

# BENNING

World Class Power Solutions  
世界级电源解决方案



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## 逆变器系统

核电站专用

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## Inverter Systems

For Nuclear Power Plants



# INVERTER SYSTEMS

## 逆变器系统

### 概述

由于核电站对设备的极高的安全性和可靠性以及运行时间较长的特性的需求，北宁制造的核电站专用逆变器系统的设计寿命可达40年以上，并同时满足核电站1-E级设备的抗震和其它技术要求，逆变器的生产制造和测试以及质量控制程序完全按照1-E标准来进行。

逆变器是核电站中的以下系统的理想后备电源：

- DCS 系统
- 计算机系统
- 仪器仪表系统
- 阀门系统
- 马达系统

逆变器及其配套的蓄电池及蓄电池充电器使负载免受市电电网的波动及停电的影响。

### 静态逆变器系列

- 单相逆变器系列WPE
- 三相逆变器系列WPD

即使负载变化达到100%，逆变器仍然能保证高精度的输出。

这两种逆变器均采用晶体管（IGBT）逆变技术，带电子旁路单元(SBS)及内部手动维修旁路。

逆变器的控制面板有状态及报警LED及模拟图显示。

逆变器有连续运行和后备运行两种工作方式。

### General

Due to the very stringent safety requirements for equipment installed in Nuclear Power Plants (NPP) and the long operating periods of such plants, the BENNING inverter systems for NPP applications have been designed for a life time of more than 40 years. The inverter systems have also been designed and qualified to fulfill seismic and other NPP requirements and are manufactured and tested according to the quality procedures required for 1-E NPP applications.

The inverters are ideally suited to provide safe backup power to all loads found in a NPP including for instance:

- DCS systems
- Computers
- Instrumentation and Metering
- Valves
- Motors

The inverter, together with a battery and battery charger, isolates the loads from irregularities and power outages on the mains supply.

### Static inverter family

- Single-Phase Inverter Series WPE
- Three-Phase Inverter Series WPD

The regulation characteristics of this range of inverters results in very small voltage deviations, even with load changes of one hundred percent.

Both series are manufactured using Transistor (IGBT) technology and have an electronic bypass (SBS) and a built-in service bypass switch.

The function and warning LEDs are on the front control panel, together with a mimic diagram.

The inverters are designed for continuous inverter operation as well as for stand-by operation.

### 单相逆变器 – WPE / Single Phase Inverter – WPE

直流电压 / DC Voltage	110 (125)	220
	5	5
	10	10
	20	20
	30	30
逆变器输出功率 Inverter output power [kVA]	40	40
	50	50
	60	60
	80	80
	100	100
	-	120
	-	160
	-	200

其它容量可选 / Other ratings on request

### 三相逆变器 – WPD / Three Phase Inverter – WPD

直流电压 / DC Voltage	110	220
	5	5
	10	10
	20	20
	30	30
逆变器输出功率 Inverter output power [kVA]	40	40
	50	50
	60	60
	80	80
	100	100
	120	120
	160	160
	-	200
	-	300
	-	400

其它容量可选 / Other ratings on request



# INVERTER SYSTEMS

## 逆变器系统

### 功能

逆变器使直流电压经过脉宽调制电路后变成正弦交流电压。由于脉宽调制频率相对基频较高，并且对脉宽调制进行了优化，故只需较少的滤波电路即可获得较低的失真因数。同时装置即使在负载变化情况下，其输出特性表现也非常的稳定。

当市电停电或故障时，蓄电池回路不间断地继续供电。在这种情况下，系统会发出“蓄电池放电”信号。并在电池电压到达设定的门限值时发出“蓄电池电压低”报警。

当负载超限时，系统将自动切换至旁路市电或其他合适的备用电源以继续不间断供电。

系统的电子旁路开关器件负责逆变器向旁路市电的切换，允许一定的误差范围。切换可通过控制信号自动进行，也可手动切换。

监视为自动监视，以避免误操作及电子旁路的误切换。

无论是自动或手动切换，只有在逆变器输出电压、频率及相序与旁路市电保持一致的条件下，切换才可以无中断。如果市电的相序超出了预设的范围，逆变器会禁止切换；如果这时逆变器故障，则切换会有中断。

只有在逆变器功能恢复正常后，才可以从旁路切换回逆变器工作状态。这种切换是无中断的，即使在试验时人为切断旁路市电时也一样。

### Function

The DC voltage is converted into AC in the inverter using sine-wave optimised pulse width regulation. Due to the relatively high switching frequency compared to the basic frequency and the optimised regulation of the pulse width a low distortion factor is achieved with low filtering needs. This again contributes to good dynamic behaviour under load changes.

In the event of mains interruption or failure, the battery connected to the DC input immediately provides power to the inverter to supply the load without any interruption. In this case a signal indicates that the inverter is operating on battery. An alarm is raised if the battery voltage falls below an adjustable threshold.

Automatic change-over of the load to the bypass mains or a suitable spare installation occurs if the supply from the inverter falls outside the preset tolerances.

The SBS component of the installation facilitates uninterrupted change-over to direct mains supply (bypass mains), keeping the specified tolerances. The change-over can be initiated manually or automatically by a control signal.

The monitoring is autonomous and prevents incorrect operation of the installation and any illogical switching functions of the SBS electronic bypass.

Thus, for example, an uninterrupted change-over, whether automatic or manual, is only possible when the voltage, frequency and phase conditions of the inverter are synchronised with the bypass mains. Mains deviations, which lie outside the preset tolerances cause blocking of the changeover, or if the inverter fails, a change-over with an interruption.

A change back can only occur to a functioning inverter, and is in every case uninterrupted even if the mains should fail on a test change-over.





# INVERTER SYSTEMS

# 逆变器系统

## 逆变器功率单元

### 主要元器件

- 输入滤波器
- 晶体管(IGBT)逆变器
- 输出隔离变压器
- 输出滤波器
- 自同步石英时钟
- 同步电路

### 保护装置

- 控制及辅助回路保护
- 输出限流保护
- 功率管限流保护
- 功率管温度监视
- 功能监视
- 逆变器输出过电压监视 (关机)
- 逆变器输入欠电压监视 (关机)

### 干接点

- 逆变器运行
- 旁路运行
- 蓄电池放电
- 电子旁路故障
- 市电扰动
- 逆变器故障 (其它报警可选)

### 手动切换 (旁路开关)

装置内置手动旁路切换开关以便在设备维护维修时继续不间断为负载供电。

## Inverter power section

### Main components

- Input filter
- Inverter bridge with transistors (IGBT)
- Output transformer with galvanic isolation
- Output filter
- Quartz timer
- Synchronising circuit

### Protection devices

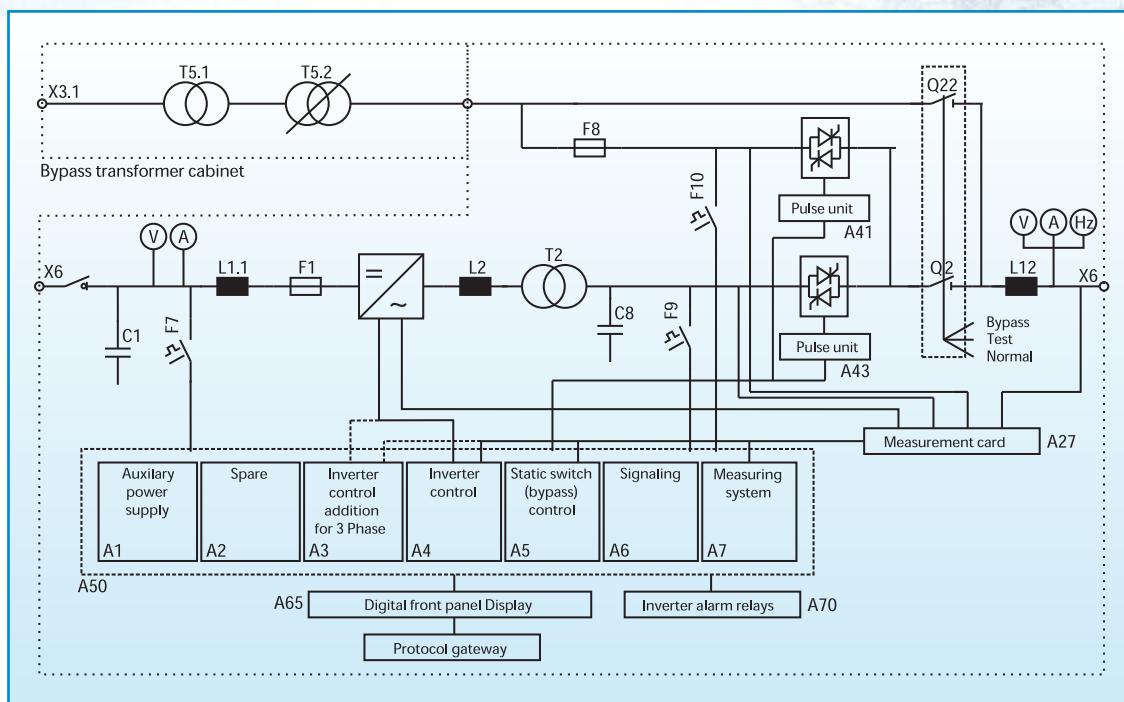
- Protection devices for control and auxiliary current circuits
- Electronic output current limiting
- Electronic transistor current limiting
- Temperature monitoring of semiconductors
- Functional monitoring
- Overvoltage monitoring with inverter off (output)
- Undervoltage monitoring with inverter off (input)

### Potential-free contacts wired to terminals

- Input operation
- Mains operation
- Battery discharging
- SBS fault
- Mains interference
- Inverter fault (other alarms are available on request)

### Manual change-over (bypass switch)

A manual change-over switch is built into the equipment to permit switching as required for servicing purposes.



逆变器单线图 / Inverter Single Line Diagram



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# 逆变器系统

## 测量表计和运行显示

### 模拟表计

- 逆变器输出电压表
- 逆变器输出电流表
- 逆变器输出频率表（其它测量表可选）

### 数字表计

- 旁路市电相电压和频率
- 逆变器输入电压和电流
- 逆变器输出：相电压，相电流，频率，用百分比柱形图表示的负载程度（的每相负载和总负载），及蓄电池电流最大存储值

### 系统运行模拟图具有以下显示

- 直流电压正常
- 逆变器运行
- 逆变器电压正常
- 逆变器供电
- 旁路供电
- 旁路市电可用
- 自动运行模式
- 手动旁路模式
- 电子开关正常
- 指示灯试验按钮

## Instruments and operating indicators

### Analog Instrumentation

- Voltmeter for the inverter output voltage
- Ammeter for the inverter output current
- Frequency meter for the inverter output frequency (other meters are available on request)

### Digital Instrumentation

- Mains feed bypass: Voltage per phase and frequency
- Inverter input circuit: Voltage and current
- Inverter output: Voltage per phase, current per phase, frequency, loading indicator in percent and bargraph per phase and total, maximum battery current storage

### Mimic diagram with integrated optical indicators

- DC voltage present
- Inverter operation
- Inverter voltage correct
- Inverter on load
- Bypass on load
- Bypass mains present
- Automatic operating mode
- Manual change-over operating mode
- Electronic switch ready
- Lamp test button



模拟图数字显示单元  
Digital display with mimic diagram

## 告警和状态接口

除了标准的干接点报警接点外，逆变器可以配置通信接口，可以通过串口（RS232, RS485）和远程控制系統如DCS或以太网进行通信。可选配多种通信协议，如MODBUS, PROFIBUS等。为了安全通信接口仅供监视，不能控制逆变器。

## Alarm and Status Interface

Besides the standard potential free alarm contacts, the Inverter can be equipped with an interface unit (protocol gateway) which allows communication with a remote control system such as a DCS via a serial (RS-485, RS-232) or Ethernet connection. Multiple protocols such as MODBUS, PROFIBUS and others are available. For safety reasons this interface only allows monitoring, but no control of the inverter.

## 技术规格

## WPE和WPD

技术参数	单相逆变器系列WPE	三相逆变器系列WPD
<b>逆变器输入</b>		
输入额定电压	110 V, 220 V	48 V, 60 V, 110 V, 220 V
输入电压范围	-10% 到 +20%	15% 到 +20% (60V系统为-10%到+20%)
输入电流对直流的影响	<10%有效值	
启动电流	<I <sub>额定</sub>	
<b>逆变器输出</b>		
输出额定电压	230 V, N, PE	400/230 V, 3-ph., N, PE
输出电压调整范围	±5%	
输出电压精度		
静态	±1%	
动态	±4% (100%负载变化)	
不平衡负载偏差	-	±2% (100%不平衡负载)
调整时间	≤ 25 ms	
输出额定电流	见型号表	
峰值因数	≤ 3%	
电机负载	100% (注意启动电流)	
过载能力	150%, 60s; 125%, 10min; 110%, 20min	
短路保护	短路保护, 短路电流达2倍I <sub>额定</sub> , 5秒	
输出频率	50 (60) Hz ±0.1%自同步或市电同步	
同步范围	50 (60) Hz ±6% (其他范围可选)	
电压波形	正弦波	
谐波失真率	<3% 线性负载	
电磁兼容等级	IEC/EN 61000-6-2, IEC/EN 61000-6-4 EN50091-2	
允许功率因数	0感性到0容性 1)	0感性到0容性 2)
<b>一般参数</b>		
允许环境温度 (100%负载)	0 到 40°C (可选 -10 °C 到 +55 °C)	
允许存储温度	-20°C 到 70°C (DIN 40040标准 HS级)	
湿度等级	≤95% r.H.无凝露 (DIN 40040标准 F级)	
安装海拔 (额定输出)	≤ 1000m 2)	
噪音	50-70dB,取决于输出功率	
防护等级	IP20 (IEC60529标准,可选配高防护等级)	
柜体颜色	RAL 7032(可选配其它颜色)	
冷却方式	自冷或风冷, 取决于输出功率大小	
效率 (额定负载)	88.5%-93%取决于不同型号	86%-93%取决于不同型号

1)功率因数从0.8感性到0.0容性输出降容

2)高海拔后降容

数据可能发生变更

# Technical Specification

## WPE and WPD inverters

Technical data	WPE (single phase)	WPD (three phase)
<b>Inverter input</b>		
Input voltage:	110 V, 220 V	48 V, 60 V, 110 V, 220 V
Input voltage range:	-15 to +20 %	-15 to +20 % (at 60 V -10 to +20 %)
Effect of inverter current on DC rails:	< 10 % eff.	
Switch-on current:	< I-nom	
<b>Inverter output</b>		
Output voltage:	230 V, N, PE	400/230 V, 3-ph., N, PE
Adjustment range of output voltage:	± 5 %	
Voltage tolerance		
Static:	± 1 %	
Dynamic:	± 4 % for 100 % load change	
Asymmetrical load:	-	± 2 % for 100 % off-centre load
Regulation time:	≤ 25 msec	
Nominal output current:	see type table	
Crest factor:	≤ 3 %	
Motor load:	100 % permitted (note starting current)	
Overload behaviour:	150%, 60s; 125%, 10min; 110%, 20min	
Short-circuit behaviour:	short-circuit proof, short circuit current 2 x I-nom. for 5 sec.	
Output frequency:	50 Hz (60 Hz) ± 0,1 % quartz or mains synchronised	
Synchronisation range:	50 Hz (60 Hz) ± 6 % (other ranges selectable)	
Wave-form:	sine wave	
Distortion factor:	< 3 % with linear load	
Radio interference grade (EMC):	IEC/EN 61000-6-2, IEC/EN 61000-6-4, EN 50091-2	
Permitted power factor:	0,0 ind. - 0,0 cap. 1)	0,0 ind. - 0,0 cap. 2)
<b>General</b>		
Permitted ambient temp.: (100% Load)	0 to 40 °C (Optional -10 °C to +55 °C)	
Permitted ambient storage temp.:	-20...+70 °C (class HS, according to DIN 40040)	
Humidity class:	≤ 95% r. H. (class F, according to DIN 40040) without condensation	
Permitted installation height at nominal load:	≤ 1000 m above sea level 2)	
Noise level:	ca. 50 - 70 dB (A) depending on power rating	
Type of protection:	IP 20 according to IEC60529 (standard, higher protection available as required)	
Paint finish:	RAL 7032, structural paint, other colors available as required	
Type of cooling:	natural or forced air cooling with redundant fans (depending on power rating)	
Efficiency at nom. load:	88.5 – 93% depending on type	86 – 93% depending on type

1) Derating from cos phi 0,8 ind. to 0,0 cap.

2) Derating for higher altitudes

Data subject to change





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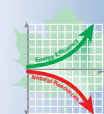
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ISO  
14001

SCC



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