User Manual
High Performance Wideband RF Preselector / Tuner (HiPerTuner™)

Part Number:
RF200-2500TUNV1

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1 HIPERTUNER™ OVERVIEW

The HiPerTuner™ is a state-of-the-art miniature broadband preselector (RF Tuner) utilized for RF signals in the band of 200 MHz to 2.5 GHz. The HiPerTuner™ meets the demanding need for high performance receiver preselection for applications involving RF communications and signal exploitation, inclusive of SIGINT, COMINT, and ELINT. The HiPerTuner™ integrates with a host controller or terminal program, and utilizes a straight-forward RS-232 command/control serial interface for ease of integration. The optional Graphical User Interface (GUI) provides the end user a simple method of controlling the center frequency and attenuation.

The HiPerTuner™ provides high dynamic range performance over the 200 MHz – 2500 MHz frequency range with low noise figure. The HiPerTuner™ is designed to allow end users the ability to select an operational frequency in 1 MHz increments.

The tuner boasts superb multiple cascaded varactor tuned filtering to remove high energy out-of-band interferers.

As an added benefit, the RF tuner incorporates robust defenses from interface sources by providing over-current and reverse voltage protection.

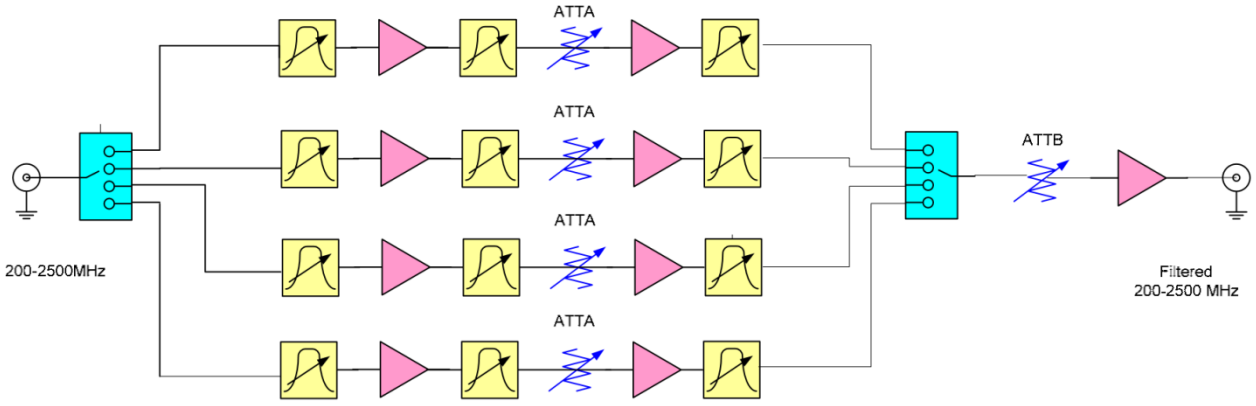


Figure 1: HiPerTuner™ Functional Block Diagram

The HiPerTuner's performance specifications are outlined in Table 1.

1.1 HIPERTUNER™ SPECIFICATIONS

Table 1: HiPerTuner™ Specifications

Parameter	Specification
Frequency Range	200 - 2500 MHz
Tuning Resolution	1 MHz
Noise Figure:	
200 - 500 MHz	≤8 dB / 5 dB (typ)
500 - 1300 MHz	≤9 dB / 6 dB (typ)
1300 - 1800 MHz	≤12 dB / 6 dB (typ)
1800 - 2500 MHz	≤10 dB / 7 dB (typ)
Gain Control	Manual Gain Control (MGC)
Gain Control Range	45 dB in 1 dB Steps
Gain:	
200 - 500 MHz	≤25 dB / 31 dB (typ)
500 - 1300 MHz	≤26 dB / 33 dB (typ)
1300 - 1800 MHz	≤23 dB / 27 dB (typ)
1800 - 2500 MHz	≤22 dB / 27 dB (typ)
	Units can be gain leveled to +/-2dB across entire frequency range – consult Factory
P1dB:	
200 - 500 MHz	≥6 dBm / 8 dBm (typ)
500 - 1300 MHz	≥7 dBm / 9 dBm (typ)
1300 - 1800 MHz	≥8 dBm / 10 dBm (typ)
1800 - 2500 MHz	≥9 dBm / 11 dBm (typ)
RF Input Level – No Damage	+20 dBm
OIP3:	
200 - 500 MHz	≥7 dBm / 15 dBm (typ)
500 - 1300 MHz	≥16 dBm / 18 dBm (typ)
1300 - 1800 MHz	≥12 dBm / 16 dBm (typ)
1800 - 2500 MHz	≥15 dBm / 17 dBm (typ)
3 dB Bandwidth:	
200 - 500 MHz	5% BW (typ)
500 - 1300 MHz	7% BW (typ)
1300 - 1800 MHz	5% BW (typ)
1800 - 2500 MHz	4% BW (typ)

Parameter	Specification
10 dB Bandwidth:	
200-500 MHz	8% BW (typ)
500-1300 MHz	14% BW (typ)
1300-1800 MHz	8% BW (typ)
1800-2500 MHz	6% BW (typ)
20 dB Bandwidth:	
200-500 MHz	13% BW (typ)
500-1300 MHz	23% BW (typ)
1300-1800 MHz	12% BW (typ)
1800-2500 MHz	10% BW (typ)
Tuning Speed	50 mS (for faster tuning consult factory)
Input VSWR	≤ 2.5:1
Output VSWR	≤ 2.5:1
Reverse Voltage Protection	40 VDC
Dimensions (Nominal)	6.5” x 4.0” x 0.75’ (L x W x H)
Power Supply	+12 VDC typical (9-16 VDC)
Current Consumption:	
Normal Mode	150 mA (typ) @ +12 VDC
Sleep Mode	15 mA (typ) @ +12 VDC
Operating Temperature	-20° C to +50° C
Storage Temperature	-40° C to +85° C
Digital Interface	RS-232
Multi-Drop RS-232 (Contact Factory)	Up to Eight Units (address configured by hardware)
Digital Interface Data Rate	9600 bps (8N1)
Control Interface Connector	9 pin micro-miniature D-sub connector (M)
RF Connectors	SMA (F)
RF Connector Impedance	50 Ω
Mode	Standard or Multi-Drop (configured at factory) Default is standard mode, Bus Address is preset at factory prior to shipping.

2 HIPERTUNER™ FUNCTIONAL DESCRIPTION

The HiPerTuner™ accepts RS-232 command/control data from a host controller with full duplex capability. The primary host functions are:

- Tune Filters
- Configure Manual Gain Control (MGC) level
- Command the RF tuner into sleep mode

The physical interface to the tuner is a micro-miniature 9-Pin panel mounted male connector which enables the tuner to be mated with a host controller or a terminal program via a cabling harness. RF input and output connections are made through two SMA female connectors.

The HiPerTuner™ simple interface consists of a single supply voltage and basic command/control and status lines. [See Figure 2.]

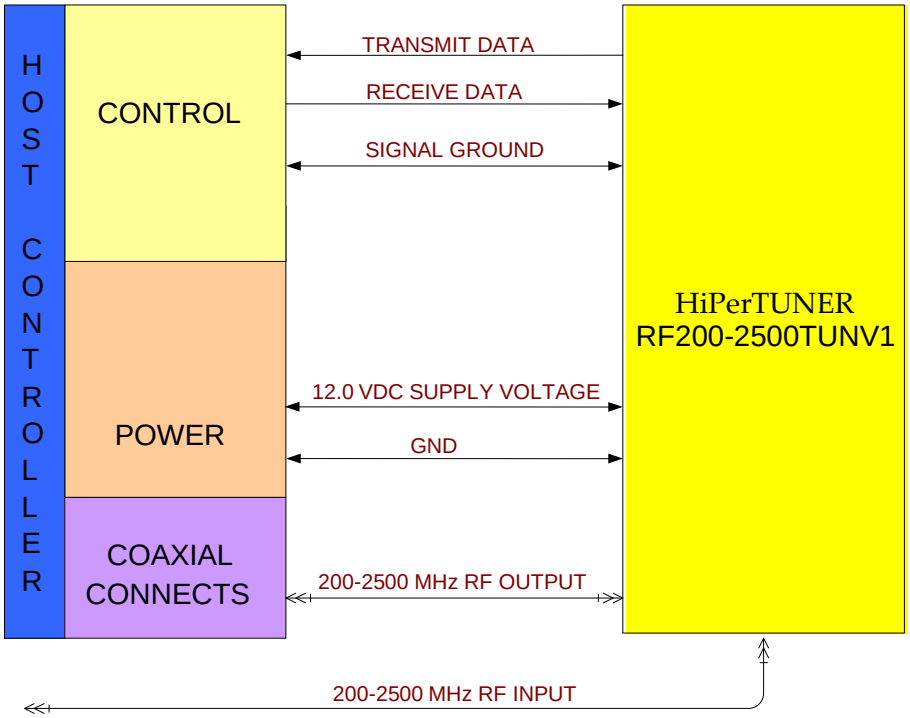


Figure 2: HiPerTuner™ Host Interface Signals

2.1 RF INTERFACES

Two RF connectors (SMA female) make up the RF Interface – RF Input, RF Output.

2.1.1 RF Input & RF Output

The RF connectors are 50 Ω impedance with excellent performance at frequencies from 200 to 2500 MHz.

2.2 DIGITAL CONTROL AND POWER INTERFACE

The connector pin-out definitions for the "I/O and Power" connector are provided in this section. In a typical installation, the HiPerTuner™ module is mated to a PC via NuWaves' interface/power cable (included with the unit) or a host controller via custom wiring harness.

The data and signal interface is provided via a 9 pin Micro-D connector. The interface provides RS-232 communications, DC power connection, and various other CMOS and analog signals as described in Table 2.

Table 2: HiPerTuner™ Pin-Out Definitions for Digital Control, Interface/Power Connector

Pin Number	Pin Name	I/O	Description
1	TX Data	O	Transmitted data to the host controller
5	RX Data	I	Received data from the host controller
3	N/C		Do not make any connections to this line.
4	N/C		Do not make any connections to this line.
8,9	V Supply	I	DC Supply Voltage, +9 to +16 VDC (+12 VDC nominal)
6,7,2	GND	-	DC Return Ground

2.3 MULTI-DROP CAPABILITY

The Multi-Drop capability permits up to eight tuners to be controlled by a single cable. The host controller selects communication with each unit by a unique bus address ID that is preset at the factory. All tuners sharing a common interface cable must be Multi-Drop capable. The operational interface for the Multi-Drop capability is depicted in Figure 3.

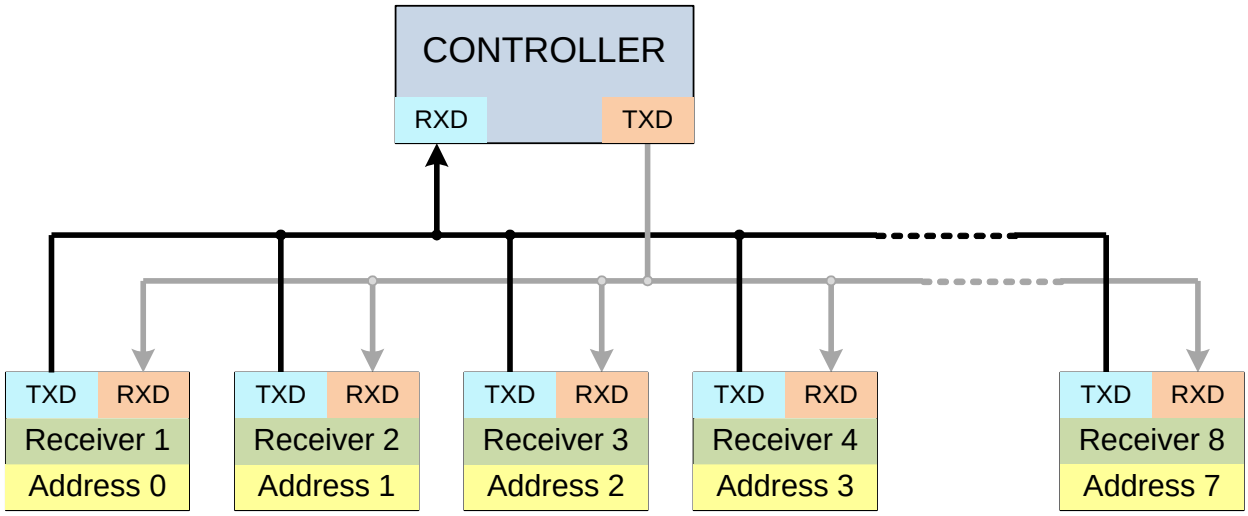


Figure 3: Block Diagram of Host Controller for Multi-Drop Operation

Cabling harnesses for Multi-Drop applications should not connect to pins 3 and 4. Connecting these pins to the common cable can cause erroneous readings of those lines.

2.4 MICROPROCESSOR CLOCK DITHERING

The HiPerTuner™ microprocessor employs a dithered clock as an on-board technique for EMI reduction. The percentage of dither as well as the rate of dither can be configured at the factory. The standard tuner is supplied with a 2% dithered clock at a rate of approximately 7800 Hz.

3 HIPERTUNER™ COMMAND STRINGS

This section provides the user with the command syntax necessary to properly configure the unit for use. The HiPerTuner™ can operate with a terminal program and all commands have the following attributes:

- A command consists of a string of characters, followed by a terminating Carriage Return character, ¿ (hex 0D).
- Command processing is not case sensitive.
- Spaces are always allowed and always ignored.
- After receiving and processing a command, the HiPerTuner™ sends a Carriage Return terminated string as a notification that the command was completed.

Table 3: Overview of Receiver Commands

HiPerTuner™ Commands	Function	ICD Section
freq	Sets the operational frequency of the tuner	0
pwr	Places the unit in a power save mode without writing settings to EEPROM	3.2
slp	Places the tuner in sleep mode to conserve power, writes current settings to EEPROM	0
attx	Sets attenuator settings for MGC mode	3.4
con	Tuner configuration storage and recall	3.5
freq?	Returns the tuned operating frequency	3.6
mgc?	Returns the value of all attenuator settings	3.6
mode?	Reads, reports, and sets the unit to the current Multi-Drop setting	3.6
stat?	Returns the status of the hardware	3.6
ver?	Returns the software version	3.6
sel	Selects the tuner to respond to the command during Multi-Drop mode	3.7

3.1 CHANNEL SELECTION/FREQUENCY CONTROL COMMANDS

The HiPerTUNER™ RF Tuner can be tuned in 1 MHz steps providing 2,300 different channels. The *"freq"* command selects the receiver's channel of operation.

The following examples apply:

- Specifying channel 0225000000_{10} will result in the tuner operating at 225 MHz
- Specifying channel 0383000000_{10} will result in the tuner operating at 383 MHz
- Specifying channel 0500000000_{10} will result in the tuner operating at 500 MHz
- Specifying channel 1230000000_{10} will result in the tuner operating at 1230 MHz
- Specifying channel 1900000000_{10} will result in the tuner operating at 1900 MHz
- Specifying channel 2490000000_{10} will result in the tuner operating at 2499 MHz

Table 4: Channel Selection Commands

Command	Parameter	Range	Description
freq	ddddddddd	0200000000 - 2500000000	Selects the operating channel

3.2 POWER SAVE & POWER UP

The HiPerTuner™ RF Tuner is capable of being placed in a power save mode to conserve power. When in power save mode (*"pwrsav"*), RF front-end and IF circuitry of the tuner is turned off. RF signal reception is unavailable during power save mode. The tuner remains in a low power standby mode until receipt of the 'power up' command (*"pwrup"*).

The power save mode does not write to EEPROM before powering down, however it does write to RAM located in the microprocessor and retains current configuration settings as long as DC power remains applied to the tuner.

Table 5: Power Save Commands

Op Code	Parameter	Description
pwr	sav	Places tuner in Power Save Mode and saves operational settings
pwr	up	Places tuner in Power Up Mode and restores operational settings

3.3 SLEEP MODE

The tuner is capable of being placed in a sleep mode to conserve power. When in sleep mode, RF front-end and IF circuitry of the unit is turned off. Reception of RF signals is unavailable in sleep mode. The

tuner remains in a low power standby mode until receipt of the 'sleep off' command ("*slpoff"*). Executing the 'sleep on' command ("*slpon"*) writes to EEPROM; therefore, should the tuner lose its prime DC power it will retain the configuration settings.

Table 6: Sleep Mode Commands

Op Code	Parameter	Description
slp	on	Places tuner in Sleep Mode and saves operational settings
slp	off	Places tuner in Active Mode and restores operational settings

When waking up from sleep mode, an acknowledgement will be sent to the host to indicate that the commands are ready to be received. Commands issued prior to the ready acknowledgement might be ignored.

The "*slpon"* command stores the current HiPerTuner™ configuration to EEPROM memory for restoration upon the next "*slpoff"* command. The EEPROM may be read as often as desired, offering an estimated durability of 100,000 storage cycles.

3.4 GAIN CONTROL SELECTION

The HiPerTuner™ RF Tuner operates in Manual Gain Control (MGC). MGC allows the user to determine the net RF gain of the tuner.

3.4.1 Manual Gain Control Setting

In MGC mode, the user has the ability to control the RF gain over a range of 45 dB. The "*attx"* (whereas "x" can be letter a or b) command selects the level of MGC by configuring the attenuator settings. The range for each attenuator is 0000-0031, which represents attenuation in 1 dB steps (i.e. 0000 represents 0 dB attenuation and 0031 represents 31 dB of attenuation). The default setting for each attenuator is 0000.

Table 7: Attenuator Control Commands during MGC Operation

Op Code	Parameter	Range	Description
atta	dddd	0000-0031	Select Manual Gain for Attenuator A
attb	dddd	0000-0031	Select Manual Gain for Attenuator B

Note 1: When the "*stat?"* or "*mgc?"* commands are issued, the values returned for the attenuator settings are displayed as five digits (00000 through 00031). The leading zero can be ignored since it is only used by the microprocessor.

Note 2: Refer to **Figure 1**, the tuner's block diagram, for the circuit placement location of the Attenuators (Attenuators A and B) in the RF line-up.

3.5 CONFIGURATION STORAGE AND RECALL

The following configurations are defaults and present upon initialization of the tuner:

- Operating Frequency 200 MHz
- Active Mode (i.e. not in Sleep Mode)
- Manual Gain Control Mode
- Attenuator set to Minimum Attenuation (i.e. a=0000, b=0000)

The *"consto"* command stores the current HiPerTuner™ configuration to EEPROM memory for restoration upon the next power on cycle. The EEPROM may be read as often as desired, however its durability is limited to an estimated 100000 storage cycles. Table 8 illustrates the commands for tuner configuration storage and recall.

Table 8: Configuration Storage Commands

Op Code	Parameter	Description
con	def	Reset configuration to factory default
con	sto	Store current configuration as startup settings

Note 1: The command *"slpon"* can also be utilized to store the configuration to memory. See section 0 for more information.

3.6 TUNER INSTRUCTION COMMANDS

Table 9: Command Queries

Op Code	Parameter	Range	Description
freq?	ddddddddd	020000000000 - 2500000000	Returns the tuned operating frequency
mgc?	ddddd ddddd ddddd ddddd	00000 - 00020 (a) 00000 - 00025 (b)	Returns the MGC Gain setting for all attenuators
mode?	dddd-ddddddd		Reads, reports, and sets the unit to the current Multi-Drop setting that is configured via the on-board dip switch
stat?			Returns settings for Reference Frequency, Software Version, AGC Mode, Attenuator Settings, Frequency, Multi-Drop Address, Multi-Drop mode, and IF Filter Bandwidth
ver?	ddd	000-099	Returns the Software Version

3.7 MULTI-DROP SELECTION COMMANDS

Multi-Drop Selection commands must be used when the HiPerTuner™ RF Tuner is in Multi-Drop Mode. In this mode, up to eight tuners can be commanded and queried individually with a common interface cable.

A Multi-Drop Selection command allows the host controller to select an individual tuner by its corresponding bus address (preset at the factory). An appropriately commanded tuner will echo a Multi-Drop Selection command and append the tuner's bus address to the returned command. The selected tuner will then process all commands until a different unit is selected with a new Multi-Drop Selection command. Similar to the standard tuner Instruction commands, the Multi-Drop Selection command is terminated with a carriage return.

All tuners sharing a common interface cable can be simultaneously commanded and queried if the Multi-Drop Selection command indicates Broadcast mode. The tuners will echo commands or reply to queries using a time-slot based on their bus address. The echoed replies will include the tuner's bus address. The tuners will act on Broadcast mode commands immediately, and then wait for a time-slot corresponding to their bus address before replying. ***The default "stat?" tuner Instruction command is not supported in Broadcast mode.*** A "stat" query in Broadcast mode will return the tuner's bus address, followed by "OK".

Table 10: Multi-Drop Selection Commands

Op Code	Parameter	Range	Description
sel	d	0-7; (B)	Selects the tuner that is to act upon subsequent tuner instruction commands. Corresponds to tuner bus address, which is set by SW2, SW3, and SW4 (configured at factory). The commanded tuner will echo the command along with its bus address formatted as "BA_", with the bus address preceded by the letters "BA" (for Bus Address). The tuner instruction command is for every tuner on the bus if the parameter is the character "B", for broadcast mode.

The following are examples of Multi-Drop Selection commands followed by tuner Instruction commands:

- **sel3<CR> consto<CR>**

  Directs the tuner at bus address 3 to store the current configuration as startup settings. The reply would be **constoBA3 OK**.

- **sel0<CR> agc?<CR>**

  Queries the tuner at bus address "0" for AGC Mode. The reply would be **ONBA0 OK** if the AGC was On, and **OFFBA0 OK** if the AGC was Off.

- **selB<CR> slpon<CR>**

  Uses Broadcast mode to place all tuners in Sleep mode. All tuners would reply based on their bus address (e.g. the tuner at bus address 5 would reply **slponBA5 OK** sent in the 6th time slot.

4 MECHANICAL

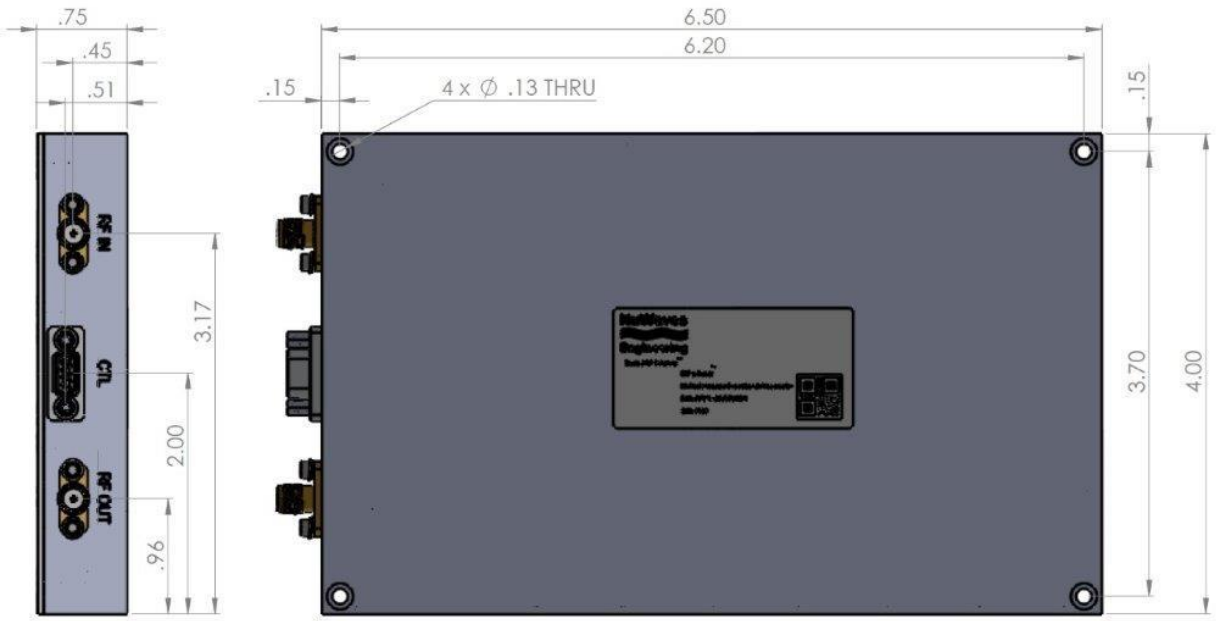
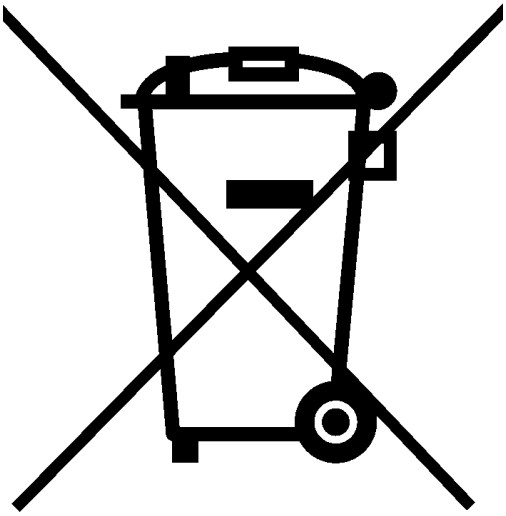


Figure 4: Mechanical Outline

5 PRODUCT DISPOSAL – END-OF-LIFE

Safety is a guiding principle of NuWaves RF Solutions. We ensure safe production and operation of our products, as well as end-of-life disposal. Improper disposal can adversely affect the environment, wildlife and human health. Please follow these guidelines when disposing of a NuWaves product:

- Do not remove the cover or any hardware
- Do not remove components from the circuit card assembly
- Do not incinerate
- Do not crush or shred
- Do not dispose of as unsorted municipal waste
- Do not export e-waste outside of the original destination country for recycling
- Utilize an e-Steward or ISO14001 certified e-waste recycler
- Consider export controls during recycler selection
- If a NuWaves product is incorporated into a larger system or sub-system, ensure that these guidelines are followed at system end-of-life



6 GETTING HELP - APPLICATIONS ENGINEERING

NuWaves RF Solutions offers technical support for basic configuration help and troubleshooting, Monday through Friday, 8 a.m. to 5 p.m. Eastern Time.

Technical Assistance and Application Engineering:

Email: product.sales@nuwaves.com

Phone: (513) 360 - 0800

NuWaves Home Page: https://www.nuwaves.com/

Product Warranty:

https://products.nuwaves.com/wp-content/uploads/NuWaves_Warranty_Repair.pdf

6.1 GENERAL INFORMATION