

TOTEM

Cogeneration (CHP) Range



TOTEM

Installation Manual

TOTEM 10 - TOTEM 20 - TOTEM 25



PRACTICAL, EFFICIENT & SUSTAINABLE
BUILDING SERVICES SOLUTIONS

Preliminary Warnings

It is strictly forbidden to tamper or carry out any kind of modification to the Product, replacement of components with non-original spare parts and/or any alteration to the original Product conformity unless approved by TOTEM ENERGY.

Every kind of modification and/or alteration to the chassis or internal components causes immediate suspension and/or exclusion of the Product Warranty.

For example but not limited to, before or after the commissioning of the Product, it is not allowed to:

- Drill holes in the chassis, canopy or any internal components of the Product;
- Weld or glue parts or components to the chassis or other parts of the Product;
- Modify electrical systems and/or internal devices of the Product;
- Transport and position of the Product not following manufacturer's recommendations;
- Electric earthing not in compliance with manufacturer's recommendations;
- Store the Product not in compliance with manufacturer's recommendations;
- Modify and/or Tamper with the software and/or the control parameters;
- Provide a power supply to the Product not following manufacturer's recommendations.

WARNING

In order to increase TOTEM unit running hours, meanwhile improving system efficiency and customer's savings, the starts of TOTEM should have priority over others heat generators. It's possible with a proper set up of temperature set point of the TOTEM and others heat generators.

In order to ensure product reliability it's user responsibility to make available a minimum thermal request to allow the properly TOTEM operation, so TOTEM must operate a minimum monthly average of 2 hours for each start cycle.



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1. General safety instructions

A. Symbols used in the guide



[Danger] This symbol indicates operating procedures whose incorrect performance can cause injury or even death.



[Warning] This symbol indicates operating procedures whose incorrect performance can seriously damage the equipment.



[Information] This symbol indicates important information related to the use of the equipment.

B. Glossary of terms and definitions

For the purposes of this Guide, Qualified Technician shall mean a trained professional possessing specialist technical expertise in the fields of heating systems, hot water production systems, electrical and electrical energy generating systems, combustible gas-fired plants and appliances equipped with Otto or Miller-cycle endothermic engines as well as components thereof. Such professionals must be licensed as required by the applicable laws in force in the place where the TOTEM® is installed.

For the purposes of this Guide, personal protective equipment (PPE) shall mean the following safety wear and equipment:

- hearing protections (earmuffs or earplugs) for the hearing protection of workers operating on the TOTEM® unit in operation with the sound insulation panels removed (which can be done solely for trouble shooting or maintenance purposes).
- protective gloves and goggles when working with battery acid, glycol and engine lubricant oil;
- safety shoes;
- dielectric face shield and gloves when carrying out operations on energized electrical parts.

C. Safety instructions



If you smell gas odor:

- turn your gas supply valve off;
- ventilate the room;
- do not operate any electrical device or appliance, including cell phones;
- leave the premises and call a qualified technician or the gas utility company immediately from a different location. If they are unavailable or in case of an emergency, call the local Fire Brigade;

- if the room is equipped with a gas leak detection system, please report any possible malfunctioning of said active safety equipment.



If you smell products of combustion:

- turn the appliance off;
- ventilate the room;
- call a Qualified Technician;
- if the room is equipped with a smoke/carbon monoxide detection system, please report any possible malfunctioning of said active safety equipment.



Installation, calibration and modification of the gas feed system must be performed by a Qualified Technician abiding by all applicable national and local standards as well as by the instructions provided in this Guide.



Installation, calibration and modification of the electrical system must be performed by a Qualified Technician abiding by all applicable national and local standards as well as by the instructions provided in this Guide.



Installation, calibration and modification of the water system must be performed by a Qualified Technician abiding by all applicable national and local standards as well as by the instructions provided in this Guide.



It is mandatory to connect the exhaust gas evacuation line of the appliance to an exhaust gas evacuation duct built in compliance with all applicable legal requirements in force in the place where the TOTEM® unit is installed. Failure to comply with said rule poses a serious risk to human and animal safety.



According to the provisions for use, the user has an obligation to keep the installed unit in good condition and to ensure the safe and reliable functioning of the micro cogenerator and of all systems connected thereto.



The user has an obligation to have the appliance maintained by a Qualified Technician in accordance with the provisions of this Guide and ensuring compliance with all applicable domestic and International standards. TOTEM ENERGY shall not be held liable for any damage to people, things or animals that may arise from incorrect installation or bad maintenance.



Before carrying out any maintenance activities as well as before opening the side panels, disconnect the appliance from the power mains and gas supply using all appropriate shut-off devices and switches.

-  Upon completion of any maintenance activity, before reconnecting the unit to the mains power, ensure that all of the unit's inner components are fully dry, free from any lubricant residues and that connection to the gas mains has been properly checked.
-  Before switching the unit on, always ensure that all protective panels and guards have been properly mounted to avoid risks to the safety of personnel.
-  Do not obstruct, not even partially, the suction duct and exhaust pipe ends.
-  Do not use or store any explosive, combustible or flammable materials in the same room where the micro cogenerator is installed.
-  All the drawings of electrical, water or gas systems installations contained in this Guide are merely indicative. All safety devices, auxiliary components as well as the diameter and section of cable ducts, water and gas pipelines must always be checked by a Qualified Technician for compliance with all applicable laws and standards.
-  This booklet is an integral and fundamental part of the micro cogenerator and it must be carefully kept by the user for future reference. In the event of a change of ownership of the micro cogenerator or of the premises where it is installed, please ensure that this booklet is handed over to the new user.
-  This booklet contains up-to-date information referring to the date it has been issued, without prejudice to possible amendments or technical updates. Since our products are constantly updated, slight differences may be found in pictures, process descriptions and technical data. If you wish to request the most updated version of this document, to suggest improvements or report any discrepancy, please contact the company.
-  This micro cogenerator must be used solely for the purpose it was expressly designed for, namely, the combined production of:
 - low voltage (400 volts) power for net metering, feed-in to the grid or self consumption depending on country of installation;
 - heating closed-circuit water systems for domestic and/or industrial purposes (heating and hot water).
-  TOTEM ENERGY shall bear no liability - either contractual or extracontractual – for any damages arising from the incorrect installation or use of the unit and, in any case whatsoever, from failure to comply with the manufacturer's instructions or with all applicable national and local laws.

-  For safety and environmental reasons, all packaging and parts thereof, fluids and replaced parts, if any, shall be disposed of in the appropriate separate waste collection centres under the applicable laws and rules of the place where the micro cogenerator is installed.

D. Potential safety risks

Risk related to Mechanical Hazards

Injuries from mechanical hazards can occur when the safety devices - panels or guards protecting the micro cogenerator's moving parts - are removed if required to perform a visual inspection, for failure diagnosis or when carrying out maintenance operations. Said activities must, therefore, be performed solely by qualified technical staff trained specifically for said purpose and wearing the appropriate PPE.

Risk related to Electrical Hazards

Electrical injuries can occur when safety devices are removed from the system, from the switchboard, or from the ignition system if required to perform a visual inspection, for failure diagnosis, when carrying out maintenance operations or during commissioning (e.g. functional testing).

Said activities must, therefore, be performed solely by qualified technical staff trained specifically for said purpose and wearing the appropriate PPE.

Before carrying out any maintenance or checking operations on the switchboard, power must be disconnected by shutting off the main power disconnecter upstream including by complying with the safety instructions affixed onto the switchboard.

The power factor correction capacitor can pose a danger, as residual voltage remains in the capacitor even after it has been disconnected from power. According to the safety instructions affixed onto the capacitor, you must wait at least 5 minutes before carrying out any operations on it.

Risk related to Thermal Hazards

During regular functioning, the temperature of some of the TOTEM®'s inner components such as the endothermic engine, heat recovery devices (exchangers), pumps, engine water and utility water pipes, exhaust gas pipes, and the exhaust muffler significantly increase – with some of them reaching 700°C.

Their temperature stays high up to a few hours after the TOTEM® is turned off.

The entire appliance must, therefore, work under safe conditions with frame panels properly mounted, thus preventing access to hot components.

Moreover, wherever possible, internal parts are heat-insulated, with the aim, amongst other things, of protecting workers in case panels have to be removed for visual inspection, failure diagnosis or maintenance purposes. Some areas remain, however, accessible and they must not be touched.

The aforementioned activities must, therefore, be performed solely by qualified technicians specifically trained to carry them out, wearing appropriate PPE.

Please remember that high temperature in the presence of potentially flammable substances can start a fire.



Risk related to Noise Hazards

In regular operation, the whole TOTEM® module must work under safe conditions with the frame's heat-insulation panels properly mounted. In the event of their removal for visual inspection, failure diagnosis purposes or during maintenance, suitable PPE ensuring 85 dB(A) level hearing protection must be worn.

Risk related to Vibration Hazards

The TOTEM® unit is fitted with suitably sized antivibration mounts to reduce vibration transmission to the structures and installations connected thereto. It is essential that antivibration couplings be also fitted onto connections with the gas supply grid, the exhaust fumes line and the heating system.

Risk related to Electromagnetic Radiation/Waves Hazards

The TOTEM® unit complies with Directive 2004/108/EC relating to electromagnetic compatibility. However, the electromagnetic fields from the asynchronous generator can cause disturbances temporarily affecting the functioning of electromedical devices such as, for example, pacemakers or hearing aids located in close proximity to it.

Risk related to Contact with Hazardous Materials and Substances

On the inside, the TOTEM® module contains chemicals that are essential to its proper functioning.

Namely, it contains substances such as battery acid, fresh/spent lube oil and glycol-water mixtures.

Any direct contact of these substances with skin and eyes must, therefore, be avoided at all times, in addition to complying with all and any safety standards for their storage and disposal.

In the event that you come into contact with these chemicals, you must thoroughly wash the affected body parts and seek medical advice if necessary, bringing the relevant Product Safety Data Sheet with you. Said substances may even be hot and cause skin burns.

When in operation, the TOTEM® module also produces a constant flow of exhaust fumes containing CO, CO₂, and NO_x content.

In the event of exhaust fumes build-up or leaks from the exhaust gas evacuation system, leave the area immediately and switch off the module if possible.

Based on the standards in force in the TOTEM®'s place of installation, you may also be required to install a CO/CH₄ gas detector in the module's room.

The TOTEM already has an incorporated CH₄ leak detector. Please contact our Technical Service for the detector's periodic calibration.

Risk related to Slip, Trip and Fall Hazards

Following breakdown or malfunctioning, lubricant oil, water-glycol fluids or battery acid leaks may occur, making the floor slippery thus creating a risk for falls.

Said spills must be readily contained and whenever possible disposed of according to the relevant laws in force.

Risk related to Unexpected Start-up Hazard

The TOTEM® start-up is governed by:

- the temperature of the user's water system;
- the Start contact;
- the Occupational Safety devices engagement;
- the emergency stop push-button.

Some of these controls may not be readily accessible to machine operators. Before carrying out any maintenance or fault detection activities, cut off the power and combustible gas supplies.

Risk related to Emergency stop/Emergency shutdown

The TOTEM® module is designed to stop immediately following the activation of one or more external safety devices connected to it.

Risk related to Power Supply Interruption

The TOTEM® is designed to enable an immediate safe stop function in the event of an interruption of the mains power supply. A suitable interface protection device – not supplied by TOTEM ENERGY - approved based on the applicable standards in the module's place of installation can implement the module's disconnection from power supply whenever the standards of applicable regulations are not met.

Risk related to Control Board malfunction/failure

The TOTEM® module is designed to enable an immediate safe stop in case of control board malfunction or failure.

Risk from Breakdown during Regular Operation

If kept intact, used for the purpose it was designed for ensuring compliance with the technical parameters set by TOTEM ENERGY as well as properly maintained, the TOTEM® is designed to work under conditions that are fully safe for machine operators and systems connected to it.

Hazards from Use in Environments at Risk of Fire/Explosion - EX

The TOTEM® is not intended for use in environments at risk of fire or explosion (Ex). Do not keep or store materials that may increase the risk of explosion or fire in the room where the TOTEM® is installed.



2. Introduction

A. General information

This Guide is intended to provide the necessary information for the designing and sizing of distributed generation systems incorporating the TOTEM® micro cogeneration units' TOTEM 10, TOTEM 20 and TOTEM 25 models.

Also, it provides detailed information on the units' components and on the requirements applicable to the auxiliary elements needed for the mCHP's installation, as well as directions for use and safety guidelines to comply with during operation.

TOTEM® micro cogeneration units are appliances that allow for the combined production of electricity and heat at the user's site, thus optimizing the use of the fuel's primary energy and reducing grid distribution and separate generation losses.

CHP units, indeed, can be easily integrated into any technological environment, enabling fulfilment of the heating requirements of different users in a variety of sectors:

- hospitality;
- wellbeing;
- catering;
- health-care;
- housing;
- public;
- agri-food;
- distribution chains.

Using a micro cogeneration unit allows to achieve significant economic savings and environmental benefits.

The heat produced in the endothermic engine's combustion process is almost fully recovered by means of a high-efficiency heat exchangers system and made available to users as hot water.

Thanks to its modern engine manufactured by FCA, specially engineered to run on gas and optimized to work under steady-state, the unit allows for optimized performance and longer maintenance intervals. Moreover, its modern Euro 6 technology enables a significant reduction of nitrate - NO_x - and carbon dioxide - CO₂ - emissions as compared to conventional condensing boilers.

WARNING

In order to increase TOTEM unit running hours, meanwhile improving system efficiency and customer's savings, the starts of TOTEM should have priority over others heat generators. It's possible with a proper set up of temperature set point of the TOTEM and others heat generators.

In order to ensure product reliability it's user responsibility to make available a minimum thermal request to allow the properly TOTEM operation, so TOTEM must operate a minimum monthly average of 2 hours for each start cycle.

TOTEM® units' compact size and versatility allows installation in tight equipment rooms and their use on existing premises, including with environmental or architectural constraints.

TOTEM® units can be linked to any BMS system via the MODBUS TCP communication protocol.

Moreover, a remote controlling systems allows to monitor and log data for power and heating load profiles.

B. Product ID

Each TOTEM® micro cogeneration module is fitted with a special plate on its front panel providing all details for its identification.

 1936-16 CE-1936CR5945	TOTEM asja group
microCHP	TOTEM 20
Serial number	
Construction year	2016
Weight	780 kg
Net electrical power (P_{el})	20 kW
Max thermal power (P_{th})	48.5 kW
Input power (Q)	64.1 kW
Inlet water temperature range	15 ÷ 70 °C
Outlet water temperature range	25 ÷ 80 °C
Max water pressure	10 bar
Tension	~400 V-3F
Frequency	50 Hz
Nominal current	30.6 A
Short circuit current generated	334 A
Max Short circuit current admitted	5.5 kA
Power factor	0.97
Electrical diagram	16110020A01
Max ambient temperature	40 °C
Max altitude	2,500 m
Appliance type	B2
Country of destination	GB
Appliance category	I2H
Gas supply pressure	20 mbar
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C. Technical datasheet

MODEL / PARAMETER		TOTEM 10	TOTEM 20	TOTEM 25
PERFORMANCE DATA				
@ data recorded at the rated electric power and water inlet of 70°C unless specified; methane @ 20mbar, the data related to LCV= 10.2 kWh/Nm ³ ; air inlet @ 25°C and 101.3 kPa				
Rated Power	kW	10	20	25
Self-consumption	kW	0.195	0.205	
Power modulation range	kW	≥5	≥7,5	
Rated thermal power	kW	21.6(25.2 ⁽¹⁾)	41.9(48.5 ⁽¹⁾)	50.2(57.6 ⁽¹⁾)
Electrical Efficiency (net)	%	29.6	31.2	32.5
Total efficiency (net)	%	93.6(104.3 ⁽¹⁾)	96.5(106.1 ⁽¹⁾)	97.8(107.4 ⁽¹⁾)
Seasonal space heating energy efficiency ⁽²⁾	%	200	226	251
Input power	kW	33.7	64.1	76.9
FEED GAS CIRCUIT				
Feed Gas		Methane		
Gas connection		G 3/4" Female		
Gas feed pressure	mBar	20 +/- 3		
Rated feed gas consumption	Nm ³ /h	3.31	6.28	7.54
WATER CIRCUIT				
User system's water max temperature at inlet	°C	15 - 70		
User system's water max temperature at outlet	°C	25 - 80		
Maximum working pressure	bar	10		
User's water system's flow rate	lt/h	2500	4000	5000
Exchangers circuit pressure drop	kPa	60		
Connection to user water's system at inlet		G1 ¼" Female		
Connection to user water's system at outlet		G1" ¼" Female		
ENDOTHERMIC ENGINE				
Manufacturer/ Model		FCA / Fire		
Displacement		1368 cc		
Rev number	RPM	1500	3000	
Shaft Power	kW	11	22	27
Carburetion		Stoichiometric ratio, with electronic control unit and lambda sensor feedback loop		
Combustion air flow rate	kg/h	45	85	105
EXHAUST CIRCUIT				
Exhaust gas temperature	°C	77		
Dry exhaust gas flow rate	kg/h	48	90	110
Max allowable back pressure	mBar	20		
Condensate flow rate	lt/h	0 (1.37 ⁽¹⁾)	0 (3.04 ⁽¹⁾)	0 (3.14 ⁽¹⁾)
Exhaust gas coupling [diameter]	mm	60		

MODEL / PARAMETER		TOTEM 10	TOTEM 20	TOTEM 25
GENERATOR/ELECTRICAL DATA				
Generator		Asynchronous - 4 poles	Asynchronous - 2 poles	
Rated apparent power [S=P/cos φ (=0,95)]	kVA	11	21	26.5
Efficiency class		IE3		
Insulation class		H		
Operation		In parallel with the grid, triangle		
Control system		Phase monitoring		
Frequency	Hz	50		
Output voltage		400 three-phase, no neutral		
Voltage to user	V	400 three-phase		
Power Factor ⁽³⁾		0.95		
Icc/In		7		
X"d		Not required for rotary async generators		
Generator's short circuit current contribution		7		
Reactive power – no load-	kW	3.5	7.3	
Capacitors capacity	KVAR	5	10	
Capacitors operating mode		Automatic		
Generators duty cycle		S1 – Continuous Duty		
Starting system		Stepper motor		
Operation interlock		The circuit breaker can operate a safety interlock		

SIZE AND WEIGHT

Length	mm	1924		
Height	mm	1283		
Width	mm	795		
Weight	kg	720	780	

AMBIENT CONDITIONS

Max ambient temperature	°C	-5 / +40		
Max relative humidity	%	75		

EMISSIONS

NO _x emissions (ref. to 5% O ₂)	mg/Nm ³	≤ 10		
CO emissions (ref. to 5% O ₂)	mg/Nm ³	≤ 10		
Noise emissions (measured at 1 mt.)	dB(A)	56.7	61.1	

LUBRICATION SYSTEM

Specific oil consumption	g/h	1/2	1/3	
Lubricant oil content	lt	Approx.4.5 in the circuit 21 reservoir for top ups	Approx.5.5 in the circuit 21 reservoir for top ups	
Lubricant Oil Type		Petronas Selenia Multipower GAS SAE 5W-40		



MODEL / PARAMETER		TOTEM 10	TOTEM 20	TOTEM 25
TOLERANCES⁽⁴⁾				
Fuel consumption tolerance	%		+/- 5	
Energy input tolerance	%		+/- 5	
Noise level tolerance	%		+/- 5	
Heat production tolerance	%		+/- 10	
MAINTENANCE INTERVALS				
Ordinary	Hours	3000		2500
Cylinder head	Hours	6000		5000
Engine replacement	Hours	30000	20000	15000
MINIMUM CLEARANCE FOR SERVICE AND REPAIR				
Sides	mm		800	
Front	mm		1000	
Back	mm		600	
Top	mm		800	
OPERATING MODALITY			Priority is given solely to heat production	
MODULATION			Available under request	
DISSIPATION SYSTEM			Not available	
ON-BOARD ELECTRICITY METERING EQUIPMENT⁽⁵⁾			IEC EN 50470-1, 50470-2, 50470-3 (2007)	
FW VERSION			Inverter not available (Not required)	
NETWORK ANALYZER				
Manufacturer			Schneider Electric	
Model			PM3250	

- ⁽¹⁾ Data refer to a user water temperature at inlet of 35°C and to machine operation using water without any anti-freeze additives, under steady state.
- ⁽²⁾ As defined by regulation EU No. 811/2013, EN 50465/2015.
- ⁽³⁾ Data referred to in asynchronous rotating machine not self-excited capable of operating with instantaneous power factor of $\cos\phi = 0.95$ in absorption of reactive and $\cos\phi = 0.95$ in supply of reactive.
- ⁽⁴⁾ Depending on type of gas, type of installation and on environmental conditions.
- ⁽⁵⁾ According to the provisions set forth in the "Guidelines for the implementation of Ministerial Decree 5/9/2011 – High Efficiency Cogeneration ". It cannot be changed by the user.

D. Size and overall dimensions

TOTEM® units are suited for installation outdoors with a cover/roof or in suitable plant rooms, in compliance with the provisions of Section 4.A of this Guide.

Their installation must fulfil all the safety and fire prevention legal requirements applicable to natural gas fired heating systems.

Section 5 of this Guide includes tables showing the TOTEM 10, TOTEM 20 and TOTEM 25's overall dimensions.

Dimensions are in mm.

E. Minimum clearance for service and repair

Clearance must be left around each TOTEM® unit so as to allow access for maintenance and repair purposes.

The minimum distance requirements to ensure proper functioning and maintenance are shown in the tables under Section 5.C of this Guide, in mm.

Further components in the systems, such as piping, pumps, and other auxiliary elements must be so positioned as to allow access to the TOTEM® module without hampering access for technician staff or causing a risk of tripping.

F. Noise emissions and vibrations

Thanks to its high-quality technical solutions and its high-performing sound insulation materials, the TOTEM® units feature low noise emissions.

The data shown in the technical datasheet are measured at 1 m distance, free-field, as per DIN 45635-01-KL 2 standards.

All units are fitted with flexible anti-vibration mounts suitably sized depending on user's applications.

It is recommended to use flexible couplings to connect the TOTEM® to the water system, feed gas and exhaust gas lines.

Despite its carefully selected sound-insulating, vibration-damping materials, when in operation the TOTEM® unit can generate small vibrations that may in some cases be transferred to surrounding structures.

For extremely sound sensitive applications, additional solutions may be necessary to further reduce noise and vibrations.

Some useful recommendations are listed hereunder:

- the exhaust gas discharge line must be built including the appropriate anti-vibe fittings, anti-vibration and sound insulating mounts complying with all applicable local regulations;
- if exhaust noise must be further reduced, the installation of a residential grade secondary silencer should be envisaged;
- the TOTEM® can be placed on an armed concrete platform, with an anti-vibration rubber mat in between the unit and the platform;
- if the units are placed on metal structures, please ensure that they are fitted with additional anti-vibration mounts whose features are compatible with the relevant vibration frequency, or install them if that is not the case;



- if additional sound insulating structures are to be built, please ensure that they are appropriately sized not to influence the amount of heat radiating from the TOTEM®'s frame and panels, nor alter the fresh air flow that enters into, circulates in and comes out from the unit's cabinet.

G. Atmospheric exhaust emissions

The TOTEM® unit's atmospheric emission measurements were taken at the labs of the Politechnic University of Milan under standard environmental conditions ($T_a = 25$ °C, $P_a = 101.3$ kpa).

H. Warehousing and storage

The TOTEM® module must be transported and stored away from excess moisture (max relative air humidity: 75%).

It must not be exposed to air containing high amounts of dust or halogens, acid or corrosive agents.

It must be kept in the original package until commissioning, ensuring protection from accidental bumps.

Units are not stackable, nor is it possible to place weights on top of them.

The TOTEM® Module is delivered by TOTEM ENERGY ready for indoor storage at a temperature ranging from 1°C to 40°C for a period not exceeding 12 months.

In case the TOTEM® has to be stored for longer or kept out of service for a continuous period of over 4 months, a protective treatment must be applied to the internal components to prevent oxidation or corrosion.

The procedure for long-term storage may vary depending on the features of the storage area environment; the treatment's effectiveness may also vary accordingly.

The procedure to perform, refresh or extend the long-term storage treatment is described in the TOTEM®'s Use and Maintenance Guide.

Failure to comply with the storage guidelines will nullify the product's warranty.

Before commissioning, the TOTEM® module must be checked for integrity of all of its components and proper functionality must be restored if necessary.

Please contact TOTEM ENERGY's Technical Support Service if required.

I. Specifications for the transport of the cogenerator

When handling or lifting the TOTEM® unit, please consider an overall weight of 720 kg for TOTEM 10 and 780 kg for TOTEM 20 and TOTEM 25. These weights include fluids – engine oil and water-glycol mixture - and all of the TOTEM®. unit's internal components.

Always keep the unit in horizontal position during transport and handling. The TOTEM® cannot be tilted or turned upside down. If is required to tilt the TOTEM® up to 45 degrees special tools are required and please contact TOTEM ENERGY's Technical Support Service.

Once put in its final position on its base, level the unit by adjusting the leveling feet.

TOTEM® units can be transported and/or lifted using forklifts, pallet trucks or hoists. When using forks to lift the unit the forks should enter the side of the unit so the forks can stick all the way through. Putting the forks in from the end will damage the base of the unit.

To lift the unit, you must use the pipes specifically designed for the purpose, suitably sized, provided alongside the unit, as reported in chapter 5.D



3. Module Main Components

Every TOTEM® module is the result of detailed engineering research and selected technological solutions combining high quality materials from specialist suppliers. A detailed description of the module main components is provided in the following sections.

A. Engine

FCA Fire 1.4 51 kW Bifuel Euro 6, four stroke, Otto cycle endothermic engine, fuel feeding system fitted with a Venturi and throttle for fuel injection adjustment; fuel injection is governed by a stepper motor.

Engine speed for the TOTEM® module 10 is set at 1,500 revs/minute.

Engine speed for the TOTEM® modules 20 and 25 is set at 3,000 revs/minute.

Displacement	cm ³	1368
Maximum shaft power	kW	51
Maximum Output Torque		104 Nm@3250 RPM
Arrangement / Number of Cylinders		L-NA / 4
Valves per cylinder		2
Compression ratio		11 : 1
Oil Pressure at 1,500 revs	bar	> 1.8
Oil Pressure at 3,000 revs	bar	> 3.5
Crankcase		Cast Iron
Cylinder head		Steel
Engine weight	kg	88

B. Suction system

Semi-airtight microgenerator sucking air from outside the box by means of synthetic fibre primary filter.

Combustion air is sucked into the unit's box by means of an original automotive filter fitted with a snorkel silencer. Airflow rate is adjusted by means of a brushless throttle body.

C. Gas feed system

The gas feed system features:

- UNI 11535 compliant corrugated stainless steel pipe;
- delivery system equipped with a zero-governor regulator and 2 safety solenoids;
- corrugated stainless steel flexible fitting for connection to the engine;
- rated fuel feed pressure 20 mBar (+/- 3mBar);
- mixing by mixer unit, air/fuel ratio stoichiometric regulation by means of a PLC-piloted closed loop stepper motor with Lambda sensor feedback signal.

D. Oil circuit

Lubrication circuit specially expanded for micro cogeneration applications, fitted with double filter with specialty mesh and brazed stainless steel exchanger for heat transfer from the engine water circuit (except TOTEM® 10).

The microgenerator is fitted with a dual oil tank for fresh and spent oil that automatically governs oil top up and replacement.

Pipes are made of stainless steel and silicon –based materials specific for applications with high-temperature engine oil.

E. Asynchronous generator

TOTEM 10 ASYNCHRONOUS GENERATOR – TECHNICAL FEATURES

Rated power	kVA	11
Electric power output	kW	10
Pole number		4 - 1500 RPM
Rotor		Squirrel cage
Cooling system		Liquid
Type of cooling fluid		water + glycol (max 30%)
Cooling circuit max pressure	bar	3
Max pressure drop with max flow rate	bar	0.5
Coolant temp. range	°C	30 - 75
Hydraulic In/Out threading/coupling size		1"
Installation environment temp. range	°C	-20 +60
Mechanical Design		B3/B5 (foot and flange mounting)
Direction of axis		horizontal
Terminal box position		On top, with cable exit holes on the back
Efficiency		91.7 (Efficiency class: IE3)
Power supply - Voltage - Frequency		Three-phase - 400V - 50 Hz
Insulation/Duty class		H/S1 – continuous duty
Rated power factor		>0.81
Winding connection		Delta/Wye 400/690 V
Height of axis	mm	160
Shaft diameter	mm	42
Length	mm	620 (shaft excluded)
Shaft length	mm	110

Compliance with standards:

- 2006/42/EC Machinery Directive;
- 2014/35/EC Low Voltage Directive;
- 2014/30/EC EMC Directive;
- IEC EN 60034;
- 1997/23/EC Directive.



TOTEM 20 ASYNCHRONOUS GENERATOR – TECHNICAL FEATURES

Rated power	kVA	21
Electric power output	kW	20
Pole number		2 - 3000 RPM
Rotor		Squirrel cage Brushless
Cooling system		Liquid
Type of cooling fluid		water + glycol (max 30%)
Cooling circuit max pressure	bar	3
Max pressure drop with max flow rate	bar	0.5
Coolant temp. range	°C	30 - 75
Hydraulic In/Out threading/coupling size		1"
Installation environment temp. range	°C	-20 +60
Mechanical Design		B3/B5 (foot and flange mounting)
Direction of axis		horizontal
Terminal box position		On top, with cable exit holes on the back
Efficiency		94.6 (Efficiency class: IE3)
Power supply - Voltage - Frequency		Three-phase - 400V - 50 Hz
Insulation/Duty class		H/S1 – continuous duty
Rated power factor		>0.81
Winding connection		Delta/Wye 400/690 V
Height of axis	mm	160
Shaft diameter	mm	42
Length	mm	620 (shaft excluded)
Shaft length	mm	110

Compliance with standards:

- 2006/42/EC Machinery Directive;
- 2014/35/EC Low Voltage Directive;
- 2014/30/EC EMC Directive;
- IEC EN 60034;
- 1997/23/EC Directive.

TOTEM 25 ASYNCHRONOUS GENERATOR – TECHNICAL FEATURES

Rated power	kW	26.5
Electric power output	kW	25
Pole number		2 - 3000 RPM
Rotor		Squirrel cage Brushless
Cooling system		Liquid
Type of cooling fluid		water + glycol (max 30%)
Cooling circuit max pressure	bar	3
Max pressure drop with max flow rate	bar	0.5
Coolant temp. range	°C	30 - 75
Hydraulic In/Out threading/coupling size		1"
Installation environment temp. range	°C	-20 +60
Mechanical Design		B3/B5 (foot and flange mounting)
Direction of axis		horizontal
Terminal box position		On top, with cable exit holes on the back
Efficiency		94.6 (Efficiency class: IE3)
Power supply - Voltage - Frequency		Three-phase - 400V - 50 Hz
Insulation/Duty class		H/S1 – continuous duty
Rated power factor		>0.81
Winding connection		Delta/Wye 400/690 V
Height of axis	mm	160
Shaft diameter	mm	42
Length	mm	620 (shaft excluded)
Shaft length	mm	110

Compliance with standards:

- 2006/42/EC Machinery Directive;
- 2014/35/EC Low Voltage Directive;
- 2014/30/EC EMC Directive;
- IEC EN 60034;
- 1997/23/EC Directive.

F. Engine-generator set

The endothermic engine and the three-phase asynchronous generator are coupled by means of a specially designed cast-iron bellhousing.

Motion transmission is achieved through a flexible coupling fitted with rubber mounts.

The engine-generator set is fixed onto its base through appropriate anti-vibration mounts that dampen the vibrations produced.



G. Heat recovery system

The TOTEM® unit is equipped with a high performance in-built heat exchange system that can recover heat energy from the generator, the engine water and oil circuits, and exhaust fumes. Temperature stabilization by thermostats is provided.

The system does not include any heat dissipator device.

Primary circuit/generator exchange: the heat recovery system is incorporated in the generator set canopy. Please refer to the "Generator" features section.

Engine oil/engine water exchange: the TOTEM® unit performs this function by means of a brazed AISI 316L stainless steel exchanger.

Engine water/user's primary circuit exchange: the TOTEM® unit performs this function by means of a brazed AISI 304 stainless steel exchanger.

Exhaust fumes/ user's primary circuit exchange: the TOTEM® unit performs this function by means of a brazed AISI 304 stainless steel tube bundle exchanger.

Engine water is pushed through the system by a high-efficiency circulator pump having the following technical features:

Power supply	V	230
Frequency	Hz	50
Max. current	A	< 2
Minimum inlet pressure		0.1 bar with fluid at 95°C
Fluid temperature	°C	-10 to + 95
Protection grade		IP X2D
Insulation class		H
Equipment class		I

The TOTEM®'s internal circuit size, flow rates, temperature deltas and circuit pressure values have been carefully calculated and set upon design. Any modification performed on the micro cogenerator's internal circuits will nullify the warranty.

H. Catalyst

Three-way catalyst on ceramic support suitably sized for gas-fired (methane) applications. Compliant with Euro 6 automotive standards.

I. Exhaust silencer

The TOTEM® is equipped with an in-built exhaust silencer developed to lower the frequencies from the micro cogenerator at the relevant rotational speed.

J. Electrical and control switchboard

In compliance with the legislation in force, the electrical switchboard holds the terminal block for connection to the user's systems, including the following available contacts:

- emergency stop input for temperature/pressure safety switches;

- machine Status (voltage free, maximum 250 V, 6 A) that can be used for feedback to the user's BMS or external relay contact;
- control switch for the external user's water system pump (voltage free, maximum 250 V, 6 A);
- fault signal (voltage free, maximum 250 V, 6 A);
- Service Due Signal (voltage-free, maximum 250 V, 6 A).

Through connection with TOTEM ENERGY's remote control platform's Gateway, the following machine parameters are shown:

- total Working Hours;
- electrical Power Output;
- total electricity produced;
- user system's water temperature at TOTEM® inlet;
- user system's water temperature at TOTEM® outlet;
- operating status (ON/OFF/RUN);
- alarm Status;
- lockdown Status.

The TOTEM® is governed by 3 control units:

- ECU (Engine Control Unit): manufactured by Magneti Marelli, it governs control of the endothermic engine. The control unit is set to work under steady state conditions and it interfaces through CANbus system with the MCU;
- MCU (Machine Control Unit) "Arya": developed to fit specific TOTEM ENERGY requirements, it governs the control and operation of the TOTEM® unit through an interface with the ECU via CANbus and with the Gateway. Also, it is connected with MODBus RTU to a multi-function multimeter that conforms to a 0.5s accuracy class in compliance with IEC 62053-22 standards;
- Gateway: unit for data communication to external networks. It governs data transmission to the in Cloud remote control platform and to external BMS if present. It communicates according MODBus TCP/IP standards via LAN, Wi-Fi, GSM and CANBus with MCU.

K. Condensate Silencer

The condensate silencer box collects moisture from the capacitor and exhaust lines, thus lowering noise emissions from the exhaust gas discharge. It is made of AISI 304 stainless steel. A water trap is required on the condensate discharge drain as near as possible to the unit.

L. Power output meter

Multi-function Multimeter conforming to the 0.5 s accuracy class in compliance with the IEC 62053-22 standard.



M. Automatic power factor correction unit

Power factor correction capacitor bank automatically controlled by the TOTEM® module's PLC.

N. User interface

Through the Gateway control unit, the module is also equipped with a Wi-Fi Hot-spot for connection via mobile devices, notebooks or tablet providing a full view of the control interface (also available via the web in Cloud, by subscribing a maintenance service contract).

O. Frame and panels

Frame with self-supporting base, made of press-bent steel panels. Panels are powder-coated with polyester based RAL 7040 (silver) coating.

4. Installation

A. Requirements for the installation room/area

The selected installation site must comply with all applicable provisions. A list of applicable laws is provided hereunder by way of non – limiting example:

IGE/UP/3 Edition 2	Gas fuelled spark ignition and dual fuel engines
IGE/UP/10 Edition 4	Installation of flued gas appliances in industrial and commercial premises
BS 6644:2011	Specification for the install and maintenance of gas fired hot water boilers rated inputs between 70 Kw and 1.8MW.
BS 5440-1:2008	Flueing and ventilation for gas appliances of rated input not exceeding 70kW net (flues)
BS 5440-2:2009	Flueing and ventilation for gas appliances of rated input not exceeding 70kW net (ventilation)
BS/EN 1856-	Chimneys- requirements for metal chimneys part 1: system chimney products. Chimneys- requirements for metal chimneys part 2: metal liners and connecting flue pipes.
BS/EN 15287-1	Chimney – Design, installation & commissioning of chimneys- Part 1: Chimneys for non-room sealed appliances.
BS/EN 13384 -2	Chimney- Thermal & fluid dynamic calculation methods part 2: Chimneys serving more than one heating appliance.
Clean air Act	For Multiple CHP unit application where total heat input exceeds 366.4 Kw (OR 150 Kw as advised within CAAM, refer to local authority.)Section D1: Height of chimney termination.

TOTEM® units are suited for installation outdoor or in suitable plant rooms, in compliance with all applicable safety regulations and provisions.

The unit's heat/sound insulated frame and cabinet provide protection of its internal components from the weather.

However, the module's combustion air suction ducts must be protected from direct exposure to heavy rain or air with high levels of relative moisture (>75%), from acids or corrosive agents and highly concentrated particulate matter or dusts. Moreover, we advise against exposing the TOTEM® module to direct sunlight in strongly sunlit areas.

The proper amount of air for recirculation in the room – which exceeds the requirements of BS6644 and IGE/UP/10 – must also be provided mechanically or through suitably sized openings in the building envelope. The details of which are found on page 27.

The unit is typically supplied to ensure proper functioning within ambient operating temperatures between 1°C and 40°C.

For applications with ambient temperatures that may, even occasionally, be equal to or lower than 0°C, it is mandatory to provide frost protection for the heating system water.

For applications in areas with ambient temperatures that may, even occasionally, get lower than -15°C, it is mandatory to provide additional protection for the micro-generator's internal antifreeze circuit . Please contact the TOTEM distributor.

The selected installation site must comply with all applicable provisions.

Applicable standards make provision for two types of installation premises:

- outdoor;
- plant rooms.

Outdoor installation

Units installed outdoor must not be placed at a distance shorter than 3 meters from combustible substances storage areas. The unit should be sited in an area away from the public, and must be fenced off to prevent vandalism. It must be installed on a concrete base high enough to ensure there is no danger of the snow or water level reaching the machine. The area must be kept clear of leaves by design or by maintenance. A roof or cover must be installed over the unit to keep it out of direct sunlight.

For safety reasons, it is vital to ensure that all openings (combustion air suction ducts, power cables inlets/outlets on the control board, heating, water and gas systems connections) are protected from insects or small animals intrusion.

Also, the presence of possible sources of particles/pollens that may cause an early clogging of the primary air filter and the unit's air filter must be checked.

When installed outdoors consideration must be given to frost protection of the unit and the system. This can be accommodated by filling the building water system with a glycol mix or providing a frost protection controls system which can be advised by the supplier. Additionally, a roof or cover is required to prevent against exposing the TOTEM® module to direct sunlight. The module's combustion air suction ducts must be protected from direct exposure to heavy rain or air with high levels of relative moisture (>70%), from acids or corrosive agents and highly concentrated particulate matter or dusts.

All Installations

Regardless of the installation type, the following general rules for installation must be observed at all times:

- the access way to the room must be at least 800 mm wide and 1300 mm high to allow transport of the frame structure;
- a properly sized access way must always be available for maintenance personnel,
- stairs, angles, or corridors, if present, must not prevent access to the equipment room;

- if Totem is placed in raised and/or cellar room, the access to the floor and the lifting of materials must be done with adequate lifting equipment in compliance with the safety conditions.
- the ground surrounding entrance to the equipment room must facilitate using transport systems such as pallet trucks or lift trucks;
- the plant room must be suitable for the installation of internal combustion engine working under steady state conditions;
- proper ventilation must be granted in the equipment room (Air recirculation > 600 m³/hour);
- the module's combustion air suction ducts must be protected from highly concentrated particulate matter, moisture or dusts.
- the units must never be installed in way of the air openings of boilers or other pre-existing generators or block the air flow designed to go into the latter;
- in addition to the power supply line for connection to the MCHP, a secondary 230V (single-phase) line must be provided for supplying maintenance equipment;
- the equipment room must be kept free from moisture and dust; temperature in the room must always be kept below 40°C under any weather conditions outside;
- the unit is very quiet; please check, nevertheless, that the room chosen for its installation does not amplify its noise emissions; if adjacent rooms are noise sensitive consideration should be given to a different location. An inertia base can be used to prevent vibration on upper floor installations.
- always use flexible couplings for connection to the water and exhaust gas systems to prevent vibrations from being transferred to the building's systems and structure;
- the room lighting system must comply with the laws and regulations applicable in the place of installation, ensuring suitable light conditions for the technical support staff on site for maintenance operations. The minimum light level recommended is equal to En: 200 lx (Maintained average illuminance); G: E (limiting glare quality class); Ra: 60 (Color rendering index group); during maintenance operations, a EN 1837 compliant portable battery operated lamp has to be made available;
- the room must be fitted with an auxiliary lighting system that is automatically engaged in case of a black-out (Emergency Lights).

Ventilation

The TOTEM® appliance uses the following combustion air volumes: 45 kg/h for the TOTEM® 10, 85 kg/h for the TOTEM® 20 and 105 kg/h for the TOTEM® 25, respectively. CHP units require additional ventilation which is beyond the requirements of BS6644 and IGEM/UP/10. The Totem T10, T20, and T25 each require 600 m³/hr of ventilation for combustion and cooling. For mechanical ventilation systems the ventilation rate for all other gas appliances should be calculated separately and then added to the 600 m³/hr required for the Totem unit.



Passive ventilation can typically be considered to provide 600 m³/hr if there is free vent area of 1000 cm² high and 1000 cm² low. If utilizing passive ventilation then any additional gas appliances should be calculated separately and added to the CHP requirement for low and high. Such air flow inlets must not interfere with pre-existing openings, if any, created for other devices or heat generators.

When other appliances are sited in the plant room with the TOTEM® a full ventilation calculation should be carried out. The plant room's ambient operating temperature must range between >0°C and 40°C. For applications with ambient temperatures that may, even occasionally, be equal to or lower than 0°C, it is mandatory to treat the user system's water properly and add an anti-freeze solution in suitable concentration or provide another means of suitable frost protection.

For applications in areas with ambient temperatures that may, even occasionally, get lower than -15°C, it is mandatory to properly treat the micro-cogenerator's internal circuit coolant, too. Please contact your supplier.

If plant room temperatures exceed 40°C in the summer at least 0.2 cm² / kW / degree C of temperature reduction required should be added. The high and low level ventilation should be direct to outside on the same wall. The vertical distance between high and low level ventilation should be as great as possible to achieve convection flow.

B. Base/foundation features

TOTEM® units must always be placed on a flat, even base capable of withstanding their weight (the unit's static mass is equal to 720 kg TOTEM 10 and 780 kg TOTEM 20 and TOTEM 25).

Please refer to applicable local laws if units have to be installed in areas with seismic or hydrogeological risk, or subject to landscape planning restrictions or other types of restrictions.

If necessary, a raised armed concrete base must be built.

If necessary, a layer of anti-vibration material can be inserted between the floor/foundation and the base.

Do not place the unit on movable bases.

C. Flue (Exhaust line)

The flue for exhaust gases must be built in compliance with the local applicable provisions of the place of installation, ensuring that there is no exhaust gas build-up in the equipment room/installation area or in adjacent spaces.

The TOTEM® is equipped with in-built:

- condensate box with silencer;
- main silencer;
- connection to the discharge lines with 60 mm diameter ending.

A suitably sized flexible stub must be used at all times to connect the TOTEM® to the exhaust gas discharge lines.

The flue pipe should be designed by taking the following requirements into account:

- the maximum exhaust gas temperature achieved is below 100°C and protected by an overtemperature cutout; it is recommended to use T120 flue;
- the maximum exhaust gas flow rate is 48 kg/h for the TOTEM® 10 module, 90 kg/h for the TOTEM® 20 module and 110 kg/h for the TOTEM 25 module, respectively;
- exhaust back-pressure measured at the module's outlet and the overall back-pressure for the entire fume discharge line must never exceed 5 mBar; it is required to use flue rated to at least H1, 5000 Pa.
- the TOTEM® is equipped with a condensate drain that must be connected to a suitable condensate trap and drainage line capable of preventing possible exhaust gas leaks;
- further condensate traps will have to be provided along the exhaust gas discharge line for long piping sections or exhaust gas discharge lines exposed to significant temperature changes;
- All traps must be water traps. Dry traps are not suitable for flue. All traps should be as close to the flue drain point as possible.
- in multiple installations including more than one TOTEM® unit, each of the units must have its own, independent flue unless permission is granted by manufacturer or agent;
- the flue pipe for the TOTEM® unit cannot be in common with other heat generators (boilers, stoves, ventilation ducts) even if working intermittently or alternatingly with the unit;
- the exhaust gas discharge line must be fitted with a service socket for emissions analysis and machine calibration; the service socket should be positioned approximately 1 meter from the TOTEM® exhaust line connection;
- there are no restrictions as to the type of materials that can be used to build the flue pipe (AISI 304, AISI 316, PPe, PPs) provided that they feature the necessary levels of resistance to high temperatures and corrosion from exhaust gas and condensate. Also, compliance with maximum discharge line back-pressure thresholds has to be ensured;
- there are no restrictions as to the length of the exhaust gas discharge line provided the maximum exhaust back-pressure thresholds set are complied with. Should an extension of the exhaust line cause an increase in pressure drop, it is possible to increase the diameter of the entire exhaust discharge line.

The flue system can be provided by the distributor in UK. The unit is supplied with a standard flue kit including an appliance adapter, flexible connector, test point, silencer, silencer adaptors, and three 1m lengths of flue as well as two 90 degree bends. This can be put together to supply the flue between the unit and the silencer with a maximum length of 3 m and 3 90 bends in 80 mm flue. The silencer can be mounted vertically or horizontally, for vertical mountings the unit should be supported with the rubber lined clips and M10 threaded bar no longer than 200 mm. After the silencer, the flue diameter must be increased to 110 mm and the maximum lengths when using the flue supplied by the distributor are given below.



110 mm flue pipe:	T10	T20	T25
Total Equiv Length	50 m	50 m	50 m
90 Bend	-0.8 m	-1.1 m	-1.7 m
45 Bend	-0.2 m	-0.3 m	-0.5 m
Vert Terminal	-1 m	-1 m	-1.6 m
Horiz Terminal	-1 m	-2 m	-3.1 m

The drawings provided in Section 6.A of this Guide shows an example of implementation of the exhaust gas discharge line. All measures shown are in mm.

Termination of the flue must be done under the guidance of IGE/UP/10. It is vital that when using horizontal terminals they must be at least 3m above ground level. The noise level from the terminal is minimized through use of the flue silencer, however in noise sensitive areas, for example near bedrooms, it is recommended that horizontal terminals are avoided and the flue should terminate above the eaves. In the case that this is not possible then a second flue silencer can be installed.

D. Condensate drain

TOTEM® modules include in their chassis a condenser that cools down exhaust gases, thus optimizing overall heat recovery performance.

The amount of condensate produced depends on the temperature of the user water in the return line, and it can range from 0 to 1.37 lt/hour for the TOTEM® 10, and from 0 to 3.04 lt/hour for the TOTEM® 20 and from 0 to 3.16 lt/hour for the TOTEM 25.

The condensate produced under standard conditions with natural gas from the grid has the following features:

- pH ranging from 4 to 5;
- sulphides: <0.1 mg/l (as H₂S);
- sulphates: < 32.6 ± 5 mg/l (as SO₄);
- chlorides: < 3.3 ± 0.9 mg/l;
- COD: < 15 mg/l O₂;
- fluorides < 1.5 mg/l;
- ammoniacal nitrogen: < 0.5 mg/l (as NH₄);
- Total surfactants: < 0.4 mg/l.

According to the condensate's characteristics and level of acidity, the possibility of its disposal into the sewage network in compliance with the regulations applicable in the place of installation must be investigated. Under no circumstances whatsoever can it be disposed of through open air discharge systems.

The condensate drain pipe must never be obstructed.

The condensate drain must be trapped in the pipework to ensure exhaust gases cannot be released through the condensate drain pipe into the building causing poisoning or oxygen depletion.

Do not discharge condensate in an area subject to water accumulation.
 Ensure that condensate is disposed of properly by facilitating its drainage with a suitable drainage point.
 Whenever possible, connect the condensate drain to the sewage network, ensuring compliance with the relevant laws in force.
 If condensate is discharged to the ground it should be through a soakaway filled with lime chippings to ensure that it does not damage foundations, asphalt or floors.
 The drain pipe must have a minimum slope of 1/50 and minimum diameter of 1.25 inch.
 Avoid reversing the slope direction in the condensate drainage line.
 Condensate drainage pipes must be protected from accidental damaging.
 The condensate drainage system must be protected against possible water back flow from the drain/siphon.
 In areas that are subject to cold weather, further measures must be taken to prevent condensate from freezing.
 Check the condensate drain for possible exhaust gas leaks. Failure to do so may cause a risk of poisoning from carbon monoxide.
 Use drains or siphons with a suitable waterhead.
 The condensate drainage duct must be connected to the TOTEM® unit by means of a flexible coupling.
 An example of condensate drainage line is shown in the drawings under Section 6.B of this Guide. All measures are in mm.

E. Fuel gas feed line

The fuel gas feed line must always be installed by a qualified technician who is licenced to issue a declaration of conformity with all applicable standards in force in the place of installation.
 The section connecting the fuel gas feedline to the TOTEM® must be built with flexible pipes that comply with the applicable standards of the place of installation. Such flexible pipes must absorb vibrations, so as to avoid breakage due to torsional stress and/or fatigue. The gas isolation valve must be up stream of the flexible appliance connector.
 All gas feed pipes must successfully pass a gas tightness test according to the relevant regulations in force in the place of installation.

The feeding pressure for the TOTEM® unit can range from 17 to 23 mBar. In case the feeding pressure available in the network exceeds the maximum allowable value, the installation of a fuel gas pressure reducer must be envisaged. Such pressure reducer must ensure a constant flow rate of at least 10 Nm³/h. Depending on gas quality, the installation of a gas filter must be envisaged for particulate matter size above 5µm. Said filter must ensure a constant flow rate of at least 10 Nm³/h and a filtering capacity equal to 5 µm or higher.

In the case of medium or high pressure gas supply a pressure regulator must be placed before the valve and the flexible coupling.



The Totem controls include for an optional safety output that can be used to power a solenoid valve. The opening/closing of the solenoid is interlocked with the Totem safety chain to provide additional gas supply protection where necessary.

For multiple installations, each TOTEM® unit must have its own filter and pressure regulator.

A list of devices to be installed on the gas feed line according to applicable regulations is provided hereunder by way of non – limiting example:

- manual reset fuel gas shutoff solenoid valve;
- a dielectric union fitting;
- a manual shutoff valve.

An example of fuel gas feed line is shown in the drawings provided in Section 6C of this Guide. All measures are in mm.

F. Connection to the user's heating and water systems

The water circuit components for connection to the user's water system must be installed by a qualified technician in compliance with the regulations in force in the place of installation. All the relevant declarations of conformity must be issued for all devices provided and all systems installed.

The TOTEM® unit must be connected to the system by means of flexible couplings. Said flexible couplings must be capable of absorbing vibrations, so as to avoid breakage due to torsional stress and/or fatigue.

The unit's water inlet and outlet are designed for connection to a primary closed loop circuit linked to a storage system with a maximum pressure of 10bar.

TOTEM®'s process water cannot be directly drawn off the domestic hot water or drinking water circuit. Appropriate hydraulic separation systems must be installed for said applications.

The following must also be provided:

Safety Devices

Please refer to the applicable regulations in force in the TOTEM® module's place of installation to ensure compliance therewith.

- Safety overpressure switch (if required in your Country);
- Safety overheat thermostat;
- Temperature and Pressure gauge;
- Safety valve, including with a tundish

Expansion Vessel

This device is vital for ensuring the proper functioning of the user water system and of all devices connected thereto; also, it is required by regulations in force. Tank size must be chosen depending on the system's operating parameters, including the following:

- overall water volume circulating in the circuit (including heating appliances, collectors, pipes, storage tanks, etc.);
- as a precautionary measure, a larger size must be preferred;
- circuit minimum and maximum temperature;
- circuit minimum and maximum pressure.

The TOTEM® contains less than 40 litres of water. A rough rule of thumb is that the expansion vessel should be equal to 10% of the volume of the system assuming pressure below 4 bar and temperatures no higher than 80C.

Dirt Separator and Y Strainer

We recommend installing a magnetic dirt separator and a Y strainer, whose size must be chosen depending on the circuit's flow rate and volume, to reduce the amount of sand, ferrous particles and dirt that may lower the system's performance and negatively affect TOTEM® module's reliability.

The Y strainer and dirt separator must be maintained regularly, taking special care with maintenance immediately after the micro-cogenerator's commissioning.

Deaerator

Depending on the system's design it might be necessary to install one or more deaerators to remove air bubbles and micro-bubbles from the circuit.

According to good practices a deaerator must always be mounted on the feed pipe right after the heat generator, where the fluid reaches its highest temperature. This is done for the purpose of removing the micro-bubbles of air that are formed as water is heated up. We recommend using a deaerator fitted with shutoff valves so as to allow for its maintenance. If left within the system, air can lead to corrosion on the piping's and exchangers internal parts, malfunctioning or failure of system components such as circulators, in addition to making heating appliances less energy efficient and more noisy.

Pressurisation unit

Installation of an automatic filling unit is recommended; such a device automatically fills the system up to the pre-set pressure.

A filling unit is particularly useful in compensating for any pressure decreases resulting from the discharge of air from the circuit via air vent valves.

Filling units can be used:

- to set the pressure based on the system requirements;
- to stop the filling of the system once the pre-set pressure is reached;
- to block any possible backflow, even in the presence of a pressure decrease within the water supply line, once the filling of the system is completed.
- In all circumstances a pressurisation unit should be installed with a water meter on the mains connection for analysing the water consumption of the system and identifying if leaks are present.



Hydraulic separator/compensator

In all cases it is necessary to install an appropriately sized hydraulic separator/compensator such as a low loss header or buffer vessel on heating water systems featuring multiple circuits fitted with multiple pumps working in parallel, to prevent the pumps serving the different circuits from interfering with each other.

Swing /Clapper check valve

To avoid backflow issues, we recommend fitting the feed pipes to circulation pumps with swing or clapper check valves so as to ensure a one-way flow.

Buffer storage tank

The size of the buffer vessel must be selected based on the loads and user systems downstream of the unit.

However, a nominal volume of at least 50 liters of water for each kW of heat capacity installed must always be made available for the TOTEM® unit alone.

If the user's primary circuit features large water volumes, due to large sized-piping, the storage volume required can be reduced.

By way of example, a TOTEM® 20 with a 42 kW heating output shall need an available storage volume of around 2000 litres of water.

It is advisable to install the buffer vessel as the low loss header or on the user's system return line.

In case of multiple installations, it might be necessary to fit a buffer vessel for each individual module. Vessels should have serial connections, avoiding reverse return or parallel arrangements.

The buffer vessel is a thermally insulated tank with no coils, connected to the module's user system's return line with a special pump, enabling regular operation of the microgenerator by avoiding interruptions due to no/reduced heating demand by the user system.

As the demand for heating varies or stops, the micro cogenerator keeps working by feeding energy to the inertial storage tank, where it will be stored.

The buffer vessel improves the overall system performance in terms of energy saving, as well as the efficiency and reliability of the TOTEM® module by avoiding quick, repeated on/off cycles.

Furthermore, an appropriate heat energy reservoir enables CHP to replace other heat generators, including with a higher heat output than a TOTEM® module, that are sized based on peak demand alone.

Circulator pump

The user's primary circuit must be fitted with a circulator pump capable of delivering the heat output made available by the TOTEM® module to the user's circuit.

Exchanger

The user's water circuit in the TOTEM® is entirely made in AISI 304 and AISI 316 stainless steel, pressure resistance grade PN10.

It is a device designed to be supplied directly with water from the user system return line with no need to install an exchanger for hydraulic separation.

If the TOTEM® is installed in pre-existing heating systems that may be subject to deterioration, including corrosion, algae formation, limescale build-up, or dirt deposits;

or whenever heat must be provided to domestic hot water, drinking water systems, or process water having such acidity/alkalinity levels or salt content that make it non compliant with the user's water requirements set forth in Section 4.G, a suitable hydraulic separation device (exchanger) shall have to be installed to protect the TOTEM® 's inner circuit from possible damages or carrier fluid alterations.

Piping

There are no restrictions as to the type of pipes for the user system, provided that the materials they are made of are compatible with the carrier fluid's temperature and characteristics.

However, pipes must be fitted with a suitable insulation coating, so as to optimize TOTEM®'s heat output and avoid heat dispersion.

Particularly lengthy or complex user circuits may increase pressure drop; special care must be taken in ensuring they are properly sized, taking into account the head and flow rate of the pump serving the user circuit.

The water circulation system's final design must comply with the rules set forth by the regulations in force in the place of installation.

Anti-vibration flexible pipes must be placed between the user system and the TOTEM® 's hot water inlet and outlet.

The pipes minimum diameter must be chosen according to the flow rate limits and pressure drop characteristics of the system.

Reference must be made to Section 6.D of this Guide. All measures are shown in mm.

G. User system's water features

TOTEM®'s process water cannot be directly drawn off the domestic hot water or drinking water circuit. Appropriate hydraulic separation systems must be installed for said applications.

The water used in the user circuit must fulfil the requirements provided in the UNI 8065:1989 standard setting forth the following chemical and chemical/physical parameters for water in heating systems for civilian applications:

- clear appearance;
- pH above 7 (below 8 for the user system's sections made in light alloys, if any);
- iron (as Fe) < 0,5 mg/kg (higher values indicate presence of corrosion that must be removed before connection to the TOTEM® unit);
- copper (as Cu) < 0,1 mg/kg (higher values indicate presence of corrosion that must be removed before connection to the TOTEM® unit);
- low limestone content, with a total water hardness between 150ppm and 250ppm, based on the installed capacity and the system's overall content; lower is better.
- fill the heating system with water having a low limestone content, with a french degree of water hardness between 15°F and 25°F, based on the installed capacity and the system's overall content;
- also, it makes mandatory to install a suitable water treatment system on heating systems

The limits set by the aforementioned provisions are to be supplemented by legal provisions and regulations in force in the place of installation, in order to:



- optimize TOTEM®'s and user systems' performance and reliability;
- guarantee system safety;
- preserve the systems components over time;
- ensure regular functioning of auxiliary equipment;
- minimize energy consumption.

Using suitably treated water for the user water system serves the dual purpose of ensuring compliance with applicable regulations and TOTEM ENERGY's / leading heat generator manufacturers' recommendations, and contributing to reducing operating costs and consumption.

Before filling the system it should be preemptively flushed and cleaned with appropriate products. If the TOTEM® is installed on pre-existing heating systems that may be subject to deterioration, including corrosion, algae formation, limescale build-up, or dirt deposits, consideration should be given to install a suitable hydraulic separation device (plate heat exchanger) to protect the TOTEM® 's internal circuit from possible damage.

For applications featuring an environment temperature below 1°C, an anti-freeze mixture (glycol) should be considered for the user circuit. Depending on its glycol content, the water/anti-freeze mixture may reduce heat exchange capacity and heating output.

Frequent refilling of the circuit should be avoided. Care should be taken in choosing water softening techniques based on deionization and cation exchange. We advise against using chemical additives as they may cause harmful dirt/residues to precipitate and possibly damage the system.

If the TOTEM® is installed in pre-existing heating systems that may be subject to deterioration, including corrosion, algae formation, limescale build-up, or dirt deposits, the user system should be preemptively flushed with appropriate products depending on the problem identified. In some specific cases, a suitable hydraulic separation device (exchanger) shall have to be installed to protect the TOTEM® 's internal circuit from possible damages and avoid treating the preexisting systems too aggressively.

H. Connection to the User's Electrical System

The TOTEM® requires to be connected to a dedicated power line fitted with appropriately sized protection via a circuit breaker or fuse to ensure current interruption as needed and thus line safety. The protection should have motor type tripping characteristics such as D type circuit breakers, BS88 fuses with gM curve, or MCCBs. Consideration should be given to the connection point with in the electrical distribution of the property, primarily getting as close as possible to the incoming point of electrical distribution.

In order to choose the size of the circuit breaker that interface the building and the TOTEM Unit we suggest the designer/installer consider the coordination between electric protections, paying attention to the following characteristics of devices already included in the Totem's main electric panel (main switch and differential thermal

breaker). System devices characteristics should be verified during design and installation respecting peculiarity of the electric system where TOTEM® is connected.

- TOTEM 10:

- nominal current switch-disconnector QS1: 40A;
- rated voltage QS1: 690 V;
- frequency: 50 Hz;
- tripping curve: D;
- earth relay calibration QF2: 0,3 A;
- max short circuit current QF2: 10 kA;

- TOTEM 20:

- nominal current switch-disconnector QS1: 40 A;
- rated voltage QS1: 690 V;
- frequency: 50 Hz;
- tripping curve: D;
- earth relay calibration QF2: 0,3 A;
- max short circuit current QF2: 10 kA;

- TOTEM 25:

- nominal current switch-disconnector QS1: 63 A;
- rated voltage QS1: 690 V;
- frequency: 50 Hz;
- tripping curve: D;
- earth relay calibration QF2: 0,3 A;
- max short circuit current QF2: 10 kA;

The TOTEM® module is also fitted with:

- An internal A2 differential relay that actuates an automatic QF1 circuit breaker to guarantee ground fault protection for the unit's inner generator;
- an automatic QF2 differential circuit breaker that guarantees protection of auxiliary equipment (24V AC adapter, 12 V battery charger unit, isolation transformer, power supply to user interface, internal engine water circulator pump, engine oil filling and discharging solenoid valves) from ground fault, short-circuit and overload.

Moreover, an interface protection relay control panel must be provided, compliant with the Rules that regulate the connection of activate users of Distribution System (CEI021, G59, VDE 4105), that includes the following:

an interface protection device (SPI) certified according to the standards in force in the place of installation; and commissioned by an approved engineer.

Failure to comply with the aforementioned provisions may lead to malfunctioning of the TOTEM® unit, making it impossible to establish a connection in parallel with the grid, in addition to posing serious hazards to people and objects.

The TOTEM® unit must be Earthed in full compliance with the regulations in force. Moreover, all Earth connections must be fitted with anti-loosening washers.



Please refer to Section 7.B of this Guide to check where the Earthing connections for the unit must be positioned.

Never connect earth wires to pipes carrying water, natural gas or other types of fuel, or to lightning conductor systems. Connection to a suitably sized Earth must be provided.

Do not energize the TOTEM® unit before commissioning, or before testing is performed by authorized TOTEM ENERGY technical staff. Failure to comply with this provision may lead to malfunctioning of the TOTEM® unit in addition to posing serious hazards to people and objects.

Non compliance with said provision will also nullify the warranty.

All electrical connections must be performed by qualified technicians, in observance of the regulations in force in the place of installation. Failure to comply with this provision may lead to malfunctioning of the TOTEM® unit in addition to posing serious hazards to people and objects.

Electrical connections must be made with suitably sized wires, in compliance with the laws in force in the place of installation and at least equal to 10 mm². The dimensions of the wires must be calculated based on the specific site characteristics, wire types and lengths.

Do not use one multi-cable to carry the electricity produced (L1, L2, L3, N) alongside signals.

Power and signal cables should be kept separated using different cable ducts.

Failure to comply with this provision may cause the unit to malfunction.

Please use cable shields for signal cables, ensuring that the shield is earthed at one end.

The unit must always be disconnected from the power mains through the main switchboard or the power metering unit prior to operating on the wiring connections.

An example of how to connect the TOTEM® module electrically is provided in the drawings of Section 7 of this Guide.

I. Controls Wiring

Connections Explained

Power Supply:

L1/L2/L3/N/PE: Connections for mains power to and from the machine via the interface protection panel. The cable size must be calculated by the installer based on the run length, voltage drop, wire type, and installation method. Regardless of calculated dimension the minimum cable size is 10 mm². Cable should meet requirements of BS7671 17th edition and be suitably protected.

Inputs:

Safety Chain:

1601/1801: Between these two terminals there is currently a link wire which can be removed to be used to connect a non-self-resetting safety chain (like external emergency shutdown, fire protection systems and so on). It requires a normally-closed (NC) relay contact. If closed TOTEM is available for running, when opened machine goes into emergency stop. This is a non-self-resetting safety contact, a manual reset needs to be carried out after the contact is opened.

External Enable:

AVCC/3B: "External Thermostat" you can connect an on/off switch or external PLC or BMS system with relay and start/stop the TOTEM in the way or purpose you prefer. If external device (thermostat) contact is closed, TOTEM will run as long as the return temperature is below set point. If the contact is open TOTEM is on standby and will not start even if return water temperature falls below the set-point. Supplied with a link. For example this contact is connected to the buffer vessel thermostat and it could run and stop the TOTEM to keep the buffer up to a temperature of 65°C if desired even though the flow temperature from the Totem could be up to 80°C.

External Enable 2:

AVCC/4B: "Start stop remote control" practically the same as "External thermostat". You could use it to shut off the machine from an external device. Normally closed NC contact. If you open it, the machine will be idle. If the contact is open, TOTEM is on standby and will not start even if return water temperature falls below the set-point. Supplied with a link. For example this could be used with the fire alarm testing or a backup generator to hold the unit off.

Modulation Switch:

AVCC/3E "Power mode": Is for power modulation (supplied with a link). An external contact that, if switch is open, causes electric power output to be modulated between minimum and maximum using "power setting" analogue (4-20 mAmp) input as reference.

Power Setting:

4J/3K "Power setting": The analogue 4-20 mAmps input to be used to regulate the electrical power output.

Outputs:

Run Signal:

2001/2002: Normally-open (NO) run signal contact available to connect other devices or BMS. When TOTEM is running, internal contact is closed, when contact is open machine is off. Nominal switching current 6A, nominal voltage 250V. The control interface cannot under any circumstances override the machine when this contact is open so this can be used as a self-resetting safety blocking contact. Note: When this contact is open the



inertia of the machine means that it will continue to use gas for approximately 5s after the contact is opened. To prevent the machine dropping the gas pressure in the main during a temporary shutdown (fire alarm test), a solenoid valve should be installed on the gas inlet. This will cause the machine to stop and it will automatically reset when it reads a reinstated gas pressure.

Fault Signal:

2003/2004: Normally-open (NO) alarm contact available to connect other devices or BMS. When contact is closed the TOTEM is in fault, when open machine is healthy. Nominal switching current 6A, nominal voltage 250V.

Considering the condition of 2001/2002 and 2003/2004 together, using a BMS, an external PLC or programmable logic relays could be managed to know if the machine is running or not, and if not, determine if is because TOTEM is in alarm or ordinary stop (standby) due to reaching maximum user water temperature.

All this information is available through the Remote Control System GPRS connection, user or service interface.

Shunt Pump Relay:

2005/2006: Shunt Pump Internal Relay. Volt free contact, can be used to switch the power supply to the external shunt pump between the machine and the buffer. Nominal switching current 6A, nominal voltage 250V. If a bigger external pump is required with higher current consumption or current peaks, the contact should be used with the coil of a relay.

Service Required Relay:

2007/2008: Normally-open (NO) output contact available to connect other devices or SCADA or GSM dialer (if needed). When contact is closed means TOTEM is approaching the maintenance visit requirement.

Nominal current 6A, nominal voltage 250V, maximum switching voltage 400V (12V is the voltage of the coil piloted by the PLC).

Healthy Output Power Supply

L1.6/N4: 230V output when healthy. As long as the unit is not in fault this will supply 230V live and neutral. Can be used for a gas solenoid or other safety device. Cuts power on safety trip.

Fire Alarms:

In most locations the fire alarm is connected to a plant room solenoid valve that will interrupt the gas supply to all appliances in case of a fire alarm. This will cause the Totem CHP to stop running and signal an error. This error is a self-resetting error. The Totem monitors the incoming gas pressure and when it is too low there is an error, but upon reinstatement of the gas supply the unit will automatically clear the error and return to operation.

Option 1:

Include no provision for the Totem unit during a fire alarm. When the gas solenoid shuts the unit will continue to operate until it has consumed all of the gas downstream of the solenoid valve at which time it will shut down. When the gas is back on the unit will run as normal.

Option 2:

If other equipment shares the gas main then reducing the pressure in the main to zero may have a negative effect on any sensitive equipment and cause nuisance trips. There is a volt free contact within the control panel to shut the unit down, but the engine inertia means that it will continue to consume gas for a short period of time after the contact is opened so the gas main could still be depressurised. If this is a problem then a local solenoid should be installed near the gas inlet to the Totem unit and it should also be controlled by the fire alarm testing. The Totem will operate in the same way as previously, but the gas main upstream of the local solenoid will still be pressurised.

J. Disposal of packaging materials

The TOTEM® unit is delivered in an outer packaging comprising:

- anti-scratch film: polystyrene [PS, EPS];
- edge-guards: polyethylene [PE];
- supporting pallet: wood.

The outer packaging and the support pallet must be removed and disposed of in compliance with the regulations in force in the place of installation.

K. Commissioning

Commissioning must be performed solely by engineers authorised by TOTEM ENERGY or their distributors.

Please contact the Technical Support Service.

Commissioning carried out without the supervision of TOTEM ENERGY or their distributors will cause the warranty to lose its validity.

During commissioning the following checks will be carried out:

Site Checks

Site Check:

- Area safety conditions;
- Ventilation and room temperature;
- Maintenance area;
- Flue termination and suitability
- Set flow rate
- Set overpressure switch setting
- Set overheat setting
- Set up Interface Protection Relay



Totem Checks

Electric Check:

- Proper connection to grid (phases order);
- Proper connection to external input (remote on/off, thermostat, safety chain, BMS);
- Proper connection to external output (external pump, shutoff EV);
- Balance between phases (tension and current);
- Electric protections onsite (interface protection, DG protection, ground connection)

Hydraulic Check:

- Proper connection to user hot water supply (inlet and outlet);
- Proper connection to exhaust piping;
- Condensate draining;
- Circuit pressure and temperatures

Natural Gas Check:

- Proper gas connection;
- Proper gas pressure

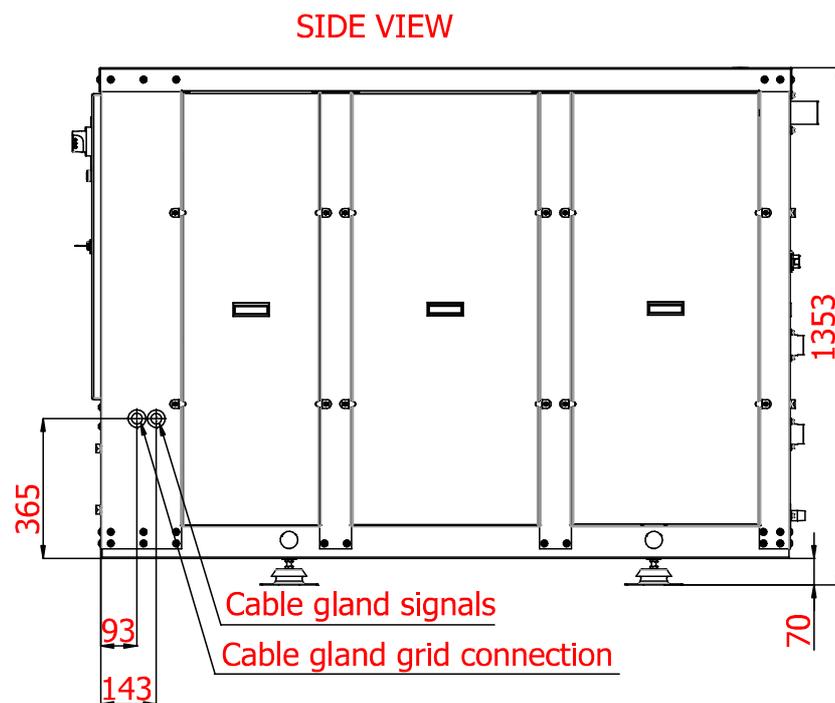
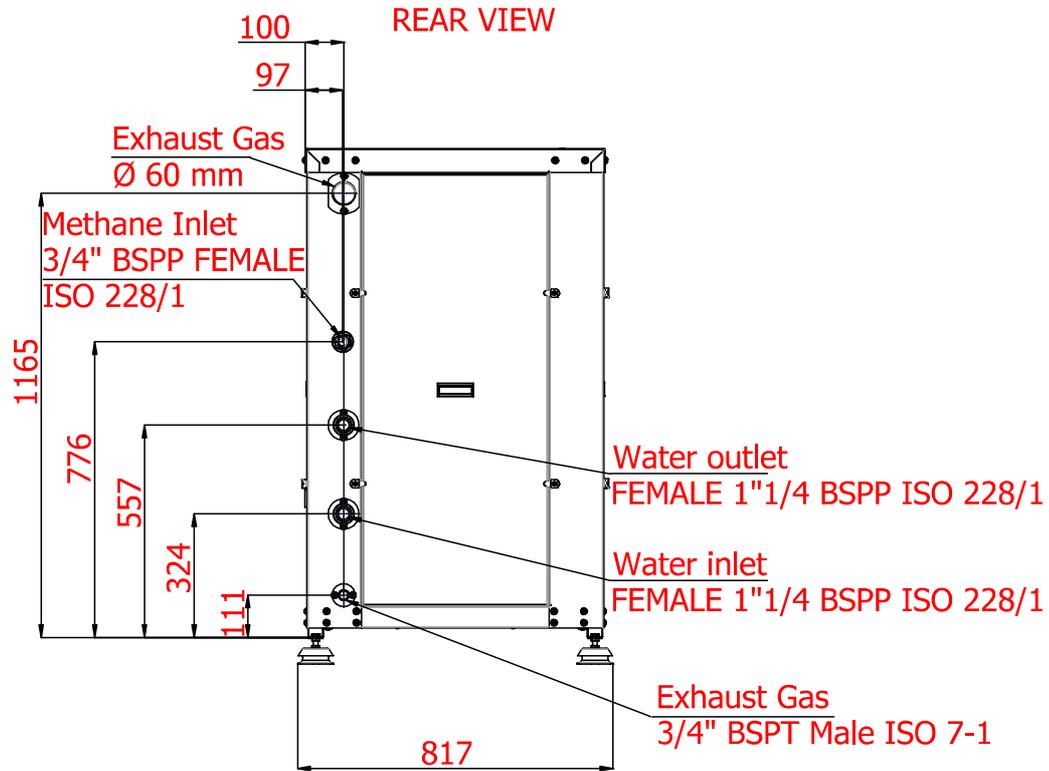
Totem Check:

- Internal ventilation;
- ECU firmware update;
- Oil level/refill;
- Coolant level/refill;
- Rotation check;
- First power supply to the machine;
- Error code troubleshooting;
- Warm-up of the machine;
- Leaking check;
- Machine stop;
- Coolant and oil level check;
- Normal start;
- Ramp up to full power;
- 4 Hours of test (if thermal load available from the user). During this operation, monitor the main functional parameters of the machine such as:

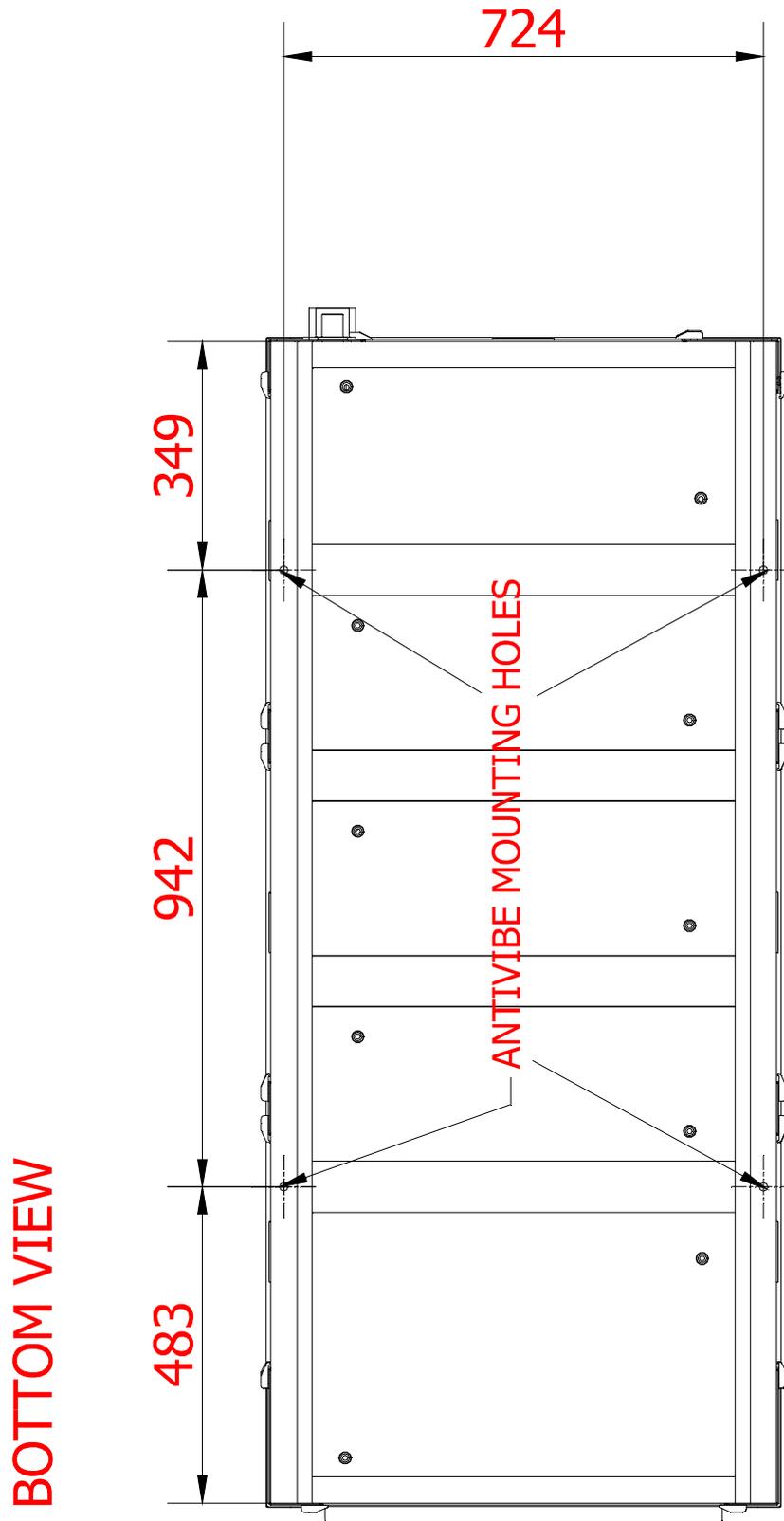
- o Water temperature (in/out);
- o Coolant temperature;
- o Pre-catalyst temperature;
- o Exhaust temperature;
- o 3 Phase currents;
- o Average power output

5. Size and overall dimensions

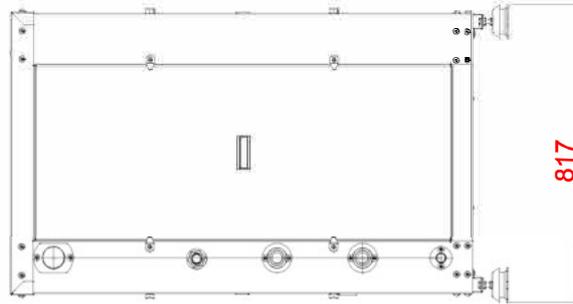
A. Position of hydraulic/electrical connection



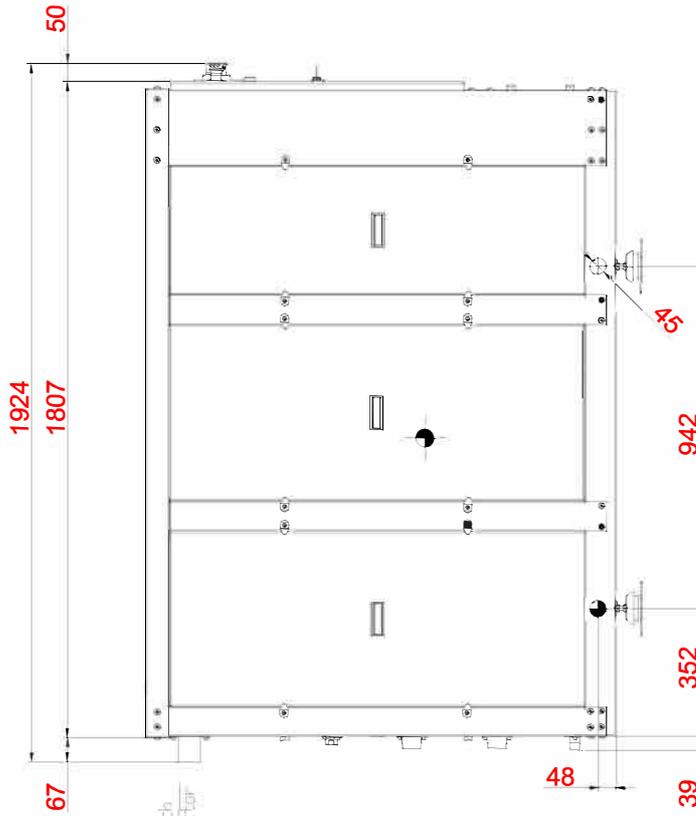
B. Position of anti-vibration mounts



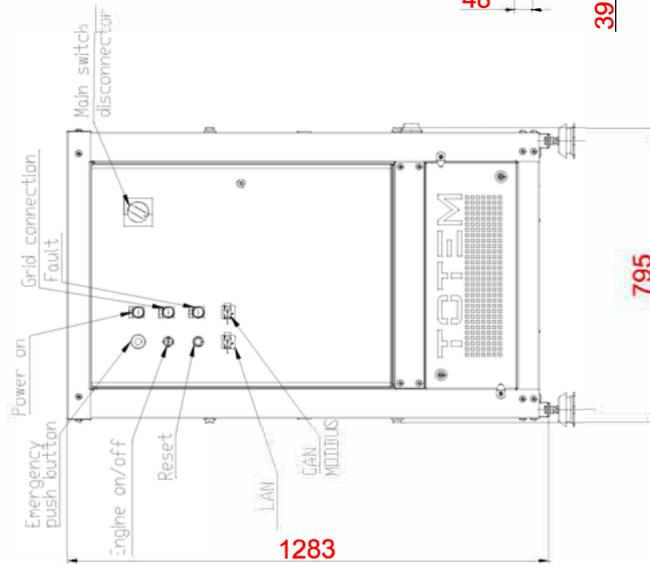
REAR VIEW



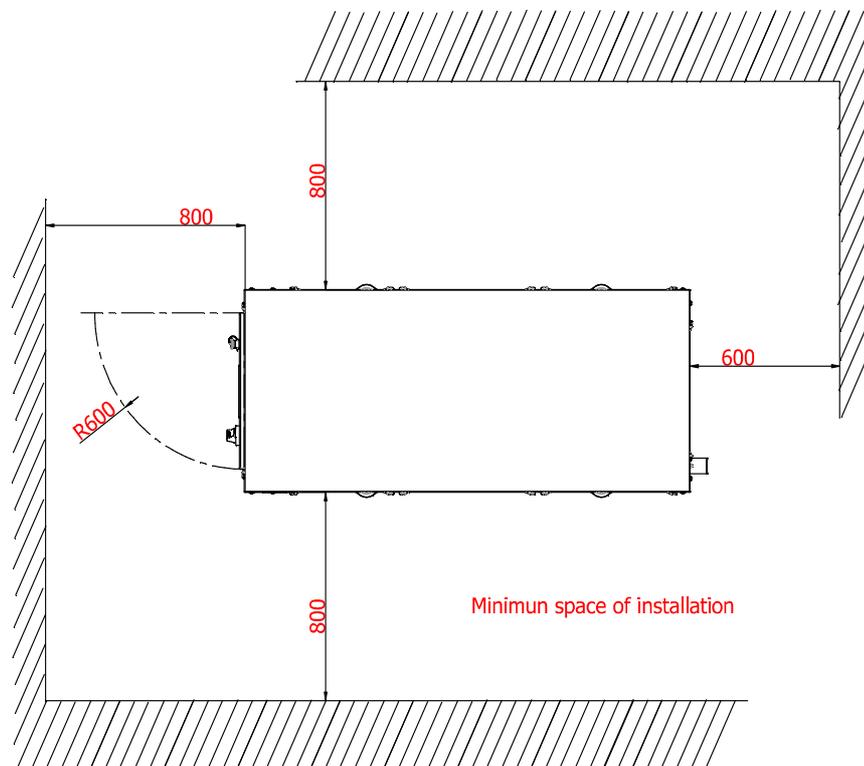
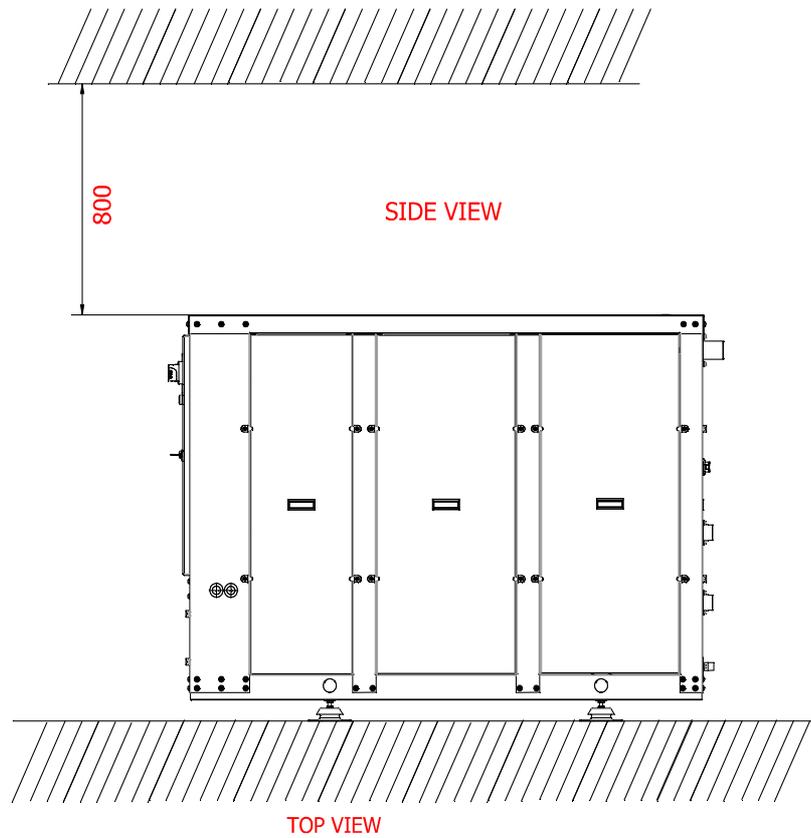
SIDE VIEW



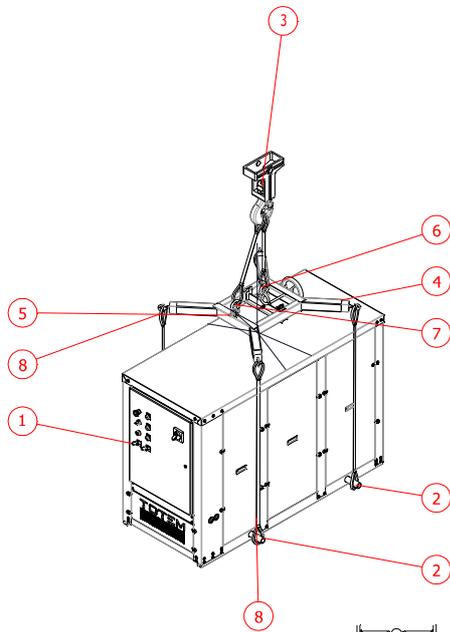
FRONT VIEW



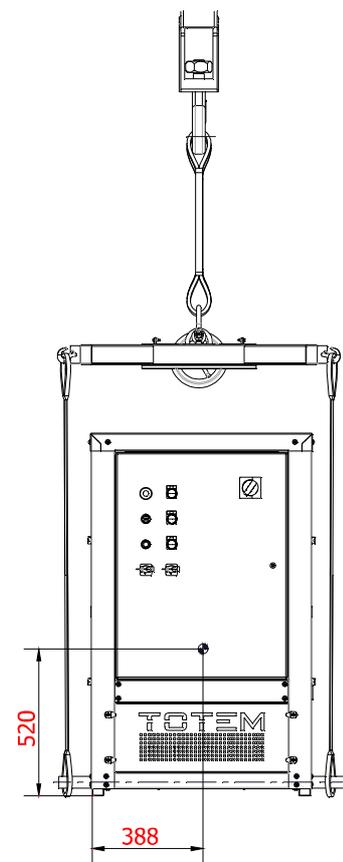
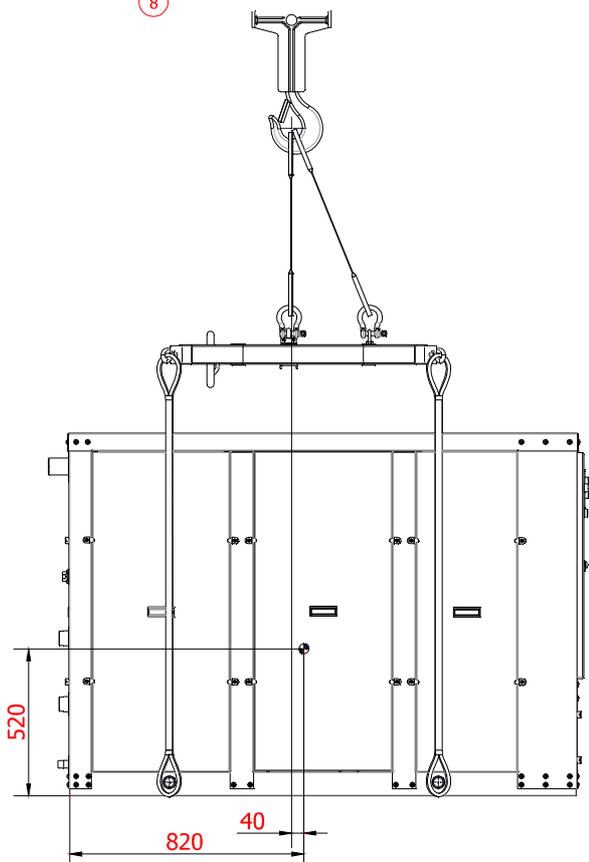
C. Minimum clearance for service and repair



D. Instructions for handling the module with hoists

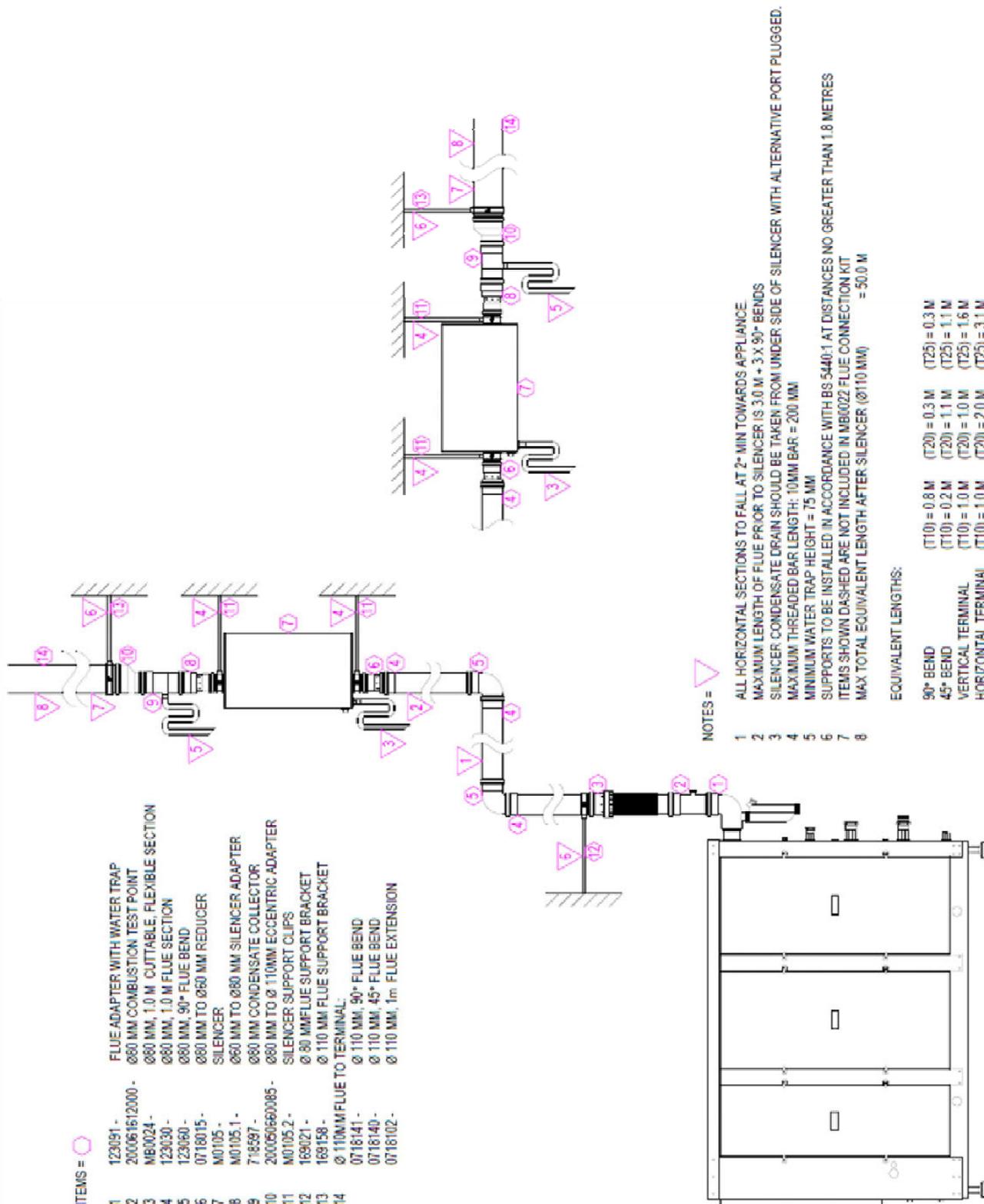


Num. article	Num. part	Description	Quantity
1	TOTEM 10/20	Total weight	1
2	Lifting Pipe	Steel Pipe S19ST	2 x 1 m
3	Lifting Hook	Hook 2000 kg	1
4	Slingbar	Slingbar 2000 kg	2
5	Lifting shackle	Lifting shackle 4000 kg	2
6	Lifting strap	Lifting strap 4000 kg	0.5 m
7	Lifting strap	Lifting strap 4000 kg	0.5 m
8	Lifting strap	Lifting strap 1000 kg	1.5 m

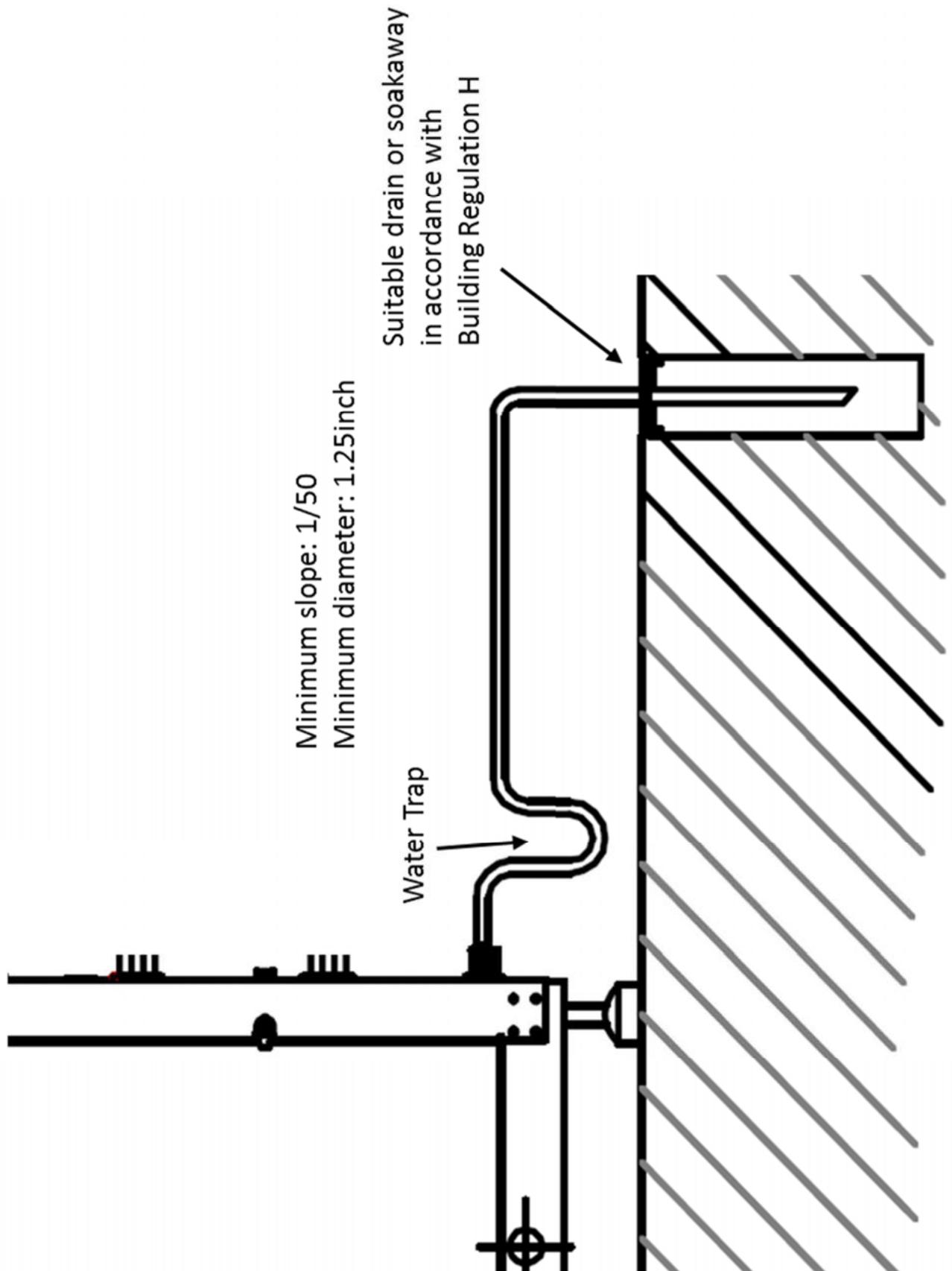


6. Standard diagram for connection

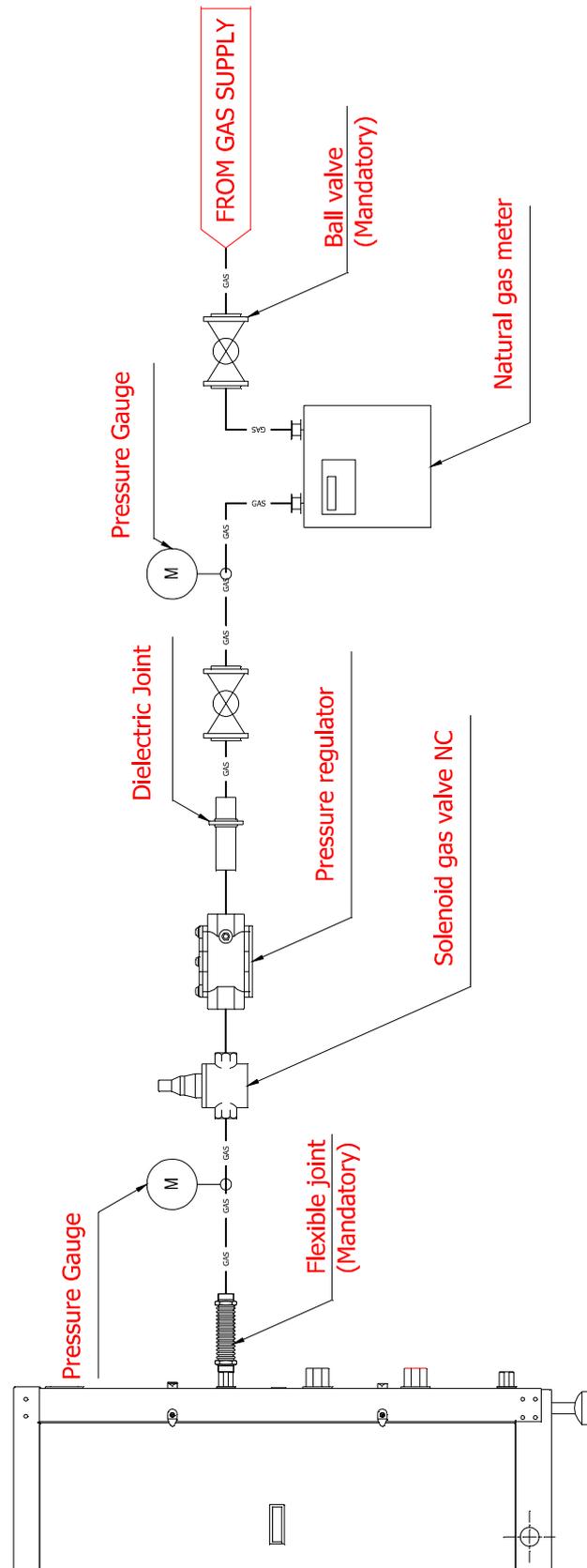
A. Exhaust gas line



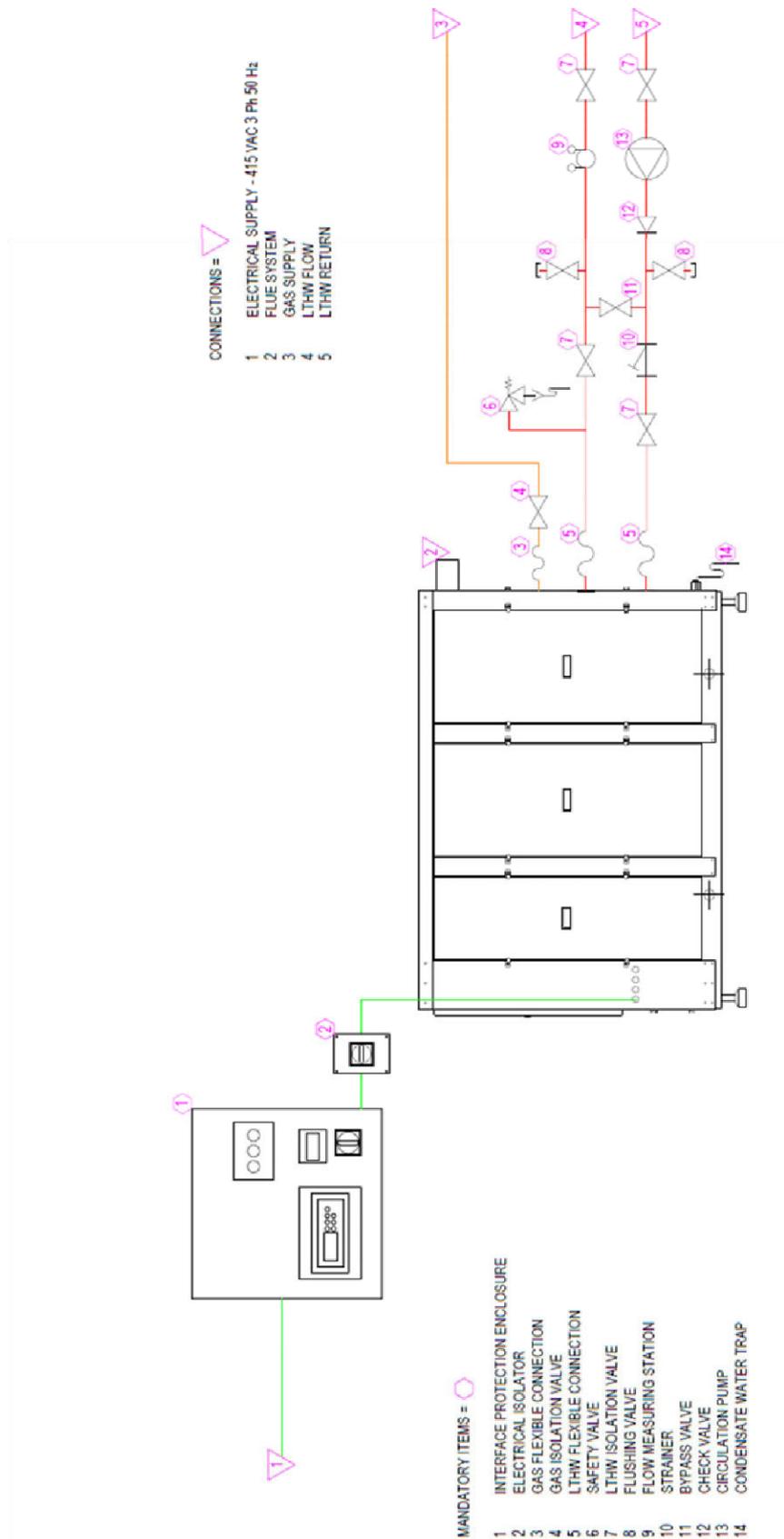
B. Condensate drainage

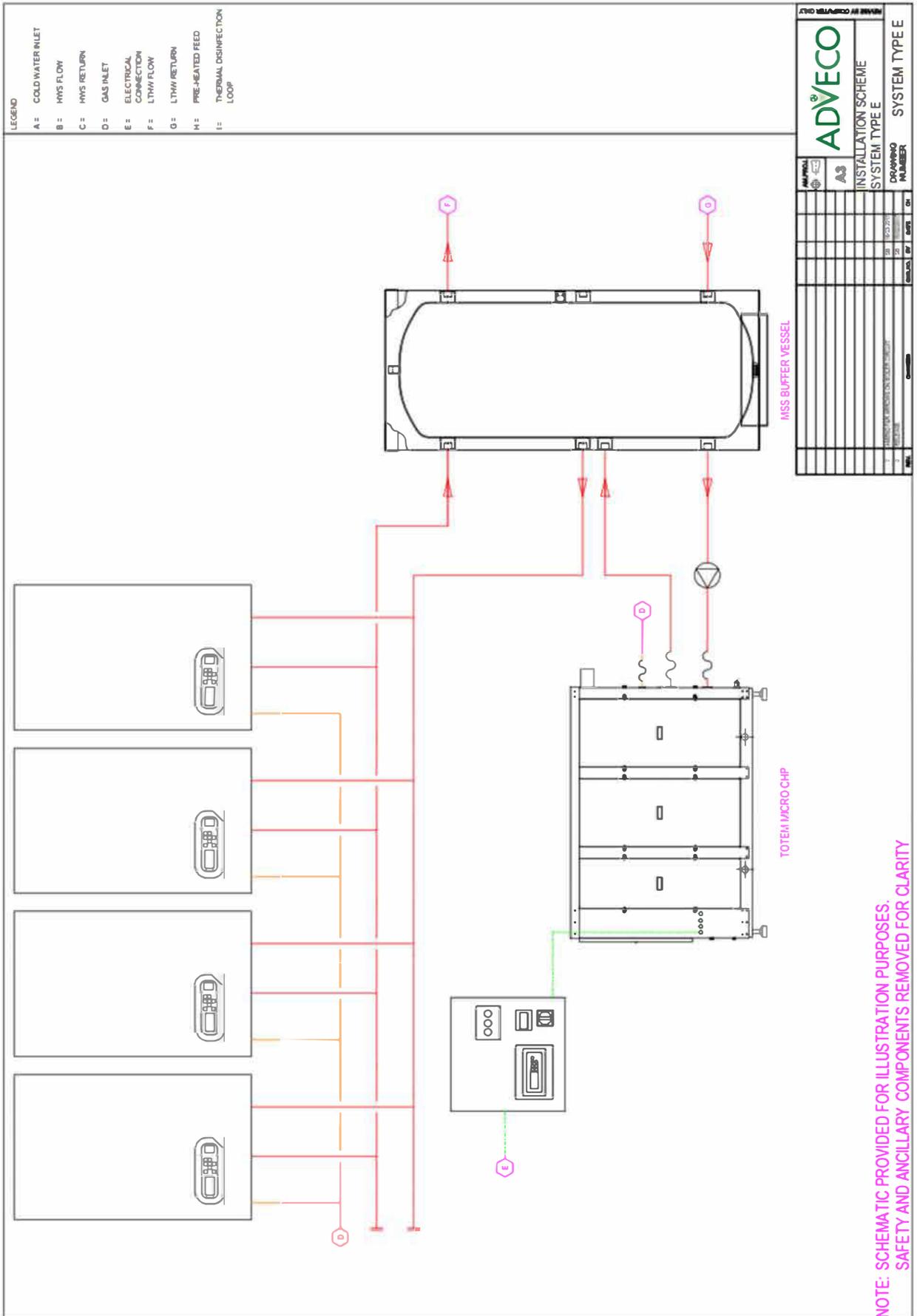


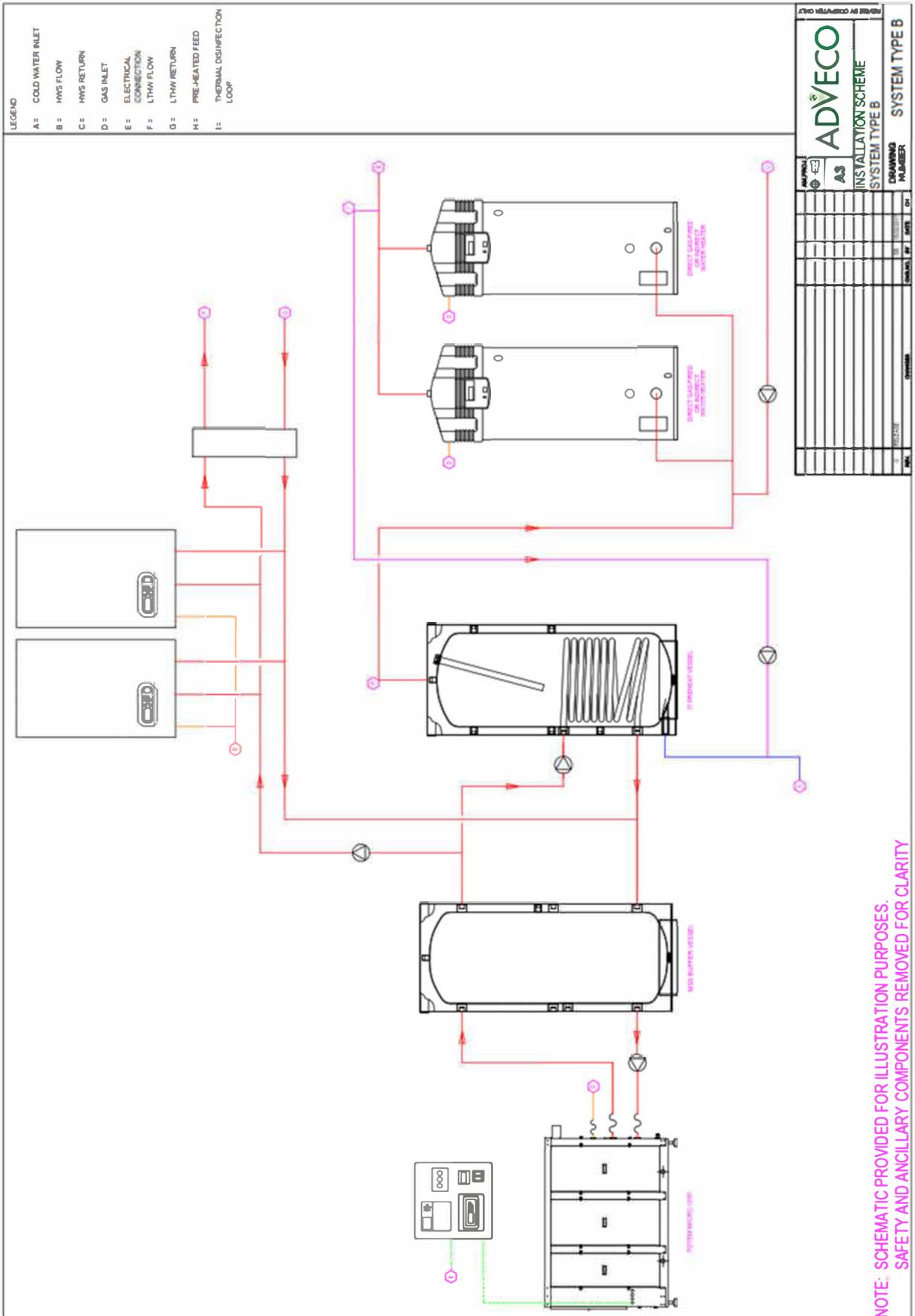
C. Suggested fuel gas installation schematic



D. Connection to the user's heating and water systems

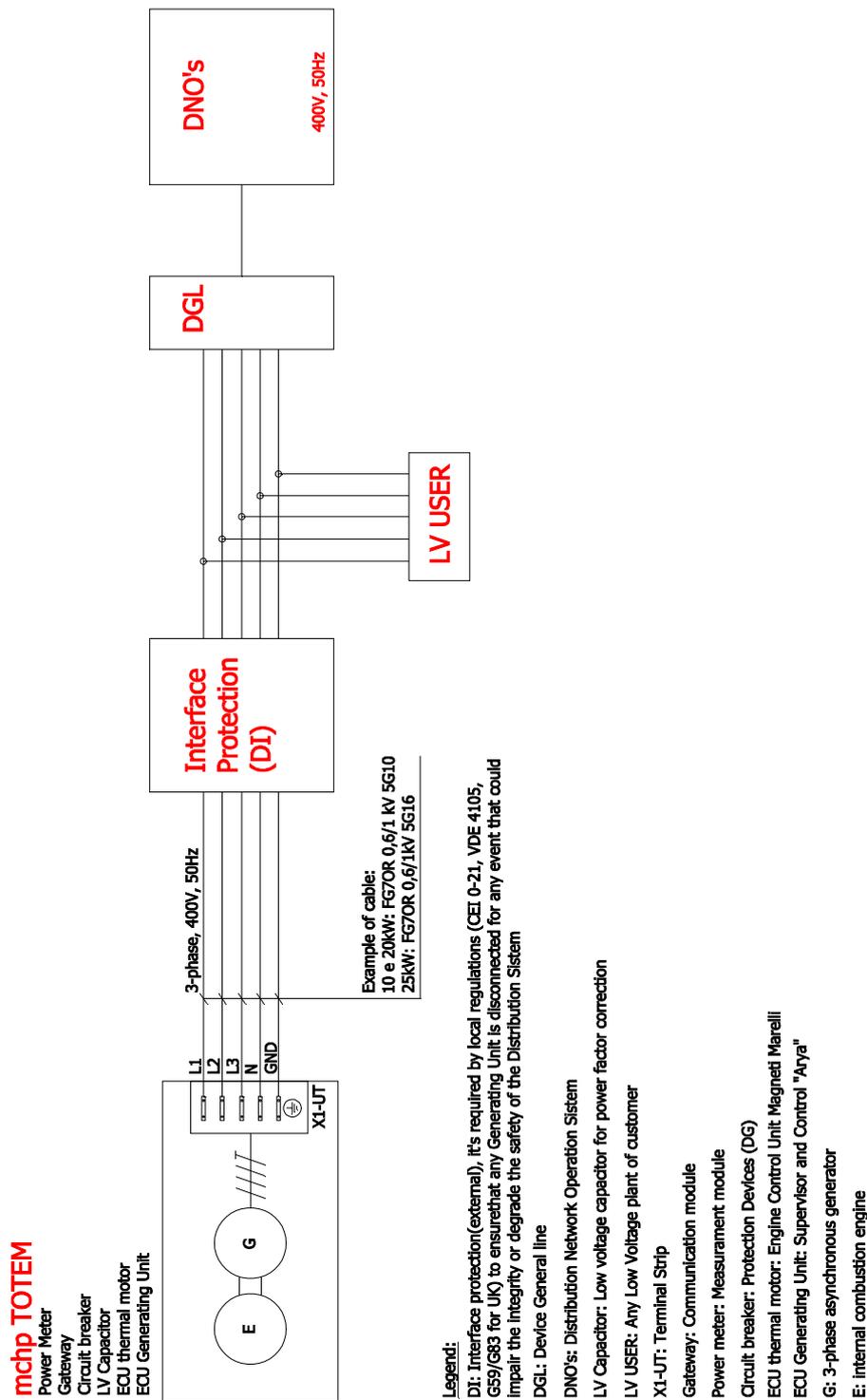






7. Standard diagram for power connection

A. Power connection single line diagram



B. Terminal block/available contacts

TERMINAL STRIP X1 - POWER SUPPLY -	
L1	Cable phase 1
L2	Cable phase 2
L3	Cable phase 3
N	Neutral cable
PE	Ground cable

TERMINAL STRIP X6 - DIGITAL INPUT -	
3J 4B	External switch-off 1
3J 3B	External switch-off 2
3J 3E	Electrical power modulation mode
3J 3H	Fuel selection

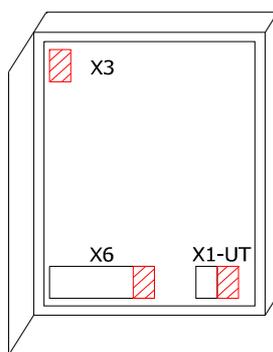
TERMINAL STRIP X6 - OUTPUT 230V -	
L1.6 N4	External EV GAS

TERMINAL STRIP X3 - DIGITAL OUTPUT (*) -	
1 2	Grid connection
3 4	Fault
5 6	Water external pump
7 8	Service
9 10	Fuel aux
11 12	Fuel

(*) Contacts: Nominal current 6A, nominal voltage 250V, maximum switching voltage 400V

TERMINAL STRIP X3 - INPUT 4 20 mA -	
4J 3k	Electrical power modulation

TERMINAL STRIP X3 - INPUT -	
1501 1701	Emergency relay power supply 24V



ELECTRICAL SWITCHBOARD LAYOUT TERMINAL STRIP

 TERMINAL STRIP FOR USER

C. Connections Explained

Power Supply:

L1/L2/L3/N/PE: Connections for mains power to and from the machine via the interface protection panel. The cable size must be calculated by the installer based on the run length, voltage drop, wire type, and installation method. Regardless of calculated dimension the minimum cable size is 10mm². Cable should meet requirements of BS7671 17th edition and be suitably protected.

Inputs:

Safety Chain:

1601/1801: Between these two terminals there is currently a link wire which can be removed to be used to connect a non-self-resetting safety chain (like external emergency shutdown, fire protection systems and so on). It requires a normally-closed (NC) relay contact. If closed TOTEM is available for running, when opened machine goes into emergency stop. This is a non-self-resetting safety contact, a manual reset needs to be carried out after the contact is opened.

External Enable:

AVCC/3B: "External Thermostat" you can connect an on/off switch or external PLC or BMS system with relay and start/stop the TOTEM in the way or purpose you prefer. If external device (thermostat) contact is closed, TOTEM will run as long as the return temperature is below set point. If the contact is open TOTEM is on standby and will not start even if return water temperature falls below the set-point. Supplied with a link. For example this contact is connected to the buffer vessel thermostat and it could run and stop the TOTEM to keep the buffer up to a temperature of 65°C if desired even though the flow temperature from the Totem could be up to 80°C.

External Enable 2:

AVCC/4B: "Start stop remote control" practically the same as "External thermostat". You could use it to shut off the machine from an external device. Normally closed NC contact. If you open it, the machine will be idle. If the contact is open, TOTEM is on standby and will not start even if return water temperature falls below the set-point. Supplied with a link. For example this could be used with the fire alarm testing or a backup generator to hold the unit off.

Modulation Switch:

AVCC/3E "Power mode": Is for power modulation (supplied with a link). An external contact that, if switch is open, causes electric power output to be modulated between minimum and maximum using "power setting" analogue (4-20 mAmp) input as reference.

Power Setting:

4J/3K "Power setting": The analogue 4-20 mAmps input to be used to regulate the electrical power output.



Outputs:

Run Signal:

2001/2002: Normally-open (NO) run signal contact available to connect other devices or BMS. When TOTEM is running, internal contact is closed, when contact is open machine is off. Nominal switching current 6A, nominal voltage 250V. The control interface cannot under any circumstances override the machine when this contact is open so this can be used as a self-resetting safety blocking contact. Note: When this contact is open the

inertia of the machine means that it will continue to use gas for approximately 5s after the contact is opened. To prevent the machine dropping the gas pressure in the main during a temporary shutdown (fire alarm test), a solenoid valve should be installed on the gas inlet. This will cause the machine to stop and it will automatically reset when it reads a reinstated gas pressure.

Fault Signal:

2003/2004: Normally-open (NO) alarm contact available to connect other devices or BMS. When contact is closed the TOTEM is in fault, when open machine is healthy. Nominal switching current 6A, nominal voltage 250V.

Considering the condition of 2001/2002 and 2003/2004 together, using a BMS, an external PLC or programmable logic relays could be managed to know if the machine is running or not, and if not, determine if is because TOTEM is in alarm or ordinary stop (standby) due to reaching maximum user water temperature.

All this information is available through the Remote Control System GPRS connection, user or service interface.

Shunt Pump Relay:

2005/2006: Shunt Pump Internal Relay. Volt free contact, can be used to switch the power supply to the external shunt pump between the machine and the buffer. Nominal switching current 6A, nominal voltage 250V. If a bigger external pump is required with higher current consumption or current peaks, the contact should be used with the coil of a relay.

Service Required Relay:

2007/2008: Normally-open (NO) output contact available to connect other devices or SCADA or GSM dialer (if needed). When contact is closed means TOTEM is approaching the maintenance visit requirement.

Nominal current 6A, nominal voltage 250V, maximum switching voltage 400V (12V is the voltage of the coil piloted by the PLC).

Healthy Output Power Supply

L1.6/N4: 230V output when healthy. As long as the unit is not in fault this will supply 230V live and neutral. Can be used for a gas solenoid or other safety device. Cuts power on safety trip.

Fire Alarms:

In most locations the fire alarm is connected to a plant room solenoid valve that will interrupt the gas supply to all appliances in case of a fire alarm. This will cause the Totem CHP to stop running and signal an error. This error is a self-resetting error. The Totem monitors the incoming gas pressure and when it is too low there is an error, but upon reinstatement of the gas supply the unit will automatically clear the error and return to operation.

Option 1:

Include no provision for the Totem unit during a fire alarm. When the gas solenoid shuts the unit will continue to operate until it has consumed all of the gas downstream of the solenoid valve at which time it will shut down. When the gas is back on the unit will run as normal.

Option 2:

If other equipment shares the gas main then reducing the pressure in the main to zero may have a negative effect on any sensitive equipment and cause nuisance trips. There is a volt free contact within the control panel to shut the unit down, but the engine inertia means that it will continue to consume gas for a short period of time after the contact is opened so the gas main could still be depressurised. If this is a problem then a local solenoid should be installed near the gas inlet to the Totem unit and it should also be controlled by the fire alarm testing. The Totem will operate in the same way as previously, but the gas main upstream of the local solenoid will still be pressurised.



8. Operating logic

WARNING

In order to increase TOTEM unit running hours, meanwhile improving system efficiency and customer's savings, the starts of TOTEM should have priority over others heat generators. It's possible with a proper set up of temperature set point of the TOTEM and others heat generators.

In order to ensure product reliability it's user responsibility to make available a minimum thermal request to allow the properly TOTEM operation, so TOTEM must operate a minimum monthly average of 2 hours for each start cycle.

TOTEM® units work based on the "thermal priority" principle that is to say, they automatically switch to simultaneous delivery of heat and electricity whenever a heat load is present that allow for recovering heat from the internal recovery system of the TOTEM® unit.

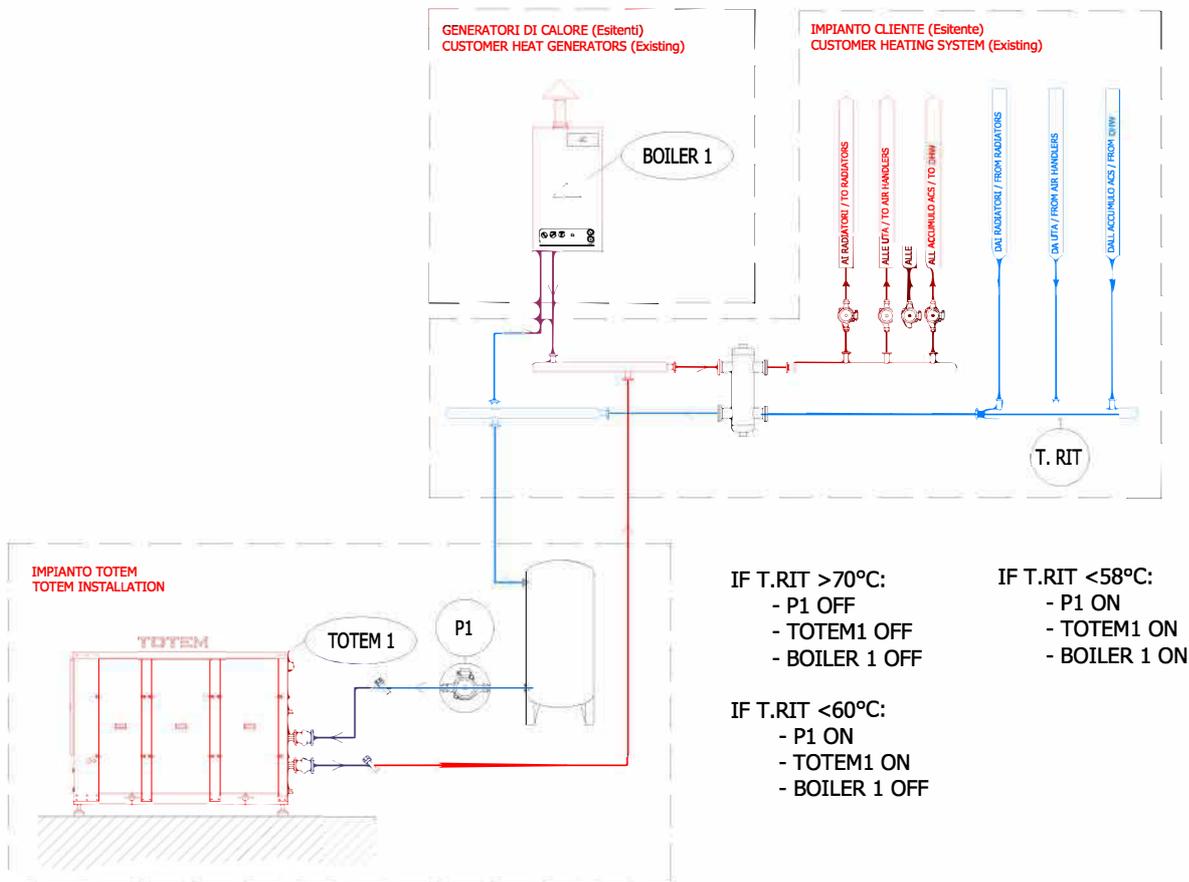
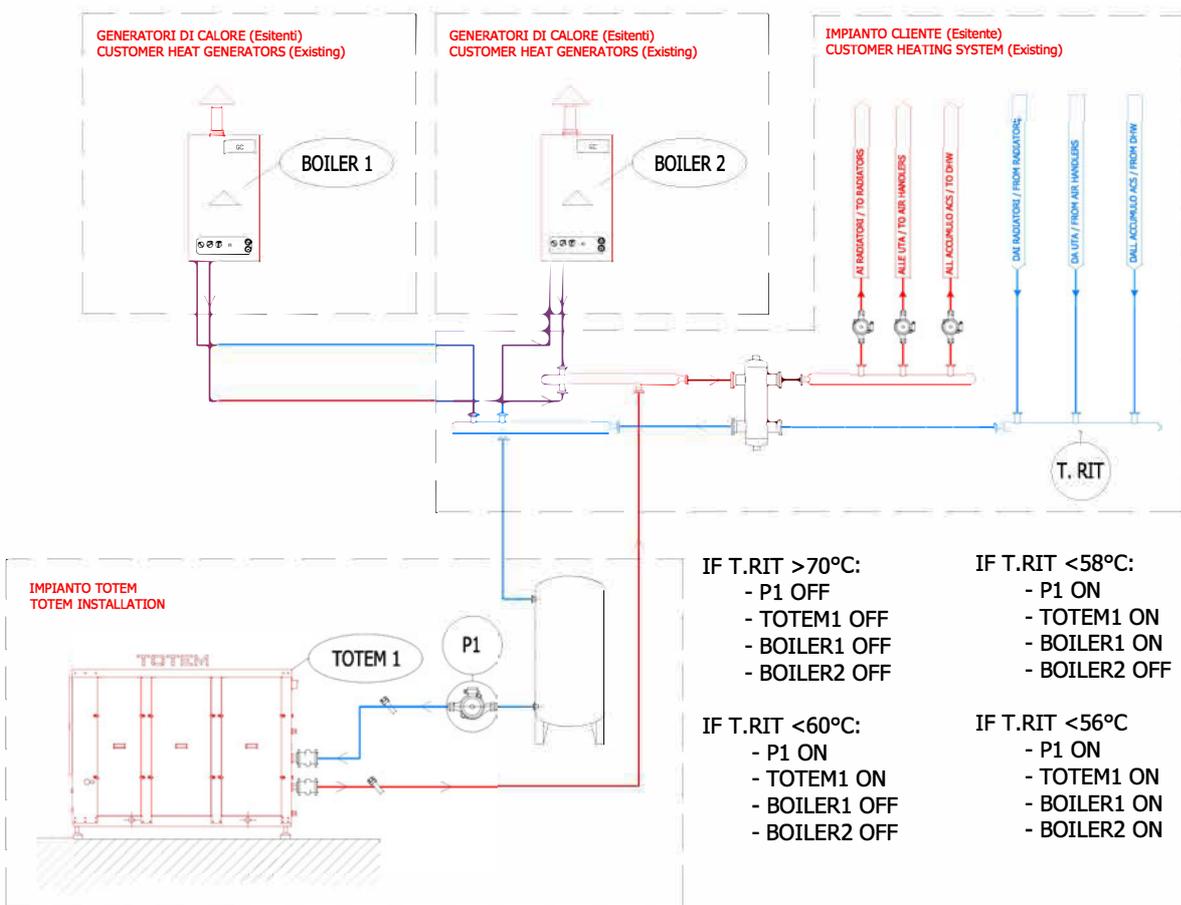
The TOTEM® can be activated by means of a thermostat placed on the user's water return line, that directly or through a suitable supervision system (BMS) can close the "external thermostat" digital input available on the X6 terminal block on the electrical board.

Then, the parameter "Restart Temperature" can be set from the TOTEM® control menu "Configuration" choosing from a range of values between 30°C and 70°C to enable activation.

Water will be delivered to the user with a Δt° increase between 8 and 12°C.

Activation can be controlled through various modes, keeping the temperature of water in the user return line as a reference.

A few cases are shown hereunder by way of example (temperature values shown are merely indicative).



Appendix A – Electric power modulation

Installation guide

TOTEM 10 - TOTEM 20 - TOTEM 25

1. Electric power modulation

A. Introduction

TOTEM® microCHP, at the request of the customer, can be configured to work in "power modulation" mode, in other words can vary the electrical power produced, proportionally to an analog electric signal.

This attachment to the installation guide is intended to provide guidance about which arrangement are required to the systems external to TOTEM®, how to connect the external signal to the on-board electrical panel and how to handle the logic of activation and deactivation of "power modulation" mode.

A. Warnings

The use of TOTEM® in "power modulation" mode may reduce the net electrical and total efficiency of the microCHP unit compared to the nominal specification.

Refer to the technical datasheet of the product to evaluate changes in efficiency in case TOTEM® works in "power modulation" mode.

The use of microCHP with reduced electric power corresponds also to a reduction of heat power output.

All installation and adjustment activities must be carried out by a professionally qualified technician and by TOTEM Energy Authorized Customer Service.

B. Plant arrangement and signal specifications

In order to allow the TOTEM® unit to operate in "power modulation" mode, the user system must be prepared, making available to the on-board electrical panel, the following signals:

- Digital input, connected to the on board terminal strip (terminal strip X6, terminal block AC-3E) able to change their status in function of user's needs.
- Proportional 4-20 mA analog signal connected to the on board terminal strip (terminal strip X3, terminal blocks 4J-3K). This analog signal will be proportional to the electrical power desired and produced.

The proportional analog signal must have the following specification:

Current: 4-20 mA

- o Signal Polarity: 3K SIG (+) / 4J COM (-)
- o Maximum allowable voltage: 12 volt
- o Input resistance: 247 Ω
- o Bandwidth: 141 Hz

Input module have the following specifications:

1. Response time: 500 ms
2. Resolution: 1 mA:
3. Precision/Tolerance: 0.5 mA



C. Operating range

- The minimum and the maximum electric power are set by TOTEM Energy Authorized Customer Service for each model.

Model	Minimum electric power	Maximum electric power
TOTEM 10	5 kW	10 kW
TOTEM 20	7,5 kW	20 kW
TOTEM 25	7,5 kW	25 kW

D. Processing logic

"Power modulation" OFF:

If the AVCC-3E contact switch is closed, the TOTEM® unit will produce nominal electric power, according to the power parameter set in the control module. It will not affect the proportional analog signal supplied to 4J-3K terminal blocks.

"Power modulation" ON:

If the AVCC-3E contact is open, the TOTEM® unit will produce electrical power proportional to the analog signal provided 4J-3K terminal blocks.

A change in analog proportional signal will correspond to a linear change in the output of the electric power, according to this scale:

- 4 mA = minimum electrical power as set by TOTEM Energy Authorized Customer Service;
- 20 mA = maximum electrical power set by TOTEM Energy Authorized Customer Service;
- 0-4 mA : The TOTEM® module goes OFF, as is considered null the electrical power required. The TOTEM® module restart if the signal value is back within the normal operating range.
- The table below shows the mA signal for the different units. The algorithm to determine the mA signal is based on the average Amperage across the three phases.
- The corresponding Amperages to kW of the unit are based on a nominal supply voltage of 230V between each phase and Neutral. The amperages should be adjusted according to the actual site electrical supply.

Model	<4 mA	4 mA	20 mA
T10	<5 kW	5 kW	10 kW
	<7.2 A/ph	7.2 A/ph	14.5 A/ph
T20	<7.5 kW	7.5 kW	20 kW
	<11 A/ph	11 A/ph	29 A/ph
T25	<7.5 kW	7.5 kW	25 kW
	<11 A/ph	11 A/ph	36 A/ph

9. Technical support service

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