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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH**

Laboratoire Européen pour la Physique des Particules  
European Laboratory for Particle Physics

*The Large Hadron Collider Project*

## **Invitation to Tender**

# **Technical Specification for the Supply of Electronics Boards for the Upgrade of the Superconducting Circuit Protection of the LHC Collider**

### **Abstract**

This Technical Specification concerns the supply of 3'000 assembled printed circuit boards for the LHC superconducting elements, 2'500 boards of type DQQBS and 500 boards of type DQAMG. The electronic boards are intended for rail mounting in 3U, 19'' crates which will be used for a new system of superconducting circuit protection. The crates are not part of the deliveries covered by this specification.

First deliveries are requested for March 2009 and are to be completed by early June 2009.

January 2009



# Table of Contents

<b>1.</b>	<b>INTRODUCTION .....</b>	<b>1</b>
1.1	Introduction to CERN.....	1
1.2	Introduction to the LHC Project .....	1
1.2	Introduction to the upgrade of the LHC Superconducting Circuit Protection .....	1
1.3	Subject of this Technical Specification .....	1
<b>2.</b>	<b>SCOPE OF THE TENDER.....</b>	<b>2</b>
2.1	Scope of the supply .....	2
2.2	Quantities.....	2
2.3	Items supplied by CERN .....	2
<b>3.</b>	<b>GENERAL CONDITIONS FOR TENDERING AND CONTRACTING .....</b>	<b>2</b>
3.1	Tender procedure.....	3
3.1.1	<i>Pre-tender discussions</i> .....	3
3.1.2	<i>Preliminary programme</i> .....	3
3.1.3	<i>Subcontractors</i> .....	3
3.1.4	<i>Country of origin</i> .....	3
3.2	Contract execution.....	3
3.2.1	<i>Responsibility for design, components and performance</i> .....	3
3.2.2	<i>Contract follow-up</i> .....	3
3.2.3	<i>Production approval process</i> .....	4
3.2.4	<i>Deviations from this Technical Specification</i> .....	4
3.3	Factory access.....	4
<b>4.</b>	<b>TECHNICAL REQUIREMENTS.....</b>	<b>4</b>
4.1	General description.....	4
4.2	Materials for the printed-circuit boards .....	5
4.3	Manufacture of printed-circuit boards .....	5
4.4	Assembly of printed-circuit boards .....	5
4.5	Information and documentation management .....	6
<b>5.</b>	<b>APPLICABLE DOCUMENTS.....</b>	<b>6</b>
5.1	CERN standards .....	6
5.2	International standards.....	6
<b>6.</b>	<b>QUALITY ASSURANCE PROVISIONS.....</b>	<b>6</b>
<b>7.</b>	<b>TESTS.....</b>	<b>7</b>
7.1	Tests to be carried out at the Contractor's premises.....	7
7.2	Tests to be carried out at CERN .....	7
<b>8.</b>	<b>DELIVERY .....</b>	<b>8</b>
8.1	Provisional delivery schedule.....	8
8.2	Packing and transport to CERN.....	8
8.3	Acceptance and guarantee .....	8
<b>9.</b>	<b>CERN CONTACT PERSONS.....</b>	<b>8</b>
<b>ANNEX A:</b>	<b>MANUFACTURING FILES (CD-ROM) .....</b>	<b>9</b>

## List of Tables

Table 1: Board types and quantity. ....	2
Table 2: Hardware summary.....	5
Table 3: Delivery Schedule.....	8

## Terms and Definitions

<b>Term</b>	<b>Definition</b>
<b>CDD</b>	CERN Drawing Directory
<b>EDMS</b>	Engineering Data Management System
<b>QAP</b>	Quality Assurance Plan
<b>DQLPU-type S</b>	'Local' Protection Unit for the new LHC Superconducting Circuit Protection Layer

## **1. INTRODUCTION**

### **1.1 Introduction to CERN**

The European Organization for Nuclear Research (CERN) is an intergovernmental organization with 20 Member States\*. It has its seat in Geneva but straddles the Swiss-French border. Its objective is to provide for collaboration among European States in the field of high energy particle physics research and to this end it designs, constructs and runs the necessary particle accelerators and the associated experimental areas.

At present more than 5'000 physicists from research institutes world-wide use the CERN installations for their experiments.

### **1.2 Introduction to the LHC Project**

The Large Hadron Collider (LHC) is the latest collider added to the complex of accelerators on the CERN site. The LHC machine is designed to accelerate and collide 7 TeV proton beams but also heavier ions up to lead. It is installed in a 27 km circumference tunnel, about 100 m underground, which previously housed the Large Electron Positron Collider (LEP). The LHC design is based on superconducting twin-aperture magnets which operate in a superfluid helium bath at 1.9 K.

### **1.3 Introduction to the Upgrade of the LHC Superconducting Circuit Protection**

In order to assure a local protection of the distributed segments of the 13 kA superconducting busbars, which interconnect the 154 series-connected main dipoles and the 47 or 51 series-connected main quadrupoles in the arcs of each of the eight sectors of the machine, a new layer of detection electronics has been designed. This new layer of electronics will also assure the protection of the magnets in case of quenches which are aperture symmetric. It shall be installed, commissioned and operated prior to resuming operation of the collider in spring 2009 after its winter shutdown. The electronics boards, covered by this specification, are parts of this additional layer of protection electronics.

### **1.4 Subject of this Technical Specification**

This specification concerns the manufacture and test of two types of electronics cards, in total 3000 cards for protection of the superconducting elements of the LHC machine.

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\* CERN Member States are: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, The Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland and the United Kingdom.

## 2. SCOPE OF THE TENDER

### 2.1 Scope of the supply

This supply comprises

- procurement of all the components and materials, except those free-issued by CERN and those explicitly indicated as not to be mounted
- manufacture of the printed-circuit boards
- mounting and assembly of the boards
- download the firmware on the boards
- quality control and complete testing of the boards according to instructions from CERN
- delivery
- packing
- warranty

### 2.2 Quantities

The total number of PCB boards required is divided into two types as listed in table 1.

Board type	Pre-Series Quantity	Series Quantity	Total Quantity
DQQBS	30	2470	2'500
DQAMG	30	470	500
<b>Total</b>	<b>60</b>	<b>2940</b>	<b>3'000</b>

Table 1 – Board types and quantity

### 2.3 Items supplied by CERN

CERN takes the responsibility for the design of both types of cards. CERN will provide the Contractor with the manufacturing file – see Annex 1.

CERN will loan to the contractor those electronic components which are identified as ‘CERN free-issued item’ in the component list of the manufacturing file – see Annex 1.

CERN will make available, free of charge, to the contractor the automatic test equipment required for this contract.

CERN will supply to the contractor, as a reference production model, one completely mounted board of each type.

## 3. GENERAL CONDITIONS FOR TENDERING AND CONTRACTING

Please refer to the commercial documents for more complete information.

### **3.1 Tender procedure**

#### **3.1.1 *Pre-tender discussions***

The Bidder is strongly encouraged to contact CERN and discuss details of this Technical Specification before submitting a tender. In particular, CERN wishes to ensure that no doubt exists as to the interpretation of this Technical Specification.

#### **3.1.2 *Preliminary programme***

The Bidder shall propose a manufacturing schedule with the Tender, based on the specified CERN provisional delivery schedule.

#### **3.1.3 *Subcontractors***

The Bidder shall declare in his Tender any subcontractors whose services he intends to use in the event of a Contract. If the Bidder wishes the manufacturing of printed circuit boards to be subcontracted, the sub-contractor shall be approved by CERN. If awarded the Contract, the Bidder shall restrict himself both to the subcontractors and the quantities indicated in the Tender. If, for some reason, he wants to change any subcontractor, or the scope of subcontracted work, or the amount subcontracted, he shall obtain CERN's prior agreement in writing.

#### **3.1.4 *Country of origin***

Please refer to the commercial documents for specific conditions concerning the country of origin of the equipment or services to be supplied.

### **3.2 Contract execution**

#### **3.2.1 *Responsibility for design, components and performance***

The Contractor shall be responsible for the production quality and the correct performance of all electronics boards produced and delivered to CERN.

CERN assumes responsibility for the design of the boards as well as for quality of the electronic components and the performance of any equipment supplied by CERN.

CERN reserves the right to make minor modifications to component values in the specification before placing the Contract. These minor changes shall not affect the contractual price.

#### **3.2.2 *Contract follow-up***

##### **3.2.2.1 *Contract engineer***

The Contractor shall assign an engineer to be responsible for the technical execution of the Contract and its follow-up throughout the duration of the Contract.

##### **3.2.2.2 *Progress report***

The Contractor shall supply, within two weeks of notification of the Contract, a written programme detailing the manufacturing and test schedules. The programme shall include preliminary dates for inspections and tests.

A written progress report shall be sent to CERN every 2 weeks until completion of the Contract.

### **3.2.3 *Production approval process***

The Contractor shall supply, within three weeks after notification of the Contract, a written proposition giving the manufacturing details for construction, tests and quality control (see § 4.7). During this time, a close cooperation will be required between the Contractor and CERN.

CERN will give its approval or refusal, in writing, within one week.

#### **3.2.3.1 *Pre-series production***

The series production shall be preceded by the production of 30 pre-series boards of each of the two types of boards. Those boards shall be manufactured with identical production procedures as the series.

#### **3.2.3.2 *Series production***

Production of the series shall not start before CERN has given its formal approval of the pre-series in writing. The pre-series units will be considered as part of the series production once accepted by CERN.

### **3.2.4 *Deviations from this Technical Specification***

If, after the Contract is placed, the Contractor discovers that he has misinterpreted this Technical Specification, this will not be accepted as an excuse for deviation from it and the Contractor shall deliver equipment in conformity with this Technical Specification at no extra cost.

During execution of the Contract, all deviations proposed by the Contractor from this Technical Specification, the Tender, or any other subsequent contractual agreement, shall be submitted to CERN in writing. CERN reserves the right to reject or accept such proposals without justification.

CERN reserves the right to modify this Technical Specification during execution of the Contract. The consequences of such modifications shall be mutually agreed between CERN and the Contractor.

### **3.3 *Factory access***

CERN and its representatives shall have free access during normal working hours to the manufacturing or assembly sites, including any subcontractor's premises, during the Contract period. The place of manufacture, as stated in the Tender, may only be changed after written approval by CERN.

## **4. TECHNICAL REQUIREMENTS**

### **4.1 *General description***

The basic hardware parameters of the boards are summarized in Table 2 below.

**Table 2: Hardware summary.**

<b>Board type</b>	<b>Total Qty.</b>	<b>Printed circuit board layers</b>	<b>Programming interface type</b>	<b>Processor type(s)</b>
DQQBS	2'500	4	RS232	ADuC834
DQAMG	500	2	RS232	ADuC831, VY27257

All printed circuit boards shall be of the size 100 mm x 220 mm. Both types of cards are based on SMD components but will also contain traditional components. All boards require firmware for operation. The firmware will be a part of the free-issued deliveries from CERN. However, it is the task of the manufacturer to download this firmware, via RS232, to the individual boards.

#### **4.2 Materials for the printed-circuit boards**

The Contractor shall be responsible for the procurement of all materials required for the production of the boards according to CERN's Technical Specification with the exception of those items listed in the manufacturing files – Annex 1 and 2, which are either not to be mounted or free-issued by CERN.

The Contractor shall purchase all electronic components to be supplied by him exactly as specified in the manufacturing file with a strict respect to rating, type, version and manufacturer. No alternative components, even in the case where the Contractor considers them equivalent, shall be used without prior permission by CERN.

#### **4.3 Manufacture of the printed circuit boards**

The manufacture of printed circuit boards may be in-house or via a CERN approved subcontractor. The manufactured circuit boards shall comply with the IEC and IPC standards (see §5.1.2).

As specified in Table 2, the boards will have up to 4 layers with metallised holes (via) and nickel-gold alloy plating as surface finish. Marking shall be with non-conducting material by a silk-screen process on the upper side (see manufacturing file). The PCB material as well the used solder must comply with EU Directive 2002/95 (RoHS).

CERN attaches great importance to the manufactured quality of all printed circuit boards and will perform provisional acceptance tests and a complete series of tests on randomly selected units. In case of non-compliance with the required standards, CERN will refuse the relevant series. The Contractor shall be responsible for the manufacture and quality control of all unpopulated printed circuit boards. CERN will supply all necessary documents (Gerber-type files, technical specifications, and drawings). These data shall be transmitted by CD and shall be checked by the Contractor, on arrival, for completeness and suitability for manufacture. CERN requires an electrical test of each manufactured printed circuit board. A written record of these test results is required for each batch of boards. The boards shall bear the manufacturer's identification and the date of manufacture (year and week). The surface finish shall be nickel/gold plated. If PCBs are made in a larger panel, the PCBs shall be separated by milling and not by "scoring. Any boards held in stock for more than one month, shall be dried out and sealed in polypropylene bags, containing bags of dry desiccant (e.g. Silica Gel).

#### **4.4 Assembly of printed-circuit boards**

The assembly of printed-circuit boards will consist of mounting and soldering of mostly SMD and some through-hole components (see manufacturing file). The SMD components include quad flat pack and ball grid array devices.

The application of the standards IPC Class 2 (see §5.1.2) shall be fully respected, especially for the following points:

- handling electronic assemblies
- component installation location/orientation
- soldering acceptability requirements
- cleanliness acceptability requirements
- marking acceptability requirements

#### **4.5 Information and documentation management**

CERN insists that the ISO 9001:2000 standards, or equivalent, are fully respected and requires that all boards to be produced are supported by an approved and formal process designed to monitor and record each phase of the manufacturing, such that complete conformity with the requirements of this specification is achieved.

This process includes individual sub-assembly inspection and test procedures accompanied by written records at each stage. This will help the Contractor to locate rapidly all faults, identify them and eliminate their causes.

### **5. APPLICABLE DOCUMENTS**

Please refer to the cover letter for the complete list of enclosed documents, which form part of this Invitation to Tender.

#### **5.1 CERN standards**

The equipment shall comply with CERN Electrical Safety Code C1 and all CERN Safety Instruction. In particular, insulating materials shall comply with the Safety Instruction IS 23. (see CERN CD-ROM Section 6).

#### **5.2 International standards**

For the manufacture of printed-circuits boards:

- Standard (IEC) Documents IEC-60097, IEC-60194, IEC-61189-2 and IEC-61249-2
- Standard (IPC) Document IPC-A-600

For the assembly of printed-circuits boards:

- Standard (IPC) Document IPC-A-610 (class 2).
- Standard (IPC) Document IPC/EIA J-STD-001C.

### **6. QUALITY ASSURANCE PROVISIONS**

The Bidder must be able to demonstrate that he has ISO 9001:2000 series certification, or an equivalent quality control certification, appropriate to the subject of the specification.

In case the Contractor has no ISO 9001:2000 series certification, he shall provide to CERN for approval, a flow-chart of its quality control procedure, which shall be aligned to

ISO 9001:2000 standards. CERN will give its acceptance or refusal of the procedure in writing within 10 days of receipt.

## **7. TESTS**

The Contractor shall be responsible for the technical conformity of the DQQBS and DQAMG boards delivered to CERN.

All printed circuit boards shall be visually inspected to determine that all components are correctly placed and have the correct values.

The Contractor shall test individually all assembled cards. All component defects and assembly errors shall be eliminated. CERN attaches great importance to accurate testing and bidders are strongly encouraged to elaborate on this aspect during pre-tender discussions.

### **7.1 Tests to be carried out at the Contractor's premises**

The Contractor shall individually inspect all assembled boards to determine that all components are correctly placed and have the correct values and orientation. All component defects and assembly errors shall be eliminated. CERN attaches great importance to accurate testing and bidders are strongly encouraged to elaborate on this aspect during pre-tender discussions.

CERN requests a functional test of each completed board. The test shall be performed with automatic test systems provided by CERN. These systems are capable of simultaneously testing a batch of 5 cards. The estimated time for the test of one batch is 10 minutes. The system will also automatically generate a test report file, which shall be transmitted to CERN. The loading of the embedded software is a part of the test.

CERN personnel will undertake the instruction of the Contractor's technicians in the use of this equipment.

All cards requiring component changes, re-soldering, or other interventions, shall be treated as untested units and passed through the entire inspection and test procedures again.

Where inspection or test operations reveal a rejection rate above 5%, a written report detailing the fault(s), shall be prepared and sent to CERN. Corrective action shall be undertaken only with the written approval of CERN.

### **7.2 Tests to be carried out at CERN**

Acceptance tests will be carried out at CERN to establish that the boards meet the specification and that no damage or changes have occurred during transport. A representative of the Contractor is not required for these tests but may be present.

In the event of any errors found during the acceptance test, the Contractor shall correct them at his cost at CERN.

In the event that during the warranty period, as defined in article 25 of the General Conditions of CERN Contracts, the boards not fully meet this Technical Specification, CERN reserves the right to repeat the acceptance tests. Any deviations from the specification shall be corrected immediately at CERN at the Contractor's cost.

Acceptance will only be granted after successful tests.

## 8. DELIVERY

### 8.1 Provisional delivery schedule

All the boards shall be delivered to the CERN not later than 08 June 2009. The following stages shall apply (table 4):

**Table 3: Delivery schedule.**

<b>Step</b>	<b>Allotted time</b>
Document approval process (Contractor)	2 weeks
Production of 30 pre-series cards of each type	3 weeks
Approval of pre-series units (CERN)	1 week
Production of series as stated in the Tender Form	10 weeks

### 8.2 Packing and transport to CERN

The Contractor is responsible for the packing and, where included, the transport to CERN. He shall ensure that the equipment is delivered to CERN without damage and any possible deterioration in performance due to transport conditions.

### 8.3 Acceptance and guarantee

Provisional acceptance will be given by CERN only after all items have been delivered in accordance with the conditions of the contract including documentation referred to in this Technical Specification, all tests specified have been successfully completed and all test or other certificates have been supplied to CERN.

The guarantee period is defined in the commercial documents.

## 9. CERN CONTACT PERSONS

Persons to be contacted for technical matters:

<b>Name/Division/Group</b>	<b>Tel-Fax</b>	<b>Email</b>
Reiner DENZ	<b>Tel:</b> 00 41 22 767 37 98	Reiner.Denz@cern.ch
	<b>Mobile:</b> 00 41 76 487 52 89	
	<b>Fax:</b> 00 41 22 767 61 80	
In case of absence use: Knud DAHLERUP-PETERSEN	<b>Tel:</b> 00 41 22 767 34 04	Knud.Dahlerup-Petersen@cern.ch
	<b>Mobile:</b> 00 41 76 487 32 79	
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	<b>Fax:</b> 00 41 22 767 61 80	

Persons to be contacted for commercial matters:

<b>Name/Division/Group</b>	<b>Tel-Fax</b>	<b>Email</b>
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### **Annex I: Manufacturing files (CD-Rom)**