Document Title	**Detailed specification of the production of Alvarez 2.0 inner tank sections Power Converters for GSI**
Description	This document describes the production process of the Alvarez 2.0 quadrupole power converters for the GSI Accelerator Facility
Division/ Organization	EPS – Electric Power Systems
Field of application	GSI GmbH

Document History

Version	Prepared/Checked by	Date	Date of Release	Comments
1	C. Hunkel	09.07.2026		Initial version
2	C. Hunkel		29.10.2026	

Abstract

This document describes the services to be provided for the production of the power converters of Alvarez 2.0 drift tube quadrupoles at the GSI Accelerator Facility

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1 Brief Description

As part of the upgrade of Alvarez sections of the UNIversal Linear ACcelerator (UNILAC) of GSI accelerator facility, 32 fast pulsed power converters are required. 20 power converters to supply the inner tank sections of Alvarez with groups of quadrupole magnets and 12 power converters to supply the inter-tank sections with individual quadrupole magnets. This results in two types of pulsed power converters.

This document specifies the production process of the inner tank section power converters.

Most of the design work for this power converter type was carried out by GSI. Two prototype power converters were built and thoroughly tested. More in detail, the following documentation was created:

- circuit diagrams,
- parts lists,
- Mechanical layout.

Based on this documentation, the power converters must be manufactured, assembled, tested and delivered to GSI.

Additionally, the CE declaration of conformity for inner tank section type of power converters is also part of the service.

2 Scope of Delivery

The power converters must be assembled within cabinets.

It must be noted, that any suggestions of the Contractor to the mechanical design that might reduce the complexity of the production process or improve the performance of the system is allowed.

2.1 Provisions of the Contractor

- Final design review (FDR) of the production according to section 3.1;
- Procurement of components and spare parts specified in the parts list [3] except components marked as provisions by the company. It must be noted that small components like e.g. screws, washers, cables, cable lugs, etc. and the cabinet itself are not listed. All such missing components are in the responsibility of the Contractor;
- Production of the first of series (FoS) cabinet based on the FDR documents;

- Factory acceptance tests (FAT) of the FoS (see Sec. 3.2.1);
- Packaging and transport of the FoS to GSI (see Sec. 3.4);
- Production of the series after successful Site acceptance tests (SAT) of the FoS at GSI (see Sec. 3.3.1);
- FAT of the series according to Sec. 3.2.2;
- Packaging and transport of the series to GSI including spare parts (see Sec. 3.4)
- Final circuit diagrams and parts list according to the final set-up and CE declaration of conformity including risk assessment and user manual (see Sec. 3.5)

2.2 Provisions of the Company

- Access to prototype power converter at GSI site.
- Main control electronics and other components according to parts list [3] marked as „Provisions“;
- Training on functional testing procedure (during FAT) of the power converters (see Sec. 3.2.1);

3 Production process

The production process of the specified system consists of the following phases (milestones):

- Final Design Review (FDR);
- Production of the FoS and FAT;
- Shipping and SAT of the FoS;
- Production, FAT and shipping of the series;
- Documentation.

All milestones are subject to a formal release procedure to be done by the Company.

The Company reserves the right to obtain information about the status of the work at any time during normal working hours at the contractor's factory and to be present during tests and measurements. This right also applies to sub-suppliers insofar as the production of important parts of the scope of delivery has been assigned to them.

3.1 Final Design Review

Final Design Review (FDR) is a formal milestone in the Quality Assurance system of GSI. Although in case of this specification, no design needs to be done, this milestone is kept as it is and its purpose is the review and release of the finalized production documents.

The approval of the FDR documentation by the Company is the official permission to start the production process and procure the components. In case of need, an early procurement of the long-lead items is possible after a written approval of the Company.

All FDR documents must be provided to the company in electronic form at least one week before the actual FDR date.

More in detail, FDR documents must contain at least the following information:

- Approach to production, time management and quality assurance;
- Production documents in their final version, including any necessary changes, previously agreed, of the documents provided by the Company:
  - Circuit diagrams;
  - Parts lists;
  - Mechanical Layout.
- Draft version of the user manual

3.2 Factory Acceptance Tests (FAT)

3.2.1 FAT of the FoS

FAT of the FoS cabinets takes place at the manufacturer's site and must be done by the contractor in the presence of the Company. All infrastructure and components needed to connect the power converters to the external supplying systems are in the responsibility of the contractor. The test results have to be documented.

The FAT of the FoS cabinets contains the following test points:

- inspection of the mechanical construction and wiring based on the technical documentation;
- Electrical tests according to DIN EN 61439-1;
- Leak test of the cooling circuits with 16 bar test pressure;
- Testing of the interlocks and internal protection systems;

- Functional power test with dummy load at nominal output current

It must be noted that GSI will provide a detailed test plan and that all tests will be performed together with the Company. Additionally, a training procedure after/during a successful FAT of the FoS will be done.

3.2.2 FAT of the Series

The FAT of the series must be done by the contractor at the manufacturer's site without a need of presence of the Company, however the Company reserves the right to assist at any time to the procedure.

The testing points to be accomplished are the same as the ones mentioned in Sec. 3.2.1.

Power converters must be tested individually and the respective test report must be created.

3.3 Site Acceptance Tests (SAT)

3.3.1 SAT of the FoS

The company reserves the right to perform a side acceptance test at GSI of the FoS power converter before series production starts.

This procedure would be definitely necessary in case major components in power electronics were replaced during FDR (e.g. semiconductors, filter capacitors/inductors).

3.3.2 SAT of the Series

The SAT of the series is done by the company at GSI without a need of presence of the contractor by incoming goods inspection.

3.4 Transport and delivery conditions

The devices must be appropriately packed for the transportation taking into account the possible dangers. Each cabinet must be packed individually and at least be equipped with edge protections.

Each package must contain information about the power converter, which is inside; more specifically the respective Component ID numbers (provided by the Company).

The Company must release the shipment of the cabinets.

3.5 Documentation

The final documents, including:

- Circuit diagrams, parts lists
- FAT reports
- CE declaration of conformity with risk assessment
- User manual

must be delivered to the Company in electronic form at latest after SAT of the series.

Circuit diagrams including parts lists must be done with the EPLAN Electric P8 (CAE).

It must be noted that the original plans that will be provided by the Company are only available in the pdf format.

4 Technical Specification

4.1 General Remarks

The production must be done taking into account the relevant points specified in Common Specification [5], Electrical Design Rules [6] and General Specification [7].

In particular, the following points must be considered for the production:

- Planning basis are the documents [1], [2], [3], [4] and [8]
- The Assembly shall be done in accordance to DIN EN 61439-1
- Plug connections for electrical power connections and cooling water connections are not allowed
- According to the manufacturer’s instructions, power semiconductors are to be provided with heat-conducting paste in a suitable manner

The contractor can propose modifications to the provided parts lists, circuit diagrams and mechanical design in order to improve the production process. Any changes must be approved by the Company.

The company reserves the right to make minor changes to parts lists, circuit diagrams, and mechanical layout until the release of the FDR.

4.2 Mechanical Assembly

4.2.1 Water cooling

Each cabinet must be equipped with a water cooling circuit (1 inlet, 1 outlet). The water cooling circuit is responsible for the elimination of the main losses, coming from the power part of the converter during operation.

The connections of the heat sinks, hose nipples and turbine flow meters must be suitable to the parameters of the specified water supply system. All components of the cooling circuits are not allowed to be soft-soldered. Only braze, screw or hose connections are allowed.

Parameters of the external water supply system:

coolant	De-ionized water
max. inlet pressure	15 bar
min. outlet pressure	2 bar
pressure drop inlet/outlet	min. 3 bar
inlet temperature	min. 12 °C / max. 28 °C
outlet temperature	max. 45 °C
electric conductivity of coolant	0,2…1 µS / cm
approved materials	stainless steel, plastics, ceramics, copper
permitted solder connection	brazing

Table 4.1: Specification of the water supply system at GSI

4.2.2 Output power connections

The output power cable connectors must be provided for the connection of coaxial power cables according to [4], [8] and Sec. 6.3.1 of [5].

4.2.3 Control- and signal wiring

All cables in the control circuits (interlock, monitoring, auxiliary supplies) must be marked with source/destination according to the circuit diagrams.

Individual wires that belong together, such as forward and return lines for interlock signals, must be twisted.

Fast switching semiconductors are used in the power electronics parts, therefore all power, control and signal wires must be routed appropriately for an EMC-compliant structure. Cable segregation by interference class in the cable ducts is mandatory.

4.2.4 **Nameplate**

Each power converter must be provided with a nameplate. The nameplate shall be water, oil and UV resistant. Layout Example:

CID: XXX	
Serial Number	XXX
“Name of the manufacturer (contractor) and address”	
Model	SVE 60-U
Output current	550 Arms/ 1300 Apeak
Max. Output voltage	300 V
Power mains	400 V, 3 ph AC
Control mains	400 V, 3 ph AC
Rated power	55 kVA
Power mains fuse	80 A
Control mains fuse	16 A
Water flow rate	10 l/min.
Wiring diagram no.	
Year of construction	

Each power converter has a unique component identification number (CID) which is given by the Company.

A consecutive serial number is to be assigned by the contractor for each power converter.

The model name of the power converter type is “SVE 60-U”.

4.3 Technical parameters

Technical parameters of the cabinet:

Dimensions (W/H/D)	1200mm / 2200mm / 800mm
Weight	1.110 kg
Mains connection	3 Phase 400 V AC
Mains frequency	50 Hz
Fuse in low voltage distribution for power part	80 A
Fuse in low voltage distribution for control part	16 A
Output power connectors (copper bars /terminal blocks, see [4])	earth symmetric 2x 2x150mm² Coaxial 300 V / 550 A DC
Output power connectors Test voltage against housing	2,5 kV
Output power connectors leakage resistance to housing (without earth fault detection device connected)	≥50 MΩ
compliance with safety regulations	DGUV Regulation 3, VDE 0100

Figure 4.1: Technical Parameters

For further electrical parameters of the power converter please refer to the circuit diagram [2].

5 Related Documents

[1] SVE60-U_Mechanical_Layout_v1

[2] SVE60-U_Circuit_Diagram_v1

[3] SVE60-U_Part_List_v1

[4] F-TN-PC-02e_PCs-connection-of-coaxial-cables

[5] F-CS-PC-01e_Common_Specification

[6] F-TG-ET-01e_Electrical_Design_Rules_and_Regulations

[7] F-GS-PMO-en-General_Specification

[8] F-TN-PC-0005e_DCCT_class3_Installation_in_Power_Converter