Dunsty Hill Farm

Energy Statement

September 2023

CONTENTS

DOCUMENT CONTROL SHEET	
Report Reference	PP2196/DHF/ES/202308-EC
Issue Purpose	For Planning
Client	Highbarrow Holdings Ltd
Author	Edward Coate
Approved By	Ryan Thrower
Date of Issue	13th September 2023

DISCLAIMER

This report has been produced to support a Planning Application and is not to be used 'For Construction', for Building Control compliance or for submission against a Planning Condition.

This report is based on drawings and specifications provided along with information assumed by NRG Consulting for the purposes of compliance. Any budget costs or plant sizing contained within this document are estimated unless otherwise specified and are to be taken as guideline only.

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1. EXECUTIVE SUMMARY

1.1 NRG Consulting have been appointed to undertake an Energy Statement on a proposed development at the Dunsty Hill Farm, Culvert Green, within the jurisdiction of Aylesbury District Council.

The proposed development is for *one new-build residential dwelling.*

1.2 SAP calculations have been undertaken and this document illustrates a reduction in CO_2 emissions over the baseline of Part L 2021 via:

Energy Efficiency Measures

- High levels of thermal insulation to achieve U-Values lower than the Part L 2021 notional building specification.
- LED Lighting with a luminous efficacy of 95lm/W.
- Air Permeability target of 5.1 m3/(hm2) @50Pa.

Renewable Technologies

- An Individual Air Source Heat Pump (ASHP) is proposed. This has been modelled as the Vaillant Arotherm (8 kW).

1.3 A carbon emissions table is shown across the page illustrating the carbon reduction of the proposed development against the target for Part L 2021 of the Building Regulations.

1.4 This proposed application is on the same site as a previously consented conversion scheme of the existing barn. In terms of carbon emissions, the conversion would have higher emissions due to certain elements that would not be able to match a new-build development including the amount of insulation, the air tightness level and the ability to minimise heat loss through the thermal bridging junctions.

	CO_2 Emissions (Tonnes per Annum)	
	Regulated	
Baseline: Part L 2021 of the Building Regulations (TER)	0.92	
Final CO_2 Emissions of Proposed Development (DER)	0.43	
Regulated CO_2 savings over Part L 2021	53.96%	

Table: Carbon Emissions Table

2. POLICY FRAMEWORK

2.1 The proposed development falls within the Government's **"minor"** category of planning applications.

NATIONAL POLICY – NPPF (2021)

The delivery of sustainable development is at the foundation of the NPPF, which defines it as "meeting the needs of the present without compromising the ability of future generations to meet their own needs.

LOCAL POLICIES

2.2 While the development now resides in the local authority of Buckinghamshire due to moved boundaries, the Local Plan here is still several years from adoption and therefore the following Planning Policies from the previous local authority are still applicable to this report:

Vale of Aylesbury Local Plan 2013-2033 – Policy C3

C3 Renewable Energy

All development schemes should look to achieve greater efficiency in the use of natural resources.

Planning applications involving renewable energy development will be encouraged provided that there is no unacceptable adverse impact, including cumulative impact, on the following issues:

a. landscape and biodiversity including designations, protected habitats and species
b. visual impacts on local landscapes
c. the historic environment including designated and non designated assets and their settings
d. the Green Belt, particularly visual impacts on openness
e. aviation activities
f. highways and access issues, and
g. residential amenity.

The Council will seek to ensure that all development schemes achieve greater efficiency in the use of natural resources, including measures minimise energy use, improve water efficiency and promote waste minimisation and recycling. Developments should also minimise, reuse and recycle construction waste wherever possible.

In seeking to achieve carbon emissions reductions, the Councilthe council will promoteassess developments using an 'energy hierarchy'. An energy hierarchy identifies the order in which energy issues should be addressed and is illustrated as follows:

h. reducing energy use, in particular by the use of sustainable design and construction measures
i. supplying energy efficiently and giving priority to decentralised energy supply
j. making use of renewable energy
k. making use of allowable solutions, and
l. an energy statement will be requiredencouraged for proposals for major residential developments (over 10 dwellings), and all non-residential development, to demonstrate how the energy hierarchy has been applied.

With continually improving standards through building regulations, new buildings carry reduced need for heating and loads are based on winter heat and all year-round hot water demands. A feasibility assessment for district heating (DH) and cooling utilising technologies such as combined heat and power (CHP), including biomass CHP or other low carbon technology, will be requiredencouraged for:

m. all residential developments of 100 dwellings or more
n. all residential developments in off-gas areas for 50 dwellings or more, and
o. all applications for non-domestic developments above 1000sqm floorspace.

Where feasibility assessments demonstrate that decentralised energy systems are deliverable and viable and can secure at least 10% of their energy from decentralised and renewable or low carbon sources, such systems will be requiredencouraged as part of the development.

Planning permission will normally be granted for off-site renewable energy (for example, but not confined, to wind, solar, biomass and energy crops, anaerobic digestion and landfill gas), where it has been demonstrated that all the following criteria have been met:

p. There is no significant adverse effect on landscape or townscape character, ecology and wildlife, heritage assets whether designated or not, areas or features of historical significance or amenity value
q. there is no significant adverse impact on local amenity, health and quality of life as a result of noise, emissions to atmosphere, electronic interference or outlook through unacceptable visual intrusion, and
r. there is no adverse impact on highway safety. Where development is granted, mitigation measures will be required as appropriate to minimise any environmental impacts. When considering the social and economic benefits, the Councilthe council will encourage community participation/ownership of a renewable energy scheme.

Aylesbury Vale is located within an area of water stress and as such the Councilthe council will seek a higher level of water efficiency than required in the Building Regulations, with developments achieving a limit of 110 litres/person/day.

Applications for the adaption of older buildings should include improved energy and water efficiency and retrofitted renewable energy systems where possible.

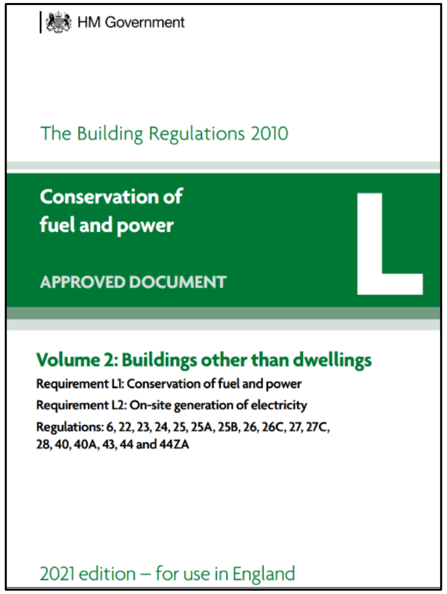
BUILDING REGULATIONS (PART L 2021 & FUTURE HOMES STANDARD)

2.3 On 24th July 2018 the Department for Business Energy & Industrial Strategy (BEIS) published their update to SAP 9.92 (Part L 2013), called SAP 10.

In October 2019, the Ministry of Housing, Communities and Local Government (MHCLG) then issued consultation on changes to Part L of the Building Regulations. Dubbed *The Future Homes Standard*, it is an aspiration to ensure all new homes will have low carbon heating and "world-leading levels of energy efficiency" by 2025 and is intended to be the primary driver in achieving the Governments desire to reduce carbon emissions in the creation of new-build housing stock.

On the June 15th 2022, Part L 2021 of the Building Regulations came into force. As per the requirements, all new homes must produce 31% less CO_2 emissions than that of Part L 2013 in-order to achieve Building Regulation compliance.

2.4 The major change in the regulations is the change in carbon factor of electricity to represent the decarbonisation of the National Grid and the push towards net-zero carbon developments.


HM Government

The Building Regulations 2010

Conservation of fuel and power

APPROVED DOCUMENT

L

Volume 2: Buildings other than dwellings

Requirement L1: Conservation of fuel and power

Requirement L2: On-site generation of electricity

Regulations: 6, 22, 23, 24, 25, 25A, 25B, 26, 26C, 27, 27C, 28, 40, 40A, 43, 44 and 44ZA

2021 edition – for use in England

Fuel	SAP 2012 CO_2 ($kgCO_2/kWh$)	SAP 10 CO_2 ($kgCO_2/kWh$)	Part L 2021 CO_2 ($kgCO_2/kWh$)	Percentage Reduction
Main Gas	0.216	0.210	0.210	2.75%
Electricity	0.519	0.233	0.136	73.8%

***Table**: Change in Carbon Factors from Part L 2013 to Part L 2021*

NRG CONSULTING

3. ENERGY CALCULATIONS

3.1 In order to estimate the predicted energy demand and regulated CO_2 emissions for the site, SAP Calculations have been carried out by a licensed and OCDEA accredited SAP Assessor using Elmhurst Design SAP 10.2 (Part L 2021).

3.2 The baseline CO_2 emissions covered by Part L 2021 of the Building Regulations will be expressed as the Target Emissions Rate (TER). This covers regulated carbon emissions from:

- Heating
- Cooling
- Hot Water
- Lighting
- Auxiliary (Pumps and Fans)

3.3 Passive Design

Passive design measures utilised by the architect in the concept and development of the schemes design include:

- Through good design and careful construction, air infiltration will be minimised and thus a low Air Permeability target has been chosen.
- Optimising orientation and site layout to reduce energy demand.
- Provision of cross-ventilation.
- Maximising thermal mass where possible to reduce internal temperature variation.
- High-performance double-glazing system to reduce heat demand and increase solar gains.
- Thermal Bridging has been reviewed and appropriate industry schemes (Timber Frame calculated PSI-Values and Timber Frame ACDs) have been used.

ELEMENT	PART L1a LIMITING FABRIC PARAMETERS	PROPOSED U-VALUES (W/m^2K)
Walls		
External Wall	*0.26 W/m^2K*	**0.16 W/m^2K**
Floors		
Ground Floor	*0.18 W/m^2K*	**0.10 W/m^2K**
Roof		
Sloping Roof	*0.16 W/m^2K*	**0.10 W/m^2K**
Openings		
Windows	*1.6 W/m^2K*	**1.2 W/m^2K**
Doors	*1.6 W/m^2K*	**1.0 W/m^2K**
Air Permeability		
5.1 $m^3/(hm^2)$ @50Pa		

Table: *Proposed Fabric Specification*

Active Design

3.4 The development will incorporate efficient building services to limit carbon emissions, including:

- A zero-NOx heating system
- LED Lighting

ELEMENT	PROPOSED DETAILS
Ventilation	**Natural Ventilation (Intermittent Extract and Trickle Vents)**
Heating	**Air Source Heat Pump - (Modelled as Vaillant Arotherm)**
Heating Controls	**Time and Temperature Zone Controls**
Heat Emitters	**Underfloor Heating**
Hot Water	**From ASHP**
Cylinder	**180ltr (1.4kWh/day heat loss)**
Lighting	**LED (95 lm/W)**
Cooling	**No**

Table: Proposed Mechanical and Electrical Specification

Unregulated Emissions

3.5 Unregulated energy use and their associated carbon emissions are often generated from systems or processes that are harder to quantify than regulated emissions which are from fixed systems.

3.6 Unregulated energy use is not counted within SAP for the purpose of Part L compliance. This is because the emissions from these items are variable and dependant on occupant behaviour and specification i.e. different levels of White Good provision and use and amount of small power equipment used.

For the proposed development unregulated emissions consist of:

- Equipment (Small Power devices)
- Cooking

3.7 Unregulated CO_2 emissions have been calculated from the SAP Worksheet in-line with the calculation previously used for *ENE 7* of the *Code for Sustainable Homes.*

These have then been translated into CO_2 by multiplying the figure by the carbon factor for electricity.

Carbon dioxide emissions (tonnes CO2 per annum)	
Proposed Development – Unregulated CO_2 emissions	**0.75**

4. RENEWABLE TECHNOLOGIES

4.1 Renewable Energy is typically defined as:

"Energy derived from a source that is continually replenished, such as wind, wave, solar, hydroelectric and energy from plant material, but not fossil fuels or nuclear energy. Although not strictly renewable, geothermal energy is generally included."

4.2 Based on recent legislation such as the Clean Air Act as well as the location of the proposed development, the following technologies have been discounted:

- Wind Turbines
- Biomass
- Hydropower / Wave Technology
- Biogas / Biofuel

4.3 The feasibility of remaining renewable and low carbon technologies is highlighted in the table opposite.

4.4 Following a review of the available technologies, the following have been integrated into the scheme:

- Air Source Heat Pump (Individual)

FEASIBILITY						
Technology	Considerations					Overall Feasibility
	Cost	Noise	Land Use	Tariffs	CO_2 Offset	
Photovoltaic Panels (PV)	There is currently an increased cost of PV installation due to supply-chain issues and shipping costs. This is partially offsetting the decreased payback time that the rise in electricity costs per kWh has created. The CO_2 offset of PV in Part L 2021 is 73.8% less than Part L 2013 therefore carbon savings for the technology are greatly diminished.					**No**
Air Source Heat Pumps (ASHP)	ASHPs provide a low-temperature heating system at high efficiency and work will with either radiators or underfloor heating as the chosen emitters. They are also zero-NOx emission systems and therefore comply with any local policies on Air Quality. Due to the continued decarbonisation of the National Grid, associated CO_2 offset with the system will increase with time.					**Yes**
Ground Source Heat Pumps (GSHP)	GSHPs are like ASHPs but operate at slightly higher efficiencies due to drawing heat from the ground, a source that is warmer than the outside air, especially in Winter. However, the technology is more expensive than Air Source and requires either significant horizontal space for a *slinky* style system or deep boreholes as part of a vertical system. As this is not proposed here, ASHPs are more suited to the scheme.					**No**
Solar Thermal	As the proposed building-use is a large residential dwelling with a built-in electrically heated HWC from the ASHP, Solar Thermal would not be suited to the scheme as the hot water needs are already met by a renewably heated source and electricity.					**No**

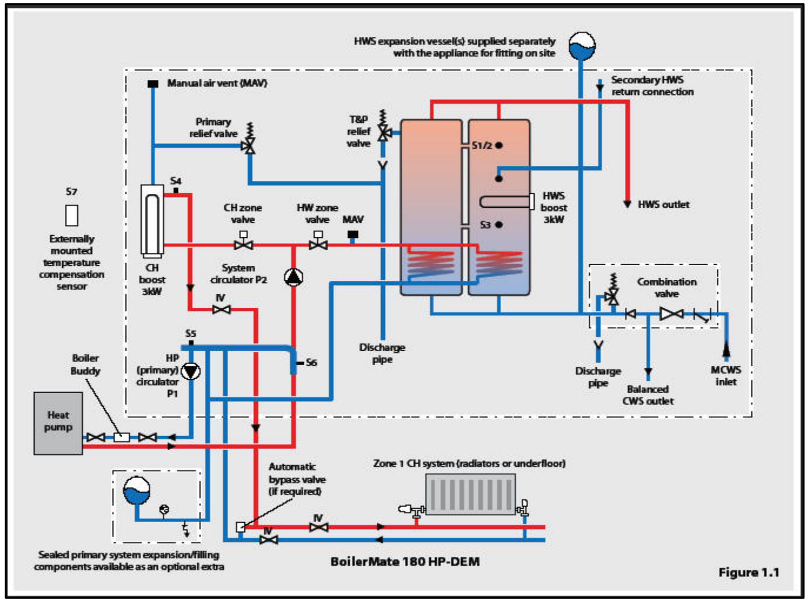
Table: Renewable Energy Feasibility

AIR SOURCE HEAT PUMPS

4.5 To provide renewable heating and hot water, individual Air Source Heat Pumps are proposed. An ASHP extracts heat from ambient air via a heat exchanger and raises the temperature of an internal refrigerant via the compression cycle.

The ASHPs will consist of an internal unit and an external unit, and the design will be in-line with the schematic below which shows a typical ASHP installation to a new build dwelling.

Figure: *ASHP Schematic*



ASHP Details

Figure: *ASHP Model (For Reference Only)– Vaillant Arotherm*

ASHP System Details	
Dwellings to be Heated	1
Number of Heat Pumps	1
Make and Model	TBC – Vaillant Arotherm 8 kW used in SAP
SCOP	4.58
Fraction of Heat	100%

Table: Proposed ASHP Specification

AIR SOURCE HEAT PUMPS – BENEFITS

4.6 ASHPs have multiple benefits - with an air source heat pump, end-users can save money on their energy bills and reduce the carbon footprint of the scheme compared to a gas or a conventional (boiler or portable heaters) electric heating system. One of the key advantages of air source heat pumps is their versatility and affordability. An ASHP can work for either heating or cooling purposes and can be used for space heating or water heating.

The most important advantages of purchasing an air source heat pump are the following:

Low Carbon Footprint

4.7 Air source heat pumps have are a form of low carbon heating, as they use the outside air to heat or cool. For every 3 to 4 units of energy produced from an air source heat pump, only 1 unit of electricity is used, making it a far better alternative to cut emissions.

Save Money on Energy Bills

4.8 ASHPs reduce energy bills as the outside air is used for heating and cooling.

Can Be Used for Heating and Cooling

4.9 Air source heat pumps can be used for both heating and cooling purposes. Depending on the model, they can provide cooling in the summer and heating in the winter.

4.10 In addition, air source heat pumps work very well with underfloor heating.

High Seasonal Coefficient of Performance (SCOP)

4.11 Air source heat pumps are efficient both in the winter and summer, thanks to a high SCOP (seasonal coefficient of performance). The COP of a heat pump is a way to measure its efficiency by comparing the power input needed to produce heat to the amount of heat output. A 'seasonal COP' figure is adjusted to seasonality.

Low Maintenance

4.12 Servicing and maintenance should be done by a technician **once a year**. As such air source heat pumps are low maintenance.

Long Lifespan

4.13 Air source heat pumps have a long lifespan, and with proper maintenance, they can be operational for up to 20 years. What's more, is that most air source heat pumps have 5-year warranties. With several technological developments modern heat pumps are able to work efficiently for close to 25 years before they need replacing.

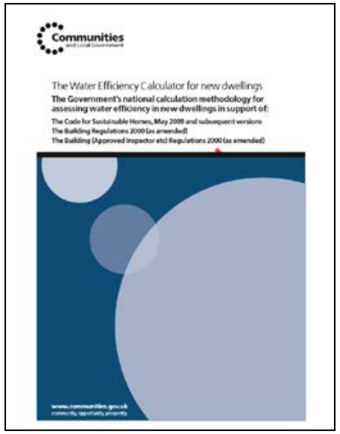
5. WATER EFFICIENCY

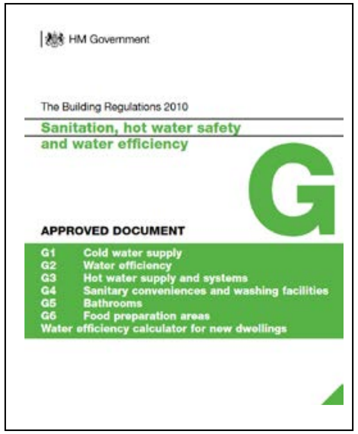
5.1 The Local Plan requires that all developments must incorporate water conservation measures to limit the consumption to 110 litres per person per day.

5.2 This target is the same as the optional target included within Part G of the Building Regulations which encourages the efficient use of potable water. The specification proposed has been produced using the calculation methodology used to assess compliance against the water performance targets in Building Regulations 17.K and is based on the Government's *"The Water Efficiency Calculator for new dwellings – September 2009"* (withdrawn in June 2016).

5.3 The current guidance and calculation methodology can now be found within *Approved Document G - Sanitation, hot water safety and water efficiency* (2015 edition with 2016 amendments): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/504207/BR_PDF_AD_G_2015_with_2016_amendments.pdf

5.4 The proposed specification for the scheme can be found on the right-hand side of the page showing compliance. For the Dishwashers and Washing Machines, default consumption figures have been used.





PROPOSED SANITARYWARE SPECIFICATION

Element	Specification	Unit of Measurement
WC	***6/3 dual flush***	*Litres per Flush*
Basin Taps	***5***	*Litres per Minute*
Kitchen Sink Taps	***9***	*Litres per Minute*
Shower	***8***	*Litres per Minute*
Bath	***155***	*Capacity to Overflow*
Washing Machine	***8.17***	*Litres per Kilo (Dry)*
Dishwasher	***1.25***	*Litres per Place Setting*
Allowance for External Use	5	*(Litres / Person / Day)*
Total Consumption (Litres / Person / Day)		**109.7**

Table : *Proposed Water Consumption (litres/person/day*

6. CONCLUSION

6.1 A full energy strategy in-line with the energy hierarchy has been undertaken and this document illustrates a reduction in CO_2 emissions over the baseline of Part L 2021 via:

Energy Efficient Measures

- High levels of thermal insulation to achieve U-Values lower than the Part L 2021 notional building specification.
- LED Lighting with a minimum luminous efficacy of 95lm/W
- Air Permeability target of 5.1 m3/(hm2) @50Pa

Renewable Technologies

An Air Source Heat Pump will be provided for maximum efficiency and carbon savings.

6.2 A final carbon emission reduction table is shown on the opposite side of the page illustrating the savings at each stage of the energy hierarchy. Overall, the scheme achieves **53.96%** CO_2 compared to that of the Part L 2021.

6.3 This development is situated on the same site that benefits from a planning consent for a barn conversion scheme, Due to the nature of this superseded dwelling being a conversion, it is inherently higher-emission when compared to any new-build development.

This Energy Statement relates to this new build development and will, by default, be more efficient in all aspects. This includes CO_2 reduction, reduction in primary energy, and an improvement to fabric efficiency.

	CO_2 Emissions (Tonnes per Annum)	
	Regulated	
Baseline: Part L 2021 of the Building Regulations (TER)	0.92	
Final CO_2 Emissions of Proposed Development (DER)	0.43	
Regulated CO_2 Savings over Part L 2021	53.96%	

Table: Carbon Emissions Table

Appendix 1

PROJECT: DUNSTY HILL FARM

Plots	Floor Area	Target Emissions (TER) *Part L Baseline*	Total TER	Dwelling Emission Rate (DER) *Proposed Dwelling*	Total DER
	m^2	$kg/CO_2/m^2/year$	$kg/CO_2/year$	$kg/CO_2/m^2/year$	$kg/CO_2/year$
House	95	9.73	924	4.48	426
Total Site Area (m^2):	95		924		426

RESULTS			OVERALL RESULTS		
Baseline Emissions - Total Site	924	$kg/CO_2/year$	Final CO_2 Emissions	426	$kg/CO_2/year$
			CO_2 reduction over Part L 2021	53.96	%
			Total CO_2 savings achieved	499	$kg/CO_2/year$

Appendix 2

Building Regulations England Part L (BREL) Compliance Report

Approved Document L1 2021 Edition, England assessed by Array SAP 10 program, Array

Date: Thu 31 Aug 2023 09:27:23

Project Information			
Assessed By	Edward Coate	Building Type	House, Detached
OCDEA Registration	EES/026101	Assessment Date	2023-08-31

Dwelling Details			
Assessment Type	As designed	Total Floor Area	95 m^2
Site Reference	Dunsty Hill Farm(REAL)	Plot Reference	00001
Address			

Client Details	
Name	TBC
Company	TBC
Address	TBC, TBC, TBC

This report covers items included within the SAP calculations. It is not a complete report of regulations compliance.

1a Target emission rate and dwelling emission rate		
Fuel for main heating system	Electricity	
Target carbon dioxide emission rate	*9.73 $kgCO_2/m^2$*	
Dwelling carbon dioxide emission rate	4.48 $kgCO_2/m^2$	OK
1b Target primary energy rate and dwelling primary energy		
Target primary energy	*52.45 kWh_{PE}/m^2*	
Dwelling primary energy	46.86 kWh_{PE}/m^2	OK
1c Target fabric energy efficiency and dwelling fabric energy efficiency		
Target fabric energy efficiency	*46.5 kWh/m^2*	
Dwelling fabric energy efficiency	46.2 kWh/m^2	OK

2a Fabric U-values				
Element	***Maximum permitted average U-Value [W/m²K]***	**Dwelling average U-Value [W/m²K]**	**Element with highest individual U-Value**	
External walls	*0.26*	0.16	Walls (1) (0.16)	OK
Party walls	*0.2*	N/A	N/A	**N/A**
Curtain walls	*1.6*	N/A	N/A	**N/A**
Floors	*0.18*	0.1	Heatloss Floor 1 (0.1)	OK
Roofs	*0.16*	0.1	Roof (1) (0.1)	OK
Windows, doors, and roof windows	*1.6*	1.19	Opening (1.2)	OK
Rooflights	*2.2*	N/A	N/A	**N/A**

2b Envelope elements (better than typically expected values are flagged with a subsequent (!))		
Name	**Net area [m²]**	**U-Value [W/m²K]**
Exposed wall: Walls (1)	75.5	0.16
Ground floor: Heatloss Floor 1, Heatloss Floor 1	95	0.1 **(!)**
Exposed roof: Roof (1)	95	0.1 **(!)**

2c Openings (better than typically expected values are flagged with a subsequent (!))				
Name	**Area [m²]**	**Orientation**	**Frame factor**	**U-Value [W/m²K]**
Opening, Opening Type 2	0.66	North	0.7	1.2
Opening, Opening Type 2	6.3	North	0.7	1.2
Opening, Opening Type 1	2.1	North	N/A	1 **(!)**
Opening, Opening Type 2	6.3	South	0.7	1.2
Opening, Opening Type 2	6.3	South	0.7	1.2
Opening, Opening Type 2	0.66	South	0.7	1.2
Opening, Opening Type 2	6.93	West	0.7	1.2

2d Thermal bridging (better than typically expected values are flagged with a subsequent (!))				
Building part **1 - Main Dwelling**: Thermal bridging calculated from linear thermal transmittances for each junction				
Main element	**Junction detail**	**Source**	**Psi value [W/mK]**	**Drawing / reference**
External wall	E2: Other lintels (including other steel lintels)	Government-approved scheme	0.083	

Main element	Junction detail	Source	Psi value [W/mK]	Drawing / reference
External wall	E3: Sill	Government-approved scheme	0.042	
External wall	E4: Jamb	Government-approved scheme	0.05	
External wall	E5: Ground floor (normal)	Government-approved scheme	0.211	
External wall	E16: Corner (normal)	Government-approved scheme	0.037 **(!)**	
External wall	E10: Eaves (insulation at ceiling level)	Calculated by person with suitable expertise	0.06	
External wall	E12: Gable (insulation at ceiling level)	Calculated by person with suitable expertise	0.24	

3 Air permeability (better than typically expected values are flagged with a subsequent (!))		
Maximum permitted air permeability at 50Pa	*8 m^3/hm^2*	
Dwelling air permeability at 50Pa	5.1 m^3/hm^2, Design value	**OK**
Air permeability test certificate reference		

4 Space heating	
Main heating system 1: Heat pump with radiators or underfloor heating - Electricity	
Efficiency	332.1%
Emitter type	Underfloor
Flow temperature	35°C
System type	Heat Pump
Manufacturer	Vaillant Group UK Ltd
Model	aroTHERM 8kW
Commissioning	
Secondary heating system: N/A	
Fuel	N/A
Efficiency	N/A
Commissioning	

5 Hot water	
Cylinder/store - type: Cylinder	
Capacity	180 litres
Declared heat loss	1.4 kWh/day
Primary pipework insulated	Yes
Manufacturer	
Model	
Commissioning	
Waste water heat recovery system 1 - type: N/A	
Efficiency	
Manufacturer	
Model	

6 Controls	
Main heating 1 - type: Time and temperature zone control by arrangement of plumbing and electrical services	
Function	
Ecodesign class	
Manufacturer	
Model	
Water heating - type: Cylinder thermostat and HW separately timed	
Manufacturer	
Model	

7 Lighting		
Minimum permitted light source efficacy	*75 lm/W*	
Lowest light source efficacy	95 lm/W	**OK**
External lights control	N/A	

8 Mechanical ventilation		
System type: N/A		
Maximum permitted specific fan power	*N/A*	
Specific fan power	N/A	**N/A**
Minimum permitted heat recovery efficiency	*N/A*	
Heat recovery efficiency	N/A	**N/A**
Manufacturer/Model		
Commissioning		

9 Local generation

N/A

10 Heat networks

N/A

11 Supporting documentary evidence

N/A

12 Declarations

a. Assessor Declaration

This declaration by the assessor is confirmation that the contents of this BREL Compliance Report are a true and accurate reflection based upon the design information submitted for this dwelling for the purpose of carrying out the "As designed" assessment, and that the supporting documentary evidence (SAP Conventions, Appendix 1 (documentary evidence) schedules the minimum documentary evidence required) has been reviewed in the course of preparing this BREL Compliance Report.

Signed:	Assessor ID:
Name:	Date:

b. Client Declaration

N/A

Appendix 3

Full SAP Calculation Printout

Property Reference	Dunsty Hill Farm(REAL)	Issued on Date	31/08/2023
Assessment Reference	00001	Prop Type Ref	
Property			

SAP Rating	81 B	DER	4.48	TER	9.73
Environmental	96 A	% DER < TER			53.96
CO₂ Emissions (t/year)	0.38	DFEE	46.20	TFEE	46.53
Compliance Check	See BREL	% DFEE < TFEE			0.72
% DPER < TPER	10.66	DPER	46.86	TPER	52.45

Assessor Details	Mr. Edward Coate	Assessor ID	Z417-0001
Client	NRG, TBC		

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	95.0000 (1b)	x	2.5000 (2b)	=	237.5000 (1b) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 95.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	237.5000 (5)

2. Ventilation rate

		m3 per hour
Number of open chimneys	0 * 80 =	0.0000 (6a)
Number of open flues	0 * 20 =	0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000 (6d)
Number of flues attached to other heater	0 * 35 =	0.0000 (6e)
Number of blocked chimneys	0 * 20 =	0.0000 (6f)
Number of intermittent extract fans	0 * 10 =	0.0000 (7a)
Number of passive vents	6 * 10 =	60.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)

		Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	60.0000 / (5) =	0.2526 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.1000 (17)
Infiltration rate		0.5076 (18)
Number of sides sheltered		0 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.5076 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.6472	0.6345	0.6218	0.5584	0.5457	0.4823	0.4823	0.4696	0.5076	0.5457	0.5711	0.5965	(22b)
Effective ac	0.7095	0.7013	0.6933	0.6559	0.6489	0.6163	0.6163	0.6102	0.6288	0.6489	0.6631	0.6779	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1			2.1000	1.0000	2.1000			(26)
Opening Type 2 (Uw = 1.20)			27.1500	1.1450	31.0878			(27)
Heatloss Floor 1			95.0000	0.1000	9.5000	110.0000	10450.0000	(28a)
External Wall 1	104.7500	29.2500	75.5000	0.1600	12.0800	190.0000	14345.0000	(29a)
External Roof 1	95.0000		95.0000	0.1000	9.5000	9.0000	855.0000	(30)
Total net area of external elements Aum(A, m2)			294.7500					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	64.2678			(33)
Internal Wall 1			109.0000			9.0000	981.0000	(32c)

```
Heat capacity Cm = Sum(A x k)                                                    (28)...(30) + (32) + (32a)...(32e) =  26631.0000 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                        280.3263 (35)
List of Thermal Bridges
        K1 Element                                                                            Length      Psi-value         Total
        E2 Other lintels (including other steel lintels)                                     14.5000        0.0830         1.2035
        E3 Sill                                                                              13.5000        0.0420         0.5670
        E4 Jamb                                                                              24.5000        0.0500         1.2250
        E5 Ground floor (normal)                                                             41.9000        0.2110         8.8409
        E16 Corner (normal)                                                                  10.0000        0.0370         0.3700
        E10 Eaves (insulation at ceiling level)                                              12.6000        0.0600         0.7560
        E12 Gable (insulation at ceiling level)                                              29.0000        0.2400         6.9600
Thermal bridges (Sum(L x Psi) calculated using Appendix K)                                                                19.9224 (36)
Point Thermal bridges                                                                                          (36a) =     0.0000
Total fabric heat loss                                                                             (33) + (36) + (36a) =  84.1902 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(38)m         55.6034    54.9660    54.3411    51.4063    50.8573    48.3011    48.3011    47.8278    49.2857    50.8573    51.9681    53.1294 (38)
Heat transfer coeff
             139.7936   139.1562   138.5313   135.5965   135.0474   132.4913   132.4913   132.0180   133.4759   135.0474   136.1582   137.3195 (39)
Average = Sum(39)m / 12 =                                                                                                            135.5939

                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP            1.4715     1.4648     1.4582     1.4273     1.4216     1.3946     1.3946     1.3897     1.4050     1.4216     1.4332     1.4455 (40)
HLP (average)                                                                                                                          1.4273
Days in mont       31         28         31         30         31         30         31         31         30         31         30         31
```

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4. Water heating energy requirements (kWh/year)

```
Assumed occupancy                                                                                                                      2.6882 (42)
Hot water usage for mixer showers
               0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
              79.9162    78.7293    77.0579    73.9763    71.6687    69.1100    67.7280    69.3876    71.1947    73.9326    77.0777    79.6460 (42b)
Hot water usage for other uses
              42.1595    40.6265    39.0934    37.5603    36.0272    34.4942    34.4942    36.0272    37.5603    39.0934    40.6265    42.1595 (42c)
Average daily hot water use (litres/day)                                                                                             112.4217 (43)

                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
             122.0757   119.3558   116.1513   111.5366   107.6960   103.6042   102.2221   105.4149   108.7550   113.0260   117.7042   121.8055 (44)
Energy conte 193.3381   169.9610   178.5203   152.6880   144.9795   127.3935   123.6288   130.5256   134.1058   153.3752   167.6912   190.7180 (45)
Energy content (annual)                                                                                  Total = Sum(45)m =    1866.9249
Distribution loss  (46)m = 0.15 x (45)m
              29.0007    25.4942    26.7780    22.9032    21.7469    19.1090    18.5443    19.5788    20.1159    23.0063    25.1537    28.6077 (46)
Water storage loss:
Store volume                                                                                                                         180.0000 (47)
a) If  manufacturer declared loss factor is known  (kWh/day):                                                                          1.4000 (48)
  Temperature factor from Table 2b                                                                                                     0.5400 (49)
Enter (49) or (54) in (55)                                                                                                             0.7560 (55)
Total storage loss
              23.4360    21.1680    23.4360    22.6800    23.4360    22.6800    23.4360    23.4360    22.6800    23.4360    22.6800    23.4360 (56)
If cylinder contains dedicated solar storage
              23.4360    21.1680    23.4360    22.6800    23.4360    22.6800    23.4360    23.4360    22.6800    23.4360    22.6800    23.4360 (57)
Primary loss  23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Combi loss     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (61)
Total heat required for water heating calculated for each month
             240.0365   212.1402   225.2187   197.8800   191.6779   172.5855   170.3272   177.2240   179.2978   200.0736   212.8832   237.4164 (62)
WWHRS          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63a)
PV diverter    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63b)
Solar input    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63c)
FGHRS          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63d)
Output from w/h
             240.0365   212.1402   225.2187   197.8800   191.6779   172.5855   170.3272   177.2240   179.2978   200.0736   212.8832   237.4164 (64)
                                                                                      Total per year (kWh/year) = Sum(64)m =   2416.7609 (64)
12Total per year (kWh/year)                                                                                                           2417 (64)
Electric shower(s)
               0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (64a)
                                                    Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =     0.0000 (64a)
Heat gains from water heating, kWh/month
             101.6436    90.2554    96.7167    86.9224    85.5644    78.5119    78.4653    80.7585    80.7438    88.3560    91.9109   100.7725 (65)
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5. Internal gains (see Table 5 and 5a)

```
Metabolic gains (Table 5), Watts
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m        134.4085   134.4085   134.4085   134.4085   134.4085   134.4085   134.4085   134.4085   134.4085   134.4085   134.4085   134.4085 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
             125.0785   138.4797   125.0785   129.2477   125.0785   129.2477   125.0785   125.0785   129.2477   125.0785   129.2477   125.0785 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
             247.9820   250.5553   244.0707   230.2658   212.8396   196.4615   185.5198   182.9466   189.4311   203.2360   220.6622   237.0404 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
              36.4408    36.4408    36.4408    36.4408    36.4408    36.4408    36.4408    36.4408    36.4408    36.4408    36.4408    36.4408 (69)
Pumps, fans    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
            -107.5268  -107.5268  -107.5268  -107.5268  -107.5268  -107.5268  -107.5268  -107.5268  -107.5268  -107.5268  -107.5268  -107.5268 (71)
Water heating gains (Table 5)
```

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	136.6178	134.3086	129.9956	120.7255	115.0059	109.0443	105.4641	108.5464	112.1441	118.7580	127.6541	135.4469	(72)
Total internal gains	573.0008	586.6662	562.4673	543.5616	516.2465	498.0761	479.3849	479.8939	494.1456	510.3950	540.8866	560.8883	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	6.9600	10.6334	0.7200	0.7000	0.7700	25.8491	(74)
South	13.2600	46.7521	0.7200	0.7000	0.7700	216.5250	(78)
West	6.9300	19.6403	0.7200	0.7000	0.7700	47.5384	(80)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	289.9125	497.0062	688.8036	868.7240	987.3725	986.6416	948.5527	858.9854	750.9111	551.6320	347.8189	247.7399	(83)
Total gains	862.9133	1083.6724	1251.2709	1412.2856	1503.6190	1484.7176	1427.9376	1338.8794	1245.0567	1062.0271	888.7055	808.6281	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	52.9173	53.1597	53.3995	54.5552	54.7770	55.8338	55.8338	56.0340	55.4220	54.7770	54.3302	53.8707	
alpha	4.5278	4.5440	4.5600	4.6370	4.6518	4.7223	4.7223	4.7356	4.6948	4.6518	4.6220	4.5914	
util living area	0.9930	0.9806	0.9531	0.8782	0.7420	0.5530	0.4047	0.4476	0.6827	0.9163	0.9837	0.9947	(86)
Living	19.8485	20.0676	20.3326	20.6377	20.8298	20.9145	20.9307	20.9287	20.8815	20.6148	20.1819	19.8266	
Non living	18.3989	18.6791	19.0104	19.3862	19.5864	19.6741	19.6825	19.6859	19.6462	19.3755	18.8449	18.3863	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.4109	20.0676	20.3326	20.6377	20.8298	20.9145	20.9307	20.9287	20.8815	20.6148	20.1819	19.9907	(87)
Th 2	19.7089	19.7140	19.7190	19.7424	19.7468	19.7674	19.7674	19.7713	19.7595	19.7468	19.7379	19.7286	(88)
util rest of house	0.9904	0.9737	0.9366	0.8387	0.6701	0.4546	0.2933	0.3312	0.5825	0.8791	0.9766	0.9927	(89)
MIT 2	19.1867	18.6791	19.0104	19.3862	19.5864	19.6741	19.6825	19.6859	19.6462	19.3755	18.8449	18.6282	(90)
Living area fraction									fLA = Living area / (4) =			0.6011	(91)
MIT	19.9225	19.5137	19.8051	20.1384	20.3338	20.4197	20.4327	20.4329	20.3887	20.1204	19.6486	19.4471	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.9225	19.5137	19.8051	20.1384	20.3338	20.4197	20.4327	20.4329	20.3887	20.1204	19.6486	19.4471	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9909	0.9724	0.9379	0.8524	0.7055	0.5077	0.3539	0.3946	0.6356	0.8917	0.9760	0.9922	(94)
Useful gains	855.0741	1053.7762	1173.5455	1203.8004	1060.7711	753.8545	505.3161	528.3248	791.3387	947.0430	867.3785	802.3059	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	2183.9272	2033.5840	1843.1763	1523.8883	1165.9697	771.0540	507.8029	532.4148	839.3879	1285.6998	1708.5888	2093.7277	(97)
Space heating kWh	988.6667	658.4308	498.2053	230.4633	78.2677	0.0000	0.0000	0.0000	0.0000	251.9606	605.6714	960.8179	(98a)
Space heating requirement - total per year (kWh/year)												4272.4838	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	988.6667	658.4308	498.2053	230.4633	78.2677	0.0000	0.0000	0.0000	0.0000	251.9606	605.6714	960.8179	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												4272.4838	
Space heating per m2											(98c) / (4) =	44.9735	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	332.1111	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	988.6667	658.4308	498.2053	230.4633	78.2677	0.0000	0.0000	0.0000	0.0000	251.9606	605.6714	960.8179	(98)
Space heating efficiency (main heating system 1)	332.1111	332.1111	332.1111	332.1111	332.1111	0.0000	0.0000	0.0000	0.0000	332.1111	332.1111	332.1111	(210)
Space heating fuel (main heating system)	297.6916	198.2562	150.0117	69.3934	23.5667	0.0000	0.0000	0.0000	0.0000	75.8664	182.3701	289.3062	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)

```
Space heating fuel (secondary)
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (215)

Water heating
Water heating requirement
               240.0365   212.1402   225.2187   197.8800   191.6779   172.5855   170.3272   177.2240   179.2978   200.0736   212.8832   237.4164 (64)
Efficiency of water heater                                                                                                              173.7000 (216)
(217)m         173.7000   173.7000   173.7000   173.7000   173.7000   173.7000   173.7000   173.7000   173.7000   173.7000   173.7000   173.7000 (217)
Fuel for water heating, kWh/month
               138.1902   122.1302   129.6596   113.9205   110.3500    99.3584    98.0583   102.0288   103.2227   115.1834   122.5580   136.6819 (219)
Space cooling fuel requirement
(221)m           0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (221)
Pumps and Fa     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (231)
Lighting        24.5630    19.7053    17.7425    12.9989    10.0407     8.2034     9.1595    11.9058    15.4645    20.2903    22.9178    25.2457 (232)
Electricity generated by PVs (Appendix M) (negative quantity)
(233a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(234a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(235a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(235c)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235c)
Electricity generated by PVs (Appendix M) (negative quantity)
(233b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(234b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(235b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(235d)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235d)
Annual totals kWh/year
Space heating fuel - main system 1                                                                                                    1286.4624 (211)
Space heating fuel - main system 2                                                                                                       0.0000 (213)
Space heating fuel - secondary                                                                                                           0.0000 (215)
Efficiency of water heater                                                                                                             173.7000
Water heating fuel used                                                                                                               1391.3419 (219)
Space cooling fuel                                                                                                                       0.0000 (221)

Electricity for pumps and fans:
Total electricity for the above, kWh/year                                                                                                0.0000 (231)
Electricity for lighting (calculated in Appendix L)                                                                                    198.2373 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                            0.0000 (233)
Wind generation                                                                                                                          0.0000 (234)
Hydro-electric generation (Appendix N)                                                                                                   0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)                                                                                           0.0000 (235)
Appendix Q - special features
Energy saved or generated                                                                                                               -0.0000 (236)
Energy used                                                                                                                              0.0000 (237)
Total delivered energy for all uses                                                                                                   2876.0416 (238)


----------------------------------------------------------------------------------------------------
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                   Energy      Emission factor         Emissions
                                                                                 kWh/year          kg CO2/kWh        kg CO2/year
Space heating - main system 1                                                   1286.4624              0.1564           201.2432 (261)
Total CO2 associated with community systems                                                                               0.0000 (373)
Water heating (other fuel)                                                      1391.3419              0.1409           196.0388 (264)
Space and water heating                                                                                                 397.2820 (265)
Pumps, fans and electric keep-hot                                                  0.0000              0.0000             0.0000 (267)
Energy for lighting                                                              198.2373              0.1443            28.6118 (268)
Total CO2, kg/year                                                                                                      425.8938 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)                                                                           4.4800 (273)


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13a. Primary energy - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                   Energy Primary energy factor      Primary energy
                                                                                 kWh/year          kg CO2/kWh           kWh/year
Space heating - main system 1                                                   1286.4624              1.5791          2031.4409 (275)
Total CO2 associated with community systems                                                                               0.0000 (473)
Water heating (other fuel)                                                      1391.3419              1.5210          2116.2221 (278)
Space and water heating                                                                                                4147.6630 (279)
Pumps, fans and electric keep-hot                                                  0.0000              0.0000             0.0000 (281)
Energy for lighting                                                              198.2373              1.5338           304.0631 (282)
Total Primary energy kWh/year                                                                                          4451.7260 (286)
Dwelling Primary energy Rate (DPER)                                                                                      46.8600 (287)


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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF TARGET EMISSIONS
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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	95.0000 (1b)	x	2.5000 (2b)	=	237.5000 (1b) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	95.0000				(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	237.5000 (5)

2. Ventilation rate

		m3 per hour
Number of open chimneys	0 * 80 =	0.0000 (6a)
Number of open flues	0 * 20 =	0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000 (6d)
Number of flues attached to other heater	0 * 35 =	0.0000 (6e)
Number of blocked chimneys	0 * 20 =	0.0000 (6f)
Number of intermittent extract fans	3 * 10 =	30.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)

			Air changes per hour
Infiltration due to chimneys, flues and fans	= (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1263 (8)
Pressure test			Yes
Pressure Test Method			Blower Door
Measured/design AP50			5.0000 (17)
Infiltration rate			0.3763 (18)
Number of sides sheltered			0 (19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	1.0000 (20)
Infiltration rate adjusted to include shelter factor		(21) = (18) x (20) =	0.3763 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4798	0.4704	0.4610	0.4139	0.4045	0.3575	0.3575	0.3481	0.3763	0.4045	0.4234	0.4422	(22b)
Effective ac	0.6151	0.6106	0.6063	0.5857	0.5818	0.5639	0.5639	0.5606	0.5708	0.5818	0.5896	0.5978	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			2.1000	1.0000	2.1000			(26)
TER Opening Type (Uw = 1.20)			21.6600	1.1450	24.8015			(27)
Heatloss Floor 1			95.0000	0.1300	12.3500			(28a)
External Wall 1	104.7500	23.7600	80.9900	0.1800	14.5782			(29a)
External Roof 1	95.0000		95.0000	0.1100	10.4500			(30)
Total net area of external elements Aum(A, m2)			294.7500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		64.2797			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 280.3263 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	14.5000	0.0500	0.7250
E3 Sill	13.5000	0.0500	0.6750
E4 Jamb	24.5000	0.0500	1.2250
E5 Ground floor (normal)	41.9000	0.1600	6.7040
E16 Corner (normal)	10.0000	0.0900	0.9000
E10 Eaves (insulation at ceiling level)	12.6000	0.0600	0.7560
E12 Gable (insulation at ceiling level)	29.0000	0.0600	1.7400

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		12.7250 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	77.0047 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	48.2089	47.8586	47.5152	45.9024	45.6006	44.1959	44.1959	43.9358	44.7370	45.6006	46.2111	46.8493	(38)
Heat transfer coeff	125.2136	124.8633	124.5199	122.9071	122.6053	121.2006	121.2006	120.9405	121.7417	122.6053	123.2158	123.8540	(39)
Average = Sum(39)m / 12 =												122.9057	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3180	1.3144	1.3107	1.2938	1.2906	1.2758	1.2758	1.2731	1.2815	1.2906	1.2970	1.3037	(40)
HLP (average)												1.2937	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.6882 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	79.9162	78.7293	77.0579	73.9763	71.6687	69.1100	67.7280	69.3876	71.1947	73.9326	77.0777	79.6460	(42b)
Hot water usage for other uses	42.1595	40.6265	39.0934	37.5603	36.0272	34.4942	34.4942	36.0272	37.5603	39.0934	40.6265	42.1595	(42c)

Average daily hot water use (litres/day) 112.4217 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	122.0757	119.3558	116.1513	111.5366	107.6960	103.6042	102.2221	105.4149	108.7550	113.0260	117.7042	121.8055	(44)
Energy conte	193.3381	169.9610	178.5203	152.6880	144.9795	127.3935	123.6288	130.5256	134.1058	153.3752	167.6912	190.7180	(45)

Energy content (annual) Total = Sum(45)m = 1866.9249

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss (46)m = 0.15 x (45)m	29.0007	25.4942	26.7780	22.9032	21.7469	19.1090	18.5443	19.5788	20.1159	23.0063	25.1537	28.6077	(46)

Water storage loss:

Store volume 180.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.5520 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.8381 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803	(56)
If cylinder contains dedicated solar storage	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	242.5807	214.4383	227.7629	200.3422	194.2221	175.0477	172.8715	179.7683	181.7600	202.6179	215.3454	239.9607	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	242.5807	214.4383	227.7629	200.3422	194.2221	175.0477	172.8715	179.7683	181.7600	202.6179	215.3454	239.9607	(64)

Total per year (kWh/year) = Sum(64)m = 2446.7176 (64)

12Total per year (kWh/year) 2447 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	103.6790	92.0938	98.7521	88.8921	87.5998	80.4817	80.5007	82.7939	82.7135	90.3914	93.8807	102.8079	(65)

5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	134.4085	134.4085	134.4085	134.4085	134.4085	134.4085	134.4085	134.4085	134.4085	134.4085	134.4085	134.4085	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	125.0529	138.4515	125.0529	129.2214	125.0529	129.2214	125.0529	125.0529	129.2214	125.0529	129.2214	125.0529	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	247.9820	250.5553	244.0707	230.2658	212.8396	196.4615	185.5198	182.9466	189.4311	203.2360	220.6622	237.0404	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.4408	36.4408	36.4408	36.4408	36.4408	36.4408	36.4408	36.4408	36.4408	36.4408	36.4408	36.4408	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	-107.5268	(71)
Water heating gains (Table 5)	139.3536	137.0444	132.7313	123.4613	117.7417	111.7801	108.1999	111.2821	114.8799	121.4938	130.3898	138.1826	(72)
Total internal gains	578.7111	592.3737	568.1776	549.2710	521.9568	500.7855	482.0952	482.6042	496.8550	516.1053	546.5960	566.5985	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.5500	10.6334	0.6300	0.7000	0.7700	18.0359	(74)
South	10.5800	46.7521	0.6300	0.7000	0.7700	151.1675	(78)
West	5.5300	19.6403	0.6300	0.7000	0.7700	33.1928	(80)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	202.3961	346.9730	480.8672	606.4636	689.2829	688.7678	662.1802	599.6612	524.2227	385.1076	242.8221	172.9543	(83)
Total gains	781.1072	939.3467	1049.0448	1155.7346	1211.2397	1189.5533	1144.2754	1082.2654	1021.0776	901.2129	789.4181	739.5528	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	59.0790	59.2448	59.4082	60.1877	60.3359	61.0352	61.0352	61.1664	60.7639	60.3359	60.0369	59.7276
alpha	4.9386	4.9497	4.9605	5.0125	5.0224	5.0690	5.0690	5.0778	5.0509	5.0224	5.0025	4.9818

```
util living area
                 0.9951     0.9875     0.9705     0.9193     0.8078     0.6240     0.4608     0.5054     0.7441     0.9414     0.9887     0.9963 (86)

MIT             19.6840    19.9149    20.2103    20.5729    20.8372    20.9663    20.9940    20.9905    20.9192    20.5707    20.0630    19.6507 (87)
Th 2            19.8267    19.8296    19.8324    19.8457    19.8482    19.8598    19.8598    19.8620    19.8554    19.8482    19.8432    19.8379 (88)
util rest of house
                 0.9933     0.9830     0.9596     0.8901     0.7448     0.5251     0.3442     0.3850     0.6504     0.9136     0.9838     0.9949 (89)
MIT 2           18.3251    18.6197    18.9915    19.4372    19.7231    19.8433    19.8583    19.8593    19.8081    19.4473    18.8197    18.2906 (90)
Living area fraction                                                                                fLA = Living area / (4) =     0.6011 (91)
MIT             19.1419    19.3982    19.7241    20.1198    20.3927    20.5183    20.5409    20.5392    20.4759    20.1225    19.5670    19.1081 (92)
Temperature adjustment                                                                                                            0.0000
adjusted MIT    19.1419    19.3982    19.7241    20.1198    20.3927    20.5183    20.5409    20.5392    20.4759    20.1225    19.5670    19.1081 (93)



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8. Space heating requirement
---------------------------------------------------------------------------------------------------

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9919     0.9809     0.9584     0.8979     0.7765     0.5837     0.4145     0.4575     0.7038     0.9213     0.9823     0.9937 (94)
Useful gains   774.8064   921.4137  1005.4034  1037.7277   940.4705   694.3084   474.3021   495.1865   718.6607   830.2884   775.4296   734.8866 (95)
Ext temp.        4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000 (96)
Heat loss rate W
              1858.4097  1810.2894  1646.6603  1378.9949  1065.7760   717.2994   477.6385   500.6017   776.2159  1167.5125  1536.1353  1846.4233 (97)
Space heating kWh
               806.2009   597.3245   477.0951   245.7124    93.2273     0.0000     0.0000     0.0000     0.0000   250.8947   547.7081   826.9833 (98a)
Space heating requirement - total per year (kWh/year)                                                                          3845.1463
Solar heating kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (98b)
Solar heating contribution - total per year (kWh/year)                                                                            0.0000
Space heating kWh
               806.2009   597.3245   477.0951   245.7124    93.2273     0.0000     0.0000     0.0000     0.0000   250.8947   547.7081   826.9833 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                 3845.1463
Space heating per m2                                                                                         (98c) / (4) =    40.4752 (99)



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9a. Energy requirements - Individual heating systems, including micro-CHP
---------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                             0.0000 (201)
Fraction of space heat from main system(s)                                                                                        1.0000 (202)
Efficiency of main space heating system 1 (in %)                                                                                 92.3000 (206)
Efficiency of main space heating system 2 (in %)                                                                                  0.0000 (207)
Efficiency of secondary/supplementary heating system, %                                                                           0.0000 (208)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Space heating requirement
               806.2009   597.3245   477.0951   245.7124    93.2273     0.0000     0.0000     0.0000     0.0000   250.8947   547.7081   826.9833 (98)
Space heating efficiency (main heating system 1)
                92.3000    92.3000    92.3000    92.3000    92.3000     0.0000     0.0000     0.0000     0.0000    92.3000    92.3000    92.3000 (210)
Space heating fuel (main heating system)
               873.4571   647.1555   516.8961   266.2106   101.0047     0.0000     0.0000     0.0000     0.0000   271.8253   593.3999   895.9732 (211)
Space heating efficiency (main heating system 2)
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (212)
Space heating fuel (main heating system 2)
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (213)
Space heating fuel (secondary)
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (215)

Water heating
Water heating requirement
               242.5807   214.4383   227.7629   200.3422   194.2221   175.0477   172.8715   179.7683   181.7600   202.6179   215.3454   239.9607 (64)
Efficiency of water heater                                                                                                       79.8000 (216)
(217)m          86.5424    86.2309    85.6776    84.5187    82.5122    79.8000    79.8000    79.8000    79.8000    84.5402    86.0608    86.6033 (217)
Fuel for water heating, kWh/month
               280.3026   248.6790   265.8372   237.0389   235.3858   219.3580   216.6309   225.2736   227.7694   239.6705   250.2248   277.0803 (219)
Space cooling fuel requirement
(221)m           0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (221)
Pumps and Fa     7.3041     6.5973     7.3041     7.0685     7.3041     7.0685     7.3041     7.3041     7.0685     7.3041     7.0685     7.3041 (231)
Lighting        25.9835    20.8450    18.7686    13.7507    10.6214     8.6778     9.6892    12.5944    16.3589    21.4637    24.2432    26.7057 (232)
Electricity generated by PVs (Appendix M) (negative quantity)
(233a)m        -71.6130   -93.3122  -124.0921  -128.7651  -130.4189  -118.8148  -117.2461  -114.5604  -108.9815  -101.1351   -75.9096   -62.8449 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(234a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(235a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(235c)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235c)
Electricity generated by PVs (Appendix M) (negative quantity)
(233b)m        -67.4857  -137.6371  -266.0150  -389.1777  -505.0688  -504.1318  -498.2482  -426.1587  -318.1940  -193.2392   -88.8543   -53.7087 (233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(234b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(235b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(235d)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235d)
Annual totals kWh/year
Space heating fuel - main system 1                                                                                             4165.9223 (211)
Space heating fuel - main system 2                                                                                                0.0000 (213)
Space heating fuel - secondary                                                                                                    0.0000 (215)
Efficiency of water heater                                                                                                       79.8000
Water heating fuel used                                                                                                        2923.2511 (219)
Space cooling fuel                                                                                                                0.0000 (221)
```

Electricity for pumps and fans:	
Total electricity for the above, kWh/year	86.0000 (231)
Electricity for lighting (calculated in Appendix L)	209.7020 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-4695.6130 (233)
Wind generation	0.0000 (234)
Hydro-electric generation (Appendix N)	0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)	0.0000 (235)
Appendix Q - special features	
Energy saved or generated	-0.0000 (236)
Energy used	0.0000 (237)
Total delivered energy for all uses	2689.2623 (238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	4165.9223	0.2100	874.8437	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2923.2511	0.2100	613.8827	(264)
Space and water heating			1488.7264	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	209.7020	0.1443	30.2665	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1247.6938	0.1363	-170.0767	
PV Unit electricity exported	-3447.9192	0.1267	-436.8038	
Total			-606.8806	(269)
Total CO2, kg/year			924.0416	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			9.7300	(273)

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	4165.9223	1.1300	4707.4922	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2923.2511	1.1300	3303.2737	(278)
Space and water heating			8010.7659	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	209.7020	1.5338	321.6479	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1247.6938	1.5039	-1876.3852	
PV Unit electricity exported	-3447.9192	0.4651	-1603.4895	
Total			-3479.8747	(283)
Total Primary energy kWh/year			4982.6400	(286)
Target Primary Energy Rate (TPER)			52.4500	(287)

Appendix 4

Vaillant

Why Vaillant?

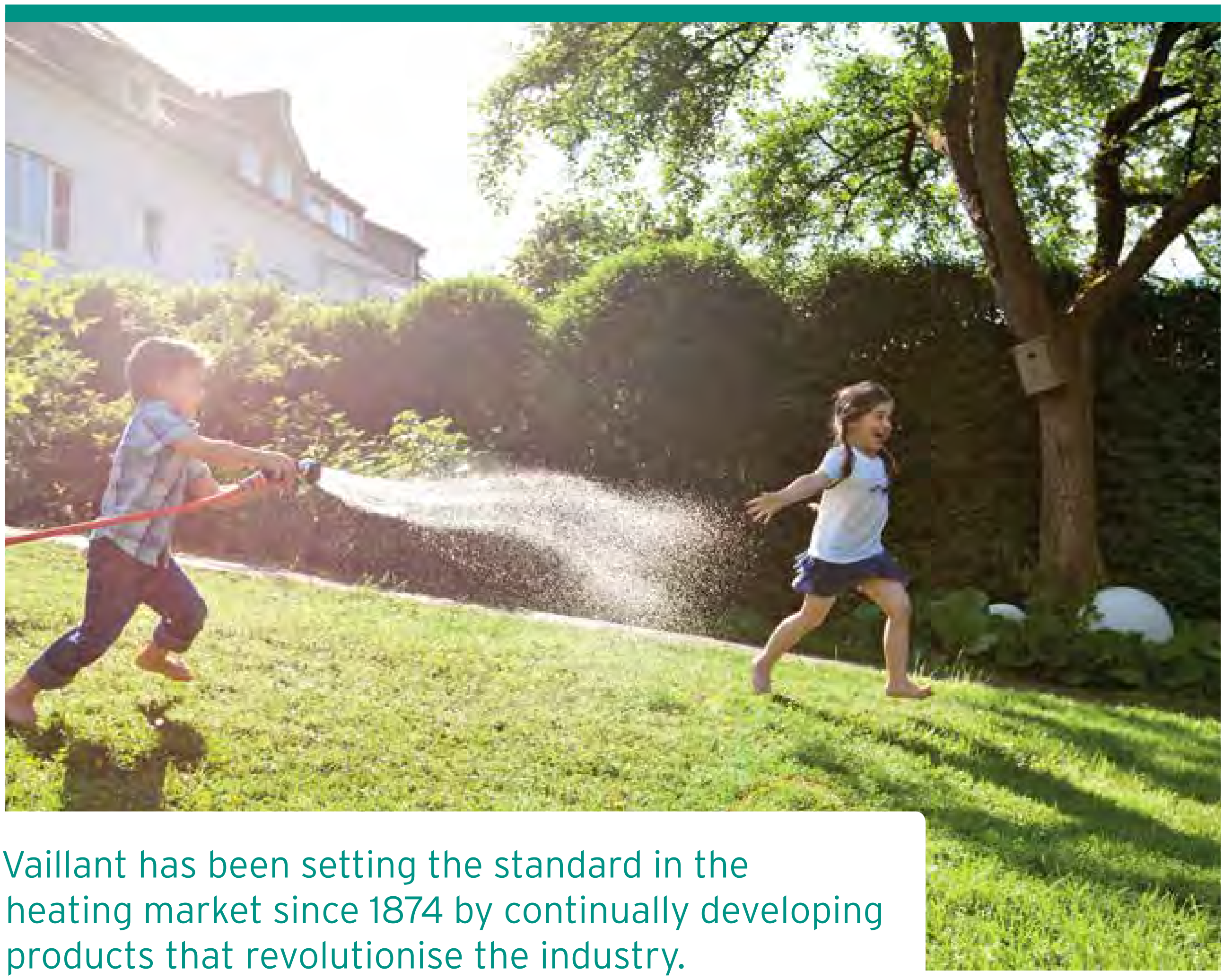
Because saving energy can be so easy

aroTHERM air-to-water heat pump

The **TECHNICAL** Brochure

Contents


Vaillant



Vaillant has been setting the standard in the heating market since 1874 by continually developing products that revolutionise the industry.

Today, our innovative solutions are still setting the standard in the heating marketplace. We have produced a comprehensive range of renewable technologies designed to utilise sustainable sources of energy.

Our products are at the very forefront of technology and deliver on the Vaillant promise to 'think ahead', safeguarding our planet for future generations whilst delivering energy efficient products that can reduce the cost of providing heating and hot water to the home.

Every product developed by Vaillant is routinely subjected to rigorous materials analysis, robustness testing, lifetime testing and acoustics analysis. This meticulous and unremitting commitment to quality is evident at every stage in the product development process, which is applied to every spare part that we sell.

Furthermore, we are committed to finding new and ever more imaginative ways to provide service excellence before, during and long after the installation of Vaillant appliances. We strongly believe that the most advanced heating solutions on the market demand the most forward-thinking service solutions – that is why we pride ourselves on our unrivalled service support.

Air-to-water heat pumps are becoming an increasingly popular choice for those looking to install renewable products in the home. The main advantage of air-to-water heat pumps is that they can help safeguard against the fluctuations in oil and LPG prices that leave homeowners vulnerable to the ever-rising costs of heating their home.

The air-to-water pumps can be integrated into UK heating systems with ease, causing minimal disruption to the homeowner. They also eliminate the need for on-site fuel storage and can be used as part of an efficient all-electric heating solution. Furthermore, air-to-water heat pumps offer excellent energy savings compared to alternatives like standard electric, LPG or oil, especially as all Vaillant heat pumps are MCS accredited and may therefore be eligible for government funding. They can also reduce carbon emissions, whilst offering a more sustainable heating solution than oil and LPG sources.

As experts within the heating industry, Vaillant can help you to develop bespoke heating systems that meet the requirements of even the most complex installations. With our extensive range of products and system accessories, you'd be hard pressed to find another manufacturer that can match our offering of flexible system solutions.

aroTHERM is Vaillant's second generation air-to-water heat pump range. Developed in-line with the exacting standards and precision engineering you would expect when you choose Vaillant.

What's more, with a 'Quiet Mark' award you can be assured knowing the aroTHERM air-to-water heat pump is one of the most understated miracles of engineering we've ever produced.

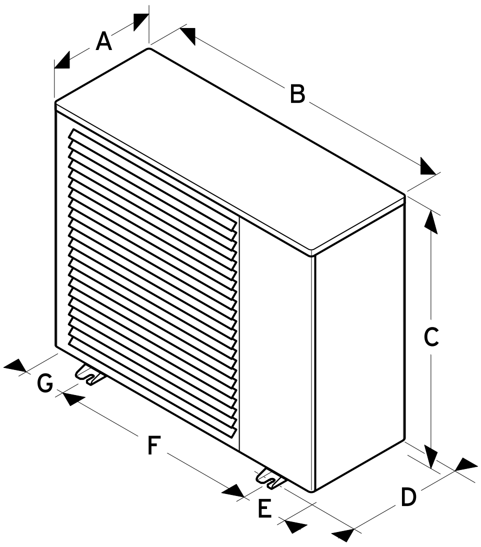
Key

1. Electronic box
2. Condenser
3. Four-way valve
4. CH pump
5. Compressor
6. Gas buffer (refrigerant heat exchanger)
7. Fan
8. Evaporator

Key features and benefits

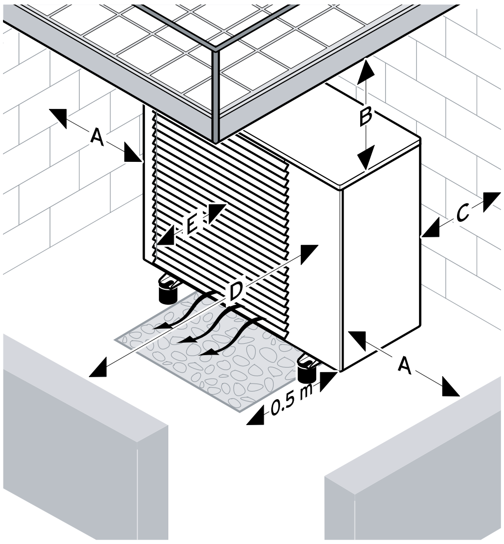
- **Four models**
  aroTHERM 5kW, 8kW, 11kW and 15kW
- **Compact size for easy siting**
  Possible to fit 5kW, 8kW and 11kW models under a standard window
- **Quiet operation**
  'Quiet Mark' approved thanks to its ultra quiet operation. Sound power as low as 58dB(A) (5kW) with permitted planning available as low as three metres
- **Blue fin coated evaporator with anti-hydro coating**
  Gives improved performance and extra protection against corrosion
- **Set-up wizard for first installation**
  With simple steps to help speed up commissioning
- **Ability to cascade up to seven aroTHERM heat pumps**
  Suitable for larger domestic and commercial properties
- **Solid case design with in-built anti-vandalism measure**
  No requirement for extra vandalism cages
- **Wider fin spacing and tray heater**
  Improves de-icing efficiency
- **MCS accredited**
  Eligible for RHI schemes

Dimensions



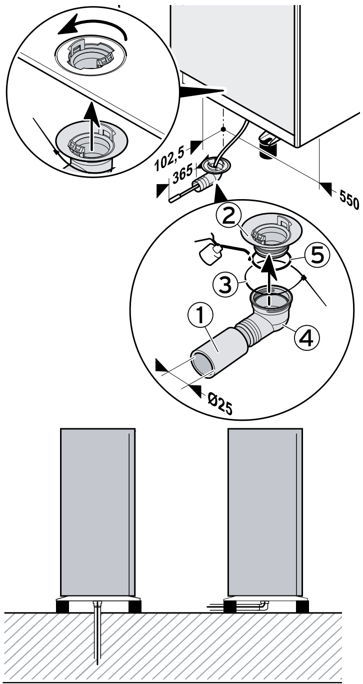
Dimension	Unit	5kW	8kW	11kW	15kW
A	mm	408	463	463	463
B	mm	980	1103	1103	1103
C	mm	840	975	975	1380
D	mm	437	437	437	437
E	mm	120	162	162	162
F	mm	740	778	778	778
G	mm	120	162	162	162

Clearances



Clearance	Unit	For heating mode
A	mm	› 250
B	mm	› 1000
C	mm	› 120
D	mm	› 600
E	mm	› 300

Condensate connections



Connection	Description
1	Condensate drain pipe
2	Adaptor
3	Cable tie
4	Elbow
5	Seal

Technical Data	Unit	aroTHERM 5kW	aroTHERM 8kW	aroTHERM 11kW	aroTHERM 15kW
Article number		0020257346	0020257347	0020257348	0020257349
Heat pump type		Monoblock air-to-water heat pump			
Flow / return heating connections	BSP	1 ¼"			
Product dimensions, width	mm	980	1,103	1,103	1,103
Product dimensions, height	mm	840	975	975	1,380
Product dimensions, depth	mm	408	463	463	463
Net weight	kg	86	102	126	165
Hydraulic lines material		Copper			
Hydraulic connections material		Brass			
Hydraulic seals material		EPDM			
Plate heat exchanger material		AISI 304 stainless steel			
Pump casing material		Painted cast iron			
Supply voltage / frequency	V / Hz	230 / 50			
Fuse type C or D	A	16	16	20	32
Inverter controller fuse	A / V	HRC 20 / 550			
IP rating		IP 25			
Maximum inrush current	A	16	16	20	25
Maximum current consumption	A	16	16	20	25
Pump power consumption	W	15 - 70	15 - 70	15 - 70	6 - 87
Fan power consumption	W	15 - 42	15 - 42	15 - 76	17 - 76 (2 x fan)
Electrical classification		I			
Overvoltage category		II			
Fan rotational speed	rpm	550	550	700	600
Sound power level for A7/W35 according to EN 12102 and EN ISO 9614-1	dB(A)	58	59	65	65
Sound power level for A7/W45 according to EN 12102 and EN ISO 9614-1	dB(A)	58	59	65	65
Sound power level for A7/W55 according to EN 12102 and EN ISO 9614-1	dB(A)	58	60	66	66
Maximum DHW flow temperature	°C	60	63	63	63
Minimum air temperature (heating and cylinder charging)	°C	-15	-20	-20	-20
Maximum air temperature (heating)	°C	28			
Maximum air temperature (cylinder charging)	°C	46			
Maximum air flow	m^3/h	2,000	2,700	3,400	5,500
Energy-related Products at 35°C*	band	A++	A++	A+	A++
Energy-related Products at 55°C*	band	A+	A++	A+	A+

* when installed with a VRC 700 / VRC 700f

Heating Circuit	Unit	aroTHERM 5kW	aroTHERM 8kW	aroTHERM 11kW	aroTHERM 15kW
Minimum operating pressure	bar	1.0			
Maximum operating pressure	bar	3.0			
Heating circuit water contents in the heat pump	l	1.1	1.6	2.1	2.7
Minimum heating circuit water contents	l	17	21	35	60
Minimum volume flow rate	l/h	380	380	540	1,200
Nominal volume flow rate	l/h	860	1,400	1,900	2,590
Hydraulic pressure difference	mbar	640	450	300	370

NOTE: see page 26 for VRC 700 / VRC 700f system controls

At Vaillant, we believe that everyone should be able to utilise renewable heating technologies, not only to protect the planet, but also to benefit from savings in running costs.

Vaillant has developed the aroTHERM hybrid system for those properties that have heat loss outside the scope of a single heat pump and/or have a relatively new heating system which can be costly to run. aroTHERM hybrid is designed to be operated with the VRC 700 / VRC 700f control. The VRC 700 / VRC 700f features the unique Vaillant triVAI® hybrid management system, which ensures the most efficient generator (air source heat pump, gas, oil or LPG) can be calculated and selected, to help reduce energy consumption and help customers to save money on their bills.

What is triVAI®?

aroTHERM hybrid is controlled via the VRC 700 / VRC 700f* which features Vaillant's triVAI® intelligent tariff selection tool. This ensures the system works as efficiently as possible at all times, whilst automatically selecting the most cost-effective heat source, regardless of the heating and hot water demands the system has to respond to. The VRC 700 / VRC 700f triVAI® feature selects the most cost-effective heat source based on a variety of coexisting variables, and crucially, does not require any intervention from the end user. It achieves this by analysing the Coefficient of Performance of the heat pump, efficiency of the auxiliary boiler and energy tariff prices for each heat source option. This smart approach to integrating renewable technology with existing heating systems offers more scope and flexibility for a wider range of properties.

Key features and benefits

- **Unique triVAI® intelligent control system feature controlled via the VRC 700 / VRC 700f**
  Three possible energy tariffs can be entered – providing maximum cost savings
- **Excellent green credentials**
  Provides significant carbon and energy bill savings
- **Compatible with all boiler systems**
  Including gas, oil and LPG
- **Reduced maintenance costs**
  Glycol only needed in the outdoor circuit to the heat pump
- **Easy to install and commission**
  Uses the Vaillant set-up wizard
- **Suitable for a wide range of properties**
  Can be installed in new build properties as well as retrofitted into older properties or those that already use an expensive heating system

Pack components

- 5kW, 8kW, 11kW or 15kW aroTHERM hybrid heat pump
- VWZ MWT 150 heat exchanger module
- VWZ MPS 40 litre decoupler module
- VR 32 eBUS coupler controls address board for use with Vaillant boilers

*VRC 700 / VRC 700f control supplied separately

aroTHERM hybrid heat pump packs for Vaillant boilers

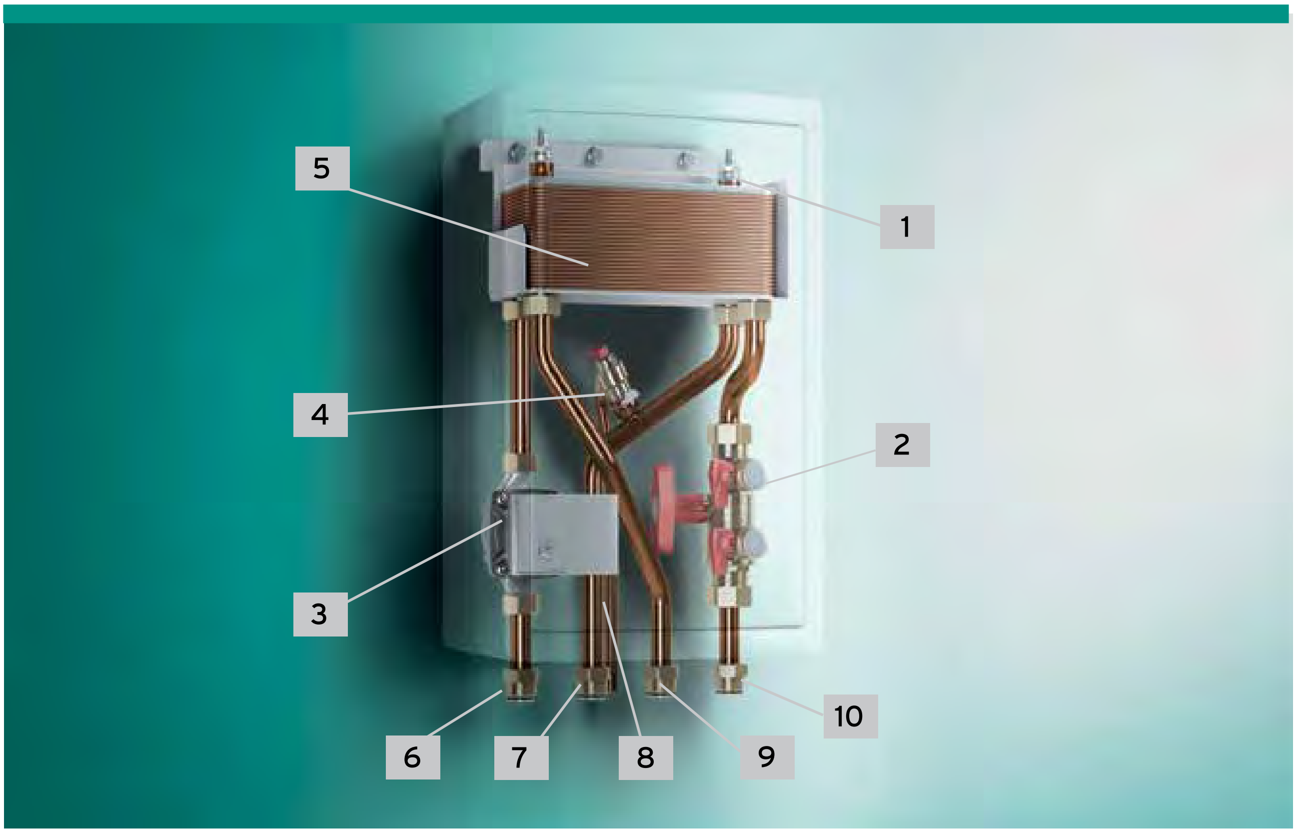
Description	Article number
aroTHERM 5kW hybrid heat pump for Vaillant boiler	0020257350
aroTHERM 8kW hybrid heat pump for Vaillant boiler	0020257351
aroTHERM 11kW hybrid heat pump for Vaillant boiler	0020257352
aroTHERM 15kW hybrid heat pump for Vaillant boiler	0020257353

aroTHERM hybrid heat pump packs for incumbent boilers

Description	Article number
aroTHERM 5kW hybrid heat pump for incumbent boiler	0020257354
aroTHERM 8kW hybrid heat pump for incumbent boiler	0020257355
aroTHERM 11kW hybrid heat pump for incumbent boiler	0020257356
aroTHERM 15kW hybrid heat pump for incumbent boiler	0020257357

NOTE: see page 26 for VRC 700 / VRC 700f system controls

The wall-mounted heat exchanger module separates the heat pump circuit from the heating system circuit.



As the heat pump is fitted outside the property, it is subjected to changing weather conditions and as such, requires the fluid flowing though the heat pump to have frost protection, to ensure that it does not freeze and damage the heat pump. Filling the entire heating system with glycol can be expensive; the heat exchanger module allows connected glycol circuits to be separated from heating circuits. The heat exchanger module will prevent the contamination of glycol circuits in the event that radiators are removed or drained and re-filled. In addition, the heat exchanger module is supplied with integral fill and flush points for a simpler installation.

The forty plates within the module ensure that the energy is transferred from the heat pump circuit to the heating circuit as efficiently as possible. Air bleed vents/valves within the module also help prevent air getting trapped within the system.

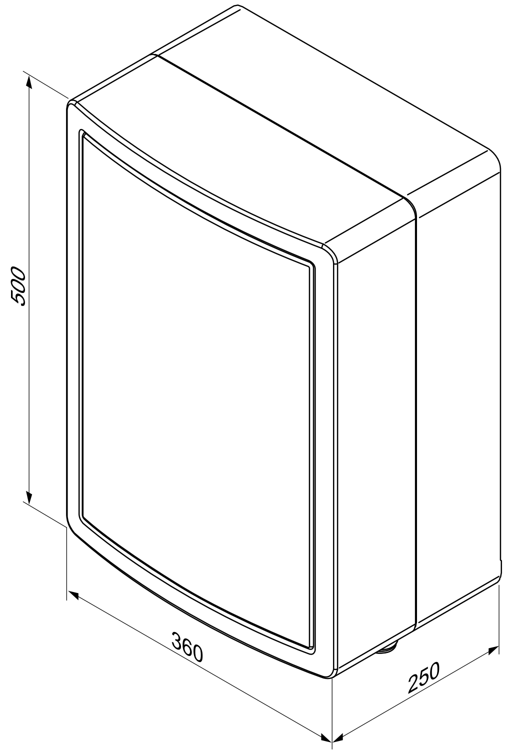
Key

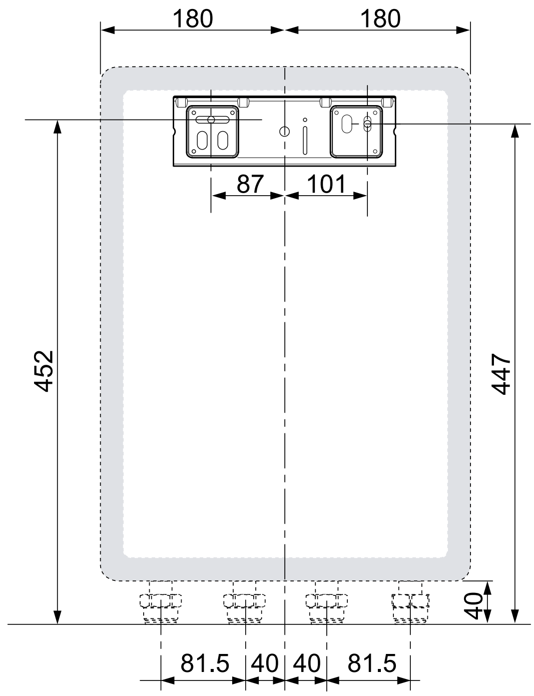
1. Air bleed vent
2. Fill and flush points
3. High efficiency CH pump
4. PRV central heating side
5. Forty plate-to-plate heat exchanger
6. Installation heating circuit inlet 1"
7. Installation heating circuit outlet 1"
8. Safety valve drain
9. Glycol water circuit outlet to heat pump 1"
10. Glycol water circuit inlet from heat pump 1"

Key features and benefits

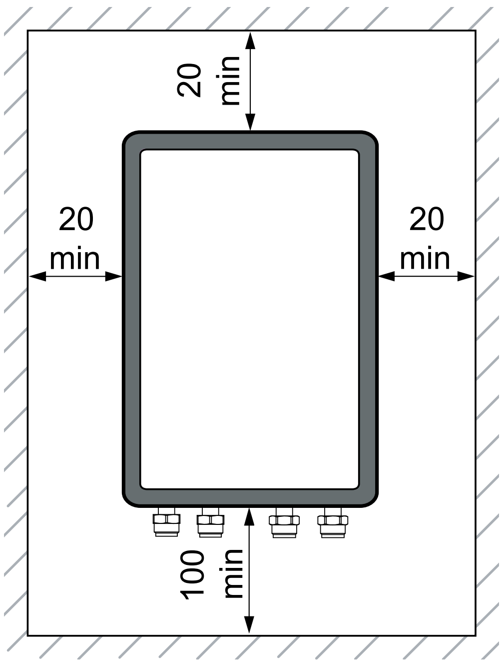
- **Designed to separate the heat pump glycol circuit from the heating circuit**
  Only a small proportion of the system is required to be filled with glycol
- **Wall-mounted, compact and lightweight**
  500mm (H) x 250mm (D) x 360mm (W) for easy and flexible siting
- **Modulating circuit pump ErP A rated**
  35% more energy efficient than a standard pump, making the heating circuit ready to comply with future legislation
- **Fill and flush points for the heat pump glycol circuit**
  Quick and easy to install with no extra cost

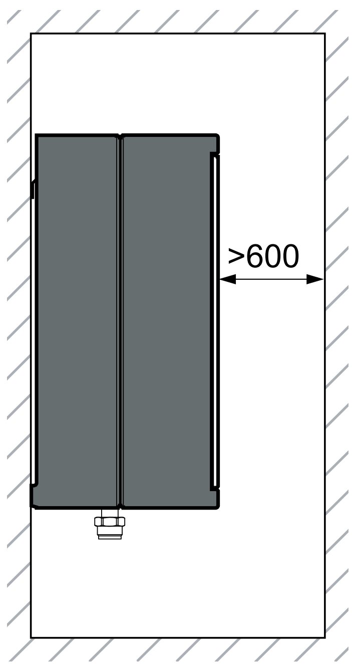
Dimensions





Clearances

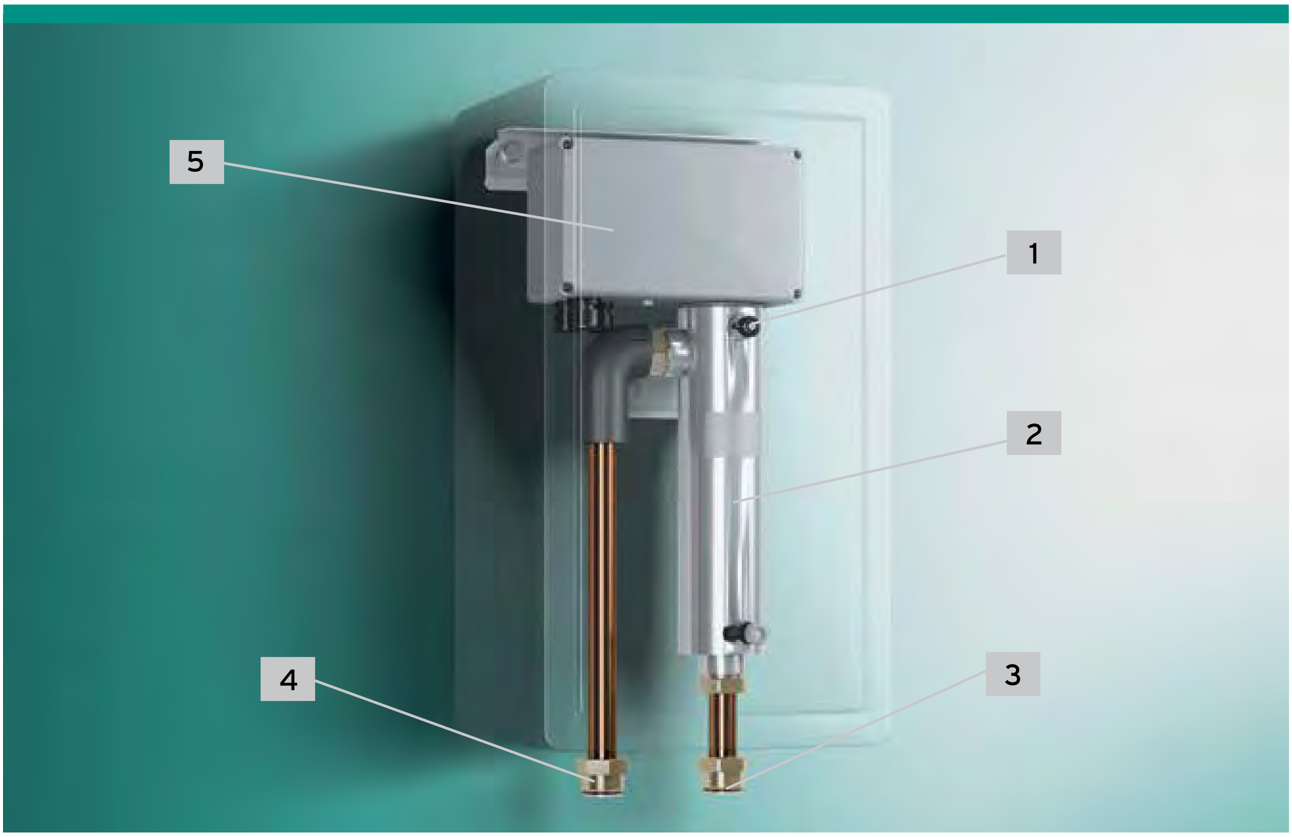




NOTE: All measurements are millimetres. Clearance necessary for the installation or maintenance of the appliance

Technical Data	Unit	Heat exchanger module VWZ MWT 150
Article number		0020222285
Product dimensions, width	mm	360
Product dimensions, height	mm	500
Product dimensions, depth	mm	250
Net weight	kg	12
Maximum admissible water pressure	bar	3.0
Minimum admissible water pressure	bar	0.05
Heating and glycol circuit connections	BSP	1"
Supply voltage / frequency	V / Hz	230 / 50
Maximum electrical consumption (pump)	W	45
IP rating		IP X4

This back-up heater is an inline immersion heater developed to give the system an extra boost when required, to ensure comfort levels are maintained in severe weather conditions such as extended cold snaps.



The back-up heater comes with a temperature sensor and sensor pocket to ensure that it only comes on when required and to limit its usage time as much as possible.

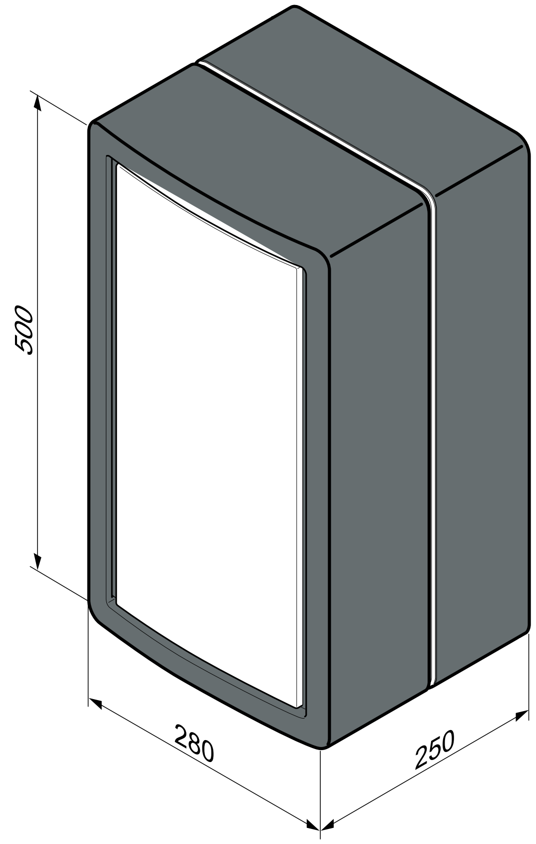
Key features and benefits

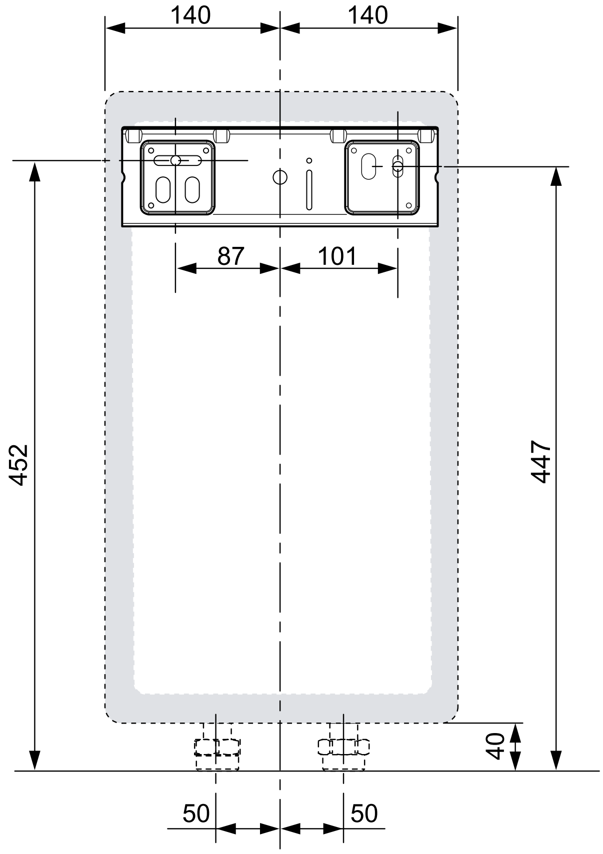
- **Provides a back-up boost to the heating system**
  Ensures comfort levels are maintained during extreme weather conditions
- **Wall-mounted, compact and lightweight**
  500mm (H) x 250mm (D) x 280mm (W) for easy and flexible installation
- **Flexible outputs**
  Can be wired to give 2kW, 4kW, 6kW or staged output

Key

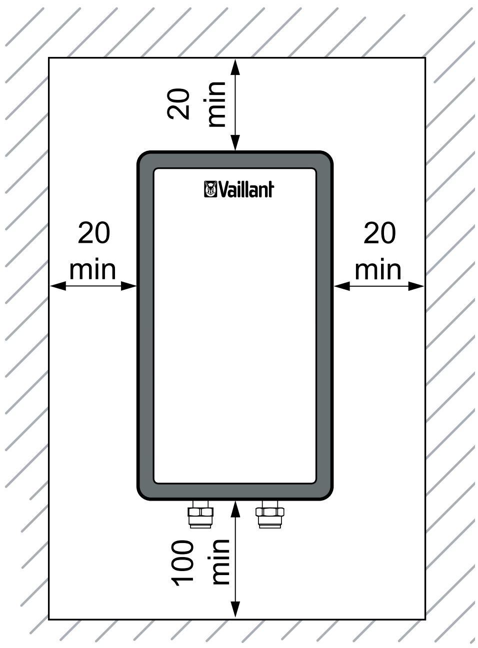
1. Air bleed vent
2. Heating element
3. Heat pump input 1"
4. Installation output 1"
5. Electrical box

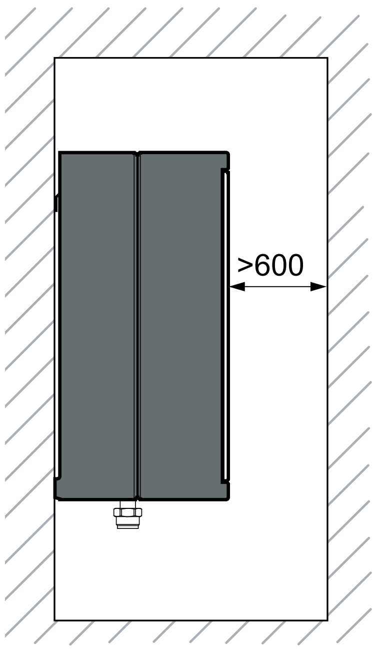
Dimensions





Clearances





NOTE: All measurements are millimetres. Clearance necessary for the installation or maintenance of the appliance

Technical Data	Unit	Inline 6kW back-up heater
Article number		0020222286
Product dimensions, width	mm	280
Product dimensions, height	mm	500
Product dimensions, depth	mm	250
Net weight	kg	4
Central heating maximum hydraulic pressure (PSH maximum)	bar	3.0
Central heating minimum hydraulic pressure (PSH minimum)	bar	0.5
Connections	BSP	1"
Supply voltage / frequency	V / Hz	230 / 50
Maximum electrical consumption (pump)	W	6
Maximum current	A	30
IP rating		IP 20
Cable size		3 G4

The wall-mounted 45 litre decoupler module gives added system flexibility to the aroTHERM range as it can act as both a hydraulic nil point in the system and a low-loss header, ensuring system flow through the heat pump and the system.

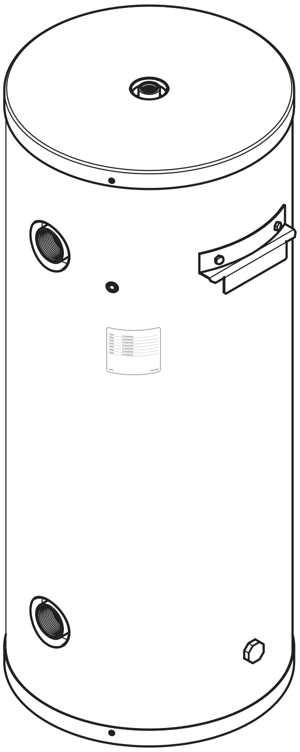
Should the system have multiple zones and/or require an additional pump to support the complete heating system, the decoupler module provides an excellent solution and is easy to site and install. The tank comes complete with an NTC sensor and pocket at the top of the tank as well as an air bleed valve/vent to help remove air from the system.

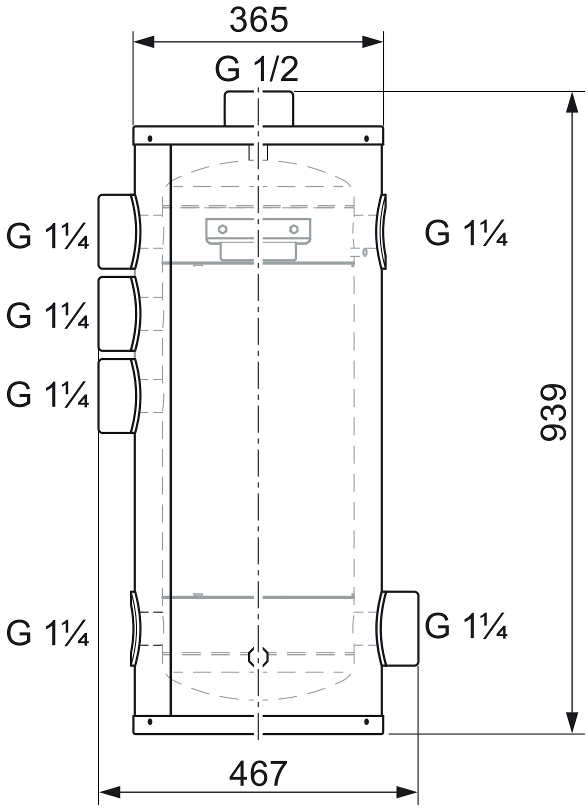
The four inlets can be used to link two heating sources and heat pumps into one heating set-up to create a hybrid system. In these cases, the decoupler module acts as a mixing module in which the heat pump acts as the primary heat source with the boiler acting as a boost or taking over once the boiler becomes less cost-effective and/or efficient than the heat pump.

Key features and benefits

- **Helps maintain heat pump and back-up appliance differentials**
  Better efficiency and performance
- **Four inlets**
  Allows more system volume to be added to meet the requirements of the heat pump or to link two heat sources together in one heating circuit for a hybrid system
- **Multiple tappings**
  Flexible system design
- **Thermally layered**
  Increased performance
- **Wall-mounted and compact**
  939mm (H) x 365mm (W) x 467mm (D) for easy and flexible installation

Dimensions





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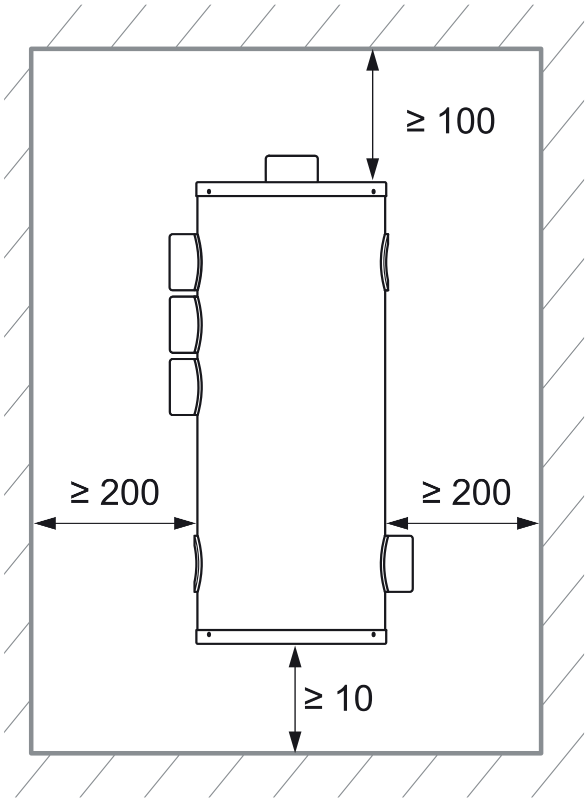
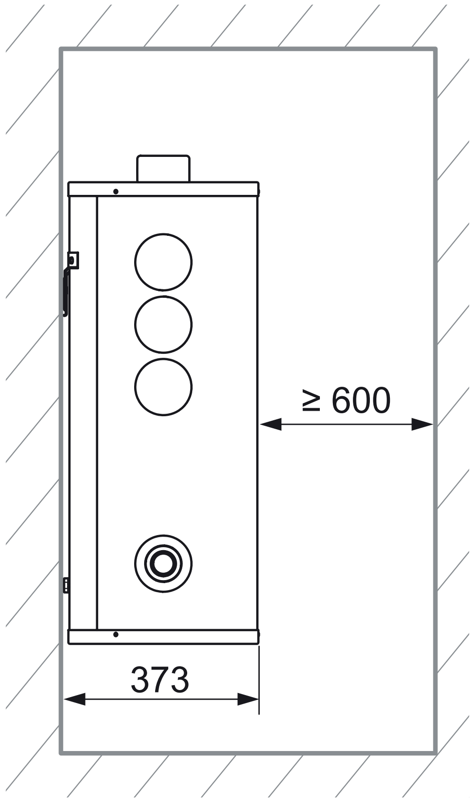




NOTE: All measurements are millimetres. Clearance necessary for the installation or maintenance of the appliance

Technical Data	Unit	Decoupler module VP RW 45/2 B
Article number		0010038365
Product dimensions, width	mm	365
Product dimensions, height	mm	939
Product dimensions, depth	mm	467
Net weight	kg	18
Nominal capacity of tank	l	45
Maximum admissible water pressure	bar	3.0
Minimum admissible water pressure	bar	0.5
Left hand side connections	BSP	1 ¼"
Right hand side connections	BSP	1 ¼"

The uniSTOR heat pump cylinder range has been developed to work in harmony with Vaillant aroTHERM heat pumps, to provide highly efficient heating and hot water systems.

uniSTOR's large surface area and smooth coil design maximises heat transfer, to ensure connected Vaillant heat pumps run at their optimum efficiency, to reduce running costs and increase hot water performance.

Ranging from 150 up to 800 litres, our uniSTOR heat pump cylinders are available in both pre-plumbed (150 to 300 litres only) and standard options, giving you and your customers even more flexibility. In addition to this, the 250 and 300 litre cylinders have an increased coil size making them compatible with a wider range of heat pump systems.

uniSTOR cylinders also have a Global Warming Potential of less than 5, thanks to thermal injected insulation, as well as a 100% recyclable stainless steel tank with an ultra-hard-wearing outer shell, to deliver a highly efficient and sustainable heating system.

Key features and benefits

- **Thermal injected polyurethane insulation combined with vacuum panels**
  Superior insulation and efficiency
- **Large diameter, smooth bore coil technology**
  Provides quiet operation, reduces build-up of scale and aids in long-term efficiency through automatic descaling
- **Global Warming Potential less than 5 and ozone depletion of 0**
  Designed around environmental requirements
- **Factory fitted immersion heater (150 to 300 litre uniSTOR cylinders)**
  Emergency back-up in case of main heat source failure
- **Thermodynamically positioned sensor pocket**
  Optimises system performance
- **Expansion vessels included or available as accessories**
  Complete system solution offering whilst meeting all building regulations

Compatibility matrix

aroTHERM	uniSTOR 150 litre cylinder	uniSTOR 200 litre cylinder	uniSTOR 250 litre cylinder	uniSTOR 300 litre cylinder	uniSTOR 500 litre cylinder	auroSTOR 500 litre cylinder*	uniSTOR 800 litre cylinder
5kW	✓	✓					
8kW	✓	✓	✓	✓			
11kW	✓	✓	✓	✓	✓	✓	
15kW		✓	✓	✓	✓	✓	✓

uniSTOR cylinders

Description	Article number
150 litre pre-plumbed slimline uniSTOR	0020237129
200 litre pre-plumbed uniSTOR	0020237130
250 litre pre-plumbed uniSTOR	0020237131
300 litre pre-plumbed uniSTOR	0020237132
150 litre standard uniSTOR	0020235271
200 litre standard uniSTOR	0020235272
250 litre standard uniSTOR	0020235273
300 litre standard uniSTOR	0020235274
500 litre large capacity uniSTOR	0010019228
800 litre large capacity uniSTOR	0010019229
500 litre large capacity auroSTOR*	0010019234

* auroSTOR 500 litre cylinder for combined heat pump and solar thermal systems.

Accessories (500 and 800 litre cylinders only)	Article number
Immersion heater 7kW (800 litre only)	0020235671
Unvented cylinder kit 1"	0020235964
Unvented cylinder kit 1¼"	0020235965
Unvented cylinder kit 1½"	0020235966
Unvented cylinder kit 2"	0020235967
Expansion vessel 50 litre (for uniSTOR and auroSTOR 500 litre)	0020229941
Expansion vessel 80 litre (for uniSTOR 800 litre)	0020229942

NOTE: One unvented kit and expansion vessel required with each 500 and 800 litre cylinder

For further details on heat pump cylinders please see the Heat Pump Cylinder Brochure.

The Vaillant wired VRC 700 and wireless VRC 700f system controls allow your customer to take control of their Vaillant heating and hot water system.

Designed to work harmoniously with all current Vaillant products, the VRC 700 and VRC 700f effortlessly use weather compensation technology to ensure your customers appliances are working to their peak performance and always maintaining optimum efficiency.

Key features and benefits

- **Designed with simplicity and familiarity in mind**
  The VRC 700 and VRC 700f controls are designed with ease of use in mind. Using a familiar menu structure, it makes controlling the system easy and efficient
- **Takes care of all Vaillant equipment automatically**
  Intelligently communicates with all Vaillant appliances. The hybrid management system will also automatically choose the most efficient appliance, to deliver the most cost effective and energy efficient solution
- **Flexible time programs**
  Three heating and three hot water time periods can be set for each week, day or over a 24 hour period
- **Holiday function**
  Prevents the heating and hot water coming on whilst away and reinstates it upon return
- **Programs stored in memory permanently**
  Holds time and temperature programs permanently, even in the event of a power failure
- **Up to three heating circuits with domestic hot water control**
  Additional heating zone controls are available in wired (VR 91) and wireless (VR 91f) options and are designed to mirror the functionality of the VRC 700 and VRC 700f. This is to provide your customers with a familiar user experience anywhere in their property
- **Clear, high contrast backlit display**
  Blue backlit display, offers outstanding contrast, resulting in clear information, with low energy consumption on both the VRC 700 / VRC 700f and VR 91 / VR 91f
- **Controls multiple heat pumps**
  Control up to seven heat pumps with a single boiler in cascade whilst also supporting solar thermal
- **Cascade functionality utilises degree minutes in order to calculate when best to use each appliance in turn**
  It simultaneously records the individual running hours to ensure every appliance is run for an equal amount of time

Pack enables control of the aroTHERM heat pump system, one wired/wireless heating zone and hot water system

Pack includes:
VRC 700(f)

Wired pack:
0020236291
Wireless pack:
0020259829

Pack enables control of the aroTHERM heat pump system, one wired/wireless heating zone using Vaillant controls and one heating zone using third party controls, hot water and heat exchanger module

Pack includes:
VRC 700(f)
and VR 70

Wired pack:
0020236292
Wireless pack:
0020259830

Pack enables control of the aroTHERM heat pump system, two wired/wireless heating zones and hot water system

Pack includes:
VRC 700(f), VR 70 and VR 91(f)

Wired pack:
0020236293
Wireless pack:
0020259831

Pack enables control of the aroTHERM heat pump system, three wired/wireless heating zones and hot water system

Pack includes:
VRC 700(f),
VR 71 and two
VR 91(f)

Wired pack:
0020236294
Wireless pack:
0020259832

Pack enables control of the aroTHERM heat pump system, one wired/wireless heating zone and solar thermal hot water system

Pack includes:
Wired VRC 700(f),
VR 70 and VR 11

Wired pack:
0020236295
Wireless pack:
0020259833

Pack enables control of the aroTHERM heat pump system, two wired/wireless heating zones and solar thermal hot water system

Pack includes:
VRC 700(f), VR 71
VR 11 and VR 91(f)

Wired pack:
0020259834
Wireless pack:
0020259835

VRC 700 and VRC 700f controls and components

Description	Article number
VRC 700 wired, weather compensating, programmable room thermostat	0020236291
VRC 700f wireless, weather compensating, programmable room thermostat	0020259829
VR 91 wired, programmable, room thermostat	0020171334
VR 91f wireless, programmable, room thermostat	0020231566
VR 70 wiring centre	0020184844
VR 71 wiring centre	0020184847
VR 32 eBUS coupler	0020139895
VR 40 two-in-seven multifunctional module	0020017744

Performance data

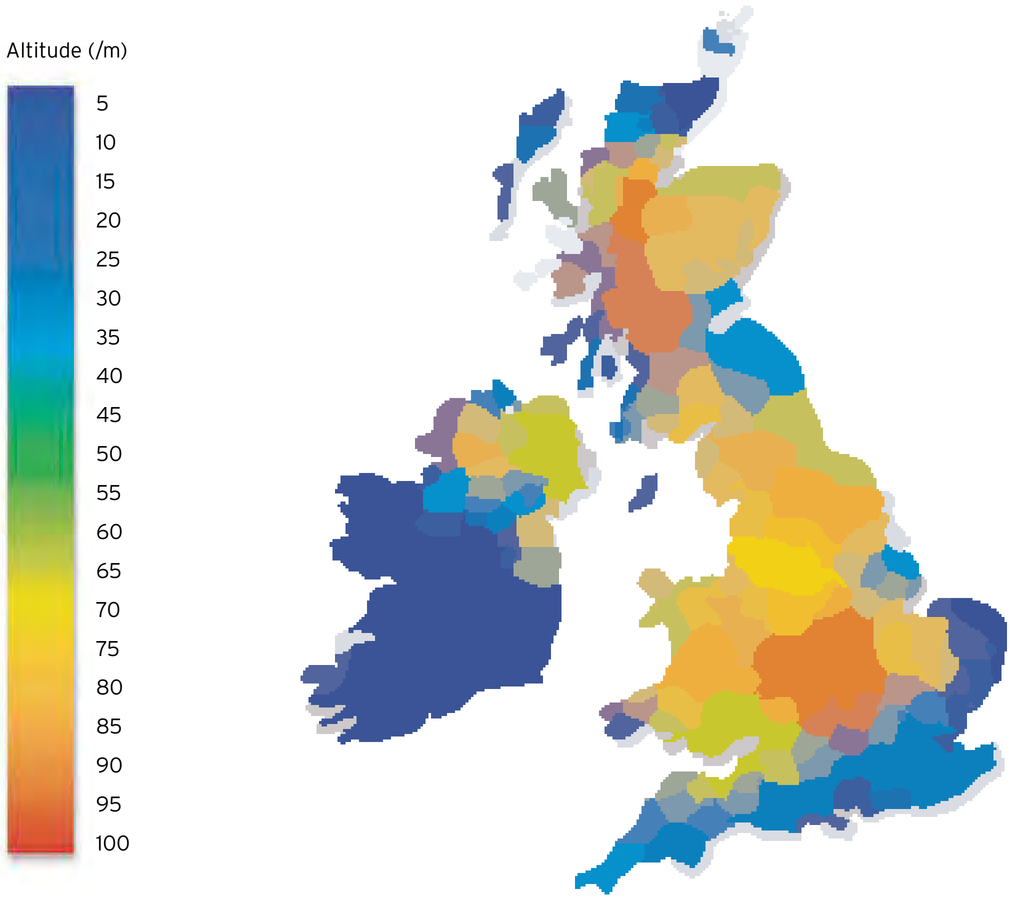
When designing a heating system that utilises a heat pump, there are a number of design factors that need to be considered.

Heat loss

MCS recommend using the MIS 3005 installation standard for designing a heat pump system. Systems should be specified at peak winter requirements, depending on location, to ensure year round comfort as detailed in the table below.

Location	Altitude (/m)	Hourly dry-bulb temperature (/°C) equal to or exceeded for 99% of the hours in a year
Belfast	68	-1.2
Birmingham	96	-3.4
Cardiff	67	-1.6
Edinburgh	35	-3.4
Glasgow	5	-3.9
London	25	-1.8
Manchester	75	-2.2
Plymouth	27	-0.2

A room-by-room heating requirement check will then need to be carried out at the set outside temperature in order to understand the heating needs of the total property.



Seasonal Coefficient of Performance

As the outside air temperature drops, the amount of energy the heat pump can extract decreases, meaning the heating output will decrease to ensure end user comfort at peak heating times.

aroTHERM output and SCoP table

		35°C flow		40°C flow		45°C flow		50°C flow		55°C flow
		output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	SCoP
5kW	-5°C	5.26	4.07	5.33	3.66	5.39	3.26	4.94	3.15	3.03
	-3°C	5.66		5.97		6.28		5.68		
	0°C	6.12		6.40		6.68		6.11		
	2°C	6.43		6.71		6.98		6.41		
		35°C flow		40°C flow		45°C flow		50°C flow		55°C flow
		output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	SCoP
8kW	-5°C	7.15	4.58	6.46	4.22	5.76	3.86	5.27	3.41	2.95
	-3°C	7.70		6.76		5.81		5.27		
	0°C	7.81		7.20		6.58		5.98		
	2°C	8.27		7.74		7.20		6.47		
		35°C flow		40°C flow		45°C flow		50°C flow		55°C flow
		output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	SCoP
11kW	-5°C	8.23	3.15	7.70	3.03	7.17	2.91	5.65	2.9	2.9
	-3°C	8.42		7.86		7.30		6.00		
	0°C	9.25		8.57		7.88		6.70		
	2°C	9.81		9.02		8.28		7.00		
		35°C flow		40°C flow		45°C flow		50°C flow		55°C flow
		output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	output (kW)	SCoP	SCoP
15kW	-5°C	12.65	3.28	12.07	3.15	11.00	3.01	10.25	3.01	3.01
	-3°C	12.90		12.20		11.50		10.65		
	0°C	13.20		12.85		12.40		11.78		
	2°C	14.00		13.55		13.10		12.45		

Seasonal Coefficient of Performance data is calculated as per EN 14825 for aroTHERM 5kW and 8kW. aroTHERM 11kW and 15kW are calculated as per EN 14511.

Planning permission

As air-to-water heat pumps are installed on the outside of the property and produce a certain level of sound (the pumps use a fan to move air which will generate noise), it must be determined if a single heat pump installation meets permitted development rules. The Vaillant MCS 020 tool can help determine sound pressure levels from our full range of air-to-water heat pumps. If the sound pressure level is 42dB(A) or above, planning permission is likely to be required. However, it is worth noting that planning permission for each county within the UK varies and that Scotland has its own rules regarding air-to-water heat pumps, which you will need to refer to.

System design considerations

System sizing

Determine the estimated heat loss from the property, taking into consideration the year of build. The value in table A will determine the approximate amount of kW required from the heat pump and will indicate which aroTHERM is required in table B. aroTHERM and aroTHERM hybrid heat pumps can also be installed in cascade for larger domestic and commercial properties. Contact Vaillant for further details.

Heat loss calculation table A

No house upgrade		Total m^2																		
Year	**Unit**	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250
1970-1995	$100W/m^2$	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00											
1996-2005	$80W/m^2$	5.60	6.40	7.20	8.00	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40	15.20						
2006-2010	$50W/m^2$	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	10.50	11.00	11.50	12.00	12.50
2010	$40W/m^2$	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00	8.40	8.80	9.20	9.60	10.00

House upgrade for double glazing and loft insulation		Total m^2																		
Year	**Unit**	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250
1970-1995	$85W/m^2$	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60	14.45	15.30							
1996-2005	$70W/m^2$	4.90	5.60	6.30	7.00	7.70	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00	14.70	15.40			
2006-2010	$50W/m^2$	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	10.50	11.00	11.50	12.00	12.50
2010	$40W/m^2$	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00	8.04	8.80	9.20	9.60	10.00

House upgrade for double glazing, loft insulation and cavity wall insulation		Total m^2																		
Year	**Unit**	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250
1970-1995	$70W/m^2$	4.90	5.60	6.30	7.00	7.00	8.40	9.10	9.80	10.50	11.20	11.90	12.60	13.30	14.00					
1996-2005	$60W/m^2$	4.20	4.80	5.40	6.00	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40	12.00	12.60	13.20	13.80	14.40	15.00
2006-2010	$50W/m^2$	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	10.50	11.00	11.50	12.00	12.50
2010	$40W/m^2$	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00	8.40	8.80	9.20	9.60	10.00

(Grey shading) Auxiliary heater required for peak heating requirements (-3°C and below)

aroTHERM calculation table B

Based on 35°C flow temperature and -3°C outside air temperature	
0 - 6kW	aroTHERM 5kW
4.5kW - 7.7kW	aroTHERM 8kW
6.5kW - 8.4kW	aroTHERM 11kW
8kW - 12.9kW	aroTHERM 15kW
11kW and above	hybrid systems

This estimating tool is to be used as a guide only and does not replace a full heat loss calculation for a property. Vaillant will not accept responsibility for the mis-sizing of a heating system. Please contact your local sales representative for more details.

750mm flexi hose

- Pre-insulated with 20mm weatherproof high-grade insulation to improve system efficiency and cut installation time
- Right angled fixing to the heat pump to minimise rear clearance
- 28mm copper compression fitting for a fast and easy installation
- 'Kink-free' bending designed to minimise the possibility of 'kinking' in the hose
- 750mm length to suit most site requirements

Description	Article number
750mm flexi hose	0020165288

Raised rubber feet

- Available in 600mm length therefore meeting all site requirements
- Raised rubber mounting that offers excellent vibration absorption to minimise noise
- Extra clearance at the base, which improves access to the condensation pipe and drainage
- Improves air flow

Description	Article number
Raised rubber feet	0020175140

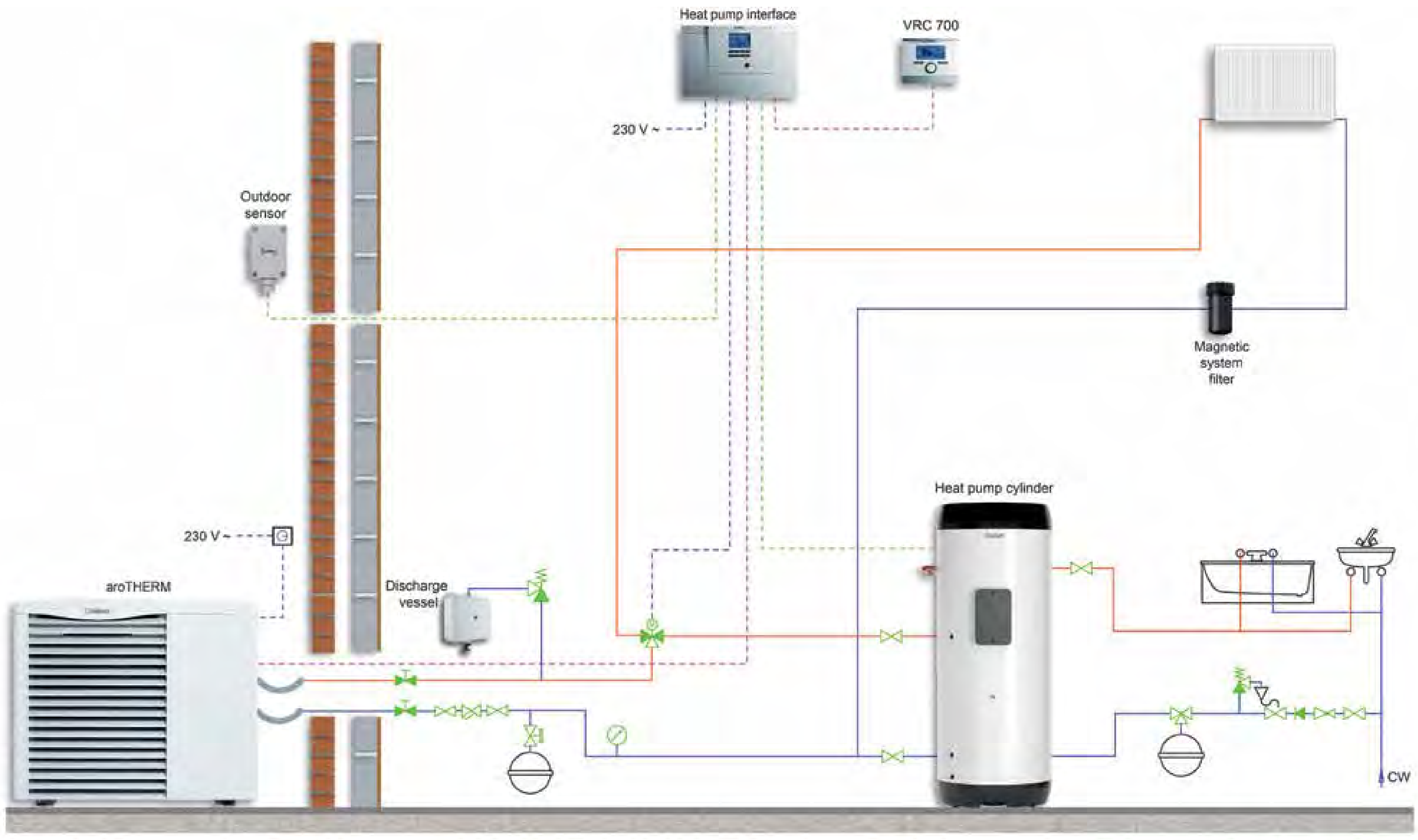
Discharge vessel

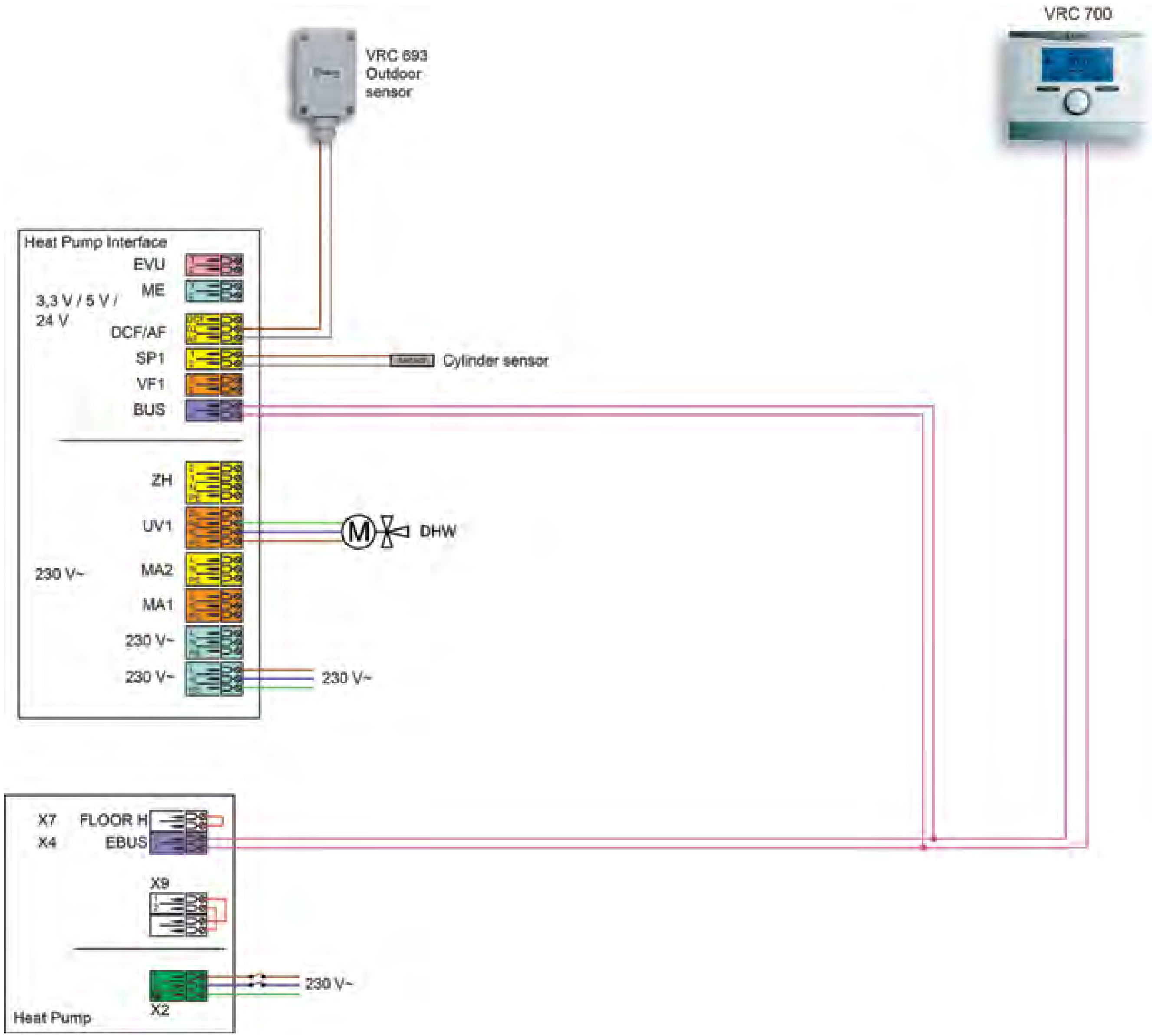
- Small wall-mounted vessel
- Collects heating system glycol if the PRV opens
- Ensures glycol does not discharge into the drainage system

Description	Article number
Discharge vessel	0020145563

Heat pump, DHW tank, single zone – schematic

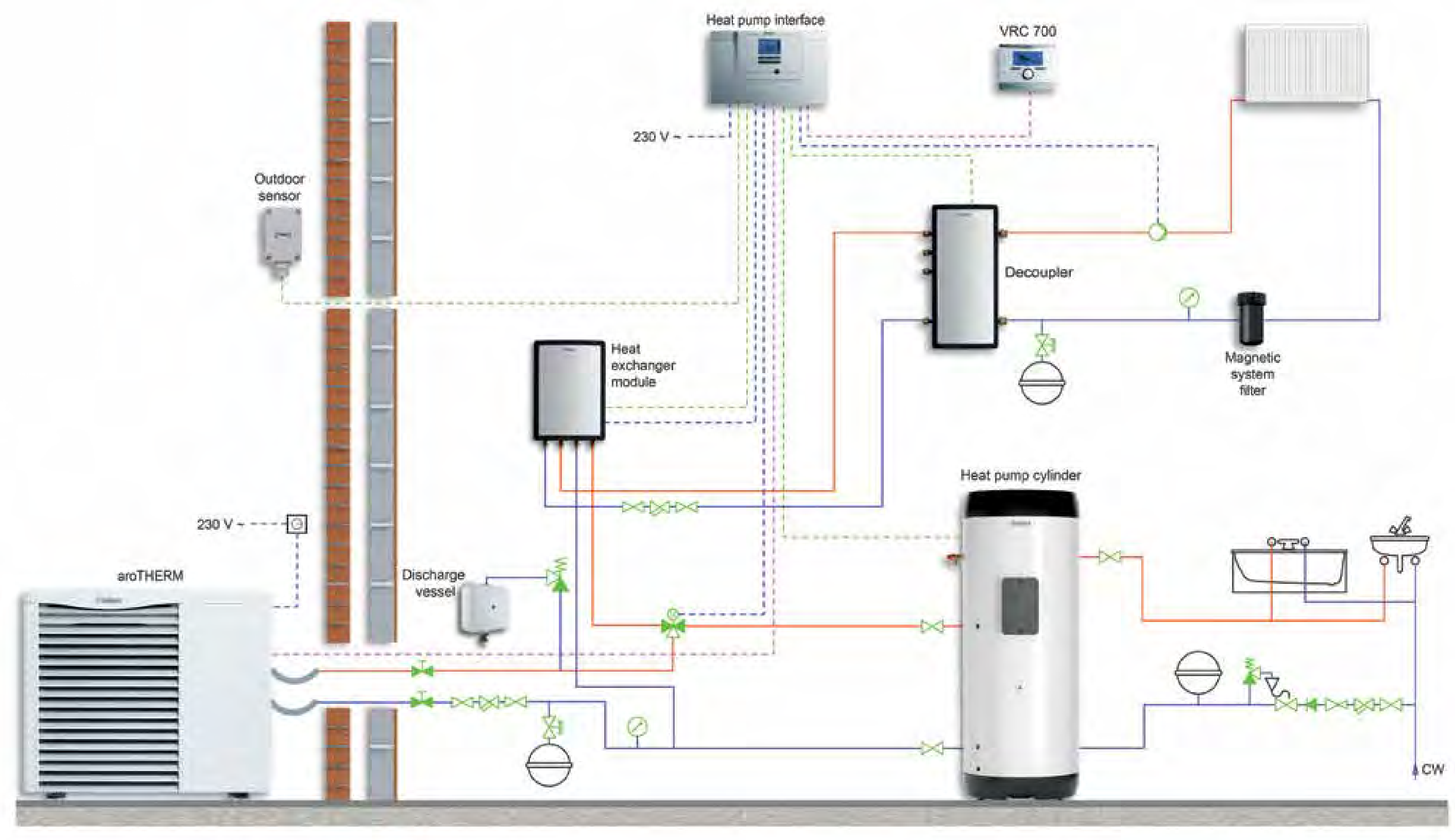
On first commissioning please select system No. 8 for VRC 700 / VRC 700f



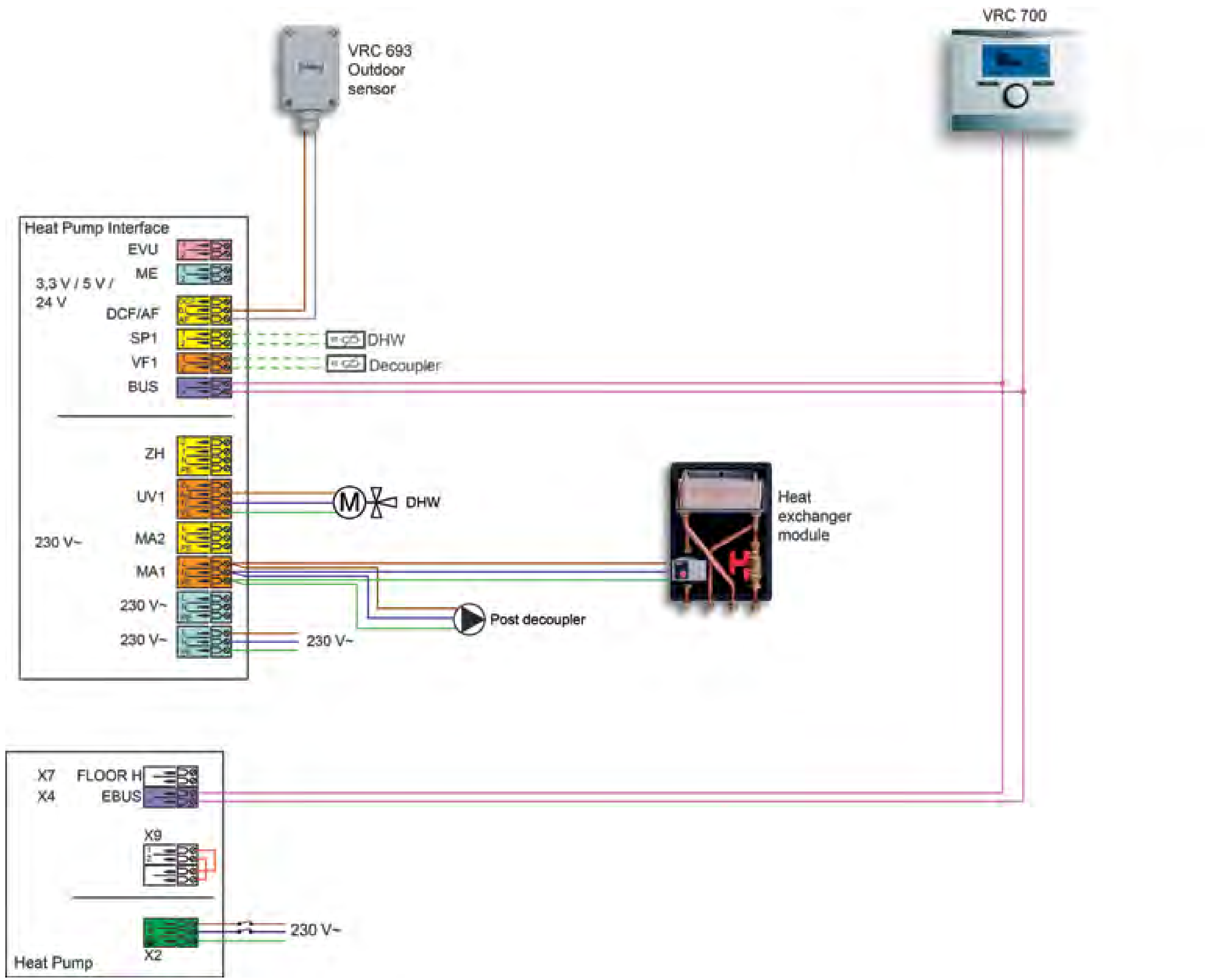

VRC 693
Outdoor
sensor
VRC 700
Heat Pump Interface
EVU
ME
3,3 V / 5 V /
24 V
DCF/AF
SP1
VF1
BUS
Cylinder sensor
ZH
UV1
DHW
230 V~
MA2
MA1
230 V~
230 V~
230 V~
X7
FLOOR H
X4
EBUS
X9
X2
230 V~
Heat Pump

Heat pump, heat exchanger module, decoupler, DHW tank, single zone - schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f

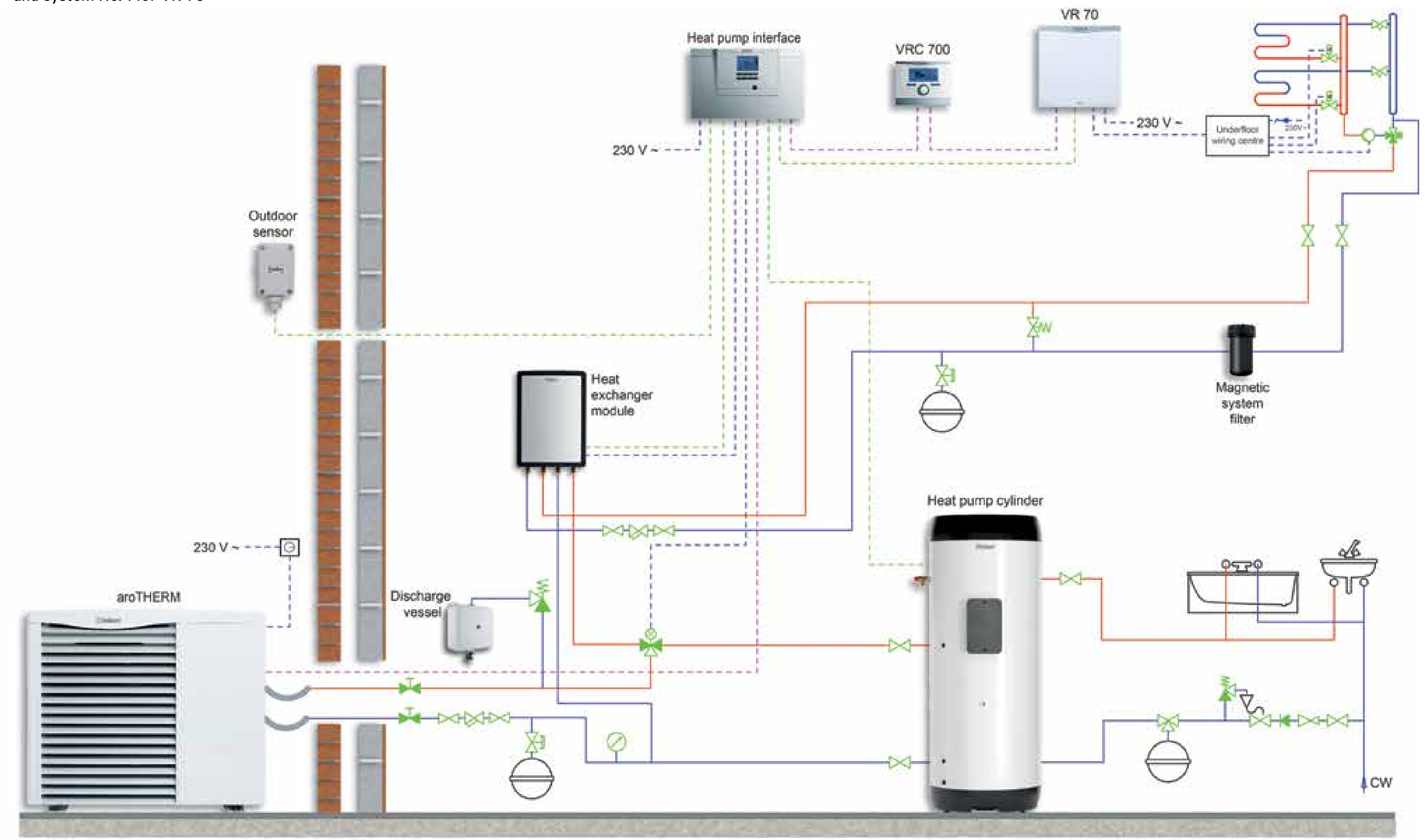


Heat pump, heat exchanger module, decoupler, DHW tank, single zone - wiring

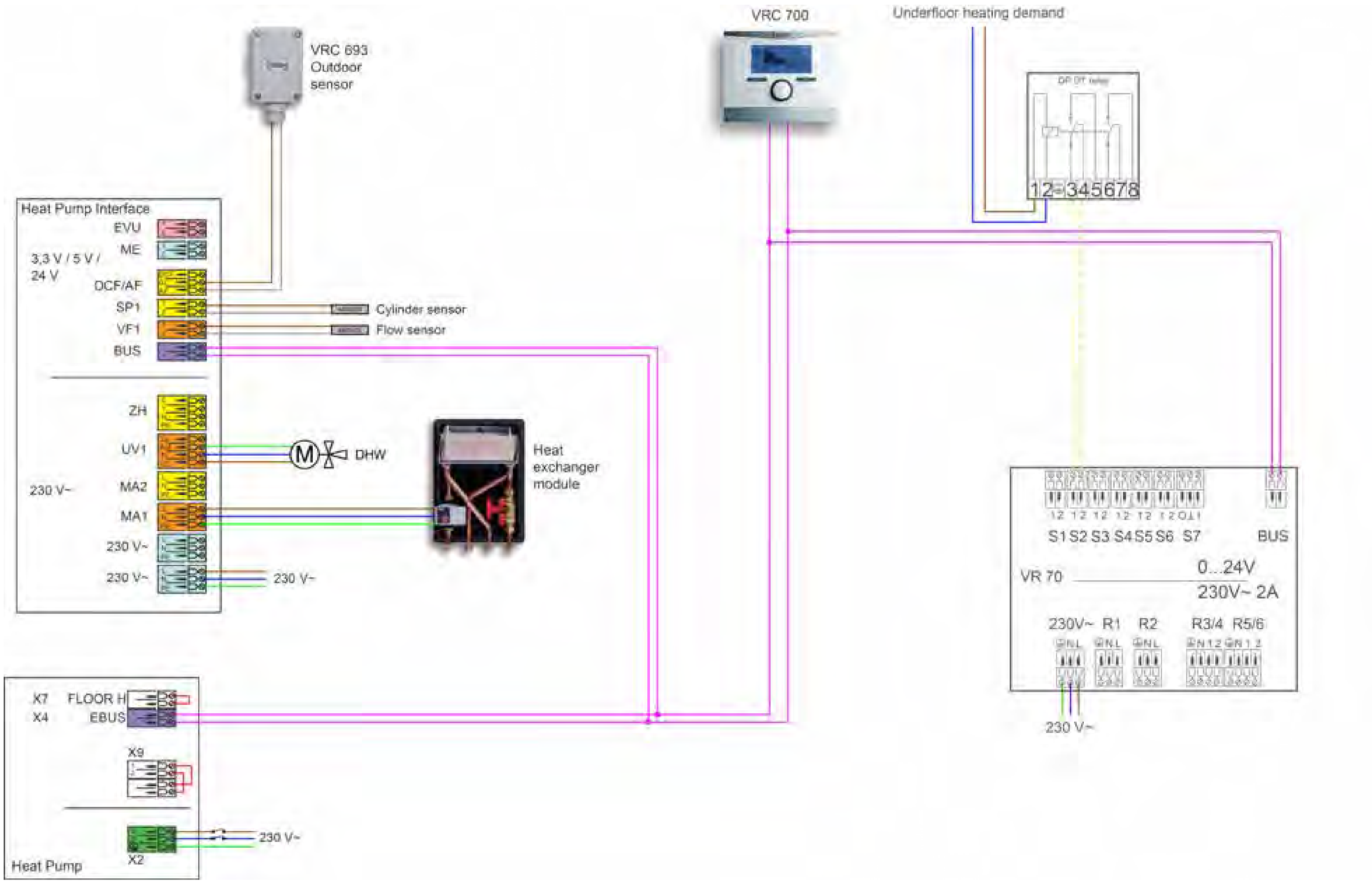


Heat pump, heat exchanger module, DHW tank, underfloor heating – schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f
and system No. 1 for VR 70

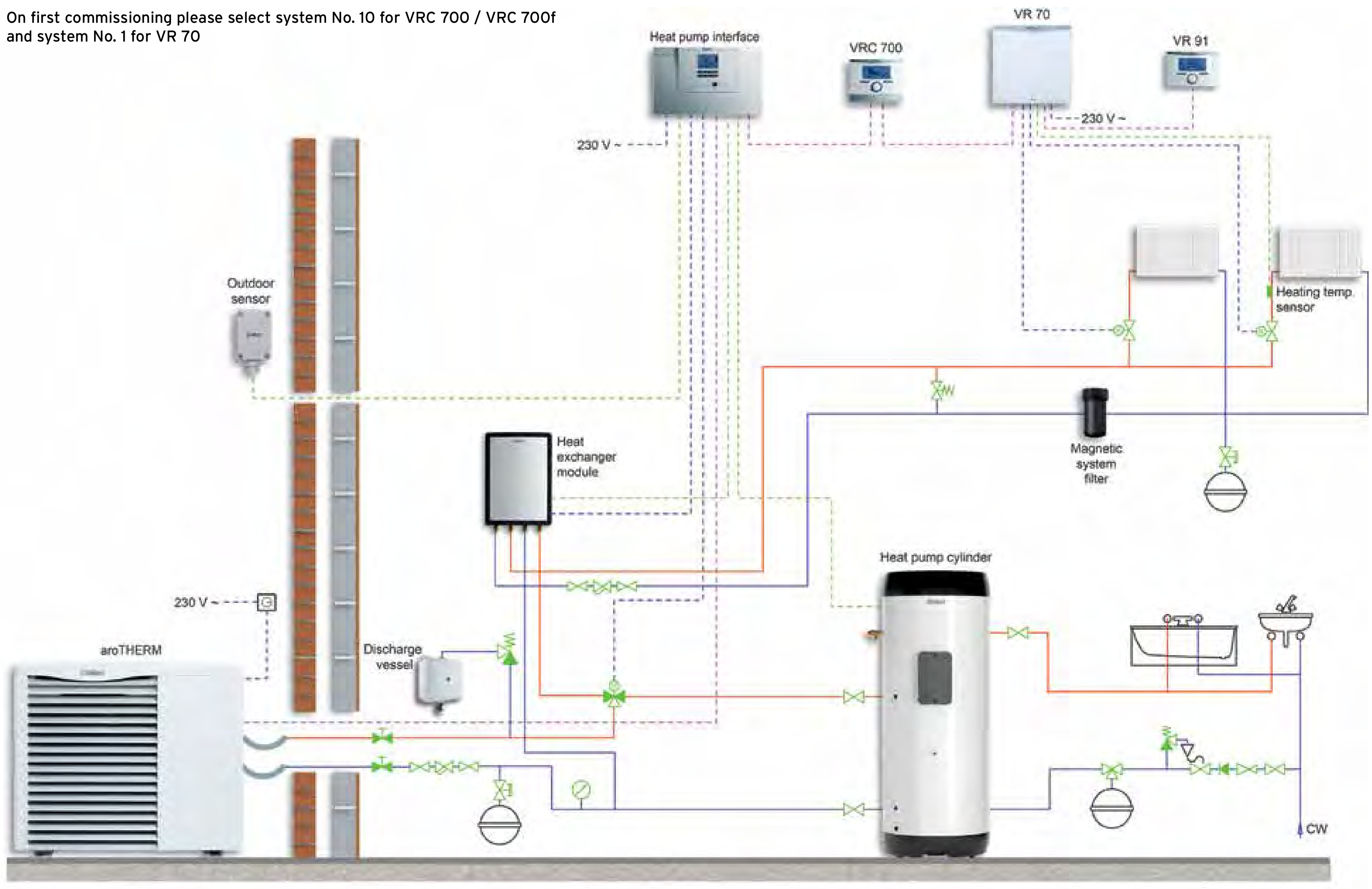


Heat pump, heat exchanger module, DHW tank, underfloor heating - wiring

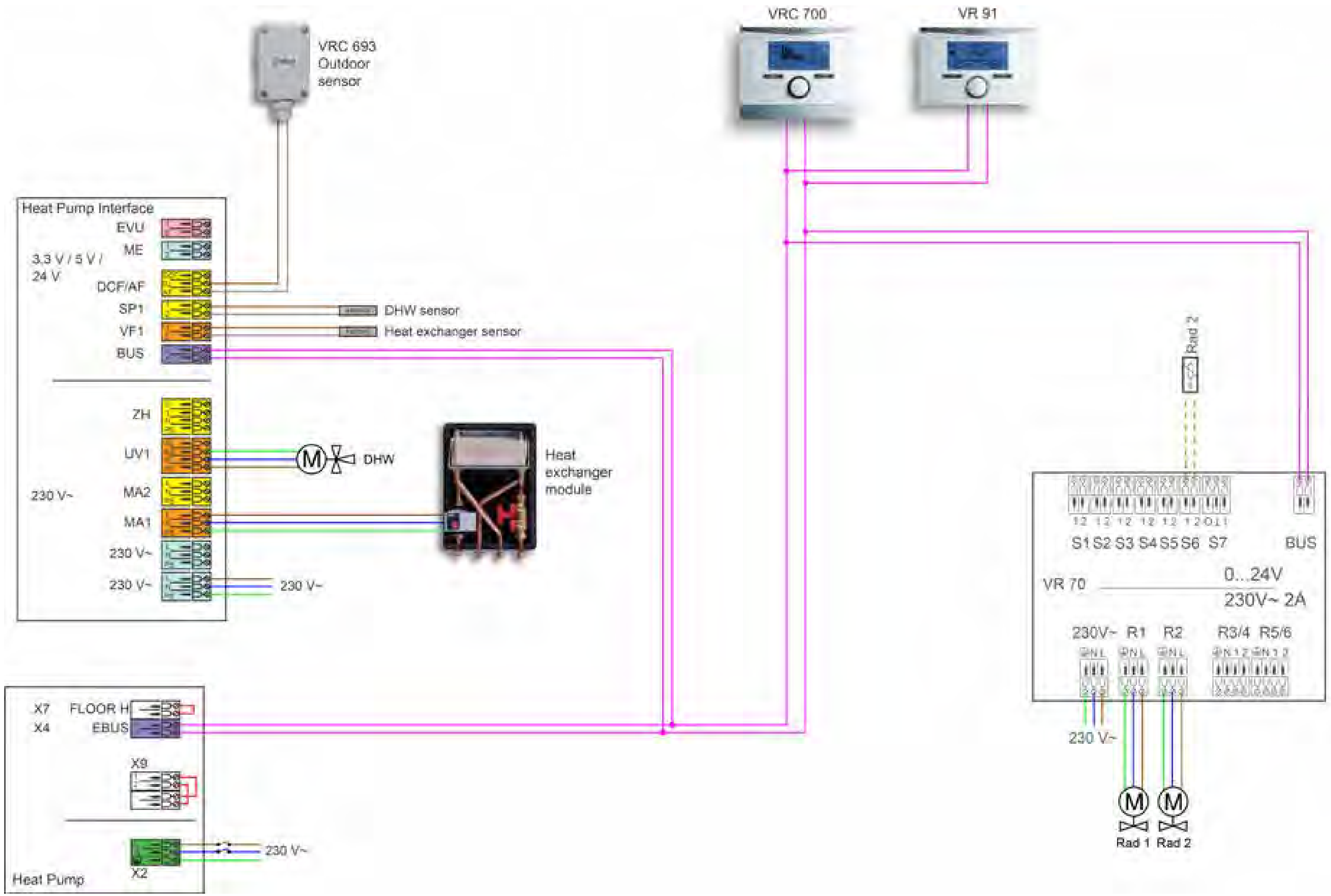


Heat pump, heat exchanger module, DHW tank, two zone – schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f and system No. 1 for VR 70

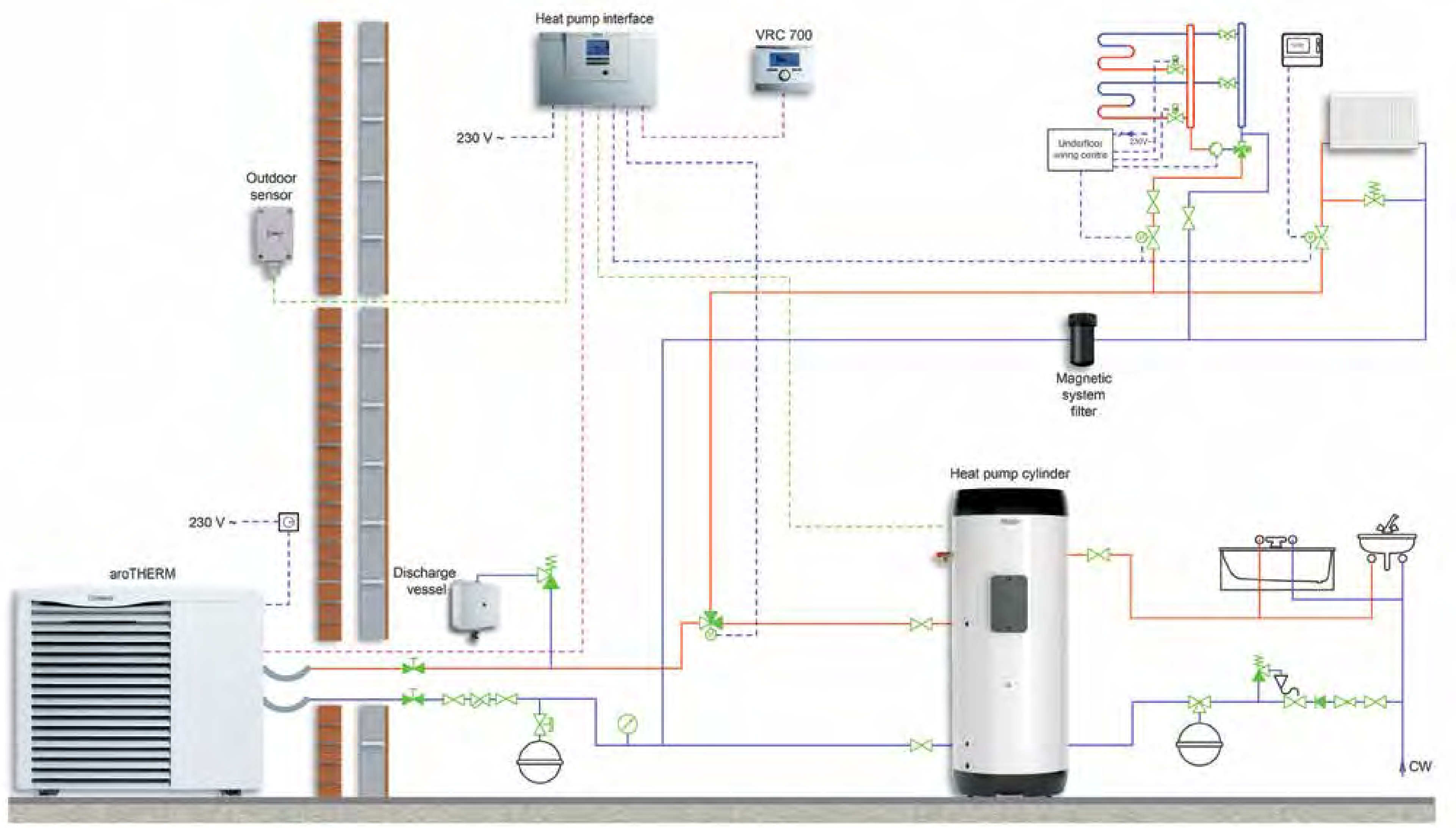


Heat pump, heat exchanger module, DHW tank, two zone – wiring

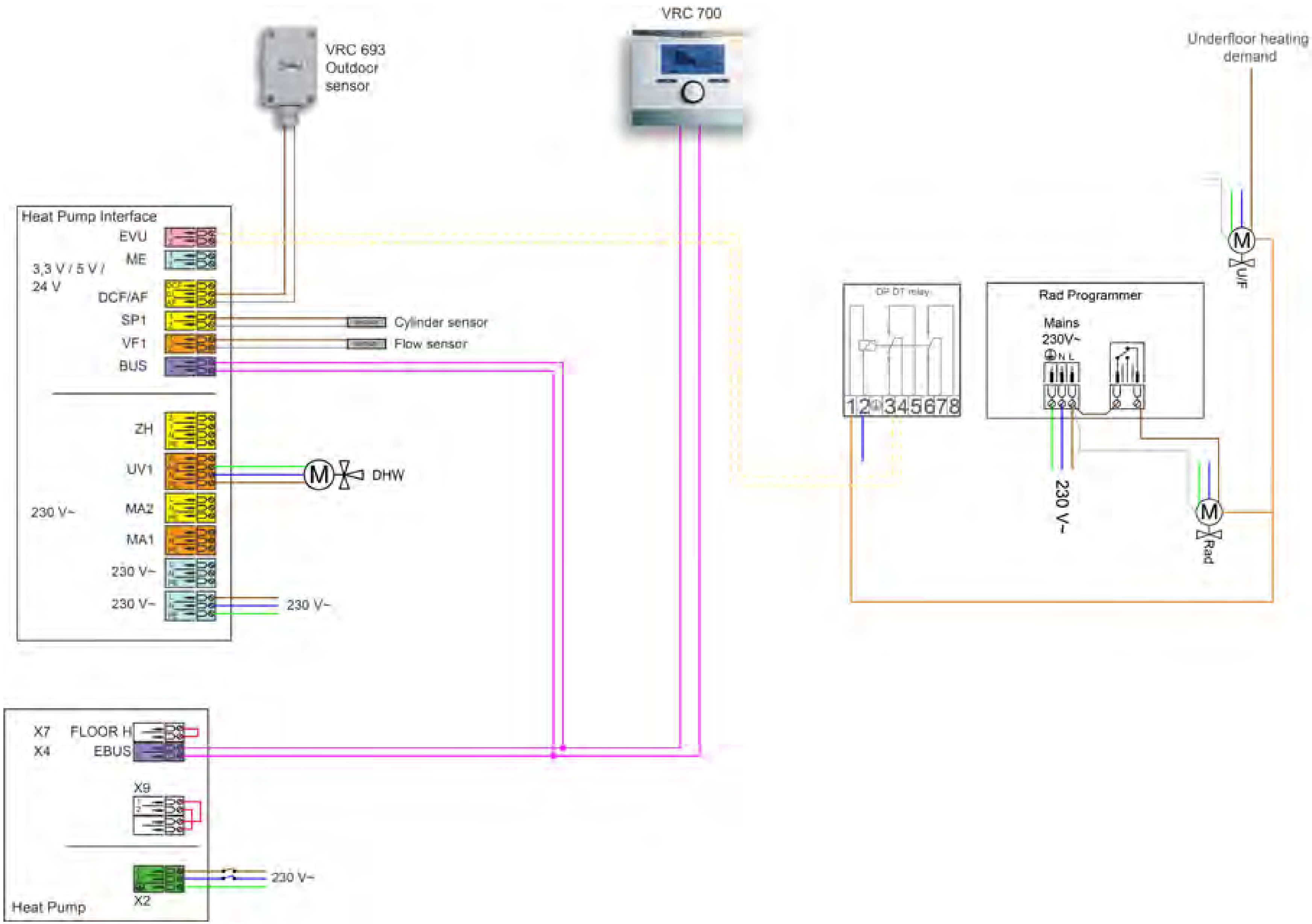


Heat pump, DHW tank, underfloor heating, one rad zone - schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f

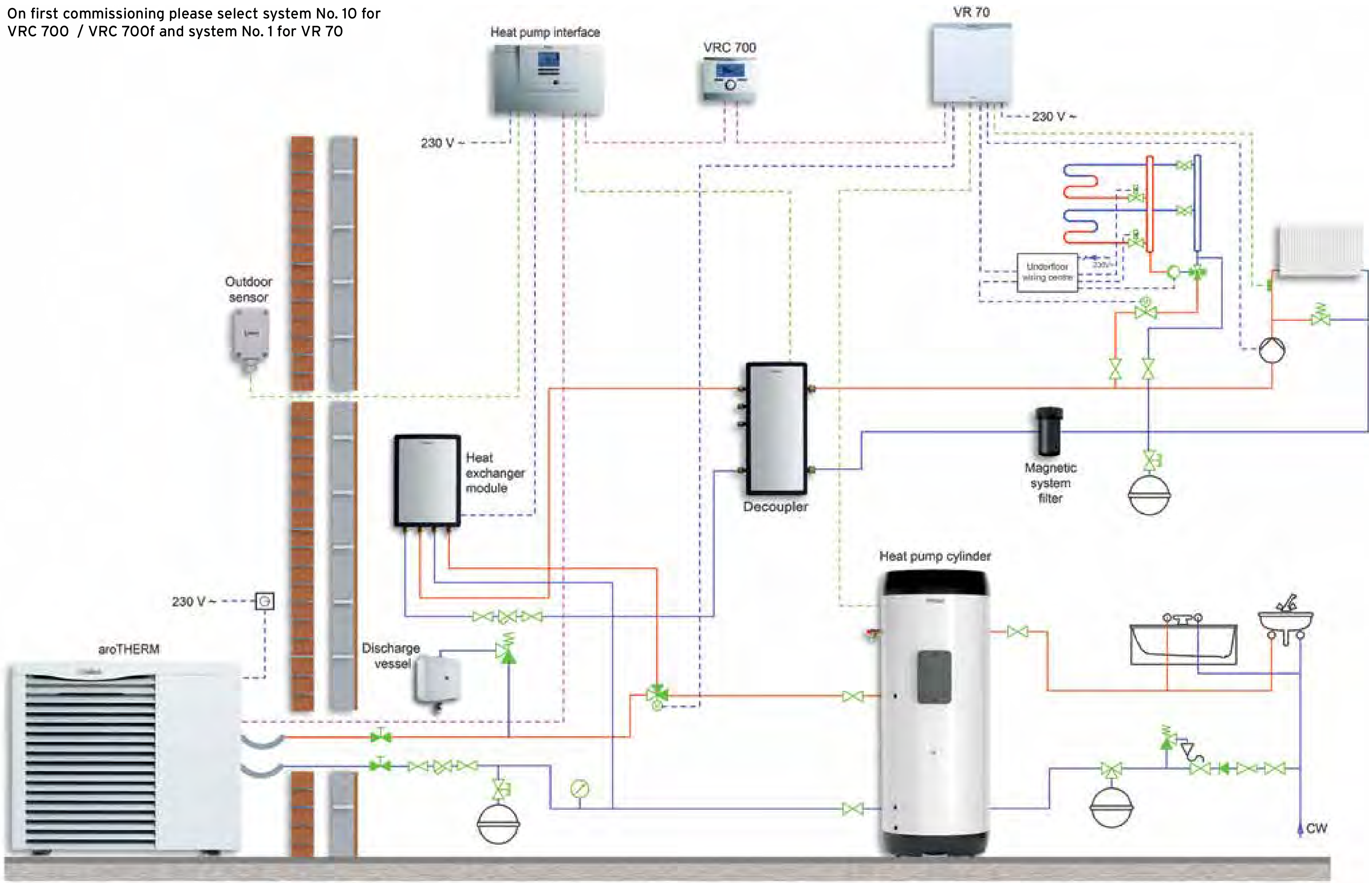


Heat pump, DHW tank, underfloor heating, one rad zone - wiring

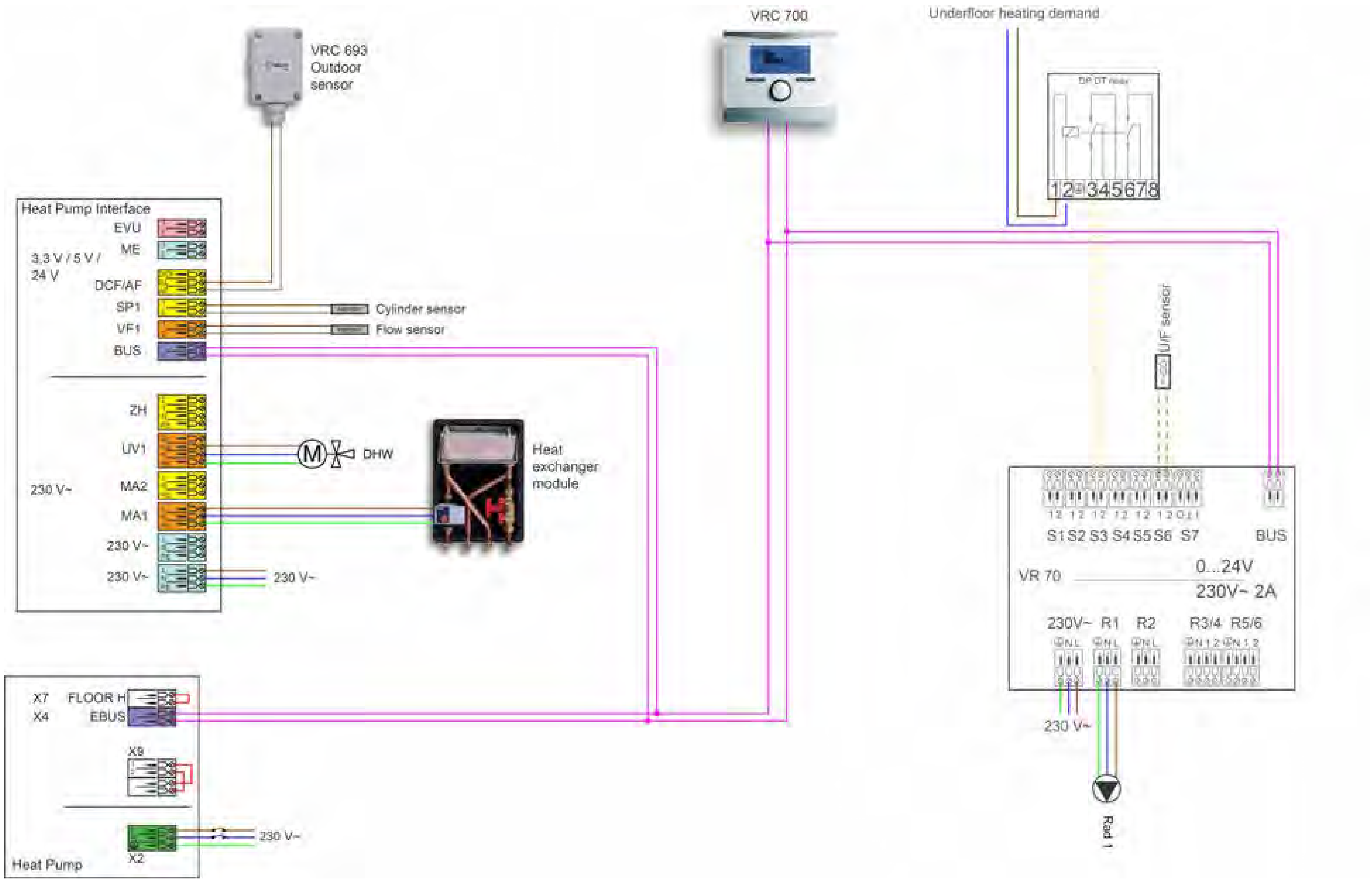


Heat pump, heat exchanger module, decoupler, DHW tank, U/F, one zone - schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f and system No. 1 for VR 70

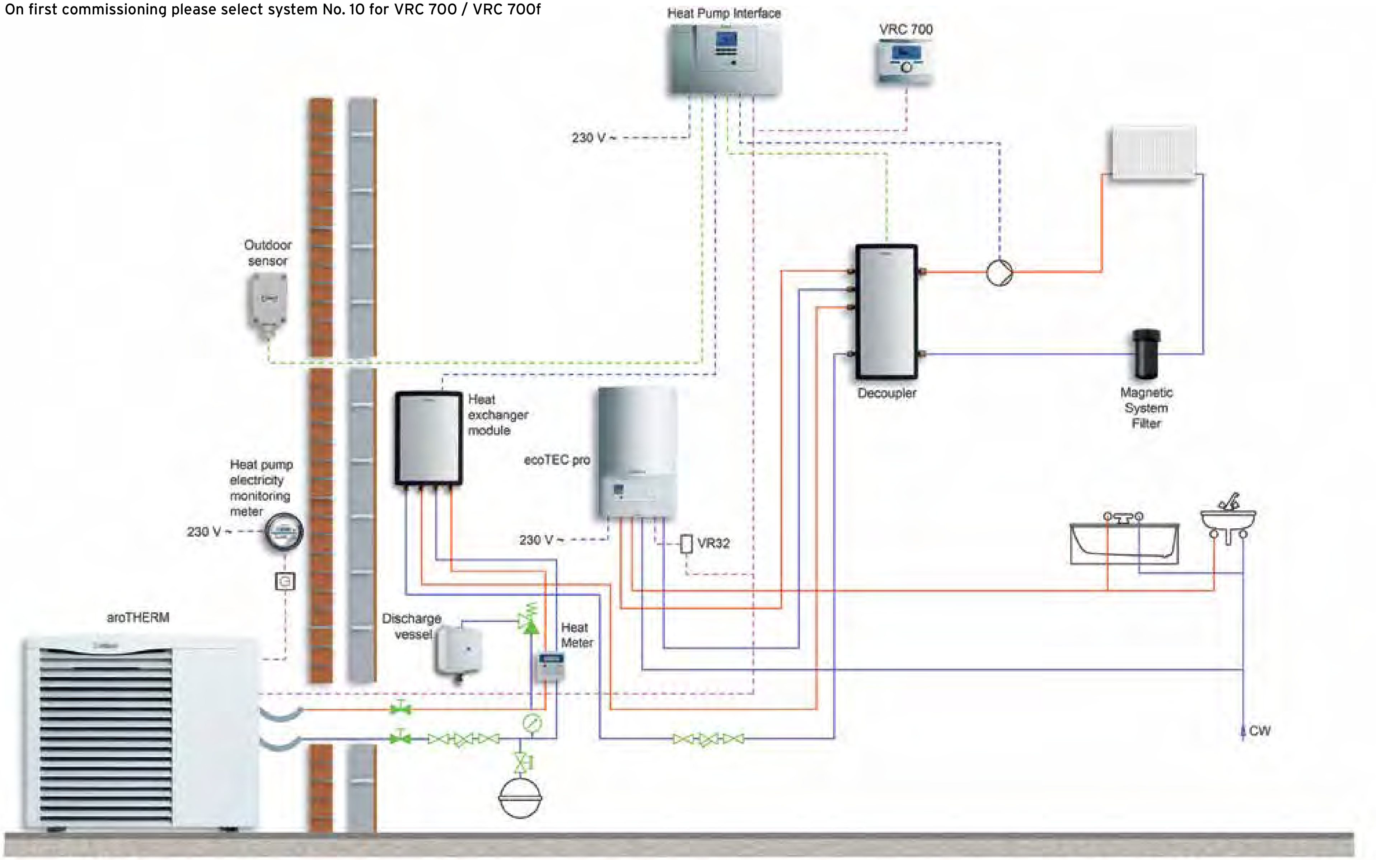


Heat pump, heat exchanger module, decoupler, DHW tank, U/F, one zone – wiring

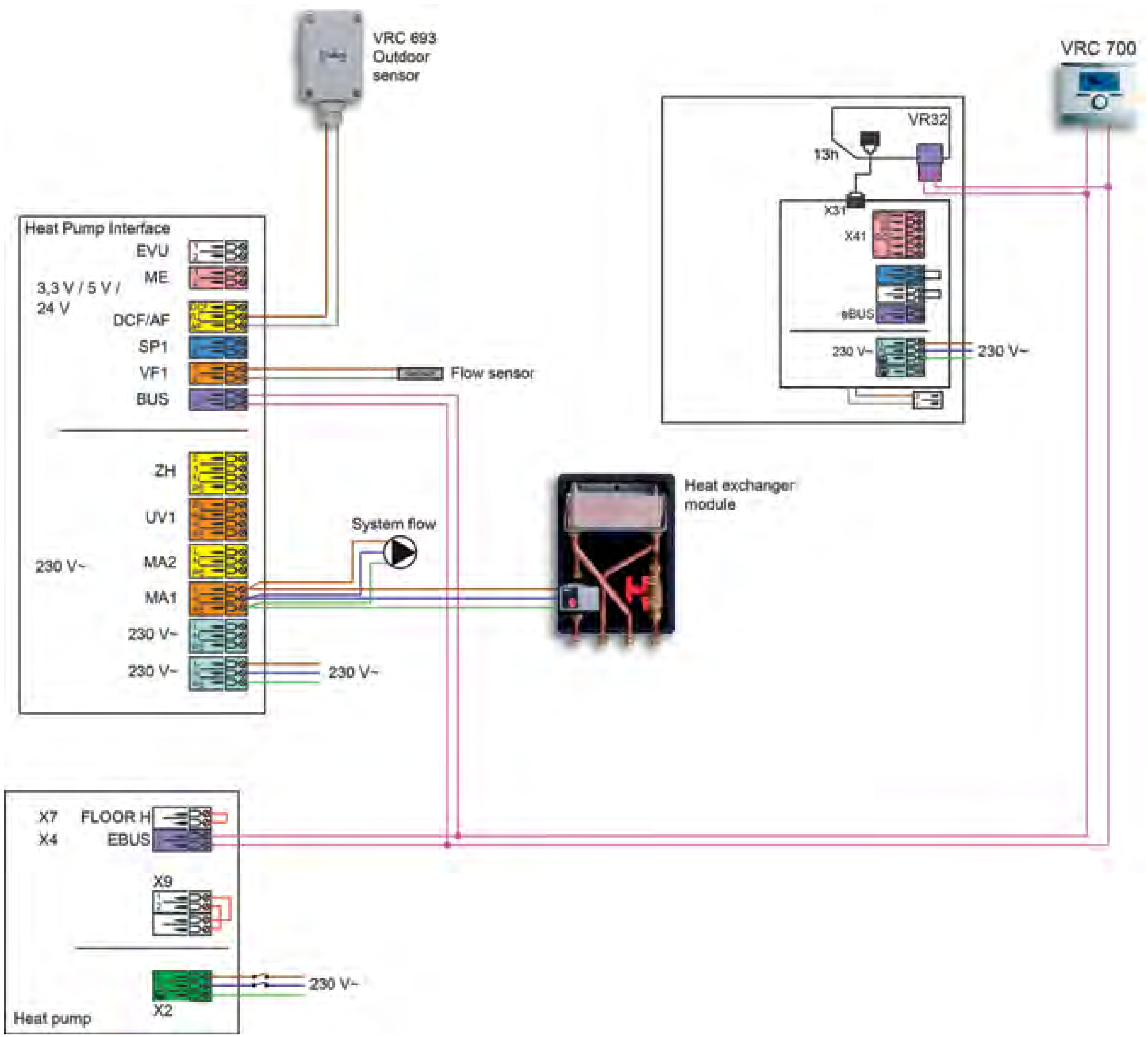


Hybrid, Vaillant combi boiler, heat exchanger module, decoupler, one zone - schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f

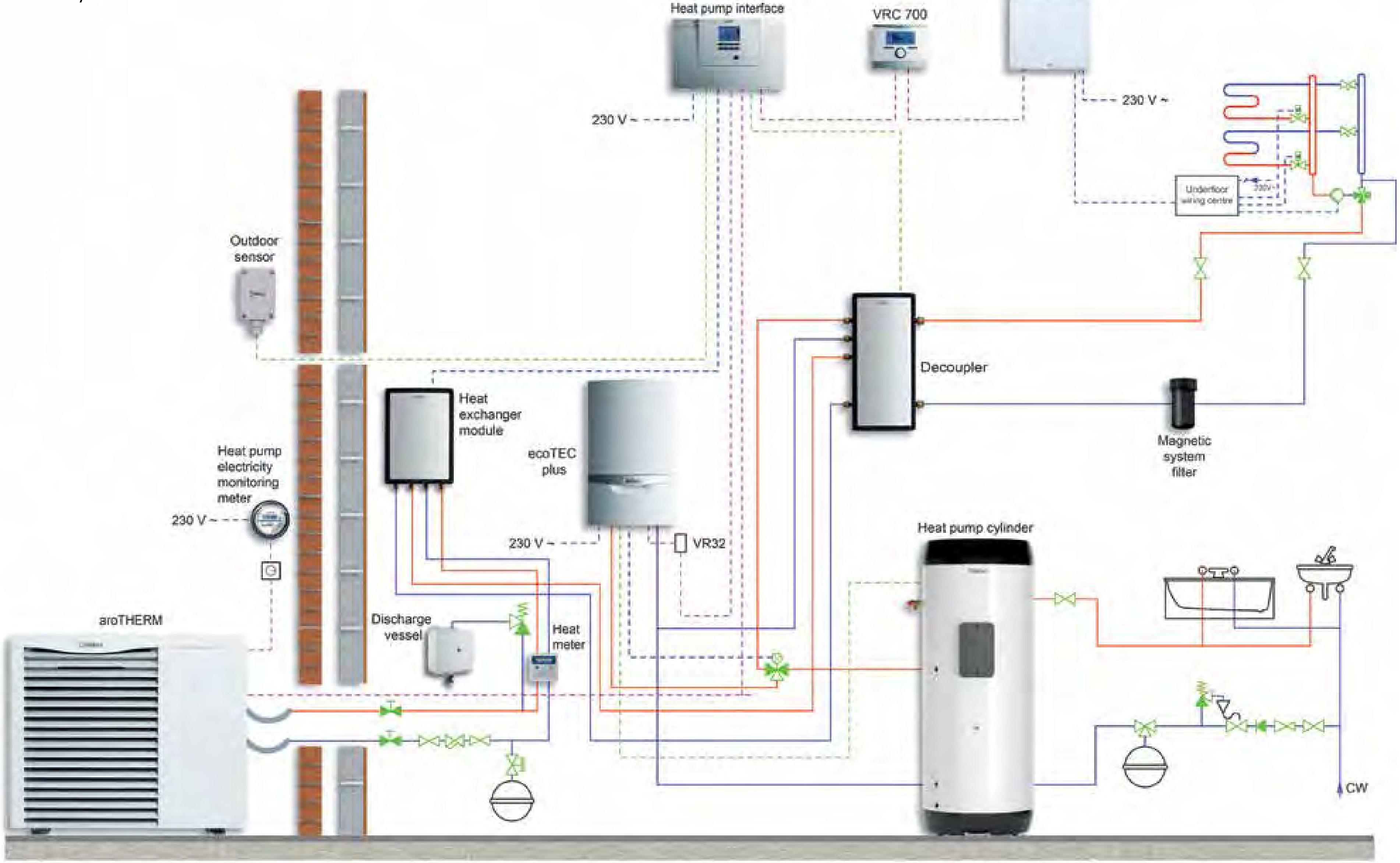


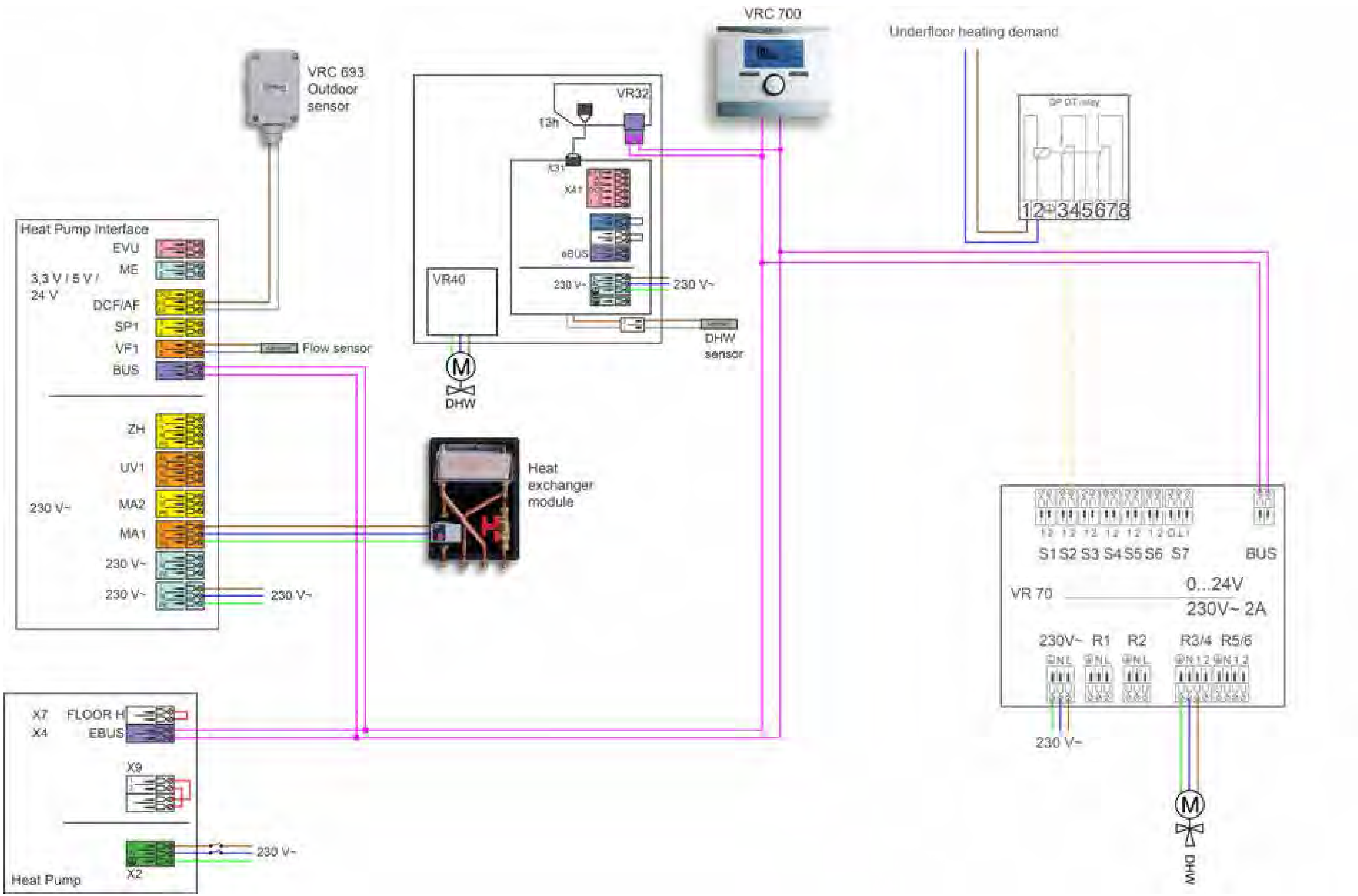
Hybrid, Vaillant combi boiler, heat exchanger module, decoupler, one zone - wiring



Hybrid, Vaillant system boiler, heat exchanger module, decoupler, U/F – schematic

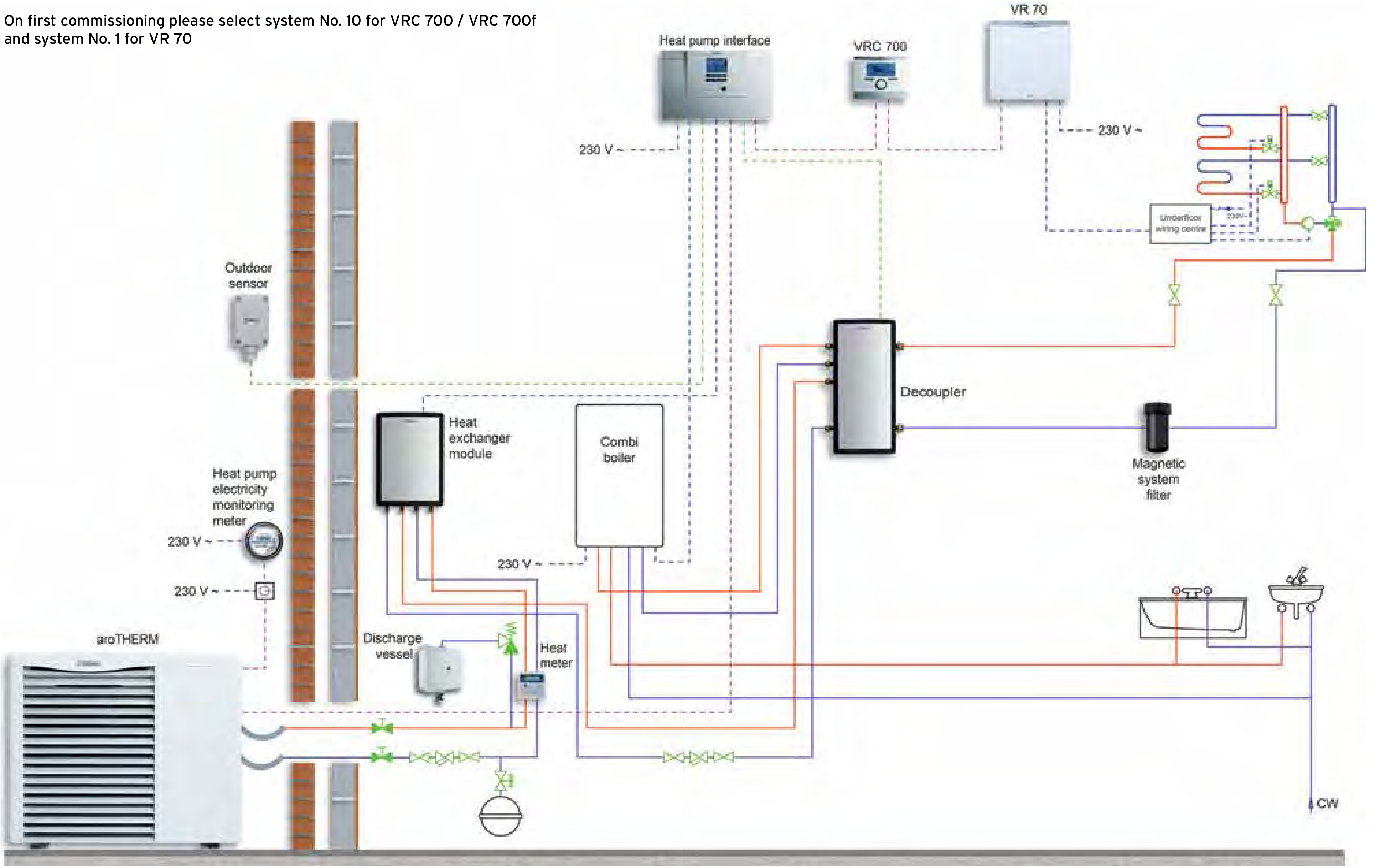
On first commissioning please select system No. 10 for VRC 700 / VRC 700f
and system No. 1 for VR 70



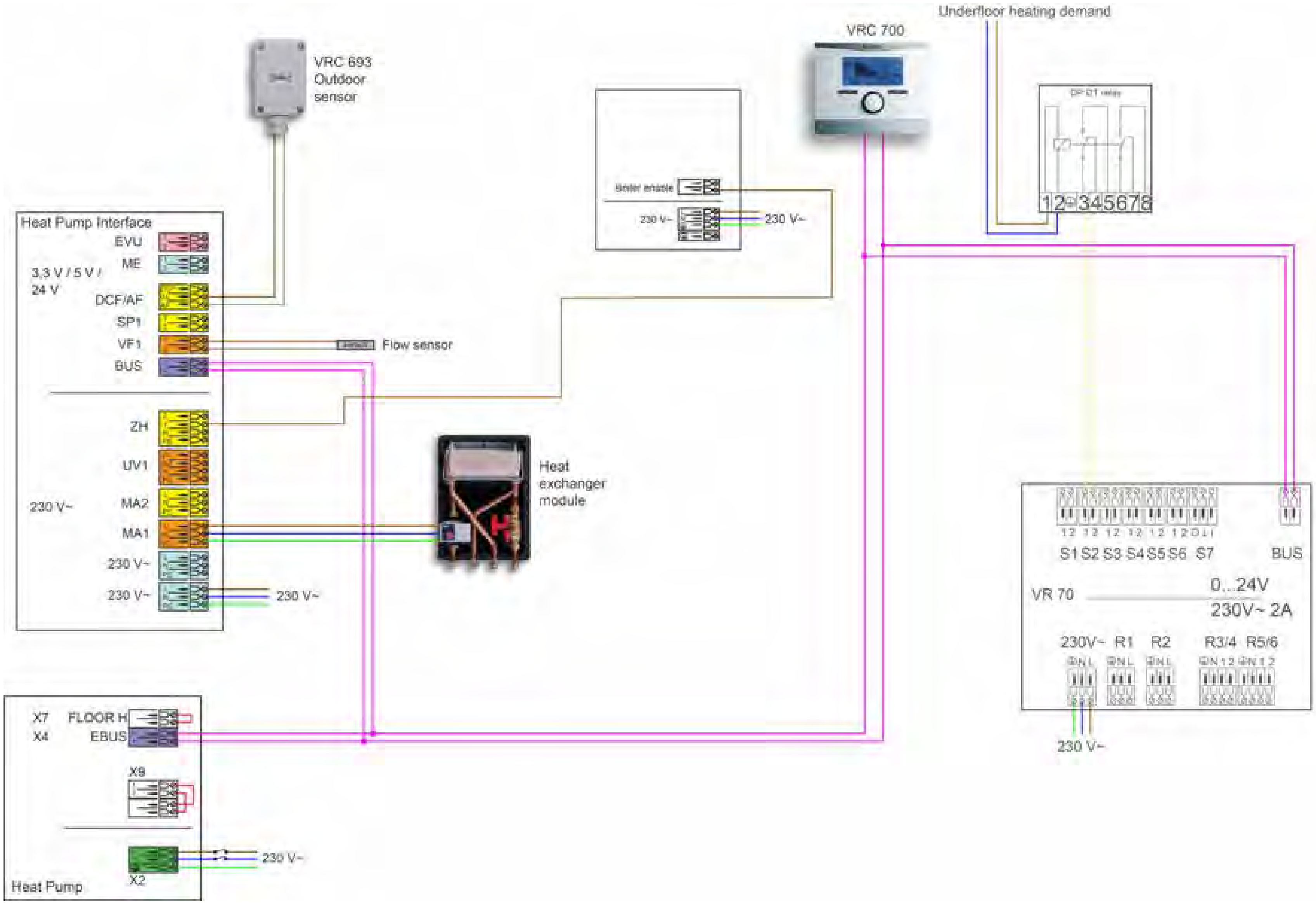

VRC 693
Outdoor
sensor
VRC 700
Underfloor heating demand
VR32
VR40
X41
eBUS
230 V~
DHW
sensor
DHW
Heat Pump Interface
EVU
ME
3,3 V / 5 V /
24 V
DCF/AF
SP1
VF1
BUS
Flow sensor
ZH
UV1
MA2
MA1
230 V~
Heat
exchanger
module
X7
X4
FLOOR H
EBUS
X9
X2
Heat Pump
12345678
S1 S2 S3 S4 S5 S6 S7
BUS
VR 70
0...24V
230V~ 2A
230V~ R1 R2 R3/4 R5/6

Hybrid, on/off third-party combi boiler, heat exchanger module, decoupler, U/F – schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f and system No. 1 for VR 70

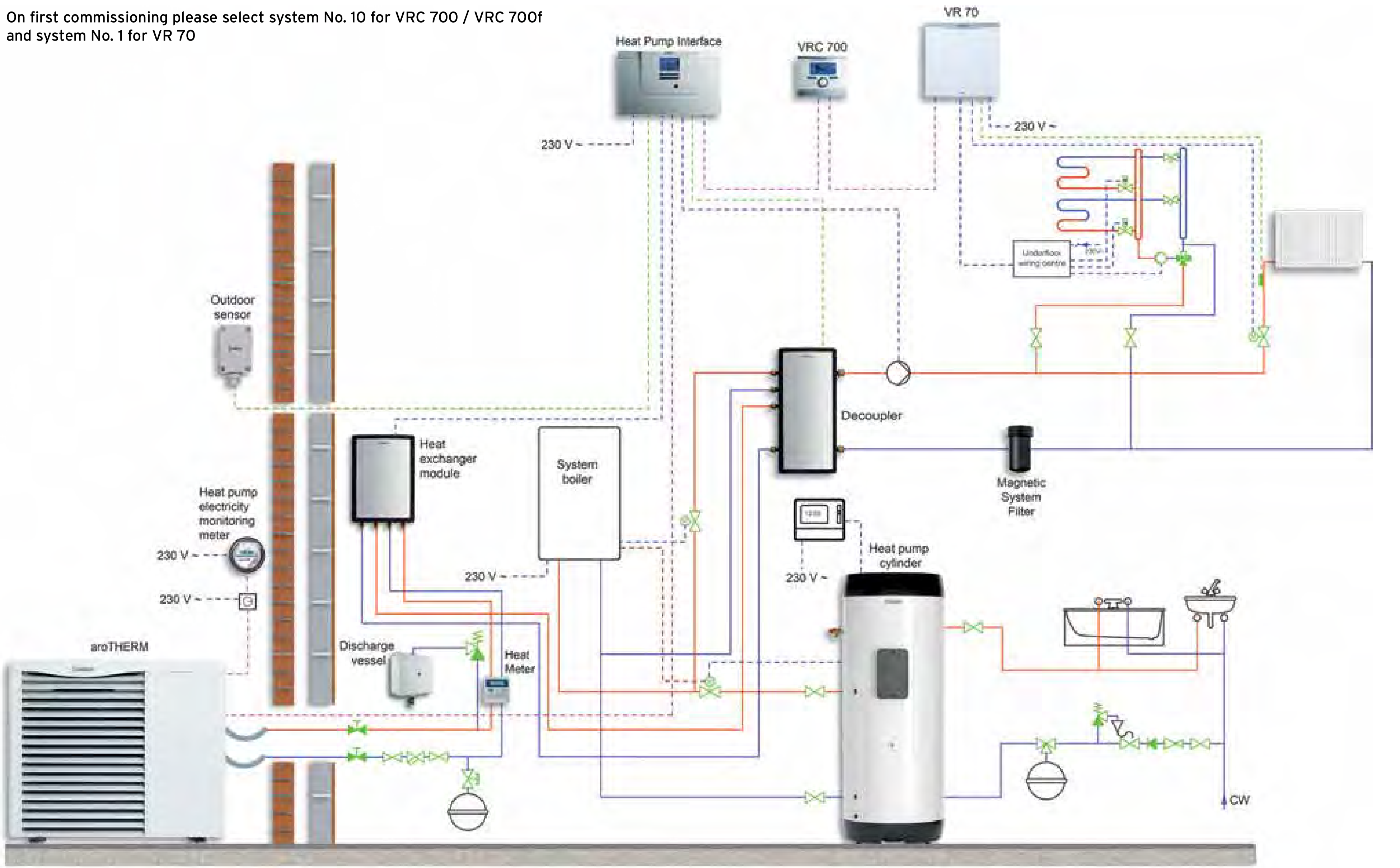


Hybrid, on/off third-party combi boiler, heat exchanger module, decoupler, U/F – wiring

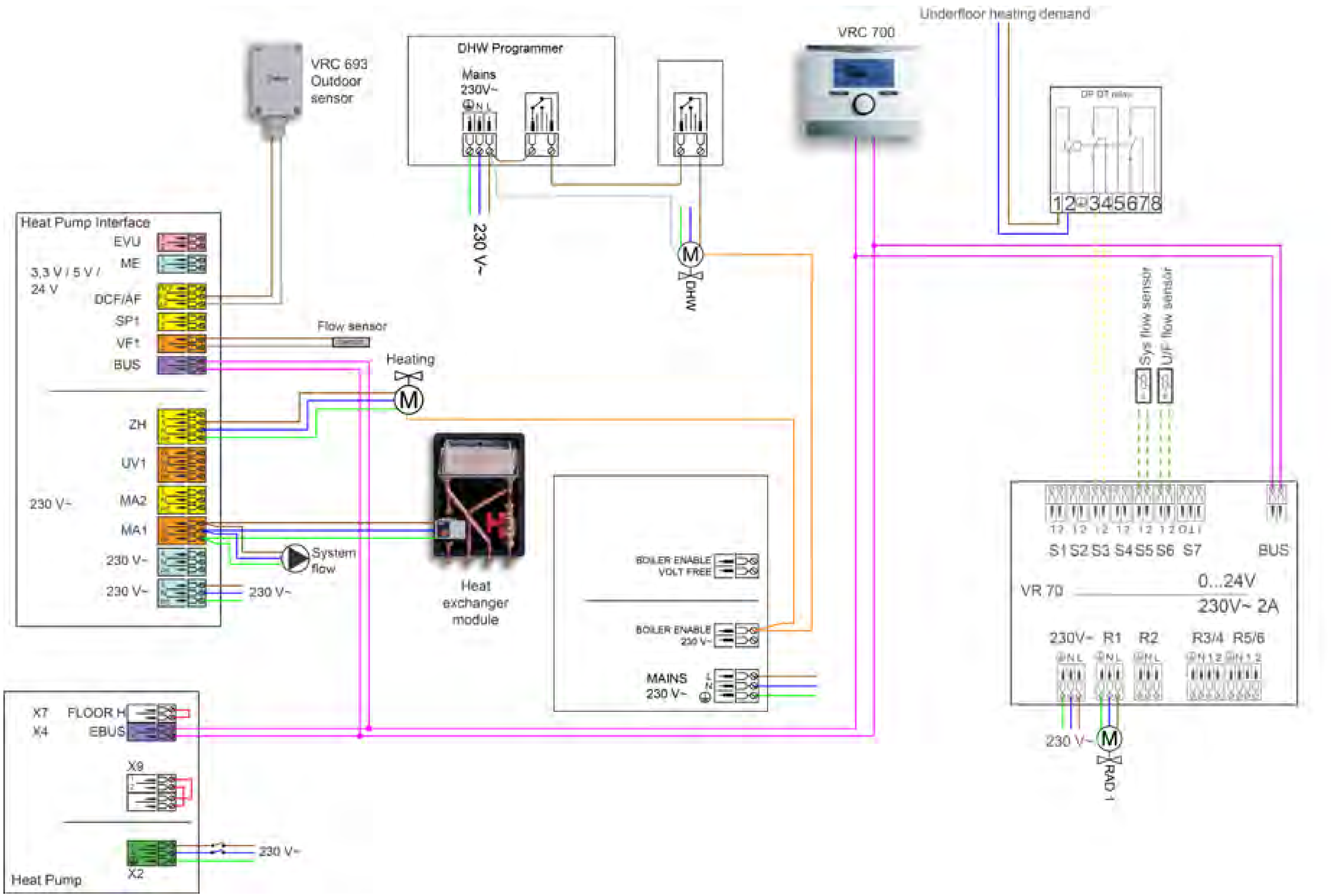


Hybrid, on/off third-party system boiler, heat exchanger module, decoupler, DHW tank, U/F, one zone – schematic

On first commissioning please select system No. 10 for VRC 700 / VRC 700f
and system No. 1 for VR 70



Hybrid, on/off third-party system boiler, heat exchanger module, decoupler, DHW tank, U/F, one zone – wiring



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Email: training.enquiriesuk@vaillant-group.com

Our dedicated team of specialist engineers support any manufacturer in the UK.

Backed by an expertly trained call centre, they're available to assist you whenever you're installing renewable products. We also have an in-house systems design team, who are on hand to answer any queries you may have during the design stage.

Straightforward delivery

We will deliver your renewable system anywhere you want, be it directly to site or to the local trade counter where you place your order. On-site deliveries will arrive with the correct lifting equipment to ensure that the goods can be unloaded safely – it couldn't be easier.

Assisted commissioning*

Service engineers will visit the installation and guide you through the first system commissioning, helping with the final stages and the handover of the installation as needed.

* A charge may apply for this service.

Spares

Our UK stockists hold extensive supplies of our heat pump ranges and the majority of Vaillant spare parts so long lead times can be avoided, removing the need for extensive notice on orders. Should you have any difficulty in sourcing a particular item, then our customer service representatives are only a phone call away and will be happy to help you locate the spares you require.

Notes

Customer service support contact details

Sales Support

Vaillant products are available to purchase from reputable heating merchants in the UK. To find contact details for your nearest Vaillant representative:
Telephone: 0345 602 0262

Renewable Service

For renewable products aftersales servicing and comissioning:
Telephone: 0330 100 3540
Email: aftersales@vaillant.co.uk

Technical Enquiries

For technical assistance:
Telephone: 0330 100 3540
Email: aftersales@vaillant.co.uk

Training Enquiries

Vaillant provide many different training courses, for more information:
Telephone: 0345 601 8885
Email: training.enqures.uk@vaillant-group.com

General enquiries

If you have a general enquiry our friendly reception staff will happily point you in the right direction:
Telephone: 0345 602 2922

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Telephone: 0345 602 2922 www.vaillant.co.uk info@vaillant.co.uk

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