

# Installation Instruction Sheet: AMP-RF-1

**Instruction:** Model AMP-RF-1  
**Applicability:** Applies to WAVES CRLU and TRX Installs only  
**Part Number:** P10-00071  
**Date:** December 4, 2012

## 1. Purpose

This sheet provides the specifications of Indoor Amplifier model AMP-RF-1 along with detailed instructions to install the 1 Watt, 2.4 GHz amplifier into a WAVES system using either a CRLU-201 or a TRX-401.

Model AMP-RF-1 is intended for indoor installations that require additional output power to compensate for long transmission runs between the CRLU/TRX and the antenna.

## 2. Cautions and Warnings

The following are specific Cautions and Warnings that must be followed when installing or operating equipment.

- Please read all instructions before attempting to install any equipment. Failure to follow directions can cause bodily injury and/or damage to the equipment.
- Ensure that precautionary measures are employed to prevent applying power to equipment at any time maintenance work is in progress.
- Do not make any unauthorized alterations to equipment or components. Changes or modifications not expressly approved by Cooper Notification can result in damage to the equipment and will void the warranty.
- When working near electricity do not use metal rules, flashlights, metallic pencils, or any other object having exposed conducting material.
- Ensure all electrical connections are secure before applying power to a unit. Failure to secure connections may cause an electrical arc resulting in physical shock or damage to the equipment.
- Do not touch electronic components with wet hands.
- When possible, avoid installing equipment during severe or wet conditions. Handling equipment with wet hands may cause slippage resulting in bodily injury and/or damage to equipment.
- Comply with all electrical codes per the local authority having jurisdiction.

## 3. Tools


Required tools and equipment needed to install the amplifier shall be determined by qualified service personnel.

## 4. Specifications

General Specifications of the AMP-RF-1 are listed below in Table 1.

**Table 1 General Specifications**

Spec	RF Amplifier Model AMP-RF-1
<b>Transmit Power</b>	1 Watt (30 dBm)
<b>Receive Gain</b>	15 dB nominal
<b>Frequency</b>	2.4 – 2.5 GHz
<b>Max Input Power</b>	100 mW (20 dBm)
<b>Min Input Power</b>	3 mW (5dBm)
<b>Dimensions</b>	4.5 x 2.5 x 1.3 in (117 x 64 x 33 mm)
<b>Weight</b>	.68 lbs (.30 Kg)
<b>Amplifier Current Draw</b>	0.8 A @12VDC
<b>Amplifier Supply Voltage</b>	9 - 12 VDC
<b>Class II Power Supply Voltage Rating</b>	110-240 VAC, 50/60 Hz
<b>Temperature</b>	0 to 49 C (32 to 120 F) Indoor Use Only
<b>Input/Output Connectors</b>	N-Type Female
<b>Compatible Access Points</b>	CRLU-201 and TRX-401 Series only

 <b>Caution</b>	<p><b>FCC WARNINGS</b></p> <ol style="list-style-type: none"> <li>1. Modifications are not allowed to the amplifier or support equipment.</li> <li>2. Any modification could void the User's authority to operate the equipment.</li> <li>3. Antenna placement must be no less than 1 meter from any potential point of human contact or exposure.</li> <li>4. The AMP-RF-1 amplifier can only be used with access point FCC ID: X2PAMPRF-1. Access point FCC ID: X2PAMPRF-1 consists of one of the antennas listed in this manual and an access point model CRLU-201 or TRX-401. Refer to Section 7 Labeling Instructions, for special access point labeling instructions.</li> </ol>
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## 5. AMP-RF-1 Outline Drawings

Figures 1 and 2 below provide outline drawings of the Front, Side, Rear, and Top views of the amplifier.

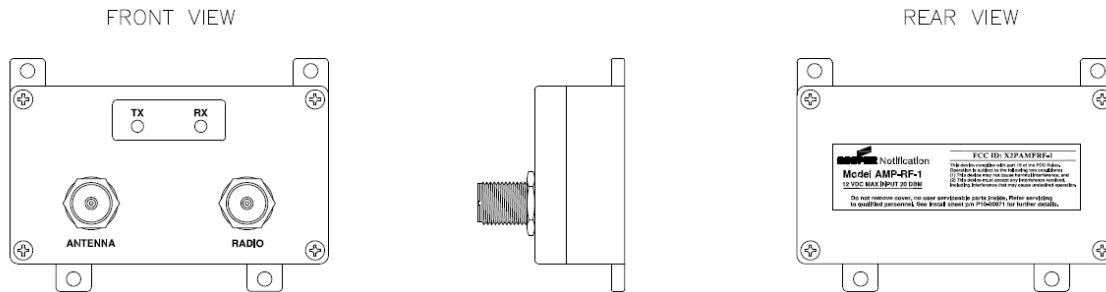


Figure 1 AMP-RF-1 Front/Side/Rear Views

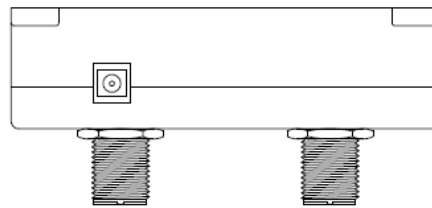


Figure 2 AMP-RF-1 Top View/DC Power Connection

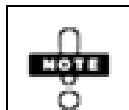
## 6. Installation

The installation of the power amplifier shall be conducted by qualified service personnel. To ensure compliance with mandatory codes and standards all instructions listed in this document should be followed.

For installations other than military applications, the use of the amplifier must meet EIRP (Effective Isotropic Radiated Power) requirements mandated by the FCC. This section provides the basic information required to define and calculate EIRP.

Each installation is unique therefore it is the responsibility of the service personnel to ensure proper installation.

1. Calculate Transmission Line Loss including connector loss. Refer to section 6.1.1 for typical loss when using LMR coax cable.
2. Identify the type of antenna in use. Refer to Table 3 for approved antenna types and their respective gains.
3. Calculate the EIRP of the antenna being used. Refer to section 6.1.2 for EIRP formula.
4. If the calculated EIRP exceeds the FCC's maximum EIRP rating, determine the additional transmission line loss needed to adjust the EIRP to meet the FCC Rules. Refer to Table 4 for EIRP values using the AMP-RF-1 amplifier.



Only antennas listed in this document are compatible with the AMP-RF-1 amplifier.

## 6.1 Calculating Transmission Line Loss and EIRP

To calculate EIRP, the total transmission line loss between the amplifier and the antenna is required. In some cases a minimum line loss is required to meet the FCC EIRP requirements. Refer to Table 4 for additional information to adjust EIRP.

### 6.1.1 Transmission Line Loss

Determining Transmission Line Loss requires knowledge of the cable type being used as well as the type and quantity of connectors in the cable run between the amplifier and the antenna. Typical loss values for LMR coax cable are listed below. However, the installer should calculate cable loss in accordance with the appropriate cable and connectors being used.

Coax Cable Loss: *LMR-240 has a 0.13 dB loss per foot*  
*LMR-400 has a 0.07 dB loss per foot*  
*LMR-600 has a 0.04 dB loss per foot*

Connector loss: *Approximately 0.22 dB per connector*  
*(Refer to specific connector type for actual loss)*

Table 2 identifies the calculated line loss for LMR-240, 400, and 600 for various cable lengths.

**Table 2 Cable Loss for Specific Cable Lengths**

Cable Length (ft)	Typical Cable loss (dB) for LMR-240	Typical Cable loss (dB) for LMR-400	Typical Cable loss (dB) for LMR-600
25'	3	2	1
50'	7	4	2
100'	13	7	4
200'	26	14	8

### 6.1.2 EIRP Calculation

The formula for calculating EIRP is as follows:

$$EIRP (dBm) = \text{amplifier output power (dBm)} - \text{transmission line loss (dB)} + \text{antenna gain (dBi)}$$

Refer to Table 3 below for amplifier output power and antenna gain of approved antennas.

**Table 3 Approved Antennas**

Antenna Model	Antenna Gain (dBi)	Amplifier Output (dBm)
ANT-109-DR	9	30
ANT-115-DR	15	30
ANT-114-YAGI	13.9	30
ANT-115-YAGI	14.5	30
ANT-103-OM	3	30
ANT-106-OM	6	30
ANT-109-OM	9	30
ANT-115-OM	15	30

### 6.1.3 Maximum and Adjusted EIRP

Table 4 below identifies compatible antennas, antenna gain, maximum EIRP and required transmission line loss (as applicable).

When determining cable lengths to meet transmission line loss between the amplifier and the antenna, if the cable distance is exceedingly long and does not provide adequate attenuation, it is acceptable to add fixed 50 ohm external attenuators to ensure the required EIRP is met.

**Table 4 Maximum and Adjusted EIRP**

Antenna Model	Antenna Gain (dBi)	Amplifier Output (dBm)	EIRP with no line loss (dBm)	Max EIRP per FCC Rules (dBm)	Minimum Loss required between amplifier and antenna* (dB)	Required Adjusted EIRP (dBm)
ANT-109-DR	8	30	38	38	5*	33
ANT-115-DR	15.5	30	45.5	42	5*	40.5
ANT-114-YAGI	13.9	30	43.9	42	5*	38.9
ANT-115-YAGI	14.5	30	44.5	42	5*	39.5
ANT-103-OM	3	30	33	36	0	33
ANT-106-OM	6	30	36	36	0	36
ANT-109-OM	9	30	39	36	3	36
ANT-115-OM	15	30	45	36	9	36

\*Indicates adjusted line loss to meet FCC EIRP exemption rules and harmonic limits

### 6.1.4 Line Loss between CRLU/TRX and Amplifier

Transmission line loss between the CRLU/TRX and the amplifier is also critical; the minimum amplifier input power should be no less than 5 dBm and should be adjusted accordingly.

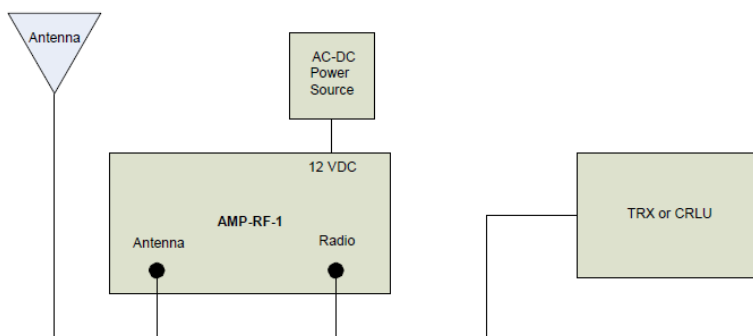
$$\text{Amp input power (dBm)} = \text{CRLU/TRX output power (dBm)} - \text{Transmission Line Loss (dB)}$$

$$\text{CRLU/TRX Output Power} = 20 \text{ dBm}$$

## 6.2 Wiring the Amplifier

Refer to the Amplifier Connection Diagram, Figure 3 below, while completing the installation steps.


**Figure 3 Amplifier Connection Diagram**



\*Use only the Class II 12 VDC Power Supply provided with the amplifier

### 6.2.1 Amplifier Location

1. For security measures, it is recommended however not required, to mount the amplifier in an enclosure.
2. The location of the amplifier is to be determined by qualified service personnel only. As mentioned previously, input/output power, line loss, and antenna gain should all be considered when identifying a location.
3. The amplifier supply must be powered from a 110 – 240 VAC, 50 – 60 Hz 15A power source using the provided Class II power supply.

	Provisions should be considered to provide backup power to the amplifier in case of power failure.
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### 6.2.2 Wiring from the CRLU/TRX to the Amplifier

1. Connect one end of the LMR coax cable to the N-Connector located on the top panel of the CRLU/TRX.
2. Connect the other end of the LMR cable to the amplifier using the N connector on the amplifier labeled *Radio*.


### 6.2.3 Wiring from the Amplifier to the Antenna

1. Connect one end of the LMR coax cable to the amplifier using the N connector on the amplifier labeled *Antenna*.
2. Connect the other end of the LMR cable to the input of the antenna.

### 6.2.4 Powering the Amplifier

	Input power to the amplifier is 12 VDC; <b>DO NOT</b> power the amplifier from the +15 VDC source on the CRLU/TRX; this may damage the equipment and void the warranty.
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1. Plug the amplifier's power supply into an AC outlet. Plug the other end of the power cable into the DC Power connection located at the top of the amplifier as indicated in Figures 2 and 3.
2. If a signal is present at the amplifier, the TX and RX LEDs on the front of the amplifier will be lit accordingly.


	It is recommended that the amplifier and related equipment be provided with a Back-Up power source to ensure operations are not disrupted when AC Power is lost.
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## 7. Labeling Instructions

The FCC ID: X2PAMPRF-1 label included with the amplifier must be installed on the amplifier's CRLU-201 or TRX-401 access point. The placement of this label must cover the existing FCC ID label on the front cover of the access point.

## 8. Revisions

Rev.	ECN #	Date	Modification
A	N/A		Original

	<p>This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his/her own expense.</p>
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