ABB drives

Hardware manual

du/dt filters
AOCH0260-70
AOCH0400-70
NOCH0016-6x
NOCH0030-6x
NOCH0070-6x
NOCH0120-6x
NOCH0260-60
NOCH0400-60
NOCH0760-60

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About this manual

What this chapter contains

The chapter describes the target audience and safety in short.

Target audience

The manual is intended for people who select, plan the installation, install, commission and use the du/dt filter. Read the manual before working on the filter. The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

The manual is written for readers worldwide. Both SI and imperial units are shown.

Safety

Only qualified specialists are allowed to install, commission and maintain the du/dt filter.

The complete safety instructions for the drive are given in the drive hardware manual. Read and follow the complete safety instructions before working on the drive.

The following instructions are intended for all who install and service the du/dt filter. Ignoring the following instructions can cause physical injury or death, or damage to the equipment.



WARNING!

- The filter is heavy. Lift the filter by the lifting holes only.
- Ground the filter properly:
  - Fasten the filter with the four fastening screws to a metallic installation base.
  - Ensure that there is a proper galvanic connection in between the base and the PE busbar of the cabinet.
- Beware of hot surfaces. The surface temperature of the du/dt filter can exceed 150 °C (302 °F) during operation. Let the filter cool off for two hours before servicing it.
- Ensure sufficient cooling. See chapter *Installation*.

Operation principle

What this chapter contains

The chapter describes the operation of the du/dt filter and the intended use.

Operation principle

The drive employs modern IGBT inverter technology. Regardless of frequency, the drive output comprises pulses of approximately the drive DC bus voltage with a very short rise time. The pulse voltage can almost double at the motor terminals, depending on the attenuation and reflection properties of the motor cable and the terminals. This can cause additional stress on the motor and motor cable insulation.

Modern variable speed drives with their fast rising voltage pulses and high switching frequencies can generate current pulses that flow through the motor bearings, which can gradually erode the bearing races and rolling elements.

The common mode filters mainly reduce bearing currents. The du/dt filters also protect the motor insulation system.

To avoid damage to motor bearings and insulation system:

- Select and install the cables according to the instructions given in the hardware manual.
- Check if the installation needs to be equipped with additional protection equipment, such as insulated N-end bearings in the motor, or the drive output filters. The requirements are specified in the drive *Hardware manual*. See chapter *Planning the electrical installation*, section *Selecting the motor,* and chapter *du/dt filter*.

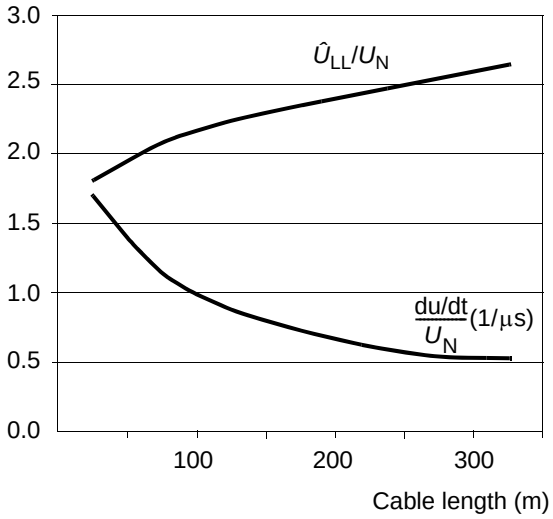
Graphs illustrating the effect of the du/dt filter

The graphs show the peak line-to-line voltage ($\hat{U}_{LL}$) and voltage change (du/dt) at the motor terminals as a function of the motor cable length. $\hat{U}_{LL}$ and du/dt are scaled to the nominal line-to-line voltage (U_N). To calculate the actual peak voltage value in volts and du/dt value in volts per microsecond, multiply the values of the graph by the supply voltage (U_N).

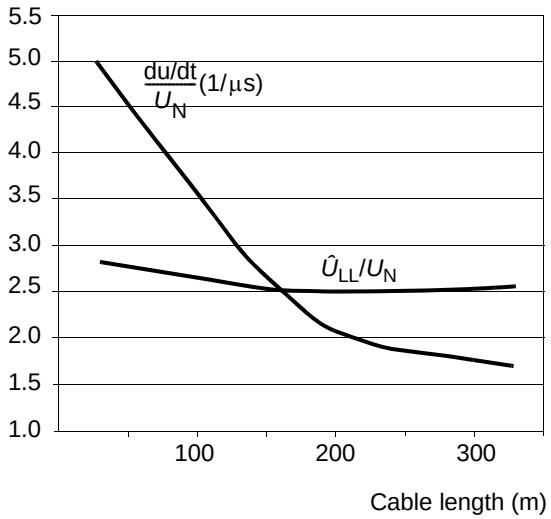
The values in the first graph are measured with an ABB du/dt filter while the second graph without any output filtering. The values in the second graph are only representative. The actual unfiltered du/dt values depend on the drive type, and are usually in the range of 1 to 5 kV/microsecond.

In case of drives with an IGBT supply unit or resistor braking, the $\hat{U}_{LL}$ and du/dt values are approximately 20% higher.

The voltage rise time can be calculated as follows: $\triangle t = 0.8 \cdot \hat{U}_{LL}/(du/dt)$.



With du/dt Filter



Without du/dt Filter

Selecting the du/dt filter

What this chapter contains

The chapter instructs in selecting a du/dt filter for your drive.

Filter selection procedure

Step	What to do	More information
1.	Check whether a du/dt filter is needed in the installation.	The requirements are specified in the drive *Hardware manual*. See chapter *Planning the electrical installation*, section *Selecting the motor*, and chapter *du/dt filter*.[1)]
2.	Pre-select a filter according to the drive type.	Filter selection tables are in the drive *Hardware manual*.[1)] The pre-selected filter is suitable for most applications.
3.	Check that the pre-selected filter is suitable for your application.	Section *Applicability checks of the pre-selected filter* below. If the checks are passed, use the pre-selected filter. If any of the conditions is not met, choose a bigger filter, use two filters in series or change the motor cabling.

[1)] For the ACS800 drives, the data can be found either from the appropriate *Technical catalog* or *Hardware manual*. The PDF files are available at www.abb.com/drives.

Applicability checks of the pre-selected filter

Long or several parallel motor cables, or special cable types may cause excessive temperature rise in the filter. Therefore, check that the pre-selected filter fulfils these general requirements valid for every installation:

- The motor cable length does not exceed the maximum allowed length. The maximum length is given in the *Hardware manua*l of the drive. For some filter types the length is still restricted independent on the drive type. Check the maximum values in section *General notes and restrictions* starting from page *11*.
- The energy loss in the du/dt filter does not exceed the maximum heat dissipation capacity of the filter (E_{max}) given in subsection *Maximum current and heat dissipation capacity of the filter* below. The energy loss is calculated as follows:

$$E = ½ \cdot C \cdot (U_{dc})^2 \text{ where}$$

E $\hat{=}$ energy loss in the du/dt filter
C $\hat{=}$ total capacitance of the motor cable(s), i.e. the product of the capacitance/length value given in the cable catalogue and the length of the motor cable. In case of parallel motor cables, the total capacitance is the sum of the individual cable capacitance.
U_{dc} $\hat{=}$ average intermediate circuit DC voltage of the drive = approximately $1.35 \cdot U_N$
U_N $\hat{=}$ supply voltage.

- The current through the filter does not exceed the maximum value given in subsection *Maximum current and heat dissipation capacity of the filter* below.

Maximum current and heat dissipation capacity of the filter

The maximum current (I_{th}) and heat dissipation capacity (E_{max}) of the filter are given in the table below.

	400 V	500 V	690 V		
Du/dt filter type	**I_{th} / A_{rms}**	**I_{th} / A_{rms}**	**I_{th} / A_{rms}**	**E_{max} / mJ**	**P_{loss} / W**
NOCH0016-60/2	19	19	15	24	110
NOCH0016-65	19	19	15	8	58
NOCH0030-60/2	41	41	28	28	167
NOCH0030-65	41	41	28	9	95
NOCH0070-60/2	112	112	65	35	210
NOCH0070-65	112	112	65	12	150
NOCH0120-60	178	164	113	94	240*
NOCH0120-62	166	157	113	47	210*
NOCH0120-65	166	157	113	15	180*
NOCH0260-60	375	345	230	134	441*
NOCH0400-60	521	495	351	252	750*
AOCH0260-70 [1)]	261	258	177	94	309*
AOCH0400-70 [1)]	445	440	280	176	525*
AOCH0260-70 [2)]	375	345	230	134	441*
AOCH0400-70 [2)]	521	495	351	252	750*

[1)] Filters mounted on top of each other
[2)] Filters mounted side by side

* Value is for a kit, which includes three filters.

Installation

What this chapter contains

This chapter contains general note and restrictions to be considered in the installation, and shows the connections diagrams.

General notes and restrictions



WARNING! Do not attempt any work on a powered drive. After switching off the mains, always allow the intermediate circuit capacitors 5 minutes to discharge before working on the frequency converter, the motor or the motor cable. Check (with a voltage indicating instrument) that the drive is in fact discharged before beginning work.

- Encase the non-enclosed (IP00) filters to meet the safety requirements (for cabinet installation solely).
- Beware of hot surfaces. The surface of the IP22/IP54 filter housing can reach a temperature up to 40 °C higher than the ambient temperature.
- Use shielded cable between enclosures.
- Mount the filter on a mounting structure that is of non-flammable material and strong enough to carry the weight of the filter.
- Ground the filter to the protective earth (PE) terminal of the cabinet. No separate grounding conductor is needed if there is proper galvanic connection through the filter fixing screws and the mounting plate.
- **Maximum allowed drive output frequency:** 120 Hz
- **Maximum allowed average switching frequency:**
  3 kHz (converter units with supply voltage $\leq$ 500 V) or
  2 kHz (converter units with supply voltage > 500 V)
  Change the switching frequency with a drive parameter. If there is no such parameter in the drive sw, apply the settings to be used with long motor cables. For example, for the ACS850 drive, set parameter 40.01 Motor noise to value Default.
- **Maximum cable length between the drive output and the filter:** 3 m
- **Maximum motor cable length for AOCH0xxx-70 filters:** 300 m (cumulative for several parallel-connected motors)

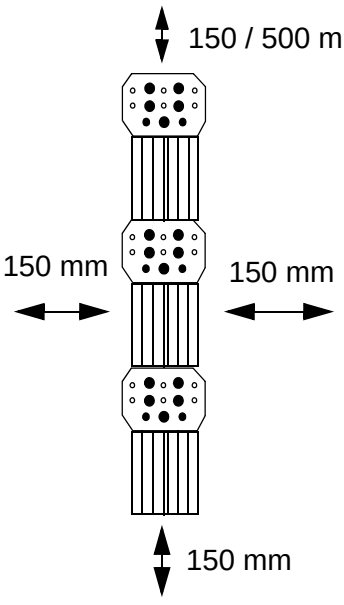
- **Maximum motor cable length for NOCH0xxx-6x filters** (cumulative for several parallel-connected motors):

NOCH0016-60/62 NOCH0030-60/62 NOCH0070-60/62 NOCH0120-62	150 m (can be increased to 300 m by connecting two filters in series)
NOCH0016-65 NOCH0030-65 NOCH0070-65 NOCH0120-65	50 m (can be increased to 100 m by connecting two filters in series)
NOCH0120-60 NOCH0260-60 NOCH0400-60 NOCH0760-60	300 m

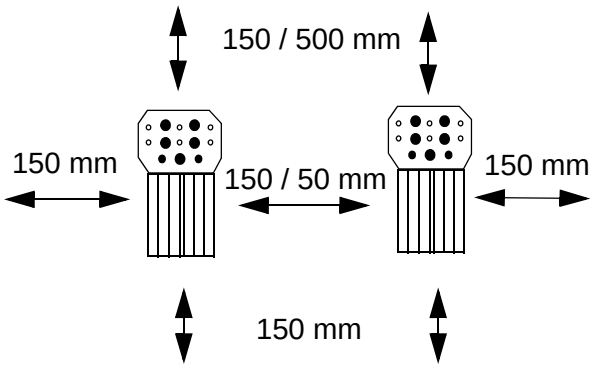
- The filters cool by natural convection. The air space above the filter is hot (up to 70 °C (158 °F) depending on the installation and operating conditions). Take this into account in the cabinet design.
- The following free space requirements apply for the **AOCH0xxx-70** filters:

  150 mm free space on each free side. *Exception:* 500 mm above the filter if installed below the drive. *Exception:* 50 mm between the single phase filters which are connected to the same drive.

  If filters are mounted on top of each other with single drive types 0320-5, 0610-5 and 0610-7, the filters need a minimum of 700 m^3/h of forced cooling. Maximum of three filters can be mounted on top of each other.



AOCH filters on top of each other



AOCH filters side by side

- **NOCH0xxx-6x** filters cool by natural convection, thus the following free space requirements apply:

  Enclosed (IP22 and IP54) filter units:
  300 mm on each free side. *Exception:* 500 mm above the filter if installed below the drive.

  Non-enclosed (IP00) filter units:
  300 mm on each free side. *Exception:* 50 mm between single phase filters connected to the same drive. *Exception:* 500 mm above the filter if installed below the drive.

- Busbar and enclosure clearance distances from the input and output terminals and coil surfaces must be at least 15 mm (0.59 in.). Pay attention to the local regulations. **Note:** Due to high temperature of the coil surfaces during operation, route the motor cables at least 50 mm (1.97 in.) away from the coil surfaces and secure them appropriately.

Mechanical installation and tightening torques

1. Lift the filter by the lifting holes to the installation position.
2. Fasten the filter with four screws at the fastening points in the mounting legs.

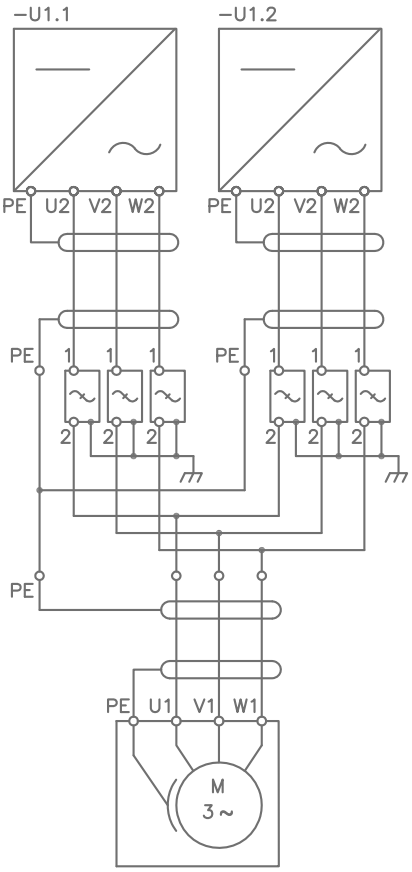
See chapter *Dimension drawings* for the dimensions.

Tightening torque

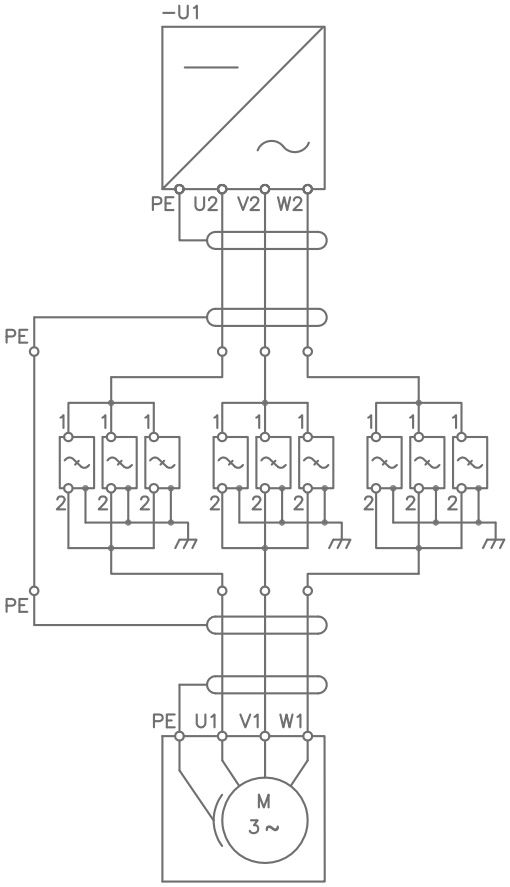
The following table applies to grade 8.8 screws with or without joint compound.

Screw	Torque	
	[Nm]	[lbf ft]
M5	3.5	2.6
M6	9	6.6
M8	20	14.8
M10	40	29.5
M12	70	51.6
M16	180	132.8

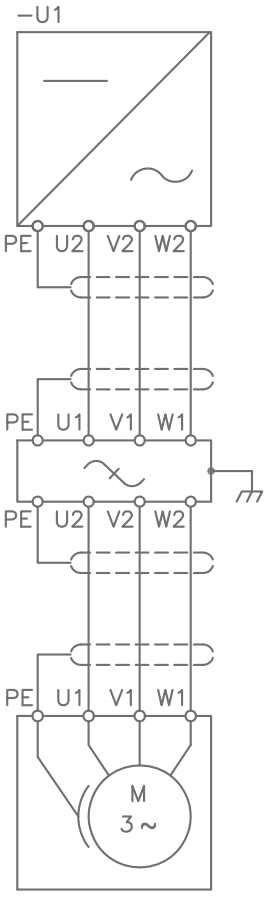
Power connection diagrams



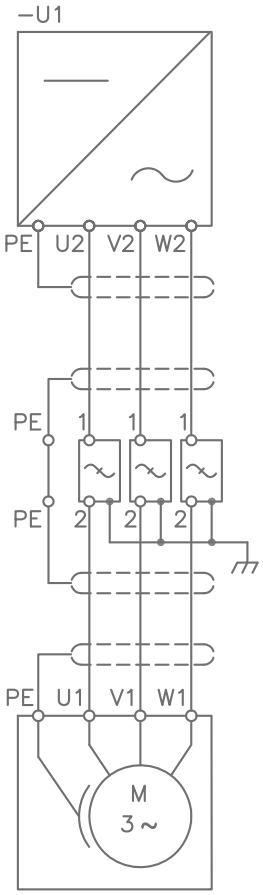
NOCH0260-60
NOCH0400-60
NOCH0760-60



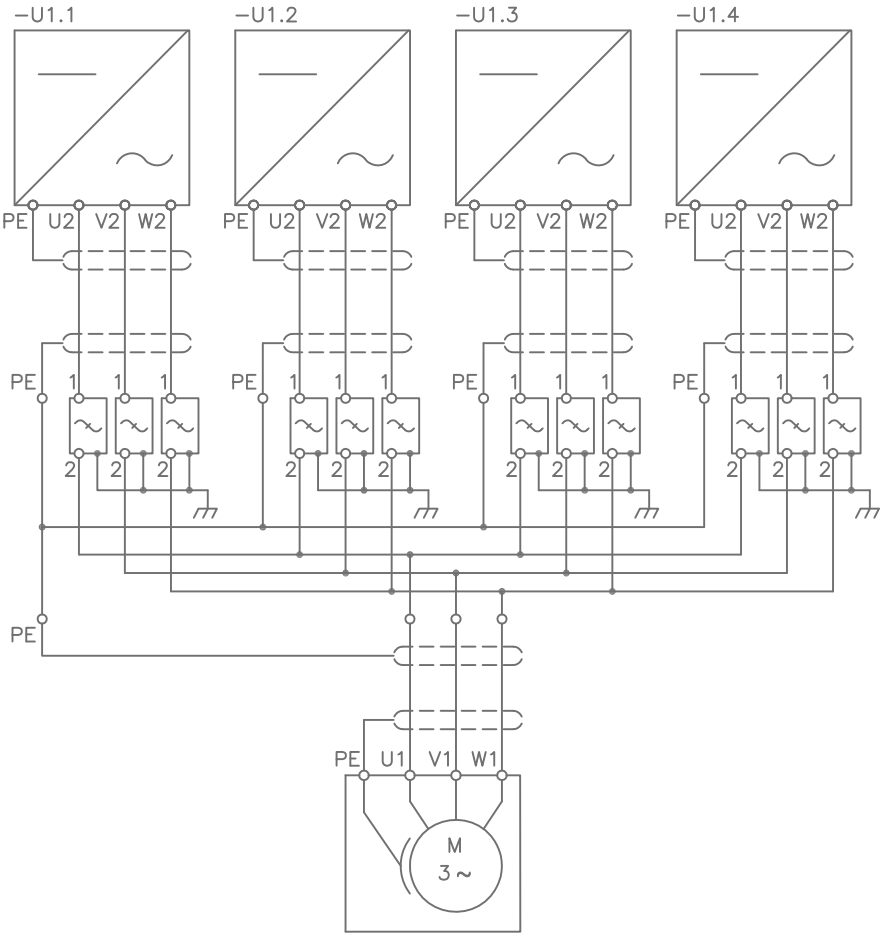
NOCH0400-60



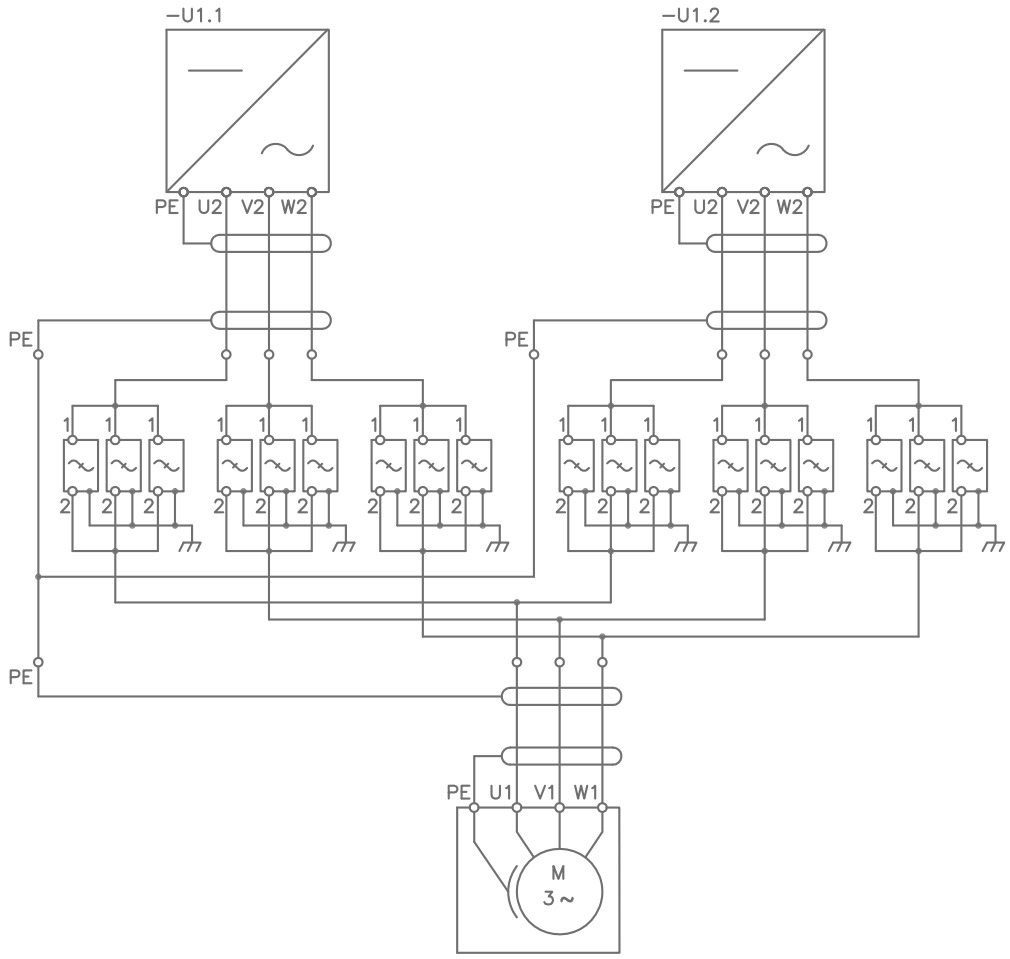
NOCH0016-6x
NOCH0030-6x
NOCH0070-6x



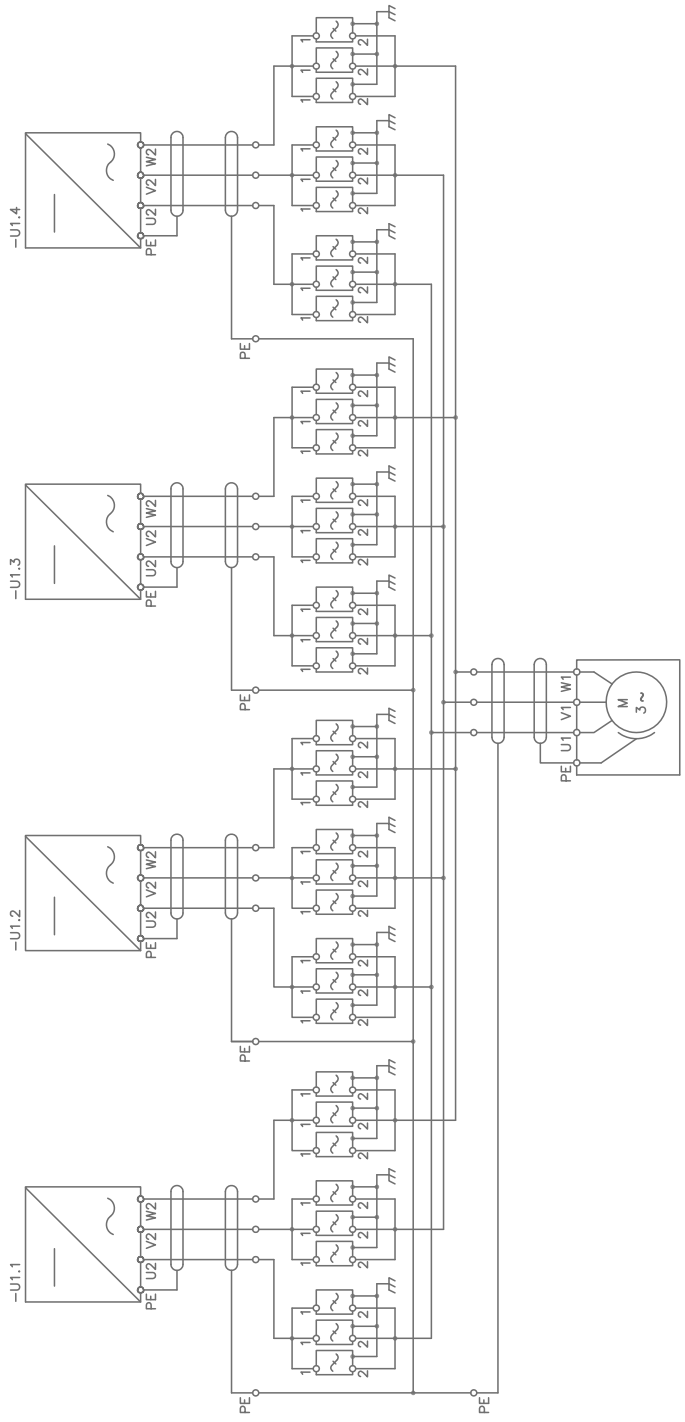
NOCH0120-6x
NOCH0260-60
NOCH0400-60
NOCH0760-60
AOCH0260-70
AOCH0400-70



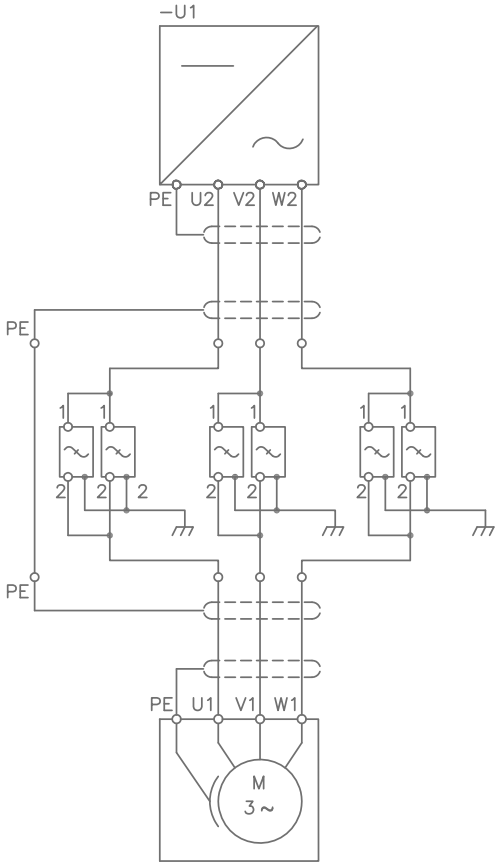
NOCH0760-60



NOCH0400-60



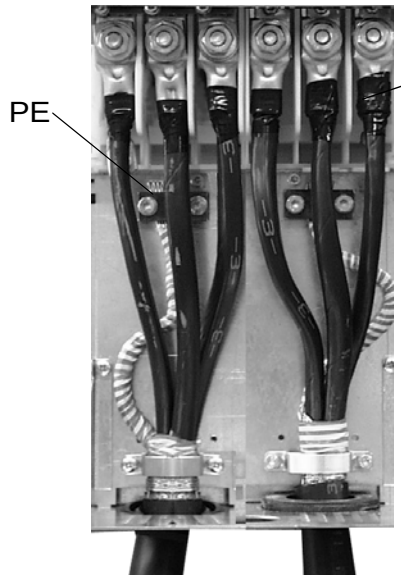
NOCH0400-60



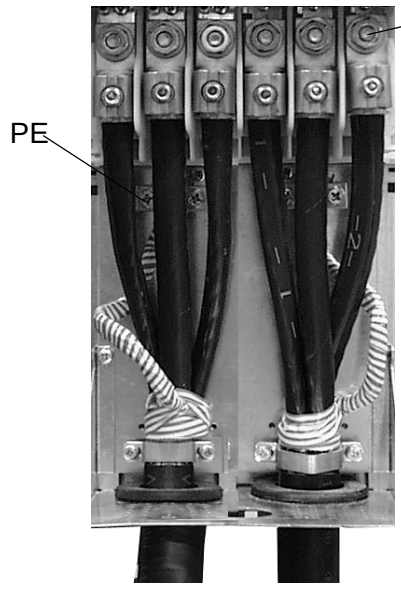
AOCH0400-70
AOCH0260-70

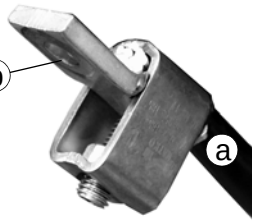
Detail photos of the NOCH0120-6 connection

NOCH0120-6x: Cable lug installation
[16 to 70 mm^2 (6 to 2/0 AWG) cables]



NOCH0120-6x: Cable terminal installation
[95 to 185 mm^2 (3/0 to 350 AWG) cables]





a. Connect the cable to the terminal.

b. Connect the terminal to the drive.

WARNING! If the wire size is less than 95 mm^2 (3/0 AWG), a cable lug must be used. A cable of wire size less than 95 mm^2 (3/0 AWG) connected to this terminal will loosen and may damage the drive.

Technical data

Nominal voltage: 380 … 690 V ± 10%.

Rated short-time withstand current: 50 kA 1 s.

Applicable standards and markings: EN 60204-1, EN 60529, EN 61800-3, EN 50178, CE marking, UL approval.

Ambient conditions, operation

Air temperature: -15 to +50 °C. At temperatures from +40 °C to +50 °C, the rated output current is decreased by 1% for every additional 1 °C. The output current is calculated by multiplying the current given in the rating table by the derating factor.

Relative humidity: 5% to 95%, no condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.

Installation site altitude: 0 to 4000 m. At altitudes from 1000 to 4000 m above the sea level, the rated output current is decreased by 1% for every 100 m.

Vibration:

AOCH0xxx-70: Max 1 mm (5 to 13.2 Hz), max 7 m/s^2 (13.2 to 100 Hz) sinusoidal (IEC 60068-2)

NOCH0xxx-6x: Max 0.3 mm (2 to 9 Hz), max 1 m/s^2 (9 to 200 Hz) sinusoidal (IEC60068-2)

Shock: Max 70 m/s^2, 22 ms (IEC 60068-2-27)

Ambient conditions, storage

Temperature: -40 to +70 °C.

Relative humidity: Less than 95%, no condensation allowed

Atmospheric pressure: 70 to 106 kPa

Vibration:

AOCH0xxx-70: Max 1 mm (5 to 13.2 Hz), max 7 m/s^2 (13.2 to 100 Hz) sinusoidal (IEC 60068-2)

NOCH0xxx-6x: Max 0.3 mm (2 to 9 Hz), max 1 m/s^2 (9 to 200 Hz) sinusoidal (IEC 60068-2)

Shock: Max 100 m/s^2, 11 ms (IEC 60068-2-27)

Ambient conditions, transportation

Ambient transportation conditions refer to the conditions du/dt filters are subjected to during transportation in the protective package.

Temperature: -40 to +70 °C

Relative humidity: Less than 95%, no condensation allowed.

Atmospheric pressure: 60 to 106 kPa

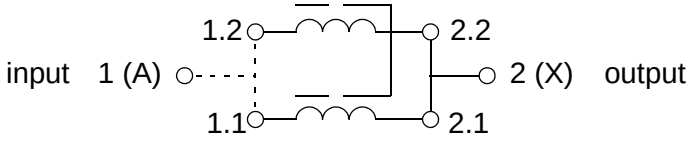
Vibration: Max 3.5 mm (2 to 9 Hz), max 15 m/s^2 (9 to 200 Hz) sinusoidal (IEC 60068-2)

Shock: Max 100 m/s^2, 11 ms (IEC 60068-2-27)

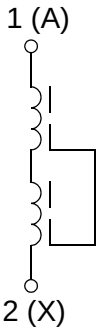
Bump: Max 300 m/s^2, 6 ms (IEC 60068-2-29)

Free fall: 250 mm

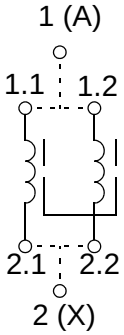
Internal circuit diagrams



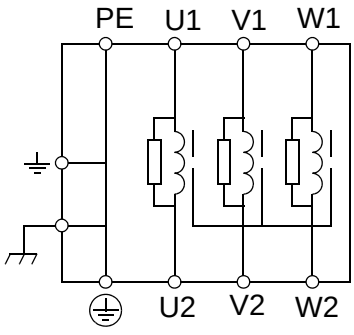
AOCH0xxx-70: Connect the input terminals together.



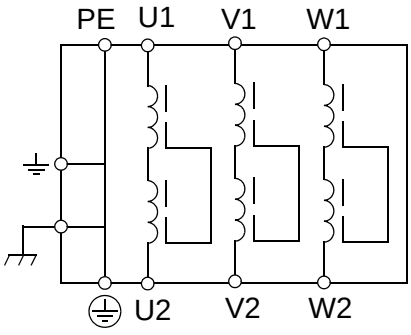
NOCH0120-60



NOCH0260-60
NOCH0400-60
NOCH0760-60



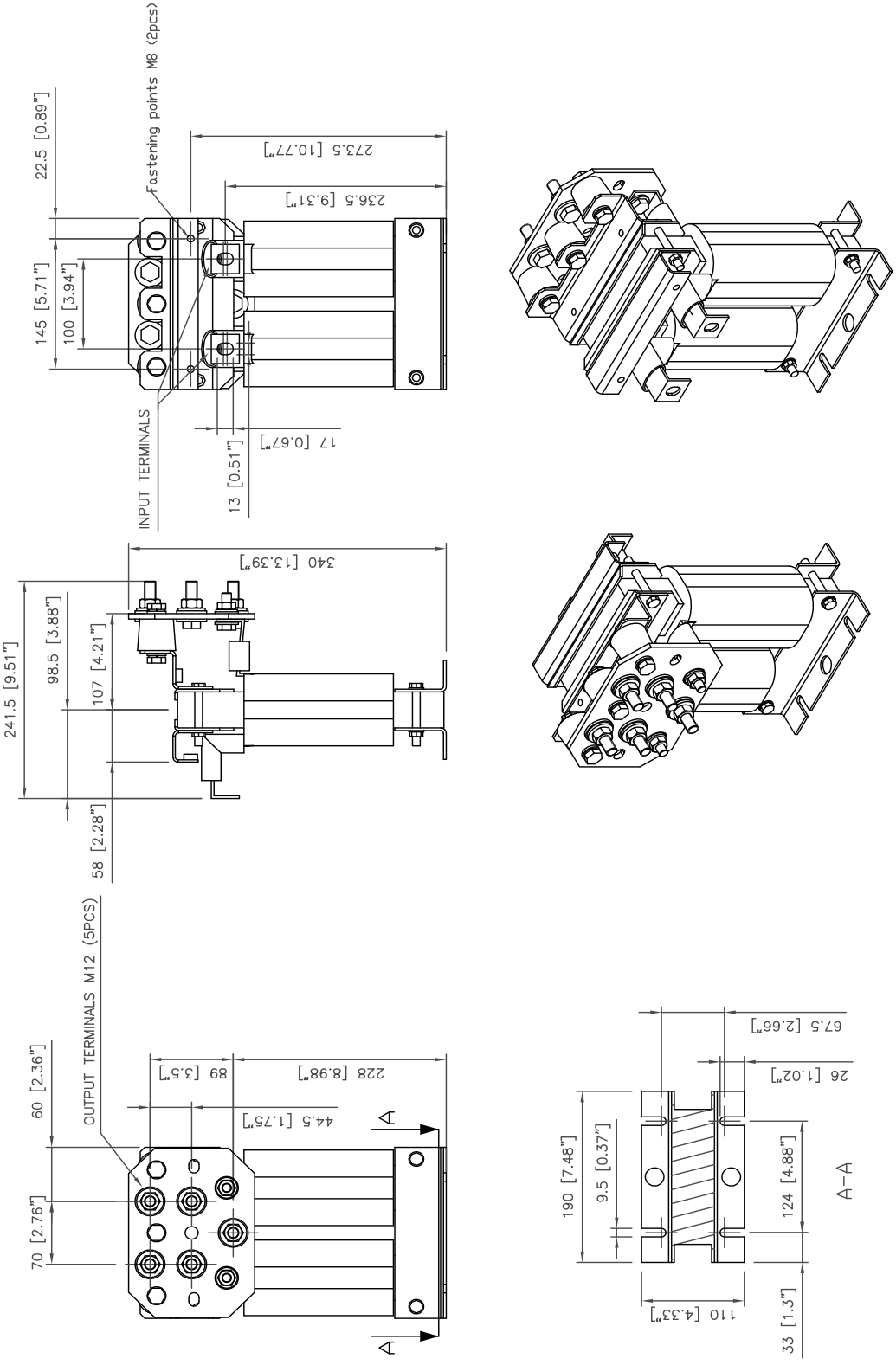
NOCH0016-6x
NOCH0030-6x
NOCH0070-6x



NOCH0120-6x

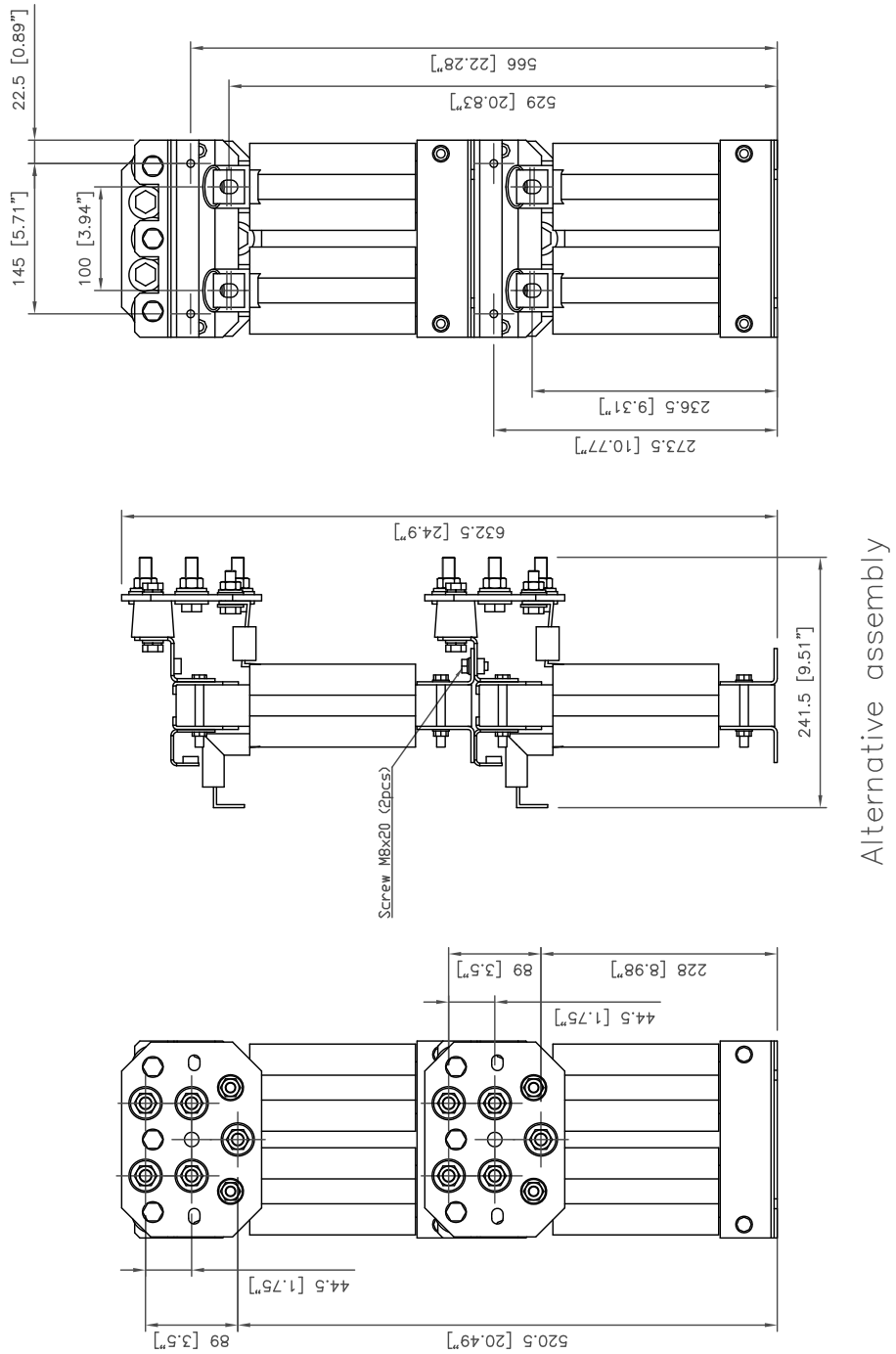
Dimension drawings

AOCH0260-70, single phase filter
du/dt filter kit includes 3 pieces of single phase filters.

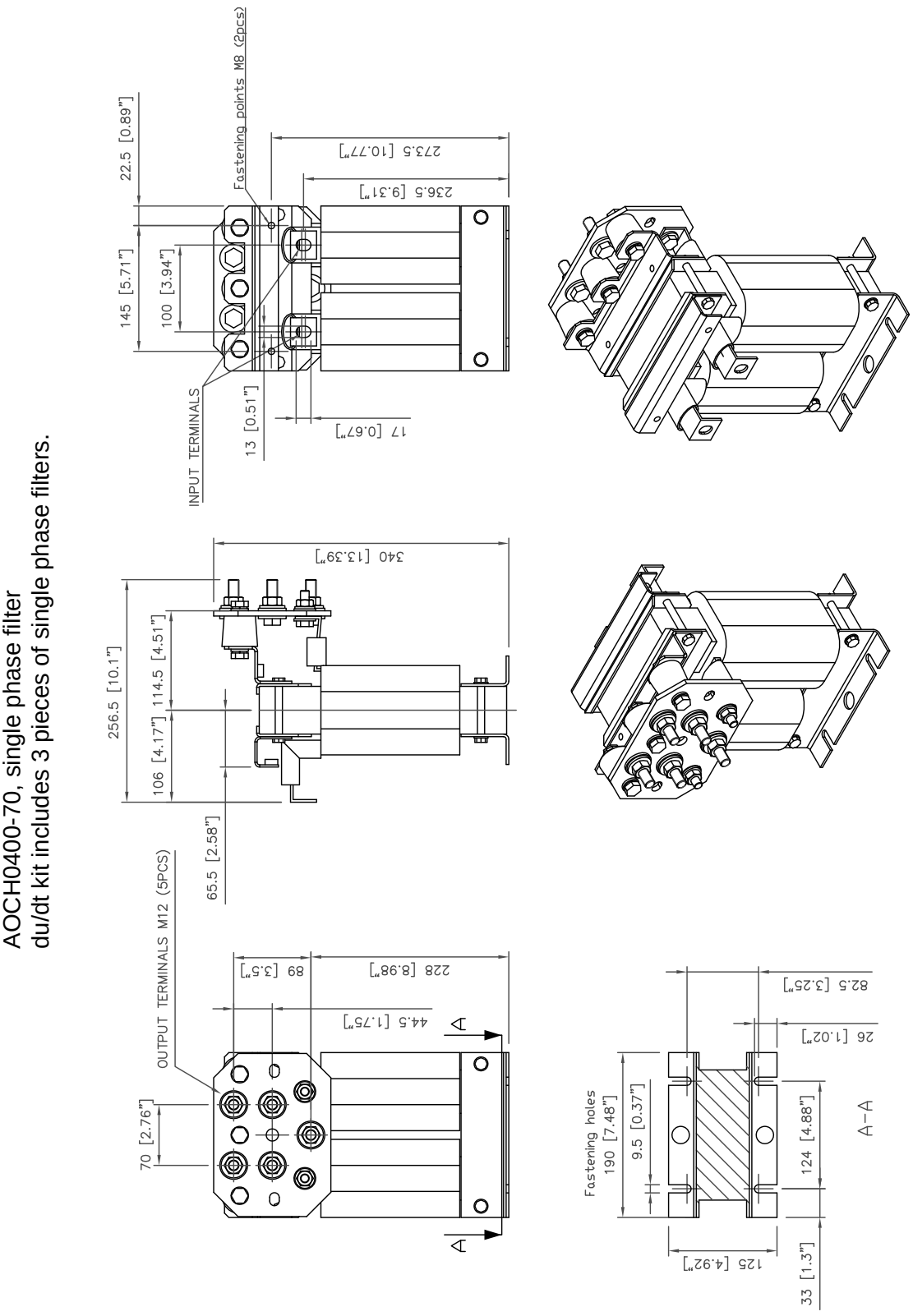


AOCH0260-70

du/dt filter kit includes 3 pieces of single phase filters.			
Cable size:	3x(3x185)	Weight:	15.9 kg (35.1 lbs)
Screw size:	M12	I_{TH}	227 A_{rms}
Power loss:	147 W	L	74 µH

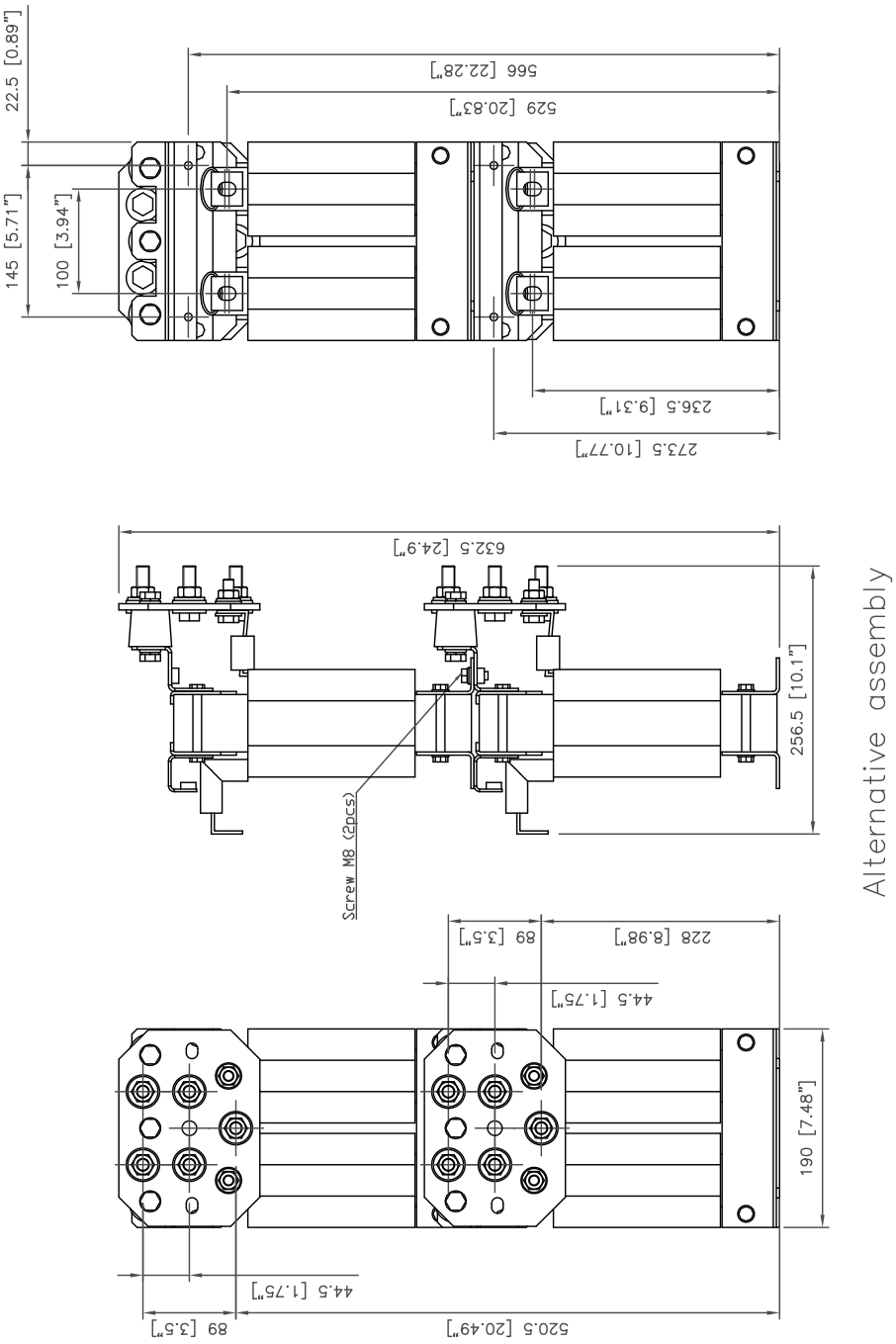


AOCH0400-70, single phase filter
du/dt kit includes 3 pieces of single phase filters.



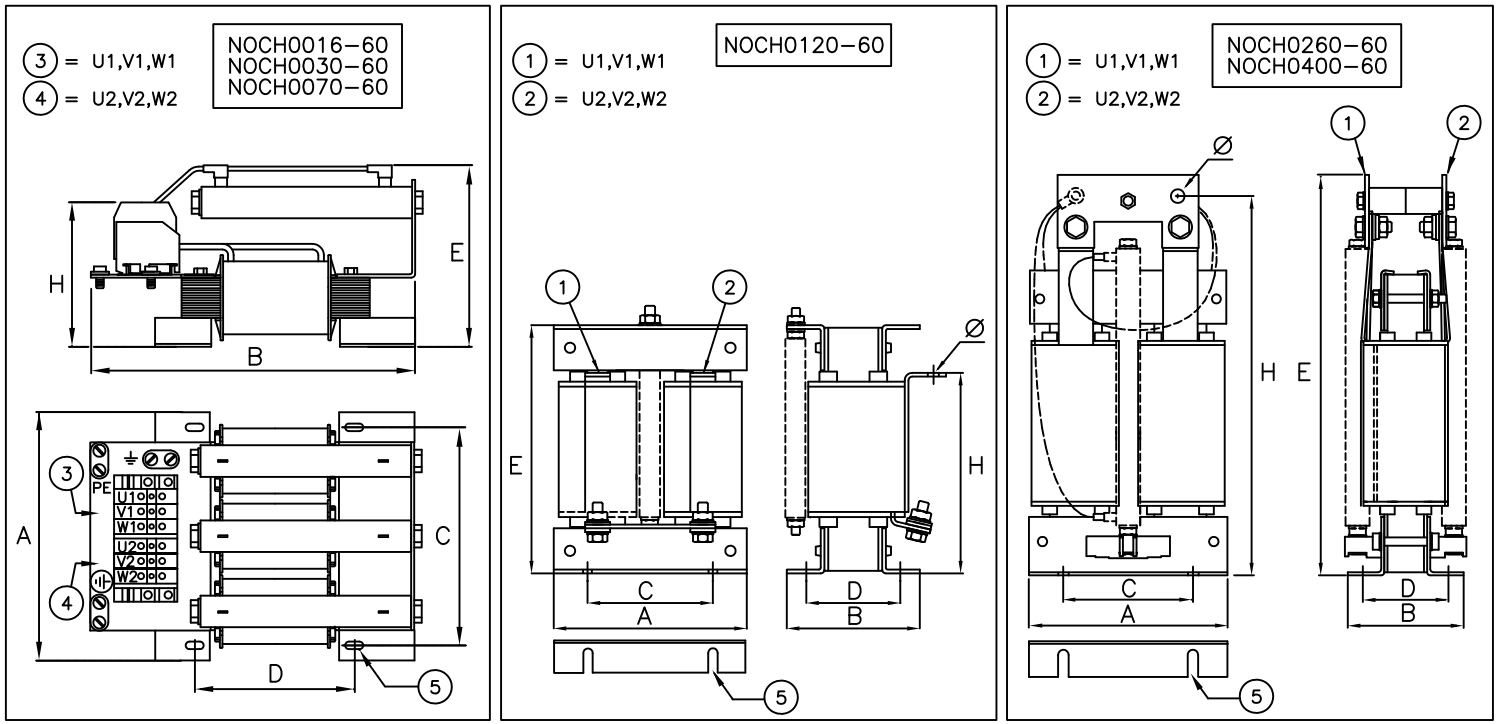
AOCH0400-70

du/dt filter kit includes 3 pieces of single phase filters.			
Cable size:	3x(3x185)	Weight:	20.7 kg (45.6 lbs)
Screw size:	M12	I_{TH}	355 A_{rms}
Power loss:	250 W	L	52 µH

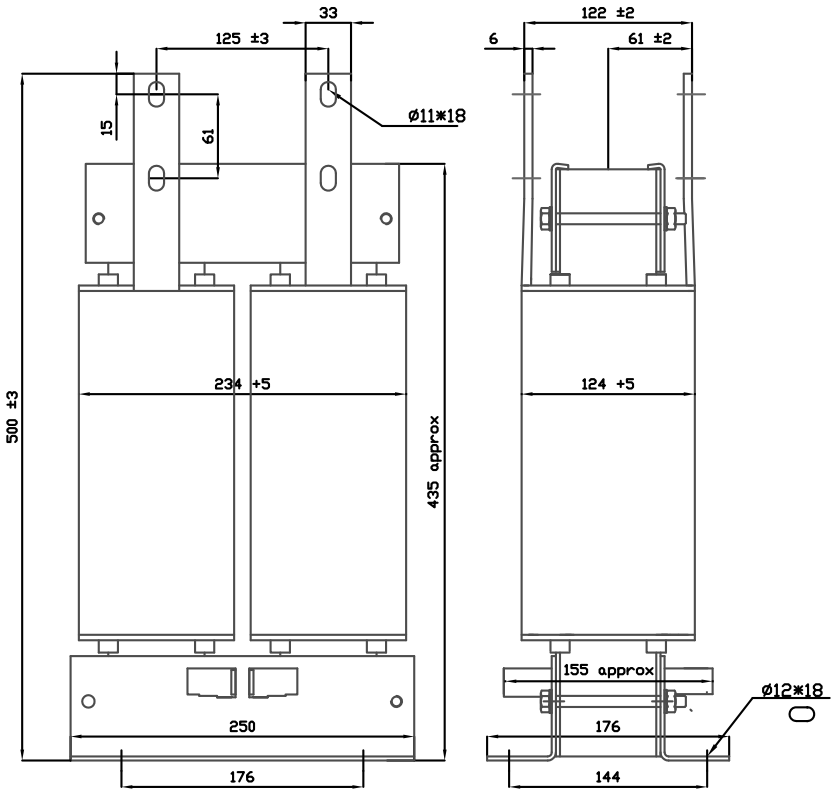


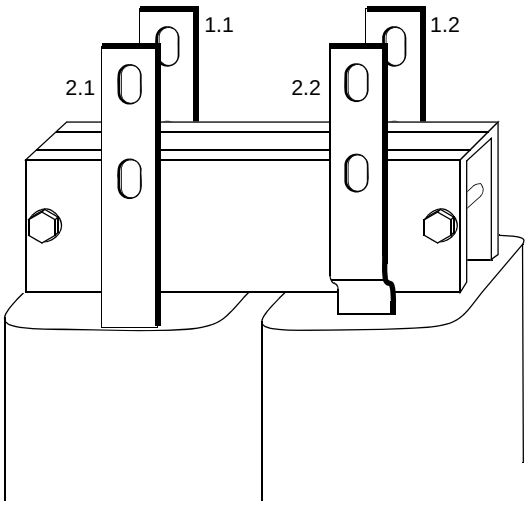
NOCH0120-60, NOCH0260-60 and NOCH0400-60 du/dt kits include 3 filters.

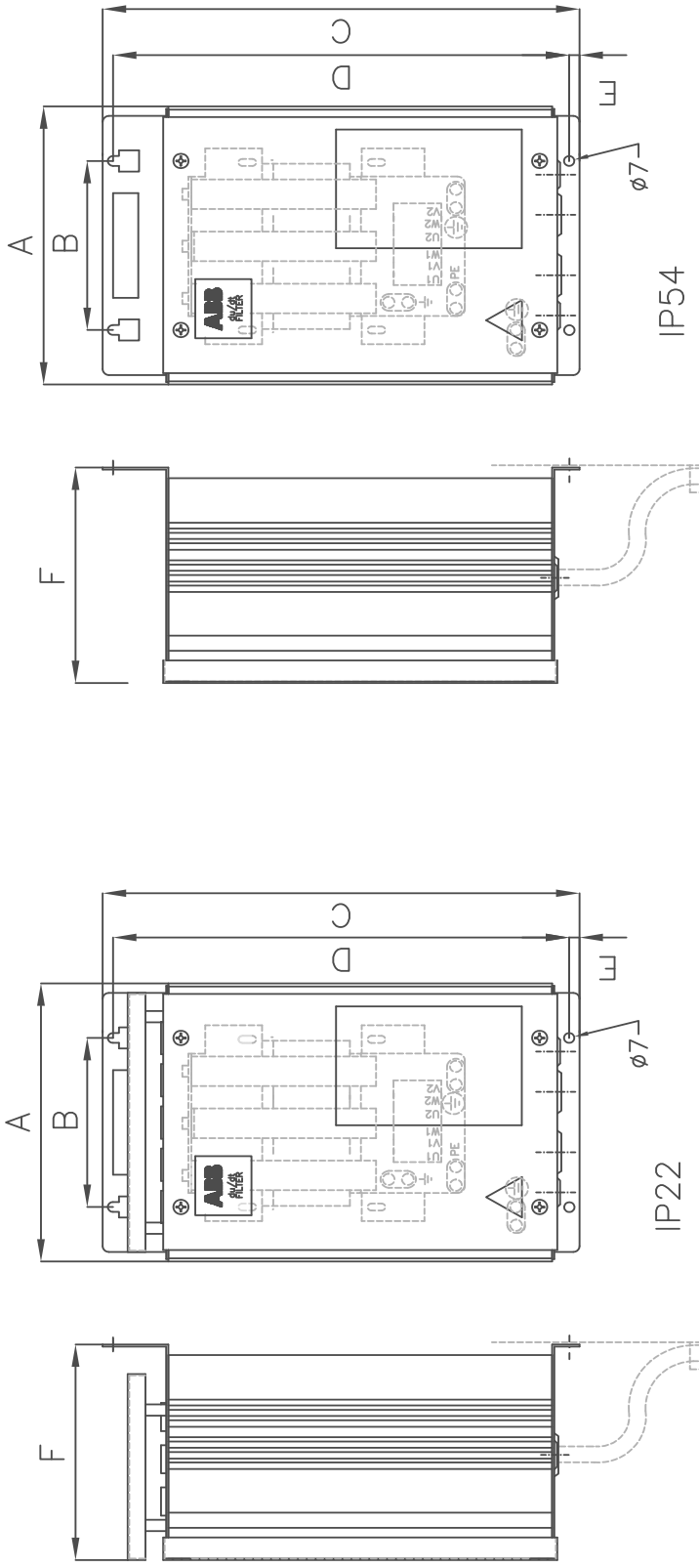
L2	mm						① ② Ø	kg /1				
~	A	B	C	D	E	H	mm	kg		→ Nm	mm²	→ Nm
NOCH0016–60	140	195	120	85	115	83	–	2.4	M5	4	0.2...10	1.5
NOCH0030–60	165	215	145	108	130	95	–	4.7	M5	4	0.5...16	1.5
NOCH0070–60	180	261	170	125	150	120	–	9.5	M6	6	10...35	2.5
NOCH0120–60	154	106	100	75	200	160	9	7	M8	20	–	–
NOCH0260–60	185	111	124	82	383	368	13	12	M10	30	–	–
NOCH0400–60	185	126	124	97	383	368	13	17	M10	30	–	–



NOCH0760-60 Weight: 43 kg (95 lbs)
du/dt filter kit includes 3 filters.

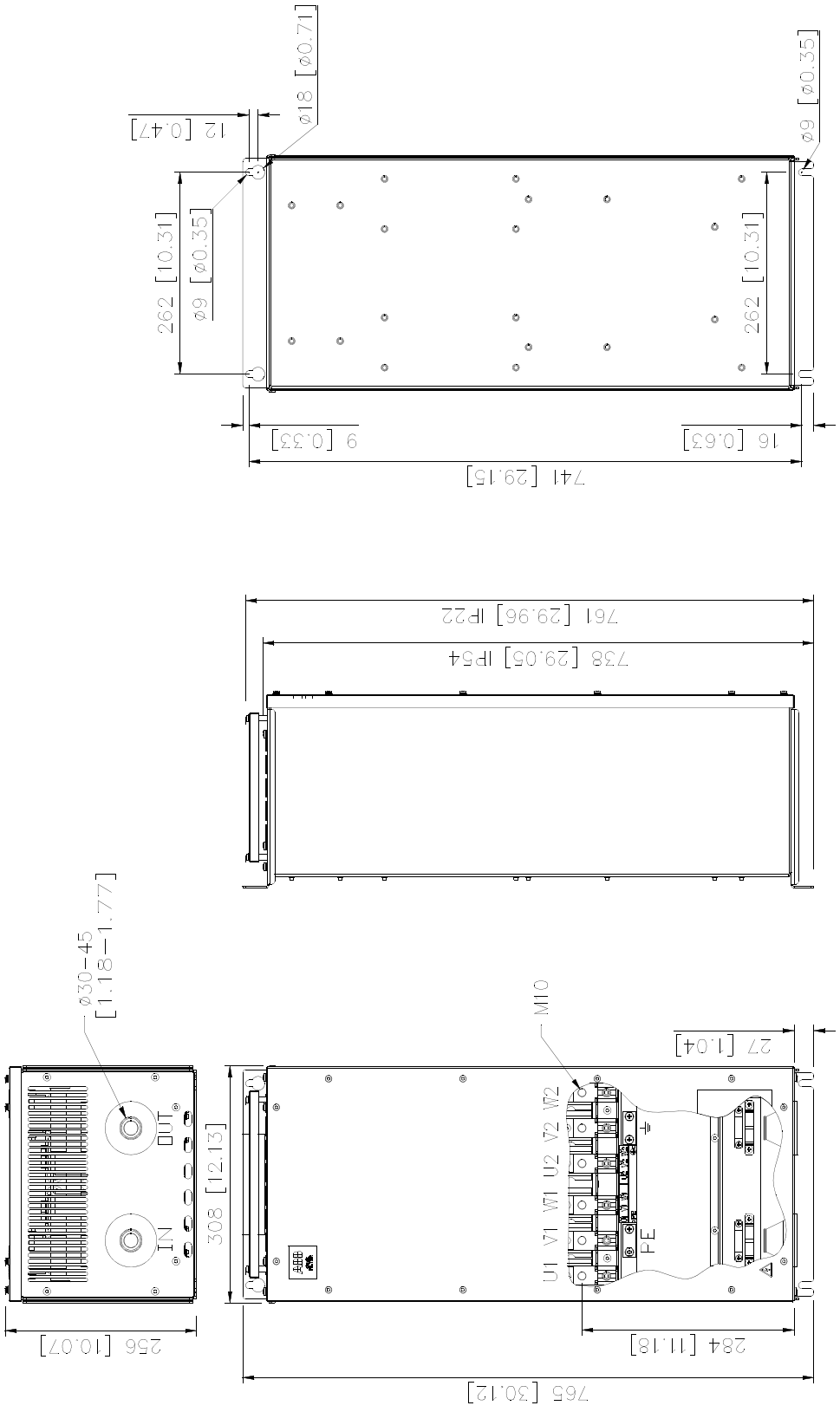






		A	B	C	D	E	F	kg/1
IP22	NOCH0016-62	199	120	323	309	7	154	6
	NOCH0030-62	249	160	348	334	7	172	9
	NOCH0070-62	279	180	433	419	7	202	15.5
IP54	NOCH0016-65	199	120	323	309	7	154	6
	NOCH0030-65	249	160	348	334	7	172	9
	NOCH0070-65	279	180	433	419	7	202	15.5

NOCH0120-62, NOCH0120-65 Weight 45 kg (99 lbs)
du/dt filter kit includes 3 filters.



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/drives and selecting *Sales, Support and Service network*.

Product training

For information on ABB product training, navigate to www.abb.com/drives and select *Training courses*.

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Your comments on our manuals are welcome. Go to www.abb.com/drives and select *Document Library – Manuals feedback form (LV AC drives)*.

Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet. Go to www.abb.com/drives and select *Document Library.* You can browse the library or enter selection criteria, for example a document code, in the search field.

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