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SP
Testing

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Testing of a HIU according to the UK HIU Test Regime

(3 appendices)

This is a revised version of the test report 9P07342 dated 2019-12-13. The revision concerns adding the serial number in figure 1, a deleted comment in test 3a about the stable conditions of DHW temperature and decimal places in the overall VWART calculated values.

1 Assignment

RISE has tested a heat interface unit (HIU) (also known as a district heating substation) from Uponor.

2 Test method

The test method is described in the UK HIU Test Regime Technical Specification, Rev-009 (October 2018), issued by the Building Engineering Services Association (BESA). This will be referred to as the Test Regime throughout this document.

The Test Regime specifies testing according to two different test packages: High temperature, with a primary supply temperature of 70 °C, and Low temperature, with a primary supply temperature of 60 °C. The current test object was tested according to both the High and Low temperature test package.

3 Test object

Manufacturer: Uponor
Model name: Combi Port PRO XU
Type/serial number: D-10-0244263
Year of manufacture: 2019
Domestic hot water priority: No

3.1 Design pressures

Primary side: 10 bar
Secondary side, space heating: 3 bar
Secondary side, DHW: 10 bar
Maximum differential pressure, primary side: 4 bar

3.2 Design temperatures

Primary side: max 85 °C
Secondary side, space heating: dimensioned for 35-60 °C
Secondary side, DHW: dimensioned for 45-60 °C

Figure 1. The test object after testing. Insulation removed.

3.3 Components and documentation

See Appendix 1.

4 Test location and time

The testing was performed at RISE in Borås, Sweden, department of Energy and circular economy, in October 2019. The test object arrived to RISE on the 17th of October 2019 with no visible damage.

5 Abbreviations

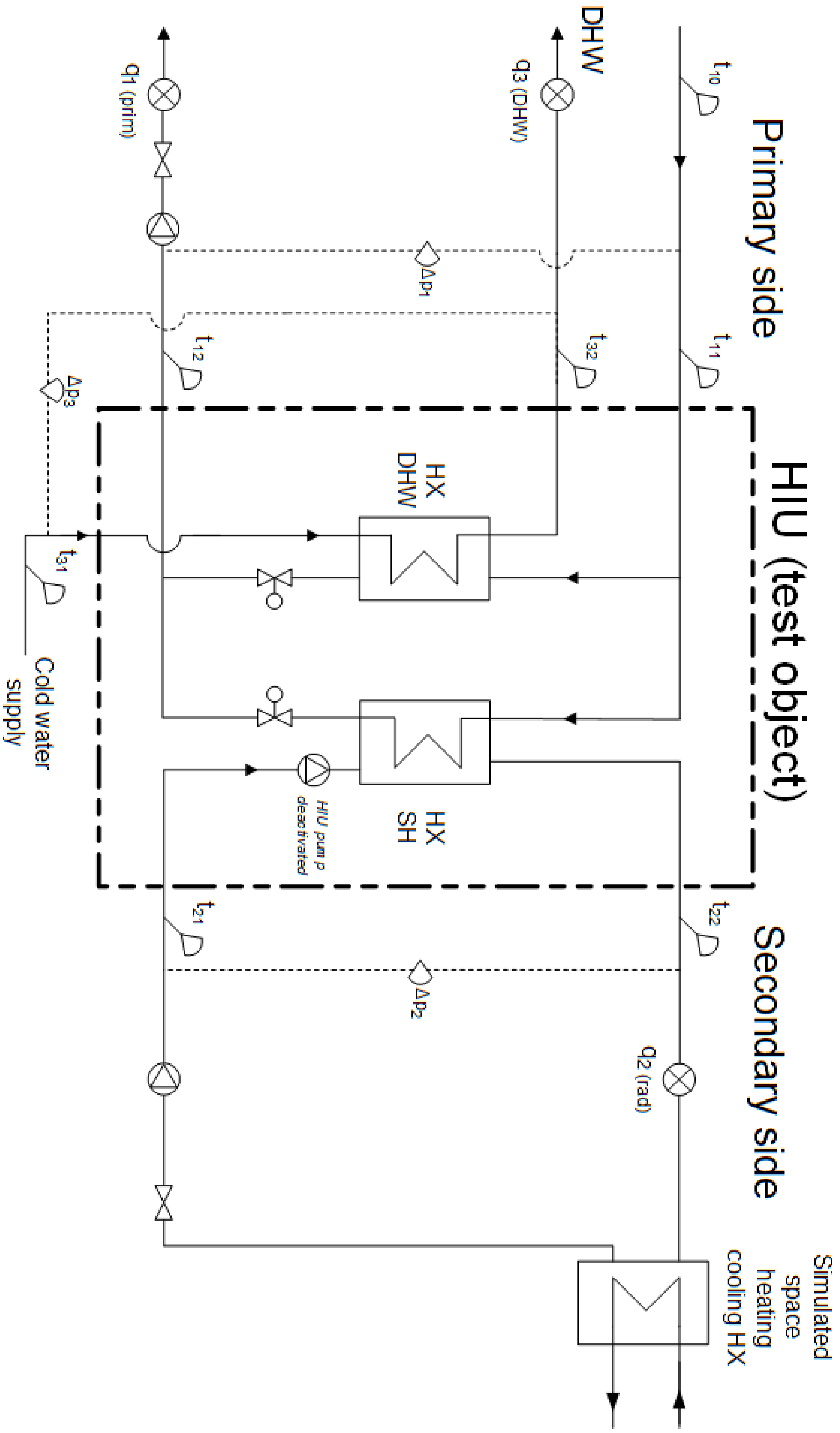
Term	Meaning (*diagram legend entry*)	
DHW	Domestic hot water	-
HIU	Heat Interface Unit	-
SH	Space heating	-
$\mathbf{P_1}$	Heat load, primary side	[kW]
$\mathbf{P_2}$	Heat load, space heating side	[kW]
$\mathbf{P_3}$	Heat load, domestic hot water	[kW]
$\mathbf{t_{11}}$	Temperature, primary supply connection (*DH supply*)	[^{o}C]
$\mathbf{t_{12}}$	Temperature, primary return connection (*DH return*)	[^{o}C]
$\mathbf{t_{21}}$	Temperature, space heating return connection (*SH return*)	[^{o}C]
$\mathbf{t_{22}}$	Temperature, space heating supply connection (*SH supply*)	[^{o}C]
$\mathbf{t_{31}}$	Temperature, cold water (*CWS*)	[^{o}C]
$\mathbf{t_{32}}$	Temperature, domestic hot water supply connection (*DHW supply*)	[^{o}C]
$\mathbf{q_1}$	Volume flow, primary side (*DH*)	[l/s]
$\mathbf{q_2}$	Volume flow, space heating side (*SH*)	[l/s]
$\mathbf{q_3}$	Volume flow, domestic hot water (*DHW*)	[l/s]
$\Delta\mathbf{p_1}$	Pressure drop, primary side across HIU	[bar]
$\Delta\mathbf{p_2}$	Pressure drop, space heating side across HIU	[kPa]
$\Delta\mathbf{p_3}$	Pressure drop, domestic hot water across HIU	[kPa]

6 Test equipment

The following equipment has been used during the tests:

District heating test rig FV3	ETu-QD CB:11
Differential pressure meter	Inv. no. 202 111
Differential pressure meter	Inv. no. 202 112
Differential pressure meter	Inv. no. 202 680
Flow meter, inductive, DN 15	Inv. no. 202 082
Flow meter, inductive, DN 15	Inv. no. 202 687
Flow meter, inductive, DN 15	Inv. no. 202 686
Flow meter, inductive, DN 4	Inv. no. BX60131
Logger for measured data	Inv. no. 202 879
Pressure meter for pressure test	Inv. no. 201 378

Figure 2. Simplified schematic diagram of the test rig used for the tests.



6.1 Collection of measurement data, static measurements

When conditions were stable, measurement results were registered for at least 300 seconds. Presented static measurement test values are averages of 300 data points. The sampling rate was 1 Hz for the static tests. The pressure in the space heating circuit was 1.5 bar.

6.2 Collection of measurement data, dynamic measurements

The sampling rate was 1 Hz for the dynamic measurements

The time constant for the temperature sensors in the measuring point t_{32} is ≤ 1.5 s and represents 63% of the final value of a momentary change of temperature from 10 to 90 °C.

The time constant for the flow meter to measure the DHW flow is ≤ 0.2 s.

The pressure for the incoming cold water was 1.5 bar for the production of DHW on demand via a heat exchanger.

For the control of DHW flow, the test rig has two parallel coupled solenoid valves. Each solenoid valve controls a set flow.

Results are presented in chart form and are verified with numerical values.

The tested HIU is intended for direct exchange of DHW. This means that the incoming cold water (10 ± 0.5 ºC), is heated directly in the heat exchanger to DHW temperature. The temperature of DHW in the measuring point t_{32} was measured in connection to the HIU DHW tap.

6.3 Control systems for DHW

The tested HIU is intended for direct exchange of DHW. This means that the incoming cold water (10 ± 0.5 ºC), is heated directly in the heat exchanger to DHW temperature. The temperature of DHW in the measuring point t_{32} was measured in connection to the HIU DHW tap.

6.4 Measurement uncertainty

Unless otherwise stated in conjunction with the reported values, the measurement uncertainty has been estimated to be better than following values:

Differential pressure, primary	± 10 kPa
Differential pressure, space heating	± 1 kPa
Differential pressure, domestic hot water	± 1 kPa
Temperature 0-100 °C	± 0.1 °C
Flow, space heating (0.06 - 0.5 l/s)	± 1.5 %
Flow, space heating (< 0.06 l/s)	Specified in conjunction with each reported measurement
Flow, primary (0.1-0.5 l/s)	± 1.5 %
Flow, primary (< 0.1 l/s)	Specified in conjunction with each reported measurement
Flow, domestic hot water (0.02-0.4 l/s)	± 1.5 %
Pressure 0-7 MPa	± 10 kPa

The measurement uncertainty for calculated average values in test points 1a-f and 4a-b is presented in conjunction with the reported value.

The measurement uncertainty has been calculated according to EA-4/16 with a coverage factor k=2.

7 Test results

The test results apply only to the tested unit.

The results of each test are presented as specified in the Test Regime. Refer to Table 1 regarding the test setup and Table 2 for details on the reporting.

Table 1. Test setup. Extract from the Test Regime.

No	Test	static pressure on primary flow	dP across HIU	Primary flow temp	DHW setpoint	DHW flow rate	DHW heat load	SH output	SH flow temp	SH return temp
		[bar]	dP_1 [bar]	t_{11} [°C]	t_{32} [°C]	q_3 [l/s]	P_3 [kW]	P_2 [kW]	t_{22} [°C]	t_{21} [°C]
Static tests										
0	Static pressure test (same static pressure on both flow and return connections)	1.43 times rated value	1.43 times rated value	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1a	Space Heating 1 kW (DH 70°C flow)	3.0	0.5	70	55	0	0	1	60	40
1b	Space Heating 2 kW (DH 70°C flow)	3.0	0.5	70	55	0	0	2	60	40
1c	Space Heating 4 kW (DH 70°C flow)	3.0	0.5	70	55	0	0	4	60	40
1d	Space heating 1 kW (DH 60°C flow)	3.0	0.5	60	50	0	0	1	45	35
1e	Space heating 2 kW (DH 60°C flow)	3.0	0.5	60	50	0	0	2	45	35
1f	Space heating 4 kW (DH 60°C flow)	3.0	0.5	60	50	0	0	4	45	35
Dynamic tests										
2a	DHW only (DH 70°C flow)	3.0	0.5	70	55	DHW test profile	DHW test profile	0	60	n/a
2b	DHW only (DH 60°C flow)	3.0	0.5	60	50	DHW test profile	DHW test profile	0	45	n/a
3a	Low flow DHW (DH 70°C flow)	3.0	0.5	70	55	0.02	Record value	0	60	n/a
3b	Low flow DHW (DH 60°C flow)	3.0	0.5	60	50	0.02	Record value	0	45	n/a
4a	Keep-warm (DH 70°C flow)	3.0	0.5	70	55	0	0	0	60	n/a
4b	Keep-warm (DH 60°C flow)	3.0	0.5	60	50	0	0	0	45	n/a
5a	DHW response time (DH 70°C flow)	3.0	0.5	70	55	0.13	Record value	0	60	n/a
5b	DHW response time (DH 60°C flow)	3.0	0.5	60	50	0.13	Record value	0	45	n/a

The cold water supply to the HIU on the test rig shall be 10 °C and at 1.5 bar for all tests.

Table 2. Reporting of test results. Extract from the Test Regime.

Test	Description	Reporting
Static tests		
0	Pressure test	Pass/Fail as to whether HIU manages pressure test without leaks or damage.
1a	Space Heating 1 kW, 60/40 °C secondary	t_{11}- primary flow temperature. t_{12}- primary return temperature. Plot of key metrics over duration of test. **Note:** Outputs readings used as input data to 'High Temperature' Space Heating Weighted Average Return Temperature calculation.
1b	Space Heating 2 kW, 60/40 °C secondary	
1c	Space Heating 4 kW, 60/40 °C secondary	
1d	Space Heating 1 kW, 45/35 °C secondary	t_{11}- primary flow temperature. t_{12}- primary return temperature. Plot of key metrics over duration of test. **Note:** Outputs readings used as input data to 'Low Temperature' Space Heating Weighted Average Return Temperature calculation.
1e	Space Heating 2 kW, 45/35 °C secondary	
1f	Space Heating 4 kW, 45/35 °C secondary	
Dynamic tests		
2a	DHW only, DH 70 °C flow, 55 °C DHW	Pass/Fail on DHW (at $\mathbf{t_{32}}$) exceeding 65.0°C (to 1 decimal point) for more than 10 consecutive seconds. State the maximum and minimum DHW temperatures over the period of the test when there is a DHW flow. Assessment of scaling risk as per criteria detailed in 2.26. Plot of key metrics over duration of test. **Note:** Outputs used as input data to 'High Temperature' Domestic Hot Water Volume Weighted Average Return Temperature calculation. Plot t_{32}, t_{31}, q_3, t_{12}, q_1
2b	DHW only, DH 60 °C flow, 50 °C DHW	State the maximum and minimum DHW temperatures over the period of the test when there is a DHW flow. Plot q_1, q_3, dP_1, dP_3 Plot of key metrics over duration of test. **Note:** Outputs used as input data to 'Low Temperature' Domestic Hot Water Volume Weighted Average Return Temperature calculation.
3a	Low flow DHW, DH 70°C flow; 55 °C DHW	Pass/Fail on DHW (at t_{32}) exceeding 65.0 °C (1 decimal place) for more than 10 consecutive seconds. Comment on ability to deliver DHW at low flow based on DHW temperature reaching at least 45.0 °C at the end of the 180 second period of low flow DHW. Comment on ability to deliver stable DHW flow temperature (at t_{32}), defined as ability to maintain 55.0 ± 3°C (1 decimal place) during the last 60 seconds of the test. Maximum temperature achieved and +/- °C variance around 55.0 °C (1 decimal place) to be stated. Assessment of scaling risk as per criteria detailed in 2.26. Plot of key metrics for 60 seconds of 0.13 l/s flow and the subsequent 180 seconds of 0.02 l/s DHW flow.
3b	Low flow DHW, DH 60°C flow; 50 °C DHW	Comment on ability to deliver DHW at low flow rate based on DHW temperature reaching at least 45° C (one decimal place) at the end of the 180 second period of low flow DHW. Comment on ability to deliver stable DHW flow temperature (at t_{32}), defined as ability to maintain 50.0 +/-3°C (1 decimal place) during the last 60 seconds of the test. Maximum temperature achieved and +/-°C variance around 55.0 °C (1 decimal place) to be stated. Plot of key metrics for 60 seconds of 0.13 l/s flow and the subsequent 180 seconds of 0.02 l/s DHW flow. Maximum temperature achieved and +/-° C variance around 50.0 °C (1 decimal place) to be stated.
4a	Keep-warm. DH 70°C flow; 55 °C DHW	Assessment of whether valid keep-warm operation, based on 5a response time criteria: Pass / Fail Plot temperature t_{10}.

Test	Description	Reporting
		Assessment of scaling risk, based on duration of temperatures in excess of 55.0°C (1 decimal place). Comment on HIU keep-warm controls options. Plot of key metrics over duration of test. State average heat load for the duration of the test. State average primary flow rate for the duration of the test. Note: Outputs used as input data to 'High Temperature' Keep-warm Volume Weighted Average Return Temperature calculation.
4b	Keep-warm, DH 60°C flow; 50°C DHW	Assessment of whether valid keep-warm operation, based on 5b response time criteria: Pass / Fail. Observation on the operation of the HIU during keep-warm. Assessment of scaling risk, based on duration of temperatures in excess of 55.0°C (one decimal place). Plot temperature t10. Comment on HIU keep-warm controls options. Plot of key metrics over duration of test. State average heat load for the duration of the test. State average primary flowrate for the duration of the test. Note: Outputs used as input data to 'Low Temperature' Keep-warm Volume Weighted Average Return Temperature calculation.
5a	DHW response time, DH 70°C flow; 55°C DHW	Pass/Fail on DHW (at t32) exceeding 65.0°C (1 decimal place) for more than 10 consecutive seconds. State time to achieve a DHW temperature 45.0 °C (1 decimal place) and not subsequently drop below 42.0oC (1 decimal place). Plot t_{32}, t_{31}, t_{12}, q_1 over duration of test.
5b	DHW response time, DH 60°C flow; 50°C DHW	State time to achieve a DHW temperature 45.0 °C (1 decimal place) and not subsequently drop below 42.0 °C (1 decimal place). Plot t_{32}, t_{31}, q_3, t_{12}, q_1 over duration of test.

7.1 Test 0: Pressure test

During the static pressure test 0, the tightness of the components on the primary side of the HIU has been checked. This has been performed by closing the primary return and pressurizing the primary flow to 14.3 bar (1.43 times the construction pressure) for 30 minutes.

No leakage or damage was detected during the static pressure test.

Test requirement: The HIU is to manage the pressure tests without leaks or damage.

Result: Pass.

7.2 Test 1a-1f: Space Heating 1-4 kW

For test points 1a-1f, a space heating load of 1-4 kW was simulated using a heat exchanger on the test rig. The HIU pump was deactivated and the space heating flow was adjusted in the test rig to deliver the required space heating load. The pressure in the space heating circuit was 1.5 bar for all tests.

While the HIU was delivering 4 kW of space heating, the space heating flow temperature t_{22} was adjusted on the HIU until it reached 60 ± 0.5 °C (for test points 1a-1c) or 45 ± 0.5 °C (for test points 1d-1f) as measured by the test rig. The space heating return temperature t_{21} was 40 °C for test points 1a-1c and 35 °C for test points 1d-1f. The primary flow temperature t_{11}

was 70 °C for test points 1a-1c and 60 °C for test points 1d-1f. The pressure in the space heating circuit was set to 1.5 bar.

Prior to performing the test points 1a-f, the test rig differential pressure control valve (DPCV) was adjusted to an average value of 0.5 ± 0.2 bar during 300 seconds while the HIU was delivering 4 kW of space heating at a flow temperature t_{22} of 45 ± 0.5 °C and a return temperature of 35 ± 0.5 °C. This setting was kept for all tests carried out in the High temp and Low temp test package.

For further details regarding the test setup, see Table 1.

During tests 1a-1c, the setpoint for space heating supply temperature t_{22} on the HIU controller was set to 5.9.

During tests 1d-1f, the setpoint for space heating supply temperature t_{22} on the HIU controller was set to 3.0

The results for test points 1a-1f are presented in Table 3 as averages of 300 data points. The measurement uncertainty has been estimated to be better than the values in Table 4. The results are also presented in Figure 3 to Figure 8, appendix 2.

Table 3. Test results for test points 1a-1f.

Test point	Primary				Secondary				
	t_{11}	**t_{12}**	**q_1**	**P_1**	**t_{21}**	**t_{22}**	**q_2**	**Δp_2**	**P_2**
	[°C]	[°C]	[l/s]	[kW]	[°C]	[°C]	[l/s]	[kPa]	[kW]
1a	69.8	40.3	0.012	1.5	40.0	61.6	0.012	0.3	1.0
1b	69.9	40.9	0.019	2.2	40.0	60.3	0.025	0.8	2.1
1c	69.9	41.6	0.036	4.2	39.9	59.9	0.048	2.2	3.9
1d	60.2	34.9*	0.018	1.9	35.1	46.9	0.021	0.6	1.0
1e	60.2	35.2	0.022	2.3	35.0	45.9	0.048	2.2	2.1
1f	60.3	35.3	0.040	4.1	34.9	44.8	0.096	7.4	3.9

*) The primary return temperature t_{12} was measured to be lower than the space heating return temperature t_{21}, which is not practically possible if considering only the heat exchanger. The measurement result was due to heat losses and thereby temperature drop in the piping from the measuring point of t_{21} at the HIU inlet to the heat exchanger on the secondary side and from the outlet of the heat exchanger to the measuring point of t_{12} at the HIU primary side outlet.

Table 4. Measurement uncertainty for test points 1a-1f.

Test point	Primary				Secondary				
	t_{11}	**t_{12}**	**q_1**	**P_1**	**t_{21}**	**t_{22}**	**q_2**	**Δp_2**	**P_2**
	[°C]	[°C]	[l/s]	[kW]	[°C]	[°C]	[l/s]	[kPa]	[kW]
1a	±0.1	±0.1	±0.0002	±0.1	±0.1	±0.1	±0.0002	±1	±0.1
1b	±0.1	±0.1	±0.0003	±0.1	±0.1	±0.1	±0.0004	±1	±0.2
1c	±0.1	±0.1	±0.0005	±0.1	±0.1	±0.1	±0.0007	±1	±0.1
1d	±0.1	±0.1	±0.0002	±0.1	±0.1	±0.1	±0.0003	±1	±0.1
1e	±0.1	±0.1	±0.0003	±0.1	±0.1	±0.1	±0.0007	±1	±0.1
1f	±0.1	±0.1	±0.0006	±0.1	±0.1	±0.1	±0.0014	±1	±0.1

7.3 Test 2a: DHW only, DH 70 °C flow

In test point 2a, a dynamic test of DHW was performed according to DHW flow rates specified in the Test Regime. The primary flow temperature t_{11} was 70 °C. The DHW setpoint was adjusted while the HIU delivered 0.13 l/s of DHW until the DHW temperature t_{32} reached 55 ± 0.5 °C as measured by the test rig. The HIU DHW setpoint was 5.1 (TWB) and 53 °C (TTV) For further details regarding the test setup, see Table 1.

- The DHW temperature (t_{32}) did not exceed 65.0 °C during the test for more than 10 consecutive seconds.
- The maximum measured temperature in point t_{32} was 58.1 °C and the minimum measured temperature in point t_{32} was 50.7 °C.

Test requirement: The DHW flow temperature t_{32} is not to exceed 65 °C for more than 10 consecutive seconds.

Result: Pass.

The test results for test point 2a are presented in Figure 9, appendix 2.

7.4 Test 2b: DHW only, DH 60 °C flow

In test point 2b, a dynamic test of DHW was performed according to DHW flow rates specified in the Test Regime. The primary flow temperature t_{11} was 60 °C. The DHW setpoint was adjusted while the HIU delivered 0.13 l/s of DHW until the DHW temperature t_{32} reached 50 ± 0.5 °C as measured by the test rig. The HIU DHW setpoint was 50 °C . For further details regarding the test setup, see Table 1.

- The maximum measured temperature in point t_{32} was 52.8 °C and the minimum measured temperature in point t_{32} was 46.5 °C.

The test results for test point 2b are presented in Figure 10, appendix 2.

7.5 Test 3a: Low flow DHW, DH 70 °C flow

In test point 3a, a low DHW flow was tested. Domestic hot water was drawn at 0.13 l/s for 120 seconds, then immediately drawn at 0.02 l/s for 180 seconds. The primary flow temperature t_{11} was 70 °C and the domestic hot water setpoint was the same as in test point 2a. For further details regarding the test setup, see Table 1.

- The HIU met the requirement of not exceeding 65 °C for more than 10 consecutive seconds in accordance with the test method (maximum temperature reached was 59.2 °C).

Result: Pass

The results for test point 3a are presented in Figure 11, appendix 2.

7.6 Test 3b: Low flow DHW, DH 60 °C flow

In test point 3b, a low DHW flow of 0.02 l/s was tested. Domestic hot water was drawn at 0.13 l/s for 120 seconds, then immediately drawn at 0.02 l/s for 180 seconds. The primary flow temperature t_{11} was 60 °C and the domestic hot water setpoint was the same as in test point 2b. For further details regarding the test setup, see Table 1.

- The unit delivered stable DHW temperature, maintaining the DHW output temperature at 50 ± 3 °C during the last 60 seconds of the test.
- The maximum and minimum DHW outlet temperatures were 52.1 °C and 51.9 °C respectively.

The results for test point 3b are presented in Figure 12, appendix 2.

7.7 Test 4a: Keep-warm, DH 70 °C flow

In test point 4a, the standby characteristics of the HIU were tested. A DHW flow of 0.13 l/s was drawn until stable conditions were reached and was then turned off. Data was then collected for 8 hours. For further details regarding the test setup, see Table 1.

The standby performance of the HIU is dependent on the standby control method used. The HIU keep warm (bypass) temperature could on the test object be adjusted independently of the DHW temperature. The keep warm temperature is measured and controlled by the district heating supply temperature sensor in the unit. In the On mode, the keep warm function is set to continuously maintain the set keep warm temperature. In the Off mode, the keep warm function is disabled.

During the tests the HIU keep-warm was set in the on mode.

If the difference between the maximum and minimum primary flow temperature t_{11} is higher than 6 °C during the final 3 hours of the test, the HIU is considered to perform keep-warm cycling.

- The temperature difference between the maximum and minimum primary flow temperature t_{11} was 0.6 °C during the final 3 hours of the test and as such the HIU was not considered to perform keep-warm through cycling.
- The unit met the requirement of a keep warm function based on the response time reaching 45 °C in test 5a.
- During the 8 hours after turning off the domestic hot water flow, the average primary flow q_1 was 10.8 l/h
- The average heat load P_1 was 124 W

The results for test point 4a are presented in Figure 13, appendix 2.

7.8 Test 4b: Keep-warm, DH 60 °C flow

In test point 4b, the standby characteristics of the HIU were tested. A DHW flow of 0.13 l/s was drawn until stable conditions were reached and was then turned off. Data was then collected for 8 hours. For further details regarding the test setup, see Table 1.

The standby performance of the HIU is dependent on the standby control method used. For a description of the keep-warm settings, see Test 4a: Keep-warm, DH 70 °C flow.

If the difference between the maximum and minimum primary flow temperature t_{11} is higher than 6 °C during the final 3 hours of the test, the HIU is considered to perform keep-warm cycling.

- The temperature difference between the maximum and minimum primary flow temperature t_{11} was 0.4 °C during the final 3 hours of the test and as such the HIU was not considered to perform keep-warm through cycling.
- The unit met the requirement of a keep warm function based on the response time reaching 45 °C in test 5b.
- During the 8 hours after turning off the domestic hot water flow, the average primary flow q_1 was 16.0 l/h
- The average heat load P_1 was 92 W

The results for test point 4b are presented in Figure 14, appendix 2.

7.9 Test 5a: DHW response time, DH 70 °C flow

Immediately after test point 4a, test point 5a was carried out. A DHW flow of 0.13 l/s was drawn until conditions were stable. For further details regarding the test setup, see Table 1.

The DHW response time might be dependent on the HIU keep-warm settings. See Test 4a: Keep-warm, DH 70 °C flow.

- The DHW temperature (t_{32}) did not exceed 65 °C during the test.
- The DHW temperature (t_{32}) reached 45 °C 10 seconds after the DHW flow was started and did not drop below 42 °C thereafter.

Test requirement: the keep-warm facility is considered valid if the DHW temperature t_{32} reaches 45 °C within 15 seconds.
Test requirement: The DHW flow temperature t_{32} is not to exceed 65 °C for more than 10 consecutive seconds.

Result: Pass.

The results for test point 5a are presented in Figure 15, appendix 2.

7.10 Test 5b: DHW response time, DH 60 °C flow

Immediately after test point 4b, test point 5b was carried out. A DHW flow of 0.13 l/s was drawn until conditions were stable. For further details regarding the test setup, see Table 1.

The DHW response time might be dependent on the HIU keep-warm settings. See Test 4b: Keep-warm, DH 60 °C flow.

- The DHW temperature (t_{32}) reached 45 °C 11 seconds after the DHW flow was started and did not drop below 42 °C thereafter.

Test requirement: the keep-warm facility is considered valid if the DHW temperature t_{32} reaches 45 °C within 15 seconds.

The results for test point 5b are presented in Figure 16, appendix 2.

7.11 Overall scaling risk assessment

Table 5. Scaling assessment

	Test	
Test designation	2a	3a
Temperature t_{32} above 60 °C for more than 5 seconds	No	No
Temperature t_{12} exceeds 55 °C at any point of the test.	No	No
Test designation	4a	4b
Temperature t_{12} exceeds 50 °C at any point	No	No

RISE Research Institutes of Sweden AB
Energy and circular economy - Combustion and Aerosol Technology

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Appendices

1. Component data and documentation
2. Diagrams
3. VWART Calculations

Appendix 1. Component data and documentation

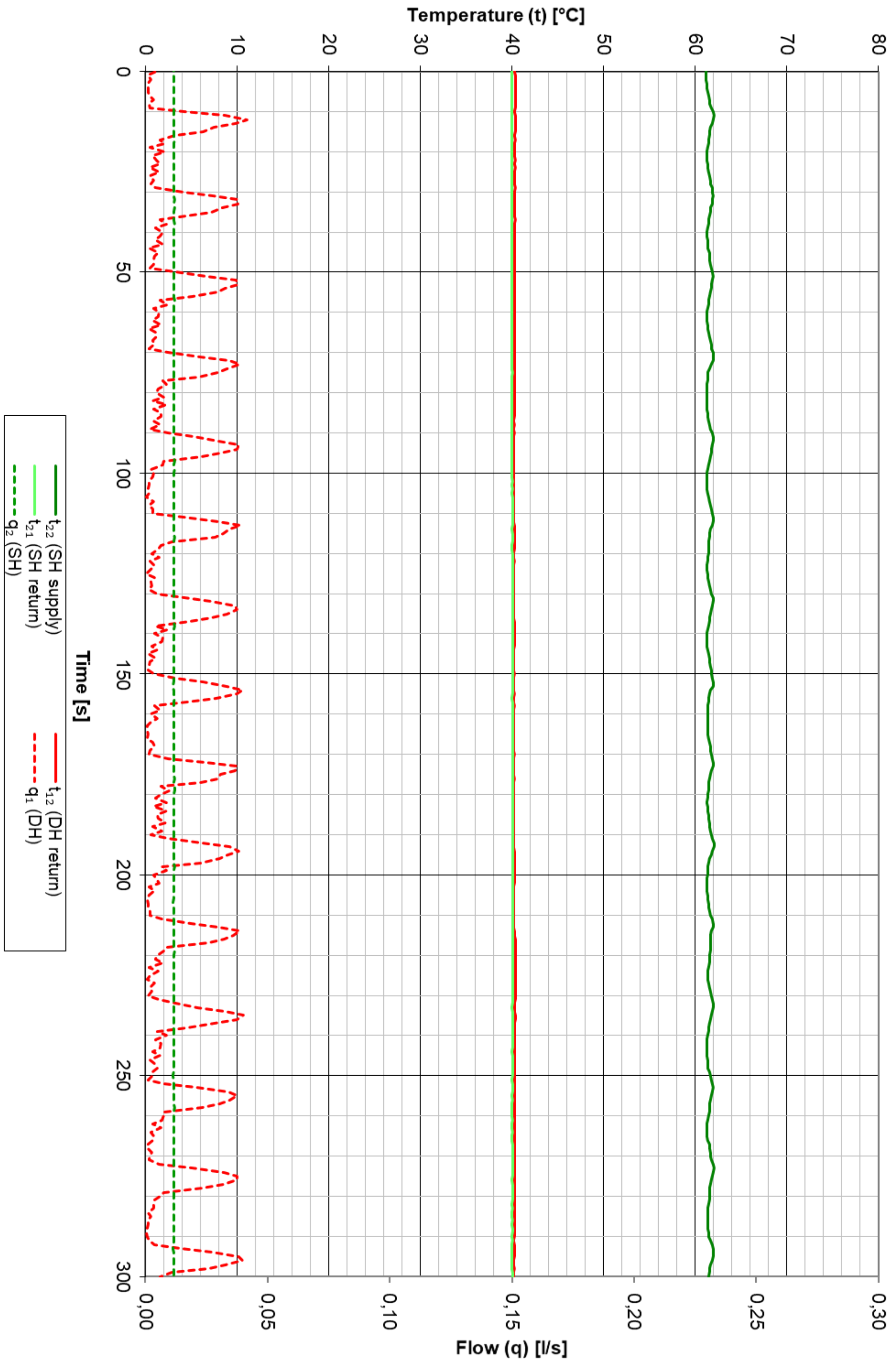
Component	Documentation submitted	Manufacturer and type
Space heating heat exchanger	Yes	Kelvion GKE 228H-24 (24 plates)
Domestic hot water heat exchanger	Yes	Kelvion GVH 228H-40 (40 plates)
Thermostat for space heating	Yes	Oventrop 35-70 °C, 1028052
Space heating strainer	Yes	Bruse Schmutzfänger, K29042223400000, mesh size 0.5mm
Control valve for domestic hot water	Yes	Oventrop valve 1026628 with insert 1021531
Thermostat for domestic hot water	Yes	Oventrop TWB 35-70 °C
Thermostat for control of the keep warm function TTV	Yes	Oventrop 1021726
Zone valve for space heating	Yes	Oventrop valve 1023321 with valve insert, 1021531
Temperature sensors	Yes	Part of thermostat for DHW and for SH
Domestic hot water isolating valve/check valve	Yes	Watts F1010 DN8
Primary side strainer	Yes	Bruse KG Sieb fur schmutzfänger
Drain valves	No	Hummel SFE-Hahn 101007
Vent valves	Yes	Arvit Drain plug 0126
Circulation pump	Yes	Wilo Yonos Para RS 15/6-RKAM
Heat meter	Yes	Sharky 774 Compact
PN valve, DHW	Yes	Delta Systemtechnik PM-Regler 3-Wege kpl. mit Sanitärteil, 1026794
Joints and connections	Yes	O-ring Eriks NBR 70 36624, brass fittings CuZn40Pb2
Gaskets	Yes	Gasket worth DN8 0886000070, OHA-Press DVGW, VP401
Pipes	Yes	Simplesta Systemrohr stainless steel DN15, piping Solar metal flex DN12
Differential pressure control valve	Yes	Frese PV Compact DN15, 1030392
Expansion vessel	Yes	Cimm RP238 8L, 1026564
Safety valves	Yes	Caleffi 531-5320 3 bar
Manometer	Yes	Afriso RF 40, D2010-10bar

Appendix 1

Documentation	Documentation submitted	Comment
Schematic diagram and drawing showing the structure and arrangement of the HIU with dimensions and weight	Yes	Uponor Combi Port Pro XU manual
Technical specification for electronic components including version of software	Yes	No electronic components included
Installation guide	Yes	Uponor Combi Port Pro XU manual
Commissioning guide	Yes	Uponor Combi Port Pro XU manual
Operation guide with a function description/description of operations and care instructions as suited to the intended user category	Yes	Uponor Combi Port Pro XU manual
Declaration of Conformity for CE-marked HIU:s	N/A	-
Full parameter list for electronically controlled HIU:s	Yes	Uponor Combi Port Pro XU manual
HIU marking	**Information present on HIU marking**	**Comment**
Model name and type number	Yes	Uponor Combi Port PRO XU
Serial number	Yes	D-10-0244263

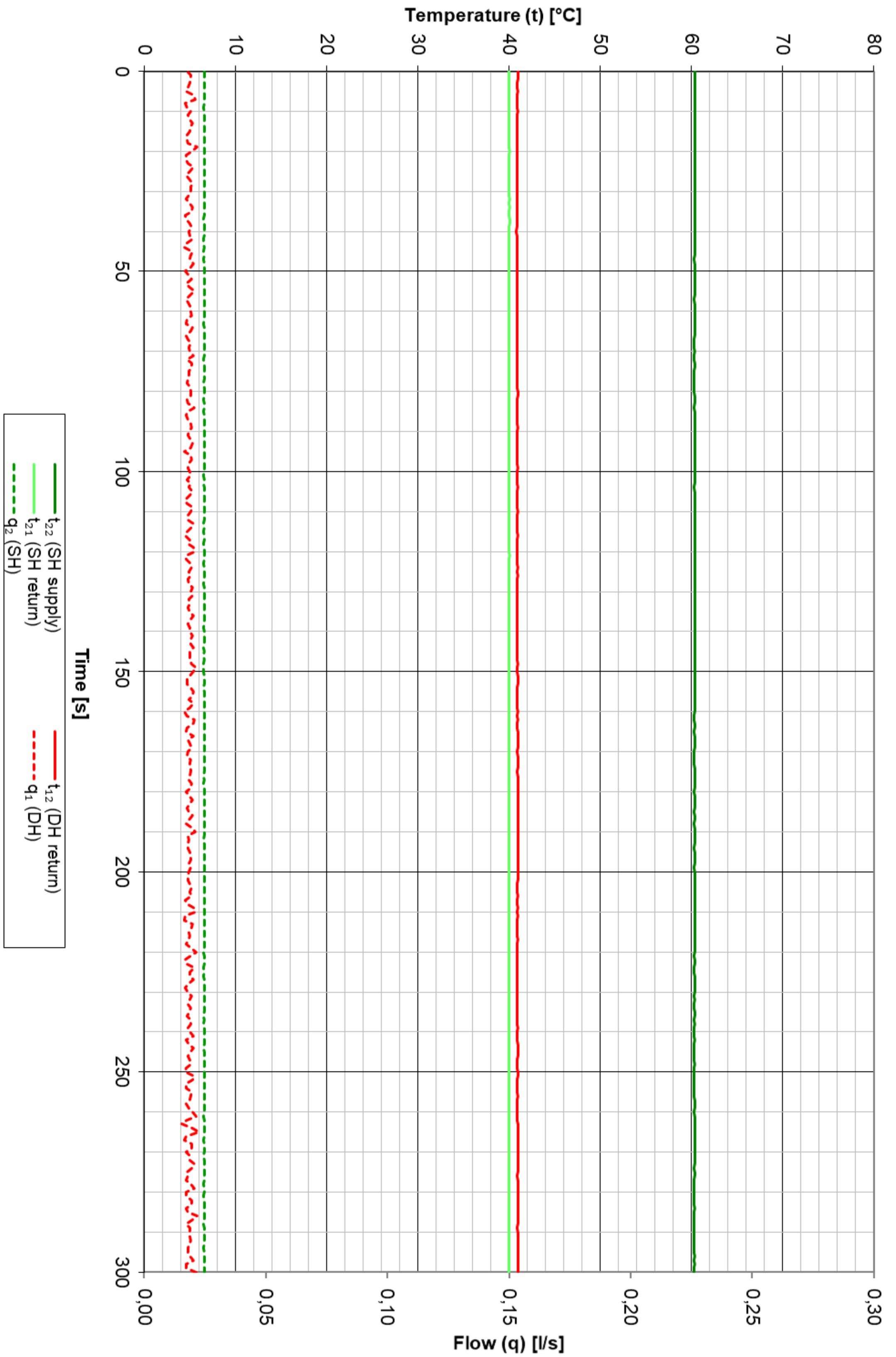
Appendix 2. Diagrams

Figure 3. Results for test point 1a: space heating 1 kW, DH 70 °C supply.



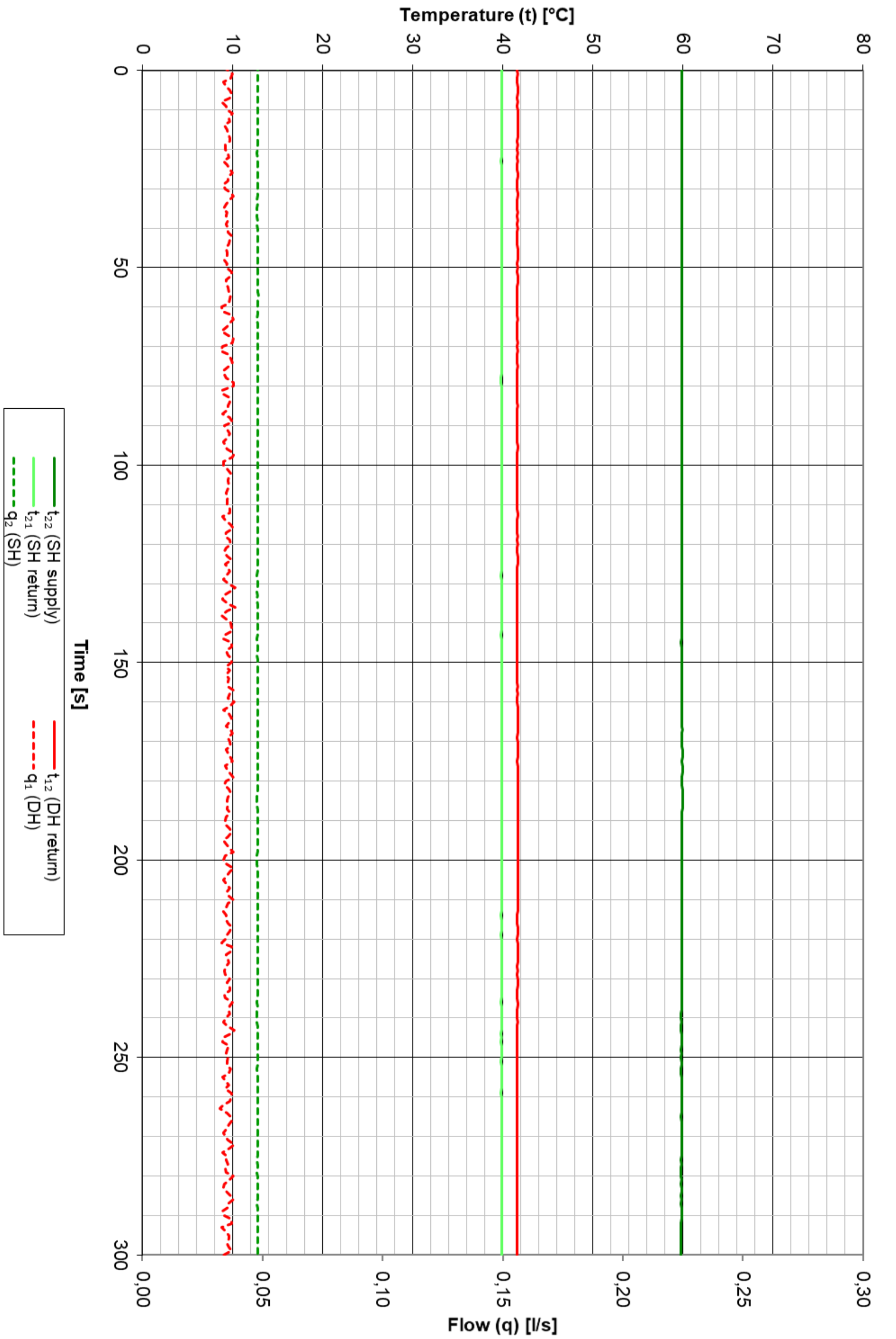
Appendix 2

Figure 4. Results for test point 1b: space heating 2 kW, DH 70 °C supply.



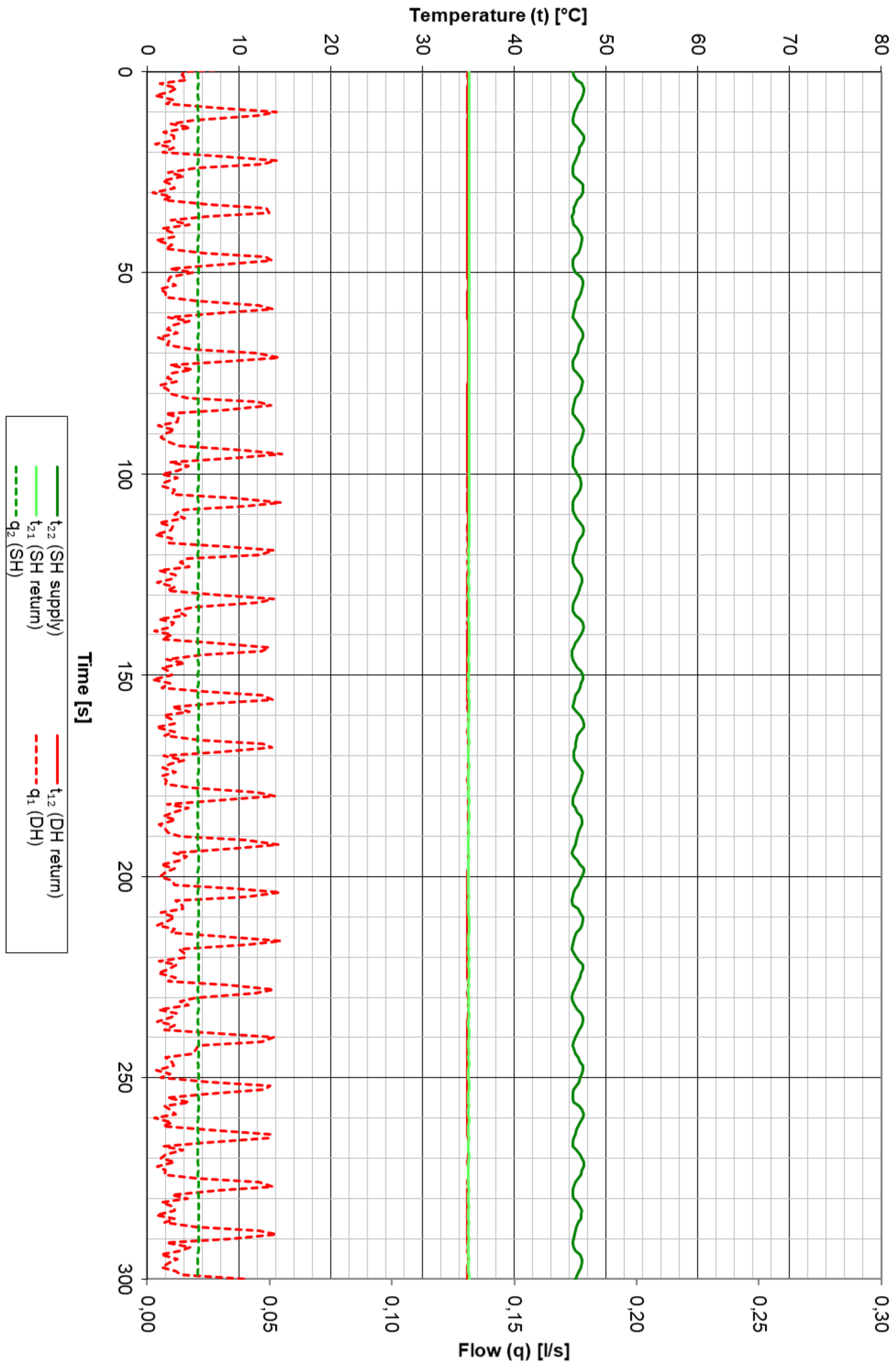
Appendix 2

Figure 5. Results for test point 1c: space heating 4 kW, DH 70 °C supply.



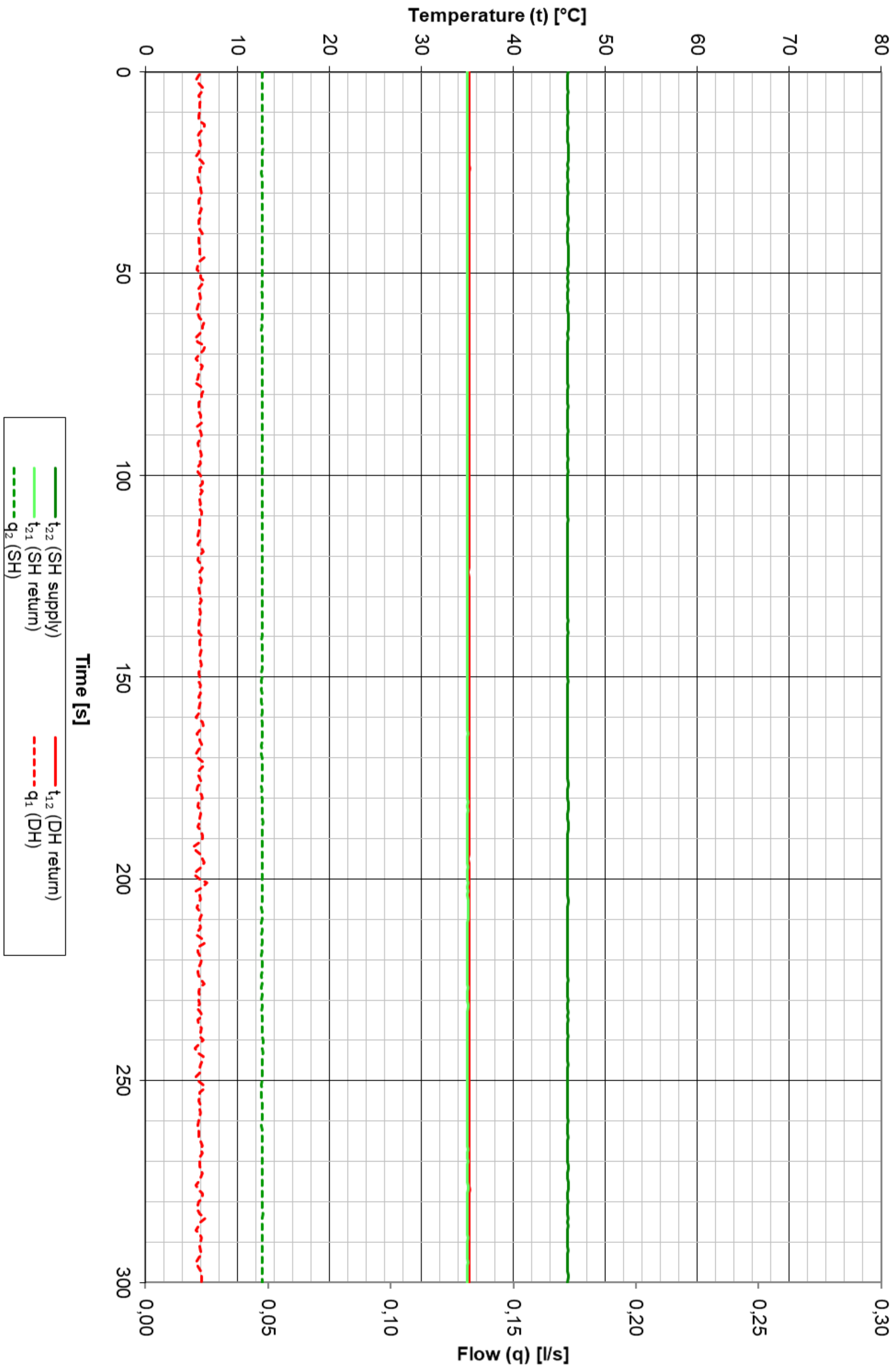
Appendix 2

Figure 6. Results for test point 1d: space heating 1 kW, DH 60 °C supply.



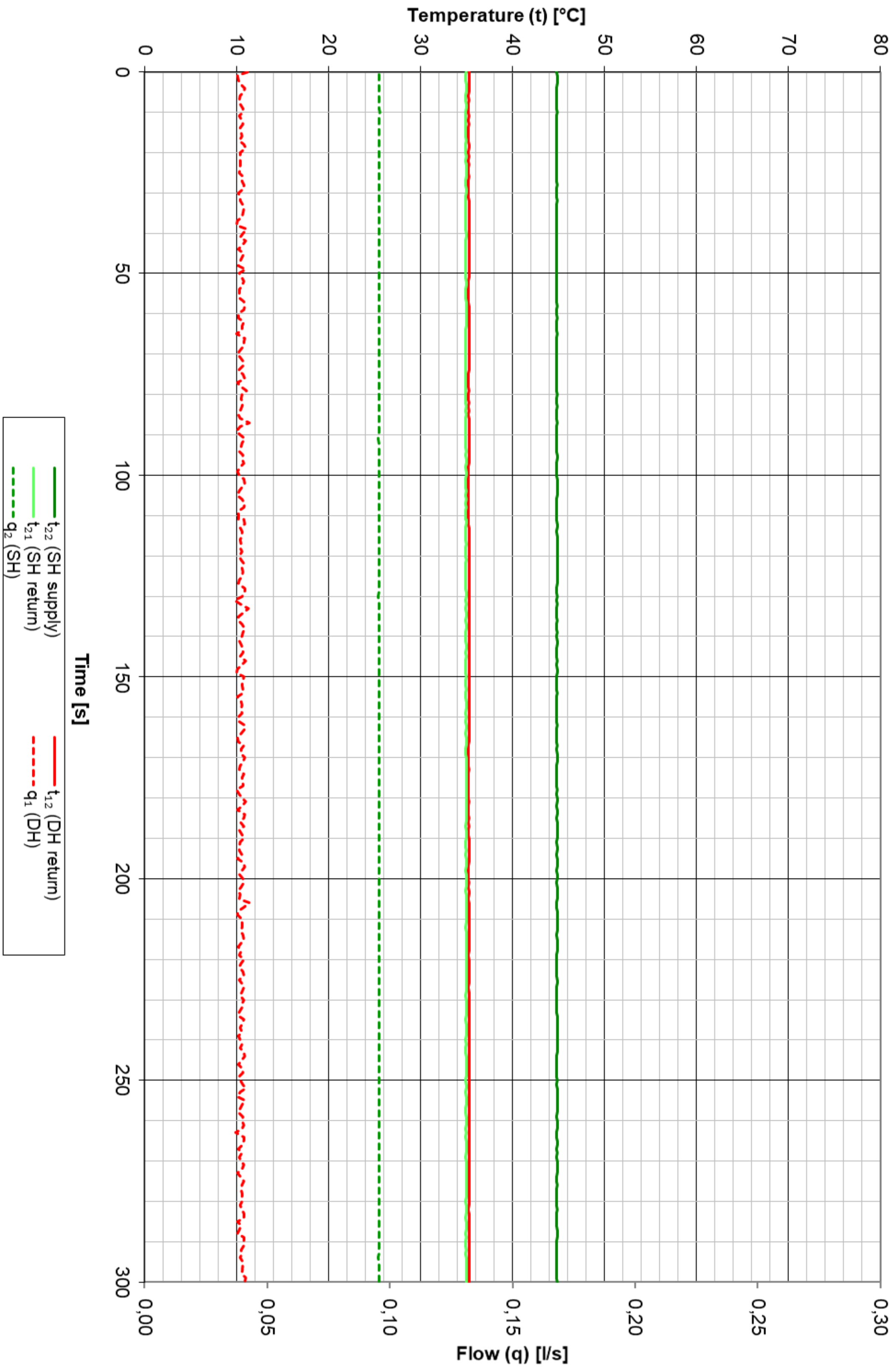
Appendix 2

Figure 7. Results for test point 1e: space heating 2 kW, DH 60 °C supply.



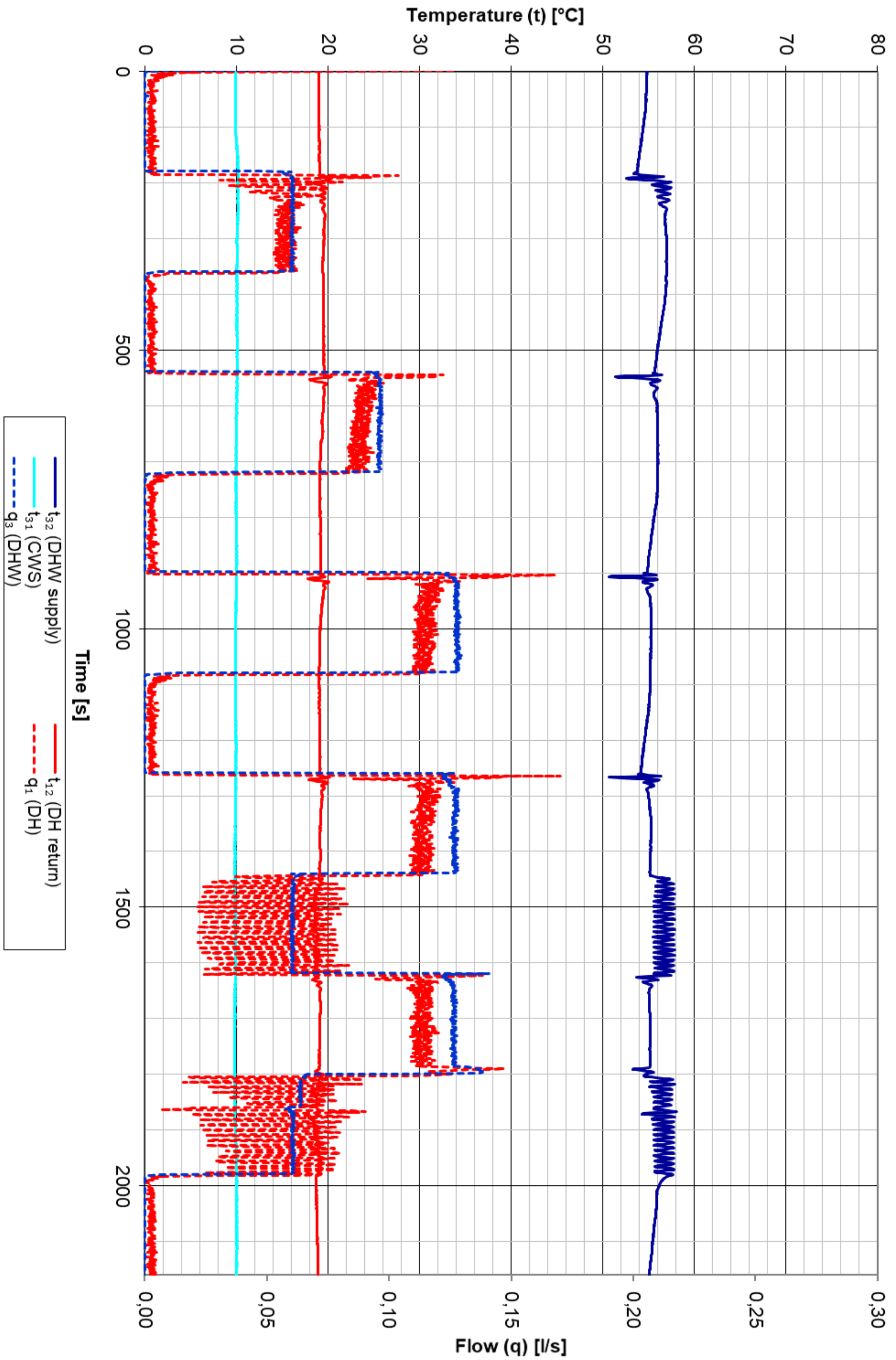
Appendix 2

Figure 8. Results for test point 1f: space heating 4 kW, DH 60 °C supply.



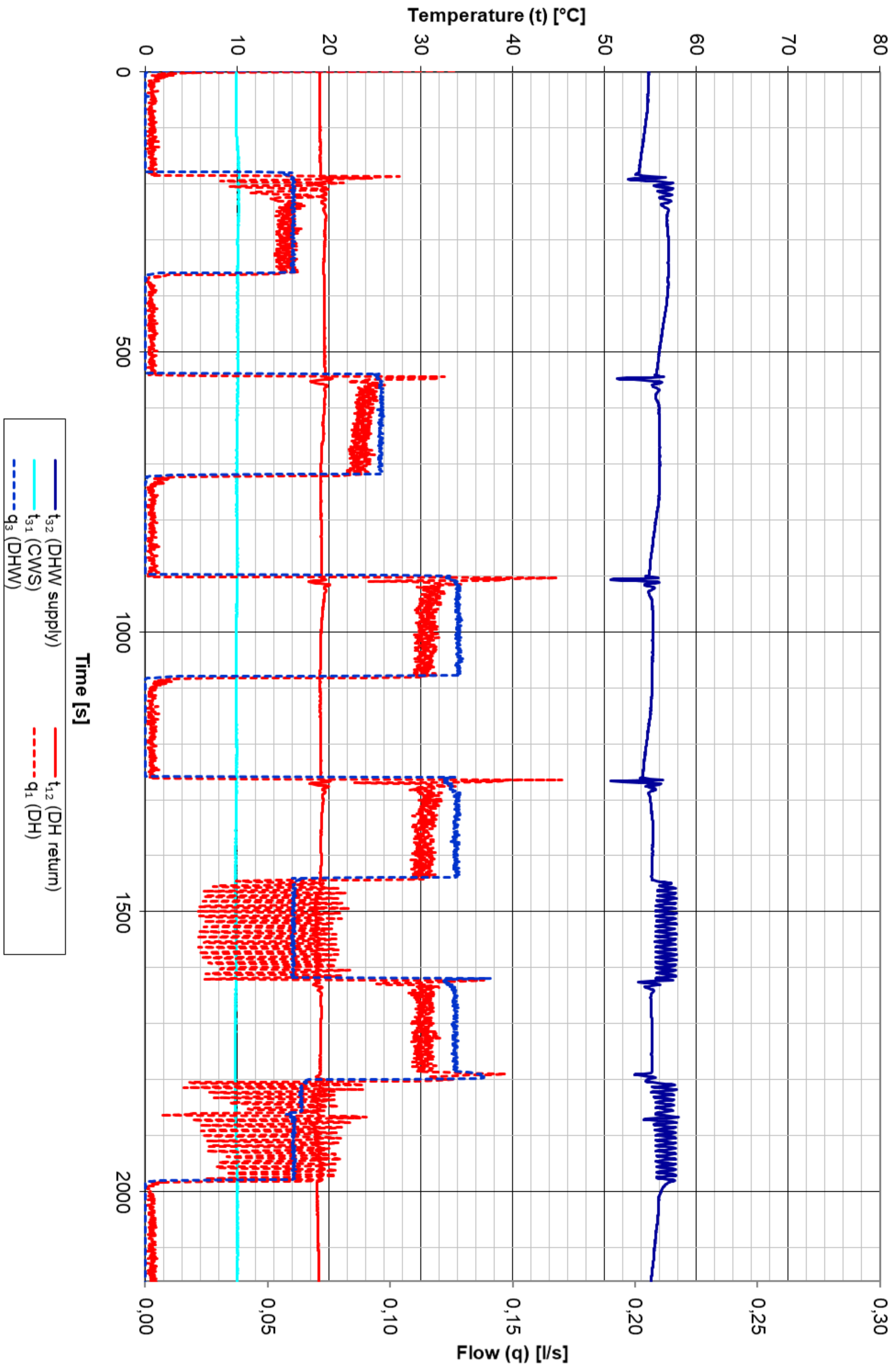
Appendix 2

Figure 9. Results for test point 2a: DHW only, DH 70 °C supply.



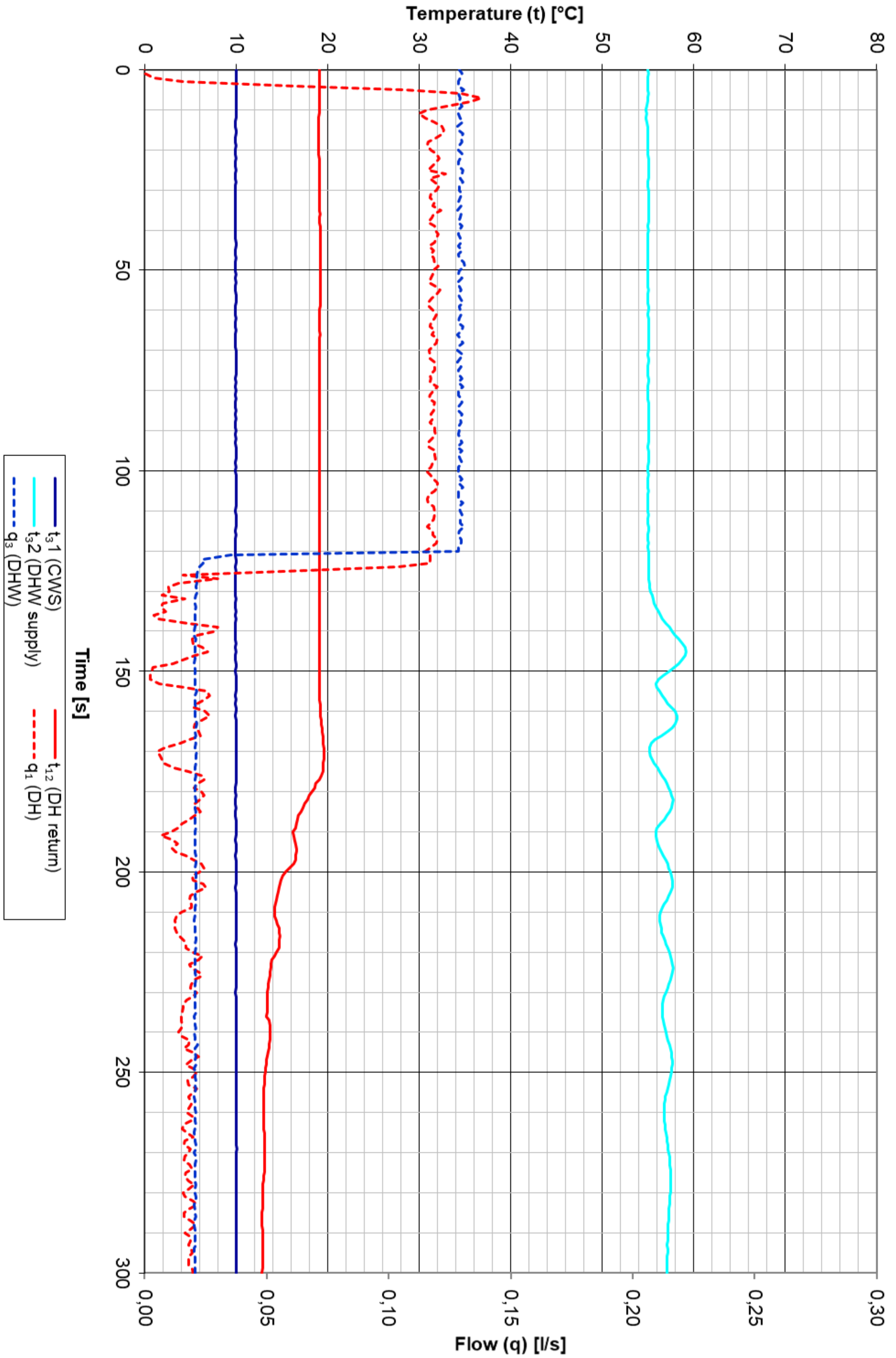
Appendix 2

Figure 10. Results for test point 2b: DHW only, DH 60 °C supply.



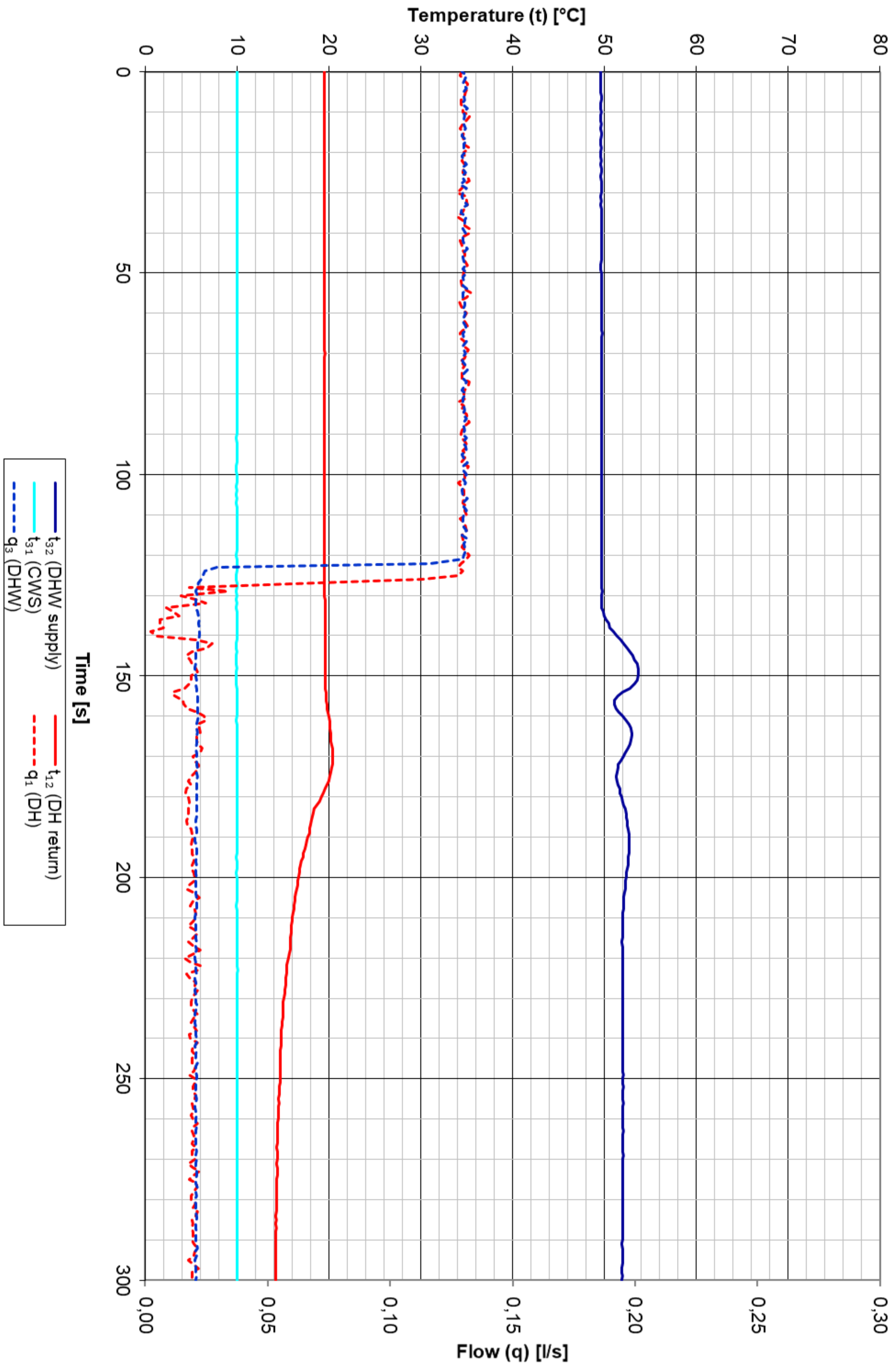
Appendix 2

Figure 11. Results for test point 3a: Low flow DHW at 0.02 l/s, DH 70 °C supply.



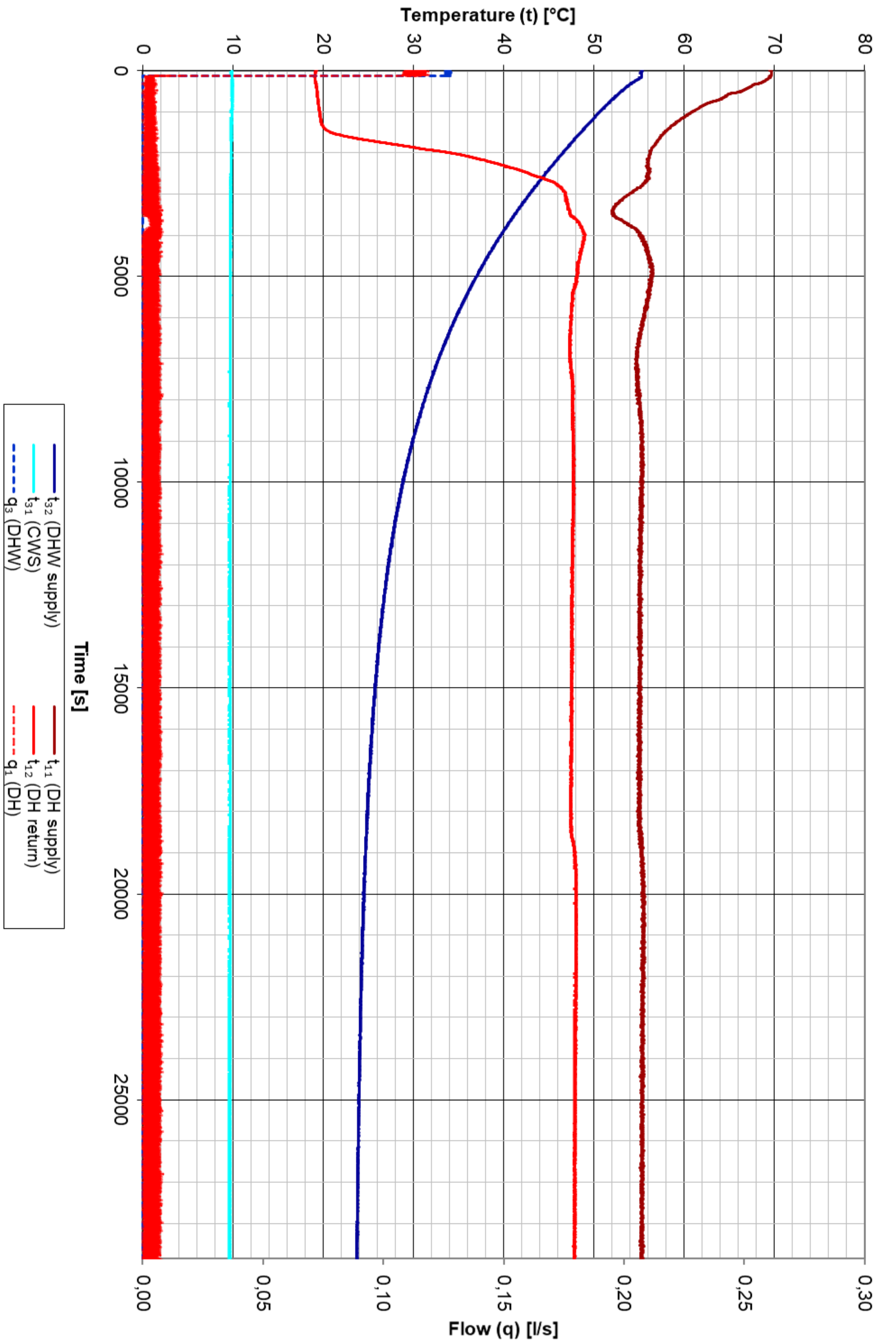
Appendix 2

Figure 12. Results for test point 3b: Low flow DHW, DH 60 °C supply.



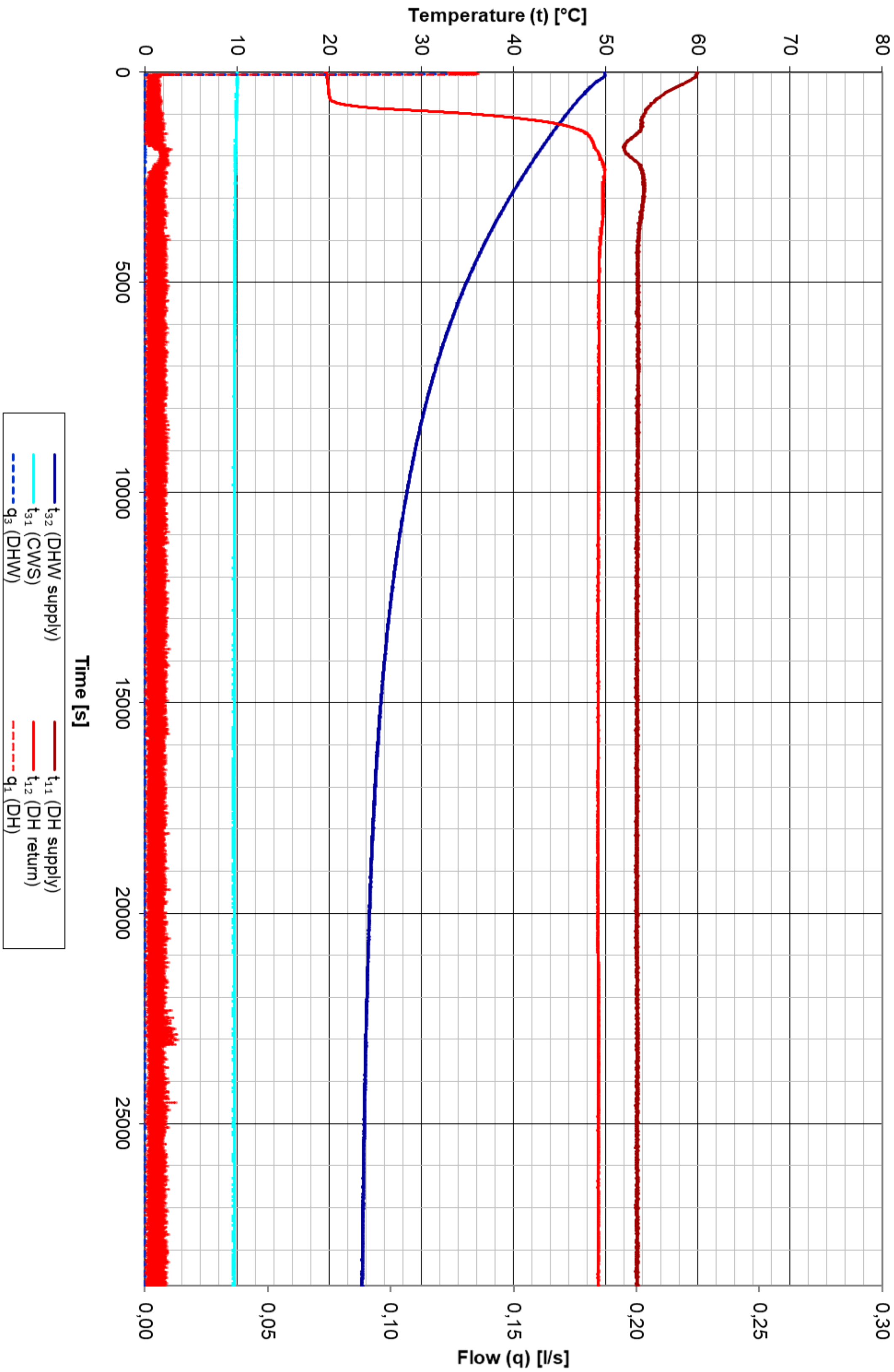
Appendix 2

Figure 13. Results for test point 4a: Keep-warm, DH 70 °C supply



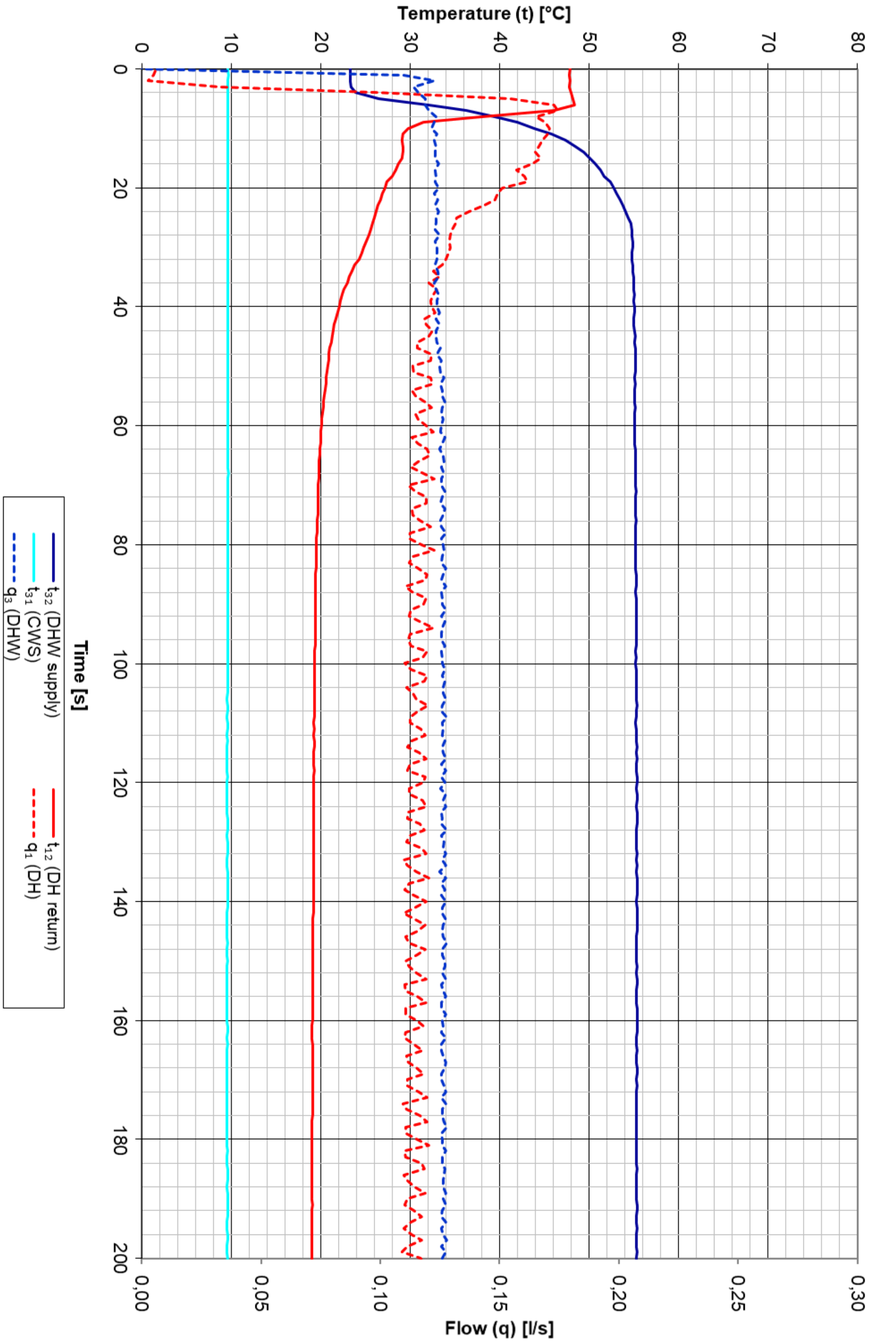
Appendix 2

Figure 14. Results for test point 4b: Keep-warm, DH 60 °C supply.



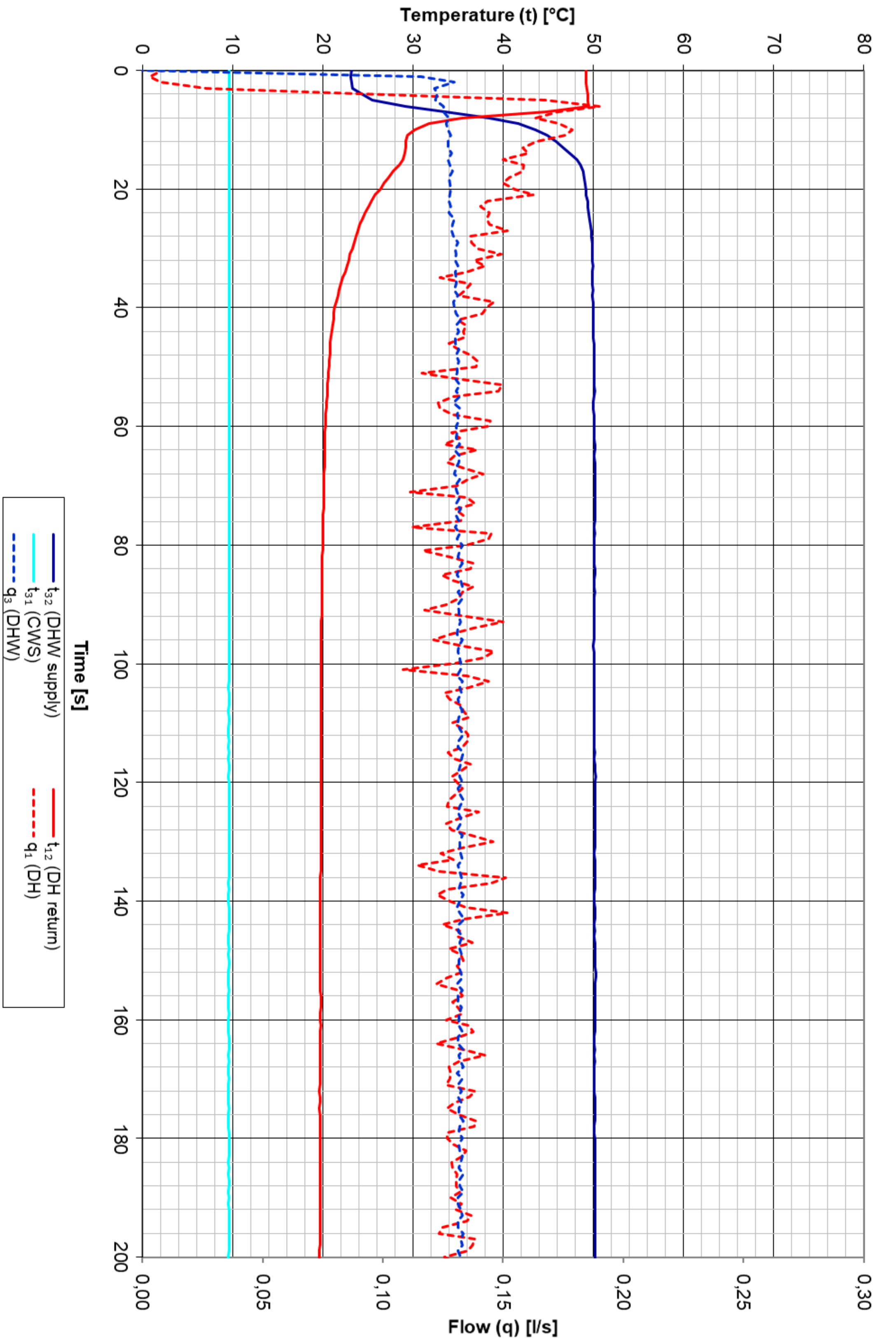
Appendix 2

Figure 15. Results for test point 5a: DHW response time, DH 70 °C supply.



Appendix 2

Figure 16. Results for test point 5b: DHW response time, DH 60 °C supply.



Appendix 3

Appendix 3. VWART calculations

High temperature VWART calculations with keep warm function active

High temperature VWART Calculation for Uponor with keep warm active

Test carried out by RISE in November 2019

Manufacturer: Uponor; Model: Combi Port PRO XU; Serial number: D-10_0244263; Year of manufacture: 2019

VWART calculation prepared by Henrik Persson of RISE on 06 December 2019

	VWART	Volume
DHW	19,4	26,69
Standby	45,9	88,43
Space Heating	41,0	16,54

Period	VWART	% Time
No Heating	39,7	93%
Heating	40,6	7%
Overall	**40**	

	DHW Draw test results			Post DHW Draw (60 seconds)	
	Power (W)	Primary flow (m3/hr)	Return Temp(°C)	Primary flow (m3/hr)	Avg Return Temp(°C)
Low	11394	0,199	19,5	0,009	19,5
Medium	17600	0,306	19,3	0,013	19,1
High	23408	0,402	19,2	0,020	19,1

DHW Draw Volumes per annum		
kWh	Hours	Volume pa (m3)
729	63,98	12,732
297	16,88	5,164
444	18,97	7,625

Post DWH Draw Volumes per annum		
Events	Average duration (secs)	Volume pa (m3)
10000	30	0,750
660	75	0,179
300	145	0,242

	Standy test results	
	Primary flow (m3/hr)	Return Temp(°C)
Standby	0,011	45,9

Standby Volumes pa	
Hours	Volume pa (m3)
8 039	88,43

	Space Heating test results		
	Power (W)	Primary flow (m3/hr)	Return Temp(°C)
1kWp	1026	0,043	40,3
2kWp	2058	0,019	40,9
4kWp	3938	0,036	41,6

Space Heating Volumes pa		
kWh pa	Hours	Volume pa (m3)
98	95,52	4,107
787	382,41	7,266
565	143,47	5,165

Low temperature VWART calculations with keep warm function active

Low temperature VWART Calculation for Uponor with keep warm active

Test carried out by RISE in November 2019

Manufacturer: Uponor; Model: Combi Port PRO XU ; Serial number: D-10-0244263; Year of manufacture: 2019

VWART calculation prepared by Henrik Persson of RISE on 06 December 2019

	VWART	Volume
DHW	20,2	34,19
Standby	48,3	128,68
Space Heating	35,2	56,16

Period	VWART	% Time
No Heating	42,4	93%
Heating	36,4	7%
Overall	**42**	

	DHW Draw test results			Post DHW Draw (60 seconds)	
	Power (W)	Primary flow (m3/hr)	Return Temp(°C)	Primary flow (m3/hr)	Avg Return Temp(°C)
Low	10283	0,227	20,5	0,020	20,4
Medium	16110	0,349	20,1	0,018	19,9
High	21202	0,453	19,8	0,022	19,6

DHW Draw Volumes per annum		
kWh	Hours	Volume pa (m3)
729	70,89	16,093
297	18,44	6,434
444	20,94	9,486

Post DWH Draw Volumes per annum		
Events	Average duration (secs)	Volume pa (m3)
10000	30	1,667
660	75	0,248
300	145	0,266

	Standy test results	
	Primary flow (m3/hr)	Return Temp(°C)
Standby	0,016	48,3

Standby Volumes pa	
Hours	Volume pa (m3)
8 043	128,68

	Space Heating test results		
	Power (W)	Primary flow (m3/hr)	Return Temp(°C)
1kWp	1025	0,066	34,9
2kWp	2144	0,080	35,2
4kWp	3916	0,142	35,2

Space Heating Volumes pa		
kWh pa	Hours	Volume pa (m3)
98	95,61	6,310
787	367,07	29,366
565	144,28	20,488