

1. Introduction

In EN ISO 13786¹, a method is given to calculate dynamic thermal characteristics of 1D building components. These characteristics can be derived using the transient Physibel programs BISTRA and VOLTRA. For the 2 example components given in the Annex D of the standard, the characteristics are derived using these programs.

2. Data highlights

The 2 example walls as defined in annex D of EN ISO 13786 are shown in BISTRA/VOLTRA format in Figure 1.

Col.	Type	Subtype	Physical flow dir.	Geometrical flow dir.	Name	ϵ_1 / ϵ_2 [- / -]	λ [W/mK]	ρ [kg/m³]	c [J/kgK]	θ [°C]	h [W/m²K]	q [W/m²]	θ_a [°C]	h_c [W/m²K]	P_c [W/m]	θ_r [°C]	Sun	ρ_s [-]	Specular [%]	τ_s [-]	Standard
120	MATERIAL				concrete		1.800	2400	1000									0.10	0	0.00	
170	BC_SIMPL	HE	HOR		exterior					0.0	25.00	0					NO				EN10077
174	BC_SIMPL	NIHIL			interior (normal)					T01	7.70	0					NO				NIHIL

Col.	Type	Subtype	Physical flow dir.	Geometrical flow dir.	Name	ϵ_1 / ϵ_2 [- / -]	λ [W/mK]	ρ [kg/m³]	c [J/kgK]	θ [°C]	h [W/m²K]	q [W/m²]	θ_a [°C]	h_c [W/m²K]	P_c [W/m]	θ_r [°C]	Sun	ρ_s [-]	Specular [%]	τ_s [-]	Standard
57	MATERIAL				coating		1.000	1200	1500									0.10	0	0.00	
120	MATERIAL				concrete		1.800	2400	1000									0.10	0	0.00	
131	MATERIAL				insulation 0.040 W/mK		0.040	30	1400									0.10	0	0.00	
170	BC_SIMPL	HE	HOR		exterior					0.0	25.00	0					NO				EN10077
174	BC_SIMPL	NIHIL			interior (normal)					T01	7.70	0					NO				NIHIL

Figure 1. Example 1 (top) and 2 (bottom) as defined in Annex D of EN 13788 – BISTRA/VOLTRA

Generally spoken, the data input is relatively simple. Some data highlights are the following.

- The standard concerns a harmonic thermal analysis. A sinusoidal temperature (mean 0 °C, amplitude 10 °C, period 24h) is defined at one side (external or internal) and a constant temperature 0°C is defined at the other side (internal or external).
- Surface heat transfer coefficients $h_e = 25 \text{ W/m}^2\text{K}$ and $h_i = 7.7 \text{ W/m}^2\text{K}$ are defined.
- A calculation duration of 1 day with a start-up calculation duration of 5 days (in order to get a harmonic regime) is defined. A time step of 10 minutes and a maximum sub-layer of 0.01 m are specified, resulting in a reasonable precision of the numerical calculation.
- Graphic output (graphs and animations) and text output are defined. In order to derive the wall dynamic thermal characteristics the output of the heat flows at both wall surfaces are essential. The BISTRA/VOLTRA text results were processed in the spreadsheet [EN ISO 13786 annex D results.xls](#).

The wall dynamic thermal characteristics obtained are listed in the next 2 sections. The results are almost identical to the ones listed in the standard.

Small differences can be explained by the simulation time step (10 minutes).

¹ EN ISO 13786:2006 Thermal performance of building components - Dynamic thermal characteristics – Calculation methods

3. Example 1 – Results

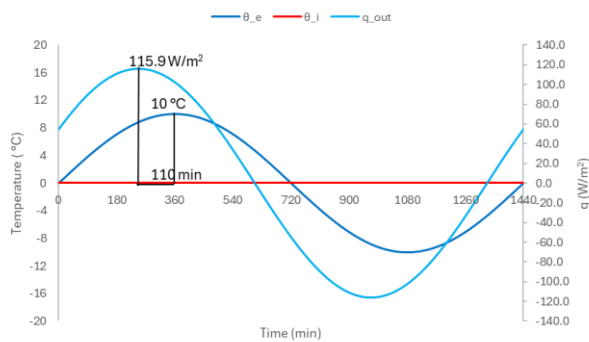


Figure 2. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at external surface [W/m²]

BISTRA data
[EN ISO 13786 annex D1 a bistra.bst](#)

VOLTRA data
[EN ISO 13786 annex D1 a voltra.vtr](#)

External thermal admittance

$$Y_{ee} = 11.59 \text{ W/m}^2\text{K}$$

Time shift

$$\tau_{ee} = 110 \text{ min}$$

Animation files

[EN-ISO-13786-annex-D1-a-voltra.mp4](#)

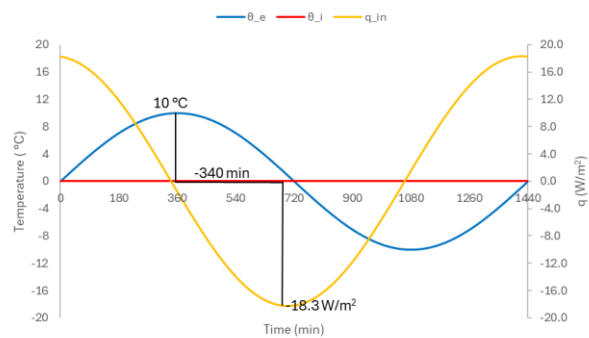


Figure 3. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]

BISTRA data
[EN ISO 13786 annex D1 a bistra.bst](#)

VOLTRA data
[EN ISO 13786 annex D1 a voltra.vtr](#)

Periodic thermal transmittance

$$Y_{ie} = 1.83 \text{ W/m}^2\text{K}$$

Time shift

$$\tau_{ie} = -340 \text{ min}$$

Animation file

[EN-ISO-13786-annex-D1-a-voltra.mp4](#)

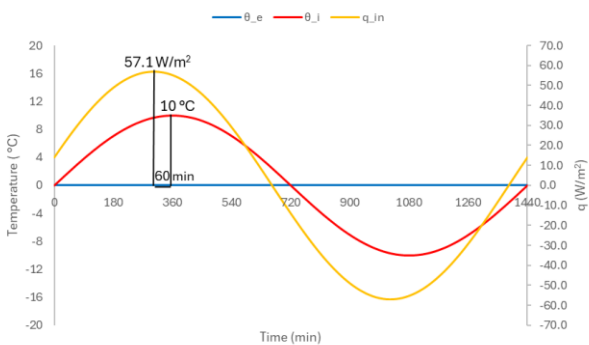


Figure 4. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]

BISTRA data
[EN ISO 13786 annex D1 b bistra.bst](#)

VOLTRA data
[EN ISO 13786 annex D1 b voltra.vtr](#)

Internal thermal admittance

$$Y_{ii} = 5.71 \text{ W/m}^2\text{K}$$

Time shift

$$\tau_{ii} = 60 \text{ min}$$

Animation file

[EN-ISO-13786-annex-D1-b-voltra.mp4](#)

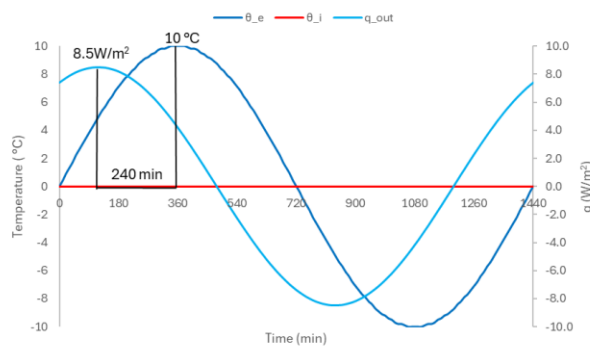
Thermal transmittance

$$U = 3.56 \text{ W/m}^2\text{K}$$

Decrement factor

$$f = Y_{ie} / U = 0.514$$

4. Example 2 – Results



BISTRA data
[EN ISO 13786 annex D2 a bistra.bst](#)
 VOLTRA data
[EN ISO 13786 annex D2 a voltra.vtr](#)

External thermal admittance

$$Y_{ee} = 0.85 \text{ W/m}^2\text{K}$$

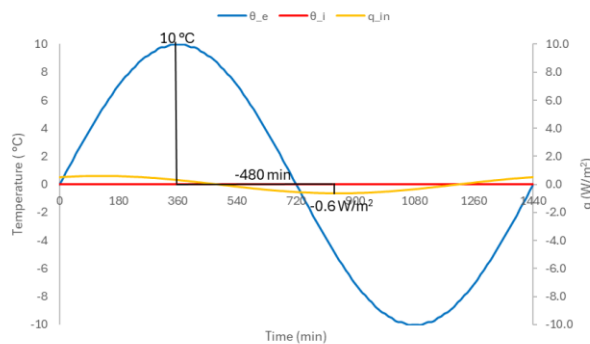
Time shift

$$\tau_{ee} = 240 \text{ min}$$

Animation file

[EN-ISO-13786-annex-D2-a-voltra.mp4](#)

Figure 5. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at external surface [W/m²]



BISTRA data
[EN ISO 13786 annex D2 a bistra.bst](#)
 VOLTRA data
[EN ISO 13786 annex D2 a voltra.vtr](#)

Periodic thermal transmittance

$$Y_{ie} = 0.06 \text{ W/m}^2\text{K}$$

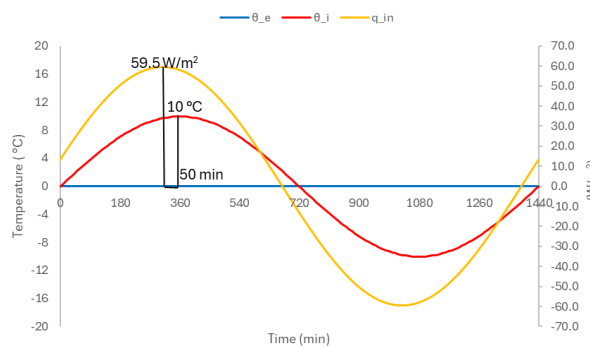
Time shift

$$\tau_{ie} = -480 \text{ min}$$

Animation file

[EN-ISO-13786-annex-D2-a-voltra.mp4](#)

Figure 6. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]



BISTRA data
[EN ISO 13786 annex D2 b bistra.bst](#)
 VOLTRA data
[EN ISO 13786 annex D2 b voltra.vtr](#)

Internal thermal admittance

$$Y_{ii} = 5.95 \text{ W/m}^2\text{K}$$

Time shift

$$\tau_{ii} = 50 \text{ min}$$

Animation file

[EN-ISO-13786-annex-D2-b-voltra.mp4](#)

Figure 7. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]

Thermal transmittance

$$U = 0.359 \text{ W/m}^2\text{K}$$

Decrement factor

$$f = Y_{ie} / U = 0.167$$