ALTRONIC RESEARCH, INC.

P.O. BOX 249
YELLVILLE, ARKANSAS 72687-0249
U.S.A.

LIQUID-COOLED
COAXIAL LOAD RESISTOR
MODEL 523000

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ILLUSTRATIONS, TABLES AND GRAPHS

INTRODUCTION

This manual gives you specific information on the installation, operation and service of OMEGALINE® coaxial resistors. The Model 523000 is not considered field serviceable and should be sent to us for any repairs. Mistakes can be costly compared to the low cost for our trained personnel to make the repairs and return the load to new performance specifications. Labor and packaging costs are minimal. We take the load completely apart, clean and inspect all parts, repair/replace as necessary, reassemble, water pressure test, power test, VSWR test and package the load for shipment. If new parts are required in the load (such as resistors etc.), this will be an additional cost. The average turn-around time on Model 523000 repairs is 4-6 weeks and generally will depend on your needs. Call for an RMA# before sending in repairs. Include with repairs: your company name and address, the operating frequency you use, fax number, telephone number and your name in case we need to talk to you about the load or obtain shipping instructions. We can accommodate most shipping modes.

SHIP TO: Altronic Research Inc., Hwy. 14 South, Yellville, AR 72687. Our mailing address is P.O. Box 249.

Note: We also repair dummy loads manufactured by many other companies.

Call for information 870-449-4093.

PRECAUTIONS

!!!DANGER!!!

THIS UNIT MUST BE TOTALLY DISCONNECTED FROM ALL RF POWER BEFORE ANY REPAIRS ARE ATTEMPTED. ANY ATTEMPT AT REPAIR WITHOUT DISCONNECTING THE POWER COULD RESULT IN *FATAL ELECTRICAL SHOCK!!!*

WARNING

DO NOT APPLY POWER WITHOUT THE MINIMUM RATED FLOW OF COOLANT THROUGH THE LOAD. A SAFETY INTERLOCK SWITCH IS RECOMMENDED. EVEN A BRIEF APPLICATION OF POWER TO THE LOAD WITHOUT THE CIRCULATION OF COOLANT WILL CAUSE IMMEDIATE BURN OUT.

WARNING

THE LOAD RESISTOR CONSISTS OF A CERAMIC SUBSTRATE COATED WITH A SPECIAL RESISTIVE FILM. IF ANY DAMAGE OCCURS TO THE RESISTOR, THERE COULD BE SHARDS OR SHARP BROKEN PIECES OF CERAMIC IN THE LOAD. CARE SHOULD BE TAKEN SO THAT NO INJURIES OR CUTS WILL OCCUR.

PRECAUTIONS

CAUTION

USE ONLY CLEAR, COLORLESS, ANALYTIC OR TECHNICAL GRADE ETHYLENE GLYCOL WITH PURE TAP OR POTABLE* WATER AS A SOURCE COOLANT. DO NOT USE ANY STOP LEAK, SEALANTS, AUTOMOTIVE ANTIFREEZE OR UNION CARBIDE UCARTHERM™ IN COOLANT. USE OF THESE SUBSTANCES WILL VOID THE WARRANTY.

IMPORTANT

ADDITION OF ETHYLENE GLYCOL TO THE WATER REDUCES THE HEAT CAPACITY OF THE COOLING SYSTEM. COOLANT FLOW RATE MUST BE INCREASED BY AT LEAST 20% OVER MINIMUM FLOW.

CAUTION

DO NOT APPLY MORE THAN THE MAXIMUM RATED RF POWER TO THE LOAD. THIS WILL CAUSE INTERNAL DAMAGE TO THE LOAD.

* **Potable Water:** The U.S. Health Department has established standards for potable water at a maximum of 500ppm of dissolved solids. Hard water (particularly dissolved salts) can cause damage to resistive film and load. Water condition can be adjusted by mixing distilled water in sufficient quantities with coolant water.

GENERAL DESCRIPTION

The OMEGALINE® dummy load is basically a termination-type unit having its characteristic impedance at the input end and tapered to zero impedance (short circuit) at the other end. The center conductor is composed of twenty cylindrical resistors whose DC resistance is equal to the characteristic impedance of the line. The outer conductor of the coaxial line is a symmetrical horn-shaped enclosure, contoured logarithmically along its length to obtain a reflection-free termination.

The dummy load housing is constructed of aluminum and/or brass sections. The power dissipating resistors consist of a conductive resistive film which is deposited on a tubular ceramic substrate with silver bands fired on the ends for electrical connection. Contact to the resistor is made by spring fingers.

The coolant flows into the resistor assembly and is directed through the middle of the flow divertor tube inside the resistor. At the RF end of the resistor the water is rerouted to a passage between the inside resistor wall and the outside region of the flow divertor. This high-velocity stream removes heat from the resistor and transports it out the outlet water port of the resistor.

The water cooling system is made up of a two-chamber water manifold assembly. Water enters one chamber from the facility water source and is routed to the water inputs on each resistor. Water flows down the inside of the flow divertor and returns along the boundary between the flow divertor and the inside wall of the resistor. The water picks up the heat generated by the resistor and transports it out the outlet port to the other chamber of the manifold where it is combined and routed to a single outlet port.

The load is designed for pulse duty applications designed to withstand 3 MW peak pulse with an average of 30 kW.

Fig. 1 - The OMEGALINE® Coaxial Load Resistor-Model 523000

ELECTRICAL CHARACTERISTICS

POWER RATING - This experimental model of the OMEGALINE® series of coaxial loads is rated for 3 MW peak, 30 kW average with the proper water flow rate and may be operated only in the vertical position (RF at top). A 10-20% GREATER FLOW RATE MAY BE USED AND IS RECOMMENDED. If the units are operated below the maximum power rating, a corresponding reduction in the coolant flow rate may be used.

All loads are electrically tested prior to shipment. Testing is done at 60 Hz with input voltage and current measured on RMS meters. The (RMS) power being dissipated in the load is simultaneously checked by calorimetry. The relationship used for calculating the power dissipated in the load from the calorimetric data is:

$$P = 0.264 (T_2 - T_1)Q$$

Where P = Power in load in kilowatts
T_2 = Outlet water temperature °C
T_1 = Inlet water temperature °C
Q = Water flow in gallons-per-minute

WARNING!

Power should never be applied before turning on the WATER FIRST and allowing sufficient time (approx. 1 minute) for complete wetting of the resistor and elimination of air bubbles. Water flow must be maintained throughout the application of power and may be turned off within 15-30 seconds after the power has been turned off. Failure to observe these precautions will result in instant failure of the resistor and possible destruction of other parts of the load.

IMPEDANCE - The impedance of the loads, in the language of VSWR (voltage-standing-wave-ratio), is quite independent of frequency, water flow rate and water temperature. It is almost purely resistive. For Model 523000, the VSWR is maintained below 1.15.

COOLANT

COOLANT - The OMEGALINE® dummy load may be used with ordinary tap water, pure, or de-ionized water in open or closed cooling systems. The use of deionized and distilled water in OMEGALINE® loads has been reported to cause premature failures under some conditions. These failures are the result of the leaching action of the coolant on the silver and silver-plated surfaces of the resistors and contact material. The reported failures have generally been associated with deionized systems, which are polished to 10-15 megohm levels and are operated intermittently. We suspect that the failure mechanism is attributable to bacterial growth in the coolant system and the subsequent high levels of sulfides usually found in conjunction with such contamination.

Altronic does offer a line of water-cooled loads with gold and gold-plated resistors and contacts, for use in systems where leaching action seems unavoidable. Contact our sales office for information.

We suggest the use of caution when determining what coolant to use. Potable water is certainly the most desirable coolant. Brackish or salt water is NOT permissible as a coolant for the load resistor! The load is designed with non-contaminating elements in the water circuit and may be used with transmitters that have pure water recirculating cooling systems. For operation below the freezing temperatures of water, ethylene glycol may be added to the water to prohibit freezing (see Fig. 2). If you have questions about coolants, please consult the factory.

IMPORTANT

We recommend a Glycol mixture of 40% (2:3) or less. Addition of ethylene glycol to water reduces the heat capacity of the mixture with a corresponding reduction in cooling effectiveness. Therefore, the coolant flow rate should be increased approximately 20% from that required with water only.

!!!WARNING!!!

Only clear, colorless analytic or technical grade ethylene glycol may be used**.** Dow Chemical Company's Dowtherm® SR1 has been reported to be fully compatible with OMEGALINE® loads when used in accordance with Dow's instructions (up to a 40% max). **DO NOT use any stop leak, sealants, automotive antifreeze or Union Carbide Ucartherm™ in coolant. To do so will void the warranty.** Damage to the resistor film may occur with applied power, resulting in failure!

CONCENTRATION OF COOLANT			FREEZING POINT		BOILING POINT	
Glycol: Water Parts by Volume at Room Temp.	**% Glycol by Volume**	**% Glycol by Weight**	**°C**	**°F**	**°C**	**°F**
(pure water)	0	0	0	32	100	212
3:7	30	32.3	-16	2	104	219
2:3	40	42.7	-26	-15	106	222
1:1	50	52.7	-40	-40	109	228

Fig. 2 - Freezing and Boiling Points of Glycol-Water Mixtures

TEMPERATURE RANGE - The impedance of the load is practically independent of glycol-water mixture, water flow rate, and water temperature. A wide range of input water temperatures (0°C to 60°C) may be used as long as the output water temperature is not allowed to exceed 90° C.

DETERMINATION OF GLYCOL CONCENTRATION –

- Obtain a 500 ml sample of the coolant to be tested and place in the hydrometer jar.
- Place the thermometer in the jar and allow the temperature reading to stabilize.
- Read the thermometer and record the reading.
- Place the hydrometer in the jar and allow to settle. Read the hydrometer and record the reading.
- See the table in Fig. 3A to determine the glycol concentration.

GLYCOL TABLE

This table shows the relationship between the specific gravity of an unknown glycol-based fluid sample and the percent by volume of a corresponding known sample. Use this table to find the approximate value of the concentration of glycol in a coolant sample.

Enter table with temperature, then go horizontally to find figure closest to observed reading of hydrometer, then go up to see the volume % of glycol	Volume % of glycol in sample ≈ 25	Volume % of glycol in sample ≈ 30	Volume % of glycol in sample ≈ 40	Volume % of glycol in sample ≈ 50
Temperature of sample	Hydrometer reading	Hydrometer reading	Hydrometer reading	Hydrometer reading
30	1.047	1.056	1.073	1.089
40	1.045	1.054	1.071	1.089
50	1.043	1.052	1.068	1.084
60	1.041	1.049	1.065	1.081
70	1.039	1.047	1.063	1.077
80	1.037	1.044	1.060	1.074
90	1.034	1.042	1.057	1.071
100	1.032	1.039	1.054	1.068
110	1.029	1.036	1.050	1.064
120	1.026	1.033	1.046	1.060
130	1.023	1.030	1.044	1.057
140	1.020	1.027	1.040	1.053
150	1.016	1.023	1.037	1.050
160	1.013	1.020	1.033	1.046
170	1.009	1.016	1.029	1.042

Fig. 2A – Glycol Concentration Table

WATER FLOW RATE - The water flow rates specified for the load is given as the least amount of water flow permissible for full power rating. AT LEAST MINIMUM FLOW OF WATER MUST BE MAINTAINED THROUGHOUT THE APPLICATION OF POWER. A greater flow rate (approx. 10% higher) should be used and is recommended. When used at lower than rated power, a reduced water flow rate may be used and combinations of power and water flow rates may be determined by using the table of Fig. 3. In all cases, ***water must be allowed to flow for about 1 minute before applying power*** so that all air bubbles are dispelled from the system.

MODEL	MINIMUM FLOW RATE (GPM)	MAXIMUM* AVERAGE (RMS) POWER (KW)	GALLONS PER KILOWATT (K_f)
523000	6	30	.2

Fig. 3 - MINIMUM Water Flow Rate Requirements

*Single Frequency CW (There is no tolerance for power over rated max power rating)

To determine the water flow rate requirements at lower power levels, multiply the average input power in kilowatts by the water flow rate coefficient (K_f) from the above table and add 20% for ethylene glycol mixtures.

WATER PRESSURE - The table of Fig. 4 gives the maximum allowable inlet pressure. Continuous operation of the load at full power and up to an outlet water temperature of 90°C is permissible within the maximum operating pressure given in the table.

NOTE: Do not use a shut-off valve on the water output side of the load in systems that have no water expansion pressure relief. Pressure in the outlet line should be as low as possible to minimize internal pressure.

MODEL	INTERNAL PRESSURE DROP (PSI)	MINIMUM FLOW RATE (GPM)	ORIFICE COEFFICIENT (Ko)	MAXIMUM INLET PRESSURE (PSI)
523000	6	15	.01667	75

Fig. 4 - Internal Pressure Drop vs. Flow Rate

To determine the pressure drop at other flow rates, use the orifice coefficient (K_o) from the above table in the following equation:

$$PSI = K_o Q^2$$

Where PSI = Internal pressure drop in lbs./sq.in.

K_o = Orifice coefficient

Q = Coolant flow rate in gallons/minute

COOLING SYSTEMS

TYPES - Four basic cooling systems are summarized in the table of Fig. 5; viz., municipal water, natural water, tank or reservoir, and heat exchanger. No single cooling system is the "best" under all the different circumstances and conditions encountered by the field. Closed loop systems are generally preferable since they afford much greater control over the purity, temperature, pressure, and flow rate of the coolant.

				BASIC COMPONENTS NEEDED			
METHOD		COOLANT	COOLANT SOURCE	COOLANT LINES & INSTRUMENT -ATION	PUMP	RESERVOIR	HOURS OF CONTINUOUS OPERATION
Open	1	Tap Water	Municipal Supply System	✓	In low-flow areas	Optional	Unlimited
	2	Natural fresh water	Lake, river, pond, etc.	✓	✓	Optional	Unlimited
Closed	3	Tap or distilled water with or without glycol□	Storage tank	✓	✓	100 to 1500 gallons	Up to 8 hrs. depends on size of load & tank. See Fig. 7
	4	Tap or distilled water with or without glycol	Accumulator	✓	✓	1 to 5 gallons	Unlimited
	5	Tap or distilled water with or without glycol	Air-cooled core	✓	✓	Optional	Depending on BTU capacity of exchanger

Fig. 5 - Alternative Cooling Systems

TAP-WATER SYSTEM - The most convenient way to cool the load resistor at the lowest initial cost is by tapping into the existing water supply on the premises. Most municipal sources can provide sufficient pressure to obtain a flow rate that will cool even the highest power model.

In the absence of a water flow meter, a measure of the available flow rate in gallons-per-minute (GPM) may be made with a stopwatch or a watch with a sweep-hand and a gallon container. Connect the dummy load to the water faucet with a short length of hose, and with the faucet full on, observe the time in seconds required to fill the gallon container at the water outlet of the load.

When using the dummy load with a tap-water system, the flow rate is usually adjusted to 10-15% above the minimum requirement and left unattended. Since water lines ordinarily serve other appliances (flush toilets, etc.) over which there is no control, a flow switch should be installed to protect the load resistor element in case the flow rate drops due to a momentary change in water pressure. Choose a flow switch with a small "ON-OFF" flow rate dead band. The switch will also protect the resistor in cases where the RF power may be turned on before the water flow, or where accidental termination of water flow (pinched hose, debris, valve closing, etc.) may occur. In the tap-water system the heated water is discharged down the drain and therefore, the cost of the water becomes an important consideration.

NATURAL WATER SYSTEM - A close proximity to a natural supply of fresh water may suggest its utilization. Brackish or salt water may NOT be used as a coolant for the load resistor. The natural water system usually requires more extensive piping and heavier pumping equipment to handle attendant pressure drop.

The quality of natural water varies widely and straining is often necessary to handle the twigs, minnows, leaves and other debris frequently encountered. Small automatic self-cleaning strainers are available for this purpose. The strainer should be installed upstream from the pump to protect the pump as well as the load resistor. Additional filtering of smaller particles is sometimes required and this can be accomplished with finer mesh "Y-TYPE" strainers inserted in series with the line.

In this system, the water from the natural source may not be directly usable as a coolant for the load resistor element due to a high contamination, such as silt, iron content, mud, etc.; but it may be used as "dirty" water coolant in a water-to-water heat exchanger. The contaminated water could be piped via plastic tubing or hose to copper coils immersed in a holding tank containing clean water coolant for the dummy load. This arrangement would require a dual pump - one section to pump the "dirty" natural-source water and the other section to pump the clean water coolant through the dummy load.

HEAT EXCHANGER SYSTEM - In this system, an accumulator or receiving tank is used which only holds about one-half the flow rate in gallons-per-minute. Accordingly, a small quantity of coolant is required. The coolant functions solely as a heat transfer agent between the load resistor and the heat sink. A heat exchanger consisting of a radiator and a fan is the type recommended for this application. With ambient air as the ultimate heat sink, the operating temperature of the coolant will always be above the air temperature for heat to be transferred from the load to the air. Some consideration should be given to exhausting the hot air to the outside so as not to have a temperature rise problem in the transmitter

area. The heat exchanger may be a complete self-contained unit (portable) which includes the dummy load or the load may be separate and apart from the heat exchanger unit to facilitate installation and maintenance requirements, etc. Both types of heat exchanger packages are available from us.

TANK OR RESERVOIR SYSTEM - In this system, a practical amount of coolant is stored in a tank or reservoir and continuously recirculated (pumped) through the load until the coolant becomes hot. (NOTE: One kilowatt of power will raise a gallon of water 7°F per minute.) This relationship was used to calculate the curves of Fig. 6. The curves show the permissible hours of continuous operation for a given quantity of water in gallons, i.e., the number of gallons of water that will be raised from room temperature (70°F) to 170°F. If water from a swimming pool is used, care should be taken to filter out foreign debris to avoid clogging the system. The water flow rate as specified for each load (GPM) must be maintained throughout the application of power. A thermal switch and a water flow switch should be used as a protection against over-temperature and low coolant flow.

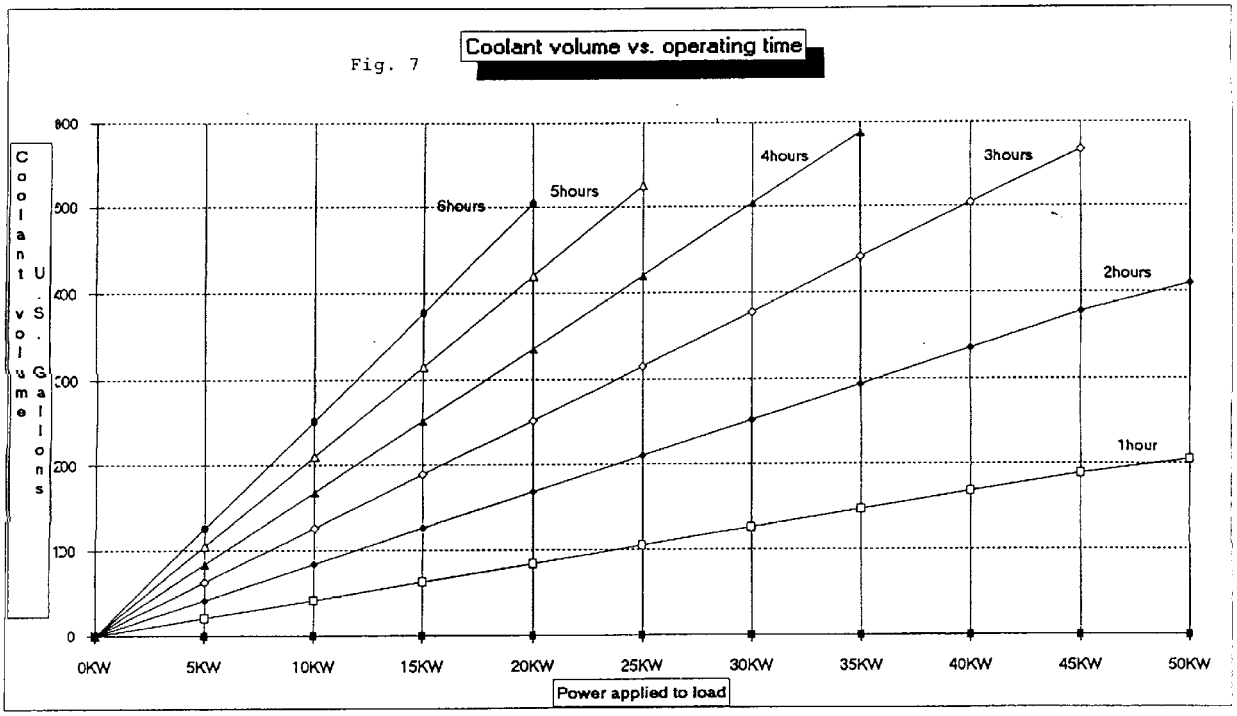

Fig. 6

Storage tanks between 200 and 500 gallons will satisfy most requirements. A waterproof concrete holding tank in the 1000 to 1500 gallon range may also be considered. (Similar to a septic tank and buried below the frost line.) It would be protected from extremes of temperature and could hold ordinary tap water as the coolant, while comparing favorably in cost to smaller metal tanks exposed to the

elements. Storage tanks are normally vented to the atmosphere and allowance should be made for determining the liquid level in the tank and for adding make-up water. Some typical sizes of cylindrical tanks in the range of interest are shown in the table of Fig. 7 below.

CAPACITY IN GALLONS	SIZE DIAMETER x LENGTH IN FEET
120	2 x 5
200	2.5 x 5.5
300	3 x 6
500	3.5 x 7
1000	5 x 7
1500	5 x 10.5

Fig. 7 - Tank Sizes

The pump selected for this service should have all wetted parts made from brass, bronze, ceramic or stainless steel. Cast iron and common steel will "poison" the water system and cause early failure of the load. Select the pump to overcome piping losses and the internal pressure drop of the load (shown in Fig. 4).

INSTALLATION

The OMEGALINE® loads may be used on both fixed and portable applications and they perform equally well in any mounting position. The units are very rugged and light and may be strapped, clamped, or secured with any practical and readily available mechanical device. They may be held by the RF connector on one end and by the plumbing on the other end. The coolant may be allowed to pass through the load in either direction without affecting its operation.

We recommend installing a "y" type filter with a stainless steel #20 mesh screen on the inlet side of the load to prevent debris from entering the load. Water lines connecting the load should be 1" copper water tubing and rigid enough to support the load. In typical installations, the rigid piping is terminated within a few feet of the load, and flexible hose is used to bridge the last few feet. The hose should be 1" I.D. and capable of withstanding the temperature and pressure of the system. The water input flange and housing cap are tapped to accommodate standard 1-11 ½ NPT tapered pipe thread.

Provisions should be made to allow interruption of the transmission line at any position where the transmitter is to be terminated by the load or measurements are contemplated. Coaxial switches may be inserted in the transmission line run to provide rapid load switching.

Proceed as follows:

1. Install the unit in the selected location.
2. Connect the outlet water fitting of the dummy load to a convenient drainage.
3. Connect the water inlet to a water source capable of delivering the required flow in gallons per minute. If the required source of water flow is not available from the local lines, refer to the previous section for a possible alternate cooling system. We highly recommend the use of a flow switch in the inlet piping to detect low flow conditions that could damage the load. We recommend a flow switch with low internal pressure drop that operates reliably in pilot-duty applications. (A switch is available from us.) Mount the switch in a horizontal section of pipe where there is a straight horizontal run of at least twelve inches on each side of the switch.
4. Connect the microswitch contacts of the flow switch in series with transmitter interlock circuit.
5. Connect the dummy load to the transmission line. The unit is designed to connect to a 50 or 75 ohm line (or as stated on label).

OPERATION

To place the dummy load in operation, the following procedure is recommended:

1. Turn on the water pressure and make certain water is flowing through the load. Allow about 1 minute of water circulation to insure complete wetting of the resistor element in the load and exhaustion of air bubbles.

2. Check the water flow rate. This can be done with a five-gallon container and a wristwatch with a sweep-hand if no water flow meter is available.

3. Apply RF power.

To cease operation, turn the RF power off and allow about 30 seconds before turning off the water.

CALORIMETRY

The OMEGALINE® loads may be used in conjunction with a flow meter, thermometer wells and thermometers to accurately measure transmitted power by calorimetry. Fig. 8 shows a complete arrangement. The flow meter and the thermometer wells may be placed at a convenient position and at eye level for ease of reading. There is no need to have them adjacent or in close proximity to the load. The components may be placed upwards of fifty feet away from the load without any loss in the accuracy of measurement.

The thermometer wells (Altronic type TW-3), which are closed to the main coolant stream, use water as the heat transfer medium and operate efficiently with the thermometers immersed in about 1 inch of water. The stabilization time for the system is approximately thirty seconds and a power measurement accuracy within 2% may be obtained with very little difficulty. Technical and component information on the calorimetry set-up may be obtained by contacting ALTRONIC RESEARCH, INC.

If an ethylene glycol and water mixture is used, a correction must be applied to the flow meter reading due to a change in density and change in specific heat and gravity of the coolant.

Use the curves of Fig. 9 to obtain the new (K_t) multiplying factor for the calorimetric power equation and curves of Fig. 10 to obtain the density value and the flow meter correction factor. The calorimetric power equation when using ethylene glycol and water mixtures will be as follows:

$$P = Kt\ (T1-T2)\ QxF$$

Where P = Power in load in kilowatts
T1 = Outlet water temperature °C
T2 = Inlet water temperature °C
Q = Water flow in gallons per minute
F = Flow meter correction factor
Kt = Coolant multiplying factor

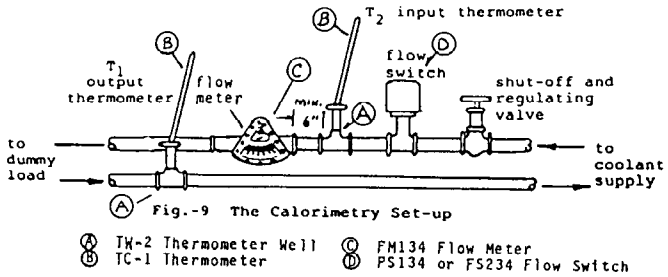

Fig. 8 - The Calorimetry Set-up

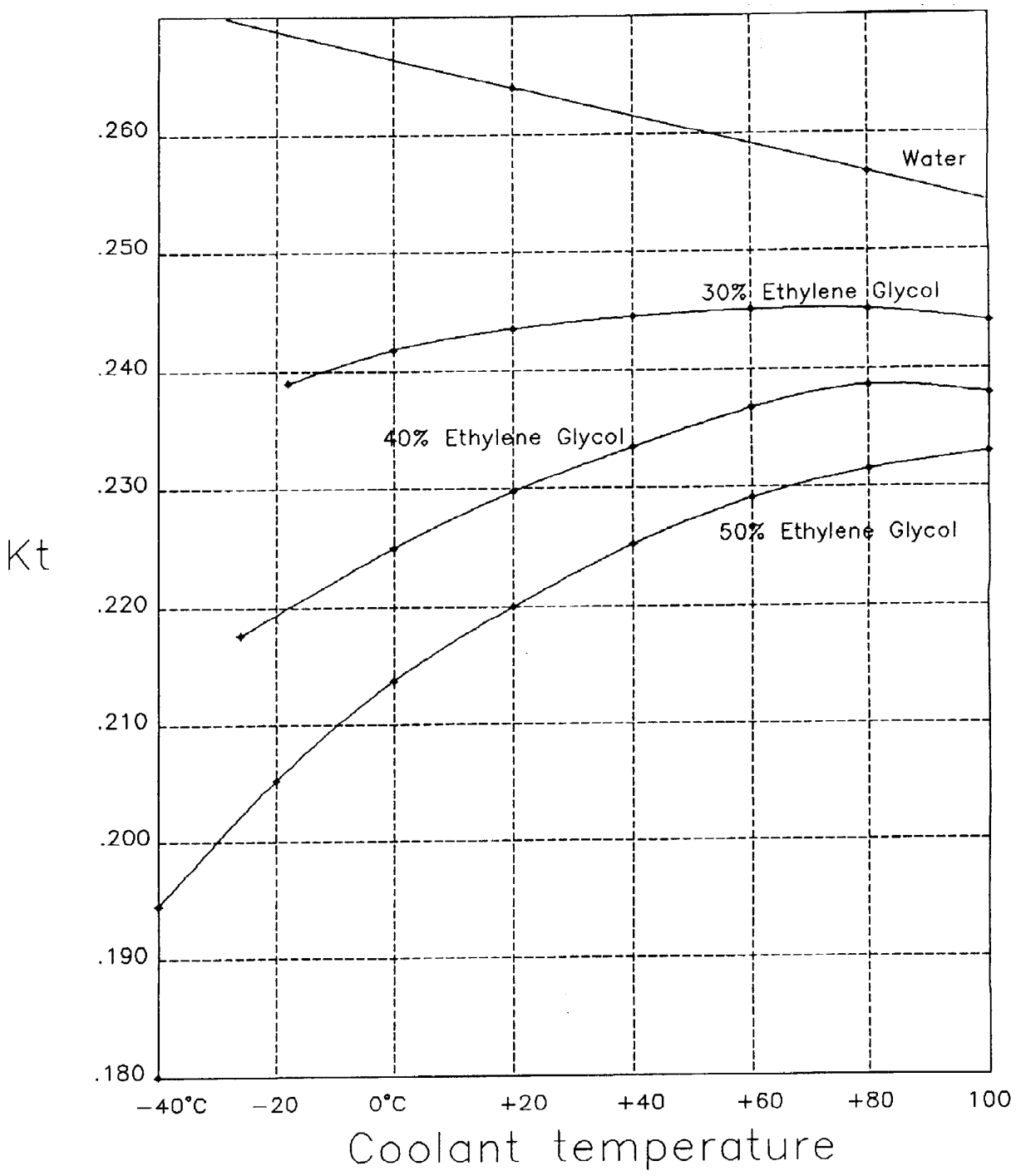

Fig. 9 - Kt for Ethylene-Glycol/Water Mixtures vs. Temperature

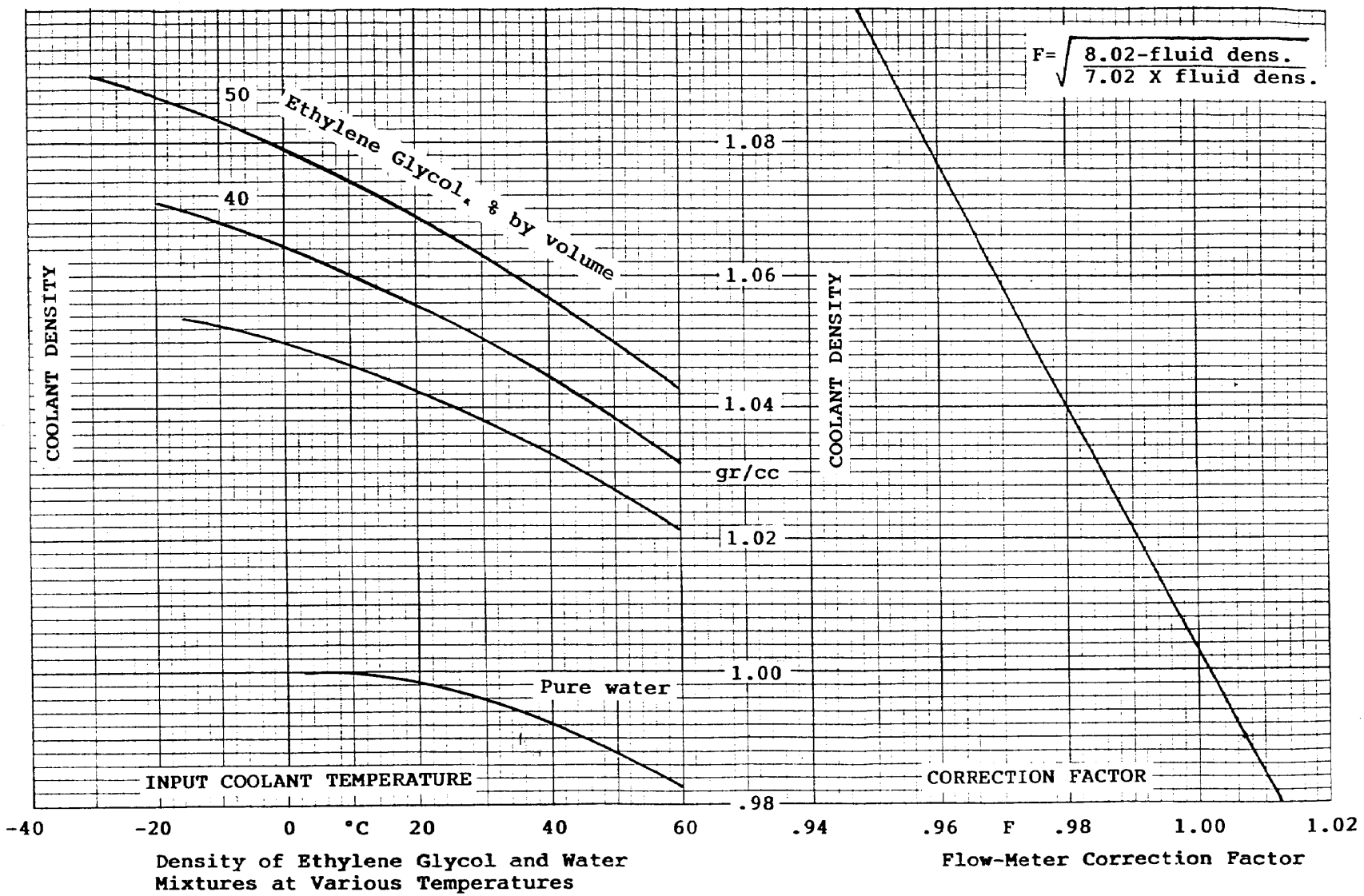

Fig. 10

(The above graphs may be used together as a nomagraph)

Altronic Research Inc., Yellville, Arkansas

SPECIFICATIONS

Model 523000

Impedance	50 ohm nominal
Maximum Power Rating CW Pulsed	7.5KW-3 MW
Maximum VSWR	1.15
Coolant	Ordinary tap or pure water; Ethylene Glycol and water mixture 50%
Water Connectors Inlet/Outlet	1" NPT Female
Min. Water Flow Rate	6 GPM
Input Water Temperature	4°C to 45°C
Output Water Temperature	Maximum: 90°C
Maximum Inlet Pressure	75 PSI Max.
Resistor	Cylindrical film type
Input Connectors	9-3/16" EIA flange
Dimensions	31.5" x 34" & 46.375" tall
Weight	200 lbs.
Operating Position	Vertical
Finish	Alodine

DC Resistance 49.5Ω

Serial No. 101

Date 1-9-02

VSWR NOMOGRAPH

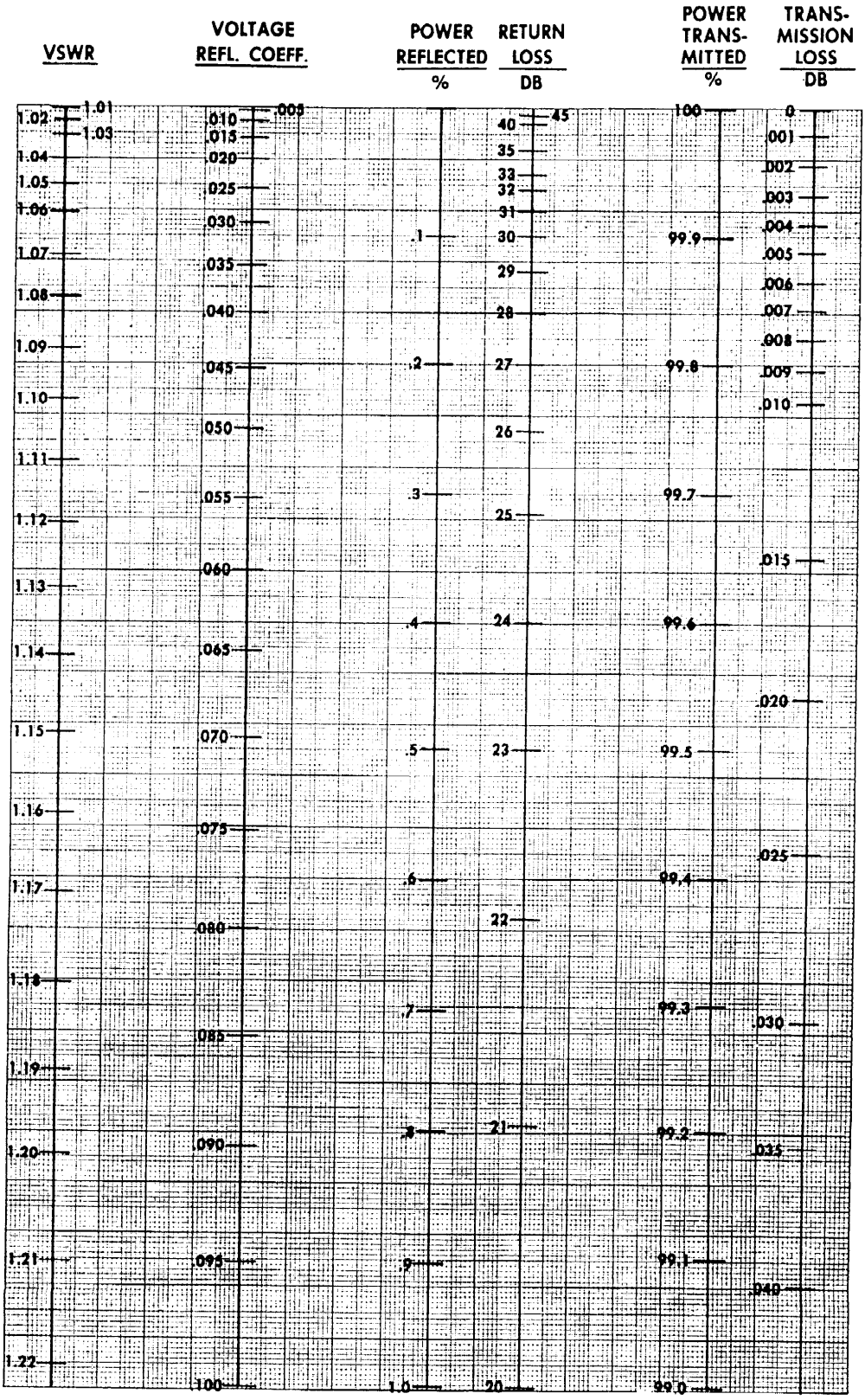

Fig. 11

MAINTENANCE

The OMEGALINE® RF loads will require little in the way of maintenance. Components located inside the unit are not subject to field maintenance. In the event of mechanical damage to the unit, operational difficulty, or information concerning a desired unusual application of the load, contact the factory.

NOTE: ANY LEAK FROM THE MAIN BODY OF THE LOAD IS AN INDICATION THAT THE UNIT SHOULD BE RETURNED TO THE FACTORY FOR REPAIRS.

The following checks, tests and procedures may be used periodically, when necessary, or when a malfunction is suspected.

1. **DC Resistance** - The DC resistance of the load may be checked at the RF input connector and a value within 4% of the required resistance is acceptable.

2. **External Filter Screen** - Should be checked regularly to prevent clogging.

3. **VSWR** - The voltage-standing-wave-ratio of the load is the same with "stand still" water as it is with flowing water. To test for VSWR, fill the load with water. When filling with water, many small bubbles will form inside. These must be flushed out with excess water before measuring VSWR. After filling, cork it, connect to a slotted line or directional coupler and measure the VSWR at SIGNAL GENERATOR LEVELS ONLY.

For technical assistance, call 870-449-4093 or fax 870-449-6000.

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.**