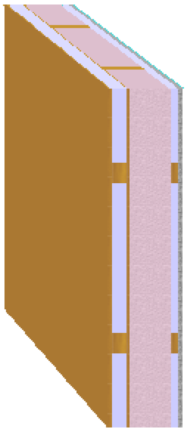
Documentation of the component
Thermal transmittance (U-value) according to BS EN ISO 6946
Source: **Lapolla Products - External walls**
Component: **Protec Timber Frame Wall - 0.17Wm2k 140mm 4G**

OUTSIDE INSIDE



This illustration of inhomogeneous layers is provided only to assist in visualising the arrangement.

On the basis of the given information about the inhomogeneous layers, it is not possible to estimate how and where bearing elements intersect each other. It was assumed that the layers intersect crosswise. The size of the areas was calculated corresponding to their percentage of the whole area.

Assignment: External wall

		Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
		Rse					0.0400
☑	1	Vulcan Systems	Composite Cladding	0.0200	0.200	E	0.1000
☑	2	Inhomogeneous material layer	consisting of:	0.0500	ø 0.115		0.4343
	2a	Unventilated Airspace BR 443	Low E cavity - 50 mm, unventilated	87.50 %	0.113	D	-
	2b	BS EN 12524	Softwood Timber [500 kg/m³]	12.50 %	0.130	D	-
☑	3	Lapolla Products	Protect TF200 Breather Membrane	0.0003	0.100	E	0.0025
☑	4	BS EN 12524	Oriented strand board (OSB)	0.0090	0.130	D	0.0692
☑	5	Inhomogeneous material layer	consisting of:	0.1400	ø 0.031		4.5167
	5a	Own catalogue Air gaps	Lapolla 4G Closed Cell Level 0: dU'' = 0.00 W/(m²K)	91.67 %	0.022	E	-
	5b	BS EN 12524	Softwood Timber [500 kg/m³]	08.33 %	0.130	D	-
☑	6	BS EN 12524	PVC foil	0.0001	0.170	D	0.0006
☑	7	Inhomogeneous material layer	consisting of:	0.0250	ø 0.138		0.1813
	7a	BS EN ISO 6946	Unventilated air layer: 25 mm, horiz. heat flow	87.50 %	0.139	D	-
	7b	BS EN 12524	Softwood Timber [500 kg/m³]	12.50 %	0.130	D	-
☑	8	BS EN 12524	Gypsum plasterboard	0.0150	0.250	D	0.0600
☑	9	BS EN 12524	Gypsum plastering	0.0020	0.570	D	0.0035
☑	10	BS EN 12524	Paint - emulsion	0.0001	0.200	D	0.0005
		Rsi					0.1300
				0.2615			

$R_T = (R_T' + R_T'')/2 = 5.82$ m²K/W

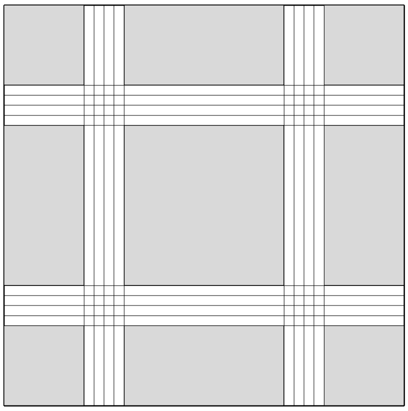
Correction to U-value for	according to	delta U [W/(m²K)]
Air gaps	BS EN ISO 6946 Annex D	~~0.000~~
		0.000

$U = 1/R_T + \Sigma\Delta U = 0.17$ W/(m²K)

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
A .. A: Data is entered and validated by the manufacturer or supplier. Data is continuously tested by 3rd party.
B .. B: Data is entered and validated by the manufacturer or supplier. Data is certified by 3rd party
C .. C: Data is entered and validated by the manufacturer or supplier.
D .. D: Information is entered by BuildDesk without special agreement with the manufacturer, supplier or others.
E .. E: Information is entered by the user of the BuildDesk software without special agreement with the manufacturer, supplier or others.

U = **0.17** W/(m²K) R_T= **5.82** m²K/W

Draft of the component (portion in %):



The intersection of the inhomogeneous layers results in 4 Zones (A, B, C, D). Information given in %.

A	5.01 + 10.03 + 5.01 + 10.03 + 20.05 + 10.03 + 5.01 + 10.03 + 5.01 consisting of material layers: 1, 2a, 3, 4, 5a, 6, 7a, 8, 9, 10	= 80.21%
B	0.91 + 1.82 + 0.91 + 0.91 + 1.82 + 0.91 consisting of material layers: 1, 2b, 3, 4, 5a, 6, 7b, 8, 9, 10	= 7.29%
C	1.43 + 2.86 + 1.43 + 1.43 + 2.86 + 1.43 consisting of material layers: 1, 2a, 3, 4, 5b, 6, 7a, 8, 9, 10	= 11.46%
D	0.26 + 0.26 + 0.26 + 0.26 consisting of material layers: 1, 2b, 3, 4, 5b, 6, 7b, 8, 9, 10	= 1.04%

Upper limit of the thermal transfer resistance R

$$U_A\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,A}) + R_{si} + R_{se}} = \frac{1}{7.22 + 0.13 + 0.04} = 0.14$$

$$U_B\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,B}) + R_{si} + R_{se}} = \frac{1}{1.94 + 0.13 + 0.04} = 0.47$$

$$U_C\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,C}) + R_{si} + R_{se}} = \frac{1}{7.18 + 0.13 + 0.04} = 0.14$$

$$U_D\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,D}) + R_{si} + R_{se}} = \frac{1}{1.89 + 0.13 + 0.04} = 0.49$$

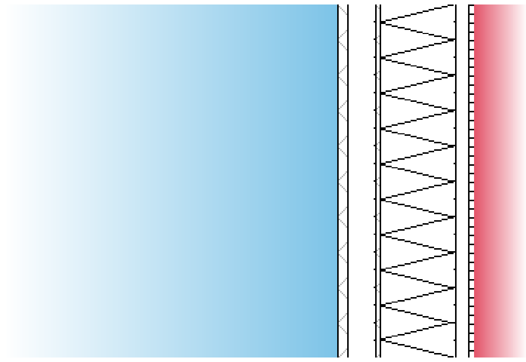
$$R_T' = \frac{1}{A * U_A + B * U_B + C * U_C + D * U_D} = 6.11\ m^2K/W$$

Lower limit of the thermal transfer resistance R

$R_{se}\ [m^2K/W]$			= 0.04
$R_1''\ [m^2K/W]$	$= d_1/\lambda_1 =$	0.0200 / 0.200	= 0.10
$R_2''\ [m^2K/W]$	$= d_2/(\lambda_{2a} * (A + B) + \lambda_{2b} * (C + D)) =$	0.0500 /(0.113 * 87.50% + 0.130 * 12.50%)	= 0.43
$R_3''\ [m^2K/W]$	$= d_3/\lambda_3 =$	0.0003 / 0.100	= 0.00
$R_4''\ [m^2K/W]$	$= d_4/\lambda_4 =$	0.0090 / 0.130	= 0.07
$R_5''\ [m^2K/W]$	$= d_5/(\lambda_{5a} * (A + C) + \lambda_{5b} * (B + D)) =$	0.1400 /(0.022 * 91.67% + 0.130 * 8.33%)	= 4.52
$R_6''\ [m^2K/W]$	$= d_6/\lambda_6 =$	0.0001 / 0.170	= 0.00
$R_7''\ [m^2K/W]$	$= d_7/(\lambda_{7a} * (A + B) + \lambda_{7b} * (C + D)) =$	0.0250 /(0.139 * 87.50% + 0.130 * 12.50%)	= 0.18
$R_8''\ [m^2K/W]$	$= d_8/\lambda_8 =$	0.0150 / 0.250	= 0.06
$R_9''\ [m^2K/W]$	$= d_9/\lambda_9 =$	0.0020 / 0.570	= 0.00
$R_{10}''\ [m^2K/W]$	$= d_{10}/\lambda_{10} =$	0.0001 / 0.200	= 0.00
$R_{si}\ [m^2K/W]$			= 0.13

$$R_T'' = \Sigma R_i'' + R_{si} + R_{se} = 5.54\ m^2K/W$$

OUTSIDE INSIDE



The list of material layers shown below may differ from those in the U-value calculation printout. Only material layers which are used in the Condensation Risk Analysis are listed.

This calculation of the Condensation risk analysis according to BS EN ISO 13788:2002 has been performed on a construction containing inhomogeneous layers. This calculation is only valid through the selected section. It is advisable that you should also select the alternative position and recalculate the Condensation Risk Analysis for a more complete assessment of the construction.

Assignment: External wall

Name	Thickn. [m]	lambda [W/(mK)]	Q	µ [-]	Q	sd [m]	R [m²K/W]
Composite Cladding	0.0200	0.200	E	5.36	E	0.11	0.1000
Low E cavity - 50 mm, unventilated	0.0500	0.113	D	1.00	D	0.05	0.4425
Protect TF200 Breather Membrane	0.0003	0.100	E	8000.00	E	2.00	0.0025
Oriented strand board (OSB)	0.0090	0.130	D	30.00	D	0.27	0.0692
Lapolla 4G Closed Cell	0.1400	0.022	E	62.10	E	8.69	6.3636
PVC foil	0.0001	0.170	D	300000.00	D	30.00	0.0006
Unventilated air layer: 25 mm, horiz. heat flow	0.0250	0.139	D	1.00	D	0.03	0.1799
Gypsum plasterboard	0.0150	0.250	D	4.00	D	0.06	0.0600
Gypsum plastering	0.0020	0.570	D	6.00	D	0.01	0.0035
Paint - emulsion	0.0001	0.200	D	1000.00	D	0.10	0.0005

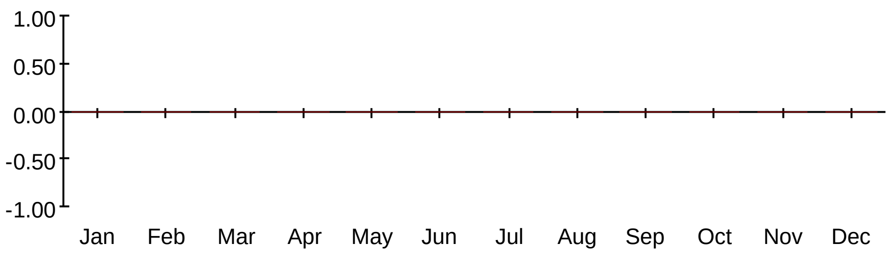
Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
A .. A: Data is entered and validated by the manufacturer or supplier. Data is continuously tested by 3rd party.
B .. B: Data is entered and validated by the manufacturer or supplier. Data is certified by 3rd party
C .. C: Data is entered and validated by the manufacturer or supplier.
D .. D: Information is entered by BuildDesk without special agreement with the manufacturer, supplier or others.
E .. E: Information is entered by the user of the BuildDesk software without special agreement with the manufacturer, supplier or others.

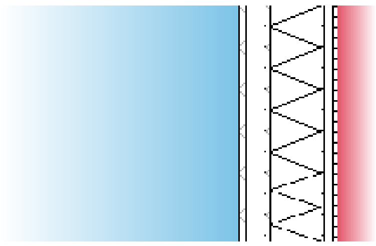
Condensation risk analysis - summary of main results
Calculation according BS EN ISO 13788

Surface temperature to avoid critical surface moisture:
No danger of mould growth is expected.

Interstitial condensation:
No condensation is predicted at any interface in any month.

Interstitial condensation and evaporation per month gc [g/m²]





Component, condensation range

CRA calculations according to BS EN ISO 13788:2002 are used as a guide in predicting interstitial condensation. This methodology uses some simplifications of the dynamic processes involved and subsequently does have some limitations. Further information can be found in Information Paper IP 2/05 'Modelling and controlling interstitial condensation in buildings'' Feb 2005.

Surface temperature to avoid critical surface humidity
Calculation according BS EN ISO 13788

Location: Plymouth/Mountbatte; Humidity class according BS EN ISO 13788 annex A: Dwellings with low occupancy

		1	2	3	4	5	6	7	8	9	10	11	12
	Month	Te	phi_e	Ti	phi_i	pe	delta p	pi	ps(Tsi)	Tsi,min	fRsi	Tsi	Tse
		[°C]	---	[°C]	---	[Pa]	[Pa]	[Pa]	[Pa]	[°C]	---	[°C]	[°C]
I	January	6.6	0.840	20.0	0.606	818	597	1415	1769	15.6	0.670	19.6	6.7
	February	6.1	0.830	20.0	0.599	781	619	1400	1750	15.4	0.670	19.5	6.2
	March	7.4	0.810	20.0	0.597	834	561	1395	1744	15.4	0.631	19.6	7.5
	April	8.8	0.760	20.0	0.582	860	499	1359	1699	15.0	0.549	19.6	8.9
	May	11.7	0.770	20.0	0.611	1058	370	1428	1785	15.7	0.484	19.7	11.7
	June	14.4	0.780	20.0	0.654	1279	249	1528	1911	16.8	0.426	19.8	14.4
	July	16.4	0.790	20.0	0.699	1473	160	1633	2041	17.8	0.398	19.9	16.4
	August	16.3	0.810	20.0	0.713	1500	165	1665	2082	18.1	0.498	19.9	16.3
	September	14.4	0.820	20.0	0.682	1345	249	1594	1993	17.4	0.545	19.8	14.4
	October	11.9	0.830	20.0	0.649	1156	361	1517	1896	16.7	0.588	19.7	11.9
	November	9.1	0.840	20.0	0.623	970	486	1456	1820	16.0	0.635	19.6	9.2
	December	7.7	0.840	20.0	0.612	882	548	1430	1788	15.7	0.654	19.6	7.8

- The critical month is January with $f_{Rsi,max}$ = 0.670
  f_{Rsi} = 0.967

$f_{Rsi} > f_{Rsi,max}$, the component complies.

Nr Explanation
1 External temperature
2 External rel. humidity
3 Internal temperature
4 Internal relative humidity
5 External partial pressure $p_e = \phi_e * p_{sat}(T_e)$; $p_{sat}(T_e)$ according formula E.7 and E.8 of BS EN ISO 13788
6 Partial pressure difference. The security factor of 1.10 according to BS EN ISO 13788, ch.4.2.4 is already included.
7 Internal partial pressure $p_i = \phi_i * p_{sat}(T_i)$; $p_{sat}(T_i)$ according formula E.7 and E.8 of BS EN ISO 13788
8 Minimum saturation pressure on the surface obtained by $p_{sat}(T_{si}) = p_i / \phi_{si}$,
where ϕ_{si} = 0.8 (critical surface humidity)
9 Minimum surface temperature as function of $p_{sat}(T_{si})$, formula E.9 and E.10 of BS EN ISO 13788
10 Design temperature factor according 3.1.2 of BS EN ISO 13788
11 Internal surface temperature, obtained from $T_{si} = T_i - R_{si} * U * (T_i - T_e)$
12 External surface temperature, obtained from $T_{se} = T_e + R_{se} * U * (T_i - T_e)$

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

Climcatic conditions
Location: Plymouth/Mountbatte; Humidity class according BS EN ISO 13788 annex A: Dwellings with low occupancy

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	60.6	59.9	59.7	58.2	61.1	65.4	69.9	71.3	68.2	64.9	62.3	61.2
External temperature [°C]	Te	6.6	6.1	7.4	8.8	11.7	14.4	16.4	16.3	14.4	11.9	9.1	7.7
External rel. humidity [%]	phi_e	84.0	83.0	81.0	76.0	77.0	78.0	79.0	81.0	82.0	83.0	84.0	84.0