



8/2013

Technical Description

Genset

JGS 320 GS-N.L

with Island Operation
no special Grid Code

Drilling Rigs 320



Electrical output

1060 kW el.

Emission values

NOx < 500 mg/Nm³ (5% O₂)



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0.01 Technical Data (at genset)

Data at:

			Full load	Part Load	
				75%	50%
Fuel gas LHV	kWh/Nm ³		9.5		
			100%	75%	50%
Energy input	kW	[2]	2,677	2,063	1,448
Gas volume	Nm ³ /h	*)	282	217	152
Mechanical output	kW	[1]	1,095	821	548
Electrical output	kW el.	[4]	1,060	795	530
Heat to be dissipated		[5]			
~ Intercooler 1st stage (Engine jacket water cooling circuit)	kW		169	71	5
~ Intercooler 2nd stage (Low temperature circuit)	kW		82	54	34
~ Lube oil (Engine jacket water cooling circuit)	kW		118	97	81
~ Jacket water	kW		361	328	262
~ Surface heat	ca. kW	[7]	90	71	62
Spec. fuel consumption of engine	kWh/kWh	[2]	2.45	2.51	2.64
Lube oil consumption	ca. kg/h	[3]	0.33	0.25	0.16
Electrical efficiency	%		39.6%	38.5%	36.6%

*) 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; ...). In the specifications in addition to the general tolerance of +/- 8% on the thermal output a further reserve of 10% is recommended for the dimensioning of the cooling requirements.



Main dimensions and weights (at genset)

Length	mm	~ 5,700
Width	mm	~ 1,700
Height	mm	~ 2,300
Weight empty	kg	~ 14,400
Weight filled	kg	~ 14,900

Connections

Jacket water inlet and outlet	DN/PN	80/10
Exhaust gas outlet	DN/PN	250/10
Fuel gas (at gas train)	DN/PN	80/16
Fuel Gas (at genset)	DN/PN	100/10
Water drain ISO 228	G	½"
Condensate drain	mm	18
Safety valve - jacket water ISO 228	DN/PN	2x1½"/2,5
Lube oil replenishing (pipe)	mm	28
Lube oil drain (pipe)	mm	28
Jacket water - filling (flex pipe)	mm	13
Intercooler water-Inlet/Outlet 1st stage	DN/PN	80/10
Intercooler water-Inlet/Outlet 2nd stage	DN/PN	65/10

Output / fuel consumption

ISO standard fuel stop power ICFN	kW	1,095
Mean effe. press. at stand. power and nom. speed	bar	18.00
Fuel gas type		Natural gas
Based on methane number Min. methane number	MZ d)	94 70
Compression ratio	Epsilon	11.80
Min./Max. fuel gas pressure at inlet to gas train	mbar	80 - 200 c)
Allowed Fluctuation of fuel gas pressure	%	± 10
Max. rate of gas pressure fluctuation	mbar/sec	10
Maximum Intercooler 2nd stage inlet water temperature	°C	43
Spec. fuel consumption of engine	kWh/kWh	2.45
Specific lube oil consumption	g/kWh	0.30
Max. Oil temperature	°C	90
Jacket-water temperature max.	°C	95
Filling capacity lube oil (refill)	lit	~ 342

c) Lower gas pressures upon inquiry

d) based on methane number calculation software AVL 3.1 (calculated without N2 and CO2)



0.02 Technical data of engine

Manufacturer		GE Jenbacher
Engine type		J 320 GS-C105
Working principle		4-Stroke
Configuration		V 70°
No. of cylinders		20
Bore	mm	135
Stroke	mm	170
Piston displacement	lit	48.67
Nominal speed	rpm	1,500
Mean piston speed	m/s	8.50
Length	mm	3,320
Width	mm	1,358
Height	mm	2,065
Weight dry	kg	5,200
Weight filled	kg	5,700
Moment of inertia	kgm ²	8.61
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

Energy input	kW	2,677
Intercooler	kW	251
Lube oil	kW	118
Jacket water	kW	361
Exhaust gas total	kW	773
Exhaust gas cooled to 180 °C	kW	506
Exhaust gas cooled to 100 °C	kW	645
Surface heat	kW	55

Exhaust gas data

Exhaust gas temperature at full load	°C [8]	460
Exhaust gas temperature at bmep= 13.5 [bar]	°C	~ 489
Exhaust gas temperature at bmep= 9 [bar]	°C	~ 527
Exhaust gas mass flow rate, wet	kg/h	5,740
Exhaust gas mass flow rate, dry	kg/h	5,308
Exhaust gas volume, wet	Nm ³ /h	4,540
Exhaust gas volume, dry	Nm ³ /h	4,021
Max.admissible exhaust back pressure after engine	mbar	60

Combustion air data

Combustion air mass flow rate	kg/h	5,548
Combustion air volume	Nm ³ /h	4,291
Max. admissible pressure drop at air-intake filter	mbar	10



Sound pressure level

Aggregate b)		dB(A) re 20µPa	96
31,5	Hz	dB	78
63	Hz	dB	90
125	Hz	dB	92
250	Hz	dB	89
500	Hz	dB	92
1000	Hz	dB	90
2000	Hz	dB	89
4000	Hz	dB	87
8000	Hz	dB	90
Exhaust gas a)		dB(A) re 20µPa	122
31,5	Hz	dB	97
63	Hz	dB	108
125	Hz	dB	118
250	Hz	dB	110
500	Hz	dB	113
1000	Hz	dB	114
2000	Hz	dB	117
4000	Hz	dB	115
8000	Hz	dB	114

Sound power level

Aggregate		dB(A) re 1pW	117
Measurement surface		m ²	109
Exhaust gas		dB(A) re 1pW	130
Measurement surface		m ²	6.28

a) average sound pressure level on measurement surface in a distance of 1m according to DIN 45635, precision class 2.

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

The spectra are valid for aggregates up to bmep=18 bar. (for higher bmep add safety margin of 1dB to all values per increase of 1 bar pressure).

For operation with 1200 rpm see above values, for operation with 1800 rpm add 3 dB to the above values.

Engine tolerance ± 3 dB



0.03 Technical data of generator

Manufacturer		Leroy-Somer e)
Type		LSA 52.2 VL85 e)
Type rating	kVA	1,570
Driving power	kW	1,095
Ratings at p.f. = 1,0	kW	1,060
Ratings at p.f. = 0.7	kW	1,046
Rated output at p.f. = 0.7	kVA	1,493
Rated current at p.f. = 0.7	A	1,437
Frequency	Hz	50
Voltage	V	600
Speed	rpm	1,500
Permissible overspeed	rpm	2,250
Power factor (lagging)		0,7 - 1,0
Efficiency at p.f. = 1,0	%	96.8%
Efficiency at p.f. = 0.7	%	95.5%
Moment of inertia	kgm ²	55.00
Mass	kg	4,800
Radio interference level to VDE 0875		N
Construction		B 20
Protection Class		IP 23
Insulation class		H
Temperature (rise at driving power)		B
Maximum ambient temperature	°C	40

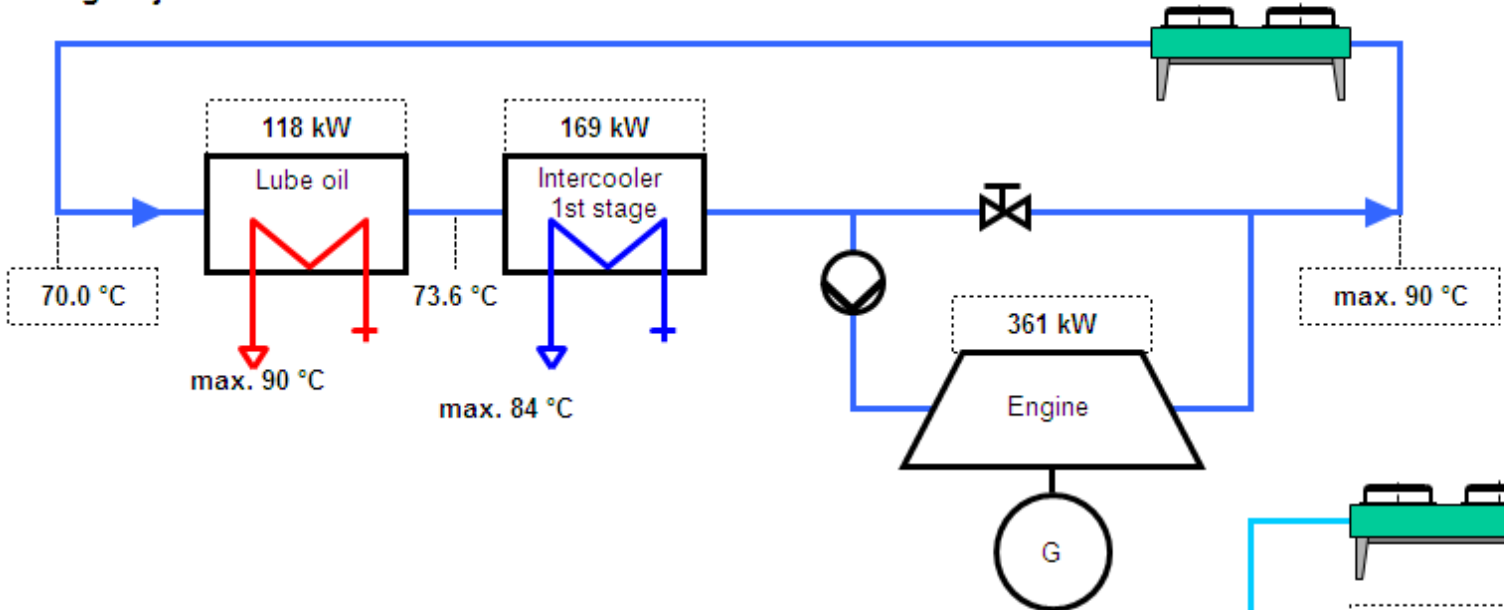
Reactance and time constants (saturated)

xd direct axis synchronous reactance	p.u.	1.87
xd' direct axis transient reactance	p.u.	0.16
xd'' direct axis sub transient reactance	p.u.	0.08
x2 negative sequence reactance	p.u.	0.10
Td'' sub transient reactance time constant	ms	26
Ta Time constant direct-current	ms	42
Tdo' open circuit field time constant	s	3.39

e) GE 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.

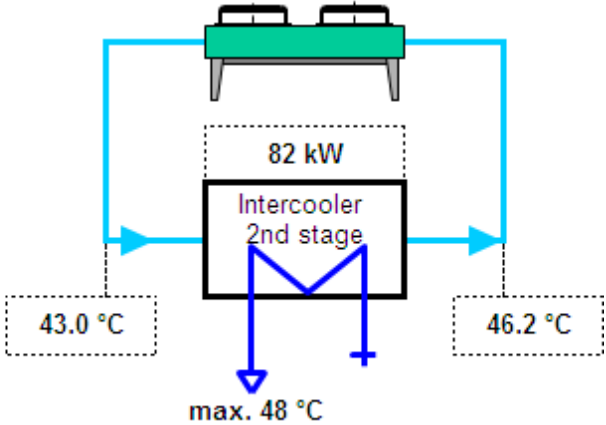
Engine jacket water cooling circuit (calculated with Glykol 37%)

Heat to be dissipated = 648 kW
 (±8% tolerance +10% reserve for cooling requirements)
 Engine jacket water flow rate = 31.2 m³/h



Low temperature circuit (calculated with Glykol 37%)

Heat to be dissipated = 82 kW
 (±8% tolerance +10% reserve for cooling requirements)
 Cooling water flow rate = 25.0 m³/h





0.05 Cooling water circuit

Oil - heat (Engine jacket water cooling circuit)

Nominal output	kW	118
Max. Oil temperature	°C	90
Loss of nominal pressure of engine jacket water	bar	0.20
Safety valve - max press. set point	bar	2.50

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

Nominal output	kW	361
Max. engine jacket water temperature (outlet engine)	°C	90
Engine jacket water flow rate	m ³ /h	31.2
Safety valve - max press. set point	bar	2.50

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

Nominal output	kW	169
Max. inlet cooling water temp. (intercooler)	°C	73.6
Nominal pressure of cooling water / (operating pressure)	PN	6
Loss of nominal pressure of engine jacket water	bar	0.40
Safety valve - max press. set point	bar	2.50

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

Nominal output	kW	82
Max. inlet cooling water temp. (intercooler)	°C	40
Aftercooler water flow rate	m ³ /h	25.0
Nominal pressure of cooling water / (operating pressure)	PN	6
Intercooler water pressure drop	bar	0.20
Safety valve - max press. set point	bar	2.50



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 DIN-ISO 3046 and DIN 6271, respectively
- (2) According to DIN-ISO 3046 and DIN 6271, 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.
- (3) Average value between oil change intervals according to maintenance schedule, without oil change amount
- (4) At p. f. = 1.0 according to VDE 0530 REM / IEC 34.1 with relative tolerances
- (5) Total output with a tolerance of +/- 8 %
- (6) According to above parameters (1) through (5)
- (7) Only valid for engine and generator; module and peripheral equipment not considered (at p. f. = 0,8)
- (8) Exhaust temperature with a tolerance of +/- 8 %

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)

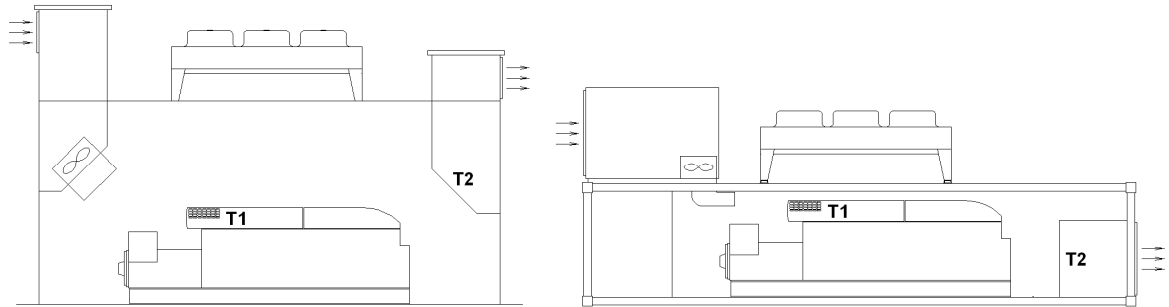
Pressure:	1013 mbar (14.7 psi)
Temperature:	0°C (32°F) or 273 K

Output adjustment for turbo charged engines

Standard rating of the engines is for an installation at an altitude ≤ 1000 m and an air intake temperature ≤ 40 °C (T1)

If air intake temperature is >40 °C at 1000m, power derating ratio is 2%/°C.

Maximum room temperature: **50°C** (T2) -> engine stop



If the actual methane number is lower than the specified, the knock control responds. First the ignition timing is changed at full rated power. Secondly the rated power is reduced. These functions are carried out by the engine management system.

Exceedance of the voltage and frequency limits for generators according to IEC 60034-1 Zone A will lead to a derate in output.

Parameters for the operation of GE Jenbacher gas engines

The genset fulfills the limits for mechanical vibrations according to ISO 8528-9.

If possible, railway trucks must not be used for transport (**TI 1000-0046**).

The following "Technical Instruction of GE JENBACHER" forms an integral part of a contract and must be strictly observed: **TI 1100-0110, TI 1100-0111, and TI 1100-0112.**

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.

1.00 Scope of supply - Genset

Design:

The genset 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 genset to be placed directly on any floor capable of carrying the static load. No special foundation is required. Prevention of sound conducted through solids has to be provided locally.

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 GE 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, made of light metal alloy, 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 GE 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.

**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 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

1.01.03 Standard tools (per installation)

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



1.02 Self-excited self-regulated three phase generator

The 2-bearing generator consists of the cylindrical-rotor (non-salient pole) main generator, a salient-pole exciter and the digital excitation system.

The regulator is provided with power from an auxiliary winding in the main stator or the PMG.

Components/sub-assemblies

- Welded steel fabricated housing
- Stator core consisting of thin insulated electro-grade steel laminations with integral cooling passages
- Stator winding
- Pitch factor: 2/3
- Rotor consisting of a shaft with laminated shrunk-on poles, exciter rotor, PMG (depending on the type) and fan
- Damper cage winding
- Exciter with rotating rectifier diodes and overvoltage protection
- Dynamically balanced as per ISO 1940, balance grade G2.5
- End shield A, regreasable roller bearings
- End shield B, regreasable roller bearings
- Cooling: IC01 open ventilation system, air inlet at the non-driven end, air outlet at the driven end
- Main terminal box, with terminals for connecting the power cable
- Regulator terminal box with additional terminals for temperature sensors and controller activation
- Standstill heating
- 3-off PT100 for monitoring the winding temperature + 3 in reserve
- 2-off PT100 for monitoring the bearing temperatures

- **OPTIONAL**
- Current transformer for protection and measuring at the generator star point xx/1 A, 10P10 15 VA, xx/1A, 1FS5, 15 VA

Electrical Data and Characteristics

- Design and construction as per standards: IEC 60034, EN 60034, VDE 0530, ISO 8528-3, ISO 8528-9
- Voltage adjustment range: ± 10 % rated voltage (continuous)
- Frequency range: -6/ +4 % rated frequency
- Overload rating: 10% for one hour within 6 hours, 50% for 30 seconds
- Unbalanced load: max. 8% I_2 continuous, in the event of a fault $I_2 \times t = 20$
- Installation height: < 1000 m
- Permissible generator intake temperature: 5°C - 40°C
- Max. air humidity: 90%
- THD Ph-Ph voltage curve: <3.5% at no-load and <3,5% at full load with linear symmetric loading
- Generator suitable for both mains parallel operation and island operation with other generators.
- Continuous short-circuit current with 3-pole terminal short-circuit: min. 3 x rated current for 5 seconds
- Overspeed: overspeed testing at 1.2-times rated speed for 2 minutes as per IEC60034



Digital Excitation system ABB Unitrol 1010 mounted in a Terminal box at the generator 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
- 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

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
 - Bearings
- No Load saturation characteristic (remanent voltage)
- Stator voltage unbalance
- Direction of rotation, phase sequence
- Excitation Test
- 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: 1000 mm (39 in)
- Width: 800 mm (32 in)
- Depth: 300 mm (12 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 **400/231 V**, **50 Hz**, xx 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

1.03.01 Engine jacket water system

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

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

Aftercooling oil pump:

Mounted on the module base frame; it is used for the aftercooling of the turbocharger; period of operation of the pump is 15 minutes from engine stop.

Consisting of:

- Oil pump 250 W, 24Vdc
- Oil filter
- Necessary pipework



1.05 Gas train

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

Consisting of:

- Shut off valve
- Gas filter, filter fineness <3 µm
- High pressure regulator with safety-cut-off-valve (SAV)
- Calming distance with reducer
- Safety-blow-off-valve (SBV)
- Pressure gauge with push button valve
- Solenoid valves
- Leakage detector
- Gas pressure switch (min.)
- TEC JET (has to be implemented horizontal)
- Gas flow meter (option)
- p/t compensation (option)

The gas train complies with DIN - DVGW regulations.

Maximum distance from gas train outlet to gas entry on engine, including flexible connections, is 2 m (78 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 – DIA.NE XT

Dimensions:

- Height: 2200 mm (87 in) [including 200 mm (8 in) pedestal]
- Width: 1000 mm (40 in)
- Depth: 600 mm (24 in)

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

Supply of power for auxiliaries from auxiliary power panel:

3 x 400/231 V, 50 Hz, xx A

Protection: IP 42 external,

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 %

Consisting of:

DIA.NE XT 3 (Dialog Network new generation) **motor management system**

System elements visualisation with central engine and module control

1) Visualisation:

Industrial control with 10,4" QVGA TFT colour graphics display and 8 function keys.

10-key numeric keyboard for parameter input.

Keys for START, STOP, Generator circuit breaker OPEN, Generator circuit breaker CLOSED/SELECTED, display selection keys and special functions.

Interfaces:

- Ethernet (twisted pair) for connection to DIA.NE WIN server
 - CAN-Bus: bus connection to the intelligent sensors and actuators
 - Data bus connection to the control in- and outputs
- Interfacing with the customer's plant management according to GE JENBACHER list of options
(MODBUS-RTU slave)

Protection class: IP 65 (front)

Dimensions: W x H x D = approx. 212 x 255 x 95 mm (8,4 x 10 x 3,75 in)

A clear and functional graphic compilation of measured values is displayed on the screen. User prompts are by means of direct-acting display selection keys and function keys.

Main displays:

- Electrical schematic
- Oil and hydraulic schematic
- Gas data
- Engine controllers
- Cylinder data
- Exhaust gas data
- Auxiliaries controllers
- Spare screen for customer specific purposes
- System display screens



- Parameter manager
- User setting
- Alarm management

Recipe handling:

Setting, display and storage of all module parameters

Alarm management:

Efficient diagnostic instrumentation listing all active fault messages both tabular and chronologically, with the recorded time.

2) Central engine and module control:

A real-time, modular industrial control system which handles all jobs for module and engine-side sequencing control (start preparation, start, stop, synchronizing, after-cooling, control of auxiliaries), as well as all control functions.

Control functions:

- Speed control in no-load and isolated operation
- LEANOX control system for control of boost pressure; dependent upon the generator terminal power and the mixture temperature via the engine-driven air-gas mixer
- Load sharing between several GE modules in isolated operation
- Linear reduction of power output in the event of excessive mixture temperature and ignition failures (only in grid parallel **mode or power mode**)

- Interface relays as per the interface list
- Multi-transducer, to record the following electrically measured variables of the generator:
 - 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

An additional 0 - 20 mA output is produced for active power, as well as a pulse output for active power demand.

The following alternator supervisions are integrated with the multi-transducer (max. 8 functions simultaneous):

- Overload/short-circuit [51], [50]
- Over voltage [59]
- Undervoltage [27]
- Asymmetric voltage [64], [59N]
- Unbalance current [46]
- Failure Excitation [40]
- Overfrequency [81>]
- Underfrequency [81<]
- Lockable operation mode selector switch positions:
 - "OFF"
No operation is possible, running set will shut down;



- "MANUAL"
Manual operation using (start, stop) is possible, unit is not available for fully automatic operation.
- "AUTOMATIC"
Fully automatic operation, according to remote demand signal:
 - Automatic start
Fully automatic operation at full load
 - Stop with cooling down run for 1 minute
Continuous operation of auxiliaries for 5 minutes after engine shutdown
- Demand switch with the positions:
 - Demand OFF
 - Demand ON
 - Remote demand
- Supply disconnecting device for auxiliaries with lockable circuit breaker

Shut-down functions with display:

- 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
- Synchronising failure
- Knocking failure

Warning functions with display:

- Low jacket water temperature
- CPU battery failure

Operational functions with display:

- Ready to start
- Operation (engine running)



- Generator circuit breaker "CLOSED"

Remote signals:

(volt free contacts)

1NO = 1 normally open

1NC = 1 normally closed

1 COC = 1 change over contact

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

External (by others) provided command/status signals:

- Engine demand (from Master control) 1NO

Single synchronizing Automatic With voltage balance

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:

- Lockable synchronizing mode selector switch, with positions "MANUAL - OFF - AUTOMATIC"
 - AUTOMATIC:
Automatic module synchronization, after synchronizing release from the control panel
 - MANUAL:
Manual initiation of synchronizing by push button. Speed adjustment and closing of the circuit breaker is automatically controlled via microprocessor
 - OFF:
Synchronization is disabled
- Additional PLC hardware for the fully automatic synchronizing of each module, and monitoring of the "CIRCUIT BREAKER CLOSED" signal.
Logic for monitoring of:
 - Non-logic breaker positions
 - Switch "ON" trouble
 - Switch "OFF" trouble
- Automatic synchronizing device to control the electronic speed governor adjustment, double voltmeter, double frequency meter and synchronoscope
- Automatic voltage balancing
- Luminous push button "GENERATOR CIRCUIT BREAKER OPEN / SELECT"
 - To indicate synchronizing mode
 - To indicate "Generator circuit breaker closed"
 - For manual synchronizing selection with the synchronizing mode selector switch in the MANUAL position
 - For manual closing of the generator circuit breaker to the voltage free bus bar (first connection) with synchronizing mode selector switch in the MANUAL position
- Luminous push button "GENERATOR CIRCUIT BREAKER OPEN"
 - To indicate "Generator circuit breaker open"



- To manually open the generator circuit breaker
- Control switch
- Required relays for control and monitoring
- Voltage relay for monitoring of bussbar voltage (only for island operation)

Operational indications for:

- Generator circuit breaker CLOSED
- Generator circuit breaker OPEN

Fault indications for:

- Generator circuit breaker return signal fault
- Generator circuit breaker closing fault
- Generator circuit breaker opening fault

Remote signals

(Volt free contacts)

- Generator circuit breaker CLOSED 1 NO

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

Remote signals (potential free contacts):

- Overload / short circuit generator circuit breaker (50/51,..) 1 NC
- Generator circuit breaker ON 1 NO
- Generator circuit breaker OFF 1 NC
- Generator transformer current 3 x 5 A, 1 FS 5, 15 VA
- Voltage for auxiliaries 3x400/231V TN-S 50Hz, xx A

- Bus bar voltage 3 x 600/110V/v3, 4A – other measurement voltages available on request
- Generator voltage 3 x 600/110V/v3, 4A – other measurement voltages available on request

Voltage transformers in star point with minimum 20VA, Class 0,5

The following volt free interface-signals will be provided by GE 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 GE module control panel to power cabinet (switchgear): 50m/164ft

Maximum distance between GE module control panel to GE interface panel at the unit: 50m/164ft

Maximum distance between GE **Interlock** panel and customer DG set panel: 50m/164ft



1.11.02 Remote information by MODBUS-RTU

Data transfer from GE 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.

Transmitted data:

Individual failure information, plant operating information, measuring values for generator power, oil pressure, oil temperature, jacket water pressure, jacket water temperature, cylinder and average exhaust gas temperatures.

GE Jenbacher limit of delivery:

Interface connector at the PLC in the module control panel.

1.11.03 Remote Data-Transfer with DIA.NE XT - HERMES

General

HERMES is the remote data transfer solution for DIA.NE XT. HERMES is available via three connection methods and two applications.

Connections methods

1.) Modem

Site - Customer connection via a Modem (analogue, ISDN, GSM).

Scope of supply

- DIA.NE WIN – Server (Industrial PC without display, keyboard or mouse, built into the control panel, including operating system)
- Modem (analogue, ISDN, GSM)

Customer Requirements

- Modem (analogue, ISDN, GSM) in the customers PC
- Public telephone connection with connection port for the DIA.NE WIN – Server (in the control panel) including over-voltage protection corresponding to the local telecommunication regulations.
- Public telephone connection with connection port for the customer's PC corresponding to the local telecommunication regulations.

2.) LAN

Site - Customer connection via a local network.

Scope of supply

- DIA.NE WIN – Server (Industrial PC without display, keyboard or mouse, built into the control panel, including operating system)
- Ethernet – Network card (10/100 BASE T)

Customer Requirements



- Ethernet – Network card (10/100 BASE T)
- Ethernet – Cabling between the DIA.NE WIN – Server the customers PC.

3.) Internet

Site – Customer connection via secure Internet access

See comments under Technical instruction **TI 2300 - 0006**

Scope of Supply

- DIA.NE WIN – Server (Industrial PC without display, keyboard or mouse, built into the control panel, including operating system)
- Ethernet–Network card (10/100 BASE T)
- Firewall–Appliance with connection feasibility to a customer network with a maximum of 10 Hosts (Installation and service by GE Jenbacher; during warranty period included, afterwards as a service package with costs) (built into the control panel)
- Feature – service package (access monitoring, clock synchronization for server)

Customer Requirements

- Broad band Internet access with at least two official IP addresses.
Connection feasibility for the Firewall–Appliance to the Internet–Router via Ethernet (RJ45 Connector, Network Address Translation (NAT) is not permitted)

Applications

1.) DIA.NE WIN

DIA.NE WIN is the Windows based „man-machine interface“ for GE Jenbacher gas engines. The system offers extensive facilities for commissioning, monitoring, servicing and analysis of the site. The option DIA.NE WIN extends the visualization of DIA.NE XT with respect to user friendliness, historical analysis and remote use. Several service stations can be independently operated in parallel. The system consists of a central PC (DIA.NE WIN – Server) which is built in to the control panel and one or more service stations (DIA.NE WIN – Clients). The system runs on a Microsoft Internet Explorer platform.

Function

Service and monitoring, trend analysis, alarm management, parameter management, long-term data analysis, multi-user system, remote control, OPC (OLE for process control), print and export functions, operating data protocols, available in several languages.

Scope of supply

- Software package DIA.NE WIN on the DIA.NE WIN – Server
- DIA.NE WIN – Client License (Right to access of the user to the server on site)

Customer requirements

- Standard PC with keyboard, mouse and monitor (min. resolution 1024*768)
- **231 V** supply for the customers' PC
- Operating system Windows 98, Windows NT, Windows 2000 or Windows XP
- Microsoft Internet Explorer (min. Version 6.0) including Java support

2.) DIA.NE RMC (OPTION)



DIA.NE RMC (Remote Message Control) is the automatic alarm system for DIA.NE XT. DIA.NE RMC can fully automatically transmit essential operational information from the DIA.NE XT Alarm Management to a remote station. The messages can be forwarded to an e-mail address, fax machine or mobile phone (SMS). Furthermore the stored messages can be visualized at the remote station. The system consists of a central PC (DIA.NE WIN – Server) which is built into the control panel and one or more customer remote stations.

Function

Automatically transfer of messages to the customer via email, fax or SMS. Display and printing of the messages (also distributed via LAN). Automatically and manually transfer of messages, trend data and operating data protocols.

Scope of supply

- Software package DIA.NE message on the DIA.NE WIN – Server
- Software package DIA.NE control and DIA.NE report on the remote station

Only for connection method “Internet”:

- Firewall–Appliance for customer computer with connection feasibility to a customer network with a maximum of 10 Hosts (Installation and service by GE Jenbacher; during warranty period included, afterwards as a service package with costs)

Customer requirements

- Standard PC with keyboard, mouse and monitor (min. resolution 1024*768)
- **231 V** supply for the customers' computer.
- Operating system Windows 2000 (Professional and Server), Windows XP Professional or Windows Server 2003.
- Internet connection (provider account) for the case that messages from the RMC should be forwarded to an email receiver (incl. SMS for mobiles and pagers). (Mobiles and pagers to be provided by the customer).
- Customer fax software for message forwarding via fax

Only for connection method “Internet”:

- Broad band Internet access with at least two official IP addresses.
Connection feasibility for the Firewall–Appliance to the Internet–Router via Ethernet (RJ45 Connector, Network Address Translation (NAT) is not permitted)



1.20.01 Starting system (without battery)

Starter battery: (not included in GEJ scope of supply)

2 piece Pb battery with 12 cells, 2 x 12 V, 200 Ah (according to DIN 72311), complete with cover plate, terminals and acid tester.

Battery voltage monitoring:

Monitoring by an under voltage relay.

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 - 550 V, 47 - 63 Hz
• max. power consumption	1060 W
• Nominal D.C. voltage	24 V(+/-1%)
• Voltage setting range	24V to 28,8V (adjustable)
• Nominal current (max.)	40 A
• Dimensions	240 x 125 x 125 mm
• Degree of protection	IP20 to IEC 529
• Operating temperature	0 °C - 60 °C
• Protection class	1
• Humidity class	3K3, no condensation.
• Natural air convection	
• Standards	EN60950,EN50178 UL/cUL (UL508/CSA 22.2)

Signalling:

Green Led:	Output voltage > 20,5V
Yellow Led:	Overload, Output Voltage < 20,5V
Red Led:	shutdown

Control accumulator:

- Pb battery 24 VDC/18 Ah



1.20.03 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.

1.20.04 Flexible connections

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

<u>No. Connection</u>	<u>Unit</u>	<u>Dimension</u>	<u>Material</u>
2 Warm water in-/outlet	DN/PN	80/10	Stainless steel
1 Exhaust gas outlet	DN/PN	250/10	Stainless steel
1 Fuel gas inlet	DN/PN	80/16	Stainless steel
2 Intercooler in-/outlet	DN/PN	80/10	Stainless steel
2 Lube oil connection	mm	28	Hose

Sealings and flanges for all flexible connections are included.

1.20.27 Return temperature control

Control of the return temperature ensures a constant warm water temperature at the inlet of the module. This is made possible by mixing warm water from the outlet flow into the return flow.

Consisting of:

- 1 x 3-way valve with electrical regulating control (delivered loose)
- 1 PT 100 (delivered loose)
- 1 PID-regulation (installed in the control panel)



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.

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

Design according to EN 60439-1 / IEC 60439-1 and ISO 8528-4.
Ambient temperature 5 - 40 °C (41 - 104 °F), 70 % Relative humidity

Standard painting: Panel: RAL 7035
 Pedestal: RAL 7020

2.01 Interlock Panel

(One panel prepared for **X GE engines**)

Purpose: **Specific release for „BLACK START OPERATION“**

Dimensions:

Height 2200 mm (87 in) [including 200 mm (8 in) foundation]
Width 800 mm (32in) - 1200 mm (48 in)
Depth 600 mm (24 in)

Control power supply (by supplier of the control power supply unit) from the battery 24 V DC, 16 A
(tolerance: min. 22 V, max. 30 V, including waviness U_{pp} 3.6 V minus-grounded).

Auxiliary power supply (by the supplier of the auxiliary power supply unit):
400/231 V, 50 Hz, 16 A.

Protection: IP 42 external,
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 %

Comprising:

- Terminal strip with cable entry from bottom
- Interface relays/contacts as per the interface list
- Lockable selector switch with the following positions:
 - "Stop" No „BLACK OUT START“possible
 - "1-6" Release for Engine no. „1 - 6“ for BLACK Start – prepared for 6 engines
- Lockable speed / power mode selector-switch with the settings:
 - „OFF,, Parallel island mode: with load sharing to customer engine
 - If existing = SPEED MODE
 - If **NO** load sharing line to customer engine is existing or possible – speed control adjusted with DROOP FUNCTION
 - „ON,, Parallel island mode: with full load of GE Jenbacher engines = POWER



MODE
(cos phi controller is working)

Function:

GEJ engines are working with full load (set point adjustable), and customer engines cover the remaining load! Possible function if power rating of customer engines are higher than the GEJ nominal power and same speed/power regulator reaction time!

- Emergency stop push button
- Interfaces from CUSTOMER ENGINE CONTROL to GE Jenbacher:
 - Load is shed for BLACK OUT Start of first engine.
 - STATUS: GENERATOR CB OF CUSTOMER ENGINE IS CLOSED
 - STATUS: GENERATOR CB OF CUSTOMER ENGINE IS OPEN

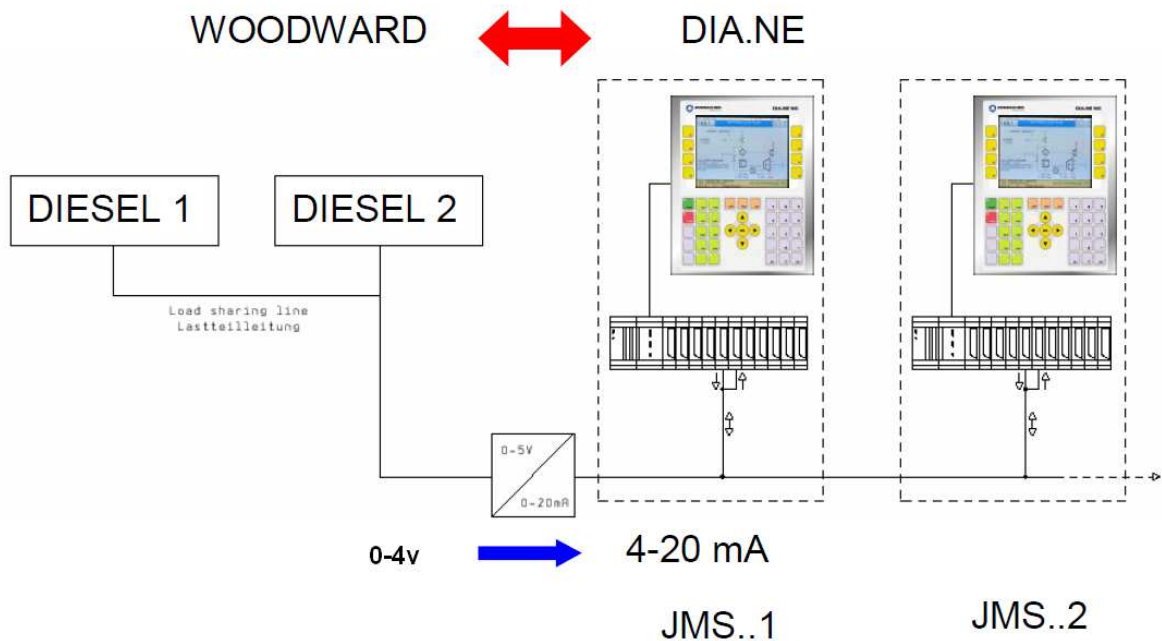
Active LOAD SHARING (KW) with customer DG units

Option 1: with a Woodward 2301A speed governor

(GE Jenbacher provides a load sharing signal with 4-16mA = 0-100%, this signal is wired on terminals in the cabinet).

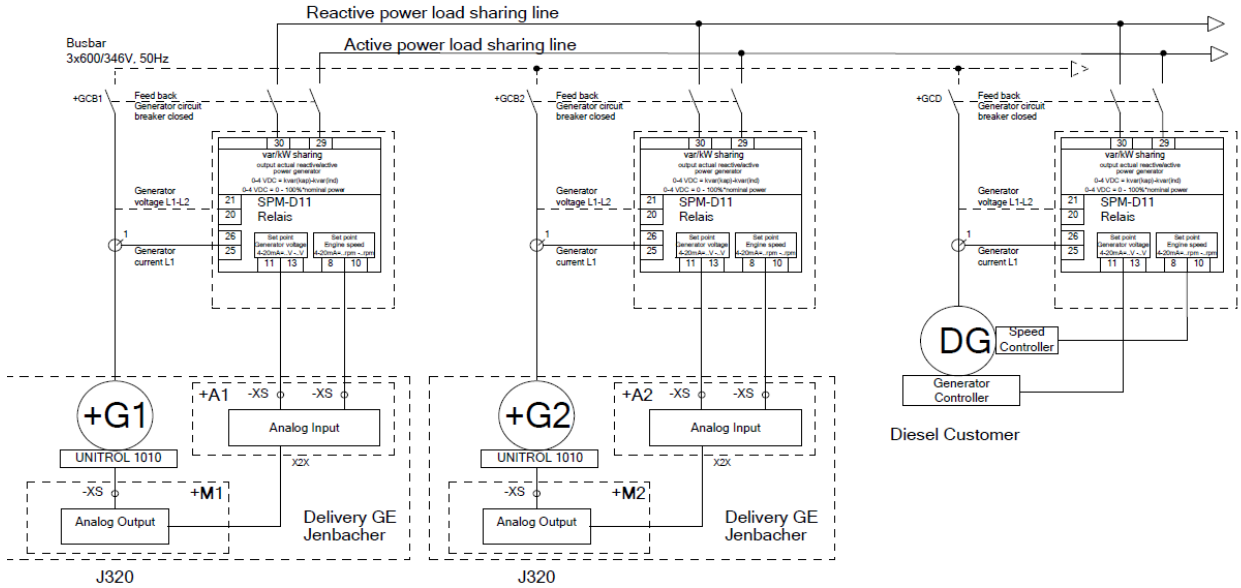
- Signal from customer is 0-4 V = 0-100% active power

Example of active load sharing.





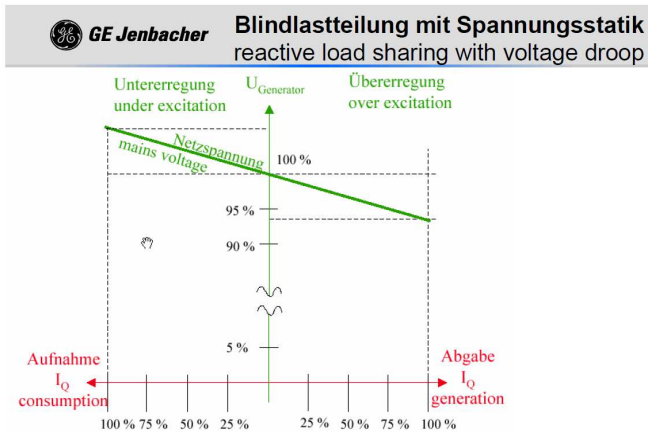
Option 2: With a Woodward SPM-D11



REACTIVE LOAD SHARING (KVAR) with customer DG units

Generator with "voltage droop" for reactive load sharing - „adjustable quadrature droop kit".
 Reactive power balance is performed through static adjustment of the generators.
 In multiple module installations, the voltage adjustment of each generator must be identical.

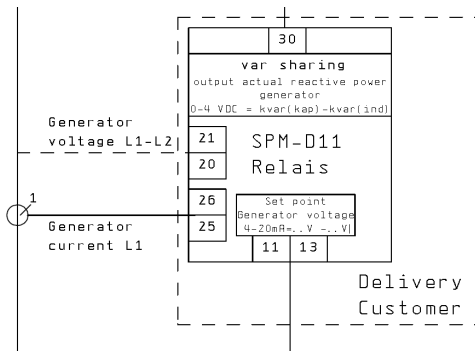
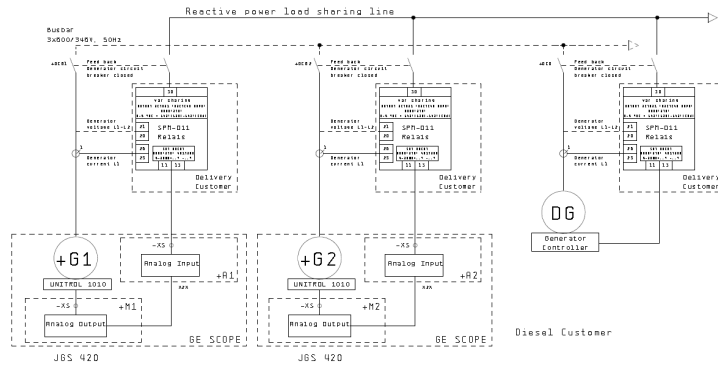
Option 1: DROOP FUNCTION as Standard GEJ



Option 2: With Analog Signal from customer according below diagram
 Customer should use following type: SPM-D11/LSRX relays!



Reactive power sharing interface Customer <-> Jenbacher = mA Signal (e.g. 4-20mA = 90%*nominal voltage – 110%*nominal voltage)



Both Options are included in the scope!

The customer engines have to fulfill some preconditions:

Low voltage Alternator winding system: <1kV

GEJ Generator with 2/3 pitch main stator winding.

If customer generator (600V) is not fitted with 2/3 pitch main stator winding a neutral choke has to be fitted to this generator – scope of supply from customer - if star points are connected together to avoid higher neutral current.

Observe also the general requirements for island operation according to : TA 2108-0031 (general information about island operation)

NOTE:

Precondition for this operation mode without interlocking signals is an attended control room!



3.10 Cooling system – Two-circuits-radiator - electrical control only!

For high temperature circuit

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

Consisting of:

- Radiator (not include GEJ's scope)
- Electrical control

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

For low temperature circuit

Radiator is used to dissipate the heat from the intercooler circuit.

Consisting of (delivered loose):

- Radiator (not include GEJ's scope)
- Pump
- Short-circuit thermostat & [Electrical TCV](#)
- Safety valve
- Expansion tank



4.00 Delivery, installation and commissioning

4.01 Carriage

According to the 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 GE Jenbacher scope of supply.

4.03 Assembly and installation

Assembly and installation of all GE Jenbacher -components **is not** included in GE 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 GE Jenbacher start-up and commissioning checklist **is** included.

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

Load Management and dummy load control: Customer scope

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

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, battery acid) 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 GE 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 according to DIN ISO 3046 at GE Jenbacher test bench. The following tests are made at 100%, 75% and 50% 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 (Russian Natural gas with methane number 94). The technical data according to the specification can only be demonstrated to a certain extent with the available natural gas.

Carried out as combined Engine- and Module test commonly with module control panel at GE Jenbacher test bench, according to ISO 8528, DIN 6280. 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%, 75% and 50% 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 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 GE JENBACHER, the manufacturers' certificate will be provided.

5.03 Documentation

Preliminary documentation 60 days after receipt of a technically and commercially clarified order:

- Module drawing 1)
- Technical diagram 1)
- Drawing of control panel 3)
- List of electrical interfaces 2)
- Technical specification of control system 2)
- Technical drawing auxiliaries (if included in GE Jenbacher-limit of delivery) 1)

At delivery:

- Wiring diagrams 3)
- Cable list 3)

At start-up and commissioning (or on clients request):

- Operating and maintenance manual 4)
- Spare parts manual 4)
- Operation report log 4)

Available Languages

1) DEU, GBR

2) DEU, GBR, FRA, ITA, ESP

3) DEU, GBR, FRA, ITA, ESP, NLD, HUN, RUS, POL, TUR, CZE

4) DEU, GBR, FRA, ITA, ESP, NLD, HUN, RUS, POL, TUR, CZE, SLOWEN, SLOWAK, SERB,

SCHWED, ROM, PRT, NORWEG, LITAU, LETT, BULGAR, CHINA, DNK, ESTN, FIN, GRC, KROAT