



*Document Title*

**FAIR Control System Development Guideline  
"Equipment Integration Guideline"**

*Document Name*

**F-DG-C-04e**

*Date yyyy-mm-dd*

**2012-09-07**

### **Abstract**

This document is the Equipment Integration Guideline for the FAIR accelerator control system.

It defines the process of integrating new equipment into the control system.

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## **1. Purpose and Classification of the Document**

The purpose of this document is to specify the development guideline as a directive for the process of integrating new equipment into the control system. Adherence to this guideline will improve product quality and maintainability of the FAIR accelerator control system.

The development guidelines complement the technical guidelines and detailed specifications for the FAIR control system in providing general rules and regulations for control system development.

Whenever regulations and requirements are specified in the General Specifications, Technical Guidelines, Common Specifications or Detailed Specifications of the Control System they are only referenced in this document. The related documents are listed in Appendix II.

No legal or contractual conditions are treated in this document. All related information is given in the General Specifications for FAIR II.

### **1.1. Responsibilities**

The responsibilities with respect to changes and modifications of the present document are entirely in the hands of the Accelerator Controls and Electronics Department of the GSI Helmholtz Centre for Heavy Ion Research GmbH (GSI) Darmstadt.

For initial information please contact the administration of the Accelerator Controls and Electronics Department.

Further information on the organigram, names of responsible persons and task leaders, as well as the agreed document release and approval procedure is summarized in the organizational note 'Controls Project for FAIR'.

## **2. Scope of this Development Guideline**

This Equipment Integration Guideline applies to all equipment that shall be connected to the control system. This document defines this process and gives hints and checklists in order to perform it. This document focuses only on the organization of the equipment integration process, not on the details of how each phase is accomplished.

Everybody who wants to integrate new equipment can use this document in order to identify the stakeholders in this process, the necessary steps and the corresponding tasks per step. It is the goal that this guideline will serve as reference and will lead to equipment well-integrated into the control system.

The process itself is a living process, therefore changes and extensions may be added to this document in the future.

This document first provides a quick overview over the Equipment Integration Process and then describes each phase in more detail.

### 3. Overview

The Equipment Integration Process applies, whenever new equipment needs to be integrated into the control system. It varies, depending on the fact, if the type of equipment already exists in the control system – then the process will be rather quickly performed – or if the equipment is of a new type and does not yet exist in the control system – then the process will be performed with all steps in detail. However, this document describes the full process. It must be clarified in the beginning with all responsables, whether certain steps can be simplified or omitted.

The Equipment Integration Process consists of several phases as shown in Figure 1. The break-down of the process into phases eases the overview and allows to concentrate in a given phase on what needs to be considered (indicated with the arrows from above in Figure 1) and what needs to be delivered for control system integration (indicated with the arrows from below in Figure 1). Although Figure 1 indicates some timely ordering of the process (equipment first has to be developed before applications can finally use it), it must *not* be interpreted as strictly sequential. Instead any development process is possible, typically some form of iterative development (indicated by the reverse arrows in the background). It must only be assured, that every phase is performed in a coordinated way, and that all necessary deliverables are produced.

Especially it must be ensured, that all involved parties communicate from the beginning to get a clear picture what the equipment shall do later on and what functionality is therefore necessary. All involved parties – from the equipment developer to the final end-user – must be taken into account from the very beginning to allow for a smooth integration. To ensure this, it is foreseen to have an overall coordinator for the Equipment Integration Process who helps integrating new equipment and brings together all necessary stakeholders. To ease understanding, this document will separate the description of the process into the description of single phases, keeping in mind that they might not be strictly sequential and that an overall coordination is necessary from the very beginning.

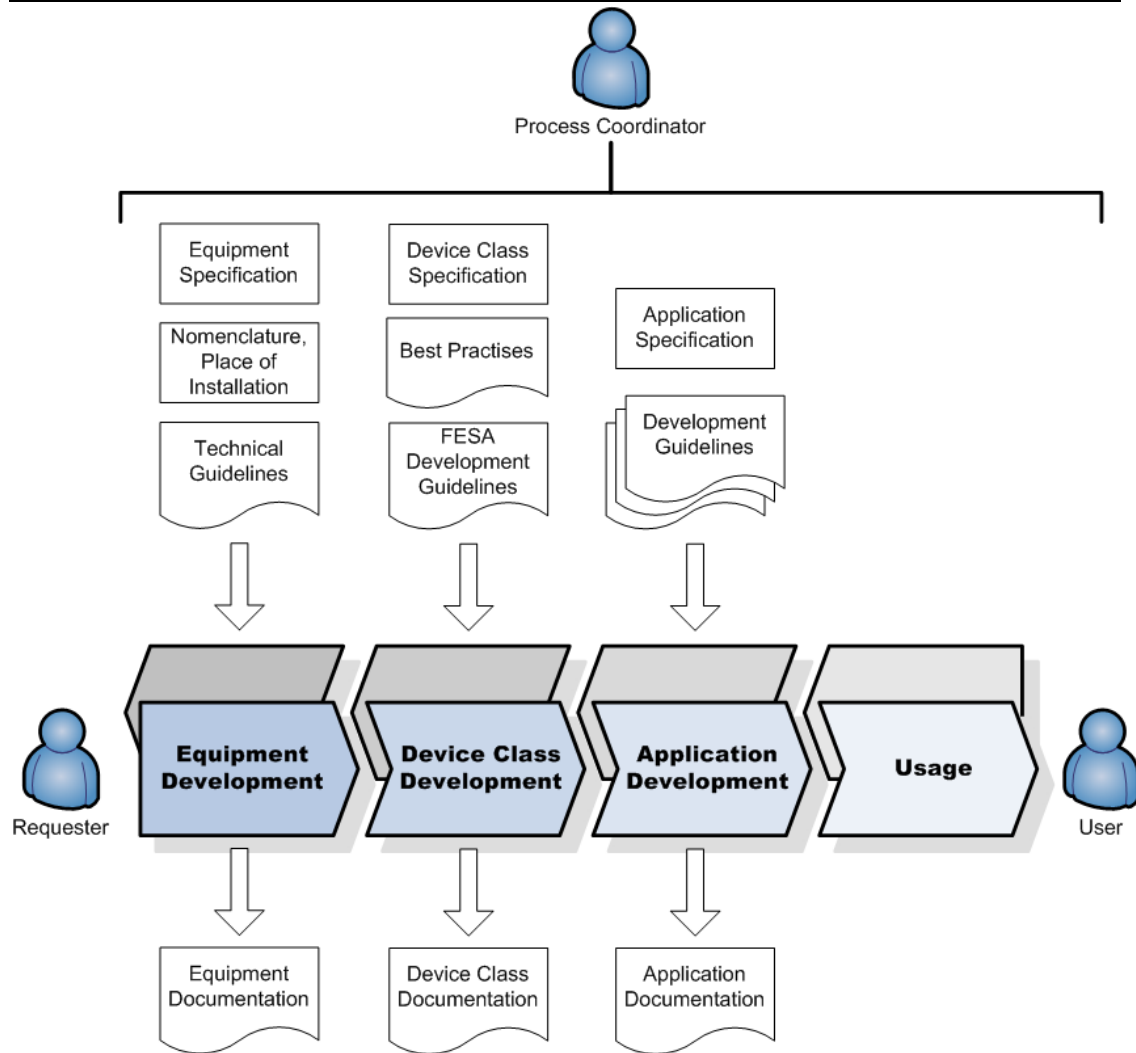


Figure 1: Overview of the Equipment Integration Process

The Equipment Integration Process starts with the development or purchase. Output of the Equipment Development / Purchase phase must be a detailed documentation of the equipment, its interface and behavior.

The next phase is the Device Class Development, i.e. the equipment is mapped into a logical device representation within the control system. Output of the Device Class Development phase is a detailed device class documentation.

Afterwards, the new equipment can be used by applications through the new device representation. The development of new applications is based on the application specification. This specification is typically created by future users, which also accompany the development itself. For the development, corresponding guidelines and templates have to be used. Output of this phase is a detailed (user) documentation.

The following chapter describes these phases in more detail, references needed documents, and gives hints and checklists.

This document can either be used to get an understanding of the full process or as quick reference. For the latter purpose, sometimes repetitions and catchwords or checklists are used.

## 4. Phases of the Equipment Integration Process

### 4.1. Equipment Development

The development or purchase of equipment is typically based on some specification. Already at this point, the corresponding guideline defining hardware connectors, functionality of equipment as well as integration with specific other components of the control system have to be taken into account to ensure that equipment can be physically connected and that it has the correct behavior.

Although the hardware itself plays an important role in this phase, the focus of this guideline and the documents to be produced lies on the integration into the control system, and thus on the necessary hardware connections and the interface towards the control system.

Guidelines that have to be taken into account are:

- F-TG-C-02e, FAIR Technical Guideline “Control System Equipment Control Interfaces” [1]

Defines hardware connectors and general equipment guidelines, mandatory.

- F-TG-C-04e, FAIR Technical Guideline “Control System Equipment Functional Requirements” [3]

General functional requirements concerning equipment, mandatory.

- F-TG-C-03e, FAIR Technical Guideline “Control System Equipment Interlock and Status Signal Interface” [2]

If the equipment shall take part in the interlock system, certain hardware connections and behavior has to be provided.

- F-TG-C-01e, FAIR Technical Guideline “Ethernet network connectivity” [4]

To connect equipment to the accelerator controls network, this guideline has to be respected.

People that have to be contacted are:

- The coordinator for the equipment integration process

It is the task of the coordinator to schedule a first meeting with all responsible people.

- The responsible person for the nomenclature system at the Accelerator Controls and Electronics Department

All equipment within GSI and FAIR follows specific naming conventions that allow unique identification [9]. To be able to use equipment from within the control system, a unique and naming-system conform name has to be assigned. Already in this phase, names will be assigned and used throughout the equipment integration process.

In order to interface the new equipment from the control system side, the output of the Equipment Development/Purchase phase must include documentation.

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Equipment documentation includes:

- what it does: what the equipment physically does with the beam (e.g. the magnet must bend the beam with increasing field strength during a ramp)
- how it works: what the equipment technically does (the function generator sends out ramp data to the power converter)
- how to connect it (e.g. via ACU or field bus), which other connection types are needed (e.g. network connection)
- how to interface with it: which data and format is needed, which time requirements must be fulfilled, how to read out status information
- how to physically install it in the accelerator as long as this concerns other parts of the control system, e.g. regarding radiation level, connection to systems like vacuum
- how to maintain it, especially regarding drivers that are used by the front-end software or firmware updates of the equipment
- if it depends on the beam schedule (support for different beams in parallel)

### 4.2. Device Class Development

In the Device Class Development phase the logical representation towards the control system is developed. Basis for the development is the specification of the device class, specifying the interface towards the rest of the control system (the properties of this device class, their meaning) and the behavior of the device itself. This specification has to be approved by the users (application developers as well as end users). Development guidelines and best practices documents have to be taken into account.

Relevant guidelines in this phase are:

- F-DG-C-03e, “Software Architecture Guideline” [5]

The architecture guideline for the control system is the basis for the control system itself and for control system development. It gives general rules and regulations for development, mandatory.

- F-DG-C-01e, “FESA Development Guideline” [6]

This Development Guideline that has to be adhered to when developing device classes. It defines the structure for device classes and includes a list of standard properties that must be supported by each device.

Integration into the Alarm System: Devices take part in the accelerator alarm system and must therefore use the provided alarm system interfaces. This Guideline also describes, how this is realized.

- Other documents like best practices which can be obtained from the FESA team at the Accelerator Controls and Electronics Department.

In order to use the new logical device from applications, the output of the Device Class Development phase must include documentation which must serve several purposes, i.e. the internal documentation, the interface documentation and the functionality description of the device.

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Device documentation includes:

- short description of the task of the device within the accelerator (e.g. how it acts on the beam)
- description regarding equipment
  - short description of the hardware of the equipment to get an overall picture (typically much shorter than any equipment documentation but focuses on the part that is relevant for control system integration)
  - the interface to the equipment
  - how the equipment is being controlled using this interface
  - equipment specific configuration and handling of constants
- description of the logical representation
  - how the device is represented logically towards the control system, the represented functionality and the detailed interface (API) description
  - how to use it / control it
  - which different status and alarms can occur? (this information has to be put also into the corresponding databases / configuration within the control system)
- documentation of the device class software itself

### **4.3. Application Development**

The application development is done to allow an end user to operate the newly integrated equipment. Users in this respect can be operators, machine physicists or device experts. Applications for daily use in operations in the main control room are written by the Applications Group within the Accelerator Controls and Electronics Department, however there might be expert applications that are written by other groups as well. Nevertheless, all new applications for use in the control room have to be developed taking into account the corresponding standards and guidelines.

New applications or enhancements of existing applications have to be specified together with the future users. Since they are the once to use the application later on a daily basis, their ideas and suggestions are valuable input for the Application Development Phase. Besides the user's point of view, standard ways of creating applications that result in a common look and feel must be used.

For specifications together with future users it is suggested to use not only descriptive text but also take benefit from paper mock-ups or GUI drawings / sketches. Help for this process can be obtained from the Applications Group within the Control System.



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Things that have to be taken into account:

- F-DG-C-02e, “GUI Guideline“ [7]  
 Guideline for developing GUI applications for the main control room, mandatory. For other types of applications, e.g. expert applications, this guideline should also be taken into account.  
 For GUI development, the Applications Group within the Accelerator Controls and Electronics Department provides a set of GUI elements (application frame, prefilled lists, special display elements etc.) that ease development and maintenance and should be used to also generate a common look and feel for the applications.
- F-DG-C-03e, “Software Architecture Guideline” [5]  
 The architecture guideline for the control system. Basis for the control system itself and for control system development. Gives general rules and regulations for development, mandatory.
- Technologies and Frameworks defined/provided by the Applications Group within the Accelerator Controls and Electronics Department have to be used
- Integration into the main control room console environment system [8]  
 In order to present an integrated work environment to operations staff, all control room applications have to integrate into an overall concept. New applications have to be defined and configured to work within the environment, but also the applications themselves have to provide certain functionality (switch some selection from the outside, e.g. centrally from a console manager etc). This has to be implemented by each application.
- Central guidelines for development  
 Guidelines for development by the Accelerator Controls and Electronics Department regarding setup of projects, repository, testing, deployment etc have to be followed

Output of the application development includes:

- end user documentation
- documentation of the application software itself

The rollout of the new application to the control room has to be organized. This includes:

- integration in the productive environment
- end user documentation is put into the central place for operators documentation
- training for the end users

## 5. Organization of the Equipment Integration Process

In general, the whole process for equipment integration heavily relies on a good coordination taking into account all involved parties from an early stage on. Users have to define, what the equipment shall do and which attributes of the equipment they want to control and view. The equipment developer has to provide the necessary hardware connections and functionality, the device class developer has to create a good logical abstraction of the equipment and the application developer has to produce a well-integrated application that allows controlling the new equipment.

Since so many parties are involved, an overall coordinator is put in place to orchestrate the equipment integration process. The coordinator brings together all stakeholders, ensures the necessary communication, takes care of necessary time schedules and acts as central contact person for all issues. The coordinator is assigned from the very first moment when equipment integration questions arise. It might be the case that for each integration process a different coordinator is chosen based on the type of equipment and the background of the coordinator.

## I. Related Documentation

- [1] F-TG-C-02e, FAIR Technical Guideline “Control System Equipment Control Interfaces“
- [2] F-TG-C-03e, FAIR Technical Guideline “Control System Equipment Interlock and Status Signal Interface“
- [3] F-TG-C-04e, FAIR Technical Guideline “Control System Equipment Functional Requirements“
- [4] F-TG-C-01e, FAIR Technical Guideline “Ethernet network connectivity“
- [5] F-DG-C-03e, “Software Architecture Guideline“
- [6] F-DG-C-01e, “FESA Development Guideline“
- [7] F-DG-C-02e, “GUI Guideline“
- [8] F-DS-C-22e, FAIR Detailed Specification “Console Environment System“
- [9] F-TG-C-05e, FAIR Technical Guideline “System for Nomenclatures“

## II. Document Information

### III.1. Document History

Version	Date	Description	Author	Review / Approval
0.1	31. Jan. 2012	First version	J.Fitzek, L.Hechler	
0.2	10. Feb. 2012	Comments from CCT incorporated	J.Fitzek, L.Hechler	
1.0	08. Aug. 2012	Adapted to revised structure	J.Fitzek, L.Hechler	
1.1	07. Sep. 2012	Prepared first version	CCT	CCT