

A RESEARCH GRADE INFRARED THERMOMETER

OPERATING MANUAL

FOR

AGRI-THERM III™ HANDHELD DIFFERENTIAL THERMOMETERS WITH OR WITHOUT DATA ACQUISITION/PROCESSING SYSTEM

MODELS 6110L AND 6210L

TEMPERATURE RANGE:

-40°C to 100°C or -40°F to 212°F

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CHAPTER 1

INTRODUCTION

Everest Interscience, Inc., offers the most sophisticated non-contact infrared thermometers on the market today. The new **AGRI-THERM III™** Handheld Differential Infrared Thermometer (Model 6110L/6210L) is the culmination of over thirty-eight years of research and development by our founder and President. These are revolutionary handheld infrared thermometers, as they can be focused in the field or lab using our **Vario-Zoom™** (U. S. Patent No. 7,355,178) variable focusing system. And they incorporate our **TTL/SLR** (Through-The-Lens/Single Lens Reflex) Intra-Optical Light Sighting System.

A major shortcoming of infrared thermometers is that the infrared “light” (radiation) is invisible to the human eye. Therefore, the position and physical characteristics of the spot being measured, such as its location, shape, size, surface texture, etc., cannot be ascertained by the operator. It is very important for the operator to know where all parts of the target spot are located, because, if any part of the spot is off the edge of the target surface, serious reading errors will occur. The Everest **TTL/SLR** (Through-The-Lens/Single Lens Reflex) Intra-Optical Light Sighting System solves this problem as explained in Chapter 3 of this manual.

The Models 6110L/6210L Portable, Handheld Infrared Thermometers take readings in a fraction of a second over a temperature range of -40°C to 100°C or -40°F to 212°F with 0.1°C or 0.1°F resolution.

The **AGRI-THERM III™** Differential Handheld Infrared Thermometer is light-weight, weighing less than two pounds. It is powered by rechargeable nickel-cadmium batteries and has a standard output of 10.0mV/°C.

A significant addition to Everest’s product line of handheld infrared thermometers for use in taking temperature measurements outdoors is the **SKY-SPY™** System. When an infrared thermometer is calibrated indoors, it will be off by 1°C to 2°C when used outdoors. This is because the cold sky reflects off of the target’s surface and into the thermometer. This reflection combines with the target’s radiation signal, causing an error or, what is called in infrared technology, “noise” in the temperature reading. The big problem is not so much that the error is there, but that it is so dynamic and unpredictable

– it can vary from 0.5°C to 2.0°C in a matter of minutes – making reproducible readings impossible. The *SKY-SPY™* System corrects for these errors.

If the *AGRI-THERM III™* that you purchased is a Model 6210L, it has the capability of saving up to four million records in the embedded data acquisition/processing system. Instructions for this data logger are sent along with the infrared thermometer, along with a USB cable.

We are pleased that you have chosen the third generation of infrared thermometers for use in the Natural Environment -- the Everest *AGRI-THERM III™* outdoor infrared thermometer. We are positive that you will be pleased with the versatility, dependability and reliability that have been engineered into these highly sophisticated infrared thermometers.

If you have questions about a particular application, or if you have difficulty with any aspect of the operation or functioning of your new infrared thermometer, please don't hesitate to contact us. Our telephone numbers are:

Telephone: 520-792-4545; FAX: 520-792-4545

1.1 UNPACKING YOUR AGRI-THERM III™ INFRARED THERMOMETER

When you unpack your *AGRI-THERM III™* Infrared Thermometer, please be sure the following items are enclosed:

1. Model 6110L or 6210L *AGRI-THERM III™* Infrared Thermometer
2. Carrying Case
3. Battery Charger
4. Signal Output Cord
5. Certification of Calibration
6. Operating Manual

In addition, if you have purchased a Model 6210L *AGRI-THERM III™*, a USB cable is enclosed.

If any items are missing or appear to have been damaged during shipment, please save the shipping box and notify Everest Interscience immediately at (520) 792-4545, or by E-mail to info@EverestInterscience.com.

CHAPTER 2

OPERATING INSTRUCTIONS

2.1 BATTERY CHARGING PROCEDURE

Your *AGRI-THERM III™* has been charged at the factory before shipment. However, you may want to charge it again overnight before extended use. To recharge the batteries in your *AGRI-THERM III™* Infrared Thermometer, plug the plug on the end of the six-foot lead of the supplied battery charger into the Rear Panel Jack of the infrared thermometer labeled “BATT.” The “BATT” jack can be found on the left hand side of the Rear Panel. Then, plug the AC adaptor into 90-250 Volt AC 50/60 Hz power source.

Allow ten (10) hours for a complete charge. When charging is complete, unplug the AC adaptor from the outlet and then remove the plug from the instrument. If the thermometer is beginning to read inaccurate temperatures, this is an indication that it needs an overnight battery charge. Partial charges will not harm the instrument, but we suggest that they be full charged overnight.

2.2 ABBREVIATIONS ON REAR PANEL

The abbreviations on the Rear Panel of the *AGRI-THERM III™* stand for the following:

- ✓ SEL = Select: IR, DIFF or AMB
This button is pushed to change mode of reading from IR Surface Temperature to Differential Readings to Ambient Air Temperature Readings
- ✓ IR = Infrared Surface Temperature Reading
This is the current infrared surface temperature reading of the target that the instrument is focused on.
- ✓ DIFF = Temperature Differential
This is the Difference between the Dry Bulb Ambient Air Temperature and the Temperature of the target.
- ✓ AMB = Dry Bulb Ambient Air Temperature
This is the temperature of the ambient air surrounding the Infrared Thermometer.
- ✓ PWR = Power: On/Off
- ✓ LITE = *TTL/SLR* Intra-Optical Light Sighting: On/Off

- ✓ DATA = Receptacle for plug to use for outputting the data selected by “SEL” at the rate of 10mV/°.
- ✓ BATT = Receptacle for plug to use in charging the battery.

2.3 TURNING THE INSTRUMENT ON

Simply move the toggle switch on the Rear Panel entitled “PWR” to “On”. The “PWR” switch is located on the left side of the Rear Panel.

2.4 EMISSIVITY SETTINGS (Target Emission Efficiency in %)

Emissivity Compensation is done by pushing the “plus” (+) or “minus” (-) buttons on the Rear Panel of the infrared thermometer. Press the “+” or “-” to set in the emissivity you desire.

2.5 SURFACE TEMPERATURE MEASUREMENT

The infrared surface temperature measurement can be made by selecting “IR” by pushing the “SEL” button the number of times necessary until the light comes on above “IR.” Then, when the instrument is on, the numbers on the display indicate the Infrared Surface Temperature.

2.6 TEMPERATURE DIFFERENTIAL

To take the Temperature Differential between the target temperature and the dry bulb ambient air temperature, first press the “SEL” button the number of times necessary until the light is shown above “DIFF.” Then, pull the antenna out of the front of the instrument. This removes the sensor on the end of the antenna from the heating and cooling effects of the instrument and the operator’s hand. Now, when the instrument is on, the Temperature Differential will be read out on the Liquid Crystal

Display. Let the instrument equilibrate for at least ten (10) minutes before making Differential readings for better accuracy.

2.7 AMBIENT TEMPERATURE MEASUREMENT

The Dry Bulb Ambient Air Temperature can be measured by pushing the “SEL” button the number of times necessary until the light is on above the “AMB” notation. Now, when the infrared thermometer is on, the display is indicating the Dry Bulb Ambient Air Temperature.

The following photograph shows where the “SEL,” “IR,” “DIFF,” and “AMB” buttons are located:



2.8 “DATA” OUTPUT

The “DATA” output is on the upper right hand side of the face place of the *AGRI-THERM III™*. The instrument is provided with a USB Cable to connect the *AGRI-THERM III™* to the port of the computer which enables you to download your data. (See Chapter 3, “Data Acquisition Operating Instructions”).

If you have purchased a Model 6110L, no data is stored in the infrared thermometer itself. The Model 6110L is provided with a signal output cord to connect to a data logger through this receptacle. The “DATA” connection provides for the capability of running the *AGRI-THERM III™* continuously and sending the data to an outside source where the analog signal can be converted to a digital signal and the data can be logged and saved.

CHAPTER 3

DATA ACQUISITION/PROCESSING INSTRUCTIONS

Computer Requirements:

USB Port, Microsoft Excel or Notepad

To collect data:

Push the red button on the instrument. Every push records the current Infrared reading, differential, and ambient readings, along with the date and time.

To obtain data:

Connect the USB cable (included) between the "DATA" port on the instrument and the USB port on the computer. The computer will recognize "Mass Storage Device" (1GB memory) and create "Log File," which opens as an Excel page. The data in the Log File can then be saved to another file. If the window does not automatically open, go to "Computer" and open the "1GB MEMORY" device.

To set the time and date for data:

Open "Time," enter the date and time in the described order.

Save as: "Time.txt"

To erase the collected data:

Erase the Log File. The device will then create a new one.

Note: The internal clock will keep the time unless the battery becomes discharged. If the instrument is not charged for ten days, the time will have to be reset.

CHAPTER 4

(*TTL/SLR*) THROUGH-THE-LENS INTRA-OPTICAL LIGHT SIGHTING

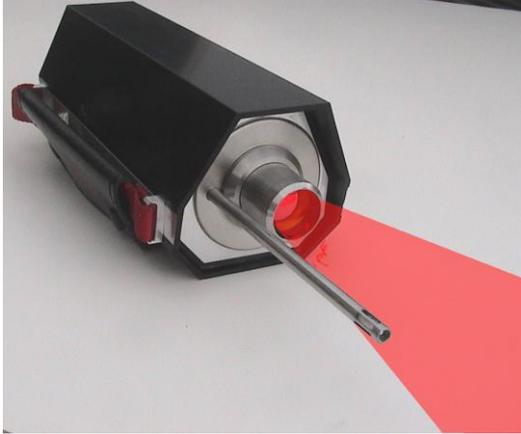
4.1 *TTL/SLR SIGHTING*

With the Everest Through-The-Lens/Single Lens Reflex (*TTL/SLR*) Intra-Optical Light Sighting System, an illuminated image of the infrared detector is projected directly through the infrared optics of the infrared thermometer, illuminating the exact area where a temperature measurement is being taken. Because this light shares the infrared thermometer's internal optical path, it can never be knocked out of alignment. It will always illuminate the area where the infrared/visible optics is focused.

4.2 *FOCUSING WITH THE Vario-Zoom™*

In order to focus on a smaller or larger area, the front of the *Vario-Zoom™* (U. S. Patent No. 7,355,178) optics of the infrared thermometer need only to be pushed in or pulled out until the target is completely illuminated and light is clearly focused. The optics will then hold at that point, as two gaskets hold it in place. Simply point the infrared thermometer at a target in subdued ambient light and push the front optics in or pull it out in order to focus the instrument and to display the field-of-view (FOV) of the instrument.

A picture of the Front Optics of the *AGRI-THERM III™* Infrared Thermometer with the antenna extended for Dry Bulb Ambient Air Temperatures is shown below:



To focus an instrument that will be used in the field or out-of-doors, first set the instrument up in subdued lighting in a laboratory. There you will be able to see the light being emitted by the Light Emitting Diode (LED) and determine the distance to spot size ratio. Then, when you are in the field, you can determine the area being measured by knowing that the ratio of the distance to spot size will remain constant as it was in the lab.

CHAPTER 5

SKY-SPY™ SYSTEM

5.1 INTRODUCTION

When taking temperature measurement outdoors, it is vital that the conditions of the sky are taken into consideration. Researchers have sometimes found that infrared temperature measurements taken outdoors can be inconsistent. Infrared Thermometers that are calibrated to 0.25°C or 0.5°C under laboratory conditions won't hold anywhere near that accuracy when used outdoors. Sky radiation noise will contribute from 0.5°C to 2.0°C random uncertainty to the end reading. The reason for these errors and a solution to the problem has been found. A U. S. Patent co-authored by the late Dr. Graham K. Walker, an Agrometeorologist at the University of Guelph, Canada, who contributed to excellence in research and operational agrometeorology, and Charles E. Everest, Design Engineer and Co-Founder of Everest Interscience, explains what is called the “*SKY-SPY*” System™ for infrared thermometers. This system provides the solution to this problem of inconsistent readings outdoors.

5.1 HISTORY

In their work, Drs. Fuchs and Tanner reported that, “Infrared thermometers with bandpass filters from 8μ to 13μ can be used to measure the *real* temperature of vegetal surfaces with errors in the range of 0.1°C to 0.3°C. To do this the emissivity must be either known or determined and a correction accounting for the reflected radiation from the surroundings must be made.” Emissivity corrections are easily made on most infrared thermometers on the market today, but only Everest's infrared thermometers for the natural environment are capable of “...accounting for the reflected radiation from the surroundings,” as Fuchs and Tanner deemed necessary.

The necessary corrections needed to give the “true” temperatures and not the “apparent” temperature readings is provided by use of Everest's *SKY-SPY* System™ which continually corrects for these errors, in real time. The *SKY-SPY* System™ is incorporated into Everest's hand-held *AGRI-THERM III*™ infrared thermometers and their Series 4000 Infrared Temperature Sensors for use in the natural environment or out-of-doors. This system continually and effectively corrects for overhead radiative conditions from clear skies atop a high mountain, such as would be the case when measuring snow pack temperature, to ambient conditions in a room where required correction is near zero.

Plant tissue surfaces, such as leaves, are Lambertian or diffusive, and, hence, radiate and reflect in all directions. Diffusion is the scattering of incident light by reflection from a rough surface.

Since the surface radiates and reflects in all directions, all segments of the sky or surrounds contribute to this radiative error. Because of this, it is not practical to take a sample of the sky temperature with an ordinary infrared thermometer with a narrow field-of-view (15° or less) and try to apply the reading as a correction. A special, wide angle, optic is needed to cover the entire sky. In addition, the sky radiation conditions change by the minute and must, therefore, be tracked and corrected in real time with less than one second time constant. This is an absolute necessity for accurate, consistent and repeatable temperature measurements. And, it is an absolute necessity in order to read the “true” surface temperature versus the “apparent” surface temperature of targets out-of-doors with an infrared thermometer

5.3 GENERAL INSTRUCTIONS

The *SKY-SPY* System™ requires no operating instructions other than to let you know that the second detector on the top of the *AGRI-THERM III*™ is constantly checking for sky conditions and making the necessary corrections to the infrared readings. There is no need to worry about it as if the sky conditions are such that no correction is necessary, it will automatically turn itself off.

If, for some reason, you do not want to take temperature measurements using the *SKY-SPY* System™, you can simply place a piece of tape over the top of it to deactivate it.

CHAPTER 6

SPECIFICATIONS

AGRI-THERM III™

SPECIFICATIONS FOR HANDHELD INFRARED THERMOMETERS

LOW-TEMPERATURE AGRI-THERM III™ DIFFERENTIAL THERMOMETERS WITH VARIO-THERM™ FOCUS, TTL/SLR INTRA-OPTICAL LIGHT SIGHTING, SKY-SPY™ SYSTEM AND WITH OR WITHOUT EMBEDDED DATA ACQUISITION SYSTEM

MODELS 6110L AND 6210L
(PROTECTED BY U.S. PATENT No. 7,377,158)

TEMPERATURE MEASUREMENT

SCALE RANGE:	-40°C TO 100°C
RESOLUTION:	0.1°C
ACCURACY:	±0.25°C FROM 0°C TO 50°C OR ±0.5°C FROM -40°C TO 0°C OR 50°C TO 100°C
REPEATABILITY:	±0.1°C
TEMPERATURE:	ALL FUNCTIONS IN °C, CORRESPONDING TO VOLTAGE OUT
NOISE EFFECTIVE TEMPERATURE:	<0.1°C
TEMPERATURE MEASUREMENT MODES:	SURFACE TEMPERATURE, AMBIENT DRY BULB TEMPERATURE AND TEMPERATURE DIFFERENTIAL

OPTICAL CONSIDERATIONS

OPTICAL CONFIGURATION:	ROBUST, AEROSPACE-QUALITY, DOUBLE-COATED ZINC SELENIDE OPTICS PER MILITARY SPECIFICATION MIL-C-13508
SPECTRAL PASS BAND:	8 < WAVELENGTHS < 14 MICRONS
SIGHTING:	TTL/SLR INTRA-OPTICAL LIGHT SIGHTING: VISIBLE LIGHT ILLUMINATES FIELD OF VIEW
ILLUMINATION SOURCE:	LIGHT EMITTING DIODE - SAFE - NO LASERS!
FOCUS:	VARIABLE FROM 4° TO 20° DOWN TO 2 MM WITH VARIO-ZOOM™ (U. S. PATENT NO. 7,377,158)
DISPLAY:	NUMERIC LIQUID CRYSTAL DISPLAY ON REAR PANEL

OPERATING CONDITIONS

OPERATING ENVIRONMENT:	-20°C TO 65°C OR +14°F TO 150°F, UP TO 99% RELATIVE HUMIDITY, NON-CONDENSING
STORAGE TEMPERATURE:	SAME AS OPERATING ENVIRONMENT TEMPERATURE

GENERAL

RESPONSE TIME:	<1 SECOND
EMISSIVITY COMPENSATION:	SETTABLE FROM 10% TO 99% ON REAR PANEL
OPERATING DISTANCE:	2 CM TO INFINITY
WARRANTY:	ONE-YEAR LIMITED WARRANTY ON PARTS AND LABOR
SKY RADIATION DETECTION:	SKY-SPY™ SYSTEM CORRECTS FOR ERRORS CAUSED BY RADIATION TO THE SKY
EMBEDDED DATA LOGGER:	MODEL 6210L ONLY

ELECTRICAL INTERFACE

POWER SOURCES:	RECHARGEABLE NICKEL CADMIUM RECHARGEABLE BATTERIES; TEN HOURS CONTINUOUS USE ON FULL BATTERY CHARGE
OUTPUT SIGNAL:	ANALOG MILLIVOLT (-400 mV TO 1000 mV AT 10.0 mV/°C) - MODEL 6110LL OPTIONAL: 0-5 VOLT AND THERMOCOUPLE TYPES J & K - MODEL 6110L USB - MODEL 6210L
BATTERY CHARGER:	120 LT, 60 Hz 3W, 230 VOLT, 50 Hz OPTIONAL

EVEREST INTERSCIENCE HAS A POLICY OF CONTINUED DESIGN UPGRADE. THEREFORE, WE RESERVE THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

CHAPTER 7

MAINTENANCE

7.1 GENERAL

This *AGRI-THERM III*™ will be virtually maintenance free. It is recommended, however, that the instrument be returned to the factory after 24 months for a calibration check and recalibration, if necessary.

It is important that you return the original battery charger with the instrument if any maintenance or repair is required and to use this battery charger only when recharging your infrared thermometer.

When returning the *AGRI-THERM III*™ for repair or recalibration, please call Toll Free at 1-800-422-4342 or 1-520-792-4545 to receive a Return Material Authorization (RMA) No. You can also request the RMA by E-Mail to info@EverestInterscience.com or an RMA form can be obtained on our website at www.EverestInterscience.com. After receiving the RMA No., please ship the instrument insured, freight prepaid, to:

EVEREST INTERSCIENCE
1891 North Oracle Road
Tucson, AZ 85705
USA

Please include an explanation of the problem or problems you are having or the service that you want performed.

7.2 CLEANING

Periodically the infrared thermometer may need to be cleaned. Use a damp cloth to remove any debris on the outside of the instrument.

To clean the optical lens, use denatured alcohol and a Q-Tip to wipe off any residue on the front optics. Do not use anything other than denatured alcohol to clean the optics. Please treat the front lens the same way that you would treat your camera lens.

CHAPTER 8

ONE-YEAR LIMITED WARRANTY SERVICE INSTRUCTIONS

Everest Interscience warrants each instrument to be free of defects in material or workmanship for a period of one year from the date of shipment to the original purchaser.

When examination of the instrument reveals that the fault has not occurred because of misuse or abnormal conditions of operation, Everest Interscience will service, replace or adjust any defective part or parts when the instrument is returned freight prepaid. ***OEM clients must show that recurring errors are not a part of the customer's assembly integration process. Upon the advice of Everest Interscience, certain malfunctions will be considered to be due to these process techniques and this warranty will be considered null and void for any instruments subjected to those methods.***

Instruments repaired when abnormal usage has occurred or beyond the effective date of the warranty will be charged at applicable rates. Everest Interscience will submit a quotation for the estimated charges before commencing repair. The customer must provide a Purchase Order or credit card information in the amount of the repair and return shipping before work will commence. After Everest has sent the repair quotation, the customer has up to one year to provide a Purchase Order or credit card information to Everest for either the repair and return or the return only of the instrument. If the customer does not provide this information within one year, Everest will recycle the instrument.

Please include a letter explaining the difficulty that you are having with the instrument, or complete the RMA Form provided to you, when returning the instrument for repair. An RMA Form can be downloaded from our website:

<http://www.everestinterscience.com/Forms/rmarequest.htm>.

If the instrument is out of warranty, it is necessary to send a check in the amount of the Evaluation Analysis Fee along with the instrument. This charge can be obtained on our RMA form on the website or by calling (520) 792-4545. Please ship the instrument insured, along with a return shipment as above.

Instruments whose warranty expiration dates exceed five years from the current date may be subject to denial for service and repair. In such instances, please contact the Service & Repair Division at (520) 792-4545.

This warranty includes recalibration and battery replacement during the warranty period, if required.

NOTE: THE WARRANTY IS NULL AND VOID IF:

- The instrument has been dismantled, or*
- The instrument case has been deformed such as dented, gouged, tool marks are present, etc.*