

Interface Control Document PLASMA FACING COMPONENTS : CENTRAL IN

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National Spherical Torus Experiment Upgrade

Interface Control Document

**PLASMA FACING COMPONENTS:
CENTRAL INSTRUMENTATION & CONTROL**

NSTX-U-ICD-007-PFC-CIC-00

**Revision 0
May 16, 2018**

Change Record

Revision	Date	Description of Change
0	May 16. 2019	Initial Release

References

- [1] GENERAL REQUIREMENTS DOCUMENT, NSTX-U-RQMT-GRD-001-01.
- [2] SYSTEM REQUIREMENTS DOCUMENT, Plasma Facing Components, NSTX-U-RQMT-SRD-003-01.
- [3] SYSTEM REQUIREMENTS DOCUMENT, CENTRAL INSTRUMENTATION AND CONTROL, NSTX-U-RQMT-SRD-009-00.

1. Purpose

This document describes the various interfaces between the following subsystems: Plasma Facing Components and the Central Instrumentation and Control. The interface locations and boundaries that connect the Plasma Facing Components to the Central Instrumentation and Control are identified based on different interface types.

2. Scope

The Plasma Facing Components consist of the Tiles and Support structures consisting of the Outboard Divertor, Inboard Divertor Vertical, Center Stack First Wall, Center Stack Angled Section, Inboard Divertor Horizontal, and PFC Thermocouples. The Central Instrumentation and Control consists of Control I/O, Plant Control and Monitoring, Timing and Synchronization System, Data I/O systems, and Data Archiving Systems. This ICD focuses on the cabling from the PFC thermocouples accessing the digitizers.

The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Plasma Facing Components
- Central Instrumentation and Control
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with the requirement prefix, ICD, followed by a number [ICD-PFC-CIC-X] where “X” is a sequential count beginning with 001, “PFC” represents Plasma Facing Components, and “CIC” represents Central Instrumentation and Control. There is also a unique identifier for all interfaces in the format [#####-#####-X]. The identifier is a concatenation of two level 5 WBS values and the interface type. This is followed by an interface description and a list of references. References that provide evidence pertaining to interfaces include but are not limited to drawings, calculations, or specifications.

Reference also includes a reference to a paragraph that identifies the set of interface definitions.

4.1. Interface Types

The top-level interface types are defined in Table 1. Within each heading there are sub-headings to address any special sub-elements that need consideration. For example, the Mechanical has four sub-elements that need to be addressed: Structural, Spatial, Location, and Wall/Floor Penetration. For those interface types with sub-interfaces there are corresponding sub-sections.

Table 1. Interface Types.

Heading	Abbreviation	Name
4.2	Me	Mechanical
4.3	Ep	Electrical Power
4.4	Si	Signal
4.5	Di	Diagnostics
4.6	Gf	Gas/Fluid
4.7	Va	Vacuum
4.8	Sw	Software
4.9	Th	Thermal
4.10	Pe	Plasma/Eddy/ Halo Current

Table 2 provides the N2 Diagram identifying all the interfaces for NSTX-U, while Table 3 provides the specific details of the interface.

Table 2. N2 Diagram Interface types.

Plasma Facing Components	Me,Th,Pe		Me,Th,Va,Pe						Me	Me	Me,Pe		Me			
	In-Vessel Structure	Me,Di,Pe			Th			Me,Th,Pe	Me		Me,Di,Pe			Di		
		Vacuum Vessel Structure			Me,Va	Me	Me	Me,Th,Pe	Me	Me,Va	Me,Di,Va		Si	Di,Si		
		Va	Centerstack Structure			Va	Me,Gf	Me	Me	Me				Di		
		Me	Me,Th,Ep	Magnets			Gf	Me			Di		Si	Di		
Si		Me,Va			Heating Systems		Gf	Th		Me		Gf,Si	Si	Si	Si	
					Si,Va,Me,Sw	Vacuum Pumping System		Si	Si	Gf,Si	Si		Si,Va	Si	Si	
				Gf,Si			Coolant System	Gf				Gf,Sw	Si,Sw	Si		
	Th,Gf	Ep,Di,Th,Va	Ep,Gf,Th,Pe		Si		Si	Bakeout System						Me	Si	
			Gf,Va	Gf,Va	Ep	Gf,Si		Gas Delivery System	Me	Va			Si,Sw	Si	Si	
		Gf	Si			Si,Gf,Va		Gf	Wall Conditioning System				Si,Sw	Si	Si	
		Me,Va	Me,Va	Me	Me	Gf,Si	Gf			Va,Ep	Diagnostics		Si,Sw	Si	Si	Si
				Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Power Systems	Si	Ep,Si	Ep,Si,Di,Gf	Ep
					Si				Me,Si	Si		Centralized Instrumentation and Control	Si,Me			
									Sw		Si	Si,Sw	Integrated Machine Operations			
								Ep						Operations & Safety Systems		
Me		Me	Me	Me	Me	Me		Me	Me	Me	Me	Me	Me	Me	Me,Ep	D-Site Locations (Test Cell)

Table 3. Callout.

PFC	Si
	CI&C

The remainder of this document addresses each of the interfaces. Note the template includes a paragraph heading for each interface and a table for each interface type. In the event there is no interface, the table will remain blank with a blank row.

The following paragraphs in Section 4 address each of the interfaces, and Section 5 addresses any off-project interfaces. Off-project interfaces are those external interfaces that interact with the NSTX-U system.

4.2. Mechanical Interfaces

This paragraph addresses any type of mechanical interfaces that include a structural, spatial, location dependent interfaces or areas where penetrations into a wall or floor are required. These are identified independently as interface parameters will likely be different.

4.2.1. Structural Interfaces

This identifies any interfaces between system elements that require a structural interface. This could be based on various forces placed on the system and by the system.

Identifier	Interface	References
N/A		

4.2.2. Spatial Interface

This identifies any interfaces between system elements pertaining to spatial restrictions or constraints.

Identifier	Interface	References
N/A		

4.2.3. Location Interfaces

This identifies any interfaces between system elements that have any particular dependencies on element location or location constraints.

Identifier	Interface	References
N/A		

4.2.4. Wall/Floor Penetration Interfaces

This identifies any interfaces between system elements and any penetrations or modifications to the wall or floor of the D-Site building.

Identifier	Interface	References
N/A		

4.3. Electrical Power Interfaces

This identifies any interfaces between the system elements requiring AC, DC, rectification or power conditioning.

Identifier	Interface	References
N/A		

4.4. Signal Interfaces

This identifies any interfaces between the system elements and signals that are used to either send or receive control information or data. It explicitly includes the type of physical interface such as Ethernet or Fiber Optic or any specific protocols.

Identifier	Interface	References
1.1.1.1.8- 1.6.1.1-Si	PFC Thermocouple Signals from digitizer via cross connects interfaced to NSTX-U data acquisition system.	See Paragraph 4.4.1 Drawing AE1024,

		AE1026,AE1027 Sheet 3.
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4.4.1. PFC Thermocouples – CI&C

Interface Notes:

- PFC Thermocouples wiring runs exit the vacuum to air side as indicated in drawing 9D1095.

ICD-PFC-CIC-001: The PFC thermocouple to Digitizer interface occurs at a cross-connect. The cross connect then connects to a into a CAMAC H359 Isolation Amplifier. The interface is defined in drawings AE1024, AE1026, & AE1027 Sheet 3.

ICD-PFC-CIC-002: The interface timing required is identified in Reference 3. The protocol includes voltages to determine temperature. For example, per the drawing $33.3 \mu\text{V}$ equals 1degreeK.

ICD-PFC-CIC-003: The Digitizer interface to the data acquisition system is shown in drawing AE1002 Sheet 15 Epics1 Link Data Map. It begins with CTC-EE-429, which is the PFC Thermocouples for the OBD and Passive Plates. In addition, CTC-EE-434 represents the thermocouples for the IBDH, IBDV, and Center Stack casing. CTC-EE-434 is connected to the CAMAC in CTC-EE-435. Note: CTC-EE-435 address non-PFC related thermocouples.

4.5. Diagnostic Interfaces

This identifies any interfaces between the system elements with any instrumentation or diagnostic equipment to collect performance data.

Identifier	Interface	References
N/A		

4.6. Gas/Fluid Interfaces

This paragraph has two different types of interfaces: Gas and Fluid.

4.6.1. Gas Interfaces

This identifies any interfaces between system elements that use any type of gas (e.g., He).

Identifier	Interface	References
N/A		

4.6.2. Fluid Interfaces

This identifies any interfaces between system elements that use any type of gas (e.g., ionized water).

Identifier	Interface	References
N/A		

4.7. Vacuum Interfaces

This identifies any interfaces between system elements that pertain to the Vacuum.

Identifier	Interface	References
N/A		

4.8. Software Interfaces

This identifies any interfaces between system elements that use software that may exchange interfaces with other software components. This includes application programming interfaces (APIs) or any other exchange of information between different software applications.

Identifier	Interface	References
N/A		

4.9. Thermal Interfaces

This identifies any interfaces between the system elements that pertain to Thermal characteristics.

Identifier	Interface	References
N/A		

4.10. Plasma Interfaces

This paragraph has two different types of interfaces: Plasma and Eddy/Halo Current.

4.10.1. Plasma Interfaces

This identifies any interfaces between the system elements with the Plasma.

Identifier	Interface	References
N/A		

4.10.2. Eddy/Halo Current Interfaces

This identifies any interfaces between system elements with the Eddy/Halo Currents.

Identifier	Interface	References
1. N/A		

5. Off-Project Interfaces

The off-project interfaces are components that are not specifically part of the NSTX-U system. They may include external systems and interfaces where the program has little control over a part of the interface. They are provided for completeness.

There are no external interfaces.