ABB INDUSTRIAL DRIVES

ACS880 multidrives cabinets and modules

Electrical planning instructions

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Introduction to the manual

Contents of this chapter

This chapter contains general information of the manual, a list of related manuals, and a list of terms and abbreviations.

Applicability

This manual is applicable with the air-cooled ACS880 multidrives cabinets and multidrive modules.

Target audience

This manual is intended for people who plan electrical installation of the drive. The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

Terms and abbreviations

Term	Description
Brake unit	Brake chopper modules and the necessary auxiliary equipment, such as control electronics, fusing and cabling
Cabinet	An enclosure that consists of one or more cubicles
CMF	Common mode filtering
Control unit	The part in which the control program runs.
Cubicle	One section of a cabinet-installed drive. A cubicle is typically behind a door of its own.
DC link	DC circuit between rectifier and inverter
Diode supply module	Diode rectifier and related components enclosed in a metal frame or enclosure. Intended for cabinet installation.
Diode supply unit	Diode supply modules under control of one control unit, and related components.
Drive	Frequency converter for controlling AC motors
EMC	Electromagnetic compatibility
FAIO-01	Analog I/O extension module
FEN-01	Optional TTL incremental encoder interface module
FEN-11	Optional absolute encoder interface module
FEN-21	Optional resolver interface module
FEN-31	Optional HTL incremental encoder interface module
FIO-11	Optional analog I/O extension module
FPTC-01	Optional thermistor protection module
FPTC-02	Optional ATEX-certified thermistor protection module for potentially explosive atmospheres
FSCS-21	Optional functional safety module
FSO-12, FSO-21	Optional functional safety modules
FSPS-21	Optional functional safety module
IGBT supply module	IGBT bridge and related components enclosed inside a metal frame or enclosure. Intended for cabinet installation.
IGBT supply unit	IGBT supply module(s) under control of one control unit, and related components.
Intermediate circuit	DC circuit between rectifier and inverter
Inverter	Converts direct current and voltage to alternating current and voltage.
Inverter module	Inverter bridge, related components and drive DC link capacitors enclosed in a metal frame or enclosure. Intended for cabinet installation.
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.
Multidrive	Drive for controlling several motors which are typically coupled to the same machinery. Includes one supply unit, and one or several inverter units.
Parameter	In the drive control program, user-adjustable operation instruction to the drive, or signal measured or calculated by the drive. In some (for example fieldbus) contexts, a value that can be accessed as an object. For example, variable, constant, or signal.
PL	Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)
Power module	Common term for drive module, inverter module, supply module, brake chopper module etc.
Rectifier	Converts alternating current and voltage to direct current and voltage
Regenerative rectifier module	Rectifier bridge and related components enclosed in a metal frame or enclosure. Intended for cabinet installation. Also called supply module in some context.
Regenerative rectifier unit	Regenerative rectifier modules under control of one control unit, and related components. Also called supply unit in some context.
SIL	Safety integrity level (1…3) (IEC 61508, IEC 62061, IEC 61800-5-2)

Term	Description
Single drive	Drive for controlling one motor
STO	Safe torque off (IEC/EN 61800-5-2)
Supply module	Rectifier bridge and related components enclosed in a metal frame or enclosure. Intended for cabinet installation.
Supply unit	Supply module(s) under control of one control unit, and related components.

Related documents

You can find manuals on the Internet. See below for the relevant code/link. For more documentation, go to www.abb.com/drives/documents.

	Manuals for ACS880 multidrives cabinets
	Manuals for ACS880 multidrives modules

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Electrical planning guidelines

Contents of this chapter

This chapter contains guidelines for planning the electrical installation of the drive.

Limitation of liability

The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations. Furthermore, if the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

North America

Installations must be compliant with NFPA 70 (NEC)[1)] and/or Canadian Electrical Code (CE) along with state and local codes for your location and application.

[1)] National Fire Protection Association 70 (National Electric Code).

Selecting the supply disconnecting device

Cabinet-installed multidrives

The drive is equipped with a main disconnecting device as standard. Depending on the size of the drive, and the selected options, the type of disconnecting device may vary. Examples: switch-disconnector, withdrawable air circuit breaker, etc.

Multidrive modules

You must equip the drive with a main supply disconnecting device which meets the local safety regulations. You must be able to lock the disconnecting device to the open position for installation and maintenance work.

To comply with European Union directives and United Kingdom regulations related to standard EN 60204-1, the disconnecting device must be one of these types:

- switch-disconnector of utilization category AC-23B (IEC 60947-3)
- disconnector that has an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector (EN 60947-3)
- circuit-breaker suitable for isolation in accordance with IEC 60947-2.

Selecting the main contactor (breaker)

Cabinet-installed multidrives

Depending on the drive type and size, it is fitted with a main contactor or a main breaker by default. With certain drive types, you can select either of the two.

Multidrive modules

You can order a pre-selected main contactor (breaker) from ABB. See the appropriate drive or supply module hardware manual.

Follow these guidelines when you select a customer-defined main contactor:

- Dimension the contactor according to the nominal voltage and current of the drive. Also consider the environmental conditions such as surrounding air temperature.
- IEC installations: Select contactor with utilization category AC-1 (number of operations under load) according to IEC 60947-4.
- Consider the application life time requirements.

Selecting the supply transformer

Basic guidelines

1. Define the apparent power of the transformer. You can use this rule of thumb:
   - if the drive is equipped with a diode supply unit, or a regenerative rectifier unit:
     S_N (kVA) = 1.32 × sum of the motor shaft powers (kW)
   - if the drive is equipped with an IGBT supply unit:
     S_N (kVA) = 1.16 × sum of the motor shaft powers (kW)
2. Define the nominal voltage for the transformer secondary winding according to the nominal input voltage of the drive. See the supply unit hardware manual.
3. Make sure that the transformer complies with the electrical power network specification of the drive. See the appropriate drive or supply unit hardware manual for:
   - nominal input voltage, allowed voltage variation and imbalance
   - nominal frequency and allowed variation
   - short-circuit withstand strength and short-circuit current protection requirements
   - etc.

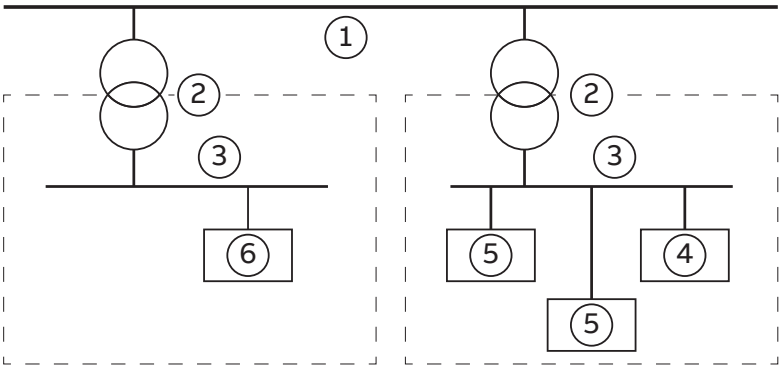
4. Consider the additional notes below.
5. Contact the transformer manufacturer for more information on the transformer selection.

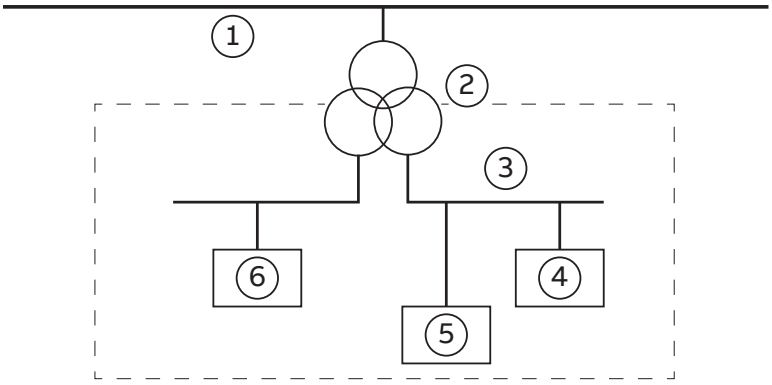
Additional notes

A drive larger than 500 kVA with an IGBT supply unit or a regenerative rectifier unit

Use a two-winding transformer dedicated to drives. Alternatively, use a three-winding transformer, and connect only drives to the same secondary winding. If it is necessary to connect other equipment to the same transformer winding, obey these instructions to prevent damage:

- Do not connect a direct online motor to the same transformer winding as the drive unless the motor is designed for use with variable frequency drives.
- Do not connect capacitive loads (for example, lighting, PCs, PLCs, power factor compensation capacitors) to the same transformer winding as the drive.





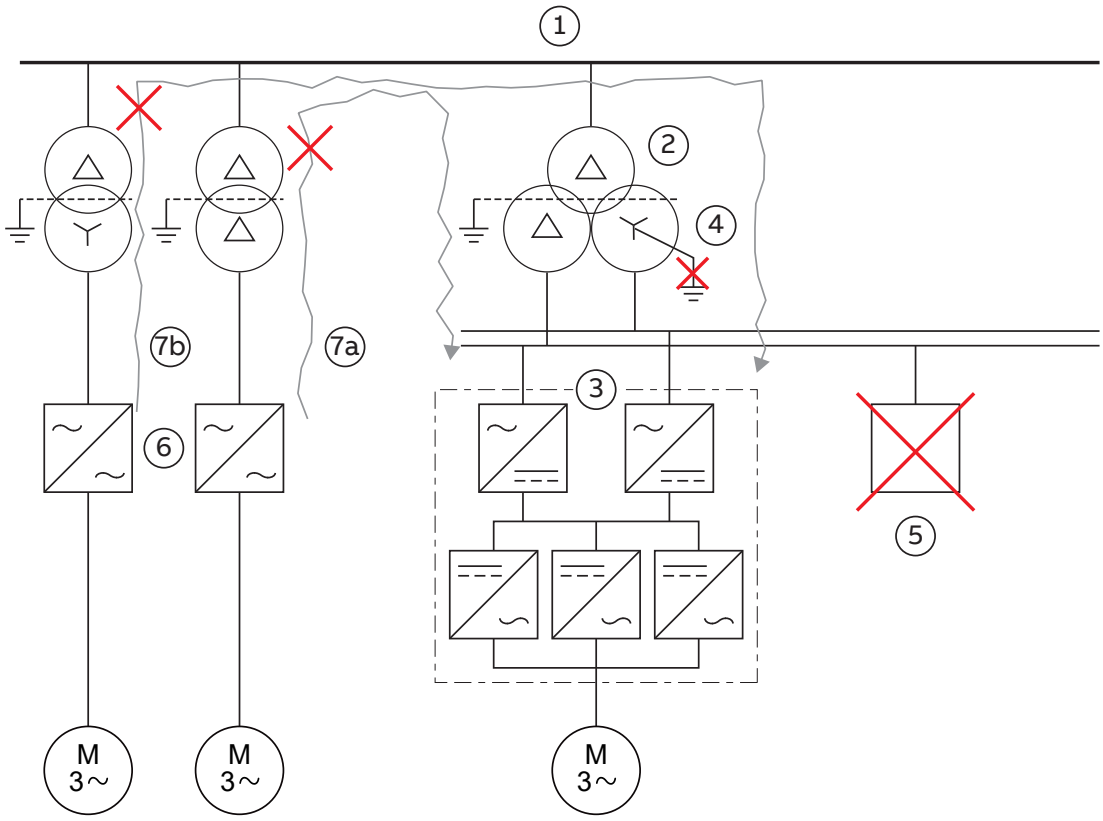
1	Medium voltage network
2	Transformer
3	Low voltage network
4	Drive
5	Other drives
6	Other load (not drives)

A drive with a 12-pulse diode supply unit

A 12-pulse diode supply unit cannot control the load sharing between its diode bridges. The load sharing depends on factors such as the transformer selection, actual state of the transformer (voltages, harmonics), supply network and cables. Load unbalance reduces the load capacity of the drive. To avoid it, and to achieve the optimal drive system performance, obey the guidelines in this section on the transformer selection and on other factors.

Use a three-winding transformer, or two two-winding transformers:

- Connection groups: three-winding transformer: Dy11d0 (or Dd0y1). Two two-winding transformers: Dy11 and Yy0.
- Phase shift between secondaries: 30° electrical
- Voltage difference between secondaries: < 0.5%
- Short-circuit impedance of secondaries: > 5%
- Short-circuit impedance difference between secondaries: < 3%
- No grounding of the secondary windings.
- Static shield is recommended.



1	Medium voltage network
2	Three-winding transformer
3	12-pulse drive
4	No grounding of transformer secondary windings is permitted
5	No load unbalance between transformer secondary windings is permitted
6	Large 6-pulse drives (possible sources of harmonics)
7	No (or only minimal) voltage distortion in medium voltage network is permitted. a. Path of harmful effect (harmonics) to one leg of the 12-pulse supply unit through transformer delta-delta connections b. Path of harmful effect (harmonics) to one leg of the 12-pulse supply unit through transformer delta-wye connections.

Use identical supply cables between the transformer secondary windings and the drive (type, size, length, quantity).

Make sure that there is no (or only minimal) voltage distortion in the medium voltage system. The distortion has a negative effect on the operation of the transformer and the 12-pulse drive. Especially 5th and 7th order harmonics are harmful. They can decrease the DC output voltage of either 12-pulse leg of the supply unit. This causes load unbalance and decreases the load capacity of the drive. Similar transformer connection of the source drive and the 12-pulse drive tend to convey the harmful effect more effectively. This strengthens the load unbalance between the two legs of the 12-pulse drive. Refer to the illustration above. Loads such as large 6-pulse drives can cause 5th and 7th harmonics.

If you must connect a load other than a 12-pulse drive to the transformer, make sure that the load is identically shared between the secondary windings.

If the three-winding transformer supplies power to multiple 12-pulse drives, derate the drive power rating from the nominal value according to the table below.

Number of 12-pulse drives	Drive power rating (%)
1	100
2	90
3	85
4	82
5	80

Two parallel-connected supply units

See the appropriate supplement for the parallel-connected supply units, or contact ABB for instructions in selecting the transformer(s).

Examining the compatibility of the motor and drive

Use asynchronous AC induction motors, permanent magnet synchronous motors, AC induction servomotors or ABB synchronous reluctance motors (SynRM motors) with the drive.

Select the motor size and drive type from the rating table on basis of the AC line voltage and motor load. You can find the rating table in the appropriate hardware manual. You can also use the DriveSize PC tool.

Make sure that the motor can be used with an AC drive. See Requirements tables (page 19). For basics of protecting the motor insulation and bearings in drive systems, see Protecting the motor insulation and bearings (page 18).

Note:

- Consult the motor manufacturer before using a motor with nominal voltage that differs from the AC line voltage connected to the drive input.
- The voltage peaks at the motor terminals are relative to the supply voltage of the drive, not to the drive output voltage.

Protecting the motor insulation and bearings

The drive employs modern IGBT inverter technology. Regardless of frequency, the drive output comprises pulses of approximately the drive DC bus voltage with a very short rise time. The pulse voltage can be expected to be around double at the motor terminals, depending on the attenuation and reflection properties of the motor cable and the terminals. This can cause additional stress on the motor and motor cable insulation.

Modern variable speed drives with their fast rising voltage pulses and high switching frequencies can generate current pulses that flow through the motor bearings. This can gradually erode the bearing races and rolling elements.

du/dt filters protect motor insulation system and reduce bearing currents. Common mode filters reduce bearing currents. Insulated N-end (non-drive end) bearing protects against circulating bearing currents. Symmetrical shielded cable and high-frequency grounding protect the bearings of the motor and driven equipment against shaft grounding current.

Requirements tables

These tables show how to select the motor insulation system and when a drive d*u*/d*t* and common mode filters and insulated N-end (non-drive end) motor bearings are required. Ignoring the requirements or improper installation may shorten motor life or damage the motor bearings and voids the warranty.

Requirements for ABB motors, P_n < 100 kW (134 hp)

See also Abbreviations (page 22).

Motor type	Nominal AC line voltage	Requirement for	
		Motor insulation system	ABB d*u*/d*t* and common mode filters, insulated N-end motor bearings
			P_n < 100 kW and frame size < IEC 315
			P_n < 134 hp and frame size < NEMA 500
Random-wound M2_ and M3_	$U_n \leq 500$ V	Standard[1)]	-
	500 V < $U_n \leq$ 600 V	Standard	+ d*u*/d*t*
		Reinforced	-
	600 V < $U_n \leq$ 690 V (cable length ≤ 150 m)	Reinforced	+ d*u*/d*t*
	600 V < $U_n \leq$ 690 V (cable length > 150 m)	Reinforced	-
Form-wound	Refer to Requirements for ABB motors, $P_n \geq$ 100 kW (134 hp) (page 20): form-wound motors, 100 kW ≤ P_n < 350 kW.		
HDP	Consult the motor manufacturer.		

1) Standard, if the drive has a diode supply unit or a regenerative rectifier unit. Reinforced, if the drive has an IGBT supply unit.

Requirements for ABB motors, $P_n \geq 100$ kW (134 hp)

See also Abbreviations (page 22).

Motor type	Nominal AC line voltage	Requirement for		
		Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings	
			100 kW ≤ P_n < 350 kW or IEC 315 ≤ frame size < IEC 400	P_n ≥ 350 kW or frame size ≥ IEC 400
			134 hp ≤ P_n < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580	P_n ≥ 469 hp or frame size > NEMA 580
Random-wound M2_ and M3_	U_n ≤ 500 V	Standard [1]	+ N	+ N + CMF
	500 V < U_n ≤ 600 V	Standard	+ N + du/dt	+ N + du/dt + CMF
		Reinforced	+ N	+ N + CMF
	600 V < U_n ≤ 690 V (cable length ≤ 150 m)	Reinforced	+ N + du/dt	+ N + du/dt + CMF
	600 V < U_n ≤ 690 V (cable length > 150 m)	Reinforced	+ N	+ N + CMF
Form-wound _XR, AM_, NMI [2]	380 V < U_n ≤ 690 V	Reinforced	+ N + CMF	P_n < 500 kW: +N + CMF
				P_n ≥ 500 kW: +N + du/dt + CMF
HDP	Consult the motor manufacturer.			

1) Standard, if the drive has a diode supply unit or a regenerative rectifier unit. Reinforced, if the drive has an IGBT supply unit.
2) For an old motor, consult the motor manufacturer.

Requirements for non-ABB motors, P_n < 100 kW (134 hp)

See also Abbreviations (page 22).

Motor type	Nominal AC line voltage	Requirement for	
		Motor insulation system [1)]	ABB du/dt and common mode filters, insulated N-end motor bearings
			P_n < 100 kW and frame size < IEC 315
			P_n < 134 hp and frame size < NEMA 500
Random-wound and form-wound	U_n ≤ 420 V	$\hat{U}_{LL}$ = 1300 V, 0.2 µs rise time	-
	420 V < U_n ≤ 500 V	$\hat{U}_{LL}$ = 1300 V	+ du/dt
		$\hat{U}_{LL}$ = 1600 V, 0.2 µs rise time	-
	500 V < U_n ≤ 600 V	$\hat{U}_{LL}$ = 1600 V	+ du/dt
		$\hat{U}_{LL}$ = 1800 V, 0.2 µs rise time	-
	600 V < U_n ≤ 690 V	$\hat{U}_{LL}$ = 1800 V	+ du/dt
		$\hat{U}_{LL}$ = 2000 V, 0.3 µs rise time	-

1) These are typical values and not indicative of the actual values that will be generated. The network topology and grounding, drive type, cable type and length, motor type and other circuit features have an effect on the actual phase-to-phase and phase-to-ground voltages of the motor. For motor dimensioning and selection, refer to IEC 60034-18-41, IEC 60034-18-42, IEC/TC 60034-25 and IEC/TS 61800-8. ABB strongly recommends to do a detailed network study for proper cable and motor selection.
The minimum IVIC motor insulation classification is C/B for a drive with a diode supply unit or a regenerative rectifier unit. In some cases, the classification must be even higher. The minimum IVIC motor insulation classification is C/C for a drive with an IGBT supply unit. In some cases, the classification must be even higher.

Requirements for non-ABB motors, $P_n \geq 100$ kW (134 hp)

See also Abbreviations (page 22).

Motor type	Nominal AC line voltage	Requirement for		
		Motor insulation system[1]	ABB du/dt and common mode filters, insulated N-end motor bearings	
			100 kW ≤ P_n < 350 kW or IEC 315 ≤ frame size < IEC 400	P_n ≥ 350 kW or frame size ≥ IEC 400
			134 hp ≤ P_n < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580	P_n ≥ 469 hp or frame size > NEMA 580
Random-wound and form-wound	U_n ≤ 420 V	$\hat{U}_{LL}$ = 1300 V, 0.2 µs rise time	+ N or CMF	+ N + CMF
	420 V < U_n ≤ 500 V	$\hat{U}_{LL}$ = 1300 V	+ du/dt + (N or CMF)	+ N + du/dt + CMF
		$\hat{U}_{LL}$ = 1600 V, 0.2 µs rise time	+ N or CMF	+ N + CMF
	500 V < U_n ≤ 600 V	$\hat{U}_{LL}$ = 1600 V	+ du/dt + (N or CMF)	+ N + du/dt + CMF
		$\hat{U}_{LL}$ = 1800 V, 0.2 µs rise time	+ N or CMF	+ N + CMF
	600 V < U_n ≤ 690 V	$\hat{U}_{LL}$ = 1800 V	+ du/dt + N	+ N + du/dt + CMF
		$\hat{U}_{LL}$ = 2000 V, 0.3 µs rise time	+ N + CMF	+ N + CMF

1) These are typical values and not indicative of the actual values that will be generated. The network topology and grounding, drive type, cable type and length, motor type and other circuit features have an effect on the actual phase-to-phase and phase-to-ground voltages of the motor. For motor dimensioning and selection, refer to IEC 60034-18-41, IEC 60034-18-42, IEC/TC 60034-25 and IEC/TS 61800-8. ABB strongly recommends to do a detailed network study for proper cable and motor selection.
The minimum IVIC motor insulation classification is C/B for a drive with a diode supply unit or a regenerative rectifier unit. In some cases, the classification must be even higher. The minimum IVIC motor insulation classification is C/C for a drive with an IGBT supply unit. In some cases, the classification must be even higher.

Abbreviations

Abbr.	Definition
U_n	Nominal AC line voltage
$\hat{U}_{LL}$	Peak line-to-line voltage at motor terminals which the motor insulation must withstand
P_n	Motor nominal power
du/dt	du/dt filter at the output of the drive
CMF	Common mode filter of the drive
N	N-end bearing: insulated motor non-drive end bearing
n.a.	Motors of this power range are not available as standard units. Consult the motor manufacturer.

Availability of d*u*/d*t* filter and common mode filter by drive or inverter type

Inverter frame size	du/dt filter	Common mode filter (CMF)
Multidrive cabinets		
R1i … R5i	Option +E205	-
R6i, R7i	Option +E205	Standard
R8i	Option +E205 / standard [1)]	Standard
Multidrive modules		
R1i … R5i	Add-on kit [2)]	-
R6i, R7i	Add-on kit [2)]	Add-on kit [2)]
R8i	Option +E205 / standard [1)]	Add-on kit [2)]

1) 400 V and 500 V single-module units: Option +E205. 690 V units, and units with parallel-connected modules: Standard.
2) For ordering information, refer to ACS880-104 inverter modules hardware manual (3AUA0000104271 [English]).

Additional requirements for explosion-safe (EX) motors

If you use an explosion-safe (EX) motor, obey the rules in the requirements tables above. In addition, consult the motor manufacturer for any further requirements.

Additional requirements for ABB motors of types other than M2_, M3_, _XR, AM_, NMI

Use the selection criteria given for non-ABB motors.

Additional requirements for braking applications

When the motor brakes the machinery, the intermediate circuit DC voltage of the drive increases, the effect being similar to the motor supply voltage increasing by up to 20 percent. Consider this voltage increase when specifying the motor insulation requirements if the motor will be braking a large part of its operation time.

Example: Motor insulation requirement for a 400 V AC line voltage application must be selected as if the drive were supplied with 480 V.

Additional requirements for drives with an IGBT supply unit when using a DC voltage boost

It is possible to increase the intermediate circuit DC voltage from the nominal (standard) level with a parameter in the supply unit control program. If you choose to do this, select the motor insulation system that withstands the increased DC voltage level.

Additional requirements for ABB high-output and IP23 motors

The rated output power of high output motors is higher than what is stated for the particular frame size in EN 50347 (2001).

This table shows the requirements for protecting the motor insulation and bearings in drive systems for ABB random-wound motor series (for example, M3AA, M3AP and M3BP).

Nominal AC supply voltage	Requirement for			
	Motor insulation system	ABB d*u*/d*t* and common mode filters, insulated N-end motor bearings		
		P_n < 100 kW	100 kW ≤ P_n < 200 kW	P_n ≥ 200 kW
		P_n < 140 hp	140 hp ≤ P_n < 268 hp	P_n ≥ 268 hp
U_n ≤ 500 V	Standard[1)]	-	+ N	+ N + CMF
500 V < U_n ≤ 600 V	Standard	+ d*u*/d*t*	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF
	Reinforced	-	+ N	+ N + CMF
600 V < U_n ≤ 690 V	Reinforced	+ d*u*/d*t*	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF

1) Standard, if the drive has a diode supply unit or a regenerative rectifier unit. Reinforced, if the drive has an IGBT supply unit.

Additional requirements for non-ABB high-output and IP23 motors

The rated output power of high-output motors is higher than what is stated for the particular frame size in EN 50347 (2001).

If you plan to use a non-ABB high-output motor or an IP23 motor, consider these additional requirements for protecting the motor insulation and bearings in drive systems:

- If motor power is below 350 kW: Equip the drive and/or motor with the filters and/or bearings according to the table below.
- If motor power is above 350 kW: Consult the motor manufacturer.

Nominal AC supply voltage	Requirement for		
	Motor insulation system[1)]	ABB d*u*/d*t* and common mode filters, insulated N-end motor bearings	
		P_n < 100 kW or frame size < IEC 315	100 kW < P_n < 350 kW or IEC 315 < frame size < IEC 400
		P_n < 134 hp or frame size < NEMA 500	134 hp < P_n < 469 hp or NEMA 500 < frame size < NEMA 580
U_n ≤ 420 V	$\hat{U}_{LL}$ = 1300 V, 0.2 µs rise time	+ N or CMF	+ N or CMF
420 V < U_n < 500 V	$\hat{U}_{LL}$ = 1300 V	+ d*u*/d*t* + (N or CMF)	+ N + d*u*/d*t* + CMF
	$\hat{U}_{LL}$ = 1600 V, 0.2 µs rise time	+ N or CMF	+ N or CMF
500 V < U_n ≤ 600 V	$\hat{U}_{LL}$ = 1600 V	+ d*u*/d*t* + (N or CMF)	+ N + d*u*/d*t* + CMF
	$\hat{U}_{LL}$ = 1800 V, 0.2 µs rise time	+ N or CMF	+ N + CMF
600 V < U_n ≤ 690 V	$\hat{U}_{LL}$ = 1800 V	+ N + d*u*/d*t*	+ N + d*u*/d*t* + CMF
	$\hat{U}_{LL}$ = 2000 V, 0.3 µs rise time	+ N + CMF	+ N + CMF

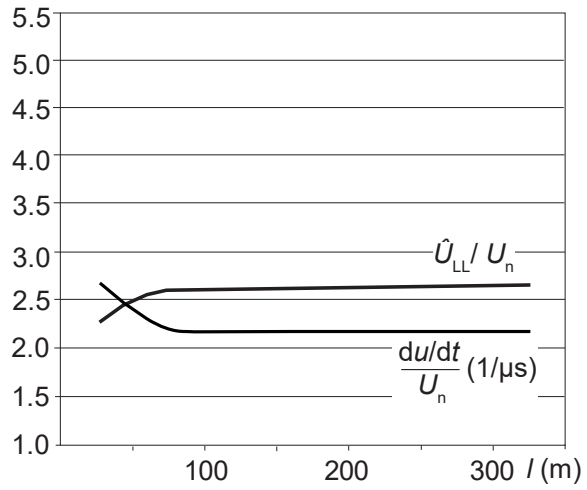
1) These are typical values and not indicative of the actual values that will be generated. The network topology and grounding, drive type, cable type and length, motor type and other circuit features have an effect on the actual phase-to-phase and phase-to-ground voltages of the motor. For motor dimensioning and selection, refer to IEC 60034-18-41, IEC 60034-18-42, IEC/TC 60034-25 and IEC/TS 61800-8. ABB strongly recommends to do a detailed network study for proper cable and motor selection.
The minimum IVIC motor insulation classification is C/B for a drive with a diode supply unit or a regenerative rectifier unit. In some cases, the classification must be even higher. The minimum IVIC motor insulation classification is C/C for a drive with an IGBT supply unit. In some cases, the classification must be even higher.

Additional data for calculating the rise time and the peak line-to-line voltage

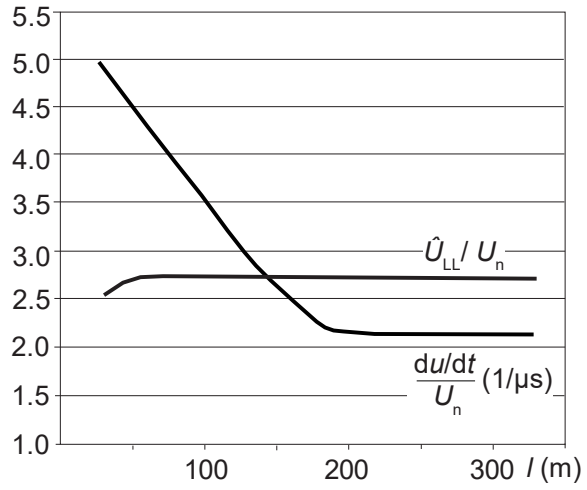
The diagrams below show the relative peak line-to-line voltage and rate of change of voltage as a function of the motor cable length. If you need to estimate the peak voltage and voltage rise time considering the actual cable length, proceed as follows:

- Peak line-to line voltage: Read the relative $\hat{U}_{LL}/U_n$ value from the diagram below and multiply it by the nominal supply voltage (U_n).
- Voltage rise time (t_r): Read the relative value $(du/dt)/U_n$ from the diagram below and multiply it by the nominal supply voltage (U_n). Substitute the $\hat{U}_{LL}$ and du/dt values into equation $t_r = 0.8 \cdot \hat{U}_{LL}/(du/dt)$.

Inverter/drive with du/dt filter



Inverter/drive without du/dt filter



l	Motor cable length
$\hat{U}_{LL}/U_n$	Relative peak line-to-line voltage
$(du/dt)/U_n$	Relative voltage rate of change

Note: $\hat{U}_{LL}$ value is approximately 20% higher during resistor braking. $\hat{U}_{LL}$ value is approximately 10% higher if the drive has an IGBT supply unit.

Note: Due to installation, cable types and motor impedance, the worst case value may be higher than the estimate value (curve).

Additional note for sine filters

A sine filter also protects the motor insulation system. The peak phase-to-phase voltage with a sine filter is approximately 1.5 · U_n.

Selecting the power cables

Power cable selection procedure and applicability check

Select each power cable as follows. Obey the local regulations.

1. Select the cable type. Obey the general guidelines and recommendations for the drive power cabling. Refer to General guidelines (page 27) and Power cable types (page 27) .
2. Select the cable size.
   Cabinet-installed multidrives: Refer to the listing of typical power cable sizes given in the technical data of the multidrives unit hardware manual.
   Multidrives module: Refer to the listing of typical power cable sizes given in the technical data of the multidrives module hardware manual.
3. Make sure that the short-circuit rating of the cable is sufficient. Take into account the disconnection time of the protective device. If the rating is not sufficient, select a larger cable, increase the number of parallel cables or change the cable to a type with higher conductor temperature rating.
4. Select the cable lugs.
5. Make sure that the cable can enter the cabinet through the cable entry plate.
   Cabinet-installed multidrives: Refer to the dimension drawings of the drive delivery or technical data in the multidrives unit hardware manual. For special cable entry solutions, consult ABB.
   Multidrives module: Refer to the dimension drawings of the customer-defined cabinet.
6. Make sure that there is sufficient space to install the cable(s) and cable lugs to the terminals.
   Cabinet-installed multidrives: Refer to the terminal and cable entry data given in the technical data of the multidrives unit hardware manual.
   Multidrives module: Refer to the terminal and cable entry data of the customer-defined cabinet.

General guidelines

Select the input power and motor cables according to local regulations.

- **Current:** Select a cable capable of carrying the maximum load current and suitable for the prospective short-circuit current provided by the supply network. The method of installation and ambient temperature affect the cable current carrying capacity. Obey local regulations and laws.
- **Temperature:** For an IEC installation, select a cable rated for at least 70 °C (158 °F) maximum permissible temperature of conductor in continuous use.
  For North America, select a cable rated for at least 75 °C (167 °F).
  Important: For certain product types or option configurations higher temperature rating may be required. See the technical data for details.
- **Voltage:** 600 V AC cable is accepted for up to 500 V AC. 750 V AC cable is accepted for up to 600 V AC. 1000 V AC cable is accepted for up to 690 V AC.

To comply with the EMC requirements of the CE mark, use one of the preferred cable types. See Preferred power cable types (page 27).

Symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as the stress on motor insulation, bearing currents and wear.

Metal conduit reduces electromagnetic emission of the whole drive system.

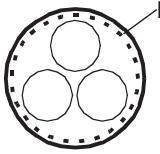
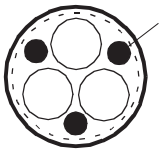
Typical power cable sizes

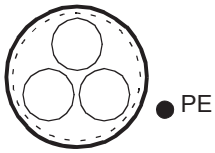
See the technical data in the appropriate hardware manual.

Power cable types

Preferred power cable types

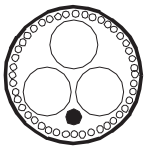
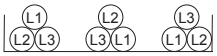
This section shows the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
 Symmetrical shielded (or armored) cable with three phase conductors and concentric PE conductor as shield (or armor)	Yes	Yes
 Symmetrical shielded (or armored) cable with three phase conductors and symmetrically constructed PE conductor and a shield (or armor)	Yes	Yes

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
 Symmetrical shielded (or armored) cable with three phase conductors and a shield (or armor), and separate PE conductor/cable [1)]	Yes	Yes

1) A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use.

Alternate power cable types

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
 Four-conductor armored cable (three phase conductors and PE)	Yes	Yes with phase conductor smaller than 10 mm^2 (8 AWG) Cu, or motors up to 30 kW (40 hp)
 Shielded (Al/Cu shield or armor) [1)] four-conductor cable (three phase conductors and a PE)	Yes	Yes with motors up to 100 kW (135 hp). A potential equalization between the frames of motor and driven equipment is required.
 A single-core cable system: three phase conductors and PE conductor on cable tray  Preferable cable arrangement to avoid voltage or current unbalance between the phases	Yes  **WARNING!** If you use unshielded single-core cables in an IT network, make sure that the non-conductive outer sheath (jacket) of the cables have good contact with a properly grounded conductive surface. For example, install the cables on a properly grounded cable tray. Otherwise voltage may become present on the non-conductive outer sheath of the cables, and there is even a risk of an electric shock.	No

1) Armor may act as an EMC shield, as long as it provides the same performance as a concentric EMC shield of a shielded cable. To be effective at high frequencies, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The effectiveness of the shield can be evaluated based on the shield inductance, which must be low and only slightly dependent on frequency. The requirements are easily met with a copper or aluminum shield/armor. The cross-section of a steel shield must be ample and the shield helix must have a low gradient. A galvanized steel shield has a better high-frequency conductivity than a non-galvanized steel shield.

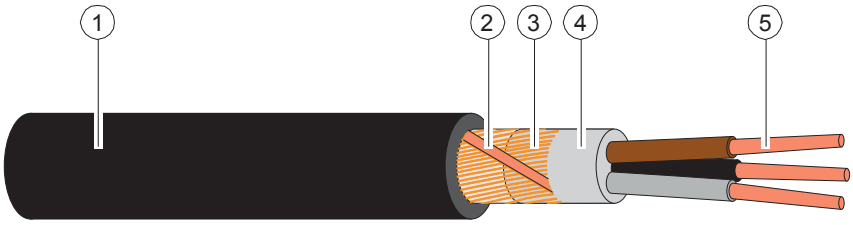
Not allowed power cable types

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
 Symmetrical shielded cable with individual shields for each phase conductor	No	No

Power cable shield

If the cable shield is used as the sole protective earth (PE) conductor, make sure that its conductivity agrees with the PE conductor requirements.

To effectively suppress radiated and conducted radio-frequency emissions, the cable shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminum shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires with an open helix of copper tape or copper wire. The better and tighter the shield, the lower the emission level and bearing currents.



1	Insulation jacket
2	Helix of copper tape or copper wire
3	Copper wire shield
4	Inner insulation
5	Cable core

Grounding requirements

This section gives general requirements for grounding the drive. When you plan the grounding of the drive, obey all the applicable national and local regulations.

The conductivity of the protective earth conductor(s) must be sufficient.

Unless local wiring regulations state otherwise, the cross-sectional area of the protective earth conductor must agree with the conditions that require automatic disconnection of the supply required in 411.3.2 of IEC 60364-4-41:2005 and be capable of withstanding the prospective fault current during the disconnection time of the protective device. The cross-sectional area of the protective earth conductor must be selected from the table below or calculated according to 543.1 of IEC 60364-5-54.

The table shows the minimum cross-sectional area of the protective earth conductor related to the phase conductor size according to IEC/UL 61800-5-1 when the phase

conductor(s) and the protective earth conductor are made of the same metal. If they are different metals, the cross-sectional area of the protective earth conductor must be determined in a manner which produces a conductance equivalent to that which results from the application of this table.

Cross-sectional area of the phase conductors S (mm^2)	Minimum cross-sectional area of the corresponding protective earth conductor S_p (mm^2)
$S \leq 16$	S [1)]
$16 < S \leq 35$	16
$35 < S$	S/2

1) For the minimum conductor size in IEC installations, refer to Additional grounding requirements – IEC.

If the protective earth conductor is not part of the input power cable or input power cable enclosure, the minimum permitted cross-sectional area is:

- 2.5 mm^2 if the conductor is mechanically protected,
  or
- 4 mm^2 if the conductor is not mechanically protected. If the equipment is cord-connected, the protective earth conductor must be the last conductor to be interrupted if there is a failure in the strain relief mechanism.

Additional grounding requirements – IEC

This section gives grounding requirements according to standard IEC/EN 61800-5-1.

Because the normal touch current of the drive is more than 3.5 mA AC or 10 mA DC:

- the minimum size of the protective earth conductor must comply with the local safety regulations for high protective earth conductor current equipment, and
- you must use one of these connection methods:
  1. a fixed connection and:
     - a protective earth conductor with a minimum cross-sectional area of 10 mm^2 Cu or 16 mm^2 Al (as an alternative when aluminum cables are permitted),
       or
     - a second protective earth conductor of the same cross-sectional area as the original protective earth conductor,
       or
     - a device that automatically disconnects the supply if the protective earth conductor is damaged.
  2. a connection with an industrial connector according to IEC 60309 and a minimum protective earth conductor cross-section of 2.5 mm^2 as part of a multi-conductor power cable. Sufficient strain relief must be provided.

If the protective earth conductor is routed through a plug and socket, or similar means of disconnection, it must not be possible to disconnect it unless power is simultaneously removed.

Note: You can use power cable shields as protective earth conductors only when their conductivity is sufficient.

Additional grounding requirements – UL (NEC)

This section gives grounding requirements according to standard UL 61800-5-1.

The protective earth conductor must be sized as specified in Article 250.122 and table 250.122 of the National Electric Code, ANSI/NFPA 70.

For cord-connected equipment, it must not be possible to disconnect the protective earth conductor before power is removed.

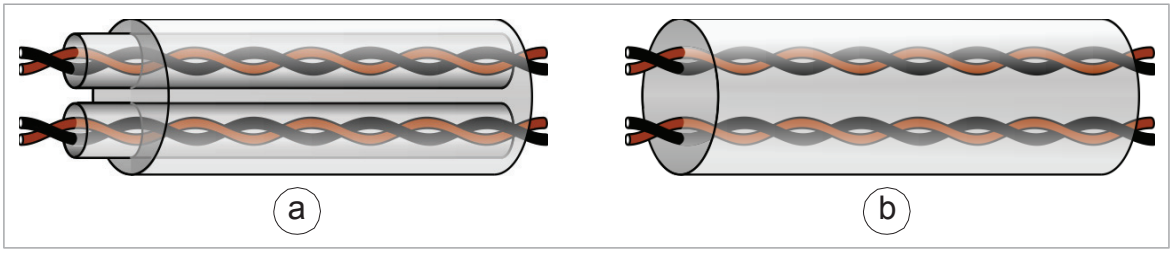
Selecting the control cables

Shielding

Only use shielded control cables.

Use a double-shielded twisted pair cable for analog signals. ABB recommends this type of cable also for the pulse encoder signals. Use one individually shielded pair for each signal. Do not use common return for different analog signals.

A double-shielded cable (a) is the best alternative for low-voltage digital signals, but single-shielded (b) twisted pair cable is also acceptable.



Signals in separate cables

Run analog and digital signals in separate, shielded cables. Do not mix 24 V DC and 115/230 V AC signals in the same cable.

Signals that can be run in the same cable

If their voltage does not exceed 48 V, relay-controlled signals can be run in the same cables as digital input signals. The relay-controlled signals should be run as twisted pairs.

Relay cable

The cable type with braided metallic shield (for example ÖLFLEX by LAPPKABEL, Germany) has been tested and approved by ABB.

Control panel to drive cable

Use EIA-485, Cat 5e (or better) cable with male RJ45 connectors. The maximum length of the cable is 100 m (328 ft).

PC tool cable

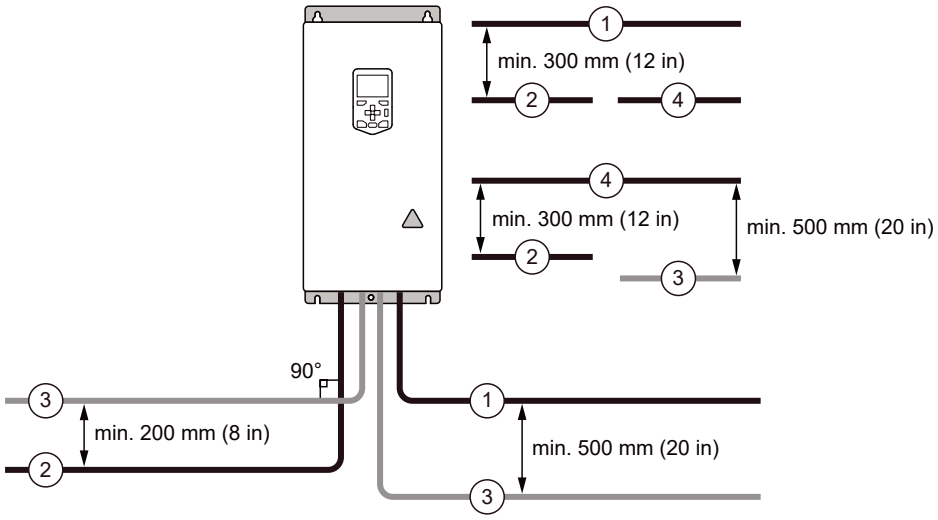
Connect the Drive Composer PC tool to the drive through the USB port of the control panel. Use a USB Type A (PC) - Type Mini-B (control panel) cable. The maximum length of the cable is 3 m (9.8 ft).

Routing the cables

General guidelines – IEC

- Route the motor cable away from other cables. Motor cables of several drives can be run in parallel installed next to each other.
- Install the motor cable, input power cable and control cables on separate trays.
- Avoid long parallel runs of motor cables with other cables.
- Where control cables must cross power cables, make sure that they are arranged at an angle as near to 90 degrees as possible.
- Do not run extra cables through the drive.
- Make sure that the cable trays have good electrical bonding to each other and to the grounding electrodes. Aluminum tray systems can be used to improve local equalizing of potential.

The following figure illustrates the cable routing guidelines with an example drive.



1	Motor cable
2	Input power cable
3	Control cable
4	Brake resistor or chopper cable (if any)

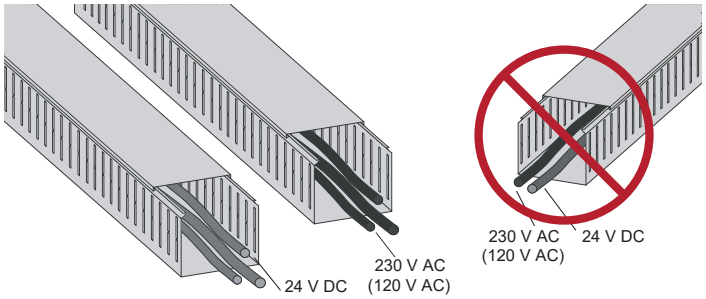
Continuous motor cable shield/conduit and metal enclosure for equipment on the motor cable

To minimize the emission level when safety switches, contactors, connection boxes or similar equipment are installed on the motor cable between the drive and the motor:

- Install the equipment in a metal enclosure.
- Use either a symmetrical shielded cable, or install the cabling in a metal conduit.
- Make sure that there is a good and continuous galvanic connection in the shield/conduit between drive and motor.
- Connect the shield/conduit to the protective ground terminal of the drive and the motor.

Separate control cable ducts

Put 24 V DC and 230 V AC (120 V AC) control cables in separate ducts, unless the 24 V DC cable is insulated for 230 V AC (120 V AC) or insulated with an insulation sleeving for 230 V AC (120 V AC).



Implementing thermal overload and short circuit protections

Protecting the drive and input power cables in short-circuit

Cabinet-installed multidrives

To protect the input cable in short-circuit situations, install fuses or a suitable circuit breaker at the supply side of the cabling.

The drive is equipped with fuses as standard. In case of a short-circuit inside the drive, the fuses protect the drive, restrict drive damage, and prevent damage to adjoining equipment.

In addition, drive with ACS880-307…+A003 diode supply unit equipped with supply module frame D6D or D7D: Protect the input power cable with the ABB-specified fuses. See the supply unit hardware manual. The fuses protect the cable, and limit the short-circuit current of the drive.

Multidrive modules

To protect the input power cable in short-circuit situations, install fuses or a suitable circuit breaker at the supply side of the cabling.

To protect the drive in short-circuit situations, install the ABB-specified fuses for the supply unit, inverter units and other units. See the appropriate hardware manuals.

In addition, drive with ACS880-304…+A003 diode supply module, frame D6D or D7D: Protect the input power cable with the ABB-specified fuses. See the supply unit hardware manual. The fuses protect the cable, and limit the short-circuit current of the drive.

Protecting the motor and motor cable in short-circuits

The drive protects the motor cable and motor in a short-circuit situation when:

- the motor cable is sized correctly
- the motor cable type complies with the motor cable selection guidelines by ABB

- the cable length does not exceed the allowed maximum length specified for the drive
- the setting of parameter 99.10 Motor nominal power in the drive is equal with the value given on the motor rating plate.

The electronic power output short-circuit protection circuitry meets the requirements of IEC 60364-4-41:2005 + AMD1:2017.

Protecting the input power cable against thermal overload

Cabinet-installed multidrives

The drive has overload protection as standard. If the sizing of the input power cable is correct, the drive overload protection protects also the cable against overload. In case of parallel input power cables, it may be necessary to protect each cable separately. Obey the local regulations.

Multidrive modules

The drive has an overload protection as standard when the supply unit, inverter units and other units are sized and installed correctly. See the appropriate hardware manuals. If the sizing of the input power cable is correct, the drive overload protection protects also the cable against overload. In case of parallel input power cables, it may be necessary to protect each cable separately. Obey the local regulations.

Protecting the drive against thermal overload

Cabinet-installed multidrives

The drive has overload protection as standard.

Multidrive modules

The drive has an overload protection as standard when the supply unit, inverter units and other units are sized and installed correctly. See the appropriate hardware manuals.

Protecting the motor cables against thermal overload

The inverter unit protects the motor cables against thermal overload when the cables are sized according to the nominal output current of the inverter unit. No additional thermal protection devices are needed.

WARNING!
If the inverter unit is connected to multiple motors, use a separate overload protection for each motor cable and motor. The drive overload protection is tuned for the total motor load. It may not detect an overload in one motor circuit only.

North America: The local code (NEC) requires an overload protection and a short-circuit protection for each motor circuit. Use, for example:

- a manual motor protector
- circuit breaker, contactor and overload relay or
- fuses, contactor and overload relay.

Protecting the motor against thermal overload

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value, the function either monitors a calculated temperature value (based on a motor thermal model) or an actual temperature indication given by motor temperature sensors.

The motor thermal protection model supports thermal memory retention and speed sensitivity. The user can tune the thermal model further by feeding in additional motor and load data.

The most common temperature sensor types are PTC or Pt100.

For more information, see the firmware manual.

Protecting the motor against overload without thermal model or temperature sensors

Motor overload protection protects the motor against overload without using motor thermal model or temperature sensors.

Motor overload protection is required and specified by multiple standards including the US National Electric Code (NEC) and the common UL/IEC 61800-5-1 standard in conjunction with UL/IEC 60947-4-1. The standards allow for motor overload protection without external temperature sensors.

The protection feature of the drive allows the user to specify the class of operation in the same manner as the overload relays are specified in standards UL/IEC 60947-4-1 and NEMA ICS 2.

The motor overload protection supports thermal memory retention and speed sensitivity.

For more information, see drive firmware manual.

Implementing a motor temperature sensor connection

WARNING!
IEC 61800-5-1 requires double or reinforced insulation between live parts and accessible parts when:

- the accessible parts are not conductive, or
- the accessible parts are conductive, but not connected to the protective earth.

Obey this requirement when you plan the connection of the motor temperature sensor to the drive.

You have these implementation alternatives:

1. If there is double or reinforced insulation between the sensor and the live parts of the motor: You can connect the sensor directly to the analog/digital input(s) of the drive. See the control cable connection instructions. Make sure that the voltage is not more than the maximum allowed voltage over the sensor.
2. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect the sensor to the drive via an option module. The sensor and the module must form a double or reinforced insulation between the motor live parts and the drive control unit. See Connecting a motor temperature sensor to the drive through an option module (page 36). Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
3. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect a sensor to a digital input of the drive via an external relay. The sensor and the relay must form a double or reinforced insulation between the motor's live parts and the digital input of the drive. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.

Connecting a motor temperature sensor to the drive through an option module

This table shows:

- option module types that you can use for the motor temperature sensor connection
- insulation or isolation level that each option module forms between its temperature sensor connector and other connectors
- temperature sensor types that you can connect to each option module
- temperature sensor insulation requirement in order to form, together with the insulation of the option module, a reinforced insulation between the motor live parts and the drive control unit.

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	**Insulation/Isolation**	**PTC**	**KTY**	**Pt100, Pt1000**	
FIO-11	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and other I/O connectors.	x	x	x	Reinforced insulation
FEN-01	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output.	x	-	-	Reinforced insulation
FEN-11	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output.	x	x	-	Reinforced insulation
FEN-21	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output.	x	x	-	Reinforced insulation
FEN-31	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and other connectors.	x	x	-	Reinforced insulation
FAIO-01	Basic insulation between sensor connector and drive control unit connector. No insulation between sensor connector and other I/O connectors.	x	x	x	Reinforced or basic insulation. With basic insulation, the other I/O connectors of the option module must be kept disconnected.
FPTC-01/02 [1)]	Reinforced insulation between sensor connector and other connectors (including drive control unit connector).	x	-	-	No special requirement

1) Suitable for use in safety functions (SIL2 / PL c classified).

Implementing a ground fault detection function

Cabinet-installed multidrives

The drive is equipped with an internal ground fault protective function to protect the unit against ground faults in the motor and motor cable. This function is not a personnel safety or a fire protection feature. See the firmware manual for more information.

An optional ground fault monitoring device (+Q954) is available for IT (ungrounded) systems. The option includes a ground fault indicator on the drive cabinet door.

Residual current device compatibility

The drive is suitable for use with residual current devices of Type B.

Note: As standard, the drive contains capacitors connected between the main circuit and the frame. These capacitors and long motor cables increase the ground leakage current and may cause nuisance faults in residual current devices.

Multidrives modules

The drive is equipped with an internal ground fault protective function to protect the unit against ground faults in the motor and motor cable. This function is not a personnel safety or a fire protection feature. See the firmware manual for more information.

Residual current device compatibility

The drive is suitable to be used with residual current devices of Type B.

Note: As standard, the drive contains capacitors connected between the main circuit and the frame. These capacitors and long motor cables increase the ground leakage current and may cause fault current circuit breakers to function.

Implementing the Emergency stop function

Cabinet-installed multidrives

You can order the drive with an emergency stop function (option).

See the appropriate option manual for more information.

Name	Code
Emergency stop, stop category 0 (option +Q951) for ACS880 multidrives user's manual	3AUA0000119885
Emergency stop, stop category 1 (option +Q952) for ACS880 multidrives user's manual	3AUA0000119886
Emergency stop, stop category 0 (option +Q963) for ACS880 multidrives user's manual	3AUA0000119891
Emergency stop, stop category 1 (option +Q964) for ACS880 multidrives user's manual	3AUA0000119893
Emergency stop, configurable stop category 0 or 1 (option +Q979) for ACS880 multidrives user's manual	3AUA0000145933

Multidrive modules

For safety reasons, install the emergency stop devices at each operator control station and at other operating stations where the emergency stop may be needed. Implement the emergency stop according to relevant standards.

Note: You can use the Safe torque off function of the drive to implement the Emergency stop function.

Implementing the Safe torque off function

The safe torque off (STO) input is available as standard in all inverter units. See the inverter unit hardware manual for implementing the Safe torque off function.

Implementing the Prevention of unexpected start-up function

Cabinet-installed multidrives

You can order the drive with a Prevention of unexpected start-up (POUS) function. The POUS function disables the control voltage of the power semiconductors of the drive (inverter) output stage. This prevents the drive from generating the torque required to rotate the motor. POUS enables a short-time maintenance work (like cleaning) on the non-electrical parts of the machinery without switching off and disconnecting the drive.

See the appropriate option manual for more information.

Name	Code
Prevention of unexpected start-up (option +Q950) for ACS880 multidrives user's manual	3AUA0000145934
Prevention of unexpected start-up (option +Q957) for ACS880 multidrives user's manual	3AUA0000119894

Multidrive modules

Prevention of unexpected start-up function is not available as an option from ABB. The cabinet builder can use the Safe torque off function of the inverter modules to implement the Prevention of unexpected start-up function.

Implementing the Safely-limited speed function

Cabinet-installed multidrives

You can order the drive with Safely-limited speed function with the encoder interface (option +Q965). The function enables the user to safely operate close to the machine by lowering the speed automatically.

For multidrives, there is also a version without the encoder interface available (option +Q966).

See the appropriate option manual for more information.

Name	Code
Safely-limited speed with the encoder interface (option +Q965) for ACS880 multidrives user's manual	3AXD50000019728
Safely-limited speed without the encoder interface (option +Q966) for ACS880 multidrives user's manual	3AUA0000145935

Multidrive modules

Safely-limited speed function is not available as an option from ABB. However, the cabinet builder can implement it with an optional safety module available from ABB. See Implementing the functions provided by the FSO safety functions module (page 40).

Implementing the functions provided by the FSO safety functions module

Cabinet-installed multidrives

You can order the drive with an FSO-12 safety functions module (option +Q973) or FSO-21 safety functions module (option +Q972). An FSO module enables the implementation of functions such as Safe brake control (SBC), Safe stop 1 (SS1), Safe stop emergency (SSE), Safely limited speed (SLS) and Safe maximum speed (SMS).

The settings of the FSO module have default values when delivered from the factory. The wiring of the external safety circuit and configuration of the FSO module are the responsibility of the user.

The FSO module reserves the standard Safe torque off (STO) connection of the drive (or inverter) control unit. STO can still be utilized by other safety circuits through the FSO module.

See the appropriate manual for more information.

Name	Code
FSO-12 safety functions module user's manual	3AXD50000015612
FSO-21 safety functions module user's manual	3AXD50000015614

Multidrive modules

You can order a safety functions module from ABB. The cabinet builder can use the module for implementing various safety functions.

Implementing the functions provided by the FSPS-21 PROFIsafe safety functions module

Cabinet-installed multidrives

You can order the drive with an FSPS-21 PROFIsafe safety functions module (option +Q986), which provides PROFINET and PROFIsafe connection to the drive and has two safety functions integrated into it: Safe torque off (STO) and Safe stop 1, time monitored (SS1-t). With the module, it is possible to control the drive via PROFINET and safely stop the drive via PROFIsafe.

The Safe torque off function can be controlled with PROFIsafe. When using FSPS-21 PROFIsafe safety functions module, other safety functions are not available. Use of PROFIsafe and PROFINET is also possible by using FPNO-21 and FSO option modules.

The settings of the module have default values when delivered from the factory. The wiring and configuration of the FSPS-21 module are the responsibility of the user.

For more information, see FSPS-21 PROFIsafe safety functions module user's manual (3AXD50000158638 [English]).

Multidrive modules

You can order the PROFIsafe safety functions module from ABB. The cabinet builder can use the module for implementing following safety functions: Safe torque off (STO) and Safe stop 1, time monitored (SS1-t).

Implementing the functions provided by the FSCS-21 CIP Safety™ functions module

Cabinet-installed multidrives

You can order the drive with FSCS-21 CIP Safety™ functions module (option +Q989). The module has two safety functions integrated into it: Safe torque off (STO) and Safe stop 1, time monitored (SS1-t). With the module, you can connect a drive to an Ethernet network and a safety PLC. The module supports the CIP Safety™ communication technology through the EtherNet/IP communication protocol. The intended use of the FSCS module is to safely stop the drive when necessary. A safety PLC can activate the safety functions of the module.

The settings of the FSCS module have default values when delivered from the factory. The wiring and configuration of the FSCS module are the responsibility of the user. The FSCS module reserves the standard Safe torque off (STO) connection of the drive (or inverter) control unit.

For more information, refer to FSCS-21 CIP Safety™ functions module user's manual (3AXD50001065478 [English]).

Multidrive modules

You can order the FSCS-21 CIP Safety™ functions module from ABB. The cabinet builder can use the module for implementing following safety functions: Safe torque off (STO) and Safe stop 1, time monitored (SS1-t).

Supplying power for the auxiliary circuits

Cabinet-installed multidrives

Power for the auxiliary circuits and cooling fans must be supplied externally, unless the drive has an auxiliary voltage transformer (option +G344) and cooling fan transformer(s) (option +G451).

The user must supply these options from external power sources:

- +G300/+G301: Cabinet heaters and/or lighting
- +G307: Connection for an external uninterruptible power supply

For the voltages and fuse sizes, refer to the circuit diagrams delivered with the drive.

Multidrive modules

The cabinet installer must connect an auxiliary power supply for the drive. Auxiliary power is needed, for example, by the control units and cabinet fan(s). See the appropriate hardware manuals for the auxiliary power consumptions, connections, etc.

Using power factor compensation capacitors with the drive

Power factor compensation is not needed with AC drives. However, if a drive is to be connected in a system with compensation capacitors installed, note the following restrictions.

WARNING!
Do not connect power factor compensation capacitors or harmonic filters to the motor cables (between the drive and the motor). They are not meant to be used with AC drives and can cause permanent damage to the drive or themselves.

If there are power factor compensation capacitors in parallel with the input of the drive:

1. Do not connect a high-power capacitor to the power line while the drive is connected. The connection will cause voltage transients that may trip or even damage the drive.
2. If capacitor load is increased/decreased step by step when the AC drive is connected to the power line, make sure that the connection steps are low enough not to cause voltage transients that would trip the drive.
3. Make sure that the power factor compensation unit is suitable for use in systems with AC drives, ie, harmonic generating loads. In such systems, the compensation unit should typically be equipped with a blocking reactor or harmonic filter.

Using a safety switch between the drive and the motor

ABB recommends to install a safety switch between the permanent magnet motor and the drive output. The switch is needed to isolate the motor from the drive during maintenance work on the drive.

Implementing the control of a contactor between drive and motor

Implementing the control of the output contactor depends on the motor control mode and stopping method selected.

When you select the DTC motor control mode and the motor ramp stop mode, use this operation sequence to open the contactor:

1. Give a stop command to the drive.
2. Wait until the drive decelerates the motor to zero speed.
3. Open the contactor.

WARNING!
If DTC motor control mode is in use, do not open the output contactor while the drive controls the motor. The motor control operates faster than the contactor, and tries to maintain the load current. This can cause damage to the contactor.

When you select the DTC motor control mode and the motor coast stop mode, you can open the contactor immediately after the drive has received the stop command. This is the case also if you use the scalar motor control mode.

Implementing a bypass connection

If bypassing is required, employ mechanically or electrically interlocked contactors between the motor and the drive and between the motor and the power line. Make sure with interlocking that the contactors cannot be closed simultaneously. The installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, “THIS MACHINE STARTS AUTOMATICALLY”.

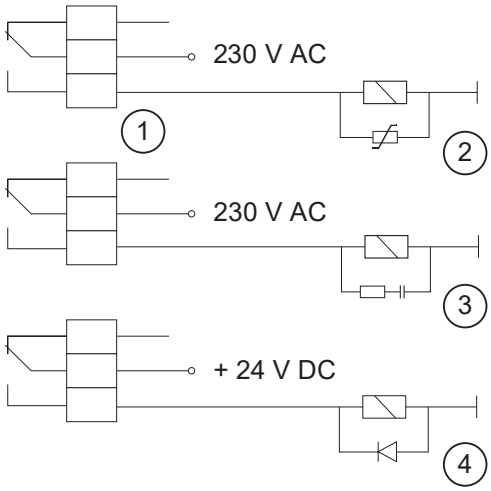
Bypass connection is available as a factory-installed option for some cabinet-installed drive types. Consult ABB for more information.

WARNING!
Never connect the drive output to the electrical power network. The connection may damage the drive.

Protecting the contacts of relay outputs

Inductive loads (relays, contactors, motors) cause voltage transients when switched off.

Install the protective component as close to the inductive load as possible. Do not install protective components at the relay outputs.



1	Relay output
2	Varistor
3	RC filter
4	Diode

3

Standards and markings

Contents of this chapter

The chapter contains a list of applicable standards, a list of markings, compliance information, and disclaimers.

Applicable standards (cabinets)

Standard	Information
European electrical safety	
EN 61800-5-1:2007 + A1:2017 + A11:2021 IEC 61800-5-1:2007 + AMD1:2016	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements – Electrical, thermal and energy
EN 62477-1:2012 + A11:2014 + A1:2017 + A12:2021 IEC 62477-1:2012 + AMD1:2016	Safety requirements for power electronic converter systems and equipment - Part 1: General
EMC performance	
EN 61800-3:2004 + A1:2012 IEC 61800-3:2017	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
IEC 60533:2015	Electrical and electronic installations in ships - Electromagnetic compatibility (EMC) - Ships with a metallic hull
IEC 62742:2021	Electrical and electronic installations in ships - Electromagnetic compatibility (EMC) - Ships with a non-metallic hull [1)]
Product requirements in North America	
UL 508A: 3rd edition	Industrial Control Panels [2)]
CSA C22.2 No. 286-17, 1st edition	Industrial Control Panels and Assemblies [2)]
Enclosure and environmental protection	
EN 60529:1991 + A2:2013 + AC:2019 IEC 60529:1989 + AMD1:1999 + AMD2:2013 + COR1:2019	Degrees of protection provided by enclosures (IP code)
UL 50: 12th edition	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 50E: 1st edition	Enclosures for Electrical Equipment, Environmental Considerations
CSA C22.2 No. 94.1-15	Enclosures for Electrical Equipment, Non-Environmental Considerations
CSA C22.2 No. 94.2-15	Enclosures for Electrical Equipment, Environmental Considerations

1) Compliance requires special arrangements for filtering, damping, and compartmentalization.
2) Applicable to drives with option +C129 or +C134.

Applicable standards (modules)

Standard	Information
European electrical safety	
EN 61800-5-1:2007 + A1:2017 + A11:2021 IEC 61800-5-1:2007 + AMD1:2016	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements – Electrical, thermal and energy
EN 62477-1:2012 + A11:2014 + A1:2017 + A12:2021 IEC 62477-1:2012 + AMD1:2016	Safety requirements for power electronic converter systems and equipment - Part 1: General
Product requirements in North America	
UL 61800-5-1: 1st edition	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
CSA C22.2 No. 274-17	Adjustable speed drives

Markings

CE	CE mark Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).
C SA US	CSA certification mark for USA and Canada Product has been tested and evaluated against the relevant North American standards by the CSA Group. Valid with rated voltages up to 600 V. • Cabinet-installed multidrives: Drive with option +C134 is CSA certified. • Multidrives modules: ACS880-304 modules are CSA certified, if option +C134 is selected. Other multidrives modules are CSA certified as standard.
EAC	EAC (Eurasian Conformity) mark Product complies with the technical regulations of the Eurasian Customs Union. EAC mark is required in Russia, Belarus and Kazakhstan.
20	Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP). Product is compliant with the People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) about hazardous substances. The EFUP is 20 years. China RoHS II Declaration of Conformity is available from https://library.abb.com.
KC	KC mark Product complies with Korean Registration of Broadcasting and Communications Equipment Clause 3, Article 58-2 of Radio Waves Act.
RCM	RCM mark Product complies with Australian and New Zealand requirements specific to EMC, telecommunications and electrical safety. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).
TÜV NORD Safety Approved	TÜV Safety Approved mark (functional safety) Product contains Safe torque off and possibly other (optional) safety functions which are certified by TÜV according to the relevant functional safety standards. Applicable to drives and inverters; not applicable to supply, brake or DC/DC converter units or modules.
UK CA	UKCA (UK Conformity Assessed) mark Product complies with the applicable United Kingdom's legislation (Statutory Instruments). Marking is required for products being placed on the market in Great Britain (England, Wales and Scotland).
c UL us LISTED	UL Listed mark for USA and Canada Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories. Valid with rated voltages up to 600 V. • Cabinet-installed multidrives: Drive with option +C129 is UL Listed. • Multidrives modules: ACS880-304 modules are UL Listed, if option +C129 is selected. Other multidrives modules are UL Listed as standard.

WEEE mark

At the end of life the product should enter the recycling system at an appropriate collection point and not placed in the normal waste stream.

EMC compliance (IEC/EN 61800-3)

Definitions

EMC stands for Electromagnetic Compatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

First environment includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

Second environment includes establishments connected to a network not supplying domestic premises.

Drive of category C1: drive of rated voltage less than 1000 V and intended for use in the first environment.

Drive of category C2: drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment.

Note: A professional is a person or organization having necessary skills in installing and/or starting up power drive systems, including their EMC aspects.

Drive of category C3: drive of rated voltage less than 1000 V and intended for use in the second environment and not intended for use in the first environment.

Drive of category C4: drive of rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

Category C2

The drive complies with the C2 category with these provisions:

1. The supply unit is C2-compliant:
   Cabinet-installed multidrives: The table below shows the C2-compliant supply units.

Type	Voltage	Frame sizes	C2 compliance
ACS880-207	380…500 V	R8i	With option +E202
ACS880-307…+A018	380…500 V	1×D8T	With option +E202
		DxT up to 980 A	With option +E202

Multidrives modules: The table below shows the C2-compliant supply modules.

Type	Voltage	Frame sizes	C2 compliance
ACS880-204	380…500 V	R1i…R4i, R6i, 1×R8i	With filter options [1)]
ACS880-304…+A018	380…500 V	1×D8T	With filter options [1)]

1) Refer to the supply module hardware manual.

2. The drive is connected to a TN (grounded) network.
3. The motor and control cables are selected, and routed according to the electrical planning guidelines of the drive. The EMC recommendations are obeyed.
4. The drive is installed according to its installation instructions. The EMC recommendations are obeyed.
5. Motor cable length (for any inverter unit) does not exceed 100 m (328 ft).

WARNING!
The drive may cause radio interference. The installer is required to take measures to prevent interference, in addition to the requirements for CE compliance listed above, if necessary.

WARNING!
Do not install a drive equipped with category 2 EMC filtering on IT (ungrounded) systems. The supply network becomes connected to ground potential through the EMC filter capacitors which can cause danger or damage the unit.

Category C3

The drive complies with the C3 category with these provisions:

1. The supply unit is C3-compliant:
   - Cabinet-installed multidrives: Supply unit is equipped with the filter option +E210.
   - Multidrives modules: Supply modules have the C3-compliant filtering installed as standard.
2. The motor and control cables are selected, and routed according to the electrical planning guidelines of the drive. The EMC recommendations are obeyed.
3. The drive is installed according to its installation instructions. The EMC recommendations are obeyed.
4. Motor cable length (for any inverter unit) does not exceed 100 m (328 ft).

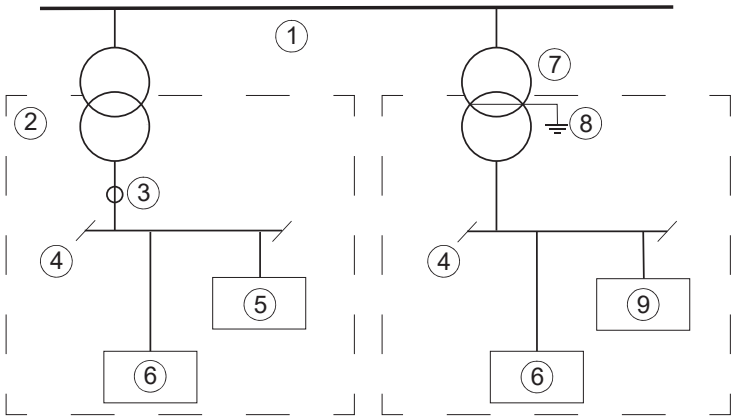
WARNING!
A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

Category C4

The drive complies with the C4 category with these provisions:

1. It is made sure that no excessive emission is propagated to neighboring low-voltage networks. In some cases, the natural suppression in transformers

and cables is sufficient. If in doubt, a supply transformer with static screening between the primary and secondary windings can be used.



1	Medium voltage network	6	Equipment
2	Neighboring network	7	Supply transformer
3	Point of measurement	8	Static screen
4	Low voltage	9	Drive
5	Equipment (victim)	-	-

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available in Technical guide No. 3 EMC compliant installation and configuration for a power drive system (3AFE61348280 [English]).
3. The motor and control cables are selected, and routed according to the electrical planning guidelines of the drive. The EMC recommendations are obeyed.
4. The drive is installed according to its installation instructions. The EMC recommendations are obeyed.

WARNING!
A drive of category C4 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

UL and CSA checklist

WARNING!
Operation of this drive requires detailed installation and operation instructions provided in the hardware and software manuals. The manuals are provided in electronic format in the drive package or on the Internet. Keep the manuals with the drive at all times. Hard copies of the manuals can be ordered through the manufacturer.

- Make sure that the drive type designation label includes the applicable marking.
- **DANGER - Risk of electric shock.** After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
- The drive is to be used in a heated, indoor controlled environment. The drive must be installed in clean air according to the enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust.
- For UL and CSA compliant installations, the maximum surrounding air temperature is 40 °C (104 °F).
- The cables located within the motor circuit must be rated for at least 75 °C in UL-compliant installations.
- The input cable must be protected with fuses or circuit breakers. These protective devices provide branch circuit protection in accordance with the national regulations (National Electrical Code (NEC) or Canadian Electrical Code). Obey also any other applicable local or provincial codes.

  WARNING!
  The opening of the branch-circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the device should be examined and replaced if damaged.

- The drive is equipped with UL listed fuses which provide branch circuit protection in accordance with the National Electrical Code (NEC) and Canadian Electrical Code.
  The fuses are listed in the appropriate supply unit hardware manual.
- The integral solid state short circuit protection of the drive does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.
- The drive provides motor overload protection. The protection is not enabled when the drive leaves the ABB factory. For enabling the protection, see the firmware manual.
- For the drive overvoltage category, see the hardware manuals of the multidrive units.

Approvals

Consult your local ABB representative.

Disclaimers

Generic disclaimer

The manufacturer shall have no obligation with respect to any product which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to the manufacturer’s instructions; or (iv) has failed as a result of ordinary wear and tear.

Cyber security disclaimer

This product is designed to be connected to and to communicate information and data via a network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Declarations of conformity

	Link to Declaration of conformity according to EU Machinery Directive 2006/42/EU (3AXD10000105027)
	Link to Declaration of conformity according to UK Supply of Machinery (Safety) Regulations 2008 (3AXD10001326695)

Further information

Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/contact-centers.

Product training

For information on ABB product training, navigate to new.abb.com/service/training.

Providing feedback on ABB manuals

Your comments on our manuals are welcome. Navigate to forms.abb.com/form-26567.

Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents.

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