INSTRUCTION BOOK FOR

MODULOAD®

RF CALORIMETER/

LOAD RESISTOR

SERIES 8645/46-600A

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25 KW MODELS COVERED IN THIS INSTRUCTION BOOK

MODELS	*VOLTS	MODELS	**VOLTS
8645-601A	115	8645-631A	115
8645-602A	230	8645-632A	230
8646-601A	115	8646-631A	115
8646-602A	230	8646-632A	230

*Without Ethylene Glycol
**With Ethylene Glycol

INSTRUCTION BOOK

OPERATING INSTRUCTIONS
WITH ILLUSTRATED
PARTS LIST

MODULOAD® RF CALORIMETER/ LOAD RESISTOR SERIES 8645/46-600A

Electronic Corporation
30303 Aurora Road, Cleveland, Ohio 44139-2794

Instruction Book Part Number 920-8645/6-600A

SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication. These precautions must be thoroughly understood and apply to all phases of operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe normal safety regulations. Do not attempt to replace parts or disconnect an RF transmission or any other high voltage line while power is applied. When working with high voltage always have someone present who is capable of rendering aid if necessary. Personnel working with or near high voltage should be familiar with modern methods of resuscitation.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstances should any person reach into an enclosure for the purpose of service or adjustment of equipment except in the presence of someone who is capable of rendering aid.

SAFETY EARTH GROUND

An uninterruptible earth safety ground must be supplied from the main power source to test instruments. Grounding one conductor of a two conductor power cable is not sufficient protection. Serious injury or death can occur if this grounding is not properly supplied.

SHOCK HAZARD

Do not attempt to remove an RF transmission line while power is present.

CHEMICAL HAZARD

Dry cleaning solvents used to clean parts may be potentially dangerous to your health. Avoid inhalation of fumes and also prolonged contact with skin.

RESUSCITATION

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

SAFETY SYMBOLS

WARNING

Warning: Warning notes call attention to a procedure, which if not correctly performed, could result in personal injury.

CAUTION

Caution: Caution notes call attention to a procedure, which if not correctly performed, could result in damage to the instrument.

The following warnings appear in the text where there is procedures, that if not carefully followed, could be detrimental to operating and maintenance personnel and are repeated here for emphasis.

WARNING

The following sections of this procedure involve the application of high power to the load. The following precautions must be observed to insure operator safety as sever burn or possibly death may result.

1. Make sure that the coaxial power cable connector is securely fastened to the load and that the water is flowing before turning on the ac power source.

2. Ensure that all Y.E.W. meter connections are tight before turning on ac power.

3. High voltage is present at the terminals of the Y.E.W. meters when the ac power source is on. Keep clear of these terminals.

4. Completely shutdown the ac power source before changing the Y.E.W. meter connections, turning off the water or removing the power cable from the load input connector.

WARNING

The resistor used in this load consists of a resistive film on a special substrate. If the substrate is broken, there will probably be sharp pieces or splinters inside the load housing. Caution should be exercised to avoid possible injury.

WARNING

The potential of electrical shock exists. Unplug the power meter from the AC line when removing its cover to avert accidental shock.

The following cautions appear in the text whenever a procedure, if not properly followed, could put the equipment in danger of damage and are repeated here for emphasis.

CAUTION

Before any RF operation of the load is attempted, the transmitter interlock and ac line attachment to the equipment must be made. First attach the transmitter interlock connections to the two binding posts on the front panel and then connect the power cable.

CAUTION

Do not use any sealants, leak-stopping material, or automotive antifreeze in the coolant. Use only distilled water and pure ethylene glycol.

CAUTION

The pump/motor must not be operated without sufficient coolant in the system. Damage to its working parts will result.

CAUTION

Do not use any drain plug other than that provided by Bird. Use of a substitute plug could cause equipment overheating by crossflow in the drain tubes.

CAUTION

Be sure flow control switch is in proper position for power level. Do not apply more than the rated RF power to the load used. Do not block air flow. Air enters housing through perforated grilles on each side and exhausts at top.

CAUTION

Do not operate load without connecting the interlock. This is very important. Even momentary application of power to the load while the cooling circulation is off or possibly functioning improperly will cause almost immediate destruction of the resistor element.

CAUTION

RF power input over 10 kW in the LO position will cause resistor burnout.

CAUTION

Do not apply RF power greater than maximum power level of load.

TABLE OF CONTENTS

TABLE OF CONTENTS [CONT]

TABLE OF CONTENTS [CONT]

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I. INTRODUCTION

1.1. PURPOSE AND FUNCTION

The Bird Series 8645/46-600A Calorimeters are instruments realized by the marriage of the popular Bird Model 6080A Calorimeter and the Series 8600 MODULOAD® RF Load Resistor. This idea was destined to evolve into an auspicious combination very useful to any type of transmitting station.

The Series 8645/46-600A Calorimeters are space saving units that are easily installed and have a serviceability similar to a MODULOAD® RF Load Resistor, yet display measured RF power very precisely, without resorting to any calculations. These units are also independent of frequency within the rated frequency of the load.

The load section is designed as a unique self cooling, low reflection and nonradiating termination for high power RF transmission. It is capable of continuous power dissipation of 25 kW with a VSWR of less than 1.10 to 1 from 1 kHz to 900 MHz (see Specifications). The Series 8645/46-600A are designed for use on CW, AM, FM, SSB, and TV modulation envelopes, and within certain limits on radar or pulse modes.

The Series 8645/46-600A Calorimeters are another unique innovation by Bird Electronic Corporation in calorimetric measurement. The need for interpolation of the flow rates, temperature differences, and system constants by the user has been eliminated. Calibration is performed by one simple adjustment before power is applied (see Section IV, Operating Instructions). The power is directly displayed in kilowatts on a digital meter. Because measurement has ± three percent or better accuracy and is not frequency dependent (it measures energy transferred into a water medium) the calorimeter is ideal for use as a standard for other wattmeters.

Lightweight and versatile, the control unit can be moved within a ten foot radius of the load/sensor unit. Combining this with a bright display permits easy to read power measurements.

1.2 DESCRIPTION

The calorimeter is comprised of the two units as described above: the calorimeter control unit and the load/sensor unit. These two units are connected by a ten foot sensor cable. A portion of the Model 6080A calorimeter's measurement system has been conveniently installed into the 8645/46 Series Load Resistor. This has been done to ease operator installation and use.

The load/sensor unit consists of four basic systems:

1. The RF load assembly - contains the resistive load element with cooling water system.

2. Sensor unit - contains two temperature sensors, input and output water temperature, and another sensor to monitor water flow rate.

3. Heat exchanger - consists of a pump/motor unit, collector tank, a finned cooling coil unit, and cover blower.

4. Interlock control system - includes the electrical interlock circuitry required to prevent damage to the transmitter or load in the case of a malfunction.

1.3. UNIT SPECIFICATIONS

SERIES 8645/46-600A

Impedance	50 ohms nominal
VSWR	1.10 maximum 1000 Hz-900 MHz
Connectors	
Model 8645-( )*	3-1/8" EIA Flanged (50 ohms)
Model 8646-( )*	3-1/8" Unflanged (50 ohms) (Flush Center Conductor)
Power Range **	
Low Range	1-10 kW continuous duty
High Range	10-25 kW continuous duty
Frequency Range	1 kHz-900 MHz
Accuracy	
1 to 5 kW	±3% of indicated power
5 to 25 kW	±2.5% of indicated power
Dimensions	
Control Unit	10-5/16"L x 10-1/8"W x 4-3/64"H (262 x 257.1 x 102.8 mm)
Load/Sensor Unit	25-15/16"L x 19-9/16"W x 19-5/32"H (659 x 497 x 487 mm)
Modes	CW, AM, SSB, TV, & certain pulse types
Ambient Temperature	
25 kW continuous	+5°C to +30°C (+41°F to +86°F) with water 0°C to +25°C (+32°F to +77°F) with 65% water and 35% ethylene glycol mixture
20 kW continuous	+5°C to +40°C (+41°F to +104°F) with water 0°C to +35°C (+32°F to +95°F) with 35% ethylene glycol mixture
Cooling Volume	2.43 U.S. Gallons (9.2 liter) distilled water or 2/3 water and 1/3 industrial grade ethylene glycol
Nonoperating (Storage)	
Distilled water	0°C minimum (+32°F min.)
35% Ethylene Glycol Mixture	-20°C minimum (-4°F min.)
Weight	
Load/Sensor Unit without water	164 lb (74.46 kg)
Load/Sensor Unit with water	184 lb (83.53 kg)
Control Unit	6 lb, 2 oz (2.78 kg)

UNIT SPECIFICATIONS [CONT.]

AC Power Requirements for Load/Sensor Unit	115 Vac, 60 Hz, single phase 11 amps 230 Vac, 50 Hz, single phase 5.5 amps
AC Power Requirements for Control Unit	115 V/230 Vac, 50/60 Hz 1 amp

* -601A for 115 V models without ethylene glycol
  -631A for 115 V models with ethylene glycol
  -602A for 230 V models without ethylene glycol
  -632A for 230 V models with ethylene glycol

**Although the 6080A Digital Calorimeter is capable of measuring power up to 80 kW, its capabilities will be limited by the maximum power rating of the RF load supplied or used with the system.

SECTION II. INSTALLATION

2.1. GENERAL

The purpose of this section is to assist the user with the initial steps that should be performed when receiving and preparing the RF Calorimeter for service. Refer to figure 2-1 throughout this section.

2.2. UNPACKING

The calorimetric control unit and 8645/46 series Load/Sensor Unit are shipped in separate containers. Included in these containers are:

- 1 6080A Control Unit
- 1 8645/46 Series Load/Sensor Unit
- 2 ac line cords
- 1 sensor cable
- 1 instruction manual

The load/sensor unit is encased in foam inside a tri-wall box. It should be lifted straight up out of the box and placed on a supportive flat surface. Personnel should take caution when removing load/sensor unit due to weight consideration. Foam can now be removed from outside surface of load/sensor unit.

The 6080A Control Unit is shipped in a separate box. The unit is protected by foam inserts and is easily removed by lifting unit straight up out of the box.

2.3. INITIAL INSPECTION

All packages are carefully wrapped and inspected by Bird prior to shipment. If the package shows any sign of damage, open and inspect the contents. If any damage is visible, notify the carrier immediately. Retain the shipping container for inspection.

2.4. MOUNTING AND LOCATION

The Series 8645/46-600A Load/Sensor unit may be installed and operated only in its original horizontal position, as the unit is shipped, and as it normally stands on its attached base brackets. Operation in any other manner will radically hamper the cooling system and almost certainly result in immediate burnout of the load resistor.

For convenience in installation of the equipment, mounting angle brackets are attached to the front and back base edges of the enclosure. They may be removed by unscrewing the four 8-32 pan head screws holding each bracket. These brackets have two slots each on 17 inch centers and spaced 24-15/16 inches (432 x 633 mm) apart to accommodate four 1/4 inch screws that may be used for mounting the unit. The main control unit may be placed conveniently within the ten foot radius of the sensor cable reach.

The load/sensor unit may be operated anywhere that appropriate ac line power is available, and ambient temperatures do not exceed those given, 40°C maximum at 20 kW or 30°C maximum at 25 kW continuous with water (see Unit Specifications, page 1-2). Note - Since 25 kW is equivalent to 85,380 Btu/h, a sufficient quantity of air must be provided. Allow room for unobstructed air intake over the whole surface of the perforated grilles on both sides of the equipment, and a clearance of at least three feet over the top of the unit.

2.5. AC LINE CONNECTION

Calorimetric Control Unit contains an ac line module located on the rear panel for input of ac power. This module is voltage selectable between 115 Vac or 230 Vac and contains the ac line fuse. The following steps explain voltage selectability and fuse accessibility:

Step 1: Determine the voltage level of the ac line. This may be 115/230 Vac.

Step 2: Compare this voltage level with the number that appears in the ac line select window.

Step 3: The control unit is factory-shipped for 115 Vac operation. Change to 230 Vac, if necessary, by opening cover door and removing voltage selector drum. See figure 2-2.

Step 4: Rotate voltage selector drum to desired voltage and reinsert.

Step 5: AC line fuse is also accessible by pulling out fuse drawer.

Figure 2-1. Installation

Figure 2-2. AC Line Module

Step 6: Close cover door.

Step 7: Locate the ac cord. Plug one end at the control unit's ac line module and the other end at the ac outlet. (Refer to paragraph 2.6 when connecting to European style sockets.)

The load/sensor unit also contains an ac line module located on the front panel. This module is wired for either 115 Vac or 230 Vac and does not supply voltage selectability. The module does contain an ac line fuse which is accessible as described in the preceding steps. Locate the ac cord. Plug one end at the load/sensor unit's ac line module and the other end at ac power outlet. (Refer to paragraph 2.6 when connecting to European style sockets.) For safety, the third wire in the ac line cord (the green wire) is the ground wire and must be connected to an earth ground. If a three wire system is not used, this wire must be properly attached to an earth ground.

2.6. EUROPEAN STYLE CONNECTORS

In order to make the ac line cord compatible with European style sockets, users must replace the connector at the end of the power cord. Then set the operating voltage selection drum for 230 Vac.

2.7. CONTROL UNIT INSTALLATION

Locate calorimetric control unit on a clean flat surface within the radius of the sensor cable. For longer distance remote monitoring various length sensor cables are available. See Section VIII, Replacement Parts.

With ac line already connected the control unit requires only one other connection, the sensor cable. Connect the sensor cable to the control unit as follows:

Step 1: A 9-pin D-shell sensor cable connector is located on the rear panel of the control unit. Correctly align the sensor cable with the sensor cable connector and mate the two parts. (The design does not permit incorrect connection.)

Step 2: Secure the provided screws, but do not overtighten them.

2.8. LOAD/SENSOR UNIT INSTALLATION

Connect nonterminated end of sensor cable to load/sensor unit cable connector located on rear panel. Follow the preceding steps for connection.

Connect the transmitter's interlock cable, not provided, to the two binding posts located on the front panel.

CAUTION

Before any RF operation of the load is attempted, the transmitter interlock and ac line attachment to the equipment must be made. First attach the transmitter interlock connections to the two binding posts on the front panel and then connect the power cable.

2.9. COOLANT

CAUTION

Do not use any sealants, leak-stopping material, or automotive antifreeze in the coolant. Use only distilled water and pure ethylene glycol.

The unit operates with 9.7 quarts (9.2 liter) of coolant. The coolant may be distilled water for an ambient temperature of +5°C to +40°C (+41°F to +104°F), or 2/3 water and 1/3 ethylene glycol for temperatures from 0°C to +35°C (+32°F to +95°F). Temperature ranges must be stated when an order is placed. Use only distilled water and industrially pure ethylene glycol. Do not use any automotive antifreeze preparations. Note - When ethylene glycol mixture is used, special calibration of the calorimeter is necessary. Any change in the concentration of the factory supplied coolant will require recalibration.

CAUTION

The pump/motor must not be operated without sufficient coolant in the system. Damage to its working parts will result.

Check the coolant level at daily intervals when the unit is in prolonged use, or when starting after a period of inaction. The coolant gauge is in the upper center of the rear face panel of the load/sensor unit. Whether the pump is on or off, when properly filled, the coolant indicator in the glass tube should show the liquid level at the upper gauge level. The level may also be checked by removing the filler plug at the top. It should be filled to a level about 4-5/8 inches (117 mm) below the top face of the filler tube opening. Add coolant if necessary to bring to the required level.

2.10. DRAINAGE AND FILLING

NOTE: All units are flushed with ethylene glycol before leaving the factory to prevent damage in shipment by freezing. All units to be used with water only (those with the suffix number of 601 and 602) must be flushed twice with distilled water before final filling to assure accuracy.

Drainage of the system is accomplished by removal of the drain plug at the bottom of the rear panel. To refill the system, pour coolant in until the tank is approximately at the requisite level stated previously, and then run the motor a few seconds to pull fluid into the system. A convenient method is to watch through the reservoir filler and stop the pump when the water level approaches the bottom. Do not run too long on original pourings, as partially dry operation of pump might ensue, with possible damage to the pump mechanism. Repeat filling in this manner until fluid level remains steady at the proper level, then run the load/sensor unit about five minutes and recheck fluid level before applying RF power (see paragraph 2.9, Coolant).

CAUTION

Do not use any drain plug other than that provided by Bird. Use of a substitute plug could cause equipment overheating by crossflow in the drain tubes.

2.11. BLOWER FAN

The fan is wired direct to the ac line input and will always operate along with the pump when the ac switch is on. In addition to the basic function of producing requisite air flow through the radiators, this ventilation materially assists in cooling the pump/motor unit.

SECTION III. THEORY OF OPERATION

3.1. GENERAL

The Series 8745/46 style TERMALINE® Coaxial Load Resistor installed in this unit is unique in having its water supply primarily directed over the outer, wet-film type resistive coating of the substrate. This technique is valuable in eliminating the need for an intermediate heat transfer fluid system. This method reduces the physical size of the load to a virtual minimum and makes it ideal for use in this calorimetric application. The construction and materials herein permit field repair of the unit (see Section V, Maintenance).

3.2. HEAT TRANSFER

The 50 ohm resistor consists of a substrate made of a special compound and has a permanently deposited resistive film on its outer surface. The heat generated by absorption of RF power is transferred from the film to the water which flows over it through a restricted chamber surrounding the resistor body. This water, first carried to the front of the load resistor, passes over the entire length of the resistor and discharges through the sealed water chamber at the rear. The composite dielectric characteristics and the distinctive design of these enclosures provide a very accurate 50 ohm termination over the specified frequency range of this load, from 1000 Hz to 900 MHz.

3.3. THEORY OF CALORIMETRY

The term calorimetry refers to the measurement of quantities of heat. Heat is energy in transition resulting from a temperature differential. This energy in transition may be expressed in ft-lb/h, Btu/min or cal/sec.

The "First Law" of thermodynamics states that energy can neither be created nor destroyed, but only converted from one form to another. This is the basic concept behind the calorimetric method of measurement. A basic definition should be noted: if a quantity of heat is transferred into one gram of water until the temperature of the water is increased one degree centigrade, it would be called one gram-calorie, more commonly referred to as one calorie. In the English system, if one pound of water will increase its temperature one Fahrenheit degree, one Btu of heat has been transferred into it.

Equation 1. $1\ \text{Btu} = 1\ \text{lb} \times 1°\text{F}$
$1\ \text{Calorie} = 1\ \text{gram} \times 1°\text{C}$

The relationship of grams to pounds and °C to °F is such that it makes one Btu equal to 251.996 calories.

Another factor in calorimetric measurement should also be taken into consideration: the specific heat of a substance. It has been proven that different substances having a weight of one pound will require different amounts of energy to increase their temperature one degree Fahrenheit. To compensate for this behavior of different materials, including water, a correction factor was assigned called specific heat. The units for specific heat are Btu/lb°F. By applying this correction factor to Equation 1, the calorimetric formula for heat thus becomes:

Equation 2. $1\ \text{Btu} = 1\ \text{lb} \times 1°\text{F} \times 1\ \text{Btu/lb°F}$
$\text{heat} = \text{mass} \times T \times Cp$

Since 1 Btu of heat is equal to 778.16 ft-lb of work, and the time rate of doing work is power, ft-lb/h or Btu/h could be a description of electrical watts or mechanical ft-lb power. Thus, when the time element is introduced into Equation 2, it simply becomes:

Equation 3. $\text{Btu/h} = \text{mass (lb/h)} \times T(°\text{F}) \times Cp\ (\text{Btu/lb°F})$

This is the equation of calorimetry. Knowledge of delta T, rate of mass flow, and specific heat would produce Btu/h, equal to power.

3.4. DIGITAL RF CALORIMETER

Calorimetry as applied to this calorimeter series is essentially the same as described in the preceding paragraphs. The water cooled loads, installed in the Series 8646/46-600A Load/Sensor unit, have the ability to transfer almost 100 percent of RF heating power into a cooling liquid. Availability of these loads, such as the Series 8700 TERMALINE® Coaxial Load Resistor, provides a means with which an elementary calorimetric formula may be utilized.

Equation 4. RF Power = flow x T x constant x Cp

The electronic calorimeter synthesizes the flow rate, temperature differential, and conversion factor, displaying the final result in kilowatts on a digital readout.

To determine the temperature it is necessary to linearly track temperatures between 0°C and 50°C. This is accomplished through electronic thermometers that produce a voltage output as a direct function of temperature in °C. The temperature difference is found by placing an electronic thermometer at the load water input and also at the load drain. Their voltage outputs are fed into a differential amplifier and the resulting output will be the temperature difference.

Flow rate is measured by a magnetic sensor which is located at the water input of the load. This metering device utilizes a turbine-bladed rotor to generate a pulse output. These pulses are then fed into a frequency to voltage converter that produces a gallon per minute voltage output. By adjusting the output gain to the systems constant we implement our conversion factor. To synthesize these system variables, an analog multiplier is used. The X input of the multiplier is used for flow rate and the Y input is for temperature difference. By applying the output of the multiplier to a digital panel meter, the voltage measured will be the power consumption in kilowatts.

3.5. FLOW INTERLOCK CONTROL CIRCUIT

The interlock control circuit provides instantaneous fail-safe protection of the transmitter and load in the event of even momentary interruption of the cooling water supply. This protection is necessary because dissipation of the heat generated by the RF power is critically dependent upon a required minimum water flow at all times regardless of system water temperature.

The water flow switch, installed close to the output port of the pump, is a "normally open" type; i.e. its electrical contact opens when deactivated. Closed during equipment operation, the switch is adjusted to open whenever water flow drops below the safe flow point for the specific unit. When this occurs, the timer relay is instantly deactivated, thereby opening the interlock circuit and causing immediate transmitter shutdown. Also, the centrifugal impeller of the water pump is carefully selected for the necessary current flow. The proper operation of this equipment depends on these conditions being maintained. Do not alter the flow switch setting or disturb the pump.

After resuming operation of the load/sensor unit and restoring the calibrated water flow, the time delay switch will keep the transmitter interlock open for approximately two seconds. This special safeguard assures proper operation of the cooling system before RF power can be applied to the load, preventing damage or burnout of the resistor element. Note - A special FLOW CONTROL switch is added to the front panel of this model. For the safety of the load resistor, it is important that this switch be in the correct position for RF power level used. In the LOW position, input of over ten kilowatts will cause quick burnout of the load resistor; use care in LOW position. The switch controls a solenoid valve, normally closed, which opens to bypass some of the load resistor's water supply.

SECTION IV. OPERATION INSTRUCTIONS

4.1. GENERAL

CAUTION

Be sure flow control switch is in proper position for power level. Do not apply more than the rated RF power to the load used. Do not block air flow. Air enters housing through perforated grilles on each side and exhausts at top.

The Series 8645/46-600A RF Calorimeters have only one operating control, the FLOW CONTROL switch located on the front panel of the unit. This switch must be set for the power level used before operation: LOW setting, one to ten kilowatts; HI setting, above ten kilowatts power. Unless calorimetric measurements are to be taken, it is advised that this switch remain in the HI POWER position even though the load is used at low power. Once set, the presence of an operator is not required.

4.2. CONNECTING RF POWER TO LOAD

After installation, the coaxial RF transmission line may be attached. For the respective Models 8645 and 8646 the connections are as follows:

a. Model 8645, 3-1/8 inch EIA, 50 ohms with swivel flange.

1. Use 3-1/8 inch EIA coupling kit, P/N 4600-020, which includes: six each 3/8-16 x 1-1/2 inch bolt and nut sets, O-Ring, and insulated center bullet.

2. Insert the center bullet, push into the bottom of the insulator in the recess of facing and install O-Ring in groove.

3. Connect coaxial input in straight line, push carefully on center contact to close. The swivel flange on the load/sensor unit makes connection independent of a fixed flange on the coaxial input.

4. Insert bolt sets, tighten evenly all around.

b. Model 8646, 3-1/8 inch unflanged, 50 ohms.

1. Use coupling kit, P/N 5-726 or RCA MI-27791K-4A which includes: outer sleeve with two clamping bands and the center conductor coupling bullet.

2. Insert center bullet and bottom it on the midpoint nibs.

3. Position the outer sleeve, with clamps, over input connector.

4. Introduce transmission line and seat snugly against the coupling stops.

5. Position clamp bands evenly about 1-3/4 inches apart and tighten.

4.3. NORMAL OPERATION AS A LOAD RESISTOR

CAUTION

Be sure flow control switch is in proper position for power level. Do not apply more than the rated RF power to the load used. Do not block air flow. Air enters housing through perforated grilles on each side and exhausts at top.

CAUTION

Do not operate load without connecting the interlock. This is very important. Even momentary application of power to the load while the cooling circulation is off or possibly functioning improperly will cause almost immediate destruction of the resistor element.

a. Turn interlock supply on.

b. Turn on 115 V or 230 Vac power. For fan operation see 2.11, Blower Fan.

c. Apply RF power to load.

4.4. SHUTDOWN

a. Turn RF power to load off.

b. Wait five minutes, allowing pump and fans to run.

c. Turn ac power off. Stopping the load/sensor unit automatically opens the interlock connection.

4.5. PERFORMANCE NOTES

Important - For correct calorimeter readings, the FLOW CONTROL SWITCH on the front panel must be set as follows:

	Control Unit Power Reading	Load/Sensor Unit Switch Setting
Low Range	1-10 kW	LOW Power
High Range	above 10 kW	HI Power

There are two thermoswitches used in the load/sensor unit. One switch is located in a well on the load drain line, for the low power range. The other, located in the coolant storage tank, is for high power operation. These switches are in series with the flow switch circuit, supplying voltage to the interlock relay. Controlled by the HI-LOW setting switch, only one thermoswitch will be in operation at a time depending on power level used.

The Series 8645/46-600A Calorimeter will handle continuous power dissipation of 25 kW, at a maximum ambient temperature of 30°C. For other values, see Specifications on page ix. The Series 8645/46-600A are intended for use on CW, AM, FM, SSB, TV modulation envelopes, and within certain limits on radar or pulse modes. For information involving pulse type signals, contact the factory.

4.6. COOLING CHARACTERISTICS

The electrical performance of the Series 8645/46-600A RF Calorimeter is affected by impurities or other chemical additives in the cooling liquid. Therefore, the cooling liquid should be distilled water with industrially pure ethylene glycol, when used, and be kept clean at all times.

Thermal performance is affected by impurities, particularly those which accumulate in the form of scale on the surface of the ceramic tube and other water passages. This results in an increase of thermal resistance of the load and may cause the load to overheat and fail.

4.7. CONTROL UNIT (MODEL 6080A)

This section describes the operation of the calorimetric control unit.Operator is given a description of front and rear panel features and is guided through a step by step format of how to take measurements. Control unit is installed per installation procedures (see Section II, Installation).

4.8. FRONT PANEL LAYOUT

The following is a description of front panel features (see figure 4-1).

1. ON/OFF Switch - Controls ac line power

2. FLOW INDICATOR - Gives visual indication of coolant flow in gallons per minute (GPM). The flow indicator has two ranges, a low power range which indicates a flow of 3 to 5.25 GPM and a high power range which indicates a flow of 6 to 10.5 GPM. These ranges are selectable through the use of the HI/LOW pushbutton. The 8630 series, having a maximum power level of ten kilowatts, uses only the low power range.

3. DISPLAY - Gives a visual indication of the present value being measured. This value represents kilowatts of RF power being seen by the load/sensor unit.

Figure 4-1. Front Panel Layout

4. RF POWER/CAL SWITCH - When not depressed RF power mode is selected. This mode is implemented during normal operating conditions and is used in conjunction with the HI/LOW range button.

When the button is depressed, CAL mode is selected. The unit is now ready to perform initial system calibration.

5. HI/LOW SWITCH - With unit in RF power mode this button will select between High or Low power and flow ranges. In LOW mode the usable power range is 1 to 10 kW and flow range is 3 to 5.25 GPM. In HI power mode the upper power limit is determined by the load/sensor unit (Series 8630-600 uses only low power mode). The HI range of the flow sensor is 6 to 10.5 GPM.

With unit in CAL mode the HI/LOW button allows operator to perform initial calibration for both ranges.

6. CAL ADJUST - This is the adjustment potentiometer for nulling power ranges when unit is in CAL mode.

4.9. REAR PANEL LAYOUT

The following is a description of rear panel features (see figure 4-2).

a. AC LINE MODULE - The ac line module provides a three-function capability:

1. Contains the ac line socket for input of ac power.

2. Provides line voltage selection 115/230 volts.

3. Contains internally, an ac line fuse.

Location of fuse and instructions on line voltage selection are detailed in paragraph 2.5.

b. SENSOR CABLE - This 9-pin D-shell connector supplies the mating contacts for the sensor cable. Input/Output data passes to and from the control unit via this connector. Pin assignments for this connector are given below:

Pin No.	Function
1	Flow Frequency
2	Sensor Supply Voltage (+15 V)
3	Input Voltage Reference (+5 V)
4	Input Voltage Ratio
5	Input Temperature Voltage
6	Signal Ground
7	Output Voltage Reference (+5 V)
8	Output Voltage Ratio
9	Output Temperature Voltage

c. BCD OUTPUT - This 25-pin D-shell connector supplies a BCD output for remote use. Various applications for this output are described in Section IX. Pin assignments for this connector are given below:

Pin No.	Function
1	BCD 100
2	BCD 200
3	BCD 400
4	BCD 800
5	NC
6	BCD 10
7	BCD 20
8	BCD 40
9	BCD 80
10	BCD 1
11	BCD 2
12	BCD 4
13	BCD 8
14	BCD Ground
15	Hold
16	NC
17	BCD 1000
18	+5 V
19	OE3 (Tens)
20	OE2 (Hundreds)
21	OE4 (Units + Overrange)
22	OE1 (Thousands + Polarity)
23	Overrange
24	Polarity
25	Data Valid

4.10. START UP

Before applying ac line power to load/sensor unit or control unit make certain that ac line module is matched to the available line voltage and all safety

Figure 4-2. Rear Panel Layout

precautions are taken.

Perform the following steps to achieve a proper start up condition:

CAUTION

The pump/motor must not be operated without sufficient coolant in the system. Damage to its working parts will result.

a. Turn on ac power switch on load/sensor unit. This will start the coolant pump directly, regardless of the condition of the control system. The line power supply to the load/sensor unit will usually be remotely controlled, and generally may be switched in conjunction with RF power loading of the system.

Operation of the pump/motor, initiating coolant flow, will close the pressure switch contacts. The high temperature thermoswitch in series with it is normally closed and this will start operation of the time delay. In approximately two seconds it will close contacts and the transmitter interlock will then permit the application of RF power. Do not apply RF power at this time.

b. Allow coolant flow and load/sensor unit to stabilize for a minimum of five minutes.

c. Turn on ac power to control unit.

d. Set RF POWER/CAL switch to CAL mode.

e. Perform an initial calibration on both the HI and LOW power ranges by first selecting the HI range and adjusting the CAL adjustment for a display indication of zero. Now select the LOW range and adjust the CAL adjustment for zero. NEVER CALIBRATE UNIT WITH RF POWER APPLIED.

f. Return RF POWER/CAL switch to RF power mode.

g. If display still doesn't indicate zero a fine adjustment can be made to the CAL adjustment while in RF power mode.

NOTE: If null setting could not be achieved then see Maintenance Section.

h. Flow indicator should show a stable flow of approximately 3.5 GPM on the LOW range. If flow is below 3.25 or above 3.75, see Maintenance Section.

Series 8645/46-600A RF Calorimeter is now ready for normal operation.

4.11. NORMAL OPERATION

CAUTION

Do not apply RF power greater than maximum power level of load.

With the calorimetric control unit set in RF power mode, LOW power range, RF power measurements can now be made.

Apply RF power. The display will indicate RF power being measured in kilowatts. With large changes of transmitter power allow three minutes stabilization time to achieve stated accuracy.

4.12. SHUTDOWN

The following steps apply to 8645/46-600A system shutdown.

a. Turn off transmitter power.

b. Turn off control unit.

c. Wait five minutes before turning off ac line power to load/sensor unit.

SECTION V. MAINTENANCE

5.1. GENERAL

Only a moderate amount of preventive maintenance is required for the Series 8645/46-600A RF Digital Calorimeter. Use reasonable care in handling; do not drop the main control unit or load assembly.

The coaxial load resistor installed in the load/sensor unit of the calorimeter is rugged and simple, requiring only nominal and routine attention. The load is designed to operate for long periods of time if care is taken not to exceed its power handling capabilities.

5.2. PREVENTIVE MAINTENANCE

Following the routine below will ensure years of failure free operation.

a. Cleaning -

1. A main factor in effective preventive maintenance is cleanliness. For optimum performance and service life, the calorimeter must be kept in a clean and dust-free condition. When not in use keep the main control unit in a clean cool environment.

2. The outside surface of the unit should be wiped free of dust and dirt at regular intervals. Particular attention should be given to the air intakes (see paragraph c, 2). Occasionally, check condition of RF Coaxial connection. If required, disconnect parts, both metallic and insulator surfaces. The control cable connector must be kept clean. Carefully wipe the metallic contacts and connector body. A cotton swab stick is useful for this. The operating panel should be wiped clean with a soft cloth. Wipe the meter face only when necessary.

b. Inspection - Periodic inspection should be performed at three to six-month intervals dependent on amount of continuous use.

1. Water Flow Switch - The water flow switch should be inspected periodically for accumulated scale and cleaned, if necessary, to permit free movement of the sliding valve. This should be done only by removing the wired sensor plug with a 1-1/2 inch end wrench. The component is not repairable and must be replaced if its performance is defective. Operation can be checked by monitoring the interlock circuits while starting or stopping pump/motor with RF power off. See paragraph 6.6, Water Flow Switch Removal.

2. Connectors - Inspect all interconnections to load/sensor unit and control unit for bent, broken, and missing pins.

c. Routine Service Checks

1. When the equipment is in use, watch the coolant level at regular intervals. Check once or twice a week normally, more often if used continuously or under high ambient temperatures. The coolant level should remain at upper gauge mark on the back panel, whether the load/sensor unit is running or not. For test measurement and addition or liquid if required, see paragraphs 2.9, Coolant, and 2.10, Drainage and Filling. Use only distilled water and industrially pure ethylene glycol - no automotive anti-freeze.

2. The radiator surfaces, particularly on the outside, should be checked through the grilles periodically for possible collection of dust and lint. If necessary release screws, 18 each, from edges of grilled side panels and remove these panels. Clean off any collected dust and lint with a radiator brush or any stiff bristle brush. If there is a buildup remove and clean under grille. Heavy line coatings on outside surface of the radiator unit can impair efficiency of the load/sensor unit - keep these clean.

3. The coolant strainer, located inside the load/sensor unit, is used to trap any small particles that may hinder the operation of the flow meter or load. This strainer is subject to occasional cleaning or element replacement. If the unit is heavily used the strainer should be checked and cleaned about once a month. This interval may be extended if experience shows that only a small amount of residue is found in the sediment bowl. Always check the strainer within 30 days after a coolant change.

Blockage of the filter screen of over 75 percent could reduce the flow in the system to an unacceptable level and cause the interlock relay to activate. For cleaning or replacement of strainer, see paragraph 6.8.

5.3. PERFORMANCE TEST

5.4. RF LOAD RESISTOR

Accurate measurement of the dc resistance between the inner and outer conductors of the RF input connector will provide a good check of the condition of the load resistor. For this measurement a resistance bridge or ohmmeter with an accuracy of one percent or better at 50 ohms is recommended. Use low resistance leads, preferably a short piece of 50 ohm cable with test clips attached. The measured resistance should not deviate more than ±2 ohms from the nominal value. Note - It is recommended that this resistance check be performed each time the load is to be used.

If measured resistance is greater than ±2 ohms from nominal value, see paragraph 6.4.

SECTION VI. TROUBLESHOOTING AND REPAIR

6.1. GENERAL

Due to its electronic complexity, repair of 8645/46-600A Series RF Calorimeter systems is recommended only for certain malfunctions. Table 6-1 contains a list of problems that are commonly experienced with their probable cause and remedy.

Table 6-1. TROUBLESHOOTING CHART

LOAD/SENSOR UNIT

PROBLEM	POSSIBLE CAUSE	REMEDY
Fan and pump not operational	Power cord not connected ON/OFF switch is off	Check power cord connection, turn switch on.
AC applied but fan and pump not operational	Defective fuse Defective ON/OFF switch	Check fuse. Check switch.
	Disconnected wire	Connect loose wire using schematic as a reference. See Appendix A figure A1 or A2.
AC applied but fan not operational	Defective starting capacitor	Check capacitance. The capacitance should be 3μF.
	Defective fan	Replace fan.
AC applied but pump not operational	Pump overheated	Pump is thermally protected. Check ambient temperature specifications.
	Defective pump	Replace pump.

CONTROL UNIT

Panel meter does not illuminate	Power cord not connected ON/OFF switch is off	Check power cord connection. Turn switch on.
AC applied but panel meter not illuminated	Defective fuse Defective ON/OFF switch	Check fuse. Check switch.
	Loose or disconnected wires	Check connections at header J3 and J5.
	Improper supply voltage	Check the voltage at screw terminal No. 8 located on the lower card of the panel meter. Check connections at screw terminals and check voltage. Should be approximately 5 V. If voltage is not present replace PC board.
	Defective meter	Replace meter.

TROUBLESHOOTING [CONT.]

RF CALORIMETER SYSTEM

Refer to figure 6-4 for location of header J1. J1 will be used as a test header throughout the remainder of the troubleshooting procedures. Figure 6-6 gives the pin functions for header J1.

PROBLEM	POSSIBLE CAUSE	REMEDY
Flow indicator inoperative	Poor cable connection	Check cable connection at load/sensor unit and control unit.
	Loose or disconnected wires	Check connection of J1 on flow indicator PC board.
	Faulty flowmeter	Check frequency at pin 8 of header J1. If frequency is not approximately 350 Hz and the reading is erratic, then proceed to replace flowmeter.
	Flow circuit defective	Check the voltage at pin 10 and frequency at pin 8 of header J1. The voltage should be approximately one volt and the frequency approximately 350 Hz. If these readings are not present proceed to replace PC board.
	Faulty indicator	If all of the above corrections have already been tried, proceed to replace flow indicator PC board.
Display will not zero	Poor cable connection	Check cable connection at load/sensor unit and control unit.
	Sensor cable	Check sensor cable zero disconnected connection inside load/sensor unit.
	Temperature sensors out of adjustment	Realign temperature sensors. See paragraph 6.13.
	Input temperature sensor defective	Check the voltage at pin 3 of header J1. If the voltage is not approximately 625 mV replace sensor. See paragraph 6.14.
	Output temperature sensor defective	Check voltage at pin 12 of header J1. If the voltage is not approximately 625 mV, replace sensor. See paragraph 6.14.

TROUBLESHOOTING [CONT.]

Temperature sensor circuit defective	Check voltage at pins 4 and 11. They should be the same, approximately 240 mV. At 24°C ambient temperature if the voltage levels of the two pins are different and the above corrections have already been tried, proceed to replace PC board.

6.2. LOAD/SENSOR UNIT REPAIR/REPLACEMENT

The Series 8645/46-600A Load/Sensor Units are especially designed for independent, long term, trouble-free operation. Regular mechanical maintenance procedures, other than routine checks and cleaning care described just previously, are not required. In case of malfunction of the unit or replacement of a major component, the entire unit may be returned to the factory. This applies especially to any calorimeter still under the one year warranty. Consult the factory. Note - Do not tamper with operational as settings or do other unauthorized maintenance work during the first year, as it could be cause to void the warranty. Field repair of the load resistor may be performed as described in Section IX, Internal Repair of the Load Resistor. Other replacement procedures that might be needed are given in this section:

a. RF Load Resistor Removal, 6.4.
b. Pump/Motor Removal, 6.5.
c. Water Flow Switch Removal, 6.6.
d. Time Delay Relay, 6.7.
e. Coolant Strainer Cleaning or Replacement, 6.8.
f. Flowmeter Removal, 6.9.

Refer to figure 6-3 throughout this section for overall component location. Figure 2-1 gives locations of outside panel features.

6.3. SPECIAL INSTRUCTIONS

Whenever maintenance work has been performed, including resistor repair, or there is reason to suspect that contamination has been introduced or dislodged into the load/sensor unit coolant, the system should be thoroughly flushed out. Do this by running the load/sensor unit with coolant but without RF power for a period of three to five minutes (see paragraph 2.10). Follow immediately by as complete as possible a drainage of the circulating system and refill with fresh clean water. Note - Clear tap water, if not excessively hard, may be used for flushing until the last steps, which must be done with distilled water. The sequence should be repeated as required until the drained liquid is clear. Then fill with distilled water and/or approved ethylene glycol mixture (see paragraphs 2.9, Coolant and 2.10, Drainage and Filling).

6.4. RF LOAD RESISTOR

Resistor repair in the load may be done directly, without removing the water connections; follow procedures and diagrams in Section IX, Internal Repair Of The Load Resistor. They contain full dismounting and resistor change procedures. The full load assembly may be removed from the load/sensor unit case, as described in paragraphs 6.4, a through d. Then follow Section IX, Internal Repair of the Load Resistor.

To remove the load resistor unit take off the top panel by removing 18 screws around its perimeter. Turn all four handles outward and lift up the top panel assembly. Disconnect the small fan-supply plug seated on top of radiator block. Refer to figure 6-1 for the following procedures:

Note - Observe the angular position of the flowmeter and temperature sensor to the load before removal. It must be returned to this position when reinstalled.

a. Unscrew drain plug at center of rear panel of unit and allow coolant to drain. Note - Be careful not to mislay this plug; do not replace it with any substitute plug. Then using an ordinary screwdriver, unscrew the hose clamp on the input and output sensor

assembly and remove the hoses. Remove flow, input and output sensor cable assemblies by unscrewing the circular connectors.

b. On the inside of the front panel, remove six 1/4-20 nuts with a 7/16 inch wrench. Nuts on the bottom side are accessible with a short length end-wrench. Note - Loosen the nuts only. Do not twist or disturb the screw heads on the front of the load resistor flange, as this will open its front connection.

c. Remove the saddle strap from the load by removing the two 1/4-20 bolts with a 7/16 inch wrench.

d. Position the load resistor to allow for enough clearance to remove the output sensor assembly from the load water chamber. Remove by turning assembly counterclockwise.

e. Using care, the load resistor assembly may now be withdrawn straight out through the front panel. If the load resistor is to be returned to the factory for repair, do not disturb the water chamber fastened by six socket hexed cap screws on bolt circle at the back end of the load. Unscrew the flowmeter assembly from the inlet port at the back of the water chamber. Keep these components carefully stored with the load/sensor unit for further use. If the unit is to be field repaired it is not necessary to remove the flowmeter assembly from the water chamber. Proceed with Resistor Replacement as described in Section IX, Internal Repair of the Load Resistor.

f. Replace the load resistor by careful reversal of the preceding procedure. Be sure to replace coolant (see paragraph 2.10, Drainage and Filling). Check for leaks, especially at restored connections.

6.5. PUMP/MOTOR REMOVAL

For removal of the pump/motor unit, proceed as in paragraph 6.4, including drainage of step a above, since it will be necessary to partially remove the load resistor. However, it will not be necessary to remove the connections to the water chamber.

a. Detach 3-wire leads from the 3-lug terminal block on the inside of the front panel. For reference, the color codes of the motor supply wires generally match the input wires, with the green ground wire going on the blue (ground) wire from the socket.

b. Loosen the hose clamp nearest the pump on the input hose and carefully remove the hose from the 45° input elbow at the center of the volute. In the same manner loosen the output hose clamp and remove hose from flow switch assembly (refer to figure 6-2).

c. Remove flow switch wire leads from thermoswitch in tank and unplug from main wire harness.

d. Reach under the input elbow and loosen the hose clamp on drain fitting at the base of the volute. Disconnect hose from fitting.

e. Using a 9/16 inch hex socket extension wrench, remove two 3/8-16 nuts from the base studs holding the motor feet. Lift the motor slightly to clear the studs, then carefully inch the pump assembly backwards while detaching all connections. The freed assembly may be lifted out of the equipment.

f. Before removing the fittings, note their positions carefully. Just twist off, counterclockwise, the input and output assemblies, respectively. Watch the 45° upward tilt of the 45° input elbow. Store the detached parts with the load/sensor unit and return the pump/motor to the factory for replacement. Note - Be sure to also remove small drain hose fitting.

g. Reverse all above procedures to replace. When replacing the threaded fittings, be sure to first coat only the external joints with a good pipe sealing compound. Coating just the external thread aids in keeping the pipe sealant compound from pressing into the cooling system and contaminating the coolant. Twist on all parts to their original angular position. Use care to rewire to the same terminal block connections.

6.11. SYSTEM COMPONENT REPAIR/REPLACEMENT

After troubleshooting the complete calorimeter it may be necessary to repair or replace one of the following components.

a. Sensor cable

b. Perform a temperature sensor realignment

c. Replace temperature sensor

6.12. SENSOR CABLE

Remove sensor cable connectors from mating connectors on both the control unit and load/sensor unit. This is done by unscrewing the connector mounting screws and pulling straight back on connector.

Pin to pin continuity from connector to connector can now be checked using a standard VOM. Refer to table 6-2 for pin to pin connection. Any shorts or opens contrary to table 6-2 require replacement of the sensor cable.

Table 6-2. Sensor Cable Pin Connections

Connector 1 Pin	Connector 2 Pin
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Outside connector shells are at system ground and should be electrically connected together.

6.13. TEMPERATURE SENSOR REALIGNMENT

Each temperature sensor will have a voltage output of 10 mV/°C. If sensors are out of calibration (after temperature stabilizes the sensors should read within 1 mV of each other), the following procedure for realignment must be performed:

a. Circulate water through the system until sensors stabilize. Measure temperature of circulating water and voltage output (pins 4 and 11 of header J1, figure 6-6) of both sensors. The sensor's output should read within 1 mV, at header. This output voltage is determined by the water temperature in °C.

Example: Water temperature is 5.5°C. Output voltage of both sensors then will be adjusted to 10 mV x 5.5 = 55 mV.

b. To adjust the output voltage, adjust 25 K ohm potentiometer (R1 or R2) until proper settings are reached.

6.14. TEMPERATURE SENSOR REPLACEMENT

To replace a temperature sensor take off the top panel by removing 18 screws around its perimeter. Lift off top panel assembly, disconnecting the small fan-supply plug seated on top of the radiator block. To remove sensor:

a. Remove sensor cable assembly by unscrewing the circular connector.

b. Temperature sensor can now be removed by gripping sensor housing and turning by hand counterclockwise. Take care not to lose O-Ring on bottom of housing.

c. To install new temperature sensor assembly reverse the above steps. Take care to make sure O-Ring is properly seated in housing when screwing in temperature sensor assembly. Hand tighten this assembly.

d. Complete calibration is now required (see Section VII).

6.15. CUSTOMER SERVICE

Bird Electronic Corporation maintains a complete repair and calibration department at our corporate headquarters. This department is set up to provide the best possible service of Bird equipment.

All instruments returned for service must be shipped prepaid and to the attention of the Customer Service Group.

Bird Electronic Corporation
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Cleveland (Solon), OH 44139
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6.16. REPACKAGING

Should you need to return the RF calorimeter, or associated parts, use the original shipping package if possible. If the original package is not available, use a heavy duty corrugated box with shock-absorbing material around all sides of the unit to provide firm cushion and to prevent movement in container. Container should be properly sealed.

SECTION VII. CALIBRATION AND TEST PROCEDURES

7.1. GENERAL

This section contains information on both high and low power calibration.

7.2. REQUIRED TEST EQUIPMENT

ITEM	QTY	TYPE UNIT	RECOMMENDATIONS
1	1	DC millivoltmeter	Digitec 268 or equivalent
2	1	DC power supply	Sorensen QRD30-1 or equivalent
3	1	AC ammeter	Y.E.W., Model 2013-09
4	1	AC voltmeter	Y.E.W., Model 2013-17
5	1	Potential transformer	Y.E.W., Model 2261
6	1	Thermometer (mercury)	0° to 30° Centigrade (0.1° accuracy)
7	1	AC signal source	20 kW output minimum at 50 or 60 Hz

7.3. CALIBRATION PROCEDURE

Load/sensor Unit Preparation -

a. Connect load/sensor unit and control unit operating power cords to the appropriate voltage supply of 115 V/60 Hz or 230 V/50 Hz.

b. Check calorimetric control unit's ac line module for correct selection of line voltage.

c. Turn on control unit by depressing ON/OFF button on front panel.

d. Turn on load/sensor unit by placing ON/OFF rocker switch in the ON position.

7.4. TEST EQUIPMENT PREPARATION

a. Turn dc millivolt meter on.

b. Turn dc power supply on.

c. Remove filler plug from the load/sensor unit and insert the thermometer into the coolant in the tank.

d. Connect the sensor cable, P/N 6080-320-1, to connector at the back panel of the load/sensor unit and back panel of control unit.

e. Connect the ac power source output cable to the load/sensor unit input connector but leave the ac power source turned off.

f. Connect Y.E.W. meters, if not already connected, as illustrated in figure 7-1.

g. Leave the above equipment on for 15 minutes to stabilize before proceeding.

7.5. TEMPERATURE CALIBRATION

a. Assure that the coolant temperature has stabilized by reading the temperature indicated on the thermometer in the coolant; then recheck the thermometer after a few minutes. If the coolant temperature is the same both times and the system is stabilized you may proceed.

Page # 5 changed to 7-

b. Remove four screws from upper cover to expose calorimetric control unit internal circuitry.

c. Short the inputs to the temperature OP Amps by:

1. Disconnecting the sensor cable from the rear panel connector of the load/sensor unit.

2. Shorting pins 3 and 12 of PC board connector J1 to PC board ground.

d. Connect the negative lead of the dc millivoltmeter to PC board ground and the positive lead of the dc millivoltmeter to the output temperature, pin No. 11 of header J1.

e. Set the dc millivoltmeter to the 200 mV range or lower, and observe the indication on the voltmeter. Then adjust the voltage at (output temp) by turning the offset null adjust potentiometer R12, to read zero ±20 microvolts. For location of adjustment potentiometer, see figure 7-2.

f. Move the positive lead of the dc millivoltmeter to the input temperature, pin No. 4 of header J1, and repeat step e above by adjusting the offset null potentiometer R11. This adjusts the OP Amps to produce an output voltage of zero volts when the input voltage is zero volts. Disconnect the shorting jumpers from pins 3 and 12 and reconnect the sensor cable to the rear panel of the load/sensor unit.

g. With the negative lead of the dc millivoltmeter still connected to PC board ground, measure and record the voltage at pin 12 (^{V}temp out) and pin 3 (^{V}temp in) of header J1 (see figure 7-2). Then read and record the coolant temperature in the load/sensor unit tank. Check these values three times to insure repeatability. Substitute these values into Equation 5 to solve for "r".

Equation 5. $$r = \frac{V_{TEMP}}{10\ (Ta + 273)}$$

Where: r = Temperature calibration ratio.
Ta = Ambient temperature of coolant in °C (Thermometer Reading)
^{V}TEMP = Voltage measured at (^{V}TEMP in) and (^{V}TEMP out) in millivolts.

Calculate for "r" using both the measured (^{V}TEMP in) and (^{V}TEMP out) values.

Example 1:

When: Ta = 25°C
^{V}TEMP in = 600 mV
^{V}TEMP out = 610 mV

$$r_1 = \frac{V_{TEMP\ In}}{10\ (Ta+273)} = \frac{600}{10\ (25 + 273)} = \frac{600}{10 \times 298} = \frac{600}{2980} = 0.2013$$

$$r_2 = \frac{V_{TEMP\ out}}{10\ (Ta + 273)} = \frac{610}{10\ (25 + 273)} = \frac{610}{10 \times 298} = \frac{610}{2980} = 0.2046$$

h. V_B may now be determined by Equation 6.

Equation 6. $V_B = r \times 100\ mV$

Calculate for V_B using r_1 and r_2 for both input and output temperature OP-Amps respectively.

Example 2:

$r_1 = 0.2013$
$r2 = 0.2046$
$VB1 = r1 \times 100\ mV = 0.2013 \times 100\ mV = 20.13\ mV$
$VB2 = r2 \times 100\ mV = 0.2046 \times 100\ mV = 20.46\ mV$

i. Set the ON/OFF switch of the calorimetric control unit to OFF. Set switch S1 on the PC board to position shown in figure 6-3. Connect the dc power supply and the dc millivoltmeter as described below.

DC Power Supply:
Positive lead to (output temp.) pin No. 11 of header J1.
Negative lead to ground.

DC Millivoltmeter:
Positive lead to (output temp.) pin No. 11 of header J1.
Negative lead to ground.

j. Adjust the dc power supply output to read 100 mV ±10 V on the dc millivoltmeter using the 200 mV range. Keeping the voltage at this level in the following adjustments is very critical.

k. When 100 mV is stable remove the positive lead of the dc millivoltmeter and connect to pin No. 13 of header J1. Now adjust R8 ratio adjust potentiometer, to read the $^{V}B2$ value calculated for output temperature OP Amp. When this is done reconnect the positive lead of dc millivoltmeter back to pin No. 11 of header J1 (output temp.) to check if the 100 mV is still being applied. If not, adjust to 100 mV and adjust your $^{V}B2$ value again. This may take a few times to reconcile.

l. Keep the ON/OFF switch of the calorimetric control unit in the OFF position. Set switch S1 on the PC board to position shown in figure 7-4. Connect the dc power supply and dc millivoltmeter as described below.

DC Power Supply:
Positive lead to (input temp.) pin No. 4 of header J1.
Negative lead to ground.

DC Millivoltmeter:
Positive lead to (input temp.) pin No. 4 of header J1.
Negative lead to ground.

Again adjust the dc power supply output to read 100 mV ±10 V on the dc millivoltmeter using the 200 mV range. Keeping the voltage at this level in the following adjustments is very critical.

m. When 100 mV is stable remove positive lead of the dc millivoltmeter and connect to pin No. 2 of header J1. Now adjust R7, (ratio adj.) potentiometer, to read the $^{V}B1$ value. When this is done, reconnect positive lead of dc millivoltmeter back to the (input temp.) pin No. 4 of header J1 to check if the 100 mV is still being applied. If not, adjust to 100 mV and adjust the $^{V}B1$ value again. This may also take a few times to reconcile.

n. Remove dc power supply leads and return switch S1 to its center position and turn the calorimetric control unit on.

o. Set the dc millivoltmeter selector switch to the 2 V range and connect the positive clip lead to (input temp.) pin No. 4 of header J1 and negative lead to ground (see figure 7-5). Adjust R1 (temp. cal.) potentiometer, to read the same temperature as the thermometer in the coolant (Using 10 mV = 1°C).

p. Keeping the dc millivoltmeter on 2 V range, move the positive clip lead to the (output temp.) pin No. 11 of header J1 and leave the negative lead attached to ground. Adjust R2 (temp. cal.) potentiometer, to also read the same temperature as the thermometer in the coolant.

q. Place the ON/OFF switch of the load/sensor unit in the OFF position and wait a few minutes to allow the calorimetric control unit to stabilize. Short pin 10 of PC board connector J1 to PC board ground. Set dc millivoltmeter on 200 mV range and connect the positive clip lead to the side of R26 that is common to pin 6 of op. amp. U3 as shown in figure 6-6. Adjust potentiometer R13 to read zero on the dc millivoltmeter. When this is done, remove all clip leads.

r. Place the ON/OFF switch of the load/sensor unit in the ON position and check unit calibration by pushing in (CAL) button on the front of the calorimetric control unit. Adjust the potentiometer on the front of the control unit for a display reading of zero. Then switch the (CAL) button to the out position and, if necessary, readjust the front panel potentiometer for a display reading of zero.

WARNING

The following sections of this procedure involve the application of high power to the load. The following precautions must be observed to insure operator safety as sever burn or possibly death may result.

1. Make sure that the coaxial power cable connector is securely fastened to the load and that the water is flowing before turning on the ac power source.

2. Ensure that all Y.E.W. meter connections are tight before turning on ac power.

3. High voltage is present at the terminals of the Y.E.W. meters when the ac power source is on. Keep clear of these terminals.

4. Completely shutdown the ac power source before changing the Y.E.W. meter connections, turning off the water or removing the power cable from the load input connector.

7.6. HI Range AC Power Calibration

a. Connect Y.E.W. meters as shown in figure 7-1. Make sure that all connections are tight.

b. Turn on ac power source and adjust the power Variac to produce a reading of 17.3 amps on the Y.E.W. ammeter. In this position the ac power source output will be approximately 15 kW.

c. Determine the actual power applied to the load/sensor unit coaxial input by reading the Y.E.W. meters and using Equation 7.

Equation 7. Power = V x I x K

Where:
V = Voltage read at Y.E.W. voltmeter
I = Current read at Y.E.W. ammeter
K = Potential transformer ratio (20.067 for 2200 V to 110 V position)

Example 3:
V = 43.3 V I = 17.3 AMPS
P = V x I x K = 43.3 V x 17.3 A x 20.067
P = 15.032 kW

d. Adjust R16, (HI CAL) potentiometer on the calorimetric control unit PC board, slowly to make the DPM indicate the actual power being applied. Only a slight turn of the potentiometer is required to change the reading. Allow the display to stabilize after each slight amount of turn. Repeat steps c. and d. several times, due to power fluctuations, to assure accuracy of the unit to be within $\pm$2.5 percent of actual power. The error percentage can be determined by Equation 8.

Equation 8:

$$\% \text{ error} = \frac{\text{ActualPower} - \text{IndicatedPower}}{\text{Actual Power}} \times 100$$

Where:
Actual Power = Y.E.W. meter reading
Indicated Power = control unit reading

e. Turn off ac signal source and allow load/sensor unit to run for several minutes to cool until calorimetric control unit's display is stabilized at zero.

7.7. LOW Range Power Calibration

a. Shift the flow control switch on the front panel of the load/sensor unit to the (LOW POWER) position.

b. Push in button marked RF POWER (LOW) on the calorimetric control unit. Adjust front panel potentiometer for a zero display on the DPM. Then turn on the ac power source and adjust the power to 10 amps on the Y.E.W. ammeter. In this position the power source output will be approximately 5 kW.

c. Again using Equation 7, determine the actual power applied to the load.

Where:
V = 25.6 V = reading on voltmeter
I = 10 amps = reading on ammeter
K = 20.067 = ratio constant

Example 4:
P = 25.6 x 10 x 20.67
P = 5.14 kW

d. Adjust R17, (LO CAL) potentiometer, on the calorimetric control unit main PC board, slowly until the display of the DPM indicates the actual power being applied. After each adjustment allow the display to stabilize. The accuracy of the display reading must be within ±2.5 percent of actual power. If not, readjust R17 until it is within tolerance.

e. Shut off ac power source and let load/sensor unit run for several minutes to allow unit to cool until calorimetric control unit display is stabilized at zero.

7.8. HI RANGE FLOW INDICATOR CALIBRATION

This section explains calibration of flow indicator HI range. Refer to figure 7-7 while following the steps below.

a. Place the calorimetric control unit unit in the HI range by releasing the range selector button. Also place the flow control switch on the load/sensor unit to the HI position.

b. Connect the positive lead of dc millivoltmeter to the common leg of resistors R1 and R2 and negative lead to Pin 2 of J1 on flow indicator PC board. Adjust the voltage between the common leg of R1 and R2 and Pin 2 of J1 on flow indicator PC board to 511 mV ±1 mV by adjusting R4.

c. Disconnect millivoltmeter and connect positive lead of frequency counter to pin 8 of header J1 on the main PC board and negative lead to PC board ground (see figure 7-2). The frequency output will depend on the model of load resistor being used. Adjust R9 flow indicator PC board until the appropriate LED is lighted based on the expression 100 Hz = 1 GPM and that each LED represents 1/2 GPM with the scale starting at 6 GPM.

7.9. LOW RANGE FLOW INDICATOR CALIBRATION

This section explains calibration of flow indicator LOW range. Refer to figure 7-7 while following the steps below.

a. Place the calorimetric control unit in LOW range by depressing the range selector button. Also place the flow control switch on the load/sensor unit to LOW range.

b. Connect the positive lead of dc millivoltmeter to the common leg of resistors R1 and R2 and the negative lead to pin 2 of J1 on flow indicator PC board. Adjust the

voltage between the common leg of R1 and R2 and pin 2 of J1 on flow indicator PC board to 687 mV ±1 mV by adjusting R3.

c. Disconnect millivoltmeter and connect positive lead of frequency counter to pin 8 of header J1 on the main PC board and negative lead to PC board ground (see figure 7-2). The frequency output should be 350 Hz ±5 Hz. If it is, proceed to adjust R10 (flow indicator PC board) until the third LED is lighted, which represents 3.5 GPM. If the frequency output is not 350 Hz ±5 Hz, the flow control valve will have to be adjusted appropriately. See figure 6-3 for location of flow control valve.

7.10. TEST PROCEDURES

a. Testing HI Power Range Accuracy -

1. Shift the flow control switch on the load/sensor unit back to (HI POWER) position. Set HI/LOW switch to HI position on the calorimetric control unit and adjust CAL potentiometer on the front panel for a display indication of zero.

2. Turn ac power source on and adjust power to read 14 amps on Y.E.W. ammeter to check accuracy for approximately 10 kW. Using Equation 7 and new example as follows:

Where:
V = 36 V = reading on voltmeter
I = 14 amps = reading on ammeter
K = 20.067 = ratio constant

Example 5:
36 volts x 14 amps x 20.067 = 10.11 kW

The display reading should be within ±2.5 percent of actual power being applied. If not, recalibrate HI range per calibration procedure.

3. Now increase the power to approximately 20 kW. Check the accuracy at 20 kW by comparing the actual power according to the Y.E.W. meters to the power indicated on the display. The calorimetric control unit must still be within ±2.5 percent of the actual power.

4. Turn off ac power source and run load/sensor unit for several minutes to allow unit to cool until calorimeter control unit display indicates zero.

b. Testing LOW Power Range Accuracy -

1. Shift the flow control switch of the load/sensor unit to the (LOW POWER) position. Set HI/LOW switch to LOW position and adjust CAL potentiometer until the display indicates zero.

2. Turn ac power source on and apply approximately 10 kW, 14 amps on Y.E.W. ammeter, and check to see that the calorimetric control unit accuracy is within the ±2.5 percent specification as described above.

3. Turn off ac power source and allow load/sensor unit to cool until calorimetric control unit's DPM display is stabilized at zero.

4. Connect potential transformer and Y.E.W. meters as shown in figure 6-8.

5. Turn on ac power source and adjust power to read 4.5 amps on Y.E.W. ammeter to check accuracy at approximately 1 kW. Use Equation 7 and new example as follows:

Where:
V = 56.9 V = reading on voltmeter
I = 4.5 amps = reading on ammeter
K = 4 = ratio constant

Example 6:
56.9 volts x 4.5 amps x 4 = 1.02 kW

The display reading should be within ±3 percent of actual power being applied. If not, recalibrate LOW range per calibration procedures.

6. Turn off ac power source and let load/sensor unit run for several minutes

to allow unit to cool.

7. After cooling is complete, turn off power to load/sensor unit and control unit.

8. This completes all calibration and unit is now ready for use.

Figure 7-1. Y.E.W. Meter Connections - Hi Power Calibration

Figure 7-2. Null Temperature Sensors

Figure 7-3. Calibrate Output Temperature Sensor Ratio

Figure 7-4. Calibrate Input Temperature Sensor Ratio

Figure 7-5. Calibrate Temperature Sensors

Figure 7-6. Unit Calibration

Figure 7-7. Flow Indicator Calibration

Figure 7-8. Y.E.W. Meter Connections - Low Power Calibration

SECTION VIII. REPLACEMENT PARTS

8.1. GENERAL

The purpose of this section is to provide the user with a consumables type spare parts listing. Quantities used within the control unit and load/sensor unit are indicated.

Refer to figure 8-1 for location of spare parts. Item numbers correspond to call outs in figure.

LOAD/SENSOR UNIT PARTS:

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Sensor box assembly (includes Items 2 & 3)	8640-633-3
2	2	Temperature sensor cables	6080-096-1
3	1	Flow sensor cable	6080-025-2
4	1	Flow switch assembly	8630-035
5	1	Temperature sensor assembly (input)	6080-095-1
6	1	Temperature sensor assembly (output)	6080-095-2
7	1	Flowmeter	5-1145-1
8	1	Pump 115 V	5-1053-1
		230 V	5-1053-2
9	1	Strainer	5-1676
10	1	Time delay relay - 115 V	5-1627
		- 230 V	5-1625
11	1	Bypass valve - 115 V	8640-623-2
		- 230 V	8640-623-1
12	1	Coolant gauge	5-1200
		Replacement kit includes:	
		Self-sealing body screws and O-Ring seals	
13	1	RF Load Resistor	
		Model 8645-( )	8745-101
		Model 8646-( )	8746-101
14*	2	Fan assembly - 115 V	8640-668-1
		- 230 V	8640-668-2
15*	2	Capacitor	5-873-2
16**	1	AC line cord - 115 V	5-1836
		- 230 V	5-1837
17**	2	Fuse - 115 V	5-1828-36
		- 230 V	5-1828-33

* Located on fan panel, which was removed in figure 7-1 to expose load/sensor unit internal components.

** Refer to figure 1-1 for location of these parts.

Refer to figure 8-2 for location of spare parts. Item numbers correspond to call outs in figure.

Figure 8-1. Replacement Parts Illustration - Load/Sensor Unit

CONTROL UNIT PARTS

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Main PC board	6080-306
2	1	Flow indicator PC board	6080-318
3	1	3-1/2 digit panel meter with optional BCD output	5-1910
4	1	Cable assembly, BCD option	6080-315
5	1	Power assembly switch	6080-305
6*	1	AC line cord	4421-055
7*	1	Fuse	5-721-6

* Refer to figures 1-1 and 1-2 for location of these parts.

ADDITIONAL PARTS

1	1	Sensor cable	6080-320-1

NOTE: Sensor cables can be purchased in various lengths. For more information contact Bird Electronic Corporation.

Figure 8-2. Replacement Parts Illustration - Control Unit

SECTION IX. INTERNAL REPAIR OF THE LOAD RESISTOR

9.1. REPLACEMENT PROCEDURE FOR RESISTIVE ELEMENT

The water cooled load used in this load/sensor unit is designed to be quickly and easily repaired in the field. If in performing the dc resistance check, described in paragraph 5.4 of this manual, a significant change in resistance is noted, or if for any reason the resistive element should fail, inexpensive replacement resistors are available. Installation is accomplished as described in this section. Note - These repairs can be made by removing the load resistor entirely as described in paragraph 6.4. However, it may usually be desirable to leave the water connections to the water chamber undisturbed. This may be accomplished by following step a., below, removing the main housing portion only.

9.2. RESISTOR REMOVAL

Note - Numbers in brackets [ ] are item numbers so indicated in figures 9-1 and 9-2.

a. Using a 3/16 hex socket wrench, unscrew the six 1/4-20 x 2-1/2 inch socket head cap screws [6] holding the water chamber [3] to the main load housing. When all screws are loose, pull the water chamber assembly, with screws, straight off. It may be necessary to rock the chamber gently while pulling it off carefully. Then remove the six 1/4-20 nuts and washers on the inside of the front panel flange of housing out the front end, leaving the water chamber [3] attached to its water line.

b. The inner flow tube [9] will usually come out with the water chamber assembly being held to it by the compression of the inner O-Ring [4] water input seal. This is normal and if the resistor body is unbroken there will be no need to remove the inner flow tube from the water chamber assembly. The ground cap assembly [10] is fitted tightly within the water chamber and should normally remain with it. If the inner flow tube has stayed in the resistor section simply grasp the resistor stop sleeve [7] on the flow tube and pull out the assembly. Note - This includes the cushioning O-Ring [8] which fits loosely below the stop sleeve; always take care not to lose it. Also, if the brass stop sleeve [7] is removed at all notice that it has a small escape hole at the side and an access counterbore leading to it. In reassembly, be sure this counterbore is facing toward the O-Ring and the resistor [1]. This is essential for internal water venting. Notice the water outlet holes and also the small shoulder at the base of the inner flow tube. At reassembly, this must fit into a mating recess in the input fitting at the bottom.

c. If the resistor [1] is intact it may be easily pulled straight out of the load housing, and is ready for replacement. The outer flow tube is captive and will not come out of the housing at this stage.

9.3. INSPECTION

At this point, if the resistor has been successfully removed, inspect it carefully to insure that it is not fractured. In the majority of cases, even in the event of resistor failure, the resistor substrate will remain intact. Next, examine the inside of the load housing assembly for any apparent damage to the internal parts. If no damage had been found, continue with 9.4, Resistor Replacement. However, if the resistor is broken, other internal parts appear to be damaged or if they do not fit together properly, proceed to 9.5, Replacement Procedure for Fractured Resistors.

9.4. RESISTOR REPLACEMENT

a. Insert new resistor [1] into the load housing until it reaches its fitting. Push in the resistor until it bottoms snugly. If resistor seems to be loose, refer to the procedure for the replacement of fractured resistors for instructions on how to tighten the resistor fitting.

b. Place the inner flow tube [9] inside the resistor and lower it until it reaches the resistor fitting. Gently work and twist the inner flow tube until it seats in the bottom of the input resistor fitting. This operation may also be done if the inner flow tube is still in position in the water chamber when the main

housing is being reinstalled.

c. Make sure that the O-Ring [8] cushion is placed on the inner flow tube next to the resistor and the backup resistor sleeve [7] is right behind it. Watch orientation of sleeve (see subparagraph 9.2, b). There is no need to disturb the resistor cap assembly [10] in the water chamber for this procedure.

d. Now replace the water chamber [3] gently rocking and twisting the chamber to achieve the proper flat seat on the outer housing. Note - If the water chamber [3] does not seem to fit properly refer back to step b. to see that the inner flow tube is properly in place.

e. Tighten the six 1/4-20 x 2-1/2 inch socket head cap screws [6]. Check the dc resistance between the inner and outer conductors - it should be approximately 50 ohms (see paragraph 5.4). Remount the ECONOLOAD® Load Resistor to the panel reversing the procedures in 9.2, Resistor Removal. If the load resistor has been entirely removed reattach the water connections and the sensor subassemblies reversing the procedure in 6.4. Be sure to reattach sensor correctly. Restore coolant per paragraph 2.9, Coolant. Run pump/motor for five minutes and check thoroughly for leaks before applying any RF power to load/sensor unit.

9.5. REPLACEMENT PROCEDURE FOR FRACTURED RESISTORS

WARNING

The resistor used in this load consists of a resistive film on a special substrate. If the substrate is broken, there will probably be sharp pieces or splinters inside the load housing. Caution should be exercised to avoid possible injury.

Resistor Removal - Load previously removed from load/sensor unit.

a. The load should already be disassembled to the point of Subparagraph 9.2, b. Now turn the load on end with the RF input connector up to allow any loose pieces of resistor to fall out of the load housing.

b. Using a 3/16 Allen wrench, loosen and remove the six 1/4-20 x 1-1/2 inch socket head cap screws [16] from the flanged end of the load housing, as shown in figure 9-2. The outer conductor assembly [12] or [14] may now be easily removed.

c. Next remove the input center conductor assembly [11] or [13], figure 9-2, by pulling it out of the load housing and then carefully removing any remaining pieces of the resistor. Normally in this disassembly, the outer flow tube will remain with the load housing. Restore it to this position after inspection and cleaning if it should come out. Inspect the inside of the load housing for any apparent damage.

d. Also, if it is in place in the water chamber pull out the inner flow tube. Inspect carefully for broken pieces. Then grasp the projecting hub of the resistor cap assembly [10] firmly with your fingers and pull straight off with a strong even force.

e. Thoroughly wash all the inside portions of the three assemblies under clear running water: input section, load housing, and water chamber. To reinstall the resistor cap assembly, push in firmly to bottom in the water chamber.

Resistor Replacement -

a. Insert replacement resistor [1] into the resistor fitting of the input center conductor assembly to test its tightness. The resistor should not have to be forced into the fitting but should be quite snug.

b. If the resistor is loose in the fitting, press the slotted finger contacts of the fitting together slightly and try the resistor again. Continue closing the ends of the resistor fitting until a snug fit is obtained. Then bottom the resistor in the fitting.

c. With the resistor still in place in the resistor fitting, insert the resistor and the input center conductor assembly into the load housing as illustrated in figure 9-2, reversing procedure in Resitor Removal, c. Then replace the outer conductor assembly and the six 1/4-20 x 1-1/2 inch socket head cap screws and tighten.

d. Stand the load on end with the RF input connector down, place the inner flow tube inside the resistor and lower it until it reaches the resistor fitting. Gently move and twist the inner flow tube until it seats in the bottom of the resistor fitting.

e. Continue same procedure as given in paragraph 9.4, Resistor Replacement, steps c-e.

9.6. FRONT CONNECTOR ASSEMBLY

This portion of the load unit consists of the inner conductor [11] or [13] and the outer conductor [12] or [14], respectively. They may be released by removing the six screws [16] at the front of the housing flange as described in Resistor Removal, b. When the inner conductor has been pulled out, the O-Ring [15] seal to the outer water flow tube may be readily changed if desired. Do not attempt further disassembly of this part. If necessary, return to the factory for repair.

9.7. REPLACEMENT PARTS LIST

Models 8745-101 & 8746-101 Load Resistors for Load/Sensor Unit 8645/46

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Resistor	8755-027-5
2	1	Outer resistor cap seal O-Ring	8410-009
3	1	Water chamber	8755-014
4	1	Inlet seal O-Ring	5-099
5		(shown on drawing not used)	
6	6	Socket head cap screws 1/4 x 20 x 2-1/2" stainless steel	Standard
7	1	Resistor sleeve	8755-026
8	1	Sleeve backup O-Ring	8110-059
9	1	Inner flow tube	8755-025
	1	Outer flow tube	8755-024
10	1	Resistor ground cap assembly	8755-005
Front Connector Parts Assigned Per Model Type:			
Model 8745 - 3-1/8" EIA Connector 50 Ohms			
11	1	Center conductor input assembly	8755-007
12	1	Outer conductor assembly	8755-004
Model 8746 - 3-1/8" Unflanged Connector Flush Center Conductor 50 Ohms			
13	1	Center conductor input assembly	8756-003
14	1	Outer conductor assembly	8756-002
For Both Models			
15	1	Center conductor assembly O-Ring	5-1127
16	6	Socket head cap screws 1/4-20 x 1-1/2" stainless steel	Standard
17	1	Inner resistor cap seal O-Ring	5-567

Figure 9-1. Resistor Removal

Figure 9-2. Connector Removal

SECTION X. BINARY-CODED-DECIMAL (BCD) OUTPUT

10.1. GENERAL

A 25-pin D-shell connector for the Binary-Coded-Decimal outputs is provided on the upper left hand portion of back panel of the calorimetric control unit. A drawing of the pin locations for same, with description of the pin assignments, is provided in figure 10-1.

Pin No.	Function
1	BCD 100
2	BCD 200
3	BCD 400
4	BCD 800
5	NC
6	BCD 10
7	BCD 20
8	BCD 40
9	BCD 80
10	BCD 1
11	BCD 2
12	BCD 4
13	BCD 8
14	BCD Ground
15	Hold
16	NC
17	BCD 1000
18	+5 V
19	OE3 (Tens)
20	OE2 (Hundreds)
21	OE4 (Units + Overrange)
22	OE1 (Thousand + Polarity)
23	Overrange
24	Polarity
25	Data Valid

Figure 10-1. BCD Connector Pin Functions

10.2. SUPPLY WIRING (See figure 10-1)

a. Pin 18 must be powered by an external power supply, which must supply a regulated power of +5 Vdc @ 6 mA.

Pin 14 is connected to the external power supply ground.

IMPORTANT NOTE:

BCD output and logic signals are referenced to the external power supply.

10.3. LOGIC INPUT WIRING (See figure 10-1)

a. All Output Enable (OE) lines are internally pulled to ground through a 100 k ohm resistor.

For a multiplexed BCD output, each digit can be disabled by putting a Logic "1" (+5 Vdc) on its OE line, and enabled by disconnecting it or pulling the OE line down to Logic "0" (0 Vdc).

b. Putting a Logic "1" (+5 Vdc) on Data Hold (Pin 15) locks the present data into the output storage latches until the Data Hold is returned to Logic "0" (0 Vdc). With removal of Logic "1", Data Hold will automatically return to Logic "0".

10.4. DATA OUTPUT WIRING

There are three commonly used output formats compatible with the Model 6080A. Once you have determined which format is required, follow the wiring instructions for that format only.

a. Full Parallel BCD Output Lines (See figure 19-1):

1. For a fully parallel BCD output, no connections to the four output enable lines are necessary.

2. The Data Valid Signal (Pin 25) is Logic "1" when data is valid. See note at the end of paragraph 10.4.

b. Multiplexed BCD Output (Bit Parallel, Digit Serial) See figure 10-1:

1. BCD Output

2^0 - Pin 10
2^1 - Pin 11
2^2 - Pin 12
2^3 - Pin 13

2. Jumpers Required

Pin to Pin	Pin To Pin
12 - 3	10 - 1
3 - 8	1 - 6
8 - 24	6 - 17
13 - 4	11 - 2
4 - 9	2 - 7

3. Each digit will appear at these pins when its OE line is enabled, and all other lines are disabled.

NOTE: Thousand bit will appear at 2^0 (Pin 10). Polarity bit will appear at 2^2 (Pin 12).

c. 8 Bit Multiplexed (Sometimes used with 8 bit computers) See figure 10-1:

1. BCD OUTPUT

	OE3 and OE4*	OE1 and OE4*
PIN	LOGIC "0"	LOGIC "0"
10	Units 2^0	Hundreds 2^0
11	2^1	2^1
12	2^2	2^2
13	2^3	2^3
6	Tens 2^0	Thousand
7	2^1	--
8	2^2	Polarity
9	2^3	--
23	Overrange	--

2. Jumpers Required

PIN TO PIN

10 - 1
11 - 2
12 - 3
13 - 4
6 - 17
8 - 24

* All other OE lines must be Logic "1".

3. The Data Valid Signal (Pin 25) is Logic "1" when data is valid.

NOTE: For low input signals (less than 10 counts), Data Valid Signal may not go to Logic "0" when data is updated, because its length is proportional to input signal and may become difficult to detect.

APPENDIX A - LOAD/SENSOR UNIT SCHEMATICS

A.1. GENERAL

This section contains the schematics for load/sensor unit wired for 115 V or 230 V.

Figure A-1. 25 kW Load/Sensor Unit Schematic, 115 V, 60 Hz Supply

Figure A-2. 25 kW Load/Sensor Unit Schematic, 230 V, 50 Hz Supply