ACS 600

Water-cooled Units

Supplement to Product Catalogue
and Installation Manual

ACS 600 MultiDrive Modules

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and Installation Manual

3BFE 64491474 R0125
EN
EFFECTIVE: 17.12.2001

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Chapter 1 – Overview

Introduction

This supplement gives information specific to water-cooled units available in the ACS 600 MultiDrive Modules product range. This document contains the information that differs from, or adds to, what is stated in

ACS 600 MultiDrive Modules Product Catalogue
(code 3BFE 64104268 [English])

and

ACS 600 MultiDrive Modules Installation Manual
(code 3BFE 94119010 [English]).

The above manuals are referred to in the text as *Product Catalogue* and *Installation Manual* respectively.

Water-cooled vs Air-cooled Modules

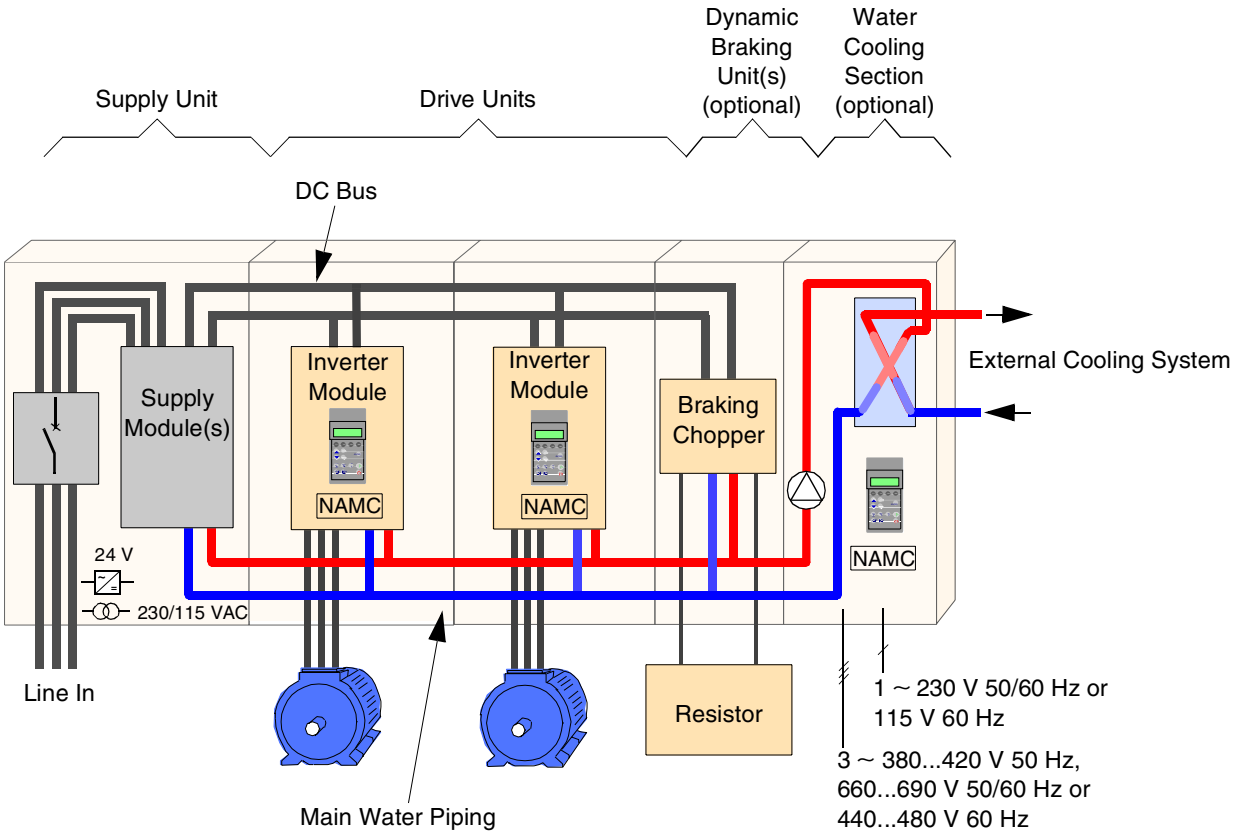
The water-cooled power modules in the ACS 600 MultiDrive Modules range have the same functional and performance features, electronics hardware, and control options as the air-cooled modules. The water-cooled components are also mechanically compatible with the air-cooled components; for example, a common DC bus can be used.

Using the water-cooled power modules of the ACS 600 MultiDrive Modules range provides the following advantages:

- Compact size. For example, a water-cooled drive system is approximately 30% smaller than an equivalent air-cooled system
- Need of high-volume air cooling ducts eliminated
- The power semiconductors are insulated from the cooling elements thus allowing use of fresh cooling water instead of special non-conducting coolant
- Reduced need of cleaning and better serviceability compared to air-cooled units
- Lower audible noise compared to air-cooled units
- High protection (IP) degree.

Principle of Water Cooling

The figure below shows a typical water-cooled drive system.



Most of the power loss – approximately 70% – of the supply and drive modules is transferred to the coolant. The remainder is transferred to the cooling air flowing through the power modules. If a totally closed cabinet is required (so that no air can pass through), it must be equipped with air-to-water heat exchangers.

Almost all of the power loss of the braking choppers is transferred to the coolant. The remainder can usually be dissipated through the walls of the cubicle.

Cooling of the Power Modules

See Chapter 2 for more information on the cooling of the different power modules.

See also *Appendix A – Technical Data and Specifications*.

Water-cooled Modules Available

The following MultiDrive Modules product groups contain water-cooled modules:

- Diode supply modules
- Thyristor supply modules
- Inverter modules
- Braking choppers
- Water cooling sections.

Chapter 2 – Water-cooled Components

Diode Supply Modules

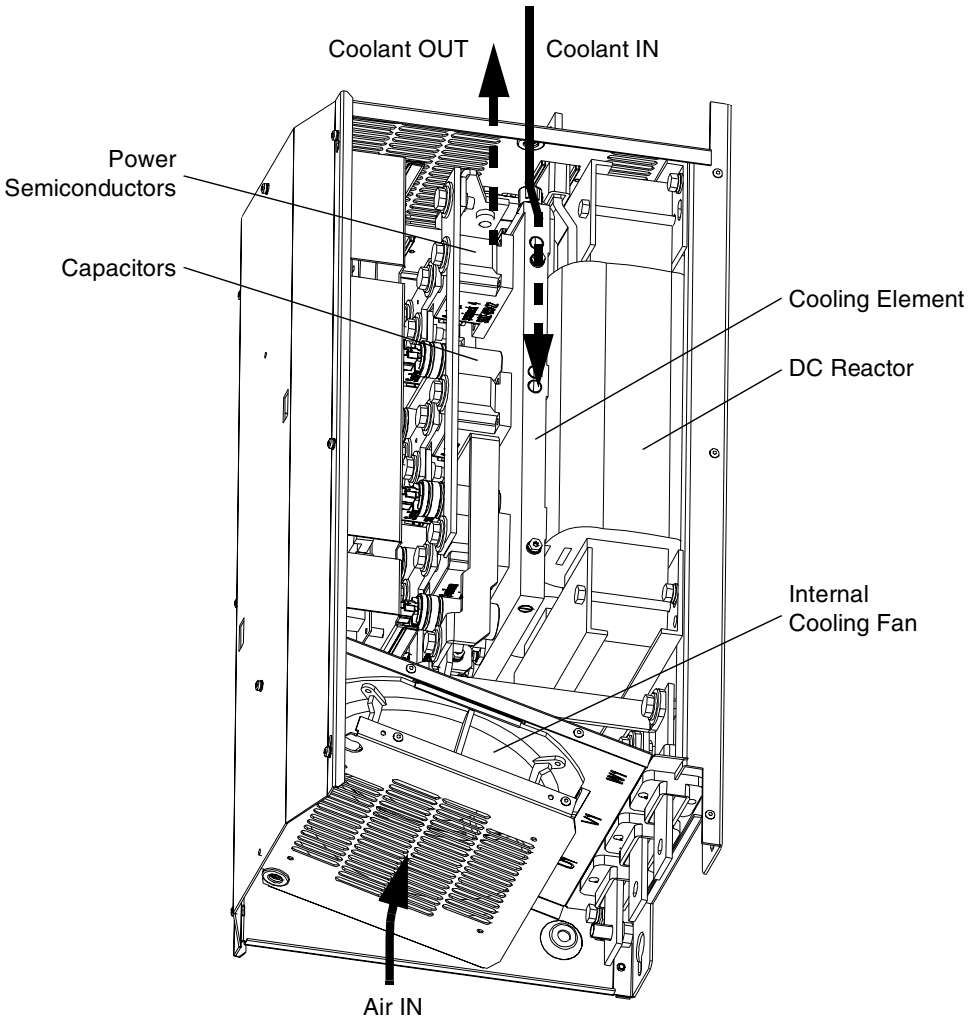
The frame sizes available as water-cooled are B3 and B5. These modules can be connected in parallel to form the following supply units:

Water-cooled Diode Supply Modules											
Type	Auxiliary Voltage (V AC)	(Qty ×) Ordering Code	T_A = 40 °C, IP22				Duty Cycle (10/60 s)		Duty Cycle (1/5 min)		Frame
			S_N (kVA)	I_{1N} (A)	I_{DC} (A)	P_N (kW)	I_{DCBase} (A)	I_{DCMax} (A)	I_{DCBase} (A)	I_{DCMax} (A)	
690 V – 6-pulse Supply Units											
ACW 684 0700 6	230	64464256	700	586	718*	646*	–	–	–	–	B3
	115	64506471									
2 × ACW 684 0700 6	230	2 × 64464256	1400	1171	1435*	1283*	–	–	–	–	2×B3
	115	2 × 64506471									
ACW 684 2600 6	230/115**	64269062	2600	2176	2664	2400	1598	4316	1598	3373	B5
ACW 684 3600 6	230/115**	64269089	3415	2858	3500	3152	2100	5670	2100	4431	B5
690 V – 12-pulse Supply Units											
2 × ACW 684 0700 6	230	2 × 64464256	1400	1171	1436*	1292*	–	–	–	–	2×B3
	115	2 × 64506471									
4 × ACW 684 0700 6	230	4 × 64464256	2660	2226	2727*	2438*	–	–	–	–	4×B3
	115	4 × 64506471									
2 × ACW 684 2600 6	230/115**	2 × 64269062	5200	4352	5326	4798	3197	8631	3197	6745	2×B5

*This is the maximum value with no overload possibility.
**These modules include a 3-phase cooling fan powered from the main supply (no auxiliary voltage required).

Cooling Characteristics of Water-cooled Diode Supply Modules				
Type	**Power Loss**		**Coolant**	
	into Coolant (kW)	**into Cooling Air (kW)**	**Capacity (l)**	**Flow (kg/h)**
ACW 684 0700 6 (6-pulse)	4.7	0.7	1.4	700
2 × ACW 684 0700 6 (6-pulse)	9.4	1.4	2 × 1.4	2 × 700
ACW 684 2600 6 (6-pulse)	8.8	1.6	2.0	1500
ACW 684 3600 6 (6-pulse)	11.1	3.0	2.0	1500
2 × ACW 684 0700 6 (12-pulse)	9.4	1.4	2 × 1.4	2 × 700
4 × ACW 684 0700 6 (12-pulse)	18.8	2.8	4 × 1.4	4 × 700
2 × ACW 684 2600 6 (12-pulse)	17.6	3.2	2 × 2.0	2 × 1500

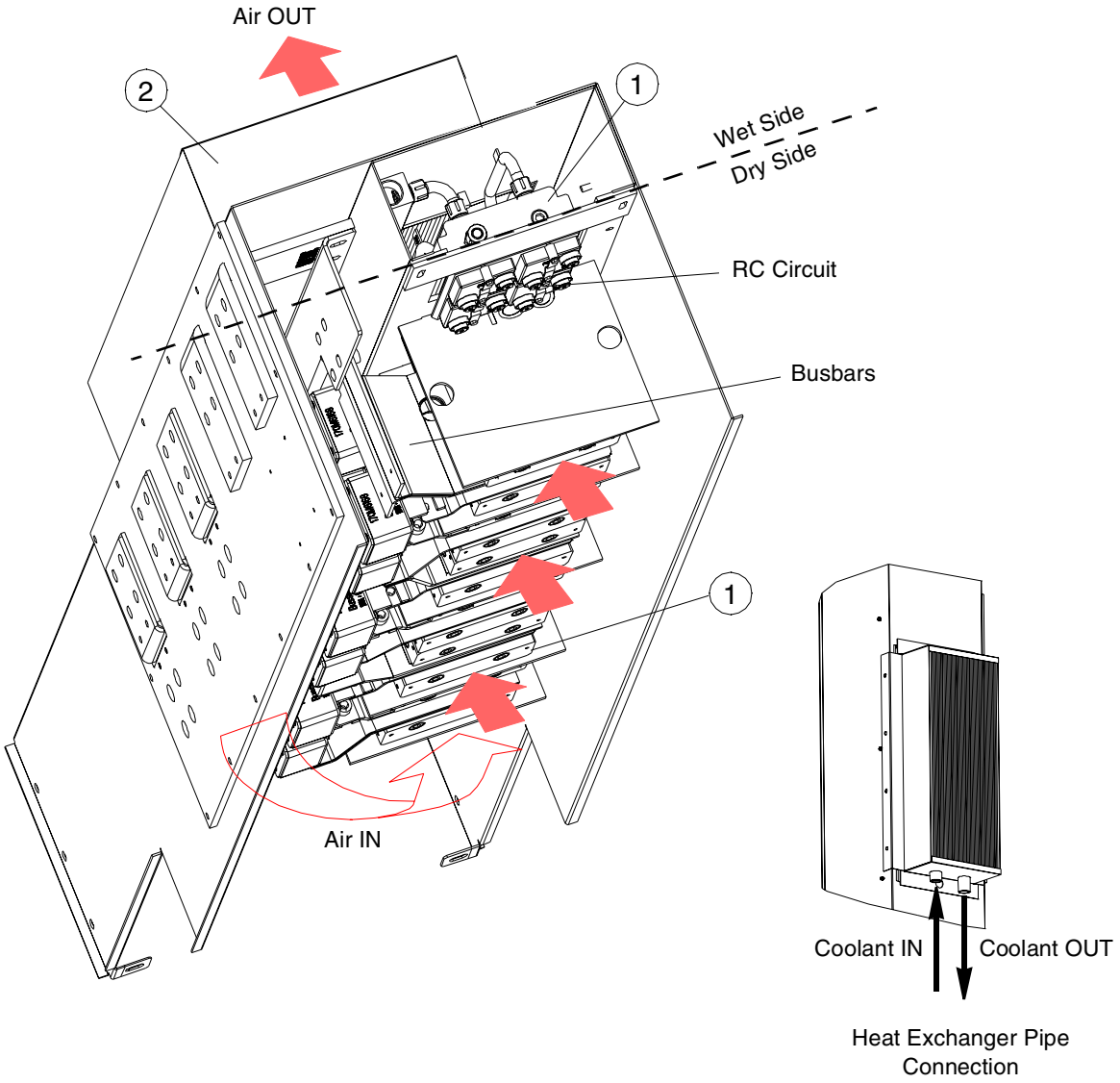
Cooling Principle (B3) The power semiconductors and capacitors are attached to a cooling element through which the coolant flows. The internal cooling fan at the bottom of the module blows air upwards.



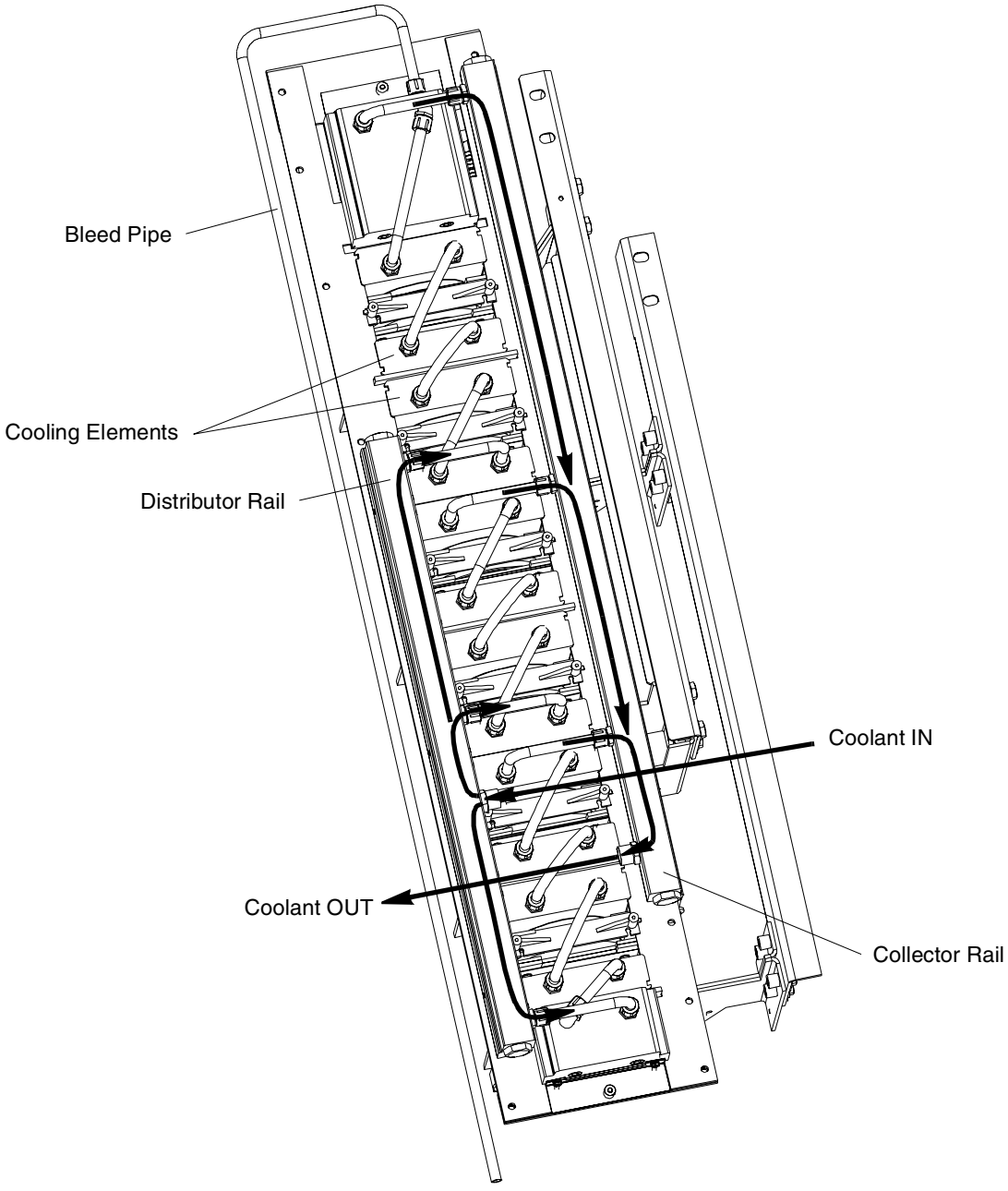
With a ventilated cubicle, an air baffle must be installed to prevent the cooling air from circulating inside the cubicle.

With a closed-type cubicle, an air-to-water heat exchanger must be used together with an additional fan (see Chapter 3).

Cooling Principle (B5) The power semiconductors of the module are cooled by water cooling elements (1), piled up into a block between the semiconductors and their accompanying busbars under the pressure of a leaf spring clamp. The heat generated by e.g. fuses and busbars is conducted by the cooling air to an air-to-water heat exchanger (2) at the back of the module. The cooling air also flows through the block in narrow air channels round the semiconductors, thus preventing coolant from entering the dry side if a leakage occurs.



The coolant enters the cooling element block through a distributor rail on the left-hand side of the block and flows through the elements into the collector rail on the right-hand side.

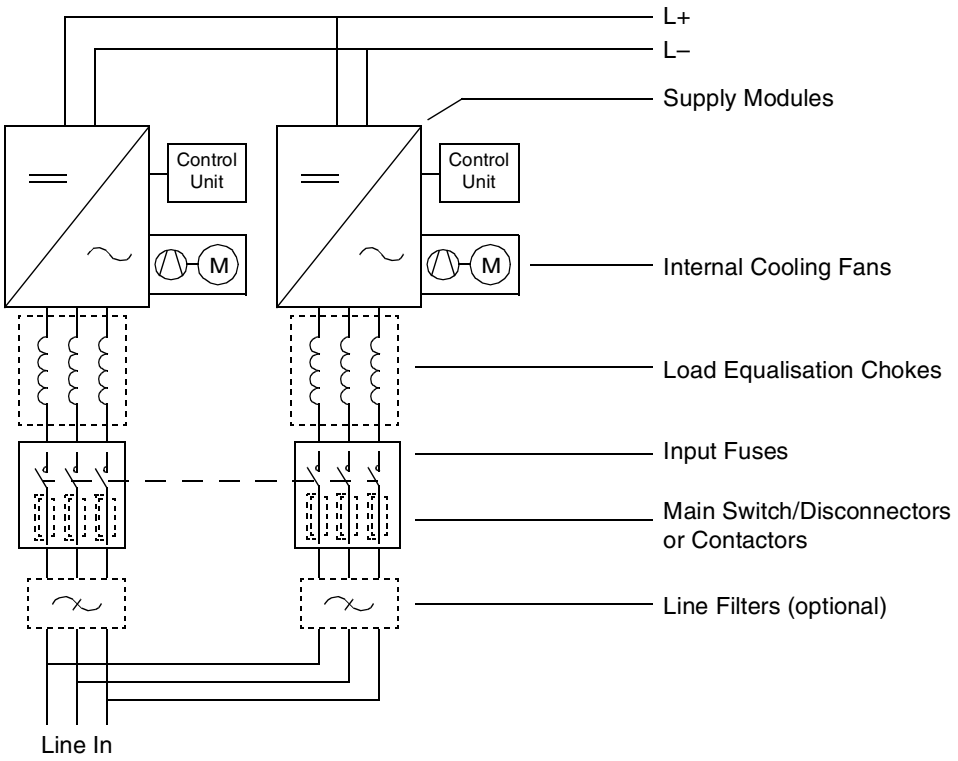


With a ventilated cubicle, an air baffle must be installed to prevent the cooling air from circulating inside the cubicle.

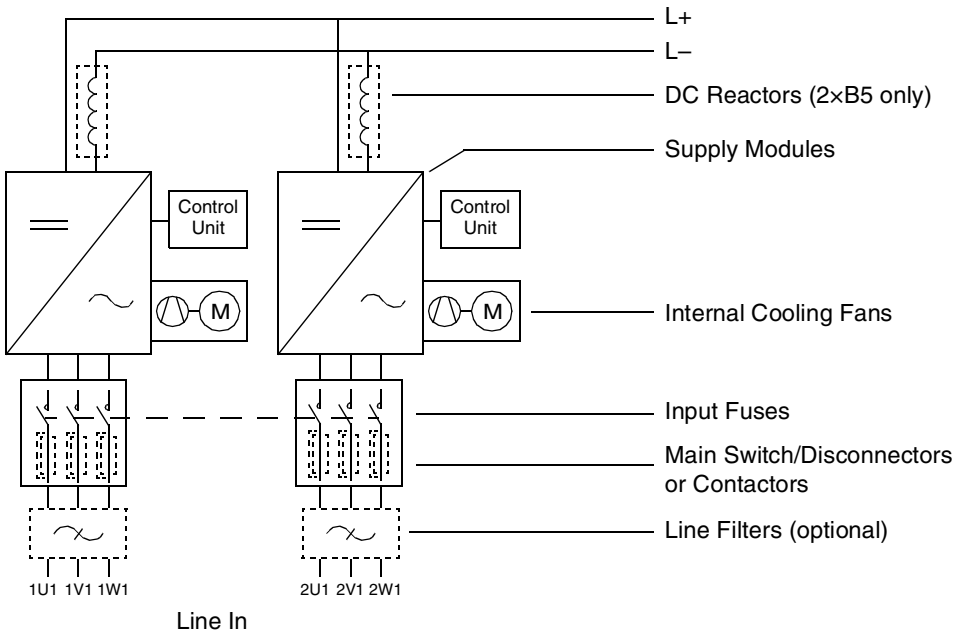
With a closed-type cubicle, an air-to-water heat exchanger must be used. (No additional fan is needed.)

Configuration The configurations of the water-cooled B3 and B5 supply units are as illustrated for the air-cooled units in the *Product Catalogue.* The water-cooled 2×B3, 4×B3 and 2×B3 units are constructed as shown below.

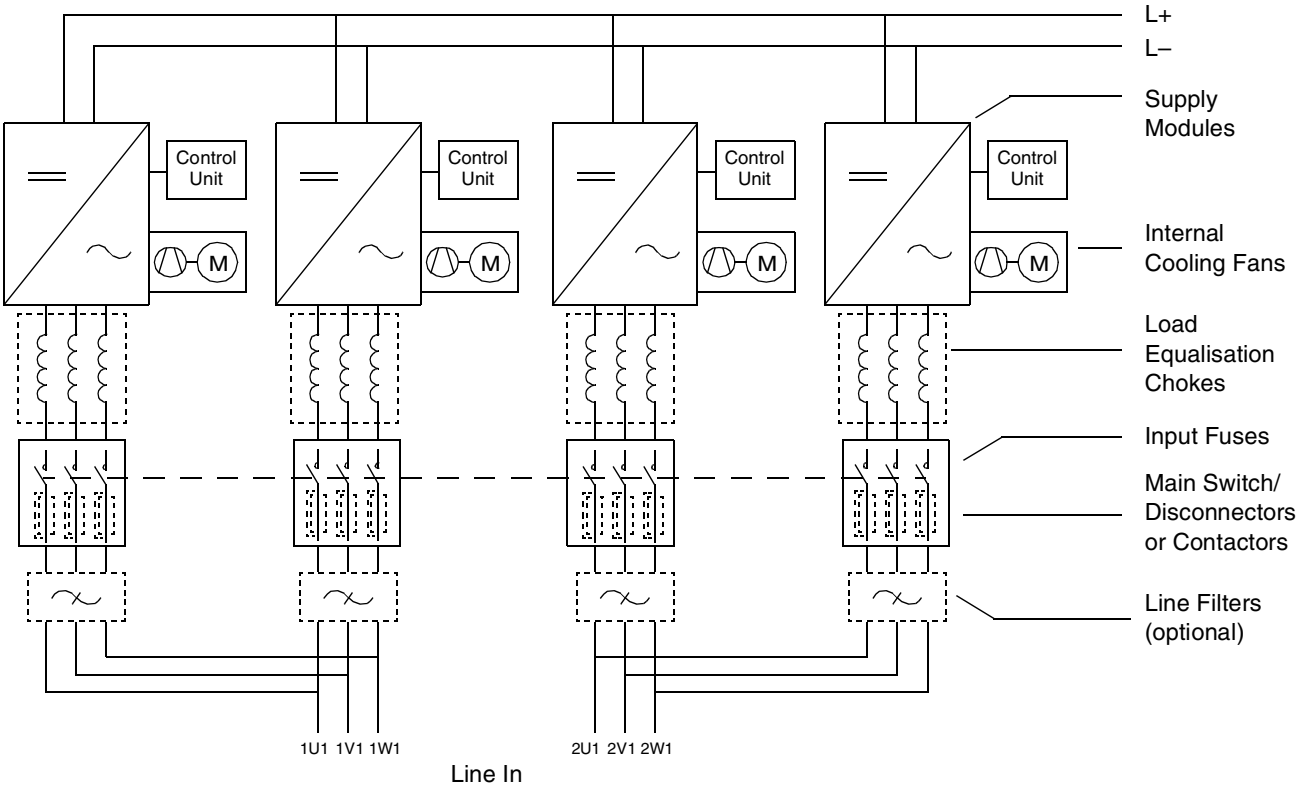
2×B3 (6-pulse)



2×B3, 2×B5 (12-pulse)



4×B3 (12-pulse)


L+
L–
Supply Modules
Control Unit
Control Unit
Control Unit
Control Unit
M
M
M
M
Internal Cooling Fans
Load Equalisation Chokes
Input Fuses
Main Switch/ Disconnectors or Contactors
Line Filters (optional)
1U1 1V1 1W1
2U1 2V1 2W1
Line In

Components The components specific to the water-cooled diode supply units are presented below.

Input (AC) Fuses for Frame B3, 2×B3 and 4×B3 Water-cooled Diode Supply Units						
Supply Unit Type	**Qty**	**Ordering Code**	**Type**	**U_N (V)**	**I_N (A)**	**Size**
ACW 684 0700 6 (6-pulse)	3 ×	10030625	170M6814	690	1000	03
2 × ACW 684 0700 6 (6-pulse)	6 ×					
2 × ACW 684 0700 6 (12-pulse)	6 ×					
4 × ACW 684 0700 6 (12-pulse)	12 ×					

For fuseholders, see the *Product Catalogue.*

Line Filters for Frame B3, 2×B3 and 4×B3 Water-cooled Diode Supply Units				
Supply Unit Type	**Qty**	**Ordering Code**	**Type**	**Data**
ACW 684 0700 6 (6-pulse)	3 ×	10031923	B84143-B600-S21	(See the *Product Catalogue.)*
2 × ACW 684 0700 6 (6-pulse)	6 ×			
2 × ACW 684 0700 6 (12-pulse)	6 ×			
4 × ACW 684 0700 6 (12-pulse)	12 ×			

Load Equalisation Chokes for Frame 2×B3 (6-pulse) and 4×B3 (12-pulse) Water-cooled Diode Supply Units							
Supply Unit Type	**Qty**	**Ordering Code**	**Type**	**Power Loss (kW)**	**U_N (V)**	**I_{RMS} (A)**	**L (µH)**
2 × ACW 684 0700 6 (6-pulse)	2 ×	64444093	NLAC-0740-01	0.5	690	620	15
4 × ACW 684 0700 6 (12-pulse)	4 ×						

DC Reactors for Frame B5 and 2×B5 Water-cooled Diode Supply Units								
Supply Unit Type	**Qty**	**Ordering Code**	**I_N (A)**	**L (µH)**	**Power Loss**		**Coolant**	
					into Coolant (kW)	**into Cooling Air (kW)**	**Capacity (l)**	**Flow (kg/h)**
ACW 684 2600 6 (6-pulse)	1 ×	64251147	3690	30	2.0	1.2	0.4	600
ACW 684 3600 6 (6-pulse)	1 ×	64251147	3690	30	2.6	2.8	0.4	600
2 × ACW 684 2600 6 (12-pulse)	2 ×	64251147	3690	30	2 × 2.0	2 × 1.2	2 × 0.4	2 × 600

The DC reactors above are themselves water-cooled by a pipe round the perimeter of the winding.

Air-to-Water Heat Exchangers for Water-cooled Diode Supply Units						
Supply Unit Type	**Qty**	**Ordering Code**	**Type**	**P_N (kW)**	**Coolant**	
					Capacity (l)	**Flow (kg/h)**
ACW 684 0700 6 (6-pulse)	1 ×	64345095	201702	2.0	2.0	700
2 × ACW 684 0700 6 (6-pulse)	2 ×			2 × 2.0	2 × 2.0	2 × 700
ACW 684 2600 6 (6-pulse) ACW 684 3600 6 (6-pulse)	1 ×	64302345	201703	5.0	2.0	1500
2 × ACW 684 0700 6 (12-pulse)	2 ×	64345095	201702	2 × 2.0	2 × 2.0	2 × 700
4 × ACW 684 0700 6 (12-pulse)	4 ×			4 × 2.0	4 × 2.0	4 × 700
2 × ACW 684 2600 6 (12-pulse)	2 ×	64302345	201703	2 × 5.0	2 × 2.0	2 × 1500

Additional Fans for Air-to-Water Heat Exchangers (DSU)					
Supply Unit Type	**Auxiliary Voltage (V AC)**	**Qty**	**Ordering Code**	**Type**	**Connection Cable Length**
ACW 684 0700 6 (6-pulse) 2 × ACW 684 0700 6 (6-pulse)	230	1 ×	64490052	D2E146-AP47-79	2.1 m
	115	1 ×	64490061	D2E146-AP51-80	
ACW 684 2600 6 (6-pulse)	(not required)				
ACW 684 3600 6 (6-pulse)					
2 × ACW 684 0700 6 (12-pulse) 4 × ACW 684 0700 6 (12-pulse)	230	2 ×	64490052	D2E146-AP47-79	2.1 m
	115	2 ×	64490061	D2E146-AP51-80	
2 × ACW 684 2600 6 (12-pulse)	(not required)				

Thyristor Supply Modules

This is the technical data of the water-cooled thyristor supply modules.

Water-cooled Thyristor Supply Modules (Rectifying bridge only)											
Type	Auxiliary Voltage (V AC)	Ordering Code	T_A = 40 °C, IP22				Duty Cycle (10/60 s)		Duty Cycle (1/5 min)		Frame
			S_N (kVA)	I_{1N} (A)	I_{DC} (A)	P_N (kW)	I_{DCBase} (A)	I_{DCMax} (A)	I_{DCBase} (A)	I_{DCMax} (A)	
690 V											
ACW 654 3600 6	230/115*	64444743	3415	2658	3500	3152	2100	5670	2100	4431	B5

*The module includes a 3-phase cooling fan powered from the main supply (no auxiliary voltage required).

Water-cooled Thyristor Supply Modules (Regenerative bridge only)											
Type	Auxiliary Voltage (V AC)	Ordering Code	T_A = 40 °C, IP22				Duty Cycle (10/60 s)		Duty Cycle (1/5 min)		Frame
			S_N (kVA)	I_{1N} (A)	I_{DC} (A)	P_N (kW)	I_{DCBase} (A)	I_{DCMax} (A)	I_{DCBase} (A)	I_{DCMax} (A)	
690 V											
ACW 664 3600 6	230/115*	64444751	3415	2658	3500	2837	2100	5670	2100	4431	B5

*The module includes a 3-phase cooling fan powered from the main supply (no auxiliary voltage required).

Cooling Characteristics of Water-cooled Thyristor Supply Modules				
Type	Power Loss		Coolant	
	into Coolant (kW)	into Cooling Air (kW)	Capacity (l)	Flow (kg/h)
ACW 654 3600 6 ACW 664 3600 6	11.8	4.0	2.0	1500

Configuration

The configuration is identical to that of B5 air-cooled modules, i.e. the bridges are connected in parallel. One separate DC reactor is to be used.

Components

The control electronics are identical to the corresponding air-cooled thyristor supply units. The data of the air-to-water heat exchanger (used with a closed-type cubicle) is as follows:

Air-to-Water Heat Exchangers for Water-cooled Thyristor Supply Units						
Supply Unit Type	Qty	Ordering Code	Type	P_N (kW)	Coolant	
					Capacity (l)	Flow (kg/h)
ACW 654/664 3600 6	1 ×	64302345	201703	5	2.0	1500

Inverter Modules

The frame sizes available as water-cooled are R8i to 4×R12i. The technical data of these modules are presented below.

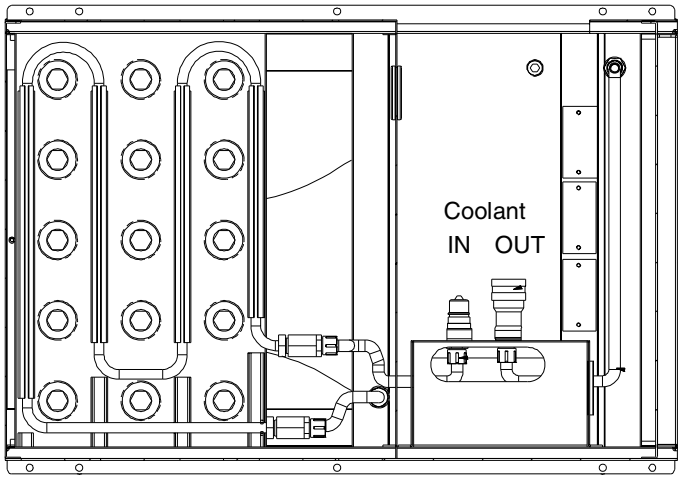
Water-cooled Inverter Modules										
Type	**Ordering Code***	**S_N (kVA)**	**P_N (kW)**	**I_{2N} (A)**	**Duty Cycle 200% (10/60 s)**		**Duty Cycle 150% (1/5 min)**		**DC Capacitance (mF)**	**Frame**
					I_{2Base} (A)	**I_{2Max} (A)**	**I_{2Base} (A)**	**I_{2Max} (A)**		
690 V										
ACW 634 0210 6	64332350	210	160	176	127	254	132	198	3.13	R8i
ACW 634 0320 6	64332341	310	250	264	179	358	198	297	4.70	
ACW 634 0380 6	64311140	370	315	310	225	450	233	349	6.27	R9i
ACW 634 0490 6	64311158	490	400	410	265	530	308	461	7.83	
ACW 634 0710 6	64451731	704	563	589	428	855	443	663	12.54	2×R9i
ACW 634 0930 6	64451723	931	745	779	504	1007	585	876	14.10	
ACW 634 1050 6	64269135	1040	832	874	641	1282	656	983	18.80	R12i
ACW 634 1390 6	64269160	1380	1104	1156	755	1510	867	1301	23.50	
ACW 634 1985 6	64310763	1985	1588	1661	1218	2436	1245	1868	37.60	2×R12i
ACW 634 2625 6	64310771	2625	2100	2196	1435	2869	1647	2471	47.00	
ACW 634 2945 6	64310828	2945	2356	2465	1808	3615	1849	2773	56.40	3×R12i
ACW 634 3900 6	64310801	3900	3120	3260	2129	4258	2445	3667	70.50	
ACW 634 5145 6	64310810	5140	4112	4300	3020	6040	3225	4838	94.00	4×R12i

*This is the ordering code for units with coated boards, and with the Prevention of Unexpected Start option (see the *Product Catalogue* for details on these options).

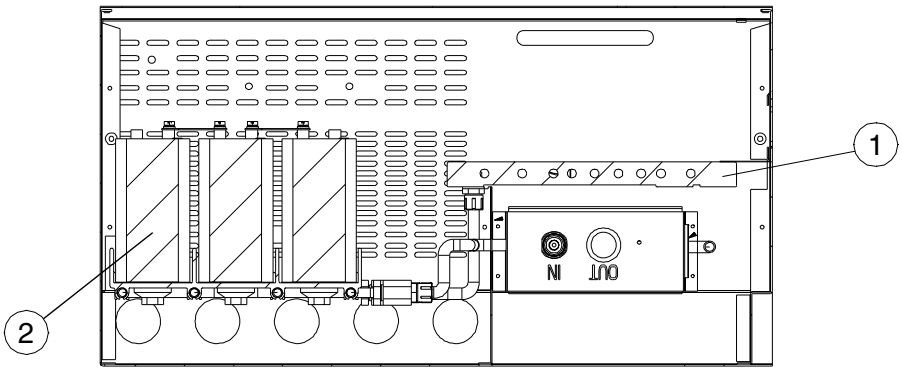
Cooling Characteristics of Water-cooled Inverter Modules				
Type	**Power Loss**		**Coolant**	
	into Coolant (kW)	**into Cooling Air (kW)**	**Capacity (l)**	**Flow (kg/h)**
ACW 634 0210 6	2.2	1.0	0.5	580
ACW 634 0320 6	3.3	1.4		
ACW 634 0380 6	3.9	1.7		
ACW 634 0490 6	5.2	2.2		
ACW 634 0710 6	7.0	3.0	2 × 0.5	2 × 580
ACW 634 0930 6	9.8	4.2		
ACW 634 1050 6	10.9	4.7	3 × 0.5	3 × 580
ACW 634 1390 6	14.5	6.2		
ACW 634 1985 6	18.0	7.7	2 × 3 × 0.5	2 × 3 × 580
ACW 634 2625 6	26.7	11.4		
ACW 634 2945 6	29.4	12.6	3 × 3 × 0.5	3 × 3 × 580
ACW 634 3900 6	40.7	17.5		
ACW 634 5145 6	54.0	23.1	4 × 3 × 0.5	4 × 3 × 580

Cooling Principle The figure below shows the cooling of one phase module. The coolant circulates through the mounting plate of the power stage components (1) and through the capacitor bank.

REAR VIEW



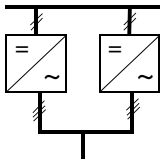
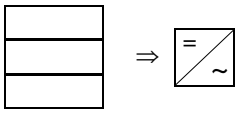
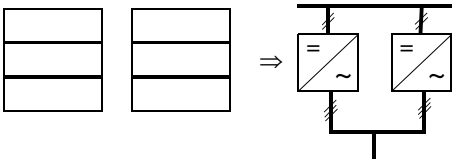
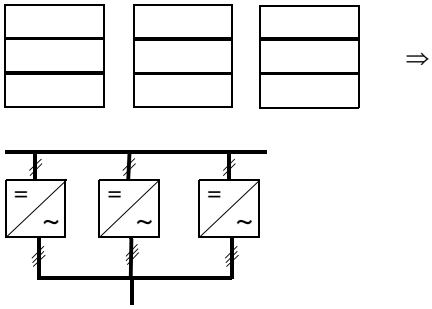
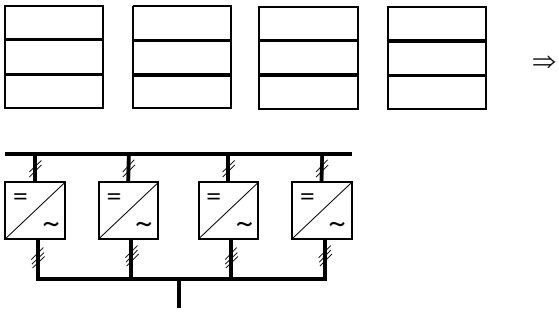
TOP VIEW



With a ventilated cubicle, an air baffle must be installed to prevent the cooling air from circulating inside the cubicle.

With a closed-type cubicle, an air-to-water heat exchanger must be used. (No additional fan is needed.)

Configuration The basic configurations of the inverter modules are as follows:

Frame Size	Configuration
R8i, R9i	
2 x R9i	
R12i	Three phase modules = one inverter 
2 x R12i	2 × three phase modules = two phase module blocks ⇒ one inverter 
3 x R12i	3 × three phase modules = three phase module blocks ⇒ one inverter 
4 x R12i	4 × three phase modules = four phase module blocks ⇒ one inverter 

Components

The control electronics are identical to the corresponding air-cooled drive units. Units that consist of parallel-connected smaller (phase) modules (2×R9i, 2×R12i, etc.) require an optical PPCS branching unit.

The components specific to the water-cooled drive units are presented below.

Cooling Fans for Water-cooled Inverter Modules				
Inverter Module Frame	**Auxiliary Voltage (V AC)**	**Qty**	**Ordering Code**	**Type**	**Connection Cable Length**
R8i, R9i, 2×R9i	230	1 ×	10028841	W2E250-HL06-05	Not included. Connector: Screw terminal block
	115	1 ×	10032318	W2E250-HL08-06	
R12i	230	2 ×	64490052	D2E146-AP47-79	2.1 m
	115	2 ×	64490061	D2E146-AP51-80	
2×R12i	230	4 ×	64490052	D2E146-AP47-79	
	115	4 ×	64490061	D2E146-AP51-80	
3×R12i	230	6 ×	64490052	D2E146-AP47-79	
	115	6 ×	64490061	D2E146-AP51-80	
4×R12i	230	8 ×	64490052	D2E146-AP47-79	
	115	8 ×	64490061	D2E146-AP51-80	

Mounting Frames for Water-cooled Inverter Modules				
Inverter Module Frame	**Qty**		**Ordering Code**	**Dimensions**
R8i, R9i	1	×	64497821	(See Appendix B.)
2×R9i	2	×	64497821	
R12i	1	×	64497812	
2×R12i	2	×	64497812	
3×R12i	3	×	64497812	
4×R12i	4	×	64497812	

Input (DC) Fuses for Water-cooled Inverter Modules						
Inverter Module Frame	**Qty**	**Ordering Code**	**U_N (V)**	**I_N (A)**	**Type**	**Size**
R8i, R9i	2 ×	10001773	1250	630	170M6205	03SHT
2×R9i	4 ×					
R12i	6 ×					
2×R12i	12 ×					
3×R12i	18 ×					
4×R12i	24 ×					

For fuseholders, see the *Product Catalogue.*

Switch Fuse Kits for Water-cooled Inverter Modules Fuses and fuseholders are not included.					
Aux. Voltage (V AC)	**Inverter Module Frame**	**Qty**	**Ordering Code**	**Kit Contents**	**Charging Circuit Type**
230	R8i, R9i	1 ×	64349686	1–Switch Fuse (OESA630D2PL-21/1, including: locking device, charging contacts, 1–NC contact, 1–NO contact) • 2–Resistor (ZRF 30×165) • 1–Charging Monitoring Unit (NCHM-21C) • 1–Wire Set, OESA control wiring	3
	2×R9i	1 ×	64349473	1–Switch Fuse (OESA630DF4PL-21/1, including: locking device, charging contacts, 1–NC contact, 1–NO contact) • 4–Resistor (ZRF 30×165) • 1–Charging Monitoring Unit (NCHM-21C) • 1–Wire Set, OESA control wiring	
	3×R12i	4 ×			
	R12i	1 ×	64349538	1–Switch Fuse (OESA630D6PL-21/1, including: locking device, charging contacts, 1–NC contact, 1–NO contact) • 6–Resistor (ZRF 30×165) • 1–Charging Monitoring Unit (NCHM-21C) • 1–Wire Set, OESA control wiring	
	2×R12i	2 ×			
	4×R12i	4 ×			
115	R8i, R9i	1 ×	64349694	1–Switch Fuse (OESA630D2PL-21/2, including: locking device, charging contacts, 1–NC contact, 1–NO contact) • 2–Resistor (ZRF 30×165) • 1–Charging Monitoring Unit (NCHM-11C) • 1–Wire Set, OESA control wiring	
	2×R9i	1 ×	64349481	1–Switch Fuse (OESA630DF4PL-X, including: locking device, charging contacts, 1–NC contact, 1–NO contact) • 4–Resistor (ZRF 30×165) • 1–Charging Monitoring Unit (NCHM-11C) • 1–Wire Set, OESA control wiring	
	3×R12i	4 ×			
	R12i	1 ×	64349546	1–Switch Fuse (OESA630D6PL-21/2, including: locking device, charging contacts, 1–NC contact, 1–NO contact) • 6–Resistor (ZRF 30×165) • 1–Charging Monitoring Unit (NCHM-11C) • 1–Wire Set, OESA control wiring	
	2×R12i	2 ×			
	4×R12i	4 ×			

Charging Circuit Fuses for Water-cooled Inverter Modules						
Inverter Module Frame	**Qty**	**Ordering Code**	**U_N (V)**	**I_N (A)**	**Type**	**Size**
ACW 634 0210 6 ACW 634 0320 6 ACW 634 0380 6 ACW 634 0490 6 ACW 634 0710 6 ACW 634 0930 6 ACW 634 1050 6 ACW 634 1390 6	2 ×	10032601	1000	10	170M2690	00
ACW 634 1985 6 ACW 634 2625 6	4 ×					
ACW 634 2945 6 ACW 634 3900 6	6 ×					
ACW 634 5145 6	8 ×					

For fuseholders, see the *Product Catalogue.*

Optical (PPCS) Branching Unit Kits for Water-cooled Inverter Modules		
Inverter Module Frame	**Ordering Code**	**Kit Contents**
2×R9i, 2×R12i	64349091	1–NPBU-42C 2–Fibre Optic Cable (2000 mm) 2–Fibre Optic Cable (3000 mm)
3×R12i, 4×R12i	64349139	1–NPBU-42C 4–Fibre Optic Cable (3000 mm) 4–Fibre Optic Cable (5000 mm)

du/dt Filters for Water-cooled Inverter Modules							
Inverter Module Frame	**Qty**	**Ordering Code**	**Type**	**I_{RMS} (A)**	**L (µH)**	**Power Loss (W)**	**Connection Size**
R8i, R9i	3 ×	10030340 58982911*	NOCH0400-60	351	52	250	M10
2×R9i	6 ×						
R12i	9 ×						
2×R12i	18 ×						
3×R12i	27 ×						
4×R12i	36 ×						

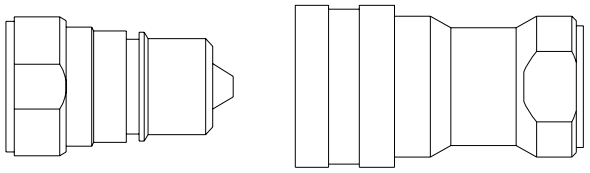
*Connecting busbars and insulating supports included

Common Mode Filters (CMF) / Light Common Mode Filters (LCMF) for Water-cooled Inverter Modules						
Inverter Module Type	**CMF**			**LCMF**		
	Qty		**Ordering Code**	**Qty**		**Ordering Code**
ACW 634 0210 6 ACW 634 0320 6 ACW 634 0380 6	1	×	64315811	1	×	64392611
ACW 634 0490 6	2	×	64315811	2	×	64392611
ACW 634 0710 6	3	×	64315811	3	×	64392611
ACW 634 0930 6	4	×	64315811	4	×	64392611
ACW 634 1050 6 ACW 634 1390 6	6	×	64315811	6	×	64392611
ACW 634 1985 6 ACW 634 2625 6	12	×	64315811	12	×	64392611
ACW 634 2945 6	16	×	64315811	16	×	64392611
ACW 634 3900 6 ACW 634 5145 6	24	×	64315811	24	×	64392611

Air-to-Water Heat Exchangers for Water-cooled Inverter Modules							
Inverter Module Type	**Qty**		**Ordering Code**	**Type**	**P_N (kW)**	**Coolant**	
						Capacity (l)	**Flow (kg/h)**
ACW 634 0210 6 ACW 634 0320 6 ACW 634 0380 6 ACW 634 0490 6 ACW 634 0710 6 ACW 634 0930 6	1	×	64433041	–	2.0	1.0	240
ACW 634 1050 6 ACW 634 1390 6	1	×	64345095	201702	2.0	2.0	700
ACW 634 1985 6 ACW 634 2625 6	2	×	64345095	201702	2 × 2.0	2 × 2.0	2 × 700
ACW 634 2945 6 ACW 634 3900 6	3	×	64345095	201702	3 × 2.0	3 × 2.0	3 × 700
ACW 634 5145 6	4	×	64345095	201702	4 × 2.0	4 × 2.0	4 × 700

Quick Release Coupling Kits for Water-cooled Inverter Modules			
Inverter Module Type	**Qty**	**Ordering Code**	**Type**
ACW 634 0210 6 ACW 634 0320 6 ACW 634 0380 6 ACW 634 0490 6	1 ×	64438841	1–ALGR520-6 R3/8 HK SH-3-63 1–ALGR510-06 R3/8 HK SH-3-62
ACW 634 0710 6 ACW 634 0930 6	2 ×		
ACW 634 1050 6 ACW 634 1390 6	3 ×		
ACW 634 1985 6 ACW 634 2625 6	6 ×		
ACW 634 2945 6 ACW 634 3900 6	9 ×		
ACW 634 5145 6	12 ×		

Each kit contains both the female and male halves of a complete quick release coupling.



Size: 3/8”

Braking Choppers

The NBRW-669C is the water-cooled counterpart of the air-cooled NBRA-669C braking chopper.

Water-cooled Braking Chopper														
U_N (V)	Ordering Code	Type	P_{brmax} (kW)	P_{cont} (kW)	I_{max} (A)	I_{rms} (A)	R (ohm)	C (mF)	Duty Cycle (10/60 s)		Duty Cycle (1/5 min)		U_{br_on} (V)	U_{br_off} (V)
									P_{br} (kW)	I_{rms} (A)	P_{br} (kW)	I_{rms} (A)		
690	64260049	NBRW-669C	404	119	414	107	2.72	20.1	404	361	298	267	1120	1096

U_N = Nominal voltage
P_{brmax} = Maximum short-term (1 min every 10 mins) braking power
P_{cont} = Maximum continuous braking power
I_{max} = Maximum peak current
I_{rms} = Corresponding RMS current
R = Recommended resistance
C = Assumed DC bus capacitance (including supply and inverter modules) per chopper. If actual DC bus capacitance (per chopper) is lower than this value, see derating instructions given in *The ACS 600 MultiDrive Modules Engineering Tool,* or contact an ABB representative.
P_{br} = Braking power for the specified duty cycle
U_{br_on} = DC bus voltage at which chopper starts conducting
U_{br_off} = DC bus voltage at which chopper stops conducting

NBRW-669C units can be connected in parallel to form the following dynamic braking units. Note that each chopper must have their own resistor system.

Water-cooled Braking Units										
U_N	Chopper(s)	Qty	Ordering Code	R (ohm)	P_{brmax} (kW)	P_{cont} (kW)	I_{max} (A)	Duty Cycle (10/60 s)		Duty Cycle (1/5 min)	
								P_{br} (kW)	I_{rms} (A)	P_{br} (kW)	I_{rms} (A)
690 V	NBRW-669C	1 ×	64260049	2.72	404	119	414	404	361	298	267
	2 × NBRW-669C	2 ×	64260049	2.72	807	238	828	808	722	596	534
	3 × NBRW-669C	3 ×	64260049	2.72	1211	357	1242	1212	1083	894	801
	4 × NBRW-669C	4 ×	64260049	2.72	1615	476	1656	1616	1444	1192	1068
	5 × NBRW-669C	5 ×	64260049	2.72	2019	595	2070	2020	1805	1490	1335
	6 × NBRW-669C	6 ×	64260049	2.72	2422	714	2484	2424	2166	1788	1602

U_N = Nominal voltage
R = Recommended resistor resistance (per chopper)
P_{brmax} = Maximum total short-term (1 min every 10 mins) braking power
P_{cont} = Maximum total continuous braking power
I_{max} = Maximum total peak current at recommended resistance
P_{br} = Total braking power for the specified duty cycle
I_{rms} = Corresponding total RMS current

Cooling Characteristics of Water-cooled Braking Units				
Choppers	Power Loss		Coolant	
	into Coolant (kW)	into Cooling Air (kW)	Capacity (l)	Flow (kg/h)
1 × NBRW-669C	1.8	0.2	0.4	140
2 × NBRW-669C	3.6	0.4	2 × 0.4	2 × 140
3 × NBRW-669C	5.4	0.6	3 × 0.4	3 × 140
4 × NBRW-669C	7.2	0.8	4 × 0.4	4 × 140
5 × NBRW-669C	9.0	1.0	5 × 0.4	5 × 140
6 × NBRW-669C	10.8	1.2	6 × 0.4	6 × 140

Braking Resistors

There are currently no water-cooled resistors available in the *ACS 600 MultiDrive Modules* product range. However, the air-cooled resistors specified in the *Product Catalogue* can be used if otherwise allowed by the application.

Configuration

The configuration of a water-cooled dynamic braking unit is the same as with air-cooled choppers.

Components

The attenuator, DC fuses, and fuse bases are identical to those used with an air-cooled unit (see the *Product Catalogue* for the ordering codes). However, in a water-cooled braking unit, the cooling fan is different due to the fact that it is only required for circulating the air inside the cubicle.

Cooling Fan Kits for Water-cooled Braking Units				
Auxiliary Voltage (V AC)	Choppers	Qty	Ordering Code	Type	Connection Cable Length
230	1 × NBRW-669C 2 × NBRW-669C	1	× 10012171	W2E 200-HH38-06	Not included. Connector: Screw terminal block.
	3 × NBRW-669C 4 × NBRW-669C	2	× 10012171		
	5 × NBRW-669C 6 × NBRW-669C	3	× 10012171		
115	1 × NBRW-669C 2 × NBRW-669C	1	× 10032300	W2E 200-HH86-14	
	3 × NBRW-669C 4 × NBRW-669C	2	× 10032300		
	5 × NBRW-669C 6 × NBRW-669C	3	× 10032300		

ACW 695 Water Cooling Sections

A water cooling section can be used to isolate the cooling system of the drive from an external system. This is necessary if the water quality, temperature variation, etc. of the on-site cooling system do not match those required by the drive.

The water cooling section contains a water/water heat exchanger, a pump, and a control unit to adjust the coolant flow in the drive.

The ACS 600 MultiDrive Modules product range contains these complete water cooling sections:

Water Cooling Sections

Type	Ordering Code	P_N (kW)	Power Loss		Coolant			Operating Point at 150 kPa (kg/h)	Pressure Loss (kPa)
			into Coolant (kW)	into Cooling Air (kW)	Capacity (internal system) (l)	Capacity (external system) (l)	Nominal Mass Flow (kg/h)		
380 to 690 V									
ACW 695 xxxxx*	xxxxx	38	1.4	0.6	20.0	4.0	8700	4800	150
ACW 695 050	Contact an ABB sales representative.	50	1.8	0.2	36.0	7.0	14400	12960	150
ACW 695 100		100	2.1	0.2	39.0	10.0	26300	19800	150
ACW 695 175		175	2.3	0.2	41.0	12.0	35300	23400	150

*This type consists of the components installed in a mounting frame. The other types are housed in a cubicle.

For dimensions, see *Appendix B – Dimensional Diagrams*.

The water cooling sections are detailed in the *ACW 695 Water Cooling Sections User's Manual* (3BFE 64314912 [English]).

Chapter 3 – Installation

Supply and Inverter Modules

All closed-type cubicles require an air-to-water heat exchanger. B3 modules require an additional fan. Ventilated cubicles must be fitted with an air baffle to prevent air from recirculating.

Power Connections

Supply Modules

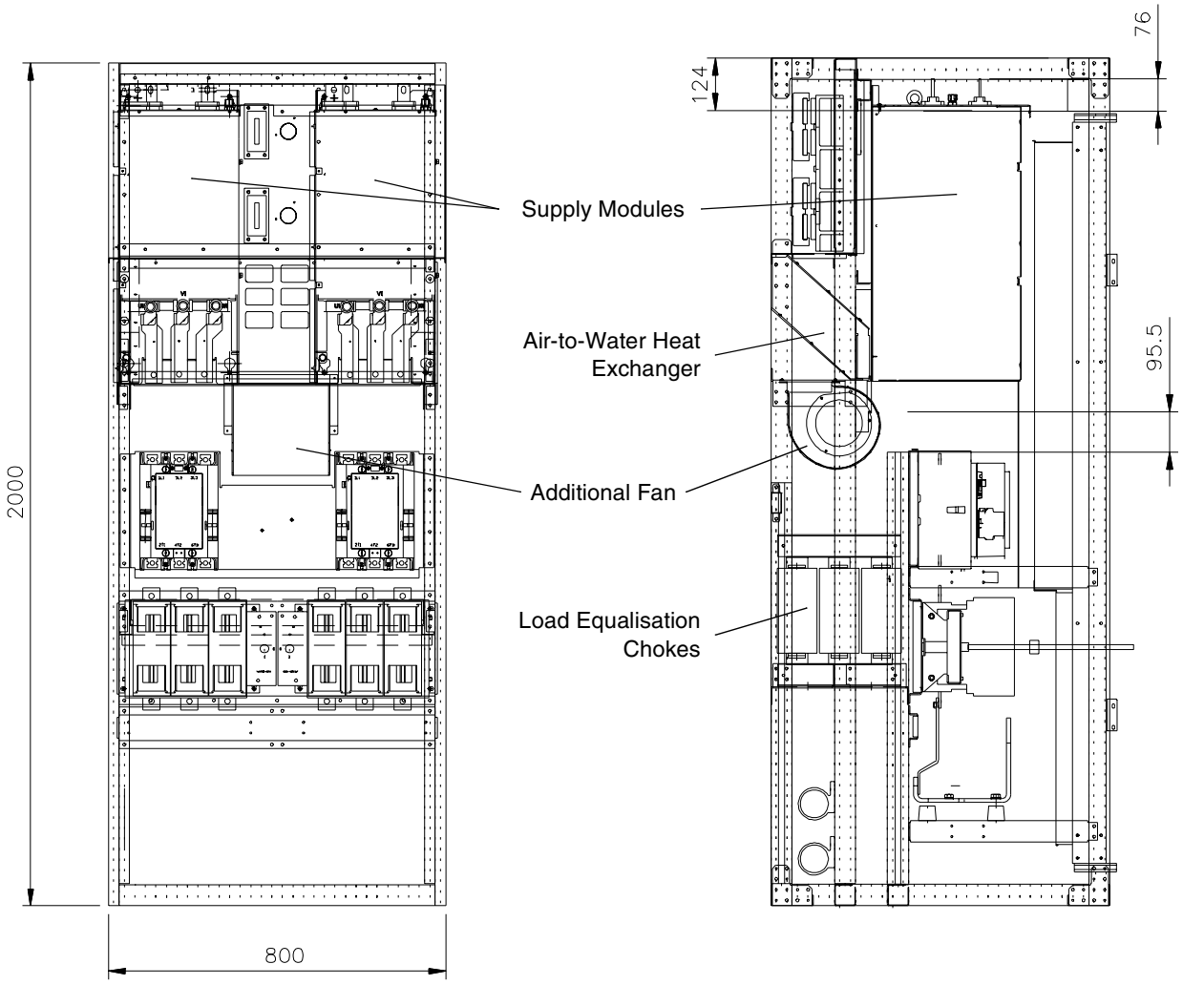
Module Type	AC Connection		DC Connection	
	Connection Hole for Busbar	Cross-section (per leg)	Connection Hole for Busbar	Cross-section (per leg)
Diode Supply Modules				
ACW 684 0700 6	Ø13 mm	8 × 30 mm	Ø13 mm	8 × 40 mm
ACW 684 2600 6	4 × Ø13 mm	2 × (10 × 100 mm)	Ø14 mm	2 × (10 × 100 mm)
ACW 684 3600 6	4 × Ø13 mm	2 × (10 × 100 mm)	Ø14 mm	2 × (10 × 100 mm)
Thyristor Supply Modules				
ACW 654/664 3600 6	4 × Ø13 mm	2 × (10 × 100 mm)	Ø14 mm	2 × (10 × 100 mm)

Inverter Modules

Module Type	DC Connection		AC Connection	
	Connection Hole for Busbar	Cross-section (per leg)	Connection Hole for Busbar	Cross-section (per leg)
ACW 634 0210 6 ACW 634 0320 6 ACW 634 0380 6 ACW 634 0490 6	Ø10 mm (M8)	4 × 40 mm	Ø11 mm (M8)	6 × 25 mm
ACW 634 0710 6 ACW 634 0930 6	Ø10 mm (M8)	2 × (4 × 40 mm)	Ø11 mm (M8)	2 × (6 × 25 mm)
ACW 634 1050 6 ACW 634 1390 6	Ø10 mm (M8)	3 × (4 × 40 mm)*	Ø11 mm (M8)	3 × 284 mm** 3 × (6 × 25 mm)***
ACW 634 1985 6 ACW 634 2625 6	Ø10 mm (M8)	2 × (3 × (4 × 40 mm)*)	Ø11 mm (M8)	2 × (3 × 284 mm**) 2 × (3 × (6 × 25 mm)***)
ACW 634 2945 6 ACW 634 3900 6	Ø10 mm (M8)	3 × (3 × (4 × 40 mm)*)	Ø11 mm (M8)	3 × (3 × 284 mm**) 3 × (3 × (6 × 25 mm)***)
ACW 634 5145 6	Ø10 mm (M8)	4 × (3 × (4 × 40 mm)*)	Ø11 mm (M8)	4 × (3 × 284 mm**) 4 × (3 × (6 × 25 mm)***)

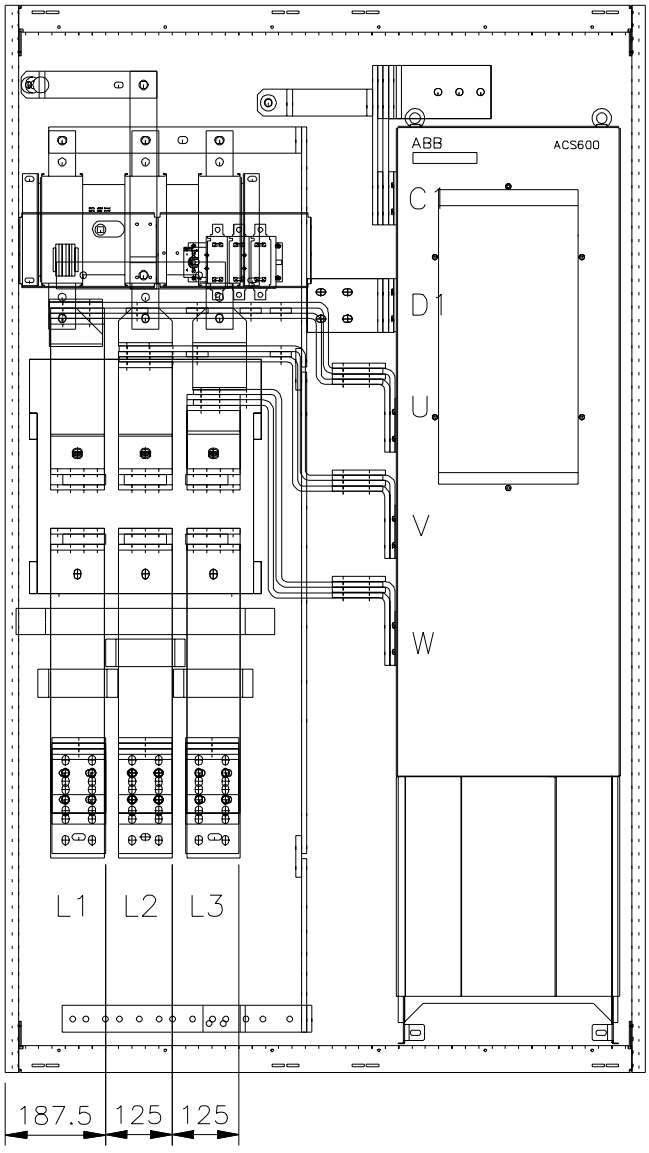
*DC busbar connection point as provided by the optional mounting frame.
**AC busbar(s) of the module as provided by the optional mounting frame.
***AC busbar(s) of the individual phase modules.

Example –
2×B3 Supply Unit



Note: Frame B3 supply modules have two L– output terminals which have to be externally connected to each other.

Example – B5 Supply Unit



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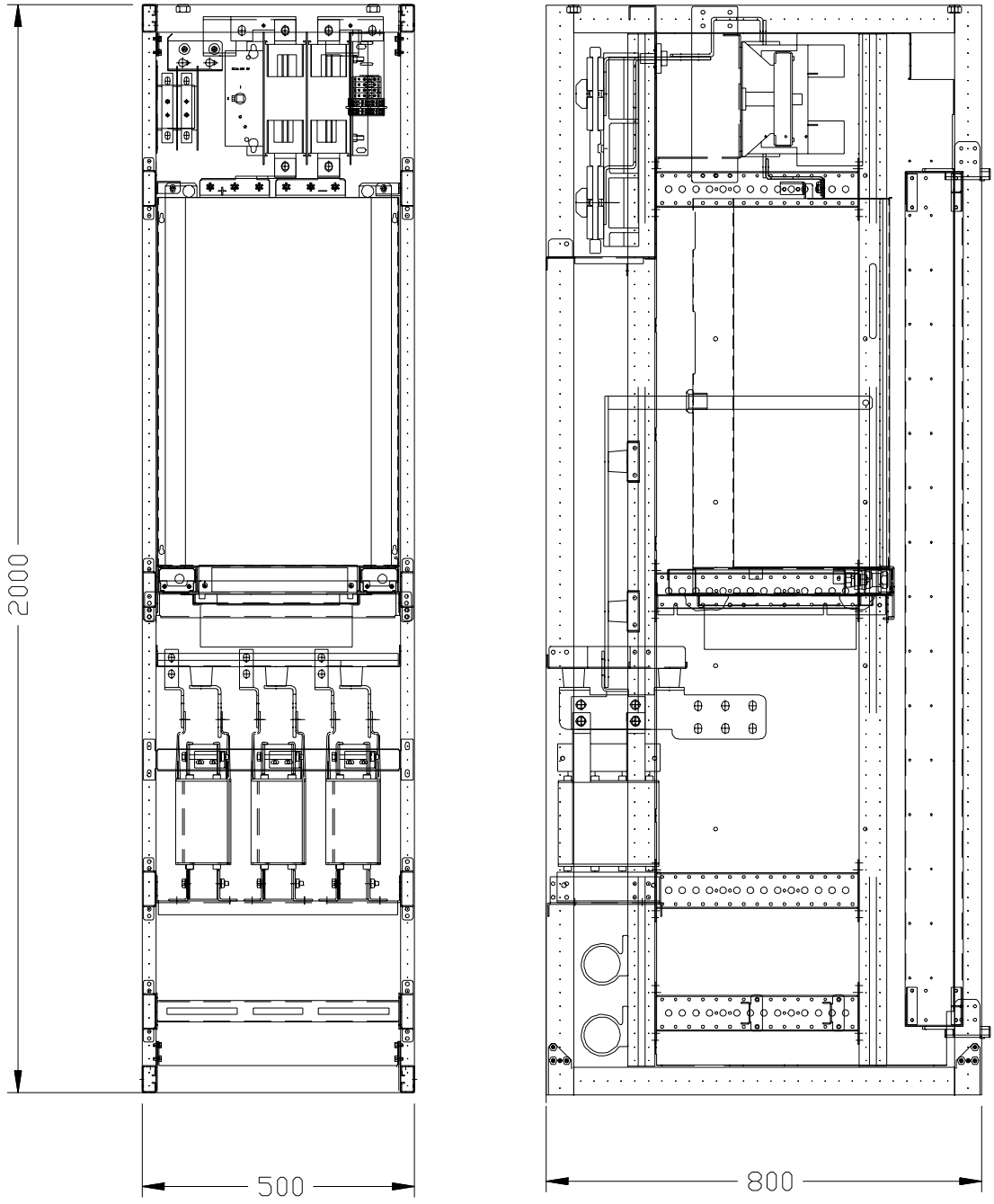
Example – R8i/R9i
Inverter Unit



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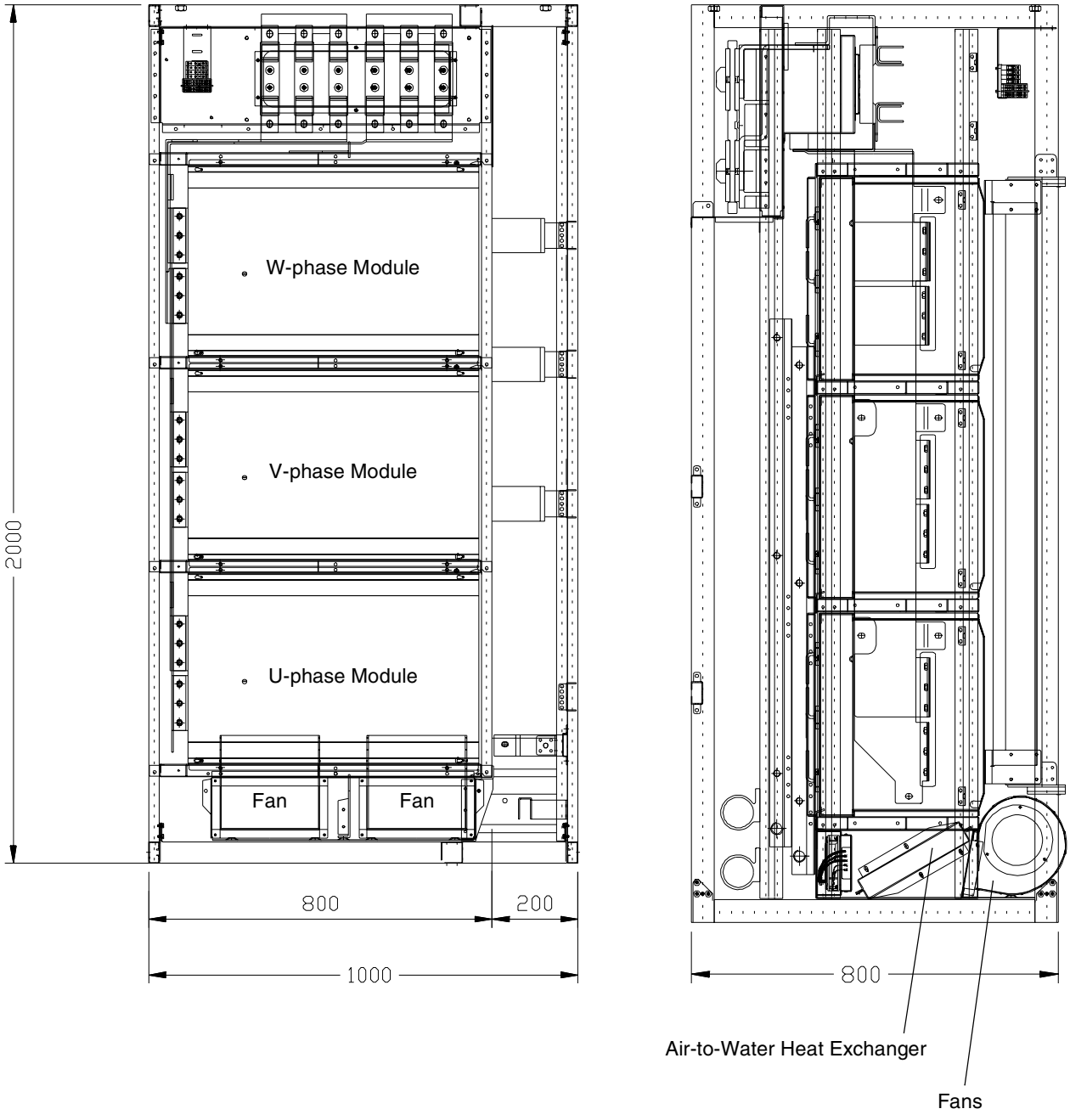
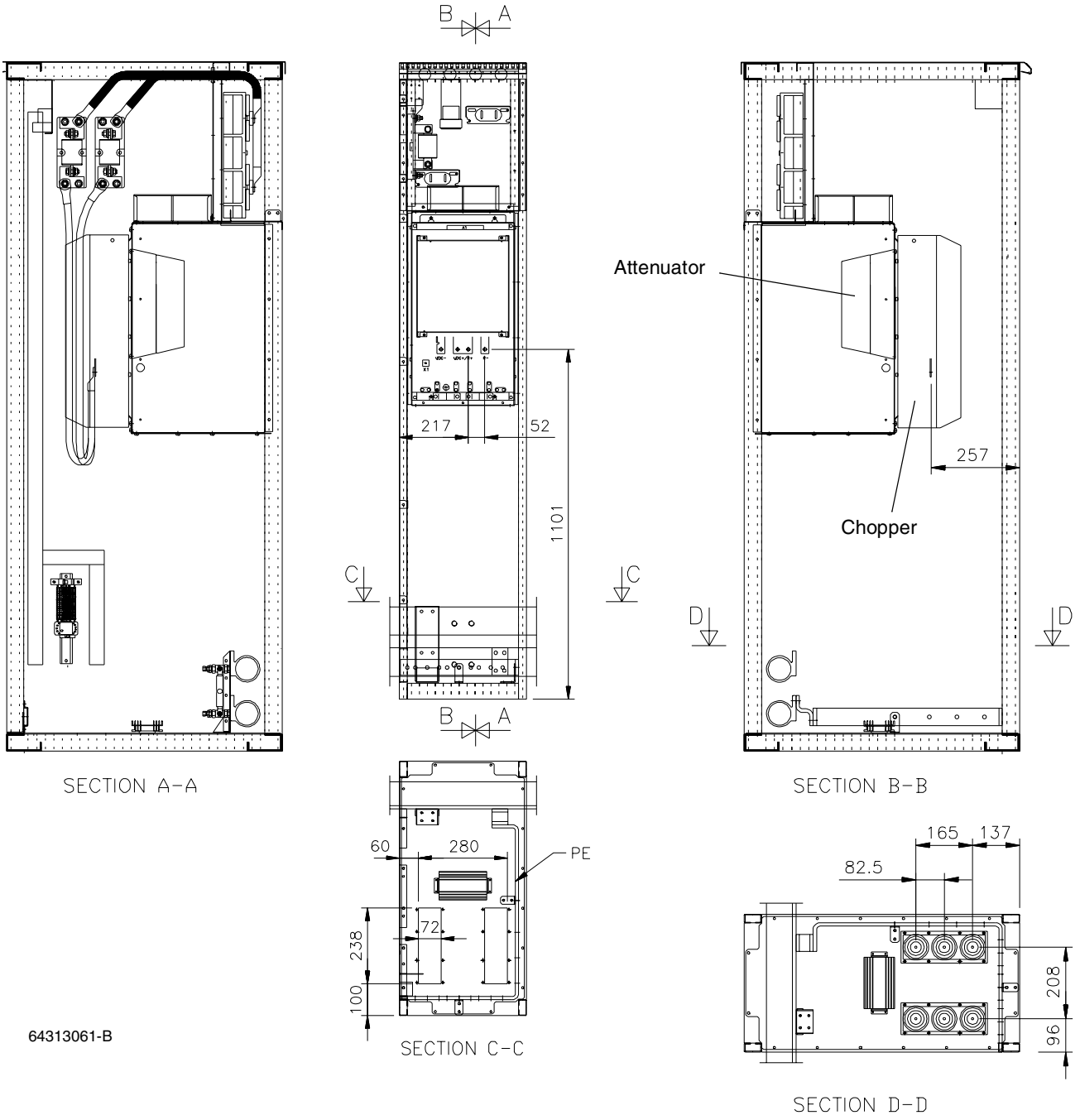
Example –
R12i Inverter Unit



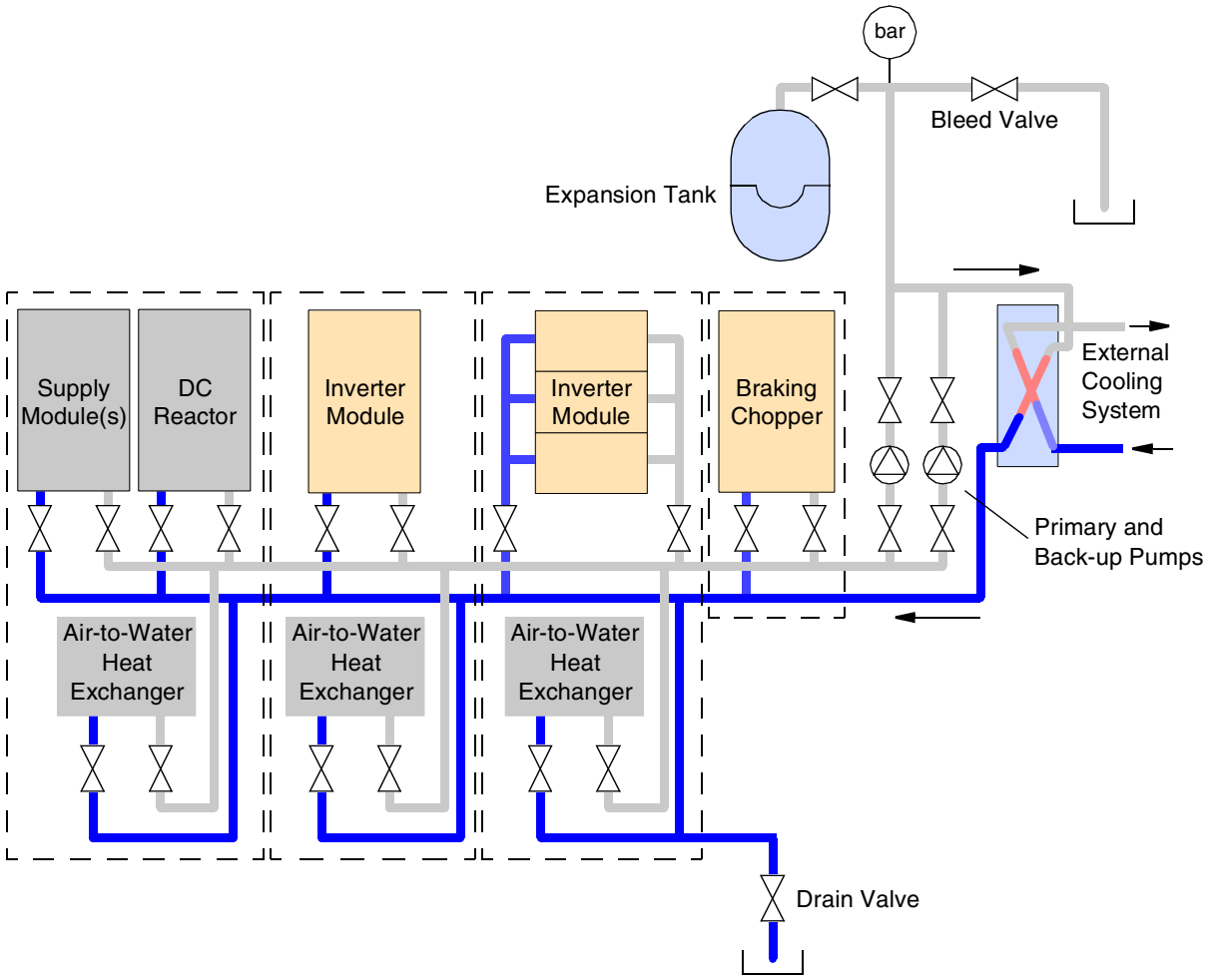
Example – Braking Unit



Water Cooling System

Follow the specifications for piping materials, coolant and ambient conditions given in Appendix A.

Below is a simplified example diagram of the water cooling system of the drive. The air-to-water heat exchangers are used when the cabinet is of the closed type.

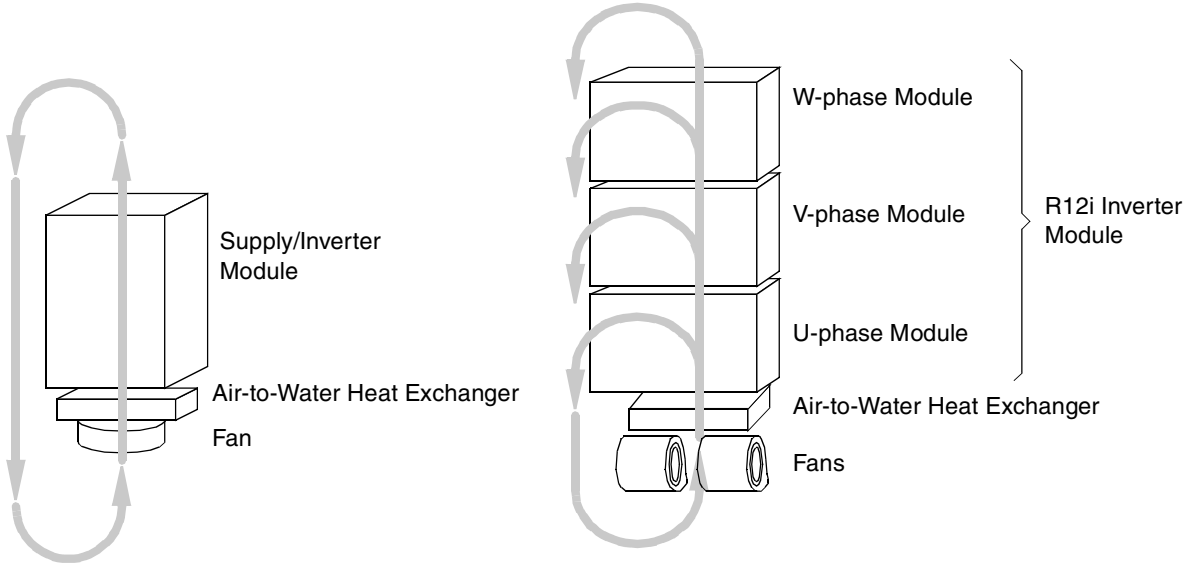


Water Pipe Connections The following table describes the water pipe connections of each water-cooled component.

Water Pipe Connections						
Module/Unit	**Connection**	**Qty**	**Type of Connection**	**Type of Connector**	**Size**	**Recommended Pipe**
B3 Supply Module	IN	1	Pipe connector	CK-3/8-PK-9AL (Festo)	3/8”	3/8”
	OUT	1				
B3 Heat Exchanger	IN	1	Female thread	N/A	3/8”–19	3/8”
	OUT	1				
B5 Supply Module	IN	1	Male thread	N/A	1/2”–14	1/2”
	OUT	1	Male thread			
	Bleed	1	Pipe connector	CK-3/8-PK-9AL (Festo)	3/8”	3/8”
B5 DC Reactor	IN	1	Pipe connector	CK-3/8-PK-9AL (Festo)	3/8”	3/8”
	OUT	1				
B5 Heat Exchanger	IN	1	Female thread	N/A	1/2”–14	1/2”
	OUT	1				
	Bleed	1	Female thread	N/A	3/8”–19	3/8”
R8i, R9i Inverter Module	IN	1	Quick release coupling (male)	ALGR520-6 (Dunlop Hiflex)	3/8”	3/8”
	OUT	1	Quick release coupling (female)	ALGR-510-06 (Dunlop Hiflex)		
R8i, R9i Heat Exchanger	IN	1	Female thread	N/A	3/8”–19	3/8”
	OUT	1				
R12i Inverter Module	IN	3	Quick release coupling (male)	ALGR520-6 (Dunlop Hiflex)	3/8”	3/8”
	OUT	3	Quick release coupling (female)	ALGR-510-06 (Dunlop Hiflex)		
R12i Heat Exchanger	IN	1	Female thread	N/A	3/8”–19	3/8”
	OUT	1				
NBRW-669C Braking Chopper	IN	1	Plain pipe	PEX 6/4, length 1.5 m	3/8”	3/8”
	OUT	1				

Cooling Air Flow in a Closed-type Cubicle

In a closed-type cubicle, the air must circulate as shown in the figure below.



Appendix A – Technical Data and Specifications

Technical Data

The technical data given in the *Product Catalogue* applies with the following exceptions:

Cooling Method: Direct water cooling. Requirements for cooling water: See *Water Cooling System* below.

Water Cooling System

Nominal Values

Maximum pressure of the water cooling system: 6 bar.

Base pressure of the water cooling system: Recommended base pressure 1...1.5 bar. Maximum allowed base pressure 2 bar.

This table lists the nominal values for the water cooling system.

Temperature/Pressure	Secondary Circuit	Primary Circuit
Minimum inlet temperature (°C)	5	5
Maximum inlet temperature (°C)	42	38
Minimum inlet pressure (kPa)	100	10
Maximum inlet pressure (kPa)	600	600
Maximum temperature variation (°C)	±4	±7
Maximum temperature rise* (°C)	7	4
Minimum difference in pressure (kPa)	150	100
Maximum difference in pressure (kPa)	Equals maximum inlet pressure (600 kPa) - actual inlet pressure.	

*Depends on mass flow.

Intake Water Temperature:
Units with the optional Water Cooling Section ACW 695: minimum +5 °C, maximum +38 °C. Maximum allowed seasonal difference: 14 °C. See also *Minimum Water Temperatures*.

Units without an optional water cooling section: minimum +5 °C, maximum +42 °C. Maximum allowed seasonal difference is 8 °C. See also *Minimum Water Temperatures*.

Minimum Water Temperatures

The following table lists the minimum cooling water temperatures (at an atmospheric pressure of 1 bar, height above sea level) as a function of the relative humidity (ϕ) of the room temperature (T_{air}). Condensation occurs below these water temperatures.

T_{air} (°C)	Min. T_{water} (°C)				
	ϕ = 95%	ϕ = 80%	ϕ = 65%	ϕ = 50%	ϕ = 40%
5	4.3	1.9	< 0	< 0	< 0
10	9.2	6.7	3.7	< 0	< 0
15	14.2	11.5	8.4	4.6	1.5
20	19.2	16.5	13.2	9.4	6.0
25	24.1	21.4	17.9	13.8	10.5
30	29.1	26.2	22.7	18.4	15.0
35	34.1	31.1	27.4	23.0	19.4
40	39.0	35.9	32.2	27.6	23.8
45	44.0	40.8	36.8	32.1	28.2
50	49.0	45.6	41.6	36.7	32.8

Example With air temperature of +45 °C and water temperature of +37 °C, the relative humidity of the site may not exceed 65%.

Water Quality

This table lists the requirements on the cooling water quality for units without an optional water cooling section and requirements on the internal circuit water for units equipped with the optional water cooling section ACW 695.

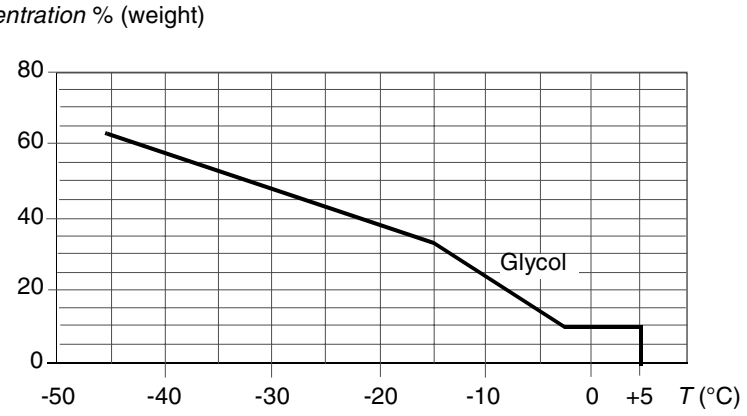
Tap Water The use of tap water is allowed as follows. Tap water must fulfil the requirements of the Council Directive 98/83/EC of 3/11/98 on the quality of water intended for human consumption. Corrosion inhibition with 0.5% by volume Cortec VCI-649 is required.	
pH value	6.5-9.5
Chloride	< 50 mg/l
Sulphate	< 100 mg/l
Total dissolved solids	< 250 mg/l, no deposits are allowed at the temperature of +57 °C
Total hardness as $CaCO_3$	< 250 mg/l
Conductivity	< 400 µS/cm (this equals resistance > 2500 Ω/cm)
The water must be clean of solid matter.	

Freeze Protection

A water-glycol solution is allowed for freeze protection. Corrosion inhibition with 0.5% (vol.) Cortec VCI-649 (by Cortec Corporation, *www.cortecvci.com)* is required. The glycol must be pure Dow Propylene Glycol (CAS Number: 57-55-6, available from The Dow Chemical Company, *www.dow.com)*.

Water/Glycol Concentration

This graph shows the required glycol concentration in weight percentage according to ambient/storage temperature *T*.



Materials

Recommended materials for the cooling water installation piping are

- stainless steel AISI 316L (UNS 31603)
- heavy gauge aluminium
- plastic materials such as PEX and Teflon
  Note: PVC hoses are not suitable for use with antifreeze.
- rubber gasket NBR (nitrile rubber).

WARNING! Copper and brass materials may not be used under any circumstances. Even minor dissolution of copper can cause copper precipitation on aluminium and subsequent galvanic corrosion. The water cooling system may not contain any zinc (e.g. galvanized pipes) at all since zinc would react with the inhibitor.

If the plant incorporates normal iron pipes or cast iron accessories (e.g. motor housings), a water cooling section with a heat exchanger (such as the ACW 695) must be used to separate the systems.

Example Resistance Curve

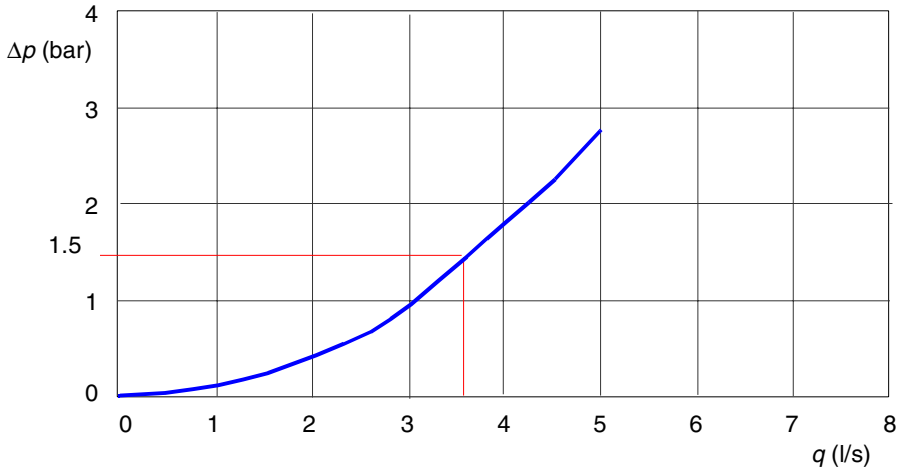
The example drive system consists of an ACW 684-3600-6 supply unit and four ACW 634-1390-6 drive units. Note that the calculation applies to a closed-type cabinet, and includes the mass flows of air-to-water heat exchangers and power losses into cooling air.

Use the cooling characteristics tables in Chapter 2 to calculate the total nominal flow of the drive system. Remember to include the values for all required water-cooled components, such as the DC reactor and heat exchangers. (The nominal flows are the minimum values at a pressure difference of 1.5 bar.)

The flow of an ACW 684-3600-6 is 1500 kg/h + 1500 kg/h + 600 kg/h = 3600 kg/h.

The flow of one ACW 634-1390-6 is 1740 kg/h + 700 kg/h = 2440 kg/h. Thus the total flow of the drive system is 3600 kg/h + 4 × 2440 kg/h = 13360 kg/h. This approximates to 3.7 l/s.

The resistance curve of the system follows the equation $\Delta p = k\, q^2$. At the nominal point, $1.5 = k \cdot 3.7^2$ -> k = 0.11. Calculate a few points of the curve and draw it in a diagram.

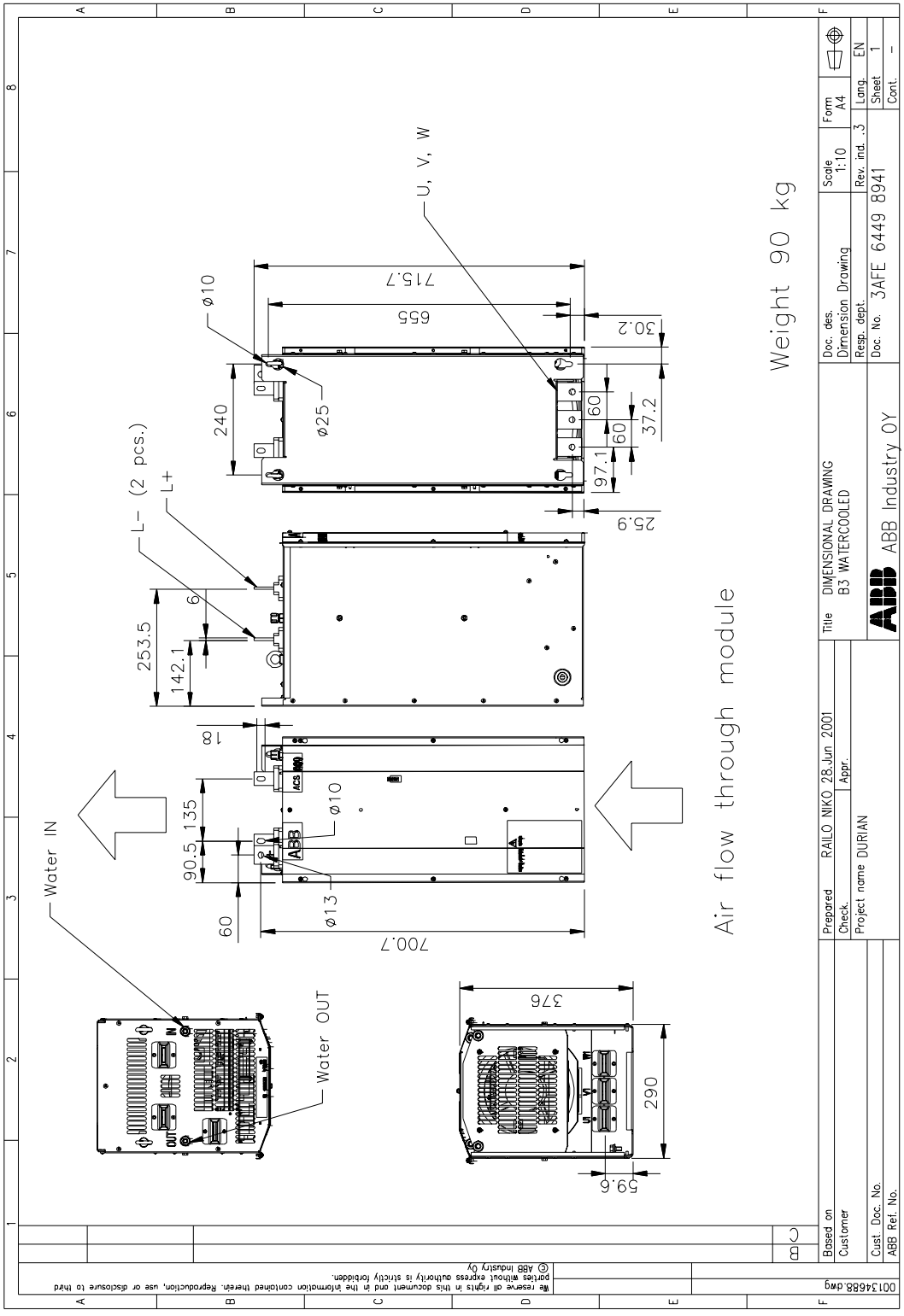


The power loss of an ACW 684-3600-6 is 11.1 kW + 3.0 kW. The loss of the DC reactor required is 2.6 kW + 2.8 kW. The total power loss of the supply unit is 21.5 kW (including 2 kW estimated to be the loss of the busbar system and other auxiliary equipment of the unit).

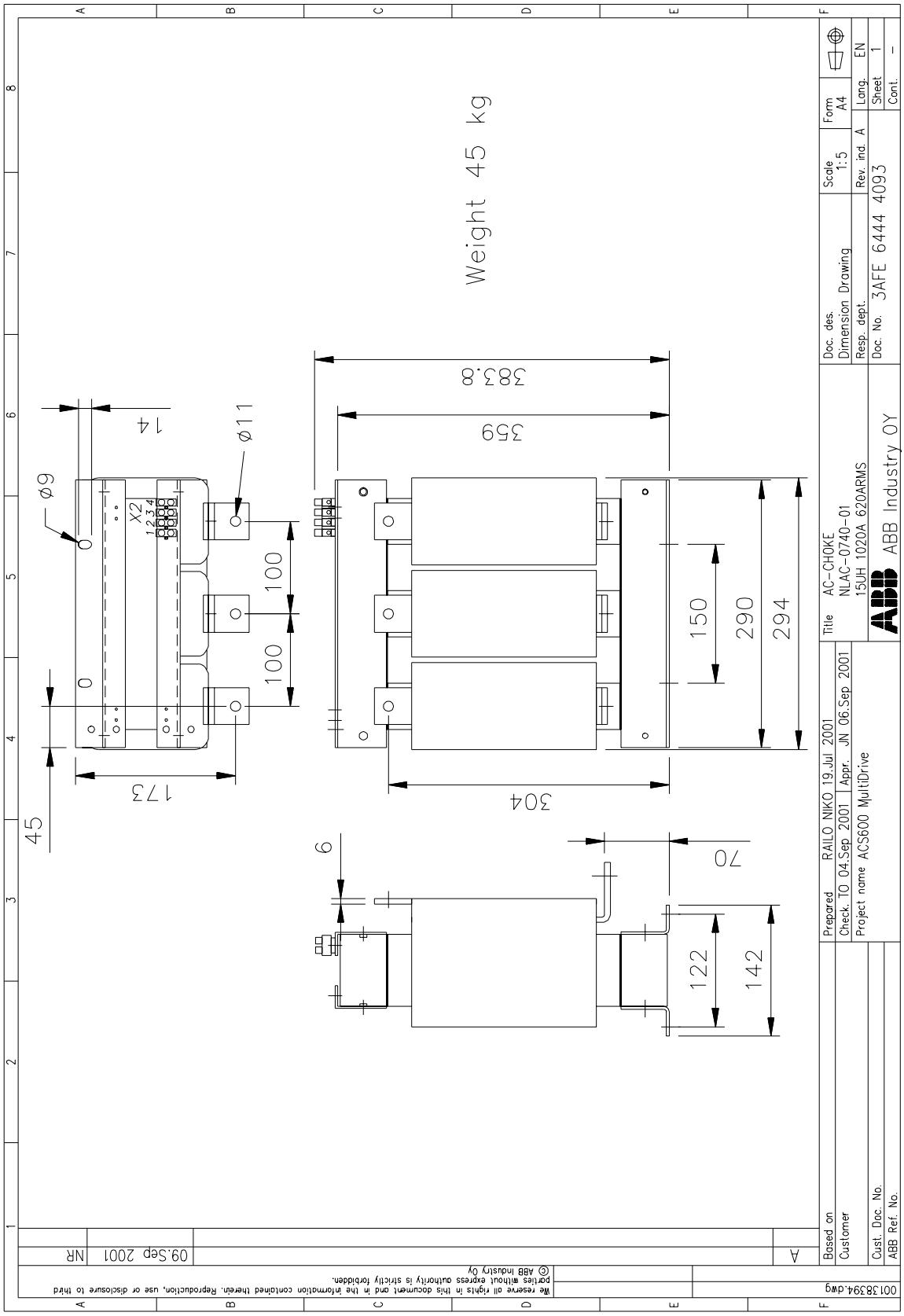
The power loss of one ACW 634-1390-6 is 14.5 kW + 6.2 kW = 20.7 kW. Thus the total power loss of the drive system is 21.5 kW + 4 × 20.7 kW = 104.3 kW, and a water cooling section with a capacity of 100 kW will suffice (if the drive is not running at maximum load all the time, or the water intake temperature is lower than +38 °C). The operating point is at the intersection of the pump curve and the system curve.

Appendix B – Dimensional Diagrams

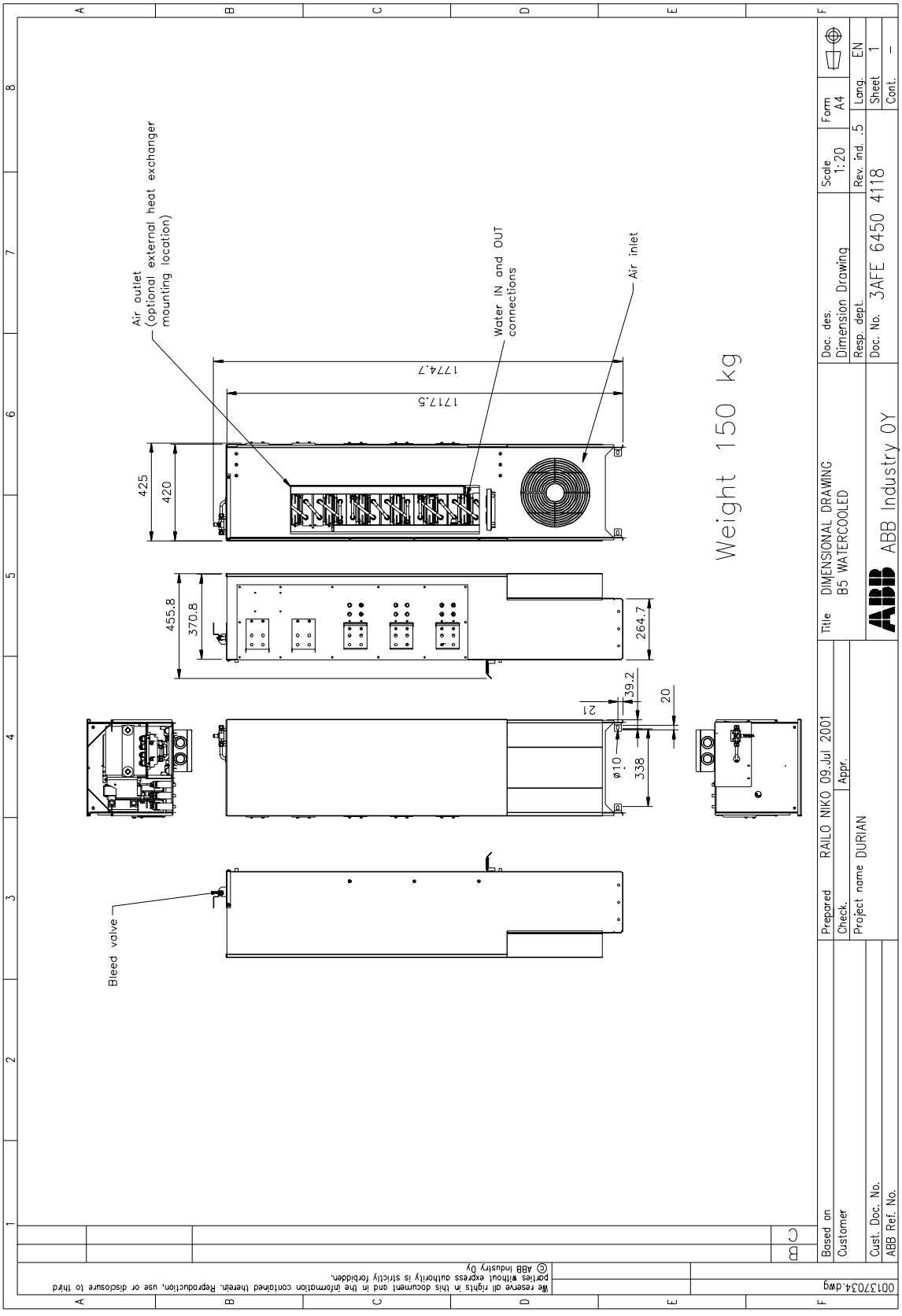
Frame B3 Supply Modules



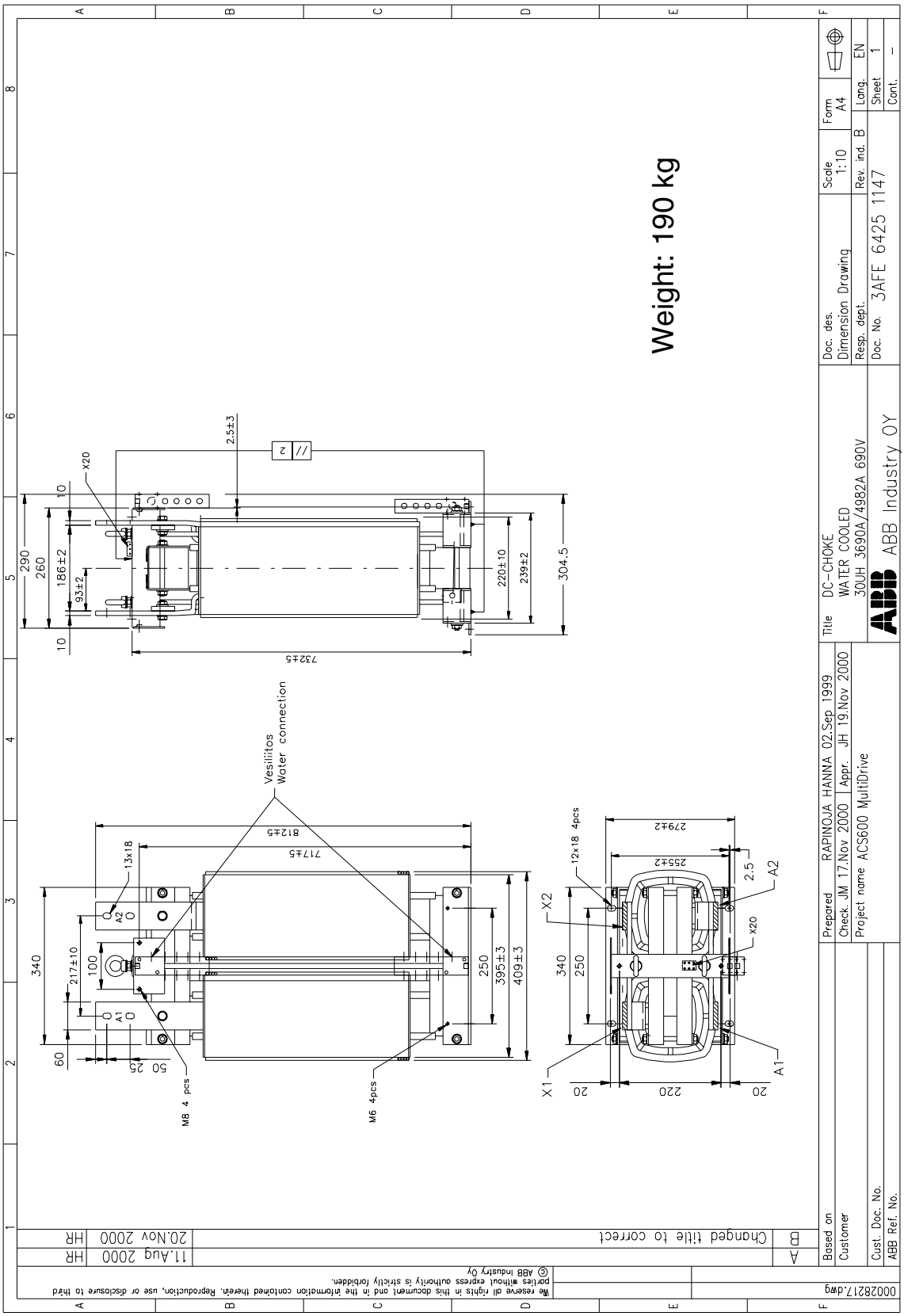
Load Equalisation Choke



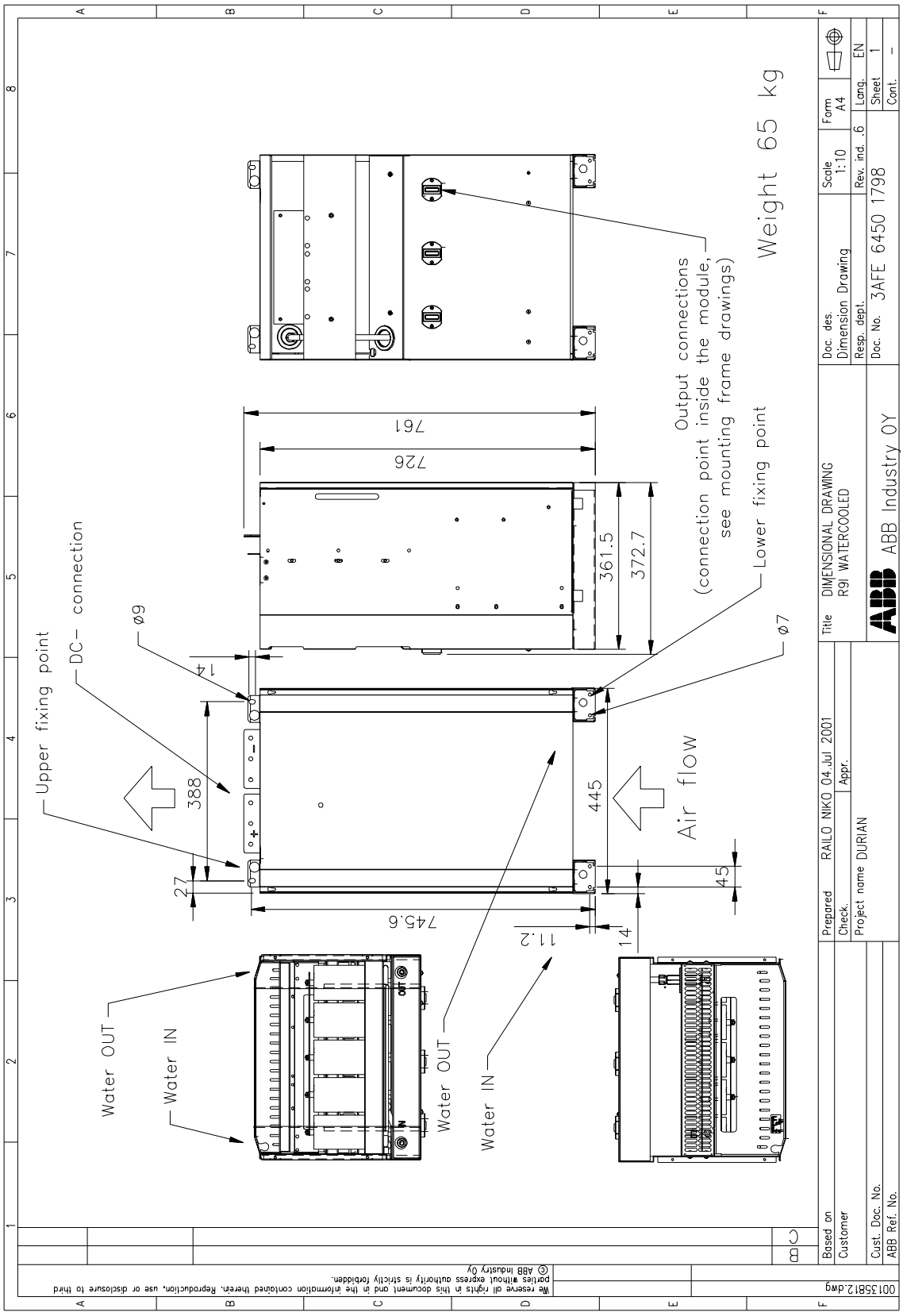
Frame B5 Supply Module



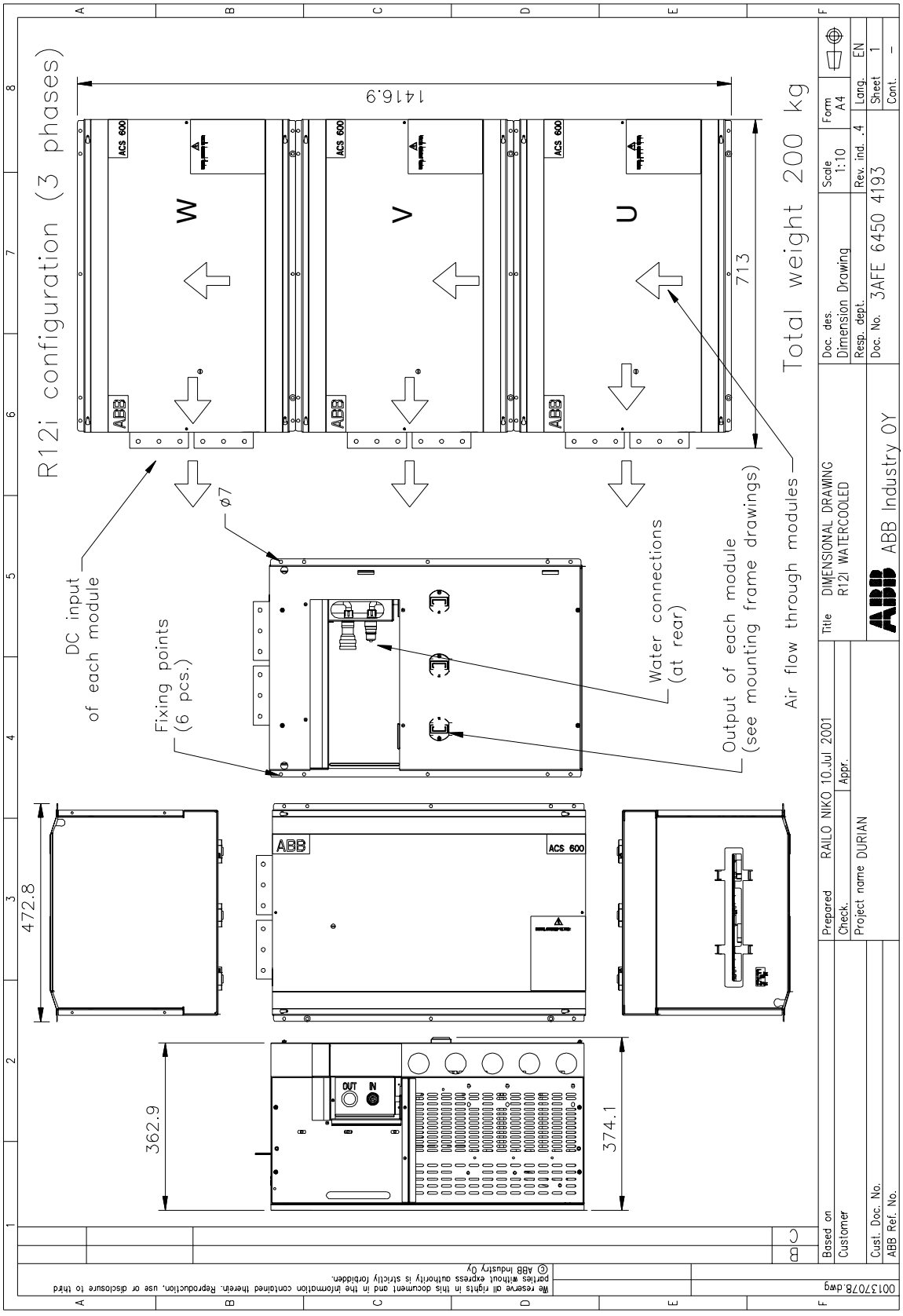
DC Reactor (B5 and 2×B5)



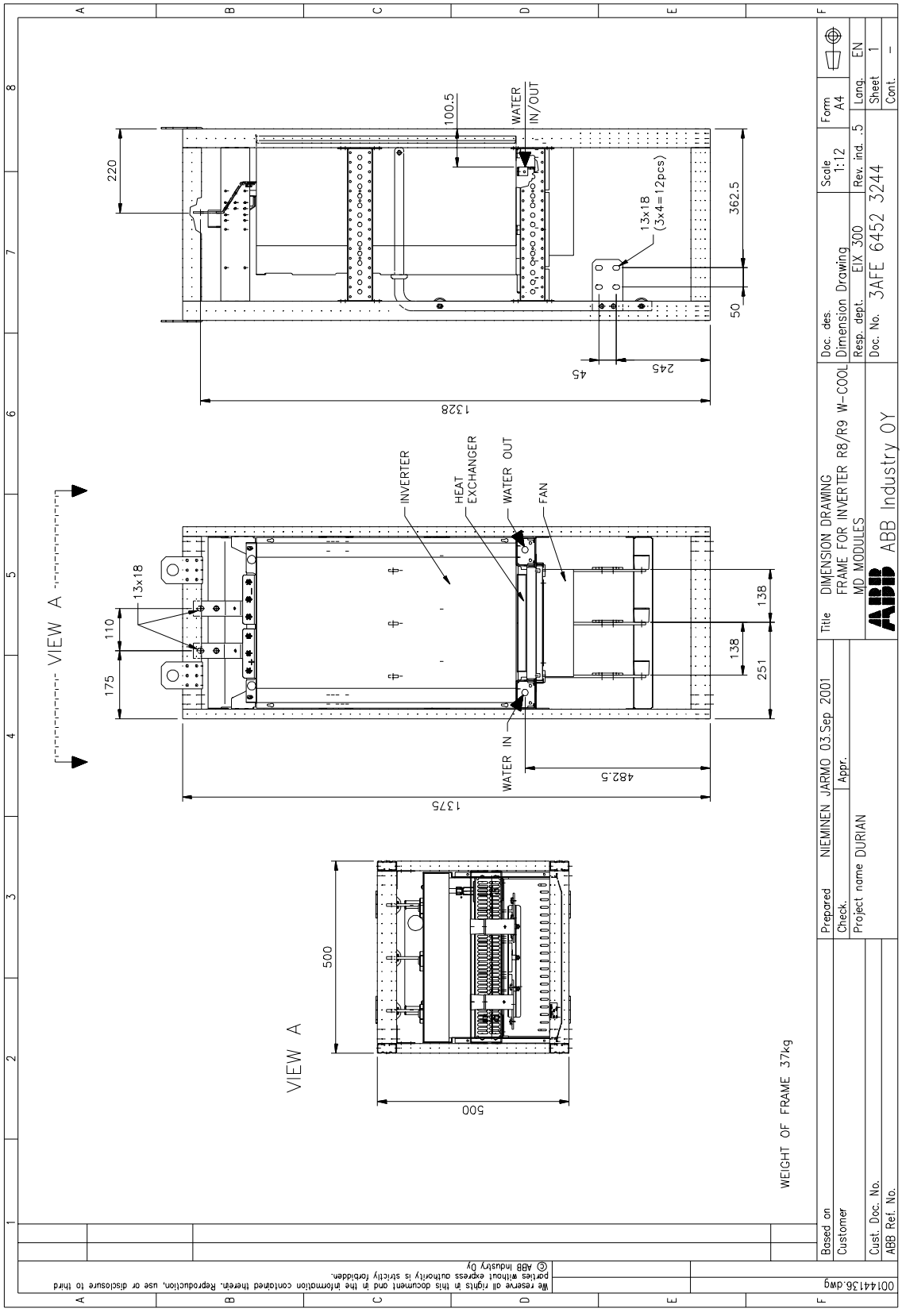
Frame R9i Inverter Module



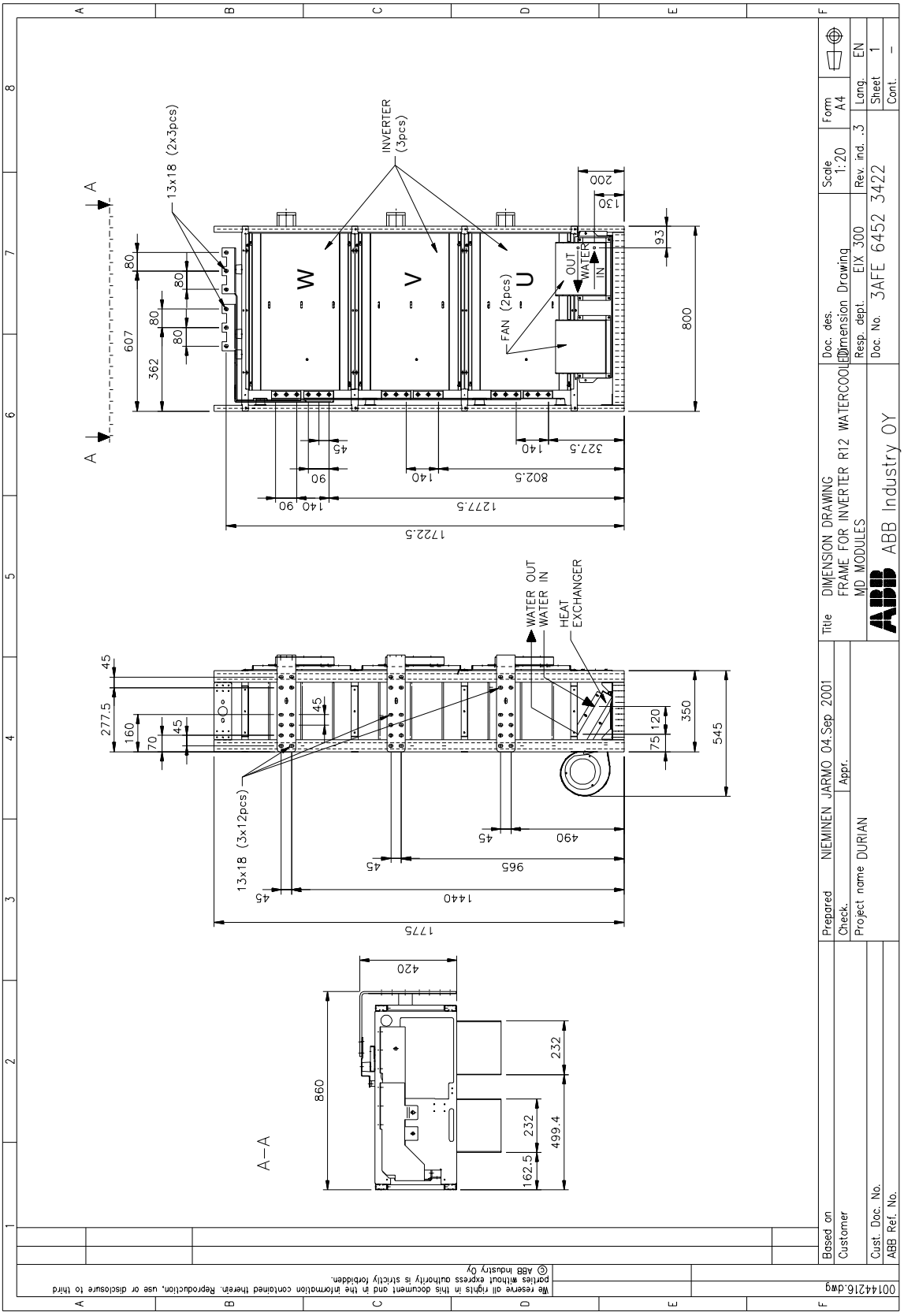
Frame R12i Inverter Module



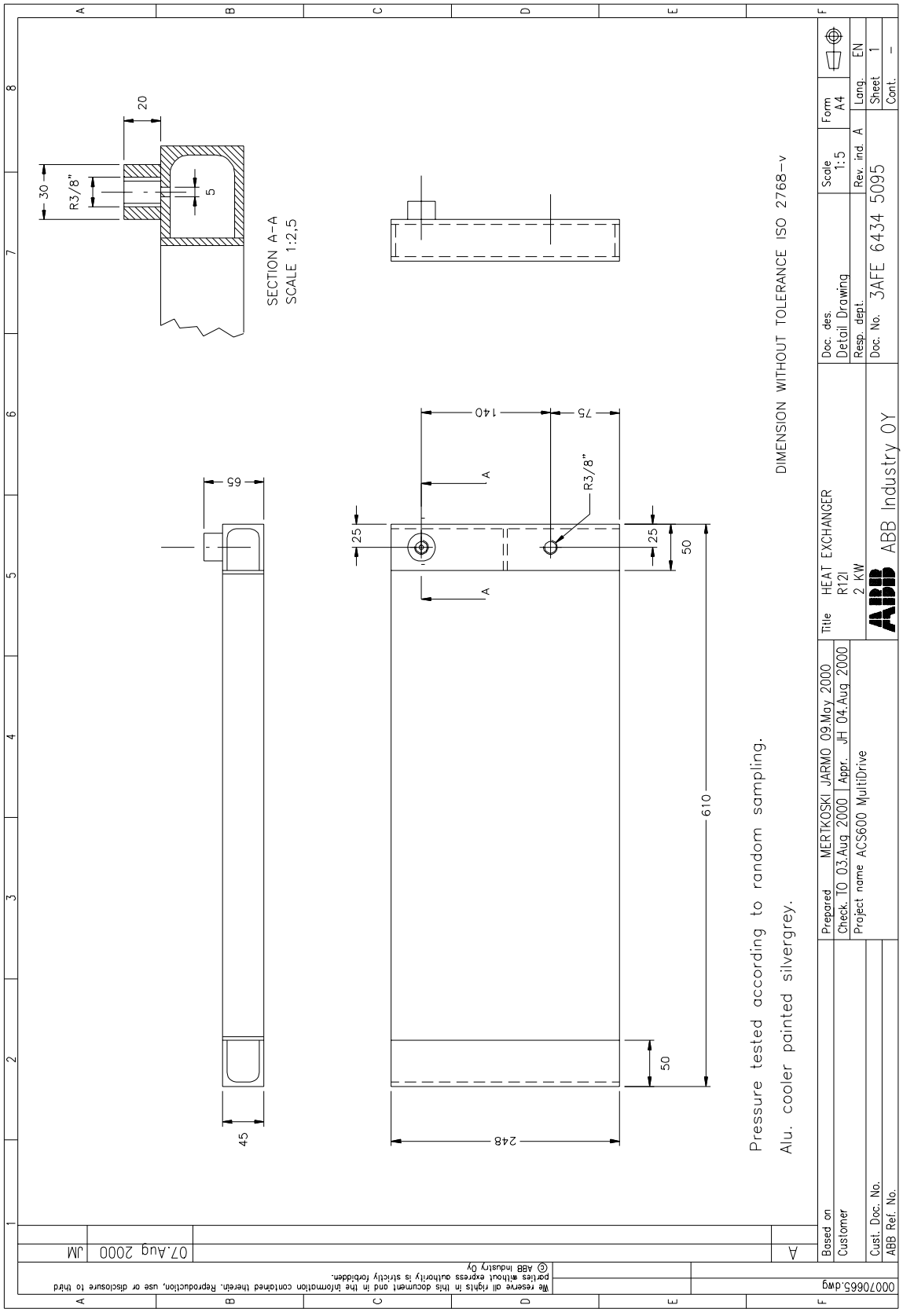
Mounting Frame (R8i, R9i)



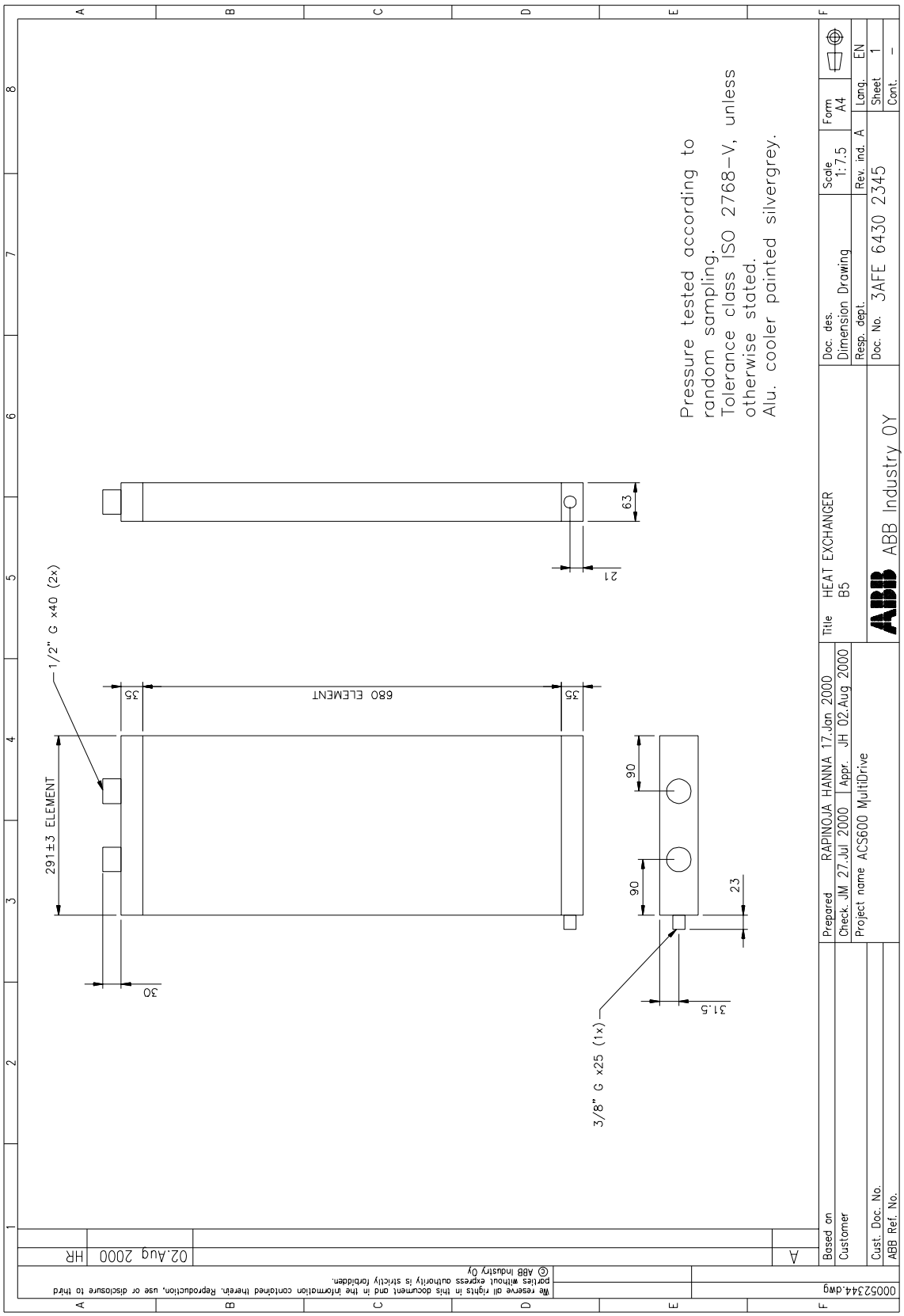
Mounting Frame (R12i)



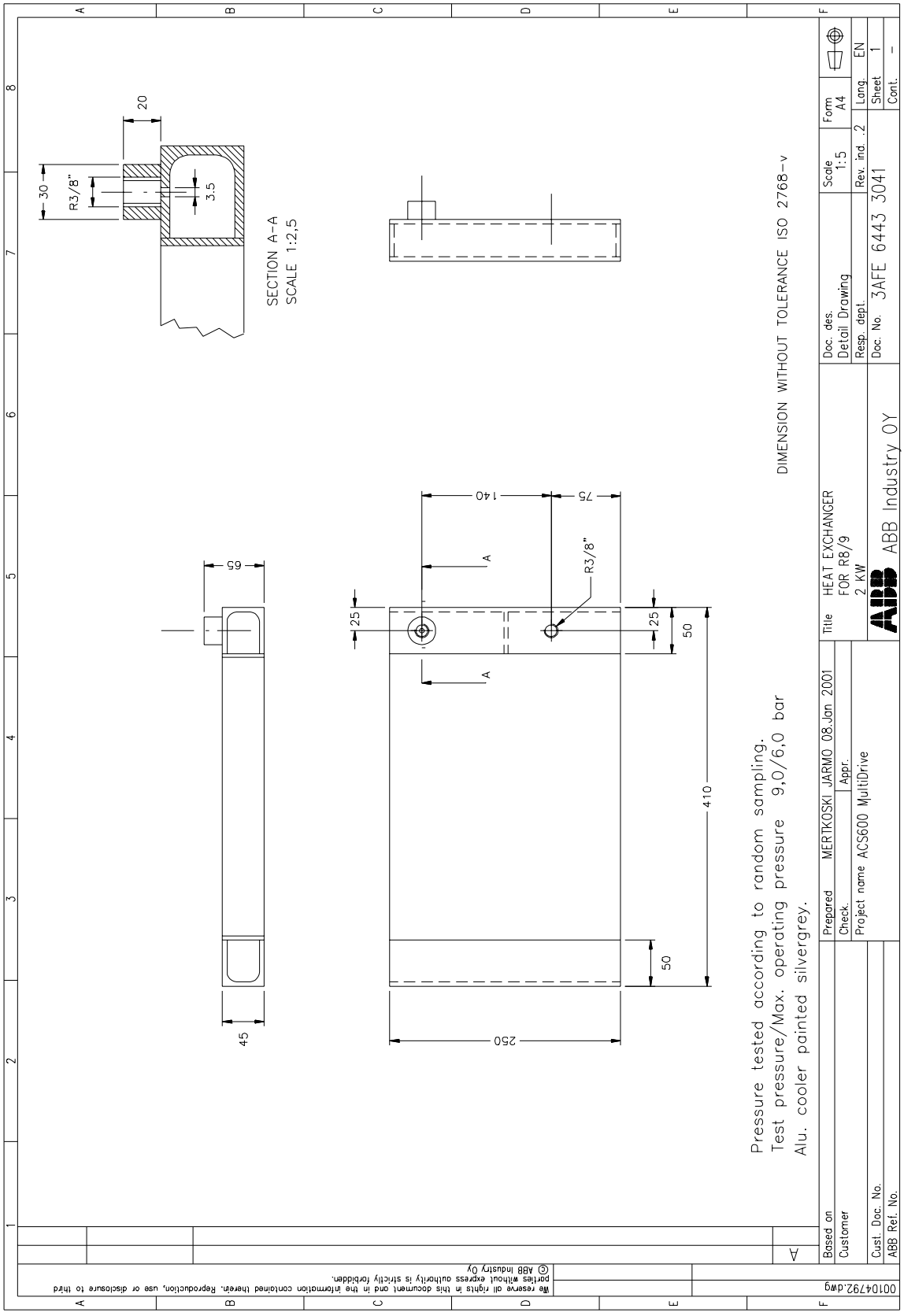
Air-to-Water Heat Exchanger (B3, R12i – Type 201702)



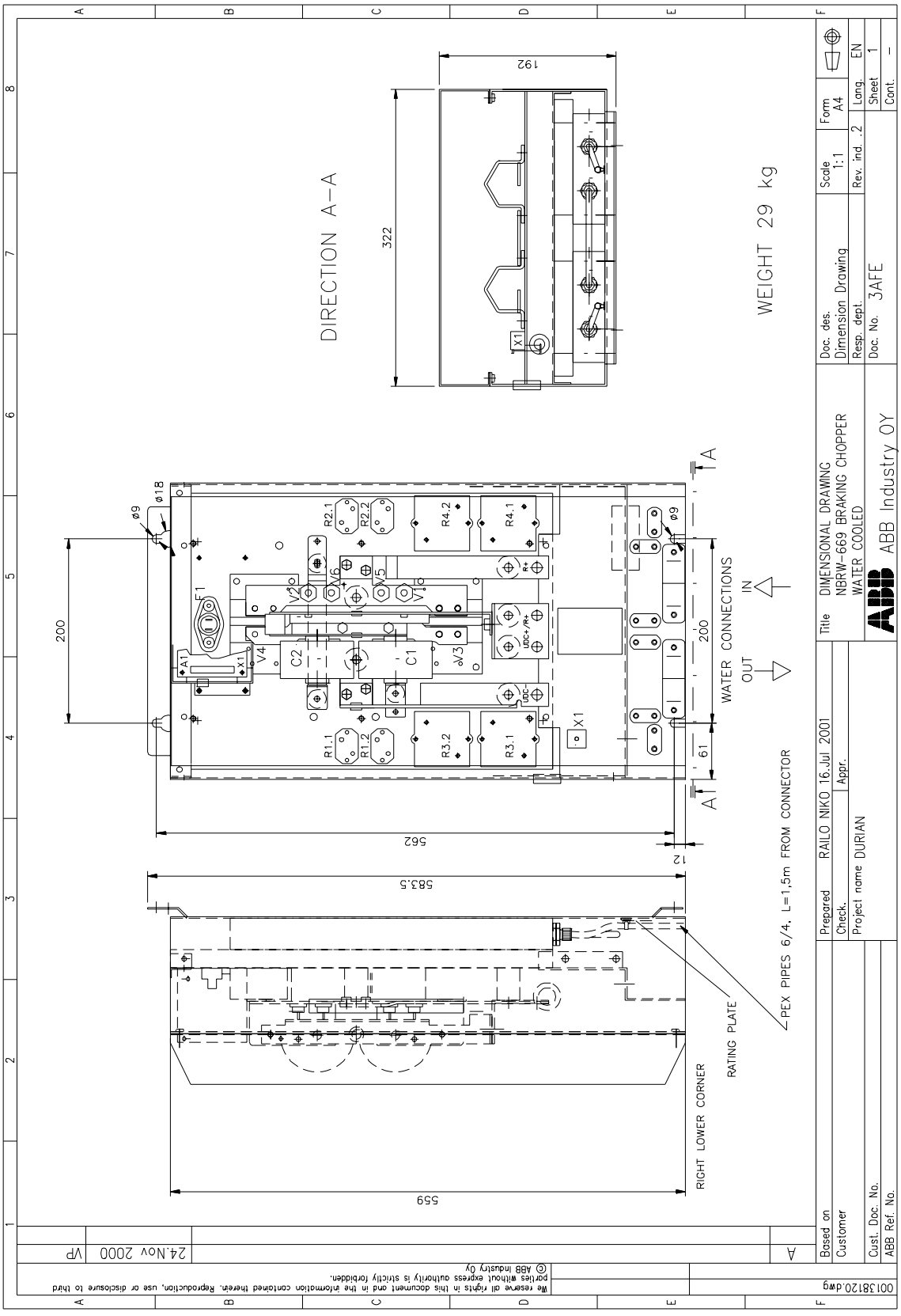
Air-to-Water Heat Exchanger (B5 – Type 201703)



Air-to-Water Heat Exchanger (R8i, R9i)

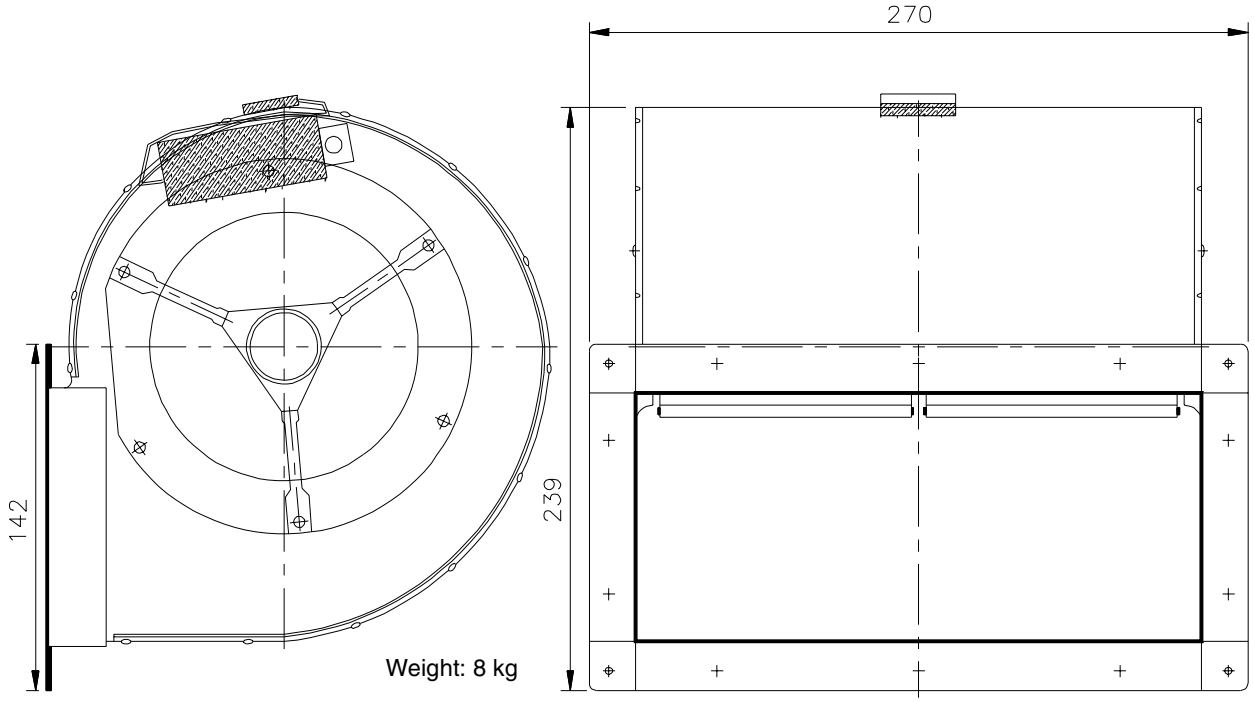


NBRW-669C Braking Chopper



Cooling Fans

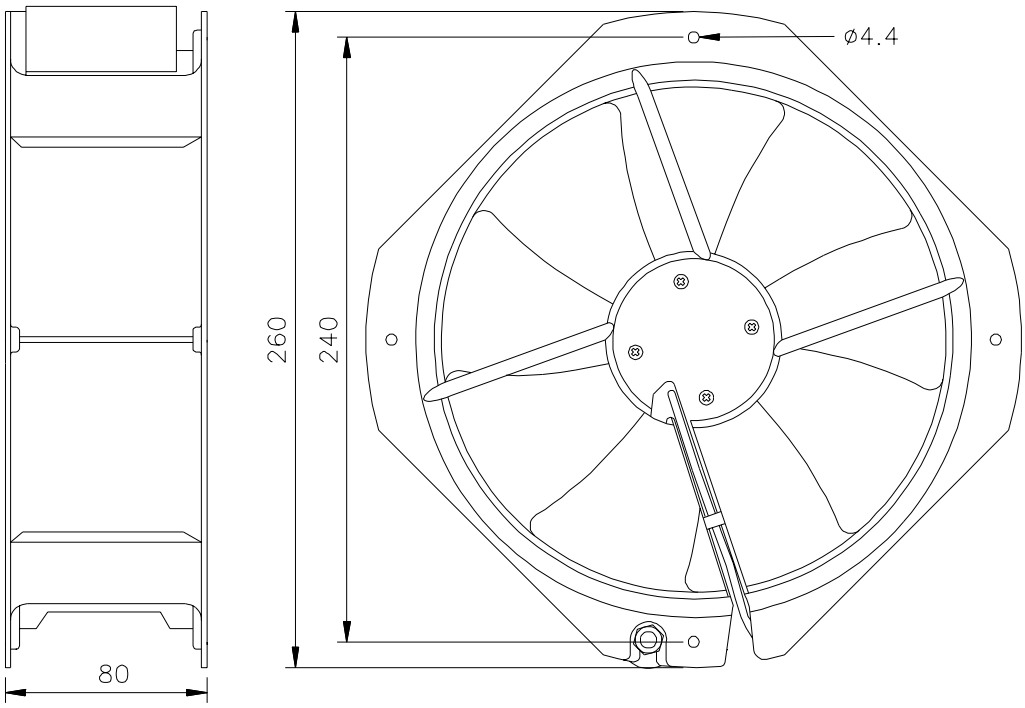
D2E146-APxx-xx
(64490052/64490061)



Weight: 8 kg

PDM-140254-A

W2E200-HHxx-xx
(10012171/10032300)

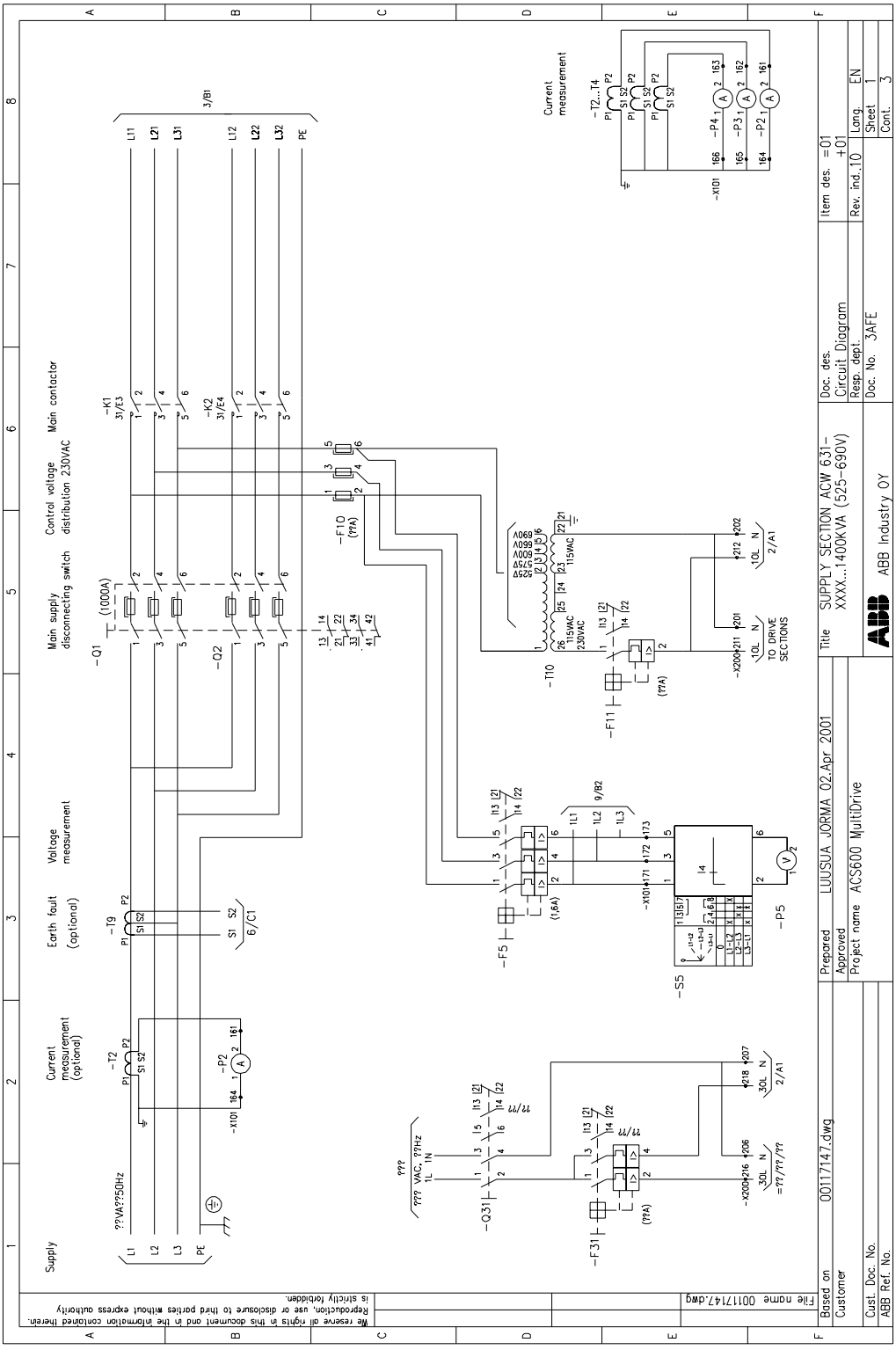


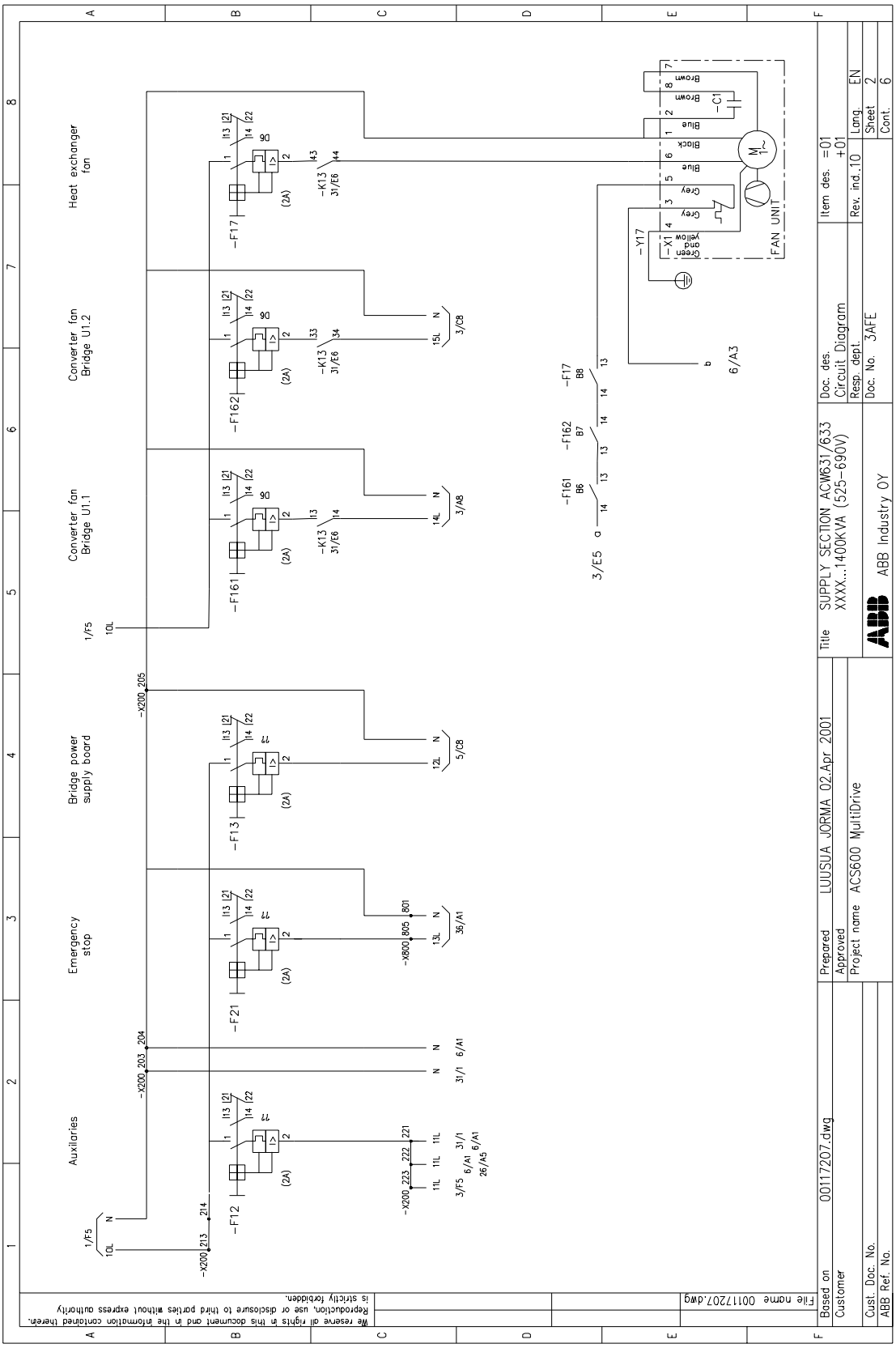
Weight: 2 kg

PDM-163683-2

Appendix C – Circuit Diagrams

Supply Unit (2 × B3, 6-pulse)




Heat exchanger fan
Converter fan Bridge U1.2
Converter fan Bridge U1.1
Bridge power supply board
Emergency stop
Auxiliaries
FAN_UNIT
-C1
-Y17
-F17
-F162
-F161
-F13
-F21
-F12
-K13 31/E6
-X200 205
-X200 204
-X200 203
-X200 214
-X200 213
-X800 805
-X800 801
1/F5
3/E5
6/A3
3/C8
3/A8
5/C8
36/A1
31/1 6/A1
ABB Industry OY
SUPPLY SECTION ACW631/633 XXXX...1400KVA (525-690V)
Circuit Diagram
3AFE
LUUSUA JORMA 02 Apr 2001
ACS600 MultiDrive
00117207.dwg
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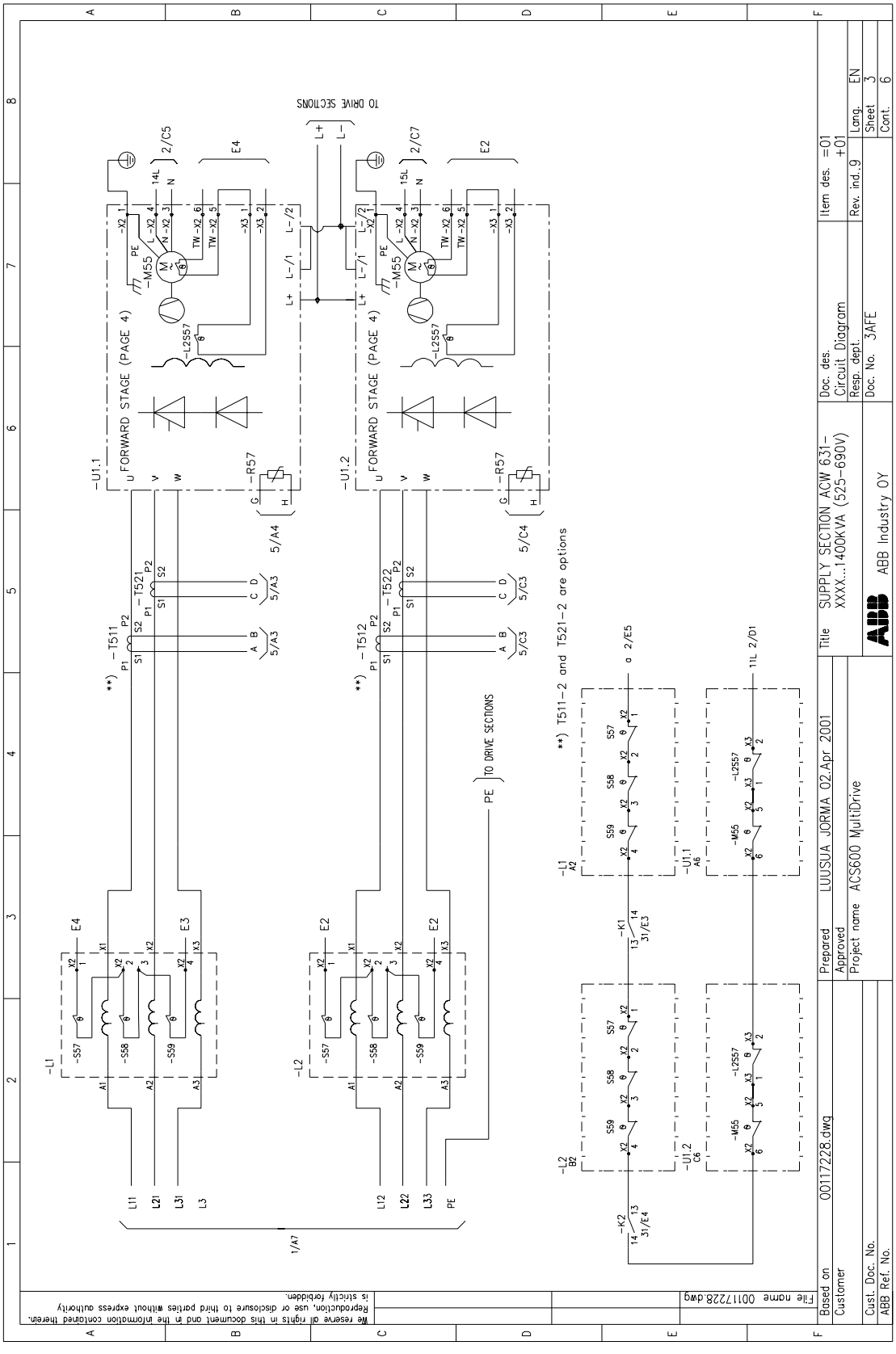
TO DRIVE SECTIONS
FORWARD STAGE (PAGE 4)
-U1.1
-U1.2
-M55
-L2557
-R57
-T511
-T512
-T521
-T522
**) T511-2 and T521-2 are options
TO DRIVE SECTIONS
SUPPLY SECTION ACW 631-
XXXX...1400KVA (525-690V)
ABB Industry OY
ACS600 MultiDrive
00117228.dwg
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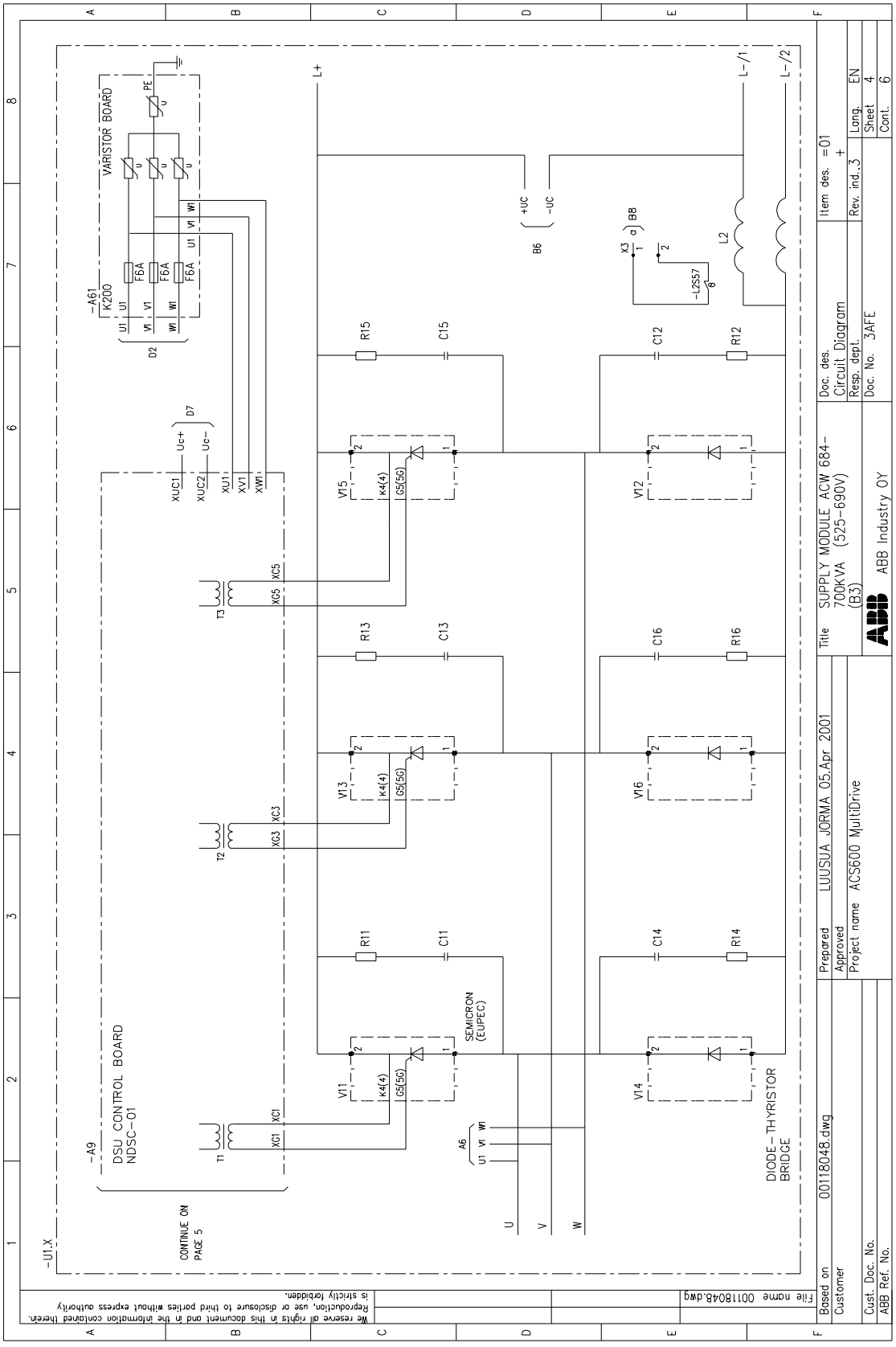
-A61
K200
VARISTOR BOARD
F6A
D2
PE
L+
L-/1
L-/2
+UC
-UC
B6
B8
X3
-L2SS7
L2
D7
Uc+
Uc-
XUC1
XUC2
XU1
XV1
XW1
R15
C15
C12
R12
V15
V12
k4(4)
G5(5G)
T3
XC5
R13
C13
C16
R16
V13
V16
T2
XC3
R11
C11
C14
R14
V11
V14
T1
XC1
SEMICRON
(EUPEC)
-A9
DSU CONTROL BOARD
NDSC-01
A6
U1 V1 W1
U
V
W
DIODE-THYRISTOR
BRIDGE
CONTINUE ON
PAGE 5
-U1.X
Item des. =01
Doc. des.
Circuit Diagram
Resp. dept.
Doc. No. 3AFE
Rev. ind. 3
Lang. EN
Sheet 4
Cont. 6
Title SUPPLY MODULE ACW 684-
700KVA (525-690V)
(B3)
ABB Industry OY
Prepared LUUSUA JORMA 05.Apr 2001
Approved
Project name ACS600 MultiDrive
Based on 00118048.dwg
Customer
Cust. Doc. No.
ABB Ref. No.
File name 00118048.dwg
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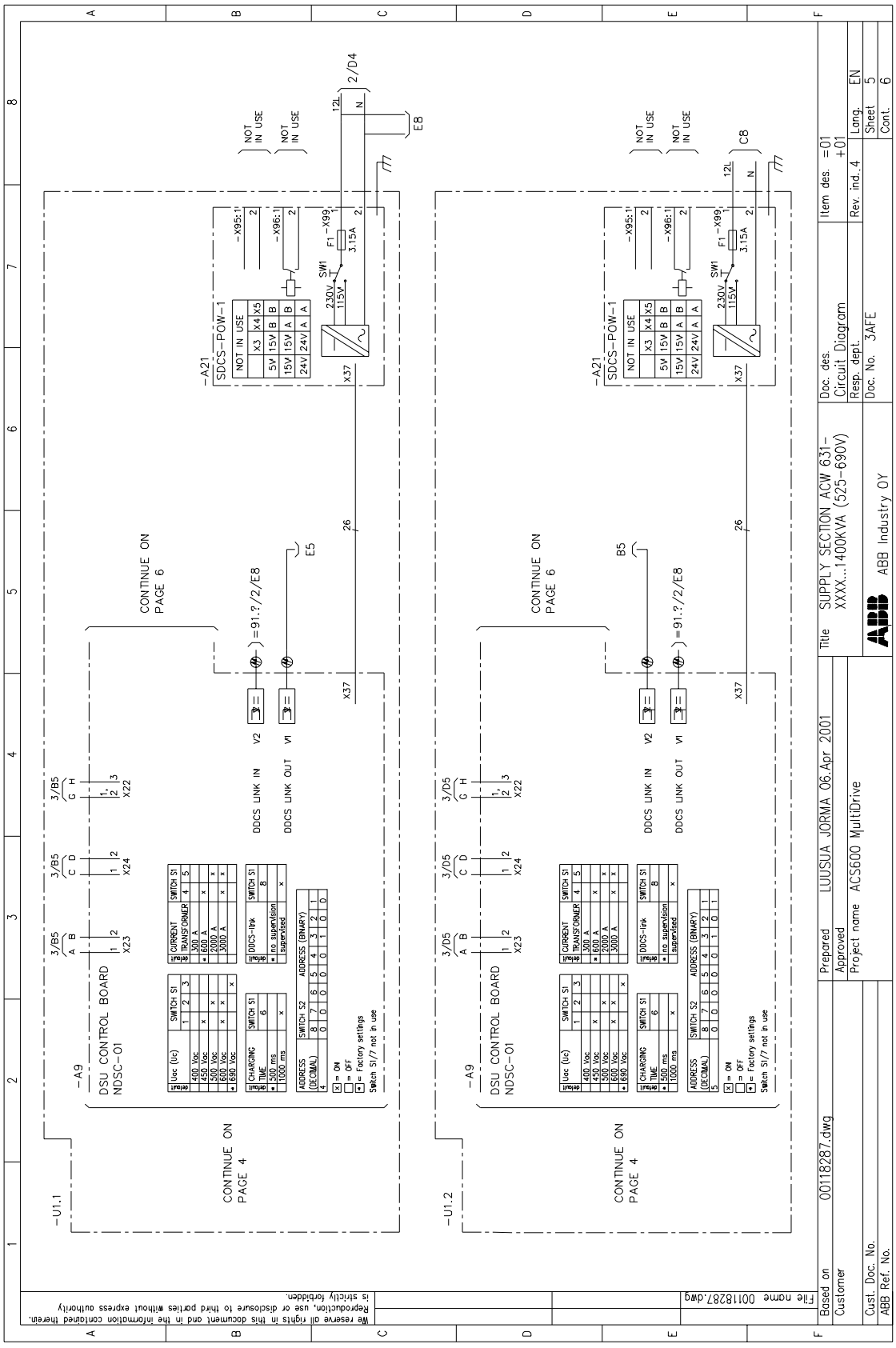
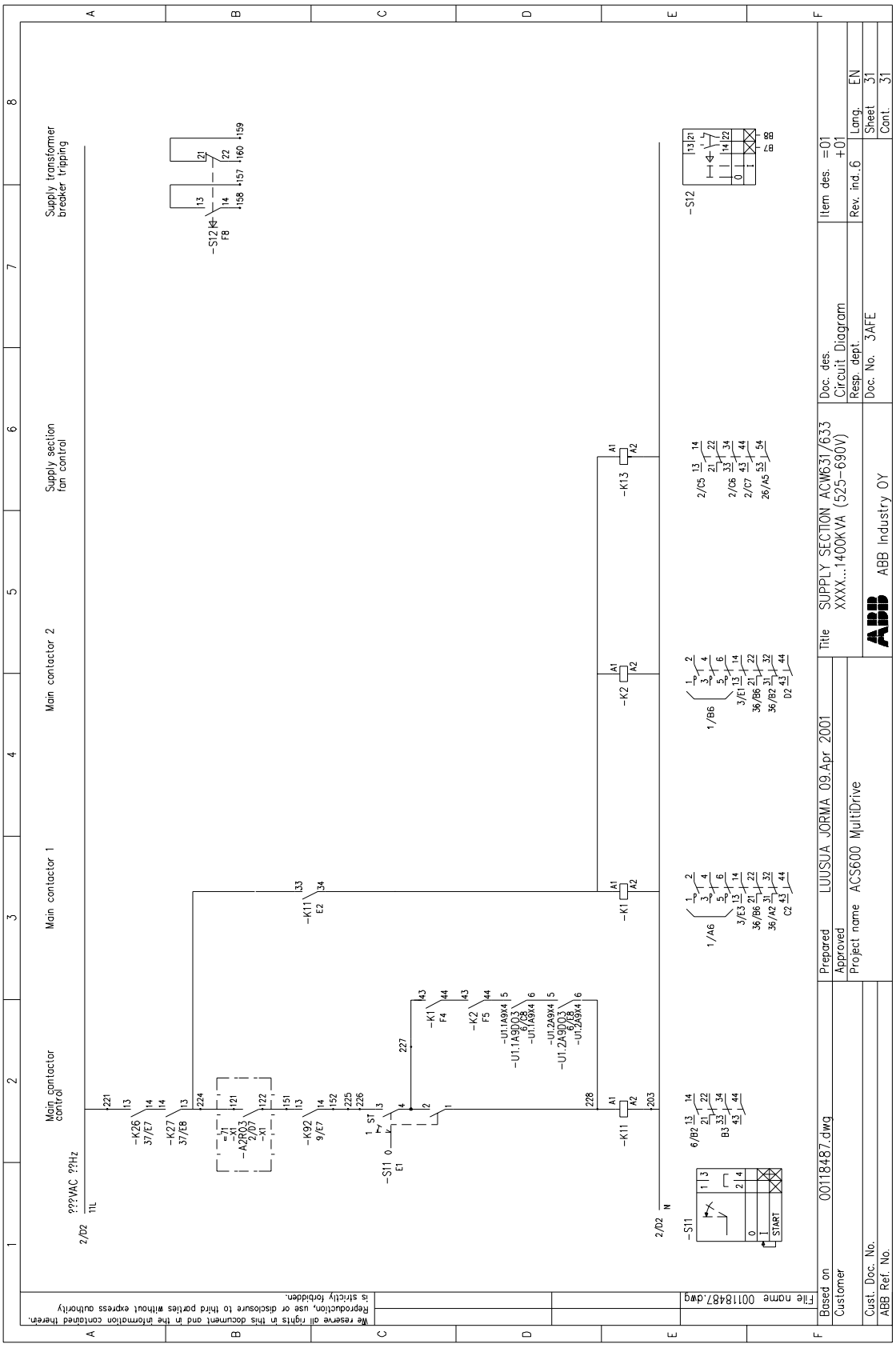

-U1.1
-U1.2
-A9
DSU CONTROL BOARD
NDSC-01
-A21
SDCS-POW-1
CONTINUE ON PAGE 4
CONTINUE ON PAGE 6
DDCS LINK IN
DDCS LINK OUT
SUPPLY SECTION ACW 631-XXXX...1400KVA (525-690V)
ABB Industry OY
ACS600 MultiDrive
00118287.dwg
LUUSUA JORMA 06.Apr 2001


Supply transformer breaker tripping
Supply section fan control
Main contactor 2
Main contactor 1
Main contactor control
???VAC ??Hz
11L
2/D2
-K26 37/E7
-K27 37/E8
-A2R03 2/D7
-K92 9/E7
-K11 E2
-K1 F4
-K2 F5
-S11 E1
START
-S12 F8
-K13
-S12
1/A6
1/B6
3/E3
3/F1
2/C5
2/C6
2/C7
26/A5
36/A2
36/B2
36/B6
36/B8
Doc. des. Circuit Diagram
Item des. =01 +01
Resp. dept.
Rev. ind. 6
Lang. EN
Doc. No. 3AFE
Sheet 31
Cont. 31
Title SUPPLY SECTION ACW631/633 XXXX...1400KVA (525–690V)
ABB Industry OY
Prepared LUUSUA JORMA 09.Apr 2001
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Project name ACS600 MultiDrive
Based on 00118487.dwg
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File name 00118487.dwg
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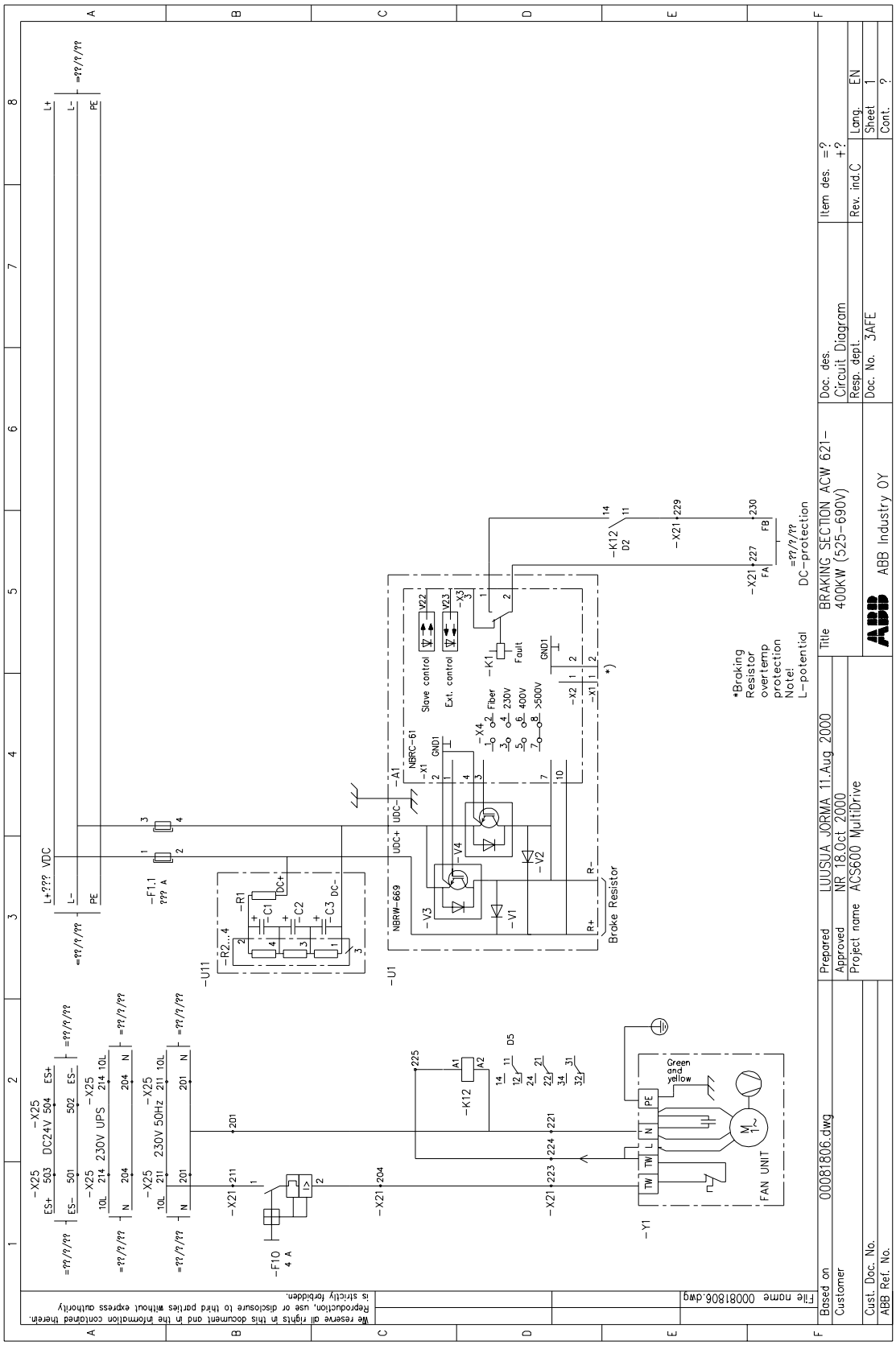
Dynamic Braking Unit



MultiDrive Modules Water-cooled Units/EN
3BFE 64491474 R0125
EFFECTIVE: 17.12.2001

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