CHAPTER 1: GETTING STARTED

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User Manual Overview

Overview of this Publication

This user manual describes the installation, configuration, accessories, and methods of operation of the *IronHorse* ACN Series Variable Frequency AC Drives.

Who Should Read This Manual

This manual contains important information for those who will install, maintain, and/or operate any of the *IronHorse* ACN Series AC Drives.

Supplemental Publications

The National Electrical Manufacturers Association (NEMA) publishes many different documents that discuss standards for industrial control equipment. Global Engineering Documents handles the sale of NEMA documents. For more information, you can contact Global Engineering Documents at:

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Special Symbols

NOTE: When you see the "notepad" icon in the left-hand margin, the paragraph to its immediate right will be a special note.

WARNING: When you see the "exclamation mark" icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death (in extreme cases).

Purpose of AC Drives

AC drives are generally known by many different names: Adjustable Frequency Drives (AFD), Variable Frequency Drives (VFD), and Inverters. Drives are used primarily to vary the speed of three phase AC induction motors, and they also provide non-emergency start and stop control, acceleration and deceleration, and overload protection. By gradually accelerating the motor, drives can reduce the amount of motor startup inrush current.

AC drives function by converting incoming AC power to DC, which is then synthesized back into three phase output power. The voltage and frequency of this synthesized output power is directly varied by the drive, where the frequency determines the speed of the three phase AC induction motor.

Selecting the Proper Drive Rating

Determine Motor Full-Load Amperage (FLA)

Motor FLA is located on the nameplate of the motor.
NOTE: FLA of motors that have been rewound may be higher than stated.

Determine Motor Overload Requirements

Many applications experience temporary overload conditions due to starting requirements or impact loading. Most AC drives are designed to operate at 150% overload for 60 seconds. If the application requires an overload greater than 150% or longer than 60 seconds, the AC drive must be oversized.

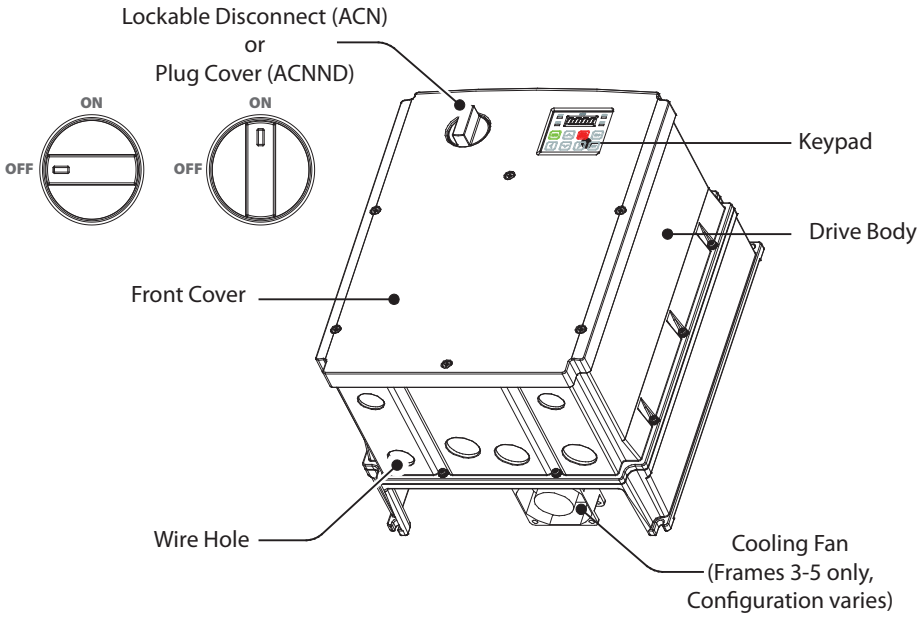
NOTE: Applications that require replacement of existing motor starters with AC drives may require up to 600% overload.

Determine Application Type; Constant Torque or Variable Torque

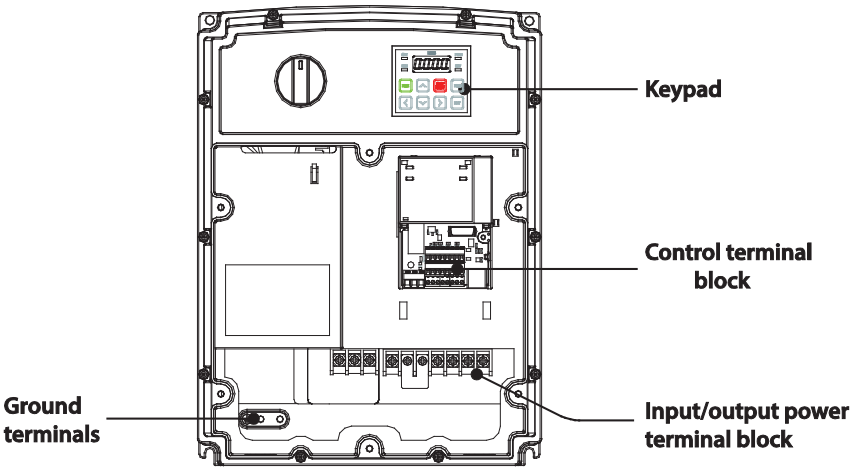
This torque requirement has a direct effect on which drive to select. Variable Torque applications are generally easier to start; typically fans and pumps. Most other applications outside fans and pumps fall into the Constant Torque category (machine control, conveyors, etc.). If you are unsure of the application, assume Constant Torque. ACN drives are specified with constant torque ratings only.

Parts Locater

The illustrations below show part names and locations. Details may vary between product groups.



Front Cover Removed

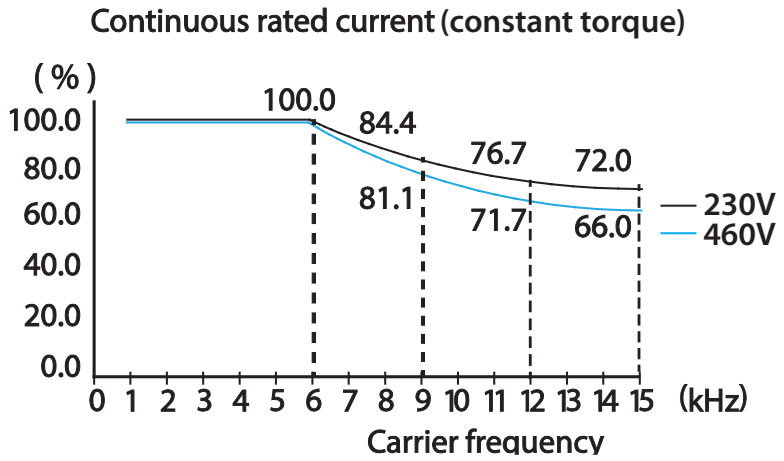


NOTE: The ACN version of the drive is equipped with a disconnect switch that allows lockout of the input power to the drive. This switch can be used for power isolation to perform maintenance and other duties to the motor and associated equipment. See Chapter 6 for disconnect operation.

Continuous Rated Current Derating

Derating by Carrier Frequency

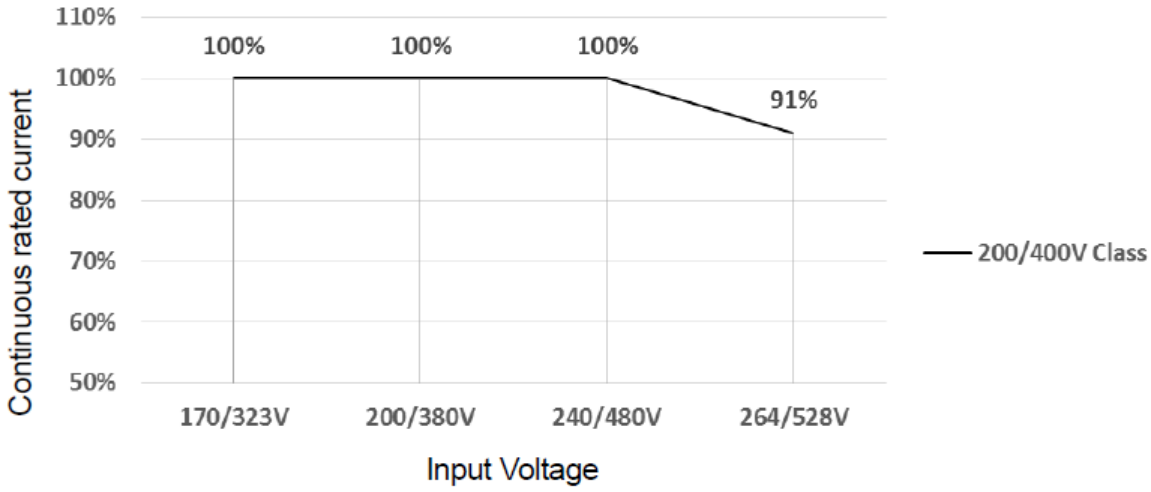
The continuous rated current of the drive is limited based on the carrier frequency. Refer to the following graph.



Derating by Carrier Frequency			
230V		***460V***	
Carrier Frequency (kHz)	***Constant Rated Current (%)***	***Carrier Frequency (kHz)***	***Constant Rated Current (%)***
1-6	100	1-6	100
9	84.4	9	81.1
12	76.7	12	71.7
15	72.0	15	66.0

Derating by Input Voltage

The continuous rated current of the drive is limited based on the input voltage. Refer to the following graphs.



Heat Emission

The following graph shows the drive's heat emission characteristics (by product capacity). Heat emission data is based on operations with default carrier frequency settings, under normal operating conditions. For detailed information on carrier frequency, "Operational Noise Settings (carrier frequency settings)" on page 4–171.

Watt Loss and Efficiency

IronHorse ACN Watt Loss and Efficiency							
Model Number ACN(ND)-xxxx	Voltage	Rated Power (kW)	Efficiency (%)	Total Losses (W)	Internal Losses (W)	External (Heat) Losses (W)	Heat Losses (Kcal)
20P5	230	0.4	96.6	21.6	12.6	9	7.7
21P0	230	0.8	96.7	42.4	12.6	29.8	25.6
22P0	230	1.5	96.9	76.5	16.8	59.7	51.3
23P0	230	2.2	97	110	16.8	93.2	80.2
25P0	230	4	97.3	188	18.9	169.1	145.4
27P5	230	5.5	97.5	247.5	38.7	208.8	179.6
2010	230	7.5	97.5	337.5	38.7	298.8	257
2015	230	11	97.8	462	38.7	423.3	364
2020	230	15	98	600	38.7	561.3	482.7
40P5	460	0.4	96.7	21.2	12.6	8.6	7.4
41P0	460	0.8	96.7	42.4	12.6	29.8	25.6
42P0	460	1.5	96.9	76.5	16.8	59.7	51.3
43P0	460	2.2	97	110	16.8	93.2	80.2
45P0	460	4	97.3	188	21	167	143.6
47P5	460	5.5	97.4	253	43	210	180.6
4010	460	7.5	97.5	337.5	43	294.5	253.3
4015	460	11	97.5	495	43	452	388.7
4020	460	15	97.5	675	43	632	543.5
4025	460	18.5	97.6	814	43	771	663.1
4030	460	22	97.7	946	43	903	776.6

This watt loss and efficiency data were measured under the following test conditions:
- *Operation at 60Hz and room temperature*
- *100% load*
- *Carrier Frequency (Default value)*

IronHorse ACN Series AC Drive Environmental Information

Storage and Transportation

AC drives should be kept in the shipping cartons or crates until they are installed to maintain the warranty coverage. Should they not be installed within three months of delivery, please store them as described below.

- *Store in a clean and dry location free from direct sunlight and corrosive fumes.*
- *Store within environmental conditions shown below in the "Environmental Conditions" table.*
- *DO NOT store in an area with rapid changes in temperature , to avoid condensation and frost.*
- *DO NOT place directly on the ground.*
- *Do not transport the drive by lifting with the drive's covers or plastic surfaces. The drive may tip over if covers break, causing injuries or damage to the product. Always support the drive using the metal frames when moving it.*
- *Hi-capacity drives are very heavy and bulky. Use an appropriate transport method that is suitable for the weight.*

If the drive is stored or is otherwise unused for more than a year, the drive's internal DC link capacitors should be recharged before use. Otherwise, the capacitors may be damaged when the drive starts to operate. We recommend recharging the capacitors of any unused drive at least once per year.

Environmental Conditions

Environmental Conditions for IronHorse ACN Series AC Drives	
Installation Location	IEC60529 standard IP66; NEMA standard 4X for indoor use. Not suitable for use in direct sunlight.
Cooling	Forced fan cooling structure Forced cooling type: 0.4-15 kW 230V/0.4-22 kW 460V (excluding some models)
Ambient Temperature	-10 to 40°C (14 to 104°F); No ice or frost should be present.
Storage Temperature*	-20° to 65°C (-4 to 149°F)
Relative Humidity	Max 90% (to avoid condensation)
Air Pressure	70 to 106 kPa
Pollution Level	Pollution level 3 environment: Prevent contact with corrosive gases, inflammable gases, oil stains, dust, and other pollutants.
Altitude	No higher than 3280ft (1,000m). From 1000 to 4000m, the rated input voltage and rated output current of the drive must be derated by 1% for every 100m.
Vibration	Less than 9.8 m/sec^2 (1G)
Installation Orientation	Max allowed offset angle = 0 degrees. (Vertical orientation only). Do not install the drive on the floor or mount it sideways against a wall. The drive MUST be installed vertically, on a wall or inside a panel, with its rear flat on the mounting surface.
** The ambient temperature is the temperature measured at a point 2" (5 cm) from the surface of the drive.*	

IronHorse ACN Series AC Drive Specifications

230V Class – (Model Specifications)

ACN 230V Class Constant Torque Specifications; Frame Sizes 1~2							
Model Name: ACN(ND)-xxxx			20P5	21P0	22P0	23P0	25P0
Frame Size			1		2		
Applied Motor	Max Motor Output - 3ph input	hp	0.5	1.0	2.0	3.0	5.4
		kW	0.4	0.75	1.5	2.2	4.0
	Max Motor Output – 1ph input	hp	1/6	0.5	1.0	1.5	2.0
		kW	0.1	0.4	0.7	1.1	1.5
Output Rating	Rated Capacity–3ph input	kVA	1.0	1.9	3.0	4.2	6.5
	Rated Current–3ph input	A	2.5	5.0	8.0	11.0	17.0
	Rated Current–1ph input	A	1.5	2.8	4.6	6.1	9.3
	Output Frequency	Hz	0-400 Hz (IM Sensorless: 0-120 Hz)				
	Output Voltage	V	3-phase 200-240 V				
Input Rating	Working Voltage–3ph input	V	3-phase 200-240 VAC (-15% to +10%)				
	Working Voltage–1ph input	V	1-phase 240VAC (-5% to +10%)				
	Input Frequency–3ph input	Hz	50-60 Hz (±5%)				
	Input Frequency–1ph input	Hz	60Hz (±5%)				
	Rated Current–1 or 3ph input	A	2.2	4.9	8.4	11.8	18.5
Weight (lb [kg])			7.9 [3.6]	7.9 [3.6]	11.5 [5.2]	11.9 [5.4]	12.13 [5.5]
Cooling Method			Forced Fan–Internal				

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 230V drives is based on a 220V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*

230V Class – (Model Specifications)

ACN 230V Class Constant Torque Specifications; Frame Sizes 3~5						
Model Name: ACN(ND)-xxxx			**27P5**	**2010**	**2015**	**2020**
Frame Size			3		4	5
Applied Motor	***Max Motor Output - 3ph input***	***hp***	7.5	10	15	20
		kW	5.5	7.5	11	15
	Max Motor Output – 1ph input	***hp***	3.0	5.0	7.5	10
		kW	2.2	3.7	5.6	7.5
Output Rating	***Rated Capacity–3ph input***	***kVA***	9.1	12.2	17.5	22.9
	Rated Current–3ph input	***A***	24.0	32.0	46.0	60.0
	Rated Current–1ph input	***A***	13.0	18.0	26.0	33.0
	Output Frequency	***Hz***	0-400 Hz (IM Sensorless: 0-120 Hz)			
	Output Voltage	***V***	3-phase 200-240 V			
Input Rating	***Working Voltage–3ph input***	***V***	3-phase 200-240 VAC (-15% to +10%)			
	Working Voltage–1ph input	***V***	1-phase 240VAC (-5% to +10%)			
	Input Frequency–3ph input	***Hz***	50-60 Hz (±5%)			
	Input Frequency–1ph input	***Hz***	60Hz (±5%)			
	Rated Current–1 or 3ph input	***A***	25.8	34.9	50.8	66.7
Weight (lb [kg])			19.4 [8.8]	19.4 [8.8]	20.7 [9.4]	26.2 [11.9]
Cooling Method			Forced Fan–Internal & Single External		Forced Fan-Internal & Dual External	

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 230V drives is based on a 220V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*

460V Class – (Model Specifications)

ACN 460V Class Constant Torque Specifications; Frame Sizes 1~2							
Model Name: ACN(ND)-xxxx			40P5	41P0	42P0	43P0	45P0
Frame Size			1		2		
Applied Motor	*Max Motor Output - 3ph input*	*hp*	0.5	1.0	2.0	3.0	5.4
		kW	0.4	0.75	1.5	2.2	4.0
	Max Motor Output – 1ph input	*hp*	1/6	0.5	0.8	1.0	2.0
		kW	0.1	0.4	0.6	0.7	1.5
Output Rating	*Rated Capacity–3ph input*	*kVA*	1.0	1.9	3.0	4.2	6.5
	Rated Current–3ph input	*A*	1.3	2.5	4.0	5.5	9.0
	Rated Current–1ph input	*A*	0.8	1.5	2.3	3.1	5.4
	Output Frequency	*Hz*	0-400 Hz (IM Sensorless: 0-120 Hz)				
	Output Voltage	*V*	3-phase 380-480 V				
Input Rating	*Working Voltage–3ph input*	*V*	380-480 VAC (-15% to +10%)				
	Working Voltage–1ph input	*V*	480VAC(-5% to +10%)				
	Input Frequency–3ph input	*Hz*	50-60 Hz (±5%)				
	Input Frequency–1ph input	*Hz*	60Hz (±5%)				
	Rated Current–1 or 3ph input	*A*	1.1	2.4	4.2	5.9	9.8
Weight (lb [kg])			8.2 [3.7]	8.2 [3.7]	11.7 [5.3]	12.1 [5.5]	12.3 [5.6]
Weight–Non EMC Filter Type (lb [kg])			7.9 [3.6]	7.9 [3.6]	11.5 [5.2]	11.9 [5.4]	12.13 [5.5]
Cooling Method			Forced Fan–Internal				

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 460V drives is based on a 440V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*

460V Class – (Model Specifications)

ACN 460V Class Constant Torque Specifications; Frame Sizes 3~5								
Model Name: ACN(ND)-xxxx			47P5	4010	4015	4020	4025	4030
Frame Size			3		4		5	
Applied Motor	*Max Motor Output - 3ph input*	*hp*	7.5	10	15	20	25	30
		kW	5.5	7.5	11	15	18.5	22
	Max Motor Output – 1ph input	*hp*	3.0	5.0	7.5	10.0	10.0	15.0
		kW	2.2	3.7	5.6	7.5	7.5	11.2
Output Rating	*Rated Capacity–3ph input*	*kVA*	9.1	12.2	18.3	22.9	29.7	34.3
	Rated Current–3ph input	*A*	12.0	16.0	24.0	30.0	39.0	45.0
	Rated Current–1ph input	*A*	7.1	9.5	15.0	18.0	23.0	27.0
	Output Frequency	*Hz*	0-400 Hz (IM Sensorless: 0-120 Hz)					
	Output Voltage	*V*	3-phase 380-480 V					
Input Rating	*Working Voltage–3ph input*	*V*	3-phase 380-480 VAC (-15% to +10%)					
	Working Voltage–1ph input	*V*	1-phase 480VAC (-5% to +10%)					
	Input Frequency–3ph input	*Hz*	50-60 Hz (±5%)					
	Input Frequency–1ph input	*Hz*	60Hz (±5%)					
	Rated Current–1 or 3ph input	*A*	12.9	17.5	26.5	33.4	43.6	50.7
Weight (lb [kg])			19.4 [8.8]	19.6 [8.9]	21.2 [9.6]	21.6 [9.8]	27.3 [12.4]	27.3 [12.4]
Weight–Non EMC Filter Type (lb [kg])			18.9 [8.6]	19.2 [8.7]	20.7 [9.4]	21.2 [9.6]	26.9 [12.2]	26.9 [12.2]
Cooling Method			Forced Fan–Internal & Single External		Forced Fan-Internal & Dual External			

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 460V drives is based on a 440V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*

Specifications Applicable to All ACN Series Models

IronHorse ACN Series General Specifications (All Models)		
Control Characteristics	**Control Method**	V/F, Slip Compensation, Sensorless Vector (IM or PM), Torque
	Applicable Motor	AC Induction Motor(IM), AC Permanent Magnet Motor(PM)
	Frequency Settings Power Resolution	Digital command: 0.01 Hz; Analog command: 0.06 Hz (60 Hz standard)
	Starting Torque	150% / 3Hz (V/F) 150% / 0.1 Hz (IM Sensorless) 100% / 3Hz (PM Sensorless
	Speed Regulation	± 3% of max freq (V/F) ± 0.3% of max freq (IM Sensorless) ± 1% of max freq (PM Sensorless)
	Speed Control Range	40:1 (V/F) 100:1 (IM Sensorless) 20:1 (PM Sensorless)
	Torque Mode Accuracy	± 10%
	Torque Mode Limits	± 180%
	V/F Pattern	Linear, square reduction, user V/F
	Overload Capacity	Constant Torque rated current: 150% for 1 minute; 200% for 4 sec
	Torque Boost	Manual torque boost, automatic torque boost
Operation Characteristics	**Operation Command Signal**	Keypad, Digital, Serial Communication
	Frequency Setting Signal	Analog type: -10~10 V, 0~10 V, 4~20 mA Digital type: keypad, pulse train input Serial Communication
	Main Functions	• PID control • 3-wire operation • Frequency limit • Second function • Anti-forward and reverse direction rotation • Commercial transition • Speed search • Power braking • Leakage reduction • Up-down operation • DC braking • Frequency jump • Slip compensation • Automatic restart • Automatic tuning • Energy buffering • Flux braking • Fire mode • Programmable User Sequence
	Digital Inputs	Five (5) - 24VDC NPN or PNP, includes 1 configurable 32kHz frequency input
	Digital Outputs	Two (2) - (1)-26VDC,100mA, configurable as 32kHz Pulse Output ; (1) Relay-250VAC/30VDC, 1A
	Analog Inputs	Two (2) - (1) voltage or potentiometer, (1) selectable Voltage or Current
	Analog Outputs	One (1) - selectable voltage (0-10 V) or current (0-20 mA)
	Safe Torque Off	SA and SB inputs- 24VDC

IronHorse ACN Series General Specifications (All Models)		
Function Characteristics	***Trip***	• External signal trip • ARM short circuit current trip • Overheat trip • Input imaging trip • Ground trip • Motor overheat trip • I/O board link trip • No motor trip • Parameter writing trip • Emergency stop trip • Command loss trip • External memory error • CPU watchdog trip • Motor normal load trip • Temperature sensor trip • Inverter overheat • Option trip • Output imaging trip • Inverter overload trip • Fan trip • Pre-PID operation failure • External break trip • Low voltage trip during operation • Low voltage trip • Safety A (B) trip • Analog input error • Motor overload trip
	Alarm	Command loss trip alarm, overload alarm, normal load alarm, drive overload alarm, fan operation alarm, resistance braking rate alarm, number of corrections on rotor tuning error
	PCB Conformal Coating	IEC 60721-3-3(3C2), IEC 60068-2-43, IEC 60068-2-60
Accessory	***Communication Card***	EtherNet/IP and Modbus TCP (ACN-ETH)
	IO Extension	3 DI, 2 DO, 2 AI, 1 AO (ACN-EIO)
Agency Approvals		UL, CE, TÜV NORD (SIL 2)

Receiving and Inspection

Drive Package Contents

After receiving the ACN Series AC drive, please check the following:

1) Make sure that the package includes the product insert.
2) Carefully follow the unpacking instructions contained in this chapter of this user manual when unpacking your AC drive.
3) Please inspect the unit after unpacking to assure it was not damaged during shipment. Make sure that the part number printed on the package corresponds with the part number indicated on the nameplate.
4) Make sure that the part number indicated on the nameplate corresponds with the part number of your order.
5) Make sure that the voltage for the wiring lies within the range as indicated on the nameplate. Please install the AC drive according to this manual.
6) Before applying the power, please make sure that all the devices, including power, motor, control board, and digital keypad are connected correctly.
7) When wiring the AC drive, please make sure that the wiring of input terminals and output terminals are correct to prevent drive damage.
8) When executing a trial run, please begin with a low speed, and then gradually increase the speed until the desired speed is reached.

The ACN series AC drive should be kept in the shipping carton or crate before installation. In order to retain the warranty coverage, the drive should be stored properly when it is not to be used for an extended period of time. Refer to the preceding “Environmental Information” section for proper storage conditions.

Model Number Explanation

ACN- 2 0P5

Applicable Motor Capacity with 3-Phase Input

0P5: 0.5 hp	010: 10 hp
1P0: 1.0 hp	015: 15 hp
2P0: 2.0 hp	020: 20 hp
3P0: 3.0 hp	025: 25 hp
5P0: 5.0 hp	030: 30 hp
7P5: 7.5 hp	

Input Voltage
2: 230VAC
4: 460VAC

Series Name

Nameplate Information