ASCENT
Communication Technology

ARF321e RF Amplifier Upgrade Kit

QRG

Revision B

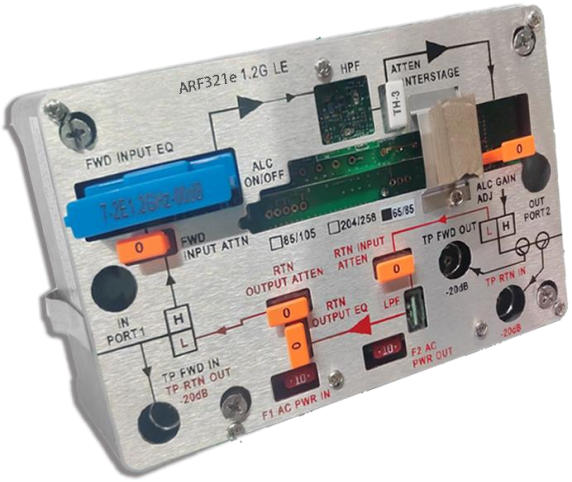
ACT ARF321e Upgrade Kit QRG

ACT Document Number: ACT ARF321e Upgrade Kit QRG

Quick Reference Guide Revision B

This document is produced to assist professional and properly trained personnel with installation and maintenance issues for the product. The capabilities, system requirements and/or compatibility with third-party products described herein are subject to change without notice.

For more information, contact ACT: support@ascentcomtec.com



Revision History

Revision	Date	Reason for Change
A	02/24/2023	Initial release
B	06/28/2025	Update format

Table of Contents

1 Introduction

1.1 Safety Symbols

WARNING Personal injury might result if instructions are not followed.

CAUTION Equipment damage might result if instructions are not followed.

Note Read for added information and reminders, including when a service interruption could occur.

Tip Read for helpful hints.

1.2 Tools and Materials

The lists below describe the tools, equipment, and materials that may be required to operate, maintain, and test the Flex Max321. Anyone performing the procedures in this manual is expected to be familiar with the appropriate, safe use of these tools. Tools or equipment with superior specifications may be substituted for those listed.

Installing ARF321e Modules

- 3/8-inch nutdriver
- torque wrench
- TORX driver with T-9 and T-15 bits
- a small, nonconducting alignment tool
- needlenose pliers
- wire cutters
- all necessary plug-in circuits in an assortment of values, according to system design

Setting Up a Forward Amplifier Cascade

- The system design
- Afield signal-level meter or spectrum analyzer capable of measuring frequencies up to 1002 MHz with associated cables
- Nedlenose pliers for installing or pulling any non-WC (with cover) plug-ins, jumpers, or fuses
- A 3/8-inch nutdriver, torque wrench
- A socket-type (female) G or F push-on fitting
- Pen or pencil for recording data on the label inside the housing lid
- A small, nonconducting alignment tool

- Attenuators in an assortment of values
- 7-2E-WC series equalizers1 in an assortment of values

Note: 6-2E series equalizers are compatible with 7-2E-WC series equalizers.

1.3 Setting Up the Return System

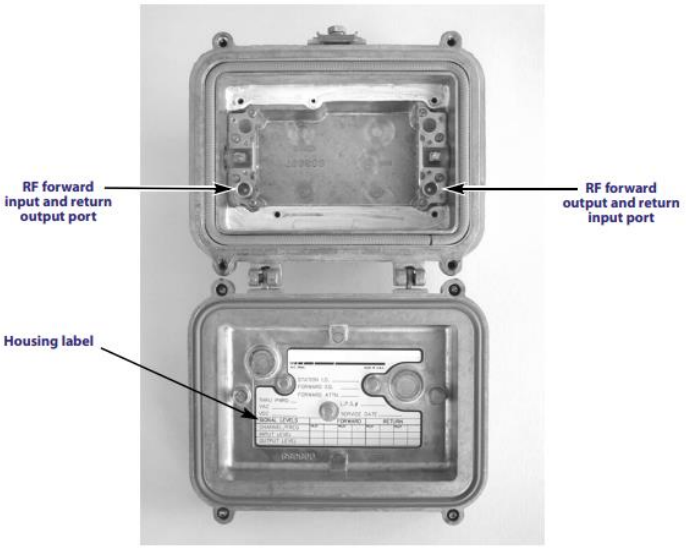
1.3.1 Test Equipment

- A spectrum analyzer
- A return signal generator capable of generating two RF carriers within the return bandwidth
- Equipment to view the return path signals in the headend from the field:
  - A video camera and a dedicated modulator in the forward path of an RF return system

    OR
  - A sweep system to set up the coaxial portion of the return plantConfiguration Mode

2 9-LH Series Line Extender Housing(Not Included)

2.1 Ports and Points of Connection



3 ARF321e RF Module

3.1 Forward RF Signal Flow

3.1.1 RF Input Port (Port 1)

The input port routes forward incoming signal to the line extender. (This port also routes outgoing return signal to the cable.)

3.1.2 Forward Input Testpoint

The input testpoint is a –20 dB resistive coupler. Accessible through a cut-out in the module cover, this testpoint allows verification of the forward signals at the forward input port without interrupting the module's operation. (Return output signal also can be measured here.)

3.1.3 Diplex Filter

A plug-in diplex filter consists of a pair of filters, a high-pass and a low-pass, on one circuit board isolating forward and return bands and determining forward and return band edges. The high-pass filter passes forward signals but blocks return signals. The low-pass filter passes return signals but blocks forward signals.

Note: Line extenders are shipped with the input attenuator and input equalizer positions empty; you must install both plug-in circuits for the module to work.

3.1.4 Input Attenuator

A plug-in attenuator reduces RF levels at the pre-amp input to meet design specifications. Line extenders are shipped with the input attenuator position empty. You'll need to select and install the appropriate value based on the station's location in your network.

3.1.5 Input Equalizer

The plug-in equalizer compensates for the effects of cable preceding the line extender.

Line extenders are shipped with the input equalizer position empty. You'll need to select and install the appropriate value based on the station's location in your network. (6-2E series equalizers are compatible with 7-2E-WC series equalizers.)

3.1.6 Pre-Amplifier

An input hybrid provides gain. This pre-amplifier sets the line extender's noise figure.

3.1.7 Interstage Attenuator

An interstage attenuator reduces overall line extender gain. A jumper, or "zero" attenuator, is shipped in this slot for circuit continuity. An optional thermal plug-in compensates for changes of attenuation in the cable due to changes in temperature in the line extender.

3.1.8 ALSC Equalizer

If installed, the AMP2902 series plug-in equalizer alters the slope of the line extender response to compensate for changes in attenuation due to the effects of temperature on the cable and passives preceding the amplifier.

3.1.9 Post-Amplifier

This output hybrid provides additional gain and routes the signal to Port 2.

3.1.10 ALSC Controller

If installed, the AMP2902 series plug-in controller provides a DC control voltage to the ALSC equalizer. The voltage is proportional to the change in the pilot carrier level due to the effects of temperature on the cable and passives preceding the amplifier.

3.1.11 Output Testpoint

The forward output testpoint is a –20 dB directional coupler. Accessible through cut-outs in the module cover, this testpoint allows verification of the forward signal at the output port without interrupting the line extender's operation.

Tip: The output testpoint allows access to the return band as well. You can't measure return signal here, but you can inject return test signals.

3.1.12 RF Output Port (Port 2)

The output port routes forward outgoing signal to distribution cable. (This port also routes incoming return signal to the line extender.) AC and RF separation is performed. AC power is blocked on the RF path.

3.1.13 RF Output Port (Port 2)

The output port routes forward outgoing signal to distribution cable. (This port also routes incoming return signal to the line extender.) AC and RF separation is performed. AC power is blocked on the RF path.

3.2 Return RF Signal Flow

3.2.1 Return Input Port (Port 2)

The return input port routes incoming return signal to the line extender. (This port also routes forward outgoing signal to distribution cables.)

3.2.2 Return Test Signal Injection Point (Output testpoint)

Since the forward output testpoint allows access to the return band, you can inject return test signals here (although you can't measure return signal at this testpoint).

3.2.3 Return Input Testpoint

This –20 dB resistive testpoint, which is accessible through a cut-out in the module cover, allows verification of the incoming return signal without interrupting the line extender's operation.

3.2.4 Return Amplifier

This hybrid, which amplifies the return signal, features an improved compression point and bit error rate (BER) for digital-loaded traffic over a discrete amplifier design.

3.2.5 Return Output Attenuator

An attenuator reduces signal levels at the return output port (Port 1). Line extenders are shipped with the return output attenuator position empty. You'll need to select and install the appropriate value based on the station's location in your network.

3.2.6 Attenuator for Return Output Equalization

Accessible through a cut-out in the module cover, this attenuator for return output equalization creates an output tilt at the return amplifier that will adjust for a flat input at the next return amplifier or match the reference at the headend. Line extenders are shipped with this attenuator position empty. You'll need to select and install the appropriate value based on the station's location in your network. (See Setting Up the RF Return Plant (ARF321e Line Extenders) on page 6-4 and Determining Values for Attenuators to Adjust for Return Equalization on page A-10.)

Note: Line extenders are shipped with the return output attenuator and return output attenuator for equalization positions empty; you must install both plug-in circuits for the module to work.

3.2.7 Return Output Attenuator

This –20 dB resistive testpoint is used to measure the return signal as it will be sent to the return output port, that is, Port 1. (Forward input signal also can be measured here.)

3.2.8 Return Output Port (Port 1)

The return output port routes outgoing return signal via the cable system back to the previous module. (This port also routes incoming forward signal to the line extender.)

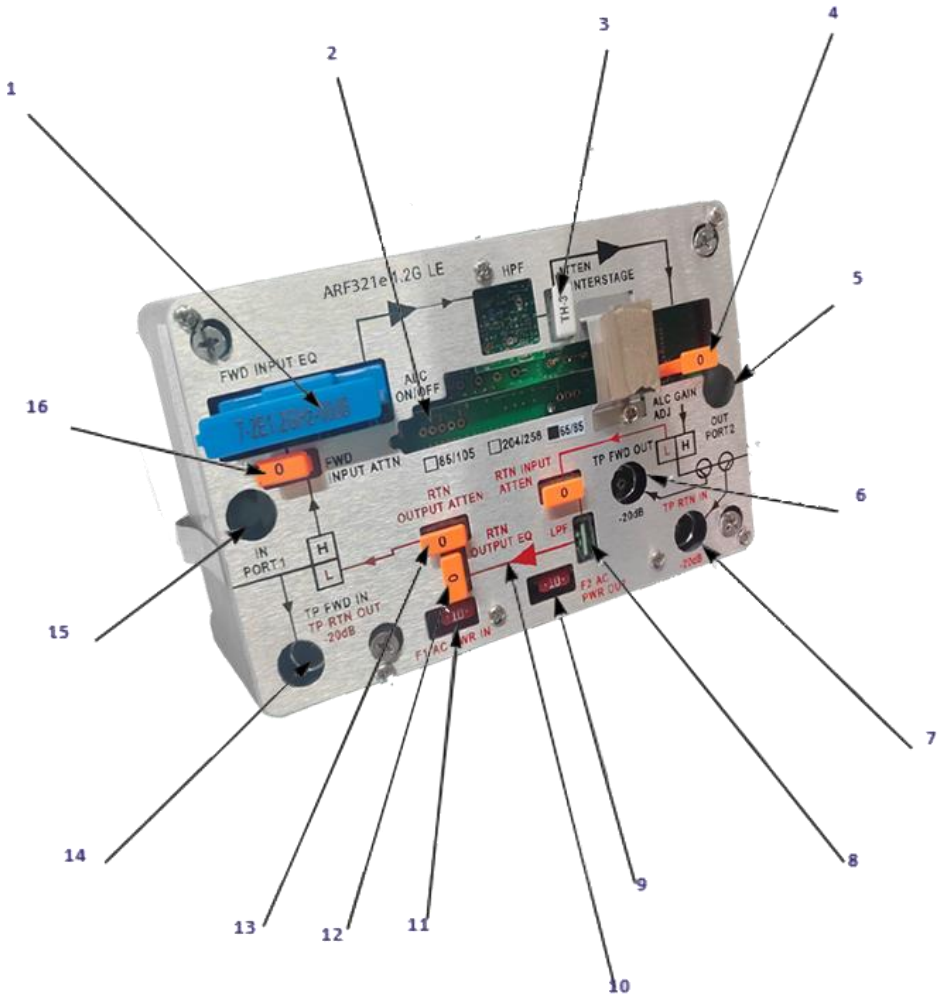
3.3 Powering

The ARF321e's power supply, an integral subassembly of the module, receives the incoming AC power and converts it into DC power. This high-efficiency, switched-mode power converter supplies 24 VDC to the circuitry of the line extender. Intended for use in both 60 and 90 VAC networks, the power supply contains stability-enhancement quasi-square-wave circuitry for applications requiring equipment capable of operation over a wide input-voltage range.

Surge protection is provided by a crowbar protection circuit.

AC power may enter the housing at either (but not both) of the RF ports and either pass through it or be blocked. The line extender's power supply converts the AC power into DC power. An AC bypass path provides high impedance to RF signals.

3.4 Controls and Plug-in Locations



ARF321e Module, Controls, and Connectors

Item	Designation	Description
1	Input Equalizer (7-2E-WC)	Plug-in equalizer compensates for the attenuation of the cable and passives preceding the line extender. (6-2E series equalizers are compatible with 7-2E-WC series equalizers.)
2	ALSC On/Off Switch	Switch located on ALSC circuit board. Turns automatic level and slope control on (automatic mode) or off (manual mode).
3	Interstage Attenuator (9-A-WC or 10-A-WC)	An attenuator reduces overall line extender gain. A jumper, or "zero" attenuator, is shipped in this slot for circuit continuity.
4	ALSC Gain Control	Potentiometer located on ALSC circuit board. Controls the gain set point in automatic mode (ALSC on).
5	Output Seizure Screw, Port 2	Access point to the output connection seizure screw.
6	Forward Output testpoint	–20 dB directional coupler testpoint. Used to measure the forward output signals at Port 2, without interrupting the line extender's operation. The output testpoint allows access to the return band as well. You can't measure return input signal here, but you can inject return test signals.
7	Return Input testpoint	–20 dB resistive testpoint. Allows verification of the incoming return signal without interrupting the line extender's operation.
8	AC/CBR Jumper	The AC jumper maintains the connection to the power supply but also connects the CBR circuit. The line extender is shipped with the CBR jumper installed. When the jumper is plugged in, AC passes to the line extender power supply. Removing the jumper prevents power from going to the power supply but still allows power to pass through the station. For a description of the crowbar, see *CBR-MMLE-90 Surge Arrestor* on page 3-8.

Item	Designation	Description
9	F2 AC Power Output Fuse	15-Amp automotive-style fuse, directing power to or from output port (Port 2).
10	Crowbar Surge Arrestor	Protects the RF components and the power supply from transients and power surge, limiting sustained voltage surges to 220V.
11	F1 AC Power Output Fuse	15-Amp automotive-style fuse, directing power to orfrom input port (Port 1).
12	Attenuator for Return Output Equalization (9-A-WC or 10-A-WC)	An attenuator for equalization creates an output tilt at the return amplifier that will adjust for a flat input at the next return amplifier or match the reference at the headend.
13	Return Output Attenuator (9-A-WC or 10-A-WC)	An attenuator reduces signal levels at the return output port (Port 1).
14	Forward Input/Return Output testpoint	–20 dB resistive testpoint. Used to measure the forward input signal without interrupting the module's operation and the return signal as it will be sent to the return output port (Port 1).
15	Input Seizure Screw, Port 1	Access point to the input connection seizure screw.
16	Forward Input Attenuator (9-A-WC or 10-A-WC)	Plug-in attenuator reduces the input signal uniformly across the spectrum to the correct level for input to the pre-amplifier.

Plug-In Circuits

Other Information About These Plug-Ins	Refer To
Which plug-ins are factory-installed, required, and optional?	Below table
How does signal flow through the plug-ins and how do they act on the signal?	Functional Description

Accessories

Plug-ins for a ARF321e	**Plug-in Series**

Factory-Installed Plug-Ins

Circuits or jumpers are factory-installed in these positions according to customer or product requirements.

Crowbar-Protection Circuit	AMP3580/009

Required Plug-Ins

The ARF321e is shipped with these positions empty. Install values based on the station's location.

Input Attenuator	9-A-WC or 10-A-WC	
Input Equalizer	7-2E-WC or PEQ-1G	1,2

Plug-ins for a ARF321e	**Plug-in Series**
Return Output Attenuator for Equalization	9-A-WC or 10-A-WC
Return Output Attenuator	9-A-WC or 10-A-WC

Optional Plug-Ins

Jumpers, or "zero" value circuits, may be shipped in these positions. Install different values based on system design.

ALSC Equalizer and Controller, under cover	AMP2902/***
Thermal Attenuator	7-CT15

Notes:

1. 6-2E series equalizers are compatible with 7-2E-WC series equalizers for 750 or 862MHz systems.
2. PEQ-1G series equalizers are used for 1GHz systems.
3. Specific frequencies available as follows: 427.25MHz = AMP2902/009, 499.25MHz = AMP2902/019, and 423.25MHz = AMP2902/039.

3.5 CBR-MMLE-90 Surge Arrestor

A solid-state crowbar-protection circuit, model number AMP3580/009, is provided with the ARF321e as the surge-protection device. This crowbar circuit will perform as required for 60 and 90 VAC powered line extenders.

4 Installation

4.1 Field Installation

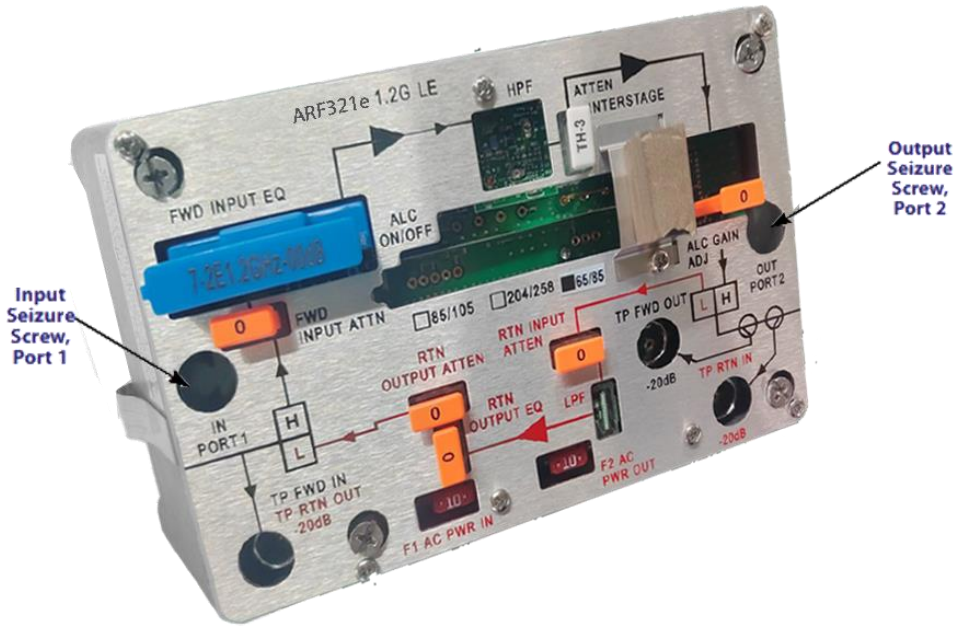
In most cases, fully configured ARF321e RF modules are delivered to customers enclosed in a 9-LH series housing. You can mount the 9-LH housing in the field with the ARF321e RF module inside.

To install the housing in the field

1. Install the housing in the desired location and orientation.

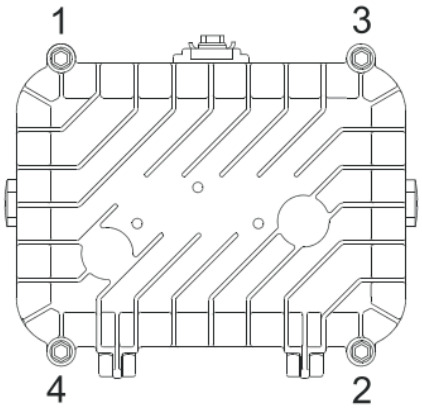
Note: ***Feed-through connectors may also be used when installing the housing.***

2. Insert pin connectors (see note) into the input and output ports. Center conductor length should ideally be 4.1 cm (1.6 in).
3. Using a torque wrench, tighten the pin connectors into the housing port to the torque specified by the pin connector's manufacturer.
4. Using a torque wrench or screwdriver, tighten the seizure screws between 0.3 and 0.45 N·m (4 and 6 in-lbs).



5. Install the connectors according to the connector manufacturer's installation instructions, and use appropriate methods to prevent water ingress.

4.2 Opening the Housing



To open a 9-LH series housing

1. Use a 3/8-inch nutdriver to partially loosen all housing bolts in the order shown in above figure. If you loosen the bolts fully in this first round, the last bolt will be hard to turn.
2. Fully loosen the bolts in the same order.
3. Open the housing.

4.3 Installing Equalizers and Attenuators

Note: See Controls and Plug-in Locations on page 3-6 for plug-in locations in ARF321es.

To install equalizers and attenuators

1. Install the user-changeable equalizers and attenuators. If factory-installed jumpers or zero-value circuits are installed in these positions, remove them as you go.

Tip: Because the system design is normally based on the same gain at each amplifier station, you will normally install the same value interstage attenuator in all amplifiers in the system.

2. Verify that the amplifier gain (per amplifier specifications) matches the designed gain. If the gains don't match, use an interstage attenuator. (Interstage attenuators reduce the signal between amplifier stages to minimize the effect on carrier-to-noise, allowing you to customize the amplifier gain to match your system's designed gain.)

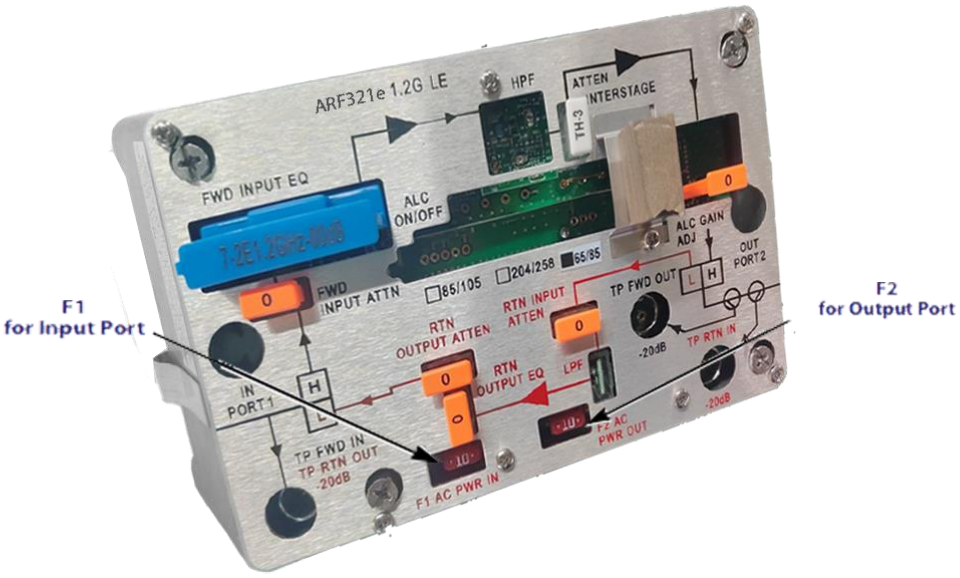
   To find the value, use this formula:

   interstage attenuator value = operating gain (from amplifier specifications) - designed gain (system-wide)

3. You have now installed the designed attenuators and equalizers. Keep in mind that field conditions often vary from the worst case conditions used in system design. You may need to change the values of some of the plug-ins during setup.
4. For RF modules not yet installed in the housing, proceed to Installing the ARF321e RF Modul.

4.4 Installing the Fuses

ARF321es offer flexible power routing through 15 A automotive-style fuses, also called power directors: F1 and F2. The fuses' main function is to direct power through the amplifier module. Figure 4.3 features a manual model.



ARF321e RF modules are shipped with two power-directing fuses installed. During installation of the

ARF321e, you will either leave both fuses in the unit, or you will pull one of the two fuses.

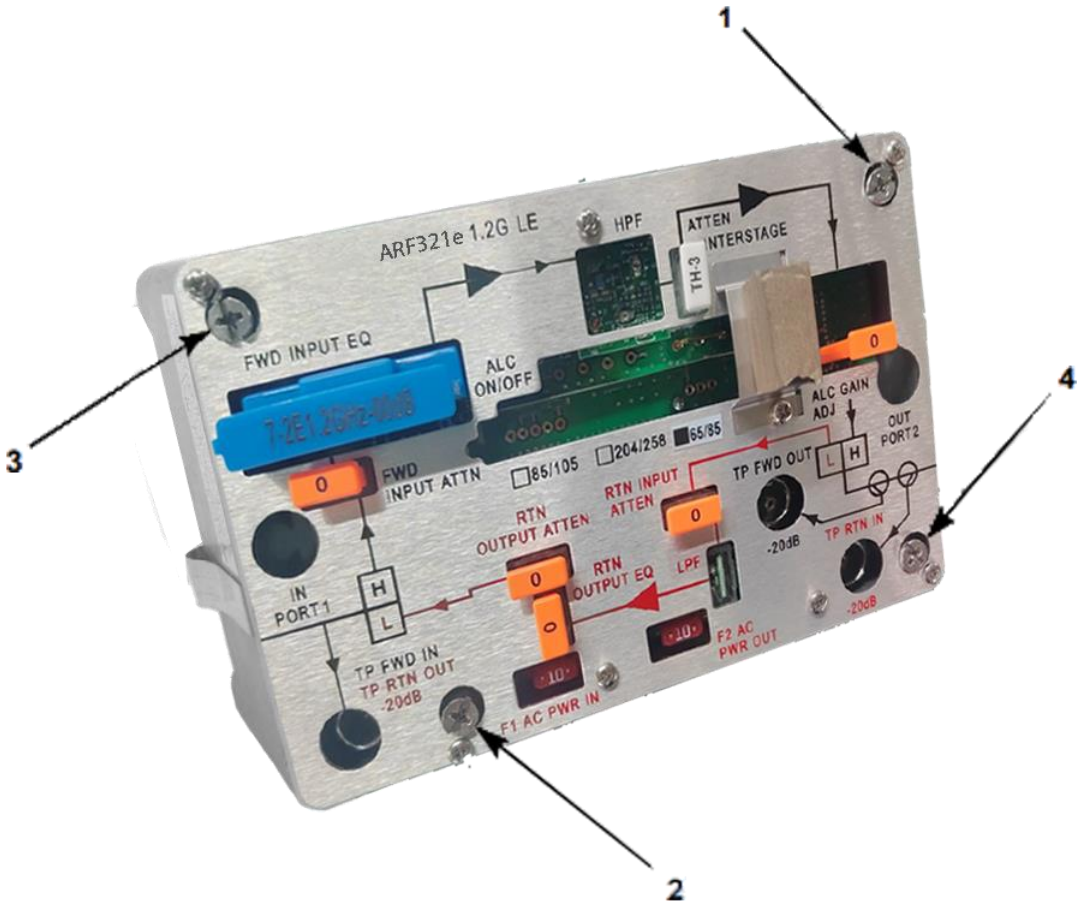
To determine how to fuse the ARF321e

1. Determine from the system design which port should have power applied.
2. If the ARF321e will be powered through, leave both fuses in the unit. If the unit will not be powered through, pull the appropriate fuse to stop power from passing through the module (see Figure 4.3).
3. For RF modules not yet installed in the housing, proceed to Installing the ARF321e RF Module.

WARNING: Live power may be applied to the RF amplifier housings. Before inserting amplifiers into housings, make sure the fuses are installed only in the port positions where power will be directed.

4.5 Installing the ARF321e RF Module

Tightening the ARF321e RF module screws in three rounds, in the proper order and to the proper torque, seats it properly.



WARNING: Dangerous Voltage! Installing the amplifier module into the housing exposes you to potentially high voltages and should be performed only by qualified technicians experienced with cable and/or telephony technologies. Users new to cable and/or telephony technologies and procedures should not rely on this manual for comprehensive guidance.

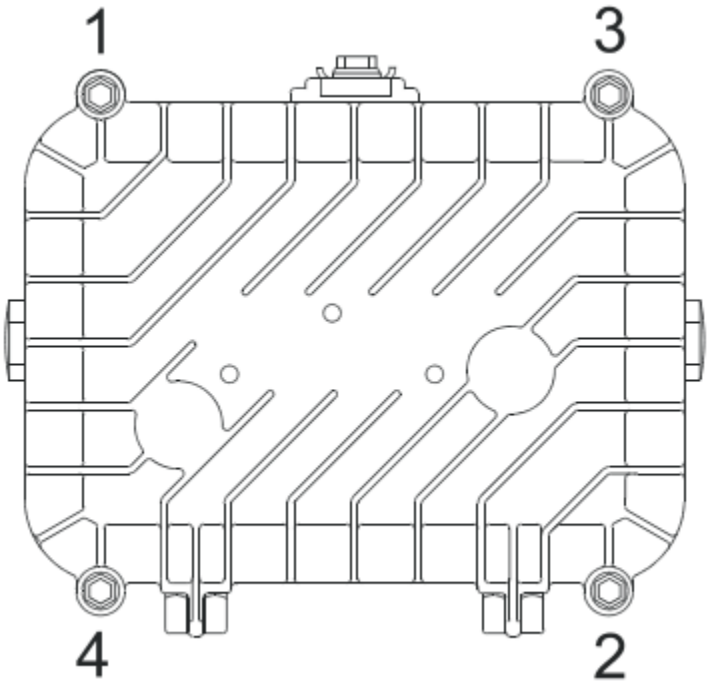
To install a ARF321e RF module into an open housing

1. Press the RF module firmly into the housing connectors. Following the order shown in Figure 4.4, tighten the module screws to 20 to 30 in-lbs (2.3 to 3.4 N·m). Repeat twice more for a total of three rounds.
2. Verify that the input AC power to the housing is near what the design calls for.

Proceed to *Closing the Housing* or Chapter 5, *Setting up the Forward Cascade*.

4.6 Closing the Housing

Tightening the housing bolts in this order, in several rounds, assures that the gaskets stay seated and the torque is correct.



To close the 9-LH housing

1. Make sure that the housing is free of moisture and dirt.
2. Make sure that the rubber weather gasket is firmly seated in its groove on the housing lid. The gasket should appear uniform, with no wrinkles or bulges. The edge of the rubber weather gasket that will seal against the housing base should point straight out. If the weather gasket has been disturbed, reposition it.
3. Close the housing. Tighten the bolts just enough to make contact with the lid, following the sequence shown in Figure 4.10.
4. In the same sequence, tighten the bolts to a torque of 30 to 40 in-lbs (3.4 to 4.5 N·m).
5. Repeat Step 4 to make sure the bolts are still at the proper torque in case they have relaxed.

5 Setting up the Forward Cascade

5.1 Setting Up the Cascade

Because field conditions may not match design assumptions, setting up each amplifier in cascade is essential to ensure that the system works properly. Perform this entire set of procedures, in the sequence documented, at the first amplifier in a cascade, then proceed downstream through the rest of the amplifiers. Repeat for each cascade in your system. Once an amplifier is in service, you may perform individual procedures as needed.

Tip: *When your measurements vary slightly from designed levels, you may need to make minor changes to the plug-ins. If the measurements vary significantly from the designed levels, you may need to investigate a system problem.*

Remember to account for the 20 dB loss of the RF testpoints. That is, testpoint measurements are 20 dB lower than the actual levels, so you may need to add 20 dB to any testpoint measurement to calculate the true level.

Also remember that all field verification must be done with the amplifier set in manual mode (ALSC off).

As you go, record information on the housing labels and/or on paper as required by your system.

Note: *Once the attenuator and equalizer have been properly set, you shouldn't need to readjust the amplifier unless the plant or design changes. If loss of level occurs, find and address the problem creating this differential.*

5.2 Preparing the Amplifier for Initial Setup

To prepare the amplifier for setup the first time.

1. Open the 9-LH series housing. (See Opening the Housing.)
2. Verify that the design-specified input equalizer and input attenuator are installed in the amplifier you are setting up. If any components other than the design-specified plug-ins are in these positions, remove them and install the designed plug-ins.

Note: When setting up an amplifier, the succeeding amplifier must be installed, including an input attenuator and input equalizer, to provide proper termination for the amplifier you are setting up. If there is no succeeding amplifier, the amplifier or distribution line must be terminated in 75 ohm.

4. Note For input equalizer and input attenuator locations in the ARF321e module, see Controls and Plug-in Locations.

Proceed to Checking AC Power.

5.3 Checking the Input Levels

To check the input levels

1. Connect the signal-level meter to the amplifier's input test point.
2. Measure the input levels at the defined low-end and high-end frequencies. Verify that they are near the designed levels for this location. If not, check the network for possible problems.

Proceed to Checking the Input Equalizer.

5.4 Checking the Input Equalizer

This procedure ensures that the input equalizer is correct for the amplifier's actual operating environment.

To check the installed input equalizer

1. If the amplifier has ALSC, turn it off.
2. Connect the signal level meter to the amplifier's Port 2 output testpoint (TP2).
3. Measure the output levels at the defined low-end and high-end frequencies. Calculate the difference between these levels. If the difference varies significantly from the system design, check the network for possible problems.
4. Compare the amplifier's Port 2 output measurements with the system design specifications. If the output tilt does not match the system design specifications (within the accuracy of the equipment), replace the input equalizer to adjust the tilt response to greater than or equal to the desired tilt. DO NOT SET FOR LESS THAN THIS TILT TO ACHIEVE OPTIMUM DISTORTION PERFORMANCE.

Proceed to Checking the Input Attenuator.

5.5 Checking the Input Attenuator

This procedure ensures that the input attenuator is correct for the amplifier's actual operating environment.

To check the installed input attenuator.

1. Make sure you have checked the input equalizer. (See Checking the Input Equalizer.)
2. Compare the amplifier's Port 2 output measurements with the system design specifications, offsetting for temperature. If the output RF level at the high-frequency point does not match the system design specifications (within the accuracy of the equipment), replace the input attenuator to obtain the nearest specified output level at the
3. High-frequency point. DO NOT EXCEED THE DESIGNED OUTPUT RF LEVEL FOR OPTIMUM DISTORTION.
4. PERFORMANCE (taking into account the temperature offset). See Determining the Temperature Offset.

If using ALSC, proceed to Setting Up the ALSC.

If not using ALSC, proceed to When You're Finished.

5.6 Setting Up the ALSC

If you are using automatic level slope control (ALSC), this procedure helps you set it up to compensate for the effects of temperature on the ca ble and passives preceding the amplifier.

Note: In alternating ALSC cascades, use an interstage attenuator in each non-ALSC station to achieve unity gain (that is, to match the operating gain of the ALSC stations). The attenuator's value should match the ALSC flat loss, rounded down to the nearest value. For ALSC flat loss, see Installing ALSC.

To set up the ALSC

1. Make sure you have checked the input equalizer and input attenuator.
2. Switch the ALSC control to ON (see Figure ARF321e Module, Controls and Connectors).
3. Measure the defined high-end frequency.
4. Adjust the ALSC GAIN control (see Figure ARF321e Module, Controls and Connectors) to achieve the specified output at that high-end frequency. (The ALSC GAIN control may require several turns to effect a change.) With ALSC on, you do not adjust for temperature offset.

5.7 When You're Finished

When you're finished with the forward setup at a given station, if desired, you may set up the return path for this station (see Chapter 6), or you may sweep this station (see Chapter 7).

When all required procedures are finished at this station, close the housing (see Closing the Housing). Repeat the forward setup procedure until all of the amplifiers in the cascade have been set up.

6 Setting up the RF Return System

6.1 How to Set Up the RF Plant

Note*:* The following injected levels are examples; use whatever levels apply for your system.

To set up the ARF321e path

1. Begin at a station that feeds return signals to an optical node (or feeds the headend directly), and work outward in the system, toward subscribers.
2. Accurately calibrate the output level of the carriers or sweep signal you'll be injecting in this step:

   a) First, inject into the forward output testpoint two carriers or return sweep at 22 dB greater than the desired return input, allowing for the –20 dB testpoint and 2 dB of embedded losses. For example, injecting two carriers into the forward testpoint at 32 dBmV corresponds to 12 dBmV at the station's return input and 10 dBmV at the return amplifier input.

   b) Then, view the signal received at the headend. If using sweep equipment, obtain an automated spectral display of the return spectrum. If using a remote TV set, view a picture of a headend spectrum analyzer sent out on an unused channel in the forward system.

Note: For plug-in locations in ARF321e modules, see Controls and Plug-in Locations.

3. If the tilt at the headend doesn't match the established reference (on the display), replace the return output attenuator for equalization until the tilt matches.
4. If the level at the headend doesn't match the established reference (on the display), replace the return output attenuator until the level matches.

Once you have achieved proper levels at the headend, the amplifier is set up. Proceed downstream to the next amplifier. Repeat this procedure, moving one amplifier farther out into the system until you reach the end of the cascade.

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Specifications and product availability are subject to change without notice.

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