ALTRONIC RESEARCH, INC.

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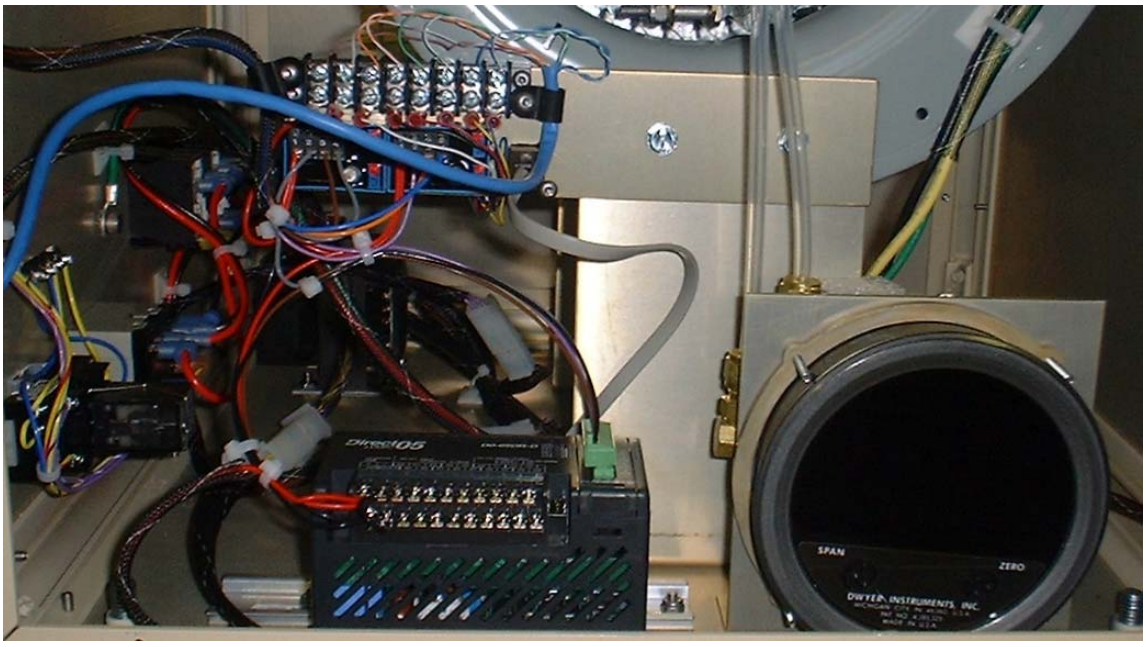
U.S.A.

CALORIMETRY
MODEL 3500
REMOTE OPTION

MODEL 3500
DIGITAL CALORIMETRY



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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 network, it is transformed into heat by the resistors. Forced air is passed over the resistors, carrying away the heat. Calorimetry techniques require measuring the rise in temperature between the cold (inlet air), the hot (outlet air) and by measuring the rate of airflow. (See Section IV Theory of Operation). Considerable detail has been given to insure high accuracy while still maintaining a rapid response system.

1-2. **GENERAL DESCRIPTION.** The remote display is contained in a 19-inch panel mount. It consists of the display, a power supply and an ON/OFF switch. The assembly is designed to operate from 110/120 VAC and may be plugged into a standard receptacle. The temperature sensors are mounted in the intake and exhaust of the load. A differential pressure sensor is located in the bottom of the load. This device measures the pressure drop across the load.

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 at 24 VDC which is supplied by the AC to DC power supply.

1-4. **DATA ACQUISITION MODULE.** Data acquisition and conversion is performed by the temperature module that transforms the analog signals from the temperature sensors to a 4-to-20 ma. signal level.

1-5. **SENSORS.** Airflow is determined by measuring the differential pressure on each side of the fan(s). This differential signal is converted to a 4-20 ma signal.

a. 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.

b. 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. The low-level temperature signal is changed to a 4-20 ma signal by a transmitter.

c. Thermistor

Thermistors have a fast response to temperature changes and are available in very small sizes and produce high signal levels.

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 or with a module which may be plugged in.

1-7. **ALARMS / INTERLOCKS.**

These features are available as add-on options. Check www.altronic.com or call Altronic Research Inc. for updates.

SECTION II

DEFINITIONS

ACTUAL POWER
Calculated as follows: $\frac{K \times FLOW \times \Delta T}{14{,}330}$
FLOW = Inlet Area x Linear Flow Ft./Min. Measured in Cu.Ft / Min.
* K ≅ 9 Dependent on Temperature, Humidity, Pressure, Efficiency of load

DELTA TEMP
The difference between hot and cold temperature.

Hot temperature: temperature in degrees C. of the air that is exiting the load.
Cold temperature: temperature in degrees C. of the air that is entering the load.

FLOW
A quantitive measure of the volume of air that is passing through the load.

HOT OFFSET
A calibration number that may be used to correct any errors in the hot temperature sensors.

COLD OFFSET
A calibration number that may be used to correct any errors in the cold temperature sensor.

HOT GAIN
A multiplier to convert the temperature in engineering units to degrees C.

COLD GAIN
A multiplier to convert the cold temperature in engineering units to degrees C.

FLOW OFFSET
Used to calibrate the flow meter and represents the minimum flow measurement capabilities of the flow meter.

FLOW GAIN
A multiplier that is used to convert from engineering units to Cubic Feet Per Minute.

GAINMOD
A multiplier used to control the slope of the flow curve.

GAINPRIME
The operative multiplier which is varied by the computer based on flow temperature and programmable variables programmed into the computer.

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

SCREEN
The screen button forces the display to change display screens.

SECTION III

OPERATION

3-1. 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:

$$kW = \frac{9.1\ gmCal/Ft^3 \times Flow\ CFM \times Delta\ Temperature}{14330\ GramCalories}$$

Altronic Research Inc. utilizes a unique approach which incorporates a data acquisition unit located in the RF hardened enclosure. This unit samples and scales 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. 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 determined by measuring the differential pressure on each side of the fan(s).

Measurements

On current models all temperature measurements are displayed in degrees Celsius. All flow measurements are displayed in cubic feet per 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. Air-cooled loads require 10 to 15 minutes for a stable reading. Some models of calorimetry do not have the projected power feature.

Options

The display and control capabilities may be operated remotely 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.

3-2. INSTALLATION

The calorimetry system is self-contained and only requires connection to AC power. The temperature sensors are terminated in a junction box. The wires are connected to pin 3,4 of the level convertor module which is located inside the junction box. The positive wire from the PLC connects to pin (1) of the level convertor terminal block and the signal wire connects to pin (2).

The interface between the Remote Display and the load must be provided and installed by the customer when the load is installed. Drawings are provided to show inter connections. It is recommended that stranded cable 18ga or larger be used.

3-3. POWER CALCULATIONS

1Kw = 9.1 gm cal (K factor) * flow F X temp 14330 gm cal/KW
gm - cal = gram calories
FT^3 = cubic feet/minute
T = difference in temp hot - temp cold

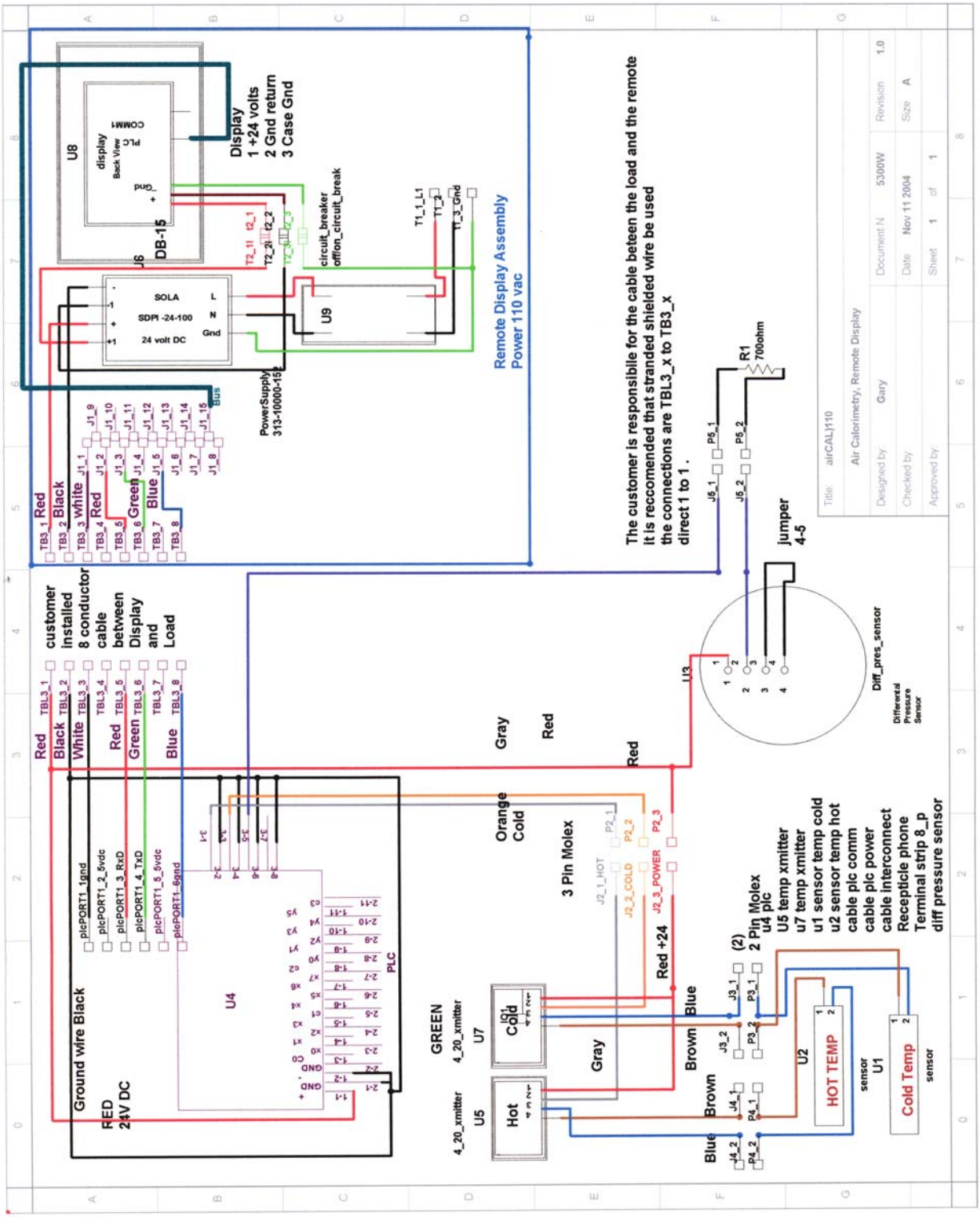
SECTION IV

TOUCH SCREEN / DISPLAY OPERATION

- The touch screen / display has several screens which allow programming and viewing. The first screen that is displayed only once after power on contains information for contacting Altronic Research should there be any problems.
- To advance to another screen press the start bar at the bottom of the display.
- The second screen displays the temperature, flow, and power information.
- To advance out of this screen press the screen change button at the lower left of display.
- The third screen provides an interface to enter variables into the computer.
- The data for these values is provided in the calibration section of this manual.
- At the lower left of the display is a reset button. When this button is pressed the factory settings that are burned into memory are loaded.
- When data is programmed into the individual values, they are stored into nonvolatile memory until they are reprogrammed or the reset is pressed. To exit from this screen, press the change screen button in the lower left side of the display.
- The fourth screen may be used to adjust the contrast/view angle and increment the time. To exit from this screen touch the change screen button located in the lower left of the screen.
- On some units an additional screen may be provided. It displays the raw acquisition numbers, hot, cold and flow.

SECTION V

SCHEMATIC



SECTION VI

REPLACEMENT PARTS LIST
MODEL 3500

(CONSULT FACTORY)

SECTION VII

SPECIFICATIONS
Calorimetry Model 3500

INPUT POWER

Voltage---------- 90 - 130 VAC

Frequency Range ---------- 40 - 400 Hz

MECHANICAL VARIATIONS

ENVIRONMENTS

Operating Temperature ---------- > 5°C - 40°C

Storage Temperature ---------- > - 20°

Altitude non-operating---------- <20,000 ft.

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

Serial No. 102 **Software Revision AD**

Model 3500 **Inspected by GLJ** **Date 1-5-2007**

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SECTION VIII

CALIBRATION CERTIFICATION
MODEL 3500 Serial # 102

TEST RESULTS SHOWN ON FOLLOWING PAGES

Source power was determined utilizing voltage and current measurements with test equipment, possessing in date calibration and a total accumulated error of less than 4%.

I certify the calibration data as accurate.

Gary L. James
Altronic Research Inc.
January 2007