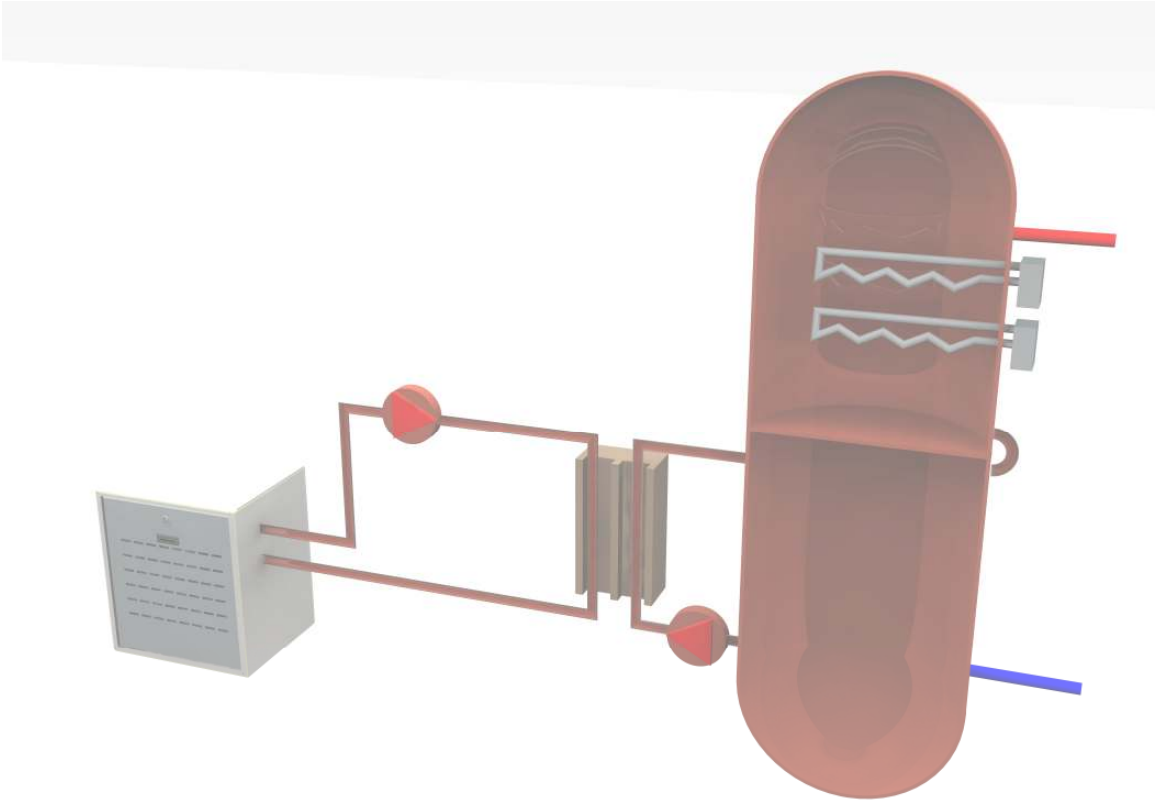
Applications Guide

PQFY

City Multi VRF
Water Heating Unit



MITSUBISHI ELECTRIC

Introduction

This guide gives a basic description and explanation of how to apply the PQFY and its adjoining accessories successfully in all applications. It also describes parameters and settings of the unit. For more detail, please see the PQFY & ACH1 install manuals.

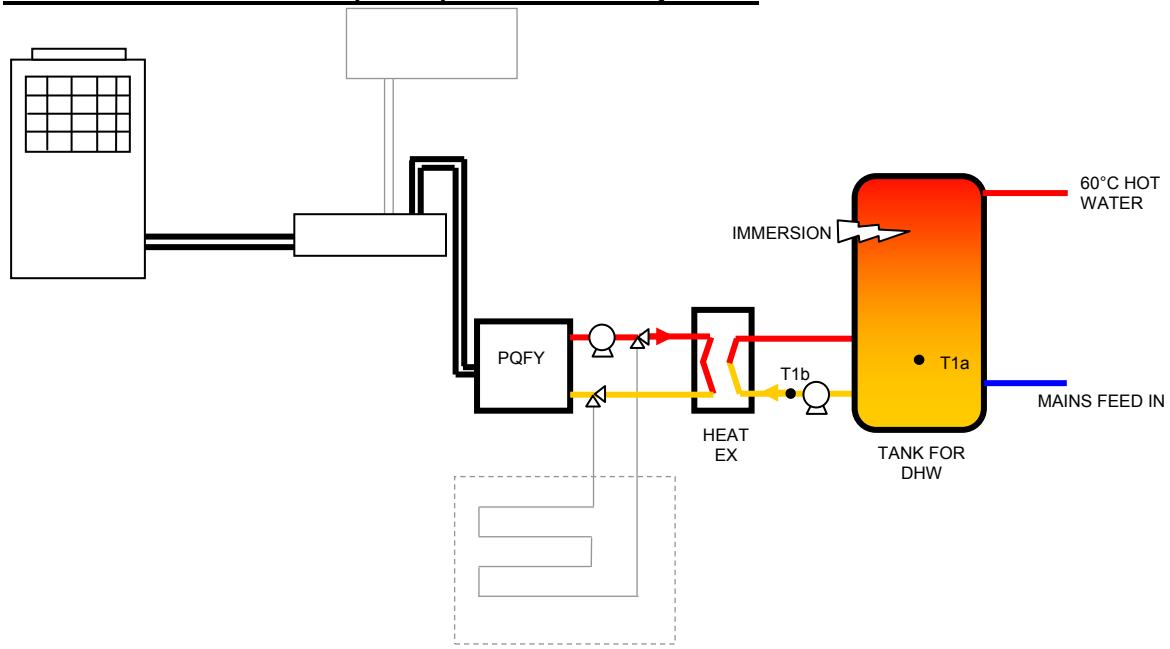
The guide is split into different applications of domestic hot water and under floor systems, both heating and cooling. The PQFY acts as a normal VRF indoor unit so can adhere to the same principles for heat recovery R2 systems to optimise the efficiency of the system.

The guide also covers other applications such as swimming pools and using multiple units together.

All applications use the same diagram as a representation of a system. *This doesn't mean that you need all parts for the configuration to work*; it's just to show how they all compare. The parts of the system being used in each case are highlighted in bold and/or colour.

Contents

1. Domestic Hot Water (DHW) with Direct Cylinder



COMPRESSOR UNIT (see capacity sizing tool)

- PUMY-P100, 125 or 140 for a single PQFY-P140. PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY

- Attach PAR21 to PQFY unit on TB15. Set to AUTO 28 (Set dipswitch on outdoor unit – SW6-6 on PUMY, SW2-8 all other. Also may need to enable auto function on controller – see PQFY manual).
- TH1H – attach thermistor (supplied) to T1a or T1b. In both cases temperature will be controlled to 45°C.
- T1a is the ideal application – if the cylinder has reached 45°C, then the water within has also.
- T1b would only be used if tank surface is inaccessible.

CYLINDER

- Any indirect cylinder (e.g. Manco). Please note, if using a direct cylinder, a stratification pump has to be used on the 45°C water to stop the risk of legionella if water is to be stored at 45ºC.

OTHER (not included)

- Heat exchanger situated outside of the unit (plate heat exchanger), sized to the kW rating of the total PQFY kW.
- All heat exchangers and pipe work should be well lagged to reduce heat losses.
- Pipe connection from PQFY is copper (for sizes see PQFY spec)
- Two water pumps are required. One on a primary loop, circulating the water through the PQFY. The second circulating the domestic water should be brass.
- Standalone immersion heater can be used to heat the water to 60°C with separate control.

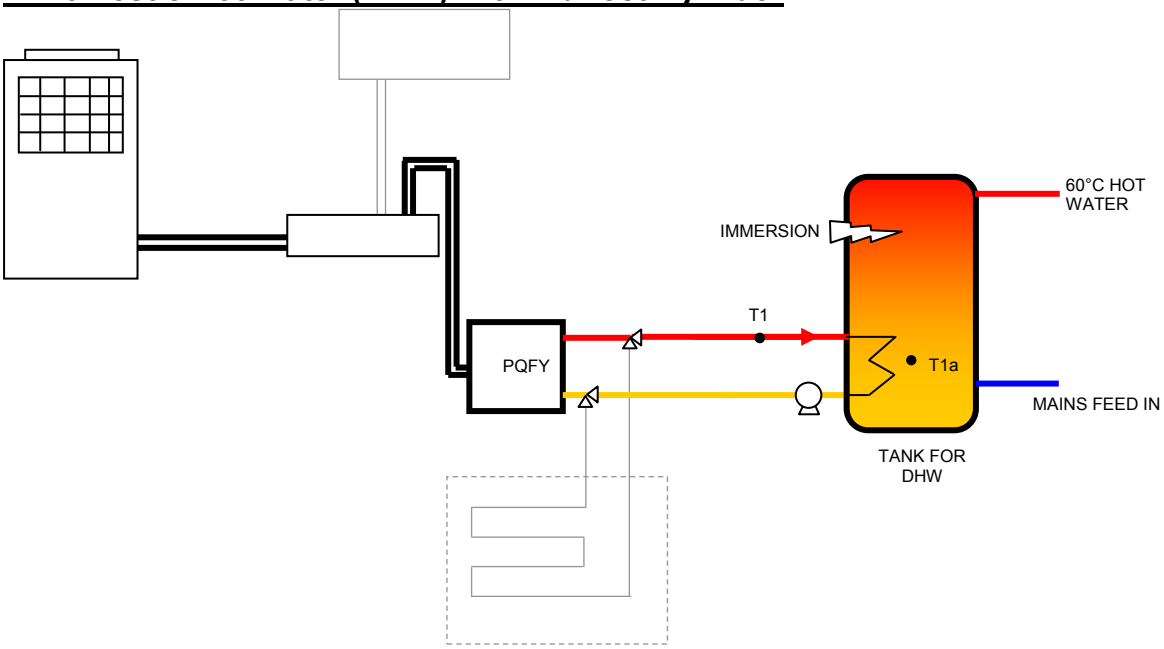
IMMERSION HEATER (IH) control

- An ACH1 is required (*see page 17 for more detail on ACH1*)
- Set binary to 0000 (all off) on DHW dipswitch on ACH1, to enable 45°C water heating with immersion heating control to 60°C.
- Thermistor (T1) HAS to be attached to cylinder (T1a). Connect TH1 on ACH1 to TH1H on PQFY.
- 5 wire adapter (included with ACH1) connect to CN52 on PQFY PCB.
- Immersion signal will be sent when T1 = 44°C. The PQFY will then switch off at 45°C. The immersion heater signal will then be kept until 60°C is sensed on T1, even if the DHW signal is lost (legionella control). The IH will then not come on again until the DHW connection is renewed. If T1 drops below 45°C, the PQFY will heat back to 45°C. When DHW is reset, IH will heat from 45-60°C once. (For more info see ACH1 install manual).

CONTROL

- Volt free operation signal needs to be attached to PQFY (distant signal) from the cylinder system to let the unit know when to come on and turn off if ACH1 is not used.

1. Domestic Hot Water (DHW) with Indirect Cylinder



COMPRESSOR UNIT (see capacity sizing tool)

- PUMY-P100, 125 or 140 for a single PQFY-P140. PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY

- Attach PAR21 to PQFY unit on TB15. Set to AUTO 28 (Set dipswitch on outdoor unit – SW6-6 on PUMY, SW2-8 all other. Also may need to enable auto function on controller – see PQFY manual).
- TH1H – attach thermistor (supplied) to T1a and the temperature will be controlled to 45°C.
- T1a is the ideal application – if the cylinder has reached 45°C, then the water within has also.
- T1b would only be used if tank surface is inaccessible. An ACH1 is required - set temperature to 53°C to ensure the temperature in the tank is 45°C.

CYLINDER

- Suggested tank - Gledhill HP Boilermate. Volt free connection from Boilermate (DHW, UFH & UFC signals). Use DHW signal to operational signal on PQFY if no ACH1 is required. Use DHW signal to DHW select on ACH1 if using ACH1.

OTHER (not included)

- Heat exchanger situated inside of the cylinder sized to the kW rating of the PQFY.
- All heat exchangers and pipe work should be well lagged to reduce heat losses.
- Pipe connection from PQFY is copper.
- One water pump required
- Standalone immersion heater can be used to heat the water to 60°C with separate control.

IMMERSION HEATER control

- See explanation on previous page.

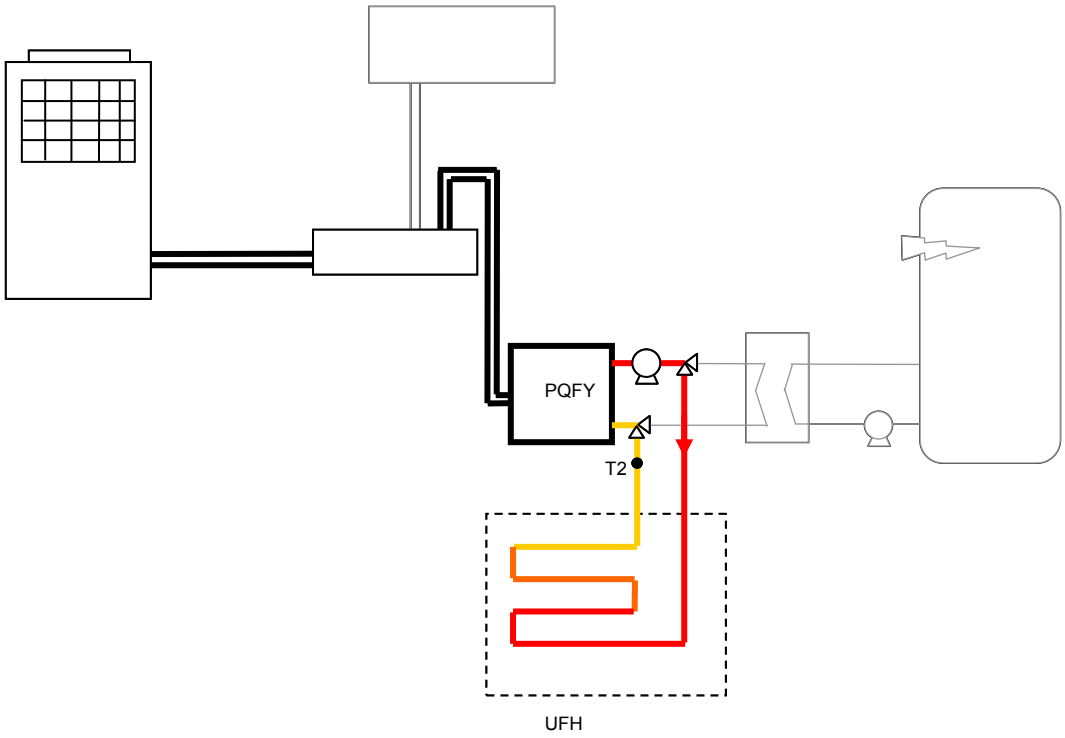
CYLINDER INACCESSIBLE

- ACH1 must be used. Set ACH1 unit up as on previous page without immersion control.
- Attach T1 to inlet water pipe to the cylinder and set to 53°C to ensure water in tank is up to 45°C.

CONTROL

- Volt free operation signal needs to be attached to PQFY (distant signal) from the cylinder system to let the unit know when to come on and turn off if ACH1 is not used. See CYLINDER.

2. Under Floor Heating (UFH)



COMPRESSOR UNIT (see capacity sizing tool)

- PUMY-P100, 125 or 140 for a single PQFY-P140.
- PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY

- Attach PAR21 to PQFY unit on TB15. Set to Heat 23 (Set dipswitch on outdoor unit – SW6-6 on PUMY, SW2-8 all other. Also may need to enable auto function on controller – see PQFY manual).
- TH1H – attach thermistor (supplied) to T2 on the return water pipe.
- Thermistor will control to ~35°C return temperature, giving a flow temperature ~45°C.

OTHER (not included)

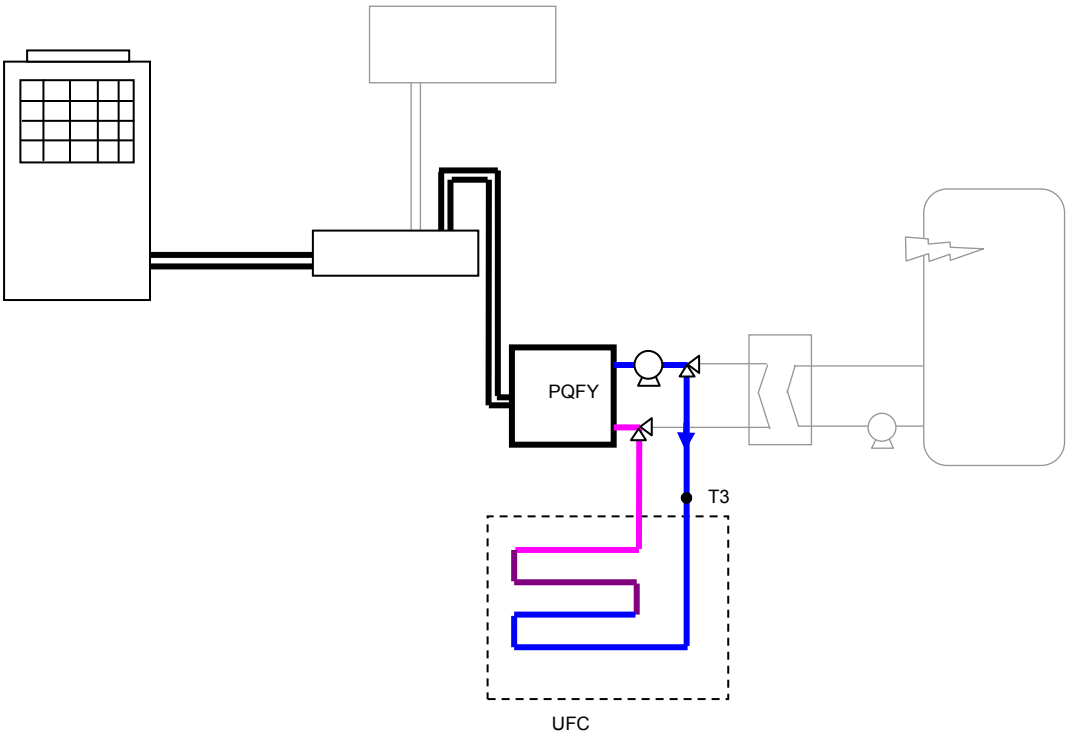
- All pipe work should be well lagged to reduce heat losses.
- Pipe connection from PQFY is copper.
- One water pump should be installed to pump water around the under floor circuit.
- Under floor pipe work is all externally supplied (e.g. OSMA).

- The return water temperature can be set from 26°C - 45°C by changing the controller from heat 28 to auto 17 (see PQFY install manual).

CONTROL

- Volt free operation signal needs to be attached to PQFY (distant signal) from the cylinder system to let the unit know when to come on and turn off. See CYLINDER.

3. Under Floor Cooling (UFC)



If UFC is required, it is almost inevitable that UFH will also be utilised. Therefore, UFC always requires an ACH1 and PAR21 to enable changeover between modes/set points.

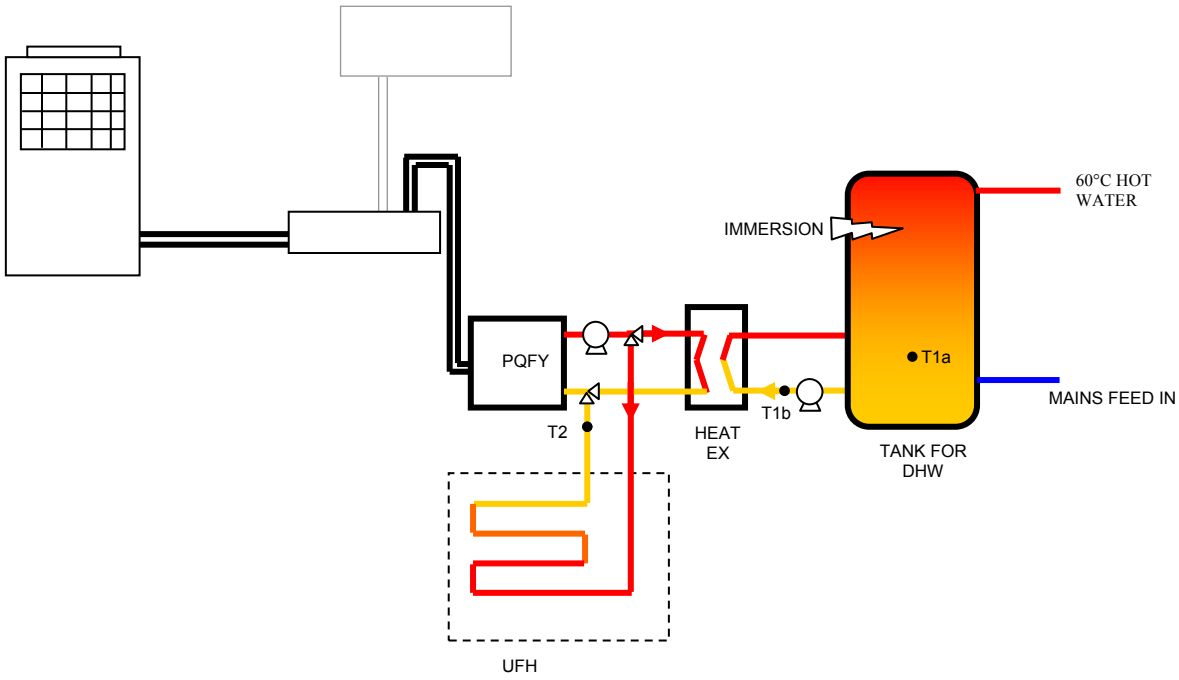
COMPRESSOR UNIT (see capacity sizing tool)
- PUMY-P100, 125 or 140 for a single PQFY-P140.
- PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY
- Attach PAR21 to PQFY unit on TB15. Set to AUTO 28 (Set dipswitch on outdoor unit – SW6-6 on PUMY, SW2-8 all other. Also may need to enable auto function on controller – see PQFY manual).
- Attach ACH1 wiring to PQFY (5 wire to CN52 and TH1 on ACH1 to TH1H on PQFY)
- Attach thermistor for UFC from ACH1 to the water outlet from the PQFY
- T3 will control to anywhere between 10°C – 20°C using binary dipswitches (see ACH1 manual).
- No lower than 18°C is suggested as a flow temperature to avoid condensation on floor surfaces, e.g. laminate.

OTHER (not included)
- All pipe work should be well lagged to reduce heat losses.
- Pipe connection to PQFY should be copper.
- One water pump should be installed to pump water around the under floor circuit.
- Under floor pipe work is all externally supplied (e.g. OSMA).

CONTROL
- Volt free operation signal to ACH1 'UFC select', on when closed, off when open.

4. DHW & UFH



COMPRESSOR UNIT (see capacity sizing tool)

- PUMY-P100, 125 or 140 for a single PQFY-P140.
- PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY

- Attach PAR21 to PQFY unit on TB15. Set to AUTO 28 (Set dipswitch on outdoor unit – SW6-6 on PUMY, SW2-8 all other. Also may need to enable auto function on controller – see PQFY manual).
- Attach ACH1 to PQFY (5 wire adapter to CN52 and TH1 to TH1H – 2 core)
- T1 – attach thermistor (supplied) to T1a or T1b. *(CAN ALSO BE USED WITH INDIRECT CYLINDER)*
- In both cases (T1a and T1b) water temperature will be controlled to 45°C. This temperature water will be fed around the under floor system if it is required, until the tank temp achieves 45°C. Only then will the PQFY be controlled to T2 (typically 35°C)
- T1a is the ideal application – if the cylinder has reached 45°C, then the water within has also.
- T1b would only be used if tank surface is inaccessible (see DHW 1a & 1b)
- T2 should be attached to return from under floor system and set to ~35°C.

CYLINDER, OTHER & IMMERSION HEATER control required

- See DHW & UFH

CONTROL

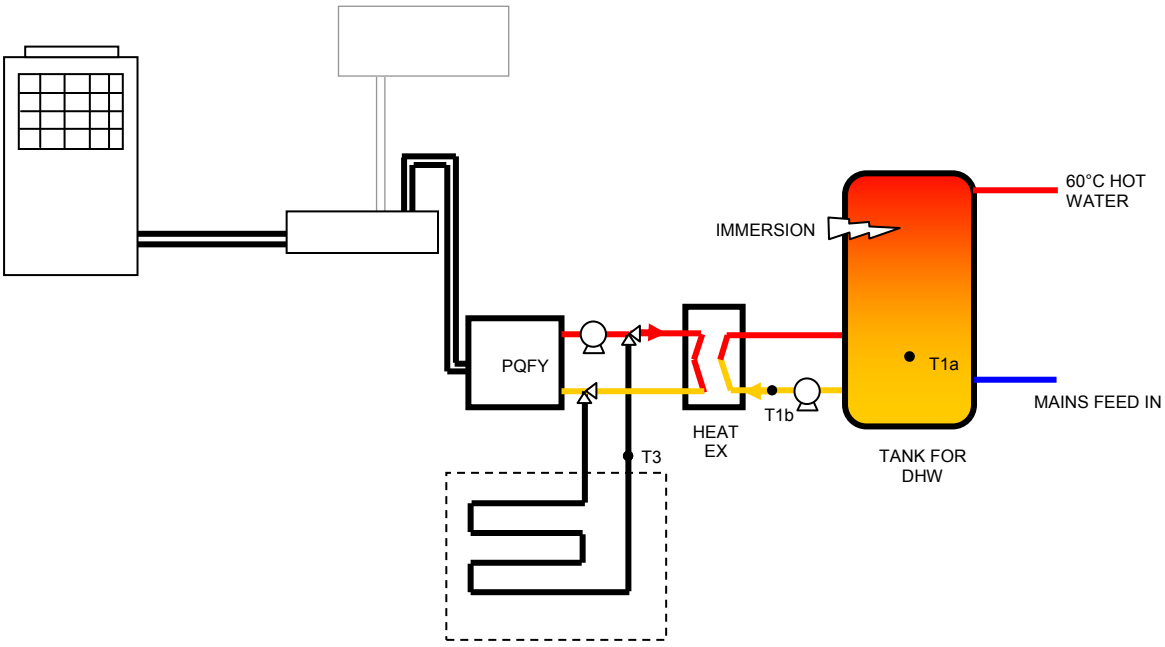
- Volt free contacts required to ACH1 for both UFH signal and DHW signal on. If both in operation, PQFY will control to DHW temperature until set point is reached on T1, then UFH temperature T2 will control the PQFY operation set point.

ACH1

Temperatures can be altered to apply to different situations

- DHW can be controlled from 41-55°C on ACH1 (+45°C IH)
- UFH can be controlled from 30-45°C on ACH1

5. DHW & UFC



COMPRESSOR UNIT (see capacity sizing tool)
- PUMY-P100, 125 or 140 for a single PQFY-P140.
- PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY
- Attach PAR21 to PQFY unit on TB15. Set to AUTO 28 (Set dipswitch on outdoor unit – SW6-6 on PUMY, SW2-8 all other. Also may need to enable auto function on controller – see PQFY manual).
- Attach ACH1 to PQFY (5 wire adapter to CN52 and TH1 to TH1H – 2 core)
- T1 – attach thermistor (supplied) to T1a or T1b. *(CAN ALSO BE USED WITH INDIRECT CYLINDER)*
- In both cases (T1a and T1b) water temperature will be controlled to 45°C. This temperature water will be fed around the under floor system if it is required, until the tank temp achieves 45°C. Only then will the PQFY be controlled to T3 (typically 18°C).
- T1a is the ideal application – if the cylinder has reached 45°C, then the water within has also.
- T1b would only be used if tank surface is inaccessible (see DHW 1a and 1b).
- T3 should be attached to feed to under floor system and set to ~18°C.

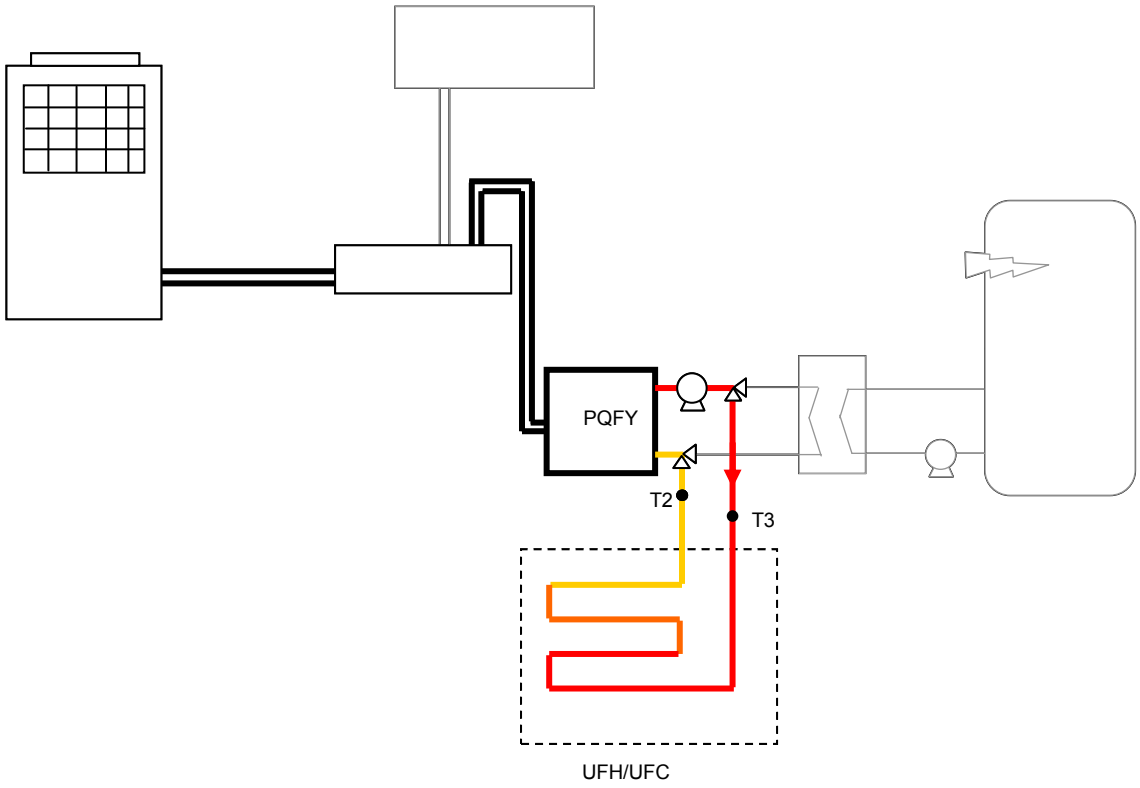
CYLINDER, OTHER & IMMERSION HEATER control required
- See DHW & UFH

CONTROL
- Volt free contacts required to ACH1 for both UFC signal and DHW signal on. If both in operation, PQFY will control to DHW temperature and UFC will not operate until set point is reached on T1, then UFC temperature T3 will control the PQFY operation set point.

Note: Installation plumbing should ensure that and valve supplying water to the UFC are shut when hot water is being supplied to the DHW cylinder and vice versa; for any valve supplying water to the hot water cylinder when UFC is being supplied cold water.

ACH1
Temperatures can be altered to apply to different situations
- DHW can be controlled from 41-55°C on ACH1 (+45°C IH)
- UFH can be controlled from 30-45°C on ACH1

6. UFH & UFC



COMPRESSOR UNIT (see capacity sizing tool)

- PUMY-P100, 125 or 140 for a single PQFY-P140.
- PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY

- Attach PAR21 to PQFY unit on TB15. Set to AUTO 28 (Set dipswitch on outdoor unit – SW6-6 on PUMY, SW2-8 all other. Also may need to enable auto function on controller – see PQFY manual).
- Attach ACH1 to PQFY (5 wire adapter to CN52 and TH1 to TH1H – 2 core)
- T2 should be attached to return water pipe from UFH system. Set to ~35°C.
- T3 should be attached to feed water pipe to UFC system. Set to ~18°C.

CYLINDER, OTHER & IMMERSION HEATER control required

- See UFH & UFC.

CONTROL

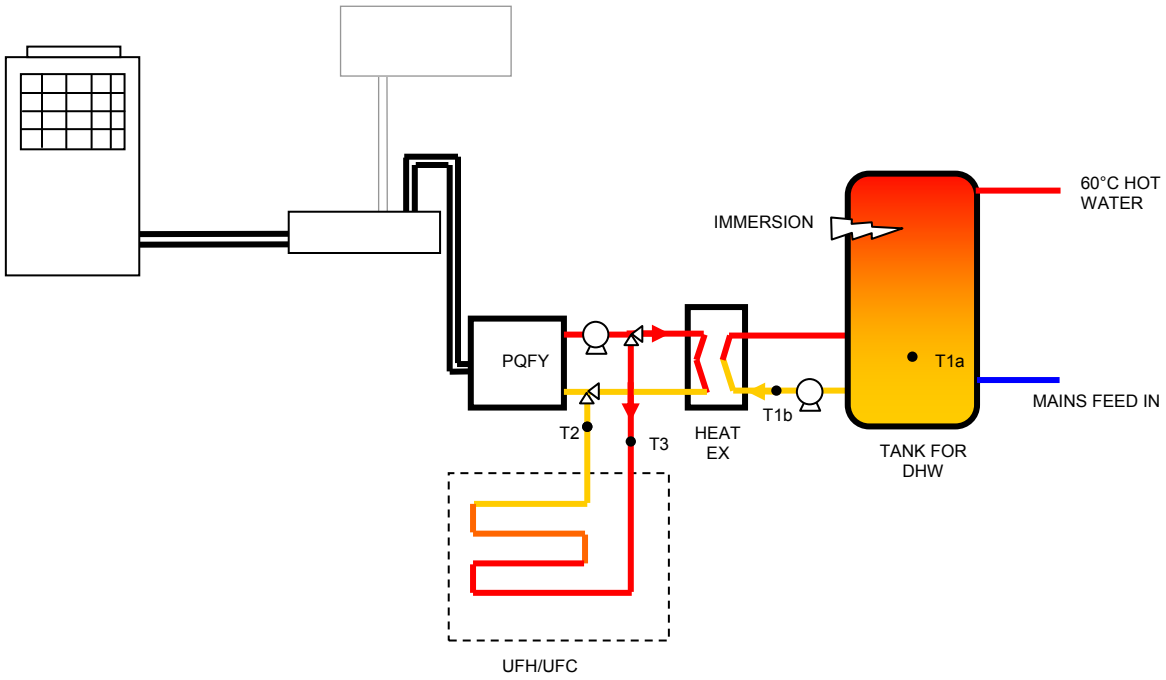
- Volt free contacts required to ACH1 for both UFH signal on and UFC signal on. If both selected, there will be no operation. PQFY will either do UFH or UFC and will control to T2 or T3 temperature accordingly.

ACH1

Temperatures can be altered to apply to different situations

- DHW can be controlled from 41-55°C on ACH1 (+45°C IH)
- UFH can be controlled from 30-45°C on ACH1

7. DHW, UFH & UFC



COMPRESSOR UNIT (see capacity sizing tool)

- PUMY-P100, 125 or 140 for a single PQFY-P140.
- PUHY or PQHY for PQFY-P250 or multiple PQFY units.

PQFY

- See as DHW & UFH [5].
- Additionally add T3 to water feed to under floor system (see UFC [3])

CYLINDER, OTHER & IMMERSION HEATER control required

- See DHW & UFH. *(Can also be used with indirect cylinder).*

CONTROL

- Volt free contacts required to ACH1 for UFH, UFC signal and DHW signal on.
- DHW signal (T1) takes priority, and after which UFH (T2) or UFC (T3) thermistors will take control.
- If DHW is then required again, the unit will prioritise to that temperature (T1) until it is satisfied.
- If DHW and UFH are required at the same time, both are controlled to (T1) DHW temperature and that same water is fed around the UFH circuit. Once achieved, the temperature is controlled by (T2). This may lead to slightly hotter than 45ºC water being supplied to the UFH for a short period of time.
- If DHW and UFC are required, DHW temperature (T1) is controlled. Once reached, the system controls to UFC temperature (T3).

ACH1

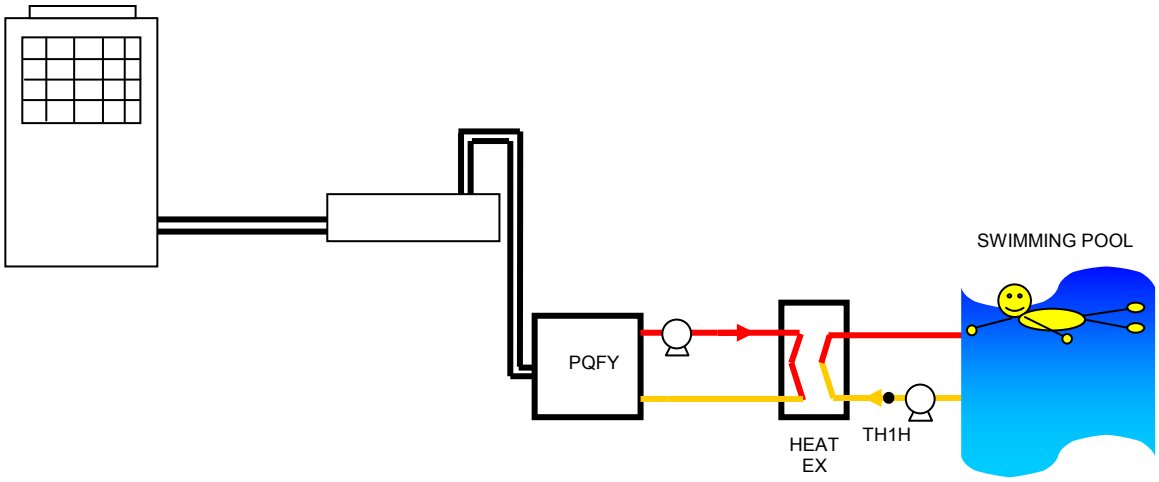
Temperatures can be altered to apply to different situations

- DHW can be controlled from 41-55°C on ACH1 (+45°C IH)
- UFH can be controlled from 30-45°C on ACH1
- UFC can be controlled from 10-20°C on ACH1

8. Swimming Pool

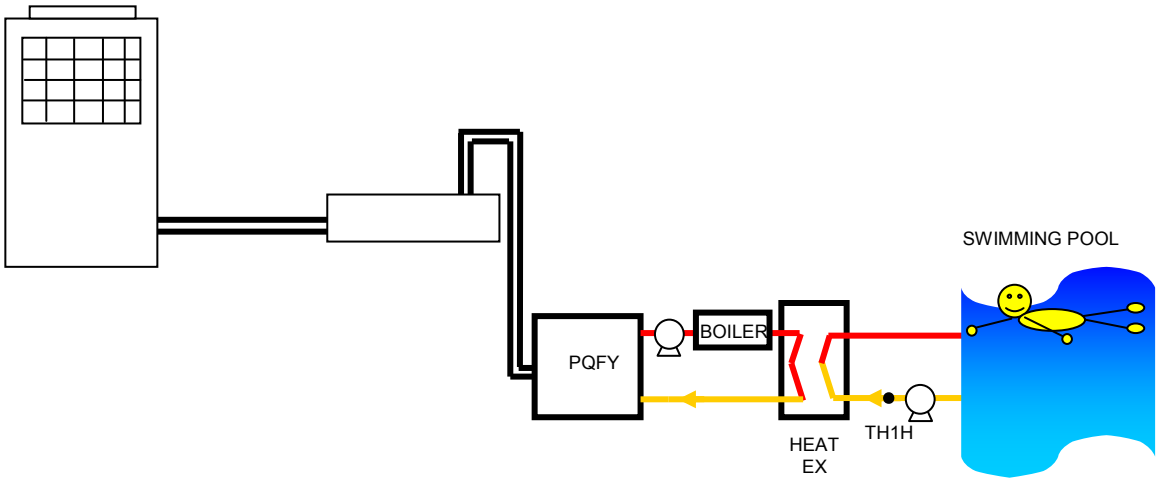
In each case, the swimming pool water volume can be treated as an under floor piping system in heating. The return water from the swimming pool is like the return water from the under floor system. Therefore the thermistor TH1H (or T2 if an ACH1 is used) is attached to the return from the swimming pool, and set to the desired water temperature of the swimming pool. Typically a swimming pool temperature is anywhere between 28°C and 31°C. So to achieve these temperatures the PAR21 would be set to either AUTO 18, 19 or 20 to achieve 28, 29 or 31°C respectively (see PQFY install manual).

A – PQFY taking the entire heating demand



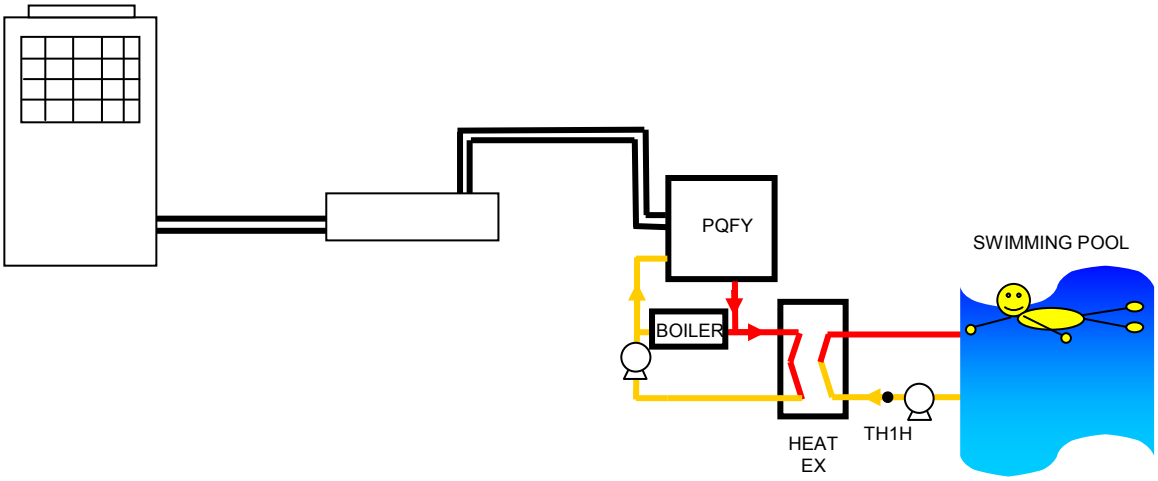
This is the case when the heating system for a swimming pool is being covered completely by the PQFY, for example on new build or new heating install.

B – PQFY with boiler



If an existing boiler is being used, a PQFY can be used to supplement the heat load, to take load off the boiler. Also this set up can be used if the PQFY is required only to take part of the demand from the boiler.

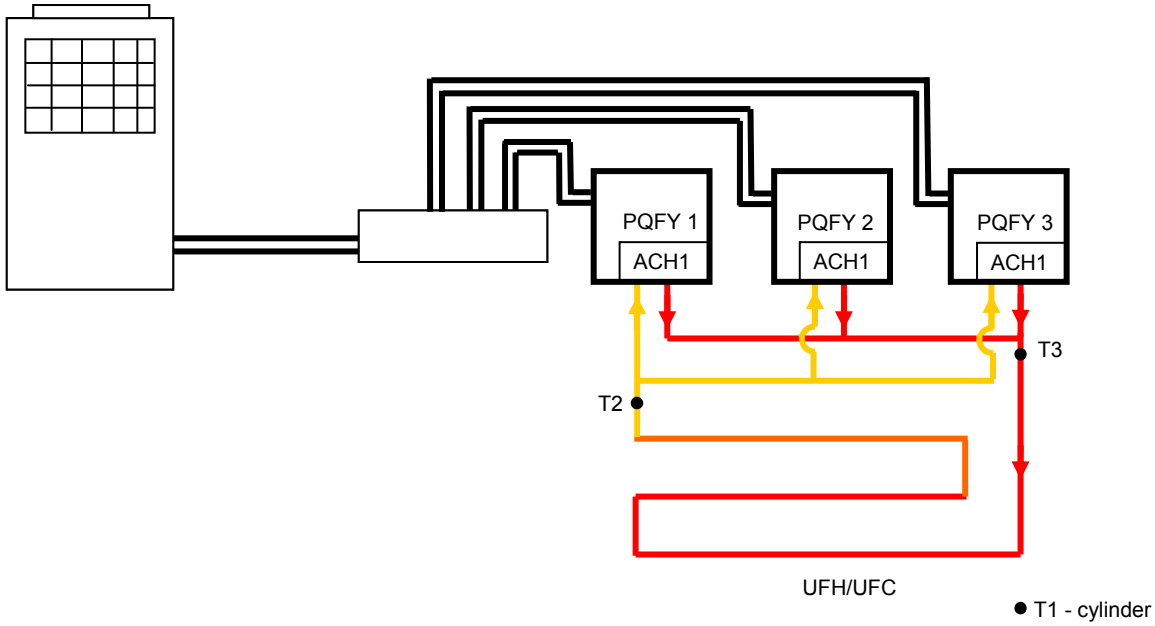
C – PQFY with top up boiler



If the PQFY was installed on a swimming pool which had heavy and constant use with large heat losses, a top up boiler in parallel can be used. The PQFY can maintain the temperature of the pool at around 30°C, however over time this temperature may slowly drop. When, for example, the temperature reaches 28°C, the boiler comes on and heats the pool back up to 31°C. The PQFY may heat the pool for several days before the temperature drops by 1ºC.

9. Multiple Units

Multiple Operation (UFH, UFC, DHW)



OUTDOOR UNIT (see capacity sizing tool)

- PUHY or PQHY.
- If using in conjunction with fan coils in different mode, then an R2 outdoor is required.

PQFY

Although there are x units in this example, they are all piped in parallel, so the water going into the header at T2 is at constant temperature and coming out the header at T3 at a constant temperature. Therefore, the system acts just as if there was one PQFY unit with an increased capacity.

When using more than 1 x PQFY;
2 x PAR21 required
1 x ACH1 for each PQFY required

- Address units 01, 02, 03, xx for PQFY 01, 02, 03, xx respectively.
- Attach 2 core MNET from TB3 on outdoor to TB5 on PQFY 01. Then daisy chain to each TB5 on PQFY 02, 03, xx.
- Attach 1xPAR21 to unit 01on TB15. Attach 1xPAR21 to unit 02 on TB15.
- Attach 1xACH1 to unit 01, 1xACH1 to unit 02, 03, xx.
- Unit 03, xx will be controlled by PAR21 on unit 02.
- Attach 1x 5 wire adapter from ACH1 to CN52 on each PQFY.
- Thermistors attached as shown for each ACH1. (T2 UFH, T3 UFC, T1 DHW - for DHW see guide on page 2/3).
- If using single heating operation, thermistor supplied can be used. Follow DHW or UFH.

- T1 ideally on tank set to 45°C with immersion control.
- T2 on return from under floor before header set to 35°C.
- T3 on feed after header out of under floor system set to 18°C.

CONTROL

- Same as other PQFY applications – volt free contact needed to start operation (DHW, UFH and UFC). DHW takes priority. See previous applications for more detail.

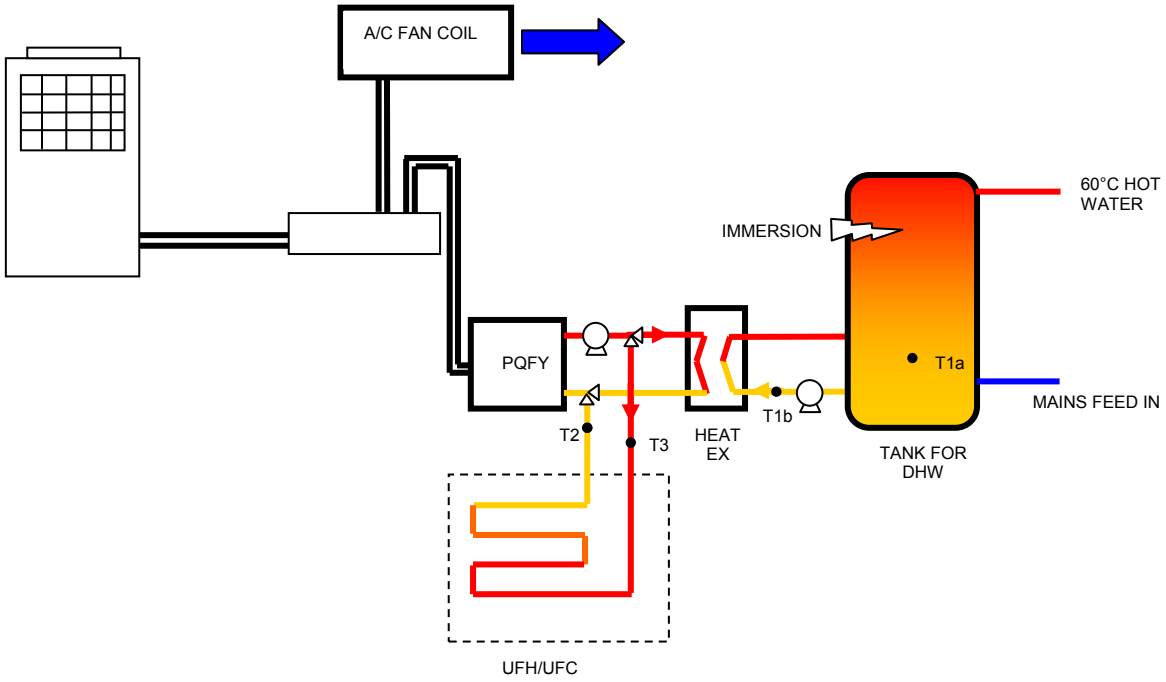
IMMERSION HEATER control required

- See explanation on DHW. Use immersion control from one ACH1 unit.

Heat Recovery Operation

The PQFY can be used on all heat recovery R2 and WR2 systems with the addition of a BC controller. Normal rules apply – if the fan coils are going to ever be in cooling and the PQFY in heating (for DHW or UFH), then a R2 system has to be used to enable everything to work at the same time giving maximum energy efficiency.

However, if there was a system with fan coils which were going to be used for cooling in the summer, and the PQFY was going to be used for UFH in the winter, then a Y or WY series Heat Pump will work. A Y series can also be used to heat water in the summer for DHW use if it is used in the night time when the cooling demand on fan coils is zero.



Below is an explanation of each PQFY configuration with the addition of fan coils/units to the system.

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*1. DHW**

If using with fan coils, an R2 system is only required if the PQFY is going to be used to heat water the same time the fan coils are on in cooling. All other cases a Y series can be used.

Y - *Domestic water is heated at night and the cooling fan coils are used in the day.*
R2 - *A constant demand for hot water is required throughout the day, whilst the building required cooling (free water heating using heat recovery).*

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2. UFH

If using with fan coils, an R2 system is only required if the PQFY is going to be used for the under floor heating the same time as fan coils are in cooling. All other cases a Y series can be used.

Y - *UFH is used in the winter to heat the building, and fan coils are used in the summer to cool.*
R2 - *UFH is required in one part of the building in winter and cooling a/c is required in another part (e.g. IT suite, canteen, and food storage).*

***Note:* If hot water & fan coil heating is needed, the outdoor unit should be sized to cope with total heating duty.**

3. UFC

If using with fan coils, an R2 system is only required if the PQFY is going to be used for the under floor cooling the same time as fan coils are in heating. All other cases a Y series can be used.

Y - *UFC used in the summer months to cool the building with fan coils used to supplement the cooling.*
R2 - *Two or more PQFY units used on the same system in summer, one giving UFC to a room, the other heating domestic water (e.g. washing up).*

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4. DHW & UFH

If using with fan coils, the same applies as with 1 DHW and 2 UFH. If using the PQFY with fan coils in cooling on the same system, an R2 system is required. All other cases a Y series can be used.

Y - *UFH is used in winter (office hours) to heat the building, and fan coils are used in cooling on the same system to cool in summer (office hours) with the domestic hot water always being heated at night.*
R2 - *In summer, fan coils are used to cool the building whilst the PQFY is used to heat water for continual domestic use and in winter UFH used with daily DHW use.*

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5. DHW & UFC

If using with fan coils, the same applies as with 1 DHW and 3 UFC. If using the PQFY for DHW with fan coils in cooling on the same system, or fan coils in heating with the PQFY in cooling for UFC, an R2 system is required. All other cases a Y series can be used.

Y - *Fan coils are only used for space heating in winter (office hours) and the UFC is only used in summer (i.e. not at the same time) and DHW is heated during the night.*
R2 - *UFC is supplemented by fan coils and DHW is required during the day. DHW would take priority on the PQFY, giving no UFC and no a/c cooling. R2 system means both heating and cooling modes are possible.*

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6. UFH & UFC

If using with fan coils, the same applies as with 2 UFH and 3 UFC. If using the PQFY in heating for UFH with fan coils in cooling on the same system, or fan coils in heating with the PQFY in cooling for UFC, an R2 system is required. All other cases a Y series can be used.

Y - *UFH is used in winter with fan coils in heating to supplement high demand areas. UFC is used in summer with the same fan coils in cooling to supplement high demand areas.*
R2 - *UFH is used in winter, with e.g. food storage area requiring cooling from fan coils on the same system. UFC is used in summer with a separate PQFY on the same system being used to heat DHW.*

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7. DHW, UFH & UFC

If using with fan coils the same applies as in 4 DHW & UFH and 5 DHW and UFC. If using the PQFY in heating for DHW or UFH with fan coils in cooling on the same system, or fan coils in heating with the PQFY in cooling for UFC, an R2 system is required. All other cases a Y series can be used.

Y - *PQFY used to heat DHW at night and UFH in heating during the day with fan coils supplementing in heating in winter and in summer UFC used with fan coils in cooling supplementing.*
R2 - *PQFY used to heat water for DHW, and is also used for UFH in winter, UFC in summer, with a constant demand for a/c cooling in e.g. food storage year round.*

Flow Rate and Capacity Sizing Tool

PQFY-P140

$$Q = M \times C_P \times (T_1 - T_2)$$

Q = Capacity (kW)
M = Water flow rate (l/s)
C_P = Specific heat capacity of water (J g^{-1} K^{-1})
T_1 = Outlet water temperature (°C)
T_2 = Inlet water temperature (°C)

The maximum discharge temperature from the PQFY is 45°C; this and the maximum capacity of the unit are the only fixed parameters.
As the water flow rate varies the water inlet and outlet temperature will also vary.

e.g. 1
Q = 14 kW
M = 0.3 l/s
C_P = 4.2 Constant
T_1 = ?
T_2 = 20°C

$$Outlet\_Water\_Temperature\_T_1 = \left(\frac{Q}{M \times C_P}\right) + T_2$$

T_1 = 31.1°C

e.g. 2
Q = 14 kW
M = 0.2 l/s
C_P = 4.2 Constant
T_1 = ?
T_2 = 10°C

$$Outlet\_Water\_Temperature\_T_1 = \left(\frac{Q}{M \times C_P}\right) + T_2$$

T_1 = 26.6°C

e.g. 3
Q = 14 kW
M = 0.2 l/s
C_P = 4.2 Constant
T_1 = ?
T_2 = 35°C

$$Outlet\_Water\_Temperature\_T_1 = \left(\frac{Q}{M \times C_P}\right) + T_2$$

T_1 = 51.6°C

This is impossible as the max outlet temperature is 45°C.
The system will now use the inverter to reduce the capacity to achieve a 45°C discharge water temperature.

Capacity Q = M x C_P x (T_1 – T_2)
Capacity Q = 0.2 x 4.2 x (45 - 35)
Q = 8.4kW

If a desired inlet and outlet temperature are known for under floor heating and the capacity is also known then the required flow rate can be calculated thus:

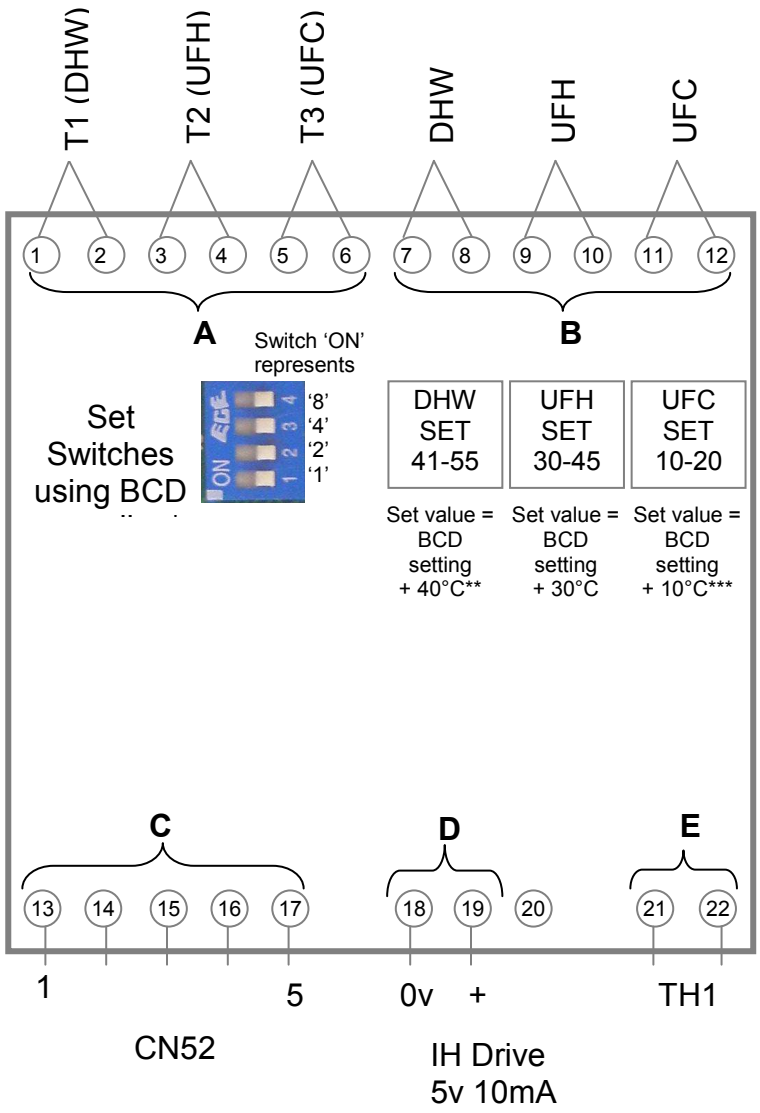
$$Water\_Flow\_Rate = \frac{Q}{C_P \times (T_1 - T_2)}$$

e.g.1
Q = 14 kW
M = ?
C_P = 4.2 Constant
T_1 = 45°C
T_2 = 35°C

$$Water\_Flow\_Rate = \frac{14}{4.2 \times (45 - 35)}$$

M = 0.33 l/s

ACH1



A Thermistors (5K NTC, R = 5K Beta = 3980 : at 25°C
B Mode select (require volt free inputs)
C 5 wire connector to CN52 on PQFY (1 = black)
D Immersion heater output
E Connection to TH1H on PQFY