be high enough insuring that the compressor(s) on line plus the compressor being added would not operate in surge.

If additional compressors need to be brought on line after going through the above process, then the operating compressor(s) must be unloaded (slowed down) to decrease the discharge pressure and increase the suction pressure. Continue to reduce the pressure ratio to less than 2.5, then start the next compressor. Operate all energized compressors in parallel as described above (load them equally so all running compressors can pass through surge boundaries).

A compressor should be cycled off when insufficient load causes the operating compressor(s) to go into surge, then the remaining operating compressors can speed up to meet the demand.

To improve operating efficiency during part loads in a multiple compressor system, maximize the number of compressors in operation without allowing them to go into surge.

During the lag compressor staging, if the operating compressors can not be unloaded down to less than 2.5 pressure ratio before starting the lag compressor, then Load Balancing valve needs to be activated. We recommend installing Load Balancing Valve upstream of the non-return valve to help the lag compressor at the start up.

However, if the pressure ratio still stays higher than 2.5 the operating compressor(s) may need to be cycled off and then started them and the lag in parallel .

NOTE:
These control guidelines are specifically written for single circuited (multiple compressors on a common refrigerant circuit) applications. Individually circuited applications have similar staging requirements. However, the ramping down before adding additional compressors is not required.

NOTE:
Pressure Ratio is the ratio of absolute discharge to absolute suction pressures.

Electrical Specification

Supply Voltage and Frequency

Turbocor compressors are designed to operate with a power supply that is within an acceptable tolerance for each nominally rated voltage and frequency. The tables below specifies the acceptable supply voltage and frequency ranges. Using a supply voltage/frequency at or beyond the range limit will cause the compressor to shut down.

Nominal Voltage	Acceptable Voltage Range
400V (50Hz)	400V ±10% (360V - 440V)
460V (60Hz)	460V ±10% (414V - 506V)
575V (60Hz)	575V ±10% (518V - 633V)

Nominal Frequency	Acceptable Frequency Range
50Hz	50Hz ±5% (47Hz - 53Hz)
60Hz	60Hz ±5% (57Hz - 63Hz)

Disconnects

An input disconnect (for example, a switch or circuit breaker) must be installed in the line before the compressor in accordance with applicable local, national, and international codes (e.g., NEC/CEC). Size the disconnect according to the full-load current.

⚠ WARNING

The full-load current rating is based on insertion of a line reactor in the power line; refer to Appendix E for specifications. Failure to use a line reactor will result in poor power factor and higher full-load current.

Refer to Figure 8 for interconnection details.

AC Input Line Protection

⚠ WARNING

Most codes require that upstream branch protection be provided to protect input power wiring. To guard against personal injury and/or equipment damage caused by improper line fusing, use only properly rated, fast-acting fuses. Branch circuit breakers or disconnect switches cannot provide this level of protection for compressor components.

User-supplied branch circuit protection fuses must be installed according to the applicable local, national, and international codes (e.g., NEC/CEC). The fuses must be installed in the line before the compressor AC input terminals.

Power Line Contactor

The power line contactor is optional. Consult local codes to determine if a power line contactor is necessary for your application.

CE Compliance and EMI/EMC Filtering

Although the TT300 and TT400 compressors are CE listed, the compliance of the compressor with the EMC directive depends on the use of the CE EMI/EMC filter provided by Danfoss Turbocor; refer to Figure 8 and to TPS-00021 in Appendix E for further details. If for some reason or due to the nature of your application and or installation, the use of this component is not possible, an alternative component with the same attenuation characteristics must be used to maintain compliance with the EMC Directive. It is the responsibility of the user to maintain compliance with the Directives. Contact a Danfoss Turbocor sales engineer for further details.

To strictly address EMI/EMC problems, Danfoss Turbocor recommends the installation of UL-approved EMI/EMC filter device on the input power line; refer to TPS-00020 in Appendix E for further details.

Proper installation of the EMI/EMC filter can have a dramatic effect on overall performance. Although the filter reduces electrical noise on the power lines (conducted emissions), it should be located as close as possible to the compressor to reduce broadcasting of the noise (radiated emissions) from the power lines themselves. The capacitors within the filter short the noise to ground, so it is imperative that the filter maintains a good ground. A short, heavy, stranded conductor from the filter chassis to the main ground bus is recommended for top performance. A battery braid, litz wire, or flexible welding cable with many fine strands is recommended for best grounding performance. The multiple strand cabling provides more surface area in order to conduct the high frequencies that are on the grounding cable.

Radiation of noise is also a concern for power line routing, as it can effectively bypass the filter. Input and output filter leads should be separated by a maximum practical distance within enclosures and should be routed separately in interconnecting conduits when used.

Surge Protection

The TT300 and TT400 compressors have been tested in accordance with IEC Standard 1000-4-4. Electrical Fast Transient/Burst Requirement, section 6.1.1 and figures 2 and 3.

For additional protection, a surge suppressor can be installed between the line reactor and the compressor.

Harmonic Filtering (IEEE 519)

Danfoss Turbocor recommends the installation of a harmonic filter device between the line reactor and the compressor in order to comply with IEEE 519 requirements, as shown in Figure 8.

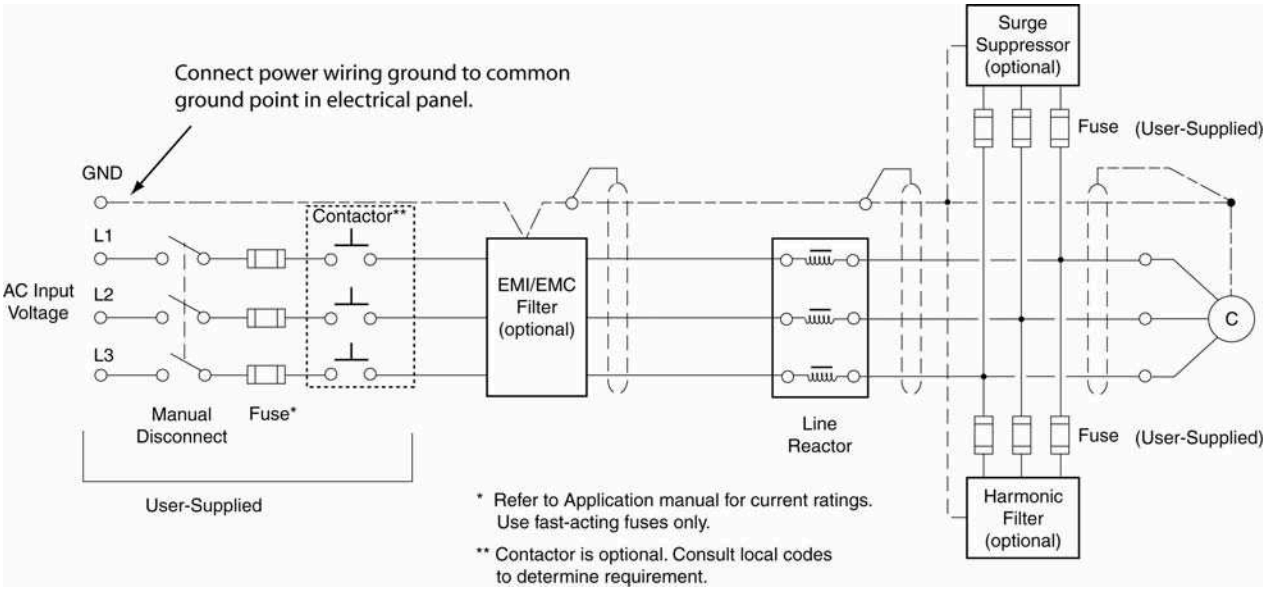

Figure 8 Typical Electrical Connections

Earth Connections

Grounding Guidelines

1. All metal parts should be connected to ground, including the shields of electrical cables.
2. Verify continuity of all ground connections.
3. Ensure solid ground connections (both mechanical and electrical).

At one point, usually the entrance of the power supply panel, all grounds should be connected together; refer to “Equipment Panel” on page 11.

From an EMC standpoint it is best to categorize different types of grounds and treat them independently:

- Safety ground (PE) and shields of mains cables
- Analog grounds, shielding of interface cables
- Digital grounds
- Reference ground (panel doors, backplate, etc.)

Refer to Figure 9.

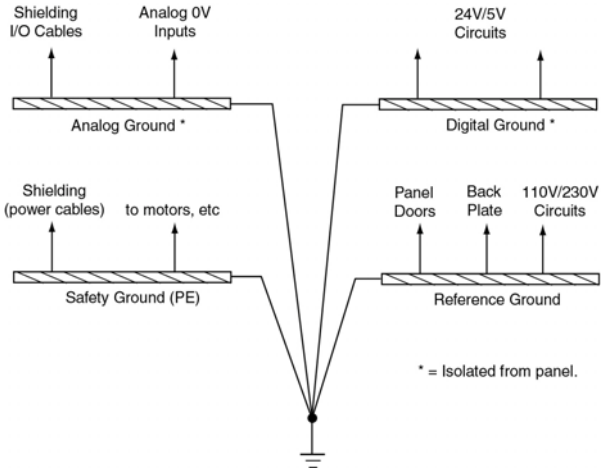

Figure 9 Typical Ground Connections

Equipment Panel

Normally, the line reactor, EMI/EMC filter(s), and the harmonic filter will be installed in a panel. This could be the same panel where the controls are located. When designing a panel, attention should be given to the following recommendations:

- All metal parts should be properly connected to insure an electrical connection. Connect panel doors with braided cable.
- Separate panel into sections for power, and interface/ control functions.
- Keep power cables and interface cables separate. Use metal cable glands for shielded cables.
- In case of a wire-loom going to the panel door, shield it using a metal-braided hose that is connected to ground at both ends.
- Electrical panel must have a dedicated ground conductor as per relevant electrical codes. See Figure 10.
- Verify that the panel ground conductor is sized in accordance with relevant electrical codes.

NOTE:
The installing electrical contractor is responsible for connecting the panel ground to the facility ground in accordance with relevant electrical codes and standards such as NEC section 250 in the US or equivalent for other countries.

Mains Input Cable Specification

The aim of electrical cables is to be a carrier (conductor) for electrical power. The influence of the power source on the environment, or the influence of the environment on the power source, should be such that neither the proper functioning of the compressor nor equipment in its environment is adversely affected. Therefore, Danfoss Turbocor advises to use some type of shielded cable for the mains input.

When using shielded cable, select a cable with an effective shield. A cable with an aluminum foil will be far less effective than a specially designed conductive braid. It is best to connect both ends of the cable shield to ground, since the shield is not part of the signal path.

The mains input cable should be CSA, UL, or CE approved, 3-wire with a common shield and single ground. The cable must be rated for 90° C (194 °F) minimum and maximum current according to the applicable model; refer to Table 1. It is recommended that the cable be double-jacketed, i.e., teck cable type. Refer to Table 3 for cable gland specifications.

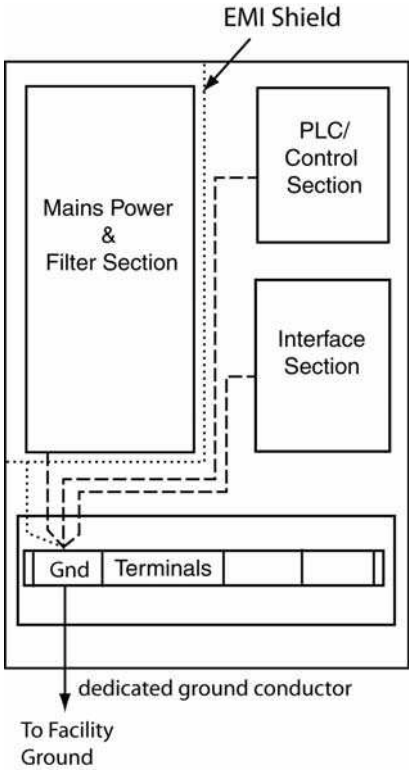

Figure 10 Recommended Panel Layout

Table 1 Maximum Current Ratings for TT300 Compressors

Model Number	Voltage	Current	
		FLA	LRA
TT300-G2-1-ST-N-O-NC	460V	72	80
TT300-G3-1-ST-N-O-NC	460V	80	88
TT300-G4-1-ST-N-O-NC	460V	100	110
TT300-G6-1-ST-N-O-NC	460V	120	132
TT300-G7-1-ST-N-O-NC	460V	135	145
TT300-G2-1-ST-P-O-NC	460V	72	80
TT300-G3-1-ST-P-O-NC	460V	80	88
TT300-G4-1-ST-P-O-NC	460V	100	110
TT300-G6-1-ST-P-O-NC	460V	120	132
TT300-G7-1-ST-P-O-NC	460V	135	145
TT300-G7-1-MT-P-O-NC	460V	135	145
TT300-H6-1-ST-N-O-NC	400V	135	145
TT300-H6-1-ST-P-O-NC	400V	135	145
TT300-H6-1-MT-P-O-NC	400V	135	145
TT300-H6-1-ST-N-O-CE	400V	135	145
TT300-H6-1-ST-P-O-CE	400V	135	145
TT300-H6-1-MT-P-O-CE	400V	135	145
TT300-F2-1-ST-N-O-NC	575V	64	71
TT300-F3-1-ST-N-O-NC	575V	72	80
TT300-F4-1-ST-N-O-NC	575V	80	88

Table 1 Maximum Current Ratings for TT300 Compressors

Model Number	Voltage	Current	
		FLA	LRA
TT300-F5-1-ST-N-O-NC	575V	90	99
TT300-F6-1-ST-N-O-NC	575V	100	110
TT300-F7-1-ST-N-O-NC	575V	110	121
TT300-F2-1-ST-P-O-NC	575V	64	71
TT300-F3-1-ST-P-O-NC	575V	72	80
TT300-F4-1-ST-P-O-NC	575V	80	88
TT300-F5-1-ST-P-O-NC	575V	90	99
TT300-F6-1-ST-P-O-NC	575V	100	110
TT300-F7-1-ST-P-O-NC	575V	110	121
TT300-F7-1-MT-P-O-NC	575V	110	121

Table 2 Maximum Current Ratings for TT400 Compressors

Model Number	Voltage	Current	
		FLA	LRA
TT400-G4-1-ST-P-O-NC	460V	100	110
TT400-G5-1-ST-P-O-NC	460V	110	121
TT400-G6-1-ST-P-O-NC	460V	120	132
TT400-G8-1-ST-P-O-NC	460V	140	154
TT400-G9-1-ST-P-O-NC	460V	150	165
TT400-H10-1-ST-P-O-NC	400V	180	200
TT400-H10-1-ST-P-O-CE	400V	180	200

Notes:
FLA: Full Load Amps
LRA: Locked Rotor Amps

FLA and LRA are referenced for wire, overload, and disconnect sizing purposes. Actual design operating currents, which are usually lower than FLA values, can be provided by the Danfoss Turbocor Selection Program.

Underwriters' Laboratories (UL) certification authorities require compressor manufacturers to specify the Locked Rotor Amps (LRA) rating for their equipment. For the Turbocor compressor, LRA is a hypothetical value that generates a critical alarm leading to compressor shutdown.

Full Load Amps (FLA) refers to the maximum current draw during normal compressor operation. The detection of FLA generates a warning alarm that causes the compressor to adjust its operating conditions so as not to exceed the alarm value.

Table 3 Cable Gland Hole Size Using Teck Cable (TT300 Compressors)

Model Number	Trade Size	Actual Size
TT300-G2-1-ST-N-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-G3-1-ST-N-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-G4-1-ST-N-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-G6-1-ST-N-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-G7-1-ST-N-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-G2-1-ST-P-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-G3-1-ST-P-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-G4-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-G6-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-G7-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-G7-1-MT-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-H6-1-ST-N-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-H6-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-H6-1-MT-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-H6-1-ST-N-O-CE	2.0 (51 mm)	2.48” (63 mm)
TT300-H6-1-ST-P-O-CE	2.0 (51 mm)	2.48” (63 mm)
TT300-H6-1-MT-P-O-CE	2.0 (51 mm)	2.48” (63 mm)
TT300-F2-1-ST-N-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-F3-1-ST-N-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-F4-1-ST-N-O-NC	1.5 (38 mm)	1.97” (50 mm)

Table 3 (Continued) Cable Gland Hole Size Using Teck Cable (TT300 Compressors)

Model Number	Trade Size	Actual Size
TT300-F5-1-ST-N-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-F6-1-ST-N-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-F7-1-ST-N-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-F2-1-ST-P-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-F3-1-ST-P-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-F4-1-ST-P-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-F5-1-ST-P-O-NC	1.5 (38 mm)	1.97” (50 mm)
TT300-F6-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-F7-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT300-F7-1-MT-P-O-NC	2.0 (51 mm)	2.48” (63 mm)

Table 4 Cable Gland Hole Size Using Teck Cable (TT400 Compressors)

Model Number	Trade Size	Actual Size
TT400-G4-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT400-G5-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT400-G6-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT400-G8-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT400-G9-1-ST-P-O-NC	2.0 (51 mm)	2.48” (63 mm)
TT400-H10-1-ST-P-O-NC	2.5 (64 mm)	3.0” (76 mm)
TT400-H10-1-ST-P-O-CE	2.5 (64 mm)	3.0” (76 mm)