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CALORIMETRY
MODEL 3500

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CALORIMETRY MODEL 3500

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.

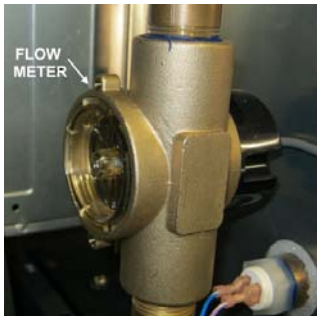
Calorimetry sequences require the precise measurement of the temperature difference of the inlet and outlet temperature and the flow rate. (See Section IV Theory of Operation). Considerable detail has been given to insure high accuracy. The electronics are housed in a shielded enclosure.

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.

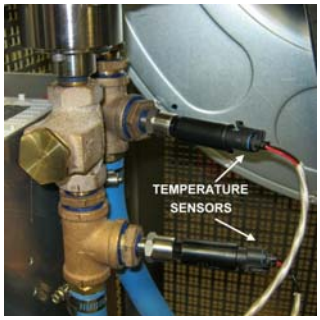
1.3. **COMPUTER ASSEMBLY.** The computer assembly consists of a Programmable Logic Controller which has a 2 input 4-to-20 ma. inputs. The program is stored in non-volatile memory. Display and interface functions are handled by a touch-screen display. These devices operate on 24 VDC which is supplied by the AC to DC power supply.

1-4. **DATA ACQUISITION MODULE.** Data acquisition and conversion is performed by two modules: (1) The temperature sensor transforms the signals to a 4-to-20 ma. signal level. (2) The flow sensor converts the flow information to a pulse frequency 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 hail effect sensor. An electronic sensor monitors the frequency of rotation.



b. Temp Sensors
Altronic Research utilizes different temperature sensing devices for the various application requirements. RTD's are generally used in air and 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.

1.6. SOFTWARE. The program for the PLC is written in ladder logic and may be updated via connection from a PC. 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 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 quantitive 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*DeltaT.

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

SCREEN
The function buttons force the display to change display screens. The running screens display the temperatures of the Hot And Cold sensors along with the difference between them. Flow in gallons per minute is then displayed. Power is displayed based on the DTemp and Flow conditions. The "Cal" calibration is a dual indicator and push button. The upper section displays the Calibration mode condition and the lower section provides a touch push button to activate or disengage the mode. The calibration should not be pressed when power is applied. Refer to page 11, calibration mode.

SECTION III

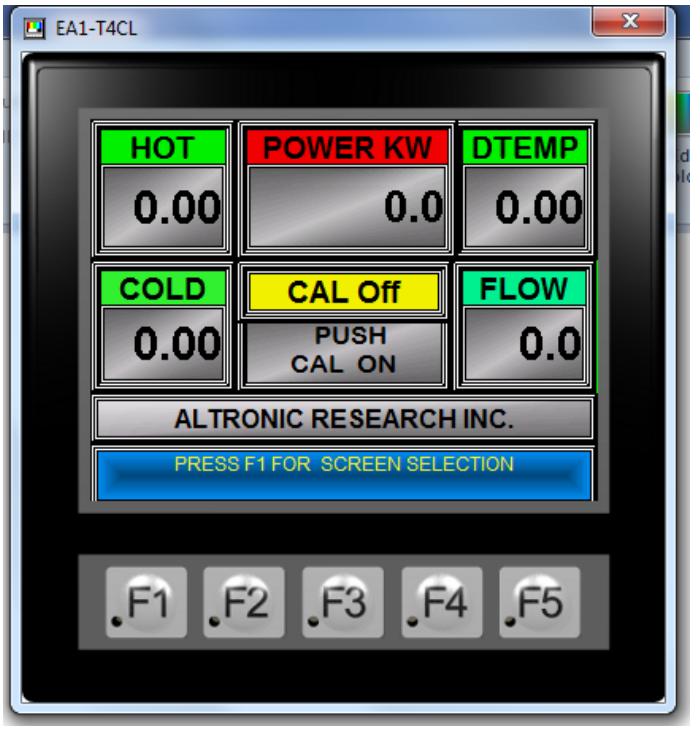
PREPARATION FOR USE

3-1. UNPACKING EQUIPMENT

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

3-2. FIELD INSTALLATION

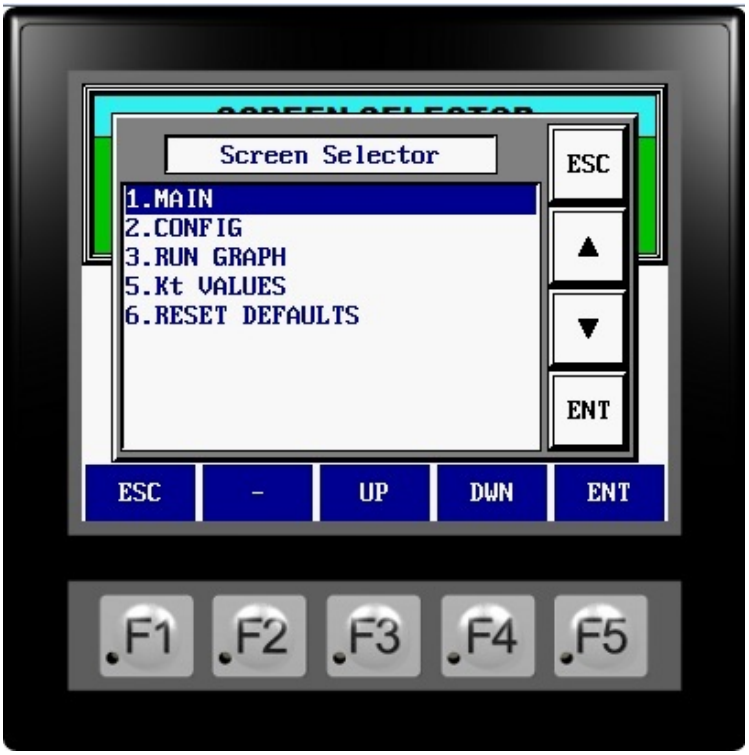
MAIN POWER ON SCREEN



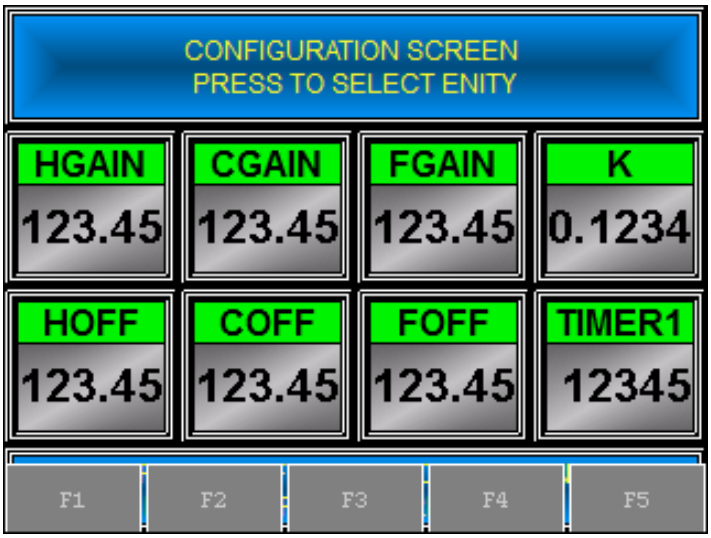
PRESSING F1 WILL GO TO SCREEN SELECT MENU

PRESS THE GREEN AREA TO ACCESS THE MENU OPTIONS

SCROLL TO THE DESIRED MENU AND PRESS ENT



CONFIGURATION SCREEN

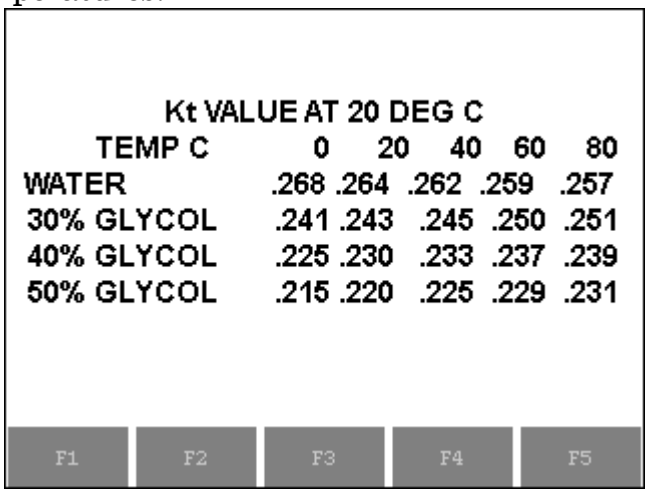


Note: These values are calibrated at the factory and should only be changed if the system is reconfigured.

This screen enables the configuration of the system variables for a specific application. To change a specific item, press the screen at that area. When the item is pressed, a calculator-type screen is overlaid. Extra buttons are included for Escape, Backspace, Clear and Entry. After the change data has been entered, press the "Ent" button to program the data and return to the configuration screen.

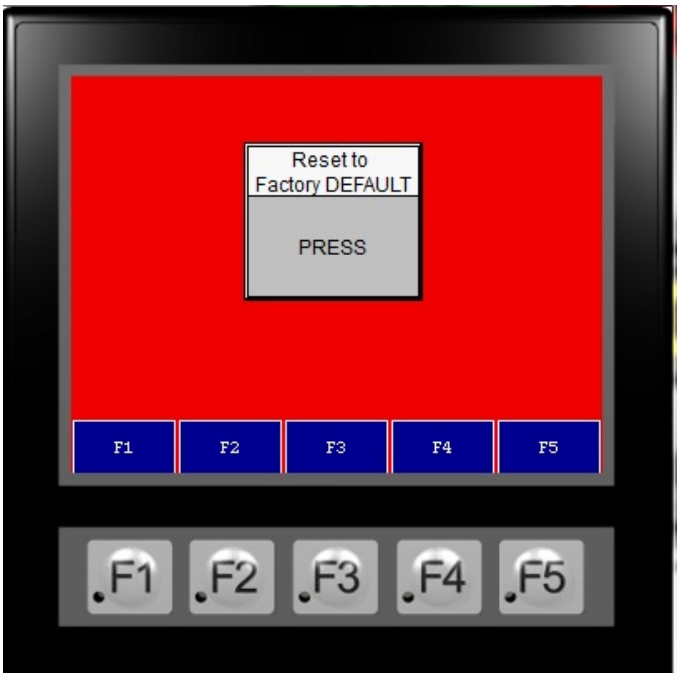
Kt FACTORS

A reference screen is provided for Kt Value look-up table for different fluid contractions and temperatures.



NOTE: THE SYSTEM IS SHIPPED WITH 30% GLYCOL SOLUTION THE KT FACTOR SHOULD BE SET TO .244

CALIBRATION MODE



Fluids flowing through a restriction absorb the energy required to force them through. For example, if a 1-hp pump was required to force a volume of fluid past a orifice, the fluid would experience a rise in Delta Temperature proportional to the Horsepower. The calibration option was created to remove this flow-induced error and provide an actual power reading. This should be initiated only when no power is applied to the load.

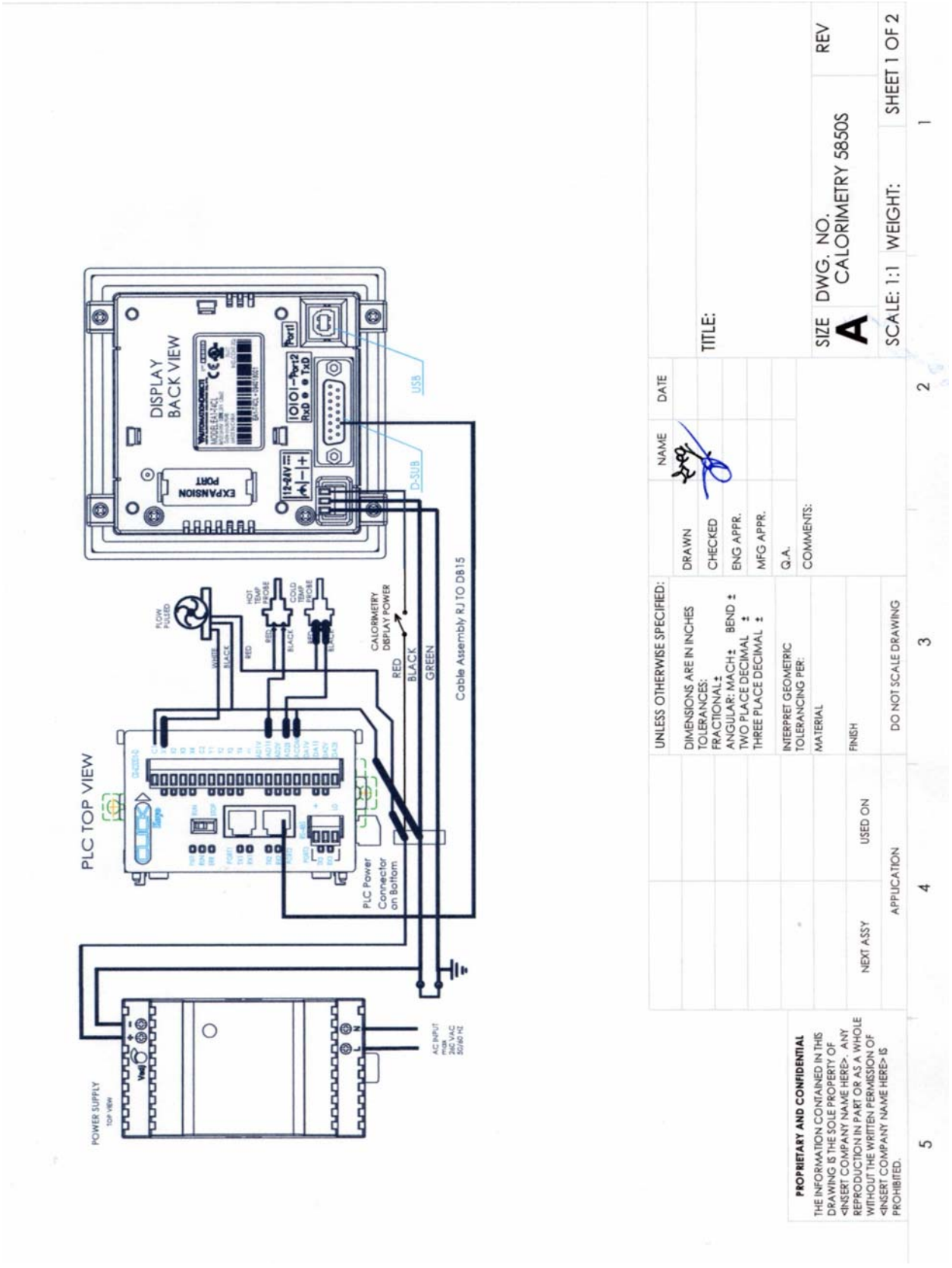
3-3. SENSOR CALIBRATION

Network thermistors demonstrate a precise resistance vs. temperature of Rt = (1000Ω@0°C) TCR = (.00385Ω/Ω/C°) Variations in the thermistors and electronic measurement is compensated by individual offset and gain. The offset establishes the resistance at 0°C and the gain establishes the correct reading at 100°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. **<u>THEORY OF OPERATION.</u>** 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:

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

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

kW = * Flow * Delta Temperature * 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. Airflow is measured by bypassing a representative sample of the exchange air through the rotary sensor in the flow measurement assembly.

<u>Measurements</u>

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 * Gal/Min * △ T.
△ T = difference in temp hot-temp cold

SECTION V

REPLACEMENT PARTS LIST

MODEL 3500

(CONSULT FACTORY)

SECTION VI

SPECIFICATIONS
Calorimetry Model 3500

INPUT POWER

Voltage _____ 90 - 270 VAC

Frequency Range _____ 40 - 400 Hz

MECHANICAL VARIATIONS

Flow _____3 - 30 GPM

ENVIRONMENTS

Operating Temperature _____> 5°C - 40°C

Storage Temperature _____> - 20° Dry

Humidity _____ 95% R.H. (non-condensing)

Serial No. _____ Software Revision _____

Model 3500W Inspected by GLJ Date _____

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SECTION VII

CALIBRATION CERTIFICATION
MODEL 3500 Serial # ____
FEBRUARY 2012

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.