This test summary, downloaded from the BESA website, indicates that the HIU listed below has been tested against the criteria of the BESA HIU Test Regime.

BESA BUILDING ENGINEERING SERVICES ASSOCIATION

Model: MTA Plus

Serial Number: 220407

Year of manufacture: 2022

Test carried out by Enertek Int-S.Broxham On: 6/7/22 Reference: E4640

NOTE: The VWART accuracy is in the range +/-2°C	HIGH TEMP VWART °C	LOW TEMP VWART °C
DHW	13	13
Keep-warm	33	34
Space heating	40	34
Overall with keep warm	26	24

Pressure test		
No HIU damage	Pass	Pass

Dynamic DHW operation	2a	
DHW not exceed 65°C	Pass	Pass

Low flow test at BESA flow rate of 0.02l/s	3a	3b
DHW not exceed 65°C	Pass	Pass
DHW temperature at set point +/- 3°C	Fail	Fail

Low flow test at manufacturer declared flow rate	3c	3d
Declared minimum flow rate (l/sec)	0.032	0.032
Not exceed 65°C	Yes	n/a
DHW temperature at set point +/- 3°C	Yes	Yes

Keep-warm test	4a	4b
Standby heat consumption - average (Watts)	24	27
Standby electricity consumption - average (Watts)	2.04	2.02
Total HIU heat loss (DH + electrical input) (Watts)	26	29
Standby flow rate (the average flow rate) (l/hr)	4.3	3.1

DHW Response time test	5a	5b
DHW response time (Seconds)	15	15
Peak electrical heat during test (Watts)		
Output		
DHW temperature not exceed 65°C for more than 10 secs	Pass	Pass
DHW reaches 45°C with 15 secs	Pass	Pass

Scaling risk assessment as defined in 2.26	If any of the factors below occur then the risk of scaling of the DHW PHE in hard water areas increases		
HIU has a TMV or TRV on the DHW	No		
Test	2a	3a	3c
t32 above 60°C for more than 5 secs	No	No	No
t12 exceeds 55°C at any point of the test	No	No	No
Test	4a		4b
t12 exceeds 50°C at any time	No		No

Photo of HIU being tested with the cover off.

Photo of HIU being tested with the cover on.

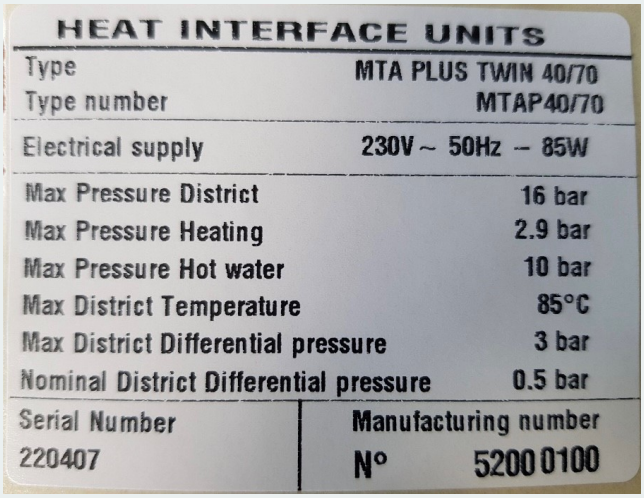

Photo of Manufacturers label and serial number.

COMPONENT DATA AND DOCUMENTATION

Component and Part No.	Manufacturer and Type	Documents submitted
Space Heating Heat Exchanger	SWEP E8LAS	Yes
DHW Heat Exchanger	SWEP E8LAS	Yes
Controller for space heating and DHW	Vergne Innovation electronic board 121090-0416 2.0	Yes
Control valve and actuator for Space heating	Vergne innovation NMB Stepper motor	Yes
space heating strainer	N/A	n/a
Control valve and actuator for hot water heating	Vergne innovation NMB stepper motor	Yes
Temperature sensors	Tasseron NTC TSD00E5	Yes
DHW Isolating valve	LA B&G di Bardini Enrico & C.s.r.l Brass ball	Yes
Primary side strainer	Stainless steel mesh 316L 0.8mm	Yes
Drain valves	Brass with EP856 O-Ring	Yes
Vent valves	Kramer GE10/P Automatic air vent	Yes
Circulation pump	Wilo para MS/8-75 PWM1	Yes
Heat meter	Itron Ultramaxx	Yes
DHW Flow sensor	Huba Type 201.910121 paddle switch	Yes
Pipes	Brass	Yes
Connections	Brass	Yes
Joints	N/A	Yes
Gaskets	EP856	Yes
O Rings	EP856	Yes
Pressure sensor	Vergne Innovation proportional DC Signal sensor	Yes
Expansion vessel	CIMM RP250 10L	Yes
Insulation	PLASTYROBEL - Expanded polystyrene	Yes
		Yes
		Yes
		Yes
		Yes
		Yes

Schematic diagram and drawing showing the structure and arrangement of the HIU with dimensions and weight	Installation Guide	Yes
Technical specification for electronic components including version of software	Installation Guide	Yes
Installation guide		Yes
Commissioning guide		Yes
Operation guide with a function description/ description of operations and care instructions as suited to the intended user category		Yes
Declaration of Conformity for CE-marked HIUs		Yes
Full parameter list for electronically controlled HIUs		Yes

HIU Marking	Comment	Info present
Model name and type no.	MTA PLUS- MTAP	Yes
Serial no.	220407	Yes

HIU MANUFACTURERS' DECLARED INFORMATION (TO BE COMPLETED BY THE MANUFACTURER)

HIU Model	MTA PLUS
Part No.	52000100
Software version	
Test Date:	06/06/2022
Test No.	

DIMENSIONAL INFORMATION	
Dimensions with casing (HxDxW) (mm)	600x312x500
Primary connections top/bottom	Bottom
Secondary HTG connections top/bottom	Bottom
Secondary BCW/DHW connections top/bottom	Bottom
Connection sizes Prim/Sec DHW/Sec HTG (mm)	18/22/22
Empty weight kg** (Kg)	28
Operating weight kg** (Kg)	32

ELECTRICAL INFORMATION	
Power supply (230V 1 phase)	**230V 1~**
Maximum power (Watts)	85
Standby power demand (Watts)	5

HYDRAULIC INFORMATION	
Maximum primary pressure (Bar g)	16
Maximum primary temperature (°C)	85
Primary water volume (l)	2
Maximum secondary DHW pressure (Bar g)	10
Maximum secondary DHW temperature (°C)	60
Secondary DHW water volume (l)	1
Maximum secondary HTG pressure (Bar g)	2.9
Maximum secondary HTG temperature (°C)	80
Primary operating DP range min/max (kPa)	10-100

DECLARED MAXIMUM PERFORMANCE LT TEST CONDITIONS	
DHW	
Maximum DHW production at 70°C (kW)	59.49 (50kPa dp)
Primary flow temperature (°C)	**70**
Primary return temperature (°C)	15.20
Primary flow (m3/h)	0.957
Primary △P* (kPa)	50
Secondary in/out temperature (°C)	**10/55**
Secondary △P (bar)	0.461
HTG	
Maximum HTG production (kW)	23.32 (50kPa dp)
Primary flow temprature (°C)	**70**
Primary return temperature (°C)	41.68
Primary △P* (bar)	0.5
Secondary in/out temperature (°C)	**40/60**
Secondary available DP at the output of HIU	50kPa

DECLARED MAXIMUM PERFORMANCE LT TEST CONDITIONS	
DHW	
Maximum DHW production at 60°C (kW)	47.89 (50kPa dp)
Primary flow temperature (°C)	**60**
Primary return temperature (°C)	16.10
Primary flow (m^3/h)	0.957
Primary △P* (kPa)	50
Secondary in/out temprature (°C)	**10/50**
Secondary △P (bar)	0.379
HTG	
Maximum HTG production (kW)	11.66
Primary flow temprature (°C)	**60**
Primary return temperature (°C)	35.10
Primary △P* (bar)	0.5
Secondary in/out temperature (°C)	**35/45**
Secondary avialable DP at the output of the HIU (kPa)	50kPa
HIU P&ID supplied by manufacturer with a legend for the components	Yes

*DP pressure not to include HM. Designers must add HM pressure drop.
** Including HIU, casing and wall hung bracket

The information included in this page is for the specific model of HIU detailed in this test report. It is additional information voluntarily provided by the manufacturer who is solely accountable for the details sumbmitted.

MANUFACTURERS' DECLARATION

This is to confirm that the information supplied by relates to the specific HIU tested and is an accurate representation of the product listed on the BESA HIU Register.

Signed Ian Bradley Position Managing Director Company Modutherm Limited

COMMENTS/HISTORY

Enertek International

International Consultants in Product
Research, Design, Development
& Certification

BESA HIU TEST REPORT

MTA Plus

Client: Modutherm

Project Number: E4640 Report Issue: 2

08 June 2022

Prepared By:

Simon Broxham – Principal Engineer

Approved By:

Josh Welburn – Project Engineering Manager

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1 BRIEF

1.1.1 Enertek international Limited (EIL), were contracted to receive, install, and commission a production sample, of the Modutherm MTA Plus.

1.1.2 To carry out the work involved to evaluate the performance of Domestic Hot Water (DHW) and Space Heating (SH) in accordance with the BESA UK HIU Test regime Technical Specification, Rev-009 October 2018, a publicly available online test regime. This is here-on referred to as the Test Regime throughout this document.

1.1.3 To provide a report detailing the tests carried out and generated results in accordance with the Test Regime criteria, including calculations for Volume Weighted Average Return Temperatures (VWART).

2 DEFINITIONS

2.1.1 The following definitions and abbreviations which have been used within this report can be found in table 2.1 below.

Table 2.1 – Definitions and Abbreviations

Symbol	Description	Unit
P_1	Power, Primary Side	kW
P_2	Power, Space Heating Side	kW
P_3	Power, Domestic Hot Water	kW
t_{11}	Temperature, Primary Side Supply Connection	°C
t_{12}	Temperature, Primary Side Return Connection	°C
t_{21}	Temperature, Space Heating Side Return Connection	°C
t_{22}	Temperature, Space Heating System Supply Connection	°C
t_{31}	Temperature, Cold Water Supply	°C
t_{32}	Temperature, Domestic Hot Water Output from HIU	°C
q_1	Volume Flow, Primary Side	L/s
q_2	Volume Flow, Space Heating Side	L/s
q_3	Volume Flow, Domestic Hot Water	L/s
Δp_1	Primary Pressure Drop Across Entire HIU Unit	kPa
Δp_2	Pressure Drop, Space Heating System Across HIU	kPa
Δp_3	Pressure Drop, Domestic Hot Water Across HIU	kPa
$VWART_{DHW}$	DHW Volume Weighted Return Temperature	°C
$VWART_{SH}$	Space Heating Volume Weighted Return Temperature	°C
$VWART_{KWH}$	Keep Warm Volume Weighted Return Temperature	°C
$VWART_{HEAT}$	Annual Volume Weighted Return Temperature for Heating Period	°C
$VWART_{NONHEAT}$	Annual Volume Weighed Return Temperature for Non-Heating	°C
$VWART_{HIU}$	Total Annual Volume Weighted Return Temperature	°C
DHW	Domestic Hot Water	–
HIU	Heat Interface Unit	–
SH	Space Heating	–
TMV	Thermostatic Mixing Valve	–
EIL	Enertek International Limited	-

3 TEST OBJECT

3.1 Appliance Details

3.1.1 Details of the HIU MTA Plus appliance are given in Table 3.1. Photograph of the installed appliance is given in Figure 8.2.

Table 3.1 – Appliance Details

Item	Description
Manufacturer	Modutherm
Model	MTA Plus
Serial Number	220407
Year of Manufacture	2021
DHW Priority	Yes

3.2 Appliance Design Pressures

3.2.1 The maximum design pressures of the MTA Plus appliance for the primary side and the secondary side for both Space Heating and DHW are given in Table 3.2.

Table 3.2 – Appliance Design Pressures

Item	Value	Unit
Primary Side	16	Bar
Secondary Side Space Heating	2.9	Bar
Secondary Side DHW	10	Bar

3.3 Appliance Design Temperatures

3.3.1 The maximum design temperatures of the MTA Plus appliance for the primary side and the secondary side for both Space Heating and DHW are given in Table 3.3

Table 3.3 – Appliance Design Temperatures

Item	Value	Unit
Primary Side	85	°C
Secondary Side Space Heating	80	°C
Secondary Side DHW	60	°C

4 TEST METHOD

4.1 Installation of Appliance

4.1.1 The appliance was installed and commissioned (as received) and as defined in the product literature provided. Testing was carried out without further adjustment other than disabling the internal space heating pump and adjusting the setting of the SH and DHW set points through the user interface on the HIU controller to suit the conditions of the HIU test rig. The HIU rig schematic is given in Figure 4.1.

4.2 Test Regime

4.2.1 The testing described in this report was carried out in accordance with the BESA test regime. The Test Regime outlines a series of static and dynamic tests to determine the performance of a HIU's DHW and SH functions. The Regime outlines the test method including the reporting of the results, the performance requirements and the VWART calculations.

4.2.2 The setup of the BESA tests is reproduced in Table 4.1. The basis of reporting the performance of the HIU from the BESA Test Regime is reproduced in Table 4.2.

4.2.3 The Test Regime specifies the testing of two different test temperature packages. The first is the high temperature package, with a district primary supply of 70 °C and the second is the 'low temperature' package, with a district primary supply temperature of 60 °C.

1.1.1 As the MTA Plus is suitable for both high and low temperature operation, both test packages were carried out and results recorded within this report.

4.3 Measurement & Uncertainties

4.3.1 All measurements and uncertainties adhere to the requirements stipulated in the BESA Test Regime. All measurements were sampled at a rate of 1 Hz for all tests.

4.3.2 The BESA uncertainties of measurement requirements are as follows: Differential Pressure, ± 1 kPa; Temperature, ± 0.1 °C; Volume Flow, ± 1.5 %. Note: the time constant for the temperature sensors is less than 1.5 s.

4.3.3 EIL's reported uncertainty is based on a standard uncertainty by a coverage factor K=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements. The EIL equipment list and uncertainties are given in Table 8.2, Appendix B.

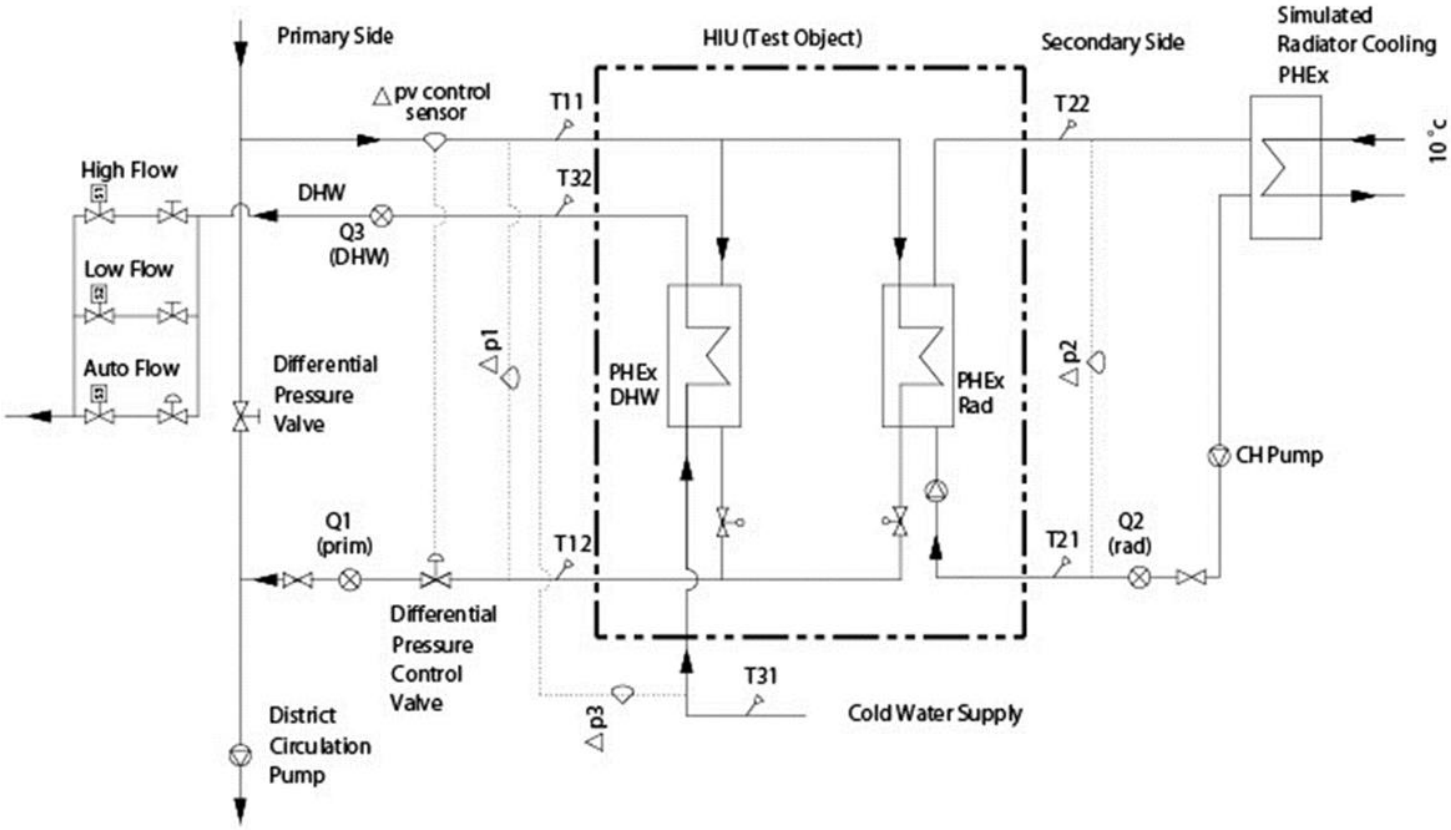

Figure 4.1 – EIL's HIU Test Rig Schematic

Table 4.1 – Setup of Tests (Based on BESA Test Regime, Table 1: Test Schedule)

		District Circuit			***Domestic Hot Water***			***Space Heating***		
		Static Pressure	Differential Pressure	Flow Temperature	Temperature Set Point	Flow Rate	Heat Load	Flow Temperature	Return Temperature	Heat Load
Symbol		*[p_1]*	*[Δp_1]*	*[t_{11}]*	*[t_{32}]*	*[q_3]*	*[P_3]*	*[t_{22}]*	*[t_{21}]*	*[P_2]*
Units		*[kPa]*	*[kPa]*	*[°C]*	*[°C]*	*[Ls^{-1}]*	*[kW]*	*[°C]*	*[°C]*	*[kW]*
Static Tests										
0a	District Pressure Test	1.43 X Claimed Value	-	-	-	-	-	-	-	-
1a	1kW Space Heating	3.0	0.5	70	-	-	-	60	40	1
1b	2kW Space Heating	3.0	0.5	70	-	-	-	60	40	2
1c	4kW Space Heating	3.0	0.5	70	-	-	-	60	40	4
1d	1kW Space Heating	3.0	0.5	60	-	-	-	45	35	1
1e	2kW Space Heating	3.0	0.5	60	-	-	-	45	35	2
1f	4kW Space Heating	3.0	0.5	60	-	-	-	45	35	4
Dynamic Tests										
2a	Dynamic Tapping	3.0	0.5	70	55	See Test Profile	See Test Profile	-	-	-
2b	Dynamic Tapping	3.0	0.5	60	50			-	-	-
3a	Low Flow	3.0	0.5	70	55	0.02	Record Value	-	-	-
3b	Low Flow	3.0	0.5	60	50	0.02	Record Value	-	-	-
4a	Keep-Warm	3.0	0.5	70	55	0.00	0	-	-	-
4b	Keep-Warm	3.0	0.5	60	50	0.00	0	-	-	-
5a	DHW Response	3.0	0.5	70	55	0.13	Record Value	-	-	-
5b	DHW Response	3.0	0.5	60	50	0.13	Record Value	-	-	-

Table 4.2 – Test Reporting, (Adapted from BESA Test Regime, Table 5)

Test Designation		Reporting
0	District 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 used as input data to 'High Temperature' Space Heating Volume 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 ° Secondary	t_{11} – Primary flow temperature. t_{12} – Primary return temperature. Plot of key metrics over duration of test. **Note**: Outputs used as input data to 'Low Temperature' Space Heating Volume Weighted Average Return Temperature calculation.
1e	Space Heating 2 kW, 45/35 °C Secondary	
1f	Space Heating 4 kW, 45/35 °C Secondary	
2a	DHW only, DH 70 °C Flow, 55 °C DHW	Pass/Fail on DHW (at 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 the criteria detailed in 2.26. **Note:** Outputs used as input data to 'High Temperature' Space Heating 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. **Note:** Outputs used as input data to 'Low Temperature' Domestic Hot Water Volume Weighted Average Return Temperature calculation. Plot q_1, q_3, dp_1, dp_3
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 (1 decimal place) at the end of the 180 second period of low flow DHW. Comment on the ability to deliver stable DHW flow temperature (at t_{32}), defined as ability to maintain 55.0 +/- 3.0 °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. Assessment of scaling risk as per criteria detailed in 2.26.
3b	Low Flow DHW, DH 60 °C Flow, 50 °C DHW	Comment on the ability to deliver DHW at low flow rate based on DHW temperature reaching at least 45 °C (1 decimal place) at the end of the 180 second period of low flow DHW. Comment on the ability to deliver stable DHW flow temperature (at t_{32}), defined as ability to maintain 50.0 +/-3°C (1 decimal place) to be stated. Maximum temperature achieved and +/-°C variance around 50.0°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.

Test Designation		Reporting
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. Comment on HIU keep-warm controls options. Assessment of scaling risk based on duration of temperatures in excess of 55.0 °C (1 decimal place). State average heat load for the duration of the test. State the 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. Plot of key metrics over duration of test.
4b	Keep-Warm, DH 60 °C Flow, 50 °C DHW	Assessment of whether valid Keep-Warm operation, based on 5a response time criteria: Pass/Fail. Observation on the operation of the HIU during Keep-Warm. Comment on HIU Keep-Warm controls options. Assessment of scaling risk based on extent and duration of temperatures in excess of 55.0 °C (1 decimal place). State average heat load for the duration of the test. State the 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. Plot of key metrics over duration of test.
5a	DHW Response Time, 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. State time to achieve 45.0 °C (1 decimal place) and not subsequently drop below 42.0 °C (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). Comment on stability of DHW temperature. Plot t_{32}, t_{31}, t_{12}, q_1 over duration of test.

5 TEST RESULTS

5.1 Test 0 – Pressure Test

5.1.1 The appliance has passed the requirements of the static pressure test, Test 0 of the BESA Test Regime as:

5.1.2 There was No damage observed during the static pressure test, with the primary flow pressurised to 22.9 bar (1.43 times the rated value), and,

5.1.3 There were No leaks observed during the static pressure test, with the primary flow pressurised to 22.9 bar (1.43 times the rated value).

5.2 Test 1a to 1f – Space Heating 1-4 kW at 70 and 60°C

5.2.1 The plot of the key metrics of Tests 1a-1f for the space heating 1 - 4 kW at both 70 and 60 °C are displayed in Figure 7.1 to Figure 7.6 respectively. See Table 5.1 for summarised test results including the average primary return temperature, t_{12}.

Table 5.1 - Test Results for Space Heating Tests 1a to 1f

Test No & Description	Primary					Secondary				
	Flow Temperature $[t_{11}]$ [°C]	*Return Temperature* $[t_{12}]$ [°C]	*Flow Rate* $[q_1]$ $[Ls^{-1}]$	*Differential Pressure* $[\Delta p_1]$ [kPa]	*Heat Load* $[P_1]$ [W]	*Return Temperature* $[t_{21}]$ [°C]	*Flow Temperature* $[t_{22}]$ [°C]	*Flow Rate* $[q_2]$ $[Ls^{-}]$	*Differential Pressure* $[\Delta p_2]$ [kPa]	*Heat Load* $[P_2]$ [W]
1a - 1 kW Space Heating (DH 70 °C flow)	69.6	39.5	0.009	48.7	1152	39.9	59.9	0.012	4.3	1001
1b - 2 kW Space Heating (DH 70 °C flow)	70.0	39.3	0.017	50.4	2178	39.8	60.5	0.023	2.1	1969
1c - 4 kW Space Heating (DH 70 °C flow)	69.6	40.0	0.033	49.6	4089	40.2	60.5	0.046	2.6	3876
1d - Space Heating 1 kW (DH 60 °C flow)	59.9	34.0	0.011	50.6	1200	34.6	45.2	0.022	0.6	987
1e - Space Heating 2 kW (DH 60 °C flow)	59.8	34.0	0.021	50.4	2277	34.6	45.1	0.045	0.5	1956
1f - Space Heating 4 kW (DH 60 °C flow)	59.9	34.5	0.043	49.8	4603	35.1	45.5	0.097	3.4	4400

5.3 Test 2a – DHW Dynamic Tapping at 70 °C

5.3.1 The appliance has passed the requirements of the DHW only at 70 °C, Test 2a of the BESA Test Regime as:

5.3.2 The domestic hot water output temperature, t_{32} did not exceed 65 °C for more than 10 seconds.

5.3.3 The maximum and minimum temperatures of t_{32} were 57.8 °C and 46.6 °C respectively.

5.3.4 The plot of the key metrics of the duration of Test 2a is displayed in Figure 7.7, Appendix A.

5.4 Test 2b – DHW Dynamic Tapping at 60 °C

5.4.1 The maximum and minimum temperatures of t_{32} were 53.4 °C and 43.3 °C respectively.

5.4.2 The plot of the key metrics of the duration of Test 2b is displayed in Figure 7.8, Appendix A.

5.5 Test 3a & 3c – Low Flow DHW at 70 °C

5.5.1 The appliance has passed the requirements of the Low Flow at 70 °C, Test 3a of the BESA Test Regime as:

5.5.2 The domestic hot water output temperature, t_{32} did not exceed 65 °C for more than 10 seconds.

5.5.3 The appliance did not maintain the DHW output temperature, t_{32} at 55 ± 3 °C during the last 60 seconds of the test.

5.5.4 The maximum and minimum temperatures of t_{32} were 59.8 °C and 13.4 °C respectively.

5.5.5 As the appliance did not maintain a stable flow temperature at 1.2 l/min, the appliance was retested as test 3c at the manufacturers declared low flow rate which was 1.9 l/min.

5.5.6 At the manufacturers low flow rate of 1.9 l/min the appliance did maintain the DHW output temperature t_{32} at 55±3 °c during the last 60 seconds of the test.

5.5.7 The plot of the key metrics of the duration of Test 3a is displayed in Figure 7.9, Appendix A.

5.5.8 The plot of the key metrics of the duration of Test 3c is displayed in Figure 7.11, Appendix A.

5.6 Test 3b & 3d – Low Flow DHW at 60 °C

5.6.1 The appliance did not maintain stable flow temperatures during Low Flow at 60 °C, Test 3b of the BESA Test Regime.

5.6.2 The appliance was retested as test 3d at the manufacturers declared low flow rate which was 1.9 l/min, the appliance was then seen to maintain DHW output temperature t_{32} at 50°c during the last 60 seconds of the test. The maximum and minimum temperatures of t_{32} during test 3b were 53.36 °C and 13.28 °C respectively.

5.6.3 The plot of the key metrics of the duration of Test 3b is displayed in Figure 7.10, Appendix A.

5.6.4 Test 3d is displayed in Figure 7.12, Appendix A.

5.7 Test 4a – Keep-Warm at 70 °C

5.7.1 The appliance has passed the requirements of the Keep-Warm at 70 °C, Test 4a of the BESA Test Regime as:

5.7.2 This is a valid Keep-Warm operation based on 5a response time criteria, see 5.9.3.

5.7.3 The appliance is performing Keep-Warm cycling as the primary flow temperature, t_{11} varies by more than ± 3 °C during the final 3 hours of the test. Please see BESA HIU standard technical note TN-018 Version 1 for a more detailed definition of cyclical data.

5.7.4 The average heat load on the primary side P_1 is 24 W.

5.7.5 The average electrical consumption was 2.04 W.

5.7.6 The average primary flow q_1 over the 8 hours test was 4.3 l/hr.

5.7.7 The Keep-Warm control was set to on.

5.7.8 The plot of the key metrics of the duration of Test 4a is displayed in Figure 7.13, Appendix A.

5.8 Test 4b – Keep-Warm at 60 °C

5.8.1 The appliance has passed the requirements of the Keep-warm at 60 °C, Test 4b of the BESA Test Regime as:

5.8.2 This is a valid Keep-Warm operation based on 5b response time criteria, see 5.10.1.

5.8.3 The appliance is performing Keep-Warm cycling as the primary flow temperature, t_{11} varies by more than ± 3 °C during the final 3 hours of the test. Please see BESA HIU standard technical note TN-018 Version 1 for a more detailed definition of cyclical data.

5.8.4 The average heat load on the primary side P_1 is 27 W.

5.8.5 The average primary flow q_1 over the 8 hours test was 3.1 l/hr.

5.8.6 The average electrical consumption was 2.02 W.

5.8.7 The Keep-Warm control was set to on.

5.8.8 The plot of the key metrics of the duration of Test 4b is displayed in Figure 7.14, Appendix A.

5.9 Test 5a – DHW Response Time at 70 °C

5.9.1 The appliance has passed the requirements of DHW Response Time at 70 °C, Test 5a of the BESA Test Regime as:

5.9.2 The domestic hot water output temperature, t_{32} did not exceed 65 °C for more than 10 seconds.

5.9.3 The DHW response time for t_{32} to reach 45 °C was 15 seconds. As the appliance maintained temperature above 42 °C and within 15 seconds this is a valid keep warm and a pass.

5.9.4 The plot of the key metrics of the duration of Test 5a is displayed in Figure 7.15, Appendix A.

5.10 Test 5b – DHW Response Time at 60 °C

5.10.1 The DHW response time for t_{32} to reach 45 °C and not subsequently drop below 42 °C was 15 seconds. As the appliance maintained temperature above 42 °C and within 15 seconds this is a valid keep warm and a pass.

5.10.2 The plot of the key metrics of the duration of Test 5b is displayed in Figure 7.16, Appendix A.

5.11 Overall Scaling Risk Assessment

5.11.1 If any of the below factors occur, then the risk of scaling of the DHW plate in hard water areas increases.

Table 5.2 - Overall Scaling Risk Assessment

HIU has a TMV or TRV on the output of the DHW plate heat exchanger	No	
Test Designation	**2a**	**3a**
t_{32} above 60°C for more than 5 seconds	No	No
t_{12} exceeds 55°C at any point of the test	No	No
Test Designation	**4a**	**4b**
t_{12} exceeds 50°C at any time	No	No

5.12 VWART Calculations

5.12.1 The Volume Weighted Average Return Temperatures (VWART) have been calculated as stipulated in the BESA UK HIU Test Regime document. The calculated VWART values for both the high temperature and low temperature tests described in this report are given below in Table 5.3 and Table 5.4 respectively.

Table 5.3 – High Temperature VWART Calculations

Description	Symbol	Value	Unit
Annual Heating Period Percentage	SH_{PROP}	7.3	%
Annual Non-Heating Period Percentage	NSH_{PROP}	92.7	%
Space Heating Volume Weighted Return Temperature	$VWART_{SH}$	40	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	13	°C
Keep Warm Volume Weighed Return Temperature	$VWART_{KWM}$	33	°C
Annual Volume Weighted Return Temperature for Heating Period	$VWART_{HEAT}$	38	°C
Annual Volume Weighted Return Temperature for Non-Heating	$VWART_{NONHEAT}$	25	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	26	°C

Table 5.4 – Low Temperature VWART Calculations

Description	Symbol	Value	Unit
Annual Heating Period Percentage	SH_{PROP}	7.2	%
Annual Non-Heating Period Percentage	NSH_{PROP}	92.8	%
Space Heating Volume Weighted Return Temperature	$VWART_{SH}$	34	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	13	°C
Keep Warm Volume Weighed Return Temperature	$VWART_{KWM}$	34	°C
Annual Volume Weighted Return Temperature for Heating Period	$VWART_{HEAT}$	33	°C
Annual Volume Weighted Return Temperature for Non-Heating	$VWART_{NONHEAT}$	23	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	24	°C

6 CONCLUSIONS

6.1.1 The appliance has passed the performance requirements of the BESA HIU Test Regime.

7 APPENDIX A

7.1 Key Metric Plots

7.1.1 The graphical plots of the key metrics of the tests described in this report are given in this section.

GRAPHICAL PLOTS START ON NEXT PAGE

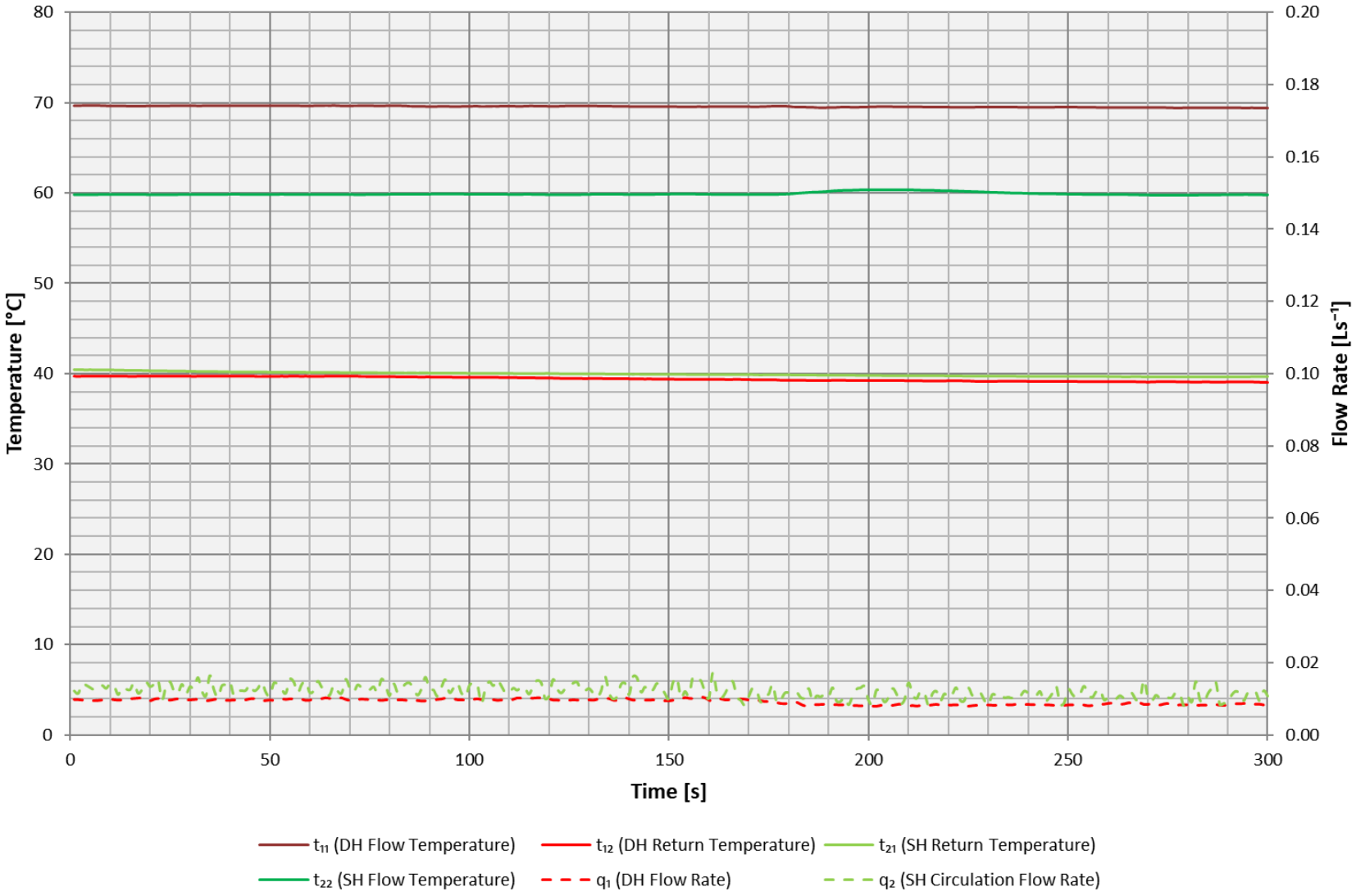

Figure 7.1 - Test 1a – Space Heating 1 kW at 70 °C

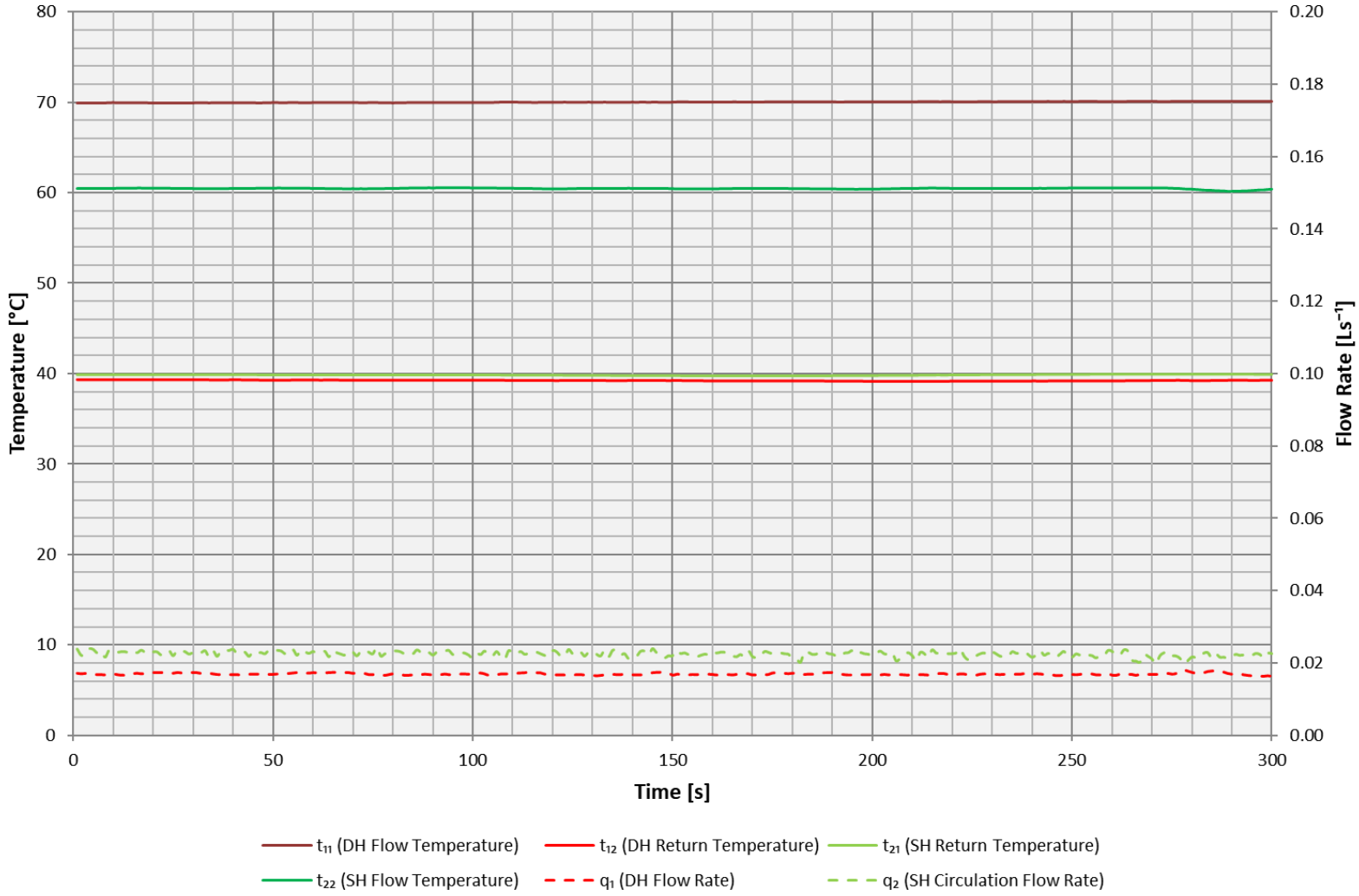

Figure 7.2 - Test 1b – Space Heating 2 kW at 70 °C

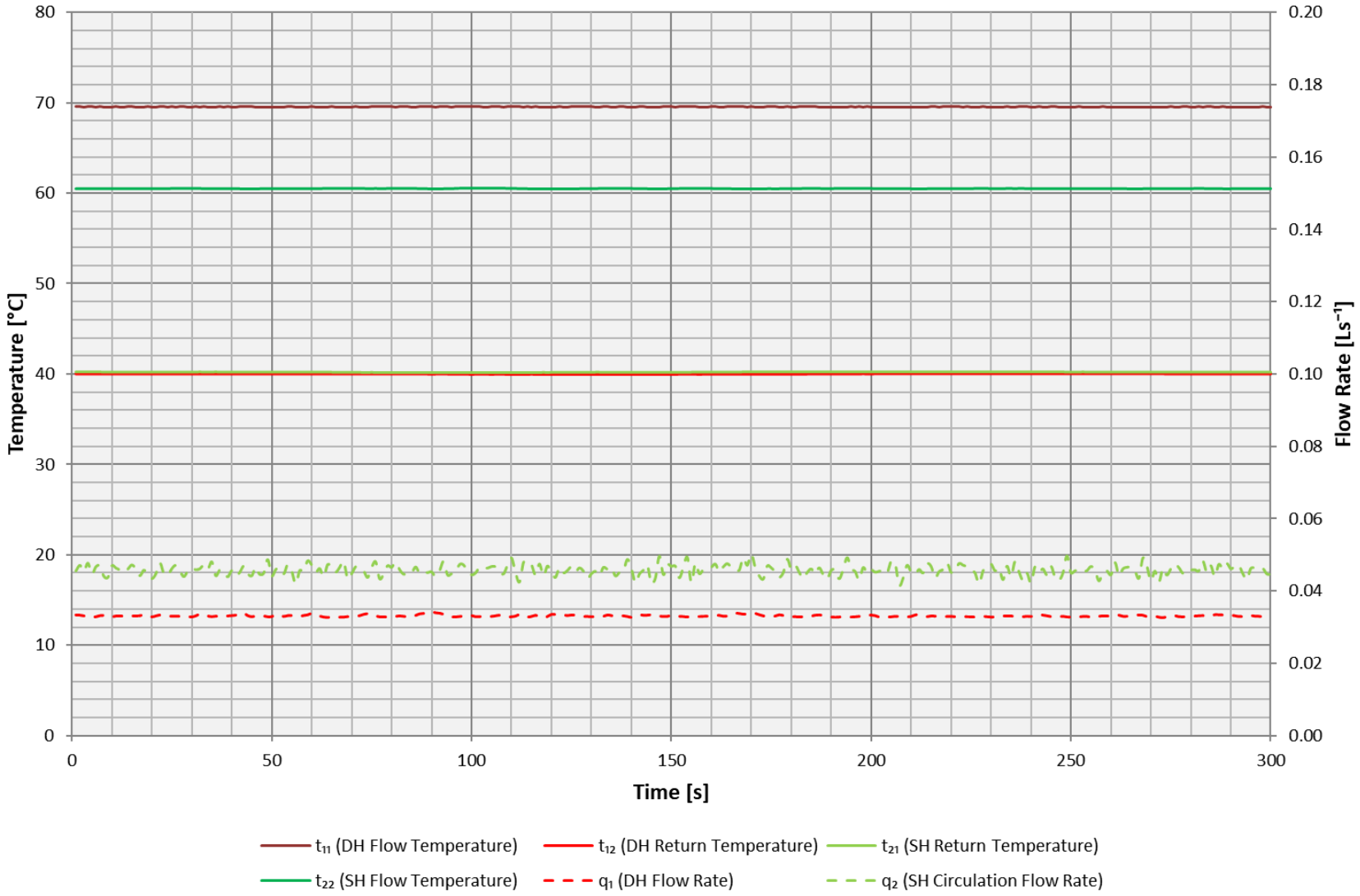

Figure 7.3 - Test 1c – Space Heating 4 kW at 70 °C

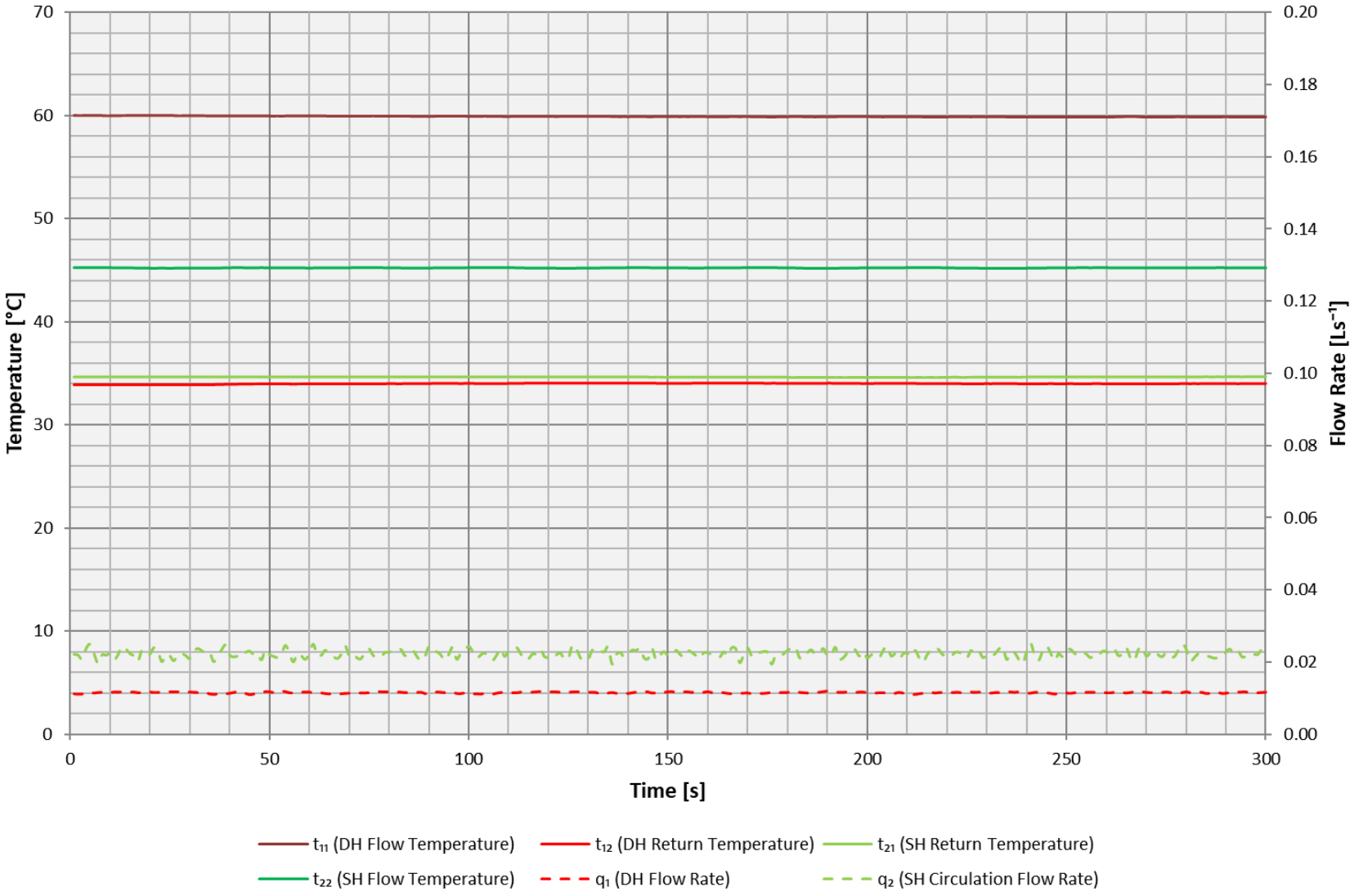

Figure 7.4 - Test 1d – Space Heating 1 kW at 60 °C

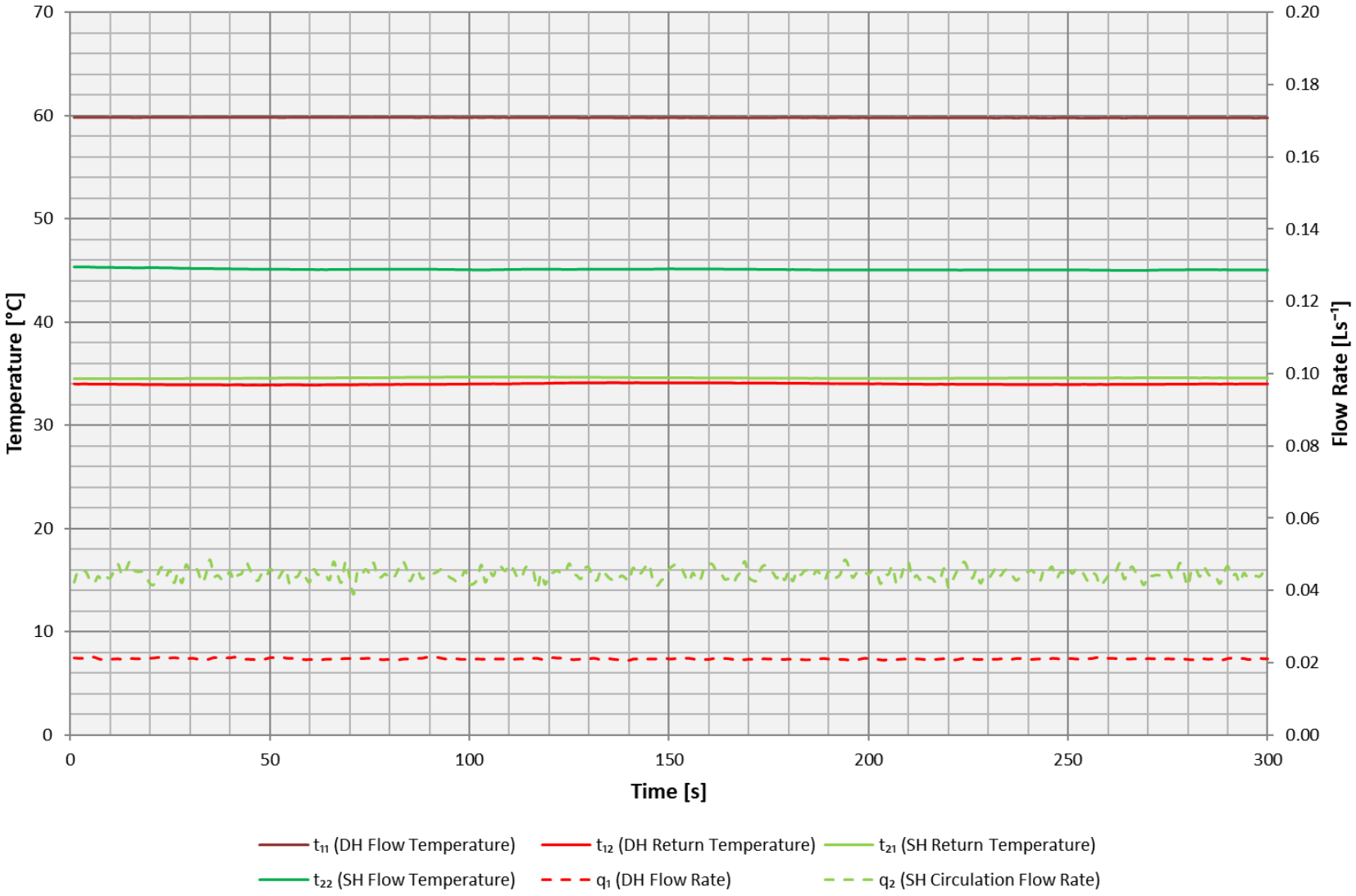

Figure 7.5 - Test 1e – Space Heating 2 kW at 60 °C

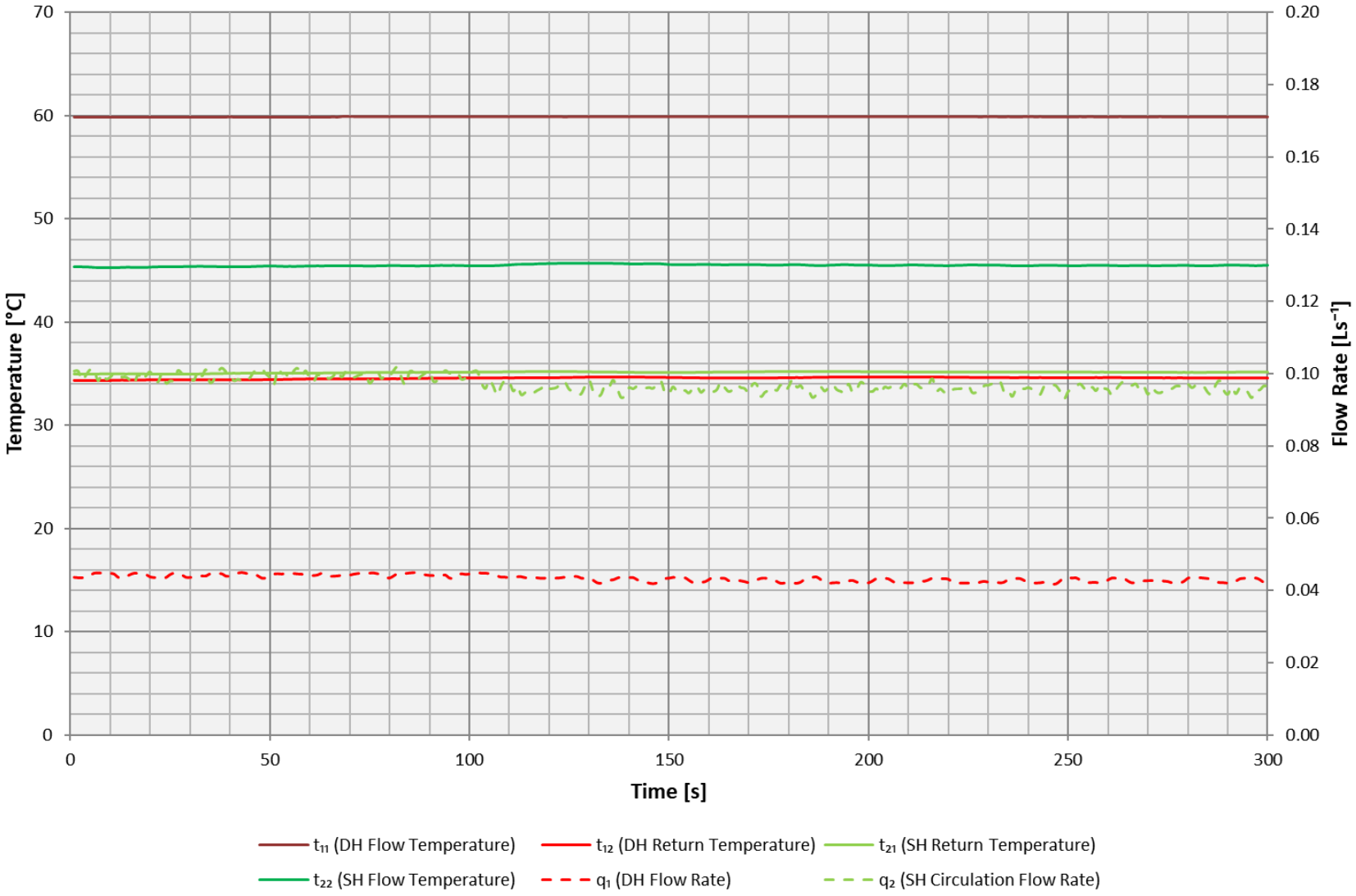

Figure 7.6 - Test 1f – Space Heating 4 kW at 60 °C

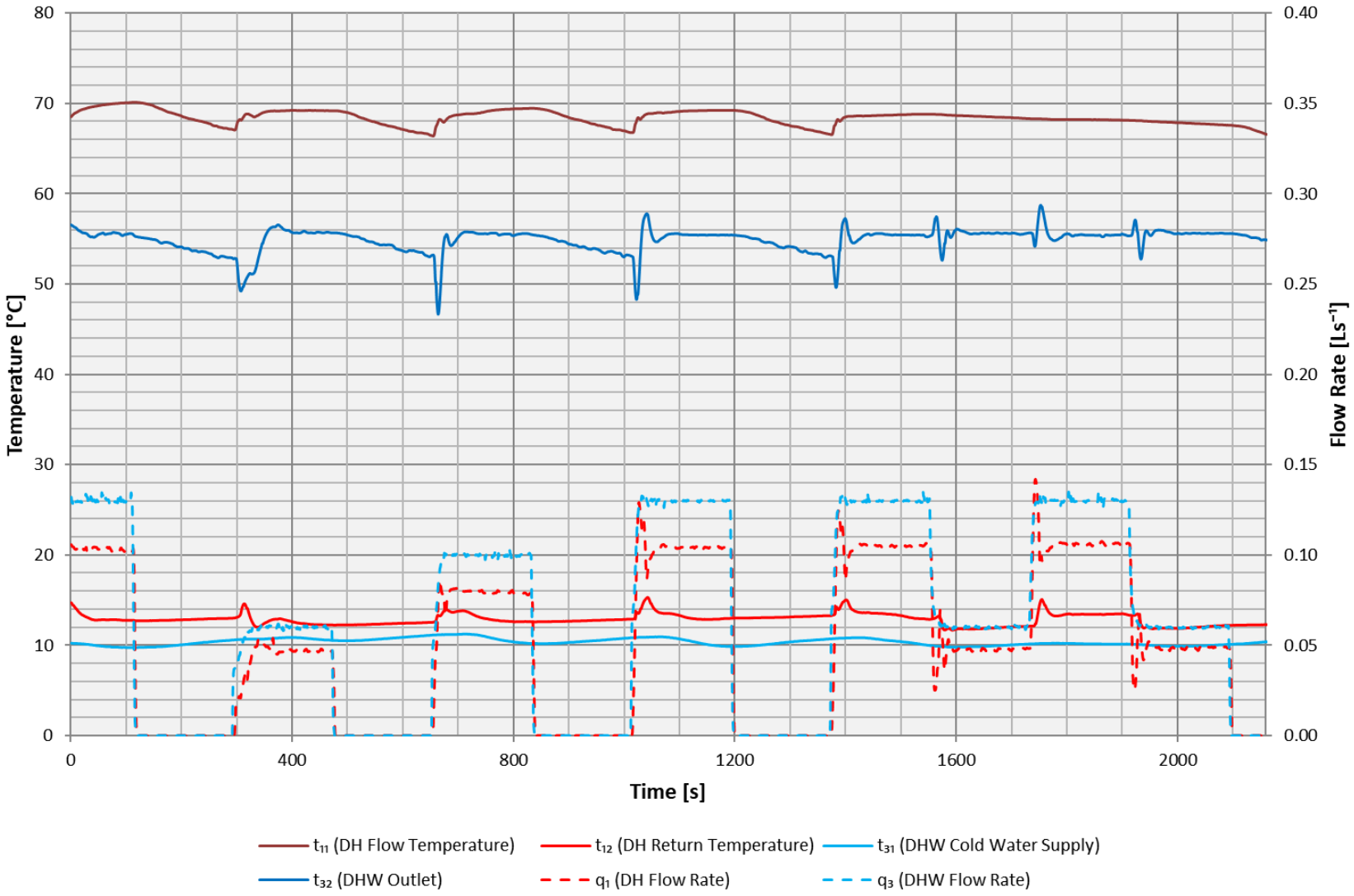

Figure 7.7 - Test 2a – DHW only at 70 °C

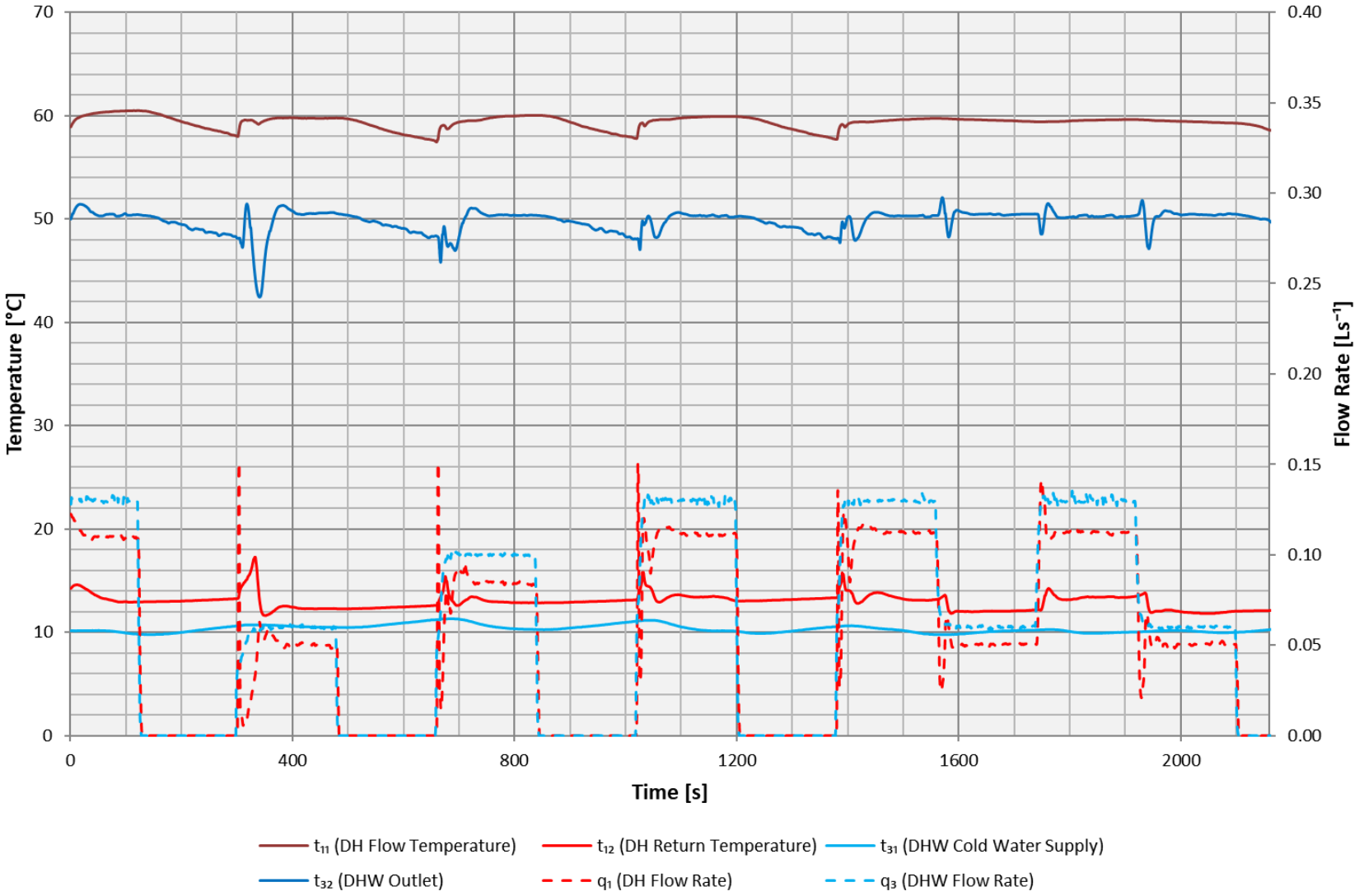

Figure 7.8 - Test 2b – DHW only at 60 °C

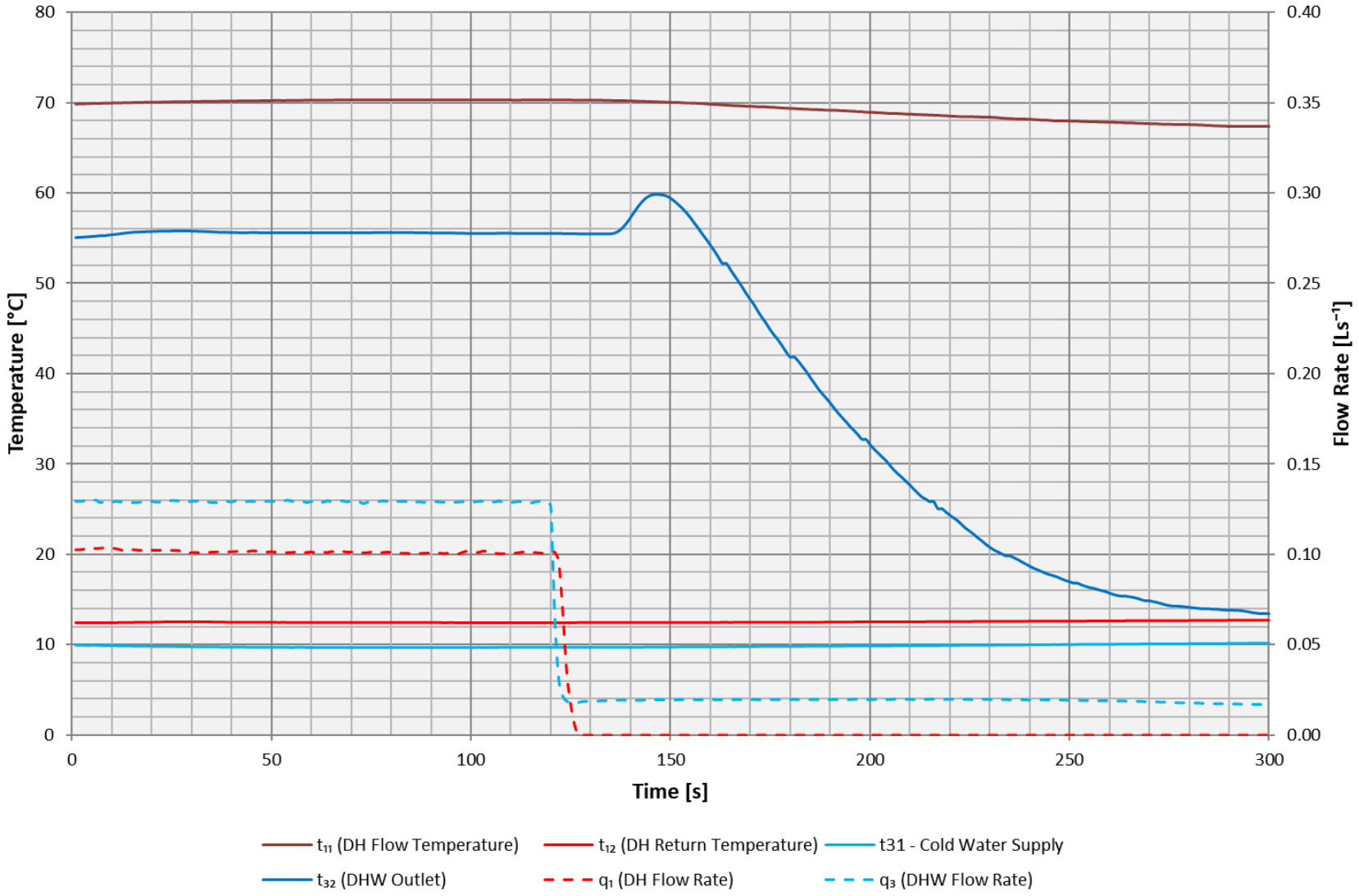

Figure 7.9 - Test 3a – Low Flow DHW at 70 °C

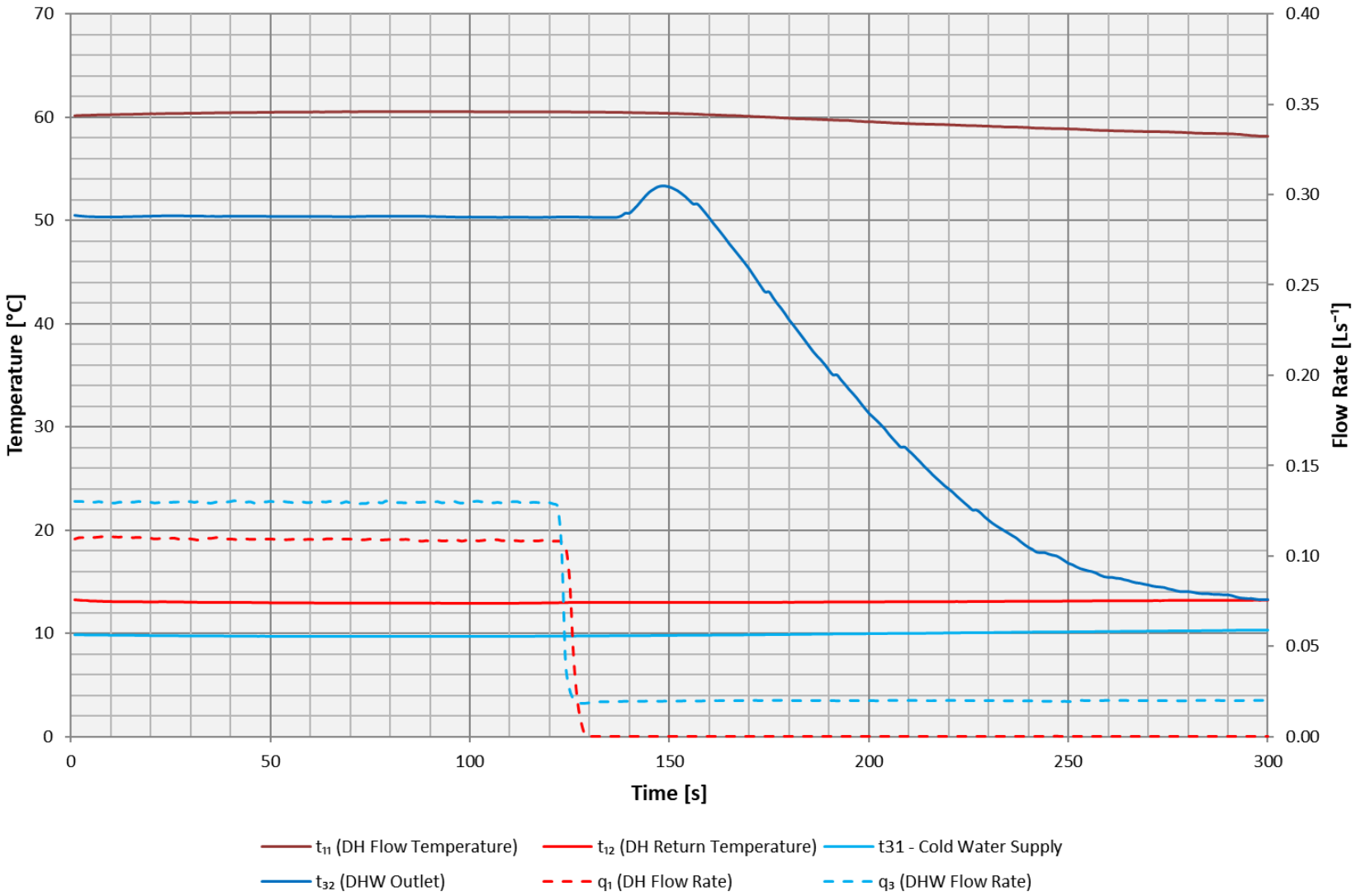

Figure 7.10 - Test 3b – Low Flow DHW at 60 °C

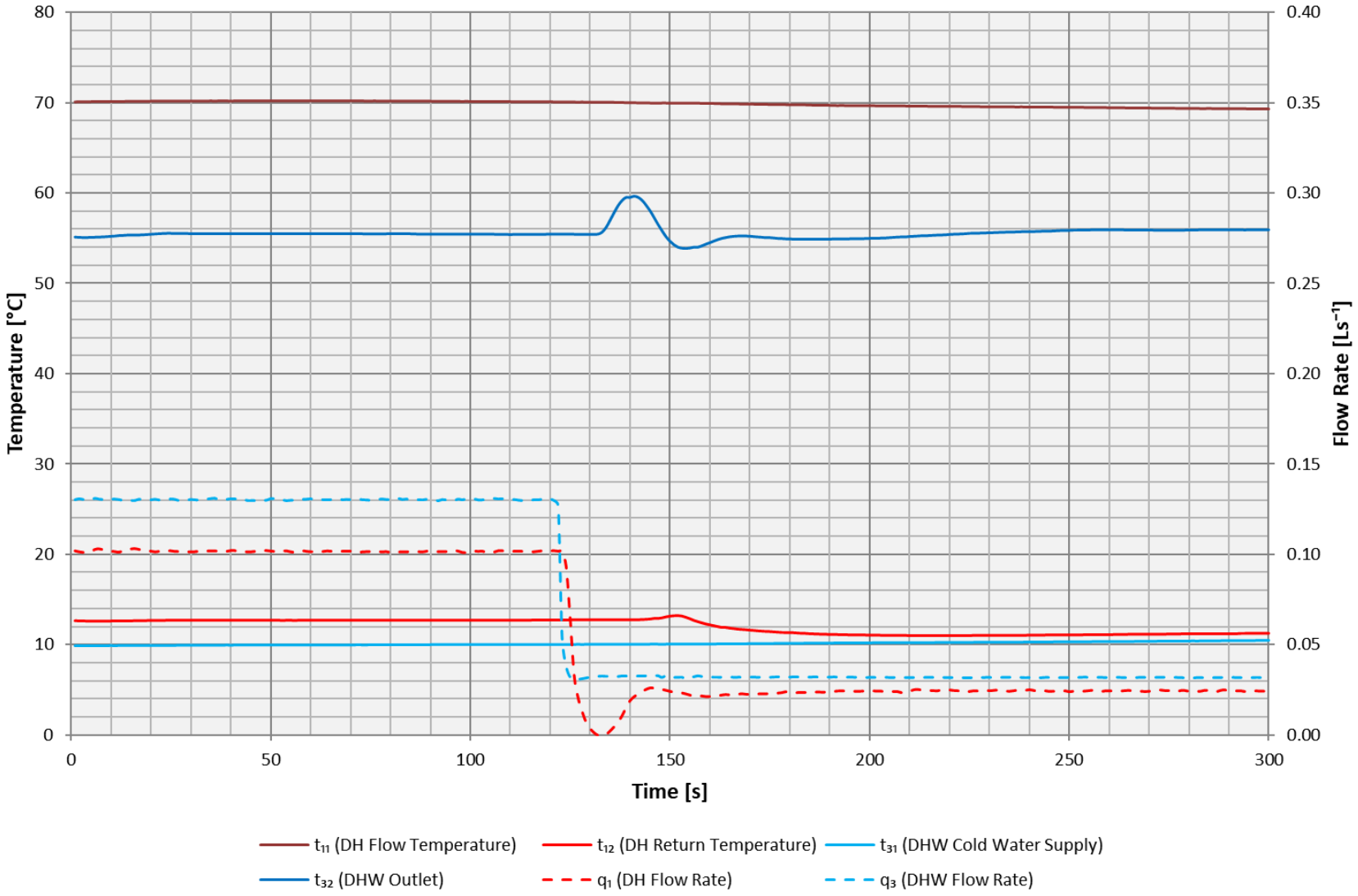

Figure 7.11 - Test 3c – Manufacturers Declared Low Flow DHW at 70 °C

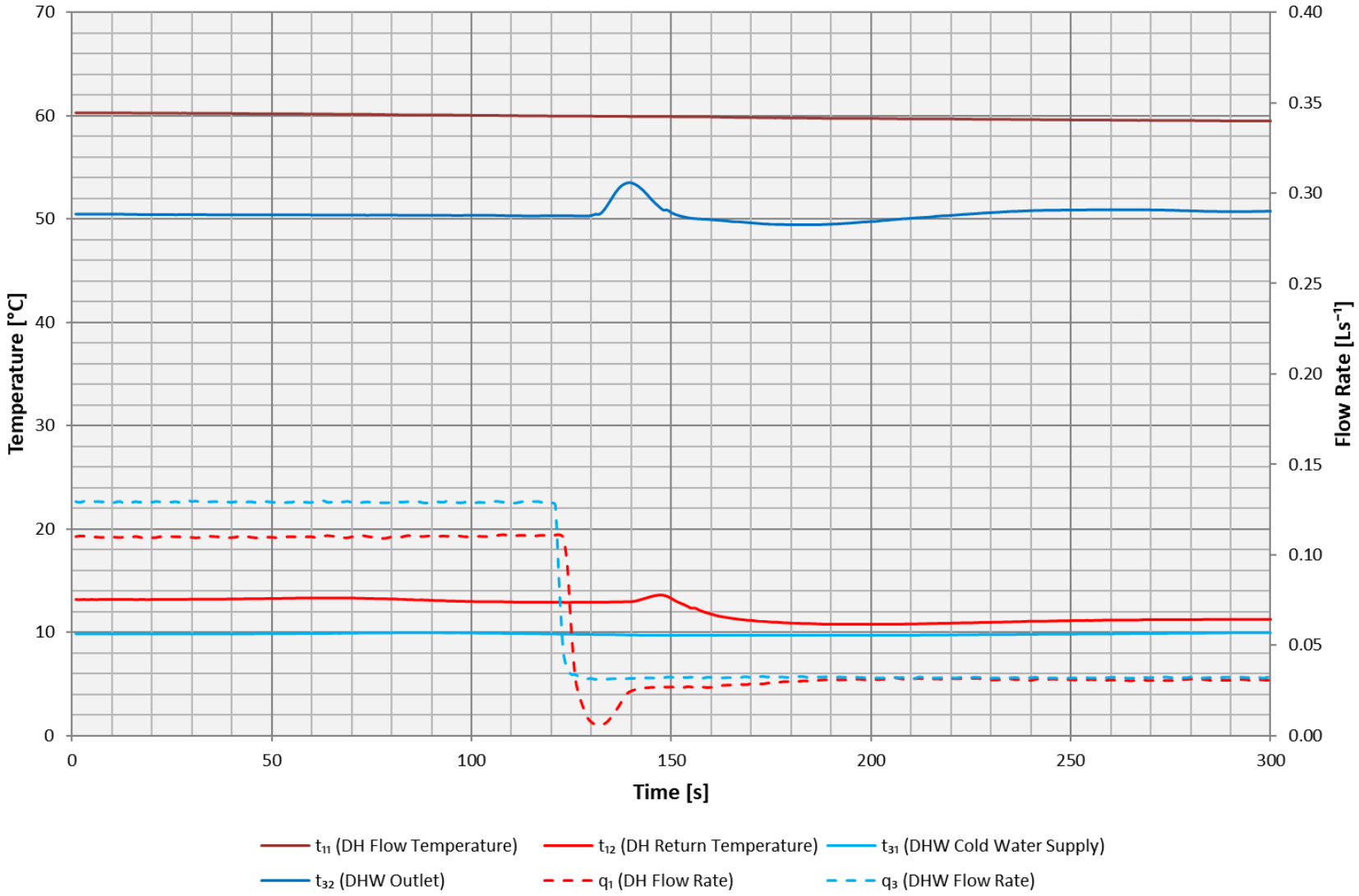

Figure 7.12 - Test 3d – Manufacturers Declared Low Flow DHW at 60 °C

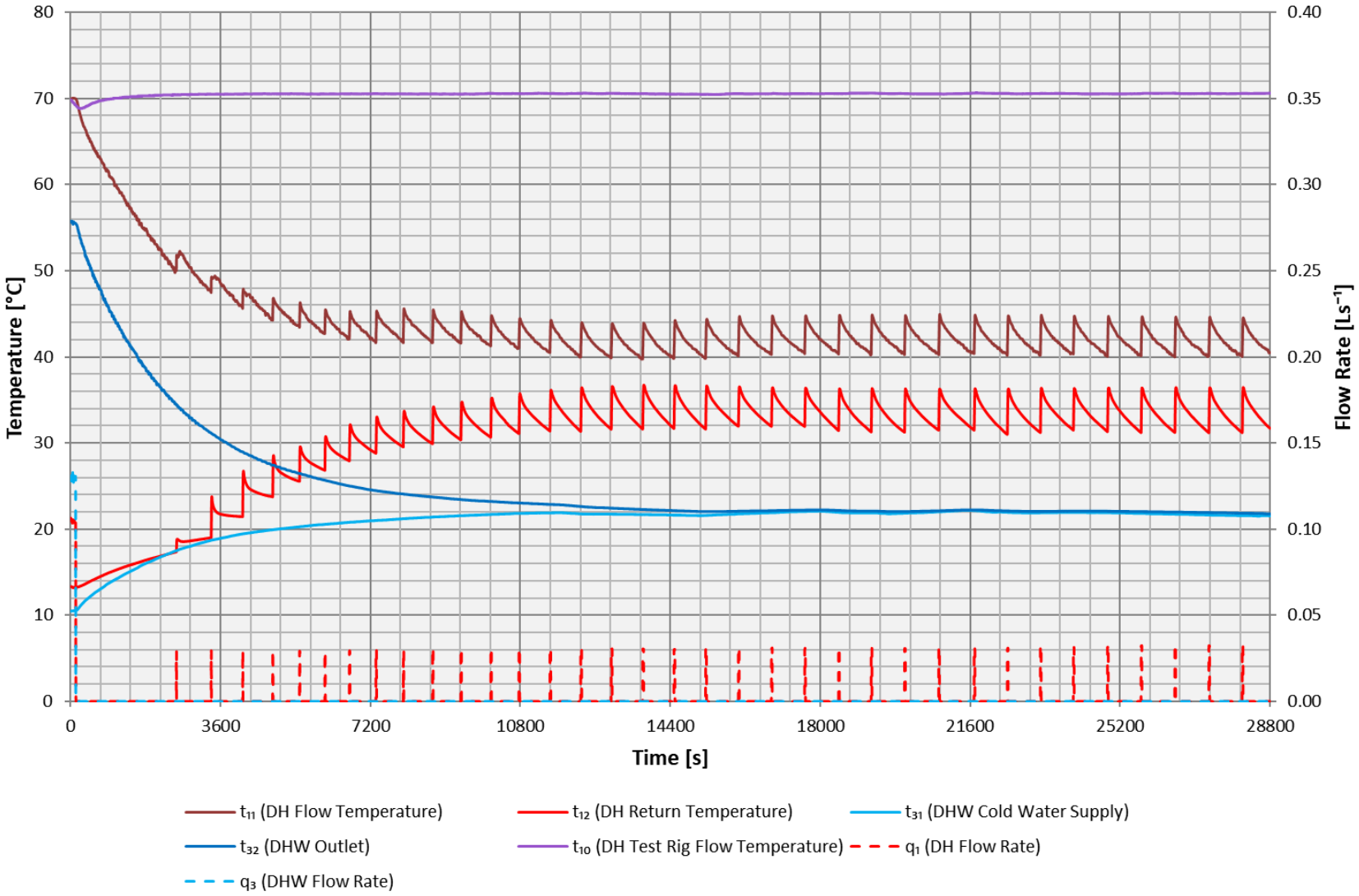

Figure 7.13 - Test 4a – Keep-Warm at 70 °C

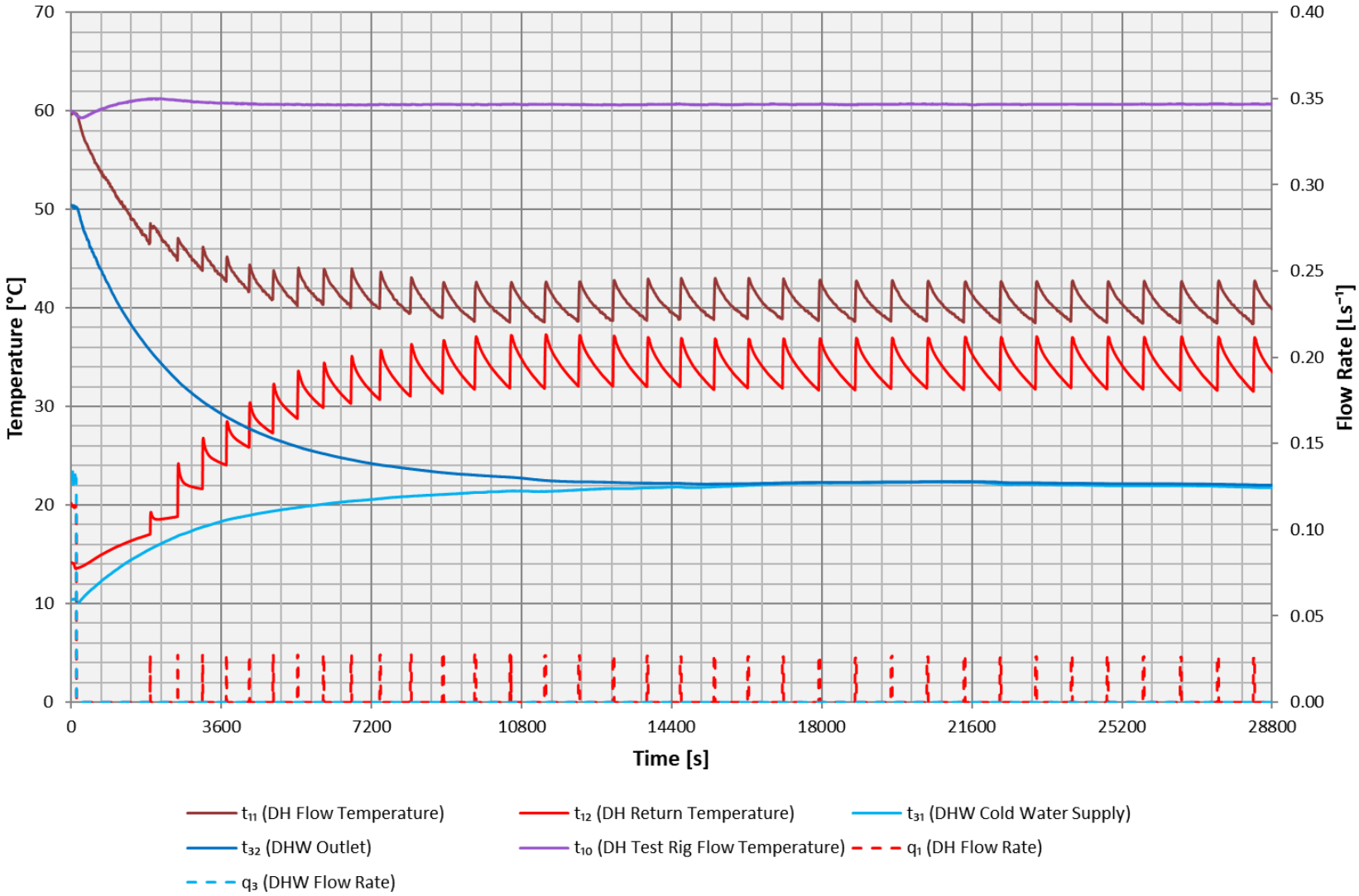

Figure 7.14 - Test 4b – Keep-Warm at 60 °C

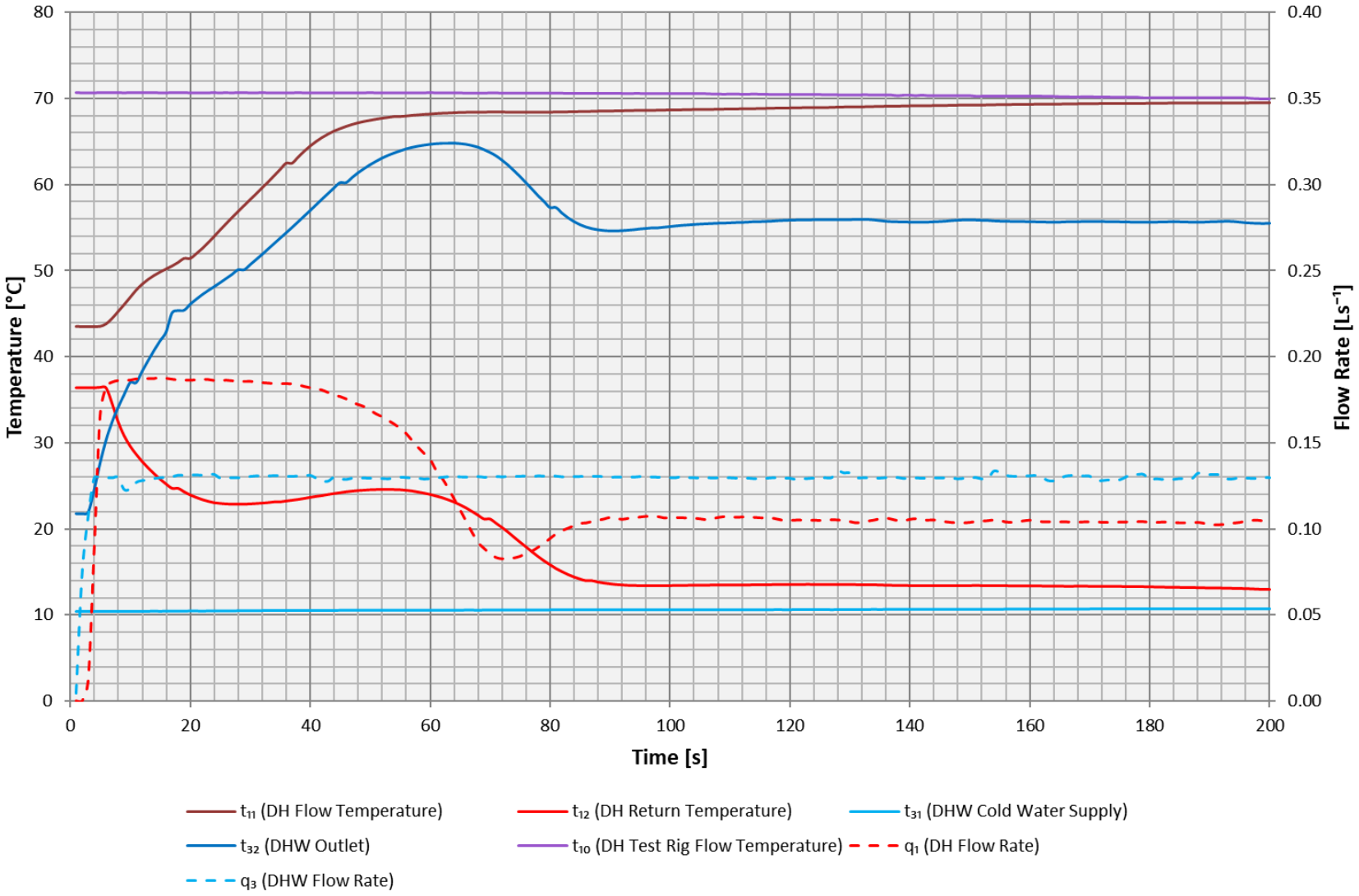

Figure 7.15 - Test 5a – DHW Response Time at 70 °C

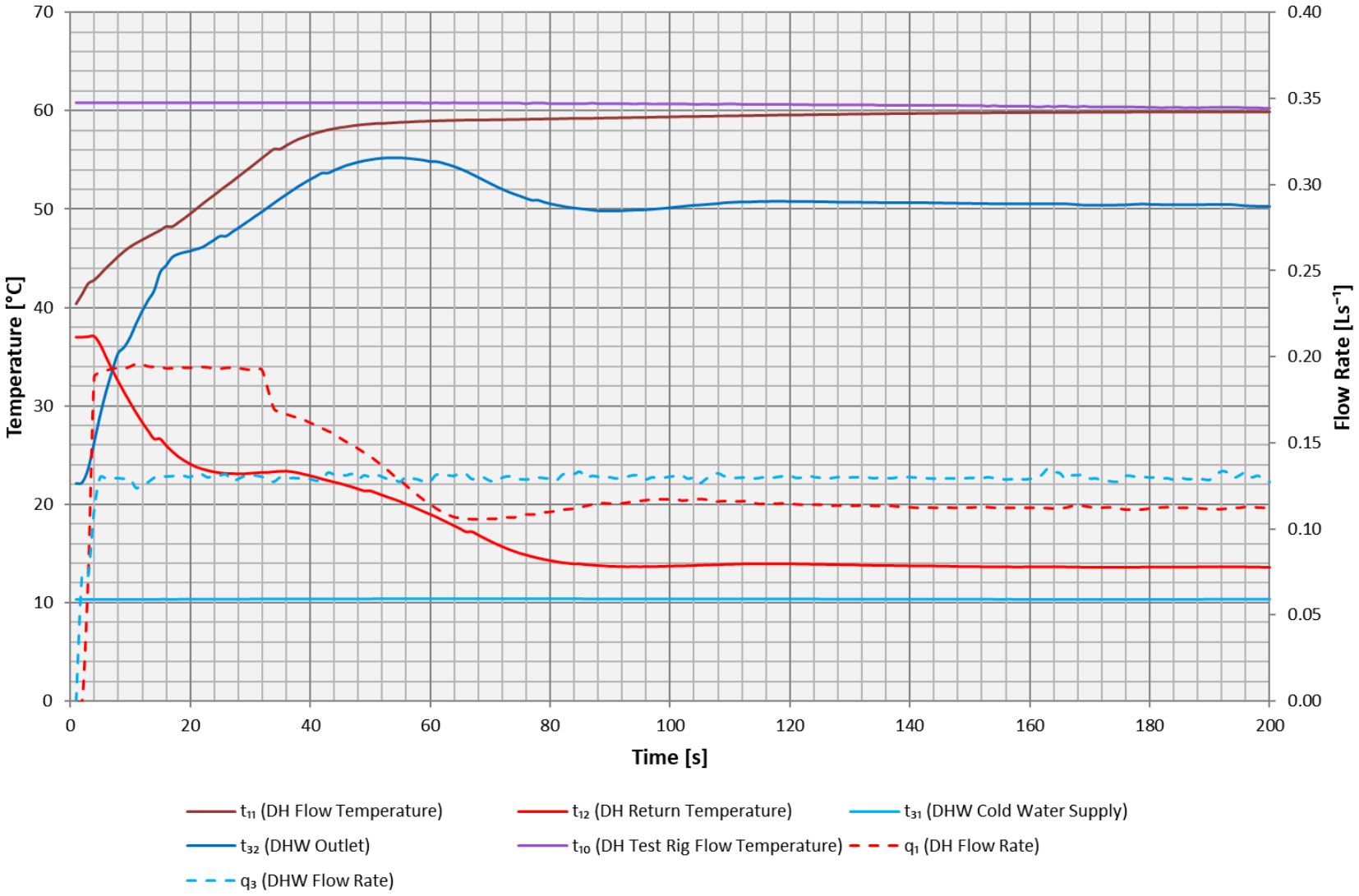

Figure 7.16 - Test 5b – DHW Response Time at 60 °C

7.2 Key Metric and VWART Summary

7.2.1 The summary tables of the key metrics and VWARTs of the tests described in this report are given in this section.

SUMMARY TABLES START ON NEXT PAGE

VWART Calculation with Keep Warm

Test carried out by Enertek International for High Temperature BESA Tests

Manufacturer:	Modutherm
Model:	MTA PLUS
Serial number:	220407
Calculation performed by S.Broxham of Enertek on:	26/05/2022

Primary Flow Temperature:	70°C
DHW Setpoint:	55°C
Space Heating Temperature:	60/40°C

	VWART (°C)	Volume (m3)
DHW	13	22.1
Standby	33	34.6
Space Heating	40	45.1

	VWART with keep warm active	
Period	**VWART (°C)**	**% Time**
No Heating	25	93%
Heating	38	7%
Overall	**26**	

		Test Results							
		Power (p1) [W]	Primary flow [m³/hr]	VWART [°C]	Energy Used [kWh]	Annual Operation [Hours]	Volume [m³]	Events [Per Year]	Average duration [Seconds]
1kW Space Heating	1a	1152	0.033	39	113	97.9	3.26	-	-
2kW Space Heating	1b	2178	0.061	39	870	399.7	24.45	-	-
4kW Space Heating	1c	4089	0.119	40	596	145.8	17.41	-	-
DHW Low Flow Rate	2a	10610	0.156	13	702	68.7	10.70	-	-
DHW Medium Flow Rate	2a	17909	0.275	13	296	16.6	4.56	-	-
DHW High Flow Rate	2a	23659	0.363	13	440	18.8	6.81	-	-
DHW Post Low Flow Rate	2a	-	0.000	0	-	-	0.00	10000	30
DHW Post Medium Flow Rate	2a	-	0.000	0	-	-	0.00	660	70
DHW Post High Flow Rate	2a	-	0.000	0	-	-	0.00	300	145
DHW Keep Warm Standby	4a	-	0.004	33	-	8012.5	34.61	-	-

Table 7.1 - Key Metrics of High Temperature Package

VWART Calculation with Keep Warm

Test carried out by Enertek International for Low Temperature BESA Tests		Primary Flow Temperature:	60°C
Manufacturer:	Modutherm	DHW Setpoint:	50°C
Model:	MTA PLUS	Space Heating Temperature:	45/35°C
Serial number:	220407		
Calculation performed by S.Broxham of Enertek on:	26/05/2022		

	VWART (°C)	Volume (m3)
DHW	13	26.6
Standby	34	25.0
Space Heating	34	54.7

	VWART with keep warm active	
Period	**VWART (°C)**	**% Time**
No Heating	23	93%
Heating	33	7%
Overall	**24**	

		Test Results							
		Power (p1) [W]	Primary flow [m³/hr]	VWART [°C]	Energy Used [kWh]	Annual Operation [Hours]	Volume [m³]	Events [Per Year]	Average duration [Seconds]
1kW Space Heating	1d	1200	0.041	34	119	99.3	4.11	-	-
2kW Space Heating	1e	2277	0.076	34	916	402.3	30.57	-	-
4kW Space Heating	1f	4603	0.156	35	591	128.4	20.05	-	-
DHW Low Flow Rate	2b	9390	0.166	13	705	77.6	12.88	-	-
DHW Medium Flow Rate	2b	15800	0.291	13	296	18.8	5.48	-	-
DHW High Flow Rate	2b	20946	0.388	14	442	21.2	8.23	-	-
DHW Post Low Flow Rate	2b	-	0.000	0	-	-	0.00	10000	30
DHW Post Medium Flow Rate	2b	-	0.000	0	-	-	0.00	660	70
DHW Post High Flow Rate	2b	-	0.000	0	-	-	0.00	300	145
DHW Keep Warm Standby	4b	-	0.003	34	-	8012.4	25.00	-	-

Table 7.2 - Key Metrics of Low Temperature Package

8 APPENDIX B

8.1 Appliance Documentation

8.1.1 The details of the appliance documentation are given in Table 8.1 below.

Table 8.1 – Documentation Supplied

	Component:	Document Submitted (Y/N):	Manufacturer and type:
1	Space Heating Heat Exchanger	Y	SWEP E8LAS
2	Domestic Hot Water Heat Exchanger	Y	SWEP E8LAS
3	Controller for Space Heating and Hot Water Heating	Y	Vergne Innovation Electronic Board 121090-0416, Firmware version 2.0
4	Control Valve and Actuator for Space Heating	Y	Vergne Innovation NMB Stepper Motor
5	Space Heating Strainer	Y	N/A
6	Control Valve and Actuator for Hot Water Heating	Y	Vergne Innovation NMB Stepper Motor
7	Temperature Sensors	Y	Tasseron NTC TSD00E5
8	Domestic Hot Water Isolating Valve	Y	LA B&G di Bardini Enrico & C. s.r.l. Brass Ball
9	Primary Side Strainer	Y	Stainless Steel Mesh 316L 0.8mm
10	Drain Valves	Y	Brass with EP856 O-Ring
11	Vent Valve	Y	Kramer GE10/P Automatic Air Vent
12	Circulation Pump	Y	Wilo Para MS/8-75 PWM1
13	Heat Meter	Y	Itron Ultramaxx
14	Domestic Hot Water Flow Sensor	Y	Huba Type 201.910121 Paddle Switch
15	Pipes	Y	Brass
16	Connections	Y	Brass
17	Joints	Y	N/A
18	Gaskets	Y	EP856
19	O Rings	Y	EP856
20	Pressure Sensor	Y	Vergne Innovation Proportional DC Signal Sensor
21	Expansion Vessel	Y	CIMM RP250 10L
22	Insulation	Y	Made from PLASTYROBEL – Expanded Polystyrene
A1	Commissioning Guide	Y	Provided with Unit and Attached
A2	Operation Guide	Y	Provided with Unit and Attached
A3	Declaration of Conformity	Y	LVD, EMC
A4	Full Parameter List	Y	Provided with Unit and Attached
A5	Maximum Primary Static Operating Differential Pressure	Y.	3 Bar
	Software Version	Y	30018
	Model Name and Type Number	Y	MTA PLUS
	Serial Number	Y	220407

8.2 Appliance Photographs

Figure 8.1 – Photograph of Appliance [Case Fitted]

Figure 8.2 – Photograph of Appliance [Case Removed]

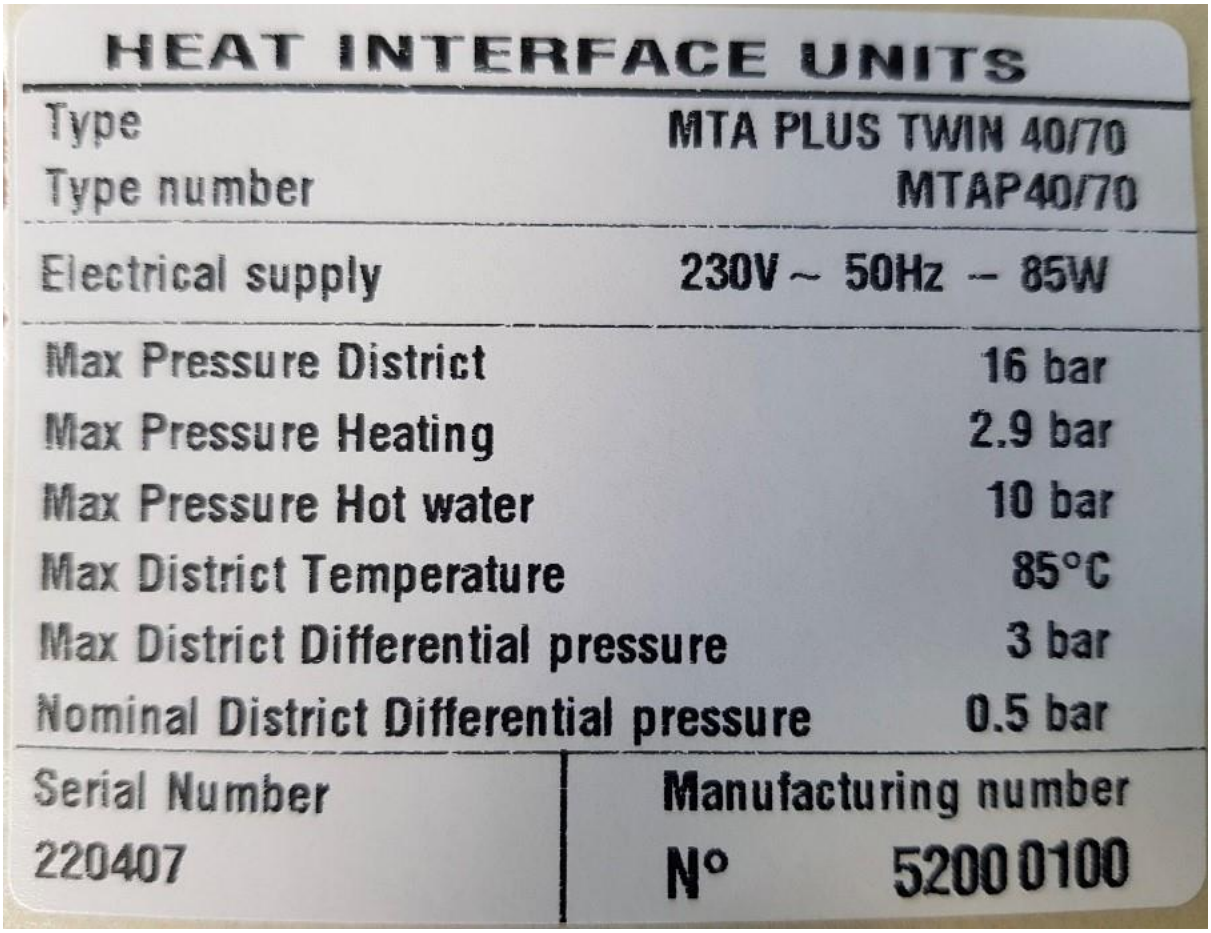

Figure 8.3 – Appliance Data Label

8.3 Calibrations and Uncertainties

8.3.1 A list of equipment, their calibrations and uncertainties are given in table 8.2 below.

Table 8.2 - EIL Equipment Calibration and Uncertainties

Equipment Name	ID Number	Calibration Certificate	Measurement Uncertainty K=2 $\frac{U}{\sqrt{20}}$	Units	Calibration Date	Calibration Due
Flow Meter [Primary Flow Rate]	FM 601	U99513-19	±0.0004	l/s	26-06-2019	26/06/2021
Flow Meter [DHW Flow Rate]	FM 602	U98515-19	±0.00305	l/s	26-06-2019	26/06/2021
Flow Meter [SH Flow Rate]	FM 603	U98530-19	±0.04871	l/s	27-06-2019	27/06/2021
Flow Meter [DHW Flow Rate]	FM 605	U98539-19	±0.00576	l/s	28-06-2019	28-06-2021
Pressure Transducer [Primary Supply]	PT 086	U98458-19	±6.82	kPa	22-06-2019	22/06/2021
Pressure Transducer [Primary Return]	PT 085	U98460-19	±7.88	kPa	22-06-2019	22/06/2021
Pressure Transducer [DHW Output Pressure]	PT 083	U98469-19	±7.73	kPa	23-06-2019	23/06/2021
Pressure Transducer [DHW Cold Water Supply]	PT 084	U98468-19	±7.31	kPa	23-06-2019	23/06/2021
Pressure Transducer [SH Flow]	PT 087	U98463-19	±7.26	kPa	22-06-2019	22/06/2021
Pressure Transducer [SH Return]	PT 088	U98461-19	±7.30	kPa	22-06-2019	22/06/2021
PRT Probe [Primary Supply Temp]	PRT 4709	EIL 436771	±0.4	°C	31/07/2019	31/07/2021
PRT Probe [Primary Return Temp]	PRT 4708	EIL 436771	±0.6	°C	31/07/2019	31/07/2021
PRT Probe [DHW Output Temp]	PRT 4711	EIL 436772	±0.4	°C	31/07/2019	31/07/2021
PRT Probe [Cold Water Supply Temp]	PRT 4710	EIL 436771	±1.9	°C	31/07/2019	31/07/2021
PRT Probe [SH Supply Temp]	PRT 4707	EIL 436771	±0.4	°C	31/07/2019	31/07/2021
PRT Probe [SH Return Temp]	PRT 4706	EIL 436771	±1.0	°C	31/07/2019	31/07/2021

Equipment Name	ID Number	Calibration Certificate	Measurement Uncertainty K=2 $\frac{U}{\sqrt{20}}$	Units	Calibration Date	Calibration Due
Pressure Transducer [Static Pressure Test]	PT 090	U100553-19	±50	kPa	21/11/2019	20/11/2021
Power Meter [Electrical Consumption]	PM1022	U103585-20	±1.03	W	27/07/2020	27/07/2021
Software	VERSION – LabVIEW, Version 5, Service pack 1					

Report Issue No	Reason for Report Update
1	Original Issue
2	Minimum temperature updated for test 2b.

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