

FM Branched Combiner

Model 2530



Installation, Operation,
& Maintenance

Congratulations!

Thank you for purchasing one of the finest branched combiners on the market today. The Shively Labs Model 2530 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 combiner: 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 combiner 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

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IMPORTANT

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

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

Precautions

WARNING

Don't expose personnel to the potential medical hazards of intense radio frequency (RF) radiation. Whenever working on the combiner, turn off the transmitter and lock it out 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 VAC. This voltage 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.

General description

The Shively Labs Model 2530 branched combiner accepts the outputs of two or more transmitters of different frequencies and passes the combined signal to a single antenna. We use standard bandpass cavities and optional cross-coupling feedback loops to provide excellent operating specifications and to prevent the generation of spurious signals.

Each filter cavity is temperature-compensated to make the combiner stable over its entire operating temperature range.

[Figure 1](#) on page 2 shows the basic layout of a Shively Labs branched combiner system. Not shown is the coax support stand at the combiner output of some units.

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

The input ports and output ports, designed to your specifications, are shown in the installation drawing.

Cooling

Because the RF filters are not perfect conductors, some energy is lost from the RF signal during operation and converted to heat within them. They must be allowed to dissipate this energy to the air. This is accomplished by either convection or forced air cooling.

Convection cooling

Many filters achieve adequate cooling by simply allowing air to flow upward through them by natural convection ("hot air rises").

NOTE

If your combiner does not include a cooling blower, please disregard all references to blowers and air flow switches in this manual.

Forced-air cooling

More efficient cooling (and higher power handling) can be achieved by the use of a blower to force cooling air through the filter.

The electrical schematic diagram for the blower motor is shown in [Figure 2](#) on page 5.

Each blower on a forced-air-cooled filter is provided with an air flow switch, shown in [Figure 3](#) on page 5. This switch is intended to shut down the transmitter if cooling air flow is lost.

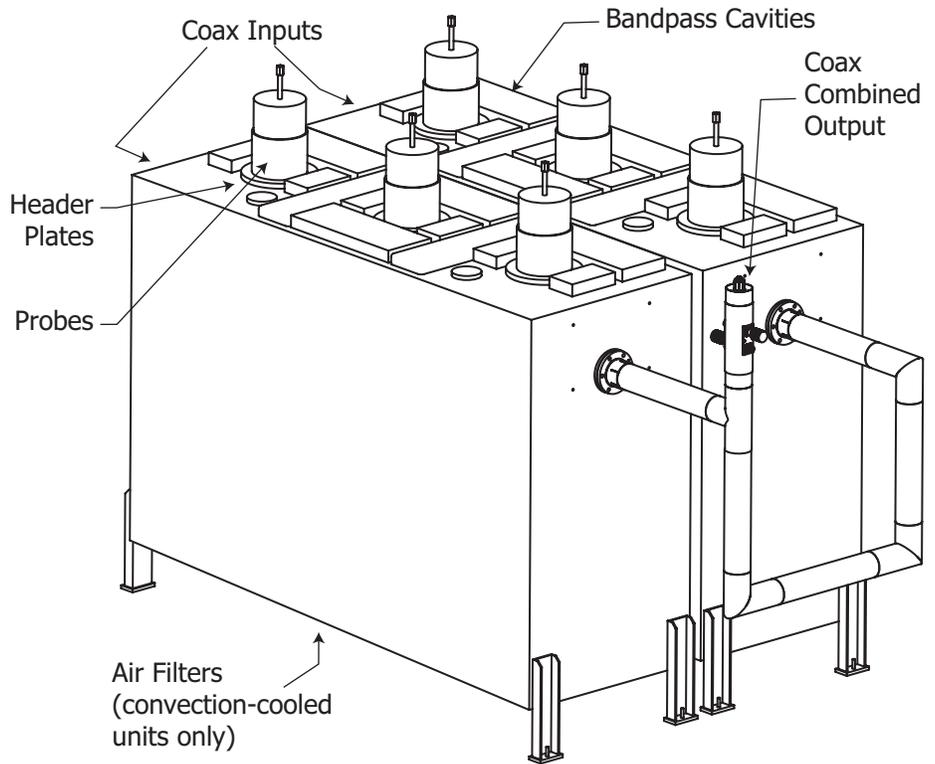


Figure 1. Typical branched combiner

Test specifications

The following are performance specifications your combiner will meet:

- VSWR:
 - at $f_0 \pm 100$ kHz: 1.04:1 maximum
 - at $f_0 \pm 150$ kHz: 1.06:1 maximum
 - at $f_0 \pm 200$ kHz: 1.10:1 maximum.
- Insertion Loss: -0.30 dB.
- Typical frequency response:
 - at $f_0 \pm 100$ kHz: -0.04 dB
 - at $f_0 \pm 150$ kHz: -0.08 dB
 - at $f_0 \pm 200$ kHz: -0.10 dB.
- Typical group delay:
 - at $f_0 \pm 100$ kHz: 25 nsec
 - at $f_0 \pm 150$ kHz: 50 nsec
 - at $f_0 \pm 200$ kHz: 200 nsec.
- Typical bandwidth: ± 200 kHz.
- Spur rejection at operating frequency ± 800 kHz: greater than 80 dB.

Power rating

The power capacity of each channel of your Model 2530 combiner is as follows:

Table 1. Power ratings

Size of cavity:	16"	24"
Convection Cooled	10 kW	30 kW
Forced Air Cooled	30 kW	75 kW

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

2 Installation

Unpacking

CAUTION

When handling the combiner, be careful not to damage the air filters at the bottoms of the cavities.

Unpack the unit carefully. The RF filters may be left on their skids 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.

Installation location

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

Never expose the combiner components to water or other liquids. For example, do not place open beverage containers on the filter modules.

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

Installation procedure

- a. The installation drawing that came with your combiner shows the positions of the RF filter modules. The combiner input ports are labeled by frequency. Place the filters in the positions shown in the installation drawing.
- b. Assemble any input coax components shown in the installation drawing. Connect the input port of each channel to the appropriate transmitter output.
- c. Assemble the output coax tee and connecting elbows and coax segments as shown in the installation drawing.
- d. Place the output directional coupler as shown at the combiner output.
- e. Connect the directional coupler output to the transmission line leading to the antenna.
- f. Once all components are in place, the holes provided may be used to lag the RF filters to the floor.
- g. Connect the blower wiring, if applicable, in accordance with the next section.

Electrical wiring (forced-air-cooled units only)

WARNING

The blower wiring and the electrical interlocks operate on 115 VAC. This voltage can kill. Turn off electrical power external to the unit before beginning installation.

The blowers of a forced-air-cooled unit are 115 VAC, 60 Hz unless otherwise specified. Near the blower is a shutoff switch. Electrical wiring is shown schematically in [Figure 2](#) on page 5.

- a. Connect your power leads to motor shutoff switch, complying with all electrical codes at your location.
- b. If your combiner is equipped with an air flow interlock switch, carefully pull the cover off the switch.

WARNING

Electrical wiring should be done only by qualified, authorized personnel.

- c. Solder the interlock leads from your transmitter to the COM and NO terminals on the switch, as shown in [Figure 3](#).
- d. Reinstall the switch cover.

Motor circuit schematic

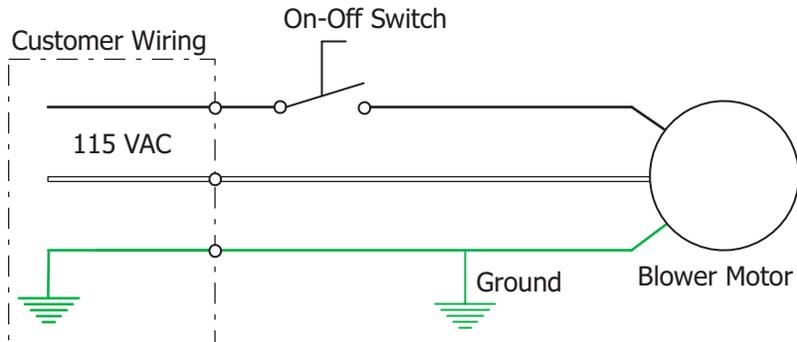


Figure 2. Motor circuit schematic (forced-air-cooled units only)

Air flow switch schematic

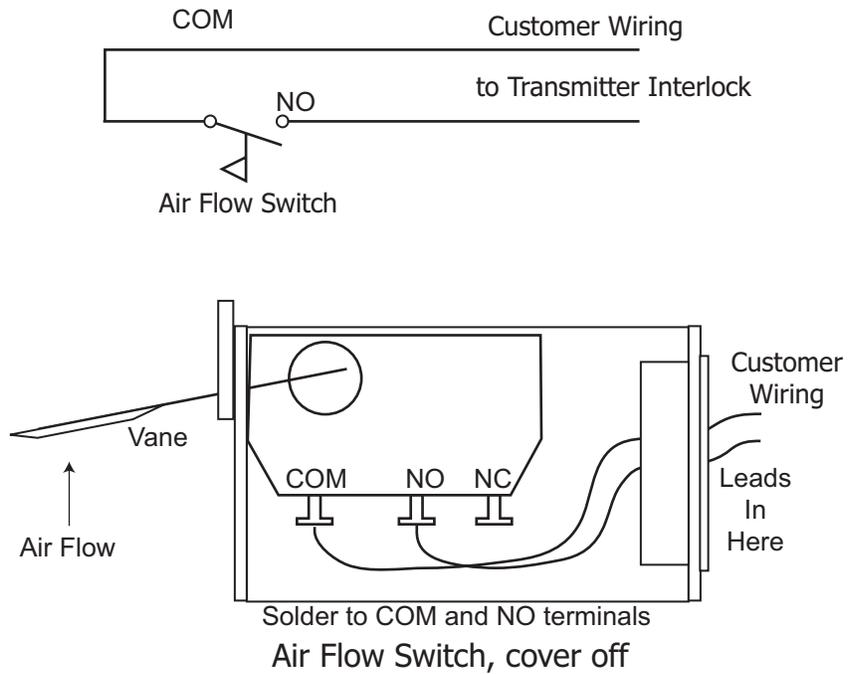


Figure 3. Air flow switch schematic (forced-air-cooled units only)

Checkout

Your Model 2530 combiner 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 flange and each clamp is properly connected and secure. Make no other mechanical adjustments to the unit.

Your combiner is provided with a precision output directional coupler. Using the directional coupler and test power levels, check VSWR, insertion loss, and channel-to-channel isolation against the data in the factory report. If any of these parameters does not agree closely with the factory-provided data, contact Shively Labs before applying power to the combiner.

3 Startup and Operation

Initial startup

Double-check to be sure that all installation instructions have been followed carefully.

Establish air flow

- a. Check to be sure the air filter(s) is clean and that air flow through the unit is not impeded.

CAUTION

(forced-air-cooled units only) Start your combiner cooling blowers before applying transmitter power.

- b. (forced-air-cooled units only) Provide electrical power to the blower.

Check at low power, then full power

- a. Bring one transmitter to half power. Using the combiner's precision output directional coupler, monitor the transmitter VSWR.

NOTE

If the transmitter does not come on, you may have a low-air-flow interlock that is not satisfied. Check your air filter(s) and blower again.

- b. Wait until that transmitter's operation is stable and acceptable.

NOTE

Because power is dissipated in the combiner, the RF filters will heat up. Temperatures as high as 120° to 140° F (50° to 60° C) are normal and not a cause for concern.

- c. Take the transmitter you checked above to full power. Allow the system to stabilize.
- d. Check the filter temperature. It will generate its highest temperature at the header plates and around the probes (see [Figure 1](#) on page 2). Check each cavity by hand for the hottest areas. Measure and record this temperature. This may be considered the normal operating temperature of that filter.

Complete startup check

- a. Repeat [Check at low power, then full power](#) for the other frequency(ies).
- b. When everything appears to be operating properly, apply full transmitter power. Your combiner is now in operation.

NOTE

Any major change from the measured temperature, unless caused by a large change in ambient temperature, signals a problem with the cooling system or within the RF system.

Normal startup

CAUTION

There is no low-air-flow safety interlock on a convection-cooled combiner, so damage may occur if insufficient air flow is provided during transmitter operation.

- a. Check to be sure the air filter(s) is clean and that air flow through the unit is not impeded.

CAUTION

(forced-air-cooled units only) Start your combiner cooling blower before applying transmitter power.

- b. (forced-air-cooled units only) Provide electrical power to the blower by turning on the blower power switch. Confirm that the blowers appear to be operating properly.
- c. Apply transmitter power. Your combiner is now in operation.

NOTE

If the transmitter does not come on, you may have a low-air-flow interlock that is not satisfied. Check your air filter(s) and blower again.

Shutdown

CAUTION

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

- a. Remove transmitter power.
- b. (forced-air-cooled units only) Turn off the blower power. Your combiner is now shut down.

4 Troubleshooting and Maintenance

Precautions

WARNING

Don't expose personnel to the potential medical hazards of intense radio frequency (RF) radiation. Whenever working on the combiner, turn off the transmitter and lock it out so that it cannot be turned on accidentally.

WARNING

The blower wiring and the electrical interlocks operate on 115 VAC. This voltage 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.

Periodic checks

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

Weekly:

- Check the dust buildup on the air filters. Replace filters if necessary.

Quarterly:

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

Annually:

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

Filter replacement

CAUTION

Always turn off transmitter power before changing air filters.

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 one 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.

Troubleshooting

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 build-up 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 of about 30" is sometimes necessary.

Improper RF readings

If RF performance changes, record the new readings in your maintenance log and compare them with the initial readings. Take particular note of whether the change occurred during or just after a period of severe weather.

Call Shively Labs; we will help you correct the problem.

Air flow switch check

Check the function of the air flow switch circuit (forced-air-cooled units only) 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.
 - d. Remove the flex hose on the inside of the flow switch tube.
 - e. Unscrew the screw and withdraw the switch from the air plenum.
 - f. 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.
 - g. If the switch behaves properly, reinstall it and check the relay and wiring in the transmitter's interlock circuit.
-

Cavities

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

Return policy

When returning any material to the factory, be sure to call your salesman and obtain an returned materials authorization (RMA) 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.

Maintenance log

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