MOTION CONTROL SYSTEMS

HARDWARE INSTRUCTION MANUAL
STEPPING MOTOR DRIVES
PLUS ET B SERIES

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R.T.A. s.r.l. – PLEBME02 – 11/20

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WARNING: it is user RESPONSIBILITY to check that this manual refers to product model and version that will be used

Symbol meaning

⚠ The section marked with this symbol contains warnings regarding safety problems. If the directions indicated in these sections are not fulfilled, it could arise hazardous situations .

⃠ The section marked with this symbol contains information regarding operations which are strictly forbidden.

1 - NOTICES AND MANUAL STRUCTURE

1.1 - This manual covers the following items:

- PLUS ET series stepping motor drives in all their standard versions.
- Standard characteristics of special versions of PLUS ET series stepping motor drives (see chapter 1.2).
- For models and versions identification see also chapter 3.

1.2 - For the purposes of this manual the terms used assume the meaning below described (see fig. 1).

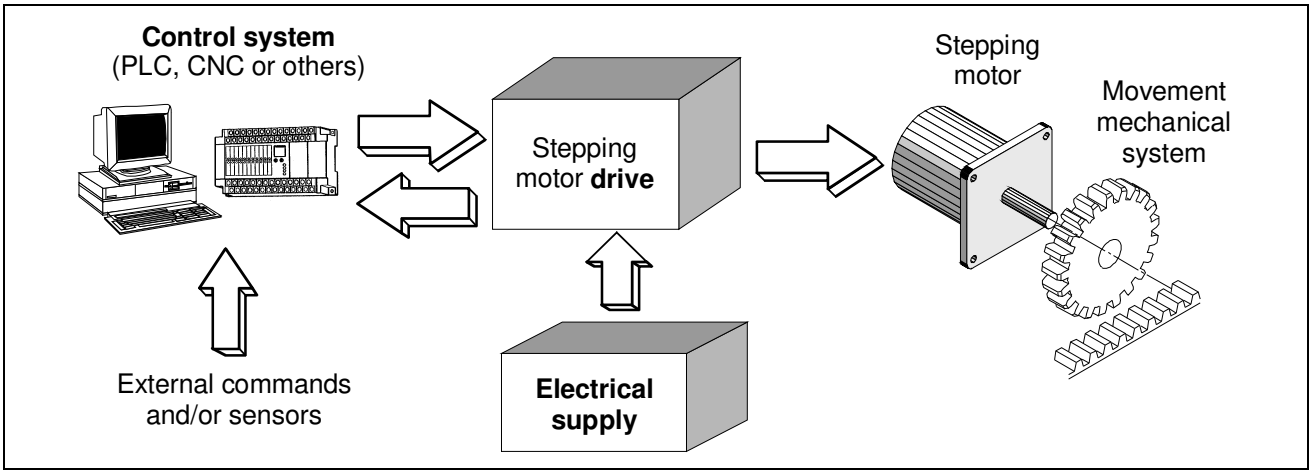


Fig. 1

- Drive: electronic part of an electromechanical motion system, which receives some digital or analog input signals from an external control system and gives to the stepping motor the suitable phase excitation sequences, in order to obtain the mechanical movements required by the control system. The drive can also communicate its status to the control system through some logic signals. In this manual we consider the drive as a BDM (EN 61800-3, chap.3, Fig.1).
- Control system: part of the machine which decides and controls all machine functions and gives to the drive all execution commands. It could be a numerical or programmable control, a personal computer or a specific control card. In the simplest machines it could also be a group of sensors and electromechanical switches.
- Electrical supply: all machine parts suitable to supply the drive in a correct way; usually filter capacitor, transformer separating from the main, anti-interference filter and all switches and protection systems.
- Standard drives are all models (see chapter 3 for identification) whose characteristics comply completely with those described in this manual. Special versions are all models in which some characteristics differ from the description given in this manual. For these models, some part of the manual does not apply and, in these cases, you must have the specific "variation sheet" which becomes an integral part of the manual itself.

1.3 - Products described in this manual (see list in chapter 1.1 and identification code in chapter 3) are CE marked and comply with the following directives:

1) Low Voltage (2014/35/CE).
2) Electromagnetic Compatibility (2014/30/CE).

1.4 - Remember that, as stated in all directives, compliance exists only when a product is used in accordance with its destination and following manufacturer prescriptions. Thereby, all relevant indications about use, cautions, installation and limitations here described must be followed by user in order to stay within compliance limits: from this point of view, chapter 2, 8 and 10 are particularly important, but the entire content of this manual has to be carefully read and considered in order to obtain the information necessary for a correct use.

1.5 - Conformity declaration regarding above mentioned products is kept by R.T.A. (as manufacturer residing in EEC country) together with technical construction file at authority disposal.

1.6 - This manual is conceived in a way to offer to the personnel involved in project and safety verification of a machine all information concerning characteristics, working conditions, application limits and cautions about PLUS ET series stepping motor drives. The knowledge of this information is essential for a correct project of machines, apparatus and systems in which the drives are used, it is strongly recommended not to start any operation with the drives before you have completely read and understood the content of this manual. If you find some part of this manual not completely understandable or lacking regarding your particular application, do not hesitate to contact directly R.T.A. that can provide, if necessary, further information in order to make the user able to design his machine and the related safety systems in the best way. Take into account that an incorrect use or installation, a wrong dimensioning of external safety elements related with the drive could bring to economical damages and also to hazards for human life.

1.7 - Consider the fact that these are products with a very wide range of possible applications in many different working and environment conditions. For this reason this manual can only fix limits and general rules but cannot take in consideration every single possible application condition. If you have problems to understand some part of this manual or to meet its indications with your specific application, do not hesitate to contact R.T.A. for further information. Take into account that R.T.A. has twenty years of experience in any kind of applications, which cannot be condensed in a manual but can always be at customer disposal.

1.8 - The terms "user and customer" often used in this manual always indicate a skilled person as defined in chapter 2.9.

1.9 - This manual is considered valid at the moment of the selling of the product. It cannot be considered inadequate as a consequence of product or manual changes or improvements after the selling. R.T.A. reserves the right of products and manual revisions without notice neither obligation of previous products and manuals revision.

2 - ⚠⃠ LIMITATIONS, HAZARDS AND CAUTIONS

2.1 - PLUS ET series drives are suitable to drive two phases stepping motors with 4, 6 or 8 terminals. It is not allowed the use of stepping motors with 5 terminals.

2.2 - It is not allowed the use of these drives for any purpose different from the one above indicated.

2.3 - It is also not allowed the use in any condition not complying with one or more specific limitations stated in this manual for electrical, mechanical and environmental quantity or characteristics.

2.4 - PLUS ET series drives are classified as protection degree IP20. This means that they must be located inside a protective enclosure meeting requirements of standards applicable in the specific application in which they are used.

2.5 - PLUS ET series drives and related power supply contain capacitors able to store a certain amount of electrical energy. As a consequence, in some cases, according with application conditions and supply dimensioning, a dangerous voltage could remain on the drive, after switching off, for a time greater than 5 seconds. So it is recommended to wait an adequate time before working on the drive.

2.6 - The heatsink can reach high temperatures during normal working conditions (for example about 80 °C). Do not touch this component for some minutes, after switching off, in order to avoid scald hazard.

2.7 - After a failure due to connection mistakes or others, in the drives could arise a temporary hot spot. For this reason avoid absolutely to install in explosive or flammable environments. **Avoid also to install near easily flammable materials and components;** we recommend to verify that all the components located in the enclosure are realized using self-extinguishing materials.

2.8 - All products considered in this manual are sub-assemblies without a direct function, foreseen to be integrated in a more complex machine. Only a professional assembler, expert in the field of motor drives and in their related problems, can install and put in service this component. It is exclusive responsibility of the designer of the complete machine or installation in which this component is used to take care of the safety and reliability of his project. It is forbidden to use this material in application covered from one or more EEC directives (for instance 2014/30/CE, 2006/42/CE, etc.) before the conformity to those directives has been declared. Regarding 2014/30/CE directive, see chapter 10.

2.9 - Use for safety related functions is forbidden (EN 60204-1). Moreover, when the application arrangement is in such way that a drive fault or failure could generate a dangerous condition, external independent safety protection system must be provided in the machine.

2.10 - In some case of drive failure, dangerous high voltage could appear at logic low voltage input and output terminals, even if this event is extremely rare. For this reason, from the point of view of evaluation of the machine safety during a single fault condition, the external control system, connected to these inputs, has to be considered potentially subjected to high voltage, unless an external separation is provided.

2.11 - EtherCAT commands used to switch off the drive output power and internal electronic functional protections use semiconductor devices; they cannot be used to interrupt power in emergency stop function or in any function involving personnel safety.

3 - GENERAL CHARACTERISTICS AND IDENTIFICATION

3.1 - DIMENSIONS

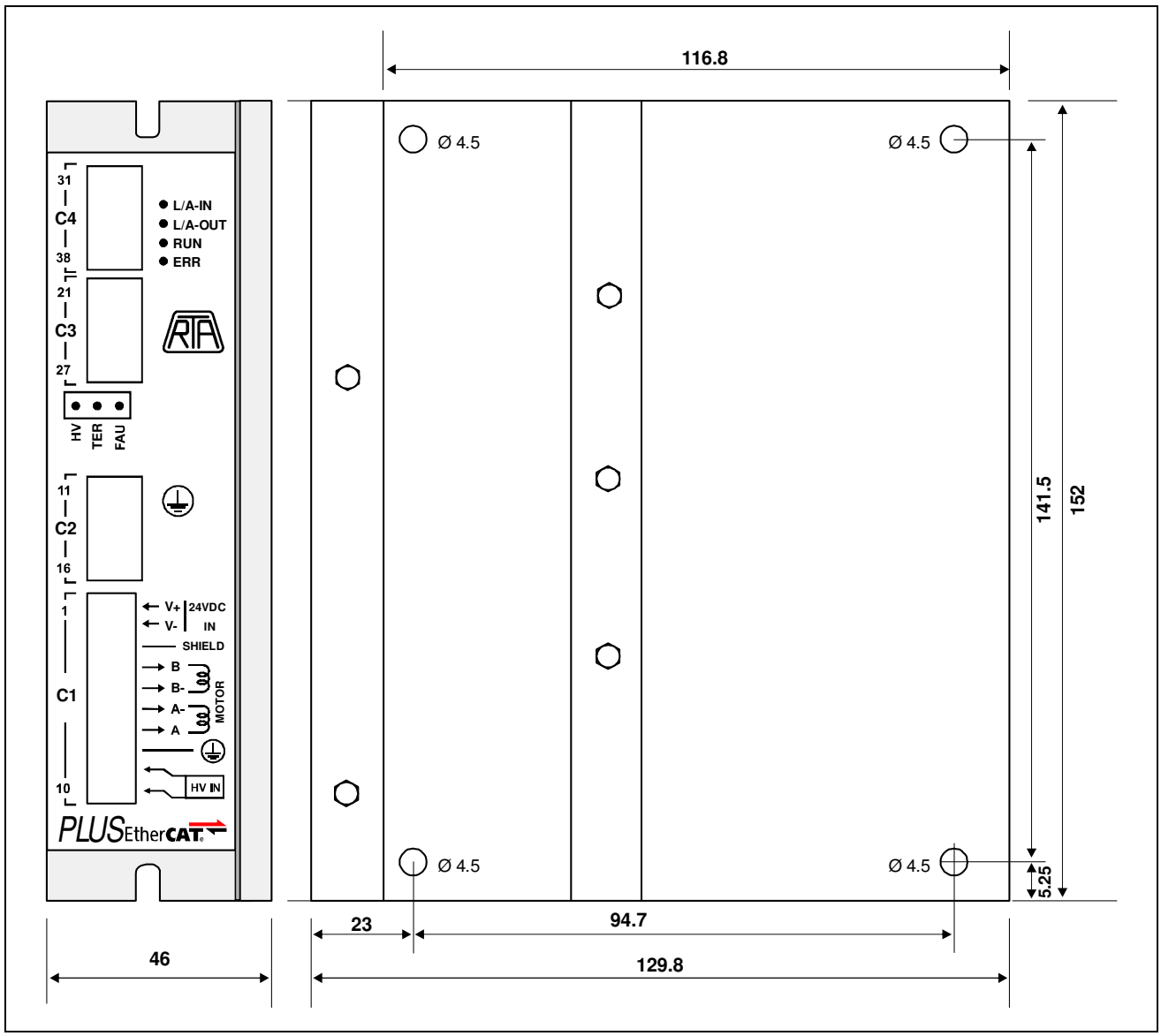


Fig. 2 – Dimensions: all measures in mm.

3.2 - IDENTIFICATION

The models identification of PLUS ET B series drives is as follows:

PLUS ET BX.Y

where:

X can be: 3 or 4 and identifies a standard model, differing for current value.

.Y is not present in standard models. If present Y can be a number or an alphanumeric character identifying a special version with some variations with respect to standard models.

Each sample is also identified with a serial number.

4 - INPUT AND OUTPUT LOGIC SIGNALS
(C2 and C3 Connectors, see Fig. 2, 4 and 6)

All input and output logic signals are optically insulated among them and from internal power circuits.

4.1 - INPUTS (C3)

An input is ON when at its terminals is present a voltage within the following limits:

8 Volt < Vin < 24 Volt

For each input signal correspondent terminals numbers of connector C3 are indicated.

21, 22: **NOT CONNECTED.**
23 (I3): **I3 INPUT.** Auxiliary input.
24 (I2): **I2 INPUT.** Auxiliary input.
25 (I1): **I1 INPUT.** Auxiliary input.
26 (I0): **I0 INPUT.** Auxiliary input.
27: **COMMON OF INPUTS.**

NOTE: Depending on status of object 320Ch, inputs I0, I1, I2 can be used as special function inputs (see software manual).

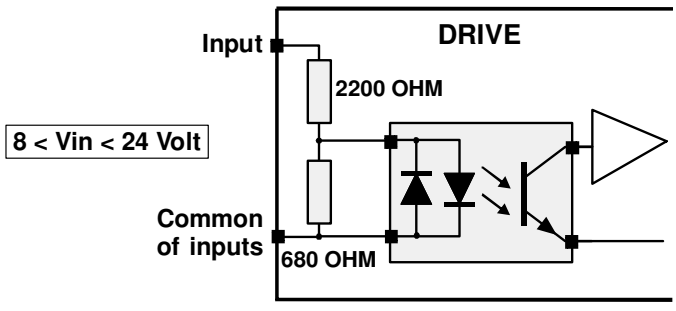
4.2 - OUTPUTS (C2)

The outputs are considered ON when they are closed as regards to common of outputs (16). For each signal the correspondent terminals numbers of connector C2 are indicated.

11, 12: **NOT CONNECTED.**
13 (O2): **O2 OUTPUT.** Auxiliary output (50 mA max).
If it is set as **Driver FAULT OUTPUT** (see software manual), output is ON when drive is active; output is OFF when drive is blocked by a protection.
14 (O1): **O1 OUTPUT.** Auxiliary output (50 mA max).
If it is set as **BRAKE OUTPUT** (see software manual), output is ON when drive is in Operation Enable state. Please use a relay with a flyback diode to drive the brake.
15 (O0): **O0 OUTPUT.** Auxiliary output (5 mA max).
16: **COMMON OF OUTPUTS.**

NOTE: Depending on status of object 320Ah, user can set output values (see software manual).

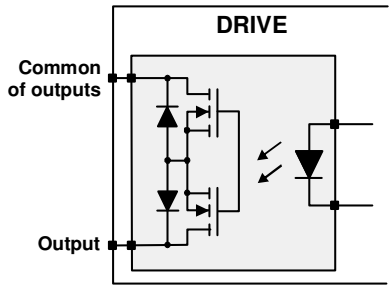
Inputs structure scheme



(3a)

Output structure

Vmax = 45 Volt
Imax = 5 mA for O0 output
Imax = 50 mA for other outputs
Vsat ≤ 1 Volt



NOTE:
Insert a protection diode in parallel with the load in case of inductive load (ex. relay)

(3b)

Fig. 3 – Inputs and outputs scheme.

4.3 - ENCODER INPUTS AND POWER SUPPLY (C4 Connector, see Fig. 2, 4 and 6)

For each signal the correspondent terminals numbers of connector C4 are indicated.

Pin	Description	RTA cable colors
31	**+5 V_{DC}** (Imax = 150 mA)	RED
32	**IN- I.** IN- INDEX.	WHITE
33	**IN+ I.** IN+ INDEX.	ORANGE
34	**IN- B.** IN- phase B encoder.	PURPLE
35	**IN+ B.** IN+ phase B encoder.	GREEN
36	**IN- A.** IN- phase A encoder.	BROWN
37	**IN+ A.** IN+ phase A encoder.	BLUE
38	**GND**: Negative encoder power supply	BLACK

Note1: Negative encoder power supply (terminal 38) is internally connected to 2, 3 and 8 terminals of C1.
Note2: C4 connector must be used to connect encoder of RTA EM / RM series motor

See also software manual for proper motor setting in combination with drive, with reference to setting of object 0x3210. For different motors with encoder please contact RTA.

4.4 - RJ-45 CONNECTORS (EtherCAT communication)

Two standard Ethernet RJ-45 modular connectors (IN, OUT) are provided for the EtherCAT communication. The same pin disposition (same signal) is assigned for both connectors. Figure 4 shows connector RJ-45 used for connection between the drive and the control system.

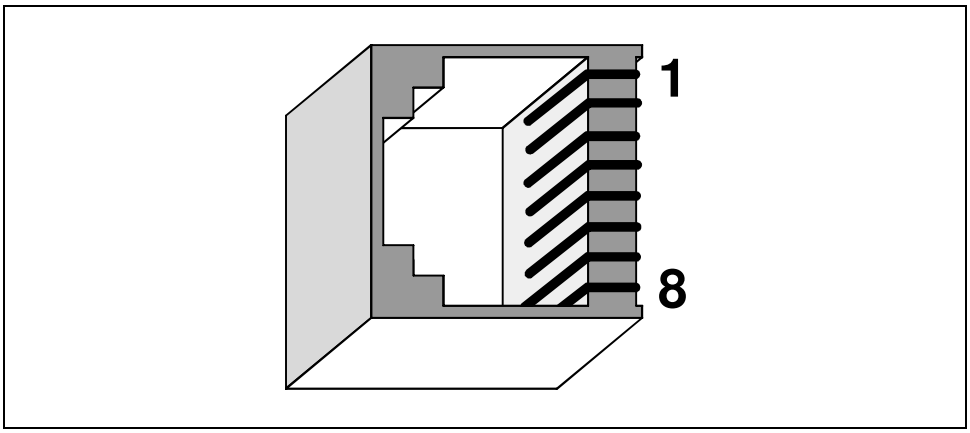


Figure 4 – RJ-45 modular connector

Terminal Number (IN / OUT)	Signal (Ethernet Connection)	Description
1	TX+	Transmitting signals +
2	TX-	Transmitting signals -
3	RX+	Receiving signals +
4	--	75 Ω Connection
5	--	75 Ω Connection
6	RX-	Receiving signals-
7	--	75 Ω Connection
8	--	75 Ω Connection

Table 1

Connect IN to the higher-level device and OUT to the next slave.
Use twisted-pair cables that satisfy at least “Category 5e” to connect the cable.

When you make cables using exclusive tools, use STP (Shielded twisted pair cable) and RJ-45 modular plug with shield.

5 - INPUTS AND OUTPUTS POWER LINES

In this chapter drive inputs and outputs power lines and the required power supply lines are described.

5.1- Drive power outputs are the four phase lines driving the stepping motor winding. Drive power inputs are two lines that must be connected to $\mathbf{V_{AC}}$ power supply. All terminals in connector C1 are listed in the following Table 2.

TABLE 2	
CONNECTOR C1	**DESCRIPTION**
1	Positive terminal logic supply (LV_{DC} 24V)
2	Negative terminal logic supply (LV_{DC} 24V)
3	Shield of shielded motor cable
4	Motor winding terminal B
5	Motor winding terminal B-
6	Motor winding terminal A-
7	Motor winding terminal A
8	GND
9	Terminal power supply (HV_{AC})
10	Terminal power supply (HV_{AC})

5.2- Earth terminal (see Figure 5) – Earth terminal is on the frontal panel in the middle of it and has to be electrically connected to earth (PE terminal of the machine in which the drive is installed).

5.3- The terminal indicated as GND is the point of motor-drive system that has to be connected to earth (PE terminal) in order to guarantee the correct operation of some drive protection systems. No other point at a different potential of logic circuit and of power circuit has to be connected to earth; in particular it has not to be connected to earth transformer secondary winding. Shield of shielded cables of motor outputs must be connected to terminal 1 of C1 connector and shield of shielded cables of signal outputs must be connected to PE with connection with the less possible length. Furthermore it is important to note that GND terminal is internally connected to terminal 3 and 8 of C1 and to terminal 38 of C4. See connection schemes of Fig. 6, 11 and 12.

5.4- Table 3 shows power inputs and outputs characteristics:

TABLE 3		PLUS ET B3
HV_{AC} nom	**(VOLT)**	from 28 to 62
LV_{DC} nom	**(VOLT)**	24
Tolerance V_{AC} nom	**(%)**	+/- 10
I_{NP} nom	**(AMP)**	6
Phase inductance	**(mH)**	from 0.8 to 12
Dimensions	**(mm)**	152 × 129 × 46
Operating temperature		from +5°C to +40°C (see par. 8.3)

5.5- Definition of terms used in Table 3:

HV_{AC} nom: value of alternate voltage at which the drive can be supplied.

LV_{DC} nom: value of logic continue voltage at which the drive can be supplied.

I_{NP}: indicates nominal phase current (peak value), which flows in each motor winding, it can be measurable with motor turning at **low speed**. The drive provides an automatic current reduction equal to 50% of the nominal value when the motor is in hold condition.

6. DRIVE SETTING AND ALERT SIGNALS

6.1- PLUS ET series drives are general purpose products which can be used to drive many different motor models in different kind of applications. For this reason they can be set with proper commands (see programmer's manual) suitable to adapt drive characteristics to the specific motor and/or application. **Do not forget to do these settings: wrong setting could get application errors and also motor damages and hazard conditions.** Three led indicate the drive status.

6.2- Fig. 4 shows the position of alert LED, connectors and labels on the case.

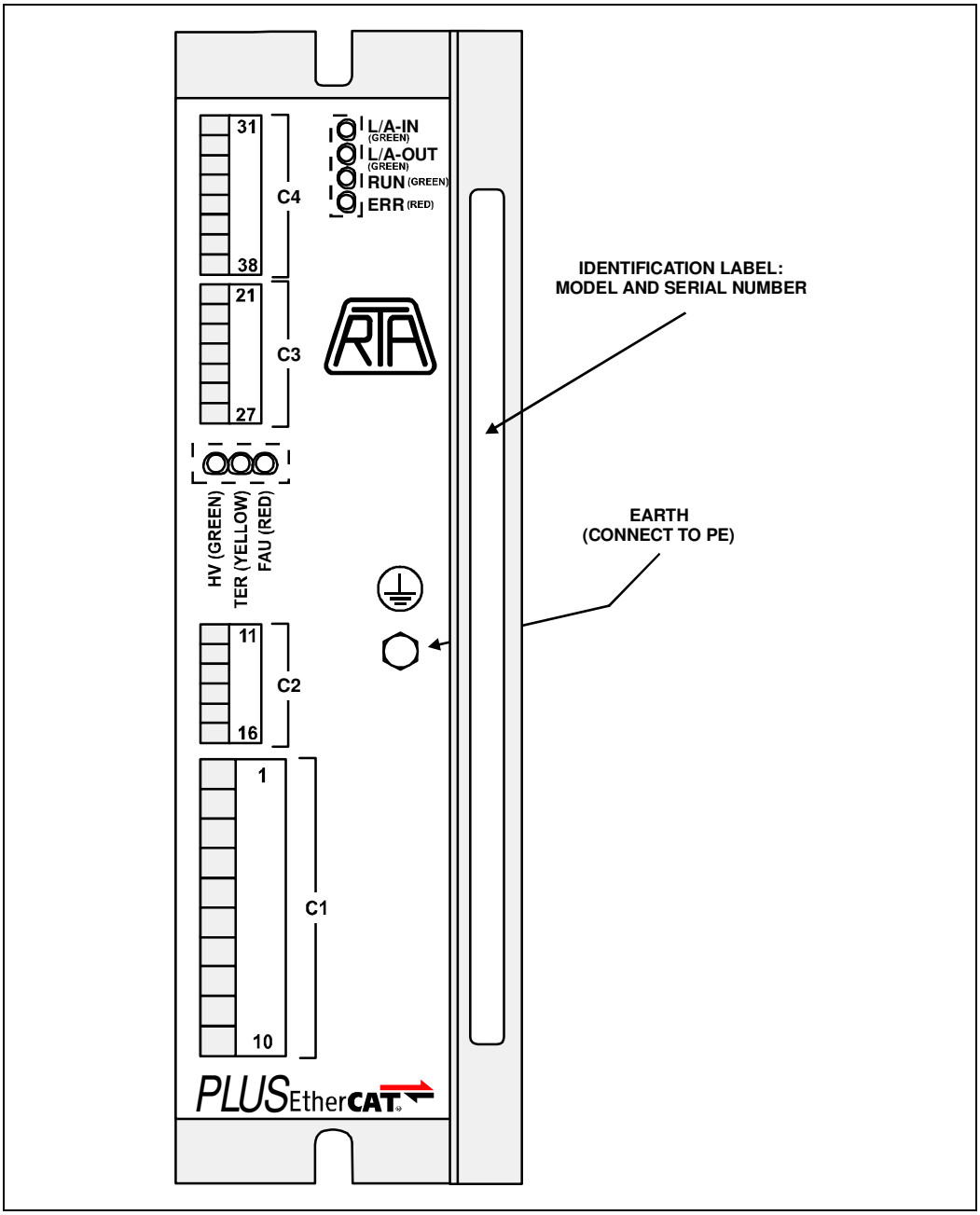


Fig. 5 – Alert led and connectors.

6.3- Fig. 5 shows the position of EtherCAT connectors located on the high side of the case.

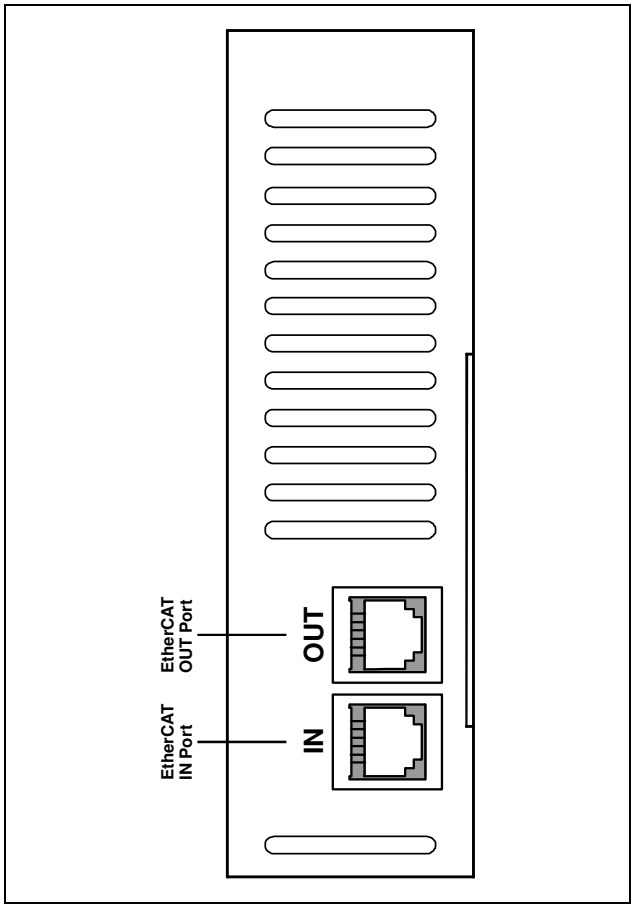


Fig. 5 – EtherCAT connectors (PLUS ET series drives high side view).

6.4- The following list shows the meaning of the alert LEDs.

***LED HV (green)*:** ON = supply voltage is in the correct operating range.

OFF = drive is not supplied or supply voltage is out of the correct range (in the second case also LED FAU is ON).

***LED FAU (red)*:** ON = drive is in no-working state due to one of the following protection:

a- Thermal protection (if LED TER is ON).
b- Max or Min supply voltage (if LED HV is OFF).
c- Short circuit or wrong motor connection (if LED HV is ON and LED TER is OFF).

OFF = drive is in working state if LED HV is ON.

***LED TER (yellow)*:** ON = drive is in no-working state by thermal protection (in this case LED FAU is ON).

OFF = heatsink temperature is lower than the limiting value.

When one of the above-written protections occur, the drive goes in Fault state, in accordance with standard EtherCAT (see software manual).

6.5- The following list shows the meaning of the alert LEDs provided for the EtherCAT communication:

PORT0 Link/Activity indicator: L/A – IN (green)
PORT1 Link/Activity indicator: L/A – OUT (green)
RUN indicator: RUN (green)
ERR indicator: ERR (red)

7. DRIVE EXTERNAL CONNECTIONS

7.1- Design the power transformer: the power of transformer has to be higher than the sum of the power requested from drive and motor (total power). This one can be calculated as the sum of the following terms:

- Mechanical power delivered to load: mainly depending on application characteristics like friction, inertia, efficiency of mechanical transmission etc.
- Motor losses: mainly depending on motor type, drive voltage, speed and duty cycle.
- Drive losses: mainly depending on drive model, current setting and duty cycle; according with these parameters these losses can approximately vary between 60 and 130 Watt. It is often very hard to estimate drive and motor losses; in this case an over-dimensioning of the supply elements proportional to the inaccuracy is recommended. To get more accurate information, contact R.T.A. and describe the particular application. Obviously if a single power supply is used for more than one drive, the total power is equal to the sum of the single drive powers.

7.2- Transformer must meet the following requirements:

- Supply the correct voltage through a transformer secondary winding. The V_{AC} voltage value is intended as measured at secondary terminals in no load condition and with primary voltage equal to the nominal value. Maximum voltage drop at full power load must be less than 5%.
- Ensure the galvanic insulation between the drive circuits and the main. **Remember that direct connection of drive circuits to the main is strictly forbidden. The use of autotransformer is strictly forbidden.**
- Ensure the galvanic insulation between the drive circuits and all other circuits of the same machine. **This means that the drive dedicated transformer secondary has to be used exclusively for the drive.**

7.3- The use of one secondary winding for more drives (max 3 drives) is allowed only if the total power required by the drives is less than 600VA. In any case, two fuses (F1 and F2 showed in Figure 6) for each drive must be used.

7.4- **Branch circuit protection fuses F1 and F2 (see Fig. 6) must be 10 Amp, at least 250 Volt with I^2t between 150 A^2s and 400 A^2s (for example Littelfuse 215010.P or Cooper Bussman model KTK-R-10).**

7.5- The cross-section area of conductors used in power supply circuit must be chosen according with power dimensioning (see 7.1). The cross-section area of the four shielded conductors connecting motor to the drive must be chosen with regard to the nominal current which has been set in the drive.

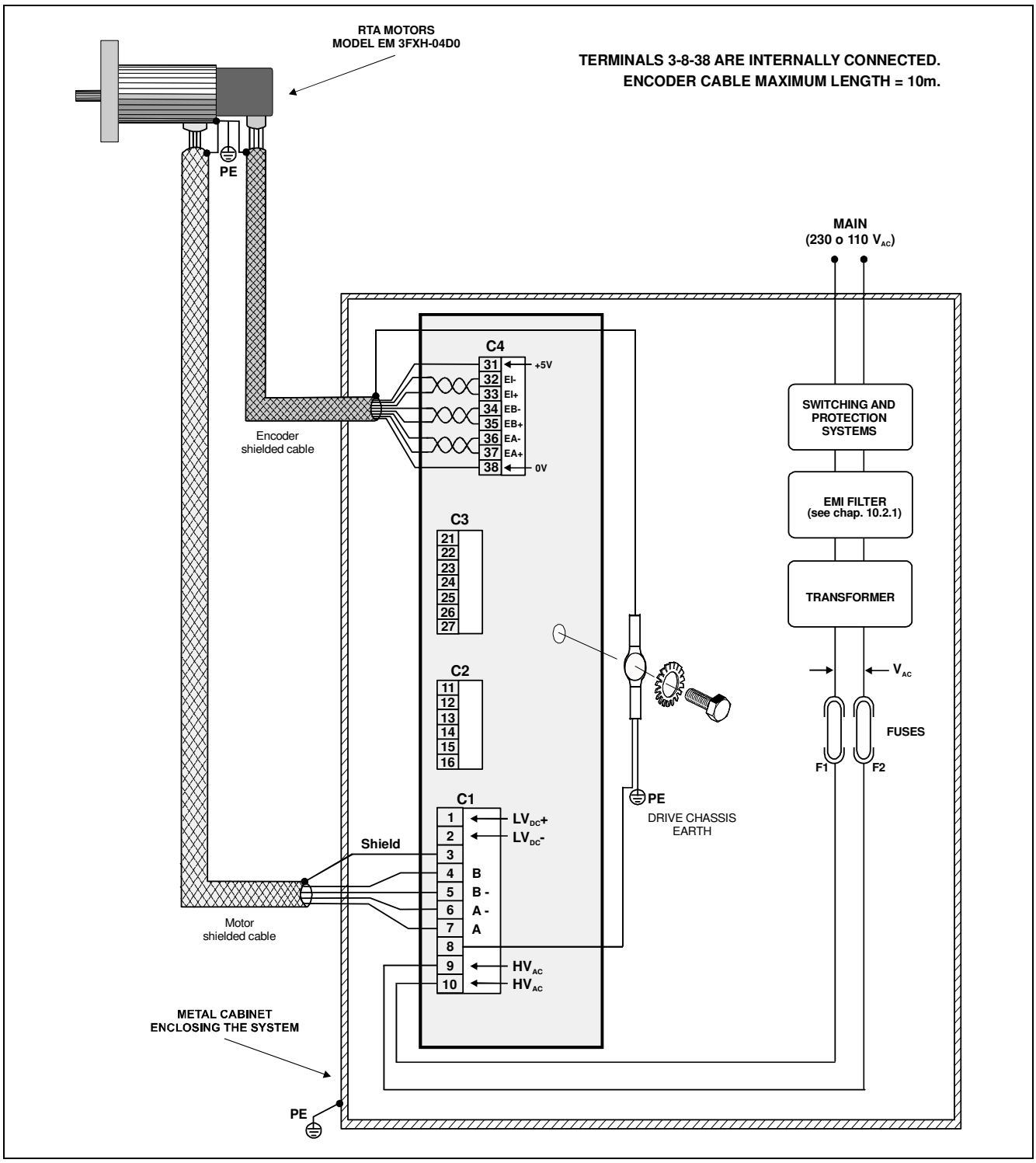


Fig. 6 – Drive external connections scheme.

NOTE: For connection drive-encoder use twisted-pair shielded cable (EI- and EI+; EB- and EB+; EA- and EA+).

8. ⚠ ⃠ INSTALLATION AND ENVIRONMENT LIMITS

All products described in this manual are subjected to the following characteristics:

8.1- IP20 protection degree: it is user responsibility to provide an adequate protection enclosure suitable to meet the standards regarding the specific application in which the products are used.

8.2- Direct connection with the main is not allowed. Transformer separation is mandatory.

8.3- Installation and work environment. Installation is allowed in a micro-environment with:

- **Environment conditions class 3K3** (IEC 721-3-3): it includes a working temperature from +5°C to +40°C and relative humidity from 5% to 85% non condensing.
- **Pollution degree 2**: it includes that installation in environments in which explosive and/or flammable and/or chemically aggressive and/or electrically conductive gas, vapor or dust could be present is strictly forbidden.
- **Mechanical conditions class 3M1** (IEC 721-3-3).

If the environment in which the machine is used does not satisfy these conditions, suitable conditioning system or suitable case have to be used.

8.4- Storage environment limits with drive in its original packaging:

- Temperature: from -25°C to +55°C. Relative humidity: from 5% to 95%.
- Environment conditions class 1K3 (IEC 721-3-1). Pollution degree 2.

8.5- The drive generates some amount of heat (see chap. 7.1). This must be considered during the global electrical cabinet design. In order to ease air flowing around the drive, install the drive vertically (not turned upside down) with at least 5 cm of free space over and under the drive and 1 cm on the left and on the right of the drive. Do not obstruct air gratings.

9. LOGIC INTERFACING EXAMPLES

In this chapter some interfacing techniques are shown. They have to be considered only as examples. The best way to interface the drive with the control system can be chosen only with a complete knowledge of the control system and application requirements.

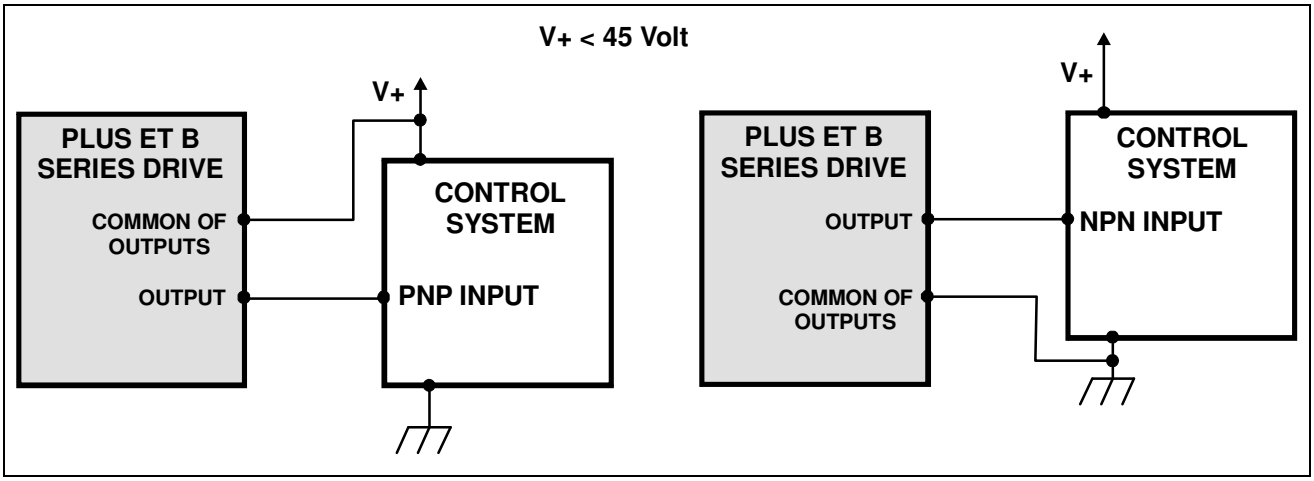


Fig. 7 – Electric connection between a PLUS ET B logic output and an input of a control system operating at V+ voltage.

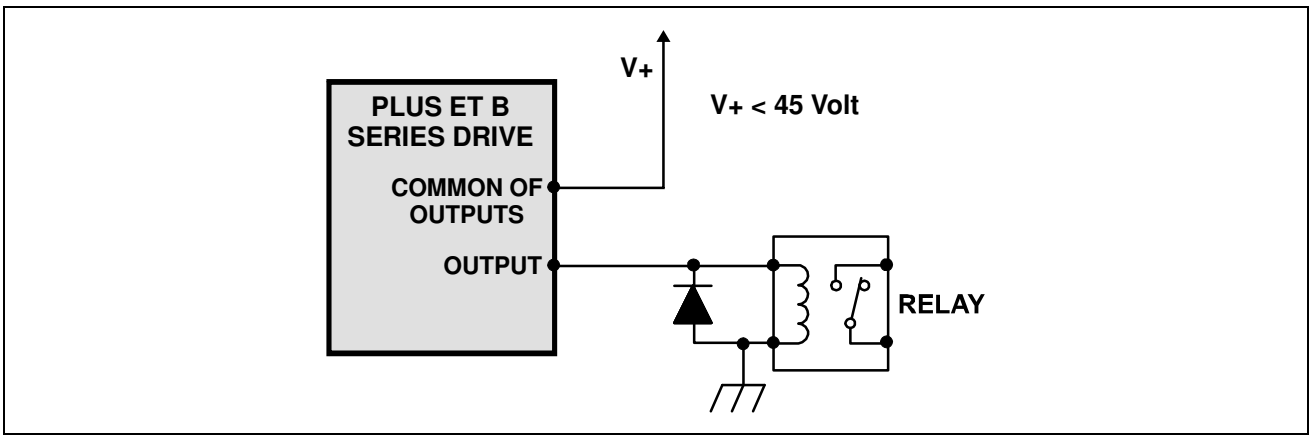


Fig. 8 - Driving a micro-relay by means of a PLUS ET B logic output.

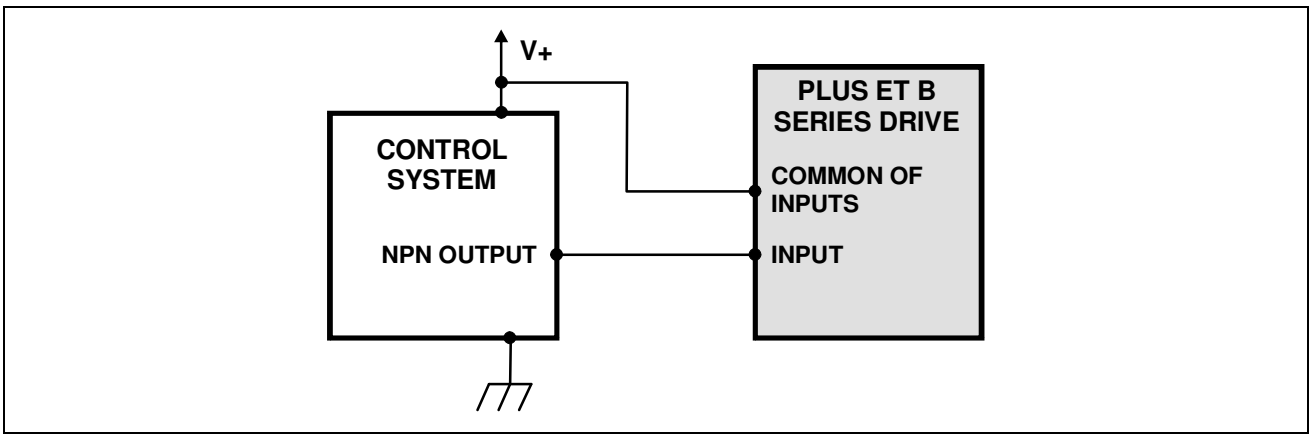


Fig. 9 - Driving a PLUS ET B logic input from a control system with a NPN open collector output.

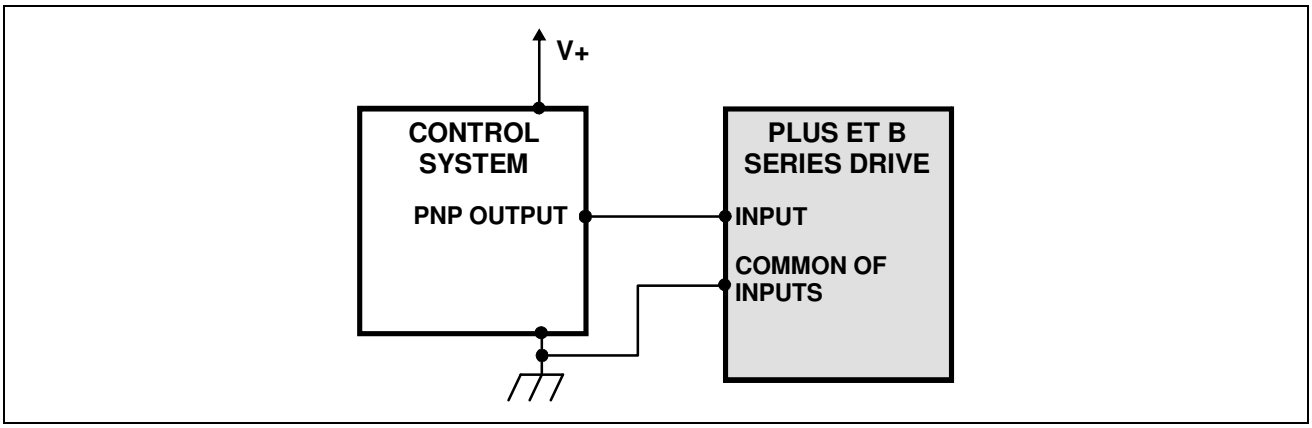


Fig. 10 - Driving a PLUS ET B logic input from a control system with a PNP output.

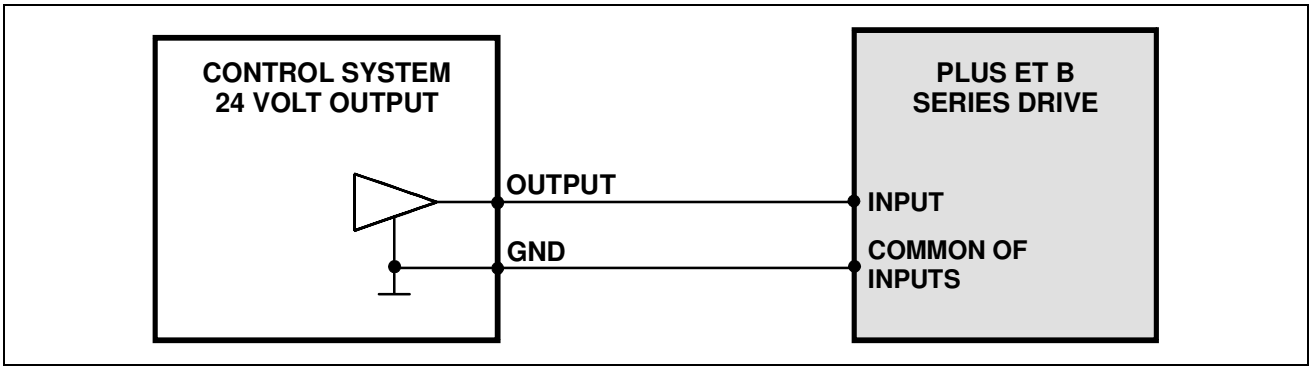


Fig. 11 - Connection example with control system with 24 Volt TOTEM-POLE (PUSH-PULL) output.

10. ⚠⃠ APPLICATION NOTES

10.1- Drive (or drives) power supply can not be used to supply other machines.

10.2- Electromagnetic compatibility (directive 2014/30/CE). PLUS ET B series drives are BDM (Basic Drive Module), as defined in the EN 61800-3. Only a professional assembler, expert in the field of motor drives and in their EMC aspects, can install and put in service this component. R.T.A. has the responsibility to verify the products compatibility in some typical way of use in order to give correct installation information. In any cases, it is responsibility of the professional assembler, who installs this product, to verify the compatibility of the complete machine or system with the above and other possible specific directives.

10.2.1- The set consisting of drive, motor, transformer and all related cablings are source of electromagnetic interferences. The assembler of installation must consider these problems during the project of the plant where the drive (or drives) will be installed in order to shield and/or reduce these interferences. Tests performed by R.T.A. show that the most effective measures able to reduce these interferences are the following:

- Shielding of cables for the connection between motor and drive. The shield of this cable has to be directly connected to PLUS ET B series drive terminal 3. The shield of encoder cable, if it is available, has to be directly connected to the earth screw of the drive. This shielding can be avoided only in case of very small and compact machine where motor, drive and related connections are located in the same enclosure, showing adequate shield performance.
- It is suggested not to exceed the maximum length of 10 meters for the wiring between motor and drive. In case of application requires the exceeding of this limit, please contact RTA.
- Connect earth line to motor chassis. To reduce the radio-frequency emissions, the mechanical connection of motor to machine chassis (by means of mounting flanges and screws), is typically simple and effective solution. In this case, both screws and chassis must be of conductor material and the chassis must be connected to earth. See fig. 11.
- Location of motor-drive set in the same cabinet shielded from electromagnetic interferences.
- Use a power supply transformer with a metallic shield, connected to earth, interposed between primary and secondary winding.
- Interpose a filter between the transformer primary and the main (220 or 380 V_{AC}). The filter is used to reduce conducted electromagnetic interferences. Filter characteristics in a specific installation depend on the following factors:
  - The specific standard limits the machine (in which drive is used) is subjected to.
  - Power level of application (voltage and current setting of the drive).
  - Presence of other filtering systems in the general electrical machine connections.

  In any case, the following filter types are recommended:
  - CORCOM VDK series for single-phase power supply.
  - CORCOM FCD10 series for three-phase power supply.

  Different types of these series differ for current rating. Choose the specific model according to the power level of the specific installation.
- Consider that the position of the filter in the system is extremely important: no electromagnetic coupling must take place between electromagnetic source and circuits (and lines). To this end, filter and main must be kept as close as possible.
- All earth connections mentioned above have to be realized with the less possible inductance.

10.2.2- To improve the drive logic input/output signals immunity from external noise the following well known procedures, to manage the relatively fast signals treatment must be considered:

- Use shielded cables with shield connected to PE.
- When cables length exceeds 5-6 meters, prefer "buffer" type driving signals instead of "open collector" type.

- Keep signal cables separate from power cables. In particular keep signal cables separate from motor output cables.
- Carefully verify logic level compatibility when interfacing drive with control system.

10.2.3- Following these procedures is essential to realize an installation which complies with the requirements of 2014/30/CE directive. The real specific standard compliance have to be proved in the complete installation. In fact the effectiveness of the suggested application notes depends also on machine topology and on the measurement setup. Test performed by R.T.A. simulating typical installations and following the mentioned above indications show that EN61800-3 standard compliance applications can be achieved.

10.2.4- In some cases, due to the characteristics of particular installations, conflicts between ground connections necessary for shielding purposes and ground connections necessary for safety reasons could arise. Remember that, in such cases, prescriptions regarding safety take priority, but remember also that, in almost all of the cases it is possible to find a solution meeting both prescriptions; R.T.A. is available for further information about these problems.

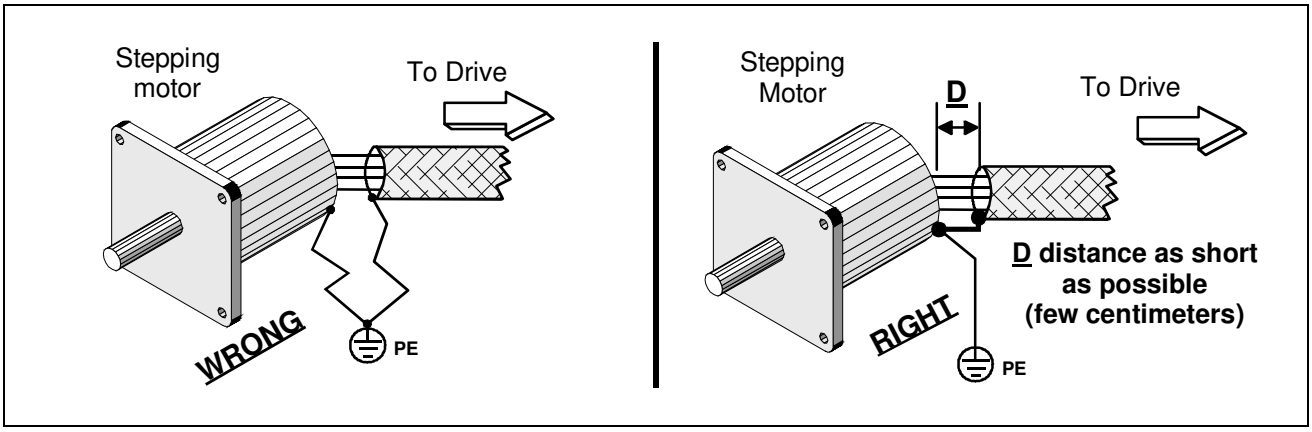


Fig. 11 - Shielded connection at stepping motor side.

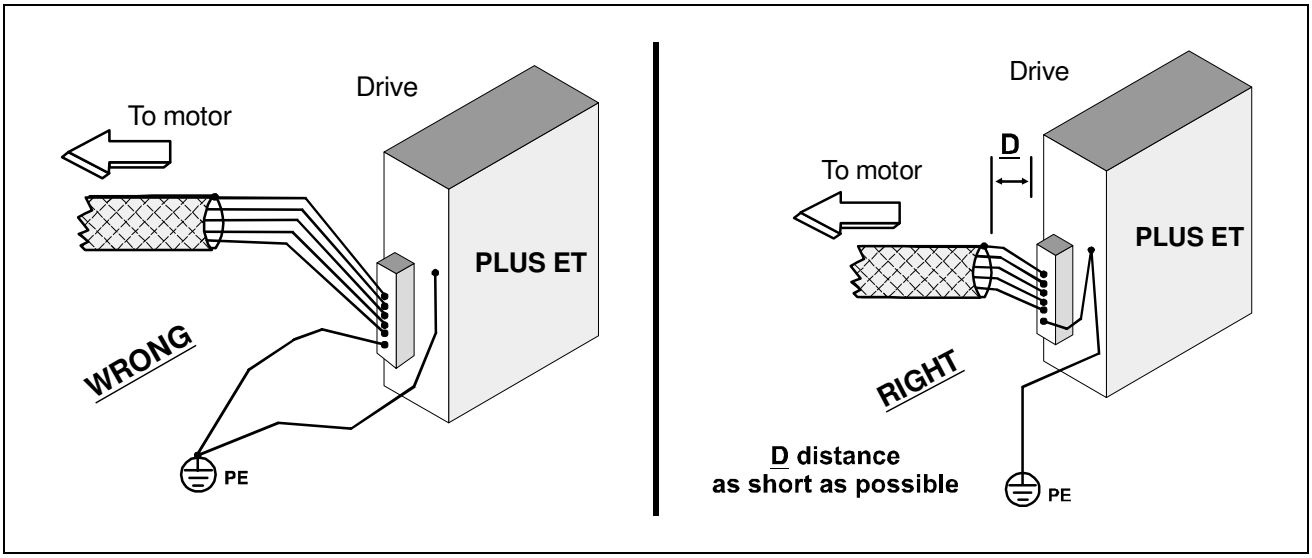


Fig. 12 - Shielded connection at drive side.