B GSE Group

DIM 22.5 - 180

DIM Concept

Solid state ground power technology

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B POWER

1 DIM – Dynamic Inverter Module

1.1 Technical Characteristics

Input	
Frequency	50 / 60 Hz ± 5%
Voltage	3 x 380 V ± 10%, 3 x 480 V ± 10%, other voltage levels on request
Power Factor	0.99 through PFC (power factor correction)
Current distortion	< 4%
Inrush current	None (< I nominal)
Output	
Power	22,5 – 180 kVA
Voltage	3 x 200 / 115 V
Frequency	400 Hz
Efficiency	> 94%
Load power factor	0.6 lagging / inductive to 0.95 leading / capacitive
Static voltage regulation	< 0.5%
Crest factor	1.414 ± 3%
Phase angle symmetry	120° ± 1° for balanced load120° ± 2° for 30% unbalanced load
Total harmonic content	< 2 %
Protection	
Protection class	IP55 Standard
Input / Output	Short circuit protection Over and under voltage protection Overload protection
General	No break power transfer Over-temperature protection
Operating temperature	-22°F (-30°C) to 130°F (52°C), other temperatures available upon request)
Overload	125% for 10 min, 150% for 1 min, 200% for 30 sec., 300% for 10 sec., 400% for 1s.
Weight	507 lb (≈ 230 kg) for 90kVA model

Main characteristics:

- Output power range:
  - 22.5 kVA (2 modules)
  - 45.0 kVA (4 modules)
  - 67.5 kVA (6 modules)
  - 90.0 kVA (8 modules)
  - 112.5 kVA (10 modules)
  - 135.0 kVA (12 modules)
  - 157.5 kVA (14 modules)
  - 180.0 kVA (16 modules)
- Efficiency > 94%
- Operating temperature up to 140°F (60°C) at aircraft load possible
- With DIM Design most lightweight solid-state frequency converter in the market

1.2 Technology – DIM

The **D**ynamic **I**nverter **M**odule (DIM) is a bidirectional 3-phase inverter module built with the latest semiconductor technology. As it is an inverter with power flow in both directions, the DIM is used both for rectifying the mains voltage and for inverting into the 400 Hz voltage (back to back operation). The hardware of rectifier (**p**ower **f**actor **c**orrection – PFC) and inverter (DC / AC) is therefore the same, the firmware of course different. The switching of the firmware takes place via the CAN address, which receives the module from the plug-in system on the back of the module. No address configuration is required – just Plug and Play.

The inverter is built in 3-level structure with silicon carbide semiconductor. This allows a very high switching frequency, whereby very compact passive components (chokes, capacitors) can be selected. Due to the high-power density a module has only 11 lb (≈ 5 kg). Therefore, the entire active part at 90 kVA output power with 8 modules has only 88 lb (≈ 40 kg).

The modules can be easily exchanged via a plug-in system and locked by a lever. As many modules of the same function are operated in parallel, there are numerous advantages:

- Number of input and output modules does not necessarily have to be same, e.g. if a output power factor of 0.8 instead of 1.0 for 90 kVA (72 kW) is requested, 4 modules for the output but only 3 modules on the input side are required, in total 7 instead of 8 modules.
- Redundancy: If a module fails due to a fault, the performance is only reduced by 22.5 kVA and the unit still supplies power, e.g. 67.5 kVA instead of 90 kVA.
- In the partial-load operational range, modules may even be switched off to further increase the overall efficiency of the unit.
- Customers/Clients can stock a spare power module to make the unit ready for 100% use immediately in the event of a fault by exchanging the faulty power module at relatively low cost as one module is only 1/8 of the active part.

The unit is designed according to the specifications in the DFS 400 standard for modified protective separation in agreement with the main German airports with very low leakage capacitance at the output, very low leakage currents and low neutral against earth voltage.

1.3 Active PFC (Power Factor Correction) vs. 12-pulse (B12) rectifier

In the ever-growing market of the civil aircraft, there has been a constant need for improvement in many fields. The improving trend is mainly oriented into replacing heavy and maintenance costly parts with electrical equivalents. Any part of a ground power unit must not fail during ground supply, thus making the reliability of the equipment of the utmost importance. Moreover, the component weight and volume of the GPU is of major concern due to easy component change and spare part management.

The conventional rectifiers employed in electrical ground power units are relying on the passive solutions which are robust, but heavy and require tight mains regulation in order to operate within specifications. The twelve-pulse three-phase rectifier (B12) is one of the typical representatives of the auto-transformer based rectifiers. It achieves reasonable values concerning input power factor and current harmonics, but pure sinusoidal input currents are not possible. Apart from line filtering inductors, the interphase transformers are key part of the rectifier which increments the weight of the rectifier. Without adding an active stage at the output, no control over the DC output voltage is possible. Thus, DC link quality suffers on input voltage unbalance and distortion.

The active rectifiers (active power factor correction PFC) utilize semiconductors switching at high frequencies in order to provide control to the rectifier input currents. Thus, sinusoidal input currents are reachable even at low loads. Additionally, the DC output voltage is actively stabilized and influences from mains are reduced to a minimum. The active rectifiers provide an opportunity to reduce size and weight of magnetic components dramatically compared to passive solutions.

The three-phase Vienna rectifier is an advantageous topology of active rectifier. It is three-level converter which allows smallest values of input inductance.

This architecture has been incorporated into inverter modules called DIM (Dynamic Inverter Module). Each DIM has been designed based on Vienna rectifier topology and can be implemented in back to back operation. This means that one DIM rectifies the main voltage into DC and second DIM inverts the DC into 400Hz AC. Splitting up the 50/60Hz to 400Hz functionality into two equivalent units, increase in reliability and a simplified spare part management can be achieved. Furthermore, it is possible to connect several DIMs in parallel to adjust input and output power capability on customer demands. E.g. a typical 90kW solid state unit is designed with 8 DIM modules (4x 22.5kVA Input and 4x 22.5 kVA output). Due to these facts, our APF (active power factor correction) DIM concept compared to competitors using 12- pulse rectifier scores with highest performance, efficiency and reliability in combination with easiest handling and spare part management

Information taken from

[1] http://oa.upm.es/42587/1/INVE_MEM_2015_230374.pdfDIM Pictures

1.4 Reference pictures