BENNING

World Class Power Solutions

Excellent Technology, Efficiency and Quality

INVERTRONIC modular

Three Phase Inverter System with Modular, Hot-Plug Design

INVERTRONIC modular - Three Phase Inverter with Modular Hot-Plug Design

High Power Protection with INVERTRONIC *modular*

More and more mission critical loads in information, telecommunication and industrial applications demand continuous power protection and availability in the event of mains failure and reasonable power quality in the event of critical mains conditions.
On the public network, major loads as well as lightning strikes, generate dynamic overvoltages, undervoltages, sags / brownouts and transients.

Fig.1 illustrates some examples of mains disturbances which can influence microprocessor-based equipment in production or communication systems

Voltage Phenomenon	Time	e.g.
1. Outage - blackouts	> 10 ms	
2. Sags/brownouts	< 16 ms	
3. Dynamic overvoltage	4...16 ms	
4. Undervoltage	continuous	
5. Overvoltage	continuous	
6. Transients (Surge)	< 4 ms	
7. Lightning	sporadic	
8. Voltage distortion HF (Burst)	periodically	
9. Voltage harmonics	continuous	
10. Frequency variations	sporadic	

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Fig. 1: Mains Disturbances

For power protection in these business-critical environments inverter systems provide continuous power with high availability and ensure continuous and high quality power protection of mission critical loads in the industrial and commercial marketplace.

BENNING´s new advanced inverter system INVERTRONIC *modular* is a hot-plug modular three phase system which operates from a central (battery based) 48V, 110V or 220V DC source.

INVERTRONIC *modular* ensures cost-effective System Scalability and continuous Power Protection and Availability

Todays traditional three phase inverter systems are heavy and bulky and are not scaleable.
The output power is fixed and cannot be adapted to changing load demands.

The new INVERTRONIC *modular* inverter system consists of rack mounted, parallel operating inverter modules.This design allows scaleable redundant systems with the highest power availability.

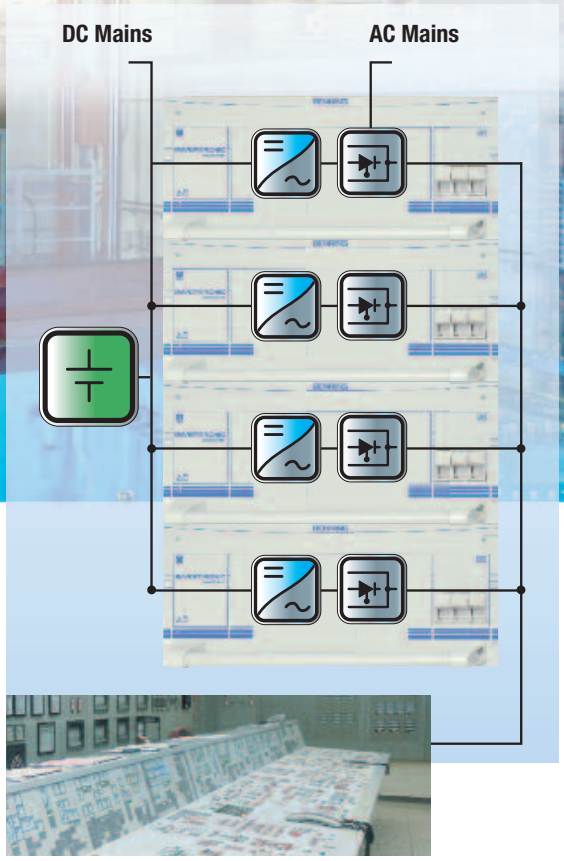


Fig. 2: Principle of the modular parallel architecture

With the modular hot-plug design of the INVERTRONIC *modular,* any up or downgrading of the system output power is possible.

Each INVERTRONIC *modular* inverter module has its own static by-pass to transfer the load to the mains if the output of the inverter deviates outside the acceptable tolerances for both voltage and frequency, caused by short circuit, overload or inverter failure.

The static by-pass will transfer the load back to the inverter without any break after the inverter output has returned within tolerance.

INVERTRONIC modular
Availability without any Compromise

Hot-plug modular redundant Design means highest Availability and short MTTR (MEAN TIME TO REPAIR)

The modular redundant concept of the INVERTRONIC *modular* system together with real hot plug design provides the highest level of continuous power protection availability and minimizes service and maintenance costs.

High Efficiency at rated as well as partial Loads, means less TCO (Total Cost of Ownership)

The INVERTRONIC *modular* inverter system has been designed to provide ≥ 90% efficiency even at 50% partial load (systems with 110V and 220V DC input voltage). (Fig.4) Systems with 48V DC input, have appr.3% less. efficiency.

INVERTRONIC modular Features

- **Scaleable three phase inverter system with hot-plug power modules**
- **Each Inverter module with its own electronic by-pass**
- **Short MTTR (Mean TIME To Repair) Replacement of modules without any load interruption**
- **N+1 redundancy ensures highest availability**
- **High energy efficiency also at partial load saves energy costs**
- **Advanced inverter technology with DSP processors and IGBT /MOSFET semiconductors**
- **Less volume and weight of the INVERTRONIC modular inverter systems results in reduced floor space and lower transport and installation costs**

Fig 3: INVERTRONIC modular 90 kVA DC input 220 V

The redundant design (n+1) is still providing 100% power to the load even if one module fails.

The replacement of the faulty module can be done in less than 15 minutes, if the module is available on site. After the replacement the INVERTRONIC *modular* system is back to redundant operation.

The modular hot-plug design means system redundancy as well as reduction of service and maintenance costs.

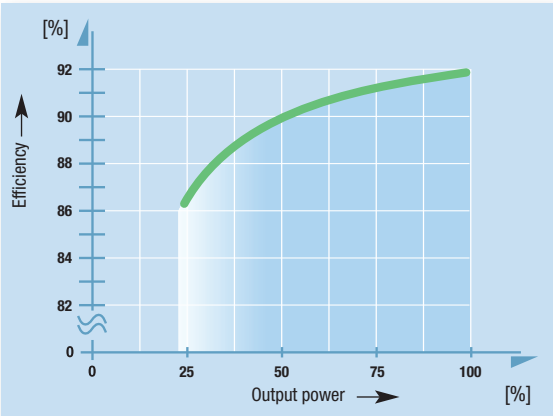


Fig. 4: Efficiency as function of output power

High efficiency is essential to reduce the energy consumption of the inverter system as well as the investment and operational costs for the cooling system.

INVERTRONIC modular

Cost Saving High Efficiency

The light and compact System Cabinets of the INVERTRONIC *modular* Inverters save Packing and Transport Costs.

The light weight system cabinets of the INVERTRONIC *modular* line are easily handled compared to the heavy cabinets of conventional (one bloc) inverter systems.

Redundant INVERTRONIC *modular* Systems have less Energy Consumption and require less Floor Space, compared with traditional redundant Inverter Configurations.

Fig. 5+6 show the comparison of traditional and modular n+1 redundant 60 kVA inverter systems.

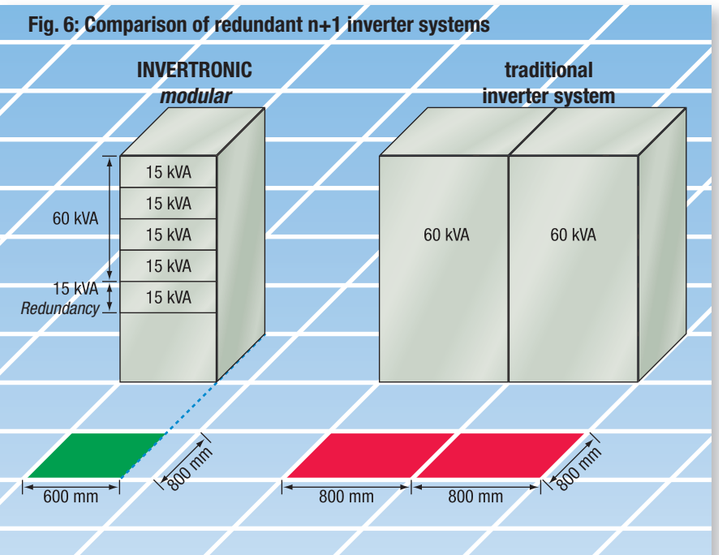
To acheive redundancy using traditional inverter systems, you need to have a second complete 60kVA system for parallel operation.
The total foot print of the two systems will be two times 800mm x 800mm.

To achieve redundancy using the INVERTRONIC *modular* system, only one 15kVA inverter module has to be added. The foot print of that system (800mm x 600mm) will not increase, as the existing system cabinet can be used.

The foot print and the operational power consumption of the traditional two x 60 kVA systems are higher compared to the INVERTRONIC *modular* system.

Fig. 5: Comparison of redundant parallel inverter configurations.
INVERTRONIC modular to traditional stand-alone inverter systems.

Fig. 6: Comparison of redundant n+1 inverter systems



INVERTRONIC modular

Simple Operation, Rapid Diagnosis

Operation and Monitoring Front Panel (Fig. 7)

The operation and monitoring of the INVERTRONIC *modular* is made via the front door panel.
The operating and fault signals are indicated by 17 LED`s and the system status is displayed and controlled via the built in LCD mimic diagram.
An event recorder stores each occurring event (max.250 entries) date and time.

Customer interfaces:

- RS 232 or RS 485 with MOD bus protocol
- 6 voltage free relay contacts

Options:

- Interface profibus
- Network adapter

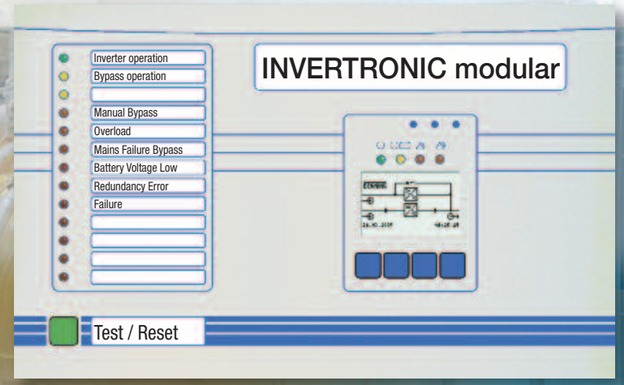
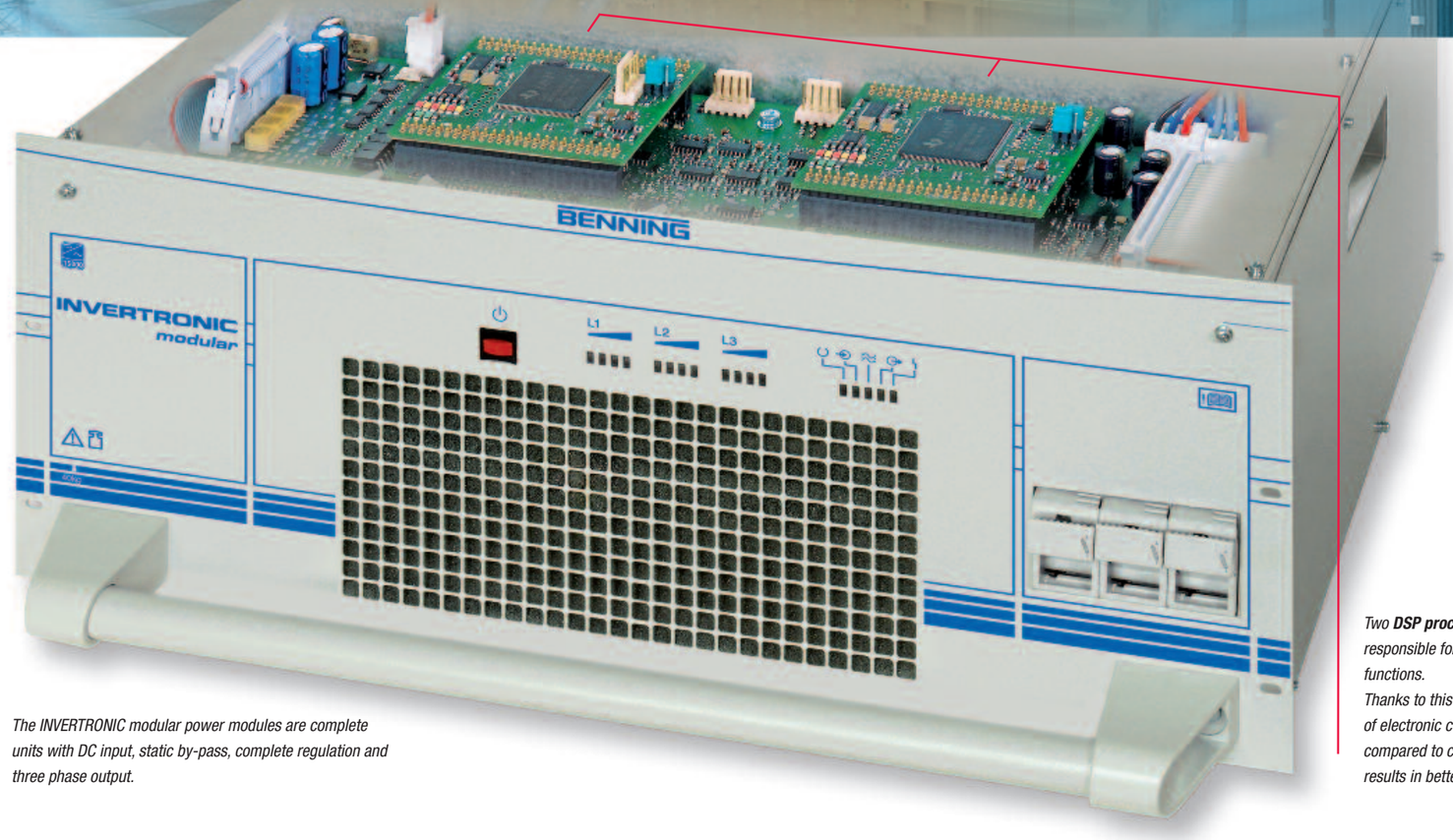


Fig. 7: Display and control unit



The INVERTRONIC modular power modules are complete units with DC input, static by-pass, complete regulation and three phase output.

*Two **DSP processors** with high reliability are responsible for all regulation and monitoring functions.*
Thanks to this advanced design the quantity of electronic components has been reduced compared to conventional inverters, which results in better MTBF figures.

INVERTRONIC modular
Scaleable Power Capacity

Scaleable Power Capacity with INVERTRONIC *modular Inverter modules*

INVERTRONIC *modular* inverter modules are available for 48V, 110V and 220V DC input. Each inverter power module with DC input 48V can supply 10kVA output power and the modules with DC input 110V or 220V can supply 15kVA output power.

Available Inverter Output Power depending on Load Power Factor

The output power of the INVERTRONIC *modular* inverter depends on the load power factor. (Fig. 8)
The Invertronic modular inverter can supply 100% output power if the leading cos phi of the load is 0,8. or less.

INVERTRONIC modular 30 kVA

INVERTRONIC modular 45 kVA

INVERTRONIC modular 90 kVA

These inverter modules allow the design of scaleable three phase inverter systems,and it is easy to add or remove output power.

This eliminates high initial investment costs of purchasing power capacity that is not required at the stage of installation.

Each 2000 mm high INVERTRONIC *modular* system cabinet is able to accommodate 6 inverter modules, and the 1800 mm high cabinet 5 inverter modules.

The total output power of one system cabinet with 48V DC input can be 50kVA and the total output power of one system cabinet with 110V or 220V DC input, can be 90kVA or 75kVA. Two INVERTRONIC *modular* system cabinets can be paralleled, to increase the output power capacity.

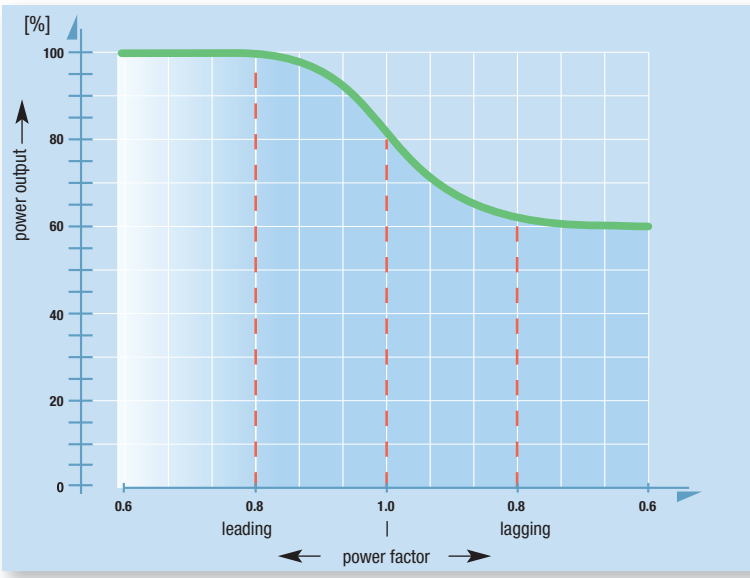


Fig. 8: Available inverter apparent output power depending on power factor

Technical Data

INVERTRONIC modular 10 – 100 kVA / 15 – 180 kVA

Technical Data

Three Phase Inverter Range INVERTRONIC *modular*

Rated output power at (each system cabinet*2)

DC-Input 48 V	**[kVA]**	**10**	**20**	**30**	**40**	**50**	**-**
DC-Input 110 V / 220 V	**[kVA]**	**15**	**30**	**45**	**60**	**75**	**90**
No. of modules		**1**	**2**	**3**	**4**	**5**	**6**
Inverter input							
Input voltage range	[%]	-15 to +20					
Permitted overlaid AC	[%]	< 5 eff.					
Current input at 48 V DC	[A]	195	390	585	780	975	-
Current input at 110 V DC	[A]	116	232	348	464	580	716
Current input at 220 V DC	[A]	58	116	174	232	290	348
DC Power at battery operation	[kW]	13*1	26*1	39*1	52*1	65*1	78*1

*1 Input voltage DC 110V / 220 V

Inverter output		
Output voltage	[V]	400/230 3-ph., N, PE
Adjustment range of output voltage	[%]	± 5
Voltage tolerance		
static	[%]	± 1
dynamic	[%]	≤ 5 for 100 % load step
unbalanced load	[%]	≤ 2 at 100 % unbalanced load
Regulation time	[msec]	≤ 25
Motor load		100 % permitted (note inrush current)
Overload behaviour	[%]	50 for 60 sec.
	[%]	25 for 10 min.
Short-circuit behaviour		short circuit proof
Short-circuit current	[A]	2 x I-nom for 4 sec.
Output frequency	[Hz]	50 (60) ± 0,1 % quarz or mains synchronised
Synchronisation range	[Hz]	50 (60) ± 3 %
Wave form		Sine wave
Distortion factor	[%]	≤ 2 with linear load
	[%]	≤ 5 with non linear load according to EN 50091-1-1
Efficiency		
Input voltage DC 48 V	[%]	≥ 89
Input voltage DC 110 V / 220 V	[%]	≥ 92
General Data		
Radio interference (EMC)		in accordance with IEC 62040-C3
Noise level (at 75 - 100 % load)	[dB(A)]	approx 65
Cooling		forced cooling with speed controlled fans at air inlet
Permitted ambient temperature	[°C]	0 to +40
Permitted storage temperature	[°C]	-25 to +70
Relative humidity	[%]	5 – 95 non condensing
Per. installation altitude at nom. load	[m]	1000 m over absolute altitude without derating
Protection		IP 20 in accordance with DIN 40050
Painting		RAL 7035, structured paint finish
Dimensions		
Cabinet UC 1868 (5 modules)	[mm]	1800 (H) x 600 (W) x 800 (D)
Cabinet UC 2068 (6 modules)	[mm]	2000 (H) x 600 (W) x 800 (D)

*2: Two system cabinets with maximum 12 modules can be paralleled, to increase the output power capacity. Specifications are subject to change without notice.

With the scaleable INVERTRONIC *modular* inverter system it is easy to change the output power capacity.
Up or down-grading is possible without removing the power or transferring the load to the mains.
High initial investment costs can be eliminated.

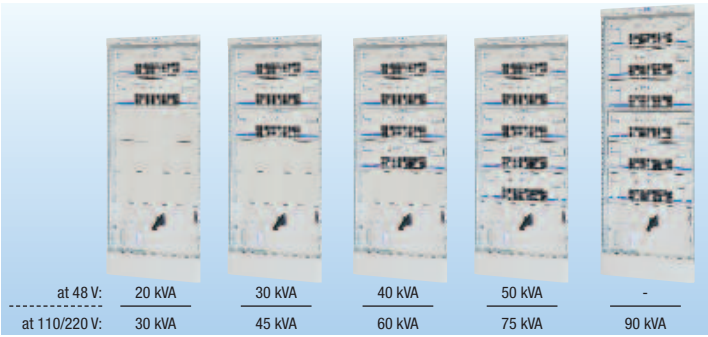


Fig. 9: Scalability of the INVERTRONIC modular inverter systems

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