

## 2x6 wood; 5.5 wood stud 24oc

### Description:

- 1/2-in. gypsum board
  - Thermal conductivity – 1.11 Btu-in/h-ft<sup>2</sup>-F
  - Density – 50 lb/ft<sup>3</sup>
  - Specific Heat – 0.26 Btu/lb-F
- 5.5-in. R-19 fiberglass batts
  - Thermal conductivity – 0.32 Btu-in/h-ft<sup>2</sup>-F
  - Density – 5.3 lb/ft<sup>3</sup>
  - Specific Heat – 0.23 Btu/lb-F
- 2x6 wood studs
  - Thermal conductivity – 1.0 Btu-in/h-ft<sup>2</sup>-F
  - Density – 36 lb/ft<sup>3</sup>
  - Specific Heat – 0.39 Btu/lb-F
- 1/2-in. plywood
  - Thermal conductivity – 0.8 Btu-in/h-ft<sup>2</sup>-F
  - Density – 34 lb/ft<sup>3</sup>
  - Specific Heat – 0.29 Btu/lb-F
- 1/2-in wood siding
  - Thermal conductivity – 0.5 Btu-in/h-ft<sup>2</sup>-F
  - Density – 34 lb/ft<sup>3</sup>
  - Specific Heat – 0.30 Btu/lb-F

## COMPUTATION RESULTS

### Three-dimensional model

**Table 2.1**  
**Resistance, transmittance and capacitance of the wall**

	<i>IP</i>		<i>SI</i>	
R-value	17.48678	ft <sup>2</sup> °F h/Btu	3.07767	m <sup>2</sup> K/W
R <sup>-1</sup>	0.32492	Btu/h ft <sup>2</sup> °F	0.05719	W/m <sup>2</sup> K
Capacitance	1.83167	Btu/ft <sup>2</sup> °F	37.42786	kJ/m <sup>2</sup> K

**Table 2.2**  
**Dimensionless 3D z-transfer function coefficients**

<i>n</i>	<i>b<sub>n</sub></i>	<i>c<sub>n</sub></i>	<i>d<sub>n</sub></i>
0	0.15322	10.64983	1.0000
1	0.25518	-17.95135	-0.97292
2	-0.21002	8.12819	0.19791
3	0.00873	-0.60887	-0.00718

$$\Sigma c_n = 0.20712 \quad E_1 = -0.04905$$

**Table 2.3****3D response factors calculated with the help of the finite difference computer code  
HEATING 7.2 [Btu/h ft<sup>2</sup> °F]**

$n$	$X_n$	$Y_n$
0	6.0902174E-01	8.7621028E-03
1	-4.3403617E-01	2.3117776E-02
2	-7.7993557E-02	8.7476666E-03
3	-2.0427411E-02	4.4978789E-03
4	-7.5564507E-03	3.2221099E-03
5	-3.8906173E-03	2.4286323E-03
6	-2.4215473E-03	1.8015577E-03
7	-1.6322261E-03	1.3128218E-03
8	-1.1344542E-03	9.4588873E-04
9	-7.9820464E-04	6.7718206E-04
10	-5.6459311E-04	4.8314840E-04
11	-4.0032967E-04	3.4408698E-04
12	-2.8419371E-04	2.4481757E-04
13	-2.0186814E-04	1.7410065E-04
14	-1.4343370E-04	1.2377841E-04
15	-1.0193009E-04	8.7989609E-05
16	-7.2441703E-05	6.2544308E-05
17	-5.1486460E-05	4.4455816E-05
18	-3.6593744E-05	3.1598123E-05
19	-2.6009114E-05	2.2458969E-05
20	-1.8486165E-05	1.5963061E-05
21	-1.3139216E-05	1.1345965E-05
22	-9.3388372E-06	8.0642905E-06

**Table 2.4****3D response factors ratio, dimensionless 3D response factors and transfer functions of the first order**

$n$	$X_n/X_{n-1}$	$Y_n/Y_{n-1}$	$R^*X_n$	$R^*Y_n$	$R^*X'_n$	$R^*Y'_n$
0			10.64983	0.15322	10.64983	0.15322
1	-0.71268	2.63838	-7.58990	0.40426	-15.15939	0.29535
2	0.17969	0.37840	-1.36386	0.15297	4.03075	-0.13436
3	0.26191	0.51418	-0.35721	0.07865	0.61217	-0.03007
4	0.36992	0.71636	-0.13214	0.05634	0.12175	0.00044
5	0.51487	0.75374	-0.06803	0.04247	0.02588	0.00242
6	0.62241	0.74180	-0.04235	0.03150	0.00601	0.00132
7	0.67404	0.72871	-0.02854	0.02296	0.00155	0.00057
8	0.69503	0.72050	-0.01984	0.01654	0.00045	0.00022
9	0.70360	0.71592	-0.01396	0.01184	0.00014	0.00009
10	0.70733	0.71347	-0.00987	0.00845	0.00005	0.00003
11	0.70906	0.71218	-0.00700	0.00602	0.00002	0.00001
12	0.70990	0.71150	-0.00497	0.00428	0.00001	
13	0.71032	0.71114	-0.00353	0.00304		
14	0.71053	0.71096	-0.00251	0.00216		
15	0.71064	0.71086	-0.00178	0.00154		
16	0.71070	0.71081	-0.00127	0.00109		
17	0.71073	0.71079	-0.00090	0.00078		
18	0.71074	0.71078	-0.00064	0.00055		
19	0.71075	0.71077	-0.00045	0.00039		
20	0.71076	0.71077	-0.00032	0.00028		
21	0.71076	0.71076	-0.00023	0.00020		
22	0.71076	0.71076	-0.00016	0.00014		

$$\alpha = 0.71076, \tau_1 = 2.92896$$

**Equivalent wall model: 3 layers plane wall**

**Table 2.5**  
**Structure factors and time constants**

<i>Structure factors</i>		<i>Time constants [h]</i>	
$\Phi_{ii}$	0.41899	$R \cdot C \cdot \Phi_{ii}$	13.420
$\Phi_{ie}$	0.07297	$R \cdot C \cdot \Phi_{ie}$	2.337
$\Phi_{ee}$	0.43507	$R \cdot C \cdot \Phi_{ee}$	13.935
		$R \cdot C$	32.030

**Table 2.6a**  
**Thermophysical properties of equivalent the wall - IP units**

<i>Layer</i>	$R_n$	$C_n$	$l_n$	$k_n$	$\rho_n$	$c_{pn}$
<i>N</i>	ft <sup>2</sup> -°F-h/Btu	Btu/ft <sup>2</sup> -°F	in	Btu-in/h-ft <sup>2</sup> -°F	lb/ft <sup>3</sup>	Btu/lb-°F
1	0.791	0.6	0.75	0.948	40	0.24
2	16.1084	0.61583	5.25	0.326	5.87	0.24
3	0.58738	0.61583	1	1.702	30.79	0.24

**Table 2.6b**  
**Thermophysical properties of the equivalent wall - SI units**

<i>Layer</i>	$R_n$	$C_n$	$l_n$	$k_n$	$\rho_n$	$c_{pn}$
<i>n</i>	m <sup>2</sup> K/W	kJ/ m <sup>2</sup> K	m	W/m K	kg/m <sup>3</sup>	kJ/kg K
1	0.13922	12.260	0.019	0.137	640	1.006
2	2.83508	12.584	0.133	0.047	93.84	1.006
3	0.10338	12.584	0.025	0.246	492.67	1.006

**Table 2.7**  
**Dimensionless z-transfer function coefficients and first time constants for the equivalent wall**

<i>n</i>	$b_n$	$c_n$	$d_n$	$\tau_n$
0	0.01187	12.73766	1.00000	
1	0.26109	-17.01635	-0.49381	1.209
2	0.23841	4.98535	0.02507	0.334
3	0.01962	-0.17614	-0.00015	0.194
4	0.00013	0.00059		0.141

$$\Sigma c_n = 0.53111, \alpha = 0.43724$$

**Table 2.8**  
**Response factors for the equivalent wall [Btu/h ft<sup>2</sup> °F]**

$n$	$X_n$	$Y_n$
0	7.284163E-01	6.788456E-04
1	-6.133990E-01	1.526596E-02
2	-3.607148E-02	2.115499E-02
3	-1.239889E-02	1.118577E-02
4	-5.275465E-03	5.002824E-03
5	-2.299508E-03	2.193135E-03
6	-1.005089E-03	9.592185E-04
7	-4.394508E-04	4.194264E-04
8	-1.921462E-04	1.833922E-04
9	-8.401466E-05	8.018708E-05
10	-3.673486E-05	3.506130E-05
11	-1.606208E-05	1.533032E-05
12	-7.023044E-06	6.703087E-06
13	-3.070780E-06	2.930881E-06
14	-1.342679E-06	1.281509E-06
15	-5.870776E-07	5.603317E-07
16	-2.566960E-07	2.450014E-07
17	-1.122387E-07	1.071253E-07
18	-4.907562E-08	4.683983E-08
19	-2.145801E-08	2.048042E-08
20	-9.382376E-09	8.954931E-09
21	-4.102383E-09	3.915487E-09
22	-1.793741E-09	1.712021E-09

**Frequency response for the three-dimensional model and equivalent wall;  
dimensionless amplitude and phase angle**

**Table 2.9a  
3-D model**

period	<i>Transmittance</i>		<i>Admittance</i>	
	amplitude	phase angle	amplitude	phase angle
48	0.94	-17°	2.11	54°
24	0.83	-29°	3.68	60°
12	0.64	-43°	6.50	57°
6	0.48	-63°	10.96	44°

**Table 2.9b  
Equivalent wall**

period	<i>Transmittance</i>		<i>Admittance</i>	
	amplitude	phase angle	amplitude	phase angle
48	0.99	-17°	2.06	58°
24	0.95	-34°	3.69	68°
12	0.82	-66°	6.84	70°
6	0.56	-118°	12.23	68°