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Technical Information

Recommendations for EMC-compliant wiring of servo drivers and motors

1. Preface

This document contains recommendations for wiring, to reduce noise emissions generated by servo drives.
These recommendations are based on information from the MINAS series manuals and the practical experience of our engineers. Their goal is compliance with European EMC requirements.

The user is responsible for implementing the measures considered necessary to comply with applicable installation requirements of EMC directives.

2. What is EMC?

Electrical and electronic devices and components generate electromagnetic fields during operation. The electromagnetic fields thus generated fluctuate due to varying internal electrical processes and depend on the kind and intensity thereof. Alternating currents and switching operations likewise generate various frequency spectra of these electromagnetic fields that disperse, on the one hand, as electricity through electroconductive material (e.g. power lines) and, on the other hand, in the form of radiation through the air.

Electromagnetic fields resulting from the operation of one device are not necessarily “compatible” with the operation of other devices and are hence a source of disturbance. In order for various devices to function free of disturbance, the type and occurrence of radiation emitted by one source may not influence the operation of other devices in its field of influence.

ElectroMagnetic Compatibility, i.e. EMC, identifies a device’s or system’s ability to operate–within certain limits–in such a way so as not to disturb other devices. One should differentiate between whether the device is seen as an “emitter of electromagnetic disturbance” or as a susceptible device, i.e. one whose performance can be degraded by an electromagnetic disturbance.

2.1 Causes of electromagnetic fields

The most common sources of high-frequency disturbances are switching electrical and electronic devices, e.g. choppers, clocked microprocessors, switching regulators as well as communication devices and their transmission media (cables, radio).

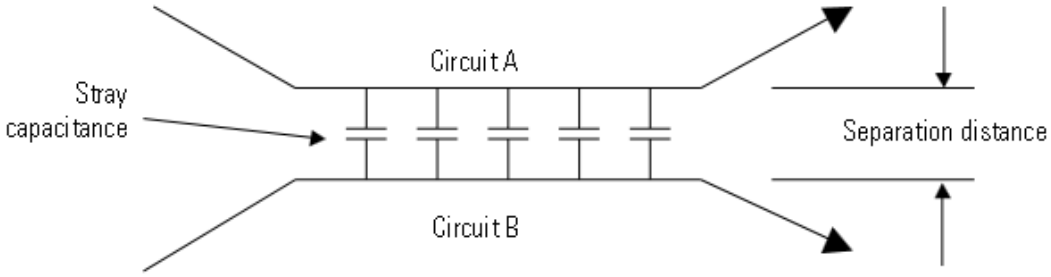
Servo drivers belong to the chopper category. Although they suffer little power loss from fast switching power semiconductors, they generate high-frequency disturbance voltage and disturbance currents from these fast switching operations (e.g. dU/dt = 2000V/s). One cannot clearly differentiate here between conducted and radiated high-frequency disturbances because the borderline is fluid. Similarly one cannot differentiate between immunity (to a disturbance) and emission (of a disturbance) since these two effects are strongly intertwined.

2.2 How is disturbance transmitted?

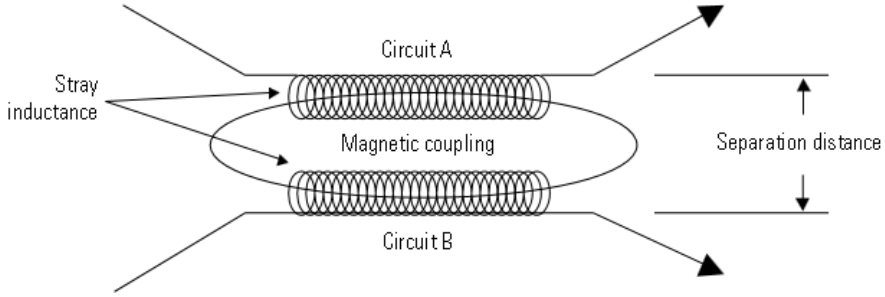
There are four types of electromagnetic interference:

Direct coupling:
This is caused by two or more circuits connected by a common line. In this way interference can be transmitted from one circuit to another.

Capacitive coupling:
The reason for this is differences in potential between the conductors of a cable of a line. In systems that work at high frequency (for example 10 MHz), the polarity reversal of the capacitance in a line cannot take place quickly enough, resulting in signal level losses. The greater the distance between the conductors, the less the effect of capacitive coupling



Inductive coupling:
This is caused by live wires that run parallel to each other. In systems that work at high frequency (for example 10 MHz), each line forms an inductance and the lines affect each other mutually (as in a transformer). This can produce interference currents. As the distance between the lines increases, the effect of inductive coupling is reduced.



Radiation coupling:
This is caused by electromagnetic fields (radio or wireless signals, etc). Conductors in a signal cable can act as an antenna and receive these fields, which then pass into the system through the insulated conductors.

3. General considerations

<u>General considerations on grounding:</u>

- ✓ The electrical cabinet must be connected with ground (PE).
- ✓ The contact with ground should cover a large surface area. Generally this is achieved by the metal mounting plate for the hardware components in the electrical cabinet.
- ✓ Use only low-resistance connections between the metal mounting plate and the electrical cabinet. The plate must be made of galvanized steel (lacquer-free).
- ✓ Inside the switch cabinet it is important for all metal mounting plates to be connected to each other to ensure low-resistance connections at high frequencies.
- ✓ Keep all physical connections to frame ground as short as possible.
- ✓ To achieve low-resistance transition to the enclosure, it may be necessary to use special screws (lacquer-free) or special connections for EMC-compliant protection.
- ✓ Follow all applicable local safety requirements for grounding.
- ✓ Checking the frame ground connections for low-resistance transitions should be added to the maintenance checks as a service routine.

General considerations on shielding:

- ✓ The enclosure of the electrical cabinet already acts as a shield.
- ✓ The motor enclosure also acts as a shield.
- ✓ The advantage of shielded cables is that they are less sensitive to undesirable external electromagnetic radiation. Emitted interference is also reduced by the cables. To prevent noise emissions and increase noise resistance, all cables that are connected with the servo driver must therefore be shielded.
- ✓ The three safety devices mentioned above (electrical cabinet, motor enclosure, shielded cables) must be connected to each other with a low resistance to contribute effectively to the protection of the entire system.
- ✓ The shield connections should be designed so that low-resistance connections in the megahertz range can be achieved. We recommend using special connectors.

General considerations on filters:

- ✓ Suitable filters (noise filters) should be used to filter out conducted interference produced by the power supply or servo drivers. Filters prevent emitted interference acting on the power line and vice versa.

- ✓ **The filter section is an essential element of protection against electromagnetic disturbance**

4. Initial check

Servo drivers are potential emitters of electromagnetic disturbance that can affect other devices. Internally in the servo drive a sampling rate is used for the frequency pulse sequence (assigned by the PLC or controller). The standard sampling rate is 4 MHz.

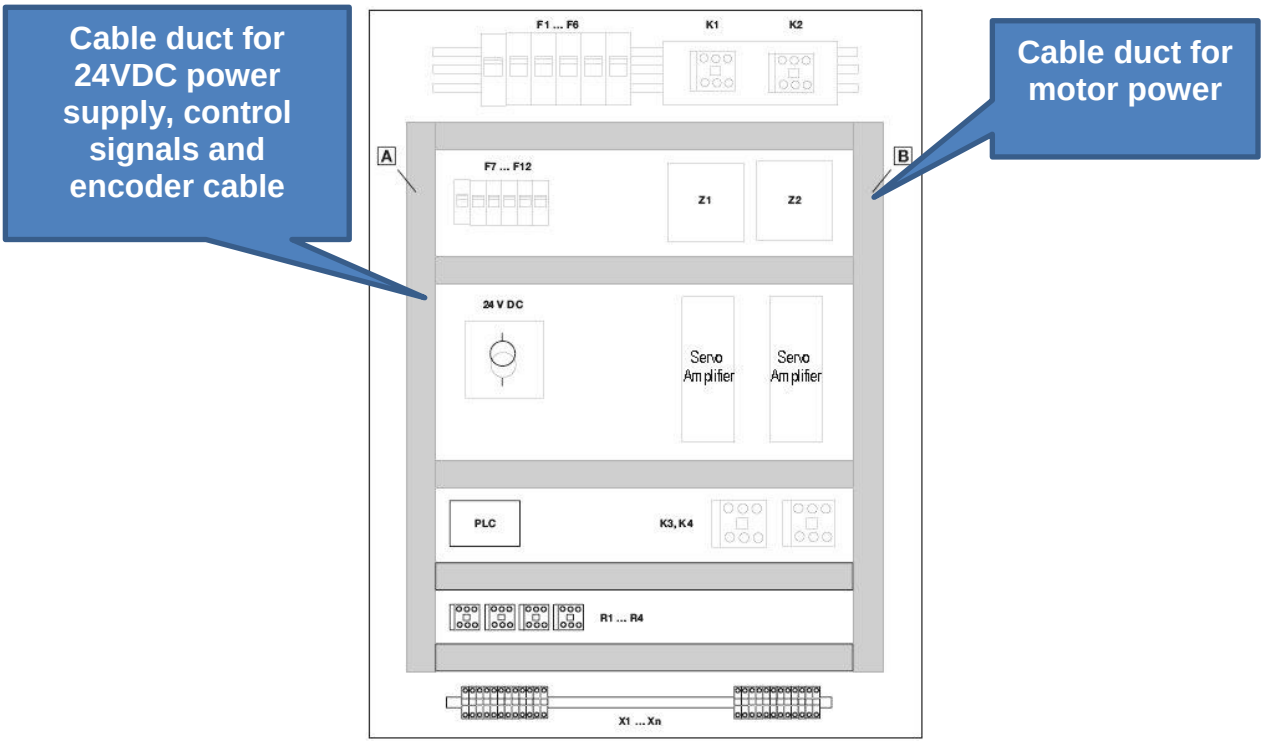
We recommend matching the sampling rate of the servo driver with the frequency pulse sequence of the PLC to reduce noise emission. The lower the sampling rate the better.

Adjust the sampling rate using the appropriate parameter (for example Pr. 5.32 for MINAS A5) according to the requirements of the application regarding the frequency pulse sequence.

5. General wiring instructions

✓ Interference should be avoided in the electrical cabinet. If possible use separate ducts for power cables and control lines.

Sample configuration:



✓ Keeping in mind the recommended distances between individual components according to the manual, make certain the electrical cabinet is appropriately dimensioned.

- ✓ Use power cables with the recommended conductor cross sections according to the manual.

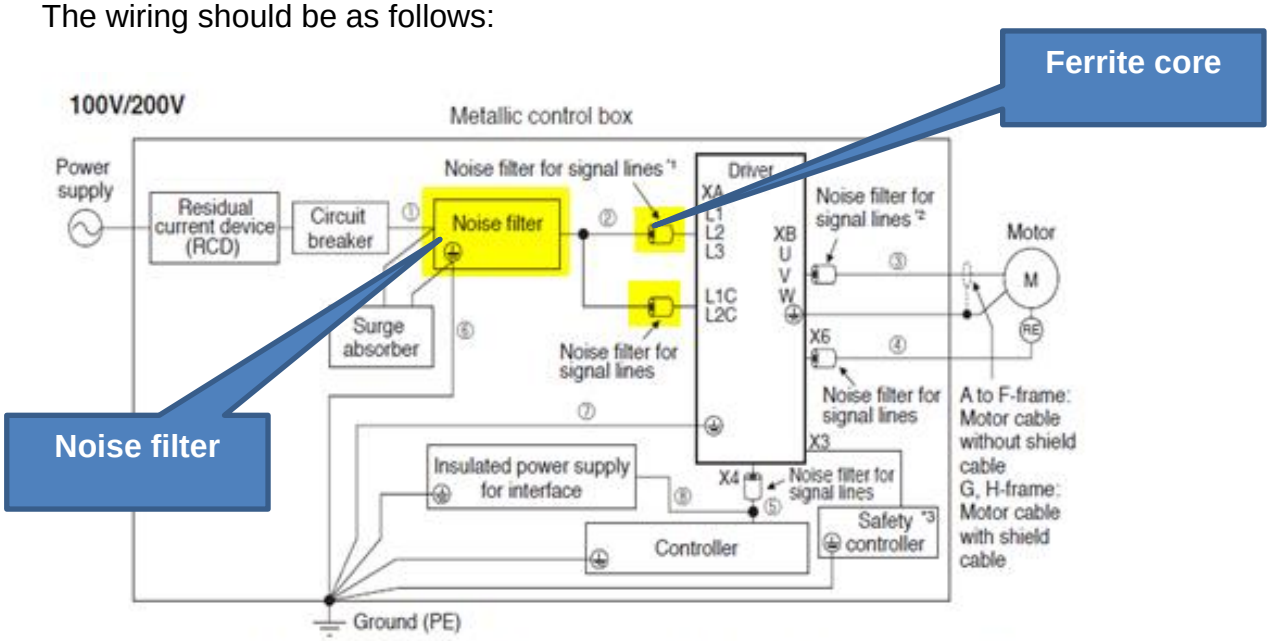
- ✓ Install the servo driver on the metal mounting plate of the electrical cabinet. The electrical cabinet must be connected to ground (PE). Make certain to use a low-resistance connection between the frame ground terminals of the servo driver and mounting plate.

- ✓ Make certain the internal temperature of the electrical cabinet remains within the specification. Otherwise forced ventilation is necessary.

6. From the supply grid to the servo driver

The servo driver has 2 circuits:
Connected load (L1, L2 and L3)
Control circuit (L1C, L2C)

The wiring should be as follows:



*1 A to D-frame: Noise filter for signal lines, E to H-frame: Noise filter for signal lines <Power supply cable>
*2 A to F-frame: Noise filter for signal lines, G, H-frame: Noise filter for signal lines <Motor cable>
*3 Only for position control type is not provided with X3 terminal.

✓ To select the correct noise filters, follow the instructions in the table in the Panasonic MINAS catalog for servo drives or the recommendations in the manual.

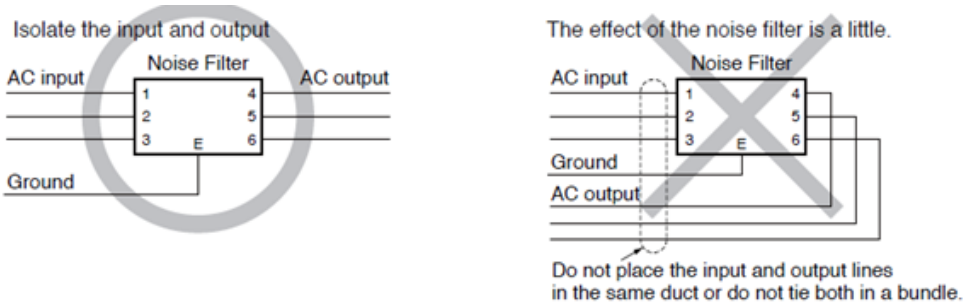
The following Panasonic ferrite core is recommended for the power supply wire:

Option part No.	Manufacturer's part No.	Manufacturer
DV0P1460	ZCAT3035-1330	TDK Corp.

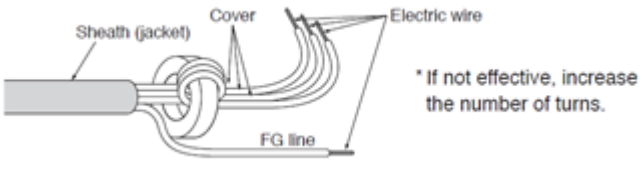
Keep the connection cable between the filter and servo driver **as short as possible** (recommended <10 cm). For greater distances (>30 cm), a shielded connection with a ground terminal on both sides can be used instead of ferrite cores.

✓ Use shielded lines for the power supply of the servo driver.

✓ The supply cable to the noise filter and outgoing cables from the noise filter must not run parallel to each other (see illustration):



✓ If you are using ferrite cores, increase the maximum number of turns around the ferrite for optimum results.



✓ Install overvoltage protection elements in the power supply wire of the servo driver.

✓ Filter enclosures often have connections for a ground connection on each end. They must be properly grounded before turning on the power.

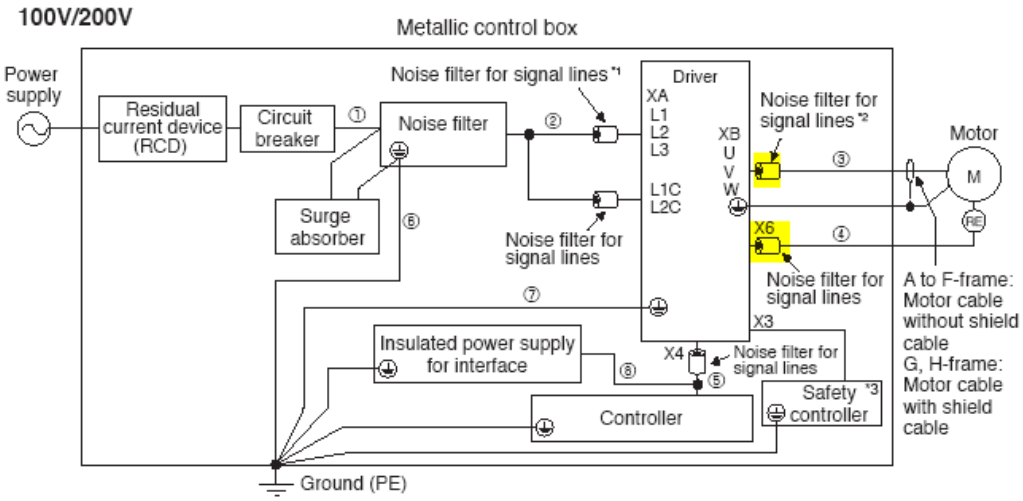
- ✓ When you are installing the noise filter on the metal mounting plate, it is important to ensure low impedance (no lacquer!).

- ✓ Filters can produce high leakage currents.

7. From the servo driver to the servo motor

- ✓ Disconnect the motor cables and encoder cables from each other physically (about 20 cm apart).

- ✓ Install ferrite cores at the ends of the motor cable and encoder cable.
  Note: Ferrite cores are not necessary with shielded cables.



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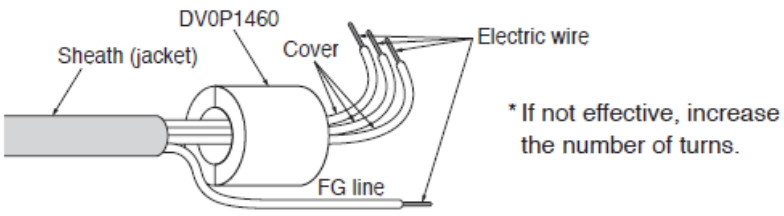
*3 Only for position control type is not provided with X3 terminal.

- ✓ If you are using ferrite cores, increase the maximum number of turns around the ferrite for optimum results.

- ✓ Install the ferrite core on the motor cable as shown in the illustration below (protective conductor must not be included in the ferrite core!):

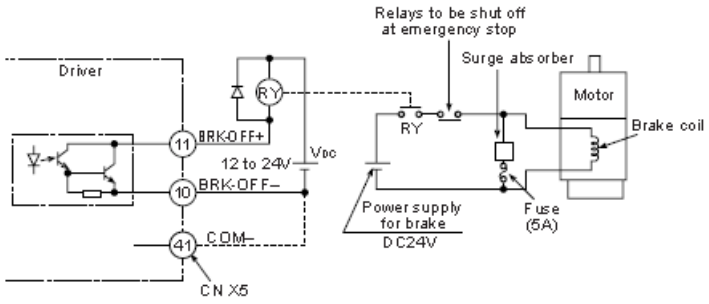


- ✓ Use the shortest possible cables and no spliced cables.

✓ If the servo driver will be using the brake signals (BRK-OFF), note the following requirement for wiring:

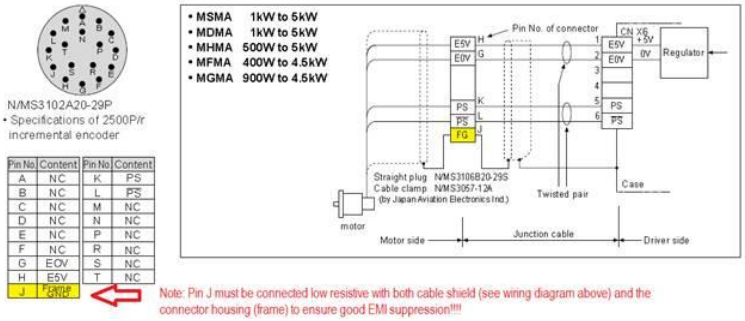
Connecting Example

The following shows the example when the brake is controlled by using the brake release output signal (BRK-OFF) of the driver.



- To release the brake, use a separate 24V DC source for the control signals of the servo driver.
- Install overvoltage protection and protect the overvoltage circuit with a 5A fuse. For further instructions please refer to the MINAS manual.

✓ The shield of the encoder cable must be connected to frame ground on both the drive side and motor side (Panasonic cables are already properly wired).



✓ Use the shielded, twisted lines for the encoder cable.
(Panasonic cables are already shielded and twisted).

8. From the servo driver to the PLC or controller

- ✓ Disconnect the signal lines coming from the servo driver from the power supply cables.
- ✓ Use shielded and twisted signal cables
- ✓ Keep signal cables as short as possible.
- ✓ If you are only using a few conductors of the signal cable, use the Panasonic conductor set. (Unused conductors of the standard signal cable can create an antenna effect, thereby looping in interference signals.)
- ✓ The shield must be in contact the metal mounting plate by means of clamps on both sides held by a screw connection.
- ✓ Avoid connecting terminals or other interruptions in the shielding.
- ✓ The unshielded length of the signal cable should be maximum 10 cm.