

Three-Phase Brushless Synchronous Alternators



Three-Phase Brushless

Synchronous Alternators



Based on state-of-the-art manufacturing facility and continuously developed technology, Hyundai has been manufacturing Synchronous Alternators for its marine and industrial customers throughout the world for the past 25 years. Our customers have come to rely on our strict quality control procedures and on-time delivery programs.

Hyundai Marine-purpose Generators have been widely acknowledged not only by major world classification societies such as LRS of U.K., ABS of U.S.A., DNV of Norway, GL of Germany, NK of Japan, CCS China KR of Korea, but also by leading shipowners around the world.

Hyundai's quality control system is certified to conform to the Quality Control System Standard (ISO 9001) and the Environmental Management System certification (ISO14001).

Hyundai Synchronous Alternators have long been recognized for their dependability and have been playing a significant role in the world's marine vessels and power industries. Hyundai will continue to produce unique product innovations through continuous product research and development.

Electrical

Constant voltage excitation with rapid dynamic voltage response

Mechanical

TERMINAL BOX can be located in the alternator frame at left or right side as required
EXCITATION SYSTEM are mounted inside of protective housing

Maintenance

Easier maintenance with brushless excitation

Due to continuous development the technical data are subject to change without prior notice.

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Constant Voltage Brushless Synchronous Alternators

Application

The constant voltage brushless synchronous alternator is of a self-excited type with an electronic voltage regulator integrated in the excitation unit.

It is used as main and standby units for land based power installations and for marine electrical supplies. Units can be driven by internal combustion engines, gas, steam or water turbines and electric motors.

Excitation system

The alternator is fitted according to size and type with an excitation system with THYRIPART excitation system (load dependent excitation, compounded with thyristor voltage regulator). This method results in excellent dynamic response to load switching applications and short circuits.

Standards and codes of practice

The alternator conforms to the applicable IEC requirements, DIN standards and VDE codes, particularly to VDE 0530 specification for rotating electrical machines. Other standards on inquiry.

Construction

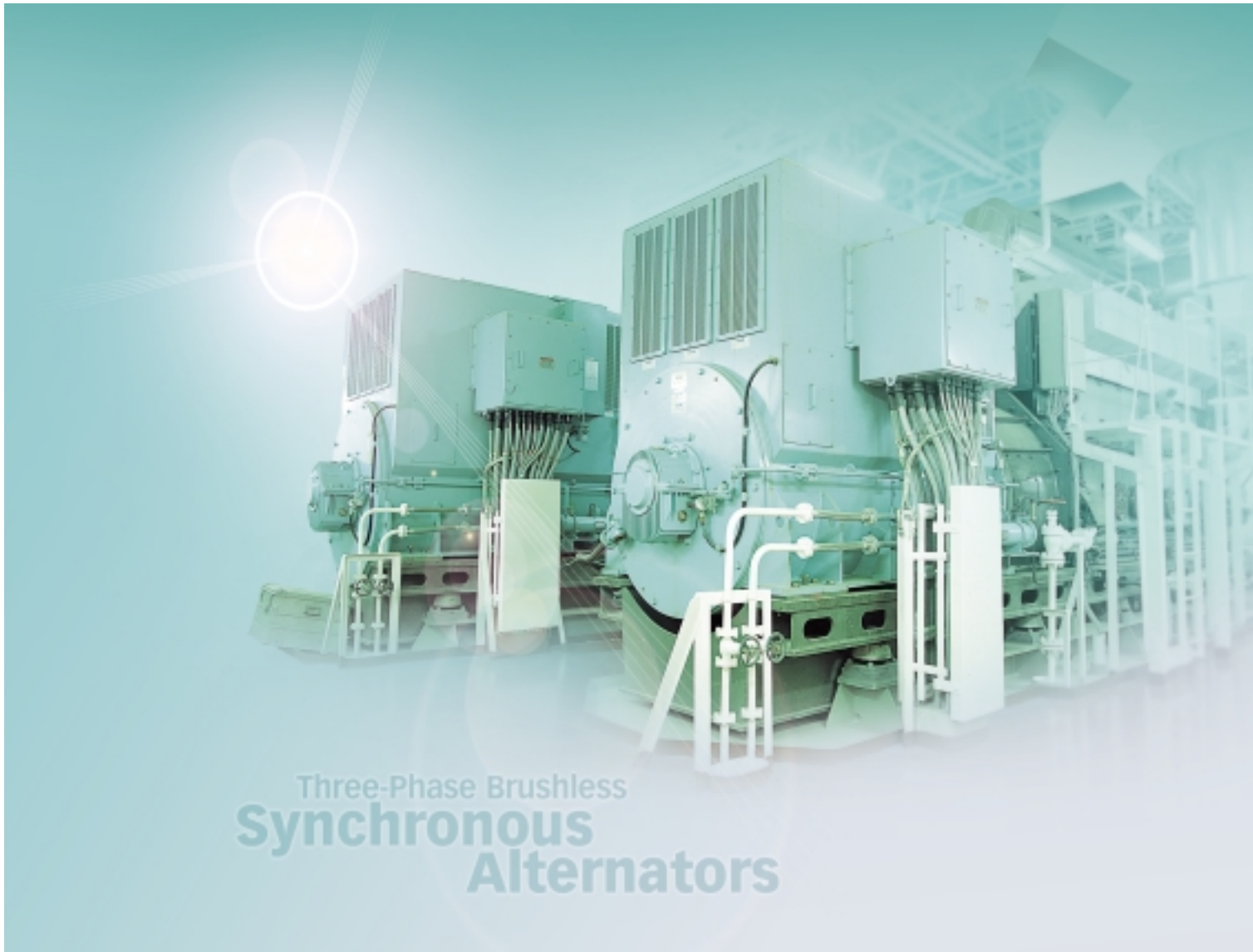
The alternator comprises the main machine (revolving field machine with cylindrical rotor and damper winding), exciter (revolving armature machine) and excitation equipment.

The excitation power is supplied to the rotor of the main machine via rotating rectifiers.

For type of cooling, see page 08.

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Three-Phase Brushless **Synchronous** **Alternators**



Technical Data

Output

The rated outputs (kVA) given in the selection tables see (page 16~23) are valid for

- continuous duty at 50 or 60 Hz rated frequency
- power factors from 0.8 to 1 (LAGGING)
- class F insulation
- sinusoidal load current
- symmetrical load

Site rated output

A deduction must be made from the nominal output to VDE 0530 (rated output at 40°C and 1000 m above sea level) in each of the following cases:

1. Coolant temperature exceeds 40°C and all practices for marine alternators not complying with classification society rules (see the selection tables).
A special inquiry should be made if the coolant temperature exceeds 55°C.
At a coolant temperature of 30°C, the mean output is increased by 4% over that permissible at 40°C.
2. Site altitude exceeds 1000 m above sea level (applicable for in-land power installations only)

Site altitude m a. s. l.	Permissible output % of rated value
1000	100
1500	97
2000	94
2500	91
3000	87
3500	82
4000	77

If no coolant temperature is stated, it will be assumed that the altitude-induced reduction in the cooling efficiency is compensated by a lower coolant temperature, i.e. adjustment of the maximum temperature rise to VDE 0530 is not necessary (no de-rating).

The following coolant temperatures have been obtained for the thermal utilization corresponding to Class F insulation:

Altitude in m a.s.l.:						
1000	1500	2000	2500	3000	3500	4000
Coolant temperature in °C:						
40	35	30	25	19	14	9

3. Power factor <0.8

cos phi Power facto	Permissible output % of rated value	
	HFC5	HFC6
0.8...1 ¹⁾	100	100
0.7	95	96
0.6	91	92
0.5	89	91
0.4	87	90
0.0	84	88

¹⁾ A shaft end of large diameter may be required for HFC5-alternators when the power factor is greater than 0.8.

4. Unbalanced load (see page 11)

5. Overload (see page 11; for marine alternators page 12)

6. Slight voltage dip when large loads like squirrel-cage motors are switched in (see page 10).

7. Load current is not sinusoidal in case of static converter load (please inquire).

Voltage and frequency

The alternator is suitable for operation at 50 Hz or 60 Hz as shown in the selection tables.

The alternator voltages on our standard design are 400 V at 50 Hz and 450 V at 60 Hz.

Load voltages corresponding to the alternator voltages are respectively 380 V at 50 Hz and 440 V at 60 Hz.

The alternator can supply voltages up to 600 V for HFC 280 otherwise up to 1100 V. Please separately inquire if alternator should supply voltage less than 230 V.

Inquiries are also welcomed for special voltages and for frequencies other than 50 Hz or 60 Hz.

The output data (except rated currents) correspond roughly to those given in the selection tables for nominal voltages.

Apart from an internal reference value potentiometer fitted in the regulator, the rated voltages can be adjusted $\pm 5\%$ using a reference value setter to be mounted in an external panel. The three-phase stator winding of the alternator is connected in star.

Efficiency

The efficiency allows for the total losses in the alternator, including those of the field winding and excitation system.

Insulation system

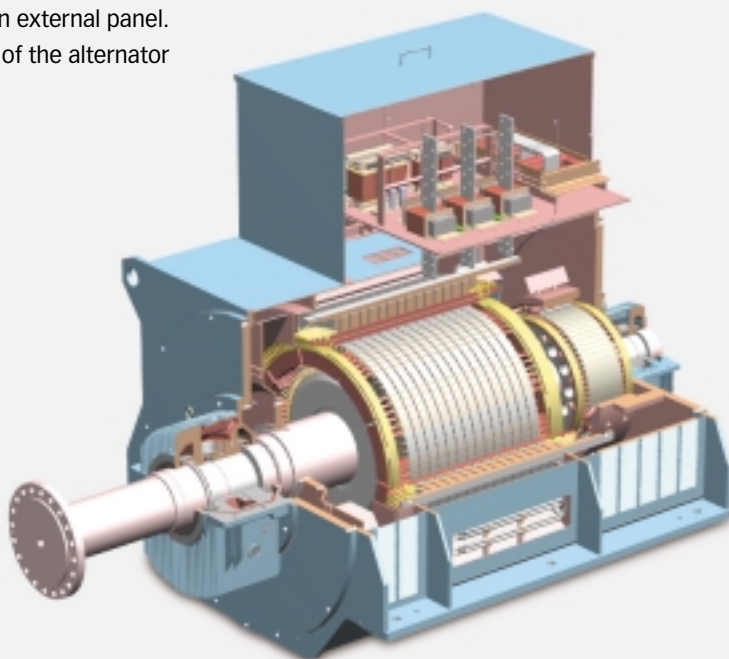
The insulation materials used are non-hygroscopic, non-tracking and can withstand severe thermal and mechanical stress.

The stator windings of the alternator are made of special enameled wire of high hydrolysis-resisting quality or flat copper bars with mica paper.

The standard insulation system employs a special resin impregnation process. This results in high mechanical strength, vibration resistance and excellent dielectric strength.

Radio interference suppression

The alternator is supplied with radio interference suppression grade N to VDE 0875.



Mechanical Data

Speed and direction of rotation

At the rated speed given in the selection tables, the alternator produces the rated frequency of 50 Hz or 60 Hz.

The alternator is designed for clockwise rotation, when viewed from the drive-end if not otherwise specified. It can also be made for counterclockwise rotation.

In accordance with VDE 0530, the sequence "U, V, W" of the terminals in the terminal box corresponds to the phase sequence in clockwise rotation. For parallel operation with an existing system, the phase sequence must be checked before making the connections.

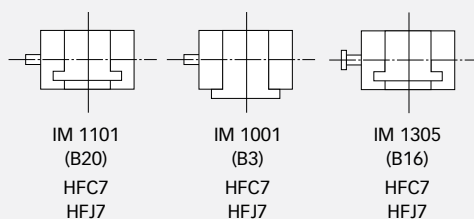
Overspeed for alternators is normally specified to be $n_{\max} = 1.2 \times n_n$. Higher values on request. With the alternator main switch open, there is no restriction on operating the alternator with THYRIPART® - excitation at less than rated speed (like in the case of starting up the prime mover).

This does not apply to special alternators with sleeve bearings which may only be run at a reduced speed to about 20% of their rated speed.

Types of construction

The alternator can be supplied in the following versions to IEC 34-7 (IM=international mounting).

For the different types of construction other than those illustrated below, please inquire.



Degree of protection

The alternator normally has the degree of protection IP 23 (IEC 34-5) if not specified otherwise.

The HFJ7 45. to 56. series have IP44/IC81W according to IEC.

The HFJ7 63. to 80. have IP44/IC81 in accordance with IEC (IC81: closed circuit cooling system with air/water cooler mounted). See page 13.

The terminal box or terminal space has the degree of protection IP54.

Other degree of protection on inquiry.

Air filter

Air filter can be provided in HFC7 series for special conditions (on request).

If the design calls for air filter, it is recommended that temperature sensors be fitted in the stator winding so that the alternator can be immediately alarmed or tripped in case of abnormal temperature rise due to a dirty filter.

Anti-condensation heating

Anti-condensation heating is available for the alternator.

The supply voltage to the anti-condensation heater must be 220 V or 110 V of single phase.

Terminals and connection bus bars

Cable entry to the main connections (U,V,W) and 2 field terminals (+F1, -F2) can be made at the left or right side as instructed. The cable entry plates are normally supplied undrilled.

Moment of inertia

All values for the moment of inertia (J in kg- m₂) given in the selection tables are subject to a tolerance of $\pm 10\%$ to VDE 0530. The values are for the rotor without coupling.

Cooling

The HFC7 series are internally cooled with shaft-mounted fan to VDE 0530, IC 01 to IEC. The fan provided at the drive-end draws the cooling air axially through the machine.

For details of air inlet and discharge openings, see the dimension tables.

Noise emission

The noise level of the alternator will not exceed that specified in Part 9, VDE 0530 (1981).

Vibration stability

Reciprocating engines used as prime mover impress vibrations on the alternator because of the pulsating torque output.

Permissible vibration stress measured at the bearings is

<10 Hz	vibration amplitude	$\hat{S}$	$\leq 0.40 \text{ mm}$
10 - 100 Hz	vibration velocity	V_{eff}	$\leq 18 \text{ mm/s}$
> 100 Hz	acceleration	b	$\leq 1.6 \text{ g}$

Please inquire if higher vibration stress level are expected.

Bearings

If required, alternators with HFC7 453 and above can be fitted with sleeve bearings at extra cost. Alternators with HFC7 63. - 80. for marine use are generally fitted with sleeve bearings. Alternators with HFC7 350 and above a miniature Pt 100 screw-in resistance thermometer can be fitted in the bearings for remote display (optional).

Sleeve bearings

Lubricating system reference for alternators in B3, and B16 and B20 type of construction, with sleeve bearings:

Alternator Type	No. of Poles	Lubrication system at					
		50Hz			60Hz		
		Coolant temperature (°C)					
		50	45	40	50	45	40
HF 7 45	4	○	○	○	●	○	○
	6 to 12	○	○	○	○	○	○
HF 7 50	4	●	○	○	●	○	○
	6 to 12	○	○	○	○	○	○
HF 7 56	4	●	○	○	●	●	●
	6 and 8	○	○	○	●	○	○
	10 and 12	○	○	○	○	○	○
HF 7 63	4	●	●	○	●	●	●
	6 and 8	○	○	○	●	○	○
	10 and 12	○	○	○	○	○	○
HF 7 71	4	●	●	●	●	●	●
	6	●	●	●	●	●	●
	8 and 10	●	○	○	○	○	○
	12	○	○	○	○	○	○
HF 7 80	4	●	●	●	●	●	●
	6	●	●	●	●	●	●
	8 and 10	●	○	○	○	○	○
	12	○	○	○	○	○	○

○ Ring lubrication, air cooled

● Forced lubrication, with oil cooling

Drive and coupling

Alternators provided with two bearings can be driven by reciprocating engines via highly flexible shaft couplings.

The coupling is not a part of the scope of delivery by the alternator manufacturer.

The torsional vibration has to be calculated for rigidly coupled single bearing alternators.

If necessary, preliminary outline and shaft dimension drawings can be made available. Shaft reinforcements if necessary may entail extra costs.

Performance Data

Steady state voltage variation

Throughout the range from no-load to rated load at rated power factor, the following voltage regulating accuracies are achieved

	THYRIPART excitation
Isolated operation (without droop compensation device)	UN ± 0.5%
Parallel operation (with droop compensation device)	UN ± 2.5%

The voltage variation of alternators with droop compensation device can be improved to that of isolated operation value by short-circuiting the droop compensation devices, while not in parallel operation.

Calculation example

It is assumed that three-phase induction motor with squirrel-cage rotor maybe switched on to an unloaded brushless constant voltage synchronous alternator.

Generator Data

Alternator type	HFC7 504-10
Capacity	880 KVA
PF	0.8
Voltage	450 V
X'd	28.2%=0.282 pu.
X''d	15.1%=0.151 pu.

Motor Data

Capacity	170 kW
PF	88.5%
Efficiency	93.5%
Nominal Current(I _n)	269.6 A
Starting Current(I _s)	760% at direct on line starting
Starting Method	Auto-TR 65% tap starting

Momentary voltage drop caused by starting of load is calculated by the following formula;

※Calculation of starting capacity of largest motor 90kW

$$= \sqrt{3} \times \text{voltage} \times \text{starting current}$$

$$= \sqrt{3} \times 0.44 \times (269.9 \times 7.6 \times 0.65^2)$$

$$660 \text{ [KVA]}$$

Generator reactance (X''D)

$$X''D = \frac{0.282 + 0.151}{2} = 0.2165$$

Formula for calculating starting load reactance XL ;

$$XL = \frac{\text{generator capacity}}{\text{starting capacity of thrown-on load}}$$

$$= \frac{880}{660} \times 1.334$$

Voltage drop ΔV is calculated by the following formula ;

$$\Delta V = \frac{X''D}{X''D + XL} \times 100$$

$$= \frac{0.2165}{0.2165 + 1.334} \times 100$$

$$14\%$$

ΔV : Allowable momentary voltage drop

(Max. - 15% according to LRS requirement)

X'D : Direct-axis transient reactance of generator

X''D : Direct-axis sub-transient reactance of generator

Note

If the voltage variation exceeds the given value, the load is to be reduced by an appropriate starting circuit with induction motors; otherwise, a larger frame size of alternator is necessary.

Short-circuit current and short-circuit rating

Owing to the load dependent operation of the static excitation system, the alternator meets the requirements for the lowest possible voltage dips and rapid voltage recovery (like in case of sudden loading with large squirrel-cage induction motors).

The excitation principle employed features sustained short-circuit currents of approximately 3 to 5 times of the rated current. This enables the use of selective protective relays. The alternator must be relieved from the sustained short-circuit current in 5 seconds.

Unbalanced load

In accordance with VDE 0530, the alternator can withstand unbalanced loading of up to 20%. It should be noted, however, that the voltage variation and the rated outputs indicated in the tables are not attained under unbalanced load.

Overload

In accordance with VDE 0530, the alternator can have an overload of 1.5 times of the rated current at rated voltage for 2 minutes.

The alternator has been designed to match the overload capabilities of diesel engines. For one hour out of every 6 hours, the alternator can supply 110% of rated power without harmful overheating. (Also see page 09, overload data for marine alternators.)

Parallel operation

During such a short period for no break load transfer, alternators can be operated in parallel regardless of design variants and manufacturer.

Continuous parallel operation between **HFC7** and **HFJ7** alternators is possible, provided that following points be fulfilled:

1. All alternators equipped with **damper windings** which reduce phase swinging in parallel operation
2. **Active load sharing** controlled with the governor of the driving engine. The speed characteristics of the engine should be linear, turing change-over from rated load to no-load and the speed variation should fall between 3 to 5% of the rated speed
3. **Reactive load** sharing assured by droop compensation or cross current compensation device

A droop compensation device can be fitted into the main body for HFC7 280 to 356 if requested (extra cost) and is also available for HFC7 40 to HFC7 80.

Owing to the droop compensation device provided, alternators are suitable for parallel operation with other alternators, having the same voltage droop or supply system.

Neutral point connection

Direct interconnection of alternator neutrals and/or those of transformers and load neutrals may give rise to circulating current by three times of the power frequency in the neutral conductors.

The magnitude of these currents must be measured in the alternator neutral conductors under the highest conceivable load condition. To avoid thermal overloading of the alternators the circulating currents occurring at three times of the rated frequency should not exceed about 50% of the alternator rated current. Higher current values should be limited by means of neutral reactors or other equivalent means.

Protection equipment

The stator winding can be provided with thermal protection in the form of PTC sensors or resistance thermometers (optional).

Please inquire when alternator protection gear necessitates opening of neutral. Please indicate type designation if it is intended to use a star-point current transformer.

Alternators to be operated in parallel should be provided with reverse power protection. The necessary monitoring and tripping devices must be provided separately and are not included in the alternator scope of supply.

Special Provisions for Marine Alternators

In addition to compliance with the standards and codes quoted on page 03, HFC7 and HFJ7 marine alternators also conform to the requirements of the following classification societies:

Classification society	Abbreviation Coolant	temperature (CT)°C
American Bureau of Shipping	ABS	45, 50
Bureau Veritas	BV	45, 50
China Classification Society	CCS	45, 50
Det Norske Veritas	DNV	45
Germanischer Lloyd	GL	45
Korean Register of Shipping	KR	45, 50
Lloyd's Register of Shipping	LRS	45, 50
Registro Italiano Navale	RINa	45, 50

Marine alternators can also meet the requirements of other classification societies such as

Polish Register of Shipping (PRS) Russian Maritime Register of Shipping

In case of shaft alternators (driven by the main engine of turbine), attention must be paid to the special speed characteristics and to the excess torque protection, if applicable. Please inquire for further information.

Works inspection and acceptance

Marine alternators are subject to works inspection and acceptance as stipulated in the table below:

Abbreviation	Work inspection	Acceptance
ABS	≥ 100 kW	≥ 100 kW
BV	≥ 100 kW	all
GL	—	≥ 50 kVA
LRS, RINa	≥ 100 kW	≥ 100 kW
DNV	all	all

Alternator intended particularly for ship's propulsion system are subject to works inspection and acceptance test, irrespective of the output rating.

Overload requirements (Also refer to Overload, page 09.)

Rules	Overload current in % of rated current	Overload duration	Remarks
VDE	150	2 min	-
ABS	150	30 sec	no overload capability specified upon owner's request only; steady-state temperature rise from previous operation not to be more than 15K
	125	2 h ¹⁾	
BV	150	2 min	at p.f.0.6 (lagging)
GL	110	2 min	at p.f.0.5 (lagging)
LRS	150	15 sec	-
DNV	150	30 sec	only for alternators at p.f.0.6 and rated frequency
RINa	150	2 min	at p.f.0.6 (lagging)

¹⁾ The rated output given in the selection tables is to be reduced to 88%.

During overload testing, the voltage must be kept as close as possible to its rated value.

Air/water cooler

If required HFJ7 45. to 80. alternators can be supplied with a top-mounted air/water cooler.

The cooler can be used for fresh water or seawater and can be made of double-or single-tube type.

The type designation for the alternator with air/water cooler is HFJ. Due to the closed-circuit cooling system, the degree of protection has been upgraded from IP23 to IP44.

The electrical particulars of the alternators with air/water cooler remain unchanged.

The alternator HFJ can easily be converted for emergency operation as an open circuit air-cooled machine if the coolant system of the cooling element fails. In such a case, the degree of protection is IP23 with the rated output maintained.

Please always provide the following information for any inquiry:

- Coolant temperature (air)
- Cooling water inlet temperature
- Fresh water or seawater
- Type of cooler (single or double tube)

Classification society rules

Classification society	Anti-condensation heating ¹⁾ (Also see page 08.)	Thermometer Temperature sensor (See page 12, protection equipment.)
ABS	For alternators with a total weight (less shaft) of more than 1000 lbs (~450kg) applicable for HFC7 280 and above	Resistance thermometer to measure the temperature of stator winding for the output of 500 kVA and above
GL	For alternators with 500 kVA and above	Temperature sensors in the stator winding for alternators with air filters; thermometer in the cooling air circuit and a temperature sensor in the stator with air/water cooler; bearing thermometer for sleeve bearings; alarm device for excessive temperature rise in bearing with external lubrication
LRS	For alternators with 500 kVA and above	Temperature sensor in the cooling air circuit for alternators with air/ water cooler.

¹⁾ It is always recommended that alternators for emergency and port use be ordered with anti-condensation heater, regardless of the classification society rules.

Notes for The Selection of Alternators



Three-Phase Brushless
Synchronous Alternators

Determination of output and current

$$P_a = \frac{S \cdot \cos \phi \cdot 100}{\eta}$$

$$S = \frac{P_a \cdot \eta}{\cos \phi \cdot 100}$$

$$I = \frac{S \cdot 1000}{\sqrt{3} \cdot U}$$

P_a : Power input in kW

I : Current in A

S : Alternator output in kVA

η : Efficiency in %

U : Voltage in V

(Also refer to site rated output, page 06.)

Standard design of the alternator

Brushless

THYRIPART® - excitation with thyristor regulator

Class F insulation

Radio interference suppression N to VDE 0875

Main terminals (U, V, W)

Cable entry plate undrilled

Type of construction;

IM B5/20 with HFC7 18. to 40.

IM B3 with HFC7 45. to 56. and HFC7 63. to 80.

IM B20 with HFC7 45. to 56. and HFC7 63. to 80.

Flange and shaft extensions to DIN

Degree of protection IP23.

Antifriction bearings (sleeve bearing for marine alternators ; HFJ7 and HFC7)

Damper winding

Droop compensation (built-in)

for HFC7 40. to 56. and HFC7 63. to 80.

Optional accessories and variations to standard design

- Reference value setter (for control pannel)
- 3 or 6 PTC temperature sensors (alarm and/or trip)
- 3 resistance thermometers Pt 100 (6 thermometers for HFC7 350 and above)
- Radio interference suppression grade K to VDE 0875
- Anti-condensation heater
- Miniature Pt 100 screw-in resistance thermometers for bearing installation for HFC7 350 and above
- Droop compensation
- Star-point current transformers for HFC7 45. to 56. and HFC7 63. to 80.
- Air filter
- Air/water cooler for HFJ7 45. to 56. and HFJ7 63. to 80.

Spare parts

Recommended spare for stock purpose

- Bearing or bearing shells for sleeve bearing (as applicable)
- Rotating rectifier stack
- Rectifiers for the excitation equipment
- Voltage regulator

Three-Phase Brushless Synchronous Alternators



Selection Tables

450/260 V, 60 Hz

- 1800 rev/min (4-pole)
- 1200 rev/min (6-pole)
- 900 rev/min (8-pole)
- 720 rev/min (10-pole)

400/231 V, 50 Hz

- 1500 rev/min (4-pole)
- 1000 rev/min (6-pole)
- 750 rev/min (8-pole)
- 600 rev/min (10-pole)

Dimension Tables

HFC7 280 to HFC7 406

HFC7 454 to HFC7 806

HFJ7 564 to HFJ7 806

Selection Tables 450/260 V, 60 Hz 1800 rev/min (4-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

Column				Rules	Net Weight	Moment of inertia (J)	Rated current at 450 V, 60 Hz
1	2 CT	3	4				
°C	°C	°C	°C				
40	45	50	55	VDE			
-	-	40	45	KR			
-	-	-	50	ABS			
-	40	45	50	BV			
40	45	-	-	GL			
-	40	45	50	LRS			
35	-	45	-	DNV			
-	45	50	-	RINa			
					B16 approx.	approx.	
kVA	kVA	kVA	kVA		kg	kg m2	A
1800 rev/min (4-pole)					IP23		
130	125	120	118	HFC7 280-4	700	1.98	167
170	160	155	150	282	710	2.07	218
210	205	200	195	284	920	3.01	269
255	250	235	230	286	930	3.20	327
310	300	290	280	HFC7 350-4	1,220	4.3	398
350	340	330	320	352	1,280	4.6	449
445	435	425	415	354	1,400	5.2	571
560	530	515	500	356	1,600	6.4	718
570	560	545	525	HFC7 400-4	1,750	9.1	731
650	620	600	585	402	1,820	9.6	834
690	660	630	605	404	1,910	10.9	885
740	710	680	650	406	1,955	11.4	949
1,015	970	945	925	HFC7 454-4	3,000	29.0	1,302
1,230	1,170	1,135	1,105	456	3,100	32.0	1,578
1,390	1,340	1,300	1,270	HFC7 502-4	3,350	34.0	1,783
1,620	1,570	1,530	1,500	504	3,600	37.0	2,078
1,770	1,690	1,640	1,600	506	3,800	40.0	2,271
2,245	2,130	2,075	2,025	HFC7 564-4	4,650	54.1	2,880
2,450	2,400	2,345	2,290	566	5,300	59.5	3,143
2,645	2,590	2,535	2,475	568	5,700	63.0	3,394
2,810	2,725	2,640	2,555	HFC7 632-4	6,980	94.0	3,605
3,285	3,190	3,085	3,000	634	7,400	102.0	4,215
3,710	3,605	3,490	3,380	636	7,950	109.0	4,760
3,905	3,785	3,670	3,555	HFC7 710-4	8,800	155.0	5,010

Selection Tables 450/260 V, 60 Hz 1200 rev/min (6-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

Column								
1	2	3	4					
°C	CT °C	°C	°C					
40	45	50	55	VDE				
		40	45	KR				
-	-	-	50	ABS				
-	40	45	50	BV				
40	45	-	-	GL		Net	Moment of	Rated current
-	40	45	50	LRS		Weight	inertia (J)	at 450 V, 60 Hz
35	-	45	-	DNV				
-	45	50	-	RINa		B16		
						approx.	approx.	
kVA	kVA	kVA	kVA			kg	kg m2	A
1200 rev/min (6-pole)						IP23		
205	200	195	190	HFC7	350-6	1,160	4.3	263
250	245	240	235		352	1,250	5.8	321
290	285	280	275		354	1,400	7.8	372
400	390	380	370		356	1,460	8.5	513
520	510	500	490	HFC7	404-6	1,810	11.8	667
645	635	625	615		406	2,010	14.1	828
765	745	725	705	HFC7	454-6	2,810	19.6	981
890	870	850	830		456	2,960	22.7	1,142
1,230	1,205	1,180	1,155	HFC7	502-6	3,350	32.8	1,578
1,360	1,330	1,300	1,270		504	3,600	37.2	1,745
1,565	1,535	1,505	1,475		506	4,000	43.2	2,008
1,710	1,680	1,650	1,620		508	4,300	45.5	2,194
1,870	1,830	1,785	1,740	HFC7	564-6	4,900	63.1	2,399
1,940	1,900	1,860	1,840		566	5,200	68.8	2,489
2,100	2,050	2,000	1,950		568	5,400	72.0	2,694
2,700	2,620	2,540	2,450	HFC7	634-6	7,200	146	3,464
3,060	2,980	2,895	2,810		636	7,600	157	3,926
3,230	3,140	3,050	2,955		638	7,800	162	4,144
3,500	3,400	3,300	3,200	HFC7	712-6	9,100	226	4,491
3,900	3,800	3,700	3,580		714	9,700	245	5,004
4,400	4,300	4,200	4,090		716	10,500	277	5,645

Selection Tables 450/260 V, 60 Hz 900 rev/min (8-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

Column				Rules	Net Weight	Moment of inertia (J)	Rated current at 450 V, 60 Hz
1	2 CT	3	4				
°C	°C	°C	°C				
40	45	50	55	VDE			
-	-	40	45	KR			
-	-	-	50	ABS			
-	40	45	50	BV			
40	45	-	-	GL			
-	40	45	50	LRS			
35	-	45	-	DNV			
-	45	50	-	RINa			
					B16 approx.	approx.	
kVA	kVA	kVA	kVA		kg	kg m2	A
900 rev/min (8-pole)					IP23		
670	635	620	605	HFC7 454-8	3,000	29	860
725	685	670	655	456	3,100	32	930
865	820	800	780	HFC7 502-8	3,350	39	1,110
1,025	975	950	925	504	3,600	43.5	1,315
1,250	1,190	1,160	1,130	506	3,800	47.9	1,604
1,380	1,310	1,280	1,250	508	4,100	52.5	1,771
1,570	1,500	1,450	1,415	HFC7 564-8	5,060	92.0	2,014
1,670	1,600	1,545	1,505	566	5,244	96.2	2,143
1,840	1,790	1,730	1,690	568	5,428	102.0	2,361
1,940	1,885	1,825	1,765	HFC7 634-8	6,528	144	2,489
2,385	2,310	2,240	2,170	636	6,720	166	3,060
2,465	2,390	2,315	2,240	638	7,008	180	3,163
3,025	2,930	2,840	2,750	HFC7 712-8	9,200	241	3,881
3,455	3,350	3,245	3,145	714	9,500	266	4,433
3,885	3,765	3,650	3,535	716	9,900	300	4,984
4,445	4,305	4,180	4,045	HFC7 802-8	12,100	440	5,703
5,125	5,040	4,890	4,730	804	13,100	510	6,575
5,895	5,770	5,600	5,420	806	14,500	585	7,563

Selection Tables 450/260 V, 60 Hz 720 rev/min (10-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

Column								
1	2	3	4					
°C	CT °C	°C	°C					
40	45	50	55	VDE				
-	-	40	45	KR				
-	-	-	50	ABS				
-	40	45	50	BV				
40	45	-	-	GL				
-	40	45	50	LRS				
35	-	45	-	DNV				
-	45	50	-	RINa				
					Net Weight	Moment of inertia (J)	Rated current at 450 V, 60 Hz	
					B16 approx.	approx.		
kVA	kVA	kVA	kVA		kg	kg m2	A	
720 rev/min (10-pole)					IP23			
615	600	585	565	HFC7 500-10	3,740	39.6	789	
725	710	690	670	502	3,800	44.3	930	
925	905	880	850	504	3,900	52.0	1,187	
975	950	925	895	506	4,100	58.8	1,251	
1,245	1,210	1,180	1,145	508	4,300	66.0	1,597	
1,400	1,325	1,300	1,255	HFC7 564-10	5,500	102.2	1,796	
1,616	1,530	1,500	1,450	566	5,700	106.9	2,073	
1,777	1,680	1,650	1,595	568	5,900	114.2	2,280	
1,809	1,755	1,700	1,645	HFC7 632-10	6,300	158.2	2,322	
1,948	1,890	1,830	1,770	634	6,800	176.4	2,499	
2,129	2,065	2,000	1,935	636	7,000	184.1	2,731	
2,235	2,170	2,100	2,030	638	7,300	197.2	2,868	
2,795	2,705	2,625	2,545	HFC7 710-10	8,600	274.4	3,586	
2,960	2,865	2,780	2,695	712	9,300	304.4	3,798	
3,180	3,085	2,990	2,900	714	9,700	322.9	4,080	
3,415	3,310	3,210	3,110	716	10,100	339.5	4,381	
3,800	3,680	3,570	3,460	718	10,900	374.7	4,875	
3,890	3,805	3,700	3,595	HFC7 800-10	11,800	456	4,991	
4,345	4,250	4,130	4,015	802	13,000	503	5,575	
5,050	4,940	4,800	4,665	804	14,200	550	6,479	
5,260	5,145	5,000	4,860	806	15,000	596	6,749	

Selection Tables 400/231 V, 50 Hz 1500 rev/min (4-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

Column				Rules	Net Weight	Moment of inertia (J)	Rated current at 400 V, 50 Hz
1	2 CT	3	4				
°C	°C	°C	°C				
40	45	50	55	VDE			
-	-	40	45	KR			
-	-	-	50	ABS			
-	40	45	50	BV			
40	45	-	-	GL			
-	40	45	50	LRS			
35	-	45	-	DNV			
-	45	50	-	RINa			
					B16 approx.	approx.	
kVA	kVA	kVA	kVA		kg	kg m2	A
1500 rev/min (4-pole)					IP23		
120	115	110	106	HFC7 280-4	700	1.98	154
150	145	140	135	282	710	2.07	192
185	180	175	170	284	920	3.01	237
225	220	210	205	286	930	3.20	289
265	255	245	240	HFC7 350-4	1,220	4.3	340
300	290	280	270	352	1,280	4.6	385
380	370	360	355	354	1,400	5.2	488
475	450	440	425	356	1,600	6.4	609
485	480	465	445	HFC7 400-4	1,750	9.1	622
550	530	510	500	402	1,820	9.6	706
585	560	535	515	404	1,910	10.9	
630	605	580	555	406	1,955	11.4	808
855	815	795	785	HFC7 454-4	3,000	29.0	1,097
1,035	985	955	930	456	3,100	32.0	1,328
1,175	1,135	1,100	1,075	HFC7 502-4	3,350	34.0	1,508
1,370	1,330	1,295	1,270	504	3,600	37.0	1,758
1,495	1,430	1,385	1,355	506	3,800	40.0	1,918
1,950	1,850	1,800	1,760	HFC7 564-4	4,650	54.1	2,502
2,125	2,085	2,035	1,990	566	5,300	59.5	2,726
2,295	2,250	2,200	2,150	568	5,700	63.0	2,944
2,360	2,290	2,220	2,145	HFC7 632-4	6,980	94.0	3,028
2,760	2,680	2,590	2,520	634	7,400	102.0	3,541
1,335	3,030	2,930	2,840	636	7,950	109.0	1,713
3,280	3,180	3,085	2,990	HFC7 710-4	8,800	155.0	4,208

Selection Tables 400/231 V, 50 Hz 1000 rev/min (6-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

Column				Rules		Net Weight	Moment of inertia (J)	Rated current at 400 V, 50 Hz
1	2 CT	3	4					
°C	°C	°C	°C					
40	45	50	55	VDE				
-	-	40	45	KR				
-	-	-	50	ABS				
-	40	45	50	BV				
40	45	-	-	GL				
-	40	45	50	LRS				
35	-	45	-	DNV				
-	45	50	-	RINa				
						B16 approx.	approx.	
kVA	kVA	kVA	kVA			kg	kg m2	A
1000 rev/min (6-pole)						IP23		
175	170	165	160	HFC7 350-6		1,160	4.3	225
210	205	200	195		352	1,250	5.8	269
255	245	235	225		354	1,400	7.8	327
340	330	320	310		356	1,460	8.5	436
435	425	415	405	HFC7 404-6		1,810	11.8	558
550	535	520	505		406	2,010	14.1	706
650	625	600	575	HFC7 454-6		2,810	19.6	834
760	730	700	670		456	2,960	22.7	975
1,060	1,030	1,000	970	HFC7 502-6		3,350	32.8	
1,170	1,140	1,110	1,070		504	3,600	37.2	1,501
1,340	1,310	1,280	1,250		506	4,000	43.2	1,719
1,480	1,440	1,400	1,360		508	4,300	45.5	1,899
1,590	1,540	1,490	1,440	HFC7 564-6		4,900	63.1	2,040
1,960	1,885	1,560	1,500		566	5,200	68.8	2,515
1,800	1,740	1,680	1,620		568	5,400	72.0	2,309
2,280	2,200	2,120	2,040	HFC7 634-6		7,200	146	2,925
2,570	2,490	2,410	2,330		636	7,600	157	3,297
2,710	2,630	2,550	2,470		638	7,800	162	3,477
2,920	2,840	2,755	2,670	HFC7 712-6		9,100	226	3,746
3,260	3,180	3,090	3,000		714	9,700	245	4,183
3,670	3,590	3,500	3,410		716	10,500	277	4,709

Selection Tables 400/231 V, 50 Hz 750 rev/min (8-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

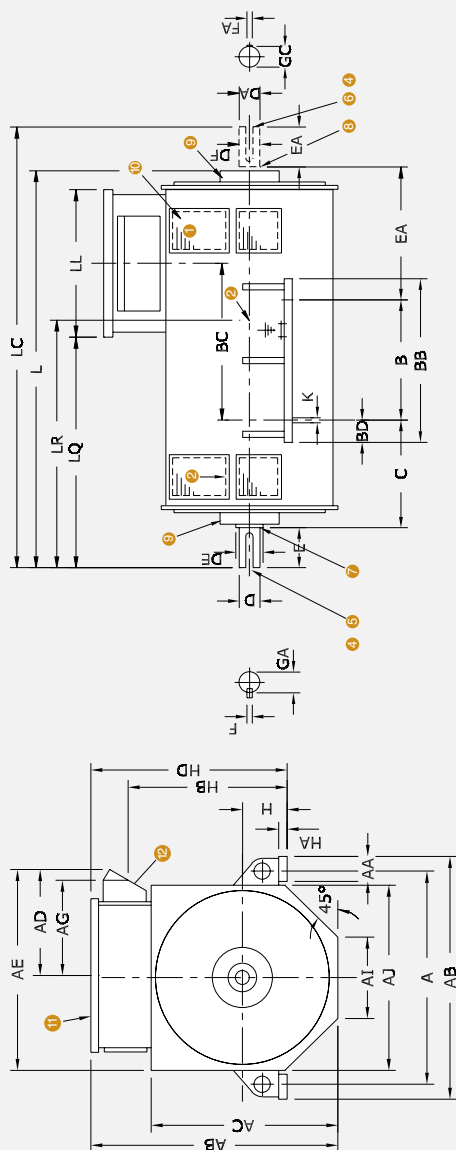
Column				Rules		Net Weight	Moment of inertia (J)	Rated current at 400 V, 50 Hz
1	2 CT	3	4					
°C	°C	°C	°C					
40	45	50	55	VDE				
-	-	40	45	KR				
-	-	-	50	ABS				
-	40	45	50	BV				
40	45	-	-	GL				
-	40	45	50	LRS				
35	-	45	-	DNV				
-	45	50	-	RINa				
						B16 approx.	approx.	
kVA	kVA	kVA	kVA			kg	kg m2	A
750 rev/min (8-pole)						IP23		
555	530	515	505	HFC7 454-8		3,000	29.0	712
605	570	555	545	456		3,100	32.0	776
720	680	665	650	HFC7 502-8		3,350	39.0	924
850	810	790	670	504		3,600	43.5	1,091
1,040	990	965	940	506		3,800	47.9	1,333
1,145	1,090	1,065	1,040	508		4,100	52.5	1,471
1,305	1,245	1,205	1,175	HFC7 564-8		5,060	92.0	1,674
1,390	1,330	1,285	1,250	566		5,244	96.2	1,783
1,530	1,485	1,440	1,405	568		5,428	102.0	1,963
1,610	1,565	1,515	1,465	HFC7 634-8		6,528	144.0	2,066
1,980	1,920	1,860	1,805	636		6,720	166.0	2,540
2,050	1,985	1,925	1,860	638		7,008	180.0	2,630
3,690	3,575	3,470	3,355	HFC7 712-8		9,200	241.0	4,734
4,255	4,185	4,060	3,925	714		9,500	266.0	5,459
4,895	4,790	4,650	4,500	716		9,900	300.0	6,280
3,710	3,590	3,485	3,375	HFC7 802-8		12,100	440.0	4,760
4,275	4,205	4,080	3,945	804		13,100	510.0	5,485
4,915	4,815	4,670	4,520	806		14,500	585.0	6,306

Selection Tables 400/231 V, 50 Hz 600 rev/min (10-pole)

Rated output
at p.f.0.8 to 1.0
and coolant temperature
(CT)···°C

Column								
1	2	3	4					
°C	CT °C	°C	°C					
40	45	50	55	VDE				
-	-	40	45	KR				
-	-	-	50	ABS				
-	40	45	50	BV				
40	45	-	-	GL				
-	40	45	50	LRS				
35	-	45	-	DNV				
-	45	50	-	RINa				
					Net Weight	Moment of inertia (J)	Rated current at 400 V, 50 Hz	
					B16 approx.	approx.		
kVA	kVA	kVA	kVA		kg	kg m2	A	
600 rev/min (10-pole)					IP23			
510	550	485	475	HFC7 500-10	3,740	39.6	654	
605	590	575	555	502	3,800	44.3	776	
770	750	730	705	504	3,900	52.0	988	
810	790	770	745	506	4,100	58.8	1,039	
1,035	1,005	980	950	508	4,300	66.0	1,328	
1,165	1,100	1,080	1,045	HFC7 564-10	5,500	102.2	1,495	
1,340	1,270	1,245	1,205	566	5,700	106.9	1,719	
1,475	1,395	1,370	1,325	568	5,900	114.2	1,892	
1,505	1,460	1,415	1,370	HFC7 632-10	6,300	158.2	1,931	
1,620	1,575	1,525	1,475	634	6,800	176.4	2,078	
1,775	1,720	1,665	1,610	636	7,000	184.1	2,277	
1,860	1,805	1,750	1,690	638	7,300	197.2	2,386	
2,325	2,250	2,185	2,120	HFC7 710-10	8,600	274.4	2,983	
2,465	2,385	2,315	2,245	712	9,300	304.4	3,163	
2,645	2,565	2,490	2,415	714	9,700	322.9	3,394	
2,840	2,755	2,670	2,590	716	10,100	339.5	3,644	
3,160	3,065	2,970	2,880	718	10,900	374.7	4,054	
3,240	3,170	3,080	2,995	HFC7 800-10	11,800	456	4,157	
3,620	3,540	3,410	3,345	802	13,000	503	4,644	
4,205	4,115	3,995	3,885	804	14,200	550	5,395	
4,380	4,285	1,465	4,045	806	15,000	596	5,620	

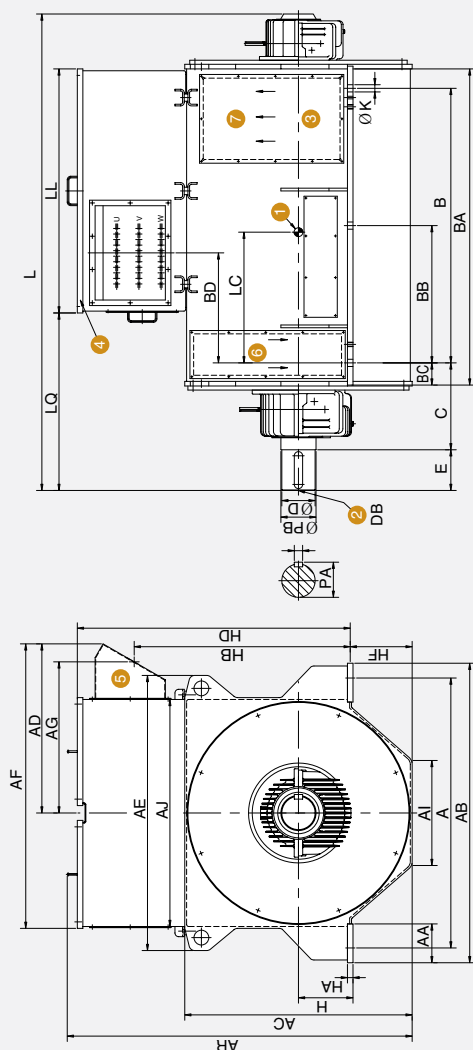
HFC7 280 to HFC7 406 Type of construction IM B20 Anti-friction bearing



- 1 Air inlet
- 2 Air outlet
- 3 Center of gravity
- 4 Shaft end to DIN 748
- 5 Tapped hole DB to DIN 332
- 6 Tapped hole DC to DIN 332 from HFC7 354
- 7 Relief groove DG to DIN 509
- 8 Relief groove DH to DIN 509 from HRC7 354
- 9 Greasing nipple from HFC7 350
- 10 Covering for rotating rectifier multicore
Cover for terminals and excitation equipment
Cable gland for multicore cable

[illegible]

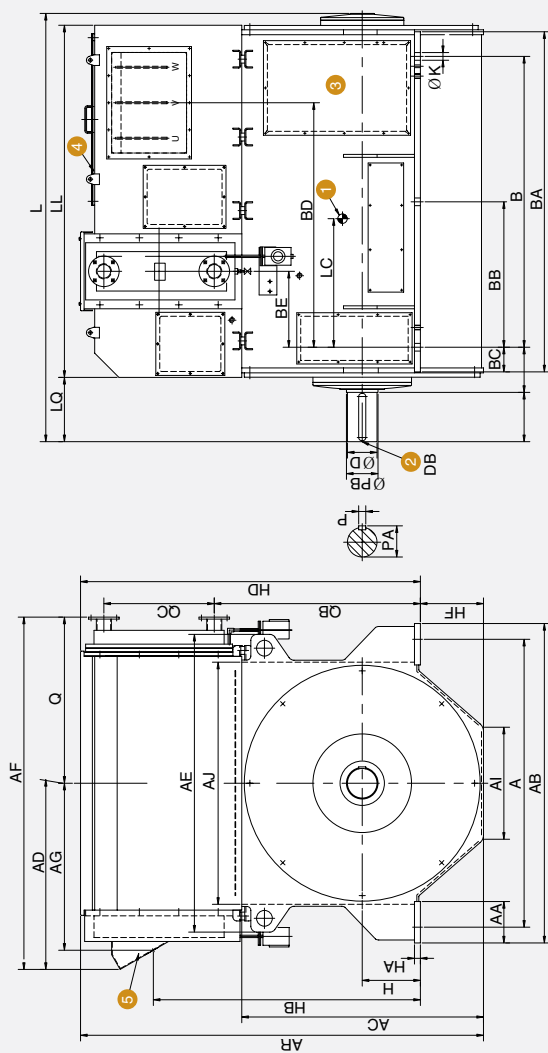
HFC7 454 to HFC7 806 Type of Construction IM B20 Sleeve bearing



- ① Center of gravity
- ② Tapped hole DB to DIN 332
- ③ Cover for rotating rectifier
- ④ Cover for terminal and excitation equipment
- ⑤ Cable gland holder
- ⑥ Air outlet
- ⑦ Air inlet

Type HFC7	No. of Poles	Unit = mm																																
		A	AA	AB	AC	AD	AE	AF	AG	AJ	AR	B	BA	BB	BC	BD	C	H	HA	HB	HD	HF	K	L	LC	LL	LQ	Shaft end						
454	4 or 8	1060	150	1210	914	675	1220	1220	604	442	894	1300	690	900	345	105	515	664	185	30	1040	260	260	2140	807	625	807	1074	Ø110	M24	185	28	116	Ø110
455/456	4...10	1160	180	1380	1013	726	1212	659	482	994	1430	710	1450	725	125	948	440	247	30	852	1090	250	Ø28	2472	745	644	1286	Ø120	M24	220	32	127	Ø120	
502																																		
504																																		
506	4...10																																	
508	8...10																																	
564	4...10	1460	210	1620	1226	944	1510	1786	847	568	1228	2044	1440	1690	720	125	705	466	295	30	1135	1492	259	Ø39	2528	665	1140	1094	Ø160	M24	220	40	169	Ø180
566	4...10																																	
568	4...6																																	
568	8...10																																	
632	4...10	1460	210	1620	1230	915	1488	1539	818	568	1228	1862	1485	1725	742.5	120	595	470	295	30	1184	1492	320	Ø39	2577	707	1320	960	Ø180	M30	220	40	169	Ø190
634	4...10																																	
636	4...10																																	
638	4...6																																	
638	8...10																																	
710	4...10	1540	160	1700	1380	1002	1685	1715	905	776	1403	2016	1700	1930	850	118	622	529	295	35	1270	1576	385	Ø42	2963	729	1490	1126	Ø200	M30	300	50	211	Ø215
712	4...6																																	
712	8...10																																	
714	4...10																																	
716	4...10																																	
718	4...6																																	
718	8...10																																	
800	8...10	1620	190	1800	1460	1100	1800	1850	930	748	1440	2106	1945	2205	400	880	589	510	40	1535	1832	219	Ø42	3355	805	1490	1462	Ø240	M36	318	56	252	Ø250	
802	8...10																																	
804	8...10																																	
806	8...10																																	

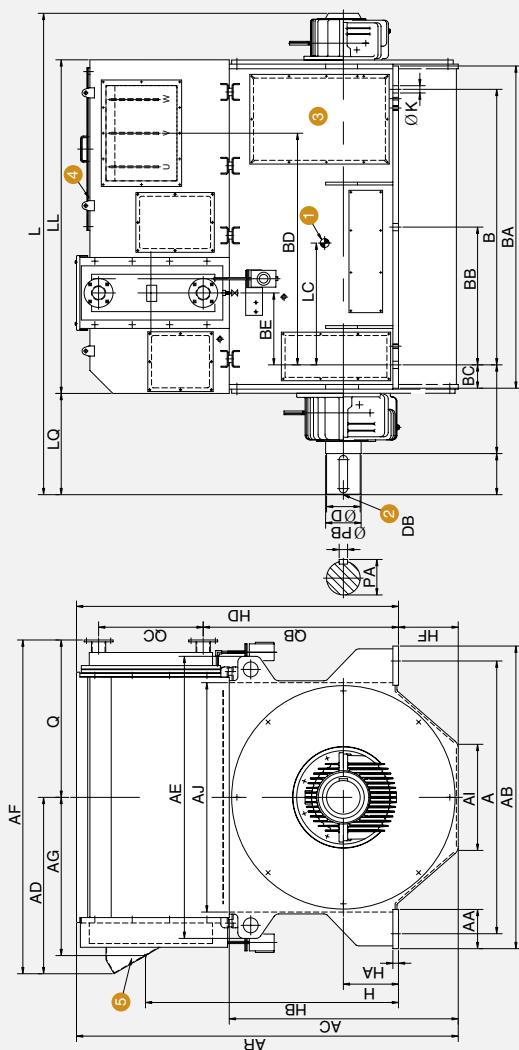
HFJ7 564 to HFJ7 806 Type of Construction IM B20 Anti-friction bearing



- 1 Center of gravity
- 2 Tapped hole DB to DIN 332
- 3 Cover for rotating rectifier
- 4 Cover for terminal and excitation equipment
- 5 Cable gland holder

[illegible]

HFJ7 564 to HFJ7 806 Type of Construction IM B20 Sleeve bearing



- 1 Center of gravity
- 2 Tapped hole DB to DIN 332
- 3 Cover for rotating rectifier
- 4 Cover for terminal and excitation equipment
- 5 Cable gland holder

[illegible]

Order Specification of Synchronous Generator

CUSTOMER : _____
 PROJ. NAME/SHIP NO. : _____
 STANDARD / CLASS : _____
 CUSTOMER CHARGER / TEL. : _____

OUR REF. NO. : _____
 DELIVERY : _____
 QUANTITY : _____
 SALES MAN : _____

- (1) RATED OUTPUT : _____ KVA/kW
 (2) RATED VOLTAGE : _____ V
 (3) RATED FREQUENCY
☐ 50 Hz ☐ 60Hz
 (4) NUMBER OF POLES : _____ P
 (5) RATED SPEED : _____ RPM
 (6) RATED POWER FACTOR

* ☐ 0.8 LAGGING
☐ SPECIAL _____

(7) PHASE AND WIRES

* ☐ 3 PHASE, 3 WIRES, Y-CONN.
☐ 3 PHASE, 4 WIRES, Y-CONN.
☐ SPECIAL _____

(8) INSULATION CLASS / TEMPERATURE RISE

* ☐ F / F ☐ F / B
☐ SPECIAL _____

(9) AMBIENT TEMP./ COOLING MEDIUM TEMPERATURE

☐ 40°C * ☐ 45°C ☐ 50°C ☐ SPECIAL °C

(10) ALTITUDE

* ☐ BELOW 1000 METERS ABOVE SEA LEVEL
☐ SPECIAL _____

(11) OPERATION

☐ PARALLEL OPERATION
☐ WITH COMMERCIAL LINE
☐ WITH THE ONLY IDENTICAL TYPE GENERATOR
☐ WITH THE ONLY OTHER TYPE GENERATOR
☐ ONLY SINGLE OPERATION

(12) PRIME MOVER [MAKER : _____, TYPE : _____]

☐ DIESEL ENGINE
☐ TURBINE
☐ OTHERS

(13) TYPE OF BEARING & Q'TY

- Q'TY ☐ DOUBLE BEARING
☐ SINGLE BEARING

- TYPE OF BEARING

☐ SLEEVE BEARING

LUBRICATION TYPE [☐ SELF LUB., ☐ FORCED LUB.]

☐ ROLLER BEARING

(14) COUPLING

* ☐ RIGID COUPLING
☐ FLEXIBLE COUPLING
☐ SPECIAL _____

NOTE : IN GENERAL, COUPLING BELONGS TO SUPPLY SCOPE OF THE MANUFACTURER OF PRIME MOVER. IN CASE THAT THE SUPPLIER OF GEN. IS REQUESTED TO SUPPLY COUPLING, EXTRA COST SHALL BE CHARGED.

(15) ENCLOSURE

* ☐ DRIP-PROOF / IP23

☐ AIR FILTER

* ☐ NOT REQUIRED
☐ REQUIRED

☐ TOTALLY-ENCLOSED WATER-AIR-COOLED / IP44

☐ COOLER TYPE

* ☐ DOUBLE TUBE TYPE
☐ SPECIAL _____

☐ WATER LEAKAGE DETECTOR

* ☐ REQUIRED

☐ COOLING AIR TEMP. DETECTOR

* ☐ NOT REQUIRED

☐ REQUIRED

☐ PT100 OHM (AT 0°C)

☐ SPECIAL _____

☐ SPECIAL _____

(16) STATOR WINDING TEMP. DETECTOR

* ☐ NOT REQUIRED

☐ REQUIRED, ____ EA PER PHASE [SPEC : _____]

NOTE : CONTROLLER AND/OR INDICATOR FOR STATOR WINDING TEMP DETECTOR ; EXTRA COST

(17) BEARING TEMP. DETECTOR / ONLY FOR SLEEVE BEARING

* ☐ NOT REQUIRED

☐ REQUIRED, 1 EA PER BEARING [SPEC : _____]

NOTE:CONTROLLER AND/OR INDICATOR FOR BEARING TEMP DETECTOR IS OUT OF SUPPLY SCOPE.

(18) ANTI-CONDENSATION HEATER

☐ POWER SOURCE

1 Ø, ☐ 110V ☐ 220V ☐ SPECIAL

(19) DIRECTION OF ROTATION VIEW FROM DRIVE END

☐ CLOCK-WISE

☐ COUNTER CLOCK-WISE

(20) LOCATION OF TERMINAL BOX VIEW FROM DRIVE END

☐ LEFT HAND SIDE

☐ RIGHT HAND SIDE

☐ SPECIAL _____

(21) CABLE ENTRY OPENING

☐ CABLE GLAND

☐ DIRECTION OF CABLE GRAND

☐ CONDUCT SIZE

☐ SPECIAL _____

(22) PAINT COLOR

* ☐ MUNSELL NO. 7.5 B/G 6/1.5

☐ SPECIAL _____

(23) SPECIAL LOAD

☐ UPS

☐ RECTIFIER

☐ SPECIAL

(24) SPARE PART

☐ NOT REQUIRED

☐ REQUIRED, SPECIFY ITEMS AND QUANTITY

(25) TEST AND INSPECTION

☐ HHI STANDARD

☐ OWNER'S INSPECTION

☐ PUBLIC INSTITUTE INSPECTION

☐ SPECIAL _____

(26) SPECIAL REQUIREMENT, PLEASE SPECIFY

NOTE : MARKED * IS HHI STANDARD