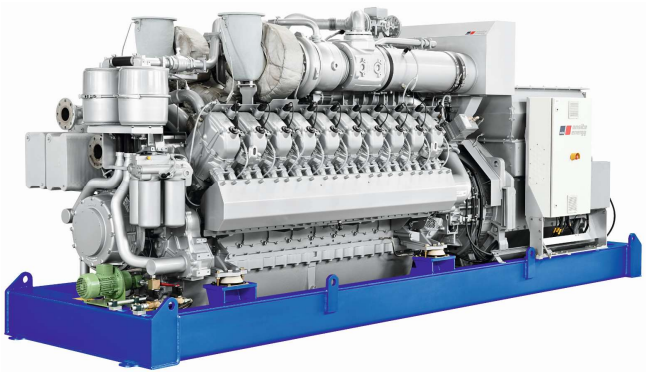

Technical Specification

and

Scope of Supply

MTU 20V4000 GS
GG20V4000D1

Customer:

MTU Project:
Quotation:

25.06.2024

I. System Description

Product type	GG20V4000D1 MTU 20V4000 GS
Application Group	3A - Heavy duty, unrestricted, ICXN

Power as per MTU Sales Program

Power per genset (ISO 8528)	2.600	kW
Engine speed	1.500	rpm
Intake air temperature	35	°C
Coolant temperature	58	°C
Altitude	100	m

On-site Power

Power per genset (ISO 8528)	2.600	kW
Engine speed	1.500	rpm
Intake air temperature	35	°C
Coolant temperature	58	°C
Altitude	100	m

Requirements

Frequency	50 Hz
Gas type	Natural gas
Generator voltage	400 V
EngineType	20V4000L64FNER
Generator model	Leroy Somer
Island operation	Yes
Grid guideline	No requirements
Methanzahl	>= 80

Technical Data:

1. DATA-RELEVANT DESIGN			
Technical data sheet		-	023290122_290124_Q01_2_20L64_2539_50_500_EN_SI_V1 *)
2. POWER-RELATED DATA, ELECTRICAL			
Electrical power, 100% CP		kWel	2539 *)
Engine power ISO 3046-1 – 100% CP	A	kW	2600

* = contract value, L = limit value, A = design value, R = guideline value

Note: The timeliness of the technical specifications may change until the binding contract is closed. Changes due to further technical development cannot be excluded. MTU underlines that the latest status may be obtained through MTU's communication platform Business Portal under "Applications & Products" – "Tools" → "TEN".

II. Selection Criteria for the Scope of Supply

Criteria	*Selection*	*for Product No.*
Application fine	Electricity supply stationary	1,
Application group	3A - Heavy duty, unrestricted, ICXN	1,
Instruction for exhaust emission	See technical data	1,
Power	See technical data	1,
PowerUnit	kW	1,
Speed	1500 rpm	1,
Frequency	50 Hz	1,
Generator voltage	400 V	1,
Engine type	20V4000L64FNER	1,
EPS	12.5	1,
Generator manufacturer	Leroy Somer	1,
Gas type	Natural gas	1,
Country of operation	outside Germany	1,
Island operation capability	Yes	1,
Raw emission engine	< 500mg NOx at 5% O2	1,
Engine with NOx-sensor	without NOx-sensor	1,
Operating mode	Grid parallel operation with grid failure operation	1,
Build type	Genset without heat recovery (GB)	1,
Fast start capability	without fast start capability	1,
Auxiliary drive voltage	400 V	1,
Control panel	MIP	1,
Qualitative NOx measurement	without qualitative NOx measurement	1,
Operation in combination	No	1,
grid type generator	TN-S-grid	1,
grid type auxiliary supply	TN-S-grid	1,
Altitude (only for control components)	Altitude up to 1000 m	1,
Ambient temperature MIP	0°C up to 45°C	1,
High temperature extraction	without extraction of high temperature circuit	1,
Flexible connections	with flexible connections	1,

Acceptance Testing	Factory acceptance	1,
Packing	Standard commercial	1,
Shipment	FCA Augsburg	1,

III. Scope of Supply

valid for product no.

1 SYSTEM CONFIGURATION 1,

1.1 System Description 1,

Note Emission Compliance: 1,
The engines and/or systems, may only be certified to comply with the required country or region specific emission regulations. Where applicable, the engines and/or systems are only certified to those specific emission regulations/standards which are clearly stated in the respective RRPS/MTU defined technical specifications. It is the customer's sole responsibility to ensure that the export/import, installation and use of the engine and/or system complies with the applicable emissions regulations in the country or region where the engine and/or system will be used.

The compact design genset consist of the following basic assemblies: 1,
- Engine (including gas train)
- Alternator and coupling
- Base frame
- MIP (MTU Interface Panel) as interface to engine management, control and diagnostic system

Engine and alternator are rigidly connected via a direct coupling and housing. The engine-alternator unit is isolated from the base frame via resilient mounts.

The alternator is mounted on two rails to facilitate replacement of the coupling element.

For further details, refer to the attached technical description of the scope of supply.

With integrated coolant preheating including temperature control as well as lube oil pump as prelubricating and waste oil pump with safety valve for forced feed lubrication and piston cooling.

The hardware and software in the MIP control cabinet ensure closed-loop genset control functions, open-loop control and monitoring features as well as the communication to and from external systems. A cogeneration control system with visualization and user interface is required in addition to MIP to operate the genset (e.g. MTU MMC or on site customer's control).

Flexible connections 1,

Flexible connections are supplied to compensate thermal expansion and to provide vibrational isolation.

Hose connections for lube oil supply and disposal and extended oil circulation volume
Flexible connection for engine coolant circuit with flange connection
Flexible connection for mixture coolant circuit with flange connection

Exhaust bellows with flange connection and companion flange 1,

Genset preservation 1,

Standard corrosion protection is provided for long-distance transport and/or extended storage for

valid for product no.

maximum of 12 month from readiness for dispatch.
The specified preservation period applies to unopened packing and dry, normal storage conditions as follows:

- Frost-free, closed, heated, clean rooms
- Storage temperature between 10°C and 40°C.
- Monthly average relative humidity not above 65%
- Re-preservation required after 12 months

Safety standards 1,
MTU Onsite Energy GmbH within its system borders of the scope of supply delivers all required safety components according to the valid Safety Standard DIN EN ISO 13849 (Safety of Machinery - Safety-related Parts of Control Systems). For the peripheral system not included in MTU's scope of supply, the principal has to make sure that any required safety component also complies to DIN EN ISO 13849 (refer also to "Component Quality Guideline DIN EN ISO 13849" attached).

Further applied harmonized standards:
EN ISO 12100:2010
EN ISO 8528-13:2016
EN 1679-1:1998+A1:2011
EN 60204-1:2006

Antifreeze measures 1,
In case of frost damages MTU-OEG will not be liable for components, which after delivery have not been filled with a suited antifreeze according to MTU-OEG specifications. The client must make sure that functioning heating mechanisms reliably prevent freezing.

Remaining and site conditions 1,

Continuous power, no overload capability, refers to mains parallel operation, at nominal speed and standard reference conditions according to technical datasheet.

The nominal power output specified in the datasheet is available at site altitudes up to 400 m above sea level without power reduction. For further details, refer to the attached datasheet.

In case of knocking due to low methane number or increased mixture temperature the ignition timing of the affected cylinders is adjusted. If knocking persists, the power output is reduced automatically

Definition of operating modes 1,

Mains parallel operation: 1,
The genset is synchronized to the public mains.
Mains is defined as a power source with at least ten times the output power of the generator to be connected.

Mains backup operation: 1,
The term "mains backup" defines a design in which a gas engine genset ensures the continuous power supply to certain electrical consumers in case of a temporary loss of power in the public grid system. The resulting loads of the respective consumers will be switched on or off in steps.

In all operation modes, the admissible load steps approved by MTU Onsite Energy must not be exceeded and the transient recovery times must not be fallen short of. 1,

Other site conditions for isolated or mains backup operation
- Consumer structure
- Operating conditions
- Performance characteristic
- Load steps and tolerances

are applicable in accordance with the attached specification DK-LS-1001.

These operating modes might require an extended CHP plant control system and a higher-level I&C system (e.g. for load management). The review of the project-related requirements for the given operating mode as well as the components are not included in the scope of supply of MTU Onsite Energy.

1.2 Starting Aids 1,

Set starter batteries 1,
- Maintenance-free starter batteries, mounted on base frame.

1.3 Base Frame 1,

Base frame designed as welded steel profile structure including lifting eyes; with integrated safety oil sump for the oil volume contained in the engine, with oil leakage monitoring. 1,

1.4 Vibration Isolation 1,

The engine-alternator unit is mounted on the base frame with resilient mounts. This design isolates the vibrations generated by the engine and/or alternator from the base frame. 1,
To minimize the remaining residual vibration level, resilient mats are provided between base frame and foundation (sylomer straps, supplied as loose parts, for installation on site).

2 ENGINE CONFIGURATION 1,

2.1 Engine System 1,

Series 4000 four-stroke turbocharged Otto gas engine with mixture cooling - compact, high-performance, reliable, maintenance-friendly and extremely economical. 1,

Lean mixture technology, state-of-the-art electronic ignition system with individual ignition timing and automatic ignition power control, anti-knock control as well as highly responsive mixture and load control ensure economical and safe genset operation with optimum use of the energy input.

Basis
- counter-clockwise rotation engine
- coolant cooled
- lean mixture supercharging
- two-stage mixture cooling

- open combustion chamber
- microprocessor-controlled high-voltage ignition system
- exhaust turbocharging
- two cooling system circuits
- piston cooling

Core engine
- Gray cast iron crankcase with assembly holes, gray cast iron oil pan,
- Forged crankshaft, forged connecting rods,
- Individual, cylinder heads with four valves each

1. Crank drive
The crank drive is installed in the crankcase. It is supported in sleeve bearings and locked in axial direction. Engine oil from the crankcase is used to lubricate the bearings, vibration damper and pistons. Carefully matched components ensure high performance and minimum wear.

Crankcase with oil pan
The oil pan is attached to the bottom of the crankcase; gearcase, coolant distribution housing and flywheel housing are bolted to the front.
The cylinder heads and engine lifting points are mounted left and right on the top decks.
Technical data
- Single-cast crankcase
- Integral coolant ducting
- Main oil gallery integrated in top cover
- Replaceable, wet cylinder liners
- Split sleeve bearings for crankshaft
- Sleeve bearings for camshaft
- Crankshaft bearing caps secured vertically and horizontally
- Integrated oil supply for piston cooling
- Crankcase ventilation (closed circuit)
- Large inspection port covers

Benefits
- High rigidity
- Low noise and vibration levels

Pistons
- Piston with integral cooling duct

valid for product no.

– Piston cooling though oil-spray nozzles

Connecting rods
– Forged

– Machined as one piece, providing high rigidity and weight optimization

Crankshaft
– Forged

– Bolted counterweights

– Pressed-on crankshaft gear

– Low-wear sleeve bearing, oil supply from lube oil system

– Locked in axial direction

Flywheel (driving end)
– PTO flange

– Ring gear for starter pinion

Crank drive benefits:
– High performance

– Minimum weight

– Long service life

2. Cylinder head with add-on components
The cylinder heads with valve drive and spark plug are mounted on the crankcase.
Coolant for cylinder head cooling as well as engine oil for valve gear lubrication are supplied from the crankcase.
Technical data
– Individual cylinder heads

– Two inlet and exhaust valves

– Centrally arranged spark plug

Benefits
– Designed for high ignition pressures

– Low exhaust emissions

– Long maintenance intervals

3. Mixture formation, turbocharging 1,

Venturi gas mixer with gas supply through electronically controlled metering valve.

Mixture cooling
– Two-stage mixture cooling

valid for product no.

– 1st stage is either integrated as high temperature stage (HT) in the engine cooling system or designed as HT circuit integrated in the heating system

– 2nd stage is designed as low temperature stage (LT) with external cooling circuit

Charging
– Mixture compression by exhaust turbocharger

– Throttles between mixture coolers and mixture distribution lines

4. Engine cooling system with 2 separate circuits
– HT circuit with integrated oil cooling, first-stage mixture cooling and cylinder cooling

– Integrated coolant preheating

5. Starting equipment 1,
– Electrical starter

– Two starters (16V and 20V)

6. Ignition system
– Microprocessor-controlled high-voltage ignition system with low-voltage distribution, no moving parts, wear-free

– Automatic ignition power control

– One ignition coil per cylinder

– High-performance sparkplugs

7. Engine monitoring
Measurement and monitoring of the following values:
– Engine oil pressure, engine oil temperature and engine oil level

– Coolant pressure and coolant temperature before and after engine

– Intake air pressure and intake air temperature

– Mixture pressure and mixture temperature

– Crankshaft speed, camshaft speed, turbocharger speed

– Crankcase pressure

– Exhaust bulk temperature

– Cylinder exhaust temperatures

8. Control
Engine governor
– Controls the starting, stopping and emergency stop sequence

valid for product no.

– Monitors the engine operating parameters

– Controls throttles and sets gas mixture for requested speed/power

– Monitors the first gas solenoid valve the gas train to the engine

Engine monitoring

– Evaluation unit for PT 1000 temperature sensor to determine and monitor exhaust temperatures of individual cylinders

– Monitors the second gas solenoid valve the gas train to the engine

Ignition system

– Cylinder-selective adjustment of ignition voltage and ignition timing

Anti-knock control AKR

– Controls the cylinders with regard to the knock characteristics.

Gas control valve

– Controls the required amount of gas

2.2 Exhaust System 1,

The exhaust system consists of the following: 1,

– 1 turbocharger 8V, 12V, 16V

– 2 turbochargers 20V, two exhaust pipes / outlets,

– Uncooled, insulated exhaust manifolds in engine Vee, arrangement ensures protection against accidental contact

2.3 Fuel System 1,

The gas train is supplied in accordance with the pressure equipment directive (DGRL as amended), with CE declaration of conformity in accordance with DGRL. One hose connection is supplied loose for installation on site. 1,

– Flow direction gas control path: left to right 1,

The gas train consists of aluminum pressure die casting, sealing material NBR and completely pre-assembled. 1,

Components of the gas train include:

– Gas filter

– Double solenoid valve

– Balanced pressure regulator

valid for product no.

- Valve tightness check
- Pressure monitor
- Flexible stainless steel hose assembly for direct connection of the gas train to the gas control valve

Cabling between MIP and gas train according to the basic MTU wiring diagrams.

2.4 Oil System 1,

Lubrication Oil System 1,

The lubrication oil system consists of the following:
- Engine-mounted gear-type lube oil pump with safety valve for forced-feed lubrication and piston cooling and connection to an extended lube-oil circulation volume
- Lube oil heat exchanger, engine-mounted
- Paper-type lube oil filter with exchangeable filter cartridges
- Oil float switch with Reed contacts to control the solenoid valve to control automatic oil replenishment system
- Oil level dipstick
- Crankcase ventilation via oil separator with discharge to the mixture line before the turbocharger
- Connections for oil replenishment and oil extraction

The lube oil system comprises an integrated waste oil pump, which is used for **emptying and prelubricating** the genset. Pipe connections on site:
- Oil sump under the genset (without WHG approval)
- Waste-oil/oil priming pump with three-way solenoid valve mounted on the base frame
- Oil sump under the pump assembly (without WHG approval)
- Solenoid valve for fresh-oil replenishment and prepared for an extended oil volume

2.5 Air Intake System 1,

Intake air system 1,

The Air Intake System includes the following:

- Air intake through dry-type air filters mounted on engine or intake housing
- Intake air filters designed as dry-type filter cartridges
- 1 intake air filter 8V, 12V, 16V
- 2 intake air filters incl. intake housing 20V
- incl. service indicator and sensor for automatic pollution monitoring

valid for product no.

3 GENERATOR CONFIGURATION 1,

3.1 Generator Specification 1,

Highly efficient, self-excited brushless synchronous alternator 1,

General data:

- Housing
- Isolation class H with thermal usage < F, for optimization of efficiency and increase lifetime
- 2-bearing alternator, lubricatable bearing
- Dynamically balanced as per ISO 1940 and NFC 51-111
- Self ventilated alternator IC 0A1
- Protection class IP23
- Alternator terminal box for main and auxiliary power circuit
- Outlet for power cable at left from drive end view, including non magnetic inlet cover
- Alternator suitable for operation mode S1, for mains parallel operation and in parallel or island operation among other alternators
- Excitation system: AREP
- Sustained short circuit current at 3-pole terminal short circuit is minimum 3 times rated current for 10 seconds
- Maximum overspeed 2250 rpm, for maximum 2 minutes
- Digital voltage regulator with diode failure monitoring
- Protection transformer xxx/1A 5P10
- Measuring transformer xxx/1A
- 2 times PT100 winding temperature monitoring for each phase integrated in stator winding
- 1 time PT100 bearing temperature monitoring per bearing
- Alternator anti condensation heater integrated

Norms and regulations

- IEC 60034-1, -5
- EN 55011 group 1 class B
- ISO 8528-3

valid for product no.

Regulations for static and dynamic grid support (grid guideline) 1,

The alternator does not comply with eventual regulations for static and dynamic grid support

3.2 Power Transmission 1,

The torque produced by the engine is transmitted to the alternator via a highly resilient flange coupling. 1,

5 CONTROL PANEL CONFIGURATION 1,

5.1 Genset Control 1,

If a country-specific certification is available (currently: Italy and Poland): 1,
If no MMC control is included in our scope of delivery, then a large part of the functions required for the grid guideline are covered by the design of the genset and the MIP control. But not all.
The following functions, which are listed exemplary in the certificate but not comprehensively, must then be implemented in a separate customer control system and approved by the locally responsible bodies and authorities for network approval:

- Automatic reactive power regulation to a characteristic curve cos phi = f(P)
- Verification of active power limitation in local logic, for voltage values close to 110% of Vn
- Implementation and verification of automatic active power reduction in the presence of over – frequency transients on the network
- Required Grid protection functions with appropriate parameters

The MTU Interface Panel (MIP) contains the genset control including alternator and mains monitoring, synchronization equipment and is the standard interface between genset control system and the required cogeneration control system including visualization, which is mandatorily required (e.g. e.g. MTU MMC or on site customer's control according to MIP interface description MS13097) 1,

The MIP includes the following components and control functions:

Communication with the engine governor via hardware signals and CAN-bus.
Communication with the customer's plant via hardware signals and Ethernet.
Control elements (EMERGENCY STOP button).
Integrated safety chains for machinery EMERGENCY STOP and manual EMERGENCY STOP.
Alternator current transducer wired within the scope of supply.
Alternator voltage wired within the scope of supply in case of low voltage.
Alternator protection

- Overfrequency (ANSI: 81, IEC: f>)
- Underfrequency (ANSI: 81, IEC: f<)
- Overvoltage (ANSI: 59, IEC: U>)
- Undervoltage (ANSI: 27, IEC: U<)
- Phase overcurrent (ANSI: 51, IEC: I>)
- Short-circuit current (ANSI: 50, IEC: I>>)
- Overload (ANSI: 32F, IEC: Pf>>)

- Reduced power (ANSI: 32R/F, IEC: Pr>, Pf>)
- Load unbalance (ANSI: 46, IEC: I2>)

Alternator monitoring/measurement
- Alternator active power – P (kW)
- Alternator reactive power – Q (kVAr)
- Alternator apparent power– S (kVA)
- Alternator frequency
- Alternator voltage U12, U23, U31
- Alternator current L1, L2, L3
- Alternator power factor cosphi
- Alternator active energy (kWh)

Busbar monitoring/measurement
- Busbar voltage U12, U23, U31
- Busbar frequency

Mains monitoring/measurement
- Mains voltage U12, U23, U31
- Mains frequency

Synchronization
- Alternator circuit breaker (ACB): Floating contact only, power circuitry in customer's system.
- Mains circuit breaker (MCB): Floating contact only, power circuitry in customer's system.

Performance range
Alternator temperature monitoring
- Winding temperature monitoring U1/V1/W1 and limit value monitoring (including wiring in scope of supply)
- Bearing temperature monitoring driving end/non-driving end and limit value monitoring (including cabling in scope of supply)

Alternator features
- Control of the alternator space heater (power circuitry including wiring in scope of supply)
- Control of the voltage alternator (including wiring in scope of supply)
- Control of the alternator de-excitation (power circuitry including wiring in scope of supply)

Gas system (monitoring and safety features)
- Gas pressure min / max (safety feature)
- Control of the gas-tightness test (power circuitry in scope of supply)
- Control of the gas solenoid valves (power circuitries in scope of supply)

valid for product no.

General control functions

- Control of the auxiliary drives (floating contact or software signal)
- Control to open the backup switches (floating contact or software signal)
- Control of the lube oil solenoid valves (power circuitry including wiring in scope of supply)
- Control of the waste-oil/prelubricating pump (power circuitry including wiring in scope of supply)
- Control of the waste-oil solenoid valve (power circuitry including wiring in scope of supply)
- Control of the heating elements of the engine coolant preheating (power circuitry including wiring in scope of supply)

For further details, refer to the MIP 4000 interface description MS13097.

The MIP including fan is designed for a control panel temperature of 0°C to 45°C. 1,

Connectivity 1,

- The engine system automatically collects and transfers engine data to the manufacturer from time to time.
- Data transmission is via customer LAN (standard), optionally via mobile communications network.
- The data is used by the manufacturer for the purposes of product development and improvement as well as service optimization.
- Such data includes operational data, GPS data, records of malfunctions and warning messages which are generated by the engine system. It does not include any personal data whatsoever.
- Users can log in or register via *https://mtu-go.com* and also gain insight into the data. This access provides beside a status overview of the engine system e.g. trend analysis over different time periods of the operating data transmitted almost in real time as well. Additional fees may apply if you subscribe to advanced functionalities.

Mains parallel operation with mains backup function 1,

- Single unit system

Grid type generator feed/supply 1,

- TN-S-grid generator feed/supply 1,

Grid type auxiliaries supply 1,

- TN-S-grid type auxiliaries supply 1,

8 HEAT EXTRACTION 1,

8.1 Heat Extraction Jacket Water 1,

valid for product no.

Heat recovery from jacket water is not included in the scope of supply. 1,

11 MISCELLANEOUS 1,

11.1 Documentation 1,

Standard Publications in English-Language 1,
Set of standard operating, maintenance documentation and test run certificate
– Hardcopy

Supplementary documentation 1,
This delivery specification is only valid together with the following enclosures:
– Technical guideline Gas system emissions MS61026
– Assembly Instructions M060803
– Installation Conditions MS65032
– Supplemental Safety Guidelines MS60227
– Billing rates

The selected scope of delivery corresponds to an incomplete machine. 1,

If an incomplete machine is delivered, a declaration of incorporation will be issued by Rolls-Royce Solutions.

The following directives and standards have been observed depending on the scope of delivery:
Directive 2006/42/EC (Machinery Directive)
DIN EN ISO 12100 (Safety of machinery, risk assessment)
DIN EN ISO 13849-1 (Safety of machinery, safety-related parts of control systems)

Third Language: 1,
– Genset name plate in German and English
– Automation Visualization in German, English
– Electrical drawing in the selected third language
– MMC operating key switches in German, English
– Genset safety labels in German, English
– Engine name plate in English
– Alternator name plate in English

11.2 Painting 1,

Standard painting of the genset components as follows: 1,
– Engine, alternator RAL 7001

valid for product no.

–	Base frame	RAL 5002
–	Control cabinet / MIS / MIP	RAL 7035
–	Option Head Recovery Module	RAL 9005

11.3 Packing 1,

Standard packing 1,

– Genset covered with plastic sheet, accessories packed in carton or wooden box

– Requirements for Packing / Handling / Storage and Transportation can be found in MTU-specification M060813 valid for gas series 400 and series 4000 and to be considered accordingly. 1,

11.4 EXCLUSIONS 1,

Please mind: 1,
Additional auxiliary systems are required to complete the system ready for operation on-site.
Since costs will depend on the local conditions and requirements of the particular installation site, these items are – unless specifically mentioned above or in attached specifications* - not included in our offer:

– Components to be installed at plant site, for e.g.: fuel supply, lube oil supply and disposal; air ventilation; cooling systems with radiators, pumps, expansion vessels etc.; preheating units; transformers; silencer, sound enclosure, exhaust systems; load banks or any other

– Mechanical and electrical erection i.e. any piping, ducting and cabling for the auxiliary systems at plant site, foundations or other civil works

– Overall plant load management systems in case of multiple gensets plant

– Commissioning of other components than offered

– Gas pressure reduction / increase unit for constant flow pressure or gas treatment systems if required

– Heat insulation on genset or supplied lose items

– Generator circuit breaker, switchboard, auxiliary drive panel, power cables

– Batteries with starting cables or mains starting unit

– Earthing material/connections and lightning protection

– Installation materials, civil works and tanks (water / lube oil)

– Operating media, including first filling

– Engineering, supervision and technical support for not contracted scope / specifications

– Any necessary permits / working permits

– Special synchronization devices as per local standard

– Any necessary certificates, reports or approvals as required in the country of operation

valid for product no.

– All external connections

12 FUNCTIONAL TESTING 1,

12.1 Acceptance Testing 1,

The genset is tested according to document MS60162 on the test bench. The measured values and operating parameters are documented in the acceptance protocol. 1,

Power node 100 % 1,

13 SHIPPING CONDITIONS 1,

13.1 Freight 1,

FCA Augsburg (Incoterms 2020) 1,