

# PIP-II Project

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## PIP2IT HWR RF Distribution Technical Requirements Specification

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## Revision History

Version #	Date	Author	Comment
0.0	May 22 2019	James Steimel	Initial Version of the document
			Changes / revisions

- 1. Section Heading (use the Heading 1 for style here)...** Error! Bookmark not defined.
  - 1.1. Subsection Heading (use Heading 2 for style here) .....**Error! Bookmark not defined.

## 1. Purpose

The purpose of this document is to list detailed, technical specifications for the proposed design of the RF distribution for the HWR cryomodule in PIP2IT. The information should be sufficient to specify components and services for procurement.

## 2. Scope

The scope of these requirements include the RF distribution for the HWR cryomodule in PIP2IT. The RF distribution transports the RF power from the output of the RF amplifiers to the input coupler of the HWR cavities and includes the reflected power isolator and directional coupler. An interlock system for component protection is also part of the scope of the design.

## 3. Acronyms

FESHM	Fermilab ES&H Manual
FRCM	Fermilab Radiological Control Manual
FRS	Functional Requirements Specification
HPRF	High Power Radio Frequency
HWR	Half Wave Resonator
LLRF	Low Level Radio Frequency
PIP2IT	Proton Improvement Plan II Injector Test
RF	Radio Frequency
SCD	System Configuration Document
SRF	Superconducting Radio Frequency

## 4. Reference Documents

#	Reference	Document #
1	RF Power Systems EPDM	ED0002850
2	Interface Specification Document for PIP2IT HWR RF Distribution LLRF and Cooling System	ED000xxxx
3	<a href="#">Fermilab Engineering Manual</a>	NA
4	<a href="#">Fermilab Environmental Safety and Health Manual</a>	NA
5	Interface specification for the HWR power amplifier	NA

	Interface specification for the HWR cryomodule	
	PIP2IT SRF RF Distribution Functional Requirements	
	Power Requirements for PIP2IT SRF RF Distribution	

## 5. Overview

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## 6. Technical Requirements

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### 6.1. General RF Distribution Requirements

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Requirement #	Description	Value	Comments
1	Center Frequency	162.5 MHz	
2	Bandwidth	>5 MHz	Defined bandwidth where insertion loss and isolation specifications are valid
3	Total Loss	< 0.5 dB	
4	Insertion VSWR	< 1.5:1	To protect RF amplifier from tripping
5	Power Handling	>7 kW CW forward >3 kW CW full reflection	Cable and circulator cannot overheat

### 6.2. Circulator Requirements

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Requirement #	Description	Value	Comments
1	Center Frequency	162.5 MHz	
2	Bandwidth	>5 MHz	
3	Insertion Loss	< 0.3 dB	
4	Insertion VSWR	< 1.5:1	To protect RF amplifier from tripping

5	Power Handling	>7 kW CW forward >3 kW CW full reflection >5 kW pulse full reflection	Pulse full reflection is from cavity field decay after power interruption
6	Isolation	20 dB minimum	
7	Inlet water pressure handling	150 psig maximum	
8	Water pressure drop	60 psi	@ rated flow
9	Water flow		
10	Inlet water temperature range	25-35 °C	To maintain specified operation

### 6.3. Circulator Load Requirements

Requirement #	Description	Value	Comments
1	Center Frequency	162.5 MHz	
2	Bandwidth	>20 MHz	
3	Insertion VSWR	< 1.1:1	
4	Power Handling	>3 kW CW >5 kW pulse	
5	Inlet water pressure handling	150 psig maximum	
6	Water pressure drop	60 psi	@ rated flow
7	Water flow		
8	Inlet water temperature range	25-35 °C	

### 6.4. Directional Coupler Requirements

Requirement #	Description	Value	Comments
1	Center Frequency	162.5 MHz	
2	Bandwidth	>5 MHz	
3	Insertion Loss	< 0.1 dB	

4	Insertion VSWR	< 1.1:1	To protect RF amplifier from tripping
5	Power Handling	>7 kW CW forward >3 kW CW full reflection >5 kW pulse full reflection	Pulse full reflection is from cavity field decay after power interruption
6	Isolation	20 dB minimum	
7	Coupling	58-62 dB	Keep full power below 10dBm out of coupled port