Clyde CG

Carnot Consult

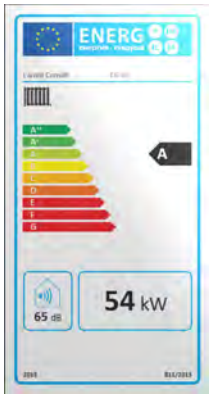
Wall hung condensing boilers

Natural Gas

LP Gas

60 kW
to
180 kW

ErP



- ***Fully modulating burner and efficiency of up to 110.6% ncv***
- ***Now fitted with modulating boiler pump***
- ***ERP compliant***
- ***Stainless steel heat exchanger***
- ***Cascade up to 12 boilers in back-to-back frames***
- ***Integrated controls package***
- ***Up to 180 kW output from a single wall-hung boiler***
- ***Up to 2160 kW output from a cascaded system***
- ***Supporting frame and pipework kits available***
- ***All models suitable for use with concentric balanced flues***

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Engineering Data Sheet 769/7

April 2017

General information

Operating principles

The CG is a wall-mounted condensing boiler with stainless steel counter flow twin heat exchangers (the CG 60 has a single heat exchanger), pre-mix gas burner and integral combustion air fan (refer Figs 1 and 2). When operating in condensing mode with a flow of 50°C and a return of 30°C, it will give efficiencies of up to 110.6% (ncv). Gas is supplied through a zero governor valve (2). The air intake fan (4) and venturi (3) accurately control the volumes of gas and air and mix them prior to ignition. A small flame is held on the entire surface of the burner combustion head (6). This ensures that there is optimum combustion at any point in the modulation range of the boiler.

System return water is passed through a number of tubes in the secondary (condensing) heat exchanger, and then the primary heat exchanger. An integral modulating boiler circulation pump (11) ensures an even and constant flow through the heat exchanger - refer page 8. The modulation of this pump is operated by the burner control. System circulating pumps should be hydraulically separated from the boiler(s) by a low velocity header.

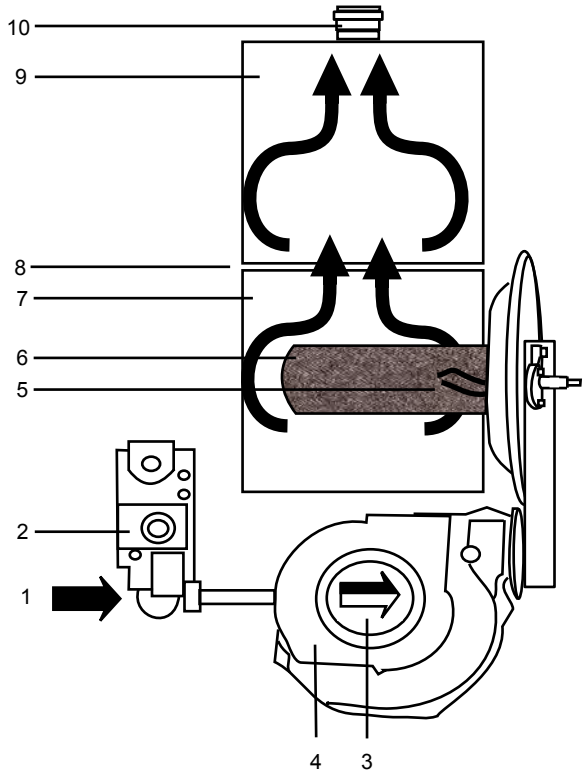


Fig 1 Diagram of operating principles

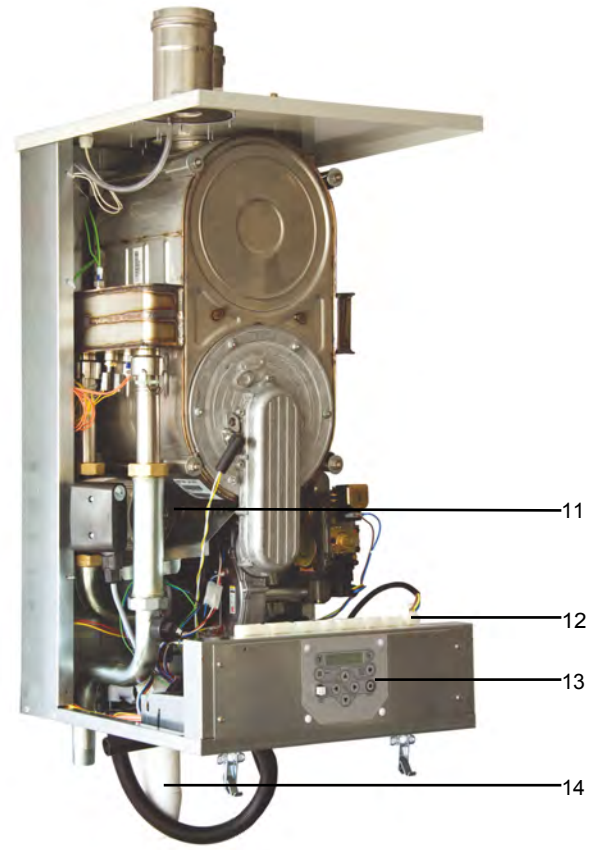


Fig 2 CG boiler with jacket panels removed

Key to Figs 1 & 2

1	Gas supply	8	Baffle plate
2	Gas valve	9	Second (condensing) heat exchanger
3	Gas and air mixing by venturi	10	Flue gas outlet
4	Fan unit	11	Boiler circulation pump
5	Ignition and flame ionisation electrode	12	Electrical connection strip
6	Burner head	13	Control display
7	First heat exchanger	14	Condensate siphon

General information

Application

CG boilers are manufactured and tested in accordance with the Gas Appliances Directive 90/396/EEC, the Boiler Efficiency Directive 92/42/EEC, EN 483 and EN 677 and CE marked accordingly. They are suitable for use in LTHW heating systems with a maximum operating pressure of 4.0 bar and a maximum working temperature of 90°C (see Technical data).

CG 60, 80, 100, 120, 150 and 180 boilers are suitable for use with Natural gas (G20) and Propane gas (G31).

The boiler is suitable for use in pressurised (sealed) or open vented heating systems with a minimum static head of 1 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. All models in the range are suitable for use with a concentric balanced 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

Carnot 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 and IGE/UP/4.

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, all equipment is guaranteed for twelve months from the date of despatch. Boiler heat exchangers are guaranteed for a period of ten years from the date of manufacture.

The guarantee is not valid if the boiler is not installed in accordance with these instructions (please refer to page 5), 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.

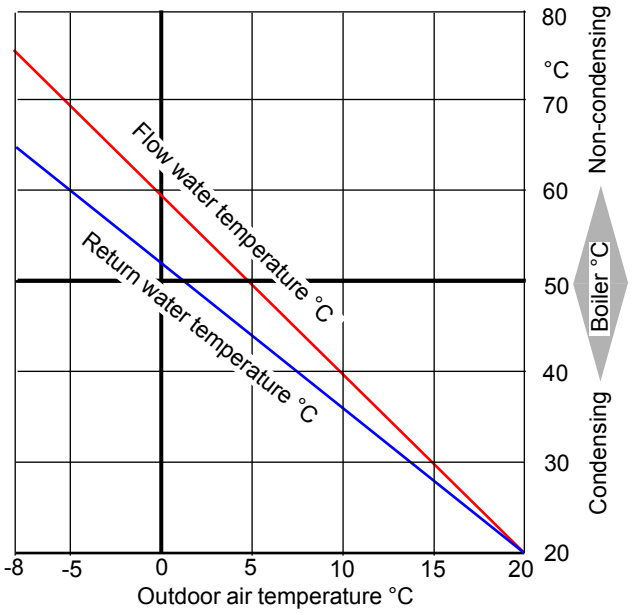
Boiler Log book

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 on every occasion that routine or emergency work is carried out on the boiler.

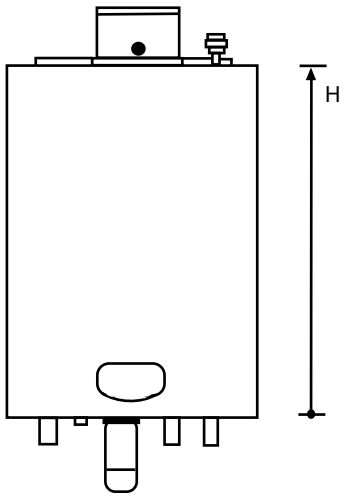
Emitter sizing (radiators)

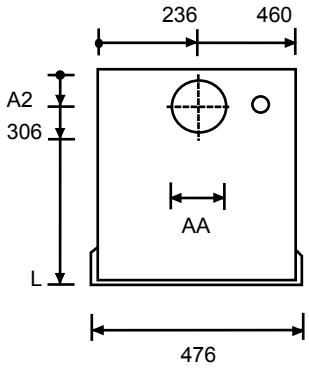
The boiler will operate in condensing mode whenever the return water is below 50°C and will reach its full potential if the flow water temperature is also below 50°C. However, the latter condition will mainly occur when the boiler is heating an underfloor heating scheme or transiently when recharging a HWS 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 (ΔT50) 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.

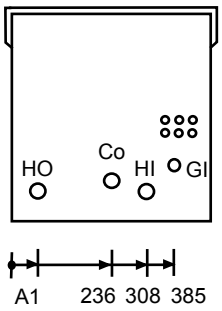


Dimensions and Technical data





Plan



Below

Dimensions

Boiler model / output		kW	60	80	100	120	150	180
Boiler flow connection	HO		R1.25	R1.25	R1.25	R1.5	R1.5	R1.5
Boiler return connection	HI		R1.25	R1.25	R1.25	R1.5	R1.5	R1.5
Condensate outlet	Co	mm	25					
Gas Inlet	GI		R¾	R¾	R¾	R¾	R1	R1
Flue connection (standard concentric)	AA	mm	80/125	80/125	100/150	100/150	100/150	100/150
Flue connection parallel (special order)		mm	80-80	80-80	100-100	100-100	130-130	130-130
Boiler depth	L	mm	486	486	486	486	677	677
Boiler height	H	mm	842	842	842	842	898	898
Position of HO	A1	mm	73	73	73	73	123	123
Centre line of flue outlet	A2	mm	155	112	112	112	109	109

Technical data

Flow 50°C / Return 30°C

Heat output	Max	kW	57.4	77.5	96.2	116	144	175
Heat input (ncv)	Max	kW	55.6	74.3	92.2	111	138	166
Efficiency (ncv)		%	110.6	110.6	110.6	110.6	110.6	110.6

Flow 80°C / Return 60°C

Heat output	Max	kW	53.5	71.2	88.4	106	132	160
Heat input (ncv)	Max	kW	56.6	74.3	92.2	111	138	166
Efficiency (ncv)		%	96	96	95.9	95	95.9	96.3
Flue gas temperature at full load	G20	°C	85 - 95					
Flue gas mass flow (max) (4)	G20	kg/s	0.034	0.045	0.055	0.067	0.083	0.1
CO_2 in flue gas G20 (1)	min/max	%	8.7 / 9.0					
PH of condensate produced			4 to 5.5					
Natural gas consumption (net cv) (2)		m³/h	5.9	7.8	9.7	11.8	14.6	17.6
Natural gas consumption (gross cv) (2)		m³/h	5.8	7.7	9.5	11.5	14.3	17.2
Boiler seasonal efficiency (3)		%	96.3	97.1	96.6	96.9	96.6	96.6
N0x emmissions		mg/kWh	38	46	40	45	41	44
G31 propane consumption (net cv)		m³/h	2.3	3	3.8	4.5	5.7	6.8
CO_2 in flue gas G31 (1)	min/max	%	9.3 / 10.5					
Dry weight		kg	46	73	78	83	92	102
Water volume		l	3.9	5	6.5	8.3	10.4	12.9
Maximum allowable temperature		°C	90					
Hydraulic working pressure min/max		bar	1.0 / 4.0					
CE Registration number			CE 0063 BP3254					
Max electrical power consumption		W	111	136	142	151	214	229
Electrical protection			IPX4D					

Notes : (1) Measured at the flue gas adaptor (2) Based on GCV 38.76 MJ/m³

(3) Calculated from the non-domestic heating and cooling compliance guide for conformance with ADL2A and ADL2B 2010 using the formula **$n_{seasonal} = 0.81n_{30\%} + 0.19n_{100\%}$**

(4) Both wet and dry products @ STP

Water flow rates and hydraulic resistances

Water flow rate at 20°C temp. rise	l/s	0.71	0.95	1.19	1.43	1.79	2.14
Hydraulic resistance at 20°C temp. rise	kPa	22.4	45.8	38.2	35.6	44.8	33.6

Installation requirements

Regulations governing installation

CG 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
BS 5440-2	Ventilation for appliances not exceeding 70 kW net input
BS 6891	Low pressure gas installation pipework of up to 28mm (R1)
BS 5449	Forced circulation hot water central heating systems for domestic premises

CIBSE Guides B and C, AM14:2010 Non-domestic hot water heating systems and Commissioning Code B.
Institution of Gas Engineers Utilization Procedures 1, 1A, 2, 4, 7 and 10.

Water treatment

CG boilers have a stainless steel 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. Carnot 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 7.5 and 9.5. If system water is in contact with aluminium, the pH value must be less than 8.5. Temporary hardness (calcium carbonate and magnesium carbonate) can be removed by boiling and its effects limited by preventing ingress of fresh, untreated water. Permanent hardness must be between 50 ppm and 150 ppm $CaCO_3$.. The boiler guarantee will be invalidated by the use of incorrect or incompatible water treatment. Specialist advice should be obtained, eg from;

Fernox Tel. 01483 793200

For full information on cleaning, flushing and protecting hot water systems, refer to BSRIA Application Guide AG 1/2001.

Deaeration

It is a condition of warranty that there is effective air separation and removal from the system. The air separator should be fitted at the hottest part of the system.

Boiler condensate

CG boilers have a 25mm flexible condensate drain that is compatible with standard plastic waste pipe. Do not use other materials, as they will corrode. The pipe size must not be reduced and there must be a continuous fall to drain. As a further precaution against freezing, condensate pipes should be run internally whenever possible and lagged when run externally.

Pressurisation of systems

CG boilers should be installed as part of a pressurised (sealed) or open vented system with a minimum pressure of 1 bar. The maximum allowable pressure for the boilers is 4 bar. They are not to be used with a gravity system.

Boiler location

CG boilers must not be installed external to a building. The boiler must be mounted on a sound internal wall, capable of supporting its weight. 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	500 mm
Sides	20 mm
Below	100 mm
Above	300 mm (subject to flue installation requirements)

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 balanced flue, BS 6644:2011 calls for minimum ventilation of 2 cm^2 free area per kW net input at both high and low level unless the ambient temperature of the plant room ceiling exceeds 40°C.
For a single 60 kW boiler with a Type B powered flue, the ventilation requirements of BS 5440-2 apply, and they are partly summarised in Table 1. For ventilation direct to outside air, the requirement is for 5 cm^2 per kW net rated heat input above 7 kW.

Appliance	Ventilation direct to outside air
CG 60	248 cm^2

Table 1 Ventilation for single boiler installations complying with BS 5440-2

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 2 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 2 Ventilation for multiple boiler installations in a boiler room complying with BS 6644:2011

Heat exchanger hydraulic resistance

The CG boiler has a high resistance heat exchanger. A modulating Grundfos pump is supplied as an integral part of the boiler to overcome this resistance and ensure a constant water flow through the boiler. This is not a system circulating pump. The boilers are designed to work at ΔT20K or higher (refer Technical data on page 4). When operating at full load at ΔT 20, the CG60 has a pump head of 3.7m available for system circulation, but there is no significant pump head available for the other models. At a higher ΔT (eg ΔT25K), there is some available head with all models, and reference should be made to the charts in the Installation Instructions. If operation at a reduced load is acceptable, there may be adequate head for a small heating circuit or HWS calorifier.

Although there may be adequate head for primary circulation through a HWS calorifier, in all cases additional circulating pump(s) will be required for the heating distribution. These should be hydraulically separated from the boiler(s) by a low velocity header - see below.

Low velocity headers

Low velocity headers are used to separate hydraulically the boilers from the rest of the system. They should be used whenever a circulating pump is installed in addition to the boiler pump. Used in conjunction with a system filter and air separator (refer page 5), they are invaluable when connecting a new boiler to an existing system.

Fig 3 shows two models of LVH suitable for use with a ΔT20 system. Refer to sales office for advice and sizing for other system operating parameters. Refer also Clyde EDS 778 - pipework sets and frames for CG boilers.

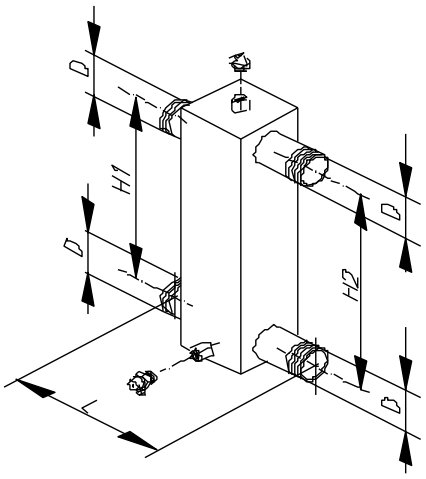


Fig 3a LVH for up to 2 no CG60 to 120 boilers

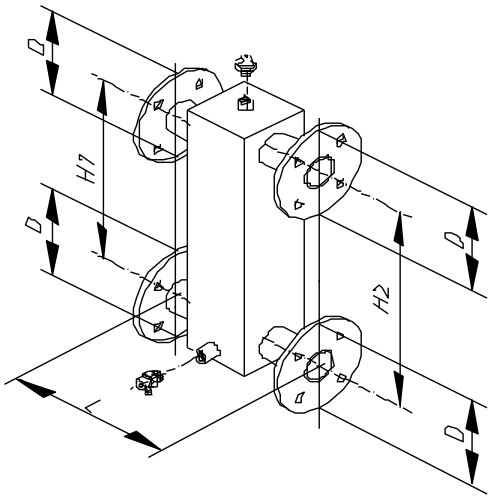
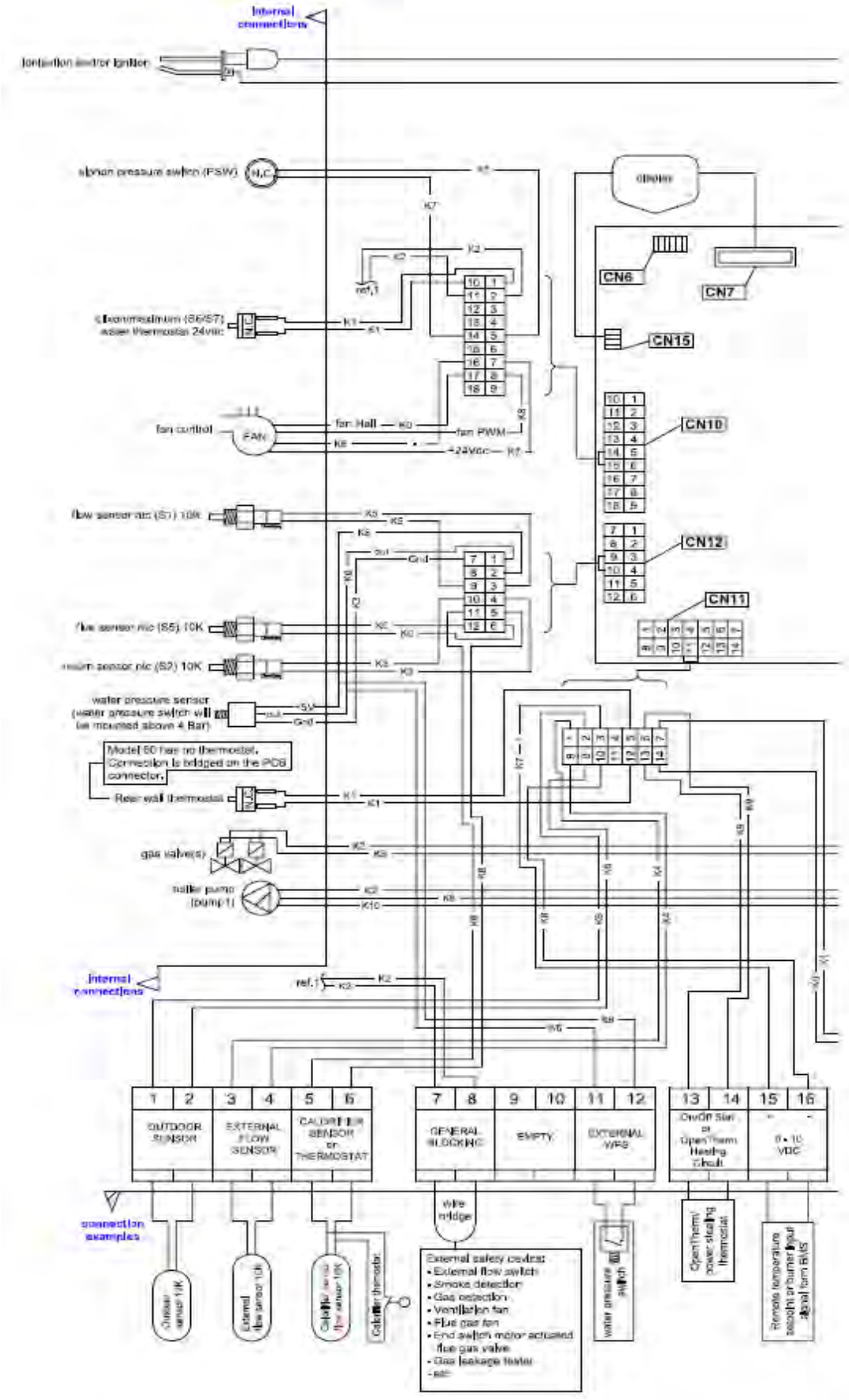


Fig 3b LVH for up to 4 no CG boilers

Boiler selection	**2 x 60 - 120**	**3 x 60 - 120** **2 x 150 - 180**	**4 x 60 - 120** **3 x 150 - 180**	**4 x 150 - 180**
D mm	R 1 ½	DN65 PN6 (2 ½")	DN80 PN6 (3")	DN100 PN6 (4")
H1 mm (primary side)	330	330	330	330
H2 mm (distribution side)	436	487	440	439
L mm	190	265	290	355

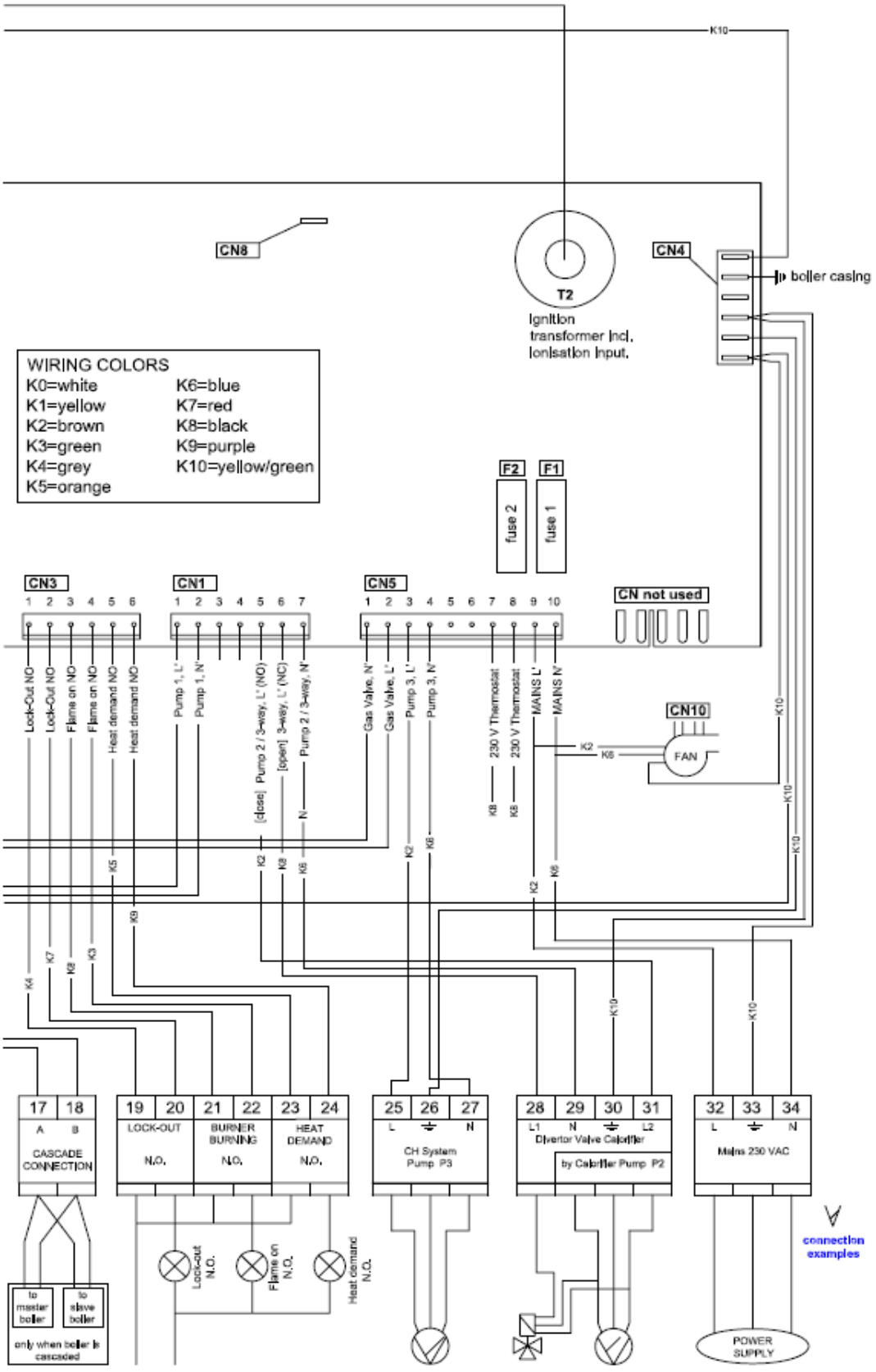
Table 3 Dimensions for LVH

Boiler wiring diagram



For strip connector details, refer to Fig 4 on page 8

Boiler wiring diagram



For strip connector details, refer to Fig 4 on page 8

Boiler wiring diagram

⊗ Fit link if not using

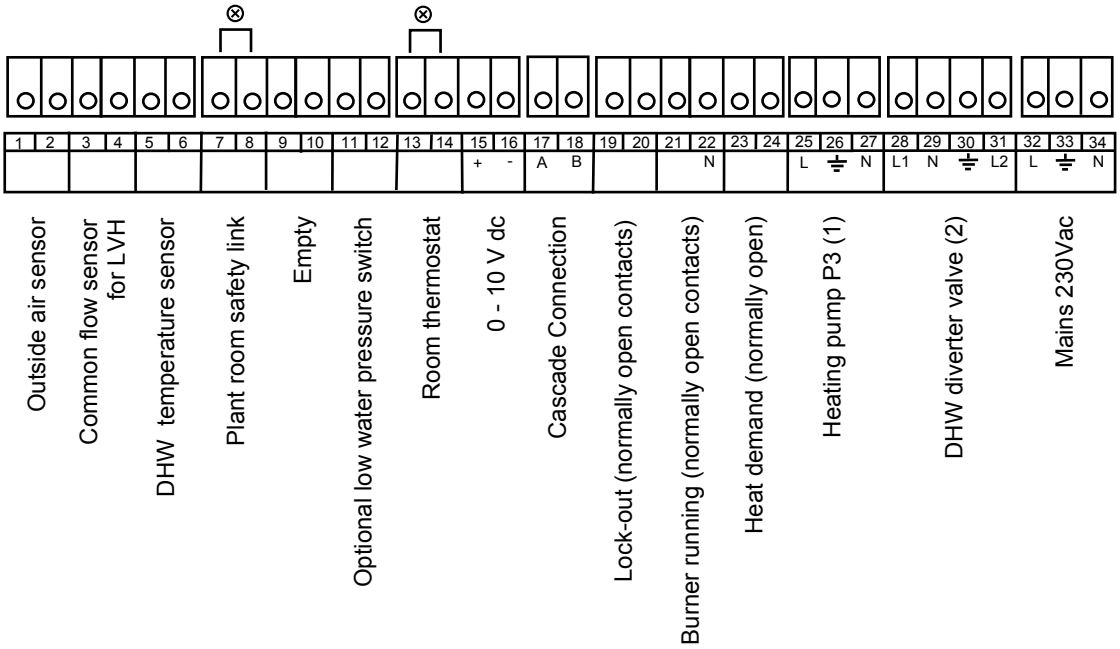


Fig 4 Termination of external control components to the strip connector

Note

(1) External pumps should not be powered directly from the boiler, but powered via a contactor.

(2) When using a diverter valve for DHW production, terminal 28 (L2) is heating demand, terminal 29 is neutral and terminal 31 is hot water demand. Alternatively, a hot water loading pump can be connected to terminals 29, 30 and 31.

Boiler control panel

Fig 5 opposite shows the boiler control panel.

This has been designed so that most operating parameters and all user parameters, including setting the gradient and slope of the weather compensation curve in the integral PID control, can be set without the need for a laptop and specialised software.

A laptop communications port is provided for use by approved Clyde service engineers.

Full details for the use of this panel are provided in the Clyde Installation Instructions INS 780.

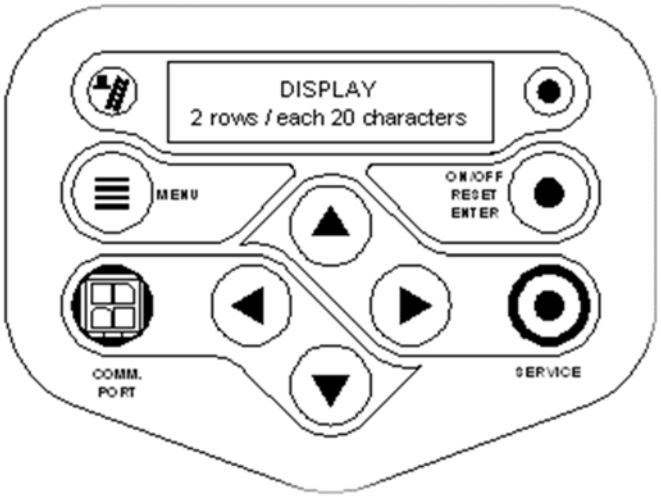


Fig 5 boiler control panel

General

CG boilers can be used with stainless steel and plastic flue systems. Aluminium flue components **must not** be used.
Standard items available from are;
Type C concentric balanced flue for horizontal termination.
Type C concentric flue for vertical termination through a flat or pitched roof.
Also available to special order are;
Type C twin tube flue for horizontal or vertical termination.
Type B powered flue for vertical termination (ie combustion air is taken from within the boiler room, so ventilation must comply with either BS 5440-2:, BS 6644:2011 or IGE/UP/10 as appropriate - refer page 5).
Type B powered flue common headers for multiple boilers - contact sales office for information on these.

Type C concentric flues

The standard horizontal and vertical flue kits are 80/125 mm for the CG 60 and 80 and 100/150 mm for the CG 100, 120, 150 and 180 models - refer Figs 5 and 6.
Additional straight lengths of 1m and 2m, plus 45° and 90° bends are available to complete the system. All additional lengths and fittings are supplied with the necessary sealing collars. The straight lengths can be cut with a hacksaw at the plain end.
A separate condensate drain tee should be installed for long horizontal or vertical flue runs. For this reason, horizontal flues should have a slight fall (3°) back to the boiler.
The 80/125 concentric flue is adequate for short runs and ideal for horizontal termination through an adjacent wall. However, the smaller size increases the resistance of the flue and longer runs may require 100/150 concentric flue or twin pipe.
The EL (Equivalent Length) pressure drop of the straight flue lengths, fittings and terminals must not exceed 200 Pa. Table 4 gives the resistance of flue components.

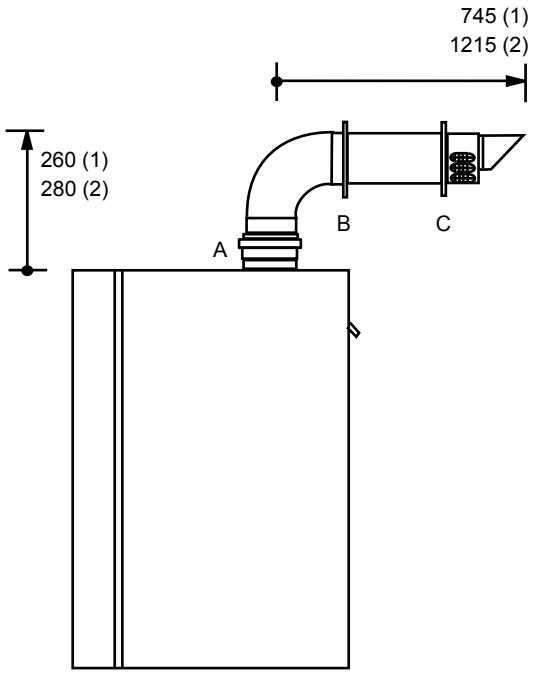


Fig 6 80/125 and 100/150 concentric horizontal flue arrangement

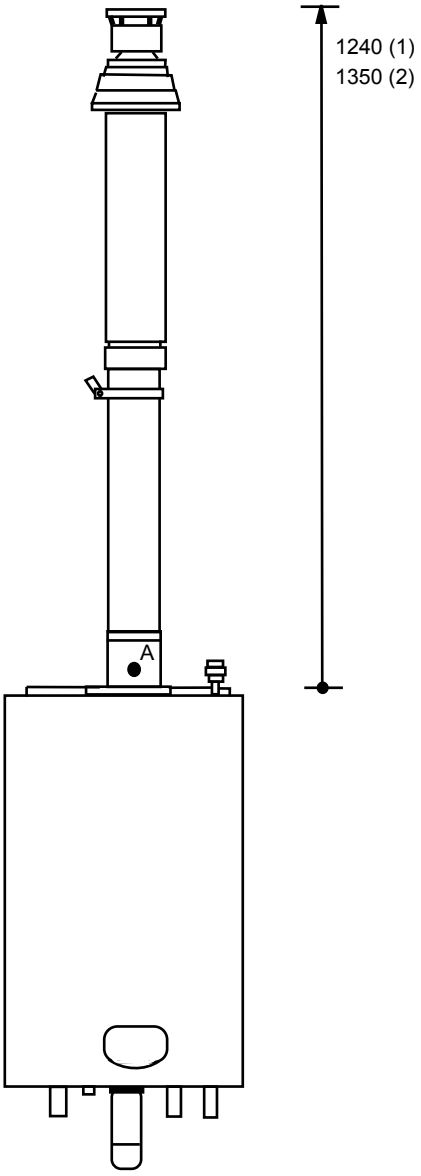


Fig 7 80/125 and 100/150 concentric vertical flue arrangement

Key to Figs 6 and 7

A	Flue gas sampling point
B	Interior wall cover plate
C	Exterior wall cover plate

Notes;
(1) Dimensions for 80/125 concentric flue
(2) Dimensions for 100/150 concentric flue

Flue component	Resistance (Pa) CG60	Resistance (Pa) CG80	Resistance (Pa) CG100	Resistance (Pa) CG120	Resistance (Pa) CG150	Resistance (Pa) CG180
80/125 concentric wall terminal	13	22	N/R	N/R	N/R	N/R
100/150 concentric wall terminal	N/R	N/R	19	24	40	48
80/125 concentric roof terminal	34	61	N/R	N/R	N/R	N/R
100/150 concentric roof terminal	N/R	N/R	19	24	40	48
80/125 concentric pipe (per m)	9	12	N/R	N/R	N/R	N/R
100/150 concentric pipe (per m)	N/R	N/R	8	10	14	16
80/125 concentric 45° bend	5	7	N/R	N/R	N/R	N/R
100/150 concentric 45° bend	N/R	N/R	8	9	14	16
80/125 concentric 90° bend	8	13	N/R	N/R	N/R	N/R
100/150 concentric 90° bend	N/R	N/R	11	13	22	28
80 mm flue gas duct (per m)	5	8	13	N/R	N/R	N/R
100 mm flue gas duct (per m)	2	3.5	4	6.5	N/R	N/R
130 mm flue gas duct (per m)	0.45	0.8	1.2	1.8	3.8	6
150 mm flue gas duct (per m)	N/R	N/R	0.5	0.8	1.7	3
80 mm flue gas 45° bend	2.5	4	N/R	N/R	N/R	N/R
100 mm flue gas 45° bend	1	1.7	2	3.2	N/R	N/R
130 mm flue gas 45° bend	0.2	0.4	0.6	0.8	1.9	3
150 mm flue gas 45º bend	N/R	N/R	0.2	0.4	0.8	1.5
80 mm flue gas 90° bend	5	8	N/R	N/R	N/R	N/R
100 mm flue gas 90° bend	2	3.5	4	6.5	N/R	N/R
130 mm flue gas 90° bend	0.4	0.8	1.2	1.8	3.8	6
150 mm flue gas 90º bend	N/R	N/R	0.5	0.7	1.7	3
80 mm air supply duct (per m)	4	7.5	N/R	N/R	N/R	N/R
100 mm air supply duct (per m)	1.2	3	3.5	4	N/R	N/R
130 mm air supply duct (per m)	0.35	0.75	0.8	1.1	1.2	2
150 mm air supply duct (per m)	N/R	N/R	0.3	0.4	0.6	1.2
80 mm air supply 45° bend	2	3.5	N/R	N/R	N/R	N/R
100 mm air supply 45° bend	0.6	1.5	1.7	2	N/R	N/R
130 mm air supply 45° bend	0.2	0.4	0.4	0.5	0.6	1
150 mm air supply 45º bend	N/R	N/R	0.15	0.2	0.3	0.6
80 mm air supply 90° bend	4	7	N/R	N/R	N/R	N/R
100 mm air supply 90° bend	1.2	3	3.5	4	N/R	N/R
130 mm air supply 90° bend	0.3	0.7	0.8	1.1	1.2	2
150 mm air supply 90º bend	N/R	N/R	0.3	0.4	0.6	1.2

Table 4 flue gas component resistances

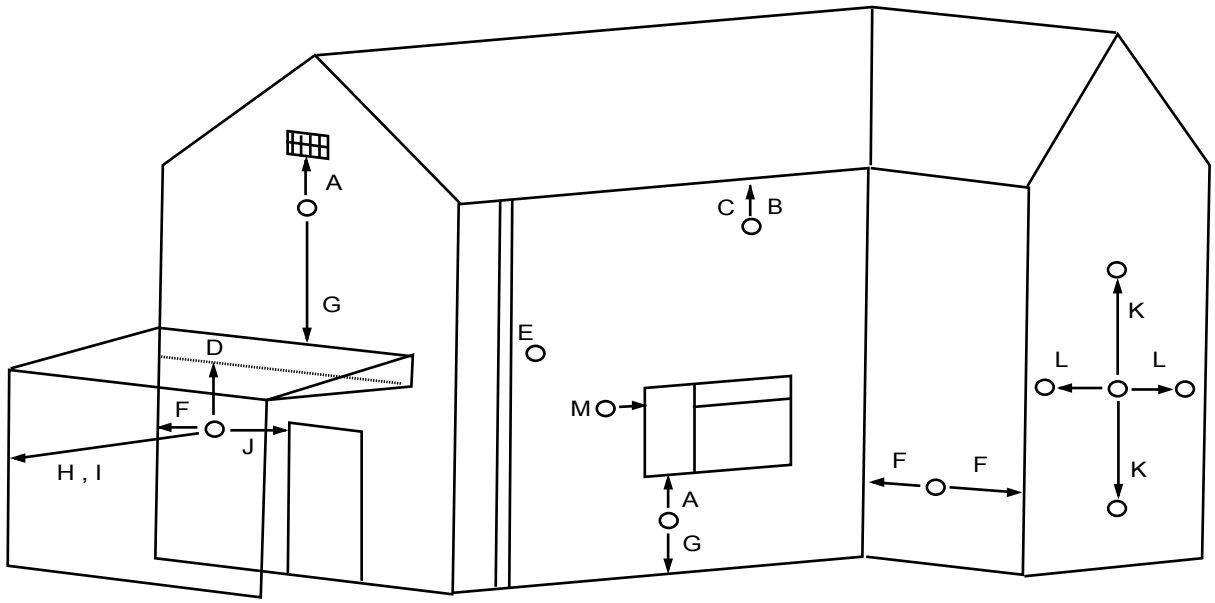


Fig 8 Location of concentric balanced flue terminals

Key to Fig 8

A	Directly below an opening	300 mm
B	Below gutters, soil pipes or drain pipes	75 mm
C	Below soffit / eaves	200 mm
D	Below balconies or car port roof	200 mm
E	From a vertical soil pipe or drain pipe	75 mm
F	From an internal or external corner	300 mm
G	Above ground, roof or balcony level	300 mm
H	From a surface facing the terminal	600 mm
I	From a terminal facing the terminal	1200 mm
J	From an opening in the car port	1200 mm
K	Vertically from a terminal on the same wall	1500 mm
L *	Horizontally from a terminal on the same wall	300 mm
M	Horizontally from an opening	300 mm

For further information, refer to BS 5440-2

* BS 5440-2 is concerned with boilers with a net input of up to 70 kW (ie CG 60). IGE UP/10 gives guidance for boilers of greater output. To conform with this Utilisation Procedure, dimension L should be increased to 600 mm.

Where boilers with a total output of 150 kW or more are to have horizontal terminals on the same wall, reference should be made to the Clean Air Act to determine whether dispensation should be sought.

Hydraulic system design and control

General

The BIC controller built into each boiler can provide cascade control of up to twelve boilers without the need for external controls. The boilers themselves can be mounted in banks of up to 4, each bank having its own frame set, pipework and low velocity header - see Clyde EDS 778 - pipework sets and frames for CG boilers for more details. A 230 Vac permanent supply must be provided for each boiler. One boiler is designated as the master, and the others connected in series by a two wire bus (RS 485 serial communication system). A full weather compensation program is included in the BIC controller, and this is activated by connecting an Outside Air Sensor to the master controller. A time clock or programmable room thermostat (PRT) can also be connected to the master, or an open therm modulating controller (RC).

The arrangement shown in fig 9 will heat a single heating circuit, directly compensated on the common boiler flow temperature by activating the weather compensation program. Carnot recommend that boilers should be hydraulically separated from the system by a Low Velocity Header (LVH). However, fig 10 shows a single boiler installation without a LVH. If a LVH is not used, all circulating pumps **must** be positioned in the return pipework. This arrangement is only suitable for use with a single heating circuit. If more than one heating circuit or multiple boilers are to be used, a LVH **must** be used. If TRVs are used for an installation without a LVH, a differential pressure bypass valve may be required, as the boiler has no internal bypass to provide a minimum water flow.

DHW calorifiers can be connected either side of the LVH, controlled from the master boiler by an immersion sensor and either a loading pump or 3-port diverting valve.

0 - 10 Volt connections are provided with the SIT controller. Ordinarily, 0 V = no demand and 1 V = minimum demand. Control can be on the basis of ‘power’ (boiler output is directly proportional to voltage ie 4.5 V = 50%) or ‘temperature’ (the signal changes the temperature set point of the boiler) and this must be selected as part of the boiler commissioning process.

If plastic pipework is used in the heating system (either proprietary push-fit for conventional radiator circuits or underfloor heating), this must be hydraulically separated from the boiler (eg by a plate heat exchanger) if it does not incorporate an oxygen barrier. This is to prevent magnetite fouling the boiler heat exchanger.

Key to figs 9 to 11

Items supplied as part of optional controls packs

FA	Outside Air Sensor
FB	HWS calorifier sensor
FK	Common flow temperature sensor
PRT	Programmable Room Thermostat / Timeclock
RC	Modulating Room Controller
RCO	Local heating circuit controller
CGCPU	Pressurisation unit

Items not supplied as standard by Clyde;

AS	Air Separator
DV	3-port diverting valve
F	Filter
KR	Non-return valve
PH	Heating circuit pump
PS	HWS primary pump

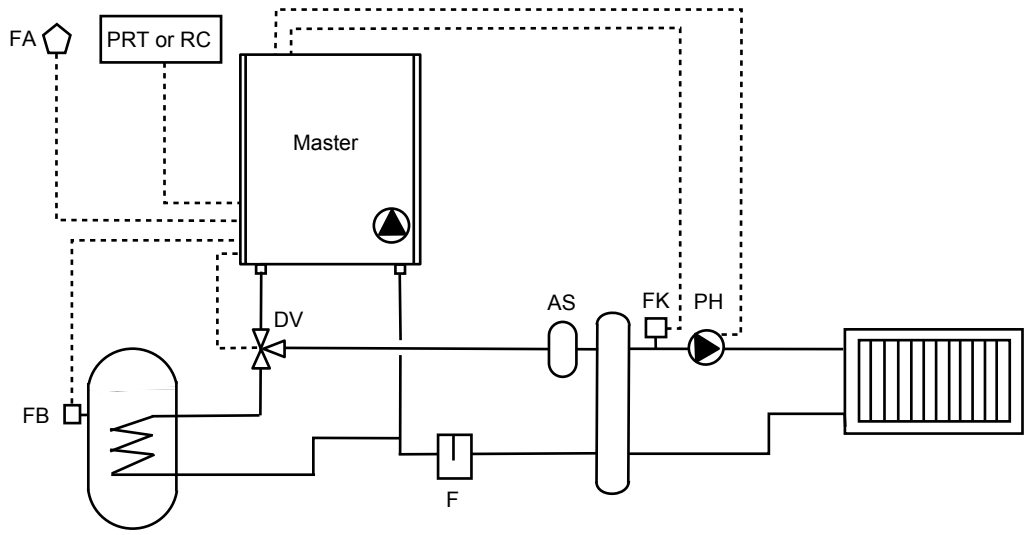


Fig 9 Single boiler with one heating zone and optional HWS calorifier connected to the "High" temperature side of the LVH
The HWS calorifier is directly controlled from the boiler via the 3-port diverting valve (DV) and HWS sensor (FB). The PRT or RC (Programmable Room Thermostat/ modulating control) gives time control of the heating circuit (the RC also gives time control of the HWS). The addition of the Outside Air Sensor (FA) will provide direct weather compensation of the boiler flow temperature. HWS always has priority.

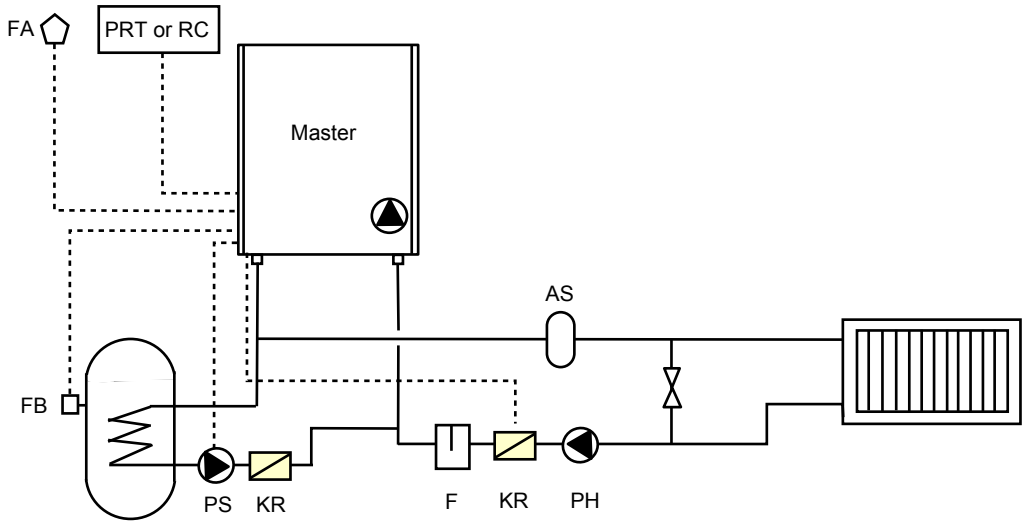


Fig 10 Single boiler with one heating zone and optional HWS calorifier without LVH
The HWS calorifier has a loading pump (PS) on the primary circuit, controlled from the boiler. The PRT or RC (Programmable Room Thermostat/ modulating control) gives time control of the heating circuit (the RC also gives time control of the DHW). The addition of the Outside Air Sensor (FA) will provide direct weather compensation of the boiler flow temperature. Hot water will always have priority. All circulating pumps **must** be located on the return if a LVH is not used. A differential pressure bypass valve may be required to guarantee a minimum water flow though the boiler if TRVs are being used.

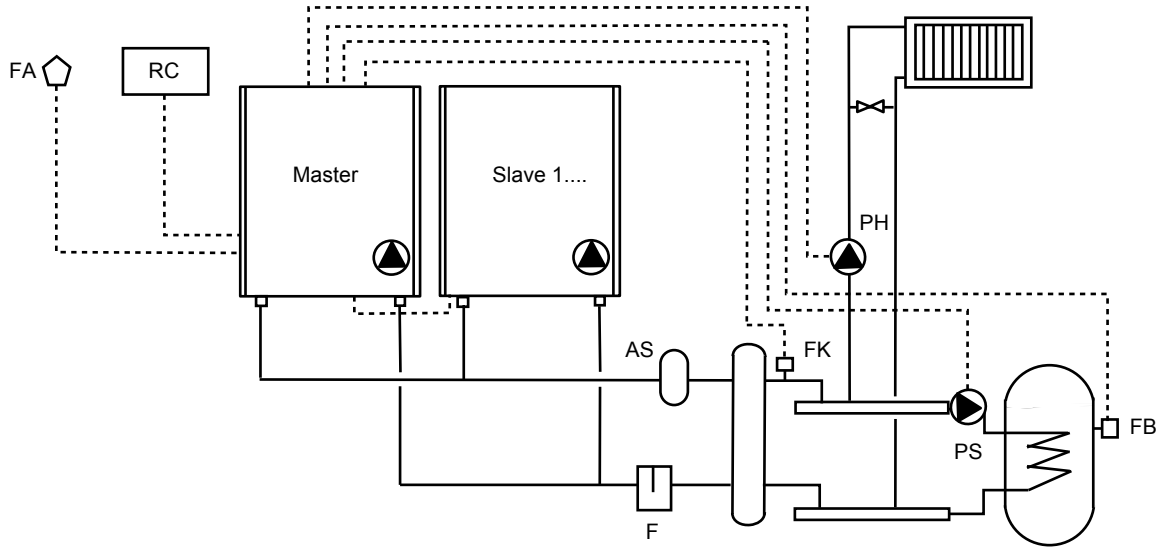


Fig 11 Up to 12 boilers in cascade with optional DHW on "Low" temperature side of LVH.
The DHW calorifier is directly controlled by the master boiler via the sensor (FB) and loading pump (PS). The boilers are connected together by a cascade bus.

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