Installation Manual

for

mCHP Equipment

Valid for North American Series “C” Models:

Natural Gas: 336016

Propane Gas: 336017

AXIOM
ENERGY GROUP

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WARNING: The exhaust from the burning of fossil fuels in the engine in this product contains chemicals, such as soot, formaldyhyde, and carbon monoxide, known to the State of California, to cause cancer, birth defects or other reproductive harm.

WARNING: Components in this product and accessories contain chemicals, such as nickel (metallic), and ethylene glycol, known to the State of California to cause cancer, birth defects or other reproductive harm. Wash your hands after handling.

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Safety Guidelines

This manual provides Warnings and Cautions to alert readers of possible dangers or safety hazards associated with performing the installation, operation, or servicing of the microCHP.

The **WARNING** symbol identifies special instructions or procedures, which if not correctly followed could result in serious injury, or loss of life.

The **CAUTION** symbol identifies special instructions or procedures, which if not strictly observed, could result in personal injury, damage to, or destruction of equipment, or may be a violation of a law, ordinance, standard, or code requirement.

Read Section 1, Safety, prior to installing or operating the equipment. Observe all safety instructions for safe and reliable operation.

Forward

The microCHP has a unique engine as a prime mover, designed and developed by the Gas Research Institute (GRI) and Briggs & Stratton Corporation for extended duration operation on gaseous fuels.

To meet the continuous duty requirements and long service interval durations, the engine was designed with a number of high reliability features. These features are intended to reduce sliding friction and wear of moving engine and valve train components, which helps to improve the engine efficiency and reduce lubricating oil contamination. These features allow the engine to operate up to 4,000 hours before routine service is required.

This Installation Manual is provided to microCHP installers, to serve as a general guide for installation, as well as general technical specifications and information on the system unit. Refer to site specific drawings and specifications for your installation.

WARNING: Exhaust gases contain CARBON MONOXIDE which is an odorless, colorless, and deadly poison.

Install a carbon monoxide alarm according to the manufacturer's and UL/NFPA guidelines.

DO NOT place hands near moving or rotating parts (engine - flywheel coupling).

To prevent accidental starting when servicing the engine or equipment, always first turn off electrical power to the unit at the external circuit breaker / disconnect and lock out/tag out.

INTRODUCTION

This manual is divided into sections as follows. The sections are intended to be essentially independent as regards the activities described, although there may be references to other sections in the manual.

Section 1 **Important Safety Instructions**
Health and safety information.

Section 2 **Principle of Operation / Overview**
Information on

Section 3 **Technical Data**
Basic requirements for

Section 4 **Transportation / Storage**
Instructions for

Section 5 **Required Space - Physical Installation**
Instructions for

Section 6 **Tanks**
Instructions for

Section 7 **Hydraulic Connections**
Instructions for

Section 8 **Gas Supply**
Instructions on

Section 9 **Exhaust Gas Systems and Fresh Air Supply**
Technical information on

Section 10 **Electrical Integration**
Information on

Section 11 **Initial Operation**
Information on

Section 12 **Maintenance**
Information on troubleshooting minor operation problems.

Section 13 **Summary for Planner**
Repair instructions for module and parts replacement.

Section 14 **Spare Parts** Information on

Appendices **A** - Diagrams; **B** - Installation Layout Examples

The installation instructions in this Manual are based on good commercial practices and the requirements, recommendations, and guides of applicable US National Codes, Standards, and Equipment Listings. These Codes, Standards, and Equipment Listings include the National Fire Protection Association (NFPA), which include the National Electrical Code
(NEC), and Underwriters Laboratories Inc., (UL) Standards, as well as the Code of Federal Regulations (CFR). There may be other state and local codes, ordinances, restrictions, and safety requirements that may also apply to this type of equipment. Observe all state and local codes.

WARNING: Failure to follow the instructions and recommendations in this Manual or the restrictions and requirements of the Codes, Standards, or Equipment Listing Standards referenced in this Manual, or other Country, State, and local Codes, may result in Safety Hazards. These Safety Hazards could cause personal injury or death and could result in damage to the microCHP or components. Failure to follow the instructions or recommendations of this Manual may also void the Warranty on workmanship and materials.

CAUTION: It is the responsibility of the Installation Contractor to ensure that the microCHP equipment is installed in compliance with all Federal, State, and Local Codes and Ordinances.

TERMS AND CONVENTIONS

The microCHP is contained in a single unit with physical connections for fuel supply to engine and electrical power input/output. A heat exchanging water loop is also connected to the microCHP, as well as combustion air and exhaust gas connections.

The primary engineering units shown in this manual are the English system, with the primary units of pounds (lb) for unit mass or force, inches (in.) for unit length, and seconds (s) for unit time. The metric equivalent unit is shown in parentheses following the English quantity. The metric units are based on the International System of Units, abbreviated as SI. The primary metric units are kilogram (kg), for mass, meter (m), for unit length, and second (s), for unit time.

Note however that temperature units in the software displays are in metric. Temperatures are indicated in Celsius, with fahrenheit in parentheses in the manual.

ACRONYMS AND ABBREVIATIONS

A	Amperes
AC	Alternating Current
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
AWG	American Wire Gage
BTU	British Thermal Unit
°C	Degrees Celsius
CIR	Circular

CCA	Cold Cranking Amperes
CFR	Code of Federal Regulations
DB9	D Subminiature 9 pin Connector
DC	Direct Current
°F	Degrees Fahrenheit
cm	Centimeter
dB	Decibels
DC	Direct Current
H	Height
Hz	Hertz
in	Inches
kW	Kilowatts
LED	Light Emitting Diode
L	Length
lb-in	Pound-Inch Torque
LPG	Liquid Petroleum Gas
mCHP	microCHP
MPa	MegaPascal
m	Meters
mm	Millimeters
mV	MilliVolts
NEC	National Electrical Code
–	Negative
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
N•m	Newton-Meters
NPT	National Pipe Tapered
O_2	Oxygen
OD	Outside Diameter
PC	Personal Computer
+	Positive

ACRONYMS AND ABBREVIATIONS (Continued)

psi	Pounds Force per Square Inch
rpm	Revolutions per Minute
SAE	Society of Automotive Engineers
s	Second
SI	International System of Units (le Systeme International d’Unites)
SCF	Standard cubic feet
STP	Standard Temperature and Pressure
TBD	To Be Determined

UL	Underwriters Laboratory
U.S.	United States
USA	United States of America
VGA	Video Graphics Adapter
V	Volts
W	Watts or Width
w.c.i.	Water column inch

TRADEMARKS

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1 Important Safety Instructions

Read the instructions before planning and installing a microCHP (mCHP).

SAVE THESE INSTRUCTIONS - This manual contains important instructions for models 336016 (natural gas) and 336017 (propane gas) that shall be followed during installation and maintenance of the microCHP.

Signs, Symbols, and Installation Notes


Alternating Current


Protective Earth Ground


Electrical/Shock Hazard


Safety Instruction


Information for the plumber/pipe fitter


General Information

1.1 Installation Notes

Ambient (Electronics Cabinet) Temperature Range: 32 – 104 °F (0 – 40 °C) Input

power wiring: Use No. 10 AWG, 194 °F (90 °C) copper wire.

The installer is responsible for installing the branch circuit protection. Install a 30 amp, 2-pole breaker on the building side of the provided distribution (isolation) transformer.

The overall installation shall comply with standards ANSI/NFPA 37: Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; ANSI/NFPA 70: National Electrical Code and any applicable local codes. For installations in Canada the installation shall comply with CSA C22.2, No. 0, Canadian National Electrical Code.

U.S.A. Safety Code References (current edition):

NFPA 30, Flammable and Combustible Liquids Code for information regarding fuel tanks and piping on installation site.

NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines regarding mounting, fuel tanks, and lines on installation site.

NFPA 54 (ANSI Z223.1), National Fuel Gas Code, regarding piping and control equipment and installation of fuel burning equipment.

NFPA 58, Liquefied Petroleum Gas Code regarding LP gas equipment, appliances, and engine fuel systems.

NFPA 59/59A, Standard for the Storage and Handling of Liquid Petroleum Gases at Utility Gas Plants regarding LP Handling.

NFPA 70, National Electrical Code, regarding electrical equipment design and installation.

Observe all local building codes. This unit or system is provided with fixed trip limits and must not be aggregated above 30 kW on a single point of common connection. Only licensed electricians and plumbers shall perform the microCHP installation.

Only use flexible water pipe connections to reduce noise and prevent damage from vibration.

A manual gas supply shut-off valve must be installed between the microCHP and the main gas supply, in a location that is easily accessible to emergency personnel.

Within this manual all references made to “propane” refer to “propane gas” and not to “liquefied propane.”

Use the flexible gas supply hose that is provided with the microCHP.

Use only flexible electrical conduit to reduce noise and prevent damage from vibration.

The electrical, water, and gas supply connections must be free of stress in order to prevent damage due to transmitted vibration.

The distribution transformer that is provided with the microCHP must be installed between the microCHP and the main disconnect device.

Install a 30 amp two-pole breaker as the main disconnect device. Install the disconnect device on the building side of the distribution transformer as near to the microCHP as permissible.

A separate earth ground conductor must be installed between the building’s earth ground and the microCHP.

WARNING: A proper ground connection is essential for safety.

The input power and ground connections must be connected to the terminal block and ground terminal connector located inside the power section in the back portion of the microCHP cabinet.

The electrical wiring for the water circulation pump, temperature sensors, and the 3-way valve actuator (240 VAC service) must be conduit-connected in the power section at the rear of the microCHP cabinet. The wires must then be fed through and terminated at the appropriate Pro-E terminal block connection under the back cover. Special attention should be given to the temperature sensor wires to be sure that they are shielded for a minimum of six feet (1.83 m) from the back of the microCHP. This ensures that the sensor wires will not act as antennas in the presence of strong EMI fields.

The microCHP neutral and earth ground circuits are bonded together by the factory to meet UL safety requirements. This connection must not be altered.

1.2 Safety instructions microCHP

WARNING: **The exhaust from the burning of fossil fuels in the engine in this product contains chemicals, such as soot, formaldyhyde, and carbon monoxide, known to the State of California, to cause cancer, birth defects or other reproductive harm.**

WARNING: **Components in this product and accessories contain chemicals, such as nickel (metallic), and ethylene glycol, known to the State of California to cause cancer, birth defects or other reproductive harm. Wash your hands after handling.**

1.2.1 Assembly and adjustment

Only trained specialists shall perform assembly, adjustment, and maintenance of the microCHP.

1.2.2 Gas odor

WARNING: In case of gas odor, the following safety instructions shall be followed:

Evacuate the building.

Do not touch or activate any electrical switches in the hazard area.

Do not smoke in the hazard area.

Do not use any telephones or cell phones in the hazard area.

Shut (close) the gas shutoff valve.

Ventilate the jeopardized area.

Notify your gas utility via their emergency contact method.

1.2.3 Modifications of the microCHP

The following fixtures and fittings must not be modified:

microCHP and fittings,

Pipes for gas, supply air, water, and power,

Exhaust gas pipe,

Drain pipe and the safety valve for the heating circuit water,

Structural conditions, which may have an influence on the operational safety of the unit.

1.2.4 Installation

The fresh, outdoor combustion air, which is ducted to the unit, must be free of chemical substances containing corrosives, e.g., fluorine, chlorine or sulphur. Sprays, solvents or detergents, colors, and adhesives may contain such substances, which will result in corrosion even in the exhaust gas system when operating the unit.

In homes or commercial buildings, a separate room should be used for installation, even though the unit is operating independent of room ambient air. Ensure the outdoor combustion air supply remains free of all chemical substances and that the fuel supply, exhaust, and condensate systems are properly installed. Maintain the installation room at average room temperature. An overly hot installation room will cause performance problems and degrade the electronics.

The fuel supply line must be purged prior to operation.

A large clearance between the unit and installation components made of non-inflammable materials is not required (minimum clearance to the microCHP wall is 24 in. (61 cm)), but is highly recommended. Servicing and maintenance logistics will be much easier with at least a 30 inch (76.2 cm) clearance. A clearance of 36 inches (91.4 cm) on either side is required for maintenance access. There is, at nominal heat output of the microCHP, no higher than the permissible temperature of 185 °F (85 °C). However, the minimum clearances quoted for installation and maintenance must be observed.

Before installing the microCHP, obtain an evaluation of the gas supplier, and permission of the electrical utility company, per state utility commission approved procedures.

The microCHP must be installed by trained specialists who have been trained by Axiom Energy Group. They also take the responsibility for proper installation and initial operation. Flush the heating system thoroughly before connecting the unit. By doing so, you remove residues such as welding beads, tinder, hemp, putty, rust, crude dirt, and the like from the pipe work. Otherwise these substances may remain in the unit and cause malfunctions. The dirt separator must be cleansed and cauterized before flushing.

Ensure stress-free assembly of the connecting pipelines and gas pipes. Use the supplied gas safety hose and the specified microCHP return control group with the corresponding hose set (standard accessories) to connect to the heating system, so no leakage in the heating system or at the gas connection will occur. Install two tank fill/drain manual shutoff valves for easy maintenance and cleaning of the microCHP plate heat exchanger.

When tightening or loosening screw fittings, always use matching open-ended wrenches (no gas pipe pliers, extensions, etc.). The specified torques must be complied with. Improper use and/or inappropriate tools can cause damage (e.g., gas or water leakage). For closed heating systems a type-approved safety valve corresponding to the heat output must be installed.

WARNING: The gas control multiblock maximum input pressure is .94 psi (65 mbar). Maximum output pressure from the gas control multiblock is 6 in. w.c. / .22 psi (15 mbar).

Only qualified specialists who also have been trained by Axiom Enegy Group must perform the electrical installation.

WARNING: There is mortal danger due to electric shock at live parts! Line voltage is present in the circuits of the microCHP even if the engine switch is switched off. Before working on the microCHP, remove power at the external circuit breaker / disconnect and lock it out.

WARNING: Capacitors store hazardous energy. For servicing, do not remove cover until 5 minutes after disconnecting all sources of electricity.

WARNING: Exhaust gases contain CARBON MONOXIDE which is an odorless, colorless, and deadly poison.

Install a carbon monoxide alarm according to the manufacturer's and UL/ NFPA guidelines.

WARNING: Electrical hazard exists. Before gaining access to the inside of the microCHP all supply circuits of the unit must be switched off via the external circuit breaker / disconnect and locked out.

For installation of the air / flue gas evacuation, the supplied accessories must be used exclusively.

1.2.5 Important information for propane units

Deaerate the liquid gas tank during the first installation of the unit: before installing the unit make sure that the gas tank is deaerated. The supplier of the liquid gas is generally responsible for the proper deaeration of the tank. If the tank is improperly deaerated, ignition problems may occur. In this case, please first contact the person who has filled the tank.

Installation below ground level: When installing in rooms below ground level the requirements of the local safety codes and regulations (technical regulations for liquid gas) shall be followed. The deployment of an external magnetic valve is not required.

1.2.6 Startup

CAUTION: Use only 50/50% coolant DOWTHERM SR-1 / water mixture. Do not enrich the heating circuit water with more coolant or anticorrosives. Use of high percentages of coolant or anticorrosives may cause changes to the seals and also lead to noises when heating. It will also reduce efficiency of the system. For these cases, (as well as for potential consequential damage) Axiom Energy Group cannot assume liability. Please inform the user about the restrictions regarding coolant.

WARNING: If the microCHP is operated with an empty condensation water drain trap, there is risk of intoxication by escaping exhaust gas. Make sure the drain trap is filled with water before operating.

CAUTION:

For natural gas: The maximum input gas pressure is .94 psi (65 mbar) at the multiblock. If the pressure is higher than .94 psi, do not make any adjustments to the gas train and do not operate the microCHP.

CAUTION:

For propane gas: The propane models are supplied with a pre-regulator with a maximum input gas pressure of 2 psi (140 mbar) for propane gas. If the supply pressure is higher than the rated pressure, do not install or make any adjustments to the gas train and do not operate the microCHP.

Use only distilled water in the cooling circuits.

1.2.7 Inspection and maintenance

Only recognized specialists trained by Axiom Energy Group may perform inspection, maintenance, and repair work. There are no user serviceable parts.

WARNING: Omitted inspections / maintenance work may lead to personal injury and property damage and may void your warranty.

WARNING: Mortal danger due to electric shock at live parts! Before working on the microCHP, switch off at the external circuit breaker / disconnect and lock out against switching on again.

Protect the electric circuits from liquids.

WARNING: Capacitors store hazardous energy. For servicing, do not remove cover until 5 minutes after disconnecting all sources of electricity.

WARNING: Explosion hazard due to gas leakage! Only qualified specialists who have been trained by Axiom Energy Group must exchange the internal gas safety hose.

After maintenance perform a leakage test.

WARNING:

At all water-bearing components there is risk of injury and scald. Do not work on components until they have cooled down.

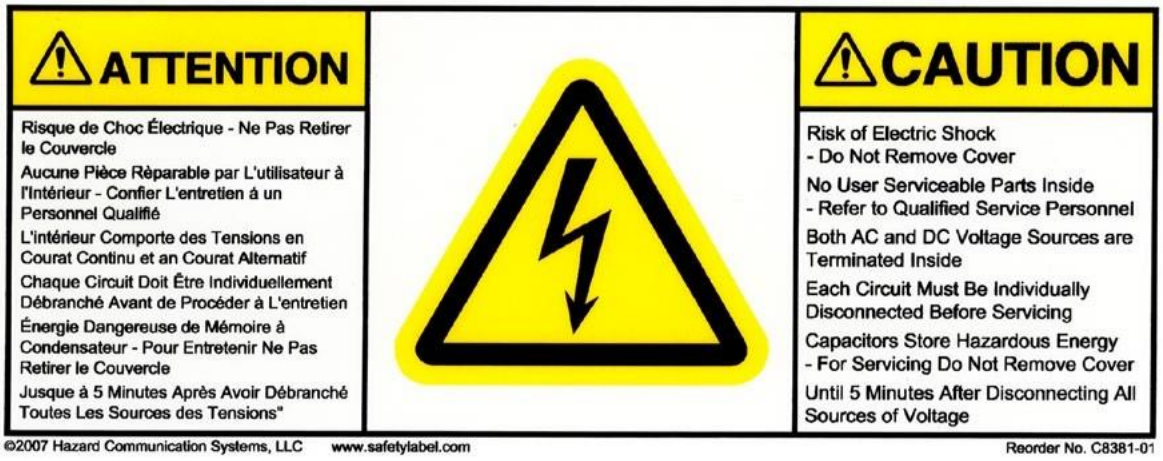


Figure 1.1 Equipment Caution Label, Electrical Hazard

Figure 1.2 Warning Label, Electrical Hazard for Rear Cover Removal

Figure 1.3 Warning Label for the Engine ON / OFF Switch (Electrical Connection in the microCHP even when the Engine Switch is in OFF position)

WARNING: If the microCHP is operated with an empty condensation water drain trap, there is risk of intoxication by escaping exhaust gas. Make sure the drain trap is filled with water before operating.

1.2.8 Troubleshooting:

Disconnect the microCHP and any optionally installed peak load tank / backup heater unit from the grid power supply before starting work. Close the gas valve and the maintenance valves. Drain the microCHP if you want to replace water-bearing components of the microCHP.

WARNING: There is mortal danger due to electric shock at live parts! Line voltage is present in the circuits of the microCHP even if the engine switch is in the off position. Before working at/on the microCHP, remove power at the external circuit breaker / disconnect and lock it out.

WARNING: Capacitors store hazardous energy. For servicing, do not remove cover until 5 minutes after disconnecting all sources of voltage.

Use new seals and O-rings only. Perform an operational test after finishing work and completely fill in the service or maintenance report. Observe all safety instructions.

2 Principle of Operation / Overview

2.1 Brief Description of Combined Heat and Power (CHP) Generation Principle

The microCHP contains a generator driven by an internal combustion engine. The system generates heat energy and electrical power. These units are called combined heat and power (CHP) systems. With the microCHP (mCHP) utilizing a gaseous-fuel engine, approximately 65% of the input energy is converted to heat energy and approximately 25% is converted to electrical energy. Figure 2.1 shows the principle of a microCHP and the energy flow.

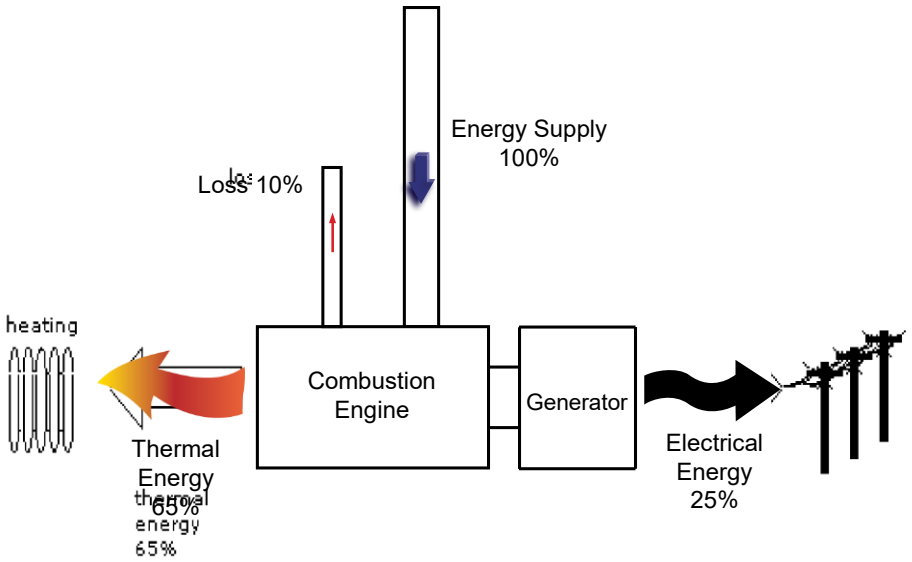


Figure 2.1 Conceptual Drawing of the microCHP Energy Efficiency

2.2 General

The microCHP is a product of Axiom Energy Group. In comparison with the conventional combined heat and power units, it has the advantage of modulating the output, i.e., variation of power output by adjusting the engine speed. The microCHP is a compact heating system ready for installation, which produces electrical energy at the same time.

The microCHP now makes it possible to utilize the principle of combined heat and power in single-family homes, apartment buildings, and commercial businesses, and contributes to the proliferation of this efficient energy use. By comparison, grid-supplied electrical power is on average less than 40% energy efficient, with the remainder of the power lost / wasted as heat into the atmosphere.

Figure 2.2: Front Diagonal View of the microCHP Cabinet

2.3 Views of the open microCHP

The owner must not open the side panels or the front cover. Before removing the side doors for servicing by service personnel, disconnect the microCHP from the public power supply (at the external circuit breaker / disconnect).

WARNING: There is mortal danger due to electric shock at live parts! Line voltage is present in the circuits of the microCHP even if the engine switch is in the off position. Before working at/on the microCHP, remove power at the external circuit breaker / disconnect and lock out/tag out.

WARNING: Capacitors store hazardous energy. For servicing, do not remove cover until at least 5 minutes after disconnecting all sources of voltage.

WARNING The equipment inside the microCHP side doors may have live wires or be hot to the touch. Beware of electrical and burn hazards!

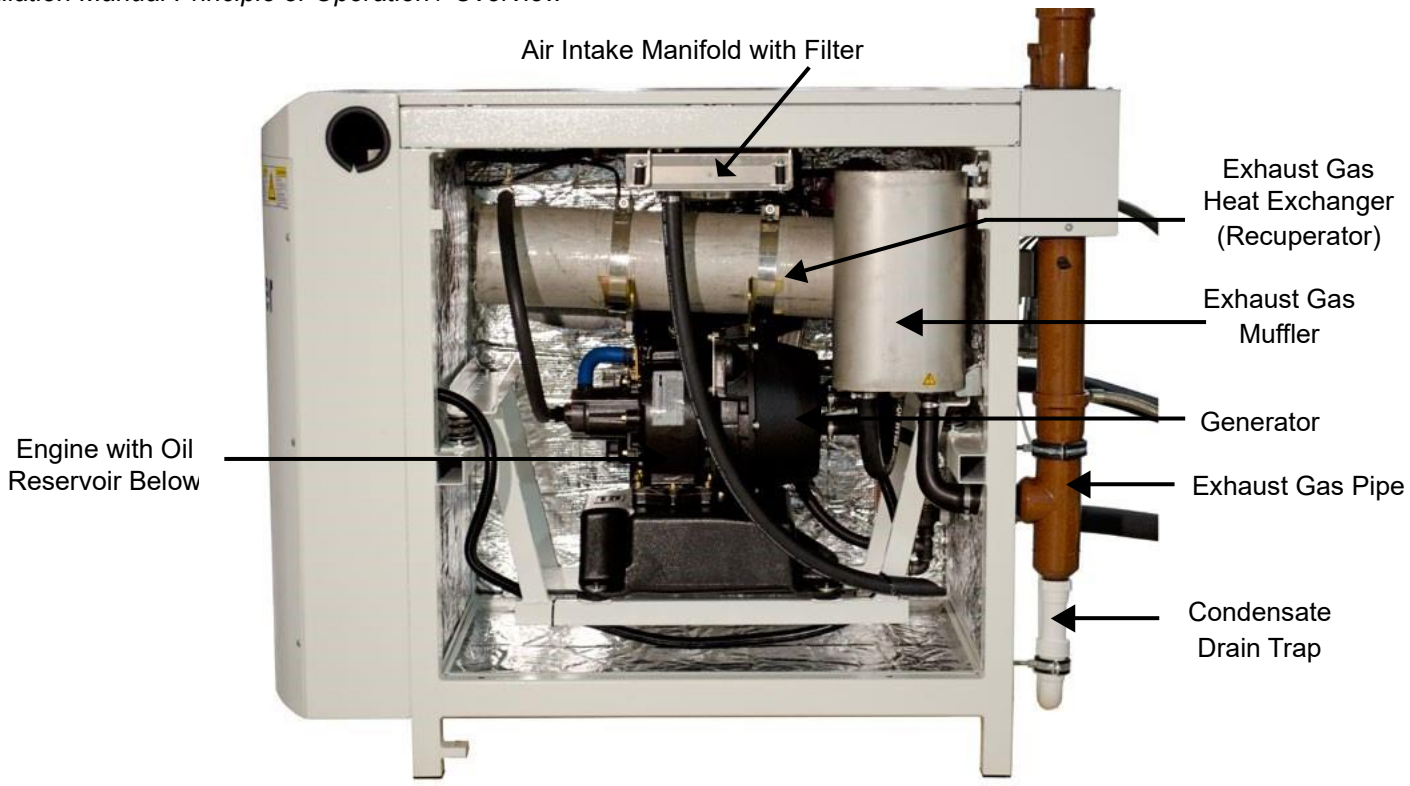
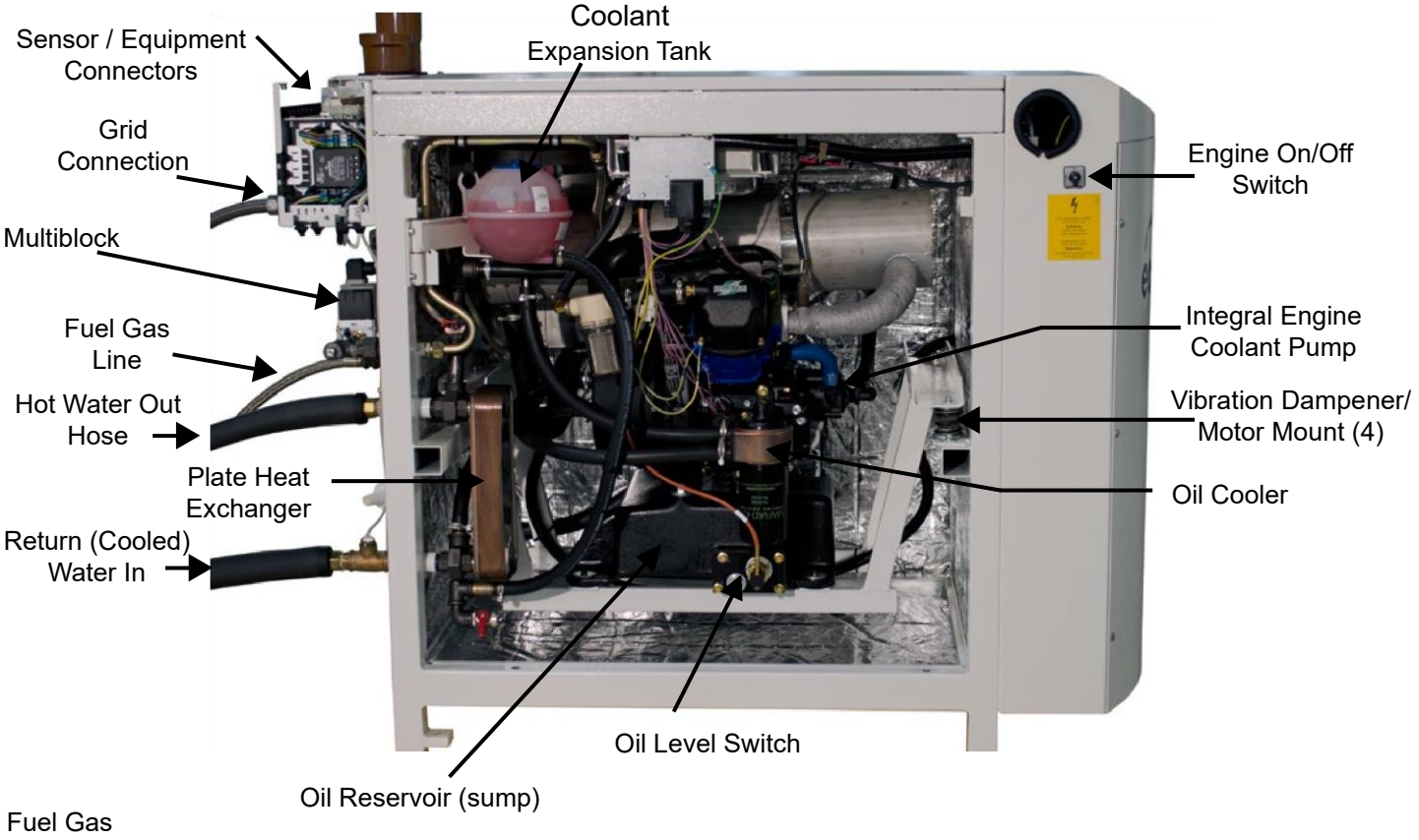


Figure 2.3: Side View 1 of the microCHP



Fuel Gas

Figure 2.4: Side View 2 of the microCHP

2.4 Range of Applications

The microCHP can be installed in a wide range of applications including, but not limited to, AC Coupling and Residential and Commercial Water Heating Below 75,000 BTUS with a case by case field label when required. It is appropriate for operation in single-family homes, multifamily residences, small industrial / commercial buildings, pubs, restaurants, and hotels, to name a few.

Because the microCHP engine runs modulating, i.e., with variable speed and output performance, the unit can be operated in a stand-alone mode, without additional centralheating boilers. But it is recommended in all instances that the microCHP be installed in combination with a complementary heating boiler. The modulating control of the backup heater by microCHP control is particularly economical. The microCHP is typically installed with an insulated buffer tank to store heat for later use.

The electrical output can reduce the consumption of utility-supplied electrical energy fully and/or during costly utility-specified peak power periods. The choice for this strategy is the operational mode “current/electricity led,” in which the operator determines the microCHP electrical output requirements and schedule. In the design and planning phase it should, however, always be observed that the optimum return line water temperature is <140 °F (60 °C). The various operational modes and function of the controls are explained in detail in the operating manual. Typically the unit runs in “heat” mode because priority is given to the production, storage, and use/dissipation of heat. Domestic hot water preparation by the microCHP is possible.

2.4.1 Single Family Homes and Apartment Buildings

The microCHP can be used in single-family homes and apartment buildings. The heating output is typically combined with a backup boiler and in such a configuration is sufficient for many homes, depending on the climate, building construction and other factors. Ask an expert (energy consultant, architect) for energy verification to ensure that the microCHP can meet the required heating output or portion assigned to it. Typically the microCHP should be undersized and installed with a backup boiler to maximize microCHP run time and electrical output, and for backup. For larger heat loads (exceeding 12.5 kW) thermal load, an additional heat supplier (e.g. a second or third microCHP connected in parallel or complementary boiler) must be installed. The manufacturer recommends this installation together with the option peak load tank activation. (This option cannot be used for units with higher-level control and peak load tanks >150 kW (guideline value).) The microCHP contains a heating control program. This supports common temperature and low temperature heating systems. As an option, a second independent heating circuit can be controlled.

2.4.2 Small Business and Other Buildings

The microCHP, together with a peak load tank / backup heater, is suitable for use in small businesses such as pubs and restaurants, hotels, fitness centers, car washes, laundromats, and retail shops. Public facilities such as administrative departments, swimming pools, and schools are also candidates for installation of one or several microCHPs. In small businesses, the microCHP is capable of delivering electric and thermal base loads. In service areas with high fees for peak load, it can be deployed and programmed to shave peak power period usage.

2.5 Installation Standards and Building Codes

U.S.A. Safety Code References (current edition):

The overall installation shall comply with standards ANSI/NFPA standards:

NFPA 30, Flammable and Combustible Liquids Code for information regarding fuel tanks and piping on installation site.

ANSI/NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines regarding mounting, fuel tanks, and lines on installation site.

NFPA 54 (ANSI Z223.1), National Fuel Gas Code, regarding piping and control equipment and installation of fuel burning equipment.

NFPA 58, Liquefied Petroleum Gas Code regarding LP gas equipment, appliances, and engine fuel systems.

NFPA 59, Standard for the Storage and Handling of Liquid Petroleum Gases at Utility Gas Plants regarding LP Handling.

ANSI/NFPA 70, National Electrical Code, regarding electrical equipment design and installation.

Observe all applicable state and local building codes.

Canada

For installations in Canada the installation shall comply with CSA C22.2, No. 0, Canadian National Electrical Code, CAN/CSA B149.1, Natural Gas and Propane Installation Code, and any applicable local codes.

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3 Technical Data

3.1 microCHP

Table 3.1 Technical Data

operational modes	heat feed priority / current feed priority
fuel	natural gas minimum methane number: 59 1.2 - 4.4 kW propane gas: propane minimum octane number: MOZ 92 (EN 589) 1.2 – 4.4 kW
electrical power, modulating[1]	(natural gas) 1.2 - 4.4 kW (propane gas) 1.2 – 4.4 kW
thermal output, modulating[1, 2]	(natural gas) 4.0 - 12.5 kW (propane gas) 4.5 – 13.8 kW
total input power	5.9 – 19.0 kW (natural gas) 6.5 - 20.0 kW (propane gas)
fuel consumption	Natural Gas: .21 - .65 therms/hr. LPG (propane gas): 0.26 - 0.78 gal./hr.
overall efficiency	~ 90%
exhaust gas emissions	On-site settings: <250 ppm CO, <30 ppm NOx
noise pressure level	approx. 55 dB (A), in 3.3 ft. distance (1 m)

[1] depending on gas quality and air pressure, see Table 3.2

[2] the ratio of thermal output to electric power is almost constant over the entire range of performance

Note: Certified third party test results tested in accordance with laboratory testing protocols. System performance can be affected by atmospheric conditions and energy content of fuel.

Table 3.2 System Performance vs Altitude

Altitude	Electrical Power	Thermal Output	Air Pressure	Temperature[1]
0 ft. (0 m)	4.4 kW	12.5 kW	1,013 mbar	68 °F (20 °C)
1,640 ft. (500 m)	Consult Factory	Consult Factory	955 mbar	68 °F (20 °C)
3,280 ft. (1,000 m)			899 mbar	68 °F (20 °C)
	Consult Factory	Consult Factory		

[1] ambient air

4,921 ft. (1,500 m)			846 mbar	68 °F (20 °C)
	Consult Factory	Consult Factory		
6,560 ft. (2,000 m)			794 mbar	68 °F (20 °C)
	Consult Factory	Consult Factory		

3.2 Gaseous Fuel Engine

Table 3.3 Engine Data

engine	water-cooled, single cylinder, four stroke piston gas combustion engine, designed for long running time; displacement 16.6 in.^{3} (272 cm^3)
speed range	1,200 – 3,600 RPM (factory max. setting: 3,400 RPM)
coolant temperature:	operation: 167 – 176 °F (75 – 80 °C) short-term: 194 °F (90 °C)
maintenance interval	every 4,000 hrs. or at least once a year
maintenance coverage (typical, varies over life of the engine)	oil change, oil and air filter replacement, spark plug, ignition cable, engine check over the entire speed range, adjustment of exhaust gas values; visual inspection of every component, cleaning of cabinet interior
engine electronics	control of the gas – air ratio (λ = 1 – control) and monitoring the engine operation, accomplished by microcontroller

3.3 Generator and Inverter

Table 3.4 Generator and Inverter Data

generator	brushless, permanent magnet generator directly flanged to the engine, with water cooling system
inverter	three-phase inverter with integrated safety monitoring, microcontroller control (single phase output for North America)

3.4 Control

Table 3.5 Control Data

microCHP control	Heating control, buffer tank temperature control and safety monitoring, controlled by microcontrollers.

recording operating data:	Hours of operation, number of starts data recording (storage, heating, engine, production record for 7 days).
heating control	Outdoor temperature normal, outdoor temperature with night deactivation, room temperature and outdoor temperature with night deactivation, or constant supply; heating program per day of the week (capable of half hour increment adjustments) with 3 temperature levels (day, night, convenience). Automatic changeover winter / summer mode.
tank supply / power supply	Hot water preparation for the heating circuits and the buffer tank with automatic changeover from high and medium production to low production in summer mode. Heat fed: performance control based on the current heat requirement and the production program. Current fed: performance control based on the electrical power requirement (based on the speed profile with the option of prioritizing heat load; heating or hot water preparation).
User Interface	Program display on LCD. Displays the current state, heating and storage parameter settings, heating and production programs, selection of the operating mode, display of temperatures, performances, production data, and error messages.
I/O	RS-232 Diagnostic/Setup Interface (RS-232 - USB converter null modem cable supplied.) RS-485 (Parallel operation)
options	First, Second heating circuit activation Peak load tank on / off activation Heating device 7,8,9 - Circuit 1/Circuit 2 activation according to standard hot water circulating pump activation (custom complementary boiler) (Standard activated) circulating pump/discharge pump activation Remote Monitoring via internet PC-PC (1 PC with ecoServ software locally connected to microCHP). Remote monitoring via telephone network with modem. Parallel operation with multiple microCHP

3.5 Safety

Table 3.6 Safety Data

safety	The three microcontrollers (inverter, system control, and engine control) in the microCHP monitor operating conditions and each other.
monitoring functions microCHP	Temperature sensor (interrupt; short-circuit) engine oil pressure, engine speed, electronic oil level monitoring, temperatures (engine compartment, exhaust gas, coolant) exhaust gas backpressure, low gas supply pressure.
monitoring functions grid supply	Surge, low voltage, frequency phase currents, power phase failure / power failure power factor cos φ.

3.6 Assembly of the microCHP

Table 3.7 microCHP Assembly

installation location	Central heating room, according to local codes.
weight microCHP	approx. 860 lb. (390 kg)
medium floor loading microCHP	691 lb./yard^2 (375 kg/m²)
microCHP – dimensions	60 x 30 x 42.7 in. (1370 x 762 x 1085 mm)
required space	Approx. 76 ft^2 (7.1 m²) Mechanical rooms typically larger. Note: Allow space for maintenance activities.
connections	Supply and return of the heating water supply. Gas supply. Supply combustion air. Exhaust gas pipe with condensate drain. Electrical grid connection. Temperature sensors, control signals, pumps, mixers, valves, complementary boiler.

3.7 Electrical Data

Table 3.8 Electrical Data

voltage / frequency / power factor	230V nominal / 60 Hz / 0.98 – 1.00 power factor. The microCHP adapts to the grid phase sequence.
phase sequence	Corresponds to the grid phase sequence phasing.

3.8 Gas Supply

Table 3.9 Gas Supply Data

maximum gas multiblock inlet pressure	26.1 in. w.c. / .94 psi (65 mbar)
maximum gas multiblock outlet pressure	6 in. w.c. / .22 psi (15 mbar)
maximum inlet gas pressure PG to Regulator / Reducer	Propane: 2.0 psi (140 mbar)

3.9 Heating System

Table 3.10 Heating System Data

heating return temperature	Min. 95 °F (35 °C), max. 140 °F (60 °C)
heating supply temperature max.	167 °F (75 °C)
pressure drop at the plate heat exchanger	1.0 psi (0.07 bar) at a flow rate of 211 gal/Hour (800 L/h)
temperature sensor	Standard NTC sensor Outdoor, room, supply, return, and storage temperature, depending on the operating mode
hot water	Adjustable: 41 – 158 °F (5 - 70 °C) (the factory setting of 140 °F (60 °C) is recommended)

3.10 Exhaust / Air Supply

Table 3.11 Exhaust / Air Supply Data

exhaust gas temperature	Operation: < 194 °F (90 °C); maximum: 248 °F (120 °C); [general approval by site supervision] up to 320 °F (160 °C)
exhaust gas pipe	Exhaust gas pipe per NFPA 54 (ANSI Z223.1) and local code Max. length: 65 ft. (19.8 m) with maximum of six 90 degree bends Inner diameter: 2.76 in. (70 mm) (outer diam. 2.95 in. (75 mm)) Total drag 0.2 wci (0.5 mbar) Maximum high pressure (back pressure) 1.2 w.c.i. (3.0 mbar) with wind impact
condensate drain	Drained via drain trap into the sewage water system maximum 0.5 gal/hour (2 L/h). Connection diameter: 1.57 in. (40 mm) Pipe connection diameter Minimum.: 1.18 in. (30 mm) The unit's drain trap for the condensate drain must be assembled, installed on site and filled with water (see Figure 7.1).
combustion air	Depending on regulations, from outside of the installation location, fresh air from outside, pipe maximum length: 65 ft. (19.8 m) with maximum of six 90 degree bends min. inner diam. 2.76 in. (70 mm) (outer diam. 2.95 in. (75 mm))

Note: Specifications are subject to change without notice.

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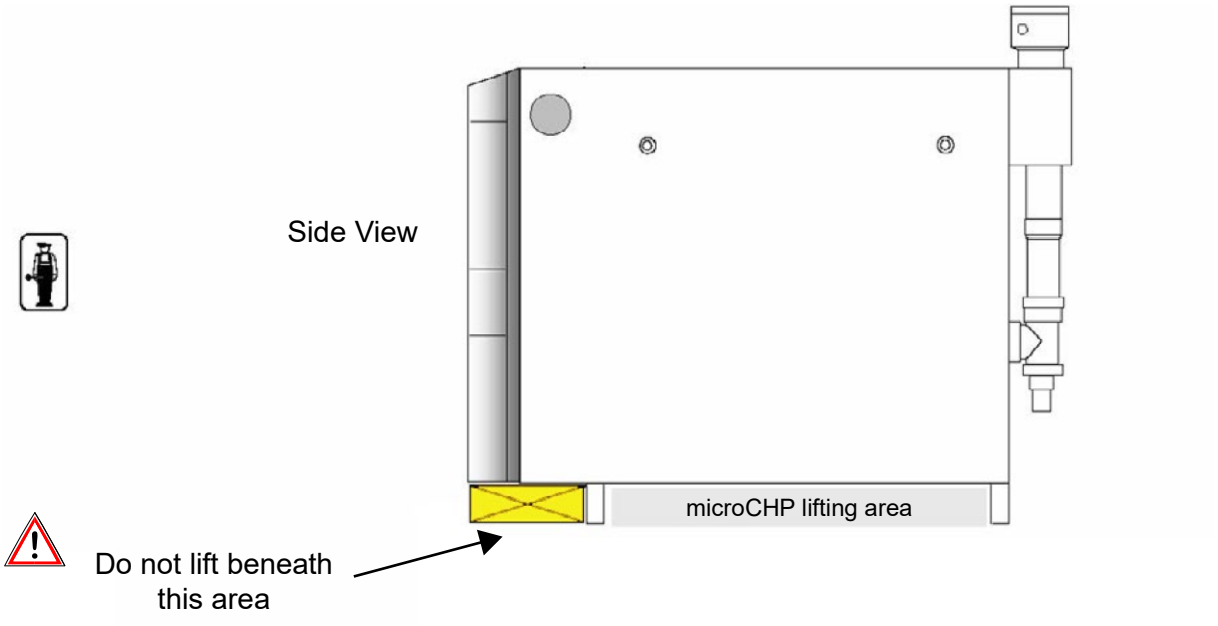
4 Transportation / Storage

4.1 Transportation

For transport of the microCHP (mCHP), a lift truck or pallet hand truck is recommended. The four base pedestals are arranged on the bottom of the housing (lifting area space between them is 34 in. (865 mm) by 22.4 in. (570 mm)). The microCHP may only be lifted in the area as shown in Figure 4.1, otherwise it may be damaged. In the depicted area a suitable lift truck can be attached at any place on the case frame. The entire unit weighs 860 lb. (390 kg). Adequate personnel must be available.

CAUTION: Do not under any circumstances lift the microCHP at the gas control path components, as it may be damaged.



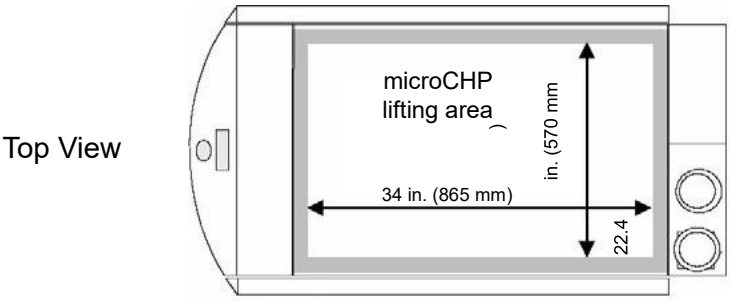


Figure 4.1 Lifting Area

4.2 Storage

The engine storage procedure should be followed if the engine is to be out of service for a period of more than one month.

WARNING: Electrical hazard exists. Before gaining access to the inside of the microCHP all supply circuits of the unit must be switched off via the external circuit breaker / disconnect and locked out.

WARNING: The microCHP capacitors store hazardous energy. For servicing, do not remove covers until 5 minutes after disconnecting all sources of electricity.

CAUTION: Damage to the engine can result from improper storage. Damage to the engine as a result of improper storage is not covered under the Axiom Energy Group warranty.

1. Wipe the external surfaces of the engine clean of any accumulated dirt and contamination.
2. Spray the metal surfaces (especially those that are unpainted) of the engine (not the generator) with an all-purpose thin film lubricant.
3. Coat electrical connections with an anti-corrosion spray / gel that is safe for electrical contacts.
4. Remove the spark plug. Spray ~ ½ – 1 oz. of engine storage fogging oil directly into the cylinder. Crank / turn the engine over to evenly distribute the oil onto the cylinder walls. Reinstall the spark plug.
5. If the engine oil in the sump is old / used, drain and refill with fresh engine oil. Used engine oil contains contaminants (acids, moisture, etc.) that could damage engine components over time. Dispose of the used engine oil according to local codes and regulations.
6. Crank / turn the engine over once per month to ensure the engine / piston rings freely rotate.

5 Required Space

5.1 Dimensions of the microCHP

The following Figure 5.1 shows three views of the microCHP.

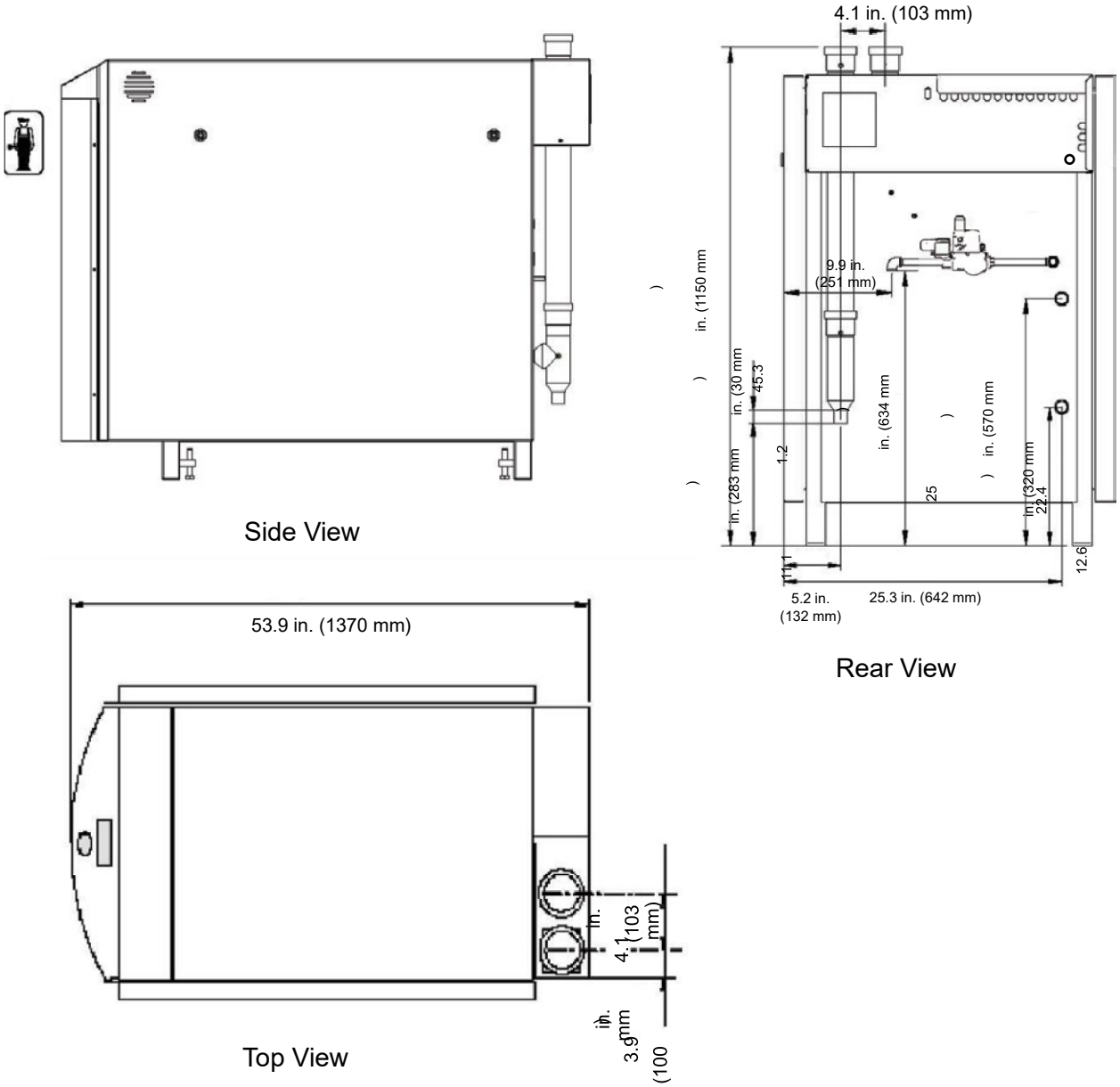


Figure 5.1 Dimensions of microCHP

5.2 Required Space of a microCHP

The minimum required space for the installation of a microCHP (Figure 5.2) is approx. 76 ft² (7.1 m²). Typically, mechanical rooms are much larger, with other equipment installed (such as buffer tank, boiler, and hot water tank). The unit must be easily accessible all around in order to provide service access. A minimum clearance of 24 in. (61 cm) is needed behind the microCHP for all connections. Allow additional space (30 in. (76.2

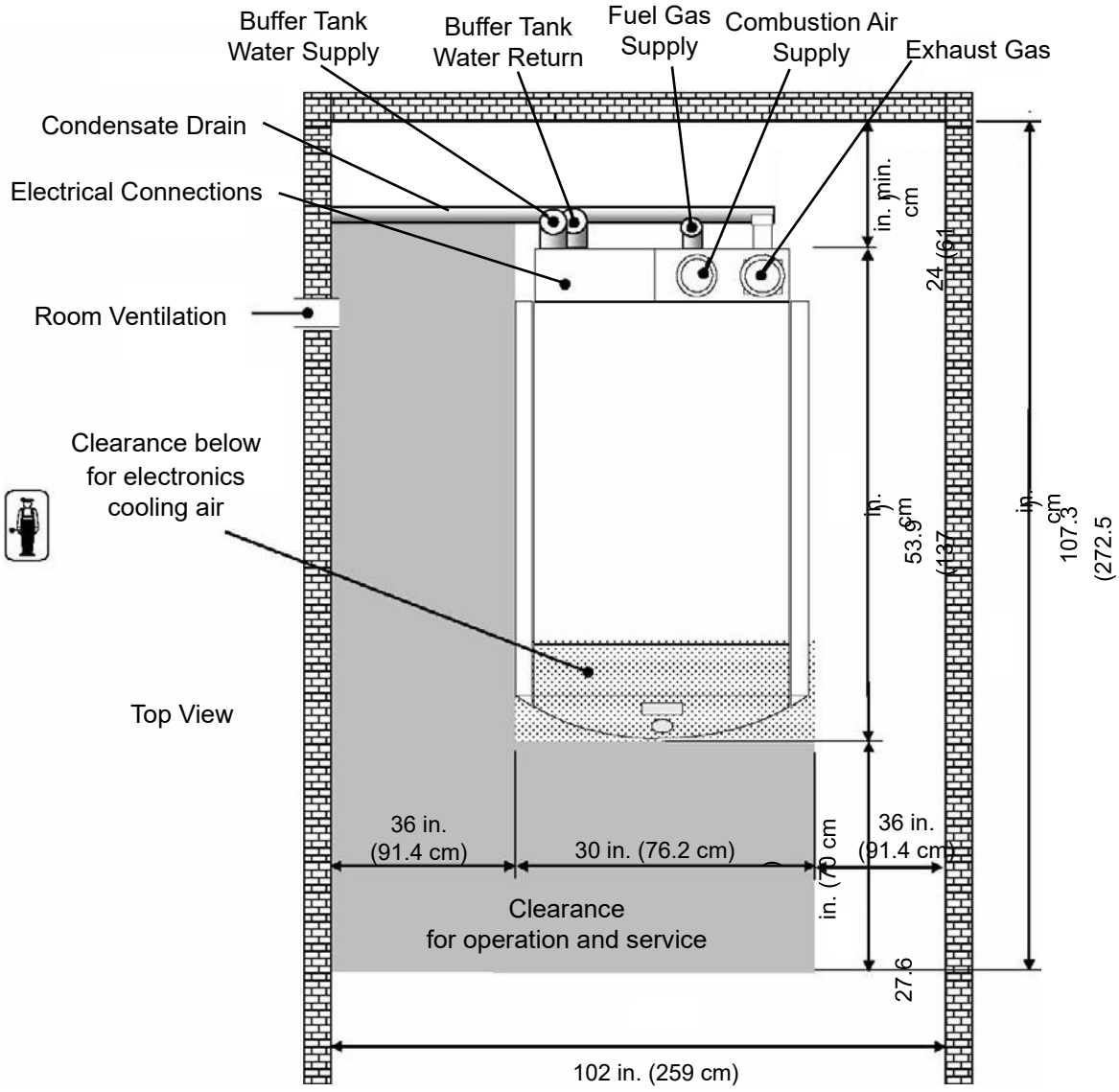


Figure 5.2 microCHP Setup: Enclosure Clearances (Top View) cm)) for maintenance convenience. A clearance of 36 inches (91.4 cm) on either side is required for maintenance access.

Below the electronics compartment, at the cabinet front, adequate clearance is needed to provide cooling air for the power electronics with the internal air intake fans. Do not place anything beneath the microCHP.

5.3 Requirements for the Installation Room

Set up the microCHP on an even floor, otherwise the unit may shift due to vibrations. For impact sound decoupling we recommend placing the microCHP on a base plate, capable of supporting at least 882 lb. (400 kg), which is separated from the other building materials. Additionally place the supplied vibration dampening pads under the base pedestals.

WARNING **Secure the unit against shifting or moving!**

The required air renewal must be guaranteed in the installation room:

Natural gas: If the microCHP is a natural gas installation, the installation room must be positively ventilated (directly from outdoors) with at least a 24 in.^{2} (150 cm^2) cross-section, high lying fresh air vent, which cannot be closed;

Propane gas: The propane gas microCHP must be installed above surface, otherwise special safety precautions become necessary (artificial ventilation, gas detector); one upper and one lower vent (min. 30 in.^{2} (190 cm^2) cross-section each) shall be provided.

NOTE: The combustion air suction duct from outside does not count as room ventilation.

5.4 Interfaces

In the following figure the various connections to the microCHP are depicted schematically.

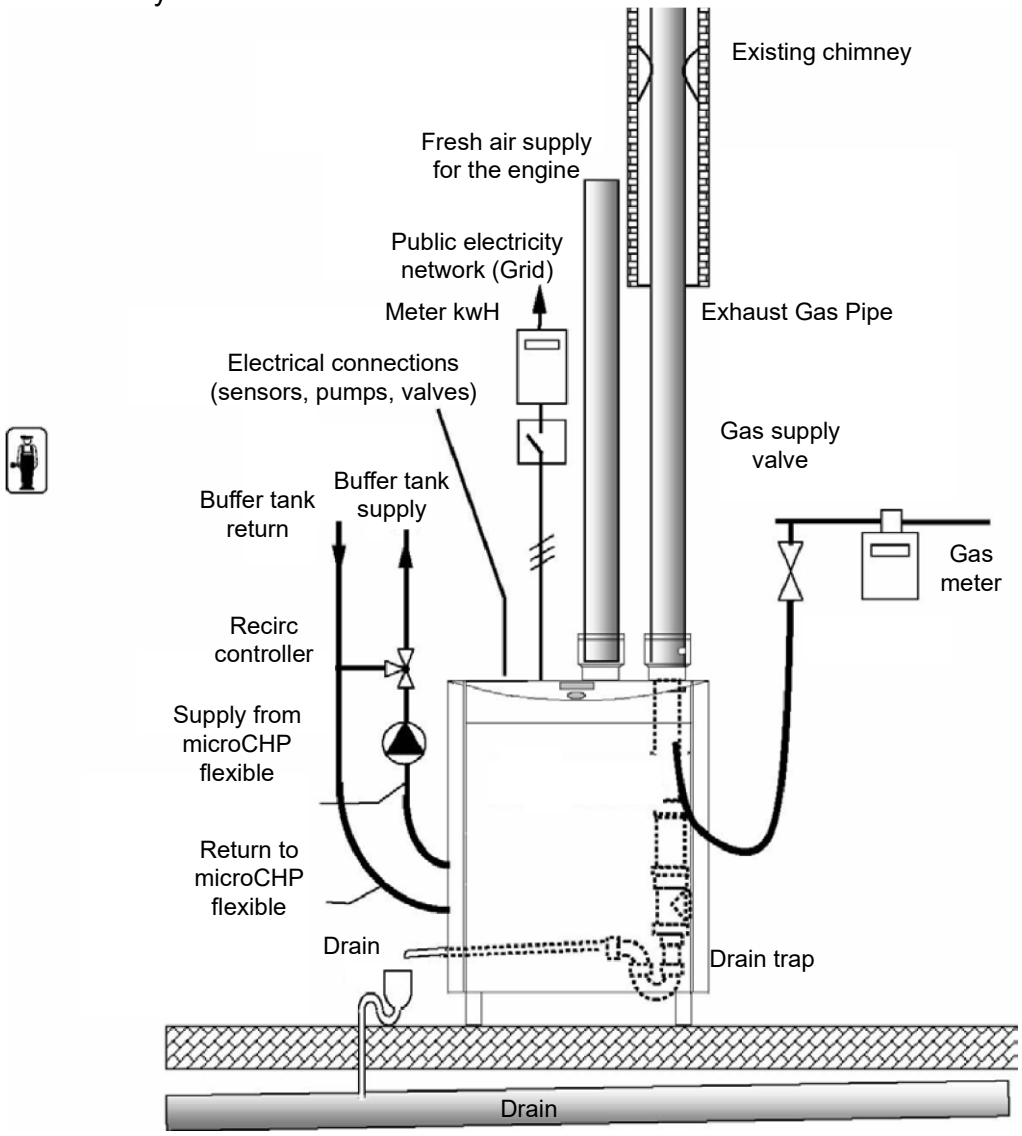


Figure 5.3 microCHP Schematic Diagram Interfaces

5.5 Dimension Diagram and Connections Rear Side microCHP

All connectors of the unit are located on the rear side of the microCHP.

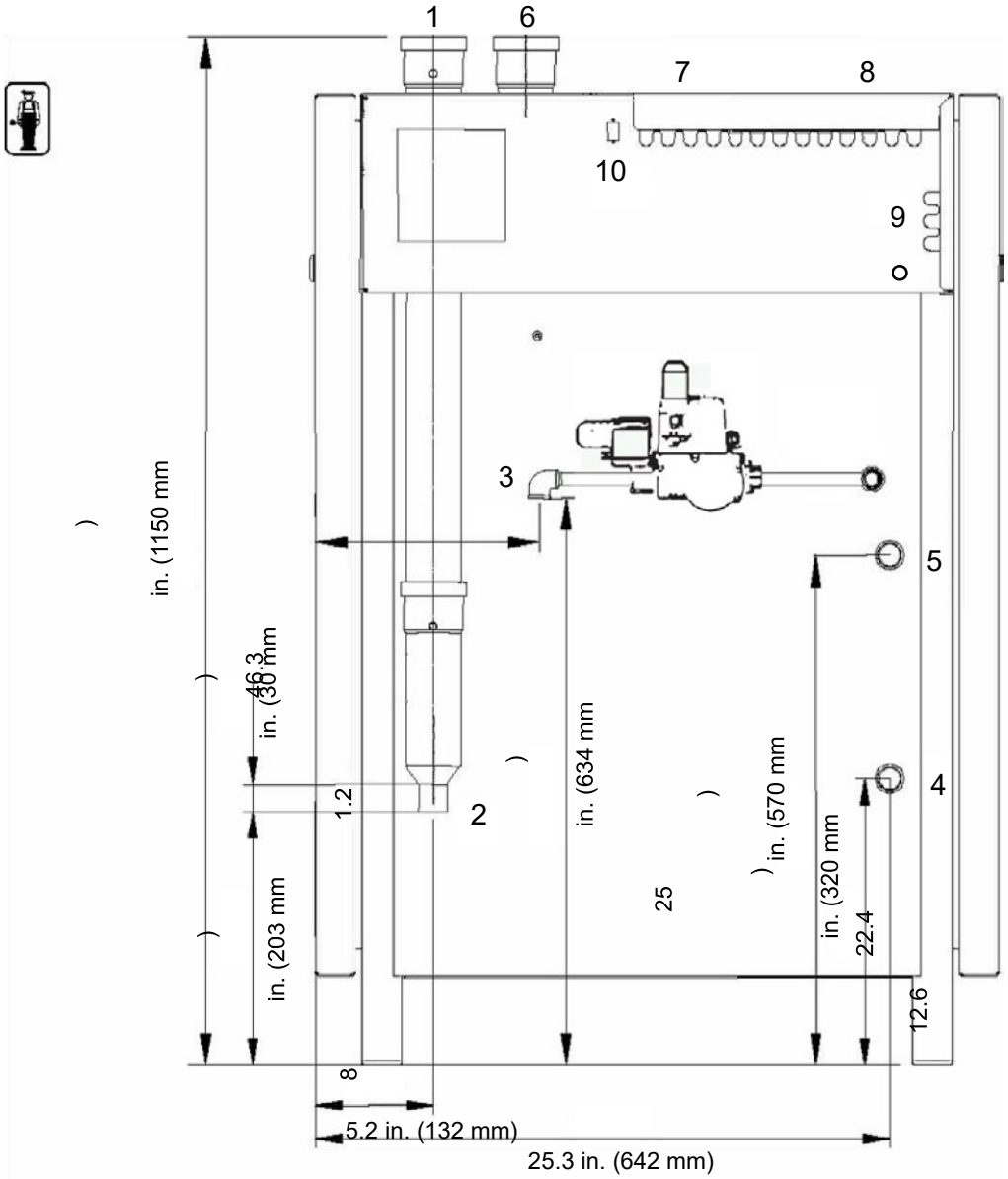


Figure 5.4 Dimensioned Rear Side (View from Back Panel)

1	Flue outlet φ 3 in. (75 mm) (connection exhaust gas pipe) 2 Condensate drain φ 1.57 in. (40 mm).
3	Gas supply; ½ in. (12.7 mm) inside thread ISO 7-1
4	microCHP return; ¾ in. (19 mm) outside thread ISO 7-1 (including return temperature sensor)
5	microCHP supply; ¾ in. (19 mm) outside thread ISO 7-1
6	Fresh air socket φ 3 in. (75 mm) outer diameter (connections fresh combustion air supply)
7	Electrical connections (signal inputs / outputs)
8	Electrical connections (grid voltage / line voltage connections)
9	Grid connections
10	Diagnostic interface (RS-232)

5.6 Left Side of the microCHP

WARNING The engine On/Off switch only controls the engine. When in the Off position line voltage is still present in the microCHP. Remove power at the building power panel or the circuit breaker switch and lockout the power before removing any panels.

The engine switch is mounted behind the left side panel (see Figure 5.5).

Figure 5.5 Side view (Left) of the microCHP

WARNING A good ground connection is essential for safety!

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6 Tanks

The tanks (buffer and potable hot water tanks) are operated in conjunction with the microCHP. Their integration is described in the microCHP Operating Manual and integration examples in this manual. Refer to Appendix B for integration example diagrams.

The buffer tank must be matched with the building heat requirement, type of heating system, and the individual location circumstances. Use ASME approved tanks. The minimum utilizable hot water volume is 80 gallons (303 L). Typical size of a buffer tank is 240 gallons (908 L) or larger. A larger tank allows a better decoupling of the thermal output from the electric power, i.e., with higher power production, the overproduced heat is charged and stored in the tank and later transferred to the heating system.

WARNING Installation of the buffer tank must be according to all national, state, and local codes. Refer to NFPA 54 (ANSI Z223.1).

WARNING Approved listed temperature and pressure (T&P) relief valves shall be installed on all tanks.

Refer to the buffer and hot water tank manufacturer instructions for installation instructions. Local plumbing and electrical codes must be followed in the installation of the buffer tank. If no local codes, the Uniform Plumbing Code and the NFPA Code must be followed.

Axiom Energy Group offers standard buffer tanks. See Figure 6.1 for details on the 240 gallon buffer tank.

Tanks

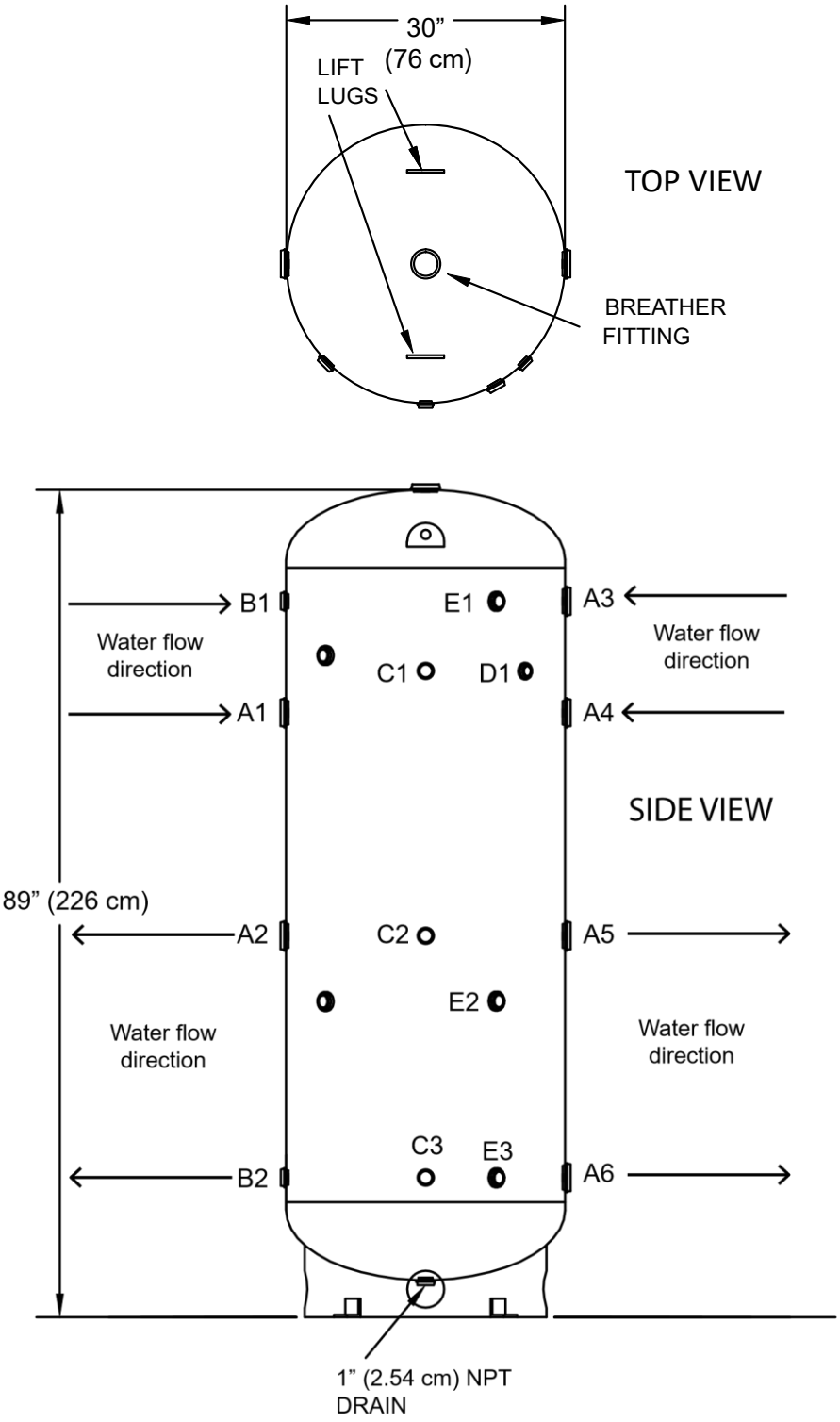
30”
(76 cm)
LIFT
LUGS
TOP VIEW
BREATHER
FITTING
B1
E1
A3
Water flow
direction
Water flow
direction
C1
D1
A1
A4
SIDE VIEW
89” (226 cm)
A2
C2
A5
E2
Water flow
direction
Water flow
direction
C3
E3
B2
A6
1” (2.54 cm) NPT
DRAIN

Figure 6.1 Example Buffer Tank 240 gallons (908 L)

Table 6.1 Buffer Tank Flanges As Shown in Figure 6.1

Location	Description	Flange Size
A1	Boiler Supply	2 inch (5.08 cm)
A2	Boiler Return	2 inch (5.08 cm)
A3	Heating System Supply	2 inch (5.08 cm)
A4	Water Heater Supply	2 inch (5.08 cm)
A5	Water Heater Return	2 inch (5.08 cm)
A6	Heating System Return (Drain Tee Typically Attached)	2 inch (5.08 cm)
B1	microCHP supply	1 inch (2.54 cm)
B2	microCHP return	1 inch (2.54 cm)
C1	Sensor SP1_ww (top)	3/4 inch (1.905 cm)
C2	Sensor SP2 (middle)	3/4 inch (1.905 cm)
C3	Sensor SP3 (bottom)	3/4 inch (1.905 cm)
D1	Relief Valve	3/4 inch (1.905 cm)
E1	Spare	1 inch (2.54 cm)
E2	Spare	1 inch (2.54 cm)
E3	Spare	1 inch (2.54 cm)

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7 Hydraulic Connections

7.1 Connections

The microCHP (mCHP) supply and return (to / from the buffer tank) must be connected with the respective hose set and the recirculation controller group (pump and mixing valve) as illustrated in Figures 5.3, 5.4, 7.2, and 7.4. Refer to installation drawings and vendor literature for further details. The buffer tank is typically installed parallel to the heating circuit. Similar to a conventional heating installation, the mCHP can be incorporated in the same way as an existing or new heating system. Permanent heat consumption on a low temperature level must be targeted in the planning to maximize electrical output. The maximum possible supply temperature of the heating circuit is 167 °F (75 °C). The supply temperature of the mCHP is between 149 °F (65 °C) and 167 °F (75 °C). We recommend installing shutoff ball valves between the mCHP and the buffer tank to isolate the unit from the heating system during maintenance work.

7.1.1 Flexible Connections

In order to obtain an optimal decoupling of impact sound (water hammer), the heating-circuit water connections must be designed to be flexible. The hose sets as supplied in the mCHP accessories, must be installed flexible with “give,” i.e., they must not be assembled stretched taut. To fasten the heating pipes, pipe clamps with a rubber bed may be used.

7.1.2 Filter and Dirt Separator

In the return, a (crud) filter and a dirt separator (e.g. vent/trap strainer) must be installed in order to prevent any fouling of the plate heat exchanger. The efficiency of the heat exchanger will be reduced if dirt / impurities are allowed to build up in it.

NOTE The heating system must be cleaned (flushed) prior to installation. Install the tank safety and fill / drain valves.

7.1.3 Condensate Drain

The condensate pipe is connected via a drain trap (see Figure 7.1) at the condensate drain of the mCHP. The mCHP drain trap is included in the assembly. The site drain is not included in delivery and must be provided by the customer. The condensate pipeline must not have a tight (sealed) connection with the sewage water system. The condensate must flow freely into the drain or a neutralization system. (see Figures 5.3 and 7.1).

WARNING: The mCHP drain trap must be connected and filled with water before initial operation, otherwise toxic exhaust gases, including carbon monoxide (CO), may leak.

Figure 7.1 mCHP Drain Trap

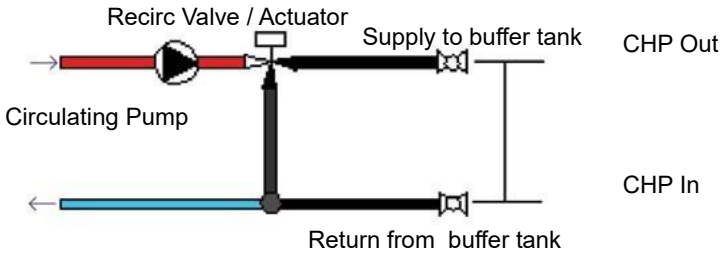


Figure 7.2 Buffer Tank Supply / Return with Recirculation Controller

7.1.4 CHP Recirculation Controller

The mCHP recirculation controller group (pump, three-way recirculation (mixture / diverter valve with actuating drive) components are supplied with the mCHP and are an installation requirement. The recirculation valve helps control the engine temperature. When the recirculation valve is in the closed position (see Figure 7.5), hot water from the mCHP plate heat exchanger is diverted back to warm up the engine. When the recirculation valve is in the open position (see Figure 7.6), hot water from the mCHP heat exchanger is sent to the buffer tank.

Intermediate steps between open and closed help regulate the engine temperature.

Refer to manufacturer literature and 7.3.

7.1.5 Domestic Hot Water Preparation

WARNING: A combined tank installation is not recommended. Because the temperatures in the top area of a combined tank (with indirect hot water preparation) sometimes exceed 158 °F (70 °C), install an admixture valve regulating the domestic hot water temperature for scald protection.

Typically, domestic hot water preparation installations will include a buffer tank and a separate, indirect heating hot water tank. Refer to the manufacturer's instructions and drawing for installation of the tank.

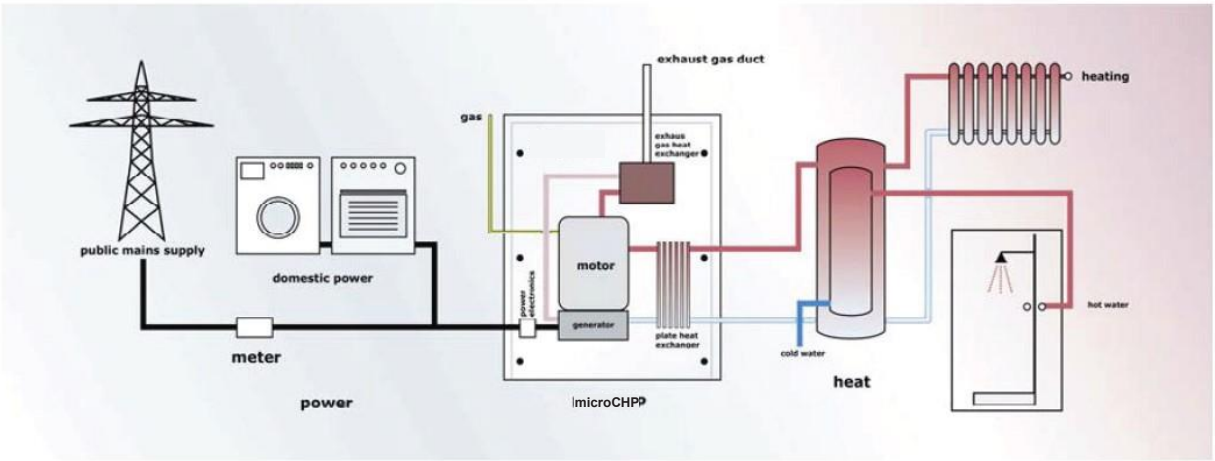


Figure 7.3 Basic Description Hydraulic Scheme of the mCHP

Figure 7.4 Circulation Pump and Recirculation Mixer Valve

NOTE: Refer to and fill out the mCHP Initial Operation Record.

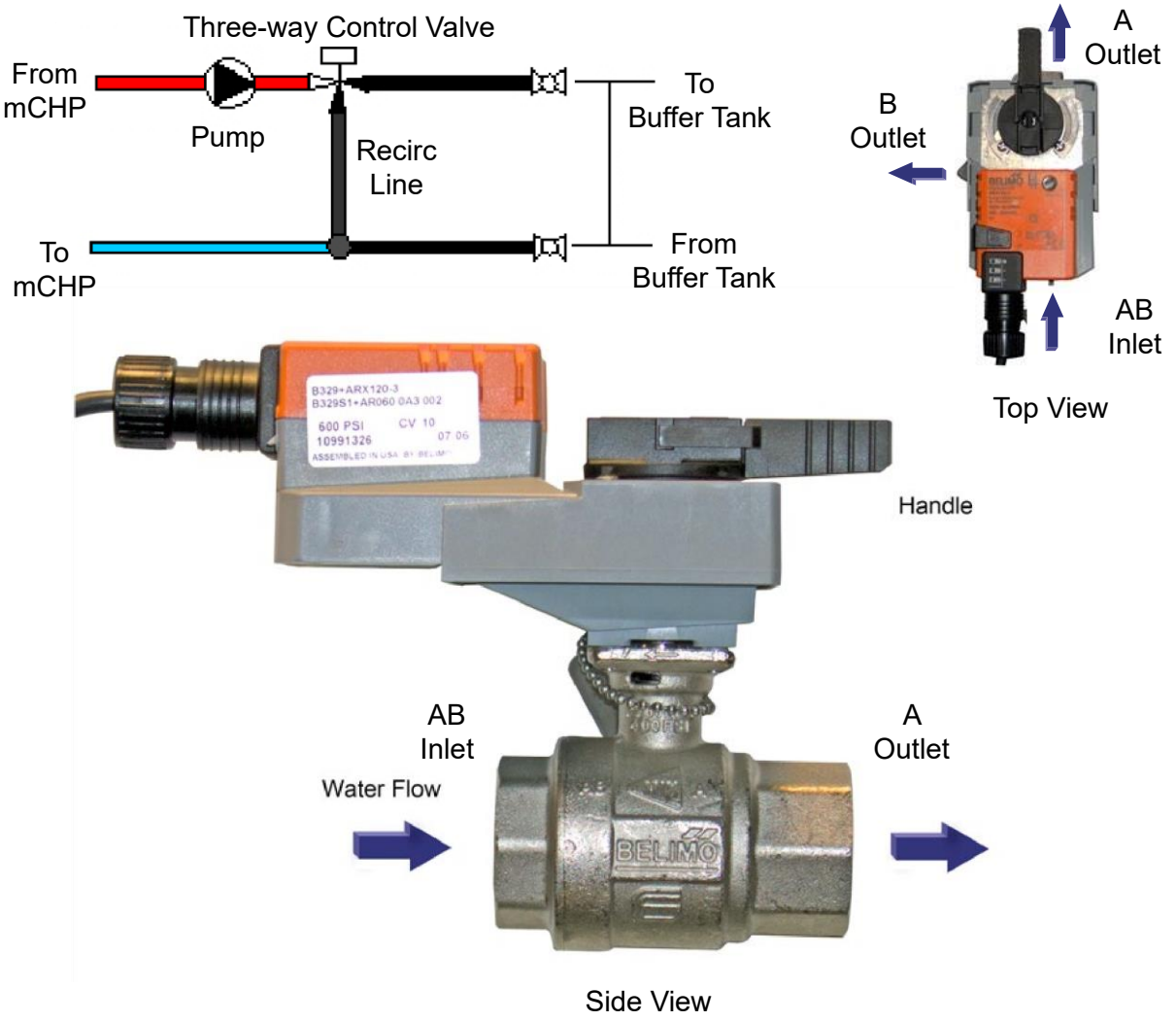


Figure 7.5 Three-way Control Valve with Actuator

7.2 Hydraulic Basic Schemes (with tank)

You will find examples for the mCHP installation in the Appendix B integration example drawings, including single unit and parallel unit installations.

7.3 mCHP 3-way Control Valve Installation Considerations

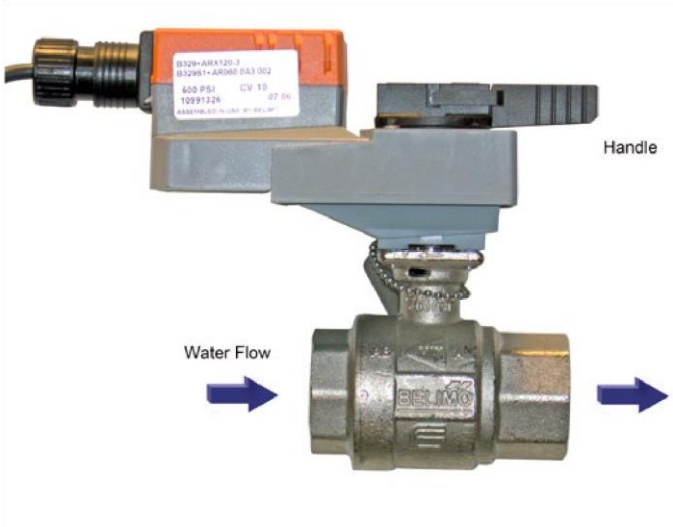
Care must be taken to correctly install the three-way control valve (Figure 7.7) in the Buffer Tank supply line. The valve is used to divert water back to the mCHP for warm up and heat modulation. Optional plumbing configurations of the valve accommodate various physical piping layouts.

Please note the water flow points opposite of the arrow indicator. The water inlet for the mCHP application is at position AB inlet. Water passes through A outlet to the Buffer Tank. Water is diverted to B outlet in varying amounts to modulate heat programmatically.

Top View

Valve Top View with Actuator Removed and Showing Indicator Notches on Stem

Figure 7.6 Three-way Control Valve in Closed Position (Water is diverted back to the mCHP plate heat exchanger)



Top View

Valve Top View with Actuator Removed and showing Indicator Notches on Stem

Figure 7.7 Three-way Control Valve in Open Position (Water is sent to the Buffer Tank)

7.4 Actuator Direction

Depending on the plumbing of the internal stainless steel ball of the three-way valve, the actuator turns clockwise or counterclockwise to divert the water flow. A switch located on the actuator housing (concealed by peel-away plastic) allows reversing of the actuator direction.

Figure 7.8 illustrates the three-way valve with the internal stainless steel ball plumbed such that the actuator rotates clockwise to divert water to valve outlet B.

Figure 7.9 illustrates the three-way valve with the internal stainless steel ball plumbed such that the actuator rotates counterclockwise to divert water to valve outlet B.

CAUTION The handle of the actuator must be adjusted so that the handle stops coincide with the movement of the valve ball

CAUTION Do not inadvertently plumb the three-way valve so that the water flow is blocked by the stainless steel ball. Also ensure both limit position stops of the actuator lever correctly allow water flow through the outlets and do not block lever movement.

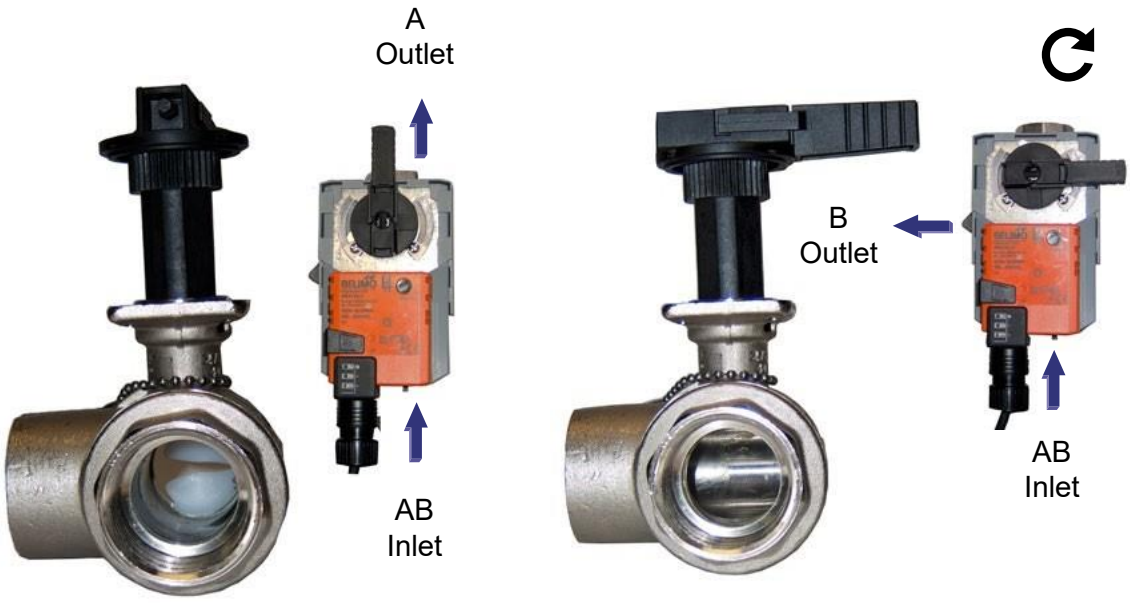


Figure 7.8 Example Three-way Valve Plumbing — Clockwise Rotation of Actuator

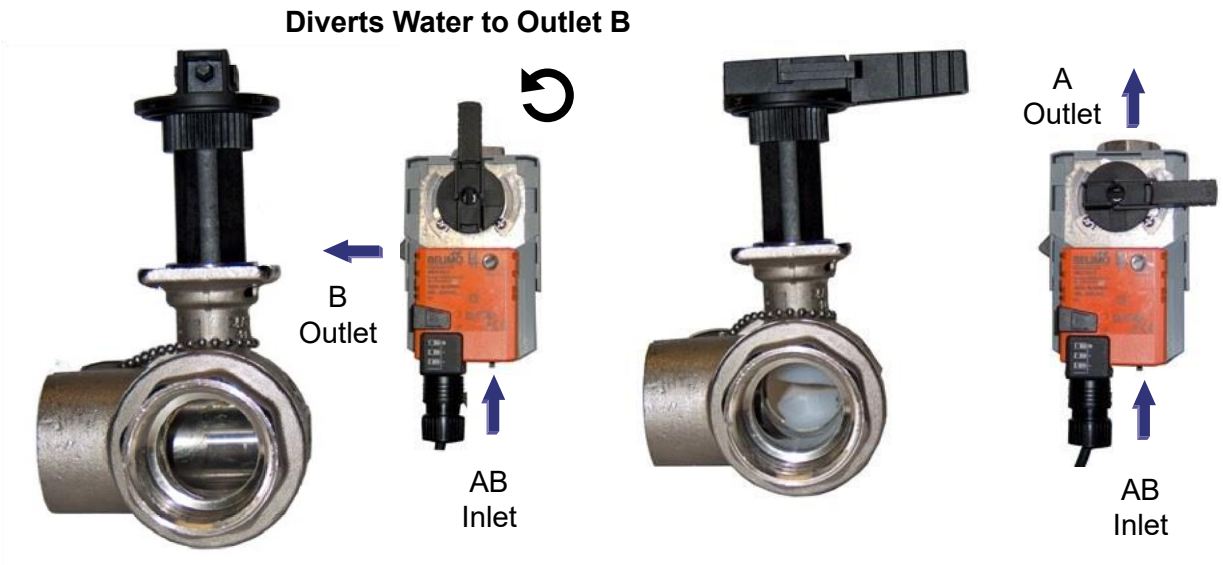


Figure 7.9 Example Three-way Valve Plumbing — Counterclockwise Rotation of Actuator Diverts Water to Outlet B

Figure 7.10 illustrates an example where the internal ball valve is incorrectly plumbed and blocks all water flow. Do not plumb incorrectly. Refer to the manufacturer's documentation for further information..

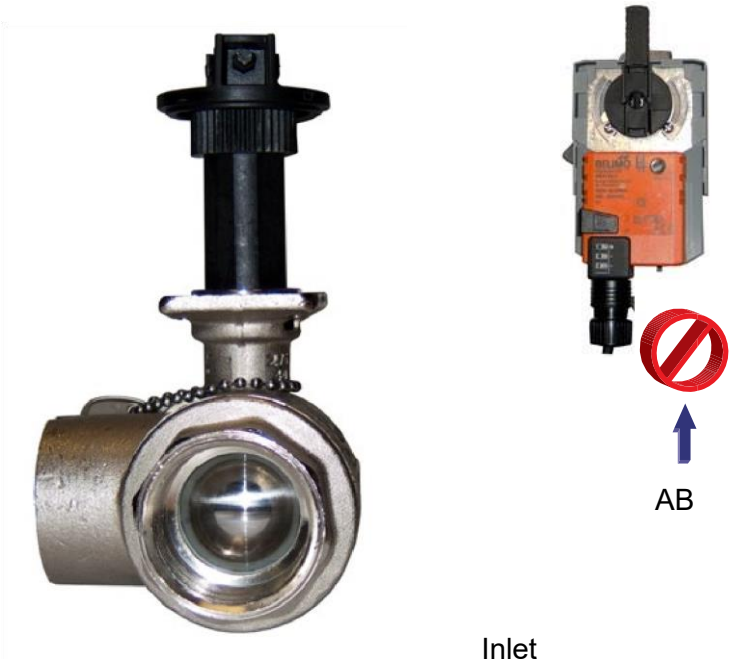


Figure 7.10 Example Three-way Valve — Incorrect Plumbing, All Water Flow is Blocked

The actuator direction can be reversed by adjusting the rotating polarity switch located on the actuator housing. The switch is accessed by peeling off the thin plastic cover on the switch (see Figure 7.11).

Figure 7.11 Actuator Polarity Switch Located on Actuator Housing.

8 Gas Supply

A licensed plumber or qualified specialist must install the gas supply. The gas used must comply with the type of gas shown on the type label. Only trained factory technicians may perform adjustments at the gas safety valve. The gas control path at the microCHP must not be altered. The secured set screw of the gas safety valve must not be readjusted.

Refer to and fill out the microCHP Initial Operation Record.

WARNING The microCHP must be connected to the gas distribution system with a flexible gas hose[1], which complies with the local regulations and is approved for this use by the manufacturer. The gas hose must resist the maximum operating pressure together with the corresponding safety factors and the vibrations of the unit. The assembly instructions of the hose manufacturer must be observed. The gas hose must be assembled free of torsion.

The gas hose provided by the manufacturer shall be used. The connection to the gas distribution system must be tightly fitted. An easily accessible gas valve shall be installed in front of the gas hose (per local code). A simplified gas supply diagram is shown in Figure 9.1. The connection at the microCHP has a ½ in. (12.7 mm) inside thread. Maximum propane gas pressure to the supplied pressure reducing regulator inlet is 2.0 psi (140 mbar). In the case of a high gas pressure, a separate gas pressure-regulating valve must be used. The maximum permissible primary pressure from the gas distribution system for natural gas to the multiblock inlet is .94 psi (65 mbar). Typical inlet pressure to the gas multiblock is between 6 and 8 in. w.c. Maximum multiblock outlet pressure is 6 in. w.c. / .22 psi (15 mbar). Multiblock output is set to approx. 3.25 in. w.c. For the fastening of the gas pipes use only pipe clamps with rubber beds. If requested, a separate gas meter can be installed for the microCHP.

1 supplied metal hose pipe for gas connection microCHP

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9 Exhaust Gas Systems and Fresh Air Supply

9.1 General

WARNING: Exhaust gases contain CARBON MONOXIDE which is an odorless, colorless, and deadly poison. The exhaust gas pipe must be leakproof as it is operated with high pressure. It must be approved for a maximum exhaust gas temperature of up to 248 °F (120 °C).

A trained installer must install the connections. The fresh air supply and the exhaust gas pipes and vents must comply with NFPA 54 (ANSI Z223.1) installation guidelines or state and local codes. The rules and regulations of the respective country and locality must be observed.

Maximum length of the air intake path: 65 ft. (19.8 m) minimum inner diameter 2.76 in. (70 mm) with a maximum of six 90 degree bends.

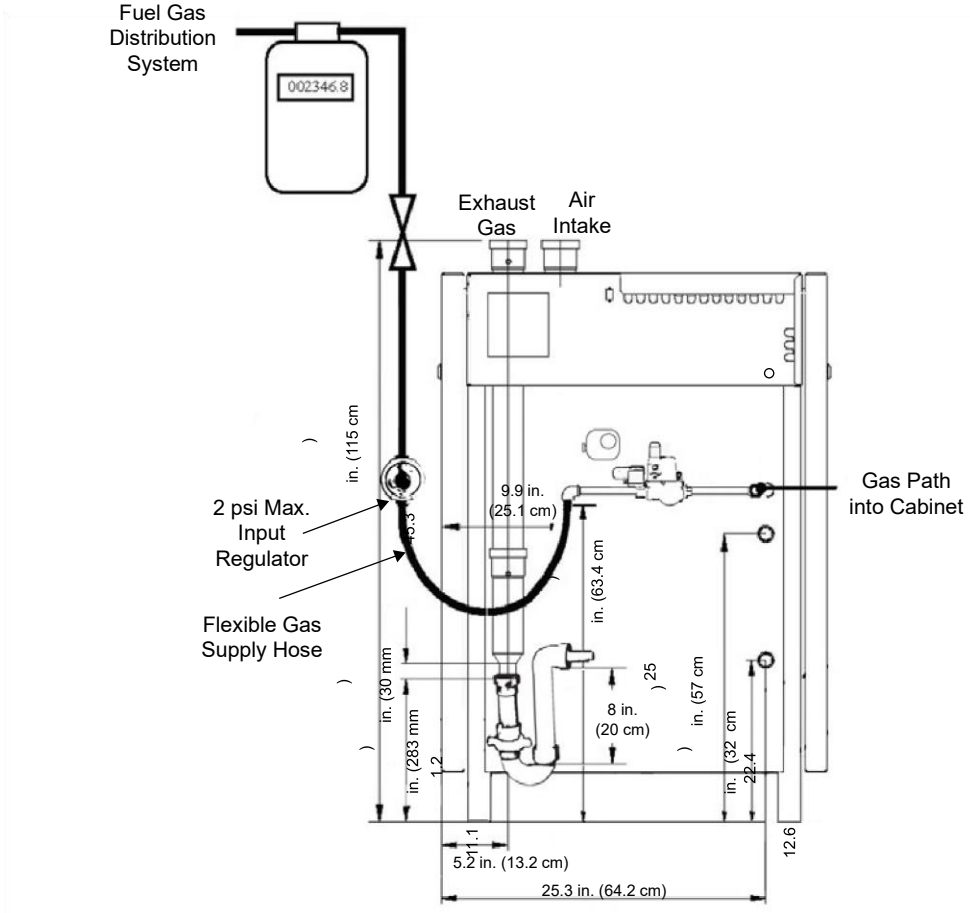


Figure 9.1 Gas Supply and Exhaust Gas Pipe

Maximum length of the exhaust system: 65 ft. (19.8 m) at minimum inner diameter 2.76 in. (70 mm), with a maximum of six 90 degree bends. Total drag: 0.2 in. w.c. (0.5 mbar). Maximum high (back) pressure 1.2 in. w.c. (3 mbar) with wind impact.

The exhaust gases of the microCHP are vented out via the included microCHP exhaust gas pipe accessories, designed and manufactured to withstand high exhaust temperatures. As the exhaust gas is routed through a heat exchanger, the temperature is normally less than 194 °F (90 °C), and the exhaust gas condenses. The pipe must be connected to flue piping (as with condensing gas heating). During the installation, the supplied connecting pipes shall be installed and connected to the venting pipes; all (connecting) pipes must be installed with pipe clamps and rubber beds.

The exhaust gas pipe is protected by an exhaust gas temperature limiter (248 °F (120 °C)). The temperature is measured by a sensor beneath the exhaust muffler. A safety error and engine shutdown occurs if the measured exhaust gas temperature measured at the muffler exceeds 241 °F (116 °C).

NOTE: Use only approved listed pipe materials and vent systems appropriate for the application and install per national, state, and local codes.

Refer to the vent pipe or vent system manufacturer's installation instructions. We recommend the use of high temperature resistant plastic for vents, where appropriate. Use flexible connectors. But refer to regulations, codes, and ordinances and the venting system manufacturer instruction particulars of each installation, as these take precedence.

For the exhaust gas and fresh air supply, a parallel two-pipe system (exhaust gas system) is used. The exhaust gas pipe must comply with the local regulations. Vent as directly as possible (within code requirements) using a minimum amount of pipe fittings.

WARNING: Do not extend a venting system into or pass it through a fabricated air duct or furnace plenum.

Up to 0.5 gal (2 L) condensate accumulate per hour, this must be fed into the sewage water system via the drain trap and drain system or into a neutralization system.

The exhaust gas and condensate pipelines must not be laid horizontally. They must have a minimum incline of 2% so that the condensate can drain.

WARNING: The microCHP drain trap must be connected and filled with water before initial operation, otherwise toxic exhaust gases, including cabon monoxide (CO), may leak. See also Section 7, Figure 7.1.

Refer to and fill out the microCHP Initial Operation Record documentation.

9.2 Shared Exhaust Gas Pipe Not Allowed

Do not install the microCHP exhaust gas piping into a shared exhaust gas pipe. (Observe local regulations).

10 Electrical Integration

10.1 General

The mCHP must be installed according to national and local electrical codes by a licensed electrician.

Before the installation of the mCHP, the connection of the mCHP to the grid must be coordinated and approved by the local power company. The installation of the mCHP must be completed in compliance with the local codes, regulations, and requirements of the power company before initial operation.

All connections must be made in accordance with the installation provisions.

All power supply, adjustment, and control connections are in the terminal connection box and power section on the rear side of the microCHP cabinet.

All connections must be equipped with sufficient strain-relief, meeting local regulations.

Use the provided isolation transformer. Install the transformer between the mCHP and the building's power panel. See Appendix A for electrical wiring drawings and schematic.

Connect a separate earth ground from the building's power panel to the input terminal block on the mCHP.

Electrical grid supply 3 x 10 AWG (1.5 mm^2) 194 °F (90 °C) wires must be connected to a 30 A 2-pole circuit breaker with ≥ 0.118 in. (3 mm) contact spacing.

10.2 Electrical Installation

1. Install an isolation (distribution) transformer between the mCHP and the building's power panel or AC coupled inverter. Axiom Energy Group provides the following transformer with your mCHP unit:

    a) Eaton (Cutler-Hammer) MES Part No. EC-3000-012 (Figure 10.2) (see enclosed specification sheets).

2) The building's power source requires two legs of 240 VAC. Install a 30 amp, twopole circuit breaker in the building's power panel.

3) Wire and connect the transformer and mCHP as follows (240V In ➔ 216 V out) (see Figure A-4):

    a) Connect the transformer wire X2 to transformer wire X3 using a wire nut.

    b) Transformer wire H3 is not used, cap with a wire nut for safety.

    c) Transformer wire H4 is not used, cap with a wire nut for safety.

    d) Connect the transformer wires H1 and H5 to mCHP "line" (L1).

    e) Connect transformer wires H6 and H2 to mCHP "neutral" (N).

    f) Connect the transformer wire X1 to one leg of the building's 30 amp circuit breaker.

g) Connect the transformer wire X4 to the other leg of the building's 30 amp circuit breaker.

h) Connect the building earth ground directly to the mCHP earth ground. A good ground connection is essential for safety.

4) The mCHP could draw up to 23 amps depending on the number of pumps, valve actuators, and other accessories that are being run. Size your wire accordingly. We recommend using 10 AWG wires.

10.3 Electrical Grid Supply Integration

The mCHP is connected in parallel to the public grid supply. If the produced power exceeds the electrical demand (in the building), the electric power is fed into the public grid supply. If more power is needed than produced by the mCHP unit, the additional electric power is drawn from the public grid supply (your electric utility supplier).

The grid connection must be made with a 10 AWG (1.5 mm^2) rated 194 °F (90 °C) line. The line must be protected with a 30 amp, 2-pole circuit breaker with a minimum of 0.118 in. (3 mm) contact spacing.

- Mount the circuit breaker as close to the mCHP as possible. Observe local codes.

10.3.1 Field Wiring Label

The electrical grid connection from the isolation transformer is made at the 3-position terminal block located in the power section on the back of the mCHP cabinet (Figure 10.1).

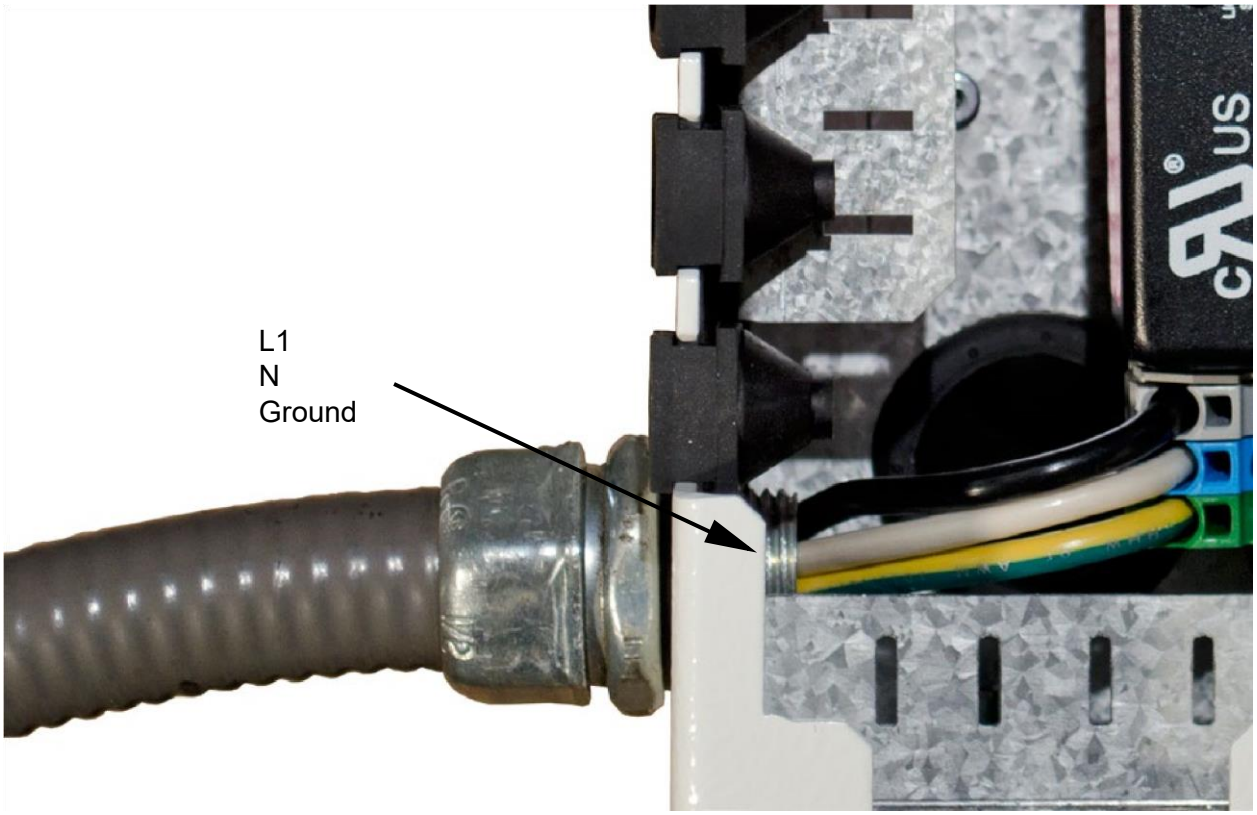


Figure 10.1 mCHP Field Power Wiring

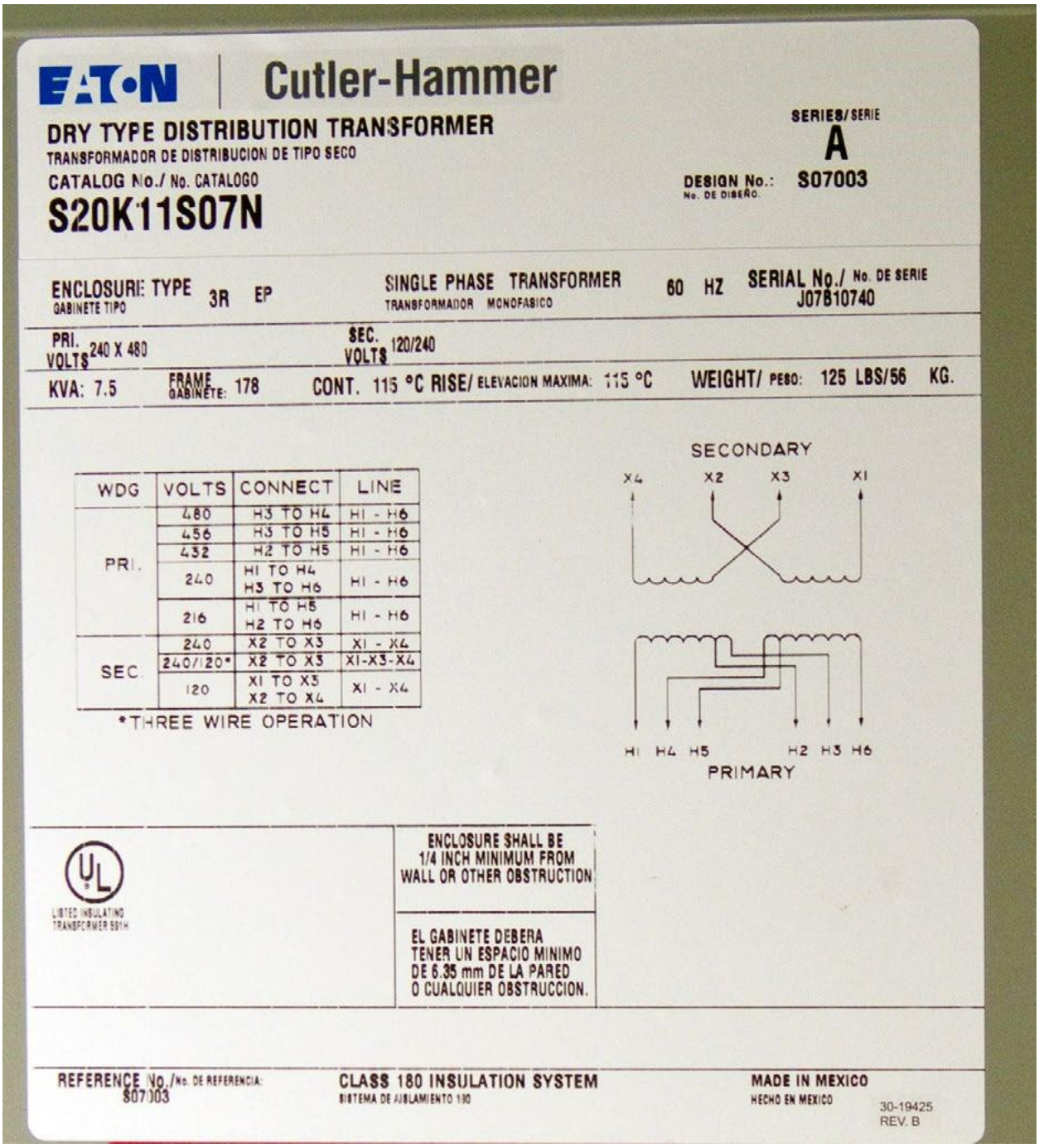


Figure 10.2 Isolation Transformer Label

10.4 Control Connections

Depending on the operating mode and system configuration, the following temperature sensors and actuating elements, must be installed and connected in order for the mCHP system to operate correctly (see Table 10.1):

- Required inputs to be connected

- Temperature sensors according to tables:

Table 10.1 Temperature Sensors

Component	Operating mode / Utilization	FT Tot	FT H1	RT H1	FT H2	RT H2	Odt	RmT	ST1 TOP	ST2 MID	ST3 BOT	T_RL (water return to CHP)	Connection option
CHP	All								X	X	X	X (factory installed)	None
Buffer tank	All									X	X	X (factory installed)	None
Domestic hot water tank	All								X			X (factory installed)	None
Heating circuit 1	Constant supply	X	X									X (factory installed)	None
Heating circuit 1	Outdoor temperature normal	X	X				X					X (factory installed)	None
Heating circuit 1	Outdoor temperature deactivation at night	X	X	X			X					X (factory installed)	None
Heating circuit 1	Outdoor temperature and ambient temperature with deactivation at night	X	X				X	X				X (factory installed)	None
Heating circuit 1	Heating OFF											X (factory installed)	None

Table 10.2 Temperature Sensors Heating Circuit 2 (option)

Component	Operating mode / Utilization	FT Tot	FT H1	RT H1	FT H2	RT H2	Odt	RmT	ST1 TOP	ST2 MID	ST3 BOT	T_RL CHP	Connection option
Heating circuit 2	Constant supply	X			X							X (factory installed)	Required
Heating circuit 2	Outdoor temperature Normal	X			X		X					X (factory installed)	Required
Heating circuit 2	Outdoor temperature deactivation at night	X			X	X	X					X (factory installed)	Required

Heating circuit 2	Outdoor temperature and ambient temperature with deactivation at night	X			X		X	X				X (factory installed)	Required
Heating circuit 2	Heating Off											X (factory installed)	Required

Table 10.3 Actuating Elements

Component	Operating mode / Utilization	Connection option
Circulating pump / discharge pump	Hot water tank /or discharge pump for buffer tank	Required
Hot water charging pump		None
2nd heating circuit		Required
Additional heating unit boiler (7-8-9 C1 / C2)		Required
Tank On/Off		Required
Parallel operation CHP		Required
Remote monitoring		Required

10.4.1 Return Controller Group

The mixer / diverter valve and actuator affect the temperature of the coolant returning to the mCHP by diverting coolant back to the plate heat exchanger as needed (see Figure 7.2). The pump circulates the water through the buffer tank to mCHP plate heat exchanger loop.

The maximum power for pumps and mixer valves: Imax = 3 A.

Figure 10.3 shows the factory standard (default) wiring to the pro-E terminals on the back panel of the mCHP from the return controller group pump and mixer / diverter valve actuator.

Please consult the factory or vendor literature for alternate wiring if you modify the return controller group components (i.e., make a modification to the actuator position).

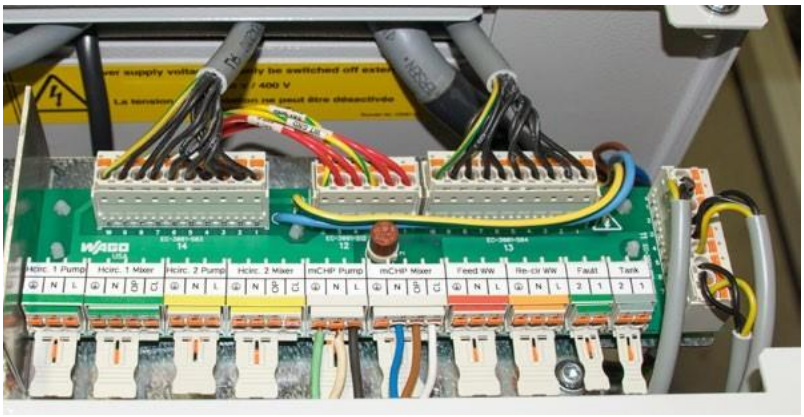
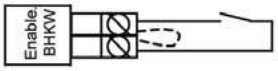


Figure 10.3 mCHP Return Controller Group Contacts (Standard)
Pump: Grd-Grn N-Wht L-Blk / Mixer: N-Blue OP-Brown CL-Wht



connection enable microCHP

Potential-free (dry) contact (12V/10mA). Remove bridge for use.

Figure 10.4 mCHP Remote Control Contacts

Optional Inputs

The mCHP may be remotely enabled. A jumper wire on the Enable BHKW (enable mCHP) connector in the Low Voltage section of the connector block must be removed first (see Figure 10.4).

Connect the mCHP external disabling / enabling to the mCHP by connecting a floating contact (U=12V, Imax=10 mA).

A second heating circuit for the optional second heating circuit, connection of temperature sensors can vary from the first circuit. Parameters are individually set.

NOTE: The temperature limiter of an under floor heating system must be provided on site and be wired in series with the activation of the corresponding heating circuit pump. If the temperature rises above the setpoint, the pump switches off and the mixer valve is shut. The selector switch must be designed for grid voltage. This applies to both heating circuits 1 and 2.

Possible outputs to be connected for heating circuit 1 (heating circuit 2)

- Mixer valve On/Off: controls the supply temperature of the heating circuit by various position settings.
- Pump: circulates the water in the heating system.
- Malfunction: external malfunction message (e.g., flashing light, building master control system) series C: relay contact (shutter) max. 240V/10A.

Peak load tank: for the option “peak load tank,” activation of another heat supplier (heating tank, gas boiler) peak load tank release is recommended for the optimal operational tuning: series C: relay contact (shutter) max. 240V/10A.

Backup heater unit:

Pump outputs: hot water charging pump / circulating pump / discharge pump Impulse

On: Electrical meter monitoring.

10.5 Installation of the Outdoor Sensor, Tank Sensor, & Supply Sensor

10.5.1 General Information

Supplementary information is needed for installation of a shared supply sensor, FT Tot, when used with a peak load tank.

The supplied standard sensors must be installed properly, otherwise operational malfunctions may occur. The Ft Tot is the control sensor for the entire activation of the peak load tank and the speed control of the mCHP. The shared supply sensor (Ft Tot, see hydraulics examples in Appendix B) must be installed in the buffer tank approx. 4 – 6 in. (10 – 15 cm) below the shared supply connection in the buffer tank. The sensor FT Tot must not be placed above the supply connection as this may result in loss of dampening. It must not be installed in the pipeline of the shared supply connection, either, as there is not always the circulated hot water area (overheating of the buffer tank). It is essential to install FT tot (as shown in the hydraulics examples in Appendix B) in the provided tank sensor sleeve. Take care that the location of the sensor installation is not subject to continuously wide temperature fluctuations as this will lead to excessive performance adjustments of the CHP and the peak load tank.

Always use the recommended buffer tanks for the mCHP series C to ensure optimum operation.

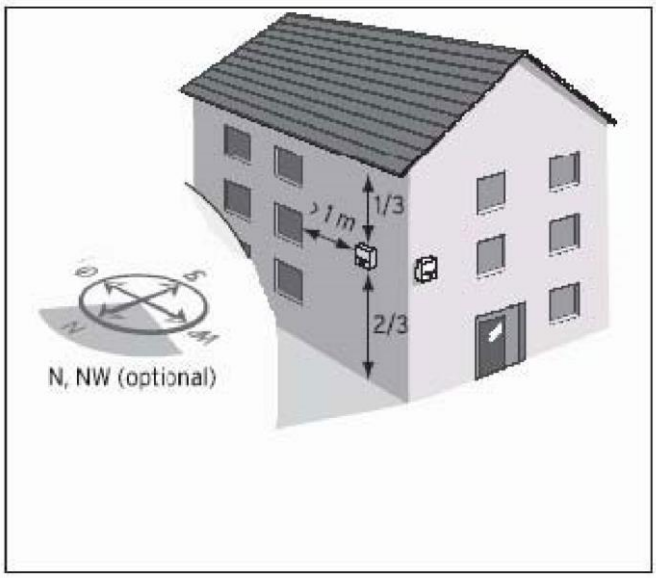


Figure 10.5 Placement of Optional Outdoor Sensor

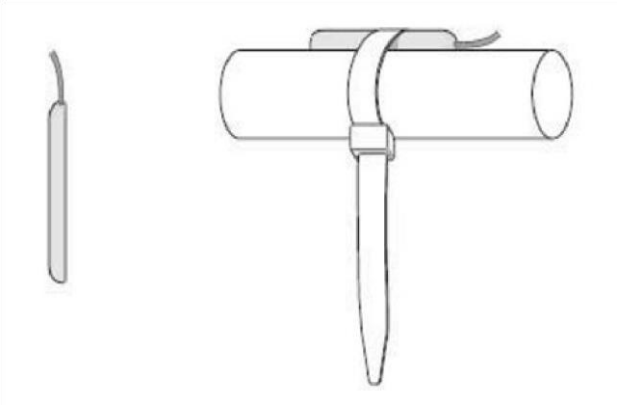


Figure 10.6 Installation of Sensor on Pipe

10.5.2 Installation Supply Sensor / Tank Sensor

Standard Sensor

Depending on the system configuration, additional sensors for supply, return, collector or tank may be necessary. For these purposes a standard sensor is available in the mCHP accessories program. The standard sensor is designed to be used as an immersion sensor, e.g. as a tank sensor, in a tank sensor pipe, as a supply sensor in a hydraulic diverter or in the sensor sleeve of heating circuit pump groups. If the sensor is used in an immersion sleeve a safe contact between sensor and sleeve must be provided. Apply thermal conductance paste. In order to guarantee good heat transmission the sensor is flattened at one side.

Important: The installation of the shared supply sensor must be located where both supply heat flows (CHP+tank) meet. Therefore it is installed in the buffer tank. The exact positions must be taken from the hydraulic integration examples or site

drawings. Configured buffer tanks supplied by Axiom Energy Group provide the correct flanges.

10.5.3 Installation of the Outdoor Sensor

Outdoor Sensor

Attach the outdoor sensor to the side of the house adjacent the most frequently occupied rooms. If this side cannot be definitively determined, the sensor should be attached to the northern or northwestern side of the house. For the optimum registration of the outdoor temperature the device should be mounted at approximately two thirds of the height of the facade for buildings of up to three stories. For higher buildings, attach between the 2nd and the 3rd story. The sensor location should be neither wind-protected nor particularly drafty and should not be exposed to direct insulation. The device must be located at least 3.3 feet (1 m) from vents on the outside wall out of which hot air may flow. Depending on the accessibility of the assembly location, on-wall or in-wall mounting may be done.

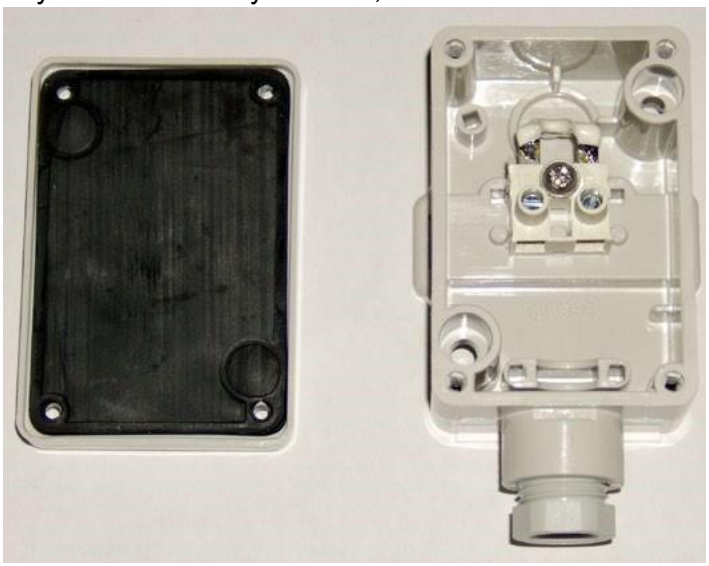


Figure 10.7 Optional Outdoor Sensor and Housing

10.5.4 Mounting the Optional Outdoor Sensor

Remove the cover panel from the case and fasten the case to the wall with 2 screws on top of the mounting holes.

The device must be attached to the wall in the mounting position as shown in Figure 10.5. The cable entry (3) must point downwards. Run one connector cable of min. 20 AWG (2 x 0.75 mm^2) on site and pull in from below through the cable entry. Reattach the cover panel.

Water impermeability of the sensor and the building must be ensured by appropriate cable routing as well as appropriate care and attention to seals.

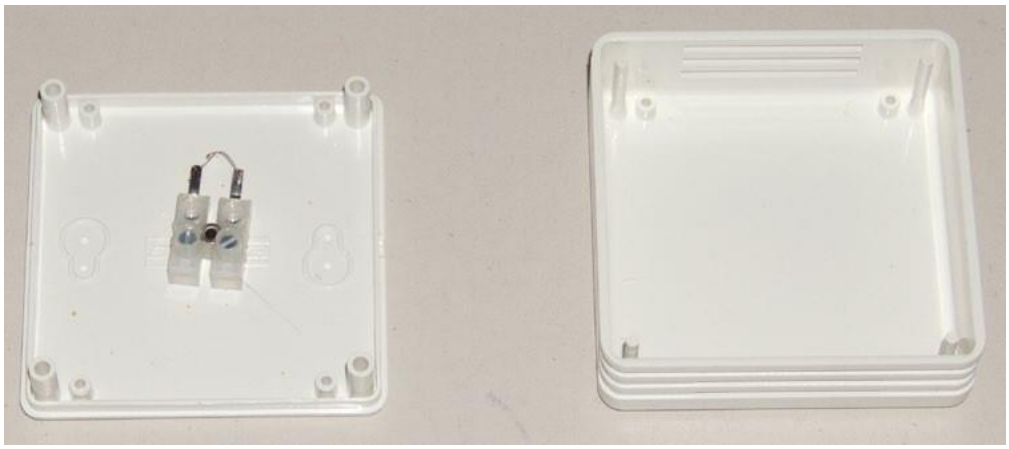


Figure 10.8 Room Sensor

10.5.5 Room Sensor

Install the room sensor (Figure 10.8) using 20 AWG (2 x 0.75 mm^2) cable.

Follow these guidelines:

- Do not install near a heat source that may disrupt readings.
- Do not use any direct insulation.
- Install in the main living area (for instance, living room).
- Install the sensor 5 feet above the floor.

10.6 Connection Scheme

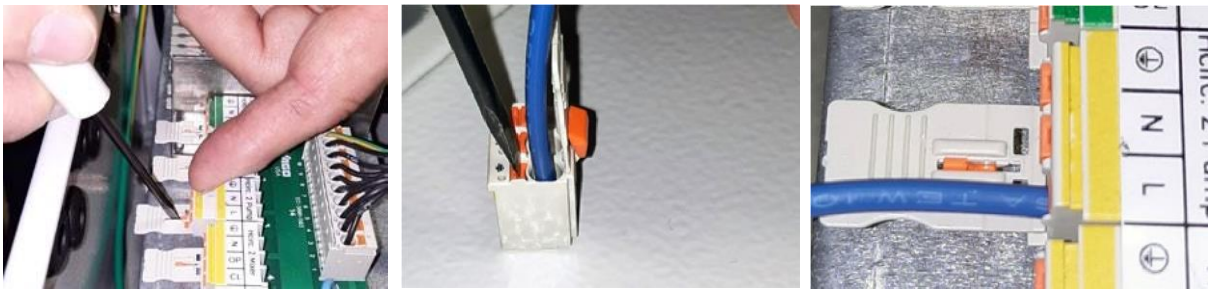
All electrical connections are in the connection box low/high voltage boards and power connection section on the rear side of the mCHP.

The temperature limiter of under floor heating, if provided, must be provided on site and must be wired in series with the activation of the corresponding heating circuit pump. Install per national and local codes. If the temperature climbs above set point, the pump switches off and the mixer valve 2 is shut. The change over switch must be designed for grid voltage.

Note: The primary power wires from the isolation transformer are to be connected to the 3-position terminal block located inside the power section on the back of the mCHP. Use 10 AWG, 194 °F (90 °C) wire. Follow the wiring practices required by your national and local codes.

10.7 Strain Relief

All connections must be provided with strain relief that complies with local regulations. The connection panel on the back of the mCHP provides strain relief components.



Insert flat blade screwdriver Insert flat blade screwdriver Push the connector back into and push orange release tab into connector terminal the terminal block, locking it in inwards towards connector. orange release and push wire place. Slide connector out. into connector. Remove the

screwdriver to lock the wire in place.

Figure 10.9 Securing Wires on Terminal Connectors

Figure 10.10 Tightening Cable Strain Relief Nut

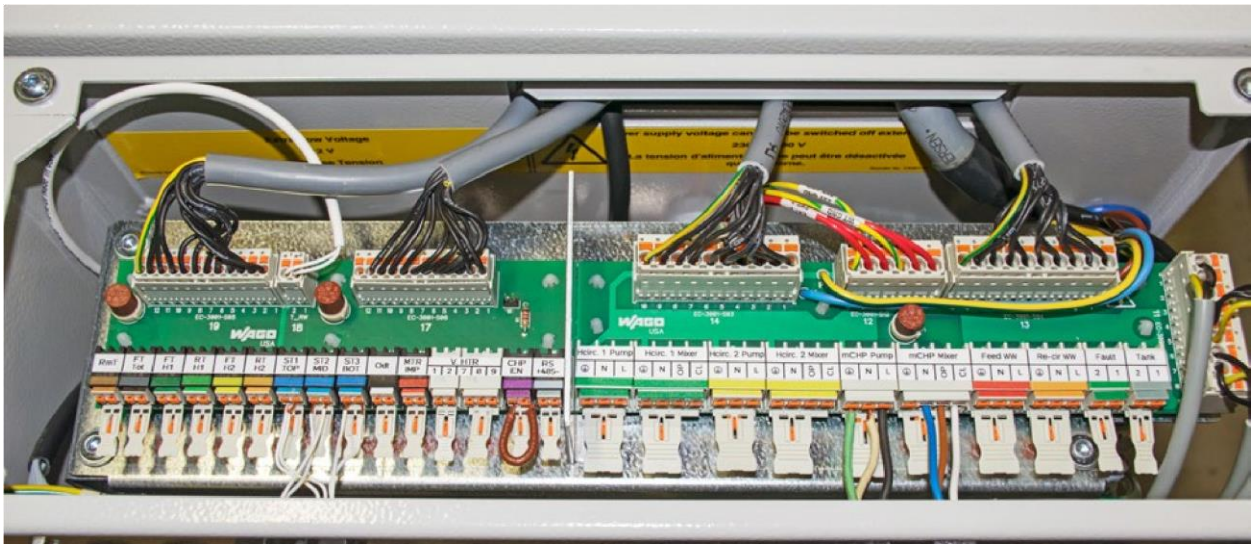


Figure 10.11 Terminal Layout on mCHP (Basic Installation) See

Appendix A, Figure A.2, for the connection diagram.

10.8 LV/HV Board Connections

Electrical connections on the low and high voltage boards are made using Wago connectors. The sensor, heating circuit pump, and mixer wiring are assigned to a respective connecting plug, which is color coded. The wires are mechanically connected and secured with clamps. The cables must be in one-wire technology or they must be provided with wire end sleeves.

10.9 AC Coupling Requirements

In order to remain compliant with UL 1741 Rule 21 and SB, SA the microCHP may be AC coupled with a utility accepted UL1741 SB.SA compliant grid forming inverter. The simulated grid (AC Coupling) protocols are detailed in the following section.

10.9.1 microCHP

The protection functions of the grid simulating inverter shall the maximum clearing times listed in the following tables for abnormal voltage and/or frequency conditions. These ranges will likely need to be adjusted on the grid simulating inverter in the field upon installation.

Table 10.12 Abnormal Voltage

Voltage Range (% of base voltage)	Clearing Time (seconds)
V<50	0.16
50≤V<88	2.00
110<V<120	1.00
V≥120	0.16

Table 10.13 Abnormal Frequency

Frequency Range (Hz)	Clearing Time (seconds)
>60.5	0.16
<59.3	0.16

11 Initial Operation / Commissioning

Only trained service technicians may initially operate the microCHP for commissioning.

Adjustments and settings are made and recorded in the Initial Operation Record.

Refer to the microCHP Operating Manual or, for service personnel, the ecoServ Software Operating Manual.

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12 Maintenance

After every 4,000 operating hours, or at least once a year, maintenance must be performed by a trained service technician. Maintenance includes changing wear and tear parts of the engine (spark plug, ignition cable, air and oil filter, and engine oil) as well as performance checks, such as of the exhaust gas adjustments.

Refer to the microCHP 4,000 Hour Maintenance Manual for information on the maintenance schedules. Refer to the microCHP Operating Manual and the Maintenance Manual for information on troubleshooting codes.

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13 Summary for the Planner

13.1 Scope of delivery microCHP, including heating control and assembly components as per the purchase.

- For further assembly components refer to the site service specifications.

13.2 Installation Location

- In order to provide access for maintenance work on the microCHP, the minimum clearances as illustrated in Figure 5.2 must be observed.
- For safety reasons, the installation room must be ventilated according to codes and regulations (see Section 1.1 and Section 5).
- The venting system shall be designed and constructed so that the positive flow is sufficient to convey the vented gases outdoors.
- The electronics are cooled via the electronics compartment air and fans. Keep unobstructed the ventilation slots located below and on the sides of the microCHP cabinet.

13.2.1 Taking steps against noise and vibrations:

- All leads to and from the microCHP must be flexible, i.e., use flexible hoses, cabling, and expansion joints.
- The cables and hoses must hang loose, i.e. they must not stretch or be taut.
- The microCHP can be placed on the provided absorption dampers (pads); when using other dampers the unit must be secured so it does not move due to vibration.
- The installation surface must be level, otherwise the microCHP might move or shift due to vibration.
- All (connecting) pipes must be installed with pipe clamps with rubber beds.
- If possible, the microCHP should be mounted on a heavy foundation (minimum support of 882 lb. (400 kg)), decoupled from the ground.
- No open lead-through from the heating room to living space such as laundry chutes, cable ducts, etc.
- A separation of heating rooms from living space by means of 2 doors often is more cost effective than building in a noise-guard door.

13.3 Hydraulics

- The supplied water circulation pump and mixer / diverter valve must be used and installed according to the supplied instructions.
- A filter and a dirt separator (e.g., Spiro vent/trap) must be installed in the heating return.
- The condensate drain: drain trap (microCHP included equipment) must be properly installed. (see Figure 7.1 and Section 7.1.3).
- The exhaust gas pipe condensate of the house can be ducted via an existing drain trap (if safety regulations permit).
- Behind the drain trap the condensate must be ducted via an open drain trap into the sewage water system or, if required, into a neutralization system (maximum condensate flow rate: 0.5 gal/hr. (2 L/h)).
- Observe the correct mounting direction of the mixer valves (refer to supplied instructions and the vendor literature).
- •Observe proper connection of the heating system supply and return. Refer to the vendor literature.
- Do not size the (potentially speed controlled) pump in the heating circuit too large, so that a temperature difference of approximately ΔT 18 °F (10 °C) is guaranteed for heating systems with radiators.
- Pressure drop above the plate heat exchanger at 800 L/h (211 gal./hr.) flow rate = 1.0 psi (0.07 bar).
- Clean, i.e., flush old heating systems before the initial operation of the microCHP
- Sufficient heat consumption must be secured and the temperature level must be below 140 °F (60 °C) return and max. 167 °F (75 °C) supply.

13.4 Gas Supply

- The gas supply must be installed by a licensed plumber or qualified technician only.
- The components used must comply with the relevant local regulations and must be installed in accordance with the assembly instructions.
- The gas hose must comply with the effective regulations and must absorb the vibrations of the microCHP; use the gas safety hose supplied by the manufacturer.
- An easily accessible gas valve must be installed to cut off the gas supply at any time.
- The gas control path of the microCHP must not be altered.
- (Lead) seals must not be removed.
- The microCHP must be installed according to local codes.

13.5 Air Inlet Path

- Supply the combustion air from outside of the building via the air intake piping.
- Maximum length of supply pipe with 2.8 in. (70 mm) inner diameter: 65 ft. (20 m) with a maximum of six 90 degree bends.

- The provided connection adapter must be used.

13.6 Exhaust Gas Path

- Use approved listed leak-proof exhaust gas pipe (high pressure).
- For the exhaust gas pipe we recommend high temperature resistant plastic pipes.
- Maximum length of exhaust gas pipe with inner diameter 2.75 in. (70 mm) diameter: 65 ft. (19.8 m) with a maximum of six 90 degree bends.
- The provided connection adapter (high temperature resistant PVDF) must be used.

13.7 Tank

- Buffer tank sizes of 200 or 250 gallons (757 or 946 L) are typical. Larger tanks allow better decoupling and storage of the heat for longer periods of lower heat demand but higher electrical demand. See Section 6 for more details
- The minimum usable tank volume must be at least 80 gallons (303 L).
- It is imperative to observe the correct installation of the tank temperature sensors.

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14 Spare Parts

If you require spare parts for your microCHP, contact your local dealer or inquire at:

Axiom Energy Group
2050 Energy Drive
East Troy, Wisconsin 53120
USA

Phone: (262) 642-6436
FAX: (262) 642-6437
Website: www.axiom-energy.com

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Appendix A

Appendix A

1 mCHP
2 Buffer tank
3 mCHP pump
5 Hot water charging pump
8 Check valve
9 Automatic mixing valve hot water
10 Return mixing valve
10a Components to regulate the mCHP return temp
11 Cold water group
12 Safety valve
13 Air vent/separator
14 Expansion tank
15 Regulating valve
17 Thermostat
18 Strainer
19 Rinse connections
Odt - Outdoor temp sensor
Auxiliary boiler, modulating
Hcirc 1 pump - Heating circuit 1 hot water pump
Hcirc 2 pump - Heating circuit 2 hot water pump
RmT - Room temp sensor
RT H1 - Return temp heating circuit 1
RT H2 - Return temp heating circuit 2
ST1 - Top hot water temp
ST2 - Mid hot water temp
ST3 - Bottom hot water temp
FT Tot - feed temp total
FT H1 - feed temp heating circuit 1
FT H2 - feed temp heating circuit 2

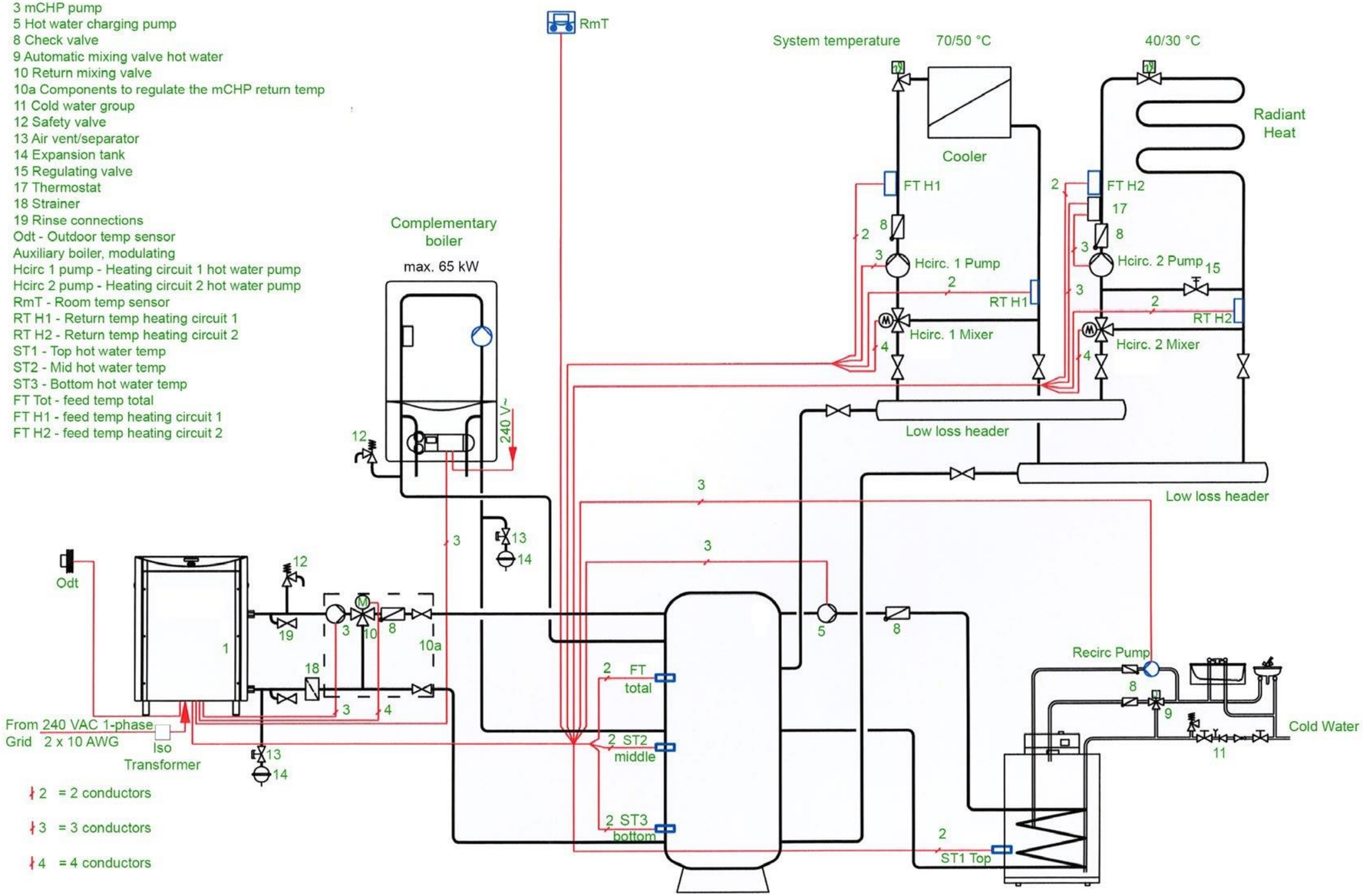

Figure A.1 microCHP C Main Power Schematic

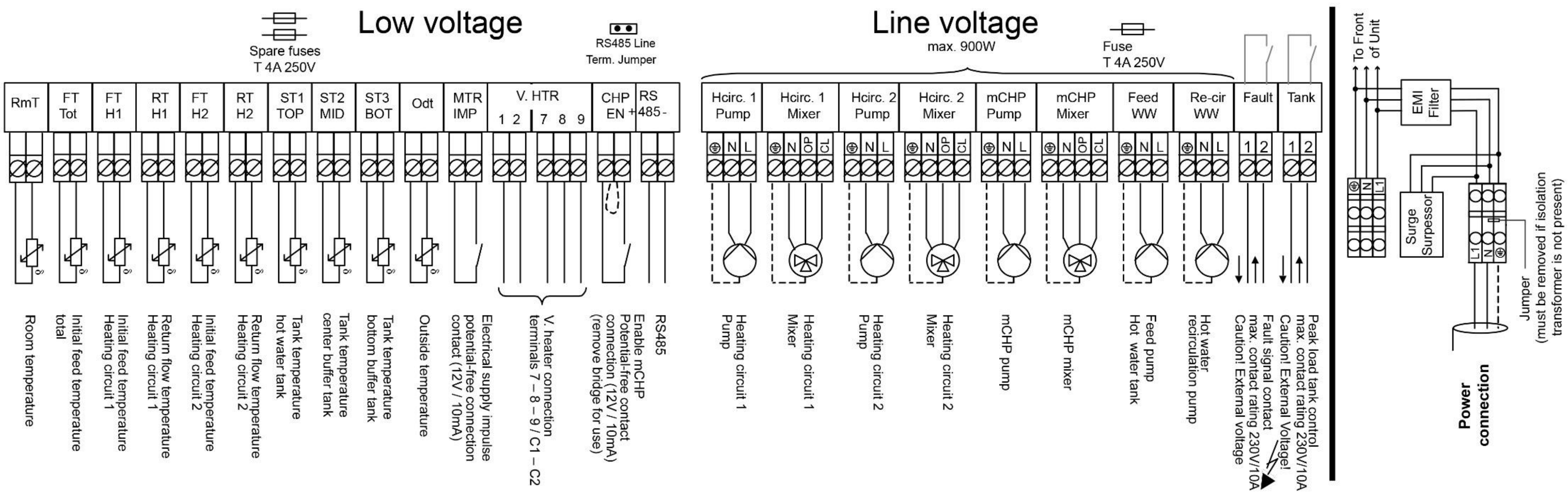
Low voltage
Spare fuses
T 4A 250V
RS485 Line
Term. Jumper
Line voltage
max. 900W
Fuse
T 4A 250V
RmT
FT Tot
FT H1
RT H1
FT H2
RT H2
ST1 TOP
ST2 MID
ST3 BOT
Odt
MTR IMP
V. HTR
1 2 7 8 9
CHP EN
RS 485 + -
Hcirc. 1 Pump
Hcirc. 1 Mixer
Hcirc. 2 Pump
Hcirc. 2 Mixer
mCHP Pump
mCHP Mixer
Feed WW
Re-cir WW
Fault
Tank
N L
N OP CL
1 2
To Front of Unit
EMI Filter
Surge Surpessor
L1 N
Room temperature
Initial feed temperature total
Initial feed temperature Heating circuit 1
Return flow temperature Heating circuit 1
Initial feed temperature Heating circuit 2
Return flow temperature Heating circuit 2
Tank temperature hot water tank
Tank temperature center buffer tank
Tank temperature bottom buffer tank
Outside temperature
Electrical supply impulse potential-free connection contact (12V / 10mA)
V. heater connection terminals 7 – 8 – 9 / C1 – C2
Enable mCHP Potential-free contact connection (12V / 10mA) (remove bridge for use)
RS485
Heating circuit 1 Pump
Heating circuit 1 Mixer
Heating circuit 2 Pump
Heating circuit 2 Mixer
mCHP pump
mCHP mixer
Feed pump Hot water tank
Hot water recirculation pump
Peak load tank control max. contact rating 230V/10A Caution! External Voltage!
Fault signal contact max. contact rating 230V/10A Caution! External voltage
Power connection
Jumper (must be removed if isolation transformer is not present)

Figure A.2-1 HV/LV Connections (for units built prior to 2023)

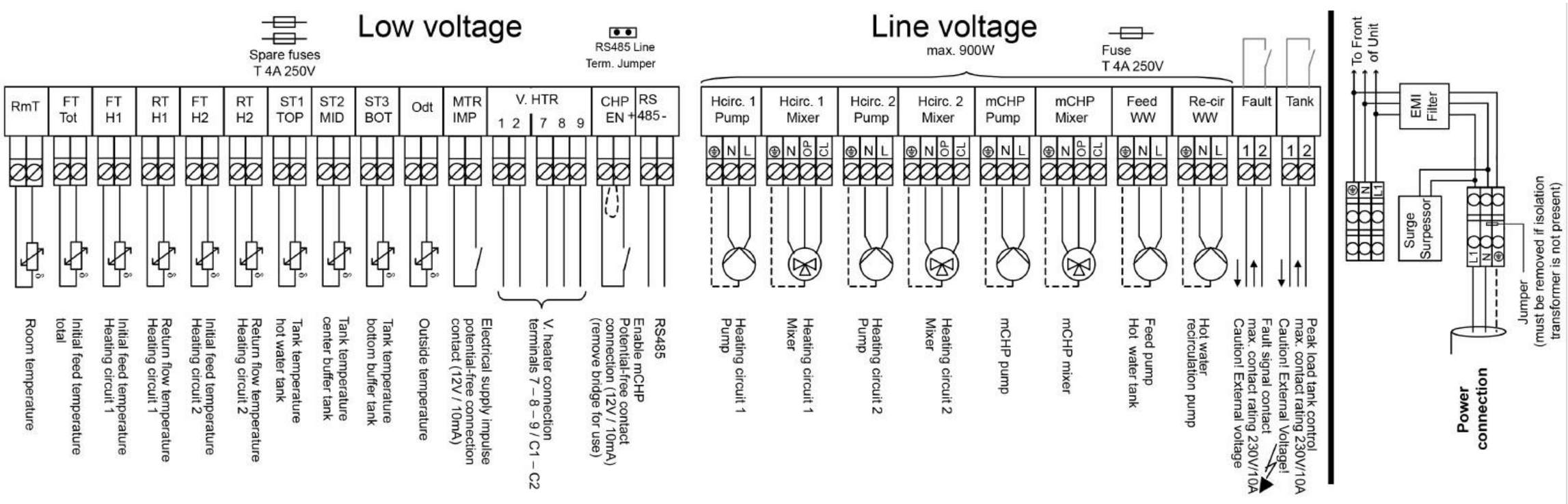

Figure A.2-2 HV/LV Connections (for units built in 2023 and after)

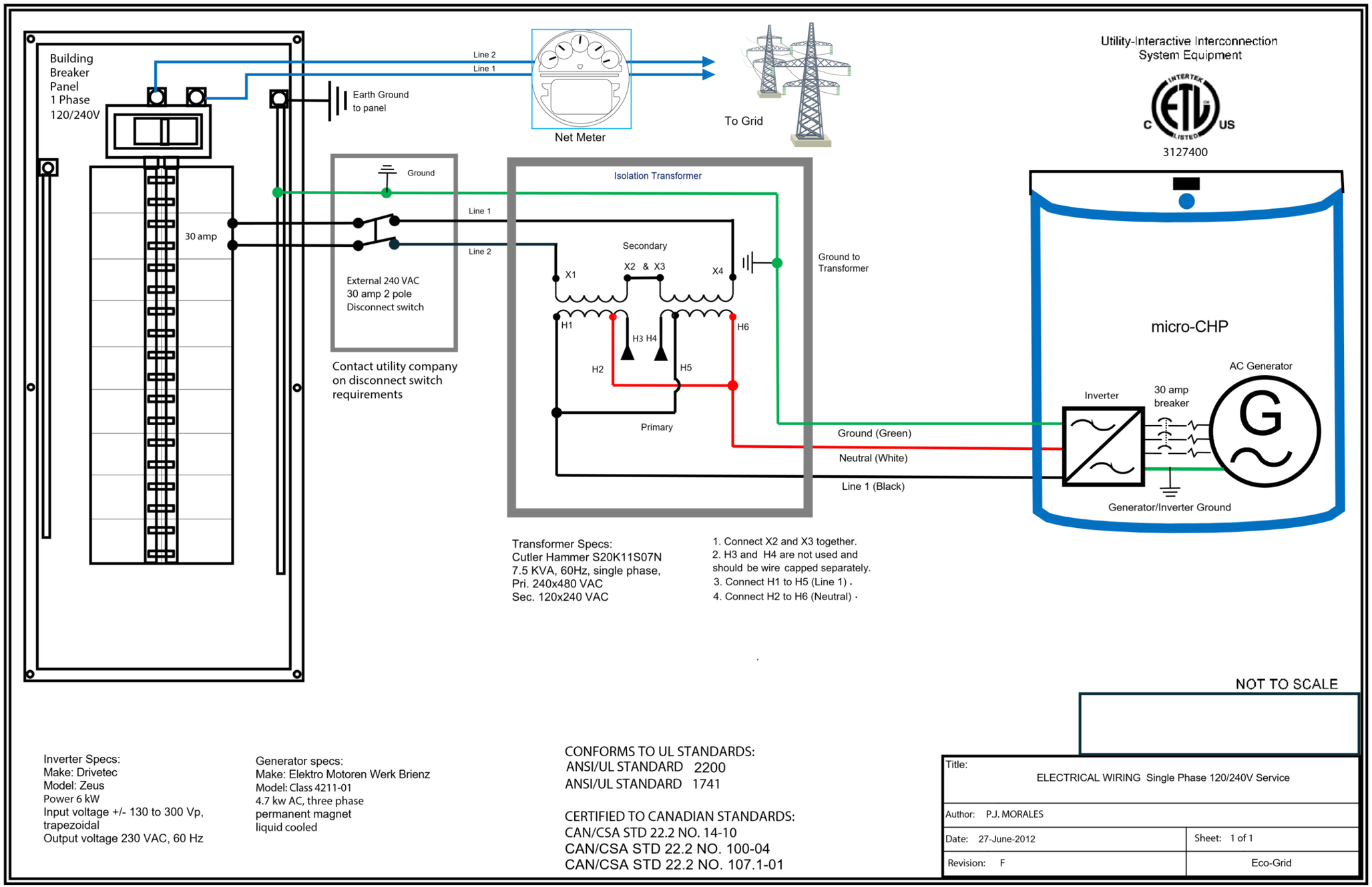

Figure A.3 microCHP Electrical Wiring, 1 Phase 120/240V

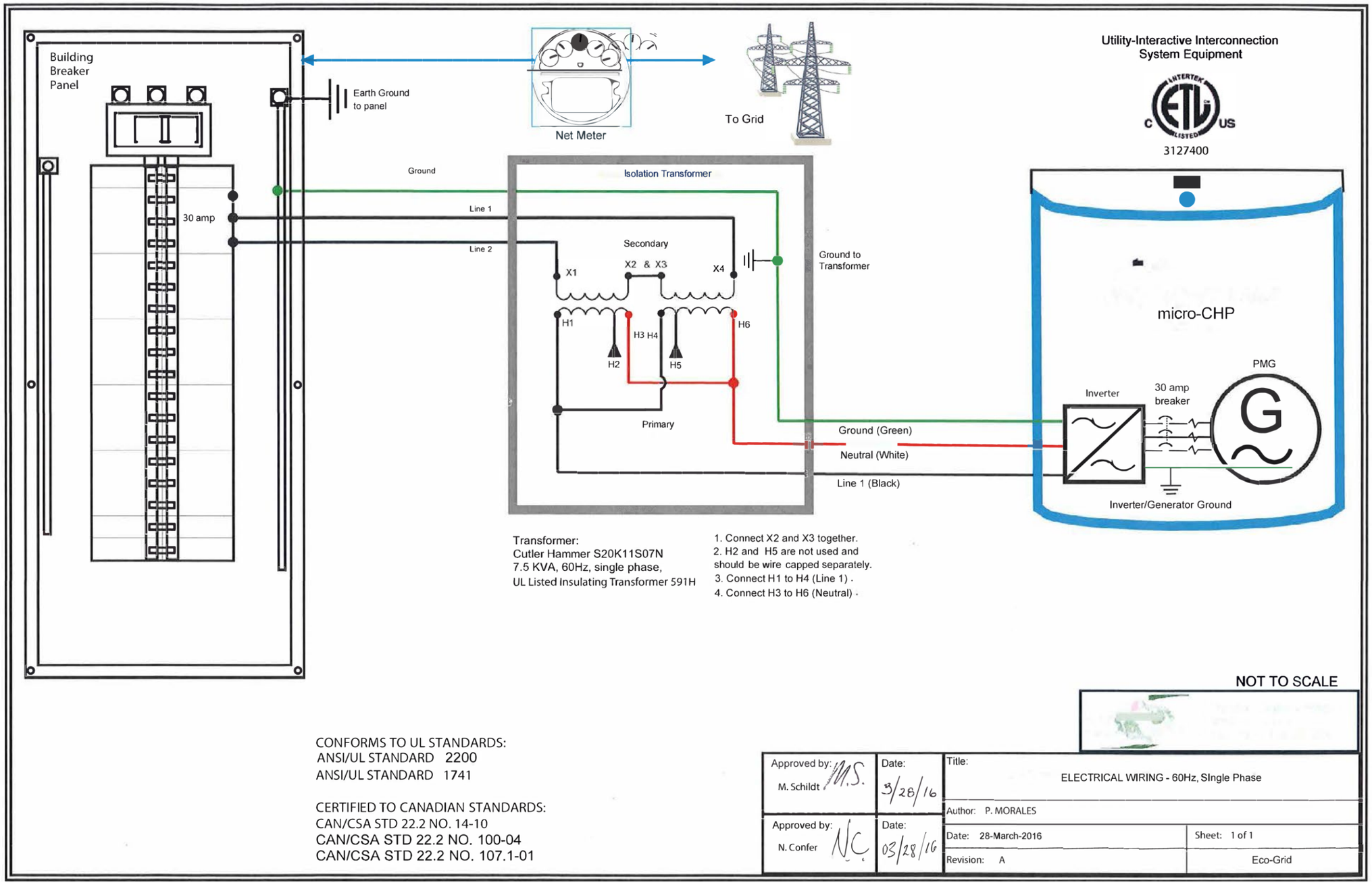

Figure A.4 microCHP Electrical Wiring - 60 Hz, Single Phase

Appendix B

1 mCHP
2 Buffer tank
3 mCHP pump
5 Hot water charging pump
8 Check valve
9 Automatic mixing valve hot water
10 Return mixing valve
10a Components to regulate the mCHP return temp
11 Cold water group
12 Safety valve
13 Air vent/separator
14 Expansion tank
15 Regulating valve
17 Thermostat
18 Strainer
19 Rinse connections
Odt - Outdoor temp sensor
Auxiliary boiler, modulating
Hcirc 1 pump - Heating circuit 1 hot water pump
Hcirc 2 pump - Heating circuit 2 hot water pump
RmT - Room temp sensor
RT H1 - Return temp heating circuit 1
RT H2 - Return temp heating circuit 2
ST1 - Top hot water temp
ST2 - Mid hot water temp
ST3 - Bottom hot water temp
FT Tot - feed temp total
FT H1 - feed temp heating circuit 1
FT H2 - feed temp heating circuit 2

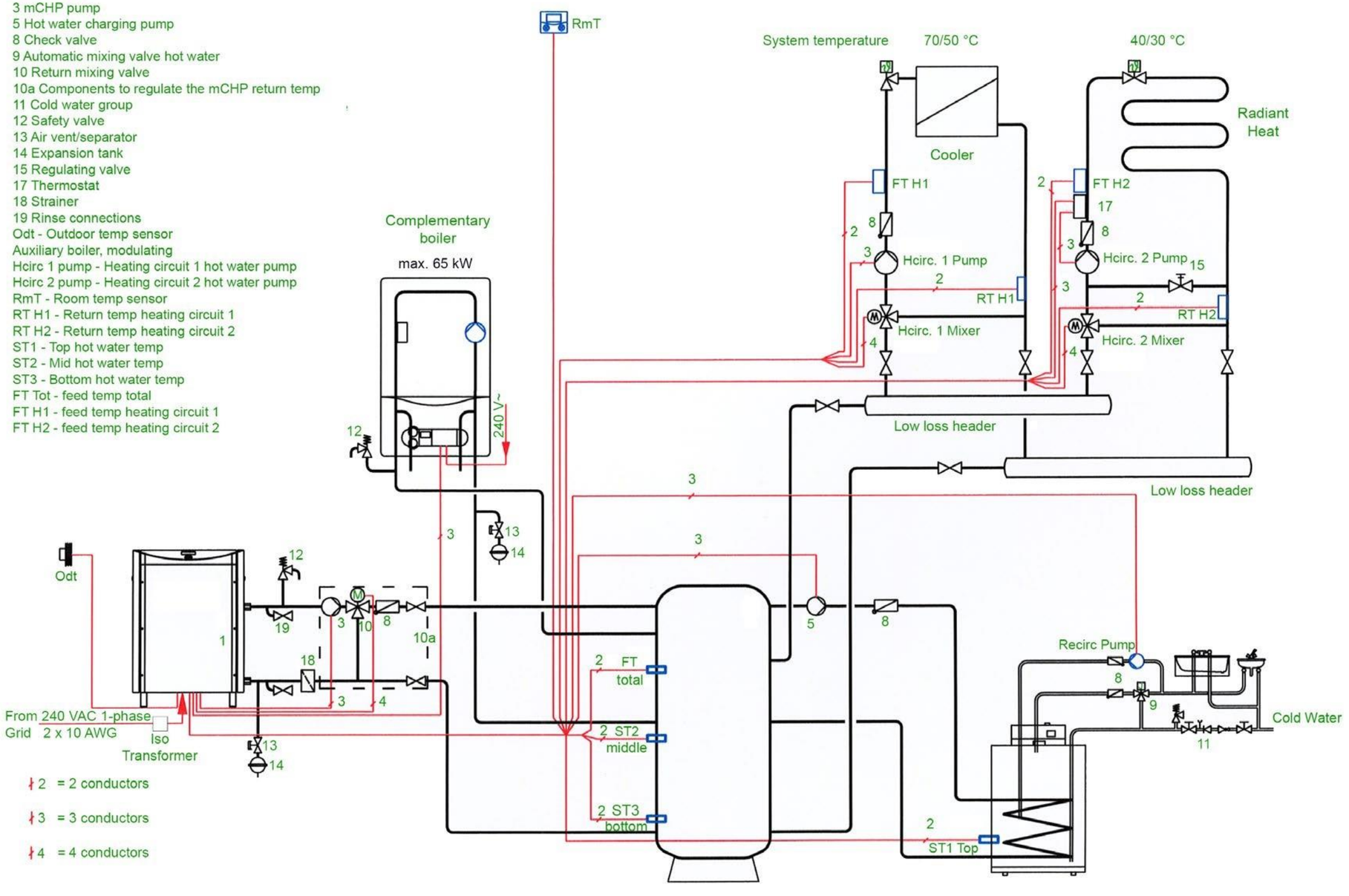

Figure B.1 Installation Layout Example 1

1 mCHP
2 Buffer tank
3 mCHP pump
5 Hot water charging pump
8 Check valve
10 Return mixing valve
10a Components to regulate the mCHP return temp
12 Safety valve
13 Air vent/separator
14 Expansion tank
17 Thermostat
18 Strainer
19 Rinse connections
Odt - Outdoor temp sensor
ST1 - Top hot water temp
ST2 - Mid hot water temp
ST3 - Bottom hot water temp

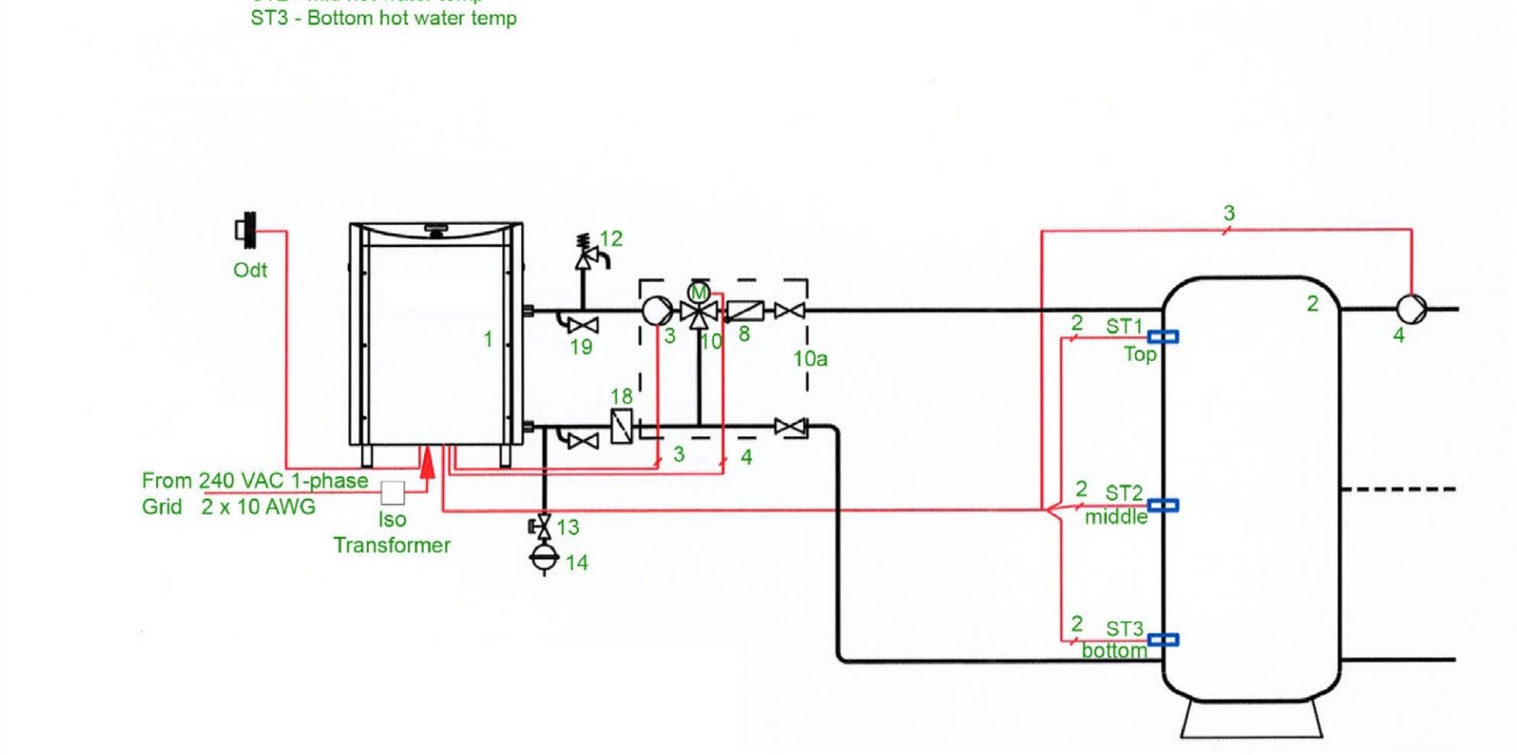

Figure B.2 Installation Layout Example 2

1a mCHP server
1b mCHP client
2 Buffer tank
3 CHP circulation pump
5 Hot water tank
8 Check valve
9 Portioning valve
10 Return mixer valve
10a Components to regulate the mCHP return temperature
18 Strainer
19 Thermostat
20 Rinse connections
27 Pump
31 Regulating valve
32 Trim valve
42a Safety valve
42b Expansion tank
Odt Outside temperature
Auxiliary boiler, modulating
H1 pump - Heating circuit 1 hot water pump
H2 pump - Heating circuit 2 hot water pump
RmT - Room temp sensor
RT H1 - Return temp heating circuit 1
RT H2 - Return temp heating circuit 2
ST1 - Top (or separate hot water tank) hot water temp
ST2 - Mid hot water temp
ST3 - Bottom hot water temp
FT Tot - feed temp total sensor
FT H1 - feed temp heating circuit 1
FT H2 - feed temp heating circuit 2

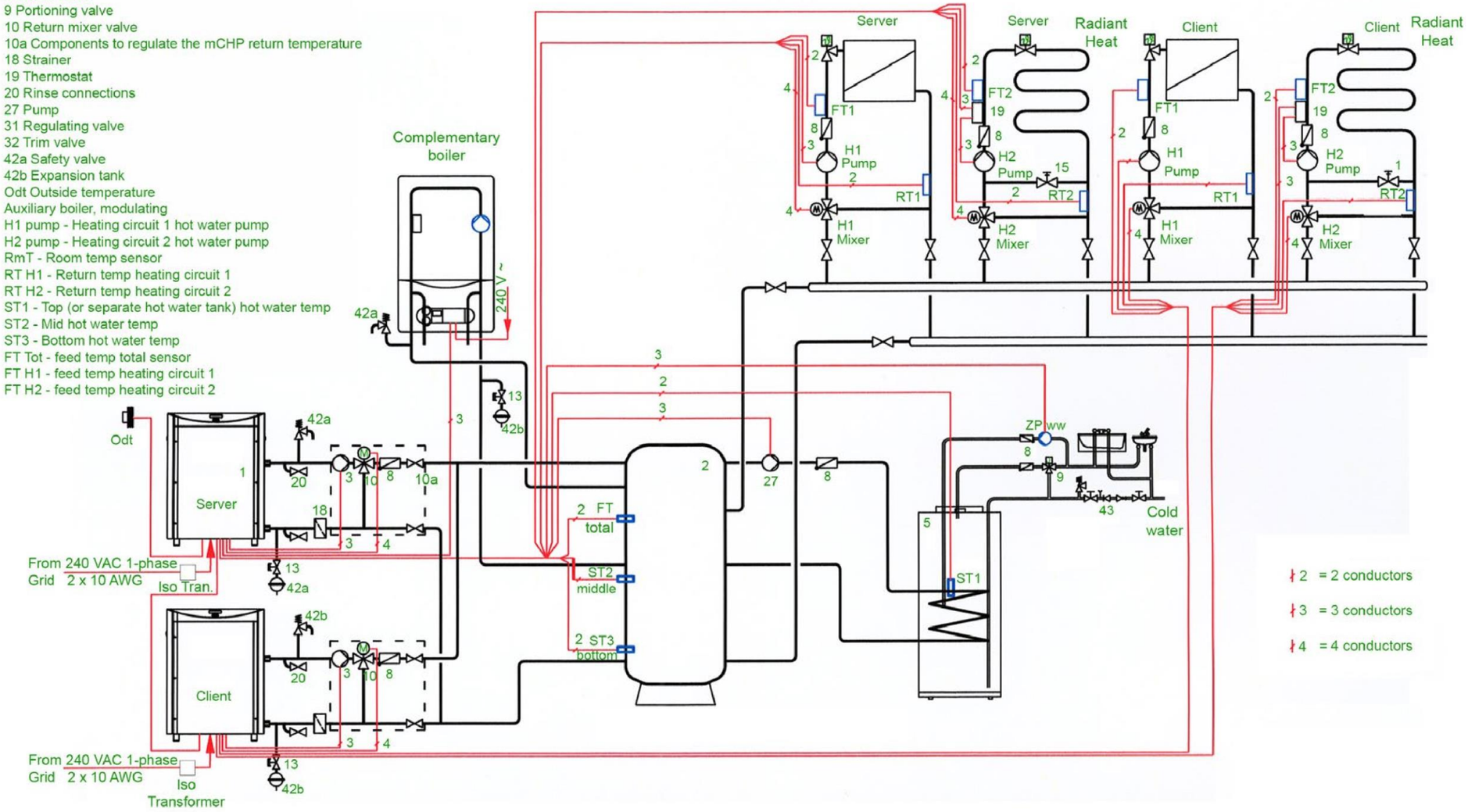

Figure B.3 Installation Layout Example 3