Power System - Magnets ICD

Interface Document: NSTXU_1-1-3_IC_100

REVISION 0

June 24, 2019

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National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

POWER SYSTEMS: MAGNETS

NSTX-U-ICD-PWR-MAG-0

Revision 0
June 19, 2019

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Change Record

Revision	Date	Description of Change
0	June 19, 2019	Initial Release

References

[1] GENERAL REQUIREMENTS DOCUMENT, NSTX-U-RQMT-GRD-001-01.

[2] SYSTEM REQUIREMENTS DOCUMENT, POWER SYSTEMS NSTX-U-RQMT-SRD-006-01.

[3] SYSTEM REQUIREMENTS DOCUMENT, MAGNET SYSTEMS NSTX-U-RQMT-SRD-002-02.

1. Purpose

This document describes the various interfaces between the following subsystems: Power Systems and the Magnets. The interface locations and boundaries that connect the Power Systems to the Magnets are identified based on different interface types.

2. Scope

The Power Systems consists of consist of the AC Power, AC/DC Conversions, DC Rectifiers, and control and protection. The Magnets consists of Inner and Outer PF and TF coils, and OH Solenoid, RWM Coils and Bus Bar System. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Power Systems
- Magnets
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD, followed by a number [ICD-PWR-MAG-X] where "X" is a sequential count beginning with 001, PWR represents Power Systems, and MAG represents Magnets. 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 provide evidence pertaining to interfaces and include but are not limited to drawings, calculations, or specifications. Reference also include 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.

Table 2. N2 Diagram Interface Types.

Plasma Facing Compenents	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, Th	Me, Gf	Me	Me					Di		
		Me	Me, Th, Ep	Magnets			Gf	Me			Di		SI	Di	Me	
Si		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							Si, Me	
			Gf,Va		Ep	Gf,Si			Gas Delivery System	Me	Va		Si,Sw	Si	Me	
		Gf				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, Me	Si
				Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Power Systems	Ep,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	Me	
								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.

Magnets	
Ep	Power Systems

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 that 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 to include structural, spatial, location dependent interfaces or areas where penetrations in a wall or floor are required. These are identified independently as the interface parameters will likely be different.

4.2.1. Structural Interfaces

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

Identifier	Interface	References
N/A		

4.2.3. Location Interfaces

This identifies any interfaces between the 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 the system elements 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
1.5.3.1-1.1.3.4.Ep	Current is delivered to the **Bus Bar Systems,** and therefore coils of the **TF Convertor DC Systems** at the Power Cable Termination Structure.	See Paragraph 4.3.1 Drawings 4FJ001, 4FD055, DC1200
1.5.3.2-1.1.3.4-P	Current is delivered to the **Bus Bar System** and therefore coils of the **OH Convertor DC Systems** at the Power Cable Termination Structure.	See Paragraph 4.3.2 Drawings 4FJ001, 4FD-055, DC1200
1.5.3.3-1.1.3.4.Ep	Current is delivered to the **Bus Bar Systems** and therefore PF coils of the **PF Convertor DC Systems** at the Power Cable Termination Structure.	See Paragraph 4.3.3 Drawings 4FJ001, 4FD-055, DC1200
1.5.3.4-1.1.3.4. Ep	Current is delivered to the **Bus Bar Systems** , and therefore the **Switching Power Amplifier DC Systems** at SPA interconnection box, in the test cell.	See Paragraph 4.3.4

Interface Notes:

- The PF-1b scope is part of Recovery scope. The other interfaces are included for completeness.

- Figures 1 provides a view of the PCTS that are protected with a shield preventing access to the Magnet hardbus. Ground cables are connected to the Power Cable Termination Structure (PCTS) bus work. When in operation, a flex conductor connects the power systems to the bus bar.

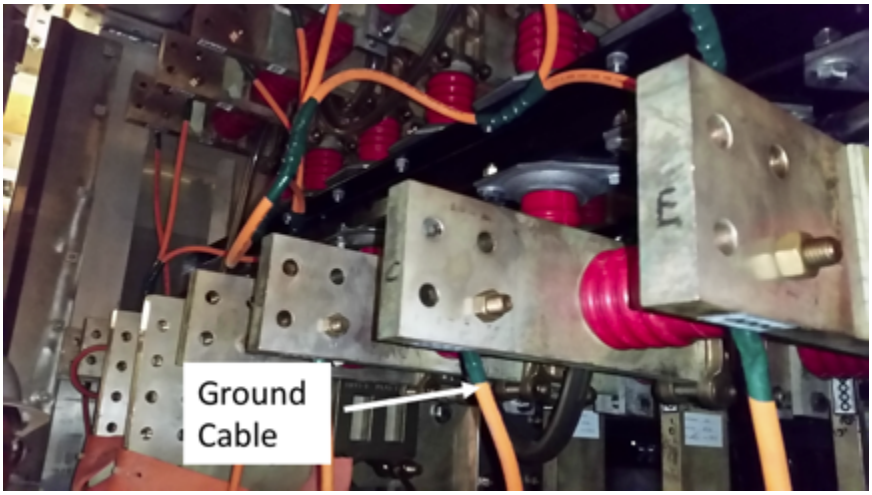

Figure 1. PCTS Grounding

- For operation, the shield will be removed and either flex conductors or cables are used. Figure 2 provides a photo of the PCTS connections to the magnet hardbus. The cables are black and hard to see so there were outlined in white. Subsequent sections identify the location and type of connection.

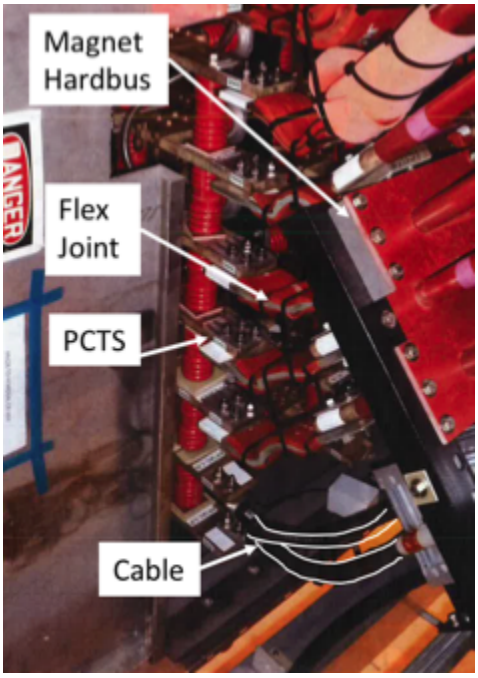

Figure 2. Flex Joints Connection between PCTS and Magnet Hardbus

4.3.1. TF DC Convertor to Bus Bar

ICD-PWR-MAG-003: The power connection type is using LBX-600 1X6” on Bus F&G per Drawing 4FD055.

ICD-PWR-MAG-004: The voltage range is from -1kv to 1 kV from the TF Power supply. The maximum current range is 130kA [Ref 3].

4.3.2. OH DC Convertor to Bus Bar

ICD-PWR-MAG-003: The power connection type is 1/c-1000 kcmil cable for both OHP and OHN per drawing 4FD055.

ICD-PWR-MAG-004: The voltage waveforms for long and short pulse scenarios are identified in 5.4.-2 of Ref 3. The max current is 24 KA [Ref 3].

4.3.3. PF DC Convertor to Bus Bar

Interface Notes:

- Drawing 4FD055 currently does not consider either PF-1c or PF-5 connections. However, they are connected in the field.

ICD-PWR-MAG-005: The power connection flex joint connector plates follow per drawing 4FD055:

Bus Identification	Bus Location	Material
PF-1a P|C|N	A,B,C Lower	LBX-400 1/2 x 6” Connecting Plate
PF-1b P|N	Cable Lower	TBD
PF-1c	-	-
PF-2 P|C|N	D|E|F Upper	-LBX-400 1/2 x 6” Connecting Plate
PF-3 P|C|N	ABC Upper	LBX-400 1/2 x 6” Connecting Plate
PF-4 P|N	Cable Upper	1/c-1000 kcmil cable
PF- 5	-	-

ICD-PWR-MAG-006: The voltages and currents follow**:**

Name	Voltage (kV)	Min Current (kA)	Max Current (kA)
PF-1a	2.026	0	20
PF-1b	2.026	-10	21
PF-1c	2.026	-7	20
PF-2	2.026	0	15
PF-3	2.026	-16	12
4	2.026	0	16
5	3.039	0	25

ICD-PWR-MAG-007:PF Bus Bar Connector types A-G are identified in Drawing DC1200

4.3.4. SPA to Bus Bar

ICD-PWR-MAG-008: The power interconnections are contained in a dedicated box as shown in Figure 3.

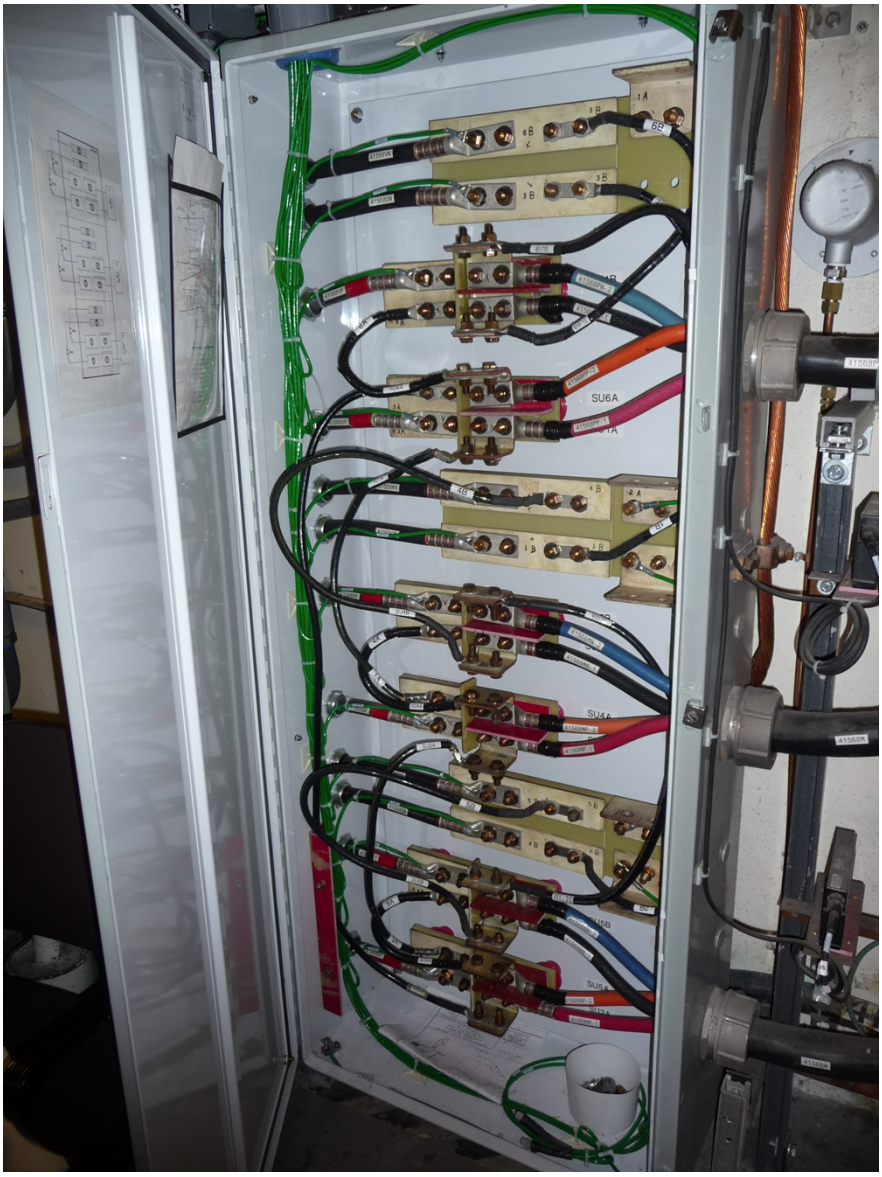

Figure 3. SPA - Bus Bar Interconnection Box.

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
N/A		

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 the 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 the 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 the system elements that pertain to the Vacuum.

Identifier	Interface	References
N/A		

4.8. Software Interfaces

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

Identifier	Interface	References
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 on part of the interface. They are provided for completeness.

There are no external interfaces.