

YSI MODEL 73A

... indicating, on-off controller with recorder output

This versatile temperature controller has the unique capability of simultaneously maintaining temperature within precise limits, accurately indicating temperature, and providing a continuous signal for temperature recording. It is one of the few controllers to incorporate a DC probe to eliminate interference often caused by AC control systems. These features make the YSI Model 73A ideal for medical applications, as well as many research and industrial tasks.

Models are available in 16 temperature ranges from -45° to $+146^{\circ}\text{C}$. Control temperature can be dialed directly without external reference, sensitivity can be varied from 0.02° to 0.4°C for optimum control, panel lights indicate operation in "heat" or "cool" mode, and any YSI Series 400 interchangeable probe can be used for temperature sensing.

Control Range:

16 temperature ranges available from -45° to $+146^{\circ}\text{C}$. (See Temperature Range Selection Chart.)

Sensitivity:

Adjustable from at least .02 to .4 $^{\circ}\text{C}$

Control Point:

Settable by direct dial to $\pm 0.5\%$ of control range using YSI Series 400 Probes. Stability $\pm 0.02^{\circ}\text{C}$ with 5% (6 VAC) line voltage variation and $\pm 2^{\circ}\text{C}$ ambient change.

Ambient Temperature:

-25° to $+50^{\circ}\text{C}$ (-13 to $+120^{\circ}\text{F}$)

Relay:

Double pole-double throw plug-in relay. Both sets of contacts rated at 1000 watts, non-inductive load. One set connects line voltage to outlets, second set accessible by a terminal strip on rear panel.

Recorder Output:

105-125 to 0 mV full scale for each temperature range. Recorder should have minimum 100K ohm impedance.

Power:

Available 115 or 230 VAC, 50/60 Hz, 6 watts. Total load to 1000 watts non-inductive. Outlets protected by 10 Amp fuse on 115 VAC models, 5 Amp fuse on 230 VAC models. Terminal strip contacts not fused.

Size:

14 X 22.5 X 23.5 cm, 3 kg (5½ X 8½ X 9¼ inches, 7 lbs.)

Probes:

Designed for use with YSI Series 400 probes. In certain situations 500 Series probes can be used. Consult factory for details.

HOW TO ORDER:

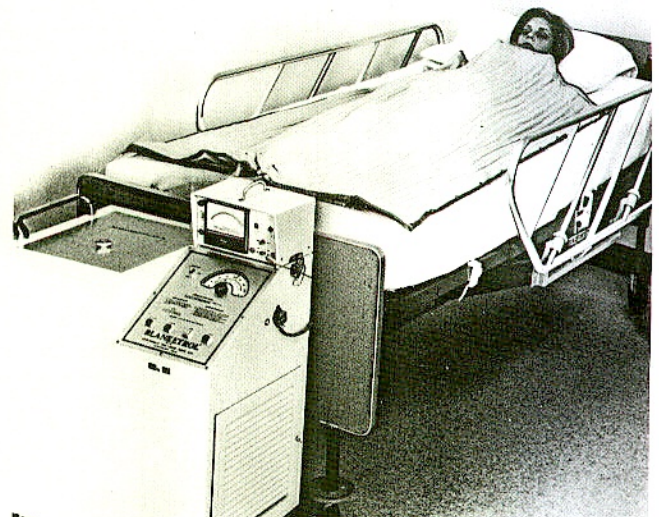
Order directly from YSI franchised dealers using the following part numbers:

- YSI Model 73A (plus Range Code) for 115 VAC operation
- YSI Model 73A (plus Range Code) — 230 for 230 VAC operation
- YSI 41604 Spare Relay

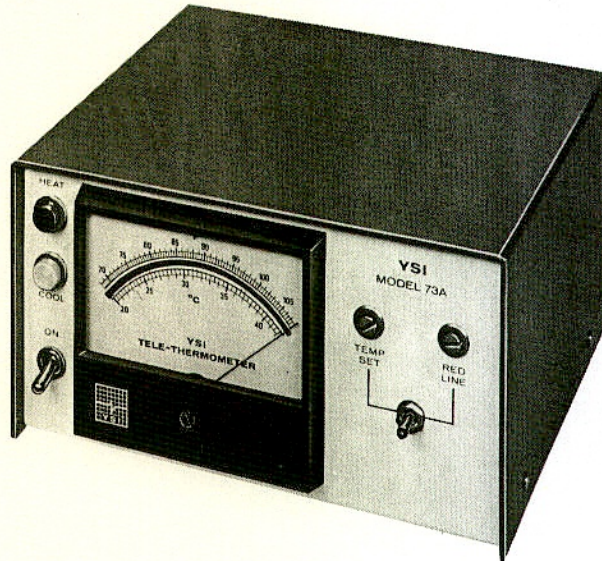
MODEL 73A RANGE SELECTION CHART

YSI Model	Temperature		Accuracy of Readout $^{\circ}\text{C}$	Readability $^{\circ}\text{C}$
	$^{\circ}\text{C}$	$^{\circ}\text{F}$		
(Stock Ranges)				
73ATA	20 to 42	68 to 108	0.2	0.1
73ATD	0 to 50	32 to 122	0.5	0.2
73ATC	15 to 100	60 to 212	0.8	0.4
73ATF	35 to 46	95 to 115	0.1	0.05
(Semi-Stock Ranges)				
73ATV	-45 to $+10$	-50 to $+50$	0.5	0.2
73ATY	-40 to -13	-40 to $+10$	0.3	0.2
73ATE	-23 to $+40$	-10 to $+105$	0.6	0.3
73ATZ	-17 to $+48$	0 to 120	0.6	0.3
73ATH	-4 to $+37$	25 to 100	0.4	0.2
73ATB	0 to $+40$	32 to 105	0.4	0.5
73ATS	0 to $+66$	32 to 152	0.6	0.3
73ATJ	10 to 40	50 to 104	0.3	0.2
73ATW	24 to 146	70 to 300	1.2	0.5
73ATG	25 to 45	77 to 113	0.2	0.1
73ATK	27 to 43	80 to 110	0.2	0.1
73ATP	35 to 60	95 to 140	0.3	0.2

A special-purpose temperature controller built for a leading manufacturer of hyperthermia/hypothermia equipment to control patient temperature.



**INSTRUCTIONS FOR
YSI MODEL 73A
INDICATING TEMPERATURE
CONTROLLER**



YSI Scientific

Yellow Springs, Ohio 45387 USA • Phone 513 767-7241 • 800 343-HELP

PRICE INCLUDING HANDLING \$5.00

INSTRUCTION BOOK YSI MODEL 73A CONTROLLER

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YSI MODEL 73A INDICATING TEMPERATURE CONTROLLER

1. General Description

The YSI Model 73A is an indicating temperature controller with many unique features including:

- availability in 15 individual temperature ranges within a total range of -45° to $+150^{\circ}\text{C}$ (-50° to 300°F).
- direct dial settability.
- adjustable temperature control point throughout the entire span of each temperature range.
- capability of continuous and simultaneous temperature control and temperature indication.
- adjustable control sensitivity for a variety of applications.
- DC Wheatstone bridge, which means there is only DC in the temperature sensing probe, eliminating interference with other low-level signals often caused by AC control systems.
- use with any YSI Series 400 thermistor temperature probes.
- extra relay contact for alarms, motors, solenoids, heating or cooling devices with independent power supplies.
- control of up to 1000 watts of power per set of contacts.
- recorder output for permanent records.
- rugged solid-state transistor circuitry suitable for laboratory, medical, and industrial applications.

2. Theory of Operation

A control system generally consists of a YSI Model 73A indicating temperature controller, the mass whose temperature is to be controlled, a thermistor temperature sensing probe, and in many cases a means of distributing energy throughout the control mass, such as a stirrer in a temperature controlled bath.

The temperature probe is connected to a DC Wheatstone bridge in the controller. When the probe senses a temperature that is the same as the temperature control set point, the bridge has a zero voltage output. When the probe resistance changes due to a control mass temperature change the bridge output voltage varies from zero. This voltage variation is amplified to close the contacts of a relay through which power is provided to heat or cool the control mass until such time as the control mass returns to the temperature set point.

SPECIFICATIONS

1. 117 Volt Instruments

Temperature Range: determined by temperature range of meter.

Dead Zone: variable from .02°C to at least .4°C. Dead Zone is set to 0.1°C at the factory.

Accuracy:

1. Temperature indication is accurate to $\pm 1\%$ of the meter range under normal line voltage variations and ambient temperature excursions of $\pm 10^\circ\text{C}$.
2. Settability – temperature may be set to $\pm 5\%$ of range.
3. Control Stability – better than $\pm 0.02^\circ\text{C}$ with stable line voltage ($\pm 5\%$) and ambient temperature ($\pm 2^\circ\text{C}$). The control point will not change more than $\pm 0.15^\circ\text{C}$ for ambient temperature changes of $\pm 25^\circ\text{C}$ from 25°C or more than $\pm 0.02^\circ\text{C}$ for 10% line voltage variations.

Relay: (with controller set for 0.1°C dead-band) double pole, double throw contacts rated at -

10 amp non-inductive	–	500,000 operations
5 amp non-inductive	–	2,000,000 operations
2 amp inductive	–	1,000,000 operations

Recorder Output:

Recorder signal of 0 to 105-126 mv corresponding to the range span, is available from the barrier strip on the back panel of the instrument. The recorder used should have an input impedance of at least 100,000 ohms.

Power Requirements:

1. Controller – 117 VAC, 50-60 HZ, 6 watts – operable from 95 to 125 VAC
2. Load – dependent upon application, limited by the 10 ampere rating of the relay contacts (each set).
3. Fuse – all three outlet receptacles are protected by the rear-mounted fuse. The controller is shipped with a 10 ampere fuse installed. This is the maximum line cord rated current and should not be exceeded.

2. 230 Volt Instruments

If this instrument is a 230 VAC model, the following notes apply to statements made in this manual.

Power Requirements:

1. 230 VAC, 50-60 Hz, 6 watts, operable from 190 to 250 VAC.

2. Current requirement of instrument and relay contact ratings is 1/2 that stated.

Schematics:

1. The schematic drawing contains notes indicating variations required in the circuit.

Line Cord and Outlets:

1. Line cord is the standard 3-conductor grounded type rated at 7.5 amps at 250 volts. The green insulated conductor is connected to chassis ground and the ground prong of a Bryant #5666N attachment plug.
2. Outlets are 3-conductor grounded Hubbell #5658 receptacles.

OPERATING PROCEDURES

This section describes the general step by step procedure for setting up the instrument, including a discussion of problems which may be encountered.

1. Setup

- a. adjust meter zero (if necessary) by turning the bakelite screw on the meter face so that meter needle coincides with the extreme right hand mark on the scale.
- b. connect instrument to power source.
- c. attach temperature probe, YSI Series 400
- d. connect instrument to heating or cooling device. (See Load Considerations.)
- e. turn instrument on.
- f. **calibrate the meter** by setting the switch to RED LINE and adjusting the RED LINE control until the needle coincides with the red line on the meter dial. Release the switch.
- g. **set the control temperature** by setting the switch to TEMP SET and adjusting the TEMP SET control to the desired temperature. Release the switch.
- h. when temperature equilibrium has been established, cycling rate should be one cycle per second or longer. If too rapid, adjust control range by:
 1. repositioning heater and/or probe.
 2. reducing heater power.
 3. changing sensitivity control. (See Sensitivity Adjustments.)

2. Probe Selection

The YSI Model 73A indicating temperature controller is designed specifically for use with YSI Series 400 interchangeable temperature probes. In special situations YSI Series 500 and 600 probes may be used with the aid of a conversion chart to convert indicated temperature to actual temperature.

Complete specifications and recommended applications for standard probes are contained in the YSI Thermistor Probes Catalog.

The YSI Model 73A should be purchased with a temperature range covering your application requirements. In situations where a range is required outside of that shown on the meter, it is sometimes possible to use a specially constructed probe and conversion chart. For more detail please consult the factory.

3. Probe Location

Probes are attached through the phone jack at the rear of the instrument. Placement of the probe is of great importance when close temperature control is required. If the probe is located close to and down stream from the heating or cooling unit, often the temperature can be held to narrower limits than the dead zone of the controller, typically $\pm 0.05^{\circ}\text{C}$ when the dead zone is set at $.1^{\circ}\text{C}$.

If the thermal load on the system varies widely, locating the probes at a greater distance from the heating or cooling unit will result in better average temperature stability, but at the cost of somewhat greater temperature undershoot and overshoot.

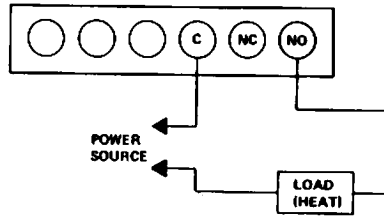
4. Load Considerations

- A. The size of the heating or cooling unit must be determined by the operating conditions. Normal 117 VAC, 50-60 Hz heating and cooling loads may be connected to the marked convenience outlets on the back of the instrument. Contact ratings should not be exceeded.
- B. When applications call for large amounts of power for heating or cooling to maintain temperature, control will be improved by dividing the load, powering one portion from an external source and the other portion from the HEAT or COOL receptacle.

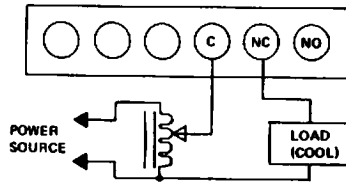
In addition, this will permit using a total load greater than the rating of the relay contacts. If the total load does not exceed 10 amps, the uncontrolled portion of the load may be powered through the auxiliary outlet.

The auxiliary outlet is powered by the front panel power switch and may be used to operate blowers, stirring motors, circulation pumps, etc.

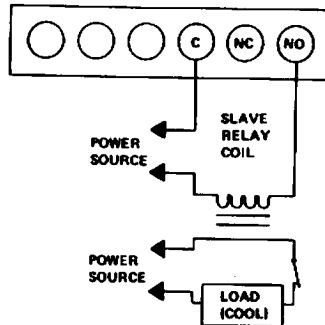
- C. The second set of control relay contacts is connected to a barrier strip at the rear of the instrument.
 1. If it is desirable to use other than 117 VAC power for the heating or cooling units, connect one side of the power source to terminal C (common) and the other side to the unit being controlled. For heating units the terminal NO (normally open), or for cooling units the terminal NC (normally closed), should be used for the load return line.



2. When only a small amount of heat is needed to maintain temperature, heat input may be reduced by adjusting the voltage to the heater with a variable transformer. Connect the heater as a load on the secondary or output of the variable transformer through the NO or C terminals on the barrier strip. The line (primary or input) side of the variable transformer should be ON at all times, that is, it should be connected to the auxiliary outlet or other power source. This method of connecting the transformer prevents overloading of the relay contacts with the "inrush" current when the variable transformer is first energized.



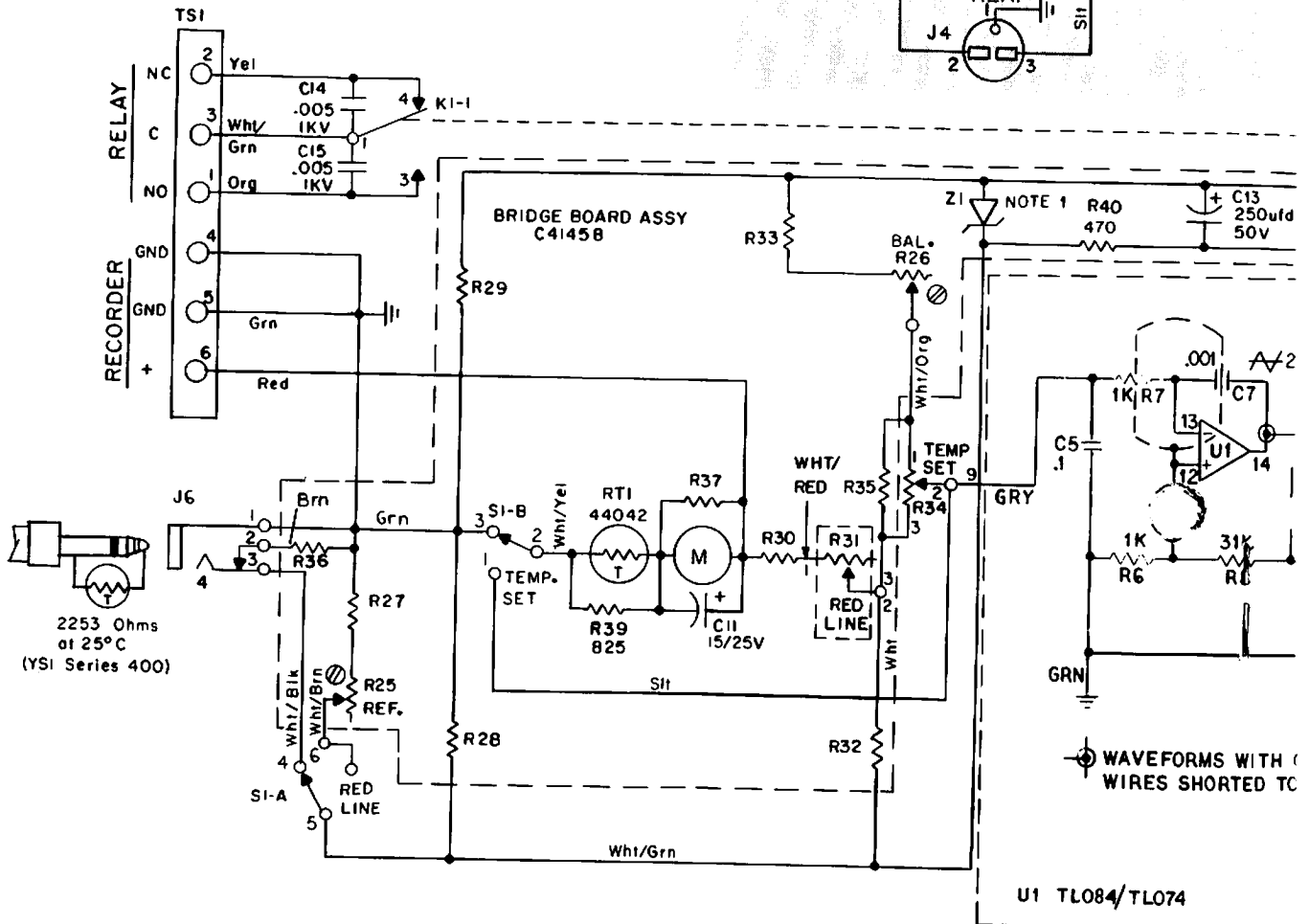
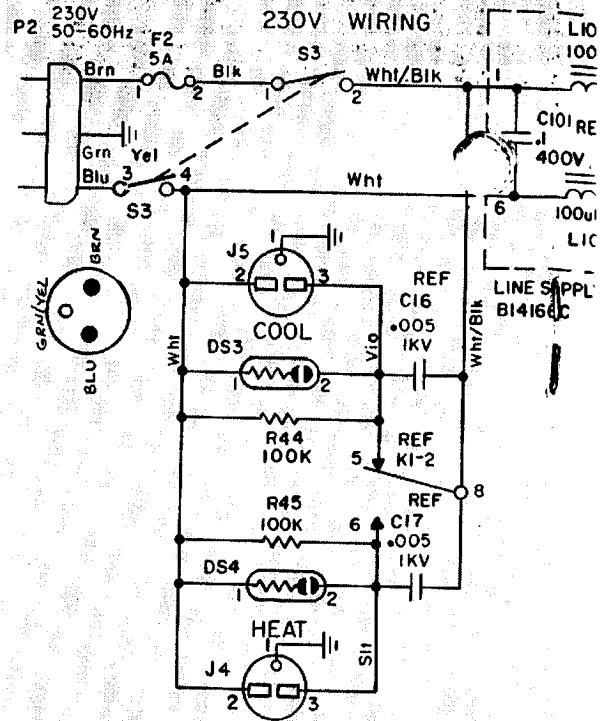
3. When control of very large or inductive loads is desired a supplementary external relay or contactor may be used. Connect the activating coil to the controller in place of the load to be controlled. For cooling loads either wire slave to NC and use normally open slave relay, or wire slave to NO and use normally closed slave relay. For heating loads either wire slave to NO and use normally open slave relay, or wire slave to NC and use normally closed slave relay.



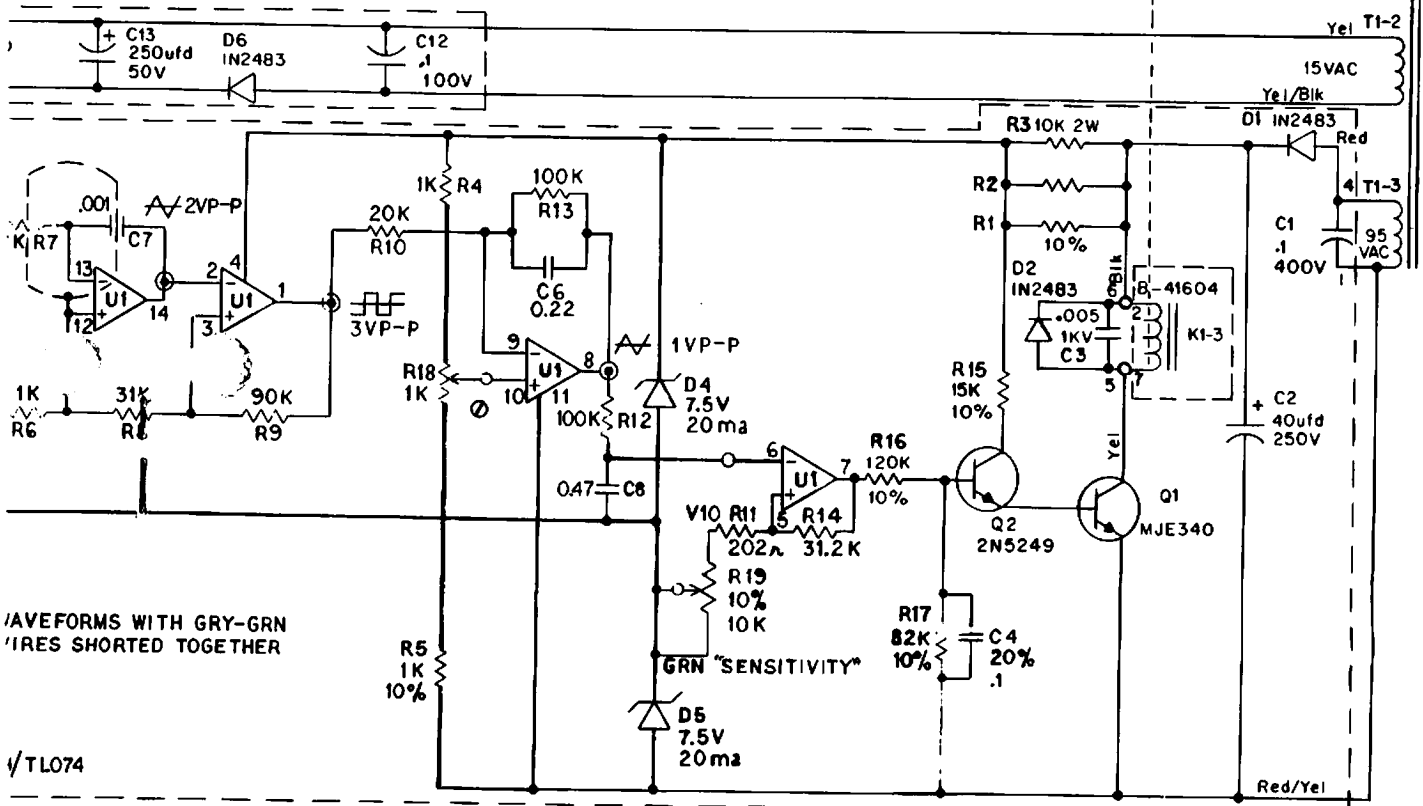
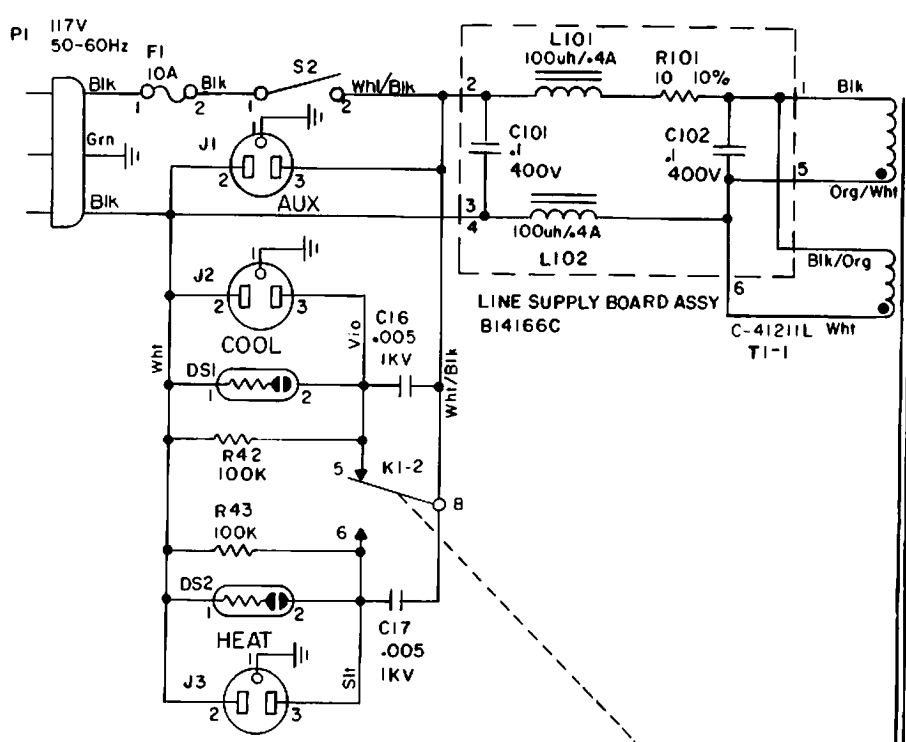
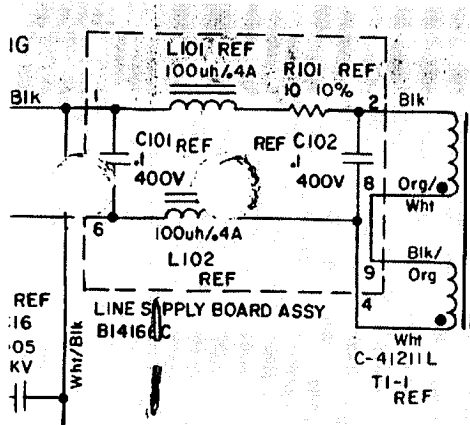
- D. The barrier strip connections also may be used for remote indicating and signaling purposes while the load is connected to the receptacle outlets.

NOTE:

1. Z1 is 6.5V on all ranges except TC is 6.2V and TF is 7.5V.
2. Selected at factory—consult factory.
3. For unmarked component values—consult factory.
4. All resistors are 1/2W 1% unless otherwise specified. All resistors in ohms K=1000, M=1,000,000. All capacitors are in microfarads.
5. The values shown on the schematic may differ from those in the instrument; if so, either value can be used for replacement purposes.
6. See inset for 230 wiring.



2253 Ohms
at 25°C
(YSI Series 400)



WAVEFORMS WITH GRN-GRN
TERMINALS SHORTED TOGETHER

TL074

MODEL 73A

C41578

WARNING

Heat lamps and lightbulbs have high inrush currents at the moment of turning on. The current may be 18 times the lamp operation current and can cause serious erosion and early failure of relay contacts. Consult your lightbulb manufacturer for information on derating the relay contacts. Divide between receptacle outlets and barrier strip, and use auxiliary relays, if required.

5. Sensitivity Adjustments (control range)

The dead band of the YSI Model 73A is set in the factory to $.1^{\circ}\text{C}$ and is quite adequate for a large variety of applications. However, where a closer or wider control range is desired, the sensitivity may be altered by the screwdriver SENS adjustment on the back panel of the instrument. Clockwise rotation of the SENS control increases the dead band while counter-clockwise rotation decreases the dead band. The point at which the relay is energized (when the NO contacts are closed) remains relatively constant for any particular setting of TEMP SET control. Increasing the dead band has the effect of moving to a higher temperature the point at which the relay is de-energized. The dead band may be set from less than $.02^{\circ}\text{C}$ to at least $.4^{\circ}\text{C}$.

Caution must be used when increasing the instrument sensitivity, because the relay life is shortened and the performance is not always improved.

6. Application to Critical Processes

If a critical application requires a high degree of long-term temperature stability, on the order of $\pm .02^{\circ}\text{C}$, two stabilizing factors should be considered — ambient temperature and line voltage variations. If ambient temperature is maintained within $\pm 2^{\circ}\text{C}$ and line voltage within $\pm 5\%$, instrument stability will not limit the control temperature stability.

7. Recorder Output

Where a permanent record of the temperature indication is required, a recorder output is available at the barrier strip on the back panel of the instrument. The output for the recorder is taken from across the instrument meter and meter temperature compensation network. The span is 0 to 105-126 millivolts DC. The recorder should have an input impedance of at least 100,000 ohms. The YSI Model 80A recorder is recommended. Readjust RED LINE after attaching recorder.

CALIBRATION

The instrument is initially calibrated at the factory and should not require recalibration during its life unless parts are replaced or the settings of the potentiometers are disturbed. Whenever calibration is necessary, it is recommended that the instrument be returned to the factory. If this is not possible, use the following procedures.

The calibration consists of two separate steps; calibration of the bridge and calibration of the controller. These are independent and calibration of one does not require recalibration of the other.

1. Calibration of the Bridge

- a. Obtain a precision resistance decade box, such as the General Radio Type 1432-M or precision fixed resistors in the values needed. Accuracy of the resistance should be at least $\pm .5\%$.
- b. Connect two leads from the resistance source to a standard phone plug. The outside terminal of the phone plug should be connected to the grounded terminal of resistance decade box.
- c. Remove instrument dust cover by removing 4 screws, 2 on each side of the instrument.
- d. Adjust meter zero (if necessary) by turning the bakelite screw on the meter face so that the meter needle coincides with the extreme right-hand upper scale mark.
- e. Remove probe and turn instrument on. The meter should deflect to the right of the right-hand end of the meter scale. This is normal.
- f. Locate the potentiometer BAL (R2) and REFERENCE (R1) on the printed circuit board mounted on the meter and locate Table I.
- g. Set the decade resistance box to a resistance corresponding to "Resistance at balance" in Table I.
- h. Plug in the decade resistance box in place of the probe and adjust the BAL pot (R2) so that the meter pointer coincides with the extreme right-hand upper scale mark.
- i. Change the decade to a resistance corresponding to the "Resistance at the Red Line" in Table I.
- j. Adjust the RED LINE control on the front panel so that the meter pointer coincides with the red line on the scale.
- k. Set the switch to RED LINE adjust the REFERENCE pot (R1 on P.C. board) until the meter pointer coincides with the red line on the scale. Releasing the switch should cause no change in indication. If it does, it means that Step J or K was not performed accurately and should be repeated.

Step K completes the bridge calibrating procedure.

Table I

RANGE	TEMP. RANGE		REDLINE		LOW		MED		BALANCE HIGH	
	°C	°F	Calib.	Th. Res.	Temp.	Res.	Temp.	Res.	Temp.	Res.
	TA	20 to 42	68 to 108	74 °F	2424	68 °F	2814	88 °F	1731	108 °F
TC	15 to 100	60 to 212	35 °C	1471	15 °C	3539	57 °C	625.2	100 °C	153.2
TD	0 to 50	32 to 122	5 °C	5720	0 °C	7355	25 °C	2253	50 °C	811.7
TF	35 to 46	95 to 115	37 °C	1355	95 °F	1471	105 °F	1174	115 °F	942.5

2. Calibration of the Controller

- a. Remove the instrument dust cover by removing 4 screws, 2 on each side.
- b. With the instrument turned on, and the spring-loaded switch held toward RED LINE, adjust the meter pointer to the red line on the meter face by means of the screwdriver adjustment on the front panel.
- c. Connect a decade resistor in place of the probe, as described in "Calibration of the Bridge," and set it to the resistance indicated in the chart at the top of page 9 under MED for your instrument range. Observe the reading.
- d. With the spring-loaded switch held toward TEMP SET, use the front panel screwdriver adjustment to set the meter pointer to the same reading observed in the previous step.
- e. Short from point A on R7 on the controller board (see drawing on next page) to point B on D4 (or any other ground).
- f. Connect a DVM between point C on R12 and point B on D4 (or any other ground).
- g. Adjust the potentiometer (R18) on the controller board to obtain a reading of 0.00 volts \pm 0.05 volts on the DVM.
- h. Disconnect test leads and reassemble the instrument.

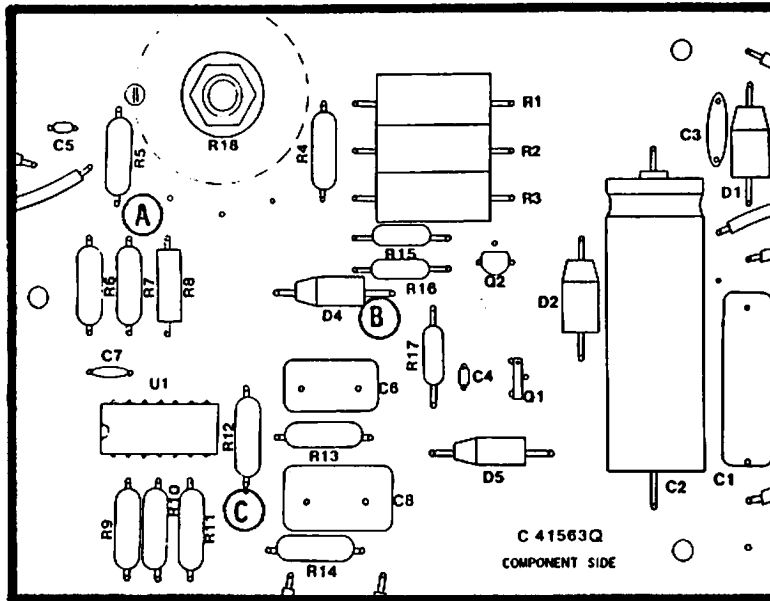


Figure 1. Amplifier Calibration Setup

WARRANTY

All YSI products carry a one-year warranty on workmanship and parts exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge, if possible, when the item is returned to the factory or to an authorized YSI dealer.

If you are experiencing difficulty with any YSI product, it may be returned for repair, even if the warranty has expired. YSI maintains complete facilities for prompt serving of all YSI products.

YELLOW SPRINGS INSTRUMENT CO., INC.
 SERVICE DEPARTMENT
 P.O. BOX 279
 YELLOW SPRINGS, OHIO 45387, U.S.A.

PHONE: 513-767-7241

When temperature and voltage instrument version changes. A correction factor is expected to a correction factor. Measure for data consistency use the measurement offset. Measure range. The circuit circuit

All wire-leads, local he inadequate that capacity probe cable. In medical surgical units, electro-surgical should be checked frequencies point which by using pa

APPENDIX YSI SERIES 500 PROBES

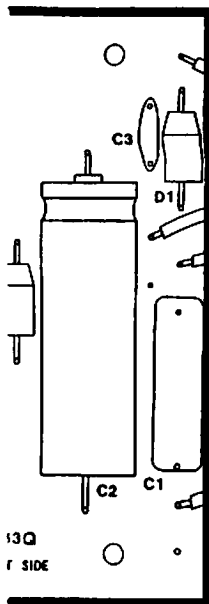
When temperature measurement applications require probes of fast response time and very small physical size, YSI Series 500 probes can be used with this instrument. These probes are not interchangeable and must be used with a conversion chart to correct the temperature indication which the instrument displays. A conversion chart is furnished with each Series 500 probe. It is unique to that probe, and is identified by serial number. The conversion chart should be inspected to assure that the temperature of interest, when corrected by the proper correction factor, falls within the display range of the instrument.

Measurement accuracy using Series 500 probes is conditioned by the need for data conversion and by errors associated with thermistor self-heating. Thermistors used in these probes have very low thermal dissipation, and therefore the measurement current itself can produce a small but significant temperature offset. Measurement currents differ with instrument model and instrument range. The error due to self-heating must be determined in the specific measurement circumstance.

WARNING

All wire-lead patient-connected transducer assemblies are subject to reading error, local heating and possible damage from high-intensity sources of RF energy. Inadequately grounded electrosurgical equipment represents one such source in that capacitively-coupled currents may seek alternate paths to ground through probe cables and associated instruments. Patient burns may result.

In medical use, remove the probe from patient contact before activating the surgical unit or other RF source. If probes must be used simultaneously with electrosurgical apparatus, the instruments to which the probes are connected should be chosen to provide adequate isolation from electrical grounds at radio frequencies. Hazards can also be reduced by selecting a temperature monitoring point which is remote from the expected RF path to the ground return pad and by using pads having the largest practical contact area.



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