SBA SERIES
Installation & Operating Manual

Rev 8/06

SBA - SAFETY INSTRUCTIONS

Read this page carefully before installation and use of the instrument, and follow all instructions in section 6 of Installation Procedures for safe installation of this product.

INTRODUCTION

The following clauses contain information, cautions and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition.

As this product is intended for incorporation into a machine or end-product, the end product must comply with all safety aspects of the relevant requirements of the European Safety of Machinery Directive 89/392/EEC as amended, and with those of the most recent versions of standards EN60204-1 and EN292-2 at least.

Installation, adjustment, maintenance and repair of the instrument shall be carried out only by qualified personnel.

WARNINGS

Any removal from the structure or removal of parts, except those to which access is permitted, is likely to expose live parts and accessible terminals which can be dangerous to live. If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a qualified person who is aware of the hazard involved.

The instrument shall be disconnected from all voltage sources before it is opened (for service method).

Any interruption of the protective earth conductors inside the instrument, is likely to make the instrument dangerous.

Components which are important for the safety of the instrument, may only be renewed by components obtained through Elmo service organization.

Before switching on, ensure that the instrument has been installed in accordance with the Installation Instructions.

Maximum DC supply according to the types described in the operating manual.

How to use this manual - Flow Chart

The SBA amplifier represents a flexible design approach which enables the use of various feedback sensors and allows several modes of operation.

Use the following flow chart in order to determine the chapters that you should read. If you are a new user of the SBA, you should read chapters 1-4 which will familiarize you with the product.

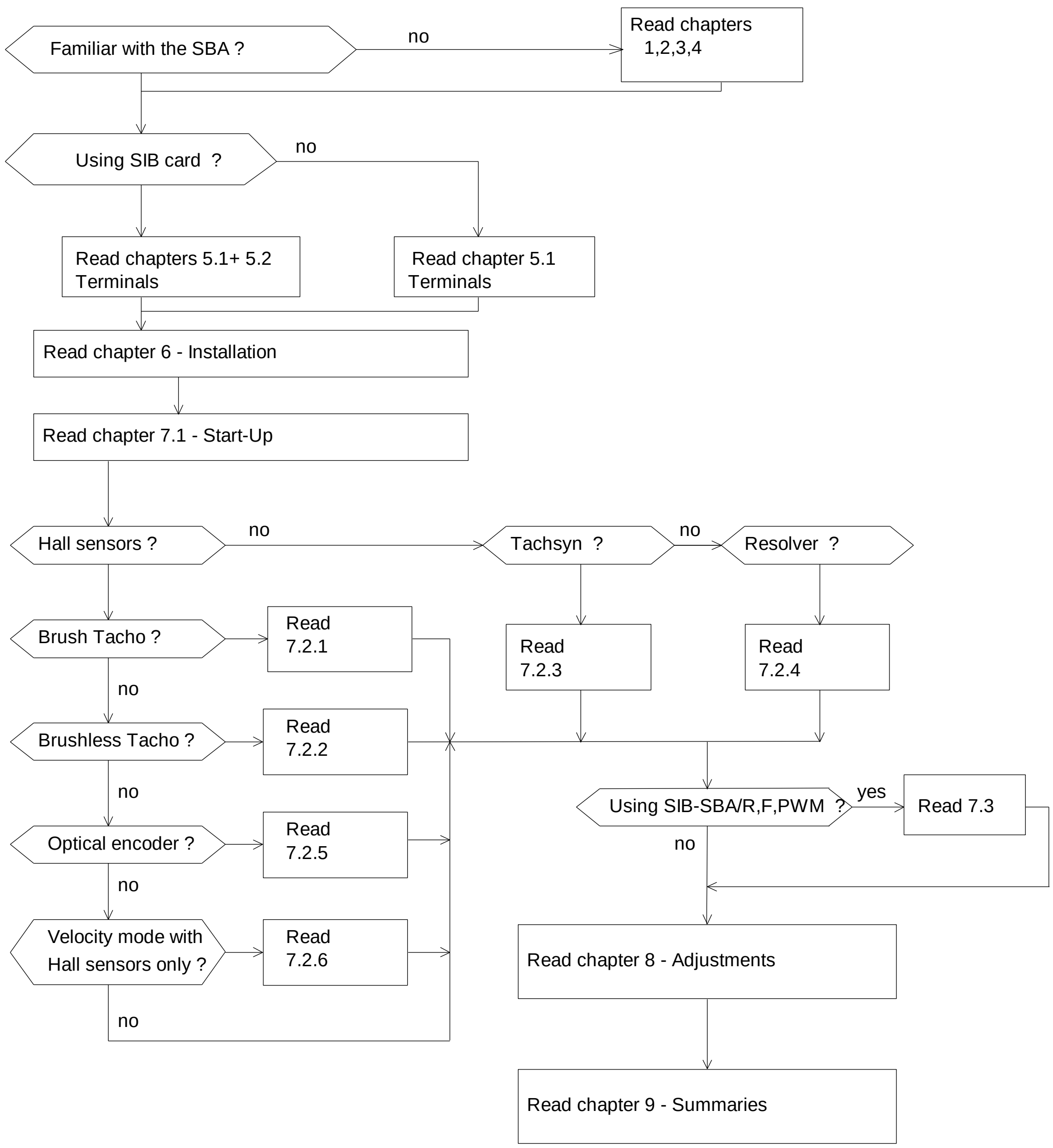


TABLE OF CONTENTS

1. Description

The SBA is a miniature PWM, full wave, three phase servo amplifier designed for high performance brushless servo motors in the range of up to 0.7KW. It utilizes power MOSFETs and Surface Mounting Technology which contribute to its high efficiency and compact design. The SBA is constructed from two PCBs mounted on a heat sink plate. The lower board contains the power switching transistors which drive the motor, terminals for the power stage, the switch mode power supply and the protection logic. The upper PCB contains the control logic, commutation logic, terminals for the control stage, adjusting trimmers and indication LED's.

An optional third board is installed for velocity sensors others than a brush type tacho.

Standard Features

* Internal DC to DC converter allows operation from a single supply.
* 20 KHz switching frequency (40KHz or 60KHz on request).
* 2KHz current loop response.
* 97% efficiency.
* Output voltage is up to 90% of input voltage.
* Zero deadband.
* Better than 1% linearity.
* 2 inputs.
* Motor current monitor.
* Operation in velocity or current mode.
* Remote inhibit.
* Inhibit/fault indication (logic level).
* Latch/self-restart modes for protective functions.
* Adjustable compensation.
* External current limit inputs.
* Current feedback multiplier.
* Input balance (offset).
* LED diagnostics.
* Removable terminals (Panel mount type) for easy installation and service.
* Standard commutation sensors: Hall effect, Resolver, or Tachsyn.

* Outputs voltages of +5V and $\pm$13V for external use.

The amplifier is fully protected against the following faults:

- Under/over voltage.
- Shorts between: outputs, output to ground.
- Excess temperature.
- Loss of commutation signals.

SIB-SBA

The SIB-SBA is an interface board for the SBA that is used to convert the SBA flat ribbon connector to screw type Phoenix terminals. This board has the same size as the SBA board and it can be assembled as an add-on card on top of any SBA amplifier or as a separate panel mount unit.

The SIB-SBA is connected to the SBA amplifier via a 26 wires ribbon cable.

Three derivatives of the basic SIB-SBA are available in addition to the basic SIB-SBA:

- SIB-SBA/R

In this option the following features are included:

- Buffered and differential outputs for the encoder channels.
- Inhibit output relay
- Inhibit input optocoupler

- SIB-SBA/F

In this option the following features are included:

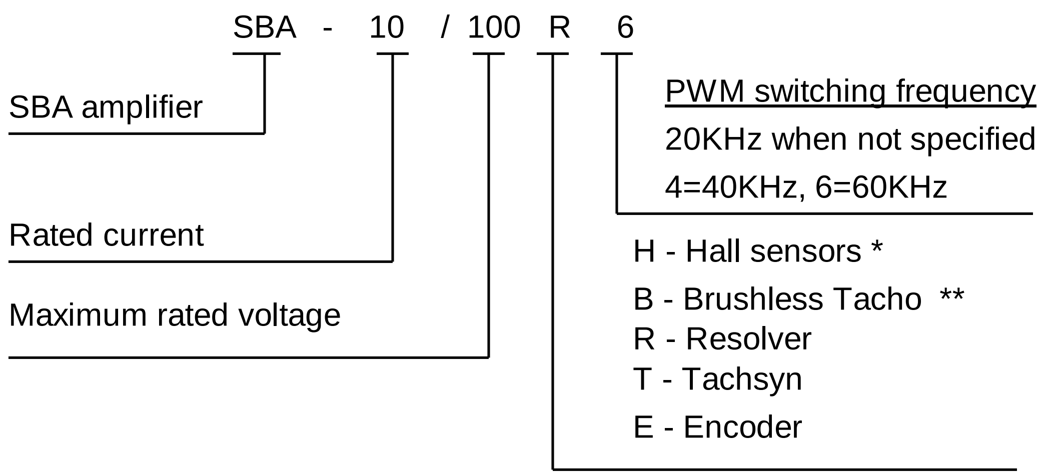
- Buffered and differential outputs for the encoder channels.
- Inhibit output relay
- Inhibit input optocoupler
- Differential amplifier for input 1 (terminal 26)
- Linear Acc/Dec (for input 1) adjustable by trimmers.

- SIB-SBA/PWM

In addition to the features of the SIB-SBA/R, this option includes an opto-isolated decoding circuit for a PWM and direction reference input. The output of this circuit is fed into input 1 (terminal 26).

This option is useful when the reference signal comes from a position controller like the LM629.

2. Type Designation



* The Hall effect version accepts a brush tachogenerator for velocity feedback and Hall effect sensors for commutation.

** The B and E versions require Hall effect sensors for commutation.

3. Technical specifications

Type	DC Supply Min.-Max.(V)*	Current limits Cont./Peak(A)	Size (mm)	Weight Kg
SBA-10/100	20-94	10/20	130x78x30	0.3
SBA-5/200	40-195	5/10	130x78x30	0.3
SBA-2.5/330	90-330	2.5/5	130x78x30	0.3

* DC output voltage is 90% of DC input voltage.
* 20KHz, 40KHz or 60KHz switching frequency.
* 2KHz current loop response (minimum)
* Outputs voltages of +5V, ±13V for external use.
* Efficiency at rated current - 97%.
* Drift: 10↘V/▪C (referred to input)
* Operating temperature: 0-50▪C.
* Storage temperature: -10 - +70▪C.

Resolver option features:

- 10, 12, 14 and 16 bit resolution, set by user.
- Maximum tracking rate 1040 rps (10 bit).
- Encoder A,B outputs + programmable index output.

Optical encoder velocity feedback features:

- Maximum input frequency: 800KHz
- Speed regulation: 500:1
- Encoder frequency: x1 or x4
- Encoder output voltage range: 2-30V
- Output supplies: 5V/50mA, 12V/20mA.

---

* These are the absolute minimum-maximum DC supply voltage under any condition.

4. Operation of the servo control

4.1 Inputs

The SBA has 2 inputs: single ended input (terminal 26) and a differential input (terminals 11,12). The current gain of terminal 26 (current mode) is given by:

$$G_c = \frac{0.533 \times I_c}{1 + 0.11 \times R3} \quad \text{(Amp/Volt)}, \quad R3 \text{ in Kohm}$$

Ic - amplifier rated continuous current

The current gain of the differential input for R7=R8 (current mode) is given by:

$$Gc_d = \frac{5.33 \times I_c}{R7} \quad \text{(Amp/Volt)}$$

R7 in Kohm

The current gain in velocity mode is given by (place the appropriate Gc for each input):

$$G_v = \frac{50 \times G_c}{R5} \quad \text{(Amp/Volt)}, \quad R5 \text{ in Kohm}$$

All the gains are divided by 2 if CFM is ON

The maximum input voltage at terminal 26 is calculated by:

$$V26max = 8 + 0.9R3 \quad \text{(Volts)}, \quad R3 \text{ in Kohm}$$

4.2 Velocity mode

In the velocity mode, op amp U1/2 is employed as a high gain error amplifier. The amplifier sums velocity command and the velocity feedback signal, and provides the necessary servo compensation and gain adjustments, resulting in stable, optimum servo operation.

This op amp is configured with two feedback paths:

One, in the form of a resistive T network, controls the DC gain of this amplifier. The equivalent value of a T network is given by:

$$R_f = \frac{10^{10}}{R5} \quad \text{(Ohm)}$$

Resistor R5 is mounted in solderless terminals so it can be changed easily whenever the DC gain of the error amplifier is to be changed. The AC gain is controlled by C2, R4 and T1. Maximum AC gain is obtained with T1 set fully CCW. Setting T1 fully CW removes AC gain and no lag in response occurs. R4 and C2 are mounted in soldering terminals and can be easily replaced in cases when T1 range is not enough to get optimum response (See 8.4 for details).

The output of the error amplifier is:

$$Vo=(V26xG_{V26}+VdxGd)x\left[\frac{1 + SxC2xR4}{1 + SxC2xR4(1 + RfxK/R4)}\right]$$

V26 - Input signal at terminal 26.

G_{V26} - Gain of input in terminal 26.

Vd - Input signal at the differential inputs (terminals 11,12).

Gd - Gain of differential input.

K = Position factor of the wiper of T1.

Full CCW = 1

Full CW = 0.01

4.3 Velocity feedback sensors

There are three (optional) boards that are installed on top of the SBA for processing velocity sensors other than brush tacho:

E (Optical Encoder/Hall Sensors):

The encoder interface gives a bi-directional velocity feedback for 4-Q speed control when using an optical encoder or Hall effect sensors.

- Encoder: Two channels with 90ø phase shift are required.
- Hall sensors: the commutation sensors can be used for high speed applications.

B (Brushless Tacho) and T (Tachsyn):

- Three phase brushless tacho (30▪/60▪ Hall effect can be selected).
- Two phase brushless tachogenerator: the logic board accepts the two independent Hall effect signals for commutating the two windings.
- Tachsyn: the logic board provides the oscillator for the Tachsyn.

R (Resolver):

- Resolver: A flexible oscillator for various types of resolvers is provided.

For the above mentions "brushless" sensors, the velocity output of the velocity processor is internally connected to terminal 1 that serves also as velocity monitor.

A filtering capacitor, C2, is placed in parallel to R4 to minimize noise carried on the input signals. This is specially beneficial when employing motors where a significant degree of electromagnetic coupling is present between armature and Tachogenerator. Values in the range of 1000pF - 6800pF are recommended.

4.4 Current mode

In order to operate the servo amplifier as a current amplifier, the velocity loop should be disabled. This is done by converting the error amplifier into a low gain DC amplifier which has a flat response beyond the desired current bandwidth. In this mode, R5 and C2 have to be removed from the circuit.

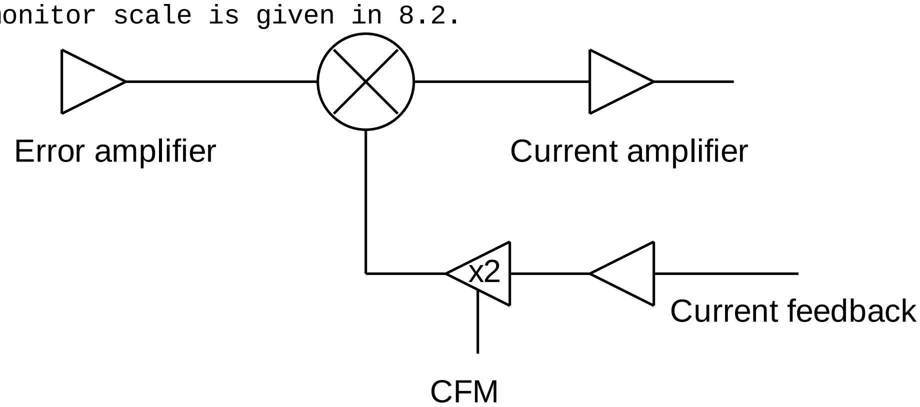
Current mode operation with Resolver or Tachsyn options requires that the input resistor of the velocity signal will be removed.

4.5 Current feedback

Current feedback multiplier

Current loop

Three current feedbacks are obtained by measuring the voltage drop across current sensing resistors. These three signals are synthesized and multiplexed which result in a single voltage signal proportional to phases currents. It is then compared to the error amplifier output. The error is processed by the current amplifier to provide a voltage command to the PWM section. The actual motor current can be monitored by measuring the voltage at terminal 20. The current monitor scale is given in 8.2.



Current loop control is obtained by op amp U1/3 (current amplifier) and R6, C1 which form a lag-lead network for current loop. The standard amplifier is equipped with R6 and C1 to get optimum current response for an average motor in this power range. These components are mounted in solderless terminals.

The amplifier is equipped with Current Feedback Multiplier (CFM). By turning DIP switch 4 to ON the signal of the current feedback is multiplied by 2 and consequently the following changes occur:

- Current gains are multiplied by 2.
- Current monitor is divided by 2.

- Current limits are divided by 2.
- Dynamic range is improved.
- Commutation ripple is reduced.

This function should be activated whenever the rated current AND the peak current of the motor are less than 20% of the amplifier rated continuous and peak limits respectively.

Sometimes, oscillations may occur in the current loop due to the fact that the feedback gain was multiplied. This can be resolved by substituting R6 with a lower value.

4.6 Current limits

The servo amplifier can operate in the following voltage-current plane:

-Ip	**-Ic**	**+V** **Ic**	**Ip**
Intermittent zone	**Continuous zone**	**-V**	

Ic - Continuous current Ip - Peak current

Fig. 4.1: Voltage-Current plane

Each amplifier is factory calibrated to have this shape of voltage-current operating area with rated values of continuous and peak current limits. In addition the peak current limit is time dependent as explained in 4.6.1.

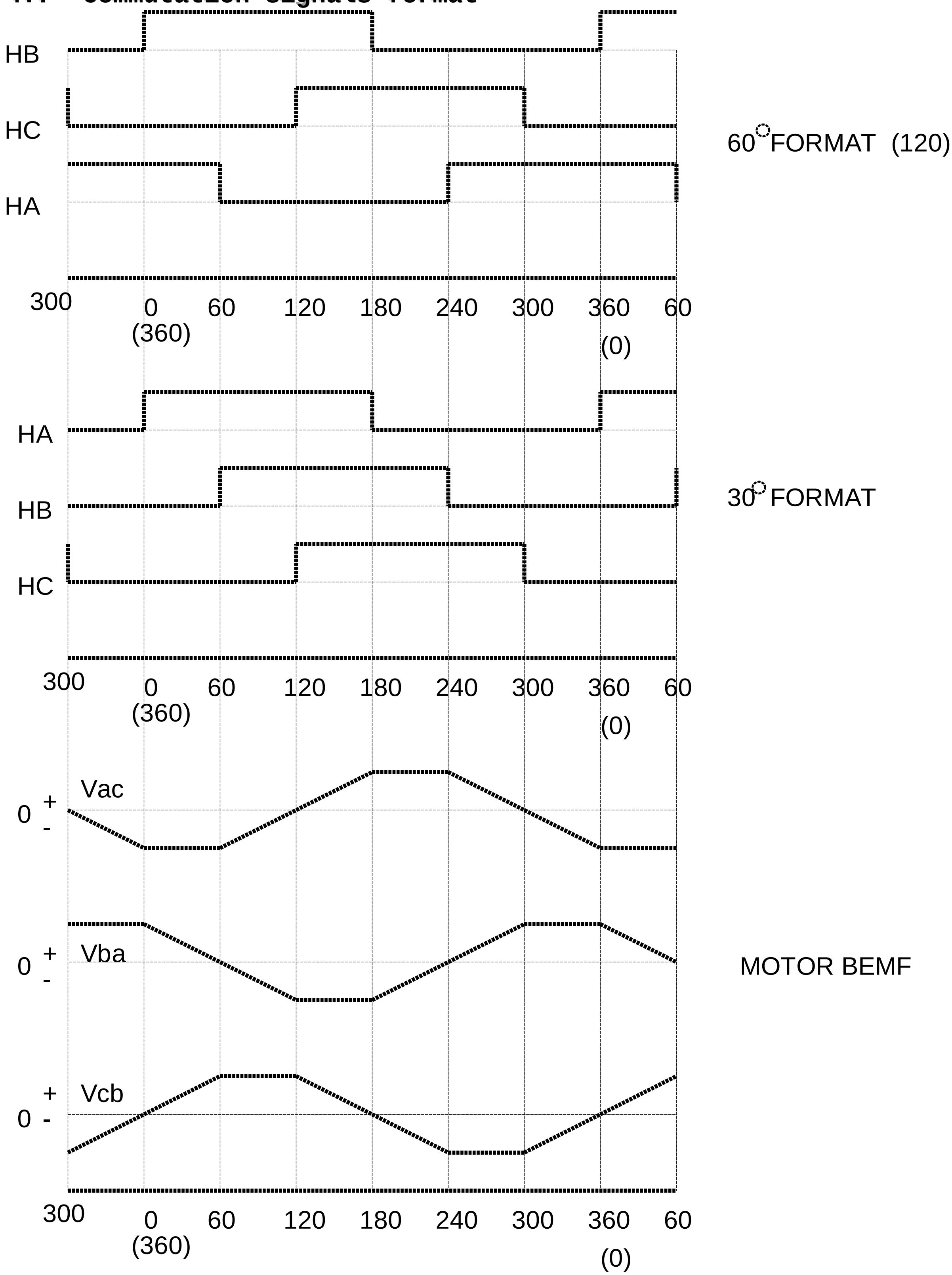
4.6.1 Time dependent peak current limit

The peak current is so designed that its duration is a function of the peak amplitude and the motor operating current. The maximum peak current is available for 1 second. The duration of Ip is given by:

$$Tp = 2.2\ln \frac{Ip - Iop}{Ip - Ic}$$

Iop - Actual operating current before the peak demand.

4.7 Commutation signals format



4.8 Protective functions

All the protective functions activate internal inhibit. There are two modes of resetting the amplifier after the cause of the inhibit disappears: Auto Restart and Latch. Self Restart (DS6-OFF): The amplifier is inhibited only for the period that the inhibit cause is present. Latch (DS6-ON): All failures latch the Inhibit and the In LED. For restart (after clearing the failure source), reset has to be performed either by turning DS6 to "OFF" or by applying logic 0 at the reset input (terminal 19).

4.8.1 Short circuit protection

The short circuit protection uses the capability of the power MOSFET to tolerate high energy peaks for short periods of time. This protection is realized by sensing current in the DC line. Every current peak above a certain value will inhibit the amplifier for a period of approx. 30mS. If a short circuit condition still exists, the cycle will repeat endlessly. The amplifier is protected against shorts between outputs and output to ground.

4.8.2 Under/over voltage protection

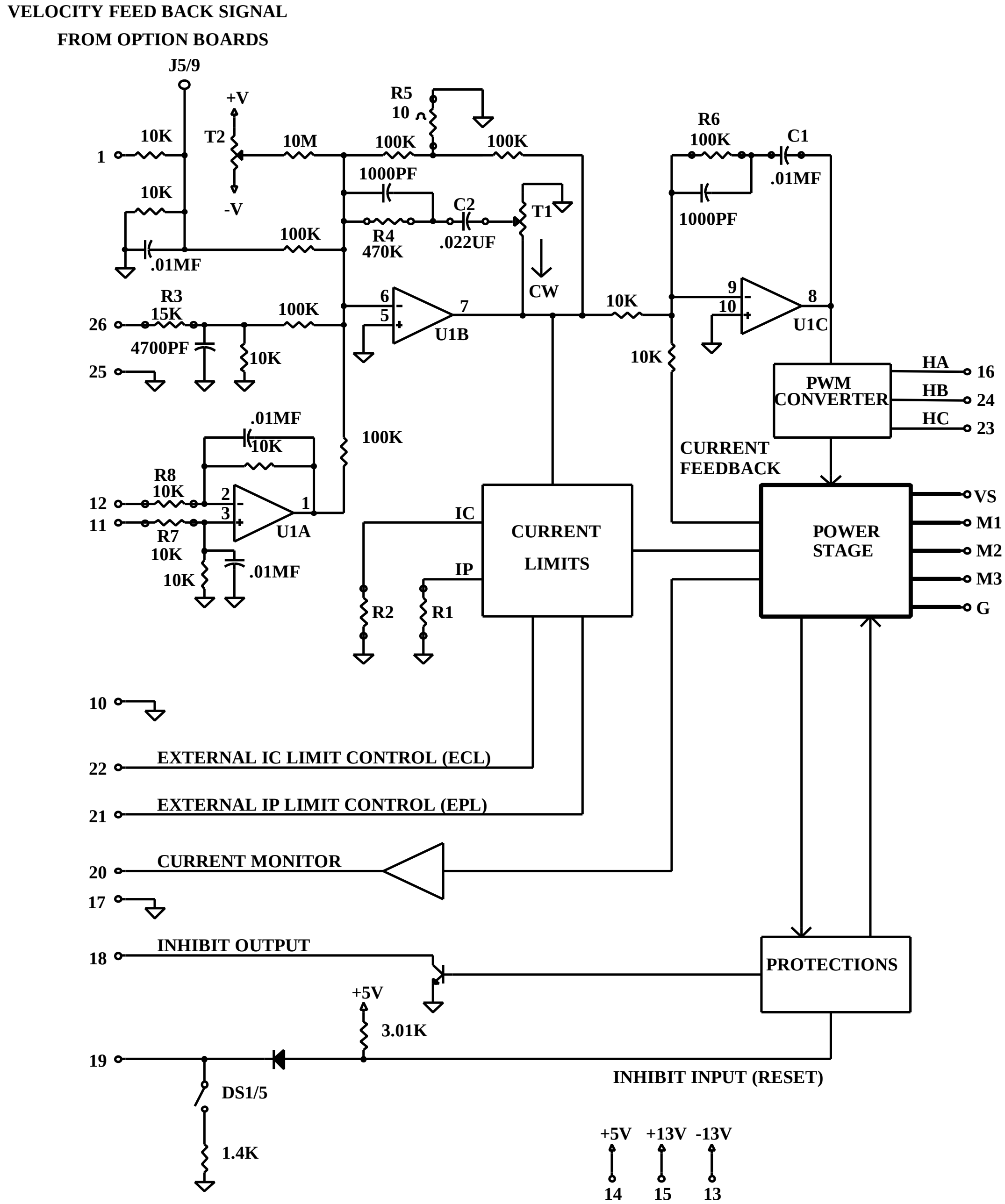
Whenever the DC bus voltage is under or over the limits indicated in the technical specifications, the amplifier will be inhibited.

4.8.3 Temperature protection

Temperature sensor is mounted on the heatsink. If, for any reason, the temperature exceeds 85▪C the amplifier will be inhibited. The amplifier will restart when the temperature drops below 80▪C.

4.8.4 Loss of commutation feedback

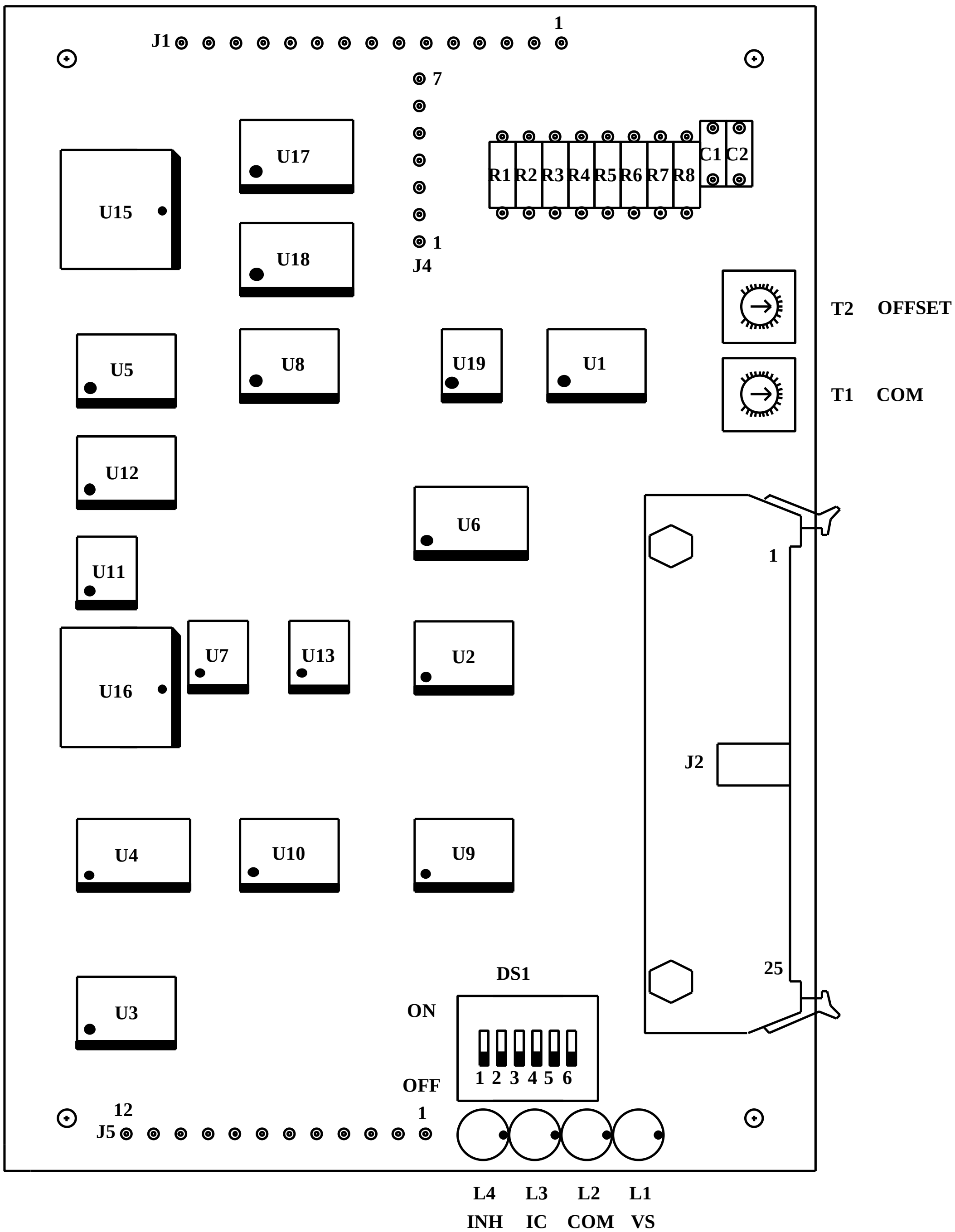
Lack of either of the commutation signals will inhibit the amplifier.



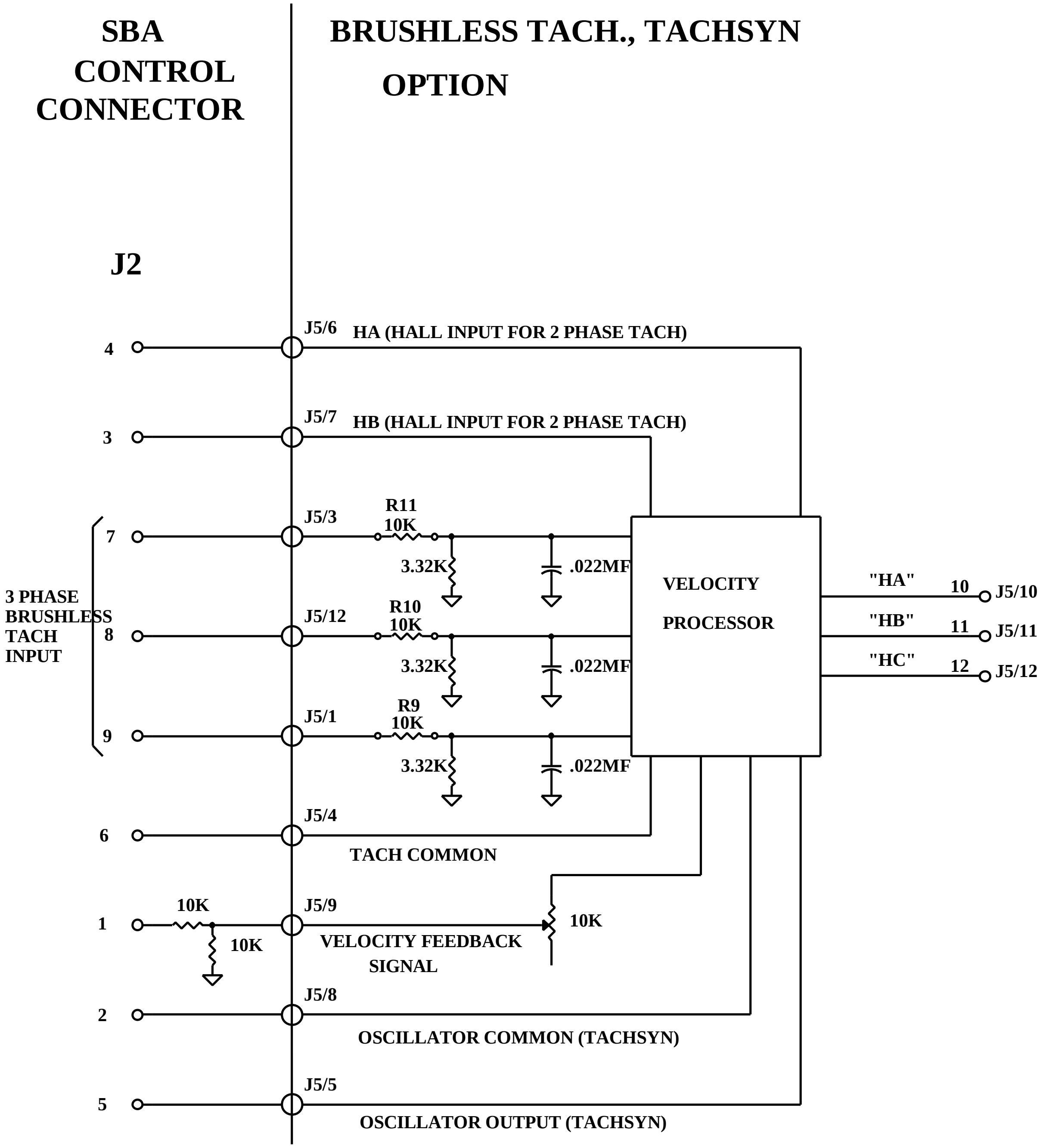
NOTES:

1. ALL COMPONENTS DENOTED BY —○
ARE MOUNTED IN SOLDERLESS PINS.

SBA - SCHEMATIC DIAGRAM

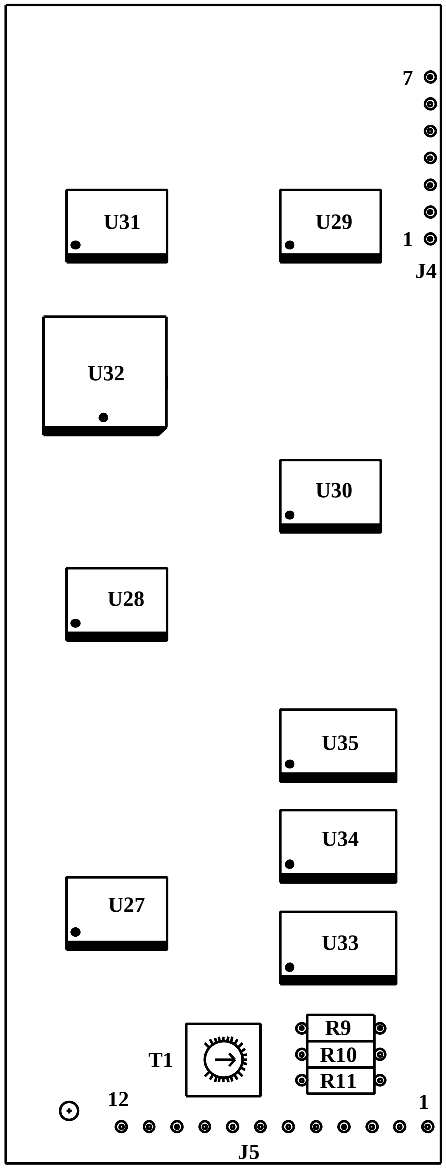


SBA - CONTROL BOARD

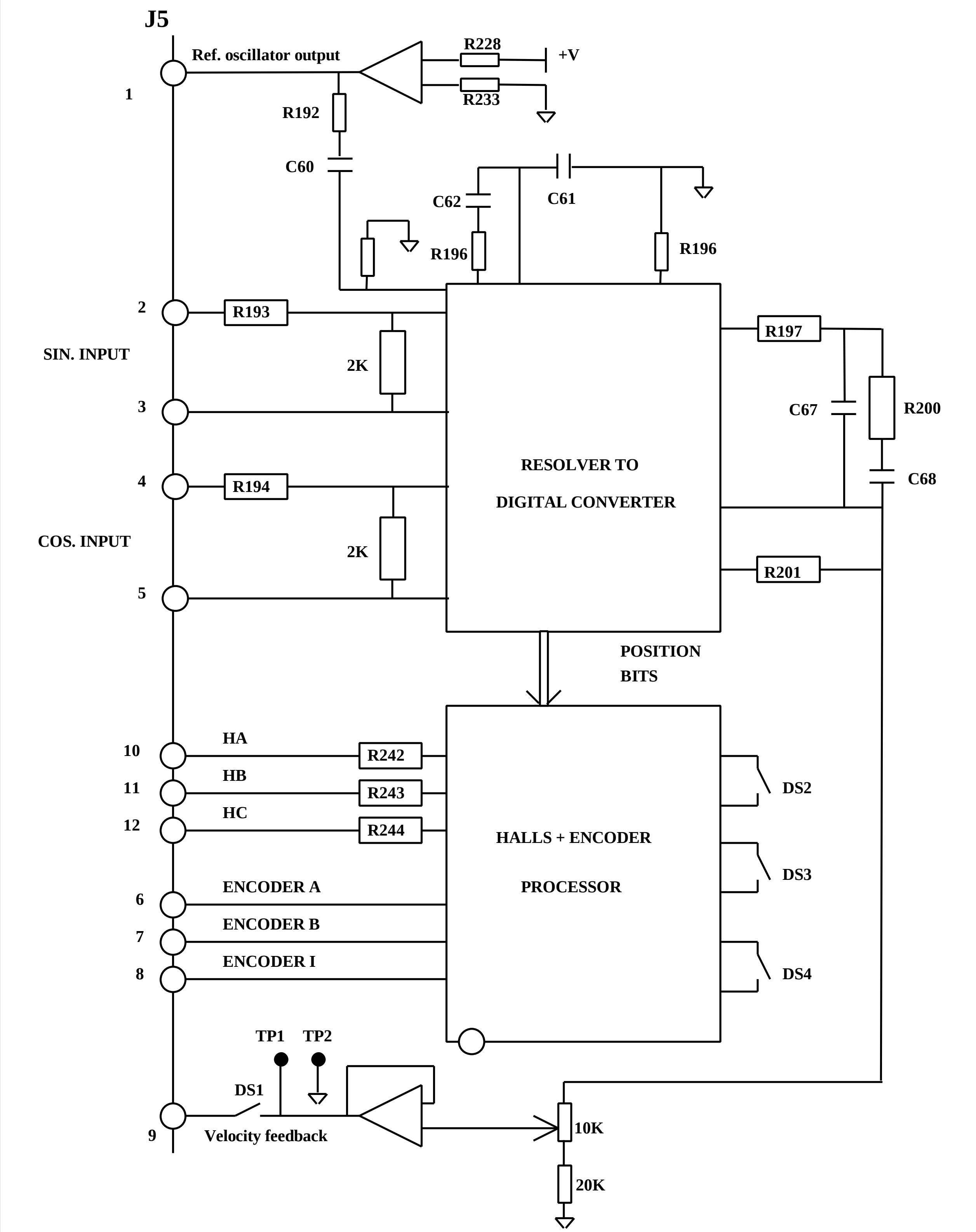


J2 - 26 PIN CONTROL BOARD CONNECTOR (THE USER CONNECTOR)

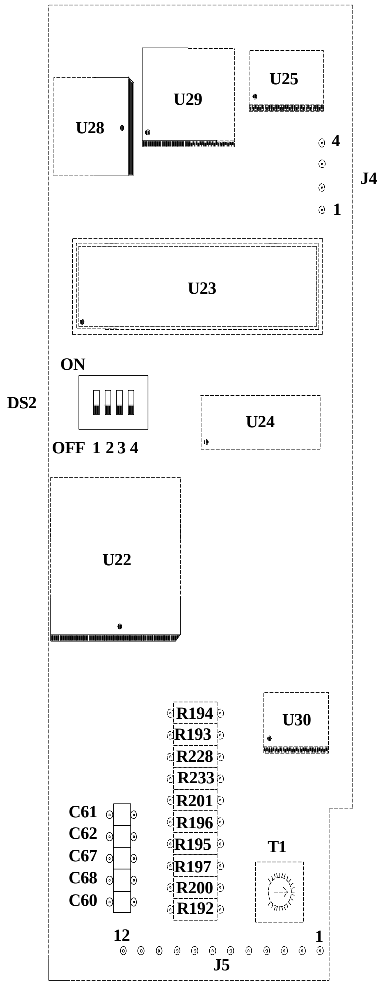
J5 - CONNECTOR BETWEEN CONTROL BOARD AND OPTION BOARD (INTERNAL CONNECTOR)



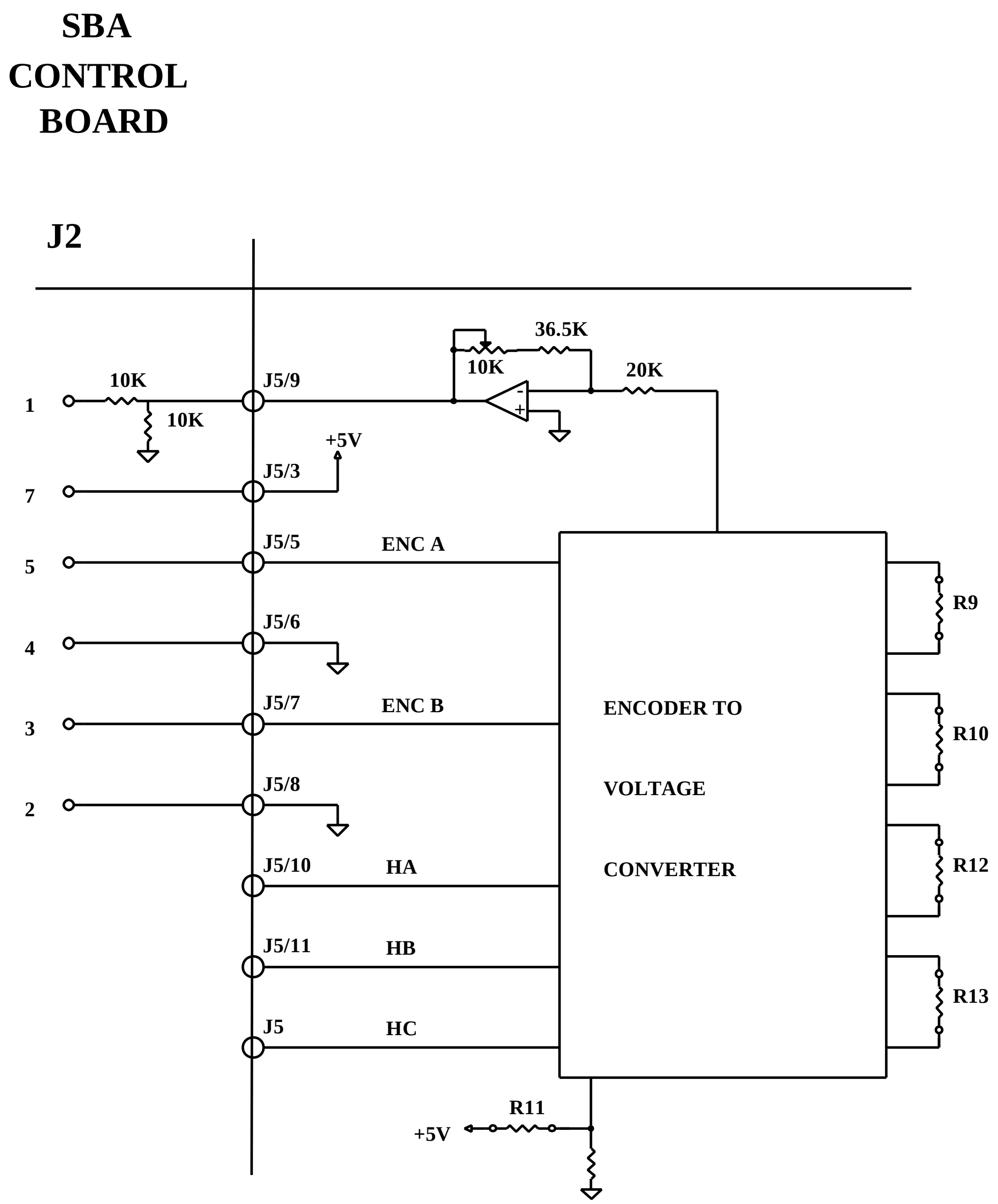
SBA BRUSHLESS TACHO AND TACHSYN OPTION BOARD



RESOLVER OPTION BLOCK DIAGRAM



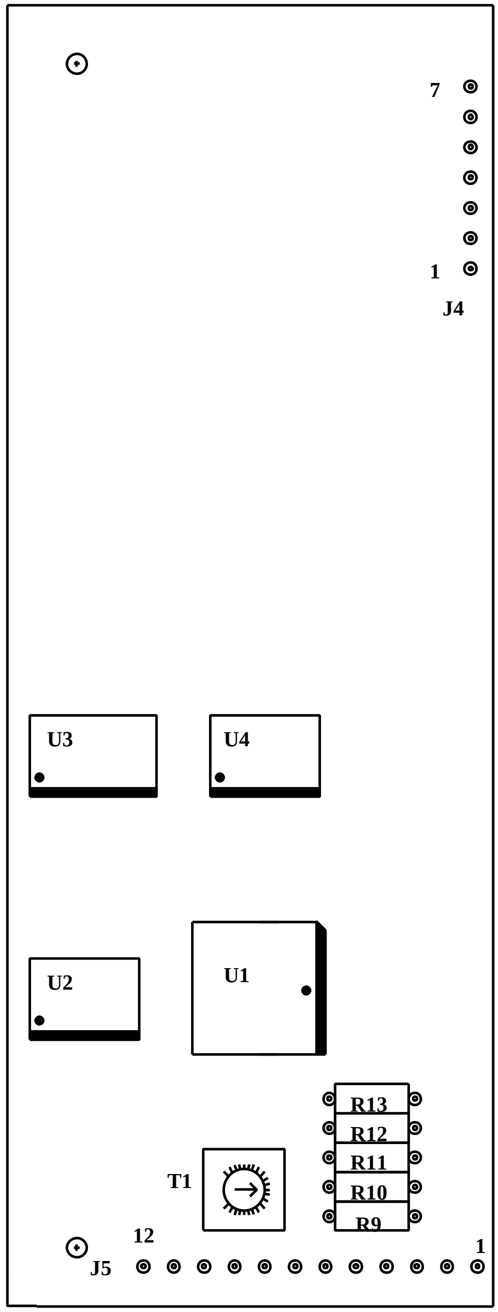
SBA - RESOLVER OPTION BOARD



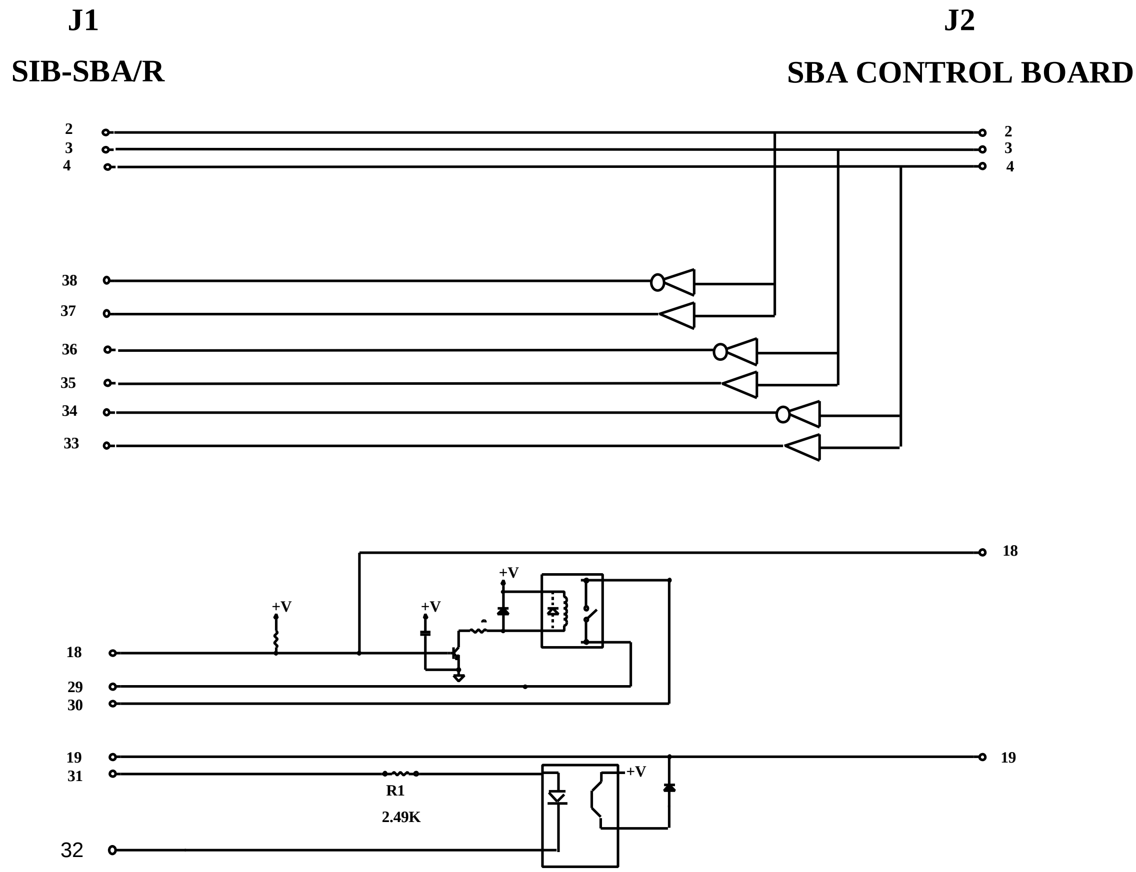
J2 - 26 PIN CONTROL BOARD CONNECTOR (THE USER CONNECTOR)

J5 - CONNECTOR BETWEEN CONTROL BOARD AND OPTION BOARD (INTERNAL CONNECTOR)

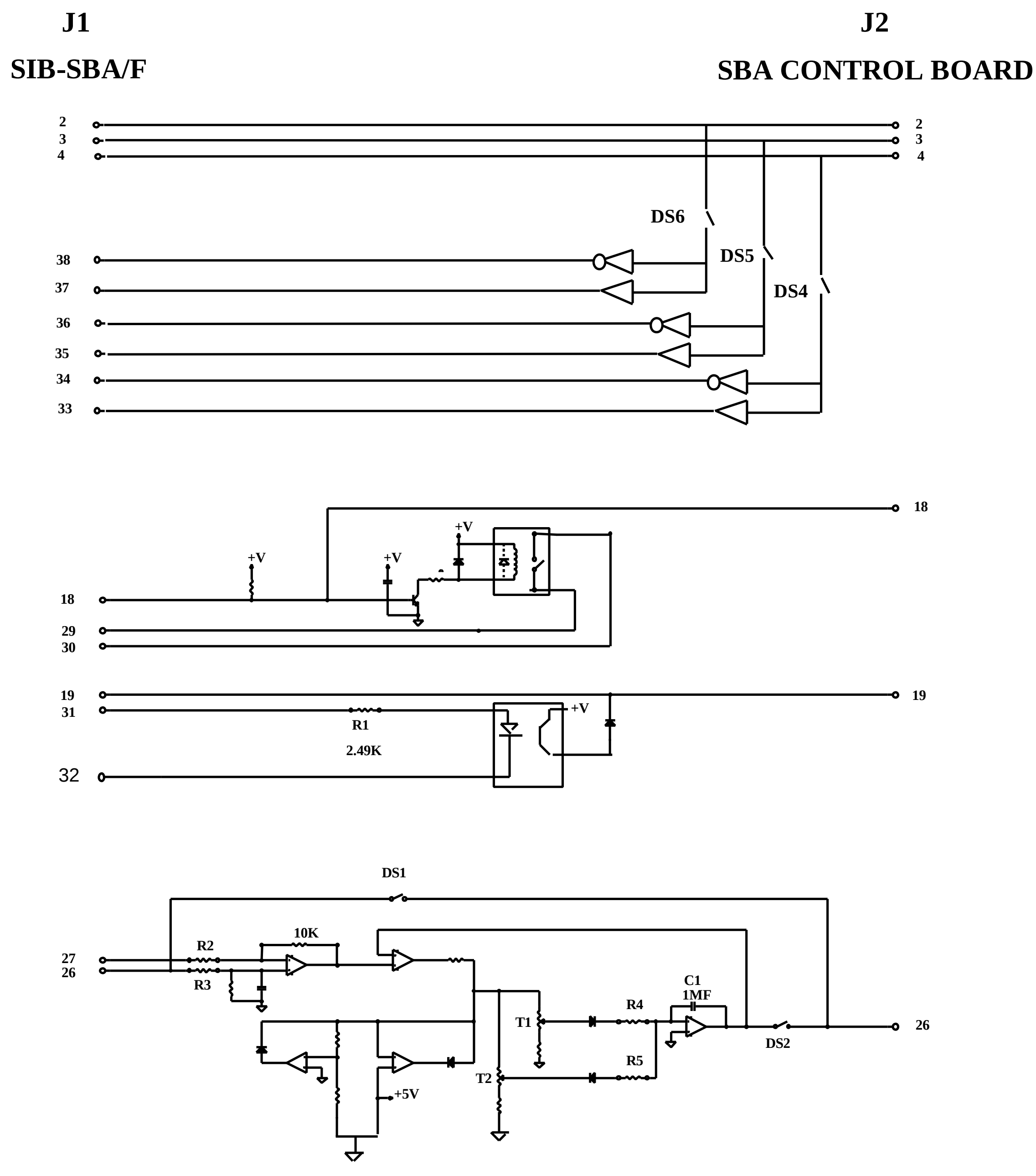
SBA - ENCODER OPTION BLOCK DIAGRAM



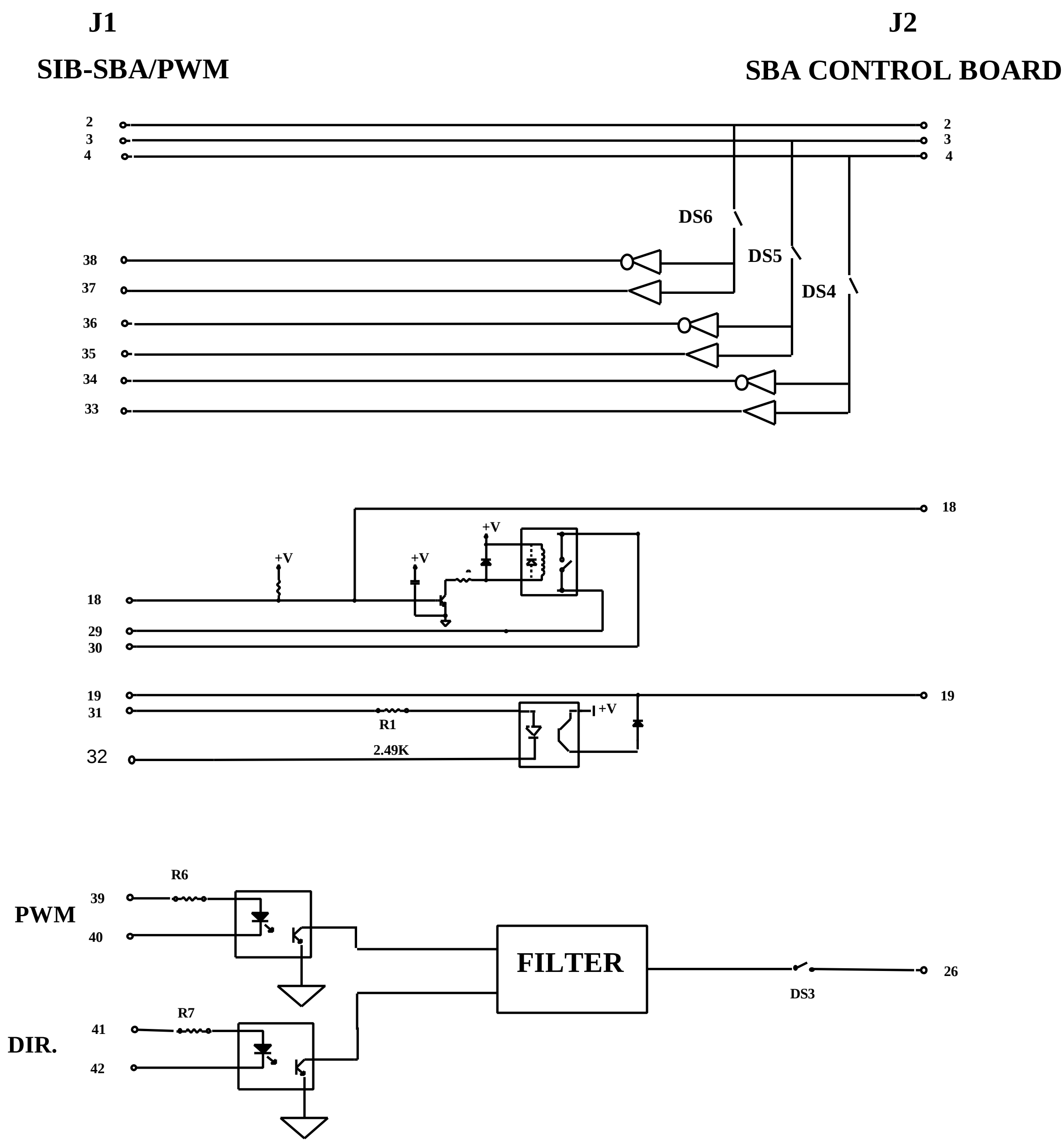
SBA - ENCODER OPTION



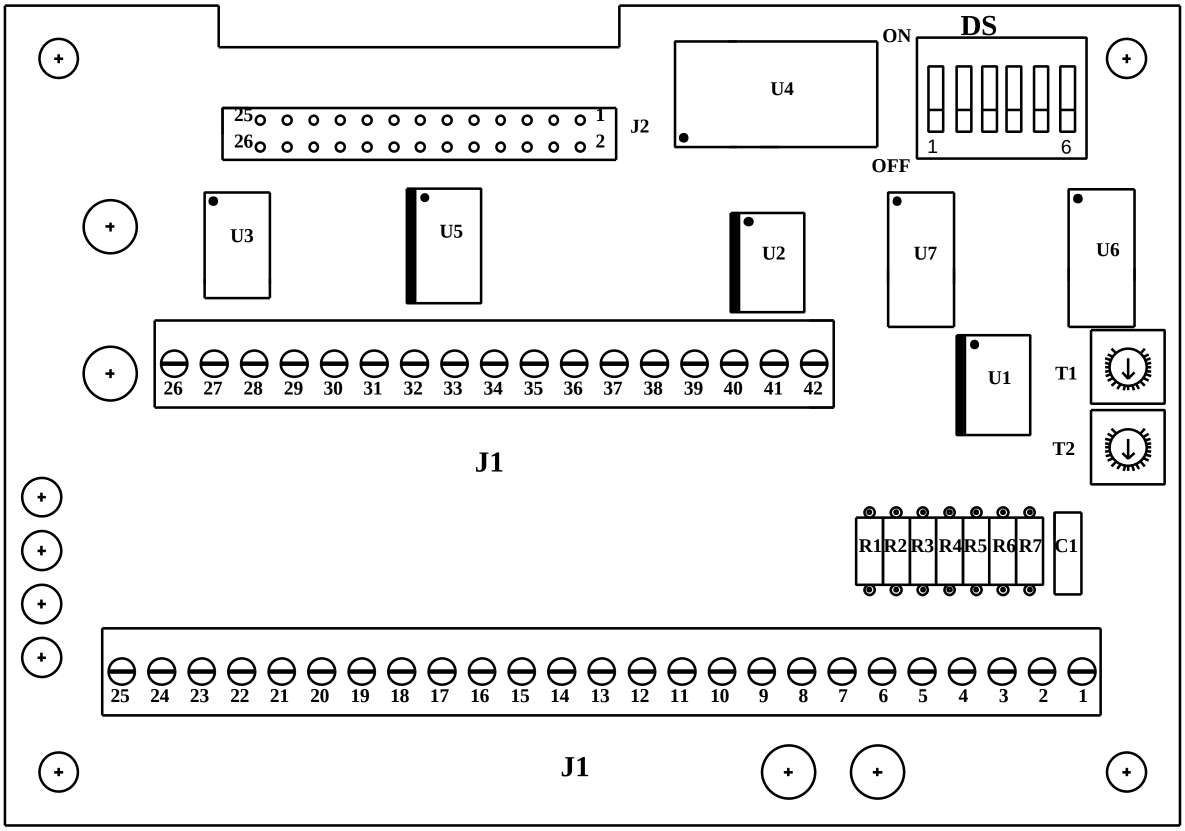
SIB-SBA/R BLOCK DIAGRAM



SIB-SBA/F BLOCK DIAGRAM



SIB-SBA/PWM BLOCK DIAGRAM



DS
ON
OFF
1
6
U4
25
26
1
2
J2
U3
U5
U2
U7
U6
U1
T1
T2
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
J1
R1 R2 R3 R4 R5 R6 R7
C1
25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
J1

SIB-SBA/F

5. Terminal Description

5.1 Terminals for H,B,T,R and E types

Power Stage

Terminal	Function
Vs	Power input positive.
M1	Motor phase A output.
M2	Motor phase B output.
M3	Motor phase C output.
G	Power input common.

Control stage

Terminals for H version (Hall effect sensors only)

Terminal	Function	Remark
1	Fix gain reference input.	
10	Circuit common.	
11	Positive input of differential amplifier.	For more details see chapter 4.1.
12	Negative input of differential amplifier.	For more details see chapter 4.1.
13	-13V stabilized	20mA external load.
14	+5V stabilized	50mA external load.
15	+13V stabilized	20mA external load.
16	Hall sensor A input	*
17	Circuit common	

* $-1V \le Vil < 1V$; $2V \le Vih < 30V$
Source sink capability - 2mA min.

Terminals for H version (Hall effect sensors only) - Cont.

Terminal	**Function**	Remark
18	**Inhibit indication output**	Whenever the amplifier is inhibited, whether by an internal or external cause, this open collector output goes low state (max. sink current 10mA, 30VDC max)
19	**Inhibit input/reset**	For inhibit logic see 7.1.3. For reset logic see 4.8.
20	**Current monitor**	This output can be used to adjust the current limits. It is equivalent to the current feedback signal. It simplifies the complexity of measuring the actual motor current in a brushless motor. For scale details see 7.1.7.
21	**External peak current limit**	External current limit input (0-7.5V range). For more details see 8.1.
22	**External continuous current limit**	External current limit input (0-3.75V range). For more details see 8.1.
23	**Hall sensor C input**	*
24	**Hall sensor B input**	*
25	**Circuit common**	
26	**Input 1**	Single ended input. See chapter 4.1 for details.

* $-1V \leq Vil < 1V$; $2V \leq Vih < 30V$

Source sink capability - 2mA

Additional terminals for B versions (brushless tacho). The rest of the terminals are the same as in H versions.

Terminal	**Function**	Remark
1	**Velocity monitor.**	
2	**N/A**	
3	**Hall 2 input of 2 phase brushless tacho.**	*
4	**Hall 1 input of 2 phase brushless tacho.**	*
5	**N/A**	
6	**Tacho common.**	
7	**Phase 3 of brushless tacho.**	
8	**Phase 2 of brushless tacho.**	
9	**Phase 1 of brushless tacho.**	

Additional terminals for T version (Tachsyn). The rest of the terminals are the same as in H versions.

Terminal	**Function**	Remark
1	**Velocity monitor.**	
2	**Oscillator common**	
3	**N/A**	
4	**N/A**	
5	**Oscillator output.**	
6	**Tacho common.**	
7	**Phase 3 of Tachsyn.**	
8	**Phase 2 of Tachsyn.**	
9	**Phase 1 of Tachsyn.**	

* $-1V \leq Vil < 1V$; $2V \leq Vih < 30V$

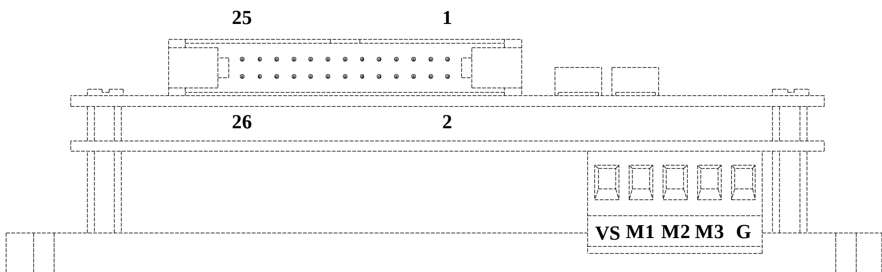
Source sink capability - 2mA

Additional terminals for R version (resolver). The rest of the terminals are the same as in H versions.

Terminal	**Function**	Remark
1	**Velocity monitor.**	
2	**Encoder output - Index**	
3	**Encoder output - Channel B.**	
4	**Encoder output - Channel A.**	
5	**Common of cosine input.**	
6	**Cosine input.**	
7	**Common of sine input.**	
8	**Sine input.**	
9	**Reference frequency output.**	

Additional terminals for E version (optical encoder). The rest of the terminals are the same as in H versions.

Terminal	**Function**	Remark
1	**Velocity monitor.**	
2	**N/A.**	
3	**Encoder input**	Channel A.
4	**N/A.**	
5	**Encoder input**	Channel B.
6	**Circuit common**	Encoder supply only
7	**+5V**	50mA encoder supply.
8	**N/A.**	N/A.
9	**N/A.**	N/A.



CONNECTORS

SBA WITHOUT SIB CARD

5.2 Terminals for SIB-SBA

The numbering of the SIB-SBA terminals (1-26) is identical to the numbering of the SBA control board connector. Following are the additional terminals for the other SIB-SBA types.

5.2.1 Terminal for SIB-SBA/R

1-26	Same as SBA.
27	N/A
28	Circuit common
29	Inhibit output - Free contact relay Contacts rating: 0.5A, 200V, 10W
30	Inhibit output - Free contact relay
31	Inhibit input (positive input to an optocoupler) The standard value of R1 (2.49Kohm) is suitable for 24V input. For other input voltage, change R1 in order to ensure input current of 10mA.
32	Inhibit input (negative input to an optocoupler)
33	Buffered channel I output, $\pm$20mA max.
34	Buffered channel -I output, $\pm$20mA max.
35	Buffered channel B output, $\pm$20mA max.
36	Buffered channel -B output, $\pm$20mA max.
37	Buffered channel A output, $\pm$20mA max.
38	Buffered channel -A output, $\pm$20mA max.
39	N/A
40	N/A
41	N/A
42	N/A

5.2.2 Terminal for SIB-SBA/F

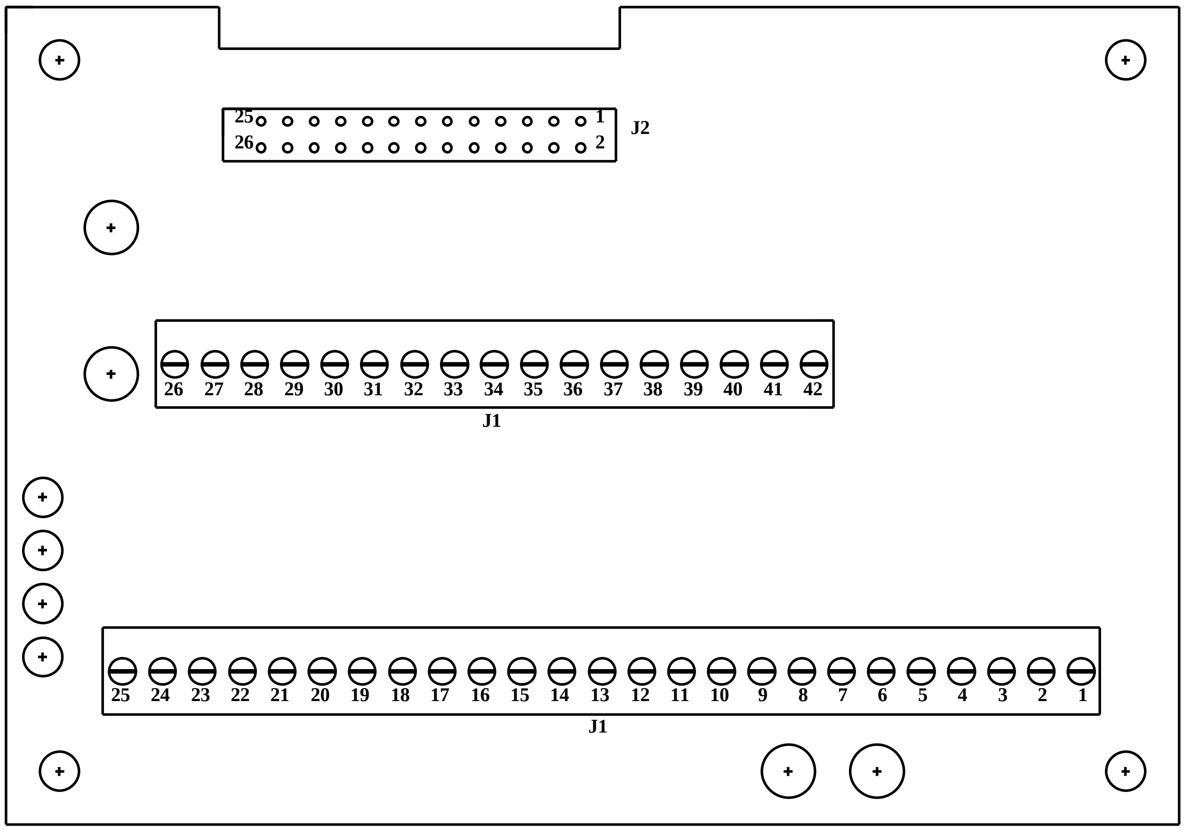
1-25	Same as SBA.
26	Positive differential input of input 1. The serial resistor for this input is R3 with a standard value of 10Kohm. If the linear Acc/Dec function is not activated, this input is a single ended input and there is no need for R3.
27	Negative input of differential input 1. The serial resistor for this input is R2 with a standard value of 10Kohm. If the linear Acc/Dec function is not activated, this input is not applicable.
28	Circuit common
29	Inhibit output - Free contact relay Contacts rating: 0.5A, 200V, 10W
30	Inhibit output - Free contact relay
31	Inhibit input (positive input to an optocoupler. The standard value of R1 (2.49Kohm) is suitable for 24V input. For other input voltage, change R1 in order to ensure input current of 10mA.
32	Inhibit input (negative input to an optocoupler)
32	Inhibit input (negative input to an optocoupler)
33	Buffered channel I output, ±20mA max.
34	Buffered channel -I output, ±20mA max.
35	Buffered channel B output, ±20mA max.
36	Buffered channel -B output, ±20mA max.
37	Buffered channel A output, ±20mA max.
38	Buffered channel -A output, ±20mA max.
39	N/A
40	N/A
41	N/A
42	N/A

5.2.3 Terminal for SIB-SBA/PWM

1-26	Same as SBA.
27	
28	Circuit common
29	Inhibit output - Free contact relay Contacts rating: 0.5A, 200V, 10W
30	Inhibit output - Free contact relay
31	Inhibit input (positive input to an optocoupler. The standard value of R1 (2.49Kohm) is suitable for 24V input. For other input voltage, change R1 in order to ensure input current of 10mA.
32	Inhibit input (negative input to an optocoupler)
32	Inhibit input (negative input to an optocoupler)
33	Buffered channel I output, ±20mA max.
34	Buffered channel -I output, ±20mA max.
35	Buffered channel B output, ±20mA max.
36	Buffered channel -B output, ±20mA max.
37	Buffered channel A output, ±20mA max.
38	Buffered channel -A output, ±20mA max.
39	PWM input (20KHZ) [*] The standard value of R6 (365ohm) is suitable for 0-5V input. For other input voltage, change R6 in order to limit the input current to 10mA. This current (Id)is calculated by [**] .
40	Negative input of an optocoupler for an isolated PWM input
41	Direction input. ***** The standard value of R7 (365ohm) is suitable for 0-5V input . For other input voltage change R7 in order to limit the input current to 10mA. This current (Id) is calculated by **.
42	Negative input of an optocoupler for an isolated Direction input

[*] Low level signal is 0V
High level signal is 4-10V

[**] Id = (Vin-1.5)/R6 ; 10mA<Id<20mA



SIB-SBA CONNECTORS

6. Installation procedures

6.1 Mounting

As there are hazardous voltages in some models, and all models require protection against environmental effects/elements, and each may be required to provide adequate earth, these models must be adequately enclosed in accordance with electric shock protection and earth requirements and Enclosure Degrees of Protection requirements in accordance with the most recent version of standard EN60204-1.

The SBA series dissipates its heat by natural convection up to loads of 600W. For higher output load the amplifier should be mounted on an additional heat sink or cooled by fan.

6.2 Wiring

Warning! As the units (some of the models) are used with hazardous voltages (>60vdc), and there is no electrical isolation provided, adequate electrical separation in accordance with the requirements of EN60204-1 (latest version) must be provided at their outputs, and to the supplies.

Proper wiring, grounding and shielding techniques are important in obtaining proper servo operation and performance. Incorrect wiring, grounding or shielding can cause erratic servo performance or even a
complete lack of operation.

a) Keep motor wires as far as possible from the signal level wiring (feedback signals, control signals, etc.).
b) If additional inductors (chokes) are required, keep the wires between the amplifier and the chokes as short as possible.
c) Minimize lead lengths as much as is practical. Although the amplifier is protected against long (inductive) supply wires it is recommended to keep the leads as short as possible.
d) Use twisted and shielded wires for connecting all signals (command and feedback). Avoid running these leads in close proximity to power leads or other sources of EMI noise.
e) Use a 4 wires twisted and shielded cable for the motor connection.
f) Shield must be connected at one end only to avoid ground loops.
g) All grounded components should be tied together at a single point (star connection). This point should then be tied with a single conductor to an earth ground point.

h) After wiring is completed, carefully inspect all conditions to ensure tightness, good solder joints etc.

6.3 Load inductance

The total load inductance must be sufficient to keep the current ripple within the limits (10%-20% of rated current is recommended). The current ripple (Ir) can be calculated by using the following equation:

$$Ir = \frac{0.5 \times Vs}{f \times L} \quad (A)$$

L - load inductance in mH.

Vs - Voltage of the DC supply in Volts.

f - Frequency in KHz.

If motor inductance does not exceed this value, 3 chokes should be added (to each motor phase) summing together the required inductance

$$Lch = L - Lp$$

Lch - Choke inductance

Lp - Total inductance between two phases (in Y connection it is the sum of two phases).

6.4 DC power supply

DC power supply can be at any voltage in the range defined within the technical specifications (chapter 3). The supply source must comply with the safety aspects of the relevant requirements in accordance with the most recent version of the standard EN60950 or equivalent Low Voltage Directive Standard, all according to the applicable over voltage Category. If the power source to the power supply is the AC line (through a transformer), safety margins have to be considered to avoid activating the under/over voltage protection due to line variations and/or voltage drop under load.

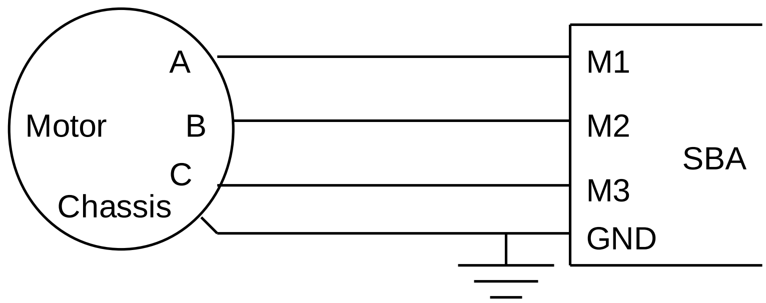
The transformer power should be calculated to have the capability to deliver power to the amplifier (including peak power), without significant voltage drops. While driving high inertia loads, the power supply must be equipped with a shunt regulator, otherwise, the amplifier will be disabled whenever the capacitors are charged above the maximum voltage or below the minimum will disable the amplifier.

In addition to the above, the transformer must comply with the safety aspects of the relevant requirements in accordance with the most recent version of the standard EN60742 (Isolating and Safety Isolating Transformers). See the following wiring diagrams for details

While driving high inertia loads, the power supply must be equipped with a shunt regulator, otherwise, the amplifier will be disabled whenever the capacitors are charged above the maximum voltage.

6.5 Wiring diagrams

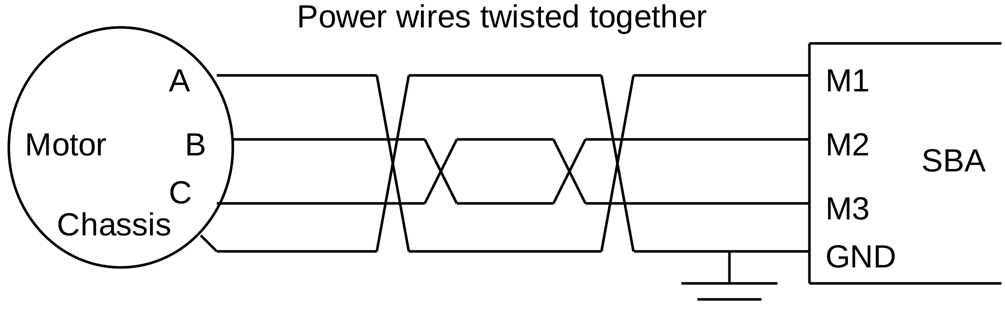
MOTOR WIRING



Minimum acceptance

==

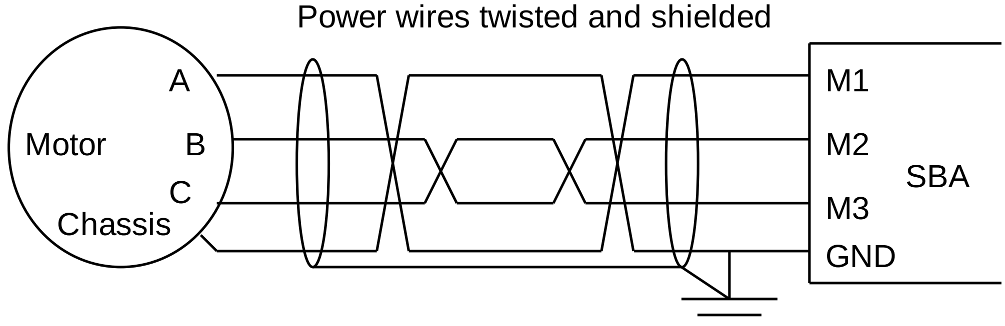
Power wires twisted together



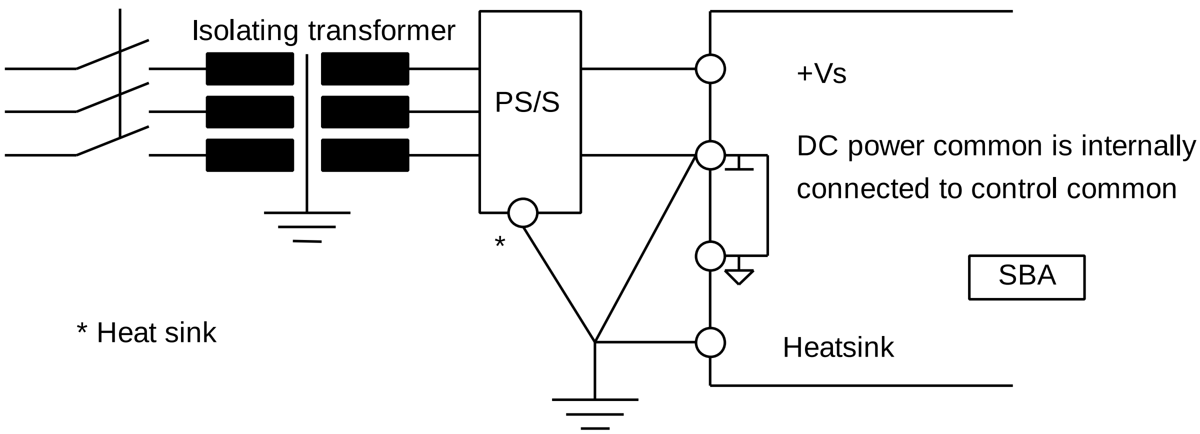
Acceptable for most applications

==

Power wires twisted and shielded



Optimum wiring, minimum RFI



Guide lines for connecting a non isolated amplifier with an isolating power transformer

Ground:

DC power common

Motor chassis

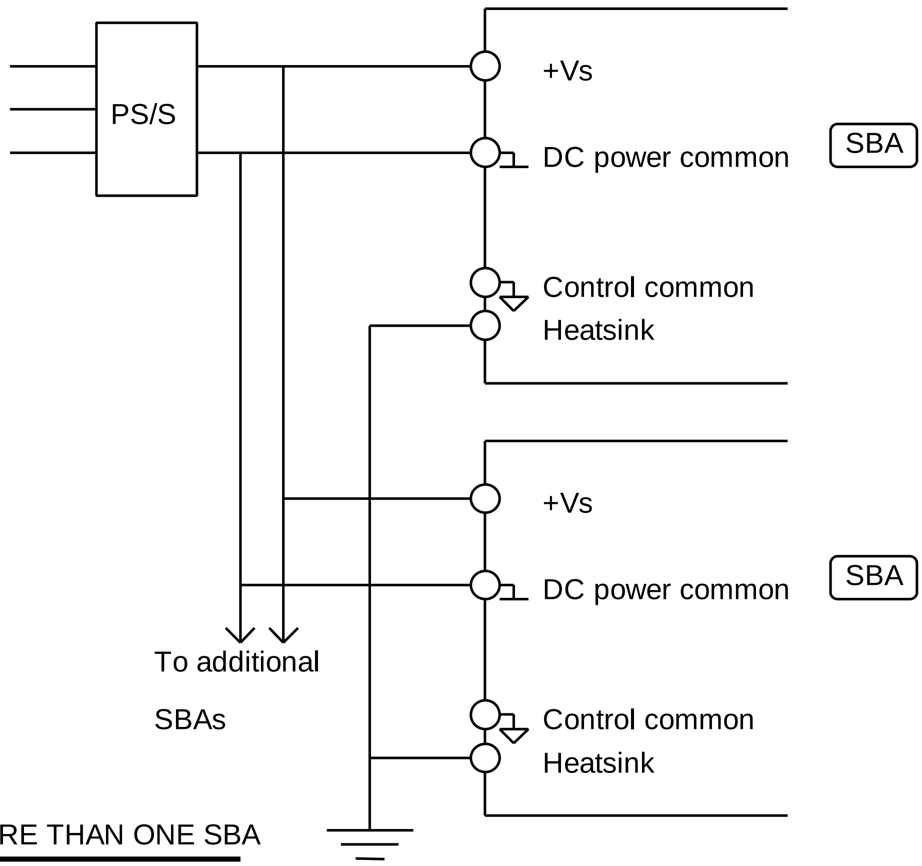
Amplifier's heat sink

Do not ground:

Control common - It is internally connected to the power common. Grounding the control common will create a ground loop.

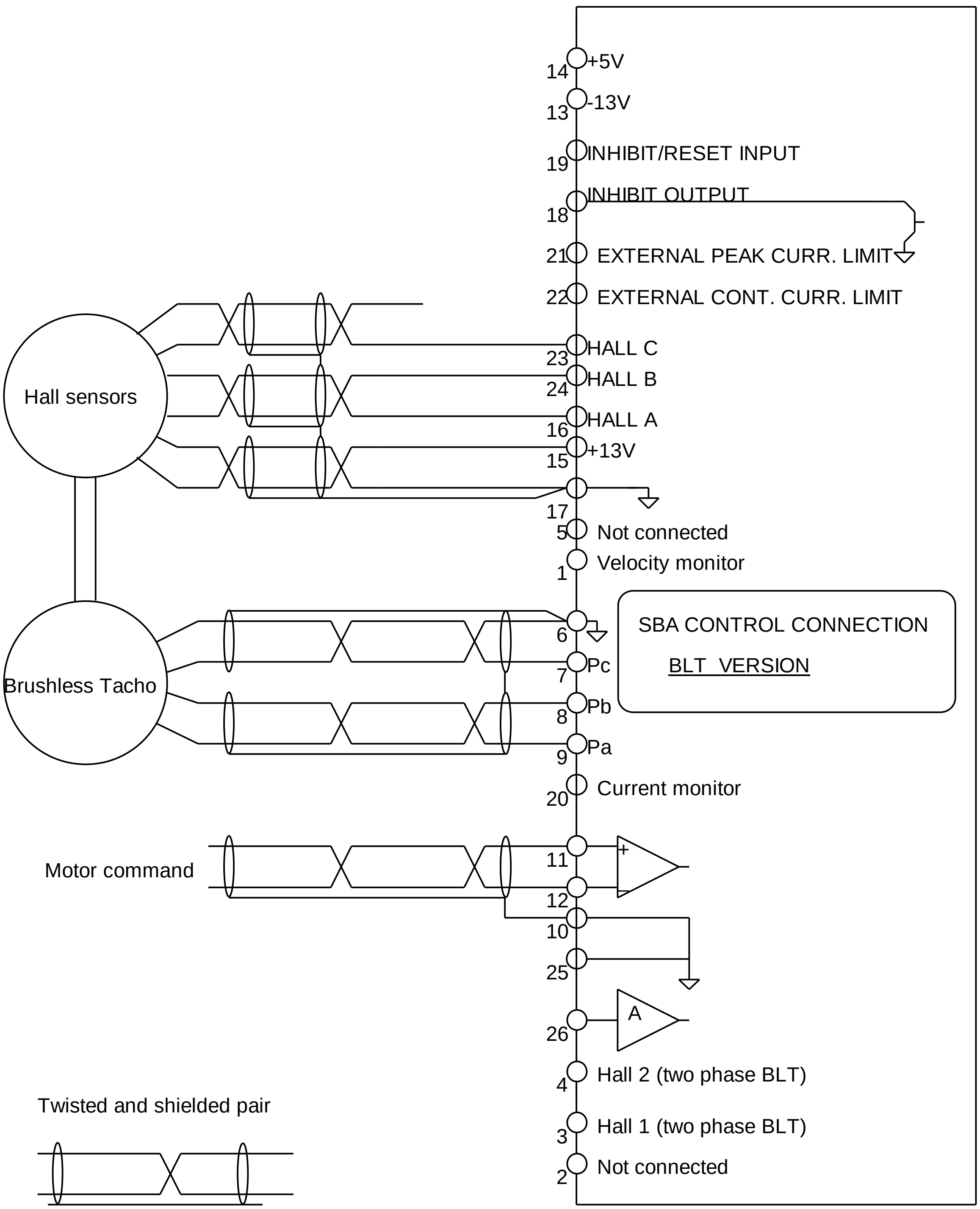
Caution:

- If source of motor command is grounded, use amplifier's differential input. Otherwise, ground loop is created.

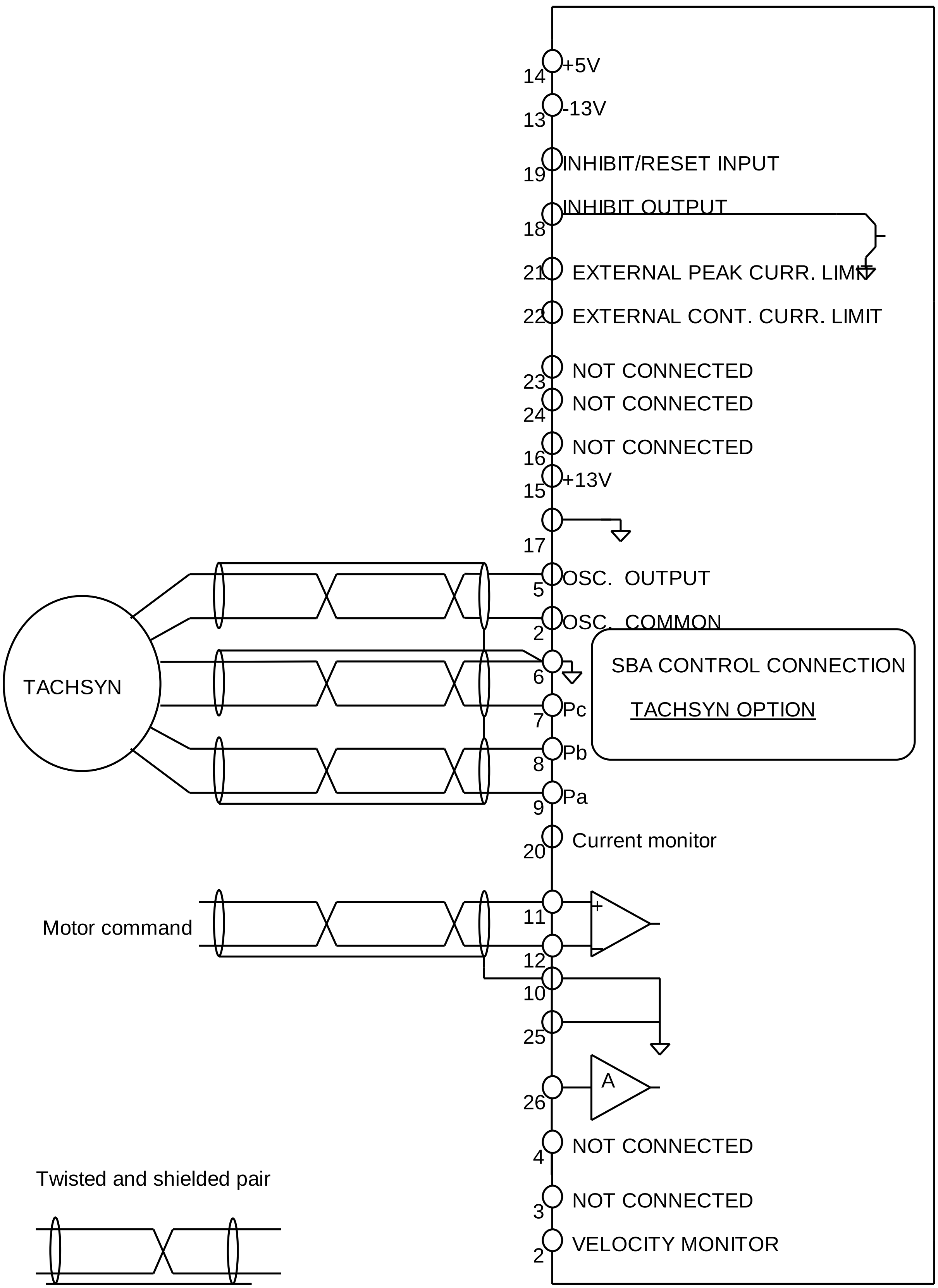


CONNECTING MORE THAN ONE SBA

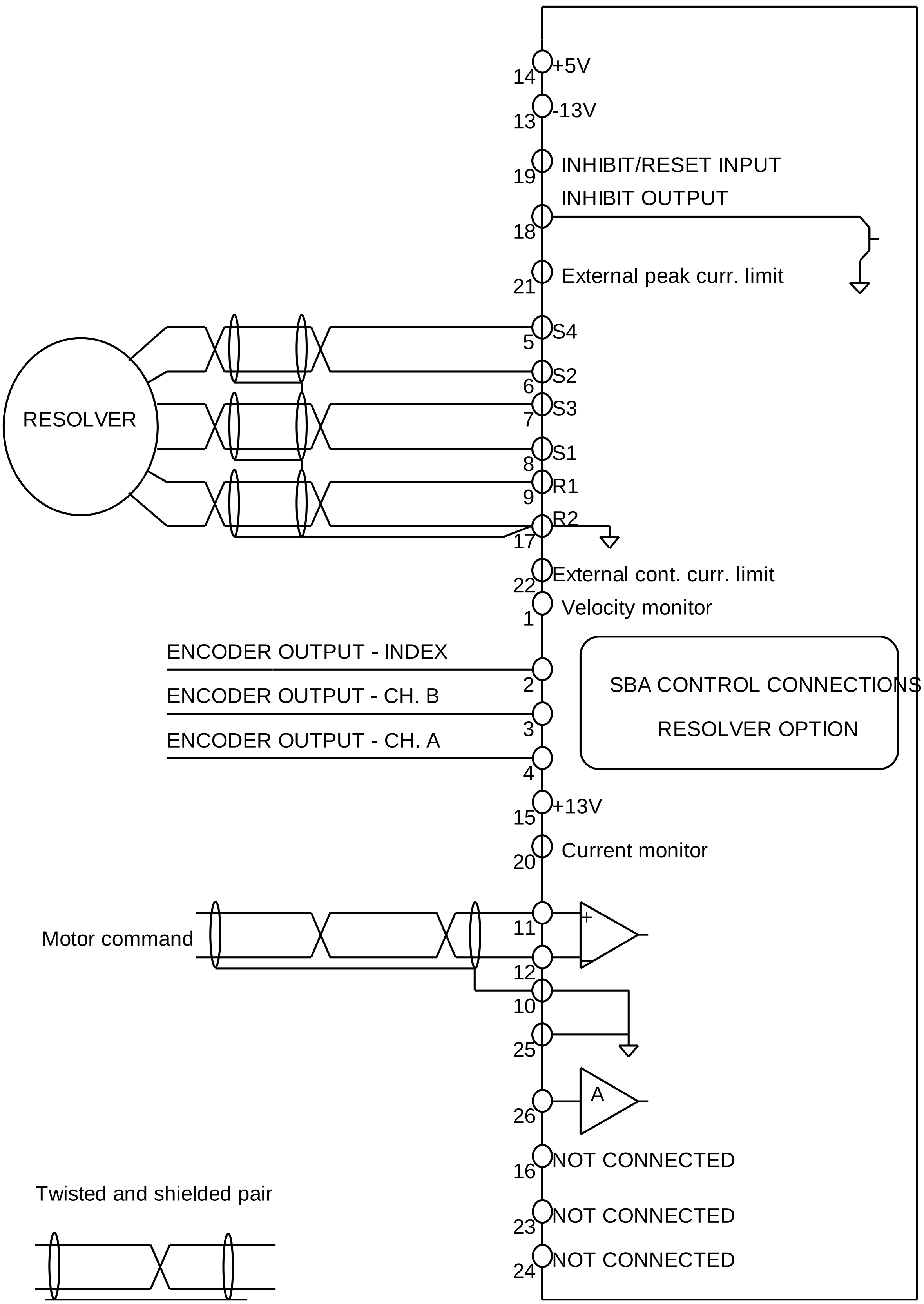
All rules about supply connections described in the previous page are also valid for multi-SBA connection.



14 +5V
13 -13V
19 INHIBIT/RESET INPUT
18 INHIBIT OUTPUT
21 EXTERNAL PEAK CURR. LIMIT
22 EXTERNAL CONT. CURR. LIMIT
Hall sensors
23 HALL C
24 HALL B
16 HALL A
15 +13V
17
5 Not connected
1 Velocity monitor
SBA CONTROL CONNECTION
BLT VERSION
Brushless Tacho
6
7 Pc
8 Pb
9 Pa
20 Current monitor
Motor command
11
12
10
25
26
A
4 Hall 2 (two phase BLT)
3 Hall 1 (two phase BLT)
2 Not connected
Twisted and shielded pair



14 +5V
13 -13V
19 INHIBIT/RESET INPUT
18 INHIBIT OUTPUT
21 EXTERNAL PEAK CURR. LIMIT
22 EXTERNAL CONT. CURR. LIMIT
23 NOT CONNECTED
24 NOT CONNECTED
16 NOT CONNECTED
15 +13V
17
5 OSC. OUTPUT
2 OSC. COMMON
6
7 Pc
8 Pb
9 Pa
SBA CONTROL CONNECTION
TACHSYN OPTION
TACHSYN
20 Current monitor
Motor command
11
12
10
25
26
A
4 NOT CONNECTED
3 NOT CONNECTED
2 VELOCITY MONITOR
Twisted and shielded pair


14
+5V
13
-13V
19
INHIBIT/RESET INPUT
INHIBIT OUTPUT
18
21
External peak curr. limit
RESOLVER
5
S4
6
S2
7
S3
8
S1
9
R1
17
R2
22
External cont. curr. limit
1
Velocity monitor
ENCODER OUTPUT - INDEX
2
ENCODER OUTPUT - CH. B
3
ENCODER OUTPUT - CH. A
4
SBA CONTROL CONNECTIONS
RESOLVER OPTION
15
+13V
20
Current monitor
Motor command
11
+
12
10
25
26
A
16
NOT CONNECTED
23
NOT CONNECTED
24
NOT CONNECTED
Twisted and shielded pair

7. Start - Up Procedures

If you use a SIB-SBA card (of any type) you have to remove it temporarily from the SBA in order to make the following adjustments.

7.1 Common procedures for all amplifiers types

7.1.1 Commutation signals format

Select the position of DIP switch 1 on the control board according to the commutation signal format of the motor.

DS1 positions:	ON : 30▪	OFF : 60▪

For all Resolver versions it should be 60▪.

7.1.2 CFM function

Select the position of DIP switch 4 on the control board according to the motor's rated current. If it is less than 20% of the amplifier's rated current select:

DS4 to ON - Active CFM

Otherwise,

DS4 to OFF - No CFM

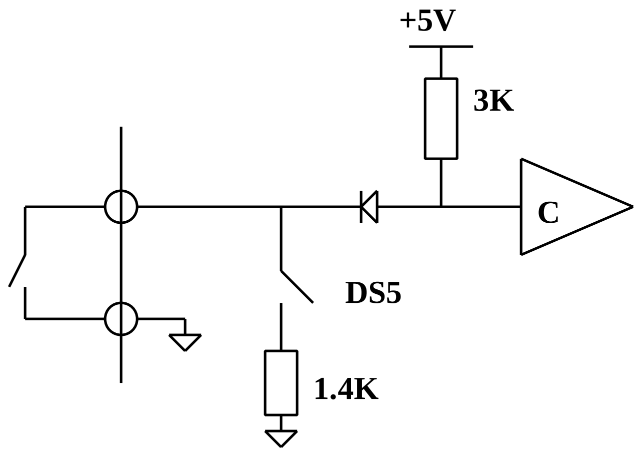
7.1.3 Inhibit logic

Select the desired Inhibit logic you need:

a) Disable by Low

Inhibit function will be activated by connecting its input (terminal 19) to a low level signal. If no signal is applied to this input the amplifier will be enabled upon power on.

DS5 - OFF



SBA DISABLED BY ACTIVE LOW OR CLOSED CONTACT

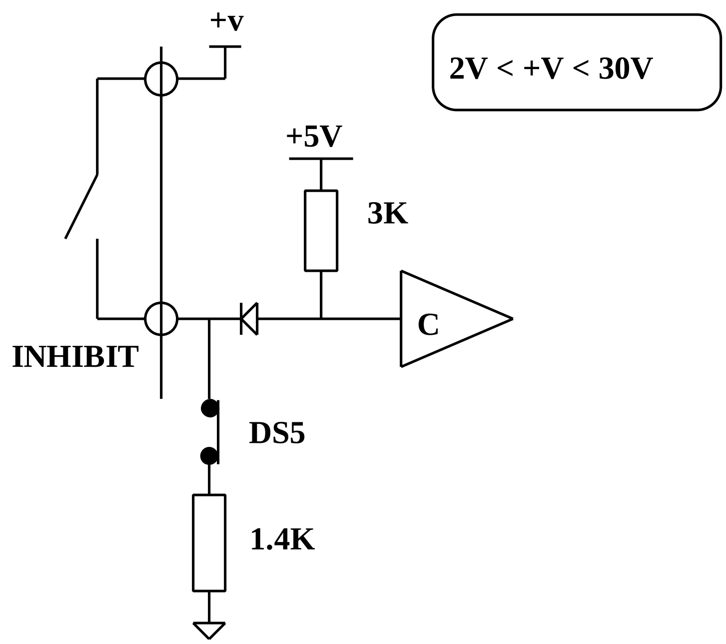
$-1V \leq Vil < 1V$

$2V \leq Vih < 30V$

b) Enable by High

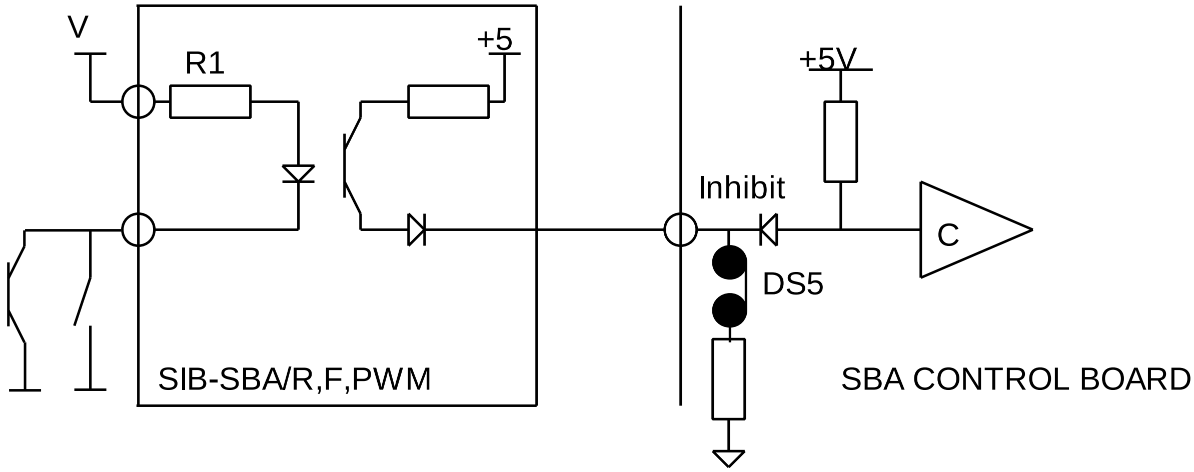
Inhibit function will be de-activated by connecting its input (terminal 19) to a high level signal. If no signal is applied to this input the amplifier will be disabled upon power on.

DS5 - ON

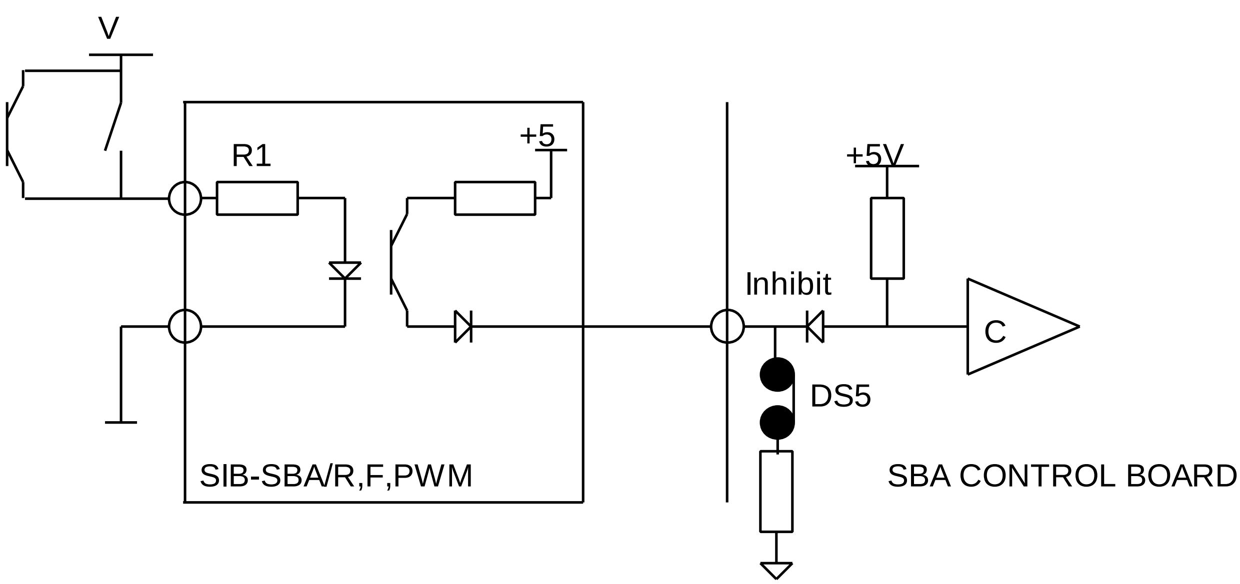


SBA ENABLED BY ACTIVE HIGH OR CLOSED CONTACT

OPTO-ISOLATED INHIBIT WITH SIB-SBA/R,F,PWM



SBA WITH SIB-SBA ENABLED BY ACTIVE HIGH OR CLOSED CONTACT



SBA WITH SIB-SBA ENABLED BY ACTIVE LOW OR CLOSED CONTACT

R1 = 100 x V (ohm)

V - Voltage at the inhibit input.

Standard value for R1 is 2.4K (for 24V). Source must be capable to source or sink 10mA.

7.1.4 Current mode

To operate in current mode the velocity loop should be disabled by converting the error amplifier to a low gain proportional amplifier.

- Remove R5 (in solderless terminals).
- Remove C2 (in solderless terminals).

In addition, you must make sure that the velocity feedback signal is not entering the error amplifier. If a Resolver or Tachsyn options are used, the input resistor of the velocity signal should be removed:

- Remove R97 (SMD component)

The current limits of the amplifier remain the same as in velocity mode.

7.1.5 Velocity mode

To operate in velocity mode the velocity loop should be enabled by converting the error amplifier to a high gain PI amplifier. Make sure that R4,R5 and C2 (in solderless terminals) are installed on the board.

If a Resolver board is installed on the SBA amplifier, you have to make sure that the velocity feedback signal is entering the error amplifier:

DS1 (on the Resolver board: ON.

7.1.6 Selecting the reference signal gain

The SBA has 2 inputs: single ended input (terminal 26) and a differential input (terminals 11,12). Care must be taken not to apply input voltage above the maximum input voltage as this will cause the input op amp to operate beyond its limits (10V) and in extreme cases may even damage the op amp. The standard procedure recommends to use the single ended input (terminal 26) for the velocity feedback signal and to use the differential input for the reference signal.

Following are the input maximum voltage and impedance with the standard values of input resistors:

INPUT - RESISTOR	STANDARD VALUE	MAX. VOLTAGE	Current Gain(A/V) (in current mode)	INPUT IMPEDANCE
Terminal 26 - R3	15 Kohm	25V	0.2xIc	25 Kohm
Differential - R7,8	10Kohm	20V	0.533xIc	30 Kohm

All the gains are divided by 2 if CFM is ON

See chapter 4.1 for calculation of other values

7.1.7 Static current limit adjustment

The amplifiers' current limits can be adjusted statically (without load) by inserting fix resistors on the logic board, and/or dynamically by two external voltage signals. The current limits are factory adjusted to the amplifier's rated values. Reducing the nominal limits is performed as follows:

a) Continuous current limit adjustment

R2 should be calculated and inserted as follows:

$$Q = \frac{Ic(new)}{Ic(nom)} \qquad 0 < Q < 1$$

Ic(new) - new value of continuous current limit

Ic(nom) - nominal current rating of the amplifier (10, 5 or 3A)

$$R2 = \frac{5Q}{1-Q} \quad (Kohm)$$

b) Peak current limit adjustment

R1 should be calculated and inserted as follows:

$$P = \frac{Ip(new)}{Ip(nom)} \qquad 0 < P < 1$$

Ip(new) - new value of peak current limit.

Ip(nom) - peak current rating of the amplifier (20, 10 or 6A)

$$R1 = \frac{10P}{1-P} \quad (Kohm)$$

To measure the current limit a load must be connected (chokes or a motor) to the motor's outputs. Measurement can be done either by direct current measurement or by using the current monitor (terminal 20).

$$\text{Current monitor scale} = \frac{3.75}{Ic(nom)} \qquad (V/A)$$

The current monitor scale is double if CFM (DS4) is ON.

7.1.8 Latch mode of the protective functions

All the protective functions activate internal inhibit. There are two modes of resetting the amplifier after the cause of the inhibit disappears:

Self Restart (DS6-OFF): The amplifier is inhibited only for the period that the inhibit cause is present.

Latch (DS6-ON): Each failure latches the Inhibit and the In LED. For restart (after clearing the failure source), reset has to be performed either by turning DS6 to "OFF" or by applying logic 0 at the reset input (terminal 19).

For safety reason it is recommended to use the amplifier in the LATCH MODE

7.2 Connecting the velocity feedback elements

7.2.1 Brush Tachogenerator

The output leads of the tacho are connected to terminal 26 and to the circuit common (Negative feedback). The tacho voltage is adjusted by calculating R3 as follows:

$$R3 = 1.14 x V_{Tm} - 9.1 \quad (Kohm)$$

V_{Tm} - Voltage generated by tachogenerator at max velocity.

Actual resistor value should be as close as possible to the calculated value.

7.2.2 Brushless Tachogenerator

A) Three Phase Brushless Tachogenerator

Selecting this option is done by arranging the following switches:

DS2 = ON
DS3 = OFF

The three leads should be connected to terminals 9, 8, 7 - phases A,B,C). If the tacho windings are connected in Y (star) and the common connection is available as an output lead, it should be connected to the tacho common (terminal 6).

The output of the tacho processor is available at terminal 1.

R9, R10 and R11 should be calculated and installed as follows:

$$R9 = R10 = R11 = 0.415 V_{Tm} - 3.32 \quad (Kohm)$$

The speed of the motor (N) in RPM is given by:

$$N = \left(\frac{R9}{3.32} + 1\right) x \; V1/(Ke_{tach} \; x \; Ki) \quad (R9 \text{ in Kohm})$$

V_{Tm} - Voltage generated by tachogenerator at max velocity.

Ke_{tach} - Tacho back EMF constant (Volt/RPM).

V1 - Voltage at terminal 1.

Ki - Trimmer wiper position (0.5-1 full scale)

B) Two Phase Brushless Tachogenerator

Selecting this option is done by arranging the following switches:

DS2 = ON
DS3 = ON

Two leads (one from each phase) should be connected to terminals 9(phase A) and 8 (phase B). The other two leads should be connected together to terminal 6. Its Hall effect sensors should be connected to terminal 4 (A) and 3 (B).

The output of the tacho feedback processor is available at terminal 1.

R9 and R10 should be calculated and installed as explained in the previous paragraph (three phase brushless tachogenerator).

7.2.3 Tachsyn

Selecting this option is done by selecting DS2 = OFF. The three phases leads should be connected to terminals 9,8,7 -phases A,B,C). The tachsyn oscillator reference signal is at terminal 2.

R9,R10 and R11 should be calculated and installed as follows:

$$R9=R10=R11= 0.332V_{Tc} - 3.32 \quad (\text{Kohm})$$

V_{Tc} - Voltage generated by Tachsyn at max velocity.

The speed of the motor (N) in RPM is given by:

$$N = \left(\frac{R9}{3.32} + 1\right) \times V_1 / (Ke_{tc} \times Ki) \qquad (\text{R9 in Kohm})$$

Ke_{tc} - tachsyn back EMF constant (Volt/RPM).

V_1 - voltage at terminal 1.

The output of the velocity processor is available at terminal 1.

Ki - Trimmer wiper position (0.5-1 full scale)

7.2.4 Resolver

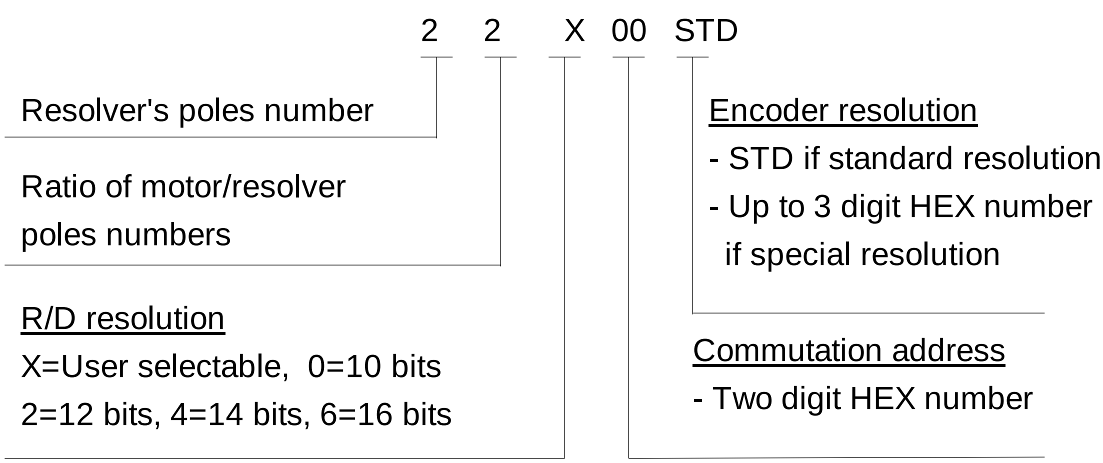
The Resolver interface circuit consists of three basic blocks:

R/D converter

The R/D conversion is done by a variable resolution, monolithic converter type 2S82 of Analog Devices. It accepts two signals from the Resolver (sine and cos.) and converts them into binary position data bits. The resolution of the position bits is user selectable 10, 12 ,14 and 16 (only for standard encoder resolution). In addition, the R/D creates a signal that is proportional to the Resolver velocity. This signal is used as a velocity feedback.

EPROM

The EPROM creates "Hall" signals by mapping the position data bits accepted from R/D into suitable Hall signals to operate a specific BLM. In addition, the encoder index (marker) signal is also produced from the EPROM. The EPROM is designated as follows:



When the commutation address is 00, the zero crossing of phases B C occurs at position address "0" of the Resolver.

The EPROM is usually supplied without any programming and in such case the amplifier will have no commutation information.

Oscillator

Creates sinusoidal waveform signal to excite the primary of the Resolver.

Oscillator Frequency/Amplitude Selection (R228,R233)

The frequency (fr) and amplitude (Vr) needed to excite the Resolver are taken from the Resolver data sheet.

Selecting the frequency:

$$\boxed{R228 = 110/fr \quad (Kohm)}$$

$0.1KHz < fr\ (KHz) < 20KHz$

Selecting the amplitude:

Take care that the RMS amplitude does not exceed 7Vrms or that the peak-to-peak (ptp) value is within the range of $2V \le Vr_{ptp} \le 20V$.
For Vr in peak-to-peak value:

$$\boxed{R233 = 6/(Vr - 2) \quad (Kohm)}$$

For Vr in RMS value:

$$\boxed{R233 = 6/(2.82Vr - 2) \quad (Kohm)}$$

Reference Voltage level to R/D (R192)

In order to adjust the reference voltage input level to 2Vrms, select R192 as follows:

$$\boxed{R192 = 50 \times (Vr_{rms} - 2) \quad (Kohm)}$$

For Vr_{rms} <2V, install R192=100 ohm.

Signal input level (R193,R194)

The R/D inputs (Vin_{rms}) are adjusted to the sin/cos. Resolver outputs by:

Resolver output = Vin_{rms} = Vr_{rms} x Transformation ratio

R193 = R194 = Vin_{rms} - 2 - R_{stator} (Kohm)

(R_{stator} in Kohm).

When Vin_{rms}<2V, install R193=R194=100 ohm.
The standard R/D converter will not operate for Vin_{rms}<1.8V. Consult factory for OEM applications.

Velocity Signal

The tracking converter technique generates an internal signal at the output of the integrator that is proportional to the rate of change of the input angle. This dc analog output (velocity signal) is buffered and represented at terminal 1. It can be internally connected to input 1 (the single ended input) by turning DS1 (on the resolver board) to ON.

Max output voltage is ±8V.

Select maximum actual velocity of the application and calculate the maximum tracking rate T of the Resolver as follows:

T = rpm x Q / 120

T unit is rps: Resolver electrical revolution per second

Q - number of poles of Resolver ;

rpm - mechanical revolution per minute.

Selecting the Resolution

The resolution can be selected to be 10,12,14 or 16 bits by use of DIP switches 3 and 4. When selecting the resolution the rps limits should not be exceeded:

10 bit = 1040 rps

12 bit = 260 rps

14 bit = 65 rps

16 bit = 16.5rps

Resolution	DS3	DS4
10	ON	ON
12	ON	OFF
14	OFF	ON
16	OFF	OFF

Note:

- Each resolution change must be followed by new components selection procedure.
- When changing resolution under dynamic conditions, a period of uncertainty will exist before position and velocity data is valid.

<u>Encoder resolution</u>

In the STD mode (DS2 OFF), the encoder signals A,B are created by the EPLD and can have only the following basic resolutions (for 2 pole Resolver):

256 for 10 bits

1024 for 12 bits

4096 for 14 and 16 bits

When the Resolver is more than 2 poles, the resolution for one shaft rotation will be:

$$\boxed{Er = QxS / 8}$$

Q = number of Resolver poles ;

S = resolution of converter (2^{10},2^{12},or 2^{14})

When different encoder resolution is needed the encoder signals are generated by the EPROM and the R/D resolution is no longer user selectable.

This option requires

- DS2 at ON
- Special EPROM which is programmed for this resolution.

HF Filter (R195, R196, C61, C62)

The function of the HF filter is to reduce the amount of noise present on the signal inputs to the 2S82, reaching the Phase Sensitive Detector and affecting the outputs. Values should be chosen so that

$$15\text{Kohm} < R195 = R196 < 30\text{Kohm}$$

$$C61 = C62 = \frac{160\times10^{3}}{R195 \times fr} \quad (\text{pF})$$

fr = Reference frequency in KHz

R195 in Kohm

This filter gives an attenuation of 3 times at the input to the phase sensitive detector.

AC Coupling of Reference Input (C60)

Select C60 so that there is no significant phase shift at the reference frequency. That is,

$$C60 = \frac{10^{6}}{fr(\text{KHz}) \times Rx} \quad (\text{pF}) \qquad Rx = \frac{100 \times R192}{100 + R192} \quad (\text{Kohm})$$

R192 in Kohm

If RX yields less than 50K, install a value of Rx=50K in the C60 equation.

Maximum Tracking Rate (R201)

The VCO input resistor R201 sets the maximum tracking rate of the converter and hence the velocity scaling as at the maximum tracking rate, the velocity output will be 8V.

Decide on your required maximum tracking rate, "T" , in Resolver electrical revolutions per second. Note that "T" must not exceed the specified maximum tracking rate or 1/16 of the reference frequency.

$$R201 = 5.92 \times 10^{7} / T \times p \qquad (\mathrm{Kohm})$$

where p = bit per rev
= 1,024 for 10 bits resolution
= 4,096 for 12 bits
= 16,384 for 14 bits
= 65,536 for 16 bits

Whenever the actual tracking rate (T) is lower than half of the maximum tracking rate (see "Selecting the Resolution"), R201 should be half of the value calculated above. This improves significantly the low speed performance. In this case the velocity signal at maximum velocity will be $\pm$4V.

Closed Loop Bandwidth Selection (C67, C68, R200)

a. Choose the Closed Loop 3dB Bandwidth (f_{bw}) required ensuring that

$$f_{ref} > 10 \times f_{bw}$$

Recommended bandwidth values:
250Hz for 3KHz
300Hz for 5KHz
500Hz for 10KHz

b. Select C67 so that

$$C67 = \frac{2.5\times10^9}{R201 \times f_{bw}^2} \quad (pF)$$

with R201 in Kohm and f_{bw} in Hz as selected above.

c. C68 is given by

$$C68 = 40 \times C67 \quad (pF)$$

d. R200 is given by

$$R200 = \frac{127 \times 10^7}{f_{bw} \times C68} \quad (Kohm)$$

f_{bw} in Hz, C68 in pF

R200 value should be at least three times R197.

Gain Scaling Resistor (R197)

R197 should be installed according the following table:

536Kohm for 10 bits resolution

130Kohm for 12 bits

33Kohm for 14 bits

8.2Kohm for 16 bits

7.2.5. Optical Encoder

Set DS3 to OFF

Adjusting maximum speed

Derive the application maximum operating frequency using the following equation:

$$fn = \frac{N \times R}{60} \quad (Hz)$$

N - maximum speed in RPM

R - Encoder resolution (PPR)

If fn < 200,000 Hz you can improve the low speed performance by using the frequency x4 multiplier (DS2 - OFF).

Calculate and insert R9 and R10:

$$R9 = R10 = \frac{5x10^6}{K1xK2xfn} \quad (Kohm); \qquad (fn \text{ in } Hz)$$

K1 = 1.05 for 150KHz<fn<200K

K1 = 0.95 for 100KHz<fn<150KHz

K1 = 0.9 for 20KHZ<fn100KHz

K1 = 0.85 for 0KHz<fn< 20KHz

K2 = 1 for x1 encoder basic frequency

K2 = 4 for x4 encoder basic frequency

K2 = 1 for Hall sensors feedback

The minimum value of R9,R10 is 5.11Kohm.

Adjusting the circuit bandwidth

Most of the applications will be well met when the f/v converter bandwidth is set to 500Hz. Adjusting the bandwidth frequency (fbw)is done by R12 and R13:

$$R12 = R13 = \frac{5000}{fbw} \quad (Kohm); \quad (fbw\ in\ Hz)$$

When fast mechanical response motor is being used, the bandwidth of the f/v converter should be increased by increasing R12 and R13 till optimal performance is achieved.

7.2.6. Hall effect sensors

Set DS2 to OFF
Set DS3 to ON

Adjusting maximum speed

Derive the application maximum operating frequency using the following equation:

$$fn = \frac{P \times N}{20} \quad (Hz)$$

P - number of motor poles

N - maximum speed in RPM

Calculate and insert R9 and R10 as given in 7.2.5.

Adjusting the circuit bandwidth

The f/v bandwidth should be around 250Hz. Adjusting the bandwidth frequency(fbw) is done by R12 and R13:

$$R12 = R13 = \frac{5000}{fbw} \quad (Kohm); \quad (fbw\ in\ Hz)$$

If feedback voltage causes a positive feedback, R11 should be removed.

7.3 SIB-SBA/R,F,PWM

If you use SIB-SBA/R or SIB-SBA/F or SIB-SBA/PWM, you can use the buffered and differential outputs of the encoder channels. In order to activate them, turn to following DIP switches (on the SIB card):

DS4 to ON for the Index signal
DS5 to ON for channel B
DS6 to ON for channel A

If you have SIB-SBA/F card proceed to 7.3.1. If you have SIB-SBA/PWM card proceed to 7.3.2. If you have SIB-SBA/R card proceed to chapter 8.

7.3.1 SIB-SBA/F

To activate the Linear Acc/Dec function turn

DS2 to ON
DS1,DS3 to OFF.

Whenever the linear Acc/Dec circuit is activated, the reference signal is first filtered by the differential input. Resistors R2 and R3 should be calculated and inserted according to the following equation:

$$Vout = \frac{(V26-V27)x10}{R} \qquad R=R2=R3 \text{ (in Kohm)}$$

Vout - Output voltage from the differential amplifier which is fed to the linear Acc/Dec circuit.

V26-V27 - Input voltage to terminals 26,27 (input 1).

R4+T1 (T1 is trimmer 1 on the SIB-SBA card) determine the Dec. time and R5+T2 (T2 is trimmer 2 on the SIB-SBA card) determine the Acc. time.

To calculate the time that the output voltage (fed to input 1) will equal to the input voltage (fed to the Acc/Dec circuit), use the following equation:

$$Vin = \frac{K \times 5 \times t}{R4 \times C} \quad \text{(volt)}$$

Vin is the input voltage to the Acc/Dec circuit.

t is ramping time in seconds.

C1 value should be in Farads (standard value is 1↘F).

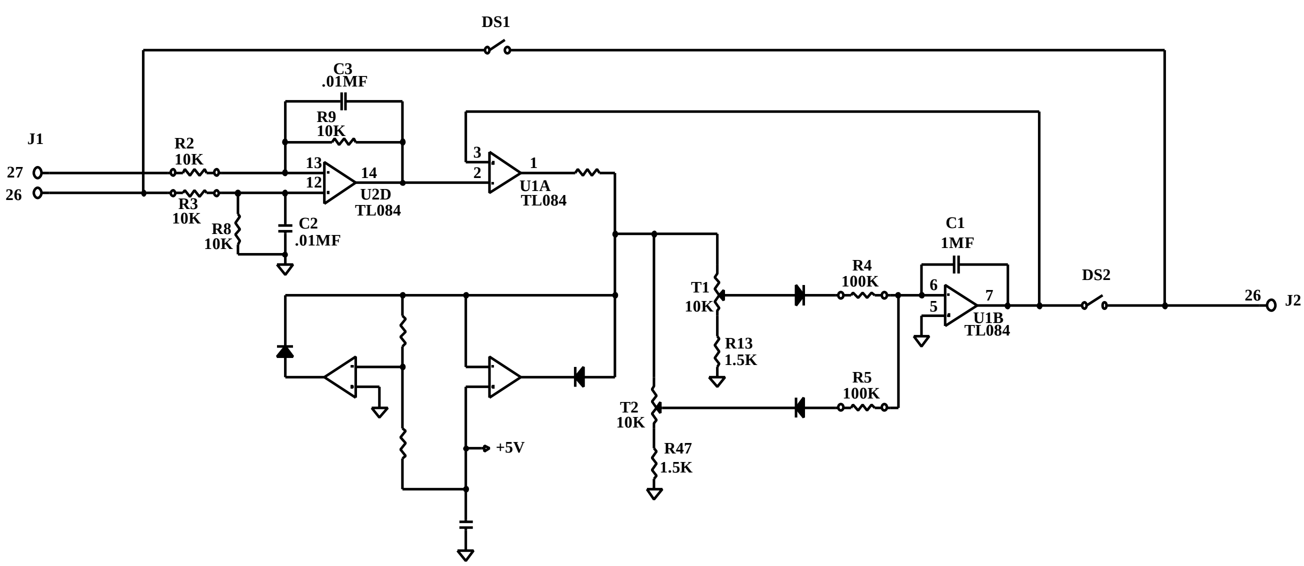
R4 (or R5) value should be in ohm.

K - position of trimmer's wiper

CCW - 1

CW - 0.05

Standard values of 100Kohm with 10V signal yield 0.05-1s ramping time.



After you finish with the adjustment of the SIB-SBA/F, re-install the card on the SBA.

7.3.2 SIB-SBA/PWM

To activate the PWM input turn the following DIP switches on the SIB-SBA/PWM card as follows

DS1 to OFF
DS2 to OFF
DS3 to ON

After you finish with the adjustment of the SIB-SBA/PWM, re-install the card on the SBA.

8. Amplifier adjustment

Important remarks:

A. If you use a SIB-SBA card (of any type) you have to mount it back on the SBA.

B. If all the previous steps were accomplished you may now turn on the power and continue with the following adjustments. You may omit the step for current mode or velocity mode according to your application.

C. In some applications, especially those where the motor electrical parameters (total inductance and resistance in the armature circuit) are much smaller or larger than normally encountered, the current loop response should be optimized before proceeding with the following steps - See Appendix A.

8.1 Balance adjustment

If the motor is rotating with the command signal at zero voltage, a balance adjustment will be necessary. Turn the balance trimmer (T2) as required until the motor stops. As a rule, have the command signal connected and set to zero when balancing the amplifier. This way, any offset in the command signal will be canceled.

8.2 Dynamic current limit adjustment

The amplifiers' current limits can be adjusted dynamically by two external voltage signals. If you do not use this feature you can proceed to chapter 8.3.

Dynamic adjustment

The ECL signals scale down the current limits as selected in the static adjustment (7.1.7).

ECL function on continuous current limit:

$$I_c = \frac{V_{22} \times I_c(nom)}{3.75}$$

V22 - voltage applied at terminal 22

Voltages between 0 to 3.75V will control continuous current limit from zero to Ic(nom) or Ic(new) as set in the static adjustment.

ECL function on peak current limit:

$$I_p = \frac{V_{21} \times I_p(nom)}{7.5}$$

V21 - voltage applied at terminal 21.

Voltages between 0 to 7.5V will control peak current limit from zero to Ip(nom) or Ip(new) as set in the static adjustment. Maximum permissible voltage at these terminals is ñ12V. Ic and Ip will be half if CFM (DS4) is ON.

8.3 Adjusting the motor speed (velocity mode only)

Adjusting the speed is done by the feedback trimpot (for B, T, R and E versions) or by using the input gain resistors (either the command or tacho feedback).

- Increasing/decreasing the feedback gain will decrease/increase the speed.
- Increasing/decreasing the command gain will increase/decrease the speed.

The range of the trimmer is from 0.7x (for max. CCW) up to 1.0x (for max. CW) of feedback signal value.

8.4 Response adjustment (Velocity mode only)

In most applications optimum response is achieved by adjusting the compensation (COMP) trimmer. Adjustment procedure is as follows:

- Provide the amplifier with a low frequency, bi-directional square wave velocity command (A 0.5Hz, ñ2.0V waveform is often employed).
- Apply power to the amplifier, and while monitoring the tachometer signal, gradually adjust the COMP trimmer from the CW toward the CCW position. Optimum response (critically-damped) should be achieved at some position before reaching full CCW on T1. Fig 8.1 illustrates the types of waveforms observed for various setting of T1.

In some applications, especially those where the load inertia is much smaller or larger than normally encountered, the standard compensation components values of 0.022æF for C2 and 470Kohm for R4 may not allow an optimum setting of the COMP trimmer T1. In fact, the velocity loop may be unstable for any setting of T1.

In these cases different values for C2 and R4 must be chosen. The following procedure can be used to select these values:

- Short circuit C2 with a short jumper wire.
- Replace R4 with a decade resistance box Initially set the box resistance at 20Kohm.
- Set T1, the COMP trimmer to approximately midrange.
- Input a 0.5Hz, 2V bi-directional square wave velocity command signal to the amplifier.
- Apply power, and while monitoring the tachometer signal, gradually increase the value of the box resistance until optimum response as depicted in Fig 8.1 is achieved.
- Substitute the closest standard value discrete resistor for R4 and remove the decade resistance box.
- Remove the shorting jumper across C2, and again check the response using the squarewave test signal. If near optimum results are obtained, trim the response using COMP trimmer-T1 for the optimum.

- If the previous step does not yield satisfactory results, if unacceptable overshooting has been noted, substitute a larger value than 0.022æF; or, if the response is overdamped substitute a smaller value than 0.022æF. Repetition of this procedure should yield an optimum choice for C2.

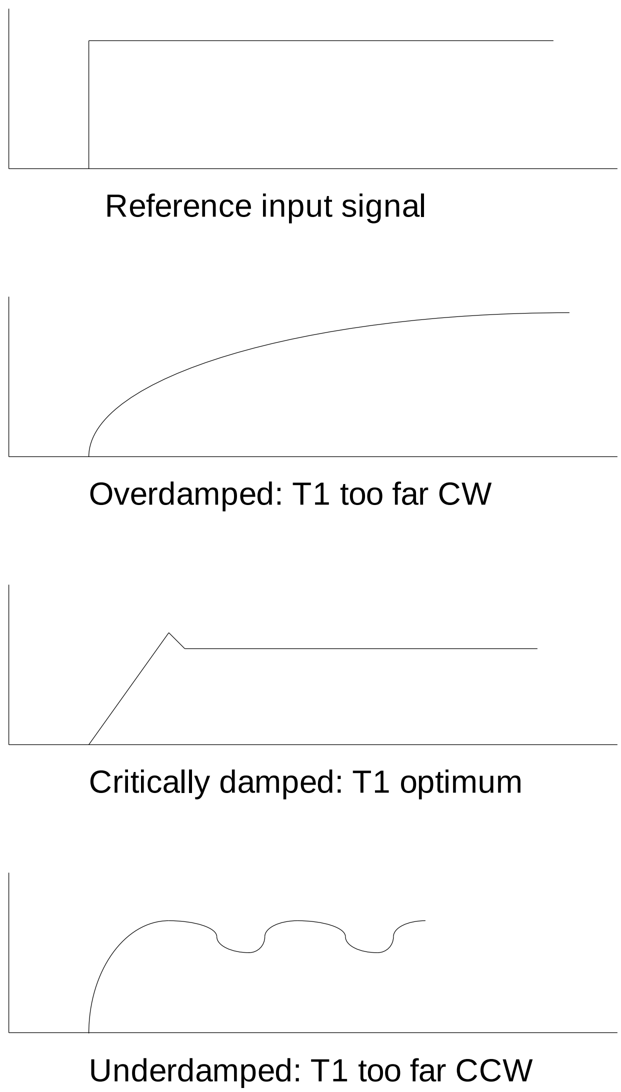


Fig. 8.1

Typical velocity response waveforms

9. Tables and Summaries

9.1 Adjusting trimmers - summary

Two trimmers are installed on the control board:

T1 (compensation) - See 8.4.

T2 (Balance) - see 8.1.

T3 (Gain) - This trimmer is installed on B, T, R and E boards only.

9.2 LED diagnostics

Four LEDs are installed on the logic board of the amplifier with the following designations: In, Ic, Com, Vs. Under normal operation only Vs should illuminate (Vs indicates the existence of supply voltages). The following table represents the faults' indications of the LEDs:

	1	2	3	4
In	X		X	X
Ic	X	X		
Com			X	
Vs	X	X	X	X

X - Illuminated LED

1. One or more of: external inhibit, under/over voltage, short circuit, excess temperature.
2. Continuous current limit.
3. Loss of commutation signal.
4. Same as 1 but in latch mode of protective functions.

9.3 DIP switches summary

DS1	ON	OFF
1	30° Hall sensors	60° Hall sensors
2	Brushless tacho	Tachsyn
3	2 phase brushless tacho	3 phase brushless tacho
4	CFM ON (see 5.1.3)	CFM OFF
5	Inhibit: high level enable	Inhibit: low level disable
6	Latch mode of protections	Auto-restart of protection

Resolver version

DIP switch module 1 (on the basic SBA control board):

DS1	ON	OFF
1	30° Hall sensors	60° Hall sensors
2	N/A	N/A
3	N/A	N/A
4	CFM ON (see 5.1.3)	CFM OFF
5	Inhibit: high level enable	Inhibit: low level disable
6	Latch mode of protections	Auto-restart of protection

DIP switch module 2 (on the resolver interface board):

DS2	ON	OFF
1	Velocity feedback signal connected to the velocity loop.	Veloc. signal disconnected
2	Non-standard EPROM	Standard EPROM
3	R/D resolution (see appendix A)	
4	R/D resolution (see appendix A)	

Encoder version

DIP switch module 1 (on the basic SBA control board):

DS1	ON	OFF
1	30° Hall sensors	60° Hall sensors
2	Basic encoder frequency	x4 encoder or x6 Hall free.
3	Hall sensors velocity feedback	Encoder velocity feedback
4	CFM ON (see 5.1.3)	CFM OFF
5	Inhibit: high level enable	Inhibit: low level disable
6	Latch mode of protections	Auto-restart of protection

SIB-SBA DIP SWITCH SUMMARY

DIP SWITCH	ON	OFF
1	Single ended input for input 1. In this position, the linear Acc/Dec circuit is inactive. DS2 and DS3 must be in OFF	
2	Activate Linear Acc/Dec Function. DS1 and DS3 must be in OFF.	
3	Activate the PWM input. DS1 and DS2 must be in OFF.	
4	Activate the complementary output of the Index signal	Tachsyn or Brushless Tacho or encoder options
5	Activate the complementary output of channel B	Tachsyn or Brushless Tacho or encoder options
6	Activate the complementary output of channel A	Tachsyn or Brushless Tacho or encoder options

Appendix A - Response adjustment - current loop

In most applications it is not necessary to adjust the current loop to achieve the optimum response. When there are extreme electrical parameters in the armature circuit (inductance and resistance) the standard components values of 0.01µF for C1 and 100Kohm for R6 may not yield with the optimum response. The current loop should be optimized as follows:

- Turn the amplifier to a current amplifier by removing R5 and C2
- Provide the amplifier with a bi-directional square wave current command (100-200Hz, $\pm$2.0V waveform is often employed).
- Apply power to the amplifier, and monitor the load current by a current probe or by the current monitor. If the current response is not critically damped, use the following procedure:
- Short circuit C1 with a short jumper wire.
- Replace R6 with a decade resistance box. Initially set the box resistance at 10Kohm.
- Apply the square wave test signal to the amplifier input.
- Apply power, and while monitoring the load current, gradually increase the value of the box resistance until optimum response as depicted in Fig A-1 is achieved.
- Substitute the closest standard value discrete resistor for R6 and remove the decade resistance box.
- Remove the shorting jumper across C1, and again check the response using the square wave test signal.
- If the previous step does not yield satisfactory results, if unacceptable overshooting has been noted, substitute a larger value than 0.01 µF; or, if the response is overdamped, substitute a smaller value than 0.01 µF. Repetition of this procedure should yield an optimum choice for C1.

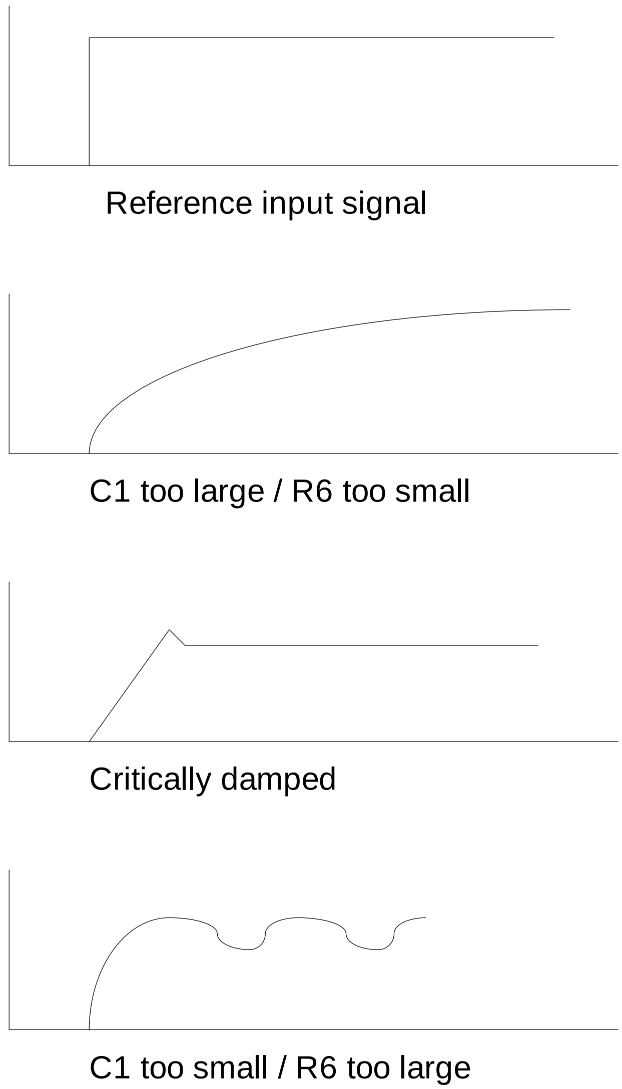
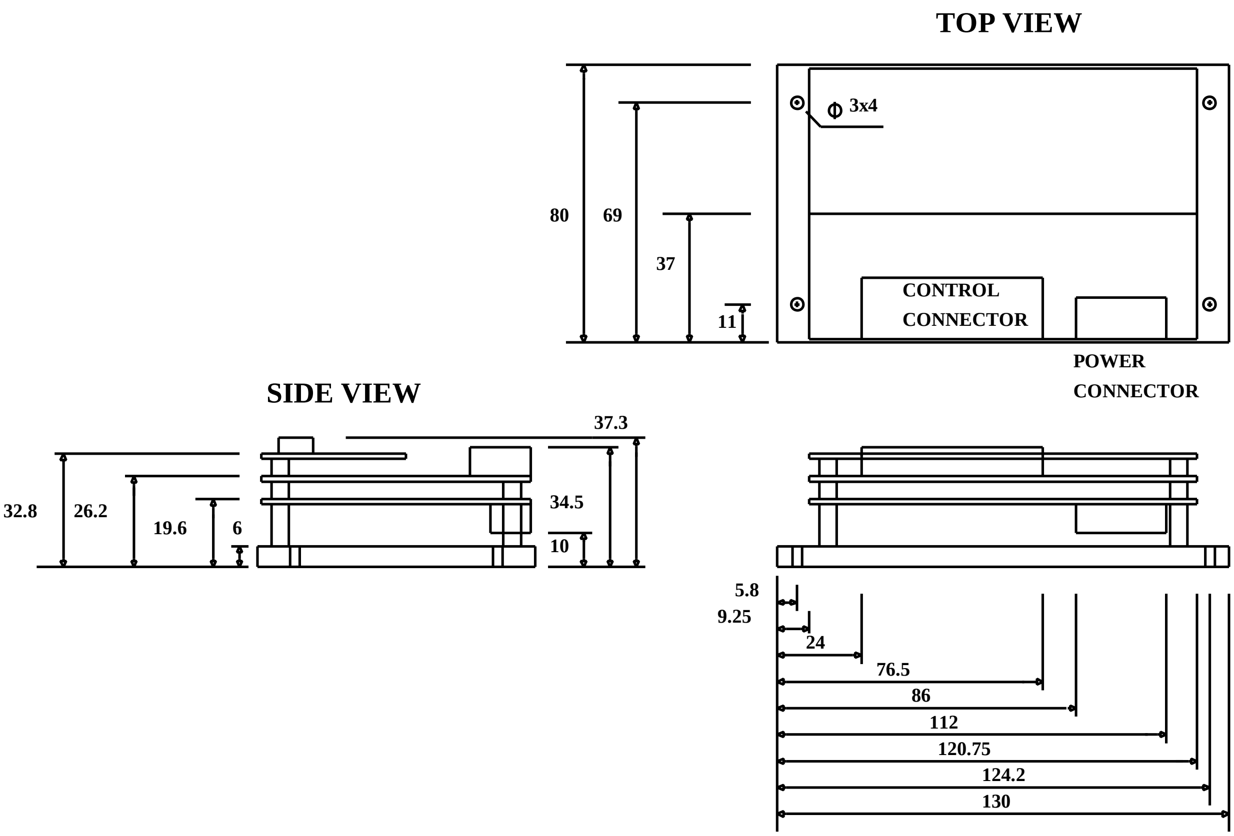


Fig. A-1

Typical current response waveforms

DIMENSIONAL DRAWINGS

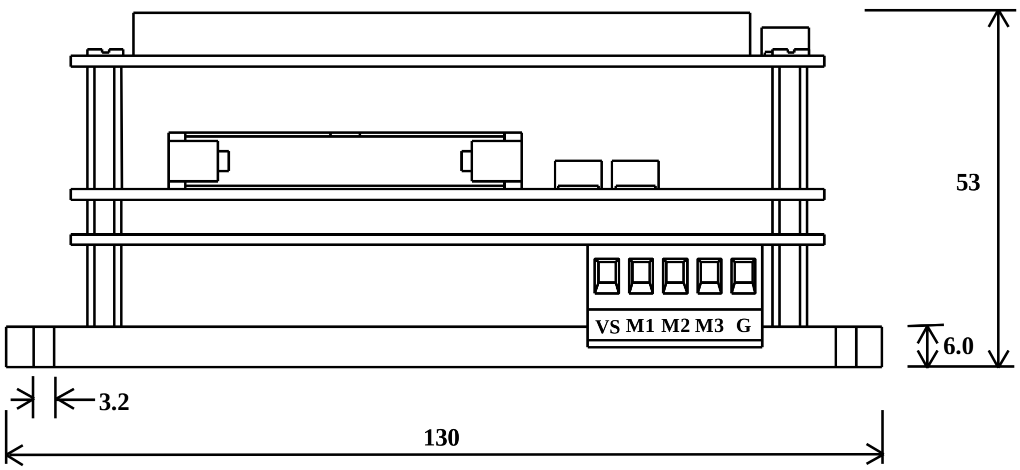


FRONT VIEW

NOTE:

ALL DIMENSIONS ARE IN mm.

SBA WITH OPTION BOARD



SBA WITH SIB-SBA CARD

List of ELMO Service Centers

ISRAEL

Elmo Motion Control LTD

64 Gisin ST.

Petah-Tikva 49103

Tel: (03)922-0864

Fax: (03)922-6949

EUROPE

Elmo Motion Control

7 Stanserstrasse

CH-6362 Stansstad

Switzerland

Tel: (041)6100775

Fax: (041)6100778

U.S.A

Elmo Motion Control INC.

1200 Woodruff Road, Suite C-22,

Greenville, SC 29607-5731

Tel: (864) 288-9316

Fax: (864) 288-9318

WARRANTY PERFORMANCE

The warranty performance covers only ELMO's products and only the elimination of problems that are due to manufacturing defects resulting in impaired function, deficient workmanship or defective material. Specifically excluded from warranty is the elimination of problems which are caused by abuse, damage, neglect, overloading, wrong operation, unauthorized manipulations etc.

The following maximum warranty period applies:

12 months from the time of operational startup but not later than 18 months from shipment by the manufacturing plant.

Units repaired under warranty have to be treated as an entity. A breakdown of the repair procedure (for instance of the repair of a unit into repair of cards) is not permissible.

Damage claims, including consequential damages, which exceed the warranty obligation will be rejected in all cases.

If any term or condition in this warranty performance shall be at variance or inconsistent with any provision or condition (whether special or general) contained or referred to in the Terms and Conditions of Sales set out at the back of Elmo's Standard Acknowledge Form, than the later shall prevail and be effective.