BALDOR®
MOTORS AND DRIVES

BSC Series 2000/ 3000
Servo Control

Installation & Operating Manual

7/92

CONTENTS

1.0 Specification

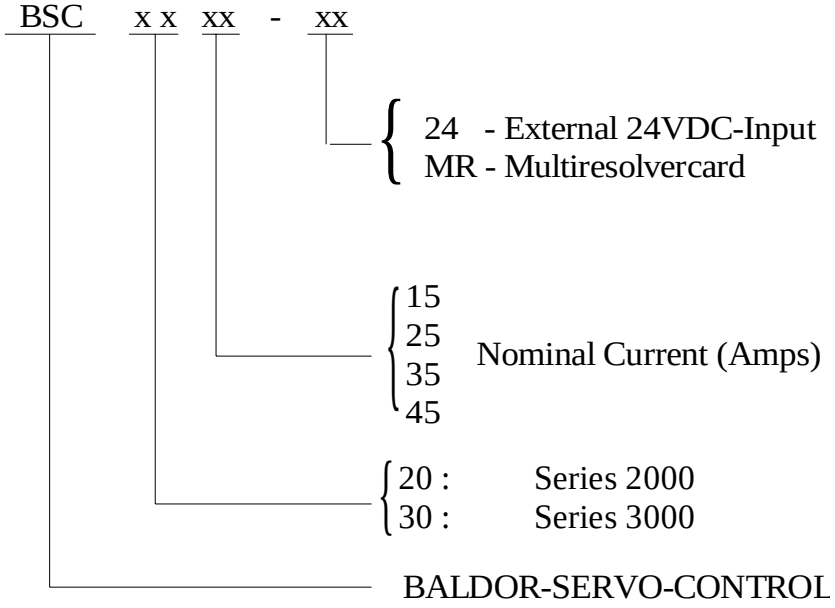
1.1 Usage Definitions

The amplifiers of the series BSC2000/3000 are electrical equipment for industrial power installations. They are designed for machine applications, which need variable speed controlled three-phase A.C. motors.

This product is only for use in industrial applications as described in norms EN 60204 and VDE 0160. This means use BSC2000/3000 in stationary groundbased applications only. It is not meant for use in home appliances, medical technics, cars, ships or airplanes.

Before the BSC is put into operation, please contact your Electric-Supply-Company for special operating conditions.

1.2 Identification



1.3 Features

A BSC is an analog 1 axis amplifier with integrated power stage.
It provides the following features:

POWER SECTION:	
• 3 respectively 4 output current versions (15/25/35/45A) available.	• Output power up to 30kVA
• Ratio peak : nominal current = 2:1. Both values independently adjustable.	• Brushless-servomotors (2 to 8 poles) can be connected. (Feedback: 2-pole resolver)
• All BSC amplifiers are short circuit proof and require no minimum load.	• Power wiring via terminal screws (max. wiring diameter 10mm²/AWG7)
CONTROL I/O Section:	
• 5 opto isolated control inputs for dedicated amplifier functions	• Wiring of control inputs and outputs via plug type screw connection (max. wiring diameter 1,5mm²/ AWG15) or SUB-D connector
• Diagnostic display on front panel	
GENERAL:	• Isolation classification according to DIN 0110 with overvoltage category II
• Protection class IP20 (acc. to DIN40 050 / IEC144)	• Contamination level 2
• Cooling: self-ventilation	

1.4 Declaration of Conformity

Herewith we declare, that our products are components only and not ready for immediate or instant use within the meaning of "Safety law of appliance", "EMC Law" or "Machine directive".

The final mode of operation is defined only by the insertion into the user´s construction.

It is the responsibility of the user to verify that his construction is in accordance with existing regulations.

It is prohibited by law to put the machine into operation before verifying that the machine is in accordance with EC directive 89/392 and 921/368.

The supplier declares product conformity with the following standards:

DIN VDE 0160 / 05.88	Electronic equipment for use in electrical power installations
DIN VDE 0100	Erection of power installations with nominal voltages up to 1000V
DIN IEC 326 Part 1 / 10.90	Design and use of printed boards
DIN VDE 0110 Part 1-2 / 01.89 DIN VDE 0110 Part 20 / 08.90	Dimensioning of clearance and creepage distances
EN 60529 / 10.91	Degrees of protection provided by enclosures

1.5 EMC - Conformity and CE - Marking

The application of EMC conformal component and partly systems relieves the observance of EMC Guidelines and the guaranty of conformity for the manufacturer of machines. Therefore all standard components and partly systems will be tested according to the requirements of EMC regulation. Those tests will be executed by a competent and indepen-dent institution. The conformity of the products will be confirmed by a declaration of conformity from the European Community. The installation instructions refer to elimination of radio interference as well as to immunity from noise for BALDOR Drive Systems.
Thereby the user is informed about the EMC critical parts. The examples don´t show the complete possibilities of cabinet components or constructions.

Guidelines for EMC Conformity

⇒ **Machine Guideline (89/392/EWG)** **- Machine Safety Law**
Application since 01.01.95

⇒ **EMV Guideline (89/336/EWG)** **- EMC Law**
Applicade 01.01.96 on

⇒ **Low Voltage Guideline (73/23/EWG)** **- Machine Safety Law**
Applicade 01.01.97 on

1.5.1 EMC Installation Instructions

To ensure electromagnetical compatibility (EMC) at hostile environment inside the cabinet following instructions are to be observed for construction. Only the implementation of following provisions enables the reduction of interference down to required values.

For the Drives Technology following key points are to be considered:

- **Grounding**
- **Screening**
- **Filtering**

Furthermore the relevant chapters of the Installation manual for the controllers have to be observed.
For installation of the drives system the starting point is the installation into a cabinet.

For construction of a cabinet the following installation instructions have to be considered:

A) All metal conducting parts of a cabinet are to be connected arealy and conductable.Eventually the connections should be placed with an earthing strap at a central grounding point .[1)]

B) Signal lines and Power Cables are to be connected separately. (Avoid interaction space)

C) The screen connection of the signal lines and the power cables has to be ensued on a screen linequaranteeing enough space. This screen line also has to be conductable and connected to the remaining housing parts.

D) The cable to the regeneration resistor has to be screened. The screen connection should be on both sides.

E) The mounting of the mains filter has to be situated at the input of the cabinet or behind the transformer. The filter is to connect on ground (cabinet housing, mounting plate etc.).

F) Wiring has to be conducted bundled and close to the cabinet housing or at the mounting line. The unused leads of a cable have to be connected on one side with ground. [1)]

G) In case of worse potential balance between the screen connections a compensating leak with at least 10mm2 (AWG) has to be provided parallely in addition to reduction of the screen current.

1) Grounding in general describes all metal parts which can be connected to a protective conductor, e.g. housing of switch cabinet, motor housing, fundament grounder.

1.5.2 Specifications and Additional Components

1.5.2.1 Mains Filter

Following results are desired through the application of mains filters:

The electronic system should be protected from high frequency interferences which could enter via the mains cable (immunity from noise) and vice versa the mains cable may not transmit interferences from the electro-nic systems to the adjoining components (elimination of radio interference).

In the main line a mains input filter has to be provided between transformer and controller (In case of direct connecton this has to be in front of the controller).

To choose the fitting mains filter types following points have to be considered:

1. The need of power of the connected controller. Thereby the capacity and the ability of peak phase current has to be considered.
2. The required or prevailing mains impedance.

This table shows the corresponding mains filter types for 3 phase input:

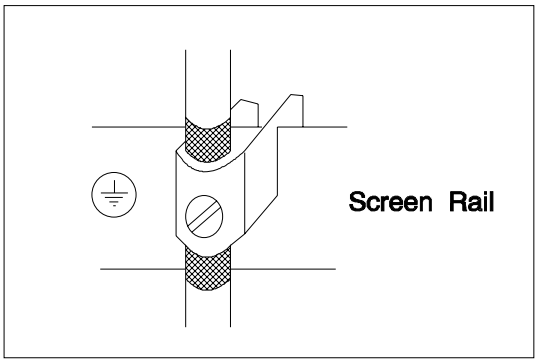
Type	Rated Voltage [V]	Rated Current (at 40°C) [A]	Leakage Current [mA]	Power Losses [W]	Weight [kg]	BALDOR - ID-No
FN 351 - 8 - 29	3x 440	8	16	8.0	1.8	24667
FN 351 - 16	3x 440	16	16	9.0	1.8	24668
FN 351 - 25	3x 440	25	170	9.0	3.0	24669
FN 351 - 36	3x 440	36	170	10.5	3.0	24670
FN 351 - 50 - 29	3x 440	50	190	12.5	3.1	24671
FN 351 - 80 - 29	3x 440	80	210	26.0	9.5	24672
FN 351 - 110 - 29	3x 440	110	210	28.0	9.5	24673

1.5.2.2 Connection Cables

All cables have to be screened.

Motorcable and Signalcable		BALDOR ID - No.
Motorcable	4 x 1.0 mm^2	21599
Motorcable	4 x 2.5 mm^2	21364
Motorcable	4 x 6.0 mm^2	21597
Resolvercable	3 x [2 x 0.14 mm^2]	19413
Regen Resistorcable	3 x 2.5 mm^2	11302

1.5.2.3 Screen Connection



Siemens Clamp		Siemens -No.
5mm Rail	Wiring Diameter 1.5 - 16 mm^2 1.5 - 35 mm^2 16 - 70 mm^2 16 - 120 mm^2	 8US19 21 -2AA00 -2AB00 -2AD00 -2AC00
10mm Rail for T- and double T-profile	Wiring Diameter 95 - 300 mm^2	 8US19 41 -2AA00

1.5.2.4 Connectors

Connection	Designation	BALDOR - ID -No.	
for Motorcable Plug Socket	 CONN SET FEM CONN SET MALE	 2 x 4 pole 2 x 4 pole	 24654A 24656A
for Resolvercable Plug Socket	 CONN SET FEM CONN SET MALE	 12/6 pole 12/6 pole	 24655A 24657A
for BSC with EMC-Regulation connector X2 with housing			
Connector Housing		25043A 25049A	

1.5.2.5 PG - Cable Glands

PG Cable Gland	Cable Dimensions	Designation	BALDOR ID - No.
PG 9	4 - 8 mm Resolvercable BALDOR ID-No.19413	SCREWING	24658
PG 13.5	6 - 12 mm Motorcable BALDOR ID-No. 21599	SCREWING	24659
PG 21	13 - 18 mm Motorcable BALDOR ID-No. 21364	SCREWING	24660

1.6 Technical Data

All values at T_{amb} = 40 °C, if not otherwise specified.

1.6.1 Power Section

General	**Unit**	**BSC 2015**	**BSC 2025**	**BSC 2035**	**BSC 2045**	**BSC 3015**	**BSC 3025**	**BSC 3035**
Nominal DC-Bus-Voltage U_{in} (BPS) = 230V	V_{DC}	320				-		
Nominal DC-Bus-Voltage U_{in} (BPS) = 400V	V_{DC}	-				560		
Nominal DC-Bus-Voltage U_{in} (BPS) = 460V	V_{DC}	-				650		
DC-Bus-Voltage absolute min./max.	V_{DC}	0 ... 350				0 ... 740		
Output Voltage Line/Line fundamental wave; @$V_{DC\text{-}Bus}$ (nom.)	V_{RMS}	0 ... 250				0 ... 500		
Nominal Phase Current (±10%)	A_{RMS}	15	25	35	45	15	25	35
Peak Phase Current (±10%) 1.5s ±0.5s	A_{RMS}	30	50	70	90	30	50	70
Nominal Output Power	kVA	6.5	10.8	15.1	19.5	13.0	21.6	30.3
Efficiency	%	> 95						
Min. Load Inductance	µH	200						
Output Frequency	Hz	0 ... 500						
Nominal Switching Frequency	kHz	8.5						

1.6.2 24V$_{DC}$ Input

24V-Input	Unit	BSC2000	BSC3000
Input Voltage Range absolute min./max. max. V_{Ripple} = ±10%	V_{DC}	20 ... 29	
Input Current; @ 28V_{DC}	A_{RMS}	1.6	
Surge Current at Power On @ 28V_{DC}; @ 100ms	A_{RMS}	2.5	

1.6.3 Velocity Controller

Preamplifier	Unit	BSC2000	BSC3000
Command Input	V_{DC}	0 .. ±10	
Drift (velocity controller)	rpm/K	0.4	
Balance (velocity controller)	rpm	typ. 8; adjustable to 0	

Resolverfeedback	Unit	BSC2000	BSC3000
Resolution	bit	12	
Encoder-Simulation	ppr	250 / 500 / 1000 / 1024	
Signal		5V TTL ; A;A/; B;B/; C;C/	
Reference Pulse		available; non adjustable	

1.6.4 Mechanical Section

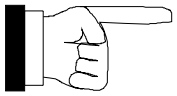
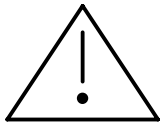
Mechanical	Unit	BSC2000	BSC3000
Mounting	-	Bookstyle or Thru the Wall	
Dimensions	mm	105 x 357 x 328 / 140 x 357 x 328 1)	
Weight	kg	8.5 / 9.5 1)	

1) : BSC2045/3035

1.6.5 Environmental Section

Environmental	Unit	BSC2000	BSC3000
Operating Temperature Range	°C	+5 ... +45	
Storage Temperature Range	°C	-25 ... +70	
Humidity	%	10 ... 90; not condensating; according to DIN40 040, Class F	
Class of Protection (Enclosure)	-	IP20; according to DIN40 050 / IEC 144	
Max. Installation Altitude / M.S.L.	m	1000	
Shock	-	10G; according to DIN IEC 68-2-6/29	
Vibration	-	1G; 10 ... 150 Hz; according to DIN IEC 68-2-6/29	

Legend:

	This is an *INFORMATION* sign. If this information is read, installation and / or amplifier operating problems can be avoided in advance.
	This sign means *ATTENTION*. In all cases it must be read and taken into account. Non-observance can cause dangerous situations for equipment and personnel.

2.0 Installation Recommendations

2.1 Mechanical Installation

- For installation of your system use a cabinet with a protection class that suits your environmental conditions.

- As cooling air freely enters the unit, the environment must be free from corrosive chemical substances, oil, vapour, steam, metal particles and dust.

- Make sure that cooling is provided.

- Make sure that the top of the unit is covered during installation to prevent particles from falling into the unit.

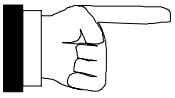
- Keep DC-bus links as short as possible. Therefore always mount BSC2000/3000-combinations side by side.

- Mount all BSC vertical (Terminal blocks to the top).

- Use BSC2000/3000 in stationary groundbased applications only.

2.2 Electrical Installation

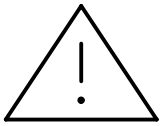
Qualified or trained personnel only should install the machine. Electrical rotating equipment can result in property damage, serious injury, or death, when improperly installed. Equipment should be installed in accordance with the local codes and safety standards for construction and guide for selection, installation and use of electric motors and generators.



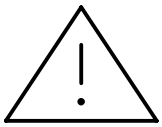
The wiring, fusing, and grounding must be in accordance to the national electrical code and any local codes.

Electrical and/or mechanical alterations are permitted only when power is removed!

Sudden blocking of the rotating motorshaft can cause serious damage to motor and amplifier. It is strongly recommended to install elastic stoppers in the driven machine.

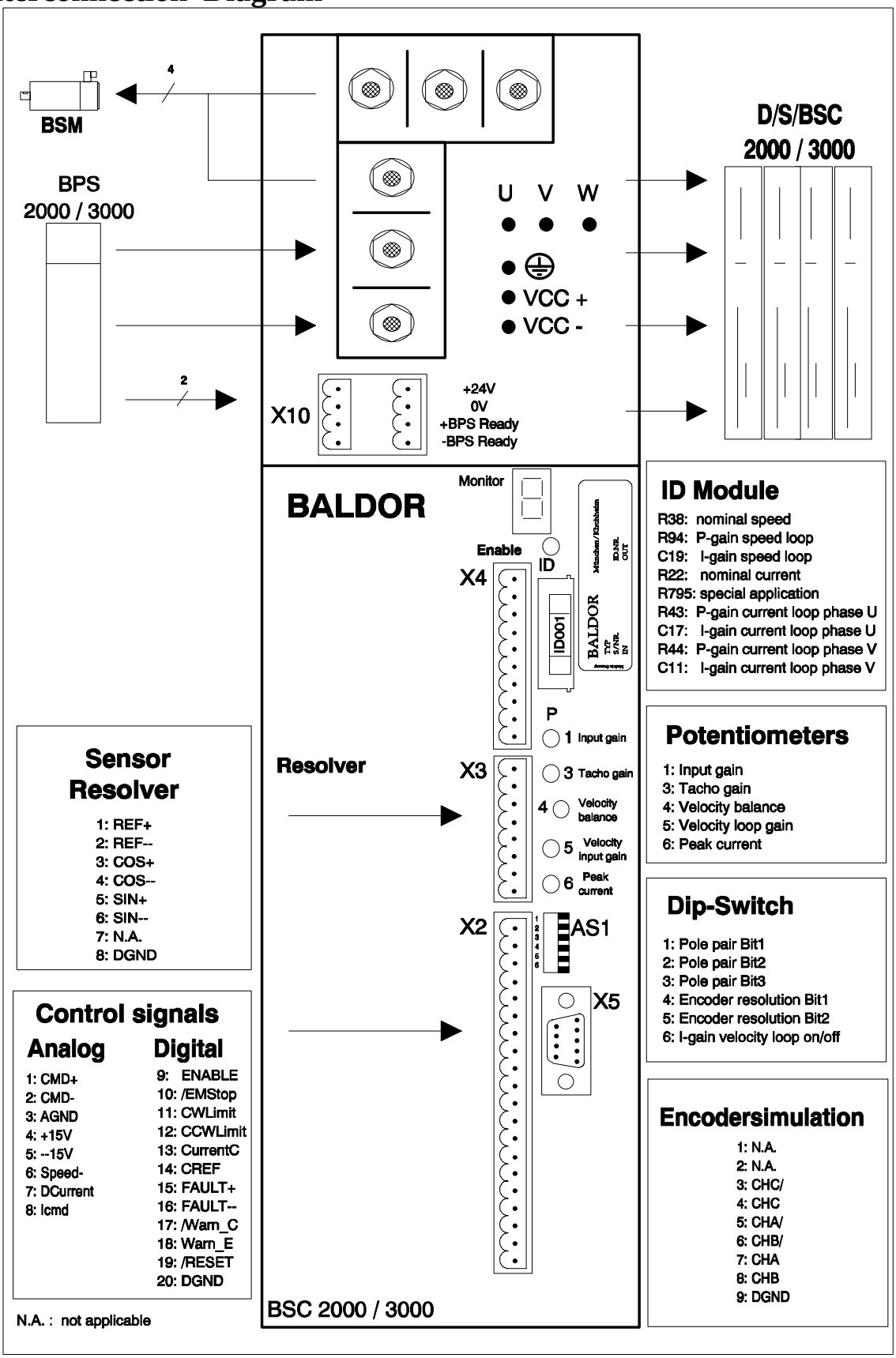


BSC amplifiers have a 24V input to supply the control circuits. If the 24V supply is off, the power connectors can have dangerous voltage levels without any indication. The Monitor and the LED "READY " illuminate only if 24V is switched on.



Connect the PE of all systems to a central point. The diameter of the cablelead must be AWG7(10qmm) min.

3.0 Interconnection Diagram



Content of delivery: mating connector to X1 - 4 and X10. Order-no´s for mating connectors (spare part or completion): **X2**: #16000 (20 pole, female); **X3**: #20506 (8 pole, female); **X4**: #17934 (10 pole, female); **X5**: #16215 (9 pole, male) Connector X4 is reserved for option Multi-Resolver (Absolute positioning). For interconnection diagram refer to manual Multi-Resolver.

4.0 BSC Wiring

In chapter 4.3 you will find the typical (minimum) wiring of the system . The following pages show some special applications and the typical wiring in more detail.
This chapter is valid for all BSC versions.

ATTENTION: For the system set up (chapter 6) it is nessesary to wire the system step by step.
It is recommended to follow the system set up procedure, especiallly for users who are not very familar with the BSC amplifier series.

4.1 Power Wiring

4.1.1 Power Supply

The BSC amplifier will be supplied from a BPS with the DC-bus voltage. The connection between BSC and BPS must be as short as possible. The wiring can be done with copper bars (#23176).

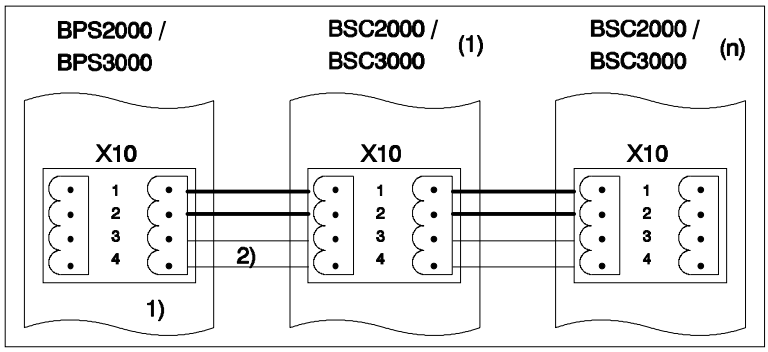
Wiring Power Supply:

Chapter 4.3 shows the wiring in detail

4.1.2 24V$_{DC}$ - Connection

A BSC2000/3000 needs an external 24V control supply. This voltage supplies the amplifiers control circuits.
The advantage is, if main power is switched off, control circuits are still supplied and position information gets not lost.
This supply must be linked to BSC connector X10 (Pin 1 and 2). The BPS2000/3000 provide the needed 24V output. This output is for that purpose and has the same denotation on BPS.
If the BSC is not supplied with the BPS, an external power supply must be connected to connector X10.
The external power supply must fullfil certain specifications (see chapter 1.6.2).

Wiring 24V$_{DC}$-option:



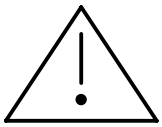
1) The shown BPS, can be replaced by an external 24V-power-supply.
The amount of connected BSC´s (n) which can be connected to one BPS, is "5"
(refer to BPS2000/3000 manual)
2) The wiring of X10 pin 3 and 4 is nessesary for proper BSC operation. For details please refer to chapter 4.2.1.

4.1.3 Motor Wiring

The motor must be connected to the following terminals:

U	**Phase U**
V	**Phase V**
W	**Phase W**

A wiring example is shown in chapter 4.3.



The sequence of the motor leads is not arbitrary. Therefore the motor leads must be wired in the right sequence to avoid uncontrolled motor function.

4.2 Control- and Signal Wiring

This chapter is valid for all BSC versions.

The wiring of the control in- and outputs can be achieved with *one* cable only unlike shown in the pictures below. The outputs *can be* wired. But there is no need for BSC operation.

4.2.1 Control Inputs

The control inputs below are optoisolated. The ground return for all inputs is "CREF", connector X2.14.

Control Input Function:

Signalname	Connector Pin	Switch Position / Function	
		closed	open
ENABLE	X2.9	Amplifier enabled	Amplifier disabled
EMStop	X2.10	Amplifier is active	Motor decellerates with torque to velocity 0
CWLimit	X2.11	Clockwise direction of rotation enabled	Clockwise direction of rotation disabled
CCWLimit	X2.12	Counterclockwise direction of rotation enabled	Counterclockwise direction of rotation disabled
CurrentC	X2.13	Current Mode active	Velocity Mode active

A wiring proposal for the control inputs above you will find in chapter 4.3. The hardware description of the optoisolated input is show in chapter 10.1.

About CurrentC (X2.13):

It is **not permitted** to activate or deactivate the input during amplifier is operating. The controller behavior is completely different. The input should be fixed wired.

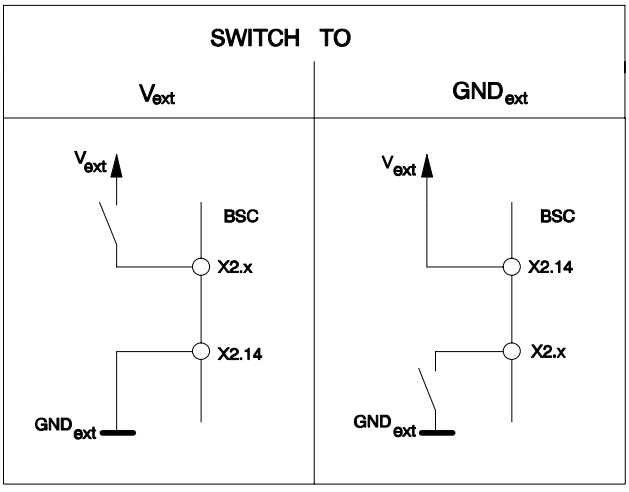
Functional example of control inputs:

The wiring of the control inputs is also shown in chapter 4.3 .
The picture by-stander shows the function and the two wiring principles of the control inputs:

The two wiring versions are:

1) Switching to the external control input power supply. The switch will be linked between the control input (X2.x) and the external power supply (V_{ext}). The ground return (GND_{ext}) is permanetly wired with CREF (X2.14).

2) Switch to the ground return of the external power supply. The switch will be linked between the control input and the external ground return (GND_{ext}). The external power supply (V_{ext}) is permanently wired with CREF (X2.14).

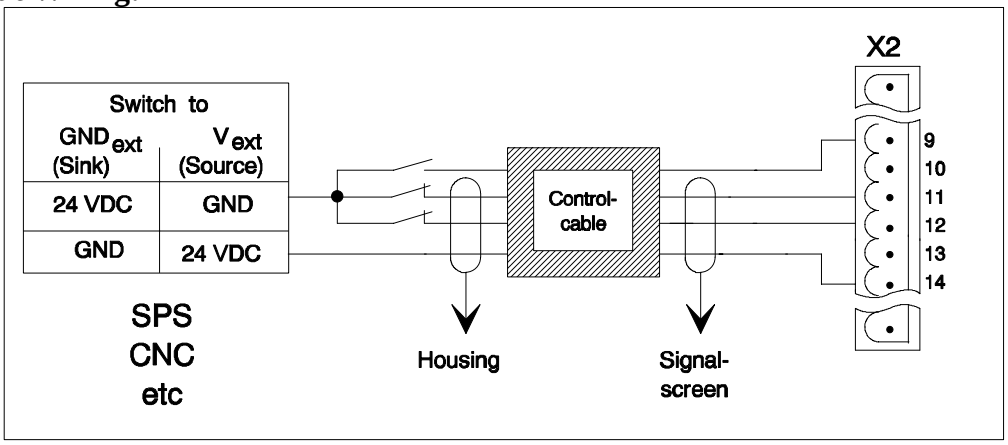


Voltage range of V_{ext} : +12 ... 29V_{DC}

X2.x: "x" for connector pin,
e.g. x=9 → X2.9 = Enable-Input

The control inputs only work properly, if they are supplied with an external voltage.

Control Input Wiring:



Control Input "±BPS Ready"

a) BSC with BPS2000/3000:

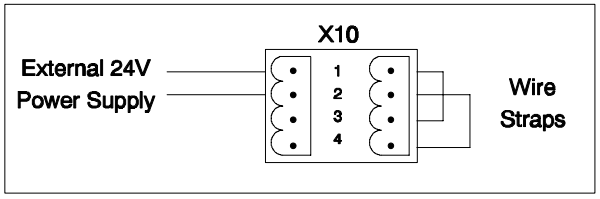
The BSC provide as default a control input "BPS Ready". If the BPS2000/3000 has an internal malfunction, the BPS will disable the connected BSC amplifiers. The input is on connector X10 pin 3 and 4.
Under BPS fault condition, this input will be deactivated and the BSC will show the following state:

LED Ready = *RED*
Monitor = *2* (Undervoltage)

With this fault indication the BSC will be disabled.

b) BSC with external 24V Power Supply:

If the BSC is not operated with the BPS, an external power supply must be connected to connector X10 as shown below. In that case, the control input "±BPS Ready" has no more function. Nevertheless the input *must* be wired. Without the wiring below, the BSC will indicate fault condition like above (see a)).



4.2.2 Control Outputs

The BSC is equipped with a fault relais. The relais contact can be used to observe the amplifier status. The wiring of the fault relais contact is optional and not nessesary for proper amplifier operation.

Control Output Function:

Signalname	Connector Pin	Switch Position / Function	
		closed	open
FAULT+	X2.15	BSC happy	BSC not happy
FAULT -	X2.16	no fault indication	fault indication / monitor

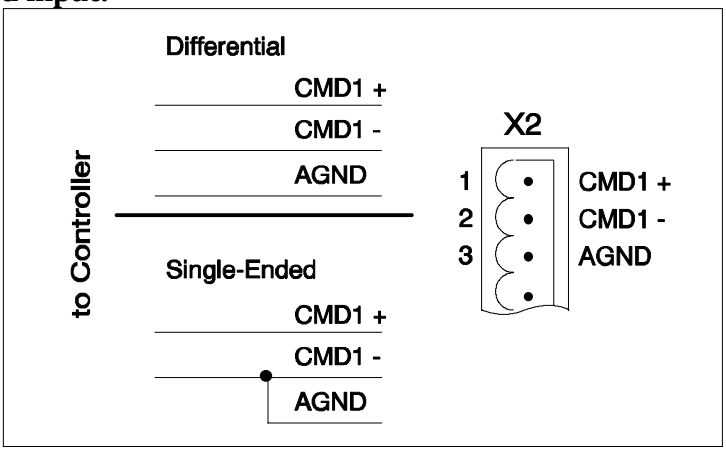
Control Output Wiring:

see chapter 4.3

4.2.3 Command Input

The BSC has an analog command input (±10V). The input can be wired in "single-ended" or in "differential mode".

Wiring of the command input:



4.2.4 Encoder Output

The BSC has an encoder output, which can be used for position- and/or velocity feedback for a superset controller.
The encoder output resolution (*p*ulse *p*er *r*evolution; ppr) can be configured via software. The following binary resolu-tions are available with the BSC20xx/30xx-Axx version:

250ppr 500ppr 1000ppr1024ppr

Wiring of the encoder output:

A wiring proposal is shown in chapter 4.3.
It is strongly recommended to make the wire connection with twisted pairs and screened cable.
We recommend the use of the BALDOR encoder cable #13036.

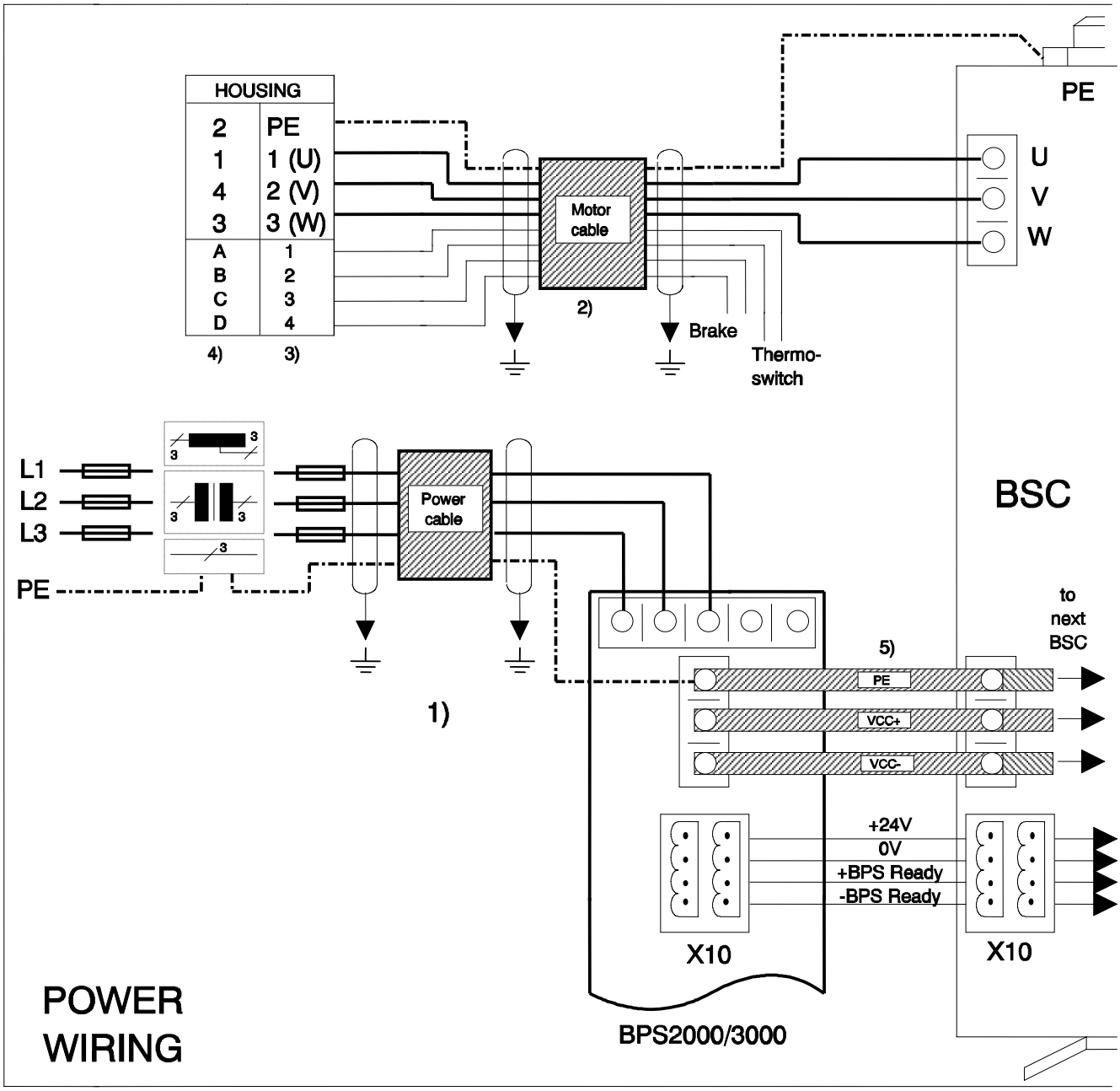
4.2.5 Resolver

The resolver must be connected to connector X9.

Wiring of the resolver in- and outputs:

The wiring is shown in chapter 4.3.
We recommend the use of the special BALDOR resolver cable #19413.

4.3 Minimum Wiring Diagram "The wiring proposal gives no warranty for



1) The power supply must be wired according to the BPS2000/3000 manual (#22705A)

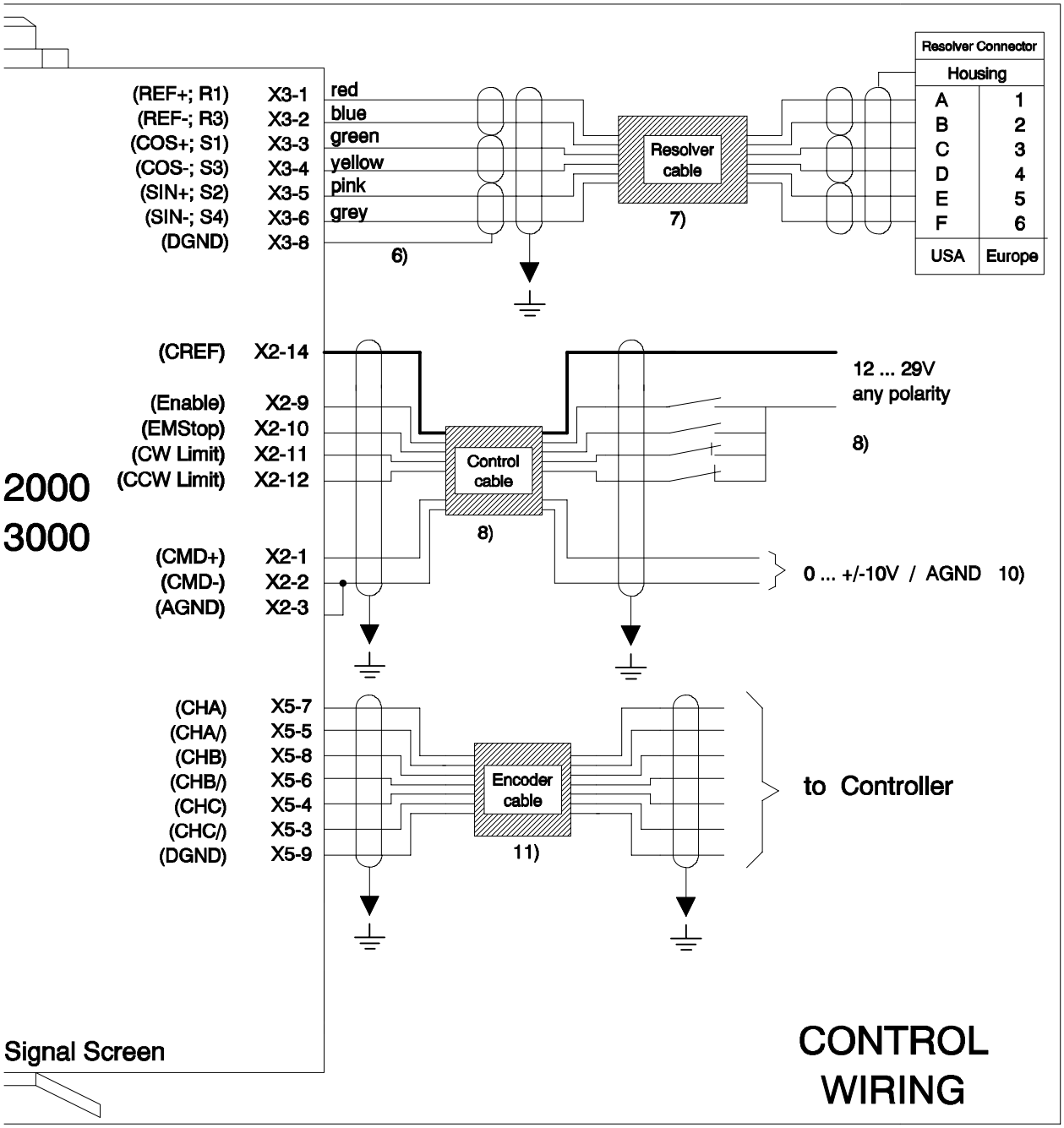
2) Motorcable:
- # 21599: Wire diameter: 1.0mm² / AWG17 Cable outer diameter: (11.6 ±0.4)mm
- # 21364: Wire diameter: 2.5mm² / AWG13 Cable outer diameter: (14.5 ±0.5)mm
- # 21597: Wire diameter: 6.0mm² / AWG9 Cable outer diameter: (18.5 ±0.6)mm
- # 21598: Wire diameter: 10mm² / AWG7 Cable outer diameter: (22.8 ±0.4)mm

3) Terminal box BSM 6R, BSM90A/90B/100A/100B

4) Connector BSM 63/80 Europe

5) The wiring diameter must fit to nominal BPS output current. The connection between BPS and the BSC amplifiers must be as short as possible.
The wiring between BPS and BSC can be done with copper bars (ID-No.: #23176). Also wiring between BSC´s can be done with copper bars. ID-No´s.: #23177 (105mm housing) #23179 (140mm housing)

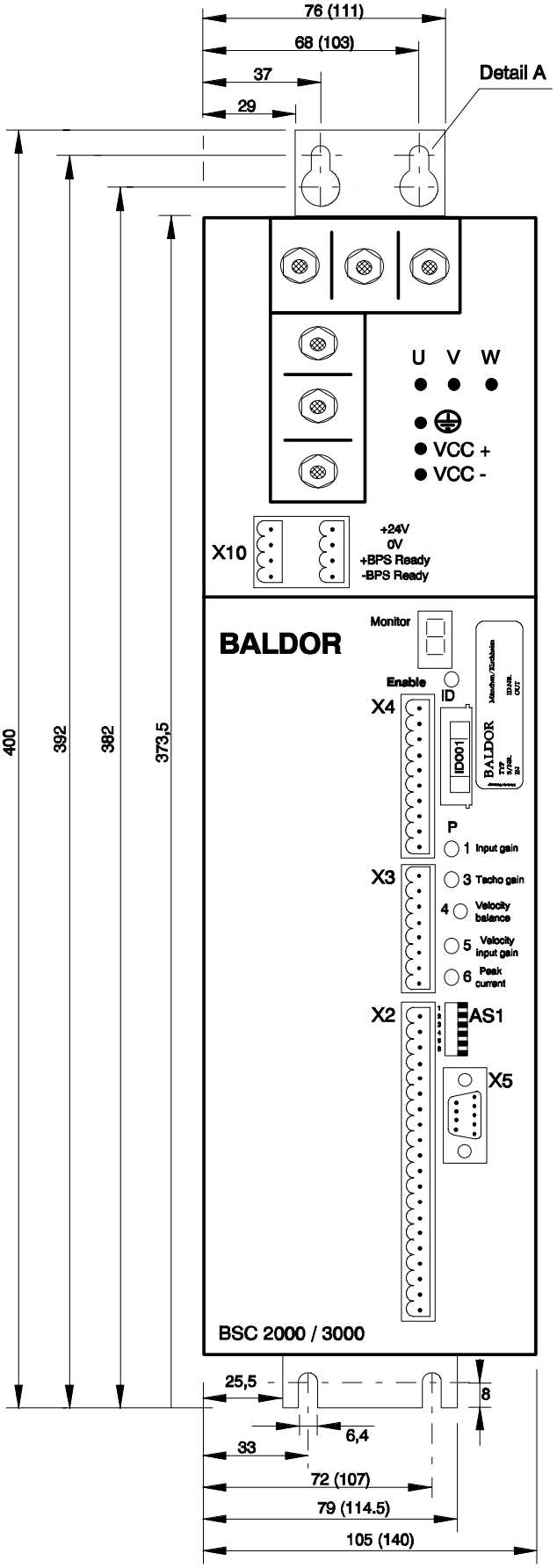
“Observance of valid EMI - standards"

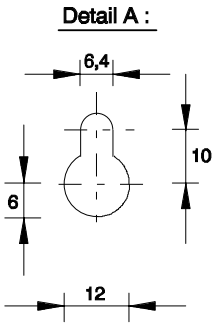


6) If a very strong affect of EMI will be expected, it is recommended to connect the inside screens to DGND.
7) Resolvercable: #19413
8) Functional description of the control inputs see chapter 4.2.1. The control inputs must be supplied with an external voltage source.
9) Control cable not available from BALDOR. Drawing shows the wiring principle only. Can be one or more cables
10) If the wiring is done like shown in the drawing, the motor rotates clock wise (view at motor shaft) with a positive voltage on X1.1 referenced to X1.2.
11) Encodercable #13036, twisted and screened

ATTENTION: Please note also chapters 4.0. to 4.2.

5.0 Dimensions





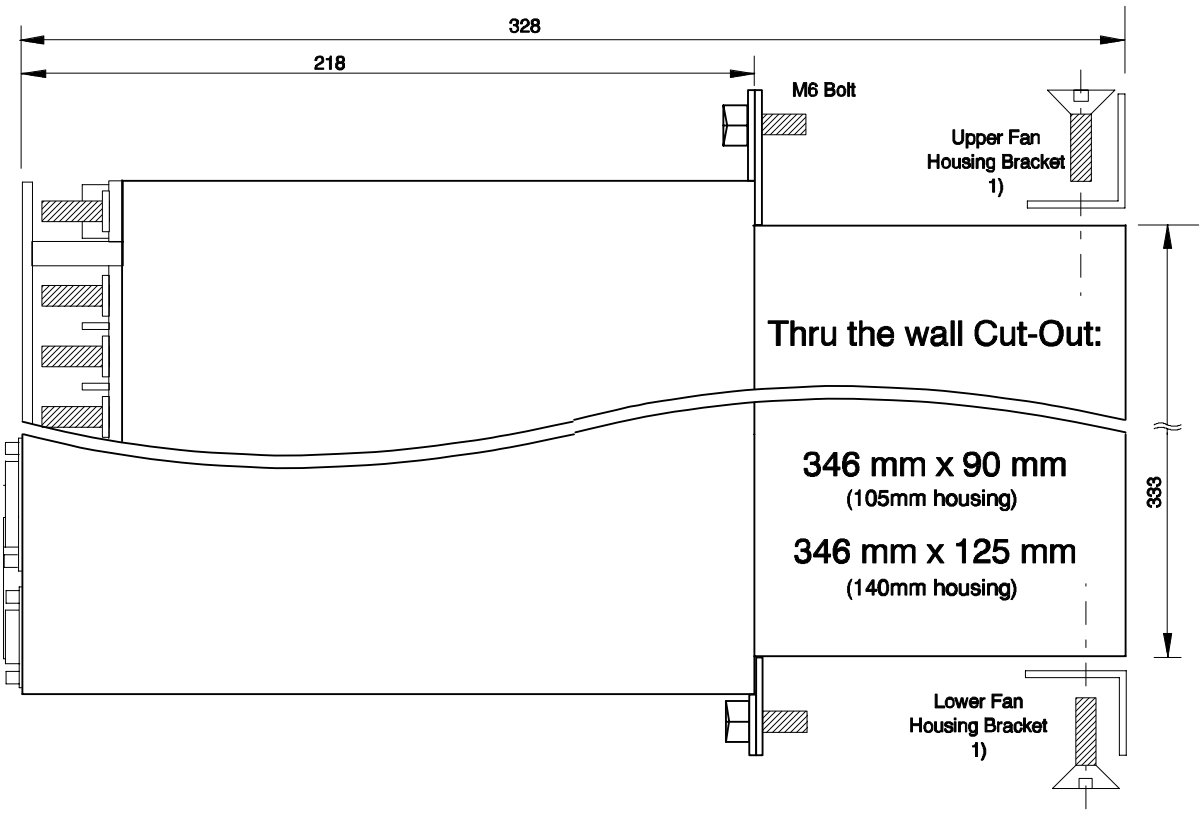
VIEW:

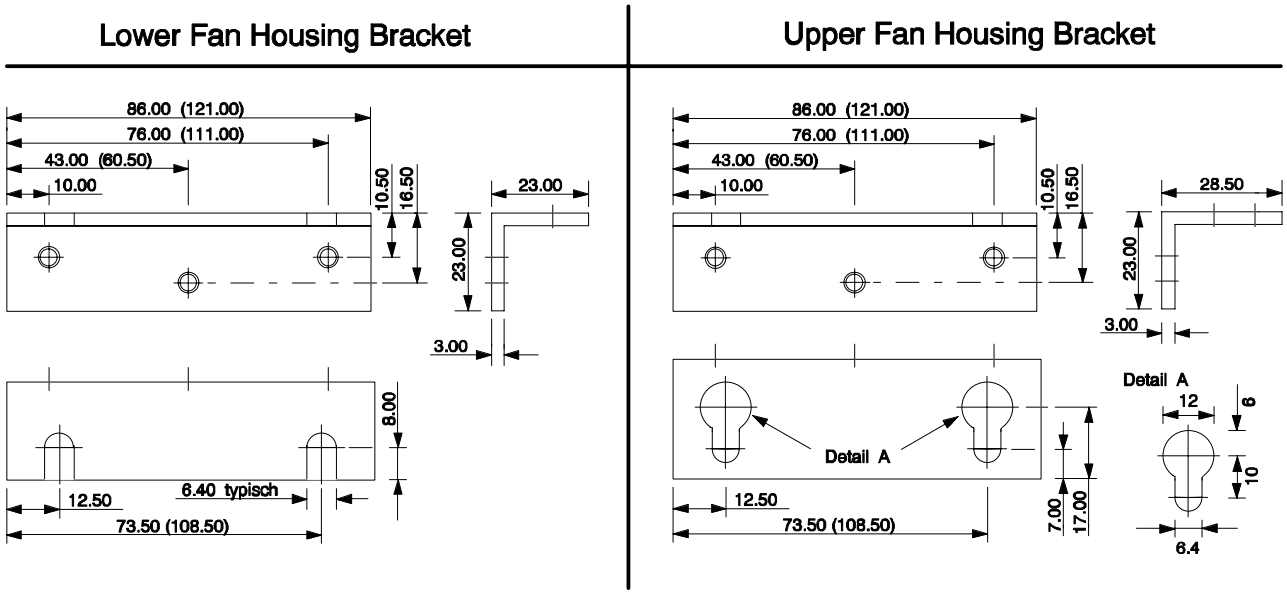
"Thru the wall" mounting

(105mm housing)

Values within brackets for
BSC2045 and BSC3035 (140mm housing)

not scaled (dimensions in mm)





not scaled (dimensions in mm)

1) Upper and lower fan housing brackets are not contents of delivery. They must be ordered seperately according table below. The sets below contain both brackets and the screws.

BALDOR ID - Numbers for Fan Housing Bracket Sets	
BSC2015 / 2025 / 2035 BSC3015 / 3025	**BSC2045 BSC3035**
22570A	23098A

6.0 System Set Up Procedure

6.1 Presets

Before applying power to the system, the following settings must be checked.

6.1.1 Potentiometer Preset

	Function	adjustable from / to	Presets ex factory
P1	Reference Input gain	33 .. 100%	Clockwise for max. input gain (100%)
P3	Velocity feedback gain	33 .. 100%	Clockwise for max. gain (100%)
P4	Velocity Balance	-110mV to +110mV	Standstill at zero input command
P5	Velocity loop gain	4.8 .. 100%	Anti-clockwise for min. gain
P6	Peak current	9 .. 100%	Clockwise for max. current (100%)

6.1.2 DIP - Switch Settings

POLE PAIR SELECT				
AS1-1	**AS1-2**	**AS1-3**	**Number of POLEPAIRS**	**TYPE OF MOTORS**
OFF	OFF	OFF	1	BSM 2 R
ON	OFF	OFF	2 *)	BSM 63A / 80A / 80B
OFF	ON	OFF	3	BSM 6 R
ON	ON	OFF	4	BSM 90A / 90B / 100A / 100B

ENCODER - SIMULATION		
AS1-4	**AS1-5**	**PULSES / REVOLUTION**
OFF	OFF	1024
ON	OFF*)	1000
OFF	ON	500
ON	ON	250

*) Ex factory

- DIP - Switch AS1-6

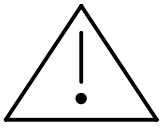
AS1-6 (*ON*) switches *OFF* the Integral- part of the velocity loop. This improves the transient response of the controller in positioning mode. (ex factory *OFF*)

- Velocity or current mode select

Ex factory the amplifier is set to operate as a velocity controller. If you want to operate in current control mode, connect 12..29 V_{DC} to the input X2-13 (CurrentC) in reference to CGND.

6.2 System Set Up Step by Step

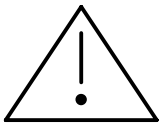
With all initial settings completed (chapter 6.1), the set-up procedure can begin.



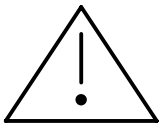
Please perform the initial set-up of the system with no load applied to avoid damaging your equipment due to erraneous handling.

1. Before you connect the BSC amplifier to the BPS, the BPS must be wired and checked according to the manual

After the output voltage of the power supply (BPS2000/ 3000) has been tested, switch off the main supply.



After turning off the power supply, wait about 5 min. to allow discharging the capacitors inside the main power supply.



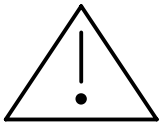
The BSC has no internal fuse for the DC-bus voltage. Make sure, that the system is fused primary.

2. Now you can wire the BSC amplifier under observance of chapter 4.
It is not permitted to connect the motorcable yet. On the other hand the resolver **must** be linked to the motor.

3. Now switch *ON* the main power. The LED "READY" and the "MONITOR" must show the following:

LED "READY"	=	*GREEN*	
MONITOR	=	"•"	Decimal point on the lower right corner is illuminating (Amplifier enabled)

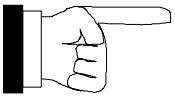
Now switch off main power.



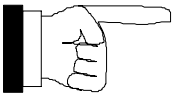
After turning off the power supply, wait about 5 min. to allow discharging the capacitors inside the main power supply.

4. Connect the motorcable. Switch *ON* the main power and activate the ENABLE-Input (X2.9); switch must be closed (see chapter 4). The monitor will show the state:

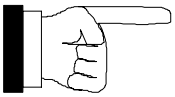
MONITOR = "•" Decimal point on the lower right corner is illuminating



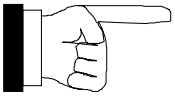
Random power on sequence for 24V resp. bus supply.



If the motor develops no torque, check the wiring of CW-, CCW-limits (X2-11; X2-12), ENABLE input (X2-9) and EMStop input (X2.10).



If the motor shaft accelerates, remove power immediately and check resolver and motor wiring.



If the monitor does not show the decimal point (lower right corner), check the wiring of the ENABLE input (X2.9) and whether the ID-Module is plugged in correctly.

Now turn *OFF* the main power.

5. Now connect a variable DC- voltage (±10 V_{DC}) to the reference input CMD+ (X2-1) and CMD- (X2-2) (see also chapter 4). Turn on the power supply. Apply a voltage between 0..+10 V_{DC}: the motor will rotate clockwise. The DC-voltage level corresponds with the speed and the polarity corresponds with the direction of the motion.

6.3 System Tuning

The BSC amplifier consists of two control loops; current- and velocity loop. The control loops can be optimized by changing the variable components. The variable components are located on the ID-module (see chapter 9.0).

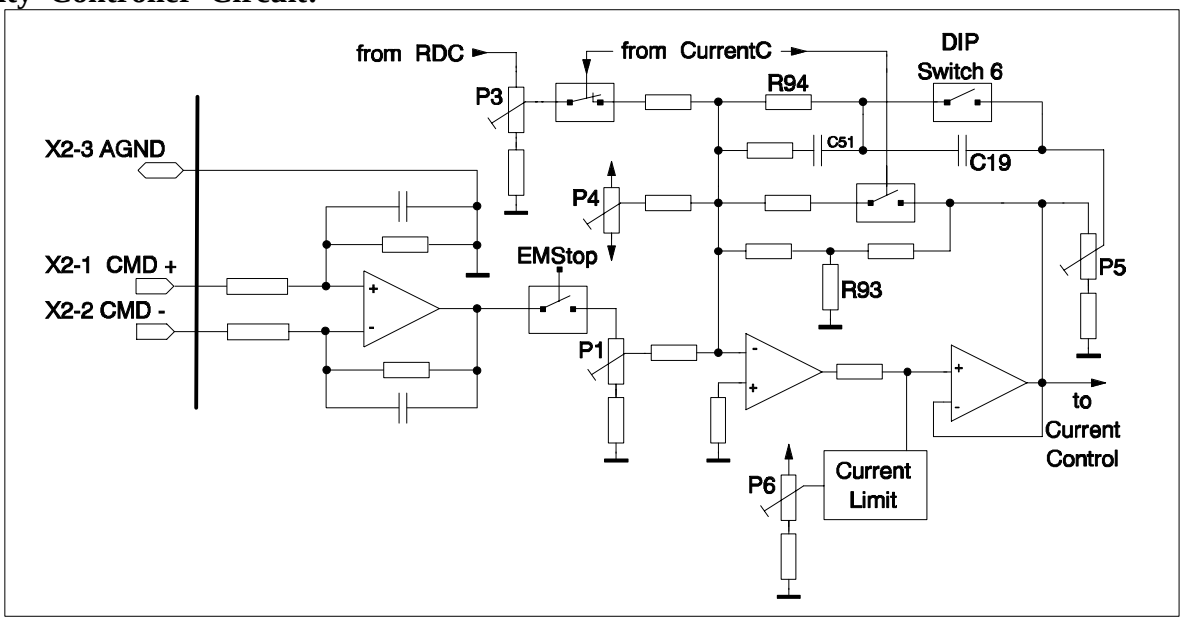
a) Current Controller

There are two current controllers for motor phase U and V. The current controller setting depends only on the motor attached. The controllers are adjusted ex factory to the BSM motors. In general there is no need for optimization.

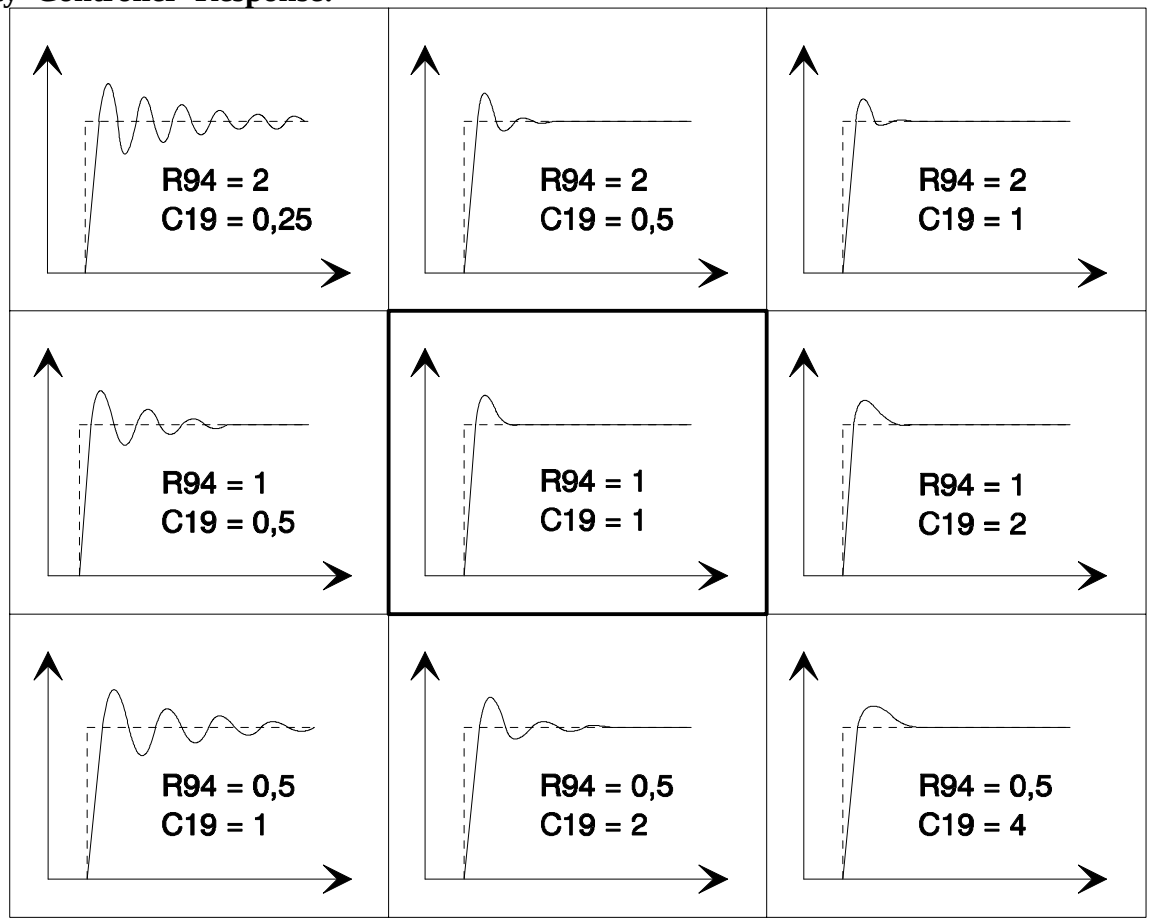
b) Velocity Controller

The circuit of the velocity controller is shown below. The velocity controller performance depends on the motor load. Most of all applications do not need an additional optimization.
With variable components R94 and C19 the velocity controller can be optimized. For this purpose a small command step (2V_{DC}) should be applied to the command signal input. The step response can be observed with an oscilloscope on testpoint I_{CMD} (X2.8). Below are shown different step responses. The optimum is the picture in the middle. R94 and C19 are shown in normalized manner.
For an optimization in more detail, refer to the bode-diagram for velocity controller. It shows all variable components of the velocity controller and how they act.

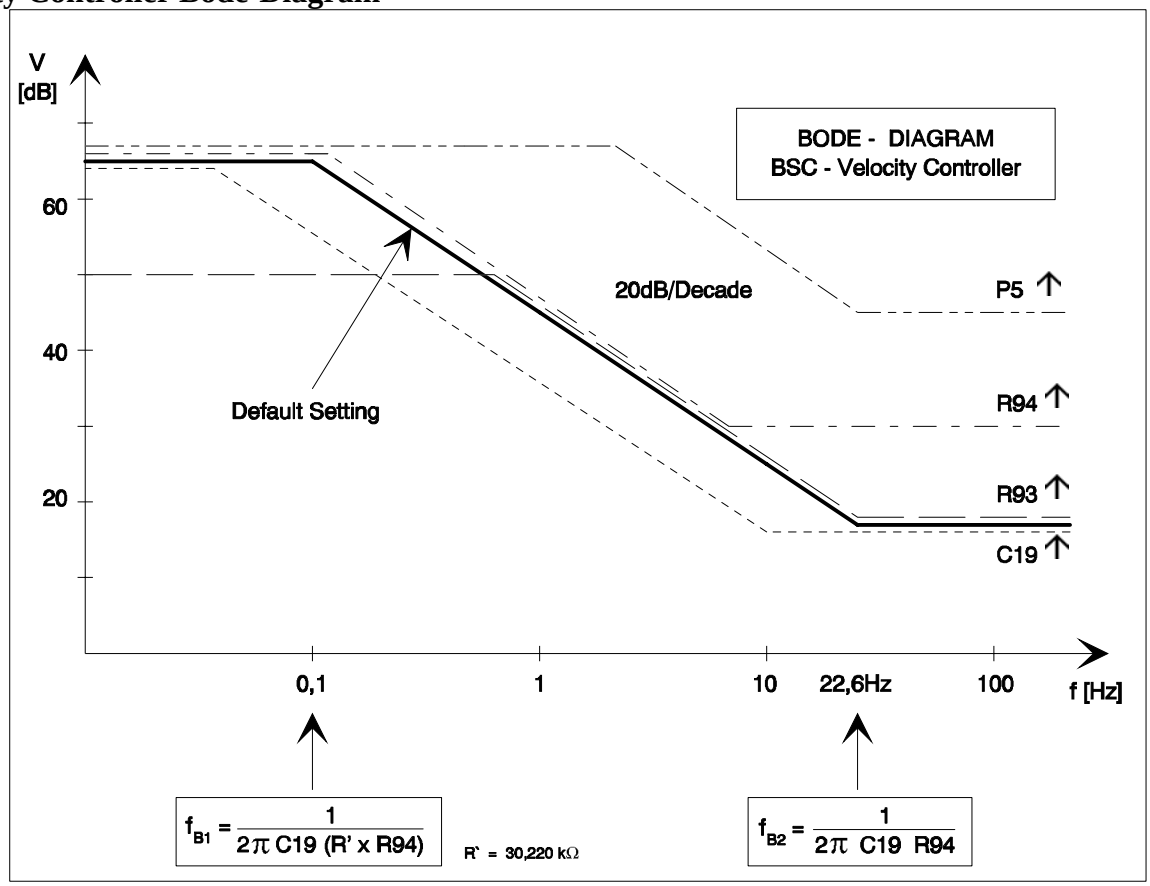
Velocity Controller Circuit:



Velocity Controller Response:



Velocity Controller Bode-Diagram

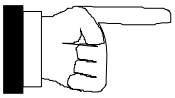


7.0 Status Monitor

For convience of monitoring the performance, the BSCprovides a status monitor. The indicated signs, as well as the LED Ready have the following meaning:

LED Ready	Monitor	Status	Cause
Green	OFF	Amplifier disabled	no fault
Green	. (DP)	Amplifier enabled	no fault
Red	1	Overvoltage amplifier DC bus voltage	Missing, damaged or wrong designed regeneration resistor.
Red	2	Undervoltage	Missing wiring of X10 or problems with BPS2000/3000; see also chapter 4.2.1
Red	3	Overcurrent 2x Peak Current Crest Value	Power stage fault or motor leads short circiut
Red	4	Over- or Undervoltage; Internal 15V supply	Internal control voltage fault
Red	5	Resolver fault	Parting of the cable or resolver leads short circuit or missing plug-in connection
Red	6	Electronic Fusing (see Fault 7 also)	Amplifier or motor active current overload. Fault detection via software.
Yellow	7	I^2t-Limit If I^2t-limit is reached, amplifier will reduce output current to it´s nominal value. After 1.5s ±0.5s BSC switches off (amplifier disable) with fault indication "6; electronic fusing"	Cycle time between motor acceleration and deceleration is too short.

Furthermore special display indications for operating modes are available. For detailed informations of these operating mode indications refer to operating manual.



With main power OFF and 24V-supply ON (X10), status monitor works for fault diagnostic.

8.0 Testsignals

To allow you an effective set-up of the amplifier and its control loops (PI-controller) three testsignals are acces-sible. These testsignals allow you an optimal adjustment of the load versus the motor. Also you can monitor these signals during operations.

Testpoint		Function and Scaling
X2 - 6	Speed -	Actual velocity of the motor ± 10V equal ± 6000rpm
X2 - 7	DCurrent	Actual output current 0..+10V; 10V equal peak current
X2 - 8	Icmd	Output of the velocity controller ± 10V equal peak current

9.0 Identity Modul (ID)

9.1 Component Functions

Components	Function	Value *)
R38	Scaling of Tacho (4000rpm)	4.99kΩ
D401	Plug-in protection	-
R94	P-gain for velocity loop	100kΩ
C19	I-gain for velocity loop	47nF
R22	It-switching threshold (nom.current)	-
R765	Special function	26.7kΩ
R43	P-gain for current loop phase U	150kΩ
C17	I-gain for current loop phase U	4.7nF
R44	P-gain for current loop phase V	150kΩ
C11	I-gain for current loop phase V	4.7nF
D402	Plug-in protection	-
RES	Reserved for special applications	-

*) Standard values

-Scaling of tacho (R38):

0Ω	for	6000rpm
4.99kΩ	for	4000rpm
10.0kΩ	for	3000rpm
20.0kΩ	for	2000rpm

Applications over 6000rpm on request ex factory Munich.

By changing R38 the speed monitor (X2-6) scaling is not influenced.

10V equal 6000rpm

- It-switching threshold adjust:

With resistor R22 on the ID-card it is possible to adjust the It-switching threshold (It-Limit) from 0% upto 100%. Table below shows nom. current to peak current by changing R22:

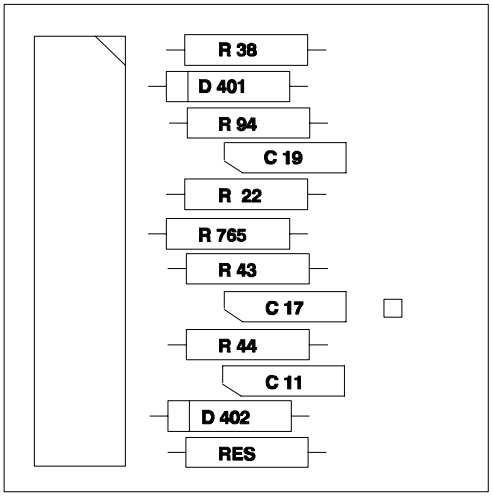
R22	BSC x015 I_{peak} = 30A	BSC x025 I_{peak} = 50A	BSC x035 I_{peak} = 70A	BSC 2045 I_{peak} = 90A
-	I_{nenn} = 15,0A	I_{nenn} = 25,0A	I_{nenn} = 35,0A	I_{nenn} = 45,0A
20kΩ	I_{nenn} = 12,0A	I_{nenn} = 20,0A	I_{nenn} = 28,0A	I_{nenn} = 36,0A
10kΩ	I_{nenn} = 10,0A	I_{nenn} = 16,7A	I_{nenn} = 23,3A	I_{nenn} = 30,0A
5kΩ	I_{nenn} = 7,5A	I_{nenn} = 12,5A	I_{nenn} = 17,5A	I_{nenn} = 22,5A

x: 2 or 3; e.g.: BSCx015 stands for BSC2015 and BSC3015

Equation for R22:

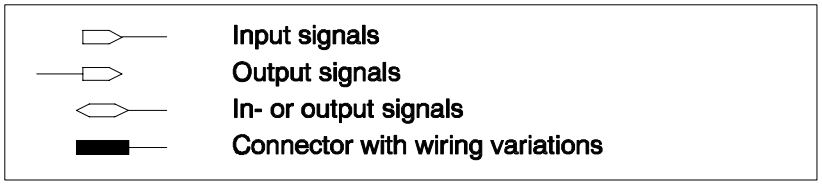
$$R22 = \frac{10k\Omega}{\frac{I_{nenn}}{I_{peak}} - 2}$$

9.2 Component Layout

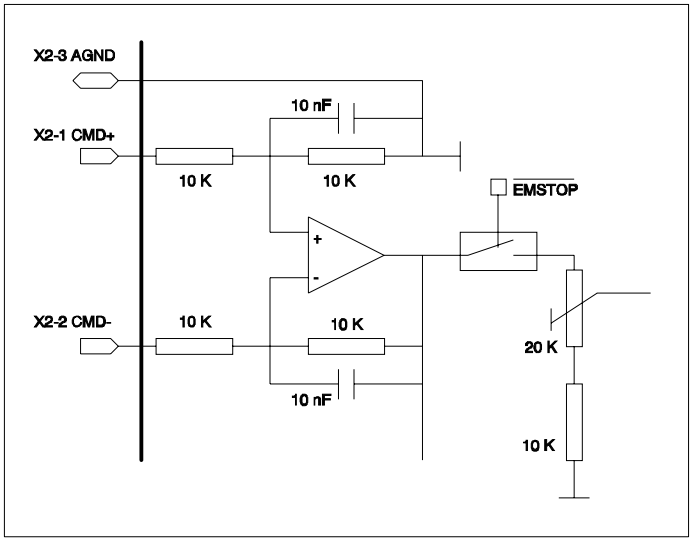


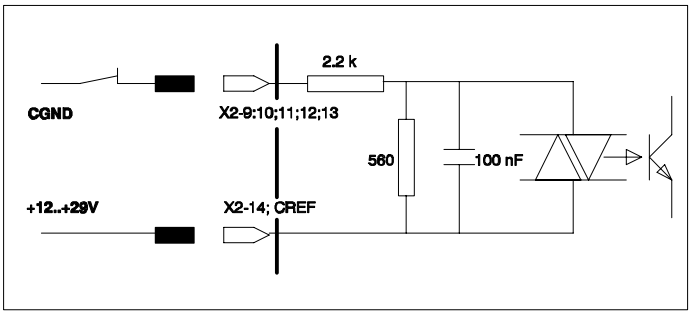
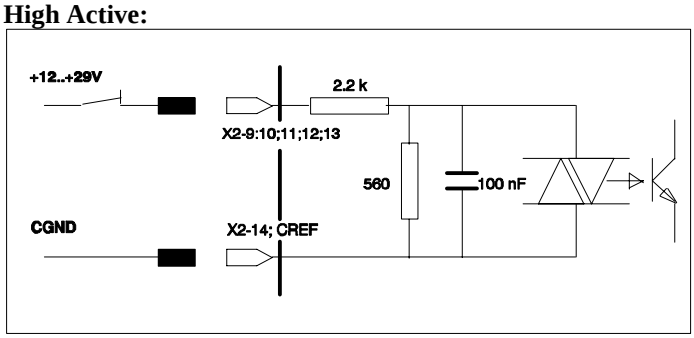
10.0 I/O Hardware Description

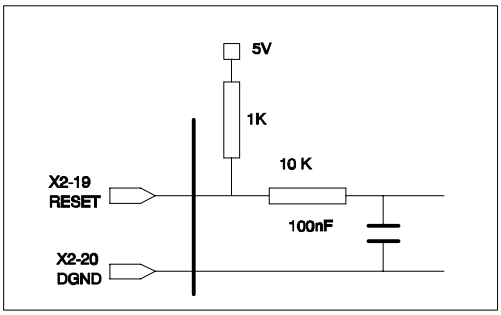
- Legend:



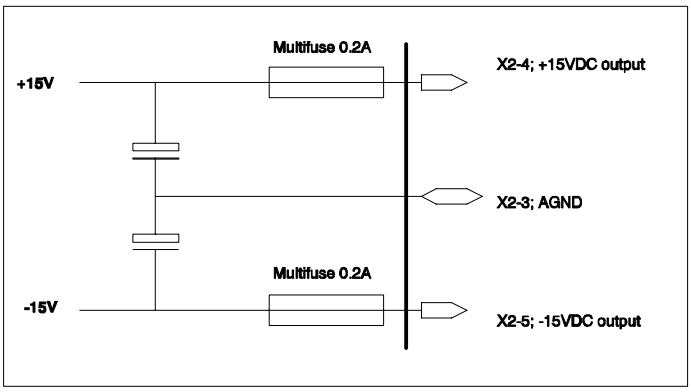
10.1 Input Signals

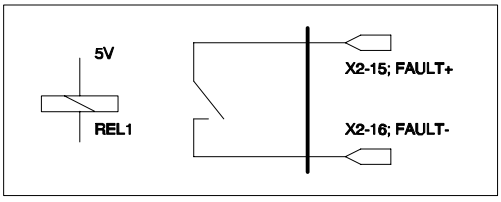
Analog Input Connector X2			
Function	Signal	PIN	Hardware
Velocity- or Current- Command	CMD+ CMD- AGND	1 2 3	$U_{cmd} = \pm 10V_{DC}$ 

Digital Inputs Connector X2			
Function	Signal	PIN	Hardware
Enable	ENABLE	9	**- Low Active:** 
Emergency Stop	EMStop	10	
CW-Limit	CWLimit	11	
CCW-Limit	CCWLimit	12	**- High Active:** 
Current Control	CurrentC	13	
Ground Return	CREF	14	min. Input Impedance R_{IN} = 2.2kΩ; opto coupled; U_{IN} = 12 .. 29V_{DC}; Delay time T_d = 60µs max. current at 24V; I = 10mA

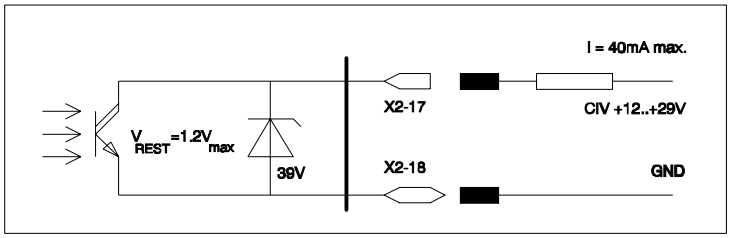
RESET - Input Connector X2			
Function	Signal	PIN	Hardware
RESET- Input	Reset DGND	19 20	 Pull-up to +5V; not opto coupled Connect RESET to DGND, this resets the following faults: - Overvoltage - Undervoltage - Resolver fault - Electronic fusing

10.2. Output signals

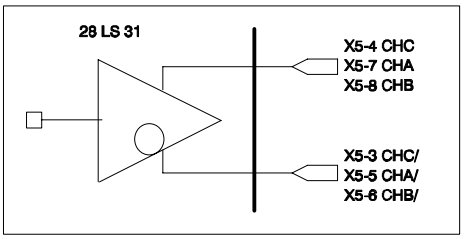
±15V - Output Connector X2			
Function	Signal	PIN	Hardware
±15VDC Outputs	+15VDC AGND -15VDC	4 3 5	 **CAUTION:** A short circuit will generate a "RESET" Short circuit proof; I_{max} = 100mA

Digital Outputs Connector X2			
Function	Signal	PIN	Hardware
Fault Relay	Fault+ Fault-	15 16	 contact is closed, if system works correct U_{AC} = 110V I_{max} = 0.3A U_{DC} = 24V I_{max} = 0.8A

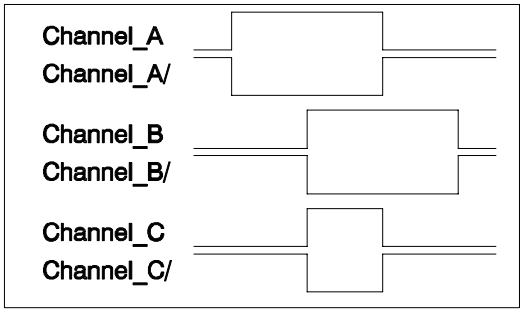
Analog Outputs Connector X2			
Function	Signal	PIN	Hardware
Testsignals see chapter 8	Speed- DCurrent Icmd	6 7 8	All testsignals are terminated with a resistor R = 4.7kΩ and scaled to 10V Load resistor R ≥ 100kΩ

Digital Outputs Connector X2			
Function	Signal	PIN	Hardware
It - Warning	Warn_C Warn_E	17 18	 It-Limit and overtemperature warning

10.3 Encoder Output

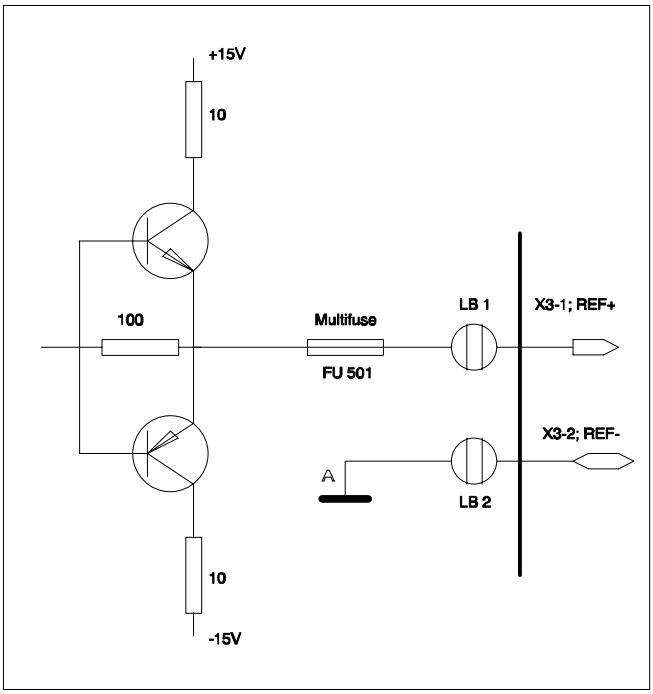
Encoder Signals Connector X5			
Function	Signal	PIN	Hardware
Encoder Channel_C	CHC/ CHC	3 4	
Encoder Channel_A	CHA/ CHA	5 7	
Encoder Channel_B	CHB/ CHB	6 8	
			I/O-standard RS422 TTL-Signal; (f < 275kHz)

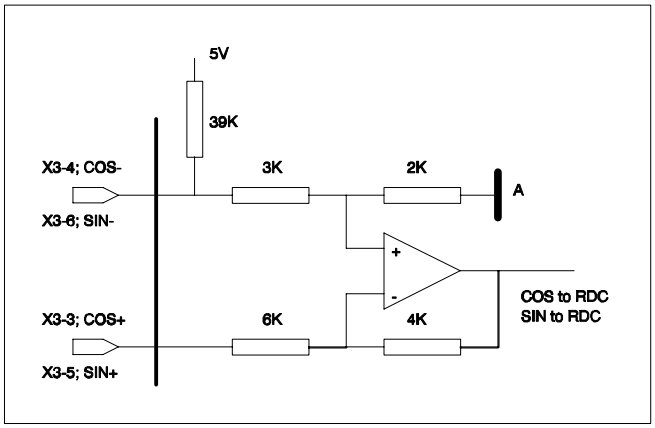
10.3.1 Encoder Signals



This drawing shows the encoder signals if the motor shaft rotates clock wise (view at the motor shaft).

10.4 Resolver

Resolver Signals Connector X3			
Function	Signal	PIN	Hardware
Reference Signal	REF+ REF-	1 2	 Signal waveform sinusoidal; f = 7.2 .. 8.0kHz; 17.0V_{pp} ±5% + 0 .. 0.4 V_{DC}; I_{peak} = 0.2A; short circuit proof

Resolver Signals Connector X3			
Function	Signal	PIN	Hardware
COSINE Input	Cos+ Cos-	3 4	 Signal waveform sinusoidal; U_{IN} = 0 .. 10V_{pp} + 0 .. 0,4V_{DC}; 7.2 .. 8.0kHz
SINE Input	Sin+ Sin-	5 6	