

RD4006A2

Compressor Drive

Specification

V1.0

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Revision History

Version	Release Date	Amendments
V0.1	2025-03-28	First Version

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1 General Introduction

This design specification applies to RD4006A2 Drive, which is used to operate HVAC variable speed compressors. The document covers drive general introduction, technical design parameters, functionalities

The Drive consists of EMI filter (fuses included), Active PFC circuit, DC choke and DC inverter with a front end converter stage, DC storage element, output inverter stage for compressor control, control circuits and power supply, circuitry to interface. The product will implement in control algorithms needed for efficient operation and protection of the VS Compressor.

2 Diagram, 2D drawing and interface

2.1 System Block Diagram

Fig.2.1 is the system functional block diagram of the drive.

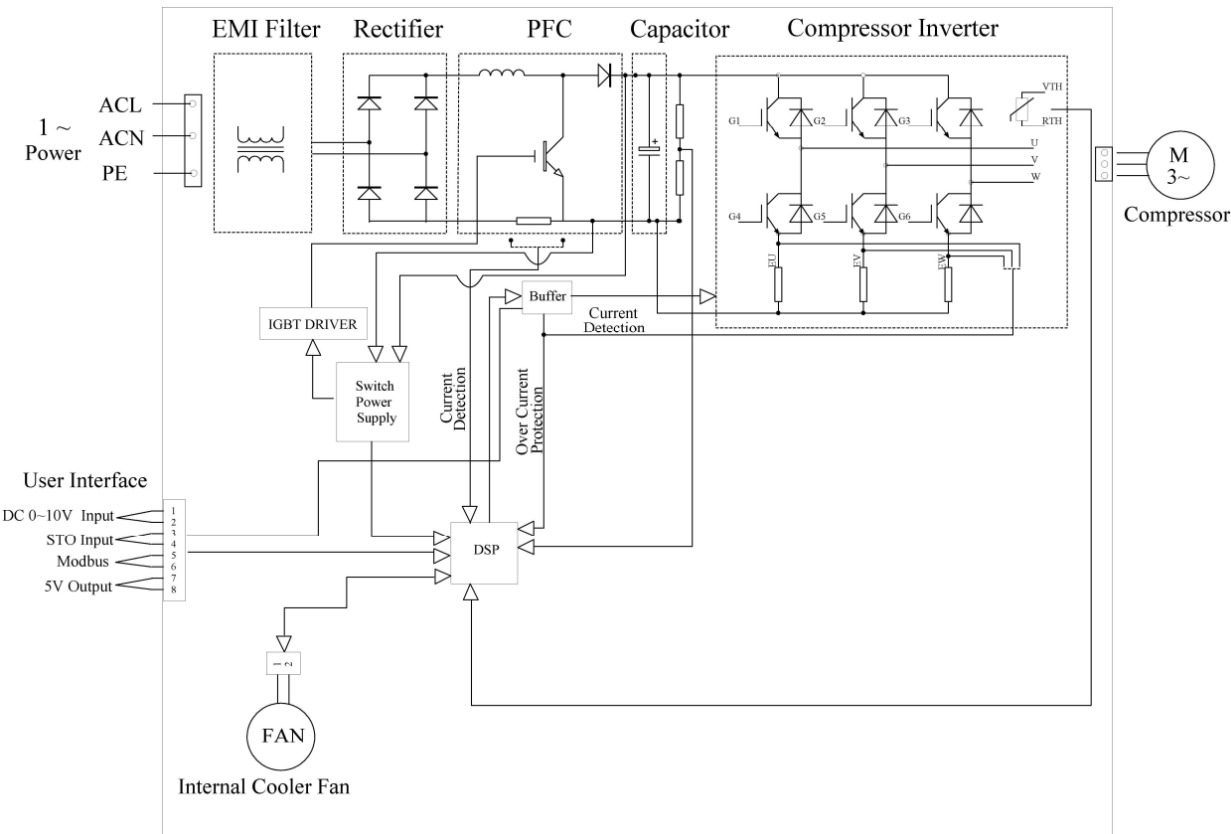


Fig.2.1 System block diagram

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The drive includes the following basic functions: EMI Filter, Active Power-Factor Correction, Inrush Current Protector Circuits, Rectifier, DC capacitors, compressor inverter, Active air cooling, switching power supply (SMPS), isolation RS485 Modbus communication, etc.

Safety Extra Low Voltage (SELV or PELV) circuit is applied for the communication circuit to control board, STO connection, Analog input.

2.2 Drive Assembly and Sizes

Fig.2.2 is the 2D drawing of the drive with vertical Heat-sink, with key sizes information.

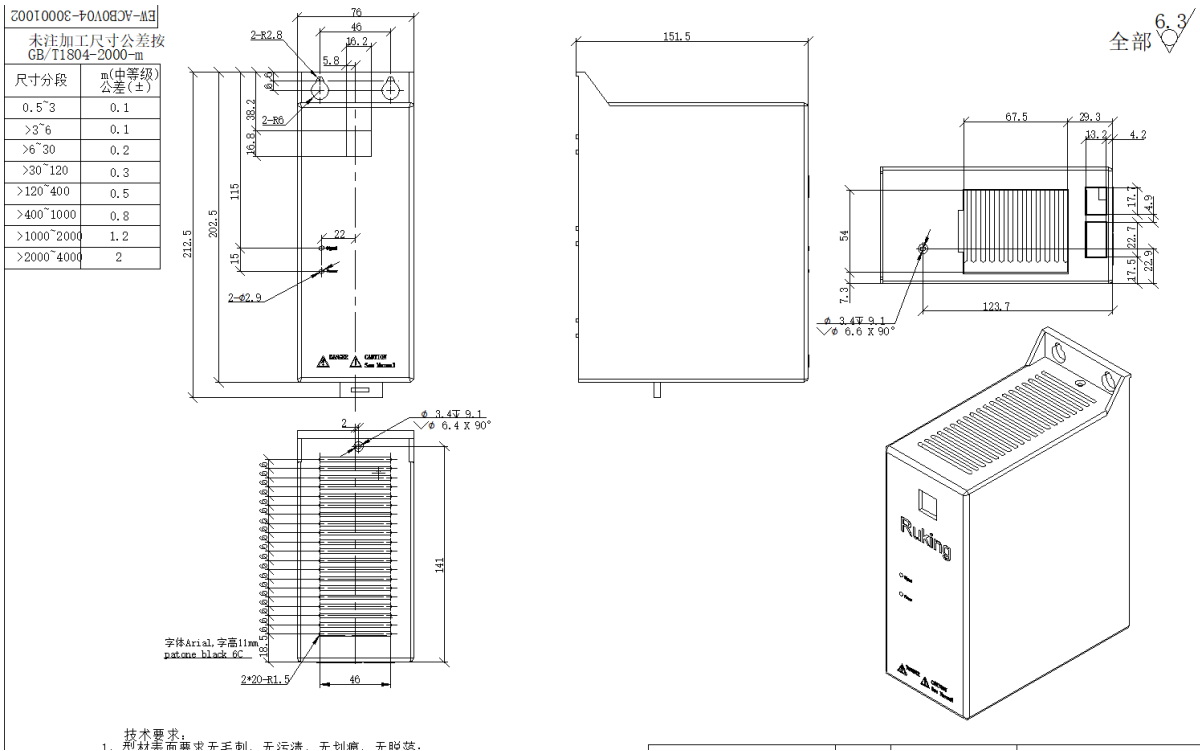


Fig.2.2 RD4006A2 drive assembly sizes

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2.3 Drive Interface Description

The Drive interface information is shown in Table 2.1.

NO.	Terminal	Terminal marking	Location	Model
1	AC power supply	ACL	CN1	2EDGRC-5.08-03P-13-00AH
		ACN		
		PE		
2	Compressor	W	CN5	2EDGRC-5.08-04P-13-00AH
		V		
		U		
		PE		
3	Communication	1: 5V / 5VDC optional for the RS485 communication 2: GND / Modbus Ground (Physical RS485) 3: A / Modbus Data Channel A (Physical RS485) 4: B / Modbus Data Channel B (Physical RS485) 5: 5V / 5VDC STO (Powering the High-Pressure Switch) 6: STO / Safety Torque Off (High-Pressure Switch) 7: 0-10V DC control (DC 0~10V Input) 8: GND	CN4	15EDGVHB-THR-3.5-08P-1Y-10A&Z(H)

Table 2.1 Drive interface

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2.4 Drive Wiring Diagram

The Drive wiring diagram is shown in Figure 2.3.

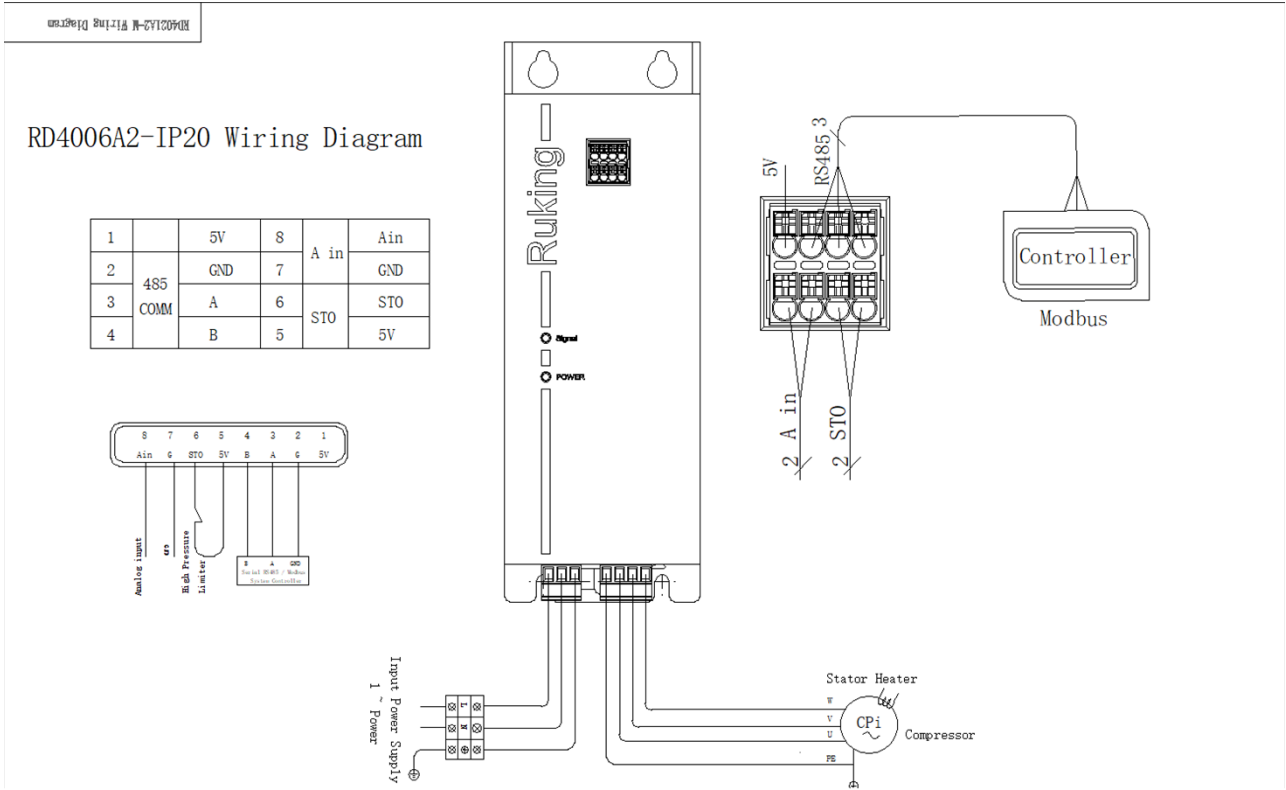


Fig.2.3 Wiring diagram

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3 Drive Application Performance

3.1 Basic Parameters

Total Drive	Drive IP Class	IP20
	Rated voltage	AC230V/50Hz
	Full-load Input voltage range	AC230V ± 10%
	Allowed input voltage range	AC230V ± 20%
	Power frequency range	50/60Hz±5%
	Maximum input current(RMS)	8A @ Active air cooling
	Power factor correction	>0.99 @Full load
	Efficiency	≥0.95@ 100%Load
	Input active power sampling accuracy	Sampling-Actual ≤5% (To be defined by both of sides)
	Standby power	< 3W
	Drive dimensions	151.5mm *76mm *212.5mm
Compressor Drive	Discharge time	60S
	Maximum output current of compressor(RMS)	6A @ Active air cooling
	Speed range of compressor	900-7200 RPM
	Frequency range of compressor	15-120HZ
	Compressor frequency control accuracy	±60 RPM
	Compressor switching frequency	4.8KHz

Table 3.1 Drive basic specification

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3.2 Electrical Insulation Properties

Leakage current standard: IEC60335-2-40:2022 Clause 13.2
Electric Insulation standard: IEC60335-2-40:2022 Clause 13.3
Pollution level: Level 2
Overvoltage level: Level 3

3.3 Application Environment

Storage temperature range	-40 ~85°C
Operating temperature range	-25~60°C
Full-load operating temperature range	-25~60°C
Active air cooling	IPM Temperature $\geq 60^{\circ}\text{C}$,ON IPM Temperature $\leq 45^{\circ}\text{C}$,OFF
Operating humidity range	0%~95%, no frost and condensation
Vibration standard	10~60Hz 0.15mm displacement, 60~150Hz 2g acceleration
Altitude	< 2000m

Table 3.2 Drive application environmental

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3.4 Lifetime

The Drive is designed for a minimum lifetime of 15 years (110 000 hours) under the conditions specified in the table below and performs ≥ 170 000 startups.

	Hours/ Year	Ambient Temp Dry Side °C	Comments
Total Run Hrs	7200		Cooling + Heating
High Load Cooling Hrs (Severe Summer Climate)	10	53	85-100% Load
	67	48	70-85% Load
	448	43	55-70% Load
	720	38	< 55% Load
High Load Heating Hrs (Severe Winter Climate)	47	13	85-100% Load
	445	18	70-85% Load
	1654	23	60-50% Load
	1876	28	50-40% Load
	1943	33	< 40% Load

Table 3.3 Operating schedule of drive in a year

3.5 Material Compatibility

The drive meets the RoHS and REACH compliant.

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4 Drive Functionalities

4.1 Compressor Control

If the drive gets the running command, the MCU will generate PWM signal to drive the PIM module, then the drive will output a AC voltage to the compressor and also detect the real compressor frequency after some calculation, if the real frequency is not the same as command frequency, the drive will modulate its output to make sure the compressor is running as wanted.

This function is achieved by MCU.

4.2 Communication

The communication uses the Modbus protocol, and there are two sets of communication protocols: one bases on the platform protocol “EcoKing RD4 Modbus Map V1.9”, another one bases on the customer-provided protocol “Modbus_interface_description”.

4.3 Drive Status Display

The drive has one LED to indicate the drive status, it works as follows:

Drive Board LED	Description
LED2	Flash 1 sec ON, 1 sec OFF: Compressor is working normally & Compressor is in standby mode
	First 2 sec ON, 2 sec OFF, then begin first rapid flashing (0.25 sec OFF, 0.25 sec ON) × m times to display fault type; after first flashing ends, 3 sec steady ON; then begin second rapid flashing (0.25 sec OFF, 0.25 sec ON) × n times to display fault bit; after second flashing ends, return to 2 sec ON and 2 sec OFF cycle: Compressor failure mode active

Table 4.1 LED flash description

NOTICE: Please refer to table 4.2 in chapter 4.4 for flash times(“n”) in the above table.

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4.4 Protections

The drive has several protections to make sure the drive and compressor are safe, this function is achieved by MCU.

All protections of the drive are shown in following table.

Compressor protection overview					
Protection name	HW/SW	Limitation value	Response time	Recovery condition	LED2 flash timers (type m, bit n)
Compressor HW over current	Hardware	17.2A-peak	5us	NA	1 1
Compressor U-Phase over current	Software	16A-peak	417us	NA	1 2
Compressor V-Phase over current	Software	16A-peak	417us	NA	1 3
Compressor W-Phase over current	Software	16A-peak	417us	NA	1 4
Compressor loss of phase	Software	NA	2s	NA	1 5
Compressor lost rotor	Software	Lost rotor/ phase current no change/ Phase current fast change	10s/4.17ms/ 41.7ms	NA	1 6
Compressor startup failure	Software	NA	24s/5s/5s/5s	NA	1 7
Compressor over load	Software	Based on compressor parameter(8A)	20s	NA	1 9
IPM protection	Hardware	17.2A-peak	5us	NA	1 12
PFC HW over current	Hardware	27.7A-peak	<1us	NA	2 1
PFC SW over current	Software	20A-peak	123us	<18A	2 2
PFC over voltage	Software	430V-peak(not warning)	5ms	<400V	2 3
Communication lost fault	Software	Lost communication from controller	30s	Communication recovery	3 1
EEPROM fault	Software	Lost communication between DSP & EEPROM	60s	Repower or load EE program	3 2
AC over current fault	Software	10A	5s	<8A	3 3
AC over voltage fault	Software	280V	2s	<250V	3 4

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AC under voltage fault	Software	165V	2s	>185V	3 5
DC over voltage fault	Software	450V	2s	<400V	3 6
DC under voltage fault	Software	170V	1ms	>190V	3 7
High pressure Fault	Hardware	NA	417us	High pressure switch short	3 8
IPM over heart fault	Software	Shut off:100°C	5s	<78°C	3 10
Compressor code fault	Software	Compressor code mismatch	immediately	Write correct code	3 12
Compress U-current sampling fault	Hardware	value >1.85V or <1.35V	1s	Hardware repaired and repower	4 1
Compress V-current sampling fault	Hardware	value >1.85V or <1.35V	1s	Hardware repaired and repower	4 2
Compress W-current sampling fault	Hardware	value >1.85V or <1.35V	1s	Hardware repaired and repower	4 3
PFC current sampling fault	Hardware	value >0.475V or <0.152V	1s	Hardware repaired and repower	4 4
IPM Temperature sampling fault	Hardware	AD value<15	5min	AD value >60	4 5

Table 4.2 Basic information of protections

Warning name	Fast drop value	Slow drop value	Recovery value	Response time
Input current warning	9Arms	8Arms	6Arms	immediately
Output current warning	7Arms	6Arms	4Arms	immediately
IPM Over heat warning	98°C	95°C	90°C	immediately
Weak magnetic warning	Slow drop value+5°	Related to compressor parameter information	Slow drop value-5°	immediately

Table 4.3 Basic information of warnings

Supplement: All protections will cause the drive to trip, warnings will cause it to fold back on speed.

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5 LVD and EMC standards conformity

The drive is designed according to following LVD and EMC standards, and CE-LVD, CB certified.

5.1 Safety reference documents

The drive design meets the LVD standards as follows:

Standard No.	Region	Description
IEC/EN 60335-1	EU/AS	Household and similar electrical appliances –Safety Part 1: General requirements.
IEC/EN 60335-2-34	EU/AS	Household and similar electrical appliances Safety Part 2-34: Particular requirements for motor-compressors.
IEC/EN 60335-2-40	EU/AS	Household and similar electrical appliances Safety Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers.
IEC/EN 60335-2-89	EU/AS	Household and similar electrical appliances –Safety Part 2-89:Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor

Table 5.1 Safety standard reference

The drive software is certified according Standard EN 60335-1 CLASS B.

5.2 EMC reference documents

The drive design meets the EMS standards as follows:

Standard No.	Region	Description
IEC/EN55014-2	Global	Electromagnetic compatibility-Requirements for household appliances, electric tools and similar apparatus-Part 2: Immunity-Product family standard.
IEC/EN 61000-4-2	Global	Electromagnetic compatibility (EMC) -Part 4-2: Testing and measurement techniques, Electrostatic discharge immunity test 1. Test Level Air Discharge - Level 4 (15KV) Contact Discharge - Level 4 (8kV) 2.Performance criterion: B
IEC/EN 61000-4-3	Global	Electromagnetic compatibility (EMC)- Part 4-3: Testing and measurement techniques- Radiated, radio-frequency, electromagnetic field immunity test 1. Test Level 10V/m, 80-1000 MHz; 2. Performance Criterion: A
IEC/EN 61000-4-4	Global	Electromagnetic compatibility (EMC) -Part 4-4: Testing and measurement techniques, Electrical fast transient/burst immunity test 1. Test Level 2kV/5kHz (Signal line) , 4kV/5kHz (Power line) ; 2. Performance Criterion: B

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IEC/EN 61000-4-5	Global	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques, Surge immunity test 1. Test Level 1kV (differential mode) 2kV (common mode) 2. Performance criterion: B
IEC/EN 61000-4-6	Global	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques, Immunity to conducted disturbances, induced by radio-frequency fields 1. Test Level 3V (Signal line) ;10V (Power line) 2. Performance criteria : A
EN 61000-4-8	Global	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test 1. Test Level 3A/m 2. Performance Criterion: A
IEC/EN 61000-4-11	Global	Electromagnetic compatibility (EMC). Testing and measurement techniques. Voltage dips, short interruptions and voltage variations immunity tests 0% for 0.5 cycle; Criterion B 40% for 10 cycles; Criterion C 70% for 50 cycles; Criterion C
IEC/EN 61000-4-13	Global	Electromagnetic compatibility (EMC) - Part 4-13: Testing and measurement techniques, Harmonics and inter-harmonics including mains signaling at AC power port, low frequency immunity tests 1. Test Level : Class 2; 2. Performance Criterion B

Table 5.2 EMS standards reference

The drive design meets the EMI standards as follows:

Standard No.	Region	Description
EN 55014-1	EU	Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Emission
EN 61000-3-2	EU	Electromagnetic compatibility (EMC). Limits. Limits for harmonic current emissions (equipment with rated current per phase <16A)
EN 61000-3-3	EU	Electromagnetic compatibility (EMC) -Part 3-3: Limits -Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
EN 61000-6-3	EU	Electromagnetic compatibility (EMC). Generic standards. Emission standard for residential, commercial and light-industrial environments

Table 5.3 EMI standards reference

Declaration: The drive design follows the above standards and RK is able to provide the certification test reports from 3rd party.

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