JENBACHER

Technical Description

Genset

JGS 412 GS-B.L

Grid Parallel with Island Operation
static Grid Code

UMW Industrial Power Services

Electrical output 901 kW el.

Emission values
NOx < 500 mg/Nm³ (5% O2) | < 190 mg/Nm³ (15% O2)

0.01 Technical Data (at genset)

			100%	75%	50%
Power input	[2]	kW	2,114	1,631	1,147
Gas volume	*)	Nm³/h	384	297	209
Mechanical output	[1]	kW	928	696	464
Electrical output	[4]	kW el.	901	675	448
Heat to be dissipated (calculated with Glykol 3%)	**[5]**				
~ Intercooler 1st stage (Engine jacket water cooling circuit)	[9]	kW	206	115	44
~ Intercooler 2nd stage (Low temperature circuit)		kW	39	33	18
~ Lube oil (Engine jacket water cooling circuit)		kW	116	100	85
~ Jacket water		kW	240	213	177
~ Surface heat	ca. [7]	kW	70	~	~
Spec. fuel consumption of engine electric	[2]	kWh/kWel. h	2.35	2.42	2.56
Spec. fuel consumption of engine	[2]	kWh/kWh	2.28	2.34	2.47
Lube oil consumption	ca. [3]	kg/h	0.19	~	~
Electrical efficiency			42.6%	41.4%	39.0%
Fuel gas LHV		kWh/Nm³	5.5		

*) approximate value for pipework dimensioning
[_] Explanations: see 0.10 - Technical parameters

All heat data is based on standard conditions according to attachment 0.10. Deviations from the standard conditions can result in a change of values within the heat balance and must be taken into consideration in the layout of the cooling circuit/equipment (intercooler; emergency cooling; ...).

Main dimensions and weights (at genset)

Length	mm	~ 5,400
Width	mm	~ 1,800
Height	mm	~ 2,200
Weight empty	kg	~ 11,000
Weight filled	kg	~ 11,600

Connections

Jacket water inlet and outlet	DN/PN	80/10
Exhaust gas outlet [C]	DN/PN	300/10
Fuel Gas (at genset) [D]	DN/PN	125/16
Water drain ISO 228	G	½"
Condensate drain	mm	~
Safety valve - jacket water ISO 228 [G]	DN/PN	1½"/2,5
Lube oil replenishing (pipe) [I]	mm	28
Lube oil drain (pipe) [J]	mm	28
Jacket water - filling (flex pipe) [L]	mm	13
Intercooler water-Inlet/Outlet 1st stage	DN/PN	80/10
Intercooler water-Inlet/Outlet 2nd stage [M/N]	DN/PN	~

Output / fuel consumption

ISO standard fuel stop power ICFN	kW	928
Mean effe. press. at stand. power and nom. speed	bar	20.26
Fuel gas type		Biogas
Based on methane number | Min. methane number	MZ	135 | 117 d)
Compression ratio	Epsilon	12.5
Min./Max. fuel gas pressure at inlet to gas train	mbar	80 - 200 c)
Max. rate of gas pressure fluctuation	mbar/sec	10
Maximum Intercooler 2nd stage inlet water temperature	°C	55
Spec. fuel consumption of engine	kWh/kWh	2.28
Specific lube oil consumption	g/kWh	0.20
Max. Oil temperature	°C	~ 85
Jacket-water temperature max.	°C	~ 95
Filling capacity lube oil (refill)	lit	~ 315

c) Lower gas pressures upon inquiry
d) based on methane number calculation software AVL 3.2

0.02 Technical data of engine

Manufacturer		JENBACHER
Engine type		J 412 GS-B25
Working principle		4-Stroke
Configuration		V 70°
No. of cylinders		12
Bore	mm	145
Stroke	mm	185
Piston displacement	lit	36.66
Nominal speed	rpm	1,500
Mean piston speed	m/s	9.25
Length	mm	3,200
Width	mm	1,495
Height	mm	2,085
Weight dry	kg	5,200
Weight filled	kg	5,695
Moment of inertia	kgm²	9.42
Direction of rotation (from flywheel view)		left
Radio interference level to VDE 0875		N
Starter motor output	kW	7
Starter motor voltage	V	24

Thermal energy balance

Power input	kW	2,114
Intercooler	kW	245
Lube oil	kW	116
Jacket water	kW	240
Exhaust gas cooled to 180 °C	kW	347
Exhaust gas cooled to 100 °C	kW	463
Surface heat	kW	35

Exhaust gas data

Exhaust gas temperature at full load	[8]	°C	410
Exhaust gas temperature at bmep= 15.2 [bar]		°C	~ 430
Exhaust gas temperature at bmep= 10.1 [bar]		°C	~ 459
Exhaust gas mass flow rate, wet		kg/h	4,853
Exhaust gas mass flow rate, dry		kg/h	4,523
Exhaust gas volume, wet		Nm³/h	3,789
Exhaust gas volume, dry		Nm³/h	3,379
Max.admissible exhaust back pressure after engine		mbar	60

Combustion air data

Combustion air mass flow rate	kg/h	4,489
Combustion air volume	Nm³/h	3,473
Max. admissible pressure drop at air-intake filter	mbar	10

basis for exhaust gas data: natural gas: 100% CH4; biogas 65% CH4, 35% CO2

Sound pressure level

Aggregate a)			dB(A) re 20µPa		96	
31,5	Hz		dB		87	
63	Hz		dB		88	
125	Hz		dB		95	
250	Hz		dB		95	
500	Hz		dB		94	
1000	Hz		dB		90	
2000	Hz		dB		86	
4000	Hz		dB		84	
8000	Hz		dB		86	
Exhaust gas b)			dB(A) re 20µPa		117	
31,5	Hz		dB		105	
63	Hz		dB		120	
125	Hz		dB		115	
250	Hz		dB		113	
500	Hz		dB		113	
1000	Hz		dB		111	
2000	Hz		dB		108	
4000	Hz		dB		109	
8000	Hz		dB		107	

Sound power level

Aggregate	dB(A) re 1pW	116
Measurement surface	m²	101
Exhaust gas	dB(A) re 1pW	125
Measurement surface	m²	6.28

a) average sound pressure level on measurement surface in a distance of 1m (converted to free field) according to DIN 45635 and ISO 3744, precision class 3.
b) average sound pressure level on measurement surface in a distance of 1m according to DIN 45635 and ISO 3744, precision class 2.

The spectra are valid for aggregates up to bmep=19 bar. (for higher bmep add safety margin of 1dB to all values per increase of 1 bar pressure).
Engine tolerance ± 3 dB

0.03 Technical data of generator

Manufacturer		STAMFORD e)
Type		PE 734 C e)
Type rating	kVA	1,268
Driving power	kW	928
Ratings at p.f. = 1,0	kW	901
Ratings at p.f. = 0.8	kW	893
Rated output at p.f. = 0.8	kVA	1,116
Rated reactive power at p.f. = 0.8	kVar	670
Rated current at p.f. = 0.8	A	1,552
Frequency	Hz	50
Voltage	V	415
Speed	rpm	1,500
Permissible overspeed	rpm	1,800
Power factor (lagging - leading) (UN)		0,8 - 0,95
Efficiency at p.f. = 1,0		97.1%
Efficiency at p.f. = 0.8		96.2%
Moment of inertia	kgm²	36.33
Mass	kg	2,967
Radio interference level to EN 55011 Class A (EN 61000-6-4)		N
Cable outlet		left
Ik'' Initial symmetrical short-circuit current	kA	16.33
Is Peak current	kA	41.58
Insulation class		H
Temperature (rise at driving power)		F
Maximum ambient temperature	°C	40

Reactance and time constants at rated output (saturated)

xd direct axis synchronous reactance	p.u.	1.980
xd' direct axis transient reactance	p.u.	0.130
xd'' direct axis sub transient reactance	p.u.	0.094
x2 negative sequence reactance	p.u.	0.137
Td'' sub transient reactance time constant	ms	10
Ta Time constant direct-current	ms	20
Tdo' open circuit field time constant	s	2.23

e) JENBACHER reserves the right to change the generator supplier and the generator type. The contractual data of the generator may thereby change slightly. The contractual produced electrical power will not change.

JENBACHER

connection variant 1K

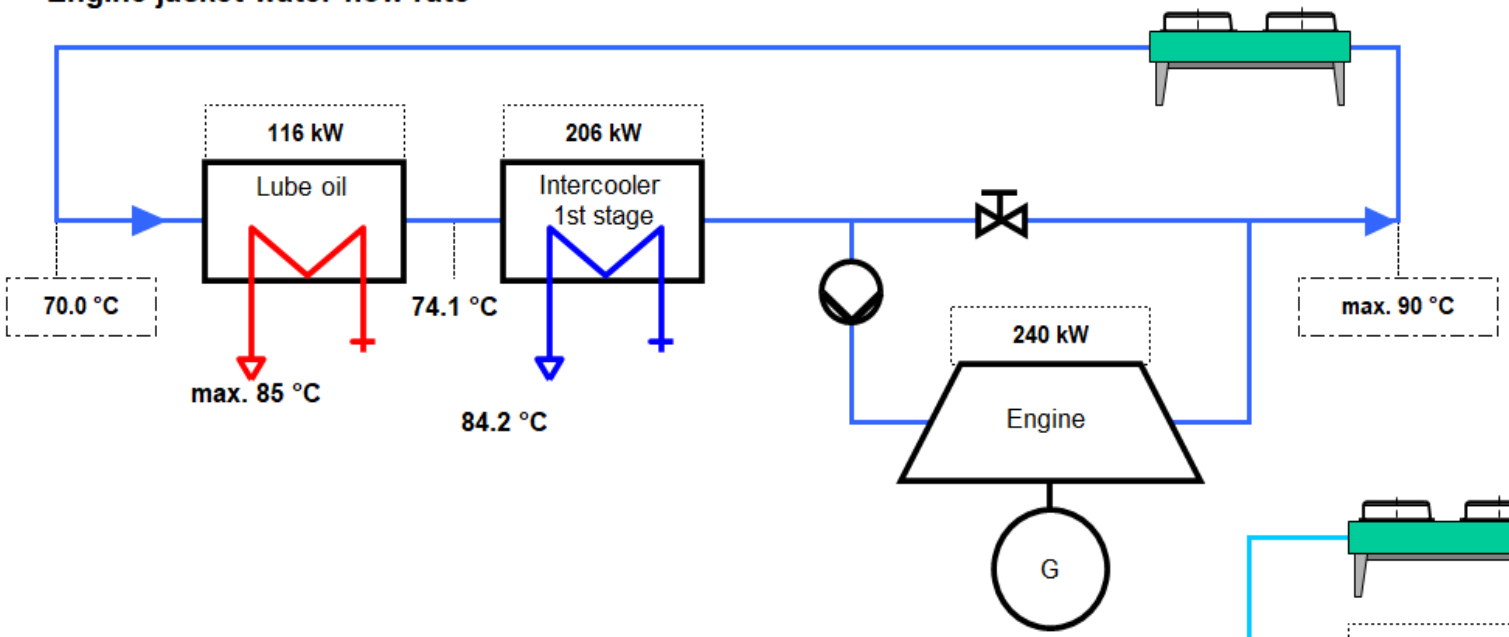
J 412 GS-B25

Engine jacket water cooling circuit (calculated with Glykol 3%)

Heat to be dissipated = **562 kW**

(+12/-8 % tolerance)

Engine jacket water flow rate = **24.3 m³/h**

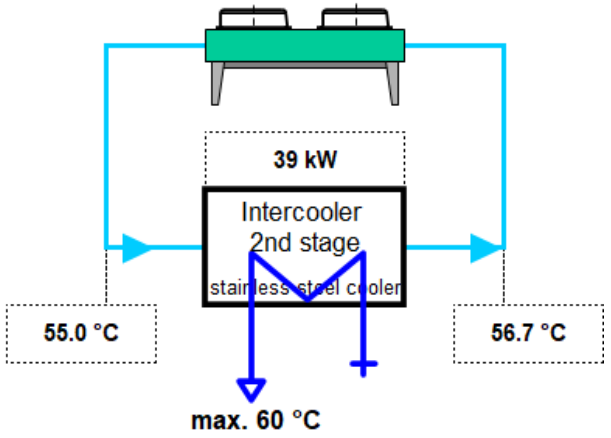


Low temperature circuit (calculated with Glykol 3%)

Heat to be dissipated = **39 kW**

(+12/-8 % tolerance)

Cooling water flow rate = **20.0 m³/h**



0.05 Cooling water circuit

Oil - heat (Engine jacket water cooling circuit)

Nominal output	kW	116
Max. Oil temperature	°C	85
Loss of nominal pressure of engine jacket water	bar	0.50
Safety valve - max press. set point	bar	2.50

Engine jacket water - heat (Engine jacket water cooling circuit)

Nominal output	kW	240
Max. engine jacket water temperature (outlet engine)	°C	90
Engine jacket water flow rate	m³/h	24.3
Safety valve - max press. set point	bar	2.50

Mixture Intercooler (1st stage) (Engine jacket water cooling circuit)

Nominal output	kW	206
Max. inlet cooling water temp. (intercooler)	°C	74.1
Nominal pressure of cooling water / (max. operating pressure)	PN	10
Loss of nominal pressure of engine jacket water	bar	0.30
Safety valve - max press. set point	bar	2.50

Mixture Intercooler (2nd stage) (Low temperature circuit)

Nominal output	kW	39
Max. inlet cooling water temp. (intercooler)	°C	55
Aftercooler water flow rate	m³/h	20.0
Nominal pressure of cooling water / (max. operating pressure)	PN	10
Intercooler water pressure drop	bar	0.80
Safety valve - max press. set point	bar	2.50

The final pressure drop will be given after final order clarification and must be taken from the P&ID order documentation.

0.10 Technical parameters

All data in the technical specification are based on engine full load (unless stated otherwise) at specified temperatures and the methane number and subject to technical development and modifications.

All pressure indications are to be measured and read with pressure gauges (psi.g.).

[1] At nominal speed and standard reference conditions ICFN according to ISO 3046-1, respectively
[2] According to ISO 3046-1, respectively, with a tolerance of +**5** %.
Efficiency performance is based on a new unit (immediately upon commissioning).Effects of degradation during normal operation can be mitigated through regular service and maintenance work.
reference value --> 65%CH4 / 35%CO2
[3] Average value between oil change intervals according to maintenance schedule, without oil change amount
[4] At p. f. = 1.0 according to IEC 60034-1:2017 with relative tolerances, all direct driven pumps are included
[5] Total output with a tolerance of +12/-8 %
[6] According to above parameters [1] through [5]
[7] As a guiding value at p.f. 0.8 and only valid for (engine, generator, TCM). Other peripheral equipment is not considered.
[8] Exhaust temperature with a tolerance of ±8 %
Note: an optimised operating mode to minimise methane slip can result in changed exhaust gas data (exhaust gas temperature, NOx emissions, etc.) and must be taken into account in the design of the exhaust gas aftertreatment
[9] Intercooler heat on:
*** standard conditions** - If the turbocharger design is done for air intake temperature > 30°C w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/°C starting from 25°C. Deviations between 25 – 30°C will be covered with the standard tolerance.
*** Hot Country application (V1xx)** - If the turbocharger design is done for air intake temperature > 40°C w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/°C starting from 35°C. Deviations between 35 – 40°C will be covered with the standard tolerance.

Radio interference level
The ignition system of the gas engines complies the radio interference levels of CISPR 12 and EN 55011 class B, (30-75 MHz, 75-400 MHz, 400-1000 MHz) and (30-230 MHz, 230-1000 MHz), respectively.

Definition of output
- ISO-ICFN continuous rated power:
  Net break power that the engine manufacturer declares an engine is capable of delivering continuously, at stated speed, between the normal maintenance intervals and overhauls as required by the manufacturer. Power determined under the operating conditions of the manufacturer's test bench and adjusted to the standard reference conditions.
  - Standard reference conditions:

Barometric pressure:	1000 mbar (14.5 psi) or 100 m (328 ft) above sea level
Air temperature:	25°C (77°F) or 298 K
Relative humidity:	30 %

- Volume values at standard conditions (fuel gas, combustion air, exhaust gas)
  Pressure: 1013 mbar (14.7 psi)
  Temperature: 0°C (32°F) or 273 K

Loss of engine performance

a) Performance reduction due to gas quality

If the reference methane number is not reached and the knock control responds, the ignition timing at full performance is adjusted in conjunction with the engine management system; only then is performance reduced.

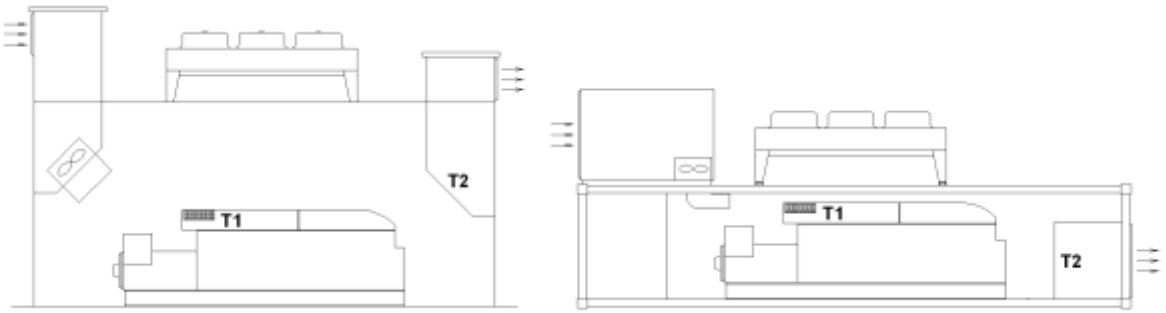
H2 admixtures in the range of 3–5 Vol% into the natural gas network are generally regarded as non-critical. Prerequisites for this are rates of change according to TA 1000-0300, as well as the knock resistance (minimum methane number) of the natural gas-H2 mixture according to the specification. For reliable compliance with required NOx emissions, the JENBACHER LEANOX^{plus} control is recommended (measurement of NOx emissions and correction of the LEANOX controller). Higher H2 addition rates into the natural gas network must be assessed on a project-specific basis.

b) Performance reduction due to voltage and frequency limits

If the voltage and frequency limits for generators specified in IEC 60034-1 Zone A are exceeded, performance is reduced.

c) Performance reduction due to environmental conditions

Standard rating of the engines is for an installation at an altitude ≤ **0 m** and combustion air temperature ≤ **35 °C** (T1)
Engine room outlet temperature: **50°C** (T2) -> engine stop



The minimum recommended air change ratio (C) must be observed to maintain the required air quality and prevent unwanted gas accumulations (refer to Section ⇨ Potentially explosive Atmospheres as per TA1100-0110). The calculation is based on TA 1100-0110 and is C_{min}= 50h^{-1} for JENBACHER modules.

Parameters for the operation of JENBACHER gas engines

The genset fulfils the limits for mechanical vibrations according to ISO 8528-9.
The following forms an integral part of a contract and must be strictly observed: **TA 1000-0004, TA 1100 0110, TA 1100-0111**, and **TA 1100-0112.**
Transport by rail should be avoided. See **TA 1000-0046** for further details

Failure to adhere to the requirements of the above-mentioned TA documents can lead to engine damage and may result in loss of warranty coverage.

Parameters for the operation of control unit and the electrical equipment

Relative humidity 50% by maximum temperature of 40°C.
Altitude up to 2000m above the sea level.

Parameters for using a gas compressor
The gas quantity indicated under the technical data refers to standard conditions with the given calorific value. The actual volume flow (under operating conditions) has to be considered for dimensioning the gas compressor and each gas feeding component – it will be affected by:

- Actual gas temperature (limiting temperature according to **TA 1000-0300**)
- Gas humidity (limiting value according to **TA 1000-0300**)
- Gas Pressure
- Calorific value variations (can be equated with methane (CH4) variations in the case of biogas)
- The gas compressor is designed for a max. relative under pressure of 15 mbar(g) (0.22 psi) and a inlet temperature of 40°C (104°F) , if within scope of supply JENBACHER.

0.20 Mode of Operation

Grid Parallel and Island Operation - Multi Units (Auto Re-sync)
While Grid connected, the unit/units load can be adjusted via its power control set point or designated option. In the event of a loss of utility, the unit/units will be able to continue operating locally without utility power. When the mains monitor relay (protective relay ANSI No. 27, 59, 81, 78- provided either by JENBACHER or the customer) is activated due to a mains failure, the engine is isolated from the mains by opening the mains circuit breaker.

The load adding and shedding capabilities of the genset documented in

- TA 2108-0031 - general island operation
- TA 2108-0027 for type 2 engines
- TA 2108-0025 for type 3 engines
- TA 2108-0029 for type 4 engines
- TA 2108-0026 for type 6 engines
- TA 2108-0032 for type 9 engines

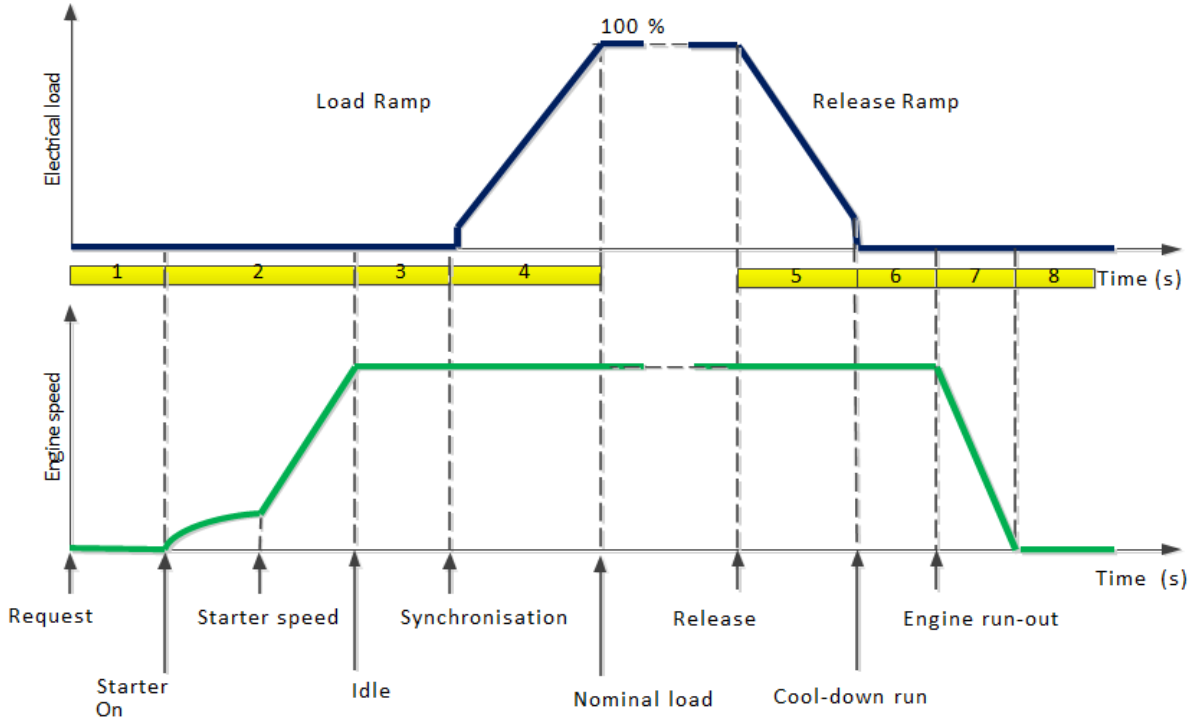
needs to be considered by the customer in order to ensure proper operation of the equipment.

When grid is restored, the unit is provided with an automatic re-synchronization feature which will synchronize the units back to the utility through a JENBACHER Master Synchronizing Control (optional, see appropriate Spec Section) or a higher-level control system provided by the customer. The unit(s) can perform "Black-out" start without external auxiliary power supply to the "dead busbar".

0.20.01 Guide values for genset - start/stop times and el. load ramps

Basic boundary conditions for engine start:

Engine conditions	Oil temperature (°C / °F)	Cooling-water temperature (°C / °F)
Fast start release	> 27 / 81 (type 3/4/6 engines)	> 55 / 131



The following time data of the individual start sections up to the nominal load are **guide values** for a fully automatic start under preheated conditions. Only the total start time is observed under the various engine conditions. The individual time segments given in the table therefore do not necessarily add up to the indication of the total start time.

Deviations are possible for special designs.

	J208	Type 3	Type 4	Type 612 – 620	J624
(1) Start preparation [1] *)	0	0	20	70	90
(2) Engage starter until reaching nominal speed [s] *)	20	20	25	40	40
(3) Synchronisation [s] *) **)	1-50	1 – 50	1 – 50	1 – 50	1 – 50
(4) Load application up to nominal load [s] *) **)	180	180	180	160	160
Total start-up time from request to nominal load [s]	<300	<300	<300	<300	<330

The following **times for unloading the engine** are guide values for engine/generator combination inertia constant H<1 kWs/kVA (with LS, CGT, TDPS generators) and the hot operating condition.

(5) Load reduction ramp [s]	160	160	160	160	120
(6) Cool-down run [s]	60	60	60	10	10
(7) Run-down [s]	60	60	60	60	60
Total time from nominal load to run-down time [s]	280	280	280	220	180
(8) Blocking time for restart [s]	~100	~100	~100	~200	~400

*) The times for start-up preparation and synchronisation can vary greatly and depend on project specifications.
****) Fast start function and faster load ramps are available on request.**

0.30 General information for connection to the public mains

Technical Instruction TA 1530-0188 describes the - possibly optional - functions and parameters for complying with the boundary conditions defined in the country-specific "Grid Codes".

Network operator-dependent requirements must always be coordinated with JENBACHER.

0.30.10 Generator operating range in mains parallel operation

Frequency:
Normal operation fn +/-2% - without power output reduction
Extended operation: fn +4/-6%- with power output reduction between 2 – 10%/Hz
Frequency-measurement resolution: <= 10mHz (resolution)
Generator - voltage range: +/-10% of generator Un
Generator power factor cos phi at the generator terminals: as specified in "0.03 Generator technical data"

FRT (Fault Ride Through) – capability: at mains connection point
Profile 1: 150ms/30%Un (applies to natural gas and biogas)
Profile 2 (150ms/5%Un) and Profile 3 (250ms/5%Un) upon request.

Requirement:
- mains short-circuit power must be at least 5 x SrE or 50MVA
- FRT capability of the onsite auxiliaries

Extended project requirements and country-specific design are optionally possible after consultation and approval with JENBACHER.

0.30.20 Possible mains operator requests

To protect the generating unit in mains parallel operation, appropriate mains protection monitoring functions are necessary to disconnect the generator from the mains in case of a mains fault.

The mains operator-dependent specifications such as e.g.: voltage and frequency range, active power limitation, load ramps, reactive power limitation and control, protection concept, necessary certification or

declarations, process data and interfaces are to be specified in project enquiries and must be agreed with JENBACHER before conclusion of the contract.

- Selectivity assessment, protection tests and recurring tests: on-site by the system operator
- Control power provision via pool operator: on request e.g., primary, secondary, tertiary
- Black start capability and countering in own use: on request
- Power generation system (EZA) controller or central control: on-site or possible on request
- Process data scope / remote control:
  - System data must be provided by the connectee for the mains operator.
  - Remote control interface to the mains operator: on-site
  - Interface specification!

Billing measurements - installation, operation, maintenance and remote data transmission: on-site.

Models of genset and generator: simplified models executed as effective value models for mains parallel operation optionally available.
Model formats: Powerfactory, or PSS/E (as of PP23)
Validated genset models in Powerfactory according to FGW TR3, TR4 and TR8 by a body accredited for this purpose according to DIN EN ISO/IEC 17065

Functional scope of the models in mains parallel operation:
- static voltage stability
- dynamic mains support
- Provision of reactive power
- Behaviour at active power setpoint
- Active power adjustment in the event of overfrequency and underfrequency (LFSM-O, LFSM-U)
- Protective devices and settings

0.30.20.01 Active power adjustment in the event of overfrequency and underfrequency

The following functions are available:
- LFSM-U: Limited Frequency Sensitive Mode - Underfrequency
- LFSM-O: Limited Frequency Sensitive Mode - Overfrequency
- FSM

Reduced power output at overfrequency: (LFSM-O function)
The frequency threshold is freely adjustable from fn + (200 - 500mHz) and the static from 2% to 12%.
Unless the relevant mains operator specifies otherwise for the LFSM-O mode, a threshold of fn + 200mHz and a static of 5% is set.

Power increase in the event of underfrequency (LFSM-U function) – (OPTIONAL as of XT4.5)
activated according to the mains operator's specifications
The frequency-sensitive active power feed-in has the effect that the generating plant
also moves permanently up and down on the frequency characteristic curve ("driving on the characteristic curve") in the frequency range between fn - 200mHz (unless otherwise specified by the mains) and fn - 2.5Hz with regard to its maximum possible active power feed-in.
The prerequisite for this is a corresponding power setpoint.

Reduced power output at underfrequency:

below 98% of fn, reduction by standard 10% of maximum capacity per Hz. Reduction up to maximum fn - 6%.
Lower reduction ramps of 2 - 10%/Hz on request
The FSM function is available as an option

The power generation system is capable of continuing to operate at this minimum power when the minimum power for controllable operation is reached.

1.00 Scope of supply - module

Design:
The module is built as a compact package. Engine and generator are connected through a coupling and are mounted to the base frame. To provide the best possible isolation from the transmission of vibrations the engine is mounted to the frame by means of anti-vibrational mounts. The remaining vibrations are eliminated by mounting the module on isolating pads (e.g. Sylomer). This, in principle, allows the module to be placed directly on any floor capable of carrying the static load.

1.01 Spark ignited gas engine

Four-stroke, air/gas mixture turbocharged, aftercooled, with high performance ignition system and electronically controlled air/gas mixture system.
The engine is equipped with the most advanced

LEANOX® LEAN-BURN COMBUSTION SYSTEM

developed by JENBACHER.

1.01.01 Engine design

Engine block
Single-piece crankcase and cylinder block made of special casting; crank case covers for engine inspection, welded steel oil pan.

Crankshaft and main bearings
Drop-forged, precision ground, surface hardened, statically and dynamically balanced; main bearings (upper bearing shell: 3-material bearing / lower bearing shell: sputter bearing) arranged between crank pins, drilled oil passages for forced-feed lubrication of connecting rods.

Vibration damper
Maintenance free viscous damper

Flywheel
With ring gear for starter motor

Pistons
Single-piece light metal alloy (Two-part steel piston), with piston ring carrier and oil passages for cooling; piston rings made of high quality material, main combustion chamber specially designed for lean burn operation.

Connecting rods
Drop-forged, heat-treated, big end diagonally split and toothed. Big end bearings (upper bearing shell: sputter bearing / lower bearing shell: sputter bearing) and connecting rod bushing for piston pin.

Cylinder liner
Chromium alloy gray cast iron, wet, individually replaceable.

Cylinder head
Specially designed and developed for JENBACHER-lean burn engines with optimised fuel consumption and emissions; water cooled, made of special casting, individually replaceable; Valve seats, valve guides and spark plug sleeves individually replaceable; exhaust and inlet valves made of high quality material.

Crankcase breather
Connected to combustion air intake system.

Valve train
Camshaft, with replaceable bushings, driven by crankshaft through intermediate gears, valve lubrication by splash oil through rocker arms.

Combustion air/fuel gas system
Motorized carburetor for automatic adjustment according to fuel gas characteristic. Exhaust driven turbocharger, mixture manifold with bellows, water-cooled intercooler, throttle valve and distribution manifolds to cylinders.

Ignition system
Most advanced, fully electronic high performance ignition system, external ignition control.
MORIS / SEMIC: Automatically, cylinder selective registration and control of the current needed ignition voltage.

Lubricating system
Gear-type lube oil pump to supply all moving parts with filtered lube oil, pressure control valve, pressure relief valve and full-flow filter cartridges. Cooling of the lube oil is arranged by a heat exchanger.

Engine cooling system
Jacket water pump complete with distribution pipework and manifolds.

Exhaust system
Turbocharger and exhaust manifold

Exhaust gas temperature measuring
Thermocouple for each cylinder

Electric actuator
For electronic speed and output control

Electronic speed monitoring for speed and output control
By magnetic inductive pick up over ring gear on flywheel

Starter motor
Engine mounted electric starter motor

1.01.02 Additional equipment for the engine (spares for commissioning)

The initial set of equipment with the essential spare parts for operation after commissioning is included in the scope of supply.

1.01.03 Engine accessories

Insulation of exhaust manifold:
Insulation of exhaust manifold is easily installed and removed

Sensors at the engine:
- Jacket water temperature sensor
- Jacket water pressure sensor
- Lube oil temperature sensor
- Lube oil pressure sensor
- Mixture temperature sensor
- Charge pressure sensor
- Minimum and maximum lube oil level switch
- Exhaust gas thermocouple for each cylinder
- Knock sensors
- Gas mixer / gas dosing valve position reporting.

Actuator at the engine:
- Actuator - throttle valve
- Bypass-valve for turbocharger
- Control of the gas mixer / gas dosing valve

1.01.04 Standard tools (per installation)

The tools required for carrying out the most important maintenance work are included in the scope of supply and delivered in a toolbox.

1.02 Generator-low voltage

The 2-bearing generator consists of the main generator (built as rotating field machine), the exciter machine (built as rotating armature machine) and the digital excitation system.
The digital regulator is powered by an auxiliary winding at the main stator or a PMG system

Main components
- Enclosure of welded steel construction
- Stator core consist of thin insulated electrical sheet metal with integrated cooling channels.
- Stator winding with 2/3 Pitch
- Rotor consists of shaft with shrunken laminated poles, Exciter rotor, PMG (depending on Type) and fan.
- Damper cage
- Excitation unit with rotating rectifier diodes and overvoltage protection
- Dynamically balanced as per ISO 1940, Balance quality G2,5
- Drive end bracket with re greaseable antifriction bearing

- Non-drive end bracket with re grease antifriction bearing
- Cooling IC01 - open ventilated, air entry at non-drive end, air outlet at the drive end side
- Main terminal box includes main terminals for power cables
- Regulator terminal box with auxiliary terminals for thermistor connection and regulator.
- Anti-condensation heater
- 3 PT100 for winding temperature monitoring+3 PT100 Spare
- 2 PT100 for bearing temperature monitoring

Option:
Current transformer for protection and measuring in the star point
xx/1A, 5P10 15VA, xx/1A, 1FS5, 15VA

Electrical data and features

- Standards: IEC 60034, EN 60034, ISO 8528-3, ISO 8528-9
- Voltage adjustment range: +/- 10 % of rated voltage (continuous)
- Frequency: -6/+4% of rated frequency
- Overload capacity: 10% for one hour within 6 hours, 50% for 30 seconds
- Asymmetric load : max. 8% I2 continuous, in case of fault I2 x t=20
- Altitude: < 1000m
- Max permitted generator intake air temperature: 5°C - 40°C
- Max. relative air humidity: 90%
- Voltage curve THD Ph-Ph: <3,5% at idle operation and <5% at full load operation with linear symmetrical load
- Generator suitable for parallel operating with the grid and other generators
- Sustained short circuit current at 3-pole terminal short circuit: minimum 3 times rated current for 5 seconds.
- Over speed test with 1.2 times of rated speed for 2 minutes according to IEC 60034

Digital Excitation system ABB Unitrol 1010 mounted within the AVR Terminal box with following features:

- Compact and robust Digital Excitation system for Continuous output current up to 10 A (20A Overload current 10s)
- Fast AVR response combined with high excitation voltage improves the transient stability during LVRT events.
- The system has free configurable measurement and analog or digital I/Os. The configuration is done via the local human machine interface or CMT1000
- Power Terminals
  3 phase excitation power input from PMG or auxiliary windings
  Auxiliary power input 24VDC
- Excitation output
- Measurement terminals: 3 phase machine voltage, 1 phase network voltage, 1 phase machine current
- Analog I/Os: 2 outputs / 3 inputs (configurable), +10 V / -10 V
- Digital I/O: 4 inputs only (configurable), 8 inputs / outputs (configurable)
- Serial fieldbus: RS485 for Modbus RTU or VDC (Reactive power load sharing for up to 31 JENBACHER engines in island operation), CAN-Bus for dual channel communication
- Regulator Control modes: Bump less transfer between all modes
  Automatic Voltage Regulator (AVR) accuracy 0,1% at 25°C ambient temperature
  Field Current Regulator (FCR)
  Power Factor Regulator (PF)

Reactive Power Regulator (VAR)
- Limiters: Keeping synchronous machines in a safe and stable operation area
  Excitation current limiter (UEL min / OEL max)
  PQ minimum limiter
  Machine current limiter
  V / Hz limiter
  Machine voltage limiter
- Voltage matching during synchronization
- Rotating diode monitoring
- Dual channel / monitoring: Enables the dual channel operation based on self-diagnostics and setpoint follow up over CAN communication. As Option available
- Power System Stabilizer (PSS) is available as option. Compliant with the standard IEEE 421.5-2005 2A / 2B, the PSS improves the stability of the generator over the highest possible operation range.
- Computer representation for power system stability studies: ABB 3BHS354059 E01
- Certifications: CE, cUL certification according UL 508c (compliant with CSA), DNV Class B,

- **Commissioning and maintenance Tool CMT1000** (for trained commissioning/ maintenance personal)
- With this tool the technician can setup all parameters and tune the PID to guarantee stable operation. The CMT1000 software allows an extensive supervision of the system, which helps the user to identify and locate problems during commissioning on site. The CMT1000 is connected to the target over USB or Ethernet port, where Ethernet connection allows remote access over 100 m.
- Main window
  - Indication of access mode and device information.
  - Change of parameter is only possible in CONTROL access mode.
  - LED symbol indicates that all parameter are stored on none volatile memory.
- Setpoint adjust window
  - Overview of all control modes, generator status, active limiters status and alarms.
  - Adjust set point and apply steps for tuning of the PID.
- Oscilloscope
- 4 signals can be selected out of 20 recorded channels. The time resolution is 50ms.Save files to your PC for further investigation.
- Measurement
  - All measurements on one screen.

Routine Test

Following routine tests will be carried out by the generator manufacturer
- Measuring of the DC-resistance of stator and rotor windings
- Check of the function of the fitted components (e.g. RTDs, space heater etc.)
- Insulation resistance of the following components
  Stator winding, rotor winding
  Stator winding RTDs
  Bearing RTDs
  Space heater
- No Load saturation characteristic (remanent voltage)
- Stator voltage unbalance
- Direction of rotation, phase sequence
- High voltage test of the stator windings (2 x Unom. + 1000 V) and the rotor windings (min. 1500 V)

1.03 Module accessories

Base frame
Welded structural steel to accommodate engine, generator and heat exchangers.

Flexible coupling
With torque limiter to couple engine with generator. The coupling isolates the major subharmonics of engine firing impulses from the generator.

Bell housing
To connect engine with generator housing. With two ventilation and control windows.

Anti-vibration mounts
Arranged between engine/generator assembly and base frame. Isolating pads (SYLOMER) for placement between base frame and foundation, delivered loose.

Exhaust gas connection
Connection of exhaust gas turbocharger; including flexible connection to compensate for expansions and vibrations.

Combustion air filter
Dry type air filter with replaceable filter cartridges, including flexible connection to carburetor and service indicator.

Interface panel
Totally enclosed sheet steel cubicle with front door, wired to terminals, ready to operate. Cable entry at bottom.

Painting: RAL 7035

Protection: IP 54 external, IP 20 internal (protection against direct contact with live parts)

Design according to IEC 439-1 (EN 60 439-1/1990) and DIN VDE 0660 part 500, respectively.
Ambient temperature: 5 - 40 °C (41 - 104 °F), Relative humidity:70 %

Dimensions:
- Height: 1200 mm (47 in)
- Width: 1200 mm (47 in)
- Depth: 400 mm (16 in)

Power supply from the starter battery charger.

Power distribution to the engine mounted auxiliaries (power input from the supplier of the auxiliaries power supply):
3 x 415/240 V, 50 Hz, 16 A

Essential components installed in interface panel:
- Terminal strip
- Decentralised input and output cards, connected by a data bus interface to the central engine control of the module control panel.
- Speed monitoring
- Relays, contacts, fuses, engine contact switch to control valves and auxiliaries
- Measuring transducer for excitation voltage
- Air conditioning system **(option)**

1.03.01 Engine jacket water system

Closed cooling circuit, consisting of:
- Expansion tank
- Filling device (check and pressure reducing valves, pressure gauge)
- Safety valve(s)
- Thermostatic valve
- Required pipework on module
- Vents and drains
- Electrical jacket water pump, including check valve
- Jacket water preheat device

1.03.02 Automatic lube oil replenishing system incl. extension tank

Automatic lube oil replenishing system:
Includes float valve in lube oil feed line, including inspection glass. Electric monitoring system will be provided for engine shut-down at lube oil levels "MINIMUM" and "MAXIMUM". Solenoid valve in oil feed line is only activated during engine operation. Manual override of the solenoid valve, for filling procedure during oil changes is included.

Oil drain
By set mounted cock

Oil sump extension tank 150 **l**
To increase the time between oil changes

Pre-lubrication- and aftercooling oil pump:
Mounted on the module base frame; it is used for pre-lubrication and aftercooling of the turbochargers.
Period of operation: Pre-lubrication: 1 minute
Aftercooling: 15 minutes from engine stop
Consisting of:
- 1 piece oil pump 1500 W, 24 V
- All necessary vents
- Necessary pipework

1.05.01 Gas train <500mbar

Pre-assembled, delivered loose, for installation into gas pipework to the module.

Consisting of:
- Shut off valve
- Gas filter, filter fineness <3 µm
- Pressure gauge with push button valve
- Gas admission pressure regulator
- Solenoid valves
- Leakage detector
- Gas pressure switch (min.)

- TEC JET
- Gas flow meter (option)
- p/t compensation (option)

The gas train complies with DIN - DVGW regulations.
Maximum distance from TEC JET outlet to gas entry on engine, including flexible connections, is 1 m (39,37 in).

1.07 Painting

• Quality:	Oil resistant prime layer Synthetic resin varnish finishing coat	
• Colour:	Engine:	RAL 6018 (green)
	Base frame:	RAL 6018 (green)
	Generator:	RAL 6018 (green)
	Module interface panel:	RAL 7035 (light grey)
	Control panel:	RAL 7035 (light grey)

1.11 Engine generator control panel per module- DIA.NE XT4 incl. Single synchronization of the generator breaker

Dimensions:

- Height: 2310 mm (including 200 mm (8 in) pedestal *)
- Width: 800 -1200mm *)
- Depth: 600 mm *)

Protection class:

- external IP42
- Internal IP 20 (protection again direct contact with live parts)

*) Control panels will be dimensioned on a project specific basis. Actual dimensions will be provided in the preliminary documentation for the project.

Control supply voltage from starter and control panel batteries: 24V DC

Auxiliary equipment supply (by the supplier of the auxiliary equipment supply system)
The following network forms are possible for the supply of the auxiliary equipment. Depending on these, appropriate protective measures are provided:

Standard: TN- S (L1/2/3, N, PE)

- Power supply via the module control cabinet via connection terminals or directly at the 3-pole mains disconnection unit. Protection against electric shock by automatic disconnection with miniature circuit breaker or fuse.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA
- Option:
  - According to national requirements or customer wishes, a 4-pole mains disconnecting device can also be used. Especially if the neutral conductor is not considered to be reliably earthed.

- Downstream outputs for auxiliary equipment with neutral conductors are fused using 2 or 4 poles.

Option: TN-C (L1/2/3, PEN)

- Power supply via the module control cabinet via connection terminals or directly at the 3-pole mains disconnection unit. Protection against electric shock by automatic disconnection with miniature circuit breaker or fuse.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA

Option: TT (L1/2/3, N)

- Power supply via the module control cabinet via connection terminals or directly at the 4-pole mains disconnection unit. Protection against electric shock by automatic disconnection through integrated differential current monitoring (RCD) type A.
- Downstream outputs for auxiliary equipment with neutral conductors are fused using 2 or 4 poles.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA
- Option:
  - When using frequency converters, an additional differential current monitoring device (RCD) type B is mounted.

Option: IT (L1/2/3, N, PE)

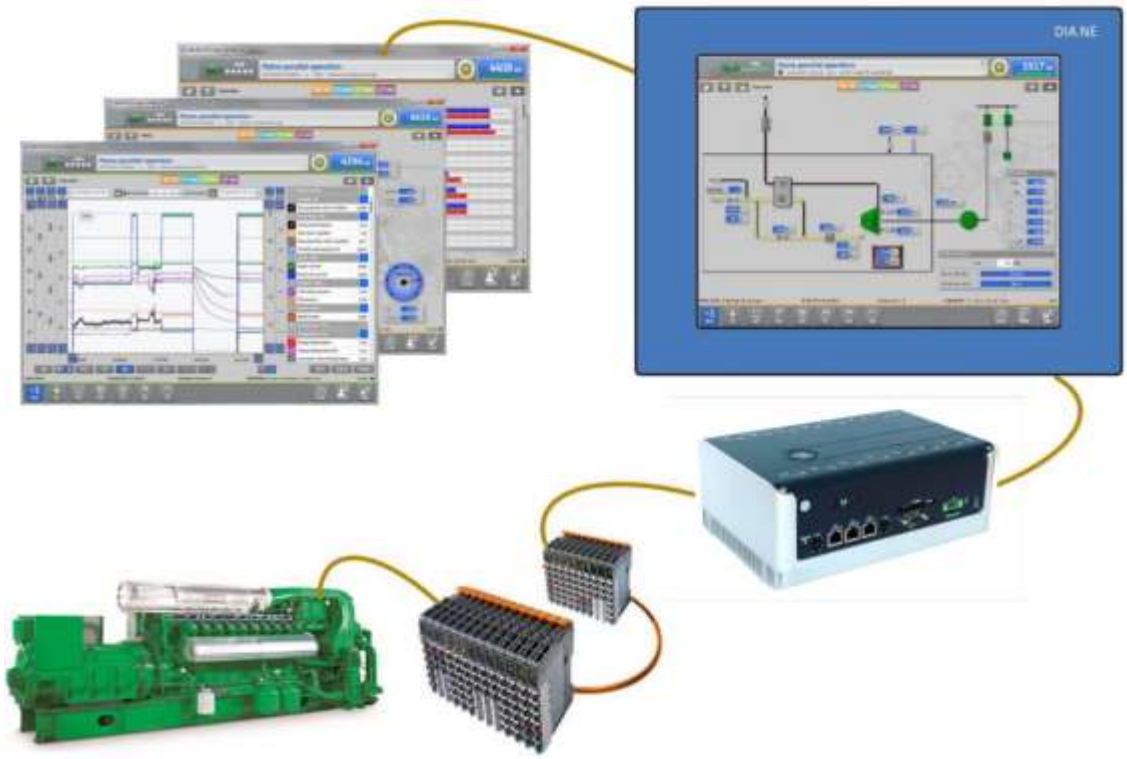
- Power supply via the module control cabinet via connection terminals or directly at the 4-pole mains disconnection unit. Protection against electric shock by automatic disconnection through integrated differential current monitoring (RCD) type A. Insulation monitoring is part of customer's scope of supply. Preparations have already been made for the transfer of error messages to the module control cabinet and alarm signaling via DIA.NE.
- Downstream outputs for auxiliary equipment with neutral conductors are fused using 2 or 4 poles.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA
- Option:
  - When using frequency converters, an additional differential current monitoring device (RCD) type B is mounted.
- Option:
  - An insulation monitoring device connected to the auxiliary power supply with automatic disconnection in case of insulation faults. Alarm signaling via DIA.NE.
- Option:
  - Overvoltage protection for auxiliary equipment, protection module with integrated remote signaling.
  - SPD in conformity with EN 61643-11 type 2
  - Nominal voltage Un 230/400V

3 x **415**/**240** V, **50** Hz

Consisting of:
Motor - Management - System DIA.NE

Setup:

- a) Touch display visualization
- b) Central engine and unit control



Touch Display Screen:

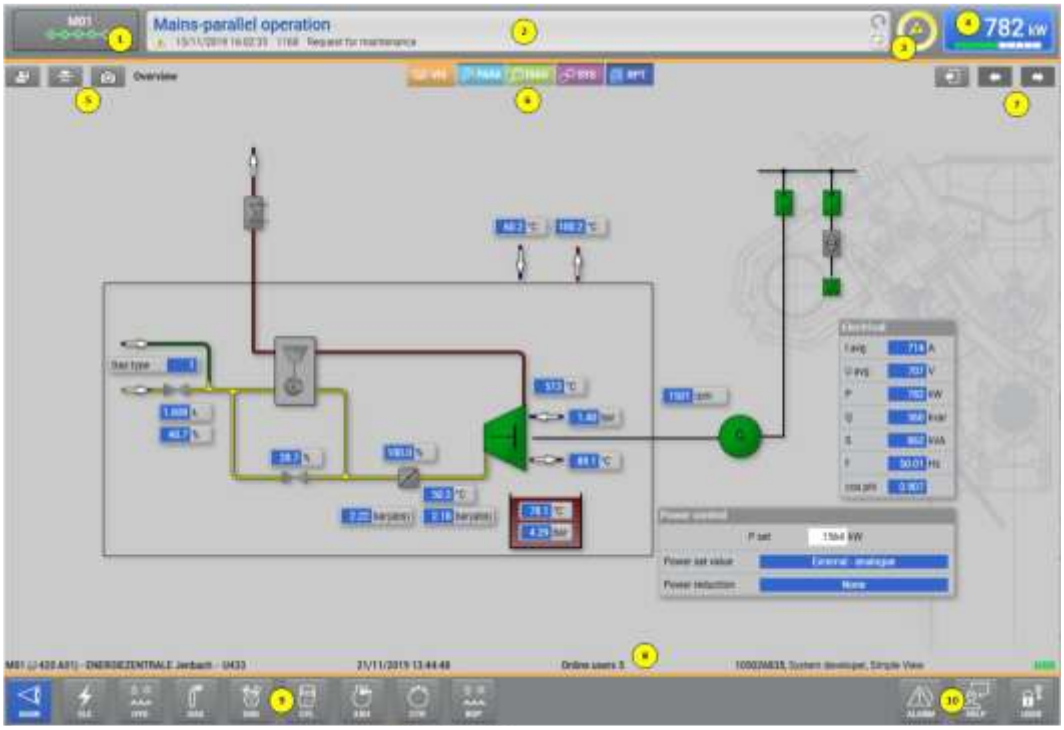
15“Industrial color graphic display with resistive touch.

Protection class of DIA.NE XT panel front: IP 65

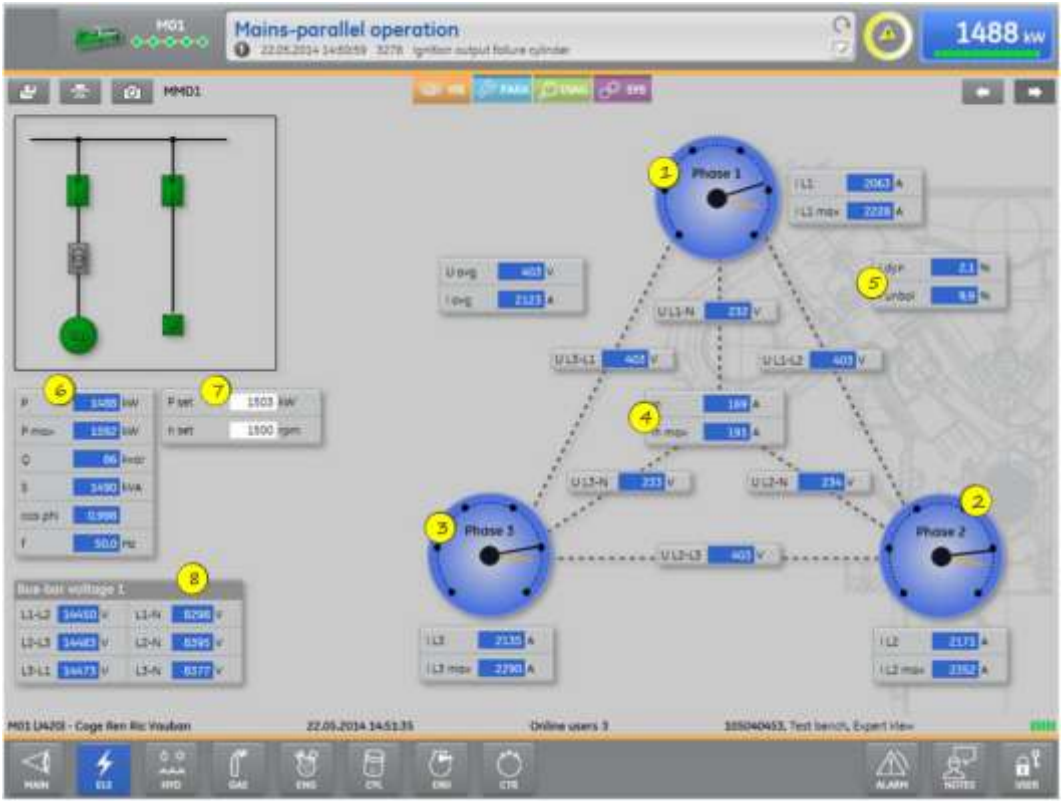
The screen shows a clear and functional summary of the measurement values and simultaneously shows a graphical summary.

Operation is via the screen buttons on the touch screen
Numeric entries (set point values, parameters…) are entered on the touch numeric pad or via a scroll bar.
Determination of the operation mode and the method of synchronization via a permanently displayed button panel on the touch screen.

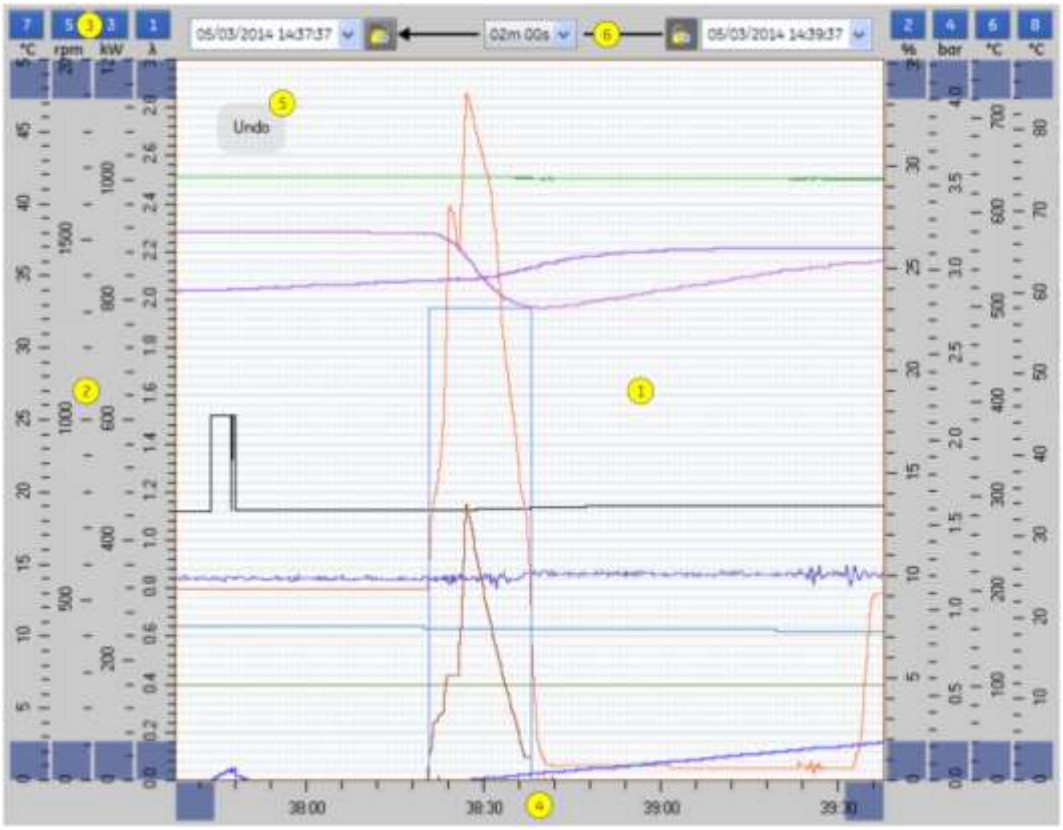
Main screens (examples):
Main: Display of the overview, auxiliary's status, engine start and operating data.



ELE: Display of the generator connection with electrical measurement values and synchronization status



Trending
Trend with 100ms resolution



Measurement values:

- 500 data points are stored
- Measurement interval = 100ms
- Raw data availability with 100ms resolution: 24 hours + max. 50.000.000 changes in value at shut down (60 mins per shut down)
- Compression level 1: min, max, and average values with 1000ms resolution: 1 day
- Compression level 2: min, max, and average values with 30s resolution: 1 month
- Compression level 3: min, max, and average values with 10min resolution: 10 years

Messages:
1.000.000 message events

Actions (operator control actions):
100.000 Actions

System messages:
100.000 system messages

Central engine and module control:

An industrial PC- based modular industrial control system for module and engine sequencing control (start preparation, start, stop, aftercooling and control of auxiliaries) as well as all control functions.

Interfaces:

- Ethernet (twisted pair) for remote monitoring access
- Ethernet (twisted pair) for connection between engines
- Ethernet (twisted pair) for the Powerlink connection to the control input and output modules.

Connection to the local building management system according to the JENBACHER option list (OPTION)

- MODBUS-RTU Slave
- MODBUS-TCP Slave,
- PROFIBUS-DP Slave (120 words),
- PROFIBUS-DP Slave (190 words),
- ProfiNet Slave
- OPC DA Server

Control functions:

- Speed control in idle and in island mode
- Power output control in grid parallel operation, or according to an internal or external set point value on a case by case basis
- LEANOX control system which controls boost pressure according to the power at the generator terminals, and controls the mixture temperature according to the engine driven air-gas mixer
- Knocking control: in the event of knocking detection, ignition timing adjustment, power reduction and mixture temperature reduction (if this feature is installed)
- Load sharing between engines in island mode operation (option)
- Linear power reduction in the event of excessive mixture temperature and misfiring
- Linear power reduction according to CH4 signal (if available)
- Linear power reduction according to gas pressure (option)
- Linear power reduction according to air intake temperature (option)

Multi-transducer to record the following alternator electrical values:

- Phase current (with slave pointer))
- Neutral conductor current
- Voltages Ph/Ph and Ph/N
- Active power (with slave pointer)
- Reactive power
- Apparent power
- Power factor
- Frequency
- Active and reactive energy counter

Additional 0 (4) - 20 mA interface for active power as well as a pulse signal for active energy

The following alternator monitoring functions are integrated in the multi-measuring device:

- Overload/short-circuit [51], [50]
- Over voltage [59]
- Under voltage [27]
- Asymmetric voltage [64], [59N]
- Unbalance current [46]
- Excitation failure [40]
- Over frequency [81>]
- Under frequency [81<]

Lockable operation modes selectable via touch screen:

- "OFF" operation is not possible, running units will shut down immediately;
- "MANUAL" manual operation (start, stop) possible, unit is not available for fully automatic operation.
- "AUTOMATIC" fully automatic operation according to external demand signal:

Demand modes selectable via touch screen:

- external demand off („OFF“)
- external demand on („REMOTE“)
- overide external demand („ON“)

Malfunction Notice list:

Shut down functions e.g.:

- Low lube oil pressure
- Low lube oil level
- High lube oil level
- High lube oil temperature
- Low jacket water pressure
- High jacket water pressure
- High jacket water temperature
- Overspeed
- Emergency stop/safety loop
- Gas train failure
- Start failure
- Stop failure
- Engine start blocked
- Engine operation blocked
- Misfiring
- High mixture temperature
- Measuring signal failure
- Overload/output signal failure
- Generator overload/short circuit
- Generator over/undervoltage
- Generator over/underfrequency
- Generator asymmetric voltage
- Generator unbalanced load
- Generator reverse power
- High generator winding temperature
- Synchronizing failure
- Cylinder selective Knocking failure

Warning functions e.g.:

- Cooling water temperature min.
- Cooling water pressure min.
- Generator winding temperature max.

Remote signals:
(volt free contacts)

1NO = 1 normally open

1NC = 1 normally closed
1COC = 1 change over contact

- Ready for automatic start (to Master control) 1NO
- Operation (engine running) 1NO
- Demand auxiliaries 1NO
- Collective signal "shut down" 1NC
- Collective signal "warning" 1NC

External (by others) provided command/status signals:
- Engine demand (from Master control) 1S
- Auxiliaries demanded and released 1S

Single synchronizing Automatic

For automatic synchronizing of the module with the generator circuit breaker to the grid by PLC-technology, integrated within the module control panel.

Consisting of:
- Hardware extension of the programmable control for fully automatic synchronization selection and synchronization of the module and for monitoring of the generator circuit breaker closed signal.
- Lockable synchronization selection via touch screen with the following selection modes:
  - "MANUAL" Manual initiation of synchronization via touch screen button followed by fully automatic synchronization of the module
  - "AUTOMATIC" Automatic module synchronization, after synchronizing release from the module control
  - "OFF" Selection and synchronization disabled
    Control of the generator circuit breaker according to the synchronization mode selected via touch screen.
  - "Generator circuit breaker CLOSED/ Select" Touch-button on DIA.NE XT
  - "Generator circuit breaker OPEN" Touch-button on DIA.NE XT
  - Measurement Generator breaker closing time last synchronization

Status signals:
- Generator circuit breaker closed
- Generator circuit breaker open

Remote signals:
(volt free contacts)
- Generator circuit breaker closed 1 NO

The following reference and status signals must be provided by the switchgear supplier:

- Generator circuit breaker CLOSED 1 NO
- Generator circuit breaker OPEN 1 NO
- Generator circuit breaker READY TO CLOSE 1 NO
- Mains circuit breaker CLOSED 1 NO
- Mains circuit breaker OPEN 1 NO

- Mains voltage via voltage transformers 3x 100 or 110V/v3 - other measuring voltages on request!
- Busbar voltage via voltage transformers 3x 100 or 110V/v3 - other measuring voltages on request!
- Generator voltage via voltage transformers 3x 100 or 110V/v3 - other measuring voltages on request!
- Generator voltage via voltage transformers 3x 100V or 110V/3 homopolar voltage for 59N for medium voltage generators

Voltage transformer in the star/star connection with minimum 50VA and Class 0,5

The following volt free interface-signals will be provided by JENBACHER to be incorporated in switchgear:

- CLOSING/OPENING command for generator circuit breaker (permanent contact) 1 NO + 1 NC
- Signal for circuit breaker undervoltage trip 1 NO

Maximum distance between module control panel and engine/interface panel:	30m
Maximum distance between module control panel and power panel:	50m
Maximum distance between module control panel and master control panel:	50m
Maximum distance between alternator and generator circuit breaker:	30m

1.11.02 Remote information by MODBUS-RTU

Data transfer from JENBACHER-module control to customer's plant management system by MODBUS-RTU-network (RS 485).
The Jenbacher module control panel works as a SLAVE.
The data transmission by the customer's MASTER shall be cyclical.

Data transmitted:
Fault messages, operating messages, measured values (generator power, oil pressure, oil temperature, cooling water pressure, cooling water temperature, etc.) according to JENBACHER standard (interface list).

JENBACHER limit of delivery:
Interface connector at the PLC in the module control panel.

1.11.06 Remote Data-Transfer with DIA.NE XT4

General
DIA.NE XT4 offers remote communication using an Ethernet connection.

1.) DIA.NE XT4 HMI
DIA.NE XT4 HMI is the Human-Machine-Interface of DIA.NE XT4 engine control and visualization system for JENBACHER gas engines.
The system offers extensive facilities for commissioning, monitoring, servicing and analysis of the site.

By installation of the DIA.NE XT4 HMI client program it can be used to establish connection to site, if connected to a network and access rights are provided.
The system runs on Microsoft Windows Operating systems (Windows 7, Windows 8, Windows 10)

Function
Functions of the visualization system at the engine control panel can be used remotely. These functions provide control, monitoring, trend indications, alarm management, parameter management, and access to long term data recording. By providing access to multiple systems, also with multiple clients in parallel, additional useful functions are available like

- Multi-user system
- Remote control
- Print and export functions
- Data backup.

The DIA.NE XT4 is available in several languages.

Option - Remote demand/blocking
If the service selectors switch at the module control panel is in position "Automatic" and the demand-selector switch in position "Remote", it is possible to enable (demanded) or disable (demand off) the module with a control button at the DIA.NE XT4 HMI
Note:
With this option, it makes no sense to have an additional clients demand (via hardware or data bus) or a self-guided operation (via JENBACHER master control, grid import /export etc.).

Option - Remote - reset (see TA-No. 1100-0111 chapter 1.7 an d1.9)
Scope of supply

- Software package DIA.NE XT4 HMI Client Setup (Download)
- Number of DIA.NE XT4 HMI - Client user license (Simultaneous right to access of one user to the engine control)

Nr. of license	Access
1	1 Users can be logged in at the same time with a PC (Workplace, control room or at home).
2 - “n“ (Optional)	2- “n” Users can be logged in at the same time with a PC (Workplace, control room or at home). If 2- “n” users are locally connected at Computers from office or control room, then it is not possible to log in from home.

Caution! This option includes the DIA.NE XT4 HMI client application and its license only – NO secured, encrypted connection will be provided by JENBACHER! A secured, encrypted connection – which is mandatory – has to be provided by the customer (via LAN connection or customer-side VPN), or can be realized by using option myPlant™.

Customer requirements

- Broad band network connection via Ethernet(100/1000BASE-TX) at RJ45 Connector (ETH1) at DIA.NE XT4 server inside module control panel
- Standard PC with keyboard, mouse or touch and monitor (min. resolution 1024*768)
- Operating system Windows 7, Windows 8, Windows 10
- DirectX 9.0 c compatible or newer 3D display adapter with 64 MB or higher memory

2.) myPlant™
myPlant* is the remote data transfer and diagnostics solution from JENBACHER

basic / advanced monitoring			
Liver operating status	✓	✓	✓
Historic and live data trending		✓	✓
Alarm management and notification	Alarm management only	✓	✓
Access to all engine documents	✓	✓	✓
Mobile app	✓	✓	✓
Daily status logbooks	✓	✓	✓
Remote access to engine controller		✓	✓
Fleet management		✓	✓
Engine status notifications (SMS/Email)		✓	✓
increased productivity / strong performance			
Recommended maintenance[1] (coming soon)	✓	✓	✓
Support case management[1]	✓	✓	✓
Predictive maintenance for spark plugs, oil and air filters[2]	Spark plugs lifetime prediction only	✓	✓
Oil & coolant quality monitoring[3]		✓	✓
Fleet emission monitoring[4]	Engine emission monitoring only	✓	✓
artificial intelligence & predictive analytics			
Operator analytics package			✓
Historic performance analysis			✓
User-defined monitoring			✓
On demand: Access to myPlant data via API (Application Programming Interface) service[5]			✓

[1] Available soon for JENBACHER direct markets only
[2] Spark plugs, oil and air filters data might not always be available and is depending on the engine version/type ant the sensors installed
[3] Oil and coolant reports are available in myPlant for the following laboratories: Spectro, JetCare, Polaris, MIC GSM
[4] May require additional hardware installation for emission monitoring (available as upgrade)
[5] Might require development work on customer/service provider side and includes 70 API calls per engine per month

Scope of supply

- Access to myPlant™
- Integration of the plant in the myPlant™ system
- Access to Basic and Care level as per new installation contract
- Access to Professional level via separate contract

Equipment to be provided by the customer

- Permanent Internet connection (wired or wireless)
  (see also option 4)
- Technical requirements as per TA 2300-0008
- Outward data connection (from the plant server to the Internet) - INWARD connections are NOT PERMITTED!

CAUTION: The customer must take technical precautions to ensure that direct access to the plant server from the Internet is prevented (e.g. by means of a firewall):
This security measure CANNOT be assumed and guaranteed by JENBACHER

3.) Mobile Internet (OPTION)
Connection Plant - Customer via secured Internet - connection
See also technical instruction **TA 2300 - 0006**

Scope of delivery

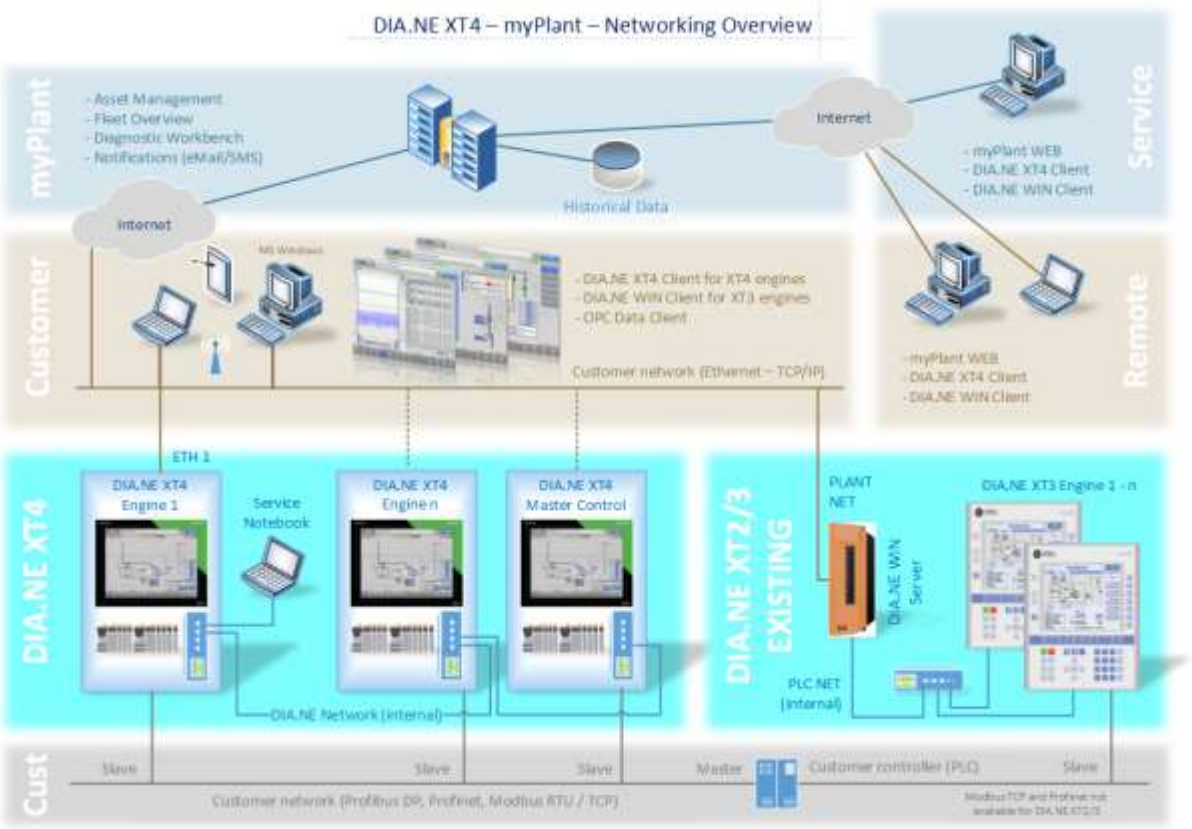
- Mobile Internet router with antenna to connect to the DIA.NE Server XT4

Customer requirements

- SIM card for 3G / 4G

4.) Network overview

For information only!



1.11.13 Out-of-step protection / pole slip protection (integrated in DIA.NE XT4)

ANSI Function Code 78

- 3-phase monitoring, integrated in DIA.NE XT4 controller
- Uses voltage measurement at the generator and engine speed measurement (supplied by JENBACHER).
- Allows real-time calculation of rotor angle during dynamic operations
- Allows safe detection of a pole slip risk and allows operation up to the maximum limit value
- Acting on generator circuit breaker and generator de-excitation.
- Alarm message on the DIA.NE screen.
- Active in Grid and Island parallel operation

OPTIONAL on special release:
separate digital protection relay (ATTENTION: different detection as generator and mains voltage are evaluated. Tripping only possible if pole slip has occurred)

Following monitoring are integrated in the DIA.NE generator protection package
- Load angle / pole slip monitoring
- Exciter failure monitoring [ANSI 40]

1.20.03 Starting system

Starter battery:
2 piece 12 V AGM battery, 125 Ah (according to DIN 72311).

Battery voltage monitoring:
Monitoring by PLC.

Battery charging equipment:
Capable for charging the starter battery with I/U characteristic and for the supply of all connected D.C. consumers.
Charging device is mounted inside of the module interface panel or module control panel.

- **General data:**

• Power supply	**3 x 320 - 575 V, 47 - 63 Hz**
• max. power consumption	1040 W / 1550 W (5 sec)
• Nominal D.C. voltage	24 V(+/-1%)
• Voltage setting range	24V to 28V (adjustable)
• Nominal current (max.)	40 A
• Degree of protection	IP20 to IEC 60529
• Operating temperature	0 °C - 70 °C
• Protection class	1
• Humidity class	3K3, no condensation.
• Natural air convection	
• Standards	EN60950,EN50178 UL/cUL (UL508 / UL 60950-1)

Signalling:
Green Led: Output voltage > 21,6V

Control accumulator:
- Pb battery 24 VDC/18 Ah

1.20.05 Electric jacket water preheating

Installed in the jacket water cooling circuit, consisting of:
- Heating elements
- Water circulating pump

The jacket water temperature of a stopped engine is maintained between 56°C (133 °F) and 60°C (140°F), to allow for immediate loading after engine start.

1.20.08 Flexible connections

Following flexible connections per module are included in the JENBACHER -scope of supply:

No.	Connection	Unit	Dimension	Material
2	Warm water in-/outlet	**DN/PN**	**100/10**	Stainless steel
1	Exhaust gas outlet	**DN/PN**	**300/10**	Stainless steel
1	Fuel gas inlet	**DN/PN**	**125/16**	Stainless steel
2	Intercooler in-/outlet	**DN/PN**	**100/10**	Stainless steel
2	Lube oil connection	**MM**	**28**	Hose

Seals and flanges for all flexible connections are included.

2.00 Electrical Equipment

Totally enclosed floor mounted sheet steel cubicle with front door wired to terminals. Ready to operate, with cable entry at bottom. Naturally ventilated or with forced ventilation.

Protection: IP 42 external
IP 20 internal (protection against direct contact with live parts)

Design according to EN 61439-2 / IEC 61439-2 and ISO 8528-4.
Ambient temperature 5 - 40 °C (41 - 104 °F), 70 % Relative humidity

Standard painting:	Panel:	RAL 7035
	Pedestal:	RAL 7020 (Rittal TS8)
		RAL 9005 (Rittal VX25)

2.02 Grid monitoring device

Standard with static Grid Code - 50Hz alternator

Function:
For immediate disconnection of the generator from the grid in case of grid failures.

Consisting of:
- High/low voltage monitoring
- High/low frequency monitoring
- Specially adjustable independent time for voltage and frequency monitoring
- Vector jump monitoring or df/dt monitoring for immediate disconnection of the generator from the grid for example at short interruptions
- Indication of all reference dimensions for normal operation and at the case of disturbance over LCD and LED
- Adjusting authority through password protection against adjusting of strangers

Scope of supply:
Digital grid protection relay with storage of defect data, indication of reference dimensions as well as monitoring by itself.

Grid protection values:

Parameter	Parameter limit	max time delay[s]	**Comments**
49-51HZ			Do work normal
f<[ANSI 81U]	47,5Hz	0,1	Load reduction with 10% /HZ below 49Hz!
f>[ANSI 81O]	51,5Hz	0,1	Load reduction with 30% /HZ above 51Hz!
U<[ANSI 27]	80%	1	Load reduction with 1%P /%U below 95%
U<<[ANSI 27]	75%	0,2	Load reduction with 1%P /%U below 95%
U>[ANSI 59]	108%	60	Load reduction with 1%P /%U above 105%
U>>[ANSI 59]	115%	0,1	Load reduction with 1% P/%U above 105%
Df/dt [ANSI 81R] **Or** **Vector shift** [ANSI 78]	2Hz/s ,5 Periods Or 8° - 3pol		Cos phi range: 0,8ind (overexcited) - 0,95cap. (underexcited)

2.04 Generator circuit breaker panel TN-CS networks according to IEC/EN

Nominal voltage: 3x**415**/240V, **50**Hz
Nominal current: **2000**A
Earthing system: TN-CS
Protection: IP54 external, IP20 internal
Ambient temperature: +5°bis 40°C (50°C with de-rating)
Standard: IEC/EN61439-2 und IEC/EN60204-1
Color: RAL 7035
Dimensions: Height: 2000mm (+base)
With: 600mm
Depth: 600mm – 800mm
(depends on cable connection)

Function:

The generator circuit breaker (CB) is the electrical connection between the generator and the grid. Closing of the generator circuit breaker is every time initiated by the gas engine control system. The breaker opens in case of engine shut down.
Cable length between generator CB panel and Module control panel: < 50m

Essential components installed in generator circuit breaker panel:
- 1 circuit breaker:
  - Mount type: Fix construction CB
  - Motorized 3-phase
  - Integrated electronic trip unit consisting of:
    - Adjustable delayed release for overload protection
    - Adjustable selective short circuit protection
  - Under voltage trip coil, shunt trip coil, control coil: 24VDC
  - Status messages and command signals are connected to terminals
  - Lockable with up to 3 padlocks
  - CB closing time <70msec
  - CB opening time <60msec
  - Short circuit capability 65kA:
  - Short circuit breaking capacity Icu; Ics (440/690VAC): 65/50kA
  - Short circuit making capacity Icm (440/690VAC): 143105kA
  - Short time withstand current Icw (1 sec): 65kA

- 3 current transformers for measuring: **2000**A/1A, 1FS5, 30 VA (0,5FS5, 15VA)
- 1 copper busbar system (L1, L2, L3, PE, N + PEN bridge) for cable connection
- Terminals for control cables
- Panel fan, temperature controlled
- Surge arrestor type 2 EN 61643-11, Up <2,5kV. for auxiliaries
- Generator voltage for synchronizing and measuring, connected to terminals
- Busbar voltage for synchronizing, connected to terminals
- Auxiliaries power supply for gas engine (3 pol. xxx A, only with 3x230/400V,50Hz)

3.03.01 Exhaust gas silencer

Residual sound pressure level:
Designed for a residual sound pressure level of 65 dB(A) in 10 m (32 ft) (as measuring area level according to DIN 45635 or ISO 3744) measured at the chimney escape.

Material:
Stainless steel or carbon steel, based upon exhaust gas temperature

Consisting of:
- Exhaust gas silencer
- Flanges, seals

Insulation:
The insulation for reducing surface irradiations of the exhaust gas silencer is not included in our scope of supply and must be provided locally.

Insulation thickness for outdoor installation:

- For 50 dB(A) in 10 m (32ft) — 100 mm (4 inch) rock wool covered with 1 mm (0,04 inch) galvanized steel sheet
- From 55 dB(A) in 10 m (32ft) — 100 mm (4 inch) rock wool covered with 0,75 mm (0,03 inch) galvanized steel sheet
- For < 50 dB(A) in 10 m (32ft) — insulation thickness is determined for each project

Insulation thickness for indoor installation:
- Insulation has to be dimensioned upon heat radiation

3.10.03 Cooling system - dual-circuit radiator

The heat produced by the engine (jacket water, lube oil, intercooler) is dumped through a radiator, installed outside.

Sound pressure level 65 **dB(A) at 10 m (32 ft)** (as measuring area level according to ISO 3744 bzw. EN 13487)

Consisting of:
- Radiator
- Pump
- Electrical control
- Expansion tank

The radiator is designed for an ambient temperature of 35°C (95°F). Special versions for higher ambient temperatures are available upon request.

4.00 Delivery, installation and commissioning

4.01 Carriage
According to contract.

4.02 Unloading
Unloading, moving of equipment to point of installation, mounting and adjustment of delivered equipment on intended foundations is not included in JENBACHER scope of supply.

4.03 Assembly and installation
Assembly and installation of all JENBACHER -components is not included in JENBACHER scope of supply.

4.04 Storage
The customer is responsible for secure and appropriate storage of all delivered equipment.

4.05 Start-up and commissioning
Start-up and commissioning with the JENBACHER start-up and commissioning checklist is not included. Plants with island operation require internet connection.

5.01 Limits of delivery - Genset

Electrical:
- Genset:
  - At terminals of genset interface panel
  - At terminals of generator terminal box
    (screwed glands to be provided locally)
- Genset control panel:
  At terminal strips
- Auxiliaries:
  At terminals of equipment which is supplied separately

Cooling water
At inlet and outlet flanges on genset

Exhaust gas
At outlet flange of the genset

Combustion air
The air filters are set mounted

Fuel gas
At inlet and outlet flange of gas train (shipped loose)
At inlet flange of gas pipework on genset

Lube oil
At lube oil connections on genset

Draining connections and pressure relief
At genset

Insulation
Insulation of heat exchangers and pipework is not included in our scope of supply and must be provided locally.

First filling
The first filling of genset, (lube oil, engine jacket water, anti freeze-, anti corrosive agent) is not included in our scope of supply.

The composition and quality of the used consumables are to be strictly monitored in accordance with the "Technical Instructions" of JENBACHER.

Suitable bellows and flexible connections **must be provided locally** for all connections.
Cables from the genset must be flexible.

5.02 Factory tests and inspections

The individual module components shall undergo the following tests and inspections:

5.02.01 Engine tests

Carried out as combined Engine- and Module test based on ISO 3046-3 at JENBACHER test bench. The following tests are made at 100% load, and the results are reported in a test certificate:

- Engine output
- Fuel consumption
- Jacket water temperatures
- Lube oil pressure
- Lube oil temperatures
- Boost pressure
- Exhaust gas temperatures, for each cylinder

5.02.02 Generator tests

Carried out on test bench of the generator supplier.

5.02.03 Module tests

The engine will be tested with natural gas (methane number 94). The performance data achieved at the test bench may therefore vary from the data as defined in the technical specification due to differences in fuel gas quality.
Carried out as combined Engine- and Module test commonly with module control panel at JENBACHER test bench, based on ISO 8528-6. The following tests are made and the results are reported in a test certificate:
Visual inspection of scope of supply per specifications.

- Functional tests per technical specification of control system.
  - Starting in manual and automatic mode of operation
  - Power control in manual and automatic mode of operation
  - Function of all safety systems on module
- Measurements at 100% load:
  - Frequency
  - Voltage
  - Current
  - Generator output
  - Power factor
  - Fuel consumption
  - Lube oil pressure
  - Jacket water temperature
  - Boost pressure
  - Mixture temperature
  - Exhaust emission (NOx)

The module test will be carried out with the original generator, except if it is not possible because of the delivery date. Then a test generator will be used for the module test.
To prove characteristics of the above components, which are not tested on the test bench by JENBACHER, the manufacturers' certificate will be provided.

5.03 Documentation

List of standard pre-documentation provided based on the technical status at the time of order receipt:

- Module drawing **1)**
- Technical diagram **1)**
- Drawings of the cabinet views **3**
- Electrical interface list **2)**

- Technical specification of the control system **2)**

Before delivery (depending on progress in ordering the components, on request)
- Technical drawings for BoP components/accessories supplied separately (if included in scope of supply of INNIO Jenbacher GmbH & Co OG) **1)**

Upon delivery
- Circuit diagrams **3)**
- Cable list **3)**

Delivered with the engine
- Brief instructions (transport, erection, moving) **1)**

For commissioning
- Operation and maintenance instructions **4)**
- Spare parts catalogue **4)**
- Original supplier operation and maintenance instructions for any BoP components (installed in the INNIO Jenbacher GmbH & Co OG scope of supply) as Appendix **1)**

  All the components found in the INNIO Jenbacher GmbH & Co OG scope of supply are described in the operation and maintenance instructions, and in the spare parts catalogue.
  In addition, the manufacturer's original operation and maintenance instructions will be provided for every BoP component, in German and English as standard, as an Appendix for the operation and maintenance manual provided.

  Additional costs of producing or providing the required documents using the KKS (power station coding system) and/or integration in subcontractors' documentation, or additional approval, design and proof of testing documentation must be negotiated or ordered separately.

  This standard offer does not include:
  - Approval documentation
  - Design documentation
  - Proof of testing documentation
  - Printed copies and digital off-line versions (e.g. printed versions, CD, pdf, etc.) must be negotiated separately and ordered accordingly.

Available languages (language codes as per ISO 639-1):

4	3	2	1		
				de	German
				en	English
				fr	French
				it	Italian
				es	Spanish
				nl	Dutch
				hu	Hungarian
				ru	Russian
				pl	Polish
				tr	Turkish
				cs	Czech
				pt	Portuguese
				da	Danish
				sk	Slovakian
				sl	Slovenian
				sr	Serbian
				lv	Latvian
				et	Estonian
				ro	Rumanian
				no	Norwegian
				hr	Croatian
				fi	Finnish
				zh	Chinese
				el	Greek
				bg	Bulgarian
				lt	Lithuanian
				sv	Swedish