UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Zachodniopomorski Uniwersytet Technologiczny w Szczecinie

APPENDIX

PROJECT OF ELECTRIC YACHT PROPULSION WITH HYBRID POWER SYSTEM

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Degree:
Naval Systems and Technology Engineering

Erasmus+ Program
Szczecin 2018

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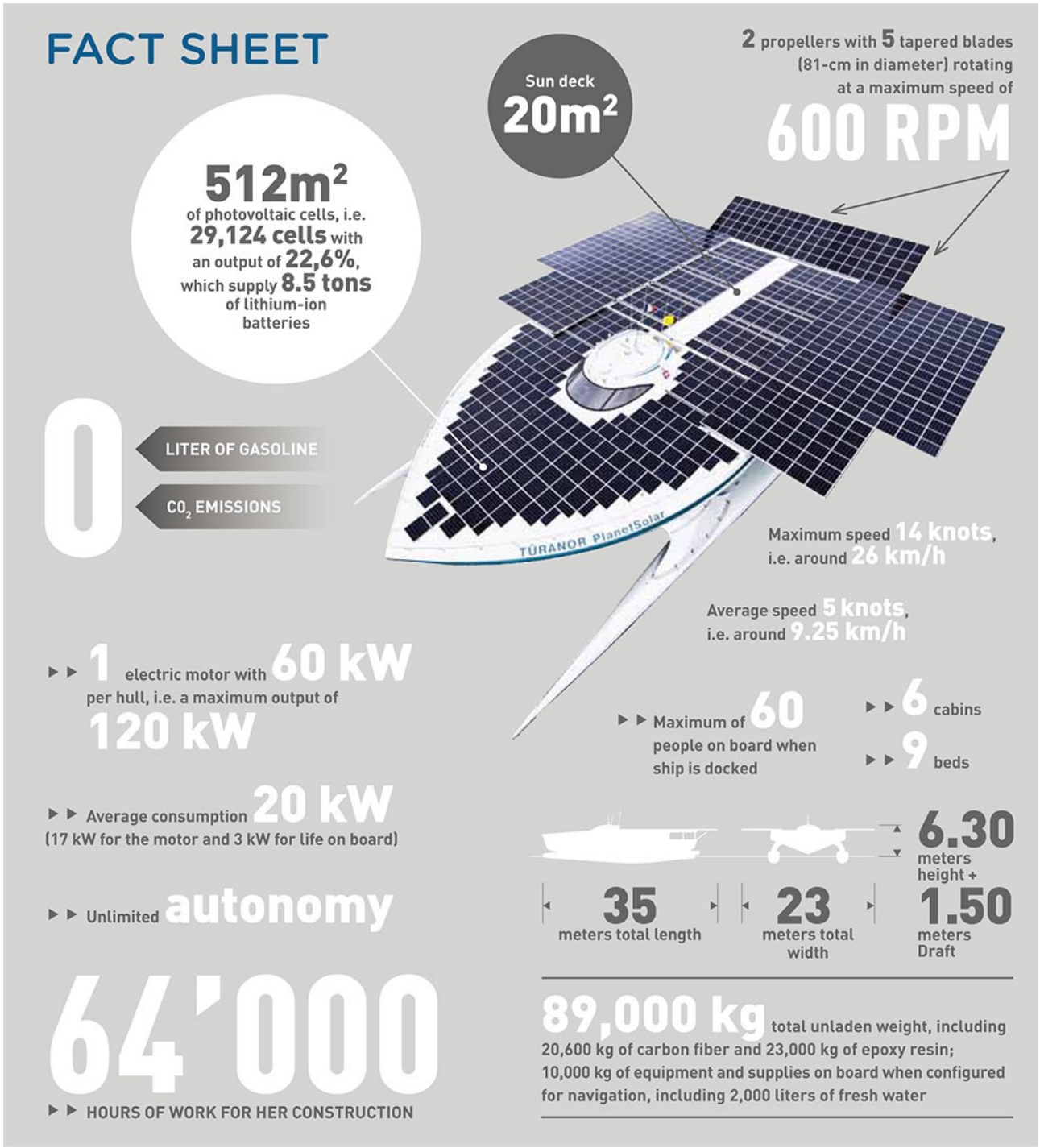
ANNEX A: Applicable Ship Types and Reduction Factors (in %), EEDI.

Source: INDIAN REGISTER OF SHIPPING, Implementing Energy Efficiency Design Index (EEDI) <www.irclass.org> Oficial web site (consultation: 26th March 2018).

Ship Type	Size	Phase 0 1 Jan 2013 – 31 Dec 2014	Phase 1 1 Jan 2015 - 31 Dec 2019	Phase 2 1 Jan 2020 – 31 Dec 2024	Phase 3 1 Jan 2025 and onwards
Bulk Carrier	20,000 DWT and above	0	10	20	30
	10,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
Gas Carrier	10,000 DWT and above	0	10	20	30
	2,000 – 10,000 DWT	n/a	0-10*	0-20*	0-30*
Tanker	20,000 DWT and above	0	10	20	30
	4,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
Container Ship	15,000 DWT and above	0	10	20	30
	10,000 – 15,000 DWT	n/a	0-10*	0-20*	0-30*
General Cargo Ship	15,000 DWT and above	0	10	15	30
	3,000 – 15,000 DWT	n/a	0-10*	0-15*	0-30*
Refrigerated Cargo Carrier	5,000 DWT and above	0	10	15	30
	3,000 – 5,000 DWT	n/a	0-10*	0-15*	0-30*
Combination Carrier	20,000 DWT and above	0	10	20	30
	4,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
LNG Carrier ***	10,000 DWT and above	n/a	10**	20	30
Ro-ro cargo ship (vehicle carrier)***	10,000 DWT and above	n/a	5**	15	30
Ro-ro cargo ship***	2,000 DWT and above	n/a	5**	20	30
	1,000 – 2,000 DWT	n/a	0-5* **	0-20*	0-30*
Ro-ro passenger ship***	4,000 GT and above	n/a	5**	20	30
	1,000 - 4,000 GT	n/a	0-5* **	0-20*	0-30*
Cruise passenger ship*** having non-conventional propulsion	85,000 GT and above	n/a	5 **	20	30
	25,000 – 85,000 GT	n/a	0-5* **	0-20*	0-30*

ANNEX B: Fact sheet of the catamaran PLANETSOLAR.

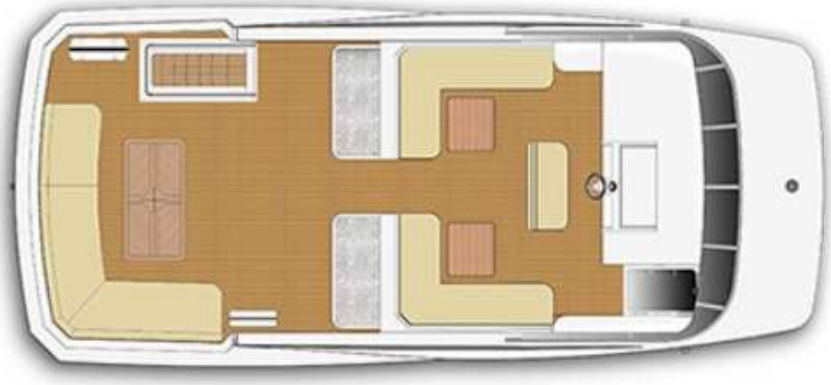
Source: Official web site of the project PlanetSolar. <https://www.planetsolar.ch> (consultation: 3 April 2018).



ANNEX C: Deck plans of the Nomad 65 by Gulft Craft.

Source: Official web site of Gulft Craft. <https://www.gulfcraftinc.com/nomad-65> (consultation: 11 April 2018).

FLY BRIDGE



MAIN DECK

LOWER DECK

ANNEX D: Electric power demand. Total consumption of power on the yacht distributed by zones and divided into different operations times [W].

ANNEX D: Electric power demand

										Navigation		MANEUVER		MOORED	
	SERVICE	ROOM	EQUIPMENT		Units	Units in use	Unit Power [W]	Installed Power [W]	Kn	Ksr	W	Ksr	W	Ksr	W
PROPULSION	**ELECTIC MOTOR**	Engine Room	Electric motor	3300 V	1	1	1000000	1000000	1	1	1000000	0,5	500000	0	0
HABITATION	**LIGHT**	Flybridge	LED lights	24 V dc	10	10	2	20	1	0,5	10	0,5	10	0,5	10
			Emergency LED lights	24 V dc	6	6	1	6	1	0	0	0	0	0	0
		Main Helm	LED lights	24 V dc	5	5	2	10	1	0,5	5	0,5	5	0,5	5
			Emergency LED lights	24 V dc	3	3	1	3	1	0	0	0	0	0	0
		Kitchen	LED lights	24 V dc	3	3	2	6	1	0,5	3	0,5	3	0,5	3
			Emergency LED lights	24 V dc	1	1	1	1	1	0	0	0	0	0	0
		Main Bathroom	LED lights	24 V dc	2	2	2	4	1	0,5	2	0,5	2	0,5	2
			Emergency LED lights	24 V dc	1	1	1	1	1	0	0	0	0	0	0
		Corridor Main Deck	LED lights	24 V dc	2	2	2	4	1	0,5	2	0,5	2	0,5	2
			Emergency LED lights	24 V dc	1	1	1	1	1	0	0	0	0	0	0
		Saloon	LED lights	24 V dc	16	16	2	32	1	0,5	16	0,5	16	0,5	16
			Emergency LED lights	24 V dc	6	6	1	6	1	0	0	0	0	0	0
		Cockpit	LED lights	24 V dc	8	8	2	16	1	0,5	8	0,5	8	0,5	8
			Emergency LED lights	24 V dc	4	4	1	4	1	0	0	0	0	0	0
		Stern	LED lights	24 V dc	8	8	2	16	1	0,5	8	0,5	8	0,5	8
			Emergency LED lights	24 V dc	4	4	1	4	1	0	0	0	0	0	0
		Bow	LED lights	24 V dc	6	6	2	12	1	0,5	6	0,5	6	0,5	6
			Emergency LED lights	24 V dc	3	3	1	3	1	0	0	0	0	0	0
		Engine Room	LED lights	24 V dc	12	12	4	48	1	0,5	24	0,5	24	0,5	24
			Emergency LED lights	24 V dc	8	8	1	8	1	0	0	0	0	0	0
		Crew Area	LED lights	24 V dc	4	4	2	8	1	0,5	4	0,5	4	0,5	4
			Emergency LED lights	24 V dc	2	2	1	2	1	0	0	0	0	0	0
		Crew Cabin	LED lights	24 V dc	3	3	2	6	1	0,5	3	0,5	3	0,5	3
			Emergency LED lights	24 V dc	1	1	1	1	1	0	0	0	0	0	0
			Lecture LED lights	24 V dc	2	2	1	2	1	0,2	0,4	0,2	0,4	0,2	0,4
		Crew Head	LED lights	24 V dc	1	1	2	2	1	0,5	1	0,5	1	0,5	1
			Emergency LED lights	24 V dc	1	1	1	1	1	0	0	0	0	0	0
		Owner’s Cabin	LED lights	24 V dc	12	12	2	24	1	0,5	12	0,5	12	0,5	12
			Emergency LED lights	24 V dc	6	6	1	6	1	0	0	0	0	0	0
			Lecture LED lights	24 V dc	2	2	1	2	1	0,2	0,4	0,2	0,4	0,2	0,4
		Owner's Head	LED lights	24 V dc	5	5	2	10	1	0,5	5	0,5	5	0,5	5
			Emergency LED lights	24 V dc	3	3	1	3	1	0	0	0	0	0	0
		Corridor Lower Deck	LED lights	24 V dc	3	3	2	6	1	0,5	3	0,5	3	0,5	3
			Emergency LED lights	24 V dc	2	2	1	2	1	0	0	0	0	0	0
		Port Guest Cabin	LED lights	24 V dc	6	6	2	12	1	0,5	6	0,5	6	0,5	6
			Emergency LED lights	24 V dc	3	3	1	3	1	0	0	0	0	0	0
			Lecture LED lights	24 V dc	2	2	1	2	1	0,2	0,4	0,2	0,4	0,2	0,4
		Guest Head	LED lights	24 V dc	3	3	2	6	1	0,5	3	0,5	3	0,5	3
			Emergency LED lights	24 V dc	2	2	1	2	1	0	0	0	0	0	0
		VIP Cabin	LED lights	24 V dc	9	9	2	18	1	0,5	9	0,5	9	0,5	9
			Emergency LED lights	24 V dc	3	3	1	3	1	0	0	0	0	0	0
			Lecture LED lights	24 V dc	2	2	1	2	1	0,2	0,4	0,2	0,4	0,2	0,4
		Stairs (Lower / Main Deck)	LED Lights	24 V dc	15	15	2	30	1	0,5	15	0,5	15	0,5	15
			Emergency LED lights	24 V dc	3	3	1	3	1	0	0	0	0	0	0
	AIR CONDITIONING	Cold	Chiller	230 V ac	1	1	3500	3500	1	1	3500	1	3500	1	3500
		Saloon	Fan coil	230 V ac	1	1	240	240	1	0,5	120	0,5	120	0,5	120
		Main Helm	Fan coil	230 V ac	1	1	240	240	1	0,5	120	0,5	120	0,5	120
		Crew Cabin	Fan coil	230 V ac	1	1	240	240	1	0,5	120	0,5	120	0,5	120
		Owner’s Cabin	Fan coil	230 V ac	1	1	240	240	1	0,5	120	0,5	120	0,5	120
		Port Guest Cabin	Fan coil	230 V ac	1	1	240	240	1	0,5	120	0,5	120	0,5	120
		VIP Cabin	Fan coil	230 V ac	1	1	240	240	1	0,5	120	0,5	120	0,5	120
	APPLIANCE	Flybridge	Fridge	230 V ac	1	1	65	65	1	0,8	52	0,8	52	0,8	52
			Freezer	230 V ac	2	2	70	140	1	0,8	112	0,8	112	0,8	112
			Speakers	230 V ac	1	1	15	15	1	0,2	3	0,2	3	0,2	3
		Kitchen	Fridge	230 V ac	1	1	65	65	1	0,8	52	0,8	52	0,8	52
			Microway / owen	230 V ac	1	1	2200	2200	1	0,2	440	0,2	440	0,2	440
			Dishwasher	230 V ac	1	1	300	300	1	0,2	60	0,2	60	0,2	60
			Washing machine	230 V ac	1	1	2200	2200	1	0,2	440	0,2	440	0,2	440
			Ceramic hob x2	230 V ac	1	1	2400	2400	0,8	0,2	384	0,2	384	0,2	384
			Flue pipe	230 V ac	1	1	300	300	1	0,2	60	0,2	60	0,2	60
		Saloon	T.V. 40”	230 V ac	1	1	100	100	1	0,2	20	0,2	20	0,2	20
			Digital Player CD/DVD	230 V ac	1	1	25	25	1	0,2	5	0,2	5	0,2	5
			Satellite TV antenna	230 V ac	1	1	30	30	1	0,5	15	0,5	15	0,5	15
			Speakers	230 V ac	2	2	15	30	1	0,2	6	0,2	6	0,2	6
		Cockpit	Fridge	230 V ac	1	1	65	65	1	0,8	52	0,8	52	0,8	52
			Speakers	230 V ac	1	1	15	15	1	0,2	3	0,2	3	0,2	3
		Crew Area	Fridge	230 V ac	1	1	65	65	1	0,8	52	0,8	52	0,8	52
			Microway / owen	230 V ac	1	1	2200	2200	1	0,2	440	0,2	440	0,2	440
			Ceramic hob x4	230 V ac	1	1	3500	3500	0,8	0,2	560	0,2	560	0,2	560
			Flue pipe	230 V ac	1	1	300	300	1	0,2	60	0,2	60	0,2	60
		Owner’s Cabin	T.V. 26”	230 V ac	1	1	60	60	1	0,2	12	0,2	12	0,2	12
			Digital Player CD/DVD	230 V ac	1	1	25	25	1	0,2	5	0,2	5	0,2	5
			Speakers	230 V ac	2	2	15	30	1	0,2	6	0,2	6	0,2	6
		Port Guest Cabin	T.V. 19”	230 V ac	1	1	60	60	1	0,2	12	0,2	12	0,2	12
			Digital Player CD/DVD	230 V ac	1	1	25	25	1	0,2	5	0,2	5	0,2	5
			Speakers	230 V ac	1	1	15	15	1	0,2	3	0,2	3	0,2	3
		VIP Cabin	Speakers	230 V ac	1	1	15	15	1	0,2	3	0,2	3	0,2	3
	AC POWER PLUGS	All yacht	Extra use of electricity	230 V ac	1	1	2000	2000	0,15	0,5	150	0,5	150	0,5	150
	SECURITY	Flybridge	Security camera	230 V ac	2	2	10	20	1	1	20	1	20	1	20
		Cockpit	Security camera	230 V ac	3	3	10	30	1	1	30	1	30	1	30
								0							

										Navigation		MANEUVER		MOORED	
	SERVICE	ROOM	EQUIPMENT		Units	Units in use	Unit Power [W]	Installed Power [W]	Kn	Ksr	W	Ksr	W	Ksr	W
ARRANGEMENT FOR PROPULSION	SANITARY	Engine Room	Fresh water generator	220 V ac	1	1	1100	1100	0,33	0,7	254,1	0,7	254,1	0,7	254,1
			Fresh water pump	400 V	2	1	350	700	0,5	0,5	175	0,5	175	0,5	175
			Pressure taps pump	400 V	2	1	200	400	0,5	0,5	100	0,5	100	0,5	100
			Hot water circulation pump	400 V	2	1	90	180	0,5	0,1	9	0,1	9	0,1	9
			Water heater	230 V ac	1	1	5000	5000	1	0,5	2500	0,5	2500	0,5	2500
			Greywater and wastewater pump	400 V	2	1	300	600	0,5	0,7	210	0,3	90	0,1	30
	BILGE/ FIRE PROTECTION	Engine Room	Mud pump	400 V	1	1	3000	3000	1	0,5	1500	0,5	1500	0,5	1500
			Bilge Pump	400 V	3	1	850	2550	0,33	0,5	420,75	0,5	420,75	0,5	420,75
	FUEL	Engine Room	Fuel pump	400 V	2	1	450	900	0,5	0,2	90	0,8	360	0	0
	GENERAL SERVICES	Engine Room	Seawater pump	400 V	2	1	1900	3800	0,5	0,2	380	0,2	380	0,5	950
	PNEUMATIC	Engine Room	Compressor	230 V ac	1	1	5000	5000	1	1	5000	1	5000	1	5000
	HYDRAULIC	Engine Room	Stabilizer pump/ variable pitch propeller	400 V	2	1	1100	2200	0,5	1	1100	1	1100	0	0
	PROPELLER		Bow propeller	230 V ac	1	1	100000	100000	0,9	0	0	1	90000	0	0
	ANCHORING / MOORING	Bow	Anchor windlass	230 V ac	1	1	2000	2000	1	0	0	1	2000	0	0
		Bow	Winch	230 V ac	1	1	180	180	1	0	0	1	180	0	0
NAVIGATION	DIRECTION/ MANEUVER		Autopilot	24 V dc	1	1	40	40	1	0,8	32	0,8	32	0	0
	RADAR		Antenna	24 V dc	1	1	100	100	1	1	100	1	100	1	100
	TREATMENT OF DATA		Computer	24 V dc	1	1	200	200	1	1	200	1	200	1	200
	POSITIONING		AIS	24 V dc	1	1	25	25	1	1	25	1	25	0	0
	COMMUNICATIONS		Radio Phone	24 V dc	1	1	25	25	1	1	25	1	25	1	25
			Satellite antenna	24 V dc	1	1	30	30	1	1	30	1	30	0	0
	DATA		PLC	24 V dc	1	1	30	30	1	1	30	1	30	0	0
			Gateway	24 V dc	1	1	5	5	1	1	5	1	5	0	0
			Servomotor	24 V dc	1	1	10	10	1	0,1	1	0,3	3	0	0
	AUXILIARY		Weather Station	24 V dc	1	1	3	3	1	0,8	2,4	1	3	0,2	0,6
			Horn	24 V dc	1	1	60	60	1	0	0	0,2	12	0	0
			Probe	24 V dc	1	1	20	20	1	1	20	1	20	1	20
			Windshield wipers	24 V dc	1	1	50	50	1	0,2	10	0,2	10	0	0
	NAVIGATION LIGHTS		Side Lights	24 V dc	2	2	1	2	1	0,5	1	0,5	1	0	0
			Masthead Light	24 V dc	1	1	3	3	1	0,5	1,5	0,5	1,5	0	0
			Stern Light	24 V dc	1	1	3	3	1	0,5	1,5	0,5	1,5	0	0

TOTAL POWER REQUIRED [W]	1019651,85	611996,45	18713,05
TOTAL POWER REQUIRED [kW]	1019,65185	611,99645	18,71305

ANNEX E: Specifications of the solar panels.

Source: BOSCH SOLAR ENERGY AG. Bosch Solar Module c-Si M 48 S. Official web site of BOSCH (consultation: 1 June 2018).

Powerful performance – high stability.
Bosch Solar Module c-Si M 48 S
EU44123

High-quality – high-performance – reliable.
Solar modules from Bosch Solar Energy.

BOSCH

Our crystalline solar modules offer impressive features including:

- Excellent quality assured through use of the best Europeanstandard components
- Excellent processing and long-term stability right along the valueadded chain
- Higher specific yields due to positive power sorting

Quality
Salt corrosion resistance tested
Ammonia resistance tested

Product features
Performance sorting –0/+4.99 Wp
Temperature coefficient P_{mpp} –0.44 % K

Value chain
Crystal – Wafer – Cell – Module

Components
Black anodized aluminum frame, black back sheet, AR-Glas, Structured cell connector, MC4, Bosch Solar Cell M 3BB

Warranty
10 years product and
25 years performance guarantee
(90% up to 10 years, 80% up to 25 years)

Power classes
200 – 215 Wp

Our certificates – quality stamped in writing
Bosch Solar Energy modules go through strict quality tests during the different stages of production according to international standards.

Length [x]	Width [y]	Frame height [z]	Weight	Junction box	Plug connector type	Cable [l]	Front glass surface
1342.0	990.0	50.0	16	IP65	MC4	–800 +1200	Structured with anti-reflective coating

x, y, l in mm, ±2; z in mm, ±0.3; weight in kg ±0.5

Crystalline solar module	
Performance classes	**200 Wp, 205 Wp, 210 Wp, 215 Wp**
Performance sorting	–0/+4.99 Wp
Structure	**Glass-foil laminate** ▶ Black anodized aluminum frame ▶ Junction box (IP65) with 3 bypass diodes ▶ Weather-resistant back sheet (black)
Cells	**48x monocrystalline solar cells** in 156 mm x 156 mm format
Mechanical load	**5400 Pa superimposed load, 2400 Pa suction load,** in accordance with IEC 61215 (extended test)

Electrical characteristics for STC[1]:

Performance classes	Pmpp [Wp]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	Reverse-current load capacity Ir [A]
200 Wp	200	24,01	8,33	30,13	8,87	25
205 Wp	205	24,37	8,42	30,28	8,97	25
210 Wp	210	24,59	8,55	30,48	9,11	25
215 Wp	215	24,81	8,67	30,69	9,26	25

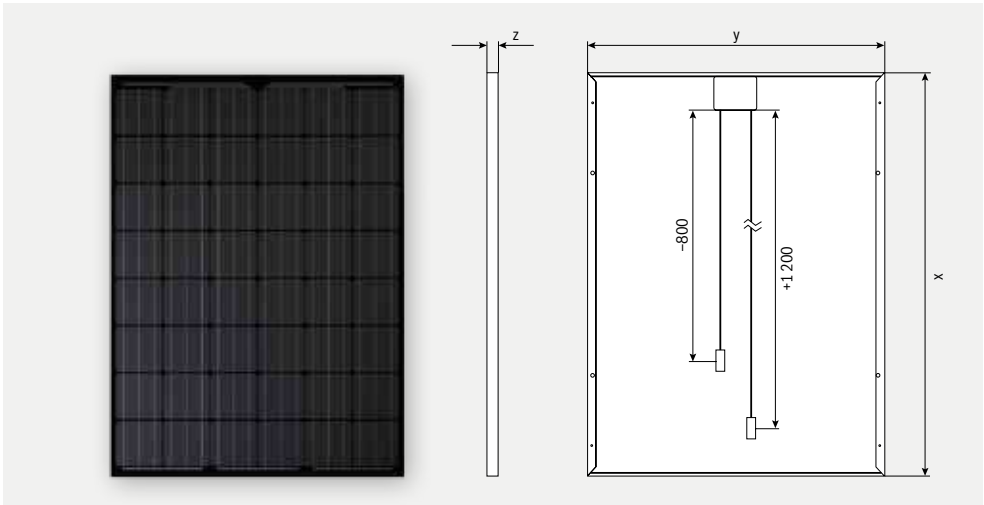
Reduction in module efficiency with decrease in irradiation level from 1000 W/m² to 200 W/m² (at 25 °C): –0.51% (absolute); measuring tolerance Pmpp ±3%, other parameters ±5%

Electrical characteristics for NOCT[1]:

Performance classes	Pmpp [W]	Vmpp [V]	Voc [V]	Isc [A]
200 Wp	146.03	21.52	27.82	7.23
205 Wp	149.61	21.72	28.01	7.34
210 Wp	153.20	21.93	28.20	7.46
215 Wp	156.79	22.11	28.38	7.58

NOCT: Normal Operation Cell Temperature 48.4 °C: Irradiation level 800 W/m², AM 1.5, temperature 20 °C, wind speed 1 m/s, electrical open circuit operation

Dimensions[2]:



Notes on assembly:
- ▶ See installation and operating manual at: www.bosch-solarenergy.com
- ▶ Horizontal and vertical assembly possible
- ▶ System voltage max. 1000 V
- ▶ Operating temperature range –40 to 85 °C

Weak light performance:

Intensity [W/m²]	Vmpp [%]	Impp [%]
800	0.35	–20
600	0.38	–40
400	–0.23	–60
200	–2.57	–80
100	–5.66	–90

The electrical data applies for 25 °C and AM 1.5.

Thermal characteristics:

Temperature coefficient	TK [%/K]
Pmpp	–0.44
Uoc	–0.31
Isc	0.031

[1] Electrical parameters are typical mean values from historical production data. No guarantee is made for the accuracy of this data for future production batches.

[2] Drawings are not to scale. For detailed dimensions and tolerances, see above.

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Version: 03/2013

ANNEX F: Specifications of the flexible photovoltaic panels.

Source: SOLBIAN ENERGIE ALTERNATIVE SRL. SOLBIAN Flex CP140Q. Official web site of SOLBIAN (consultation: 1 June 2018).

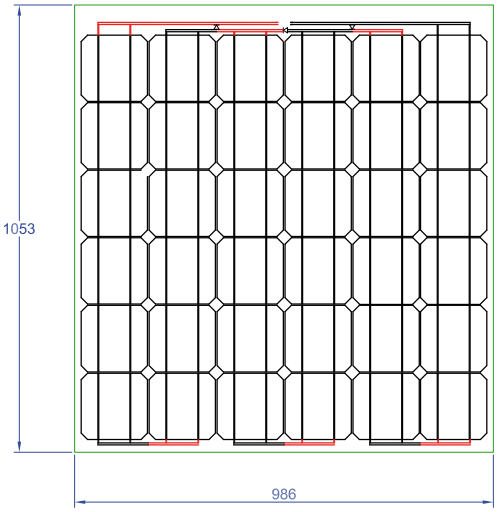
SOLBIAN FLEX™

FLEXIBLE
PHOTOVOLTAIC
PANELS
MOTORHOME SERIES

FLEX CP140Q

The flexible solar panels of **CP series** are made using monocrystalline silicon cells, with an **efficiency greater than 18%**, incorporated in **polymers with high strength**. These materials make the panels flexible, walkable, and heavy 1/6 compared to traditional glass panels. Their specific manufacturing technology therefore makes them suitable to be installed in places where resistance, flexibility and walkability it will be necessary.

MADE IN ITALY



INSTALLATION

CONNECTION AND FIXING OPTIONS

CONNECTION: JUNCTION BOX

FIXING: DOUBLE SIDED TAPE

FLEX CP140Q

DATASHEET

ELECTRICAL CHARACTERISTICS	
Peak Power (+/- 5%) - Pmax	**144 Wp**
Rated Voltage - Vmp	**18 V**
Rated Current - Imp	**8 A**
Open Circuit Voltage - Voc	**23 V**
Short circuit Voltage - Isc	**8.5 A**
Temp. coeff. Pmax	**-0.43%/°C**
Temp. coeff. Voc	**-0.33%/°C**
Temp. coeff. Isc	**0.05%/°C**
PHYSICAL CHARACTERISTICS	
Length	**1053 mm**
Width	**996 mm**
Thickness	**2 mm**
Weight	**2.6 kg**
Num. of cells	**36**

SOLBIANFLEX PANELS series CP are made with a special adhesive that allows, thanks to their flexibility, easy installation even on surfaces not totally flat.
On request we can supply the complete kit for installation:

- ✓ Photovoltaic panel
- ✓ Charge regulator
- ✓ Connectors (pair)
- ✓ Cable (4 m)

WARRANTIES AND CERTIFICATION

- ✓ **5 year** limited power warranty
- ✓ **2 year** limited product warranty

CE

SOLBIAN ENERGIE ALTERNATIVE SRL
Legal and Operative Headquarter: Via Gandhi 21b - 10051 Avigliana (TO) - ITALY
Telephone: +39 011.966.35.12 - Fax: +39 011.966.47.20 - **info@solbian.eu**

ANNEX G: Specifications of the inverter.

Source: VICTRON ENERGY B.V., Phoenix Inverters. Official web site of Victron Energy (consultation: 1 June 2018).

Phoenix Inverters

250VA – 1200VA 230V and 120V, 50Hz or 60Hz

Phoenix 12/375 VE.Direct

Phoenix 12/375 VE.Direct

VE.Direct communication port

The VE.Direct port can be connected to:

- A computer (VE.Direct to USB interface cable needed)
- Apple and Android smartphones, tablets, MacBook's and other devices (VE.Direct Bluetooth Smart dongle needed)

Fully configurable:

- Low battery voltage alarm trip and reset levels
- Low battery voltage cut-off and restart levels
- Dynamic cut-off: load dependent cut-off level
- Output voltage 210 - 245V
- Frequency 50 Hz or 60 Hz
- ECO mode on/off and ECO mode sense level

Monitoring:

- In- and output voltage, % load and alarms

Proven reliability

The full bridge plus toroidal transformer topology has proven its reliability over many years.
The inverters are short circuit proof and protected against overheating, whether due to overload or high ambient temperature.

High start-up power

Needed to start loads such as power converters for LED lamps, halogen lamps or electric tools.

ECO mode

When in ECO mode, the inverter will switch to standby when the load decreases below a preset value (min load: 15W). Once in standby the inverter will switch on for a short period (adjustable, default: every 2,5 seconds). If the load exceeds a preset level, the inverter will remain on.

Remote on/off

A remote on/off switch can be connected to a two pole connector, or between battery plus and the left hand contact of the two pole connector.

LED diagnosis

Please see manual for a description.

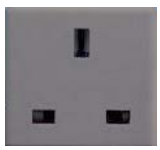
To transfer the load to another AC source: the automatic transfer switch

For our low power inverters we recommend our Filax Automatic Transfer Switch. The Filax features a very short switchover time (less than 20 milliseconds) so that computers and other electronic equipment will continue to operate without disruption.

Available with different output sockets

Schuko

UK



AU/NZ

IEC-320
(male plug included)

Nema 5-15R

DC connection with screw terminals

No special tools needed for installation

Phoenix Inverter 12 Volt / 24 Volt / 48 Volt	12/250 24/250 48/250	12/375 24/375 48/375	12/500 24/500 48/500	12/800 24/800 48/800	12/1200 24/1200 48/1200
Cont. power at 25°C (1)	250VA	375VA	500VA	800VA	1200VA
Cont. power at 25°C / 40°C	200 / 175W	300 / 260W	400 / 350W	650 / 560W	1000 / 850W
Peak power	400W	700W	900W	1500W	2200W
Output AC voltage / frequency (adjustable)	230VAC or 120VAC +/- 3% 50Hz or 60Hz +/- 0,1%				
Input voltage range	9,2 - 17 / 18,4 - 34,0 / 36,8 - 62,0V				
DC low shut down (adjustable)	9,3 / 18,6 / 37,2V				
Dynamic (load dependent) DC low shut down (fully configurable)	Dynamic cut-off, see https://www.victronenergy.com/live/ve.direct:phoenix-inverters-dynamic-cutoff				
DC low restart and alarm (adjustable)	10,9 / 21,8 / 43,6V				
Battery charged detect (adjustable)	14,0 / 28,0 / 56,0V				
Max. efficiency	87 / 88 / 88%	89 / 89 / 90%	90 / 90 / 91%	90 / 90 / 91%	91 / 91 / 92%
Zero-load power	4,2 / 5,2 / 7,9W	5,6 / 6,1 / 8,5W	6 / 6,5 / 9W	6,5 / 7 / 9,5W	7 / 8 / 10W
Default zero-load power in ECO mode (default retry interval: 2,5 s, adjustable)	0,8 / 1,3 / 2,5W	0,9 / 1,4 / 2,6W	1 / 1,5 / 3,0	1 / 1,5 / 3,0	1 / 1,5 / 3,0
ECO mode stop and start power setting	Adjustable				
Protection (2)	a - f				
Operating temperature range	-40 to +65°C (fan assisted cooling) Derate 1,25% per °C above 40°C				
Humidity (non-condensing)	max 95%				
ENCLOSURE					
Material & Colour	Steel chassis and plastic cover (blue Ral 5012)				
Battery-connection	Screw terminals				
Maximum cable cross-section	10 mm² / AWG8	10 mm² / AWG8	10 mm² / AWG8	25/10/10mm² / AWG4/8/8	35/25/25 mm² / AWG 2/4/4
Standard AC outlets	230V: Schuko (CEE 7/4), IEC-320 (male plug included) UK (BS 1363), AU/NZ (AS/NZS 3112) 120V: Nema 5-15R				
Protection category	IP 21				
Weight	2,4kg / 5,3lbs	3,0kg / 6,6lbs	3,9kg / 8.5lbs	5,5kg / 12lbs	7,4kg / 16,3lbs
Dimensions (hxwxd, mm) (hxwxd, inch)	86 x 165 x 260 3.4 x 6.5 x 10.2	86 x 165 x 260 3.4 x 6.5 x 10.2	86 x 172 x 275 3,4 x 6,8 x 10,8	105 x 216 x 305 4.1 x 8.5 x 12.1 (12V model: 105 x 230 x 325)	117 x 232 x 327 4.6 x 9.1 x 12.9 (12V model: 117 x 232 x 362)
ACCESSORIES					
Remote on-off	Yes				
Automatic transfer switch	Filax				
STANDARDS					
Safety	EN-IEC 60335-1 / EN-IEC 62109-1				
EMC	EN 55014-1 / EN 55014-2 / IEC 61000-6-1 / IEC 61000-6-2 / IEC 61000-6-3				
Automotive Directive	ECE R10-4				

1) Nonlinear load, crest factor 3:1
2) Protection key:
   a) output short circuit
   b) overload
   c) battery voltage too high
   d) battery voltage too low
   e) temperature too high
   f) DC ripple too high

Battery Alarm
An excessively high or low battery voltage is indicated by an audible and visual alarm, and a relay for remote signalling.

VE.Direct Bluetooth Smart dongle (must be ordered separately)

BMV Battery Monitor
The BMV Battery Monitor features an advanced microprocessor control system combined with high resolution measuring systems for battery voltage and charge/discharge current. Besides this, the software includes complex calculation algorithms to exactly determine the state of charge of the battery. The BMV selectively displays battery voltage, current, consumed Ah or time to go. The monitor also stores a host of data regarding performance and use of the battery.

ANNEX H: Specifications of the batteries.

Source: OMNIPOWERBANK, The Powerbank Lithium-ion battery solution.
Official web site of SINETECH (consultation: 1 June 2018).

THE

POWERBANK

LITHIUM-ION BATTERY SOLUTION

- Solar / Backup Power systems
- Alternative energy storage systems
- Medium- to high-cycle applications
- Wall mounted
- Compact

ENERGY STORAGE FOR SOLAR & BACKUP SYSTEMS

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Randburg, Johannesburg, 2194
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sales@sinetech.co.za | www.sinetech.co.za

OmniPower
The Professional Choice

ENERGY STORAGE FOR SOLAR AND BACKUP SYSTEMS

The Lithium Iron Phosphate, LiFePO4, cells used in the OmniPower Powerbank offer a longer cycle life and are inherently safer than other Lithium-ion cells. This makes the OmniPower Powerbank ideal for solar and backup power applications. More compact than AGM/GEL or flooded batteries

FEATURES:

- Higher Depth of Discharge capability (80%)
- Higher charge rate (0.5C)
- Display showing voltage, current and power
- Colour changing LEDs indicate battery voltage
- 5000 cycles at DoD of up to 80%
- IP33 cabinet
- 12 to 14 year design life in high-cycle applications
- 18 to 20 year design life in backup applications

OPB6.5-48 TECHNICAL DATA:	
Stored Energy Content	6.4 kWh
Nominal Voltage	51.2 V
Recommended Absorption Voltage	57.6 V
Recommended Float Voltage	54.4 V
Absolute Minimum Voltage	46.4 V
Absolute Maximum Voltage	58 V
Maximum Discharge Current	125 A
Maximum Discharge Power	6.5 kW
Recommended Max. Charge Current	60 A
Operating Temperature Range	5 °C - 25 °C
Humidity	<95% non-condensing
Height	665 mm
Width	552 mm
Depth	255 mm
Weight	65 kg

CHARGING METHOD:
The Powerbank should be charged in 3 stages. In the first stage a constant current is applied to the battery, steadily increasing the voltage until the voltage limit per cell is reached. The second stage is a constant voltage stage whereby the voltage is kept relatively high in order to fully recharge the cells. The third and last stage is also a constant voltage stage whereby the voltage is lowered to a standby level; this compensates for any self-discharge in the cells.

The Powerbank can only be used with 48V inverter systems capable of being programmed to the charging specifications as indicated. The battery charger should be temperature compensated.

TEMPERATURE EFFECTS:
Temperature affects all batteries in different ways; nominal capacity and optimum performance is based on operating temperatures of 5 °C to 25 °C. Low temperatures reduce the charge and discharge rate and high temperatures will degrade the battery performance.

ANNEX I: Specifications of the Genset (Generator and Engine).

Source: VOLVO PENTA Marine Genset D16 MG (01 / 2017). Official web site of Volvo Penta (consultation: 13 June 2018).

VOLVO PENTA MARINE GENSET

D16 MG

415–525 kVA (332–420 kWe) at 1500rpm 50Hz/400V, 488–596 kVA (390–477 kWe) at 1800rpm 60Hz/440V

Volvo Penta Genset system

The Volvo Penta Genset systems are the complete solution for a ship's onboard power requirements. You will not only get reliable marine diesels, well-matched generators and a monitoring system, but also a wide range of products and services to optimize your investment.

Each Volvo Penta Genset is built in the Volvo factory fully adapted to the customer's requirements and comes complete and tested, ready for installation onboard.

The basis for the Volvo Penta Gensets is the smooth running and reliable marine diesel engines. Compact in design, they occupy less space in the engine room, and their good accessibility makes service and maintenance easy. Auto-start and synchronizing is rapid and reliable, meeting all standards with a comfortable margin.

All the Volvo Penta Gensets are type approved by the major classification societies, and can be delivered under complete certification.

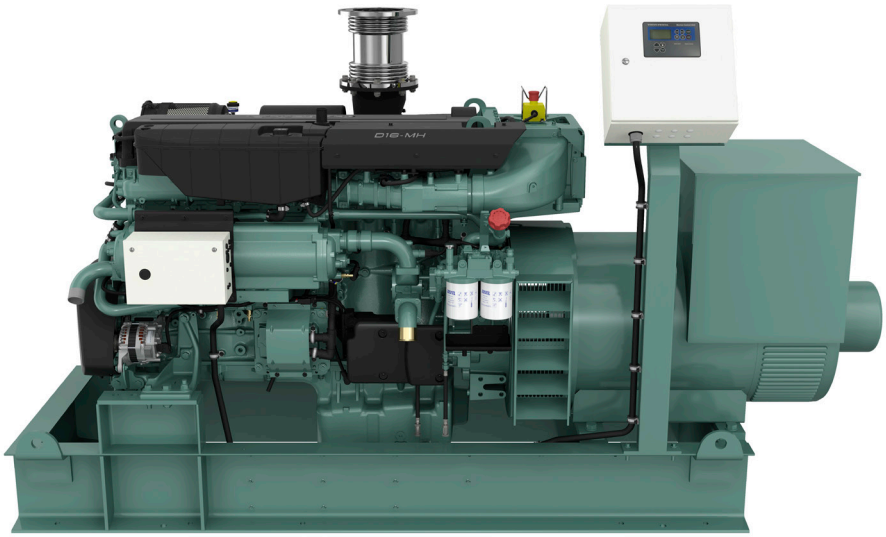
Engine

The Volvo Penta engines are well balanced and have excellent emission performance. With growing care for the environment all over the world, emission regulations are becoming increasingly stricter. The D16 MG is certified for IMO NOx limits and the comprehensive emission requirements according to EPA Tier 2, EU IWW and CCNR Stage 2.

Volvo's basic engine design in combination with a highly efficient speed control system gives superior load taking capability.

Generator

All the standard Gensets are equipped with a generator built by Newage Stamford. Stamford is the market leader in this power range and provides for worldwide service coverage. These generators are of a long proven design, based on years of experience of power generation for land-based and marine applications.



Technical Data Engine

Engine designation	D16 MG	
No. of cylinders and configuration	in-line 6	
Method of operation	4-stroke, direct-injected, turbocharged diesel engine with aftercooler	
Bore, mm	144	
Stroke, mm	165	
Displacement, l	16.1	
Compression ratio	17.5:1	
	1500 rpm	1800 rpm
Crankshaft Power HE Cooling, kW	450	500
Crankshaft Power RC Cooling, kW	433	470
Crankshaft Power KC Cooling, kW	450	500
Specific fuel consumption HE/KC, g/kWh	208 (50%)	212 (50%)
	203 (75%)	209 (75%)
	206 (100%)	213 (100%)
Recommended fuel to conform to	ASTM-D975 1-D & 2-D, EN 590 or JIS KK 2204	

10% overload available acc. to class requirements. Fuel temperature 40°C (104°F). Technical data according to ISO 3046 Fuel Stop Power with a tolerance ±4%. Fuel with a lower calorific value of 42700 kJ/kg and density of 840 g/liter at 15°C (60°F). Merchant fuel may differ from this specification which will influence engine power output and fuel consumption. The engine is certified according to IMO NOx, EPA Tier 2, EU IWW and CCNR Stage 2.

VOLVO PENTA

D16 MG

Technical description

Complete Genset
- High system efficiency as a result of system optimization of the complete Genset
- All used components of highest quality from well reputed suppliers
- Reinforced set dimensioned for high output and low sound level
- Mono-block engine/generator rigidly mounted on a common bed frame
- Engine directly coupled to generator via a flexplate

Engine and block
- Cylinder block and cylinder head made of cast iron
- One piece cylinder head
- Replaceable wet cylinder liners and valve seats/guides
- Drop forged crankshaft with induction hardened bearing surfaces and fillets with seven main bearings
- Four valve per cylinder layout with overhead camshaft
- Each cylinder features cross-flow inlet and exhaust ducts
- Gallery oil cooled forged aluminum pistons, three piston rings (keystone top ring)
- Senders for oil pressure (after filter), oil temp, oil pressure piston cooling, oil level, fuel pressure, freshwater pressure, exhaust temp, crankcase pressure, speed crank and cam, boost pressure/temp, seawater pressure (not KC or RC cool.), coolant level, coolant temp

Lubrication system
- Freshwater-cooled oil cooler integrated in cylinder block
- Twin full flow oil filter of spin-on type and single by-pass filter

Fuel system
- Electronic Unit Injectors
- Gear-driven fuel pump, driven by timing gear
- Electronically controlled injection timing
- 5-hole high pressure injector nozzles
- Twin engine-mounted spin-on fine fuel filters with change over valve

Turbocharger
- Dry twin entry turbocharger

Heat Exchanger cooled system (HE)
- For seawater- and central-cooled Gensets
- Engine-mounted tubular heat exchanger with expansion tank
- Belt-driven centrifugal freshwater pump
- Gear-driven rubber impeller raw water pump (optional)

Radiator cooled system (RC)
- For aircooled Gensets
- V-belt-driven radiator fan
- Belt-driven centrifugal cooling water pump
- Water-cooled CAC (Charge Air Cooler)

Keel cooled system (KC)
- 2-circuit cooling system
- Belt-driven centrifugal cooling water pump in HT circuit
- Engine mounted expansion tank in HT circuit
- Gear driven rubber impeller cooling water pump in CAC LT circuit

Generator
- 4-pole, brushless, AC marine generator
- Temperature rise class F
- Tropical insulation class H
- Stator winding as standard with short 2/3 pitch winding, ideal for non-linear load (thyristor load)
- Automatic Voltage Regulator (AVR) for accurate voltage regulation
- Permanent magnet mounted on generator for independent power supply to AVR
- Single bearing generator as standard
- Voltage available range up to 690V
- IP23 enclosure as standard
- Anti condensation heating

Control System
- Two options for onboard electronic control:

  1. MCC a new flexible and expandable control and monitoring system for classified installations. Incl. separate safety shutdown system

  2. Open CAN Interface, engine delivered without control system. Different options with or without shut down senders and switches.
- Meets new classification requirements of separate shutdown and monitoring system
- Easy to interface with leading suppliers of ship control systems
- Possibility to connect relays for remote control functions (potential free contacts)
- Classifiable by all major classification societies

Optional equipment

Engine
- Twin fuel pre-filters/water separator with change over valve
- Flexible exhaust compensator
- Cooling water connection bellows
- Electrical and air starting systems available individually or in parallel.
- Raw water pressure indication (only in combination with raw water pump)
- Exhaust temperature indication
- Engine heater 2000W

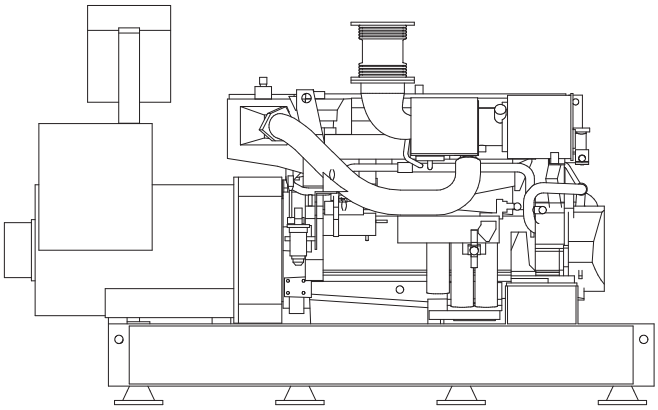
Generator
- Air inlet filters according to IP23
- Air inlet louvres/filters according to IP44
- Parallel equipment mounted in generator
- Thermistors (1 or 2 per phase) mounted in generator for temperature measurement of windings in generator
- PT100 elements (1 or 2 per phase) mounted in generator for temperature measurement of windings in generator
- Double bearing generator (on request)
- PT100 elements mounted in generator bearings for temperature measurement

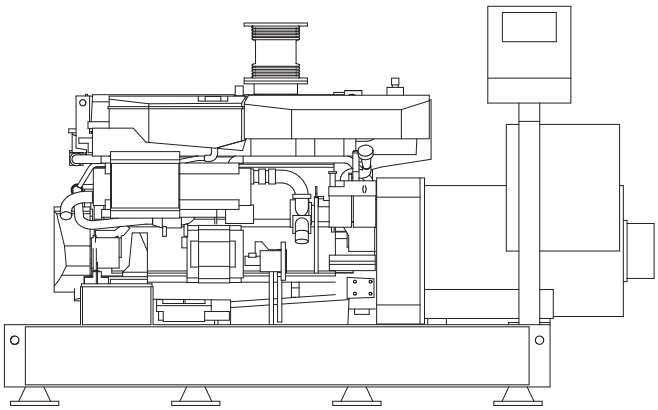
Miscellaneous
- Dry exhaust silencer with or without spark arrestor
- 80A alternator with integrated charging sensor (Only available for HE/KC)
- Flexible mountings including welding plates mounted under the frame
- Basic toolkit
- Spare parts according to classification recommendations

Contact your local Volvo Penta dealer for further information.

Not all models, standard equipment and accessories are available in all countries. All specifications are subject to change without notice.

The Genset illustrated may not be entirely identical to production standard Gensets.





Technical Data HE Genset

Power output at 1500 rpm 50Hz/400V, kVA (kWe)

D16 MG / HCM534D-1	415 (332)
D16 MG / HCM534E-1	490 (392)
D16 MG / HCM534F-1	525 (420)

Power output at 1800 rpm 60Hz/440V, kVA (kWe)

D16 MG / HCM534D-1	488 (390)
D16 MG / HCM534E-1	588 (470)
D16 MG / HCM534F-1	596 (477)

10% overload available according to class requirements.

Fuel temperature 40°C (104°F). Technical data according to ISO 3046 Fuel Stop Power and ISO 8665. Fuel with a lower calorific value of 42700 kJ/kg and density of 840 g/liter at 15°C (60°F). Merchant fuel may differ from this specification which will influence engine power output and fuel consumption.

Dimensions L x W x H_1/H_2 (mm), not for installation

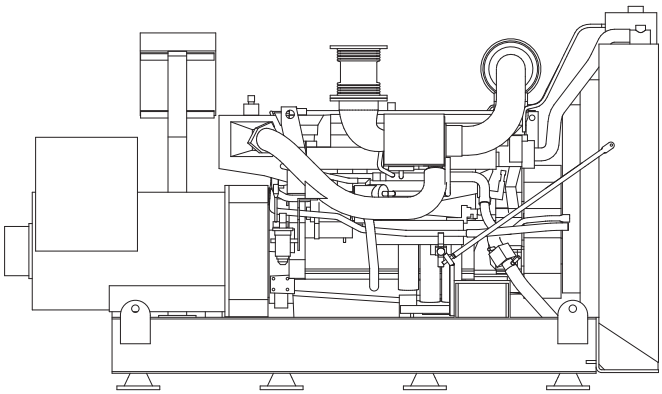
D16 MG / HCM534D-1	3122 x 1177 x 1842/1912
D16 MG / HCM534E-1	3122 x 1177 x 1842/1912
D16 MG / HCM534F-1	3165 x 1177 x 1842/1912

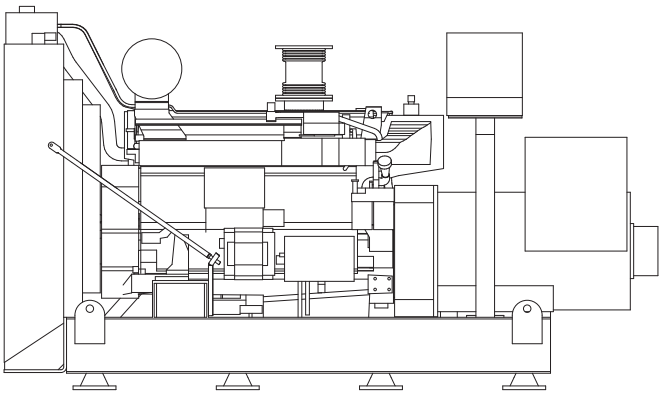
Weight, kg

D16 MG / HCM534D-1	3636
D16 MG / HCM534E-1	3786
D16 MG / HCM534F-1	3926

H_1 = Height including exhaust compensator

H_2 = Total genset height including control box





Technical Data RC Genset

Power output at 1500 rpm 50Hz/400V, kVA (kWe)

D16 MG / HCM534D-1	415 (332)
D16 MG / HCM534E-1	490 (392)
D16 MG / HCM534F-1	518 (414)

Power output at 1800 rpm 60Hz/440V, kVA (kWe)

D16 MG / HCM534D-1	488 (390)
D16 MG / HCM534E-1	560 (448)

10% overload available according to class requirements.

Fuel temperature 40°C (104°F). Technical data according to ISO 3046 Fuel Stop Power and ISO 8665. Fuel with a lower calorific value of 42700 kJ/kg and density of 840 g/liter at 15°C (60°F). Merchant fuel may differ from this specification which will influence engine power output and fuel consumption.

Dimensions L x W x H_1/H_2 (mm), not for installation

D16 MG / HCM534D-1	3448 x 1380 x 1843/2055
D16 MG / HCM534E-1	3448 x 1380 x 1843/2055
D16 MG / HCM534F-1	3505 x 1380 x 1843/2055

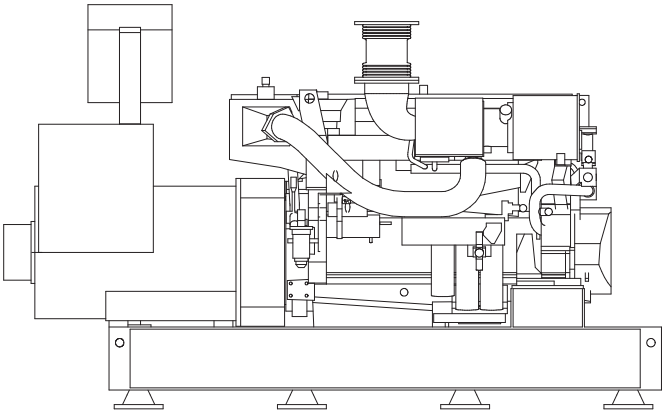
Weight, kg

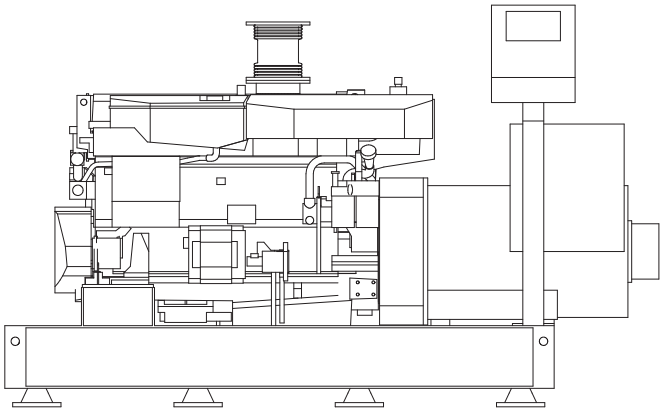
D16 MG / HCM534D-1	3810
D16 MG / HCM534E-1	3960
D16 MG / HCM534F-1	4100

H_1 = Height including exhaust compensator

H_2 = Total genset height including expansion tank

D16 MG





Technical Data KC Genset

Power output at 1500 rpm 50Hz/400V, kVA (kWe)

D16 MG / HCM534D-1	415 (332)
D16 MG / HCM534E-1	490 (392)
D16 MG / HCM534F-1	525 (420)

Power output at 1800 rpm 60Hz/440V, kVA (kWe)

D16 MG / HCM534D-1	488 (390)
D16 MG / HCM534E-1	588 (470)
D16 MG / HCM534F-1	596 (477)

10% overload available according to class requirements.
Fuel temperature 40°C (104°F). Technical data according to ISO 3046 Fuel Stop Power and ISO 8665. Fuel with a lower calorific value of 42700 kJ/kg and density of 840 g/liter at 15°C (60°F). Merchant fuel may differ from this specification which will influence engine power output and fuel consumption.

Dimensions L x W x H_1/H_2 (mm), not for installation

D16 MG / HCM534D-1	3122 x 1177 x 1842/1912
D16 MG / HCM534E-1	3122 x 1177 x 1842/1912
D16 MG / HCM534F-1	3165 x 1177 x 1842/1912

Weight, kg

D16 MG / HCM534D-1	3581
D16 MG / HCM534E-1	3731
D16 MG / HCM534F-1	3871

H_1 = Height including exhaust compensator
H_2 = Total genset height including control box

VOLVO PENTA

AB Volvo Penta
SE-405 08 Göteborg, Sweden
www.volvopenta.com

ANNEX J: Specifications about the electric motor.

Source: WEG S/A Three Phase Induction Motor. Squirrel Cage (13 June 2018). Official web site of WEG S/A (consultation: 13 June 2018).

DATA SHEET

Three Phase Induction Motor - Squirrel Cage

Customer	:

Product line	: W50 Three-Phase	Product code :	13007582

Frame	: 450J/H	Locked rotor time	: 36s (cold) 20s (hot)
Output	: 1000 kW	Temperature rise	: 80 K
Poles	: 2	Duty cycle	: S1
Frequency	: 60 Hz	Ambient temperature	: -20°C to +40°C
Rated voltage	: 3300 V	Altitude	: 1000 m.a.s.l.
Rated current	: 200 A	Protection degree	: IP55
L. R. Amperes	: 1343 A	Cooling method	: IC411 - TEFC
LRC	: 6.7	Mounting	: B3R(E)
No load current	: 42.9 A	Rotation[1]	: CW
Rated speed	: 3588 rpm	Noise level[2]	: 82.0 dB(A)
Slip	: 0.33 %	Starting method	: Direct On Line
Rated torque	: 2660 Nm	Approx. weight[3]	: 4980 kg
Locked rotor torque	: 80 %		
Breakdown torque	: 250 %		
Insulation class	: F		
Service factor	: 1.00		
Moment of inertia (J)	: 26.4 kgm²		

Output	25%	50%	75%	100%
Efficiency (%)	96.1	96.2	96.7	96.7
Power Factor	0.63	0.85	0.89	0.90

Foundation loads	
Max. traction	: 11080 N
Max. compression	: 59933 N

		Drive end	Non drive end
Bearing type	:	6220 C3	6220 C3
Sealing	:	Taconite Labyrinth	Taconite Labyrinth
Lubrication interval	:	2223 h	2223 h
Lubricant amount	:	31 g	31 g
Lubricant type	:	Mobil Polyrex EM	

Notes

This revision replaces and cancel the previous one, which must be eliminated.
(1) Looking the motor from the shaft end.
(2) Measured at 1m and with tolerance of +3dB(A).
(3) Approximate weight subject to changes after manufacturing process.
(4) At 100% of full load.

These are average values based on tests with sinusoidal power supply, subject to the tolerances stipulated in IEC 60034-1.

Rev.	Changes Summary	Performed	Checked	Date

Performed by				
Checked by			Page	Revision
Date	13/06/2018		1 / 2	

DATA SHEET

Three Phase Induction Motor - Squirrel Cage

Customer :

Thermal protection

ID	Application	Type	Quantity	Sensing Temperature
1	Winding	PT100 - 3 wires	2 x Phase	-
2	DE bearing	PT100 - 3 wires	1 x Bearing	-
3	NDE bearing	PT100 - 3 wires	1 x Bearing	-

Space heater information

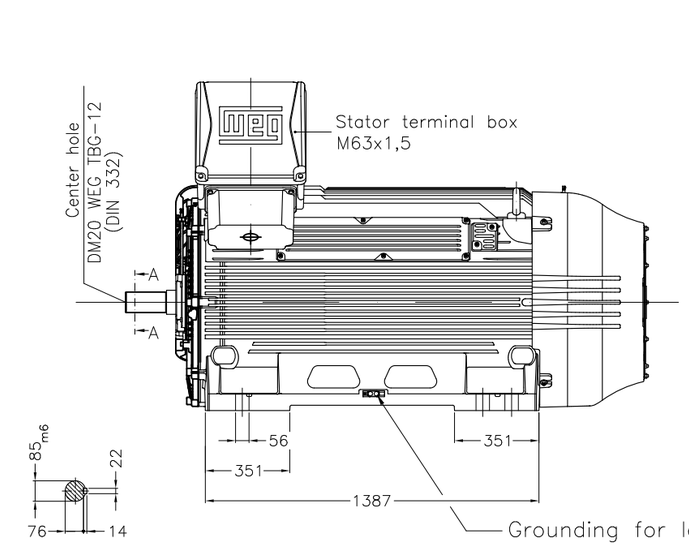
Voltage: 110-127/200-240 V

Rev.	Changes Summary	Performed	Checked	Date

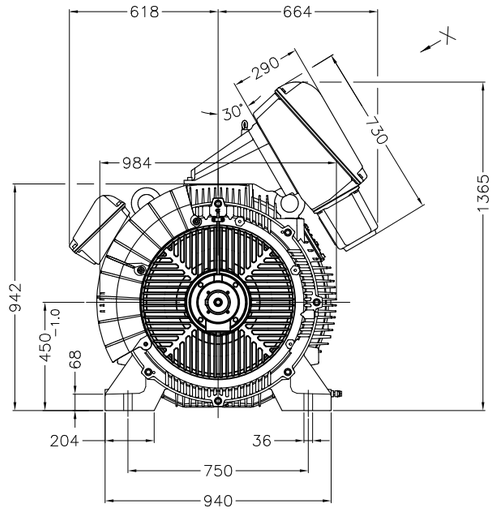
Performed by				
Checked by			Page	Revision
Date	13/06/2018		2 / 2	

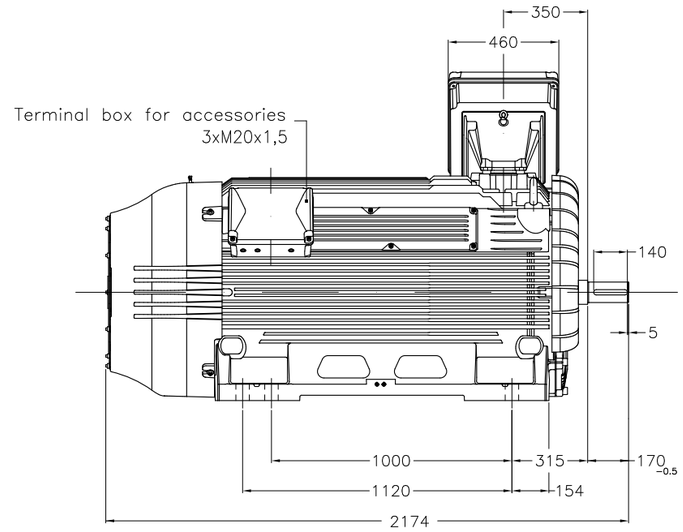
Dimensões em mm
Dimensions in mm

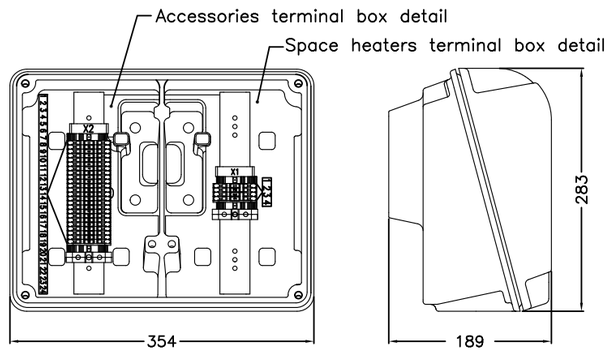
THIS IS AN UPDATED REVISION, THE PREVIOUS ONE MUST BE DISREGARDED.



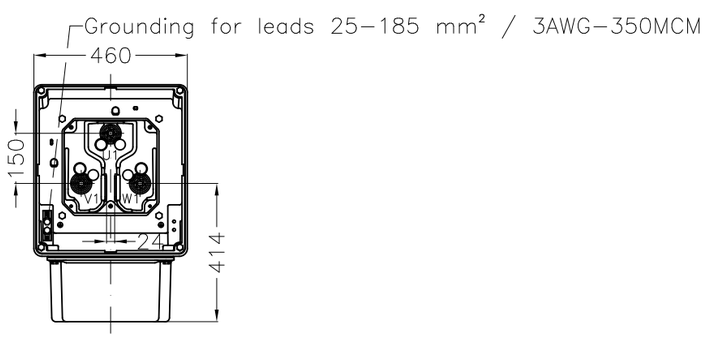
Section A–A



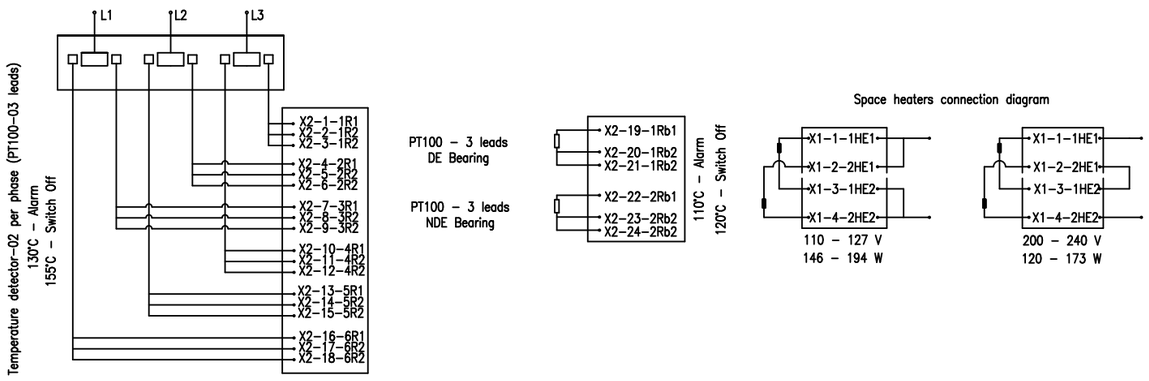




Scale 1:7



View X
Scale 1:18



NDE endshield with electrically insulated bearing hub (HGF)
Color RAL 5009
Painting plan 214P
Mounting B3R(E)

					SCALE	1:25	
ECM	LOC	SUMMARY OF MODIFICATIONS	EXECUTED	CHECKED	RELEASED	DATE	VER

EXECUTED	USERADMIN	THREE PHASE W50 MOTOR			
CHECKED		FRAME 450J/H IP55 TEFC			
RELEASED		WEG code: 13007582			
REL DT	13.06.2018	WMO	Jaragua do Sul	Product Engineering	SHEET 1 / 1

1000 kW 02 Poles 60Hz 3300 V

A

ZME A3