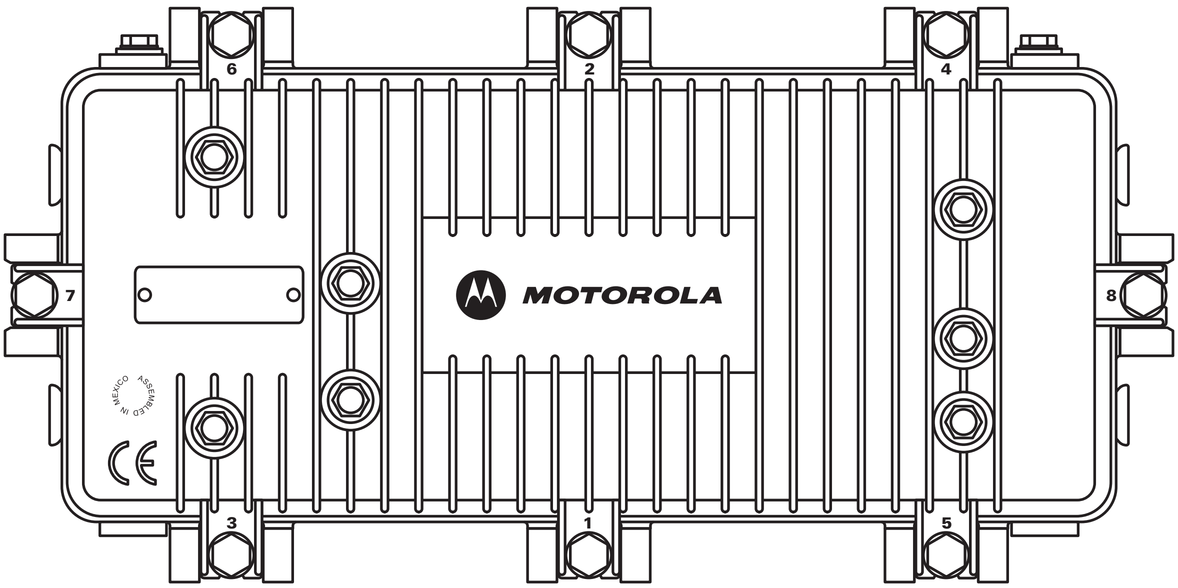
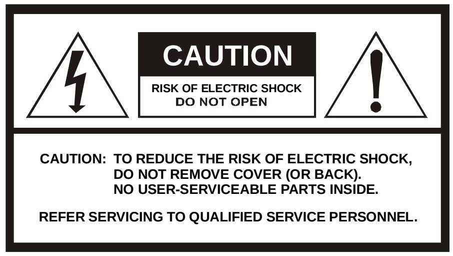
Installation and Operation Manual

BT100 1 GHz Broadband Telecommunications Amplifier

MOTOROLA

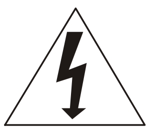




Caution

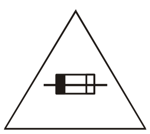
These servicing instructions are for use by qualified personnel only. To reduce the risk of electrical shock, do not perform any servicing other than that contained in the Installation and Troubleshooting Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Special Symbols That Might Appear on the Equipment

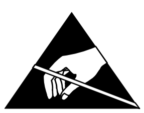


This symbol indicates that dangerous voltage levels are present within the equipment. These voltages are not insulated and may be of sufficient strength to cause serious bodily injury when touched. The symbol may also appear on schematics.

The exclamation point, within an equilateral triangle, is intended to alert the user to the presence of important installation, servicing, and operating instructions in the documents accompanying the equipment.



For continued protection against fire, replace all fuses only with fuses having the same electrical ratings marked at the location of the fuse.

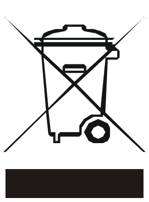


Electrostatic discharge (ESD) can damage the BT100 unit and circuit card assemblies. Wear an antistatic wrist strap attached to a chassis ground to prevent ESD damage.

This equipment operates over the marked Voltage and Frequency range without requiring manual setting of any selector switches. Different types of line cord sets may be used for connections to the mains supply circuit and should comply with the electrical code requirements of the country of use.

It is recommended that the customer install an AC surge arrestor in the AC outlet to which this device is connected. This is to avoid damaging the equipment by local lightning strikes and other electrical surges.

Caring for the Environment by Recycling



When you see this symbol on a Motorola product, do not dispose of the product with residential or commercial waste.

Recycling your Motorola Equipment

Please do not dispose of this product with your residential or commercial waste. Some countries or regions, such as the European Union, have set up systems to collect and recycle electrical and electronic waste items. Contact your local authorities for information about practices established for your region. If collection systems are not available, call Motorola Customer Service for assistance.

FCC Compliance

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 Installation 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. Any changes or modifications not expressly approved by Motorola could void the user's authority to operate this equipment under the rules and regulations of the FCC.

You may find the following booklet, prepared by the Federal Communication Commission, helpful: *How to Identify and Resolve Radio-TV Interference Problems*, Stock No. 004-000-0342-4, U.S. Government Printing Office, Washington, DC 20402.

Changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Canadian Compliance

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
Cet appareil numérique de la classe A respects toutes les exigences du Règlement sur le matériel brouilleur du Canada.

International Declaration of Conformity

We — Motorola, Inc.
101 Tournament Drive
Horsham, PA 19044, U.S.A.

declare under our sole responsibility that the

STARLINE — Model BT100

to which this declaration relates is in conformity with one or more of the following standards:

EMC Standards

EN55022 EN55024 EN55013 EN50083-2 CISPR-22 CISPR-24 CISPR-13

Safety Standards

EN60065 EN60825 EN50083-1 EN60950 IEC 60950 + A1: 1992 + A2: 1993 + A3: 1995 + A4: 1996

IEC60065

following the provisions of the Directive(s) of the Council of the European Union:

EMC Directive 89/336/EEC Low Voltage Directive 73/23/EEC WEEE Directive 2002/96/EC

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Section 1

Introduction

The Motorola 1GHz STARLINE® series of Broadband Telecommunications Amplifiers, model BT100, accept a single input and provide high operational gain to three or four power-doubled bridger outputs in a three-stage hybrid design. The BT100 amplifier series meets Telcordia GR-1098-core voltage surge requirements using surge waveforms as described in IEEE C62.41. The BT100 is also FCC, CE and CCC approved.

BT100 features include:

- 1003 MHz power doubling technology in enhanced gallium arsenide (E-GaAs)
- Ergonomics
- Multiple modular diplex filter (frequency-split) options
- 16 dB return loss (forward path)
- 60/90 VAC line power option
- Power-factor-corrected power supply
- Auto-controlled Bode equalization
- -20 dB directional coupler test points
- Optional return path ingress control accessories
- Two-way operation capability
- 15 A AC bypass capability
- Externally accessible test points
- Drop-in capability of new electronics chassis to older BT housings

Figure 1-1 illustrates a closed BT100.

Figure 1-1
BT100 - closed

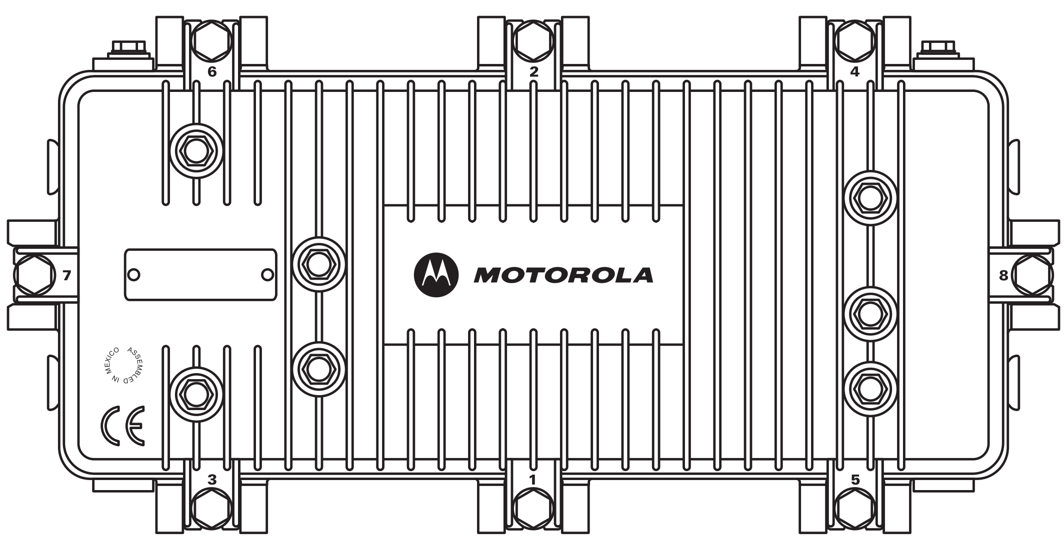
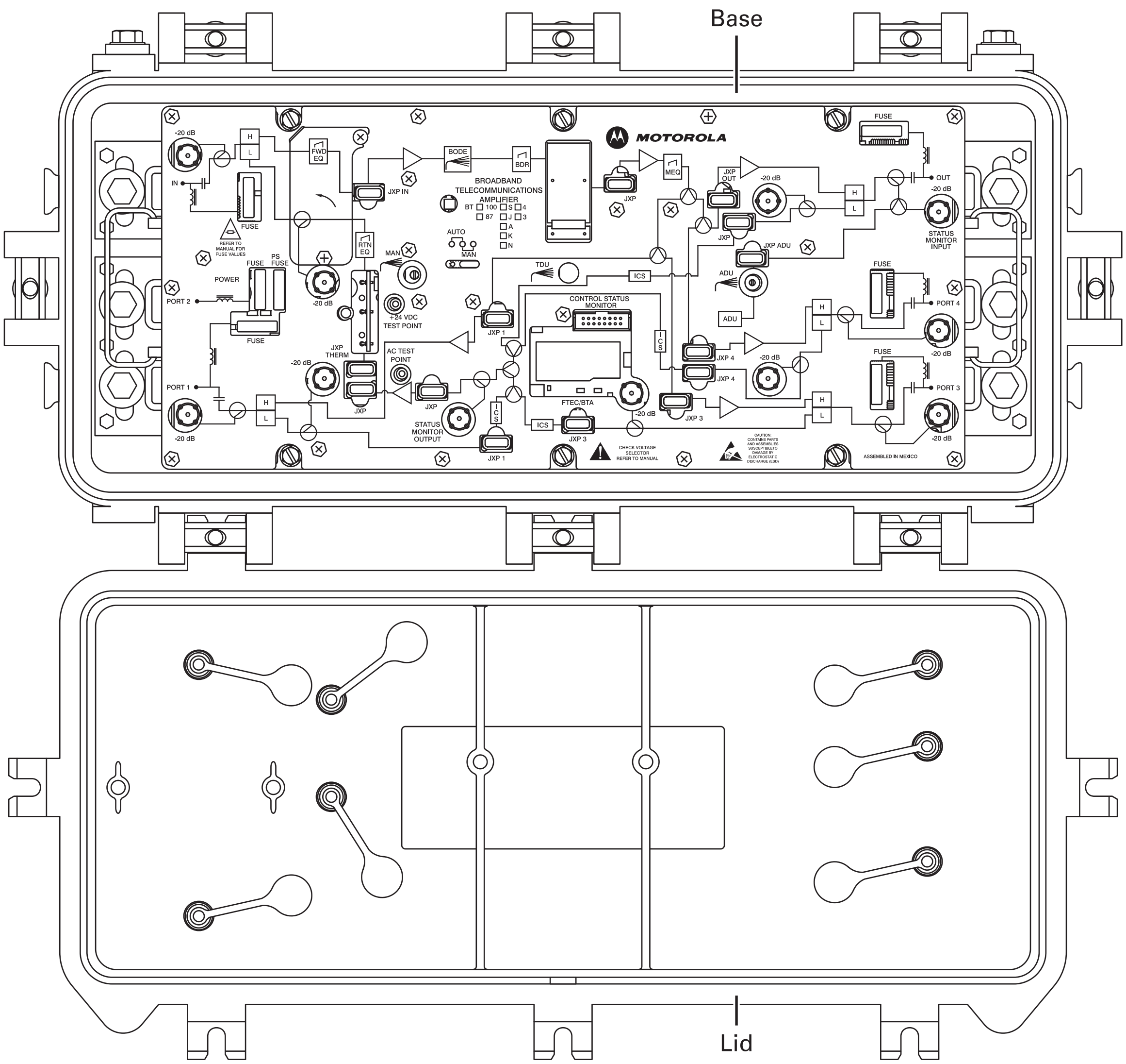


Figure 1-2 illustrates an open BT100.

Figure 1-2
BT100 – open



Using This Manual

The following sections provide information and instructions to bench test, install, and operate the BT100.

Section 1	**Introduction** provides a brief description of the product, identifies the information contained in this manual, and gives the help line telephone number and repair return information.
Section 2	**Overview** describes the BT100 and includes details on the various options and their functions.
Section 3	**Amplifier Setup** provides instructions for full configuration and forward- and return-path alignment.
Section 4	**Bench Testing** describes the bench test procedures that are recommended before you install the BT100.
Section 5	**Installation** provides instructions for installing the BT100 and performing field alignment.
Section 6	**Operating Tips** provides suggestions for handling field-encountered variables and addressing maintenance tasks.
Appendix A	**Specifications** lists the applicable technical specifications for the BT100 and options.
Appendix B	**Torque Specifications** provides the appropriate torque specifications for the screws, clamps, connectors, and bolts used in the BT100.
Abbreviations and Acronyms	The **Abbreviations and Acronyms** list contains the full spelling of the short forms used in this manual.

This Installation and Operation Manual assumes that all channels are standard National Television Standards Committee (NTSC) analog channels. Refer to catalog specifications for further details pertaining to signal levels of digital channels above 550 MHz.

This Installation and Operation Manual also uses 1003 MHz as the reference frequency unless another frequency is given. For example, quoted cable loss is understood to be at 1003 MHz.

Related Documentation

This Installation and Operation Manual is complete and you should not require any additional documents to install, test, or operate the BT100 amplifier.

Document Conventions

Before you begin using the BT100, familiarize yourself with the stylistic conventions used in this manual:

Bold type	Indicates text that you must type exactly as it appears or indicates a default value.
SMALL CAPS	Denotes silk screening on the equipment, typically representing front- and rear-panel controls, input/output (I/O) connections, and LEDs
*** (asterisk)**	Indicates that several versions of the same model number exist and the information applies to all models; when the information applies to a specific model, the complete model number is given
Italic type	Denotes a displayed variable, or is used for emphasis

If You Need Help

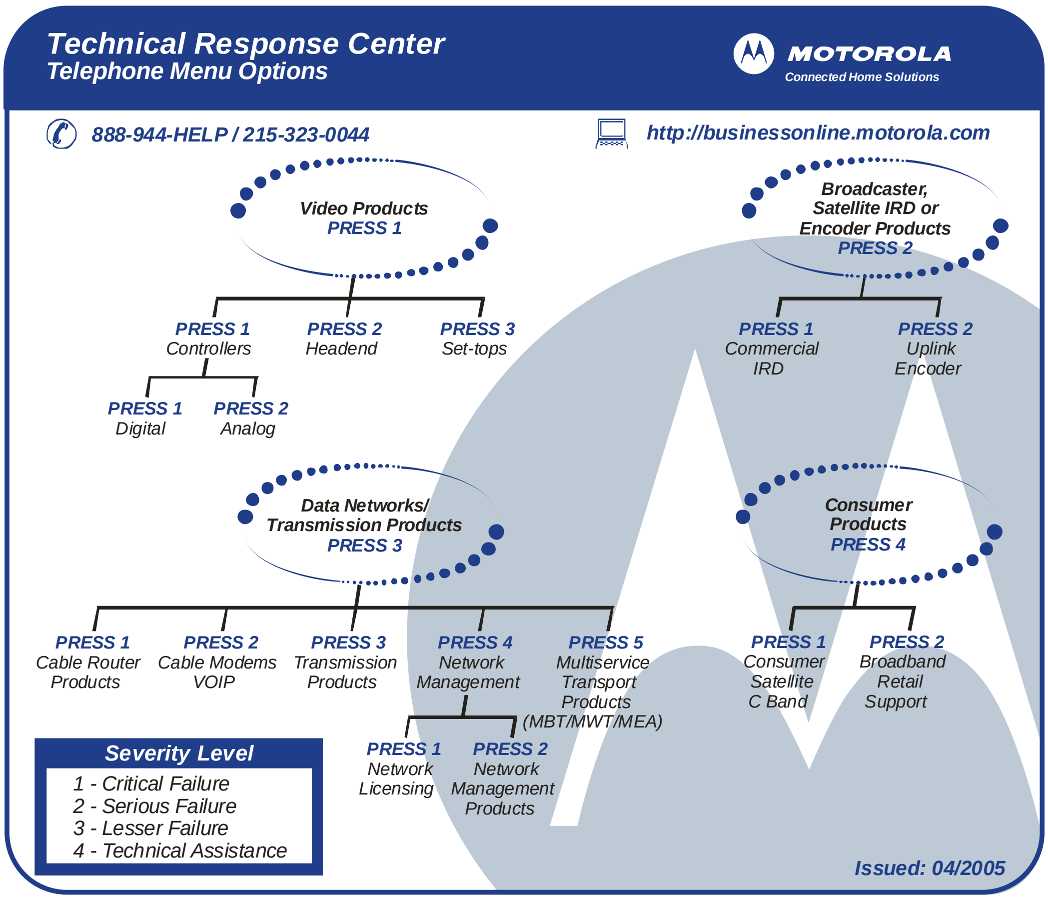
If you need assistance while working with the BT100, contact the Motorola Technical Response Center (TRC):

Inside the U.S.: **888-944-HELP** (1-888-944-4357)

Outside the U.S.: **215-323-0044**

Motorola Online: http://businessonline.motorola.com

The TRC is on call 24 hours a day, 7 days a week. In addition, Motorola Online offers a searchable solutions database, technical documentation, and low-priority issue creation and tracking.



Calling for Repairs

If repair is necessary, call the Motorola Repair Facility at **1-800-227-0450** for a Return for Service Authorization (RSA) number before sending the unit. The RSA number must be prominently displayed on all equipment cartons. The Repair Facility is open from 8:00 AM to 5:00 PM Central Time, Monday through Friday.

When calling from outside the United States, use the appropriate international access code and then call **956-541-0600** to contact the Repair Facility.

When shipping equipment for repair, follow these steps:

1. Pack the unit securely.
2. Enclose a note describing the exact problem.
3. Enclose a copy of the invoice that verifies the warranty status.
4. Ship the unit **PREPAID** to the following address:

   BCS Nogales Repair Center
   Attn: RSA #_________
   6908 East Century Park Drive
   Tucson, AZ 85706
   US

Section 2

Overview

The BT100 is a three or four output, two-way capable amplifier used in Cable Access Television (CATV) distribution systems. All models are high gain, three-stage hybrid amplifiers designed to drive both a cascade and a local distribution system. The BT100 is powered by the 60/90 VAC cable supply and can be configured to pass this power to additional amplifiers and line extenders. Installation of the return path enables two-way signal flow.

The standard model BT100 includes an amplifier electronics module with an integrated power supply, which is furnished complete in the model BT*-100*/15 housing, as shown in Figure 2-1. You may also purchase the electronics module only with no housing.

Figure 2-1
BT100 - open

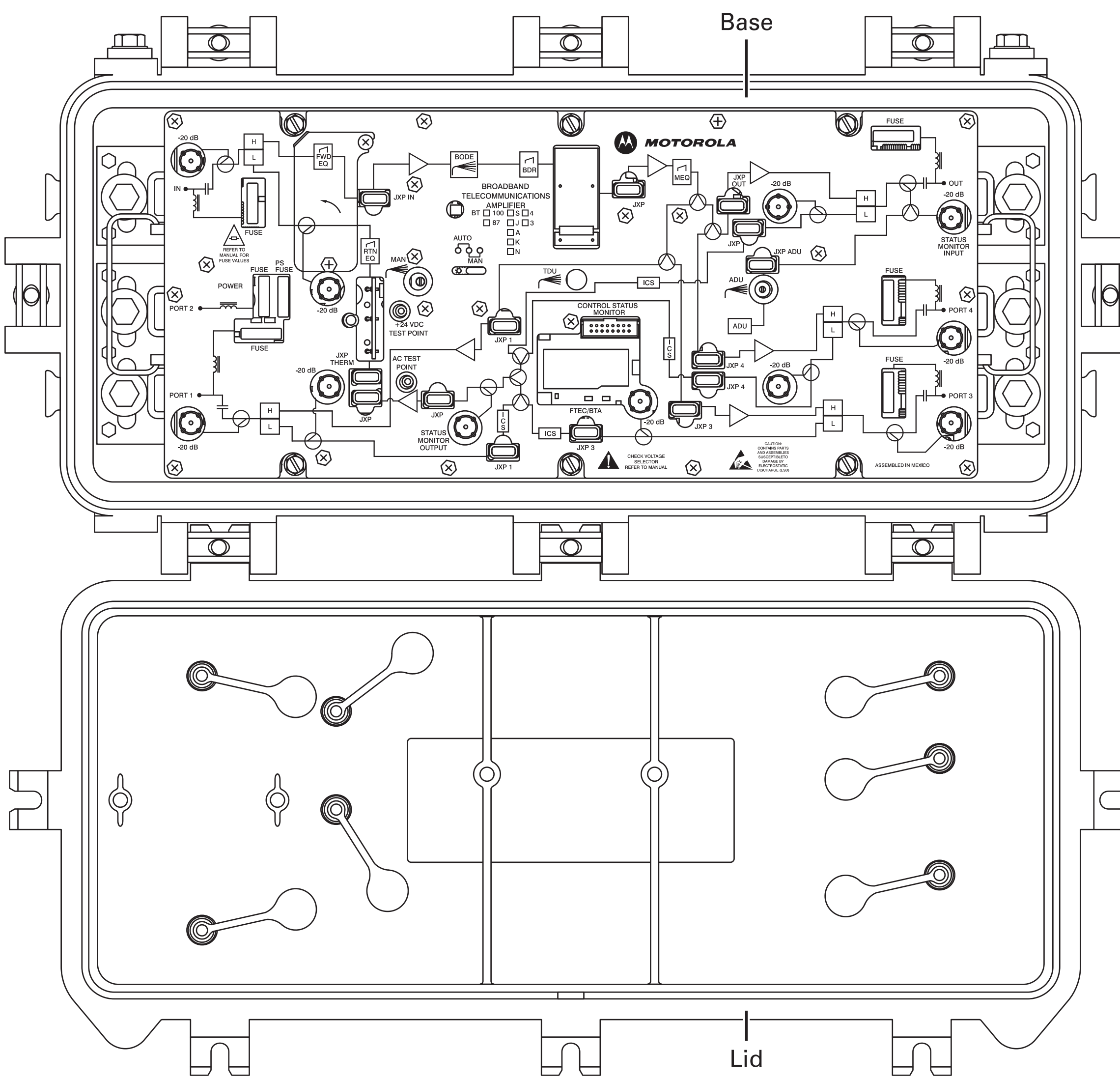
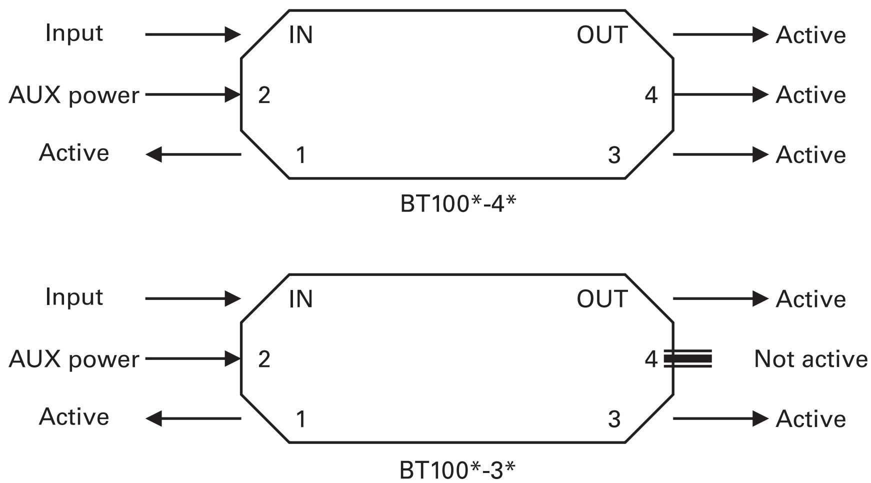


Figure 2-2 illustrates the various output-port configurations:

Figure 2-2
BT100 output-port configurations

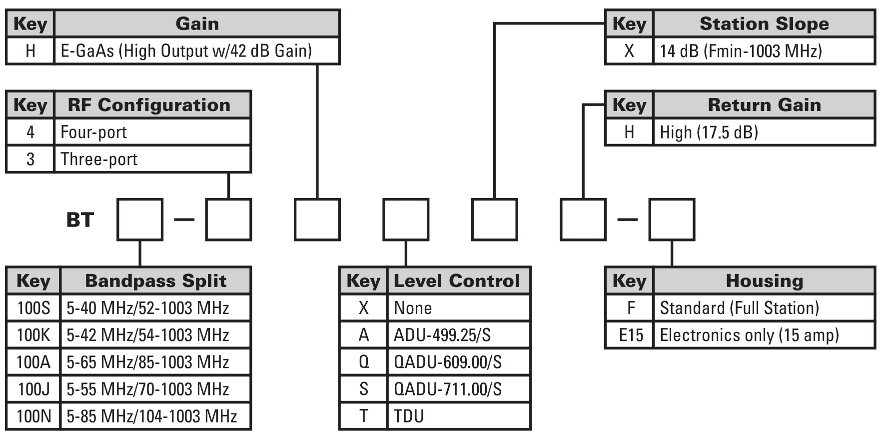


Ordering Guide

Several models of the BT100 are available. The BT100 is fully configured in the factory per model requested. You can find the model name on labels on the outside of the shipping carton, the side of the BT100 housing, and the side of the electronics module.

Figure 2-3 identifies and describes the model strings.

Figure 2-3
BT100 ordering guide



Notes:
1. Not all combinations in the ordering guide are available. This is a guide only. Please see list of available models in the data sheet located online.
2. FTECs are included in all models as standard, except for the basic models, BT*-100*H, which contain the standard gas tube surge arrestor.
3. 20A fuses are included in all amplifiers as standard.
4. ICS and status monitor transponders will continue to be customer configurable options.
5. For RoHS models, add "-R" to the end of the configuration string.

Housing

The BT100 RF amplifier and DC power-supply circuitry are integrated into a single electronics chassis that is furnished in the BT*-100*/15 housing. The housing protects the electronics from weather and dissipates internally generated heat.

Figure 2-4 illustrates the top view of the BT*-100*/15 housing and provides its dimensions.

Figure 2-4
BT*-100*/15 dimensions – top view

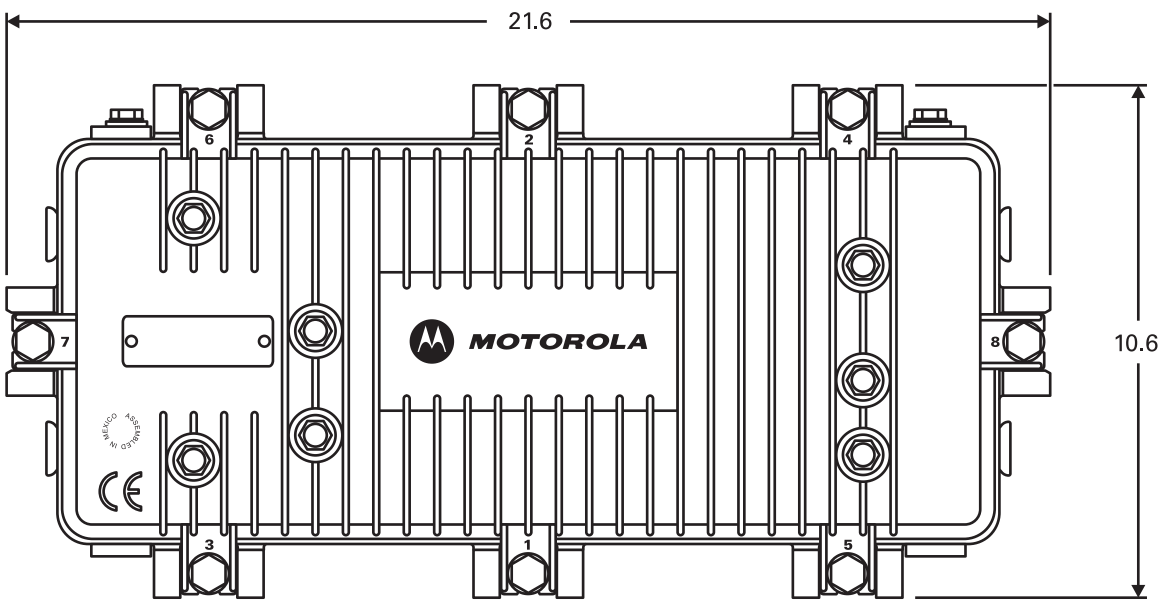
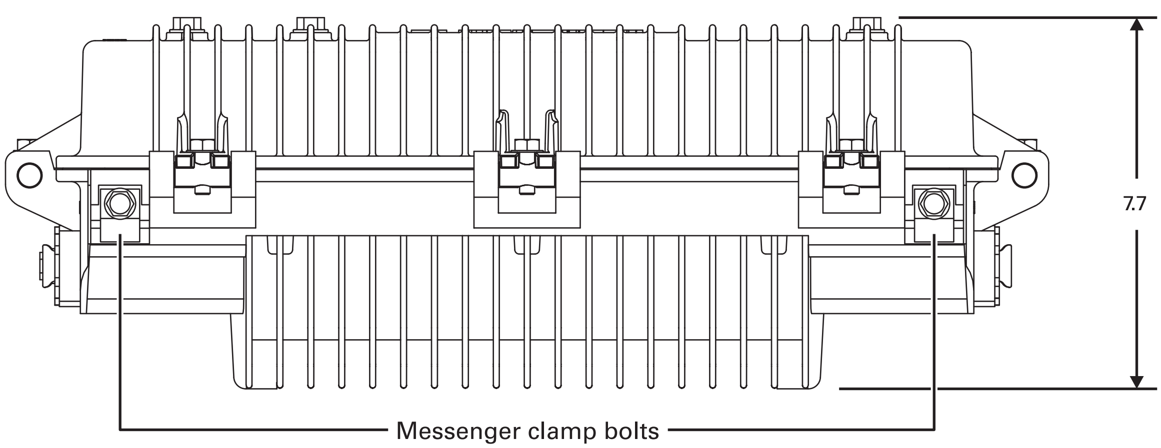


Figure 2-5 illustrates a side view of the BT*-100*/15 housing and provides its dimensions.

Figure 2-5
BT*-100*/15 dimensions – side view



Coaxial cable connections to the housing are made using conventional 5/8 inch x 24 threads per-inch stinger-type connectors. Seven port plugs in the cover enable access to internal test points without opening the housing.

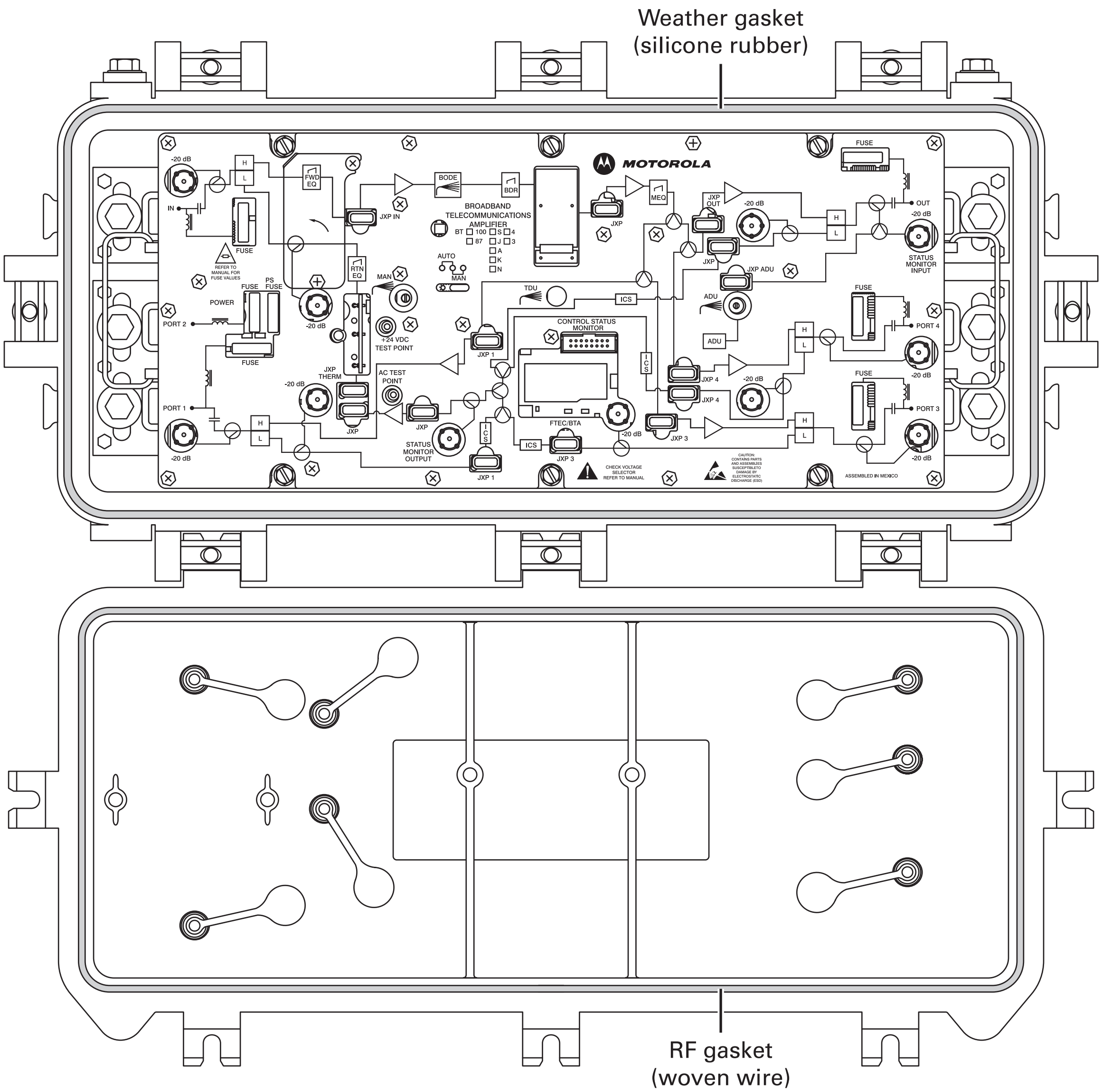
Two messenger clamps are attached to the side of the housing (Figures 2-5, 2-7) and are secured with 5/16 inch x 24 threads-per-inch stainless-steel bolts for strand (aerial) mounting. The bottom of the housing also contains two 5/16 inch x 24 threaded holes located on the horizontal center-line separated by eleven inches center-to-center (Figure 2-7). Use these holes and the bolts from the messenger clamps for pedestal and surface-mounting installations.

Housing Gaskets

Each housing is equipped with a recessed woven-wire RF gasket and a silicone-rubber weather gasket to provide a seal between the housing base and lid (Figure 2-6). These gaskets provide efficient ground continuity, RF shielding, and weather protection. Both gaskets must be in place and in good condition to ensure proper operation and protection of the station. The weather gasket should be lightly coated with silicone grease each time the amplifier is opened. Replace this gasket if it becomes damaged or deformed.

Figure 2-6 illustrates the housing gaskets:

Figure 2-6
Housing Gaskets

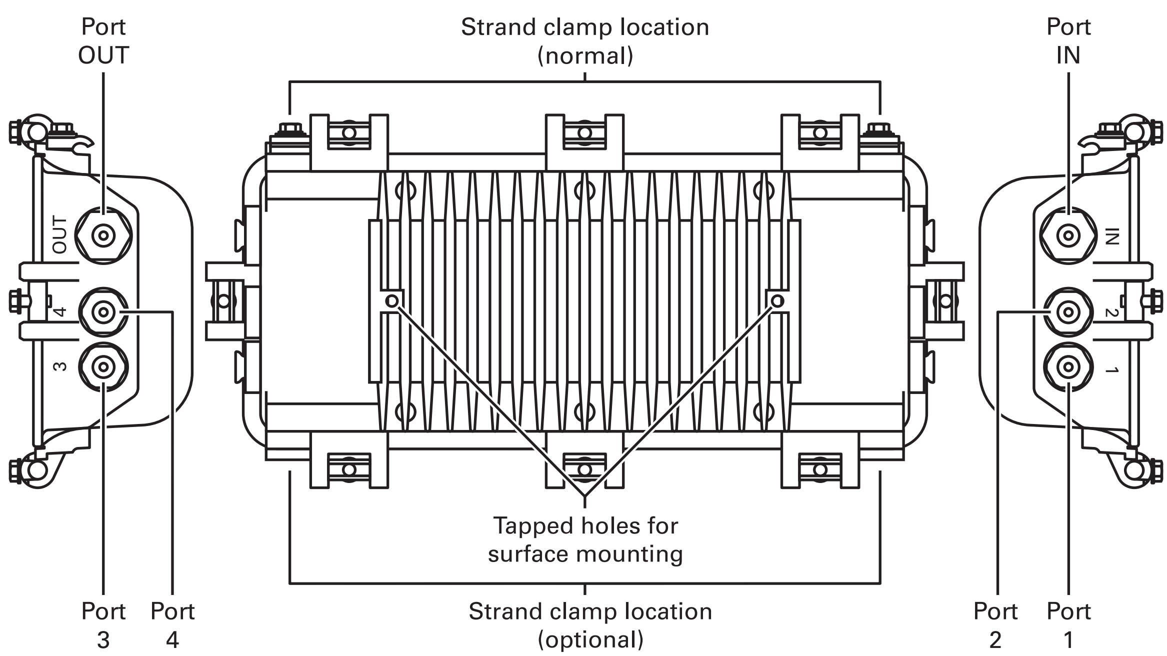


Port Locations

Seven port plugs in the cover enable access to internal test points. The input and four output ports provide connection for coaxial cables and are protected by factory-inserted threaded plugs or plastic cap plugs. Discard the plastic cap plugs when you install the cable connectors. Port 2 is used only for connection to an external 60 VAC or 90 VAC power supply. Side-by-side connector fittings are limited to 0.750 inches at ports 1, 2, 3, and 4.

Figure 2-7 illustrates the port locations and the rear view of the housing.

Figure 2-7
Housing port locations and rear view of housing



Power Supply

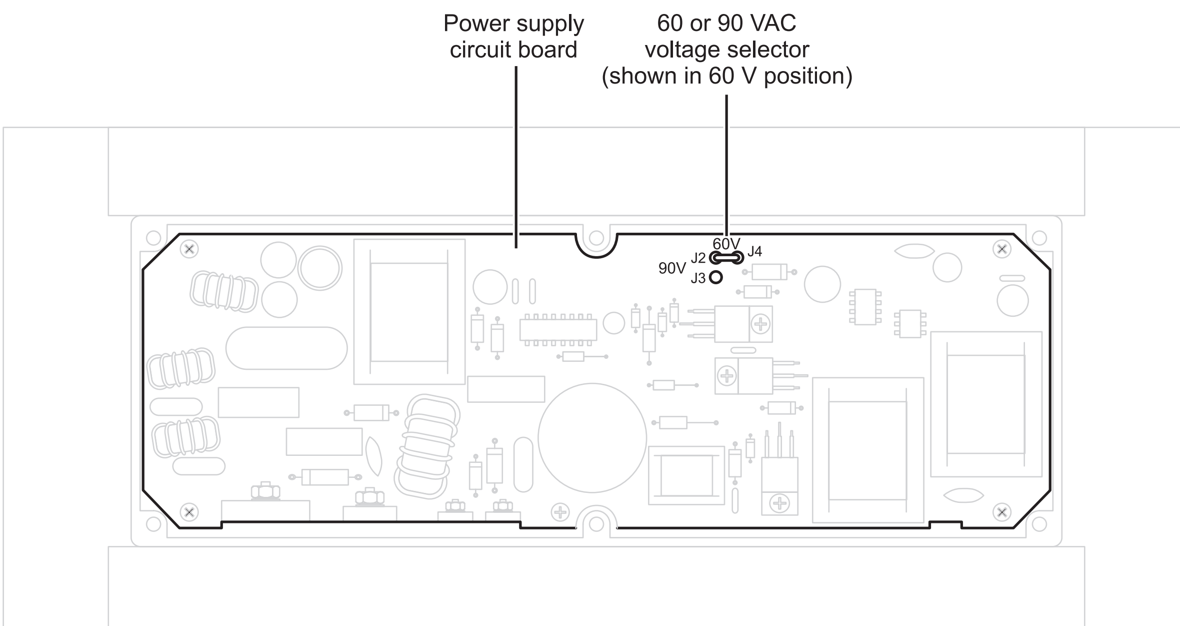
The integrated DC power supply of the BT100 is a separate circuit board mounted to the underside of the electronics chassis and is capable of 60 VAC or 90 VAC powering. The waveshape of the input voltage can be either squarewave or sinewave. The power supply incorporates power-factor correction that presents a near perfect power factor to the input line. This reduces the AC current and improves the efficiency of the DC supply system that delivers 2.5 A at 24 VDC. The AC input to the power supply is between 38 VAC and 90VACrms, in two ranges, with a line frequency from 50 Hz through 60 Hz. A precision output regulator protects against overcurrent and short circuits. If a short circuit is detected, the power supply shuts down and the regulator initiates a sequence of line test pulses at approximately one-half second intervals. The regulator continues these pulses for the duration of the short circuit but returns to normal operation when the fault is cleared.

The power supply contains a two position 60/90 V selector that sets the *start-up voltage* for 38 VAC or 55 VAC. The BT100 is shipped with the selector in the 60 V position which is the standard configuration. The selector should be switched to the 90 V position only for a 90 VAC system. This sets the start-up voltage at 55 VAC. Because this is only 5 V below 60 VAC, it is not practical to switch to 90 V in a 60 VAC system. There is no damage to the amplifier if the selector is not changed from the standard 60 V setting. However, changing the selector ensures that the DC supply does not turn on until the proper input voltage, 38 VAC or 55 VAC, is reached. This prevents excessive loading of the system power supply during turn-on after a system shutdown.

The power supply also includes the fast-transfer electronic-crowbar (FTEC/BTA) surge protector, except for the basic models (BT*-100*H) which include a gas discharge tube. The FTEC/BTA fires at approximately 245 V and presents a short circuit to the line during periods of over voltage. After the AC input voltage returns to normal, the FTEC/BTA resumes its open state. Although the power supply is located under the electronics chassis, you can access the gas discharge tube or FTEC/BTA through the cover on the top side of the electronics chassis.

Figure 2-8 illustrates the location of the 60/90VAC voltage selector on the power supply circuit board.

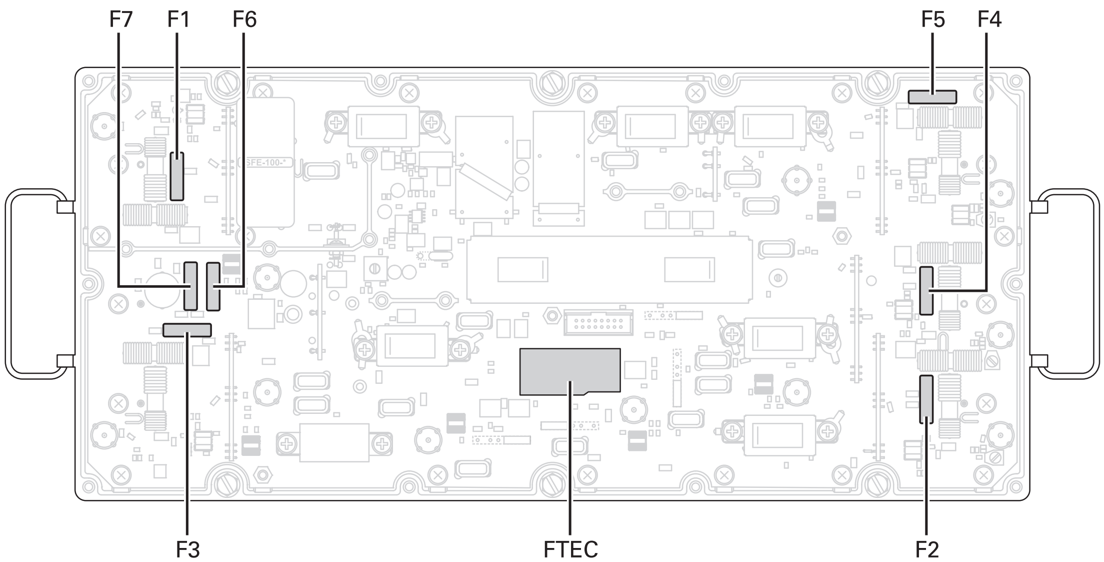
Figure 2-8
BT100 power supply



You must remove the power supply cover to access the selector illustrated in Figure 2-8. Section 3, “Amplifier Setup” explains changing the setting of this selector to meet system requirements.

The factory provides 20-ampere fuses to power additional amplifiers. Figure 2-9 illustrates the location of these fuses. Power to each output port is also provided through 20-ampere fuses. You can remove the fuses to eliminate power at any of the ports.

Figure 2-9
Fuse locations



Forward Path

The forward path of the amplifier provides an operational gain of 42 dB. The operating gain includes provisions for the insertion loss of the input cable equalizer and required reserve gain to operate the Bode equalizer in the middle of its range.

The standard four output forward path's electronics consist of four parallel three-stage paths consisting of: (1) pre-amplifier (input hybrid), (2) intermediate amplifier (midstage hybrid), and (3) power-doubling output hybrid. The first two stages are common to both paths. The pre-amplifier stage provides a low noise figure while the output stage contributes the preferred power at low distortion. The amplifier input provides a facility to install a cable equalizer and a socket for a model JXP-*B attenuator. The attenuator and equalizer are customer installed options.

Several circuits comprise the mid-stage amplifier. The Bode equalizer is a voltage-controlled device that receives its input from the manual gain control, the automatic drive unit (ADU-*), the QAM automatic drive unit (QADU-*), or the thermal drive unit (TDU). Following the Bode board, the BDR controls response flatness and provides equalization and a JXP pad facility adjusts the RF level into the mid-stage hybrid amplifier. Because these losses are located interstage, the noise figure is only significantly impacted by the insertion loss of the forward cable equalizer or a broadband cable simulator.

To increase tilt after the midstage amplifier, there is a mid-stage equalizer, model MEQ-100-*. Following this MEQ-100-* and various splitters, there are JXP-*B pad sockets leading into the power-doubling output stage. The number of pads depends on the number of outputs configured.

Accurate –20 dB directional coupler test points are available at the input and at the outputs of the amplifier. Because these test points are 75-ohm source impedance, they do not require special test probes.

After the output amplifier, a second directional coupler provides signal to the optional ADU board. As this signal is used only with the ADU, you do not need to terminate this port when the ADU is not installed.

Figure 2-10 illustrates the interconnection between these components in the four output BT100*-4*.

Figure 2-10
BT100*-4* four output block diagram

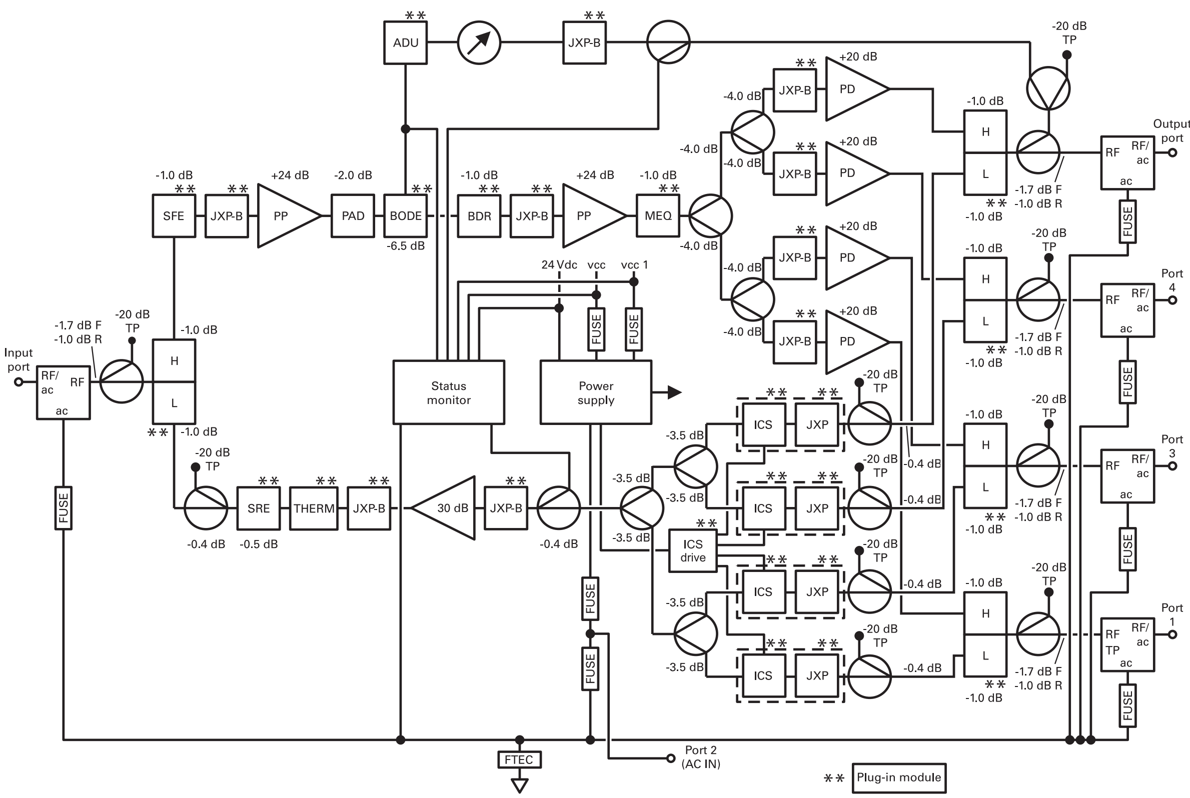
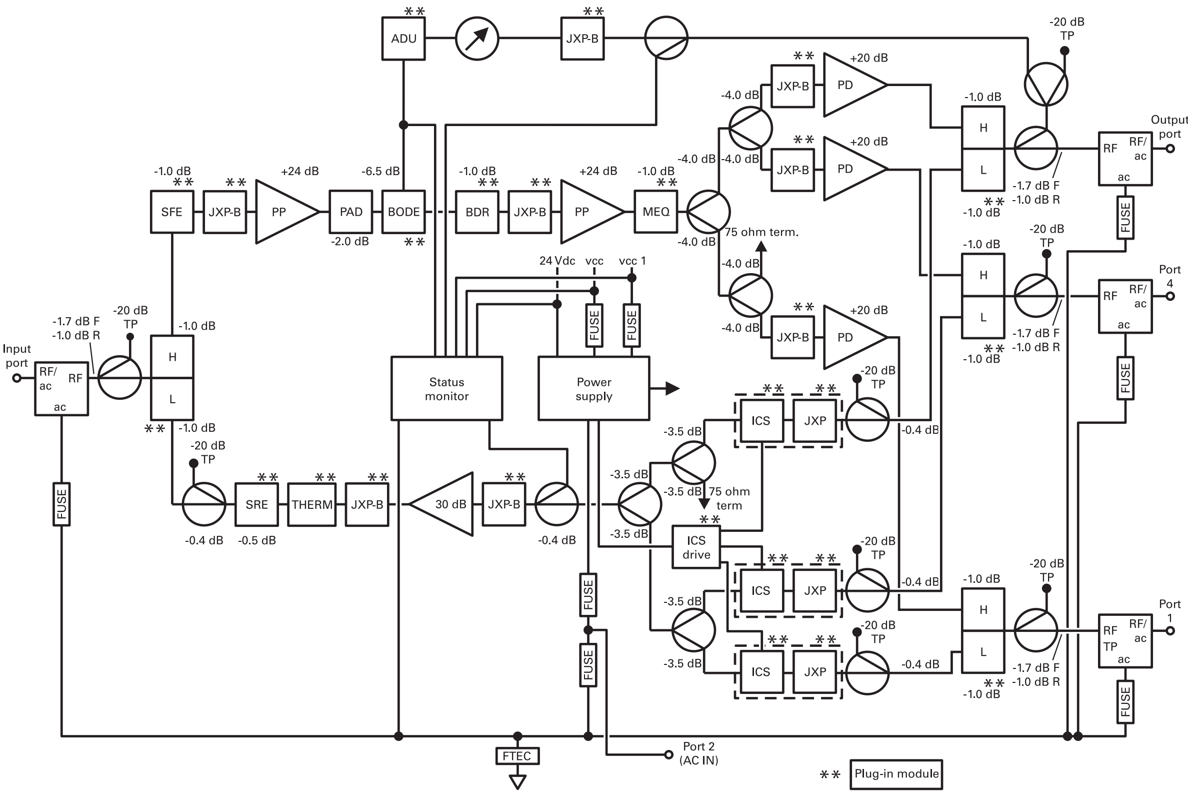


Figure 2-11 illustrates the interconnection between these components in the three output BT100*-3*.

Figure 2-11
BT100*-3* three output block diagram



Return Path

The BT100 main amplifier circuit board includes the return path. This equips the BT100 to pass signals in the return or upstream direction. The standard circuit board contains all components including the diplex filters with extended return bandwidth for the amplifier input and output.

Optional SRE-*-* return equalizers compensate for cable attenuation and are available in 1 dB increments for S-split, and 2 dB increments for all other splits, from 0 dB through 12 dB. You must install a return equalizer to activate the return path.

There are JXP-*B pad facilities located at the inputs and output of the return path. You can use these pad facilities as test points or signal injection points. The output pad value is normally selected to control the return signal level into the next upstream amplifier, while the input pad value is selected to attenuate excessive input signal.

The return-input test points and the return-output test point are –20 dB directional couplers. These test points present a 75-ohm source impedance and do not require special test probes.

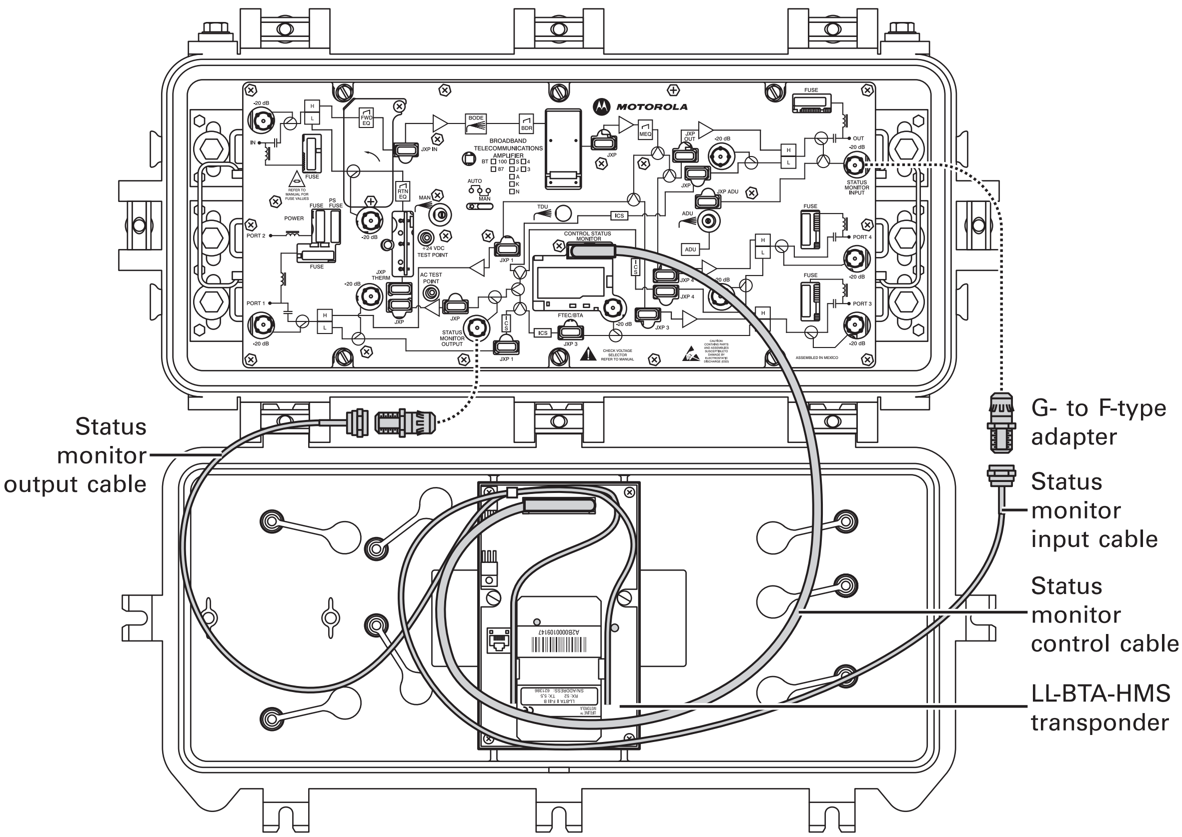
Optional return path thermal compensation is provided by plug-in JXP-TH2C or JXP-TH3C modules that stabilize gain and match over temperature extremes.

Ingress Control Switch

The ingress control switches (ICS) provide return-path signal attenuation or cutoff in the BT100. An ICS is required for each output port. Therefore the standard four output BT100 requires four ICS's. Switching is accomplished through the frequency agile LIFELINE status-monitoring transponder, which you can purchase directly from AM Networks.

Figure 2-12 illustrates the LL-BTA-HMS and the required cable connections to the electronics chassis.

Figure 2-12
LL-BTA-HMS status monitor



The ICS provides a means of isolating sources of ingress from a centralized location. Using a downstream command through the LIFELINE status-monitoring system, you can attenuate the return path through the amplifier by 6 dB or by 38 dB. By reducing the ingress level at the headend or monitoring point, you can further isolate the ingress source. After you isolate an ingress source to the last possible amplifier, node, or line extender, you can shut the return path off at that location. This limits the impact of the ingress on the remainder of the network while eliminating the source of ingress.

Options and Accessories

The factory ships the BT100 as a fully functional unit, but you must configure it appropriately for the field location requirements. You must install the correct forward equalizer or broadband cable simulator and input pad to place the unit into service. Section 3, “Amplifier Setup” provides information to assist you in this task. Use model JXP-*B pads to control field signal levels. To compensate for temperature, install the ADU, QADU, or TDU before placing the BT100 into service. You can install other items such as return thermal attenuators or ICSs at your discretion, but these do not render the BT100 inoperative if they are not included.

Table 2-1 provides a comprehensive list of options and accessories for the BT100 amplifier. See Section 3, “Amplifier Setup,” or the Motorola online product catalog for additional information.

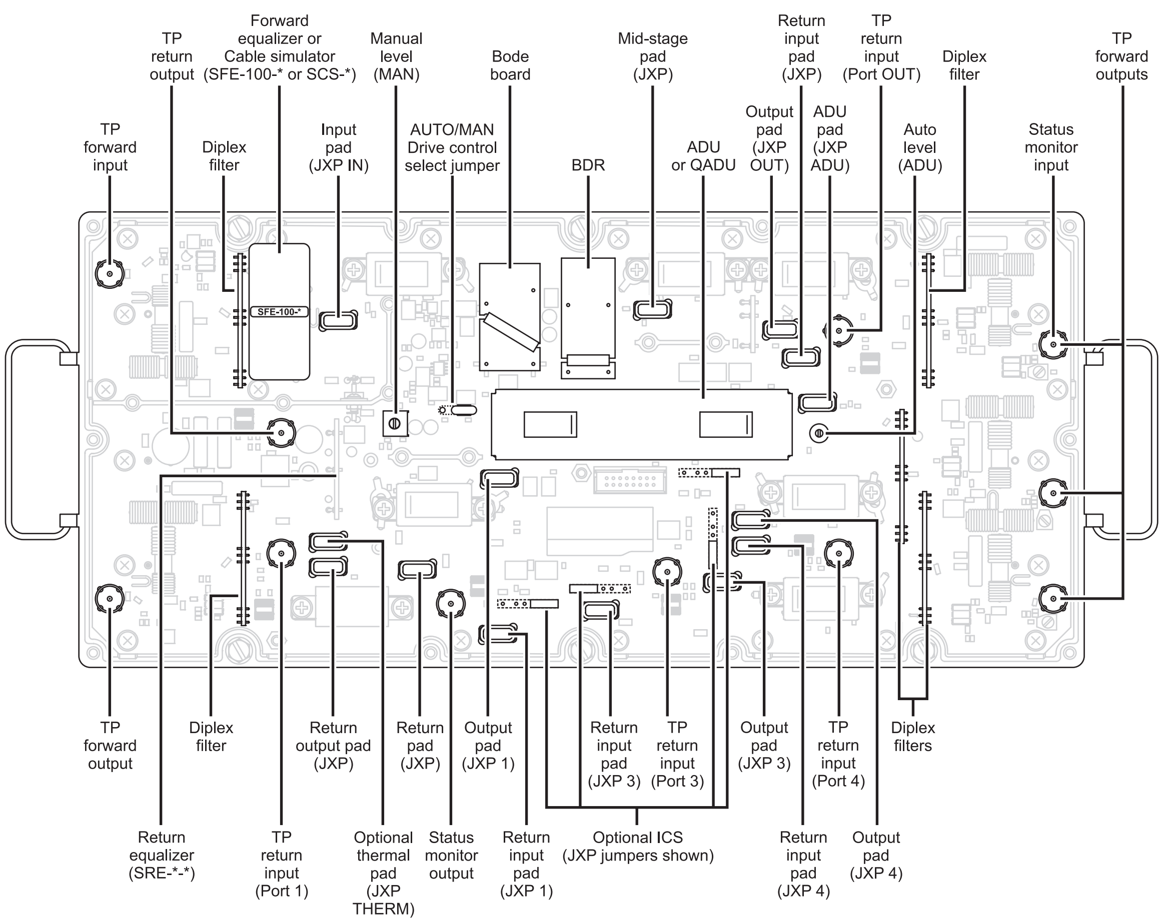
Table 2-1
BT100 options and accessories

Model	Description	Function
ADU-*	Automatic Drive Unit	By monitoring changes in level of the selected pilot carrier, this board automatically controls amplifier output levels that change with cable attenuation and hybrid output for the sensed temperature.
QADU*	QAM Automatic Drive Unit	This board automatically controls amplifier output levels that change with cable attenuation and hybrid output. The selection of a pilot frequency (QAM modulated digital channel) is required.
TDU	Thermal Drive Unit	This board controls amplifier output levels that change with cable attenuation for the sensed temperature.
SFE-100-*	STARLINE Forward Equalizer	This 1GHz equalizer compensates for cable properties in 1 dB increments from 0 dB through 22 dB. You must install the appropriate value.
SRE-*-*	STARLINE Return Equalizer	This bandwidth specific equalizer compensates for cable attenuation in 1 dB increments from 0 dB to 12 dB for S-split (2 dB increments for all other splits). You must install the appropriate value.
SCS-*	STARLINE Cable Simulator	This simulator compensates for cable properties. You must install the appropriate value.
JXP-*B	Fixed attenuator	This pad is used to attenuate excessive input signal and can be used to adjust amplifier gain. It is available in 1 dB increments from 0 dB to 26 dB. You must install the appropriate value.
JXP-TH*C	Thermal attenuators	This option compensates for gain changes with temperature in the return path.
FTEC-230-R	Fast Transfer Electronic Crowbar	This surge arrestor is used for overvoltage protection.
ICS-II	Ingress Control Switch	This option enables remote monitoring, isolation, and reduction of ingress on the return path by providing signal attenuation of 6 dB or cutoff of 38 dB typical. The unit is shipped with jumpers in these locations. The ICS can be ordered separately and customer installed. To control the ICS, you must install the LIFELINE status monitor available from AM Networks.

Model	Description	Function
MEQ-100-*	Cable equalizer	This unit is selected to provide the desired station slope. It is used in conjunction with the BDR board to provide additional tilt in the interstage section of the amplifier.
JXP-RPC	Return Path Correction Board	This optional board provides additional flatness response correction in the return path for systems that must meet especially stringent return-path flatness requirements.

Figure 2-13 illustrates the location of options and accessories in the BT100.

Figure 2-13
BT100 Options and Accessories



If you are not using an ADU, QADU, or TDU, you can select manual control of the Bode board. Figure 2-13 illustrates the location of the AUTO/MAN jumper on the main circuit board.

Section 3

Amplifier Setup

This section provides instructions on how to properly handle and configure the BT100. It also describes the proper forward and return path alignment procedures. It is recommended that you read this entire section before you install the BT100.

Proper Handling Procedures

The following information is useful in reducing GaAs RF amplifier failures caused by Electrostatic Discharge (ESD) or Electrical Over Stress (EOS).

Many electronic components are vulnerable to ESD and EOS. Improper handling during service and installation can subject the BT100 to performance degradation or failure. All closed operational units are equally protected. Compliance with proper handling procedures can significantly reduce ESD and EOS related failures.

To avoid excessive signal level which causes EOS, follow the procedures listed below:

Field Practice

Proper field procedures include:

- Installing the system design value forward equalizer and a high value (20 dB or above) input pad before you install or remove the electronics chassis or activate the system. This significantly reduces RF signal level and avoids possible EOS which can damage the hybrids.
- Leaving the input pad location open if a high value pad is not available. A more accurate forward input test point reading is achieved with a high value pad installed.
- Avoiding handling of the hybrids. If you need to remove or install the hybrids, follow proper ESD grounding practices as stated under Bench Setup.

Bench Setup

Proper bench handling practices include:

- Grounding of the test bench with ESD matting on the work surface and wearing a wrist strap connected to a continuous ground monitor checker. These practices are particularly important when handling hybrids.
- Terminating all unused ports with a 75-ohm load.
- Securing all electronics module cover screws or removing the cover completely. Loose screws can cause the BT100 to oscillate and degrade performance.

To successfully setup the BT100, you need to perform the following tasks:

- Forward path alignment
- Return path alignment
- Check powering and surge protection options

Forward Path Alignment

You must perform the following BT100 alignment procedures for proper performance in the forward path:

- Select the appropriate cable equalizer or cable simulator
- Select the appropriate input, midstage, and output pads
- Verify proper flatness control
- Verify proper level control

Before You Begin

Before you begin to set-up the amplifier and perform forward-path alignment, please read the following instructions and recommendations.

For proper forward alignment obtain:

- RF output levels and tilts of all BT100s in the forward or return path
- RF input level for the BT100 being set up (from system design or as-built map)
- A carrier at the system's highest frequency. It can be modulated or continuous wave (CW) and should be inserted in the headend at standard video levels. This carrier is used to simplify field set-up.

It is recommended that you:

- Install the system design value SFE-100-* and a high value (20 dB or above) forward input pad (JXP IN) before you install or remove the electronics chassis or apply power to the BT100.

  Leave the forward input pad location open if a high value pad is not available. A more accurate forward input test point reading is achieved with a high value pad installed.
- Do not remove or install the electronics chassis cover while the BT100 is powered.
- ***If you need to remove or install the electronics chassis cover for any reason, shut off the AC power first. Verify that all chassis cover screws are tightened to 10–12 in-lbs.***
- Do not use wire jumpers to bypass the SFE-100-* location.
- Recognize that actual pad and SFE-100-* values may differ slightly from their design values. This is caused by factors such as walkout errors, worst-case data utilization during design and temperature variation from 70°F.
- Secure the electronics chassis in the housing and torque to 18 to 22 in-lbs. to facilitate heat transfer and avoid damage from overheating.
- Perform a bench alignment. Pre-aligning the BT100 response on the bench (Section 4, "Bench Testing") for a system signature simplifies field alignment.
- Field sweep the entire bandwidth of the amplifier to correct frequency response for passive signature and roll-off.
- Close the housing in accordance with the instructions in Section 5, "Installation."

STARLINE Forward Equalizers

Select the appropriate model SFE-100-* to compensate for cable attenuation versus frequency and to obtain the proper output tilt. The BT100 is equipped with the BDR-1G interstage equalizer and flatness board, which compensates for cable attenuation. You must compensate for any cable or passive slope beyond that of the BDR-1G by selecting and installing the appropriate SFE-100-* cable equalizer.

Equalizers are available in 1 dB steps from 0 dB to 22 dB. The following examples describe how to choose the correct equalizer.

Example 1

The amplifier location includes 20 dB of cable (at 1 GHz) between its input and the preceding amplifier. Consider cable loss only. Exclude any flat loss due to splitters or other passive devices. The internal equalizer, model BDR-1G, compensates for approximately 14 dB of cable. Subtract this cable length from the 20 dB of this example (20 – 14 = 6). The SFE-100-6 is the proper equalizer in this case. With this equalizer installed, the amplifier reproduces the output tilt of the last upstream amplifier.

When selecting an equalizer, choose the next lower value if the exact value is not available or in cases where the calculated value makes two choices possible.

Example 2

The BT100 amplifier is used in a link following a fiber node. The fiber receiver output is flat and connects to the input of the amplifier through 18 dB of cable plus passive loss. Determine which is the proper equalizer to achieve 11 dB output tilt from the BT100.

Calculate the equalizer value using the following equation:

$$SLOPE_{eq} = TILT_{out} + SIG_{lo} - SIG_{hi} - SLOPE_{ieq}$$

where:

$SLOPE_{eq}$ = required SFE-100-* slope

$TILT_{out}$ = required amplifier output tilt

SIG_{lo} = signal input level at 54 MHz (channel 2)

SIG_{hi} = signal input level at 1 GHz

$SLOPE_{ieq}$ = interstage equalizer slope (14 dB)

From various references, such as manufacturer’s catalogs, you can determine that at an operating frequency of 1003 MHz, 18 dB of cable produces approximately 3.6 dB of loss at 54 MHz. This suggests that the channel 2 signal input to the BT100 is 14.4 dB greater (18 – 3.6 = 14.4) than it is at 1003 MHz. Our example assumes that the high-end frequency level into the BT100 is +12 dBmV.

Substituting this information into the above equation provides the following result:

$$11 \text{ dB} + 26.4 \text{ dB} - 12 \text{ dBmV} - 14 \text{ dB} = 11.4 \text{ dB}$$

The slope of the required equalizer is 11.4 dB. Table 3-1 and the graph in Figure 3-1 show that 11.4 dB of slope is caused by approximately 14 dB of cable at 1003 MHz. Therefore the correct equalizer is model SFE-100-14.

When selecting an equalizer, choose the next lower value if the exact value is not available or in cases where the calculated value makes two choices possible.

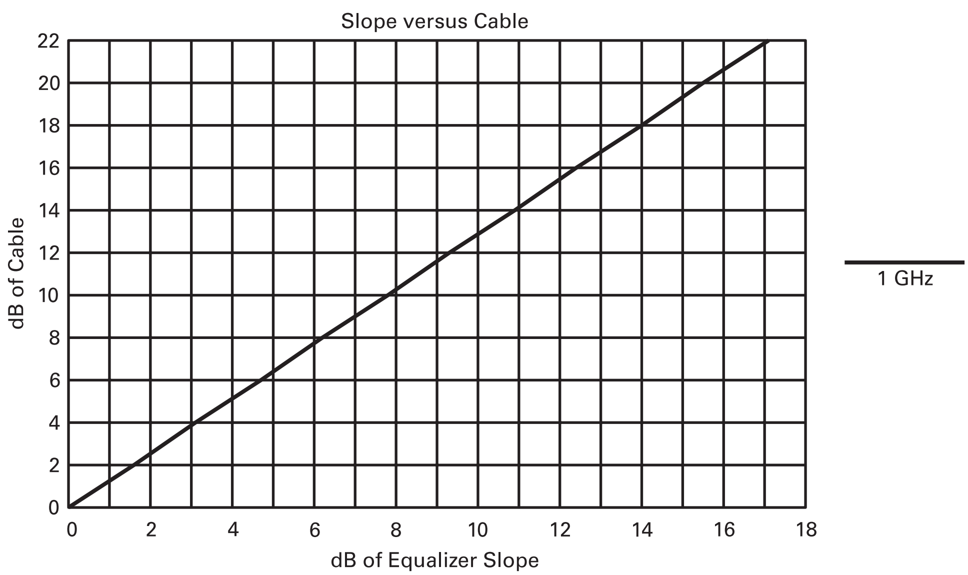
Table 3-1 helps you choose the correct equalizers and also lists insertion loss at various frequencies.

Table 3-1
Starline Forward Equalizers — SFE-100-*

		Frequency (MHz) versus Insertion Loss (dB)								
Equalizer Value	Equalizer Slope	50	200	300	450	550	650	750	870	1003
SFE-100-*										
22	17.1	18.1	13.2	11.0	8.3	6.7	5.3	4.0	2.5	1.0
20	15.5	16.5	12.1	10.1	7.6	6.2	4.9	3.7	2.4	1.0
18	14.0	15.0	11.0	9.2	6.9	5.7	4.5	3.4	2.2	1.0
16	12.4	13.4	9.9	8.2	6.3	5.2	4.1	3.2	2.1	1.0
14	10.9	11.9	8.7	7.3	5.6	4.6	3.7	2.9	2.0	1.0
12	9.3	10.3	7.6	6.4	5.0	4.1	3.3	2.6	1.8	1.0
10	7.8	8.8	6.5	5.5	4.3	3.6	2.9	2.4	1.7	1.0
8	6.2	7.2	5.4	4.6	3.6	3.1	2.6	2.1	1.5	1.0
6	4.7	5.7	4.3	3.7	3.0	2.6	2.2	1.8	1.4	1.0
4	3.1	4.1	3.2	2.8	2.3	2.0	1.8	1.5	1.3	1.0
2	1.6	2.6	2.1	1.9	1.7	1.5	1.4	1.3	1.1	1.0

Figure 3-1 illustrates a graph of the equalizer slope versus equalizer value information presented in Table 3-1. The amount of cable equals the equalizer value.

Figure 3-1
Equalizer slope versus cable



When selecting an equalizer, choose the next lower value if the exact value is not available or in cases where the calculated value makes two choices possible.

To determine the proper cable for bench testing, subtract the interstage equalizer value (14 dB) from the cable connected to its input. The output is flat with a flat signal source.

Because of errors in cable attenuation, slope in passive devices, and other independent variables, you may need to change the final value of the equalizer before you install the BT100.

STARLINE Cable Simulators

STARLINE cable simulators, model SCS-*, are used in place of fixed equalizers in systems where: (1) the amplifiers are located close together, (2) there are large amounts of flat loss from passive components, or (3) it is necessary to compensate for reverse cable tilt. The simulators fit in the same location as the equalizers.

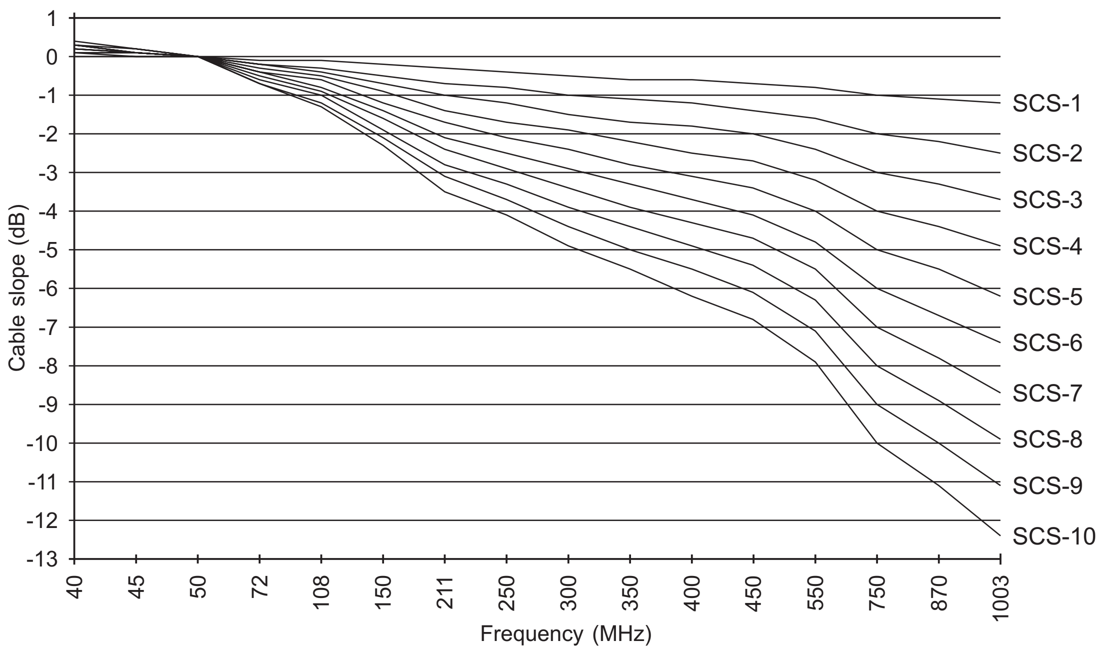
Table 3-2 and Figure 3-2 help you choose the correct simulators:

Table 3-2
Starline cable simulators

SCS-*	1	2	3	4	5	6	7	8	9	10
Frequency	Cable slope in dB									
40 MHz	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
45 MHz	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
50 MHz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72 MHz	-0.1	-0.2	-0.2	-0.3	-0.4	-0.4	-0.5	-0.6	-0.7	-0.7
108 MHz	-0.1	-0.3	-0.4	-0.5	-0.6	-0.8	-0.9	-1.0	-1.2	-1.3
150 MHz	-0.2	-0.5	-0.7	-0.9	-1.2	-1.4	-1.6	-1.9	-2.1	-2.3
211 MHz	-0.3	-0.7	-1.0	-1.4	-1.7	-2.1	-2.4	-2.8	-3.1	-3.5
250 MHz	-0.4	-0.8	-1.2	-1.7	-2.1	-2.5	-2.9	-3.3	-3.7	-4.1
300 MHz	-0.5	-1.0	-1.5	-1.9	-2.4	-2.9	-3.4	-3.9	-4.4	-4.9
350 MHz	-0.6	-1.1	-1.7	-2.2	-2.8	-3.3	-3.9	-4.4	-5.0	-5.5
400 MHz	-0.6	-1.2	-1.8	-2.5	-3.1	-3.7	-4.3	-4.9	-5.5	-6.2
450 MHz	-0.7	-1.4	-2.0	-2.7	-3.4	-4.1	-4.7	-5.4	-6.1	-6.8
550 MHz	-0.8	-1.6	-2.4	-3.2	-4.0	-4.8	-5.5	-6.3	-7.1	-7.9
750 MHz	-1.0	-2.0	-3.0	-4.0	-5.0	-6.0	-7.0	-8.0	-9.0	-10.0
870 MHz	-1.1	-2.2	-3.3	-4.4	-5.5	-6.7	-7.8	-8.9	-10.0	-11.1
1003 MHz	-1.2	-2.5	-3.7	-4.9	-6.2	-7.4	-8.7	-9.9	-11.1	-12.4
50 MHz loss (typical)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

The information in Table 3-2 is shown as a graph in Figure 3-2:

Figure 3-2
Frequency versus cable slope



Input, Midstage, and Output Pads

Install model JXP-*B pads to attenuate the signal per system design drawings. Generally, this consists of attenuating excessive input levels. You should pad the input to system level for unity gain. Select and install the specified pad in the socket labeled JXP IN on the amplifier cover.

The midstage pad (JXP) and output pads (JXP OUT, JXP 1, JXP 3, and JXP 4) can be used to adjust the gain level and achieve the gain specification. Refer to Section 6, “Operating Tips” for midstage/output padding information and recommendations.

Flatness Control

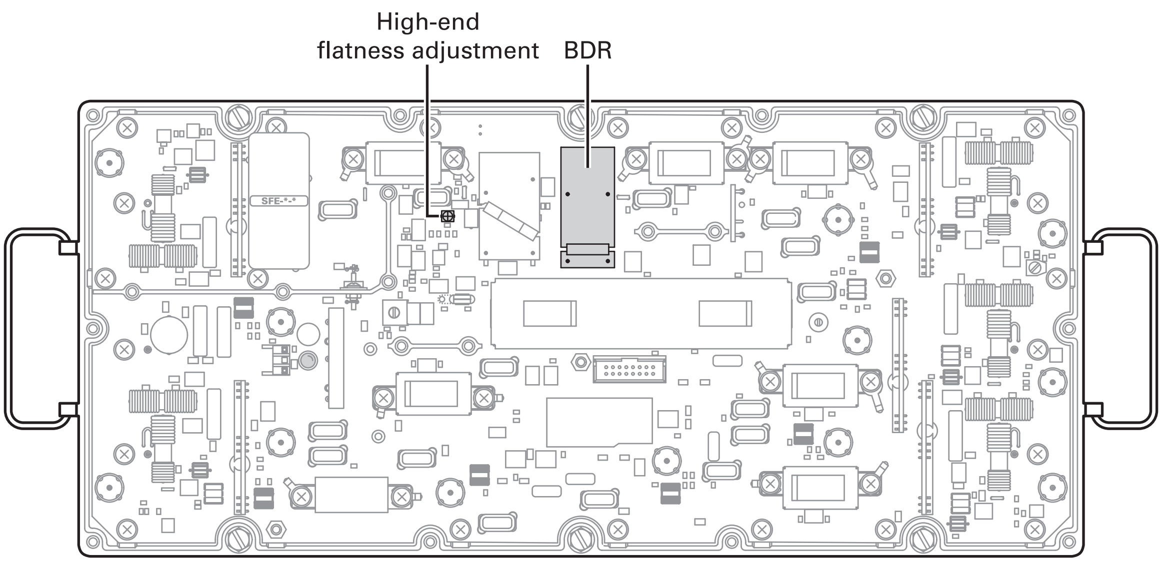
All amplifiers are factory-aligned for optimal station flatness, therefore, there is usually no need to adjust the BDR board. However, you can make minor adjustments, if necessary to achieve flatness across the passband.

The BDR-1G board includes flatness controls and a fixed cable equalizer for 1003 MHz. This equalizer, plus the contribution of the hybrid gain stages, produces approximately 14 dB of tilt.

Adjust the BDR-1G board to correct peak-to-valley response variations. Adjust or replace the equalizer if the response exhibits tilt.

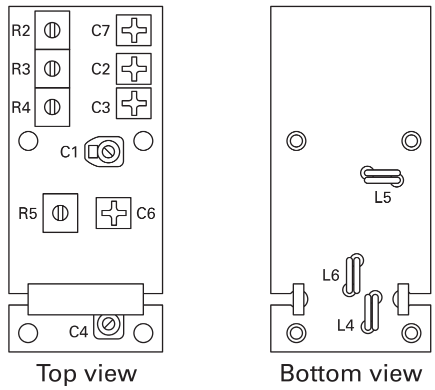
Figure 3-3 illustrates the location of the BDR-1G board and the high-end flatness adjustment capacitor:

Figure 3-3
Flatness controls



You can adjust the variable resistors and capacitors on the BDR-1G board to flatten the response across the passband. Use C1, C2, C3, C4, C6, C7, R2, R3, R4, R5, L4, L5, and L6 on the BDR-1G board (illustrated in Figure 3-4) to obtain a flat response.

Figure 3-4
BDR-1G board – top (left), bottom (right)



To obtain maximum flatness:

1 On the main board, adjust the high-end flatness adjustment (C129) to minimum capacitance to place the peak out of the bandwidth.

This should not need adjusting as it is properly set during manufacturing.

2 On the BDR-1G board adjust:

a. R5 and C6 for the response across the lower end of the mid-band.

b. C1 and L6 for the mid-band response.

c. C3 and R4 for more mid-band response adjustment; C2 and R3 for response around 100 MHz.

d. C7 and R2 for the response at Fmin.

e. C4, L4, and L5 for the response at the upper frequency range.

3 You may adjust tilt by changing the MEQ-100-* equalizer value.

- If the module's response is up tilted, increase the MEQ-100-* value by l dB.
- If the module's response is down tilted, decrease the MEQ-100-* value by 1 dB.

Directional Coupler Test Points

Accurate – 20 dB directional-coupler test points are available at the input and at the output of the BT100. Because these test points are 75-ohm source impedance, they do not require special test probes.

After the output hybrid, a second directional coupler provides signal to the optional ADU or QADU board. This signal is used only when the ADU or QADU board is installed. It is not necessary to terminate this port when the ADU/QADU is not installed.

Do not remove the ADU pad (JXP ADU). Removing this pad affects the output test points.

Bode Equalization

The Bode board, which is an electronically controlled equalizer, receives its control input from the ADU or QADU control boards. The response of the Bode board compensates for cable attenuation changes due to temperature. If necessary, you can control the Bode board manually using the potentiometer labeled manual level (MAN) in Figure 2-13.

Amplifier Level Control

Signal levels vary in a cable system primarily because cable attenuation changes with temperature. Other components such as passives and amplifier hybrids are also affected by temperature changes. To automatically compensate for these signal level fluctuations and control output level, you must select the optional ADU, QADU, or TDU. The use of the ADU, QADU, or TDU is recommended for improved output level stability.

When necessary and appropriate, you can also use manual gain control. The gain of the BT100 is then determined by the potentiometer marked MAN on the electronics chassis cover.

Manual Gain Control

To use manual gain control:

1. Verify that the electronics chassis is installed correctly.
2. Ensure that there is continuity in the forward path by installing the design-value forward equalizer and design value input JXP-*B attenuator.
3. Ensure that the drive control select jumper is in the MAN position.
4. Use a signal-level meter to measure the high band-edge carrier input level at the input test point: 750 MHz = channel 116, 870 MHz = channel 136, 1003 MHz = channel 158.

   This carrier should be at standard analog level, non-scrambled.
5. Verify that the input level agrees with the design specification input.

   If the level is different from design, adjust accordingly. For example: the design level is 19 dBmV at the highest frequency and the design pad value is JXP-3B. If the actual measured level is 21 dBmV, then you must change the pad to a JXP-5B.

   If the actual levels are significantly different from the design levels, it is recommended that you investigate or consult system management before proceeding.
6. Connect the signal-level meter to the output test point and tune the meter to the high-end channel.
7. Turn the manual gain reserve (MAN) control (illustrated in Figure 2-13) to maximum (fully clockwise) and then reduce the output as noted in Table 3-3 below:

   Table 3-3
   Gain reserve versus ambient temperature

Temperature	Gain Reserve
Above 110°F (43°C)	3 dB
32°F (0°C) to 110°F (43°C)	4 dB
Below 32°F (0°C)	5 dB

8. Check the amplifier output tilt by measuring the high band- and low band-edge carriers.
   - High = channel 116 (745.25 MHz), channel 136 (865.25 MHz), or channel 158 (997.25 MHz).

- Low = channel 2 (55.25 MHz) or channel 3 (61.25 MHz)
- If the tilt is less than required, install a higher value input equalizer
- If the tilt is greater than required, install a lower value input equalizer
- If the high value equalizer provides too much tilt and the low value equalizer provides too little tilt, use the lower value equalizer. Under-equalization is preferred to over-equalization.

If you set up the BT100 using an SCS-*, you must increase or decrease the JXP input pad by the amount of change you made in the SCS-* value. Therefore, to maintain a proper gain level, it is necessary to adjust the input pad value as follows:

- For each increase in SCS-* value, decrease the input pad by 1 dB.
- For each decrease in SCS-* value, increase the input pad by 1 dB.
- If you replace an SFE with an SCS-*, reduce the value of the input pad by the value of the SCS-*.

9 Measure the output level at the highest frequency.

It should be within 1 dB of the system design level. If it is not, you must adjust the midstage pad (JXP) and/or the output pads (JXP OUT, JXP 1, JXP 3, JXP 4) accordingly. Refer to Section 6, “Operating Tips,” for midstage/output padding information and recommendations.

Thermal Drive Unit

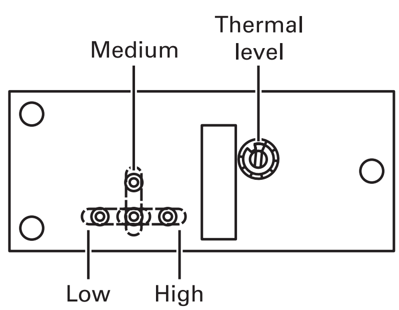
The TDU senses temperature and controls the Bode board. It is assumed that the cable is subjected to the same or similar temperature; therefore, the TDU should not be used for underground installations.

To set-up the TDU:

1 Place the jumper on the TDU (Figure 3-5) to the LOW, MEDIUM, or HIGH position to specify the amount of cable for which the TDU compensates at the highest frequency preceding the BT100 station.

Low = 0 dB to 15 dB of cable, medium = 15 dB to 37 dB of cable, and high = 38 dB or more of cable.

Figure 3-5
TDU cable selector



2 Position the drive control select jumper (Figure 2-13) temporarily in the MAN position and perform the complete procedure described in Manual Gain Control if not already completed.

3 Position the drive control select jumper to AUTO.

4 Connect a signal-level meter to the FWD OUT test point and tune the meter to the high band-edge carrier.

5 Turn the thermal level potentiometer on the TDU fully clockwise and then reduce to obtain the level obtained in Step 9 under Manual Gain Control.

Automatic Drive Unit/QAM Automatic Drive Unit

The ADU and QADU operate by using surface acoustic wave (SAW) filters to select a pilot frequency and then monitoring the amplitude of this frequency. Any change in signal level is fed back to the Bode equalizer. It is assumed that the encountered signal level changes are due to changes in cable attenuation and hybrid output associated with a change in temperature. The Bode equalizer then changes its insertion loss to maintain a constant output level. The ADU (illustrated in Figure 3-6) and QADU (Figure 3-7) maintain a more precise output level than using the TDU or leaving the BT100 in manual control.

Figure 3-6
ADU

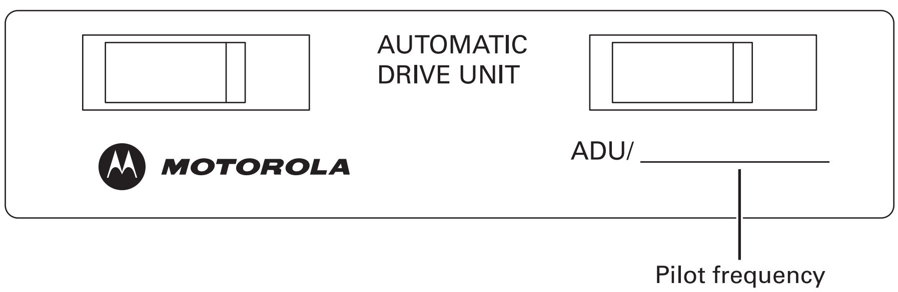
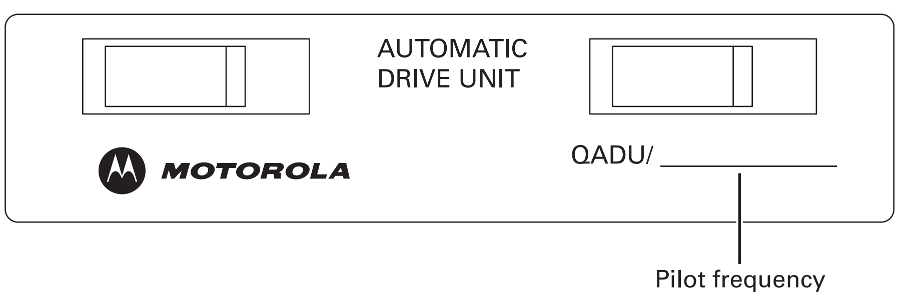


Figure 3-7
QADU



To set-up the ADU/QADU:

1 Position the drive control select jumper (Figure 2-13) temporarily to the MAN position and perform the complete procedure described in Manual Gain Control if not already completed.

2 Verify that the frequency stamped on the ADU/QADU control unit is the same as the system pilot frequency. For the ADU, the pilot frequency is a CW pilot or an available NTSC television channel not scrambled using sync suppression and not a digital channel. For the QADU, the pilot signal is a QAM modulated digital channel.

3 Position the drive control select jumper to AUTO.

4 Connect a signal-level meter to the FWD OUT test point and tune the meter to the high band-edge carrier.

5 Turn the auto level (ADU) potentiometer (illustrated in Figure 2-13) fully clockwise and then reduce to obtain the level obtained in Step 9 under Manual Gain Control.

ADU/QADU Pads and Levels

This subsection provides information regarding the proper ADU/QADU padding requirements for the BT100.

A JXP-*B pad is installed in the input line to the ADU/QADU location. This pad adjusts the ADU/QADU input level for the standard application of the BT100 but you can change this pad depending on the operational output of the BT100.

In the BT100 analog ADU circuit, a JXP-7B pad is generally recommended. This is the standard ADU pad value as shipped from the factory and is appropriate for an amplifier output level range from +43 dBmV to +49 dBmV at 550 MHz. Use a JXP-1B pad for output levels below +43 dBmV and a JXP-11B for output levels above +49 dBmV.

The standard pad for the QADU is a JXP-0B. This pad value works for a BT100 output level from +38 dBmV to +47 dBmV at 550 MHz. Use a JXP-7B when operating above +47 dBmV at 550 MHz.

Motorola does not recommend operating the BT100 above +46 dBmV at 550 MHz.

Use of an ADU or QADU is recommended for improved output level stability although you can operate the BT100 in the manual mode. Select manual mode by placing the drive control select jumper, illustrated in Figure 2-13, in the MAN position. The gain of the BT100 is then determined by the potentiometer marked MAN on the amplifier cover.

Return Path Alignment

The following subsections describe the BT100 alignment procedures required for proper performance in the return path.

Before You Begin

Before you begin to set-up the amplifier and perform return-path alignment, please read the following instructions and recommendations.

For proper return alignment obtain:

- RF alignment levels and insertion points for all BT100s
- RF reference output level of the headend optical receivers

Equipment required for return-path alignment includes:

- Full complement of JXP-*B pads and STARLINE Return Equalizers (SRE-100-*)

- Reverse signal generator — must produce at least one signal within the return bandpass and have variable output
- Return sweep or alignment equipment

It is recommended that you:

- Do not remove or install the electronics chassis cover when the BT100 is powered
- Do not use wire jumpers to bypass the SRE-100-* location
- Perform the return optical link set up before performing amplifier set up
- Specify reverse alignment design levels for a single carrier
- Consider sweep equipment as a single carrier and operate at design levels
- Do not include injection point losses in reverse design levels

If JXP THERM devices (JXP-TH*C) are specified for level control, they should be installed in the JXP THERM pad facility (illustrated in Figure 2-13) prior to alignment.

Alignment Procedure

The return amplifier configuration includes one high-gain (30 dB) return amplifier hybrid, and an appropriate SRE-100-* equalizer. All components are plug-in and are easily installed.

To align the return path:

1. If the BT100 is powered, remove all fuses before you perform the following steps.
2. Install the design value pad in the return output pad location (JXP) which is located directly beneath the JXP THERM.
3. Install the design value return equalizer, SRE-100-*, in the location “RTN EQ”.
4. Verify that the return input pad locations (JXP, JXP 1, JXP 3, and JXP 4) have 0 dB pads (or JXP-ZX jumpers) installed.
5. If you require ICSs, install them in the ICS locations illustrated in Figure 2-13. If you plan to install the ICSs later, install JXP-2Bs to simulate the through-loss of the ICSs. This eliminates the need to rebalance the return path if you install the ICS later.
6. Verify that the return pad (JXP location located to the right of the return hybrid) has a 0 dB pad (or JXP-ZX jumper) installed.
7. Verify that the return thermal pad socket (JXP THERM), located between the hybrid output and the SRE-100-*, has a 0 dB pad (or JXP-ZX jumper) or a JXP-TH*C installed.
8. Set the sweep equipment output level to the amplifier’s design input level. Add insertion point loss.
9. If required, change the return output pad and/or equalizer to achieve, as close as possible, a match of the reference level as compared to the node.
10. Verify the sweep response of all insertion points, if applicable.
11. Verify that the pad and equalizer values are similar to the map design values.

For systems that must meet especially stringent return-path flatness requirements, you may need additional flatness response correction in the return path. You can obtain additional flatness by installing the JXP-RPC board in one of the return-path JXP pad facilities. The recommended location is the JXP-THERM pad facility. However, if you are using JXP-THERMS in the return *path, you may install the JXP-RPC in the return output pad facility, or the common pad facility located prior to the return hybrid.*

You can verify proper return alignment by injecting a carrier, at the design level, into any amplifier at random. Proper alignment is achieved if you observe the reference level at the headend optical receiver output.

Return levels used for alignment are not necessarily operational system levels. These levels vary from system to system due to differences in equipment, architectures and design philosophies. For an in-depth analysis and discussion of the return path, refer to Motorola reference guide, *Return Path Level Selection, Setup and Alignment Procedure*.

Powering and Surge Protection

In conventional applications, BT100s are powered either through the input port (Port IN) or the powering port (Port 2).

CAUTION!

⚠	To avoid damage to the hybrids, it is recommended that you remove the input pad (JXP-IN) before you apply power to the BT100.

A 20-ampere, blade-type fuse is furnished in each active port of the amplifier module and provides overcurrent protection for AC power applied to the input. You can power the BT100 from the output without passing power through to the input port. To block power from the input port, remove the 20-amp fuse located in the input port as illustrated in Figure 2-9.

WARNING!

⚠	To avoid possible injury to personnel or damage to the equipment, remove 60/90 volt AC power from the system before you remove any components from the housing.

The BT100 is shipped from the factory configured for 38 through 90 VAC powering as described in Section 2, "Overview". To configure the BT100 for 55 VAC through 90 VAC operation:

1. Remove the power-supply cover.
2. Move the 60/90 V selector on the power-supply board from the J2 to J4 (60 V) position to the J2 to J3 (90 V) position. Figure 2-8 illustrates the 60/90 V selector.
3. Reinstall the power-supply cover and torque the screws to 10 to 12 in-lbs.

Section 4

Bench Testing

Motorola's recommended procedure for placing a new BT100 into service is to fully test it on the bench before it is installed. There are specific alignment procedures that ensure proper functioning of all components and simplify final installation. If the BT100 is properly aligned on the bench, only minor adjustments may be required in the field.

The following subsections provide instructions to bench align the BT100.

Before You Begin

The BT100 is shipped with a 20 ampere blade-type fuse in each active port for over current protection.

CAUTION!

> To avoid applying 60/90 Vac to the test equipment during testing, remove the fuse from the connected output port F2, F3, F4 or F5 (illustrated in Figure 2-9). Terminate all unused ports.

Open the housing and remove the electronics chassis cover. Refer to your system drawings or records to confirm the presence of the required options as described in Section 2, "Overview," Options and Accessories.

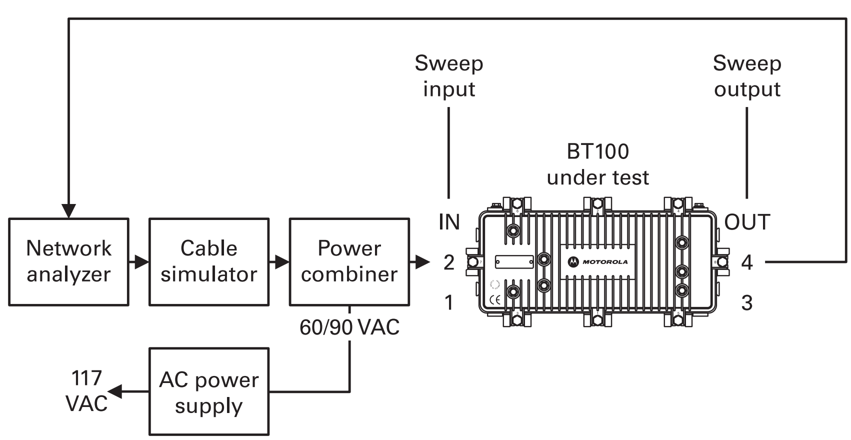
Reinstall the electronics chassis cover and torque the screws to 10–12 in-lbs.

Test Equipment and Connections

The equipment typically used for testing the BT100 consists of a network analyzer, such as the HP8712 or 8713 series, a 60/90 VAC bench power supply, a cable simulator, a Motorola model SSP-PIN power combiner, and a variety of jumper cables, adapters, and fittings.

Fabricate a cable simulator that you can configure to provide the desired cable loss in 1 dB increments, up to approximately 30 dB. Then, connect the test equipment as shown in Figure 4-1:

Figure 4-1
Test equipment connections for bench sweeping



CAUTION!

⚠	To protect the network analyzer, you must configure the SSP-PIN power combiner to block AC power from the input port.

To preserve signal quality, verify that all unused ports are terminated.

CAUTION!

⚠	Before you begin the following subsection, remove the input pad (JXP IN) before you apply power. This is necessary to avoid damage to the hybrids.

Measuring Forward Gain

This subsection provides instructions for measuring the full gain and the operational gain and flatness of the BT100.

To measure the full gain of the amplifier:

1 Determine whether the power-supply jumper is positioned for 60 V or 90 V operation.

2 Connect the BT100 to the test equipment as illustrated in Figure 4-1 and apply power.

3 Verify that the DC voltage is 24 V ± 0.4 V and re-install the input pad.

4 Apply the sweep signal and adjust test equipment as needed.

5 Select manual gain by placing the drive control select jumper in the MAN position and turn the MANUAL LEVEL control (MAN) (Figure 2-13) fully clockwise.

6 Measure the gain at mixed forward frequency using the procedure outlined in the operator manual provided with the test equipment in use.

   To correct this number, add the insertion loss of the SSP-PIN power combiner (0.6 dB at 750 MHz, 0.7 dB at 870 MHz, or 1.1 dB at 1 GHz), the loss of the cable simulator at mixed forward frequency, and the loss of the cable equalizer (1.0 dB), if it is installed.

Example

The test equipment indicates a measured gain of 24 dB with a BT100 and the cable simulator is set to 20 dB.

1.1 dB (power combiner)
+ 1.0 dB (cable equalizer)
+ 20.0 dB (cable simulator)
+ 24.0 dB (measured gain).
46.1 dB (unit gain).

The result must meet advertised specifications for the unit.

The operational gain of the BT100 provides reduced gain capability. This enables the unit to operate in the proper region of the Bode board when it is controlled by the ADU or QADU drive units.

To measure the operational gain and flatness of the amplifier:

1 Perform steps 1 through 6 in Measuring Forward Gain above.

2 Estimate the ambient temperature and find the required gain reserve by referring to Table 3-3. Reduce the gain at the highest frequency by the amount given in the table.

Example:

The ambient temperature is 70°F. The table indicates that the required gain reserve is 4 dB. Reduce the gain by 4 dB.

The operational gain is the sum of the measured gain after performing Step 2, plus all losses, such as power combiner, cable loss, equalizer, and cable simulator.

The sweep response is essentially flat at this point. If the response exhibits tilt, the cable equalizer must be changed. Install a higher equalizer value if the gain is greater at the low frequencies; install the next lower equalizer value if the gain is less at the low-end frequencies.

3 Measure the gain excursions from an average value within the bandpass.

The result is the peak-to-valley flatness. Some improvement is possible by adjusting the flatness controls on the BDR board as described in Section 3, “Amplifier Setup,” Flatness Control. Figure 3-4 illustrates the location of these controls on the BDR.

Testing Return Gain and Response

After configuring the return path, you can test the return bandpass to ensure compliance with specifications. When testing the return path, remember that it is a flat response. Therefore, the cable simulator must remain in the test set-up and must remain set to the same cable equivalent as in the forward sweep test. This provides an approximate indication of the frequency response, which you can achieve in the field.

To test for return gain and response:

1 Reconnect the test equipment and switch the *sweep input* and *sweep output* leads of the BT100 under test to be opposite of the connection shown in Figure 4-1.

2 Remove the 20 A fuse (F1) at the input port and replace the 20 A fuse (F2, F3, F4, or F5) at the output port (Figure 2-9) before you apply power.

3 Re-adjust the test equipment to sweep from 4 MHz through the maximum return band frequency plus 10 MHz (Example – 50 MHz for S-split).

The expected response is flat. Any tilt, which is due to the return equalizer, must average out to a flat response in a cascade of amplifiers. A slope adjustment is not available in the return bandpass.

4 Measure the gain at the maximum return band frequency (example 40 MHz for S-split).

The amplifier gain is the sum of: the measured gain, the insertion loss of the return cable equalizer at the maximum return band frequency, the insertion loss of the power combiner, any pads installed in either the input or output pad locations, plus the cable simulator loss at the maximum return band frequency. The amplifier gain must meet advertised specifications for the return path.

Example:

11.2 dB (measured gain)
+ 1.0 dB (equalizer insertion loss)
+ 1.1 dB (power combiner)
+ 0.0 dB (pads)
+ 4.6 dB (cable simulator at 40 MHz)
17.9 dB (unit gain)

Completing the Test Procedures

The amplifier is now approximately tailored for a specific field location. Additional adjustments after installation are minor in nature. Re-install the fuses removed during testing.

Complete station records by recording pertinent information. Remove test-equipment connections and close the housing following instructions provided in Section 5, “Installation,” Closing the Housing.

Section 5

Installation

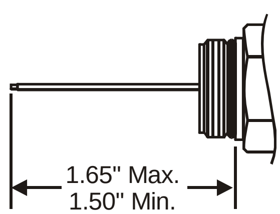
The field installation procedures presented in the following subsections assume that the amplifier was previously tested and bench aligned. Cable power and RF signal must be available on the system. Although it is preferable to have a full complement of channels available for balancing, you can adjust the BT100 adequately with a limited number of channels.

You can install the BT100 housing on a messenger strand (aerial) or on a pedestal. The following subsections provide details on each application.

Aerial Installation

The housing is normally mounted horizontally below the strand, with the electronics chassis removed, to avoid possible damage during installation. Connections are made using standard pin-type connectors with a nominal center-conductor diameter of 0.067 inches. The minimum length of the center-conductor pin is 1.5 inches and the maximum length is 1.65 inches. Longer pins can extend past the center-conductor seizure mechanism and degrade the match. Extremely long pins can result in a short circuit.

Figure 5-1
Center-conductor pin length



To install the unit:

1 Power down the cable before you install the housing. This avoids blown fuses, tripped circuit breakers, and possible personal injury.

2 Mount the housing, and torque the two 5/16-inch messenger clamp bolts, located on the long sides of the housing (illustrated in Figures 2-5 and 2-7) to 12 ft-lbs.

3 Form the customary expansion loops and make all cable connections according to system design.

4 Tighten the center-conductor seizure screw using a Phillips-head screw driver. An alternative method is to use a 3/16-inch socket and a torque wrench. The recommended torque is 12 in-lbs. maximum.

5 To avoid water ingress, ensure that aluminum connectors are torqued to the specifications recommended by the connector manufacturer.

6 If previously removed, re-install the electronics chassis and fasten it to the housing with the six captive bolts. Torque to 18 to 22 in-lbs.

7 *Remove the input pad (JXP IN) to avoid damage to the hybrids.*

8 Apply power to the unit and allocate a few minutes for warm up.

9 Check the AC voltage setting (Figure 2-8).

Jumper position	Description
60 V (J2 to J4)	The voltage must be greater than 38 VAC as read with a true rms voltmeter or 42 VAC when using a conventional, average reading, AC voltmeter.
90 V (J2 to J3)	The voltage must be greater than 55 VAC when read with a true rms voltmeter or 61 VAC when using a conventional, average reading, AC voltmeter.

10 Check the DC voltage. Verify that it is between 23.6 V and 24.4 V and reinstall the input pad.

11 If necessary, rebalance the amplifier following the instructions in Section 3, "Amplifier Setup."

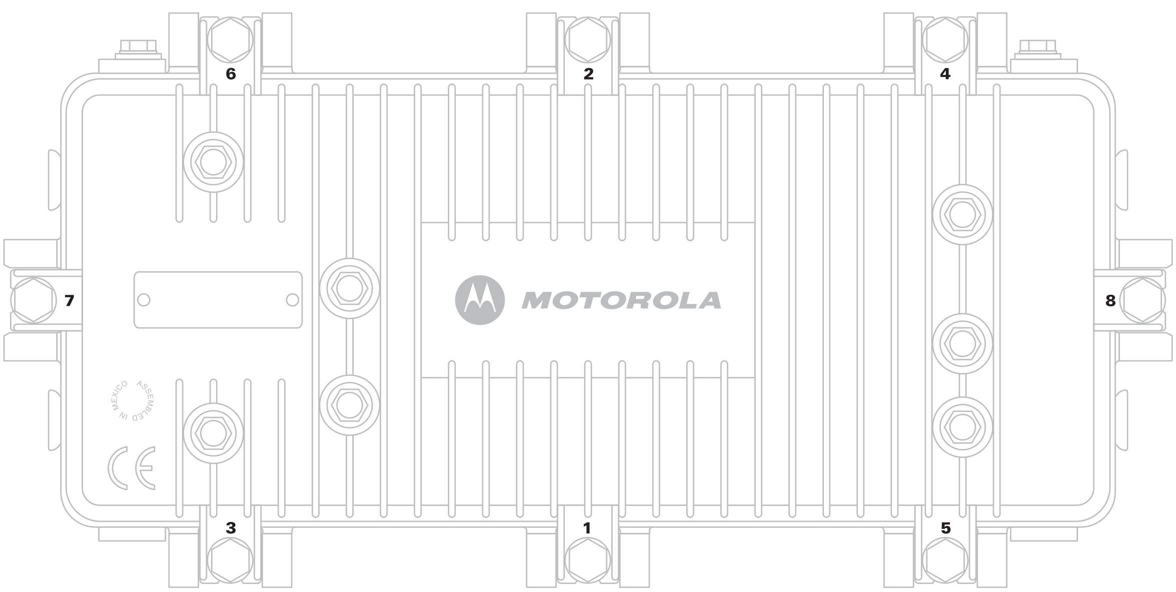
12 Check the tightness of the electronics chassis cover screws (10 to 12 in-lbs.) and hold-down bolts (18 to 22 in-lbs.).

13 Check the condition of the RF and weather gaskets and replace them if necessary. If needed, also apply a light coating of silicone grease.

14 Ensure that the electronics chassis handles are folded down and that any cables between the base and lid are not pinched.

15 Close the housing and use a torque wrench to sequentially and progressively tighten the housing bolts to a final torque of 15 ft-lbs in the sequence specified on the housing cover and illustrated in Figure 5-2.

Figure 5-2
Torque sequence



Torque housing bolts to 15 ft/lbs. in sequence shown.

Pedestal Installation

Pedestal installation is similar to the aerial installation with the exception of temperature and mounting procedure. In an aerial installation, the cable and amplifier are subject to the same temperature. In contrast, pedestal installation provides a stable temperature environment for the buried cable while subjecting the elevated amplifier to higher temperatures. The ADU/QADU, if installed, functions the same as in an aerial installation, and does not require further attention. See Section 3, “Amplifier Setup,” Amplifier Level Control for additional information.

Manual thermal compensation provided by the TDU can be inaccurate and result in signal level changes with ambient temperature change. One approach to this problem is to select the least amount of cable setting (low) on the TDU. This results in minimal gain change with temperature. A preferred approach is to install a JXP-TH*C thermal attenuator while operating the BT100 in the manual mode.

To mount the BT100 on a pedestal:

1. Remove two 5/16-inch messenger clamp bolts located on the long sides of the BT100 housing.
2. Locate the two 5/16-inch holes (Figure 2-7) eleven inches center-to-center cast in the lower housing.
3. Use the two 5/16-inch bolts to install the BT100 to the pre-drilled pedestal mounting plate and torque to 10 to 12 ft-lbs.

Grounding the BT100

The BT100 housing requires a good earth ground to function properly. You can establish a good earth ground by one of the following methods.

For aerial metal-strand installations — the metal strand clamp normally provides adequate grounding. However, if additional grounding is needed, you may attach a wire from earth ground to a 5/16 x 24 bolt that is tightly secured to one of the pedestal mounting holes on the bottom of the housing base.

For pedestal installations — the BT100 should be adequately grounded by routine mounting to the pedestal. However, if additional grounding is needed, attach a ground wire to a 5/16 x 24 bolt and tighten it into one of the strand clamp holes.

Section 6

Operating Tips

This section describes using amplifiers in lower frequency systems and in lower gain systems.

Using Amplifiers in Lower Frequency Systems

When using the BT100 in 870 MHz or 750 MHz systems, you must consider the best method for handling the reduced bandwidth and channel-loading requirement. The following information helps you determine the best approach.

For distribution systems designed and installed as 1 GHz systems, but carrying a reduced channel load, there are no further concerns. You can add or remove channels at your discretion. If the system operates with ADUs/QADUs, the pilot channel cannot be disturbed. Reduced channel loading improves distortion.

For lower-frequency systems, such as 870 MHz or 750 MHz, you will need to take into account the reduced gain from 1 GHz. Due to the amplifier tilt, there will be some loss in gain from the published operational specification at 1 GHz. For example, a 42 dB 1 GHz BT100, with 14 dB of output tilt, will lose approximately 1.3 dB of gain at 870 MHz, resulting in approximately 40.7 dB of gain at 870 MHz. If you need to adjust tilt, you may accommodate by changing the forward equalizer (SFE) value. Also, to avoid any additional loss in gain, it is optimal to use the equalizers that match the system frequency. For an 870 MHz system, the SFE-87-*s are the best choice, even in a 1 GHz amplifier. Note also, that the equalizer cuts off at the frequency value for which it is designed. For example, an SFE-87-* cuts off frequencies above 870 MHz. Therefore, if you have a 1 GHz system and need the equalizer to perform to 1 GHz, you must use an SFE-100-*.

Using Amplifiers in Lower Gain Systems

There are three pad facilities in the forward path: (1) is the pad location (JXP IN) at the input to the amplifier, (2) is the midstage pad (JXP) located between the pre-amplifier and the interstage hybrid, and (3) are the output pads (JXP OUT, JXP 1, JXP 3, and JXP 4) located between the interstage hybrid and the output hybrids.

The input pad (JXP IN) is normally changed to accommodate excessive input levels. When operating at the same output levels, a BT100 with an input pad has the same carrier-to-noise (c/n) and distortion performance as a BT100 without the input pad. Because it only attenuates excess signal, it has no effect on the overall performance of the BT100.

If necessary, to achieve the amplifier gain specification, you can use the midstage pad (JXP) or output pads (JXP OUT, JXP 1, JXP 3, and JXP 4) to reduce the gain of the BT100. However, this will affect amplifier performance. Output padding degrades the station distortion performance while having minimal effect on the carrier-to-noise performance. Midstage padding is the opposite and therefore has little effect on distortions, but degrades the carrier-to-noise performance. In general, we recommend you pad to the amplifier gain specification on the output. However, if you are unsure about the optimal padding technique for your system, we recommend you split the required padding evenly between the midstage and output pads.

It is recommended that you contact Motorola’s TRC or your account representative for more specific information regarding use of the midstage and output pads.

Appendix A

Specifications

Specifications are valid over the given bandpass and operating temperature range of –40°F to +140°F (–40°C to +60°C). Specifications are stated typical unless otherwise noted, and are subject to change. Refer to the Motorola CHS web site or contact your account representative for the latest specifications.

Model BT100

Specification	Forward Amplifier
Passband	52 through 1003 MHz
Gain	
Full	46 dB (with SFE-*-*)
Operational	42 dB (with SFE-*-* and slope reserves)
Flatness	
52 through 1003 MHz	±0.70 dB maximum
Level control, automatic	Bode board using ADU/QADU/TDU
Gain control	Fixed pads, JXP-∗B
Performance - reference frequency (MHz)	1003/550/52
At typical output (dBmV)	45/44/37
Channels	79 analog/320 MHz digital (suppressed by 6 dB)
Crossmod (worst case)	–66 dB
CTB (worst case)	–75 dB
CSO (worst case)	–71 dB
Noise figure	
At 52 MHz	10 dB (with SFE-1)
At 1003 MHz	10 dB (with SFE-1)
Interstage equalizer, BDR-1G	14 ±1 dB
Hum modulation	–70 dB
Return loss, input/output	16 dB at operational level
Test points, input/output	20 ±1.0 dB
Housing dimensions	21.6 L × 10.6 W× 7.7 D inches (54.9 × 26.9 × 19.6 cm)
Weight	27 pounds (12.25 kg)

AC Current

AC Voltage	One-way	With RA-Kit
90 VAC	0.75 A	0.80 A
75 VAC	0.91 A	0.96 A
60 VAC	1.15 A	1.22 A
53 VAC	1.31 A	1.39 A
45 VAC	1.57 A	1.66 A
38 VAC	1.90 A	2.00 A

RA-Kit/H Return Amplifier

Parameter	Specification
Passband (S–split)	5 through 40 MHz
Gain, station (minimum)	17.5 dB
Flatness	±0.75 dB
Level control	Fixed pads, JXP-∗B, input and output
Performance – reference frequency (MHz)	40
At typical output	35 dBmV, flat
Channels	6 NTSC
Crossmod (worst case)	–74 dB
CTB (worst case)	–86 dB
CSO (worst case)	–82 dB
Noise figure	12.5 dB
Power requirements	24 VDC, 125 mA

ADU/QADU Automatic Drive Unit

Parameter	Specification
Pilot channel	See current catalog
Adjacent channel frequency	±6 MHz
Minimum BT100 output at pilot frequency	+36 dBmV
ALC stiffness	±0.3 output change for ±3.0 dB input change
Power requirement	24 VDC, 75 mA

Torque Specifications

Torque specifications are valid for the BT100.

Fastener	Screw Size	Wrench Size	Torque In-lbs	Torque Ft-lbs	N•M
Strand clamp/pedestal mounting	5/16-18	1/2 inch	120-144	10-12	13.6-16.3
Housing/lid closure	5/16-18	1/2 inch	180	15.0	20.4
Test point plugs	5/8-24	1/2 inch	25-40	2.1-3.3	2.8-4.5
Seizure screw	#8-32	3/16 inch or Phillips	12	1.0	1.4
Hybrid	#6-32	Phillips	10-12	0.8-1.0	1.1-1.4
Chassis (electronics module)	#10-32	5/16 inch	18-22	1.5-1.8	2.0-2.4
Chassis (electronics module) cover	#6-32	1/4 inch or Phillips	10-12	0.8-1.0	1.1-1.4
Status monitor	#10-32	5/16 inch	24-30	2.0-2.5	2.7-3.4
Power supply cover	#6-32	1/4 inch or Phillips	10-12	0.8-1.0	1.1-1.4

Abbreviations and Acronyms

The abbreviations and acronyms list contains the full spelling of the short forms used in this manual.

ADU	Automatic Drive Unit
c/n	carrier-to-noise
CSO	Composite Second Order
CTB	Composite Triple Beat
cw	Continuous wave
dB	Decibel
dBmV	Decibels referenced to one millivolt
E-GaAS	Enhanced Gallium Arsenide
FTEC	Fast Transfer Electronic Crowbar
GHz	Gigahertz
ICS	Ingress Control Switch
MEQ-*-*	mid-stage equalizer
MHz	Megahertz
NTSC	National Television Standards Committee
QADU	Quadriture Amplitude Modulated (QAM) Automatic Drive Unit
rms	root-mean-square
RSA	Return for Service Authorization
SAW	Surface Acoustic Wave
SCS-*	STARLINE Cable Simulator
SFE-*-*	STARLINE Forward Equalizer
SRE-*-*	STARLINE Return Equalizer
TDU	Thermal Drive Unit
TRC	Technical Response Center

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