

# **ALTRONIC RESEARCH, INC.**

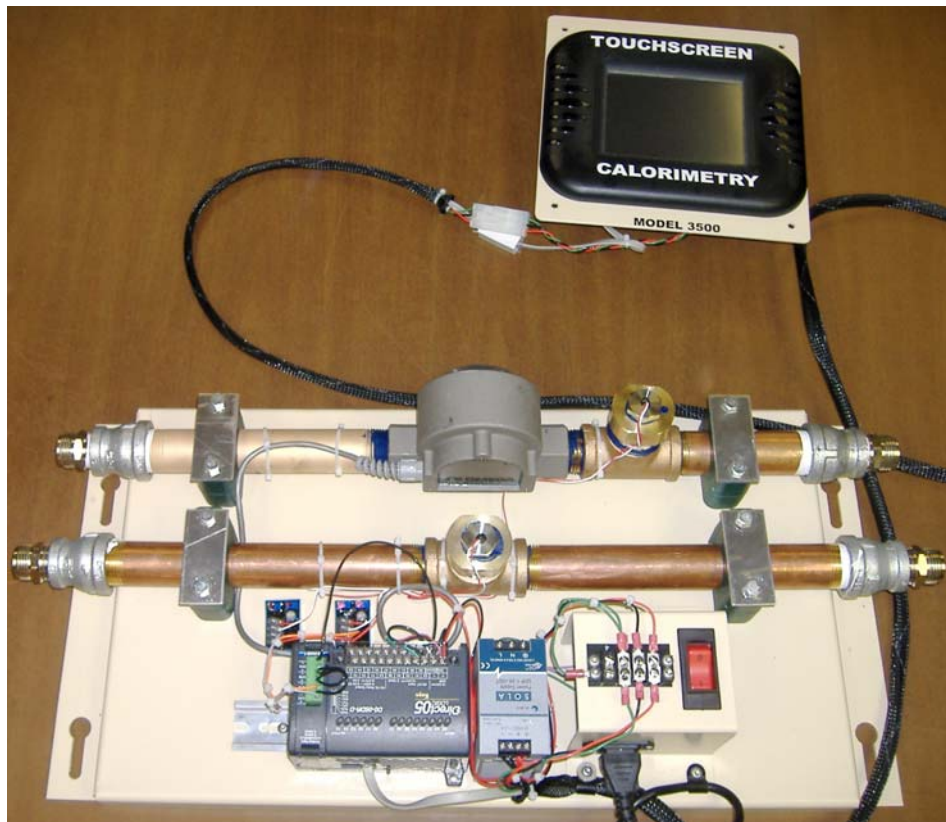
**P.O. BOX 249**

**YELLVILLE, ARKANSAS 72687-0249**

**U.S.A.**

## **CALORIMETRY**

**MODEL 3500**



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## CALORIMETRY MODEL 3500

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# LIMITED WARRANTY

We take pride in manufacturing products of the highest quality and we warrant them to the original purchaser to be free from defects in material and workmanship for the period of one year from date of invoice. Additionally, products of our manufacture repaired by us are warranted against defects in material and workmanship for a period of 90 days from date of invoice, with the provisions described herein.

Should a product, or a portion of a product of our manufacture prove faulty, in material or workmanship, during the life of this warranty, we hereby obligate ourselves, at our own discretion, to repair or replace such portions of the product as required to remedy such defect. If, in our judgment, such repair or replacement fails to be a satisfactory solution, our limit of obligation shall be no more than full refund of the purchase price.

This warranty is limited to products of our own manufacture. Equipment and components originating from other manufacturers are warranted only to the limits of that manufacturer's warranty to us. Furthermore, we shall not be liable for any injury, loss or damage, direct or consequential, arising out of the use, or misuse (by operation above rated capacities, repairs not made by us, or any misapplication) of the equipment. Before using, the user shall determine the suitability of the product for the intended use; and the user assumes all risk and liability whatsoever in connection therewith.

The foregoing is the only warranty of Altronic Research Incorporated and is in lieu of all other warranties expressed or implied.

Warranty returns shall first be authorized by the Customer Service Department and shall be shipped prepaid. **Warranty does not cover freight charges.**

# INTRODUCTION

This handbook was prepared for technical personnel as an aid in understanding and performing installation procedures for the Calorimetry Model 3500. Personnel are considered to be skilled if they have the necessary knowledge and practical experience of electrical and radio engineering to appreciate the various hazards that can arise from working on radio transmitters, and to take appropriate precautions to ensure the safety of personnel.

## SECTION I

### DESCRIPTION AND LEADING PARTICULARS

- 1-1. **PURPOSE AND APPLICATION OF EQUIPMENT.** When RF energy is terminated into the broadband resistor/resistor network, it is transformed into heat by the resistor/resistor network. Forced air is passed over the resistors, carrying away the heat.

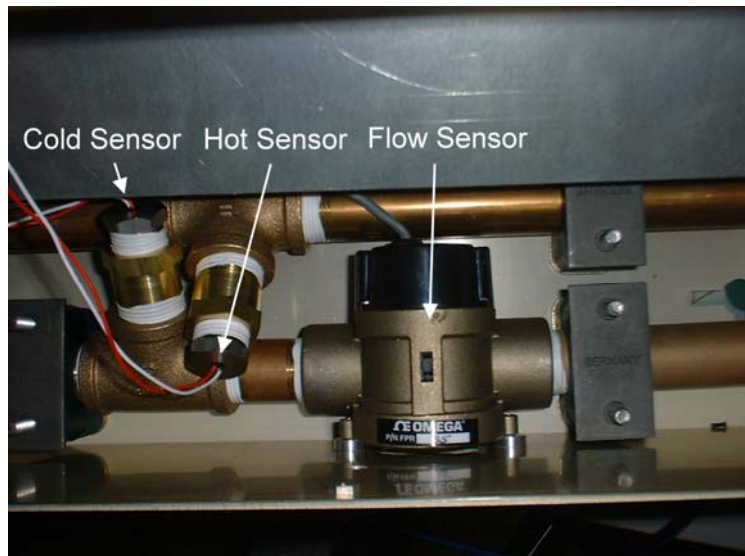
Calorimetry sequences require the precise measurement of the temperature difference of the inlet and outlet temperature and the flow rate. (see Section IV Theory of Operation). Considerable detail has been given to insure high accuracy. The electronics are housed in a shielded enclosure.

- 1-2. **GENERAL DESCRIPTION.** The temperature sensors are located in the supply and return lines to the load. A flow sensor manifold houses the paddle wheel flow sensor. The sensors are routed to the acquisition unit which is located on the bulkhead.
- 1-3. **COMPUTER ASSEMBLY.** The computer assembly consists of a Programmable Logic Controller which has a 4 input 4-to-20 ma. module. The program is stored in non-volatile memory. Display and interface functions are handled by a touch-screen Liquid Crystal Display. These devices operate on 24 VDC which is supplied by the AC to DC power supply.
- 1-4. **DATA ACQUISITION MODULE.** Data acquisition and conversion is performed by two modules: (1) the temperature module transforms the analog signals from the thermistors to a 4-to-20 ma. signal level. (2) The flow module supplies power to the flow meter and converts the pulse flow information to a 4-to-20 ma. signal level.

## 1-5. SENSORS.

### a. Water Flow Meter/Sensor.

Water flow is measured by passing the water through a manifold which houses a paddle wheel sensor. The signal is magnetically coupled to a hall effect sensor. An electronic sensor monitors the frequency of rotation. Flow information is routed to a frequency to voltage converter which removes ripple.



### b. Temp Sensors

Altronic Research utilizes different temperature sensing devices for the various application requirements. RTD's are generally used in air loads and thermistors in water loads.

### c. RTD

RTD's are linear over the wide operating ranges as experienced when utilized in an air load. They are interchangeable over extended ranges and exhibit excellent stability at high temperatures. They may be made up in any length which allows them to perform as an averaging temperature sensor.

### d. Thermistor

Thermistors have a fast response to temperature changes and are available in very small sizes and produce high signal levels. A dual thermistor "therem linear" network is used to measure temperatures. This network is terminated with a combination series/parallel resistor network to provide a measurement system which spans 100°C and affords a resolution of 1/50th of a degree. This configuration is ultra linear.

1-6. SOFTWARE. The program for the PLC is written in ladder logic and may be updated by a RS-232 connection from a PC or updated from a plug-in memory card. The program for the display may be updated from a PC.

## 1-7. ALARMS / INTERLOCKS.

Alarms and alerts are not used in this version of Calorimetry. Alarms and alerts will be available in future releases. Check [www.altronic.com](http://www.altronic.com) or call Altronic Research Inc. for updates.

# SECTION II

## DEFINITIONS

### **DELTA TEMP**

**Hot temperature:** temperature in degrees C. of the coolant that is entering the system from the load.

**Cold temperature:** temperature in degrees C. of the coolant that is entering the load.

### **FLOW**

This is a quantitative measure of the coolant that is passing through the load.

### **HOT OFFSET**

This is a calibration number that may be used to correct any errors in the hot temperature sensors.

### **COLD OFFSET**

This is a calibration number that may be used to correct any errors in the cold temperature sensor.

### **HOT GAIN**

This is a multiplier to convert the temperature in engineering units to degrees C.

### **COLD GAIN**

This is a multiplier to convert the cold temperature in engineering units to degrees C.

### **FLOW OFFSET**

This is used to calibrate the flow meter and represents the minimum flow measurement capabilities of the flow meter.

### **FLOW GAIN**

This is a multiplier that is used to convert from engineering units to Gallons Per Minute.

### **KT FACTOR**

The kt factor is a measure of the coolant to transport heat when water is used. This value is .264 and is corrected for temperature changes in the power measurement calculations. If coolants with different values are used, the appropriate kt factor should be entered at the temperature of operation. When a power-on reset is

accomplished or the reset push button is pressed, the system will change back to the default value of .264.

### **POWER**

Power is displayed in kW and is derived from the formula  $Kt * GPM * \Delta T$ .

### **RESET**

Pressing of the reset push button will cause all default calibration numbers to be loaded into the system equations.

### **SCREEN**

The screen button forces the display to change display screens.

# SECTION III

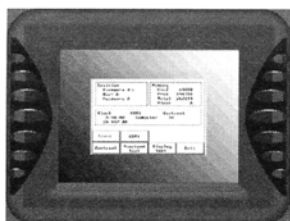
## PREPARATION FOR USE

### 3-1. UNPACKING EQUIPMENT

1. Remove the acquisition and calorimetry units from cardboard shipping containers.
2. Inspect for damage.

### 3-2. FIELD INSTALLATION

#### Communications Setup



After the EZTouch Panel is powered up, you may enter the Setup Mode by simultaneously pressing the extreme upper left and lower left touch cells on the panel screen. The following screen is displayed. Information is displayed in the upper left hand corner about the current revision of the Firmware, Hardware, and Boot program. Also shown is RAM memory — Used, Free and Total, and Flash memory. Below that is displayed the time and date, whether the COM1 port is connected to a computer or a printer, and the current Contrast setting. There are six buttons at the bottom of the screen. They are labeled **Clock**, **COM1**, **Contrast**, **Touchpad Test**, **Display Test** and **Exit**.

<b>Revision</b> Firmware A.1 Boot A Hardware A		<b>Memory</b> Used 67888 Free 194344 Total 262144 Flash 0	
<b>Clock</b> 8:56:08 28-SEP-08		<b>COM1 Computer</b> Contrast 37 Part # EZ-S8C-F	
<b>Clock</b>	<b>COM1</b>		
<b>Contrast</b>	<b>Touchpad Test</b>	<b>Display Test</b>	<b>Exit</b>

Main Setup Screen

#### Clock

SET TIME AND DATE									
0			9:58:23 28-SEP-08 Time is in 24 hour format.						
7	8	9	Hr		Day				
4	5	6	Min		Mon				
	0	CL	Sec		Yr				
									<b>EXIT</b>

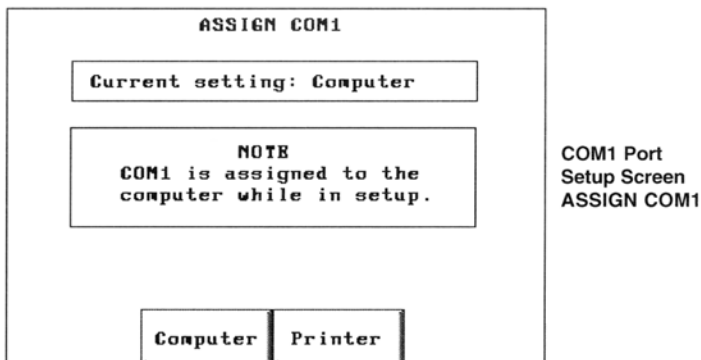
Clock Setup Screen  
SET TIME AND DATE

When you press the **Clock** button, the screen shown above will appear.



Enter the current time and date. Press the keypad button of the number you want to enter. It will show in the display window. If correct, press **Hr, Min, Sec, or Day, Mon, Yr** corresponding to the time or date position you are setting. If not correct, press **CL** to clear the window. For the month, enter the number of the month and the three letter abbreviation for the month will be displayed (e.g., 7 = July = JUL).

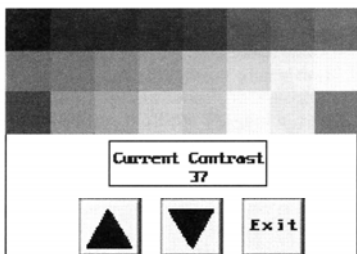
### COM1



COM1 Port Setup Screen  
ASSIGN COM1

The COM1 button is used to assign the COM1 port for use with an external device. When you press the COM 1 button, the screen shown above will appear. Press the **Computer** button if the port will be connected to the programming computer. Press the **Printer** button if the port will be connected to a printer.

### Contrast



When you press the **Contrast** button, the screen shown above will appear (except that the monochrome units will not have color). From this screen you can adjust the panel screen contrast (except on the 10" TFT Color units). Press **Exit** to return to the previous screen. In the **Current Contrast** window, the current contrast setting is displayed. The 6" Monochrome units will have a contrast range of 87 to 119. The 10" and 15" TFT Color units will not have a contrast adjustment feature. The 8" Color unit will have a contrast range of 21 to 52, and the 6" Color unit's contrast range is 0 to 32. Press the up and down arrow buttons to adjust the screen display contrast. Press **Exit** to return to the setup screen.

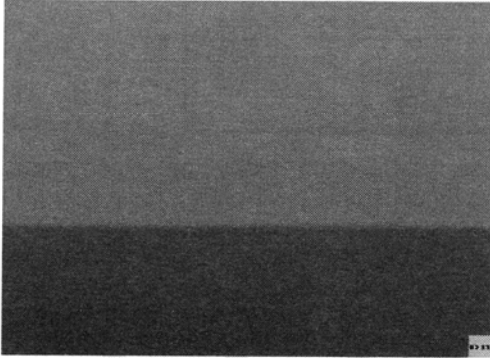
### Touchpad Test

0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	14.0	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7	17.8	17.9	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	19.0	19.1	19.2	19.3	19.4	19.5	19.6	19.7	19.8	19.9	20.0	20.1	20.2	20.3	20.4	20.5	20.6	20.7	20.8	20.9	21.0	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8	21.9	22.0	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	22.9	23.0	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	23.9	24.0	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	25.0	25.1	25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	26.0	26.1	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.9	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	28.9	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.7	30.8	30.9	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	31.9	32.0	32.1	32.2	32.3	32.4	32.5	32.6	32.7	32.8	32.9	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.7	33.8	33.9	34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	35.0	35.1	35.2	35.3	35.4	35.5	35.6	35.7	35.8	35.9	36.0	36.1	36.2	36.3	36.4	36.5	36.6	36.7	36.8	36.9	37.0	37.1	37.2	37.3	37.4	37.5	37.6	37.7	37.8	37.9	38.0	38.1	38.2	38.3	38.4	38.5	38.6	38.7	38.8	38.9	39.0	39.1	39.2	39.3	39.4	39.5	39.6	39.7	39.8	39.9	40.0	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	41.0	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	42.0	42.1	42.2	42.3	42.4	42.5	42.6	42.7	42.8	42.9	43.0	43.1	43.2	43.3	43.4	43.5	43.6	43.7	43.8	43.9	44.0	44.1	44.2	44.3	44.4	44.5	44.6	44.7	44.8	44.9	45.0	45.1	45.2	45.3	45.4	45.5	45.6	45.7	45.8	45.9	46.0	46.1	46.2	46.3	46.4	46.5	46.6	46.7	46.8	46.9	47.0	47.1	47.2	47.3	47.4	47.5	47.6	47.7	47.8	47.9	48.0	48.1	48.2	48.3	48.4	48.5	48.6	48.7	48.8	48.9	49.0	49.1	49.2	49.3	49.4	49.5	49.6	49.7	49.8	49.9	50.0	50.1	50.2	50.3	50.4	50.5	50.6	50.7	50.8	50.9	51.0	51.1	51.2	51.3	51.4	51.5	51.6	51.7	51.8	51.9	52.0	52.1	52.2	52.3	52.4	52.5	52.6	52.7	52.8	52.9	53.0	53.1	53.2	53.3	53.4	53.5	53.6	53.7	53.8	53.9	54.0	54.1	54.2	54.3	54.4	54.5	54.6	54.7	54.8	54.9	55.0	55.1	55.2	55.3	55.4	55.5	55.6	55.7	55.8	55.9	56.0	56.1	56.2	56.3	56.4	56.5	56.6	56.7	56.8	56.9	57.0	57.1	57.2	57.3	57.4	57.5	57.6	57.7	57.8	57.9	58.0	58.1	58.2	58.3	58.4	58.5	58.6	58.7	58.8	58.9	59.0	59.1	59.2	59.3	59.4	59.5	59.6	59.7	59.8	59.9	60.0	60.1	60.2	60.3	60.4	60.5	60.6	60.7	60.8	60.9	61.0	61.1	61.2	61.3	61.4	61.5	61.6	61.7	61.8	61.9	62.0	62.1	62.2	62.3	62.4	62.5	62.6	62.7	62.8	62.9	63.0	63.1	63.2	63.3	63.4	63.5	63.6	63.7	63.8	63.9	64.0	64.1	64.2	64.3	64.4	64.5	64.6	64.7	64.8	64.9	65.0	65.1	65.2	65.3	65.4	65.5	65.6	65.7	65.8	65.9	66.0	66.1	66.2	66.3	66.4	66.5	66.6	66.7	66.8	66.9	67.0	67.1	67.2	67.3	67.4	67.5	67.6	67.7	67.8	67.9	68.0	68.1	68.2	68.3	68.4	68.5	68.6	68.7	68.8	68.9	69.0	69.1	69.2	69.3	69.4	69.5	69.6	69.7	69.8	69.9	70.0	70.1	70.2	70.3	70.4	70.5	70.6	70.7	70.8	70.9	71.0	71.1	71.2	71.3	71.4	71.5	71.6	71.7	71.8	71.9	72.0	72.1	72.2	72.3	72.4	72.5	72.6	72.7	72.8	72.9	73.0	73.1	73.2	73.3	73.4	73.5	73.6	73.7	73.8	73.9	74.0	74.1	74.2	74.3	74.4	74.5	74.6	74.7	74.8	74.9	75.0	75.1	75.2	75.3	75.4	75.5	75.6	75.7	75.8	75.9	76.0	76.1	76.2	76.3	76.4	76.5	76.6	76.7	76.8	76.9	77.0	77.1	77.2	77.3	77.4	77.5	77.6	77.7	77.8	77.9	78.0	78.1	78.2	78.3	78.4	78.5	78.6	78.7	78.8	78.9	79.0	79.1	79.2	79.3	79.4	79.5	79.6	79.7	79.8	79.9	80.0	80.1	80.2	80.3	80.4	80.5	80.6	80.7	80.8	80.9	81.0	81.1	81.2	81.3	81.4	81.5	81.6	81.7	81.8	81.9	82.0	82.1	82.2	82.3	82.4	82.5	82.6	82.7	82.8	82.9	83.0	83.1	83.2	83.3	83.4	83.5	83.6	83.7	83.8	83.9	84.0	84.1	84.2	84.3	84.4	84.5	84.6	84.7	84.8	84.9	85.0	85.1	85.2	85.3	85.4	85.5	85.6	85.7	85.8	85.9	86.0	86.1	86.2	86.3	86.4	86.5	86.6	86.7	86.8	86.9	87.0	87.1	87.2	87.3	87.4	87.5	87.6	87.7	87.8	87.9	88.0	88.1	88.2	88.3	88.4	88.5	88.6	88.7	88.8	88.9	89.0	89.1	89.2	89.3	89.4	89.5	89.6	89.7	89.8	89.9	90.0	90.1	90.2	90.3	90.4	90.5	90.6	90.7	90.8	90.9	91.0	91.1	91.2	91.3	91.4	91.5	91.6	91.7	91.8	91.9	92.0	92.1	92.2	92.3	92.4	92.5	92.6	92.7	92.8	92.9	93.0	93.1	93.2	93.3	93.4	93.5	93.6	93.7	93.8	93.9	94.0	94.1	94.2	94.3	94.4	94.5	94.6	94.7	94.8	94.9	95.0	95.1	95.2	95.3	95.4	95.5	95.6	95.7	95.8	95.9	96.0	96.1	96.2	96.3	96.4	96.5	96.6	96.7	96.8	96.9	97.0	97.1	97.2	97.3	97.4	97.5	97.6	97.7	97.8	97.9	98.0	98.1	98.2	98.3	98.4	98.5	98.6	98.7	98.8	98.9	99.0	99.1	99.2	99.3	99.4	99.5	99.6	99.7	99.8	99.9	100.0
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Shown above is the **Test** screen for the 8" Color screen touch pad. There are 192 touch cells on some of the 6" models (see table, above, right) and on the 8", 10", and 15" panel screens (16 x 12), and 48 (8 x 6) on the other 6" models.

Each touchpad is numbered for reference. Press on each or any square to test that it is active. It will be highlighted after pressing to show that it has been tested. Press the square again to deselect it. Each square should beep when pressed. Press **Exit** in the lower right hand corner to quit.

## Display Test



The Display Test button is primarily used for production testing at the factory. Bands of color scroll horizontally and vertically across the screen during this test. It is used to check the pixel quality of the display before shipping the unit.

## Exit

Press the Exit button to display the Powerup screen you have selected in your project (selected under Project Attributes.)

## Reboot

To reboot the EZTouch Panel from any programmed screen, simultaneously press the extreme upper left and extreme lower left touchpad area on the panel screen.

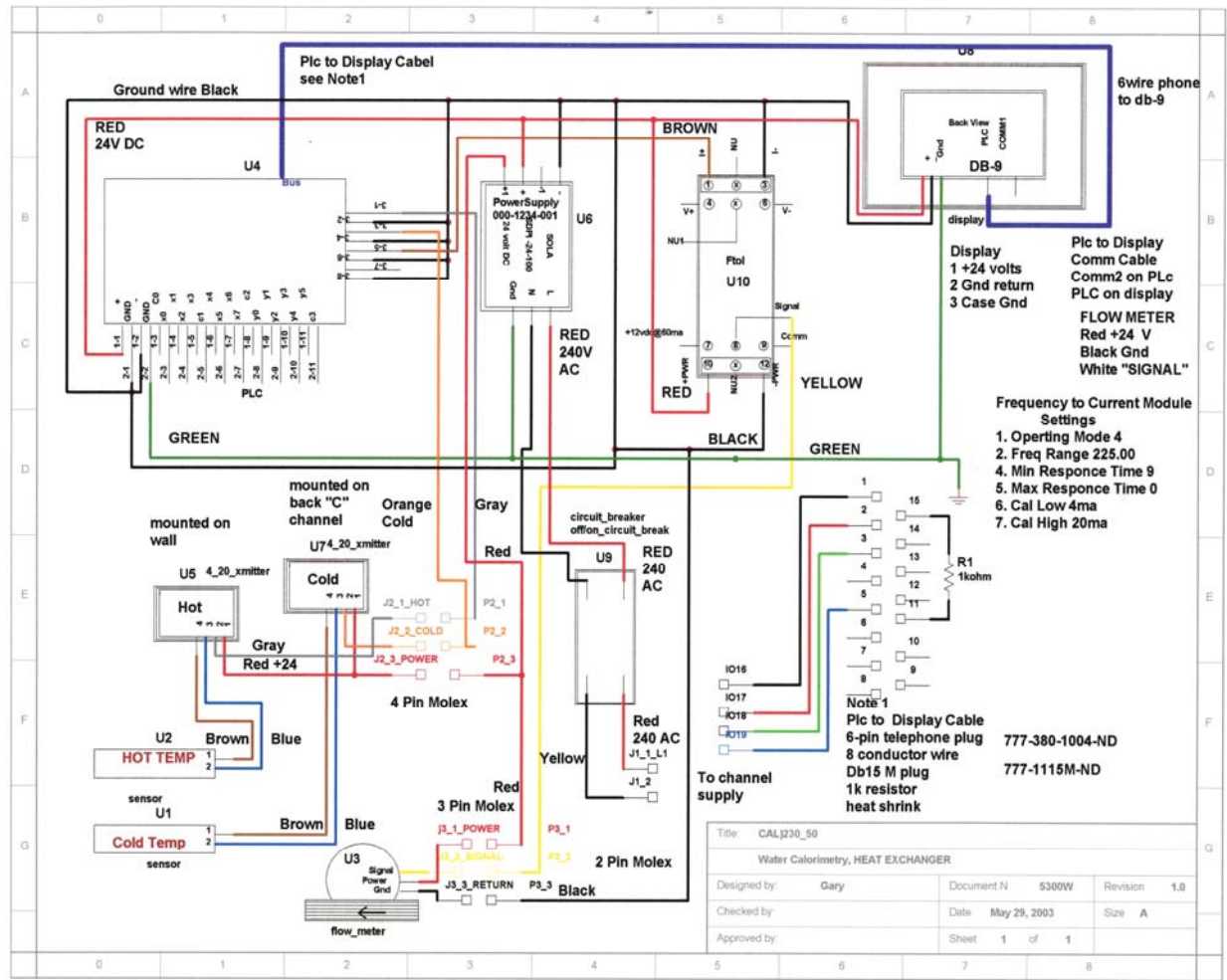
### **3-3. CALIBRATION**

Network thermistors demonstrate a precise resistance vs. temperature of  $R_t = (1000\Omega @ 0^\circ\text{C})$   $\text{TCR} = (.00385\Omega/\Omega/^\circ\text{C})$  variations in the thermistors and electronic measurement is compensated by individual offset and gain. The offset establishes the resistance at  $0^\circ\text{C}$  and the gain establishes the correct reading at  $100^\circ\text{C}$ . See section 4-2 for software calibration.

### **3-4. CONNECTORS AND SENSOR WIRING**

With the exception of the AC cord, all wiring is internal to the assembly. This provides EMI/RFI protection.

### 3-5. SCHEMATICS / INTERFACE



### Data Acquisition Module Interface

The flow and temp sensors are connected internally.

### 3-6. TROUBLE SHOOTING

If the system halts or fails to run, cycle the off/on power switch.

# SECTION IV

## OPERATION

4-1. **THEORY OF OPERATION.** RF energy is terminated into a cermet film resistor network, housed in a broadband cavity. The electromotive energy is transformed into heat by resistive action. A medium flows over the resistor and carries away the heat. The amount of heat the medium absorbs is directly proportional to the applied energy, the amount of medium, and the temperature differences between the inlet and outlet streams. This describes the operation basics for both air and water-cooled loads.

Air calculations utilize the following equation with K representing the specific heat of air:

$$\text{kW} = \frac{7.27 \text{ GramCalories} * K * \text{Flow} * \text{Delta Temperature}}{14330 \text{ GramCalories}}$$

Water, having a significantly higher specific heat capacity, utilizes the following equation:

$$\text{kW} = * \text{Flow} * \text{Delta Temperature} * \text{The Specific Heat of Water}$$

Altronic Research Inc. utilizes a unique approach which incorporates a data acquisition unit located in the RF hardened enclosure. This unit samples and digitizes the output from flow and temperature sensors.

Different temperature-sensing devices are used for the various application requirements. RTD's are generally used in air-cooled loads and thermistors in water-cooled loads. The RTD's used are linear over the wide operating ranges as experienced in an air-cooled load. They are interchangeable over extended ranges and exhibit excellent stability at high temperatures. Air flow is measured by bypassing a representative sample of the exchange air through the rotary sensor in the flow measurement assembly.

### **Measurements**

On current models all temperature measurements are displayed in degrees Celsius. All flow measurements are displayed in cubic feet per minute. Water flow measurements are in gallons/minute. Power measurements auto range from watts to megawatts.

In the course of taking a measurement in air-cooled loads, the applied energy has to heat up the load resistors and the load itself. This takes several minutes and the displayed power lags behind the actual power. The projected power is derived by tracking measurements related to the rise in temperature over a period of time and calculating the final temperature. The projected power normally will project within 8% of the actual reading in approximately one minute. The projected power is blanked when within 4% of the actual power. In water, the power measurement is more dynamic since heat change in water is more instantaneous. Taking measurements in water-cooled loads requires less time than air, although accurate measurements should be used after unit is less stabilized, usually within 1 minute.

### **Options**

The display and control capabilities may be remoted from the unit via radio link or dedicated line.

Optional communication interfaces are RS-232 and RS-485 formats. RS-232 signals may be remoted up to six meters. RS-485 signals can be remoted up to 2000 meters. Balanced line receivers and transmitters provide for high-level noise immunity.

## **4-2. GENERAL OPERATIONS.**

### **Installation**

The calorimetry system is self-contained and requires only plumbing hook-up and connection to AC power.

### **Calibration**

To calibrate the software for your application follow the steps below. For your convenience the original calibration numbers are included with this documentation.

- Run the calorimetry software. Do this by clicking the Start button, followed by Programs, then Calorimetry.
- Click the Calibrate button. A separate calibration window should appear.
- Enter the pertinent numbers. ***Make sure the numbers are correct as they determine the proper functioning of this software.***
- After entering the new calibration numbers, close the calibration window by clicking the large X at the top right of the window.
- The new calibration will take effect immediately.

Hot Offset \_\_\_\_\_

Flow Offset \_\_\_\_\_

Hot Gain \_\_\_\_\_

Flow Gain \_\_\_\_\_

Cold Offset \_\_\_\_\_

Kt \_\_\_\_\_

Cold Gain \_\_\_\_\_

#### 4-3. POWER CALCULATIONS

$$kW = kT * \text{Gal/Min} * \Delta T.$$

$\Delta T$  = difference in temp hot-temp cold

# **SECTION V**

## **REPLACEMENT PARTS LIST**

**MODEL 3500**

**(CONSULT FACTORY)**





# SECTION VII

## CALIBRATION CERTIFICATION

MODEL 3500 Serial # 122

April 2009

FLOW  
GPM

APPLIED  
POWER KW

INDICATED  
POWER KW


\*Source power was determined utilizing voltage and current measurements with test equipment, possessing in date calibration and a total accumulated error of less than 1%.

I certify the calibration data as accurate.



Gary L. James  
Altronic Research Inc.