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RF-7000E Repeater

Microwave Repeater Systems

Applications

- Low-cost, highly reliable 8-GHz microwave through repeater for extending range of or clearing obstructed microwave radio paths.
- Excellent performance with analog, digital, or video microwave radios; channel capacity to 2400 FDM, 2016 PCM (3 DS3 or 135 Mb/s) or multiple video.
- Compatible with any manufacturer's 8-GHz radio terminal.
- Solar power compatible -- economical in thin routes and remote locations.

Features

- RF output power up to +28 dBm analog, +26 dBm digital.
- Power consumption only 2.3 amperes at 12 Vdc for regular-power-duplex operation.
- Solar powered, ac powered, or primary cell powered.
- Compact and lightweight -- ideally suited for remote sites that do not have access roads or commercial power.
- Environmentally protected aluminum, weathertight, lockable cabinet. No extra environmental shelter required in most installation.
- Suitable for use at unimproved sites anywhere in the world -- Alaska to Saudi Arabia.
- Internally protected duplex, frequency diversity, and three-way (or "Y junction") configurations available.
- Only one active element per channel, the internally redundant linear amplifier.
- AGC/ALC provided to correct input fades and reduce overload.
- In the case of single duplex configuration, amplifiers can be replaced without disrupting service.
- RMAS-120 Alarm system (optional) can remotely monitor repeater.
- Equipped with directional couplers for in-service RF output power measurements.
- No frequency conversion -- received signal is filtered, amplified, and re-radiated.
- Very reliable, greater than 85,000 hours MTBF for duplex.
- Available as a self-contained RF repeater for use with customer-furnished antenna and power equipment or as a complete package including repeater, antenna, solar electric panels, battery charger and batteries.

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1. GENERAL

- The RF-7000E can be used with any manufacturer's 7 GHz radio operating in the 7.1 to 7.9 GHz frequency range to provide an intermediate repeater.
- The RF-7000E assembly is an RF-throughrepeater designed for remote locations. No alignment is required, and the use of highly reliable components and minimum active circuitry eliminates most subsequent maintenance.
- The repeater assembly consists of an equipment mounting panel contained in an aluminum weatherproof cabinet. If desired, the complete assembly can be wall-mounted. In most applications, however, the complete assembly is pole-or tower-mounted. Front views of the repeater are shown in Figure 1 and Figure 2 for different enclosure sizes.
- In addition to the RF-7000E repeater assembly, Repeater Technologies offers accessory equipment consisting of antennas and mounted hardware, waveguide, batteries and hardware, and an AC power supply with an integral standby battery. The recommended antennas are solid or high performance types chosen per application.

2. FUNCTIONAL DESCRIPTION

Basic Repeater

- The RF-7000E duplex repeater uses internally redundant amplifiers for transmission in each of two directions. Each amplifier is powered by two separate battery supplies for added reliability. Bandpass filters and circulators that form a duplexer network direct the received signals to the amplifiers and combine the amplifier outputs with the received signals to a common antenna port for transmission in each direction (see Figure 3 through Figure 8). Dual polarized antenna ports repeaters are available (see Figure 9).
- The received signal from "A" antenna, identified as frequency "f1," enters the repeater panel by way of the cabinet mounted CPR-112G W/G connector and then is fed to an RXTX

branching circulator. Then, from the channel branching circulator, the f1 signal is passed to the f1 receive bandpass filter.

- The bandpass filter passes the f1 signal to a terminated coaxial circulator and (optional) f1 receive pad and then to amplifier 1. The amplified signal passes through the (optional) f1 transmit pad.
- From the transmit pad, the f1 signal passes through a terminated coaxial circulator and the f1 transmit bandpass filter to the channel branching circulator and then to the RX-TX branching circulator.
- From there the signal passes to the cabinet mounted CPR-112G W/G connector for connection to the "B" antenna.
- In the other direction, the receive signal from "B" antenna, identified as frequency "f2," enters the repeater panel by way of the cabinet mounted CPR-112G W/G connector and is fed to an RX-TX branching circulator. From the branching circulator, the f2 signal is passed to the f2 receive bandpass filter.
- The bandpass filter passes the f2 signal to a terminated coaxial circulator and (optional) f2 receive pad, and then to amplifier 2. The amplified signal passes to (optional) f2 transmit pad.
- From the transmit pad, the f2 signal passes through a terminated coaxial circulator and the f2 transmit bandpass filter to the transmit channel branching circulator.
- The signal then passes to the RX-TX branching circulator and the cabinet mounted CPR-112G W/G connector for connection to the "A" antenna.
- Receive pads RX f1 and TX f2 reduce the repeater receive signals to approximate the recommended input level. The transmit pads designated TX f1 and TX f2 reduce the output signal levels of the repeater to prevent overloading of the terminal receiver in a short path.
- Pads are mounted on input and output of amplifiers. The nominal input and output power level for various repeater channel configurations are listed in the Technical Summary .

RF-7000E Repeater

Amplifiers

- In digital radio applications, in order to maintain linearity over the entire signaling envelope, the amplifiers operate at a reduced average power level to meet the output power level requirement as shown in the Technical Summary.
- Each amplifier is mounted on the front of the panel to allow easy AGC/ALC adjustment and amplifier replacement in the field. Necessary information for ordering spare or replacement amplifiers is provided in Ordering.

Directional Couplers

- Directional couplers, built into the amplifiers, provide signal monitor points (Figure 11). These monitor points allow inservice measurement of transmit output power. The monitor points are calibrated to indicate actual RF output power at the antenna connector.
- When measuring transmit power, the power meter reading obtained, plus the loss (in dB) marked at the amplifier monitor point, minus the branching loss (in dB) marked on the panel, equals actual transmit output power.

For example:

(1)	Power meter indication	=	+5.0dBm
(2)	Loss marked at monitor	=	18.2dB
(3)	Branching Loss	=	-2.2dB

	Output Power	=	+21.0dBm

AGC/ALC Adjustment

- There is a field-adjustable potentiometer on the amplifier (shown in Figure 9). The repeater output level and nominal gain is adjusted by AGC/ALC potentiometer.

Linear Gain Adjustment

- On the amplifier, there is a second field adjustable potentiometer for linear gain adjustment to limit its maximum gain.

Power Supply

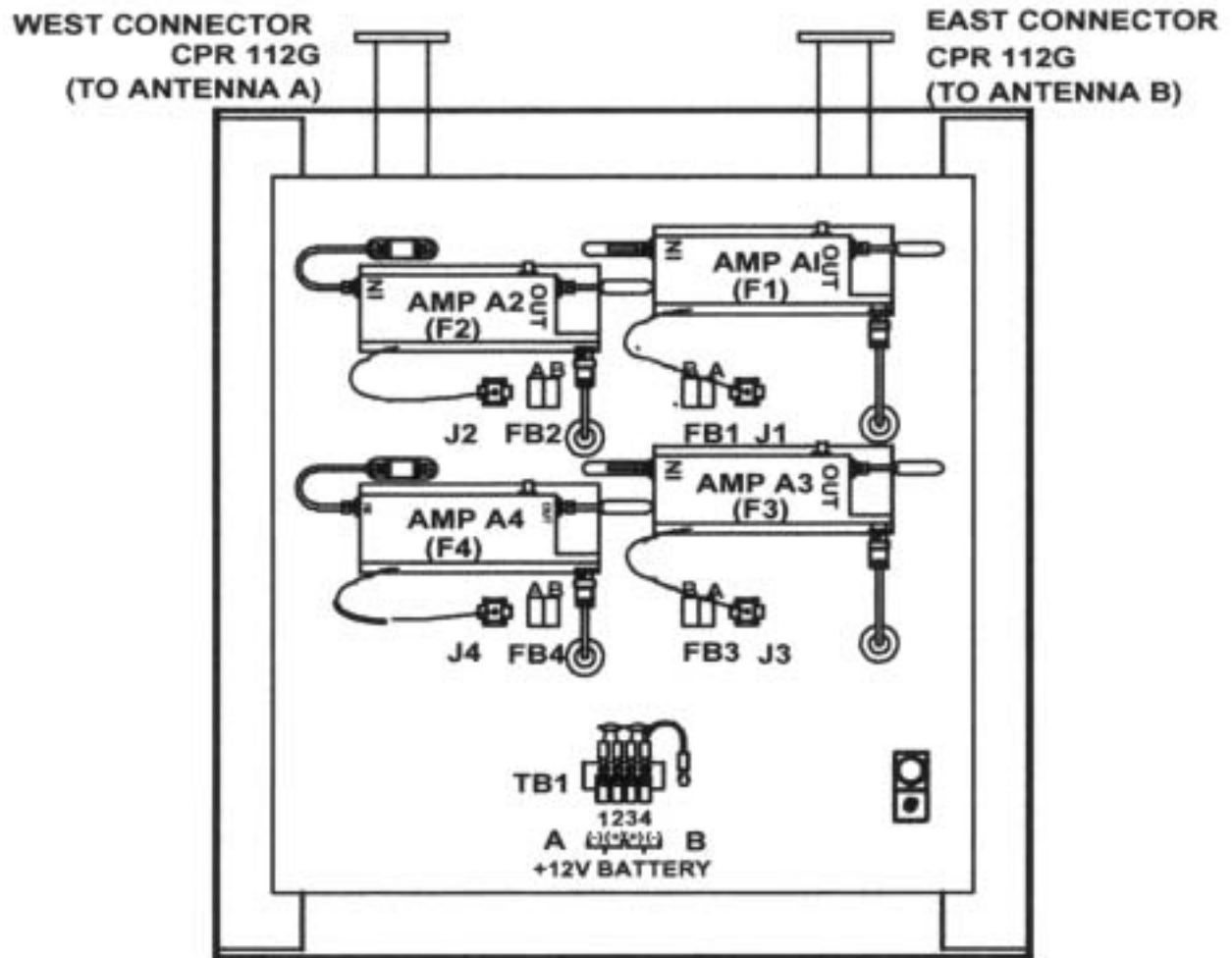
- The only active elements in the RF-7000E assembly are the

amplifiers, which operate from a +13.5 Vdc source. Current requirements are 1.15 Amperes per Power Level 1 amplifier and 1.9 Amperes per Power Level 2 amplifier. The repeater assembly may be powered from solar panels or batteries, primary cells only, or from an AC/DC supply with standby battery (shown in Figure 12 and Figure 13).

- Storage batteries and solar cell panels are selected on the basis of the average insolation and temperature range at the site. The batteries are engineered to provide the required reserve capacity across the temperature range and during periods when the output from the solar panels is low or not available.
- Controllers are used with the solar panels to efficiently charge the batteries without overcharging. Repeater Technologies can determine the solar and battery capacity. The location of the site should be specified when requesting assistance.
- In areas in which commercial power is available, an AC power supply can be provided. Although one AC power supply provides ample current to power all amplifiers, dual AC power supplies are recommended for higher reliability.
- The dual AC power supply system also contains two charge controllers and two sets of standby battery to provide power during AC power failures. Each battery is float-charged while the power supply is on and has 100 Amphours as standard capacity. Additional batteries can be purchased if the system requirement needs.
- In locations in which commercial power is not available and solar panel charging is not practical, primary cell batteries capable of powering an RF-8000E repeater for in excess of a year are available. In such applications, the battery installation should be given an environmental shelter according to the manufacturers' recommendations.

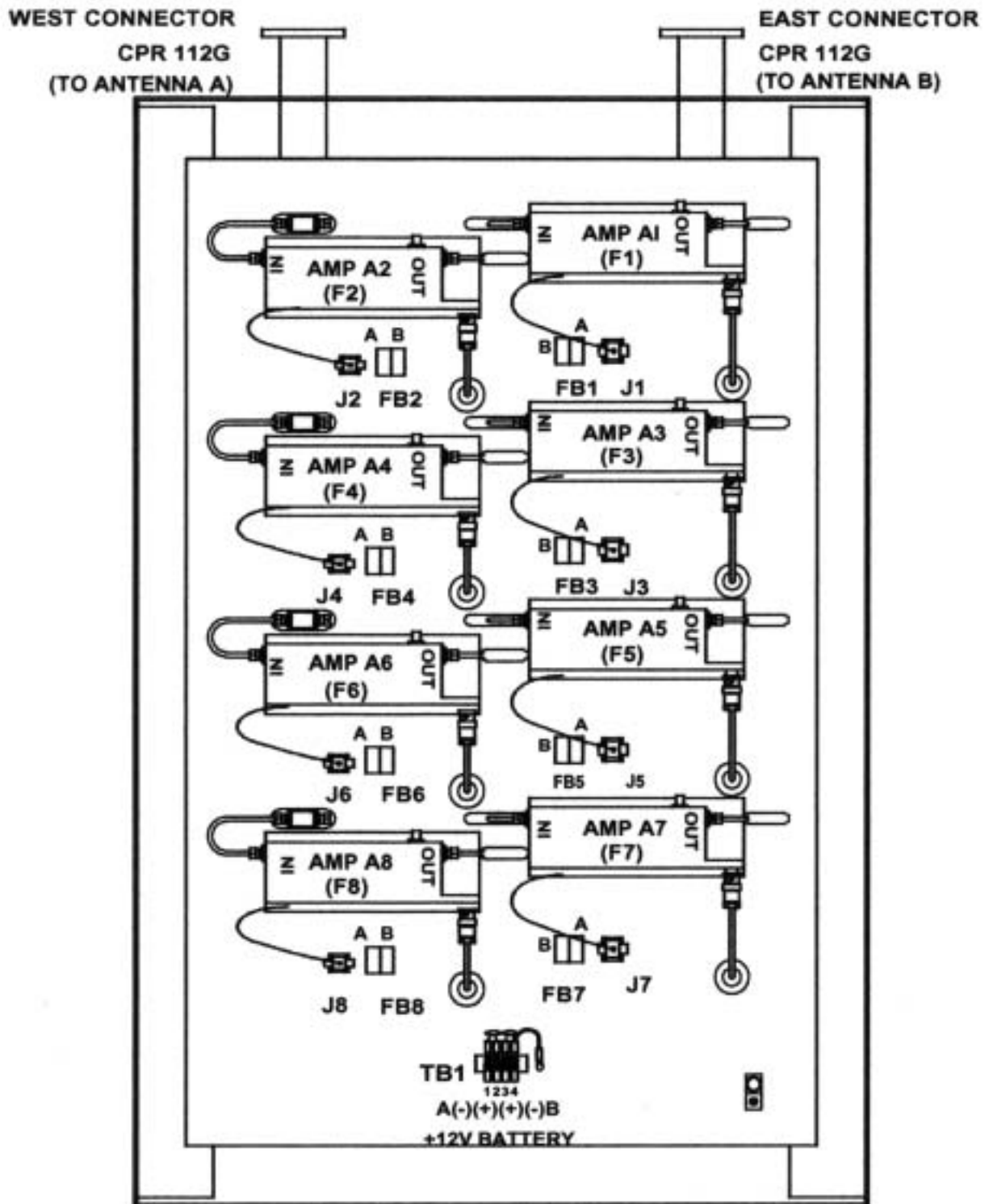
3. ALARMS

- The RF-7000E repeater can be provided with an optional alarm system to remotely monitor the repeater site.
- The alarms are relayed back to the terminal through the use of a low rate telemetry signal directly modulated on the RF in



Fuse Designation A,B refers to Battery A, Battery B.

Figure 1. Mechanical Layout (3-4 Freq. Channels)



Fuse Designation A,B refers to Battery A, Battery B.

Figure 2. Mechanical Layout (5-8 Freq. Channels)

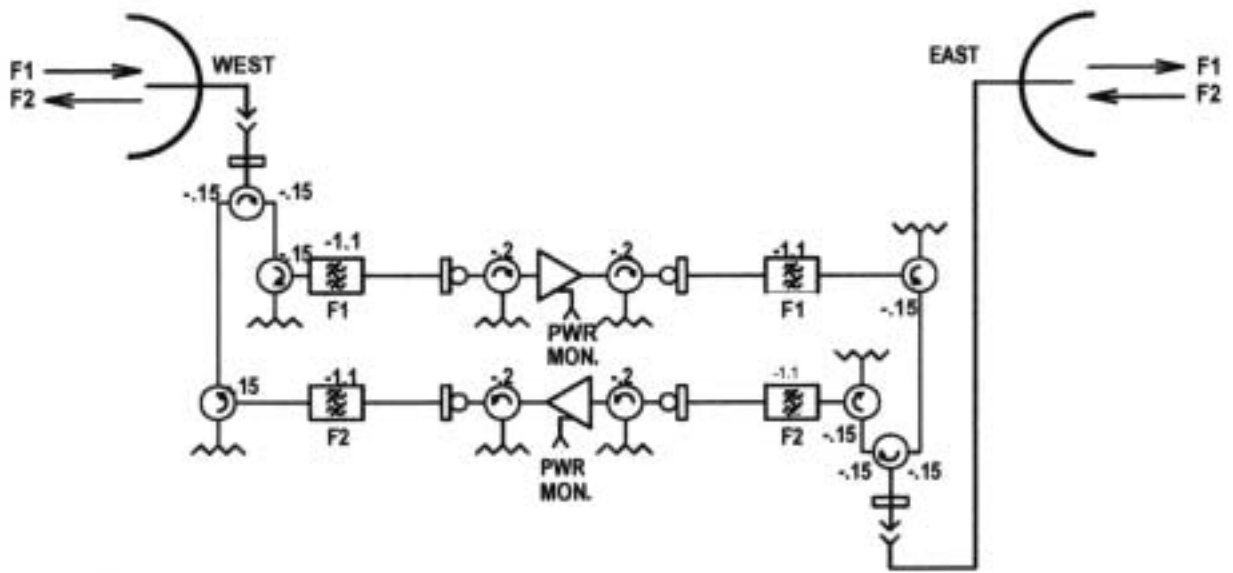


Figure 3. RF-7000E, -01, -21, 41, (1+0)

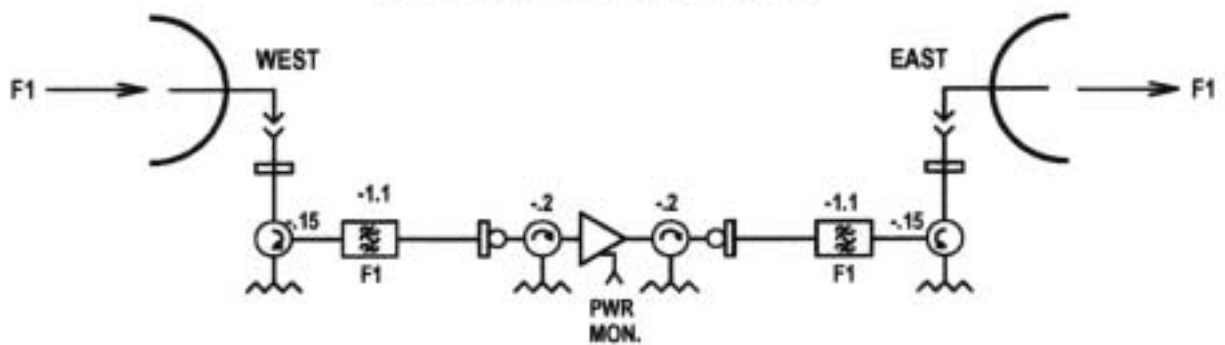


Figure 4. RF-7000E, -03, -43 (One Way)

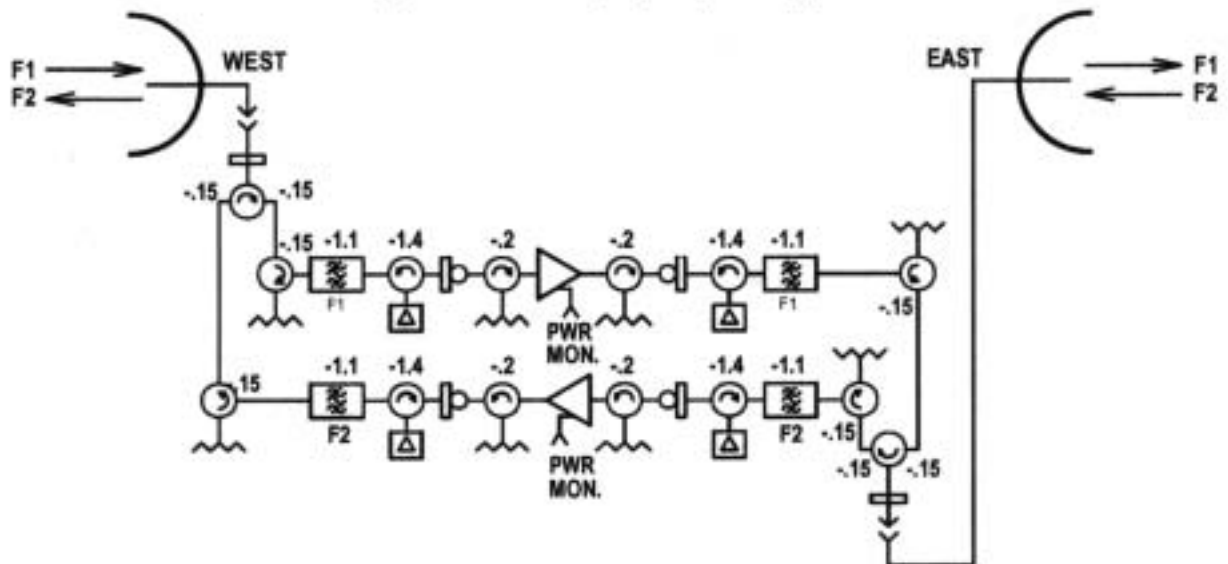


Figure 5. RF-7000E, -11, -31, -51, (1+0, Equalized)

RF-7000E Repeater

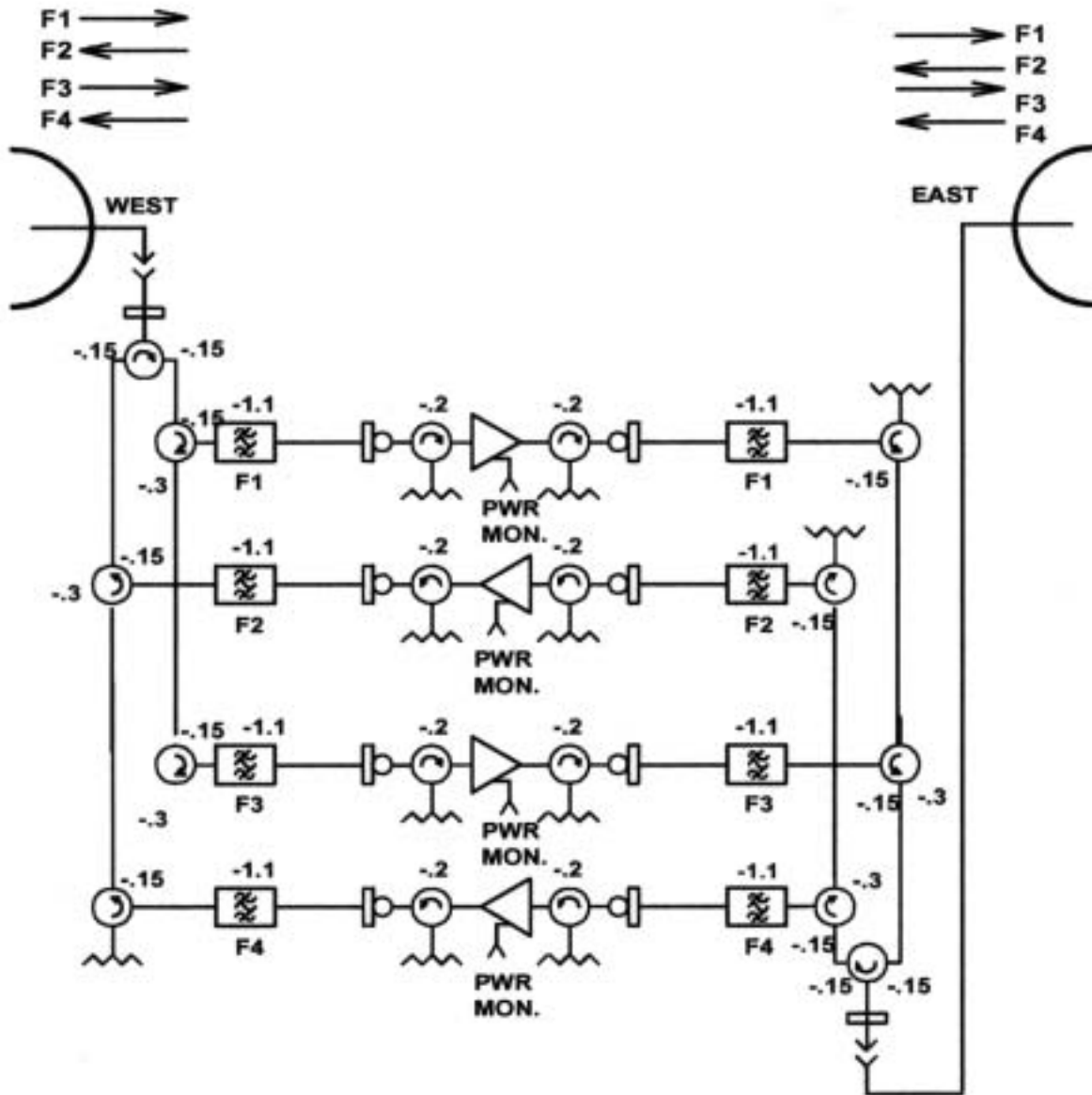


Figure 6. RF-7000E, -02, -22, -42, (1+1)

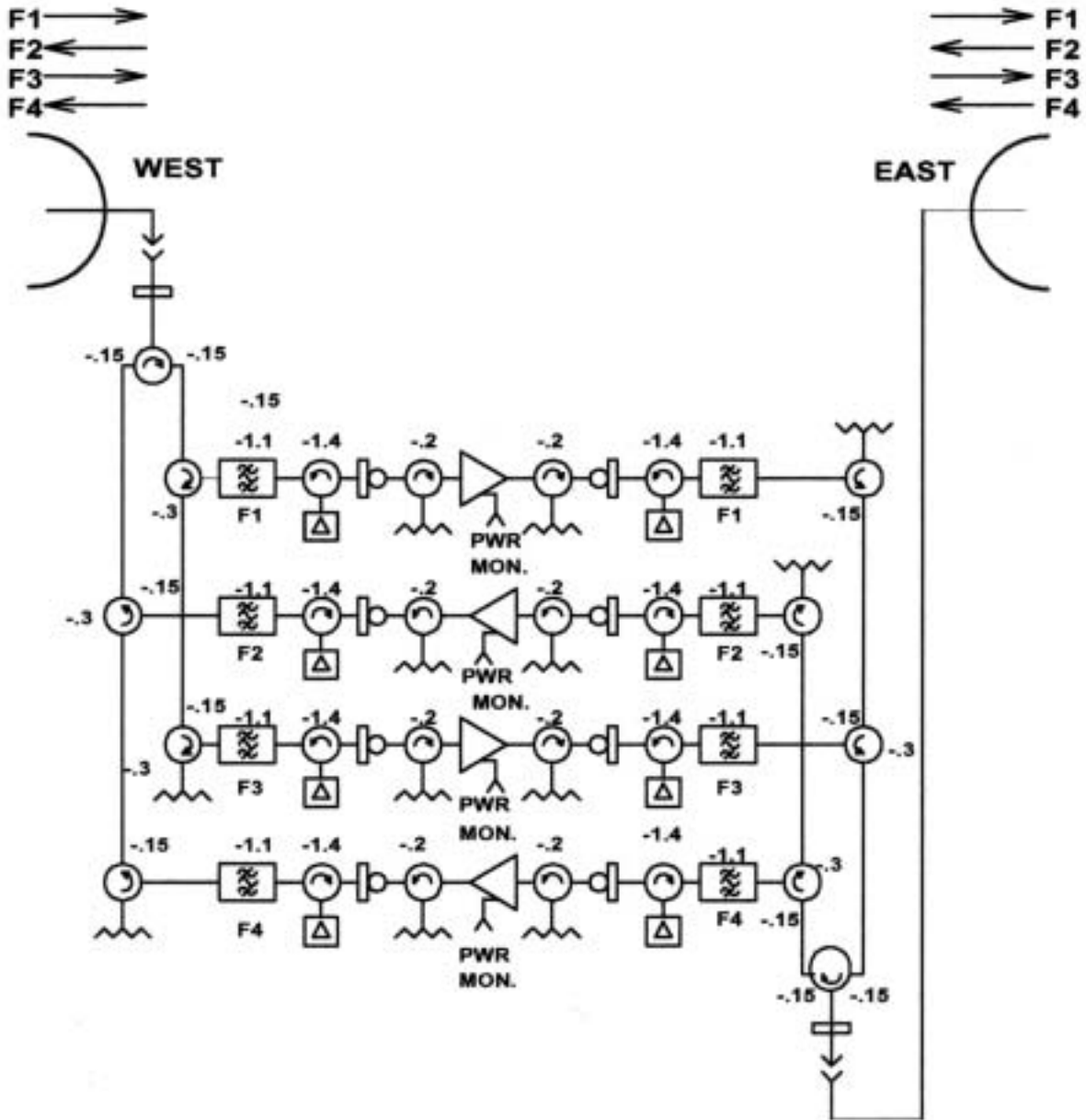


Figure 7. RF-7000E, -12, -32, -52, (1+1, Equalized)

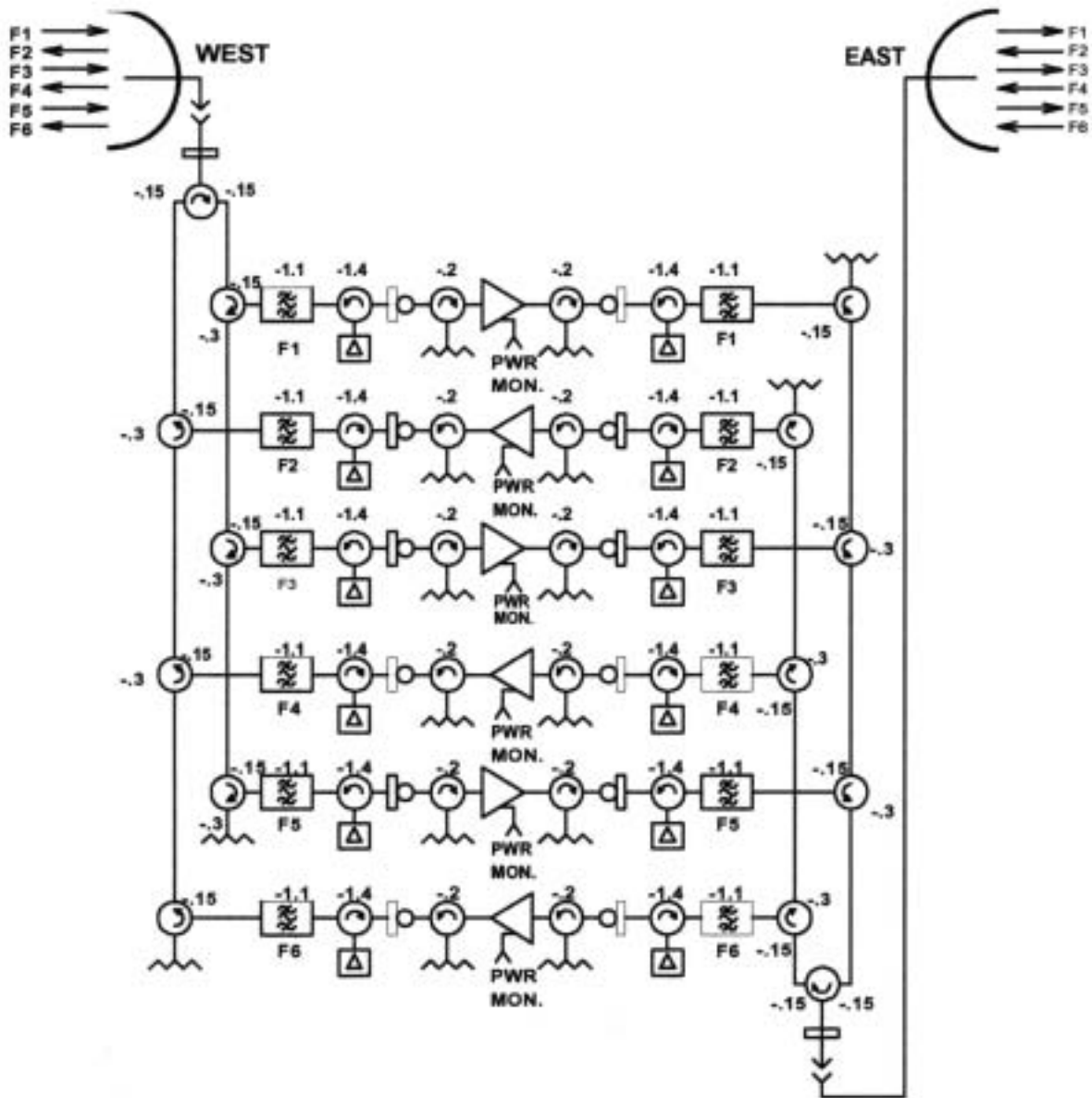


Figure 8. RF-7000E, -15, -35, -55, (2+1, Equalized)

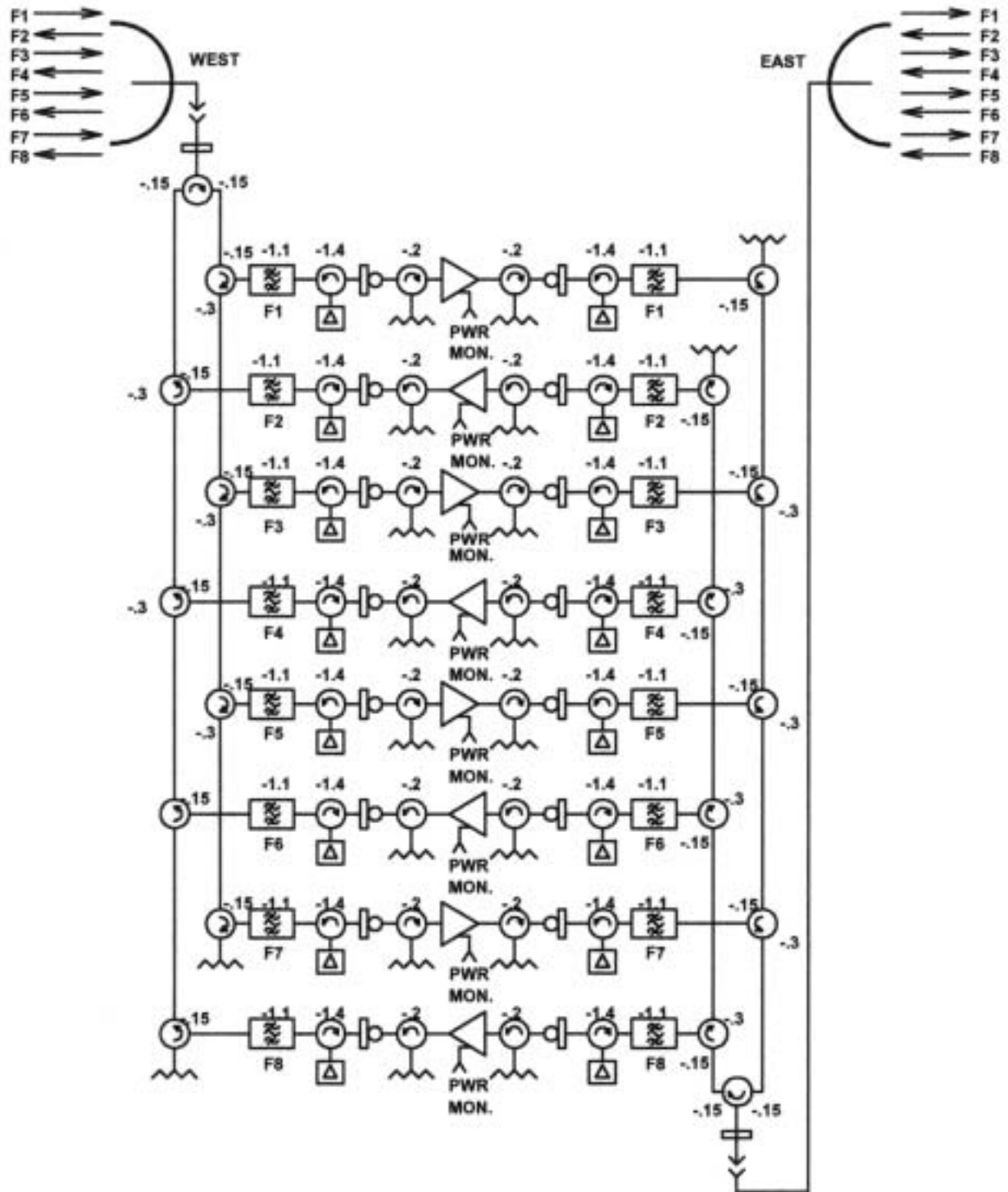


Figure 9. RF-7000E, -16, -36, -56, (3+1, Equalized)

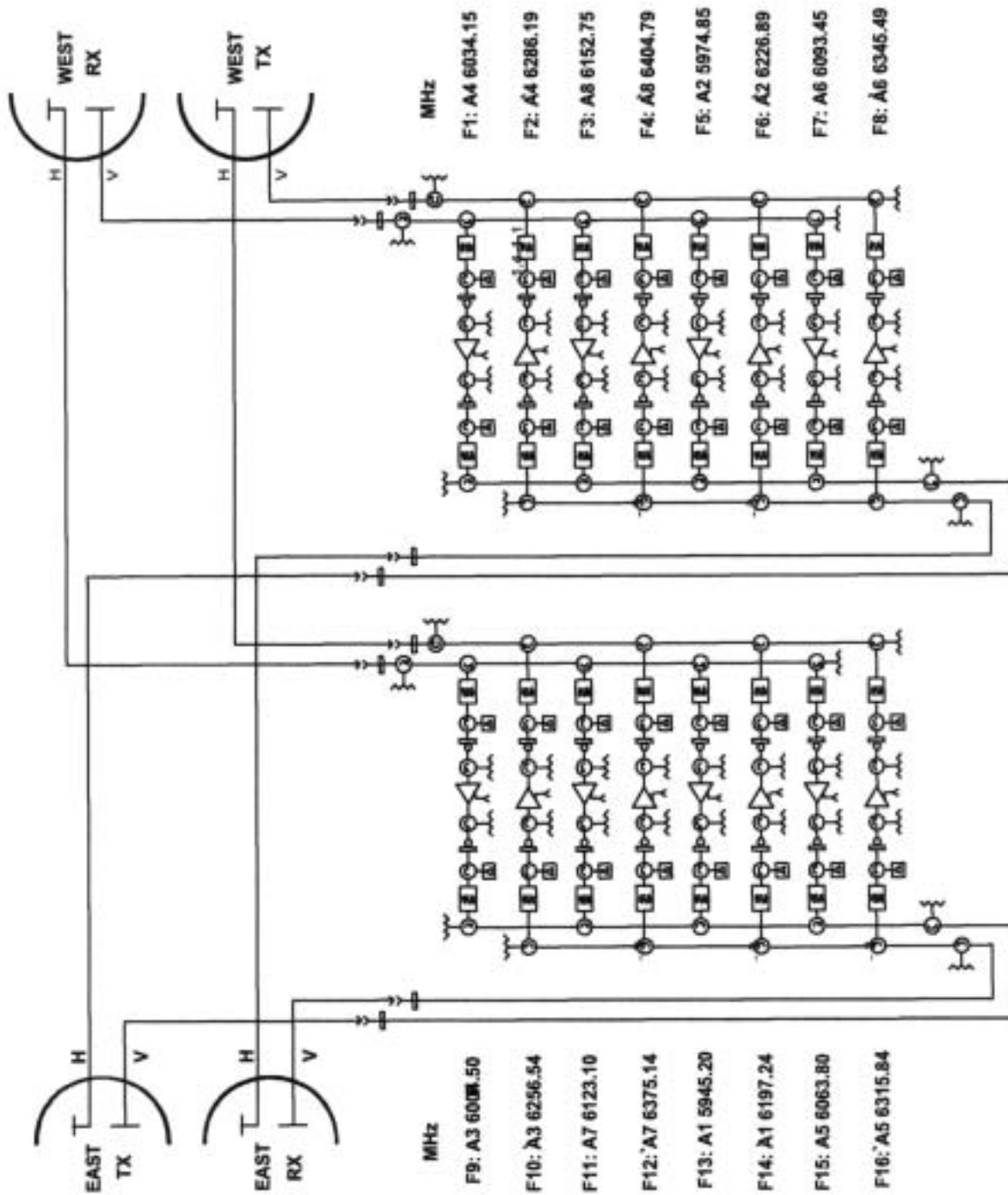
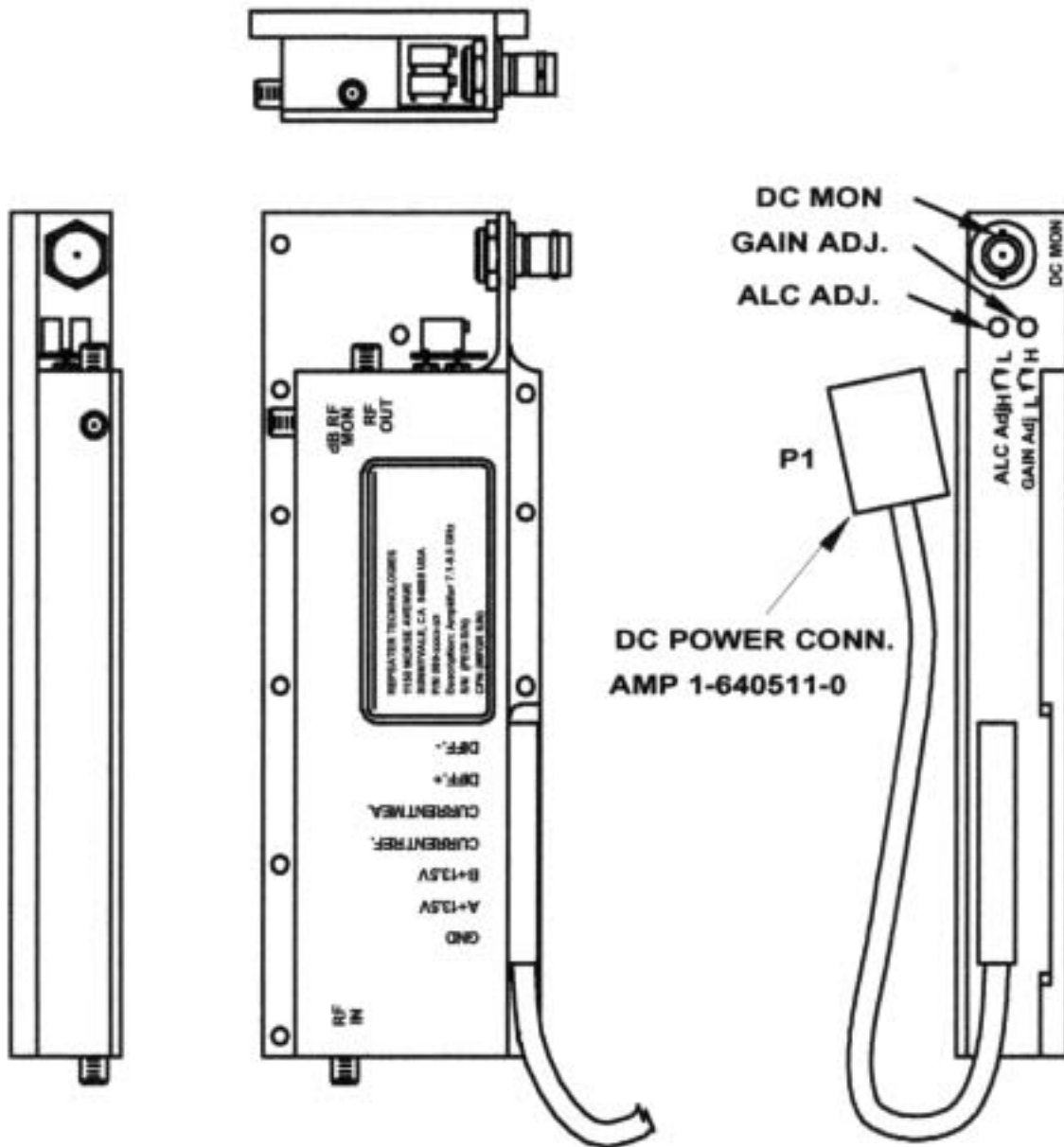


Figure 10. RF-7000E, (7+1, Equalized)



LOW POWER AMP: 090-0168-02

HIGH POWER AMP: 090-0168-04

Figure 11. Amplifier

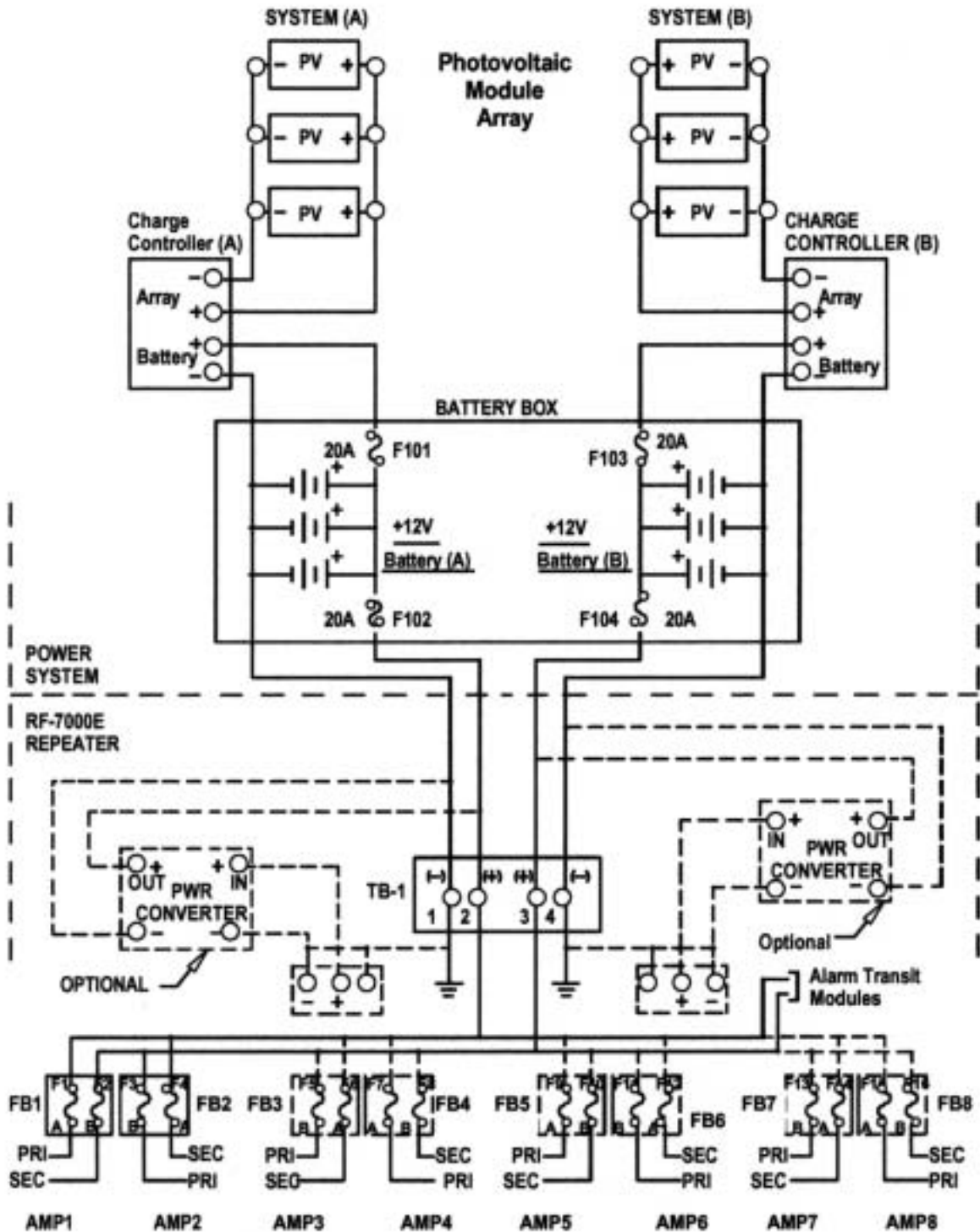


Figure 12. Power Block Diagram

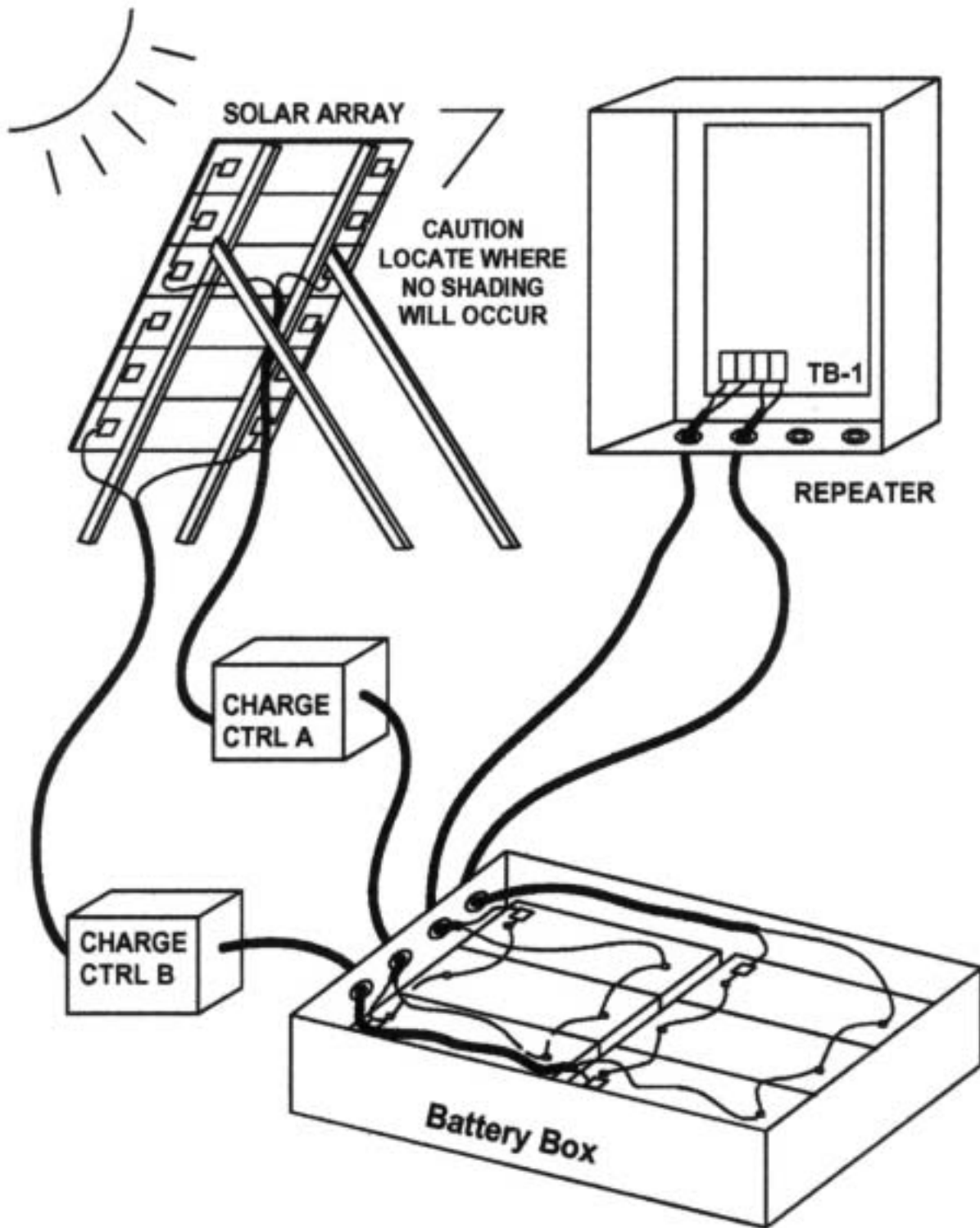


Figure 13. Repeater Power Wiring Pictorial

RF-7000E Repeater

a noninterfering fashion. Alarms are visually displayed on the terminal receiver unit. Alarm contact closure outputs are available for input to standard microwave supervisory systems.

- Conditions that typically are monitored are:

Standard Telemetry:

- A and B Battery Voltage
- Battery Temperature

Standard Trip Points:

- A and B Battery Major Alarm (2)
- East and West RF Output Low (2)
- Amplifier Alarm
- Cabinet Door Open
- Feedline pressure low
- 7 Each User Points, Strappable:
Closed or Open = Alarm

4. ORDERING

• The RF-7000E RF Repeater Assembly is ordered by specifying the system model number RF-7000E, as shown in Table 1. Attenuators are provided by specifying their part numbers. Transmission engineering must be completed before ordering because the necessary attenuator values are determined from the path calculations. Part numbers are listed in Table 3.

- When doing the initial system layout of a radio hop that includes an RF-7000E RF Repeater Assembly, several factors must be considered prior to ordering to ensure correct antenna connections.

- Terminal transmit-Repeater receive frequencies (F1 and F2 or F1, F3 and F2, F4, etc).
- Physical mounting of RF-7000E repeater on tower (or crossarms) in relation to mounting of antennas.

- The RF-7000E repeater can be factory-tuned so that f1 RCV (A, LEFT) associates with the lower of the two frequencies and f2 RCV (B, RIGHT) with the higher, or vice versa. By comparing the factors listed previously, correct antenna/coaxial feeding connections result. The equipment order must specify all frequencies. For example:

f1 RCV = 7136 MHz

f2 RCV = 7324 MHz

- Alarm system is optional. It should be ordered according to Table 5.

- Orders should include a shipping destination and a billing address. Upon receipt of your order, Repeater Technologies returns an acknowledgment with the scheduled shipping date. An equipment list, showing the equipment ordered and shipped, is included with the shipment.

Table 1
RF-7000E RF Repeater Ordering Information 30 MHz

Part Number	Description	Frequencies (MHz)
900-0155-01	Duplex, All Directions Power Level 1, Maximum loading 2400 FDM channels, 2016 PCM channels, or multiple color video channels	F1, F2
900-0155-02	Duplex, Frequency Diversity, All Directions Power Level 1	F1, F2, F3, F4
900-0155-03	One-Way, Power Level 1	F1
900-0155-11	Duplex, Delay Equalized, All Directions Power Level 1	F1, F2

Table 1
RF-7000E RF Repeater Ordering Information 30 MHz

Part Number	Description	Frequencies (MHz)
900-0155-12	Duplex, Frequency Diversity, Delay Equalized, All Directions Power Level 1	F1, F2, F3, F4
900-0155-13	One-Way, Delay Equalized, Power Level 1	F1
900-0155-15	Duplex 2+1, Delay Equalized, All Directions Power Level 1	F1, F2, F3, F4, F5, F6
900-0155-16	Duplex 3+1, Delay Equalized, All Directions Power Level 1	F1, F2, F3, F4, F5, F6, F7, F8
900-0155-21	Duplex, One Direction Power Level 1 One Direction Power Level 2	F1, F2
900-0155-22	Duplex, Frequency Diversity, One Direction Power Level 1, One Direction Power Level 2	F1, F2, F3, F4
900-0155-31	Duplex, Delay Equalized, One Direction Power Level 1, One Direction Power Level 2	F1, F2
900-0155-32	Duplex, Frequency Diversity, Delay Equalized, One Direction Power Level 1, One Direction Power Level 2	F1, F2, F3, F4
900-0155-35	Duplex, 2+1, Delay Equalized, One Direction Power Level 1, One Direction Power Level 2	F1, F2, F3, F4, F5, F6
900-0155-36	Duplex, 3+1, Delay Equalized, One Direction Power Level 1, One Direction Power Level 2	F1, F2, F3, F4, F5, F6, F7, F8
900-0155-41	Duplex, All Directions Power Level 2	F1, F2
900-0155-42	Duplex, Frequency Diversity, All Directions Power Level 2	F1, F2, F3, F4
900-0155-43	One-Way, Power Level 2	F1
900-0155-51	Duplex, Delay Equalized, All Directions Power Level 2	F1, F2

Table 1
RF-8000E RF Repeater Ordering Information 30 MHz

Part Number	Description	Frequencies (MHz)
900-0155-52	Duplex, Frequency Diversity, Delay Equalized, All Directions Power Level 2	F1, F2, F3, F4
900-0155-53	One-Way, Delay Equalized, Power Level 2	F1
900-0155-55	Duplex, 2+1, Delay Equalized, All Directions Power Level 2	F1, F2, F3, F4, F5, F6
900-0155-56	Duplex, 3+1, Delay Equalized, All Directions Power Level 2	F1, F2, F3, F4, F5, F6, F7, F8

Table 3
Coaxial Attenuator

Stock Number	Attenuation	Part Number	Attenuation
149-0128-01	1.0dB	149-0128-11	11.0dB
149-0128-02	2.0dB	149-0128-12	12.0dB
149-0128-03	3.0dB	149-0128-13	13.0dB
149-0128-04	4.0dB	149-0128-14	14.0dB
149-0128-05	5.0dB	149-0128-15	15.0dB
149-0128-06	6.0dB	149-0128-16	16.0dB
149-0128-07	7.0dB	149-0128-17	17.0dB
149-0128-08	8.0dB	149-0128-18	18.0dB
149-0128-09	9.0dB	149-0128-19	19.0dB
149-0128-10	10.0dB	149-0128-20	20.0dB

149-0128-XX Coaxial Attenuator. Equipped with SMA male and female connectors. May be inserted in receive line or transmit line for RF level coordination.

Table 4
Spare/Replacement Amplifier Ordering

Description	Stock Number
Amplifier, Pwr Level Opt. 1	090-0168-02
Amplifier, Pwr Level Opt. 2	090-0168-04
Sparing Kit	091-0005-01

One alarm transmit module can send information to terminals at one or both ends of the Repeater Link. Order receive modules for one or two locations as needed. Frequency diversity or two-channel duplex (1+1) systems require an additional frequency diversity sensor card for the transmit module.

Table 5
Alarms Ordering, RMAS-120-02 Alarm System

Standard Assembly Part Number	Applicable to System
900-0782-01	1+0
900-0782-02	1+1
900-0782-03	1+2
900-0782-04	1+3

5. INSTALLATION

General

- When the RF-7000E equipment is received, inspect it carefully for damage. Report claims for damage directly to the transportation company involved immediately, in accordance with their instructions.
- The RF-7000E assembly can be mounted on crossarms on a wood pole structure, a steel tower, or on a wall. At extremely hot environments, such as desert, shading from direct sunshine may be required.
- The length of all power leads should be limited and the wire size adequate to minimize the voltage drop. The repeater assembly, battery boxes, solar panels, and antennas should all be mounted before any wiring is done. Mounting hole dimensions for the repeater enclosures are shown in Figure 15 and Figure 16.

- Verify which repeater receive frequency associates with each antenna port prior to cutting to length and connecting the waveguide feedlines. The repeater receiving frequencies and transmitting frequencies are marked on the top of the repeater, near waveguide manifolds. Use external pressure windows on repeater entrances if the antenna waveguide is pressurized.

Power Wiring

- Remove fuses from all fuse blocks (FB1, FB2, and so on) on repeater and remove the fuses (F101, F102, F103, and F104) from the holders in the battery boxes if storage batteries are used. The power leads can be brought into the repeater housing through the 1/2-inch (13 mm) non-metallic conduit (NMT) fittings provided. Use paired 10-gauge (2.50 mm) wire from the batteries to the repeater terminal block and from the solar panels to the charge controller terminal block.
- Connect the NEGATIVE leads from negative battery terminals to terminals 1 and 4 of terminal block TB-1 as shown in

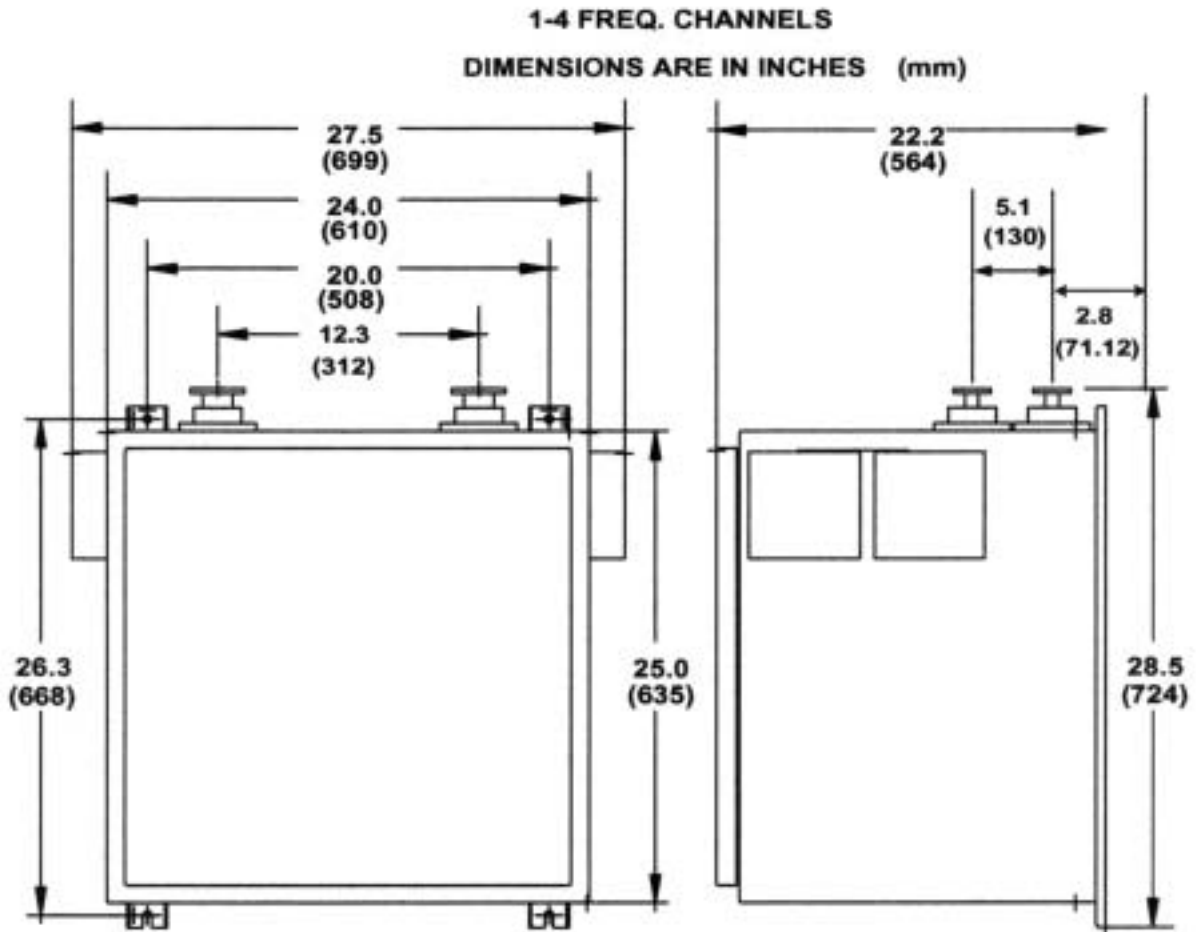


Figure 14. Cabinet Mounting Dimensions, 1-4 Freq. Channels

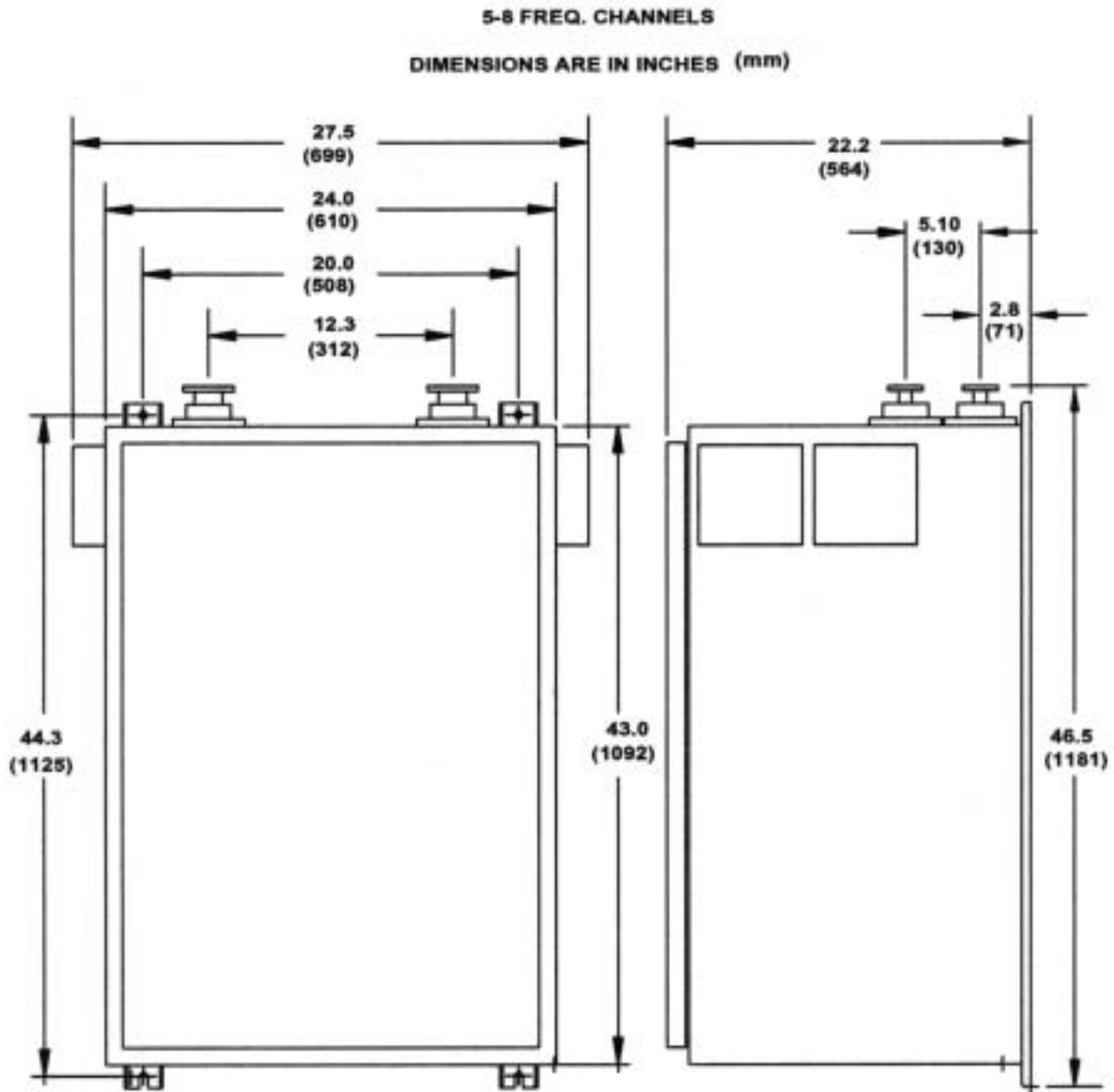


Figure 15. Cabinet Mounting Dimensions, 5-8 Freq. Channels

RF-7000E Repeater

Figure 12. Then connect the POSITIVE leads from positive battery terminals to terminals 2 and 3 of terminal block TB-1. If a single AC supply is used, jumpers must be installed between terminals 2 and 3 on the lower side of the terminal block as shown in Figure 12. Note that the equipment uses a negative ground.

DO NOT REPLACE ANY FUSE AT THIS TIME.

DC Power

- The repeater normally is powered from a dual battery system designated "A" and "B." The "A" battery is wired to power the "A" side of the equipment. Similarly, the "B" battery is wired to power the "B" side of the equipment. Standby power switchover is accomplished within each amplifier. Each amplifier has a primary and secondary battery input. If the primary battery should fail, operation immediately continues on the secondary battery.

- Few adjustments are required on the RF-7000E repeater. After application of power, AGC/ALC adjustment, and proper antenna orientation, the equipment is ready to be placed into service.

- Use of portable or mobile radio to establish a talk path between the RF-7000E repeater site and the terminals aids in completing the tests and in verification of normal (calculated) system operation.

6. TESTS

General

- The description of test equipment in the following table includes the manufacturer's type or model numbers that are available as of the publication date. Because certain models of test equipment can be discontinued or superseded by the manufacturer at any time, Repeater Technologies recommends that a manufacturer's current catalog be used when ordering the equipment. The test equipment manufacturers listed are for reference only and are not intended to show a preference for any one manufacturer. Equivalent test equipment can be used unless otherwise noted. Regardless of the test equipment used, it must be properly maintained, calibrated, and operated according to instructions given by the manufacturer.

Table 6
Recommended Test Equipment

Item	Manufacturer and Type Number	Use	Quantity
DVM	Fluke 75 or equivalent	Measure 12 to 15 Vdc and current from 150mA to 20A	1
RF Power Meter	Hewlett-Packard 435B equipped with 8481A or equivalent	Antenna orientation and output power measurements (-10 to +25 dBm)	1
Spectrum Analyzer	Hewlett-Packard 8563A or equivalent	Antenna orientation	1
Attenuator	Microlab/FXR AJ-500F, 30 dB or equivalent	Antenna orientation and power alarm set (RMAS-100)	1

Application of Power

- a) Remove all fuses from the holders in the battery boxes and fuse blocks on repeater if they are in place.
- b) Measure the voltage across Charge Controller input terminals (+) and (-) if solar panels and storage batteries are used.
- c) Confirm the proper polarity. The voltage reading should be between 12 and 17 Vdc. If the polarity is incorrect or there is no voltage, check and correct the wiring to the solar cell panels.
- d) If the voltage is low, check to be sure the surfaces of the solar panels are not obscured from sunlight.
- e) Replace battery box output fuses F102 and F104.
- f) Measure the voltage across terminals 1(⎓) and 2(+), and across terminals 3(+) and 4(⎓) of repeater terminal block TB-1.
- g) Confirm the proper polarity. The voltage reading should be +12.5 to +13.5 Vdc for storage batteries or +13.0 to +15.0 Vdc for an AC power supply. If the polarity is incorrect or there is no voltage, check and correct the wiring of the batteries or AC power supply.
- h) REMOVE battery box output fuses F102 and F104.
- i) Replace battery box input fuses F101 and F103.
- j) Replace all fuses of fuse blocks (FB1, FB2, and so on) on repeater.
- k) Set the digital voltmeter (dvm) to read in a range of 20A or greater and put its test leads in series between positive lead from battery system A and terminal 2(+) of TB-1 on the repeater (Figure 12). Alternatively, use leads on fuse holders of F102 and F104. After the current stabilized in half a minute, the current should be within the limits as shown in Table 7.

- l) Log all voltage and current readings in Table 9 for reference during routine maintenance or trouble location procedures.

Table 7
Current Requirement
with One Power Supply On

Model	Power
RF-7000E-01, -11	2.3 A Max.
RF-7000E-02, -12	4.6 A Max.
RF-7000E-03, -13	1.15 A Max.
RF-7000E-15	6.9 A Max.
RF-7000E-16	9.2 A Max.
RF-7000E-21, -31	3.1 A Max.
RF-7000E-22, -32	6.2A Max.
RF-7000E-35	9.3 A Max.
RF-7000E-36	12.4 A Max.
RF-7000E-41, -51	3.9 A Max.
RF-7000E-42, -52	7.8 A Max.
RF-7000E-43, -53	1.95 A Max.
RF-7000E-55	11.7 A Max.
RF-7000E-56	15.6 A Max.

- Repeat the above procedure to measure current from battery system B and terminal 3(+) of TB-1 on the repeater. The current should also be within the limits as shown in Table 7. Log them in Table 9. Replace battery system B output fuse (F104).

- Then make current measurement from Battery System A to terminal 2(+) of TB-1 again. The current reading should be within the limits as shown in Table 8. Log in Table 9. Replace battery system A output fuse (F102).

Table 7
Current Requirement
with One Power Supply On

Model	Power
RF-7000E-01, -11	1.15 A Max.
RF-7000E-02, -12	2.3 A Max.
RF-7000E-03, -13	1.15 A Max.
RF-7000E-15	3.45 A Max.
RF-7000E-16	4.6 A Max.
RF-7000E-21, -31	1.15 A Max. Or 1.95 A Max.
RF-7000E-22, -32	2.3 A Max. Or 3.9 A Max.
RF-7000E-35	3.45 A Max. Or 5.85 A Max.
RF-7000E-36	4.6 A Max. Or 7.8 A Max.
RF-7000E-41, -51	1.95 A Max.
RF-7000E-42, -52	3.9 A Max.
RF-7000E-43, -53	1.95 A Max.
RF-7000E-55	5.85 A Max.
RF-7000E-56	7.8 A Max.

Antenna Isolation Measurement

- To prevent oscillation or severe passband distortion, the antenna must have a minimum port-to-port isolation. Refer to Appendix—Antenna System for detailed information.
- Measure the isolation by sending a signal into one of the antenna feeders and measuring the level of that signal at the other antenna feeder. The signal power level difference in dB is the isolation of two antennas. Be aware that the motion of objects near the antenna can change the isolation.
- Make any tests with any expected objects present, if possible, to ensure the isolation does not drop below minimum.
- Repeat the test at several frequencies across the designated bandwidth, making sure the minimum isolation is met at ALL frequencies.
- If isolation is not met, try repositioning the antenna or adding intervening shielding, and then measure again.

Antenna Orientation, AGC/ALC set and Output Measurement

- Before antenna orientation begins, the amplifiers must be

operating in their full gain mode (out of AGC/ALC range). The setting of the AGC/ALC along with a high input level (greater than [desired output power level in dBm-max. linear gain in dB]) may cause the normal action of the AGC/ALC circuit to mask changes in power due to azimuth and elevation sweeping of the antennas.

- The output power of an amplifier increases in level as the input level is increased to the point at which the AGC/ALC has been set (for example, +18 dBm). Further increases in input level are absorbed in the AGC/ALC circuit. Use the amplifier power monitor point as a signal strength indicator.
- The input level can be reduced temporarily by inserting a fixed or variable attenuator pad ahead of the amplifier. The attenuation required ranges from 0 to 20 dB depending upon desired power and input signal level.

- Remove the input semi-rigid coax cable and place the attenuator in series with the coax, or use flexible coax as required for fit.
- Reduce the input level until the output power drops below the desired power level.
- If during antenna orientation the power rises to the desired power level, reduce the input level again and then continue with antenna orientation.

NOTE: For those amplifiers equipped with field-adjustable gain, their maximum gain can be reduced such that the system is out of AGC/ALC for antenna alignment. Be sure to return the potentiometers to their normal positions after antennas are aligned.

- Connect the power meter or spectrum analyzer to the f1 amplifier, A1, RF PWR MON port.
- With a signal transmitted from the A terminal, position Antenna A for a maximum power reading on the meter or analyzer.
- After Antenna A is aligned, remove any temporarily installed input attenuators.
- Reset the power level with the AGC/ALC adjustment if needed. The AGC/ALC adjustment is located near the output end of each amplifier (see Figure 11). Use a screwdriver to adjust the AGC/ALC potentiometer CW to reduce the power setting or CCW to increase the AGC/ALC set point.
- Log the power reading to fulfill FCC requirements.
- Remove the meter from the f1 Amplifier PWR MON to

the f2 Amplifier PWR MON.

- j) With a signal transmitted from the B terminal, position the antenna B for a maximum power reading on the meter or analyzer.
- k) After antenna B is aligned, remove any temporarily installed input attenuators.
- l) Set the power level with the AGC/ALC adjustment if needed.
- m) Log the power reading to fulfill FCC requirements.
- n) Measure and log the power at any additional amplifier directional couplers so equipped (f3, f4, and so on).
- o) Remove the meter. After the antenna orientation has been completed at both terminals and at the repeater, AGC readings should be taken at the end terminals and logged for reference. A maintenance test record is shown in Table 9.

RX/TX Pad Installation

- If required in the field, the RX/TX pads should be installed at the RF input or output of amplifiers.
- To install it:
 1. Turn off the DC power supply first.
 2. Disconnect the input/output semi-rigid cable from the amplifier.
 3. Connect the SMA male end of the pad to the amplifier SMA female input/output.
 4. Then connect input/output cable to the other end of the pad.
 5. Check all coaxial connections for tightness (8 in-lbs).
 6. Set output power level by adjusting AGC/ALC.
- Unless unique conditions require more frequent maintenance, routine maintenance should be performed annually.
- Clean the surfaces of the solar cell panels with isopropyl alcohol or a mild detergent solution. Do not use alcohol compounds containing acetone.
- Check and clean the wiring connections to the solar charge controllers and the battery connectors as necessary.
- Following the procedures in Application of Power, measure the current of the repeater system. The current reading should be within the same limits. Also measure the

power level at PWR MON for each amplifier with a power meter. Log current and power reading in Table 9.

Amplifier Requirements

- The Local Telecommunications Administrations may require measurement of the output power of the repeater at installation or when any changes are made that cause the output power to change. Using the power meter, measure and log the output power in Table 9 as indicated in Application of Power.

Trouble Location

- Soft failure of one amplifier is indicated by a drop of approximately 6 dB in the received signal level at the terminal in the direction of transmission, which is indicated on the AGC meter on the terminal equipment. Amplifier AGC/ALC can correct for this drop. The failure of one amplifier most likely is caused by a failure of DC power to the amplifier. Using the DVM, check for presence of DC voltage at the amplifier power feed through connections.
- Another way to check is to insert DVM probes to pins #1 and #2 (or #3) from the back side of the amplifier wire harness, as shown in Figure 11.
- If the received signal at the terminals is low but does not indicate a complete failure on one amplifier, the most likely cause is low voltage from the batteries.
- Low voltage is an indication of a possible battery failure or a failure of the charging system. In the case of the primary cell batteries, the batteries are probably reaching the limit of their life. Check the batteries and all power lead connections. If solar panels are used, be sure they are not obstructed from sunlight and that the surfaces are clean.
- If an AC power supply is used, low voltage probably is the result of a power failure, the duration of which exceeded the reserve power limits of the standby battery. Check the standby battery in accordance with the instructions given by the manufacturer of the power supply.

Amplifier Replacement, Out of Service

- When an amplifier must be replaced in an Out of Service

condition, do the following:

- a) Unplug amplifier's power connector.
- b) Disconnect input and output SMA cables.
- c) Disconnect BNC cable from DC monitor point.
- d) Remove mounting hardware (6 screws).
- e) Remove amplifier.

• To install the replacement amplifier:

- a) Mount the amplifier on the panel securing with mounting hardware.
- b) Connect the BNC cable to DC monitor point.
- c) Connect input and output SMA cables.
- d) Check all coax connections for tightness (8in/lbs)
- e) Plug-in the amplifier's power connector.
- f) Verify operation by measuring power at SMA power monitor.
- g) Set output power by adjusting AGC/ALC.

Amplifier Replacement, In Service

(For Duplex and One-Way Options Only)

• When an amplifier must be replaced while the repeater is in service (for example, soft failure), do the following:

- a) Mount a temporary spare amplifier and orient in the same input/output direction as the amplifier to be replaced.
- b) Remove the SMA terminations from the coaxial circulators in series, identified by F1 or F2, with the amplifier to be replaced (shown in Figure 1 and Figure 2).
- c) Connect the flexible coaxial cables or semi-rigid coaxial cables (part of the sparing kit) from the input (RX) coax circulator open port to the temporary spare amplifier's input SMA. Likewise, connect the output (TX) coax circulator open port to the temporary spare amplifier's output SMA connector.
- d) Connect the DC leads from the temporary spare amplifier using the power adapter in the sparing kit to the "A" battery if replacing amplifier A1, or "B" if replacing amplifier A2.
- e) Disconnect the input coaxial cable from the amplifier to be replaced. The signal is now carried in the temporary spare amplifier, but may be 20 dB down.
- f) Unplug the power connector of the amplifier to be replaced.
- g) Disconnect the output coaxial cable from the amplifier to be replaced.

- h) Reset the output power of the temporary spare amplifier by adjusting its AGC/ALC.
- i) Remove the BNC cable from the DC monitor point of the replaced amplifier to the temporary spare amplifier.
- j) Unscrew mounting hardware (6 each) and remove the defective amplifier.

• To install a replacement amplifier in service:

- a) Mount the amplifier on the panel, securing with mounting screws.
- b) Connect the BNC cable to the DC monitor point.
- c) Connect the output coaxial cable to the replacement amplifier's output. Signal level will drop 20 dB.
- d) Plug in the amplifier's power connector.
- e) Connect the input coaxial cable to the replacement amplifier's input. Signal level should be close to normal. Set the power by adjusting AGC/ALC.
- f) Remove the power connections from the temporary spare amplifier.
- g) Disconnect the flexible or semi-rigid coax cables from the coax circulators and from the temporary spare amplifier.
- h) Replace the SMA terminations on the coax circulators. Check the output power of the amplifier. Reset its power by adjusting AGC/ALC if needed.
- i) Remove the temporary spare amplifier.

CAUTION

Due to unpredictable reflections with the RF-7000E operation with a temporary spare amplifier, it may be degraded somewhat from normal, particularly in high capacity digital and analog systems. Be sure the AGC/ALC is set for the correct power level in your system.

Return Procedure

- Once it is determined that a unit is faulty, contact the Peninsula Engineering Repair Department at: 1-925-901-0103. A representative will issue a Return Authorization Number (RMA) and shipping instructions.
- Reship the units in containers similar to those (if not the same) in which the units were originally delivered in order to minimize the potential for shipping damage. Insure that the packing material adequately isolates the units from undue contact with the shipping container.

**TABLE 9
PENINSULA ENGINEERING
RF-7000E MAINTENANCE RECORD**

Date				
Solar Panel, System A Voltage :				
Solar Panel, System B Voltage :				
Battery, System A Voltage : Temperature :				
Battery, System B Voltage : Temperature :				
Current Drawn From Battery A Only				
Current Drawn From Battery B Only				
Current Drawn From Battery A While Battery B is Connected				
Amplifier, A1 F1 Power Monitor :				
Amplifier, A2 F2 Power Monitor :				
Amplifier, A3 F3 Power Monitor :				
Amplifier, A4 F4 Power Monitor :				
Amplifier, A5 F5 Power Monitor :				
Amplifier, A6 F6 Power Monitor :				
Amplifier, A7 F7 Power Monitor :				
Amplifier, A8 F8 Power Monitor :				

APPENDIX A

Antenna System

The antenna system is vital to the success of any RF repeater. It was only when high performance microwave antennas became available that high capacity RF repeaters became practical. The antennas must have high gain (25-50 dB), clean pattern, low sidelobes, and good Front-to-Back ratio. It is the sidelobes and Front-to-Back ratio that control much of the echo that results from antenna-to-antenna coupling. Foreground obstructions also produce an echo component that is site-specific.

The objective for permissible echo varies with the type of transmission and its bandwidth. High capacity analog radios require 50-55 dB C/I while low capacity analog and digital radios require 24-30 dB C/I. The actual amount of echo permitted must be calculated based on the radio manufacturer's specifications and end system design requirements.

For example, a 16 QAM digital system requires 33 dB C/I at the repeater. The 6 GHz RF repeater gain is 50 dB. Antenna-to-antenna decoupling required is $33 + 50 = 83$ dB. This can be obtained from two 41 dB gain standard antennas

with 48 dB Front-to-Back ratio (F/B). Cross polarization of the antenna is recommended.

An antenna Cross Polarization (XPD) of 20 dB is easily obtained. Antenna separation loss of 498 dB is assumed by taking 75% of free space loss between the feeds of the two antennas. The decoupling is now:

+48	dB	F/B of Antenna #1 (standard)
-41	dB	Gain of Antenna #1 (8 foot)
+48	dB	F/B of Antenna #2 (standard)
-41	dB	Gain of Antenna #2 (8 foot)
+20	dB	Antenna XPD
+49	dB	Antenna separation loss (25 feet)

+83	dB	Total decoupling loss
-50	dB	Repeater Gain

33 dB C/I

In this situation, two standard antennas are adequate. If the repeater antennas could not be cross-polarized, one or even two of the high performance antennas should be used.

The following tables show the required RFD repeater C/I with different types of radios.

Table 10
C/I Requirements For Digital Radios

MODULATION TYPE	MINIMUM C/I
4 PSK	24
8 PSK	28
16 QAM	33
64 QAM	40
MSK/FSK	30
9 QPRS/QPR 3	31
25 QPRS/QPR 5	32
49 QPRS/QPR 7	33
81 QPRS/QPR 9	35

Table 11
C/I REQUIREMENTS FOR ANALOG RADIOS

The following table assumes full power available, with emphasis, 175 nsec of delay:

CAPACITY (CHAN)	DEVIATION	C/I for 10 dBmco IM	C/I fo 20 dBmco IM	C/I for 30 dBmco IM
300	200	45	35	25
420/480	200	53	43	33
600	200/141	54	44	34
960	200	55	45	35
1200	141	55	45	35
1800	141	55	45	35

NOTE*: Operation with C/I less than these required values can cause other problems such as increasing the potential for oscillation and is therefore not recommended.