

Installation Manual

Ver 1.00

FC Series Drives

Firmware ver: _____

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The manufacturer accepts no liability for any consequences resulting from inappropriate,
negligent or incorrect installation or adjustment of the
optional operating parameters of the equipment or from mismatching the variable speed drive with the motor.

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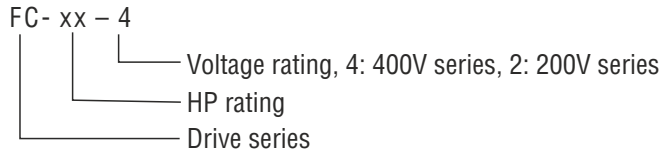
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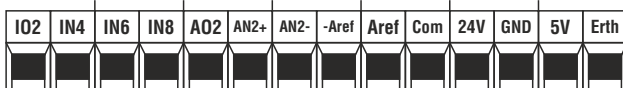
1 Quick Start

1.01 Model description:

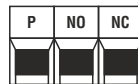


Kolorrol Energy Pvt Ltd.
 Model: FC104
 Sr no: _____
 Input 3ph
 Vn:380-480VAC,16A,48-63Hz
 Output 3ph
 0-Vn,16A,0-500Hz,7.5KW/10hp

1.02 Control Terminal Layout



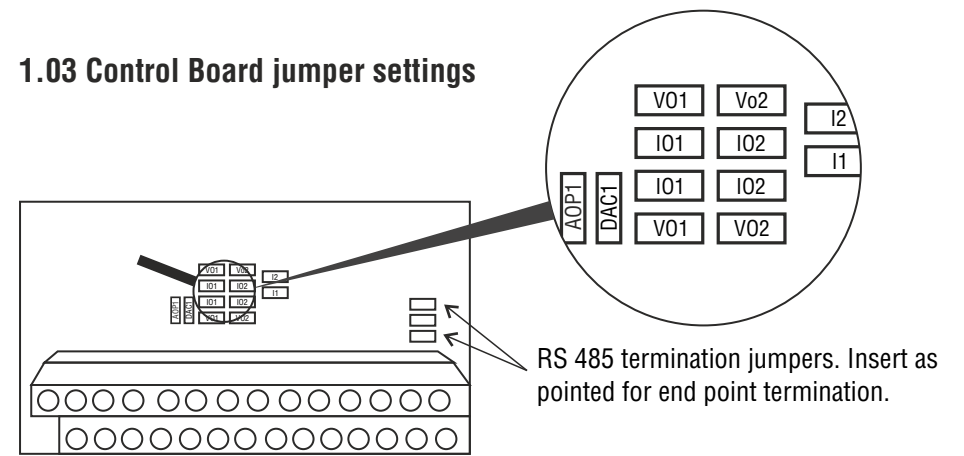
Max Torque : 0.4 Nm



Actuation voltage for digital inputs: 24V
 Minimum actuation voltage: 12V(not recommended)
 Max total output current: 200mA

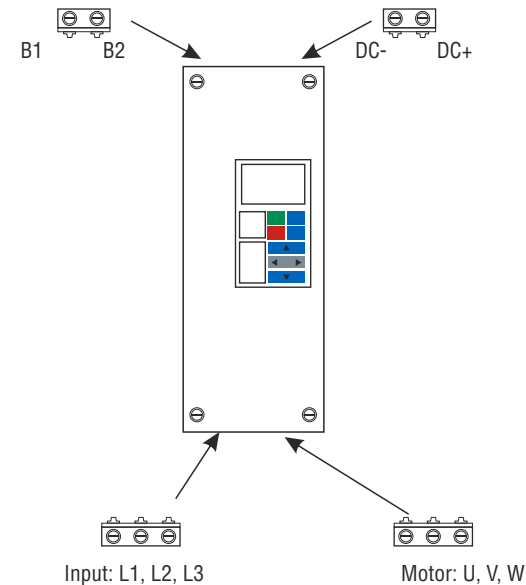
Digital Inputs:	IO1,IO2,IO3,IN4 to IN8	24V
Digital Outputs:	IO1,IO2,IO3	24V
Analog Inputs 12b: 0-10V/0-20mA	<ul style="list-style-type: none"> • AN1+ , AN1- differential or single ended, Rin:200k/500E • AN2+ , AN2- differential or single ended, Rin:200k/500E • AN3+ , AN3- single ended, -10V to 10V,Rin:200k 	
RS485 terminals:	RA, RB	
Analog outputs(0-10V) /0-20mA	AO1, AO2 with ref to GND, Rload < 500E for 0-20mA. (max continuous current: 30mA)	
Precision Analog output 12b 0-10V/0-20mA	VO1/IO1 (selectable with jumper setting)	
Frequency input	IN8 (maximum 32Khz)	24V pulses
Frequency output	IO1 (3Hz to 32Khz)	24V pulses
Relay contacts	P(Pole), NO(normally open), NC (normally closed) 230VAC, 2A	

1.03 Control Board jumper settings

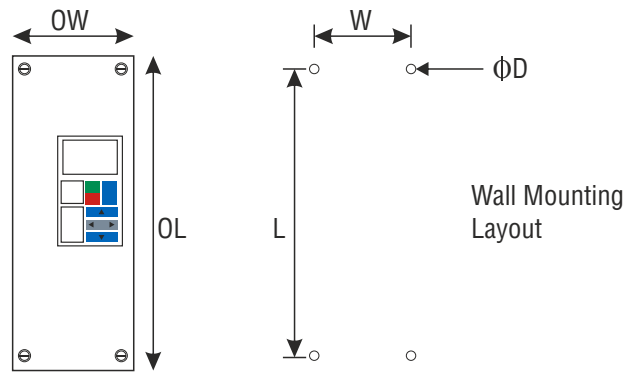


Signal selection	Insert Jumper at
Analog voltage output VO1	VO1(remove IO1 jumper)
Analog current output IO1	IO1(remove VO1 jumper)
Analog voltage output VO2	VO2(remove IO2 jumper)
Analog current output IO2	IO2(remove VO2 jumper)
12b precision DAC output at VO1/IO1	DAC1(remove jumper from AOP1)

1.04 Power Terminals



1.05 Mounting Details



Size	L(length) mm	W(width) mm	D(depth) mm	OL(over all length)mm	OW(over all width)mm	Dmm
1	tbd	tbd	tbd	tbd	tbd	tbd
2	286	94	200	315	125	6.5
3	tbd	tbd	tbd	tbd	tbd	tbd
4	tbd	tbd	tbd	tbd	tbd	tbd
5	tbd	tbd	tbd	tbd	tbd	tbd
6	tbd	tbd	tbd	tbd	tbd	tbd

*tbd : to be disclosed

1.06 Drive Ratings

All specifications below are for a switching frequency of 3Khz and 40°C ambient temperature.
Operating temperature: -10°C to 55°C.

Model	Normal duty			Heavy Duty		
	Kw	HP	Max output current	Kw	HP	Max output current
FC-01-4	0.75	1	2.1	0.75	1	2.1
FC-02-4	1.5	2	4.2	1.5	2	4.2
FC-03-4	2.2	3	5	1.5	2	4.2
FC-05-4	3	5	6.9	1.5	2	4.2
FC-05A-4	4	5	8.8	3	5	6.9
FC-07-4	5.5	7.5	11	4	5	7.5
FC-10-4	7.5	10	16	7.5	10	11
FC-10A-4	7.5	10	19	7.5	10	11
FC-15-4	11	15	22	7.5	10	16
FC-20-4	15	20	29	15	20	25
FC-25-4	18.5	25	35	15	20	25
FC-30-4	22	30	43	18.5	25	35
FC-40-4	30	40	55	22	30	46
FC-50-4	37	50	68	30	50	60
FC-60-4	45	60	83	37	60	75
FC-75-4	55	75	104	tbd	tbd	tbd
FC-100-4	75	100	138	tbd	tbd	tbd
FC-125-4	90	125	168	tbd	tbd	tbd
FC-150-4	110	150	205	tbd	tbd	tbd
FC-200-4	132	200	236	tbd	tbd	tbd

Light duty rating: 110% overload is allowed for 1min.

Heavy duty rating: 150% overload is allowed for 1min.

1.07 Cable and Fuse selection chart

Drive model	Rated input current(A)	IEC fuse gG rated current(A) 500V	UL fuse class T 600V	Cable size	
				mm2 EN60204	AWG UL508C
FC-01-4	3.2	6	6	0.75	16
FC-02-4	5.6	10	10	0.75	16
FC-03-4	6.8	10	10	1	16
FC-05-4	10	16	15	1.5	14
FC-07-4	12.6	20	20	2.5	14
FC-10-4	15.7	25	25	4	12
FC-14-4	20.2	25	25	4	10
FC-15-4	20.2	32	35	4	10
FC-20-4	26.6	40	35	6	8
FC-25-4	34.2	50	45	10	6
FC-30-4	40.2	50	50	16	6
FC-40-4	51.3	63	70	25	4
		IEC fuse gR			
FC-50-4	61.2	80	80	25	3
FC-60-4	76.3	100	100	35	2
FC-75-4	94.1	125	125	70	1
FC-100-4	126	200	200	95	2/0
FC-125-4	152	250	250	120	4/0
FC-150-4	224	315	350	2x70	2x2/0
FC-200-4	247	315	350	2x120	2x4/0

Note:

PVC insulated cables should be used.

Cables selection is as per IEC60364-5-52, cable installation method B2(multi core cable in conduit), ambient temperature 40°C with correction factor of 0.87.

B1 – separate cables in conduit

C- multicore cable in free air.

Cable sizes may be reduced depending upon ambient temperature and installation conditions.

Refer to local wiring regulations for correct sizes of cables.

A fuse or other protection should be used between all live connections to the ac supply.

A MCB or MCCB of appropriate ratings can also used in place of the fuse.

Maximum Cable Length at 3Khz switching frequency:

For FC01xx to FC40xx = 150m(490ft)

For FC50xx to FC200xx = 250m(820ft)

1.08 Dimensions and weight

Drive size	Drive model nos	H (mm)	W (mm)	D (mm)	Weight (kg)
1	FC-01-4 FC-02-4 FC-03-4 FC-05-4	tbd	tbd	tbd	tbd
2	FC-07-4 FC-10-4 FC-10A-4	315	125	200	6kg
3	FC-15-4 FC-20-4 FC-25-4	tbd	tbd	tbd	tbd
4	FC-30-4 FC-40-4	tbd	tbd	tbd	tbd
5	FC-50-4 FC-60-4 FC-75-4	tbd	tbd	tbd	tbd
6	FC-100-4 FC-125-4	tbd	tbd	tbd	tbd
7	FC-150-4 FC-200-4	tbd	tbd	tbd	tbd

1.09 Input line Choke Selection

Model number	Value	Rated current(A)
FC-01-4	7mH	2.5
FC-02-4	4mH	4.5
FC-03-4	3mH	5.5
FC-05-4	1.7mH	10
FC-07-4	1.3mH	12
FC-10-4	1mH	17
FC-10A-4	0.7mH	23
FC-15-4	0.7mH	23

Drives of rating higher than FC-15-4 have built in dc chokes or line chokes.
For further reference and choke calculation ref to section 3.06

1.10 Braking resistor values

Model no	Min Brake resistor in ohms (symbol)	Instantaneous Braking power (kw)	Average power for 60s (kw)	Recommended resistor value for 10% duty cycle
FC-01-4	tbd	tbd	tbd	tbd
FC-02-4	100E	6.5	3	100E,120W
FC-03-4		6.5	3	100E,120W
FC-05-4	51E	12.5	4.4	51E,250W
FC-07-4		12.5	7	51E,250W
FC-10-4	33E	19.3	9.1	33E,350W
FC-10A-4		19.3	9.1	33E,350W
FC-15-4	25E	25.6	13.1	25E,500W
FC-20-4	18E	35.5	19.3	18E,650W
FC-25-4			22.5	18E,650W
FC-30-4	10E	64	27.8	10E,1200W
FC-40-4		64	33	10E,1200W

For models above FC40-xx, Brake chopper is optional.

2. Mechanical Installation

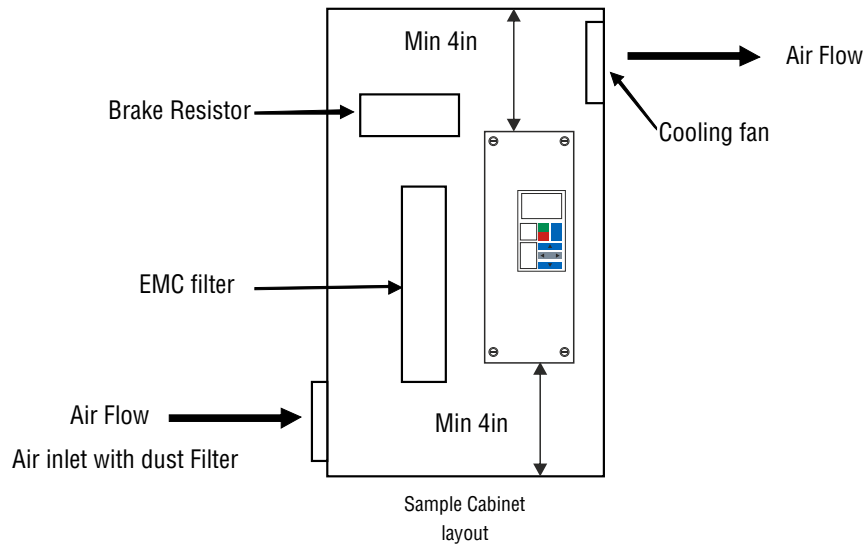
This chapter describes mechanical installation of a drive inside a cabinet or for standalone application.

2.01 Planning the installation

Drives are suitable for indoor use in a Pollution degree 2 environment. This means that non conductive pollution environment is suitable for normal operation.

Important considerations:

- In areas with heavy dust, suspended particles it is recommended to select a gasketed cabinet with dust filters.
- Cabinet should be sufficiently rigid to support the drive.
- Sufficient clearance should be provided above and below the drive for proper air circulation and wiring access.
- If the assembled cabinet is to be transported appropriate anti vibration measures should be used to prevent excessive vibration and shock during transportation. This can be done by placing anti vibration pads at the cabinet bottom surface.



- Cabinets should be placed in areas where there are no splashing or dripping liquids.
- Cabinets should have provision for forced cooling to remove hot air from the top and take in cold air from the bottom. Gratings should be provided at the air inlet and outlet to guide the air flow.

2.02 Opening the drive package



Contents of the package:

1. Drive unit
2. Optional IP56 grommet kit.
3. User manual
4. CD with detailed user manual
5. Optional units as ordered.
For eg: remote on/off unit, extra cables etc.

2.03 Installing the drive

The drive can be installed either in a cabinet or can be wall mounted.

Mounting dimensions



The drive should never be placed horizontally or mounted on table top as this could cause over heating.



The drive should be installed indoors.

Note: All drives are intended for use without further enclosure and comply with table- 11, clause 4.3.7.3 of IEC61800-5-1:2007.

2.04 Removing the top cover for wiring

The top cover of the drive should be removed as shown for input, output and control wiring.



! Before removing the top cover drive should be isolated from the mains supply. After disconnecting mains supply drive capacitors hold charge for about 10mins. Drive should be accessed only after this period.

2.05 Cabinet temperature rise considerations

Approximately 2% losses can be considered for power dissipation inside an enclosure. These values are for Tamb = 40°C and switching frequency = 3Khz

$$\text{Surface area of the enclosure } A_{\text{encl}} = \frac{\text{Power dissipation inside enclosure}}{K \times (T_{\text{internal}} - T_{\text{amb}})}$$

T_{internal} = Maximum permissible temperature inside the cabinet (suggested 50°C or 10°C greater than Tamb)

K = Heat transmission coefficient of enclosure material in $W/m^2/^\circ C$.
= 5.5 $W/m^2/^\circ C$ for painted sheet steel

T_{amb} = Ambient temperature

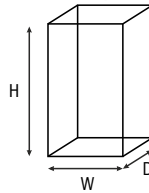
A_{encl} = surface area of enclosure

Eg: Consider a case of 2 nos 10hp drives in an enclosure.

Now total power dissipation = 2% x 7500W = 150W. Add dissipation of any other components inside the enclosure.

Taking $T_{\text{amb}} = 40^\circ C$ and $T_{\text{internal}} = 50^\circ C$

$$\text{Now, } A_{\text{encl}} = 150/5.5 \times (50 - 40) = 2.72m^2$$



$$A_{\text{encl}} = W(H+D) + 2HD$$

2.06 Calculating Air flow requirement in an enclosure

$$\text{Air flow CFM} = 3.16 \times P / (T_{\text{internal}} - T_{\text{amb}})$$

Consider the same example of 2 x 10hp drives in an enclosure.

Total power dissipation = 150W

$$\text{Required air flow CFM} = 3.16 \times 150 / (50 - 40) = 47.4$$

2.07 Gaskets for enclosures

Adhesive tape gaskets can be used for drive enclosures to prevent moisture and dust ingress. Neoprene closed cell adhesive tape can be used for this purpose.

3 Electrical installation

This chapter describes procedures for electrical installation of the drive unit.

- !** Risk of lethal electric shock at input(L1,L2,L3), output(U,V,W), dc brake(B1,B2), dc bus(+,-) terminals
- !** After disconnecting mains supply drive capacitors hold charge for about 10mins. Drive terminals should be accessed only after this period.
- !** Drive should be disconnected from the mains supply before accessing terminals for wiring.

3.01 Motor selection

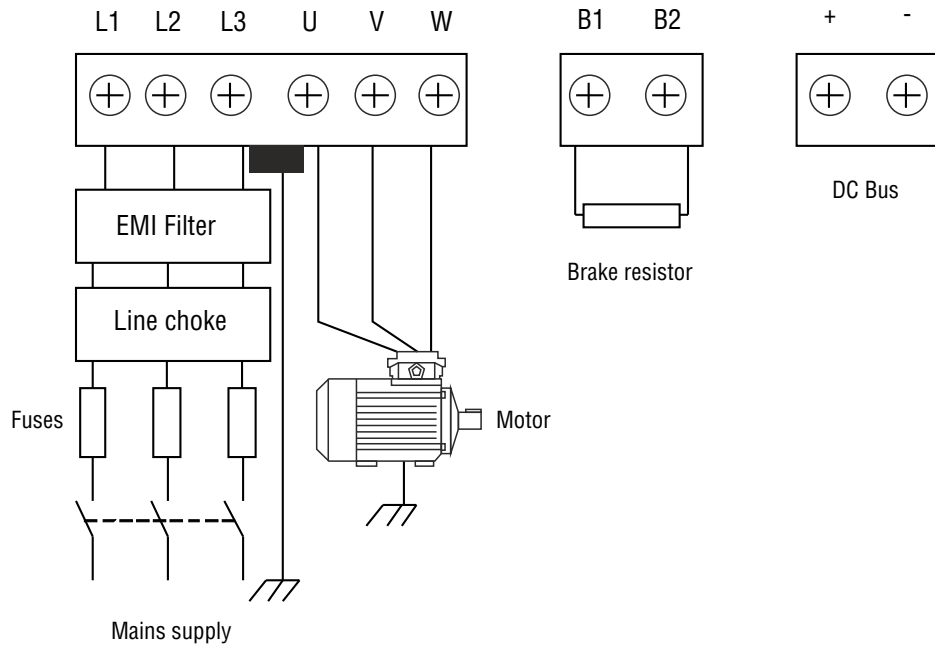
If multiple motors are connected to a single drive they will all run with the same speed reference. Also, the sum of the kw rating of each motor should be less than the drive kw rating. Depending upon the number of motors used the reduction in total rating could be more.

Motor selection table for reference purposes. 1500rpm, 4 pole, TEFC, 50Hz, 415V
Note: Exact ratings of the installed motor should be referred to.

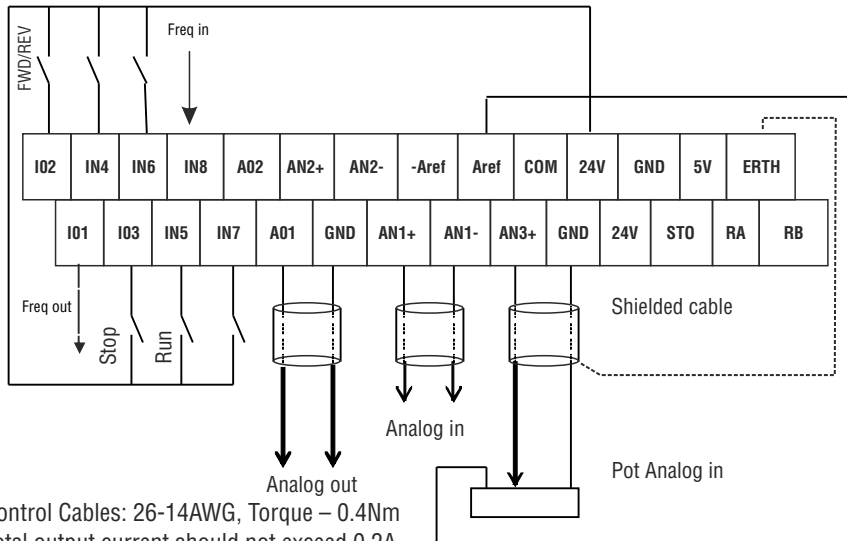
HP	KW	Current (A)
1	0.75	1.75
2	1.5	3.25
3	2.2	4.55
5	3.7	7.3
7.5	5.5	10.4
10	7.5	14.5
15	11	20.5
20	15	27.6
25	18.5	33.2
30	22	39
40	30	51.5
50	37	64
60	45	76.5
75	55	94
100	75	124
120	90	149
150	110	180
200	150	248
240	180	300

Motor selection table

3.02 Power connections



3.03 Control terminal connections

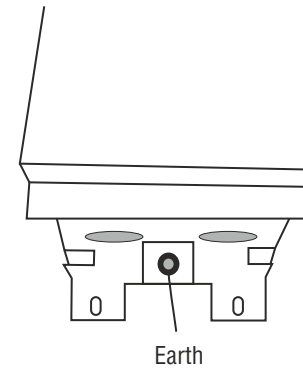


Control Cables: 26-14AWG, Torque – 0.4Nm
Total output current should not exceed 0.2A

3.04 Earthing

As per IEC61800-5-1 following earthing systems are possible:

1. TN
2. TT
3. IT



Operation with IT(ungrounded)supplies

! Using internal or external EMI filters with ungrounded supplies, could overstress filter or drive could fail to trip in the event of an earth fault. As a default factory setting, drives are shipped with internal RF capacitor earth link removed.

! Touch current through protective conductor exceeds 10mA DC or 3.5mA AC if internal RF capacitors are connected to protective earth.

3.05 AC supply voltage

FC-xx-4 series 380V to 480V ± 10%,
50hz or 60Hz ±2% (as per IEC61800-3, 2nd environment),
3 phase

Maximum voltage unbalance producing a negative sequence component of 3% is allowable. (as per IEC61800-3, 2nd environment)

All drive series are suitable for Overvoltage category III or lower(as defined in IEC61800-5-1).

3.06 Input Line reactors

Input line reactors protect the drive from damage in case of power line disturbances and imbalances. Input line reactors of approximately 2% impedance are preferable for input protection.

Supply line disturbances are caused by:

1. Large motors operating on DOL starters
2. Power factor correction equipment

These disturbances can cause excessive input current to flow in the drive and also cause nuisance tripping. Each drive should have its own input line reactor.

Input line reactor ratings:

Rated continuous current of the reactor should not be less than the input current rating of the drive.

For a 2% impedance reactor, the inductance value can be calculated as follows:

$$L = \frac{2}{100} \times \frac{V}{\sqrt{3}} \times \frac{1}{2\pi f I}$$

Where V = Input voltage across phases

f = Input line frequency

I = Rated drive input current

Ref to table 1.09 for input line choke selection

Models FC-20-4 (20hp)onwards have internal DC chokes.

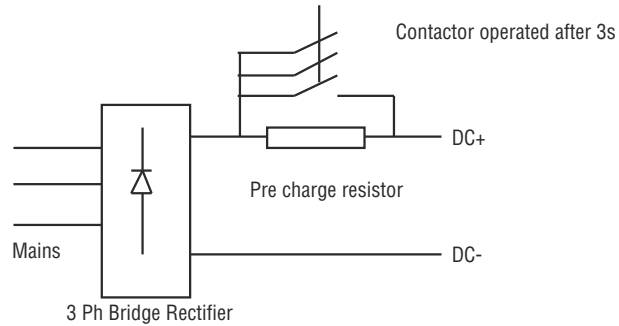
Models FC-125-4(125hp) onwards have internal AC chokes

3.07 Common DC Bus

DC bus of multiple drives can be paralleled if operating from a single dc supply. This can be done in case of a common regenerative dc supply or to avoid dc bus over voltage if one of the drives is regenerating and the other is in the Motoring mode.



Soft start action is required to power up multiple drives on a common dc bus. This can be accomplished by a three phase bridge rectifier arrangement or a line controlled converter.



Pre charge resistor should be selected properly. Peak charging current depends on the number of drives in parallel and their KW ratings. Consult factory for pre charge resistor selection.

3.08 Derating

Drive output ratings have to be derated with temperature, switching frequency and altitude. All continuous ratings are at 40°C ambient, 3khz switching frequency and 1000m altitude. Ambient temperature derating of 1% is applied for every 1°C rise in ambient temperature above 40°C. Eg: At 55°C ambient, drive output rating is reduced to 85% of rated value.

Altitude derating

Altitude range : 0 to 3000m above sea level

Above 1000m (above sea level) reduce maximum output current by 1% per 100m.

For example at 2000m(above sea level) the maximum drive output current reduces by 10%.

3.09 Braking

Dynamic braking is required to stop or decelerate the drive in case of loads with high inertia. Without dynamic brake , these loads could cause over voltage tripping.

Use of dynamic brake can be avoided if more than one drives are connected to a common dc bus. In this way regenerated energy is fed back to the drives in motoring mode. See section 1.10 for recommended braking resistor values.



Braking resistor values below min permissible values of table 1.10 should never be used. This could cause permanent damage to the drive.

Braking resistor values in table 1.10 are for a braking duty cycle of 1/100. For higher braking duty cycles , braking resistor wattage has to be increased.

Metal clad braking resistors in aluminum housing can be used as braking resistors.

Recommended braking resistors: Enapros, www.resistorsonline.com



Braking resistors might be required to be mounted on a fan cooled heatsink if power dissipation is higher.

3.10 Electromagnetic compatibility EMC as per IEC61800-3:2011

Compliance to the following standards as per IEC61800-3:2011 has been met.

Phenomena	Standard	Test level	Type of environment
Harmonics THD	IEC 61000-2-4	12%	2nd
All other harmonic orders As per table 24	IEC 61000-4-13 class 3	As per table 24	2nd
Commutation notches	IEC 60146-1-1 Class B	Depth = 40 %, total area = 250 in % degrees	2nd
Voltage deviations (> 60 s)	IEC 61000-2-4 Class 2	± 10 %	2nd
Voltage dips	IEC 61000-4-11 Class 3 or IEC 61000-4-34 Class 3	As per Table 5	2nd
Short interruptions	IEC 61000-4-11 Class 3 or IEC 61000-4-34 Class 3	Volts remaining 0%, Cycles 250/300	2nd
ESD	IEC 61000-4-2	4 kV CD or 8 kV AD	2nd
Radio frequency electromagnetic field (AM)	IEC 61000-4-3	As per table 12 IEC61800-3	2nd
Fast Transient Burst	IEC 61000-4-4	2 kV/5 kHz(power ports) 1 kV/5 kHz Capacitive clamp (signal interface)	2nd
Surge 1,2/50 s, 8/20 s	IEC 61000-4-5	1 kV line to line 2 kV line to earth	2nd
Conducted radio frequency common mode	IEC 61000-4-6	0,15 MHz to 80 Mhz 10 V 80 % AM (1 kHz) – Power Ports 0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz) – Signal interface	2nd

Emission

The drive has a basic filter for emission control.

Additional filters are required to meet the emission requirements of IEC61800-3

Suitable EMC filters can be selected from Schaffner. www.schaffner.com

As per IEC61800-3 following classifications of PDS(power drive system) are defined:

First environment

Environment that includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes.

Second environment

Environment that includes all establishments other than those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

PDS of category C1

PDS of rated voltage less than 1 000 V, intended for use in the first environment.

PDS of category C2

PDS of rated voltage less than 1 000 V, which is neither a plug in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional.

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

PDS of category C3

PDS of rated voltage less than 1 000 V, intended for use in the second environment and not intended for use in the first environment.

PDS of category C4

PDS of rated voltage equal to or above 1 000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

Category C2 and C3 compliance can be ensured by:

1. Electrical installation as per guideline in section 3.02.
2. Motor cable is restricted to 100m.
3. Installing external EMC filter.

3.11 Option boards

Following option boards are available:

1. Encoder board: For interfacing with incremental encoders.
2. Extended I/O board: 6 digital inputs, 3 relay outputs, 2 analog inputs and 2 analog outputs
3. Custom 2nd processor board.
4. EtherCAT board
5. Modbus TCP

Safety

4.1 Warning, Caution and Notes



A warning contains information necessary to avoid a safety hazard.

4.2 Electrical safety – general warning

The voltages used in the drive can cause severe electrical shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the drive.

Specific warnings are given at the relevant places in this User Guide

4.3 System design and Safety

The drive is intended to be used as a component in a system or equipment. Professional knowledge of electrical systems and the drive is essential for proper installation. If installed incorrectly there may be a safety hazard.

High voltages and currents, stored electrical charge are present in the drive.

Electrical installation and system design should be done carefully to avoid safety hazards during operation or malfunction.

Stop command on the drive does not isolate dangerous voltages from the output of the drive.

Drive parameters must be set considering all the safety aspects of the application.

For eg: In torque mode, there is a risk of high speeds in case of very low load torque as compared to the reference torque. Over speed threshold should be properly setup to ensure safety.

Important system design considerations:

1. Ensure proper cable sizes(or ratings)
2. Ensure proper tightening of all electrical connections
3. Drive rating should be compatible with the motor being used.
4. Drive rated current should be properly set.

4.4 Access

Drive access must be restricted to authorized personnel only.

4.5 Compliance with regulations

The system installer is responsible for ensuring compliance to various PDS(power drive system) standards.

Applicable PDS standards:

- | | |
|--------------|---|
| IEC61800-5-1 | Adjustable speed electrical power drive systems – Safety requirements –Electrical, thermal and energy |
| IEC61800-3 | Adjustable speed electrical power drive systems – EMC requirements and specific test methods |

Within the European Union, all machinery in which this product is used must comply with the following directives:

2006/42/EC: Safety of machinery.

2004/108/EC: Electromagnetic Compatibility

The user manual has guidelines for compliance to these standards.