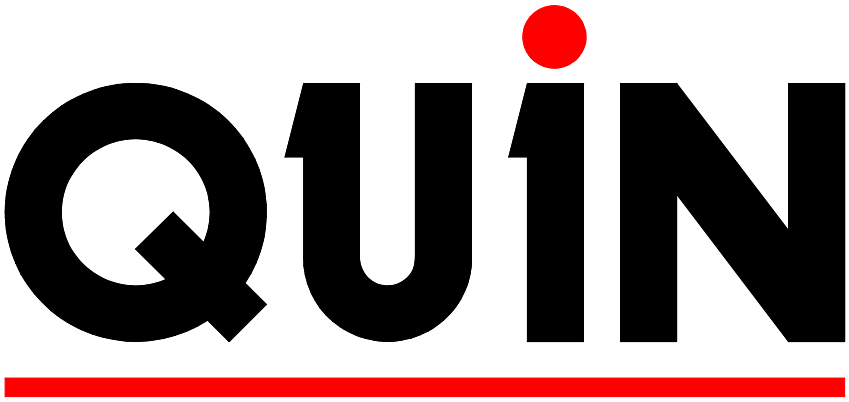

Quin Systems Limited
1500 Series Servo Amplifier
Installation & Users Manual

Issue 1.1
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(MAN518)

1 Description & Technical Data

1.1 Introduction

The Quin Systems Ltd. 1500 series servo-amplifiers are intended to control 3 phase AC servo-motors with electronic commutation and resolver feedback, up to a maximum rating of 18 Amps, 6.8kW continuous.

Such servo-motors are generally called AC Brushless, but to avoid any confusion, motors which can be used with the 1500 series servo-amplifiers should have the following characteristics:

- Rotor constructed with permanent magnets arranged in 1, 2, 3, 4, 5 or 6 pole pairs, without commutator or slip rings.
- Stator constructed with 3 windings connected in star or delta.
- Electronic commutation is only effected by means of a resolver (motors with Hall effect sensors or tachogenerators are not suitable).

Note :

Servo-amplifiers which deliver a 3 phase sinusoidal supply are usually called AC Brushless. The name DC Brushless is reserved for servo-amplifiers whose output supply is trapezoidal.

1.2 Description

The main characteristics of the 1500 series servo-amplifiers are as follows :

- Digital servo-amplifier with +/- 10V analogue speed command, for Brushless motors with resolver.
- Compact unit with built in braking module.
- Monobloc version. Double Eurocard format using SMD Technology.
- Completely programmable by RS 232 serial link.
- Sinusoidal current output assures smooth torque and optimum performance at low speed.
- Power and command circuits are opto-isolated from each other.
- Ruggedly protected for use in severe conditions.
- Simulated incremental encoder output with adjustable resolution to 1024 ppr and adjustable marker pulse. Differential line driver outputs.
- Input for proximity sensor.
- 7 segment status indicator for diagnostic display.
- Short-circuit protected output stage.
- I^2t protection.
- Detection of resolver fault, and motor overheating.
- Velocity or current regulation.
- All auxiliary voltages required are produced within the equipment.
- End limit switches.
- Opto-coupled or 24V DC Enable input
- Motor connection supervision

1.3 Technical Data

1.3.1 General data for all drive types

- Supply frequency 45 to 65 Hz
- Supply voltage 3 x 220V AC +/- 15%
- Operating temperature range 0 to 60° C
- Operating temperature range at full power 0 to 45° C
  (from 45°C, reduce output current by 2%/°C to 60°C)
- Storage temperature range - 20 °C to + 70 °C
- PWM chopper frequency 9.99 kHz
- Differential input reference +/- 10V
- Speed control range 1/5000
- Bandwidth
  - speed loop 300 Hz
  - Current loop 2 kHz
- Rated power dissipation during braking
  with standard resistance 125 W
- Maximum output to motor 3 x 210 V, 0 to 500 Hz

General data for all drive types, cont.

- Incremental encoder : Output 5V
  - "low speed" settings available 128, 256, 512, 1024 ppr
  - "high speed" settings available 128, 256, 512 ppr
- Theoretical maximum speed for motor with resolver :
  - "low speed" 3500 rpm
  - "high speed" 6000 rpm
- Switching threshold of brake module 385 V DC
- Trip threshold of over voltage 415 V DC
- Trip threshold of voltage drop 180 V DC
- RS 232 serial link
  - **baud rate** Standard : 9600 Bd
  - Configurable by solder bridge : 19200 Bd
  - **transmission** Full duplex
  - **format** 1 Start bit
    8 Data bit
    no parity
    1 Stop bit

    CTS signal controls transmission flow

1.3.2 Electrical data

Servo-amplifier type :		**1506**	**1510**	**1518**
Rated rms current	(A)	5.9	10	18.7
Rated peak current	*(A)*	*8.3*	*14.2*	*26.4*
Max. rms current	(A)	11.8	20.1	37.3
Max. peak current	*(A)*	*16.7*	*28.4*	*52.8*
Rated power	(kW)	2.1	3.6	6.8
Max. power	*(kW)*	*4.3*	*7.3*	*13.6*

Note :

$I_{rms} = I_{peak} / 1.41$

$P = 1.73 \times I_{rms} \times V_{rms}$ or $P = 3 \times I_{rms\ phase} \times V_{rms\ phase}$

- in star $V_{rms\ phase} = 210V / 1.73$

  $I_{rms\ phase} = I_{rms}$

- in delta $V_{rms\ phase} = 210V$

  $I_{rms\ phase} = I_{rms} / 1.73$

Ex: Type 1506 $I_{rms\ max} = 11.8$ A $I_{rms\ rated} = 5.9$ A

$P_{max} = 1.73 \times 11.8 \times 210 = 4.3$ kW

$P_{rated} = 1.73 \times 5.9 \times 210 = 2.1$ kW

1.3.3 Analogue readings on the motherboard

The 1503 motherboard shown in appendix A.3 gives the location of several measurement points which permit an analogue reading of the three following parameters:

Measurement point	Description	Scaling
Current	Instantaneous Current	10V corresponds to the max. current of the unit
Command	Internal command voltage	$V_{command} = V_{ext.\ cmd}$
Speed	Motor speed	+/- 10V corresponds to the max. speed of 6000 rpm

1.4 Configuration and Fuses

The location of the configuration links and fuses is given in appendix A.2 and A.3
Usually the drive will have been set up correctly by Quin Systems in accordance with the customer's requirement and therefore no further adjustment should be required.

1.4.1 Servo-amplifier configuration

NAME	LINK	FUNCTION
SAD	Solder bridge	**1-2** : analogue command voltage (in standard) **2-3** : numeric command voltage through RS 232 serial link or through synchronous link (option)
VITCRT	Solder bridge	**1-2** : speed regulation (in standard) **2-3** : current regulation
BD1 **BD2**	Solder bridge	RS 232 serial link baud rate : only BD2 soldered : 9600 Bd (in standard) only BD1 soldered : 19200 Bd
BD3 **BD4** **BDOUT**	Solder bridge	Synchronous link (option) : only BD3 and BDOUT soldered : internal clock at 38400 Hz only BD4 soldered : external clock
INCABS	Solder bridge	**2-3** : incremental position given at the encoder outputs (in standard) **1-2** : absolute position required by the serial link (option)

1.4.2 1503 Motherboard configuration (appendix A.3.)

NAME	ELEMENT	FUNCTION
REF	Jumper or solder bridge	**set "-" side** : "S-" differential input connected to 0V (terminal CO3-12) **set "+" side**: "S+" differential input connected to 0V (terminal CO3-11)
VALID and **COM**	Jumper	**2 jumpers set** : "Drive Enable" is non opto-coupled with contact closure between CO5-14 and CO5-17
VALID and **COM**	Jumper	**2 jumpers not set** : "Drive Enable" is opto-coupled with 24V ground connected to CO5-14 and +24V to CO5-17 via contact closure.
SW1 and **SW2**	Jumper	**2 jumpers set** : end switches non opto-coupled **2 jumpers not set** : end switches opto-coupled with : ground 24V on CO5-14 +24V on CO5-15 and CO5-16

1.4.3 Servo-amplifier fuses

The following fuses are factory fitted to 1500 series drives :

Servo-amplifier type	1506	1510	1518
DC-BUS	10 AT	15 AT	20 AT
Braking module	4 AF	5 AF	8 AF
Supply	1 AT	1 AT	1 AT

DC-BUS FUSE (F1)

The fuses used on the DC-BUS are "Littelfuse 326". Dimensions : 6.3 x 32 mm.

Braking module fuse (FFR)

For 1506 drive units the "Wickmann 19194" type fuses are used.
Dimensions : 5 x 20 mm.

For other drive units in the 1500 series, the "Littelfuse 314" type fuses are used.
Dimensions : 6.3 x 32 mm.

Supply fuse (FHT)

All drive units in the 1500 series use a 5 x 20 mm fuse.

Warning :

The replacement of a blown fuse should be carried out by a suitably qualified engineer and only after the fault has been identified and rectified

1.5 Options List

ABSOLUTE POSITION	The resolver and associated circuits are permanently supplied with a +/- 12 V external supply to maintain positional information when the mains supply to the drive is disconnected. This option includes the +/- 12V battery terminals on motherboard.
DIGITAL COMMAND	The command is transmitted by RS 232 serial link to an accuracy of 12 bits.
GROUND DEFECT	Works only with an auto-transformer.
220V AUXILIARY SUPPLY	Single phase 220V auxiliary supply (the power amplifier side of the drive is not supplied but the supply to the processor and DSP chip is maintained. Hence communication with the drive is still possible.) This option includes a 1401B motherboard.
MULTI-MODULES	4 RDC modules. Each module defines a max. speed motor for a command of +/- 10V. Ex : 6000 rpm, 3000 rpm, 1500 rpm, 700 rpm
HOUSING	Aluminium

2 Drive Parameters

2.1 Serial Link

The serial link is used to set or monitor drive parameters stored in non-volatile memory using the configuration program.

This program allows the user to :

set all user adjustable parameters,
monitor inputs and fault status

With the serial link connected, it is possible to monitor the position of the resolver (0-4095) within one motor revolution.

Hardware :

A Personal Computer (PC) can be connected to the drive via an RS232 serial cable, using d-type sockets, wired as follows:

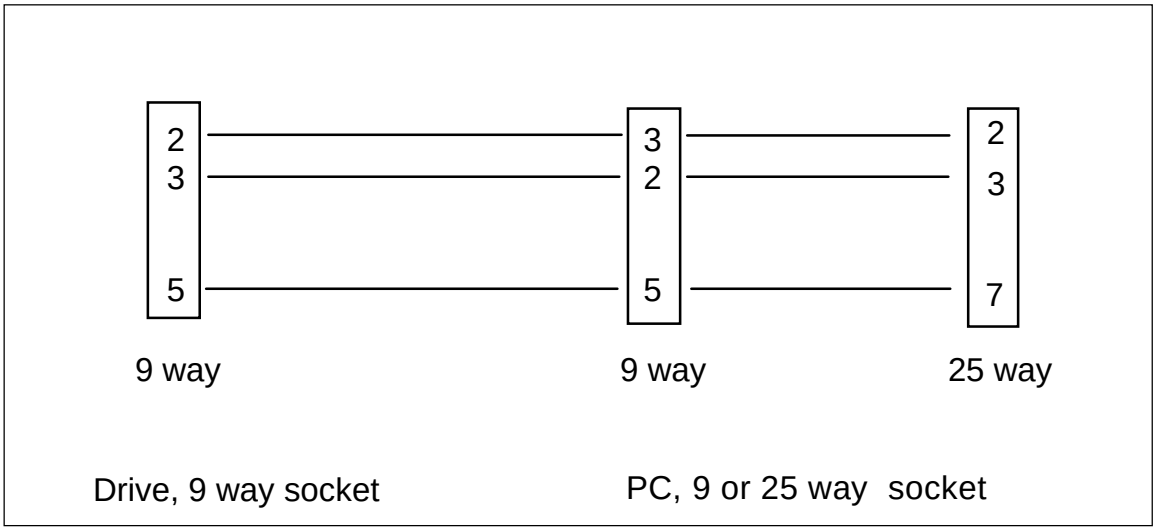

*Fig. 2.*1 Serial cable

2.2 Getting around the Configuration program

- A program called 1500.EXE is supplied on a 3.5" disk with this manual. The program once installed on a PC is used to set the drive parameters and to monitor the servo-amplifier status.
- This program presents the servo parameters using four pages or screens. The first three pages involve the set-up of the servo-amplifier and the absolute position of the resolver. The last page is used to monitor the inputs and alarm states. Only the parameters on the first three pages can be modified through the computer program and only if the password (MOTOR) has been entered.

- CHANGE PAGES :

  The page displayed on the PC is changed by pressing the **<TAB >** key.

- SELECT PARAMETERS :

  The up/down arrow keys **< ↑ >** and **< ↓ >** are used to select the desired parameter on each page. The selected parameter appears in reverse video.

- CHANGE VALUES :

  The plus key **< + >** and the minus key **< - >** change the value of the selected parameter displayed in reverse video.
  Note: Page 4 of the program is not affected by these keys.

- SAVE SETTINGS :

  The **< F2 >** key saves all settings on the first three pages to non-volatile (EEPROM) memory.

- EXIT PROGRAM :

  Press **< ESC >** to exit the program.

2.3 Parameters Description

2.3.1 Page 1 parameters

The page 1 parameters are displayed as follows :

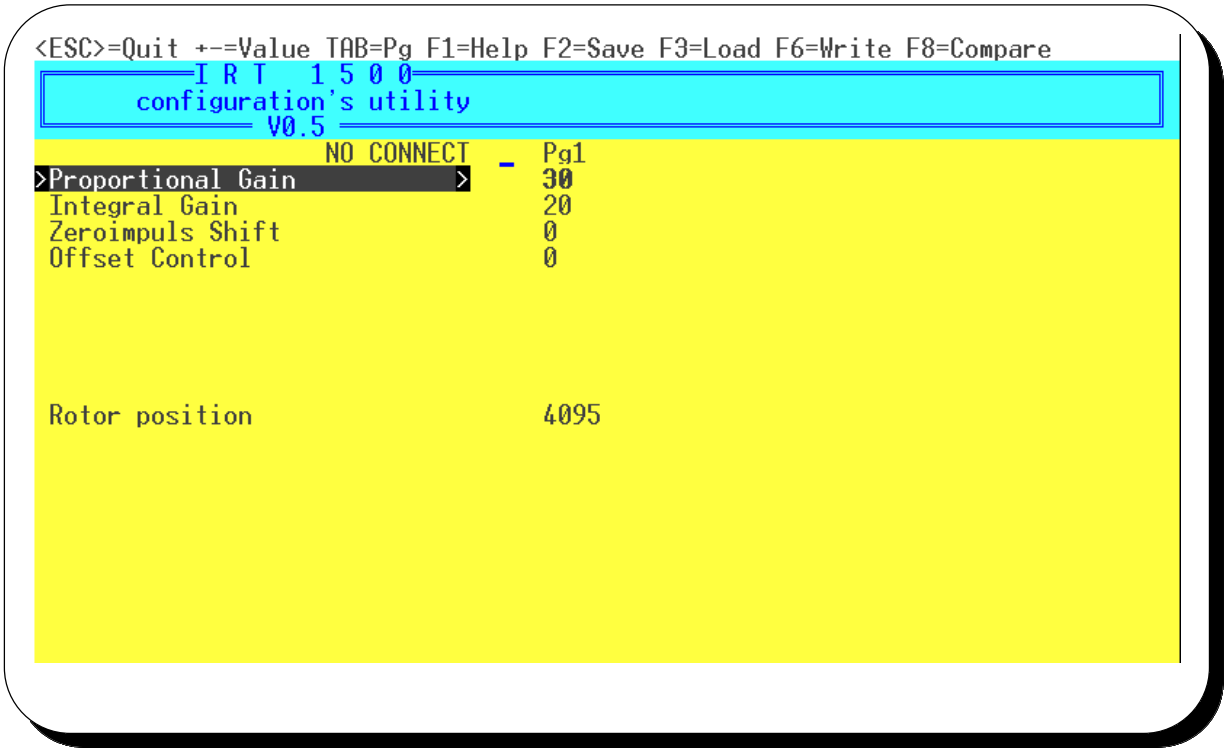

Fig. 2.2 Page 1 Parameters

- **Proportional Gain and Integral Gain :**

  These two parameters determine the proportional and integral gain of the servo velocity control loop.

  They are programmable from 0 to 127. Higher values represent higher gains.

  The integral gain is disabled if a value lower or equal to 3 is set.

- **Zero pulse shift :**

This parameter is used to shift the simulated Z pulse by +/- 180° relative to the null position of the resolver.
It is programmable over a range of

-512 (-180°) to +512 (+180°).

- **Offset control :**

The setting of the servo-amplifier speed offset is done with this parameter.
The **offset control** parameter is adjustable between -127 and +127.

Press the **< F2 >** key to save the **offset control** parameter.

2.3.2 Page 2 parameters

The page 2 parameters are displayed as follows :

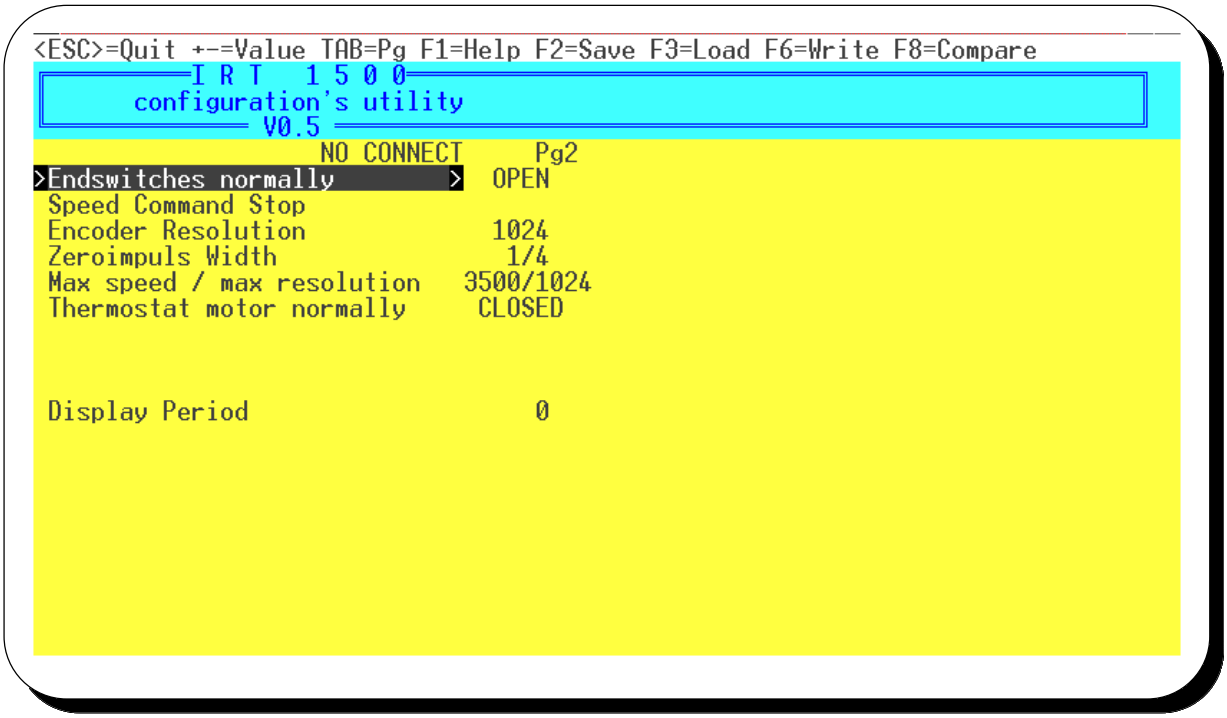

*Fig. 2.*3 Page 2 Parameters

- **End switches normally OPEN or CLOSED :**

  This parameter allows any end switches connected to the end switch inputs to be selected as normally OPEN or normally CLOSED. If no end switches are fitted then this parameter should be set to OPEN.

  For example:
  If selected as normally closed, motion will stop when one of the end switch inputs is opened.

- **Speed command stop :**

  This parameter allows a direction of motor rotation to be prohibited. The following possibilities are programmable :

Parameter	Speed Command Prohibited
<blank>	none
+	positive
-	negative
+/-	no movement permitted

Encoder resolution:

This parameter selects the number of pulses per revolution of the motor resolver.

The following values are available : 128, 256, 512 and 1024 ppr

Zero pulse width :

This parameter selects the width of the simulated encoder marker pulse (Z pulse) relative to the width of the A channel pulse.

The following values are available : 1/4, 1/2 and 1

Max. speed / max. resolution :

This parameter selects one of two maximum motor speeds in order to enable the servo-amplifier for the appropriate encoder resolution range.

The limits are :

(1) Max. speed = 3500 rpm
Max. resolution = 1024 ppr

(2) Max. speed = 6000 rpm
Max. resolution = 512 ppr

The simulated encoder signals will not function if the following parameters are set :

Encoder Resolution : 1024
Max. speed/max. resolution : 6000/512

Thermostat motor normally :

The servo-amplifier is set-up for the motor thermal overload switch type by selecting:

CLOSED : for motor thermal switch normally CLOSED (or for PTC)
OPEN : for motor thermal switch normally OPEN (or for NTC)

2.3.3 Page 3 parameters

The page 3 parameters are displayed as follows :

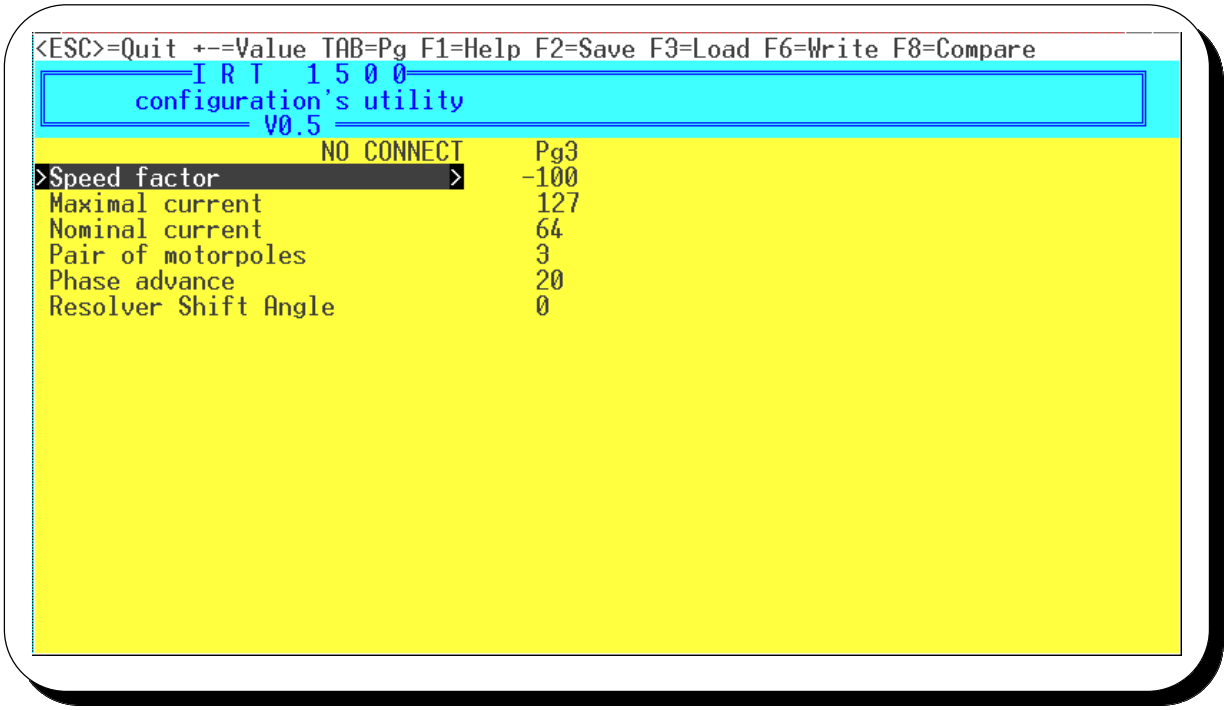

Fig. 2.4 Page 3 parameters

Speed factor :

This parameter sets the max. speed and the direction of rotation of the motor.

This parameter is programmable from -127 to +127 corresponding to a speed of -6000 rpm to +6000 rpm +/- 10%.

Maximum current :

This parameter sets the peak current delivered to the motor.

This parameter is programmable from 0 to +127 (where +127 is equivalent to the maximum rms current of the amplifier as shown in section 1.3.2).

Nominal current :

This parameter sets the continuous current delivered to the motor.

This parameter is programmable from +10 to +64
(where +64 is equivalent to the rated RMS current of the amplifier, as shown in section 1.3.2).

Pair of motor-poles :

This parameter sets the number of motor-pole pairs for proper commutation.

This parameter is programmable from 1 to 6 (number of motor-pole pairs).

Phase advance :

This parameter is used to optimise the phase advance angle for each type of motor.

At max. speed (speed factor parameter = +127), this parameter can vary the phase advance angle from 0 to +180 electrical degrees.

This parameter is programmable from 0 to +180° (typical value : +20).

Resolver shift angle :

This parameter is used to set the resolver shift angle in software. This removes the need for motor manufacturer to adjust the resolver/rotor phase angle.

This parameter is programmable from -180 to +180 (electrical degrees).

2.4 Description of Inputs and Alarms states

The inputs and alarms states on the fourth page are displayed as follows :

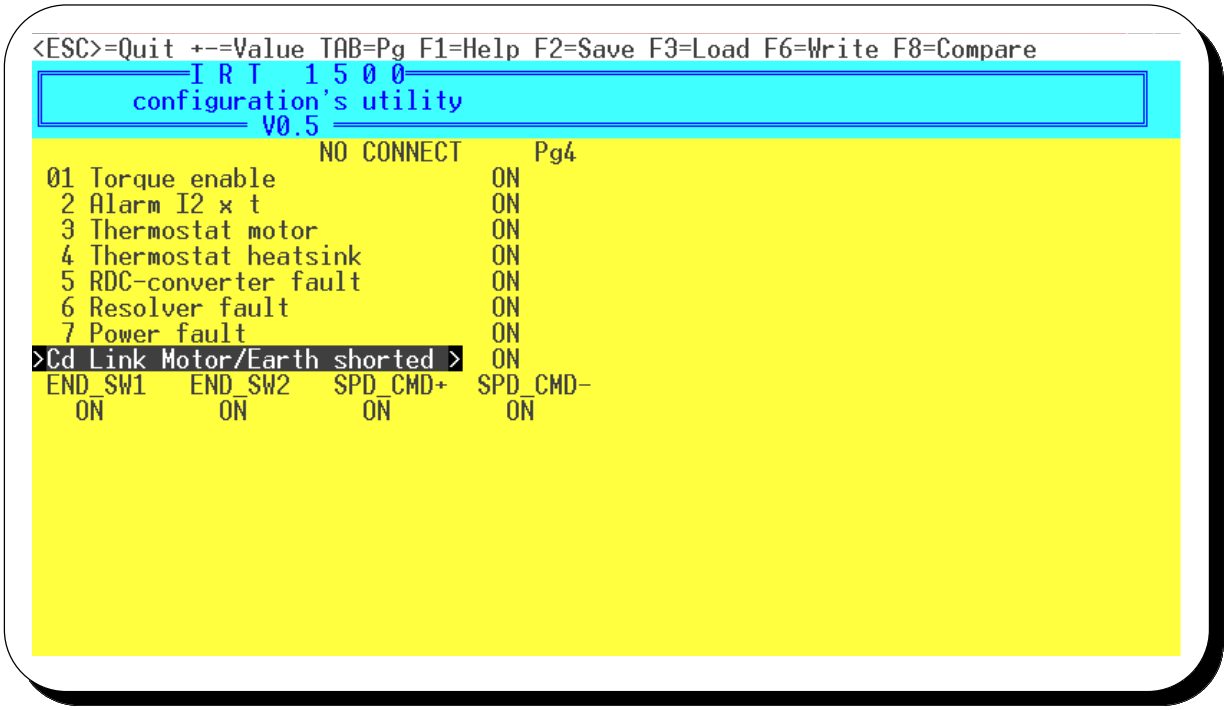

*Fig. 2.*5 Page 4, inputs & alarms

2.4.1 Alarms states

Torque enable	ON OFF	→ →	servo-amplifier enabled servo-amplifier disabled
Alarm I^2 t	ON OFF	→ →	limit of continuous current reached continuous current within limits
Thermostat motor	ON OFF	→ →	motor overheating motor within temperature limits
Thermostat heatsink	ON OFF	→ →	amplifier heatsink over temperature amplifier heatsink within temperature limits
RDC-converter fault	ON OFF	→ →	resolver/digital converter fault resolver/digital converter OK
Resolver fault	ON OFF	→ →	resolver fault (check resolver wiring) resolver OK
Power fault	ON OFF	→ →	drive power section alarm power OK
Link motor/Earth shorted	ON OFF	→ →	motor wiring failure or detection of ground defect (option) motor wiring OK and without ground defect

2.4.2 Inputs states

END_SW1	OFF ON	→ →	negative speed command free negative speed command cancelled
END_SW2	OFF ON	→ →	positive speed command free positive speed command cancelled

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3 Installation

In order to achieve the best possible performance from the servo amplifier and motor combination we recommend that setting up should be done according to the following instructions.

3.1 Positioning

The 1500 series servo-amplifier is available in a compact boxed unit provided with a support plate which allows the drive to be mounted on a panel inside a control cabinet. The brake resistance is an integral part of the drive but the cooling fan when required has to be separately mounted. A free space of 100mm above and below the servo-amplifier is required in order to guarantee good cooling.

The dimensions of the unit are given in appendix **A.3**.

3.2 Wiring and connectors

The wiring of the 1500 series servo-amplifiers must be carried out according to these instructions. Local wiring regulations must be observed particularly with regard to earthing.
The earth wire to the amplifier, motor and housing must be as short as possible and connected to a common earth point.
A typical wiring plan is shown in **fig. 3.1** on the next page. Please note that the resolver wiring will vary depending upon the type of resolver used

3.2.1 Cable lengths and sizes

The use of the following cable sizes is recommended.

		1506	**1510**	**1518**
Supply voltage	mm^2	1,50	2,50	4,00
Motor	mm^2	1,50	2,50	4,00
Earth	mm^2	1,50	2,50	4,00
Command signals	mm^2	0,18	0,18	0,18

The length of cable between servo-amplifier and motor generally should not exceed 15m, although in some applications longer lengths may be permissible.

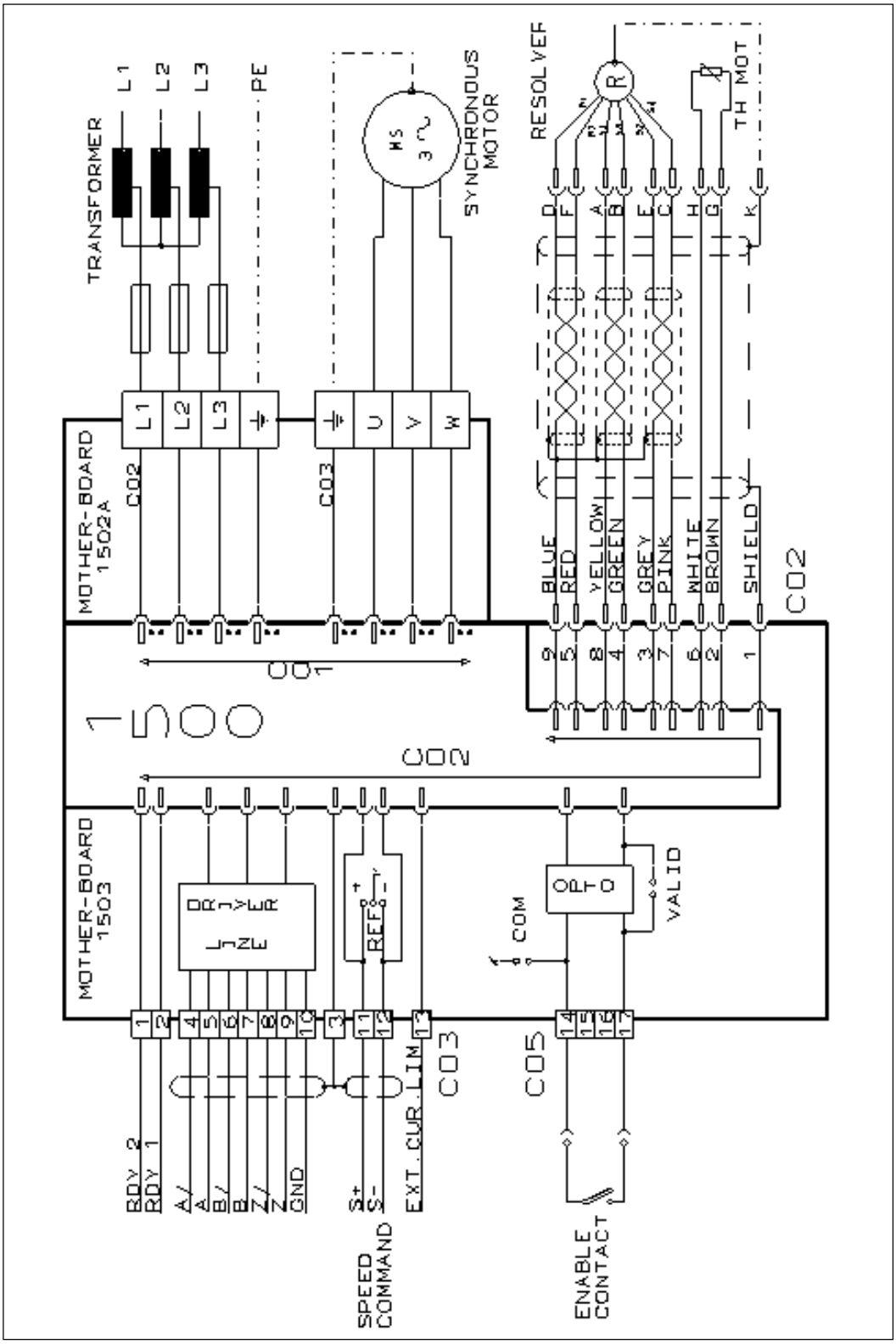


*Fig. 3.*1 Typical wiring plan of 1500 series servo-amplifier.

Two types of motherboards are used for the power connection :

- The **1502A** motherboard for the 1506 and 1510 type servo-amplifiers.

- The **1401B** motherboard for the 1518 type servo-amplifier.

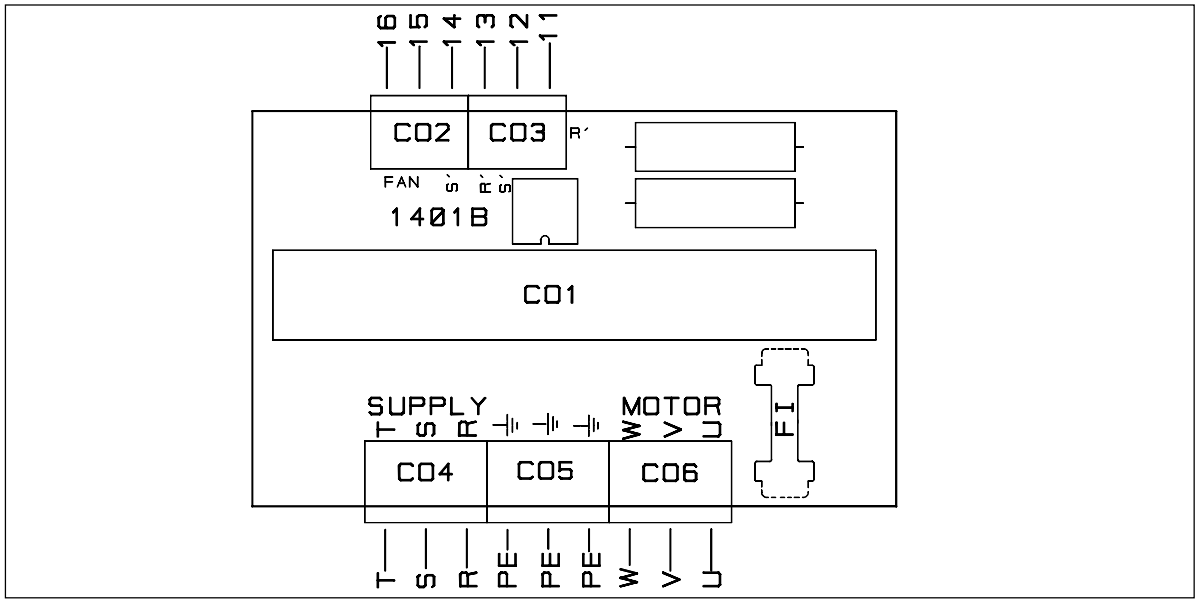


Fig. 3.2 1401B motherboard

Connector Description

CO2 & CO3: These two connector form a 6 way block used for the optional fan and backup supply connections.

CO4: The single or three phase supply is connected to this terminal block. Single phase should be connected to terminals 'S' and 'R'.

CO5: CO5 has three earth connections which should be used to connect the 'Supply Earth' and 'Motor Earth' leaving one spare.

CO6: Power to the motor is taken from this connector block.

Wiring with 1502A motherboard

The wiring of the supply voltage, motor and earth is done through the WAGO connectors with clamp-type terminals. These can accept conductors up to 2.5 mm^2.

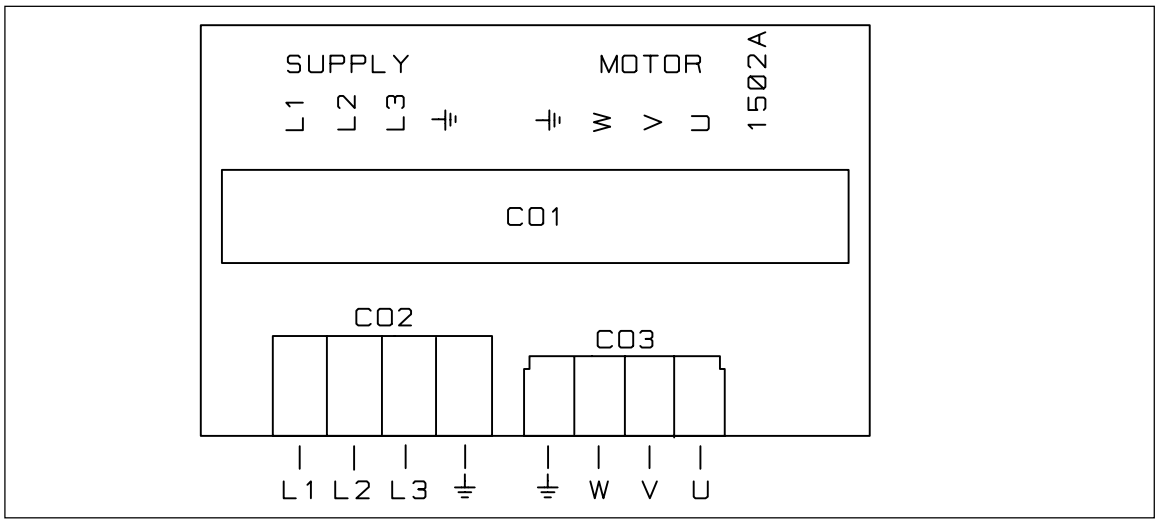


*Fig. 3.*3 1502A motherboard

CO2: Four way WAGO connector used for the single or three phase power supply connections, L1, L2, L3, PE. PE should be connected to the incoming power supply earth

CO3: Four way WAGO connector, used to connect the motor to the power amplifier, U, V, W, PE. PE should be connected to the motor chassis

Wiring with 1401B motherboard

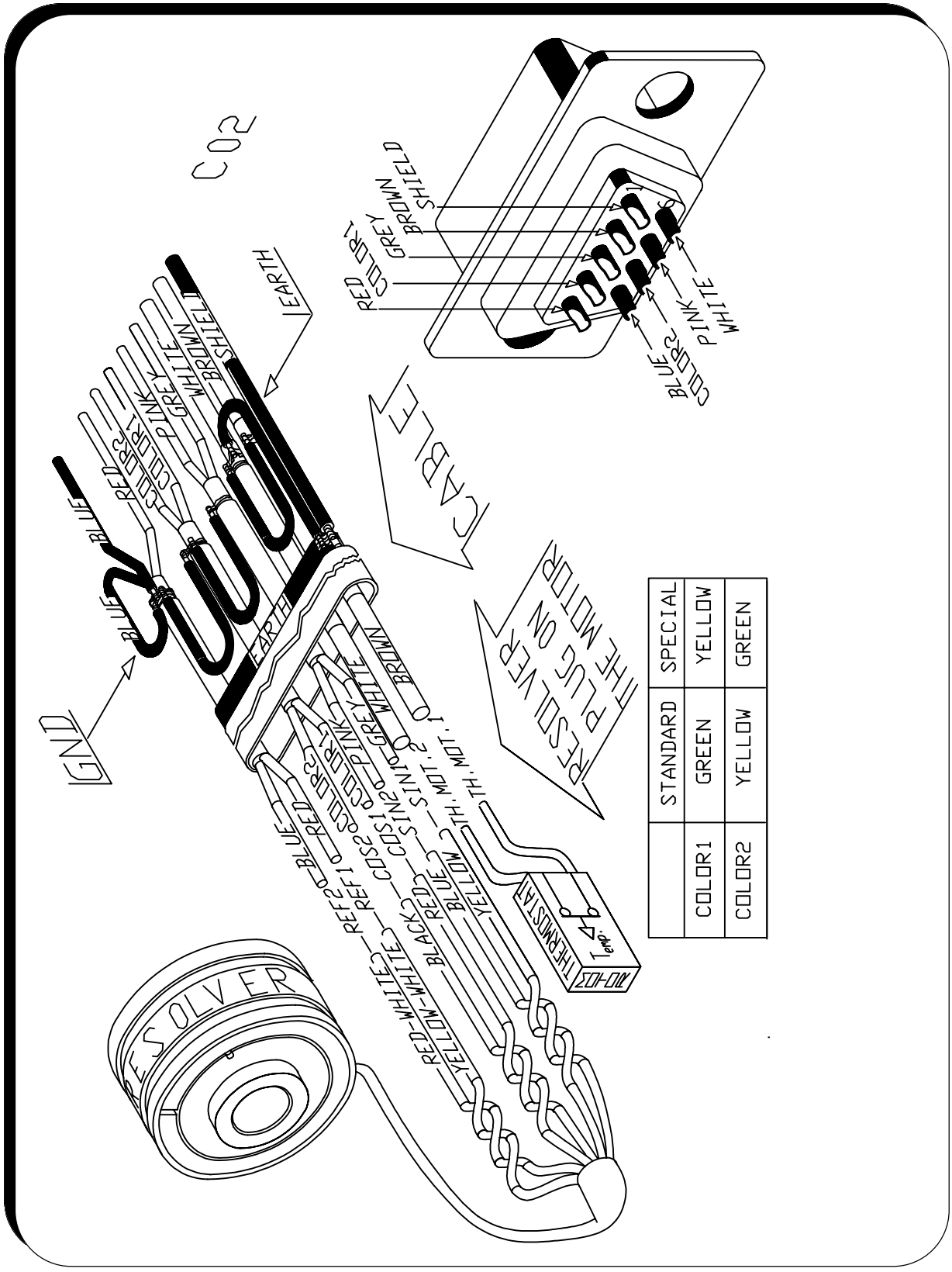
The wiring of the supply voltage, motor and earth is done through the junction blocks CO4, CO5 and CO6 which can accept conductors up to 4mm^2. The cooling fan and 220V auxiliary supply are wired using the junction blocks CO2 and CO3 which can accept conductors up to 2.5mm^2.

Fig. 3.3 *P*ower connection of cooling fan and 220V auxiliary supply voltage

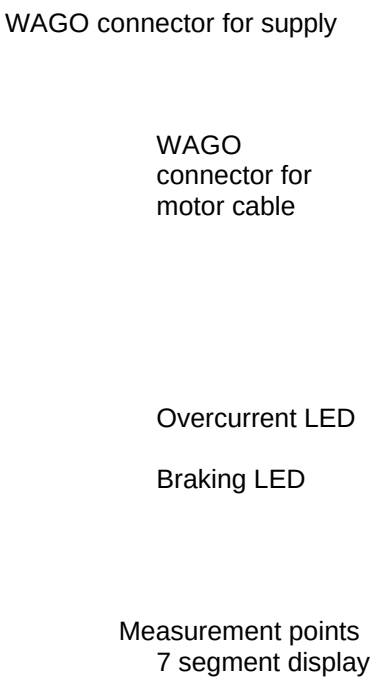
Important
Please note that the phase of the auxilliary supply must match the phase of the main three phase supply. For example if the blue phase is connected to R then it must only be the blue phase that is connected to R'. This is also true for S and S', i.e. if the yellow phase is connected to S then the only yellow phase should be connected to S'. If this not done then the fuse F1 will blow and the drive will stop working. This fuse must be in place regardless of whether or not the auxilliary supply facility is used

Pin-out of Junction blocks (Motherboard 1401B)

Connector	Terminal	Function
CO6	U V W	Motor wiring
CO5	PE PE PE	Earth wiring
CO4	R S T	Supply voltage wiring
CO3 (option)	11 12 13	Auxiliary supply voltage connection R' Auxiliary supply voltage connection S' Auxiliary supply voltage connection R'
CO2	14 15 16	Auxiliary supply voltage connection S' Cooling fan wiring Cooling fan wiring



	STANDARD	SPECIAL
COLOR1	GREEN	YELLOW
COLOR2	YELLOW	GREEN


WAGO connector for supply
WAGO connector for motor cable
Overcurrent LED
Braking LED
Measurement points
7 segment display
WAGO connector of enable contact (CO5)
SUB-D male connector for RS232 serial link port (CO500)
SUB-D female connector for resolver feedback (CO2)

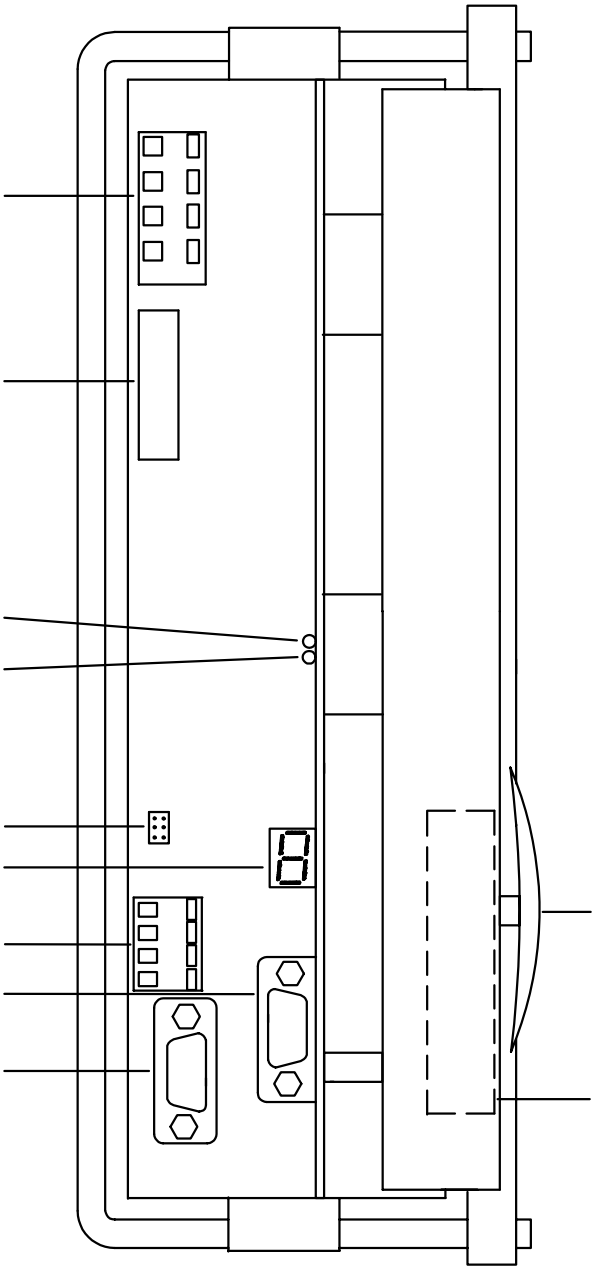


*Fig. 3.*4 Connectors, display and measurement points

The following cable connectors are delivered with each unit in the 1500 series:

Resolver feedback connector (CO2)9 poles SUB-D

3.2.2 Wiring of the resolver and motor thermal switch

Correct wiring of the resolver is the vital for reliable operation of the 1500 series servo-amplifiers. Failure to comply with the wiring details contained in this manual will result in a deterioration of the drive's performance.

A cable with the following characteristics is needed :

- 3 pairs of conductors 0,14 mm^2 twisted in pairs and shielded separately
- 2 conductors of 0,5 mm^2 shielded separately
- an overall shield not connected to the previous shields

(It is recommended to use HEIDENHAIN cable reference 200 775 02)

The cable wiring should be as shown **fig. 3.5**

The 3 internal shields should be connected only on the servo-amplifier side. The external shield should be connected at both ends of the cable (amplifier end and motor end) but **must be connected at the amplifier end**. It is recommended that the convention (signal / conductor colour) used in this manual is followed.

Contacts 2 and 6 are intended for the motor thermal switch wiring. The contact can be either normally closed, or normally open, and should have the following characteristics:

contact closed	:	*1 k ohm* Maximum
contact open	:	*10 k ohm* Minimum

*Fig. 3.*5 Resolver and motor thermal switch wiring

3.2.3 Control signals wiring

The signals necessary for the control of the 1500 series servo-amplifier are available on the CO3 connector of the 1503 motherboard (see appendix A.3 and fig. 3 of chapter 3.1.2.3).

The signals **A, /A, B, /B, Z, /Z** and **GND** are similar to the signals of an incremental encoder with differential outputs. The line driver used is type 75172. The line receiver of the position controller should be type **75175** or equivalent.

These signals are always present and do not require any external supply.

The **GND** signal should be commoned to the position controller and to the servo-amplifier. The cable connecting the position controller to the servo-amplifier should be shielded with twisted pairs.

The shield can be connected to the **EARTH** pin of the servo-amplifier.

The **READY** relay of the 1500 series servo-amplifier is a change-over contact type. The breaking power of this contact is as follows : **100 V - 0.5 A - 10 V A**

The relay state is as follows:

State of the servo-amplifier	State of the contact **RDY1 - RDY2**
Not energised	open
Energised, operating normally	closed
Energised, malfunction	open

Pin-out of CO3 connector (Wago 13 poles)

Pin No.	Designation	Function
1	RDY2	contact of READY relay
2	RDY1	contact of READY relay
3	EARTH	speed command shield
4	A /	Channel A complementary output
5	A	Channel A output
6	B /	Channel B complementary output
7	B	Channel B output
8	Z /	zero pulse complementary output, one pulse per motor turn
9	Z	zero pulse output, one pulse per motor turn
10	GND	potential of digital reference (0V)
11	S+	analogue speed command, (non inverting) -10V to +10V
12	S-	analogue speed command, (inverting) -10V to +10V
13	EXT.CUR.LIMIT	external current limit, +10V corresponds to the peak current of the servo-amplifier

3.2.4 Enable wiring

The servo-amplifier enable is obtained from the connector CO5 of the 1503 motherboard (see appendix A.3 and fig. 3 of chapter 3.1.2.3).

Pin-out of CO5 connector (Wago 4 poles)

Pin No.	Designation	Function
14	VALID REF	Drive Enable - Connect to pin 17 via external volt free contact to enable drive.
15	END SWITCH 1	Endswitch 1
16	END SWITCH 2	Endswitch 2
17	VALID	Servo-amplifier enable through enable contact closure

3.3 Resolver ratio

The ratio and the amplitude to the reference winding of the resolver is determined by the resistors RSIN, RCOS and RREF.

Standard equipment :

RSIN = RCOS = 0 (bridge) for resolver ratio 2:1
RREF = 12 k ohm to obtain 4 V_{eff} to the resolver reference

Special cases :

Use the following formula :

$$RREF = \frac{88}{Vref} - 10 \quad \text{(k ohm)}$$

where : -Vref is rms voltage applied to the resolver reference winding.

Vref max. = 6 V !

$$RSIN = RCOS = \frac{4400 \times Kr}{10 + RREF} - 100 \quad \text{(k ohm)}$$

where : - RREF is given in k ohm
- Kr is the resolver ratio
(Resolver ratio 2 : 1 corresponds to Kr = 0.5)

3.4 Transformer choice

The 1500 series servo-amplifiers should be supplied from a 220V three phase supply via either:

- a direct 220V three-phase supply,
- an isolating transformer or
- an auto-transformer

A surge limiting device in series with the supply lines has the function to limit the peak switching current and protect the bridge rectifier.

If the equipment is to be operated directly from the 220 V supply, it is necessary to fit a 4 mH three-phase choke between the isolator and the servo-amplifier.

The size of the mains transformer is approximately calculated from the incoming power per axis as follows:

Mechanical power :

$$P_{mech.}\ (kW) = \frac{\text{motor torque (Nm)} \times \text{motor speed (rpm)}}{9550}$$

The power of the transformer in kVA is approximately equal to the mechanical power.

4 Commissioning

4.1 Switching the Servo-amplifier on without a Motor

The first time the amplifier is switched on should be done with the enable contact open (CO5 connector, terminals 14 and 17). The resolver should be connected to the servo-amplifier.

The three phases of the motor MUST NOT be connected to the servo-amplifier.

4.1.1 Checking LED's and 7 segment display

"OVER I" red LED	normally off This LED lights up during a short-circuit between two motor phases or a power stage fault.

The state of LED and the output stage inhibit are latched.

"Braking" yellow LED	normally off This LED lights up when the braking module operates.

4.1.2 Checking the Seven segment display on the front panel

This display shows the state of the servo-amplifier and motor. The alarm **"d"** has the highest priority (followed by **C**, **7**, **6**, **5** etc.). If some alarms take place simultaneously, only the one with the higher priority will be displayed. An alarm reset is only possible by switching off the servo-amplifier supply.

servo-amplifier powered up
enable contact closed

servo-amplifier powered up
enable contact closed and zero position

servo-amplifier powered up
enable contact open

servo-amplifier powered up
enable contact open and zero position

continuous current limit reached

motor over temperature fault (alarm latched)

amplifier heatsink over temperature fault (alarm latched)

resolver digital converter powered down (alarm latched)

resolver feedback fault (alarm latched)

alarm indicated by the power section of the amplifier

decimal point displayed when the motor turns clockwise

motor connection failure

detection of ground defect (option)

4.1.3 Checking the electrical rotation sense of the resolver

The decimal point of the 7 segment display lights up when the motor shaft is turned clockwise.

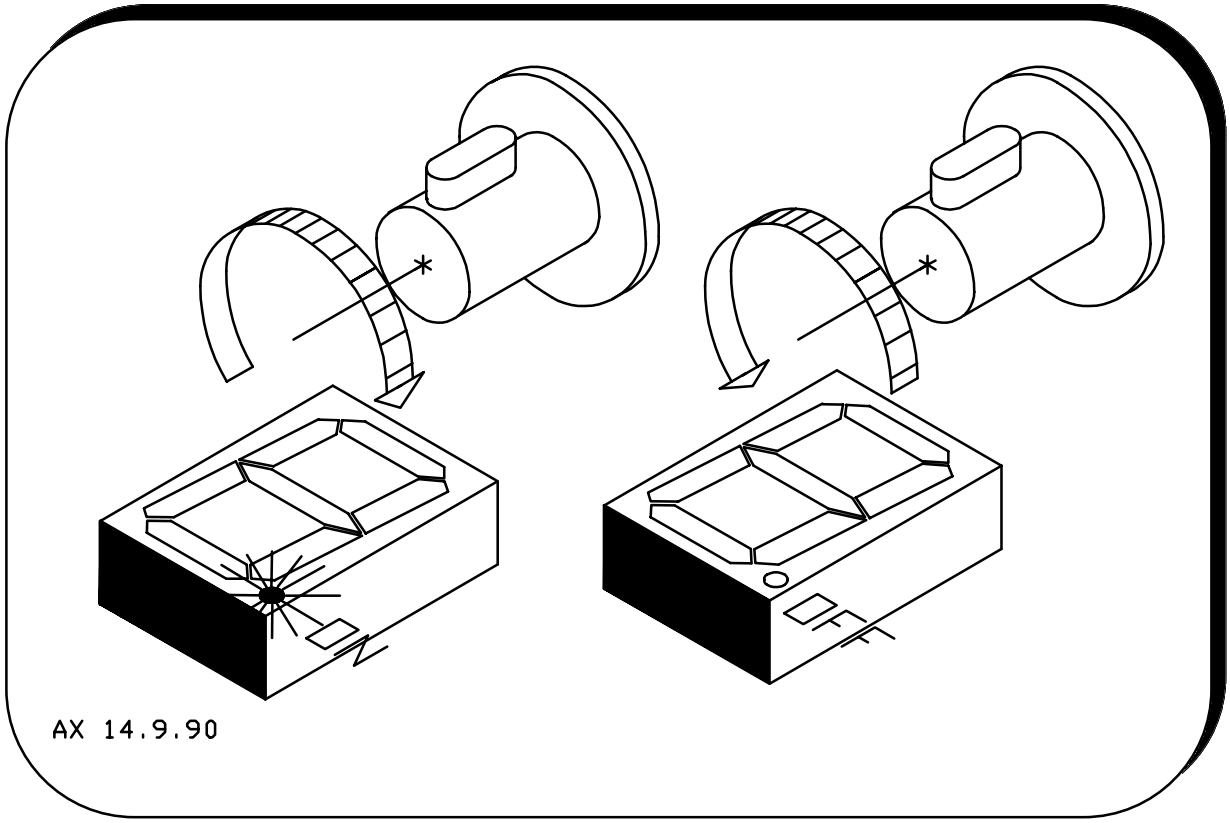


*Fig. 4.*1 Electrical rotation sense of the resolver

If the decimal point lights up during anti-clockwise rotation, connections to CO2 connector, Pin 4 (COS1) and 8 (COS2) must be reversed.

4.1.4 Determining the motor phases

Generally this operation is only necessary when the termination details of the three-phase motor are unknown (prototype motor or no documentation).

It is necessary to have a DC supply of about 3A.

The procedure is as follows :

1. Define arbitrarily one of the 3 motor phases as Phase **U**

2. Connect **U** to **"+ve"** and a **2nd phase** on the motor to **"-ve"** of the DC supply.

3. Switch supply on. The shaft will move to a stable position.

4. Mark the new shaft position with a pencil, at top dead centre.

5. Disconnect the **"-ve"** of the supply from the **2nd phase** of the motor and connect to the **3rd phase**. Observe the direction in which the axis rotates.

6. Mark with a pencil the new shaft axis position.

7. With the help of the table below, determine the 2 unknown motor phases.

sense of axis rotation	2nd phase	3rd phase
clockwise	V	W
anti-clockwise	W	V

4.2 Switching the Servo-amplifier on with a motor

4.2.1 Preparation before switching the mains voltage on

a) *Disconnect the motor from the machine.*
The 3 phase motor should be connected to the servo-amplifier.
Check if the axis is stopped and that the motor brake (if fitted) is released.

b) Check the following connections :

- motor cable /	CO3	on the 1502A or 1401B motherboard
- resolver cable /	CO2	on the 1503 motherboard
- control signals cable /	CO3	on the 1503 motherboard
- enable contact cable /	CO5	on the 1503 motherboard

c) Reduce the max. current of the servo-amplifier by setting the **max. current** parameter to 3. Save this value using the key **< F2 >**.

d) Open the enable contact connected on CO5 between the terminals 14 and 17.

4.2.2 Determining the Resolver shift angle

Before the motor can be used the resolver shift angle needs to be found as follows.

a) Connect the resolver and motor drive cables, and then switch on the drive amplifier.

b) Enable the drive amplifier by shorting pins 14 and 17 on CO5. If the motor immediately becomes unstable then turn off the power to the drive and disable the drive by opening the contact between pins 14 & 17. Wait for15 seconds and then re-apply power. Set the resolver shift to 90 degrees and re-enable the drive. If the drive again becomes unstable then repeat this process, but set the angle to -90 degrees. At one of these settings the motor will run which will allow the correct resolver shift angle to be set as detailed in the following paragraphs.

c) Using the "Resolver shift angle" parameter on page 3 of the program, slowly reduce the value from the starting point (established in "b" above) towards -180 degrees

and observe the behaviour of the motor. At some point the motor will start to become unstable and oscillate. Increase the value to remove the instability; the resolver shift angle lower limit has now been established.

d) Repeat the process described in paragraph c) above but in the positive direction increasing the resolver shift angle value to the point of instability and then reducing the value to bring the motor back into the stable region. This establishes the resolver shift angle upper limit.

e) Set the Resolver shift angle to the mid point between the upper and lower limits and save this value using the key **< F2 >**. Open the enable contacts and turn off the power.

4.2.3 Switching the mains voltage on

a) Switch on the amplifier.

b) The 7 segment display should indicate "1".

c) Set a positive speed voltage (about 1 V) to the servo-amplifier and close the enable contact. The 7 segment display shows "0".

d) Increase the **max. current** parameter until the motor starts running.

If the motor doesn't turn or turns very slowly, check the two end-switch contacts.

e) Reverse speed command.
Check that the motor turns in the reverse direction.

f) Set the **max. current** parameter to the required state.
Save the **max. current** using the key **< F2 >**.

4.2.4 Compensating the speed controller

Correct operation of the motor over the whole speed range can be obtained by optimising the **Proportional gain** and **Integral gain** parameters as follows:

1. Connect a P.C. to the amplifier and start the configuration program :

2. Set the two gain parameters, Kp and Ki to 10 (low gains).

3. Connect an oscilloscope between measuring points **"SPEED MONITOR"** and **"GND"** (on the 1503 motherboard).

4. Switch on the servo-amplifier and close the enable contact.

5. Apply a low command speed voltage (<100 m V)

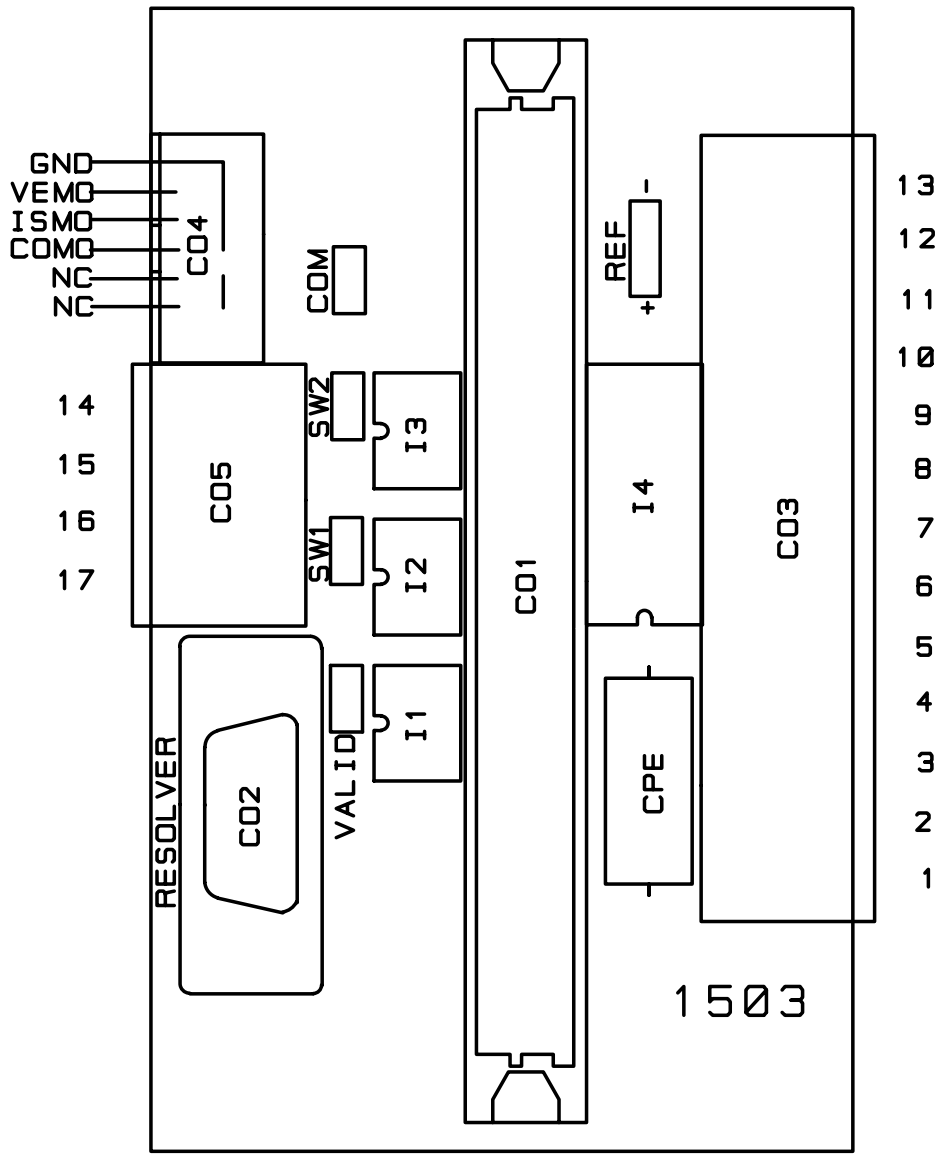
6. Increase the value of the **Integral gain (Ki)** parameter to obtain the following requirements :

a) good static torque
b) smooth shaft rotation

7. Check the oscilloscope signal having applied a step voltage of about 2V. Several results can occur :

a) The signal shows several oscillations	:	in this case, increase **Proportional gain** value
b) The motor is noisy	:	in this case, decrease **Proportional gain** value
c) The signal shows only one small overshoot	:	in this case, the speed loop is optimised

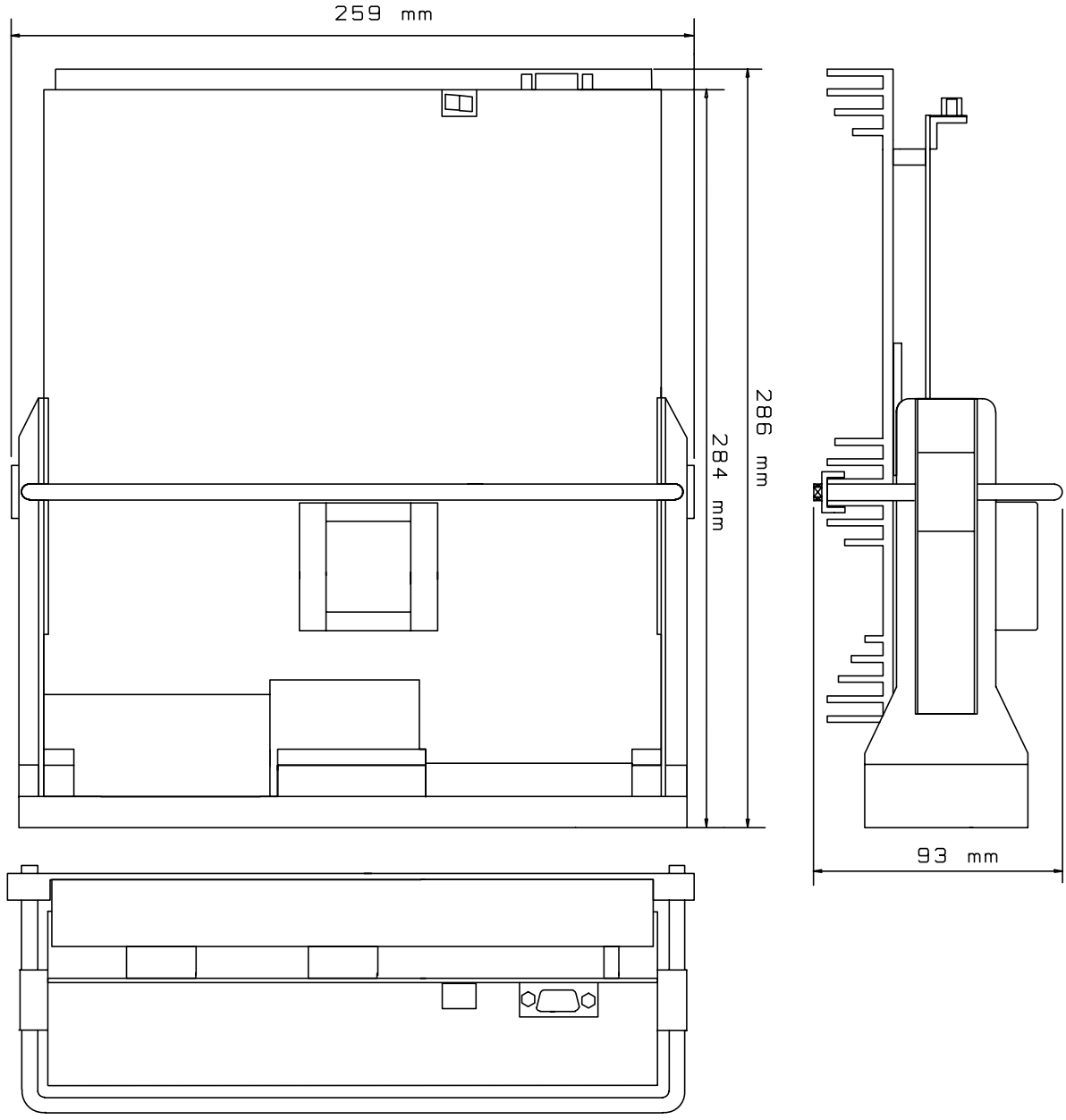
8. When the condition **7 c)** is achieved, save the gains obtained with key <**F2**>.



4.2.5 Offset and speed compensation

a) Offset compensation

The setting of the servo-amplifier speed offset is done with the **Offset control** parameter.



The setting of the offset should be done without the position controller connected to the drive.

If the offset correction is used to zero any output offset present in the position controller as well as input offset in the servo-amplifier, then set a zero speed command from the position controller and adjust the **Offset control** parameter to obtain a zero position (i.e. stationary) on the motor.

Press the **< F2 >** key to save this value.

b) Speed compensation

Adjust the **Speed factor** parameter to correspond to the maximum speed and direction of the motor.

Press the **<F2>** key to save this value.

4.3 Fault Finding

The following table shows the most frequent troubles and their causes.

No	Trouble	Possible cause
1	LED "OVER I" switched on	- short-circuit between 2 motor terminals
2	Display 2	- limit of continuous current reached - **Resolver shift angle** parameter misadjusted
3	Display 3	- motor overloaded - miswired or loose connection of wires for motor thermal switch
4	Display 4	- servo-amplifier overloaded - cooling fan failure
5	Display 5	- resolver conversion circuit failure - **Resolver shift angle** parameter misadjusted
6	Display 6	- resolver failure - resolver wiring failure
7	Display 7	- appears with OVER I LED - brake fuse failure or missing - appears in case of over-voltage or supply missing
8	Display C	- motor connection failure
9	Display d	- detection of a motor ground defect (option) with auto-transformer
10	Motor doesn't turn when 0 is displayed and a speed command signal is applied	- endswitch enabled - max. current of servo-amplifier limited too low - motor brake engaged - speed reference short-circuited by **REF** Jumper
11	Motor rotation is not smooth	- **Motor pole pairs** parameter misadjusted - Motor wiring on terminals U, V, W not in the correct sequence
12	Motor turns in wrong direction	- wrong polarity of the speed reference Reverse wiring of CO3-11 and CO3-12 and move jumper REF or reverse **Speed factor** parameter

A APPENDICES

A.1 Block Diagram

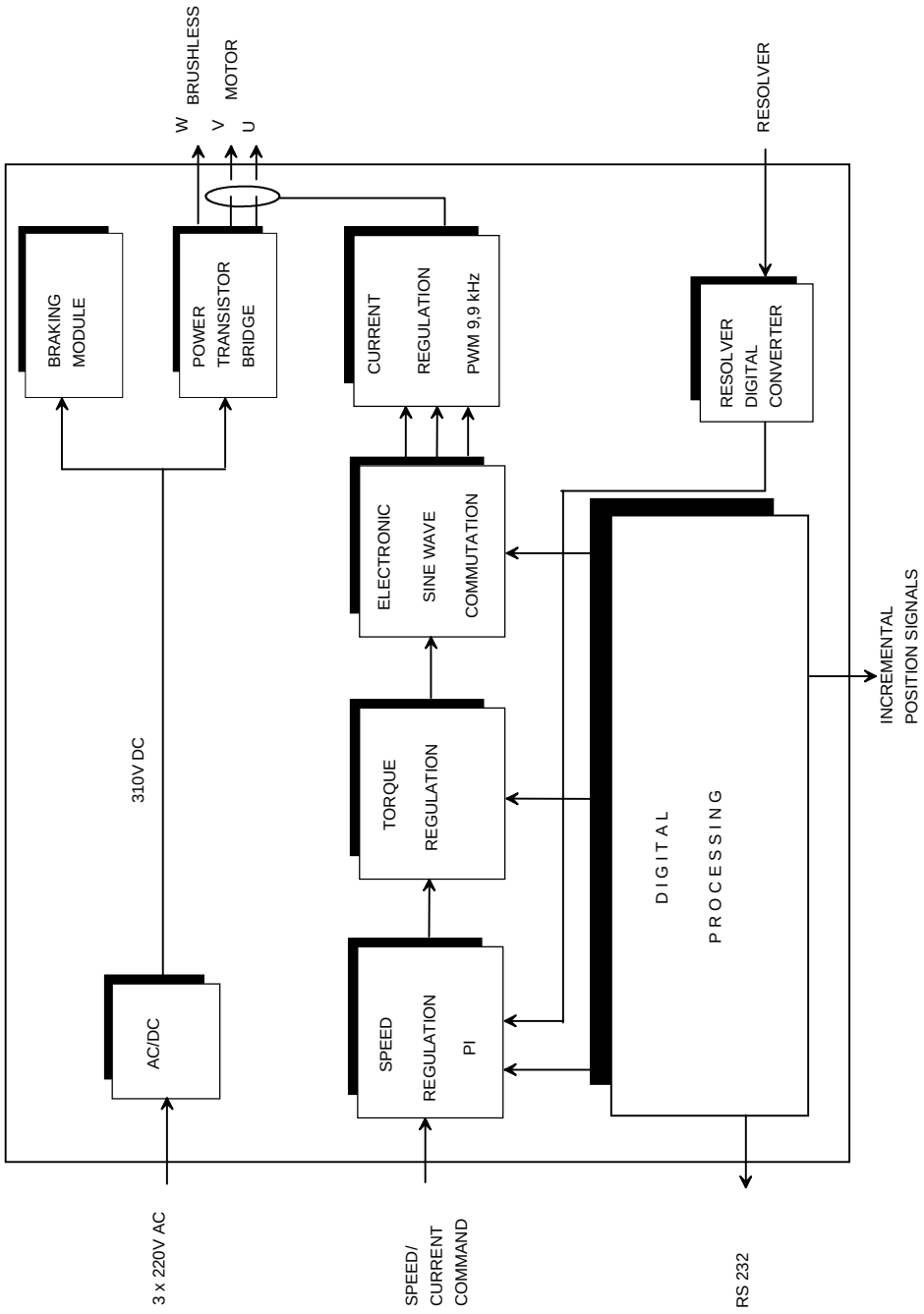


Fig. A.1 Block diagram

A.2 Layout of Drive Amplifier

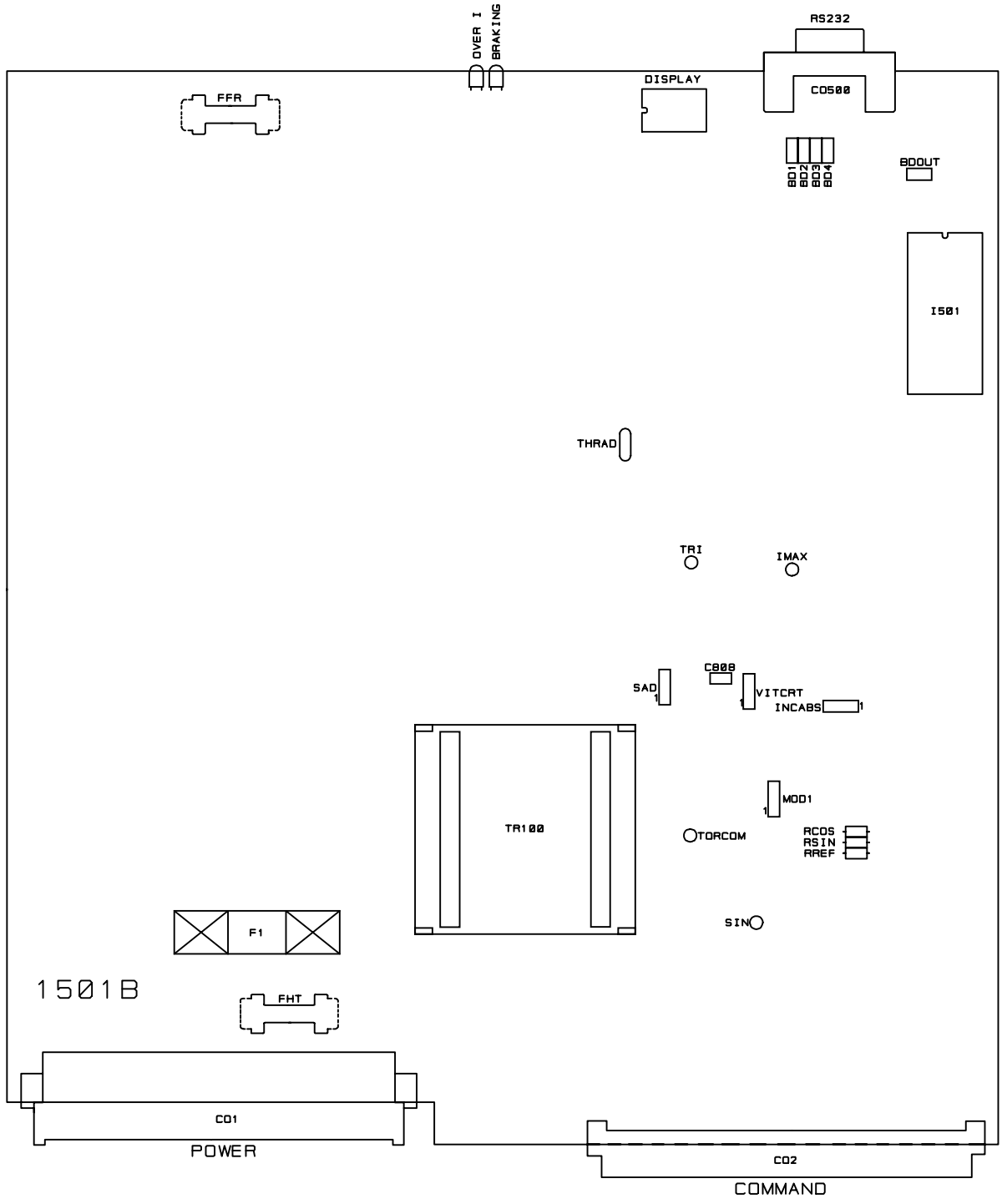


Fig. A.2 Drive Amplifier Layout

A.3 Layout of 1503 Motherboard

Fig. A.3 1503 Motherboard

A.4 Dimensions of Drive Amplifier

Fig. A.4 Drive amplifier Dimensions

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