ABB DRIVES

ACH580-31 and ACQ580-31

Hardware Manual Supplement

ACH580-31 (208/230V, 5-75 HP)
ACQ580-31 (208/230V, 5-75 HP)

Table of Contents

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Introduction to the supplement

Contents of this chapter

This chapter describes the supplement.

Applicability

This supplement is applicable to ACH580-31 and ACQ580-31. Information in this document supersedes corresponding information in these manuals:

ACH580-31 Drive Hardware Manual (3AXD50000037066)

ACQ580-31 Drive Hardware Manual (3AXD50000045935)

Target Audience

This supplement is intended for people who plan the installation and install the drive. Read the supplement before you work on the drive. You are expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

Purpose of the supplement

This supplement provides technical data and other information for the ACH580-31 and ACQ580-31 208/230V drives.

Related documents

You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents. For manuals not available in the Document library, contact your local ABB representative. The codes below open an online listing of the manuals applicable to the product.

ACH580-31 manuals

ACQ580-31 manuals

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Product Description

Contents of this chapter

This chapter describes the 580-31 ultra-low harmonic series drive for use in 208/230V applications.

Product overview

The purpose of this supplement is to provide information for 580-31, ultra-low harmonic series drive for use in 208/230V applications. These ratings are only available in North America.

NOTICE: In this manual, the reference “580 series” refers to any of the types: ACH580 or ACQ580. References to “Hardware Manual” refers to the respective ACH580 or ACQ580 Hardware Manual.

ACH580-31 Drive Hardware Manual (3AXD50000037066)

ACQ580-31 Drive Hardware Manual (3AXD50000045935)

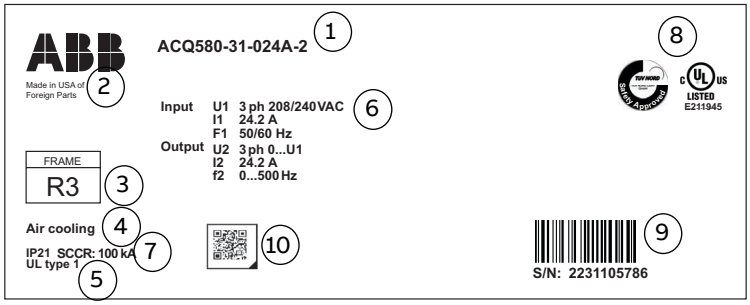
Operation principle

The 580-31 is an ultra-low harmonic drive for controlling asynchronous AC induction motors, permanent magnet motors in open loop control and synchronous reluctance motors.

The drive includes a line-side converter and a motor-side converter. The parameters and signals for both converters are combined into one primary user program.

NOTE: Unless specified in this manual, the 208/230V ultra-low harmonic drives share the same features, functions and characteristics as the existing 480V UL (NEC) rated ultra-low harmonic drives.

Type designation label



1 Type designation
2 Name of manufacturer
3 Frame size
4 Cooling method and additional information
5 Degree of protection
6 Nominal ratings in the supply voltage range, see the technical data.
7 Rated conditional short-circuit current, see the technical data.
8 Valid markings
9 S/N: Serial number of format MYYWWXXXX, where
M: Manufacturer
YY: 21,21, 23... for 2021, 2022, 2023
WW: 01,02, 03... for week 1, week 2, week 3...
XXXX: Integer starting every week from 0001
10 Link to product information

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Technical Data

Contents of this chapter

This chapter contains the technical specifications of the 580-31 ULH series drive for use in 208/230V applications including the ratings, technical requirements and provisions for fulfilling the requirements for approval marks.

Electrical ratings

UL (NEC) ratings

580-31-...	Frame Size	Input rating[1)]	Max. current	App. Power	Output ratings			
		I_1	I_{max}	S_n	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}
		A	A	kVA	A	hp	A	hp
3-phase Un = 208/230 V								
-017A-2	R3	14	22.6	6.0	16.7	5	10.6	3
-024A-2	R3	20	28.8	8.7	24.2	7.5	16.7	5
-031A-2	R6	28	43.6	11.1	30.8	10	24.2	7.5
-046A-2	R6	40	62.4	16.6	46.2	15	30.8	10
-059A-2	R6	53	83.2	21.4	59.4	20	46.2	15
-075A-2	R6	66	107	26.9	74.8	25	59.4	20
-088A-2	R6	76	124	31.7	88	30	74.8	25
-114A-2	R8	98	158	41.1	114	40	88	30
-143A-2	R8	128	181	51.5	143	50	114	40
-169A-2	R8	152	247	60.9	169	60	143	50
-211A-2	R8	188	287	76.0	211	75	169	60

[1)] When the DC voltage is boosted, the drive can be drawing more input current than what is shown on the type designation label. This is the case when the motor is running continuously at or near the field weakening area and the drive is running at or near nominal load. It can be a result of certain combinations of DC voltage boost levels and drive-type-specific derating curves.

The rise in input current can heat the input cable and fuses. To avoid heating, select an input cable and fuses according to the increased input current caused by the DC voltage boost. For more information, refer to ACH580-31, ACQ580-31, ACH580-34 and ACQ580-34 drives product note on DC voltage boost (3AXD50000769407 [English]).]

Definitions

U_n	Nominal input voltage of the drive. Input voltage range is 3~ 208…240 V AC +10%...-15%, 60 Hz.
I_1	Nominal input current (rms) at 40°C (104°F). Continuous rms input current (for dimensioning cables and fuses).
I_{max}	Maximum output current. Available for two seconds at start. Then as long as allowed by drive temperature.
S_n	Apparent power at nominal load.
I_{Ld}	Maximum current with 10% overload, allowed for one minute every ten minutes when parameter 97.02 Minimum switching frequency is set to 2 kHz or less.
P_{Ld}	Typical motor power in light-duty use (10% overload). The horsepower ratings apply to most NEMA 4-pole 230 V motors.
I_{Hd}	Maximum current with 50% overload, allowed for one minute every ten minutes
P_{Hd}	Typical motor power in heavy-duty use (50% overload). The horsepower ratings apply to most NEMA 4-pole 230 V motors.

Sizing

Drive sizing is based on the rated motor current and power. To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current. Also, the rated power of the drive must be higher than or equal to compared to the rated motor power. The power ratings are the same regardless of the supply voltage within one voltage range.

Deratings

The load capacity (I_{Ld}, I_{Hd}; note that I_{max} is not derated) decreases for certain situations, as defined below. In such situations, where full motor power is required, oversize the drive so that the derated value provides sufficient capacity.

Derating in case of several situations

If several situations are present at a time, the derating effect is cumulative. See drive Hardware Manual for examples of this scenario.

Surrounding air temperature derating

Surrounding air temperature derating for 208/230V 580-31 ULH series drive is equivalent to that of the 480V 580-31 ULH series drive. See drive Hardware Manual for additional details.

Altitude derating

Altitude derating for 208/230V 580-31 ULH series drive is equivalent to that of the 480V 580-31 ULH series drive. See drive Hardware Manual for additional details.

Switching frequency derating

To calculate the output current, multiply the current given in the rating table by the derating factor given in the table below.

Note: If you change the minimum switching frequency with parameter 97.02 Minimum switching frequency, derate according to the table below. Changing parameter 97.01 Switching frequency reference does not require derating.

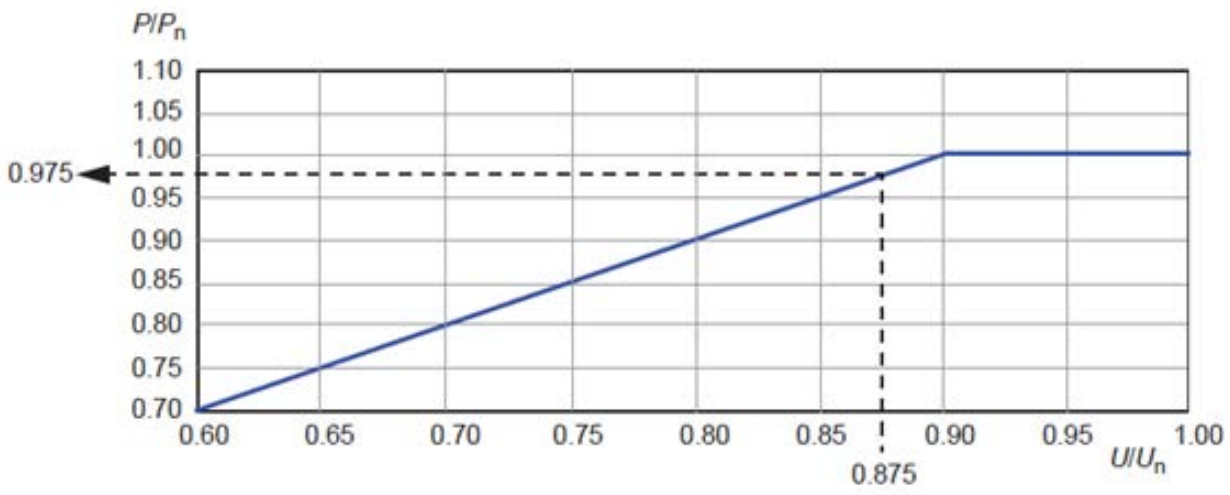
UL (NEC) Ratings						
580-31...	**Derating factor (k) for the minimum switching frequencies**					**Frame**
	1 kHz	**2 kHz**	**4 kHz**	**8 kHz**	**12 kHz**	
-017A-2	1.0	1.0	1.0	0.86	0.74	R3
-024A-2	1.0	1.0	1.0	0.86	0.74	R3
-031A-2	1.0	1.0	1.0	0.75	0.67	R6
-046A-2	1.0	1.0	1.0	0.75	0.67	R6
-059A-2	1.0	1.0	1.0	0.75	0.67	R6
-075A-2	1.0	1.0	1.0	0.75	0.67	R6
-088A-2	1.0	1.0	1.0	0.75	0.67	R6
-114A-2	1.0	1.0	1.0	1.0	-	R8
-143A-2	1.0	1.0	1.0	0.84	-	R8
-169A-2	1.0	1.0	1.0	0.72	-	R8
-211A-2	1.0	1.0	1.0	0.63	-	R8

Output voltage boost derating

The drive can output a higher motor voltage than the supply voltage. This can require derating of the drive output power depending on the difference between the supply voltage and the output voltage to the motor for continuous operation.

208/230 V drive type

This graph shows the required derating for 208/230 V drive types.



U	Actual supply voltage to the drive (Nominal values: U = 208/230 V when P_n refers to nominal power ratings in the UL (NEC) tables)
U_n	Motor nominal voltage or the required drive output voltage
P	Derated output power of the drive
P_n	Nominal power rating of the drive

Fuses (UL)

The UL Listed fuses in this manual are required for branch circuit protection and required per NEC. The drives are suitable for use on a circuit capable of delivering not more than 100 kA symmetrical amperes (rms) at 240 V maximum when protected by the fuses described below.

ABB recommends Class T fuses listed below. Also allowed are UL Listed 248-8 Class J fast acting, time delay, and high speed fuses, UL Listed 248-4 Class CC fast acting fuses and 248-17 Class CF fast acting and time delay fuses of the same nominal voltage and current rating.

Refer to notes below the tables.

NOTE: The supplement manual will list all the fuses. The official HW manuals will eventually only add the Bussmann UL 248-15 Fast Acting Class T fuses and the other fuses will be listed in the US Branch Circuit Protection document (3AXD50000645015)

580-31-...	Input current	UL (one fuse per phase)		UL 248-15 Fast Acting Class T Fuses				UL 248-8 Fast Acting Class J Fuses			
		Nominal current	Voltage rating	Bussmann	Littlefuse	Mersen / Ferraz Shawmut	Edison	Bussmann	Littlefuse	Mersen / Ferraz Shawmut	Edison
	A	A	V								
3-phase Un = 208/230 V											
-017A-2	14	25	600	JJS-25	JLLS025	A6T25	TJS25	JKS-25	JLS25	A4J25	JFL25
-024A-2	20	35	600	JJS-35	JLLS035	A6T35	TJS35	JKS-35	JLS35	A4J35	JFL35
-031A-2	28	40	600	JJS-40	JLLS040	A6T40	TJS40	JKS-40	JLS40	A4J40	JFL40
-046A-2	40	60	600	JJS-60	JLLS060	A6T60	TJS60	JKS-60	JLS60	A4J60	JFL60
-059A-2	53	80	600	JJS-80	JLLS080	A6T80	TJS80	JKS-80	JLS80	A4J80	JFL80
-075A-2	66	90	600	JJS-90	JLLS090	A6T90	TJS90	JKS-90	JLS90	A4J90	JFL90
-088A-2	76	110	600	JJS-110	JLLS110	A6T110	TJS110	JKS-110	JLS110	A4J110	JFL110
-114A-2	98	150	600	JJS-150	JLLS150	A6T150	TJS150	JKS-150	JLS150	A4J150	JFL150
-143A-2	128	200	600	JJS-200	JLLS200	A6T200	TJS200	JKS-200	JLS200	A4J200	JFL200
-169A-2	152	225	600	JJS-225	JLLS225	A6T225	TJS225	JKS-225	JLS225	A4J225	JFL225
-211A-2	188	300	600	JJS-300	JLLS300	A6T300	TJS300	JKS-300	JLS300	A4J300	JFL300

580-31-...	Input current	UL (one fuse per phase)		UL 248-8 Time Delay Class J Fuses				UL 248-8 High Speed Class J Fuses			
		Nominal current	Voltage rating	Bussmann	Littlefuse	Mersen/ Ferraz Shawmut	Edison	Bussmann	Littlefuse	Mersen/ Ferraz Shawmut	Edison
	A	A	V								
3-phase Un = 208/230 V											
-017A-2	14	25	600	LPJ-25SP	JTD25	AJT25	JDL25	DFJ-25	LDFJ025	HSJ25	JHL25
-024A-2	20	35	600	LPJ-35SP	JTD35	AJT35	JDL35	DFJ-35	LDFJ035	HSJ35	JHL35
-031A-2	28	40	600	LPJ-40SP	JTD40	AJT40	JDL40	DFJ-40	LDFJ040	HSJ40	JHL40
-046A-2	40	60	600	LPJ-60SP	JTD60	AJT60	JDL60	DFJ-60	LDFJ060	HSJ60	JHL60
-059A-2	53	80	600	LPJ-80SP	JTD80	AJT80	JDL80	DFJ-80	LDFJ80	HSJ80	JHL80
-075A-2	66	90	600	LPJ-90SP	JTD90	AJT90	JDL90	DFJ-90	LDFJ90	HSJ90	JHL90
-088A-2	76	110	600	LPJ-110SP	JTD110	AJT110	JDL110	DFJ-110	LDFJ110	HSJ110	JHL110
-114A-2	98	150	600	LPJ-150SP	JTD150	AJT150	JDL150	DFJ-150	LDFJ150	HSJ150	JHL150
-143A-2	128	200	600	LPJ-200SP	JTD200	AJT200	JDL200	DFJ-200	LDFJ200	HSJ200	JHL200
-169A-2	152	225	600	LPJ-225SP	JTD225	AJT225	JDL225	DFJ-225	LDFJ225	HSJ225	JHL225
-211A-2	188	300	600	LPJ-300SP	JTD400	AJT300	JDL300	DFJ-300	LDFJ300	HSJ300	JHL300

580-31-...	Input current	UL (one fuse per phase)		UL 248-4 Fast Acting Class CC Fuses				UL 248-17 Time Delay Class CF Cube Fuses	UL 428-17 Fast Acting Class CF Cube Fuses
		Nominal current	Voltage rating	Bussmann	Littlefuse	Mersen/ Ferraz Shawmut	Edison		
	A	A	V					Bussmann	Bussmann
3-phase Un = 208/230 V									
-017A-2	14	25	600	KTK-R-25	KLKR25	ATMR25	HCLR25	TCF25RN	FCF25RN
-024A-2	20	35	600	-	-	-	-	TCF35RN	FCF35RN
-031A-2	28	40	600	-	-	-	-	TCF40RN	FCF40RN
-046A-2	40	60	600	-	-	-	-	TCF60RN	FCF60RN
-059A-2	53	80	600	-	-	-	-	TCF80RN	FCF80RN
-075A-2	66	90	600	-	-	-	-	TCF90RN	FCF90RN
-088A-2	76	110	600	-	-	-	-	TCF110RN	-
-114A-2	98	150	600	-	-	-	-	TCF150RN	-
-143A-2	128	200	600	-	-	-	-	TCF200RN	-
-169A-2	152	225	600	-	-	-	-	TCF225RN	-
-211A-2	188	300	600	-	-	-	-	TCF300RN	-

1. Fuses are required as part of the installation, are not included in the base drive configuration and must be provided by others.

2. Fuses with a higher current rating than specified must not be used.

3. The UL listed fuses recommended by ABB are the required branch circuit protection per NEC.

4. The recommended size or smaller UL listed 248 fast acting, time delay, or high speed fuses must be used to maintain the UL listing of the drive. Additional protection can be used. Refer to local codes and regulations.

5. A fuse of a different class can be used at the high fault rating where the I_{peak} and I^2t of the new fuse is not greater than that of the specified fuse.

6. UL listed 248 fast acting, time delay, or high speed fuses from other manufacturers can be used if they meet the same class and rating requirements specified in the rules above.

7. When installing a drive, always follow ABB installation instructions, NEC requirements and local codes.

Circuit breakers (UL)

The 208/230V ULH drives have not yet been evaluated for use with circuit breaker protection. The fuses listed in the table above should be used as branch circuit protection.

Losses, cooling data and noise

The air flow direction is from bottom to top.

This table shows typical heat loss values, required air flow and noise at the nominal ratings of the drive. The heat loss values can vary depending on voltage, cable conditions, motor efficiency and power factor.

UL (NEC)								
580-31-...	**Heat dissipation**				**Air flow**		**Noise**	**Frame**
	Main circuit at rated I_1 at I_2	**Control circuit minimum**	**Control circuit maximum**	**Main circuit and control boards**				
	W	**W**	**W**	**W**	**m3/h**	**ft3/min**	**dB(A)**	
Un = 208/230 V								
-017A-2	280	4.1	36	316	361	212	57	R3
-024A-2	427	4.1	36	463	361	212	57	R3
-031A-2	464	4.1	36	500	550	324	71	R6
-046A-2	694	4.1	36	730	550	324	71	R6
-059A-2	834	4.1	36	870	550	324	71	R6
-075A-2	1166	4.1	36	1202	550	324	71	R6
-088A-2	1487	4.1	36	1523	550	324	71	R6
-114A-2	1466	4.1	36	1502	860/ 913[1)]	506/ 537[1)]	68	R8
-143A-2	2334	4.1	36	2370	860/ 913[1)]	506/ 537[1)]	68	R8
-169A-2	2498	4.1	36	2534	860/ 913[1)]	506/ 537[1)]	68	R8
-211A-2	3156	4.1	36	3192	860/ 913[1)]	506/ 537[1)]	68	R8
[1)] UL Type 1 (IP21) / UL Type 12 (IP55)								

These losses are not calculated according to the ecodesign standard IEC 61800-9-2.

Cooling air flow and heat dissipation for flange mounting

UL (NEC)							
580-31-...	Heat dissipation		Air flow				Frame
	Heatsink	Front	Heatsink		Front		
	W	W	m3/h	ft3/min	m3/h	ft3/min	
Un = 208/230 V							
-017A-2	239	41	361	212	0	0	R3
-024A-2	384	44	361	212	0	0	R3
-031A-2	420	44	498	293	52	31	R6
-046A-2	645	49	498	293	52	31	R6
-059A-2	783	51	498	293	52	31	R6
-075A-2	1107	58	498	293	52	31	R6
-088A-2	1422	65	498	293	52	31	R6
-114A-2	1401	65	800	471	113	66	R8
-143A-2	2247	88	800	471	113	66	R8
-169A-2	2406	92	800	471	113	66	R8
-211A-2	3043	113	800	471	113	66	R8

These losses are not calculated according to the ecodesign standard IEC 61800-9-2.

Typical power cables

The table below gives typical copper cable types.

580-31-...	Frame size	UL (NEC)1) Cu cable type AWG/kcmil
Un = 208/230 V		
-017A-2	R3	10
-024A-2	R3	10
-031A-2	R6	8
-046A-2	R6	4
-059A-2	R6	4
-075A-2	R6	2
-088A-2	R6	1/0
-114A-2	R8	2/0
-143A-2	R8	4/0
-169A-2	R8	250 MCM
-211A-2	R8	300 MCM

1) The cable sizing is based on NEC Table 310-16 for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly buried). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

In the USA, aluminum cables must not be used.

Temperature: For North America, power cables must be rated for 75 °C (167 °F) or higher. For surrounding air temperatures above 40 °C (104 °F) or frame R6 with option +B056 (UL Type 12), select a cable rated for at least 90 °C (194 °F) maximum permissible temperature of conductor in continuous use.

Voltage: 600 V AC cable is accepted for up to 500 V AC.

Electrical power network specification

Voltage (U_1)	580-31-xxxx-2 drives: Input voltage range 3~ 208…240 V AC +10%…. -15%. This is indicated in the type designation label as typical input voltage levels 3~208/230 V AC.
Network type	Public low voltage networks.TN (grounded) and IT (ungrounded) systems. See section Grounding system compatibility check in the Hardware manual.
Rated conditional short-circuit current (IEC 61439-1)	65 kA when protected by the fuses given in the fuse table.
Short-circuit current protection (UL61800-5-1)	The drive is suitable for use on a circuit capable of delivering not more than 100,000rms symmetrical amperes at 480 V maximum when protected by the fuses given in the fuse table.
Frequency (f_1)	47.5…63Hz. This is indicated in the type designation label as typical input frequency F1 (50/60Hz).
Imbalance	Max.± 3% of nominal phase to phase input voltage
Fundamental power factor (cos phi_1)	1 (at nominal load)

Harmonic distortion

Harmonics are below the limits defined in IEEE 519-2014, and G5/4.

The drive complies with IEC 61000-3-2, IEC 61000-3-4 and IEC 61000-3-12.

The table below shows typical values of the drive for short-circuit ratio (Isc/I1) of 20 to 100. The values will be met if the supply network voltage is not distorted by other loads and when the drive operates at nominal load.

Nominal bus voltage V at PCC	**THDi (%)**	**THDv (%)**
V = 690 V	3*	< 3**

PCC — Point on a public power supply system, electrically nearest to a particular load, at which other loads are, or could be, connected. The PCC is a point located upstream of the considered installation.

THDi — Indicates the total harmonic current distortion of the wave form. This value is defined as the ratio (in %) of the harmonic current to the fundamental (non-harmonic) current measured at a load point at the particular moment when the measurement is taken:

$$THDi = \frac{\sqrt{\sum_{2}^{40} I_n^2}}{I_1} \cdot 100\%$$

THDv — Indicates the total magnitude of the voltage distortion. This value is defined as the ratio (in %) of the harmonic voltage to the fundamental (non-harmonic) voltage:

$$THDv = \frac{\sqrt{\sum_{2}^{40} U_n^2}}{U_1} \cdot 100\%$$

I_{sc}/I_1 — Short-circuit ratio

I_{sc} — Maximum short-circuit current at PCC

I_1 — Continuous rms input current of the drive

I_n — Amplitude of the current harmonic n

U_1 — Supply voltage

U_n — Amplitude of the voltage harmonic n

* The short-circuit ratio can influence the THDi value

** Other loads can influence the THDv value

Efficiency

Efficiency at nominal power level:

Approximately 94% for frame R3

Approximately 94.5% for frame R6

Approximately 95.5% for frame R8

The efficiency is not calculated according to the ecodesign standard IEC 61800-9-2.

Markings

These markings are attached to the drive:

	BTL (BACnet Testing Laboratories) mark Product has BACnet conformance certificate.

	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.

	UL Listed make for USA and Canada Product has been tested and evaluated against the relevant North American standards by the Inderwriters Laboratories. Valid with rated voltages up to 600 V.

	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.

4

The Safe torque off function

Contents of this chapter

This chapter describes the Safe torque off (STO) function of the drive and gives instructions for its use.

Description

The Safe torque off function can be used, for example, as the final actuator device of safety circuits (such as an emergency stop circuit) that stop the drive in case of danger. Another typical application is a prevention of unexpected start-up function that enables short-time maintenance operations like cleaning or work on non-electrical parts of the machinery without switching off the power supply to the drive.

When activated, the Safe torque off function disables the control voltage for the power semiconductors of the drive output stage, thus preventing the drive from generating the torque required to rotate the motor. If the motor is running when Safe torque off is activated, it coasts to a stop.

The Safe torque off function has a redundant architecture, that is, both channels must be used in the safety function implementation. The safety data given in this manual is calculated for redundant use, and does not apply if both channels are not used.

The Safe torque off function complies with these standards:

Standard	Name
IEC 60204-1:2016 EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
IEC 61000-6-7:2014	Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
IEC 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2017	Functional safety – Safety instrumented systems for the process industry sector
IEC 61800-5-2:2016 EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation

The function also corresponds to Prevention of unexpected start-up as specified by EN ISO 14118:2018 (ISO 14118:2017), and Uncontrolled stop (stop category 0) as specified in EN/IEC 60204-1.

Compliance with the European Machinery Directive and the UK Supply of Machinery (Safety) Regulations

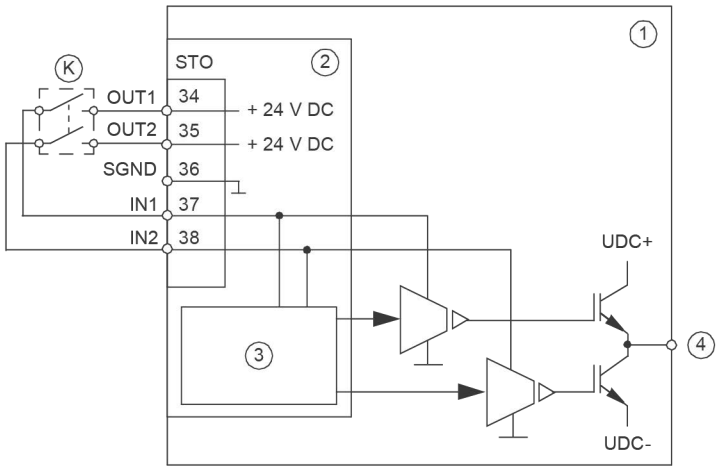
The Declarations of conformity are shown at the end of this chapter.

Wiring

For the electrical specifications of the STO connection, see the technical data of the control unit.

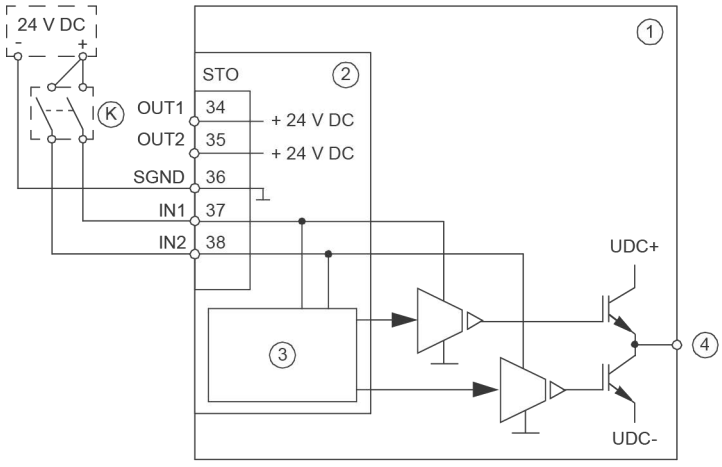
Connection principle

Single ACH580-31 drive, internal power supply



1	Drive
2	Control unit
3	Control logic
4	To motor
K	Activation switch

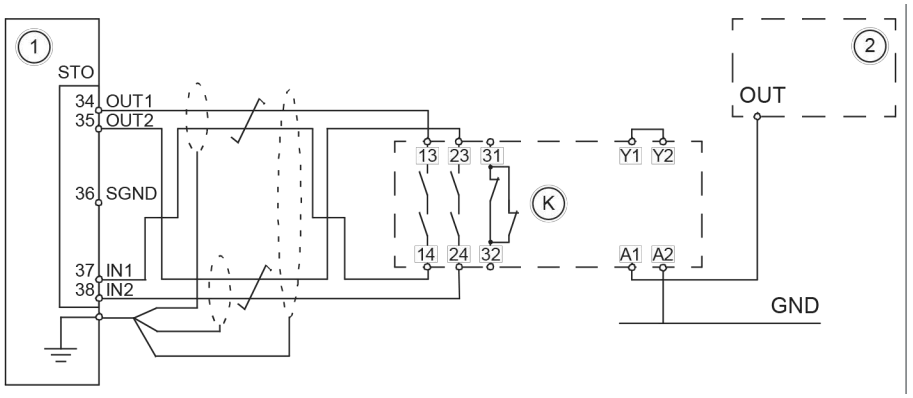
Single ACH580-31 drive, external power supply



1	Drive
2	Control until
3	Control logic
4	To motor
K	Activation switch

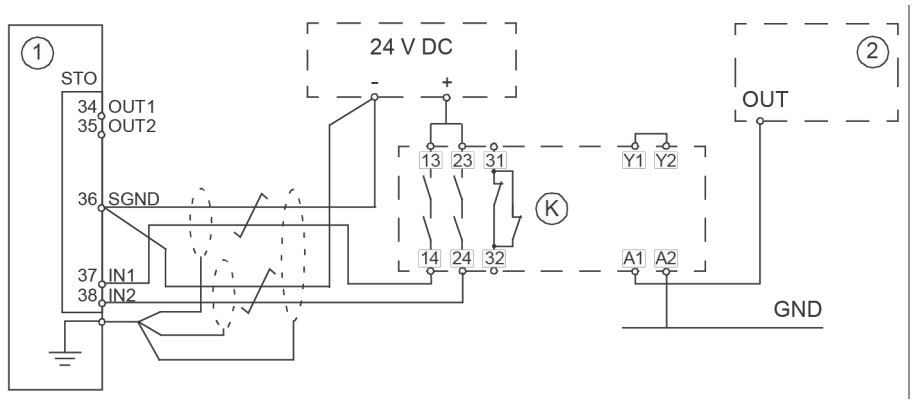
Wiring examples

Single ACH580-31 drive, internal power supply



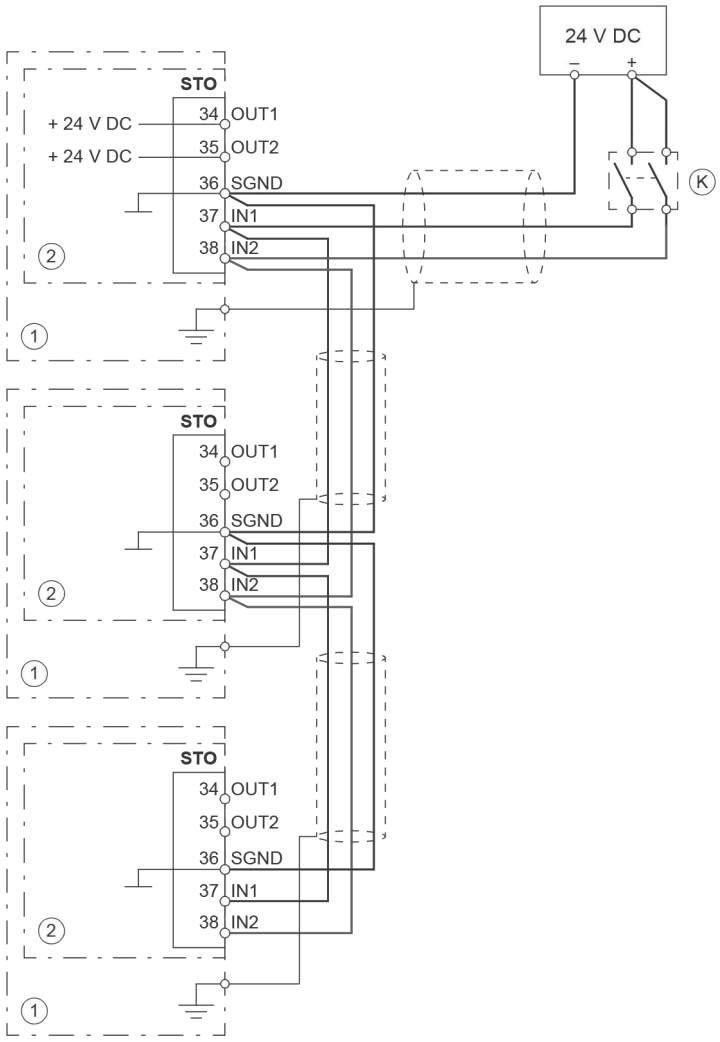
1	Drive
2	Safety PLC
K	Safety relay

Single ACH580-31 drive, external power supply



1	Drive
2	Safety PLC
K	Safety relay

Multiple ACH580-31 drives, internal power supply



1	Drive
2	Control unit
K	Activation switch

Activation switch

In the wiring diagrams, the activation switch has the designation [K]. This represents a component such as a manually operated switch, an emergency stop push button switch, or the contacts of a safety relay or safety PLC.

- In case a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.
- The contacts of the switch or relay must open/close within 200 ms of each other.
- A CPTC thermistor protection module or an FSPS safety functions module can also be used. For more information, see the module documentation.

Cable types and lengths

- ABB recommends double-shielded twisted-pair cable.
- Maximum cable lengths:
  - 300 m (1000 ft) between activation switch [K] and drive control unit
  - 60 m (200 ft) between multiple drives
  - 60 m (200 ft) between external power supply and first control unit

Note: A short-circuit in the wiring between the switch and an STO terminal causes a dangerous fault. Therefore, it is recommended to use a safety relay (including wiring diagnostics) or a wiring method (shield grounding, channel separation) which reduces or eliminates the risk caused by the short-circuit.

Note: The voltage at the STO input terminals of the drive must be at least 13 V DC to be interpreted as "1".

The pulse tolerance of the input channels is 1 ms.

Grounding of protective shields

- Ground the shield in the cabling between the activation switch and the control unit at the control unit only.
- Ground the shield in the cabling between two control units at one control unit only.

Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety relay contacts open).
2. The STO inputs of the drive control unit de-energize.
3. The control unit cuts off the control voltage from the output IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (see the firmware manual of the drive).

   The parameter selects which indications are given when one or both STO signals are switched off or lost. The indications also depend on whether the drive is running or stopped when this occurs.

   Note: This parameter does not affect the operation of the STO function itself. The STO function will operate regardless of the setting of this parameter: a running drive will stop upon removal of one or both STO signals, and will not start until both STO signals are restored and all faults reset.

   Note: The loss of only one STO signal always generates a fault as it is interpreted as a malfunction of STO hardware or wiring.
5. The motor coasts to a stop (if running). The drive cannot restart while the activation switch or safety relay contacts are open. After the contacts close, a reset may be needed (depending on the setting of parameter 31.22). A new start command is required to start the drive.

Start-up including validation test

To ensure the safe operation of a safety function, validation is required. The final assembler of the machine must validate the function by performing a validation test. The test must be performed

1. at initial start-up of the safety function
2. after any changes related to the safety function (circuit boards, wiring, components, settings, replacement of inverter module, etc.)
3. after any maintenance work related to the safety function
4. after a drive firmware update
5. at the proof test of the safety function.

Competence

The validation test of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

Validation test reports

Signed validation test reports must be stored in the logbook of the machine. The report shall include documentation of start-up activities and test results, references to failure reports and resolution of failures. Any new validation tests performed due to changes or maintenance shall be logged into the logbook.

Validation test procedure

After wiring the Safe torque off function, validate its operation as follows.

Note: If a CPTC-02 or an FSPS-21 module is installed, refer to its documentation.

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Make sure that the motor can be run and stopped freely during start-up.	☐
Stop the drive (if running), switch the input power off and isolate the drive from the power line using a disconnector.	☐
Check the STO circuit connections against the wiring diagram.	☐
Close the disconnector and switch the power on.	☐

Action	☑
Test the operation of the STO function when the motor is stopped. Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Make sure that the drive operates as follows: Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter 31.22 (see the firmware manual). Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. Close the STO circuit. Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the STO function when the motor is running. Start the drive and make sure the motor is running. Open the STO circuit. The motor should stop. The drive generates an indication if one is defined for the 'running' state in parameter 31.22 (see the firmware manual). Reset any active faults and try to start the drive. Make sure that the motor stays at a standstill and the drive operates as described above in testing the operation when the motor is stopped. Close the STO circuit. Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the failure detection of the drive. The motor can be stopped or running. Open the 1st input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA81 fault indication (see the firmware manual). Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. Close the STO circuit. Reset any active faults. Restart the drive and check that the motor runs normally. Open the 2nd input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA82 fault indication (see the firmware manual). Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. Close the STO circuit. Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Document and sign the validation test report which verifies that the safety function is safe and accepted for operation.	☐

Use

1. Open the activation switch, or activate the safety functionality that is wired to the STO connection.
2. The STO inputs on the drive control unit de-energize, and the control unit cuts off the control voltage from the output IGBTs.
3. The control program generates an indication as defined by parameter 31.22 (see the firmware manual of the drive).
4. The motor coasts to a stop (if running). The drive will not restart while the activation switch or safety relay contacts are open.
5. Deactivate the STO by closing the activation switch, or resetting the safety functionality that is wired to the STO connection.
6. Reset any faults before restarting.

WARNING!
The Safe torque off function does not disconnect the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on electrical parts of the drive or the motor can only be carried out after isolating the drive from the supply and all other voltage sources.

WARNING!
The drive cannot detect or memorize any changes in the STO circuitry when the drive control unit is not powered. If both STO circuits are closed and a level-type start signal is active when the power is restored, it is possible that the drive starts without a fresh start command. Take this into account in the risk assessment of the system. This is also valid when the drive is only powered by a CMOD-xx multifunction extension module.

WARNING!
Permanent magnet or synchronous reluctance [SynRM] motors only:
In case of a multiple IGBT power semiconductor failure, the drive can produce an alignment torque which maximally rotates the motor shaft by 180/p degrees (with permanent magnet motors) or 180/2p degrees (with synchronous reluctance [SynRM] motors) regardless of the activation of the Safe torque off function. p denotes the number of pole pairs.

Notes:

If a running drive is stopped by using the Safe torque off function, the drive will cut off the motor supply voltage and the motor will coast to a stop. If this 232 The Safe torque off

function causes danger or is not otherwise acceptable, stop the drive and machinery using the appropriate stop mode before activating the Safe torque off function.

- The Safe torque off function overrides all other functions of the drive.
- The Safe torque off function is ineffective against deliberate sabotage or misuse.
- The Safe torque off function has been designed to reduce the recognized hazardous conditions. In spite of this, it is not always possible to eliminate all potential hazards. The assembler of the machine must inform the final user about the residual risks.

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 10 years; see section Safety data (page 236). It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the Validation test procedure (page 230).

Note: See also the Recommendation of Use CNB/M/11.050 (published by the European co-ordination of Notified Bodies) concerning dual-channel safety-related systems with electromechanical outputs:

- When the safety integrity requirement for the safety function is SIL 3 or PL e (cat. 3 or 4), the proof test for the function must be performed at least every month.
- When the safety integrity requirement for the safety function is SIL 2 (HFT = 1) or PL d (cat. 3), the proof test for the function must be performed at least every 12 months.

The STO function of the drive does not contain any electromechanical components. In addition to proof testing, it is a good practice to check the operation of the function when other maintenance procedures are carried out on the machinery. Include the Safe torque off operation test described above in the routine maintenance program of the machinery that the drive runs.
If any wiring or component change is needed after start-up, or the parameters are restored, do the test given in section Validation test procedure (page 230).

Use only spare parts approved by ABB.

Record all maintenance and proof test activities in the machine logbook.

Competence

The maintenance and proof test activities of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6.

Fault tracing

The indications given during the normal operation of the Safe torque off function are selected by drive control program parameter 31.22.

The diagnostics of the Safe torque off function cross-compare the status of the two STO channels. In case the channels are not in the same state, a fault reaction function is performed and the drive trips on an FA81 or FA82 fault. An attempt to use the STO in a non-redundant manner, for example activating only one channel, will trigger the same reaction.

See the firmware manual of the drive control program for the indications generated by the drive, and for details on directing fault and warning indications to an output on the control unit for external diagnostics.

Any failures of the Safe torque off function must be reported to ABB.

Safety data

The safety data for the Safe torque off function is given below.

Note: The safety data is calculated for redundant use, and applies only if both STO channels are used.

Table 2. Safety data for manuals

Frame	SIL/ SILCL	PL	SFF [%]	PFH [1/h]	PFDavg (T1=2a)	PFDavg (T1=5a)	PFDavg (T1=10a)	PFDavg (PTC=0%)	MTTFD [a]	DC [%]	SC	Cat.	HFT	CCF	Mission Time TM[a]	PFHdiag [1/h]	MTTFD, diag [a]	λDiag_s [1/h]	λDiag_d [1/h]	Prior FMEDA source data
R3 200V/500V	3	e	87.99	3.91E-09	3.26E-05	8.15E-05	1.63E-04	3.26E-04	4802*	≥90	3	3	1	80	20	1.40E-12	8.15R+05	6.43E+01	1.40E-01	3AXD10000606249
R6 200V/500V	3	e	87.99	3.91E-09	3.26E-05	8.15E-05	1.63E-04	3.26E-04	4639*	≥90	3	3	1	80	20	1.40E-12	8.15E+05	6.43E+01	1.40E-01	3AXD10000606249
R8 200V/500V	3	e	>99	4.22E-09	3.69E-09	9.24E-05	1.85E-04	3.69E-04	2805*	≥90	3	3	1	80	20	3.00E-12	3.81E+05	7.60E+01	3.00E-01	3AXD10000606249

3AXD10001613538 rev. C

* new values

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with ΔT = 71.66 °C
  - 1340 on/off cycles per year with ΔT = 61.66 °C
  - 30 on/off cycles per year with ΔT = 10.0 °C
  - 32 °C board temperature at 2.0% of time
  - 60 °C board temperature at 1.5% of time
  - 85 °C board temperature at 2.3% of time
- The STO is a type A safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested
  - A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO response times:
  - STO reaction time (shortest detectable break): 1 ms
  - STO response time:
    - Frames R3 and R6: 2 ms (typical), 10 ms (maximum)
    - Frame R8: 2 ms (typical), 15 ms (maximum)
  - Fault detection time: Channels in different states for longer than 200 ms
  - Fault reaction time: Fault detection time + 10 ms.
- Indication delays:
  - STO fault indication (parameter 31.22) delay: < 500 ms
  - STO warning indication (parameter 31.22) delay: < 1000 ms.

Terms and abbreviations

Term or abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage (%)
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	EN ISO 13849-1	Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD_{avg}	IEC 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time
PFH_{diag}	IEC/EN 62061	Average frequency of dangerous failures per hour for the diagnostic function of STO
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL
Proof test	IEC 61508, IEC 62061	Periodic test performed to detect failures in a safety-related system so that, if necessary, a repair can restore the system to an “as new” condition or as close as practical to this condition
SC	IEC 61508	Systematic capability (1…3)
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1…3)
STO	IEC/EN 61800-5-2	Safe torque off
T_1	IEC 61508-6	Proof test interval. T1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. See also section Maintenance.
T_M	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any TM values given cannot be regarded as a guarantee or warranty.
?Diag_d	IEC 61508-6	Dangerous failure rate (per hour) of the diagnostics function of STO
?Diag_s	IEC 61508-6	Safe failure rate (per hour) of the diagnostics function of STO

TÜV certificate

The TÜV certificate is available on the Internet at www.abb.com/drives/documents.

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/searchchannels

Product training

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

abb.com/drives

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