

Natural gas
Propane Gas

100 kW
to
900 kW

Unical Modulex EXT

Modular condensing gas boiler



- **Modular boiler with multiple burner units to maximise flexibility and reliability**
- **Turn-down ratios of up to 40:1 to match boiler output to heating load**
- **Manual switch allows boiler to run at 50% of nominal output in the event of boiler controls failure, ensuring security of heat generation**
- **Seasonal efficiency of up to 97.3% gives compliance with ADL2A and ADL2B of Part L 2013**
- **Weather proof casing permits installation in external locations**

Contents	Page
General information	2 & 3
Dimensions	4 & 5
Technical Data	4 & 5
Installation requirements	6 & 7
Boiler wiring	8
Hydraulic system design	9

General information

Operating principles

Modulex is a cast aluminium condensing boiler, with each section a self-contained heat generating module. Each module has a down-firing pre-mix gas burner with its own control and safety (limit) thermostats. The in-built *BCM (Boiler Cascade Manager)* will modulate the boiler on a cascade down to a minimum output of 12 kW for models 100 to 350 and 22 kW for models 440 to 900 - the minimum output of a single module. If any of the modules fail, the others will continue to operate. Multiple boilers can be cascaded by an external BCM or BMS. An *E8 Regulator* is mounted on each boiler to give local control of parameters and settings and control external pumps, sensors and valves. In the event of failure of the E8 Regulator, a rocker switch on the BCM will run the boiler at 50% output until a service engineer can attend.

Pre-mix burners use an air intake fan coupled to a venturi to control the volume of gas being entrained. The modulating control sets the speed of the fan, which accurately governs the volume of gas admitted through the gas valve. This ensures an optimum mixture of gas and air at any output rating, together with thorough mixing before ignition. Consequently, thermal efficiencies of up to 109% net are achieved.

Each module is a counter flow heat exchanger, to maximise heat transfer. Hot exhaust gases travel downwards under positive pressure of the air intake fan. The number of conical heat transfer pins increases towards the flue outlet at the bottom, maintaining an even heat transfer rate as the exhaust gases cool. The system water travels upwards through the modules to create the counter flow.

The modules are hydraulically connected in a reverse-return arrangement. Models 100 to 350 have water and gas connections handed on the right as standard, but can be changed on site to the left. The connections are handed on the left for models 440 to 900. A choice of flue connection positions are available - see pages 4 to 6.

The modules are cast from an aluminium / magnesium / silicon alloy that is light, strong and resistant to corrosion.

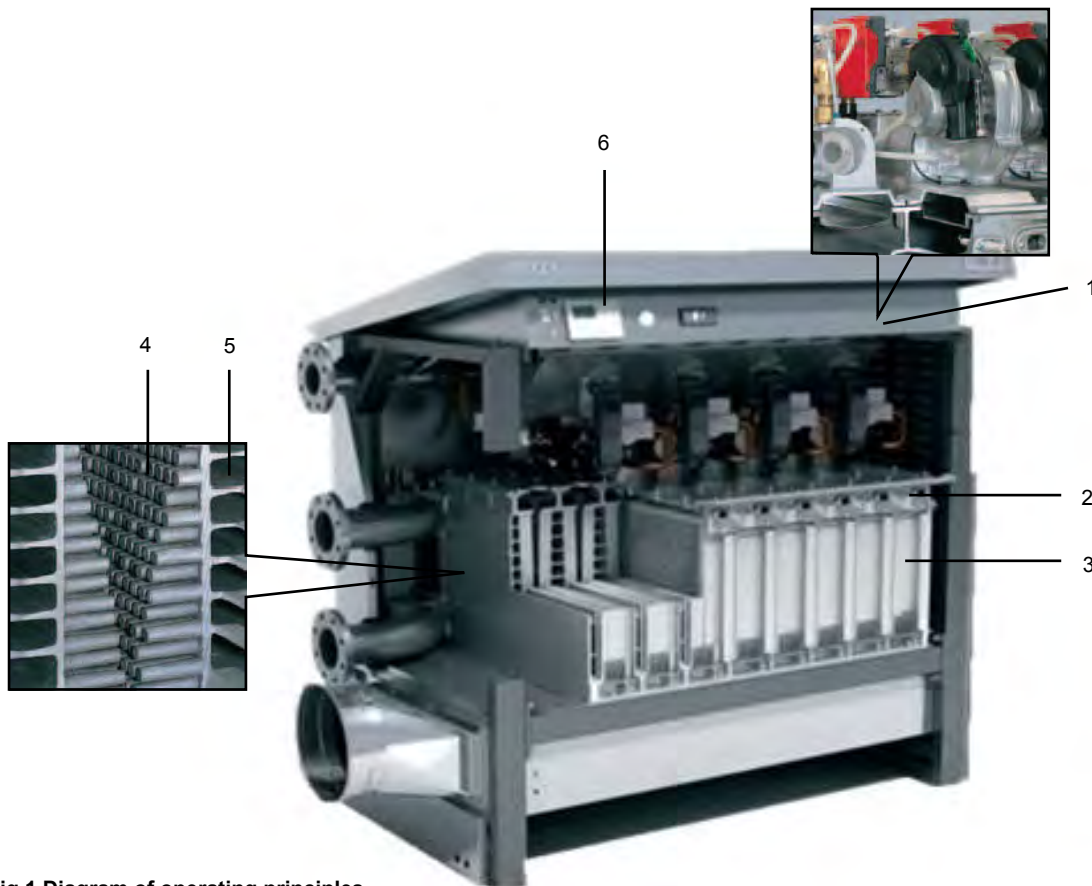


Fig 1 Diagram of operating principles

Key to Fig 1

- 1 Pre-mix gas burner
- 2 Ignition / ionisation probe assembly
- 3 Single module
- 4 Heat transfer pins
- 5 Module waterways
- 6 E8 Regulator

General information

Application

Modulex EXT boilers are manufactured and tested in accordance with the Gas Appliances Directive 2009/142 EC, the Boiler Efficiency Directive 92/42/CE, the EMC Directive 2004/108 EC, the LVD 2006/95 EC and the Machinery Directive 89/392 EC and CE marked accordingly. They are suitable for use in LTHW heating systems with a maximum operating pressure of 6 bar, a minimum pressure of 0.5 bar and a maximum working temperature of 90°C (see Technical data on pages 4 and 5).

Modulex EXT boilers are suitable for use with Natural gas (G20) or Propane (G31).

The boiler is suitable for use in pressurised (sealed) or open vented heating systems with a minimum static head of 0.5 bar. It is not suitable for use as a direct water heater. Where potable water is required, a matching calorifier or plate heat exchanger must be provided in the system. Modulex EXT is designed to operate with a Type B conventional flue.

Statutory requirements

The installation and commissioning of the boiler must be carried out by a qualified engineer in accordance with the instructions provided.

Gas supplies and gas burners must be installed, serviced and commissioned by a qualified person, eg. a Gas Safe registered engineer.

Handling

Offloading, dry storing and placing of equipment in the boiler room is the responsibility of the installer.

Equipment must be dry stored and protected from frost. Cartons must not be crushed or otherwise damaged.

Commissioning

Cannot undertake commissioning of boilers. Commissioning charges do not include servicing during the guarantee period, although this may be carried out under service contract or to specific order. Boilers should be commissioned in line with CIBSE Commissioning Code B.

Servicing

The importance of regular maintenance cannot be over-emphasised if maximum efficiency is to be maintained. Customers are strongly advised to place the equipment under service contract immediately commissioning is complete.

Guarantee

Subject to correct handling, installation and operation, the boilers are guaranteed for two years from the date of despatch.

The guarantee is not valid if the boiler is not installed in accordance with these instructions (please refer to page 6), becomes blocked with debris and/or carbonate deposits from the system water and/or there is no documented evidence of commissioning by Carnot or their appointed engineer.

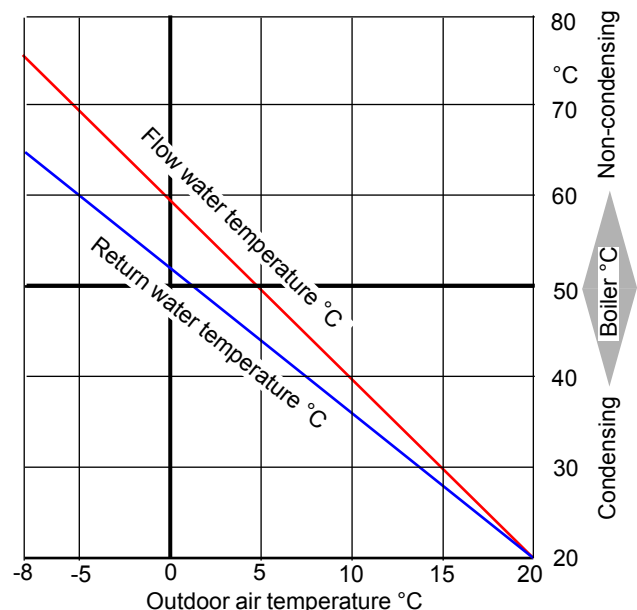
Boiler Log book

A permanent record of commissioning and servicing data and measurements should be kept in the building log book. It should be kept safe and brought up to date whenever routine or emergency work is carried out on the boiler.

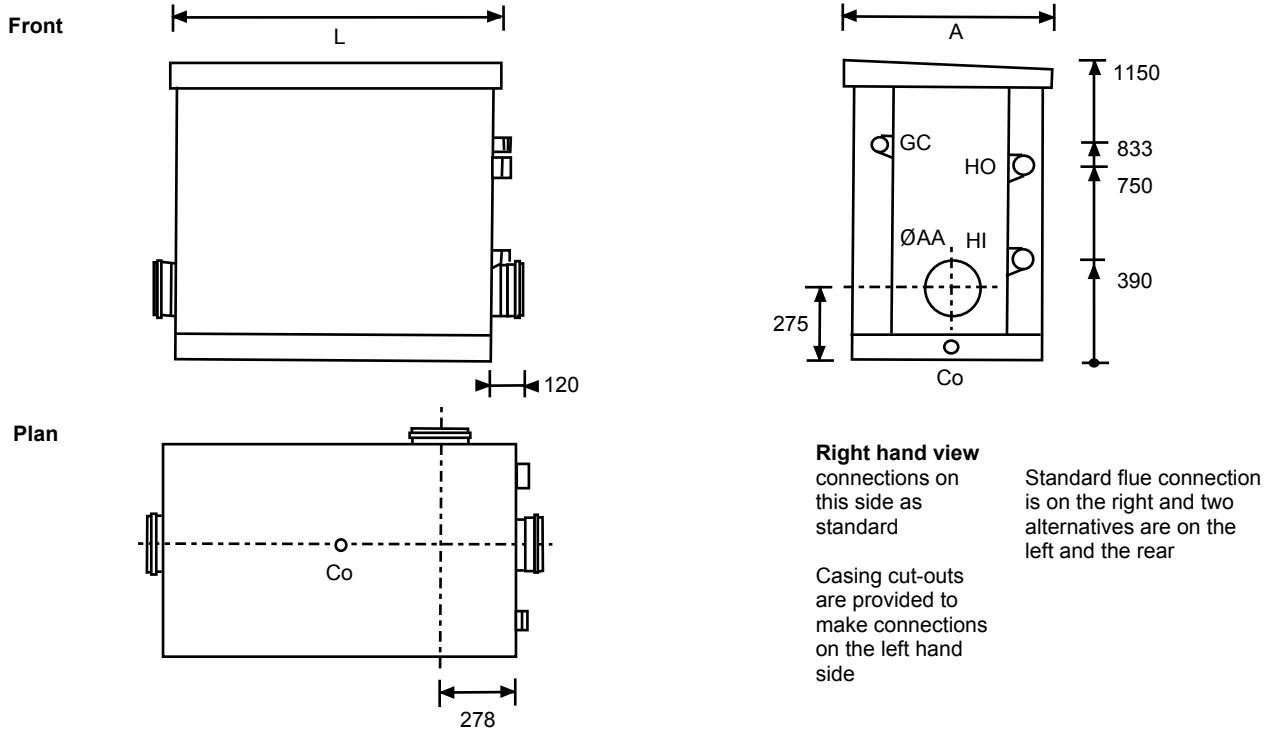
Emitter sizing (radiators)

The boiler will operate in condensing mode whenever the return water is below 50°C and will reach its full potential if the flow water temperature is also below 50°C. However, the latter condition will mainly occur when the boiler is heating an underfloor heating scheme or transiently when recharging a DHW storage tank from cold. By careful design of a traditional heating system with radiators, and with weather compensating control in operation, the return water temperature can be held below 50°C for most of the heating season, only rising above this figure when outdoor temperatures are below zero.

For optimum performance, calculate heat losses on the basis of a 20°C internal temperature and a -8°C outdoor air temperature. With no added factors, size the radiators on the basis of published EN 442 data ($\Delta T50$) and size the system pump for a 10°C temperature drop. In most cases this will ensure that the boiler begins to operate in condensing mode when the outdoor air temperature rises above 1°C and becomes fully condensing when the temperature is above 5°C. For heating schemes in buildings where the occupants have special needs, different environmental conditions may apply and further advice must be sought.



Dimensions and technical data



Dimensions

Boiler model			100	150	200	250	300	350
Number of modules			2	3	4	5	6	7
Overall length	L	mm	764	764	1032	1032	1300	1300
Overall width	A	mm	770	770	770	770	770	770
Boiler flow connection	HO	Rp	2½					
Boiler return connection	HI	Rp	2½					
Gas connection	GC	R	2					
Flue spigot (inside dimension)	AA	DN	150	150	150	200	200	200
Condensate drain	Co	mm	40					

Technical data

Nominal heat output at;	30/50°C	kW	100.1	150	200.4	251.3	302.7	354.6
	60/80°C	kW	97.2	146.1	195.2	244.5	294	342.2
Efficiency at 100% load (ncv)	30/50°C	%	100.1	100.8	100.2	100.5	100.9	101.9
Efficiency at 30% load (ncv)	30/50°C	%	106.5	106.5	106.5	106.5	106.5	106.5
Boiler seasonal efficiency (1)		%	94.9	95.0	94.9	94.9	95.0	95.2
Input (ncv)		kW	100	150	200	250	300	348
Natural gas consumption (gross cv)		m³/h	10.3	15.5	20.6	25.8	31	35.9
Dry weight		kg	203	236	295	325	386	419
Water content		l	10.1	14.2	18.3	22.4	26.5	30.6
Max flue resistance		Pa	100					
Flue gas temperature rise (Max)	30/50°C	°C	44.2	45.1	46.5	47.3	48.2	49.1
Flue gas mass flow (Max)	30/50°C	kg/h	163.4	245.2	326.9	408.6	490.3	572
Max condensate produced	30/50°C	kg/h	15.3	23	30.6	38.3	45.9	53.6
Max power consumption		W	145	210	290	362	435	507
CO ₂ in flue gas (min / max)		%	8.6 / 9.1					
NO _x (based on EN 297/A3)		Mg/kWh	53.8					
Maximum hydraulic working pressure		bar	6					
Minimum hydraulic working pressure		bar	0.5					
Sound level		dBA	<49					

Notes: (1) Calculated from the non-domestic heating and cooling compliance guide for conformance with ADL2A and

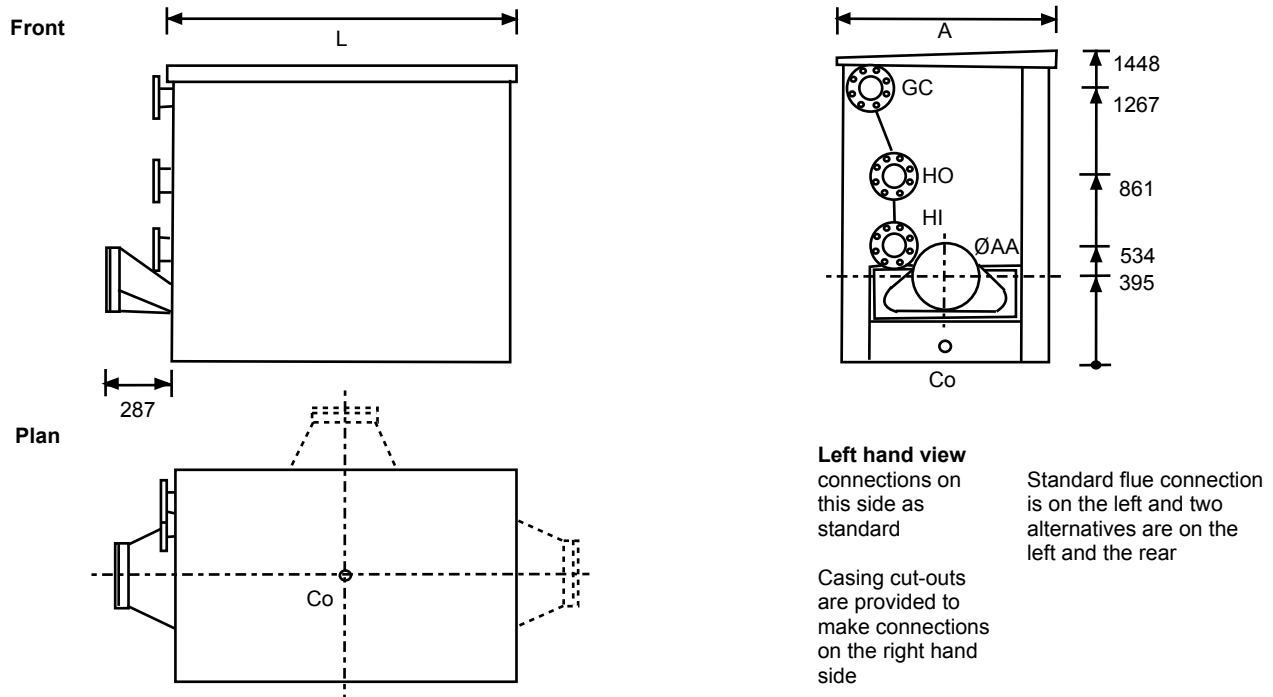
ADL2B 2013 using the formula $n_{seasonal} = 0.81n_{30\%} + 0.19n_{100\%}$

(2) Refer to sales office for data on Propane (G31) operation

Water flow rates and hydraulic resistances

Water flow rate at 15°C temp. rise	l/s	1.55	2.33	3.1	3.89	4.68	5.48
Hydraulic resistance at 15°C temp. rise	kPa	18.6	20.6	21.6	24.5	23.7	24
Water flow rate at 20°C temp. rise	l/s	1.16	1.75	2.33	2.92	3.51	4.11
Hydraulic resistance at 20°C temp. rise	kPa	8.8	10.8	11.8	12.8	13.7	14.7

Dimensions and technical data



Dimensions

Boiler model			440	550	660	770	900
Number of modules			4	5	6	7	8
Overall length	L	mm	1087	1355	1355	1623	1623
Overall width	A	mm	946	946	946	946	946
Centre line of flue	HAA	mm	395	395	395	395	395
Flue connection projection	C	mm	287	287	287	287	287
Boiler flow connection	HO	mm	DN100				
Boiler return connection	HI	mm	DN100				
Gas connection	GC	mm	DN80				
Flue spigot (inside dimension)	AA	mm	300				
Condensate drain	Co	mm	40				

Technical data

Nominal heat output at;	30/50°C	kW	445	557.8	670.1	783.2	900.3
	60/80°C	kW	424.4	530.4	636.5	742.6	849.1
Efficiency at 100% load (ncv)	30/50°C	%	104	104	104	104	104
Efficiency at 30% load (ncv)	30/50°C	%	109	109	109	109	109
Boiler seasonal efficiency (1)		%	97.3	97.3	97.3	97.3	97.3
Input (ncv)		kW	432	540	648	756	864
Natural gas consumption (gross cv)		m ³ /h	44.6	55.8	66.9	78.1	89.2
Dry weight		kg	558	643	707	806	858
Water content		l	67	80	94	108	122
Max flue resistance		Pa	100				
Flue gas temperature rise (Max)	30/50°C	°C	46.7	46.7	46.7	46.7	45.8
Flue gas mass flow (Max)	30/50°C	kg/h	693	866	1040	1213	1386
Max condensate produced	30/50°C	kg/h	73.4	91.7	110	128.4	146.7
Max power consumption		W	626	783	940	1096	1252
CO ₂ in flue gas (min / max)		%	9.1 / 9.3				
NO _x (based on EN 297/A3)		Mg/kWh	49				
Maximum hydraulic working pressure		bar	6				
Minimum hydraulic working pressure		bar	0.5				
Sound level		dBA	<49				

Notes: (1) Calculated from the non-domestic heating and cooling compliance guide for conformance with ADL2A and

ADL2B 2013 using the formula $n_{\text{seasonal}} = 0.81n_{30\%} + 0.19n_{100\%}$

(2) Refer to sales office for data on Propane (G31) operation

Water flow rates and hydraulic resistances

Water flow rate at 15°C temp. rise	l/s	6.76	8.45	10.14	11.83	13.51
Hydraulic resistance at 15°C temp. rise	kPa	20.6	11.8	47	41.4	33.4
Water flow rate at 20°C temp. rise	l/s	5.06	6.33	7.6	8.87	10.14
Hydraulic resistance at 20°C temp. rise	kPa	13.7	15.7	18.6	20.6	17.7

Installation requirements

Regulations governing installation

Modulex boilers should be installed in accordance with all prevailing regulations and codes of practice, including the Building Regulations, Health and Safety Regulations PM5, Water Bylaws and the current Gas Safety (Installation and Use) Regulations. Detailed relevant guidance will also be found in;

- BS 6644 :2011 Installation of appliances exceeding 70 kW net input
- CIBSE AM14 Non-domestic hot water heating systems

CIBSE Guides B and C and Commissioning Code B
Institution of Gas Engineers Utilization Procedures 1, 1A, 2, 4, 7 and 10.

Water treatment

Modulex EXT boilers have an aluminium alloy heat exchanger and care must be exercised to ensure that the system water and any water treatment is compatible. Whenever a new boiler is connected to an existing system, the pipework must be thoroughly cleaned and flushed. This is to remove debris, rust particles, carbonate deposits and any existing water treatment that might be incompatible with the heat exchanger. New systems must also be thoroughly flushed to remove debris and flux deposits. Cannot recommend that a permanent means of filtration be fitted into the return pipework, such as a sludge trap, hydrocyclone or full flow duplex filters. The boiler guarantee will be invalid if waterways are blocked by debris or carbonate deposits. The pH value of the system water should be measured to ensure that it is between 6.5 and 8, and regularly checked. Temporary hardness (calcium carbonate and magnesium carbonate) can be removed by boiling and its effects limited by preventing ingress of fresh, untreated water. The boiler guarantee will be invalidated by the use of incorrect or incompatible water treatment. Specialist advice should be obtained, For full information on cleaning, flushing and protecting hot water systems, refer to BSRIA Application Guide AG 1/2001.1

Deaeration

It is essential that there is effective air removal from the system to avoid corrosion of the heat exchanger. If there is underfloor heating, oxygen-barrier pipe should be used or the boiler separated from the system by a plate heat exchanger.

Boiler condensate

Modulex EXT boilers have a 40mm condensate drain that is compatible with standard plastic waste pipe (ABS or PVCu). Do not use other materials, as they will corrode. The pipe size must not be reduced and there must be a continuous fall of at least 1:30 to drain. A condensate trap must be provided external to the boiler. As a further precaution against freezing, condensate pipes should be run internally whenever possible and lagged when run externally.

Pressurisation of systems

Modulex EXT boilers should be installed as part of a pressurised (sealed) or open vented system with a minimum pressure of 0.5 bar. The maximum allowable pressure for the boilers is 6 bar. They are not to be used with a gravity system. If an open vented system is being used, it must be confirmed that static head and operating conditions will maintain the anti-flash margin.

Boiler location

Modulex EXT boilers will normally be installed inside a building. The boiler must be mounted on a sound, level and non-combustible raised plinth of at least 100mm, capable of supporting its weight and providing a continuous fall from the boiler for the condensate trap and pipework. The boiler location must be frost-free and adequately ventilated (see below). Contamination of the combustion air by inflammable vapours, high dust levels or halogenated hydrocarbons will constitute a safety hazard and will damage the boiler.

The following minimum clearances around the boiler should be observed;

- Front 600 mm
- Sides 50 mm min on one side, flue connector depth (if fitted) + 300 mm on other
- Rear Flue connector depth (if fitted) + 300 mm
- Above 600 mm

Modulex EXT boilers may be installed external to the building, since they incorporate a weather proof jacket.

Air supply and ventilation

Adequate air for combustion and ventilation is essential to the safe operation of a boiler. If the boiler is installed with a Type C room sealed flue, BS 6644:2011 calls for minimum ventilation of 2 cm² free area per kW net input at both high and low level unless the ambient temperature of the plant room ceiling exceeds 40°C.

When the installation comprises multiple boilers or single boilers above 70 kW net input with Type B flues, the ventilation requirements of either BS 6644:2011 or IGE/UP/10 must be met. Table 1 shows the requirements of BS 6644:2011. This standard requires natural ventilation at both high and low levels to the outside air, and is based on the net input of the boilers.

Ventilation direct to outside air	Total kW input (net)
Low level	4 cm ² per kW of total rated net input
High level	2 cm ² per kW of total rated net input

Table 1 Ventilation for single or multiple boiler installations in a boiler room complying with BS 6644:2011

Installation requirements

Heat exchanger hydraulic resistance

The Modulex EXT boiler has a high resistance heat exchanger. The boiler does not have an integral pump, but does require a minimum flow rate equivalent to $\Delta T 20$, as shown in the tables on pages 4 and 5. The boiler should be hydraulically separated from the heating distribution system by either a low velocity header or a plate heat exchanger and each boiler has an individual circulating pump. This will ensure the minimum flow rate at all times. With this arrangement, the boiler pump can be located in the return (where water temperature is lowest) regardless of the location of the system distribution pumps. A pump over-run should be provided via a relay if the pump is not directly controlled by the boiler.

Low velocity headers

Low velocity headers are used to separate hydraulically the boilers from the rest of the system. In addition to helping maintain a minimum flow through the boiler, they create a low velocity region for system dirt to be deposited and separation of air from the system water. Used in conjunction with a system filter (refer page 6), they are invaluable when connecting a new boiler to an existing system.

Low velocity headers should preferably be vertical and sized for a maximum water velocity of 0.5 m/s. Modulex low velocity headers are designed to ensure a water velocity of 0.2 m/s or less and for $\Delta T 10$ or 20, so will be suitable for most systems. Fig 2 proposes dimensions for the design of a low velocity header, and Table 2 shows dimensions for a $\Delta T 10$ or 20 system.

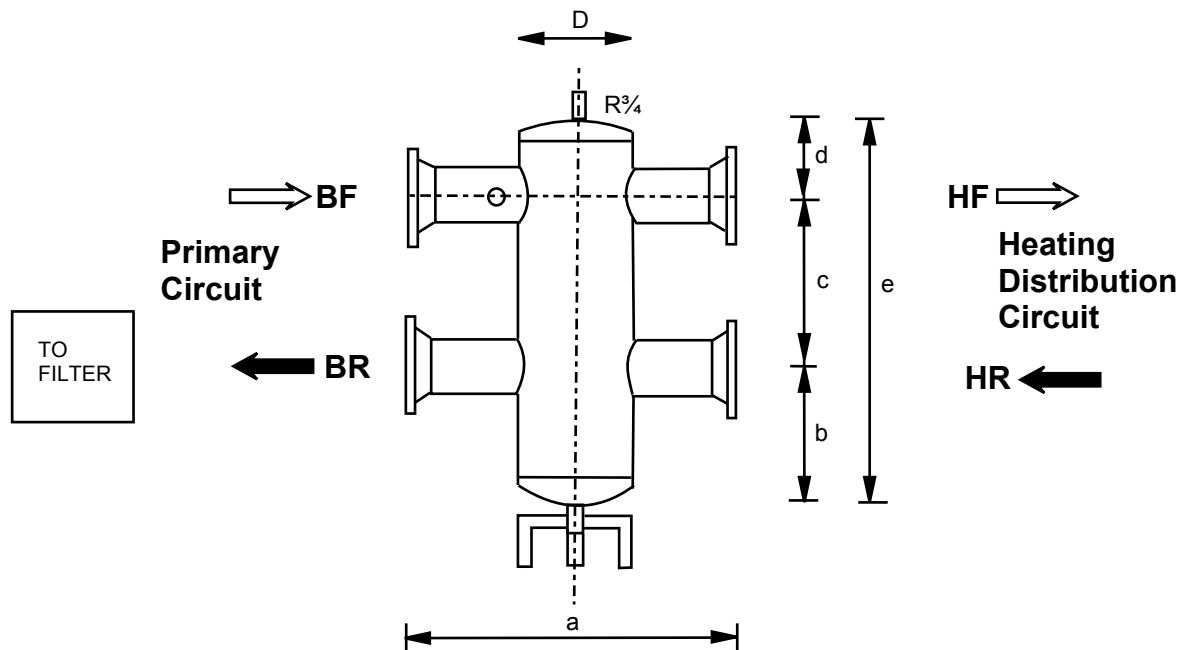


Fig 2 Design for a low velocity header

Max output (kW) $\Delta T 20 / \Delta T 10$	D mm $\Delta T 20$	D mm $\Delta T 10$	BF / BR $\Delta T 20 / \Delta T 10$	HF / HR $\Delta T 20 / \Delta T 10$	a mm	b mm	c mm	d mm	e mm
145 - 350*	220	220	DN100 PN16	DN100 PN16	668	206	359	205	770
440 - 900*	324	324	DN100 PN16	DN100 PN16	668	286	359	315	961
< 3500 / 1750	500	500	250	250	-	500	1500	500	2500
< 4600 / 2300	600	600	300	300	-	500	1800	500	2800

Table 2 Low velocity header dimensions for $\Delta T 10$ or 20 system

*Note: These first three listed low velocity headers are available from Carnot
The last two are suggested sizes for on-site fabrication

Boiler wiring

E8 Regulator

Each Modulex boiler has an E8 Regulator, from which boiler functions and auxiliary equipment are controlled. It is divided into a 230V block for pumps, mixing valves, etc and a 24V block for sensors and internal cascade control (see Fig 3). Auxiliary equipment run from the 230V block must be connected via a relay. In addition to modular control of the boiler, the E8 can directly compensate the boiler flow temperature via an Outdoor Air Sensor.

Mains connection

This boiler requires a permanent mains supply of 230V 50Hz, protected by a 3 Amp fuse. Connection is made with a Weiland socket and plug. The electrical supply to the boiler must be installed in accordance with current IEE (BS 7671) Regulations. A separate supply and isolating switch is required for each boiler.

Controls wiring for Modulex boilers is 24V and must be kept separate from 230V supplies (incoming mains and boiler pump overrun) in the conduits supplied.

Modulating boiler pump

A modulating pump can be controlled by 0 - 10V signal (3V is minimum speed, 10V maximum) from the BCM (terminals 5 and 6 on block Y2)

External control of the boilers

There are a number of ways to externally control, monitor and cascade multiple boilers;

- An external E8 Regulator designated as the Master and connected in parallel to terminals **IX 1,2,3 and 4** on the sensor block of each individual boiler E8.
- As above, but with an additional facility for a BMS to monitor each boiler by connection in parallel to terminals **Y2 1 and 2** on each boiler BCM.
- An external BCM is designated as cascade manager. This receives an enabling signal on the modbus connection from an external BMS and is connected in parallel to terminals **Y2 3 and 4** on each boiler BCM.
- No external E8 or BCM is used. An external BMS switch circuit is connected in parallel to terminals **Y2 1 and 2** on each boiler BCM.
- A BMS controller, using a variable 0 - 10V signal and connected to the two terminals shown on fig 3 page 9
- The simplest external control method is a volt-free enable switch connected to the two terminals shown on fig 3 page 9

Boiler E8 controller

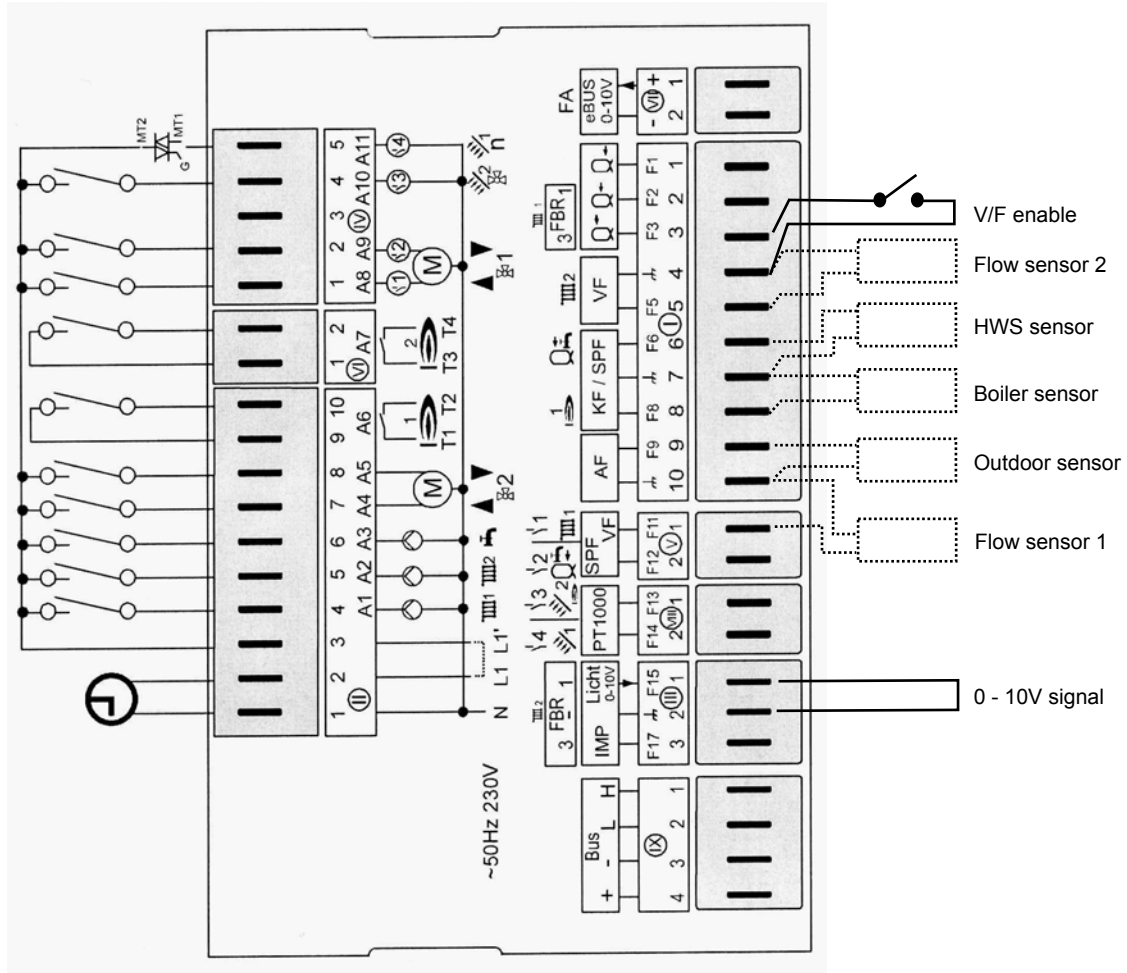


Fig 3 E8 regulator

Hydraulic system design

General

Modulux boilers should be hydraulically separated from the heating system by either a low velocity header or plate heat exchanger. Any plastic pipework without an oxygen barrier should be separated from the boiler by a plate heat exchanger.

DHW calorifiers can be connected either side of the LVH, controlled by a loading pump on the primary or high temperature side (fig 4) or a loading pump on the distribution or low temperature side (fig 5). Alternatively, Modulux boilers can be used for heating-only applications, with external control of heating zones. Figs 4 and 5 show examples of connection to the E8 Regulator. More schematics are shown in the Installation and Servicing Instructions.

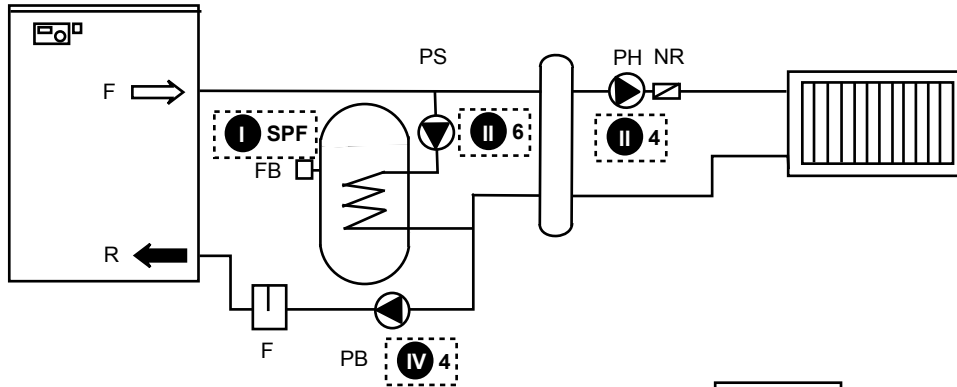


Fig 4 DHW calorifier on high temperature side

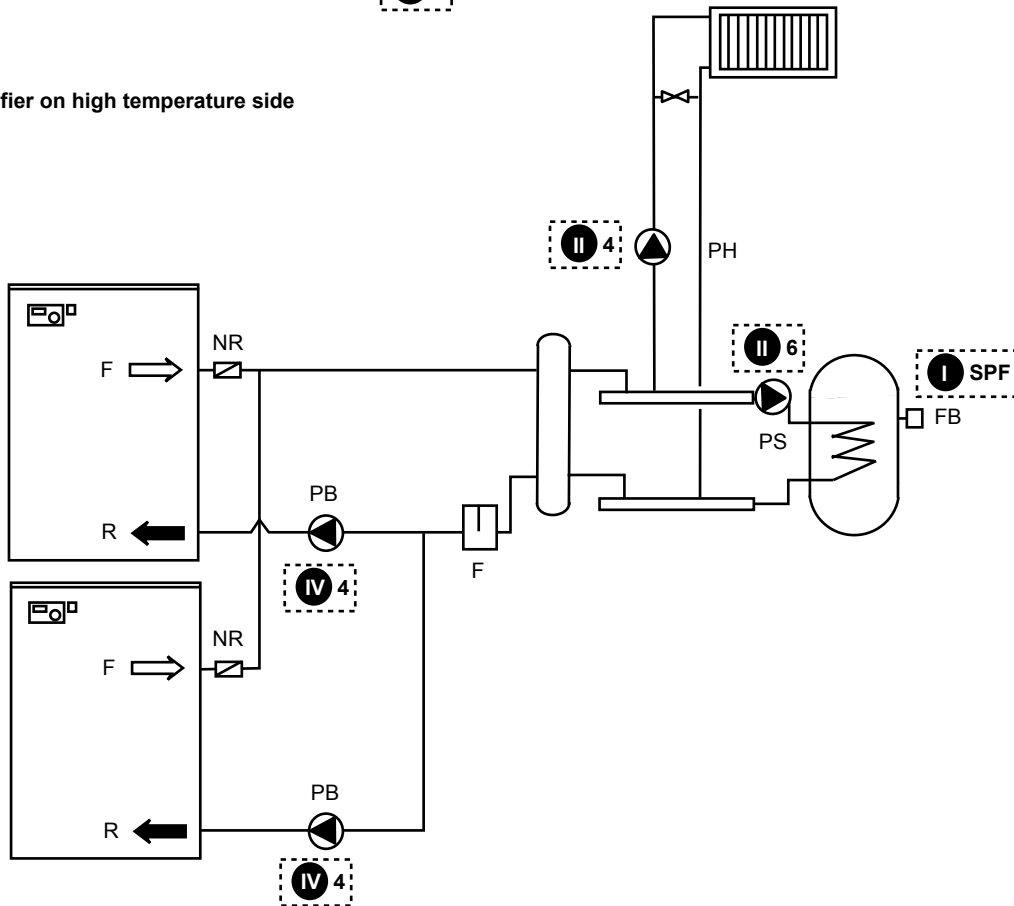


Fig 5 DHW calorifier on low temperature side

Key to figs 4 and 5

- F Filter
- FB DHW sensor
- NR Non-return valve
- PB Boiler pump
- PH Heating Pump
- PS DHW loading pump

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