Passivhaus Documentation

Detached single family house,
rue du Pilat 42410 Pélussin, Rhône-Alpes, France
(Certified building, Passivhaus database ID 4679)

2.1

Jean-Pierre BOUJOT, Architect, Project leader, ATELIER 3A, www.atelier-3a.com

This detached single-family house in a low-density district is a 2014 design; construction was completed in June 2015 and the house won its Passivhaus certification in November 2015. It consists of a two-story timber frame construction with an attached hard-built garage. The main façade faces directly south.
Its location in an "historical monument" protected area justifies the tiled roof and roughcast façade finish.

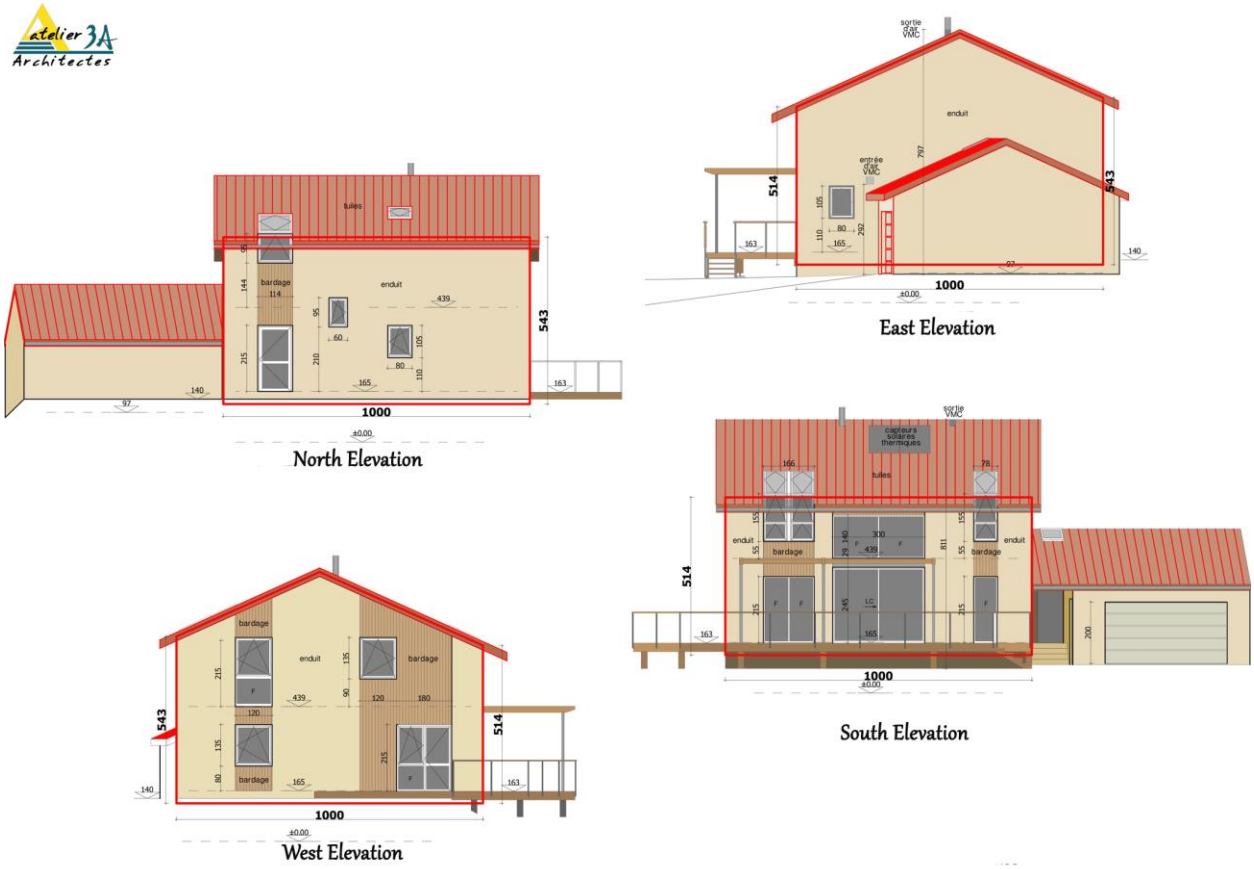
Key features: Timber construction, solar thermal panels for hot water, wood burning stove and extra electrical heater, external venetian blinds for optimum solar control

U-value external walls	0.136 W/(m²K)	**PHPP space heat demand**	**15 kWh/(m²a)**
U-value floor	0.132 W/(m²K)	PHPP primary energy demand	82 kWh/(m²a)
U-value roof	0.104 W/(m²K)	Pressure test n_{50}	0.48 h^{-1}
U-value window	0.8 W/(m²K)	Heat Recovery	75%

2.2 Brief project description

The plot of land offers undeniable advantages for a bioclimatic construction: it slopes to the south and is protected by a wall in the north with very little solar masking.

The layout of the house is a two-story square design with a double-sloping roof as required by urban planning regulations, with the south slope accommodating the installation of solar sensors for producing hot water.
This single-family house has a usable area of 144 m² (1550 ft.²) with one bedroom on the ground floor and three on the first floor. The volume is particularly compact. The first floor opening onto the ground floor living room allows better circulation of the air and ensures a particularly consistent temperature.
The frame of the house is wood to take advantage of excellent wall and roof insulation. The south-facing façade is generously glazed to make the most of solar influx in winter and the triple glazed windows are protected by adjustable venetian blinds, in the same way as on the west facing façade. The windows on the roof produce abundant light, as desired by the owners.
Thermal inertia is provided by a 15 cm thick concrete slab on the ground floor and a 45 cm thick stone-lined concrete wall in the center of the house, extending from floor to roof.
Heating is by a low power wood burning stove. The double flow ventilation offers efficiency of 84%. Domestic hot water comes from solar panels.



2.3 View of all elevations

East view

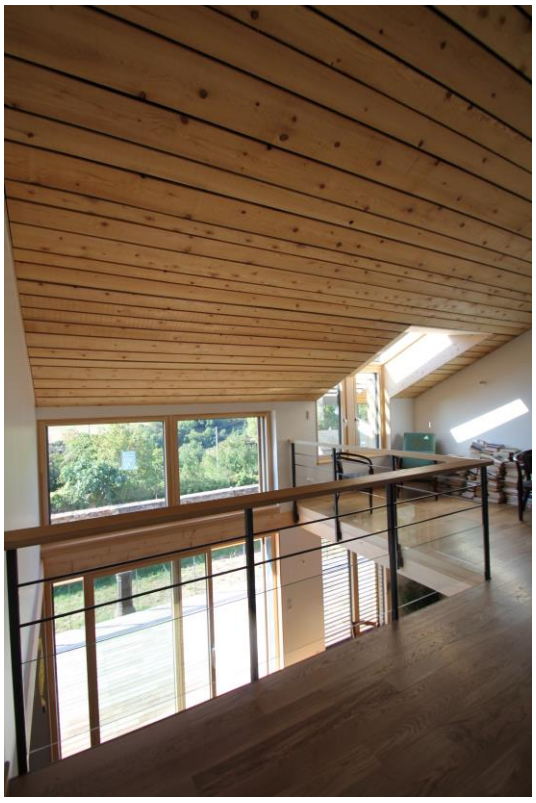
North-west view

West view

South view

Far south-west view

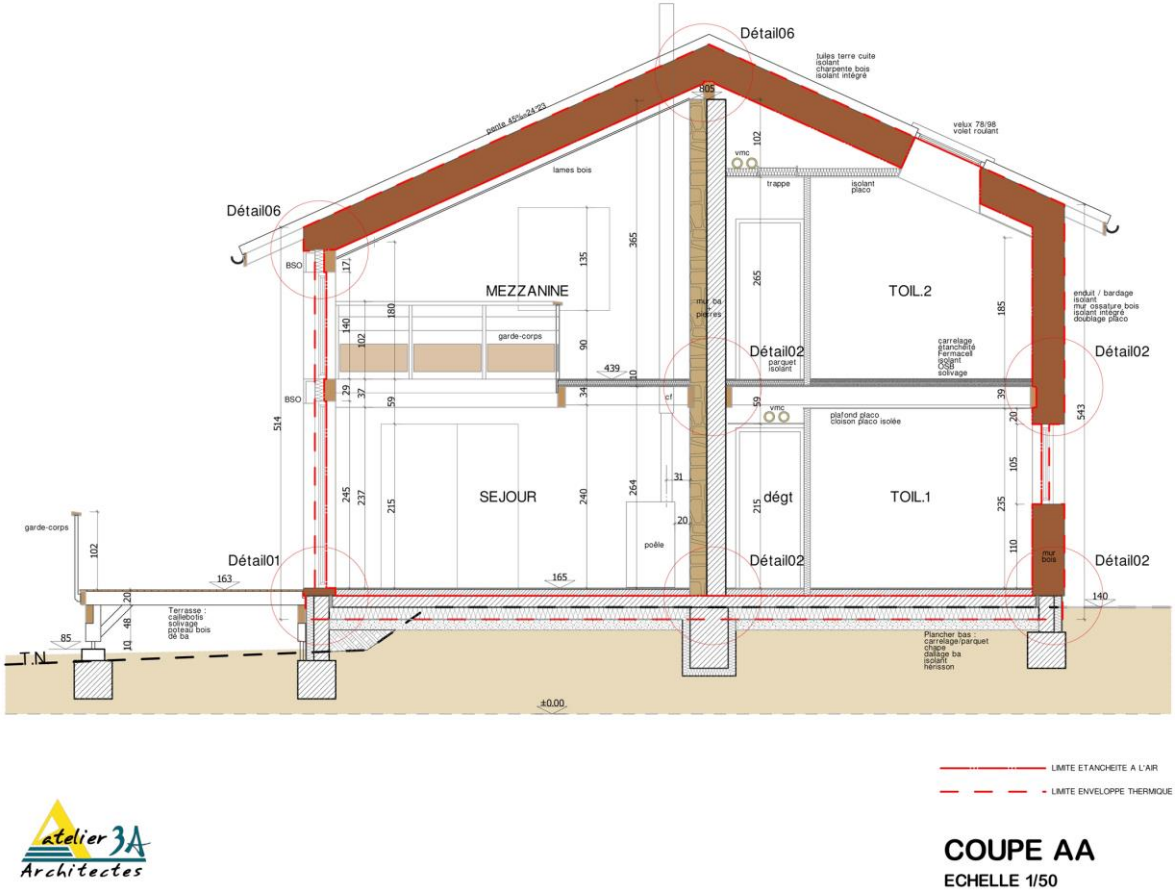
2.4 Internal views



2.5 Design drawings

Location of the building

Cross section



COUPE AA
ECHELLE 1/50

Caption:

Ground floor (internal to external): 14mm oak floorboard or ceramic floor tile, 60mm concrete screed, 150mm reinforced concrete slab on 160mm PU foam insulation

External walls (internal to external): gypsum board, air layer, airtightness film, wood structure 45x220mm, 220mm cellulose wool, OSB 12mm, 120mm wood fibres, lime plaster or wood cladding

First floor: 14mm oak or bamboo floorboard, 60mm wood fibres, 22mm OSB or fir floorboard, 240mm floor joist, gypsum board

Roof (internal to external): wood cladding or gypsum board, air layer, airtightness film, wood structure 50x300mm, 300mm cellulose wool, OSB 18mm, 120mm wood fibres, rainscreen, terracotta tiles

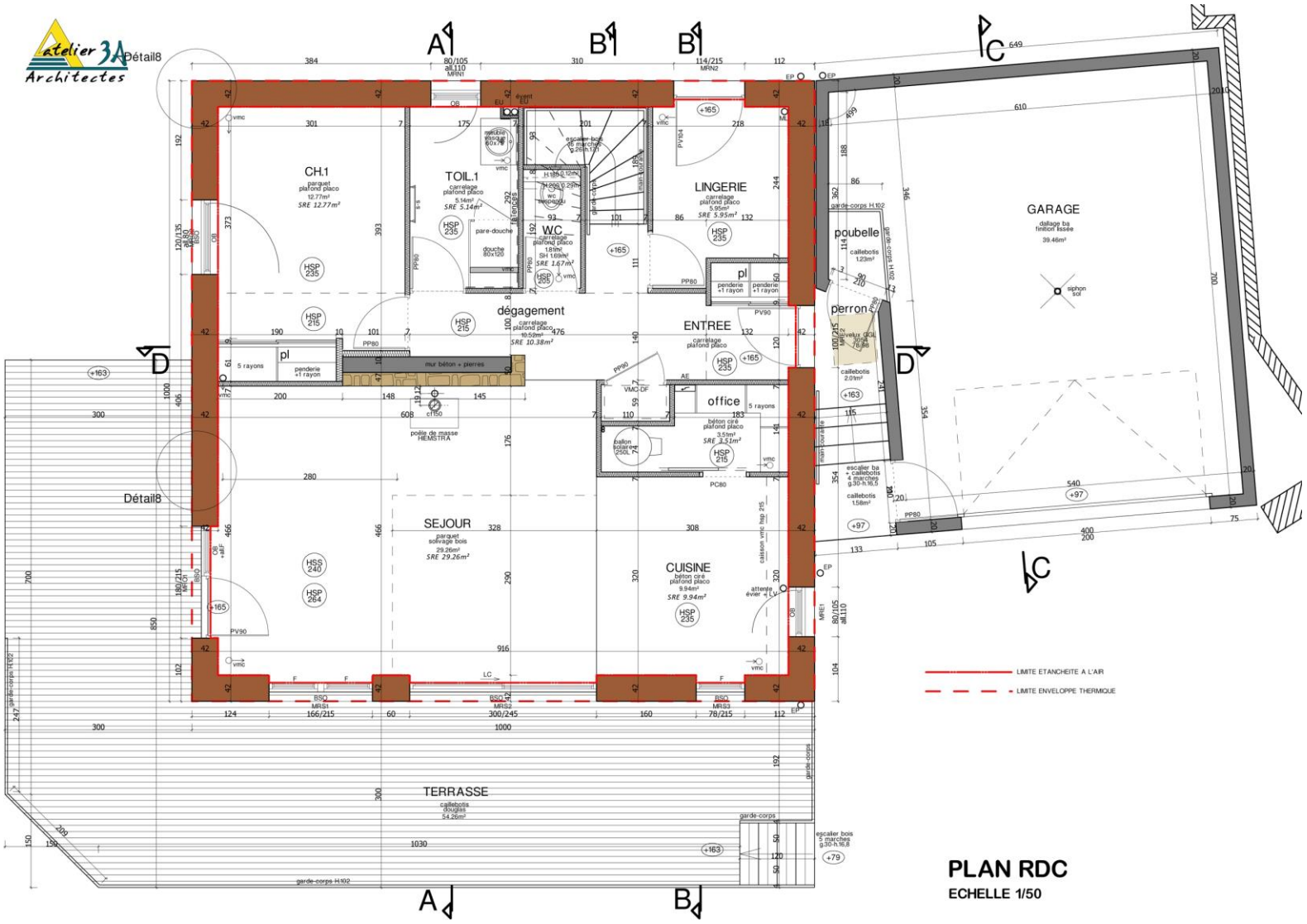
External windows and doors : triple glazed, argon filled, wood-aluminium windows and doors, venetian blinds or rolling shutters on roof windows Velux

Load bearing internal wall: 25cm reinforced concrete wall, 20cm stones

Partition walls: gypsum board, 45mm insulation between studs, gypsum board

Horizontal ceiling: gypsum board, 100mm wood fibres between frames

2.6 Floor plans

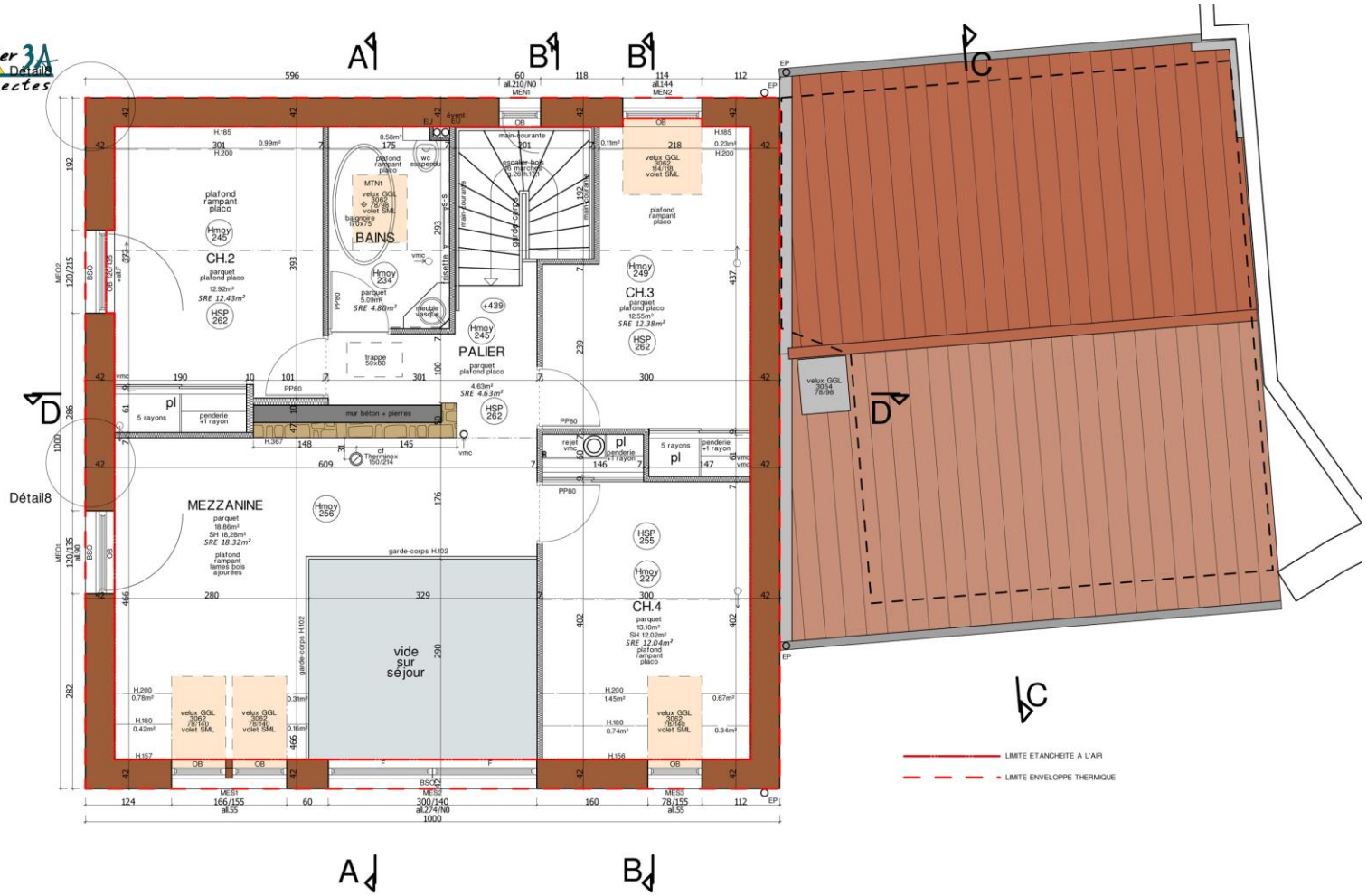


Ground floor plan

Caption:

SEJOUR: living room
CUISINE: kitchen
Office: store
ENTRÉE: entrance
CH.1: bedroom 1
TOIL.1: en-suite 1
WC: toilet
LINGERIE: utility room
Dégagement: access space
Perron: steps

First floor plan



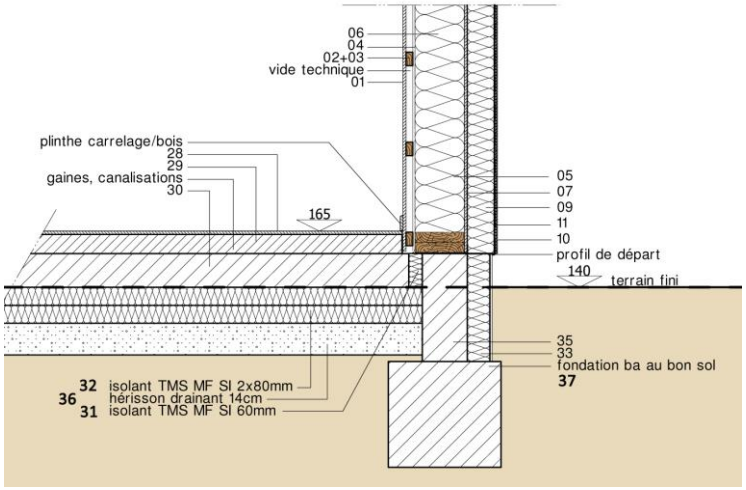
PLAN ETAGE
ECHELLE 1/50

Caption:

CH.2: bedroom 2
BAINS: bathroom
PALIER: bearing floor
Pl: cupboard
Vide sur séjour: space above living room

2.7 Construction details

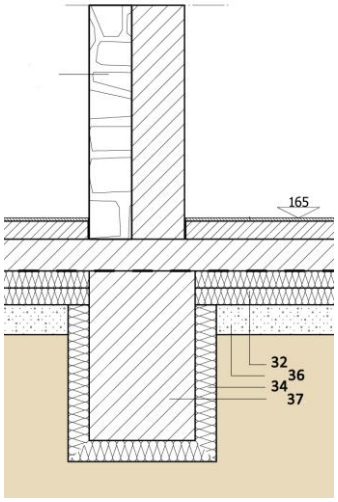
2.7.1a Ground floor details



28- ceramic floor tile or oak floorboard
29- 60mm concrete screed
30- 150mm reinforced concrete slab
31- 60mm PU EFISOL TMS MF SI – λ 0.022 W/ (mK)
32- 2x80mm PU EFISOL TMS MF SI – λ 0.022 W/ (mK)
33- 105mm+10 EPS KNAUF PERIBOARD ULTRA 30 SE – λ 0.030 W/ (mK)
34- 80mm PU EFISOL TMS MF SI – λ 0.022 W/ (mK)
35- 200mm reinforced concrete wall
36- draining underlay
37- concrete foundation

01- 13mm gypsum board
02- horizontal wood cleats
03- vertical wood cleats
04- airtightness film SIGA MAJPELL 5
05- wood structure 45x220mm
06- 220mm cellulose wool SOPREMA UNIVERCELL – λ 0.042 W/(mK)
07- 12mm OSB 4
08- 100mm wood fibres HOMATHERM HDP Q11 – λ 0.040 W/(mK)
09- 120mm wood fibres ISONAT FIBERWOOD DUO PROTECT – λ 0.046 W/(mK)
10- lime plaster PAREX LANKO PARISO
11- rainscreen

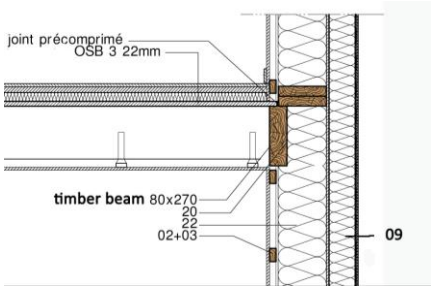
External walls



Internal load bearing wall

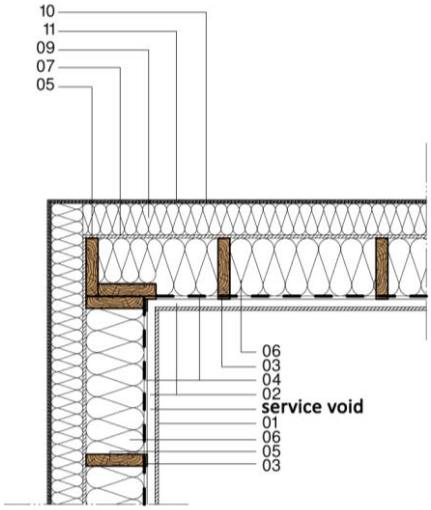
Basement insulation was designed to ensure the greatest possible continuity to counter the effect of thermal bridges, including the underlay beneath the foundation of the internal load bearing wall.

2.7.1b First floor details (connection to external wall)



09- 120mm wood fibres ISONAT FIBERWOOD DUO PROTECT – λ 0.046 W/ (mK)
20- airtightness film SIGA MAJPELL 5
22- 220mm cellulose wool SOPREMA UNIVERCELL – λ 0.042 W/ (mK)

Continuity of insulation and airtightness in external walls

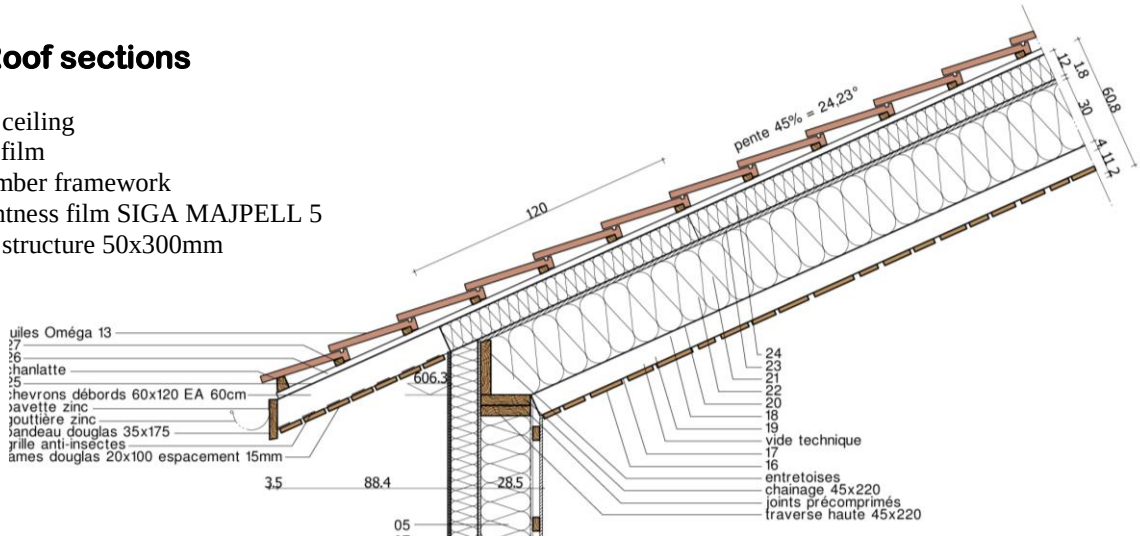


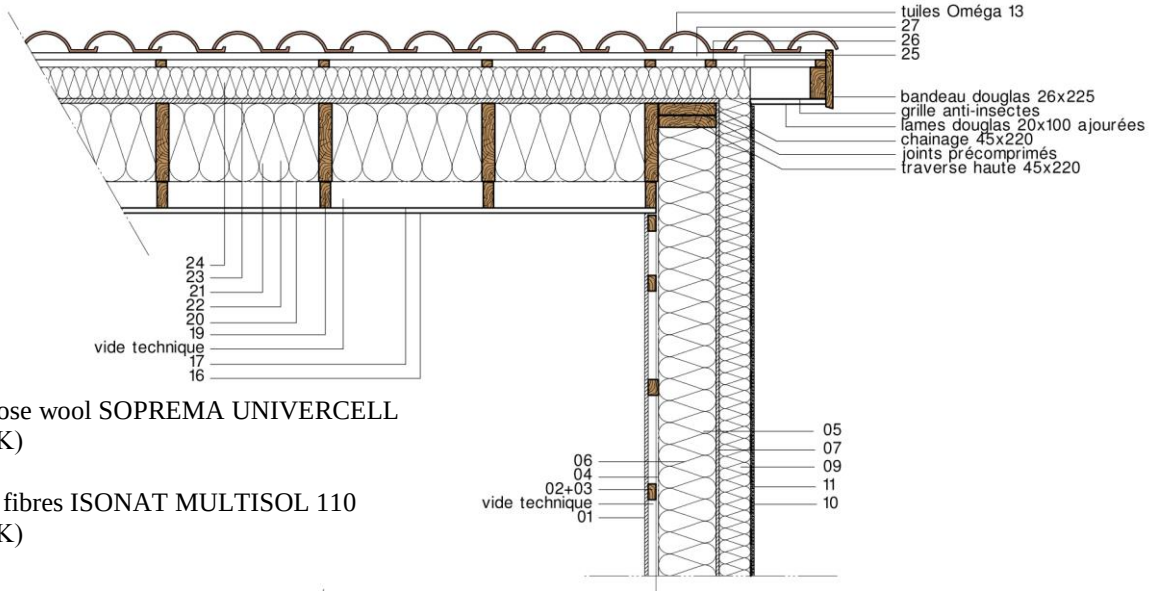
2.7.2 Exterior walls and connections

01- 13mm gypsum board
02- horizontal wood cleats
03- vertical wood cleats
04- airtightness film SIGA MAJPELL 5
05- wood structure 45x220mm
06- 220mm cellulose wool SOPREMA UNIVERCELL – λ 0.042 W/(mK)
07- 12mm OSB 4
08- 100mm wood fibres HOMATHERM HDP Q11 – λ 0.040 W/(mK)
09- 120mm wood fibres ISONAT FIBERWOOD DUO PROTECT – λ 0.046 W/(mK)
10- lime plaster PAREX LANKO PARISO
11- rainscreen

2.7.3 Roof sections

16- wood ceiling
17- black film
18+19- timber framework
20- airtightness film SIGA MAJPELL 5
21- wood structure 50x300mm





22- 300mm cellulose wool SOPREMA UNIVERCELL
λ 0.042 W/(mK)
23- 18mm OSB 4
24- 120mm wood fibres ISONAT MULTISOL 110
λ 0.040 W/(mK)
25- rainscreen

2.7.4 Windows

Windows: MENUISERIE ANDRE SMARTWIN CLASSIC
Passivhaus certified by Passivhausinstitut

Frame
Smartwin Uf: 0,70
Smartwin Fix Uf: 0,54
Smartwin sliding fix Uf: 1,29
Smartwin sliding Uf: 0,81

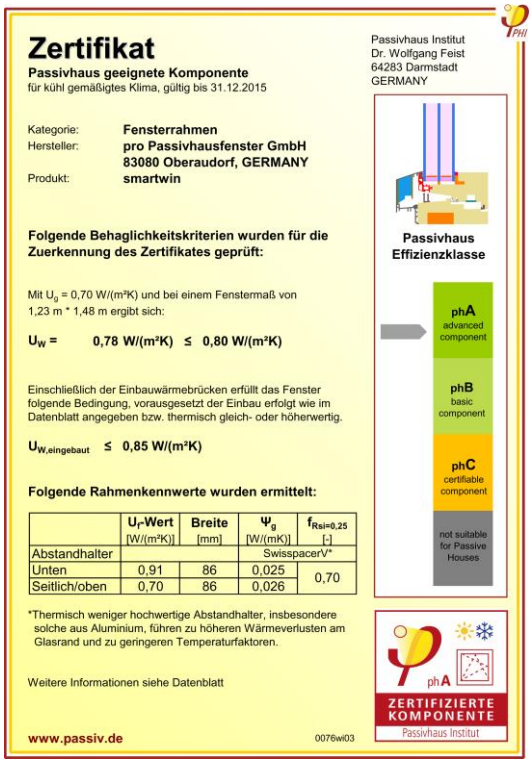
U_w-value = 0.8 W/(m²K)

Triple glazing
4-18-4-18-4 EN2+
6-16-6-16-6 EN2+
4-16-4-16-44² EN+
70/35-6-14-4-16-44² EN2

33,2-10-3-10-8
4 PUN-15-4-15-PUN 44²

U_g-value = 0.55 W/(m²K)
g -value = 53 %

Entrance door
MINCO extreme 66
U_d-value = 0.98 W/ (m²K)



Zertifikat
Passivhaus geeignete Komponente
für kühl gemäßigtes Klima, gültig bis 31.12.2015

Passivhaus Institut
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Kategorie: **Fensterrahmen**
Hersteller: **pro Passivhausfenster GmbH**
83080 Oberaudorf, GERMANY
Produkt: **smartwin**

Folgende Behaglichkeitskriterien wurden für die Zuerkennung des Zertifikates geprüft:

Mit U_g = 0,70 W/(m²K) und bei einem Fenstermaß von 1,23 m * 1,48 m ergibt sich:

U_W = **0,78 W/(m²K) ≤ 0,80 W/(m²K)**

Einschließlich der Einbauwärmebrücken erfüllt das Fenster folgende Bedingung, vorausgesetzt der Einbau erfolgt wie im Datenblatt angegeben bzw. thermisch gleich- oder höherwertig.

$U_{W,eingebaut}$ ≤ **0,85 W/(m²K)**

Folgende Rahmenkennwerte wurden ermittelt:

	U_f-Wert [W/(m²K)]	Breite [mm]	Ψ_g [W/(mK)]	$f_{Rsi=0,25}$ [-]
Abstandhalter			SwisspacerV*	
Unten	0,91	86	0,025	0,70
Seitlich/oben	0,70	86	0,026	

*Thermisch weniger hochwertige Abstandhalter, insbesondere solche aus Aluminium, führen zu höheren Wärmeverlusten am Glasrand und zu geringeren Temperaturfaktoren.

Weitere Informationen siehe Datenblatt

Passivhaus Effizienzklasse
phA advanced component
phB basic component
phC certifiable component
not suitable for Passive Houses

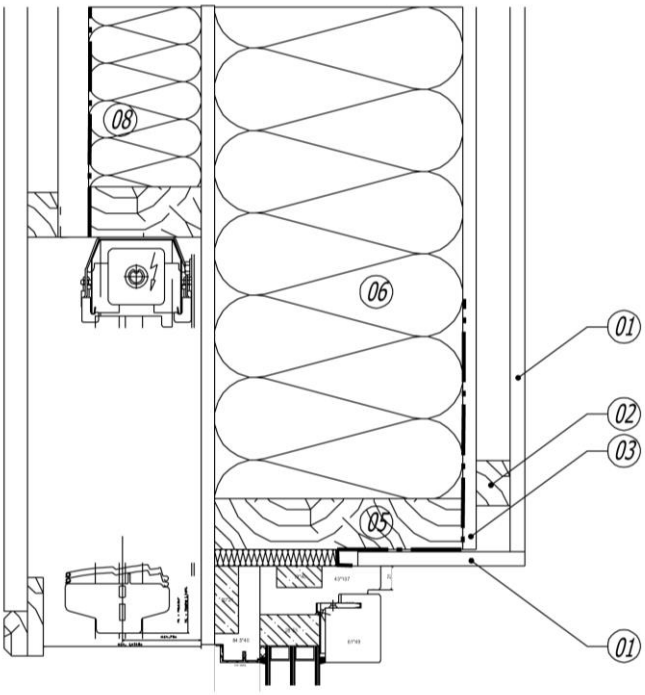
ZERTIFIZIERTE KOMPONENTE
Passivhaus Institut

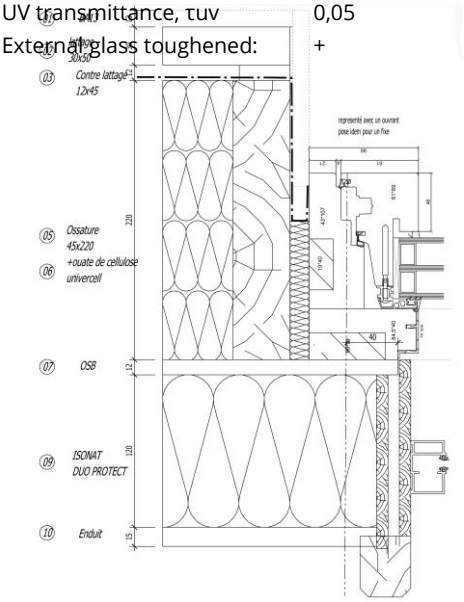
www.passiv.de
0076wi03

Roof windows Velux GGL 3062

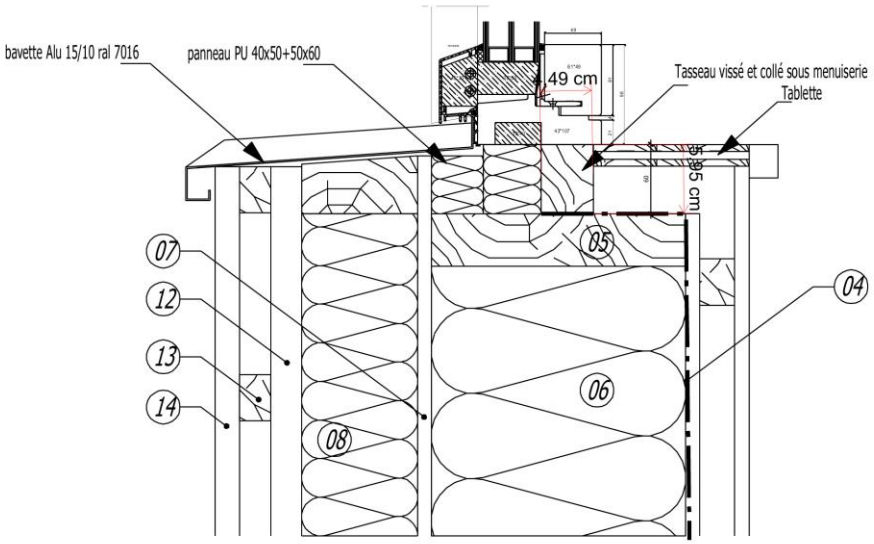
Technical specification:	GGL 3062
Window U-value:	0,83 W/m²K
Glazing U-value:	0,50 W/m²K
Rw coefficient:	42 dB
Air permeability:	Class 4
Glazing:	3-panes
Inert gas filled with panes:	Krypton
Total solar energy transmittance, g	0,50
Light transmittance, τv	0,65
UV transmittance, τuv	0,05
External glass toughened:	+

In the walls, the windows were positioned inside the wood structure against the external insulation to minimise the thermal bridge through the window

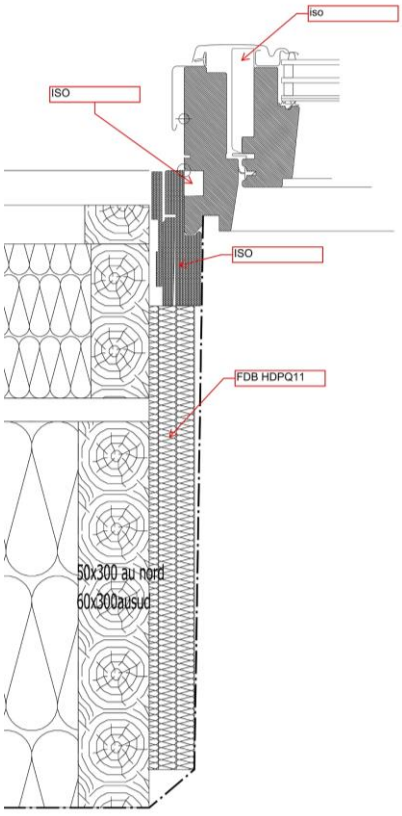




Horizontal cross section



Vertical cross section
Window with venetian blind



Vertical cross section
Roof Velux

2.7.5 Airtightness strategy and air test result

The casing of the timber frame by a layer of insulation with lime plaster coating contributes to the airtightness of the walls. So the casing of the roof by a layer of insulation improved the airtightness of the top. But, it's not sufficient.
A membrane SIGA Majpell 5 was applied with high performance adhesives as a vapour control layer for between-rafter insulation and to provide permanently airtight building envelope for walls and roof.
Floor, window and chimney junction details were very well studied.
The building has been tested two times during works and at the end of the construction.
In the blower door measurement method, the final result for test n50 was: **0,48 (h^{-1}) by depressurisation**
0,47 (h^{-1}) by pressurisation.

Exploitation des données mesurées

	Valeur	Intervalle de confiance à 95%	Bornes de l'intervalle de confiance
n	0,70	± 2,91 %	[0,68; 0,72]
C_{env}	12,97 m³/(h·Pa^n)	± 7,38 %	[12,05 ; 13,96]
C_L	12,75 m³/(h·Pa^n)	± 7,38 %	[11,84; 13,72]
Corrélation	0,999365		
$\dot{V}_{50}$	198,98 m³/h	± 1,39 %	[196,24; 201,77]
n_{50}	0,48 h-1	± 1,39 %	[0,48; 0,49]
$\dot{V}_4$	33,75 m³/h	± 4,60 %	[32,23; 35,34]
Q4Pa-Surf	0,13 m³/(h.m²)	± 4,60 %	[0,12; 0,13]

Depressurisation

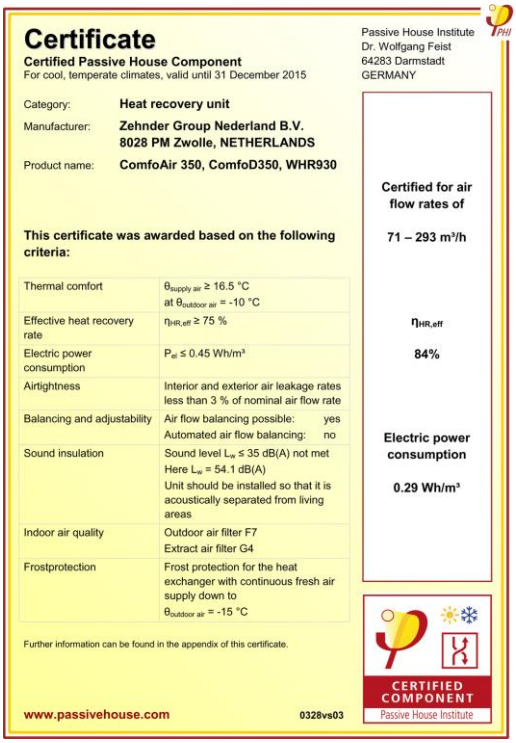
Exploitation des données mesurées

	Valeur	Intervalle de confiance à 95%	Bornes de l'intervalle de confiance
n	0,67	± 1,26 %	[0,66; 0,68]
C_{env}	14,35 m³/(h·Pa^n)	± 3,03 %	[13,92 ; 14,79]
C_L	14,07 m³/(h·Pa^n)	± 3,03 %	[13,65; 14,50]
Corrélation	0,999881		
$\dot{V}_{50}$	194,22 m³/h	± 0,58 %	[193,09; 195,36]
n_{50}	0,47 h-1	± 0,59 %	[0,47; 0,47]
$\dot{V}_4$	35,67 m³/h	± 1,89 %	[35,00; 36,35]
Q4Pa-Surf	0,14 m³/(h.m²)	± 1,89 %	[0,13; 0,14]

Pressurisation

2.7.6 – 2.7.7 Ventilation strategy

A certified passivhaus ventilation unit with heat recovery was installed:
ZEHNDER ComfoAir 350



Certificate
Certified Passive House Component
For cool, temperate climates, valid until 31 December 2015

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Category: **Heat recovery unit**
Manufacturer: **Zehnder Group Nederland B.V. 8028 PM Zwolle, NETHERLANDS**
Product name: **ComfoAir 350, ComfoD350, WHR930**

This certificate was awarded based on the following criteria:

Thermal comfort	$\theta_{supply\ air} \geq 16.5$ °C at $\theta_{outdoor\ air} = -10$ °C
Effective heat recovery rate	$\eta_{HR,eff} \geq 75$ %
Electric power consumption	$P_{el} \leq 0.45$ Wh/m³
Airtightness	Interior and exterior air leakage rates less than 3 % of nominal air flow rate
Balancing and adjustability	Air flow balancing possible: yes Automated air flow balancing: no
Sound insulation	Sound level $L_w \leq 35$ dB(A) not met Here $L_w = 54.1$ dB(A) Unit should be installed so that it is acoustically separated from living areas
Indoor air quality	Outdoor air filter F7 Extract air filter G4
Frostprotection	Frost protection for the heat exchanger with continuous fresh air supply down to $\theta_{outdoor\ air} = -15$ °C

Further information can be found in the appendix of this certificate.

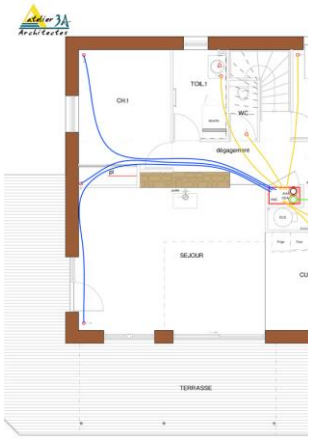
Certified for air flow rates of
71 – 293 m³/h
$\eta_{HR,eff}$
84%
Electric power consumption
0.29 Wh/m³

CERTIFIED COMPONENT
Passive House Institute

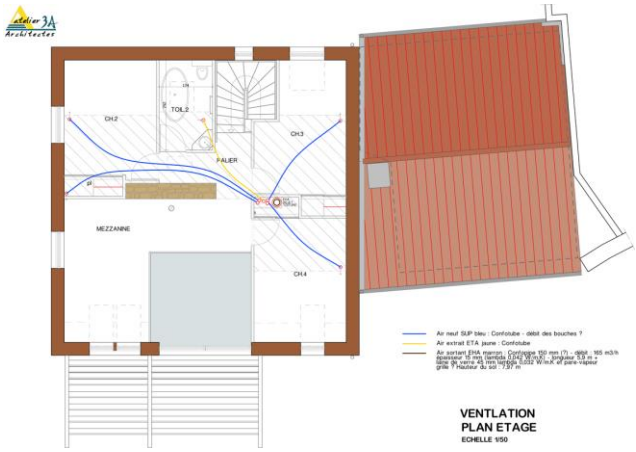
www.passivehouse.com 0328vs03

Effective heat recovery: 84% (PHI)
Electrical efficiency: 0,29 Wh/m³
The unit was housed inside the thermal envelope. The ducting system has been designed, correctly installed with Zehnder ConfoPipe then tested and air flows were adjusted.

Ground floor



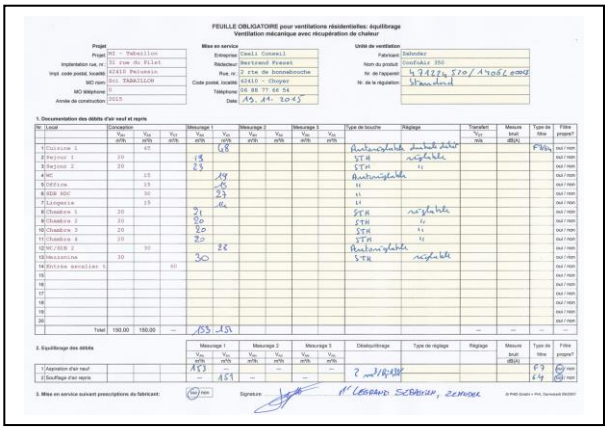
First floor



Caption:
Red square: ventilation unit Zehnder Comfoair 350
Green line: ODA - outside air 165m³/h- Confopipe 150mm + insulation – height from the floor 2,92m
Blue lines: SUP – supply air – Confotube
Yellow lines: ETA – extract air - Confotube

Brown line: EHA – exhaust air 165m³/h – Confopipe 150mm + insulation - height from the floor 7,97m

Intake of the fresh air in the house is through the East façade, above the kitchen windows. The path to the ventilation unit is very short and well insulated. The unit is placed in an acoustically isolated closet in the entrance. The output of the stale air is vertically through the roof with well insulated pipes. Air is extracted in the kitchen, the store near the kitchen, the bathrooms of the two floors, the utility room and the toilet. The air supply is in the bedrooms, the living room and the mezzanine. The transfer is facilitated by the open volume between the entrance and the living room downstairs and the mezzanine upstairs. The air flow passes the gap under doors. The ventilation nozzles have been regulated and balanced by a technician from Zehnder.



Adjusting and balancing

2.7.8 Heating strategy

The owners wanted a log burning stove because of its intimacy. To address this request and because of the low power required, we installed a HIEMSTRA NO 40 mass regulated stove in front of the concrete and stone wall at the center of the house.
The power of the stove (average 2.7 kW) was sufficient for heating requirements but we preferred to ensure comfort in the bathrooms by means of low-power electric towel racks (500W).

Domestic hot water comes from the solar sensors on the roof of the ROTEX Solaris with automatic drain-back, connected to a 300 litre hot water tank in the heated envelope of the house.

2.8 Verification

Conception bâtiment passif

Projet:	MI - Tabaillon				
Adresse:	31 rue du Pilat				
Code postal / localité:	42410 Pelussin				
Pays:					
Type de bâtiment:					
Climat:	[FR] - Lyon	Altitude de l'emplacement du bâtiment (m au-dessus NZ):	490		
Maître(s) de l'ouvrage:	Sci TABAILLON				
Adresse:	12 rue des Franchises				
Code postal / localité:	42410 Pélussin				
Architecte:	Atelier 3A				
Adresse:					
Code postal / localité:	42410 Pélussin				
Bureau d'étu. fluides:					
Adresse:					
Code postal / localité:					
Année de construction:	2015	Température intérieure en hiver:	20,0 °C	Vol. ext. du bâtiment V_e:	645,1
Nombre de logements:	1	Température intérieure en été:	25,0 °C	Refroidissement mécanique:	
Nombre d'occupants:	4,1	Apports de chaleur internes en hiver:	2,1 W/m²		
Capacité therm. surf.:	132 Wh/K / m² surface habitable	idem été:	2,8 W/m²		

Caractéristiques du bâtiment par rapport à la surface de référence de l'énergie et de l'année

				Critères	Respectés?*
	Surface de référence énergétique:	144,3	m²		
Chauffer	Besoin de chaleur de chauffage	15	kWh/(m²a)	15 kWh/(m²a)	oui
	Puissance de chauffage	13	W/m²	10 W/m²	-
Refroidir	Demande totale de refroidissement		kWh/(m²a)	-	-
	Puissance de refroidissement		W/m²	-	-
	Fréquence de surchauffe (> 25 °C)	0,2	%	-	-
Energie primaire	Chauffer, refroidir, électricité auxiliaire / Déhumidification, ECS, éclairage, électricité domestique	98	kWh/(m²a)	120 kWh/(m²a)	oui
	ECS, chauffage et électricité auxiliaire	57	kWh/(m²a)	-	-
	Réduction énergie prim. par la prod. d'élec. solaire		kWh/(m²a)	-	-
Etanchéité à l'air	Test d'infiltrométrie n_{50}	0,5	1/h	0,6 1/h	oui

* cellule vide: données manquantes; '-': aucune exigence

Bâtiment passif?	oui

2.9 – 2.10 Construction cost

Global cost 287 500 € HT (without taxes), 345 000 € TTC (all taxes included)
1 990 € HT / m², 2 390 € TTC / m²
House only: about 2 000 € TTC / m²

2.11 Year of construction:

2014-2015

2.12 – 2.15 Overviews

The design of this project was fully realized by Jean Pierre Boujot, architect in Atelier 3A, who specializes in timber construction and bioclimatic architecture, expert in environmental quality of buildings, with many references in energy efficient buildings.
From the outset of the project, the clients wanted a passive (energy very efficient) house. Our project caters to the optimal solutions available in terms of bioclimatic architecture: compactness, generous interior volume and external envelope ratio, privileged solar influx, protection from prevailing winds, south-facing living rooms, and service rooms to the north.
We opted for timber structure which provides very little thermal bridges, excellent insulation and greater ease for air tightness.

The insulation consists in two layers, one layer integrated in the timber frame and one layer outside walls and roof to avoid thermal bridges.
The walls remain thin despite strong insulation.
Lack of inertia of the timber frame was offset by the concrete slab and a stone and concrete wall in the middle of the house, behind the stove. On the ground, the insulation is placed below the concrete slab and under the foundation of central wall.
The high insulation and inertia contribute to temperature homogeneity, supplemented by the double flow ventilation.
So the winter comfort is easily obtained.
As the glazed surface on south facade is important for solar gain, it's necessary to implement effective sunscreens to maintain comfort in summer.
The clients wanted abundant natural lighting with roof-mounted Velux windows; the challenge was including these roof windows while still maintaining the required thermal level. These windows are necessarily equipped with shutters.

We partnered with Caeli Conseil for the thermal design work and the choice of the equipment.
Fine details of implementation were decided on with Maurin who built the entire insulated and airtight envelope of the house.

We opted for ecological techniques and materials to accompany this overall approach: wood, natural or recycled insulation.

We completed the design by a calculation of the environmental impact (grey energy 1125 kWhep/m² and climate change in the 90 kgeq CO^2/m^2) using GRISEN software.

2.16 Experiences

The clients moved into the house in June 2015.
They found the house to be comfortable throughout the summer despite the high outside temperatures, thanks to the adjustable venetian blinds in front of the south and west windows and the night-time ventilation.
The autumn and the early winter were not cold but there was no need to light the stove to maintain a comfortable temperature, the heat provided by the sunshine was enough.
The temperature never dropped below 19°C throughout the house and it remains uniform in all rooms.
The icy wind did not affect the comfort. The slightest ray of sunshine raised the temperature to 21-22°C, even it's freezing outside.

2.16 References

This house was the first single-family project certified as a Passive House in the Loire department.

During the building process, the house was used as an example for training in eco-construction. Visits were organized when the insulation and airtightness facilities were installed.

The local press (Le Réveil du Vivarais) published an article about it on 16 September 2015.

On 3 November 2015, a conference and a visit were organized by the Inter Forêt-Bois 42 (inter-professional wood association in the Loire Department) as part of the eco-construction program visits.
http://www.ifb42.com/filiere-bois-loire/Actualites.html#124