RF VII, Inc.

RF-6-XIII
RF GENERATOR USER MANUAL

Document # 9055-6001-D

<u>WARNING</u>

To avoid possible shock or fire hazards, connection of this product should be performed in compliance with the ANSI electrical code. Operation, Installation, and Maintenance should be performed by a qualified Technician or Engineer.

<u>WARRANTY STATEMENT</u>

All our products are warranted to the original purchaser against defective materials or workmanship for a period of one year from date of delivery. RF VII Inc. will at its own option repair or replace all defective material returned (freight prepaid) during the warranty period. Provided the unit is properly repackaged and returned without damage done by abuse or mishandling. (See Section 5 for shipping information)

<u>PROPRIETARY NOTICE</u>

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RF-6-XIII Instruction Manual

SECTION	TABLE OF CONTENTS	PAGE

SECTION 1

<u>Section 1</u>   Technical Specifications

<u>RF GENERATOR</u>

<u>*Electrical*</u>

Power Requirements	110-240Vac 50/60Hz
Power Consumption	1700 Watts
Power Connector	IEC-320C-14 EMI Filtered

<u>*Output*</u>

Frequency	13.56 MHz
Power Rating	600 Watts
Impedance Rating	50 Ohms
Reflectant Limit	60 Watts

<u>*Mechanical*</u>

Height	7.00 ″ / 17.8 cm
Width	8.00 ″ / 20.3 cm
Depth	19.00 ″ / 48.3 cm

<u>*Miscellaneous*</u>

Cooling	Air / 190 CFM
Interface Connector	15 pin **D** type (female)
	EMI/RFI Filtered
RF Output Connector	**N** type
Pulse Input	BNC (Optional)
CEX Input/Output	BNC type
Weight	22 lbs
RS-232	9 Pin D (Optional)

<u>*Safety Features*</u>

Interlock Loop	5 Vdc system close loop to ground
Over Temp	Internal heat shutdown Interlock <42 C
AC Breaker	AC overload protection
AC Fuse	AC fused second input line
Input Remote control DB 15	EMI/RFI Filtered

RF6 Product Profile

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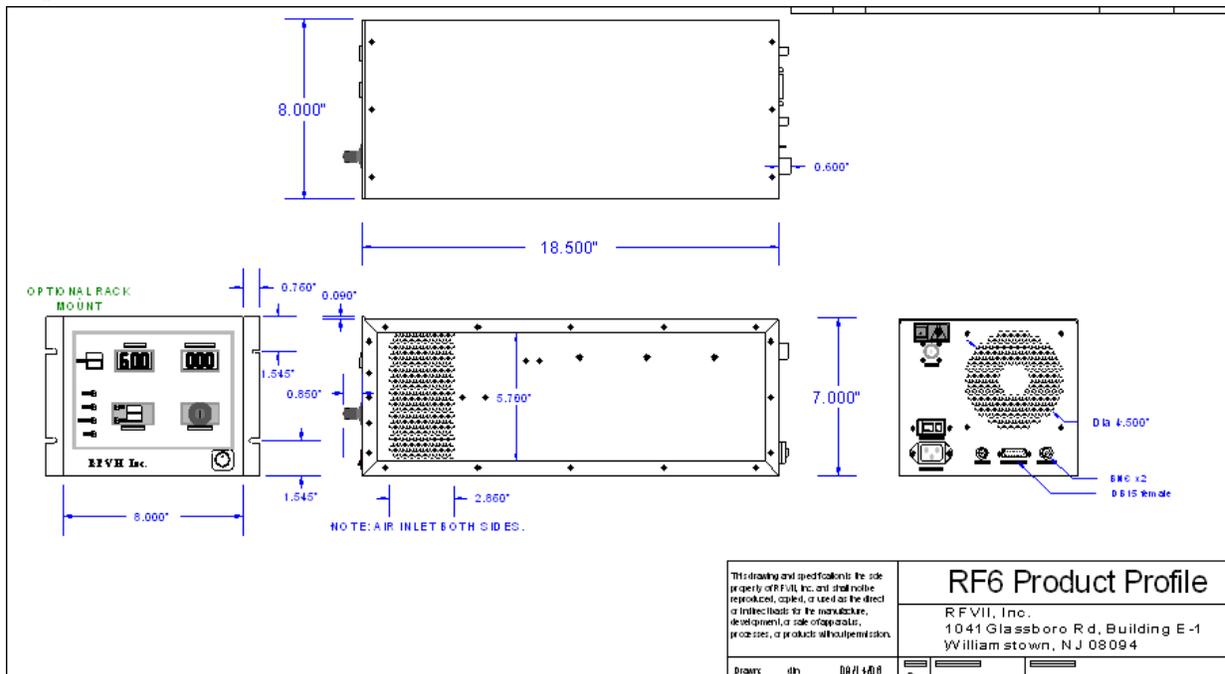
SECTION 2

Section 2   **Description**

General

        The RF-6-XXII RF Generator is designed for power delivery of
13.56 MHz at 600 Watts of output. It requires the use of RF trans-
mission cable (50 ohm / RG-393) to couple power into an Auto tuner
(ATN-10 or 15) or 50-ohm resistor load. Power is read on the front
panel or remote connector provided on the rear of the generator.
There are three types of operational controls, front panel, remote, and
optional RS-232. These functions are more explained in the operation
section of this manual.

Mechanical

        The unit is a 19" rack mount chassis with a black front panel. It is also
enclosed in yellow iridite aluminum for RF conductive ground purposes.
The DC power supply chassis is L molded for ease of assembly and
repair purposes. All metal is 0.090" or thicker for extra support during
handling and shipping.

SECTION 3

RF-6-XIII Instruction Manual

Section 3   **Controls and Indicators (For units with Front panel option)**

Indicators

        There are several indicators located on the front panel of the RF
generator. The two red led indicators are for ***RF forward and reflectant***
power readings. The four indicators (LED's) are operational mode
detection parameters.

Intlk   =   Illuminates when external interlocks are **not** satisfied.

Temp   = Illuminates when heat sink temperature exceeds safe levels.

Remote = Illuminates when remote operation is activated on back
            Panel or when the optional RS-232 mode is enabled.

Cex   = Illuminates when the CEX pin is pulled down low (J1).
            This allows for an external source input to be applied to
            J2 BNC input for dual plasma operation using 2 RF sources.

RF Enable Off =   Illuminates when RF generator is idle and RF is not
               enabled.

RF Enable On = Illuminates when RF switch is activated upon
               depressing (Enabled) red RF on button.

DC Bias Control =   By pulling Pin 13 to ground this activates DC
              Bias control. DC Bias voltage from the Auto-Tuner
              Is fed to Pin 12, and the set-point control will now
              Control the Bias Voltage created in the chamber.
              This gives better control over the systems plasma
              Developed at the source, rather than back at the RF
              Generator.

Controls

        There are three types of operational controls, ***Remote operation, RS-232,***
and ***Front Panel operation.***

1. Using Front Panel operation a preset set-point can be achieved by
   pressing and holding the blue switch and rotating the power set knob.
   Depressing the red switch will toggle RF ON and RF OFF.
2. The remote 15 pin D connector allows the customer's system the option
   of parameter control of the RF Generator. See connector pin out in the
   installation portion of this manual.
3. RS-232 is a 9 pin D connector for serial communication to systems
   Computer, Gui, PLC, or Microprocessor controls.

SECTION 3

Remote Interface Operation

1- **External Interlock** is a safety circuit which uses an internal pull-up resistor. This will disable the RF power on the generator if the analog interface connector or dummy plug is not connected. The RF will not enable if the interlock is not satisfied.
2- **RF On** is an input function with an internal pull-up resistor which can only be activated when all protective circuits are satisfied. If the generator is turned off or a protective circuit shuts off the RF at any time, all protective circuits must be re-satisfied and the control line must transition from high to low for the RF to be reactivated.
3- **Set-point Input** is a differential input which works together with the set-point return. The set-point input must be a positive voltage from 0 to 5 volts greater then the set-point return. The maximum voltage that can be used is 5.5 volts.
4- **Set-point Return** is also a differential input and works together with the set-point input. The set-point return must be from 0 to 5 volts less then the set-point input. When the set-point input and set-point return have the same voltage, the power level is at 0 watts.
5- **RF ON & OK** is an output function with an internal pull-up resistor. It tells the RF status of the generator. If the voltage level is low then the unit is operating correctly with RF on and low reflectant. If the voltage is high, then the unit is not running properly and RF can either be on with high reflectant or the RF is off.
6- **CEX Enable** is an optional circuit that allows the generator to be used with multiple generators using the same crystal signal. When low voltage is put to the pin, CEX is enabled and the generator is ready to be used as a slave unit.
7- **Reflectant Monitor** is an output function. It gives a voltage from 0 to 5 volts which shows how much reflected RF power the unit is receiving. Sealing is 5 volts which equals the rated power.
8- **Forward Monitor** is an output function. The line gives a voltage from 0 to 5 volts which shows how much forward RF power the generator is outputting. An output of 5 volts means rated forward power.
9- **Ground** is from pin 9 to 13. For proper operation of the generator, the system controlling the generator must be connected to at least one of these pins to ensure a common ground between the system and the generator.
14- **RF Enabled** tells the status of the RF as either on or off. When RF is off there is a short to ground (closed connection), and when RF is on the connection is open to ground (open connection). This output is used in conjunction with the matching network preset operation.
15- **Local/Remote Select** is an input function. It allows the user to switch between local control (optional front panel) and remote control which is also called analog interface. This line has an internal pull-up resistor. An input of 5 volts is local control, and 0 volts is remote control.

RF-6-XIII Instruction Manual
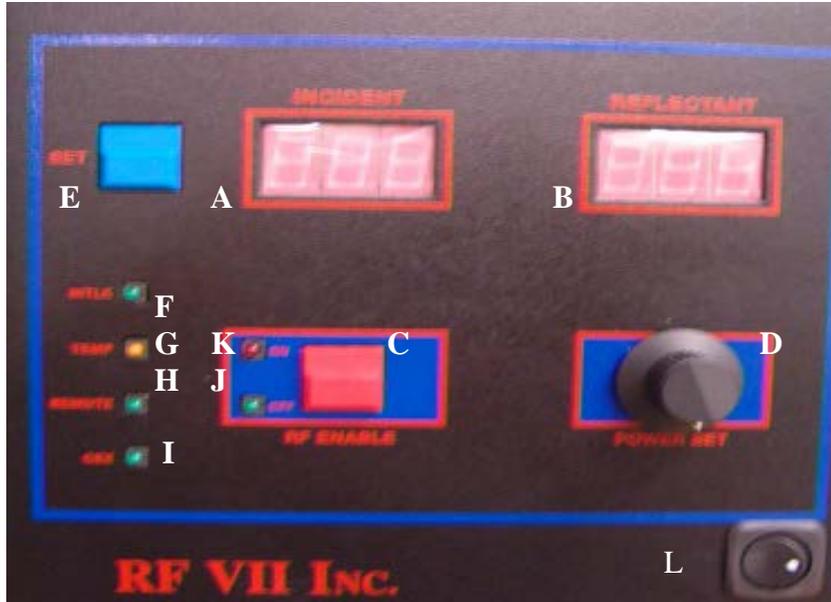
Section 3   Rear Panel
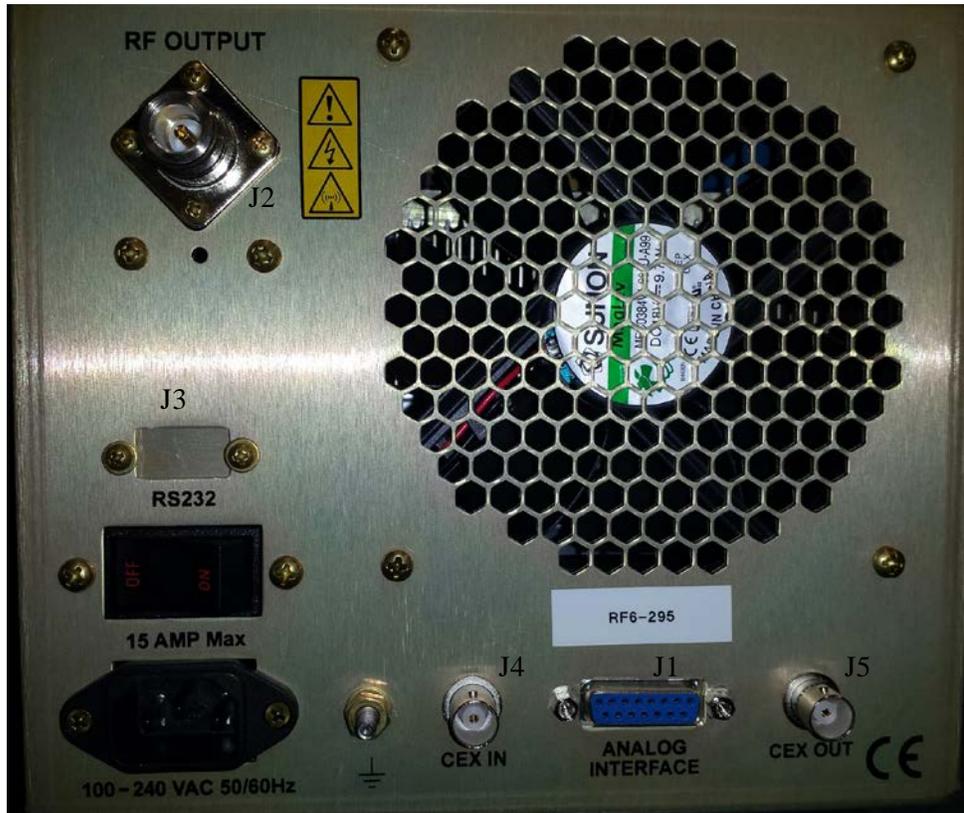
Connections

Ac Power	Single phase Hubble Male 20 A single phase
J1	Remote interface to system hardware. 15 Pin D (Female)
J2	RF output N Connector
J3	Optional RS-232 (Female 9 Pin)
J4	CEX Input
J5	CEX Output

Section 3

RF Generator Front Panel Features

Front Panel Layout	
A	<u>RF Output Display</u> -displays RF power output in watts
B	<u>RF Reflected Display</u> - displays reflected RF power in watts
C	<u>RF Enable Switch</u> - turns RF on and off (toggle)
D	<u>RF Power Set Knob</u> - adjusts the RF power output
E	<u>RF Power Pre-set</u> -Hold in and turn the RF power set knob to pre-set RF output in watts
F	<u>INTLK</u> - LED is on when external interlock is **not** satisfied
G	<u>TEMP</u> – LED is on when heat sink temperatures exceed safe levels
H	<u>REMOTE</u> -LED is on when remote operation is activated. Also indicates when RS-232 option is in use.
I	<u>CEX</u> - LED is on when the CEX is enabled allowing for slave mode operation
J	<u>RF OFF</u> - LED is on when generator is idle
K	<u>RF ON</u> - LED is on when RF is active. **Caution! Do NOT touch RF connector when this LED is on!**
L	Circuit Breaker acts as power on/off switch

SECTION 4

Section 4   **Installation**

Unpacking

        Inspect RF Generator package for any shipping damage before opening
container. Now remove the RF Generator from container and remove
antistatic wrap from unit. Check for any damage and condition of
product should be new.

Mechanic Connections

        Install RF Generator into desired enclosure (19" Rack) with some bottom
support. For proper operation, install RF Generator ensuring good
grounding to the system.

Electrical Connections

        Connect AC input and remote connections as directed in this manual.
Connect RF Cable N connector to generator and then to a dummy load or
Matching Network. This RF Cable should be in lengths of 12' feet
(Standard) or 4' increments for shorter requirements. Improper lengths
could void warranty of RF generator. Install 15 pin dummy connector
with interlock pulled low for stand alone front panel operation. Or use
section 4 and hook-up remote analog function control lines if front panel
is not available.

Set-up & Operation

        After all connections satisfied, (15 pin remote, AC Plug, and RF Cable)
turn on Breaker and/or AC power on switch. Unit's fans should turn on
with front panel or remote giving idol state status signals.
FRONT PANEL: Check front panel indicators for status and operation
readiness. If the interlock (Pin 1 low) is satisfied (interlock indicator
LED should be off) you should be able to turn _RF ON_ with the Front
panel button (RF enable). After getting the RF On Indicator illuminated,
dial the power knob up (Dummy Load) to maximum rated watts, to
ensure unit is fully functional. Or, if using an auto-tuner dial up power up
until tuner eliminates reflectant power, while reaching your desired
Incident power.
REMOTE PANEL: If the interlock (Pin 1 low) is satisfied, then toggle
Pin 2 to ground on the remote connector to enable RF ON. Check status
line on Pin 5 (should be low) indicating RF power is on. Now by
applying a _differential DC set-point_ (0-5Vdc) across Pin 3 (Set-point
return is Pin 4) you should see power readings on pin 8 close to the input
set-point voltage. Test unit to maximum rated power, which should be 5
Vdc set-point input with a close 5 Vdc monitor output.

        If you have any problems contact a service engineer at RF VII, Inc.

Warranty

        All units have a one year depot warranty effective from the date stamped
on the serial tag.

Section 4   **Installation**

Remote Control Connections (15 pin D Female)

J1

(1)	External Interlock (Low to Satisfy Interlock)
(2)	RF ON Enable (Low to activate)
(3)	Set-Point input (0-5Vdc)
(4)	Set-Point return
(5)	*RF ON & ok* (indicator/output) (Low = ok)
(6)	CEX Enable (Low to activate)
(7)	Reflectant monitor (5vdc = 600 watts)
(8)	Incident/Forward monitor (5vdc = 600 watts)
(9)	Ground
(10)	Ground
(11)	Ground
(12)	DC Probe Input
(13)	DC Probe control (pull low for activation)
(14)	RF Enabled for PT-II-CE Presets (low = RF off)
(15)	Local / Remote Select (low / Remote)

Remote Interface Operation

SECTION 4

Remote Connector Pin out

Pin	Description	In/Out*	Activate
1	External Interlock (IPR)**	In	High = Not Satisfied Low = Satisfied
2	RF ON (IPR)**	In	High = RF Off Low = RF On
3	Set-point Input	In	Differential Input of Zero to 5 Volts 5V = Rated Power
4	Set-point Return	In	
5	RF ON & OK (IPR)**	Out	High = Not Ok Low = Ok
6	CEX Enable or ATN Arc Surpression (Optional)	In	High = CEX Disable Low = CEX Enable
7	Reflectant Monitor	Out	Zero to 5 Volts 5V = Rated Power
8	Forward Monitor	Out	Zero to 5 Volts 5V = Rated Power
9	Ground	None	None
10	Ground	None	None
11	Ground	None	None
12	Bias Voltage Input	In	Zero- 1 Volt Appox.
13	Bias Voltage Input	In	Ground / Optional VTL
14	RF Enabled (Status) (Used for PT-II-CE Presets	Out	Open = RF On Closed = RF Off
15	Local/Remote Select (IPR)**	In	High = Local Low = Remote

*In/Out is used to describe the functionality
of the pin as either an input or an output.
**IPR (Internal Pull-up Resistor) must have a
transition in voltage to activate.

RS-232 Operation

RS-232 is an optional way to control the generator through serial communications to a systems computer or microprocessor.

RS-232 Setup

Baud Rate: **9600**   Parity: None

Data Bits: 8   Stop Bits: 1

RS-232 Pin out DB9 Female Connector

Pin	Initials	Description
1	DCD	Data Carrier Detect
2	**TxD**	**Transmit Data***
3	**RxD**	**Receive Data***
4	DTR	Data Terminal Ready
5	**SG**	**Signal Ground**
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

*For use with a straight serial cable.

RS-232 Commands

Command	Description
HI[CR][LF]	Enter RS-232 Mode
BYE[CR][LF]	Exit RS-232 Mode
P ####[CR][LF]	Set Power
RFON[CR][LF]	Turns RF On
RFOFF[CR][LF]	Turns RF Off
G+[CR][Lf]	Pulse Mode On
G-[CR][LF]	Pulse Mode Off
F ##[CR][LF]	Pulse Frequency 1Hz to 999Hz, 1Hz resolution
D ##[CR][LF]	Duty Cycle 10% to 90%, 5% resolution
?[CR][LF]	Status Report

Note: Commands are **NOT** case sensitive.

SECTION 4

RS-232 Operation

Status Report Example

The response from the generator is as follows:

?X SET FWD REF[LF][CR]

SET is the set point power in watts, 1-4 digits
FWD is the forward power in watts, 1-4 digits
REF is the reflected power in watts, 1-4 digits
X is an ASCII character, 0 though 7

X is actually a three bit binary number padded out to eight bits so that it will display as a numeric character. The number's bit configuration indicates the following:

Bit	True	False
DB0	RF OK	RF NOT OK
DB1	External Interlock OK	External Interlock NOT OK
DB2	RF ON	RF OFF

* Gui Software available for RS-232 communication
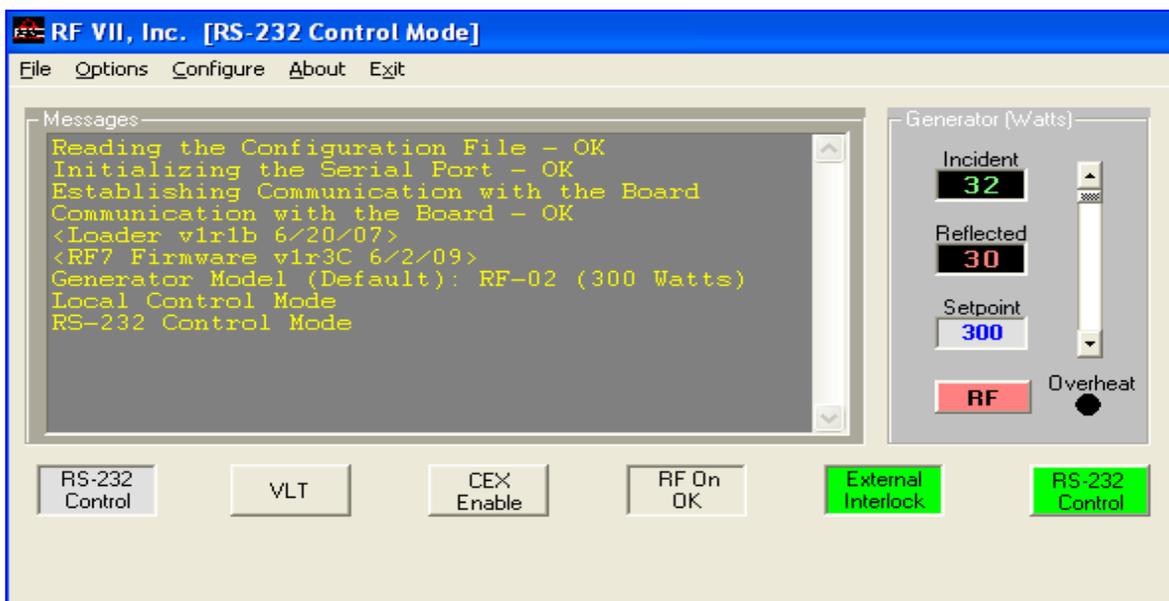
SECTION 5

<u>Section 5</u>   **Schematics / Service**

We have not included schematics, but they are available by request of your qualified service personnel. These drawing are proprietary and should not be reproduced for any company other than the original OEM customer.

For any parts or service please contact RF VII Inc. by the following listed methods. When returning equipment, please insure that you properly package the units. If you are unsure please contact RF VII Inc. for proper procedure. You can also request product packaging to be shipped to your location for a nominal fee.

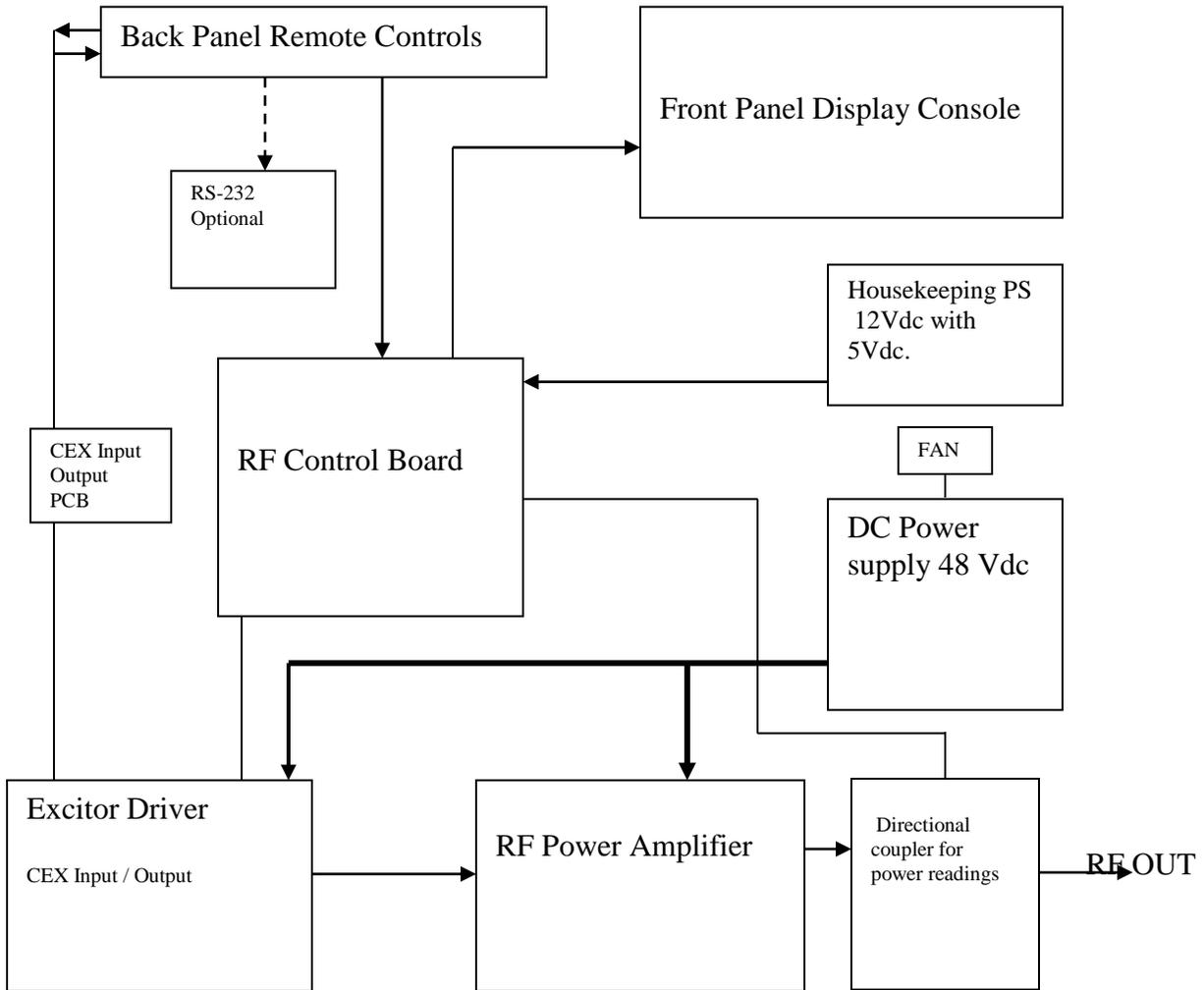**RF VII Inc.**
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RF-1-3-6 Chassis Block Diagram

Back Panel Remote Controls

Front Panel Display Console

RS-232
Optional

Housekeeping PS
12Vdc with
5Vdc.

CEX Input
Output
PCB

RF Control Board

FAN

DC Power
supply 48 Vdc

Excitor Driver

CEX Input / Output

RF Power Amplifier

Directional
coupler for
power readings

RF OUT

SYMBOL GLOSSARY

Symbol means a product has met the European Unions Consumer Health and Environmental Safety Requirements.

Symbol for the Certified Body for the International Electro-Technical Commission. Which is the worldwide System For conformity testing and certification of Electro-technical Equipment and Components (IECEE)

Electrical Shock Hazard Symbol

General Warning Symbol

Non-Ionizing Radiation Symbol

Glossary

AC – Alternating Current

ANSI electrical code – (American National Standard Institute)

CEX - An abbreviation for Common Exciter.

DC – Direct Current

GUI – **G**raphical **U**ser **I**nterface – Type of user interface that allows humans to interact with electronic devises such as computers.

HARMONICS – A component Frequency of the Signal that is an integer multiple of the fundamental frequency.

HERTZ- is equal to a CYCLE, which is the method of frequency/time of a given signal. Depending on your age is which term you use.

KHz – Kilo Hertz, 1000 Hertz / Cycles per second

IMPEDENCE – is the measurement of capacitance or inductance in a reactive circuit. Unit of measurement is in ohms of reactance (Not to be confused with electrical resistance) and classified Inductive or Capacitive.

MHz – Mega-Hertz, 1,000,000 Hertz / Cycles per second

RESONANCE- is when capacitance and inductance, in a reactive circuit, cancel each other.

Roman Numeral Frequency Conversion Table;

I   = 1.2 MHz

II   = 2.0 MHz

RF- VII   = RF- Seven "Company Pronunciation"

XIII   = 13.56 MHz

XXVII   = 27.12 MHz

XL   = 40.68 MHz