SANTA BARBARA INFRARED, INC.
a HEICO company

319-002-808
Revision NC

Operating Manual for

Nightingale

Body Temperature Reference Sources

PROPRIETARY INFORMATION

Overview

The Nightingale BTR-03 Body (Skin) Temperature Reference provides a stable, uniform, low cost and simple to operate thermal source. Features such as "set and forget" configuration, tripod mounting and thermal performance make it simple to integrate into a thermal imaging body (skin) temperature screening system.

The reference source is configured through a USB interface and stores the setpoint in non-volatile memory. After configuration, the BTR-03 automatically controls to the setpoint upon each power up. A status LED located on the front the instrument visually indicates when the reference is stable and ready for use as a calibration source.

The Nightingale's performance has been optimized for a range of absolute temperature setpoints and ambient conditions that are required by most body (skin) temperature screening systems.

Each system includes a blackbody source head, dust cover, 9.5 ft. (2.9 meter) power supply and 9.5 ft. (2.9 meter) USB cable.

Features

- 30°C to 45°C (86°F to 113°F) Settable Temperature Range*
- 3" Square Emitting Aperture
- Temperature Accuracy of ±0.15°C (±0.3°F)
- ±0.05°C (±0.1°F) Temperature Stability
- Configurable to Celsius or Fahrenheit
- "Set & Forget" Temperature Programming
- Integrated control (No Separate Controller Required)
- 1/4-20″ Tripod Mounting Features (x3)
- USB Communication Interface

Precautions

The black reference surface is a high-performance coating that enables the BTR-03 to achieve its excellent uniformity and thermal characteristics. The BTR-03 has been designed with a recessed reference surface to greatly reduce accidental contact of the coating. A cover has been provided to protect this surface when the BTR-03 is not in use. Care must be taken to avoid touching the reference surface as fingerprints or other damage can affect performance. Fingerprint damage is not covered by the warranty.

*must be above ambient temperature

Initial Setup & Installation

Box Contents

The box contains the following items packaged in protective foam and can be used to store the items when they are not in use:

- Thermal Reference Source and Dust Cover
- Power Supply
- USB Cable
- Calibration Certificate
- Quick-start Card

Thermal Reference Source

The Thermal Reference Source contains the reference surface and control electronics. It is calibrated and tested at the factory for performance criteria including uniformity, stability and accuracy. A dust cover is included to provide protection to the reference surface when not in use.

Power supply

The included power supply provides DC power to the BTR-03. It consists of a wall transformer with an attached 9.5 ft. (2.9 meter) cable. The mains plug of the power supply included with your system is dependent on the region of use. All power supplies are universal and can be connected to the mains power stated on the supply using a converter if needed.

USB Cable

A 9.5 ft (2.9 meter) USB cable is included. This cable is used to connect the BTR-03 to a computer for configuration. While used for initial setup, the USB cable is not required for the BTR-03 to be constantly connected to a computer during normal operation.

Calibration Certificate

The calibration certificate shows the date of calibration and provides traceablity to the factory calibration and testing records.

Quick-start Card

The quick-start card provides a simple to reference to some of the most used commands. It can be kept near the BTR-03 for quick reference.

Mounting (Tripod mount, Orientation)

The BTR-03 provides three tripod mounting features on the bottom of the unit. These features have ¼-20" female threads that allow for easy connection to most small standard tripods. The BTR-03 is light enough so that only one of the features is needed for mounting. The extra features are provided to allow off-set mounting if required.

The orientation of the BTR-03 is important. To provide optimal performance, it must be oriented vertically with the ventilation slot on top. There should be no obstructions above the ventilation slot. The image below shows a dual BTR system with staggered mounting to allow for a free flow of air from the ventilation slots. The BTR-03 will perform best when operated in a stable room environment away from HVAC vents, fans and other sources of direct, high-flow air.

Connections (Power, USB)

The power supply connects to the BTR-03 using a right-angle barrel connector. When connecting or disconnecting the power supply to/from the BTR-03 grip the power cable connector to ensure a stress-free mate/de-mate to the BTR-03. Do not attempt to remove the power supply from the BTR-03 by the power supply wire.

The USB connector of the BTR-03 is a standard USB Micro B type. It does not power the BTR-03. The host end of the USB cable is a standard USB type A connector.

When connecting to a computer, the USB interface functions as a standard COM port running at 9600 Baud with 8 data bits, no parity and one stop bit. Please see Appendix C & D for an example of the communication configuration for PCs or Mac OS.

Care should be taken when connecting and disconnecting the USB cable to the device. The connector should be inserted straight into the socket and removed by pulling straight out. Significant lateral force toward the back cover of the BTR-03 can damage the USB connector.

Initial Configuration

The BTR-03 is configured to a 35C setpoint from the factory. Without any configuration changes, the BTR-03 will slew the reference to the setpoint upon power up. While the BTR-03 is slewing, the LED will flash at a constant rate. Once the BTR-03 has reached the setpoint and stabilized, the LED will be lit solid.

To configure a different setpoint connect the BTR-03 to a computer using the USB cable and establish a connection. The DA command is used to configure a new setpoint. For example, the command DA36.8 will change the setpoint to 36.8C. Once entered, the BTR-03 will control the reference to the new setpoint. The MDA command can be used to verify the new setpoint. To save this setpoint to non-volatile memory use the SAVE command. Once the SAVE command is executed, the BTR-03 will control to the new setpoint upon power up. For more commands, see the Command List and Operation sections of this manual.

Command List

Below is the BTR-03 command list. Please see the Operation section of this manual for details and examples.

Command	Response	Description
Measurement & Control Commands		
MT	T= xx.xx	Gets reference temperature in selected units (C or F)
MDA	DA= xx.x	Gets temperature setpoint in selected units (C or F)
DAxx.xx	OK DA= xx.x	Gets temperature setpoint in selected units (C or F) Setpoint resolution is 0.1C or 0.2F
MAT	AT= xx.x	Gets ambient temperature in selected units (C or F)
MAH	AH= xx	Gets relative humidity percent (0-100)
MU	U= F/C	Returns F if units are Fahrenheit or C if units are Celsius
UF	OK U= F	Sets units to Fahrenheit Setpoint will adjust to match Fahrenheit resolution (0.2F)
UC	OK U= C	Sets units to Celsius Setpoint will adjust to match Celsius resolution (0.1C)
DOFF	OK DOFF	Turns off heater until a new setpoint is received
SAVE	OK SAVE	Saves user settings (Setpoint, Units) to non-volatile memory

Status Commands		
MS	SR= XX	Returns Status byte. The Status byte is returned as a decimal number but can be interpreted as a bit field. 0 : Ready and No Errors 16: Busy and No Errors 32: Ready and Errors 48 : Busy and Errors
ME	ER= XX	Returns error bit field as a decimal number. Errors are cleared on read. Bit 0: Unknown command Bit 1: Setpoint out of range Bit 2: Thermistor out of range Bit 3: ADC Error Bit 4: Configuration Error Bit 5: Calibration Error Bit 6: Ambient Sensor Error Bit 7: Unable to reach setpoint
MSTATUS	STATUS=	Returns status as string: BUSY, READY, BUSY AND ERROR, or READY AND ERROR.
MERROR	ERROR=	Returns error descriptions and clears errors or NONE if no errors.
General Commands		
MSN	SN= xxxxx	Gets Serial Number
IDENT	OK IDENT	Rapidly blinks LED for 5 seconds
ECHOx	OK ECHO= x	x = 1 Enables an echo of all bytes received, x = 0 disables this function. Default is Echo on.
VERx	OK VER=x	x = 1 enables prompt string “>>” after each command received, x = 0 disables prompt. Default is prompt enabled
RESET	N/A	Reinitializes unit

Operation

USB connection

The USB port of the BTR-03 looks like a standard serial port. It is important to use the correct port settings to ensure a reliable connection. The BTR-03 communicates at 9600 Baud. It uses 8 data bits and 1 stop bit. Parity bits are not used for this connection. Appendix C & D give examples on how to set up a serial connection to the BTR-03.

Units

The BTR-03 can operate using Celsius or Fahrenheit units. From the factory, it is configured for Celsius operation. The UF command will change the units to Fahrenheit and the UC command will change the units to Celsius. When these commands are executed, the BTR-03 will respond with *"OK U=F"* or *"OK U=C"*, informing the user the command has been accepted. At any time, the units can be read by using the MU command. The response will be either *"U=F"* or *"U=C"* depending on the unit configuration. The unit configuration can be saved so that it is active upon the next power up by using the SAVE command.

Setpoints

The command DAxx.x is used to change the setpoint of the BTR-03. This xx.x is a temperature between 30.0 and 45.0 when the units are Celsius. When the units are Fahrenheit, the range is between 86.0 and 113.0. The resolution of Fahrenheit units is 0.2 degrees. E.g. 86.2, 86.4, 86.6, 86.8. When a setpoint is entered, the BTR-03 will acknowledge the command by responding with *"OK DA=xx.x"*

The current setpoint can be verified by using the MDA command. The BTR-03 will respond with *DA=xx.x"*.

The drive to the reference can be turned off by using a DOFF command. When this command is issued, the BTR-03 will not try to drive the reference to any temperature. To restart the drive, use the DA command to set a new setpoint. The DOFF command is not stored when using the SAVE command.

Readback

The user can read back the current temperature of the reference using the MT command. The BTR-03 will respond with *"T=xx.xx"* showing the current temperature in the units selected.

The user can read back the current ambient temperature using the MAT command. The BTR-03 will respond with *"AT=xx.x"* showing the current ambient temperature in the units selected.

The user can read back the current ambient relative humidity using the HAH command. The BTR-03 will respond with *"AH=xx"* showing the relative humidity in %.

Status & Errors

IDENT command—flashes for 5 seconds when issued. Useful for identifying a single BTR-03 when there are multiple units in a system.

The BTR-03 has two methods for providing status and error feedback. Verbose and Numeric. The verbose method is useful for direct operator control while the numeric method can be simpler for automated control by a program.

MSTATUS provides verbose status feedback. There are 4 responses to the MSTATUS command:

READY	The BTR-03 reference surface is at the setpoint temperature
BUSY	The BTR-03 is controlling the reference surface, but it is not a the setpoint temperature
READY and ERROR	The BTR-03 is ready, but there is an error in the system. It is possible for the BTR-03 to maintain the setpoint while there is a non-critical error
BUSY and ERROR	The BTR-03 is not ready and there is an error in the system.

MERROR provides verbose error feedback:

ERR BAD COMMAND	An unrecognized command has been entered since the last MERROR command (non-critical)
ERR OUT OF RANGE	A parameter of a command (e.g. setpoint) has been entered that is not within the expected range since the last MERROR command (non-critical)
ERR THERM OUT OF RANGE	There is an issue with the thermistor connection to the control board (critical)
ERR ADC COMM	There is an issue reading from the device that is used to determine the reference temperature (critical)
ERR AMBIENT SENSOR	There is an issue reading from the ambient sensor(non-critical)
ERR UNABLE TO REACH SETPOINT	Setpoint temperature was not reached within the failsafe time

When the MERROR command is given, the error is cleared, and the system will continue to check for errors. The ADC error and THERM error will reappear if there is something critically wrong with those systems. A critical error will disable the drive and cause the LED to continually blink a 3-blink pattern.

See the command list section for details on the numeric feedback.

Calibration

SBIR recommends a calibration period of 2 years beginning on the date upon which the Nightingale system was previously calibrated. Contact SBIR's sales team for calibration details and pricing.

Appendix A: **Maintenance and Repair**

General

There are no user serviceable components inside of the Nightingale BTR source. If repair or calibration of this instrument is necessary, it is strongly recommended that it be returned to SBIR, Inc. Our experienced service personnel, equipped with the proper test and calibration equipment will provide prompt and effective service maintenance.

Preventative Maintenance

Under normal conditions, no preventative or routine maintenance is required for operation of the Nightingale BTR source. However, if the unit is operated in an environment prone to airborne particulate contamination or where dust accumulates, periodic cleaning/particulate removal of the external surface may be appropriate.

To clean the external surfaces **(excluding the emissive surface**) of the BTR-03 source, first ensure that the front cover is securely attached. Then, use a soft brush to remove accumulated dust/particles from the external surface.

Note: The use of unregulated and/or unfiltered pressurized gas is not recommended to clean particulate or dust from the BTR-03. If pressurized gas is used, a gN2 or CDA source that is oil-free and particulate filtered (< 0.5 micron) and dry to -10°C minimum dew point and < 20 psig (1.4 bar) is recommended.

The protective front cover should be attached during non-operation to minimize the need to clean accumulated particles from the source surface. Low levels of particle accumulation on the source plate typically do not have an appreciable impact on blackbody emissivity performance. As mentioned previously, **under no circumstances should the blackbody source plate surface be contacted physically with any object or liquid.** If dust/particle accumulation on source plate reaches a level where removal becomes necessary, the detailed cleaning procedure provided below is recommended. **Note that damage to the emissive surface by mishandling and/or cleaning will void the blackbody warranty**. Should the source plate be damaged or should the user not be suitably equipped or capable of safely cleaning the source plate when required, contact SBIR Sales for refurbishment pricing options.

Blackbody Source Plate Cleaning Procedure

This procedure provides a step-by-step procedure for cleaning the coated Nightingale BTR source plate.
WARNING: As noted in the preceding section, the source plate should only be cleaned if clearly necessary. Preventative measures should be implemented where practical to minimize the need for any periodic cleaning. Damage to the emissive surface is not covered under the SBIR warranty.

Materials and Equipment

- Nitrogen gas (gN_2) or clean, dry air (CDA)
    - Dry to -10°C minimum dew point and < 20 psig (1.4 bar)
    - Oil free and particulate filtered (< 0.5 micron)
- Fiber light (50-100W) or cell phone LED — visible white light illumination

Cleaning Procedure

1. Remove protective cover from front of BTR-03 to gain access to black emissive surface.

   Using a high intensity light source (fiber light) or cell phone LED spotlight, inspect source plate for airborne surface contamination or other contamination.

2. If surface has particle contamination, lightly blow off contamination with air source (requirements listed in Materials and Equipment above). Ensure that impinging gas stream is > 2 inches (50 mm) from surface to be cleaned.

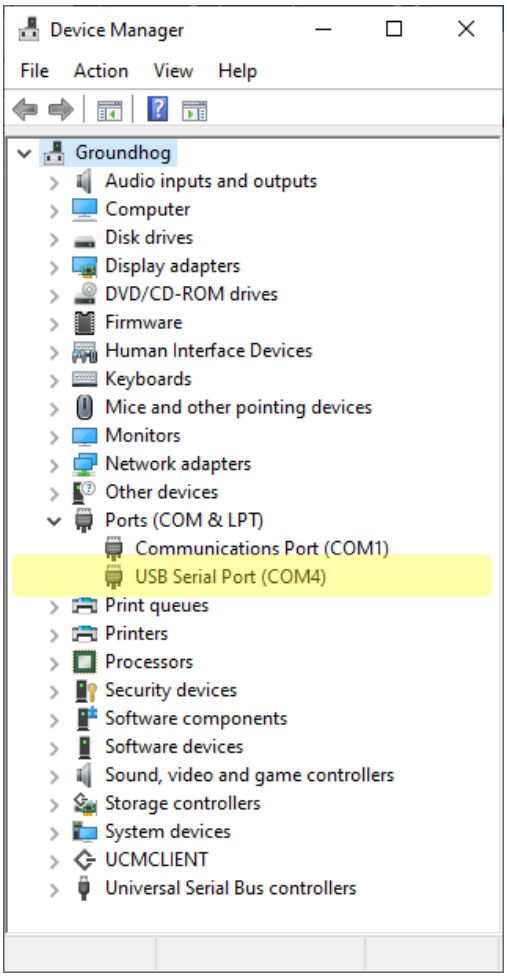
3. Visually inspect while cleaning to monitor effectiveness.

4. When contamination has been removed, replace the protective.

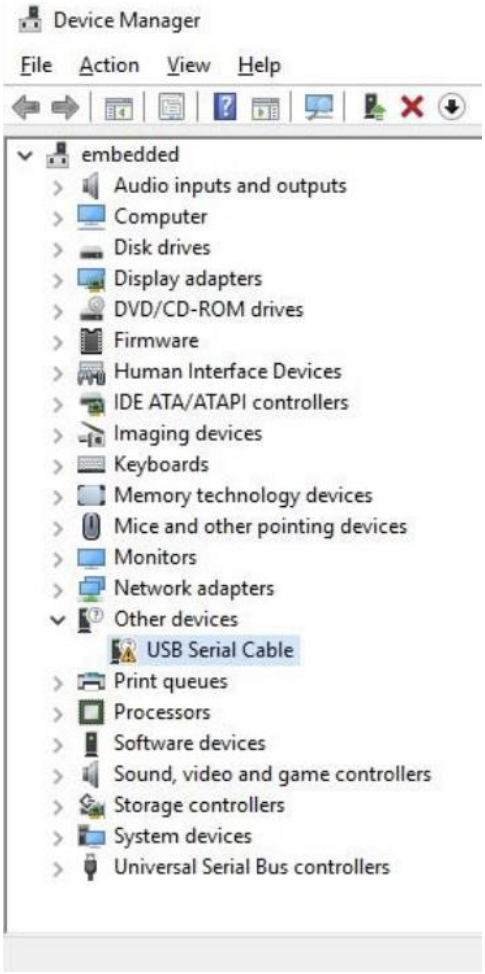
5. If contamination appears to be a hardened deposit or if the surface is scratched or damaged, contact Santa Barbara Infrared for further direction.

Appendix B: **Windows USB Communications**

1. Connect the BTR to the computer using the USB cable. When using a PC with the Windows™ operating system, navigate to the Device Manager located in Control Panel to determine the number of the COM port of the USB serial port that is associated with the plugged in BTR-03 (COM4 in this example).



2. In some Windows installations, Windows may not recognize the USB connection and will need a driver update. In these cases, the serial connection appears as a USB Serial device in the "Other Devices" section of the Device Manager (as shown below).



If the COM port is not shown, download and install the latest drivers found here:

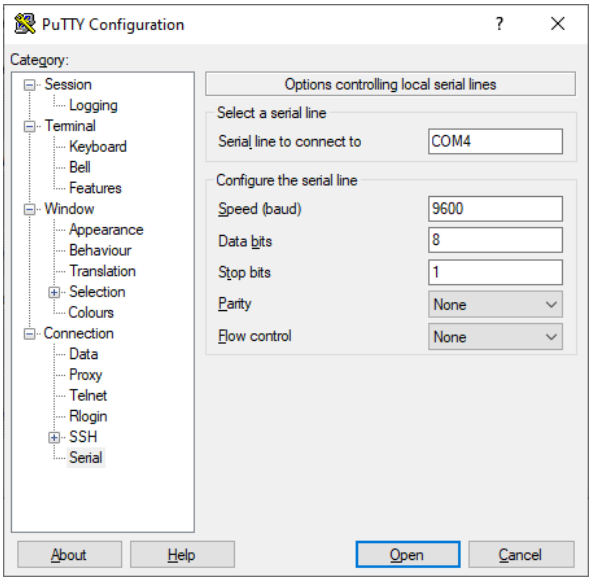
https://www.ftdichip.com/Drivers/CDM/CDM21228_Setup.zip

(If the link becomes inactive, please search for FTDI Windows drivers.) After installation, the COM port should be visible in the device manager and setup can be continued.

3. Use or download a terminal program such as PuTTY (this can be downloaded for free at www.putty.org) to connect to the USB serial port that was shown in the Device Manager (COM4 in this example).

4. The settings for the serial port that you will enter once you have a terminal program opened are listed below and described in further detail on subsequent steps:
   - Baud (Speed) - 9600
   - Data Bits – 8, Parity –No/None, Stop Bits –1

5. Once PuTTY is open.
   - Select Serial and type the COM# in the "Serial line to connect to" box (COM4 in this example)
   - Type in 9600 into the "Speed (baud)" box.
   - Type in 8 into the "Data bits" box
   - Type in 1 into the "Stop bits" box
   - Select "Open" to connect



6. The PuTTY terminal should open and connect to the BTR-03. To test the connection, type the MT command to read back the current temperature. A response should be seen from the BTR-03.

Appendix C: **Mac OS USB Communications**

1. Connect the BTR-03 to the computer using the USB cable. When connected, a "new network interface" prompt may appear. Select cancel to continue.

2. Open the terminal program and type:
   ls /dev/cu.*
   The response will show a list of devices connected to the computer. The usbserial device is the BTR-03 (cu.usbserial-AB0KHYC5 in this example)

```
sbir-BTR-03:~ SBIR$ ls /dev/cu.*
/dev/cu.Bluetooth-Incoming-Port /dev/cu.usbserial-AB0KHYC5
/dev/cu.URT0
```

3. Using the full name of the serial device type:
   screen /dev/cu.usbserial-xxxxx 9600
   where xxxxx will complete the full name of the device.
   screen /dev/cu.usbserial-AB0KHYC5 9600 (in this example)

```
sbir-BTR-03:~ SBIR$ ls /dev/cu.*
/dev/cu.Bluetooth-Incoming-Port /dev/cu.usbserial-AB0KHYC5
/dev/cu.URT0
sbir-BTR-03:~ SBIR$ screen /dev/cu.usberial-AB0KHYC5 9600
```

4. The BTR-03 should now be connected. To test the connection, type the MT command to read back the current temperature. A response should be seen from the BTR.

Appendix D: **Technical Specifications**

Nightingale BTR-03 Thermal Reference Source

Settable Temperature Range[1,5] .....30ºC to 45ºC (86ºF to 113ºF)
(must be set above ambient)

Emissivity (Average) .....> 0.95 from 3µm to 14µm

Emitting Aperture Size .....3 inch square

Uniformity[2] .....± 0.15ºC (± 0.3ºF) over central
1.5" x 1.5"region of interest

Absolute Accuracy[2].....± 0.15ºC (± 0.3ºF)

Stability[3] .....± 0.05ºC (± 0.1ºF)

Setpoint Resolution.....0.1ºC (0.2ºF)

Startup Time.....< 5 minutes

Ambient Temperature Sensor.....0ºC to 50ºC +/- 2ºC

Relative Humidity Sensor .....100%, +/- 5% R.H.

GENERAL SPECIFICATIONS

Operating Temperature.....22ºC ±6ºC (71.6ºF ± 10.8ºF)

Storage Temperature.....20ºC to 70ºC (-4ºF to 158ºF)

Relative Humidity.....5% to 95%, non-condensing

Power Requirements.....18V, 1A DC max.
AC adaptor included

Approximate Weight.....<1 lbs. reference source only

Notes:

1. **Fahrenheit values listed are rounded to nearest 0.10ºF value based on Celsius specification**
2. **Accuracy verified in lab against radiometric reference at mid-range setpoint**
3. **Stability is based on temperature sensor output**
4. **Dimensions are for reference only. All dimensions are in inches.**
   Parenthetical values are in millimeters
5. **Temperature should be at least 5ºC above ambient for optimal performance**

Appendix E: **Limited Warranty**

This instrument is warranted by Santa Barbara Infrared, Inc. against defects in materials and workmanship for a period of one year after the original date of shipment. During this period, Santa Barbara Infrared, Inc. will, at its option, either repair or replace a defective product at no charge except as stated below.

To obtain service under this Limited Warranty, contact Santa Barbara Infrared, Inc. in writing. Please give a full description of the difficulty, and include the Model and Serial number(s) of the instrument in this correspondence. Shipping instructions will be sent to you for returning the instrument. The instrument must be returned to SBIR in its original shipping container or in a carton approved by SBIR. You will be responsible for all shipping charges and insurance.

DISCLAIMER

EXCEPT AS STATED IN THIS LIMITED WARRANTY, THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, THAT EXTEND BEYOND ANY DESCRIPTION OF THE INSTRUMENT WHICH IS CONTAINED IN THE APPROPRIATE SALES CONTRACT OR LEASE OF THE INSTRUMENT. SANTA BARBARA INFRARED, INC. EXPRESSLY DISCLAIMS ANY WARRANTY, EXPRESS OR IMPLIED, THAT THIS INSTRUMENT IS OF MERCHANTABLE QUALITY OR THAT IT CAN BE USED, OR IS FIT, FOR ANY PARTICULAR PURPOSE. PURCHASER PURCHASES AND ACCEPTS THIS INSTRUMENT SOLELY ON THE BASIS OF THE WARRANTY CONTAINED HEREIN. THIS LIMITED WARRANTY SETS FORTH THE ENTIRE UNDERSTANDING OF PURCHASER AND SANTA BARBARA INFRARED, INC. AND SUPERSEDES ALL OTHER REPRESENTATIONS AND UNDERSTANDINGS BETWEEN THE PARTIES.

UNDER NO CIRCUMSTANCES SHALL SANTA BARBARA INFRARED, INC. BE LIABLE TO PURCHASER OR ANY OTHER PERSON FOR ANY LOSS OF PROFITS OR PRODUCTION OR FOR ANY OTHER INCIDENTAL, SPECIAL, OR CONSEQUENTIAL DAMAGES. THE SOLE OBLIGATION OF SANTA BARBARA INFRARED, INC. UNDER THIS LIMITED WARRANTY, SHALL BE, AT SANTA BARBARA INFRARED, INC.'S OPTION, TO REPAIR, REPLACE, OR CORRECT ANY DEFECT THAT WAS PRESENT AT THE TIME OF SHIPMENT, OR TO REMOVE THIS INSTRUMENT AND TO REFUND THE PURCHASE PRICE TO PURCHASER.

This Limited Warranty does not cover any losses or damages that occur as a result of: shipping or improper installation or maintenance; misuse, neglect, or improper environment; any cause other than ordinary laboratory application; or repair or modification by anyone other than Santa Barbara Infrared, Inc., except as specifically authorized by Santa Barbara Infrared, Inc.

Appendix F: **Certifications**

The Nightingale BTR-03 systems have undergone independent third party testing and has been declared to conform to the below standards:

1. EN61326-1:2013
2. EN55011 Class B Group 1
    a. EN61000-4-2
    b. EN61000-4-3
    c. EN61000-4-4
    d. EN61000-4-5
    e. EN61000-4-6
    f. EN61000-4-8
    g. EN61000-4-11
3. EN61010-1:2010 (CE)
4. FCC Part 15, Subpart B Class B, ANSI C63.4 (2014)