

ZebraStat®

Model ZS-2 Operation Manual



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Specifications

Your ZebraStat will give you longer life if you treat it carefully, like any other sensitive tool.

Maximum Input Voltage.....28 Volts

Maximum Current Through Unit.....5 Amps

Overall Circuit Protection.....5 A. @ 24 V.

White Wire Circuit Protection.....3 A. @ 24 V.

Unit Size.....8"L. x 5"W. x 2.25"H.

Unit Weight.....18 oz.

Warranty.....One Year Limited Warranty

Safety Information

Please read these instructions before using your ZebraStat. They contain information to protect you, your customers, and their property from harm or damage. Understanding the proper use of this tool may also assist you to make quicker and more accurate diagnostics on the equipment that you service.

Maximum Input Voltage.....28 Volts

Maximum Current Through Unit.....5 Amps

• **NEVER connect any lead to (nor allow any unconnected lead to touch) Line Voltage, or any voltage higher than 28 Volts.**

• Do not perform an activation that a normal thermostat could not perform, such as calling for heating *and* cooling simultaneously. (Unless you are servicing a heat pump.)

• If the equipment requires it, respect staging precedence. (i.e.: Do not turn on stage two if stage one is not already activated.)

• Do not allow your ZebraStat to get wet. If it does get wet; dry it thoroughly before using.

Using the ZebraStat

To use your ZebraStat, follow these steps:

- 1) Decide the **mode** that you want to use
- 2) **Hook up** appropriate leads to equipment
- 3) **Manipulate** Mode & Component switches
- 4) **Observe** the LED's and equipment tested

Explanation of steps:

1) Mode. ZebraStat operates in 3 different modes. You can easily leave it hooked up and use all 3 modes on the same equipment as needed. The 3 modes are:

- *Continuity* - This mode tests that the wires that you connect to electrically 'go somewhere'. For instance, the wire that you connect to the FAN lead normally goes through a fan relay, and the continuity mode will tell you if there is a continuous circuit through that relay on the other end of the equipment's wire.
- *Analyze* - This mode simply *displays* the power flowing through the circuits that your leads are connected to. First, the red LED's tell you power is available in the equipment. Yellow LED's light when the thermostat is calling for heating, cooling, fan, or reversing valve.

Using your ZebraStat (continued) 5

- *Activate* - This mode is like having a remote-control thermostat. Technicians often use it when the thermostat is not easily accessible: when making a diagnosis or repair to a unit in an attic, basement, roof, or new construction where the thermostat hasn't been installed yet.

2) Hook-Up. Start with the Mode Switch in the ANALYZE position and have all component switches OFF. The hookup of Zebra-Stat's leads is the same for all modes. First, connect the component lead's alligator clips to their respective wires at the equipment. (Common uses of wire colors are listed below the component switches. However, you can use any of the wires to test any other 24V function, like 'Emergency Heat'.) Then connect the Red and Blue leads to the equipment's 24V power, observing polarity. All modes except ANALYZE require that all thermostat functions be OFF.

3) & 4) Manipulate Controls & Observe LED's & Equipment. See the following sections (Continuity, Analysis, or Activation) for the proper steps to follow next.

Troubleshooting Electronic Boards

A blown fuse on an electronic control board presents special challenges. Rather than just replacing the fuse (and possibly watch it 'blow' again) the ZebraStat offers a diagnostic alternative. The White wire (the HEAT1 circuit) has a special function built into it. Between the Red and White wires is a low-amp, auto-reset, solid-state 'circuit breaker'. This circuit breaker is set to 'trip' at 3 Amps, providing a safe alternative to repeatedly replacing fuses while looking for the cause.

Here's how it works: Remove the blown fuse. Attach the Red and the White leads of the ZebraStat to the board or fuseholder where the fuse was. No other leads should be attached for this mode. Turn the mode switch to ACTIVATE and turn ON the HEAT1 component switch. All other component switches should remain off. Now, the ZebraStat's circuits are acting as a 'circuit breaker' with a rating of 3 Amps.

Troubleshooting (continued)

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If the current flowing into the ZebraStat through these two wires should exceed 3 Amps, the breaker will 'trip', and the lower Trip LED will light. The breaker will stay in this 'tripped' condition until the power is removed from one of the leads for about 15 seconds. (Some electronic thermostats may start a set/reset cycle as they lose power and drop out.)

A typical problem causing a fuse to blow on one of these boards is a shorted thermostat wire. Diagnosing which wire is accomplished much easier with a ZebraStat: Hook up the ZebraStat as described above. When the ZebraStat's breaker trips, remove power to the system for 15 seconds. While the power is off remove one thermostat wire at a time from the control board, turning on the power again after each disconnection. When the Trip LED does NOT light up after removing a wire, the suspect circuit has been found. If all external low voltage control wires are removed, and the Trip LED still lights, it's time to suspect that the board itself may have a problem.

Voltage Problems

Voltage problems in a system are frequently overlooked, but are very easy to find. For instance, many technicians don't compare the current draw on contactors when replacing one. In most cases there won't be a problem, but if the transformer is already close to its output capacity, and the new contactor requires a higher current level to close, intermittent problems are likely to arise, especially if the line voltage drops a few percent because of high demand, say, on a hot afternoon.

The ZebraStat has a built-in voltage monitor section that makes it easy to tell if the voltage being supplied at the Red and Blue leads is adequate. (These voltages could easily be determined with a voltmeter, of course; but many technicians do not check for low-voltage levels while under load, even though they *could*.)

Getting used to glancing at the VOLTAGE section of the ZebraStat may help you detect some of these problems before they actually cause a fault.

Voltage Problems (continued)

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There are 3 red LED's in the voltage section: **ON**, **??**, and **OK**. The **ON** LED will light when the voltage applied to the power input leads is *at least* 8 volts. The **??** (Questionable) LED glows about half-brightness at 19.5 volts, and full-brightness at 20.5 volts. The **OK** LED glows about half-brightness at 21.5 volts, and is fully bright at 23 volts.

Any time that you are using the ZebraStat and notice that the **OK** LED isn't fully lit, you may want to check the voltage level at the component that is farthest away from the system transformer while under load. (The voltage drop from the wires will be greatest there.) If the **OK** LED isn't glowing at least half-brightness, there is the potential that higher temperatures (higher wire resistance) and lower line voltage (due to high demand) may cause that component to not be able to close fully, or, in the case of a reversing valve, not be able to change positions. A higher-rated transformer may be called for, or larger wiring.

Feature Identification

Mode Switch

Upper Trip LED (Red)

Voltage Monitor

Lower Trip LED

Lead Compartment

Magnet (on back)

Quick Reference



ZebraStat Model ZS-2

ON

ACTIVATE

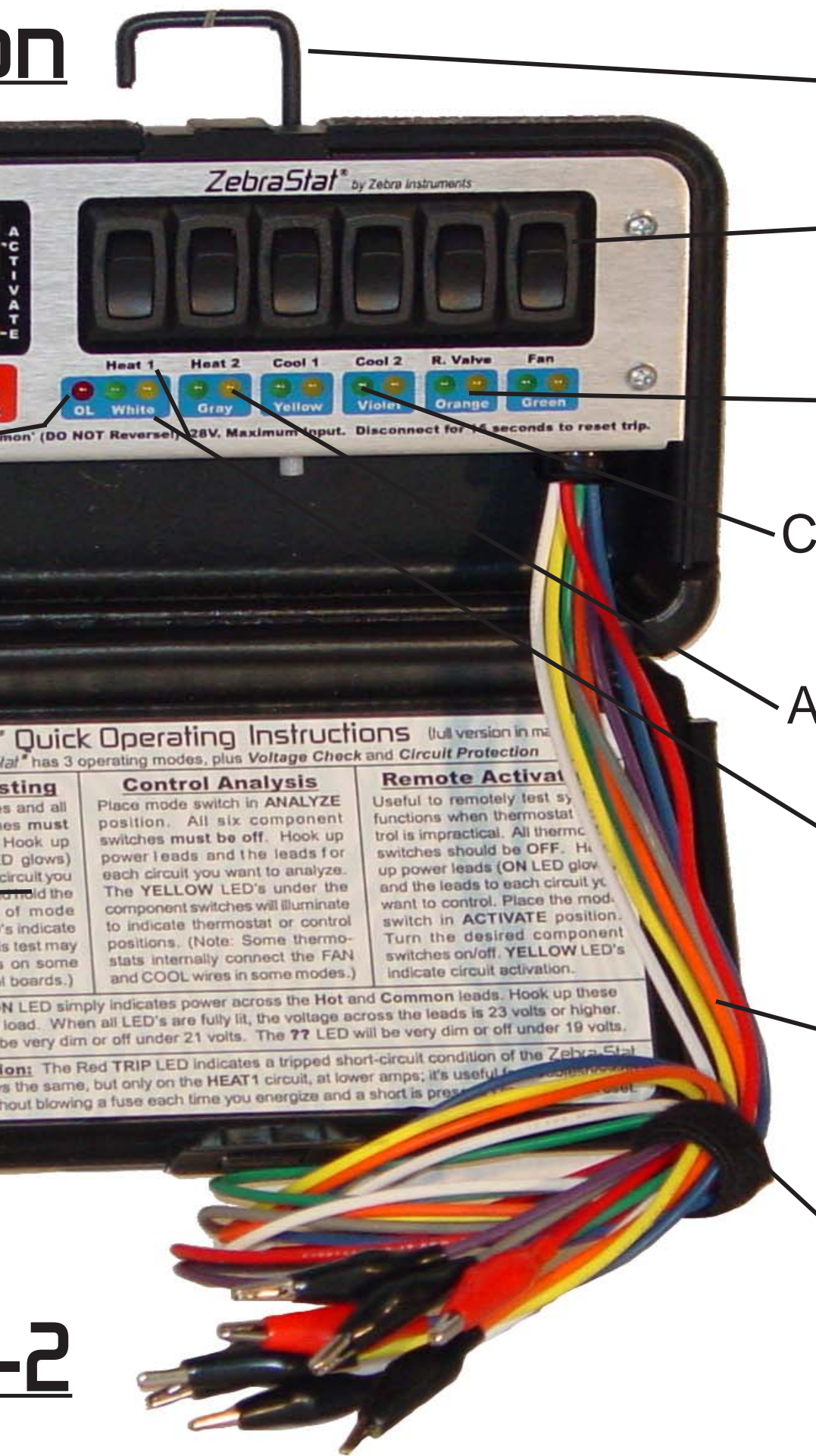
TRIP

Testing

ON LED simply indicates power across the Hot and Common leads. Hook up these leads to the circuit you want to test. When all LED's are fully lit, the voltage across the leads is 23 volts or higher. When the voltage is low, the LED's will be very dim or off under 21 volts. The ?? LED will be very dim or off under 19 volts.

Warning: The Red TRIP LED indicates a tripped short-circuit condition of the ZebraStat. It will glow red when a short is present. It will glow red throughout blowing a fuse each time you energize and a short is present.

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Hanging Hook

Component Switches

Component Displays

Continuity LED's (6 - Green)

Activation LED's (6 - Yellow)

Wire Color Codes

Leads

Velcro Strap

ZebraStat[®] by Zebra Instruments

Heat 1 Heat 2 Cool 1 Cool 2 R. Valve Fan

OL White Gray Yellow Violet Orange Green

28V. Maximum Input. Disconnect for 15 seconds to reset trip.

Quick Operating Instructions (full version in manual)

Control Analysis	Remote Activation
Place mode switch in ANALYZE position. All six component switches must be off. Hook up power leads and the leads for each circuit you want to analyze. The YELLOW LED's under the component switches will illuminate to indicate thermostat or control positions. (Note: Some thermostats internally connect the FAN and COOL wires in some modes.)	Useful to remotely test system functions when thermostat control is impractical. All thermostat switches should be OFF. Hook up power leads (ON LED glow) and the leads to each circuit you want to control. Place the mode switch in ACTIVATE position. Turn the desired component switches on/off. YELLOW LED's indicate circuit activation.

Continuity Mode

Continuity Mode tests that the wires your ZebraStat's leads are connected to 'go somewhere' electrically. For instance, the wire that you connected the FAN lead to normally goes through a fan relay. Using this mode will tell you if there is a continuous circuit through that relay on the other end of the wire.

- 1) Turn all thermostat functions to OFF.
- 2) Turn all the ZebraStat's component switches to OFF, and put the Mode Switch in the ANALYZE position.
- 3) Attach the ZebraStat's component leads to the appropriate equipment wires, then attach the Red and Blue power leads to the equipment's 24VAC hot and common wires, observing polarity.
- 4) Verify that no yellow LED's are lit before proceeding. If they are, recheck thermostat for ON (or wiring for shorts) before continuing.

Continuity (continued)

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Caution: The continuity mode passes a very small amount of current to ‘test’ each of the circuits that it is connected to. As more modern equipment uses computer-type processing boards to control equipment, some may be designed that have functions that *might* be activated by the ZebraStat’s tiny (about 7 milliamps) of current to test the different circuits. Be aware that some circuits might possibly be activated while testing in Continuity Mode. (For instance, don’t test continuity on equipment if your hand is near the fan. It *could* start during this test. Ditto for the condensing unit.)

5) Place the Mode Switch to the Continuity Position. Green LED’s should illuminate under each component being tested. No light probably indicates an incomplete circuit. A yellow LED indicates the component under test is currently ACTIVATED; the LED will change back to green when activation is removed. Control boards on some new variable speed units may give false positive indications.

Analysis Mode

Analysis Mode simply *displays* any control power that is being sent to the circuits that your leads are connected to. The red LED's will indicate the level of AC power available at the equipment. Yellow component LED's will illuminate on each circuit that is currently energized. This mode is often used by a tech to isolate the general area of a problem.

For instance, you turned the FAN switch on at the thermostat, but the fan does not start. Observing a *lit* yellow LED in the FAN section of the ZebraStat connected to the equipment would tell you that the signal is getting to the equipment (suggesting a problem inside the equipment). If the corresponding LED was *not* lit, (the signal was *not* getting to the equipment) it suggests that the problem may be in the thermostat or it's associated wiring.

- 1) Turn all of the ZebraStat's component switches to OFF, and put the Mode Switch in the ANALYZE position.

Analysis (continued)

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2) Attach the ZebraStat's component lead's alligator clips to the appropriate equipment wires, then attach the Red and Blue power leads to the equipment's 24VAC hot and common wires, observing polarity.

3) Notice which yellow LED's are illuminated under their component switches. (All of the component switches must be OFF.) These LED's indicate which circuits are currently receiving power. Technicians often use this feature to troubleshoot: (a) cross-wired thermostat wires (for instance, if the condensing unit starts when the fan switch is activated on the thermostat) or; (b) shorted thermostat wires (for instance, if the two cooling stages start simultaneously when only one is being called for; or a continuously operating fan). NOTE: Many thermostats pre-connect FAN & COOL leads when set to 'Cool' mode, etc.

4) Manipulate the thermostat's switches and observe the results on the ZebraStat to verify that all functions are working properly.

Activation Mode

Activation mode is similar to having a remote-controlled thermostat. Technicians often use this mode when the thermostat is not easily accessible, as in when making a diagnosis or repair to equipment in an attic, basement, on a roof, or other location remote from the area where the thermostat is located.

- 1) Turn all thermostat functions to OFF.
- 2) Turn all of the ZebraStat's component switches to OFF, and put the Mode Switch in the ANALYZE position.
- 3) Attach the ZebraStat's component lead's alligator clips to the appropriate equipment wires, then attach the Red and Blue leads to the equipment's 24VAC hot and common wires, observing polarity.
- 4) Verify that no yellow LED's are lit before proceeding. If any are, recheck thermostat for ON (or wiring for shorts) before continuing.

Activation (continued)

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Caution: Remote activation can surprise another technician working elsewhere on related equipment. Communicate your intentions to anyone else involved. For instance, when remotely activating the cooling stages of a system; you don't want to start a fan or compressor that someone may be inspecting.

5) Turn the Mode Switch to ACTIVATE.

6) Turn on component switches as appropriate. Use care to activate components logically; for instance, do not turn on BOTH a heating and a cooling stage at the same time. Likewise, you usually turn on FAN when a COOLing stage is active. Finally, respect the sequence of stages; don't activate stage 2 (cooling or heating) unless stage 1 is active.

NOTE: Some systems may have other components, like 'Emergency Heat' that you may test. You can use any of the four 'stage' wires, (HEAT 1 & 2, etc.) to test these components.

Circuit Protection

Your ZebraStat provides circuit protection in two ways. Each uses a solid-state, automatically-resetting circuit breaker device. The white test lead is protected with a 3 Amp device. You can learn more about its use in the “Troubleshooting Electronic Boards” section. The second device provides an overall protection for the ZebraStat. It is rated at approximately 5 Amps at 28 Volts. (150VA)

If you inadvertently hook up the ZebraStat’s power input leads using an incorrect ‘polarity’ and attempt to use the Activation Mode, or if you allow a loose ‘hot’ lead to touch ground, you will probably ‘trip’ this circuit protection, shutting down the ZebraStat, and turning on the red TRIP LED. The unit will remain in the tripped condition until you remove all power to the unit for about 15 seconds. *Before re-connecting, discover and correct the condition that caused the trip in the first place.*

This protection device is not meant to protect the unit from higher voltages than 28 Volts.

Avoiding Problems

1) The “power-in” wires (RED & BLUE) **ARE POLARIZED**, even though it’s an AC circuit! The RED lead must connect to the equipment’s HOT wire (usually red), and the BLUE lead must connect to the equipment’s COMMON wire (usually brown or blue). **REVERSING THESE LEADS CAN CAUSE THE ZebraStat’s CIRCUIT BREAKER TO TRIP.**

2) If you are getting a strange LED indication in either the CONTINUITY or ANALYZE modes, it could be caused by having one of the ZebraStat’s component switches ON. Leave all six switches OFF for testing in either of these two modes.

3) In the CONTINUITY or ACTIVATE modes, all thermostat switches should be OFF, and it must not be calling for any heating or cooling. Strange LED indications may appear on the ZebraStat if all thermostat functions aren’t completely ‘OFF’.

4) Some thermostats internally connect their ‘G’ and ‘Y’ terminals when in ‘Auto Fan’. (This will be noticed in the CONTINUITY or ANALYZE modes.)

5) Some thermostats may activate the reversing valve as soon as they are switched into ‘Heat’ or ‘Cool’. (CONTINUITY or ANALYZE modes.)

One Year Limited Warranty

For a period of one (1) year from the original end-user's date of purchase, Zebra Instruments warrants that this tool will perform as described. Should you encounter any problems, please contact us and we will attempt to resolve your problem as quickly as possible. This resolution may include replacement; exchange; or repair of a defective unit, at our option. This warranty does not apply to units that have been exposed to: voltages and/or currents that are higher than those specified in this manual; abuse or rough handling; or damage from moisture or exposure to chemicals. Out-of-warranty repairs are available for a nominal charge plus shipping. Please contact us for a return authorization number before returning any unit.

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