POWER LINE FILTERS

FOR AC, DC & SERVO MOTOR DRIVES

CE

EFFICIENT EMC SOLUTIONS

Rasmi Electronics Ltd.

Rasmi Electronics Ltd. has been established since 1974, designing and manufacturing a wide range of RFI filters, chokes and power transformers.
The company is based in Stanley and operates from its two purpose designed 30,000 sq ft factories with its skilled workforce, now totalling over 150.
Rasmi offers its customers quality products, competitive pricing and a complete design/manufacturing service.
By working closely with customers and competent body test authorities, Rasmi can be sure that its products perform effectively, efficiently and meet all the application needs imposed on them.

POWER LINE FILTERS FOR MOTOR DRIVES

AC, DC and servo motor and are now established as the most flexible means of controlling motors in virtually all mechanical equipment. However, they are a significant source of RF interference.

Recent European legislation on EMC imposes limits on RF emissions from such equipment. The DLC range of power line filters has been specifically developed for use with these drives, enabling systems incorporating them to meet the European RFI emissions standards for domestic or industrial use.
The example emission graphs in this brochure represent actual results measured by a competent body on drive equipment using Rasmi filters. These results ensured that Rasmi's customer gained the EMC certificate and was therefore able to CE mark the products.

The range comprises three types of filter in various sizes up to 990A current capacity. Although these filters are intended for use with motor drives, their high performance makes them effective in suppressing high RF emissions in virtually any installation.

- RF 1xxx DLC Series - single phase power line filters
- RF 3xxx DLC Series - three phase power line filters
- RF 4xxx DLC Series - three phase plus neutral power line filters

All filters are constructed with approved components:- self healing X and Y capacitors approved to VDE, SEMKO, NEMKO and UL are used and all assemblies are encapsulated in stainless steel cases with resin approved to UL 94-V0 flammability class. Input and output connections are made by shrouded terminals up to 170A bolt stud type terminals from 170A to 480A and tag type connections above 480A.

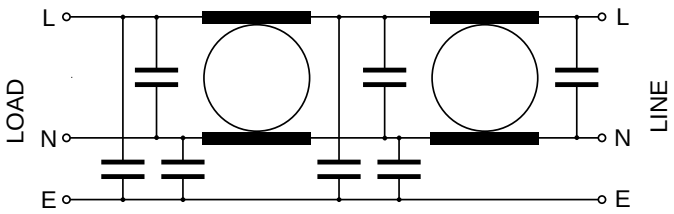
A range of output chokes is also available, to complement the power line filters and improve EMC performance, especially radiated emissions, where long motor cables are used.

APPLICABLE EMC STANDARDS

Generic Standard covered	Referenced or comparable basic/product standard	Aspects
EN50081-1	EN55022 class B EN55011 group1 class B EN55014 (conducted emission only) IEC555-2 (household apparatus only)	conducted & radiated emission power harmonics
EN50081-2	EN55022 class A EN55011 group 1 class A	conducted and radiated emission
EN50082-1	IEC801-2 IEC801-3 IEC801-4	electrostatic discharge immunity RF field immunity fast transient burst immunity
EN50082-2	ENV50140 (similar to IEC801-3) ENV50204 EN61000-4-8 EN61000-4-2 (similar to IEC801-2) ENV50141 (similar to IEC801-6) EN61000-4-4 (similar to IEC801-4)	RF field immunity RF field immunity (pulse modulation) 50Hz field immunity electrostatic field immunity conducted RF immunity fast transient burst immunity

RF 1xxx - DLC SINGLE PHASE FILTERS

Circuit Schematic

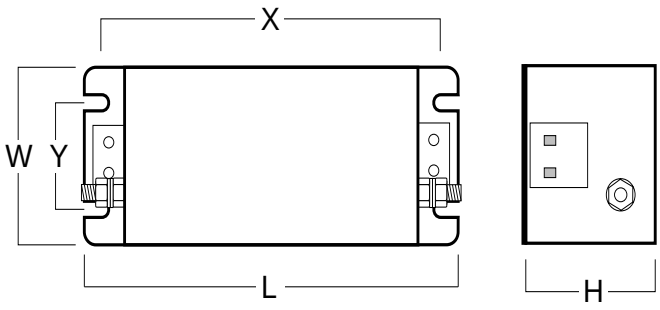


Rated Voltage: Line - Neutral 250V, 50-60Hz @ 40ºC

Part Number	Drive Input (A)	Drive output (kW)	Terminal Type	Max Cable (mm^2)	Leakage Current (mA)	Power Loss (W)	Case Style	Weight (kg)
RF 1010-DLC	10	0.75	Shrouded	6	3.2	3.8	A	0.4
RF 1015-DLC	15	1.5	Shrouded	6	3.2	6.5	A	0.5
RF 1020-DLC	20	2.2	Shrouded	10	3.2	10	B	0.9
RF 1035-DLC	35	3.7	Shrouded	10	3.2	15	B	1.0

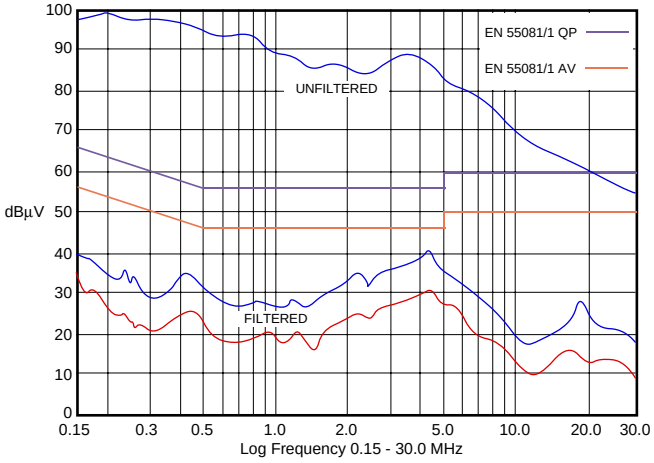
Case Dimensions (mm)

Case Style	L	W	H	X	Y	Mount
A	150	55	45	140	36	M4
B	170	80	55	160	46	M5

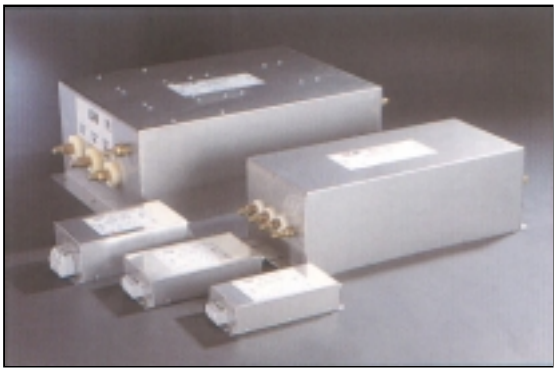


Performance

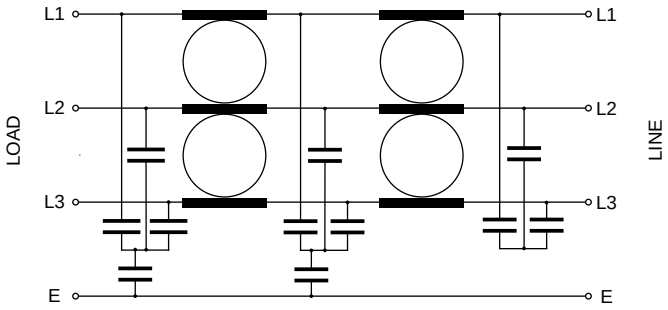
The graph opposite shows typical improvements in conducted emissions achieved from the fitting of an RF 1035-DLC filter to a 3.7kW, single phase AC Inverter running a 3.7kW motor with 25m screened motor cable.



RF 3xxx - DLC THREE PHASE FILTERS



Circuit Schematic

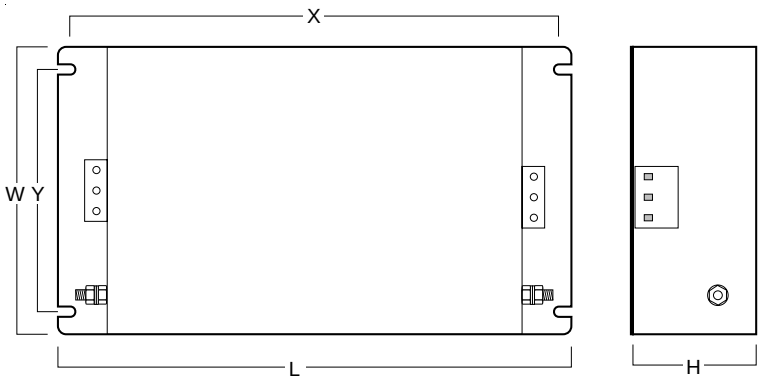


Rated Voltage: Line - Line 440 - 520V, 50-60Hz @ 40°C

Part Number	Drive Output (A)	Drive Input (kW)	Terminal Type	Max Cable (mm^2)	Leakage Current nom (mA)	Leakage Current max (mA)	Power Loss (W)	Case Style	Weight (kg)
RF 3006-DLC	6	1.5	Shrouded	6	0.5	27	8	C	1.5
RF 3012-DLC	12	3.7	Shrouded	6	0.5	27	10	C	1.5
RF 3020-DLC	20	5.5	Shrouded	10	0.5	27	15	D	1.7
RF 3040-DLC	40	11	Shrouded	10	0.5	27	30	D	1.8
RF 3060-DLC	60	18.5	Shrouded	16	0.5	27	51	E	3.2
RF 3070-DLC	70	22	Shrouded	25	0.5	27	44	F	4.9
RF 3100-DLC	100	30	Shrouded	35	0.75	130	69	G	6.8
RF 3120-DLC	120	37	Shrouded	35	0.75	130	45	G	6.8
RF 3170-DLC	170	55	Shrouded	95	0.75	130	80	H	9.2
RF 3230-DLC	230	75	Stud	M12	1.3	150	50	J	14
RF 3280-DLC	280	90	Stud	M12	1.3	150	60	J	15
RF 3400-DLC	400	132	Stud	M16	1.3	150	80	J	27
RF 3480-DLC	480	160	Stud	M16	1.3	150	90	J	27
RF 3660-DLC	660	230	Tag	M16	1.3	150	130	N	45
RF 3880-DLC	880	315	Tag	M16	1.3	150	210	N	45
RF 3990-DLC	1000	330	Tag	M16	1.3	150	300	N	45

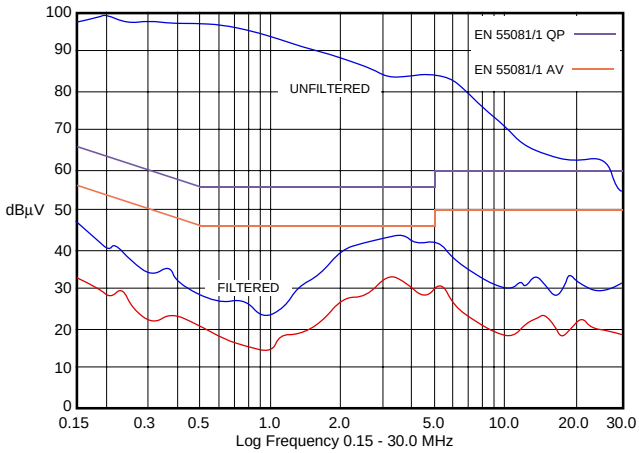
Case Dimensions (mm)

Case Style	L	W	H	X	Y	Mount
C	250	110	60	238	76	M6
D	270	140	60	258	106	M6
E	270	140	90	258	106	M6
F	365	180	90	338	146	M6
G	435	200	130	408	166	M6
H	495	200	160	468	166	M6
J	587	250	205	560	170	M6
N	688	364	180	640	300	M8

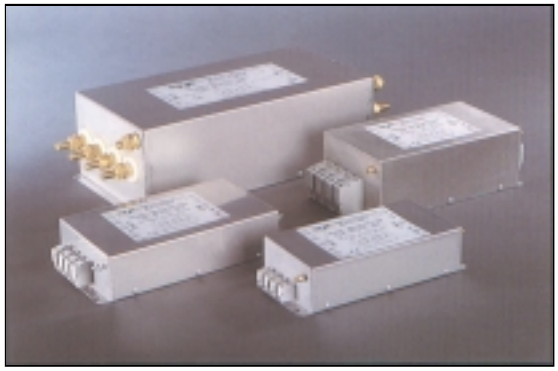


Performance

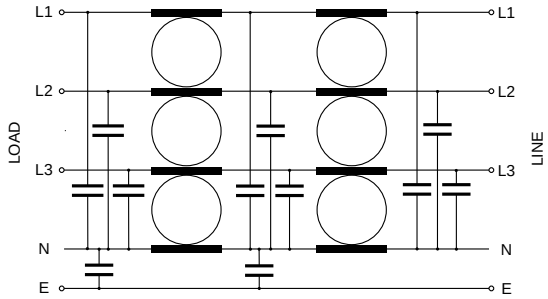
The graph opposite shows typical improvements in conducted emissions achieved from the fitting of an RF 3040-DLC filter to a 11kW, three phase AC Inverter running an 11kW motor with 25m screened motor cable.



RF 4xxx - DLC THREE PHASE + NEUTRAL FILTERS



Circuit Schematic

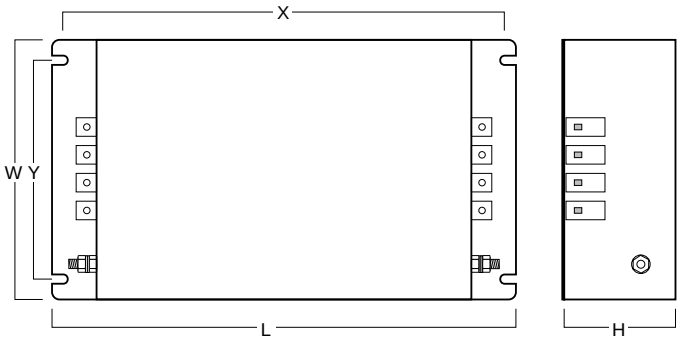


Rated Voltage: Line - Line 440 - 520V, 50-60Hz @ 40°C

Part Number	Drive Output (A)	Drive Input (kW)	Terminal Type	Max Cable (mm^2)	Leakage Current nom (mA)	Leakage Current max (mA)	Power Loss (W)	Case Style	Weight (kg)
RF 4006-DLC	6	1.5	Shrouded	6	0.1	27	8	C	1.7
RF 4012-DLC	12	3.7	Shrouded	6	0.1	27	10	D	1.9
RF 4020-DLC	20	5.5	Shrouded	6	0.1	27	13	D	1.9
RF 4040-DLC	40	11	Shrouded	10	0.1	27	28	E	2.6
RF 4060-DLC	60	18.5	Shrouded	16	0.1	27	47	F	5.1
RF 4070-DLC	70	22	Shrouded	25	0.1	27	44	F	5.1
RF 4100-DLC	100	30	Shrouded	35	0.5	130	53	G	6.8
RF 4120-DLC	120	37	Shrouded	35	0.5	130	55	G	6.8
RF 4170-DLC	170	55	Shrouded	95	0.5	130	71	H	10
RF 4230-DLC	230	75	Stud	M12	0.5	160	50	J	15
RF 4280-DLC	280	90	Stud	M12	0.5	160	60	J	16
RF 4400-DLC	400	132	Stud	M16	0.5	160	80	J	27
RF 4480-DLC	480	160	Stud	M16	0.5	160	90	J	27

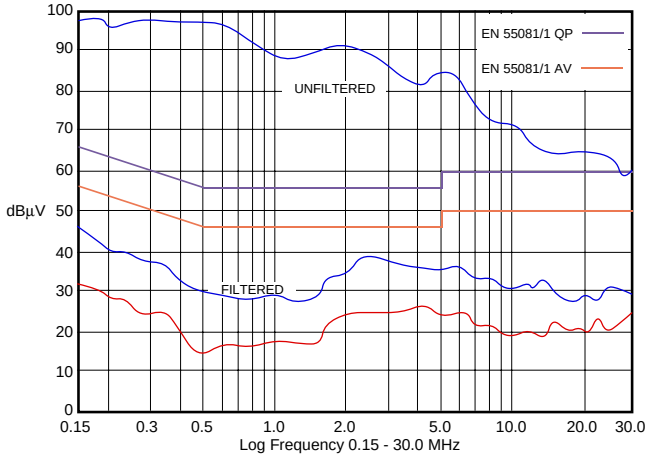
Case Dimensions (mm)

Case Style	L	W	H	X	Y	Mount
C	250	110	60	238	76	M6
D	270	140	60	258	106	M6
E	270	140	90	258	106	M6
F	365	180	90	338	146	M6
G	435	200	130	408	166	M6
H	495	200	160	468	166	M6
J	587	250	205	560	170	M6

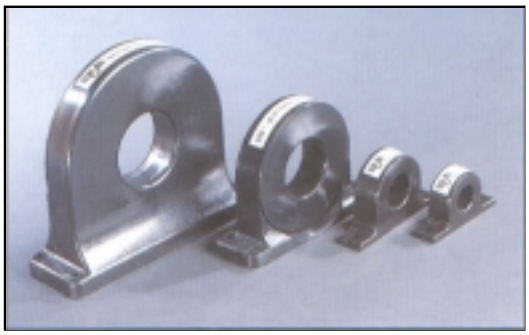


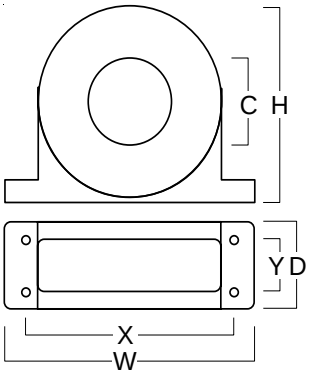
Performance

The graph opposite shows typical improvements in conducted emissions achieved from the fitting of an RF 4020-DLC filter to a 4kW three phase AC Inverter running a 4kW motor with 25m screened motor cable.



OC/x - OUTPUT CHOKES





Dimensions in mm

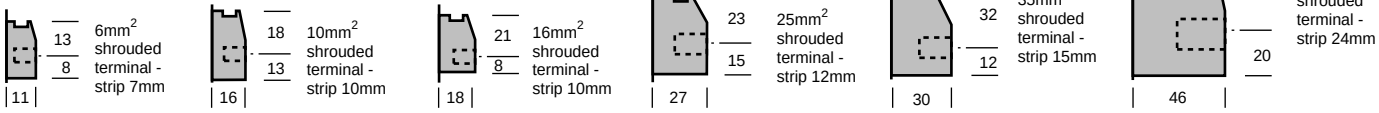
Output Choke	Approx Motor kW	Centre Hole C	Width W	Height H	Depth D	Mounting Dims X,Y	Mounting Holes Dia
OC/1	2.2	21	85	46	22	70 -	5
OC/2	15	28.5	105	62	25	90 -	5
OC/3	45	50	150	110	50	125 x 30	5
OC/4	>45	58	200	170	65	180 x 45	6

The OC/x output chokes can be used in conjunction with the filters to improve EMC performance. They are especially effective where radiated emissions from long drive to motor cables are a problem e.g. corruption of near by control or data cable signals or radio / television interference. The correct fitting of an OC/x into the motor cable can eliminate these problems.

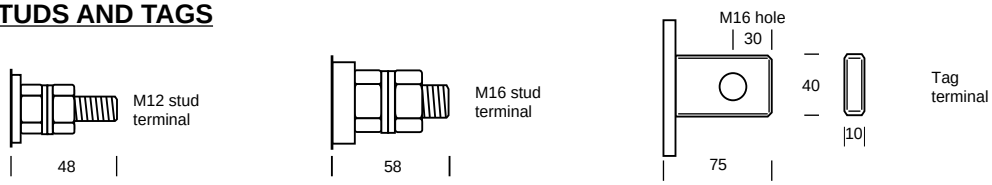
The table above gives approximate motor kW ratings for the OC/x chokes but the selection is ultimately governed by the type and thickness of motor cable fitted i.e. the motor cable must fit through the OC centre hole.

TERMINAL TYPES

SHROUDED TERMINALS

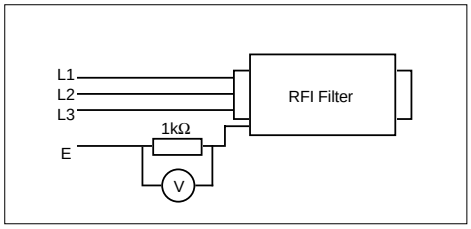


STUDS AND TAGS



EARTH LEAKAGE MEASUREMENTS

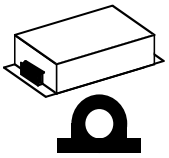
The earth leakage currents mentioned in the tables are particularly relevant when using earth leakage circuit breakers.
The currents mentioned are actual measured values by method of voltage drop across a resistor.
Under normal conditions, with the three phases balanced, earth leakage currents are extremely small - the *max* values stated are worst possible values such as would occur momentarily during switch on or failure of one or two phases.



INSTALLATION RECOMMENDATIONS

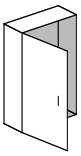
While these filters and chokes are particularly effective at suppressing RF emissions, to achieve maximum performance, it is essential that they are fitted in accordance with the following recommendations. These recommendations and the diagram overleaf should give all the information needed at the installation stage to prevent problems before they occur and ensure compliance to the relevant emission standards.

FILTERS AND OUTPUT CHOKES



The input filter should be mounted close to the drive with the filter to drive cable being as short as possible, this reduces the length of "noisy" unfiltered cable inside the cabinet.
Where long motor output cables are used an output choke may be required to reduce radiated emissions from the cable. This choke should be fitted close to the exit point of the motor cable from the drive, the three phase conductors *only* should pass through the choke, *not* the earth conductor or screen. Where possible it is preferable to wind the phase conductors through the output choke more than once as shown below.

WIRING CABINETS



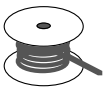
In general, all installations including motor drives will be inside a wiring cabinet - the use of a good wiring cabinet during installation will prevent radiated RF emissions from components and unscreened cabling inside. The cabinet should have a closely fitting door, preferably earthed top and bottom to the main body of the cabinet.
Usually the cabinet need not be any special or screened type, except in unusual situations where meeting domestic radiated emission levels proves difficult. The backplate should be securely earthed to the main cabinet body by removing paint from the mounting points.

EARTHING

Of all factors affecting EMC performance, earthing arrangements are certainly the most important. The point here is to clearly define the paths through which high frequency earth currents flow, and thereby minimise their harmful effect on other nearby, sensitive devices.
Paint should be removed from cabinet backplates at the mounting points of metal cased equipment All earthing leads, including filter earth, inverter earth and screened cable earths, should be made as short as possible and securely fastened to the bonded backplate earth post - poor connections and loops of cable will act as antennas and can radiate or pick up stray radiated emissions.
Screened control cables entering the enclosure, however, should be earthed *only* at the remote end - this helps to prevents high frequency earth currents from corrupting control signals.

CABLES

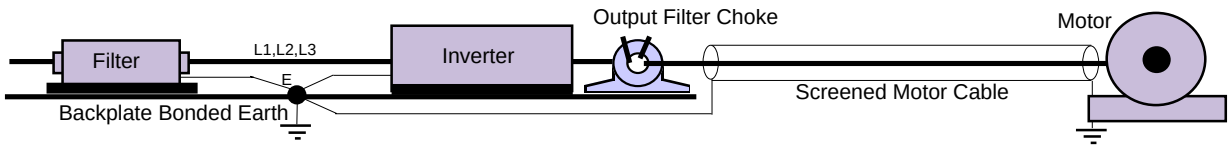
The motor output cable *must* be of a screened type with the screen and earth core bonded to the motor at one end and to the wiring cabinet backplate earth at the other.



Separation of input power cables from motor output is most important - these cables should never be run in the same trunking or conduit or come into close proximity - doing so can cause the motor output cable to "infect" the power input with RF interference and therefore defeat the purpose of the input filter.
It is advisable to separate control cables from the motor cables for the same reasons. In general, cable runs should be kept as short and direct as possible.

ADDITIONAL CHOKES

Occasionally EMC problems will occur within an installation when components in the same wiring enclosure affect one another, for example, open control boards may corrupt low level sensor signals. Usually in these cases the fitting of additional OC/x chokes into the control and sensor cables will cure the problem - a small amount of experimentation may be required to determine the optimum configuration of these additional chokes.



TYPICAL INSTALLATION SHOWING USE OF AN AC INVERTER AND FILTERING WITH SUITABLE CABLE LAYOUT AND SEPARATION

BACKPLATE HAS PAINT CLEANED WHERE METAL CASED COMPONENTS ARE MOUNTED E.G. INVERTER AND FILTER

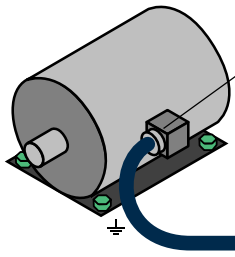
CONTROL CABLES AND CIRCUITRY WELL POSITIONED AND SEPARATED OF FROM POWER CABLES

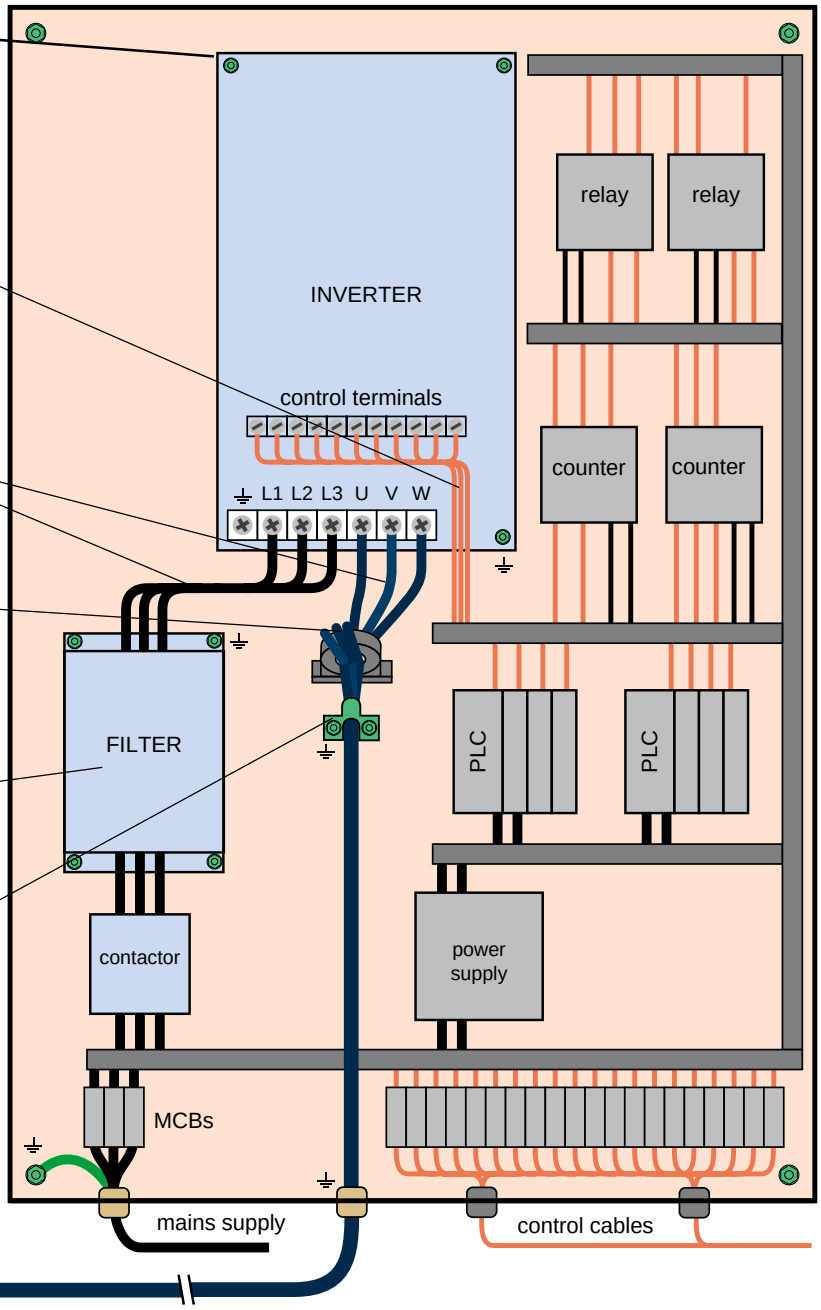
SHORT LENGTHS OF CABLE FROM FILTER TO INVERTER AND FROM INVERTER TO OUTPUT CHOKE

OUTPUT CHOKE HAS ONLY PHASE CONDUCTORS PASSING THROUGH, NOT EARTH CORE OR SCREEN

FILTER POSITION IS RELATIVELY CLOSE TO SUPPLY ENTRY POINT AND HAS MINIMUM CABLE LENGTH BACK TO ENTRY POINT

MOTOR CABLE SCREEN EARTHED BY COPPER SADDLE CLOSE TO OUTPUT CHOKE AND TO MOTOR BODY





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