

**SS 646:2019+C1:2020**

(ICS 97.100.10; 97.100.20)

**SINGAPORE STANDARD**

**Specification for water heaters for household  
use – Method for measuring energy  
performance**

Incorporating Corrigendum No. 1

**SS 646:2019+C1:2020**

(ICS 97.100.10; 97.100.20)

---

SINGAPORE STANDARD

**Specification for water heaters for household use –  
Method for measuring energy performance**

---

Published by Enterprise Singapore

All rights reserved. Unless otherwise specified, no part of this Singapore Standard may be reproduced or utilised in any form or by any means, electronic or mechanical, including photocopying and microfilming, without permission in writing from Enterprise Singapore. Request for permission can be sent to: [standards@enterprisesg.gov.sg](mailto:standards@enterprisesg.gov.sg).

© Enterprise Singapore 2019

ISBN 978-981-48-3584-8

The content of this Singapore Standard was approved on 15 August 2019 by the Environment and Resources Standards Committee (ERSC) under the purview of the Singapore Standards Council.

First published, 2019

ERSC consists of the following members:

	<b>Name</b>	<b>Representation</b>
<b>Chairman</b>	: Prof Reginald Tan	<i>Individual Capacity</i>
<b>Deputy Chairmen</b>	: Mr Dalson Chung	<i>National Environment Agency</i>
	Mr Norman Lee	<i>Individual Capacity</i>
<b>Secretary</b>	: Ms Lee Mong Ni	<i>Enterprise Singapore</i>
<b>Members</b>	: Mr Benedict Chia	<i>National Climate Change Secretariat</i>
	Dr Chiu Kuang Ping	<i>Singapore Water Association</i>
	Mr Alex Chong	<i>Agency for Science, Technology &amp; Research</i>
	Mr Michael Ho	<i>Waste Management &amp; Recycling Association of Singapore</i>
	Mr Jadhav Nilesh	<i>Nanyang Technological University</i>
	Ms Kavita Gandhi	<i>Sustainable Energy Association of Singapore</i>
	Mr Khor Seng Teng	<i>Hyflux Ltd</i>
	Mr Koh Yixiong	<i>Enterprise Singapore</i>
	Mr Kelvin Liew	<i>SembWaste Pte Ltd</i>
	Dr Lim Mong Hoo	<i>Individual Capacity</i>
	Mr Collin Lim Yew Tee	<i>Singapore Manufacturing Federation</i>
	Dr Pang Chee Meng	<i>PUB, Singapore's National Water Agency</i>
	Mr Steve Seah	<i>SP Group</i>
	Ms Yvonne Soh	<i>Singapore Green Building Council</i>
	Dr Song Bin	<i>Individual Capacity</i>
	Mr Tan Sze Tiong	<i>Housing &amp; Development Board</i>
	Ms Jen Teo Pui Heng	<i>Singapore Environment Council</i>
	Mr Toh Eng Shyan	<i>Building and Construction Authority</i>
	Mr Tok Chee Ming	<i>Singapore Chemical Industry Council</i>
	Er. Alfred Wong	<i>The Institution of Engineers, Singapore</i>
	Mr Yap Ong Heng	<i>Ministry of Transport</i>
	Mr Yeo Lai Hin	<i>Energy Market Authority</i>
	Er. Yeow Mei Leng	<i>Association of Consulting Engineers, Singapore</i>

ERSC sets up the Technical Committee on Energy to oversee the preparation of this standard. The Technical Committee consists of the following members:

	<b>Name</b>	<b>Representation</b>
<b>Chairman</b>	: Mr Norman Lee	<i>Individual Capacity</i>
<b>Secretary</b>	: Ms Barbara Bok	<i>Enterprise Singapore</i>
<b>Members</b>	: Assoc Prof Chai Kah Hin	<i>National University of Singapore</i>
	Er. Goh Chee Tiong	<i>National Environment Agency</i>
	Mr Ho Hiang Kwee	<i>National Climate Change Secretariat</i>
	Dr Lal Jayamaha	<i>LJ Energy Pte Ltd</i>
	Mr Eddy Lau	<i>Singapore Green Building Council</i>
	Ms Lee Ham Eng	<i>Singapore Accreditation Council</i>
	Er. Seow Kang Seng	<i>DNV GL</i>
	Mr Toh Eng Shyan	<i>Building and Construction Authority</i>
	Dr Wan Man Pun	<i>Nanyang Technological University</i>

The Technical Committee sets up the Working Group on Water Heaters for Household Use to prepare this standard. The Working Group consists of the following experts who contribute in their *individual capacity*:

	<b>Name</b>
<b>Co-Convenors</b>	: Mr Ang Kok Kiat
	Mr Lam Kwok Ho
<b>Members</b>	: Dr Arifeen Wahed
	Mr Cheong Ing Hun
	Ms Chew Wenyi
	Mr Raymond Chew
	Mr Marcus Foo
	Mr Christopher Hee
	Mr Derrick Lee
	Mr Edwin Leong
	Mr Poh Boon Teck
	Mr Toh Eng Shyan
	Dr Ye Shaochun

The organisations in which the experts of the Working Group are involved are:

*Ariston Thermo Pte Ltd*  
*Aumada Pte Ltd*  
*Building and Construction Authority*  
*Champs Industrial Pte Ltd*  
*City Gas Pte Ltd (as Trustee)*  
*National Environment Agency*  
*National Metrology Centre*  
*Ngee Ann Polytechnic*  
*SETSCO Services Pte Ltd*  
*SGS Testing and Control Services Singapore Pte Ltd*  
*Solar Energy Research Institute of Singapore*  
*Singapore Green Building Council*  
*TüV Süd PSB Pte Ltd*

**Contents**

	<b>Page</b>
Foreword _____	6
1 Scope _____	7
2 Normative references _____	7
3 Terms and definitions _____	7
4 Test conditions _____	8
5 Instrumentation _____	9
6 Installation _____	10
7 Test procedures _____	12
8 Computations _____	17
 <b>Annexes</b>	
A Symbol usage _____	24
B Piping and temperature measurement sensor configuration _____	26
C Summary of test procedures _____	27
D Smart control test procedure for storage-type water heaters _____	30
 <b>Tables</b>	
1 Draw pattern for electric instantaneous water heaters with rated input power < 2 kW ____	14
2 Draw pattern for electric instantaneous water heaters with rated input power ≥ 2 kW and < 3 kW _____	14
3 Draw pattern for electric instantaneous water heaters with rated input power ≥ 3 kW ____	14
4 Draw pattern for electric storage and gas water heaters _____	14
C.1 Applicable test procedures by type of water heater _____	27
D.1 Daily draw pattern for smart control test _____	30
 <b>Figures</b>	
1 Flowchart on how to determine the start and end time of the first standby interval ____	16
C.1 Simulated-use test for storage-type water heaters _____	28
C.2 Simulated-use test for instantaneous-type water heaters _____	29

## Foreword

This Singapore Standard was prepared by the Working Group on Water Heaters for Household Use set up by the Technical Committee on Energy under the purview of the ERSC.

The standard defines a set of standardised test procedures to measure the energy performance of water heaters and assess the energy efficiency of water heaters.

It is a test standard to assess the energy performance of water heater types that are commonly used in Singapore. The standard does not evaluate the carbon footprint of water heaters. Those who are interested in carbon footprint of products can refer to ISO 14067 “Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification.

In preparing this standard, reference was made to the following publications:

- |                 |  |
|-----------------|--|
| 10 CFR Part 430 | Energy conservation program for consumer products, Appendix E  |
| EN 13203-2:2015 | Gas-fired domestic appliances producing hot water. Part 2: Assessment of energy consumption  |
| EN 16147:2017   | Heat pumps with electrically driven compressors – Testing, performance rating and requirements for marking of domestic hot water units |
| EN 50193-1:2016 | Electric instantaneous water heaters. Part 1: General requirements   |
| EN 50440:2015   | Efficiency of domestic electrical storage water heaters and testing methods  |

Permission has been sought from CEN to reproduce Figure 2 of EN 50440:2015, “Efficiency of domestic electrical storage water heaters and testing methods” into the standard.

Acknowledgement is made for the use of information from the above publications.

Attention is drawn to the possibility that some of the elements of this Singapore Standard may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

### NOTE

- 1. Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions. Where SSs are deemed to be stable, i.e. no foreseeable changes in them, they will be classified as “Mature standards”. Mature Standards will not be subject to further review, unless there are requests to review such standards.*
- 2. An SS or TR is voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether the SS or TR is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document. Enterprise Singapore and the Singapore Standards Council shall not be liable for any damages whether directly or indirectly suffered by anyone or any organisation as a result of the use of any SS or TR. Although care has been taken to draft this standard, users are also advised to ensure that they apply the information after due diligence.*
- 3. Compliance with a SS or TR does not exempt users from any legal obligations.*

## Specification for water heaters for household use – Method for measuring energy performance

### 1 Scope

1.1 This Singapore Standard specifies methods for measuring the energy performance of water heaters for water heating for household use.

1.2 The standard applies to the following water heaters:

Water heater type	Rated input power
Electric storage	$\leq 12$ kW
Electric instantaneous	$\leq 12$ kW
Electric heat pump	$\leq 6$ kW
Gas instantaneous	$\leq 59$ kW
Gas storage	$\leq 22$ kW

### 2 Normative references

There are no normative references in this standard.