Service Manual
S3

3HAB 0009-25
M93A

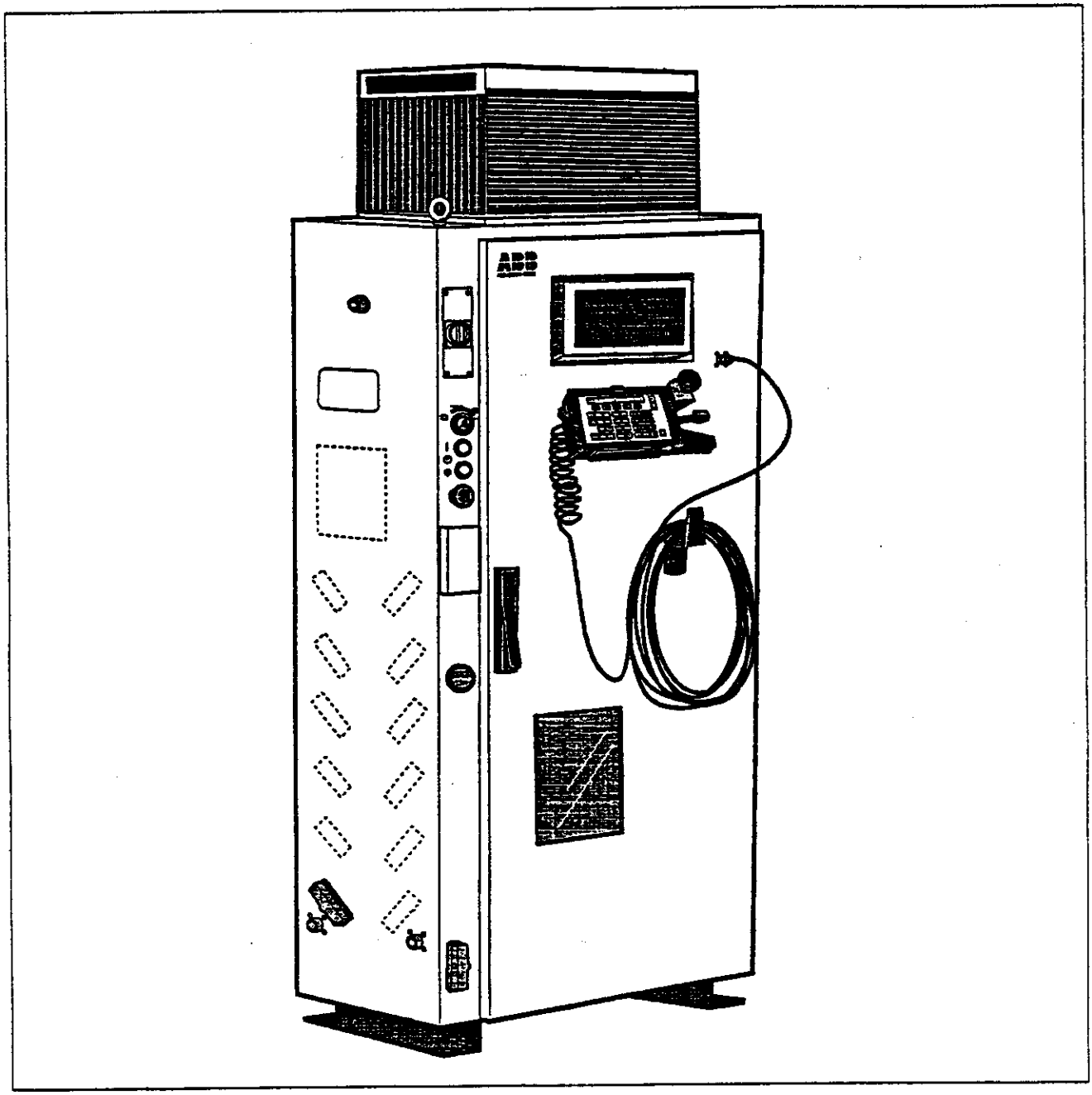

ABB Robotics Products

ABB

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1
SAFETY - INSTRUCTIONS AND RECOMMENDATIONS

1.1
General

All safety instructions regarding the operation and handling of the robot system are found in the Safety Manual in the Product Manual.

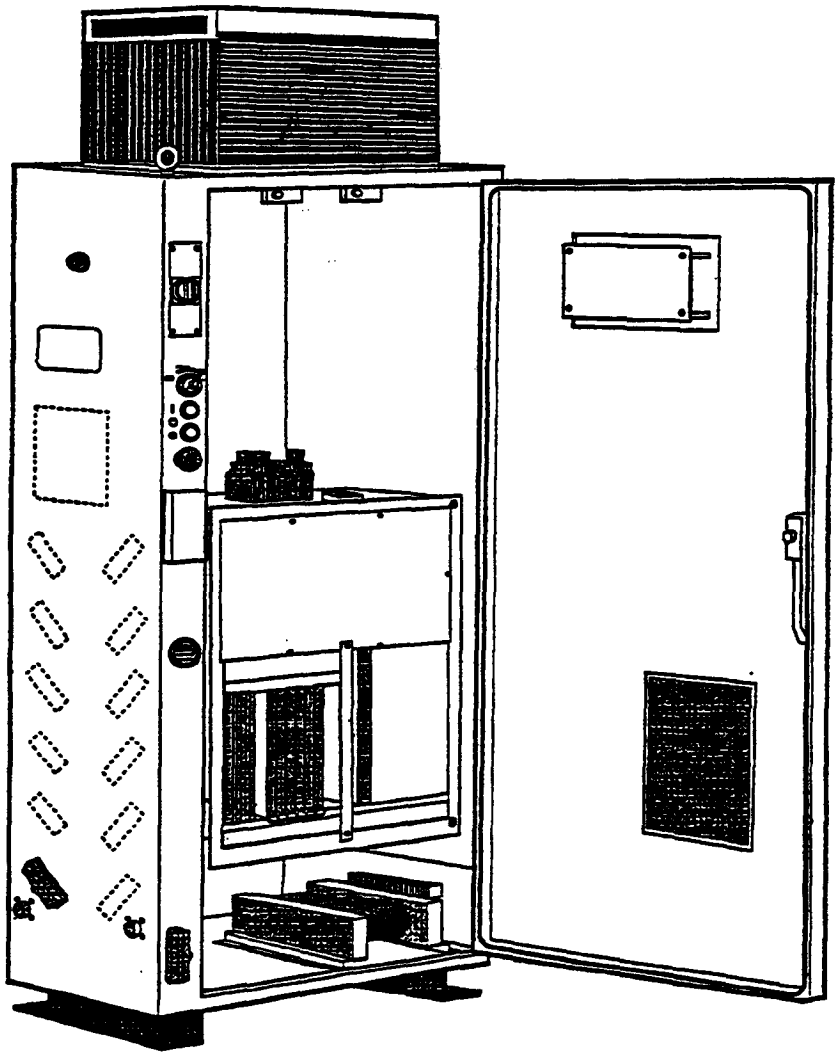
2
General description

2.1
Control system

2.1.1
Layout and unit locations

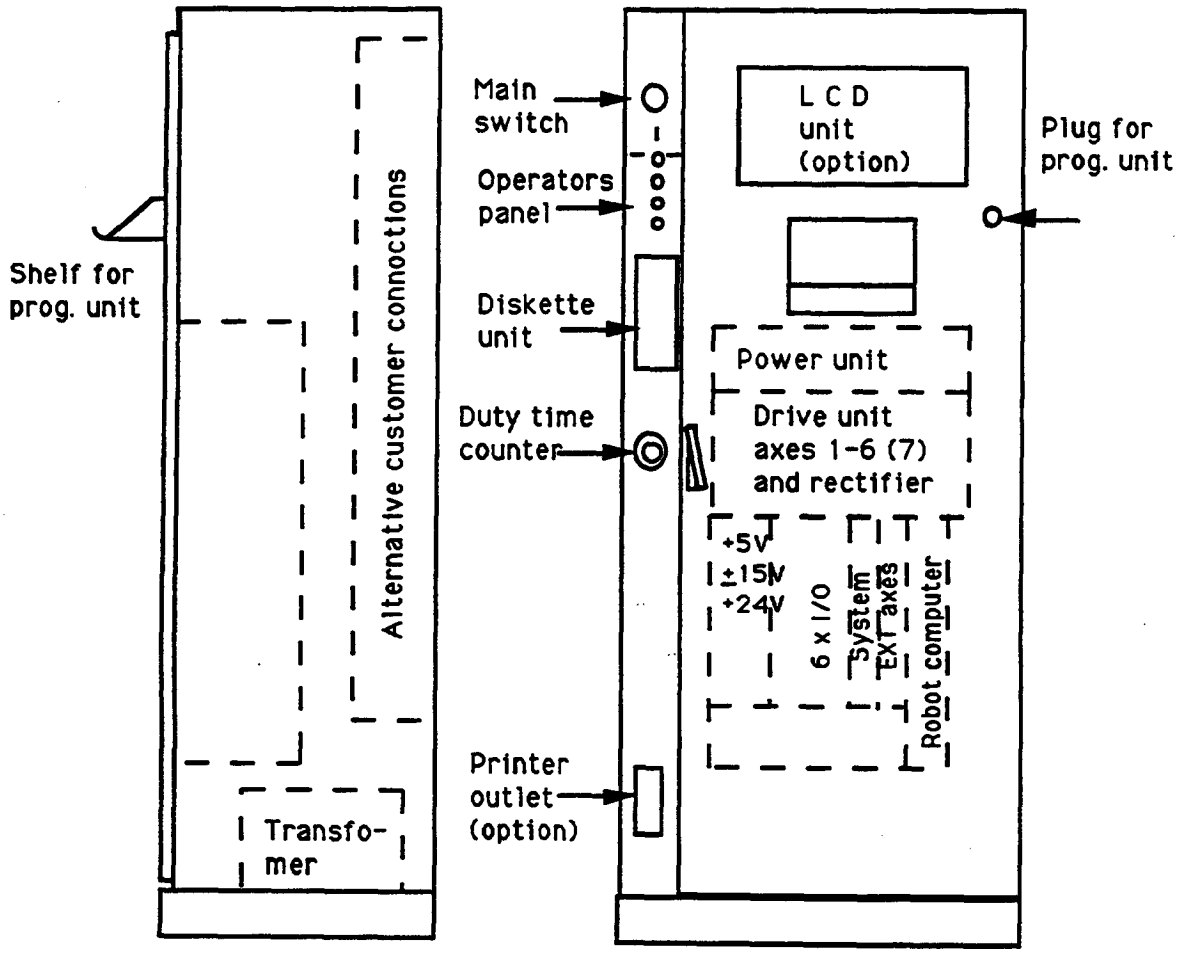
In this context, the "system" is the equipment which controls a manipulator. The control equipment consists mainly of cabinet-enclosed components to which external units, manipulator, external axes, peripherals etc. can be connected and a programming unit. The basic system can be obtained in different versions and supplemented with a number of options.

The figure below shows a typical system:



The control cabinet consists of a number of units:

The figure below shows the location of the different units in the control cabinet:



Transformer terminal block

The designations are found in the Spare Parets List, section 6, under "transformer".

Fuse location: In the upper part of the transformer.

Terminal block	Capacity	Objects protected
37	6.3 A	Supply unit, heat exchanger
30	6,3 A	Service outlet 115 / 230 V

Type: Time-lag (slow blow) fuses of miniature cartridge type.

	Capacity	Objects protected
CB	16 A	The phases to the rectifier unit

Type: Circuit breaker

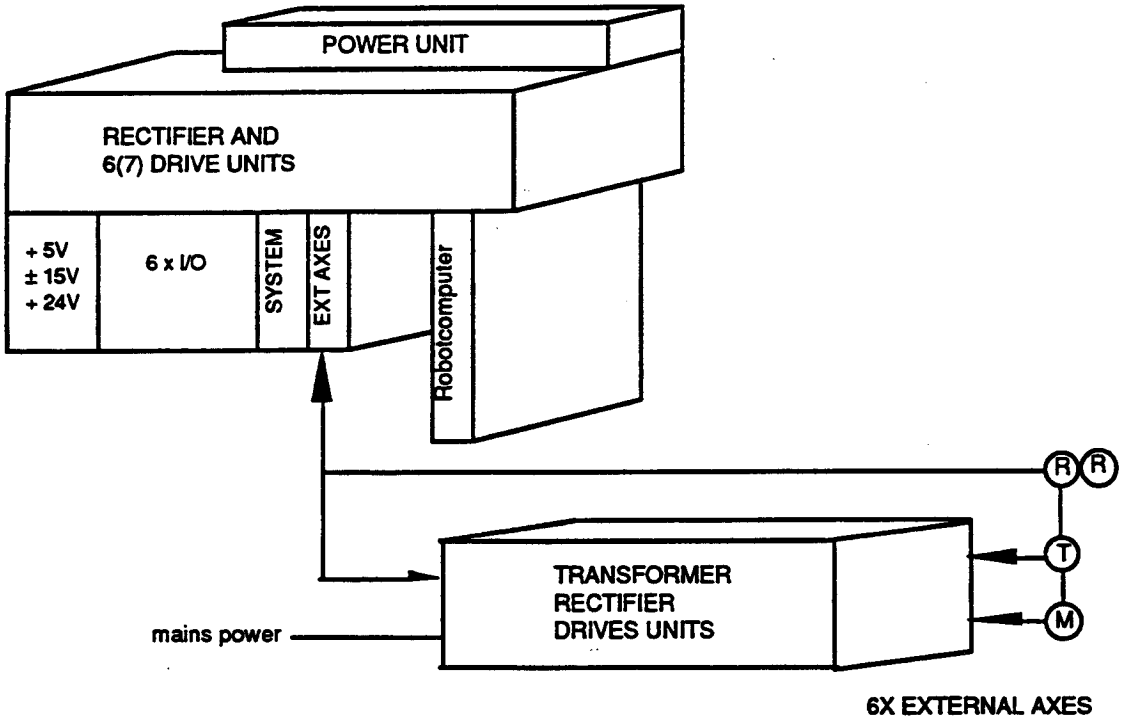
Number of poles: 3

Battery for the memory back-up (RWM)

A Lithium battery is mounted in the frame work alongside the robot computer board. The battery takes care of the back-up power for the program memory. The life time of the battery is 5 years.

2.1.3
The electronics unit

All control and supervision electronics are assembled in the pivoting frame work, with the exception of the serial measurement board, which is mounted inside the mechanical unit.



The electronics unit consists of the following sub-units:

- Robot computer, containing:
  - Main computer
  - I/O computer
  - Servo computer
  - Axis computer
  - Current reference outputs
  - RWM for robot program
  - PD-bus, three RS 232 C units and disk drive.
- Board for external axes connections
- System board containing logic for supervision of the run chains
- Digital I/O boards
- Combined I/O board
- Analog I/O board
- Voltage supply unit
- Drive units
- Rectifier unit including drive fuses
- Serial measurement board (on the manipulator)

Robot computer

The robot computer is based on a large circuit board and accommodates all of the control electronics for the robot. This consists of five function blocks:

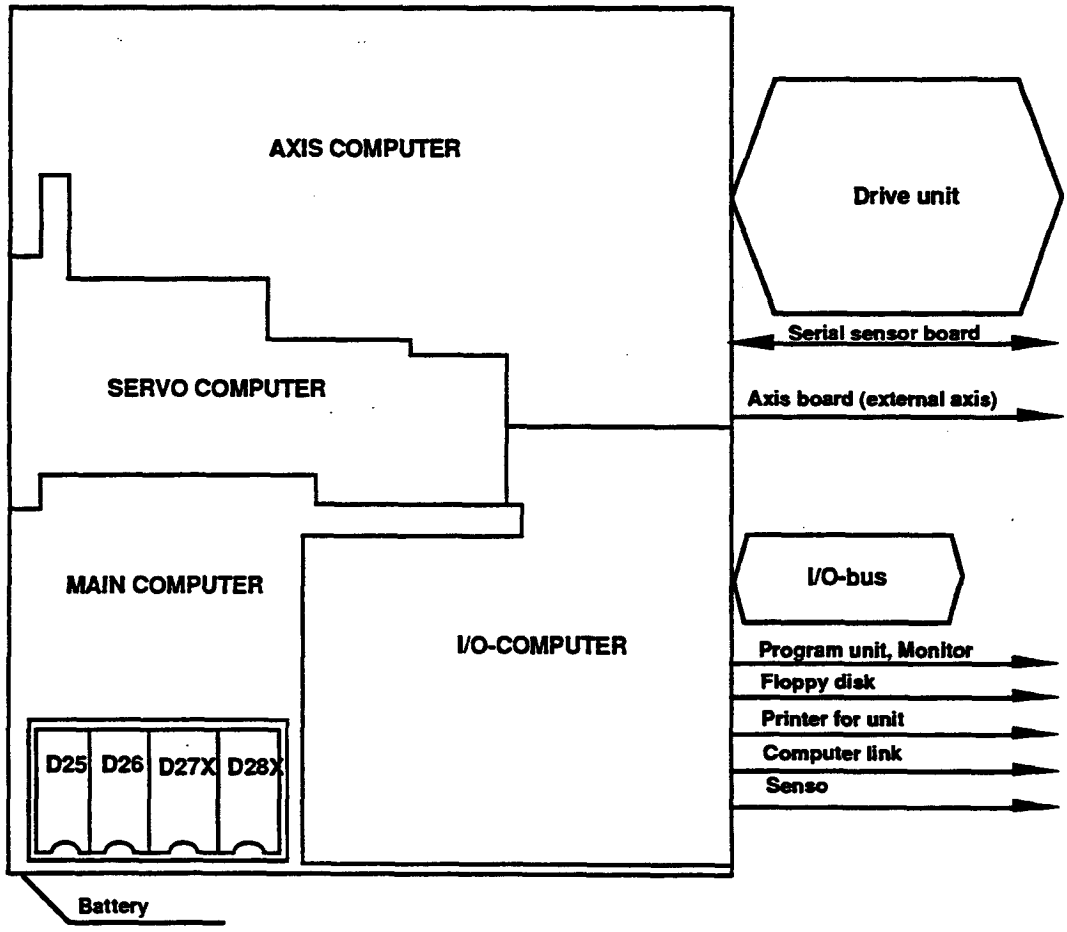
1 The main computer – the master computer in the system which controls the servo andI/O computers. The main computer consists of a CPU 68000, EPROM for program, RWM for data and user programs and a serial channel for sensors.

2 I/O computer which functions as an interface between the main computer and its environment. The I/O computer consists of a CPU 68008, RWM and bus interface for I/O bus, PD-bus, computer link and serial channel for program printout.

3 Servo computer which works between the main computer and the axis computer with set point control of internal and external axes and calculation of controller parameters. The servo computer consists of a CPU 68000, RWM and logic for adaption of signals to the axis computer.

4 Axis computer which works under the servo computer to control the measurement system, to calculate the axis position and to manage the speed control and current estimation. The axis computer consists of a CPU TMS 320C25, RWM and logic for adaption of the axes board, seriel measurement board and drive units.

The figure below shows the location of the different function blocks on the robot computer board:



Axes board (option)

This board provides up to 6 external axes with a speed reference signal, and also provides resolver excitation for up to 12 resolvers (absolute measurement system) or excitation for up to 6 resolvers and 6 synchronizing switches. Resolver feed-back is connected through the board.

System board

All signals which affect operational and personnel safety are assembled and coordinated on the system board. The board provides the link between the computer section and the run chains and supervision functions which are independent of the computer.

The board is built up around the concept that two parallel "chains" are to remain intact for voltage to reach the drive units of the motors. Several parallel monitoring functions located along the run chains breaks the continiuity of the chains in the event of danger or malfunction.

Digital, analog and combined I/O board

The I/O boards are used for communication with process equipment associated with the robot.
Each digital board has 16 inputs and 16 outputs, arranged in groups each of 8 channels. The different groups are galvanically insulated from each other and from the I/O computer.
The analog board has the following groupings of inputs/outputs:

- Four analog inputs
- Three analog outputs, 0 to ±10 V
- One analog output, 0 to ±20 mA

The different groups are galvanically insulated from each other and from the I/O computer.

The combined I/O board is an input/output board with 8+8 digital inputs, 8+8 digital outputs and 2 analog outputs. The different groups are galvanically isolated from each other and from the I/O computer.

Voltage supply unit

The voltage supply unit is connected to 230 V AC and provides four regulated and short-circuit protected output voltages with a common 0 V. The following voltages are provided:

+ 5 V d.c.
± 15 V d.c.
+ 24 V d.c.
Maximum power output 380 W

The unit contains circuits for supervision of the output voltages and the generation of four output signals.

Drive unit

The drive unit is a current amplifier for torque control of the robots permanently magnetized synchronous motors. It is built on a circuit board which contains both control circuits and power circuits.
A two-phase current reference is used for control of the control function. The drive unit is supplied with a d.c. voltage of 340 V.

Rectifier unit

The rectifier, a three-phase six pulse diode rectifier, supplies the drive units for the motors of the robot.
A 242 V three-phase a.c. voltage is rectified to 340 V with a diode bridge.

The rectifier contains control electronics for overvoltage supervision, main voltage supervision, temperature supervision of the rectifirer bridge and shunt regulator.

Seriel measurement board (on manipulator)

The board is used for collecting resolver data from max 6 resolvers. The board supervise the feed back from the resolvers and generates from that, information about which resolver turn the resolver is having.
The board is supplied with +24 V (DC). To keep the information about the resolver turns in the memory when main power is disconnected, the memory has battery back-up.

2.1.4
Power unit

The power unit is placed on the top of the pivoting frame work.

Following part are included:

- Run contacts (2)
- Supervision contacts
- Brake contacts

2.1.5
Operator's unit

The operator's unit is normally placed on the panel to the left of the dorr. The operator's unit can, as option, also be located outside the cabinet as an option.

The pushbuttons on the operator's unit have build-in lamps for indications (except the emergency stop button). The following functions are located on the operator's unit:

- Key-switch selector, for operation mode
- MOTOR ON button with indication
- MOTOR OFF button with indication
- Emergency stop button
- Flashing MOTOR OFF lamp indicates fault
- Flashing MOTOR ON lamp indicates unsynchronised external axes

2.1.6
Programming unit

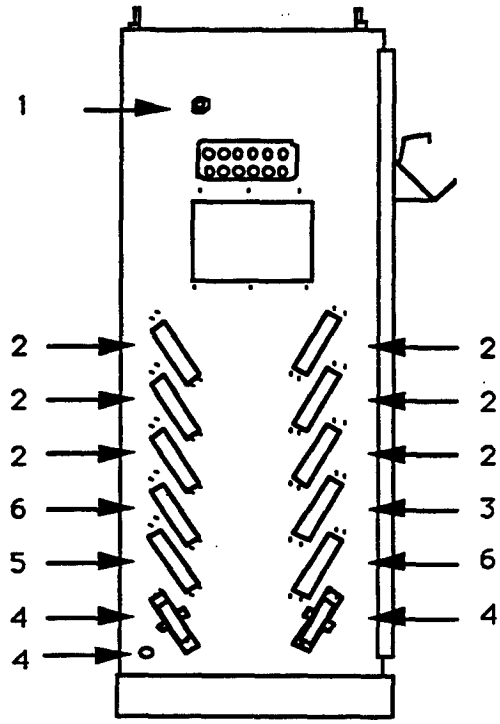
The programming unit is used for manual running of the manipulator, programming and display of error messages. The unit is connected to the control cabinet with a cable.

2.1.7
Contact unit for customer connections

A unit for connection of external cables is located at the bottom of the control cabinet. The following can be connected here:

- Main circuit connection (1)
- Connection of I/O (2), digital I/O and 3 analog I/O
- Control cable to manipulator (4)
- Run chains and robot signals (5)
- Control cables for external axes (6)

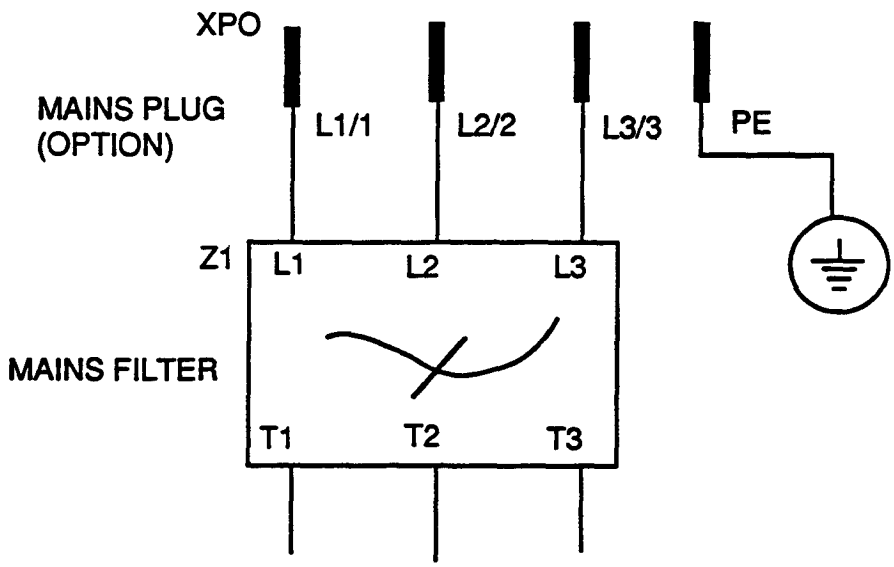
The following figure shows the contact unit:



Optional screwed terminal board can be located on the inside back wall of the cabinet. For connection of I/O and safety circuits.

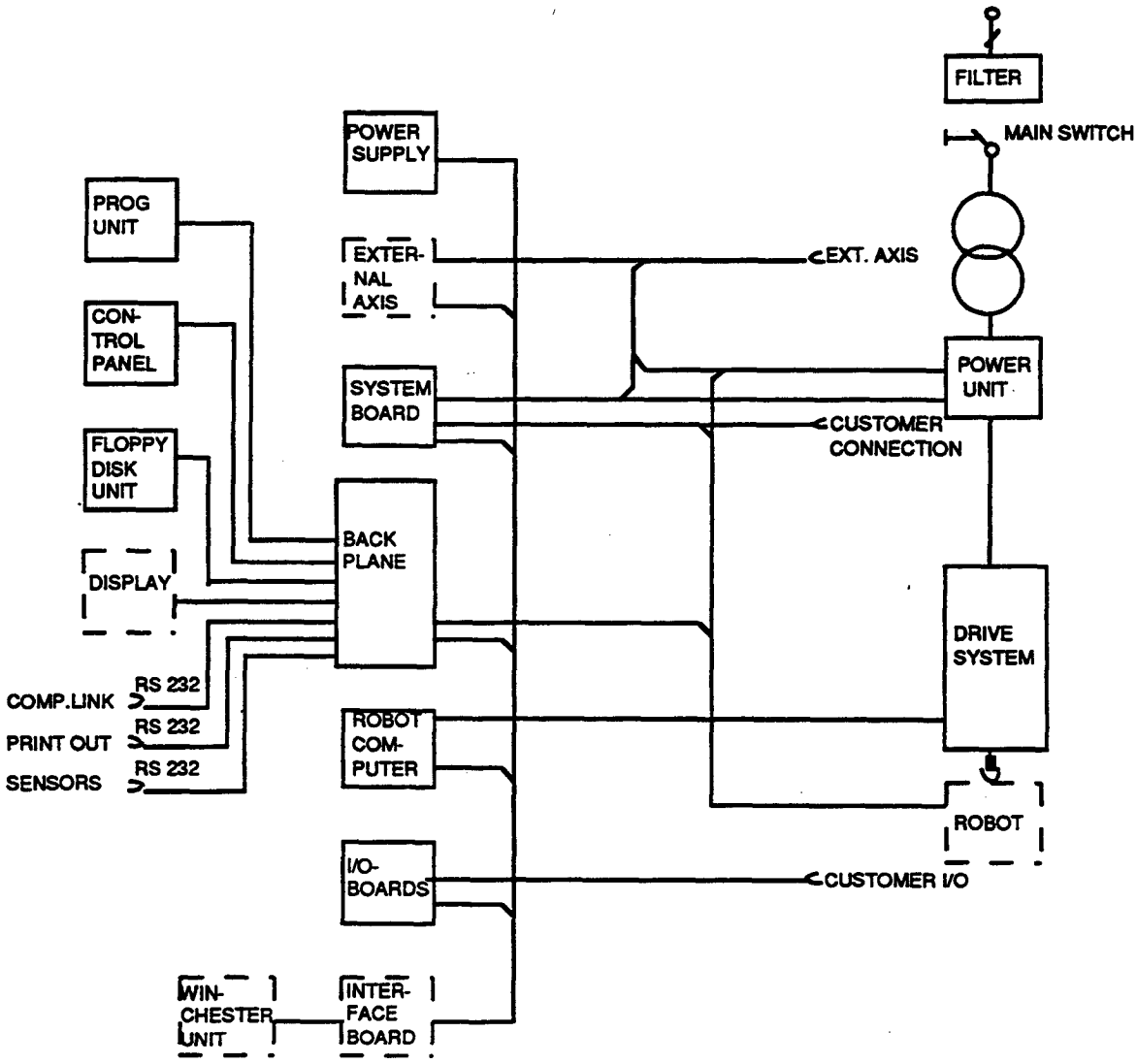
2.1.8
Mains connection

The power unit is conected to the mains supply as shown in circuit diagram 3HAA 3560-HAC.



2.1.9
Wiring and connection points

The units inside the control cabinet are connected by extensive wiring. The signals to be conducted between the units are of varying character and different types of wiring must be used for these. The signals must also be routed differently, depending on their sensitivity to interference or the amount of interference they generate. The block diagram below shows broadly how the wiring and connection point are arranged.



2.1.10
Diagnostic system

The diagnostic system monitors the status of the hardware. It consists itself of both hardware and software. The hardware is designed for testability and together with the software constitutes a cmplete system self-test function. The tests are divided into two groups, start tests and test mode.

Start-up tests

A thorough self-test of the system is performed directly each time the system is switched on. The red LED "FAULT" on the robot computer board flashes while the test is in progress. When the test is performed successfully, all red LEDs extinguish and the green LED's, "EN" on the robot computer and on the system board illuminate. The successful start-up test is followed by all of the necessary initialization before the STANDBY status is obtained.

If a fault is detected during the start-up tests, the start-up is interrupted and the system cannot be switched to the RUN or STANDBY modes. The LED "F" on the faulty unit illuminates and, in most cases, an error message is presented on the programming unit.

The parts tested during the start-up tests are:

- Robot computer
  A complete test is performed on processors, memories, communication circuits, measurement system and other hardware.

- Configuration check
  All positions on the I/O bus are checked with regard to the units connected. The result is compared with the configuration data. If any inconsistancy is detected, the start phase in interruped and the system is set to an error status in which it is possible to change the configuration data.

- Drive unit
  The offset of the current sensor is measured, thereby checking all except the power circuits.

- Programming unit and monitior
  A complete self-test program is provided to test processor, memory and logic.

- Power supply
  Built-in hardware supervision of all voltage levels.

Test mode

All units with processors have a special test mode with special tests used for fault tracing and checking. The units tested are:

- Programming unit
  Test program for joystick, display and keyboard.

- Monitor board
  An expanded start-up is executed at regular intervals

- Robot computer
  When the push-button INIT is pressed at the same time as the TEST button on the robot computer board is test mode obtained. Under test mode can a number of test programs be selected from the programming unit which, with the help of special jumpers and test units, test digital I/O and analog I/O, external axes, drive units, disk drive and monitor.

2.1.11
Safety system

The safety system is built up on three different levels. The highest and most important level relates to personnel safety. This level includes emergency stop and run/standby logic. The next level relates to functional safety and includes the functions all of units included in the system. The third level is the system design, this being intended to ensure a high degree of operational reliability and ease of fault tracing and service.

Personnel safety

Units for personnel safety are the system of conductors within and outside the control cabinet and a special system board located in the electronics rack. All personnel safety functions are assembled on this board. The personnel safety system satisfies extreme demands for personnel security and functions independently of the robot computer. The personnel safety system includes the following functions.

- Emergency stop
- MOTOR ON/OFF
- Enabling device
- Speed limitation
- Working area limits
- External units such as gates, photo-electric cells, pressure pad switches etc.
- Enable chain

RUN chain

As shown by the diagram above, emergency stop button are found on the control panel and programming unit as well as external buttons in the two channel RUN chain. In addition, limit switches are included in what is defined as emergency stop.

The work hold AUTO STOP is activated in the AUTO mode and is to be connected by the customer. In the MANUAL and MANUAL FULL SPEED modes, the enabling device on the programming unit is activated. There is also a possibility for the customer to connect additional enabling devices or some other function to the MANUAL STOP connector.

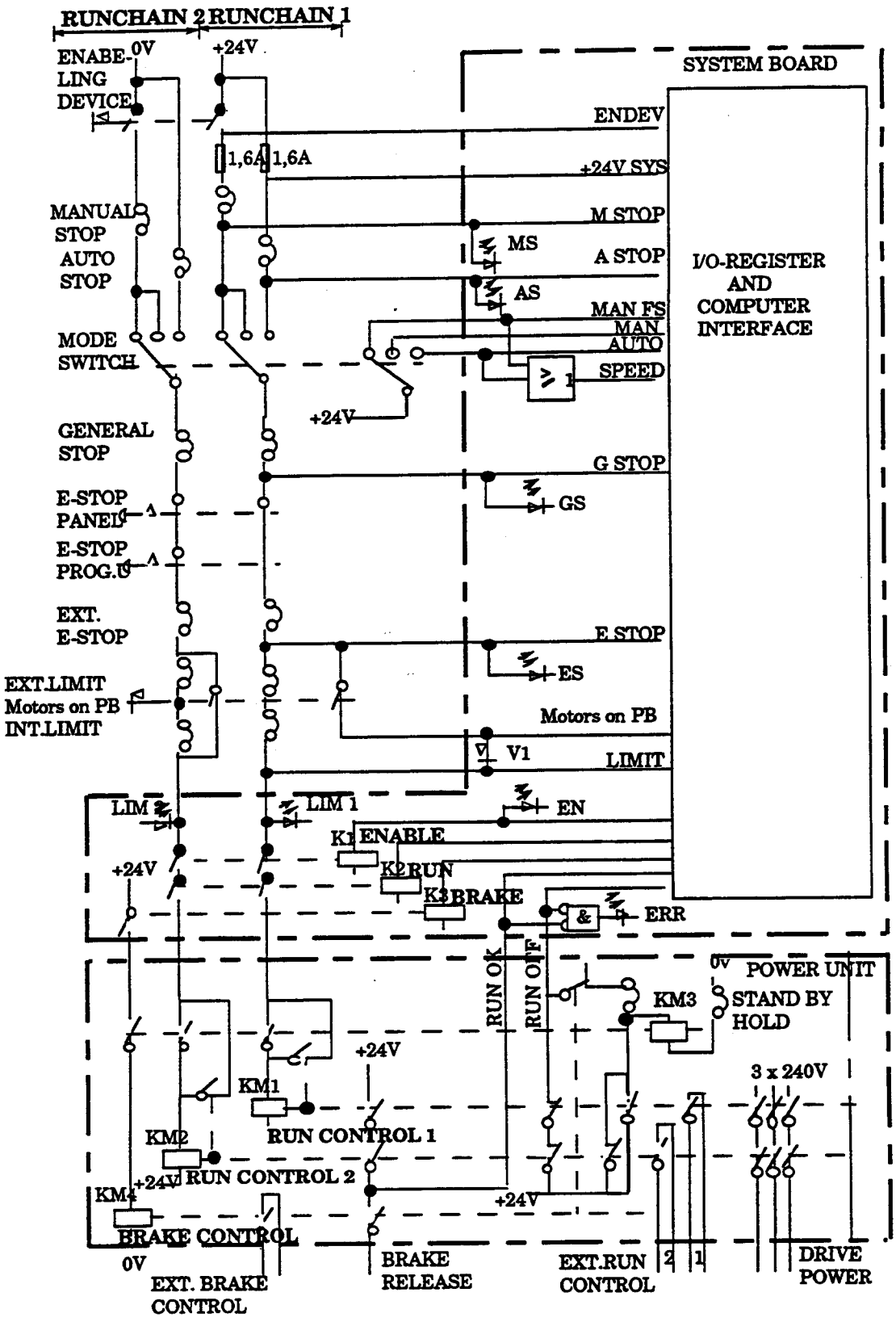
The general mode guard stop GENERAL STOP is activated in all operation modes and is to be connected by the customer.

The various stop functions described above enables creating a safe environment around the manipulator but still making it accessible for service and programming.

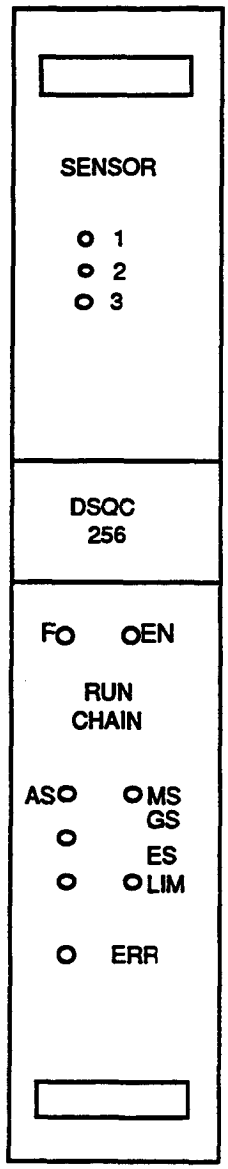
If any of the double switches in the RUN chain is opened, the RUN chain is broken, and the run contacts are deactivated, thus stopping the robot. When this happens, an interruption call is also sent straight from the system board to the robot computer board to ensure that the cause is dealt with as soon as possible.

Resetting the switches in the run chain is done by removing the cause for the stop. One exception from this is if the emergency stop has been tripped by the manipulator running to a limit switch. It is possible to run the robot out of this position if the MOTOR ON button is pressed at the same time. The MOTOR ON button is supervised and is allowed to be pressed for max. 30 sec.
If the programming unit is disconnected from the system, opens the emergency stop circuit.

The principle of the RUN chain circuit function is shown below.


RUNCHAIN 2
RUNCHAIN 1
ENABE-LING DEVICE
0V
+24V
SYSTEM BOARD
ENDEV
1,6A
1,6A
+24V SYS
MANUAL STOP
AUTO STOP
M STOP
MS
A STOP
AS
I/O-REGISTER AND COMPUTER INTERFACE
MAN FS
MAN
AUTO
MODE SWITCH
SPEED
≥ 1
+24V
GENERAL STOP
G STOP
GS
E-STOP PANEL
E-STOP PROG.U
EXT. E-STOP
E STOP
ES
EXT.LIMIT
Motors on PB
INT.LIMIT
Motors on PB
V1
LIMIT
LIM
LIM 1
EN
K1 ENABLE
+24V
K2 RUN
K3 BRAKE
&
ERR
RUN OK
RUN OFF
0V
POWER UNIT
KM3
STAND BY HOLD
+24V
3 x 240V
KM1
KM2
RUN CONTROL 1
RUN CONTROL 2
+24V
+24V
KM4
BRAKE CONTROL
0V
EXT. BRAKE CONTROL
BRAKE RELEASE
EXT.RUN CONTROL
2
1
DRIVE POWER

A number of LEDs have been connected in the run chains to permit quick location of any breaks in the circuits. These are designated diods marked (AS, MS, GS, ES, LIM) and are placed on the front of the system board as shown in the figure below.
It is only run chain 1 that have one led for each switch in the chain. Run chain 2 is indicated with the right led, LIM.
If only one of the two parallel switches in the run chain breaks during operation is the red led ERR lit.



SYSTEMKORT
DSQC 256

Handling of MOTOR ON and MOTOR OFF

The principle of the RUN chain secures that the robot will always switch to the STANDBY mode if any link in the chain is broken. The robot also checks the first and last switches (ENABLE and MOTOR ON) in the run chains.

In the AUTO mode, the transition to run mode is performed when the MOTOR ON button is pressed on the control panel. If the chain is OK, the robot computer energizes the MOTOR ON relay to complete the chain. The transition to MOTOR OFF mode is performed when the MOTOR OFF button is pressed. This causes the robot computer to open the RUN relay. If the robot does not go to the MOTOR OFF mode then, the ENABLE chain is also broken to open the ENABLE relay. This means that the RUN chain can be broken by the robot computer on two different places.

In the MANUAL and MANUAL FULL SPEED modes, the transition to the RUN mode is controlled by the pressing of the enabling device on the programming unit. If the chain is OK, the robot computer closes the RUN relay to complete the chain. The enabling device can be read independently of the state of the chain since is it placed first in the chain.

The function of the RUN chain is consequently a combination of mechanical switches and robot computer controlled relays which are all under the supervision of the robot computer.

Speed limitation

To be able to program the system, the operation mode selector must be in either position MANUAL or position MANUAL FULL SPEED. In the MANUAL position, the maximum robot speed is limited to 250 mm/s. This is partly done through supervision via the robot program and partly through a direct signal from the safety board to the robot computer..

Functional safety

The system for functional safety consists of both hardware and software. When malfunction is detected an error code is presented on the display and, if the fault is of a certain type, the system goes to STANDBY. Test and supervision of the robot system are of two different types.

1 A detailed test at initialization
2 A simpler "background test" during operations

The initialization test is performed each time voltage is switched on to the system.

Tests performed at initialization

A test of the hardware is performed in three steps during the initialization.

1 Self-test, robot computer board and programming unit.

2 Check of communication via the connections between units.

3 Check of configuration (location of drive unit and I/O boards)

During the test flashes the red led FAULT on the robot computer.
If a fault is discovered is the test interrupt and an error message is displayed on the programming unit.
The green led, EN on the robot computer, is lit when the test is approved.

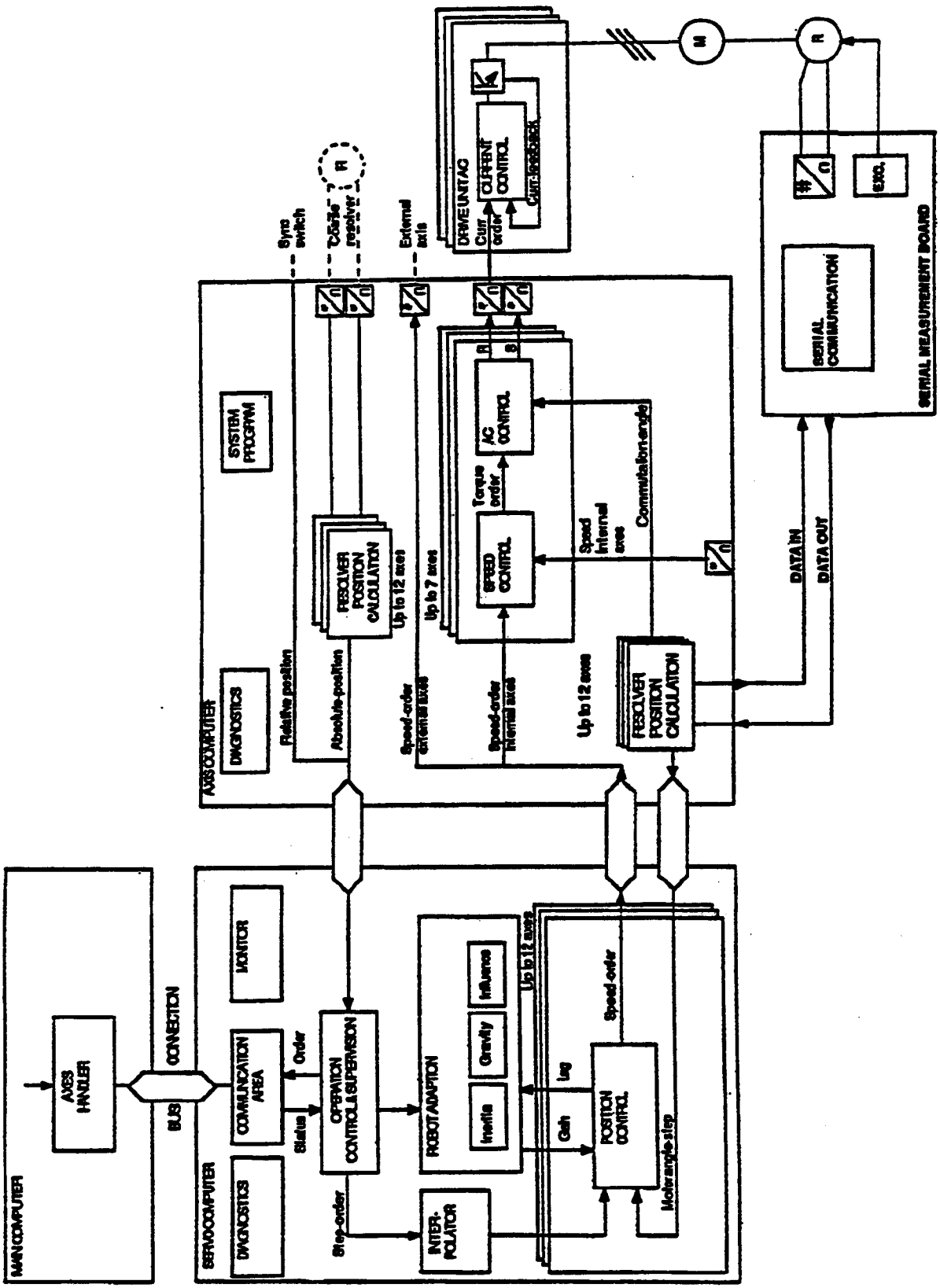
2.2
Robot servo system

2.2.1
Introduction

The servo system is a complex system which consists of several different interacting units and system sections, both hardware and software. The servo function includes:

- Digital control of speed and position of manipulator axes (maximum of 7)
- Digital control of position of external axes (max. of 6 but a maximum of 3 with 6 manipulator axes).
- Synchronous a.c. operation of manipulator axes
- Performance adaption of the controllers of the manipulator axes with respect to the effects of gravity, moment of inertia and interaction between axes.
- Control functions for selecting operation modes etc.
- Supervisions

The block diagram on the next page shows, in principle, the structure of the servo system.


MAIN COMPUTER
AXES HANDLER
CONNECTION
BUS
SERVO COMPUTER
DIAGNOSTICS
COMMUNICATION AREA
Order
Status
MONITOR
OPERATION CONTROL & SUPERVISION
Step-order
INTER-POLATOR
ROBOT ADAPTION
Inertia
Gravity
Influence
Up to 12 axes
Lag
Gain
POSITION CONTROL
Speed-order
Motor angle-step
AXIS COMPUTER
DIAGNOSTICS
SYSTEM PROGRAM
Relative position
Absolute-position
RESOLVER POSITION CALCULATION
Up to 12 axes
Sync switch
Resolver
External axis
Speed-order external axis
Up to 7 axes
SPEED CONTROL
Torque order
AC CONTROL
Speed internal axes
Commutation-angle
Speed-order internal axes
Up to 12 axes
RESOLVER POSITION CALCULATION
DRIVE UNIT AC
Curr order
CURRENT CONTROL
Curr feedback
M
R
DATA IN
DATA OUT
SERIAL MEASUREMENT BOARD
SERIAL COMMUNICATION
EXC.

2.2.2
Component units

The servo function contains the following:

Robot computer board:	1. Reference generator 2. Servo computer M68000 3. Axis computer TMS
Drive units:	1. Power board with current controller 2. Rectifier
Serial measurementboard:	1. Resolver
Motors:	1. Synchronous motors for robot axes
External drive unit:	Equipment specific for the customer

2.2.3
Servo functions

Control functions

- Absolute measurement
- Switching between operation modes
- Search stop
- Reading of resolvers (serial measurementboard)
- Activation of commutation offset
- Jerk limiting

Supervisions

- Position error at restart. The function indicates if the robot has moved despite application of the brakes.
- Stalling (robot axes only and external axes with internal control)
- Resolver supervision.The function indicates defective cable to a resolver.
- Tachometer/resolver supervision. The function compares the speed feedback from tachometer and resolver.
- Speed error (external axes only). The function checks that the resolver does not remain at rest when motion is commanded.
- Racing check with respect to the commutation setting at a new initialization.

Control functions

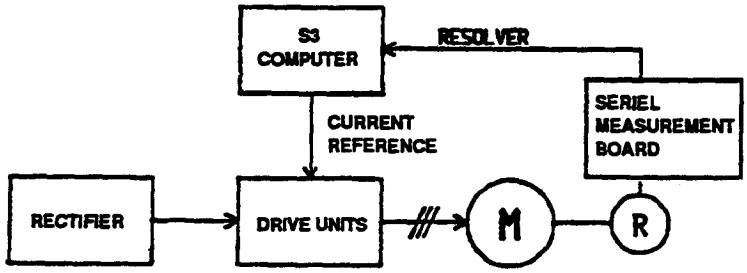
During running, new robot axis position data is generated continuously from the serial measurementboard. This data is supplied to the position controller and compared there with previous data. After comparison and amplification, new references for robot position and speed are given.

The system also contains a model of the robot which continuously calculates optimum controller parameters taking into consideration gravitational effects, moment of inertia and interaction between the axes.

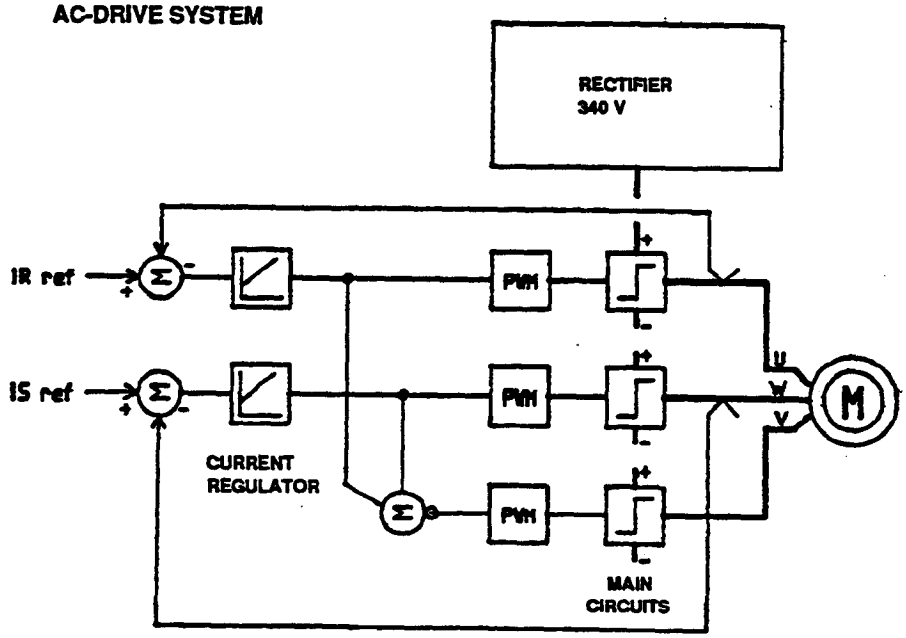
AC operation

An alternating current reference is calculated for two phases using the resolver signal and a known relation between resolver angle and rotor angle in the motor. The third phase is created from the other two.

The phases are current-controlled in the drive unit in individual current controllers. Three voltage references are obtained in this way which, via pulse modulation of the rectifier voltage are amplified to drive voltage to the motors.
The following figures show the principle of the system structure of the AC operation and the principle of the drive unit structure.



AC-DRIVE SYSTEM



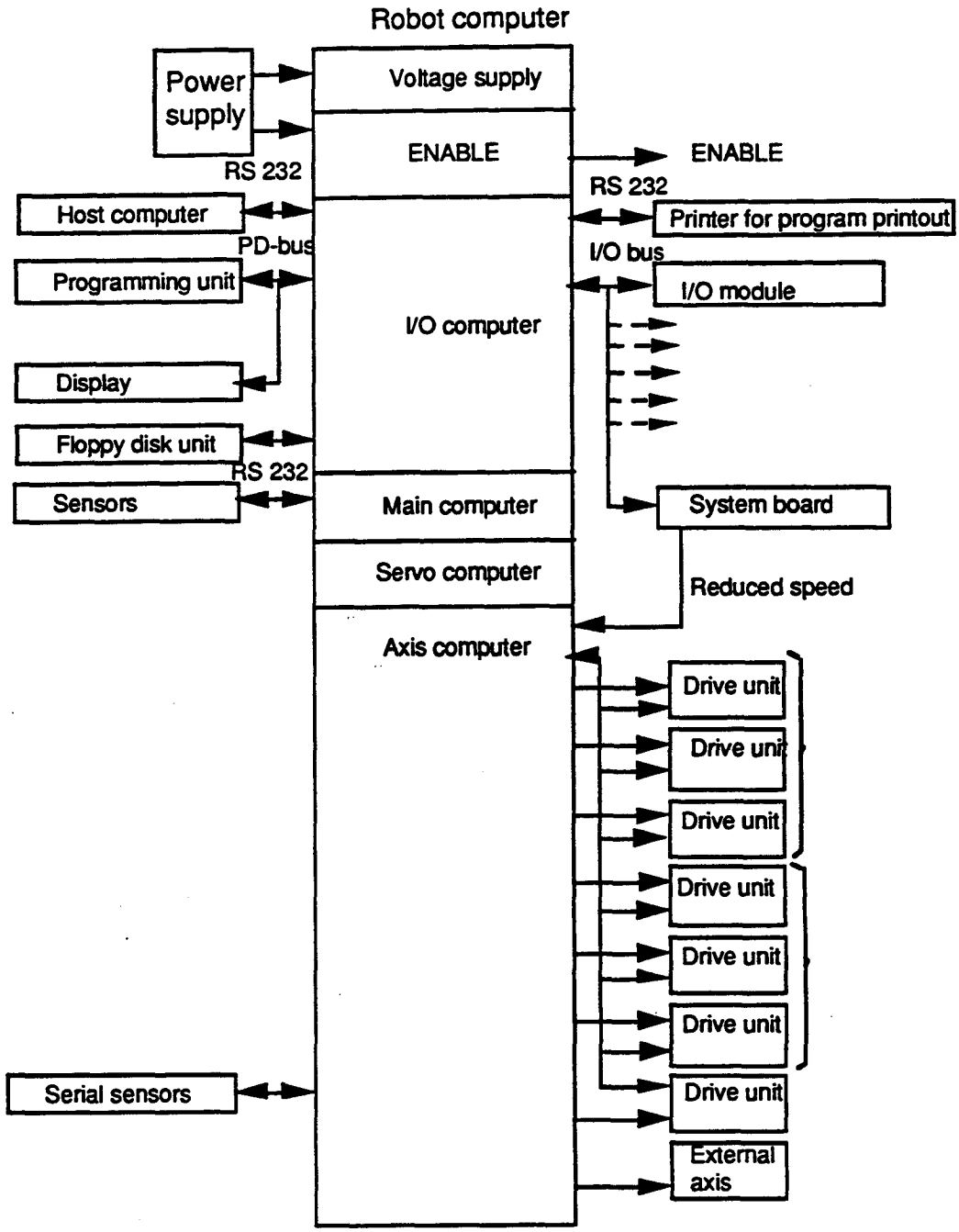
2.3
Description of units

2.3.1
Robot computer

The robot computer DSQC 230 is the robot system data-processing center. It is built up on a circuit board and has all of the functions necessary to create, run and store a robot program. It also has functions for coordinating and controlling the movements of the robot axes.

Interface

Fig. on the next page shows the interface of the robot computer and the units connected.


Robot computer
Power supply
Voltage supply
ENABLE
ENABLE
RS 232
RS 232
Host computer
Printer for program printout
PD-bus
I/O bus
Programming unit
I/O module
I/O computer
Display
Floppy disk unit
RS 232
Sensors
Main computer
System board
Servo computer
Reduced speed
Axis computer
Drive unit
Drive unit
Drive unit
Drive unit
Drive unit
Drive unit
Serial sensors
External axis

Purpose and design

The main purpose of the robot computer is to execute robot instructions and to achieve this, it consists of four independent computers, each with its own separate task.

Fig. 2 shows a block diagram of the robot computer and Fig. 3 shows the location of the different computers on the robot computer board.

Computers and measurement system

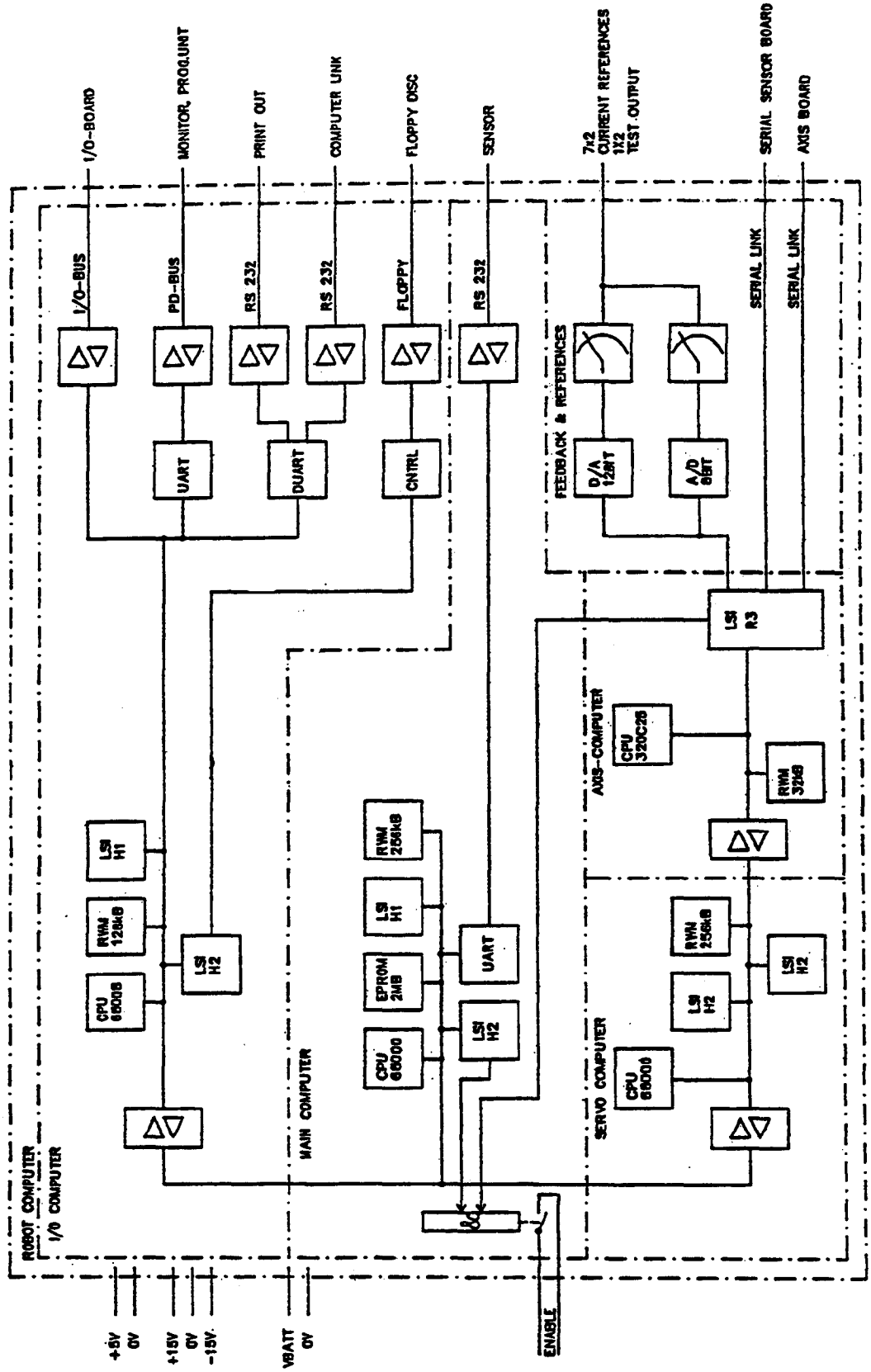
The main computer is the master computer on the robot computer board. It controls the I/O computer and the servo computer which are thus both subordinate to the main computer. The main computer communicates with the manipulator via the servo-computer and with its environment otherwise, via the I/O computer.

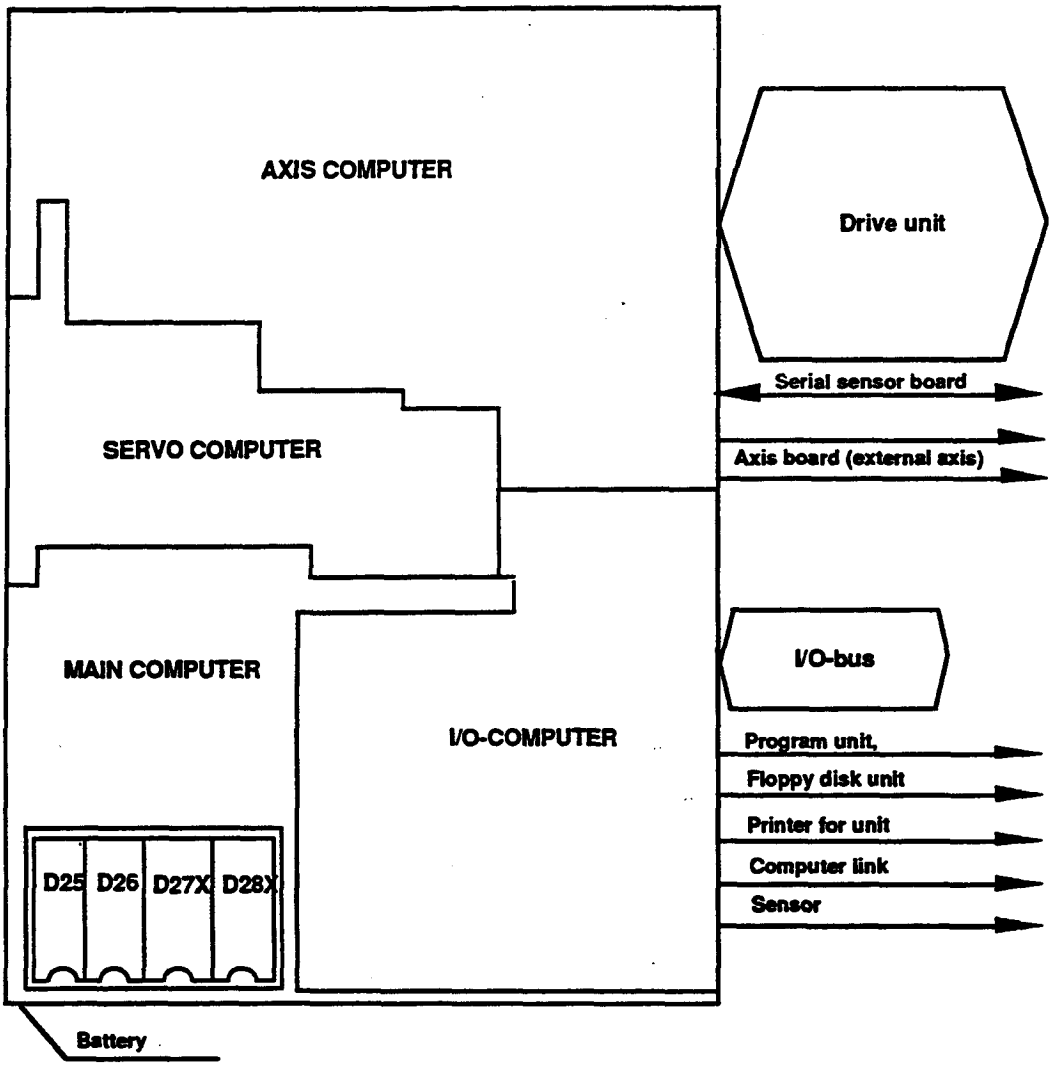
The servo computer functions as an interface between the main computer and the manipulator and the I/O computer as an interface between the main computer and its environment.

The servo computer uses the positioning commands received cyclically from the main computer to control the position of the manipulator. The axis computers, which are subordinate to the servo computer, are used for this control.

The axis computer controls the speed of the corresponding robot axes.

The position is measured with a serial sensor board which is mounted on the manipulator. The position is then transmitted to the robot computer in series.

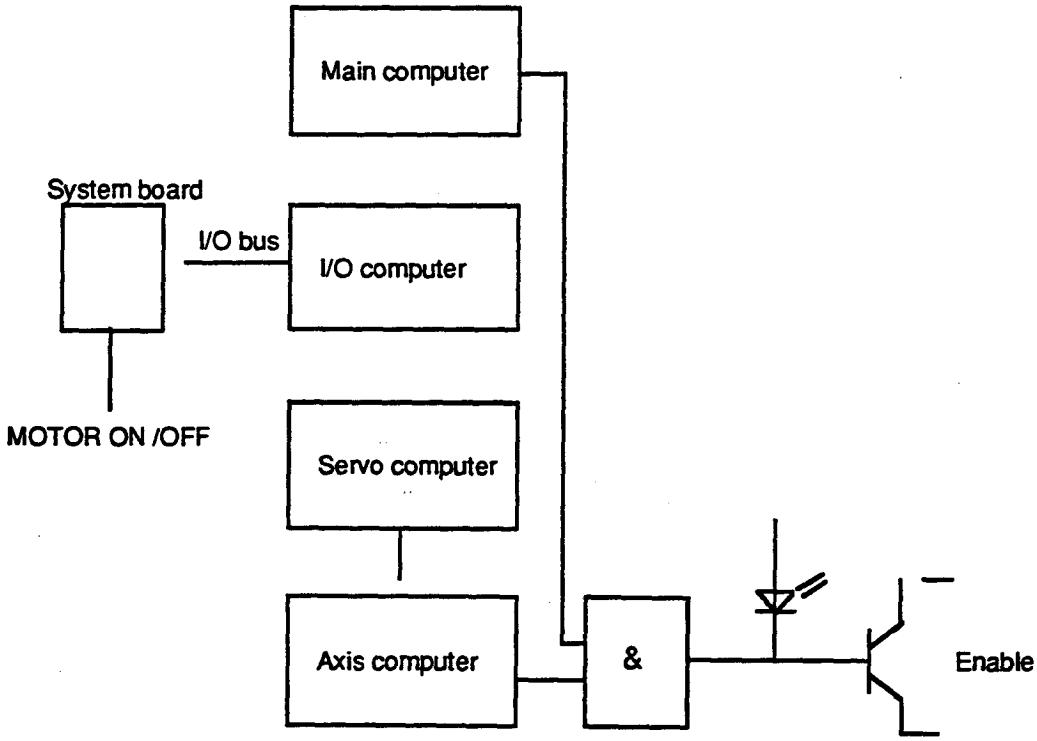

I/O-BOARD
MONITOR, PROG.UNIT
PRINT OUT
COMPUTER LINK
FLOPPY DISC
SENSOR
7x2 CURRENT REFERENCES
1x2 TEST.OUTPUT
SERIAL SENSOR BOARD
AXIS BOARD
I/O-BUS
PD-BUS
RS 232
RS 232
FLOPPY
RS 232
SERIAL LINK
SERIAL LINK
FEEDBACK & REFERENCES
UART
DUART
CNTRL
D/A 12BIT
A/D 8BIT
LSI R3
CPU 320C26
RWM 32kB
LSI H1
RWM 128kB
LSI H2
CPU 68008
RWM 256kB
LSI H1
EPROM 2MB
UART
CPU 68000
LSI H2
RWM 256kB
LSI H2
LSI H2
CPU 68000
ROBOT COMPUTER
I/O COMPUTER
MAIN COMPUTER
AXIS-COMPUTER
SERVO COMPUTER
+5V
0V
+15V
0V
-15V
VBATT
0V
ENABLE


AXIS COMPUTER
SERVO COMPUTER
MAIN COMPUTER
I/O-COMPUTER
D25
D26
D27X
D28X
Battery
Drive unit
Serial sensor board
Axis board (external axis)
I/O-bus
Program unit,
Floppy disk unit
Printer for unit
Computer link
Sensor

Enable chain

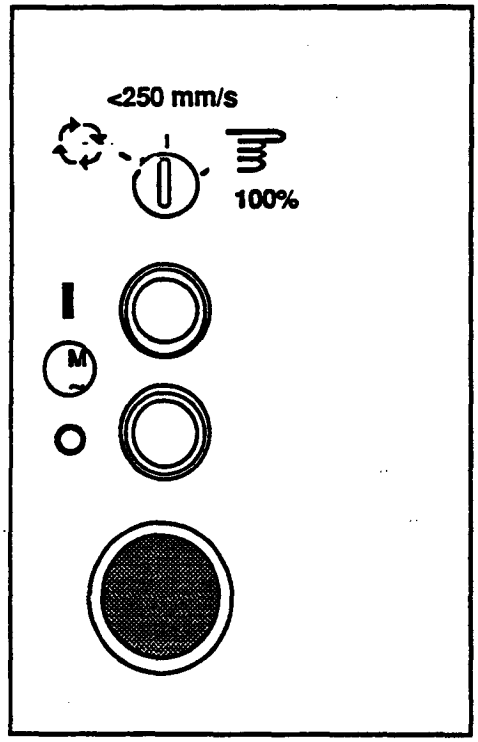
The enable chain must be closed before the robot can be started. The enable chain begins in the power supply unit DSQC 258 and the robot computer is the first link in this chain. The figure shows that only the main computer and the axis computer can directly open or close the enable chain.

The servo computer breaks the enable chain with the help of the axis computer and the I/O computer affects RUN/STANDBY via the I/O bus and the system board.



2.3.2
Operators unit

The operator's unit is used by the operator to change the operational status of the control system and in turn, present this status visually to the operator. The operator's unit is mounted on the front of the control cabinet. As an option, the unit can be mounted outside the cabinet and it is the connected to tis via a cable.

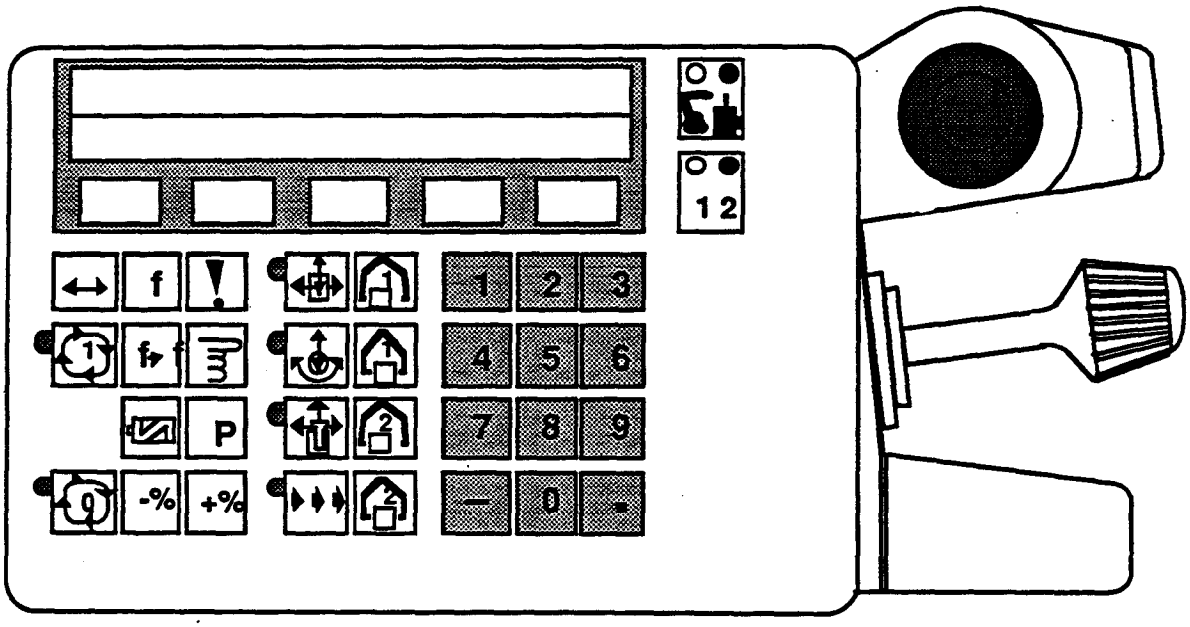


2.3.3
Programming unit

The programming unit is a portable terminal used for programming and operating the robot.

A keyboard is used for entering program instructions and other input data. Data entered, robot programs, function menus, system and error messages are presented on a two-line display. The movements of the robot axes are controlled with a joystick. Its deflection is converted to digital signals which control the robot axes. An emergency button is located by the joystick.

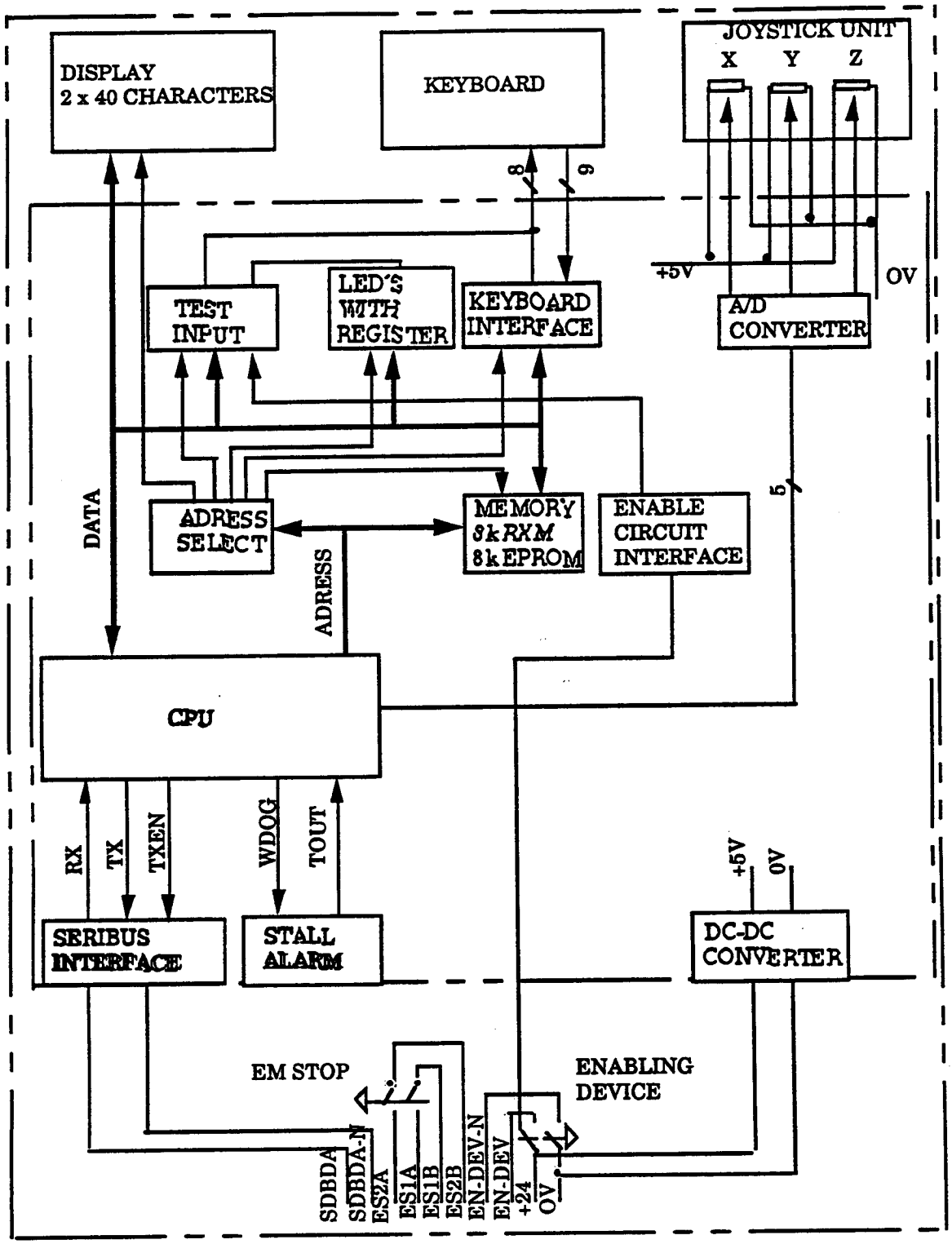
The unit is connected by a cable to the robot control cabinet. The following figure shows the programming unit:



The programming unit contains the following parts, the functions of which are handled by the circuit board DSQC 248:

- Keyboard unit with interface circuits
- Display
- Joystick with A/D convertor
- Serial bus interface
- Computer section
- Voltage regulator

The block diagram on the next page shows, in principle, the design of the programming unit and is followed by a short description of each part:


DISPLAY
2 x 40 CHARACTERS
KEYBOARD
JOYSTICK UNIT
X
Y
Z
8
6
+5V
OV
TEST
INPUT
LED'S
WITH
REGISTER
KEYBOARD
INTERFACE
A/D
CONVERTER
DATA
ADRESS
SELECT
MEMORY
8kRAM
8kEPROM
ENABLE
CIRCUIT
INTERFACE
5
ADRESS
CPU
RX
TX
TXEN
WDOG
TOUT
+5V
0V
SERIBUS
INTERFACE
STALL
ALARM
DC-DC
CONVERTER
EM STOP
ENABLING
DEVICE
SDBDA
SDBDA-N
ES2A
ES1A
ES1B
ES2B
EN-DEV-N
EN-DEV
+24
0V

Keyboard

The keyboard is of the membrane type with click-effect. All of the keys except two are connected in an 8x7 matrix. The two exceptions are keys for switching the joystick functions. Ten LEDs are associated with the keys to indicate the status of the functions concerned.

Display

The display is of the liquid crystal type and has two lines with 40 characters per line. Note that Japanese characters (katakana) can also be used.

Joystick

The joystick has three axes, movement around which vary the settings of potentiometers. The potentiometers are connected between 0 V and +5 V. The voltage from the potentiometers enter an A/D converter with input selector. 0 V and a reference voltage are also converted to compensate for offset error and variations in the supply voltage. After these two measurements, errors are corrected by the program.

Computer section

The computer section consist of a processor of type 6803, an RWM with 2 kbyte memory capacity, an EPROM (program memory) with a 9 kbyte memory capacity and a stall alarm circuit for program supervision. The computer part manages the serial communication with the main computer, reads the keyboard, checks and interprets the joystick deflection and controls the display.

Serial bus interface

A serial channel RS-422, an unbalanced differentiated two-wire bus is used for communication between the programming unit and the robot computer. The communication is bi-directional. The division between transmitted and received signals and level adaption are performed in the serial bus interface.

Voltage regulator

The voltage regulator converts incoming unregulated voltage at 20 -28 V to +5 V electronics voltage. The regulator is not short-circuit-protected.

DATA

External dimensions:	340x180x93 mm
Weight:	1.5 kg
Cable length:	10 m as standard
Shock resistance:	Resistance to a fall from 1.5 m
Temperature (operation):	Max. +50°C
Temperature (storage):	-20 - +80°C
Current supply:	20-28 V d.c, typical 150 mA, max. 250 mA
Cable cross section conductive areas:	Emergency stop circuits 0.75 mm^2, other signals 0.25 mm^2

2.3.4
Power supply unit

On the power supply unit brake- and RUN control are influenced through operating circuits, which react to signals from the system board.

The power supply unit consists of:

- Operating contactors (2)
- Supervision contacts
- Braking contactor

The design of the power unit is shown in the circuit diagram 3HAA 3560-HAC. This is followed by a short description of each function block.

Operating contactors

It is used to connect the 3-phase 3x342 V to the servo system.

Supervision contactor

Supervise the operating contactors and prevent return to operation if a fault arise in one of the two run chauns.

Brake contactor

It is used to connect 24 VDC to the brakes of the robot.

DATA

Connectdata, potentialfree run chains (EXT.BRAKE A-B, EXT.RUN 1A-B and 2A-B)

DC 48V/ 1A
AC 250V/ 1A

Operating Time Counter

The running time meter has LCD-display and is placed on the panel to the left of the door. The running time meter is supplied by 24 VDC.

The time is measured when the robot is in operation mode and when the brakes are released.

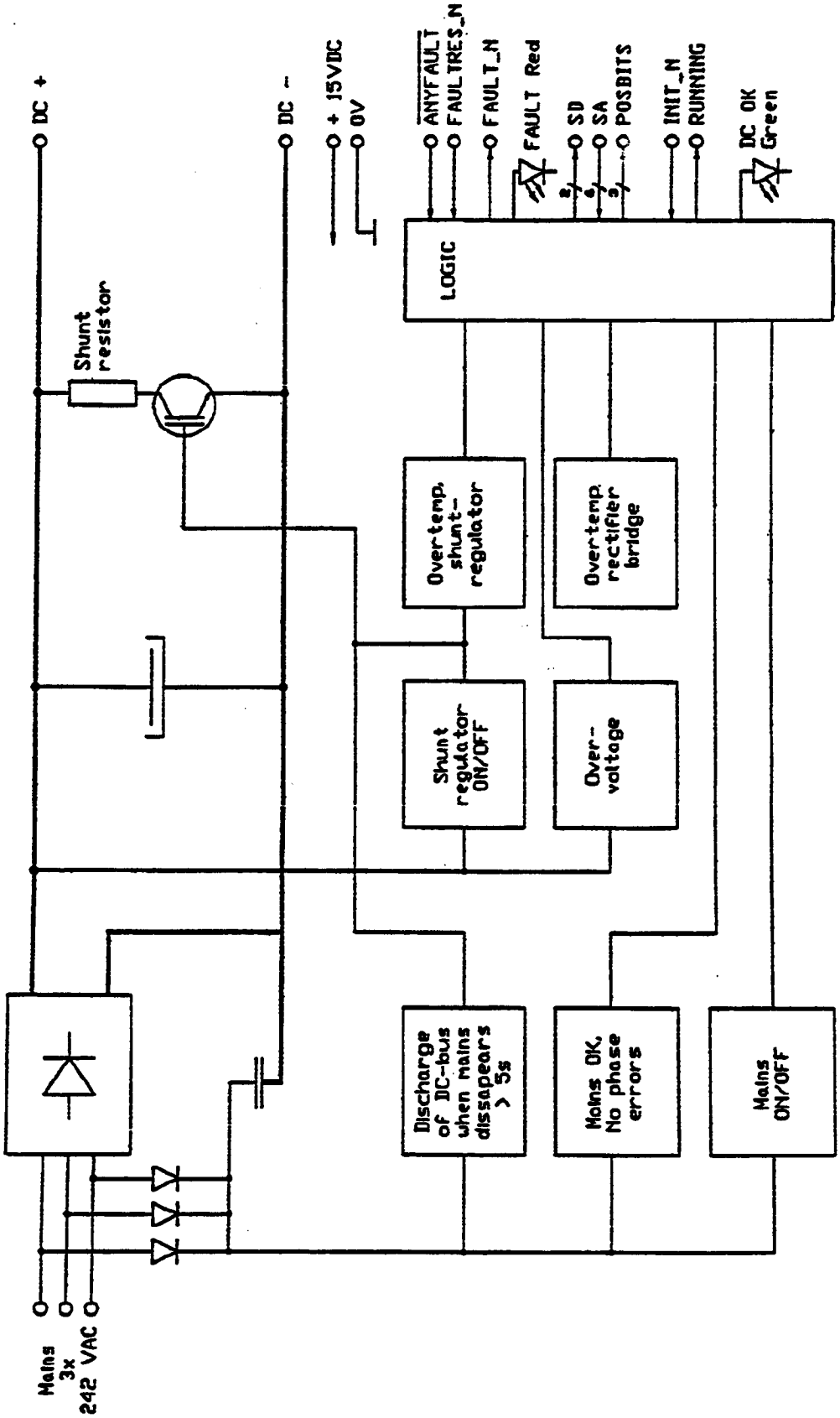
2.3.5
Rectifier DSQC 235 A / B

The rectifier consists of a three-phase six puls diod bridge, a reservoir capacitor, a shunt regulator and control electronics.

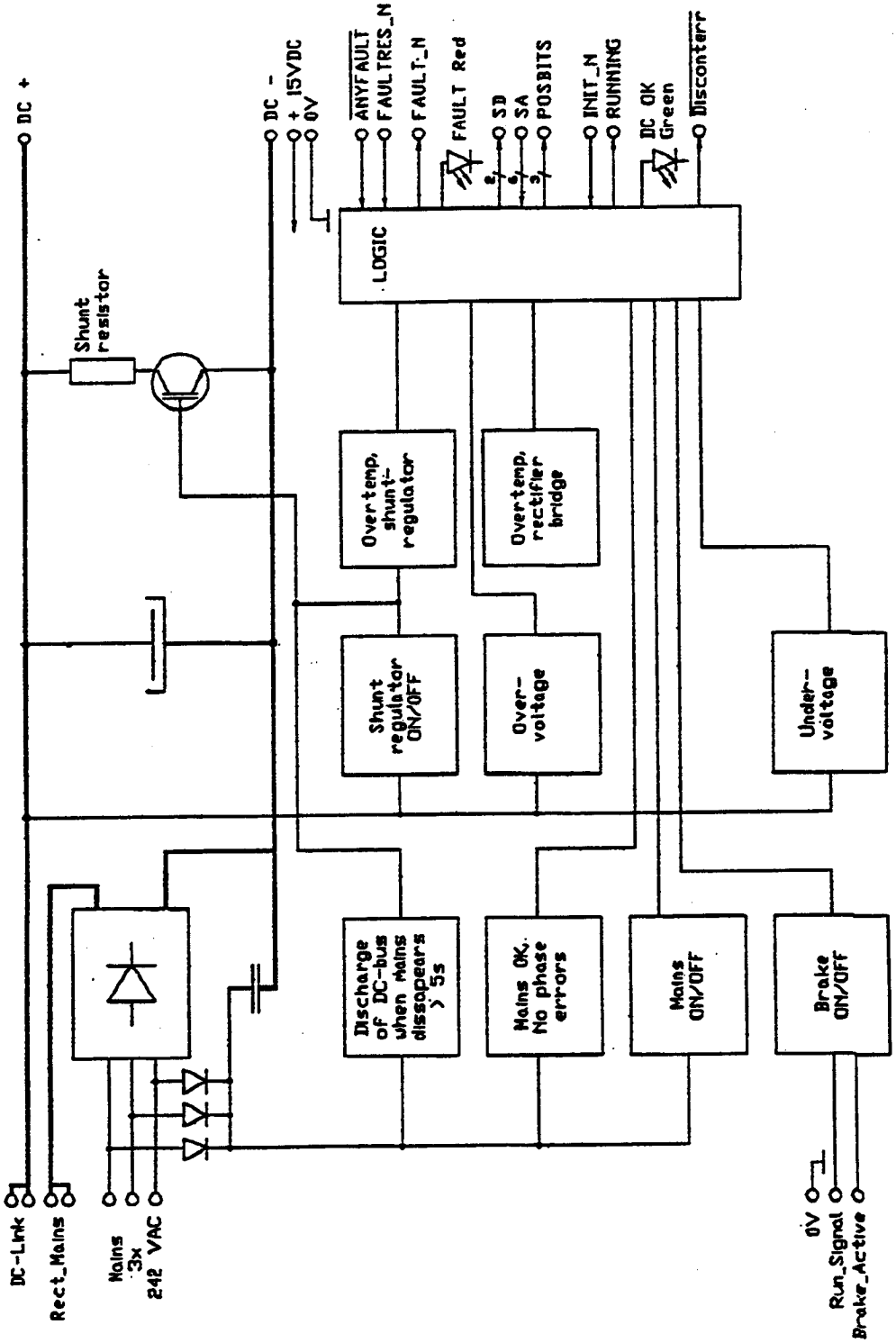
A 242 V three-phase a.c. voltage is rectified to 340 V DC, which supplies the drive units. The control elöectronics provides supervision for over voltage, main voltage and temperature supervision of the rectifier bridge and the shunt regulator. For IRB 6000 DSQC 239 also supervise the contactors for the electrical braking of the robomotors and limitation of the making current.

The shunt regulator prevents over voltage damage, when the drive units feed back more energy than the reservoir capacitor can handle.

The block diagram on the next page shows, in principle, the design of the rectifier and is followed by brief descriptions of the rectifier.


DC +
DC -
+ 15VDC
0V
ANYFAULT
FAULTRES_N
FAULT_N
FAULT Red
SD
SA
POSBITS
INIT_N
RUNNING
DC OK Green
LOGIC
Shunt resistor
Over-temp. shunt-regulator
Over-temp. rectifier bridge
Shunt regulator ON/OFF
Over-voltage
Discharge of DC-bus when mains dissapears > 5s
Mains OK, No phase errors
Mains ON/OFF
Mains 3x 242 VAC

DSQC 235 A


DC +
DC -
+ 15VDC
0V
ANYFAULT
FAULTRES_N
FAULT_N
FAULT Red
SB
SA
POSBITS
INIT_N
RUNNING
DC OK Green
Disconterr
LOGIC
Shunt resistor
Overtemp. shunt-regulator
Overtemp. rectifier bridge
Shunt regulator ON/OFF
Over-voltage
Under-voltage
Discharge of DC-bus when Mains dissapears > 5s
Mains OK, No phase errors
Mains ON/OFF
Brake ON/OFF
DC-Link
Rect_Mains
Mains 3x 242 VAC
0V
Run_Signal
Brake_Active

DSQC 235 B

The control electronics of the rectifier are power supplied by the supply unit. While the mains power is not connected to the rectifier, the shunt transistor is kept closed. When the mains power is connected, the shunt transistor is opened and the reservoir capacitor is charged. At the same time the RUNNING signal goes high if the INIT_N is high. The green LED OK is lit when the RUNNING signal goes high.

When switching off the mains power, the RUNNING goes low after approx. 800 ms, and when the mains power has been disconnected for more than 5 s, the reservoir capacitor is discharged through the shunt resistor. If the rectifier unit is pulled out of the rack or if the +15 V power supply is shut off, the reservoir capacitor is immediately discharged through the shunt resistor.

If a phase error occurs or a too low a voltage level is detected on the mains power supply, an error indication is given in the computer interface for as long as the error remains. The FAULT_N signal is not affected.

When the drive units feeds more energy than the reservoir capacitor can handle, the intermediate voltage rises and the shunt resistor is connected to limit the intermediate voltage. If more energy is fed than the shunt resistor can handle, a temperature alarm is given via FAULT_N and the LED Fault is lit. This indication remains until the FAULTRES_N signal is given.

If a too high an intermediate voltage is detected, an alarm is given via FAULT_N and the LED Fault is lit. This indication remains until the FAULTRES_N signal is given.

If a too high a rectifier bridge temperature is detected, an alarm is given via FAULT_N and the LED Fault is lit. This indication remains until the FAULTRES_N signal is given.

Any errors in any of the drive units are gathered with the ANYFAULT signal and an alarm is given via the FAULT_N signal.
DSQC 235 B.

If the intermeditate DC supply is too low, a signal is given to the drive units via DISCONTERR to disconnect the servo lag supervision.

When the RUN-button is pressed, the signal RUNNING will stay low, until the signal BRAKE-ACTIVE becomes low (contactors for electrical brake and connecting protection are energized). When the RUN-signal is disconnected, RUNNING is maintained high for at least 25 ms.

DATA	DSQC 235 A	DSQC 235 B
Connection voltage:	242 V, +10 %, -15 % 50 or 60 Hz	
Operational temperature:	0-70°C	
D.c. rating:	5 A	11.7 A
Rated d.c. voltage:	340 V	
Max. d.c. current:	22 A	64 A
Max. d.c. voltage(nominal)	380 V	
Max. mains failure:	20 ms	
Brake resistance, P_{max}:	200 W	450 W
Shunt resistance, R_{min}:	25 Ω	12 Ω
Max. discharge time for intermediate section of d.c. link:	20 s	

2.3.6
Drive unit, DSQC 236

The drive unit, DSQC 236, is intended for torque control of a.c. motors. A two-phase moment reference value is necessary for the control function. The unit is supplied with ± 15 V for the logical circuits and a d.c. voltage of a maximum of 340 V d.c.

The control enables four quadrant operation.

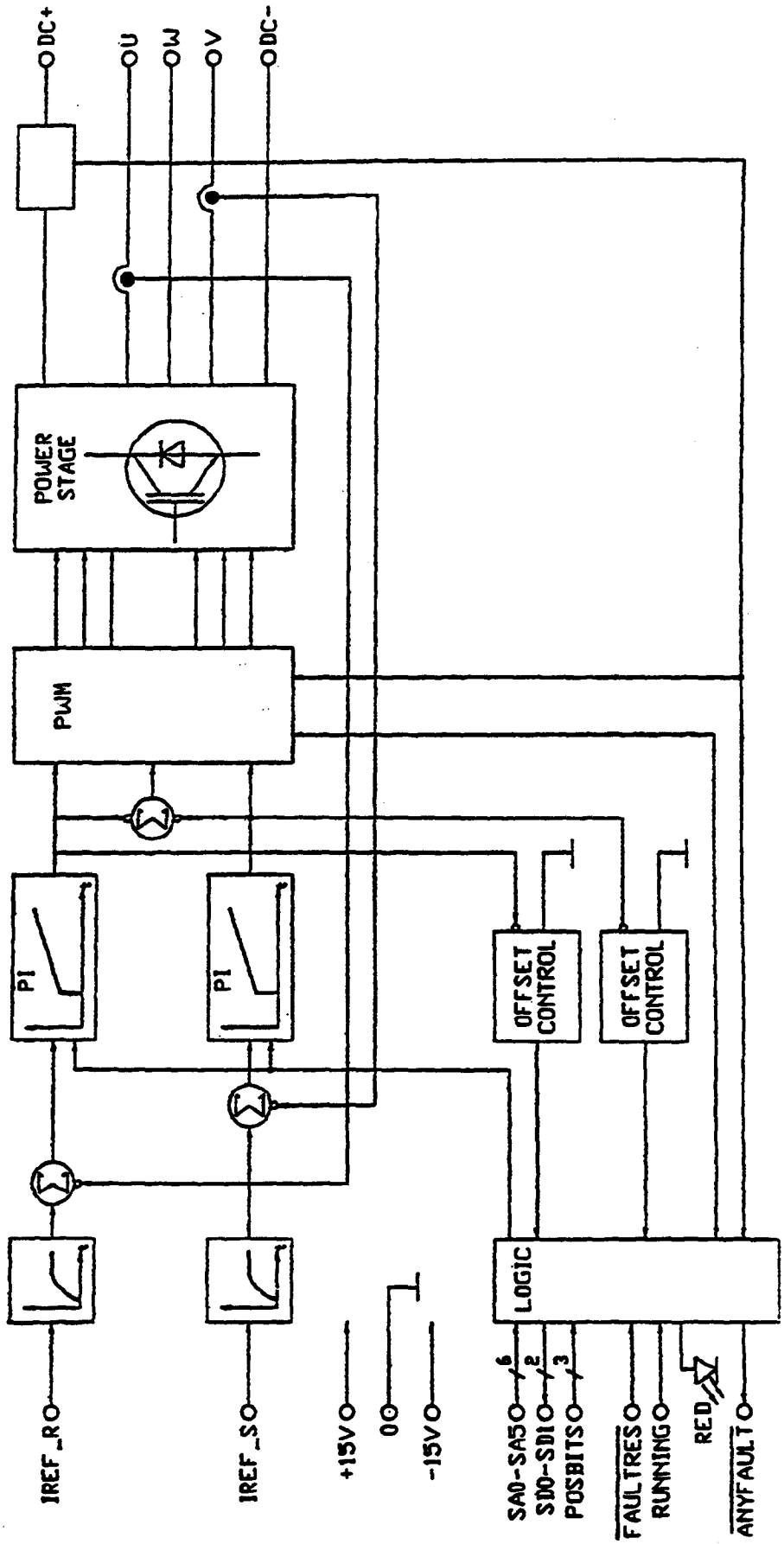
The drive unit consists of the following function blocks:

- Control unit consisting of:

  - Reference filter
  - Summator
  - Third phase summator
  - Current regulator
  - PWM-moudulator
  - Current measurement unit
  - Modulator
  - Over-current protection
  -Off-set control
  - Logic

- Power circuit

The principle of the design of the unit is given by the block diagram on the next page, and this is followed by a brief description of each function block.


DC+
U
W
V
DC-
POWER STAGE
PWM
PI
PI
OFFSET CONTROL
OFFSET CONTROL
LOGIC
IREF_R
IREF_S
+15V
0
-15V
SA0-SA5
SD0-SD1
POSBITS
FAULTRES
RUNNING
RED
ANYFAULT
6
2
3

CONTROL UNIT

Reference filter:

The filter is used to damp the steps in the reference, which occurs when the signal is generated in an D/A-converter.

Summator:

The control error is formed as the difference between the reference and the actual value.

Current regulator:

Regulator of PI-type with a control input for blocking the I part at turned off regulation and offset check.

Third phase summator:

The control signal to the uncontrolled phase is calculated according to: - (phase_R + phase_S), which defines the sum of the control signals as 0.

PWM-modulator:

The control signals to each phase is modulated by 5 kHz which means that the motor current is rippled by 10 kHz. The modulation is done by comparing the control signal with a sawtooth voltage in a comparator in which the output signal is given a mean value, directly proportional to the control signal. The output signal of the comparators are divided into two signals: one for the upper and one for the lower transistor of each phase.

Current measurement:

The motor current is measured in the two regulated phases by modules based on the Hall effect. The output of these two modules is a current, proportional to the primary current.

Over-current protection:

The current in the upper DC supply is supervised by a shunt to detect phase to phase or phase to earth short circuits in the motor cabling. The protection switches off the power amplifier in order to save the transistors from breaking due to any external short circuit. Transmission of the logic information from the DC supply potential to the logic potential is done via opto couplers.

Off-set check:

An offset check is performed at system start-up to find a reference value to compensate for the offset found in the current measurement modules and regulating circuits.

Logic:

The overall control system controls the servo system via the logic signals handled by the logic module. An output indicates if an malfunction is present in the unit, blocks at the same time the servo and lights a red LED on the front to indicate this state. An input from the control system resets the internal error condition at start up. An input from the rectifier unblocks the servo and switches on the commutation.

DATA

Temperature range:	0-70°C
Max. heat sink temperature:	90°C
Nominal d.c. link voltage:	340 V
Max. d.c. link voltage(nominal):	380 V
Max. main voltage:	180 V
Phase inductance required:	2 mH
Commutation frequency type:	5 kHz

Type-specific data:

	type A	type B	type C	type G	type T	type P	type U
Rated current (RMS value)	1.5 A	4.0 A	7.0 A	13.2 A	14.5 A	1.5 A	9.7 A
Max. current (RMS value)	3.0 A	6.5 A	9.0 A	29.0 A	36.0 A	3.0 A	53 A
Fundamental frequency	100 Hz	100 Hz	100 Hz	100 Hz	100 Hz	100 Hz	100 Hz
Fan cooling	no	no	no	yes	yes	yes	yes

	ROBOT AXIS						
ROBOT TYPE	1	2	3	4	5	6	(7)
IRB 2000	B	C	B	P*	*	*	C(T)
IRB 3000	C	C	C	B	B	A	C(T)
IRB 3200	C	C	C	B	A	A	C(T)
IRB 600.0 2.25 PE-75	U	T	T	G	G	G	T
IRB 6000 others	T	T	T	G	G	G	T

* Common drive unit for axes 4 - 6

2.3.7
Axis board, DSQC 233

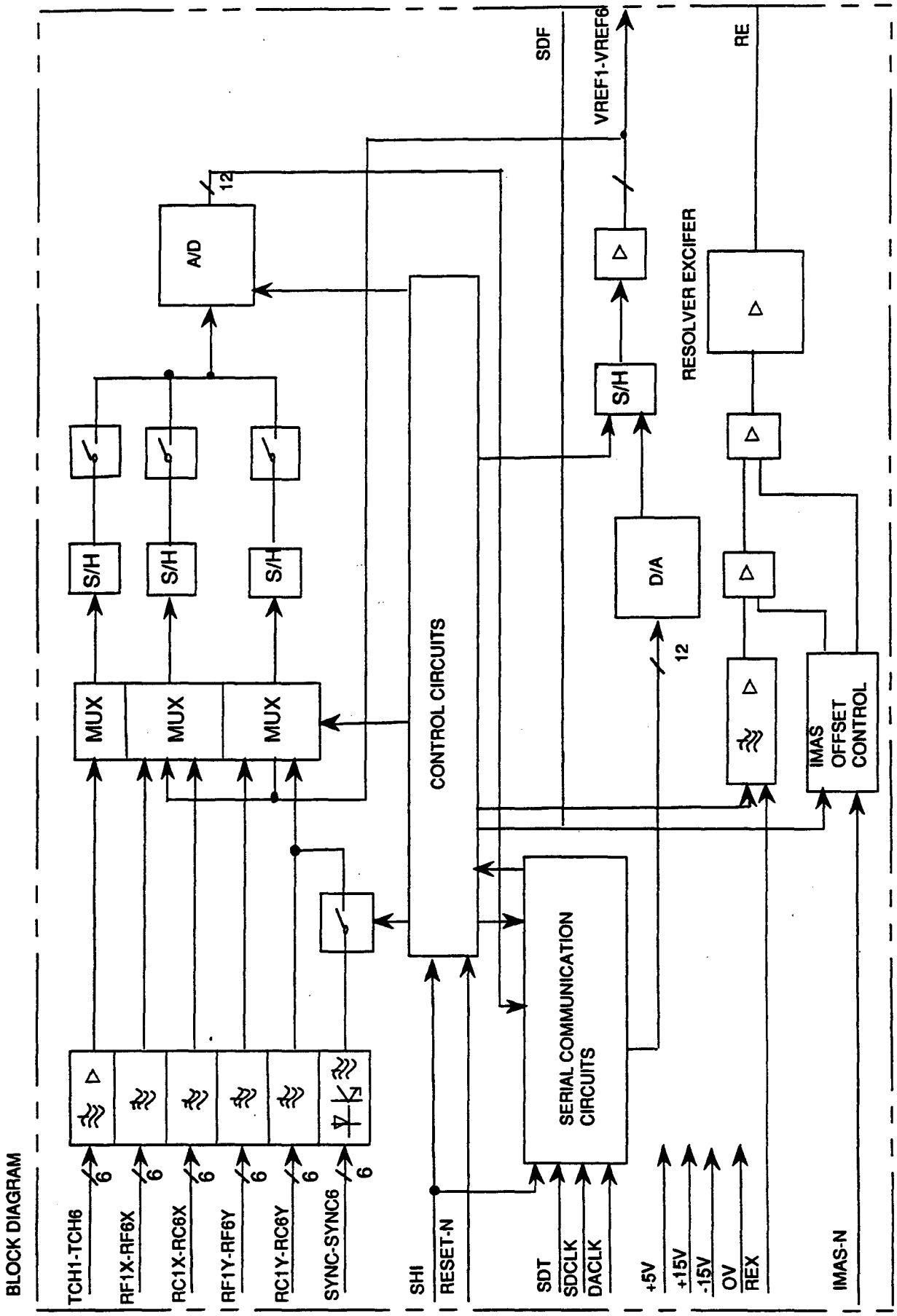
The board DSQC 233 increase the the number of input/ouput channels available in the measurement system and the number of references so that 6 external axes can be used (a total of 12 axes).

The board provides an increase in the number of inputs/outputs on the robot computer board which means that most of the technical solutions are the same as for the robot computer board.

The DSQC 233 board accommodates the following function blocks:

- Resolver inputs
- Tachometer inputs (not used)
- Resolver supply
- Analog outputs for current references of integrated axis 7 and speed references for external axes 7-12
- Inputs for synchronization switches

The block diagram on the next page shows, in principle, the design of the board and is followed by a brief description of each function block:


BLOCK DIAGRAM
TCH1-TCH6
RF1X-RF6X
RC1X-RC6X
RF1Y-RF6Y
RC1Y-RC6Y
SYNC-SYNC6
6
MUX
MUX
MUX
S/H
S/H
S/H
A/D
12
CONTROL CIRCUITS
SERIAL COMMUNICATION CIRCUITS
D/A
12
S/H
SDF
VREF1-VREF6
RESOLVER EXCIFER
RE
IMAS OFFSET CONTROL
SHI
RESET-N
SDT
SDCLK
DACLK
+5V
+15V
-15V
0V
REX
IMAS-N

Resolver inputs for axes 7-12

Each resolver input is provided with a passive input filter which removes high frequency interferences.Two multiplexers, one for x (cosine) and one for y (sinus), select channel 7-12. The outputs on the multiplexers are connected to the x and y samples respectively and the hold circuits on the board.

Tachometer inputs (not used)

Resolver supply

A separate resolver supply which can supply up to 12 resolvers is provided to supply external axes. The resolver supply is a pure current buffer with voltage gain 1. The input signal and the on/off signal are delivered from the robot computer board.

Analog output signals

6 S/H amplifiers, one for each output, are used for the analog output signals. A buffer stage has been introduced to isolate the S/H amplifiers from the outputs.

Synchronization switch inputs

The board is provided with 6 opto-isolated inputs for synchronization switches with 24 V supply.

DATA

Temperature range:	+5- +70°C
Current consumption, +5 V:	70 mA
Current consumption, ±15 V:	300 mA

Tacho inputs: (not used)

Resolver inputs:

Number of channels:	6 fine (measure range 5 V FS) 6 coarse
Resolution:	12 bits
Linearity:	12 bits
Resolver supply frequency:	1.3-4 kHz
Maximum permitted speed:	3000 rpm

Resolver supply:

Output voltage:	5.6 V_{rms}
Drive capacity:	0.5 A_{rms}, 12 resolvers
Resolver impedance on primary side Z_{RO}:	>150 Ω
Frequency:	1894 Hz
Short circuit protection:	Yes
Max. capacitive load:	10 nF

References:

Number of channels:	6
Output voltage:	0 - ±10 V
Linearity:	12 bits
Offset:	<15 mV
Gain error:	0.5 %
Resolution:	12 bits
Min. loading resistance:	5 kΩ
Time between updating:	max 12 ms

SYNC inputs:

Rated voltage:	24 Vd.c.
Input voltage range, "1":	19-35 V
Input voltage range, "0":	-21-2 V
Input current with rated voltage:	6.8 mA
Input impedance:	3.5 kΩ
Switch-over level, typical:	9 V
Power dissipation/channel with rated voltage:	190 mW
Delay, typical:	5 ms

2.3.8
System board, DSQC 256

All of the signals associated with operational and personnel safety are assembled and coordinated on the system board. In addition to accomodating all of the safety logic on system level, the board functions as the link between the computer section and the safety and supervision functions independent of the computer.

The board is based on the concept of two parallel "chains" which are to remain intact if voltage is to reach the drive units of the motor. Several supervision functions are located along the "operational chains" which, in the event of malfunction or the development of a dangerous situation, breaks the continuity of the chains. The end of the chains are connected to outputs which drives two contactors located in the power supply unit (the RUN contactors). The RUN contactor must be closed if the necessary voltage is to reach the robot motors. For activation of the RUN contactors, the chains must be intact and the computer must have commanded the RUN status.
Togheter will this function provide a very high level of safety, and at the same time is the risk for fault and fault indications in the system reduced. The error state of all mechanical switches and selectors, in chain 1, are stored in internal registers available for reading by the robot computer via its I/O bus, to which the system board is connected. The computer can also write information to the board to e.g. order RUN mode or programmed application of the brakes.

LEDs on the front of the board permit a rapid check of the system status and indicate the nature of any malfunction. The board also has inputs for sensor-signals via opto connected inputs.

The system board accommodates the following function blocks:

- Run chain, incl. soft ware controlled switches and external switches
- All switches in RUN chain 1 is supervised by the robot computer via digital inputs
- Programmed activation of the brakes
- Power fault signal
- Programmed activation of the brakes
- Bus adaption
- Inputs for PTC resistors
- Opto connected inputs for sensor signals
- The RUN chain controls interrupts direct to the robot computer

RUN CHAIN

To get the voltage from the system board to the RUN-contactors must the following items be fullfilled:

- All switches in the RUN chains must be closed
- 24 V supply must exist (i. e. 24 V SYS)
- ENABLE must reach the system board to close the first switch on the board(ENABLE-relay)
- The RUN relay is closed when order is given from the robot computer and when the condition of the chains is approved.

To the external part of the RUN chains can desired equipment be connected by the customer. The external part of the RUN chain includes standardize safety demands.

On the board there are inputs that detects the status of the switches for the different functions. The inputs detects following:

- Enabling device and extra MANUAL STOP
- AUTO STOP
- Operating mode selector
- General stop
- Emergency stop. Operators panel, programming unit and external
- Limit switch. External and internal.
- MOTOR ON-button
- MOTOR ON-contactor

High or low velocity is determind only by the operation mode selector. The velocity signal is partly sent via the I/O-bus and partly direct to the axis computer.

Enable

ENABLE is a 24 V signal generated in the power supply unit. The signal is conducted through the rear plane, passes through the robot computer and to the system board.

The signal is interrupted by malfunction in any of the units shown.

The faults which affect the ENABLE circuit are:

- In the voltage supply unit; incorrect input or output voltage.
- In the robot computer; malfunction detected by the diagnostic or the servo control program.
- In the drive unit; control error and overcurrent.

24 V -I/O safety

If the +24 V-I/O supply is interrupted, the RUN chain will be broken and the robot computer will deactivate the RUN contactor. The system will switch off the motors.

Overload protection

The thermal overload protection consists of PTC-resistors built into the robot motors. The output signals from the PTC-resistors are connected to the safety board to level-sensitive inputs which check that the correct signal level is obtained. It is also possible to supervise an external 7:e motor.

The robot computer regularly checks the motors for overload by reading the system board register. If an overload situation occurs, the system will switch off the motors.

Supervision

The supervision is performed by hardware and software functions and embraces the external section of the RUN chains with switches included and the run contactors. The hardware and software functions operate independently of each other.

The following faults are detected:

All RUN chain 1 steps are connected to registers to enable status supervision by the robot computer. When an interruption in the chain occurs, statuses up to the interruption can be read, but not the statuses after the interruption occurred. An exception is the enabling device which can always be read independently of the remaining RUN chain statuses.

Normally covers the supervision of run chain 1 all interruptions. becouse all switches are connected for interruption of both chains parallel. If some of the interruption function is incorrectly adjusted, so that only one of the chains intrrupts, discover the robot computer that when the MOTOR ON signal disappear, when one of the operation contactors falls while the MOTOR OFF still is low. The red led ERR is lit on the system board.

A fault means stand-by.

The status of all switches in the RUN- chain is also indicated with a LED as follows:

AS	(AUTO STOP)	Interrupts at automatic running
MS	(MANUAL STOP)	Interrupts at manual running
GS	(GENERAL STOP)	Interrupts both at manual and automatic running
ES	(EMERGENCY STOP)	Emergency stop. (Operators panel, prog. unit, external)
LIM	(LIMIT)	Limit switch. (Mekanical robot, external)
ERR	(ERROR)	Only one of the run chains is interrupt.

Emergency stop

The emergency stop chains are an intergrated part of the run chains and are mainlly located outside the system board. The chain includes the emergency stop buttons (PB), the external emergency stosp (EXT) and limit switches (LIM). As the emergency stop chains are intergrated in the RUN-chains requires the insertion of jumpers if some of the parts is missing in the system.

One LED (ES), states if voltage is going through the emergency stops.

Programmed activation of brakes

The brakes can be deactivated in the RUN mode by means of the BRAKE-RELEASE signal.

Note!
The function can not affect the brakes in the Motor off status as brake supply is checked by the operating contacts.

Power fault signal

This is a 24 V signal supplied from 24 V I/O. The signal can be extended to the cabinet for external axes via the connection in the side of the cabinet. The signal is interrupted when a fault is detected. Faults which activate this function are:

- in the cabinet for external axes control; faults in the rectifier

The status of the signal can also be read from the computer.

Bus interface

The bus interface block contains circuits for adaption of signals to the bus and board and internal address decoding.

2.3.9
Voltage supply unit, DSQC 258

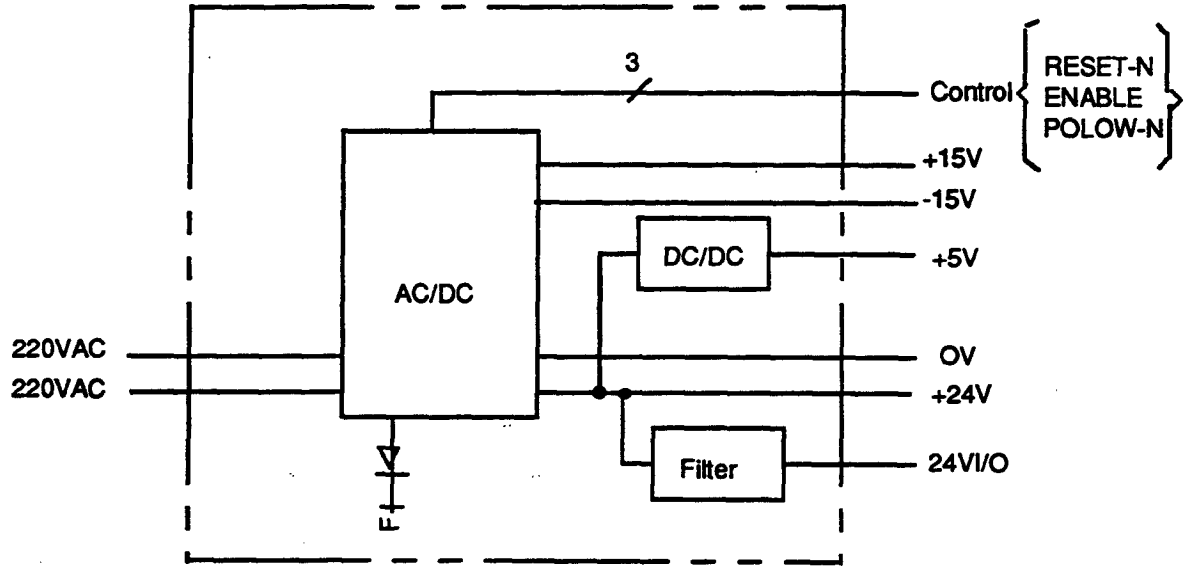
DSQC 258 is a mains-connected voltage supply unit with 4 regulated and short-circuit protected output voltages with a common zero. The unit is of the plug-in type with connections via two connectors at the rear of the unit. Indicating LEDs are located on the front of the unit.

The voltage supply unit DSQC 258 has the following functions:

- Energy reserve
- Protective devices
- Supervision devices
- Output signals
- Indications

The block diagram on the next page shows, in principle, the design of the unit and is followed by a brief description of each function block.

BLOCK DIAGRAM



Energy reserve

The unit contains an energy reserve sufficient to maintain the output voltages for 30 ms after a power failure.

Protective devices

The outputs are provided with protection against component destruction caused by overloading or short-circuiting.

Supervision devices and indications

All of the unit voltages are monitored. A red LED is located on the front of the unit. The LED illuminates if an incorrect voltage has been detected by the supervisory circuits or flashes at shortcircuit.

Output signals

POLOW-N, RESET-N, ENABLE are digital output signals controlled by the circuits for voltage supervision. If the voltage should fail or fall below a certain level, the output signals are unaffected for 20 ms. POLOW-N then goes low and 10 ms later, RESET-N goes low. POLOW-N remains low until RESET-N has been low for 1 ms, even if the voltage has returned to normal.

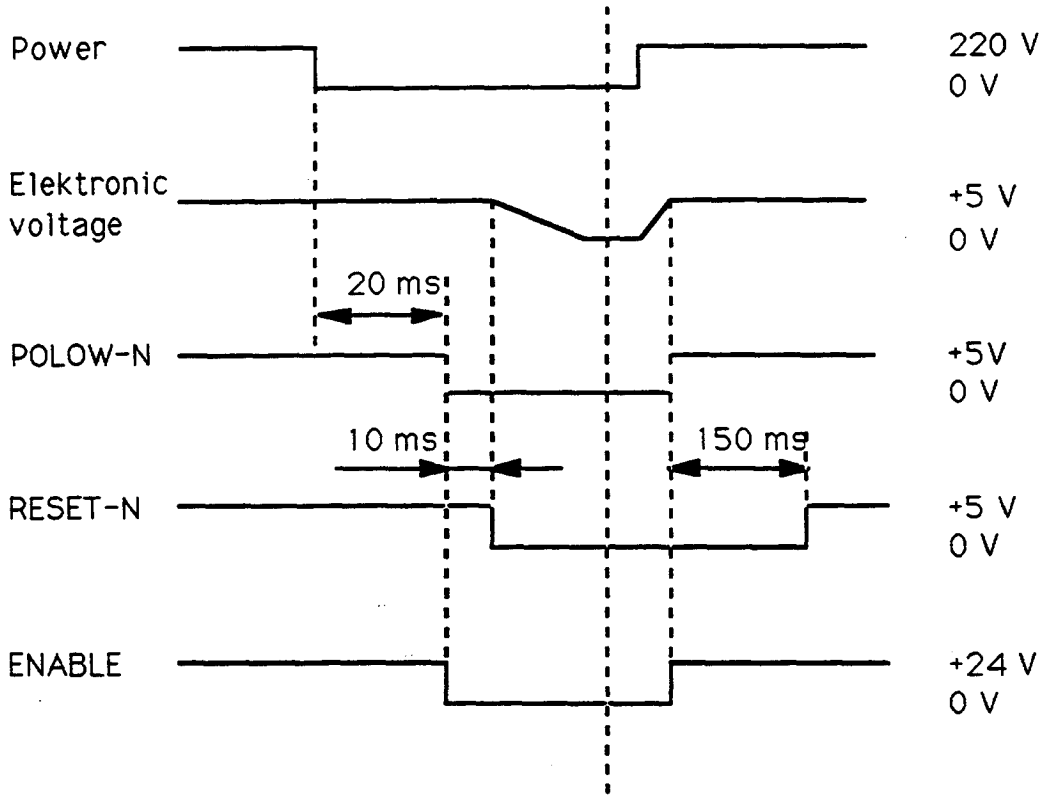
When voltage has been switched on or has recovered, POLOW-N goes high when all of the voltage supervision circuits indicate the correct voltage. RESET-N remains low until POLOW-N has been high for 150 ms.

When incorrect +5 V is detected, RESET-N is given without delay. When incorrect $\pm$15 V or 24 V is detected, switch-over of RESET-N is delayed 10 ms as with a mains power failure.

ENABLE follows POLOW-N immediately.

See also the figure on the next page.

Time table for output signals



DATA

Input voltages

Mains voltage:	220 V a.c., -30 / +12 %
Frequency:	48,5-61,8 Hz

Output voltages

+5 V d.c.	
0 - 1,0 A:	5.0 V, - 0 +10 %
1,0 - 7,0 A:	5.0 V, - 0 +4 %
Ripple:	Max. 100 mV p.t.p.
+15 V d.c.	
0 - ,02 A:	15.0 V, - 0 +5 %
Ripple:	Max. 0.1 V p.t.p.
-15 V d.c.	
0 - 2,0 A:	15.0 V, 0 / +5 %
Ripple:	Max. 0.1 V p.t.p
+24 V d.c.	
0 - 2.0 A (permitted load)*	24.0 V, -5 +10%
Ripple	Max. 0.5 V p.t.p.
+24V I/O	
0 - 10,0A (permitted load)*	24,0 V, -0 +10%
Ripple	Max. 0,5 V p.t.p.

In the event of a mains power supply failure, the unit has an energy reserve to maintain the output voltages at their normal level for 30 ms.

*) Maximum current outlet: 12 A, together
Short circuit current: 5 A, average value

Error indication

There is a LED placed on the front panel of the board. It indicates which state the board is in. Following states are possible:

• On:	An error is indicated
• Flashing:	Selftest running
• Off:	The board is working normally, no errors detected

DATA

Input signal

Supply voltage:	24 V +/- 4V
Current consumtion:	Max 0.6 A

Output signals (supply voltages to the display)

Logic voltage, Ulcdl:	+5 V, max 30 mA
Contrast voltage, Ulcdk:	-17.7 V +/-5%, max 25 mA
Illumination voltage, Ulcdb:	350 +/- 20 Vac, max 6 mA
Mechanical dimensions:	215 x 127 mm
Temperature range (operation)	0 to +70 degrees C
Temperature range (storage)	-40 to +70 degrees C

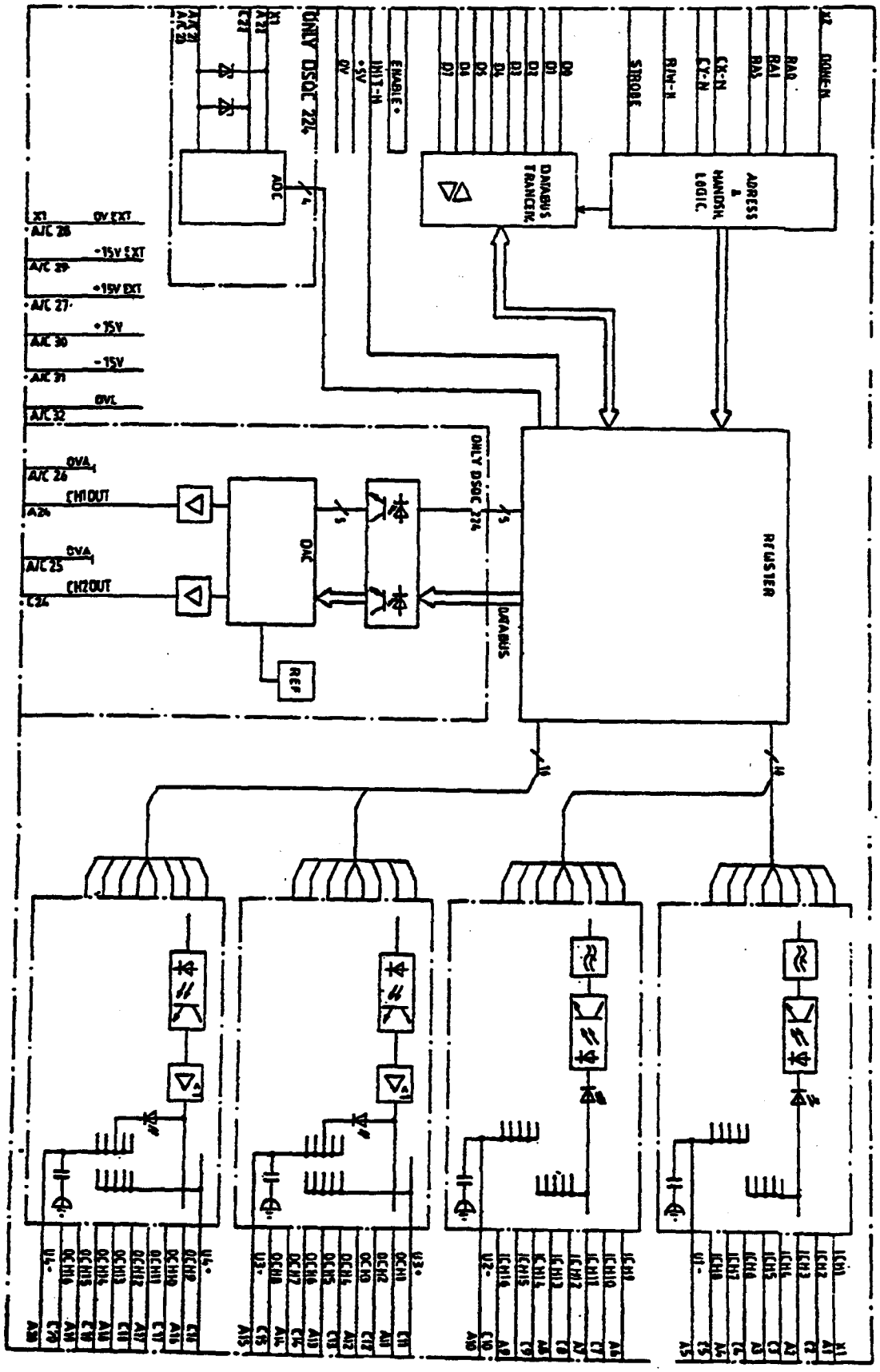
2.3.11 Digital I/O board, DSQC 223

The board is a digital I/O board with opto-coupled process connections intended for detection of 24 V d.c. signals from, for example, relay contacts and active sensors and control of 24 V d.c. voltage-supplied loads such as relays, smaller solenoids and lamps.

The board contains the following function blocks:

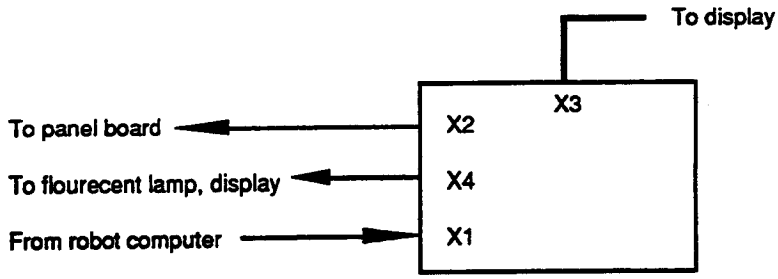
- Bus interface
- Input channels
- Output channels

The block diagram on the next page shows, in principle, the the design of the board and is followed by a brief description of each function block.


ONLY DSOC 224
ADC
DATABUS TRANCEIV.
ADRESS & HANDSH. LOGIC
STROBE
DATABUS
REMSTER
DAC
REF
ONLY DSOC 224
DATABUS

2.3.10
LCD adaption circuit board, DSQC 232

The DSQC 232 board controls the LCD display with background illumination. The display text is, for example a robot program, error lists or system data. The board is mounted on the front panel behind the display. The board has four connectors in accordance with the figure below.

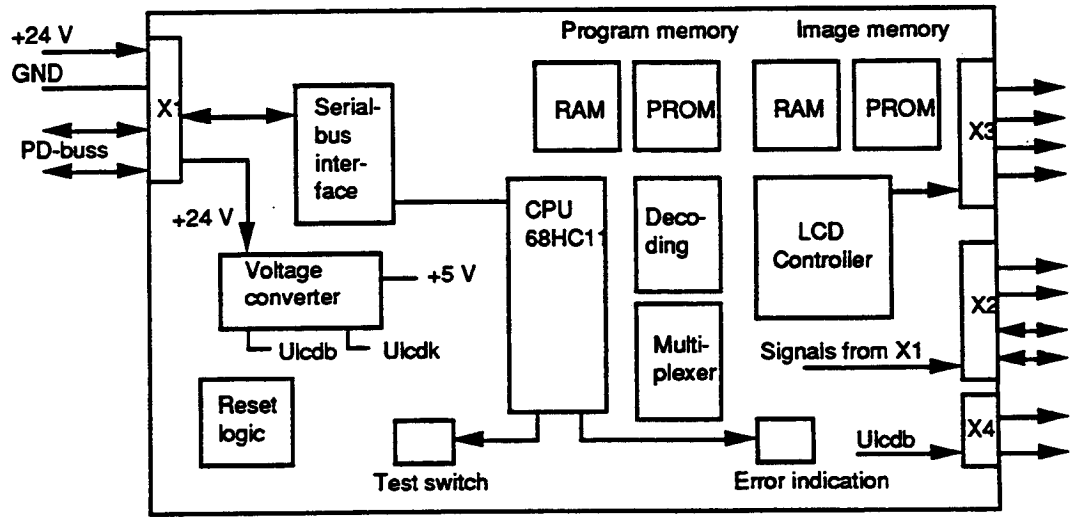


The robot computer controls the board via a serial channel, the PD-bus. Commands are interpreted and transformed into text generating signals for the display. The board also has some selftest functions.

The board consists of the following function block:

- Voltage converter
- Serial-bus interface
- CPU with program and data memory
- LCD controller with image memory
- Test switch
- Error indication

Below the block diagram is shown, followed by a short description of each function block



Voltage converter

The unit converts the incoming 20-28 V voltage to the following three voltages:
- + 5 V for the logics
- Ulcdk, negative contrast voltage for the display
- Ulcdb, alternating voltage for the display illumination

+ 5 V is generated by a switched capacitive voltage converter with a built-in regulator

Ulcdb is generated by a DC/AC converter unit.

Serial bus interface

The circuit board communicates with the robot computer through the PD-bus. It is a RS 422 type balanced differential bus with two wires. The communication is bidirectional and more slave circuit boards than the LCD-board are connected. The purpose of the serial bus interface is to divide the signals into received (RX) and transmitted (TX) signals and to adjust the level of these.

CPU with program and data memory

The main purpose of the processor is to:
- communicate with the main computer through the serial bus interface
- send signs and control data to the LCD controller
- perform different tests on the board

The processor is a Motorola 68HC11 with a data memory (static RAM) and a program memory (EPROM) connected to it.

LCD controller

A SED 1330 from Seiko Epson is used as LCD controller. The main task of the controller is to:
- receive data and commands from the CPU
- administrate access to the image memory
- generate control signals to the LCD display

Text generating memory (EPROM) and image memory (static RAM) are connected to the controller.

Test switch

A test switch is placed on the board. In the on state the board is set to a continous self test mode.
The tests run at different occasions as described below.

Test	Continously	Start-up	Operation
Test of CPU RAM	No	Yes	No
Test of CPU PROM	Yes	Yes	Yes
Test of LCD controller	Yes	Yes	No

Bus interface

The bus interface contains circuits for the adaption of signals to the I/O bus and board and internal address encoding.

Input channels

The 16 input channels are divided into two 8-channel groups, isolated from each other. The supply voltage is common within each group. The inputs are galvanically isolated from the internal logic on the board by means of opto-couplers.

The input of each channel is provided with transient protection and an RC filter is provided after the opto-coupler. The RC filter causes a nominal 5 ms delay of switch-on and switch-off. LEDs on the front of the board and in series with the inputs indicate their status.

Output channels

The 16 output channels are divided into two 8-channel groups, isolated from each other. Each group has a common voltage supply. The outputs are galvanically isolated from the internal logic on the board by means of opto-couplers. The outputs are short-circuit protected.

The outputs are provided with a transient protection which also functions as a turn-off circuit for inductive loads. LEDs on the front of the board and in parallell with the outputs indicate their status.

The output data register is cleared and the outputs are deactivated with RESET.

DATA

Rated voltage:	24 V d.c.
Supply voltage:	19-35 V d.c.

Inputs

Input voltage range "1"	15 to 35 V d.c.
Input voltage range "0"	-0.5 to 5 V d.c.
Input current with rated voltage, typical:	5.5 mA
Switch-over level, typical:	12 V
Delay, typical:	5ms (min. 3ms, max. 8ms)

Outputs

Load current, max:	200 mA/output 1000 mA/group
Voltage drop, max:	2.0 V at 200 mA

2.3.12
Combined I/O board DSQC 224

The combined I/O board is a digital I/O board with two analog outputs. The process connections are galvanically isolated.

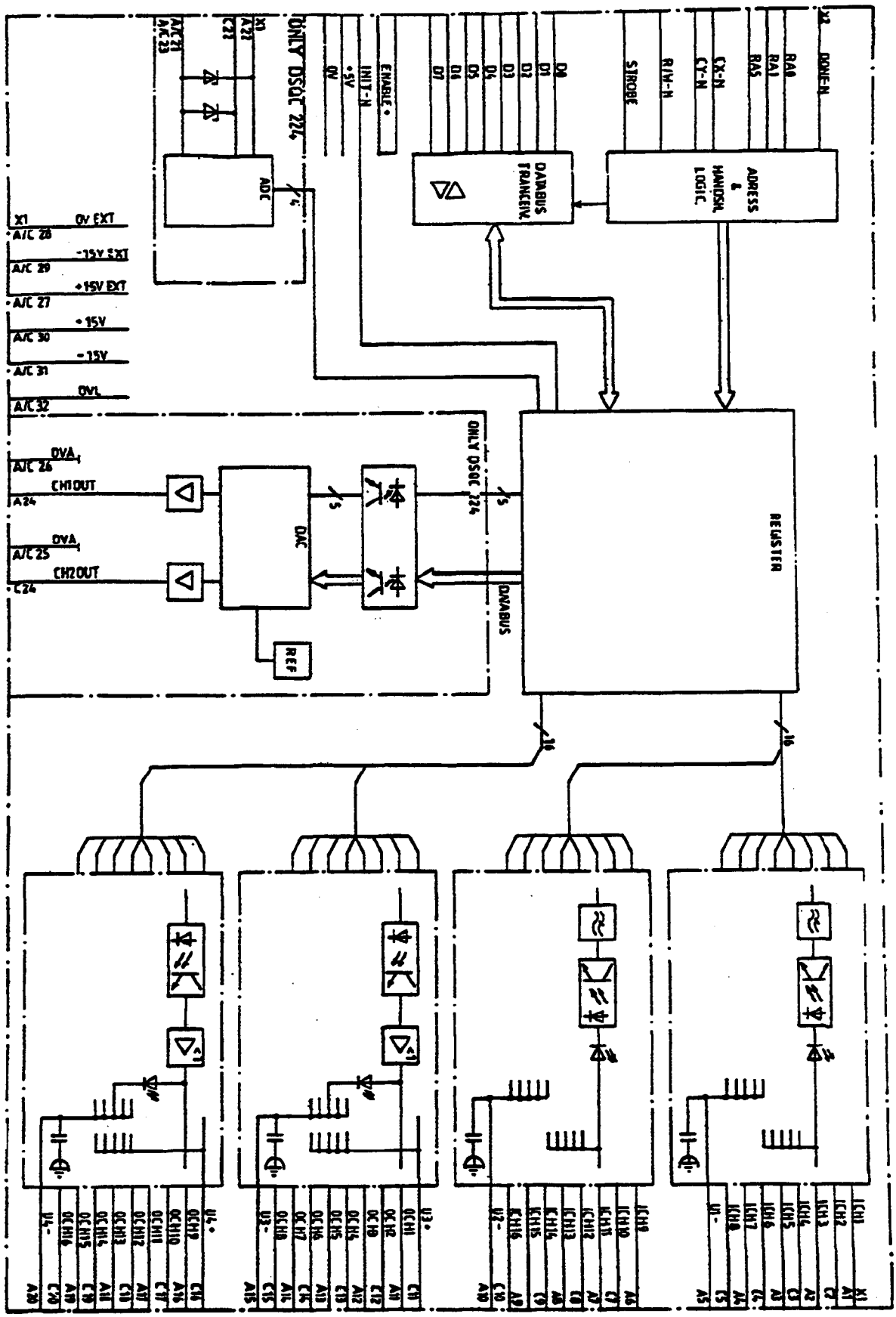
The digital input /output channels are intended for detection of 24 V d.c. voltage signals from, for example, relay contacts and active sensors and for control of 24 V d.c. voltage-supplied loads.

The two analog output channels are intended for process connections at which galvanically isolated 0V is required. Typical uses are control of current and wire feed in arc welding and control of glue flow in gluing applications.

The board contains the following function blocks.

* Bus interfacing
* 16 digital input channels
* 16 digital output channels
* 2 analog test inputs
* 2 analog voltage outputs, 0 - +10V

The block diagram on the next page shows, in principle, the design of the board. This is followed by a shortly description of each function block.


X2
DONE-N
RA0
RA1
RAS
SX-N
CY-N
R/W-N
STROBE
D0
D1
D2
D3
D4
D5
D6
D7
ENABLE
INIT-N
+5V
0V
ONLY DSOC 22x
A/C21
A/C23
X1
A/C21
C23
ADC
DATABUS TRANCEIVE
ADRESS & HANDSH. LOGIC
X1
A/C 28
0V EXT
A/C 29
-15V EXT
A/C 27
+15V EXT
A/C 30
+15V
A/C 31
-15V
A/C 32
OVL
ONLY DSOC 224
OVA
A/C 26
CH1OUT
A24
OVA
A/C 25
CH2OUT
C24
DAC
REF
DSOC 224
DATABUS
REGISTER
16
16
DCH1
DCH2
DCH3
DCH4
DCH5
DCH6
DCH7
DCH8
DCH9
DCH10
DCH11
DCH12
DCH13
DCH14
DCH15
DCH16
ICH1
ICH2
ICH3
ICH4
ICH5
ICH6
ICH7
ICH8
ICH9
ICH10
ICH11
ICH12
ICH13
ICH14
ICH15
ICH16

Bus interfacing

The bus interfacing contains circuit for signal interfacing to the I/O bus and board and internal address decoding.

Digital input channels

The 16 input channels are divided into two groups of 8 channels, each group isolated from the other and provided with a common voltage supply. The inputs are galvanically isolated from the internal logic of the board by means of opto-couplers.

Each channel is provided with protection against transients at the input and an RC filter after the opto- coupler. The RC filter gives nominal switch-off and switch-on delays of 5ms.

LEDs mounted on the front of the board are connected in series with the inputs to indicate their status.

Digital output channels

The 16 output channels are divided into two groups of 8 channels, each group isolated from the other and provided with a common voltage supply. The outputs are galvanically isolated from the internal logic of the board by means of opto-couplers. The outputs are short-circuit protected.

The outputs are provided with protection against transients which also functions as a quenching circuit for inductive loads. LEDs mounted on the front of the board are connected in parallel with the outputs to indicate their status.

Analog output channels

When supplying analog values, the I/O computer puts digital values in a register area located on the board which accomodates two registers, one per output. From here, the values are converted to analog values via the D/A converter.

Analog input channels

The two analog outputs are tested with the help of two analog input channels. The analog input channels are only used with manual tests in the Test mode

The output data register is reset to zero and outputs are deactivated when RESET is pressed.

DATA, digital channels

Rated voltage:	24 V d.c.
Supply voltage:	19-35 V d.c.

Inputs

Input voltage range"1"	15 to 35 V d.c.
Input voltage range "0"	-0.5 to 5 V d.c.
Input current with rated voltage, typical:	5.5 mA
Switch-over level, typical:	12 V
Delay, typical:	5ms (min. 3ms, max. 8ms)

Outputs

Load current, max:	200 mA/output 1000 mA/group
Voltage drop, max:	2.0 V at 200 mA

DATA, analog channels

External supply:	±15V, ±5%
Current consumption, +/- 15V with full load:	max. 15mA
Temperature range:	+ 5 to +70°C
Insulation voltage between group and control cabinet:	500 V, 50Hz/1 min

Inputs (only for test)

Input voltage:	0- +10V
Resolution:	approx. 8 bits
Inaccuracy:	approx 10 %

Voltage outputs

Output voltage:	0 to +10V
Load impedance:	>2 kΩ
Resolution:	10 mV
Inaccuracy:	0.45 % +25mV

2.3.13
Analog I/O board, DSQC 209

DSQC 209 is a general purpose analog I/O board which can be used for the control of voltage, current and wire-feed in arc welding applications.

The analog side of the board is galvanically isolated from the control system. It is provided with:

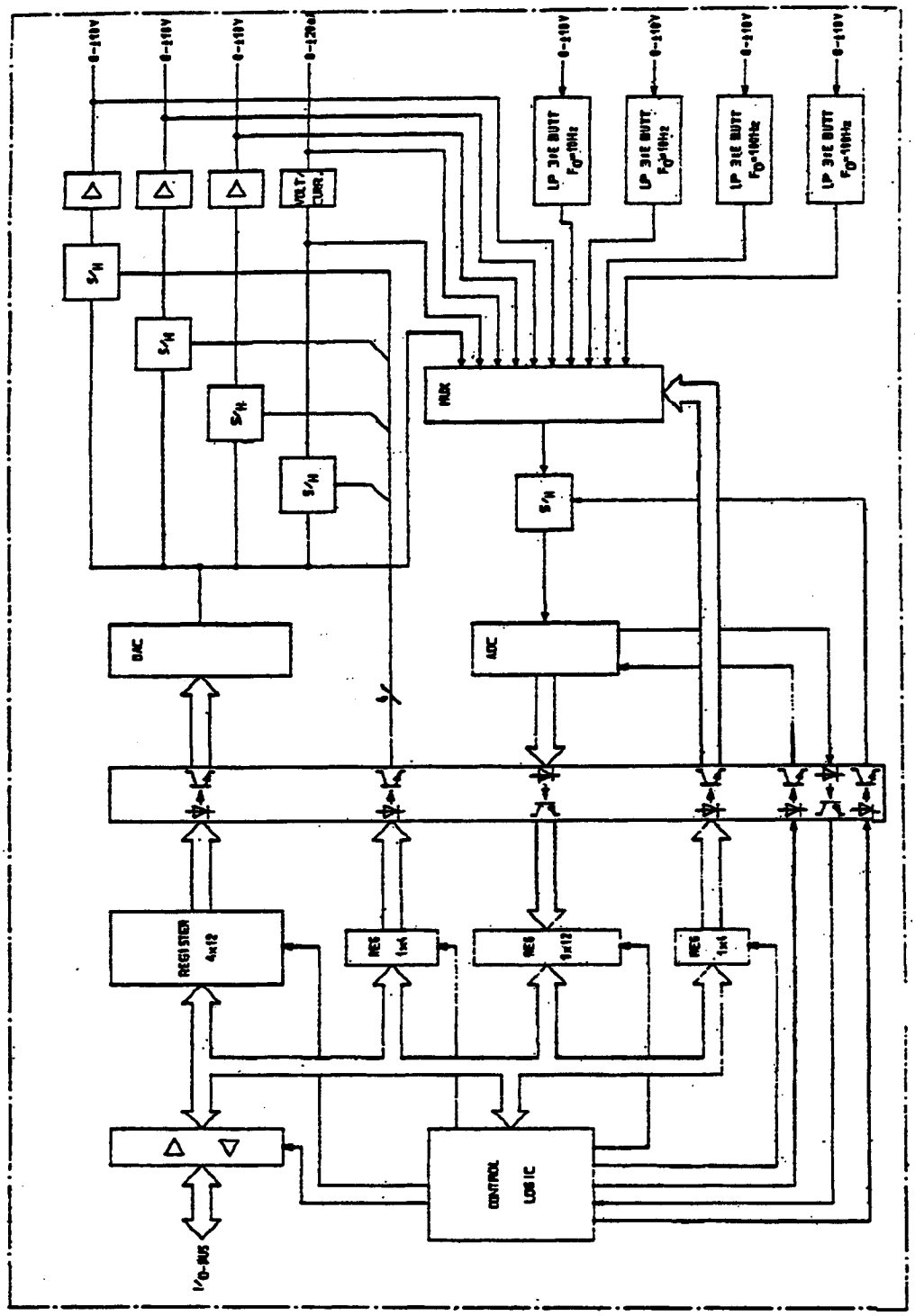
- 4 analog inputs
- 3 analog voltage outputs, 0-±10V
- 1 analog current output, 0-±20 mA

±15 V is supplied internally via a strap in the user's contact on the robot control cabinet or from an external supply unit.

The DSQC 209 board consists of the following function blocks:

- Bus adaptor and control of A/D and D/A conversion
- Inputs
- Outputs

The block diagram on the next page shows, in principle, the design of the board and is followed by a brief description of each function block:


0-±10V
0-±10V
0-±10V
0-±20mA
0-±10V
0-±10V
0-±10V
0-±10V
LP 3rd BUTT
LP 3rd BUTT
LP 3rd BUTT
LP 3rd BUTT
VOLT/CURR.
S/H
S/H
S/H
S/H
S/H
MUX
DAC
ADC
REGISTER 4x12
MUX 1x4
MUX 1x12
MUX 1x4
CONTROL LOGIC
I/O-BUS

Bus adaption and control of A/D and D/A conversion

When an analog value is read in, a multiplexer address is stated and the A/D convertor is started. After the conversion, the value of the A/D conversion is written in a register which can be read from the I/O computer.

When reading out analog values, the I/O computer emits digital values in a register area on the board which accomodates four registers, one per output. The values are copied from here and converted cyclically, via the D/A convertor, to analog values in the sample and hold circuits.

Inputs
Each input is provided with a low-pass filter to eliminate undesirable high frequency signals. The inputs are to be connected to a low-resistance source to keep the zero-error less than the maximum value.

The outputs of the filters are connected to individual inputs on a 16-input multiplexer. The remaining 12 inputs are used for supervision of the analog outputs and for measurement of 0 V. An S/H amplifier is connected to the multiplexer to sample the input signals and then give the succeeding A/D convertor a constant signal during the conversion in progress. The A/D convertor converts the 0-±10V input signal to 12 bits including sign (2-complement).

The control leads of the S/H amplifier and the A/D convertor and the outputs of the A/D convertor are coupled to the digital section via opto-couplers.

Outputs
The outputs are controlled by a 12-bit D/A convertor which supplies voltage to four S/H amplifiers, one per channel.

Buffer stages are used to isolate the S/H amplifiers from the outputs. The buffer stage to the current output is a voltage to current convertor which gives an output current which is independent of the load.

The D/A convertor data leads and the control leads to the S/H amplifiers are connected to the digital part via opto-couplers.

DATA

External supply:	±15V, ±5%
Current consumption, +15V:	max. 240 mA
Current consumption, -15V:	max. 130 mA
Temperature range:	0-70°C
Insulation voltage between group and control cabinet:	500 V, 50Hz/1 min

Inputs

Input impedance with d.c. voltage:	>1 MΩ
Input impedance with high frequency:	330 kΩ
Source impedance:	<1 kΩ
Low pass filter:	10 Hz to 100 Hz
Input voltage:	0-±10V
Resolution:	10 mV
Inaccuracy:	+0.2% +15mV
Zero error filter:	2 mV

Voltage outputs

Output voltage:	0-±10V
Load impedance:	>2 kΩ
Resolution:	10 mV
Inaccuracy:	0.45 % +25mV
Max. ripple:	2.5 mV_{ptp}, 300 Hz

Current output

Output current:	0-±20mA
Load impedance:	<450 Ω
Resolution:	0.02 mA
Inaccuracy:	0.5% +60 µA
Max. ripple:	5 μA_{ptp}, 300Hz

2.3.14
Rear Plane

The rear plane is completely passive and contains supply voltages, I/O bus, the ENABLE circuit and contacts to the robot computers process-I/O.

Power Supply

The rear plane supplies its units with +5 V, +15 V, -15 V and +24 V from the power supply unit connected.
One side of the rear plane is an almost complete ground plane, which is connected directly to the rack chassis. The +24 V voltage supply to run chain 1and robot computer has PTC-fuses. The fuses are automatically reseted after removal of the shortcircuit.

I/O Bus

The rear plane accommodates an 8-bit I/O bus from the robot computer board to the I/O board and the system board. The bus consists of 8 data conductors, 6 address conductors, 6 check conductors and 2 board selection conductors, unique for each board location which permits the computer to address typical board locations and check board locations. Address jumpers are not required on the board.

Axis board

7 conductors goes to the axis board from the robot computer board.

ENABLE circuit

On the rear plane, connections for the ENABLE circuit goes from the drive unit through the robot computer bord to the system board.

Process I/O of the robot computer

From the robot computer position is conductors extracted to process contacts for:

- PD-bus programming unit
- PD-bus LCD display
- Serial sensors
- Floppy disc data
- Floppy disc supply
- Serial link, print out

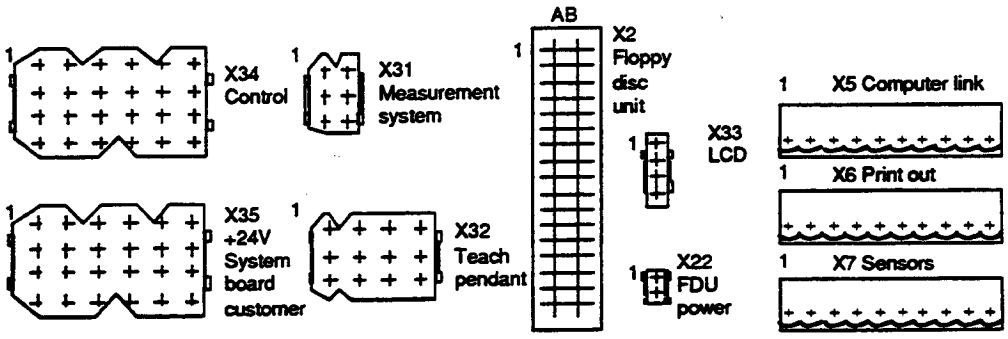
The PD-bus has PTC-fuses to protect the robot computer against incorrect connection.

Other signals

There are also certain special check signals, outside the bus, between the robot computer board, the system board and the voltage supply unit.

Connections

The robot computer connector are 96 pole European standard connectors. All other board connectors are 64-pole C-type connectors.



X2	Floppy disc control
X22	Floppy disc supply
X5	RS 232 computer link
X6	RS 232 Sensors
X31	Serial measurement transmitter
X32	Programming unit
X33	LCD-display
X34	Operators panel
X35	System board, Customer connections

2.3.15
Serial measurement board DSQC 253 (IRB 2000, 3000, 3200)
DSQC 243 (IRB 6000)

The serial measurement board is used for gathering resolver data from max. 6 resolvers, they also monitors the resolver feedback and generates information about the position of resolver.

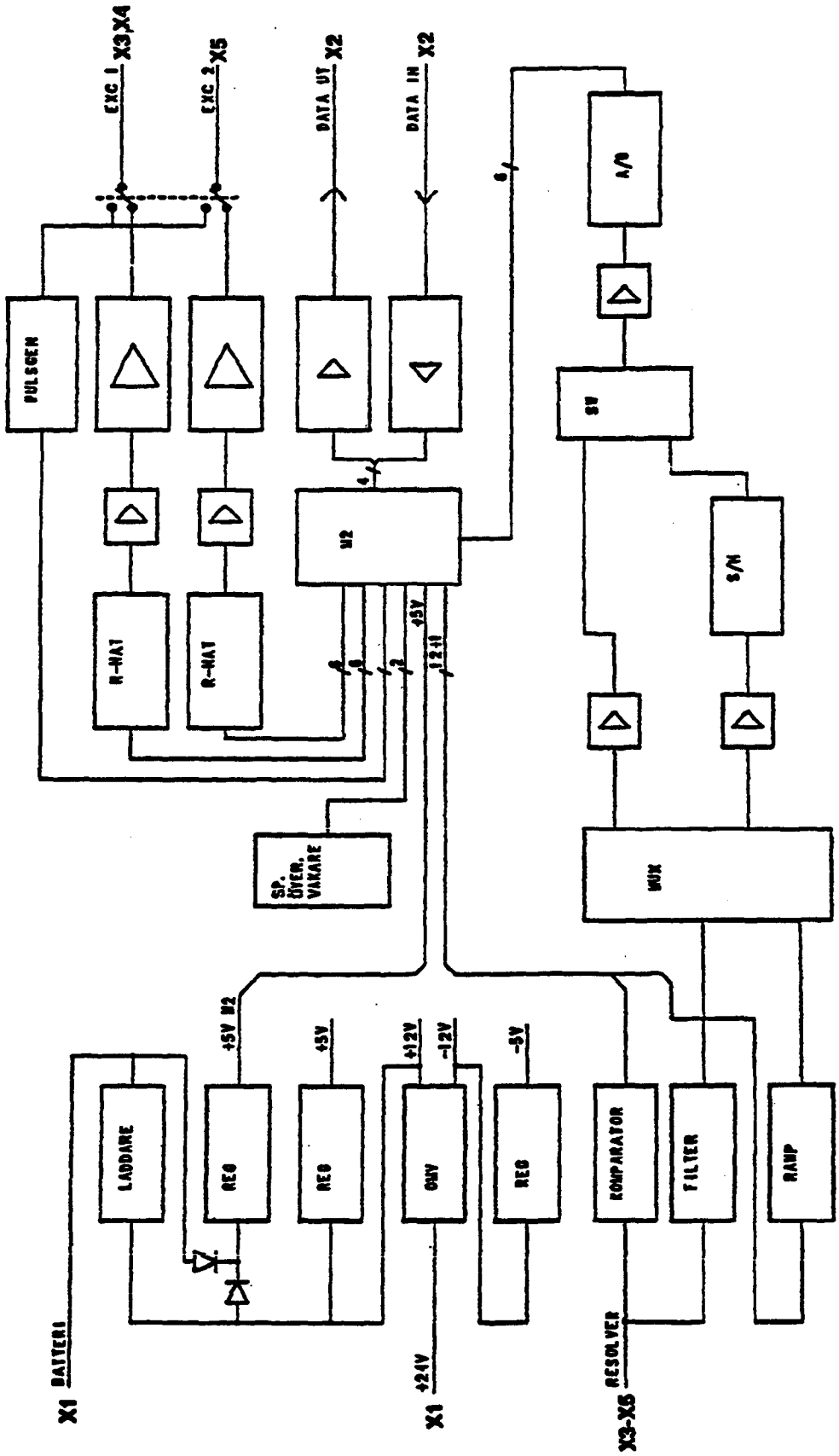
The board is supplied by + 24 V and an additional back up supply from an accumulator to be able to retain the information should the 24 V supply fail.

The serial measurement boards are designed to facilitate serial connection of up to 8 boards in one loop.

The serial measurement board consists of the following function blocks:

- Voltage regulator
- Input steps för resolver answers
- A/D converter with channel selector
- Resolver supply generation
- Communication interface
- Control circuit M2

The block diagram on the next page shows, in principle, the design of the board. This is followed by a shortly description of each function block.


EXC 1 X3,X4
EXC 2 X5
DATA UT X2
DATA IN X2
PULSGEN
R-NÄT
R-NÄT
U2
+5V
12 st
A/D
SV
S/H
MUX
SP. ÖVER. VAKARE
LADDARE
REG
REG
GMV
REG
KOMPARATOR
FILTER
RAMP
+5V U2
+5V
+12V
-12V
-5V
X1 BATTERI
X1 +24V
X3-X5 RESOLVER

Voltage regulator:

The DSQC 234 comprises a number of regulators of various kinds for internally generating +5 V, -5 V, +12 V and +12 V.
All voltages are derived from +24 V when this voltage is available. If only the accumulator voltage is available, only a 5 V voltage is generated for the parts required to retain the resolver turn information.

Input steps for resolver answers:

The resolver inputs consist of a 2nd degree RC filter for the signals which levels are to be measured, and comparator inputs to generate the signals connected directly to the control circuit M2.

A/D converter, with selector:

The A/D converter is of serial type.
The channel selector selects one of 12 inputs. In addition to the resolver inputs, an internally generated voltage ramp kan be added to the A/D converter for testing purposes.

Resolver supply generation

When +24 V is available, a sinusoidal voltage is generated according to the resolver specification. When only the accumulator voltage is available, a pulsed supply is generated since this requires less energy.

Communication interface

Bus interface: RS-422.
Four conncetion points exist: data in, data out, feedback data in and feedback data out.

Control circuit M2

The M" circuit administrates all functions of the board and decodes the values of the A/D converter to a format recognisable to the robot computer. Using the comparator inputs, M2 is also able to discover changes in resolver positions at accumulator supply only.

DATA

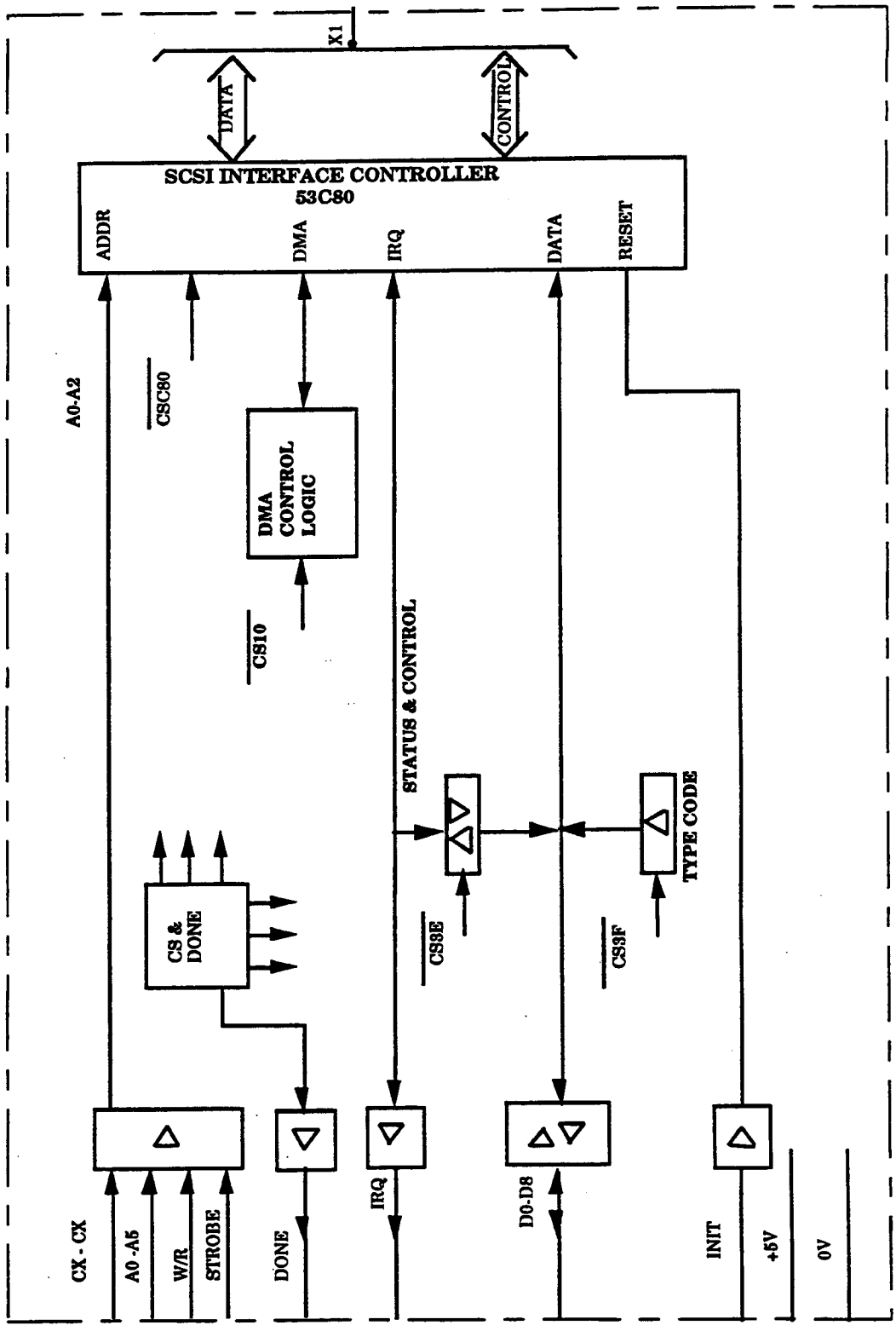
Turn counter	
Working range:	± 8191 turns
Max revolution, battery:	2400 rpm
Max revolution, 24 V:	9000 rpm
Electrical data	
Supply voltage:	+24 V (+10% / -20%)
Battery voltage:	+7 V (+2 V / - 0.5 V)
Power consumption 24 V:	0.6 A
Power consumption batt.:	2.5 mA
Re-charging time battery:	18 h
Resolver supply	
Frequens:	3968 Hz
Voltage:	5 V rms
Connected battery	
Voltage (nom NiCd):	7.2 V
Capacity:	4 Ah
Holding time:	min 1000 h
Life time:	5 year
Connected resolver	
Type:	Rotor supplied
Frequens:	3 - 4 kHz
Transformation:	0.5 ± 10%
Supply voltage:	5 V rms
Rotor impedance (Zro):	> 350 ohm
Stator impedance (Zss):	< 400 ohm
Phase displacement:	- 5° ± 3°

2.3.16
Winchester Interface DSQC 227

Interface board DSQC 227 permits communication with a winchester with SCSI-bus.

The board contains the following function block:

- Bus interfacing
- Winchester interfacing


X1
DATA
CONTROL
SCSI INTERFACE CONTROLLER
53C80
ADDR
DMA
IRQ
DATA
RESET
A0-A2
CSC80
DMA CONTROL LOGIC
CS10
STATUS & CONTROL
TYPE CODE
CS & DONE
CS3E
CS3F
CX - CX
A0 -A5
W/R
STROBE
DONE
IRQ
D0-D8
INIT
+5V
0V

Bus interface

The bus adaption contains circuits for adaption of signals to the I/O bus and control address decoding.

Winchester Interface

Data Transfer to/from the winchester is controlled by a special intergrated circuit SCSI INTERFACE CONTROLLER (53C80).
This circuit contains functions, logic and drive circuits to control the flow of data between the SCSI bus of the winchester and the I/O bus.

DATA:

Temperature range:	5-70° C
Supply voltage:	+ 5V d.c.
	type 200 mA
	max. 500 mA

2.3.17 Winchester unit

The winchester unit consists of a winchester with power supply unit located in a separate electronic frame.

Winchester

The winchester is used for storage of program blocks and can store a maximum of 250 program blocks.

Voltage supply unit

The voltage supply unit transform 24 V d.c. from the power unit to +12 V d.c.

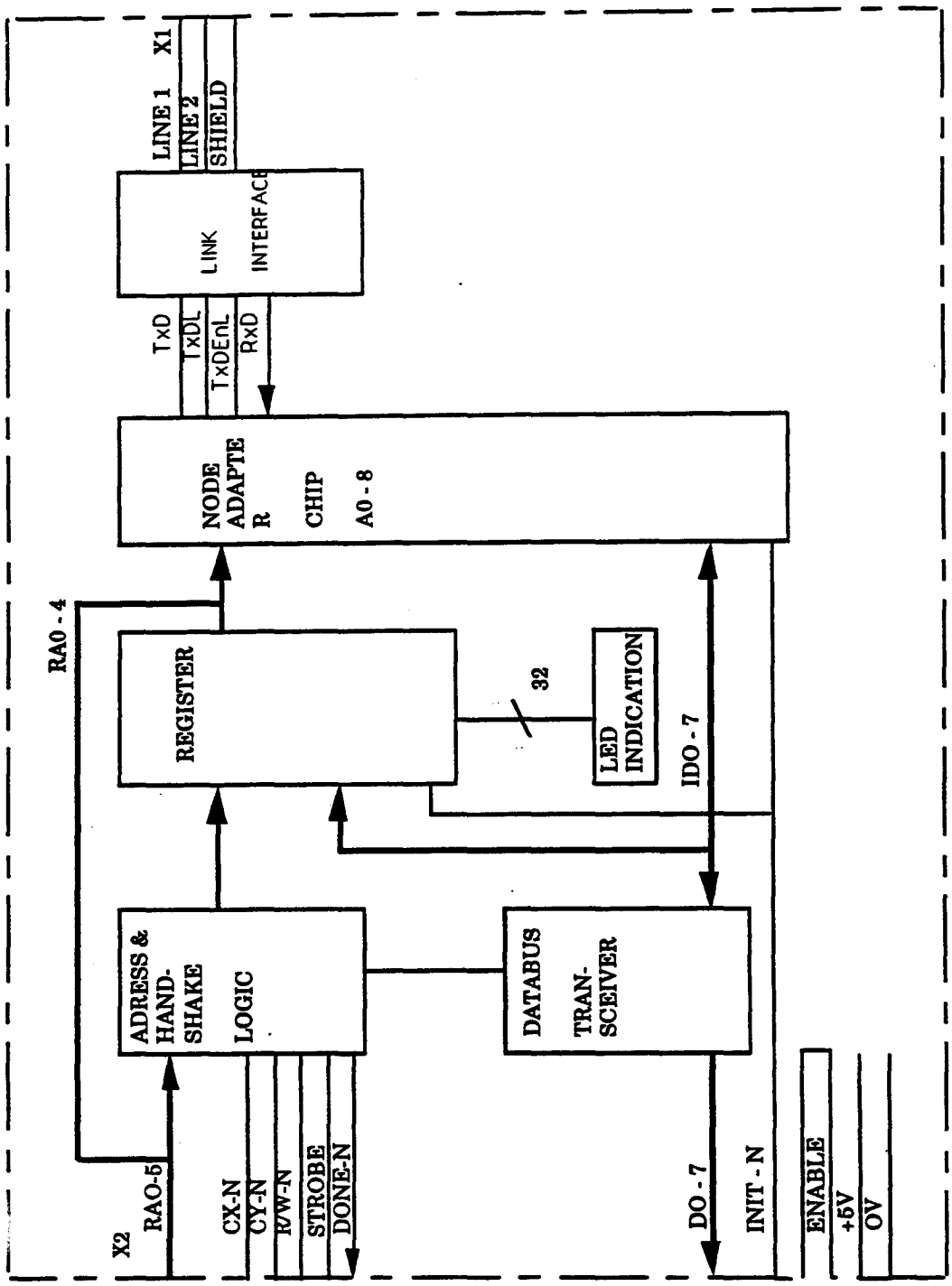
2.3.18
Remote I/O (RIO) DSQC 239

The Remote I/O-board DSQC 239 has a I/O link that permits communication qith an Allen Bradley PLC Remote I/O lin 1771. In the front of the board there are 32 Leds for status indication.

The remote I/O-board consists of following function blocks:

- Bus adaption
- Node adapter circuit
- I/O link

The block diagram on the next page shows, in principle, the design of the board. This is followed by a short description of each function block.


X1
LINE 1
LINE 2
SHIELD
LINK INTERFACE
TxD
TxDL
TxDEnL
RxD
NODE ADAPTER CHIP A0 - 8
RA0 - 4
REGISTER
32
LED INDICATION
ID0 - 7
ADRESS & HAND-SHAKE LOGIC
DATABUS TRAN-SCEIVER
X2
RA0-5
CX-N
CY-N
R/W-N
STROBE
DONE-N
D0 - 7
INIT - N
ENABLE
+5V
0V

Bus Interface

The bus adaption contains circuits for adaption of signals to the I/O-bus along with board and internal address decoding.

Status indication

32 Leds in the front of the board is used for indication of status for the first 16 inputs and the first 16 outputs.
The status information is taken from the I/O-bus.

Node adapter circuit

The Allen-Bradley node adapter circuit contains protocol for communication with an Allen-Bradley PLC.

I/O link

Adaption to the I/O links is made with the help of a transformer.

All in- and outputs are set to zero at RESET.

DATA

Operation temperature	+5° - 70° C
Supply voltage	+ 5V d.c. type 150 mA max 500 mA

3
Maintenance of electronics

The electronic components require only visual inspection and occasional vacuum-cleaning.

NOTE! The mains voltage must be disconnected when work is performed in the control cabinet. Circuit boards (pattern and components) are not to be touched without electrostatic discharge protection to prevent damage. Use the wrist band provided on the inside of the control cabinet door.

Routine inspection of control cabinet

The control cabinet is completely enclosed and the electronics thus protected from normal factory surroundings. However, in surroundings with much dust the cabinet should be inspected regularly inside.

- Check that the sealing strips and cable grommets in the cabinet seal properly, so that dirt is not drawn into the control system.
- Check that the cabling to the programming unit is not visibly damaged in any way.

Cooling device

Check the heat exchanger regulary, in normal factory surroundings clean it once a year.
Disassemble: Loosen the four screws on top of the heat exchanger. Then remove the roof of the heat exchanger. The gills are now easy to reach and to blow clean with compressed air.

Check the filter of the cooler regulary. Replace the filter once a year in normal factory surroundings. Extra dust filter is part of the delivery. The order number for the filter is 7820 004-3.
Filter exchange: Detach the grating on the left side of the cooler. Replace the filter and put the grating back in place again.

Replacing the battery for the memory back-up

The battery for backup of the memory, which is located on the gable of the frameesibe the robot computer board, should be exchanged each 5th year to ensure interference-free operation. Parameters and programs must be stored on a diskette as the memory contents are lost during the exchange.
When the battery is to be exchanged, disconnect the voltage to the system at the main power switch and disconnect the contact of the battery on the robot computer board. The order number for the battery is 4944 026-5.

Replacing fuses

Fuses are situated on the transformer terminal block on the floor mounted maintransformer.

Qty	Rating	Type	Situation
2	6.3 A	slow-blow cartridge	transformer

Fuse designations (article number) are shown in the spare parts list.

Indicator lamps

- The lamps on the controlpanel are lit for control at the end of the startsequense (INIT).
  They can also be tested by the lamp test function on the remote panel (option).
- Defective lamps can be replaced by turning the plastic lens CCW and then remove the lamp which is fastened with bayonet holder. Put a piece of plastic- or rubber hose over the lamp and then turn the lamp a quarter of a turn CCW. Mount in opposite order.

Floppy disk unit

- The floppy disk unit should be protected from dirt and fine particles as much as possible.
- Floppy disks should always be stored in an office environment and at normal room temperature. Temperatures exceeding +50°C can permanently damage the information stored on a disk. In areas where magnetic interference is likely the disks should be stored in a steel box.
- The floppy disk unit can be tested by first recording a program and then reading it back to the control system again. The built-in function tests will then check if the units is functioning correctly. As long as no error lights or error messages are apparent, the unit is satisfactory.
- If difficulty in reading or writing is experienced, the read and write head can be cleaned by using a cleaning disk (BASF 3.5" doublesided floppy disk) in conjunction with the robot computer board test mode.

4
Service and maintenance

4.1
Static electricity

All electronic equipment is sensitive to static electricity and the following rules must be observed when handling electronic units.

- Before use, always store electronics units in the packaging in which they were delivered.
- Do not touch components and conductive patterns with the fingers. Hold the board at its edges!

A discharge wrist band is connected in the robot control cabinet. Use this around the wrist when working with the electronics to discharge static electricity.

In certain cases, special instructions are provided with electronics units. Follow these carefully.

4.1.2
Aid

As the system is provided with effective functions for diagnostics and fault reporting, only a few external aids are necessary.

The aids usually needed are the following:

- Normal hand tools
- Multimeter
- Oscilloscope
- Printer for printout of test data

A special set of service equipment has been developed.

A link board for the electronics board for the electronics boards is useful when fault-tracing, to lift the relevant board out from the others so that board components and contacts are available from the side while the board is still connected.

Singel-width extension board	DSQC 206
Dubble-width extension board	DSQC 205

4.2
Fault tracing in general

Different types of error status and their general symptoms are described in this section. The different error indications presented on the front of the units and how the problems caused by static electricity are solved should be avoided is described.

4.2.1
Different types of malfunction

As the robot system is a very complex system, many types of malfunction can occur, all of which cannot be predicted. Different examples of malfunction are given below:

- The system is "dead" either at start-up or "dies" during operation.

  - The main switch is in the off position or the main fuse is blown.
  - Incorrect voltage is supplied to the electronics unit.

- The programming unit is "dead". If the robot computer receives no response from the programming unit, no error code is given but the system interprets the programming unit as "not connected".

  - Faulty cable to the programming unit.
  - The programming unit supply voltage is absent.
  - There is an internal fault in the programming unit.

- The system does not go the STANDBY mode at start-up

  - A fault has been detected by the diagnostic function during the start phase. This should be indicated by the illumination of certain LEDs or by the presentation of an error code.

- The system indicates emergency stop.

  - An emergency stop button has been depressed
  - The robot has been run to a limit switch.
  - Cable or contact fault.
  - 24 V short-circuit in the run chain

- The system indicates a servo fault.

  - Fault in rectifier or servo unit
  - Fault in resolver or servo motor.
  - Cable or contact fault.

- An external object, such as a relay or a solenoid does not react to an activated output.

  - Supply voltage to the object is absent.
  - Cable or contact fault
  - Faulty final stage on the output board

- The robot system does not react to signals from external objects.

  - Supply voltages to the external objects are absent.
  - Cable or contact fault.
  - Faulty input stage on the input board.

Initialization problems

- The initialization is not starting

  - Faulty or incorrect mounted PROM D25, D26

- The initialization is performed but when the "EN" LED on the robot computer is activated, the LED extinguishes immediately and the system assumes an error status.

  - A fault in the robot computer, wiring, robot or axes connected externally.

- Certain boards are not initialized.

  - Incorrect system parameters.
  - Fault in the rear plane or the robot computer. If any the board addressing leads have been damaged, the fault will in most cases affect certain board groups.

  1 I/O 4, 5, 6

  2 I/O 1, 2 and 3 and safety board

  3 I/O 3

  4 I/O 2 and 6

  5 I/O 1 and 5

  6 I/O 4 and safety board

The 24 V

- Failure in voltage appearance.

  - Check if the 24 V is short-circuited.

Mechanical robot

- Reduced load capacity.

  - Incorrect commutation offset.

4.2.2
Error indications, general

Certain units are provided with indication LEDs which show the status of the unit. The LEDs are of two different types indicating either a normal or an abnormal status.

A careful study of the indication LEDs is recommended when the system functions abnormally. The significance of the reactions of the different LEDs is described in detail in section 3.6.
During the start-up procedure, the indication LEDs illuminate and extinguish in a specific sequence. If the start-up does not function normally, this can be detected under certain conditions and its cause established by observing the indication LEDs.

4.3
Test signals

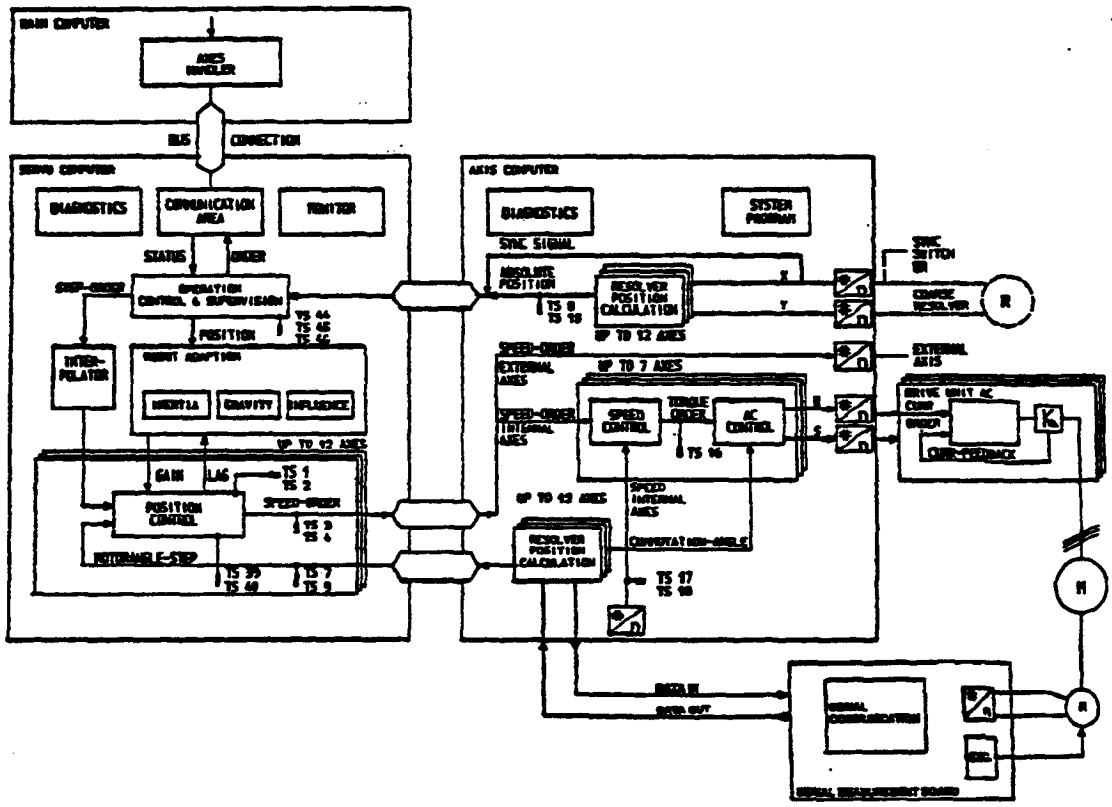
4.3.1
Introduction

Two test signal outputs marked 1 and 2 with a common zero, GND, are located on the robot computer board.

The two outputs (channels) are defined and function completely independently of each other.

Internal signals, not normally accessible for measurement can be defined for the outputs via the programming unit and measured there. Predefined signals, so-called standard test-signals, are distinguished from user-defined signals. Only standard test-signals will be described here as they are of interest during service. (The user-defined signals require more detailed knowledge of the software.)

The following block diagram of the servo program shows the test signals which can be defined for the outputs.



DATA

Max. output voltage:	± 10 V
Resolution:	5 mV
Updating speed:	2 ms
Delay:	4-6 ms internally in the servo/axis computers

4.3.2
Definition via the programming unit

The alternative TSIG (four SCAN) is included in the MANUAL-menu of the programming unit.

When SCAN is pressed four times, the display presents a request for the channel number required. The answer 1 or 2 is given as follows:

1: Test terminal 1
2: Test terminal 2

The signal type is then defined.

The test signals can be defined as:

0: User-defined test signals. **May not be used during service.**
1: Selection of predefined signal, i.e. standard-text signals intended for service.

Then specify the standard text signal to be measured in accordance with section 4.3.3.

The number of the axis concerned is requested finally. The axis number (1 - 12) is given for signals which are axis dependent. For other signals, the axis number is always set to 1.

The required signal can now be measured at the test terminal specified.

4.3.3
Standard test signals

Signal number	Description	Output signal
1	Lag (absolute value) in the position regulator	12.8 motor revs/V
2	Lag (absolute value). The same signal as 1 above, but with a higher resolution.	0.25 motor rev/V
3	Speed reference Internal reference to the speed controller. The signal is calibrated so that the maximum speed always gives the same output signal, irrespective of the max. speed of different axes.	4.74 V at maximum motor speed.
4	Speed reference. The same test signal as 3 above, but with a greater degree of resolution.	7.6 V at 10% of maximum motor speed.
7	Fine resolver angle. For robot axes, the angular value for the resolver is reduced by the value of the commutation offset before it is presented. (The value is adjusted to the internal one rev., i.e. 0 - 891 resolver increments.)	819 resolver increments/V
8	Coarse resolver angle. The resolver position is given as 0 - 819 resolver increments.	819 resolver increments/V
9	Fine resolver speed. The output signal gives the turn of the coarse resolver for each interval of 2 ms.	750 rev/min. /V

16	Torque reference from the speed controller to the current estimator.	Scale factor depends on motortype and robot. Contact service personal when needed.
17	Filtered motor speed	4.74 V at maximum motor speed
18	Filtered motor speed. The same test signal as 17 above, but with a greater degree of resolution.	7.6 V at 10% of maximum motor speed.
39	Absolute position. The absolute position minus the current lag is given. The position calculation is based on the synchronization position 1. The value is of no significance until before the robot is synchronized or when trim movements are performed.	12.8 rev/min. /V
40	Absolute position. The same test signal as 39 above, but with a greater degree of resolution.	0.25 motor revs /V
44	Position status. Given when all axes have entered a specific zero zone.	In position: 1 V Not in position: 0 V
45	Brake status. The brake status required by the servo computer is given.	Brake on: 1 V Brake off: 0 V
46	Zero speed status. Given when all axes rotate at a speed lower than a limit determined in the system.	Zero speed reached: 1 V Zero speed not reached: 0 V

4.4
Test program

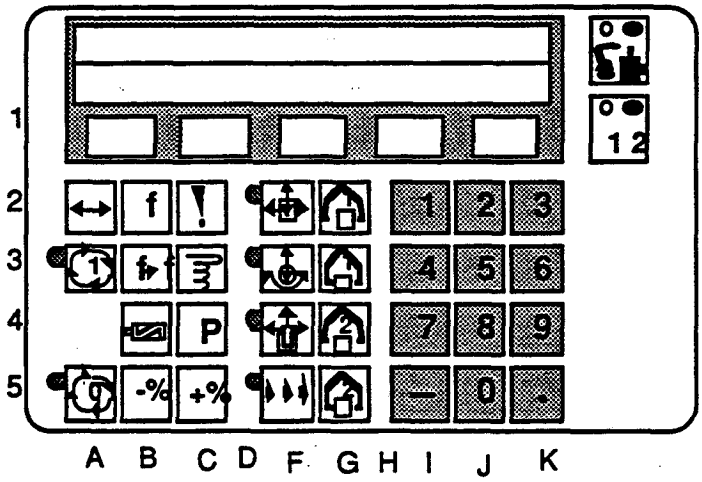
4.4.1
Self tests

The operator's units, the monitor and the programming unit have a built-in self-test. The test embraces an internal test of the unit circuit board and a test of directly connected control/information functions.

Programming unit

The programming unit test program is started by holding the INT/EXT key depressed when the voltage is applied.

1 Test of display
This routine is started first by the test program. The text "KEYBOARD TEST" and the code "NK" (No Key) appear on the display. If a key is pressed, the code is replaced by the code for the key depressed. If two or more keys are depressed simultaneously, the code "MK" (Multiple Key) appears. See the figure below for a survey of the codes of the different keys.



This test is intended to check that the keyboard is connected correctly and that all keys function.

The code "XX" signifies an incorrect code and is given if the keyboard is connected incorrectly. If a key with a red LED is pressed, the LED will illuminate to demonstrate that it functions.

The ARM/WRIST key is pressed to continue in the test-program.

2 Display test

Each character field consists of 5x8 pixels. Each of the two display lines accommodates 40 characters so that a total of 3200 pixels are to be tested. All pixels are activated twice, as described below, to permit detection of any short circuiting between the pixels.

The display test activates two vertical "lines" of 8 illuminated pixels which traverse the display from left to right.

All of the pixels in the lines are to be activated. Check that no pixel outside the activated line illuminate.

When all of the vertical lines of pixels have been scanned, a horizontal "line" of activated pixels will traverse the display from top to bottom. All pixels in the line are to be activated and none outside the line is to illuminate.

The moving line can be stopped if the PROGRAM START key is depressed during the display test and can be moved progressively, step by step by pressing the PROGRAM START key. The automatic movement of the line continues 3 sec. after the last depression of the PROGRAM START key.

The display test is repeated until the ARM/WRIST key is depressed. Note that the display test is always disconnected after the horizontal "scanning" irrespective of when the ARM/WRIST key is affected.

3 Joystick test

The program continues with a test of the joystick after the ARM/WRIST key is pressed during the display test routine.

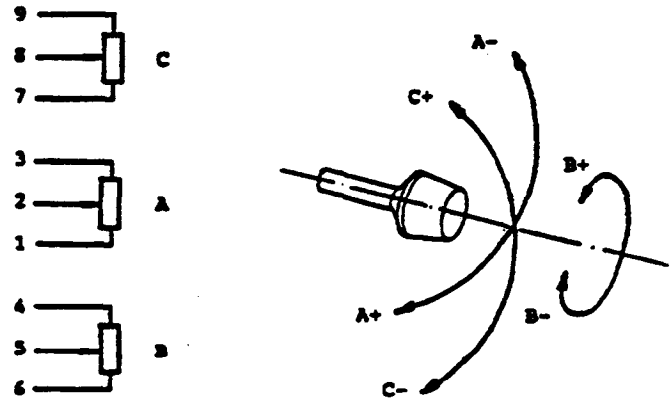
During the joystick test, the characters -A/+A, -B/+B, -C/+C are presented on the upper line of the display, depending on which joystick direction is being tested. An approved interval is also displayed on the lower line of the display. The A deflection (see figure) is tested first. The next direction is stepped forward by pressing the ARM/WRIST key.

When -A/+A is presented, deflection of the joystick in the A-direction will give a reading on the display. The maximum deflection is to remain within the limits on the lower line of the display and is to remain stable. When the joystick is in its neutral position, no reading is to appear on the display. The B and C directions are to be tested in the same way.

The message EN OFF is to appear between the interval limits on the display during the joystick test that EN ON appears instead when the safety pad is depressed.

The programming unit test can be concluded by pressing the red key (only during phase 3, the joystick test) or can be restarted from the beginning by pressing the green key.

Start-up: An internal test of the circuit board in the programming unit is also performed when the voltage is applied. Detection of any fault results in an automatic error message on the display.



Control panel

The lamps in the buttons are tested by pressing the INIT button on the robot computer or by the lamp test function on the remote panel (option).

Monitor

The display screen is tested as described in the next section.

The self-test of the circuit board is started by operating the selector on the monitor board to the TEST position. The red LED on the board flashes to indicate that the self-test is in progress.

Fault indication:
If any malfunction is detected, the red LED on the board flashes.

System mode:
The selector is operated from the TEST position for return to the system mode. Note that when the program has begun execution of a test cycle, the current cycle is concluded, irrespective of the point at which the selector was switched to OFF. Each cycle occupies approximately 30 seconds.

Start-up:
A simpler test is performed automatically at start-up with the same fault indication as previously.

4.4.2
Test mode

Tests of different parts of the control system are performed in the test mode. The test mode tests are administered by the robot computer board. Test mode is activated by holding in the TEST a few seconds at the same time as INIT is given on the robot computer board.When the start-up tests have been performed, the system shows the menu BOARDS, UNITS, INIT on the programming unit.

ROBOT COMPUTER BOARD
If INIT on the programming unit is selected at same time as TEST is pressed on the robot computer, the system will be initialized, continuously. The LED SYSTEM is to flash during the test. The test is concluded by pressing the INIT-button on the robot computer.

BOARDS
The system can test the function and the process wiring of certain boards in the rear plane with the help of extra equipment. The equipment is included in the service Equipment accessories, see IRB 2000 Description CK09-1130E. The boards which can be tested in this way are: digital I/O, analog I/O, combined I/O, drive units and the external axes board.

The test routine for circuit boards in the rack is obtained by selecting BOARDS from the menu of the programming unit.

Test of external axes board:
No jumper is needed for this test.
The test is started by selecting DSQC 233, board 2 on the programming unit. The test then starts automatically and can be interrupted by pressing BREAK after approximately 30 seconds if no malfunction has been detected.

Drive unit test:
With connected manipulator can the motors be moved step by step with one drive unit at the time. The test is started by selecting DSQC 236 on the programming unit. The drive unit required is given under AXIS. Two equal currents are transmitted on two of the phases whereas the third is to be at zero. A new phase combination is obtained with the function NEXT.

The tests can be preformed with the key switch in MANUAL FULL SPEED. Dead man´s handle must be pressed before transition between STEP 0 and STEP 1 and there after be pressed continuously during all phase combinations.
The brake for the present motor must be released with the push button on the manipulator.

Test of digital I/O:
This test is a jumper test in which the inputs and outputs are connected with the help of the diagnostic jumper 3HAB 1005-2. The jumper is connected to the contact in the cabinet wall which corresponds to the place at which the board to be tested is located.

NB 24 V is to be connected to the strap.
The test is started by selecting DSQC 233 on the programming unit after which the board position is specified. The test is then started automatically and can be interrupted with BREAK after approximately 30 seconds if no malfunction has been detected.

Test of analog I/O:
This is also a jumper test. Inputs and outputs are connected with jumper 3HAB 1006-2. The supply voltage is also jumpered to the board here. The test is started by selecting DSQC 209 on the programming unit. The board position at which the jumper and board is located is then specified. The test is then started automatically and can be interrupted with BREAK after approximately 30 seconds if no malfunction has been detected.

Test of combined I/O:
The digital inputs and outputs are connected with the help of a diagnostic jumper , 3HAB 1005-2. The jumper is connected to the contact in the cabinet wall which corresponds to the place at which the board concerned is located. Note that 24V is to be connected to the jumper.

The two analog outputs are tested with the help of the jumper, 3HAB 1007-2. The supply voltage is also jumpered here to the board. The test is started by selecting DSQC 224 on the programming unit and then specifying the board position. The test is then started automatically and can be interrupted with BREAK after approximately 30 seconds if no fault has been detected.

UNITS
Test of the display screen and cleaning of the disk-drive is also performed is the test-mode. To obtain this, UNITS is selected on the programming unit.

Disk-drive:
Select DISK on the programming unit, insert a cleaning diskette and give the command START. The cleaning of the disk-drive takes 12 seconds. READY is then presented on the programming unit. The cleaning can be interrupted with BREAK.

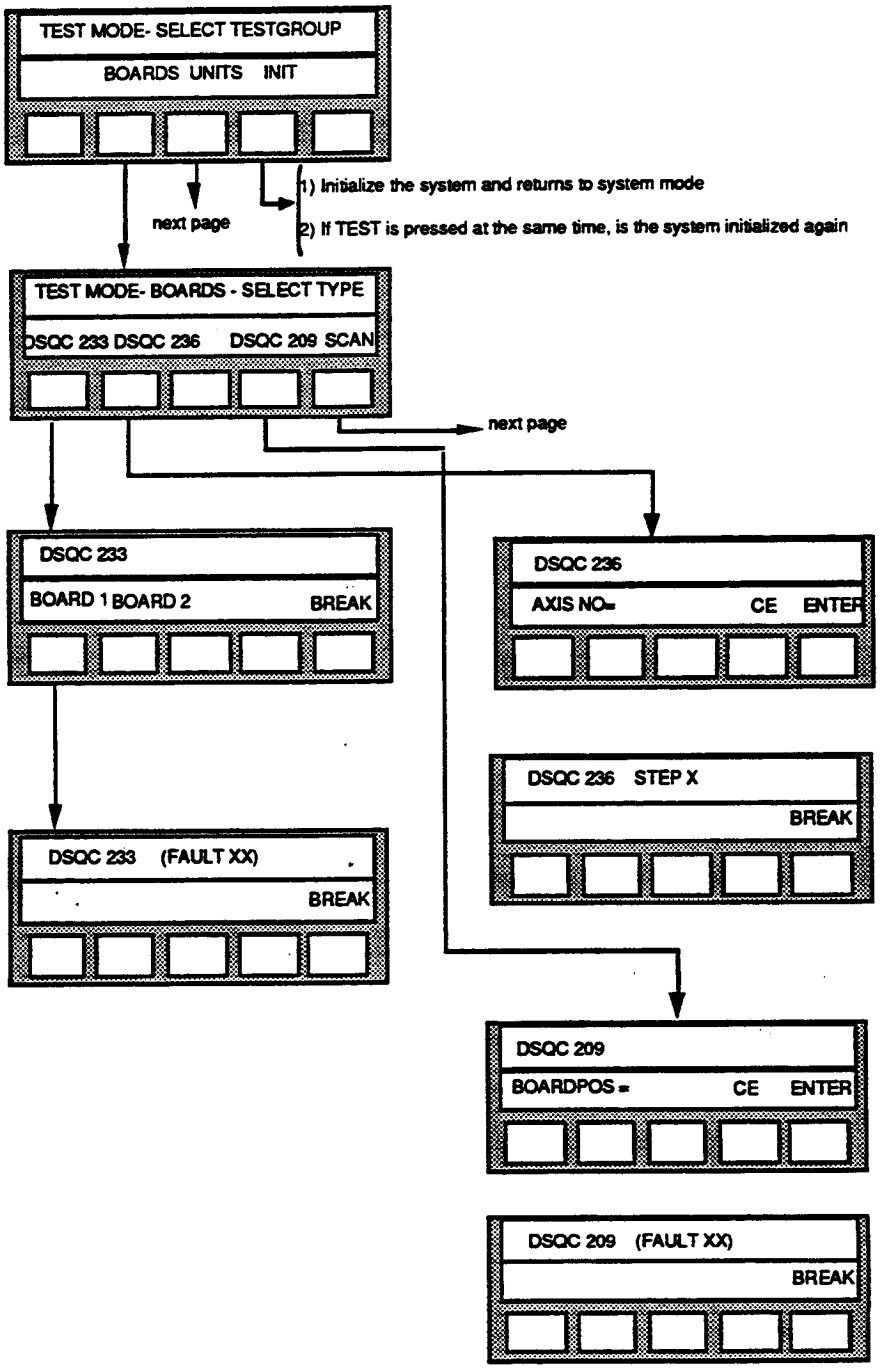
Display screen:
Select MONITOR on the programming unit. A test pattern of rectangles is presented automatically on the screen. The test pattern can be scrolled up or down with the help of the functions UP and DOWN. The function TEXT presents a text string on the display screen. The test can be interrupted with the help of BREAK.

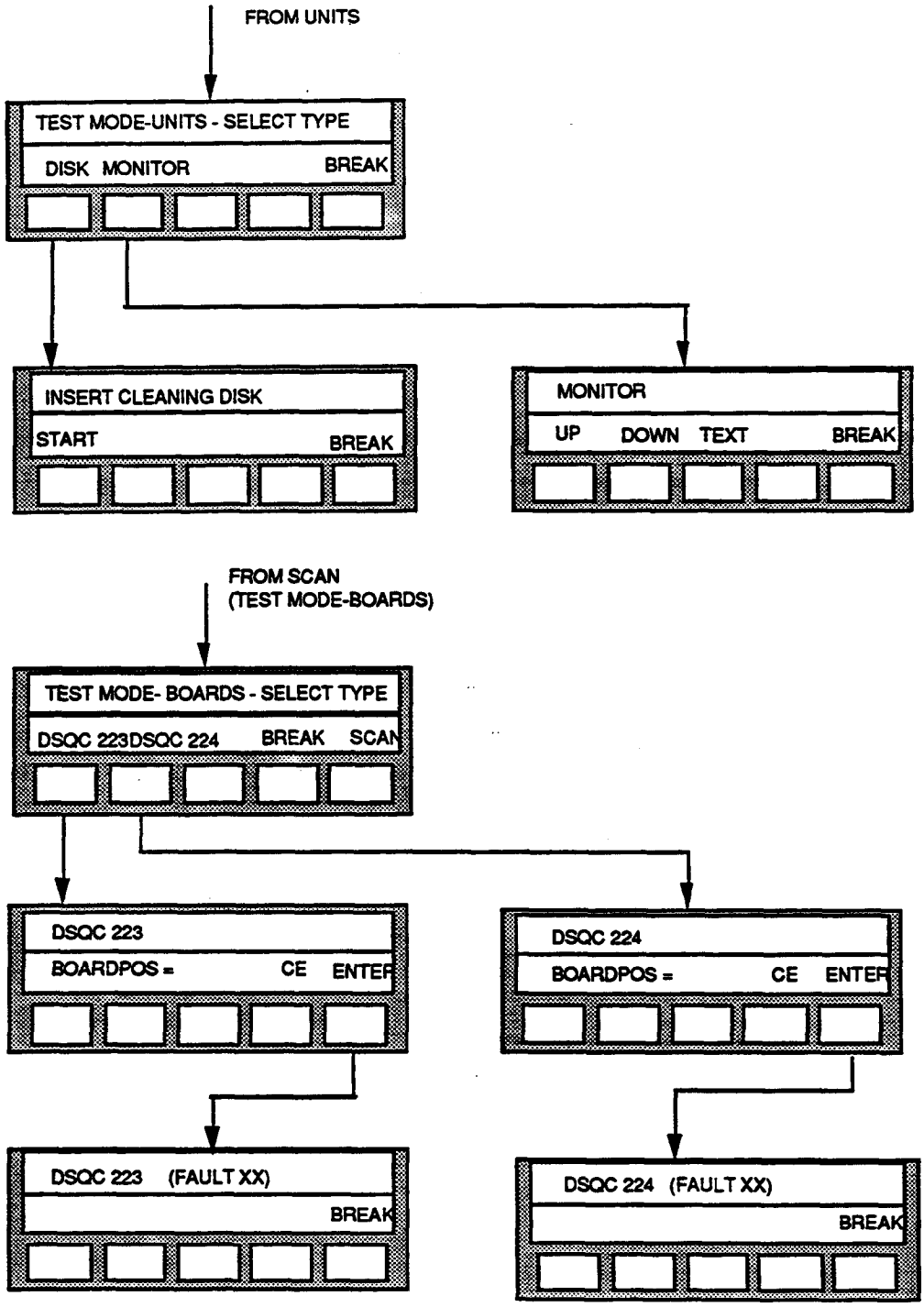
Return to system mode

Select the menu BOARDS UNITS INIT on the programming unit and press the INIT button to leave the test mode or press the INIT button on the robot computer board.

4.4.2.1
Test mode

Menus on the programming unit during Test mode:




FROM UNITS
TEST MODE-UNITS - SELECT TYPE
DISK MONITOR BREAK
INSERT CLEANING DISK
START BREAK
MONITOR
UP DOWN TEXT BREAK
FROM SCAN
(TEST MODE-BOARDS)
TEST MODE- BOARDS - SELECT TYPE
DSQC 223DSQC 224 BREAK SCAN
DSQC 223
BOARDPOS = CE ENTER
DSQC 224
BOARDPOS = CE ENTER
DSQC 223 (FAULT XX)
BREAK
DSQC 224 (FAULT XX)
BREAK

4.5
Fault indication on units

The information provided by LEDs and test points on the different units and the causes of their reactions are described here. Each unit is presented in its own section.

4.5.1
Robot computer DSQC 230

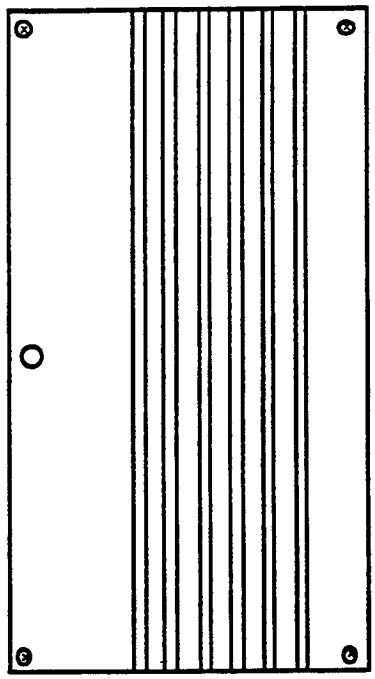
	Description	Remarks
	A: Test terminal	Described in section 4.3.
	C: Green LED, illuminates to indicate that the robot computer has closed the ENABLE-loop.	Internal error, mechanical unit, wiring between mechanical unit and computer, drive unit, rear plane, external axes (see the section relating to the unit concerned).
	D: Red LED, flashes during the self-testing of the system, illuminates steadily with robot computer malfunction	Internal fault (see also chapter Diagnostics)
	E: TEST selector	TEST mode is selected when the buttons TEST and INIT are pressed and released at the same time. INIT ought to be released just before the TEST button.
	F: Initiate selector	System reset is received when INIT is pressed and released.

4.5.2
Axis board DSQC 233

A

Description	Source of fault (with incorrect test value or fault indication)
A:Red LED, illuminates with malfunction	Robot computer board, rear plane Internal fault in the unit
Inputs (SYNC):	Low - 21V to + 2V High + 19V to + 35V

4.5.3
Power supply unit, DSQC 258



Description

There is a red LED on the front that can indicate three different status.

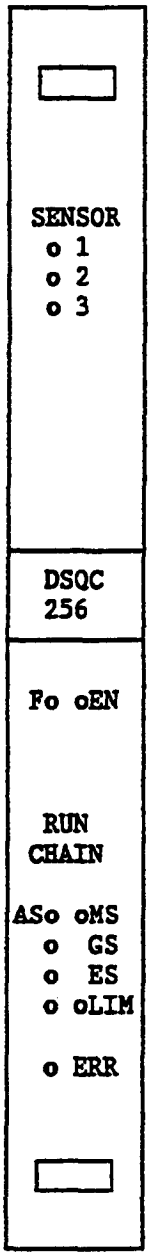
Turned off: All supply are within it´s limits (or no main supply)

Flashing: Short circuit on +24 V.

Illuminated: Short circuit on +5 V, +15 V or -15 V

Source of fault (with incorrect test value or fault indication)

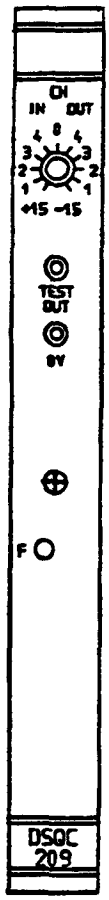
All boards in the rack including rear plane plus control board, drive unit, programming unit or monitor.
Power unit, wiring, internal fault in the unit



Description of LED's	Source of fault (with incorrect test value or fault indication)
SENSOR 1 - 3: Sensor inputs Yellow LED illuminating with an active input signal	External unit, user supply, wiring between board and external unit, internal fault in the unit.
F: Red LED, illuminates at malfunction.	The LED is controlled by the robot computer. Turns off after approved initiation.
EN: Green LED, illuminates when the ENABLE loop is intact.	Power supply unit, robot computer, drive units Bus rear plane.
AS: Yellow LED illuminates when AUTO STOP chain is closed.	Customer unit, wiring, shortcircuit in chain(PTC-fuse in rear plane tripped)
MS: Yellow LED illuminates when enabling device is in centre position and MANUAL STOP chain is closed.	Customer unit, wiring, enabling device on p-unit, shortcircuit in chain (PTC fuse in rear plane tripped.
GS: Yellow LED illuminates when chains up to GENERAL STOP, are closed.	Customer unit, wiring.
ES: Yellow LED illuminates when the chains up to EM STOP are closed.	Emergency stop buttons, customer units, wiring.
LIM: Yellow LED's illuminates when all chains incl. lilit switches are closed. Left LED shows the condition for chain 1 and the right LED is for chain 2.	Limit switches mechanical unit or external axes, wiring, jumpers missing.
ERR: Red LED illuminates if only one run chain is interrupted.	Incorrect adjusted double switch, wiring.

NB! The LED's illuminates only when the enabling device is in it's centre position, at manual running. (Not valid for AS)
It's only run chain 1 that have indication at each switch. Run chain 2 is indicated only with LIM (right) when the whole chain is closed.

4.5.5
Analog I/O board DSQC 209



Description			Source of fault (with incorrect test value or fault indication
A: Test selector			
Position	**Description**	**Setpoint**	
+ 15	+ supply	15 V - 15,8 V	User side supply, internal fault (strap missing) in the unit
IN 1	CH 1 in	input signal	External unit, wiring between unit and cabinet wall, user side supply Internal fault in the unit.
IN 2	CH 2 in	input signal	
IN 3	CH 3 in	input signal	
IN 4	CH 4 in	input signal	
0	0 V	0 V	Internal fault
OUT 4	CH 4 out*	output signal	External equipment, internal falt in the unit User side supply
OUT 3	CH 3 out	output signal	
OUT 2	CH 2 out	output signal	
OUT1	CH 1 out	output signal	
- 15	- supply	-15 V -(-15.8) V	User side supply, internal fault in the unit.

* OUT 4 is a current signal and the output voltage is therefore load dependent. The maximum output current is 20 mA
NB! The test terminals are never to be loaded. They are intended for measurement purposes only.

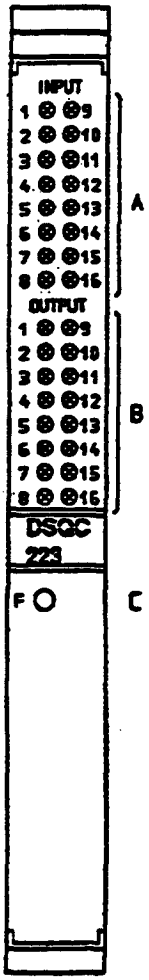
B: Test terminal (signal)

C: Test terminal (0 V)

D: Red LED illuminates with malfunction

Inputs and outputs ± 10 V

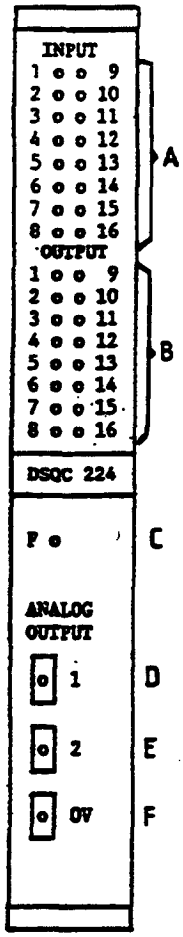
4.5.6
Digital I/O board DSQC 223

	Description	Source of fault (with incorrect test value or fault indication)
	A: 16 yellow LED´s which indicate the status of the inputs. An active LED indicates a high input.	Extern enheter, kablage mellan enhet och skåpvägg, kundsidans matning, internt fel i enheten.
	B: 16 yellow LED´s which indicate the status of the outputs. An active LED indicates a high output.	As A above
	C: Red LED witch indicates with malfunction	Robot computer board Rear plane Internal fault in the unit

Inputs Low: -25 V - 5 V High: 15 V - 35 V

Outputs Low: ≤ 5 V High: ≥ 15 V

4.5.7
Combined I/O board DSQC 224

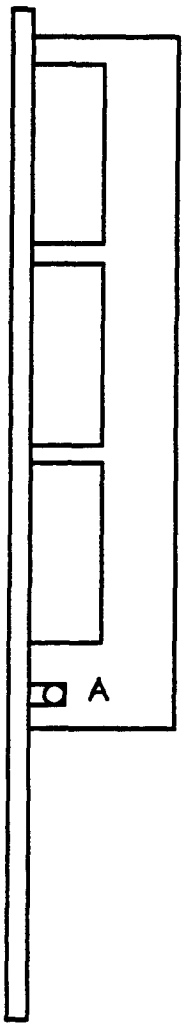


Description	Source of fault (with incorrect test value or fault indication)
A: 16 yellow LED´s which indicate the status of the inputs. An active diode indicates a "high" output.	External units. User´s power supply. Wiring between unit and cabinet Internal fault in the unit
B: 16 yellow LED´s which indicate the status of the outputs. An active diode indicates a "high" output.	As A above
C: Red LED active by malfunction	Robot computer board Rear plane Internal fault in the unit
Inputs Low: -25 V - 5 V	High: 15 V - 35 V
Outputs Low: ≤ 5 V	High: ≥ 15 V
D: Measurement terminal for CH 1 out	External equipment, wiring between unit and cabinet wall. User´s power supply. Internal fault in the unit As D above
Output: 0 - + 10 V	
E: Measurement terminal for CH 2 out	
Output: 0 - +10 V	
F: Measurement terminal 0 V	

NOTE! The test terminals are never to be loaded, they are intended for measurement purposes only.

4.5.8
Drive unit DSQC 236 A / B / C / G / T / P

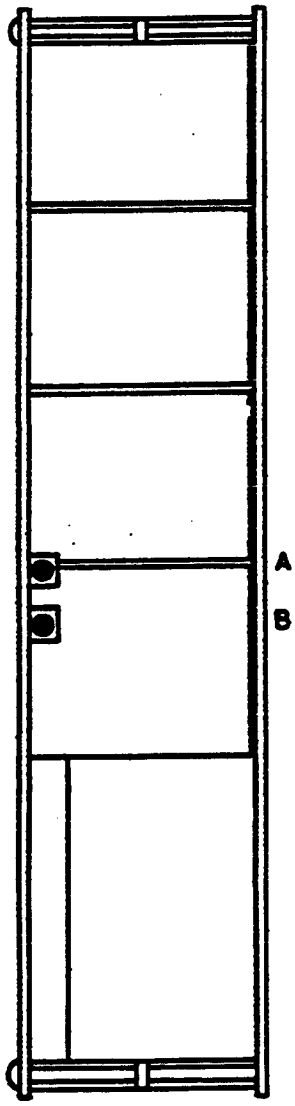
Description	Source of fault (with incorrect test value or fault indication)
A: Red LED illuminates with malfunction	Control fault in one or two phases. Interrupt in the motor circuit No sinus wave distributed references Fault in the control system Over-current caused by a shortcircuit Shortcircuit in motor or wiring Over temperature Damage servo or faulty load cycle



4.5.9
Rear plane and power unit

These units have no fault monitoring or fault indication. Fault on the back plane must be traced from the units connected to the rear plane.

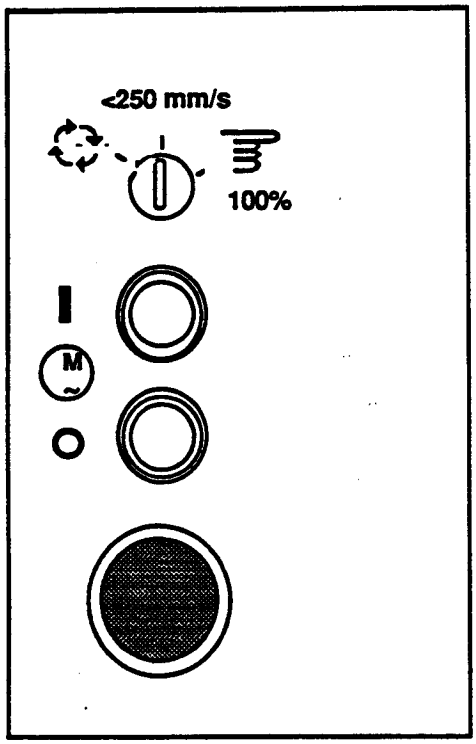
4.5.10
Rectifier DSQC 235 A/B



Description	**Source of fault** (with incorrect test value or fault indication)
D: Red LED, FAULT, illuminates with malfunction	• Over voltage in intermediate link • To powerful feedback from robotmotors so that the shunt regulator can´t keep the intermediate link voltage down • Over temperature rectifier, over temperature shunt regulator, fault in the main power • To high intermediate power, enviroment temperature to high • To high intermediate power-feedback from drive units • Some of the phases are missing or the main power is to low
B: Green LED, OK, illuminates when INIT_N is high and the rectifier is supplied by the main power.	

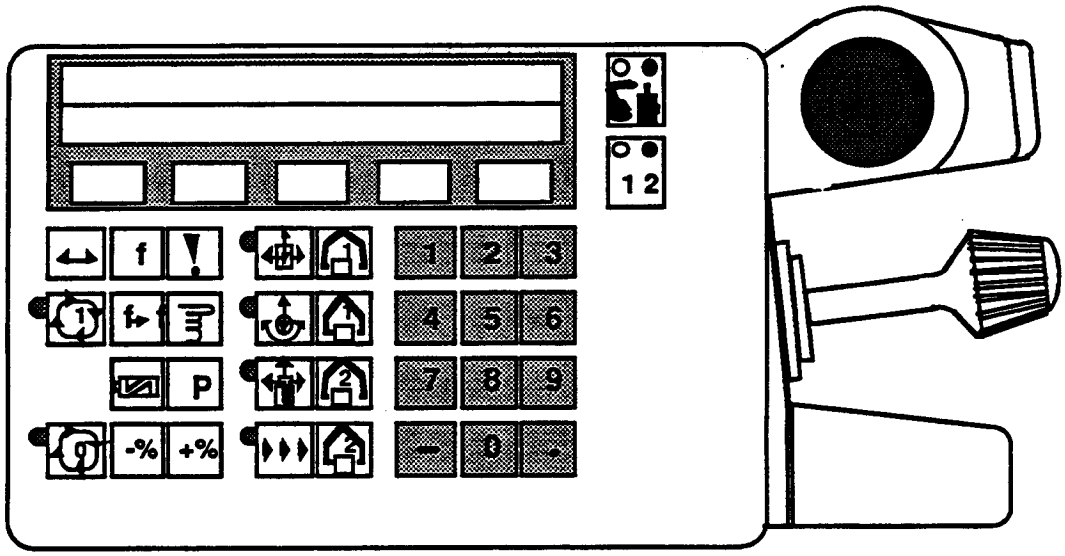
4.5.11
Control panel

Description	**Source of fault** (with incorrect test value or fault indication)
Control panel "dead"	Wiring, system board, lamps
No response to pressing buttons, in general	Wiring, system board, lamps



4.5.12
Programming unit

Description	Source of fault (with incorrect test value or fault indication)
Programming unit "dead"	Power supply unit, control panel, monitor, wiring, Internal fault
No response to pressing buttons or deflection of the joystick	Internal fault, control panel, monitor, wiring, robot computer
Safety pad function faulty	Internal fault, control panel, wiring, sytem board

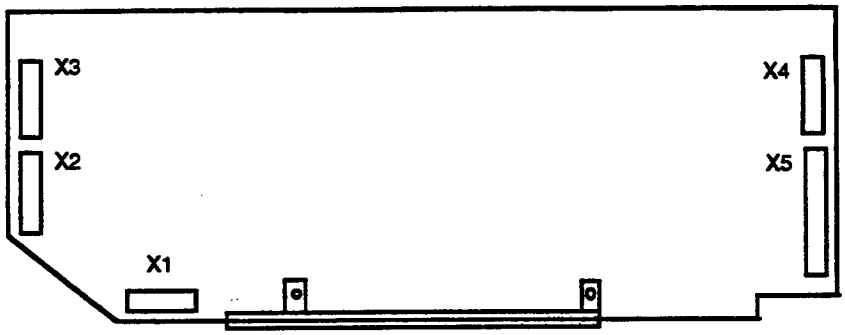


4.5.13 Monitor

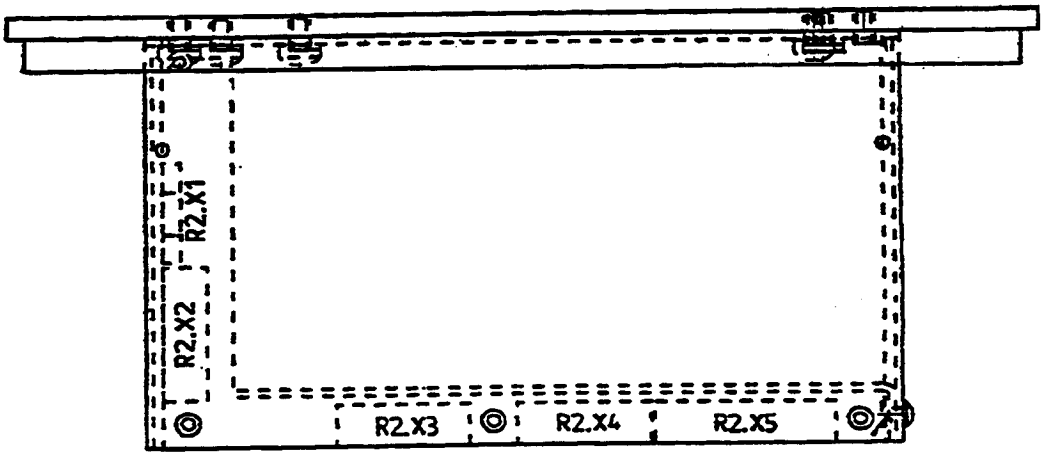
Description	Source of fault (with incorrect test value or fault indication)
Monitor "dead"	Internal fault, control panel Programming unit Wiring, power supply unit, monitor board, robot computer
The red LED on the monitor board illuminates	Internal fault on the monitor board

4.5.14
Serial measurement board DSQC 253 (IRB 2000, 3000, 3200)
(the board is placed in the mechanical unit)

Symptom description	Source of fault (with incorrect test value or fault indication)
The control system indicates that no data is given from the loop, connected DSQC 253 (´s)	Wiring, internal fault in the unit

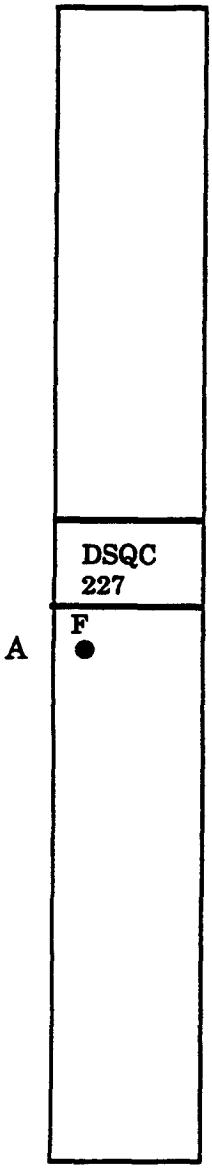


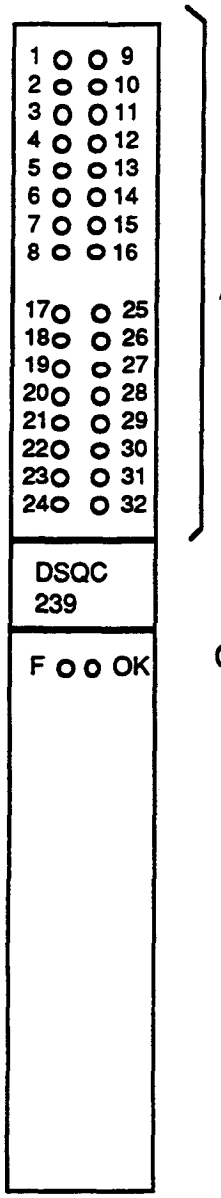
Serial measurement board DSQC 243(IRB 6000)
(the board is placed in the mechanical unit)



4.5.15
Fault indication on unit Winchester interface DSQC 227.

Symptom description	**Source of fault** (with incorrect test value or fault indication)
A: Red LED, illuminates to indicate fault.	Winchester with voltage supply unit, wiring, internal fault in the unit, robot computer board, rear plane.



		Symptom description	Source of fault (with incorrect test value or fault indication)
	A	A: 32 yellow LED´s indicates the syatus for the first 16 in and 16 outputs	Robot computer board, rear plane, internal fault in the unit, cabling
	B	B: Red LED illuminates to indicate fault	
	C	C: Green LED illuminates to indicate that the Node adapter circuit is activated	

Error Code

ERROR LIST

1 General

When an error is detected, the ERROR lamp on the control panel illuminates. If a P-unit is connected to the robot system, an error message is presented at the same time in plain language on the upper line of the display. This applies also when a P- unit is connected after the error has developed and the ERROR lamp has illuminated.

Errors which can occur are divided into:

- Operational errors; the error messages beginning with a number 001-499.
- System errors; the error messages beginning with a number 501-999.

The appropriate corrective actions for the different errors are described below.

OPERATIONAL ERRORS

1 Check the error type on the upper line of the P-unit display.
2 If further information is necessary, go directly to point 6. Otherwise continue with point 3.
3 Press the control button SHIFT - the error message is then cleared.
4 Perform the control operation correctly so that the error status is not repeated.
5 Continue with point 8.
6 Seek the error message displayed in section 3, page 6.
7 Perform the appropriate actions stipulated in section 3, page 6.
8 If the same error message returns or persists, despite the incorrect operation not being repeated, contact service personnel.

SYSTEM FAULTS

1 Seek the error message presented in section 4, page 11.
2 Perform the appropriate corrective actions as described in section 4, page 11.
3 If the same error message persists or returns, call service personnel.

N.B.

Some error messages described in the sections 2 - 4 can occur for certain types of robots only.

2
Error buffer

Means: The system contains an internal error buffer, which can store 9 error messages. In the buffer the system stores:

- All kinds of error messages (both system errors and operator errors), occurred at the latest error occasion.
- Earlier messages about system errors.

The system can, on request, present the contents of the error buffer via:

- The programming unit. (Just error messages from the latest error occasion.)
- A printer, if the optional function Program printout is provided.
- A monitor, if this optional function is provided.

Facts: Display on the programming unit of error messages
The programming unit displays one error message at a time, according to the following:

- When the system stops running due to an error, the operator will see the first error message. An arrow on the display indicates if there are any consequent errors. In this case the operator can display these messages also, one by one.

- During manual operation the operator can, on request, display stored messages from the latest error occasion, one by one. The error messages are chronologically displayed.

- For most error messages, it's possible to get text in plain language by pressing "•" on the programming unit.

Display on the programming unit of error messages
The monitor displays all the messages within the error buffer, according to the following:

- When the system stops running due to an error, the operator will see all messages, occurred during that error occasion. The error messages are chronologically displayed.
- During manual operation the operator can, on request, display all stored messages. The error messages are in plain language and chronologically displayed.

Printout of error messages

- During manual operation the operator can, on request, display stored messages from the latest error occasion, one by one.The error messages are chronologically displayed.

Erasure of the contents in the error buffer and show text in plain language

- During manual operation the operator can, on request, erase all messages stored in the error buffer.

- On request, the operator can get text in plain language for most error messages.

- On request, the operator can load the texts in plain language from disk. (See Installation manual, S3.)

Example of a list of error messages

```
ERROR MESSAGE                CODE
**********************************
506  SERVO ERROR 2           1405->
506  SERVO ERROR 2           1605
536  ENABLE CHAIN FAULT        21

506  SERVO ERROR 2           1805
506  ENABLE CHAIN FAULT        21

504  PROGRAM RUN ERROR          7
```

Used: For fault tracing and for production follow-up.

Executed: The system reacts immediately after the procedure is concluded.

Procedures: Display on the programming unit of error messages (after production stop)
Read the error message. Use the SHIFT button to display more error messages, if required.

If you want to read messages about system errors once again, select ERRORS under the MANUAL menu.

3

Operational errors

The following tables describe the errors which the operator can cause when programming or operating the robot system.

These are numbered from 001-499. The table gives.

- Error message
- Causes
- Recommended corrective action

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
1.NOT ALLOWED COMMAND	The button concerned is temporarily blocked by the system.	Select another button.
1.NOT ALLOWED COMMAND 10	Closed due to that input PROG STOP is active.	Deactivate input PROG STOP.
3.DATA ERROR	Attempted entry of incorrect numerical value.	Depress ERASE and enter new numerical value.
4.INSTR NOT FOUND	After resequencing a program the system has detected jumps to non-existing instructions.	Check the program and correct the faulty jump addresses.
5.PROGRAM MISSING	Attempt to use a program number where instructions are missing with: • programming running • editing of complete program	• Program the instruction under the program number concerned. • Select another program number.
6.MEMORY FILLED UP	Attempt to: • enter further instructions • copy program when the robot memory is full	• 1 Clear the program block. 2 Erase superfluous instructions and programs. 3 Clear program block once again. • If the system includes a floppy disk unit, it is possible to: 1. Divide the existing program and store each section on a floppy disk under a separate program number. 2. Utilize the mass memory function for automatic exchange of the different program parts in the user memory.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
7.PROGRAM END	Attempt to step past the RETURN-instruction	Call the first instruction number in the program concerned.
8.PROGRAM NUMBER OCCUPIED	Attempt to copy a program under a program number where instructions are already stored.	Select another program number for the program copy.
9. INSTRUCTION NUMBER OVERFLOW	A. Attempt to program instruction with higher number than 65530. B. Attempt to resequence a program containing more than 6553 instructions.	A. Divide the existing program into a main program and subprograms. Copy the program and erase superfluos parts. Resequence and insert CALL-instructions. If available memory space is too small, use floppy disc. B. Avoid resequencing, or split the program according to point A above.
10. ADAPTIVITY ERROR 1	A digital multi-bit sensors or analog sensor gives a signal outside its working area.	• Change one of the min. or max. -limits (or both) for the signal from the sensor concerned. • Correct current positions in the program.
10. ADAPTIVITY ERROR 2	A digital 2-bit sensor gives an illegal signal.	Check the sensor.
10. ADAPTIVITY ERROR 3	A 1-bit sensor is used for direction searching or contour following.	• Select another sensor • Replace the sensor
10. ADAPTIVITY ERROR 4	A digital sensor with 2-8 bits is completely connected to the same group of digital inputs.	Change the connection according to the Installation manual.
10. ADAPTIVITY ERROR 6	The correction movement has no direction or speed.	Determine direction and speed for the correction movement: • In a new instruction • By editing an existing instruction.
10. ADAPTIVITY ERROR 7	Sensor data for a sensor used missing.	Enter sensor data according to the Programming manual, chapter 9.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
10. ADAPTIVITY ERROR 8	The signal level programmed for search stop is outside the working range of at least one of the sensor.	Edit the instruction concerned so that the signal level for search stop is within the working range of the sensor.
11. OUTSIDE WORKING AREA 1-12	The robot axis 1 to 12 has been run outside its working area with the joystick.	Run the robot in the opposite direction with the joystick.
11. OUTSIDE WORKING AREA 20	Too large movement with axis 1, 4 or 6 using the joystick.	Switch-off and start-up the robot system again.
11. OUTSIDE WORKING AREA 23	The angle between the lower and upper arms at axis 3 is too small or too large.	Leave this area using the joystick
11. OUTSIDE WORKING AREA 99	The main processor is in a temporary fault condition.	Switch - off and start - up the robot system again.
13 ROBOT NOT SYNCHRONIZED	A Some axis is NOT positioned if it is a robot with absolute measurement system. B Some axis is not synchronized.	A Re-start the system. Remedy possible fault. B Synchronize the system.
14.AUTO MODE/ KEY LOCK	A The key-switch is in position AUTO and/or the key input on the remote control is activated. B Corresponding parameter is ACTIVE under AUTO C.	A Choose position MANUAL REDUCED SPEED or MANUAL FULL SPEED and/or deactivate the key input on the remote control. B Change to MANUAL REDUCED SPEED or MANUAL FULL SPEED mode or deactivate the parameter.
15. SENSOR NOT DEFINED	No sensor defined for sensor number entered.	Press ERASE and enter new sensor number.
16. SENSOR TYPE NOT ALLOWED	Incorrect sensor type for the adaptive function defined for the sensor number entered.	Press ERASE and enter new sensor number.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
17. WRONG INSTRUCTION TYPE	Attempt to change: • Argument • Position • Speed for an instruction which does not contain positioning.	• Change the complete instruction. • Select another instruction number.
18. INSTRUCTION NUMBER OCCUPIED	Attempt to program instruction with occupied instruction number.	• Enter another instruction number. • Renumber the program and then enter an instruction number.
19.PROGRAM START	Attempt to step backwards and pass-by the first instruction in the program.	Erase the message and continue with the next action.
20 SELECT ROBOT COORDINATES	Within this area the robot cannot be run in rectangular coordinates.	Select the robot coordinate system
21. TCP NOT DEFINED	Attempt to program activation of an undefined TCP.	• Program another TCP. • Define the TCP that is to be activated via the instruction and try again.
23. ALIGN ERROR	(MH/ASM and GLUE) Attempt to execute ALIGN with a too large angle deviation between the current tool orientation and the required one.	Turn the tool closer to the required orientation and try again.
24.NOT DEFINED	(MH/ASM and GLUE) Attempt to execute ALIGN-FETCH on an undefined orientation register not containing a tool orientation.	• Select another orientation register. • Define the orientation by means of ALIGN-STORE.
25. INCOMPATIBLE OPTION	The required option can not be activated - because to that: A Another parameter under OPTION is already activated. B Required POTION parameter can not be activated for the current robot type. SWI: System I/O or panel I/O are defined on current board.	.....

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
26 NOT ALLOWED COMMAND/ROOM FIXED TCP 1-8	1 Can not change coordinate-system, when reference point is active.	Deactivate reference point
	2 Can not define a frame or pallet in wrist coordinate-system.	Activate an ordinary TCP(0-19)
	3 The function mirror is interrupted if the position is programmed with fixed TCP. Observe that reflection has been carried out on earlier positions with ordinary TCP.	Use the function MODPOS on required positions.
	4 MODPOS can not be carried out if a fixed TCP TCP is active and the pos-instruction is made with an ordinary TCP and without external axes.	Erase the instruction and program it again, to convert to the wrist coordinate-system.
	5 The instruction is blocked when fixed TCP is active.	Program in some other way.
	6 It is not possible to define a base point with a room fixed TCP.	
	7 Not allowed to define a TCP automatic when a fixed TCP is active.	Activate an ordinary TCP.
	8 After programming an earlier pos-instruction a new TCP has been activated, so that the coordinate-system have been changed. The instructions are not of the same size, so it is not allowed to use SAME.	Program in the ordinary way.
27 NO MORE INFORMATION	Required text in plain language not with the loaded texts	–
27. WARNING: WRONG INSTRUCTION	Active instruction has not been uppdated. ..... Change program number under EDIT or puch CLEAR.	
28 LOAD TEXT FROM DISK	Required text in plain language can not be displayed. The texts have not been loaded from the system disk.	Load the texts Menu: MANUAL + ERRORS
32 CALIBRATION ERROR 2	Fault during defination of EXTFRAME. Pos 1-3 does not describe a circle in space.	Choose 3 new positions and try again

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
32 CALIBRATION ERROR 3	Fault during defination of EXTFRAME. Calulated gear ratio for the ORBIT does not correspond with the ratio entered in the parameter memory.	Check the gear ratio.
33 NOT ALLOWED EXTFRAME 1	When activating an EXTFRAME the system descovered that some "interfering" external axis is in an not allowed position for the specific EXTFRAME.	Align "interfering" external axes
33 NOT ALLOWED EXTFRAME 2	Attempt to activate an undefined EXTFRAME have been made or the robot system is trying to align with an undefined EXTFRAME.	Use only defined EXTFRAME:s
33 NOT ALLOWED EXTFRAME 4	Attempt to activate an EXTFRAME have been made while REFPOINT is active.	Deactivate the REFPOINT or don´t activate the EXTFRAME
33 NOT ALLOWED EXTFRAME 5	Attempt to activate an EXTFRAME without activated ORBIT axis. The axis belongs to an inactive STATION or Attempt to define an EXTFRAME in the rutine for calibration, that can´t be activated because it belongs to an inactive STATION.	Activate the STATION which the axis belongs to.
33 NOT ALLOWED EXTFRAME 7	Attempt to deactivate a STATION while an EXTFRAMEis active, where the EXTFRAME is an axis to the specific STATION.	Deactivate EXTFRAME first
33 NOT ALLOWED EXTFRAME 8	Attempt to align blocked axes to a specific EXTFRAME have been made while these blocked axes belongs to an inactive STATION.	Activate necessary STATIONS to activate blocked axes.

4

System faults

The errors which can occur in the robot system itself are described in the following table. These are numbered from 501 to 999.
The table gives.

- Error message
- Causes
- Recommended corrective measures.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
501 MEMORY FAULT RECORD	A The system has discovered a summary check fault in the system parameter memory. Then the system has made a restart with the parameter basic values from PROM. B The system has discovered that the systemparameters loaded has revision and version number separated from the ones in PROM. Then the system has restarted with the parameter basic values from PROM.	1 Insert the installation diskette, with the right system parameters, into the floppy disk unit. 2 Choose the functionsbutton FR DISK 3 The system starts-up. 4 Press MAN/PARAM/RESOLV and check that the system has the correct RESOLV data. (Choose the function button PROM when restarting the system for the first time. Then define the installation systemparameters including RESOLV data.) **)
502 PROGRAM MEMORY FAULT	When restarting the system has discovered a check summary fault in the robot program memory.*)	Load the program block in question from DISK. **)
503 EMERGENCY STOP	The robot has been stopped in an emergency.	1. Correct the cause of the emergency stop. 2. Press RESET on the control panel so that the emergency stop is cancelled. If the emergency stop cannot be cancelled: • Check the safety board. • Start fault tracing, acc. to Chapter 4 in the Service Manual.

*) Causes to the discovery of check summary fault in system parameter memory or program memory:
•Too low battery voltage.
•Uncorrected or damaged battery.
•Damaged robot computer board.

**) Check the robot computer board incl. the memory battery back-up according to the Service Manual.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
503 WORKING RANGE STOP 2	One axis has been driven against a limit switch.	• Correct the cause of the stop. • Place the key-switch in position TEACH. • Put the system back in operation by pressing the operation button and keeping that way and then depressing the dead man's handle. • Then drive the axis away from the limit switch with the joystick. If the stop can not be restored: • Check on not used safety circuits clamps. • Check the safety board. • Start fault tracing, acc.to Chapter 4 in the Service Manual.
504 PROGRAM RUN ERROR 3	Attempt to start program execution when program is missing.	Enter a robot program from floppy disk or from programming unit.
504 PROGRAM RUN ERROR 4	Attempt to execute a correction vector for another kind of instruction.	Call the correct instruction and try again.
504 PROGRAM RUN ERROR 5	Last instruction was not RETURN nor JUMP in an executed program. Current program has been erased by the instruction ADD BLOCK.	Insert the correct instruction.
504 PROGRAM RUN ERROR 7	A Attempt to execute a movement path outside the robot's working area. B The wrist centre of the robot or the TCP is in 20 mm range of the base Z-axis.	A Edit the movement path. Check the TCP location. B Use robot coordinates or modify the TCP track.
504 PROGRAM RUN ERROR 8	Attempt to call a subprogram or robot program without instructions.	• Edit the program number in the instruction. • Create a subprogram or robot program with this number
504 PROGRAM RUN ERROR 9	(MH/ASM AND GLUE) A Attempt to execute a weave movement with a weave subprogram where the first instruction is not a positioning-instruction.	Edit weaveprogram.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
	B (AW) Attempt to execute a weave movement with either: • No positioning intruction after weave start. • The distance between weave start and next positioning instruction is zero. (AW).	Edit the program.
504 PROGRAM RUN ERROR 10	A Attempt has been done to execute an impermisseble instruction.	A Check the program.
	B (AW) Undefined welddata number.	B •Define present welddata. •Exchange welddata nr.
	C (not AW) Attempt has been made to execute a weave movement when instruction in sub weaving program is faulty.	C Correct the sub weaving program.
504 PROGRAM RUN ERROR 12	Attempt to execute a jump to a non-existent instruction.	• Edit the jump address. • Enter an instruction with this number.
504 PROGRAM RUN ERROR 13	Attempt to execute a pattern subprogram, when the register concerned contains an incorrect value.	Check and change the value in the register concerned.
504 PROGRAM RUN ERROR 14	Attempt to execute a nested call to a 11th subprogram level (or a 12th level of interrupt program).	Edit the robot program.
504 PROGRAM RUN ERROR 15	The main processor is in a temporary fault condition.	Switch-off and start-up the robot system once again. Check electrical disturbance on inputs.
504 PROGRAM RUN ERROR 16	A Main program (program 0) is missing.	A, B Enter a main program.
	B The active program replaced by the corresponding one on floppy disk at program loading with the subfunctional ADDALL under the GET B-function	
	C Another mass memory error	C Try to perform the corresponding GET B-function manually.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
504 PROGRAM RUN ERROR 17	A. A positioning instruction after a circle point contains an illegal argument. B. Attempt to back to the start point after program stop in the middle of a circular arc.	A. Edit the instruction and repeat the attempt. B. Run if possible to the end point of the circle and back from this point instead.
504 PROGRAM RUN ERROR 18	The positions of the circle points are selected incorrectly so that either: • The radius becomes too large. • Two or several points in the circular arc coincide.	• Remove the circle point and run in straight lines instead. • Change the position of the points concerned so that a circular arc is obtained.
504 PROGRAM RUN ERROR 19	The circular interpolation has been interrupted so that it cannot continue.	1. Erase the error message with the SHIFT key. 2. Check that there is no obstacle in the direct path of the robot forward to the next point. 3. Run instruction by instruction to the next point.
504 PROGRAM RUN ERROR 20 (only for arc welding robot)	The acknowledgment of transferred data is omitted when executing the arc welding instruction EXTPOS.	Check the peripheral equipment concerned.
504 PROGRAM RUN ERROR 24 (only for arc welding robot)	A SET, RESET, INVERT or PULSE instruction for a digital output cannot be performed because the output concerned is used for communication with arc welding equipment.	A Use another digital output.
	B An incorrect attempt has been made to affect a digital output used for activation/deactivation of a station.	B When activating/deactivating a station, only SET and RESET of a digital output are used.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
504 PROGRAM RUN ERROR 26	A A robot axis with a working area>360° has ended up in a so called ambiguous point, which means that the succeeding programmed running to the programmed position can be executed in two ways by the robot axis. The resulting positions differs from the programmed one.	• Edit the program in such a way that the movement of the axis can be executed in one way only. • Check that this will not cause any problems later. Remove the check. See programming manual Section 8.5, MODIFY/HANDCHK.
	B The wrist axes are rotated more than a specified limit value (axis 4, 45°, axis 6, 90°).	• Edit the program in such a way this movement will not occur. • Check that this will not cause any problems later. Remove the check. See Programming manual Section 8.5, MODIFY/HANDCHK.
	C The time, programmed for the time positioning, is to short.	C Increase the programmed time.
	D Program running in rectangular coordinates is not possible.	D Change to program running in robot or modrect coordinates, or move the motion a little away from the singular point.
	E Weaving: the crosstime is to short compared to the amplitude.	E Increase crosstime or decrease amplitude.
504 PROGRAM RUN ERROR 27	The value in a number register is not valid.	Check the program and edit the register handling.
504 PROGRAM RUN ERROR 50	Automatic definition of a program displacement is in progress. During the process, at least two positions approach each other too closely: • When the positions are selected. • In the resulting program displacement.	Select three new positions and try again.
504 PROGRAM RUN ERROR 51	Attempt to activate an undefined TCP	• Activate another TCP. • Define required TCP and try again.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
504 PROGRAM RUN ERROR 53	(MH/ASM and GLUE) Attempt to use: A An undefined gripper. B An output which is reserved for a gripper.	A Change the number of grippers in the function parameters. B Use another gripper/output.
504 PROGRAM RUN ERROR 54	(MH/ASM and GLUE) Attempt to execute a PALLET-instruction with an undefined pallet.	A Define the pallet. B Use an already defined pallet.
504 PROGRAM RUN ERROR 55	(MH/ASM and GLUE) Attempt to execute a PALLET-instruction with the register values pointing out a position outside the pallet.	Change the register values.
504 PROGRAM RUN ERROR 57	(MH/ASM and GLUE) Attempt to execute a TOOLREL-instruction with displacements/rotations outside permitted limits.	Change the register values.
504 PROGRAM RUN ERROR 58	Attempt to execute a gluing instruction with the parameter GLUE not activated.	Activate the GLUE function parameter GLUE under OPTION - provided that the robot system is a gluing system.
504 PROGRAM RUN ERROR 62	(AW) Weaving data not defined for the current weaving data field.	• Select another weaving data field. • Define weaving data.
504 PROGRAM RUN ERROR 63	(AW) CROSSTIM is 0.	Define CROSSTIM.
504 PROGRAM RUN ERROR 64	(AW) BASEPoint not defined.	Define BASEPoint and try again.
504 PROGRAM RUN ERROR 65	(AW) Sensor data undefined for current sensor data field	• Select another sensor data field. • Define sensor data.
504 PROGRAM RUN ERROR 66	(AW) Internal error in calculation of end position for AUTOSEARCH.	Edit the start position for AUTOSEARCH and try again. If the error persists after several trials, check the computer board.
504 PROGRAM RUN ERROR 67	(AW) The robot velocity is to high at connection or disconnection of SPS.	Edit the program. Reduce the zero zone or the velocity.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
504 PROGRAM RUN ERROR 68	No position stored in the current position register.	• Select another position register. • Store a position.
504 PROGRAM RUN ERROR 69	Internal system fault.	Switch off and start-up the system once again.
504 PROGRAM RUN ERROR 70	The soft-servo number or softness vector is undefined.	Active another set of softness, or define the relevant softness set under the manual menu.
504 PROGRAM RUN ERROR 71	The wrist centre point or the TCP has entered within 20 mm of the base Z-axis. This is not allowed in rect. or modrect. coordinates.	Use robot coordinates or modify the robot pass.
504 PROGRAM RUN ERROR 72	Incorrect TCP may be active.	Check that the correct TCP is active at the programmingunit. Continue program execution by pressing instruction start or program start once more.
504 PROGRAM RUN ERROR 73	The weaving amplitude cannot be reached because the TCP is too close to the x-axis (weaving axis) of the wrist.	• Change TCP • Reduce the amplitude.
504 PROGRAM RUN ERROR 74	The robot moved when the activation/deactivation of a station was requested.	Stop the robot and repeat the attempt.
504 PROGRAM RUN ERROR 75	Timeout in supervision of a spot weld. WELD READY not received within 5 s after START 1/2.	Check welding controller.
504 PROGRAM RUN ERROR 76	Output used in SWI function not defined.	Define the function parameter for GRIPPER 3.
504 PROGRAM RUN ERROR 77	Execution of an SWI function without activated SWI parameter.	Define the SWI parameter or change the instruction.
504 PROGRAM RUN ERROR 78	The program number in the instruction is not permitted.	Change the program number in the instruction.
504 PROGRAM RUN ERROR 80	Attempt to reach a posi tion with a wrong TCP active have been made. Pos-instructions and stored positions can not be used between fixed TCP and ordinary TCP.	Check the program and active TCP.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
504 PROGRAM RUN ERROR 81	Attempt to switch coordinate-system with a TCP-instruction have been made, when the reference point is active.	The reference point has to be deactivated before change of coordinate-system is possible.
504 PROGRAM RUN ERROR 82	Attempt to execute an instruction have been made,who don't function together with a fixed TCP.	The instruction in question can only be executed with a ordinary TCP active.
504 PROGRAM RUN ERROR 84	Attempt to activate an undefined LOAD.	Activate another LOAD. Define required LOAD and try again.
504 PROGRAM RUN ERROR 85	Incorrect LOAD may be activated.	Check on the prog.unit, that the correct LOAD is active. Continue program execution by pressing instruction start or program start once more.
504 PROGRAM RUN ERROR 86	Robot coordinates are not allowed during arc welding.	Change coordinate system
504 PROGRAM RUN ERROR 87	Max. allowed velocity for an external axis limits the velocity of the robot during the arc weld process.	Reprogram so that no external axes limits the velocity of the robot.
504 PROGRAM RUN ERROR 88	The instruction can not be restarted.	Make a usual restart or move the robot.
504 WRONGLY PLACED I/O BOARD	No digital I/O-board defined in place stated by the parameter BOARD POSITION.	Check the function parameters for the I/O and SWI.
505 SERVO ERROR 1	The servo computer does not accept an order from the main computer, because of a serious system fault.	Check the computer board.
505 SERVO ERROR 8001	The axes computer has not accepted an order from the main computer, due to a serious error in the main computer.	Re-initiate the system. If the fault persists,replace the main processor board.
506 SERVO ERROR 2 1101-1124	Resolver fault, channel x. Fine resolver, axis 1(1101)- 12(1112) Coarse resolver, axes 7(1119)- 12(1124)	A Check for any fault by measuring resistance in wiring and resolver. (resolver~20ohm) B Replace the serial measurement board or the axis board.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
506 SERVO ERROR 2 1201-1224	Resolver error, channel y. Fine resolver, axis 1(1201)- 12(1212) Coarse resolver, axis 7(1219)- 12(1224)	See error type 1101 - 1124
506 SERVO ERROR 2 1301 - 1312	Speed error. The motor for axis 1 (1301)-12 (1312) runs considerably faster than is commanded from the control system. Cause, internal axes: A Considerable interference between the axes at high speeds results in incorrect speed at certain points in the user´s program. B Incorrectly commutated motor C Axis stops (the motor receives no current) D Incorrect acceleration of the motor. Cause, external axes: E See point A above. F Incorrect acceleration of the motor.	A Lower the programmed speed locally in the program where the error occurs and/or change the positioning pattern so that the axis which trips because of the incorrect speed is not so active in this part of the program. B Check that the correct commutator offset is entered for the axis. If the axis has been repaired, remeasured and enter a new offset C 1. Check all fuses. 2. Check the motor current using the test outlets. Check the wiring, the drive unit and the robot computer board. D Replace the robot computer or drive unit. F 1. Check external controller, drive stage and external wiring. 2. Replace robot computer or external axis board.
506 SERVO ERROR 2 1401-1412	Jam error, internal axes The motor for axis 1 (1401) - 7(1407) remains stationary despite the robot computer commanding current to the motor. Cause. A. The robot has run against an obstacle. B. Overload. C. The motor receives current but is incorrectly commutated. D. The motor does not receive current. E. Resolver fault. F. Motor fault. G. Mechanical fault.	A 1. Select operation mode RUN and run away from the obstacle. 2. Remove the obstacle or edit the program. B. Check that the load and its lever arm do not exceed the specified maximum limits. C. Check that the correct commutator offset is entered for the axis. If the axis has been repaired measure and enter the correct offset. D 1. Check all fuses. 2. Check the wiring, the drive unit and the robot computer board. E. Turn the axis with the system in the STAND BY mode and check if resolver fault is indicated. F. Measure motor data. G. Check, with the system in the STANDBY mode that axis movement is free in its complete working range.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
	Jam error, external axes.	A 1. Select operation mode RUN and run the axes away from the obstacle. 2. Remove the obstacle or edit the program.
	The motor for external axis 7 (1407) - 12 (1412) runs slower than 2 % despite the robot computer commanding a higher speed. Cause: A The axis has run against an obstacle. B The axis receives no torque. C Axis not correctly adjusted.	B 1. Check that any brake is released. 2. Check that a speed reference is received from the axis board. If unrepairable, replace the axis board. 3. Check the external controller, driver, wiring and motor. C. Increase the KP-value for the axis. The KP-values are defined in the system parameters.
506 SERVO ERROR 2 1500	Resolver fault, supply	1. Check for any fault by measuring resistance in wiring and resolver. (resolver~20ohm) 2. Replace the serial measurement board or the axis board.
506 SERVO ERROR 2 1601-1612	Too high speed in TEST-position for axis 1 (1601) - axis 12 (1612). The speed protection is tripped when the programming unit is connected and out and the key switch not in position 100 %. Cause: A Chain fault related to an emergency stop. B External interference on the robot or the external axes. C Low motor torque. D Incorrectly adjusted external axes 7-12.	A Correct the primary fault. B Reduce the effect of external forces C See "506, SERVO ERROR 2 1401-1407", item C and D. D Check that the adjustment of the external axes does not cause any heavy speed overshoots.
506 SERVO ERROR 2 1701-1707 (Concerns only robots with tachometer).	Resolver/tacho signal differs for axis 1 (1701) - axis 7 (1707). Cause: Tachometer signal indicates another speed than that calculated from the resolver signal.	1. If new tachometer has been installed, check that positive voltage is obtained if the axis is turned in a positive direction. 2. Check that the voltage reaches the axis board. 3. Replace the axis board.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
506 SERVO ERROR 2 1801-1812	Position error with brake activated for axis 1(1801) - 12(1812). One of axes 1-12 moved though the system has ordered the brakes to be applied. Cause: A Manual release of the brakes and movement of the axis. B Abrupt braking, with the brake, from high speed, by the Dead Man's Handle or a switch-over to STANDBY C Poor brake.	A,B Check that all axes are in safe positions for program start or synchronizing. If not, run the robot to a safe position using the programming unit. C Change the brake.
506 SERVO ERROR 2 2001-2024	Resolver error channel x or y axes 1(2001)- 12(2012) Coarse resolver, axes 7(2013)- 12(2024)	A Check for fault by measuring resistance in wiring and resolver (resolver~20 ohm) B Replace the serial measurement board or the axis board.
506 SERVO ERROR 2 2101-2107	Racing protection at start-up. The racing protection for axis 1(2101)- axis 7(2107) has tripped as the axis has not remained stationary when the RUN status was activated the first time after initialization. Cause: A Incorrect commutation offset B Faulting tachometer (B concerns only robots with tachometer). C Faulty resolver D Low motor torque	A 1. Check that the correct commutator offset is entered. 2. If the commutation has been changed because of repairs, make new measurements. See Installation manual. B 1. If the tachometer is newly installed, check that positive voltage is obtained when the axis is turned in a positive direction. 2. Check that the voltage is received at the axis board. C If the resolver is newly installed, check turning the axis very slowly in a positive direction and reading with the help of the programming unit that the resolver value increases (when reaching 8191, the value restarts from 0). D 1. Check the drive unit. 2. Check the resistances of the motor windings.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
	Servo lag error for axes 1 (2101) - 12 (2112) when running in the TEST mode. Cause: Major positioning error because the axis has not rotated in accordance with the received position references.	(See "error code 1401-1421") (See "error code 1301-1312")
506 SERVO ERROR 2201-2224	Resolver error, channels x and y. Fine resolver axes 1(2201) - 12(2212) Coarse resolver, axes 7(2213) - 12(2224)	A Check for fault by measuring the resistance of the wiring and the resolver (resolver–20 ohm). B Replace the serial or the serial measurement board or the axis board.
506 SERVO ERROR 2 23XX	Error in the revolution counter of axis XX. Axes 1-6 are supervised by measurement board 1 and axis 7 by board 2. All revolution counters on the measurement boards are uncalibrated.	Check the measurement system, especially all resolver and measurement board connections. Recalibrate the robot revolution counter. *Check the robot calibration position. If the problem persists, replace the serialmeasurement board*
506 SERVO ERROR 2 240X	To high speed on axis X.	Reduce the speed.
506 SERVO ERROR 2 5104	Incorrect input data. Cause: Parameters entered are outside specified limits.	Check that all parameters entered are within the limits specified.
506 SERVO ERROR 2 5105-5111 5120-5123 5130-5136	• External electrical equipment has jammed the robot computer. • Erroneous computer board.	Re-initiate the system and start-up again. If the error persists, replace the computer board.
506 SERVO ERROR 2 5137-5138	A External electrical equipment has jammed the robot computer or serial measurement board. B Faulty computer board or serial measurement board. C Faulty wiring between the robot computer board and the serial measurement board.	Re-initiate the system and start-up again. If the error persists, check the wiring or replace the computer board and/or the serial measurement board.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
506 SERVO ERROR 2 5150	Voltage fall from rectifier	A Check fuses B Check that voltage to rectifier
506 SERVO ERROR 2 7001	The maximum permissible waiting time for answer to the main computer from the axis computer has expired, depending on: • An earlier error has caused the servo computer to halt. • Fault in the robot computer.	Find and correct the earlier error then re-initialize the system. If the error persists, change the robot computer board.
506 SERVO ERROR 2 7002	Non-valid channel index. Communication fault between the diagnostic software and the main computer, caused by a fault in the control program.	Exchange the control program.
506 SERVO ERROR 2 7004	Erroneous sync position. The sync position of the robot is not correct, because there are no values for the sync position in the robot control program.	Exchange the control program.
506 SERVO ERROR 2 7005	Fault in internal calculation routine in the control program.	Exchange the control program.
506 SERVO ERROR 2 7006	Execution of a program module in the main computer starts, before a valid acknowledge signal has occurred.	Check the computer board. If no error is found, change the control program.
506 SERVO ERROR 2 7007	STALL ALARM. The main computer has detected that messages from the axis computer are not transmitted fast enough.	Check the computer board. If no error is found, perform a common error tracing, according to Chapter 4 in the Service Manual.
506 SERVO ERROR 2 7008	The servo computer has detected an undefined error in: • It's own program. • The main computer program.	Check the computer board.
506 SERVO ERROR 2 7009	Maximal waiting time for answer to the main computer from the servo computer, for respond on a movement segment, has been exceeded.	Re-initialize the system.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
506 SERVO ERROR 2 7010	The servo computer has given an unallowable error code to the main computer.	Re-initialize the system.
506 SERVO ERROR 2 8001	The servo computer has not approved an order from the main computer due to a serious error in the main computer.	Re-initiate the system. If the fault remains, replace the control program.
506 SERVO ERROR 2 9000	Transmission fault between the serial measurement board and the robot computer board. Causes: A External disturbances B Wiring fault C Electronic fault	A Check the installation B Check and measure the wiring C Change the serial measurement board or the robot computer board.
507 JOYSTICK ERROR	1 Indicates a fault in the joystick function. 2 Erroneous coordinate system button.	If the fault persists, check the joystick according to the Service Manual.
508 DISK MEMORY FAULT 1	Error in the floppy disk memory.	• Repeat attempt • Change disk
508 DISK MEMORY FAULT 2	Data stored has disappeared.	• Repeat attempt • Change disk
508 DISK MEMORY FAULT 3	Data stored incorrect	• Repeat attempt • Change disk
508 DISK MEMORY FAULT 4	A. Floppy disk faulty B. Floppy disk not formatted.	A. Repeat attempt B. Change disk
508 DISK MEMORY FAULT 6	Floppy disk with storage protection.	• Remove storage protection • Change disk
508 DISK MEMORY FAULT 7	Floppy disk unit not ready.	Insert disk correctly • Close hatch • Change disk
508 DISK MEMORY FAULT 8	Erroneous data at attempt of storing data on floppy disk.	• Try again • Change disk
508 DISK MEMORY FAULT 10	Internal Winchester fault	Re-initiate the system

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
508 ERROR IN TEXT PROGRAM 18	Not possible to load the block into the reserved memory area. The block contains other instructions than comment instructions or is corrupt.	Load the block into the user memory and check the contents. Edit the block or select a block from the system disk and try again.
508 TEXT PROGRAM TOO BIG 18	Not possible to load the block into the reserved memory area. More than 25% of the block is used.	Load the block into the user memory and check the contents. Edit the block or select a block from the system disk and try again.
508 DISK MEMORY FAULT 20	Attempted loading of function parameters from wrong disk.	• Change disk
508 DISK MEMORY FAULT 21	Attempt to program storage when the whole floppy disk is occupied.	• Change disk
508 DISK MEMORY FAULT 22	Attempt to load program from an empty floppy disk.	• Replace disk
508 DISK MEMORY FAULT 24	Attempt to load a program block not available on the floppy disk.	• Select another program block number. • Change disk.
508 DISK MEMORY FAULT 25	Attempt to add a program block that is larger than the user memory.	1. Erase all programs in the user memory (program numbers 0- 9999). 2. Load required program block, with the function ADDALL under the MANUAL menu. If this does not work, split the program block into two parts at the robot, where the block was originally programmed.
508 DISK MEMORY FAULT 26	An attempt has been made to add a program block as the space available in the user memory is insufficient.	1. Erase any superfluous programs in the user memory. 2. Store the remaining part of the program block as block X. 3. Load the program block containing the required program. 4. Erase all unwanted programs. 5. Add block X with the function ADDALL. If this is not successful, use the instruction GET B in the program for alternate running of program blocks X and N.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
508 DISK MEMORY FAULT 27	Error in the stored program block.	• Select another block number. • Change disk.
508 DISK MEMORY FAULT 28	Fault when formatting floppy disk.	• Change disk • Try again
508 DISK MEMORY FAULT 29	Attempt to load a non-existing subprogram from floppy disk.	• Select another block number. • Select another program number.
508 DISK MEMORY FAULT 30	Floppy disk function is faulty.	Re-initiate the system.
508 DISK MEMORY FAULT 31 (for arc welding robots only)	Weld data missing for the program block concerned.	• Select another block number • Change disc.
508 DISK MEMORY FAULT 32 (for arc welding robots only)	Incorrect version of weld data.	Select disc with right weld data version.
509 SYNC ERROR	Error when the robot system is to be synchronized.	• Press twice on SYNC on the control panel. • If repeated attempts are not successful, perform a common error tracing, according to Chapter 4 in the Service Manual.
509 SYNCHRONIZATION ERROR 10XX	Robot axis XX is outside its outside the working range Error has occurred in the control system, axis XX.	Move the axis manuell or with the joystick after pressing RESYNK (AUTO+SCAN+SCAN) into the work. range. Switch power off and the on. If the problem persists, it might be caused by DSQC 234, see the Service Manual. *Check the robot calibration position before returning the robot to production!*
509 SYNCHRONIZATION ERROR 11XX	Working range defined for external axis no. XX is too great with the gear ratio in use.	Redefine the working range under PARAM or check that the correct resolver configuration has been selected.
509 SYNCHRONIZATION ERROR 14XX	Resolver on axis no. XX not calibrated.	
509 SYNCHRONIZATION ERROR 15XX	Resolver error. Axis no. XX has obtained an impermissible resolver value with absolute measurement.	Check the measurement system.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
509 SYNCHRONIZATION ERROR 16	System fault in absolute measurement system.	See instructions in Service Manual for checking the robot system.
509 SYNCHRONIZATION ERROR 17	The robot is too far away to restart. The robot program running can not be restarted directly.	Start-up the system the conventional way. *Check the robot calibration position before returning the robot to production!*
509 SYNCHRONIZATION ERROR 20xx (concerns only robots in the 8000-serie).	Robot axis xx is outside the working area.	Manoeuvre the axis into the workingarea and switch off the system. Try once more.
509 SYNCHRONIZATION ERROR 21XX	The revolution counter for axis XX not calibrated.	Check measurements system, battery. Battery voltage should exceed 7.0V.
509 SYNCHRONIZATION ERROR 22XX	Error on the revolution counter on axis XX. The revolution counter has lost.	Check the measurement system. The robot remains unsynchronized. Operation mode is blocked until the error is remedied.
509 SYNCHRONIZATION ERROR 23XX	Error on the revolution counter on axis XX. The expected revolution counter value does NOT correspond to that of the serialmeasurementboard revolution . counter.	Check the measurement system, especially all resolver and measurement board connections. Recalibrate the robot revolution counter. *Check the robot calibration position. If the problem persists, replace the serialmeasurement board.*
510 SYSTEM FAULT 3	Internal fault in the control program module in programmed robot running.	Switch-off and start-up the robot system once again. If the fault persists exchange the control program.
510 SYSTEM FAULT 4	A. The internal restart was interrupted undefined. B. Power failure in an instruction that can't be restarted.	A,B Switch off the system and start in the conventional way.
510 SYSTEM FAULT 5	Restart data in memory is wrong.	Switch off the system and start in the conventional way.
510 SYSTEM FAULT 6	An error has occurred in the error buffer. All old messages have been erased.	

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
513 WRONGLY PLACED I/O BOARD X (X=subcode which defines the board position concerned)	A Board missing on position X. B The board on position X does not correspond to the board-type specified in the system parameters (specified manually for subcode 1-6). C The board on position X erroneous. The board positions in question are coded for the board type, that is specified in the system parameters (manual specifications for the 6 I/O positions). The board positions are coded in accordance with the following: **Subcode — Type acc to param** 0 — Safety board 1 — I/O board, position 1 2 — I/O board, position 2 3 — I/O board, position 3 4 — I/O board, position 4 5 — I/O board, position 5 6 — I/O board, position 6	A Place a board on position X (or change the system parameter for subcode 1-6). B Place the correct type of board (or change the system parameter for subcode 1-6). C Check the board.
514 COMMUNICATION ERROR 1 (apply only to robots equipped with computer link)	Insufficient space in the robot buffer memory for data from superior computer.	Restart the robot system.
514 COMMUNICATION ERROR 2 (apply only to robots equipped with computer link)	Data fault in message received from superior computer.	Check superior computer.
514 COMMUNICATION ERROR 3 (apply only to robots equipped with computer link)	Transmission error on the data link.	Repeat the attempt.
514 COMMUNICATION ERROR 4 (apply only to robots equipped with computer link)	Insufficient space in the robot memory when attempting to load a program from a superior computer	Erase any superfluous program in the robot memory.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE MEASURES
514 COMMUNICATION ERROR 5 (apply only to robots equipped with computer link)	Program with program number selected not in the robot memory.	Select a program with another program number.
514 COMMUNICATION ERROR 6 (apply only to robots equipped with computer link)	Maximum waiting time before acknowledgment from superior computer exceeded.	Check superior computer.
514 COMMUNICATION ERROR 8 (For robots with computer link only)	Computer link not implemented.	Check that function parameter C LINK is set (See Inst. manual).
514 COMMUNICATION ERROR 9 (For robots with computer link only)	Fault in vision system.	Restart the vision system. If the fault persists, check the connection or contact service personnel.
514 COMMUNICATION ERROR 10 (For robots with computer link only)	Vision timeout.	Restart the vision system. If the error persists, check the connection or contact service personnel.
514 COMMUNICATION ERROR 11 (For robots with computer link only)	Incorrect robot mode.	Set robot in STANDBY MODE.
514 COMMUNICATION ERROR 12 (For robots with computer link only)	Insufficient space in robot memory when an attempt is made to load configuration data.	Check that the block to be loaded is intended for the robot in question.
514 COMMUNICATION ERROR 13 (For robots with computer link only)	Incorrect check sum in configuration data loaded. Robot system initialized with configuration data from PROM.	Make another attempt to load the configuration data.
514 COMMUNICATION ERROR 14 (For robots with computer link only)	Incorrect weld data version.	Configurate to right weld data version on superior computer.
515 TIMEOUT ERROR (only arc welding robots)	When programming the arc-welding instruction EXTPOS, the response from the external equipment is not received before the maximum permissible waiting time has been exceeded.	Check the external equipment.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
516 OVERRIDE ERROR 1 (only arc welding robots)	Override has been defined as: A. Welding is not performed. B. The welding data number has been changed.	A. Wait until welding is performed. B. Try again.
516 OVERRIDE ERROR 2 (only arc welding robots)	The limit values for override definition has been exceeded.	Store the values and keep defining override values.
517 WELD ERROR 1010 (only arc welding robots)	The current supervision has detected that current has disappeared for longer then 500 ms.	Check the thread feeder and current supply.
517 WELD ERROR 1020 (only arc welding robots)	The gas/coolant supervision has detected that gas/coolant is missing.	Check the gas flow and coolant flow.
517 WELD ERROR 2010 (only arc welding robots)	The welding arc has not been lighted before the indicated time from welding start order.	Check thread feeder and current supply. Change the maximum time in the start data.
517 WELD ERROR 2020 (only arc welding robots)	Gas and coolant flow received has not been started before 2 seconds after the robot has moved to the position for welding start.	Check gas flow and coolant flow.
523 ERROR STATION DRIVE UNIT 1 (only arc welding robots)	At power-on the activation of manipulator 1 failed (max. allowed waiting time for acknowledgment signal from manipulator 3 seconds exceeded).	Try again. If repeated attempts are not successful, see Service Manual.
523 ERROR STATION DRIVE UNIT 2 (only arc welding robots)	The robot moved when activation/deactivation of a station was requested.	Stop the robot and repeat the attempt.
523 ERROR STATION DRIVE UNIT 3 (only arc welding robots)	An input indicates that the drive units of a station have been activated, in spite of the fact that no such order has been given on the output.	Check that the station connection is in accordance with the function parameter STATION. In that case check the external equipment.
523 ERROR STATION DRIVE UNIT 4 (only arc welding robots)	An input indicates that the drive units of a station have been deactivated, in spite of the fact that no such order has been given on the output.	Check the cables and that the station connection is in accordance with the function parameter STATION. In that case check the external equipment.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
523 ERROR STATION DRIVE UNIT 5 (only arc welding robots)	An output for activating a STATION is set, but no answer from corresponding input has been given within 5 sec.	Check the the connections from ORBIT to the robot control system.
523 ERROR STATION DRIVE UNIT 6 (only arc welding robots)	Signals for activation to STATIONS have been reset at an earlier stop. These signals have automatically been set high again.	Check that the connected stations are relevant.If that is the case, restart the program again, otherwise connect the STATIONS in question.
524 OUTSIDE WORKING AREA 7 - 12	External axis is outside working area.	Modify the program.
536 ENABLING DEVICE FAULT 1 **536 DMH FAULT 1**	A The dead man's handle has been held in an intermediate position B A fault in the contacts of the dead man's handle.	Press the dead man's handle again. If the fault remains, check the contacts under the dead man's handle.
536 SPEED SUPERVISION FAULT 5	The key switches position and reported status of the servo computer's SPEED signal do not coincide.	Examine the SPEED signal status on the back panel between the safety board and the robot computer board.
536 RUN RELAY FAULT 13	Control signal and check signal to/from the operation contactor do not coincide.	Check the operation contactor and the cabling.
536 ENABLE CHAIN FAULT 21	The ENABLE chain has been broken as a result of one of the following fault: A Drive unit/fatal fault B Rectifier/fatal fault C Measurement system/ fatal or nonfatal fault	Check the LED on the front of the safety board. A The LED is lit:(nonfatal fault) The occurred fault is automaticly reset. The enable chain is closed after a few seconds. The system can be in operation mode again. B The LED is put out:(fatal fault) The occurred fault has to be manually reset. The enable can only be reset by an system initiation.Search for the cause to the fault and remedy it. Do a system initiation.
536 SAFETY HAZARD 33	Fault in the safety board indicated via the supervision for the ENABLE loop.	Replace the safety board.
536 SAFETY HAZARD 34	An attempt has been made to start-up the system with undefined commutating offset.	Define the commutating offset.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
536 RUN BUTTON FAULT 35	The run button has been pressed for 30 seconds.	Check and if needed remedy the run button or the cabling.
536 KEY STATUS FAULT 36	The position/status of the key is incorrect updated e.i. because of two key turns in a raw, when the system was in operation or the run chain was broken.	Change the position of the key or swich the off and on the system.
536 MOTOR OVERLOAD FAULT 101-107	Overload in motor 1-7. Certain mod.: No axes number is stated.	Re-start the system.
538 AUTO MODE STOP 538 WORK STOP 1	One or several work stop switchers connected to the system have been activated.	• Check for the cause to the stop and remedy any possible problem in the system. • Then reset the activated switchers.
538 GENERAL MODE STOP 2 538 SAFETY STOP 2	One or several safety stop switchers connected to the system have been activated.	• Check for the cause to the stop and remedy any possible problem in the system. • Then reset the activated switchers. If the stop can not be reset: • Check the clamps that are not used by the safety circuits. • Check the safety board. • Perform a common error tracing according to the Service manual.
539 INTERNAL RECTIFIER POWER FAULT 1	No power from the internal rectifier.	Check if possible clamps on not used internal rectifier. Check and if needed remedy rectifier and cabling.
539 EXTERNAL RECTIFIER POWER FAULT 2	No power from the external rectifier.	Check if possible clamps on not used external rectifier. Check and if needed remedy rectifier and cabling.
539 WARNING/ RECTIFIER PHASE MISSING 3	At least one phase in the power supply to the rectifier.	Check and if needed remedy fuses and cabling.
540 BRAKES RELAY FAULT	System error which means that the brakes are not released normally.	Examine the connections to the robot brakes and locate the break in the connection.
542 MOTORTYPE NOT DEFINED	Attempt has been made to take the system in operation without that the motortype has been defined.	Define motortype according to the Installation manual S3.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
544 WARNING NEW RESOLVER DATA LOADED	The system has discovered a difference between the new new resolver values, and the resolver values already in the parameter memory.	Choose if the system is to be started on the new or old resolver data. (Remaining system parameters according to earlier executed operation). Check that the robot has the right system parameters after re-start.
547 HYDRAULIC PRESSURE ERROR 1 (ROBOTS IN THE 8000 SERIES)	Faulty pressure in the Z axis pressure unit.	Check the pressure unit.
548 ERROR IN RUN CHAIN 2	Run chain 1 is correct but run chain 2 indicates a fault	Check the run chains.
550 WELD ERROR 1	WELD READY not reset when START 1 or START 2 is activated.	Check the welding controller.
550 WELD ERROR 2	WELD READY not received within 10 s after START 1 or START 2 has been activated.	Check the welding controller.
551 WELD ERROR TIMER	Signal TIMER OK is missing.	Check the welding controller.
552 WELD ERROR CURRENT	Signal CURRENT OK is missing.	Check the welding controller.
553 WELD ERROR FLOW	Signal FLOW OK is missing for more than 5 sec.	Check the cooling water supply.
554 WELD ERROR TEMP	Signal TEMP OK is missing.	Check the welding controller.
555 WELD ERROR ENABLE MOVE	The system has been waiting for signal ENABLE MOVE more than 5 sec. upon gun opening.	Check the welding gun and sensors.
560 ERROR/ROBOT COMPUTER BOARD xxxx	A robot computer board component is malfunctioning. See chapter 5 for further information.	See subcode in chapter 5.
562 ERROR/ROBOT DRIVE UNIT xxxx	Erroneous signals from drive unit after start-up. See chapter 5 for further information.	See subcode in chapter 5.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
563 ERROR/DRIVE UNIT OFFS x	Drive unit exceeds limit values when compensating for offset. See chapter 5 for further information. **Subcode x: Unit:** 1 Drive unit 1 2 Drive unit 2 3 Drive unit 3 4 Drive unit 4 5 Drive unit 5 6 Drive unit 6 7 Drive unit 7	Check the drive unit connection. If all connections are correct, replace the drive unit. If this doesn't work, change the robot computer board.
567 ERROR/SYSTEM BOARD xxxx	Data from the safety board is incorrect. See chapter 5 for further information.	See subcode in chapter 5.
570 ERROR/MEASURE SYSTEM, AXES 1-6 xxxx	The measurement system diagnostics has discovered an error. See chapter 5 for further information.	See subcode in chapter 5.
571 ERROR/MEASURE SYSTEM, AXES 7 xxxx	The measurement system diagnostics has discovered an error. See chapter 5 for further information.	See subcode in chapter 5.
572 ERROR/MEASURE SYSTEM, AXES 8-12 xxxx	The measurement system diagnostics has discovered an error. See chapter 5 for further information.	See subcode in chapter 5.
573 ERROR/MEASURE SYSTEM, AXES 7-12 xxxx	The measurement system diagnostics has discovered an error. See chapter 5 for further information.	See subcode in chapter 5.
580 WARNING DISK xxxx	Error when starting disk. See chapter 5 for further information.	See subcode in chapter 5.
581 WARNING COMPUTER LINK xxxx	Error when starting computer link. See chapter 5 for further information.	See subcode in chapter 5.
582 WARNING PRINTER xxxx	Error when starting printer. See chapter 5 for further information.	See subcode in chapter 5.
583 WARNING SENSOR xxxx	Error when testing the main computer serial links. See chapter 5 for further information.	See subcode in chapter 5.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
585 WARNING PROG UNIT xxxx	Error when starting the programming unit. See chapter 5 for further information.	See subcode in chapter 5.
586 WARNING MONITOR xxxx	Error when starting monitor. See chapter 5 for further information.	See subcode in chapter 5.
588 WARNING WINCHESTER xxxx	Error when starting the Winchester memory. See chapter 5 for further information.	See subcode in chapter 5.
589 RECTIFIER MISSING	The configuration check of the rectifier indicates type code 0, that means no rectifier connected.	Check that: • rectifier is connected correctly
590 RECTIFIER WRONG TYPE	Wrong type of rectifier.	Check the rectifier with respect to robot type and change to the right type.
591 DRIVE SYSTEM ERROR	The drive system has indicated error, but no error status is placed in either rectifier or drive unit.	Re-initiate the system. VOLTAGE RECTIFIER CPU SAFETY POWER SUPPLY RECTIFIER DISCONNECT CABLES
592 RECTIFIER OUTPUT VOLTAGE HIGH	The voltage from the rectifier is too high.	Change rectifier.
593 RECTIFIER TEMP. HIGH	The rectifier unit is is overloaded.	Check if the surrounding temperature is too high. Reduce the intermittence during the run mode.
594 SHUNT RESISTANCE TEMP. HIGH	The return supply power from the robot motors is too high. Too high surroundings temperature and too high input voltage to the rectifier can also cause too high temperature.	Check the input voltage to the rectifier. Check the surroundings temperature around the control cabinet. Reduce the intermittence during run mode.
595 DRIVE UNIT MISSING 1-7	The configuration check of the drive unit for the axis in question, indicates type 0, that means no dive unit connected.	Check if t he drive unit on the axis in question is in the right position. Check the flat cable between drive unit and computer.
596 DRIVE UNIT WRONG TYPE X	The drive units on the axis X in question are of the wrong type.	Check the type of drive units on the axis in question, and change to the right type.

ERROR MESSAGE	CAUSES	RECOMMENDED CORRECTIVE ACTION
597 DRIVE UNIT CURRENT HIGH X	The drive unit for the axis X in question has gone into the over current limit.	Check that the cabling out of the drive units or the motor winding is short-circuit. Check that the out-put on the drive unit isn't shortcircuit.
598 DRIVE UNIT CURRENT ERROR X	The current out from the drive unit for the axis X in question do not correspond to the ordered value.	Check that the cables out from the drive unit in question are unbroken. Probable error cause is interruption in one of the cables or the motor winding.
599 DRIVE UNIT TEMP. HIGH X	The temperature on the out-put level on the drive-unit in question for the axis X in question has exceeded. The axis number can in some systems not be displayed.	Check: • if the robotaxis for the axis in question do not work slowly • the commutation offset • that the surroundings temp. around the control cabinet is below the max. allowed Reduce the intermittence during run mode.
602 VISION SYSTEM ERROR	The hardware for VISION is not available.	Otherwise see separate documentation for VISION.
700 WARNING NEW RESOLVER DATA LOADED	The system has detected a difference between down loaded resolver data and data that earlier was in the parameter memory.	Choose if the system shall start with new or old resolver data. (Other systemparam. acc. to previous operation). After start check that the robot has correct system parameters.

Diagnostic error concerns the fault- and warning message the system discovers when testing the hard ware during the start-up sequence.
Depending on the type of malfunction, two types of message may be displayed: error message or warning message.

Error message:
When this type of message is displayed on the programming unit, the system is always interrupted and put in an error mode. If the malfunction occurs during start-up, this is interrupted.

Warning message:
The printout is given after a malfunction has been detected in any of the units, but the malfunction is not serious enough to interrupt the system.
Normally, all message printouts are displayed on the programming unit display, but during the diagnostic test at start-up, no text can be displayed during certain periods of time. The error codes may then be displayed by the error LED on the computer board front. See chapter 6 for a detailed description.

Error and warning messages using a subcode:

560 ERROR/ROBOT COMPUTER BOARD xxxx
562 ERROR/DRIVE UNIT xxxx
567 ERROR/SAFETY BOARD xxxx
570 ERROR/MEASUREMENT SYSTEM, AXES 1-6 xxxx
571 ERROR/MEASUREMENT SYSTEM, AXIS 7 xxxx
572 ERROR/MEASUREMENT SYSTEM, AXES 8-12 xxxx
573 ERROR/MEASUREMENT SYSTEM, AXES 7-12 xxxx
580 WARNING DISK xxxx
581 WARNING COMPUTER LINK xxxx
582 WARNING PRINTER xxxx
583 WARNING SENSOR xxxx
585 WARNING PROGRAMMING UNIT xxxx
586 WARNING MONITOR xxxx
588 WARNING WINCHESTER xxxx

for which xxxx represents one of the following subcodes, more thoroughly describing the cause of the message.
The following is the list of the subcodes which may be displayed along with an error or warning message.

SUBCODE	CAUSE	RECOMMENDED CORRECTIVE ACTION
0001	Error at main computer instruction test	Replace the robot computer board
0002	PROM checksum error	a Replace the EPROM b Replace the robot computer board
0003	RWM error	Replace the robot computer board
0004	Code downloading error	Replace the robot computer board
0008	Main computer error when handling not allowed command	Replace the robot computer board

SUBCODE	CAUSE	RECOMMENDED CORRECTIVE ACTION
0009	Error in test 1 of communication between I/O and main computers	Replace the robot computer board
0010	Error in test 2 of communication between I/O and main computers	Replace the robot computer board
0011	Error at ending of I/O computer first test sections	Replace the robot computer board
0013	Error when testing the main computer sensors, serial channels	Replace the robot computer board
0014	Error when testing the enable chain	a Replace the robot computer board b Replace voltage supply unit DSQC 241 c Replace the computer rack rear plane
0017	Error when starting the I/O computer later test sections	Replace the robot computer board
0018	Error in test 1 of communication between servo and main computers	Replace the robot computer board
0019	Error in test 2 of communication between servo and main computers	Replace the robot computer board
0039	Servo computer communication error	Replace the robot computer board
0040	Error when starting the servo computer later test sections	Replace the robot computer board
0070	Error when testing the main computer serial channel. Out = low, In = high	Is used at manufacturing check of robot computer board
0071	Error when testing the main computer serial channel. Out = low, In = high	Is used at manufacturing check of robot computer board
0072	Error when testing the main computer serial channel A	Is used at manufacturing check of robot computer board
0075	Error when testing the I/O computer serial channel A, computer link	Is used at manufacturing check of robot computer board
0076	Error when testing the I/O computer serial channel B, printer	Is used at manufacturing check of robot computer board
0080	Error when testing the I/O bus	Is used at manufacturing check of robot computer board
0081	Erroneous data from the I/O bus	Is used at manufacturing check of robot computer board

SUBCODE	CAUSE	RECOMMENDED CORRECTIVE ACTION
0101	Error at I/O computer instruction test	Replace the robot computer board
0102	PROM checksum error, I/O computer	a Replace the EPROM b Replace the robot computer board
0105	Erroneous I/O computer "stall timer"	Replace the robot computer board
0106	Erroneous I/O computer" time out timer"	Replace the robot computer board
0107	Erroneous I/O computer" interval timer"	Replace the robot computer board
0108	I/O computer error when handling not allowed command	Replace the robot computer board
0109	Error in communication between I/O and main computers	Replace the robot computer board
0112	Internal diagnostics error in I/O computer	Replace the robot computer board
0114	Error when testing the enable chain	a Replace the robot computer board b Replace voltage supply unit DSQC 241 c Replace the computer rack rear plane
0116	Error when initiating the I/O computer	Replace the robot computer board
0120	Error when testing printer output	Replace the robot computer board if printer is to be used
0121	Error when testing computer link	Replace the robot computer board if computer link is to be used
0122	Error when testing disk	a Check main cabling b Replace mass memory c Replace the robot computer board
0124	Error when testing the safety board	a Check that 24 V I/O is there. b Replace the safety board DSQC 228
0125	Error when testing the Winchester memory	a Check main cabling b Check that the massmemory gets 12 V. c Replace the massmemory. d Replace the robot computer board
0130	Robot computer board pd bus error	Replace the robot computer board
0131	Error when testing the programming unit	a Perform a restart b Check main cabling especially the 24 V supply. c Replace the programming unit

SUBCODE	CAUSE	RECOMMENDED CORRECTIVE ACTION
0133	Error when testing the monitor	a Check main cabling b Replace monitor c Check system parameters
0134	Non standard programming unit	a Perform a restart b Check main cabling c Replace the programming unit
0138	Not allowed I/O computer interruption	Replace the robot computer board
0139	I/O computer not responding	Replace the robot computer board
0140	Computer bus error, I/O computer	Replace the robot computer board
0201	Error at servo computer instruction tes t	Replace the robot computer board
0202	PROM checksum error, servo computer	a Replace the EPROM b Replace the robot computer board
0205	Erroneous servo computer "stall timer"	Replace the robot computer board
0206	Erroneous servo computer " time out timer"	Replace the robot computer board
0207	Erroneous I/O computer" interval timer"	Replace the robot computer board
0208	I/O computer error when handling not allowed command	Replace the robot computer board
0209	Error in communication between servo and main computers	Replace the robot computer board
0210	Error at ending of servo computer first test sections	Replace the robot computer board
0211	Error at ending of servo computer last test sections	Replace the robot computer board
0216	Servo computer initiation error	Replace the robot computer board
0239	Servo computer not responding	Replace the robot computer board
0240	Data bus error, servo computer	Replace the robot computer board
0302	Checksum error, axis computer sin-arctan table	Replace the robot computer board
0315	Error when loading test program to the axis computer	Replace the robot computer board

SUBCODE	CAUSE	RECOMMENDED CORRECTIVE ACTION
0358	Start-up error, axis computer	Replace the robot computer board
0701	Status bit error, FAULTRES-N, of the drive system	Replace the robot computer board
0702	Address bit error, SA0-SA5, of the drive system	Replace the robot computer board
0722	Status POWER UP-N erroneous from drive system after reset.	a Replace rectifier b Check flat cable between robot computer board and drive system. c Replace the robot computer. d Replace drive unit rack
0723	Signal RUNNING erroneous from drive system after reset.	a Replace rectifier b Check flat cable between robot computer board and drive system. c Replace the robot computer d Replace drive unit rack
0724	Status AC-N erroneous from drive system after reset.	a Replace rectifier b Check flat cable between robot computer board and drive system. c Replace the robot computer. d Replace drive unit rack
0731	Signal FAULT-N erroneous	Is used at manufacturing check of robot computer board
0732	Signal RUNNING erroneous	Is used at manufacturing check of robot computer board
0733	Read data error, R3 SD0	Is used at manufacturing check of robot computer board
0734	Read data error, R3 SD1	Is used at manufacturing check of robot computer board
0741	Axis computer does not respond at drive unit test	Replace the robot computer board
0742	Too large AD converter offset error	a Replace the robot computer board
0743	Too large AD converter offset error	a Replace the robot computer board
0744	Too large offset error on any drive unit channel	a Replace the robot computer board b Replace the drive unit
0751	The axis computer does respond at offset compensation, drive units	Replace the robot computer board

SUBCODE	CAUSE	RECOMMENDED CORRECTIVE ACTION
0900	The axis computer does respond at first contact to the measurement system of the specified axes	a Perform a restart b Install the missing equipment c Check cabling betwwen measurement system and robot computer. d Replace measuremnt board DSQC 234 or axis board DSQC 233. e Replace the robot computer board
0902	Communication error to measurement system.	a Replace serialmeasurement board . b Replace the robot computer board
0903	Not allowed offset error on the X-channel of measurement system.	Replace serialmeasurement board.
0904	Not allowed offset error on the X-channel of measurement system.	Replace serialmeasurement board.
0905	Too large difference between X and Y channels of measurement system.	Replace serialmeasurement board.
0906	Disruption in cabling, the loop is closed without passing measurement board no 2. Linearity error on the X channel of measurement system. (X ramp does not increase)	A Do a restart. B Install missing equipment C Check the cabling between the measurement board and the robot computer. D Exchange the identified serialmeasurement board. E Exchange robotcomputer board.
0907	Linearity error on the Y channel of measurement system. (Y ramp does not increase)	Replace serialmeasurement board.
0920	Communication error to measurement system DSQC 233	a Replace measurement board DSQC 233 b Replace the robot computer board
0921	Offset error on AD converter to measurement system DSQC 233	Replace measurement board DSQC 233
0922	Offset error on DA converter, ch. 1 to measurement system DSQC 233	Replace measurement board DSQC 233
0923	Offset error on DA converter, ch. 2 to measurement system DSQC 233	Replace measurement board DSQC 233
0924	Offset error on DA converter, ch. 3 to measurement system DSQC 233	Replace measurement board DSQC 233
0925	Offset error on DA converter, ch. 4 to measurement system DSQC 233	Replace measurement board DSQC 233
0926	Offset error on DA converter, ch. 5 to measurement system DSQC 233	Replace measurement board DSQC 233

SUBCODE	CAUSE	RECOMMENDED CORRECTIVE ACTION
0927	Offset error on DA converter, ch. 6 to measurement system DSQC 233	Replace measurement board DSQC 233
0928	Linearity error, ch. 1 of measurement system DSQC 233	Replace measurement board DSQC 233
0929	Linearity error, ch. 2, 4, 6 of measurement system DSQC 233	Replace measurement board DSQC 233
0930	Linearity error, ch. 3 and 5 of measurement system DSQC 233	Replace measurement board DSQC 233
0960	Error at "local ring controller loopback"	Replace the robot computer board
0961	Error at "ring controller loopback"	Is used at manufacturing check of robot computer board
0962	Error at "ring controller loopback"	Is used at manufacturing check of robot computer board

6
Test mode errors

To enable performing tests in the test mode, the key switch must be set in either position TEACH or position TEST V=100% when the robot is in its normal initiated mode.

Then, the robot is to be initiated in the test mode by pressing both push buttons on the computer board front, and then letting the initiation button up a couple of seconds before letting up the test button.

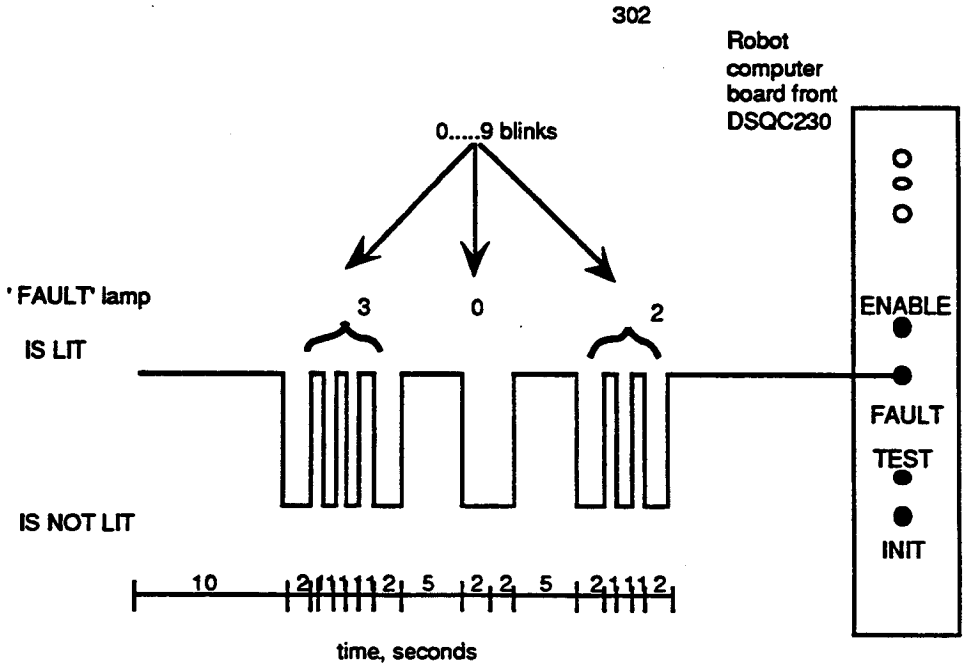
If an error is discovered during start-up diagnostics in the test mode, the subcode of the error message will not only be displayed on the programming unit but also on the robot computer board error lamp.

This enables obtaining an error code in cases where the error message is not displayed on the programming unit. The displayed subcode is one of the subcodes explained in section 5.

To obtain an subcode from a faulty system, the operator must perform an initiation to enter the test mode which. This is described above. During this restart, the diagnostic system will perform the same tests once more, and the error will be rediscovered.

The error lamp on the robot computer board front will blink repeatedly to indicate the error subcode in accordance with the following description. The blinking of the error lamp will be repeated until the system is reinitiated.

E.g. error code
560 ERROR/ROBOT COMPUTER BOARD



Test of board DSQC 233, axis board:

The error printouts available are the same as for a normal start-up according to sections 4 and 5.

I.e.
570 ERROR/MEASUREMENT SYSTEM AXES 1-6 xxxx
571 ERROR/MEASUREMENT SYSTEM AXIS 7 xxxx
572 ERROR/MEASUREMENT SYSTEM AXES 8-12 xxxx
573 ERROR/MEASUREMENT SYSTEM AXES 7-12 xxxx
(xxxx = sub codes)

Test of board DSQC 236, drive unit:

The error code parameter XX indicates output/input in accordance with the table below:

XX	Function	XX	Function
01	Enable loop error	02	Type code error
03	Test sequence error	04	Axis computer does not respond
05	Drive unit missing		

Test of board DSQC 209, analog in/output board:

The error printout parameter XX indicates the output/input in accordance to the table below:

XX	Function	XX	Function
0	Board absent	1	CH 1
2	CH 2	3	CH 3
4	CH 4		

Test of board DSQC 223 , digital in/output board:

The error printout parameter XX indicates the output/input in accordance to the table below:

XX	Function	XX	Function
0	Board absent	1	CH 1
2	CH 2	3	CH 3
4	CH 4	5	CH 5
6	CH 6	7	CH 7
8	CH 8	9	CH 9
10	CH 10	11	CH 11
12	CH 12	13	CH 13
14	CH 14	15	CH 15
16	CH 16		

Test of board DSQC 224, combined digital and analog in/output board:

The error printout parameter XX indicates the output/input in accordance to the table below:

XX	Function	XX	Function
0	Board absent	1	CH 1
2	CH 2	3	CH 3
4	CH 4	5	CH 5
6	CH 6	7	CH 7
8	CH 8	9	CH 9
10	CH 10	11	CH 11
12	CH 12	13	CH 13
14	CH 14	15	CH 15
16	CH 16		
21	Analog CH 1	22	Analog CH 2

Spare Part List

SPARE PARTS, CONTROL SYSTEM M93

Power supply side

Pos	Qty	Description	Art. no..	Comments
Z1		**Power supply filter**	3HAA 3003-60	
QS1		**Lockable circuit breaker**	5324 688-3	
		Automatic fuse	xxx	Option
		Flange disc	3HAA 7601-53	alt. for QS1
TM1		**Transformer** with automatic fuse and 5x20mm fuses (-CD, -CE, -CF with outlet for air conditioner)		
		IRB 2000, 3000,3200	3HAA 3101-CB 3HAA 3101-CC 3HAA 3101-CD	200-220 V 380-475 V 200-600 V
		IRB 6000	3HAA 3101-CF 3HAA 3101-CE	200-220 V/ 500-600 V 380-475 V
FS1	1	Automatic fuse	3HAA 3001-81	3-pole
FU1,2	2	Fuse	5672 817-2	6,3A slow, 5 x 20mm

Operating circuits

Pos	Qty	Description	Art. no.	Comments
SA1	1	Operating mode selector	3HAA 3003-21	
SA2, 3	2	Lamp push button	SK 615 202-CH	
	3	Contact block	SK 616 001-A	
	2	Lamp block	SK 616 003-A	
	2	Glow lamp	5911 069-10	36 V, 3,5 W, BA 9S
SA4	1	EM stop button	SK 615 202-TA	
	2	Contact block	SK 616 001-B	
D1		**Floppy disc unit**	3HAB 2477-001 ~~3HAA 3560-LYA~~	Contains the floppy
		Floppy disc driver	5736 067-2	disc driver
		Cable	3HAA 3101-CH S3 PC/S4 3HAB 2480-001	
PT		**Operation time counter**	3HAA 3001-7	24 V DC

Contactor unit

Pos	Qty	Description	Art. no	Comments.
			7000748	17V Contactor
KM1, 2	2	Contactor	3HAA3003-19	Run contactor
KM3	1	Contactor	~~3HAA 3001-4~~ 3HAB 2425-001	Supervision RSI T308 contactor
KM 4	1	Contactor	3HAA3001-4	Brake contactor
RV1,2,3,4	4	Varistor	2166 0757-EL	

Board in baseversion

Pos	Qty	Description	Art. no	Comments.
AP31	1	DSQC 230	YB 560 103-BN	Robot computer
AP41	1	DSQC 256	3HAA 3563-ASA	System board
GS1	1	DSQC 258	3HAA 3563-AUA	Voltage supply
AP80	1	DSQC 254	3HAA 3563-APA	Rear plane

Receptacle For 3HAA 2613-002 XS20 RSI 932?

Programmering unit

Description	Art. no	Comments.
Complete unit	~~3HAA 3560-HXA~~ 3HAB 2236-1	
Programming board	3HAA 3563-AAA	
Display	4950 499-C	
Membran keyboard	3HAA 3001-12	
Joystick unit	3HAA 3001-22	
3-mode switch	3HAA 3560-MCA	
EM stop, operating device	5372 425-171	
EM stop, contact device	5372 425-155	
Connection cable connector only	3HAA 3560-AE 3 HAA 3016-001	10 m
Extension cable	3HAA 3560-LXA	10 m cable
Shelf for prog. unit	3HAA 3560-GSA	

Drive unit, IRB 2000

Pos	Qty	Description	Art. no.	Comments
AP1,3	2	DSQC 236 B	YB 560 103-CB	Servo power unit, axes 1, 3
AP2	1	DSQC 236 C	YB 560 103-CC	Servo power unit, axis 2
AP4	1	DSQC 236D	3HAB 2207-1	Servo power unit, 3 axes (4,5,6)
AP7	1	DSQC 236 C	YB 560 103-CC	Servo power unit, axis 7(option)
AP9	1	DSQC 249A	3HAA 3563-AGA	Rectifier
AP10	1	DSQC 257	3HAA 3563-ATA	Rear plane
EV1	1	Fan	6480 096-5	24V DC

Drive unit, IRB 3000

Pos	Qty	Description	Art. no	Comments.
AP1,2,3	3	DSQC 236 C	YB 560 103-CC	Servo power unit, axes 1, 2, 3
AP4,5	2	DSQC 236 B	YB 560 103-CB	Servo power unit, axes 4,5
AP6	1	DSQC 236 A	YB 560 103-CA	Servo power unit, axis 6
AP7	1	DSQC 236 C	YB 560 103-CC	Servo power unit, axis 7(option)
AP9	1	DSQC 249A	3HAA 3563-AGA	Rectifier
AP10	1	DSQC 255	3HAA 3563-ARA	Rear plane

Drive unit, IRB 3200

Pos	Qty	Description	Art. no	Comments.
AP1,2,3	3	DSQC 236 C	YB 560 103-CC	Servo power unit, axes 1, 2, 3
AP4	1	DSQC 236 B	YB 560 103-CB	Servo power unit, axis 4
AP5,6	2	DSQC 236 A	YB 560 103-CA	Servo power unit, axes 5, 6
AP7	1	DSQC 236 C	YB 560 103-CC	Servo power unit, axis 7(option)
AP9	1	DSQC 249A	3HAA 3563-AGA	Rectifier
AP10	1	DSQC 255	3HAA 3563-ARA	Rear plane

Drive unit, IRB 6000

Pos	Qty	Description	Art. no	Comments.
AP1,2,3	3	DSQC 236 T	YB 560 103-CE	Servo power unit, axes 1,2,3
AP4,5,6	3	DSQC 236 G	YB 560 103-CD	Servo power unit, axes 4-6
AP7	1	DSQC 236 T	YB 560 103-CE	Servo power unit, axis 7(option)
AP9	1	DSQC 249 B	3HAA 3563-AHA	Rectifier
AP10	1	DSQC 255	3HAA 3563-ARA	Rear plane
EV1,2,3	3	Fan	6480 096-5	24V DC
R1,2	2	Connecting up resistance	5245 2063-210	10 ohm, 50W

Optional units

Pos	Qty	Description	Art. no.	Comments
AP11-16	≤6	**Digital I/O board** DSQC 223	YB 560 103-BD	16 inputs 24V DC 16 outputs 24V DC
		Cable	3HAB 2003-1	External connection
		Cable	2639 0351-LA	To connection unit
XT11-16		Connection unit	5231 0491-3	Screw terminals
		Connection unit	3HAA 3003-34	Disconnectable
		Connection unit, relay	3HAA 3003-35	Screw terminals
AP11	≤1	**Analog I/O board** DSQC 209	YB 560 103-AL $3,874.00	3 outputs ±10V 1 output ± 20mA 4 inputs 0 - ± 10V
		Cable	3HAB 2004-1	External connection
		Cable	~~YB 560 103-DK~~ 3HAB2125-1 = $175.00	To connection unit
XT10		Connection unit	5231 0491-3 $250.00	Screw terminals
AP11	≤1	**Combi I/O-board** DSQC 224	YB 560 103-BE	16 digital inp. 24V DC 16 digital outp. 24V DC 2 analog outp. 0 - +10V
		Cable	3HAB 2005-1	External connection
		Cable	YB 560 105-DH	To connection unit
XT10	2	Connection unit	5231 0491-3	Screw terminals
AP12-16	≤1	**Remote I/O-board** DSQC 239	YB 560 103-CH	
		Cable	6364 105-DZB	
D2	≤1	**Winchester memory**	3HAB 2043-001 ~~3HAA 3560-MKA~~	
AP16		Winchester board	YB 560 103-BK	
AP51	≤1	**Board for external axes** DSQC 233	YB 560 103-BS	
XT4		Connection unit	5231 0491-4	
		Cable	3HAA 3560-MLA	External connection
E1		**LCD unit**	YB 560 101-SV	
		Board	YB 560103-BR	
		Display	4950 499-E	
		Cable	3HAA 3560-MMA	

Optional units, cont.

Pos	Description	Art. no	Comments.
EV4	**Heat exchanger**	3699 001-2	
EV4	**Cooling device** RIGHT TOP MOUNT	3HAA 3003-57 3HAA 3560-JPA KIT	
	Dust filter for cool. dev.	7820 004-3	package with 3 pieces
	External control units	3HAA 3560-JEA	15 m cable
		3HAA 3560-JFA	22 m cable
		3HAA 3560-JGA	30 m cable

Miscellaneous

Pos	Description	Art. no.	Comments.
GB1	Battery	4944 026-5	RWM
SB1,2,3	Micro switch	5397 038-1	For fan, cool. dev..
Z2	Filter	YB 560 103-CF	
XS1,3,4,5	Industrial connector	5217 687-25	Female insert, 64-pole
	Cable, measurement	3HAA 3560-HVA	7m
	Cable, motor	3HAA 3560-HTA	7m
	Cable, measurement	3HAA 3560-HWA	15 m
	Cable, motor	3HAA 3560-HUA	15 m
	Cable, measurement	3HAA 3560-LTA	22 m
	Cable, motor	3HAA 3560-LNA	22 m
	Cable, measurement	3HAA 3560-LUA	30 m
	Cable, motor	3HAA 3560-LPA	30 m
	Cable	3HAA 3560-GHA	15 m (IRB 6000/2.25-75 PE)
XT5	Customer cable, signal	3HAA 3560-NJA	7 m
XT6	Customer cable, power	3HAA 3560-NNA	7 m
XT5	Customer cable, signal	3HAA 3560-NKA	15 m
XT6	Customer cable, power	3HAA 3560-NPA	15 m
XT5	Customer cable, signal	3HAA 3560-NLA	22 m
XT6	Customer cable, power	3HAA 3560-NRA	22 m
XT5	Customer cable, signal	3HAA 3560-NMA	30 m
XT6	Customer cable, power	3HAA 3560-NSA	30 m

Circuit Diagram

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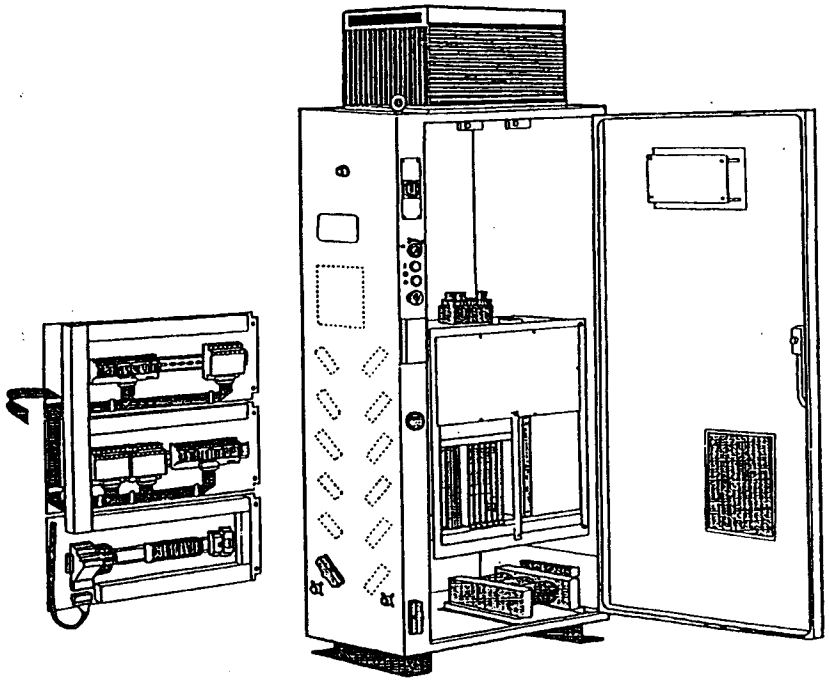


Rev Ir	Revision	Appd	Year Week

Approved: MYKLEBUST
HOLM
Prepared: KINDBERG

Title: CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A

PRIMARY PART IN ARCADE

Responsible dept: KCS 93 34

ABB Robotics Products

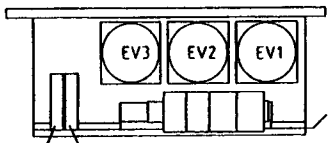
Document No.: 3HAB 2126-5

Lang: S | Sheet: 0 | Cont: 1

ABB

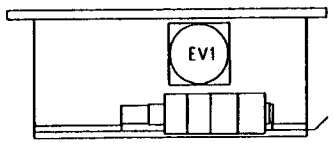
Rev In	Revision	Appd	Year Week	LIST OF CONTENTS	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126–5	Lang S / Sheet 1 / Cont 2

IRB 6000

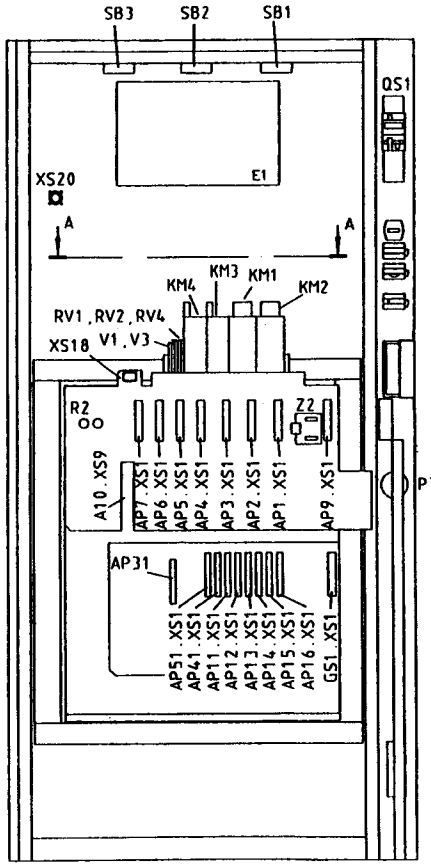


View A-A

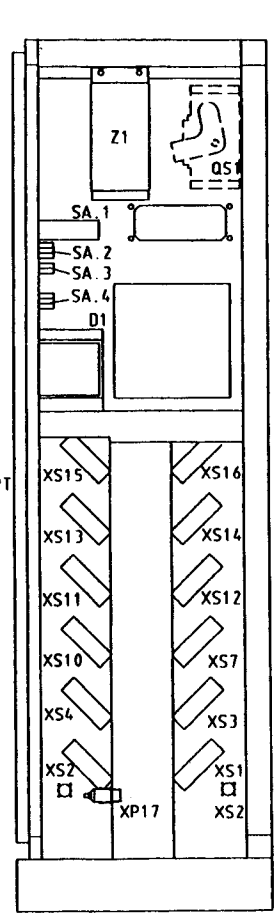
IRB 2000



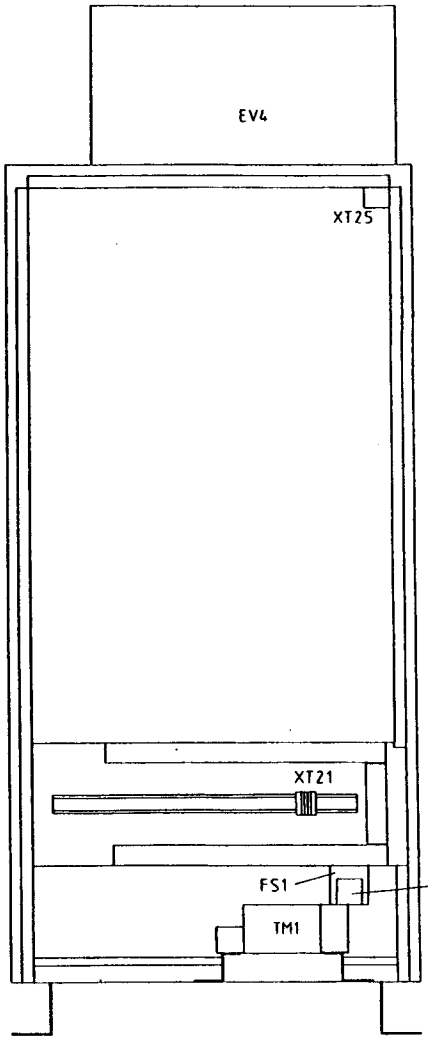
View A-A



INSIDE FRONT



INSIDE LEFT WALL



INSIDE REAR WALL

Rev In	Revision	Appd	Year Week	VIEW OF CONTROL CABINET	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products	Lang	Sheet
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	S	2 Cont 3

ABB

A	Power unit
AP1	Drive unit axis 1
AP2	Drive unit axis 2
AP3	Drive unit axis 3
AP4	Drive unit axis 4 (–6)
AP5	Drive unit axis 5
AP6	Drive unit axis 6
AP7	Drive unit axis 7
AP9	DC–link Drive system
AP10	Drive unit back plane
AP11	Analogus I/O, Combi I/O, Dig I/O no 1
AP12	Remote I/O, Digital I/O no 2
AP13	Remote I/O, Digital I/O no 3
AP14	Remote I/O, Digital I/O no 4
AP15	Remote I/O, Digital I/O no 5
AP16	Remote I/O, Digital I/O no 6, Winchester Interface
AP21	Relay output no 1
AP22	Relay output no 2
AP23	Relay output no 3
AP24	Relay output no 4
AP25	Relay output no 5
AP26	Relay output no 6
AP31	Robot computer
AP41	System board
AP51	External axes board
AP80	Back plane
AP80.X2	Floppy disc signal
AP80.X22	Floppy disc power
AP80.X5	Computer link
AP80.X6	Print out
AP80.X7	Sensors
AP80.X31	Measurement system
AP80.X32	Programming unit
AP80.X33	LCD
AP80.X34	Control panel
AP80.X35	System board, customer
D1	Floppy disc unit
D2	Winchester unit
E1	LCD unit
E2	Earth fault breaker
EL	Illumination
EV1	FAN, Drive system IRB 2000/6000
EV2	FAN, Drive system IRB 6000
EV3	FAN, Drive system IRB 6000
EV4	Heat exchanger, Air conditioning
FS1	Automatic Fuse
GB1	Battery, Robot computer
GS1	Power supply
KM1	Motor on contactor 1
KM2	Motor on contactor 2
KM3	Supervision contactor
KM4	Brake contactor
KT1	Time delay, contactor
PT	Duty time counter
QS1	Mains switch
R1, R2	Resistors, DC–link
RV1	Varistor, Motor on contactor 1
RV2	Varistor, Motor on contactor 2
RV3	Varistor Supervision contactor
RV4	Varistor, Brake contactor
SA	Control panel
SA.1	Mode switch
SA.2	Motor on, PB
SA.3	Motor off PB
SA.4	Emergency stop PB
SB1	Door switch drive system fan
SB2	Door switch, Heat exchanger, Air conditioning
SB3	Door switch illumination
TM1	Transformer
TM1.FU1–2	Fuse
XB1	Computer link
XB2	Print out
XP0	Mains Plug
XP5	Customer signal connection
XP6	Customer power connection
XP17	Mode switch customer extension
XP18	PTC, Brake extension
XS1	Outlet control cable power
XS2	Outlet control cable signal
XS3	Customer connection
XS4	External axes signal connection
XS5	Customer signal connection
XS6	Customer power connection
XS7	External axis power connection
XS10	Analogus I/O, Combi I/O Analog part
XS11	Digital I/O no 1
XS12	Digital I/O no 2
XS13	Digital I/O no 3
XS14	Digital I/O no 4
XS15	Digital I/O no 5
XS16	Digital I/O no 6
XS17	Mode switch customer extension
XS18	PTC, Brake extension
XS20	Programming unit outlet
XS21	Service 230V outlet
XT3	Customer connection
XT5	Customer signal connection
XT6	Customer power connection
XT10	Analogus I/O, Combi I/O analog part
XT11	Digital I/O no 1
XT12	Digital I/O no 2
XT13	Digital I/O no 3
XT14	Digital I/O no 4
XT15	Digital I/O no 5
XT16	Digital I/O no 6
XT17	Remote I/O board
XT18	I/O supply
XT21	Service outlet connection
XT25	Heat exchanger, Air conditioning connection
XT26	Direct supply connection
Z1	Mains Filter
Z2	Filter Lim. Switch robot

Rev In	Revision	Appd	Year Week	DESIGNATION	Approved	Title	ABB Robotics Products		
					MYKLEBUST	CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	Document No.	Long	Sheet
					HOLM		3HAB 2126–5	S	3
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34		Cont 4

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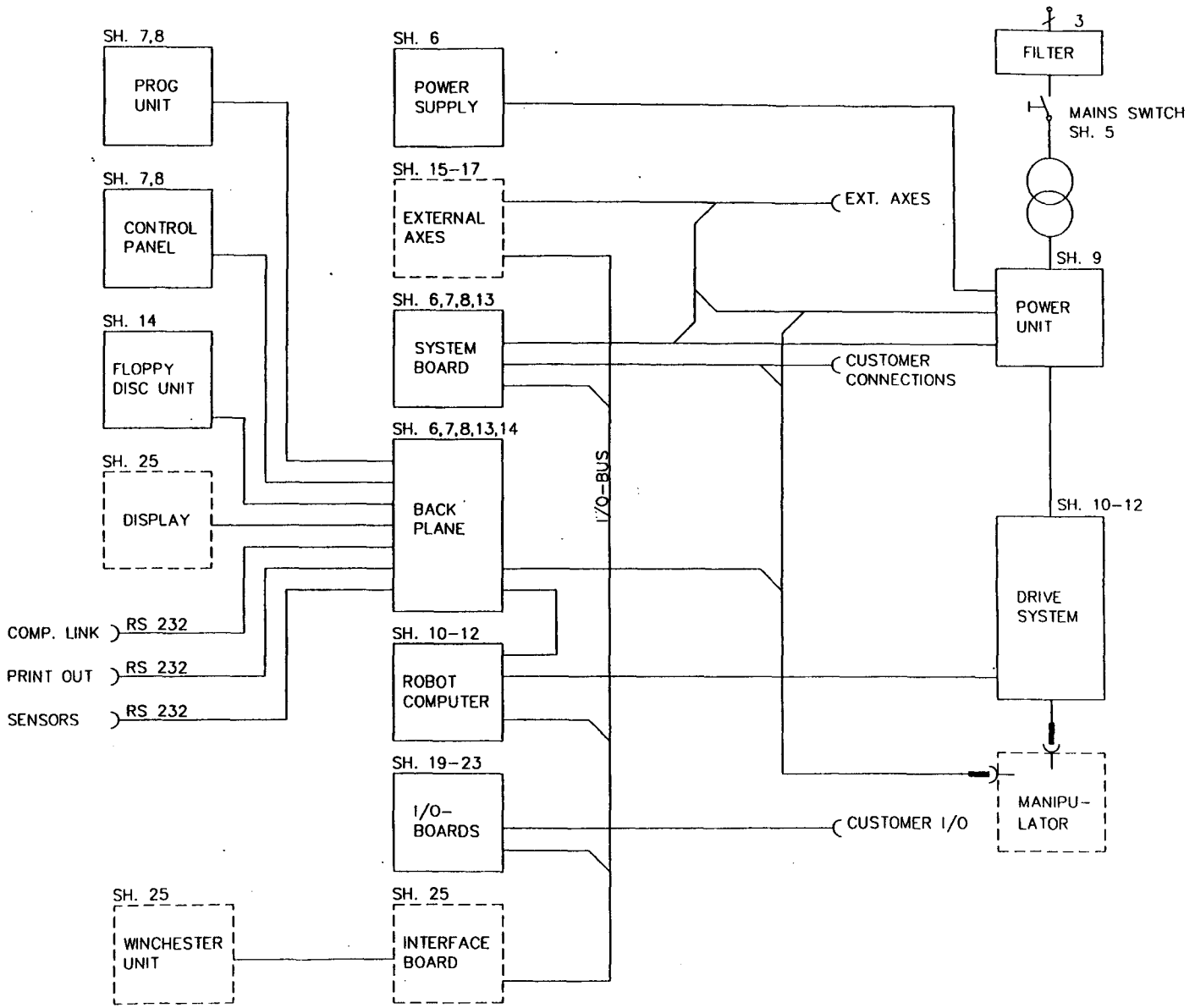
ABB



Rev In	Revision	Appd	Year Week	BLOCK DIAGRAM	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE — Responsible dept KCS KCS	Document No. 3HAB 2126-5	Lang S	Sheet 4 Cont 5

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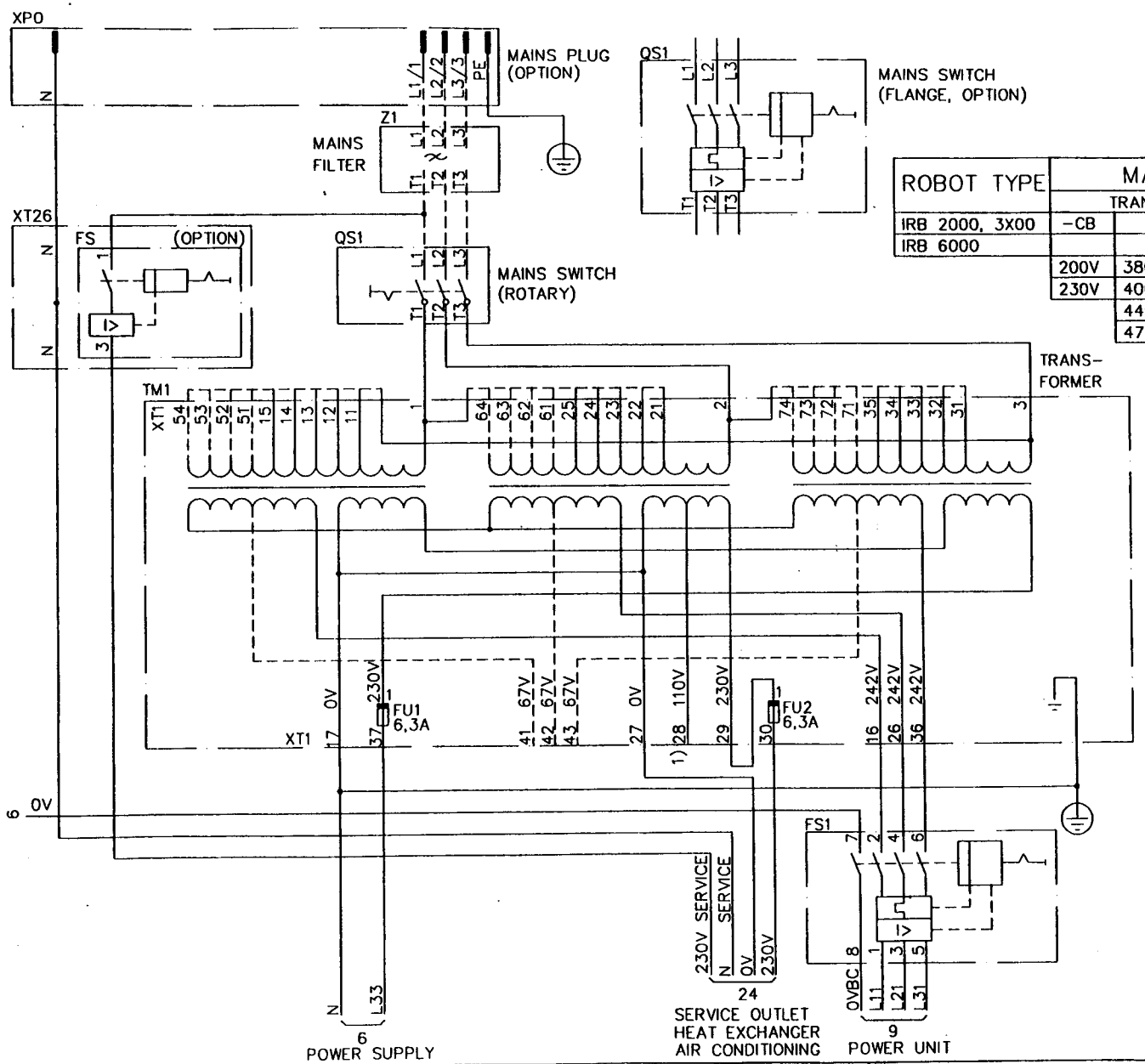

ROBOT TYPE	MAINS VOLTAGE TRANSFORMER 3HAA 3101-				JUMPERS
IRB 2000, 3X00	-CB	-CC	-CD		
IRB 6000		-CE		-CF	
	200V	380V/400V	200V	200V	1-21, 2-31, 3-11
	230V	400V/415V	230V	230V	1-22, 2-32, 3-12
		440V	380V/400V	500V	1-23, 2-33, 3-13
		475V	400V/415V	525V	1-24, 2-34, 3-14
			440V	600V	1-25, 2-35, 3-15
			475V		1-61, 2-71, 3-51
			500V		1-62, 2-72, 3-52
			525V		1-63, 2-73, 3-53
			600V		1-64, 2-74, 3-54

Rev In	Revision	Appd	Year Week
	MAINS CONNECTION		

Approved MYKLEBUST
HOLM
Prepared KINDBERG

Title
CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A
PRIMARY PART IN ARCADE

Responsible dept KCS 93 34

ABB Robotics Products
Document No.
3HAB 2126-5

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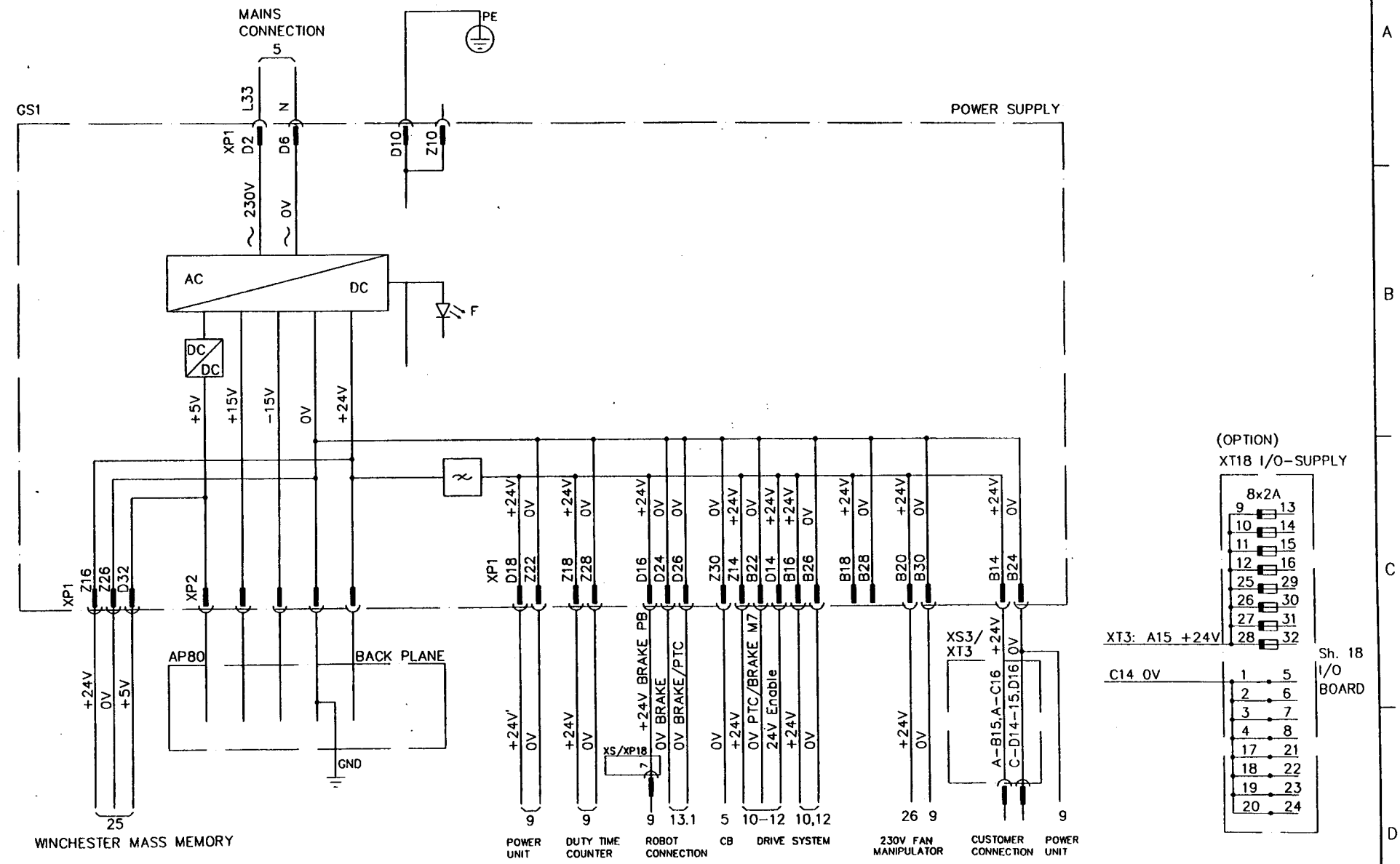

Rev In	Revision	Appd	Year Week	POWER SUPPLY	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products	
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5
								Lang S / Sheet 6 / Cont 7

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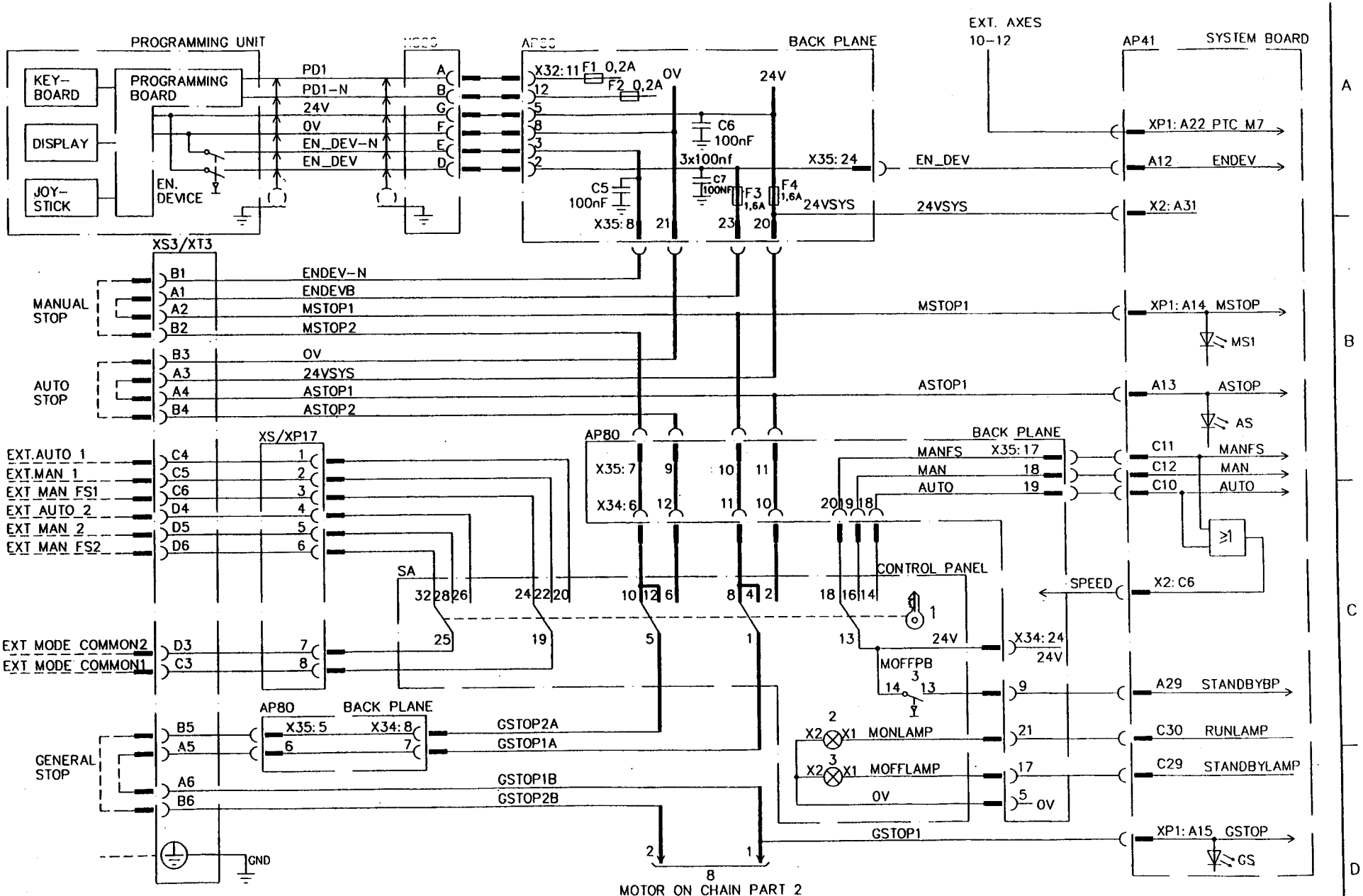

Rev In	Revision	Appd	Year Week	MOTOR ON CHAIN PART 1	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products	Long S	Sheet 7
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	Cont 8

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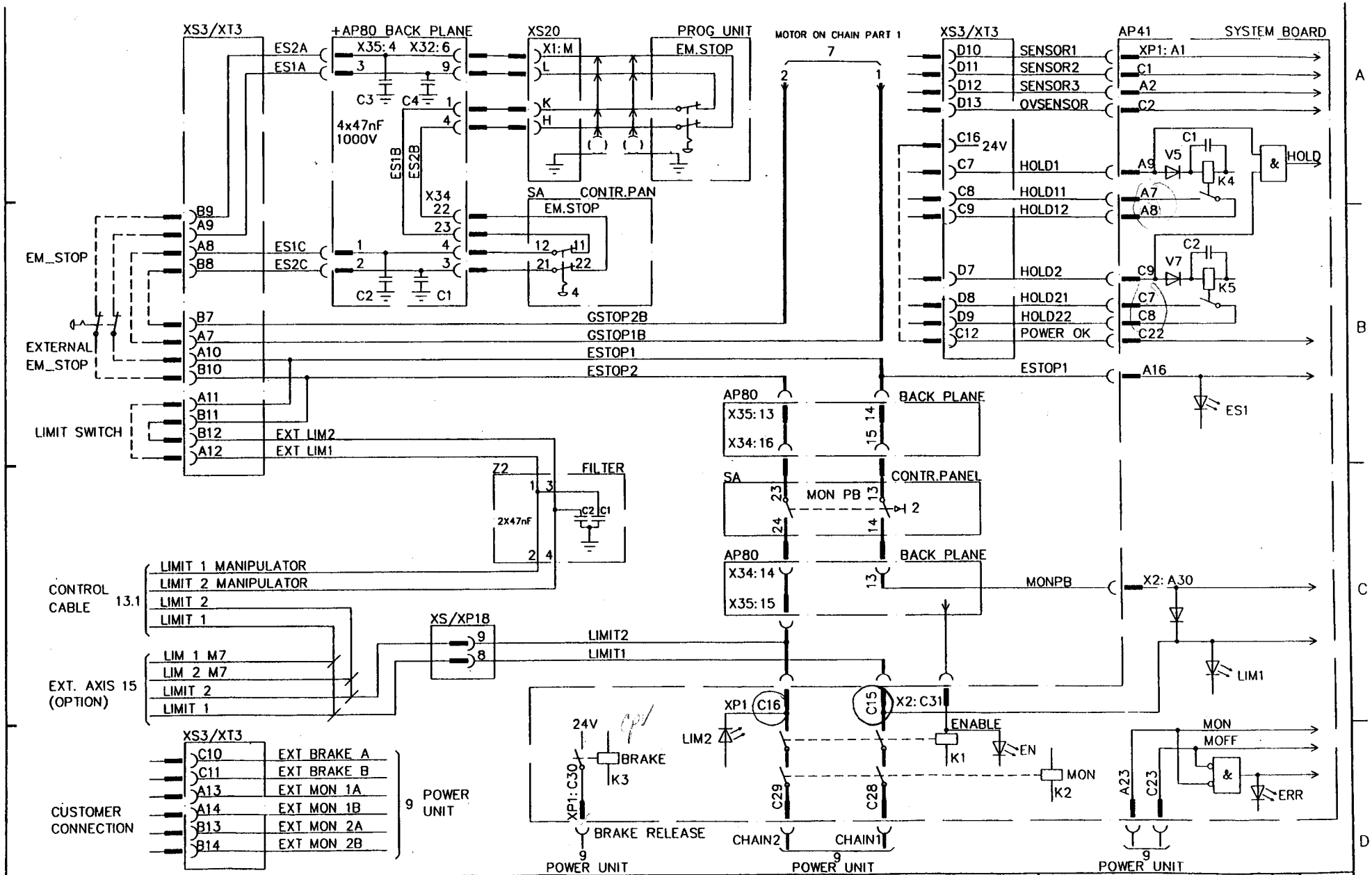


MOTOR ON CHAIN PART 2

Approved: MYKLEBUST
HOLM
Prepared: KINDBERG

Title: CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A

PRIMARY PART IN ARCADE

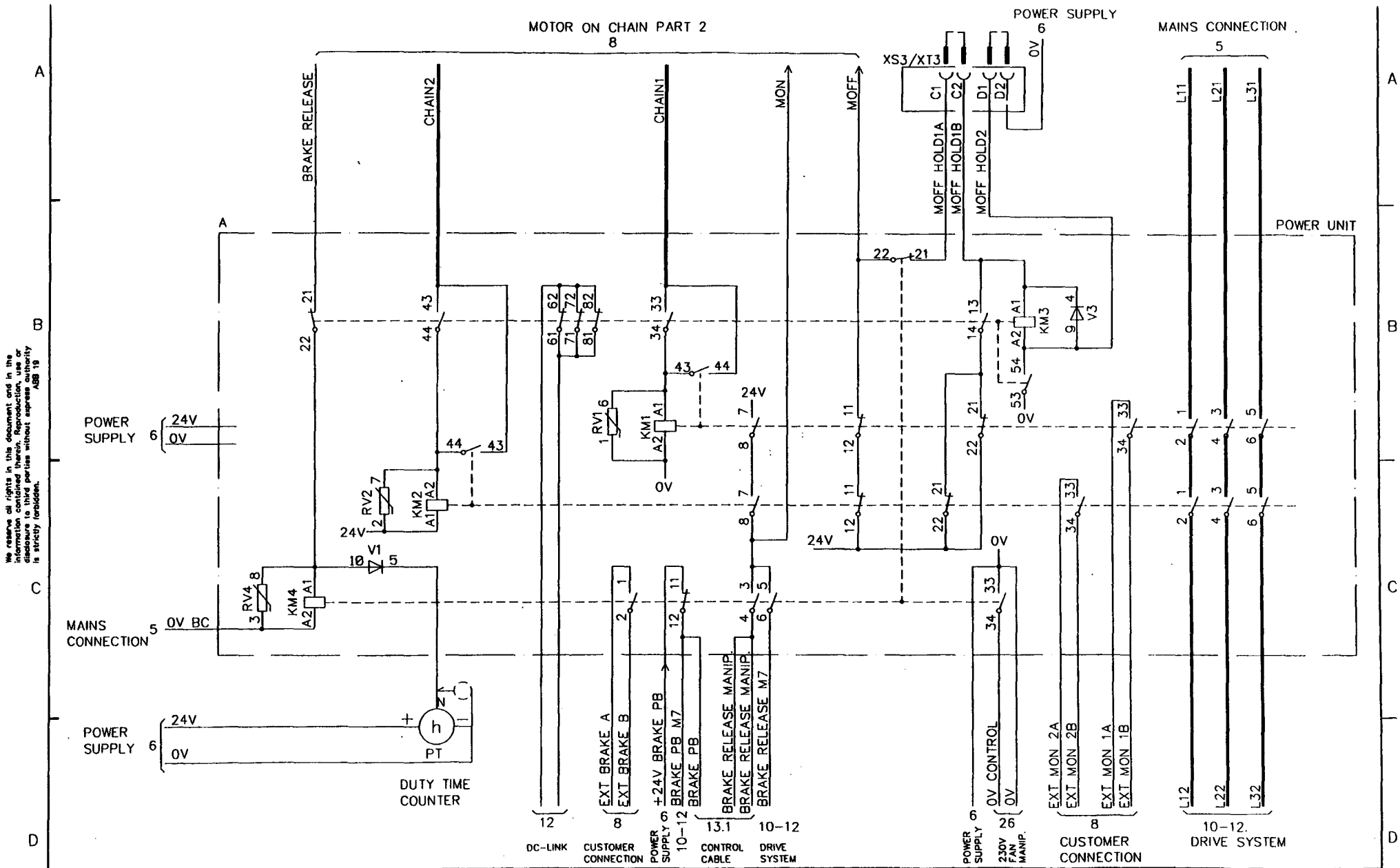
Responsible dept: KCS 93 34

ABB Robotics Products

Document No.: 3HAB 2126-5

Long: S
Sheet: 8
Cont: 9

Rev Ir | Revision | Appd | Year Week



Rev In	Revision	Appd	Year Week	POWER UNIT	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34
							Document No. 3HAB 2126-5
							Lang S / Sheet 9 / Cont 10

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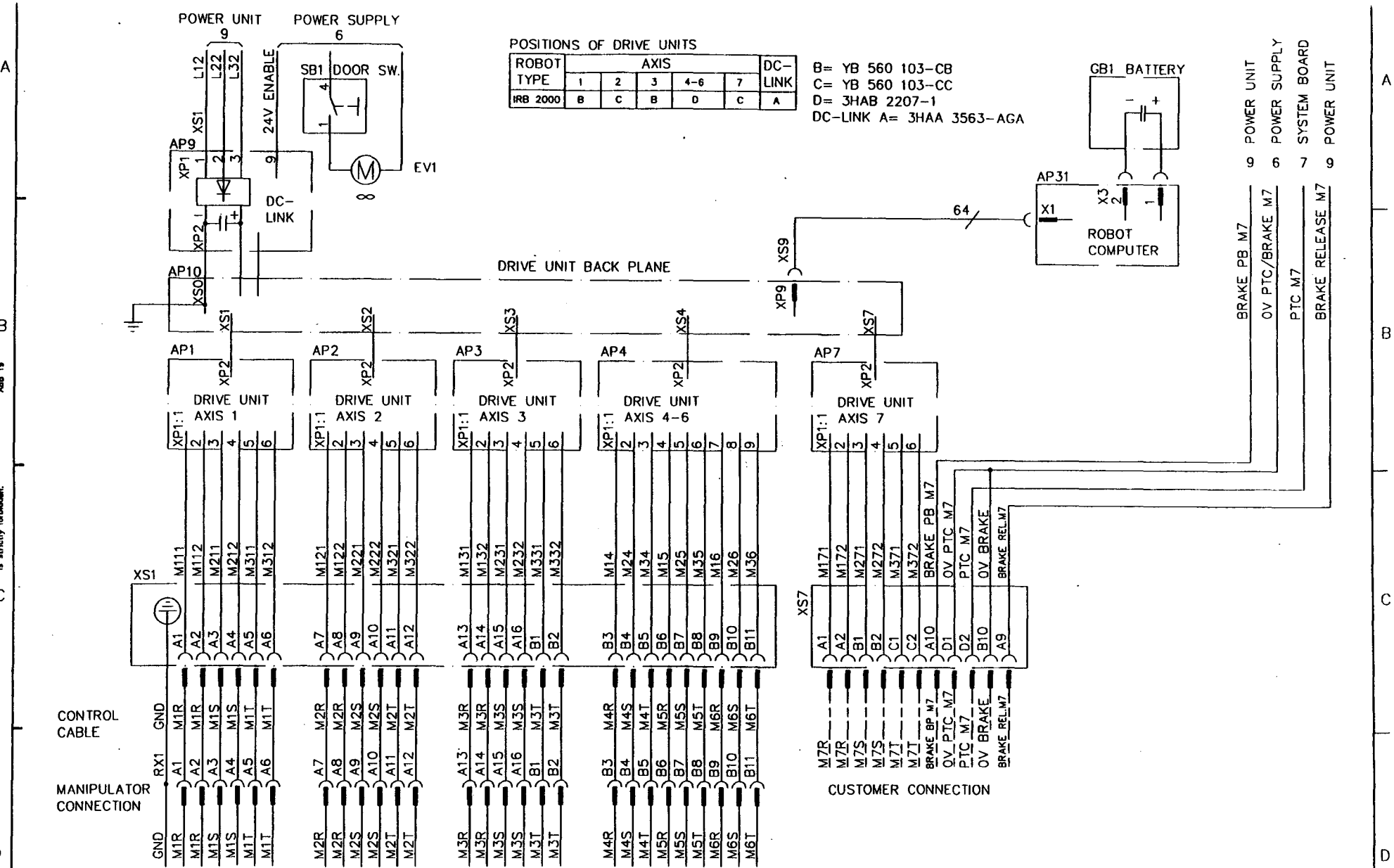

POSITIONS OF DRIVE UNITS

ROBOT TYPE	AXIS 1	AXIS 2	AXIS 3	AXIS 4-6	AXIS 7	DC-LINK
IRB 2000	B	C	B	D	C	A

B= YB 560 103-CB
C= YB 560 103-CC
D= 3HAB 2207-1
DC-LINK A= 3HAA 3563-AGA

Rev In	Revision	Appd	Year Week	DRIVE SYSTEM AND ROBOT COMPUTER IRB 2000	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34
							Document No. 3HAB 2126-5
							Lang S / Sheet 10 / Cont 11

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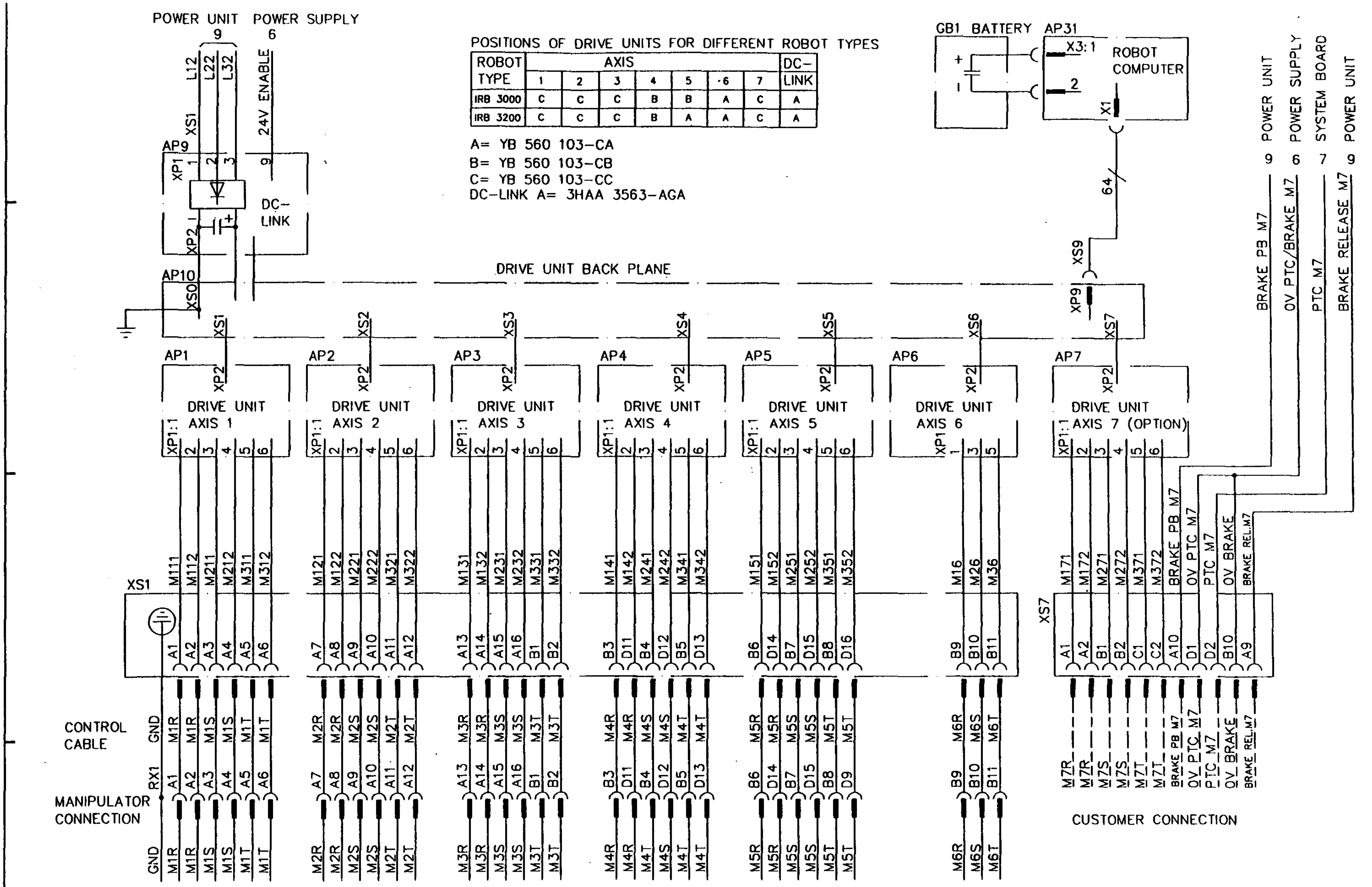


POSITIONS OF DRIVE UNITS FOR DIFFERENT ROBOT TYPES

ROBOT TYPE	AXIS 1	2	3	4	5	6	7	DC-LINK
IRB 3000	C	C	C	B	B	A	C	A
IRB 3200	C	C	C	B	A	A	C	A

A= YB 560 103-CA
B= YB 560 103-CB
C= YB 560 103-CC
DC-LINK A= 3HAA 3563-AGA

Rev	Ind	Revision	Appd	Year	Week

DRIVE SYSTEM AND ROBOT COMPUTER
IRB 3X00

Approved MYKLEBUST
HOLM
Prepared KINDBERG

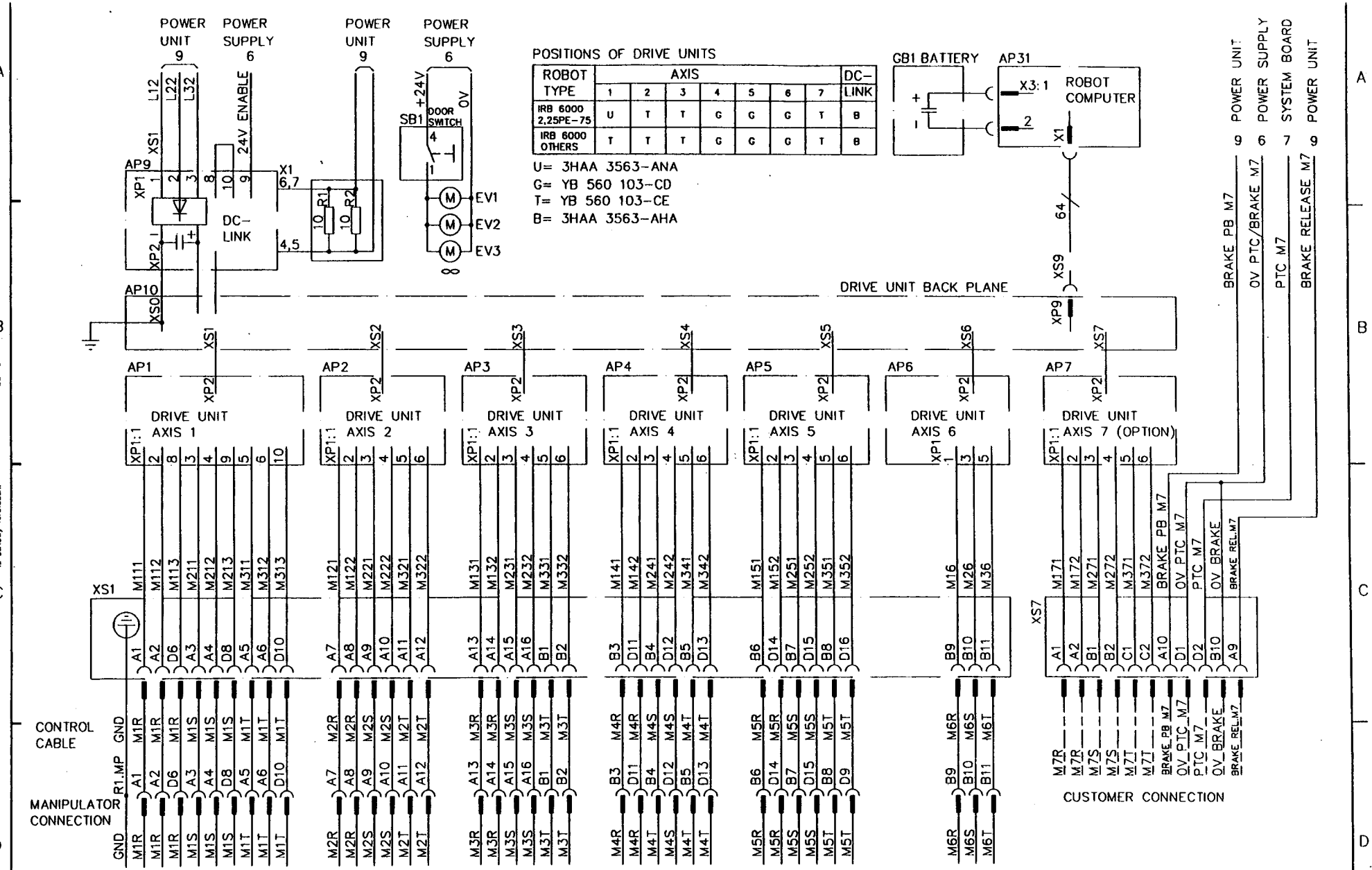
Title CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A

PRIMARY PART IN ARCADE
Responsible dept KCS 93 34

ABB Robotics Products
Document No. 3HAB 2126-5
Lang S
Sheet 11
Cont 12

1 2 3 4 5 6

ABB



DRIVE SYSTEM AND ROBOT COMPUTER
IRB 6000

Approved MYKLEBUST
HOLM
Prepared KINDBERG

Title
CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A
PRIMARY PART IN ARCADE

Responsible dept KCS 93 34

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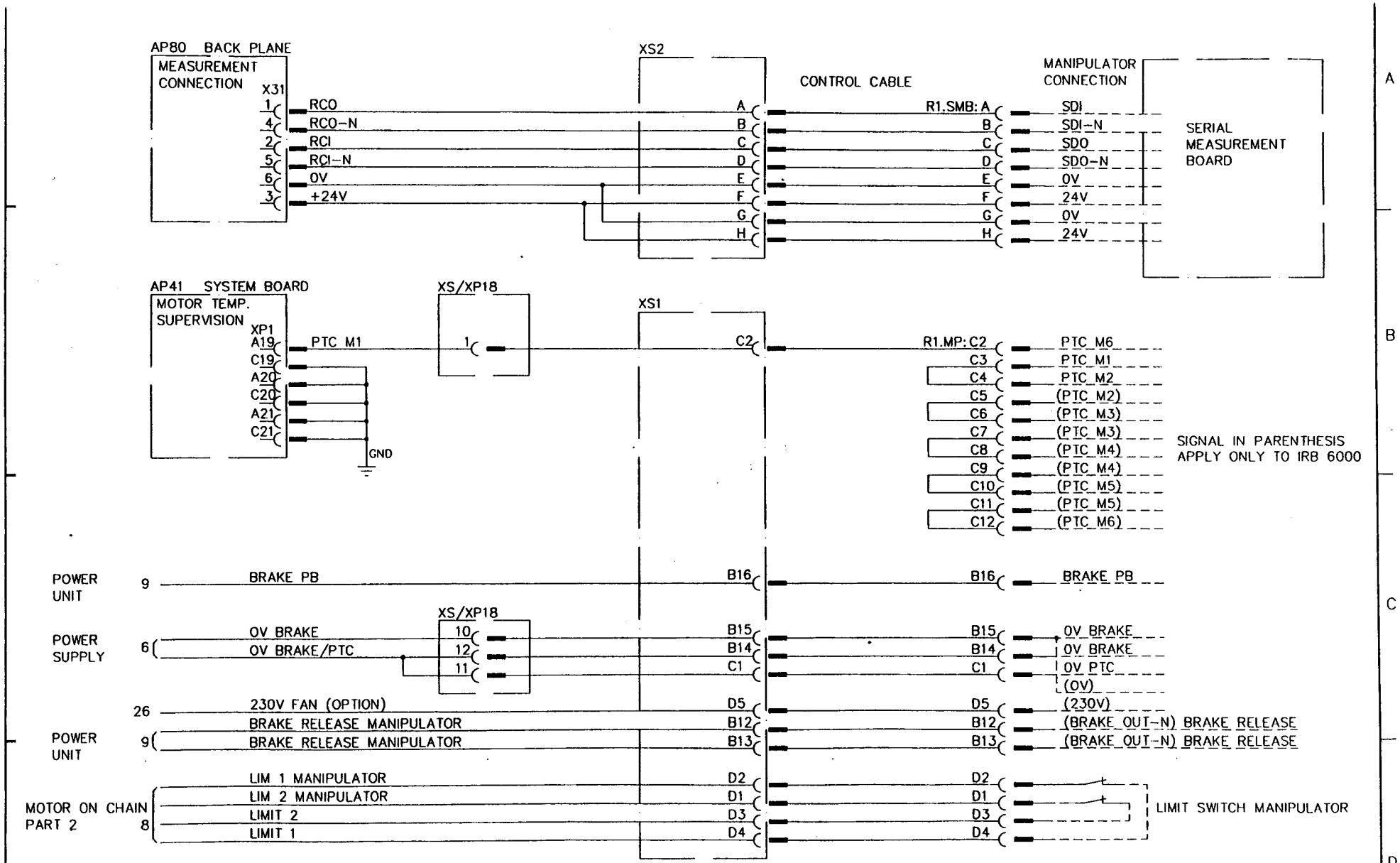
Document No.
3HAB 2126-5

Lang S
Sheet 12
Cont 13.1

Rev Ir Revision | Appd | Year Week



Rev In	Revision	Appd	Year Week

CONTROL CABLE

Approved MYKLEBUST
HOLM
Prepared KINDBERG

Title
CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A
PRIMARY PART IN ARCADE
Responsible dept KCS 93 34

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Document No.
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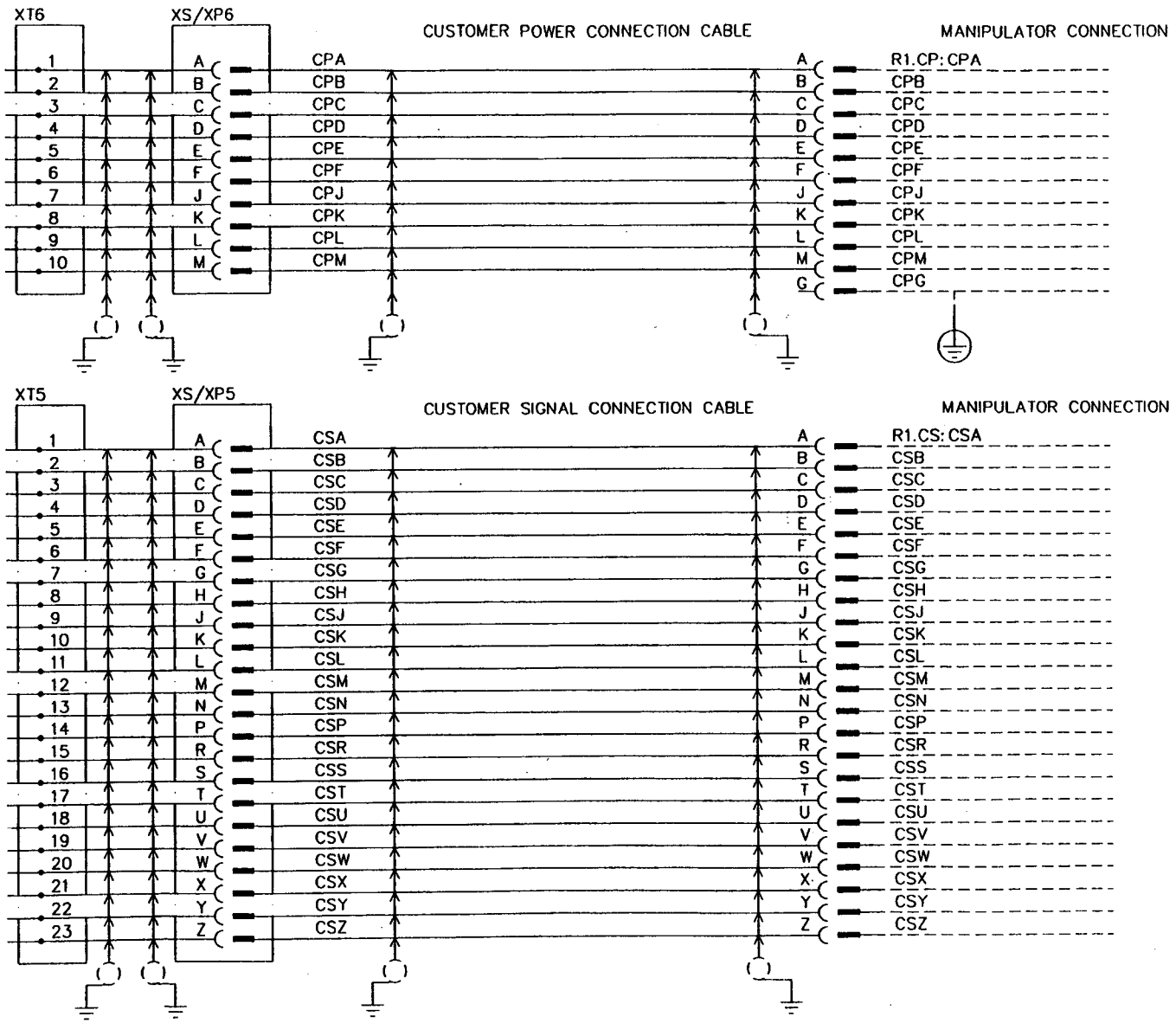
Lang S
Sheet 13.1
Cont 13.2



Rev In	Revision	Appd	Year Week

OPTIONAL CUSTOMER CONNECTIONS
MANIPULATOR

Approved MYKLEBUST
HOLM
Prepared KINDBERG

Title
CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A

PRIMARY PART IN ARCADE

Responsible dept KCS 93 43

ABB Robotics Products

Document No.
3HAB 2126-5

Long S | Sheet 13.2 | Cont 14

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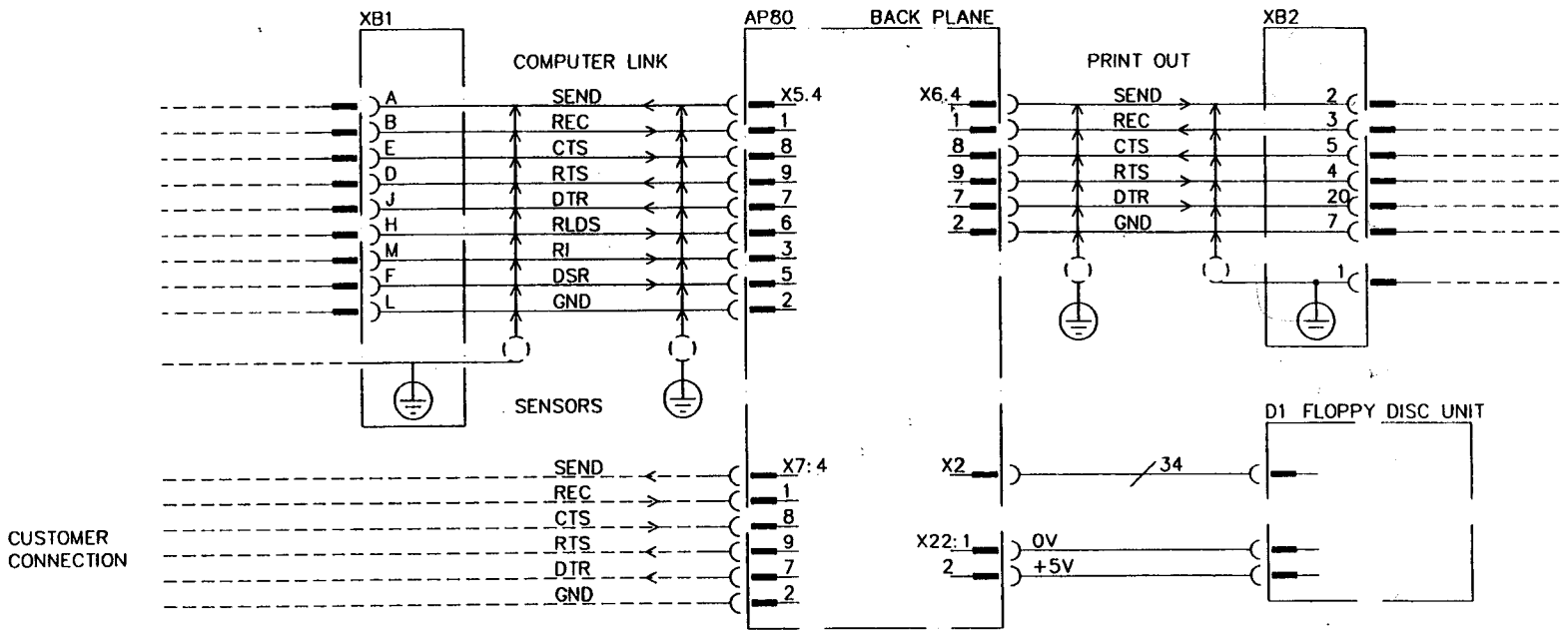

Rev In	Revision	Appd	Year	Week	FLOPPY DISC UNIT DATA PORTS	Approved MYKLEBUST HOLM Prepared KINDBERG	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	ABB Robotics Products Document No. 3HAB 2126-5	Lang S	Sheet 14 Cont 15

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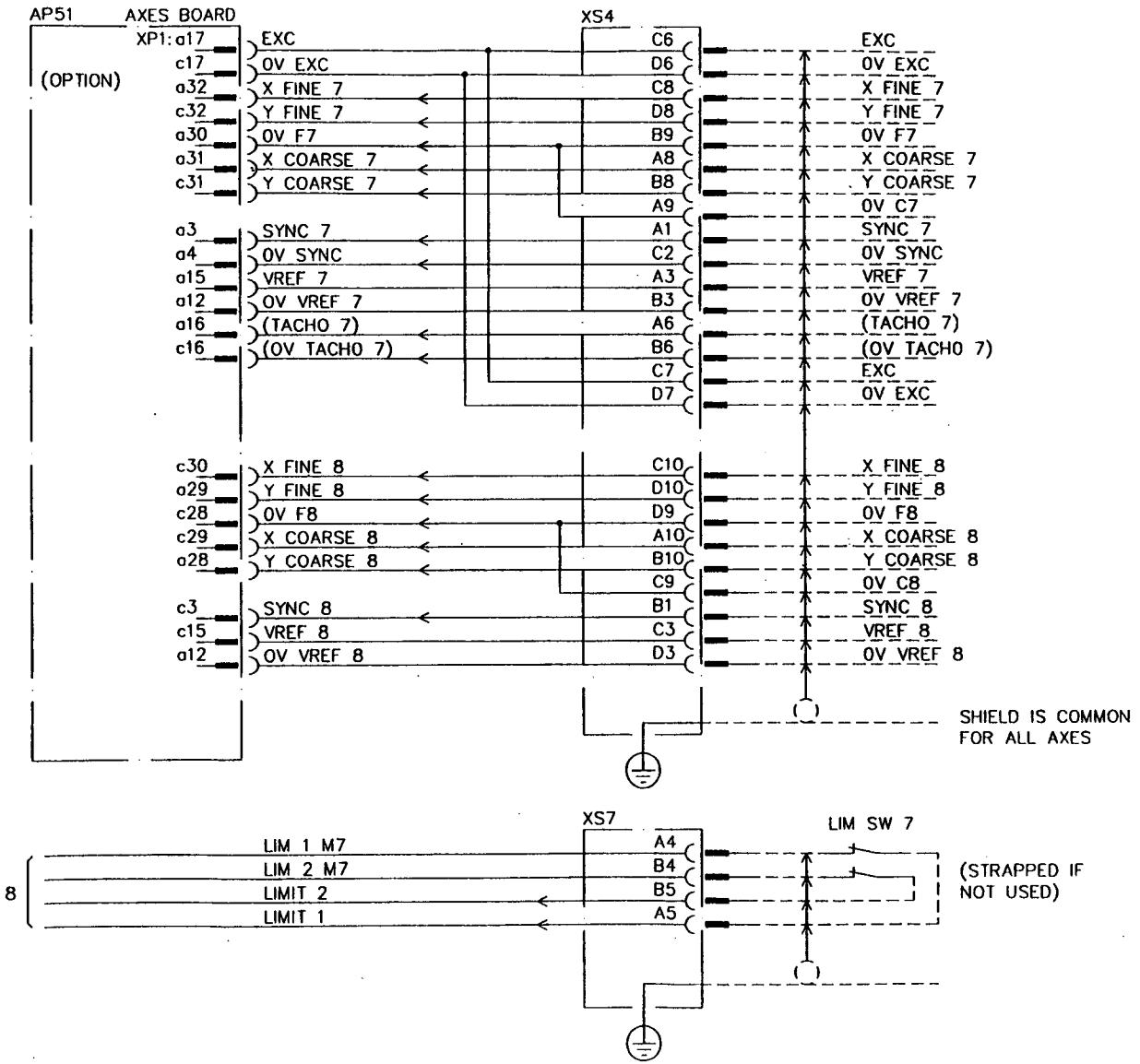
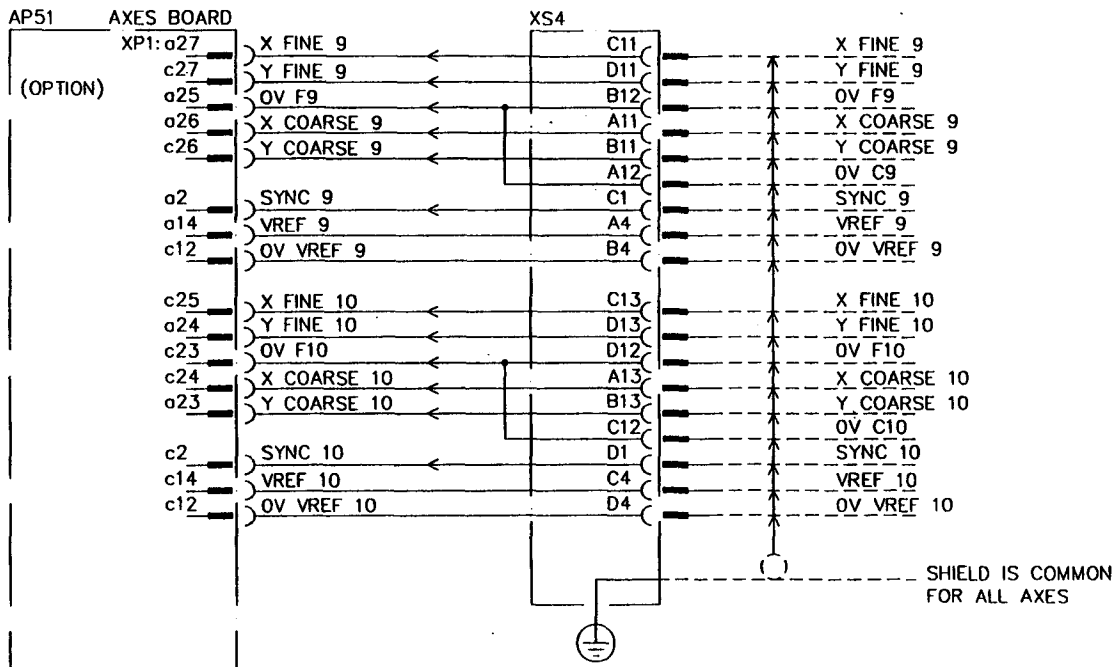


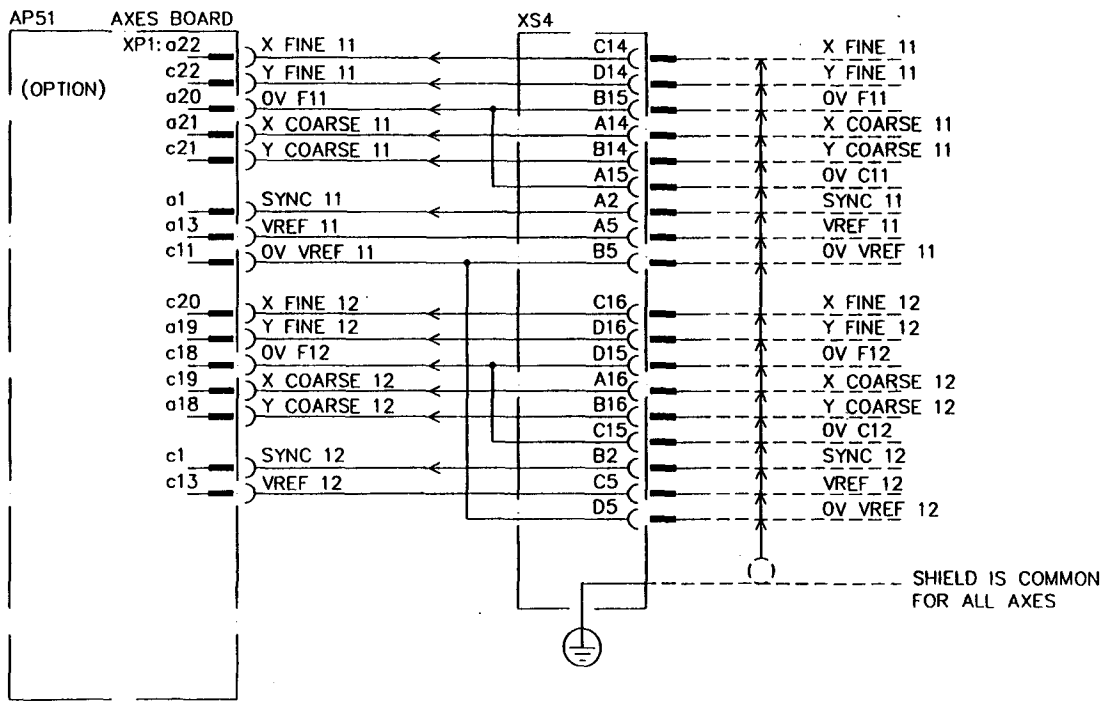
Rev Ir	Revision	Appd	Year Week	EXTERNAL AXES 7-8	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products				
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	Long S	Sheet 15	Cont 16

1 2 3 4 5 6

ABB



Rev In	Revision	Appd	Year Week	EXTERNAL AXES 9-10	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	Lang S / Sheet 16 / Cont 17

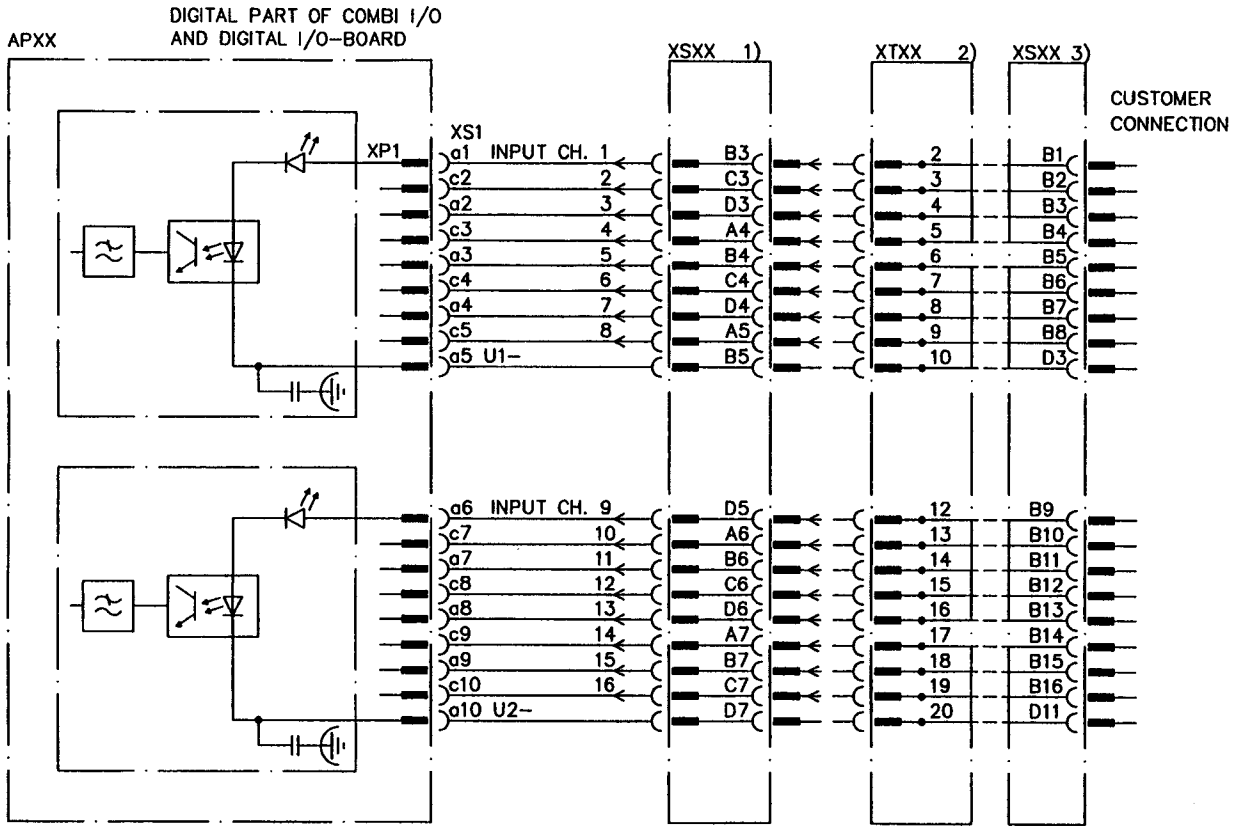


Rev In	Revision	Appd	Year Week						
				EXTERNAL AXES 11-12	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	Long S / Sheet 17 / Cont 18

1 2 3 4 5 6

OPTIONAL I/O BOARDS IN CONTROL SYSTEM S3

I/O-BOARD POSITION	I/O-BOARD DESIGNATION	I/O TYPE	CUSTOMER CONNECTIONS				INTERNAL I/O-SUPPLY	
			EXTERNAL	SCREW TERMINALS	RELAY UNIT	110V AC I/O	24V I/O	0V
1	AP11	COMBI I/O						
		ANALOGUE PART	XS10	XT10				
		DIGITAL PART	XS11	XT11	AP21	AP21	XT18.13	XT18.5
1	AP11	ANALOGUE	XS10	XT10				
1	AP11	DIGITAL	XS11	XT11	AP21	AP21	XT18.13	XT18.5
2	AP12	DIGITAL	XS12	XT12	AP22	AP22	XT18.14	XT18.6
3	AP13	DIGITAL	XS13	XT13	AP23	AP23	XT18.15	XT18.7
4	AP14	DIGITAL	XS14	XT14	AP24	AP24	XT18.16	XT18.8
5	AP15	DIGITAL	XS15	XT15	AP25	AP25	XT18.29	XT18.21
6	AP16	DIGITAL	XS16	XT16	AP26	AP26	XT18.30	XT18.22
2-6	AP12-16	REMOTE I/O-BOARD	–	XT17				

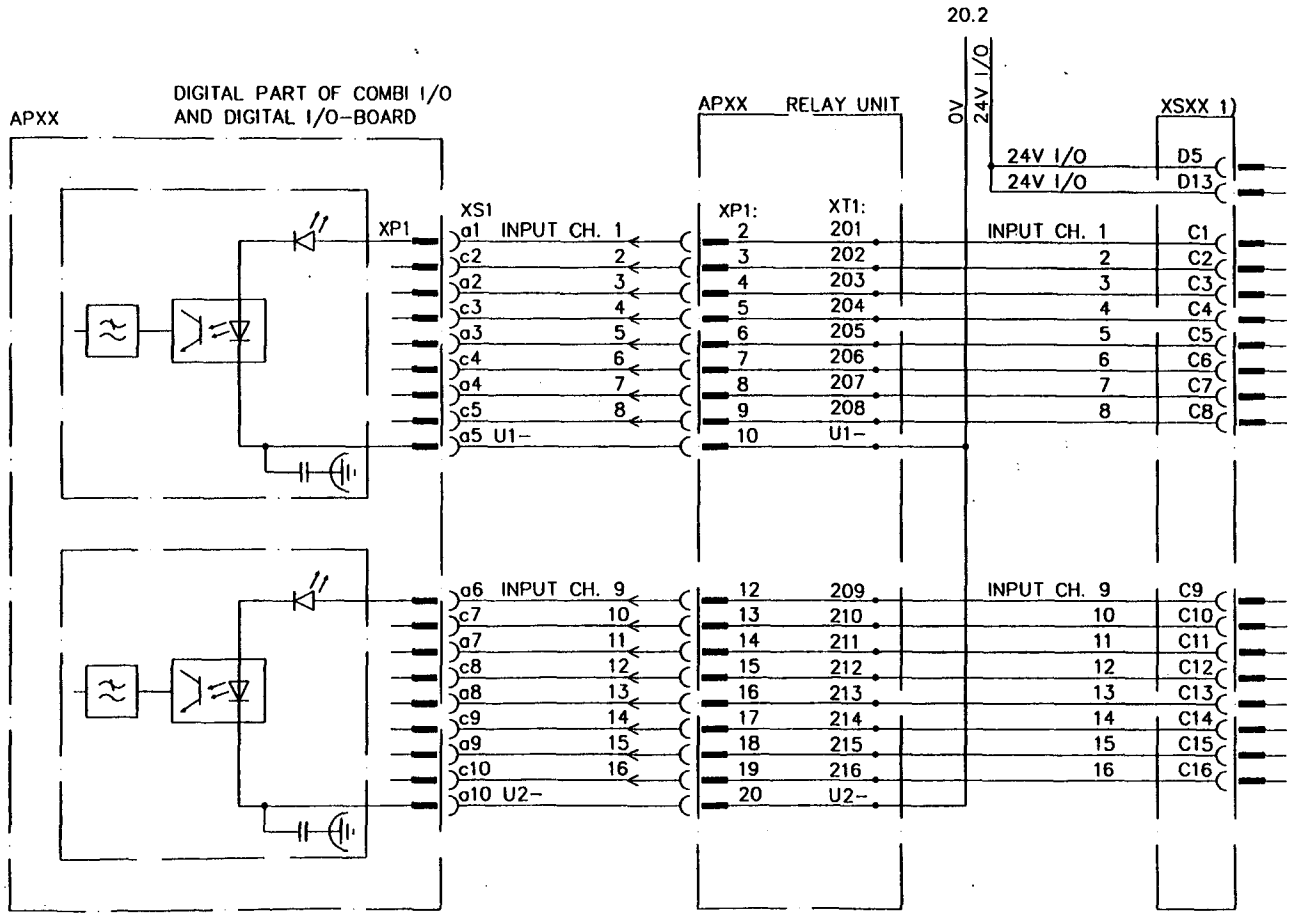


1) ONLY IF EXTERNAL CONNECTIONS

2) ONLY IF INTERNAL CONNECTIONS
OR SCREW TERMINALS/FLANGE DISCONNECTORS

3) ONLY IF EXTERNAL CONNECTIONS
AND SCREW TERMINALS

Rev Id	Revision	Appd	Year Week	DIGITAL PART OF COMBI I/O AND DIGITAL I/O-BOARD INPUT PART	Approved MYKLEBUST / HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	Lang S / Sheet 19.1 / Cont 19.2



1) ONLY IF RELAY UNIT AND INTERNAL I/O-SUPPLY

Rev Ir	Revision	Appd	Year Week

RELAY UNIT
INPUT 1-16

Approved MYKLEBUST
HOLM
Prepared KINDBERG

Title
CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A
PRIMARY PART IN ARCADE

Responsible dept KCS 93 34

ABB Robotics Products
Document No.
3HAB 2126-5

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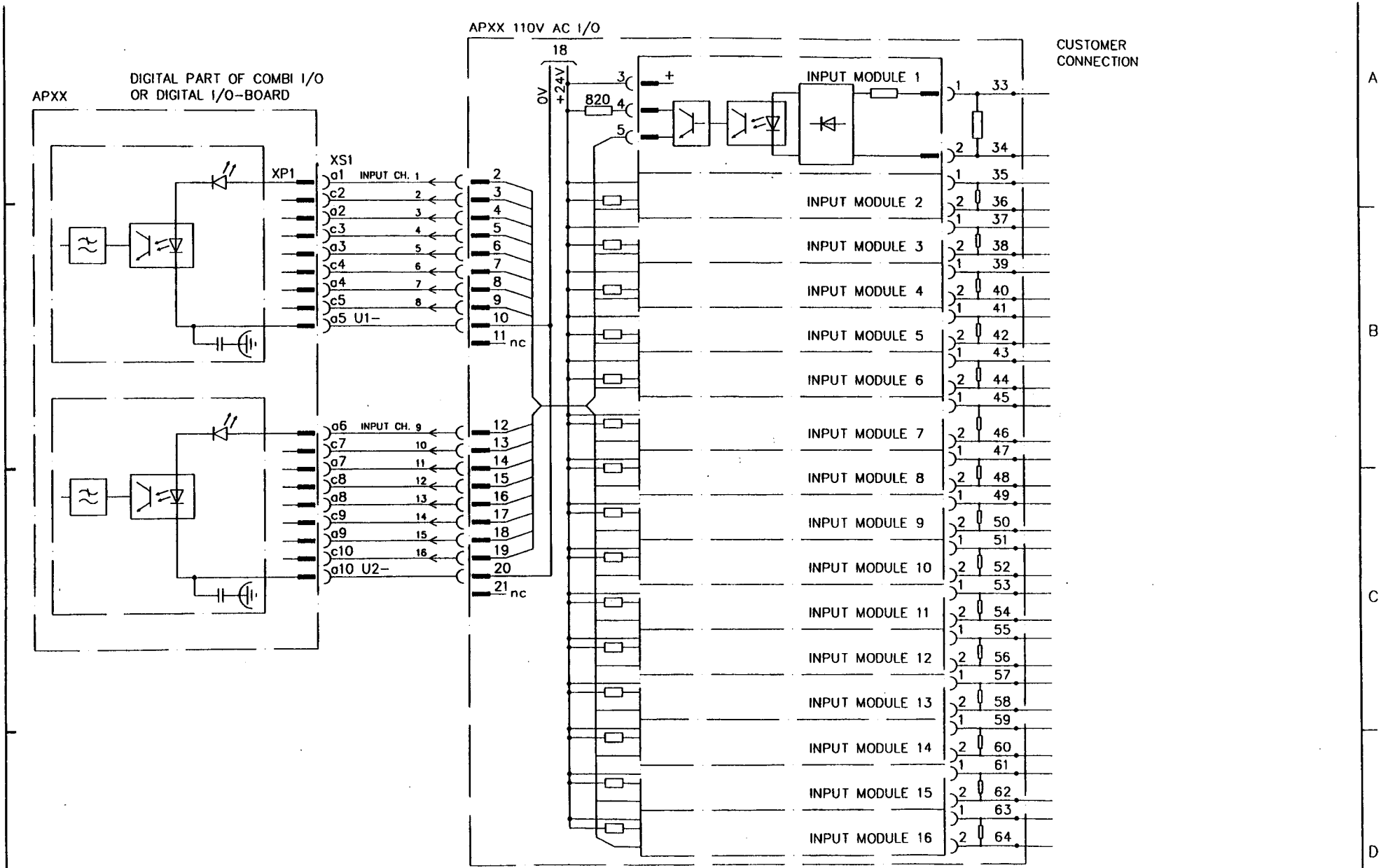
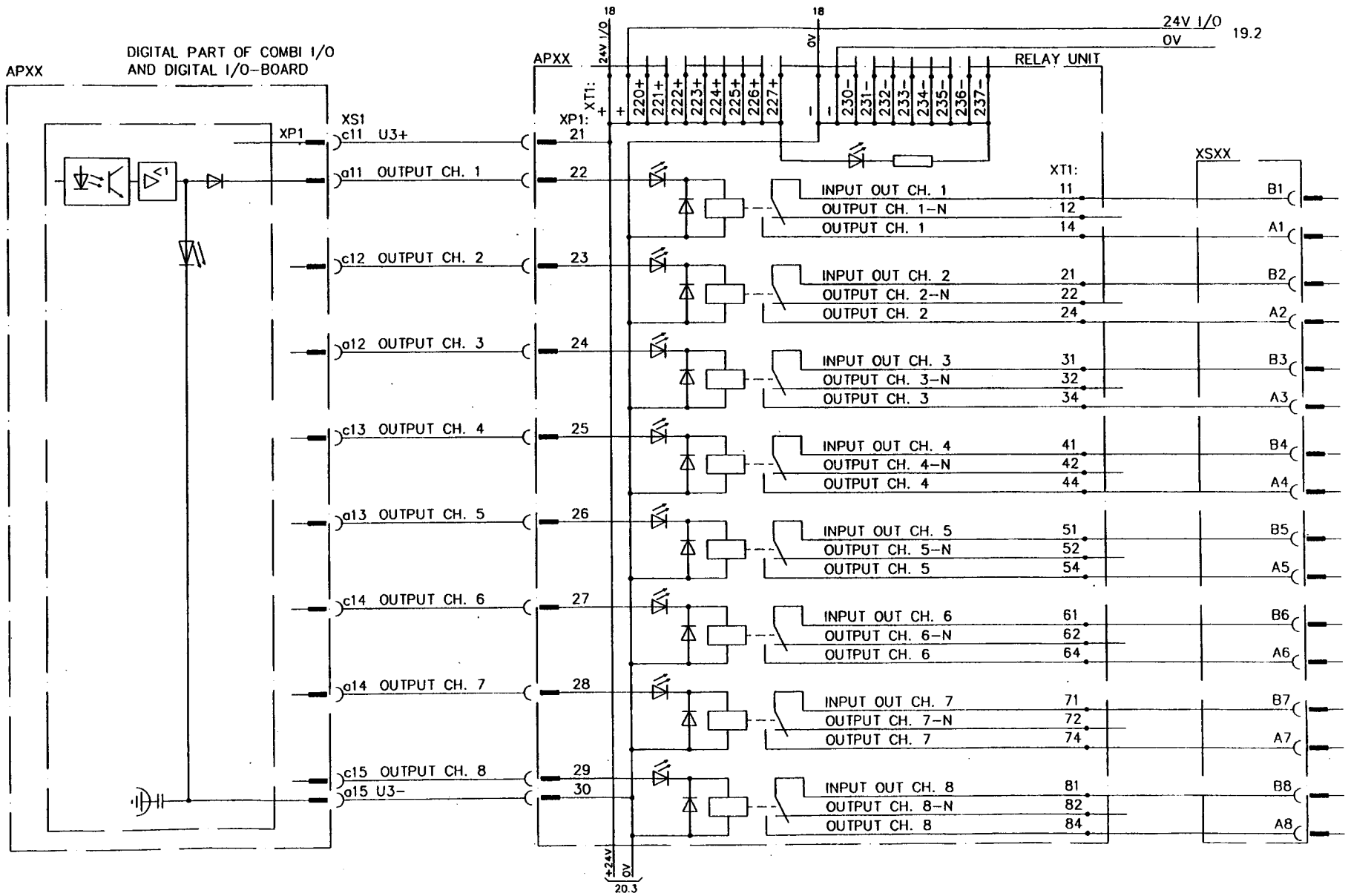
Sheet 19.2
Cont 19.3

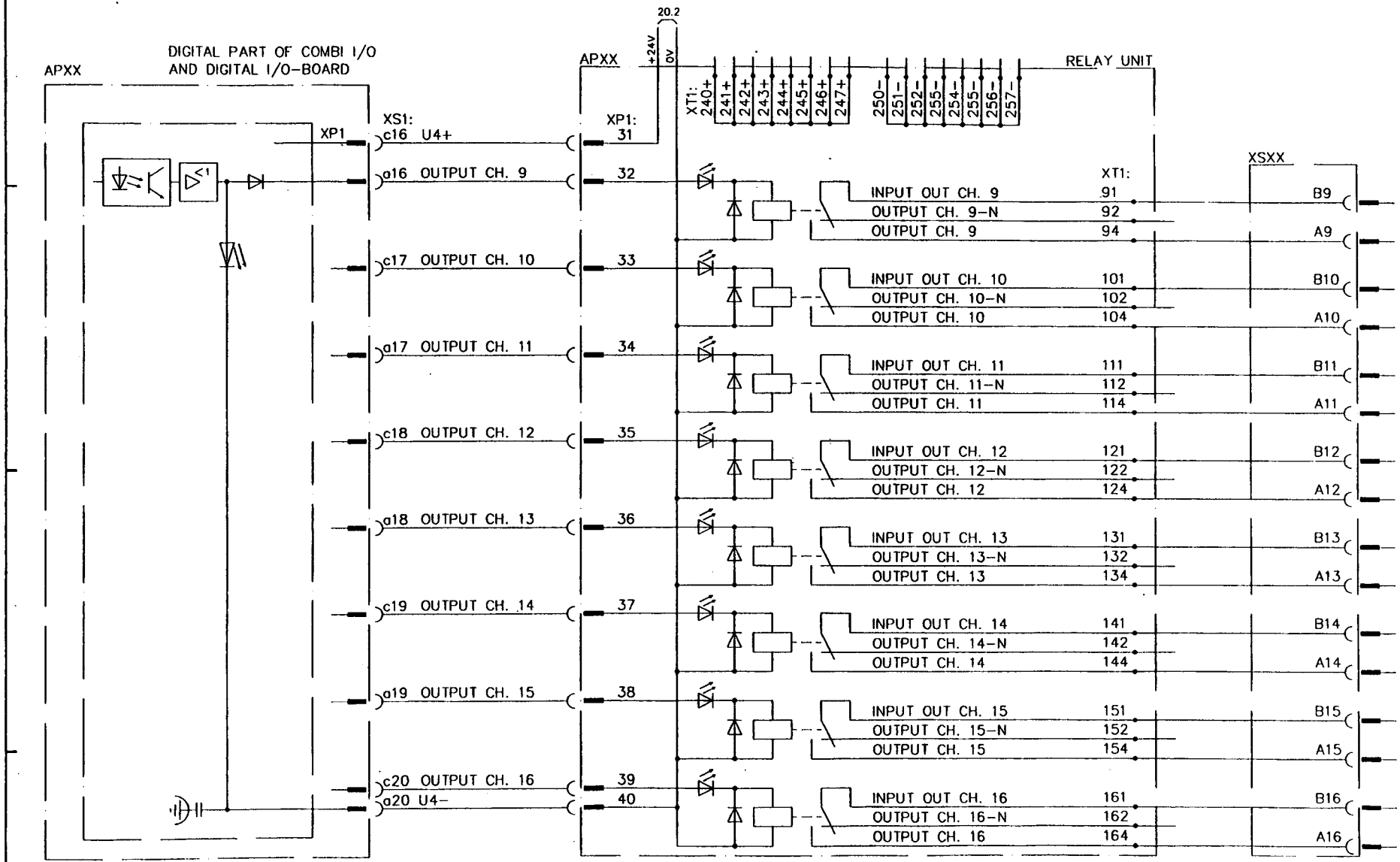
1 2 3 4 5 6



Rev Ir	Revision	Appd	Year Week	INTERFACE STAMPING MH OPTION 864	Approved MYKLEBUST HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	Lang S / Sheet 19.3 / Cont 20.1

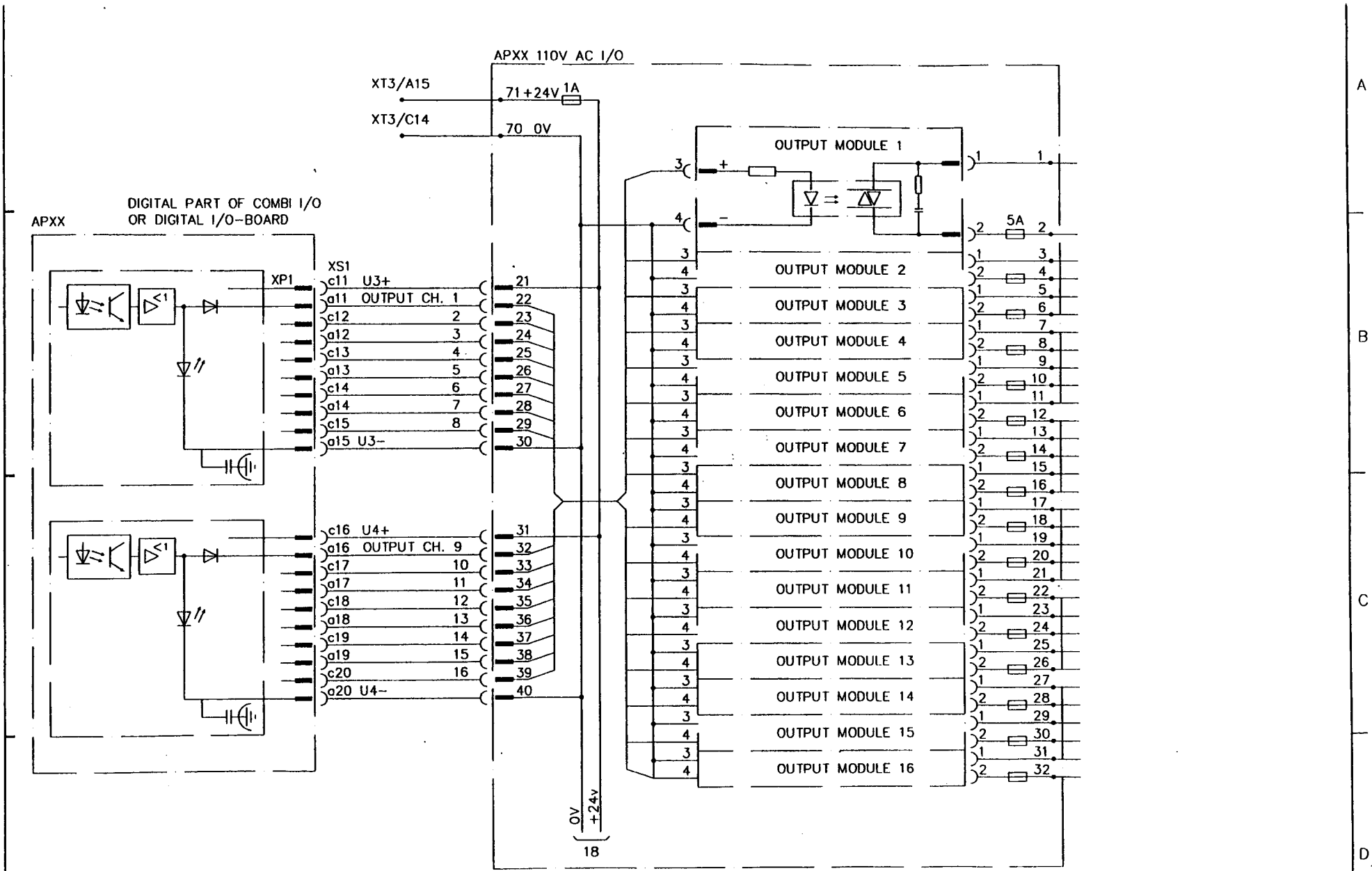


Rev In	Revision	Appd	Year Week	RELAY UNIT OUTPUT 1-8	Approved MYKLEBUST	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					HOLM		Document No. 3HAB 2126-5	Lang S	Sheet 20.2
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34		Cont 20.3

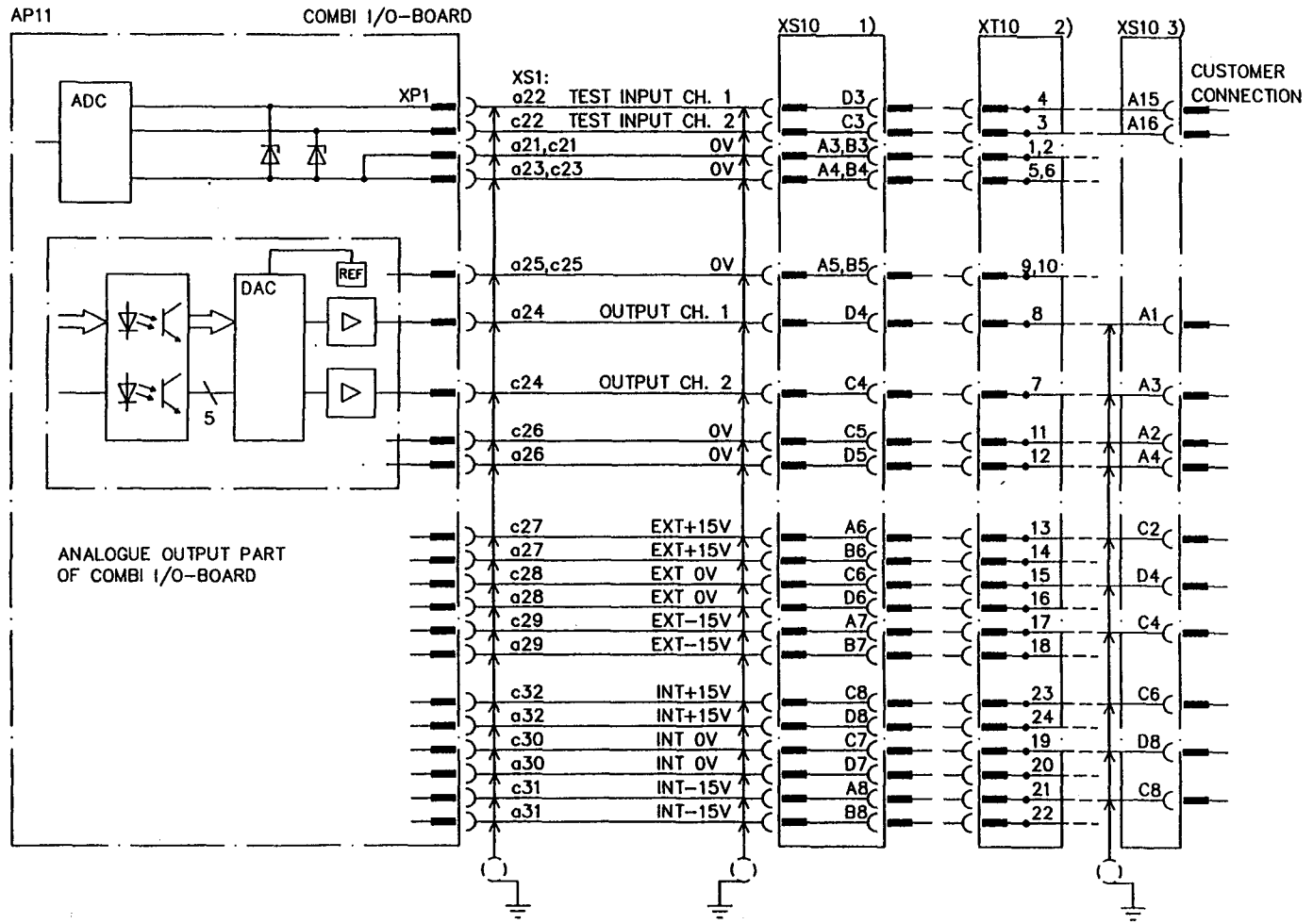


Rev Ind	Revision	Appd	Year Week	RELAY UNIT OUTPUT 9-16	Approved MYKLEBUST HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	Document No. 3HAB 2126-5	Lang S / Sheet 20.3 / Cont 20.4

1 2 3 4 5 6



Rev In	Revision	Appd	Year Week	INTERFACE STAMPING MH OPTION 864	Approved MYKLEBUST HOLM Prepared KINDBERG	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	ABB Robotics Products Document No. 3HAB 2126-5 Lang S Sheet 20.4 Cont 21



1) ONLY IF EXTERNAL CONNECTIONS
2) ONLY IF SCREW TERMINALS/FLANGE DISCONNECTORS
3) ONLY IF EXTERNAL CONNECTIONS AND SCREW TERMINALS

Rev In	Revision	Appd	Year Week
2	RI 1439		94 02

COMBI I/O-BOARD ANALOGUE OUTPUT PART

Approved: MYKLEBUST
HOLM
Prepared: KINDBERG

Title: CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A

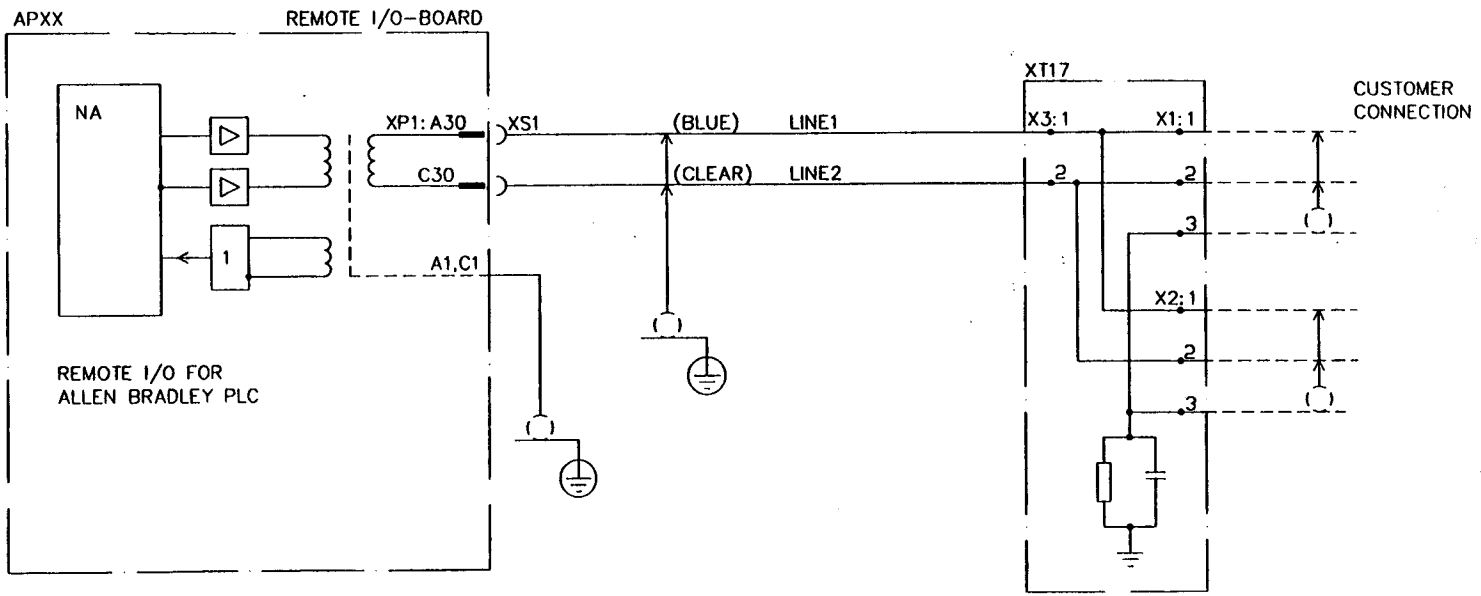
PRIMARY PART IN ARCADE

Responsible dept: KCS 93 34

ABB Robotics Products

Document No. 3HAB 2126-5

Lang: S
Sheet: 21
Cont: 22



Rev In	Revision	Appd	Year Week

REMOTE I/O-BOARD FOR
ALLEN BRADLEY PLC

Approved MYKLEBUST
HOLM
Prepared KINDBERG

Title
CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A

PRIMARY PART IN ARCADE

Responsible dept KCS 93 34

ABB Robotics Products

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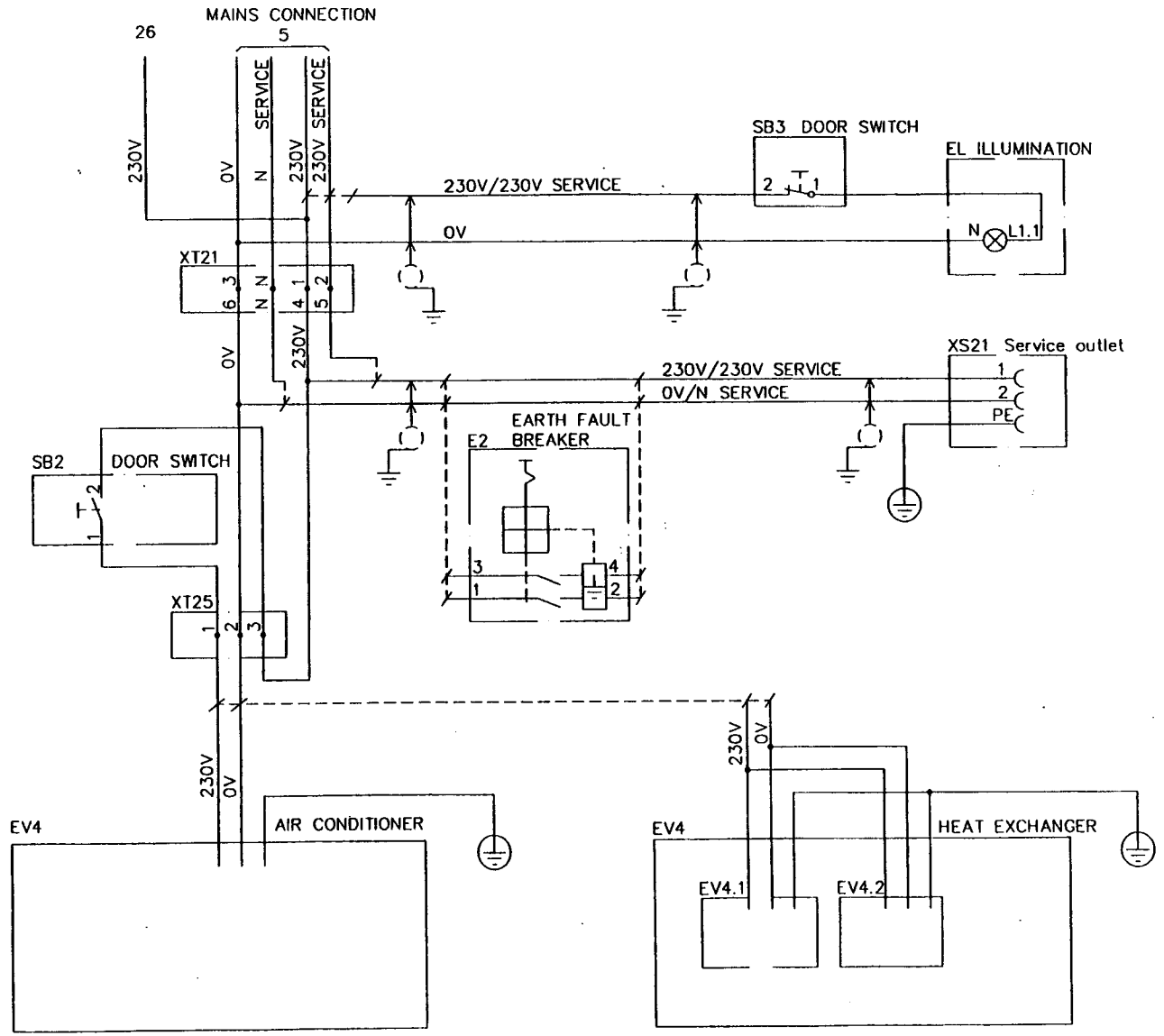
Lang S
Sheet 23
Cont 24

ABB



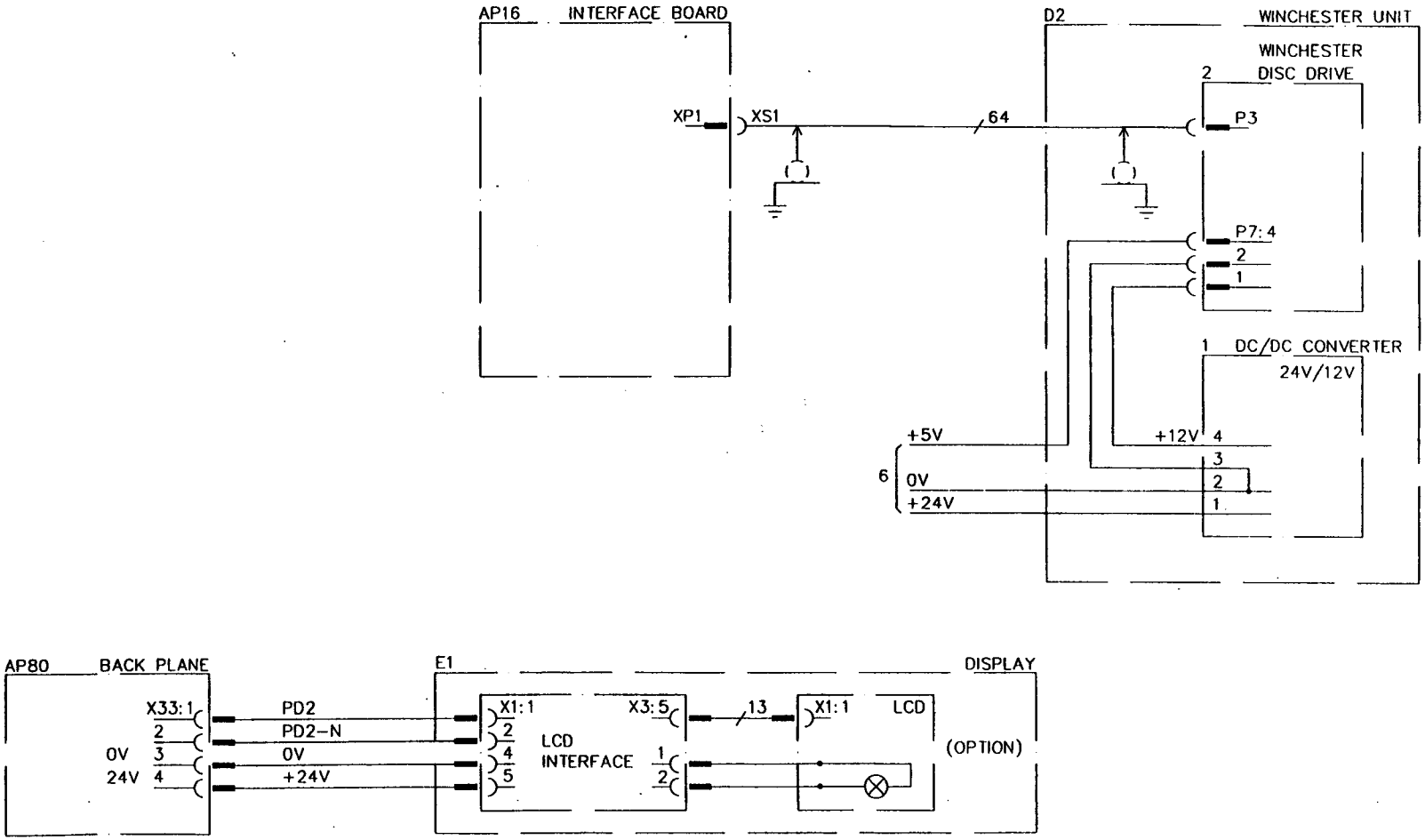
Rev Ir	Revision	Appd	Year Week	
				HEAT EXCHANGER, AIR CONDITIONER SERVICE OUTLET, ILLUMINATION (OPTION)

Approved MYKLEBUST
HOLM
Prepared KINDBERG

Title
CIRCUIT DIAGRAM
CONTROL SYSTEM S3 M93A
PRIMARY PART IN ARCADE
Responsible dept KCS 93 34

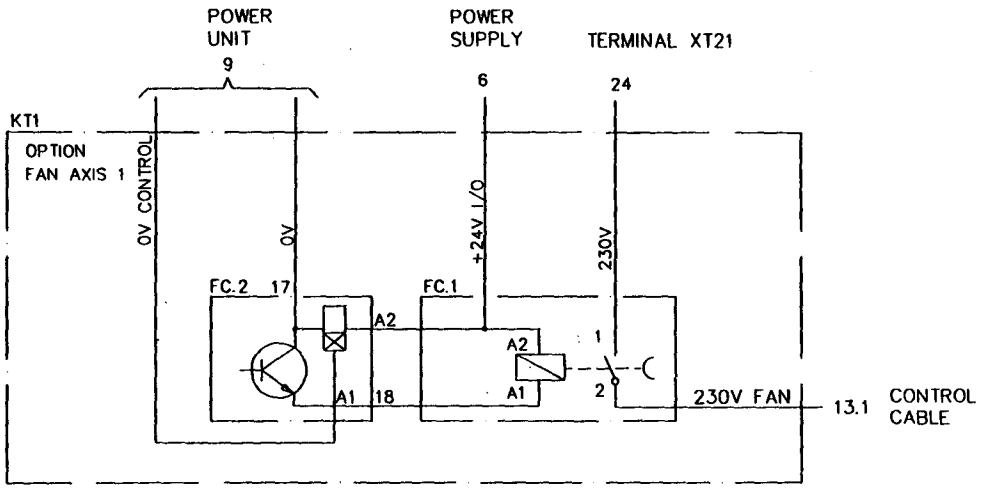
ABB Robotics Products
Document No.
3HAB 2126-5

Long S
Sheet 24
Cont 25



Rev.In	Revision	Appd	Year Week						
				WINCHESTER MASS MEMORY DISPLAY (OPTION)	Approved MYKLEBUST HOLM	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A	ABB Robotics Products		
					Prepared KINDBERG	PRIMARY PART IN ARCADE	Responsible dept KCS KCS	Document No. 3HAB 2126-5	Lang S / Sheet 25 / Cont 26

ABB



Rev In	Revision	Appd	Year Week						
				OPTIONAL FAN, AXIS 1 MANIPULATOR TIME DELAY, CONTACTOR	Approved MYKLEBUST HOLM Prepared KINDBERG	Title CIRCUIT DIAGRAM CONTROL SYSTEM S3 M93A PRIMARY PART IN ARCADE	Responsible dept KCS 93 34	ABB Robotics Products Document No. 3HAB 2126-5	Lang S Sheet 26 Cont -

1 2 3 4 5 6