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Weathertightness test to BS EN 14351-1:2006 +A1:2010 clauses 4.2, 4.5 and 4.14 on a Smart Architectural Aluminium Alitherm 700 reversible window

Prepared for: Mr. M. Walford

Smart Architectural Aluminium

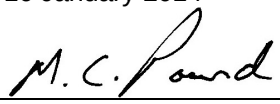
22 January 2014

Test report number 292602

UKAS TESTING

0578

Tested on behalf of BRE by:

Name	Malcolm Pound
Position	Senior Consultant and Laboratory Manager, Building Technology
Date	16 January 2014
Signature	

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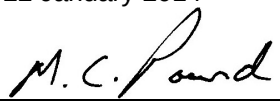
Signature	

Approved on behalf of BRE

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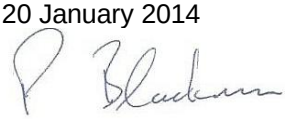
Signature	

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Contents

1 Introduction

At the request of Mr. M. Walford of Smart Architectural Aluminium, Technical Department, Arnolds Way, Yatton, Bristol, North Somerset, BS49 4QN, BRE issued proposal number 134851 on 19 December 2013. The proposal was accepted on 6 January 2014 and BRE tested a specimen Alitherm 700 reversible window on the 16 January 2014.

BS EN 14351-1:2006 +A1:2010[1] is the product standard that identifies mandated and non-mandated characteristics for windows and external pedestrian doors for the European market, and it enables products to be CE marked. Designers, specifiers, manufacturers and end users need to identify those characteristics and performance levels appropriate for the selected end use. These will vary from site to site and from country to country.

To avoid uneconomical and inappropriate specifications for the UK market recommended levels of performance have been identified. These performance levels (in this case for weathertightness) are in the National Application Document (NAD) BS 6375-1:2009[2].

The tests to methods specified in BS 6375-1:2009 are BS EN 1026[3], 1027[4] and 12211[5], they measure the weathertightness of the specimen in terms of air permeability, watertightness and resistance to wind load respectively. Classification of the results is based on BS 6375-1:2009 and BS EN 12207[6], 12208[7], 12210[8].

The tests on the specimen were carried out by Mr. M. C. Pound under the BRE Standard Terms and Conditions of Business for testing and to the UKAS BRE Specific Procedures Series F, as BRE Job number 292602 in project number CV6506. The tests were witnessed by:

Mr. M. Walford	Technical Department, Smart Architectural Aluminium
Mr. A. Perry	Technical Department, Smart Architectural Aluminium

2 Details of tests carried out

BS 6375-1:2009 specifies that the air permeability test is performed under both positive and negative test pressures and that the average of the measurements defines the results. It also specifies that water tightness test method A is used and that deflections measured during the resistance to wind load test do not exceed 1/150 of the span. The weathertightness test comprised of three parts in the sequence:

1. Air permeability to BS EN 1026: 2000; by application of a series of test air pressure differentials across the specimen with measurement of the air permeability of it at each pressure step. The maximum positive and negative pressure differential was 600 Pa reached in pressure steps of 50, 100, 150, 200, 250, 300, 450 and 600 Pa.

2. Watertightness to BS EN 1027: 2000; by applying specified amounts of water spray to the outside face of the specimen while incrementally increasing the air pressure differential across it. The test pressure, time and position of any water penetration are recorded. The maximum positive air pressure differential was 600 Pa. Pressure (Pa)/time (min) steps were 0/15, 50/5, 100/5,150/5, 200/5, 250/5, 300/5, 450/5 and 600/5.

3. Resistance to wind load to BS EN 12211: 2000; by application of a series of positive and negative test air pressures. Measurements and inspections are made to assess relative frontal deflection and resistance to damage from wind loads.

   The resistance to wind load test includes a deflection test, a repeated pressure test and operational test, an air permeability test and finally a safety test. For the purpose of the resistance to wind load test three test pressures are defined:

   P1 applied to measure the deflections of parts of the test specimen.
   P2 50 cycles of pulsating pressure to assess performance under repeated wind loads.
   P3 applied to assess the safety of the test specimen under extreme conditions.

   The values of P1, P2 and P3 are related as follows: P2 = 0.5P1, P3 = 1.5P1.
   For these tests the values are: P1 = 2400 Pa, P2 = 1200 Pa and P3 = 3600 Pa.

   Note: The repeat air permeability test is an integral part of the resistance to wind load test and its significance is as an indicator of damage that may occur during that test.

3 Classification of results

BS 6375-1:2009 classifies the results for products in the UK. For a window to be included in an exposure category the appropriate test pressures for air permeability, watertightness and resistance to wind shall be attained or exceeded. The relevant product standard BS EN 14351-1:2006[8] also states that classification of air permeability is based on the averages of the positive and negative air leakage values at each pressure step.

The specimen was tested to a UK exposure category of 2000+ (2400 Pa). The classifications set in BS 6375-1:2009 for a UK exposure category of 2000+ for windows are: Air permeability at Class 2/300 Pa when tested to 300 Pa or class 3 or 4 when tested to 600 Pa, water tightness at class 7A at 300 Pa and resistance to wind load at Class AE2400 at P1 2400 Pa, P2 1200 Pa and P3 3600 Pa.

When averages of the measurements of air permeability per square metre and length of the opening joints on the specimen give rise to adjacent air permeability classes then the specimen shall be classified in the most favourable class (according to BS EN 12207 Clause 4.6).

The BS EN classifications are explained below:

Air permeability: BS EN 12207: 1999. The classification is based on a comparison of the air permeability of the test specimen related to both overall area and length of opening joint. There are four classes; Class 4 is applicable to the most airtight specimens while Class 1 describes those with most air leakage. To meet any class the measured air permeability of the specimen must not exceed the upper limit at any test pressure step in that class.

Watertightness: BS EN 12208: 2000. The classification is based on a comparison of the watertightness of the test specimen related to test pressures and duration of the test. There are nine classes; 1A/1B up to 9A for test pressures from 0 Pa to 600 Pa. For specimens that remain watertight over 600 Pa for 5 minutes a class Exxx is used. The xxx is the maximum test pressure e.g. 750 Pa. To meet any class the specimen must remain watertight for 5 minutes up to and at the test pressure set for that class.

Resistance to wind load: BS EN 12210: 1999. The classification is based on a comparison of the resistance to wind loads of the test specimen when subjected to test pressures P1, P2 and P3. There are five classes; 1 up to 5 for P1 test pressures from 400 Pa to 2000 Pa. For specimens that are tested to P1 pressures exceeding 2000 Pa a class Exxxx is used. The xxxx is the actual test pressure P1 used e.g. 2400 Pa. To achieve any class the resistance of the specimen to wind load must meet all the requirements for that class.

Note: This report has results for air permeability under positive and negative test pressures and a graph showing the average air permeability for them at each pressure step.

4 Test specimen

The general details about the test specimen supplied by Smart Architectural Aluminium for these tests are given below:

Type: Aluminium frame members forming a window with a single reversible opening light. Reference: Smart Systems Alitherm 700 Reversible window; specimen is 1200 mm wide x 1220 mm high. Drawings and photographs in the Annex of this report show cross sections of the frame members and door details.

Frame: Aluminium sections.

Glazing: The opening light is glazed internally with an insulating glass unit with 4 mm thick toughened glass, a 20 mm wide air gap and 4 mm thick toughened glass. Aluminium snap-in beads retain the glazing and the glazing seals.

Seals: There is a compression type seal on the window frame that is mitred at the corners and bonded and a fin type seal on the light frame that is mitred at the corners and bonded.

Hardware: One lockable handle operates eight Trojan gear espagnolette locking bolts into four shared keeps at the bottom rail of the window. The opening light is hung on two PN reversible hinges. One of the hinges has a built-in opening restrictor.

Drainage: There are two slots under the opening light in the window frame. These lead to drainage slots in the nose of the sub-sill.

Fixings: For these tests the specimen was fixed with screws and sealed into a timber surround frame.

Dimensions: 1200 mm wide x 1220 mm high (overall). Area: 1.46 m²

Length of opening joint = 4.37 m

5 Test rig and preparatory procedures

The test specimen was conditioned for at least 4 hours within temperature and humidity ranges specified in the test standards of 10°C to 30°C and 25% to 75% RH respectively.

The water temperature in the watertightness test was within the specified range of 4°C to 30°C.

The specimen was mounted in the BRE test rig 'G', to form one wall of a pressure box, with the outdoor face enclosed in the box.

A spray bar with three full circular cone nozzles was mounted in the pressure box to apply water to the outside face of the specimen. The water flow rate per nozzle was 2 L/min in accordance with BS EN 1027 spraying method 1A.

Transducers were mounted on independent supports to measure deflections of a frame member. Deflections were measured on the span at the positions indicated in Figure A3.

6 Summary of test results

The test results are summarised in Table 1 below. Figures show detail of the Smart Systems Alitherm 700 reversible window and detailed results are given in Annex A.

Air permeability		**Watertightness**		**Resistance to wind loads**	
Requirements	**Results**	**Requirement**	**Results**	**Requirements**	**Results**
Class 4 at 600 Pa	Met Class 4 for the average of positive and negative test results	Class 9A at 600 Pa	Met Class 9A at 600 Pa	Class AE2400 P1 = 2400 Pa P2 = 1200 Pa P3 = 3600 Pa	Met all of the require-ments for Class AE2400

Table 1. Summary of weathertightness test results

7 Conclusions

When the specimen Smart Architectural Aluminium Alitherm 700 reversible window, 1200 mm wide x 1220 mm high was tested to the standards described herein to a UK exposure category '2000+' it was found to be:

- Sufficiently airtight to attain Class 4 based on the averages of results under positive and negative test pressures thus meeting the BS 6375-1:2009 requirements and those of BS EN 12207 for Class 4 at 600 Pa.
- Resistant to water penetration using method 1A to Class 9A up to and at 600 Pa thus meeting and exceeding the BS 6375-1:2009 requirements for Class 7A at 300 Pa. Also meets the Class 9A requirement up to and at 600 Pa in BS EN 12208.
- Resistant to wind loads of ±2400 Pa causing deflections less than 1/150 of the span of a frame member. Resistant to repeated pressure cycles of ±1200 Pa and able to sustain the corresponding safety test pressure of ±3600 Pa. The overall classification for resistance to wind load is Class AE2400 thus meeting the requirements of BS 6375-1:2009 and BS EN 12210.

8 References

1. BS EN 1026: 2000. Windows and doors – Air permeability – Test method. British Standards Institution, London.
2. BS EN 1027: 2000. Windows and doors – Watertightness – Test method. British Standards Institution, London.
3. BS EN 12211: 2000. Windows and doors – Resistance to wind load – Test method. British Standards Institution, London.
4. BS 6375-1:2009. Performance of windows and doors – Classification for weathertightness and guidance on selection and specification
5. BS EN 12207: 2000. Windows and doors – Air permeability - Classification. British Standards Institution, London.
6. BS EN 12208: 2000. Windows and doors – Watertightness - Classification. British Standards Institution, London.
7. BS EN 12210: 2000. Windows and doors – Resistance to wind load - Classification. British Standards Institution, London.
8. BS EN 14351-1:2006 Windows and doors – Product standard. British Standards Institution, London.

ANNEX A. Weathertightness test results

Pressure differential Pa	Air flow through the specimen m^3/h	Air flow per unit area of the specimen $m^3/h.m^2$	Air flow per m of opening joint on the specimen $m^3/h.m$
50	1.91	1.30	0.44
100	3.68	2.51	0.84
150	4.42	3.02	1.01
200	5.06	3.46	1.16
250	6.01	4.10	1.37
300	6.75	4.61	1.54
450	8.45	5.77	1.93
600	10.71	7.31	2.45

Table A1. Air permeability under positive air pressure

Pressure differential Pa	Air flow through the specimen m^3/h	Air flow per unit area of the specimen $m^3/h.m^2$	Air flow per m of opening joint on the specimen $m^3/h.m$
50	1.45	0.99	0.33
100	3.06	2.09	0.70
150	4.26	2.91	0.97
200	5.21	3.56	1.19
250	6.02	4.11	1.38
300	6.72	4.59	1.54
450	8.50	5.80	1.94
600	10.72	7.32	2.45

Table A2. Air permeability under negative air pressure

Pressure differential Pa	Average air flow per unit area of the specimen $m^3/h.m^2$	Average air flow per m of opening joint on the specimen $m^3/h.m$
50	1.15	0.39
100	2.30	0.77
150	2.97	0.99
200	3.51	1.18
250	4.11	1.38
300	4.60	1.54
450	5.79	1.94
600	7.32	2.45

Table A3. Averages of air permeability's under positive and negative air pressures

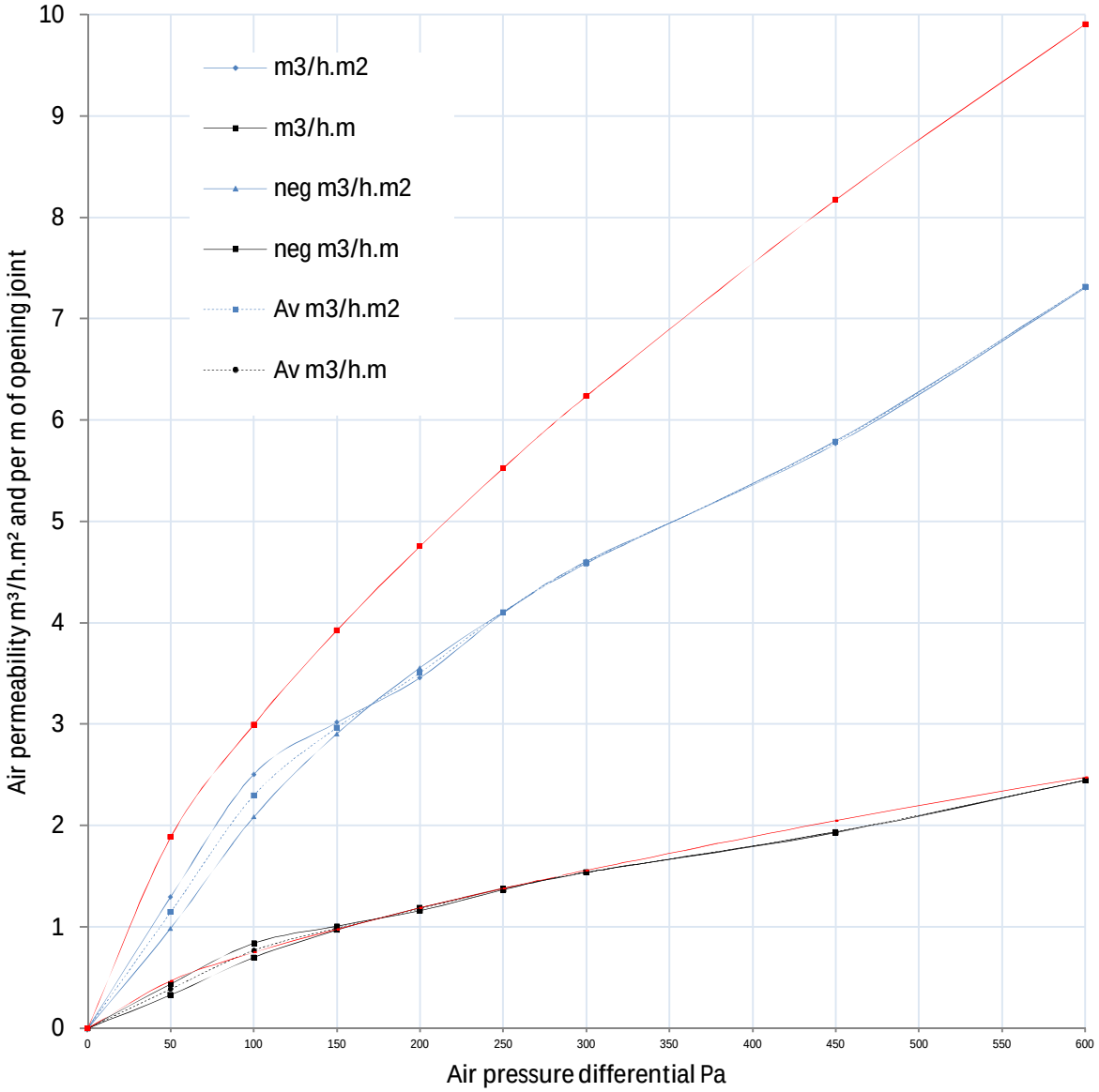


Figure A1. Test results: Air permeability under positive and negative air pressure; showing limits and averages of air permeability's measured under positive and negative test pressures

Watertightness test

Pressure differential Pa	Duration Minutes	Water leaks
0	15	Nil
50	5	Nil
100	5	Nil
150	5	Nil
200	5	Nil
250	5	Nil
300	5	Nil
450	5	Nil
600	5	Nil

Test laboratory conditions: Air temperature 18.5°C. Test chamber air temperature 18°C Air pressure 982 mb. Relative humidity 56% at 18°C. Water temperature 16.9°C

Table A4. Watertightness test results

Resistance to wind load – Deflection test at ± 2400 Pa

Position deflection measured	Positive pressure P1 to +2400 Pa		Negative pressure P1 to -2400 Pa	
	Deflection		Deflection	
	mm	defl./span	mm	defl./span
Right hand stile	0.79	1/1380	1.20	1/908

Note: The deflection at the mid-point of a member is measured relative to its ends, e.g. with reference to Figure A3: Deflection at the mid-point = deflection at the mid-point – average of deflections at the two ends of the same member.

Table A5. Deflections measured on a frame member in the resistance to wind load test at ±2400 Pa.

Resistance to wind load – Repeated pressure test including the second air permeability test

Repeated pressure	Damage or functional defects
50 cycles to P2 at ±1200 Pa	None

Table A6. Damage or functional defects after repeated pressures to P2 at ±1200 Pa

Second air permeability test under positive air pressures (part of resistance to wind load test)

Pressure differential Pa	Air flow through the specimen m³/h	Air flow through specimen measured at first air permeability test m³/h	Comparison to the air permeability measured previously (see Table A1)
50	1.94	1.91	After the test pressures P1 and P2 were applied the amounts of air flowing through the test specimen were not significantly different to those measured previously
100	3.67	3.68	
150	4.43	4.42	
200	5.08	5.06	
250	6.03	6.01	
300	6.78	6.75	
450	8.43	8.45	
600	10.71	10.71	

Table A7. Second air permeability test results under positive air pressures

Second air permeability test under negative air pressures (part of resistance to wind load test)

Pressure differential Pa	Air flow through the specimen m³/h	Air flow through specimen measured at first air permeability test m³/h	Comparison to the air permeability measured previously (see Table A2)
50	1.45	1.45	After the test pressures P1 and P2 were applied the amounts of air flowing through the test specimen were not significantly different to those measured previously
100	3.05	3.06	
150	4.25	4.26	
200	5.20	5.21	
250	5.97	6.02	
300	6.70	6.72	
450	8.34	8.50	
600	10.13	10.72	

Table A8. Second air permeability test results under negative air pressures

Resistance to wind load - Safety test

Safety test	Condition after test
One pressure pulse to pressure: P3 at – then + 3600 Pa	No parts became detached and the test specimen remained closed

Table A9. Condition of the specimen after the safety test to P3 at ±3600 Pa

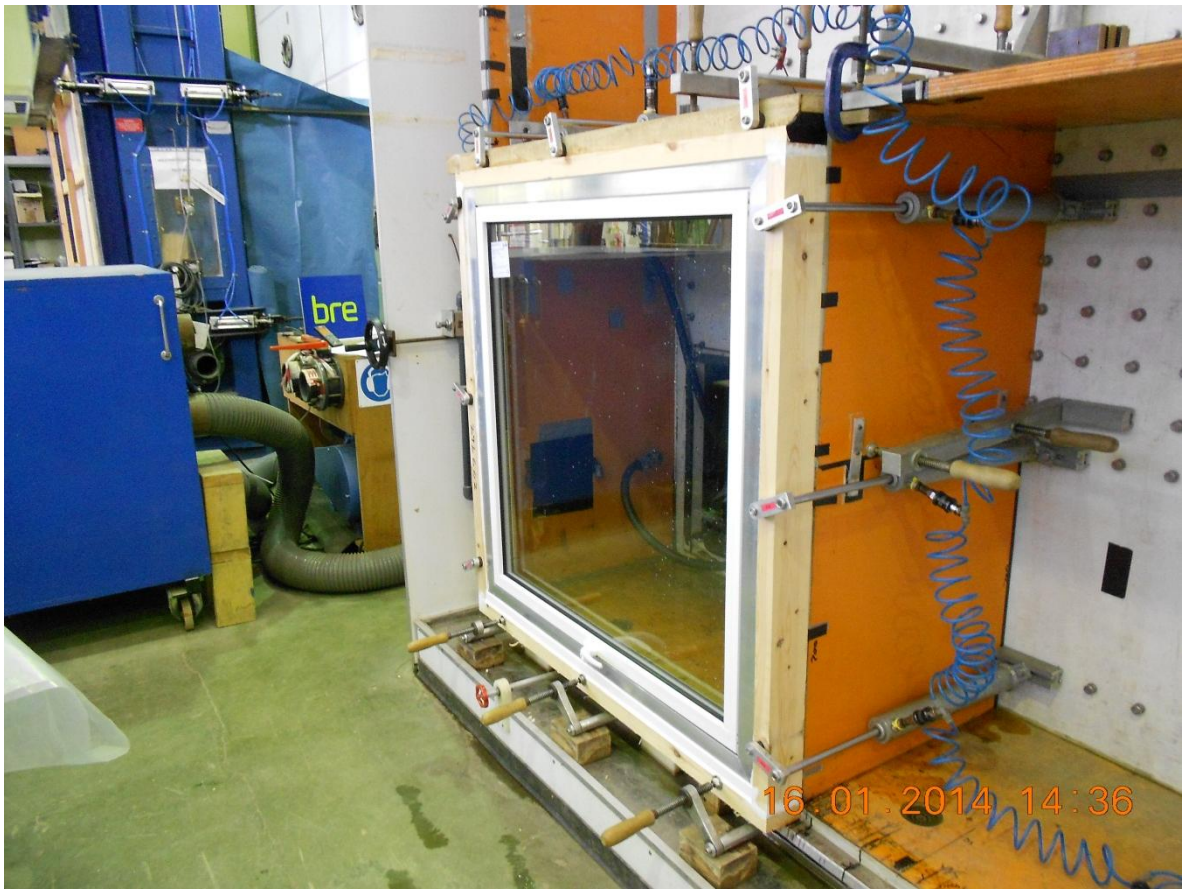
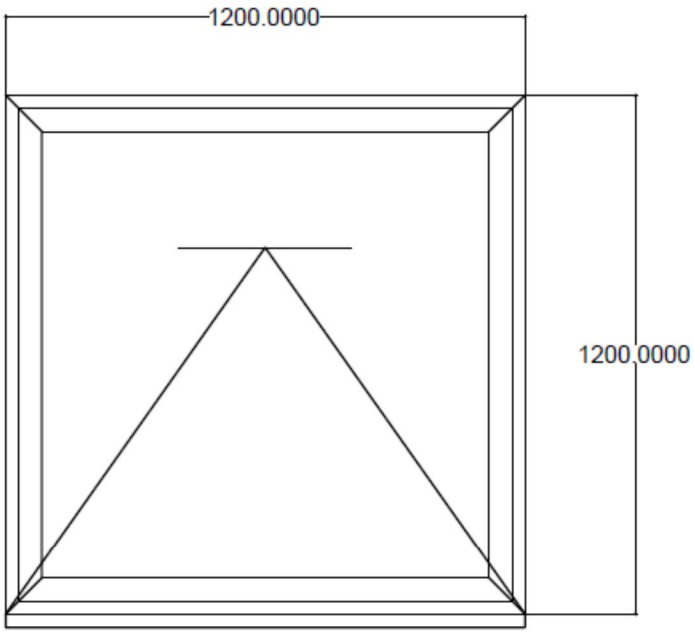


Figure A2. The test specimen mounted in BRE Test rig 'G'

Figure A3. The test specimen showing points 1, 2 and 3 where deflections were measured.

Smart Systems.

Alitherm 700 Series Reversible.



P and N Uni Reversible Hinges.

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Figure A4. Elevation of test specimen

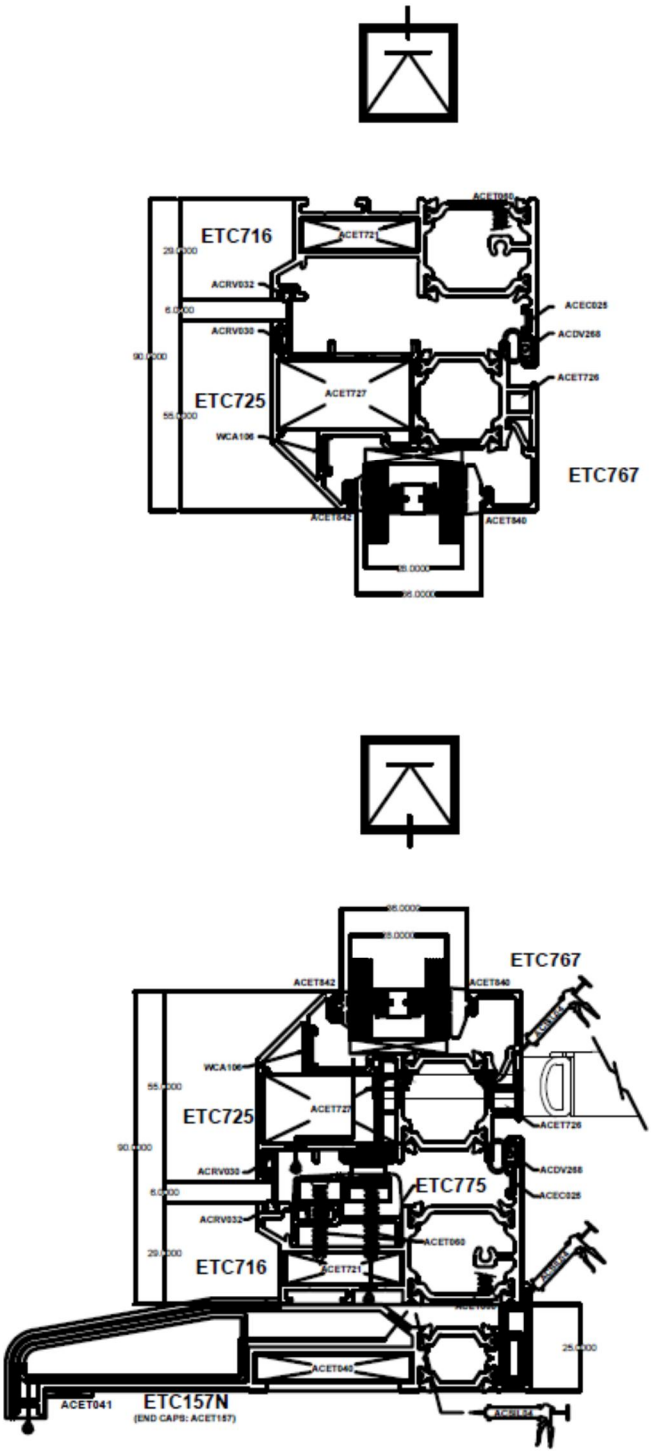

Figure A5. Vertical cross section

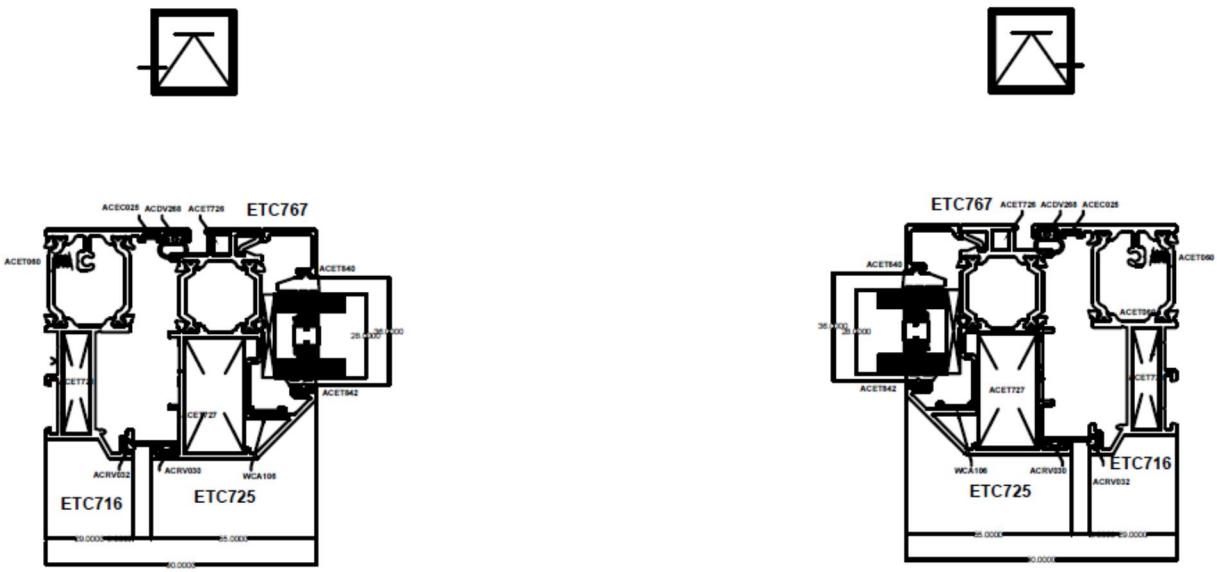

Figure A6. Horizontal sections

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