MORRISON HERSHFIELD

Galvanized Steel StoVentec Bracket Thermal Analysis

Presented to:

David Hohenstern
Senior Product Development Specialist – Ventec

Sto Corporation
120-3800 Camp Creek Parkway
Atlanta, GA 30331

Report Number: 220334401
February 27, 2024

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	MODELING PROCEDURES	4
3.	THERMAL RESULTS	5

APPENDIX A: DETAIL DRAWINGS
APPENDIX B: MODELING PARAMETERS AND ASSUMPTIONS
APPENDIX C: MATERIAL PROPERTIES
APPENDIX D: SIMULATED TEMPERATURE PROFILES
APPENDIX E: GLOSSARY OF TERMS

1. INTRODUCTION

Morrison Hershfield (MH) was retained by Sto Corporation (Sto) to evaluate the thermal performance of the StoVentec Galvanized Steel Bracket system for a variety of insulation thicknesses and bracket spacing. This report is a summary of the analysis.

The StoVentec Bracket system is composed of two brackets:

- FP: 5-1/4 inch (135 mm) tall, fixed-point bracket.
- GP: 3-3/4 inch (96 mm) tall, movement bracket.

Both FP and GP brackets includes a T-rail. A 1/4 inch (6 mm) thick PVC thermal isolator can be added between the brackets and the substrate.

The StoVentec brackets come in multiple sizes, which are used in combination with the exterior insulation thicknesses shown below in Table 1.1.

Table 1.1: StoVentec Bracket Sizes and Associated Exterior Insulation Thicknesses

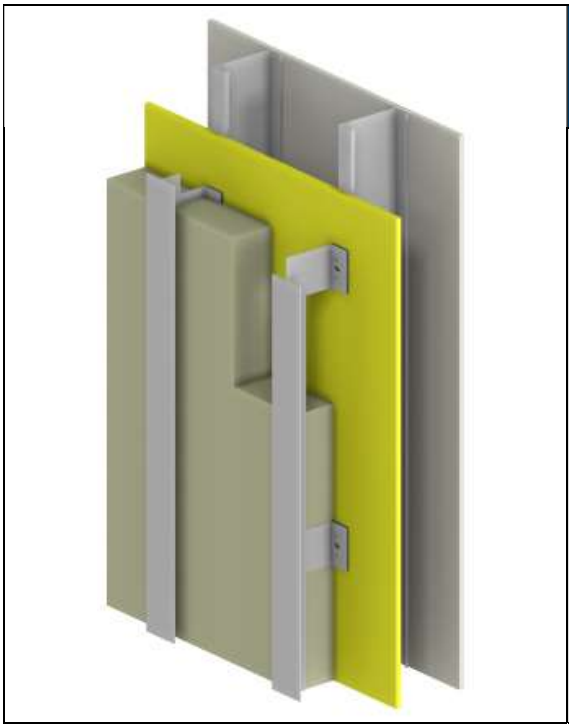
Bracket Size	Exterior Insulation Thickness inches (mm)
80	2 (51)
100	3 (76)
120	4 (102)
160	5 (127)
180	6 (152)
200	7 (178)
220	8 (203)

The thermal performance of the aluminum FP and GP StoVentec Bracket System were previously evaluated in 2020 and 2022. The results from the previous analysis were summarized in two reports titled “StoVentec Bracket Thermal Analysis” dated March 11, 2020 and “StoVentec Bracket Thermal Analysis” dated November 14, 2022. This analysis is based on scenarios from both previous reports with galvanized steel brackets.

Table 1.2 below summarizes the evaluated wall configurations, and Figure 1.1 illustrates representative configurations for all backup wall types. The geometry of the GP brackets as well as T-Rail were based on the drawings provided by Sto, and are provided in Appendix A.

Table 1.2: Evaluated StoVentec Bracket Assemblies

StoVentec Bracket	Backup Wall	Bracket Size	Stud Spacing inch (mm)	Horizontal Bracket Spacing inch (mm)	Vertical Bracket Spacing inch (mm)
Galvanized Steel GP	6 inch x 1-5/8 inch (152 mmx 41 mm) steel stud wall with Uninsulated Cavity	80, 100, 120, 160 180, 200, 220	16 (406)	16 (406)	24, 30, 36, 42, 48 (610, 762, 914, 1067, 1219)
Galvanized Steel GP		80, 100, 120, 160, 180, 200, 220	24 (610)	24 (610)	24, 30, 36, 42, 48 (610, 762, 914, 1067, 1219)
Galvanized Steel GP		80, 100, 120, 160, 180, 200, 220	16 (406)	32 (813)	24, 30, 36, 42, 48 (610, 762, 914, 1067, 1219)
Galvanized Steel FP		80, 100, 120, 160, 180, 200, 220	16 (406)	16 (406)	24, 30, 36, 42, 48 (610, 762, 914, 1067, 1219)
Galvanized Steel FP		80, 100, 120, 160, 180, 200, 220	24 (610)	24 (610)	24, 30, 36, 42, 48 (610, 762, 914, 1067, 1219)
Galvanized Steel FP		80, 100, 120, 160, 180, 200, 220	16 (406)	32 (813)	24, 30, 36, 42, 48 (610, 762, 914, 1067, 1219)



Exterior Insulated Steel Stud Assembly

- 1/2 inch (13 mm) interior gypsum
- 6 inch x 1 5/8 inch (152 mm x 41 mm) steel studs with uninsulated cavity
- 1/2 inch (13 mm) gypsum exterior sheathing
- Galvanized steel StoVentec GP and FP bracket systems
- Exterior mineral wool insulation
- Vertical T-Rail

Figure 1.1: Schematics of Evaluated StoVentec Galvanized Steel GP Assembly

The StoVentec brackets are used in conjunction with a T-Rail profile which are adjusted such that the face of the T-Rail is against the face of the StoVentec bracket. With this configuration the rail penetrates the exterior insulation, as shown below in Figure 1.2.

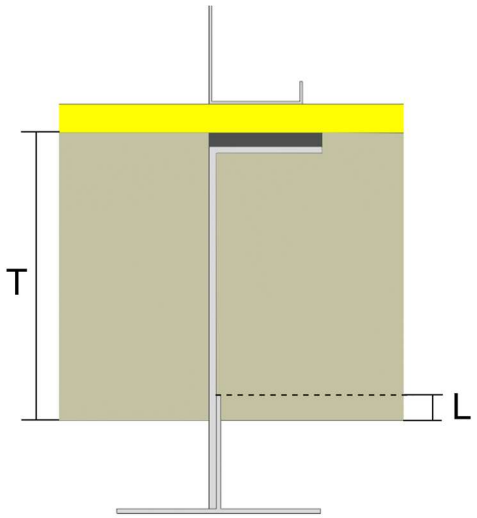


Figure1.2: T-Rail Penetration Depths for the StoVentec Bracket System with Thermal Isolator

Table 1.3: T-Rail Penetration Depth with Insulation Thickness and Bracket Size

StoVentec Bracket Size	Insulation Thickness T inch (mm)	With Thermal Isolator L inch (mm)
80	2 (51)	5/8 (16)
100	3 (76)	13/16 (21)
120	4 (102)	1(27)
160	5 (127)	1/2 (13)
180	6 (152)	11/16 (17)
200	7 (178)	7/8 (23)
220	8 (203)	1-1/8 (28)

2. MODELING PROCEDURES

The thermal performance of the different assembly scenarios was evaluated by 3D thermal simulations using the Nx and SimCenter 3D software package from Siemens, which is a general-purpose computer aided design (CAD) and finite element analysis (FEA) package. The thermal solver and modeling procedures utilized for this study were extensively calibrated and validated to within +/- 5% of hotbox testing for *ASHRAE Research Project 1365-RP Thermal Performance of Building Envelope Details for Mid- and High-Rise Construction and for the Building Envelope Thermal Bridging Guide*[1], which are in line with guidelines set in CSA Z5010:21. The thermal analysis utilized steady-state conditions, published thermal properties of materials and information provided by Sto. Additional assumptions for the thermal analysis are listed in Appendix B. Further assembly information, including material properties, are given in Appendix C.

The U-factor and effective R-value of the GP and FP galvanized steel bracket assemblies were calculated with the thermal break. Further information as to this calculation is provided in Appendix B.4.

The analysis presented in this report is limited to the thermal performance of the evaluated wall assemblies. Other requirements related the structural integrity, code and life safety, air, vapor, and moisture control should be verified by a design professional.

1 https://www.bchydro.com/thermalguide

3. THERMAL RESULTS

The U-factor and effective R-values for all galvanized steel GP and FP bracket assembly configurations are listed in Tables 3.1 to Table 3.6. Example temperature profiles for each configuration are provided in Appendix D.

The thermal performance was determined using a combination of 3D thermal simulations and approximation. Select scenarios were simulated and these results were used to calculate point transmittances of the bracket assembly which were used to approximate the thermal performance of the remaining scenarios with different bracket spacing. This approximation method is commonly used to assess thermal performance of clear wall assemblies and are accepted by most North American building energy codes and standards. Since some of these values are approximate, minor differences in thermal performance between the values below and the simulated thermal performance may occur.

Table 3.1: Thermal Performance of Exterior Insulated Steel-Frame Wall Assemblies with Studs at 16 inches (406 mm) o.c. and Galvanized Steel **GP Brackets** at **16 inch (406 mm) Horizontal Bracket Spacing**

Vertical Bracket Spacing inch (mm)	**Exterior Insulation Thickness** inch (mm)	**StoVenTec Bracket Size**	**Nominal Exterior Insulation R-value** ft² hr °F/Btu (m²K/W)	**Overall U-factor** Btu/h ft² °F (W/m² K)	**Effective R-Value** ft² hr °F/Btu (m²K/W)
24 (610)[1]	2 (51)	80	R-8.4 (1.48 RSI)	0.097 (0.55)[1]	R-10.3 (1.81 RSI)[1]
	3 (76)	100	R-12.6 (2.22 RSI)	0.078 (0.44)[1]	R-12.9 (2.27 RSI)[1]
	4 (102)	120	R-16.8 (2.96 RSI)	0.065 (0.37)[1]	R-15.4 (2.71 RSI)[1]
	5 (127)	160	R-21.0 (3.70 RSI)	0.056 (0.32)[1]	R-18.0 (3.17 RSI)[1]
	6 (152)	180	R-25.2 (4.44 RSI)	0.050 (0.28)[1]	R-20.2 (3.55 RSI)[1]
	7 (178)	200	R-29.4 (5.18 RSI)	0.045 (0.26)[1]	R-22.2 (3.91 RSI)[1]
	8 (203)	220	R-33.6 (5.92 RSI)	0.041 (0.23)[1]	R-24.2 (4.26 RSI)[1]
30 (762)	2 (51)	80	R-8.4 (1.48 RSI)	*0.091 (0.52)*[2]	*R-10.9 (1.93 RSI)*[2]
	3 (76)	100	R-12.6 (2.22 RSI)	*0.071 (0.40)*[2]	*R-14.1 (2.48 RSI)*[2]
	4 (102)	120	R-16.8 (2.96 RSI)	*0.058 (0.33)*[2]	*R-17.1 (3.01 RSI)*[2]
	5 (127)	160	R-21.0 (3.70 RSI)	*0.050 (0.28)*[2]	*R-20.1 (3.53 RSI)*[2]
	6 (152)	180	R-25.2 (4.44 RSI)	*0.044 (0.25)*[2]	*R-22.6 (3.98 RSI)*[2]
	7 (178)	200	R-29.4 (5.18 RSI)	*0.040 (0.23)*[2]	*R-25.1 (4.42 RSI)*[2]
	8 (203)	220	R-33.6 (5.92 RSI)	*0.036 (0.21)*[2]	*R-27.4 (4.83 RSI)*[2]
36 (914)	2 (51)	80	R-8.4 (1.48 RSI)	*0.091 (0.51)*[2]	*R-11.0 (1.94 RSI)*[2]
	3 (76)	100	R-12.6 (2.22 RSI)	*0.070 (0.40)*[2]	*R-14.3 (2.53 RSI)*[2]
	4 (102)	120	R-16.8 (2.96 RSI)	*0.057 (0.32)*[2]	*R-17.5 (3.08 RSI)*[2]
	5 (127)	160	R-21.0 (3.70 RSI)	*0.048 (0.28)*[2]	*R-20.6 (3.63 RSI)*[2]
	6 (152)	180	R-25.2 (4.44 RSI)	*0.043 (0.24)*[2]	*R-23.4 (4.12 RSI)*[2]
	7 (178)	200	R-29.4 (5.18 RSI)	*0.038 (0.22)*[2]	*R-26.0 (4.59 RSI)*[2]
	8 (203)	220	R-33.6 (5.92 RSI)	*0.035 (0.20)*[2]	*R-28.6 (5.04 RSI)*[2]
42 (1067)	2 (51)	80	R-8.4 (1.48 RSI)	*0.090 (0.51)*[2]	*R-11.1 (1.95 RSI)*[2]
	3 (76)	100	R-12.6 (2.22 RSI)	*0.069 (0.39)*[2]	*R-14.5 (2.56 RSI)*[2]
	4 (102)	120	R-16.8 (2.96 RSI)	*0.056 (0.32)*[2]	*R-17.8 (3.14 RSI)*[2]

	5 (127)	160	R-21.0 (3.70 RSI)	*0.047 (0.27)[2]*	*R-21.1 (3.71 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.042 (0.24)[2]*	*R-24.0 (4.22 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.037 (0.21)[2]*	*R-26.8 (4.72 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.034 (0.19)[2]*	*R-29.5 (5.20 RSI)[2]*
48 (1219)	2 (51)	80	R-8.4 (1.48 RSI)	*0.090 (0.51)[2]*	*R-11.1 (1.96 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.068 (0.39)[2]*	*R-14.7 (2.58 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.055 (0.31)[2]*	*R-18.0 (3.18 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.047 (0.27)[2]*	*R-21.4 (3.77 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.041 (0.23)[2]*	*R-24.4 (4.30 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.037 (0.21)[2]*	*R-27.4 (4.82 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.033 (0.19)[2]*	*R-30.3 (5.33 RSI)[2]*

[1]Value was simulated.
[2]Value was approximated.

Table 3.2: Thermal Performance of Exterior Insulated Steel-Frame Wall Assemblies with Studs at 24 inches (610 mm) o.c. and Galvanized Steel **GP Brackets** at **24 inch (610 mm) Horizontal Bracket Spacing**

Vertical Bracket Spacing inch (mm)	**Exterior Insulation Thickness** inch (mm)	**StoVenTec Bracket Size**	**Nominal Exterior Insulation R-value** ft² hr °F/Btu (m²K/W)	**Overall U-factor** Btu/h ft² °F (W/m² °K)	**Effective R-value** ft² hr °F/Btu (m² °K/W)
24 (610)	2 (51)	80	R-8.4 (1.48 RSI)	0.091 (0.51)[1]	R-11.0 (1.94 RSI)[1]
	3 (76)	100	R-12.6 (2.22 RSI)	0.070 (0.40)[1]	R-14.3 (2.53 RSI)[1]
	4 (102)	120	R-16.8 (2.96 RSI)	0.057 (0.32)[1]	R-17.5 (3.08 RSI)[1]
	5 (127)	160	R-21.0 (3.70 RSI)	0.048 (0.28)[1]	R-20.6 (3.63 RSI)[1]
	6 (152)	180	R-25.2 (4.44 RSI)	0.043 (0.24)[1]	R-23.4 (4.12 RSI)[1]
	7 (178)	200	R-29.4 (5.18 RSI)	0.038 (0.22)[1]	R-26.0 (4.59 RSI)[1]
	8 (203)	220	R-33.6 (5.92 RSI)	0.035 (0.20)[1]	R-28.6 (5.04 RSI)[1]
30 (762)	2 (51)	80	R-8.4 (1.48 RSI)	*0.090 (0.51)[2]*	*R-11.1 (1.96 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.069 (0.39) [2]*	*R-14.6 (2.57 RSI) [2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.056 (0.32) [2]*	*R-17.9 (3.16 RSI) [2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.047 (0.27) [2]*	*R-21.2 (3.74 RSI) [2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.041 (0.23) [2]*	*R-24.2 (4.26 RSI) [2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.037 (0.21) [2]*	*R-27.1 (4.77 RSI) [2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.033 (0.19) [2]*	*R-29.9 (5.27 RSI) [2]*
36 (914)	2 (51)	80	R-8.4 (1.48 RSI)	*0.089 (0.51)[2]*	*R-11.2 (1.97 RSI) [2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.068 (0.38)[2]*	*R-14.8 (2.60 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.055 (0.31)[2]*	*R-18.2 (3.21 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.046 (0.26)[2]*	*R-21.7 (3.81 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.040 (0.23)[2]*	*R-24.8 (4.37 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.036 (0.20)[2]*	*R-27.9 (4.91 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.032 (0.18)[2]*	*R-30.9 (5.43 RSI)[2]*
42 (1067)	2 (51)	80	R-8.4 (1.48 RSI)	*0.089 (0.51)[2]*	*R-11.2 (1.98 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.067 (0.38)[2]*	*R-14.9 (2.62 RSI)[2]*

	4 (102)	120	R-16.8 (2.96 RSI)	*0.054 (0.31)[2]*	*R-18.5 (3.25 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.046 (0.26)[2]*	*R-22.0 (3.87 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.040 (0.22)[2]*	*R-25.2 (4.45 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.035 (0.20)[2]*	*R-28.4 (5.01 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.032 (0.18)[2]*	*R-31.6 (5.56 RSI)[2]*
48 (1219)	2 (51)	80	R-8.4 (1.48 RSI)	*0.089 (0.50)[2]*	*R-11.3 (1.98 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.067 (0.38) [2]*	*R-15.0 (2.64 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.054 (0.30)[2]*	*R-18.6 (3.28 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.045 (0.26)[2]*	*R-22.2 (3.91 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.039 (0.22)[2]*	*R-25.6 (4.51 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.035 (0.20)[2]*	*R-28.9 (5.09 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.031 (0.18)[2]*	*R-32.1 (5.66 RSI)[2]*

[1]Value was simulated.
[2]Value was approximated.

Table 3.3: Thermal Performance of Exterior Insulated Steel-Frame Wall Assemblies with Studs at 16 inches (406 mm) o.c. and Galvanized Steel **GP Brackets** at **32 inch (813 mm) Horizontal Bracket Spacing**

Vertical Bracket Spacing inch (mm)	**Exterior Insulation Thickness** inch (mm)	**StoVenTec Bracket Size**	**Nominal Exterior Insulation R-value** ft² hr °F/Btu (m²K/W)	**Overall U-factor** Btu/h ft² °F (W/m² °K)	**Effective R-value** ft² hr °F/Btu (m² °K/W)
24 (610)	2 (51)	80	R-8.4 (1.48 RSI)	0.090 (0.51)[1]	R-11.1 (1.96 RSI)[1]
	3 (76)	100	R-12.6 (2.22 RSI)	0.068 (0.39)[1]	R-14.7 (2.58 RSI)[1]
	4 (102)	120	R-16.8 (2.96 RSI)	0.055 (0.31)[1]	R-18.0 (3.18 RSI)[1]
	5 (127)	160	R-21.0 (3.70 RSI)	0.047 (0.27)[1]	R-21.4 (3.77 RSI)[1]
	6 (152)	180	R-25.2 (4.44 RSI)	0.041 (0.23)[1]	R-24.4 (4.30 RSI)[1]
	7 (178)	200	R-29.4 (5.18 RSI)	0.037 (0.21)[1]	R-27.4 (4.82 RSI)[1]
	8 (203)	220	R-33.6 (5.92 RSI)	0.033 (0.19)[1]	R-30.3 (5.33 RSI)[1]
30 (762)	2 (51)	80	R-8.4 (1.48 RSI)	*0.089 (0.51)[2]*	*R-11.2 (1.98 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.067 (0.38)[2]*	*R-14.9 (2.62 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.054 (0.31)[2]*	*R-18.4 (3.24 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.046 (0.26)[2]*	*R-21.9 (3.85 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.040 (0.23)[2]*	*R-25.1 (4.42 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.035 (0.20)[2]*	*R-28.3 (4.98 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.032 (0.18)[2]*	*R-31.3 (5.52 RSI)[2]*
36 (914)	2 (51)	80	R-8.4 (1.48 RSI)	*0.089 (0.50)[2]*	*R-11.3 (1.98 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.067 (0.38)[2]*	*R-15.0 (2.64 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.054 (0.30)[2]*	*R-18.6 (3.28 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.045 (0.26)[2]*	*R-22.2 (3.91 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.039 (0.22)[2]*	*R-25.6 (4.51 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.035 (0.20)[2]*	*R-28.9 (5.09 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.031 (0.18)[2]*	*R-32.1 (5.66 RSI)[2]*
42 (1067)	2 (51)	80	R-8.4 (1.48 RSI)	*0.088 (0.50)[2]*	*R-11.3 (1.99 RSI)[2]*

	3 (76)	100	R-12.6 (2.22 RSI)	*0.066 (0.38)[2]*	*R-15.1 (2.66 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.053 (0.30)[2]*	*R-18.8 (3.31 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.045 (0.25)[2]*	*R-22.5 (3.96 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.039 (0.22)[2]*	*R-25.9 (4.57 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.034 (0.19)[2]*	*R-29.3 (5.17 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.031 (0.17)[2]*	*R-32.7 (5.76 RSI)[2]*
48 (1219)	2 (51)	80	R-8.4 (1.48 RSI)	*0.088 (0.50)[2]*	*R-11.3 (2.00 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.066 (0.37)[2]*	*R-15.2 (2.67 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.053 (0.30)[2]*	*R-18.9 (3.33 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.044 (0.25)[2]*	*R-22.7 (3.99 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.038 (0.22)[2]*	*R-26.2 (4.62 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.034 (0.19)[2]*	*R-29.7 (5.23 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.030 (0.17)[2]*	*R-33.1 (5.84 RSI)[2]*

[1]Value was simulated.
[2]Value was approximated.

Table 3.4: Thermal Performance of Exterior Insulated Steel-Frame Wall Assemblies with Studs at 16 inch (406 mm) o.c. and Galvanized Steel **FP Brackets** at **16 inch (406 mm) Horizontal Bracket Spacing**

Vertical Bracket Spacing inch (mm)	**Exterior Insulation Thickness** inch (mm)	**StoVenTec Bracket Size**	**Nominal Exterior Insulation R-value** ft² hr °F/Btu (m²K/W)	**Overall U-factor** Btu/h ft² °F (W/m² K)	**Effective R-Value** ft² hr °F/Btu (m²K/W)
24 (610)	2 (51)	80	R-8.4 (1.48 RSI)	0.103 (0.58)[1]	R-9.8 (1.72 RSI)[1]
	3 (76)	100	R-12.6 (2.22 RSI)	0.082 (0.46)[1]	R-12.3 (2.16 RSI)[1]
	4 (102)	120	R-16.8 (2.96 RSI)	0.069 (0.39)[1]	R-14.5 (2.55 RSI)[1]
	5 (127)	160	R-21.0 (3.70 RSI)	0.060 (0.34)[1]	R-16.7 (2.94 RSI)[1]
	6 (152)	180	R-25.2 (4.44 RSI)	0.054 (0.31)[1]	R-18.5 (3.26 RSI)[1]
	7 (178)	200	R-29.4 (5.18 RSI)	0.049 (0.28)[1]	R-20.3 (3.57 RSI)[1]
	8 (203)	220	R-33.6 (5.92 RSI)	0.046 (0.26)[1]	R-21.9 (3.85 RSI)[1]
30 (762)	2 (51)	80	R-8.4 (1.48 RSI)	*0.093 (0.53)[2]*	*R-10.7 (1.88 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.073 (0.41)[2]*	*R-13.7 (2.42 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.061 (0.34)[2]*	*R-16.5 (2.90 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.052 (0.30)[2]*	*R-19.1 (3.37 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.047 (0.27)[2]*	*R-21.4 (3.77 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.043 (0.24)[2]*	*R-23.5 (4.14 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.039 (0.22)[2]*	*R-25.6 (4.50 RSI)[2]*
36 (914)	2 (51)	80	R-8.4 (1.48 RSI)	*0.092 (0.52)[2]*	*R-10.8 (1.91 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.071 (0.40)[2]*	*R-14.0 (2.47 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.059 (0.33)[2]*	*R-17.0 (2.99 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.051 (0.29)[2]*	*R-19.8 (3.49 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.045 (0.26)[2]*	*R-22.3 (3.92 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.041 (0.23)[2]*	*R-24.6 (4.34 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.037 (0.21)[2]*	*R-26.9 (4.73 RSI)[2]*

42 (1067)	2 (51)	80	R-8.4 (1.48 RSI)	*0.092 (0.52)[2]*	*R-10.9 (1.92 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.070 (0.40)[2]*	*R-14.2 (2.51 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.058 (0.33)[2]*	*R-17.3 (3.05 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.049 (0.28)[2]*	*R-20.3 (3.57 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.044 (0.25)[2]*	*R-22.9 (4.04 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.039 (0.22)[2]*	*R-25.5 (4.49 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.036 (0.20)[2]*	*R-27.9 (4.92 RSI)[2]*
48 (1219)	2 (51)	80	R-8.4 (1.48 RSI)	*0.091 (0.52)[2]*	*R-11.0 (1.94 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.069 (0.39)[2]*	*R-14.4 (2.54 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.057 (0.32)[2]*	*R-17.6 (3.10 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.048 (0.27)[2]*	*R-20.7 (3.64 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.043 (0.24)[2]*	*R-23.5 (4.14 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.038 (0.22)[2]*	*R-26.2 (4.61 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.035 (0.20)[2]*	*R-28.8 (5.06 RSI)[2]*

[1]Value was simulated.
[2]Value was approximated.

Table 3.5: Thermal Performance of Exterior Insulated Steel-Frame Wall Assemblies with Studs at 24 inch (610 mm) o.c. and Galvanized Steel **FP Brackets** at **24 inch (610 mm) Horizontal Bracket Spacing**

Vertical Bracket Spacing inch (mm)	**Exterior Insulation Thickness** inch (mm)	**StoVenTec Bracket Size**	**Nominal Exterior Insulation R-value** ft² hr °F/Btu (m²K/W)	**Overall U-factor** Btu/h ft² °F (W/m² °K)	**Effective R-value** ft² hr °F/Btu (m² °K/W)
24 (610)	2 (51)	80	R-8.4 (1.48 RSI)	0.092 (0.52[1]	R-10.8 (1.91 RSI)[1]
	3 (76)	100	R-12.6 (2.22 RSI)	0.071 (0.40)[1]	R-14.0 (2.47 RSI)[1]
	4 (102)	120	R-16.8 (2.96 RSI)	0.059 (0.33)[1]	R-17.0 (2.99 RSI)[1]
	5 (127)	160	R-21.0 (3.70 RSI)	0.051 (0.29)[1]	R-19.8 (3.49 RSI)[1]
	6 (152)	180	R-25.2 (4.44 RSI)	0.045 (0.26)[1]	R-22.3 (3.92 RSI)[1]
	7 (178)	200	R-29.4 (5.18 RSI)	0.041 (0.23)[1]	R-24.6 (4.34 RSI)[1]
	8 (203)	220	R-33.6 (5.92 RSI)	0.037 (0.21)[1]	R-26.9 (4.73 RSI)[1]
30 (762)	2 (51)	80	R-8.4 (1.48 RSI)	*0.091 (0.52)[2]*	*R-11.0 (1.93 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.070 (0.40)[2]*	*R-14.3 (2.52 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.057 (0.33)[2]*	*R-17.5 (3.08 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.049 (0.28)[2]*	*R-20.5 (3.61 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.043 (0.24)[2]*	*R-23.2 (4.09 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.039 (0.22)[2]*	*R-25.8 (4.55 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.035 (0.20)[2]*	*R-28.4 (4.99 RSI)[2]*
36 (914)	2 (51)	80	R-8.4 (1.48 RSI)	*0.091 (0.51)[2]*	*R-11.0 (1.95 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.069 (0.39)[2]*	*R-14.5 (2.56 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.056 (0.32)[2]*	*R-17.8 (3.14 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.048 (0.27)[2]*	*R-21.0 (3.70 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.042 (0.24)[2]*	*R-23.9 (4.21 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.037 (0.21)[2]*	*R-26.7 (4.71 RSI)[2]*

	8 (203)	220	R-33.6 (5.92 RSI)	*0.034 (0.19)[2]*	*R-29.4 (5.19 RSI)[2]*
42 (1067)	2 (51)	80	R-8.4 (1.48 RSI)	*0.090 (0.51)[2]*	*R-11.1 (1.96 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.068 (0.39)[2]*	*R-14.7 (2.59 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.055 (0.31)[2]*	*R-18.1 (3.19 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.047 (0.27)[2]*	*R-21.4 (3.77 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.041 (0.23)[2]*	*R-24.5 (4.31 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.036 (0.21)[2]*	*R-27.4 (4.83 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.033 (0.19)[2]*	*R-30.3 (5.33 RSI)[2]*
48 (1219)	2 (51)	80	R-8.4 (1.48 RSI)	*0.090 (0.51)[2]*	*R-11.2 (1.97 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.068 (0.38)[2]*	*R-14.8 (2.61 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.055 (0.31)[2]*	*R-18.3 (3.22 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.046 (0.26)[2]*	*R-21.7 (3.82 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.040 (0.23)[2]*	*R-24.9 (4.38 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.036 (0.20)[2]*	*R-28.0 (4.92 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.032 (0.18)[2]*	*R-31.0 (5.45 RSI)[2]*

[1]Value was simulated.
[2]Value was approximated.

Table 3.6: Thermal Performance of Exterior Insulated Steel-Frame Wall Assemblies with Studs at 16 inch (406 mm) o.c. and Galvanized Steel **FP Brackets** at **32 inch (813 mm) Horizontal Bracket Spacing**

Vertical Bracket Spacing inch (mm)	**Exterior Insulation Thickness** inch (mm)	**StoVenTec Bracket Size**	**Nominal Exterior Insulation R-value** ft² hr °F/Btu (m²K/W)	**Overall U-factor** Btu/h ft² °F (W/m² °K)	**Effective R-value** ft² hr °F/Btu (m² °K/W)
24 (610)	2 (51)	80	R-8.4 (1.48 RSI)	0.091 (0.52)[1]	R-11.0 (1.94 RSI)[1]
	3 (76)	100	R-12.6 (2.22 RSI)	0.069 (0.39)[1]	R-14.4 (2.54 RSI)[1]
	4 (102)	120	R-16.8 (2.96 RSI)	0.057 (0.32)[1]	R-17.6 (3.10 RSI)[1]
	5 (127)	160	R-21.0 (3.70 RSI)	0.048 (0.27)[1]	R-20.7 (3.64 RSI)[1]
	6 (152)	180	R-25.2 (4.44 RSI)	0.043 (0.24)[1]	R-23.5 (4.14 RSI)[1]
	7 (178)	200	R-29.4 (5.18 RSI)	0.038 (0.22)[1]	R-26.2 (4.61 RSI)[1]
	8 (203)	220	R-33.6 (5.92 RSI)	0.035 (0.20)[1]	R-28.8 (5.06 RSI)[1]
30 (762)	2 (51)	80	R-8.4 (1.48 RSI)	*0.090 (0.51)[2]*	*R-11.1 (1.95 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.068 (0.39)[2]*	*R-14.6 (2.58 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.056 (0.32)[2]*	*R-18.0 (3.17 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.047 (0.27)[2]*	*R-21.3 (3.75 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.041 (0.23)[2]*	*R-24.3 (4.28 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.037 (0.21)[2]*	*R-27.2 (4.79 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.033 (0.19)[2]*	*R-30.0 (5.29 RSI)[2]*
36 (914)	2 (51)	80	R-8.4 (1.48 RSI)	*0.090 (0.51)[2]*	*R-11.2 (1.97 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.068 (0.38)[2]*	*R-14.8 (2.61 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.055 (0.31)[2]*	*R-18.3 (3.22 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.046 (0.26)[2]*	*R-21.7 (3.82 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.040 (0.23)[2]*	*R-24.9 (4.38 RSI)[2]*

	7 (178)	200	R-29.4 (5.18 RSI)	*0.036 (0.20)[2]*	*R-28.0 (4.92 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.032 (0.18)[2]*	*R-31.0 (5.45 RSI)[2]*
42 (1067)	2 (51)	80	R-8.4 (1.48 RSI)	*0.089 (0.51)[2]*	*R-11.2 (1.97 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.067 (0.38)[2]*	*R-14.9 (2.63 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.054 (0.31)[2]*	*R-18.5 (3.26 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.045 (0.26)[2]*	*R-22.0 (3.88 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.040 (0.22)[2]*	*R-25.3 (4.46 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.035 (0.20)[2]*	*R-28.5 (5.02 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.032 (0.18)[2]*	*R-31.7 (5.58 RSI)[2]*
48 (1219)	2 (51)	80	R-8.4 (1.48 RSI)	*0.089 (0.50)[2]*	*R-11.2 (1.98 RSI)[2]*
	3 (76)	100	R-12.6 (2.22 RSI)	*0.067 (0.38)[2]*	*R-15.0 (2.65 RSI)[2]*
	4 (102)	120	R-16.8 (2.96 RSI)	*0.054 (0.30)[2]*	*R-18.7 (3.29 RSI)[2]*
	5 (127)	160	R-21.0 (3.70 RSI)	*0.045 (0.26)[2]*	*R-22.3 (3.92 RSI)[2]*
	6 (152)	180	R-25.2 (4.44 RSI)	*0.039 (0.22)[2]*	*R-25.6 (4.52 RSI)[2]*
	7 (178)	200	R-29.4 (5.18 RSI)	*0.035 (0.20)[2]*	*R-29.0 (5.10 RSI)[2]*
	8 (203)	220	R-33.6 (5.92 RSI)	*0.031 (0.18)[2]*	*R-32.2 (5.67 RSI)[2]*

[1]Value was simulated.
[2]Value was approximated.

We believe that this report meets your objectives for evaluating the thermal performance for the galvanized steel StoVentec bracket system assemblies. If you have any questions or comments related to the above, please do not hesitate to contact the undersigned.

Morrison Hershfield Limited

02/27/2024 2:55:29 PM

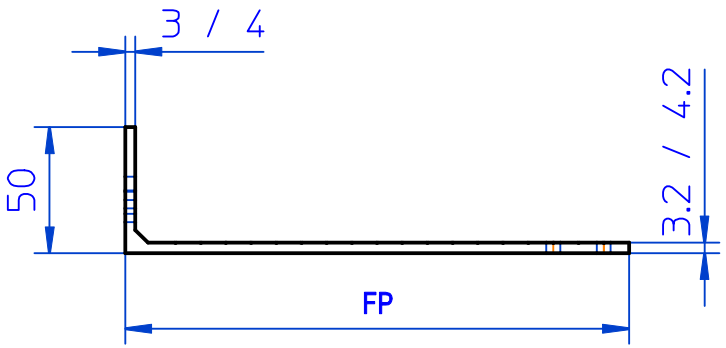
Shahima Rahmatipour, P.Eng., PMP, CEM, M.Sc.,
Building Science Engineer

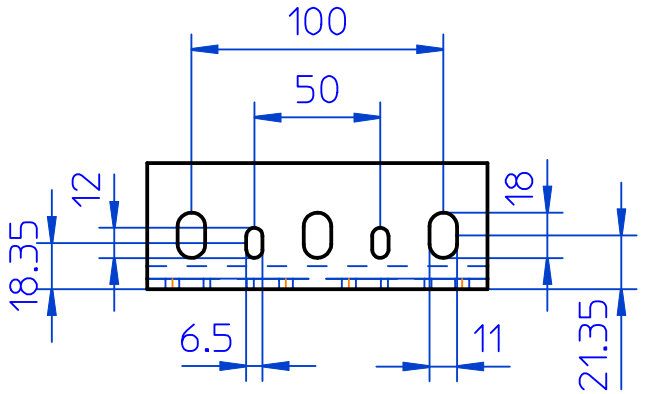
EGBC 1001424

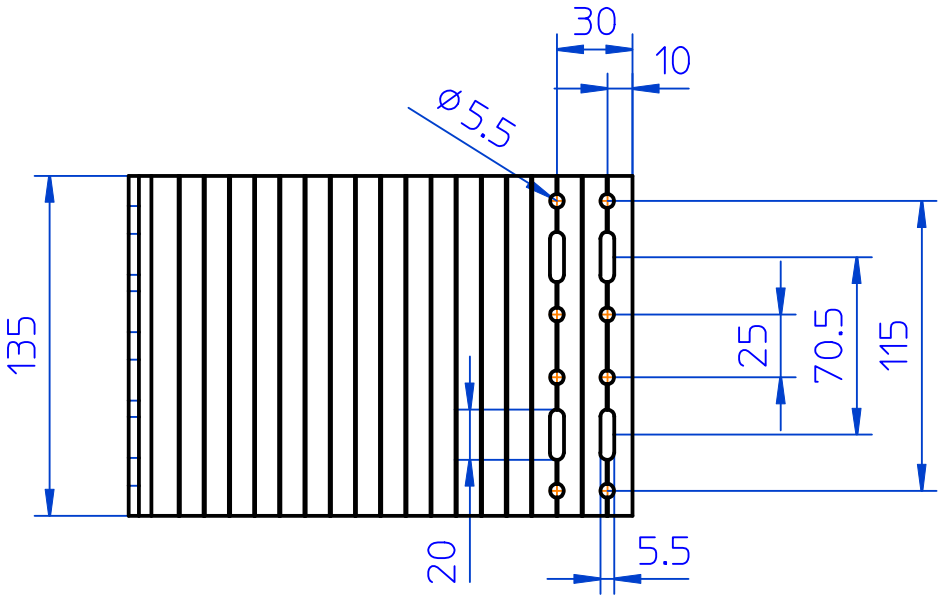
2024-02-27

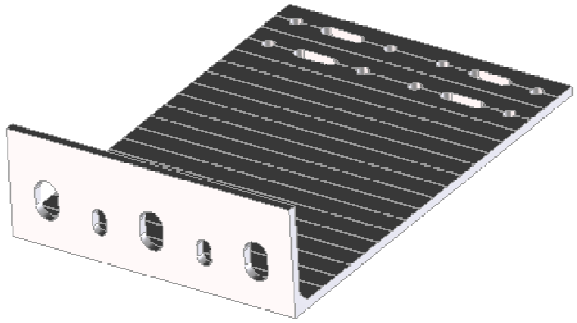
Ivan Lee, P.Eng., M.A.Sc.
Principal, Building Science Engineer

APPENDIX A:
DETAIL DRAWINGS



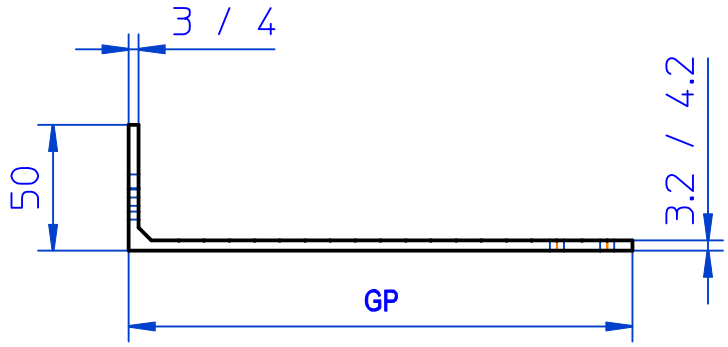


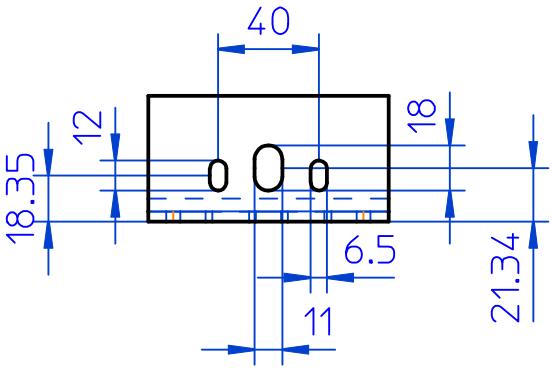


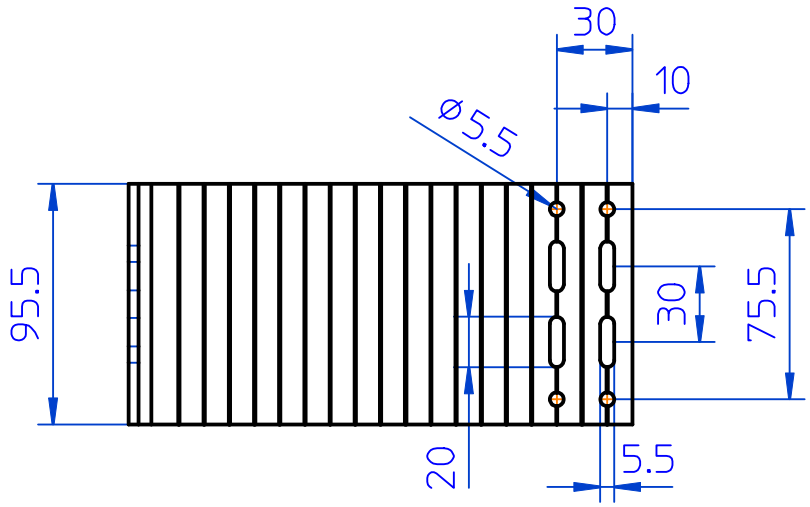


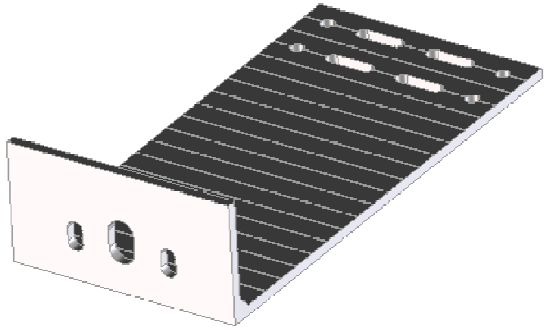
t=3,0 / 3,2 mm	Gewicht in g	t=4,0 / 4,2 mm	Gewicht in g
FP 40	94	FP 200	363
FP 60	113	FP 220	374
FP 80	132	FP 240	401
FP 100	155	FP 260	437
FP 120	180	FP 280	465
FP 140	203	FP 300	494
FP 160	230	FP 320	522
FP 180	255		

Verwendungsbereich				(zul.Abweichung)		(Oberfläche)	Maßstab 1:3 (Gewicht)
							Werkstoff: EN AW-6063 T66
					Datum	Name	(Bezeichnung)
				Bearb.	T.Käfer	20.02.18	Festpunkt
				gepr.	T.Grünewald	22.02.18	
				Norm			
							(Zeichnungsnummer) Blatt 1 v. 2
	Gewicht hinzu	11.09.18	T.K.				
Zust	Änderung	Datum	Name	(Ursprung)			(erstellt von) (erstellt durch)









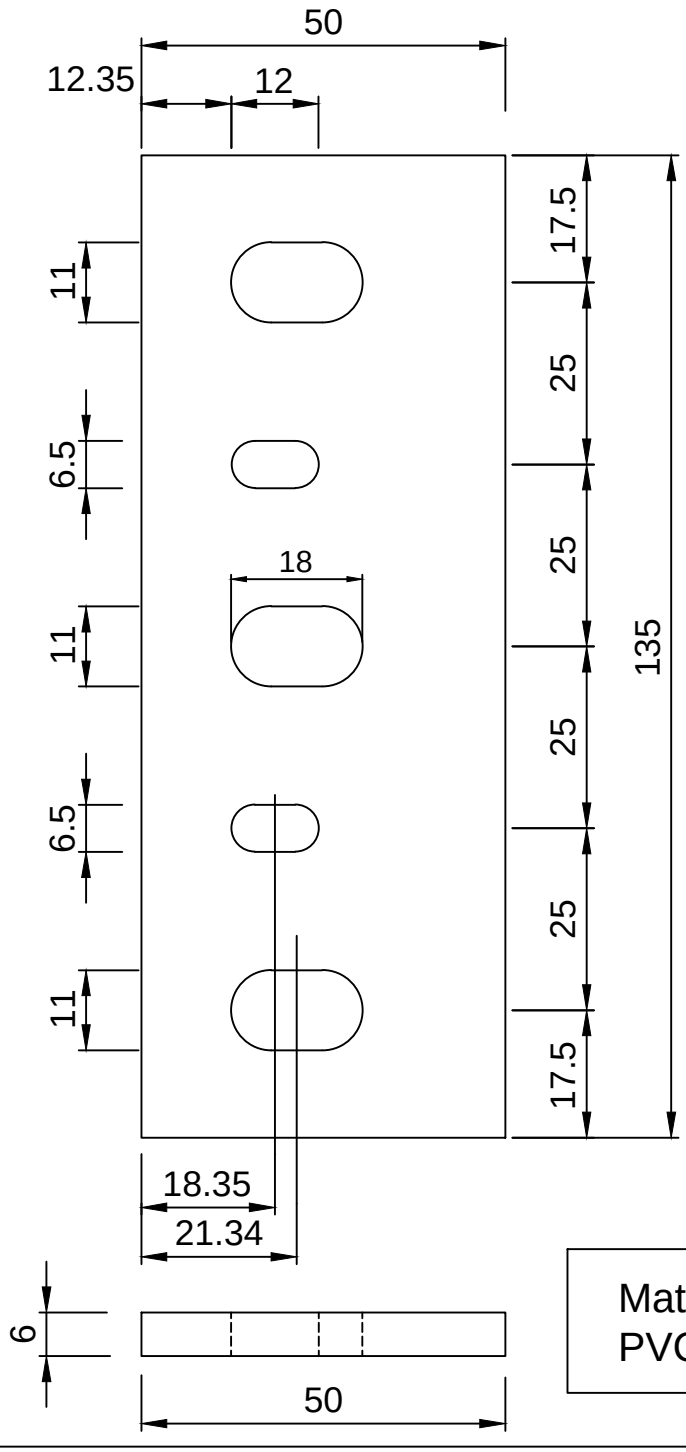
t=3,0 / 3,2 mm	Gewicht in g	t=4,0 / 4,2 mm	Gewicht in g
GP 40	68	GP 200	260
GP 60	81	GP 220	268
GP 80	94	GP 240	287
GP 100	110	GP 260	307
GP 120	127	GP 280	327
GP 140	144	GP 300	372
GP 160	162	GP 320	383
GP 180	179		

Verwendungsbereich				(zul.Abweichung)	(Oberfläche)	Maßstab 1:3 (Gewicht)
						Werkstoff EN AW-6063 T66
					Datum	Name
				Bearb.	T.Käfer	20.02.18
				gepr.	T.Grünewald	22.02.18
				Norm		
	Gewichte hinzu	11.09.18	T.K.			(Zeichnungsnummer) Blatt 2 v. 2
Zust	Änderung	Datum	Name	(Ursprung)		(erstellt von) (erstellt durch)

(Bezeichnung) Gleitpunkt

StoThermostop Alu FP (M ca. 1:1)	E28 Rev. 00
	11.02.19

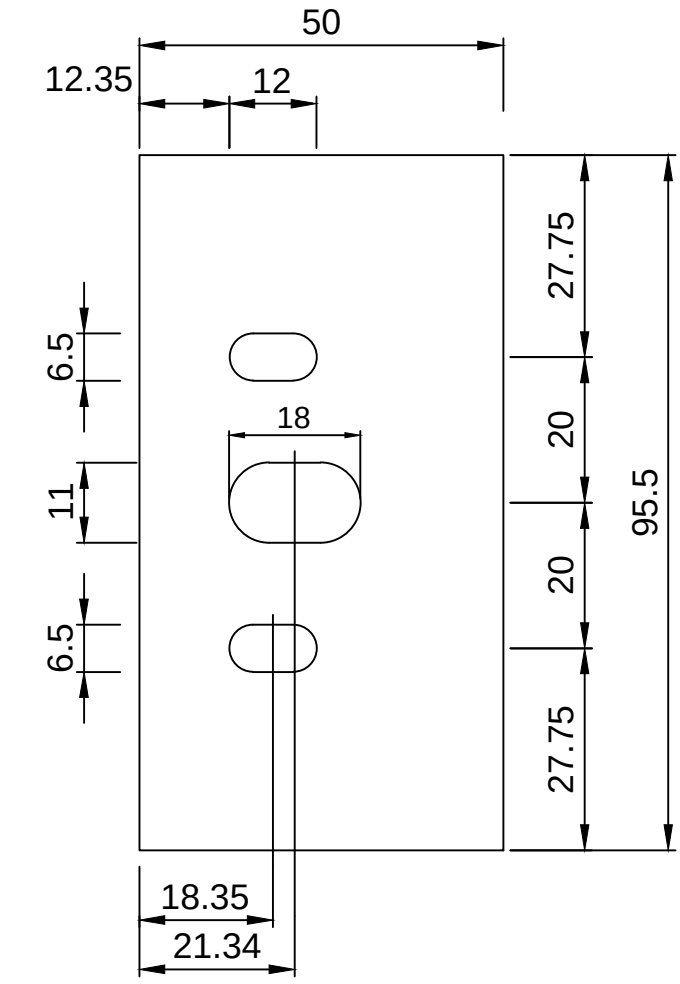
Sto-Thermostop Alu FP

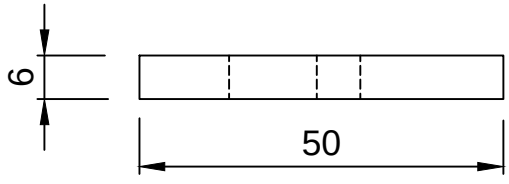


Material :
PVC Hartschaum

StoThermostop Alu GP (M ca. 1:1)	E29 Rev. 00
	11.02.19

Sto-Thermostop Alu GP

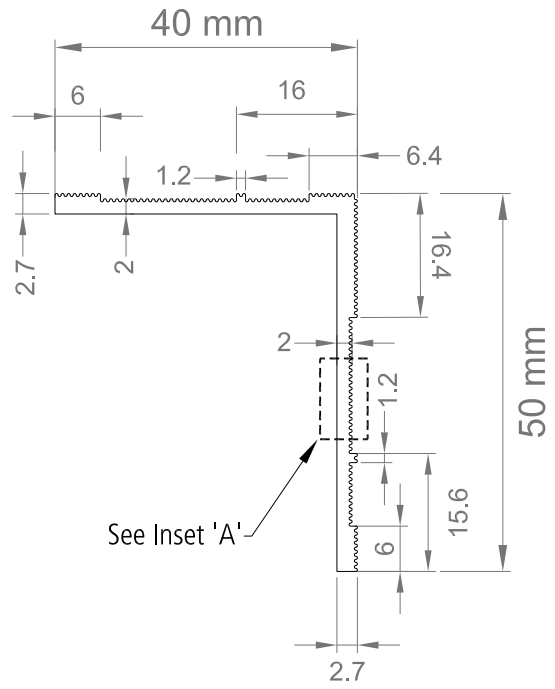




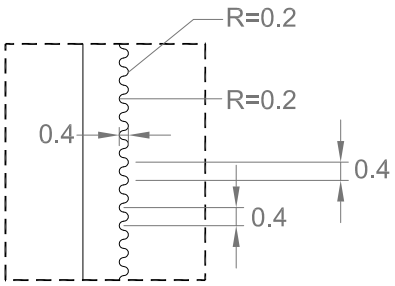
Material :
PVC Hartschaum

StoVentec® Sub-Construction
L-Rail (40mm x 50mm)

Detail No.: 90.001.SUB
Date: September 2019



L-Rail Profile
(Scale 1:1)



Inset 'A'
(NOT TO SCALE)

Notes:

1. All measurements in metric millimeter (mm)

2. L-Rail Summary

Area = 181 mm^2
Perimeter = 235 mm

Weight = 0.3286 lbs./ft.

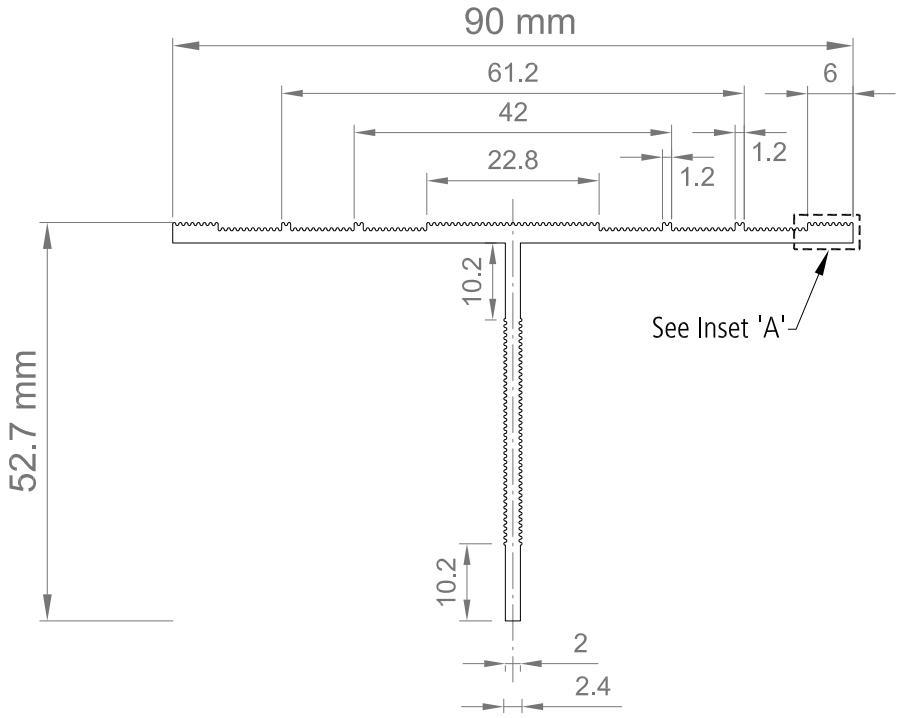
Tensile Strength
(Rm) ≥ 245N/mm^2

Yield Strength
(R_p0.2) ≥ 200N/mm^2

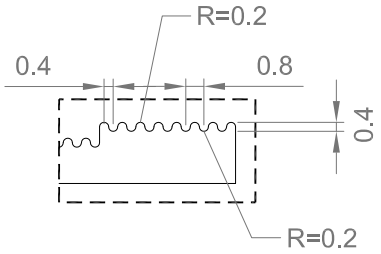
www.stocorp.com

StoVentec® Sub-Construction
T-Rail (90mm x 52.7mm)

Detail No.: 90.001.SUB
Date: September 2019



T-Rail Profile
(Scale 1:1)



Inset 'A'
(NOT TO SCALE)

Notes:

1. All measurements in metric millimeter (mm)

2. T-Rail Summary:

Area = 280 mm^2
Perimeter = 379 mm

Weight = 0.5262 lbs./ft.

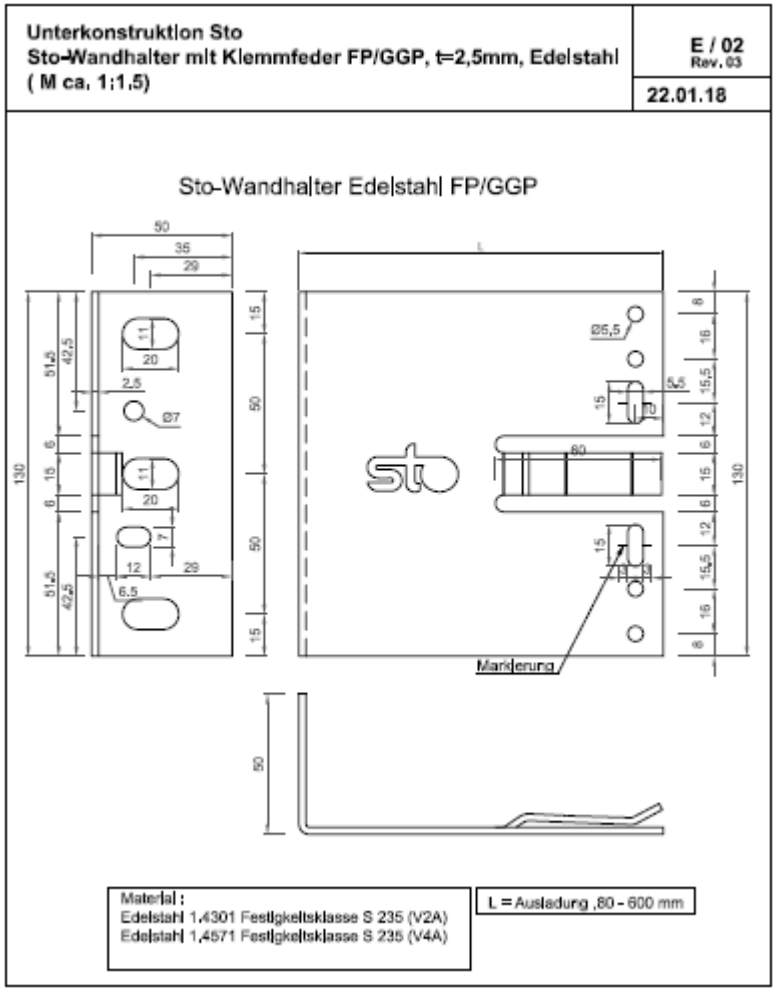
Tensile Strength
(Rm) ≥ 245N/mm^2

Yield Strength
(R_p0.2) ≥ 200N/mm^2

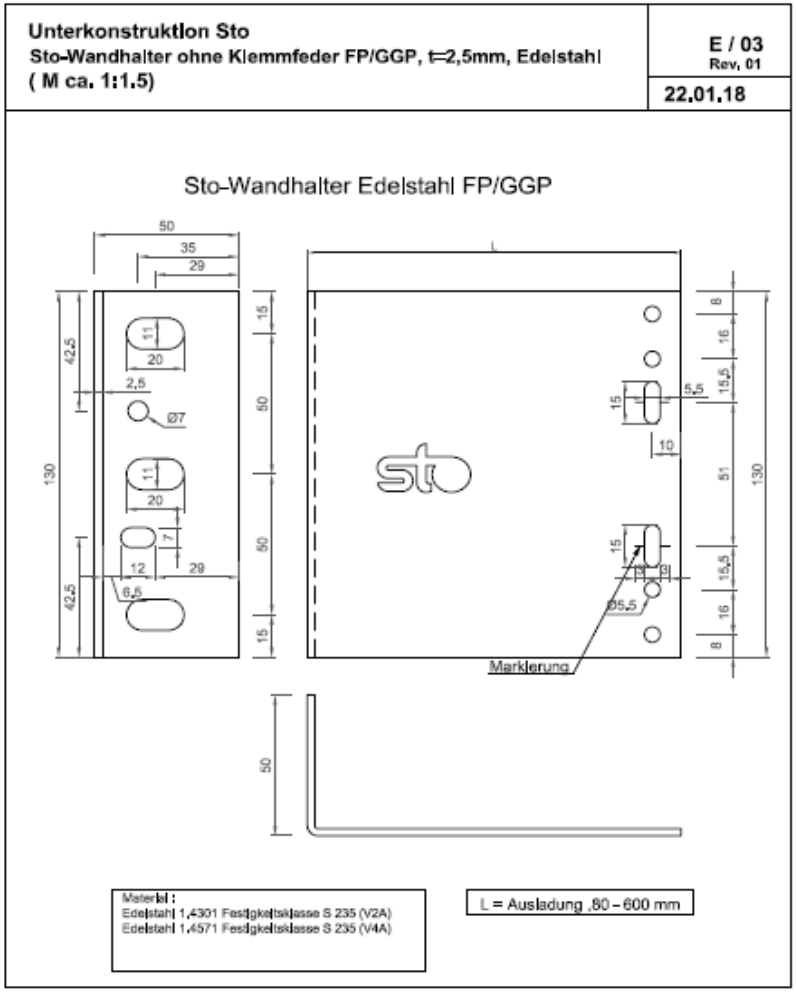
www.stocorp.com

New FP (fixing point) wallbrackets, stainless steel and galvanized steel

with holding clip



without holding clip



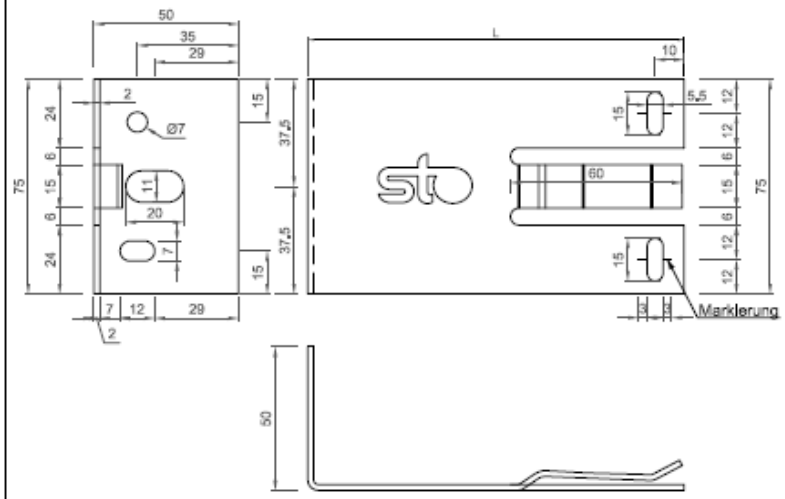
New GP (gliding point) wallbrackets, stainless steel and galvanized steel

with holding clip

Unterkonstruktion Sto
Sto-Wandhalter mit Klemmfeder GP, t = 2,0mm, Edelstahl
(M ca. 1:1.5)

E / 05
Rev. 02
05.12.17

Sto-Wandhalter Edelstahl GP



Material:
Edelstahl 1.4301 Festigkeitsklasse S 235 (V2A)
Edelstahl 1.4571 Festigkeitsklasse S 235 (V4A)

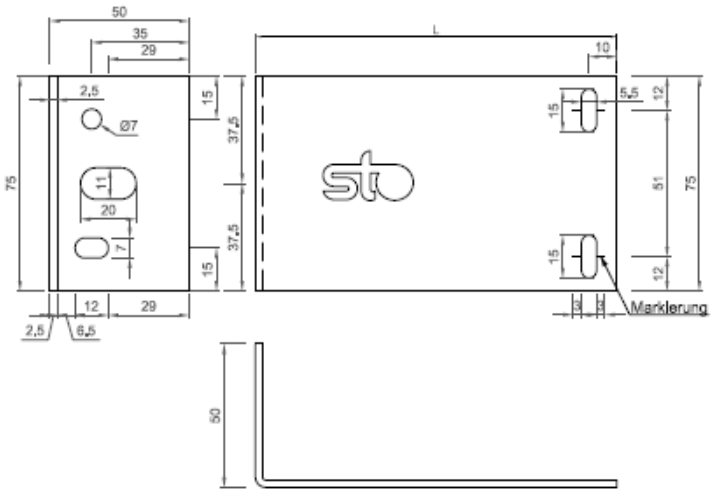
L = Ausladung , 80 - 600 mm

without holding clip

Unterkonstruktion Sto
Sto-Wandhalter ohne Klemmfeder GP, t = 2,5mm, Edelstahl
(M ca. 1:1.5)

E / 17
Rev. 00
22.01.18

Sto-Wandhalter Edelstahl GP



Material:
Edelstahl 1.4301 Festigkeitsklasse S 235 (V2A)
Edelstahl 1.4571 Festigkeitsklasse S 235 (V4A)

L = Ausladung , 80 - 600 mm

Technical Data Sheet

StoVentro Bracket L200 FP

Sub-construction element for StoVentec facades

Characteristics

Area of application	• for forming fixed and sliding points to absorb the dead weight of the facade system and the impact from wind loads
Properties	• 2 rows of holes, each with 2 oblong holes and 4 round holes • for fixing the Sto-Aluminium T- and L-profiles • with marking grooves for quick alignment of the carrier profiles and for dimensioning the wall bracket • made of aluminium: quality EN AW-6063 T66, tolerance in accordance with EN 755-9
Format	• anchor hole: 3 oblong holes: 11 mm x 18 mm, 2 oblong holes: 6.5 mm x 12 mm • height: 135 mm • material thickness at a projection of 40 - 180 mm: 3.0 / 3.2 mm • material thickness at a projection of 200 - 320 mm: 4.0 / 4.2 mm • length of wall bracket back: 50 mm
Information/notes	• order the optional thermal separating element separately • delivery time: 5 days + despatch

Substrate

Requirements	The substrate must be firm, dry, clean, and load-bearing.
Preparations	Check existing substrates for their load-bearing capacity. Facade measurement (horizontal/vertical) relating to any possible unevenness in the anchorage substrate and any resulting differing projections of the wall brackets. In the case of existing buildings (provided they are not of reinforced concrete), dowel extracts are required.

Application

Consumption

Type of application	Approx. consumption
in accordance with structural analysis	

Material consumption depends on the application, substrate, and consistency, among other factors. The stated consumption values are only to be used as a guide. If required, determine precise consumption values on the basis of the

Technical Data Sheet
StoVentro Bracket L200 FP

	specific project.
Application	if necessary, anchor in the substrate with a thermal separating element Measure (horizontally/vertically) and install (by drilling/screwing) the aluminium wall brackets with structurally defined fixing elements (screws, dowels, anchors, etc.).
Notes, recommendations, special information, miscellaneous	Drill holes must be blown out. When using galvanised anchor screws, the screw heads must be provided with a corrosion resistant protection layer. Sliding points must be fixed in the middle of an oblong hole (screw / rivet). Fixed points must be fixed in a round hole (screw / rivet). Please note the specifications of the structural analysis (if generated) of the installation plan for the (horizontal /vertical) axis spacings. We recommend always fitting a separating element with aluminium wall brackets due to their thermal conductivity.

Delivery	
Packaging	box

Storage	
Storage conditions	Do not subject the article to loads or stress.

Identification	
Product group	RSC system accessories

Safety	The product is a manufactured item. The creation of a safety data sheet in accordance with the REACH Regulation (EU) No. 1907/2006, Annex II, is not required. Detailed information can be found at www.sto.de under the category Fachhandwerker (tradesmen) / REACH.

Special notes

The information in this Technical Data Sheet serves to ensure the product's intended use, or its suitability for use, and is based on our findings and experience. Users are nevertheless responsible for establishing the product's suitability and use.
Applications not specifically mentioned in this Technical Data Sheet are permissible only after prior consultation. Where no approval is given, such applications are at the user's own risk. This applies in particular when the product is used in combination with other products.

Technical Data Sheet

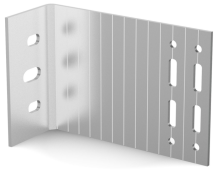
StoVentro Bracket L200 FP

When a new Technical Data Sheet is published, all previous Technical Data Sheets are no longer valid. The latest version is available on the Internet.

Sto SE & Co. KGaA
Ehrenbachstr. 1
79780 Stühlingen / Germany
Phone: +49 7744 57-0
Fax: +49 7744 57-2178
Infoservice.export@sto.com
www.sto.com

Technical Data Sheet

StoVentro Bracket L200 GP



Sub-construction element for StoVentec facades

Characteristics

Area of application

- for forming sliding points to absorb the effect of wind loads on the facade system

Properties

- 2 rows of holes, each with 2 oblong holes and 2 round holes
- for fixing the Sto-Aluminium T- and L-profiles
- with marking grooves for quick alignment of the carrier profiles and for dimensioning the wall bracket
- made of aluminium: quality EN AW-6063 T66, tolerance in accordance with EN 755-9

Format

- anchor hole: 1 oblong hole: 11 mm x 18 mm, 2 oblong holes: 6.5 mm x 12 mm
- Height: 95.5 mm
- material thickness at a projection of 40 - 180 mm: 3.0 / 3.2 mm
- material thickness at a projection of 200 - 320 mm: 4.0 / 4.2 mm
- length of wall bracket back: 50 mm

Information/notes

- order the optional thermal separating element separately
- delivery time: 5 days + despatch

Substrate

Requirements

The substrate must be firm, dry, clean, and load-bearing.

Preparations

Check existing substrates for their load-bearing capacity.

Facade measurement (horizontal/vertical) relating to any possible unevenness in the anchorage substrate and any resulting differing projections of the wall brackets.
In the case of existing buildings (provided they are not of reinforced concrete), dowel extracts are required.

Application

Consumption

Type of application	Approx. consumption
in accordance with structural analysis	

Material consumption depends on the application, substrate, and consistency, among other factors. The stated consumption values are only to be used as a guide. If required, determine precise consumption values on the basis of the specific project.

Technical Data Sheet
StoVentro Bracket L200 GP

Application	if necessary, anchor in the substrate with a thermal separating element Measure (horizontally/vertically) and install (by drilling/screwing) the aluminium wall brackets with structurally defined fixing elements (screws, dowels, anchors, etc.).
Notes, recommendations, special information, miscellaneous	Drill holes must be blown out. When using galvanised anchor screws, the screw heads must be provided with a corrosion resistant protection layer. Sliding points must be fixed in the middle of an oblong hole (screw / rivet). Fixed points must be fixed in a round hole (screw / rivet). Please note the specifications of the structural analysis (if generated) of the installation plan for the (horizontal /vertical) axis spacings. We recommend always fitting a separating element with aluminium wall brackets due to their thermal conductivity.

Delivery

Packaging	box

Storage

Storage conditions	Do not subject the article to loads or stress.

Identification

Product group	RSC system accessories

Safety	The product is a manufactured item. The creation of a safety data sheet in accordance with the REACH Regulation (EU) No. 1907/2006, Annex II, is not required. Detailed information can be found at www.sto.de under the category Fachhandwerker (tradesmen) / REACH.

Special notes

The information in this Technical Data Sheet serves to ensure the product's intended use, or its suitability for use, and is based on our findings and experience. Users are nevertheless responsible for establishing the product's suitability and use.
Applications not specifically mentioned in this Technical Data Sheet are permissible only after prior consultation. Where no approval is given, such applications are at the user's own risk. This applies in particular when the product is used in combination with other products.

Technical Data Sheet

StoVentro Bracket L200 GP

When a new Technical Data Sheet is published, all previous Technical Data Sheets are no longer valid. The latest version is available on the Internet.

Sto SE & Co. KGaA
Ehrenbachstr. 1
79780 Stühlingen / Germany
Phone: +49 7744 57-0
Fax: +49 7744 57-2178
Infoservice.export@sto.com
www.sto.com

Technical Data Sheet

StoVentro Thermostop L200

Thermal separating element between wall bracket and wall substrate

Characteristics	
Area of application	• to reduce thermal bridging between the wall bracket and wall substrate
Properties	• made of rigid PVC • with punched holes • thermal conductivity: 0.08 - 0.09 W/(m*K)
Format	• thickness: 6 mm • height: 135 mm (fixed point) or 95.5 mm (sliding point) • width: 50 mm
Information/notes	• installation in accordance with structural analysis with approved anchoring elements
Substrate	
Requirements	The substrate must be firm, dry, clean, and load-bearing.
Preparations	Blow out the drill hole.
Application	
Application	Insert the thermal separating element between the wall substrate and the base plate of the wall bracket. Fix the wall bracket and the separating element with anchors.
Delivery	
Colour shade	white
Storage	
Storage conditions	Do not subject the article to loads or stress.

Technical Data Sheet

StoVentro Thermostop L200

Identification

Product group	RSC system accessories

Special notes

The information in this Technical Data Sheet serves to ensure the product's intended use, or its suitability for use, and is based on our findings and experience. Users are nevertheless responsible for establishing the product's suitability and use.
Applications not specifically mentioned in this Technical Data Sheet are permissible only after prior consultation. Where no approval is given, such applications are at the user's own risk. This applies in particular when the product is used in combination with other products.

When a new Technical Data Sheet is published, all previous Technical Data Sheets are no longer valid. The latest version is available on the Internet.

Sto SE & Co. KGaA
Ehrenbachstr. 1
79780 Stühlingen / Germany
Phone: +49 7744 57-0
Fax: +49 7744 57-2178
Infoservice.export@sto.com
www.sto.com

Nedal Aluminium BV
Groenewoudsedijk 1
3528 BG Utrecht

P.O. Box 2020
3500 GA Utrecht
The Netherlands

+31 (0)30 292 57 11
info@nedal.com
www.nedal.com

ALLOY DATA SHEET
EN-AW 6063[AlMg0.7Si]
(Type: General extrusion alloy)

The alloy EN AW-6063 is a widely used extrusion alloy, suitable for applications where only modest strength properties are required. Parts can be produced with a good surface quality, suitable for many coating operations. Typical application fields are furniture, finishing materials, windows and doors, carbody finishing, façade construction, lighting columns and flagpoles.

Chemical composition according to EN573-3 (weight%, remainder Al)

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	remarks	others	
									each	total
0.20-0.6	max. 0.35	max. 0.10	max. 0.10	0.45-0.9	max. 0.10	max. 0.10	max. 0.10		max. 0.05	max. 0.15

Mechanical properties according to EN755-2

Temper*	Wallthickness e*** [mm]	Yield stress $Rp_{0.2}$ [MPa]	Tensile strength Rm [MPa]	Elongation A [%]	Elongation A_{50} [%]	Hardness** HB
T4	≤ 25	65	130	14	12	50
T5	≤ 10	130	175	8	6	65
	10 < e ≤ 25	110	160	7	5	65
T6	≤ 10	170	215	8	6	75
	10 < e ≤ 25	160	195	8	6	75
T66	≤ 10	200	245	8	6	80
	10 < e ≤ 25	180	225	8	6	80

*Temper designation according to EN515: T4-Naturally aged to a stable condition, T5-cooled from an elevated temperature forming operation and artificially aged, T6-Solution heat treated, quenched and artificially aged, T66-cooled from an elevated temperature forming operation and artificially aged to a condition with higher mechanical properties through special control of manufacturing processes. (T6/T66 properties can be achieved by press quenching)
** Hardness values are for indication only
***For different wall thicknesses within one profile, the lowest specified properties shall be considered as valid for the whole profile cross section

Physical properties (approximate values, 20°C)

Density [kg/m^3]	Melting range [°C]	Electrical Conductivity [MS/m]	Thermal Conductivity [W/m.K]	Co-efficient of thermal Expansion 10^{-6}/K	Modulus of Elasticity [GPa]
2700	585-650	28-34	200-220	23.4	~70

Weldability[1]
Gas: 3 TIG: 2 MIG: 2
Typical filler materials (EN ISO18273): SG-AlMg5Cr(A) or AlSi5, and AlMg3 when the product has to be anodised. Due to the heat input during welding the mechanical properties will be reduced by approximately 50% (ref. EN1999-1).

Machining characteristics[1]
T4 temper: 3 T5 and T6 temper: 2

Coating properties[1]
Hard protecting anodising: 1
Decorative/bright/colour anodising: 2

Corrosion resistance[1]
General: 1 Marine: 2

[1]Relative qualification ranging from 1-very good to 6 unsuitable

November 2017
Rev. 02

APPENDIX B:
MODELING PARAMETERS AND ASSUMPTIONS

1. GENERAL MODELING APPROACH

For this report, a steady-state conduction model was used. The following parameters were also assumed:

- Material properties were taken from information provided by Sto Corporation and the ASHRAE Handbook – Fundamentals for common materials.
- Enclosed air spaces, less than 1/2 inch (13 mm) in depth, were modeled with an equivalent thermal conductivity of the air that includes the impacts of convection and radiation within the enclosure. Calculations for this equivalent conductivity were based on ISO 10077-2.
- Enclosed air spaces, greater than 1/2 inch (13 mm) in depth, were modeled with an equivalent thermal conductivity of the air that includes the impacts of convection and radiation within the enclosure. Calculations for this equivalent conductivity were based on Table 6 of CSZ Z5010:2021 and Table 3 in Chapter 26 of 2017 ASHRAE Handbook - Fundamentals.
- Interior/exterior air films were taken from Table 8 of CSA Z5010: 2021 and Table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation. The exterior air films were based on an exterior wind speed of 15 mph.
- In ASHRAE 1365-RP, for rain screen cavity systems, most lightweight claddings have an insignificant impact on the thermal performance other than shielding the insulation from direct wind exposure. The cladding and secondary structure outboard of the clip system were not explicitly modeled but were incorporated into the exterior film coefficient.
- From the calibration in 1365-RP, contact resistances between materials were modeled and varied between R-0.01 and R-0.2 depending on the materials and interfaces.
- Insulation and other components were considered tight to adjacent interfaces.
- The clear field transmittances included in this analysis include uniform thermal bridges such as studs, brackets, and rails.

2. TEMPERATURE INDEX

The temperature index is the ratio of the surface temperature relative to the interior and exterior temperatures. The temperature index has a value between 0 and 1, where 0 is the exterior temperature and 1 is the interior temperature. If T_i is known, Equation 1 can be rearranged for $T_{surface}$. This arrangement allows the modelled surface temperatures to be applicable to any climate.

$$T_i = \frac{T_{surface} - T_{outside}}{T_{inside} - T_{outside}} \qquad \text{EQ 1}$$

Note, these indices shown in the temperature profiles for this analysis are for general information only and are not intended to predict in-service surface temperatures subject to transient conditions, variable heating systems, and/ or interior obstructions that restrict heating of the assembly. For full limitations of this modeling approach, see ASHRAE 1365-RP.

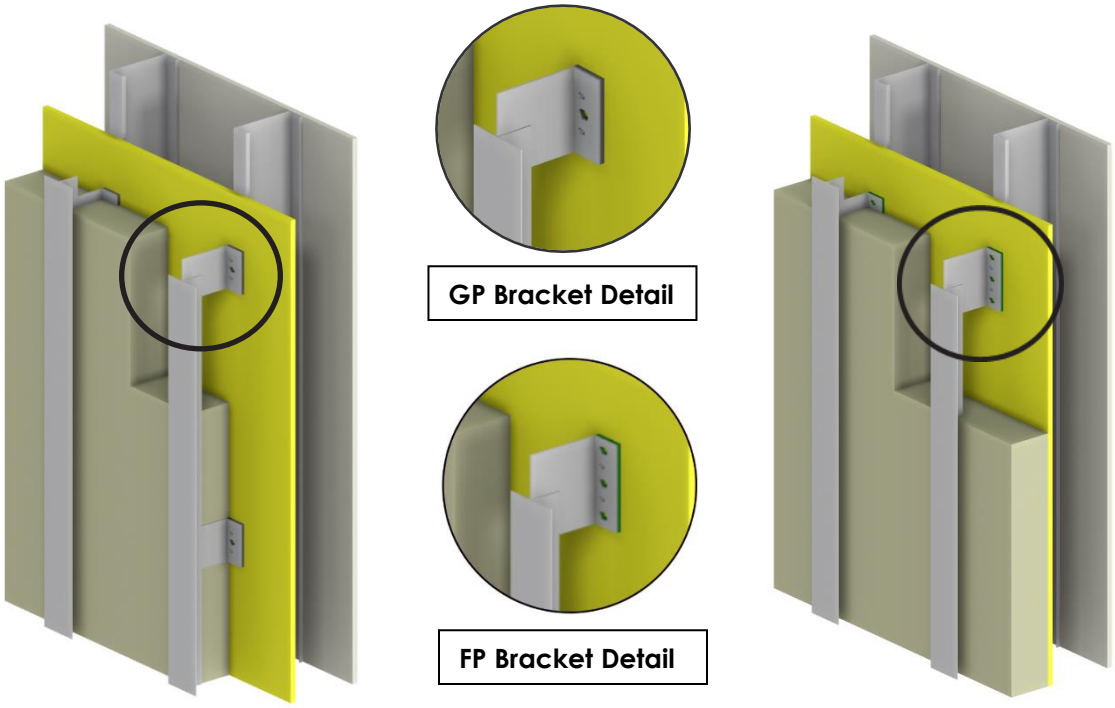
3. BOUNDARY CONDITIONS

Table B3.1: Boundary Conditions

Boundary Location	Combined Convective and Radiation Heat Transfer Coefficient BTU/hft^2^{o}F (W/m^{2}K)
Exterior Wall Surfaces with Generic Cladding	1.5 (8.3)
Interior Walls	1.5 (8.3)

APPENDIX C:
MATERIAL PROPERTIES

1. EXTERIOR INSULATED STEEL STUD ASSEMBLY



Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft² hr °F (W/m K)	Nominal Resistance[1] ft² hr °F / Btu (m² K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity[2]	Air	6 (152)	-	R-0.9 (0.16 RSI)
6" x 1-5/8" Steel Stud	Galvanized Steel	18 ga.	430 (62)	-
Sheathing	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Exterior Insulation	Mineral Wool	Varies	0.24 (0.034)	R-8.4 to R-33.6 (1.48 to 5.92 RSI)
Thermal Isolator	PVC	0.24 (6.0)	0.59 (0.085)	-
GP or FP Bracket	Galvanized Steel	0.01 (2.0)	430 (62)	-
Fasteners	Steel	0.26 (6.5) Ø	347 (50)	-
Vertical T-Rail	Aluminum	0.08 (2.0)	1110 (160)	-
Air Spaces[3]	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-11.6 to R-36.8 (2.04 to 6.48 RSI)

[1] Dash indicates not a continuous component.
[2] The thermal conductivities of large air spaces were determined according to Table 6 of CSA Z5010 and Table 3 in Chapter 26 of 2017 ASHRAE Handbook – Fundamentals
[3] The thermal conductivities of small air spaces were determined according to ISO 10077-2

APPENDIX D:
SIMULATED
TEMPERATURE PROFILES

As an example of the thermal profiles of the StoVentec Bracket system, the following figures illustrate a typical temperature distribution for the exterior insulated steel-frame wall assemblies with studs at 16 inch (406 mm) o.c. and 16 inch (406 mm) horizontal bracket spacing, 24 inch (610 mm) vertical bracket spacing, and 6 inch (152 mm) exterior insulation (R-25.2).

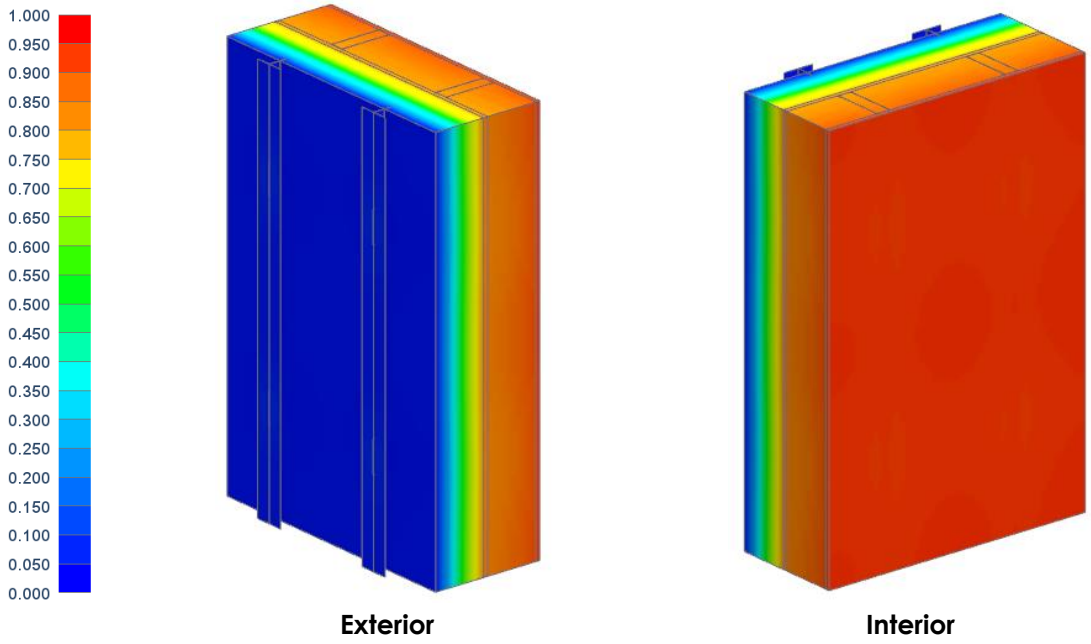


Figure D1: Simulated Temperature Profile of Exterior Insulated Steel Frame Wall Assembly with 16 inch (406 mm) stud spacing, 16 inch (406 mm) horizontal bracket spacing, 24inch (610 mm) vertical bracket spacing, and 6 inch (152 mm) mineral wool exterior insulation (R-25.2)

APPENDIX E:
GLOSSARY OF TERMS

Term	Symbol	Units Imperial	Units SI	Description
Conductivity	K	$\frac{\text{(BTU in)}}{\text{(hr ft}^2\ ^o\text{F)}}$	$\frac{\text{W}}{\text{(m K)}}$	The ability of a material to transmit heat in terms of energy per unit area per unit thickness for each degree of temperature difference.
Equivalent Conductivity	K_{eq}	$\frac{\text{(BTU in)}}{\text{(hr ft}^2\ ^o\text{F)}}$	$\frac{\text{W}}{\text{(m K)}}$	The averaged or equivalent thermal conductivity of a component consisting of several building materials, effectively treating the component as a homogeneous material that provides the same thermal characteristics.
Heat Flow	Q	BTU/hr	W	The amount of energy per unit time that passes through an assembly under a specific temperature drive of ΔT.
Thermal Transmission Coefficient	U	$\frac{\text{(BTU)}}{\text{(hr ft}^2\ ^o\text{F)}}$	$\frac{\text{W}}{\text{(m}^2\text{ K)}}$	Heat flow per unit time through a unit area of an assembly per temperature degree difference. The convention is to include the impact of air films
Thermal Resistance of a Material	R	$\frac{\text{(hr ft}^2\ ^o\text{F)}}{\text{(BTU)}}$	$\frac{\text{(m}^2\text{ K)}}{\text{W}}$	A measure of a material's resistance to heat flow.
Effective Thermal Resistance	R_{eff}	$\frac{\text{(hr ft}^2\ ^o\text{F)}}{\text{(BTU)}}$	$\frac{\text{(m}^2\text{ K)}}{\text{W}}$	A measure of an assembly's resistance to heat flow, including the effects of thermal bridging. The inverse of the assembly U-value.
Clear Field Assembly Thermal Transmittance	U_0	$\frac{\text{(BTU)}}{\text{(hr ft}^2\ ^o\text{F)}}$	$\frac{\text{W}}{\text{(m}^2\text{ K)}}$	Heat flow coefficient for an assembly with uniformly distributed thermal bridges, which are not practical to account for on an individual basis for U-value calculations. Examples of thermal bridging included in U_o are brick ties, girts supporting cladding, and structural studs.

Term	Description
Air Films	An approximation of the combined radiative and conductive-convective heat exchange at air boundary surfaces.
Clear Field Assembly	Wall, floor and roof assemblies of a building. (see definition of U_0 above).
Opaque Assembly	All areas in the building envelope, except fenestration and building services openings such as vents and grilles.
Poured-in-Place Concrete Wall	An architectural exposed concrete wall that is formed at the location of installation and is part of the building structural support.
Thermal Break	A non-conductive material that interrupts a conductive heat flow path. For example, aluminum framing for glazing in cold climates typically utilizes a low conductivity material to join an exterior and interior portion of the metal framing.
Thermal Bridge	Part of the building envelope where otherwise uniform thermal resistance is changed by full or partial penetration of the thermal insulation by materials with lower thermal conductivities and/or when the interior and exterior areas of the envelope are different, such as what occurs at parapets and corners.
Thermal Modelling	The process by which the thermal performance of assemblies is determined through computer simulations utilizing heat transfer models. Assemblies can be modeled two- or three- dimensions (2D and 3D).
Thermal Performance	A broad term to describe performance indicators related to the heat transfer through an assembly. The performance indicators include thermal transmittances, effective R-values, and metrics to evaluate condensation resistance related to surface temperatures.