



Terms of Reference

of the

“Solid State Amplifier”

for the

Synchrotron Light Source Institute (Public Organization)

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Synchrotron Light Source Institute (Public Organization)

111 University Ave., Muang District, Nakhon Ratchasima Thailand 30000



1.) Introduction

Synchrotron Light Research Institute (Public Organization) plans to replace the old Radio frequency (RF) amplifier for improving the operation efficiency of the booster synchrotron accelerator. The new RF amplifier will be based on the solid-state technology with the maximum power of 15 kW and operate at 118MHz RF frequency.

2.) General requirement system

The amplifier is based on solid-state technology. It can provide maximum power of 15 kW at 118 MHz frequency. The cooling system is the water-cooled system. Detailed specification of amplifier is in section (4).

The RF amplifier should be able to communicate with the present Low level RF control (LLRF), as illustrated in Figure 1. Details of RF signal requirements to/from LLRF and installation can be discussed with SLRI and confirmed by both parties before manufacturing.

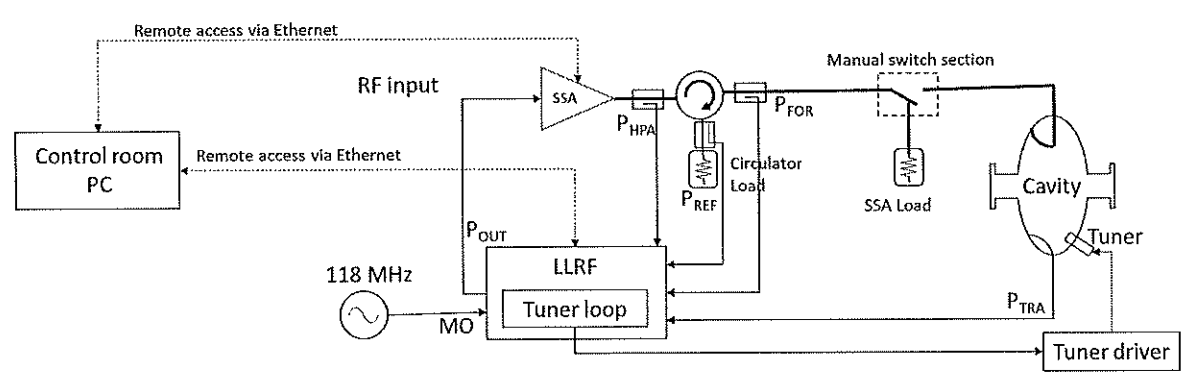


Figure 1: Block diagram of the booster ring RF system.

3.) Scope of work

3.1.) Supplier has a responsibility to supply and test such system in section (2) and transport to SLRI, installation and perform a final site acceptance test at SLRI. List of all items that should be provided by supplier is below.

Item	Description	Quantity
1	15kW solid-state power amplifier	1 set
2	15kW circulator set 2.1. RF circulator 1 ea.	1 set



Item	Description	Quantity
	2.2. RF load 1 ea.	
3	RF load	1 ea.
4	Directional couplers (1Foward/1Reflect in 1 set)	2 ea.
5	Coaxial Transmission Line network	1 set
6	Spare part 6.1. Amplifier Module 1 ea. 6.2. Power Supply Module (of amplifier module) 1 ea.	1 set
7	Installation work	1 job
8	FAT/SAT work	1 job

3.2.) Supplier has responsibility to install the amplifier and coaxial transmission line network at SLRI site (maximum length of 20m from amplifier to cavity). Layout of the installation will be provided by SLRI.

3.3.) Supplier has responsibility to provide a 3D installation drawing of RF amplifier system for SLRI approval before shipping. (step file format)

3.4.) Supplier has responsibility to perform acceptance test regarding the specifications in section (4) with the detailed acceptance tests in section (5) and to produce the reports of that tests. (English version)

3.5) Supplier should provide a report of acceptance tests to SLRI in both hard copy and electronic files. (English version)

3.6) Supplier should provide operation manual, maintenance manual, programming manual, RF amplifier circuit diagram, wiring diagram, utilities (water cooling) diagram of the rf amplifier system to SLRI in both hard copy and electronic files. (English version)

#### 4.) Specification

	Specification	Condition	Unit	Value
R	RF Parameters			
R1	Working frequency		MHz	118 ± 2
R2	Stable gain at		MHz	118 ± 0.5
R3	Rated output power	@ P1dB	kW	15



	Specification	Condition	Unit	Value
	Operation mode	CW and Pulse		
	Pulse repetition rate of pulsed operation		Hz	0.3 – 1
		Ramping time from low to high power in 750ms and run every 3 seconds (rep. rate ~0.33Hz)		
R4	Open-loop output stability at rated output power	measurement time 10 second		
R4.1	Short-term (amplitude, peak-to-peak)		%rms	≤0.5
R4.2	Short-term (phase, peak-to-peak)		°	≤0.5
R4.3	Long-term output power amplitude changes within	measurement time 8 hours with water temperature changes within ± 1°C	W	±500
R4.4	Long-term output power phase changes within	measurement time 8 hours with water temperature changes within ± 1°C	°	±1
R5	Closed-loop output stability at rated output power	measurement time 30 minutes	°	±1
R5.1	Amplitude stability	Peak-to-peak	%rms	≤0.5
R5.2	Phase stability	Peak-to-peak	°	≤0.5
R6	Phase noise		dBc	-60
R6.1	Harmonic suppression	2 <sup>nd</sup> harmonic	dBc	≤30
R6.2	Spurious suppression	n > 2	dBc	≤50
R7	RF connector			
R7.1	RF input	N-type		female
R7.2	RF output	Coaxial rigid line -Output at the top of the cabinet	EIA	3-1/8
R8	Redundancy	During operation, even if 6% of the total number of power amplifier units are damaged, the power amplifier can still meet its technical requirements (except for the P1dB parameter) and can	%	6



	Specification	Condition	Unit	Value
		operate stably for a long time (at least 8 hours)		
R9	Electromagnetic radiation	Under rated output power, measurement point is 30 cm away from the source	mW/cm <sup>2</sup>	<0.1
O	Operation environment			
O1	Ambient temperature		°C	10-35
O2	Humidity		%	<80
O3	Main AC Power input	3 phases	Vac	420
O4	Main AC Power input	single phase	Vac	230
O5	Frequency		Hz	50
O6	Water Cooling system	DI water	°C	20-30 ±1
O7	Control Interface	Local/Remote via Ethernet - At least 1 SSA ready interlock to LLRF is needed		

**5) Installation**

**5.1) RF amp set installation**

-Supplier responds to assembly and install the amplifier set at designed area at SLRI site.

**5.2) Coaxial line network installation**

- Size 3-1/8 inch coaxial rigid line
- Supplier provides coaxial and installs the network

**5.3) Utilities installation**

- SLRI will provide a cooling water manifold
- Supplier responsible for providing information on cooling water connector type/size/number of points/ flow rate
- SLRI will provide and install an electricity power line (420VAC 3 phases/5-line (3L/N/G)) from SLRI DB (distribution board) to the amplifier. Supplier is responsible for providing information on electricity requirements.

**6.) Test and Certification**

**6.1) Factory Acceptance Test (FAT)**

Supplier shall conduct the FAT (Factory Acceptance Test) according to the specifications. Supplier has responsibility to report the result to SLRI with its certification in form of electronic format files and hard copies.



## 6.2) Site Acceptance Test (SAT)

Supplier shall conduct the SAT (Site Acceptance Test) according to the specifications. Supplier has the responsibility to report the result to SLRI with its certification in form of electronic format files and hard copies.

- Long term run (15kW at RF load) at least 4 hrs run (CW mode) - with the existing LLRF control system

- Operation compatible testing with LLRF control -test with RF cavity at least 4 hrs run (ramping mode) – without beam at operation cavity voltage power (~10kW)

- Operation compatible testing with LLRF control -test with RF cavity at least 1 hrs run (ramping mode) - with beam at operation cavity voltage power (~10kW)

## 7.) Supplier qualification

Supplier has responsibility to show the reference of the manufacturing of solid-state amplifier.

## 8.) Warranty

Warranty will start when the modulator arrives SLRI at least 1 year.