CONTROL TECHNIQUES

MiniAx

60 x 5/10
60 x 10/20

300/600W Six-step brushless Variable Speed Drive

Codice: 01.0056.0 Issue 1 November 99

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1.0 Product information

The MiniAx amplifier series is distributed with the CE mark, because they are in accordance with th European Directives on EMC and Low Voltage.

ATTENTION!
ELECTRICAL AND CONTROL EQUIPMENT CAN BE DANGEROUS IF HANDLED IMPROPERLY

This manual describes the mechanical and electrical characteristics of the MiniAx servoamplifier series.
It is important that the installation procedures are performed by only qualified personnel in accordance with local safety guidelines.
Whoever installs the equipment must follow all of the technical instructions printed in this manual.

1.1 Introduction

The MiniAx BRUSHLESS is a very small bi-directional, four quadrant drive.
the output power stage (MOSFET) is controlled using the PWM technique with 22 Khz modulation frequency which allows it to drive small to medium sized brushless servomotors (up to 2Nm) where dynamic performance and noticeable rotation regularity is required.

MiniAx, is a drive with a one source power range of 20-80 Vdc along with a differential type reference input. Drive enable is furnished through continuous voltage between +10Vdc/30Vdc. It is also possible to enable through GND connection.

The velocity feedback may be through:
-Hall sensor + encoder.
-Internal PWM (Armature), + Hall sensor.

Exist the possibility to change any default setting of parameters just substituting existing components with different value.
The selection of various prearranged values setting is easily realized by opening and closing solder points.
The intervention of drive protections are all visible with LEDs on the front of the drive.

5-10A 10-20A

The nominal current, as well as peak current is adjusted through resistance on the base pcb. The drive dimensions are 135,5x82x 28,5mm. Listed below are the 2 principle sizes of the MiniAx product line:

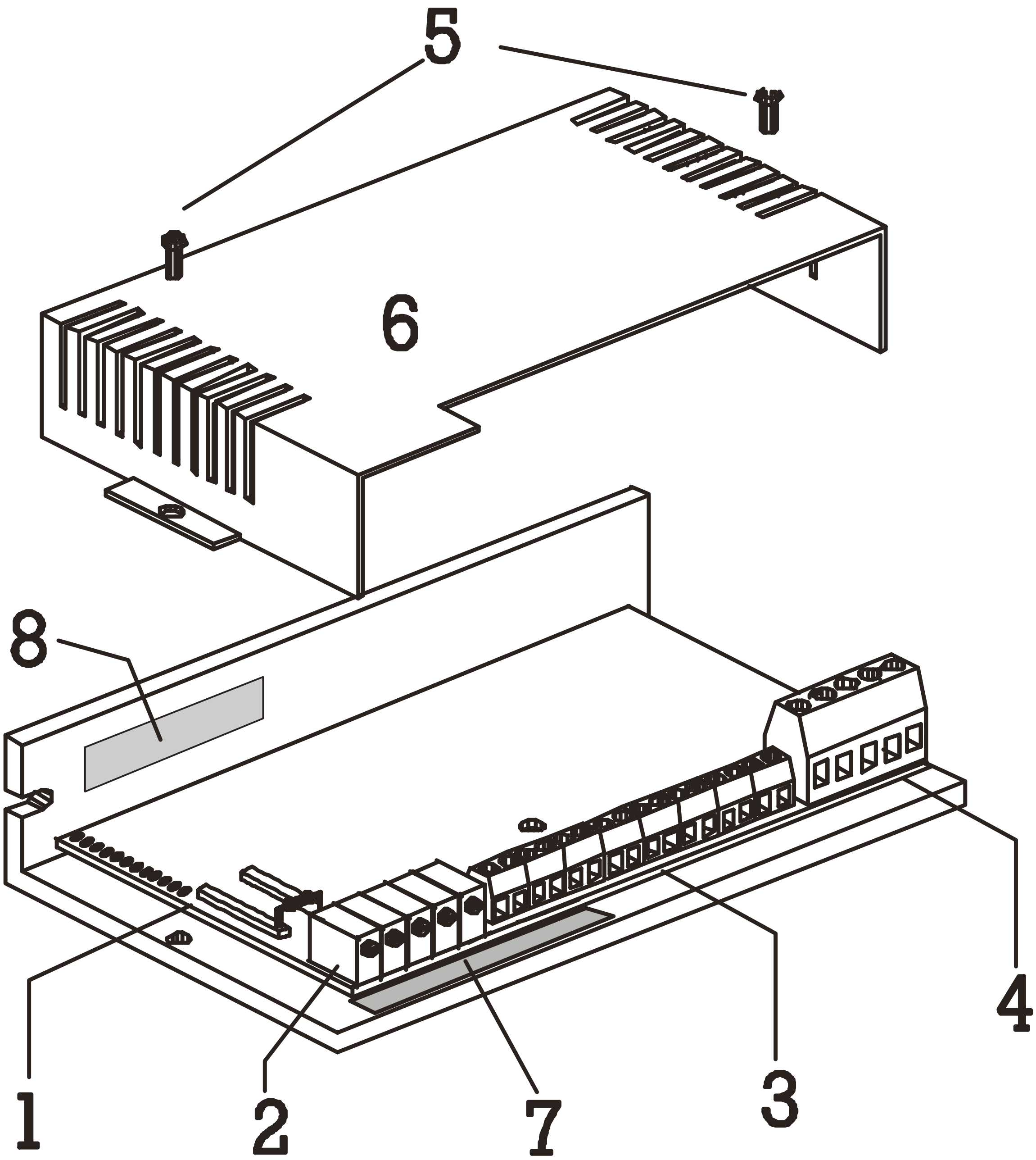
The operating temperature is from 0 to 40 °C (32° to 104°F) and no ventilating system is required as long as the spacing between the drives allow for adequate air flow.

1.2 Technical data

Input voltage Range	20-80	Vdc
Output voltage max.	0,93	V input
PWM frequency	22	kHz
Operating Temperature	0/40	C°
Storage Temperature	-10/70	C°
Drift	+/-18	uV/C°
Analogue input	+/-10	Vdc
Current monitor	+/-7	Vdc=Pk. curr.
Encoder and Hall Effect	+5	Vdc max130 mA
Auxilary power supply	+/-10	Vdc max 4mA
Max. Encoder frequency	250	kHz
Logic signals	+10/30	Vdc **
Band Width of current loop	2.5	kHz
Humidity	10/95	% w/o No condensation
Weight	350	gr.
Altitude	2000	m.slm

** The MiniAx can also be setted in negative logic.

1.3 Drive Description



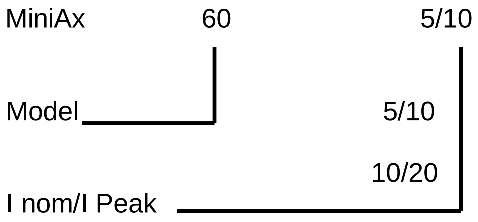
1 Calibration component area (socket and links)
2 Calibration Potentiometers
3 Signal terminals
4 Power terminals
5 Fixing screws
6 Module cover
7 Module Label
8 Serial number

1.4 Drive Label Description

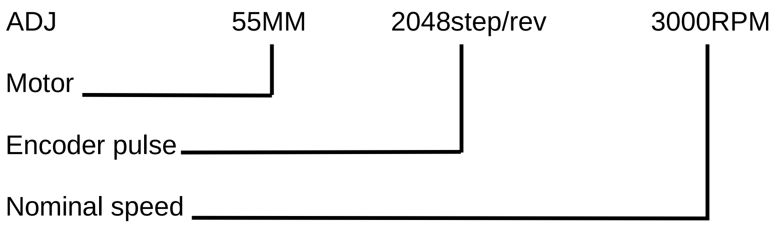
TYPE MiniAx 060-5/10-PWM- 0
ADJ 5/10A RA
Date 27/04/98 Ord.365 /98

The Product Label is on all MiniAx Drives. The Label printed above is a typical example. To identify the various options see below: Product type and Identification.

TYPE

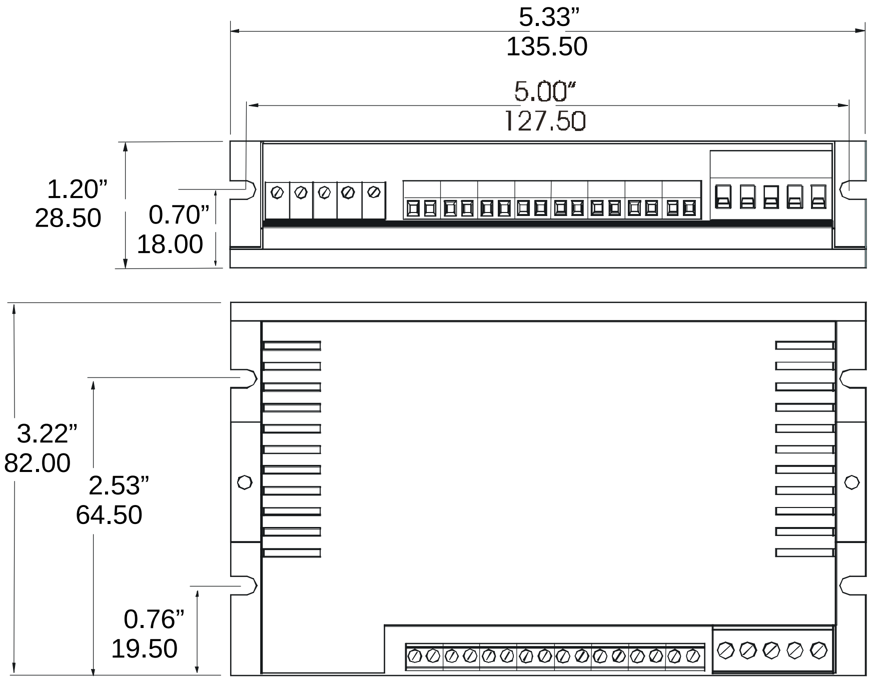


ADJ is the identification of specific adjustments on the product for specific motors. If the product is furnished Standard, the ADJ will show the disbursed current.



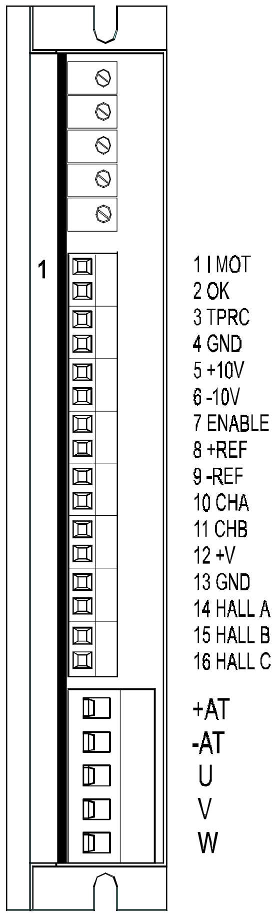
ORD is CONTROL TECHNIQUES's internal order number which relates to product distribution. Always reference this number for eventual requests.

1.5 Drive Dimensions



NOTE:Dimensions (” Inch - mm).

1.6 Connections



1.7 Signal inputs and outputs

The following is the Signal Connector Description.

1 IMOT(OUT). Current Monitor: +/-7 V corresponds to drive's Peak current. A 5K6 Kohm resistor is inserted in series on the output driver.

2 OK (OUT). Drive Ok, Open collector with 50mA max. current. (Normally closed, it opens for any type of protection intervention).

3 TPRC (IN). (OUT). This command can be used in 2 distinct modes:
A. Current Output Limitation;
happens by connecting an external resistor to zero; linear re-partitioning with R internal = 47K (the internal velocity loop remains functional). Ex. with ext. R of 47K the curent is limited 50% of the size I Max.

B. Current Reference (Torque Input): low impedance voltage drive with a signal of +/- 10V max., which corresponds to the drives peak current output.

In this case the velocity loop is automatically excluded and doesn't interfere with the system.

The TPRC terminal could be used (as an alternative in cases A and B) as a signal monitor of the drive's demand current (output impedence $\simeq$ 50k)

4 GND DriveCommon Zero Signal. Internally connected with to power supply's negative -AT input.

5 +10V (OUT). Auxilary voltage+10V max 4mA

6 -10V (OUT). Auxilary voltage-10V max 4mA

7 ENABLE (IN). Functional enabling of the drive. (Range included between +10V and 30Vdc max. positive logic).
It's also possible to enable the drive with negative logic by connecting a GND input (to enable such a function, close solder links S12-S13).

8 +REF (IN). Positive (hot) differential Reference input.

9 -REF (IN). Negative (cold) differential Reference input.

10 CHA (IN) Encoder input Chanel A (include high logic level between +5V/24Vdc max)
High logic level >3,2V Low logic level <1,5V.

11 CHB (IN) Encoder input Chanel B. (include high logic level between +5V /24Vdc max).
High logic level >3,2V Low logic level <1,5V.

12 +V (OUT). Auxilary voltage +5V max 130mA.

13 GND. DriveCommon Zero Signal. Internally connected with to power supply's negative -AT input.

14-15-16 HALL A-B-C (IN). Hall Sensor inputs internally connected to the motor. Each input has a pull-up resistor 1 Kohm at 5V.
High logic level>3,2V , Low logic level<1,5V.

NOTE !: Always power the motor's hall sensors using the auxilary power supply intrnally generated by the MiniAx SMPS (Terminal 12 +V).

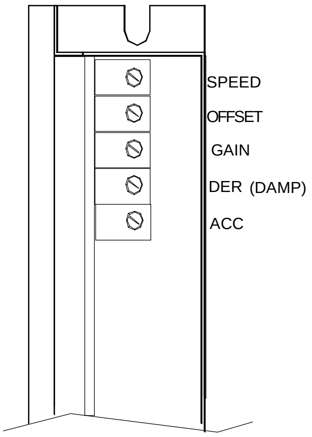
If an external power supply is used, open solder bridge S11.

WARNING: Such an external power supply, if used to supply the incremental encoder + hall effect sensors, must be applied to the motor at the same time the the MiniAx is switched on.

1.8 Power inputs and outputs

+AT	(Input).	Positive continuous power supply. (allowed range between 20V and 80V).
-AT	(Input).	Negative Continuous power supply. Internally connected to the Common Zero Signal GND.
U	(Output).	Motor connection U phase
V	(Output).	Motor connection V phase
W	(Output).	Motor connection W phase

2.1 Potentiometer adjustments



SPEED
Speed potentiometer.Turn the potentiometer clockwise (cw) to increase the maximum speed and counter-clockwise (ccw) to reduce the maximum speed.
The range of the adjustment is +/-20%.

OFFSET
Offset adjustment.Adjust this potentiometer to cancel any offset in the external speed ref. signal.
(Max ref. compensation +/- 200mV).

GAIN
With this adjustment we can improve the dynamic behaviour of the servomotor.With a clockwise turn (cw)we increase the gain of the PI “speed stage”, therefore, improving the response.

DER (DAMP)
Turn the potentiometer clockwise (cw)to increase the derivative (damping) effect,reducing the amount of overshoot in the system response.

ACC
The solder bridges S1-S3 allow insertion of the acc/dec function (ramp). With this potentiometer we can adjust the slope of the ramp in acceleration and deceleration. Turning the potentiometer clockwise (cw) increases the ramp time from 0,1 to 1 Sec (with 10 V reference).
It is also possible to increase or decrease the pre-set max time of acc/decby opening solder bridge S2 and inserting resistance RAMP.

(See chapter RAMP TIME ADJUSTMENT)

2.2 Protections

The MiniAx is equipped with a series of protections to safeguard both the drive and the motor, in case of malfunctions.

All protections are visualized using LEDs on the front of the drive. (See the next page).
The two types of interventions are Reversible and Irreversible.

Reversible Protection Intervention:

The drive is automatically reset/restarted when the cause of intervention has been corrected.

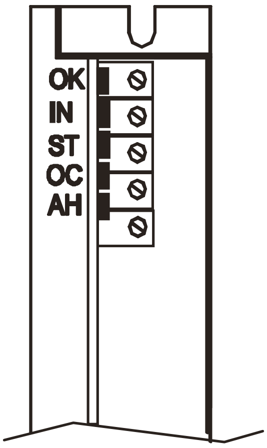
-Current limitation
-Min max voltage

Irreversible Protection Intervention:

The drive is reset but not restarted. The power supply must be removed and the cause of intervention eliminated, then the power supply can be replaced. *Note: A mininum amount of time must pass in order to ensure that the drive is completely off prior to replacing the power supply.

-Over Current
-Drive thermal switch
-Missing Hall Effect Signals

2.3 L.E.D. indicators



FiveLEDs are available on the drive and they signify the following:

- (GREEN) OK Normally ON, means proper operation of the drive. When the LED is OFF, it indicates that at least one of the drive protection functions is active.

- (RED) IN Normally OFF,it become lit when the nominal motor I-t limit is exceeded.
(Reversible alarm)

- (RED) ST Normally OFF. May come ON,because of a short circuit between motor terminals and short circuit to ground.It cannot be reset and the fault activate the memorization of the alarm.
Switch off the system,eliminate the cause and then re-start the power supply.

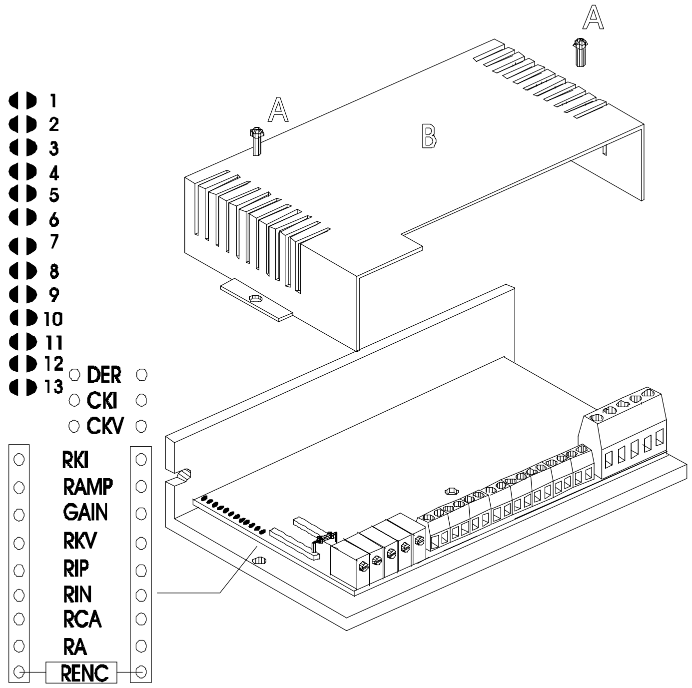
- (RED) OC Normally OFF,it represents overheating of the drive heatsink. This fault activate and memorize the alarm. To reset it is necessary to turn off the power supply, wait until the heatsink temperature is lower, and then re-start the power supply.

- (RED) AH Normally OFF. The light status indicate either missing Hall signals or incorrect 60° or 120° settings.
It cannot be reset and the fault cause the memorization of the alarm. S11 is Normally (default) closed.If Open, the alarm protection for missing Hall Effect Signals will not disable the drive.

2.4 Personalizations and settings

WARNING: After switching off to do the adjustments, please wait for at least 10 sec before working inside the drive.

If the drive isn't adjusted with the proper servomotor, follow these procedures.
All of the personalizations are located inside of the MiniAx. To gain access to the adjustment components and the solder bridges , unscrew (A) , and remove the cover (B). (See fig. below)



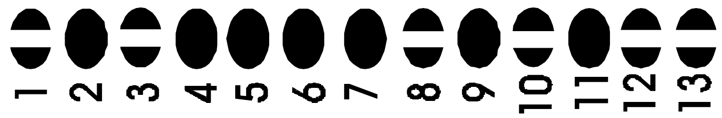
All of the adjustments are located in the area behind the potentiometers .It's there that a header containing all of the adjustment components is located..
The header is made of a double row and 9 locations of components with 10.00mm/0.4" pitch (resistors) and a double row 3 locations of components with 5.08 mm/0.2" pitch (capacitors).
The resistors may be either 1/4W or 1/8W.

RENC	Low Scale Speed Adjustment with Encoder or Hall Effect feedback.
RA	Low Scale Speed adjustment with Armature Feedback
RCA	Droop compensation of internal Motor Resistance (RI)
RIN	Nominal Current limitation resistor.
RIP	Peak current limitation resistor.
GAIN	Determines static gain of the speed loop. Insertion of new values is possible by opening Solder bridge S6 (Disable internal Constant Standard from 22Ohm).
CDER	By inserting a capacitor on the extractable card in CDER you can increase th internal pre-set speed loop's deriative constant.
RKV- CKV	resistor and capacitor values that respectively form the proportional/integral network of the Speed Loop. Substitution may be done by opening Solder bridge S5(Dynamic Constant Standard Disablement ;100 Kohm-47nF).
RKI- CKI	Resistor and capacitor values that respectively form the proportional/integral network of the current Loop. Substitution may be done by opening Solder Bridge S7 (Dynamic Constant Standard Setting; 220Kohm- 2.2nF).

2.5 Solder Links

13 Solder Links are present (in the Adj. Zone) with which it's possible to enable or disable funcitons or parts of the MiniAx. Verify the corresponding solder links closings required by the drive.

The Drive is furnished with the following Standard configuration of closed solder links:



Indicated below are the solder links that are to be opened or closed in accordance with the desired funtions.

S1 e **S3** Normally open. (See Chapter 5.7 “Ramp Time Adjustment”).

S2 Normally closed. (See Chapter 5.7 ““Ramp Time Adjustment”).

S4 Normally closed. If Open - disable the Encoder or Hall Effect speed feedback if selected.

S5 Normally closed. (Standard constant RKV=100Kohm , CKV= 47nF)
If Open - You must insert the NEW Dynamic Constant CKV, RKV on the persalization base.
(Adjustment reserved for Qualified Personnel Only !)

S6 Normally closed. If Open - you must insert the New GAIN resistor. (Static Gain). Standard value= 22ohm

S7 Normally closed. If Open - you must insert the Dynamic Constant CKI, RKI on the personalization base.
(Standard constant RKI=220 Kohm , CKI= 2,2nF)
(Adjustments Reserved for Qualified Personnel Only!)

S8 Normally open. If Closed, when the IN protection is activated the green OK LED goes off and is unable to allow the Drive OK LED to come on.

S9 Normally closed.(Encoder Feedback option). If open, you must configure the Speed feedback from the Hall Effect Signal.

S10 Normally open. (Hall Effect 120° option). If Closed - you must enable the drive for Hall Effect 60°.

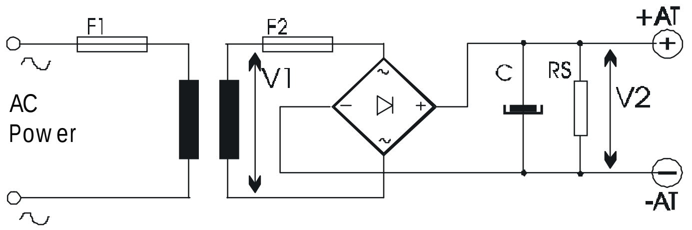
S11 Normally closed. If Open, the alarm protection for missing Hall Effect Signals will not disable the drive.

S12 - **S13** Normally open. (Configured for Drive signal with positive logic >+8V max 24V.). If Closed - configure signal with negative logic. (Enable with zero GND Voltage).

3.1 Power supply (rating) considerations

WARNING:Use the following scheme and equation shown below to calculate the power supply rating. The drive doesn't need auxiliary voltage ,all of the voltages requested come from an internal flyback DC-DC converter.

Transformer



The drive has the internal zero signal connected
with the negative (power), consequently:
-- **Do Not use auto transformers**
--If the transformer is connected using Center-Star,
Do not connect to Ground
--**Do Not connect any points of Transformer Primary or Secondary to Ground**
Therefore, use the MiniAx power supply for these.
- Keep the +AT and -AT between the power supply and the MiniAx as short as possible. If shielded cable is not used twist the 2 cables together.

Voltage: The primary voltage depends on the available main voltage. The secondary voltage will be calculated according to the motor's characteristics and according to the voltage drive range.
The Value will be:

V2 (Dc) = VM / 0,8

Where: VM = E+ (Ri x Im)

E = Ke x n° / 1000

VM=Motor voltage(V)
E =motor BEMF(V)
Im = I motor(A)
Ri =Winding resistance(Ohm)
Ke =Voltage constant (V/kRPM)
n° = Max. speed(RPM)

Considering you must keep a certain margin during the motor's breaking phase, you should never exceed a voltage of 60Vdc (44 Vac from transformer).
The max. value is 80Vdc and the min. value is 20Vdc.

Example:Brushless DC Motor with the following data:

Im =3,8 (A)
Ri = 2,5 (Ohm)
Ke =12 (V/kRPM)
n° = 3000(RPM)

E = 12 x 3000 / 1000 = 36 (V)

VM = 36 + (2,5 x 3,8) = 45 (V)

V2 = 45 / 0,8 = 56 (V) V1= 56 / 1,41 = 39,8 (Vac)

You'll use a transformer with the secondary V1= 39 Vac OK 44Vac.

Transformer power

The transformer's nominal power is calculated based upon the sum of power from the single motors driven. Or Better:
P(VA)=Power absorbed by motor 1 + Power absorbed by motor 2+....etc)
Note; however, that in multi-axis applications, the transformer's power can be derated to 30% of its initial power.

In regards to the filter capacitor we suggest a 100Vdc working voltage. It's capacity value is derived using the following formula:

$$C\ (uF) = P\ (VA)\ trafo.\ /\ V2 \times 2000$$

V2 = DC Voltage present on capacitor without load.

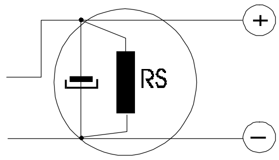
Such a capacitor is used to filter the straightened voltage from the power supply and to recover energy during the motor's braking phase..

Discharge resistor

This resistor,discharge the capacitor also when the amplifier is disconnected after the power supply is switch off.
The value can be calculated with the following formula:

$$RS\ (Ohm) = 20 \times 1.000.000\ /\ C\ (uF)$$

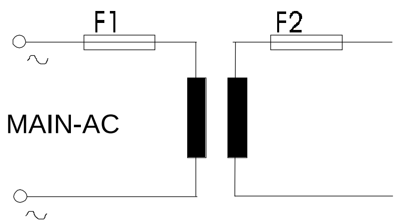
$$P\ (W) = V2^2\ /\ RS$$



Fuses

Determination of the primary and secondary F1 and F2 transformer fuses.
Such fuses can be replaced with thermomagnetic switches of the same value.
The F1 fuse inserted on the primary protects the transformer from current overloads caused by th secondary. This fuse is the “Slow” type.
The F2 fuse inserted on the secondary protects the transformer from short circuits caused by the charge or on the rectifier bridge itself. This fuse is the“Slow”type.

F 1 = P (VA) trafo. x 1,1 / V (primary) ac

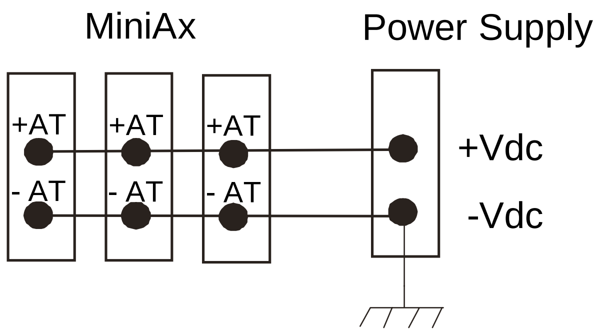


F2	for MiniAx	5/10 = 8A
	for MiniAx	10/20 = 20A

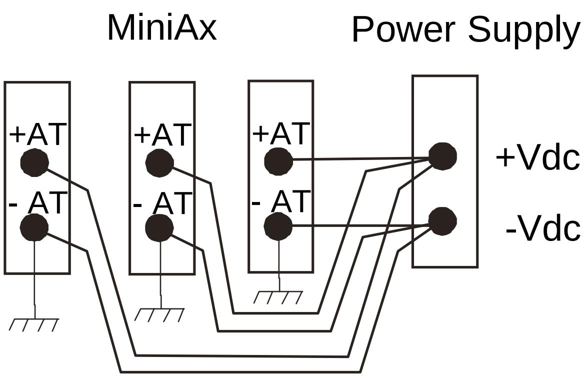
3.2 Multiple Connections

In case of Multi-axis application from a single power supply, use the "STARY" type of power supply distribution. DO NOT use cascade type connections such as "SEQUENCE".

DO NOT USE THIS WIRING!



USE THIS WIRING!



Connect the MiniAx to the power supply using the shortest route possible. Max. 1m. (Contact CONTROL TECHNIQUES for additional information.

3.3 Electro-magnetic Compatibilty Standards

The regulated standard in accordance with conformity of electromagnetic compatiibilty is summarized in Italian Regulation CEI EN 61800 (complete).
MiniAx conformity is assured only if it is installed following the precise assembly criteria expressed below:
The fundamental assembly characteristics are summarized below:

1) Use of appropriate network filters to filter the line (transformer input), from disturbances conducted or produced by the drive.
A series of filters released by CONTROL TECHNIQUES are available for this purpose.

2) Use of shielded cables, both for power connection (to the transformer and the motor), and for signal connection (also to the controller).

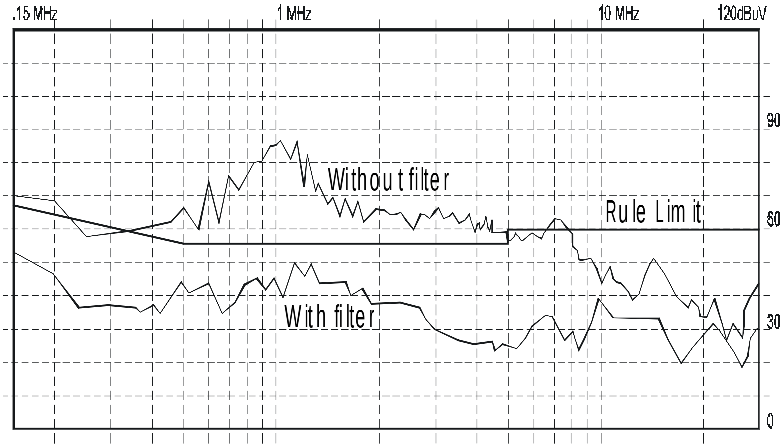
3) Using the separation of cables technique. (Separate power cables from signal cables).

4) the correct ground connection of predisposed parts.

Network filters

Of all of the mentioned sistems, the use of network filters is without a doubt fundamental in suppressing disturbances.
During product testing Control Techniques found optimal solutions for their products. Other eveutual choices of filtering by End-Users cannot be guaranteed by CONTROL TECHNIQUES.

Below is a graphic example of disturbance levels measured with and without using the type of filter indicated in the following pages.



These filters are produced by SCHAFFNER. Other products with the same characteristics may be sufficient, but have not been tested or evaluated by CONTROL TECHNIQUES.

In choosing the filter, we also considered the current absorption of its connecting devices. CONTROL TECHNIQUES recommends connecting the filter before the power supply transformer. This method, besides offering better disturbance suppression results, also allows for the use of filters capable of supporting a lot less current, consequently they're cheaper.(takes advantage of the transformers ratio).
Follow the formula below for the filter dimensions for use with the MiniAx.

$$I(A) = P\ tot. / (1.73 * 380)$$

Where:

--I is the net current expressed in Amperes for the necessary filter.
--380 is the 3 Phase Transformer primary voltage.
--P tot. is the motor's max. power absorption in VA.
P(VA)=Motor 1 power absorption + Motor 2 power absorption + ...etc.

WARNING:

For filter connection (divert to ground or earth the unwanted frequency) considering such devices can produce small leakage current towards earth or ground (this current amounts to "some" amount of milliapmeres). For these precautionary reasons, it is necessary to connect the filter to earth prior t connecting the power supply.

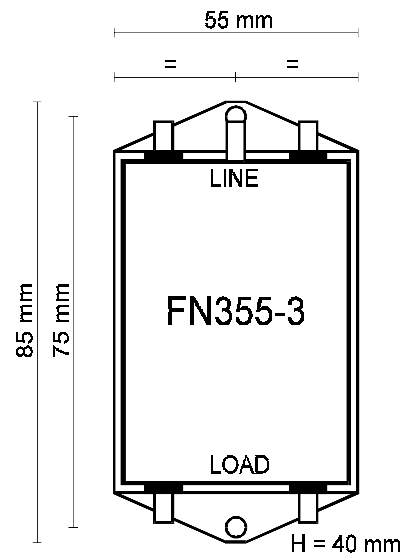
In relations to leakage current, remember that it must be considered when sizing differential switch, thus avoiding undesired interventions. The precise data relative to our filters can be found below.

Mechanical and Electrical Characteristics

Below is a table showing the electrical characteristics of our recommended filters. Pay particular attention to Leakage, differential adjustments, and nominal current in accordance with operational temperature.:

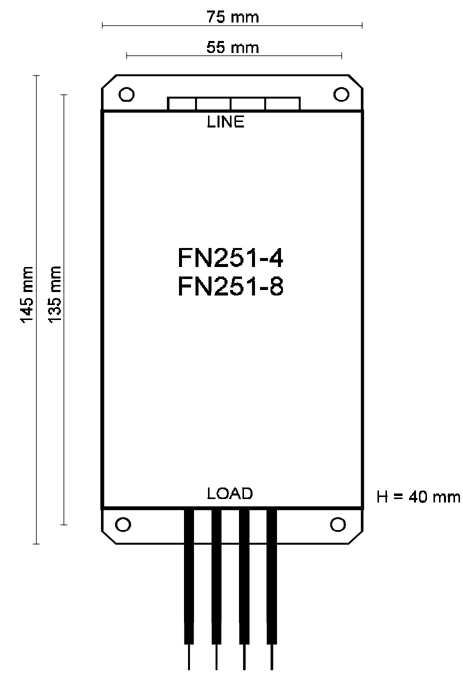
Type	Current Rating	Leakage Current	Power Loss	Weight
	(A)	(mA)	(W)	(Kg)
FN355-3	3 (40°) /3.2 (25°)	0.41(400V 50HZ)	1.5	0.25
FN251-4	4 (40°) /4.6 (25°)	1.31(400V 50HZ)	5.5	0.75
FN251-8	8 (40°) /9.2 (25°)	1.31(400V 50HZ)	7	0.75

In this section fundamental mechanical characteristics of the filters are shown:



The FN355-3 Series Filters are furnished with Fast-on connectors for both input and output.

Max Voltage: 420Vac
Max. Current: 3A @ 40°C
Working Temp: -25° +85°C

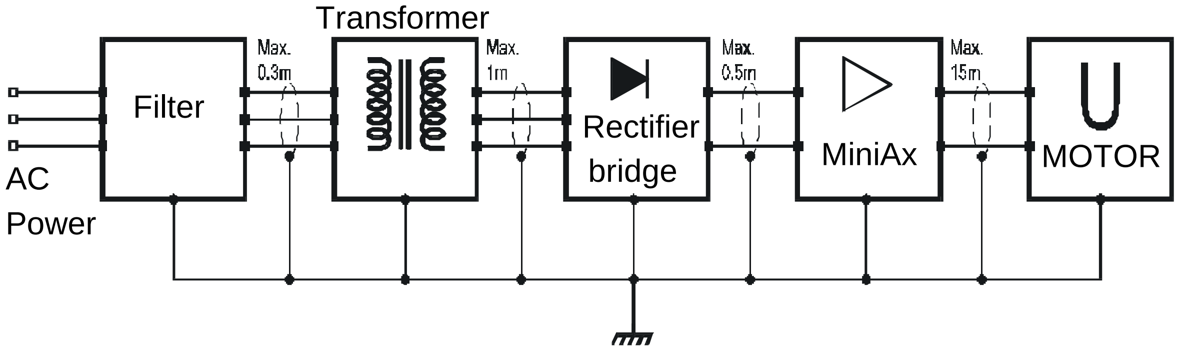


the FN251-4 and FN251-8 Filters are furnished with connector terminals for input and Flying leads for output.

Max. Voltage: 440Vac
Max. Current: 8A @ 40°C
Working Temp.: -25° +85°C

3.4 Connection and Wiring System

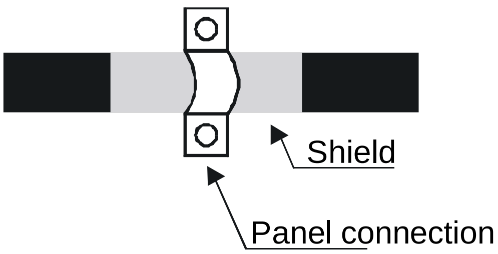
The wiring technique is important for gaining excellent results without disturbances. Shown below are connection schemes.



As shown, the filter must be placed before the transformer (where required).
--All connections of the Net filters must be shielded and shouldn't be longer than the length shown in the scheme.
--the cable shield must cover the entire length of the wire and be as close as possible to the connection terminals.
--the shielded earth connection cable should be accomplished.
--Always use shielded cable (twisted) to connect the motor and drive.
--Avoid passing signal and power cables through the same channels.

It is very important that the panel where the filter is mounted is connected to earth.
Power and Command/Signal conductors should not be placed in the same channels (keep separate). Avoid twisting, crossing, and etc.. It crossing is inevitable, try to cross at a 90 degree angle. Where possible use metallic channels connected to earth.

This type of shielding (pressed cable) is better when used on conductors close to the filters and drives.

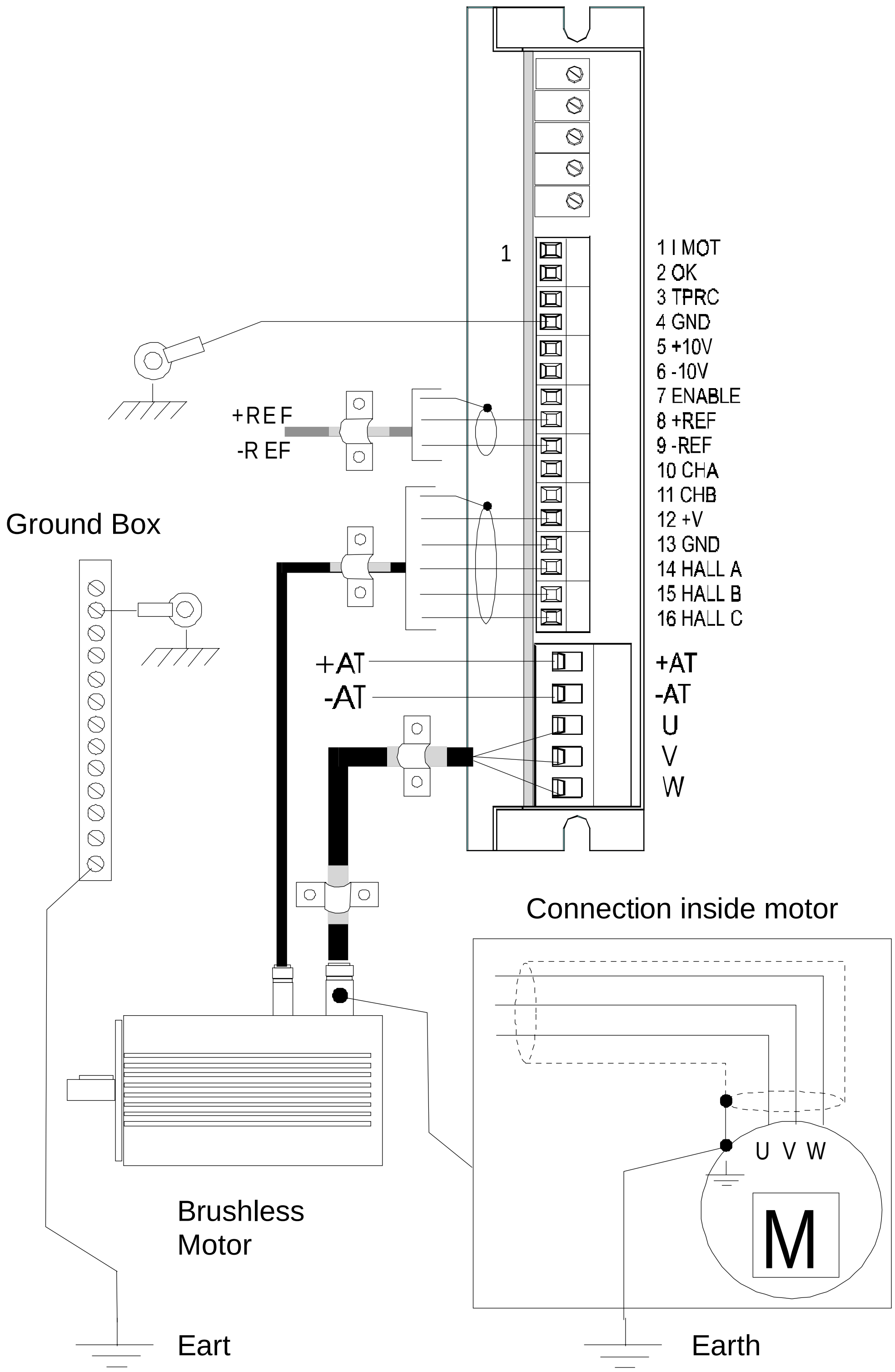


Ground and Screen Connections

It is important that the drive's ground connections are done using the shortest possible method.
These connections shouldn't be longer than 15cm. the next page shows the connection using terminals fixed to the drive's base (bottom). this connection also reduces disturbances in the net.

3.5 Connecting Ground and Screen.

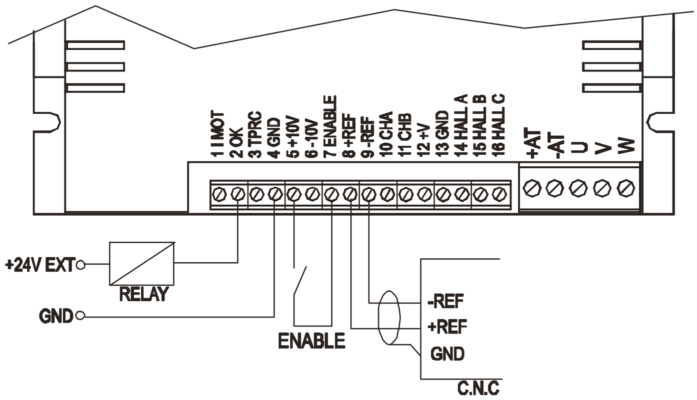
Connect the GND signal to the ground point nearest the drive.



3.6 Examples of Signal Connections

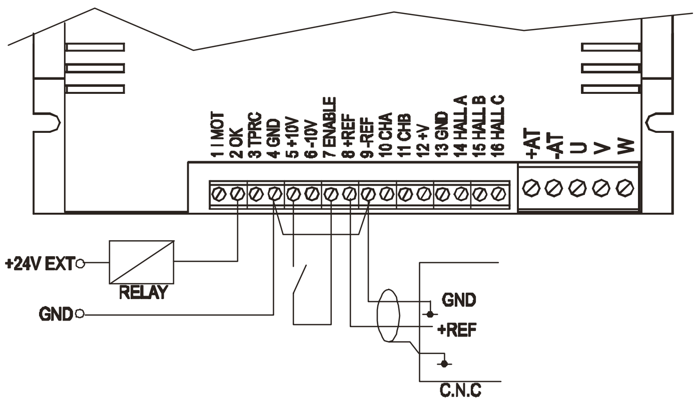
The following design shows an application utilizing a differential reference from C.N.C..

Enabling the drive is done using the Auxilary power supply +10V (Connector 5). It is possible to use a external power supply for this function (24V DC). Remember to also lik the GND of the power supply to Connector 4.
It's also possible to Enable the drive using negative logic.

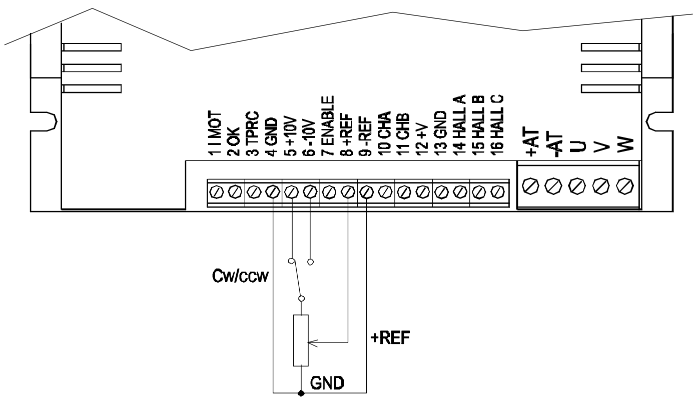


On connector 2 "OK" an external relay coil was connected. This exit has a max. output of @50mA. Do Not connect current exceeding 24Vdc. Link the Power Supply GND externally using connector 4.

The following design shows an application using speed reference connections in the Common Mode.



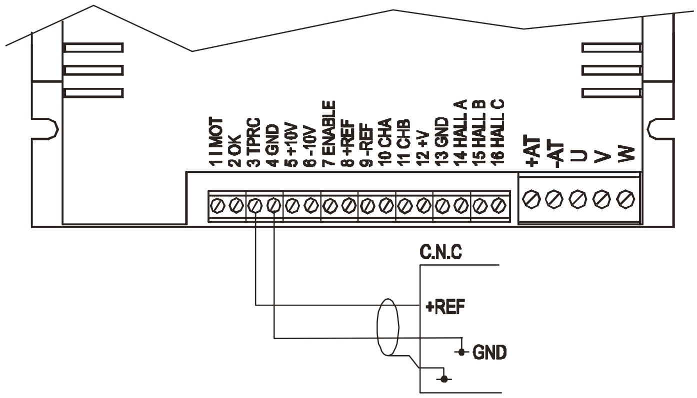
The following figure shows an application with speed reference connections using an internal MiniAx power supply.



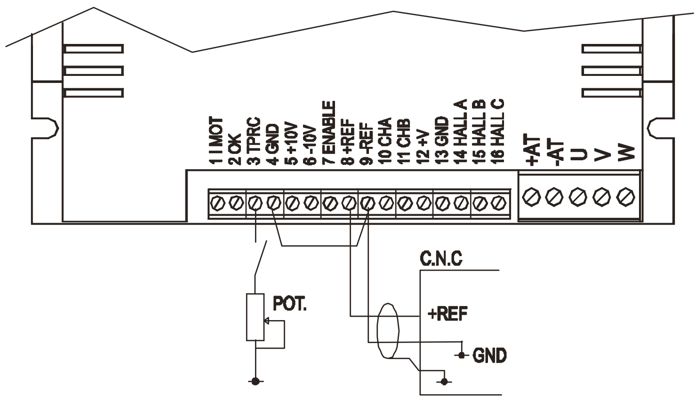
The speed potentiometer must have an included value between 5 and 47Kohm.

Torque Mode wiring

With a voltage output (ex. from a CNC) you can command the drive in torque mode. Applying a max. signal of +/- 10V in TPRC, the MiniAx furnishes the corresponding positive or negative peak current. Therefore, by applying 5V you'll obtain the nominal output current. (See figure 1).



Connecting a resistance load in TPRC (ex. a potentiometer), you'll obtain the limitation current output. In this configuration the internal velocity loop remains active.(See figure 2).

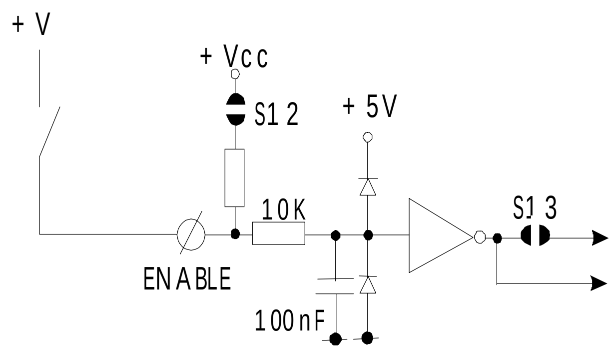


The potentiometer of the output current limitation 470K-1M Ohm.

Enabling drive with Positive Logic

Enabling drive with positive logic. Solder link S12 and S13 normally open. Logic input min. 8V, max. 24Vdc.

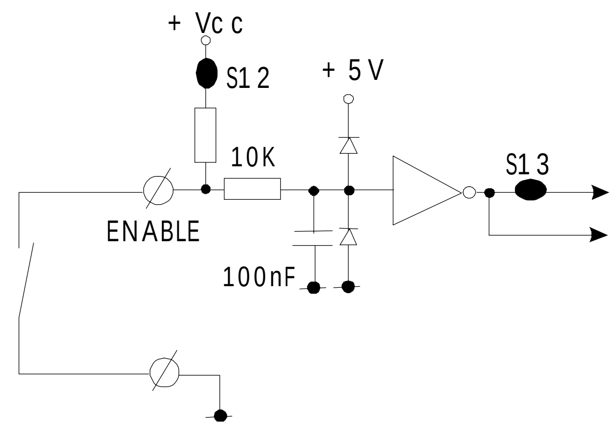
Unconnected input = Not Enabled
Input to +V = Enabled



Enabling drive with Negative Logic

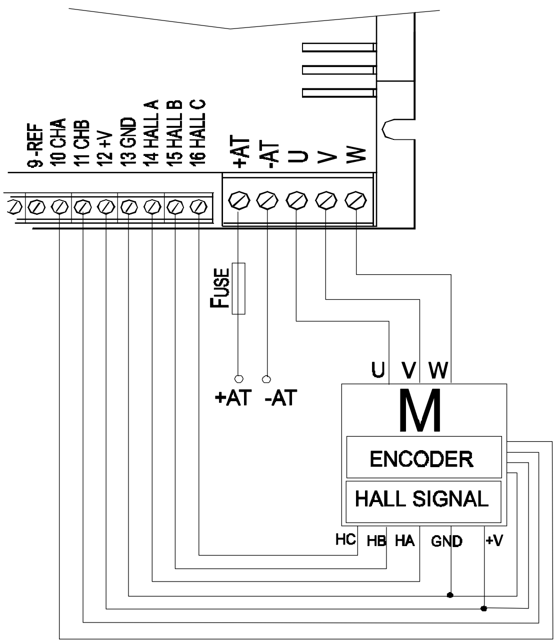
Enabling drive with negative logic. Solder link S12 and S13 closed.
Enable for input connected to GND.
Ving. < = 6V.

Unconnected input = Not Enabled
Input to GND = Enabled



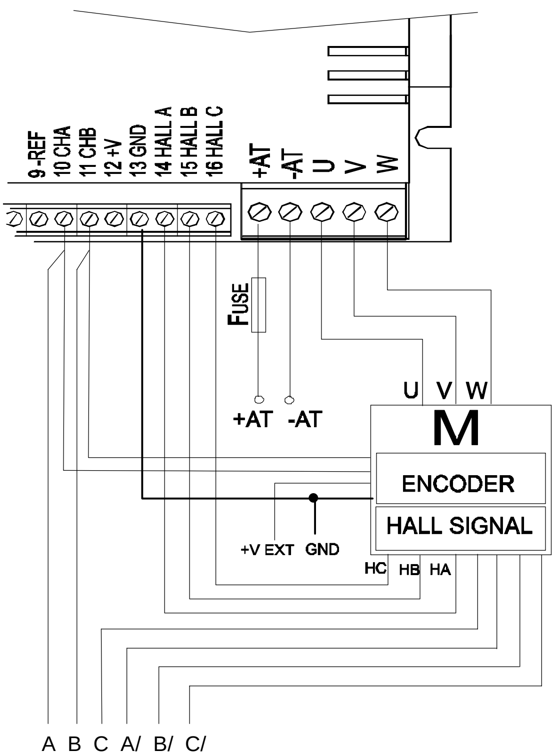
Hall Sensor + Encoder Connections

The following design shows typical connections between the drive and a brushless motor. In such configuration, Hall effect + Incremental type Encoder, A and B signals are used.
The Encoder and Hall Sensor power supply's come from the terminal +V (12) .



Encoder Connection with External Power Supply

The figure below shows a MiniAx with Hall and Encoder signals supplied externally.
The Zero of such an external power supply must be linked to the drives GND.



WARNING: If an external supply is used, is needed to **open the solder link S11** on pcb.

The incremental signals from the Encoder allows for motor speed regulation and can be used for eventual position control.
The drive can supply voltage to the connector +V equal to 5V.
(Preset in factory for 5V).
This +5 output is the incremental encoder power supply (as long as the total current required doesn't exceed @130mA). If the current required is unknow, use a tester (ampermeter) to check it. If the incremental encoder is powered by the CNC controller, connect the power supply's GND to the drive and connect incremental channels A and B.

If the Encoder used is not th **Push-pull/NPN type**, but i **+5Vdc balanced Line Drive type**, connect only the positive channels A and B, the GND and if necessary the Encoder's power supply.

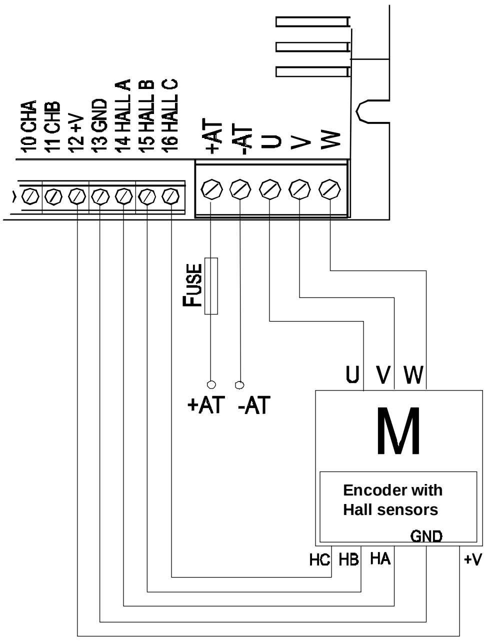
WARNING: If you insert a termination resistor between channel A and not A, between B and not B or C and not C of the Encoder Line Driver output, understand that the supply voltage will decrease.
It may not be enough to commutate the drive logic input A and B. (**V High>3,2V ,low< 1,5V**).

Encoder technical input data

Encoder input logic	Push-Pull ,Line-driver, Open-C.
Input acceptance level	Da 0 - 5V a 0 - 24V max.
Encoder max. frequency	250 Khz
Encoder power supply	+V= 5V Max @130 mA

Hall Signal wiring (ONLY)

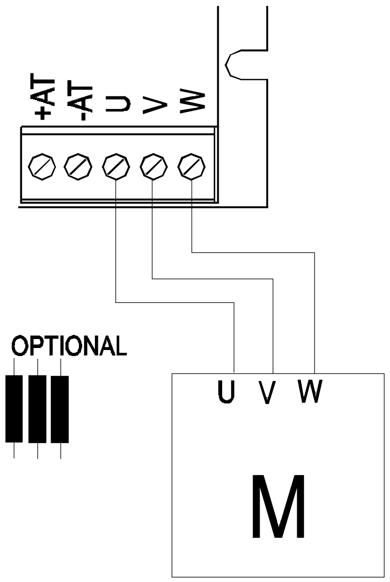
A)The following design shows connections to the drive using Hall Effect Signals (only).
Such signals are used for processing current and for motor speed regulation.
The field of regulation is inferior in respect to Encoder + Hall, but sufficient for many applications.



The Dynamic function is good from 300RPM up to max. speed. The speed is not affected of motor R*I drop.

3.7 Power wiring

The power cable sections are recommended as follows:
1.5 square mm up to 8/16 (included)
2.5 square mm up to 10/20 (included)
The U V and W drive outpust can be connected directly to the motor terminals.
The minimum motor inductance value is 200uH. In the case of motors driven with armature inductance lower than 200uH, it is necessary to use 3 chokes connected in series with the motor.
The amplifier itself is capable of driving motors with inductance between 200uH and 40mH.



If necessary, it is sufficient to adjust the current PI loop, opening solder bridge S7 and inserting a RKI resistor on the personalization area and a CkI capacitor in accordance to the table below.

Inductance Load (mH)

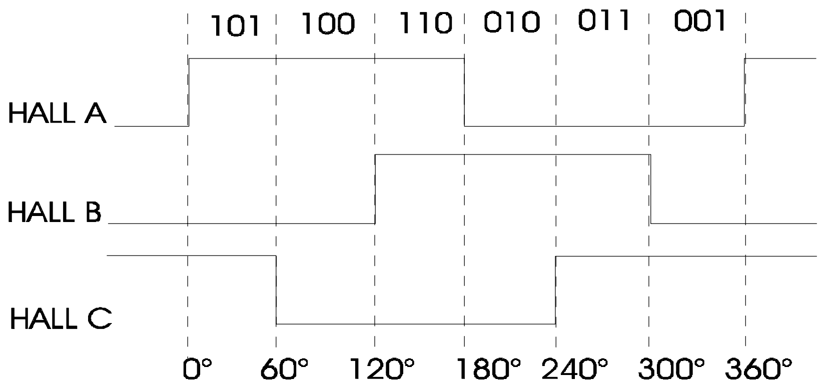
Value	0,2-1,9	2-4,9	5-14,9	15- 40
CkI	2.2nF	2.2nF	10nF	10nF
RKI	47K	220K	470K	1M

The factory configures the MiniAx for a (2-4,9 mH) inductance load.

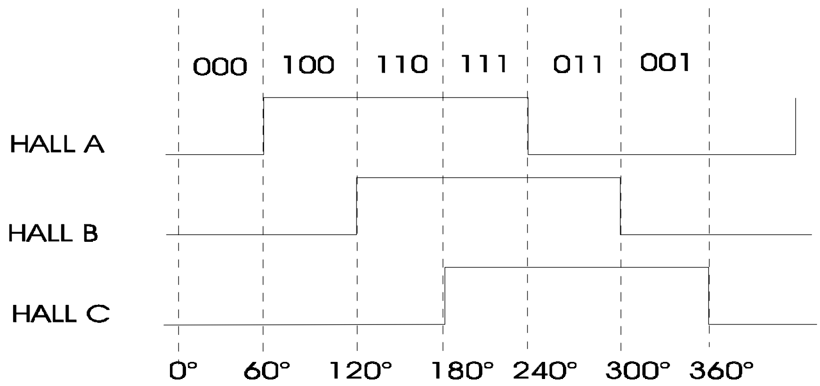
4.1 Logic Hall Signals 120° and 60°

The MiniAx is pre-arranged to function with Hall Signals 120° and 60°. This data are commonly used by th majority of manufacturers when hall sensors are present.
These signals assume the logic levels shown below during motor rotation.
The Hall sensors must be powered to be active. the logic signals are inverted when the motor rotation is changed.

120° Hall sensor



60° Hall sensor



Relative graphics with positive rotation shwon from motor shaft.

Standard configuration using 55MM Control Techniques motor is: incremental encoder +5Vdc balanced line driver output, 2048 step/rev for 3000 rpm motor and 1024 step/rev for 5000 rpm motor, with integrated Hall sensor at 120°

4.2 Practical example of Hall, Motor and MiniAx phasing.

Read the Initial Start Up note carefully. Especially if:
A) The Brushless motor wasn't purchased through and paired with the MiniAx by CONTROL TECHNIQUES.
B) the Brushless motor doesn't appear in the indicated identification table.
If this is the case, follow the following notes carefully:

1) A DC power supply from an insulated transformer (output must be between 24 - 80VDC).
2) A speed reference (A potentiometer "see figure previous connections) or a 1.5 - 3V battery.
3) Brushless motor with (60° Hall Cells or 160° Hall Cells powered with +5v).
4) A MiniAx.
5) An Enable switch (can be substituted by a wire bridge).

PROCEDURE:
--If present, Encoder channels were not mentioned to facilitate proper phasing research. They will be connected to the drive at the end of the following procedure.

--Verify the necessary power supply values for Hall effect Sensors. the drives are preset at the factory t supply +5V on the +V terminal.

--Connect DC Power Supply between +AT and AT. (Be sure that they are sectioned and properly protected.)
--Connect potentiometer as on page 33, or the battery between +ref and -ref.
--Preset the switch between +10V and enable or a wire bridge. the Enabling happens by putting positive voltage on the enable pin.
--Connect the Hall Signals between the motor and drive.
GND , +V ,Hall A , Hall B , Hall C.
--Enable MINIAX and turn motor shaft. If the OK LED remains on and the AH LED is off, the motor has Hall Effect Sensors 120° and all 3 signals are present.
If turning the motor shaft the AH LED comes on, the causes may be the following:
1)the motor has Hall Effect Sensor of 60°. In this case, close solder bridge S10 and try again. All of this must be done with the power supply off.
2) Hall Effect Sensor's are not powered.
3) Hall Effect Signal is missing. check with multimeter.

--Insert the 3 unknown motor phases in U V W which we will call A B C. There are 6 possible combinations to find the correct phasing. They are:

	U	V	W
1)	A	B	C
2)	A	C	B
3)	B	A	C
4)	B	C	A
5)	C	A	B
6)	C	B	A

Only one of these combinations is correct.

--Power MiniAx and enable it.
If the motor turns (even at low speeds and delivering torque) in both directions CW and CCW the U V W connections are correct.
The other 5 combinations (wrong) could cause the following:
-- the motor turns at max. speed without the possibility to control it by reference signal.
--vibration when motor is still in torque without the possibility to control it by reference signal.
-- Intermittent motor movement felt when touching the motor shaft.

Upon finding the correct U V W combination use it to connect the motor and drive.

5.1 Speed Adjustment with Encoder Feedback.

For this adjustment both Hall effect and Encoder signals are required from the motor.

This adjustment allows for regulation of motor speed through the use of signals from a 2 channel incremental encoder.

The functional characteristics, at low speed rotation, increases the resolution of encoder used. Use of an encoder with at least 500 Imp/Rev is recommended. A frequency multiplication circuit (internal) increases the Encoder's resolution by 4 times, thereby bettering its obtainable performance.
Example: using an Encoder with 1000 imp/rev (internal), you receive a final resolution of 4000 imp/rev.

The drives are furnished with the adjusted speed resistance RENC pre-installed. Speed adjustment=3000Rpm Encoder 500 imp/rev at 10V. In case of desired resistance variations open drive and change the resistor value. For calculations use
the following formula:

Renc = 680000 / Fenc.

The resistor RENC allows for the adjustment of low scale velocity at 10V of reference, to the desired frequency.

Where:

Fenc = Imp.g x Rpm / 60

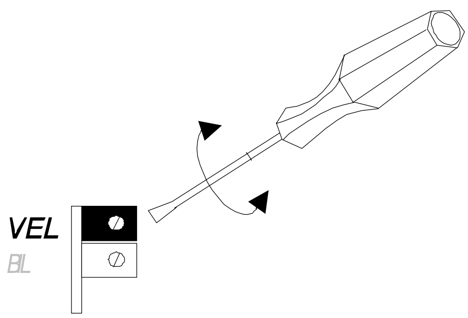
Speed Adjustment with Encoder Feedback

Example: N° Imp encoder= 500 -Motor Velociey 3000 rpm

Renc = 680000 / 25000 = 27.2Kohm

You will adapt to the nearest commercial value: 27K o 33Kohm.

Once the resistor RENC is inserted, proceed with final speed adjustment.
Operate using trimmer VEL on the front of the drive.



Clockwise Rotation.....................Speed increases

Counter Clockwise Rotation.........Speed decreases

The Range of regulation is +/- 20%

5.2 PWM Speed feedback adjustment

For this speed adjustment only Hall signals from the motor are sufficient.

The voltage from armature can be used as feedback when the motor doesn't have an Encoder.
This sistem gives less precise operation (1/20 field of regulation with a noticeable reduction in torque).
This function is enabled by opening solder bridge S4 and inserting resistors RA and RCA on personalization base.

RA resistor calculations: insert on base pin 2-23 to adapt the sistem to motor constant voltage.

RA	3K3	4K7	5K6	6K8	8K2	10K
VDC	13,6	17	19,7	23	26,5	31,8

RA	15K	18K	22K
VDC	44,5	52	62,9

On the table above the motor voltage values are shown, therefore speed gained through RA value (in Kohm).
The VDC voltage values are refer to the peak BEMF with a 10V reference. If the motor manufacturer declares RMS voltage, the corresponding VDC value will be VRMSx1,41.

Example E = 36VRMS
Nominal Speed = 4000Rpm

Consequently: VDC will be 36VRMSx1,41 = 50,76V

The table on page 52 shows a resistor with a value of 18Kohm. Inserting this resistor gives a motor scaling adjustment of 4000Rpm at 10V of speed reference.

RCA resistor calculation insert in the header(adjustment area)to compensate for voltage loss due to Ri motor resistor (internal).Thereby reducing the loss of RPM.

The formula is as follows:

RCA(k ohm) = (0,5*n*Ke) / (Vref*Ipk*Ri)

WHERE:

n= max. SPEED in rpm.

Ri=Max. cold motor resistance with brushes.

Ipk =Peak drive current.

Ke=BEMF from motor at 1000 rpm

Vref= max. applied reference voltage

If after insertion of resistor the motor is unstable, increase the Ohm value by inserting a superior value.

5.3 Hall Effect Sensor Speed Adjustment

For this speed adjustment only Hall signals from the motor are sufficient.

The voltage from armature can be used as feedback when the motor doesn't have an Encoder. This mode gives less precise operation, but is sufficient for lots of applications. (Minimum speed of 300Rpm in this configuration) For such a configuration open solder bridge S9,close S4 and insert a RENC resistor in accordance with the following formula:

$$Renc = 478000 / FHall.$$

WHERE:

FHall = K x RPM : 60	K = 1 For 2 pole motors
	K = 2 For 4 pole motors
	K = 3 For 6 pole motors
	K = 4 For 8 pole motors

Example: Motor with 4 pole motor n=4000 RPM

FHall = 2 x 4.000 / 60 = 133,3

Renc = 478000 / 133,3 = 3585 Kohm

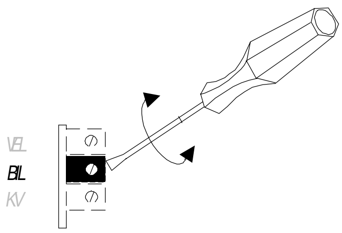
You use a resistor equal to 3,3 Mohm or 3,9 Mohm

WARNING: Be sure to take the RENC resistor off (if present). This resistor is for adjusting the encoder scaling. This value is completely different from the formula used in Hall Effect Speed adjustment.

5.4 Adjusting Speed Balance

Cont'd from previous page.

WARNING: Rotate the KV and DER trimmers counter- clockwise (ccw) when using Hall Effect Signal Feedback.
Note: The MiniAx frequency/voltage constants are pre-set according to series, for the Encoder Feedback. It is possible (in some cases) that such constants require modifications. For eventual information contatact CONTROL TECHNIQUES,



The drive is delivered with a Zero speed adjustment for Encoder feedback.
Re-adjust the Bil trimmer to correct eventual sistem offset. (You may compensate +/- 200mV from referenc input)
With the reference input at Zero turn the trimmer until the motor completely stops.

5.5 Nominal Current Adjustment

The drive is furnished pre-adjusted to give max. current according to size (R IN not mounted). To reduce and adopt to motor characteristics, insert a R IN resistor in the adjustment base. the table with obtainable curent re-entry in current (A) is shown below:

Value RIN in Kohm	*	18	8.2	4.7	3.3	2.2	1.8	1.2	1	0.82
5/10 (A)	5	4,6	4,2	3,8	3,6	3	2,8	2,4	2.2	2
10/20(A)	10	9.3	8.5	7.7	7.1	6.2	5.8	5	4.6	4.2

5.6 Peak current adjustment

To reduce the value of peak current "in the velocity mode",it's necessary to mount RIP on the header (see fig. 1) located inside of the drive.
For calculations use the following formula:

RIP=G x 48,7 / 1 - G

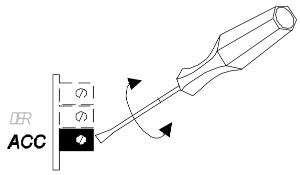
Where: G = RIP Request current
RIP drive current

Example: IPk motor 5A ,Drive 10/20A

RIP = 0,25 x 48,7 / 1 - 0,25 =16,2 Kohm

5.7 Ramp time adjustment

This function is enabled by solder bridges S1, S3 (closed).
It allows adjustment of the ramp slope during both acceleration and deceleration.
Adjusting the ACC potentiomenter, located in front of the drive, clockwise (cw) increases the ramp time between 0,1 and 1S (It corresponds to 10V reference). (See note 1)



It is also possible to modify the “range of the ramp” opening solder bridge S2 and mounting a resistor (RAMP) with the proper values reported in the table below. (see note2)

1)

S1	**S2**	**S3**	**Function**	**Range**	**Note**
Open	Close	Open	Ramp disabled	0 sec	Standard bridges
Close	Close	Close	Ramp enabled	0,1-1 sec	Adjusted by Acc pot
Close	Open	Close	Ramp enabled	RAMP	Adjusted by Acc pot

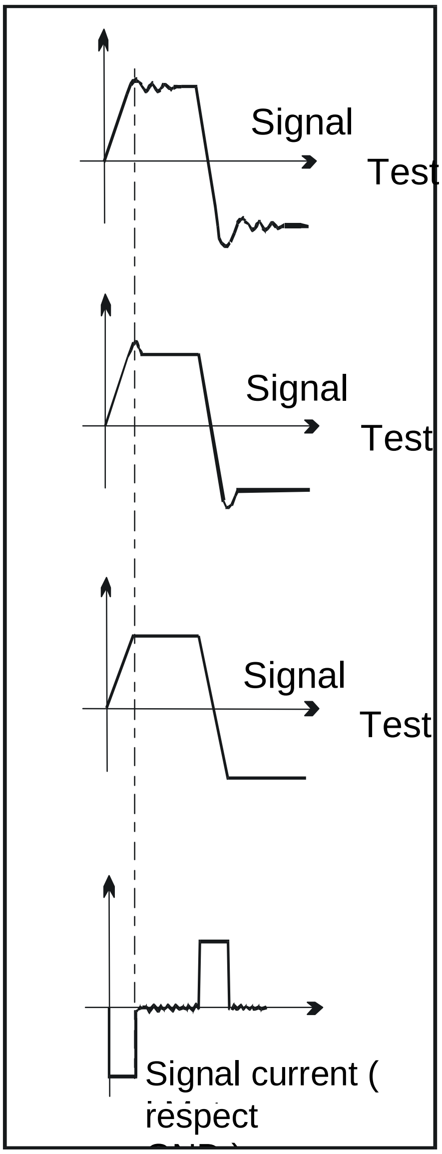
2)

RAMP Resistor	680K	820K	1Mohm
TIME	0,2-2,6sec	0,3 - 3,2sec	0,4 - 3,9sec

5.8 Dynamic constant adjustment

Usually, these calibrations are made by the factory and do not need adjusting.
Only re-tuning by KV and DER potentiometer is required.

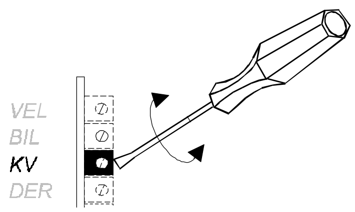
If high inertia loads are present (ratio 3:1 between load and motor),it is necessary to modify the proportional gain by “KV potentiometer” and increase the value of derivative by ”DER potentiometer”.
The adjustment procedure must take place with the load connected to the motor.
Connect a function generator with square wave (0,5 Hz +/- 1V) and apply it to the input speed referenc terminals.
Connect the probe of the memory oscilloscope “channel A” to the test point TP1. (The ground of the probe must be connected to the GND of the drive).
Adjust in a clockwise(cw) direction the “DER potentiometer”.
Be sure that the load’s motion doesn’t create a safety risk.
Apply power to the drive and start it.
The load will begin to move alternatively; if possible increase the generator amplitude up to +/-2V.
Check the signals in the oscilloscope; the waveforms should be as shown on the right.

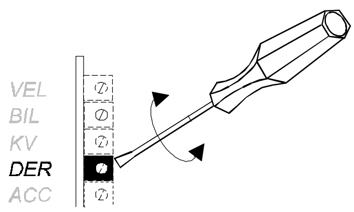


Insufficient proportional gain.

Increase the gain by turning clockwise (cw) using "KV potentiometer" until achieving a situation as shown on the left.

To reduce the overshoot adjust clockwise (cw) using "Der potentiometer" until achieving a situation as shown on the left.





Caution: Do not exaggerate with the gain:
it can cause unnecessary motor heating
caused from ocsillating currents in the motor.
It's possible to increase the velocity loop derivative constant by inserting a capacitor CDER on the personalization adjustment. See Chapter 2.4

6.1 Troubleshooting

1) Supplying power -the green OK LED doesn't come on.

- check the voltage value with multimeter (between +AT and -AT).

2) With the green OK LED on the motor doesn't run when the drive is enabled.

- Check input signal (Enable-reference)

3) When the drive is enabled the green OK LED goes off and the red O.C. LED comes on.

- Short circuit between motor terminals or motor winding is connected to ground. Switch off and measure with tester.

4) During motor deceleration phase the green OK LED blinks.

-You've exceeded max. allowed voltage. Verify filter capacitance value. (See Power Supply chapter).

5) During operation the motor stops and the S.T. LED comes on.

-Environmental temp. is to high (more than 40°C). Ventilation missing (where required).

6) Motor goes out of control when enabled.

Encoder signals incorrectly connected (CHA and CHB

inverted amongst themselves, or encoder power supply

missing).

7) At Startup or Enabling the AH Led comes on.

-Solder Bridge S10 wasn't set correctly.
-one or more missing Hall Signals.
-Missing power supply to Hall Cells.