W-2704
Rev. B
5/00

Wahl
INSTRUMENTS, INC.

ST-2000
Soldering Iron Tester
Instruction Manual

S/N _____ Date _____

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WARRANTY

WAHL warrants all its products to be free from defects in workmanship and material under normal use and service.

If any of our products is believed to be defective as to workmanship and/or material under normal use and service and if the same is returned to the Company, freight prepaid, within 12 months after date of purchase is found by the Company's inspection to be defective in workmanship and/or material under normal use and service, it will be repaired or replaced free of charge and shipped, freight prepaid, to any point in the United States. If inspection by the Company of any such product does not disclose any defect in workmanship and/or material under normal use and service, the Company's regular charges will apply. This warranty shall not apply to (1) ordinary wear and tear nor (2) any product which has been opened or modified or repaired or altered by a purchaser, (3) to any product which has been subjected to misuse, negligence or accident. The Company's obligation, under its warranty or otherwise, relative to product defects is limited to the above paragraph.

Warranty Card must be filled in and returned for above warranty to be valid.

- -

WARRANTY REGISTRATION
WAHL

MODEL NO. _____ SERIAL NO. _____

DATE PURCHASED _____

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE ____ ZIP _____

How will the instrument be used? _____

_____

Was the instrument in good order when received? _____

_____

appd 1/76
12/87

Wahl

SAMPLE

CERTIFICATE OF CALIBRATION

Customer: _____

Wahl Order Entry No.: _____

Model No.: _____ Quantity: _____

Serial Number(s): _____

This is to certify that the instrument(s) listed above were calibrated to meet Wahl published catalog specifications.

Wahl Instruments Inc. maintains a calibration system in conformance with MIL-STD-45662 specification. These instruments have been calibrated against secondary standards, traceable to the National Bureau of Standards. Test reports for the Standard Calibration Equipment are on file at Wahl Instrument Inc.

_____
Quality Control Supervisor

_____
Date

Attachment: Certification of Calibration Test Reports are included and are a part of this certification.

Report Number(s): _____

Wahl

Test
Report No.: _____

CERTIFICATION OF
CALIBRATION MODEL ST2000

SAMPLE

Model: _____ Serial Number: _____

Calibration Equipment

- Temperature: Wahl - Calibrator Model C65, Serial No.: _____
  Date Calibrated: _____ Calibration Due: _____
- Millivolts: Hewlett Packard - Oscillator, Model 209A, S/N: _____
  Date Calibrated: _____ Calibration Due: _____
- Ohms: Dekabox - Decade Resistor, Model DB52, S/N: _____
  Date Calibrated: _____ Calibration Due: _____

Temperature Calibration:

Input Temp. Wahl C65	Indicated °F Temperature ST2000	Indicated Error °F Temp.	Allowable Error °F Temp.
75°F			±1.2
500°F			±2.5
900°F			±3.7

Millivolts Calibration: (Note 60 HZ AC Signal)

Input MV RMS Hewlett Packard 209A	Indicated Millivolts RMS ST2000	Indicated Error MV RMS	Allowable Error MV RMS
Grounded Sensor			±.2
2.0			±.2

Resistance Calibration: (Note: Lead Resistance = 1 Ohm Compensated)

Input Ohms Dekabox DB52	Indicated Ohms Ohms ST2000	Indicated Error Ohms	Allowable Error Ohms
0.1			±.2
50.1			±1.2
2.1			±.24

Calibrated By: _____ Calibration Date: _____

Quality Control Accepted By: _____

Customer: _____

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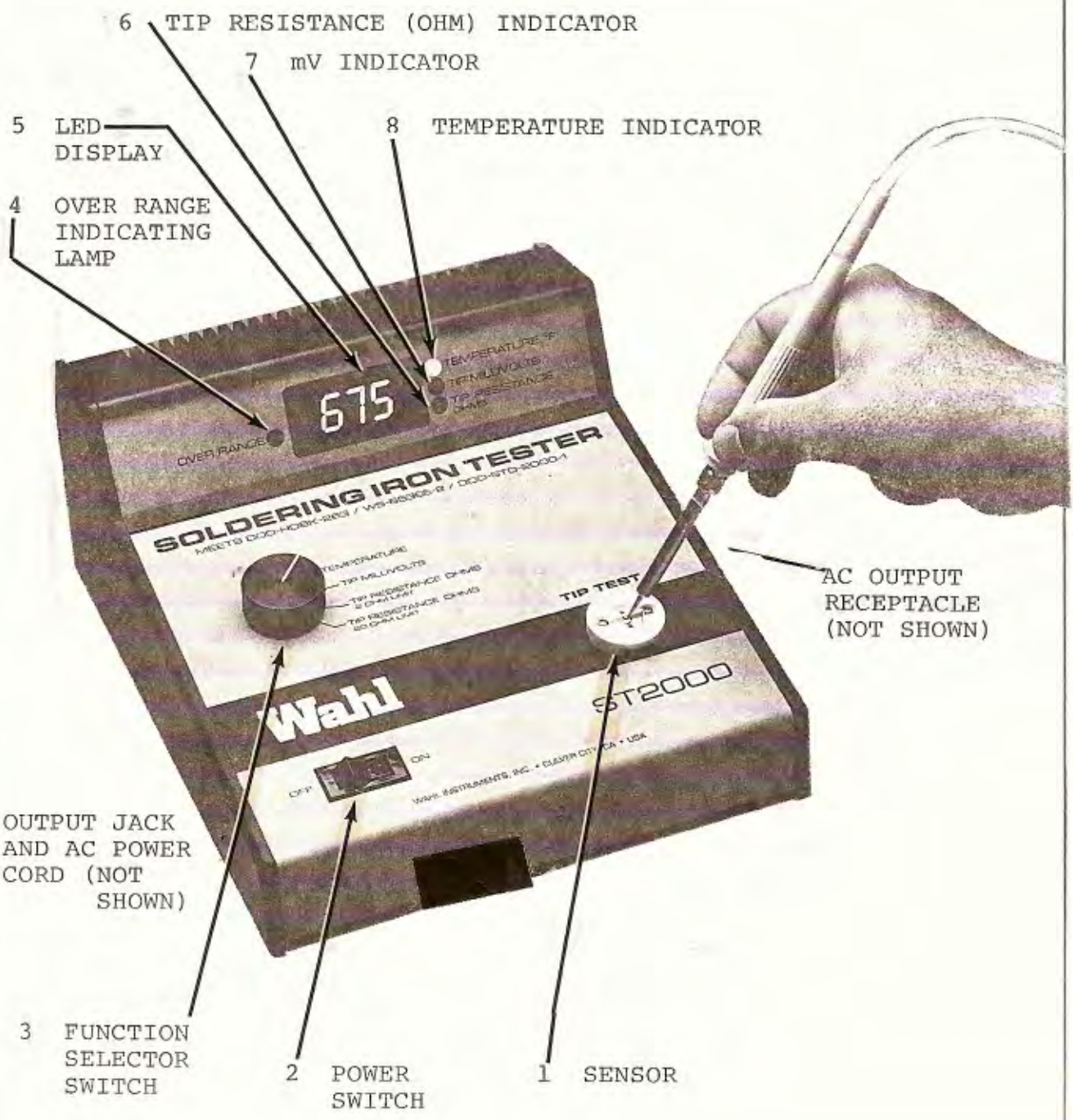
FIGURE 1-1.

ST2000 SOLDERING IRON MIL SPEC TESTER



UNPACKING

Use care in opening the carton containing the ST2000. Retain and store this carton and packing materials for use in returning the unit to Wahl for calibration to NBS standards and if necessary for use in returning the unit for repair.

LINE POWER

Each ST2000 is configured to accept line power of 115 or 230 VAC (±10%) at 50 or 60 Hz. Verify that your instrument has the proper rating for the AC line voltage to be applied. This rating is shown adjacent to the power cord exit on the rear of the instrument.

CAUTION

The display cover, line cable and fuse holder are made of thermoplastic resin. Be careful not to deform them by touching them with a soldering iron or other hot objects.

AC line output is always energized when power cord is connected to AC source.

WARRANTY

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1.0 INTRODUCTION

The Wahl Mil Spec Tester Model ST2000 is designed for testing the performance of hand-held soldering irons used in the production of electronic circuits for the U.S. military. See Figure 1-1.

Standards have been established by U.S. Government specifications that limit the allowable voltage potential at the soldering iron tip, tip to ground resistance and temperature variations at the tip. See Table I, below.

The purpose of these standards is to prevent damage to sensitive electronic components by induced voltage or overheat and to assure high quality solder joints by controlled temperature at the tip.

Table I.

REQUIREMENTS OF VARIOUS U.S. GOVERNMENT SPECIFICATIONS

Applicable Specification	Tip Temperature	Tip Voltage Potential	Tip Ground Resistance
WS-6536E-2	±10°F (max) at idle	≤2 mV	≤2 ohms
DOD-STD-2000-1B	±11°F (max) at idle	≤2 mV	≤2/20 ohms
DOD-HDBK-263	No Requirement	<15 V	<20 ohms
MIL-STD-45743E	Control ±10°F (max)	<2 mV	N/A

2.0 WAHL MIL SPEC TESTER ST2000

The Wahl ST2000 tester is easy to use since all tests are performed by touching the working tip of the soldering iron to the solder bead on the sensor. By rotating the function switch all Mil Spec requirements are conveniently verified on the large digital display.

In addition the sensor simulates a solder joint and provides the user with a means of matching the iron thermal capacity to the work. Sensors of different thermal load capacities are available from Wahl.

FEATURES

- For use in soldering and desoldering operations.
- Tip potential (RMS) measurement from ground reference to soldering iron tip.
- Ohms measurement from ground reference to soldering iron tip.
- Wide range measurement of tip temperature, 50 - 999^{O}F.
- Warning indicators for tip voltage and resistance.
- Easy operation, three measurements from one sensor.
- Quick response, completely tests a soldering iron in 30 seconds.
- Measures pot-solder resistance to ground, millivolt potential and temperature with optional probe and adapter.
- Optional battery operated model ST2000B for use where line power is not available for tester.

3.0 OPERATION OF PORTABLE MODEL ST2000

3.1 Connecting to AC Power

The ST2000 is a portable tester with the AC power cord coiled on hooks at the rear. It is used with 3-wire grounded soldering irons and is plugged into an AC receptacle with the identical ground wire as the irons to be tested.

3.2 Function Selector Switch

To operate the tester refer to Figure 1-1. Turn the power switch (2) on. With function switch (3) set to TEMPERATURE, the display will turn on and show ambient room temperature. If the selector is set for MILLIVOLTS or TIP RESISTANCE the display will be off until the soldering iron tip is placed on the sensor bead.

3.3 Mil Spec Testing

To make Mil Spec tests, preheat the iron with the working tip installed to soldering temperature. Touch the heated tip to the solder bead at the center of the sensor (1). The same firm pressure is applied as in soldering.

Rotate the function switch to read TIP RESISTANCE OHMS, TIP MILLIVOLTS and TEMPERATURE. Read actual values on the display.

The selected indicator lights (6,7) confirms the function mode and flashes when Mil Spec limits are 10% below spec. limits, as follows:

Function	Condition
Tip Millivolts (7)	In excess of 1.8 mV
Tip Resistance (2 ohm) (6)	In excess of 1.8 ohms
Tip Resistance (20 ohms) (6)	In excess of 18 ohms
Over Range (4)	When any of the functions exceed instrument limits.
Low Battery (not shown)	On ST2000B, battery operated model.

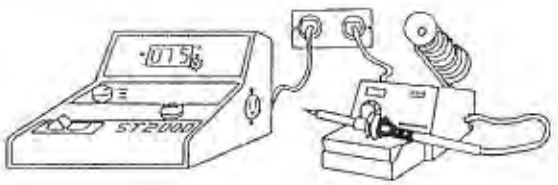
For temperature performance, observe temperature values on the display. Most soldering irons will drop in temperature when first applied to the sensor (1), recover in about 5-10 seconds, and then idle within a temperature band width of 20°F. Holding the iron on the sensor for 30 to 60 seconds will show the temperature performance of most irons.

Soldering irons with defective controls, or poor contact between tip and heater, or ones with course limit switches will cycle in excess of ±10°F (20°F band width) and should be removed from service. Some irons may drop too low in temperature for quality work and should be replaced.

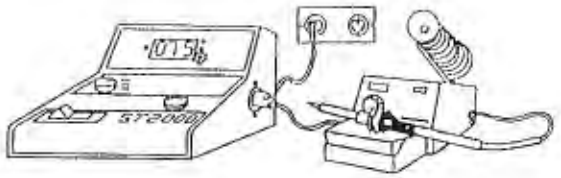
3.4 Hook Up

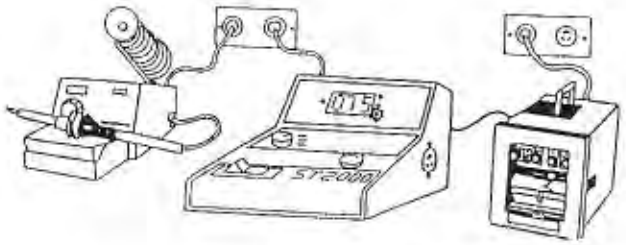
Figure 3-4, below, shows several methods for connecting testers ST2000 and ST2000B for production and inspection tests.

TESTER AND SOLDERING IRON CONNECTED TO COMMON RECEPTACLE WITH IDENTICAL GROUND

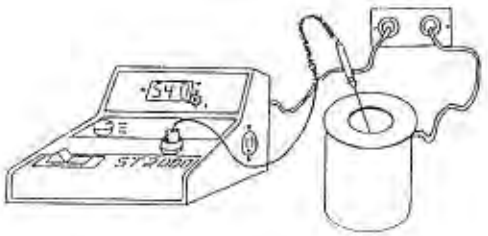


SOLDERING IRON CONNECTED TO TESTER AC OUTLET ASSURES COMMON GROUND





MILLIVOLT RECORDER CONNECTED TO TESTER TO RECORD MILLIVOLTS, OHMS AND TEMPERATURE DURING SOLDERING IRON TEST. SHOWN WITH WAHL CHART RECORDER, MODEL 211AV



USING TESTER ST2000 WITH POT SOLDER PROBE ST-801 FOR CHECKING TEMPERATURE RESISTANCE TO GROUND AND VOLTAGE POTENTIAL.

Figure 3-4. Tester Connection Methods

4.0 MODEL ST2000B BATTERY OPERATED TESTER

4.1 Battery Operation

Model ST2000B is portable and operates from either its internal, rechargeable battery pack or from AC power. It has the same features and specifications as Model ST2000.

Its use is specified when AC power is not convenient for the tester but a ground connection is available which is common to the soldering iron. Some users find battery operation a convenience on production lines for daily checks of irons.

ST2000B BATTERY OPERATED TESTER CONNECTS EITHER TO AC POWER RECEPTACLE OR TO COMMON GROUND ONLY. USE WHERE AC POWER OUTLETS ARE NOT CONVENIENT AND WHEN A COMMON GROUND CONNECTION IS PROVIDED.

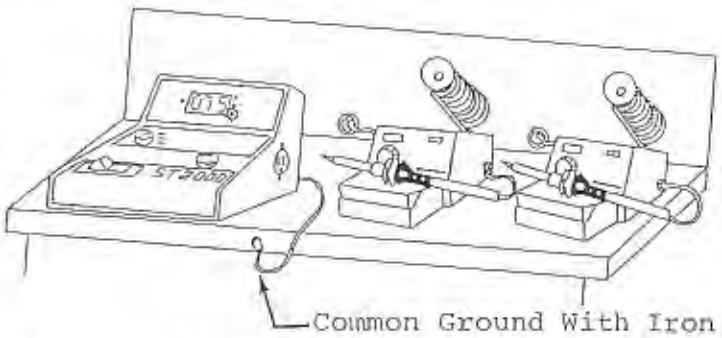


Figure 4-1. Tester Connection Methods, ST2000B

4.2 AC Line Cord Adapter Plug

When using the ST2000B battery powered unit, the round pin of the AC line cord must be connected to a reference ground in order to measure tip millivolts and tip resistance to ground, while temperature measurements can be made without such a connection. An adapter plug is provided with the battery powered ST2000B which allows the user to connect the ground reference of the ST2000B to a standard banana dimension receptacle by simply slipping the P/N WST-36 Adapter over the AC line cord plug and tightening the thumb screw of the adapter up against the round pin of the AC line cord plug. The added resistance of this adapter plug has been measured at .003 ohms maximum which will not effect either the resistance or millivolt test readings.

4.3 Battery Life

The ST2000B contains its own Gel Cel battery pack and built-in recharger for 12 hours of continuous use on a full charge.

A low battery indicating light is located on the left of the digital display

5.0 SAFETY FEATURES

5.1 ESD Protection

The ST2000 is designed for use in ESD protected areas. The case is grounded and coated with chloride-free liquid anti-stat (Resque 2). The case has been tested for triboelectric effect during normal operation. It will neither generate nor support a static electricity discharge.

The internal circuitry of the ST2000 is protected against static discharge that may be applied to the sensor during test of soldering irons or when the ST2000 is used as a temperature monitor with a thermocouple input in place of the tip sensor. (See accessories, page 9).

5.2 Circuit Protection

The ST2000 was designed with concerns for operational safety, equipment protection and ease of operation. The ST2000 will withstand AC line voltages that may be inadvertantly touched to the sensor. This protection is accomplished by a combination of input clamping circuitry and wide-compliant circuitry capable of tolerating large voltage swings without damage.

6.0 OUTPUTS (ST2000 and ST2000B)

6.1 Recorder Output Jack

Dynamic performance of tip temperature can be viewed on a strip chart recorder by using the analog output of the ST2000 in conjunction with the low mass WST-01 (.01 grams) sensor or the standard WST-02 sensor (.02 grams). These sensors present thermal loads which would normally be experienced by the soldering iron during actual use.

The output jack on the rear of the unit also permits recording data on soldering irons as part of quality audits and research. Output values are:

Tip Temperature:	1 mv/^{o}F
Tip Resistance:	10 mv/ohm
Tip Voltage:	10 mv/mv

6.2 AC Output Receptacle

An AC output receptacle is provided on the right side of both the ST2000 and the ST2000B for convenience. With the power cord plugged into an AC outlet this receptacle may be used to power a chart recorder or for the soldering iron under test to assure a common ground between them. The AC receptacle is always energized when the power cord is plugged into an AC source.

7.0 DESOLDERING EQUIPMENT TEST

Circuits undergoing desoldering repair are exposed to the same potential sources of electrical and temperature damage as normal soldering. When checking desoldering tools use the tester in the same manner as described above. When checking millivolt tip potential operate the suction switch on the desolder tool and check for voltage surges.

8.0 GENERAL PURPOSE USE

8.1 Pot Solder MIL Spec Measurements

The ST2000 and ST2000B are also used to measure pot solder temperature, solder voltage potential and pot solder to ground resistance in accordance with MIL Specs. Use optional WST-20K adapter and pot solder universal probe TC-801P

Probe TC-801P measures temperature and mV without correction and the value is accurately shown by the display. For resistance the probe has slightly higher resistance than the bead sensor due to its leads, and this difference has to be subtracted from the resistance shown by the display.

For the convenience of the user, each probe is trimmed to a total value of 1.0 ohms to be subtracted from the displayed value.

8.2 Universal Temperature Calibrator

The ST2000 and ST2000B measure temperature of soldering irons using sensor WST-01 or WST-02. It also measures temperatures of solder baths, circuit boards, components and ambient air temperature by the use of optional accessories consisting of P/N WST-20K Type K thermocouple adapter plug and a selection of probes shown in the accessories section (paragraph 10.0).

9.0 SPECIFICATIONS

Model ST2000 and ST2000B Soldering Iron Tester, Specifications

TEMPERATURE	
Range:	50°F - 999°F, 10°C - 540°C (option)
Accuracy:	±0.3% of reading ±1 digit
Resolution:	1°F or 1°C
Type K:	Thermocouple Sensor
TIP OHMS TO GROUND	
Range:	0 - 99.9 ohms
Accuracy:	2% of reading ±0.2 ohms
Resolution:	0.1 ohms
Test Current:	10 milliamperes DC
LED Warning Indicator:	Switch selectable @ >1.8 ohms or >18 ohms

TIP MILLIVOLTS TO GROUND	
Range:	0-50 millivolts DC and mV RMS, 0-30 KHZ bandwidth*
Accuracy:	2% of reading ±0.2 mV
Resolution:	0.1 mV
True RMS Conversion	
LED Warning Indicator:	Occurs @ >1.8 mV
DISPLAY	
Three Digit LED Display:	.56-inch bright red LED seven segment display with peripheral LED status indicators
OUTPUT JACK	
Temperature:	1 mV/degree of tip temperature
Resistance:	10 mV/ohm of tip resistance
Voltage:	10 mV/mV of tip voltage
SENSOR	Type K thermocouple with solder bead. Mass of metal parts is .02 grams (standard), .01 grams (optional). Senses temperature, voltage, resistance.
POWER - INPUT	
AC:	110 VAC, 50/60 Hz, or 220 VAC, 50/60Hz (Transient and surge protected)
POWER - OUTPUT	Power receptacle on side, unswitched. Same as input power. Provided on both ST2000 and ST2000B.
POWER - INTERNAL	
BATTERIES	Model ST2000B, rechargeable from AC power cord. Life, 12 hours per charge.
POWER CONSUMPTION	3 watts maximum
POWER CORD	Attached molded cable, 6 foot length.
ENVIRONMENTAL	Operation 32 to 104°F, 20 to 80% RH Storage -4 to 122°F, 10 to 80% RH
DIMENSIONS	8.5" W x 5" H x 11" D
WEIGHT	
ST2000	6 pounds
ST2000B	7 pounds

*Consult factory for other bandwidth options.

9.1 NBS Traceability

All ST2000 instruments are tested at Wahl using test equipment whose accuracy is traceable to NBS. Wahl will provide an NBS traceability report on request at time of purchase or following recalibration at Wahl.

10.0 ACCESSORIES

The following accessories and spare parts are available from Wahl:

P/N	Description
WST-02	Replacement sensor, mass of thermocouple 0.02 grams (standard)
WST-01	Alternate sensor, mass of thermocouple 0.01 gram
WST-__	User to specify mass of sensor element (grams) Special order.
WST-20K	Interchangeable miniature thermocouple adapter. Replaces temperature sensor. Use for connecting thermocouple probes when using tester as a general purpose thermometer, or when calibrating the solder pots.
WST-30	Spare power cord, 6' length.
WST-31	Spare internal battery, Model ST2000B
211AV	Chart recorder, selectable mV ranges and chart speeds.
	mV ranges: 0-1, 2, 5, 10, 20, 50, 100, 200, 500. Also 1, 5 and 10 volts.
	Chart Speeds: in./min: 1, 2, 4, 5, 10 in./hr.: ½, 1, 2, 3, 6, 12, 30
	Power: 110 VAC
211BV	Same as 211AV except operates on rechargeable battery.
WST-36	Spare ground wire adapter to use with Model ST2000B.
WST-37	Anti-static spray for use after cleaning the Model ST2000 Tester case.

TC-801P Immersion probe for checking solder bath temperatures, 0-1600°F, pot solder voltage potential and resistance to ground. P/N WST-20K adapter required.

TC-803 Surface probe for checking electronic circuit temperatures, soldering iron surface temperatures, 0 - 900°F, also specify P/N WST-20K adapter.

TC-805 Fast response air temperature probe. 0 - 450°F, also specify P/N WST-20K adapter.

TC-863 Patch probes. Use for checking electronic circuits 0 - 500°F. Package of 5. Also specify P/N TCP-6 pads and P/N WST-20K adapter.

TCP-6 Self adhesive pads for attaching P/N TC-863 patch probes to surface. Package of 100.

Figure 10-1. TC-801P Pot Solder Probe for Temperature, mV and Ground Resistance Tests. Also Adapter WST-20K.

11.0 PRINCIPLES OF OPERATION

11.1 General

This section reviews soldering iron performance and test methods to achieve effective use of Mil Spec Tester ST2000.

11.2 Tip Temperature

11.2.1 Temperature Problems

By understanding how soldering irons can cause damage to integrated circuits and other electronic components and by knowing how to measure and control it, production line productivity can be improved.

The thermocouple sensor of the ST2000 is designed for the temperature measurement of soldering iron tips. The diameter of most soldering iron tips used in I.C. device assembly lines is less than 3mm.

For these applications use Model WST-02 sensor. If the diameter is smaller than 1 or 2mm, Model WST-01 is available.

As a point of reference, typical soldering iron tip temperatures vary from 480°F to 900°F while solder melts between 350°F and 600°F.

Most integrated circuit manufacturers specify a maximum lead temperature during soldering of 572°F for 5 seconds or less. By increasing the tip temperature, it can increase devise failure and decrease devise MTBF.

Printed circuit board traces can also be damaged by high temperature causing them to lift away from the board material. The board material itself can be burned causing damage and unsightly brown burn areas.

Decreasing the tip temperature increases soldering time and can cause low quality solder joints. These low quality solder joints can have an undesirable appearance due to dullness and excessive solder build-up or may have cold solder joint characteristics such as high resistance and intermittent contact.

11.2.2 Tip Temperature Measurement

Since many different types of soldering irons are used by industry, the Wahl tester ST-2000 provides a fast, convenient way to measure most soldering iron tip temperatures with the working tip installed from 50 to 999°F.

Switch the range selector switch of the ST2000 to TEMPERATURE and note that the normal room ambient temperature will be displayed (assuming that the sensor has been allowed to reach thermal equilibrium with the surrounding ambient). The display will indicate temperature with a resolution of 1°F or 1°C (optional).

Touch the soldering iron tip to be tested to the solder bead of the sensor. The normal working area of the tip should be used and the tip should be pressed firmly onto the bead area for best results. The display will climb to the final temperature and reach equilibrium in 5-10 seconds depending on the thermal capacity of the iron. At this point, the soldering iron's ability to maintain a temperature can be checked by noting the maximum and minimum valleys that the iron traces as it heats the ST2000 sensor area.

By use of the output jack the temperature history may be recorded (paragraph 10.0).

The replaceable temperature sensor P/N WST-02, Figure 11-1 contains a high temperature Type K ribbon thermocouple (1), stainless steel support strap (2), solder bead (3), and ceramic body (4).

Type K thermocouple material is chosen for its high temperature stability, accuracy and long life in the soldering temperature range of 500 - 900°F. It is a good electrical conductor and therefore allows accurate measurements of tip voltage potential and tip to ground resistance.

The solder bead is important because it simulates a solder joint, provides excellent thermal transfer when melted by the iron and gives a good representation of effective working temperature of the tip. It reforms on cooling and has a long life. Add new solder as necessary. For fast response use only a small amount of solder.

The user may choose sensors to match the thermal capacity of the solder joint when rating soldering irons and tips best suited to the work.

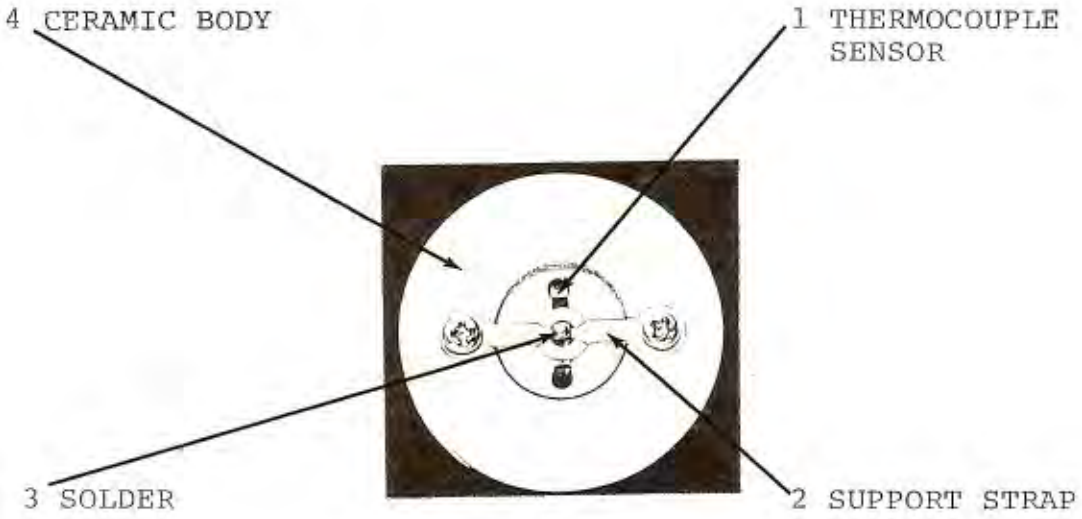


Figure 11-1. Sensor

The WST-02 sensor provided is a heavy duty long-life sensor designed for everyday use for measuring idling temperatures and for rating the draw-down of irons in a working environment. The mass of its thermocouple element is .02 gram. A light duty sensor, P/N WST-01, is available with a mass of .01 gram. Other sizes will be supplied on request.

11.2.3 Idling Temperature Test

Mil Spec 2000-1B and Weapons Spec WS6536E-2 require idling temperature tests to verify reasonable control of temperature to ±10°F during idling. It is not a requirement to calibrate the control setting of the iron.*

To conduct the idling temperature test, switch the function knob to TIP TEMPERATURE, lay the working portion of the tip on the solder bead and observe the temperature display. Press firmly for best results.

The temperature of the tip will drop, then recover and idle at the control level of the iron. Many irons available for Mil Spec soldering will stay well within the ±10°F limits required. See Figure 11-2, page 14.

*For confirmation write to:

WS6536E-2	Code 3681 Soldering Technology Standards Naval Weapons System China Lake, CA 93555
2000-1B	Code 9313 Soldering Technology Standards Naval Air Engineering Center Lakehurst NJ 08733-5100

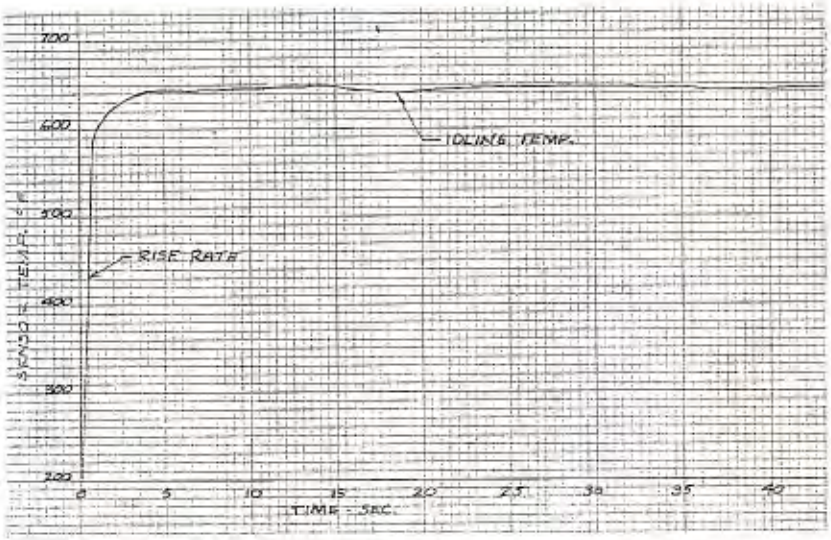


Figure 11-2. Typical Soldering Iron Tip Temperature Display

11.3 Ground Integrity

11.3.1 Soldering Iron Ground Circuit

For Mil-Spec soldering, only 3-wire grounded soldering irons are used. This is to provide a means of protecting electronic components from damage due to voltage potential at the solder joint for any reason.

The ground path on many soldering irons contains mechanical joints between replaceable tips, heater and the ground wire. These joints are subject to loosening, contamination and aging, all of which affect the ground integrity. Other designs have a direct ground connection to the tip which offers greater promise of reliability in spite of aging.

Ground integrity is improved by frequent disassembly and cleaning of irons.

11.3.2 Checking Tip Resistance to Ground

The ST2000 has two resistance measurement ranges available to the user on the front panel selector switch. Either position will correctly indicate the tip resistance to ground reference when the soldering iron tip is touched to the sensor. The difference between the two positions is that the warning indicators will flash at different levels coincident with the range selected. If the 2 ohm test position is chosen, the warning indicator will begin to flash at 1.8 ohms while the 20 ohm range will flash

at 18 ohms. These indicators are intended to warn the operator that the default limits are about to be exceeded.

All resistance measurements are made with respect to the ground reference of the AC line cord (round pin of AC plug). Therefore, the ST2000 line cord ground wire must be connected to the ground reference as chosen by the user (either power ground or earth ground). If a ground reference is chosen other than the ground available via the AC outlet powering the soldering iron, then the ground reference of the ST2000 (round pin of the ST2000 power cord) must be connected to that ground to make tip resistance measurements.

The test current for ohms measurement is 10 milliamperes DC and the ST2000 will display resistance with a resolution of .1 ohm. The operator should be aware that it is possible for circulating ground currents in the AC power distribution system to cause errors during ohms measurements. This will be evidenced by a difference in displayed ohms when the soldering iron power cord and ST2000 power cords are interchanged in their position of connection at the AC power outlet. The reason for this is that a ground current is flowing in the ground line and results in a voltage offset between the two adjacent outlets. In one orientation this offset voltage adds to the ST2000 voltage generated during ohms check and then subtracts if the orientation of the AC power cord connections is reversed. Therefore, as little as 10 millivolts of either polarity will cause a variance on the ST2000 digital display of ±1.0 ohms as the scale factor is 1.0 ohm per 10 millivolts of that voltage measured.

Should this phenomenon be seen, it would indicate that there is excessive ground current flowing (caused by a faulty piece of equipment connected to the AC line) or excessive resistance between AC outlets and should be resolved if highest accuracy measurements are to be made.

One method of avoiding the errors due to differences in ground potential is to use a multiple AC outlet adaptor that both the ST2000 and soldering iron under test can connect to. This essentially connects the ground of the ST2000 and the soldering iron under test to a single point ground reference and thereby avoids the errors due to circulating ground currents.

11.3.3 Connections to Ground

The ground reference will usually be the same ground that the soldering iron is connected to with the third wire of

11.3.3 its power cable. To test these irons, the ST2000 should be connected to the same AC line and preferably adjacent to the soldering iron connection at the AC line outlet. The most precise measurements will be made when the ST2000 and the soldering iron under test are connected to a single point ground.

The tip ohms measurement will be most easily affected by an unsatisfactory ground connection of either the ST2000 or the soldering iron under test. Contact resistances of the AC power plug and receptacle combination can have a wide variability depending on the surface area of contact, pressure of the contact interface, and cleanliness. Many times the pressure clips in an AC receptacle are broken and no ground connection is available. This would indicate itself as an open circuit when tested with the ST2000 in ohms test and would mean either the ST2000 ground or the soldering iron ground is not functional at the AC outlet. When a tip ohms measurement fails, the connections to the AC line should be investigated for intermittent contact.

During battery pack operation, a ground reference connection to the ST2000B is necessary to conduct tip millivolts or tip resistance measurements.

The same considerations apply as discussed above concerning contact resistance and the avoidance of errors due to circulating ground currents. The ST2000B makes its measurements with respect to a separate ground wire and connector. Prior to conducting tip resistance tests the ground wire with banana jack has to be inserted into the reference ground.

11.3.4 Sources of Ground Circuit Errors

A wall receptacle containing a 3-wire ground circuit cannot be relied upon to provide a true earth ground and should be verified from time to time for these problems:

a) Wall receptacle ground connector open. If a test of the iron shows high resistance, change receptacles used for test to check for broken pressure clips.

b) Nearby electrical devices sharing the same ground may induce voltages on the ground line.

c) Ground connected to power station ground. Several volts of ground potential can be expected.

d) The personnel ESD ground connections are not usually a common ground for soldering iron testing. They may contain a resistor network to bleed down ESD which

destroys the ground reference; are too far removed from the iron to be a reliable connecting point; may not be the same ground network.

e) Ground connected to water pipes are presumed to be earth ground. Some piping systems change from copper or galvanized steel to plastic and therefore are not reliable earth grounds.

f) Copper bar or water pipe earth grounds. These are not reliable in dry earth and may need to be continuously moistened with a brine solution.

Some soldering stations are planned so that the entire station shares one common ground. A battery operated tester is handy if the power receptacles are not convenient or are full. Wahl Tester ST2000B (paragraph 4.0) is a rechargeable, battery operated tester with a ground wire to plug into the same common ground to test all irons at that station. In the event of a high resistance measurement, check the ground connection of the iron at the receptacle.

11.4 Tip Voltage Potential

11.4.1 Soldering Iron Leakage Current and Insulation Impedance

Leakage current is available from the soldering tip via the insulation impedance between the tip and the AC voltage present at the heating element. Leakage current measurements taken from actual soldering irons show a range from 1 µA for new irons to in excess of 50 µA for older and more heavily used irons. This leakage current flows to the ground wire on grounded tip soldering irons and the resultant tip potential is a function of the leakage current and tip resistance to ground.

Department of Defense standard 2000-1B requires soldering irons to have three-wire cords and grounded tips with no more than 2 ohms or more than 2 millivolts RMS measured from tip to earth ground. DOD-HDBK-263 section 7.2.10 specifies tip resistance to ground to be 20 ohms or less and tip voltage to be less than 2 millivolts. Therefore, leakage current should not exceed 1000 µA RMS to meet the DOD-2000-1B requirement or 100 µA to meet DOD-HDBK-263. If the heating element is powered directly from 110 VAC, the impedance from tip to the AC line should not be less than 1.5 megohm. Typical soldering irons tested have had insulation impedance readings from 2 megohms to 95 megohms.

11.4.2 Checking Tip Potential to Ground

When the ST2000 selector switch is rotated to the TIP MILLIVOLTS position, the instrument will indicate the true RMS voltage as presented to the sensor by a soldering iron or other AC source of potential. All measurements

11.4.2 are made with respect to the third wire (round pin in AC line plug) which connects to the ground of the AC power distribution.

The 2 mV warning indicator will flash at 1.8 mV while the actual mV value is shown by the digital display from 0.0 to 99.9 mV DC, or 0-50 mV true RMS of AC voltage.

If an oscilloscope is connected to the tip and the waveform viewed with respect to the soldering iron power ground, the basic frequency of the line power is seen but the waveform may or may not be uniform. In most cases the waveform will be distorted due to the effects of distributed capacitance throughout the soldering iron heater and sensor circuitry. In any case, the true RMS feature of the ST2000 will measure the power content of the available signal and display it as an engineering unit, RMS millivolts.

Mil Specs anticipate only AC voltage potential at the tip. However, Wahl has tested irons which show both AC and DC potential at the tip, either of which can be damaging to components. ST2000 senses both AC and DC tip potentials.

11.4.3 Sources of Tip Voltage

a) The primary source of tip voltage is the 110 VAC 60 Hz line power supplied to the soldering iron heater and its temperature controller. Insulation breakdown is typically caused by the continuous high temperature operation which in time causes aging of insulation and circuit defects. For this reason it is advisable to perform frequent tests on each production iron after heating it to its working temperature.

b) Thermocouple EMF Effect

Most tips are made of copper which are steel clad and nickel plated. It is possible to experience a thermocouple EMF voltage at soldering temperature between the nickel plating and dissimilar metals when working against a 2-ohm (spec limit) or higher tip-to-ground resistance. At 2 ohms Wahl has measured 2 mV in a circuit containing a 1-megohm, 5% resistor. (See Table I).

The potential between the Wahl sensor and the nickel plated tip is negligible, 1 μV at 630°F.

On a copper plate tested in accordance with suggested Mil Spec procedures the value is also negligible, 1.72 μV at 630°F.

TABLE I

THERMOCOUPLE EFFECT

Thermocouple EMF effect from nickel plate and tinned soldering iron tip. For test purposes the soldering iron was modified to have tip-to-ground resistance of 2.0 ohms for a consistent load. Test temperature 630°F.

Results With Iron at 630°F

Component	Material	Current	* Resultant Volts
Wahl Sensor + lead	Ni, 10% Chrome	7.6 µA	15.2 µV
Wahl Sensor - lead	Ni, 5% Al, Silicon	-5.2 µA	-10.4 µV
Wahl Sensor ± shorted		-4.0 µA	-.8 µV
10Ω, 1% Resistor	Cu & Tin Plate	1.5 µA	18.0 µV
562Ω, 1% Resistor	Cu & Tin Plate	.39 µA	219.0 µV
570Ω, 5% Resistor	Cu & Tin Plate	.68 µA	389.0 µV
33Ω, 5% Resistor	Cu & Tin Plate	.89 µA	31.2 µV
Red Ammeter Clip Lead	Gold Plated Beryllium	.50 µA	1.0 µV
Copper Test Plate	Cu	.87 µA	1.72 µV
2N4391 Drain (Source & Gate Shorted R_{OS} = 46Ω)	Gold Plated Kovar	-5.7 µA	-274 µV
1 meg, 5% Resistor	Cu & Tin Plate	-.002µA	-2.0mV
1 meg, 1% Resistor	Cu & Tin Plate	-.002µA	-2.0mV

* Computed by multiplying the current measured times total resistance in circuit. The potential at the soldering iron tip would equal the above current times the tip-to-ground resistance of 2 ohms.

12.0 DESIGN INFORMATION

12.1 Circuits

Figure 12-1 is a simplified block diagram of the ST2000. There are three distinct measuring capabilities shown. During temperature measurement, the thermocouple characteristics of the type K sensor are used and the microvolt signals are amplified by the chopper stabilized amplifier, linearized, and converted to a digital display of engineering units in degrees. Degrees F is the standard output with ^{o}C output available as an option.

During the measurement of tip millivolts, the sensor is connected via the chopper amplifier to a true RMS to DC converter which scales its output to 10 millivolts per millivolt of true RMS input voltage. The tip millivolts are displayed in engineering units with a resolution of .1 millivolts RMS.

The ohms circuitry consists of a precision 10 ma DC current source and an ohms converter circuit to provide the scaling and offsets necessary to display the tip resistance to ground yet nulling out the resistance of the instrument and its power cable. Ohms are displayed in engineering units with a resolution of .1 ohm.

The analog to digital converter is a 12 bit dual slope converter which features auto zero drift nulling capability and excellent long term stability.

The display is a .56 inch ultra bright red LED display with non-multiplexed segments for minimum noise generation and best display stability. In addition, peripheral LED status indicators provide flashing go/no-go warnings at preset levels when tip voltage or tip ohms are within 10% of default levels as defined by Mil Specifications.

The AC power inputs and sensor input are transient, static and surge protected for the utmost in damage immunity. The output jack buffer is also protected against shorts to ground and overvoltage inputs.

The ST2000B is equipped with the battery option, a 6.2 amp hour heavy duty Gel Cel. This will provide for 12 hours of continuous use with a complete recharge in one overnight charging period when the AC cord is plugged into a source of AC power. A low battery indicator will flash when the battery has reached a point of approximately 5.0 volts.

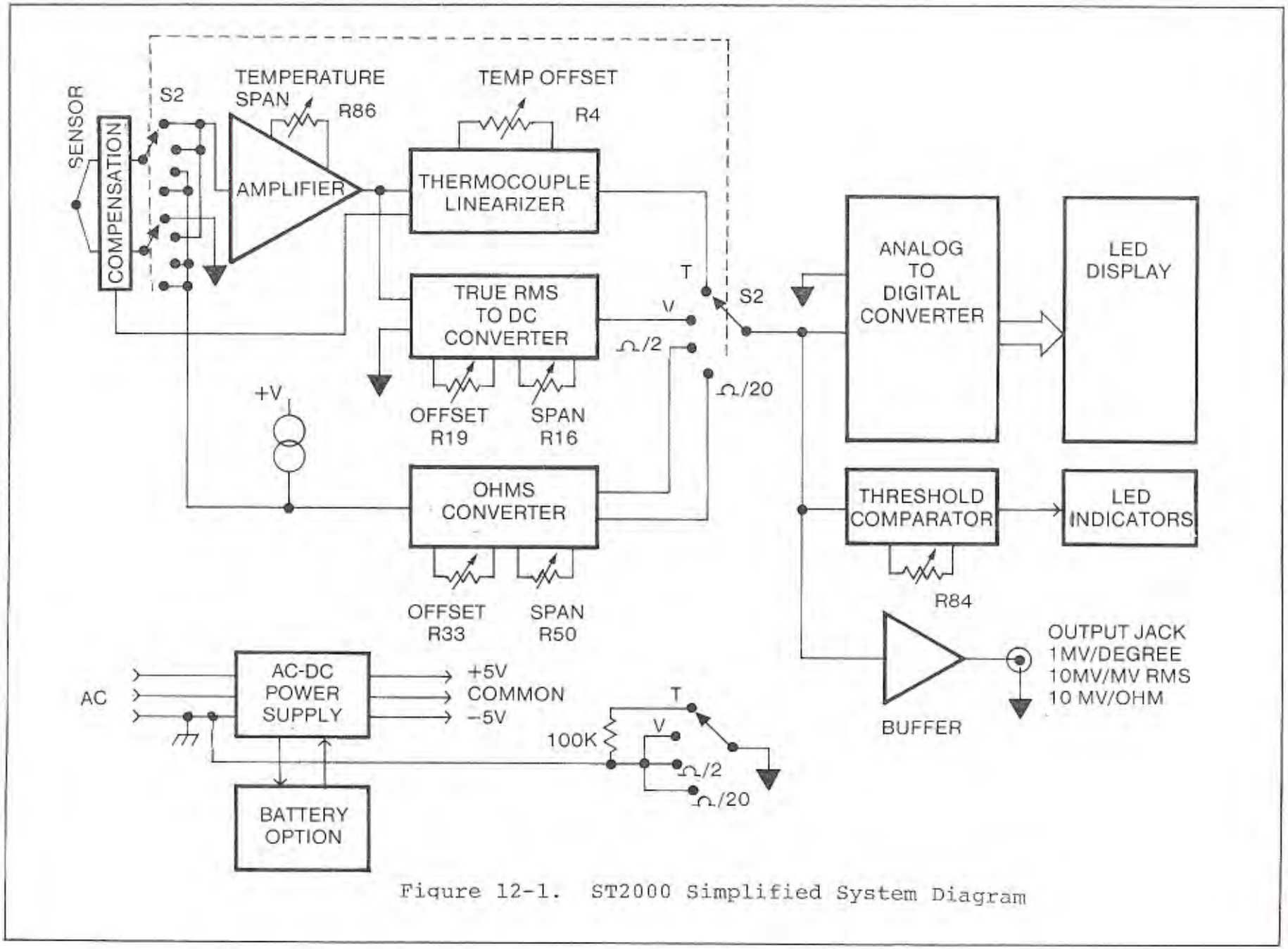


Figure 12-1. ST2000 Simplified System Diagram

Wahl

12.2 Construction

A rugged but lightweight design was selected for the ST2000 Tester. Its design was carefully considered from the standpoint of convenience and safety and for operation in ESD protected work areas.

The front operator panel is made of aluminum, as is the base and rear panel where the AC power cord enters the unit. These metal parts are connected to the power ground wire of the AC cord. The sides of the unit are made of high strength structural plastic foam with an outer painted finish. As an added precaution, the entire assembly has been treated with a cloride-free liquid anti-stat.

13.0 CALIBRATION PROCEDURE

13.1 Test Equipment Required

The ST2000 can be calibrated by using the following standard metrology calibration equipment or equivalent. Wahl Instruments, Inc., provides calibration services traceable to NBS standards by returning the tester to the factory at 5750 Hannum Avenue, Culver City, California 90231. Please contact the factory at 1-213-641-6931 to confirm current price for factory calibration.

The following calibration equipment is required:

1. A DC millivolt source to simulate type K thermocouple characteristics. Wahl Model C65-4 or equivalent is suggested.

2. Decade Resistance Box 0 to 100.0 ohms with .1 ohm resolution. Suggest a General Radio 1433-T.

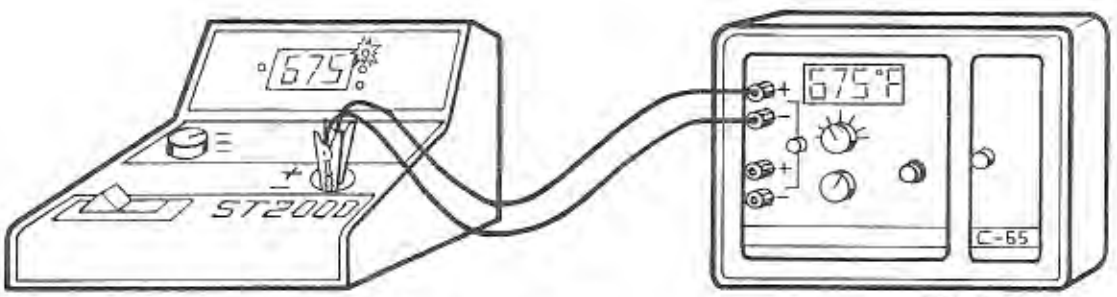
3. Digital Voltmeter with DC volts and true RMS measurement capability to 2 volts with a resolution of .01 MV DC or RMS. Suggest Solartron 7061.

4. A low level AC sine wave generator with $\leq$600 ohm output impedance and variable signal levels to 2V p-p and frequencies from 50 to 60 HZ. Suggest Hewlett Packard Models 204C, 204D, or 209A. The generator should have the capability to have its output synchronized to the applied line frequency.

13.2 Calibration of Temperature Circuitry (See Figure 13-1)

Remove the thermocouple based sensor from the front panel of the ST2000 by pulling straight up on the white outer body. Remove bottom plate of ST2000 (5 screws). Remove 4 screws holding PC board and lower the PC board while resting it on a non-conductive spacer between the bottom of the board and bench top.

With the internal banana jacks exposed, connect an external DC millivolt source via type K thermocouple wire or compensation wire to the banana jacks via low mass clips. (Suggest Wahl SC-6 calibration cable, an accessory available from Wahl that interfaces a miniature thermocouple connector to the banana jacks.) The banana jack closest to the display is + polarity.



WAHL C65

THERMOCOUPLE WIRE OR
THERMOCOUPLE COMPENSATION WIRE
WITH ALLIGATOR CLIPS

Figure 13-1. Temperature Calibration

13.2.1 A/D Converter Calibration

Connect an external calibrating DVM (Solartron 7061 or equivalent) to the main board with (+) to TP4 and (-) to TP3. See Figures 13-4,5 for test point locations. Set DVM for DC volts, 2 volt range.

Rotate the ST2000 selector switch to TEMPERATURE and turn the power switch ON. Adjust the external DC millivolts source for a reading of 900.0 millivolts on the calibrating DVM. First, calibrate the ST2000 analog-to-digital converter which is located on the display board. The internal A/D portion of the ST2000 should be adjusted so that it conforms to the externally attached calibrating DVM over a range of 0 to 900 millivolts. Adjust R28 (on the Display Board) for an exact reading of 900 ±0. Be certain that R28 is in the center of its adjustment by rotating the adjustment tool back and forth and noting where the exact 900 ±0 occurs.

Check the linearity and conformity to the external DVM by applying other inputs from 0 to 900 MV (as read on the calibrating DVM) and verify that no more than ±1 count deviation exists from the external calibrating DVM.

NOTE

The ST2000 will be reading positive values for temperature, ohms and tip potential and therefore no provision has been made to display a minus sign. However, for calibration purposes, it is desirable to know when the internal DVM portion of the ST2000 is indicating negative values. As a substitute for a minus sign, the decimal point to the right of the most significant digit will light up whenever the internal DVM senses negative inputs.

With the adjustment of R28, the calibration of the ST2000 A/D converter and display is complete.

13.2.2 Temperature Span and Offset Adjustment

The external DVM should remain connected to TP3 and TP4 as discussed in paragraph 13.2.1 above.

With the ST2000 selector switch at TEMPERATURE, adjust the external millivolt source for an input equivalent to the existing room ambient temperature (75-77^{o}F is typical). Adjust R4 for a ST2000 display reading to agree with the calibration source input. Use the external DVM with its increased resolution to more precisely adjust R4. Suggested range is 2 volts for the external DVM so that a resolution of ±.1 millivolts will be available to adjust the ST2000 display which has ±1 millivolts resolution in TEMPERATURE mode.

Next, adjust the temperature calibrator for an input of 900.0^{o}F and adjust the span adjustment R86 for an exact 900 display on the ST2000. Again, use the external DVM to make the final adjustment at 900.0 millivolts. The scale factor is 1 millivolt per degree.

13.2.3 Repeat sections 13.2.2 (R4 and R86 adjustments) until both are satisfactory.

Adjust the external millivolt source throughout the temperature range from 77 to 1000^{o}F and verify that the whole range is within ±.3% of reading ±1^{o} of the calibrating source as indicated by the external calibrating DVM. Adjust R4 and R86 as previously described to achieve the accuracy specified.

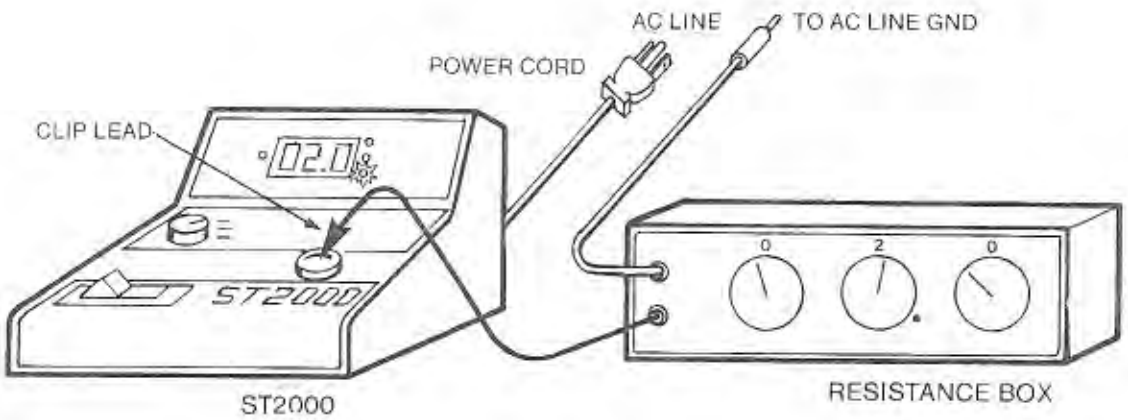


Figure 13-2. Ohms Calibration

13.3 Calibration of Ohms Circuitry (See Figure 13-2).

The thermocouple-based sensor (ST-01 or ST-02) should be installed at the TIP TEST location on the printed circuit board for this calibration. The external reference DVM must remain in place for this calibration. Also, secure a precision resistance box with a banana type plug on one lead and an alligator clip on the other lead. Use external calibration equipment to perform a four wire ohms measurement on the decade resistance box and its test leads when set at 0.0 ohms in order to determine the added resistance of the test leads including banana plug and pin probe. Use AWG #22 or larger cable for this connection. For ease of calibration, solder a resistor lead to the active area of the Tip Sensor for convenient connection to the resistance box.

With the ST2000 AC power cord plugged into an AC outlet, connect the decade box to the AC ground with a banana plug and connect the alligator clip to the resistor lead previously soldered to the ST2000 tip sensor.

NOTE

For best results and highest accuracy of calibration, the ST2000 AC line cord should have the round ground pin as clean as possible to insure a good low ohm connection to the AC

outlet. The AC outlet female receptacle should also be clean as it forms the other half of the connection. A good contact cleaner may be necessary along with some abrasive action to arrive at a connection that does not vary more than ±.1 ohms with mild tugging movement of the AC line cord. This will also be true for the decade box connection to the ground socket of the AC outlet for this calibration.

Be sure to use adjacent AC outlets for the ST2000 line cord and the decade box connection to avoid errors due to resistance in the ground connections and circulating ground currents. (See para 11.3.2 for further explanation.)

With the connection complete as described above, turn on the ST2000 power and set the decade resistance to 0.0 ohms. Now adjust R33 on the main board for a ST2000 display equal to the resistance determined earlier with the four wire measurement of the test leads. Use the external reference DVM to make a high resolution adjustment. The test current is 10 milliamperes. Therefore, the signal level available to the reference DVM will be 10MV per ohm of external resistance. The ST2000 places the decimal point after the tens digit and displays it as 1.0 ohms. For example:

If the reference DVM reads:	The ST2000 displays:
005 millivolts	00.5 ohms
010 millivolts	01.0 ohms

Adjust R33 until the external DVM reads 10.0 millivolts per applied ohm from the decade box. If the ST2000 display does not agree to within ±.1Ω, re-do calibration item 13.2.1.

Next, adjust the decade box to 50.0 ohms to adjust R50 for a reading of 50.0 plus the lead resistance. If the lead resistance was .1 ohms, the ST2000 should indicate 50.1 ohms and the external DVM should indicate 501.0 millivolts when R50 is properly adjusted.

Repeat the decade settings of 0.0 and 50.0 ohms and readjust R33 and R50 respectively for correct readings. Switch to 2.0 ohms and other points of interest and verify that the ST2000 has a proper calibration and error of no greater than ±.1 ohms.

13.3.1 Warning LEDs Adjustment

The ST2000 will flash the TIP RESISTANCE OHMS LED or the TIP MILLIVOLTS LED when the tip ohms exceed 1.8 ohms ±.1 ohm or 18 ohms ±1 ohm (depending upon which ohm range was chosen) or the tip AC RMS MILLIVOLTS exceed 1.8 MV ±.1 mV.

These levels are adjustable at R84 and move together, i.e., if the threshold is readjusted to 1.9 ohms, the new AC millivolts threshold will also be 1.9 millivolts and the 18 ohm threshold will now be 19 ohms.

To adjust these thresholds, vary the test input with the ohm decade box (and ST2000 selector switch at TIP RESISTANCE OHMS, 2 OHM LIMIT) to present a total of 1.8 ohms to the ST2000 between the sensor and the ground reference. (Remember to include the lead resistance in the total resistance.) Adjust R84 until the ohms indicator (to the right of digital display) begins to flash. If the ohms LED is flashing, turn R84 clockwise to increase the threshold voltage until the LED stops flashing and then rotate R84 counter-clockwise until the LED begins to flash. If the LED is not flashing, adjust R84 counter-clockwise until the LED begins to flash.

Now, switch the selector switch of the ST2000 to TIP RESISTANCE OHMS, 20 OHM LIMIT and increase the resistance from the ST2000 sensor to ground reference and note where the ohms LED begins to flash. The level should occur at approximately 18 ohms ±1 ohms.

Since one adjustment is available for two thresholds, it should be adjusted for a limit (2 or 20 ohms/mV) of highest interest. This is a warning indicator only. However, it can be used as a GO/NO GO indicator if the threshold level is adjusted to 20 or 200 millivolts at U3-6 for ohm/mV default points of 2 and 20 ohms/mV respectively.

13.4 Calibration of Tip Millivolts Circuitry (See Figure 13-3.)

NOTE

The ST2000 measures true RMS voltage of DC and AC voltages to 30 KHZ bandwidth. Many true RMS voltmeters have a restricted bandwidth and are AC coupled such that DC is not measured. If this is the case, there may be a discrepancy in the calibration in the event the AC millivolts source has some slight DC offset component.

The solution is to either AC couple the millivolt output to the 2 ohm resistor with a 20 µf capacitor as described below or use a true RMS AC voltmeter with a capability down to DC and bandwidth to at least 30 KHZ.

The thermocouple-based sensor must be installed at the TIP TEST area on the printed circuit board for this calibration. Connect the ST2000, reference AC voltmeter, and signal source as shown in Figure 13-3. Place a 20 µf tantalum or aluminum electrolytic capacitor in series with a 2 ohm resistor and place the network across the output terminals as shown with the polarized terminal of the capacitor to the generator HI terminal and the lead of the resistor at the LO terminal. (The capacitor removes any DC component from the test signal to be applied to the ST2000.)

The AC voltmeter should have its bandwidth limited to that of the ST2000 or there will be errors associated with measuring a spectrum of frequencies that the ST2000 cannot respond to. For a 30 KHZ bandwidth, use an 11.3 K resistor in series with the HI input and then a shunt 470 pf capacitor from the HI terminal to LO. This will provide the same frequency characteristics to the AC voltmeter as the ST2000 has, i.e., a 30 KHZ bandwidth.

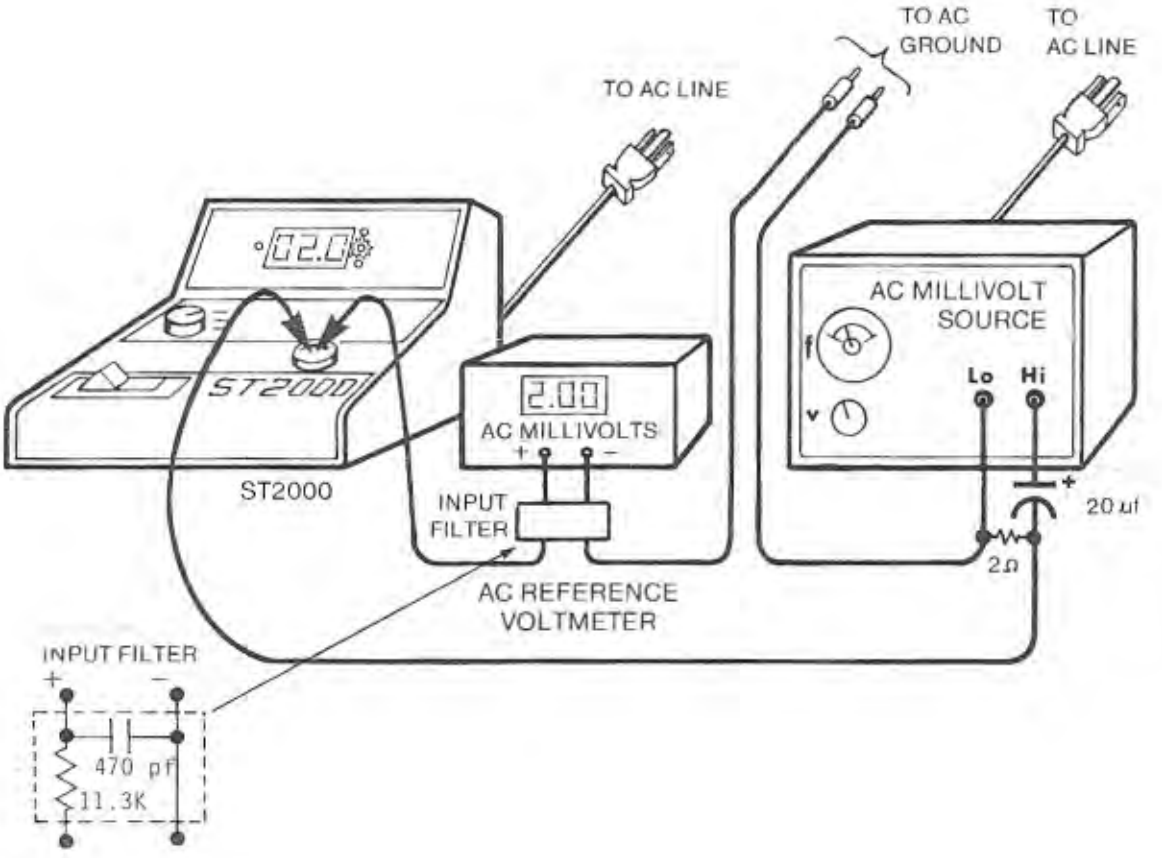


Figure 13-3. Millivolts Calibration

The AC millivolt source should be set to 60 HZ and synchronized to the line frequency for best results. If this is not done, there will be beat frequencies developed with the ambient background 60 Hz AC such that the output from the RMS to DC converter will be varying, which will give the display the appearance of being unstable.

The AC voltmeter should be connected as shown with the HI lead connected to the TIP SENSOR (the resistor lead that was soldered in for OHMS test can be used here also) and the LO lead connected to the power ground next to the AC power cable of the ST2000.

NOTE

If the ST2000 has the battery pack option, the ground reference of the ST2000 should then be connected to the AC ground and the AC voltmeter LO lead connected to the same ground or next available adjacent AC receptacle ground

With the millivolt signal source power switch off, note the AC reference voltmeter reading (call it V1) and zero out any ambient voltage that the ST2000 is sensing by adjusting R19 for a ST2000 display reading of 0.0 mV.

Next, turn on the power to the AC millivolt generator and adjust its output for 2.0 mV RMS plus V1 reading from above. The AC reference voltmeter should read 2.0 mV + V1. Now adjust R16 for a ST2000 display of 2.0 mV RMS.

Next turn off the power to the AC millivolts source and touch up R19 as necessary for a 0.0 display reading on the ST2000. Repeat the R16 and R19 adjustments as necessary for an accurate calibration.

This completes the calibration of the electronics.

13.5 TEMPERATURE CALIBRATION OF SENSOR

Prior to assembly, Wahl calibrates the sensor at 300°F and 600°F in an oven compared to sensors whose accuracy is traceable to NBS. After assembly the housing limits calibration to 350°F. Wahl will certify accuracy on new and used sensor assemblies at 300°F or the user may calibrate as described above.

When setting an output signal from a mV source for calibration, use Reference Table 13.5 to correlate mV to temperature per IPTS-68 standard. Tolerance of Type K thermocouples in the 500-800°F range is ±3/4 percent between 277°C and 1260°C.

13.5 REFERENCE TABLE - μV

TYPE K	Nickel-Chromium Vs. Nickel-Aluminum (Chromel-Alumel)					
CAL TEMP. / ROOM TEMP.	0 °F	200 °F	400 °F	600 °F	800 °F	990 °F
60 °F	-1.311	3.200	7.695	12.235	16.904	21.395
61 °F	-1.334	3.177	7.672	12.212	16.881	21.372
62 °F	-1.356	3.155	7.650	12.190	16.859	21.350
63 °F	-1.378	3.133	7.628	12.168	16.837	21.328
64 °F	-1.401	3.110	7.605	12.145	16.814	21.305
65 °F	-1.423	3.088	7.583	12.123	16.792	21.283
66 °F	-1.445	3.066	7.561	12.101	16.770	21.261
67 °F	-1.468	3.043	7.538	12.078	16.747	21.238
68 °F	-1.490	3.021	7.516	12.056	16.725	21.216
69 °F	-1.513	2.998	7.493	12.033	16.702	21.193
70 °F	-1.535	2.976	7.471	12.011	16.680	21.171
71 °F	-1.557	2.954	7.449	11.989	16.658	21.149
72 °F	-1.580	2.931	7.426	11.966	16.635	21.126
73 °F	-1.602	2.909	7.404	11.944	16.613	21.104
74 °F	-1.625	2.886	7.381	11.921	16.590	21.081
75 °F	-1.647	2.864	7.359	11.899	16.568	21.059
76 °F	-1.670	2.841	7.336	11.876	16.545	21.036
77 °F	-1.692	2.819	7.314	11.854	16.523	21.014
78 °F	-1.715	2.796	7.291	11.831	16.500	20.991
79 °F	-1.737	2.774	7.269	11.809	16.478	20.969
80 °F	-1.760	2.751	7.246	11.786	16.455	20.946
81 °F	-1.782	2.729	7.224	11.764	16.433	20.924
82 °F	-1.805	2.706	7.201	11.741	16.410	20.901
83 °F	-1.827	2.684	7.179	11.719	16.388	20.879
84 °F	-1.850	2.661	7.156	11.696	16.365	20.856
85 °F	-1.873	2.638	7.133	11.673	16.342	20.833
86 °F	-1.895	2.616	7.111	11.651	16.320	20.811
87 °F	-1.918	2.593	7.088	11.628	16.297	20.788
88 °F	-1.940	2.571	7.066	11.606	16.275	20.766
89 °F	-1.963	2.548	7.043	11.583	16.252	20.743
90 °F	-1.986	2.525	7.020	11.560	16.229	20.720

Unit:mV

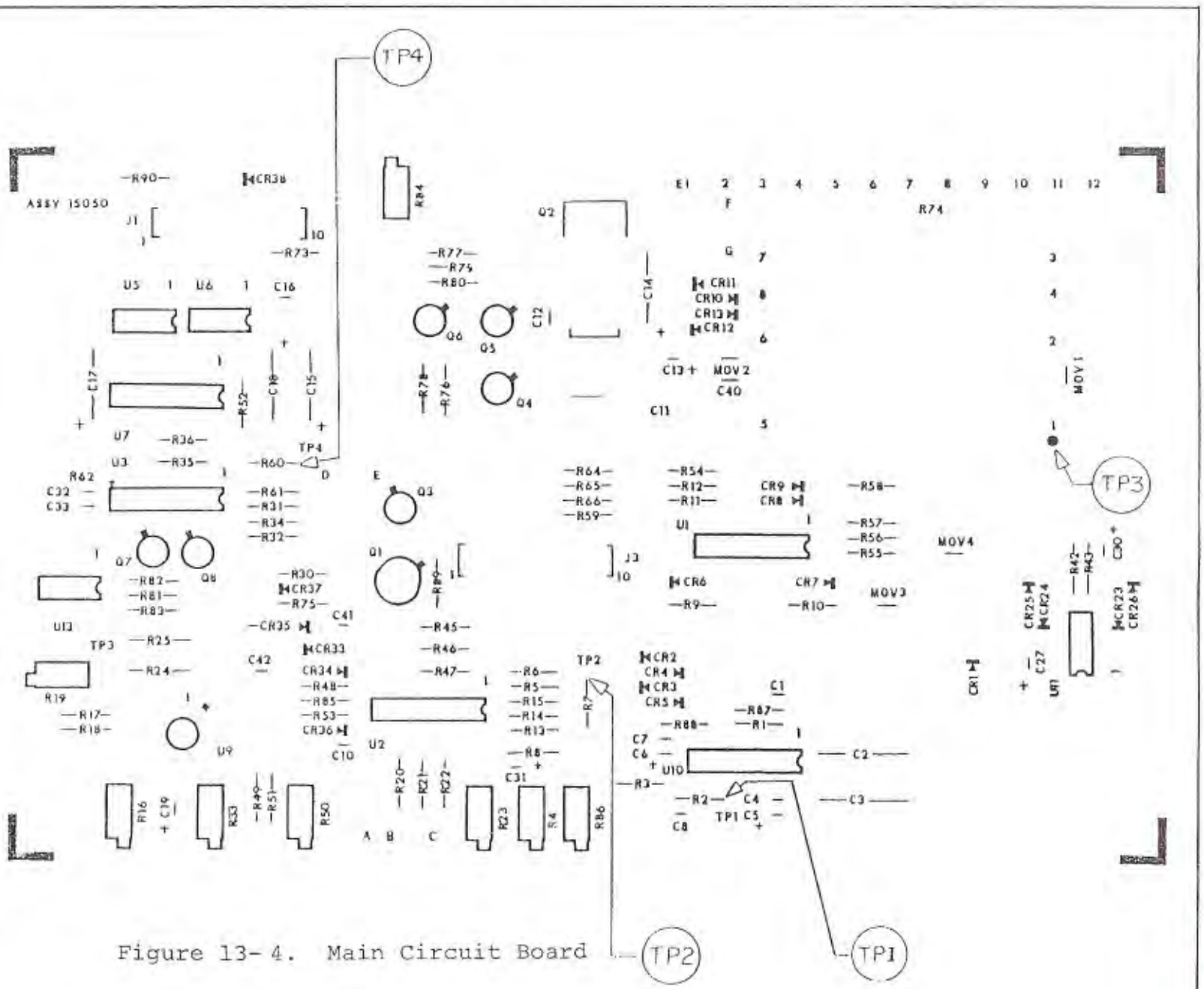


Figure 13-4. Main Circuit Board

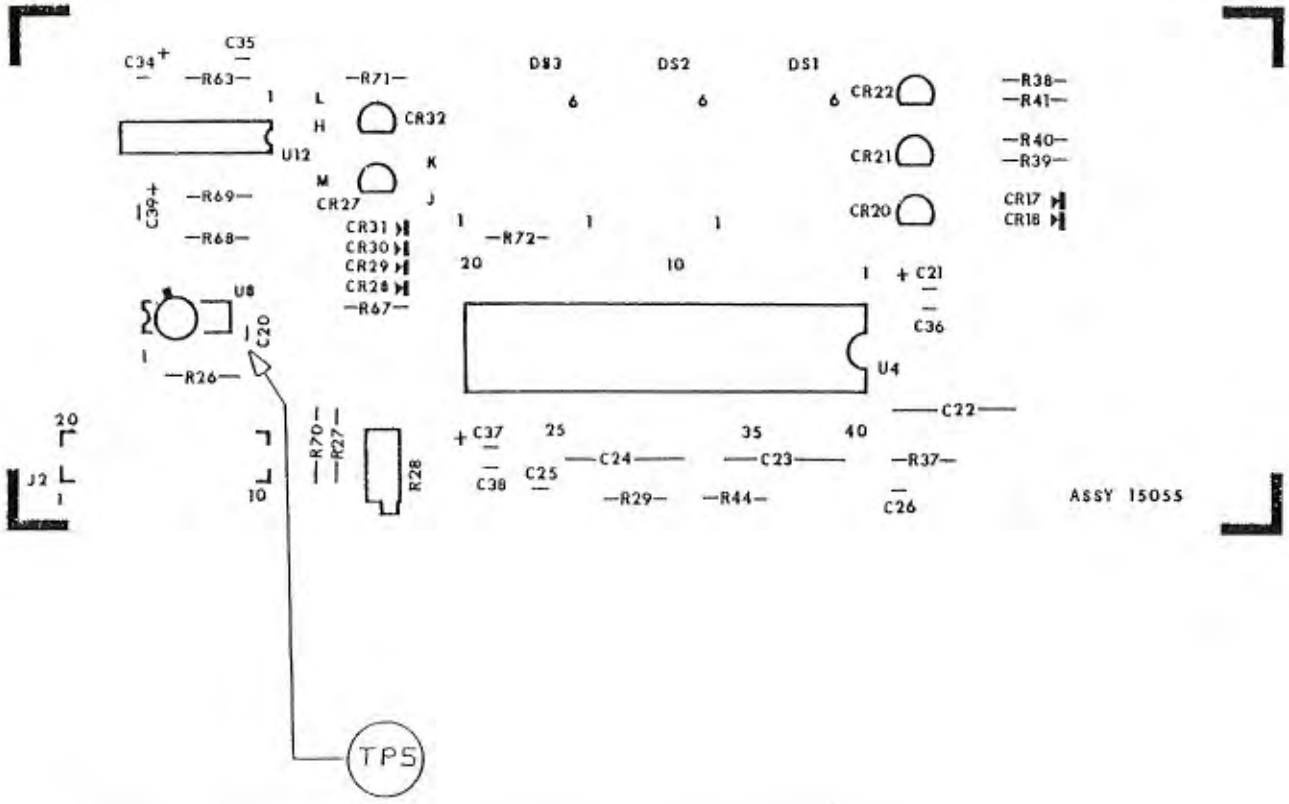


Figure 13-5. Analog/Digital Display Board

Wahl

14.0 TROUBLESHOOTING

When trouble occurs, it will usually center around three main areas.

1. Bad soldering irons which act erratically or bad connection to the AC line.

2. High contact resistance connection to ground of either ST2000 or the soldering iron.

3. A faulty ST2000.

14.1 PROBLEMS WITH TEMPERATURE MEASUREMENTS

Wahl test technicians have extensive experience with making temperature measurements and offer the following hints when temperature readings seem incorrect.

1. Add a bit of fresh solder to the soldering iron tip to insure a good thermal connection via "wet" solder.

2. Apply steady and firm pressure.

3. If readings are very high or "OVER RANGE" lights up, it may indicate an open ST-01 or ST-02 sensor. Replace and try again. If still high, soldering iron may be in runaway mode or there is an internal fault in the ST-2000. Re-calibrate. If not possible, return to factory.

14.2 PROBLEMS WITH MILLIVOLTS MEASUREMENTS

If measurements are in doubt, connect a clip lead from the ST2000 sensor to ground at the AC line. The display should indicate from 0.0 to 0.2 mV max for a "zero" input.

If there is more than this, the ST2000 may need recalibration or repair. Try reconnecting the ST2000 AC cord at the AC line and try again. The contact resistance of the ground connection at the AC line is not a major factor, but if it is over 100 ohms, erratic readings may appear. Switch to "OHMS" and measure the ohms back to the AC line. If more than the 2 or 20 ohms allowed, there may be a problem with the ground in the soldering iron or the AC line receptacle.

Other problems:

1. Cycling readings -- up, down, up, down, etc. This may be due to actual cycling of the soldering iron control.

2. Large differences between hot and cold soldering iron millivolt readings. This could indicate a bad heater or control circuit. Verify with another iron of similar design.

14.3 PROBLEMS WITH OHMS MEASUREMENT

The contact resistance from the soldering iron power cord to the AC line and the contact resistance from ST2000 power cord to AC line will cause most of the indicated error in this measurement.

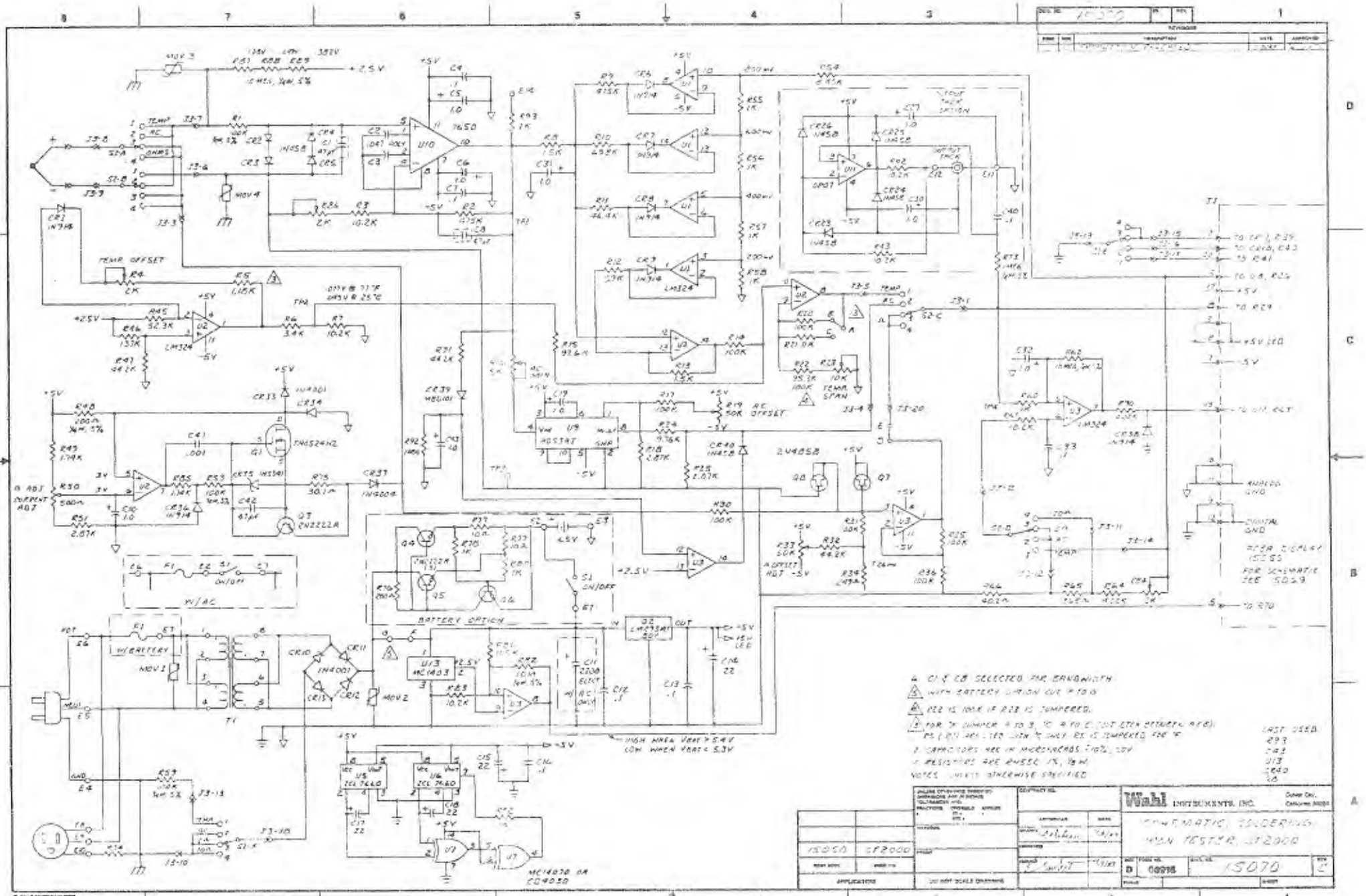
PROBLEMS AND THINGS TO CHECK:

1. High or erratic readings -- remove the AC line cord and reconnect for both the soldering iron and ST2000 and try again. If still high, connect the soldering iron to the AC power receptacle on the ST2000 and measure again. If still high, connect a clip lead from the ST2000 sensor to ground and verify that there is resistance of no more than 0.2 ohm.

   If the clip lead test is fine but the soldering iron test was high, it points to the soldering iron as the problem.

2. Display always reads "OVERRANGE." Replace the ST2000 sensor and try again with a soldering iron or clip lead from ST2000 sensor to ground. If the display still reads open, check the ground where the ST2000 line cord is plugged in. Sometimes the AC receptacle ground clips break and a ground connection is not available even though AC power is available to the ST2000.

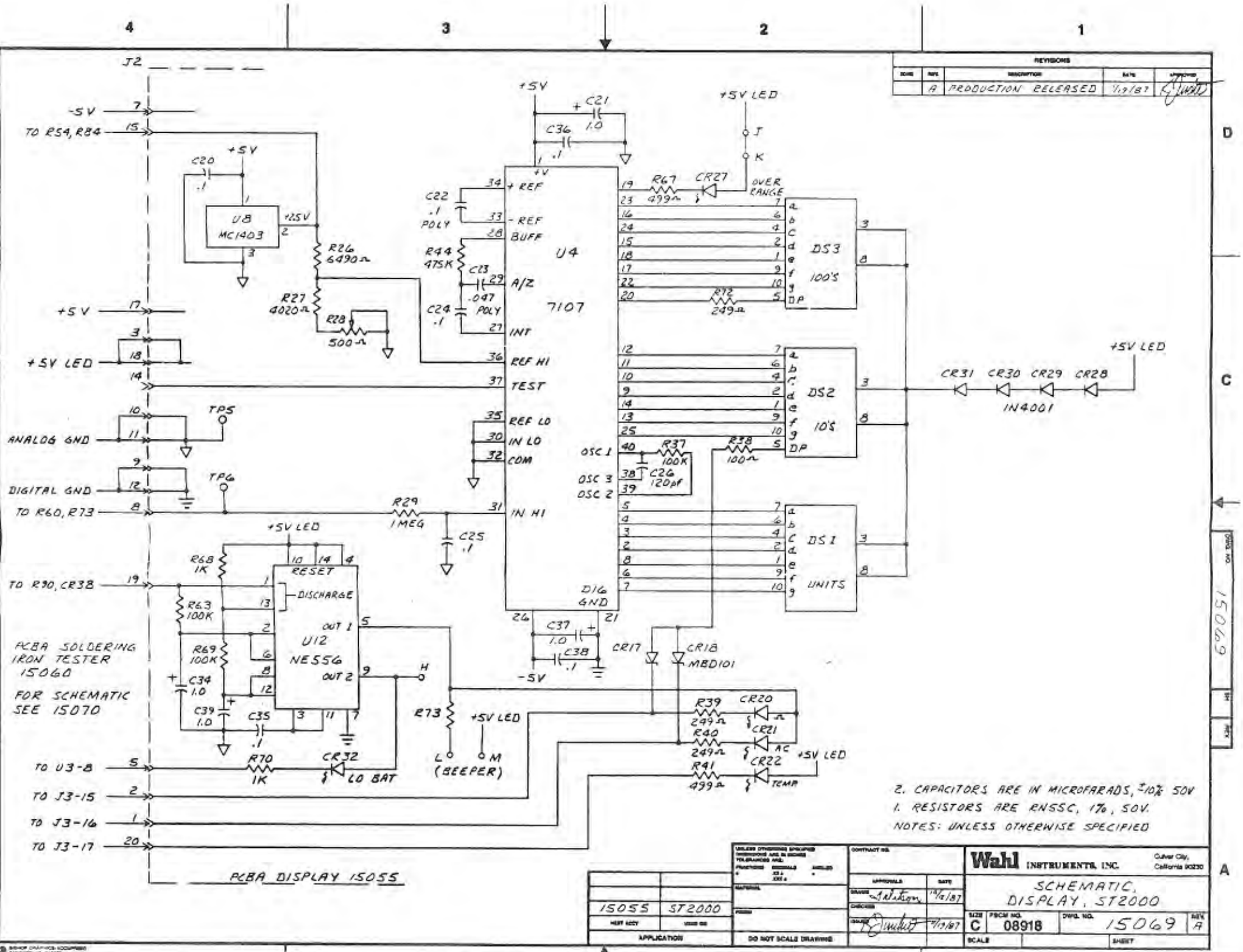
   Move to another AC outlet and repeat the above tests. If the ground has been verified and the ST2000 sensor has been replaced but "OVER RANGE" still exists, return the ST2000 to the factory for repair and recalibration.



1. C1 & C8 SELECTED FOR BANDWIDTH
2. WITH BATTERY OPTION CUT # 10 Ω
3. C22 IS 100K IF R23 IS JUMPERED.
4. FOR "A" JUMPER # TO B, "C" # TO E (CUT OTHER ATTACH'D #'S) FOR "D" #5 & #7 ARE LEFT OPEN & ONLY #6 IS JUMPERED FOR "E"
5. CAPACITORS ARE IN MICROFARADS, ±10%, 50V
6. RESISTORS ARE 4W5E 1%, ¼ W.

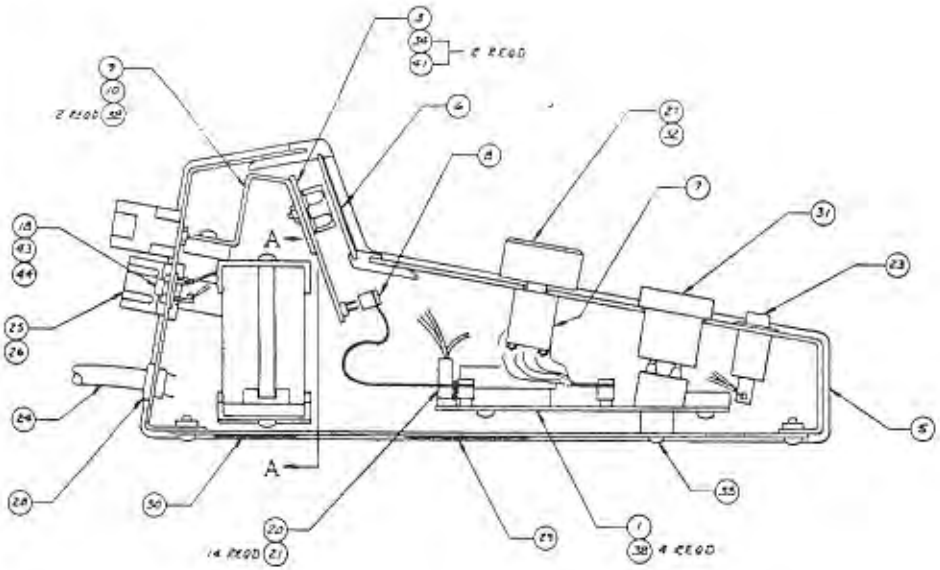
NOTES: UNLESS OTHERWISE SPECIFIED

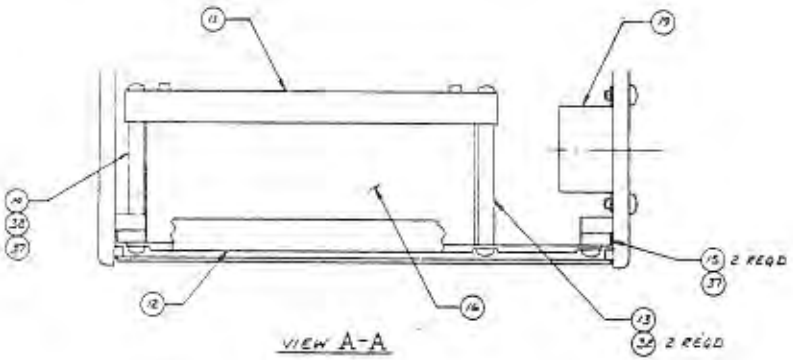
				Wahl INSTRUMENTS, INC.	Owner Dwg. Columbia 38401
				SCHEMATIC, SOLDERING GUN TESTER, ST2000	
15050	ST2000			SIZE D	CODE NO. 03016
				DWG. NO. 15070	REV. C
APPLICATION		DO NOT SCALE DRAWING			


J2
-5V
TO R54, R84
+5V
C20 .1
U8 MC1403
+12SV
R26 6490Ω
R27 4020Ω
R28 500Ω
+5V
+5V LED
ANALOG GND
TP5
DIGITAL GND
TP6
TO R60, R73
C21 1.0
C36 .1
+5V LED
J
K
OVER RANGE
R67 499Ω
CR27
C22 .1 POLY
R44 475K
C23 .047 POLY
C24 .1
U4 7107
+ REF
- REF
BUFF
A/Z
INT
REF HI
TEST
REF LO
IN LO
COM
IN HI
OSC 1
OSC 3
OSC 2
R37 100K
C26 120pf
R38 100Ω
R29 1MEG
C25 .1
D16 GND
R72 249Ω
DS3 100'S
DS2 10'S
DS1 UNITS
a b c d e f g DP
CR31 CR30 CR29 CR28
IN4001
+5V LED
R68 1K
RESET
DISCHARGE
OUT 1
U12 NE556
OUT 2
R63 100K
R69 100K
C34 1.0
C39 1.0
C35 .1
TO R30, CR38
PCBA SOLDERING IRON TESTER 15060
FOR SCHEMATIC SEE 15070
C37 1.0
C38 .1
-5V
CR17
CR18 MBD101
R39 249Ω
CR20
CR21 AC
R40 249Ω
R41 499Ω
CR22 TEMP
+5V LED
R73
L
M (BEEPER)
R70 1K
CR32 LO BAT
TO U3-8
TO J3-15
TO J3-16
TO J3-17
PCBA DISPLAY 15055
2. CAPACITORS ARE IN MICROFARADS, ±10% 50V
1. RESISTORS ARE RN55C, 1%, 50V.
NOTES: UNLESS OTHERWISE SPECIFIED
REVISIONS
A PRODUCTION RELEASED 11/9/87
Wahl INSTRUMENTS, INC. Culver City, California 90230
SCHEMATIC, DISPLAY, ST2000
15055 ST2000
APPLICATION
DO NOT SCALE DRAWING
SIZE C FSCM NO. 08918 DWG. NO. 15069 REV A
SCALE SHEET
15069

DWG. NO.	REV
15060	E

ZONE	REV	DESCRIPTION	DATE	APPROVED
	E	PRODUCTION RELEASED		





VIEW A-A

ITEM	QTY	PART NO	DESCRIPTION
49	1	12030-5	WASHER, NYLON
48	1	12051-3	WASHER, SHOULDER
47			
46	2		NUT, #4-40 SS
45			
44			
43	2		SC PAN HD #6-32 X 3/8 SS
42	2		#6-32 X .50
41			
40	1		#4-40 X .19
39	2		SC. PAN HD. #4-40 X 3/8 SS.
38			
37	1	12C108	WASHER, NON-TURN GRAYHILL
36	1	DMC-1	T/C SENSOR ANRITSU
35	1	11924-1	LABEL, SERIAL NO.
34	1	SP5045	LABEL, ANTI STATIC STATIC ABEX
33	1	2155-1	BUSHING, STRAIN RELIEF
32	1	RM-1508-6	KNOB, SELECT SW. RECO
31	1	27F651	FUSE, 1/8 AMP LITTLE FUSE
30	1	27F648	FUSE HOLDER LITTLE FUSE
29	1	6IFL078	AC LINE CORD BELDEN
28	1	8255-1	SWITCH, ON/OFF CEH
27			
26	14	12032-1	CONTACT, CRIMP
25	1	12031-1	CONN. 14 POSITION
24	1	5258	AC OUTLET HUBBELL
23	1	9796	JACK, 4V OUTPUT
22	1	15077	ASSY, AROUND PLUG
21	1	OC686	BATTERY, 6V GLOBE UNION
20	2	15063	SPACER, BATTERY BRKT
19	1	15062-2	CLAMP, BATTERY, SHORT
18	1	15062-1	CLAMP, BATTERY, LONG
17	1	15061	MTG BRKT, BATTERY
16	1	15078	TOP BRKT, BATTERY
15	1	15057-2	MTG BRKT, DISPLAY, LEFT
14	1	15057-1	MTG BRKT, DISPLAY, RIGHT
13	1	15066	CABLE, DISPLAY INTERCONNECT
12	1	15065	ASSY, SELECT SWITCH
11	1	15056-4	OVERLAY, DISPLAY
		-3	
		-2	
		15056-1	OVERLAY, DISPLAY
10	1	15067-1	CASE, W/AC OUTLET MODIF
9			
8	1	15055-2	PCBA, DISPLAY, BATTERY
		-1	AC
7			
6	1	15050-8	PCBA, ST2000
		-7	
		-6	
		-5	
		-4	
		-3	
		-2	
		15050-1	PCBA, ST2000

PARTS LIST

C FOR WIRING DIAGRAM SEE 15068
B FOR SCHEMATIC SEE 15069 & 15070
NOTES:

	ST2000
PART ASSY	MODEL NO.
APPLICATION	DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN Clarkston	7/11/97
CHECKED	
ENGR	

Wahl INSTRUMENTS, INC. Culver City, California 90232

FINAL ASSEMBLY, ST2000

SIZE	FSCM NO.	DWG. NO.	REV
D	06918	15060	E

SCALE: NONE SHEET 1 OF 1