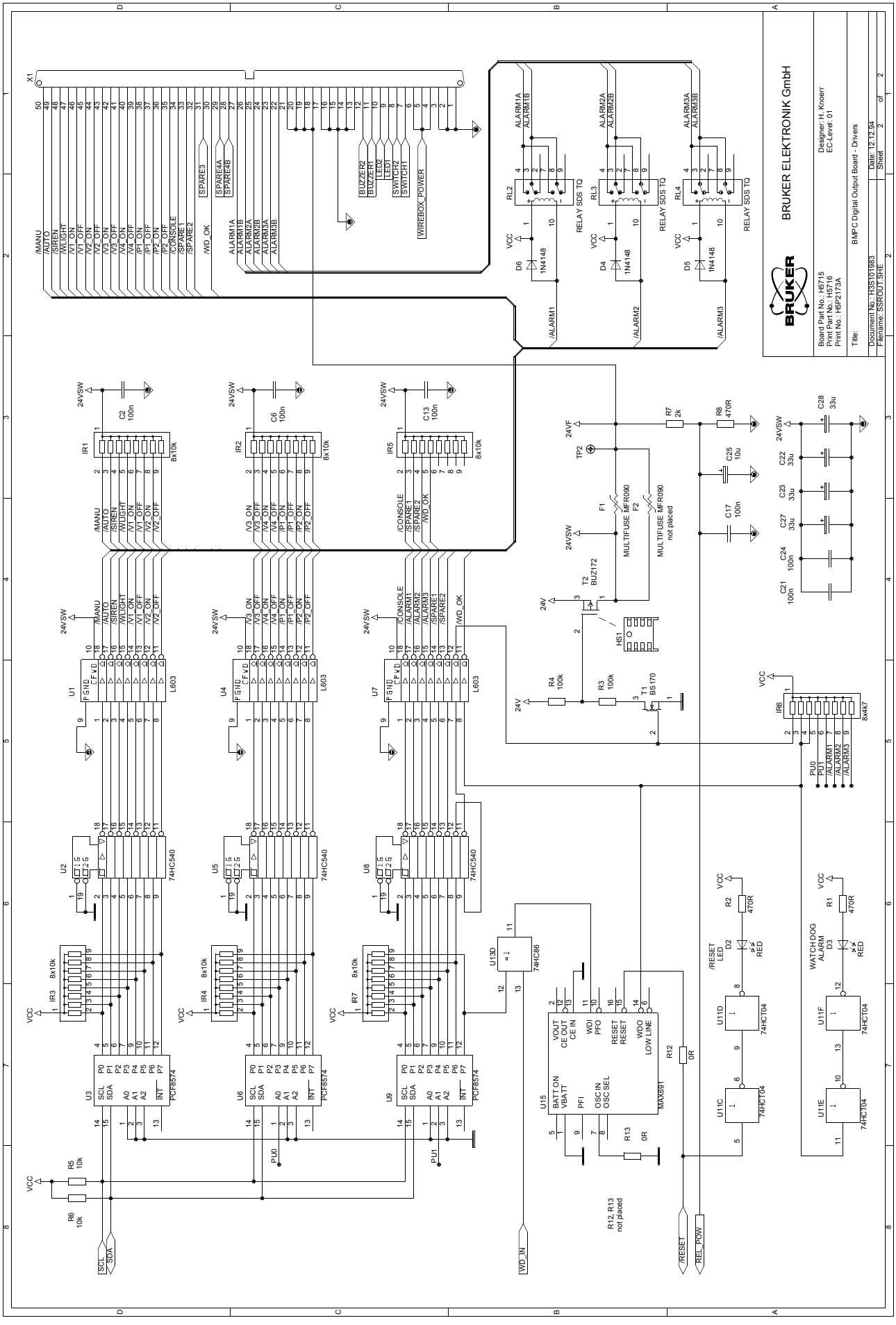


Figure A.12. BMPC Digital Input Board Page 2 of 2



Goto

Shematics BMPC Manual Control Unit

B

Figure B.1. BMPC Manual Control Unit Page 1 of 3

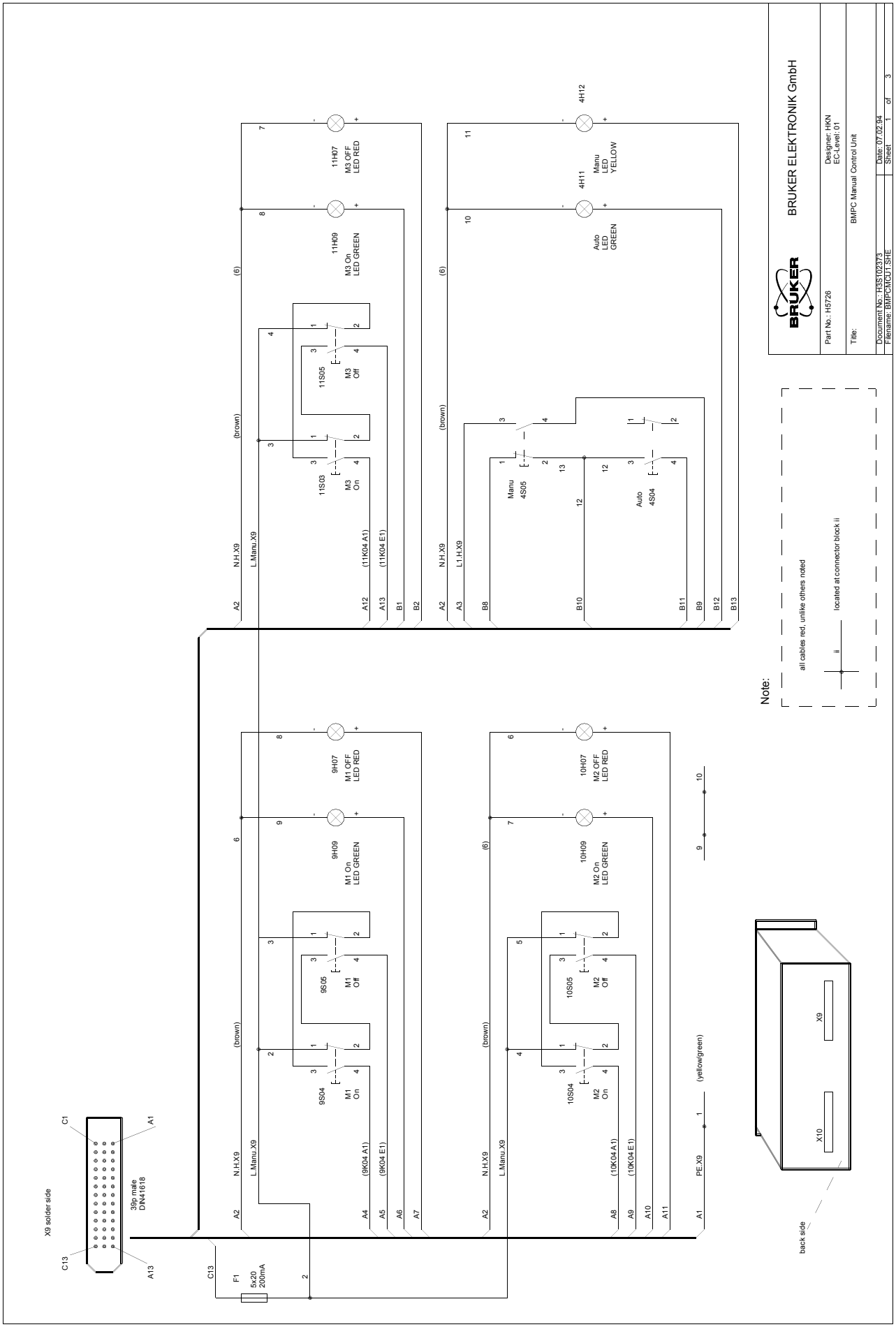


Figure B.2. BMPC Manual Control Unit Page 2 of 3

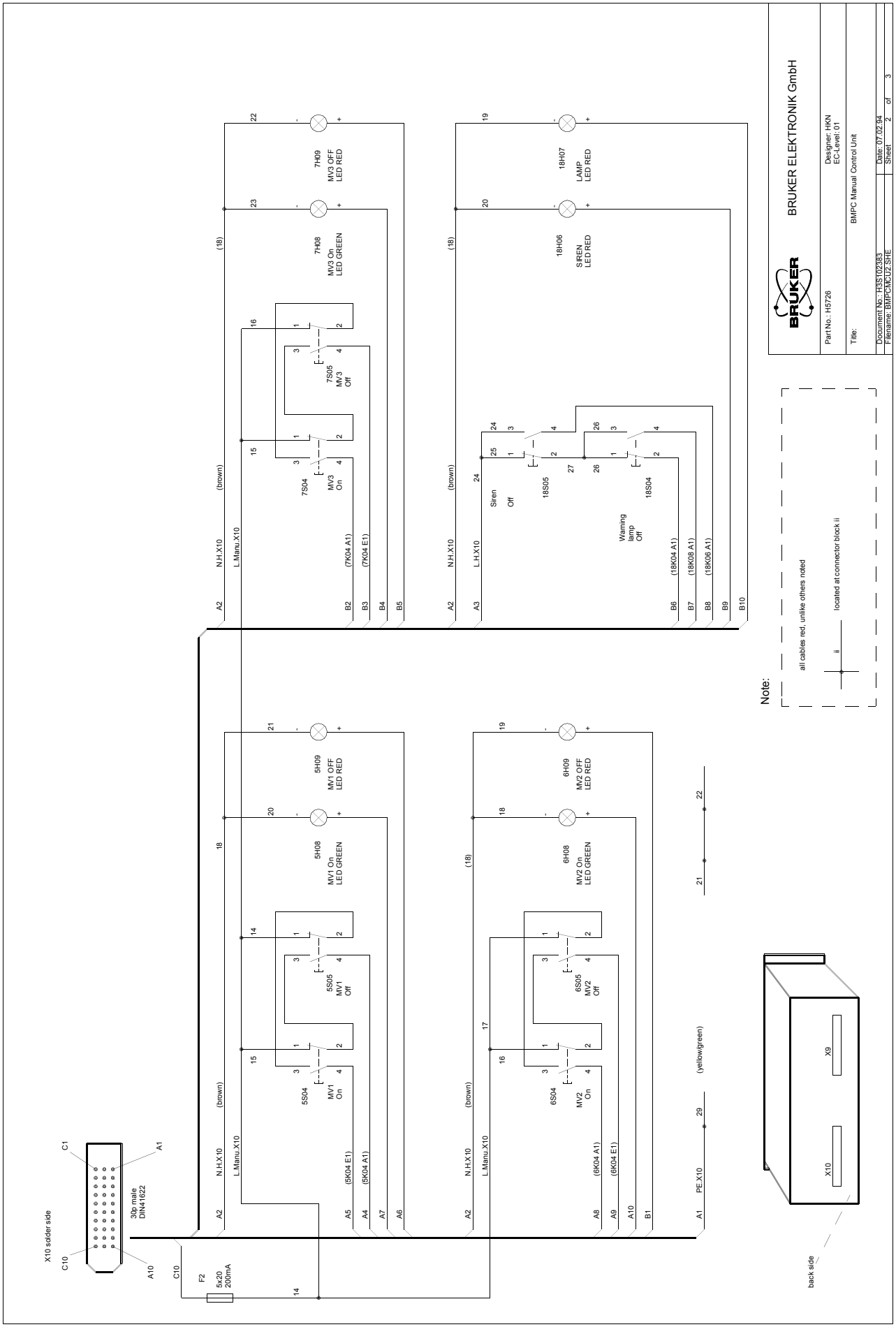
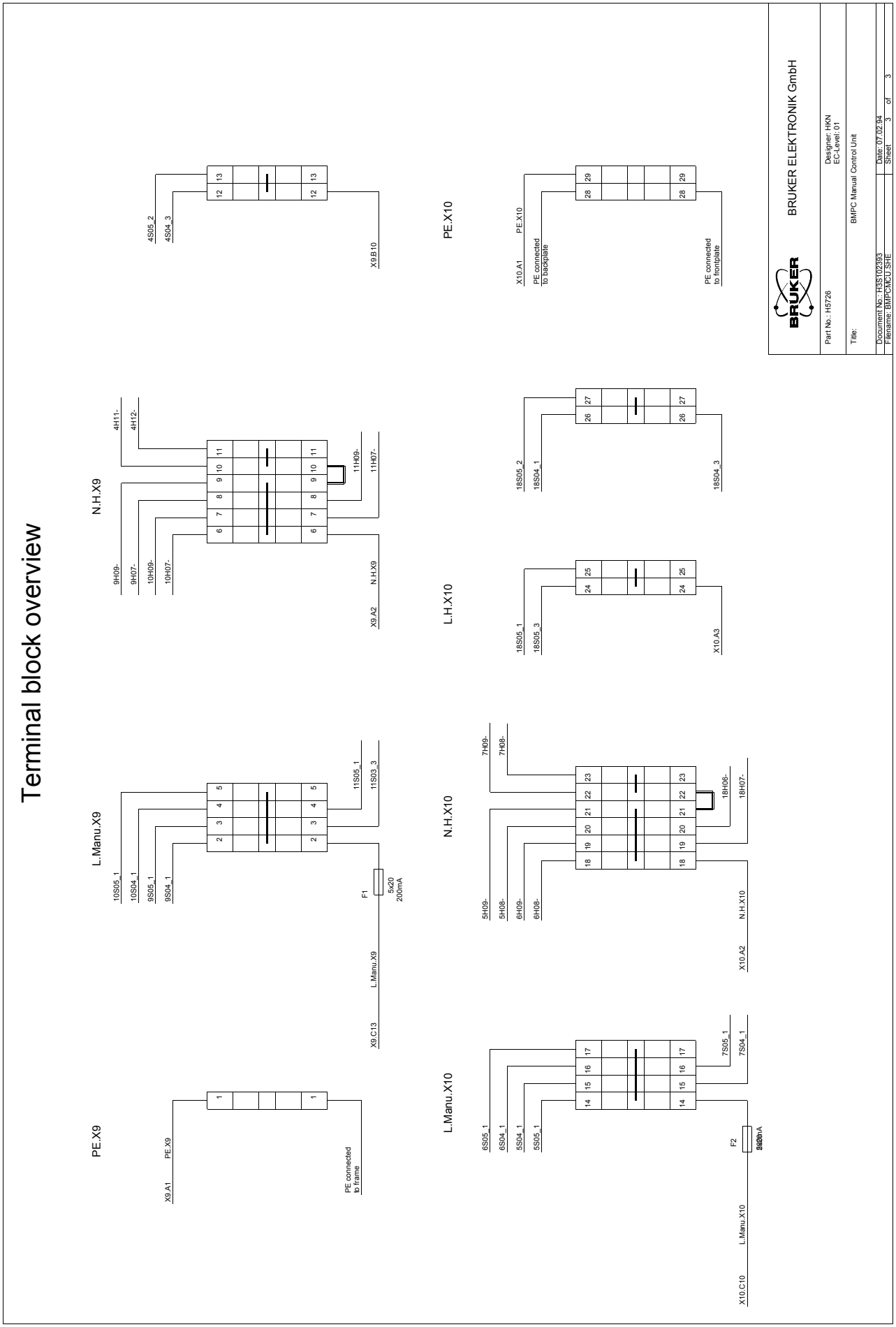


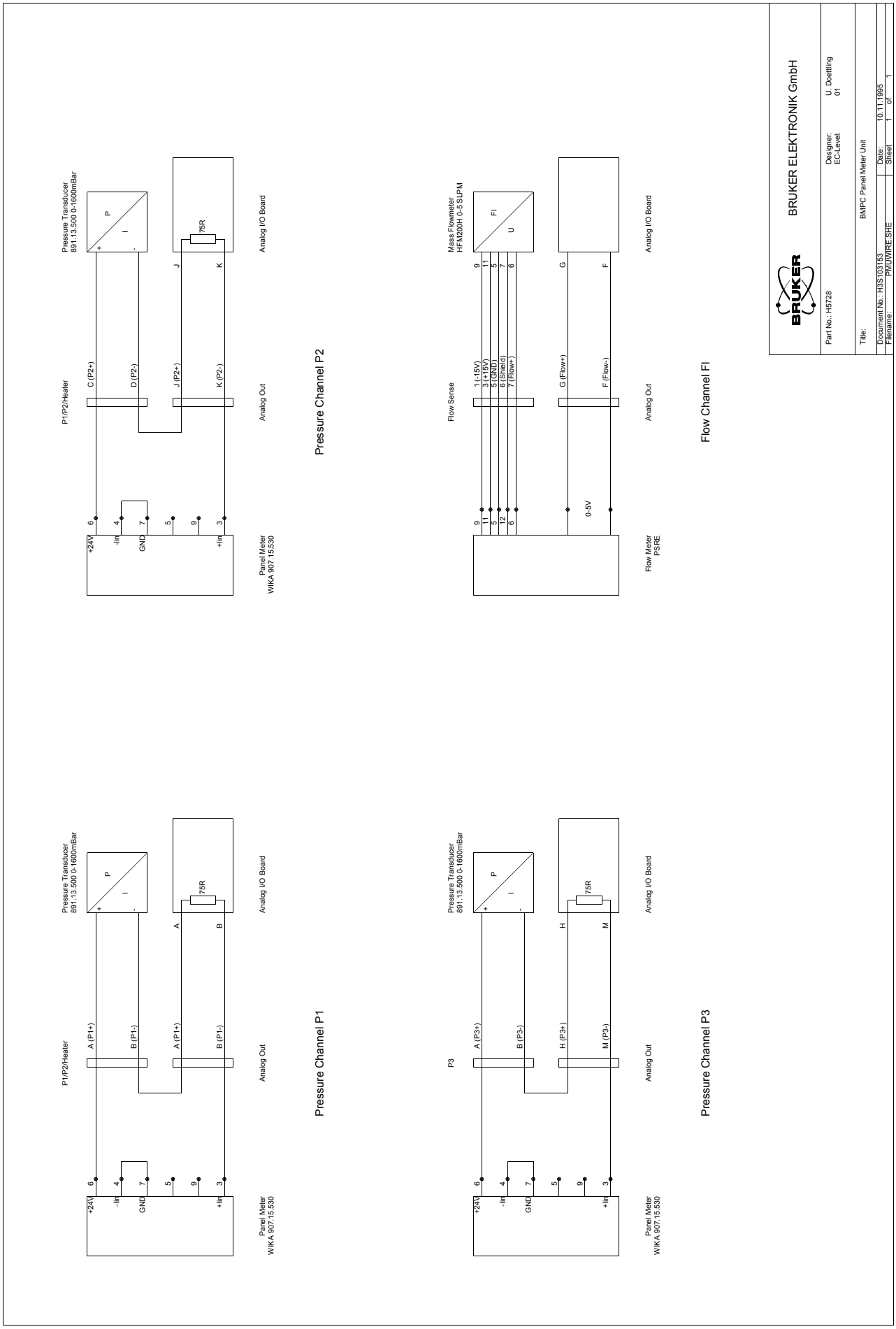
Figure B.3. BMPC Manual Control Unit Page 3 of 3



Shematics BMPC Panel Meter Unit

C

Figure C.1. BMPC Panel Meter Unit Page 1 of 1

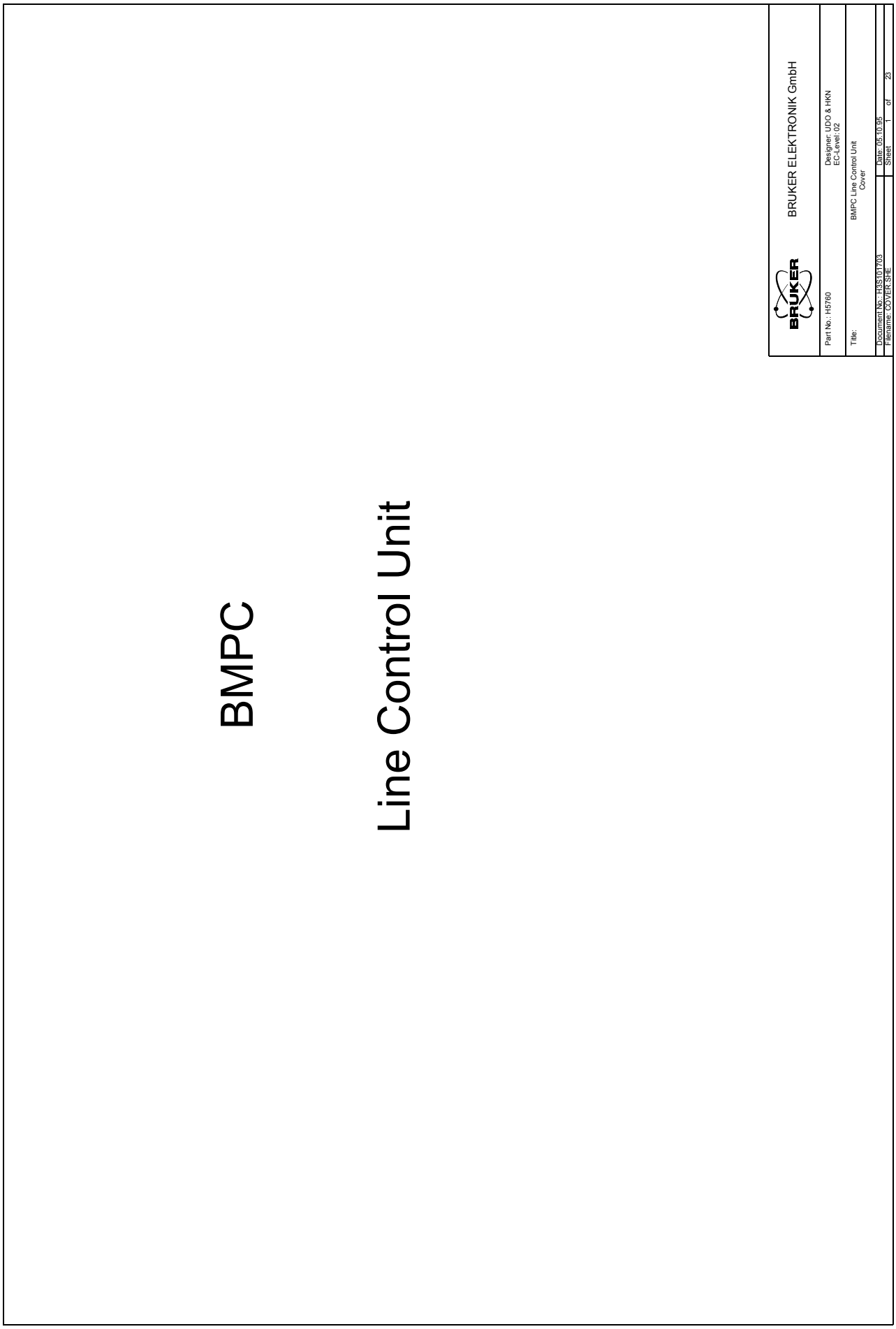


Goto

Shematics BMPC Line Control Unit

D

Figure D.1. BMPC Line Control Unit Page 1 of 23



conversion tables X7 to X23

X23	X7	X23	X7	X23	X7
A1	1	B1	14	C1	27
A2	2	B2	15	C2	28
A3	3	B3	16	C3	29
A4	4	B4	17	C4	30
A5	5	B5	18	C5	31
A6	6	B6	19	C6	32
A7	7	B7	20	C7	33
A8	8	B8	21	C8	34
A9	9	B9	22	C9	35
A10	10	B10	23	C10	36
A11	11	B11	24	C11	37
A12	12	B12	25	C12	38
A13	13	B13	26	C13	39

conversion table X8 to X24

X24	X8	X24	X8	X24	X8
A1	1	B1	11	C1	21
A2	2	B2	12	C2	22
A3	3	B3	13	C3	23
A4	4	B4	14	C4	24
A5	5	B5	15	C5	25
A6	6	B6	16	C6	26
A7	7	B7	17	C7	27
A8	8	B8	18	C8	28
A9	9	B9	19	C9	29
A10	10	B10	20	C10	30

conversion tables
new relais sockets to old relais sockets

old sockets Pin No.:	new sockets Pin No.:
11	1
A1	2
14	3
12	4
22	5
21	6
24	7
32	8
34	9
A2	10
31	11

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BRUKER ELEKTRONIK GmbH

Part No.: H5760	Designer: UDO & HKN EC-Level: 02
Title:	BMPC Line Control Unit Legend
Document No.: H3S101713	Date: 05.10.95
Filename: LEGEND.SHE	Sheet 2 of 23

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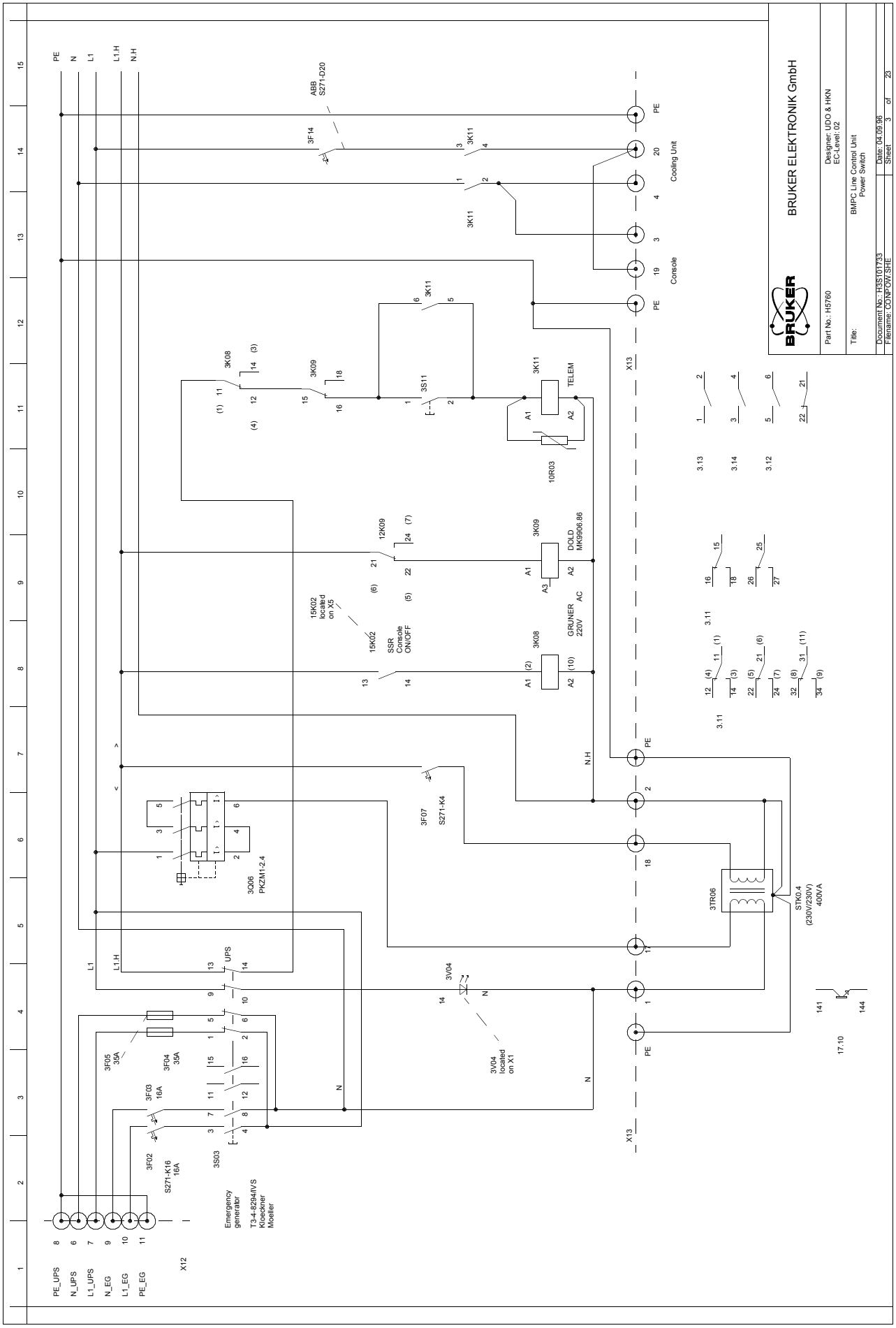


Figure D.4. BMPC Line Control Unit Page 4 of 23

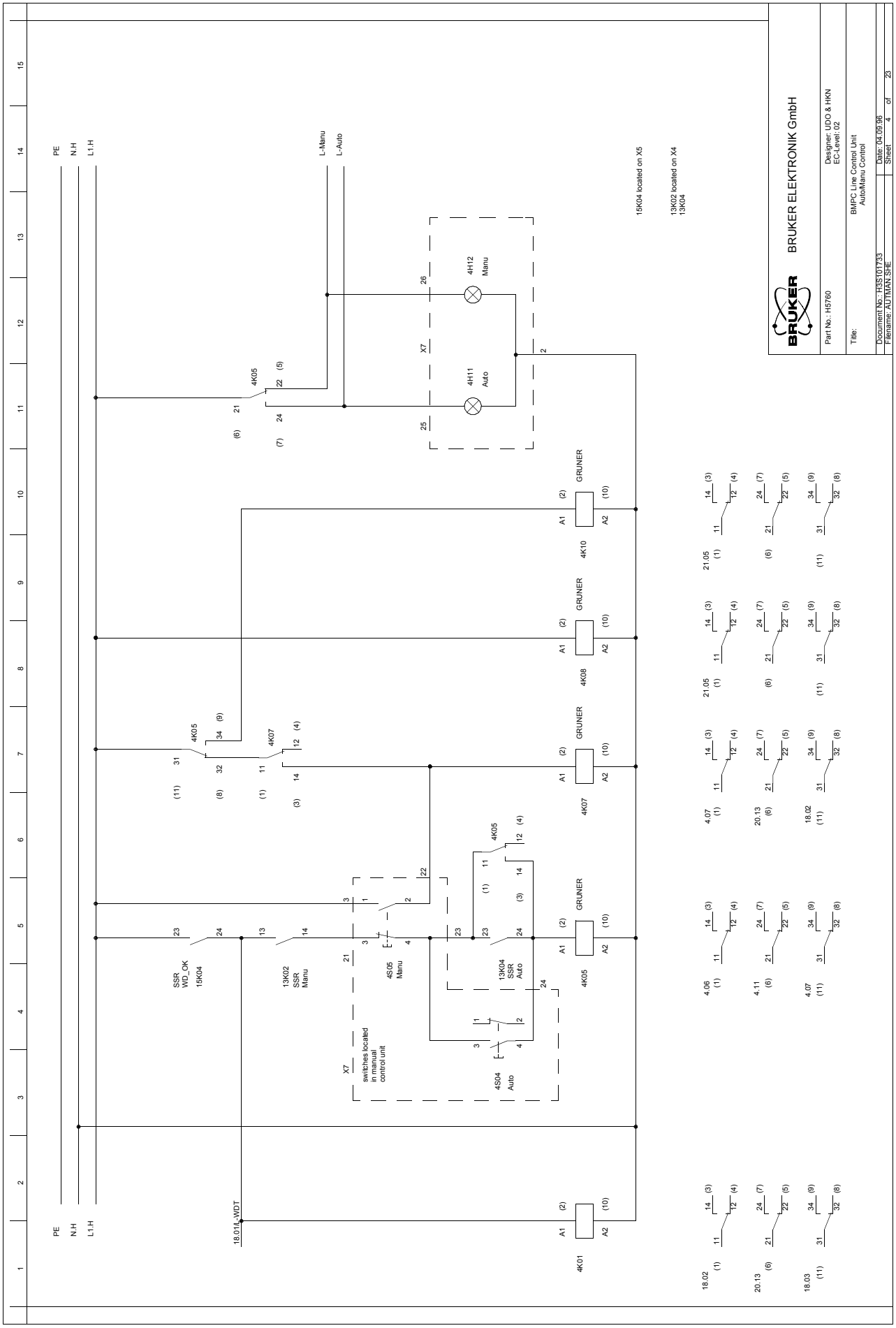


Figure D.5. BMPC Line Control Unit Page 5 of 23

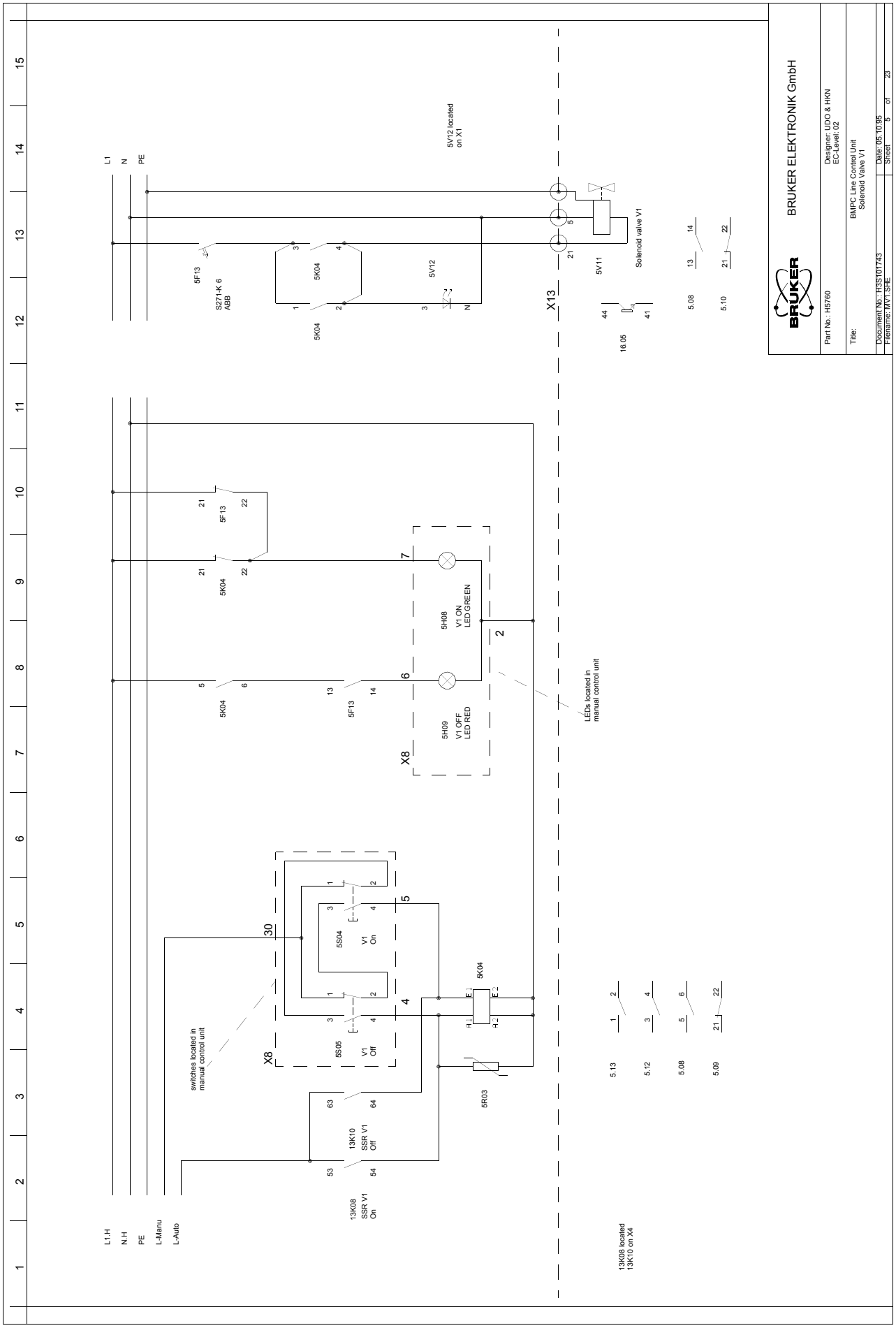


Figure D.6. BMPC Line Control Unit Page 6 of 23

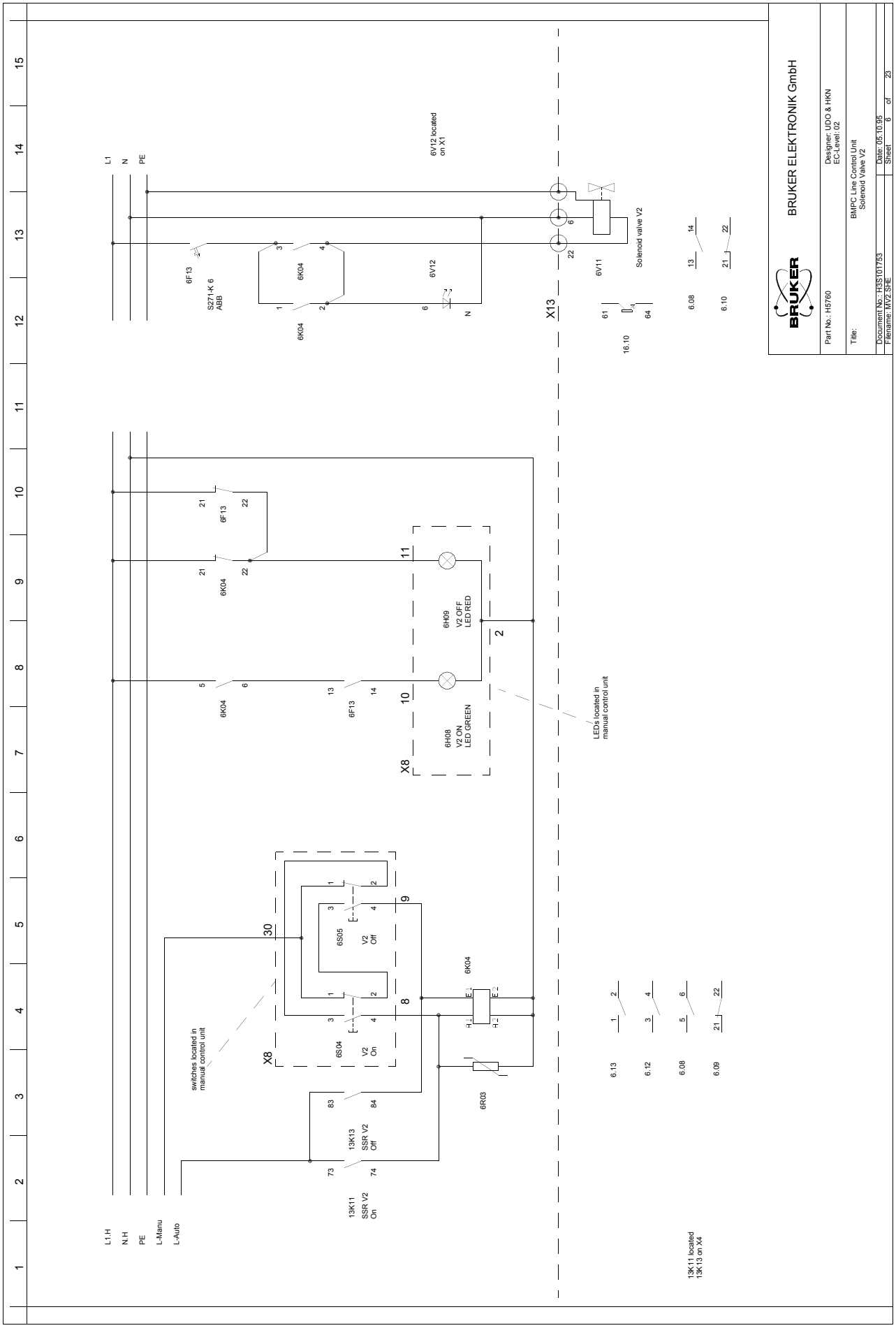


Figure D.7. BMPC Line Control Unit Page 7 of 23

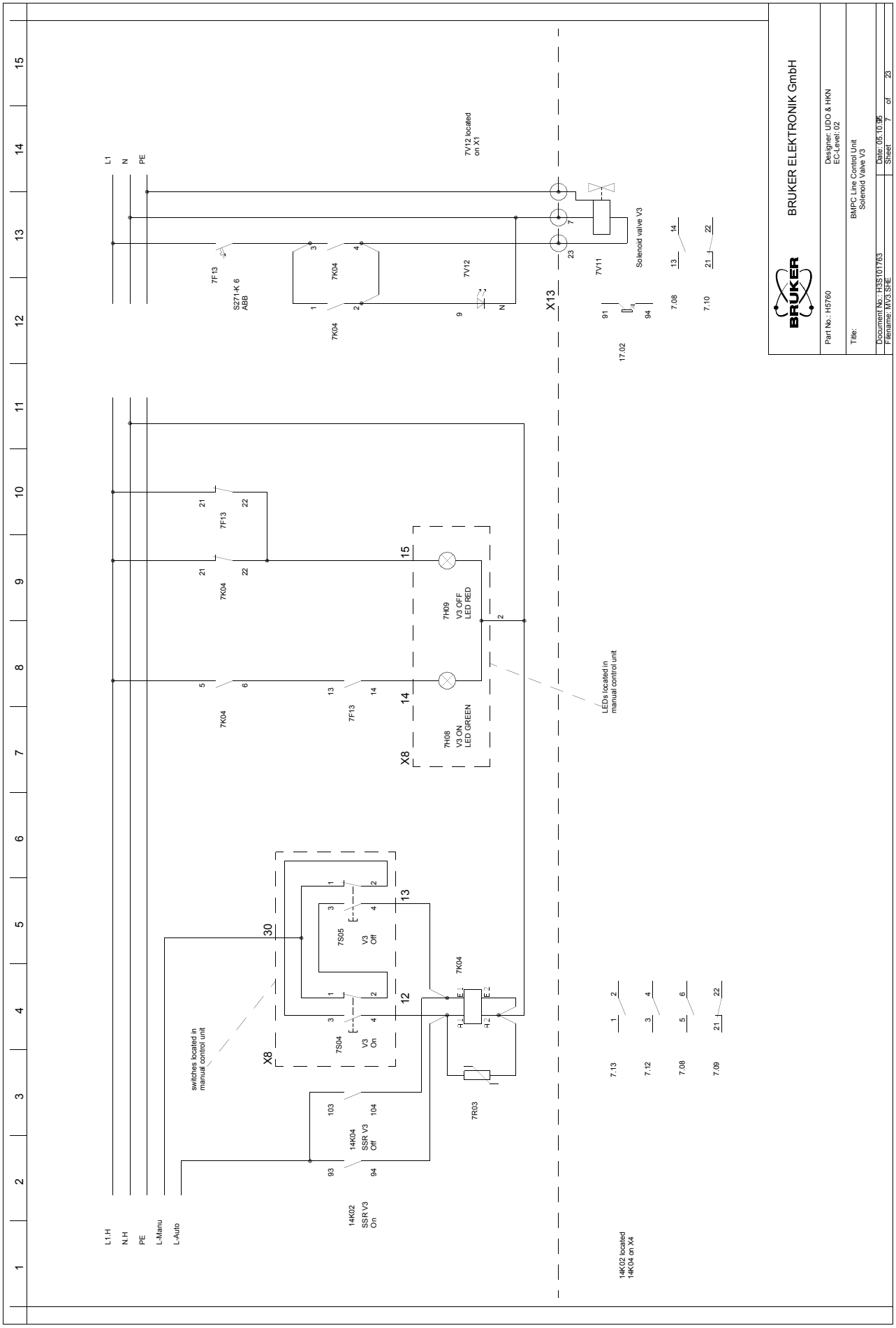


Figure D.8. BMPC Line Control Unit Page 8 of 23

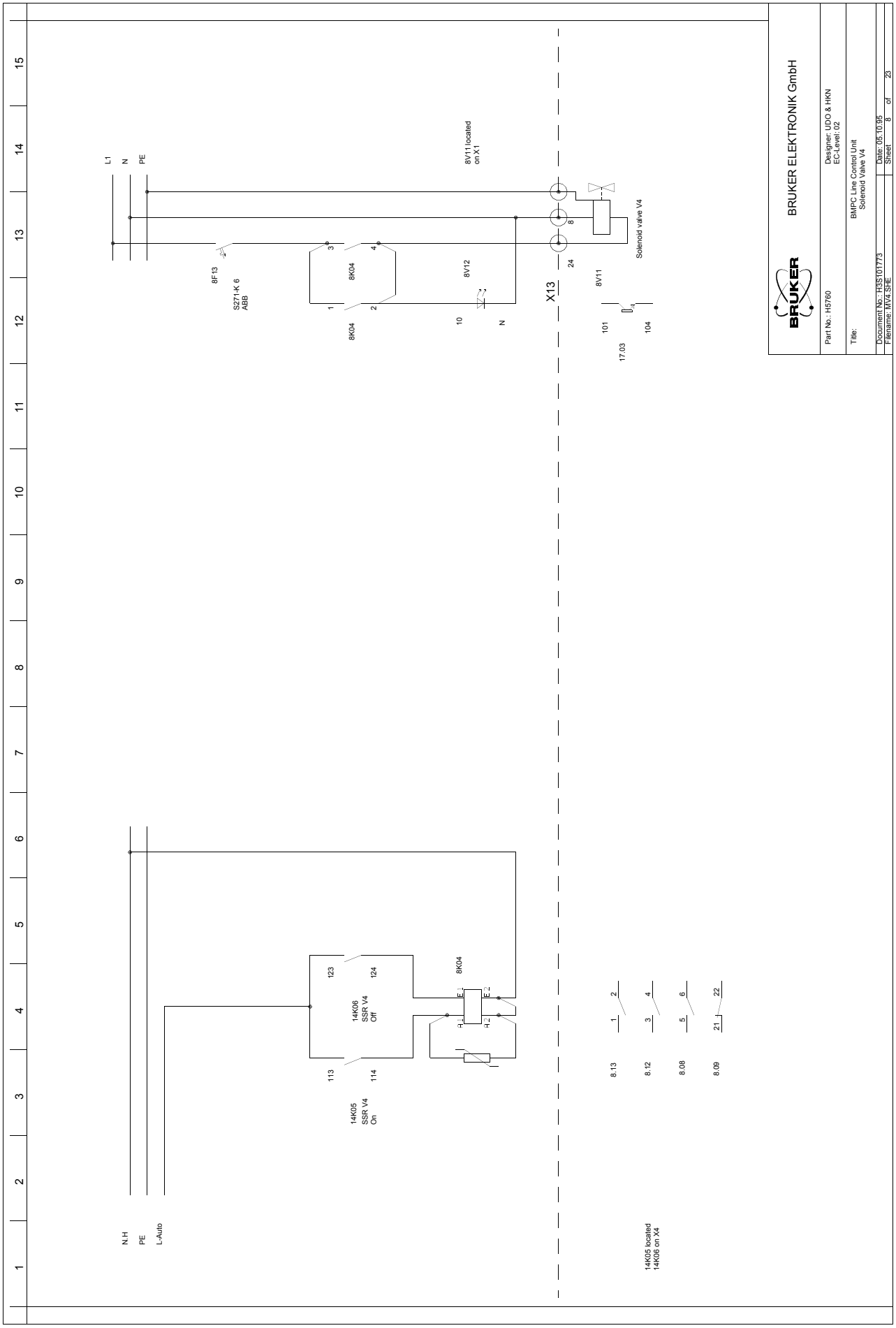


Figure D.9. BMPC Line Control Unit Page 9 of 23

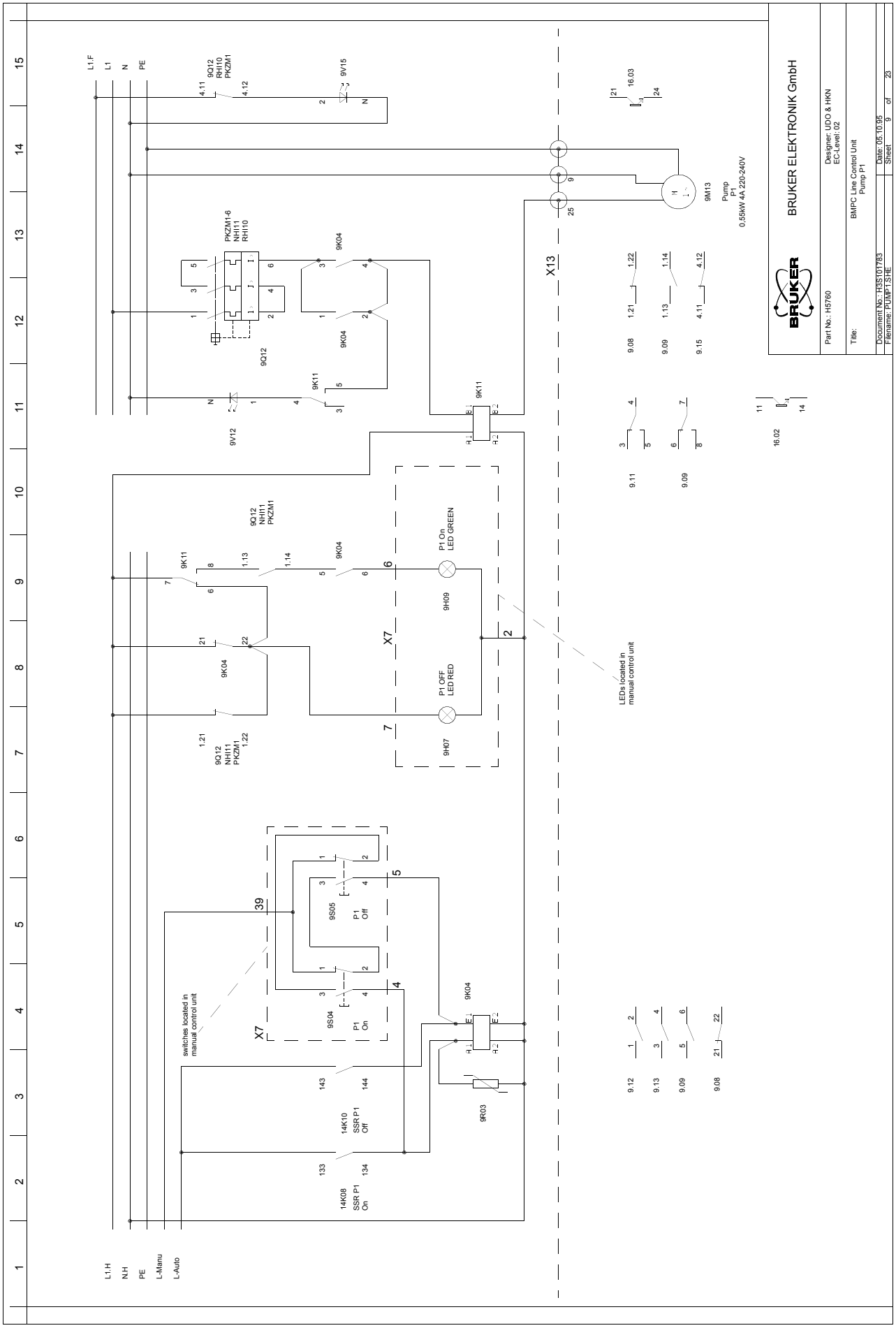


Figure D.10. BMPC Line Control Unit Page 10 of 23

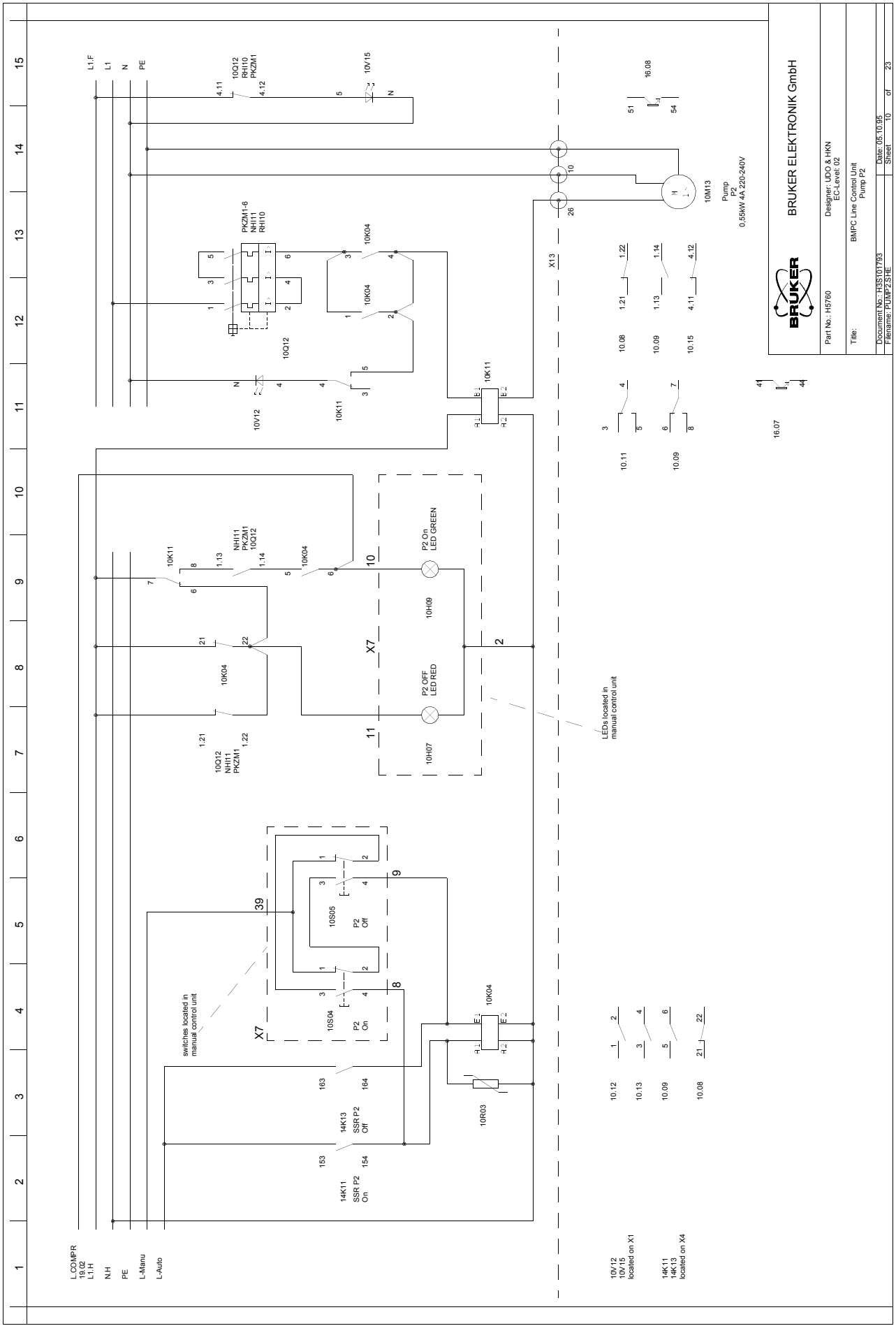


Figure D.11. BMPC Line Control Unit Page 11 of 23

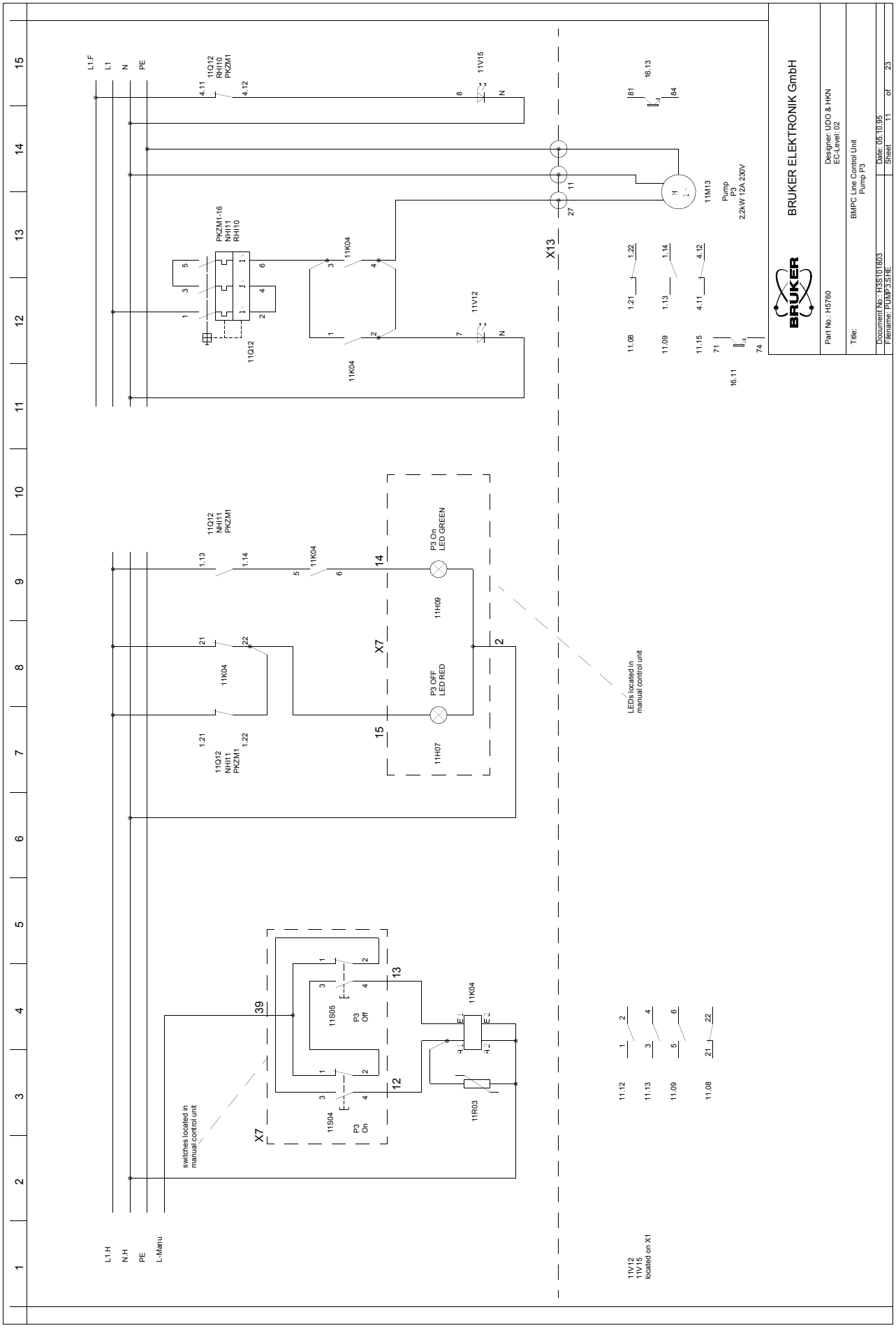
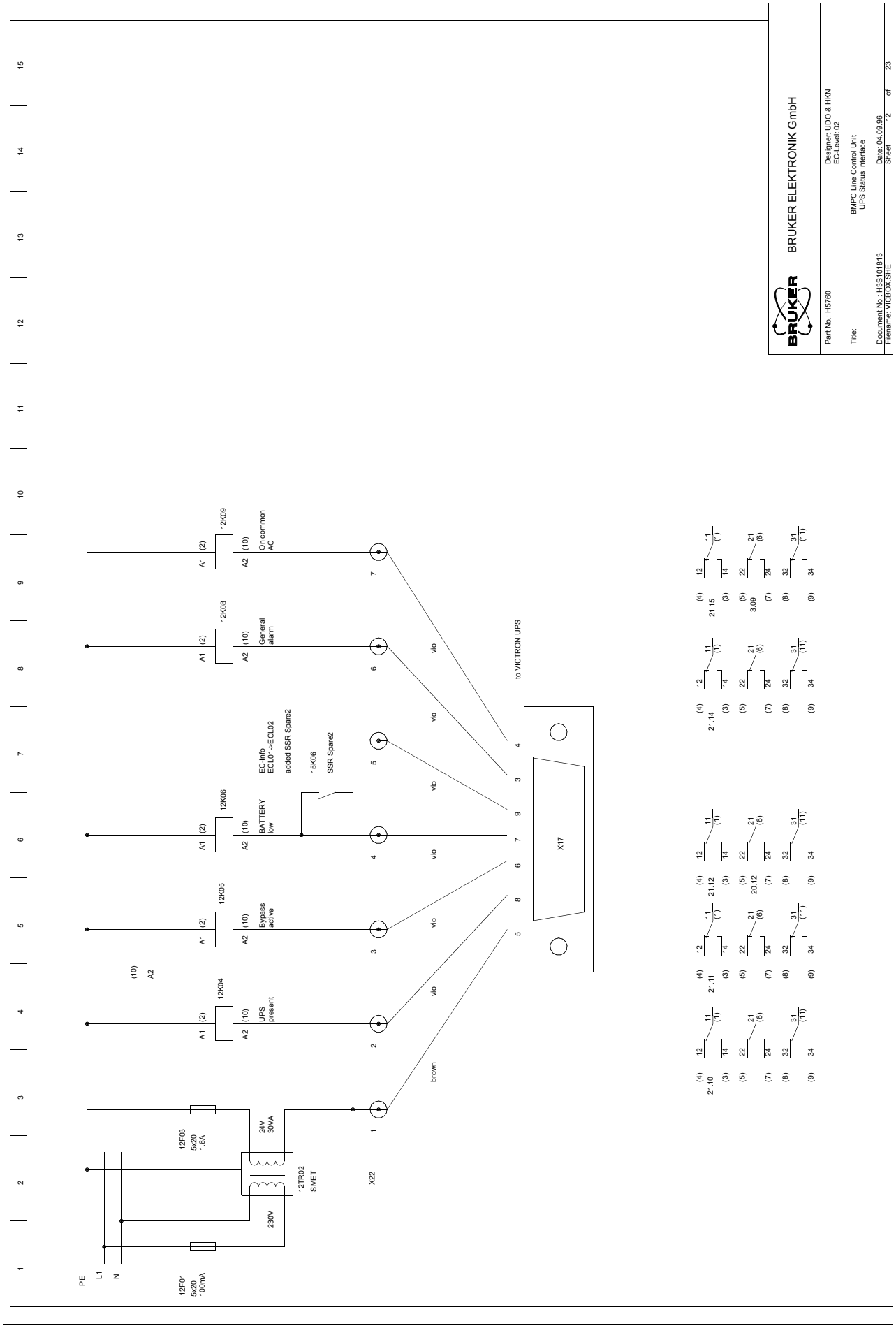


Figure D.12. BMPC Line Control Unit Page 12 of 23



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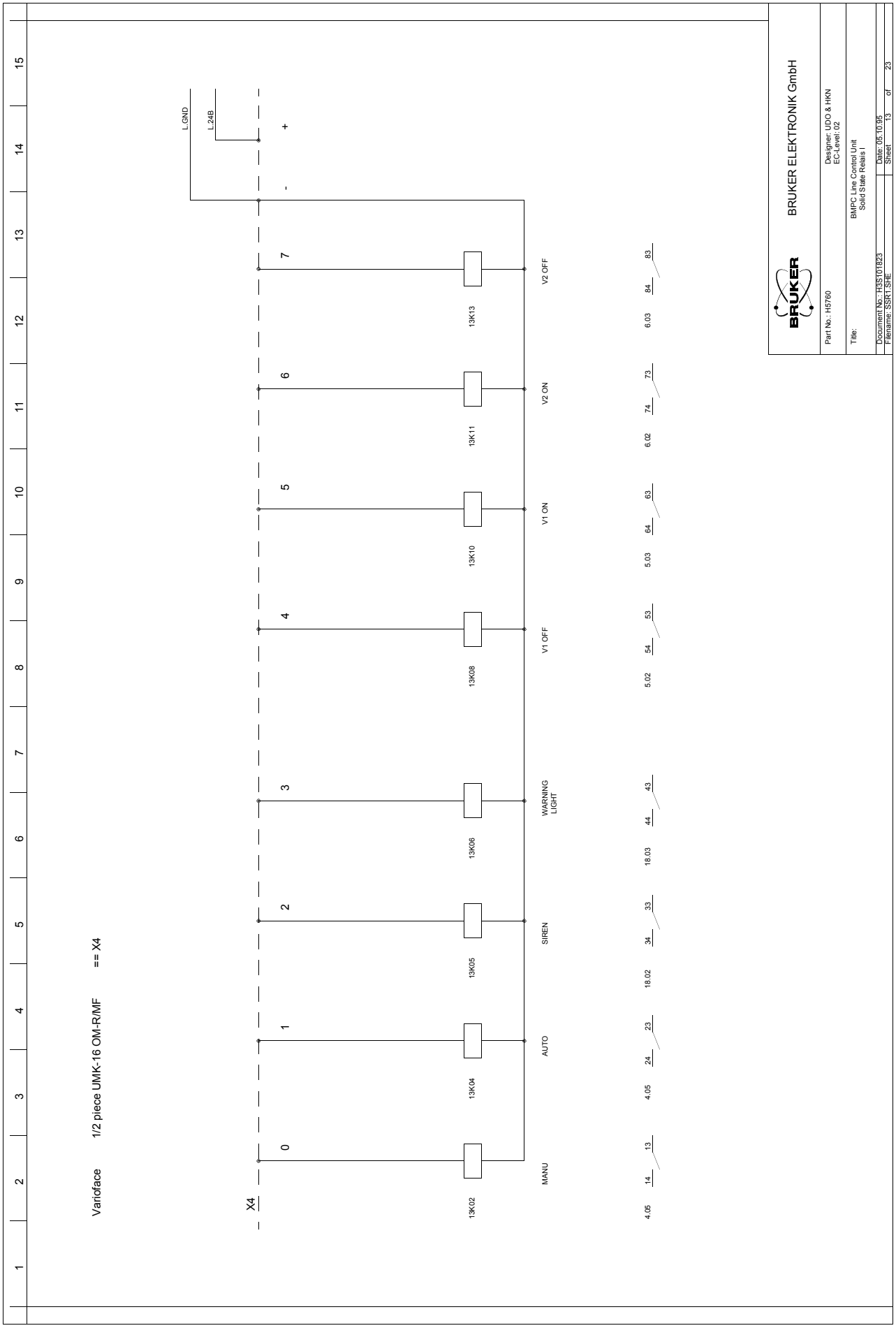

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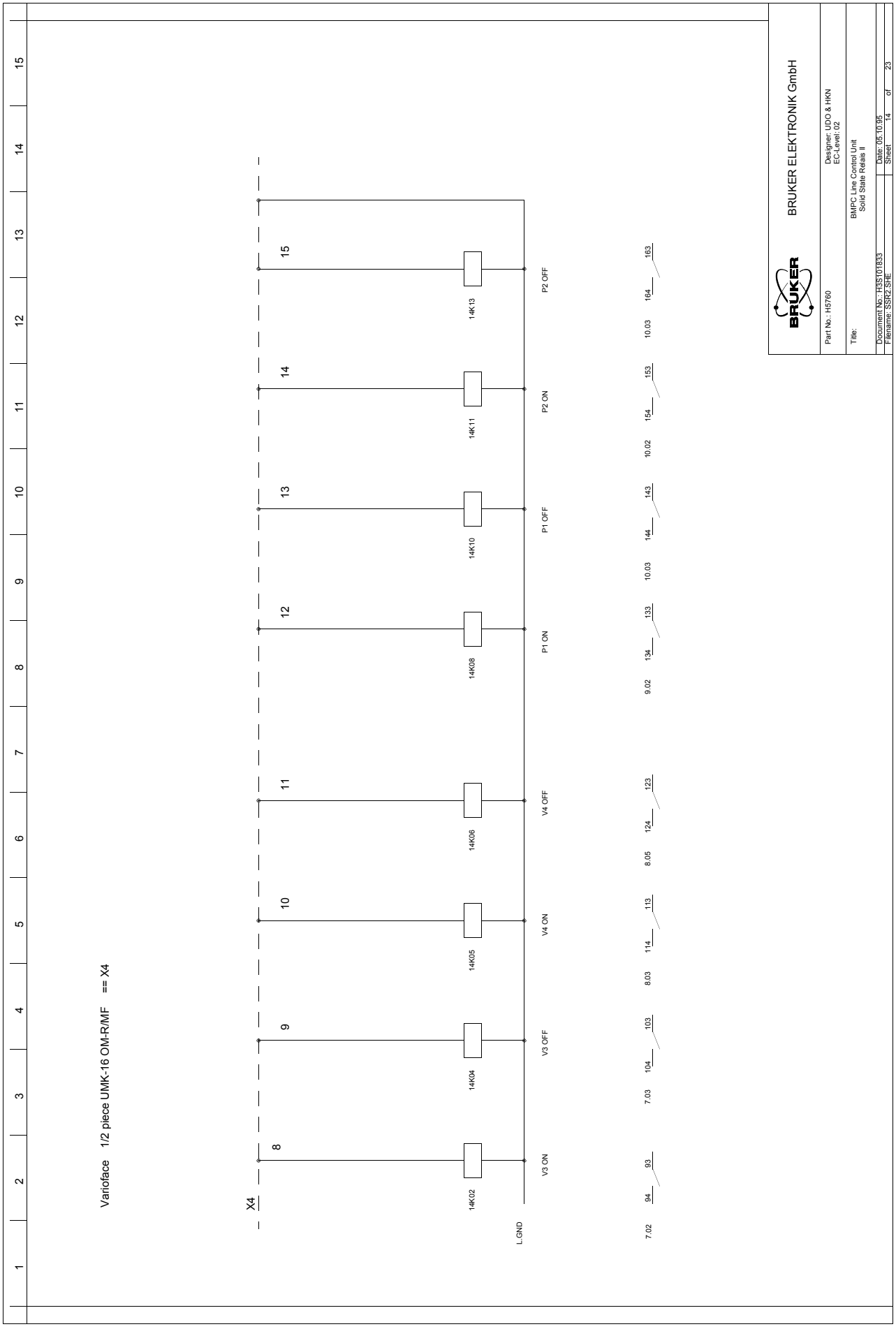

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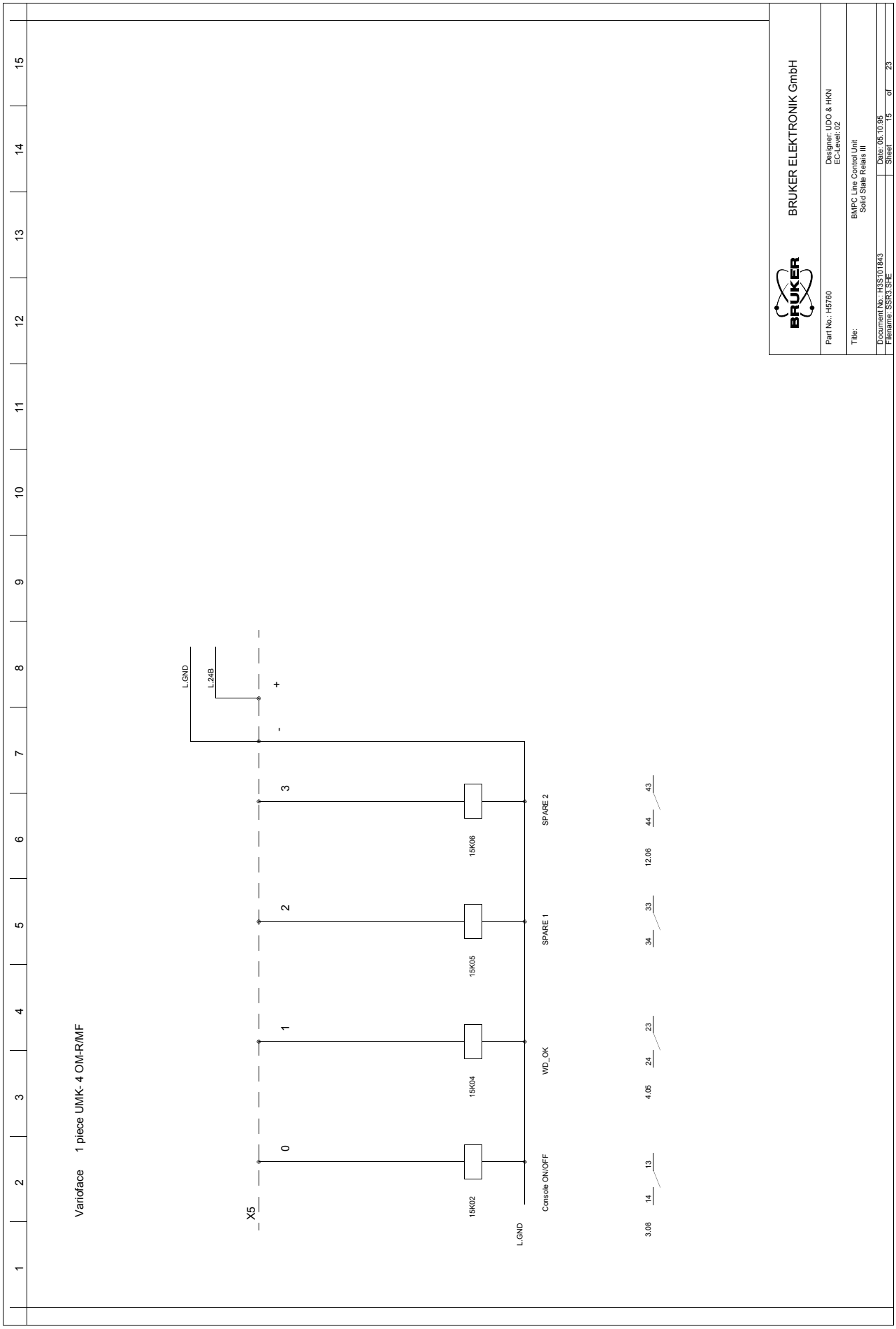
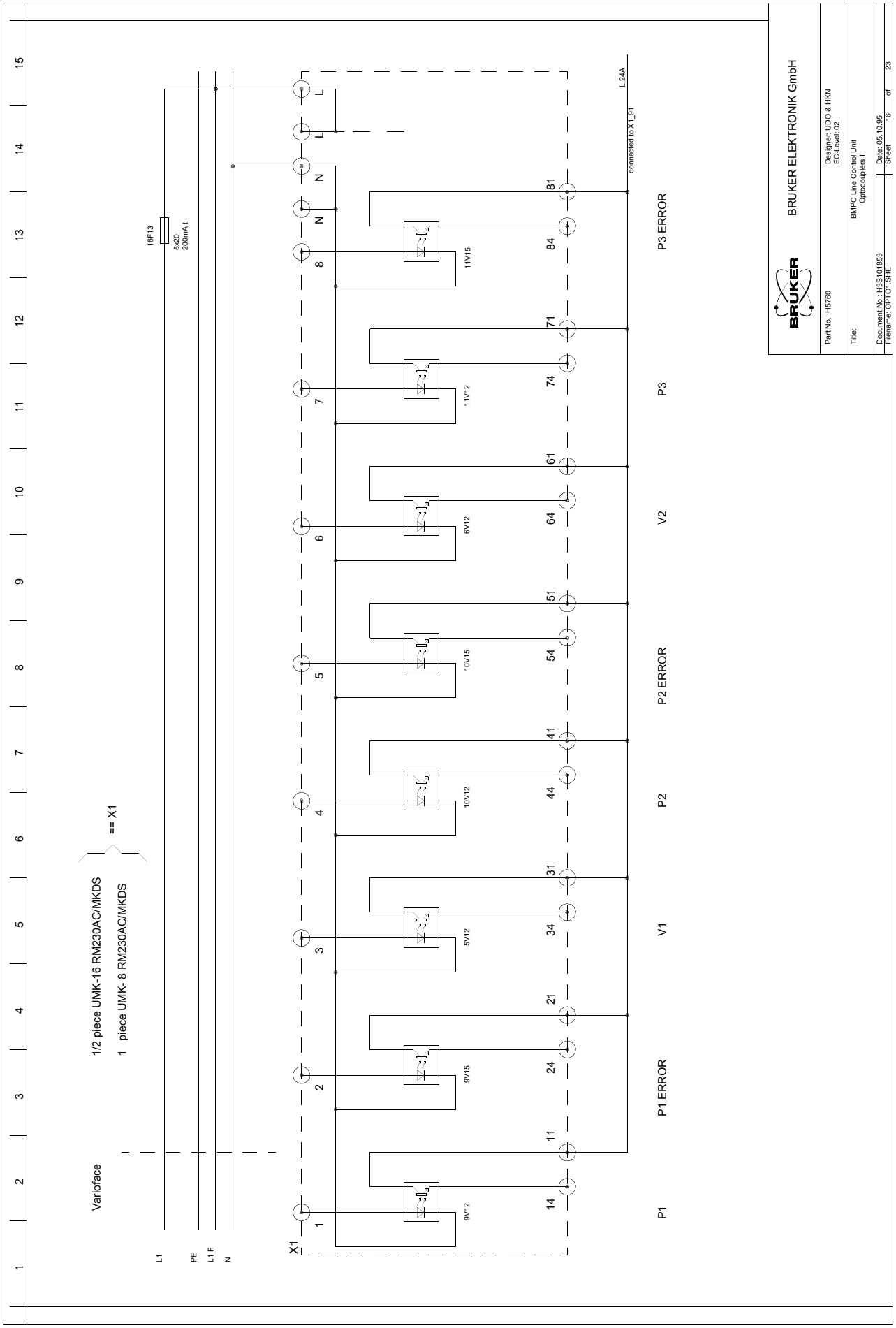


Figure D.16. BMPC Line Control Unit Page 16 of 23



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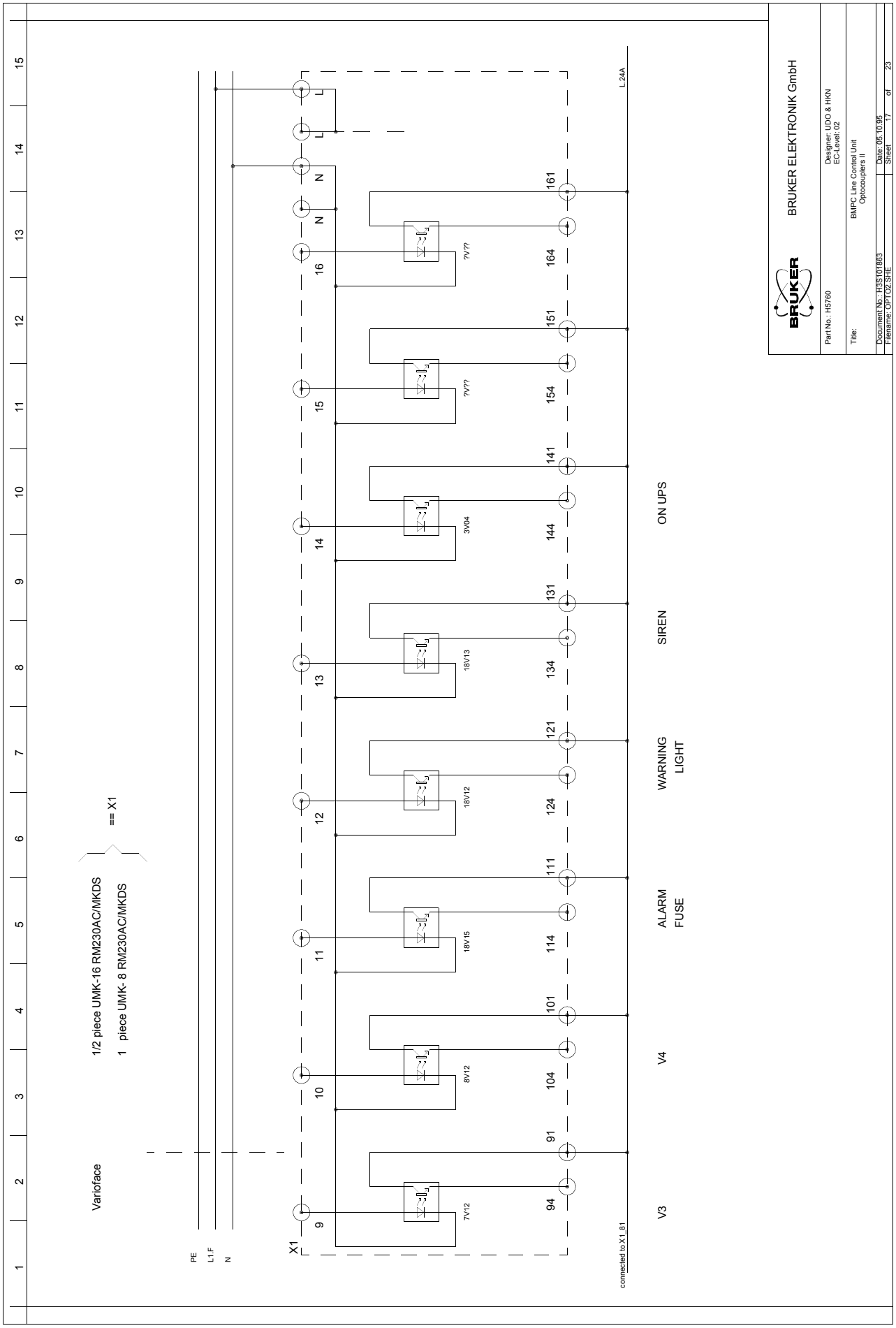

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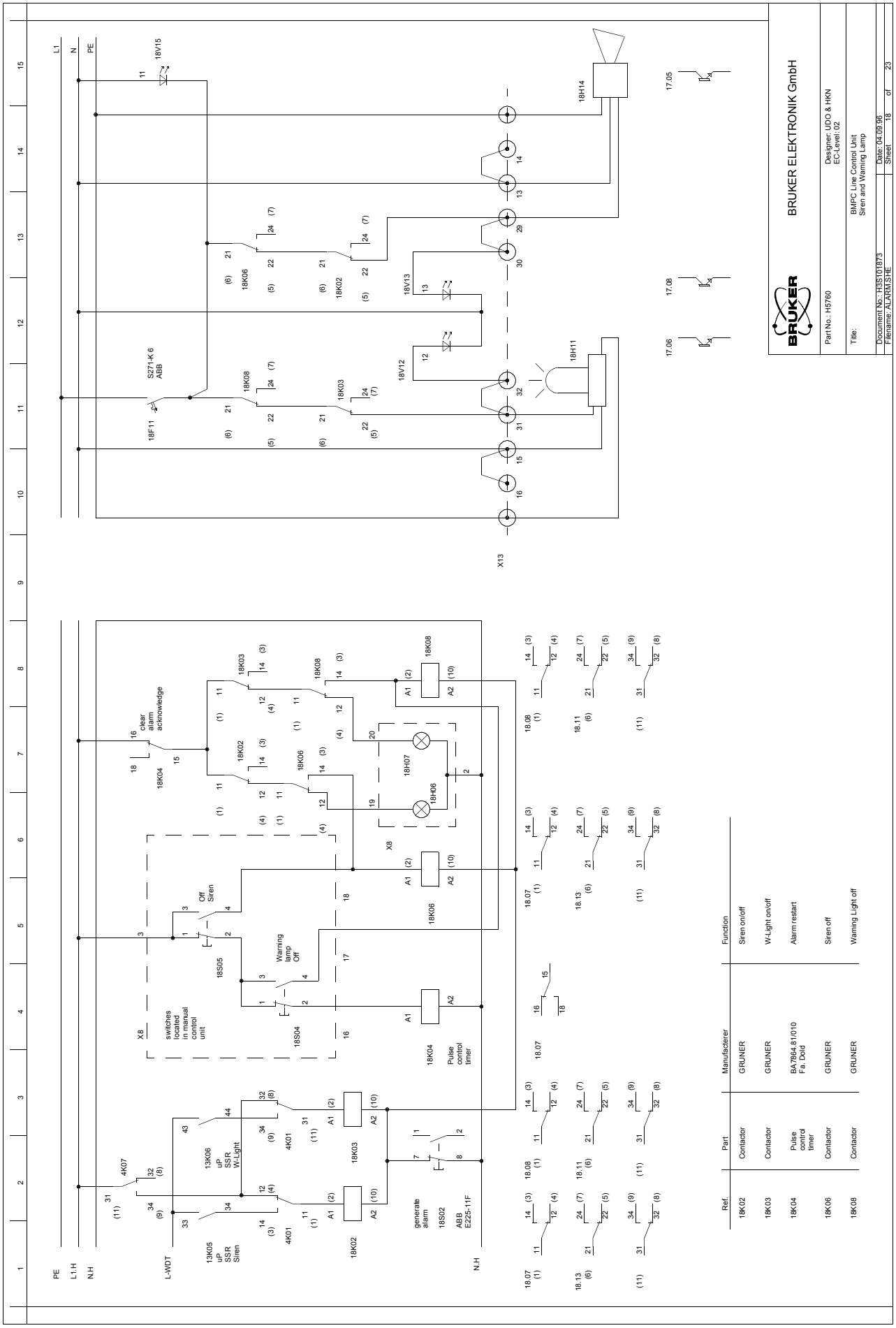

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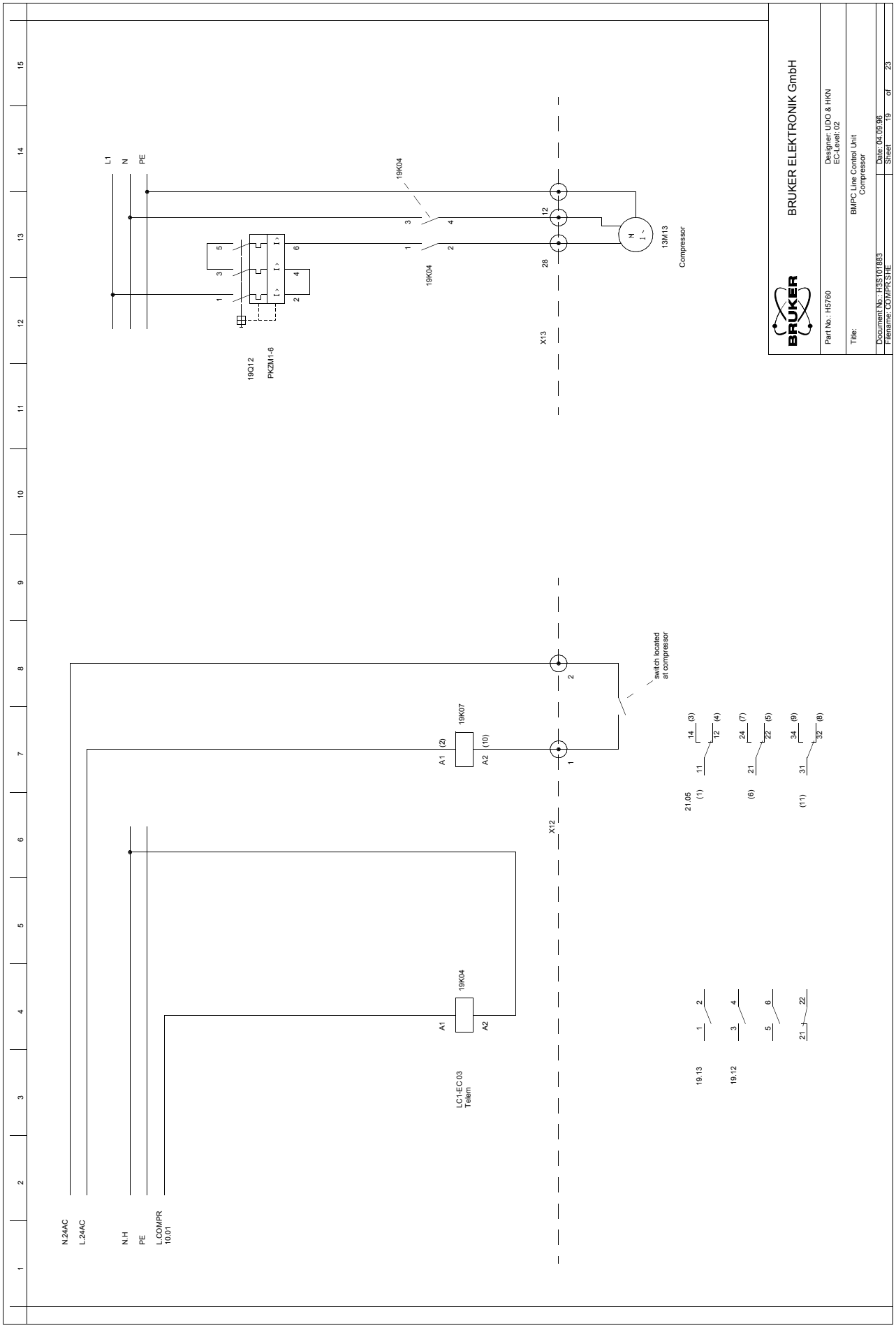

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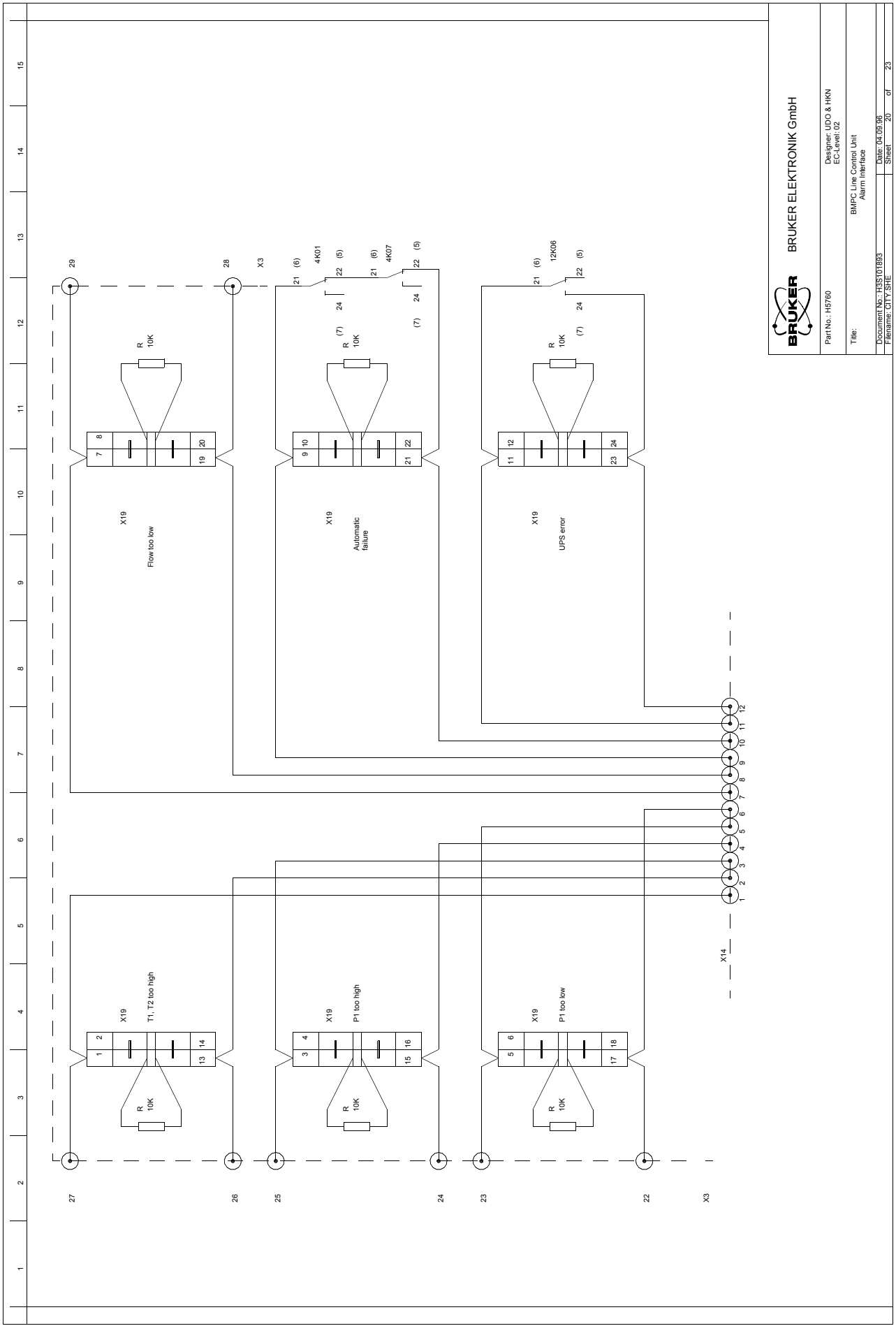

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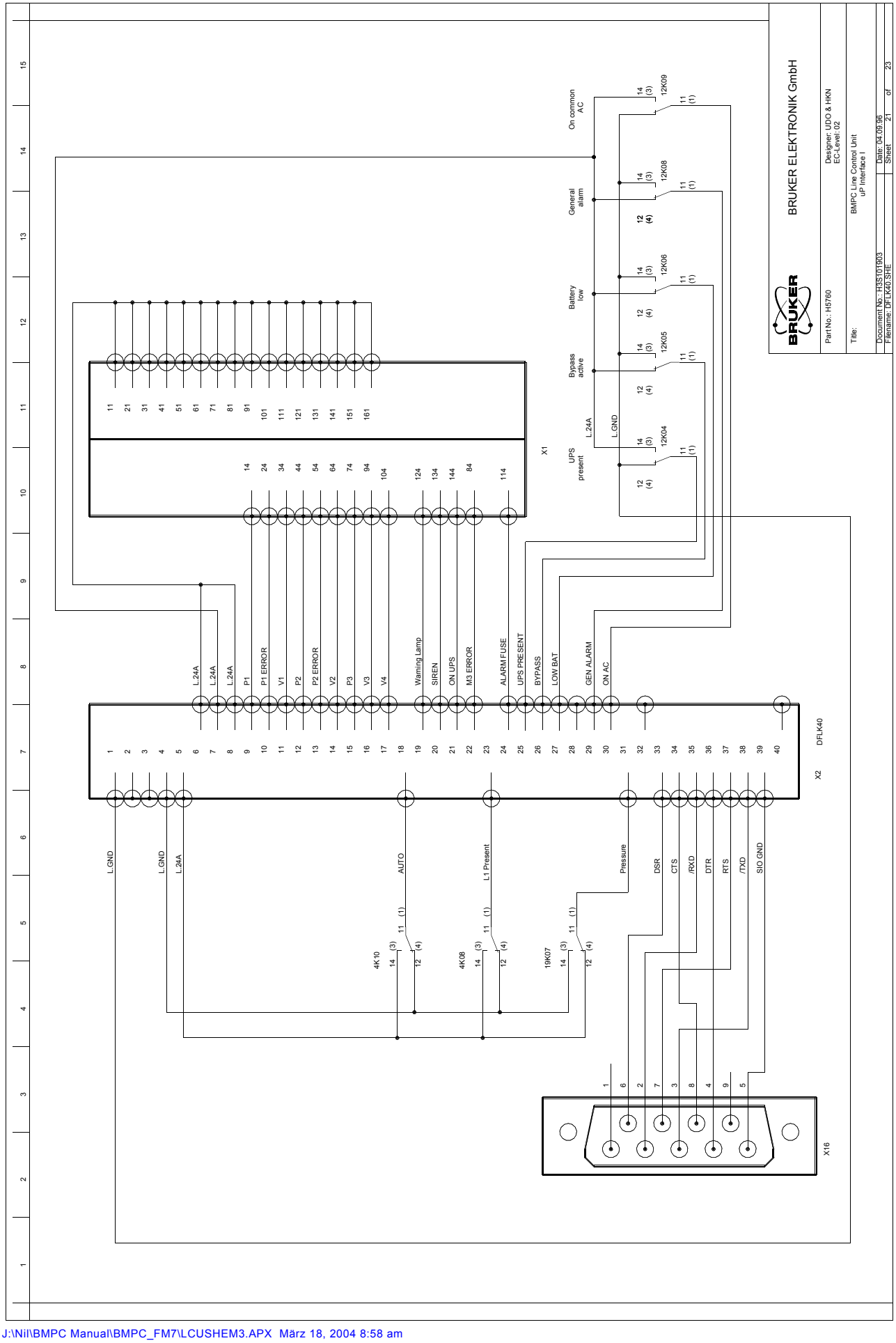

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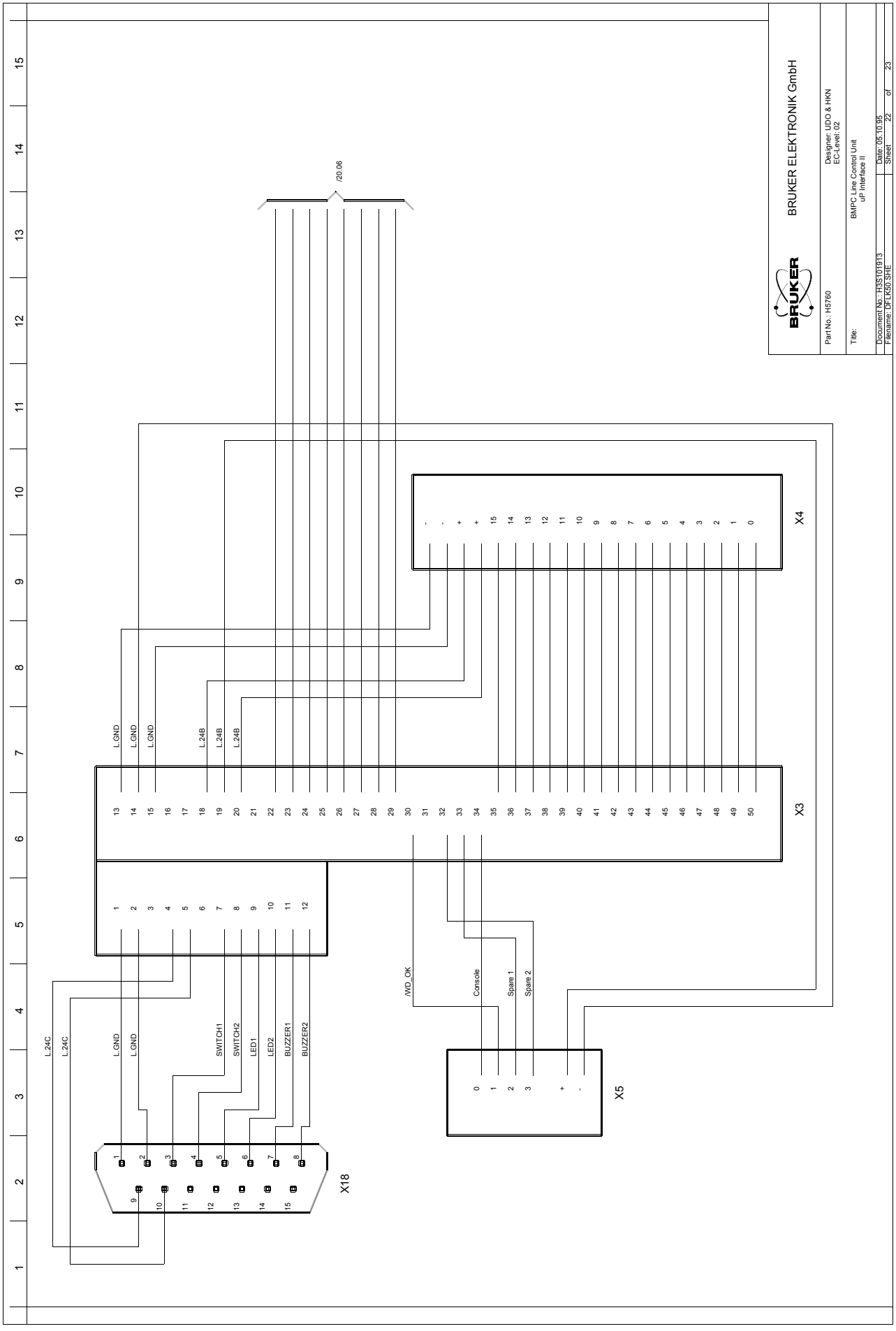

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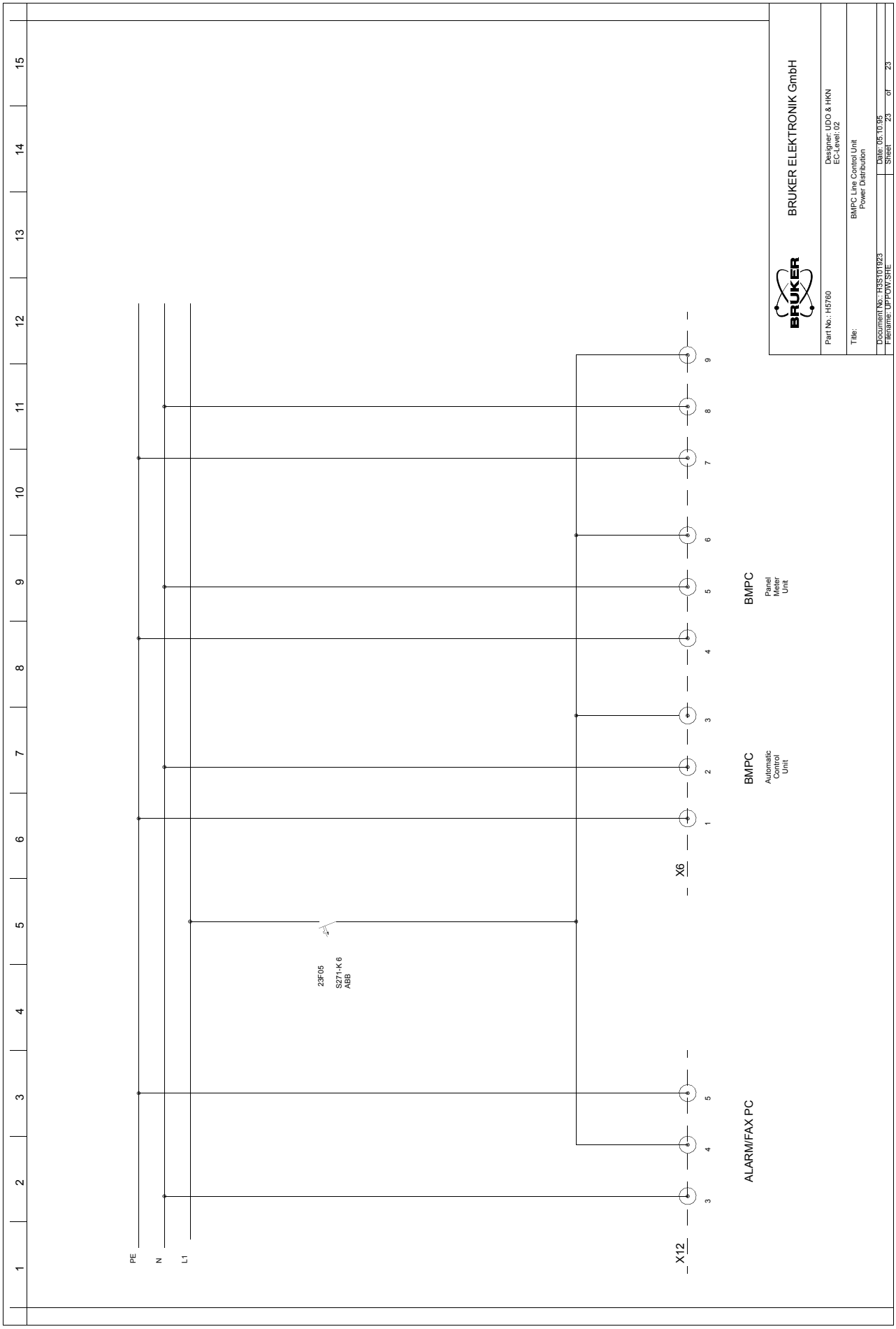

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Shematics
BMPC Wiring Box

E

Figure E.1. BMPC Wiring Box Page 1 of 1