Shively Labs®

FM Balanced Combiner

Model 2540

Installation, Operation,
& Maintenance

Congratulations!

Thank you for purchasing one of the finest balanced combiners on the market today. The Shively Labs Model 2540 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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Publication No. IM2540 (0503)

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

General Description

The Shively Labs Model 2540 balanced 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 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. The cavities are cooled by natural convection or optional forced air. Figure 1 shows the basic layout of a Shively Labs balanced combiner system.

NOTE

We produce balanced combiners 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 combiner 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 are shown in Figure 2 on page 4 and Figure 3 and Figure 4 on page 4.

Installation Parameters

Locate your combiner where the ambient temperature will not rise above 40° C (105° F), and the ambient humidity will not be above 60%.

All major components of the combiner are match-marked and must be installed according to the match-marking for proper performance.

Your combiner is designed to operate at specific frequencies within the FM frequency range of 88 - 108 MHz. These frequencies must be introduced to the combiner in the sequence indicated on the input assemblies.

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

The optional safety overtemperature switch, if provided, will shut the unit down at an internal temperature of 70° C (160° F).

Performance

Typical performance characteristics are described on Shively's data sheet for the Model 2540. The test specifications for your own unit are on its test data sheet, provided with the unit.

NOTE

Cooling blowers and air flow switches are included only on forced-air-cooled units.

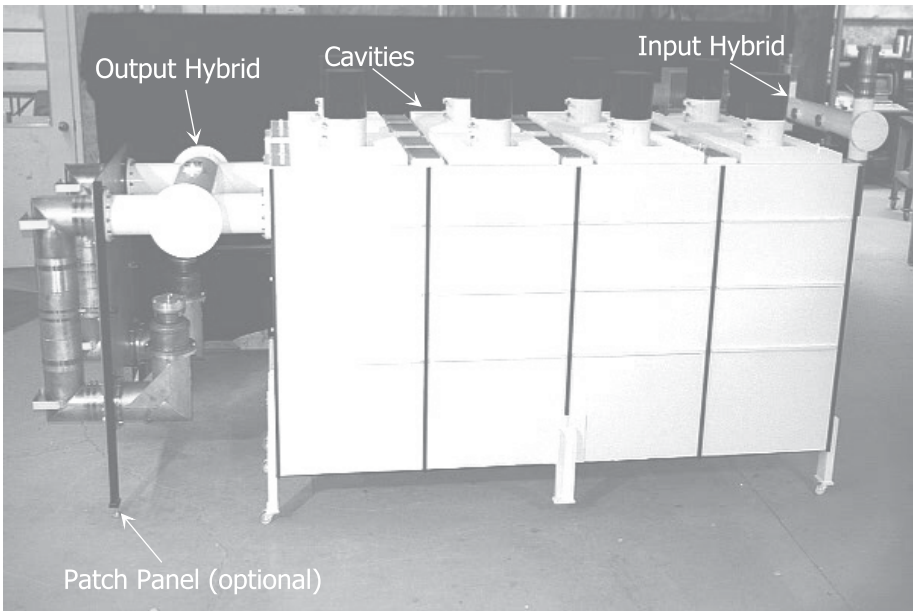


Figure 1. Typical Balanced Combiner Module, Front View

NOTE

Coax inputs and outputs are designed to your specifications.

NOTE

Patch panels and overtemperature switches are optional accessories.

2 Installation

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 combiner 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 combiner 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 (forced-air-cooled) or in the bottom of each cavity (convection-cooled).

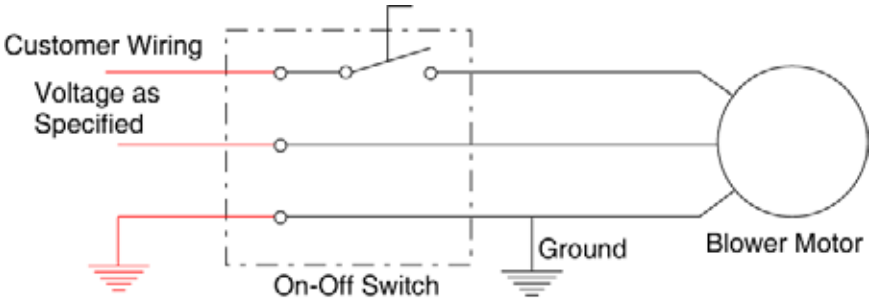
Simply place the combiner in position. You need not lag it to the floor, although you may if you want to.

Blower Wiring

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.

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

Figure 2 is a schematic of the blower wiring.



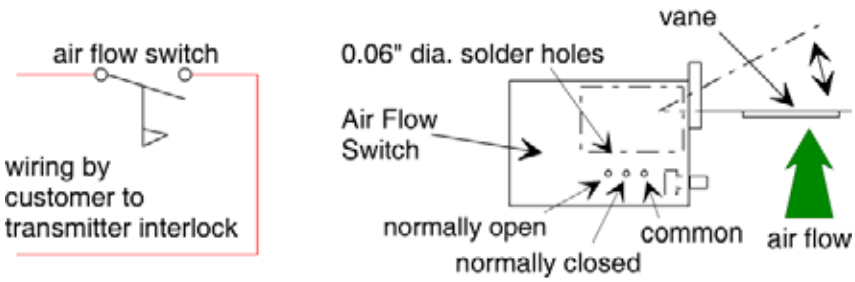
Wire to the switch inside the switch housing.

Figure 2. Blower Motor Wiring

Transmitter Interlocks

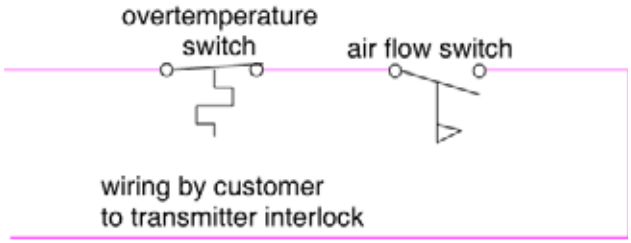
The interlocks, where applicable, are unpowered switches that make and break a low-voltage signal to the transmitter.

Wire the interlocks as shown in the electrical schematic diagrams, 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

Coax Connections

The coax connections are shown in the installation drawing.

The combiner input ports are labeled by frequency. Connect the input port of Channel 1 to the appropriate transmitter output. Do the same with the other channel(s).

Connect the output port to the coax tee at the other end of the combiner. The clamps on the tee may be loosened and the output branch of the tee rotated to any convenient orientation. Don't forget to retighten the clamps.

Checkout

Your Model 2540 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 of the many flange clamps is secure. Make no other mechanical adjustments to the unit.

Check VSWR, insertion loss, and isolation channel-to-channel 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 combiner.

3 Operation

Initial Startup, Forced-Air-Cooled Units

If your combiner 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 transmitter T1 to half power. Monitor the transmitter VSWR. Wait until transmitter T1's operation is stable and acceptable.

d. Take T1 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.

Repeat steps b through e for the other channel(s).

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

Initial Startup, Convection-Cooled Units

If your combiner 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 all channels 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 transmitter T1 to half power. Monitor the transmitter VSWR. Wait until transmitter T1's operation is stable and acceptable.

d. Take T1 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.

Repeat steps b through e for the other channel(s).

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:

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

b. 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 appropriate electrical schematic, Figure 3 or Figure 4 on page 4.

Normal Startup, Convection-Cooled Units

Before applying transmitter power, check the air filters in the bottom of the cavities to be sure they are not blocked or dirty.

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.

Apply transmitter power. Your combiner is in operation.

Normal Shutdown

Since a convection-cooled combiner is strictly a passive unit, no shutdown procedure is necessary.

Shut a forced-air-cooled combiner down as follows:

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

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

Interlock Shutdown

We use two kinds of safety interlocks on Model 2540 combiners. 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 combiner 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 enginneer. He may suggest you change the length of the coax between the transmitter and the combiner. An increase 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 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 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, if applicable.
- 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.

Air Flow Switch

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:

Turn off the transmitter to prevent RF exposure to repair personnel.

Turn off the 120 VAC power to the cooling blower.

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.

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.

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 R.F. malfunction, contact Shively Labs.

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).

WARNING

The overtemperature switch contains electrical voltage which must be shut off externally to the combiner. Be sure all voltage to the overtemperature switch is off before proceeding.

c. 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 combiner 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 2540 combiner:

Table 1. Replacement Parts

Quantity	Shively Part No.	Description
1	56120-7C504	Blower Assembly, Dayton #7C504
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