



BD EMI Installation Guide

This guide is intended to provide information to reduce electromagnetic interference from the Danfoss compressor. The guide is divided into two groups. One for the manufacturer incorporating the Danfoss compressor into their refrigeration unit and the other for the installer of the refrigeration unit into the vehicle, including boats, trucks, etc.

Introduction

Electromagnetic interference to radio receiving devices originates from periodic or near periodic sources and associated harmonic frequencies. The common sources are switching power supplies and regulators and microcomputer clocks. For the compressor, the primary source is the power drive circuits. Higher frequencies are generated by microcomputer clocks, as well, but that is less of a problem with the Danfoss compressor.

The interference leaves the compressor by any wire conductor, which serves as radiating antennas. This includes power/return wires as well as any signal or control wires, such as the thermostat.

Subsequently, the interference energy radiates from the wires and intercepted by the radio receiving antenna. An alternate path is via direct conduction out the power leads to the receiving device power.

Filtering of the wires is effective in reducing interference levels - that approach is often done by the manufacturer (Danfoss, in this case), but additional filtering can be applied externally to the controller, in extreme cases. But the handling of the wiring is the first place to look - reducing the wire lengths, reducing the loop areas, and shielding the wires.

Retrofit of existing installation

Radio interference may originate from any wire connected to the electronic unit. The primary concerns are the DC power and thermostat wires (up to about 30 MHz). Emissions from the fan and LED wires may also occur if they are quite long, and especially at higher frequencies (above 30 MHz).

1. For existing installations, it may be cumbersome to re-wire, so power line filters may be tried (for both the DC supply and the thermostat). Install filters as shown in figure 1. The filters must be mounted directly to the compressor mounting bracket. The wires running from the filters to the electronics unit should be twisted (at least one twist per inch or 2 cm) and kept as short as possible. In particular, avoid running these wires adjacent to the filtered wires. Run the filtered wires directly away from the filter for at least 10 cm before redirecting to the destination - especially avoid running these (or any) wires close to the electronic unit.

2. If filters are inadequate, shielded wires may be installed, as shown in the instructions below for new installations. In most cases, either shielding or filtering would be used, but not both - it is permissible to mix techniques (e.g. a filter for power and shield for the thermostat). In severe cases, both a shield and filter may be used in series, with the shield being terminated to the same mounting point as the filter. For lower frequencies (less than 30 MHz) the shield will work better if grounded at the mounting point. For higher frequencies, the shield may work better if also grounded at the battery negative.

3. If the remaining wires (fan and LED) are suspect, they can be rewired or shielded, as well, using the same grounding point as mentioned above. If they have been routed in close proximity to the electronic unit, simply rerouting them may help.

The installer, new installation

1. Regular Unit (No EMI Control), no shielded cables

Use of shielded cables is highly recommended, however, careful wiring will minimize interference.

Wires leaving the controller (electronic unit) should always be run in pairs, as per figure 2, preferably twisted. The number of twists is not critical – at least one full twist every 2 cm or one inch is adequate. Under no circumstances should a power or signal wire be routed separate from its return wire.

The negative wire from the electronics unit may be routed directly down to the mounting bracket to additionally reduce emissions from the voltage input, as indicated in figure 2.

Keep control and power wires well clear of other wiring or copper tubing or from nearby metal members that are not grounded directly to the compressor. Especially route the wires away from the heat sink of the electronic unit. If wires must cross, then route them at right angles to minimize coupling.

Wires from electronic unit should be run directly away from the unit for at least 5 cm or 2 inch before directing to destination - this minimizes coupling to adjacent wires.

2. Regular Unit (No EMI Control), with shielded cables

Shielded cables are highly recommended, as the above practices may not be enough - they are especially important for wires that are destined some distance away from the compressor, including the DC voltage supply and the thermostat wires. Shielded cables are far more effective in controlling RF energy, and significantly reduce the need for careful routing. Twisting is not

important for shielded cables (but still acceptable), as long as signal or power and return are routed in the same cable.

Cable shields must be grounded to the bracket, as shown in figure 3. Pigtail length for the ground termination should be kept to a minimum (1 cm or half inch) or, better yet, clamp the shield directly to the bracket.

Where the plus battery wire passes through a fuse/circuit breaker or switch, the shields should be continued by a short jumper.

Wire routing is far less critical when using shielded wires, but it is still best to keep shielded wires away from the electronic unit to the extent feasible.

If a power line filter is used in addition to the shielding, the shield should be grounded directly to the common ground point at the bracket mentioned above. Keep input wires away from the output wires.

2. Installing the EMI unit.

The EMI unit has been designed to minimize emissions, but in extreme cases, cable shielding and filtering may still be needed.

The routing practices mentioned above should be followed, with the exception that the common ground point should be the common terminal at the electronic unit, and grounds to the bracket are not necessary. Figure 4 shows the installation where no cable shielding is used and figure 5 shows the installation where cable shielding is used.

If a power line filter is installed, it should be bolted directly to the electronic unit housing, with wires routed as mentioned above.

The manufacturer

1. Regular Unit (no EMI features).

Grounding - all metal members should be grounded to a common mount, preferably the compressor or mounting bracket.

Wires leaving the controller (electronic unit) should always be run in pairs, preferably twisted. The number of twists is not critical – At least one full twist every 2 cm or one inch is adequate. Under no circumstances should a power or signal wire be routed separate from its return wire - this results in a large loop area.

Wires from electronic unit should be run directly away from the unit for at least 5 cm or 2 inch before directing to destination - this minimizes coupling to the wires. It is best to route the wires adjacent to a continuous ground path to keep the loop area as small as possible. If the path crosses a metal boundary, then the wires should be routed adjacent to a

jumper ground strap.

If cable shielding is installed on the fan (or any other wire pairs), the shield must be grounded in the same fashion as above. Cable shielding for the fan must be grounded at one point only. Do not use pigtail connections to ground - instead, route the cable to the nearest ground and insert a clamp ground at that point.

2. EMI Unit

The same practices as above apply, except that the electronic unit has a metal cover that mounts directly to the compressor, and should be used for all ground connections - ground strap to adjacent metal members, such as mounting plate is not needed. All grounds should be made directly to the electronic unit ground terminal, including the shield for any wiring.

Filter and shield mounting

Filters and shields must be mounted directly to compressor ground. For the non-EMI unit, the ground must be made directly to the mounting plate. As the compressor is isolated with a rubber mount, fastening with a bolt will be ineffective unless the bolt makes conductive contact with the bracket.

For the EMI unit, ground should be made directly to the electronic unit housing. Cable shielding may be terminated to the negative terminal of the electronic unit - but the wire length must be kept as short as possible, preferably less than one cm or ½ inch.

Corrosion Considerations

There are two ways that corrosion may occur. The first is when the compressor mounting bracket must be bared to make a conductive contact. If the bare metal surfaces are prone to corrosion (as would be the case with uncoated steel), corrosion protection is strongly advised. Nickel paint spray is inexpensive and effective. Spray the surface liberally to ensure that all exposed surfaces are covered. Mount the filter or shield ground to the bracket carefully, so as to minimize scuffing - nickel paint is fairly soft.

The second is with mating of dissimilar metals. If foil shield is used, the aluminum shield is prone to corrode when placed in contact with steel - this condition should be avoided. Contact using the drain wire is preferred, but the length of the drain wire must be minimized.

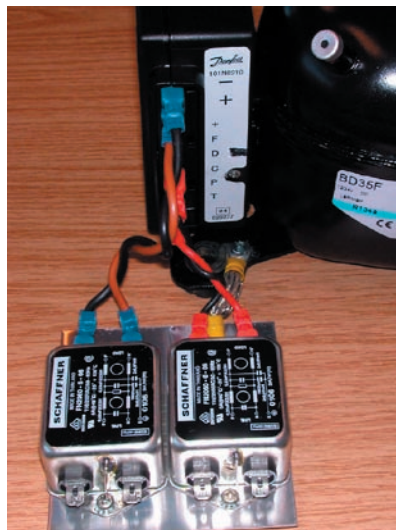
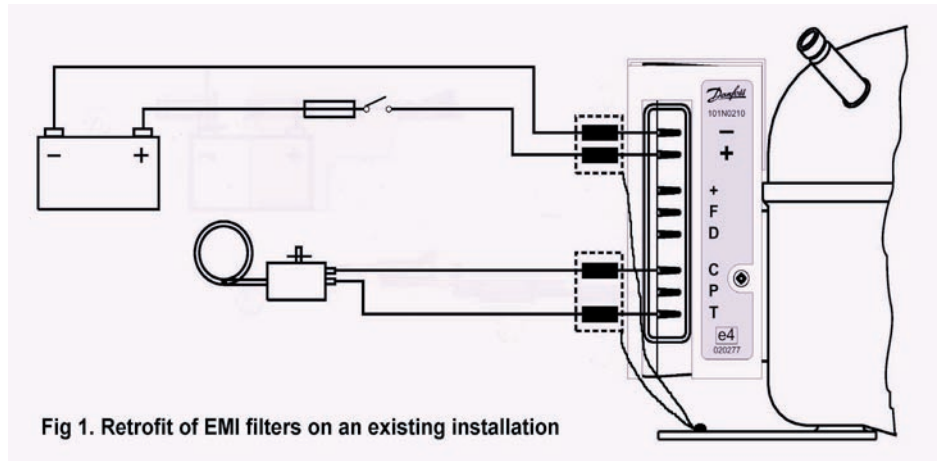
Once the mounting is complete, the affected areas should be painted with a spray enamel to cover all bare metal. Alternately, RTV may be used.

Cable shielding type

Either braid or foil shield will provide adequate shielding effectiveness, so the selection should be made for mechanical reasons. Braid is more robust and less prone to corrosion, and is therefore preferred. Foil is made of Mylar with an

aluminum metallization - the blue side is nonconductive, so contact must be made on the silvery side. Coated Mylar has very little strength, and must be secured with a clamp connection

Retrofit of EMI filters on an existing installation



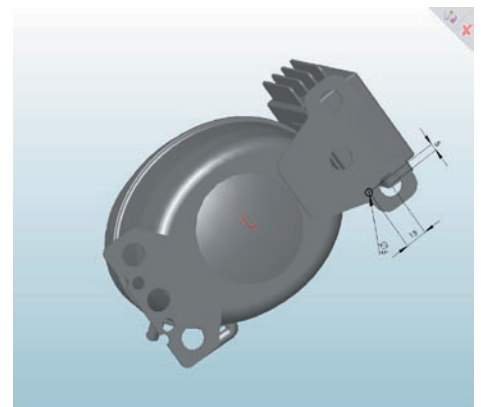
Filter on power & thermostat wires



Ground connection between the compressor and the filters



The base plate of the filters is connected to the compressor base plate by using a grounding point



Placement of the grounding point on the base plate

Installing unshielded cables on a new or existing installation on a non EMI electronic unit

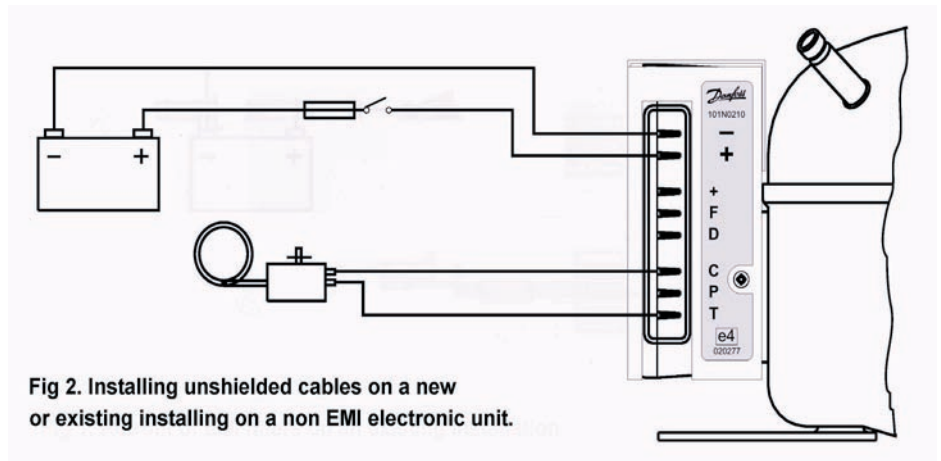
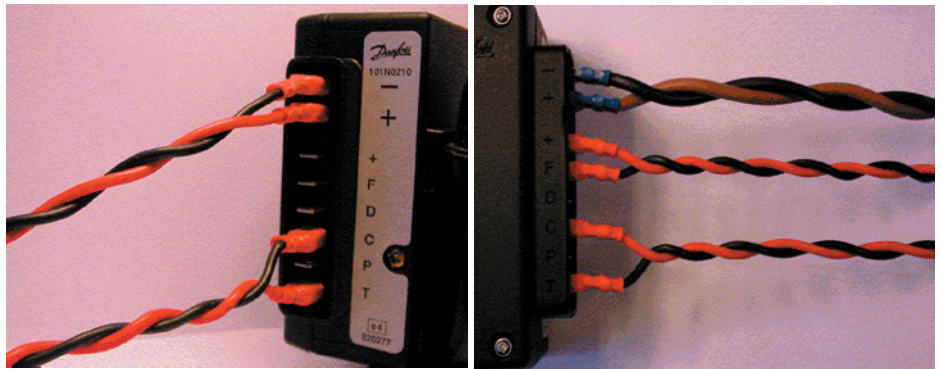
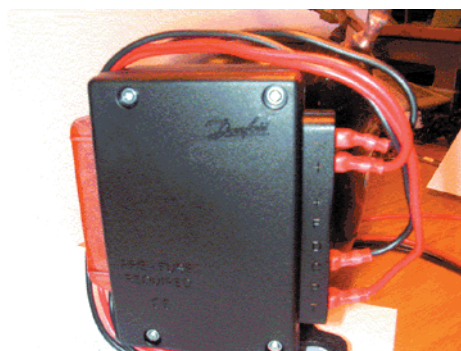


Fig 2. Installing unshielded cables on a new or existing installing on a non EMI electronic unit.

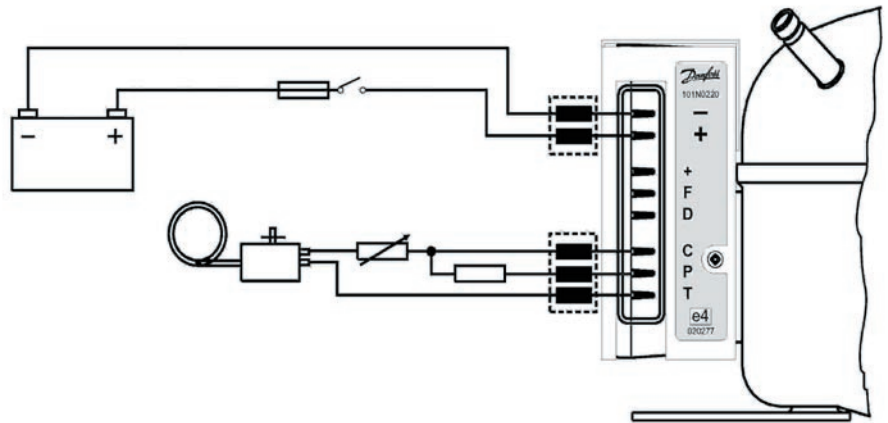


Power and thermostat wires are twisted



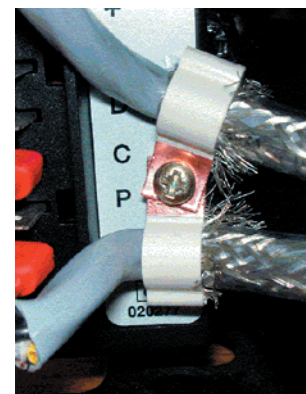
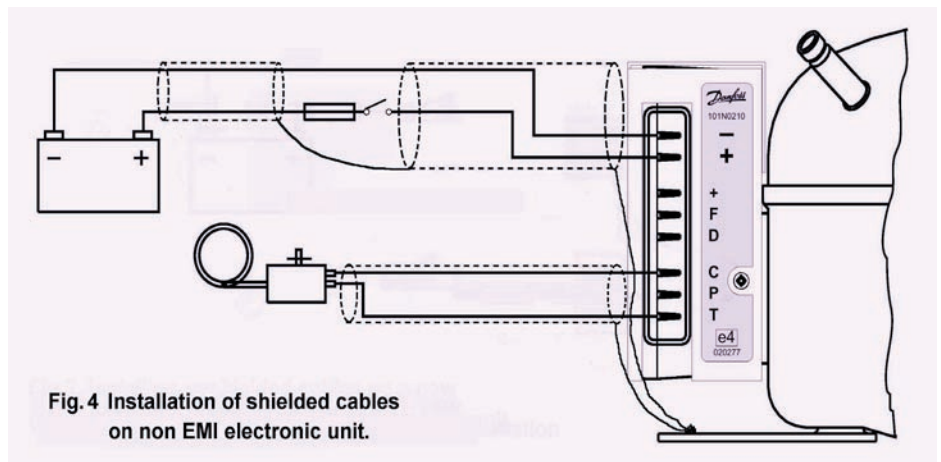
Do not place the wires close to the heat sink

Installation of EMI electronic unit without shielded cables



With unshielded cables, preferably twisted
(No cables on pictures)

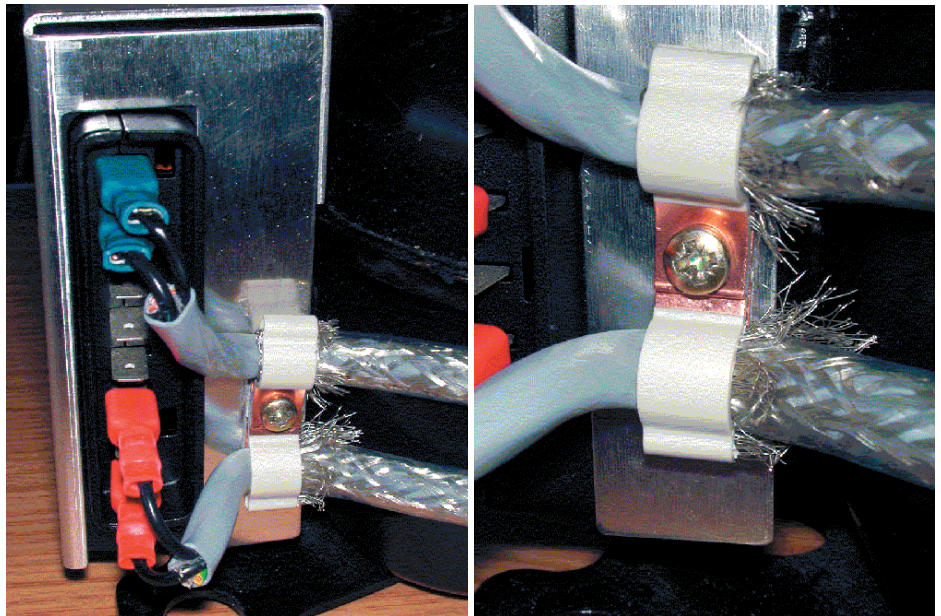
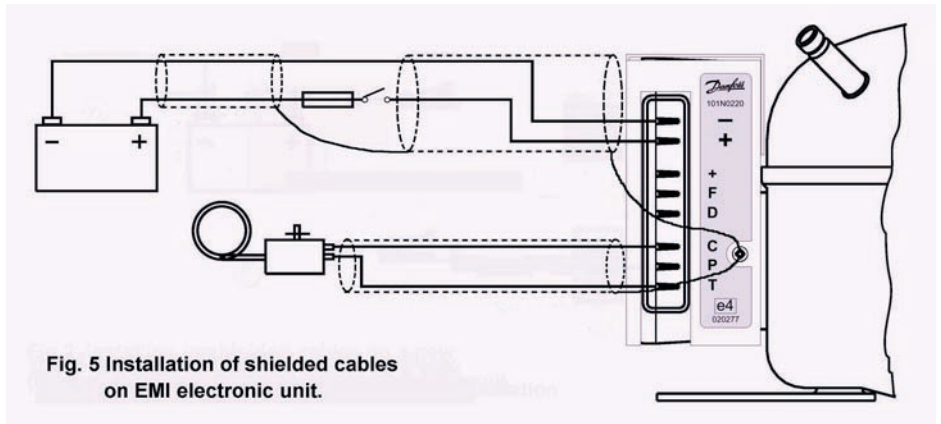
Installation of shielded cables on a non EMI electronic unit



Shielded cables on power and thermostat wires.

Connected to compressor via screw

Installation of shielded cables on a EMI electronic unit



EMI-unit with shielded cables

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