

Technical specification

filius 104 BG



Design:

50 kW el.

480 V / 60 Hz

biogas (60% CH₄, 40% CO₂)

Calorific Value = 578 BTU/ft³

NO_x < 1.0 g/BHP-h

Exhaust cooling to 356 °F

1. Genset	3
1.1 Engine	3
1.2 Generator (utility planning data)	4
2 Mixture composition	4
2.1 Combustion air	4
2.2 Fuel	5
3 Integrated heat extraction	5
3.1 Customer Heat Recovery Circuit	5
3.2 Engine circuit	5
3.3 Mixture cooling water circuit - low temperature (LT)	5
4. Exhaust system	6
5 Ventilation	6
6 Operating fluids	6
7 Electronics and software	6
8 Interfaces	7
8.1 Dimensions and weights	7
8.2 Mechanical Connections	8
8.3 Electrical connections / utility interface	8
8.4 Data interfaces	8
9 Technical boundary conditions	9

Subject to technical changes!

Note: Figure on cover page may differ

1. Genset

	75 %	100 %	Load
Electrical power	38	50	kW ⁽⁵⁾
Useful thermal power	205.998	248.719	MBTU/hr ⁽²⁾
Fuel consumption	414.483	511.189	MBTU/hr ⁽¹⁾
Efficiency Electrical	30.9	33.4	% ⁽¹⁾
Efficiency Thermal	49.7	48.7	% ^{(1), (2)}
Efficiency Combined (el. + th.)	80.6	82.0	% ^{(1), (2)}

	NOx *	CO	VOC ⁽⁸⁾	
Exh. emissions without catalytic converter	< 1.0	< 2.5	< 0.7	g/BHP-h
	< 91	< 300		ppm ^{(4),(6)}
Exh. emissions with catalytic converter	< 1.0	< 0.8	< 0.7	g/BHP-h
	< 91	< 90		ppm ^{(4),(6)}

Engine surface noise **		100	dB(A) ⁽⁷⁾
Engine surface noise with sound enclosure (not available) ***		-	dB(A) ⁽⁷⁾

1.1 Engine

Engine manufacturer	MAN		
Engine type	E 0834 LE 302		
Type	row		
No. of cylinders	4		
Operating method	4-stroke		
Engine displacement	4580	ccm	
Bore	4.25	in	
Stroke	4.92	in	
RPM	1800	1/min	
ISO standard power (mech.)	72	bhp	
compression ratio	11,0 : 1		
average effective pressure	113.3	psi	
average piston speed	24.6	ft/s	
body of balance wheel	SAE 2		
Direction of rotation (based on balance wheel)	left		
tooth rim with number of teeth	143		
Engine dead weight	1091	lbs	
Mixture cooling to	122	°F	

* Referred to MAN data sheet

** Total sound power level at full engine load in accordance with DIN EN ISO 3746

*** Average sound pressure level under open area conditions at distance of 1 m in accordance with DIN 45635
An increased noise load must be taken into account with fresh air intake from the installation room.

1.2 Generator (utility planning data)

Manufacturer	Leroy Somer	
Type	LSA 44.3 S3/4P	
Generator type	Synchronous, directly coupled	
Voltage regulator (AVR)	D510C	
Rated speed	1800	1/min
Frequency	60	Hz
Effective electrical power	50	kW
Apparent electrical power (cos ϕ 0.8)	63	kVA
Apparent electrical power (cos ϕ 1.0)	50	kVA
Rated generator current (cos ϕ 0.8)	75	A
Rated generator current (cos ϕ 1.0)	60	A
Rated generator voltage ($\pm 10\%$)	480	V
Subtransient reactance X"d	7.7	%
Short-circuit current I _k "3	1.63	kA
Power factor cos ϕ (lagging / leading)	0.8 / 0.95	
Generator circuit breaker	100	A
Additional section switch (VDE-AR-N 4105)	100	A
Efficiency (full load) at Cos $\phi = 1$	93.2	%
Mass moment of inertia	19.64	lb · ft ²
Ambient air temperature	104	°F
Stator circuit	star	
Protection class	IP 23	
Generator weight	664	lbs
Compensation	not available	
Engine startup	not available	

2 Mixture composition

2.1 Combustion air

Combustion air mass flow	594	lbs/hr
Combustion air volume flow (25 °C, 1013 mbar)	134	SCFM

2.2 Fuel

Fuel requirements in accordance with 'TA-004 Gas'

Reference methane number - minimum methane number	140 / 80	
Combustible mass flow	67.4	lbs/hr ⁽¹⁾
Combustible volume flow	14.7	SCFM ^{(6),(1)}
Gas pressure at rated load min. *	0.435	psig
Gas flow pressure at rated load max. *	1.015	psig
Gas regulation line safety pressure	7.252	psig

* At the inlet to the gas regulation line

3 Integrated heat extraction

3.1 Customer Heat Recovery Circuit

Heating water requirements in accordance with 'TA-002 Heating circuit'

Heating water volume flow (at $\Delta t = 15$ K)	18.4	gpm
Internal pressure loss in heating circuit (approx.) *	4.35	psig
Total Head ca. *	-	ft
Heating water return temperature (max)	158	°F
Heating water flow temperature (max) **	194	°F
Safety valve	87.02	psi

3.2 Engine circuit

Coolant requirements in accordance with 'TA-001 Coolant'

Jacket Water Heat	164.655	MBTU/hr
Exhaust Gas Heat up to 356°F	83.044	MBTU/hr
Engine inlet temperature (min.)	176	°F
Engine outlet temperature (max.)	190	°F
Differential inlet / outlet (max.)	10.8	°F
Jacket water flow (min.)	35.4	gpm
Jacket water flow (max.)	35.8	gpm
Operating pressure (max.)	29.0	psi
Safety valve	43.5	psi
Safety temperature limiter	230	°F
Intercooler heat high temperature circuit	1.020	MBTU/hr
Intercooler inlet high water temperature (max.)	180	°F
Intercooler coolant flow high temperature circuit (min.)	0.4	gpm

3.3 Mixture cooling water circuit - low temperature (LT)

Coolant requirements in accordance with 'TA-001 Coolant'

Intercooler heat low temperature circuit	3.713	MBTU/hr
Intercooler inlet low water temperature (max.)	108	°F
Intercooler outlet low water temperature (max.)	113	°F
Intercooler coolant flow low temperature circuit (min.)	1.6	gpm
Safety valve	44	psi

* Up to / from module interface

** Heating water supply temperature in partial load operation < 90°C

4. Exhaust system

Exhaust gas temperature after turbo charger	819	°F ⁽³⁾
Exhaust temperature after exhaust heat exchanger	356	°F
exhaust gas volume flow wet	136	SCFM ⁽⁶⁾
exhaust gas volume flow dry	120	SCFM ⁽⁶⁾
exhaust gas mass flow wet	661	lbs/hr
exhaust gas mass flow dry	608	lbs/hr
Exhaust back pressure downstream of turbine max.	0.73	psig
Pressure reserve approx. (with catalytic converter) *	0.54 (0.48)	psig
Exhaust outlet noise **	132	dB ⁽⁷⁾

5 Ventilation

Radiation heat of engine and generator (approx.)	76.397	MBTU/hr
Supply air volume flow min. (at $\Delta t = 15$ K)	2792	SCFM

6 Operating fluids

Lubricating oil approvals, see 'TA-003 Lubricating oil'		
Lubrication oil consumption (max.)	2.00	g/kWh
Filling capacity lubricant (max.)	3.43	gallons
Lubricating oil filling tank fill capacity (optional) ***	9.25	gallons
Lubricating oil volume extension tank (optional)	18.49	gallons
Coolant approvals, see 'TA-001 Coolant'		

7 Electronics and software

Generator Protection Relay	Deif GPC 3 optional redundant Relay SEL 700GT	
Touchscreen display	10	"
Protection class Control cabinet	Type 12	
Protection class Power switch cabinet	Type 1	
Switch cabinet environmental temperature	32 - 95	°F
Switch cabinet relative air humidity (max.)	65	%

* From module interface (exhaust heat exchanger / catalytic converter in standard version and new condition)

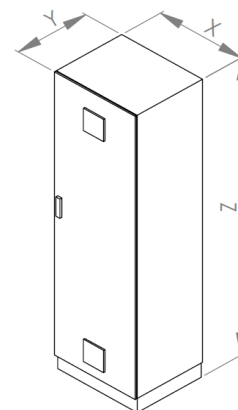
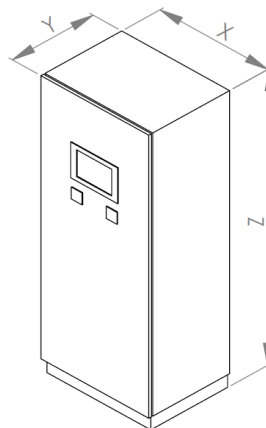
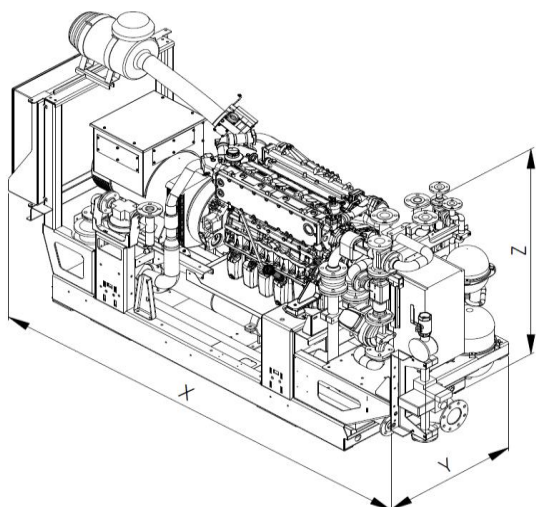
** Total sound power level at full engine load in accordance with DIN 45635-11 Annex A

*** Filling tank omitted with installation of a lubricating oil volume auxiliary tank

8 Interfaces

8.1 Dimensions and weights

(Figures may differ)



Length Module	X	112.60	in
Width Module	Y	38.58	in
Height Module	Z	61.26	in
Weight Module		4916	lbs
Weight Module with sound enclosure (not available)		-	lbs
Powder-coated CHP frame		RAL 6002	
Width Control cabinet	X	31.50	in
Depth Control cabinet	Y	19.69	in
Height Control cabinet	Z	74.80	in
Weight Control cabinet		441	lbs
Control cabinet powder coated		RAL 7035	
Width Power switch cabinet	X	23.62	in
Depth Power switch cabinet	Y	15.75	in
Height Power switch cabinet	Z	74.80	in
Weight Power switch cabinet		331	lbs
Power switch cabinet powder coated		RAL 7035	

8.2 Mechanical Connections

Interface Gas	25 / 10	DN / PN
Interface Exhaust	100 / 10	DN / PN
Interface Heating circuit	40 / 16	DN / PN
Interface Emergency cooling circuit	40 / 6, 16	DN / PN
Interface Mixture cooling circuit LT	25 / 16	DN / PN

8.3 Electrical connections / utility interface

Grid connection with pre-fuse (customer-provided)	480 V / 60 Hz	
Grid system	Y	
Short-circuit proof I _{cc} (max.)	50	kA

8.4 Data interfaces

Remote maintenance access (optional) *	DSL / UMTS (SIM)
Interfaces / Data interfaces (optional):	<ul style="list-style-type: none">- Profibus- Profinet- Modbus RTU- Modbus TCP- Ethernet IP- Hardware contacts

* Access for remote maintenance must be provided by the customer

9 Technical boundary conditions

Unless otherwise specified, all data is based on full engine load with the respective indicated media temperatures and subject to technical improvements. The generator output measured at the generator terminals serves as the basis for the delivered electrical power. All power and efficiency specifications are gross specifications. The fuel gas quality must conform to the specifications of 'TA-004 Gas'. The operating fluids and plant system layout must conform to the 'Technical instructions' of 2G.

- (1) Performance conditions in accordance with DIN ISO 3046. Tolerance for specific fuel use amounts to + 5% of nominal performance. Efficiency specifications are based on an engine in new condition. An abatement in efficiency over the service life is reduced with observance of the maintenance requirements.
- (2) The tolerance for usable heat output is +/- 8 % under normal load.
- (3) The tolerance for the exhaust temperature is +/- 8 %.
- (4) Corresponding to a residual oxygen concentration in the exhaust of 15 %.
- (5) Electrical generator terminal power at $\cos \varphi = 1.0$
- (6) Volume specifications for normal status:

Pressure	14.69 psig
Temperature	32 °F
- (7) Standard deviation of reproducibility 4 dB in accordance with DIN EN ISO 3746
- (8) Assumed gas composition (VOC calculated as NMHC):
CH₄=60 %, CO₂=40 %

Power specifications in this document relate to standard reference conditions.

Standard reference conditions in accordance with DIN ISO 3046-1:

Air pressure	14.50 psig
Air temperature	77 °F
Relative air humidity	30 %

Power reduction

Power reduction due to installation at altitude > 958ft a.s.l. and/or air suction temperature > 77°F shall be determined specifically for each project according "TI-049 Load reduction".

Technical specification

filius 106 BG



Design:

100 kW el.

480 V / 60 Hz

biogas (60% CH₄, 40% CO₂)

Calorific Value = 578 BTU/ft³

NO_x < 1.0 g/BHP-h

Exhaust cooling to 356 °F

1. Genset	3
1.1 Engine	3
1.2 Generator (utility planning data)	4
2 Mixture composition	4
2.1 Combustion air	4
2.2 Fuel	5
3 Integrated heat extraction	5
3.1 Customer Heat Recovery Circuit	5
3.2 Engine circuit	5
3.3 Mixture cooling water circuit - low temperature (LT)	5
4. Exhaust system	6
5 Ventilation	6
6 Operating fluids	6
7 Electronics and software	6
8 Interfaces	7
8.1 Dimensions and weights	7
8.2 Mechanical Connections	8
8.3 Electrical connections / utility interface	8
8.4 Data interfaces	8
9 Technical boundary conditions	9

Subject to technical changes!

Note: Figure on cover page may differ

1. Genset

	50 %	75 %	100 %	Load
Electrical power	50	75	100	kW ⁽⁵⁾
Useful thermal power	244.396	344.556	464.098	MBTU/hr ⁽²⁾
Fuel consumption	519.992	722.340	932.486	MBTU/hr ⁽¹⁾
Efficiency Electrical	32.8	35.4	36.6	% ⁽¹⁾
Efficiency Thermal	47.0	47.7	49.8	% ^{(1), (2)}
Efficiency Combined (el. + th.)	79.8	83.1	86.4	% ^{(1), (2)}

	NOx *	CO	VOC ⁽⁸⁾	
Exh. emissions without catalytic converter	< 1.0	< 2.4	< 0.7	g/BHP-h
	< 91	< 300		ppm ^{(4),(6)}
Exh. emissions with catalytic converter	< 1.0	< 0.7	< 0.7	g/BHP-h
	< 91	< 90		ppm ^{(4),(6)}

Engine surface noise **			103	dB(A) ⁽⁷⁾
Engine surface noise with sound enclosure (not available) ***			-	dB(A) ⁽⁷⁾

1.1 Engine

Engine manufacturer	MAN		
Engine type	E 0836 LE 202		
Type	row		
No. of cylinders	6		
Operating method	4-stroke		
Engine displacement	6870	ccm	
Bore	4.25	in	
Stroke	4.92	in	
RPM	1800	1/min	
ISO standard power (mech.)	141	bhp	
compression ratio	11,0 : 1		
average effective pressure	148.3	psi	
average piston speed	24.6	ft/s	
body of balance wheel	SAE 2		
Direction of rotation (based on balance wheel)	left		
tooth rim with number of teeth	143		
Engine dead weight	1334	lbs	
Mixture cooling to	122	°F	

* Referred to MAN data sheet

** Total sound power level at full engine load in accordance with DIN EN ISO 3746

*** Average sound pressure level under open area conditions at distance of 1 m in accordance with DIN 45635
An increased noise load must be taken into account with fresh air intake from the installation room.

1.2 Generator (utility planning data)

Manufacturer	Leroy Somer	
Type	LSA 44.3 L10/4P	
Generator type	Synchronous, directly coupled	
Voltage regulator (AVR)	D510C	
Rated speed	1800	1/min
Frequency	60	Hz
Effective electrical power	100	kW
Apparent electrical power (cos ϕ 0.8)	125	kVA
Apparent electrical power (cos ϕ 1.0)	100	kVA
Rated generator current (cos ϕ 0.8)	150	A
Rated generator current (cos ϕ 1.0)	120	A
Rated generator voltage (\pm 10 %)	480	V
Subtransient reactance X"d	10.2	%
Short-circuit current I _k "3	2.46	kA
Power factor cos ϕ (lagging / leading)	0.8 / 0.95	
Generator circuit breaker	250	A
Additional section switch (VDE-AR-N 4105)	250	A
Efficiency (full load) at Cos ϕ = 1	94.9	%
Mass moment of inertia	32.04	lb · ft ²
Ambient air temperature	104	°F
Stator circuit	star	
Protection class	IP 23	
Generator weight	968	lbs
Compensation	not available	
Engine startup	not available	

2 Mixture composition

2.1 Combustion air

Combustion air mass flow	1046	lbs/hr
Combustion air volume flow (25 °C, 1013 mbar)	236	SCFM

2.2 Fuel

Fuel requirements in accordance with 'TA-004 Gas'

Reference methane number - minimum methane number	140 / 80	
Combustible mass flow	123.0	lbs/hr ⁽¹⁾
Combustible volume flow	26.9	SCFM ^{(6),(1)}
Gas pressure at rated load min. *	0.435	psig
Gas flow pressure at rated load max. *	1.015	psig
Gas regulation line safety pressure	7.252	psig

* At the inlet to the gas regulation line

3 Integrated heat extraction

3.1 Customer Heat Recovery Circuit

Heating water requirements in accordance with 'TA-002 Heating circuit'

Heating water volume flow (at $\Delta t = 15$ K)	34.3	gpm
Internal pressure loss in heating circuit (approx.) *	4.35	psig
Total Head ca. *	-	ft
Heating water return temperature (max)	158	°F
Heating water flow temperature (max) **	194	°F
Safety valve	87.02	psi

3.2 Engine circuit

Coolant requirements in accordance with 'TA-001 Coolant'

Jacket Water Heat	311.982	MBTU/hr
Exhaust Gas Heat up to 356°F	124.569	MBTU/hr
Engine inlet temperature (min.)	176	°F
Engine outlet temperature (max.)	190	°F
Differential inlet / outlet (max.)	10.8	°F
Jacket water flow (min.)	67.1	gpm
Jacket water flow (max.)	78.9	gpm
Operating pressure (max.)	29.0	psi
Safety valve	43.5	psi
Safety temperature limiter	230	°F
Intercooler heat high temperature circuit	27.547	MBTU/hr
Intercooler inlet high water temperature (max.)	180	°F
Intercooler coolant flow high temperature circuit (min.)	11.8	gpm

3.3 Mixture cooling water circuit - low temperature (LT)

Coolant requirements in accordance with 'TA-001 Coolant'

Intercooler heat low temperature circuit	20.347	MBTU/hr
Intercooler inlet low water temperature (max.)	108	°F
Intercooler outlet low water temperature (max.)	113	°F
Intercooler coolant flow low temperature circuit (min.)	8.8	gpm
Safety valve	44	psi

* Up to / from module interface

** Heating water supply temperature in partial load operation < 90°C

4. Exhaust system

Exhaust gas temperature after turbo charger	750	°F ⁽³⁾
Exhaust temperature after exhaust heat exchanger	356	°F
exhaust gas volume flow wet	241	SCFM ⁽⁶⁾
exhaust gas volume flow dry	211	SCFM ⁽⁶⁾
exhaust gas mass flow wet	1169	lbs/hr
exhaust gas mass flow dry	1072	lbs/hr
Exhaust back pressure downstream of turbine max.	0.73	psig
Pressure reserve approx. (with catalytic converter) *	0.57 (0.48)	psig
Exhaust outlet noise **	133	dB ⁽⁷⁾

5 Ventilation

Radiation heat of engine and generator (approx.)	76.344	MBTU/hr
Supply air volume flow min. (at $\Delta t = 15$ K)	2892	SCFM

6 Operating fluids

Lubricating oil approvals, see 'TA-003 Lubricating oil'		
Lubrication oil consumption (max.)	1.25	g/kWh
Filling capacity lubricant (max.)	8.98	gallons
Lubricating oil filling tank fill capacity (optional) ***	9.25	gallons
Lubricating oil volume extension tank (optional)	18.49	gallons
Coolant approvals, see 'TA-001 Coolant'		

7 Electronics and software

Generator Protection Relay	Deif GPC 3 optional redundant Relay SEL 700GT	
Touchscreen display	10	"
Protection class Control cabinet	Type 12	
Protection class Power switch cabinet	Type 1	
Switch cabinet environmental temperature	32 - 95	°F
Switch cabinet relative air humidity (max.)	65	%

* From module interface (exhaust heat exchanger / catalytic converter in standard version and new condition)

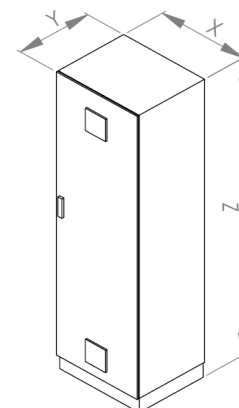
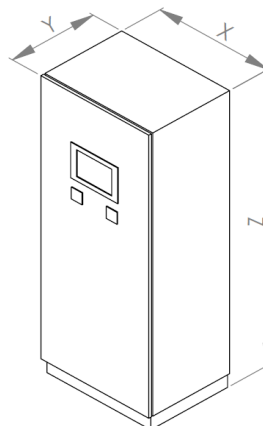
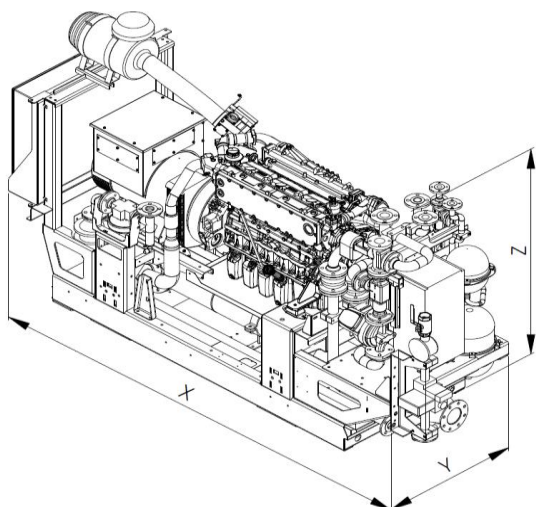
** Total sound power level at full engine load in accordance with DIN 45635-11 Annex A

*** Filling tank omitted with installation of a lubricating oil volume auxiliary tank

8 Interfaces

8.1 Dimensions and weights

(Figures may differ)



Length Module	X	119.69	in
Width Module	Y	38.58	in
Height Module	Z	66.85	in
Weight Module		5423	lbs
Weight Module with sound enclosure (not available)		-	lbs
Powder-coated CHP frame		RAL 6002	
Width Control cabinet	X	39.37	in
Depth Control cabinet	Y	23.62	in
Height Control cabinet	Z	82.68	in
Weight Control cabinet		441	lbs
Control cabinet powder coated		RAL 7035	
Width Power switch cabinet	X	23.62	in
Depth Power switch cabinet	Y	19.69	in
Height Power switch cabinet	Z	78.74	in
Weight Power switch cabinet		331	lbs
Power switch cabinet powder coated		RAL 7035	

8.2 Mechanical Connections

Interface Gas	40 / 10	DN / PN
Interface Exhaust	100 / 10	DN / PN
Interface Heating circuit	40 / 16	DN / PN
Interface Emergency cooling circuit	50 / 6, 16	DN / PN
Interface Mixture cooling circuit LT	25 / 16	DN / PN

8.3 Electrical connections / utility interface

Grid connection with pre-fuse (customer-provided)	480 V / 60 Hz	
Grid system	Y	
Short-circuit proof I _{cc} (max.)	50	kA

8.4 Data interfaces

Remote maintenance access (optional) *	DSL / UMTS (SIM)
Interfaces / Data interfaces (optional):	<ul style="list-style-type: none">- Profibus- Profinet- Modbus RTU- Modbus TCP- Ethernet IP- Hardware contacts

* Access for remote maintenance must be provided by the customer

9 Technical boundary conditions

Unless otherwise specified, all data is based on full engine load with the respective indicated media temperatures and subject to technical improvements. The generator output measured at the generator terminals serves as the basis for the delivered electrical power. All power and efficiency specifications are gross specifications. The fuel gas quality must conform to the specifications of 'TA-004 Gas'. The operating fluids and plant system layout must conform to the 'Technical instructions' of 2G.

- (1) Performance conditions in accordance with DIN ISO 3046. Tolerance for specific fuel use amounts to + 5% of nominal performance. Efficiency specifications are based on an engine in new condition. An abatement in efficiency over the service life is reduced with observance of the maintenance requirements.
- (2) The tolerance for usable heat output is +/- 8 % under normal load.
- (3) The tolerance for the exhaust temperature is +/- 8 %.
- (4) Corresponding to a residual oxygen concentration in the exhaust of 15 %.
- (5) Electrical generator terminal power at $\cos \varphi = 1.0$
- (6) Volume specifications for normal status:

Pressure	14.69 psig
Temperature	32 °F
- (7) Standard deviation of reproducibility 4 dB in accordance with DIN EN ISO 3746
- (8) Assumed gas composition (VOC calculated as NMHC):
CH₄=60 %, CO₂=40 %

Power specifications in this document relate to standard reference conditions.

Standard reference conditions in accordance with DIN ISO 3046-1:

Air pressure	14.50 psig
Air temperature	77 °F
Relative air humidity	30 %

Power reduction

Power reduction due to installation at altitude > 958ft a.s.l. and/or air suction temperature > 77°F shall be determined specifically for each project according "TI-049 Load reduction".

Technical specification

filius 204 BG



Design:

64 kW el.

480 V / 60 Hz

biogas (60% CH₄, 40% CO₂)

Calorific Value = 578 BTU/ft³

NO_x < 1.0 g/BHP-h

Exhaust cooling to 356 °F

1. Genset	3
1.1 Engine	3
1.2 Generator (utility planning data)	4
2 Mixture composition	4
2.1 Combustion air	4
2.2 Fuel	5
3 Integrated heat extraction	5
3.1 Customer Heat Recovery Circuit	5
3.2 Engine circuit	5
3.3 Mixture cooling water circuit - low temperature (LT)	5
4. Exhaust system	6
5 Ventilation	6
6 Operating fluids	6
7 Electronics and software	6
8 Interfaces	7
8.1 Dimensions and weights	7
8.2 Mechanical Connections	8
8.3 Electrical connections / utility interface	8
8.4 Data interfaces	8
9 Technical boundary conditions	9

Subject to technical changes!

Note: Figure on cover page may differ

1. Genset

	50 %	75 %	100 %	Load
Electrical power	32	48	64	kW ⁽⁵⁾
Useful thermal power	191.855	241.593	305.525	MBTU/hr ⁽²⁾
Fuel consumption	376.925	496.084	625.636	MBTU/hr ⁽¹⁾
Efficiency Electrical	29.0	33.0	34.9	% ⁽¹⁾
Efficiency Thermal	50.9	48.7	48.8	% ^{(1), (2)}
Efficiency Combined (el. + th.)	79.9	81.7	83.7	% ^{(1), (2)}

	NOx *	CO	VOC ⁽⁸⁾	
Exh. emissions without catalytic converter	< 1.0	< 2.4	< 0.7	g/BHP-h
	< 91	< 300		ppm ^{(4),(6)}
Exh. emissions with catalytic converter	< 1.0	< 0.7	< 0.7	g/BHP-h
	< 91	< 90		ppm ^{(4),(6)}

Engine surface noise **			100	dB(A) ⁽⁷⁾
Engine surface noise with sound enclosure (not available) ***			-	dB(A) ⁽⁷⁾

1.1 Engine

Engine manufacturer	MAN		
Engine type	E 0834 LE 302		
Type	row		
No. of cylinders	4		
Operating method	4-stroke		
Engine displacement	4580	ccm	
Bore	4.25	in	
Stroke	4.92	in	
RPM	1800	1/min	
ISO standard power (mech.)	91	bhp	
compression ratio	11,0 : 1		
average effective pressure	144.0	psi	
average piston speed	24.6	ft/s	
body of balance wheel	SAE 2		
Direction of rotation (based on balance wheel)	left		
tooth rim with number of teeth	143		
Engine dead weight	1091	lbs	
Mixture cooling to	122	°F	

* Referred to MAN data sheet

** Total sound power level at full engine load in accordance with DIN EN ISO 3746

*** Average sound pressure level under open area conditions at distance of 1 m in accordance with DIN 45635
An increased noise load must be taken into account with fresh air intake from the installation room.

1.2 Generator (utility planning data)

Manufacturer	Leroy Somer	
Type	LSA 44.3 S3/4P	
Generator type	Synchronous, directly coupled	
Voltage regulator (AVR)	D510C	
Rated speed	1800	1/min
Frequency	60	Hz
Effective electrical power	64	kW
Apparent electrical power (cos ϕ 0.8)	80	kVA
Apparent electrical power (cos ϕ 1.0)	64	kVA
Rated generator current (cos ϕ 0.8)	96	A
Rated generator current (cos ϕ 1.0)	77	A
Rated generator voltage ($\pm 10\%$)	480	V
Subtransient reactance X"d	9.9	%
Short-circuit current I _k "3	1.63	kA
Power factor cos ϕ (lagging / leading)	0.8 / 0.95	
Generator circuit breaker	160	A
Additional section switch (VDE-AR-N 4105)	160	A
Efficiency (full load) at Cos ϕ = 1	93.8	%
Mass moment of inertia	19.64	lb · ft ²
Ambient air temperature	104	°F
Stator circuit	star	
Protection class	IP 23	
Generator weight	664	lbs
Compensation	not available	
Engine startup	not available	

2 Mixture composition

2.1 Combustion air

Combustion air mass flow	727	lbs/hr
Combustion air volume flow (25 °C, 1013 mbar)	164	SCFM

2.2 Fuel

Fuel requirements in accordance with 'TA-004 Gas'

Reference methane number - minimum methane number	140 / 80	
Combustible mass flow	82.5	lbs/hr ⁽¹⁾
Combustible volume flow	18.0	SCFM ^{(6),(1)}
Gas pressure at rated load min. *	0.435	psig
Gas flow pressure at rated load max. *	1.015	psig
Gas regulation line safety pressure	7.252	psig

* At the inlet to the gas regulation line

3 Integrated heat extraction

3.1 Customer Heat Recovery Circuit

Heating water requirements in accordance with 'TA-002 Heating circuit'

Heating water volume flow (at $\Delta t = 15 \text{ K}$)	22.6	gpm
Internal pressure loss in heating circuit (approx.) *	4.35	psig
Total Head ca. *	-	ft
Heating water return temperature (max)	158	°F
Heating water flow temperature (max) **	194	°F
Safety valve	87.02	psi

3.2 Engine circuit

Coolant requirements in accordance with 'TA-001 Coolant'

Jacket Water Heat	188.037	MBTU/hr
Exhaust Gas Heat up to 356°F	106.897	MBTU/hr
Engine inlet temperature (min.)	176	°F
Engine outlet temperature (max.)	190	°F
Differential inlet / outlet (max.)	10.8	°F
Jacket water flow (min.)	40.4	gpm
Jacket water flow (max.)	45.0	gpm
Operating pressure (max.)	29.0	psi
Safety valve	43.5	psi
Safety temperature limiter	230	°F
Intercooler heat high temperature circuit	10.592	MBTU/hr
Intercooler inlet high water temperature (max.)	180	°F
Intercooler coolant flow high temperature circuit (min.)	4.6	gpm

3.3 Mixture cooling water circuit - low temperature (LT)

Coolant requirements in accordance with 'TA-001 Coolant'

Intercooler heat low temperature circuit	6.882	MBTU/hr
Intercooler inlet low water temperature (max.)	108	°F
Intercooler outlet low water temperature (max.)	113	°F
Intercooler coolant flow low temperature circuit (min.)	3.0	gpm
Safety valve	44	psi

* Up to / from module interface

** Heating water supply temperature in partial load operation < 90°C

4. Exhaust system

Exhaust gas temperature after turbo charger	842	°F ⁽³⁾
Exhaust temperature after exhaust heat exchanger	356	°F
exhaust gas volume flow wet	167	SCFM ⁽⁶⁾
exhaust gas volume flow dry	146	SCFM ⁽⁶⁾
exhaust gas mass flow wet	810	lbs/hr
exhaust gas mass flow dry	744	lbs/hr
Exhaust back pressure downstream of turbine max.	0.73	psig
Pressure reserve approx. (with catalytic converter) *	0.52 (0.45)	psig
Exhaust outlet noise **	132	dB ⁽⁷⁾

5 Ventilation

Radiation heat of engine and generator (approx.)	83.375	MBTU/hr
Supply air volume flow min. (at $\Delta t = 15$ K)	3065	SCFM

6 Operating fluids

Lubricating oil approvals, see 'TA-003 Lubricating oil'		
Lubrication oil consumption (max.)	1.56	g/kWh
Filling capacity lubricant (max.)	3.43	gallons
Lubricating oil filling tank fill capacity (optional) ***	9.25	gallons
Lubricating oil volume extension tank (optional)	18.49	gallons
Coolant approvals, see 'TA-001 Coolant'		

7 Electronics and software

Generator Protection Relay	Deif GPC 3 optional redundant Relay SEL 700GT	
Touchscreen display	10	"
Protection class Control cabinet	Type 12	
Protection class Power switch cabinet	Type 1	
Switch cabinet environmental temperature	32 - 95	°F
Switch cabinet relative air humidity (max.)	65	%

* From module interface (exhaust heat exchanger / catalytic converter in standard version and new condition)

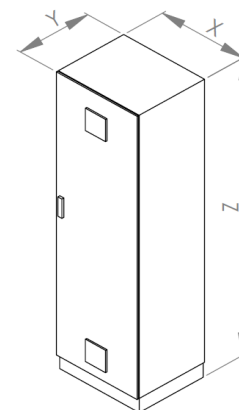
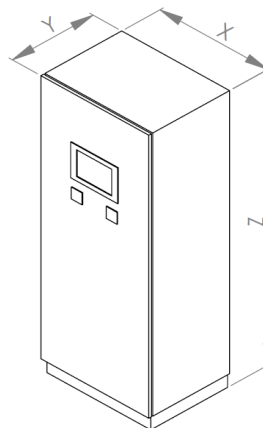
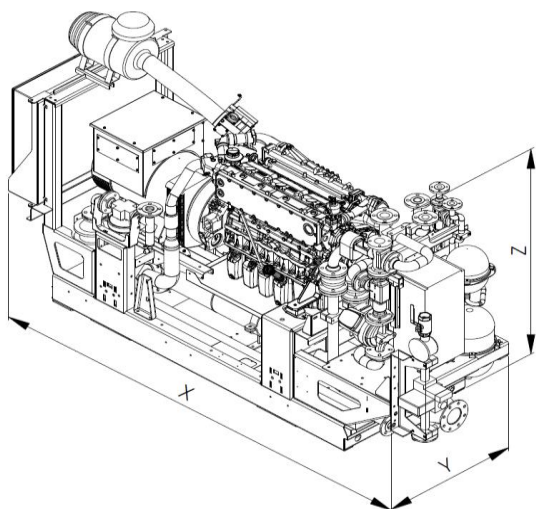
** Total sound power level at full engine load in accordance with DIN 45635-11 Annex A

*** Filling tank omitted with installation of a lubricating oil volume auxiliary tank

8 Interfaces

8.1 Dimensions and weights

(Figures may differ)



Length Module	X	112.60	in
Width Module	Y	38.58	in
Height Module	Z	61.26	in
Weight Module		4916	lbs
Weight Module with sound enclosure (not available)		-	lbs
Powder-coated CHP frame		RAL 6002	
Width Control cabinet	X	39.37	in
Depth Control cabinet	Y	23.62	in
Height Control cabinet	Z	82.68	in
Weight Control cabinet		441	lbs
Control cabinet powder coated		RAL 7035	
Width Power switch cabinet	X	23.62	in
Depth Power switch cabinet	Y	19.69	in
Height Power switch cabinet	Z	78.74	in
Weight Power switch cabinet		331	lbs
Power switch cabinet powder coated		RAL 7035	

8.2 Mechanical Connections

Interface Gas	25 / 10	DN / PN
Interface Exhaust	100 / 10	DN / PN
Interface Heating circuit	40 / 16	DN / PN
Interface Emergency cooling circuit	40 / 6, 16	DN / PN
Interface Mixture cooling circuit LT	25 / 16	DN / PN

8.3 Electrical connections / utility interface

Grid connection with pre-fuse (customer-provided)	480 V / 60 Hz	
Grid system	Y	
Short-circuit proof I _{cc} (max.)	50	kA

8.4 Data interfaces

Remote maintenance access (optional) *	DSL / UMTS (SIM)
Interfaces / Data interfaces (optional):	<ul style="list-style-type: none">- Profibus- Profinet- Modbus RTU- Modbus TCP- Ethernet IP- Hardware contacts

* Access for remote maintenance must be provided by the customer

9 Technical boundary conditions

Unless otherwise specified, all data is based on full engine load with the respective indicated media temperatures and subject to technical improvements. The generator output measured at the generator terminals serves as the basis for the delivered electrical power. All power and efficiency specifications are gross specifications. The fuel gas quality must conform to the specifications of 'TA-004 Gas'. The operating fluids and plant system layout must conform to the 'Technical instructions' of 2G.

- (1) Performance conditions in accordance with DIN ISO 3046. Tolerance for specific fuel use amounts to + 5% of nominal performance. Efficiency specifications are based on an engine in new condition. An abatement in efficiency over the service life is reduced with observance of the maintenance requirements.
- (2) The tolerance for usable heat output is +/- 8 % under normal load.
- (3) The tolerance for the exhaust temperature is +/- 8 %.
- (4) Corresponding to a residual oxygen concentration in the exhaust of 15 %.
- (5) Electrical generator terminal power at $\cos \varphi = 1.0$
- (6) Volume specifications for normal status:

Pressure	14.69 psig
Temperature	32 °F
- (7) Standard deviation of reproducibility 4 dB in accordance with DIN EN ISO 3746
- (8) Assumed gas composition (VOC calculated as NMHC):
CH₄=60 %, CO₂=40 %

Power specifications in this document relate to standard reference conditions.

Standard reference conditions in accordance with DIN ISO 3046-1:

Air pressure	14.50 psig
Air temperature	77 °F
Relative air humidity	30 %

Power reduction

Power reduction due to installation at altitude > 958ft a.s.l. and/or air suction temperature > 77°F shall be determined specifically for each project according "TI-049 Load reduction".

Technical specification

filius 206 BG



Design:

150 kW el.

480 V / 60 Hz

biogas (60% CH₄, 40% CO₂)

Calorific Value = 578 BTU/ft³

NO_x < 1.0 g/BHP-h

Exhaust cooling to 356 °F

1. Genset	3
1.1 Engine	3
1.2 Generator (utility planning data)	4
2 Mixture composition	4
2.1 Combustion air	4
2.2 Fuel	5
3 Integrated heat extraction	5
3.1 Customer Heat Recovery Circuit	5
3.2 Engine circuit	5
3.3 Mixture cooling water circuit - low temperature (LT)	5
4. Exhaust system	6
5 Ventilation	6
6 Operating fluids	6
7 Electronics and software	6
8 Interfaces	7
8.1 Dimensions and weights	7
8.2 Mechanical Connections	8
8.3 Electrical connections / utility interface	8
8.4 Data interfaces	8
9 Technical boundary conditions	9

Subject to technical changes!

Note: Figure on cover page may differ

1. Genset

	75 %	100 %	Load
Electrical power	113	150	kW ⁽⁵⁾
Useful thermal power	528.284	655.107	MBTU/hr ⁽²⁾
Fuel consumption	1131.229	1425.513	MBTU/hr ⁽¹⁾
Efficiency Electrical	33.9	35.9	% ⁽¹⁾
Efficiency Thermal	46.7	46.0	% ^{(1), (2)}
Efficiency Combined (el. + th.)	80.6	81.9	% ^{(1), (2)}

	NOx *	CO	VOC ⁽⁸⁾	
Exh. emissions without catalytic converter	< 1.0	< 2.4	< 0.7	g/BHP-h
	< 91	< 300		ppm ^{(4),(6)}
Exh. emissions with catalytic converter	< 1.0	< 0.7	< 0.7	g/BHP-h
	< 91	< 90		ppm ^{(4),(6)}

Engine surface noise **		107	dB(A) ⁽⁷⁾
Engine surface noise with sound enclosure (not available) ***		-	dB(A) ⁽⁷⁾

1.1 Engine

Engine manufacturer	MAN		
Engine type	E 2876 LE 302		
Type	row		
No. of cylinders	6		
Operating method	4-stroke		
Engine displacement	12820	ccm	
Bore	5.04	in	
Stroke	6.54	in	
RPM	1800	1/min	
ISO standard power (mech.)	212	bhp	
compression ratio	11,0 : 1		
average effective pressure	119.1	psi	
average piston speed	32.7	ft/s	
body of balance wheel	SAE 1		
Direction of rotation (based on balance wheel)	left		
tooth rim with number of teeth	160		
Engine dead weight	2161	lbs	
Mixture cooling to	122	°F	

* Referred to MAN data sheet

** Total sound power level at full engine load in accordance with DIN EN ISO 3746

*** Average sound pressure level under open area conditions at distance of 1 m in accordance with DIN 45635
An increased noise load must be taken into account with fresh air intake from the installation room.

1.2 Generator (utility planning data)

Manufacturer	Leroy Somer	
Type	LSA 46.3 S3/4P	
Generator type	Synchronous, directly coupled	
Voltage regulator (AVR)	D510C	
Rated speed	1800	1/min
Frequency	60	Hz
Effective electrical power	150	kW
Apparent electrical power (cos ϕ 0.8)	188	kVA
Apparent electrical power (cos ϕ 1.0)	150	kVA
Rated generator current (cos ϕ 0.8)	226	A
Rated generator current (cos ϕ 1.0)	180	A
Rated generator voltage (± 10 %)	480	V
Subtransient reactance X"d	11.3	%
Short-circuit current I _k "3	2.51	kA
Power factor cos ϕ (lagging / leading)	0.8 / 0.95	
Generator circuit breaker	400	A
Additional section switch (VDE-AR-N 4105)	400	A
Efficiency (full load) at Cos ϕ = 1	94.8	%
Mass moment of inertia	50.05	lb · ft ²
Ambient air temperature	104	°F
Stator circuit	star	
Protection class	IP 23	
Generator weight	1554	lbs
Compensation	not available	
Engine startup	not available	

2 Mixture composition

2.1 Combustion air

Combustion air mass flow	1599	lbs/hr
Combustion air volume flow (25 °C, 1013 mbar)	361	SCFM

2.2 Fuel

Fuel requirements in accordance with 'TA-004 Gas'

Reference methane number - minimum methane number	140 / 80	
Combustible mass flow	188.1	lbs/hr ⁽¹⁾
Combustible volume flow	41.1	SCFM ^{(6),(1)}
Gas pressure at rated load min. *	0.435	psig
Gas flow pressure at rated load max. *	1.015	psig
Gas regulation line safety pressure	7.252	psig

* At the inlet to the gas regulation line

3 Integrated heat extraction

3.1 Customer Heat Recovery Circuit

Heating water requirements in accordance with 'TA-002 Heating circuit'

Heating water volume flow (at $\Delta t = 15 \text{ K}$)	48.4	gpm
Internal pressure loss in heating circuit (approx.) *	4.35	psig
Total Head ca. *	-	ft
Heating water return temperature (max)	158	°F
Heating water flow temperature (max) **	194	°F
Safety valve	87.02	psi

3.2 Engine circuit

Coolant requirements in accordance with 'TA-001 Coolant'

Jacket Water Heat	319.035	MBTU/hr
Exhaust Gas Heat up to 356°F	299.808	MBTU/hr
Engine inlet temperature (min.)	176	°F
Engine outlet temperature (max.)	190	°F
Differential inlet / outlet (max.)	10.8	°F
Jacket water flow (min.)	68.6	gpm
Jacket water flow (max.)	84.2	gpm
Operating pressure (max.)	29.0	psi
Safety valve	43.5	psi
Safety temperature limiter	230	°F
Intercooler heat high temperature circuit	36.264	MBTU/hr
Intercooler inlet high water temperature (max.)	180	°F
Intercooler coolant flow high temperature circuit (min.)	15.6	gpm

3.3 Mixture cooling water circuit - low temperature (LT)

Coolant requirements in accordance with 'TA-001 Coolant'

Intercooler heat low temperature circuit	37.295	MBTU/hr
Intercooler inlet low water temperature (max.)	108	°F
Intercooler outlet low water temperature (max.)	113	°F
Intercooler coolant flow low temperature circuit (min.)	16.0	gpm
Safety valve	44	psi

* Up to / from module interface

** Heating water supply temperature in partial load operation < 90°C

4. Exhaust system

Exhaust gas temperature after turbo charger	967	°F ⁽³⁾
Exhaust temperature after exhaust heat exchanger	356	°F
exhaust gas volume flow wet	368	SCFM ⁽⁶⁾
exhaust gas volume flow dry	322	SCFM ⁽⁶⁾
exhaust gas mass flow wet	1787	lbs/hr
exhaust gas mass flow dry	1639	lbs/hr
Exhaust back pressure downstream of turbine max.	0.73	psig
Pressure reserve approx. (with catalytic converter) *	0.57 (0.48)	psig
Exhaust outlet noise **	140	dB ⁽⁷⁾

5 Ventilation

Radiation heat of engine and generator (approx.)	107.108	MBTU/hr
Supply air volume flow min. (at $\Delta t = 15$ K)	4087	SCFM

6 Operating fluids

Lubricating oil approvals, see 'TA-003 Lubricating oil'		
Lubrication oil consumption (max.)	1.00	g/kWh
Filling capacity lubricant (max.)	18.49	gallons
Lubricating oil filling tank fill capacity (optional) ***	9.25	gallons
Lubricating oil volume extension tank (optional)	26.42	gallons
Coolant approvals, see 'TA-001 Coolant'		

7 Electronics and software

Generator Protection Relay	Deif GPC 3 optional redundant Relay SEL 700GT	
Touchscreen display	10	"
Protection class Control cabinet	Type 12	
Protection class Power switch cabinet	Type 1	
Switch cabinet environmental temperature	32 - 95	°F
Switch cabinet relative air humidity (max.)	65	%

* From module interface (exhaust heat exchanger / catalytic converter in standard version and new condition)

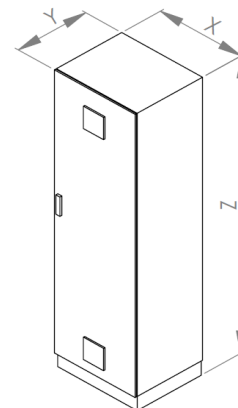
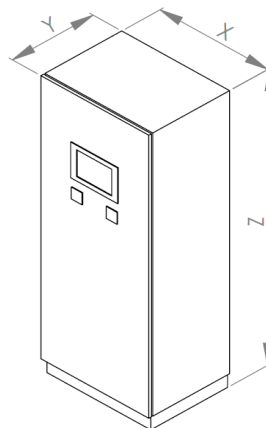
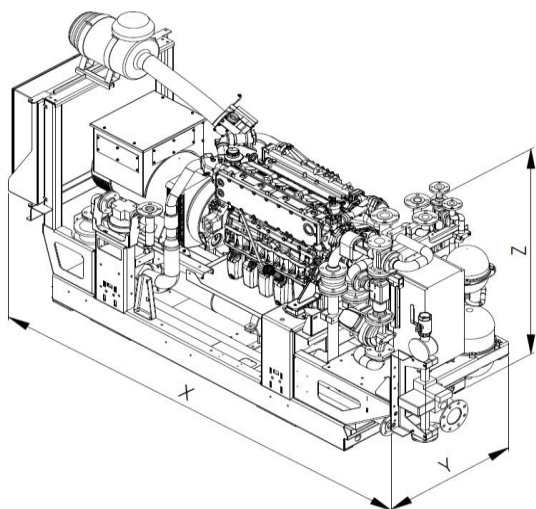
** Total sound power level at full engine load in accordance with DIN 45635-11 Annex A

*** Filling tank omitted with installation of a lubricating oil volume auxiliary tank

8 Interfaces

8.1 Dimensions and weights

(Figures may differ)



Length Module	X	149.53	in
Width Module	Y	43.70	in
Height Module	Z	76.73	in
Weight Module		7650	lbs
Weight Module with sound enclosure (not available)		-	lbs
Powder-coated CHP frame		RAL 6002	
Width Control cabinet	X	39.37	in
Depth Control cabinet	Y	23.62	in
Height Control cabinet	Z	82.68	in
Weight Control cabinet		441	lbs
Control cabinet powder coated		RAL 7035	
Width Power switch cabinet	X	23.62	in
Depth Power switch cabinet	Y	19.69	in
Height Power switch cabinet	Z	78.74	in
Weight Power switch cabinet		331	lbs
Power switch cabinet powder coated		RAL 7035	

8.2 Mechanical Connections

Interface Gas	50 / 10	DN / PN
Interface Exhaust	150 / 10	DN / PN
Interface Heating circuit	50 / 16	DN / PN
Interface Emergency cooling circuit	65 / 6, 16	DN / PN
Interface Mixture cooling circuit LT	40 / 16	DN / PN

8.3 Electrical connections / utility interface

Grid connection with pre-fuse (customer-provided)	480 V / 60 Hz
Grid system	Y
Short-circuit proof I _{cc} (max.)	50 kA

8.4 Data interfaces

Remote maintenance access (optional) *	DSL / UMTS (SIM)
Interfaces / Data interfaces (optional):	<ul style="list-style-type: none">- Profibus- Profinet- Modbus RTU- Modbus TCP- Ethernet IP- Hardware contacts

* Access for remote maintenance must be provided by the customer

9 Technical boundary conditions

Unless otherwise specified, all data is based on full engine load with the respective indicated media temperatures and subject to technical improvements. The generator output measured at the generator terminals serves as the basis for the delivered electrical power. All power and efficiency specifications are gross specifications. The fuel gas quality must conform to the specifications of 'TA-004 Gas'. The operating fluids and plant system layout must conform to the 'Technical instructions' of 2G.

- (1) Performance conditions in accordance with DIN ISO 3046. Tolerance for specific fuel use amounts to + 5% of nominal performance. Efficiency specifications are based on an engine in new condition. An abatement in efficiency over the service life is reduced with observance of the maintenance requirements.
- (2) The tolerance for usable heat output is +/- 8 % under normal load.
- (3) The tolerance for the exhaust temperature is +/- 8 %.
- (4) Corresponding to a residual oxygen concentration in the exhaust of 15 %.
- (5) Electrical generator terminal power at $\cos \varphi = 1.0$
- (6) Volume specifications for normal status:

Pressure	14.69 psig
Temperature	32 °F
- (7) Standard deviation of reproducibility 4 dB in accordance with DIN EN ISO 3746
- (8) Assumed gas composition (VOC calculated as NMHC):
CH₄=60 %, CO₂=40 %

Power specifications in this document relate to standard reference conditions.

Standard reference conditions in accordance with DIN ISO 3046-1:

Air pressure	14.50 psig
Air temperature	77 °F
Relative air humidity	30 %

Power reduction

Power reduction due to installation at altitude > 958ft a.s.l. and/or air suction temperature > 77°F shall be determined specifically for each project according "TI-049 Load reduction".