OMEGA Cladding Attachment System Thermal Analysis

July 26, 2024

PREPARED FOR

PORCELANOSA FACADE/
PORCELANOSA Facades

BY

RDH BUILDING SCIENCE

30120.000

REPORT OVERVIEW | Background Information

This report has been prepared for:

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REVISION HISTORY

Revision	Date
Original	July 26, 2024

REFERENCE DOCUMENTS

This report was based on correspondence and CAD drawings of the Omega system and bill of materials provided by PORCELANOSA Facades including the following documents:

- Shop Drawings dated August 29, 2023 (ref: 22-0533)

ACRONYMS AND SYMBOLS

R_{nom}	Nominal insulation R-value of the insulation only
R_{1D}	Nominal insulation and assembly R-value
U_o	Bracket clear field U-value, for a given framing configuration
R_o	Bracket clear field R-value, for a given framing configuration

TERMINOLOGY

Backup Wall	The primary structure of the wall assembly on which the exterior cladding system is supported. This includes all typical components inboard of the exterior insulation, such as the substrate and interior finishes, where noted.
Bracket	An intermittent structural cladding support within the exterior wall cavity that connects the substrate of the backup wall to rail supports.
Rail	Additional continuous cladding substructure support that is part of the cladding attachment system.
Cladding	The exterior most layer of a wall assembly that provides the aesthetics and is typically the primary weather shedding surface. This may have its own additional substructure that will attach to the rail supports.
Thermal Bridging	A conductive element that bypasses the insulating layer of an assembly and decreases its thermal performance
Nominal R-value	A measure of a *single material's* resistance to heat flow
U-value	The rate of heat transfer through an assembly, including thermal bridging
Effective R-value	A measure of an *assembly*'s resistance to heat flow, including thermal bridging
Clear Wall	The typical wall assembly, including all repeating thermal bridging elements, such as studs, brackets, rails etc

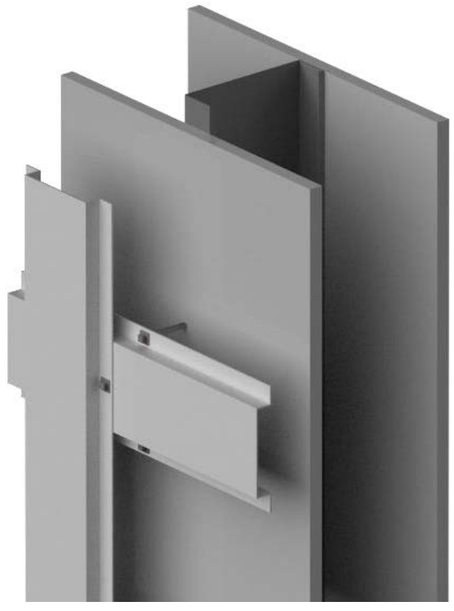
REPORT OVERVIEW | Scope and Contents

The Omega system comprises of crossing continuous aluminum rails running vertically and horizontally to support a rainscreen facade. The rails are fully exterior of the insulation and secured through the insulation with a pair of fasteners at each connection point. This system is intended for use as a cladding attachment solution for commercial and residential building projects. RDH Building Science Inc. (RDH) was retained by PORCELANOSA Facades to evaluate the thermal performance of this system and to provide clear-field U- and R-values for specific system configurations. The results are suitable for comparisons to thermal performance requirements in typical codes and standards, or as energy modelling inputs.

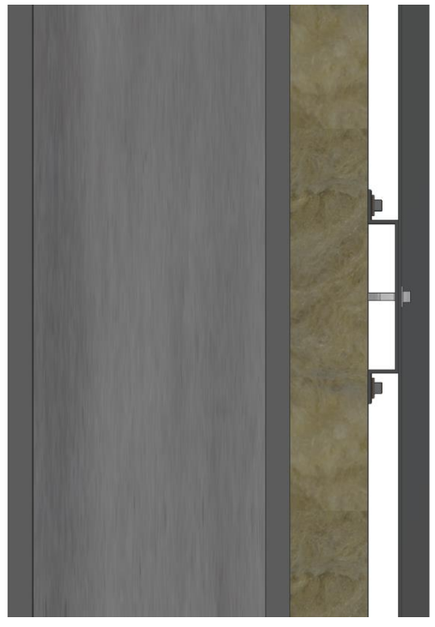
OMEGA System with an Uninsulated Steel Stud Backup Wall

SYSTEM INFORMATION | System Description

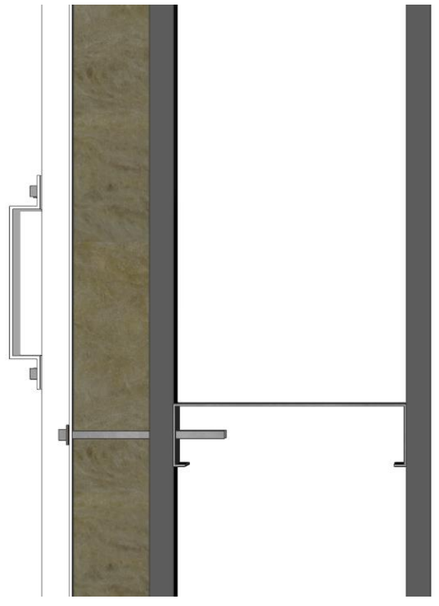
The OMEGA cladding system consists of crossing continuous aluminum rails running vertically and horizontally to support a rainscreen façade as shown below for a steel framed wall. The aluminum OMEGA profiles allow for adjustability, while variations in insulation depth up to 6” are accommodated with varying lengths of fasteners through the insulation. The fasteners are nominally provided with a non-conductive shim between the rail and the fastener.



OMEGA System
(Insulation hidden)



Section View



Plan View

SYSTEM INFORMATION | Evaluated Scenarios

Clear-field U- and R-values are provided in the reference sheets included as Appendix B.

6” Steel Stud Wall With & Without R-21 Batt

- **Sheathing:** ½” Gypsum board exterior sheathing and ½” interior sheathing..
- **Steel Stud**: 18 gauge, 6” x 1 5/8” steel studs with air in the stud cavity OR R-21 Batt
- **Fasteners:** #14 galvanized-steel fasteners x2 spaced vertically 12” O.C.
- **Washers:** EPDM washers
- **Rail:** Crossing aluminum hat-shaped girts
- **Exterior Insulation**: Mineral wool ranging in thickness from 2in to 6in, varying with fastener length

2x6” Wood Stud Wall With & Without R-21 Batt

- **Sheathing:** ½” Gypsum board exterior sheathing and ½” interior sheathing..
- **Steel Stud**: 2x6 wood studs with air OR R-21 Batt in the stud cavity.
- **Fasteners:** #14 galvanized-steel fasteners x2 spaced vertically 12” O.C.
- **Washers:** EPDM washers
- **Rail:** Crossing aluminum hat-shaped girts
- **Exterior Insulation**: Mineral wool ranging in thickness from 2in to 6in, varying with fastener length.

CMU Wall

- **Concrete:** 7 5/8” Concrete Block.
- **Fasteners:** #14 galvanized-steel fasteners x2 spaced vertically 12” O.C.
- **Washers:** EPDM washers
- **Rail:** Crossing aluminum hat-shaped girts
- **Exterior Insulation**: Mineral wool ranging in thickness from 2in to 6in, varying with fastener length.

METHODOLOGY | Analysis Approach

EVALUATION ASSUMPTIONS

PORCELANOSA Facades OMEGA system performance was evaluated using three-dimensional thermal modelling. Thermal modelling was performed in general conformance with *CSA Z5010: Calculation of Thermal Bridges in Building Enclosure Assemblies* and the *ASHRAE Handbook Fundamentals*. General assumptions include:

- Steady state conditions with no solar heating
- Constant isotropic material properties from the ASHRAE Handbook of Fundamentals, NFRC 101-2023, and other published references
- Equivalent conductivities for glazing and air cavities were determined using ISO 10077-2

Further simulation notes and modelling parameters are described in Appendix A.

INTERPOLATION

For this evaluation, over 50 scenarios were explicitly modelled for 3”, 5” and 12” insulation depths. Due to the consistency in the performance trends from the modelled scenarios, the U- and effective R-values for other insulation depths can be interpolated to a reliable level of accuracy. These interpolated values have also been included in the results tables.

BOUNDARY CONDITIONS

Values for the boundary conditions used in the analysis are shown below in Table 1. These values were derived from the ASHRAE Handbook of Fundamentals and CSA Z5010.

TABLE 1: BOUNDARY CONDITIONS

Location	Thermal Resistance $ft^2 \cdot {}^\circ F \cdot h/BTU$ ($m^2 \cdot K/W$)
Exterior (15mph wind)	0.170 (0.03)
Exterior (protected)	0.681 (0.12)
Interior (opaque wall)	0.681 (0.12)

TEMPERATURE INDEX

The temperature profiles are presented as a Temperature Index (I). The Temperature Index is a non-dimensional ratio of the surface temperature relative to the interior and exterior temperature across the assembly, as per the following equation:

$$I = \frac{T_s - T_e}{T_i - T_e}$$

As the material properties are assumed independent of temperature, surface temperatures for critical areas can be estimated for project specific temperature conditions using the following conversion:

$$T_s = I \cdot (T_i - T_e) + T_e$$

MATERIAL PROPERTIES

The thermophysical properties of all materials included in the thermal simulation were based on data provided in ASHRAE Handbook of Fundamentals, NFRC 101, or independent third-party tested values in accordance with ASTM C518. Specific materials of interest for this analysis are summarized in the table below. A full listing of materials with location references for each assembly are provided in data sheets in Appendix B.

Component	Material	Thermal Conductivity Btu · in / ft^2 · hr · °F (W/m·K)
Sheathing	Gypsum	1.1 (0.160)
Steel Studs	Galv. Steel	360 (52.0)
Exterior Insulation	Mineral Wool	0.24 (0.034)
Rail	Aluminum Alloy	1110 (160.0)
Fasteners	Galvanized Steel	360 (52.0)
Washer	EPDM	1.7 (0.25)
Concrete Block (CMU)	Concrete	10.3 (1.5)

CLOSING

We trust this report meets your current requirements for a thermal analysis of the OMEGA cladding attachment system. Please do not hesitate to contact us with any questions you might have.

AUTHORS

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RDH BUILDING SCIENCE

APPENDIX A | Simulation Notes

A.1 Additional Assumptions

In addition to the standard modelling assumptions, the following assumptions were made for the assembly:

- Steady state conditions with no solar heating
- The clear field modelling does not include the impacts of the thermal bridging from interface details, such as balcony slabs, parapets or window transitions. It only includes repeating thermal bridges such as studs and clips.
- Constant isotropic material properties from the ASHRAE Handbook of Fundamentals, NFRC 100-2023, and other published sources
- Equivalent thermal conductivities for air cavities were determined using ISO 10077-2
- The insulation was assumed to be installed tight to the fasteners and substrate with no gaps.
- Based on ASHRAE 1365-RP, contact resistances between materials were used, and are shown in A.2
- Placement and thicknesses of weather barriers and membranes were assumed to have no impact
- Excludes impact of potential air leakage through the assembly
- Exterior cladding was indirectly simulated using a protected air film. This approach is considered conservative and permits the results to be used more broadly for a range of similar cladding options.

A.2 Contact Resistances

Table A1 below presents the contact resistances assumed in the analysis, as per ASHRAE 1365-RP

TABLE A1 CONTACT RESISTANCES

Boundary Conditions	Contact Resistance $ft^2 \cdot {}^\circ F \cdot h/BTU$ ($m^2 \cdot K/W$)
Steel Flanges at Sheathing Interfaces	0.170 (0.030)
Steel to Steel Interfaces	0.051 (0.002)
Insulation Interfaces	0.254 (0.010)

A.3 Boundary Conditions

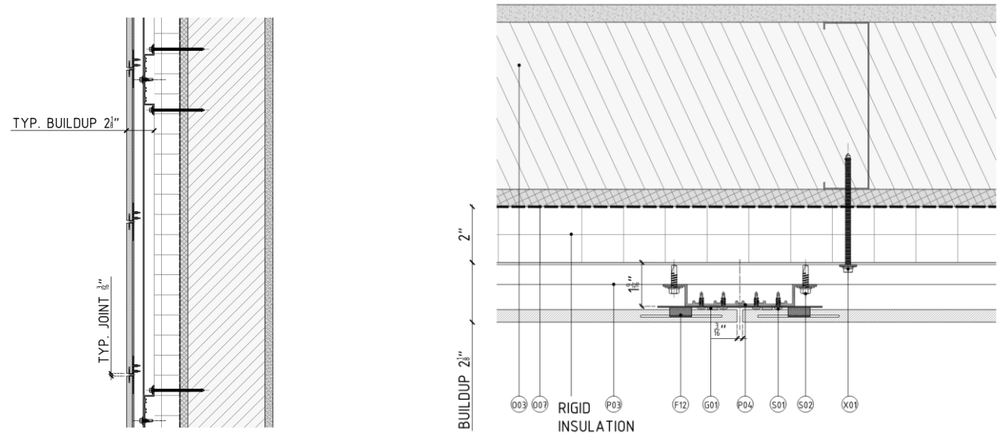
Values for the boundary conditions used in the analysis are shown below in Table A2. These values were derived from the ASHRAE Handbook of Fundamentals and CSA Z5010.

TABLE A2 BOUNDARY CONDITIONS

Location	Thermal Resistance $ft^2 \cdot {}^\circ F \cdot h/BTU$ ($m^2 \cdot K/W$)
Exterior (15mph wind)	0.170 (0.03)
Exterior (protected)	0.681 (0.12)
Interior (opaque wall)	0.681 (0.12)

A.4 Manufacturer's Detail (Sample)

An example of the manufacturer's detail is shown below. Refer to VBBL Div. C 2.3.1 for documentation requirements.



V2 EXTERIOR WALL SECTION DETAIL

TYP. 3/16" (5MM) VERTICAL JOINT - EXTERIOR

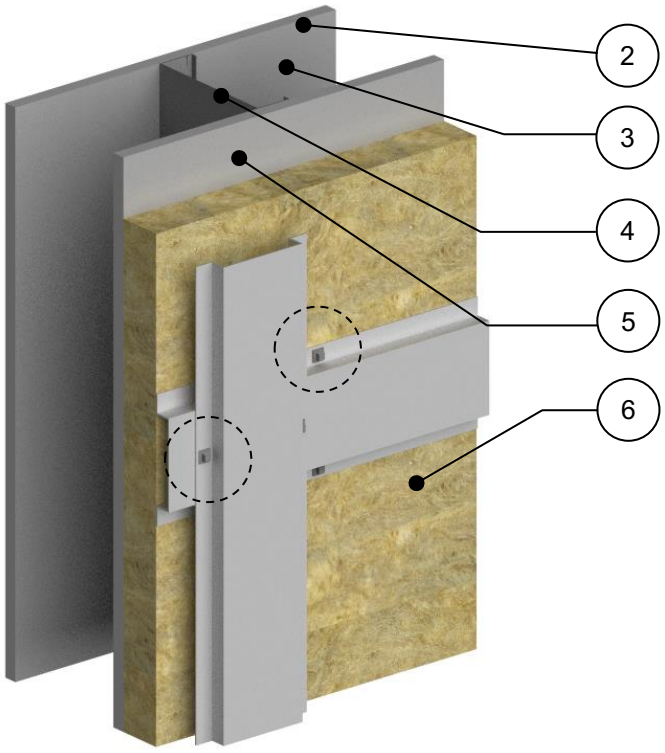
APPENDIX B | System Data Sheets

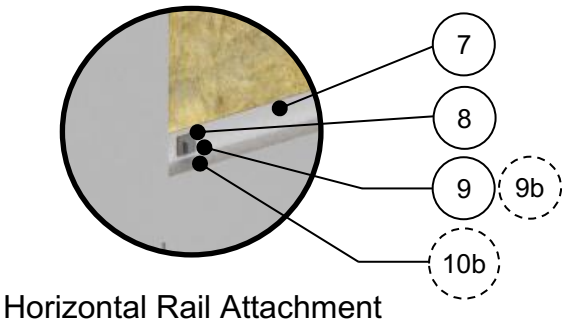
B

See following pages

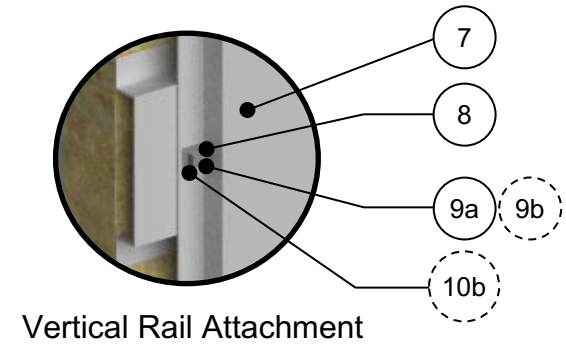
Detail 1

6” x 1 5/8” Steel Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Insulation Steel Fasteners (12” o.c. x 2) – Clear Wall





Horizontal Rail Attachment



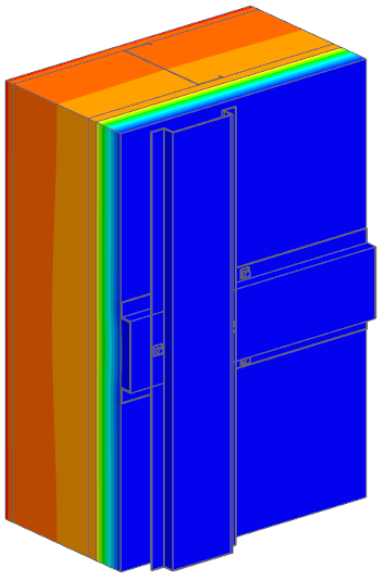
Vertical Rail Attachment

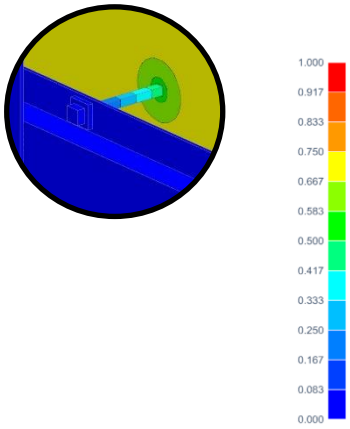
ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6” (152)	1.1 (0.948)	R-0.91 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6” x 1 5/8” Steel Studs	16 Gauge	360 (52)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
6	Exterior Mineral Wool Insulation	2” to 6” (50 to 150)	0.24 (0.034)	R-8.4 to R-25.2 (1.48 to 4.44 RSI)	4 (64)	0.20 (850)
7	Omega Hat Channel	1/16” (2)	1110 (160)	-	171 (2739)	0.21 (900)
8	Galvanized Fasteners	1/4” (6.5) Ø	360 (52)	-	489 (7830)	0.12 (500)
9a	EPDM Washer	1/32” (1)	1.7 (0.25)	-		
9b	Galvanized Washer	1/32” (1)	360 (52)	-	489 (7830)	0.12 (500)
10b	½” Polyurethane Foam[3]	½” (12.7)	0.20 (0.029)	R-2.5 (0.44 RSI)	1.0 (16)	0.35 (1470)
11	Exterior Protected Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.
[2] **Scenario A**: EPDM washers, no spray foam
[3] **Scenario B**: Galvanized steel washers with locally applied spray foam overtop of exposed fastener heads

Detail 1

6” x 1 5/8” Steel Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Insulation Steel Fasteners (12” o.c. x 2) – Clear Wall





View from Exterior

Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-3.3 (0.58 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	“Clear Wall” U- and R-value
Surface Temperature Index[1]	I	0 = Exterior temperature 1 = Interior temperature

[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Scenarios

Scenario	Description
A	EPDM Washers
B	Galvanized Steel Washers w/ Spray Foam Over Fasteners

Nominal (1D) vs. Assembly Performance Indicators

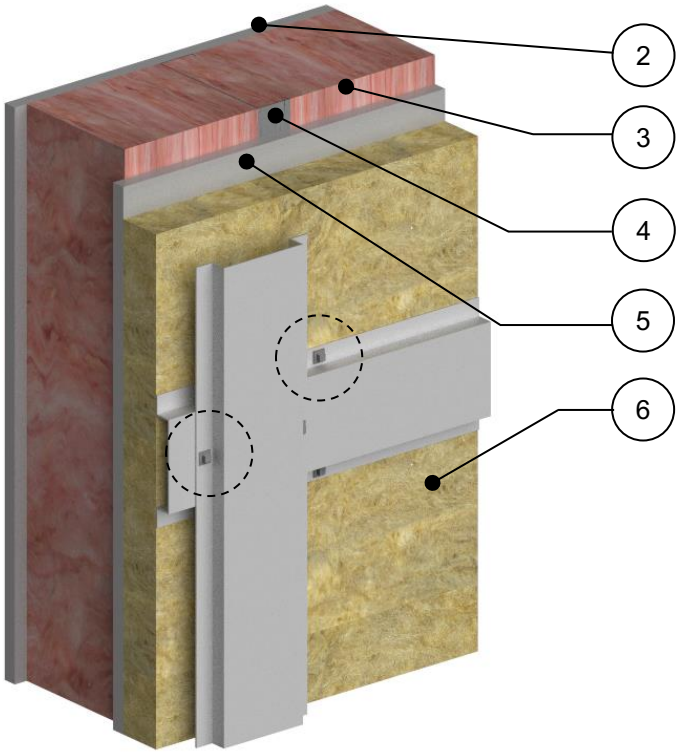
Scenario	Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	16” x 24” Rail Spacing		24” x 24” Rail Spacing	
			R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)
A	R-8.4 (1.48)	R-11.7 (2.06)	10.1 (1.79)	0.01 (0.56)	10.7 (1.88)	0.09 (0.53)
A	R-12.6 (2.22)	R-15.9 (2.80)	13.4 (2.36)	0.07 (0.42)	14.2 (2.50)	0.07 (0.40)
A	R-16.8 (2.96)	R-20.1 (3.54)	16.7 (2.95)	0.06 (0.34)	17.6 (3.10)	0.06 (0.32)
A	R-21.0 (3.69)	R-24.3 (4.28)	20.1 (3.53)	0.05 (0.28)	21.5 (3.78)	0.05 (0.26)
A	R-25.2 (4.44)	R-28.5 (5.02)	23.4 (4.28)	0.04 (0.24)	25.2 (4.44)	0.04 (0.22)
B	R-8.4 (1.48)	R-11.7 (2.06)	10.1 (1.78)	0.01 (0.56)	-	-

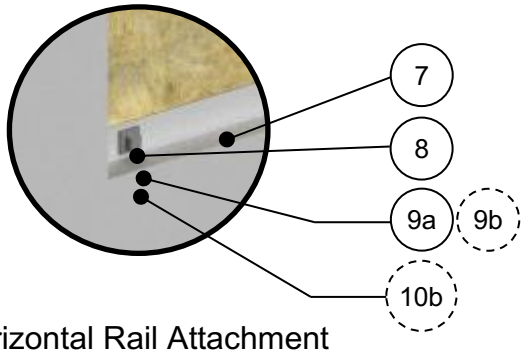
Temperature Indices

	R-8.4(A)	R-8.4(B)	R-16.8(A)	R-25.2(A)	
I	0.77	0.76	0.85	0.89	Min T on the fastener behind the exterior sheathing
	0.93	0.93	0.96	0.97	Min T on interior side of interior sheathing behind fastener penetration

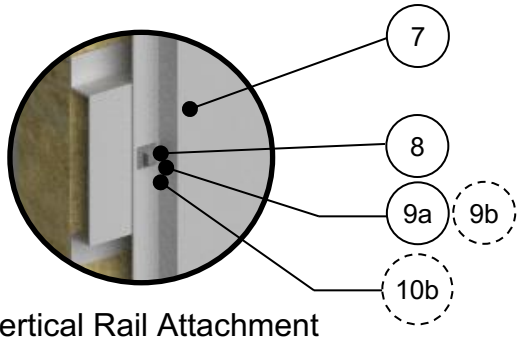
Detail 2

Split-Insulated 6” x 1 5/8” Steel Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Wall Steel Fasteners (12” o.c. x 2) – Clear Wall





Horizontal Rail Attachment



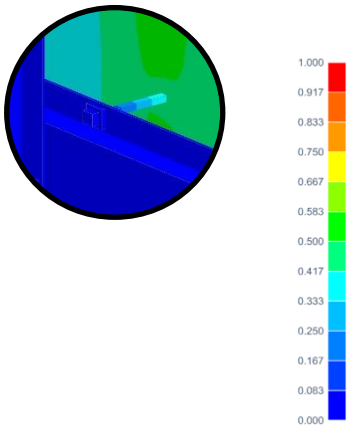
Vertical Rail Attachment

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
3	Fiber Batt	6” (152)	0.053 (0.044)	R-19 (3.4 RSI)	2 (32)	0.24 (1000)
4	6” x 1 5/8” Steel Studs	16 Gauge	360 (52)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
6	Exterior Mineral Wool Insulation	2” to 6” (50 to 150)	0.24 (0.034)	R-8.4 to R-25.2 (1.48 to 4.44 RSI)	4 (64)	0.20 (850)
7	Omega Hat Channel	1/16” (2)	1110 (160)	-	171 (2739)	0.21 (900)
8	Galvanized Fasteners	1/4” (6.5) Ø	360 (52)	-	489 (7830)	0.12 (500)
9a	EPDM Washer[2]	1/32” (1)	1.7 (0.25)	-		
9b	Galvanized Washer	1/32” (1)	360 (52)	-	489 (7830)	0.12 (500)
10b	½” Polyurethane Foam[3]	½” (12.7)	0.20 (0.029)	R-2.5 (0.44 RSI)	1.0 (16)	0.35 (1470)
11	Exterior Protected Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.
[2] **Scenario A**: EPDM washers, no spray foam
[3] **Scenario B**: Galvanized steel washers with locally applied spray foam overtop of exposed fastener heads

Detail 2

Split-Insulated 6” x 1 5/8” Steel Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Wall Steel Fasteners (12” o.c. x 2) – Clear Wall



View from Exterior

Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-21.4 (3.77 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	“Clear Wall” U- and R-value
Surface Temperature Index[1]	I	0 = Exterior temperature 1 = Interior temperature

[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Scenarios

Scenario	Description
A	EPDM Washers
B	Galvanized Steel Washers w/ Spray Foam Over Fasteners

Nominal (1D) vs. Assembly Performance Indicators

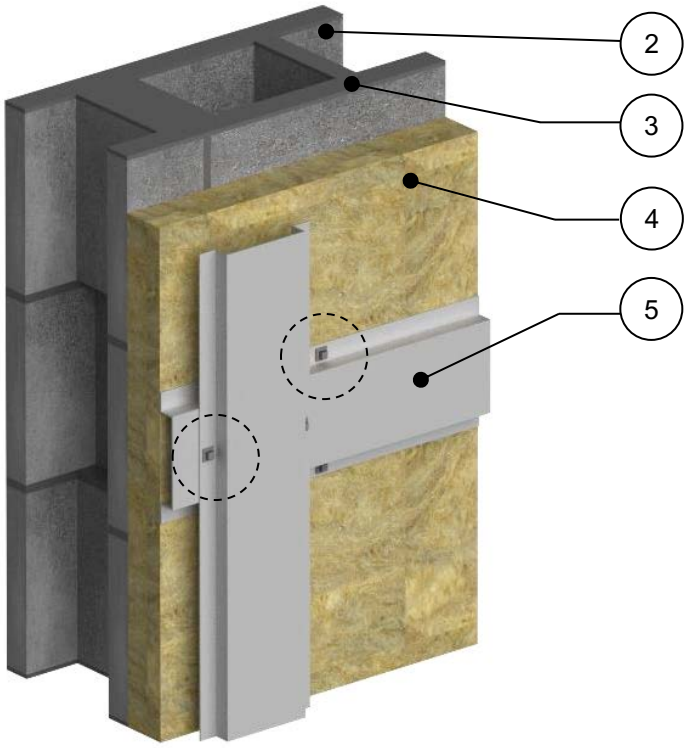
Scenario	Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	16” x 24” Rail Spacing		24” x 24” Rail Spacing	
			R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)
A	R-8.4 (1.48)	R-29.8 (5.25)	17.9 (3.16)	0.06 (0.317)	21.2 (3.73)	0.05 (0.27)
A	R-12.6 (2.22)	R-34.0 (5.98)	21.3 (3.75)	0.05 (0.27)	24.7 (4.36)	0.04 (0.23)
A	R-16.8 (2.96)	R-38.2 (6.73)	24.3 (4.28)	0.04 (0.233)	28.2 (4.96)	0.04 (0.20)
A	R-21.0 (3.69)	R-42.4 (7.47)	27.8 (4.89)	0.04 (0.20)	31.9 (5.63)	0.03 (0.18)
A	R-25.2 (4.44)	R-46.6 (8.21)	31.1 (5.48)	0.03 (0.18)	35.7 (6.28)	0.03 (0.16)
B	R-8.4 (1.48)	R-29.8 (5.25)	17.9 (3.15)	0.06 (0.32)	-	-

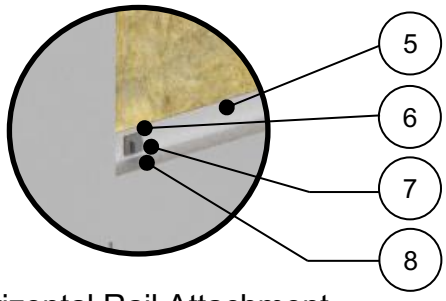
Temperature Indices

	R-8.4 (A)	R-8.4 (B)	R-16.8 (A)	R-25.2 (A)	
I	0.52	0.52	0.65	0.72	Min T on fastener behind the exterior sheathing
	0.89	0.9	0.93	0.94	Min T on interior side of interior sheathing behind fastener Penetration

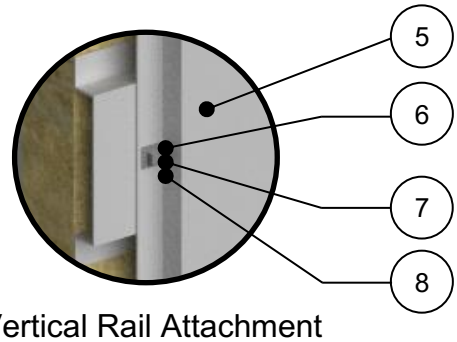
Detail 3

8” x 16” Concrete Block Wall Assembly with Mineral Wool Insulation and Through Wall Steel Fasteners (12” o.c. x 2) – Clear Wall





Horizontal Rail Attachment



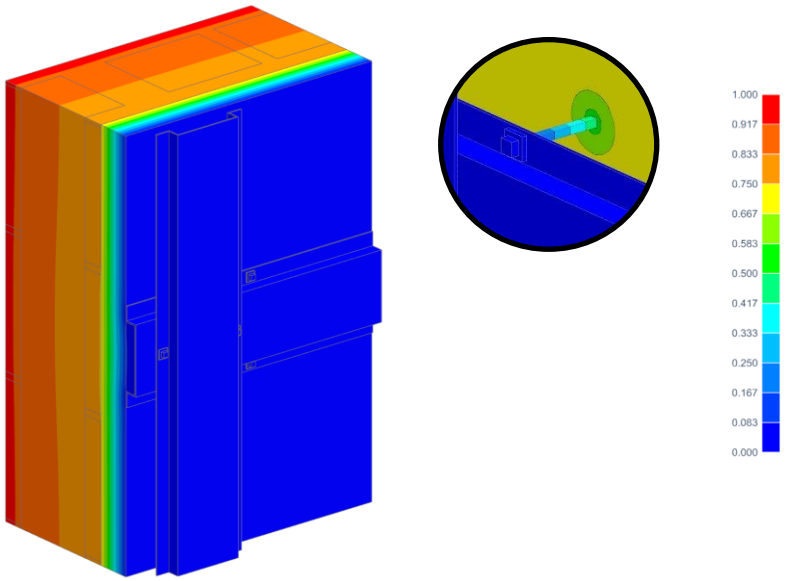
Vertical Rail Attachment

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Block	7 5/8” (190)	10.3 (1.5)	-	119 (1900)	0.19 (8000)
3	Cement Mortar	-	3.5 (0.5)	-	113 (7830)	0.12 (500)
4	Exterior Mineral Wool Insulation	2” to 6” (50 to 150)	0.24 (0.034)	R-8.4 to R-25.2 (1.48 to 4.44 RSI)	4 (64)	0.20 (850)
5	Omega Hat Channel	1/16” (2)	1110 (160)	-	171 (2739)	0.21 (900)
6	Galvanized Fasteners	1/4” (6.5) Ø	360 (52)	-	489 (7830)	0.12 (500)
7	EPDM Washer	1/32” (1)	1.7 (0.25)	-		
8	Exterior Protected Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.

Detail 3

8” x 16” Concrete Block Wall Assembly with Mineral Wool Insulation and Through Wall Steel Fasteners (12” o.c. x 2) – Clear Wall



View from Exterior

Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-1.4 (0.32 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	“Clear Wall” U- and R-value
Surface Temperature Index[1]	I	0 = Exterior temperature 1 = Interior temperature

[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Nominal (1D) vs. Assembly Performance Indicators

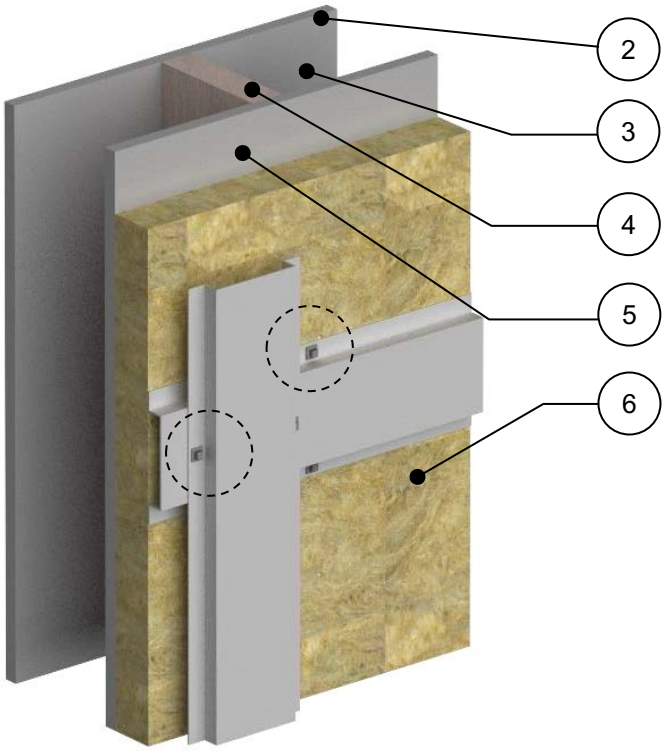
Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	16” x 24” Rail Spacing		24” x 24” Rail Spacing	
		R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 ·hr ·^oF (W/m^2 K)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 ·hr ·^oF (W/m^2 K)
R-8.4 (1.48)	R-9.8 (1.73)	9.6 (1.68)	0.10 (0.59)	10.1 (1.77)	0.01 (0.56)
R-12.6 (2.22)	R-14.0 (2.47)	12.9 (2.26)	0.08 (0.44)	13.7 (2.41)	0.07 (0.41)
R-16.8 (2.96)	R-18.2 (3.20)	16.1 (2.84)	0.06 (0.35)	17.1 (3.02)	0.06 (0.33)
R-21.0 (3.69)	R-22.4 (3.95)	19.4 (3.42)	0.05 (0.29)	21.4 (3.76)	0.05 (0.27)
R-25.2 (4.44)	R-26.6 (5.69)	22.7 (4.00)	0.04 (0.25)	25.4 (4.48)	0.04 (0.22)

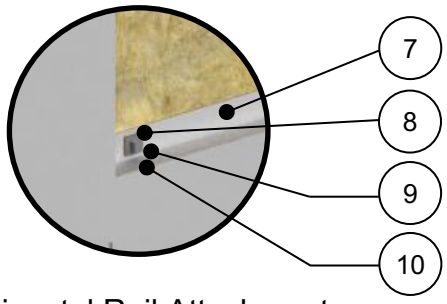
Temperature Indices

	R-8.4	R-16.8	R-25.3	
I	0.70	0.82	0.87	Min T on the fastener behind the exterior sheathing
	0.93	0.96	0.97	Min T on the interior side of interior sheathing behind the fastener penetration

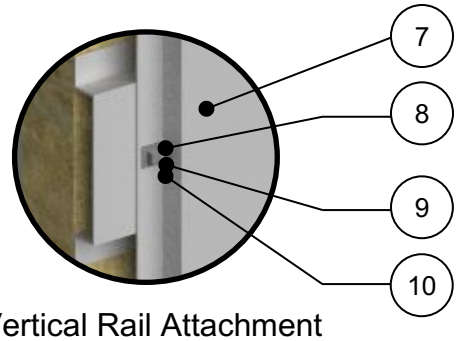
Detail 4

2x6 Wood Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Wall Steel Fasteners (12” o.c. x 2) – Clear Wall





Horizontal Rail Attachment



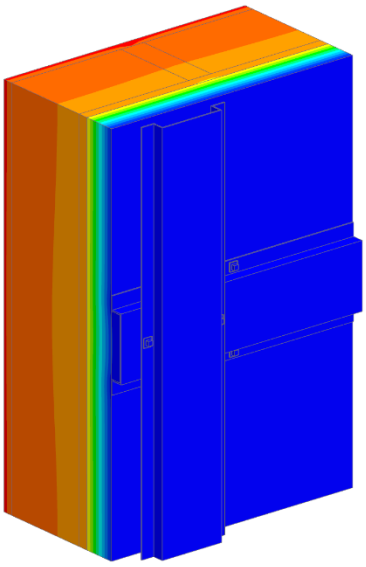
Vertical Rail Attachment

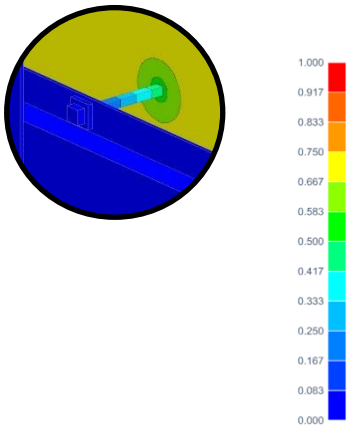
ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	5.5” (152)	1.1 (0.948)	R-0.91 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	2x6 Wood Studs	5.5”	360 (52)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
6	Exterior Mineral Wool Insulation	2” to 6” (50 to 150)	0.24 (0.034)	R-8.4 to R-25.2 (1.48 to 4.44 RSI)	4 (64)	0.20 (850)
7	Omega Hat Channel	1/16” (2)	1110 (160)	-	171 (2739)	0.21 (900)
8	Galvanized Fasteners	1/4” (6.5) Ø	360 (52)	-	489 (7830)	0.12 (500)
9	EPDM Washer	1/32” (1)	1.7 (0.25)	-		
10	Exterior Protected Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.

Detail 4

2x6 Wood Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Wall Steel Fasteners (12” o.c. x 2) – Clear Wall





View from Exterior

Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-3.3 (0.58 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	“Clear Wall” U- and R-value
Surface Temperature Index[1]	I	0 = Exterior temperature 1 = Interior temperature

[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Nominal (1D) vs. Assembly Performance Indicators

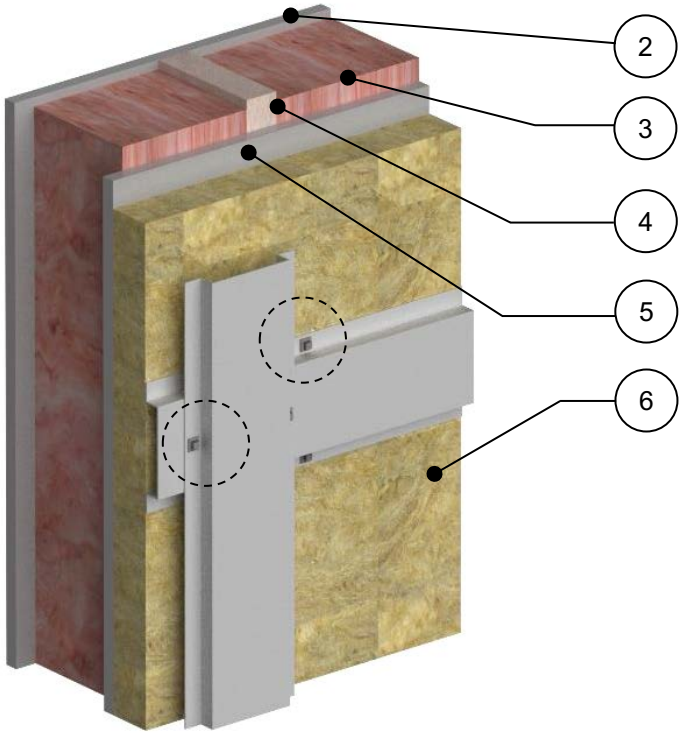
Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	16” x 24” Rail Spacing		24” x 24” Rail Spacing	
		R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)
R-8.4 (1.48)	R-11.7 (2.06)	10.9 (1.92)	0.092 (0.521)	11.2 (1.98)	0.089 (0.505)
R-12.6 (2.22)	R-15.9 (2.80)	14.3 (2.51)	0.070 (0.398)	14.8 (2.61)	0.067 (0.383)
R-16.8 (2.96)	R-20.1 (3.54)	17.7 (3.12)	0.056 (0.321)	18.5 (3.25)	0.054 (0.307)
R-21.0 (3.69)	R-24.3 (4.28)	21.0 (3.69)	0.048 (0.271)	22.0 (3.88)	0.045 (0.258)
R-25.2 (4.44)	R-28.5 (5.02)	24.3 (4.27)	0.041 (0.234)	25.6 (4.51)	0.039 (0.222)

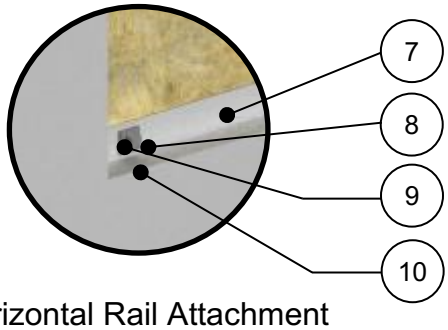
Temperature Indices

	R-8.4	R-16.8	R-25.2	
I	0.49	0.64	0.72	Min T on the fastener behind the exterior sheathing
	0.95	0.96	0.97	Min T on the interior side of interior sheathing behind the fastener penetration

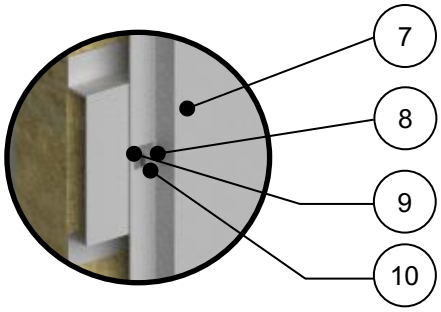
Detail 5

Split-Insulated 2x6 Wood Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Insulation Steel Fasteners (12” o.c. x 2) – Clear Wall





Horizontal Rail Attachment



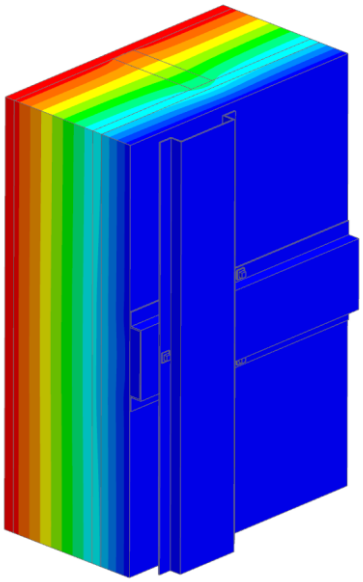
Vertical Rail Attachment

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
3	Fiber Batt	6” (152)	0.053 (0.044)	R-19 (3.4 RSI)	2 (32)	0.24 (1000)
4	2x6 Wood Studs	5.5”	1.1 (0.16)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
6	Exterior Mineral Wool Insulation	2” to 6” (50 to 150)	0.24 (0.034)	R-8.4 to R-25.2 (1.48 to 4.44 RSI)	4 (64)	0.20 (850)
7	Omega Hat Channel	1/16” (2)	1110 (160)	-	171 (2739)	0.21 (900)
8	Galvanized Fasteners	1/4” (6.5) Ø	360 (52)	-	489 (7830)	0.12 (500)
9	EPDM Washer	1/32” (1)	1.7 (0.25)	-		
10	Exterior Protected Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

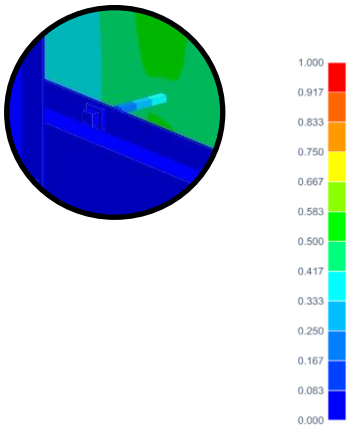
[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.

Detail 5

Split-Insulated 2x6 Wood Stud (16” o.c.) Wall Assembly with Mineral Wool Insulation and Through Insulation Steel Fasteners (12” o.c. x 2) – Clear Wall



View from Exterior



Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-21.4 (3.77 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	“Clear Wall” U- and R-value
Surface Temperature Index[1]	I	0 = Exterior temperature 1 = Interior temperature

[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-Value (RSI)	R_{1D} ft²·hr·°F / Btu (m² K / W)	16” x 24” Rail Spacing		24” x 24” Rail Spacing	
		R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)
R-8.4 (1.48)	R-29.8 (5.25)	24.2 (4.26)	0.041 (0.234)	25.5 (4.49)	0.039 (0.223)
R-12.6 (2.22)	R-34.0 (5.99)	27.8 (4.89)	0.036 (0.204)	29.1 (5.13)	0.034 (0.195)
R-16.8 (2.96)	R-38.2 (6.73)	31.6 (5.57)	0.032 (0.180)	32.7 (5.76)	0.031 (0.174)
R-21.0 (3.69)	R-42.4 (7.47)	34.5 (6.08)	0.029 (0.164)	36.4 (6.4)	0.028 (0.156)
R-25.2 (4.44)	R-46.6 (8.21)	37.7 (6.64)	0.027 (0.151)	40.0 (7.05)	0.025 (0.142)

Temperature Indices

	R-8.4	R-16.8	R-25.2	
I	0.24	0.36	0.46	Min T on fastener behind the exterior sheathing
	0.95	0.96	0.97	Min T on interior side of interior sheathing behind fastener Penetration