



**Medium Voltage AC Drives**

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Shanghai Nancal Electric Co., Ltd.

Shanghai Nancal Electrical Co., Ltd. is the holding subsidiary of Nancal (stock code: 603859). The company is specialize in R&D, production and sale of power electronic products, such as APF (Active Power Filter), SVG (Static Var Generator), Medium Voltage AC Drives, Low Voltage Industrial AC Drives , Shore Power and so on.

Glories

- High technology enterprise, software enterprise
- Type test reports, CE certification, CCS certification
- 15 patents for invention
- 54 patents for utility models
- 61 software copyrights
- Science and technology special award of Chinese Machinery Industry



NC HVPF Series Medium Voltage AC Drives



NC HVPF series medium voltage AC drive is a voltage source inverter based on IGBT and cell series multilevel PWM technology.

Nancal HVPF adopts vector control and combines PWM technology to realize variable frequency speed control of medium voltage motor.

It is used to satisfy the process automation and reducing energy consumption.

NC HVPF can achieve output voltage up to 18kV with perfect sinusoidal waveform by multilevel PWM. It also can directly drive almost all kinds of medium voltage motors without step up transformer.

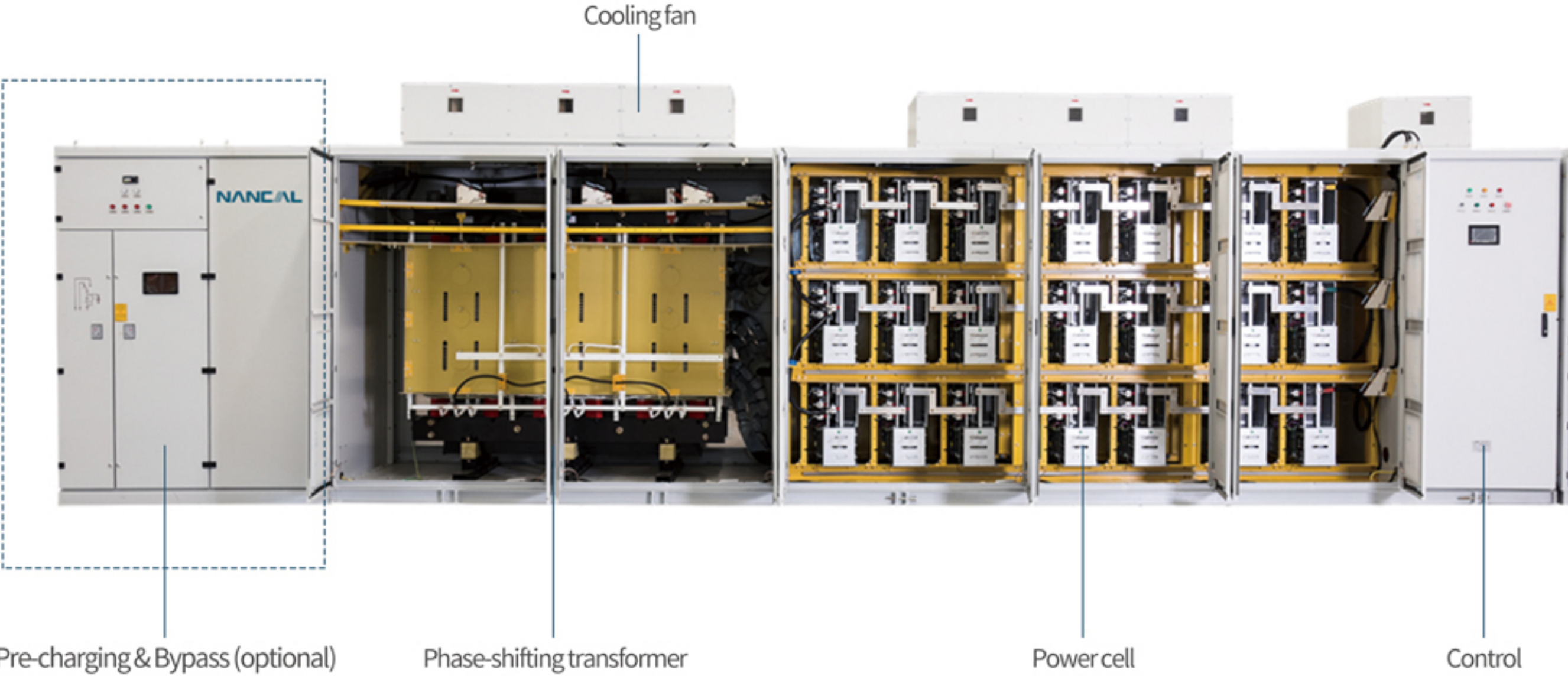
Capacity	220kW-15MW	7MW-65MW
Cooling system	Air cooling	Water cooling
Voltage	2.3kV, 3.3kV, 4.16kV,6kV, 6.6kV, 10kV, 11kV, 13.8KV, 18KV	
Input frequency	50Hz/60Hz ± 10%	
Output frequency	0.5-180Hz (higher on request)	
Load type	Synchronous motor (including permanent magnet motor), Asynchronous motor	
Low harmonic	THDi<2%	
High power factor	Input power factor > 0.95	

- Energy saving
  - Low operation and maintenance cost
- High control accuracy
  - Outstanding reliability
- User friendly HMI

Nancal can provide full range of MV drives from 220kW to 65MW, and has the most successful application cases of large capacity water-cooling drives.



# System Configuration

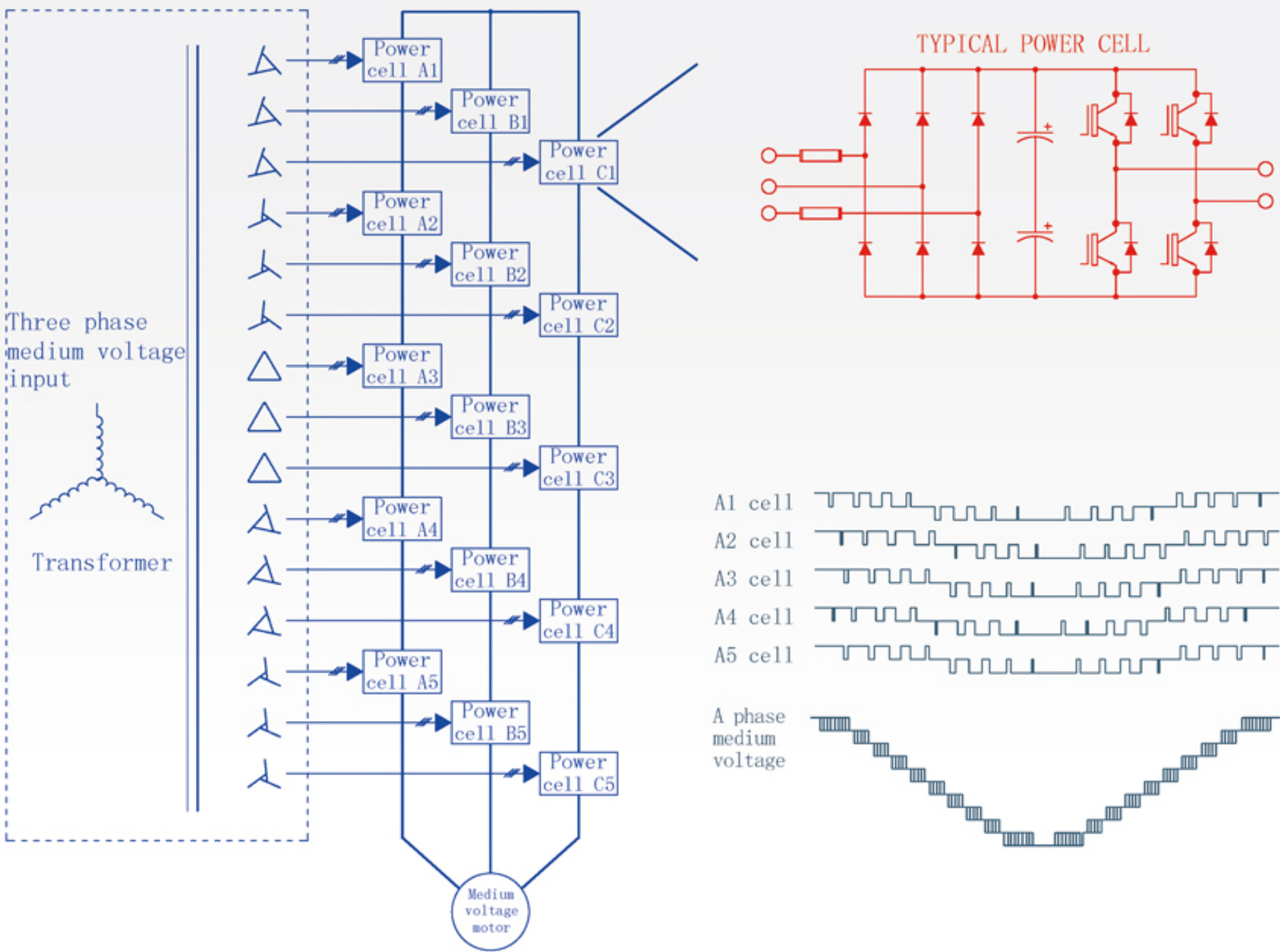


## Options

- Precharging cabinet
- Bypass cabinet (manual, automatic)
- Incoming cabinet
- Output cabinet
- Output reactor
- Power cell bypass
- UPS
- Redundant control power
- Extra I/O
- Redundant cooling fan
- Space heater
- Lighting inside cabinet

For more options, please contact us.

# Topology Structure



Number of cells in series depends on drive output voltage and cell voltage.

Take 690V power cell as an example:

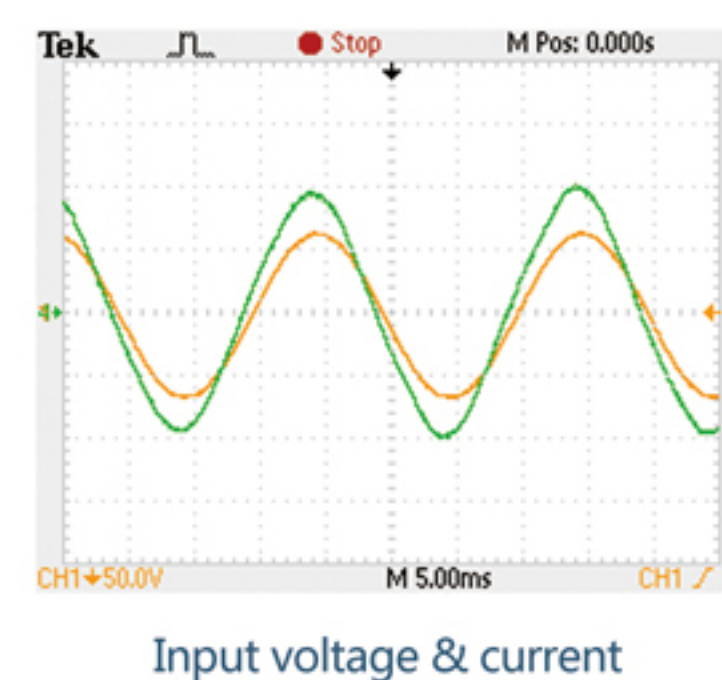
- Output voltage-3kV  
Consist of 9 power cells. Every 3 power cells will be connected in series and constitute a phase. Three phases will constitute a Y connection and directly supply voltage to 3KV motor.
- Output voltage-6.6kV  
Consist of 18 power cells. Every 6 power cells will be connected in series and constitute a phase. Three phases will constitute a Y connection and directly supply voltage to 6.6KV motor.
- Output voltage-10kV  
Consist of 24 power cells. Every 8 power cells will be connected in series and constitute a phase. Three phases will constitute a Y connection and directly supply voltage to 10KV motor.
- Output voltage-11kV  
Consist of 27 power cells. Every 9 power cells will be connected in series and constitute a phase. Three phases will constitute a Y connection and directly supply voltage to 11KV motor.

NC HVVF use cells with different voltage rating including 690V, 1350V, 1450V, 1550V and 1750V, current range from 35A to 2100A.

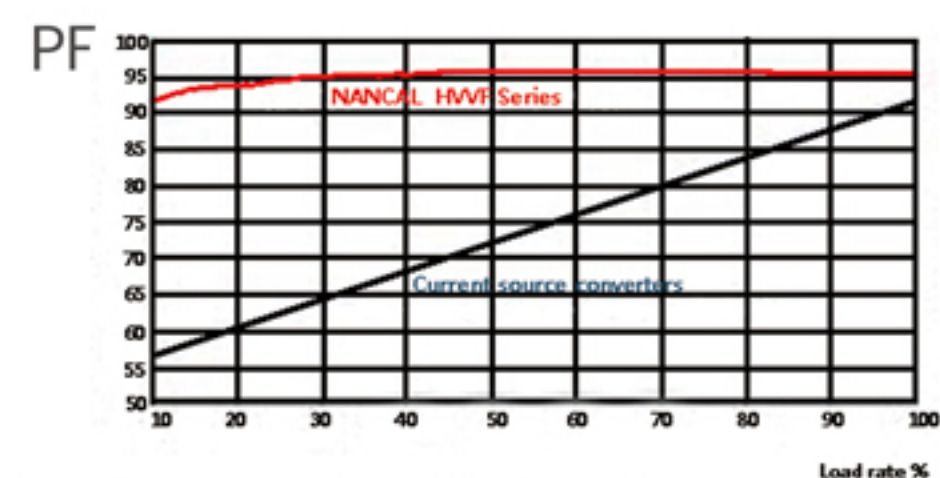


# Features

## Sinusoidal input & high power factor

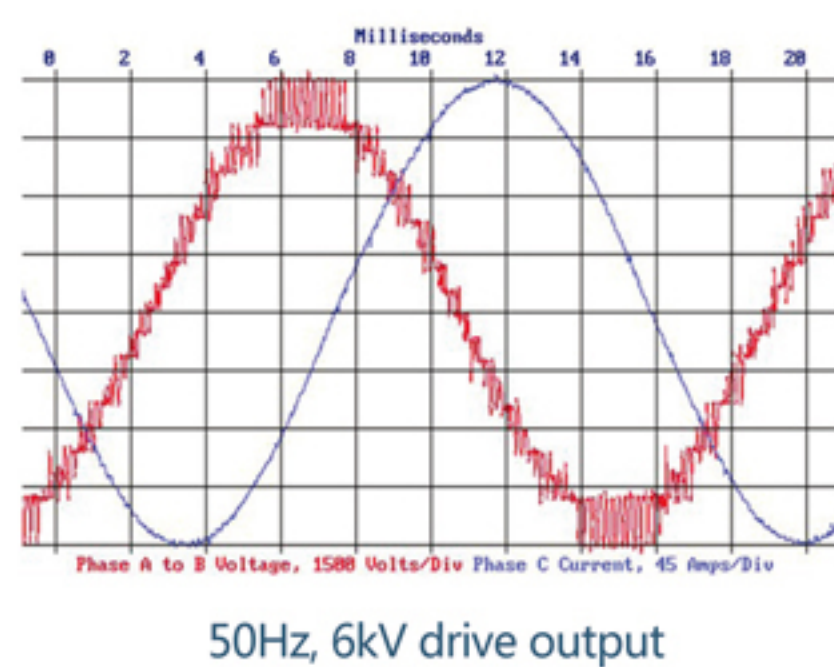


Nancal HWF use multipulse diode rectifier in input side, with phase shifting transformer, typically from 18 pulse to 54 pulse. It complies with the strictest voltage and current harmonic distortion requirements such as IEEE519-1992. No extra harmonic filter required.



Diode rectifier and multiple pulse input guarantee the input power factor over 0.95. No extra power factor correction equipment required.

## Motor friendly output



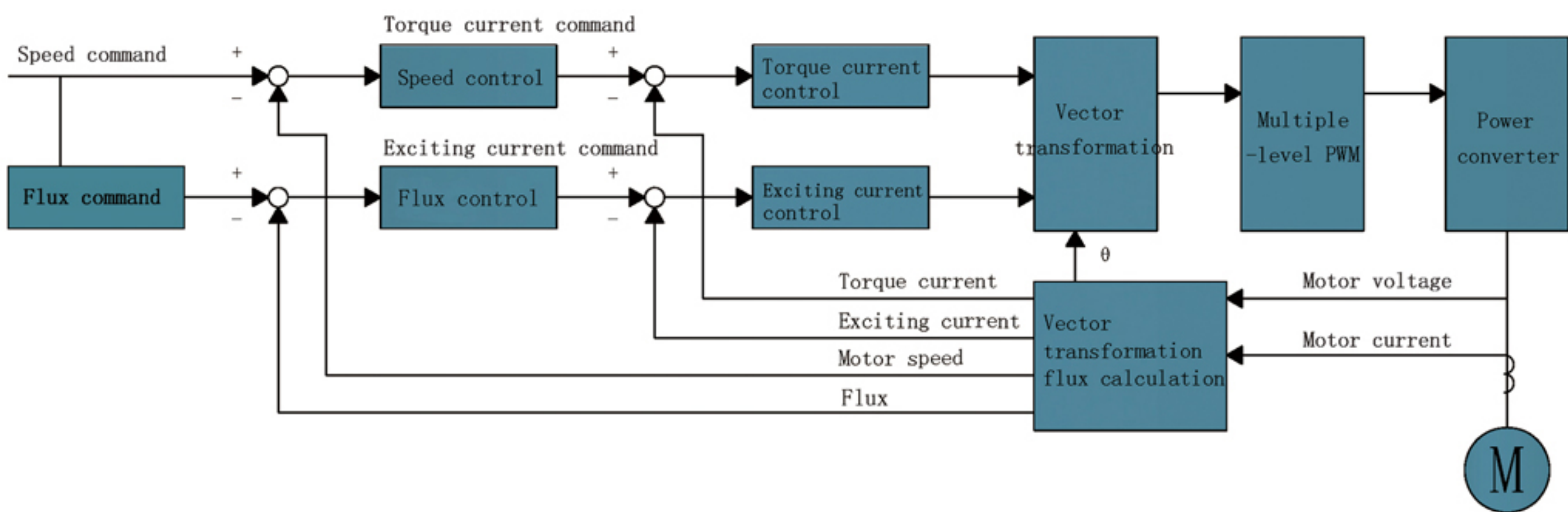
The output of the NC HWF adopts multi-level PWM technology to achieve sinusoidal waveform with very low du/dt. This will not damage the insulation of the cable and motor, also will not cause additional heating and torque pulsation on motor.

- No motor heating problems
- No motor derating
- No limit of output cable length, can be applied to special load like submersible pumps
- No motor insulation problems
- Low torque pulsation
- Low common mode voltage

## High Performance Vector Control

Control Mode	vector control with speed sensor/ vector control without speed sensor/VF control
Speed Range	1000:1(with speed sensor)/100:1(without speed sensor)
Torque Response	<3ms
Speed Accuracy	<0.02% rated speed (with speed sensor) <0.5% rated speed (without speed sensor)

### Schematic of vector control without speed sensor



Motor parameter auto tuning for control optimization.  
Motor stator resistance, rotor time constant online identification, solve motor parameter variation issues result from motor heating/saturation.

Without speed sensor, Nancal HWF also can provide precise speed control, making it suitable for special applications which require high starting torque, high speed accuracy and high dynamic performance.

Even for conventional applications such as fans and pumps, the automatic torque limiting and spinning load pickup function of Nancal HWF can effectively prevent over current at acceleration and over voltage at deceleration, as well as trip caused by power grid fluctuation and other abnormal factors to ensure the continuous operation of the process.

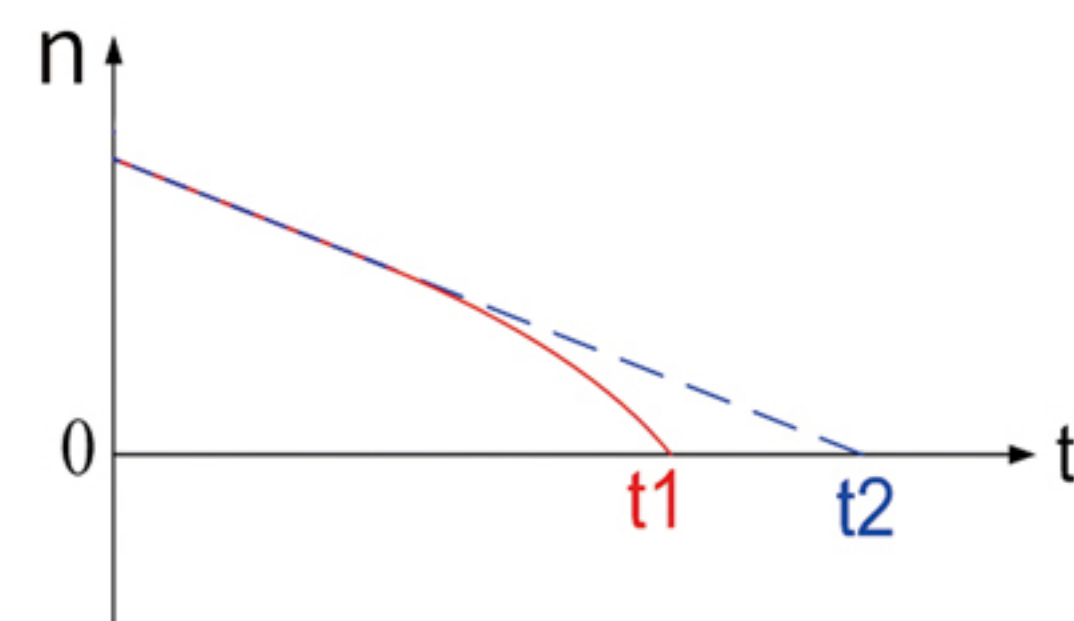
Six phase motor with two starter windings driven by two NC HWF with coordinated control is available for power expansion.



Features

Enhanced Braking Technology

- Enhanced braking technology: flux increased braking, dual-frequency braking and DC braking.
- Sophisticated control algorithm, maximize the braking torque, hence deceleration time of load is minimized.
- Compared with the traditional drive system, typical deceleration time could be reduced by 30%..



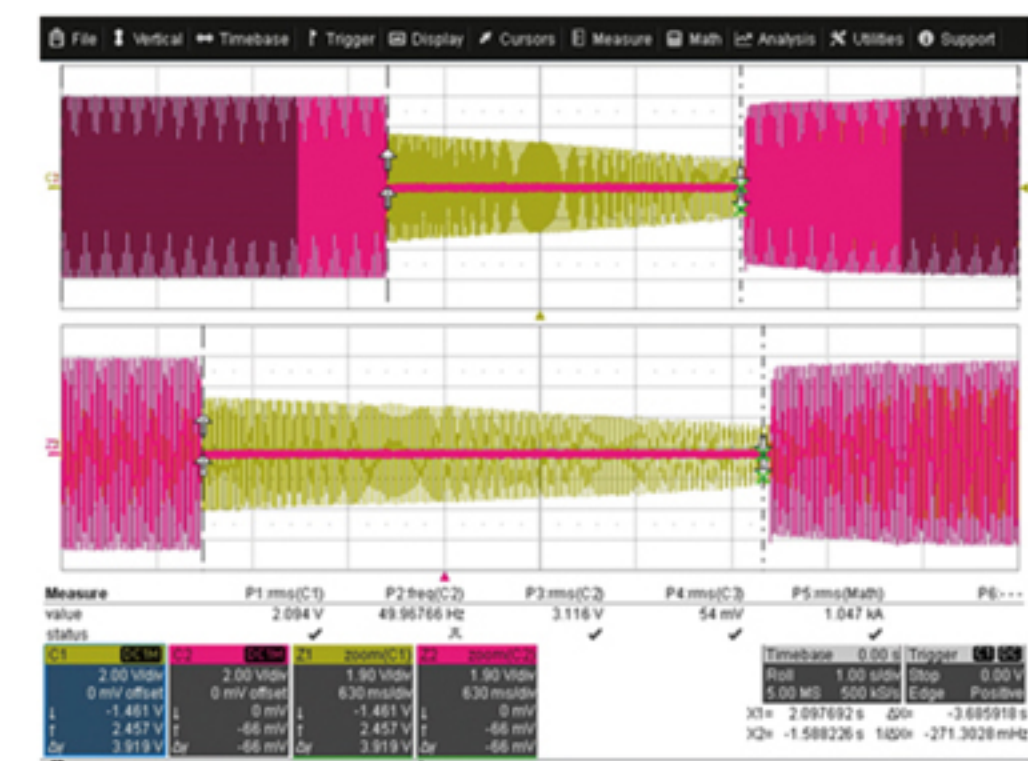
Red: with Flux increased braking  
Blue: without Flux increased braking

ProCon with LVRT (patented)

- ProCon (Process Continuous) is a technological package which could ensure the continuous operating of NC HWF under line fluctuations caused by thunder, storm, etc.
- ProCon integrates multiply technologies including: kinetic energy buffering LVRT (Low Voltage Ride Through), spinning load pickup and intelligent torque limit of quadratic load, etc.

LVRT principle

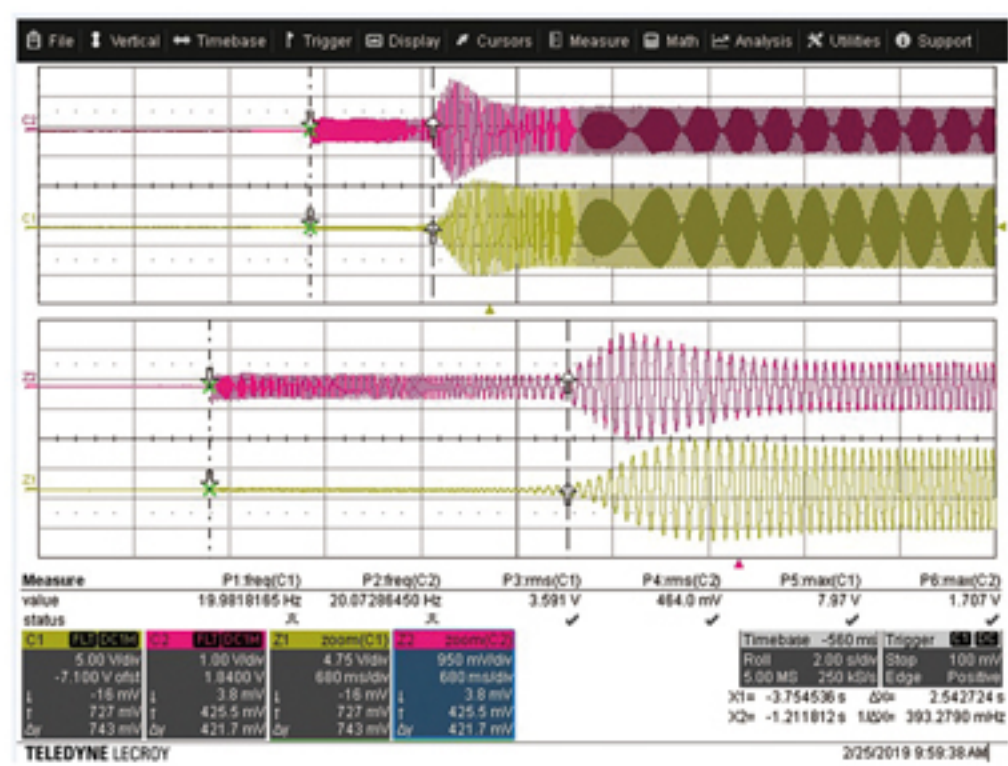
- > Each power cell’ s DC bus voltage sent to master control via fiber optic communication.
- > When cell DC voltage below a certain value, LVRT enable regeneration.
- > Through regereation torque limit, kinetic energy buffering model activated, maintain DC bus voltage level.
- > When power grid and DC bus voltage recover to a certain value, turn off LVRT, back to normal speed regulation.
- > Zero voltage ride through.
- > LVRT up to 5 second for high inertia quadratic load such as blower and compressor.



LVRT

(Red) -- input voltage  
(Yellow) -- output voltage  
The output voltage of drive can hold when the input voltage lost.

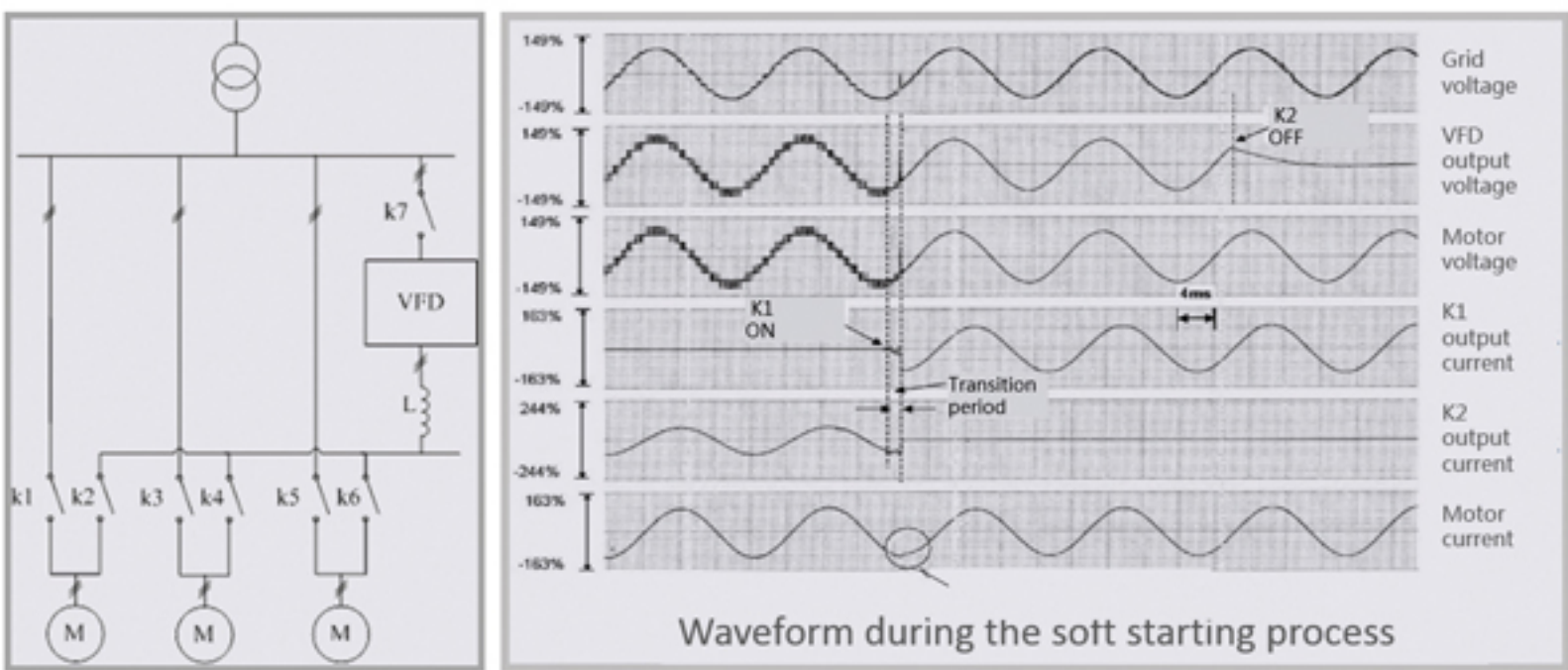
Spinning load pickup



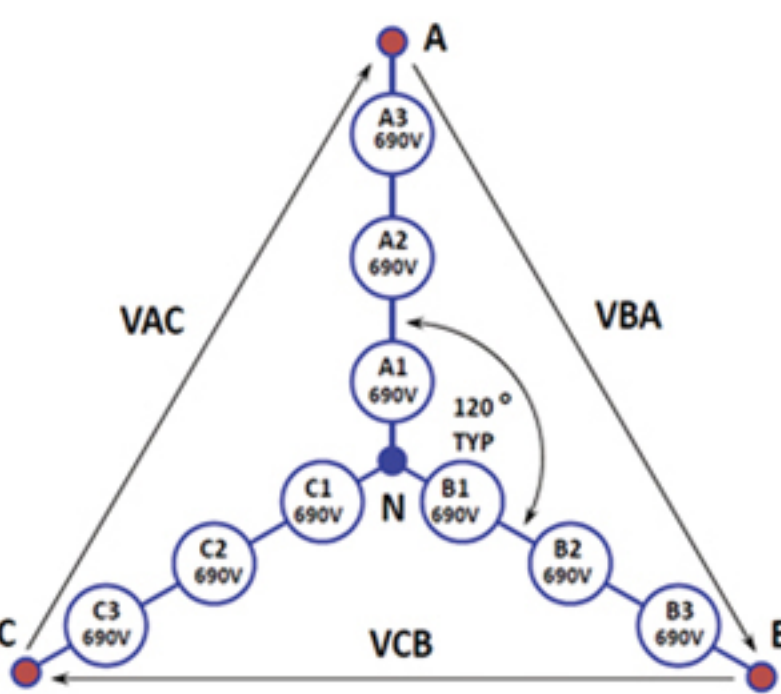
(Red)-- motor current  
(Yellow)--motor voltage  
Pick up the spinning motor at 15Hz in 2.5s

Synchronous Transfer

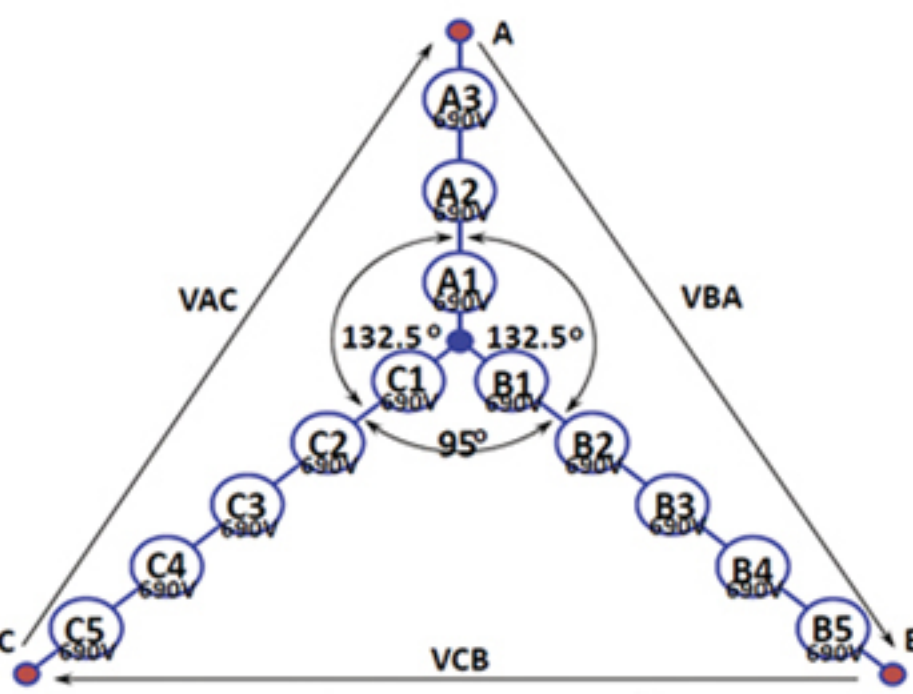
- Nancal HWF with synchronous transfer technology can transfer motor from drive to grid (up transfer) or from grid to drive (down transfer) with very stable motor current during the transition.
- It is widely used in starting multiple motors with single drive to save customer investment.
- NC HWF can also be used as soft starter to start big blowers, pumps, or compressors and transfer it to grid operation. Typically drive will be sized at 30% - 50% of motor rating with damper or valve closed during start.



Cell Bypass with Neutral Point Shift Technology



Traditional cell Bypass Technology



Nancal Neutral Point Shift Technology

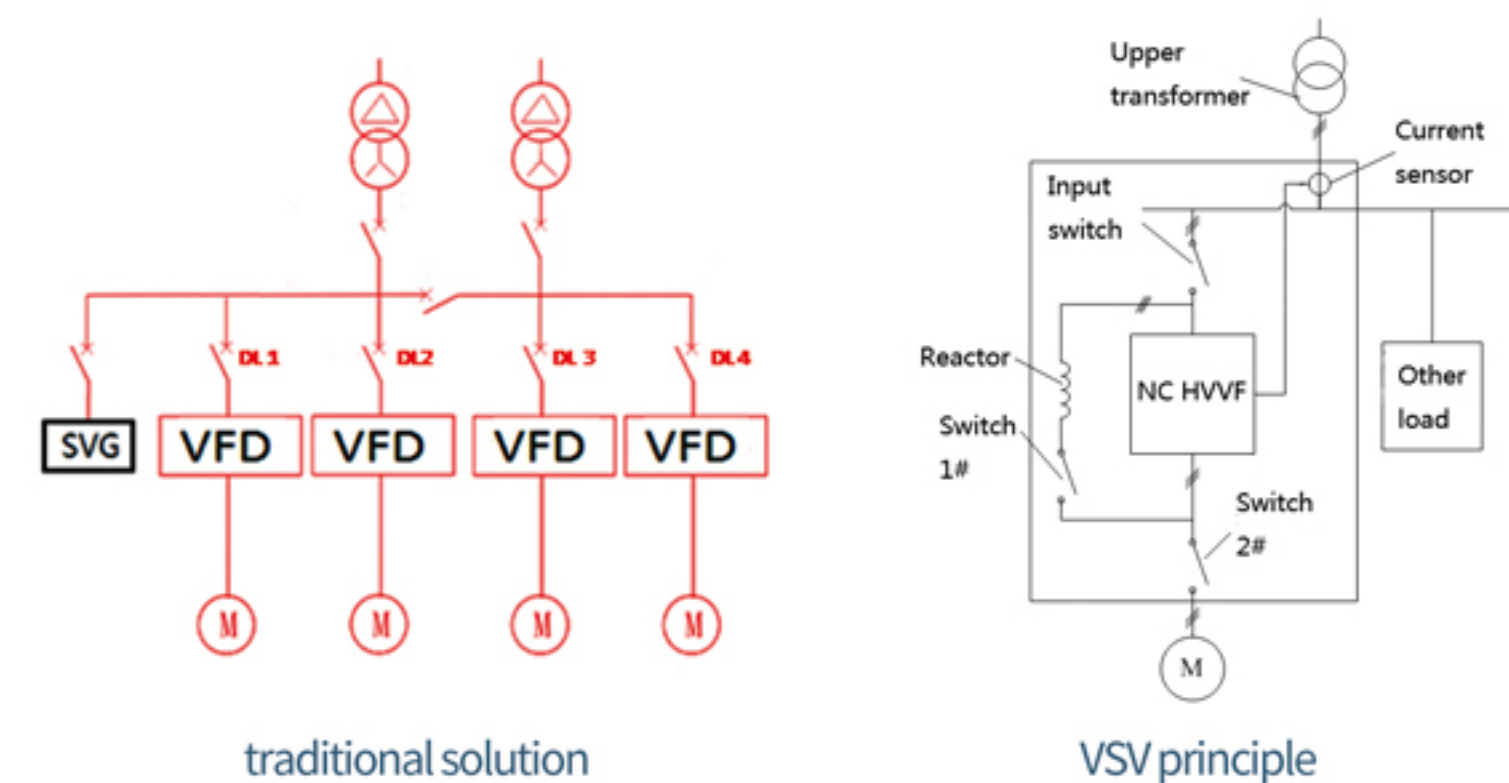


When a power cell failed, the “Neutral Point Shift Technology” (optional) can automatically bypass the faulty cell, the output voltage is automatically phase balanced, and the drive continuous to run, avoiding the loss caused by abnormal shutdown, greatly improving reliability.  
Compared with traditional power cell bypass technology, NC HVVF can ensure maximum output voltage after cell bypass.

If A4 & A5 power cells fail:

- Traditional bypass – A4, A5, B4, B5, C4, C5 bypassed.
- Nancal neutral point shift – only A4, A5 bypassed.

## VSV -- Integrated Motor Drive and SVG Technology (Patented)



No extra SVG required for system which need reactive compensation when motor is idle.

- System run in motor drive mode when input switch and switch #2 closed; run in SVG mode when input switch and switch #1 closed, generating reactive power by providing current on reactor as required.
- Low cost: base on existing drive, only add switch, reactor & software upgrade.
- Small footprint: only add one cabinet for switch and reactor.
- No extra maintenance cost.
- Also used for application with asynchronous motor soft starter, no extra SVG for reactive compensation of asynchronous motor after motor transferred to grid.

## Configurations

### Phase shifting transformer

- Provides the voltage to power cell, as well as isolation between grid and drive.
- Secondaries of transformer are phase shifted to form multiple pulse for harmonic cancelation on primary side.
- Other components in transformer cabinet: cooling fan, related control circuit, temperature monitoring device and interlock protections.
- Dry type transformer and oil immersed transformer is available.



### Power cell

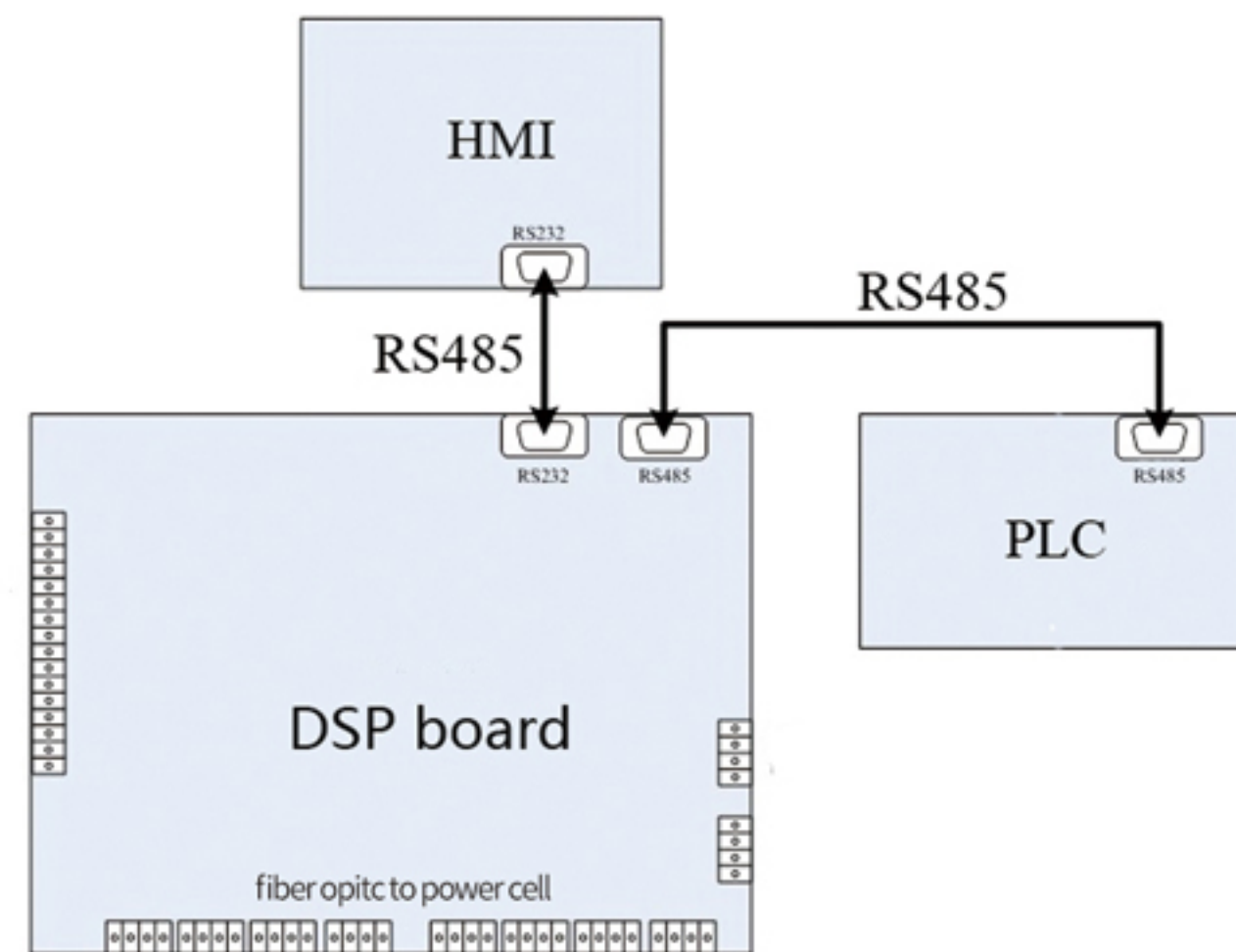
- IGBT based voltage source inverter with three phase input, single phase output.
- Each power cell has complete functions with perfect protections as well as optimized IGBT driving circuit.
- The power cells in one drive has the same mechanic and electric performance and are interchangeable.
- Due to the use of higher voltage IGBTs, NC HVVF requires the least number of power cells to improve the system reliability.
- Air cooling and water cooling, cell voltage rating range from 690V to 1750V, current range from 35A to 2100A.



### Control system

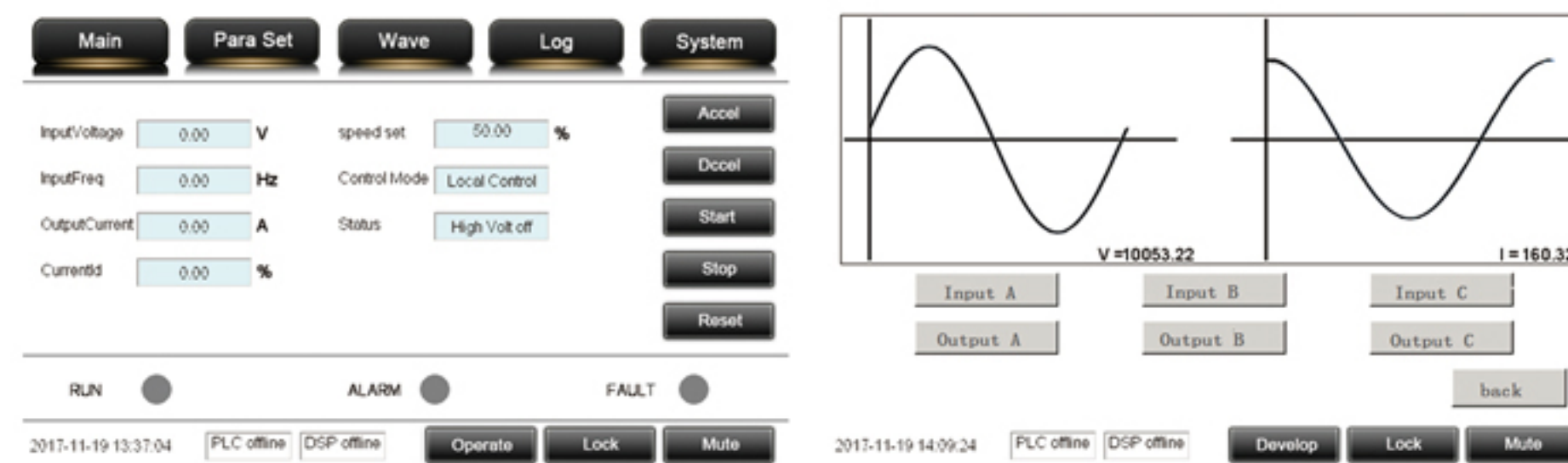
- The drive control system is composed of DSP board, HMI and PLC.
- DSP board: consist of 32-bit high speed digital processor (DSP) & FPGA.
- DSP realize related algorithm associated with vector control, FPGA realize multi-level PWM control and communication to power cells.
- The built in PLC is used for logical processing for internal I/O and for customer I/O; customer I/O is expandable.
- Redundancy design is adopted on the control power. No UPS is required. The control power fluctuation or power outage will not affect running of drive.





## HMI

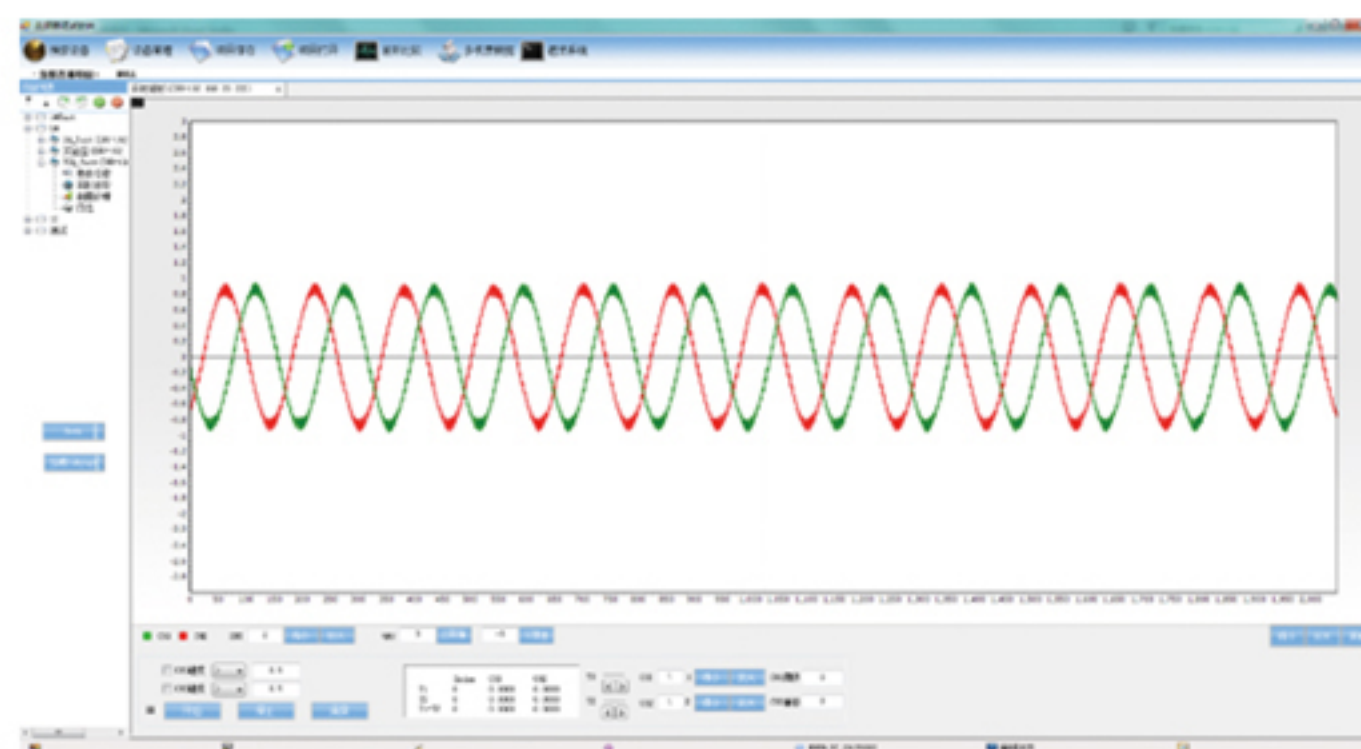
7-inch (10,12,15-inch optional) color touch screen, user friendly HMI. (English and other languages)  
Parameters setting, fault log, event log storage, etc.



## PC software

Powerful PC monitoring software

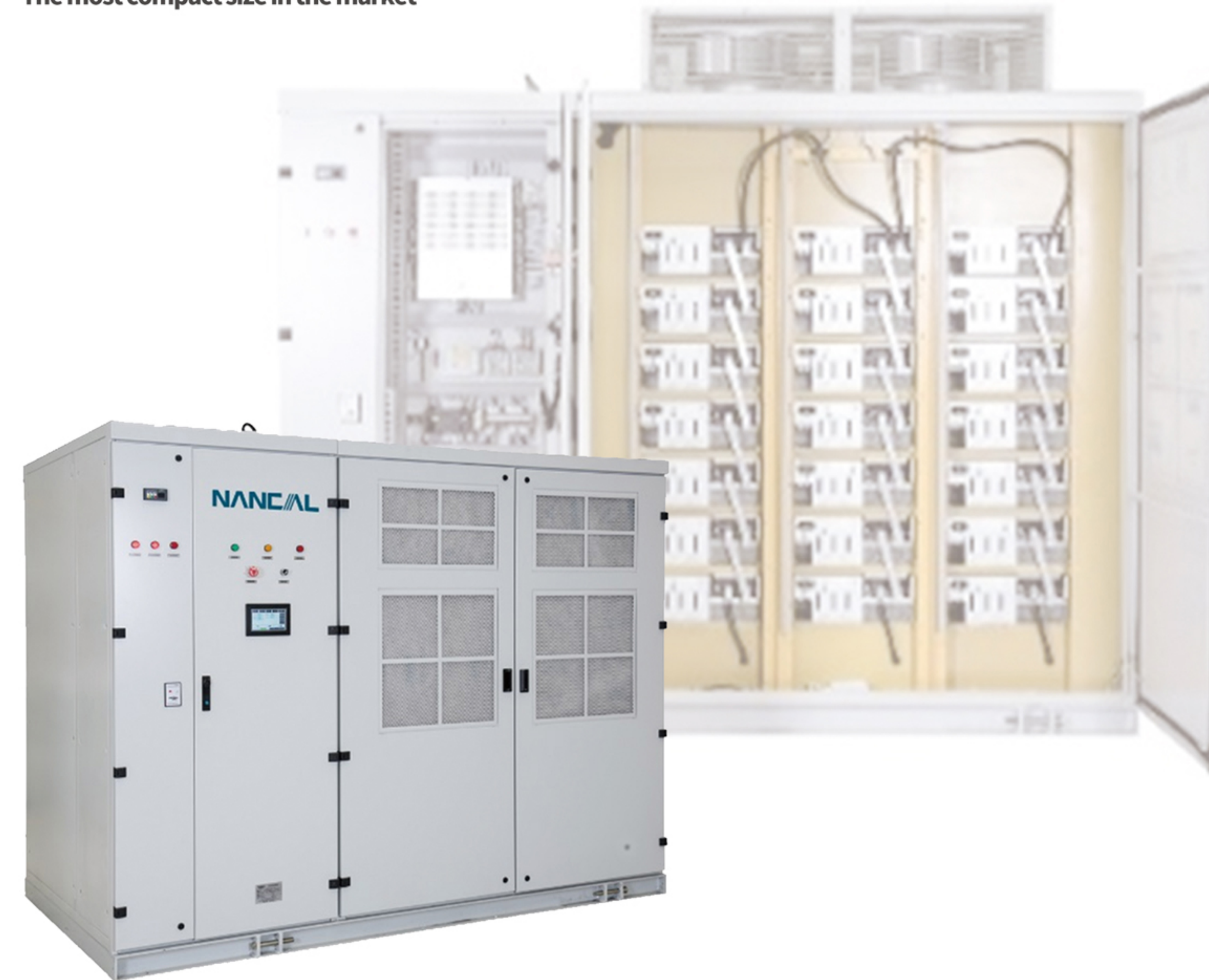
- Graphical user interface, displaying real time data and waveforms
- Debugging without oscilloscope
- Fault diagnostic and historic logs
- Remote access



## Reliable & Compact Design

Mini-series, 220kW-1400kW

**The most compact size in the market**



- Compact cabinet -- can be installed in narrow space such as containers
- Plug in power cell -- easy for maintenance

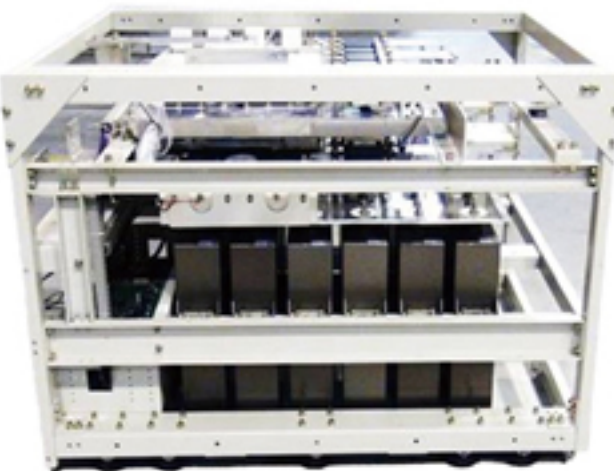




Water cooling  
large capacity up to 65MW

Integrated Power cell

Laminated bus bar, low stray inductance, low loss and high reliability.

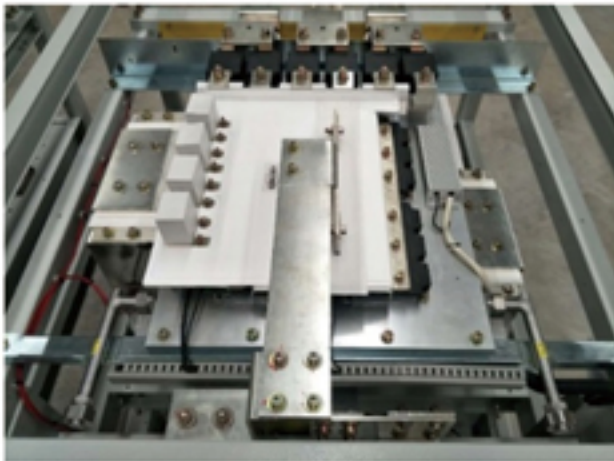


Film capacitor

Increase the product life significantly.

Single cold plate

Each cell only has single cold plate with two water connectors: in and out. Better thermal performance, no leakage risk.



Redundance water pump

Avoid the overheating problems cause by the pump fault.

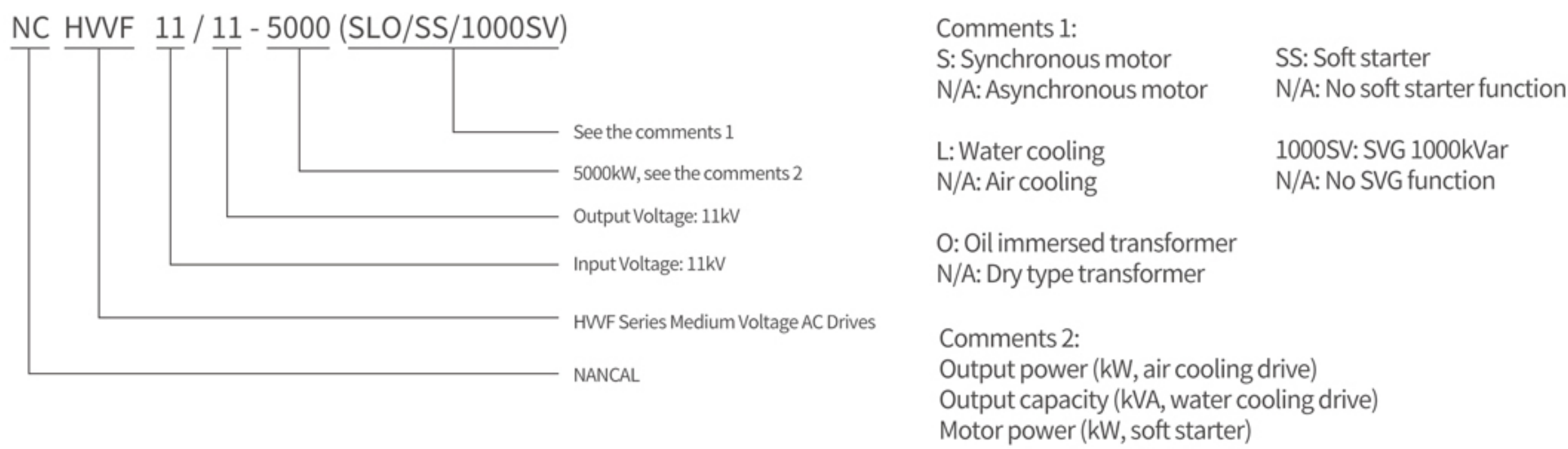


Technical Specifications

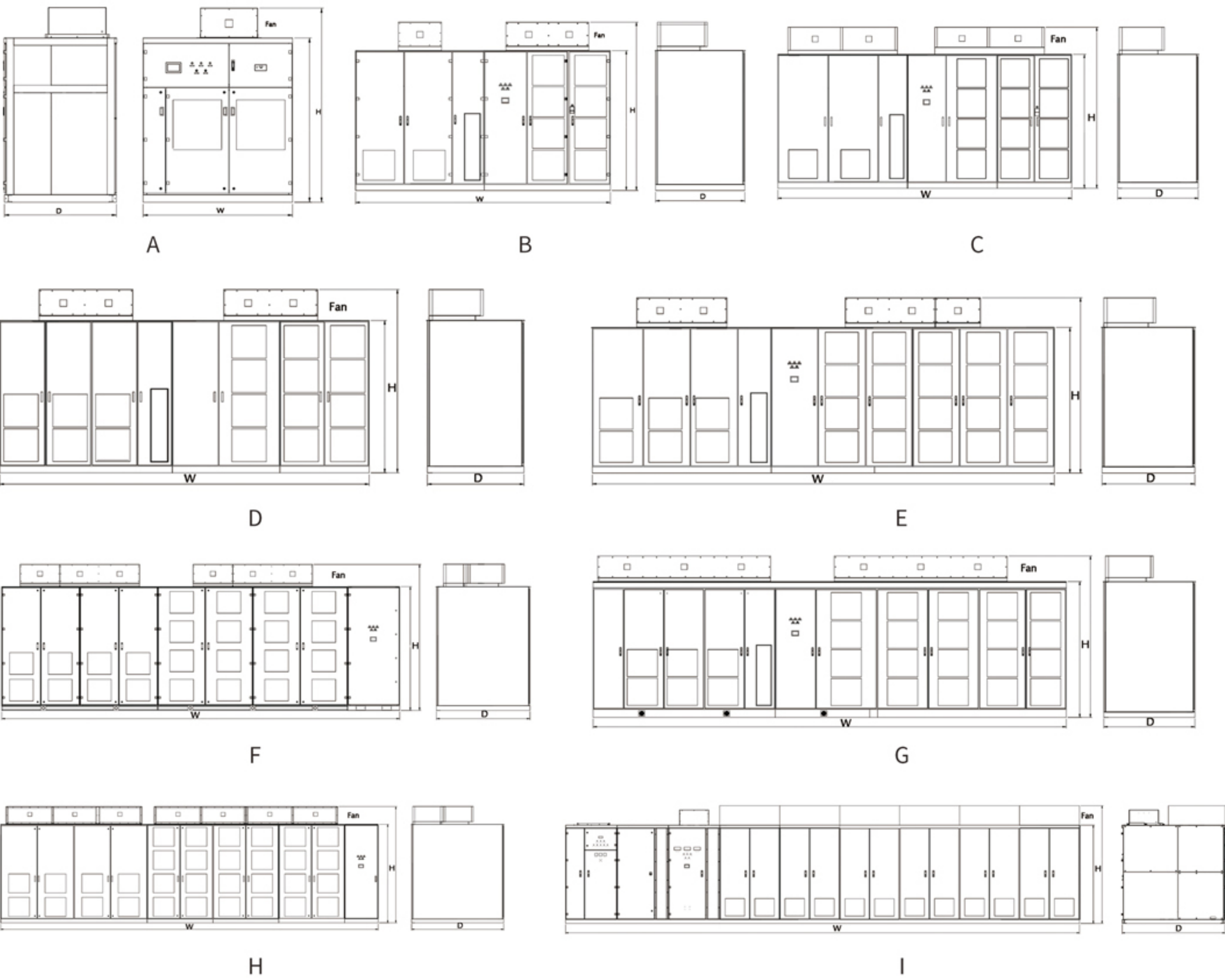
Input	Voltage Frequency Voltage variation Power factor Harmonic	Three-phase, 2.3-35kV 50Hz/60Hz ±10% "-20%~+15% without derating; -40% with derating" >0.95 <2% THDi
Output	Voltage Overload capacity Frequency Waveform Power Current	2.3-18kV 120% 1min., 150% 5s, 200% Immediate trip(special request available) 0 to 180 Hz (higher on request) Multi-level PWM 220-15000kW (air cooling),7000-65000kW (water cooling) 35 A -2100 A
System	Efficiency Driving Method Frequency resolution Control Mode Control power Auxiliary power Acceleration deceleration time Communication/ Protocol	95% ~ 98.5% 2 quadrant operation 0.01 Hz Vector control with speed sensor/ vector control without speed sensor/VF control 1 Ph, AC220V/5A, +20%, -30% (redundancy),DC220,DC110 for option 3Ph, AC380V (other voltage available) 0.1 ~ 3200s (To be determined according to load condition) Modbus ( Standard), Profibus, Ethernet etc. ( optional)
Interface	DI DO AI AO	14 channels 10 channels 2 channels: 0~10 v/4 ~20 mA, 4 channels: 0~10 v/4 ~20 mA,
Monitoring	HMI Display Protections	"7 inch color touch screen(standard) 10 inch or higher on request(optional)" Voltage, current,frequency,power,power factor,total power consumption,efficiency,total running time etc. Overvoltage,overcurrent,overload,transformer overheating, grounding,fan fault,interlock fault etc.
Structure	Enclosure/ Degree of protection Cable entry Cooling type Transformer	IP31(Other on request) Bottom/ Top Air, Water Phase shifting transformer(dry type or oil immersed type)
Environment	Altitude Ambient air temperature Relative Humidity	< 1000 m.a.s.l (higher with derating) -15 to 40° C (derating up to 50°C max) < 95%, no condensation
Certifications	CE, SIL2	
Standards	IEC 61800-3,IEC 61800-4,IEC 61800-5-1,IEC 61800-5-2, IEC 60204-1, IEC 60204-11, IEC61000-2-4,IEC61800-3:2012, IEEE 519-1992	



Nancal model explanation



Outline diagram



Outline diagram is for reference only, please contact us for the latest information.

Specification sheet

Output voltage: 6kV

Motor Power (kW)	Output Current (A)	Dimension with fan W*D*H (mm)	Weight(kg)	Ventilation (m³/min)
220	26	A Type 2000 X 1500 X 2600	3200	138
250	29		3200	138
280	33		3200	138
315	37		3200	138
355	41		3200	138
400	46		3500	138
450	50		3500	138
500	57		3600	138
560	63		3700	138
630	71	A Type 2000 X 1500 X 2600	3800	184
710	81		4000	184
800	90		4200	184
900	102		4700	277
1000	113	A Type 2700 X 1700 X 2200	4800	277
1120	127		4900	277
1250	142		5000	277
1400	159		5500	277
1600	180	B Type 4820 X 1400 X 2900	6000	460
1800	200	C Type 5070 X 1400 X 2900	6500	460
2000	220		7000	460
2240	248		7500	460
2500	275	C Type 5614 X 1400 X 3003	8500	460
2800	309		9500	460
3150	350		10000	460
3550	388	E Type 8150 X2000 X 3276	11800	1160
4000	434		12300	1160
4500	486		12800	1160
5000	546		13800	1160
5600	611		14800	1160
6300	687		15800	1160
7000	792		16800	1160
8000-20000	<2100	Water-cooling		

Note: The current is greater than 800A air-cooling variable frequency and water-cooling variable frequency cabinet size and other parameters please consult the manufacturer.



Specification sheet

Output voltage: 6.6kV

Motor Power (kW)	Output Current (A)	Dimension with fan W*D*H (mm)	Weight(kg)	Ventilation (m³/min)
220	23	A Type 2000×1500×2600	3300	140
250	26		3300	140
280	29		3300	140
315	32		3300	140
355	37		3300	140
400	41		3600	140
450	46		3600	140
500	51		3700	140
560	58		3800	140
630	65		3900	140
710	73	A Type 2200×1500×2600	4100	184
800	82		4300	184
900	93		4700	250
1000	103	B Type 3800×1400×2800	4850	250
1120	115		5000	250
1250	129		5450	375
1400	144	B Type 4030×1400×2800	5700	375
1600	165		6250	375
1800	185	C Type 5070×1400×2900	6750	375
2000	206		7250	375
2240	231		7800	450
2500	257		8800	450
2800	288	D Type 5614×1400×3003	10200	450
3150	324		10500	450
3550	365		12300	540
4000	412	H Type 8150×2000×3276	12800	540
4500	463		13300	540
5000	515		14300	540
5600	576		15300	540
6300	648		15800	540
8000-20000	<2100	Water-cooling		

Output voltage:10kV

Motor Power (kW)	Output Current (A)	Dimension with fan W*D*H (mm)	Weight(kg)	Ventilation (m³/min)
220	16	A Type 2500×1500×2600	3500	138
250	18		3500	138
280	20		3500	138
315	22		3500	138
355	25		3800	138
400	28		3800	138
450	31		3800	138
500	34		4200	138
560	38		4200	138
630	43		4200	138
710	48		4200	138
800	54		4500	138
900	60		4500	138
1000	67		4500	138
1120	75	A Type 2700×1500×2600	4800	184
1250	83		5250	184
1400	94		5450	184
1600	109	A Type 2950 X 1700 X 2200	5800	277
1800	122		5900	277
2000	136		6000	277
2240	152		6500	277
2500	170	D Type 6770 X 1400 X 2900	7000	460
2800	190		7500	460
3150	210		8000	460
3550	235		9000	460
4000	264	F Type 7794 X 1400 X 3003	9500	690
4500	298		10000	690
5000	328		11000	690
5600	365		12000	690
6300	416	G Type 10214 X 2200 X 3276	19000	1353
7100	466		20000	1353
8000	523		21000	1353
9000	583		22000	1353
10000	643		23000	1353
11000	747		24000	1353
11500	781		24500	1353
12000-25000	<2100	Water-cooling		

Note: The current is greater than 800A air-cooling variable frequency and water-cooling variable frequency cabinet size and other parameters please consult the manufacturer.

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Specification sheet

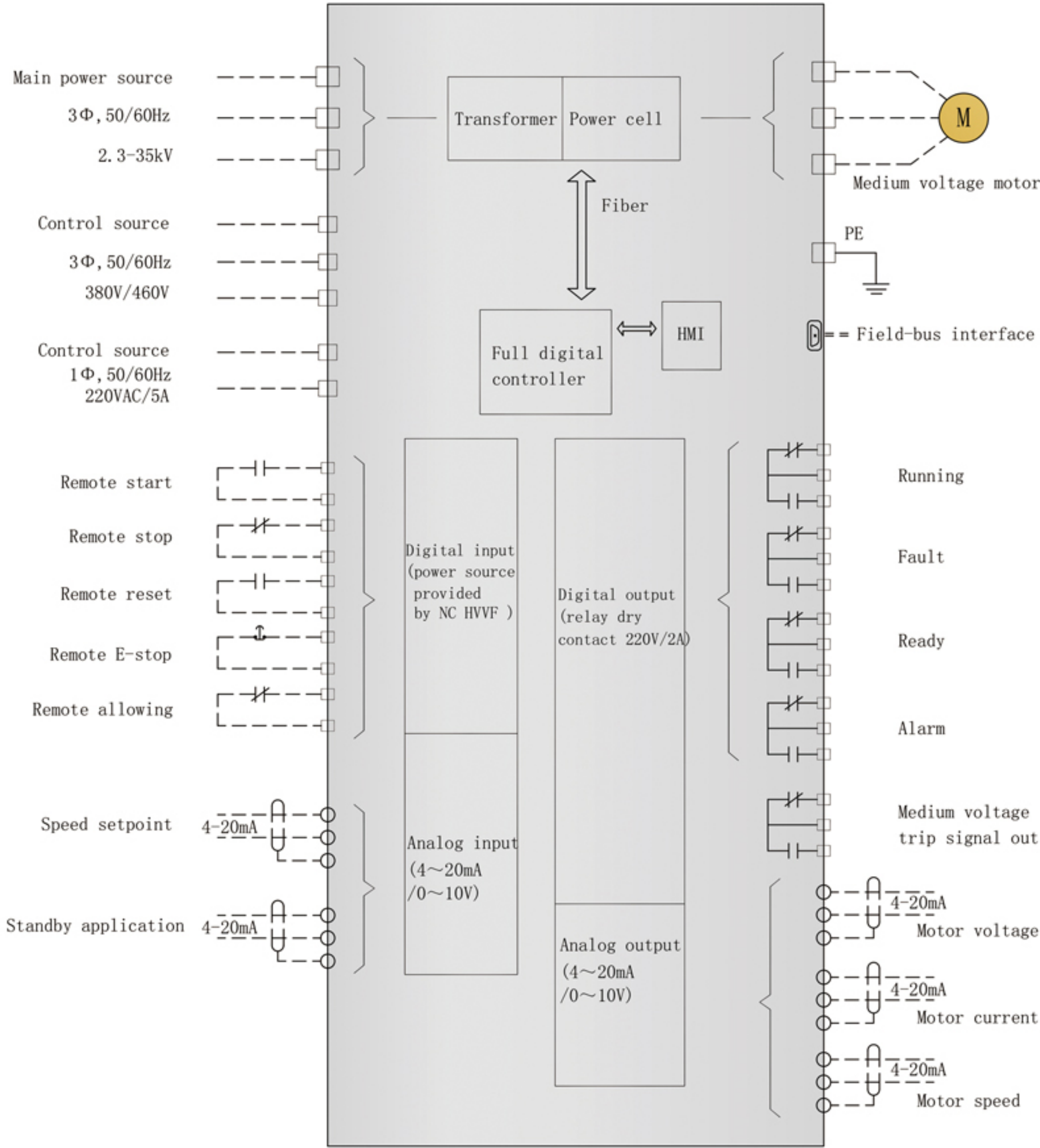
Output voltage: 11kV

Motor Power (kW)	Output Current (A)	Dimension with fan W*D*H (mm)	Weight(kg)	Ventilation (m³/min)
220	15	A Type 2500×1500×2600	3600	140
250	16		3600	140
280	18		3600	140
315	20		3600	140
355	23		3900	140
400	25		3900	140
450	28		3900	140
500	31		4300	140
560	35		4300	140
630	39		4300	140
710	44		4300	140
800	49		4600	140
900	55		4600	140
1000	61		4600	140
1120	68		4900	280
1250	75	A Type 2700×1500×2600	5350	280
1400	85		5550	280
1600	99		6200	375
1800	111	D Type 5614×1400×2800	6500	375
2000	123		6700	375
2240	136		6850	540
2500	155	D Type 5814×1400×2800	7250	540
2800	173	E Type 6770×1400×2900	7750	540
3150	191		8250	540
3550	214		9250	540
4000	240		9800	540
4500	271	G Type 7794×1400×3003	10300	540
5000	298		11300	540
5600	332		12500	540

6300	378	H Type 10214×2200×3276	19500	720
7100	424		20500	720
8000	475		21500	720
9000	530		22500	720
10000	585		23500	720
12000	707		24500	720
13000-30000	<2100	Water-cooling		

- Four pole induction motor as reference, drive output current should be higher than motor current.
- For other large capacity (>20MW), please contact us.

Standard wiring diagram





## Applications of NC HWF



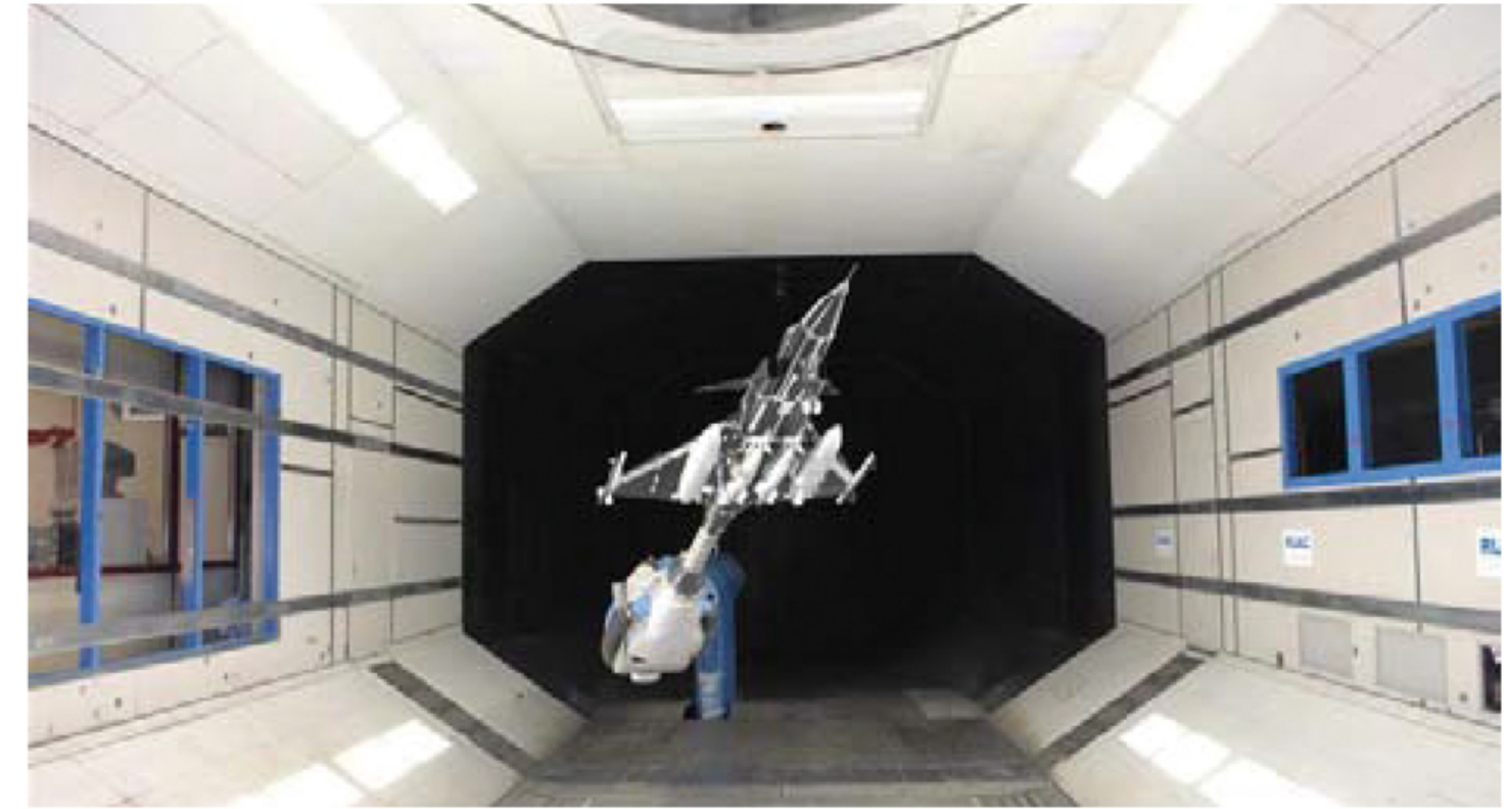
### Starter of large gas turbine generator

#### Features:

- NC HWF: 10MVA, 7.2kV
- Turbine generator: 177MVA, 15.75kV, synchronous

#### Solution Overview:

Nancal HWF was used to drive the gas turbine at various speed required by process, then accelerate the turbine to the self-sustaining speed at 2600rpm. Synchronous generator was used as motor during the starting process, after turbine was ignited, the drive would turn off, and then generator would put into the normal operation.



### Wind tunnel test stand

#### Features:

- High speed accuracy: 0.02%
- Fast speed & torque response
- Wide speed range

#### Solution Overview:

Speed regulation can be performed with Nancal HWF to make the motor speed consecutively adjustable within the range. In the range of 0.5 Hz to 50 Hz, the static speed accuracy reaches 0.02%. Meanwhile, in order to meet the requirements of rapid response of the speed, when transitions from high speed zone to the low speed zone, the drive should have a certain braking capacity. Braking can be achieved by IGBT choppers and braking resistors connected on DC bus of each power cell, or by configuring braking resistors on the output side of the drive (for synchronous motor only).



Applications



PetroChina gas pipeline project, total: 23 units, each unit over 10MW

Guangzhou station

- Model: NC HVVF 10/10 – 22000SLO
- Input voltage: 10kV
- Output voltage: 10kV
- Motor: 18000kW
- Transformer: oil immersed
- Power cell: high voltage cell
- Cooling method: water cooling

Heihe station

- Model: NC HVVF 10/10 – 23000SLO
- Input voltage: 10kV
- Output voltage: 10kV
- Motor: 20000kW
- Transformer: oil immersed
- Power cell: high voltage cell
- Cooling method: water cooling

Lushan station

- Model: NC HVVF 10/8.2 – 23500SLO
- Input voltage: 10kV
- Output voltage: 8.2kV
- Motor: 18500kW
- Transformer: oil immersed
- Power cell: high voltage cell
- Cooling method: water cooling

Zhangjiakou station

- Model: NC HVVF 10/6 – 12000SLO
- Input voltage: 10kV
- Output voltage: 6kV
- Motor: 10000kW
- Transformer: oil immersed
- Power cell: high voltage cell
- Cooling method: water cooling



Offshore platform

- Location: CNOOC Bohai
- Input voltage: 6.3kV
- Output voltage: 6.3kV
- Motor: 1000kW



Steel

- Location: Jiangsu
- Input voltage: 10kV
- Output voltage: 10kV
- Motor: 6200kW



Oil Field

- Location: Xinjiang
- Input voltage: 6kV
- Output voltage: 6kV
- Motor: 6600kW



Applications



Power Generation



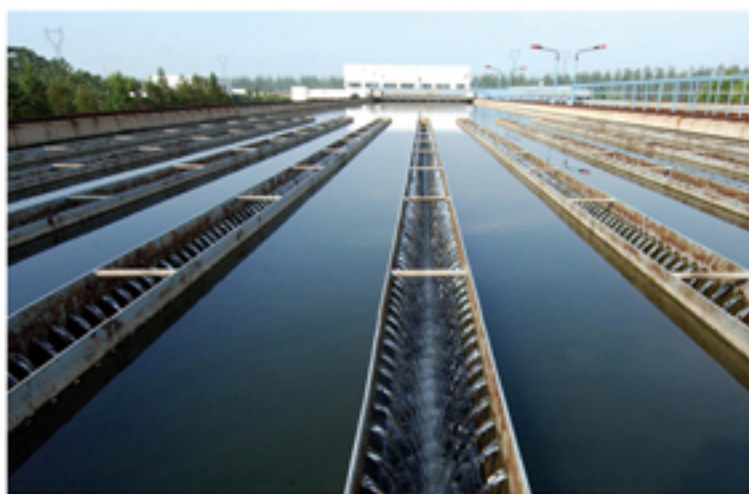
Oil & Gas



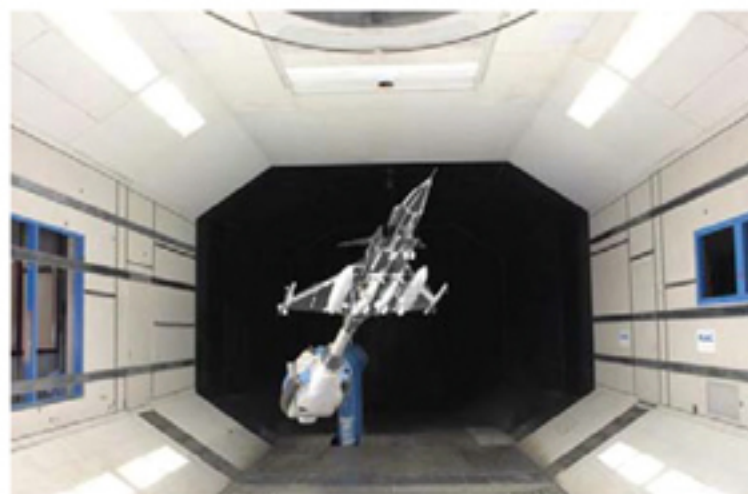
Petrochemical



Metallurgy



Municipal



Test Stand



Cement



Mining



Pulp & Paper

Certifications

- ISO 9001/ISO 14001/OHSAS 18001
- CE certification
- SIL2 (Safety Integrity Level 2)
  - \* The only company of China got SIL2 verification for medium voltage AC drives

