

Proposal of 2450MHz 1.6kW CW Microwave Generator

Revision: 0.3



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Document Revision History

Rev.	Date	Name	Description
0.1	Apr. 24, 2019	Hojoon Yoo	Initial Release
0.2	May 3, 2019	Hojoon Yoo	PSU 정보 추가, Block diagram 추가
0.3	May 10, 2019	Hojoon Yoo	PSU 정보 추가, 용어 변경
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1 DEFINITIONS: ACRONYMS, ABBREVIATIONS, AND TERMS

AC	Alternative Current
Amp	Amplifier
CON	Connector
CW	Continuous wave
dB	Decibel
dBm	Decibel relative to d1 milli watt
DC	Direct Current
DE	Drain efficiency
etc.	Et cetera
EVB	Evaluation board
GaN	Gallium Nitride
GHz	Gigahertz
GND	Ground
I_{DQ}	Quiescent drain current
MHz	Megahertz
mm	Millimeter
MW	Microwave
NC	No Connection
P/O	Purchase order
PA	Power amplifier
PCB	Printed circuit board
PLL	Phase-Locked Loop
P_{sat}	Saturated power
PSU	Power supply unit
RF	Radio frequency
RoHS	Restriction of Hazardous Substances; European directive
SSPA	Solid state power amplifier
TBD	To be determined
T_c	Case temperature
Term.	Termination
Tr.	Transistor
VCO	Voltage Controlled Oscillator
V_{DS}	Drain-source voltage
V_{GS}	Gate-source voltage
W	Watt
w/	With
w/o	Without

2 INTRODUCTION

RFHIC's 2450MHz 1.6kW Microwave generator uses GaN on SiC HEMT technology which performs high breakdown voltage and high efficiency. And, this product is designed for high power ISM (Industrial, Scientific, Medical) applications with adjustable power up to 1.6kW. This high efficiency rugged device is targeted to replace industrial magnetrons and other vacuum tubes currently powering industrial heating, microwave torch, drying, microwave CVD and sintering.

This microwave generator is based on GaN solutions. 8 affordable GaN transistors have been combined with precise combiner optimized for the SSPAs. High power efficiency will reduce OPEX for customer. In addition, extremely low spurious and precise power/frequency adjustment will offer best quality final product for valuable customer. Every

Also, every major RF characteristic will be monitored and controlled remotely.

The solid-state generator has the major advantages like

- a. Longer life time
- b. Improved spectrum even at low power.
(Narrower fundamental signal, stable frequency, and lower spurious)
- b. No high voltage the generator needed. (longer life time and safer operation)
- c. Precise output power and fine frequency adjustment.
- d. Accurate monitoring of forward and reflected power with true RMS detector
- e. Much quiet operation

3 SAFETY AND PRODUCT COMPLIANCE GUIDELINES

- DO NOT start the generator with any of the covers removed.
- DO NOT try to introduce metallic objects inside power supply or SSPA head.
- The power supply must be correctly earthed during operation
- DO NOT operate the generator without a load.
- Contain electromagnetic radiation with an efficient shield.
- On commissioning, start the generator at low power. Check for possible leakage.
- User must ensure that chiller is operational before switching ON the generator.
- SSPA Head must be prevented from water circuit freezing or condensing.
- The generator should be installed in a clean, dry place, protected against water or moisture.
- If the system accidentally gets wet, make sure to unplug the power cord from the outlet before cleaning.
- DO NOT operate the generator in a dusty environment.
- DO NOT operate the generator at altitudes over 1000m.
- If the generator is to be transported, drain the water circuits and pack the equipment to protect against shock during transport.
- SSPA generator is recommended to operate under the condition given by RFHIC to guarantee its maximum lifetime. (refer to Electrical, mechanical specification)
- DO NOT operate the generator without an isolator to protect against appropriate reflected power.
- DO NOT hesitate to consult RFHIC if there is any concern about the operating environment. (dust, cooling water quality ...)
- RFHIC is not responsible for any damage caused by inappropriate use of the generator.

4 CONFIGURATION

The MW Generator consists of the SSPA head and the Power Supply Unit (PSU). The SSPA head basically performs making CW signal source, communicating/monitoring/setting all electrical parameters of the generator, and amplifying the CW signal up to the specified output level. The PSU is converting from AC to DC 50V under control of the controller in the SSPA head.

5 BLOCKDIAGRAM

It shows each part of 1.6kW generator that consists of SSPA head and PSU.

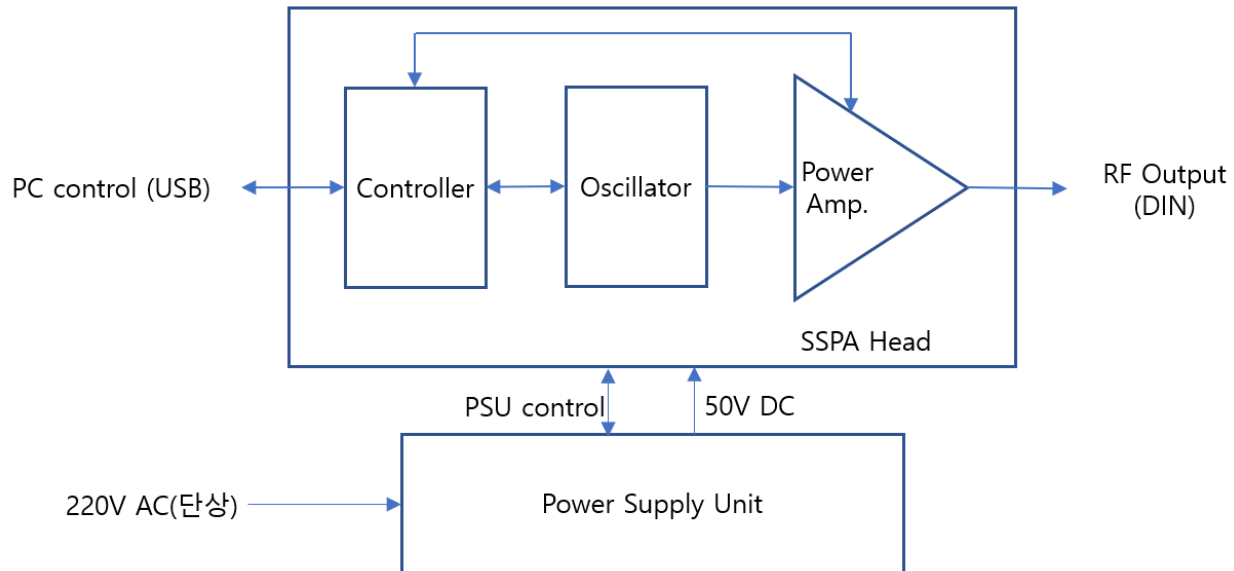


Figure 1. Block diagram for the generator

- Controller

It controls and monitors the state of the oscillator, power amplifier, and power supply. Also, it communicates to the GUI program on the computer outside to show and set them via USB port. General function is listed on "GUI."

- Oscillator

It generates a CW signal of the frequency specified in "Electrical specification." Every parameter like frequency and amplitude is changed by the controller. PLL VCO is applied for better stability and accuracy.

- Power Amp.

It amplifies the signal from oscillator up to the output power that specified in "Electrical specification." The status parameter like temperature, forward output power, reflect output power, etc are reported to the controller. RF on/off and other function that specified in "Electrical specification" are also set by the controller.

- PSU

It supplies 50V with the proper current to the generator from AC. Also, it communicates to the controller for sending the status and setting the parameters.

6 SPECIFICATIONS

All major specifications are listed as an electrical, mechanical, and functional one.

6.1 Electrical Specifications

6.1.1 SSPA Head

PARAMETER	UNIT	MIN	TYP	MAX	Note
Operating Frequency	MHz	2400	-	2500	
Operating Bandwidth	MHz	-	100	-	
CW Output Power	W	-	1600	-	
Efficiency	%	-	53	-	
Input Power	dBm	-	5	-	
Power Gain @ Peak Power	dB	-	57	-	
Gain Flatness	dB	-	1.5	2.5	
Input Return Loss	dB	-	-	-15	
Operating Voltage	V	-	50	-	
Operating Case Temperature	C	5		55	

6.1.2 PSU

PARAMETER	UNIT	MIN	TYP	MAX	Note
Input Voltage	Vac	100		250	
Input phase and configuration		1		3	3x1 phase or 3 phases
Frequency	Hz	45		66	
Output Voltage	Vdc		50		
Output Power	kW			52	

6.2 Mechanical Specifications

6.2.1 SSPA Head

PARAMETER	UNIT	VALUE Note
Dimensions (L x W x H)	mm	332 x 188 x 44 + 50 x 188 x 25 (TBD)
Weight	Kg	5.9 (TBD)
RF Output Connectors	-	7/16 DIN, Female
Control Connector	-	USB
Water Inlet/Outlet Adapter Hole		2-Rc 1/4 DP16.0, Ø8
Cooling	-	Water cooling (Water pressure: 8Bar)

6.2.2 PSU

PARAMETER	UNIT	VALUE
Dimensions (L x W x H)	mm	19"/1U/262mm
Weight	Kg	TBD
AC Input (to Electrical outlet)		220V single phase / 3 phases
Cooling	-	PSU: Air cooling
Mounting	-	19 inch standard rack

6.3 Functional specifications

6.3.1 Alarm/Shutdown Table

Item		Alarm	Shutdown
Generator Status	Output Power	> 1700W	> 1800W
	Temperature	> 55°C	> 60°C
	Reflected Power	> 300W (TBD)	> 400W
	PA Input Voltage	Vcc < 41V, Vcc > 53V	Vcc < 40V, Vcc > 54V
	PA Gain	< 50dB	-
	PLL Lock Detect	At PLL Unlock	At PLL Unlock

* Every data from the internal sensors in the amplifier.

6.3.2 User Control Function

Item	Function
Output Power Control	Range: Min. (TBD)~1.6kW, User can type in desired RF output power level in watts.
Output Power Stable Mode	Keep the output power level within $\pm 5\%$
Frequency control	2.4GHz~2.5GHz, 1MHz Step
PA Enable/Disable	50V On/Off at SSPA
RF On/Off	RF signal On/Off

6.3.3 Control Units

Item	Description
GUI	User control on PC GUI with USB connection from the control unit
Status LED(3ea)	Power On/Off, RF On/Off LED, Alarm status LED

7 EXTERIOR

It shows the example of the exterior of 1.6kW generator. External controller will be attached on the side of the amplifier. (the picture shows only the amplifier)

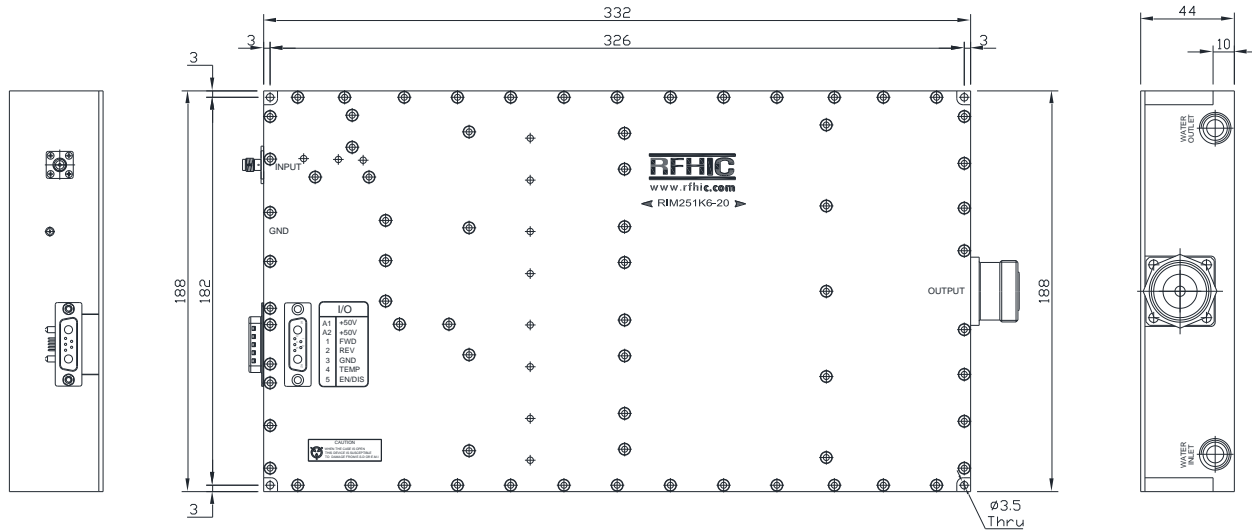


Figure 2. 1.6kW Generator example



Figure 3. 5.2kW PSU example

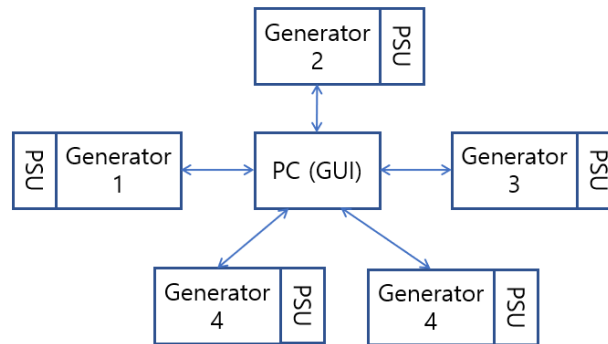
8 CONTROL CONFIGURATIONS

There are two configurations between the generator and the PC depends on the quantities of the generators

- 1:1 Connection
One generator is connected to one PC directly. Simple structure.



- 1:n Connection (Star shape)
Several generators are connected to one PC as a star connection. The distance should meet the limit of USB2.0 specification between the generator to PC



9 GUI

The graphic user interface (GUI) will be offered like the example like

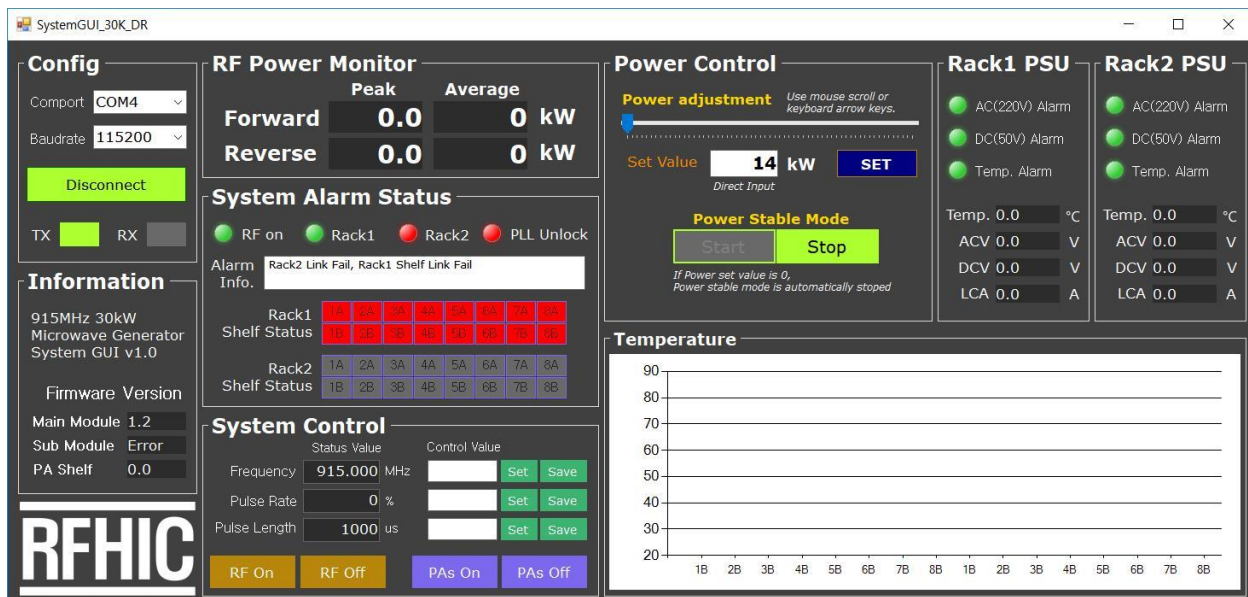


Figure 4. GUI Example (for A prototype of 915MHz 30kW MW Generator)

- RF Power Monitor
Forward and reflected powers are monitored.
- System Alarm Status
Indicates the status SSPA Head

- System Control

Operate conditions such as frequency can be adjusted.
RF ON/OFF and PA ON/OFF switches are included.

- Power Control

Desired output power value can be typed in by user.

With power stable mode ON, automatic gain control is enabled to keep the output power stayed at the set value.

- PSU Alarm

Values for PSU Alarm, Voltage, Current are read from the PSU.

- PSU Alarm

Temperature of each SSPAs from SSPA Head is monitored.

10 RESOURCES

10.1 Quotation

No.	제품	수량	단가	가격
1	1.6kW 2.4~2.5GHz MW Generator	2	10,600,000원	21,200,000원
	- Power amplieir			
	- Controller/Singal source			
	- 케이블(DC전원, USB)			
	- GUI 프로그램*			
2	Power Supply Unit (220V, 5kW)	2	1,440,000원	2,880,000원
3	1.6kW 2.4~2.5GHz MW Generator	3	10,600,000원	31,800,000원
	- 구성: 상동 (단, GUI 아래 참고*)			
4	Power Supply Unit (상동)	3	1,440,000원	4,320,000원
5	1.6kW 2.4~2.5GHz MW Generator	5	9,950,000원	49,750,000원
	- 구성: 상동 (단, GUI 아래 참고*)			
6	Power Supply Unit (상동)	5	1,440,000원	7,200,000원

- 유효기간: ~2019/6/15
- 지불방법 및 기한:
 - 1~4 항: 납품 후 30 일 이내:
 - 5~6 항: 분할 납품 및 수금 가능. 납품 후 30 일 이내: 2 대, 별도협의 (2020 년내) 3 대
 - 한 건의 주문서로 2 대 2019 년 납품 및 수금, 3 대 2020 년 납품 및 수금으로 분할 가능 (일정 별도 협의)
- 부가세 별도
- 납품일: 주문 후 10 주
- 보증기간: 납품 후 1 년 (단, 사용자 과실 판명 시 실비 유상)
- 구성품(1 세트):
 - 1.6kW Generator 본체(Power amplifier, Controller, Signal source 가 한 개로 합쳐져 구성)

- B. Power supply (220Vac 단상) 1 대
 - C. USB 케이블 1 개
 - D. Windows 용(win 7 이상) GUI 프로그램, 사용설명서(pdf, Protocol to GUI 포함)
7. GUI 는 아래 조건에 따름
- A. GUI ver.1 은 1 개 프로그램에서 1 개 Generator 만 제어 가능
 - B. GUI ver.2 는 1 개 프로그램에서 Generator 1~5 대를 모두 Control 할 수 있음
 - C. GUI ver.2 공급은 2019/10/15 이후 업데이트를 통해 공급 가능.

10.2 RFHIC Contact

Proposal Team Leader	Proposal staff
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