OPERATING MANUAL

BAT-12
Microprobe Thermometer

CONTENTS

Section

OPERATING INSTRUCTIONS FOR BAT-12 THERMOMETER

1.0 INTRODUCTION

The Physitemp BAT-12 thermometer is a compact, portable, digital thermometer for use in the lab or in the field. It can be used with any Type T thermocouple sensor and is available in two versions:

BAT-12, for battery operation only, uses a 9V alkaline battery.

BAT-12R, a rechargeable version, is supplied with a 9V Nickel/Metal-Hydride battery and may be battery operated in the field or AC operated in the lab. A heavy duty vinyl carrying case is supplied with both versions.

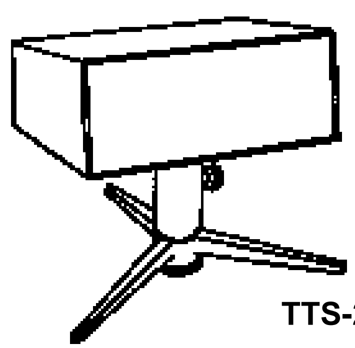
2.0 INITIAL INSTALLATION

2.1 Remove the packing list (usually found in a transparent envelope on the outside of the carton) and unpack the instrument. Check that all items shown on the packing list are present. Sensor probes ordered with the instrument will be packed in the same box if small or a separate package if they are longer than 12 inches.

2.2 BAT-12, for battery operation, is supplied ready for use with a 9V alkaline battery already installed. Shipment will include the carrying case and a male plug for connection to the analog output.

2.3 BAT-12R for AC and battery operation, is supplied with a 9V Nickel/Metal-Hydride battery installed. This is shipped with a full charge. To recharge or for AC use, connect the small phono plug on the AC adaptor to the jack on the rear of the instrument and plug the charger into a live 115V outlet. 14 hours are required for a complete recharge. Overcharging will not harm the unit. If requested, an adaptor for 220VAC operation can be supplied. A carrying case and male plug for connection to the analog output are supplied with the BAT-12R.

2.4 If Tilt Stand TTS-2 has been ordered, mount the instrument on the stand by attaching the ball and socket mount to the threaded fitting on the underside of the case.



TTS-2 TILT STAND

3.0 OPERATING INSTRUCTIONS

3.1 The following instructions are found on the metal label fixed to the BAT-12. They are reprinted here in case the label ever becomes defaced.

BAT-12

OPERATING NOTES

TO MEASURE TEMPERATURE	Insert the plug of any Type T thermocouple probe into the blue socket marked INPUT. Switch ON. Apply probe. Read temperature.
TEMPERATURE RANGE	Model BAT-12 reads -100° to +200°C 0.1° resolution
SPECIAL INDICATIONS	[1] Probe is above max. temp. See range above.
	[0] Probe is disconnected or broken
	[18:88] Colon between center digits indicates low battery.
BATTERY REPLACEMENT	Switch OFF. Use coin to undo 2 screws in back and slide case off. Remove battery from clip and replace with similar 9V battery.
RECORDER OUTPUT	3.5 mm miniature jack socket on front panel. 10mV/°C
	MODEL: BAT-12 **SERIAL NO.**

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3.2 The special indications mentioned in 3.1 alert the user to unusual conditions and can prevent the recording of erroneous readings.

3.3 When the instrument is switched on and a probe is connected, it should read room temperature. This is normally about 25°C. Hold the tip of the probe between the thumb and forefinger; if reading increases to 28-34°C, which is normal skin temperature, it may be assumed that the instrument is working correctly. If the instrument reads low, your hand may be cold. BAT-12 reads to 1/10°C.

3.4 Normal use of the thermometer is very simple. Switch ON, apply probe, read temperature.

4.0 BATTERY REPLACEMENT

4.1 When a colon (:) appears in the center of the ditigal display, the battery needs to be replaced. However, BAT-12 can be used without significant calibration error for about one hour after the appearance of the colon.

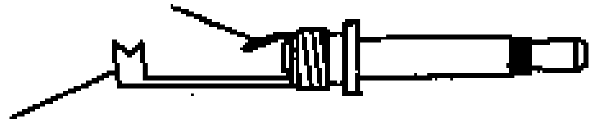
4.2 Switch instrument OFF. Use a coin to undo screws on the back of the case and slide case off. Remove battery from clip and replace with a similar 9V battery.

For **BAT-12,** alkaline batteries are recommended. Battery life will be approximately 160 hours.

For **BAT-12R**, a suitable 9V rechargeable battery should be used. DO NOT INSTALL A NON-RECHARGEABLE BATTERY IN BAT-12R. If you accidently try to recharge a non-rechargeable battery it may burst, leak and damage the instrument.

5.0 ANALOG OUTPUT

5.0 A DC output, whose amplitude is approximately proportional to instrument reading, is provided from the 3.5mm miniature jack on the front panel. A mating plug is supplied with each BAT-12. This plug may be left in the socket until it is required for use.



5.1 **Use of the analog output with strip chart recorder**

The output impedance of BAT-12 is 2 Kilohms, so connection to a potentiometric recorder will not affect either the calibration or accuracy.

The analog output is proportional to the input thermocouple voltage and is adequate for most strip chart recordings where small temperature ranges are involved. The output bears a non-linear relationship to temperature and, over wider ranges, thermocouple tables can be used to compensate for linearity changes. Physitemp will supply a copy of these tables on request.

5.2 **Use of the analog output with Physitemp TCAT-1A Temperature Control and Alarm Unit**

BAT-12 with TCAT-1A can be used to control a heating or cooling device such as a heat lamp or pad. This system is frequently used to control the temperature of animal cages, etc.

For more information on the TCAT-1A, see our website, www.physitemp.com or call us at 1-800-452-8510.

6.0 TEMPERATURE MEASUREMENT WITH THERMOCOUPLE SENSORS

6.1 The thermocouple is a simple and widely accepted device for measuring temperature. It comprises two wires of dissimilar metals fused together to form a junction which produces an electrical output proportional to temperature. The National Institute of Standards and Technology (NIST Monograph 125, 1974) has tabulated the voltage/temperature relationships of many commonly used thermocouple pairs; their tables on Copper-Constantan form the basis for calibration of Physitemp thermometers.

6.2 At one time, accurate thermocouple temperature measurements needed elaborate potentiometers and reference to a source of known temperature, such as an ice bath. The advent of modern solid state devices has made possible the design of an inexpensive thermocouple thermometer which is direct reading. The first of these was Bailey thermometer BAT-4, which was designed in 1969 and is now in use throughout the world. Your BAT-12 is an advanced version of the original equipment using the latest low power digital technology and compensated electronic reference circuitry.

6.3 As compared with thermistor sensors which were formerly used exclusively in portable thermometers, thermocouples have these advantages:

(a) Wide temperature range, e.g. -200°C to over +1300°C.
(b) High stability of output.
(c) Interchangeability - no recalibration required.
(d) Accuracy traceable to NIST calibrations.
(e) Low cost; users can even make their own sensors.
(f) Microscopic size when needed, as in Physitemp microprobes.
(g) Nearly instant response.
(h) Better measurement accuracy due to low mass with smaller heat loss.

6.4 The main disadvantage of the thermocouple, low sensitivity, was overcome by the development of auto zeroing amplifiers which are now used in all Physitemp thermometers. This type of amplifier is essentially drift-free. It makes possible an electronic thermometer which is permanently calibrated, just like a mercury thermometer. The following notes may help the user to avoid some of the errors most frequently made in temperature measurement.

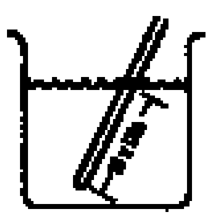
6.5 Faulty measurement technique with any type of thermometer can produce errors of several degrees. Errors attributed to "out of calibration" equipment can often be corrected by a simple change of technique.

6.6 Thermocouple probes, like all other temperature sensing devices, must be placed so that they reach, as closely as possible, the temperature of the material to be measured. Probes are tip-sensitive, but when measuring the temperatures of liquids, semi-solids or hard surfaces, it is not sufficient to bring only the tip into contact with the material being measured. This is because there will be loss of heat along both the thermocouple wires and their sheath, so readings will be low. The effect can be greatly reduced if part of the metal sheath is also placed in contact with the material. In liquids and semi-solids, the tip and sheath are simply immersed; on solid surfaces, the sheath is laid against the surface.

> *Here is a useful rough rule: Heat leakage effects are substantially reduced when an amount of probe equal to 10 or more sheath diameters is immersed or laid on the surface. For example, with a probe of 1/16" diameter, 10 x 1/16" = 10/16" = .625" = the minimum immersion depth.*

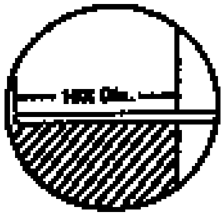
6.7 Errors between thermocouple probes. All Physitemp clinical probes and sensors are made with thermocouple wire that has been specially tested to meet our own stringent standards. Our clinical probes are guaranteed accurate to within 0.1°C in the range 0-50°C. Copper-Constantan (type T) thermocouples from other manufacturers are not normally this accurate. Probes made from wire to "special limits of error" may be accurate to ±0.5°C in this range. This interchangeability of sensor, including microprobes, is a major advantage of Physitemp thermocouple thermometers.

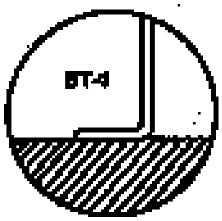
6.8 **Measurements in Liquids.** These are quite easy to make, because there is good thermal contact between liquid and probe. The latter quickly reaches liquid temperature and readings can be taken within a few seconds. However, a liquid which has been heated above or cooled below ambient will be losing or gaining heat, and convection currents will give rise to temperature variations of up to several degrees. These variations can be reduced by vigorous stirring. This simple precaution must always be taken.



6.9 **Measurements of Air Temperature.** Temperature can vary widely in different parts of a room; differences of at least several degrees will be noted. When a microprobe is used to indicate air temperature, readings will often fluctuate rapidly, responding to actual temperature changes caused by air currents. Breathing near the microprobe will produce wide fluctuations. These effects indicate the sensitivity of the BAT-12/microprobe combination, due to high discrimination of the instrument and almost instant response of the probe. Fluctuations can easily be eliminated by bringing the probe into contact with a metallic object, thus increasing its effective mass and slowing the response. Using a larger probe will have the same results.

6.10 **Measurements on Solid Surfaces**. These are most easily made with surface probes such as our BT-1 and MT-D. The right-angled tip provides the 10 diameters of probe contact specified in Section 6.6. Straight probes may also be used, provided that sufficient shaft length is in contact with the surface to be measured. In general, the smaller the probe, the more accurately it will measure the surface temperature of a solid. For instance, an MT-29 microprobe, because of its small size, needs to be in contact with the surface for as little as 1/8". SST-1 has a 1/4" gold disc sensor. Gold is an excellent conductor, and is non-allergenic and non-polluting. It makes a fine skin surface probe.





6.11 **Measurements in Electronics.** BAT-12 and ICT-4 provide the quickest and cheapest method of getting accurate reading on both discreet components and integrated circuits used in electronic equipment. ICT-4 has two important differences from the regular MT-4 probe. There is a 5 1/2" handle suitable for use in the hand or in a micromanipulator and the micro-thermocouple protrudes slightly beyond the steel sheath and has some thermal isolation from it. This probe was designed for use on areas of 5-100 microns in diameter and is used perpendicular to the surface to be measured. The heat loss described in 6.3 occurs and temperature readings are slightly low -- normally about 0.5°C low. Each probe can be readily calibrated on a larger surface. First lay it parallel to the surface and note the reading. Then take a reading with it perpendicular to the surface; note the difference. Add this difference to the subsequent reading when using the perpendicular position.

6.12 BAT-12 with a suitable probe has the ability to measure surface gradients, giving almost instant readings at each point. This feature enables heat sinks to be designed without guesswork, for maximum efficiency with minimum metal. It is equally easy to check the adequacy of thermal bonding between a power transistor or rectifier and its heat sink. General purpose probe BT-1 is suitable for this and many other measurements. When probes such as BT-1 and the larger HT-1 and HT-2 are used for surface measurements, speed of response and accuracy can often be improved by use of a heat conductive material such as 'thermal grease' or silicone grease applied between the probe and surface. Note: BT-1, HT-1 and HT-2 should not be used on electrical equipment where voltages are present as the sensor is connected to the stainless steel sheath. The following probes are isolated and suitable for use on certain electrical equipment: TFT series, RET-1, ESO-1, IT-14, IT-18, IT-21. Check with out technical department for details.

7.0 TROUBLE SHOOTING

7.1

Symptom	Check below
Readout not illuminated	a, b
Readout indicates 1	e
Readout indicates 0	d
Colon (:) in center of display	b
Calibration error suspected	c, f, g

a. Check that the instrument is switched on

b. Replace or recharge batteries

c. Excessive loading on the analog output. Remove the output plug

d. Probe or sensor may be faulty (open circuit). Check by substituting another probe or by a resistance check. All probes should read less than 2000 ohms.) If you do not have a second sensor, bend a paper clip or other suitable wire into a ‘U’ and insert into the socket instead of the probe. The instrument should read room temperature.

e. Probe temperature is too high

f. Review measurement technique (Section 6.0)

g. Probe temperature below -100°C

8.0 CHECKING CALIBRATION

8.1 The BAT-12 thermometer can have a ‘worst case’ error of 0.2°C. The ‘worst case’ is rarely met as it assumes that all sources of error are at their maximum, and that all are additive.

A further possiblity of error is in the sensor. This is a maximum of 0.1°C at 50°C, 0.2°C at 100°C, rising to 3/8% of reading, i.e. a possible 1.5°C at 400°C. This is the maximum error for Special Limits Copper-Constantan thermocouples permitted by ANSI (American National Standards Institute.)

In practice, these errors are usually much lower unless poor measurement techniques are being applied.

8.2 If errors are suspected, check F in Section 7 should first be made. Then the instrument should be checked against a glass thermometer with 1/10th degree calibrations traceable to NIST. Note that the calibration of a glass thermometer can be invalidated by overheating -- ensure that this never happens.

8.3 Bind the thermocouple probe to the tip of the glass thermometer so that they are close together. Do not compress the glass thermometer bulb.

8.4 Insert probe and thermometer in a Dewar flask or Thermos bottle containing liquid at a suitable temperature. Do not allow the probe or thermometer to touch the sides of the vessel. Ensure that the thermometer is immersed to its proper depth. STIR WELL.

8.5 Allowing for some reading error in the glass thermometer (there can be none in the digital BAT-12), readings should agree with the limits noted in 8.1. If readings are outside these limits, the instrument should be returned for further checks. (See section 10.0.) Recalibration of BAT-12 should not be attempted unless you have an accurate temperature standard and a voltage standard such as a potentiometer with one microvolt resolution.

A service manual is available. This includes circuit diagram, servicing information and calibration instructions. Price is $25.

9.0 SPECIFICATIONS

Temperature range:	-100° to +200°C
Resolution:	0.1°
Accuracy:	0.1° ±1 digit between 0 - 50°C 0.1% ± 1 digit over the full range
Calibration:	Conforms to National Institute of Standards and Technology tables -- (NIST monograph 125)
Ambient Cold Junction Temp Compensation:	±0.1°C from 0° to 50°C
Readout:	3 1/2 digits, 1/2” liquid crystal numerals
Analog output:	10mV per degree C, approximately
Power Supply:	BAT-12: 9V alkaline battery, available everywhere BAT-12R: AC 115V and NimH rechargeable battery with charger/adaptor
Dimensions:	5”W x 2.5”H x 6”D
Weight:	2 lbs, including carrying case

10.0 REPAIRS AND WARRANTY

10.1 If the BAT-12 is to be returned for any reason, please pack it with care and sent it prepaid to:

Service Department
PHYSITEMP INSTRUMENTS INC
154 Huron Avenue
Clifton, NJ 07013 USA

Please include with the instrument:

1. A note describing any problems encountered
2. The name and telephone number of a person we can contact
3. The complete return address for shipping.

For service information on this instrument contact us at:

Tel: 973-779-5577
Fax: 973-779-5954
E-mail: physitemp@aol.com

10.2 Physitemp Instruments Inc. warrants this system to be free from defects in material or workmanship for 12 months from date of shipment. Repair or replacement will be made at no charge at the discretion of Physitemp if the defect is not the result of misuse or abuse. Physitemp accepts no consequential liability for delay in delivery, alleged faulty performance of the product or any other cause.

Cables and probes are considered expendable and are not covered by this warranty.

For your protection, please pack the item carefully and insure against possible damage or loss. Physitemp will not be responsible for damage resulting from careless packaging. Please return freight prepaid.

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