

Shively Labs[®]

FM Bandpass Filter

Model 2500



Installation, Operation,
& Maintenance

Congratulations!

Thank you for purchasing one of the finest bandpass filters on the market today. The Shively Labs Model 2500 is widely recognized as the top-of-the-line in its class for its superior performance and durability.

Your purchase is backed by the best technical support in the industry. Shively is a leading manufacturer in the broadcast industry, providing an extensive range of antennas, transmission line, and components. Our technical staff has a wealth of experience in the broadcast industry and is standing by to serve you in any way.

This manual is intended to give you a good basic understanding of your bandpass filter: its proper installation, safe startup, operation, troubleshooting, and maintenance to keep it working to your satisfaction for years to come. Please have everyone involved with the filter read this manual carefully, and keep it handy for future reference.

Meanwhile, please feel free to contact your sales representative at Shively Labs at any time if you need information or help. Call or write:

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ISO 9001-Certified

IMPORTANT

Please read this manual in its entirety before beginning installation of your bandpass filter!

Failure to follow the installation and operation instructions in this manual could lead to failure of your equipment and might even void your warranty!

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1 General Information

General Description

The Shively Labs Model 2500 bandpass filter uses standard bandpass cavities to provide excellent operating specifications and to prevent the generation of spurious signals.

Each filter cavity is temperature-compensated to make the filter stable over its entire operating temperature range. The cavities are cooled by natural convection or optional forced air. [Figure 1](#) on page 2 shows the basic layout of a Shively Labs bandpass filter unit.

NOTE

We produce bandpass filter units with either forced air or convection cooling. If your combiner does not include a cooling blower, please disregard all references to blowers and air flow switches in this manual.

Each channel of a forced-air-cooled bandpass filter is provided with an air flow switch. This switch is intended to shut down the transmitter if cooling air flow is lost.

Some units, both forced-air and convection cooled, may also have an optional overtemperature switch in each cavity, which shuts down the transmitter if the cavity overheats.

Electrical schematic diagrams for the blower and electrical interlocks are shown in [Figure 2](#), [Figure 3](#), and [Figure 4](#) on page 5.

Model Nomenclature

Your bandpass filter has a part number that looks like this:

25XX-YZ,

Where the basic model number (2500-series) designates bandpass cavities, and the XX (13, 16 or 24) designates the cavity size in inches.

Y is the number of cavities in the filter.

Z is:

- A if the cooling is natural convection, or
- B if forced air.

Examples:

2516-3A is a convection-cooled filter with three sixteen-inch cavities.

2513-4B is a blower-cooled filter with four thirteen-inch cavities.

Test Specifications

The following are performance specifications your bandpass filter will meet:

Insertion Loss: 0.30 dB maximum.

Power input, each channel: 12 to 80 kW.

VSWR over each channel (± 100 kHz, with outputs terminated):

1.15 : 1 maximum.

Nominal impedance, input and output: 50 ohms.

Antenna VSWR for full-power operation: 1.5:1 maximum.

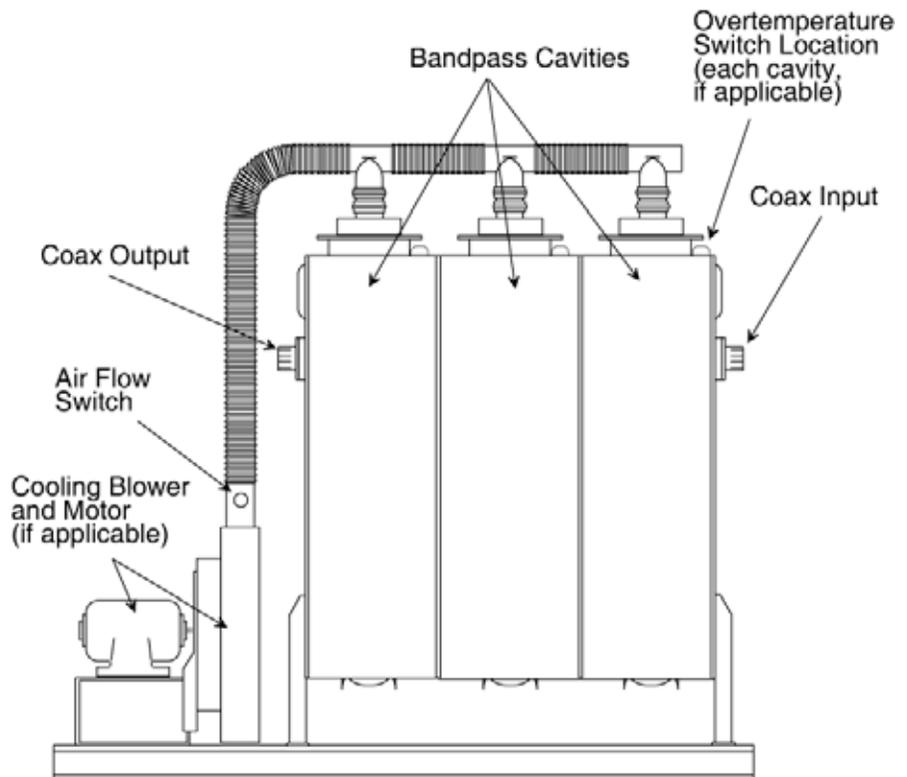


Figure 1. Typical Bandpass Filter, Front View

NOTE

The cooling blower and motor and the air flow switch are included only on forced-air-cooled units.

NOTE

Coax inputs and outputs are designed to your specification.

Overtemperature switches are an optional accessory.

Power Rating

The power capacity of the Model 2500 bandpass filter is as follows:

Table 1. Cavity Power Capacity

Size of Cavity	13"	16"	24"
Convection Cooled	5 kW	10 kW	25 kW
Forced-Air Cooled	25 kW	40 kW	75 kW

NOTE

Derate the power rating by 25% for altitudes above 7500 feet above sea level.

Installation Parameters

Your bandpass filter is designed to operate at specific frequencies within the FM frequency range of 88 - 108 MHz.

The input terminals and output terminals are shown in the installation drawing.

Locate your bandpass filter where the ambient temperature will not rise above 40° C (105° F), and the ambient humidity will not be above 60%. The optional safety overtemperature switch will turn the transmitter off if the internal temperature of the filter reaches 70° C (160° F), and not let it restart until the temperature cools to 60° C (140° F).

2 Installation

Precautions

WARNING

The blower wiring and the electrical interlocks operate on 115 or 230 VAC. These voltages can kill.

Whenever working on the blower wiring or the interlocks, turn off the electrical power external to the unit and lock it out so that it cannot be turned on accidentally.

Unpacking

Upon receiving the unit, you should look it over carefully for evidence of damage in transit. If you find any damage, report it immediately to the carrier and to Shively Labs.

We normally ship the bandpass filter bolted to a skid and covered with a wooden cover. To remove the cover, pull out the nails that hold it to the skid. Lift the cover straight up to prevent damage to the unit.

If the box is in good condition but material seems to be missing, please contact Shively Labs immediately, using the telephone or Fax number on the inside cover of this manual. For the best service, have our shop order number (S/O) handy; it's in the block at the bottom right corner of the installation drawing.

CAUTION

Lift the unit by the frame, not by the cavities.

The bandpass filter may be left on its skid if so desired. If you want to remove the skid, unbolt the unit from the skid and carefully slide the skid out from under the unit.

Location & Placement

Your bandpass filter should be installed in a clean, dust-free environment. The ambient temperature must not exceed 105° F (40° C), and the ambient relative humidity must not exceed 60%. If these conditions are not otherwise available, we strongly recommend that the room be air-conditioned and/or dehumidified.

The operator needs access only to check and replace the air filters located in the blower housing (for forced-air-cooled units) or in the bottom of each cavity (for convection-cooled units).

Simply place the bandpass filter in position. You need not lag it to the floor, although you may if you want to.

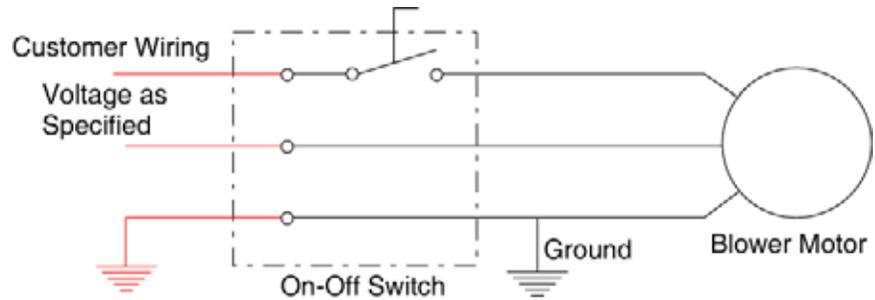
Convection-cooled units have levelers on their feet. Adjust the levelers to stabilize the unit.

Blower Wiring (forced-air-cooled units only)

The blowers of a forced-air-cooled unit are 120 VAC unless specially arranged otherwise. Near the blower is a shutoff switch; connect your power leads to this switch, complying with all electrical codes at your location.

Wire the blowers as shown in [Figure 2](#) on page 5.

Convection-cooled units have no blowers and require no 120 VAC power.



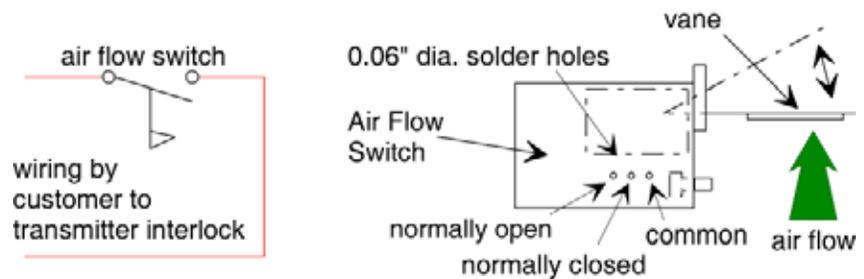
Wire to the switch inside the switch housing.

Figure 2. Blower Motor Wiring

Transmitter Interlocks (if applicable)

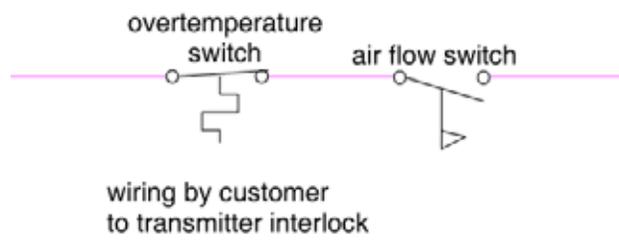
The interlocks are un-powered switches that make and break a low-voltage signal to the transmitter.

Wire the interlocks as shown in [Figure 3](#) and [Figure 4](#).



Wire directly to the switch as shown.

Figure 3. Air Flow Switch Wiring



Wire directly to both switches.

Figure 4. Air Flow Switch and Optional Thermostat Wiring

R.F. Connections

The coax connections are shown in the installation drawing.

R.F. Checkout

Your Model 2500 bandpass filter is sturdily constructed and is thoroughly tested before we ship it to you. Nevertheless, it is worth your while to check its performance before placing it in operation.

Before making any measurements, be sure that each of the many flange clamps is secure. Make no other mechanical adjustments to the unit.

Check VSWR, insertion loss, and isolation against the data in the factory report. If any of these parameters does not agree closely with the factory's data, contact us before applying power to the bandpass filter.

3 Operation

Initial Startup, Forced-Air-Cooled Units

If your bandpass filter is convection-cooled (no blowers), skip to the next section for startup instructions. If your unit has forced-air cooling (cooling blowers), start the unit as follows:

- a. Double-check to be sure that all installation instructions have been followed carefully and that installation checkout shows all channels performing close to factory specifications.
- b. Provide electrical power to the blower by turning on the blower power switch.
- c. Bring the transmitter to half power. Monitor the transmitter VSWR. Wait until the transmitter's operation is stable and acceptable.
- d. If the transmitter does not come on, you may have an interlock that is not satisfied. Check according to the electrical schematic, [Figure 2](#) on page 5.
- e. Take the transmitter to full power. Allow the temperature to stabilize.
- f. The cavities will generate their highest temperature on the header plates and around the probes. Check each cavity by hand for the hottest areas. Measure and record this temperature. It will probably be between 120° and 160° F (50° and 70° C). This may be considered the normal operating temperature of the unit.
- g. Any major change from this temperature, unless caused by a large change in ambient temperature, signals a problem with the cooling system.

Initial Startup, Convection-Cooled Units

If your bandpass filter unit is forced-air-cooled (cooling blowers), go to the previous section for startup instructions. If your unit has convection cooling (no blowers), start the unit as follows:

- a. Double-check to be sure that all installation instructions have been followed carefully and that installation checkout shows the bandpass filter performing close to factory specifications.
- b. Check to be sure the air filters in the bottom of the cavities are clean and that air flow through the unit is not impeded.
- c. Bring the transmitter to half power. Monitor the transmitter's VSWR. Wait until the transmitter's operation is stable and acceptable.
- d. Take the transmitter to full power. Allow the temperature to stabilize.
- e. The cavities will generate their highest temperature on the header plates and around the probes. Check each cavity by hand for the hottest areas. Measure and record this temperature. It will probably be between 120° and 160° F (50° and 70° C). This may be considered the normal operating temperature of the unit.

- f. Any major change from this temperature, unless caused by a large change in ambient temperature, signals a problem with the cooling system.

Normal Startup, Forced-Air-Cooled Units

Start your combiner before applying transmitter power to it. Start a forced-air-cooled combiner as follows:

Turn on blower power for each channel by turning on each external power switch.

When the blowers appear to be operating properly, apply transmitter power. Your combiner is now in operation.

If the transmitter does not come on, you may have an interlock that is not satisfied. Check according to the electrical schematic, [Figure 2](#) on page 5.

Normal Startup, Convection-Cooled Units

Check your combiner before applying transmitter power to it.

Check the air filters in the bottom of the cavities to be sure they are not blocked or dirty. There may be no overtemperature safety switch on a convection-cooled combiner, so damage may occur if insufficient air flow is provided during transmitter operation.

Apply transmitter power. Your combiner is in operation.

Normal Shutdown

Since a convection-cooled combiner is strictly a passive unit, no shut-down procedure is necessary. Shut a forced-air-cooled combiner down as follows:

Remove transmitter power.

CAUTION

Never shut off the blowers on a forced-air-cooled combiner until transmitter power has been removed.

Turn off the blower power. Your combiner is now shut down.

Interlock Shutdown

We use two kinds of safety interlocks on Model 2500 bandpass filters. Forced-air-cooled units have low-air-flow switches as standard equipment. Either forced-air or convection-cooled units may be provided with overtemperature switches as an option.

Either interlock is designed to shut down the transmitter to prevent damage to the bandpass filter from overtemperature. The problem that caused the interlock to function (i.e.: overtemperature or loss of air flow) must be corrected before the transmitter can be restarted.

4 Troubleshooting

Precautions

WARNING

The broadcast industry has recently recognized the potential medical hazards of intense radio frequency radiation. Don't expose personnel to personal harm.

Whenever working on the combiner, turn off the transmitter and lock it off so that it cannot be turned on accidentally.

For reference on RF safety, see CFR 29, Section 1910.97, the OSHA standard for exposure to non-ionizing radiation.

WARNING

The blower wiring and the electrical interlocks operate on 115 or 230 VAC. These voltages can kill.

Whenever working on the blower wiring or the interlocks, turn off the electrical power external to the unit and lock it out so that it cannot be turned on accidentally.

Startup Problems

VSWR Increases with Power Increase

As input power is increased, VSWR may increase (or reflected power may increase at a disproportionately high rate). This is most likely to occur when the transmitter is one of the so-called "high-efficiency" designs. The VSWR increase can be caused by a buildup of resonances at off-channel frequencies interacting with highly non-linear components in the transmitter.

The first thing to do is to call Shively Labs and discuss the situation with your engineer. He may suggest you change the length of the coax between the transmitter and the combiner. An increase or decrease of about 30" is common.

Problems Developed in Operation

Improper RF Readings

If RF performance changes, record the new readings in your maintenance log and compare them with the initial readings. Call Shively; we will help you correct the problem.

5 Maintenance

Precautions

WARNING

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Maintenance Log

Shively recommends that you include your bandpass filter measurements in your regular maintenance log: record performance readings of VSWR and/or reflected power, filter changes, etc. Such log readings can be invaluable in spotting and identifying problems.

Periodic Checks

The following periodic inspections should keep your combiner operating without a problem:

Weekly:

- Check the dust buildup on the air filters.

Quarterly:

- Check all the clamps and mechanical fasteners to be sure they are tight.
- Check the performance of the air flow switch.
- Check the performance of the overtemperature switches, if applicable.

Annually:

- Replace air filters. Do this more often if your log shows that more frequent changes are necessary.

Filter Replacement

Forced-air-cooled: Shut down the transmitter and stop the cooling blower by turning off the blower power switch. The filter is mounted on the side of the blower housing. Pull up on the filter element to remove it. Slide the replacement filter into its frame.

Convection-cooled: The air filters are attached to the bottom of each cavity with clasps. Remove one screw from each clasp, loosen the remaining screws, and slide the element out from under the clasps. Slide the new element into place, reinstall the clasp, and tighten the screws.

Cavities

There are no user-serviceable parts inside the cavities. In the event of RF malfunction, contact Shively Labs.

Air Flow Switch (forced-air-cooled units only)

Check the function of the air flow switch circuit by covering the air outlet with a flat object. The air flow switch should stop the transmitter when the air outlet is 80 - 100% covered. If it doesn't, check the switch's function as follows:

- a. Turn off the transmitter to prevent RF exposure to repair personnel.
- b. Turn off the 120 VAC power to the cooling blower.
- c. Gently pry off the air flow switch cover to reveal a slotted-head screw. Unscrew the screw and withdraw the switch from the air plenum.
- d. Connect an ohmmeter across the switch's contacts. Gently push the air "paddle" downstream. The switch should close as the paddle nears the end of its travel. If it doesn't, replace it.
- e. If the switch behaves properly, reinstall it and check the relay and wiring in the transmitter's interlock circuit.

Overtemperature Switches (if applicable)

- a. Turn off the transmitter to prevent R.F. exposure to repair personnel.
- b. Turn off the power switch to the cooling blower (if applicable).
- c. Remove the covers from the overtemperature switches. Remove each overtemperature switch in turn by loosening the clamp screw and withdrawing the switch from its mount.
- d. Connect an ohmmeter across the overtemperature switch's contacts. The switch should be continuous.
- e. Immerse the overtemperature switch in water between 165° and 170° F (74° and 77° C). The switch should open between 155° and 165° F (68° and 74° C). If it doesn't, you may adjust it by turning the brass adjusting screw (clockwise raises the setting).
- f. If the overtemperature switch cannot be adjusted to the above range, replace it.

Troubleshooting

Troubleshoot the filter as described in [Chapter 4](#).

Return Policy

When returning any material to the factory, be sure to call your salesman and obtain an authorized return (AR) number first. Use this number in all correspondence. This number helps us to track your returned item. It will expedite repair or replacement and prevent loss of your material.

Replacement Parts

The following are selected replacement parts for your Model 2500 bandpass filter:

Table 2. Replacement Parts

Quantity	Shively Part No.	Description
1	56120-5K586	Blower Motor, Dayton #5K586
as req'd	56123-3-CWC	Flexible Air Hose, 3-inch diameter
1/cavity	56289	Air Filter
1	56121-2A	Air Flow Switch, Rotron #2A
1/cavity	83334	Overtemperature switch