AMK

AMKASYN

VARIABLE SPEED DRIVES

AMKASYN

Digital Inverters in Modular Construction
Series AN / AZ / AW

Central Modules AZ xx

Technical manual

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4400.1E

Part-No.: 25755

AMK

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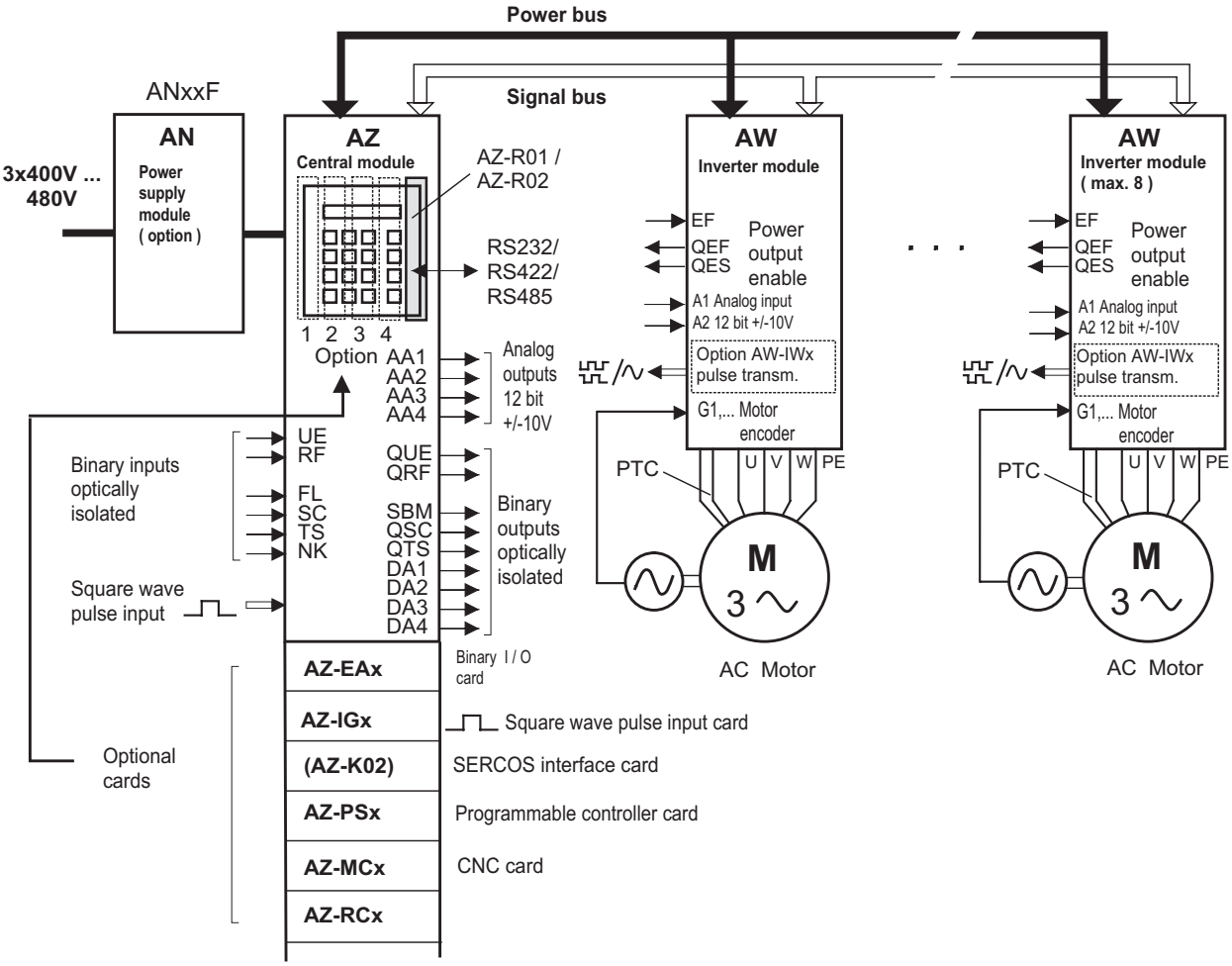
1 AMKASYN System overview



Abbreviations:

UE	DC - Bus enable	**QUE**	DC - Bus ready handshake	**EF**	Power output enable
RF	Inverters on (all)	**QRF**	Inverters ready handshake (all)	**QEF**	Power output enabled
FL	Error reset	**SBM**	System ready	**QES**	Power output disabled
SC	Status code call	**QSC**	SC handshake		
TS	Status code clock	**QTS**	TS handshake		
NK	Cam (Ref. L.S.)	**DA1**...			
		DA4	Data output DA1...DA4		

The AMKASYN series is a drive system of modular construction for feeding AMK AC motors. The digital inverters regulate the drives in 4 quadrant mode precisely and with high dynamic response. The feed is direct from a 400V three-phase power supply. The inverter modules are supplied from a common DC BUS. The latest power semiconductor technology in conjunction with high-grade integration guarantees high reliability.

2 Safety instructions

Please read and observe additionally the „Safety instructions for AMKASYN Inverters“.

Meaning of the used symbols:

Danger

Possible consequences: Dead or severest injuries!

Warning

Possible consequences: Severe injuries or death!

Warning

The operation of the drive system in a manner that does not conform to its purpose and intended use can be dangerous and can cause severe injury, up to loss of life, to the user/operator. Misuse can also cause damage to the machinery/equipment of the enduser.

In order to minimize the risk of accidents and damage it is necessary that installation, start-up, maintenance and repairs are performed diligently by trained and experienced specialists.

Drive system parameters may only be set or modified by the machine manifacturer!
Entry of non-conforming parameter values is effecting the drive behaviour and increasing the risk of accidents and damage!

Danger

Each time before working on the AMKASYN drive system: Interrupt power supply using the MASTER SWITCH!
Working under voltage is dangerous to life!
More than ONE LIVE CIRCUIT! See diagram! (2 line circuits on AZ module X01, X03).
After POWER OFF:
Because of capacitor charge don’t touch electrical connections immediately! DC voltage at terminals UZP and UZN is dangerous to life!
Before working on the modules wait for discharge time longer than 3 minutes after turning power off!

The option cards and all plug connectors must only be inserted or removed when the modules are voltage-free!

Never losen or tighten terminals under voltage!

3 Central modules AZ xx specifications

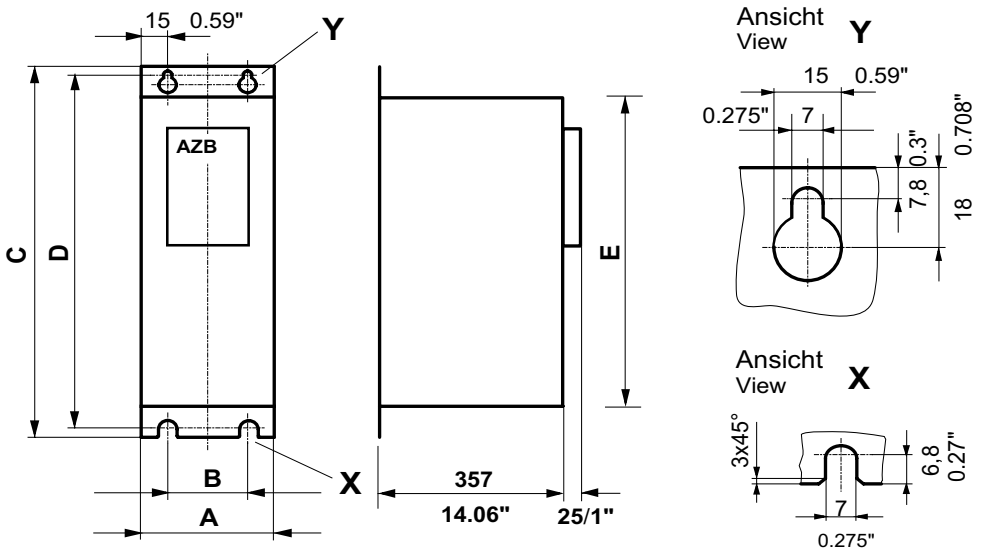
The value „xx“ characterizes the nominal DC-output power.

Type	**AZ 10**	**AZ 20**	**AZ 40**	**AZ 60**
Input voltage (range)	3 x 400V (3 x 400V...480V*) ±10%, 47...63 Hz			
DC BUS voltage	540VDC (540...650VDC)*			
Efficiency	approx. 0.98			
Power factor cosφ	> 0.9			
Number of AW modules that can be connected	max. 8, note power values			
Cooling	forced convection			
Fan voltage	230V		230V	
Fan rating	20 W		30 W	
AZ input current	16 A	32 A	64 A	96 A
Nominal output power	10 kW	20 kW	40 kW	60 kW
Overload for 60 s	25 kW	40 kW	70 kW	90 kW
Regenerative overload for 60 s / Continuous regenerative power	-	1.5 / 1.0	1.2 / 0.7	1.0 / 0.5
Braking transistor	Integrated in the AZ module			
Internal discharge/braking resistor	300 Ω			
Average braking power	200 W			
Peak braking power for 1s	1.8 kW			
Ext. braking resistor (option)	min. 20 Ω		min. 8 Ω	min. 8 Ω
Recommended cable cross-sections [mm²] / AWG	Cable cross-sections according to „Conductor Table 53.2 UL508C“. Use copper wires (75°C) only.			
X25 AN-AZ Charging circuit	3x1/AWG16	3x1/AWG16	3x1/AWG16	3x1/AWG16
X26 AN-AZ 3x400V DC Bus power input	3x2.5/AWG12	3x6/AWG8	3x16/AWG4	3x25/AWG2
X33 Fan[1)]	2x0.75/AWG18	2x0.75/AWG18	2x0.75/AWG18	2x0.75/AWG18
X21 RB Braking resistor	2x2.5/AWG12	2x2.5/AWG12	2x4/AWG10	2x6/AWG8
X24 RTB Ext. PTC resistor	2x0.5/AWG20	2x0.5/AWG20	2x0.5/AWG20	2x0.5/AWG20
PE-connection [mm] / AWG	4 / AWG10	6 / AWG8	16 / AWG4	25 / AWG2
Cross-section PE bar [mm] / [in.]	≥ 10x3 / 0.4x0.1		≥ 15x6 / 0.6x0.25	
Dimensions H x W x D [mm] / [in.]	358x170 x357 / 14.1x6.7x14.05		538x170x357 / 21.2x6.7x14.05	
Weight m [kg] / [lb]	10.5 / 23	11 / 24	16 / 35	16.5 / 36
Recommended power supply fuses, if fed without AN module	20 A	35 A	80 A	100 A

* Extended line voltage range

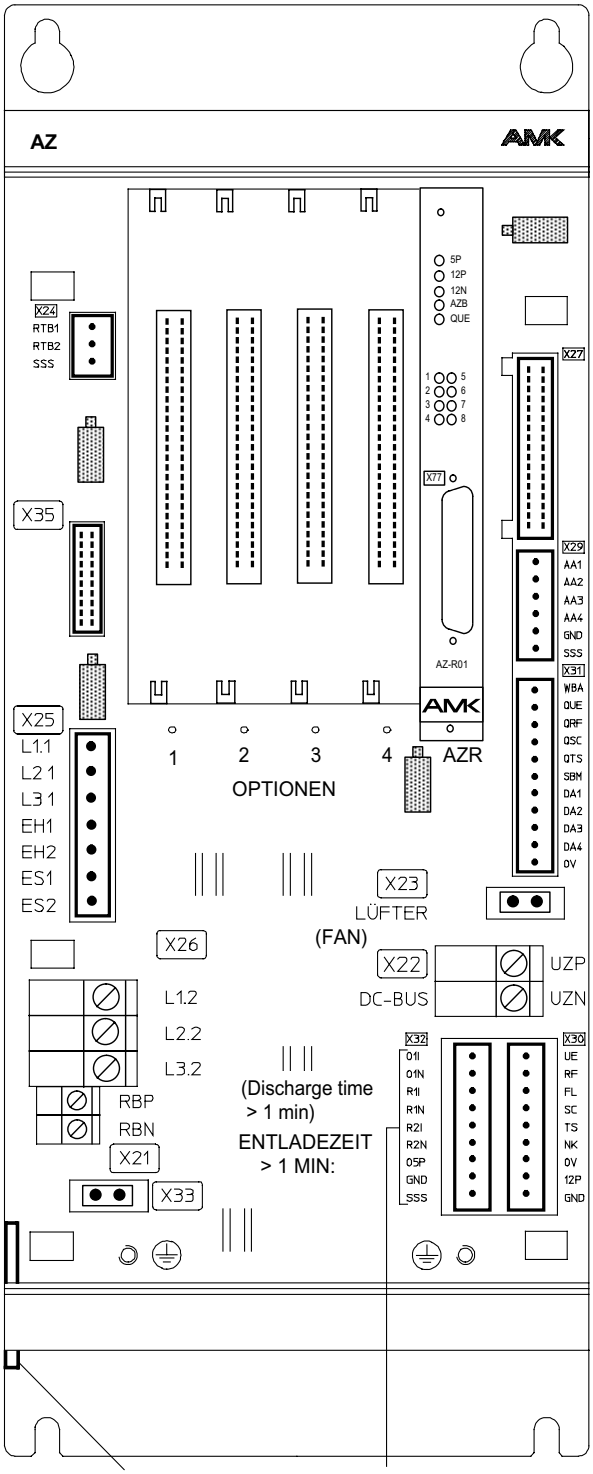
1) Socket housing Molex Minifit type 5557 (Ident-No. 23326), Crimp contact (Ident-No. 23327)

4 Dimensions Central modules AZ xx



Type	A	B	C	D	E
AZ10	170 (6.69")	140 (5.51")	415 (16.34")	400 (15.75")	358 (14.09")
AZ20	170 (6.69")	140 (5.51")	415 (16.34")	400 (15.75")	358 (14.09")
AZ40	170 (6.69")	140 (5.51")	595 (25.43")	580 (22.84")	538 (21.18")
AZ60	170 (6.69")	140 (5.51")	595 (25.43")	580 (22.84")	538 (21.18")

5 Front view Central modules AZ



X24
PTC resistor
(external brake resistor)

X35
AZB panel connection

X25
3x400V for switch mode power supply, charging circuit

Main contactor ON

Main contactor interrupt

X26
3x400V
DC-BUS supply behind main contactor

X21
External brake resistor

X33
Fan supply

X27
Signal bus

X29
Analog outputs

X31
Binary outputs

X23
Fan

X22
DC-BUS voltage

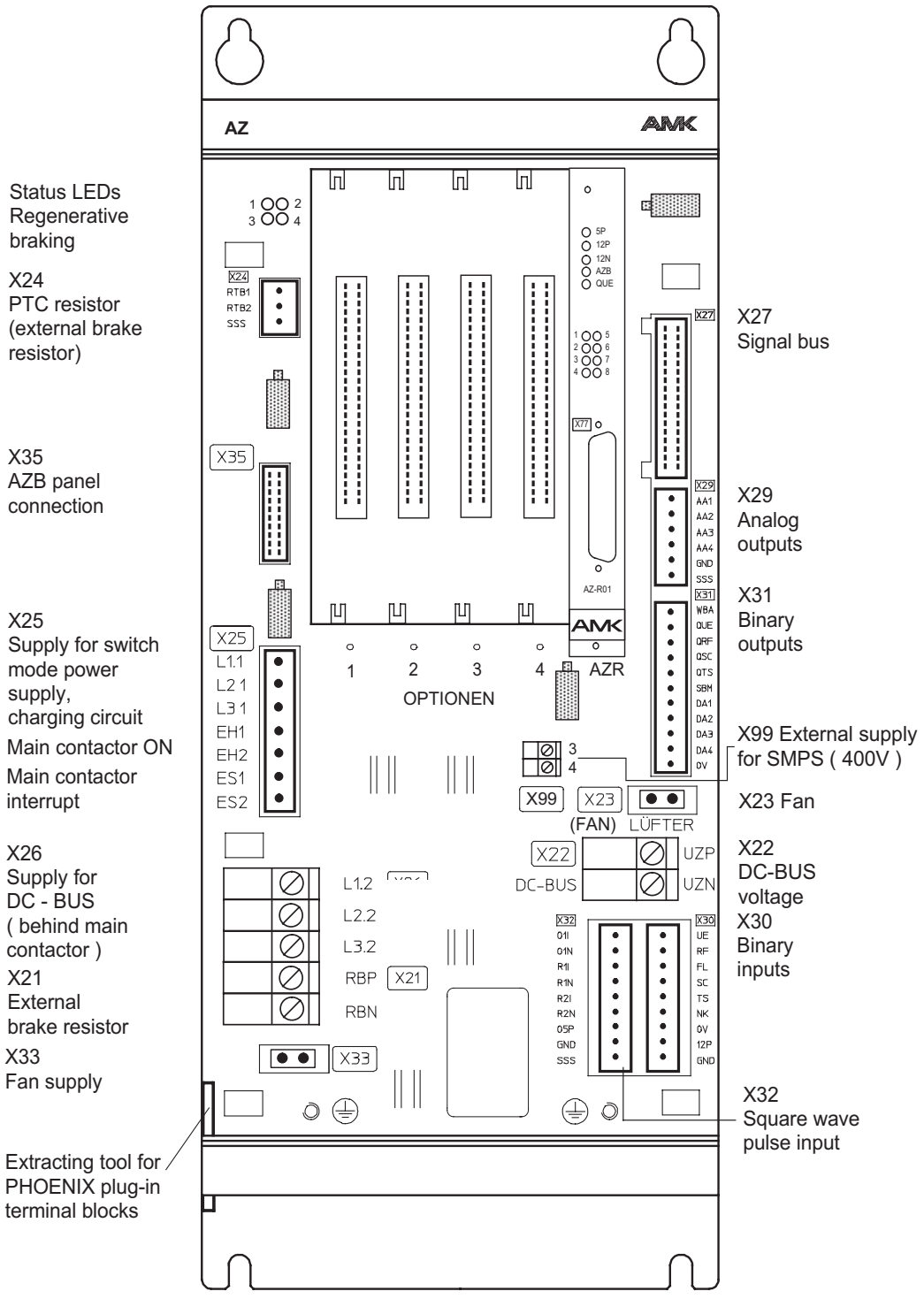
X30
Binary inputs

Extracting tool for PHOENIX plug-in terminal blocks

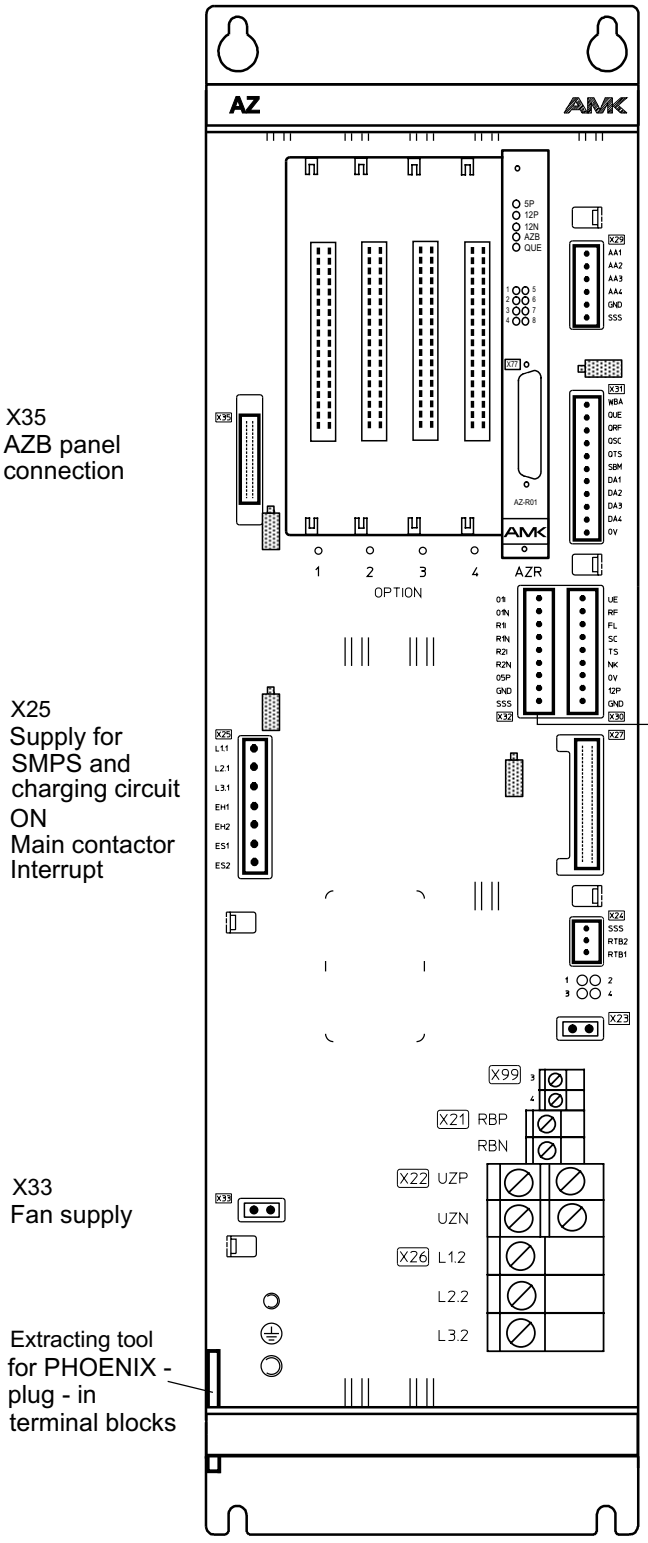
X32
Square wave pulse input

Front view Central modules AZ 10 / AZ 20

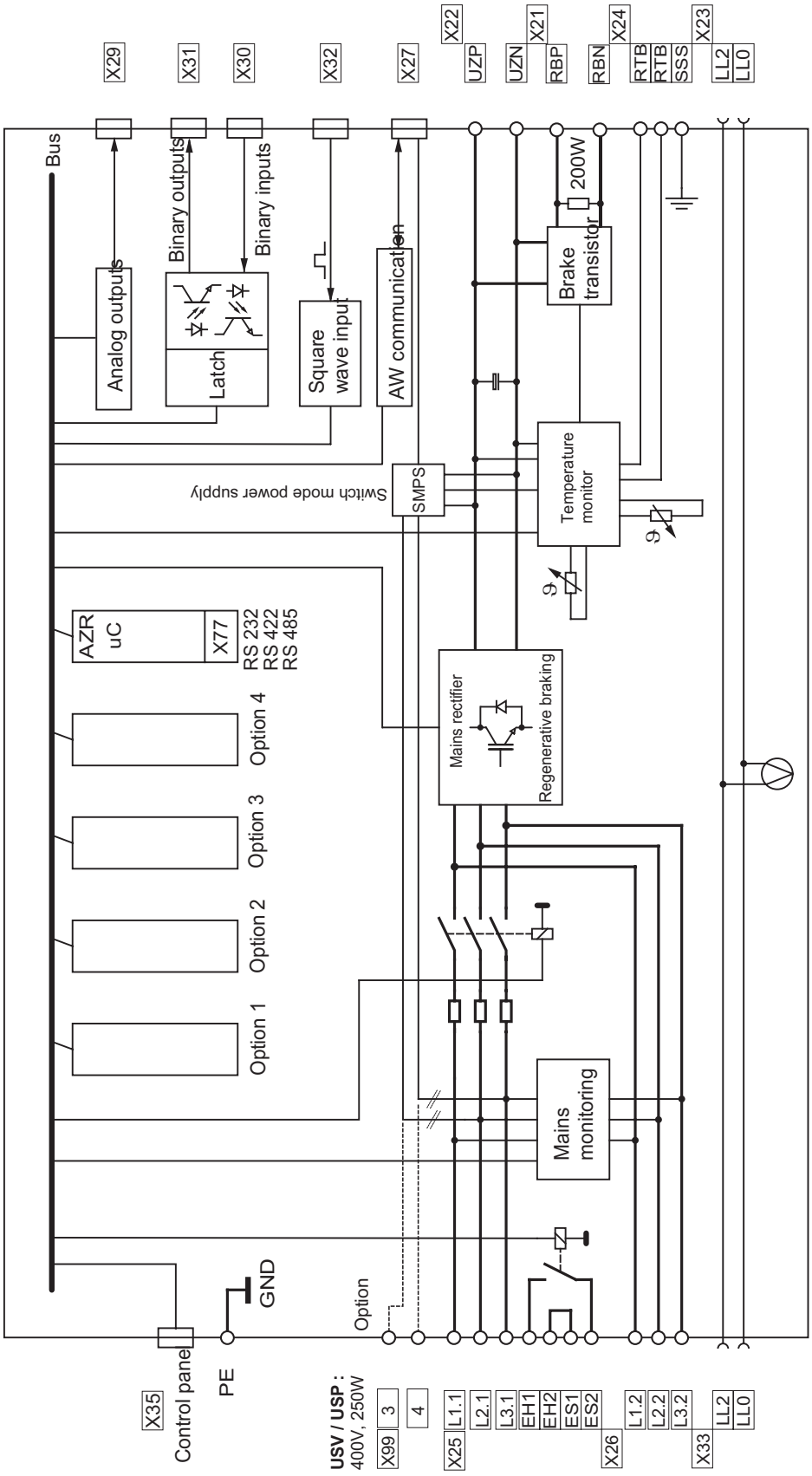
(redesigned modules with extended line voltage range)



Front view Central modules AZ 40 / AZ 60
(redesigned modules with extended line voltage range)

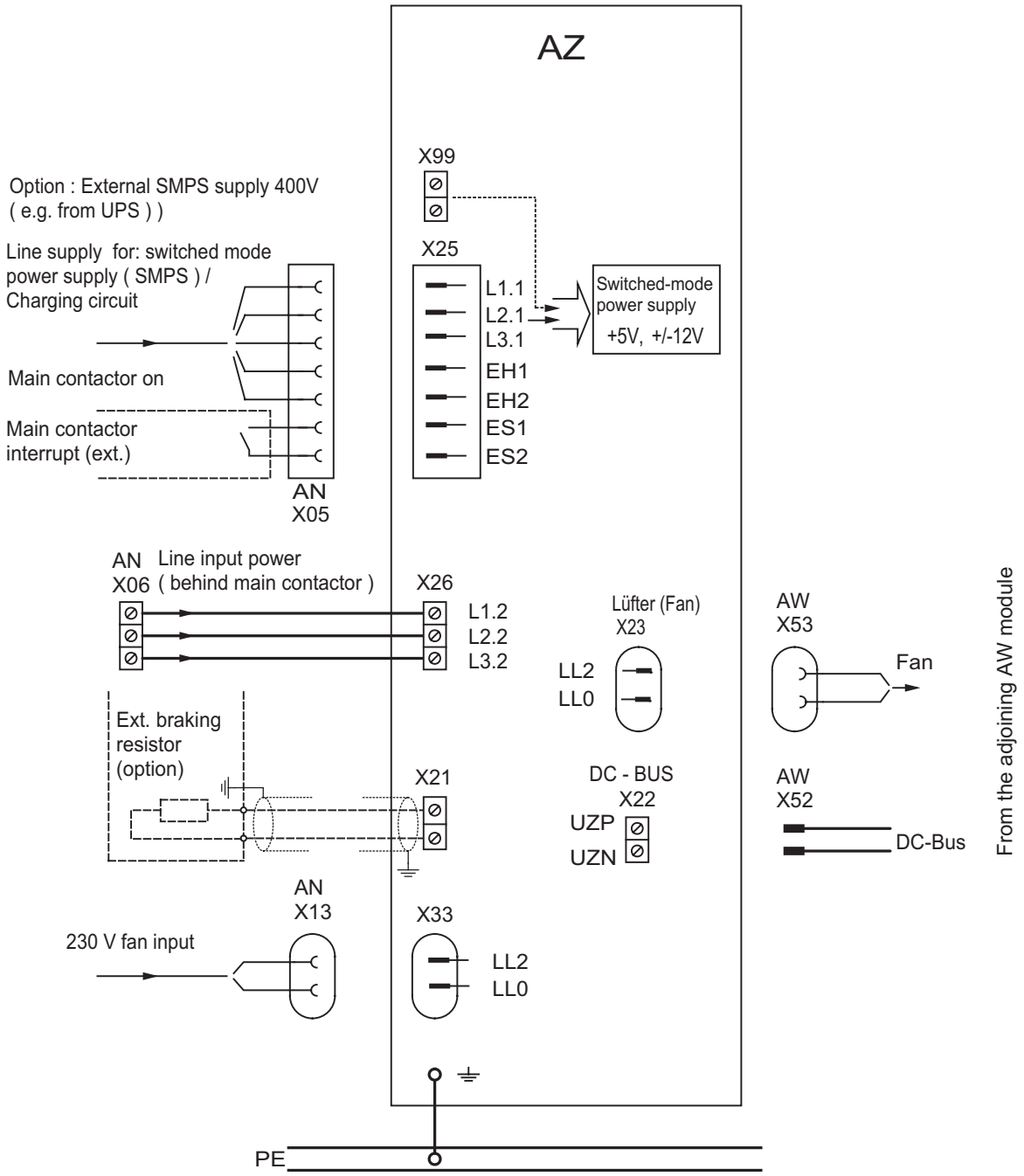


6 Block diagram Central modules AZ

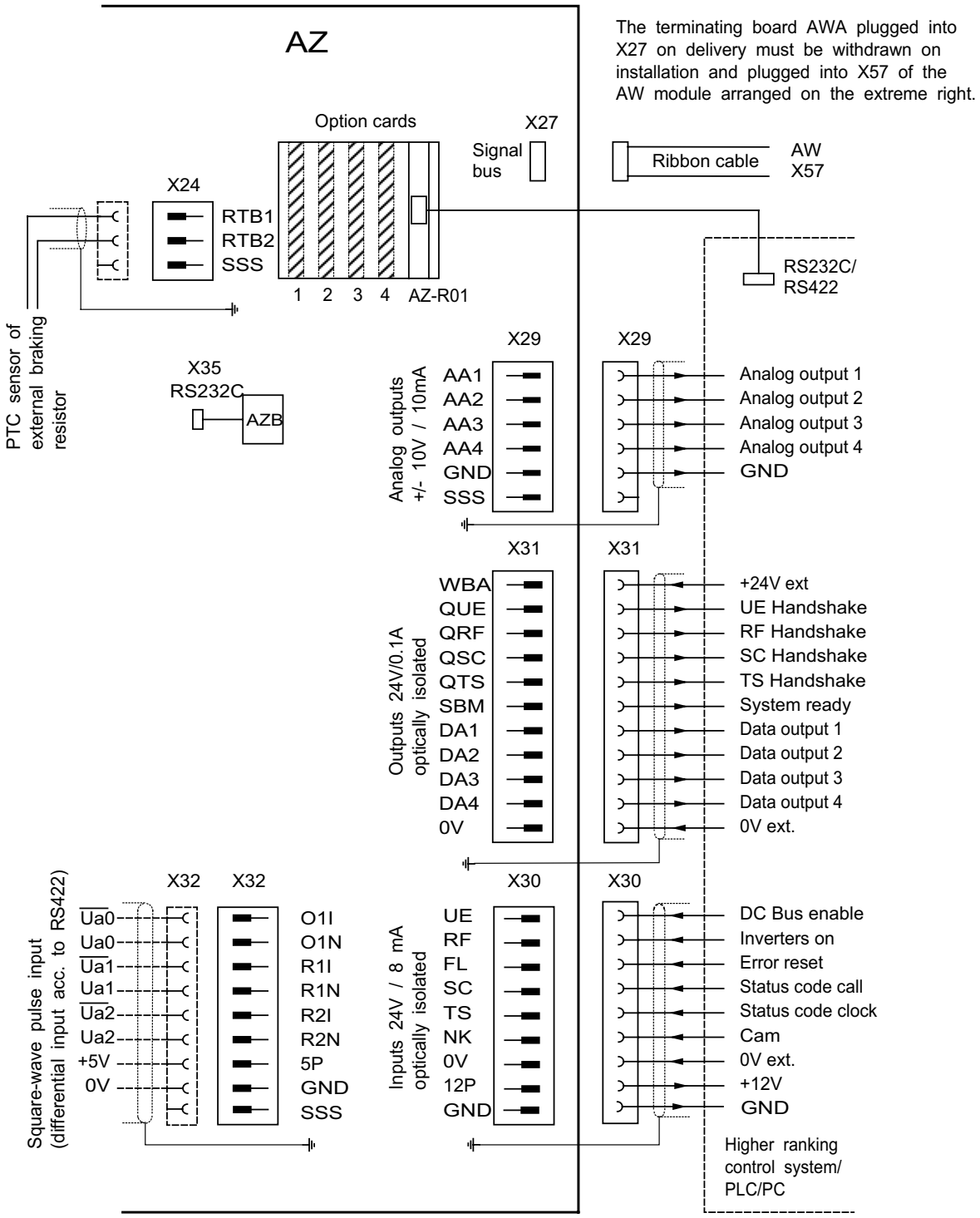


7 Connection drawing Central modules AZ

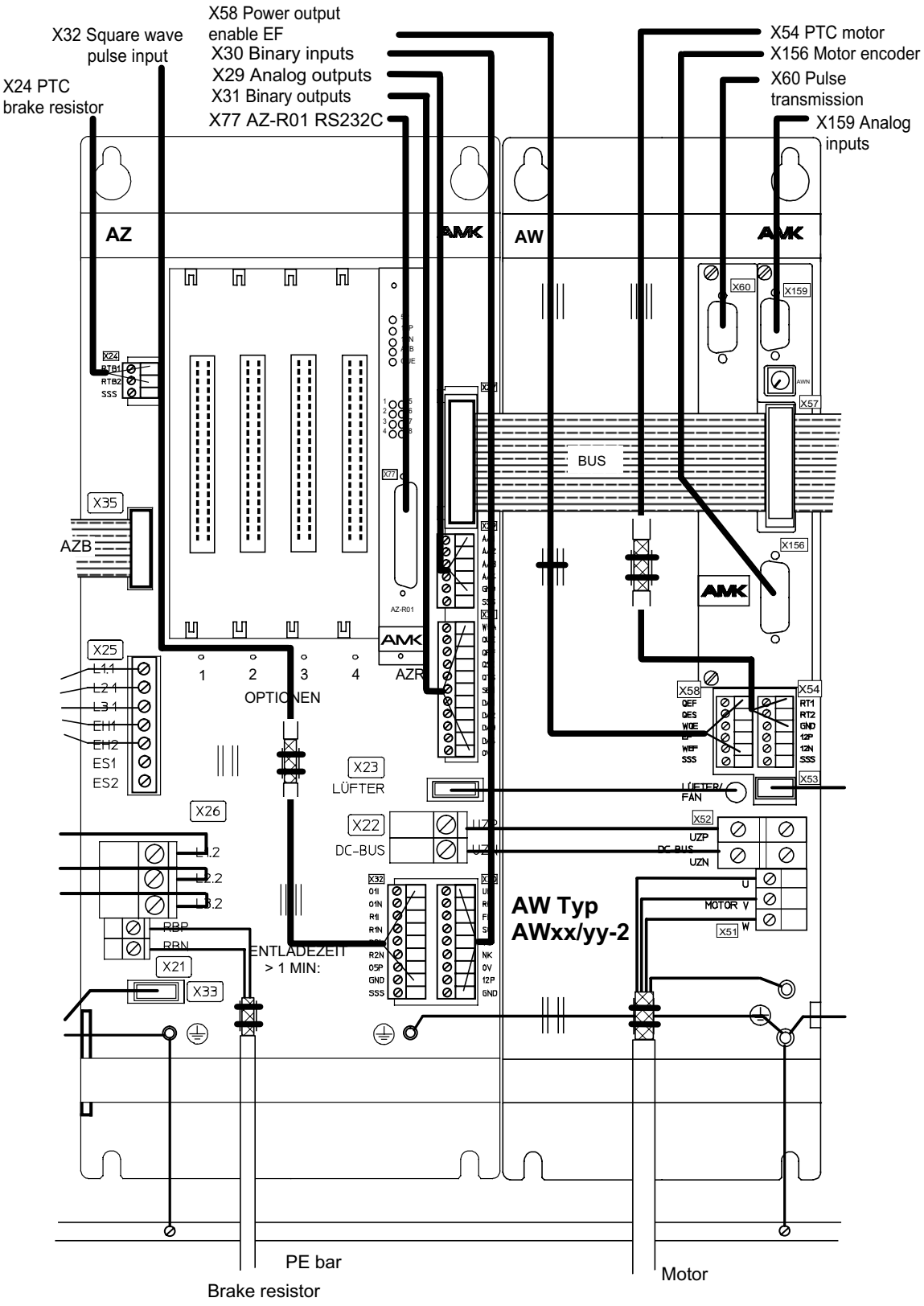
7.1 Connection drawing power side



7.2 Connection drawing signal side



8 Wiring AZ - AW



9 Functional description of Central module AZ

The central module AZ contains the following functional groups:

- **Rectifier** for generating the DC BUS voltage. All connected inverter modules for main and servo motors work from a common DC BUS. This facilitates energy balancing during acceleration/deceleration of the motors in the drive system.

- **Charging device for the DC BUS**

  The charging relay is activated with UE „DC BUS enable“. The buffer DC BUS capacitors are charged through current limiting resistors. Once the DC BUS voltage has built up, the circuit switches over to the main contactor in the AN module through EH1/EH2. The DC BUS circuit is now supplied directly from the power supply.

- **Brake device**

  Braking energy from the axes/main spindles is first fed into the DC BUS. If the DC BUS voltage exceeds its limit value, the braking transistor is activated and the surplus braking energy is converted into heat through the brake resistor. The modules AZ 20, AZ 40 and AZ 60 are designed additionally for regenerative braking, i.e. in regenerative operation surplus braking energy is fed back into the power supply.

  The braking transistor as well as a brake/discharge resistor with an average rating of 200 W is always contained in the AZ module. On removal of „DC BUS enable“, the DC BUS circuit is discharged through the braking transistor and this resistor. Low braking energy can be converted into heat through this internal brake resistor in the AZ 10. Higher braking energy requires in addition an external brake resistor. The brake resistor is monitored thermally using a PTC resistor, evaluation takes place in the AZ module.

  An external brake resistor has to be selected depending on the braking energy in the system. The following brake resistors are recommended for the different central modules AZ:

	AZ 10 AR 4000-20-0	**AZ 20 AR 4000-20-F**	**AZ 40 AR 4000-8-0**	**AZ 60 AR 4000-8-F**
Resistance	20 Ω	20 Ω	8 Ω	8 Ω
Continuous rating	600 W	1500 W	1500 W	1500 W
Peak rating	26 kW for 3 s		60 kW for 3 s	
Fan voltage	-	230V	-	230V
Fan rating	-	45 W	-	45 W

Danger

After the power is shut down, the DC BUS capacitors are still charged and carry dangerous voltage. Wait at least 3 minutes for the capacitors to discharge before working on the modules!

- **Regenerative braking (only with AZ 20, AZ 40, AZ60)**

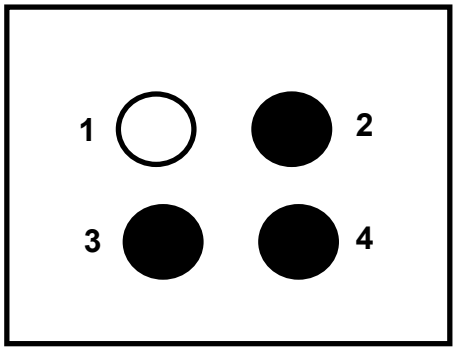
  The regenerative braking is activated by the system software after RF On (QRF). For special applications the regenerative braking can be turned off via Bit 10 in ID32901:

  ID32901, Bit 10 = 0: Regenerative braking is initiated after „Inverter On“ handshake QRF (default setting).
  ID32901, Bit 10 = 1: Regenerative braking is tuned off.

  Power OF/ON is required after each change of this bit.

  If a long-term error in the regenerative braking logic is detected, the system software generates an AZ error. The trigger pulses for the converter power stages are disabled, the motor is coasting, UE is reset. On the AZB control panel message "Regenerative braking error“ is output. More details concerning the regenerative braking error are displayed via the 4 LEDs at the AZ front plate.

Regenerative braking diagnosis through status LEDs at the AZ front plate



LED1: „OFF“
LED2, LED3, LED4: „ON“

LED1 = ON is signalling that regenerative braking is initiated.
LED2, 3, 4 are ON during trouble-free regenerative braking.
In case of malfunction LED 2, 3, 4 are reset corresponding to the cause of malfunction. A single, short-time malfunction (regenerative braking logic has disabled the trigger pulses for 1 ms respectively 1s) LED1 is not effected (= ON). By a long-term malfunction LED1 is reset (OFF), a AZ error is generated, message „Regenerative braking error“ is displayed at the AZB panel.

The error LED state is internally stored. This state is maintained until the regenerative braking is initiated again (after „RF“ ON). After a regenerative braking warning or a short-term malfunction the LED state remains on for 1 second.

	Regenerative braking was properly initiated however is not activated.	1
	Regenerative braking active, trouble-free.	2
	Regenerative braking active. IGBT trigger pulses were disabled for 1 ms because of regenerative overcurrent. LED state is maintained for 1s, then change to state 1 or 2 if no further error occurs. Possible causes: Short supply voltage dip. Short-term missing of a line half-wave or phase-failure. Short-term supply voltage interrupt. Short-term main contactor drop-out during regenerative braking. Missing or defective line reactor. Wiring or contact problems line-side.	3
	Regenerative braking active. IGBT trigger pulses were disabled for 1 ms because of motive overcurrent. LED state is maintained for 1s, then change to state 1 or 2 if no further error occurs. Possible causes: Motive power too high. Phase failure. Short-circuit motor side. Wiring or contact problems line-side.	4
	Regenerative braking active. IGBT trigger pulses were disabled for 1 ms because of short-circuit. LED state is maintained for 1s, then change to state 1 or 2 if no further error occurs. Possible causes: See „3“.	5
	Regenerative braking active. A trigger circuit state error was detected. The IGBT triggering is continued. LED state is maintained for 1s, then change to state 1 or 2 if no further error occurs. Possible causes: Line fault, in general also short-circuit respectively overcurrent messages are generated.	6
	Error condition for regenerative braking because of regenerative overcurrent. The LED state is maintained until „Error reset“ (FL) was activated or power was turned off. Possible causes: Regenerative overcurrent. Supply voltage dip. Missing of a line half-wave or phase failure. Line undervoltage. Short-term main contactor drop-out during regenerative braking. Missing or defective line reactor. Wiring or contact problems line-side.	7
	Error condition for regenerative braking because of motive overcurrent. The LED state is maintained until „Error reset“ (FL) was activated or power was turned off. Possible causes: See „4“	8
	Error condition for regenerative braking because of short-circuit. The LED state is maintained until „Error reset“ (FL) was activated or power was turned off. Possible causes: See „7“.	9
	Regenerative braking: Error during initialization or system error. The LED state is maintained until power was tuned off. „Error reset“ can’t be applied. Possible causes: Power supply for regenerative braking logic missing. Defective regenerative braking circuit.	10

- **Switched mode power supply**

  The primary switched-mode power supply (SMPS) generates the internal supply voltages +5V, +12V, -12V. These voltages are short circuit proof. The switched mode power supply is energized with power on. After „DC BUS enable“ (UE = 1), and the DC BUS voltage is built up, the switched mode power supply is then supplied from the DC BUS.

  As an option external supply for the SMPS is possible on the redesigned AZ modules with the extended line voltage range. For this 400V have to be applied to terminals X99, e.g. from an UPS, power acceptance approx. 250W.

- **Monitoring/starting sequence**

  Power supply, DC BUS and internal supply voltages are monitored for limit values. When the limits are exceeded, error messages are generated in the central computer and output through the AZB panel. Additional access to the drive system status is possible via the used interface.

  The starting sequence is implemented in the central computer AZ-R0x by programming. It administers the signals UE „DC BUS enable“ and RF „Inverters On“, switches over from the charging relay to the main contactor and outputs the associated handshake signals QUE and QRF. „Status code call“ SC, „Status code clock“ TS, „Error reset“ FL with the associated acknowledgement signals and data outputs as well as the „System ready“ SBM are further binary signals which are processed by the logic unit in conjunction with the central computer AZ-R0x.

Central processor AZ-R0x plug-in card

The plug-in card AZ-R0x is located in the rack for the additional cards at the slot on the extreme right. It is secured by means of a screw in the front panel below the card grip against inadvertent loosening.

The central processor controls the entire drive system. All data is available here and can be transferred through different interfaces internally and to the higher ranking control system. Setpoints and control data generally are transferred by interfaces on the AZ module to the controllers of the AW modules.

System parameters and configuration data are stored permanently in the EEPROM on the AZ-R0x. Access to this data is possible through the internal control panel AZB or by means of a PC with associated start up and parameterization software AIPAR through the RS 232C interface on the AZ-R0x card.

10 Standard interfaces on the AZ module

Pulse encoder input (X32)

The pulse encoder input is provided for connection of an external actual position measuring system (e.g. direct position measurement with linear scale), or for square wave setpoint pulses (e.g. stepping motor control, synchronous control). The pulse encoder input is assigned to the corresponding inverter module and the type of signal evaluation is determined by the configuration.

Analog outputs AA1...AA4 (X29)

4 configurable analog outputs ± 10V, are available.
Internal system variables (e.g. actual speed, actual torque,...) can be assigned to the analog outputs and represented as analog voltage for recording e.g. with a scope.

Data outputs DA1...DA4 (X31)

4 binary outputs DA1...DA4 which facilitate step by step output of the entire 16 bit error word are offered for outputting error codes. During fault-free operation, system-internal messages can also be output, configured via parameters.

AZB control panel

The AZB control panel is integrated in the AZ module. It has a swivel support located in front of the rack for the computer and option cards. It communicates with the central computer through the RS 232C serial interface (plug X35).

The entire drive system can be configured and parameterized using the AZB control panel. Access to certain data groups is protected by passwords. Status and error messages can be called up and displayed in plain language and speed setpoints can be set for the individual axes. Essentially the AZB control panel is provided for servicing. A PC with the start-up and parameterization software AIPAR is recommended for the initial commissioning. Menu guidance using the PC offers high convenience and reduces the time required for commissioning. Complete parameter sets can be produced and stored online or offline. Parameter sets already existing are simply loaded into the central computer AZ-R0x on start-up.

11 Signal description Central module AZ

11.1 Binary inputs (terminal block X30):

Optically isolated inputs
Input nominal voltage: $+24V_{ext.}$
Input nominal current: 8 mA
The inputs are scanned cyclicly every 10 ms by the AZ processor

Terminal UE: „DC BUS enable“, edge-controlled
With input voltage $+24V_{ext.}$ at UE the charging relay is energized and after approx. 2 s it is switched over to main contactor. The main contactor is integrated in the power supply module AN (option). In the case of delivery without AN module, the main contactor must be installed by the customer.
With switch-over to the main contactor, the charging relay is released and the message QUE „UE handshake“ is output.

Precondition: „System ready“ SBM = 1
Loop ES1-ES2 (interruption main contactor) is closed, input RF („Inverters on“) is open.
A minimum time of 15 s must have expired between two consecutive switch-on commands UE in order to protect the charging device against thermal overload. A UE signal with shorter time interval is not accepted by the AZ module. A maximum of 10 switch-on processes are allowed within 10 minutes. If these conditions are not complied with, the „System ready“ SBM is reset and an error message is generated. After the end of the delay time, the error message must be deleted by a pulse
≥ 100 ms at input FL („Error reset“). If there is no further error, then SBM is set again.

„Error Reset“ doesn’t reset the internal time monitor!

On emergency stop, UE must be interrupted by a contact of the emergency stop circuit.

Terminal RF: „Inverters on“, edge-controlled

Input voltage of $+24V_{ext.}$ at RF enables the clock pulses of all configured inverter modules. The motors are energized, the control is active.

Precondition: The signal UE is applied and has been acknowledged with QUE = 1.
„Power Output enable“ EF of all involved axes are set, single „Inverter on“ inputs are not defined by system parameters. If one of these conditions is missing, the system goes to fault. The „System ready“ signal is reset and an error message is produced. After fulfilment of the preconditions, the error message must be deleteted by a pulse ≥ 100 ms at input FL. If no further error is present, SBM is set again.

Removal of „Inverters on“ (RF = 0) in operation causes the motor to be decelerated according to a braking ramp which is specified by parameter ID-No. 32782. Subsequently the clock pulses for the power transistors are disabled, the motor is without torque.

In the case of emergenca stop, RF must be interrupted by a contact of the emergency stop circuit.

If single „Inverter on“ inputs are specified in the system parameter, then input „Inverters on“ RF is ineffective.

The single „Inverter on“ RFx are assigned to inputs of the option card AZ-EAx on configuration. Input E1 of AZ-EAx in slot 1 activates inverter on for AW1, E2 for AW2 and so on.

This card must be inserted in slot1. With the preconditions SBM = 1, QUE = 1 and Efx = 1, the activation of the corresponding RFx input causes that this drive controls. The internal bit handshake QRFx is set.

For single „Inverter on“ handshake QRFx, the related internal bits must be assigned to binary outputs.

Through evaluation of handshakes QRFx the higher ranking control system must verify that all axis active in the process are always under control.

Terminal FL: „Error reset“

Precondition:
UE „DC BUS enable“ and RF „Inverters on“ inactive.
A +24$V_{ext.}$ pulse (≥ 100 ms) at FL deletes the existing error messages, provided the cause of error has been eliminated. After an error message, a FL pulse must be output in order to set the „System ready“ message „SBM“ again. Error reset also is possible via softkey on control panel AZB, via the programmable controller AZ-PSx or through the higher ranking controller via the used interface.

Terminal SC: „Status code call“

When +24$V_{ext.}$ is applied to input SC, the first occurring error code is transferred into the output register and provided for output to the data outputs DA1...DA4. During the call-up of the individual nibbles of the error code, input SC must remain set. On removal of SC, output of the error code is interrupted.

Terminal TS: „Status code clock“

With input SC = 1, the individual nibbles of the error code are transferred to the data outputs DA1...DA4 by pulses at TS (≥ 15 ms). The customer PLC has to read DA1...DA4 and recompose the complete data value of the error code after the last nibble was output.

Terminal NK: „Cam“

Prepared for connection of a reference limit switch.
NK input scanning time is 1 ms.

Terminal 0V: Reference potential of the external control voltage $+24V_{ext.}$ for supplying the binary inputs/outputs.

Terminals 12P and GND: Provision of the internal voltage +12V for service purposes only. The voltage is output across a protective resistor.

11.2 Binary outputs (terminal block X31):

Transistor outputs, open emitter, optically isolated
Output nominal voltage: $+24V_{ext.}$
Output nominal current: 100 mA

The binary outputs are scanned cyclicly every 10 ms by the AZ computer.

Terminal WBA: Common external supply voltage $+24V_{ext.}$ for the binary outputs.

Terminal QUE: „UE handshake“

The output QUE is set if after „DC BUS enable“ the DC BUS voltage is built up across the charging device and internally switched over from charging relay to the main contactor.

As long as UE = 1 is applied and the drive system runs without error, QUE remains set. In the case of a fault, QUE is reset.

The handshake is indicated by the green LED QUE on the AZ-R0x front panel.

Terminal QRF: „RF handshake“

The output QRF is set if after RF = 1 (Inverters on), all activated drives are under control. The drive system is now ready to process setpoints.

After removal of RF (RF = 0), the drives are decelerated in speed control mode. QRF is reset only when all drives are at standstill.

In the case of single „Inverter on“ inputs via option AZ-EA „Inputs/outputs“, the output QRF is not used. In this case the single handshakes of „Inverter on“ (QRFx) must be assigned to binary outputs of the AZ-EA. The higher ranking control system has to verify that all axes involved in the process report their readiness by their single „Inverter on“ handshakes QRFx.

Single handshakes QRFx can also be formed and assigned to binary outputs (option AZ-EA) without the need to define generally single „Inverter on“ RFx inputs by system parameters. Proceed in this way in the case of motors with holding brakes. The command to release the holding brake must be triggered by the PLC by evaluation of the binary output of the single handshake QRFx = 1.

Acknowledgement of the single „Inverter on“ inputs is indicated by green LEDs on the AZ-R0x front panel. They are marked with the numbers 1...8 for QRF1...QRF8.

If single „Inverter on“ inputs are defined, it is mandatory that a card AZ-EAx (option) is inserted in slot1. The binary inputs E1...E8 are reserved with the single „Inverter on“ inputs RF1...RF8. With less than 8 AW modules, the remaining inputs can be allocated to other functions. The handshake signals QRF1...QRF8 have to be assigned to binary outputs.

Terminal QSC: „SC Handshake“

Output QSC is set if after SC = 1, the error code is transferred into the output register QSC = 1 is prerequisite for reading the error code via „Status code clock TS“.

Terminal QTS: „TS Handshake“

Output QTS is set if after TS = 1, the corresponding nibble has been transferred to the data outputs DA1...DA4. With QTS = 1, the PLC takes over the presented data and can then request the next nibble with a further clock at TS = 1.

Terminal SBM: „System ready“

Output SBM is set as long as no error status is detected in the drive system. In the case of a fault SBM is reset, system reaction depending on the type of fault.

Faults for instance in the power supply, in the computer or in the motor encoder/reset of all internal „Inverter on“ signals and thus to deceleration of all drives still capable of working. Initiation of the stop process is indicated by removal of QUE (QUE = 0). With standstill of all drives that can still be controlled, the system then resets output QRF (QRF = 0).

Overload or thermal errors generate a warning which directly resets output SBM and initiates a stop process as described above after 4 sec. It is possible for the higher ranking control system to initiate the wanted measures via the setpoint setting within this delay time.

Terminal DA1...DA4: The data outputs DA1...DA4 can be configured. During normal operation, internal messages can be allocated to these outputs. In the case of a faults, the corresponding nibbles of the error code are output through DA1...DA4 with SC = 1 and after each status code clock TS.

Terminal 0V: Reference potential $0V_{ext}$ of the external power supply $+24V_{ext}$ for the binary outputs.

11.3 Analog outputs (terminal block X29):

Terminal

AA1...AA4: Analog outputs 1...4
Each analog output can supply an output voltage of ± 10V at a resolution of 12 bits, maximum current per output: 10 mA. The analog outputs are served cyclicly every 1 ms by the AZ processor. Through parameter setting internal system variables (e.g. actual speed, actual torque,...) can be assigned to analog outputs. The variables then are represented as analog voltage.

Terminal GND: Reference potential (internal) for the analog voltage ± 10V.

Terminal SSS: Not used.
The shield of the connection cable must be grounded single-ended at the AZ housing.

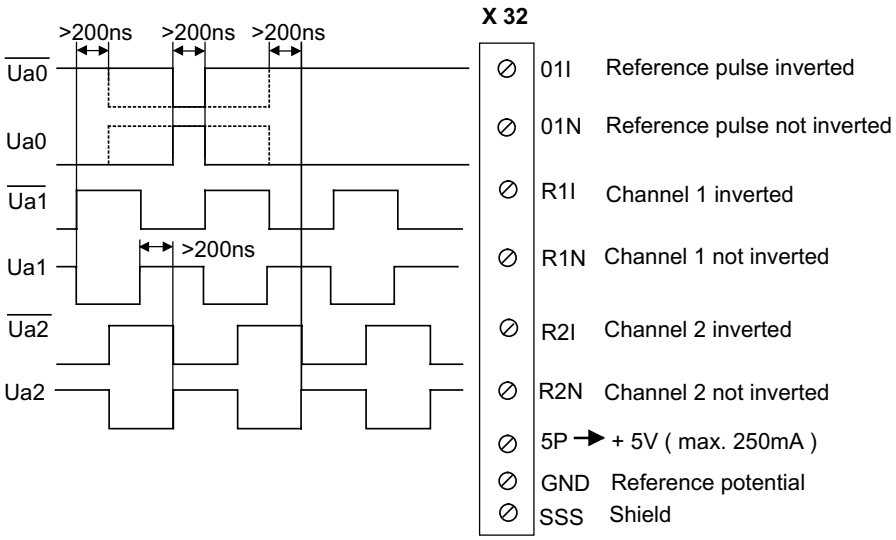
11.4 Square-wave pulse input (terminal block X32)

An actual position acquisition is possible through the differential inputs R1N, R1I, R2N, R2I with an external position measuring system with square-wave output. Also setpoint pulses e.g. for stepping motor control, synchronous control can be fed in through these inputs. Measuring system respectively source of setpoint pulses must be designed with differential outputs (line drivers acc. to RS 422).
The inputs are direct galvanically coupled. Input impedance 180 Ω (max. input current ≤ 20 mA).

On the AZ side, a power supply (5V, max. 250 mA) is made available for the external square wave source.

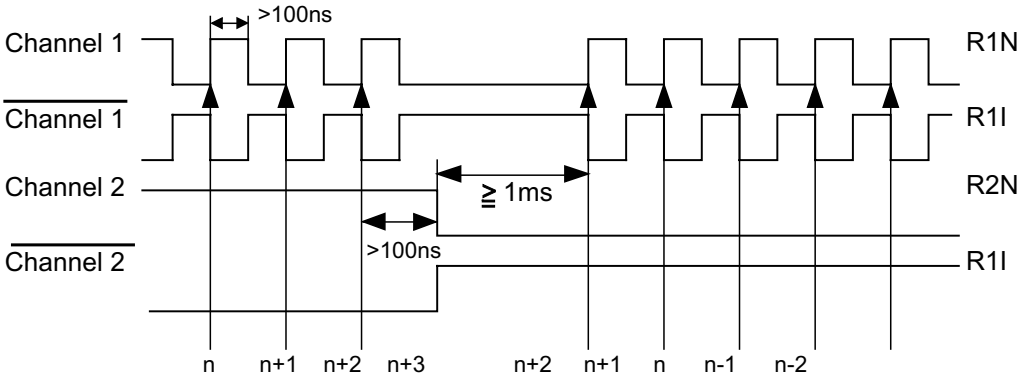
It is determined by system parameters in which form the signals are evaluated. The following signal forms can be processed:

2 square wave pulses in quadrature (offset 9o°)



The maximum input frequency is 1 MHz (until end of 1999), **500kHz from 2000!**
The encoder signals are evaluated 4-fold by the AMKASYN system.

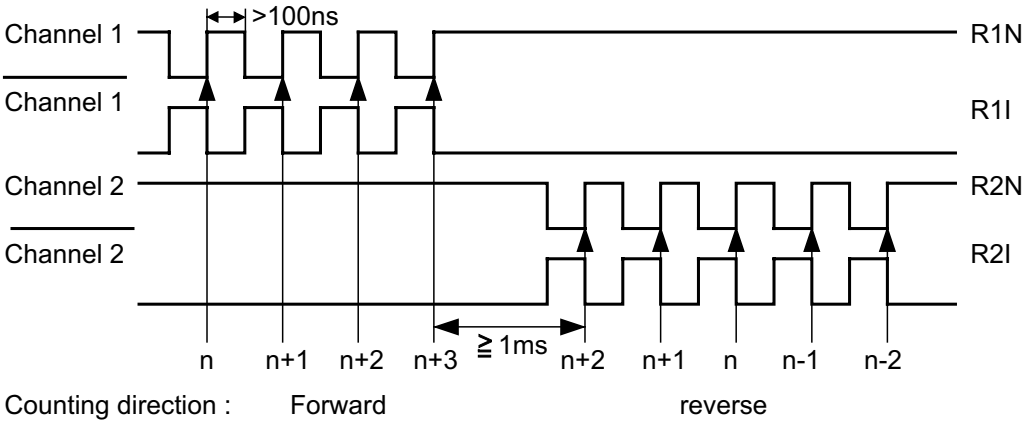
Counting pulses channel 1 , direction signal channel 2



The maximum input frequency is 4 MHz (until end of 1999), **2 MHz from 2000!**

This type of setpoint pulses permits only single evaluation of the pulses.

Forward pulses on channel 1 , reverse pulses on channel 2

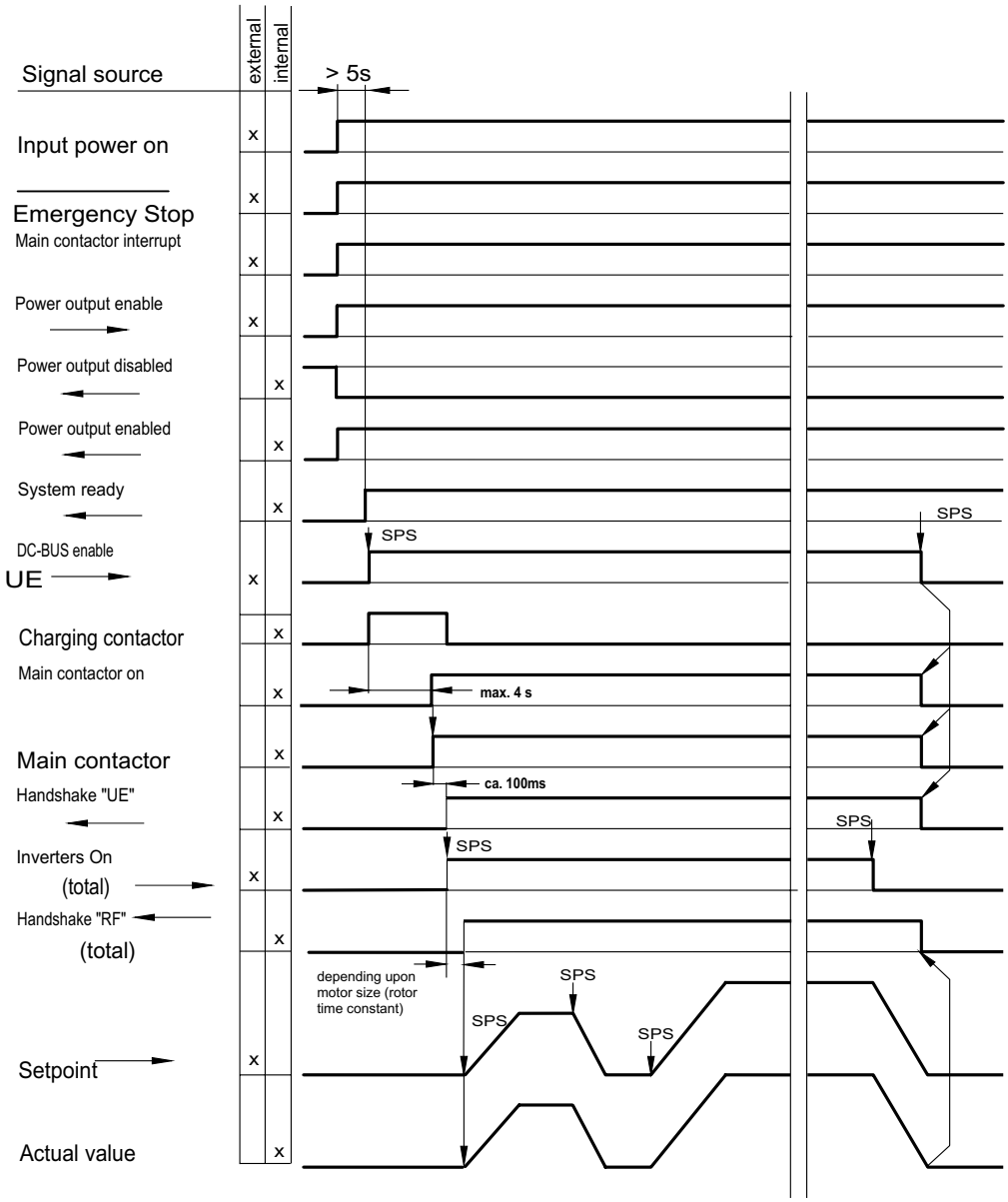


The maximum input frequency is 4 MHz (until end of 1999), **2 MHz from 2000!**

This type of setpoint pulses permits only single evaluation of the pulses.

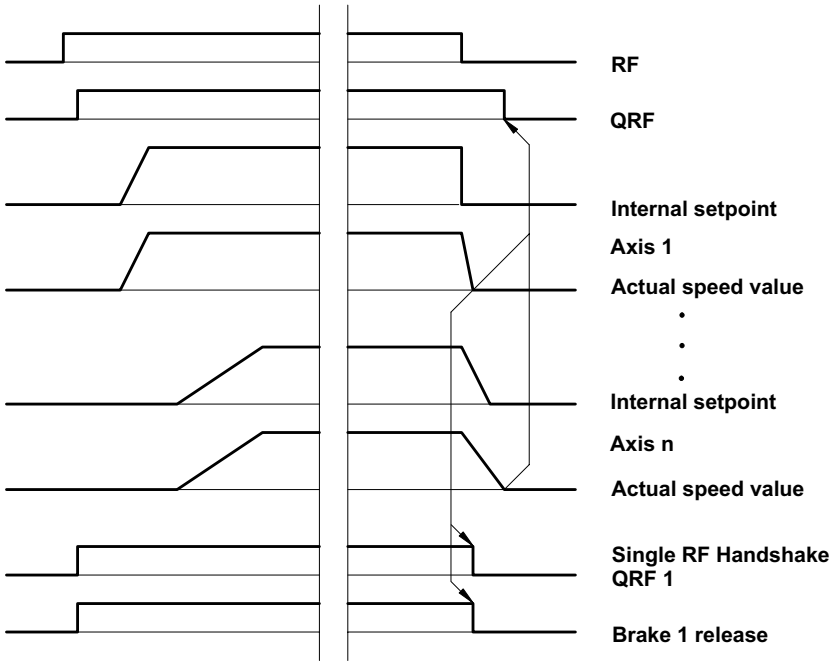
12 Pulse diagrams

12.1 Pulse diagram switching ON/OFF

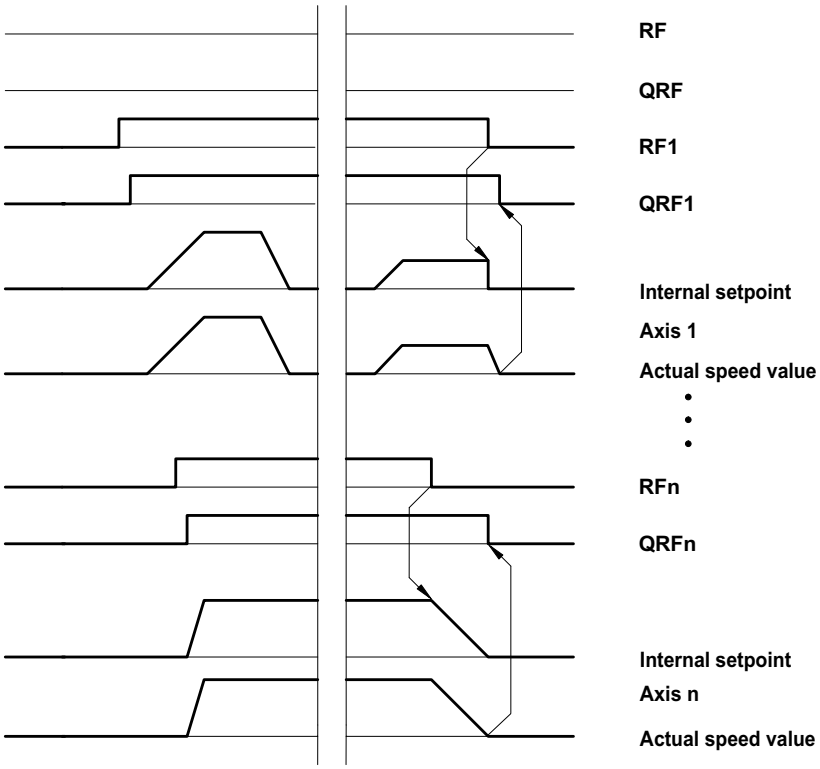


12.2 Pulse diagram Inverter ON

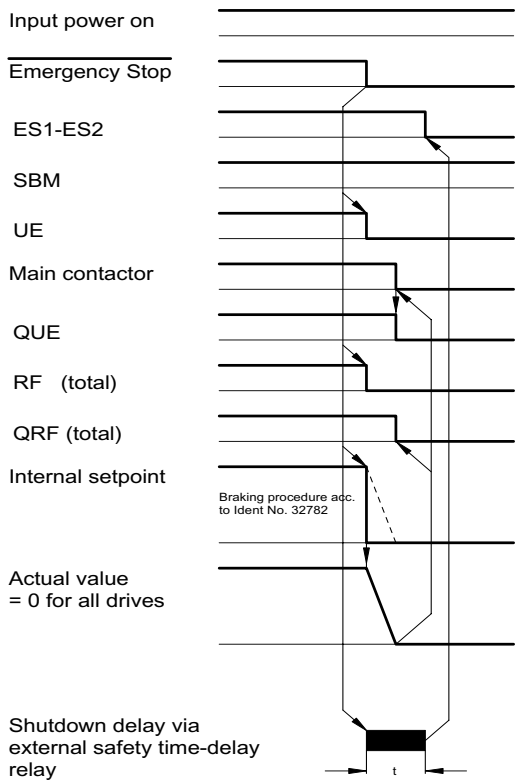
All Inverters ON (RF)



Single Inverter ON (RFx)



12.3 Pulse diagram Emergency Stop



For Emergency Stop, UE and RF must be interrupted by the hardware.

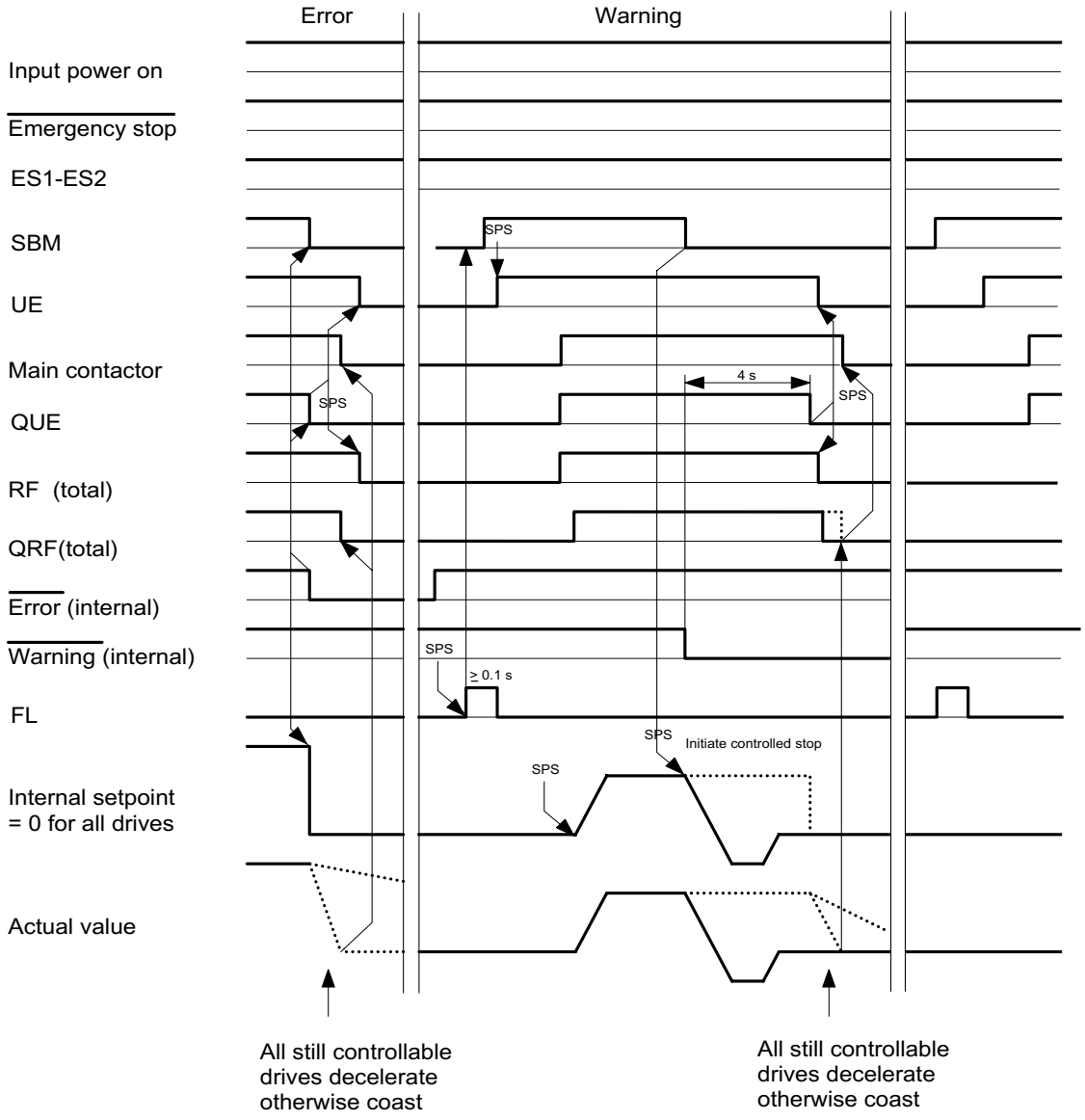
Speed set point values for all drives are set internally to "0".

The motors decelerate. Since the main contactor is still excited, the regenerative feedback remains capable of working. With standstill of all motors, QRF and QUE are reset, the main contactor opens and separates the system from the input power system.

With Emergency Stop, a shutdown delay must start via an external safety time-delay relay. Afte time t, the time delay relay interrupts ES1 - ES2 and thus opens the main contactor.

t > maximum expected deceleration time

12.4 Pulse diagram Error/Warning



13 Error messages/Status code

The AMKASYN drive system indicates operation free of fault using the binary output SBM „System ready“. In the case of a fault, the „SBM“ output is reset. The AZ computer stores the error messages in chronological order. In the error stack maximally 10 error messages can be stored simultaneously. The error messages can be called up through the serial interface of the AZ computer or through one of the possible interfaces and displayed by the higher ranking control system. The internal control panel AZB also offers access to the error messages. They are displayed in plain language in the two-line LCD display after selection of the dianosis function.

Functional description of the signals

SC: SC = 0: The internal bit messages assigned to binary outputs through the system parameters are output cyclicly at DA1...DA4.
SC = 0 → 1: The error code is loaded into the output register.

QSC: Handshake for SC signal as soon as the error code is present in the output register.

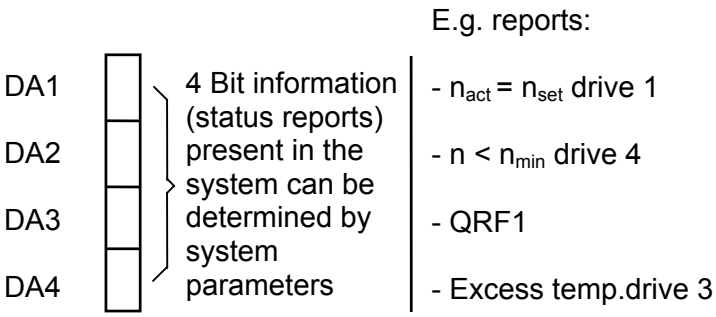
TS: SC = 0: TS without effect
SC = 1, QSC = 1: The 4 nibbles of an error code can be clocked out by means of TS. If no further error messages are present, „0“ is output in each case at DA1...DA4.

QTS: Handshake for TS signal if the data are present at the binary outputs DA1...DA4.

DA1...DA4: Binary outputs for status reports (SC = 0) and error codes (SC = 1).

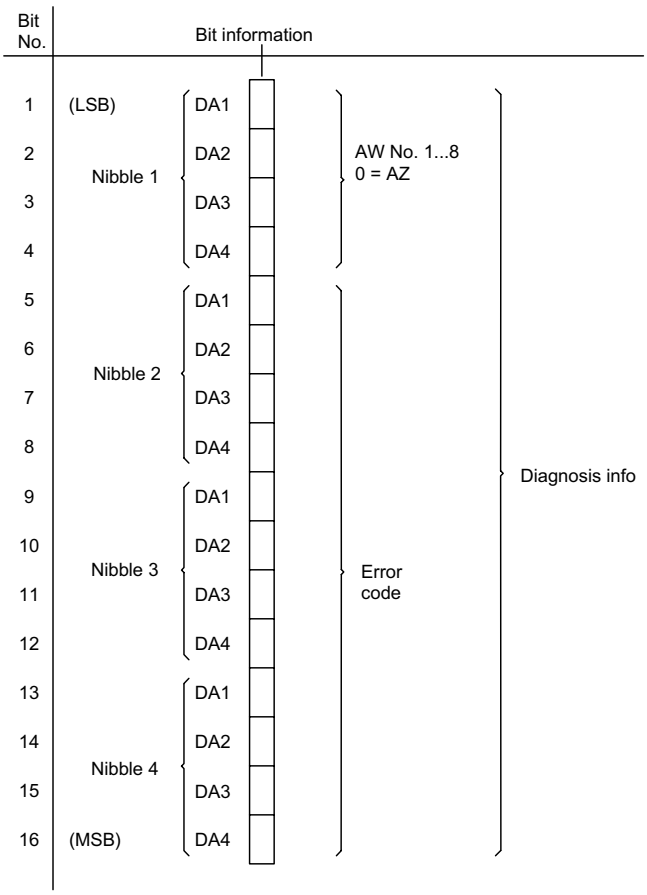
Bit data for the binary outputs DA1...DA4

Binary status reports (SC = 0)



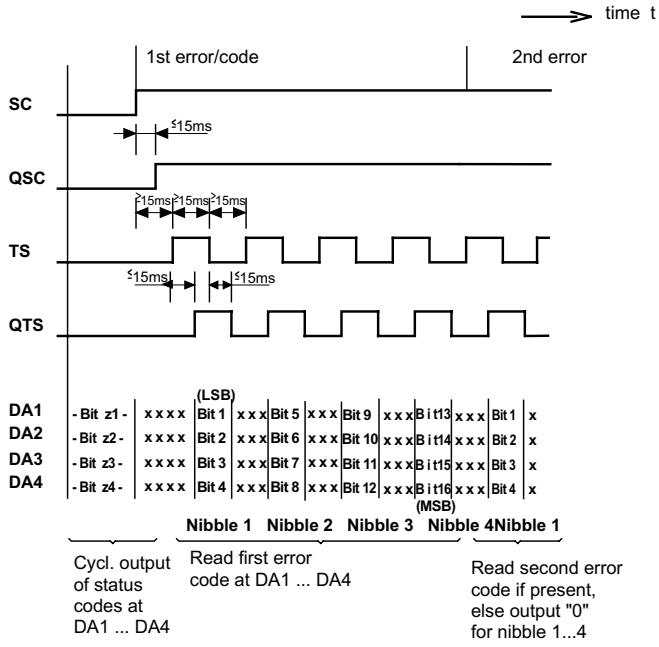
With „System ready SBM“ = 1 and SC = 0 DA1...DA4 can be used for internal bits output. In fault condition (SBM = 0) the error codes can be output through DA1...DA4. For this SC must be set to „1“. With each clock at TS (=1) four bits of the error code are output through DA1...DA4. The higher ranking control system then has to recompose the complete error code.

Structure of the error code



The corresponding error texts can be assigned to the individual error codes by reference to separate documentation „AMKASYN Diagnosis messages“.

Time diagram for error code output at DA1...DA4

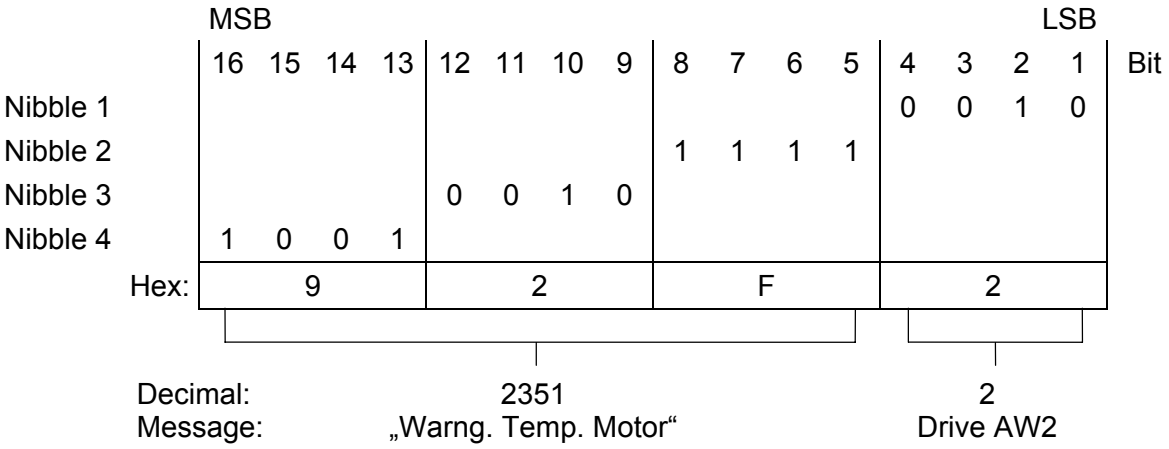


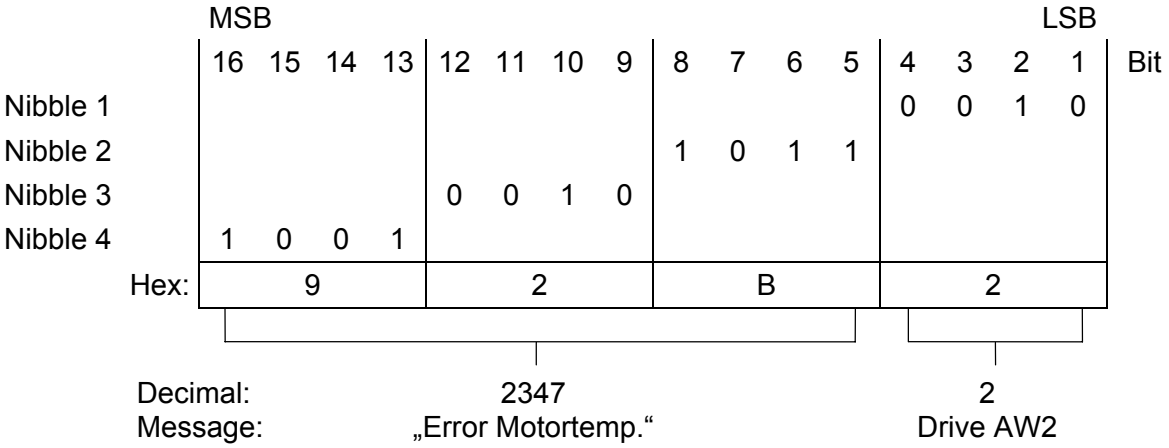
x Signals invalid **Outputs change, interrogation not permissible (inncorect information) !**

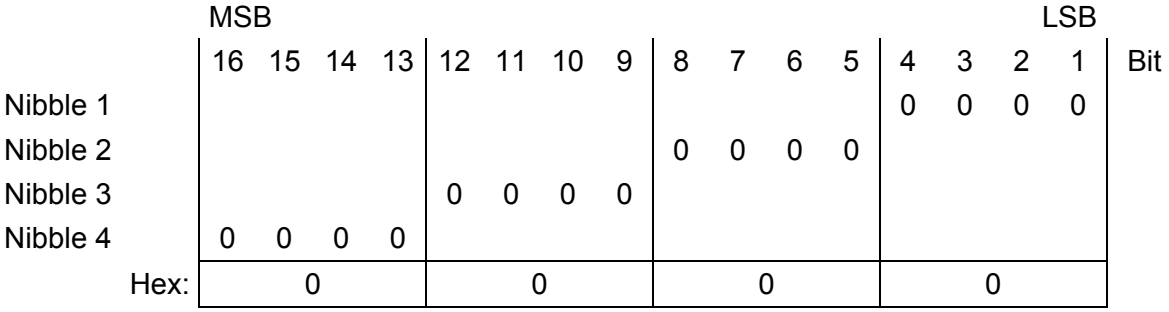
Example:

Error codes clocking out

Assumption: Motor thermal overload drive 2 (AW 2)



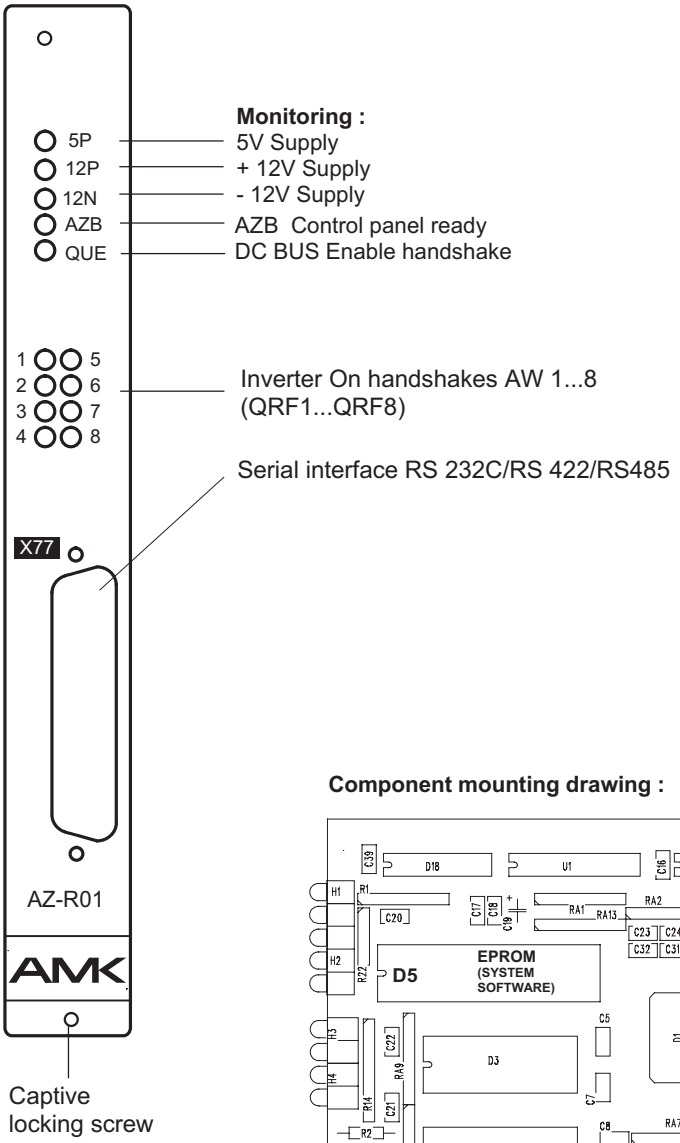




Message: No further error messages (all bits = „0“). Error code interrogation can be stopped by reset of „SC“.

14 Central processor cards AZ-R0x, hardware

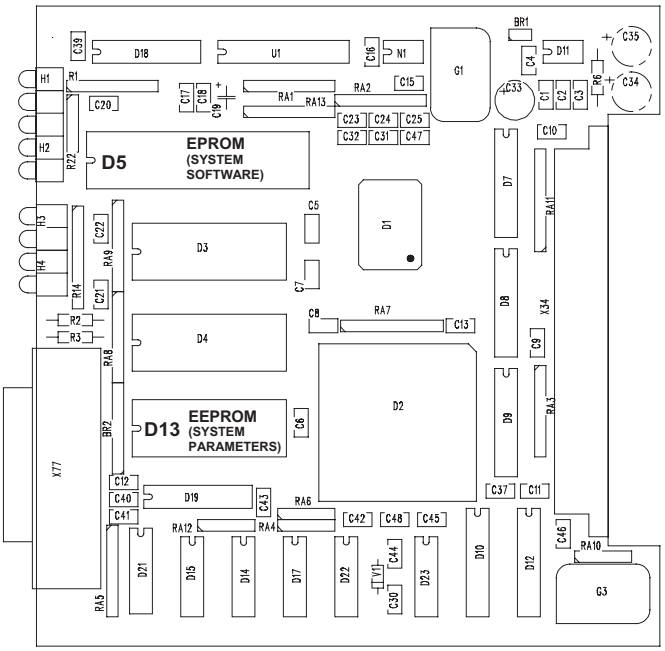
14.1 AZ-R01 Front view, component mounting drawing



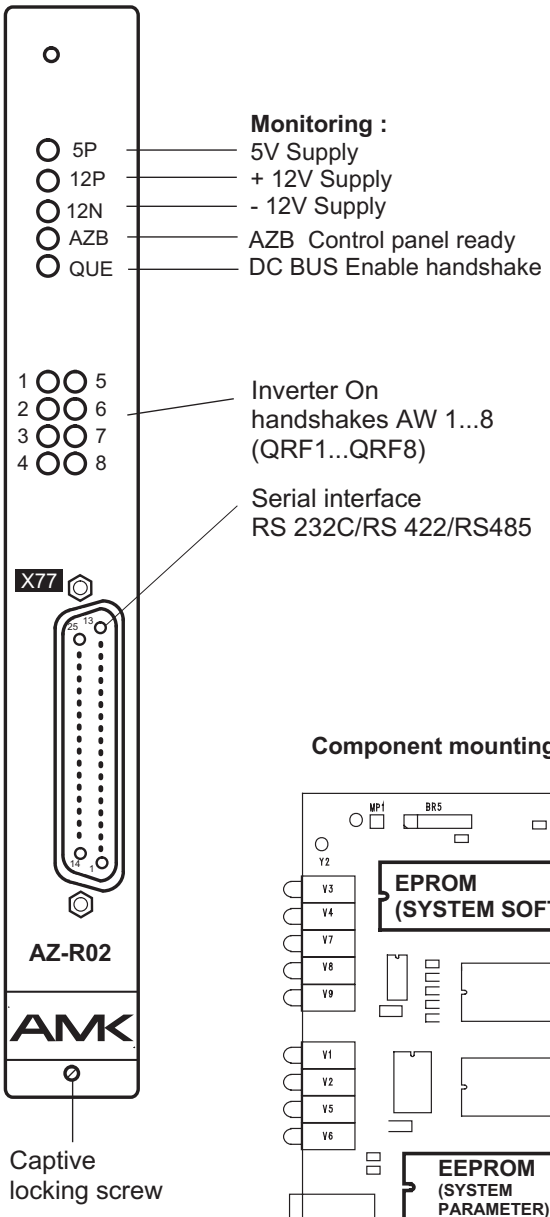
X 77 :

1	PE
2	TXD-
3	RXD-
4	RTS
5	CTS
6	n.c.
7	GND
8	n.c.
9	GND
10	5P
12	5P
13	n.c.
14	n.c.
15	n.c.
16	n.c.
17	n.c.
18	12P
19	n.c.
20	n.c.
21	n.c.
22	n.c.
23	n.c.
24	n.c.
25	12N

Component mounting drawing :



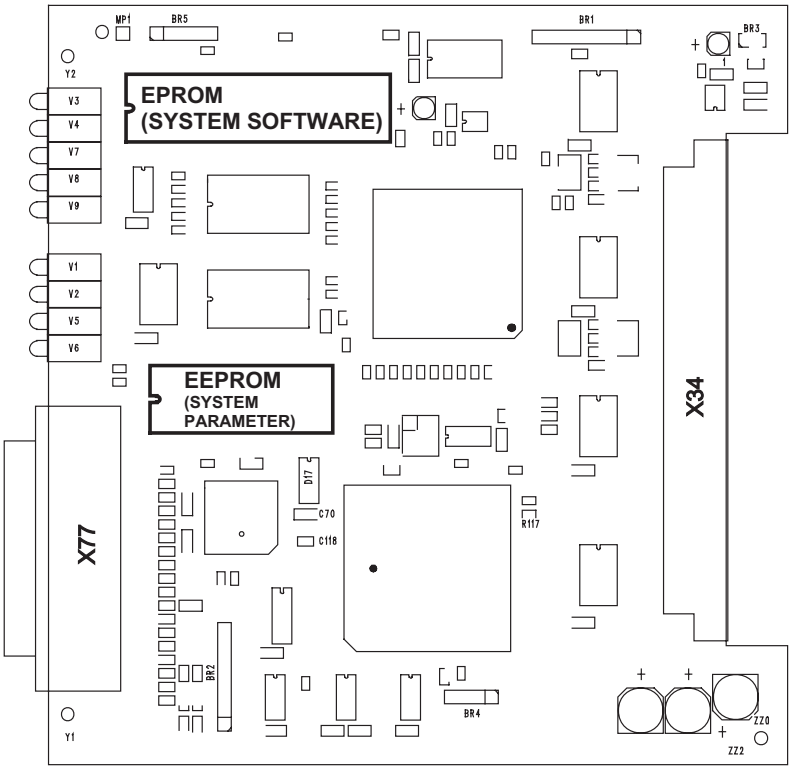
14.2 AZ-R02 Front view, component mounting drawing



X 77 :

1	PE
2	TXD-
3	RXD-
4	RTS
5	CTS
6	n.c.
7	GND
8	n.c.
9	GND
10	5P
12	5P
13	n.c.
14	n.c.
15	n.c.
16	n.c.
17	n.c.
18	12P
19	n.c.
20	n.c.
21	n.c.
22	n.c.
23	n.c.
24	n.c.
25	12N

Component mounting drawing :



15 Control panel AZB

15.1 General

The AZB control panel is integrated in the AZ module. It has a swivel support located in front of the rack for the processor card and option cards. For swing around the left-hand hinge, slightly pull the panel out of the latching at the right-hand side.
To remove the panel completely the bottom hinge pin has to be unlocked by pressing the spring pin there.

AZ modules with designation suffix „OB“ are supplied without AZB panel.

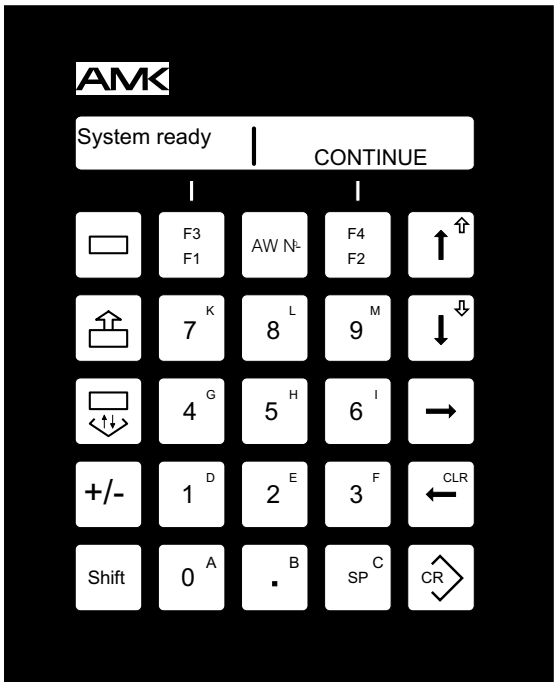
AZB functions

The AZB panel is controlled by a processor. It is designed as a service unit and a commissioning aid. For faster and more convenient start-up a PC with the AMK Software AIPAR for drive configuration and parameter setting is recommended.

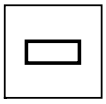
Through the AZB panel, the following items can be used:

- Drive configuration and parameter setting
- Status and error messages display
- Display of actual and setpoint values of the selected drive
- Speed setpoint entry for the selected drive

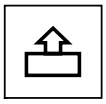
15.2 AZB keypad



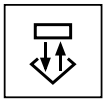
15.3 Legend of the key functions



Return to main menu



Jump to the next higher menu level



The current date is stored with Shift , other menu items can now be selected. A direct return is possible by operating the key once again.

Shift

Selection of the second key allocation

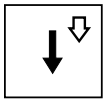
F3 F1 F4 F2

Softkeys for selection of individual functions of the main menu

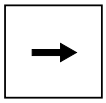
AW №

AW number selection key, current AW is displayed in the display top right

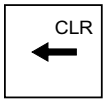
First allocation: Scrolling down
Second allocation: Scrolling down within SERCOS parameters



First allocation: Scrolling up
Second allocation: Scrolling up within SERCOS parameters

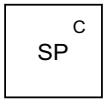


Clocking forward within appointed parameters



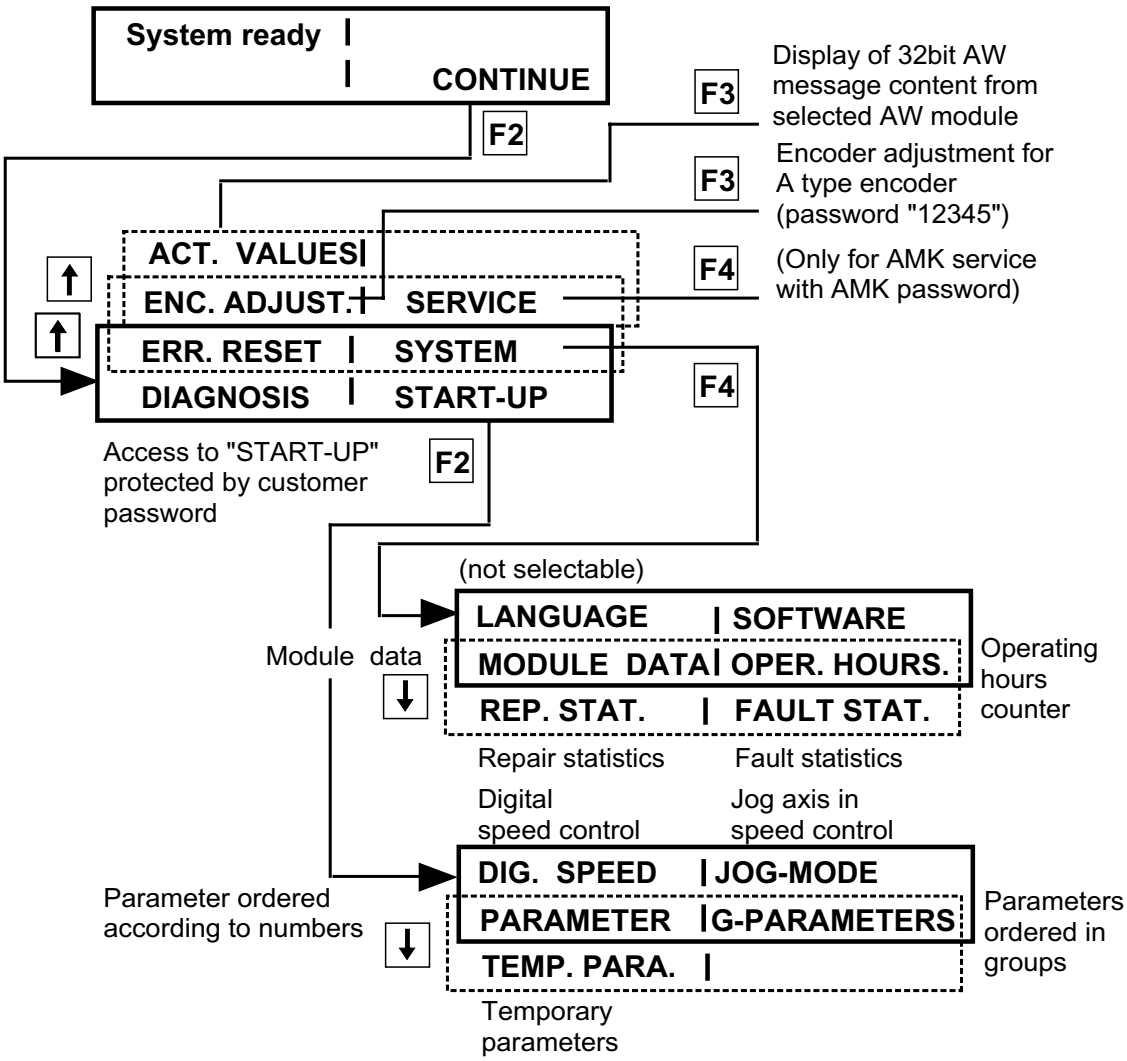
Delete key

Carriage Return (Enter)



Blank

15.4 AZB Menu overview



15.5 System booting

After Power ON the AZB display shows:

System initialization

The drive system is booted with initial checks. After successful booting the display indicates:

System ready	
	CONTINUE

With function key [F4 F2] „CONTINUE“ main menu is activated:

ERR.RESET	SYSTEM
DIAGNOSIS	START-UP

In case of a fault (e.g. configuration error) the display indicates:

Configuration	
DIAGNOSIS	CONTINUE

Function key [F3 F1] „DIAGNOSIS“ activates the diagnosis function, the corresponding error message is displayed, e.g.:

1334	AW1	1
ID 38 > ID 113		

The error message must be cancelled after elimination of the error either with [Shift] + [F3 F1] „ERR.RESET“ or through binary input „FL“. Error reset is only possible with UE and RF OFF.

[▭] Main menu

ERR.RESET	SYSTEM
DIAGNOSIS	START-UP

[Shift] + [F3 F1]

Err.reset active

ERR.RESET	SYSTEM
DIAGNOSIS	START-UP

„Main menu“ is not automatically activated after error reset through „FL“!

The single menu item are selected via function keys F1...F4. [F3 F1] „F1“ is assigned to left-hand menu item in the bottom line of the display, [F4 F2] „F2“ is assigned to the right-hand menu item in the bottom line.
[Shift] + [F3 F1] „F3“ addresses left-hand menu item in the top line of the display, [Shift] + [F4 F2] „F4“ right-hand menu item in the top line.
Menu lines can be changed with the scroll keys [↑] / [↓] and it is possible to move up and down within a menu item.

16 Parameters

K: Number of digits behind decimal point for parameter entry via AZB panel or via PC with parametrization software AIPAR.

Example: **ID No. 00036, Speed setpoint value**
Editing of this ID No. is only possible in whole RPM (K = 0) although internally the system is processing the speed with a resolution of 0,0001 RPM.

ID No. 32774, Rotor time constant TR
Input of the rotor time constant value must be in [ms] (K = 3), the internal time resolution however is [0,1 ms].

ID-No.	Designation	K		Minimum	Maximum	Unit
00001	NC cycle time	3		0.500	65.535	ms
00002	SERCOS cycle time	3		0.500	65.535	ms
00003	Drive transm.react.time	3		0.000	65.535	ms
00004	Transm/rec. trans.time	3		0.000	65.535	ms
00005	Min.feedb.acquis.time	3		0.000	65.535	ms
00006	Drive telegr.start.time	3		0.000	65.535	ms
00007	Feedb.acquis.start.time	3		0.000	65.535	ms
00008	Command valid time (T3)	3		0.000	65.535	ms
00009	Begin. address in MDT	0		1	5061	
00010	Length of MDT	0		4	5080	
00015	Telegr. type par.	0		0	7	
00017	ID-No.list all op.data					
00036	Velocity command value	0		-100000.0000	100000.0000	min^{-1}
00038	Pos. velocity limit	0		0.0000	100000.0000	min^{-1}
00039	Neg. velocity limit	0		-100000.0000	0.0000	min^{-1}
00041	Homing velocity	0		1.0000	100000.0000	min^{-1}
00043	Velocity polarity	0		0000h	0007h	
00049	Positive position limit	0		-2147483648	2147483647	Incr.
00050	Negative position limit	0		-2147483648	2147483647	Incr.
00055	Closed loop polar. par.	0		0000h	0009h	
00057	In position window	0		0	65535	Incr.
00080	Torque command value	1		-1000.0	1000.0	% MN
00082	Positive torque limit	0		0.0	1000.0	% MN
00083	Negative torque limit	0		-1000.0	0.0	% MN
00085	Torque polarity	0		0000h	0001h	
00087	Recovery transm.-transm	3		0.000	65.535	ms
00088	Recovery receive-rece.	3		0.000	65.535	ms

ID-No.	Designation	K		Minimum	Maximum	Unit
00089	Transmit time MDT (T2)	3		0.000	65.535	ms
00090	Com. val. transm. time	3		0.000	65.535	ms
00096	Slave identifier (SKLN)	0		0000h	FEFEh	
00097	Diag.mask st.class 2	0		0000h	FFFFh	
00098	Diag.mask st.class 3	0		0000h	FFFFh	
00100	Prop.gain speed control	0		1	30000	
00101	Integr.act.time sp.ctrl	0		0.0	1000.0	ms/4
00103	Modulo value	0		1	4294967295	Incr.
00104	Position loop KV-factor	0		20	30000	1/min
00110	Inverter peak current	1		0.000	200.000	A
00111	Motor nom. current	1		0.000	200.000	A
00112	Inverter nom. current	1		0.000	200.000	A
00113	Max. motor speed	0		180.0000	100000.0000	min^{-1}
00115	Position feedback type	0		0000h	000Fh	
00116	Resol. mot. encoder	0		200	1280000	Incr.
00117	Resol. ext.pos.feedb.	0		0	4294967295	Incr.
00121	Load gear input rev.	0		1	30000	Rev.
00122	Load gear output rev.	0		1	30000	Rev.
00123	Feed constant	4		0.0000	429496.7295	mm/rev
00124	Zero velocity window	0		0.0000	60000.0000	min^{-1}
00125	Velocity Threshold Nx	0		0.0000	100000.0000	min^{-1}
00126	Torque Threshold Mdx	0		0.0	1000.0	% MN
00136	Positive acceleration	0		1.000	60000.000	Rev/ss
00137	Negative acceleration	0		-60000.000	-1.000	Rev/ss
00147	Homing par.	0		0000h	FFFFh	
00150	Reference offset 1	0		-2147483648	2147483647	Incr.
00153	Spindle angle position	0		-2147483648	2147483647	Incr.
00154	Spindle posit. par.	0		0000h	FFFFh	
00157	Velocity window	0		1.0000	60000.0000	min^{-1}
00158	Power threshold Px	0		1	100000	VA
00159	Excess Error	0		0	32767	Incr.
00180	Spindle rel. offset	0		-2147483648	2147483647	Incr.
00209	Lower adaption limit	0		0.0000	100000.0000	min^{-1}
00210	Upper adaption limit	0		0.0000	100000.0000	min^{-1}
00211	Prop. gain adaptation	0		0.0	500.0	%
00212	Integ.action time adap.	0		0.0	500.0	%
00222	Spindle pos. speed	0		1.0000	100000.0000	min^{-1}
00225	Synchr. contr.par.	0		0000h	FFFFh	
00228	Synchr. pos. window	0		0	65535	Incr.

ID-No.	Designation	K		Minimum	Maximum	Unit
00230	Synchr. position offset	0		-2147483648	2147483647	Incr.
00268	Synchr. angle position	0		-2147483648	2147483647	Incr.
00270	Temp. par. list					
00278	Synchr.add.angle posit.	0		-2147483648	2147483647	Incr.
32768	Nom. motor voltage	1		0.0	1000.0	V
32769	Magnet. current IM	1		0.000	200.000	A
32770	Magnet. current IM1	1		0.000	200.000	A
32771	Nom. torque	1		0.0	2000.0	Nm
32772	Nom. velocity	0		10.0000	100000.0000	min^{-1}
32773	Service bits	0		00000000h	FFFFFFFFh	
32774	Rotor time constant	3		0.0100	1.5000	s
32775	Pole number motor	0		2	16	
32776	Motor enc.periods p.rev	0		50	5000	
32777	Torque rel.to 10V at A1	0		0.0	1000.0	% MN
32778	Speed rel. to 10V at A1	0		0.0000	100000.0000	min^{-1}
32779	Speed offset for A1	4		-100.0000	100.0000	min^{-1}
32780	Accel. ramp	0		1.0	1200000.0	ms
32781	Decel. ramp	0		1.0	1200000.0	ms
32782	Decel.ramp RF inactive	0		1.0	100000.0	ms
32785	Config.16 bit AW mess.	0		0	65535	
32786	Config.32 bit AW mess.	0		0	65535	
32787	Source analog chann. 1	1		0.0	429496729.5	
32788	Final analog val. ch. 1	0		-2147483648	2147483647	
32789	Source analog chann. 2	1		0.0	429496729.5	
32790	Final analog val. ch. 2	0		-2147483648	2147483647	
32791	Source analog chann. 3	1		0.0	429496729.5	
32792	Final analog val. ch. 3	0		-2147483648	2147483647	
32793	Source analog chann. 4	1		0.0	429496729.5	
32794	Final analog val. ch. 4	0		-2147483648	2147483647	
32795	Source UE	0		0	65535	
32796	Source RF	0		0	65535	
32798	User list 1					
32799	Conf. Stand. periph.	0		00000000h	FFFFFFFFh	
32800	AMK main op. mode	0		00000000h	FFFFFFFFh	
32801	AMK second op. mode 1	0		00000000h	FFFFFFFFh	
32802	AMK second op. mode 2	0		00000000h	FFFFFFFFh	
32803	AMK second op. mode 3	0		00000000h	FFFFFFFFh	
32804	AMK second op. mode 4	0		00000000h	FFFFFFFFh	
32805	AMK second op. mode 5	0		00000000h	FFFFFFFFh	

ID-No.	Designation	K		Minimum	Maximum	Unit
32811	Ext. pos. feedb. source	0		0	65535	
32812	Active drives	0		0000h	00FFh	
32813	Par.set assignm. AW1	0		00000000h	FFFFFFFFh	
32814	Par.set assignm. AW2	0		00000000h	FFFFFFFFh	
32815	Par.set assignm. AW3	0		00000000h	FFFFFFFFh	
32816	Par.set assignm. AW4	0		00000000h	FFFFFFFFh	
32817	Par.set assignm. AW5	0		00000000h	FFFFFFFFh	
32818	Par.set assignm. AW6	0		00000000h	FFFFFFFFh	
32819	Par.set assignm. AW7	0		00000000h	FFFFFFFFh	
32820	Par.set assignm. AW8	0		00000000h	FFFFFFFFh	
32821	Password	0		0	4294967295	
32846	Output port 1	0		0	65535	
32847	Port 1 bit 0	1		0.0	429496729.5	
32848	Port 1 bit 1	1		0.0	429496729.5	
32849	Port 1 bit 2	1		0.0	429496729.5	
32850	Port 1 bit 3	1		0.0	429496729.5	
32851	Port 1 bit 4	1		0.0	429496729.5	
32852	Port 1 bit 5	1		0.0	429496729.5	
32853	Port 1 bit 6	1		0.0	429496729.5	
32854	Port 1 bit 7	1		0.0	429496729.5	
32855	Output port 2	0		0	65535	
32856	Port 2 bit 0	1		0.0	429496729.5	
32857	Port 2 bit 1	1		0.0	429496729.5	
32858	Port 2 bit 2	1		0.0	429496729.5	
32859	Port 2 bit 3	1		0.0	429496729.5	
32860	Port 2 bit 4	1		0.0	429496729.5	
32861	Port 2 bit 5	1		0.0	429496729.5	
32862	Port 2 bit 6	1		0.0	429496729.5	
32863	Port 2 bit 7	1		0.0	429496729.5	
32864	Output port 3	0		0	65535	
32865	Port 3 bit 0	1		0.0	429496729.5	
32866	Port 3 bit 1	1		0.0	429496729.5	
32867	Port 3 bit 2	1		0.0	429496729.5	
32868	Port 3 bit 3	1		0.0	429496729.5	
32869	Port 3 bit 4	1		0.0	429496729.5	
32870	Port 3 bit 5	1		0.0	429496729.5	
32871	Port 3 bit 6	1		0.0	429496729.5	
32872	Port 3 bit 7	1		0.0	429496729.5	
32873	Input port 1	0		0	65535	

ID-No.	Designation	K		Minimum	Maximum	Unit
32874	Port 1 bit 0	1		0.0	429496729.5	
32875	Port 1 bit 1	1		0.0	429496729.5	
32876	Port 1 bit 2	1		0.0	429496729.5	
32877	Port 1 bit 3	1		0.0	429496729.5	
32878	Port 1 bit 4	1		0.0	429496729.5	
32879	Port 1 bit 5	1		0.0	429496729.5	
32880	Port 1 bit 6	1		0.0	429496729.5	
32881	Port 1 bit 7	1		0.0	429496729.5	
32882	Slot assignment	0		00000000h	FFFFFFFFh	
32883	Config. slot 1	0		00000000h	FFFFFFFFh	
32884	Config. slot 2	0		00000000h	FFFFFFFFh	
32885	Config. slot 3	0		00000000h	FFFFFFFFh	
32886	Config. slot 4	0		00000000h	FFFFFFFFh	
32890	AWIW puls multiplier	0		1	10	
32892	Sync.set.pulses divider	0		65536	2147483647	
32893	Sync.set.pulses multipl	0		-2147483648	2147483647	
32901	Global service bits	0		00000000h	FFFFFFFFh	
32922	Resid.dist.erase wind.	0		0	65535	Incr.
32924	Op.mode change par.	0		0000h	FFFFh	
32925	AMK spindle posit.par.	0		0000h	FFFFh	
32926	AMK homing cycle par.	0		0000h	FFFFh	
32927	AMK synchronous par.	0		0000h	FFFFh	
32928	Time filter 1	1		0.0	6553.5	ms
32929	Time filter 2	1		0.0	6553.5	ms
32935	Voltage standstill	1		0.0	1000.0	V
32940	High homing velocity	0		0.0000	100000.0000	min^{-1}
32941	SERCOS service	0		00000000h	FFFFFFFFh	
32948	Config. AZ message	0		00000000h	FFFFFFFFh	
32952	At sync. speed window	0		0	65535	Incr.
32953	Motor enc. type	0		0000h	FFFFh	
32954	Time ramp down monitor	2		0.00	655.35	s
32955	Delay time	2		0.00	655.35	s
32956	Add. acceleration value	0		4	255	
32960	Input M.enc. gear	0		1	65535	Rev.
32961	Output M.enc. gear	0		1	65535	Rev.
32968	Input port 2	0		0	65535	
32969	Port 2 bit 0	1		0.0	429496729.5	
32970	Port 2 bit 1	1		0.0	429496729.5	
32971	Port 2 bit 2	1		0.0	429496729.5	

ID-No.	Designation	K		Minimum	Maximum	Unit
32972	Port 2 bit 3	1		0.0	429496729.5	
32973	Port 2 bit 4	1		0.0	429496729.5	
32974	Port 2 bit 5	1		0.0	429496729.5	
32975	Port 2 bit 6	1		0.0	429496729.5	
32976	Port 2 bit 7	1		0.0	429496729.5	
32977	Input port 3	0		0	65535	
32978	Port 3 bit 0	1		0.0	429496729.5	
32979	Port 3 bit 1	1		0.0	429496729.5	
32980	Port 3 bit 2	1		0.0	429496729.5	
32981	Port 3 bit 3	1		0.0	429496729.5	
32982	Port 3 bit 4	1		0.0	429496729.5	
32983	Port 3 bit 5	1		0.0	429496729.5	
32984	Port 3 bit 6	1		0.0	429496729.5	
32985	Port 3 bit 7	1		0.0	429496729.5	

17 AZ module exchange

Important information:

1. **MASTER SWITCH OFF. AWAIT DC BUS DiSCHARGING TIME > 3 MINUTES !**
2. **On central modules with external SMPS supply:**
   Cut off external supply voltage (400V at terminals X99)!
3. Remove module front cover and swing open control panel AZB (90°).
4. Loosen strain relief for all AZ cables and disconnect all cables of possible option cards.
5. Use extracting tool to disconnect plug-in terminal blocks X30 and X31 (also X29, X32 if used).
6. Loosen the ribbon cable connector X27 (BUS cable) by pressing the two locking clips to the left and unplug cable.
   (With external control panel AZB: Unplug ribbon cable connector X35).
7. Disconnect fan connectors X23 and X33. For this loosen the latching at the narrow connector by pressing with your fingers.
8. Unscrew DC BUS connections UZP (red) and UZN (blue) at terminals X22.
9. Unscrew single wires for power input at terminals X26 (be aware of clear cable marking!).
10. If used: Disconnect external brake resistor (X21) and plug-in terminal block for associated PTC resistor (X24).
11. Unscrew PE connections at AZ module.
12. Loosen module fastening screws at the mounting panel.
13. Slightly lift the module and take it out towards you.
14. Insert the new AZ module with the same specification, lower it and securely tighten the fastening screws.
15. Draw out the option cards and the processor card AZ-R0x out of the just removed AZ module after loosening the fixing screws below the card grip. Insert the cards 1:1 into the slots of the new AZ module, securely tighten the fixing screws and connect the option card cables safely in the correct sockets.

Warning

Absolutely pay attention to:
Exchange of the processor card AZ-R0x is only permitted after consultation of the machine manufacturer and his release.

All system specific parameters are stored in the EEPROM on the processor card AZ-R0x. The machine manufacturer first has to load the actual and valid parameter set into the EEPROM of the new processor card before restart of the system. Also make sure, that the correct system software (EPROM) is used (equal or higher number of the software version). Non-observance of these instructions leads to functional problems, malfunction and machine damages!

16. Securely tighten PE connections at AZ module.

17. If used, securely connect brake resistor (X21) and insert plug-in terminal block X24.
18. Securely connect power input (X26). **Pay attention to the correct phase-sequence!** Plug-in X25.
19. Reconnect terminals X99 (if used).
20. Securely connect DC BUS UZP (red) and UZN (blue) at terminals X22.
21. Insert and latch fan connectors X23 and X33.
22. Insert ribbon cable connector (BUS cable) from the following AW module in X27. For this raise the two locking clips slightly and then plug-in the connector carefully without force until the locking clips close. (With external control panel AZB: Plug-in ribbon cable connector X35).
23. Insert plug-in terminal blocks X30 and X31 (and also X29, X32 if used) into the respective sockets.
24. For strain relief fix all cables to the bases with cable ties. With shielded cables, carefully press screen onto the bare metal front plate, contact area as large as possible.
25. Swing back control panel AZB until it is latched and then put in the module front cover.
26. Main switch on. Restart.

18 Impressum

Title **AMKASYN Central Modules AZ**

Objective Hardware description of the central modules AZ

Part-Number 25755

History

Date
2000/44

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To assure a fast and accurate response to solve customer problems we ask for your cooperation in providing us with the following information:

- Nameplate data
- Software version
- System configuration and application
- Description of problem and presumed cause of failure
- Diagnostic message (error code)

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