AMP-10
OPERATOR'S MANUAL

Version 2.0

Vatell Corporation
P.O. Box 66
Christiansburg, VA 24073

Phone: (540) 961-3576
Fax: (540) 953-3010

WARNING: **Read instructions carefully and completely before operating the AMP-10. Improper usage may damage the unit. Save this manual for safety and operating instructions, as well as warranty information.**

FORWARD

Thank you for purchasing the AMP-10 signal conditioning amplifier. The AMP-10 was designed to be used with Vatell Corporation's line of Heat Flux Microsensors. It is has selectable gains, is simple to operate, and can be powered from most wall sockets for continuous use.

To fully appreciate the capabilities of your AMP-10, please read this Operator's Manual thoroughly. If you have any questions or need any assistance please contact:

Vatell Corporation
Attn.: Amplifier Assistance
P.O. Box 66
Christiansburg, VA 24073

Phone: (540) 961-3576
Fax: (540) 951-3010

Please indicate model and serial number in all correspondence. The model and serial number is printed on the bottom of the amplifier.

CONVENTIONS

As you go through this manual, certain conventions are consistently used:

- All front and rear panel control label references are italicized capitals - for example, reference to the power switch would be shown as *POWER*.
- All safety alerts will be preceded by **"WARNING:"**
- Necessary, but not safety related information will be preceded by **"NOTE:"**
- Referenced information will be in *italics*.

AMP-10 Operators Manual

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UNPACKING AND INSPECTION

Included with each AMP-10 are the following items:

1) Operator's manual
2) AC-to-DC adapter
3) Heat Flux Microsensor connection cable
4) Small screwdriver for potentiometer adjustments
5) Gain Calibration Sheet

If any of these items are missing or damaged, contact Vatell Corporation at the address listed in the Foreword section of this manual.

AMP-10 EQUIPMENT OVERVIEW

FRONT AND REAR PANEL DESCRIPTIONS

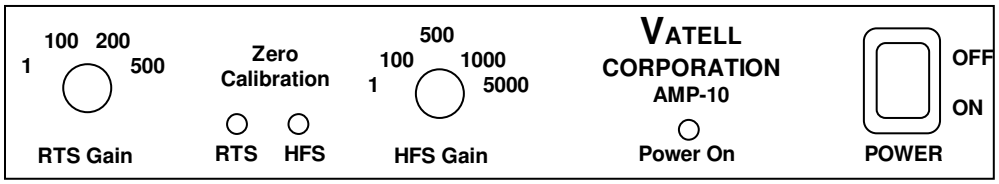


Figure 1- Front Panel

RTS Gain: Sets the gain for the RTS channel. Values are 1, 100, 200, and 500.

Zero Calibration (RTS): Precision multi-turn potentiometer used to adjust the amplifier RTS output to zero.

Zero Calibration (HFS): Precision multi-turn potentiometer used to adjust the amplifier Heat Flux Output to zero.

HFS Gain: Sets the gain for the HFS channel. Values are 1, 100, 500, 1000, and 5000.

Power On: Indicates the AMP-10 is plugged in and turned on with a green light.

Power: Turns the amplifier on.

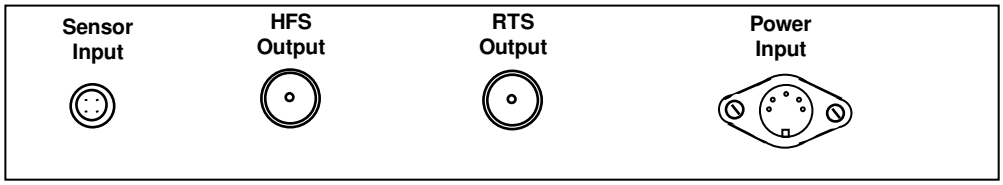


Figure 2- Rear Panel

Sensor Input: Lemo connector for the HFM cable.

HFS Output: Output of the Heat Flux amplifier channel. It is a BNC type connector.

RTS Output: Output of the RTS amplifier channel. It is a BNC type connector.

Power Input: The connecting point between the AC-to-DC adapter and the amplifier.

WARNING: **Do not attempt to power the AMP-10 with an adapter other than the one supplied by Vatell. An improper adapter could damage the unit.**

CABLING AND CONNECTIONS

The standard cable supplied with the AMP-10 is six feet in length. Cables of longer lengths can be supplied by Vatell Corporation as an option.

The standard connector supplied with each Vatell Corporation AMP-10 and HFM is a 4 pin Lemo connector. Some customers may need to make custom cables or need to replace damaged connectors. To obtain Lemo parts, you can either order them from Vatell Corporation or Lemo, USA.

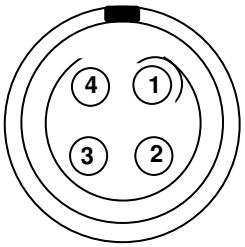
Lemo, USA
P.O. Box 11488
Santa Rosa, CA 95406

Phone: (800) 444-5366
Fax: (707) 578-1545

Lemo part numbers:

Male Lemo connector (used on cable)- FGG.0B.304.CLAD56
Female Lemo connector (used on sensor)- PHG.0B.304.CLLD21

Figures 3 illustrates the connections on each of the 4 pins of the sensors Lemo connector and their respective orientations.



Pin #	Function
1	-HFM
2	RTS
3	RTS
4	+HFM

View from Rear of Connector

Figure 3 - Female Lemo Connector Pin Out

OPERATION

PRINCIPLES OF OPERATION

The AMP-10 is a 2 channel signal-conditioning instrumentation amplifier designed to be used with a Vatell Corporation Heat Flux Microsensor (HFM). The HFM is a state-of-the-art sensor which requires low-noise, precision amplification. The AMP-10 is designed specifically with these requirements in mind to give the user quality data.

The HFM consists of two sensors on the same surface. The Heat Flux Sensor (HFS) measures heat flux flowing through the sensor surface. The Resistance Temperature Sensor (RTS) measures the temperature at the face of the sensor. One channel of the AMP-10 amplifies signals from the HFS portion of the HFM. The other channel excites the RTS portion of the HFM with a 100 μA current source and then amplifies the resulting voltage signal.

Both the HFS and RTS channels have independently selectable gain and offset controls. The HFS has gains of 1, 100, 500, 1000, and 5000. The RTS has gains of 1, 100, 200, and 500. The offset controls allow zeroing of the amplifier outputs. Prior to measurement, the gains are selected and the sensor offset is adjusted. *See Taking Measurements section for more information.*

The AMP-10 is powered by a 12 V AC-to-DC adapter that plugs into the wall.

TAKING MEASUREMENTS

In order to collect data from the HFM, proceed with the following steps. *See Front & Rear Panel Descriptions in the OPERATIONS section for illustration of control locations*.

1. The amplifier should be placed in a position that avoids strong electromagnetic

fields and large temperature excursions. *See Theory of Operations section for detailed discussion.*

2. Turn the amplifier on. The *POWER* switch is located on the front panel. Be sure the amplifier is plugged into the wall.

3. Attach one end of the 6 foot cable to the HFM and the other end to the input connection (*SENSOR INPUT)* on the back panel of the amplifier. The cable and HFM connectors are keyed to assure proper pin alignment.

4. Connect output BNC connections *HFS OUTPUT* and *RTS OUTPUT* to a measuring device (chart recorder, oscilloscope, voltmeter, etc.).

5. Allow amplifier to warm-up (become temperature stable). This takes approximately eight minutes from the time the amplifier is turned on. *See step 2.*

6. Zero Calibration: This should be done after the amplifier has warmed up. It may be necessary to zero again if the testing environment changes (i.e. temperature, humidity, or atmosphere change; connection of a different sensor; etc.).

   a. Set *RTS GAIN* to desired value (1, 100, 200, or 500).

   b. Set *HFS GAIN* to desired value (1, 100, 500, 1000, or 5000).

   c. Zero both the heat flux and RTS channels using the *ZERO CALIBRATION* potentiometers (*RTS* and *HFS*) located on the front panel. The channels are zeroed when their measured outputs read zero volts. *See Zeroing the HFS and Zeroing the RTS sections for more information.*

NOTE: The temperature (T_0) at which the amplifier is zeroed and the selected gains (G) are used in the calibration equations. *See "Use of Vatell Heat Flux Microsensor Calibration Equations" supplied with each sensor.*

7. System is now ready for measurement of heat flux and temperature.

HEAT FLUX MEASUREMENTS USING THE HFS

The heat flux predicted by the HFS is a function of the sensor temperature measured by the RTS, the gain of the HFS channel, and the voltage at the HFS output. This relationship is described in "Use of Vatell Heat Flux Microsensor Calibration Equations" included with each Heat Flux Microsensor.

Zeroing the HFS

Before zeroing, let the amplifier warm up for at least eight minutes. Zeroing is then accomplished by exposing the Heat Flux Microsensor to zero heat flux and adjusting the *HFS ZERO CALIBRATION* potentiometer until the *HFS OUTPUT* measures zero volts. The Heat Flux Microsensor will see zero heat flux if it is in still air and in thermal equilibrium with the environment.

TEMPERATURE MEASUREMENTS USING THE RTS

The temperature predicted by the RTS is a function of the initial temperature of the RTS, the gain of the RTS channel, and the voltage at the RTS output. This relationship is described in "Use of Vatell Heat Flux Microsensor Calibration Equations" included with each Heat Flux Microsensor.

Zeroing the RTS

Before zeroing, let the amplifier warm up for at least eight minutes. The RTS is a device that accurately measures changes in temperature. It is necessary to establish a reference temperature in order to know the absolute temperature at any given time. The reference temperature (T_o) is the temperature at which the RTS is zeroed and must be measured by an independent source such as a thermometer. This temperature, T_o, is used in equation (2) to find the reference resistance (R_o). Equation (2) can be found on the "Use of Vatell Heat Flux Microsensor Calibration Equations" sheet included with each heat flux microsensor. If the temperature at the sensor can not be directly measured, a measurement of the resistance of the RTS can be used as the reference resistance (R_o).

It is important to zero the RTS at a temperature between 0°C and 250°C. Zeroing is accomplished by turning the *RTS ZERO CALIBRATION* potentiometer located at the face of the amplifier until the *RTS OUTPUT* measures as close to zero volts as possible. Use the reference resistance (R_o) and the RTS channel voltage out (ΔV_{RTS}) in equation (3) to find the absolute temperature of the RTS. Equation (3) is also located on the "Use of Vatell Heat Flux Microsensor Calibration Equations" sheet. Once the sensor is zeroed, changes in temperature will produce a change in the RTS output voltage, yielding a known absolute temperature at the sensor.

THEORY OF OPERATION

The AMP-10 is a 2 channel amplifier based on 2 Analog Devices' AD624 instrumentation amplifier chips. These instrumentation amplifiers have dual supplies, differential inputs, and pre-selectable gains. The AMP-10 was designed to be used with a Vatell Corporation Heat Flux Microsensor (HFM). One channel is used to amplify the Heat Flux Sensor (HFS) portion of the HFM and the other channel is used to amplify the Resistance Temperature Sensor (RTS) portion. The HFS channel and RTS channel inputs are connected to a single 4 pin Lemo connector located on the back panel. The outputs (single ended) are connected to two male BNC coax connectors located on the back panel. The value at which the amplifiers rail is dependent on the charged state of the batteries. Most amplifiers will rail at approximately ±6 V or greater.

The heat flux channel has switch selectable gains of 1, 100, 500, 1000, and 5000. The heat flux amp has both its inputs tied directly to the Lemo connector. There are two bias resistors (200 kΩ) placed from the inputs of the amplifier to ground. Figure 4 shows a simplified circuit diagram. The heat flux channel is zeroed with the *HFS ZERO CALIBRATION* potentiometer. It should be zeroed with the sensor connected and seeing no heat flux. The sensor will produce zero output when there is no source or sink of heat flux. This zeroing process controls the input offset to the heat flux channel's instrumentation amplifier. This offset adjusts for amplifier drift, which is mostly influenced by temperature. The amplifier should be turned on at least 8 minutes prior to adjustment, and should be at the same temperature as its environment. *See specifications for operating limits.*

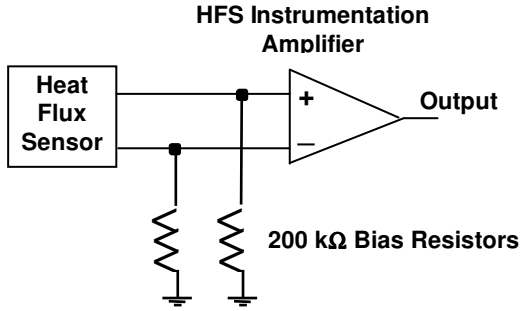


Figure 4 - Simplified Heat Flux Signal Circuit Diagram

The RTS channel has switch selectable gains of 1, 100, 200, and 500. The RTS amplifier has one input tied to a pin on the Lemo connector and the other connected to the *RTS ZERO CALIBRATION* potentiometer. The resistance temperature sensor (RTS) is driven by 100 µA of current from a precision current source (Burr-Brown REF200) referenced to ground. The RTS lead not connected to ground is fed to the positive side of the RTS differential amplifier. The negative side of the amplifier is connected to a precision potentiometer (*RTS ZERO CALIBRATION*) also driven by 100 µA. The other side of the potentiometer is connected to ground. The two current sources are mounted on the same chip to precisely equalize the currents. Figure 5 shows a simplified schematic of this

circuit. The RTS signal may be set to zero at any desired temperature. S*ee Temperature Measurements Using the RTS*.

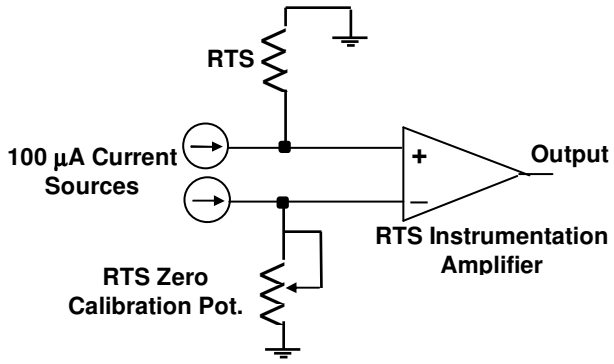


Figure 5 - Simplified RTS Signal Circuit Diagram

NOISE REDUCTION

All precision amplifiers working with small signals are susceptible to Electromagnetic Interference (EMI). Special care should be taken in the placement of the sensor and amplifier relative to any source of EMI noise. The following actions will tend to reduce EMI noise problems:

- Avoid creating ground loops.
- Do not subject the amplifier, sensor, or cables to large electrical fields.
- High frequency PWM (Pulse Width Modulated) motors tend to be very noisy. If possible, avoid data collection when motors are on.
- Use shielded, twisted pair for any connections beyond the cable supplied with the sensor and amplifier.
- Do not ground the cable supplied with the amplifier at the end nearest the sensor.

CARE AND MAINTENANCE

The AMP-10 is a durable instrument. If handled carefully, it should last for years. The AMP-10 can be cleaned with a soft dry cloth. Avoid the use of strong chemicals and solvents, especially when cleaning the front and rear panel surfaces.

In case of any difficulty with operation or maintenance of this amplifier, contact Vatell Corporation for further assistance.

WARRANTY

Vatell Corporation warrants that this product will be free from defects in materials and workmanship for a period of 90 days from the date of shipment. If the product proves defective during this warranty period, Vatell Corporation, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, the customer must notify Vatell Corporation in writing of the defect before the expiration of the warranty period and make arrangements for service. The customer shall be responsible for packaging and shipping of the defective product to Vatell Corporation with shipping charges prepaid. Vatell Corporation will pay for the return of the product to the customer, if the shipment is to a location within the United States of America. The customer is responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to locations outside of the USA.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care.

THIS WARRANTY IS GIVEN IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. VATELL CORPORATION DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. VATELL CORPORATION'S REPAIR OR REPLACEMENT OF A DEFECTIVE PRODUCT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR WARRANTED DEFECTS. VATELL CORPORATION WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

AMP-10 SPECIFICATIONS

	Heat Flux Channel	Temperature Channel
Gain Settings	1, 100, 500, 1000, 5000	1, 100, 200, 500
Gain Accuracy %		
Gain = 1	±0.6	±0.6
Gain = 100	±1.5	±1.5
Gain = 200, 500	±1.5	±1.5
Gain = 1000	±2.1	
Gain = 5000	±3.6	
Bandwidth		
Gain = 1	1 MHz	1 MHz
Gain = 100	150 kHz	150 kHz
Gain = 200		100 kHz
Gain = 500	50 kHz	50 kHz
Gain = 1000	25 kHz	
Gain = 5000	5 kHz	
Input Impedance	10^9 Ω	10^9 Ω
Input Noise	0.2 μV	0.2 μV
Maximum RTS Resistance	factory adjustable	factory adjustable
Full Scale Output	6 V	6 V

Dimensions:

Height = 4.3 cm (1.7") Width = 19 cm (7.5")

Depth = 28 cm (11") Weight = 1.1 kg (37 oz.)