Installation Manual: TR9290 Family

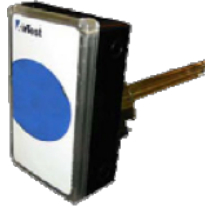## Products Covered By This Manual

TR9290-L	TR9291	TR9292	TR9293	TR9294-L
TR9290		TR9292-L	TR9293-L	TR9294
				also w/LonWorks® & BACnet®

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Contacting AirTest

1. Key Features

The TR9290 family of products are a value-engineered range of CO_2 transmitters targeted at ventilation control applications in buildings where the only requirement is a dependable CO_2 sensor that never needs calibration.

Key features of the TR9290 family include:

- ❑ Internal self-calibration method based on background measurement also eliminates need for outdoor CO_2 sensor.
- ❑ Choice of outputs: 0-10V, 0-5V or 4-20mA and LonWorks®.
- ❑ Built to ISO 9001 standards
- ❑ Mounting options include wall, duct and in-duct.
- ❑ Utilizes a proven infrared measurement technology with over 17 years of flawless operating history.
- ❑ Supported by a team of knowledgeable application specialists. We are just a phone call away if you have questions.
- ❑ LonMark® Certified output option.

2. Order Selection Guide

Model Number		Output	Display
TR9290*	Wall Mount	**A** - 0-10V, 4-20mA	_ - no display
TR9291*	In-Duct	**B** - 0-10V, 0-5V	**L** - Display
TR9292*	Duct Probe	**LON** - LonWorks®	
TR9293*	Splash Resistant	**BAC** - BACnet®	
TR9294	Wall		

* LonWorks® & BACnet® output not available

3. Transmitter Maintenance

The TR9290 family of sensors is designed to be self calibrating and should require no maintenance over the sensor life which is typically 15 to 20 years. The reason for this remarkable stability is due to a number of design features integrated into the CO_2 transmitter.

✓ **Extended Sample Path Length:** The AirTest infrared sensor incorporates a unique, patented, oval design. All competitive sensors use a straight path of infrared energy shining through an air sample to measure CO_2. The amount of gas that can be sampled, called the "path length" is limited by the size constraints of their wall-mounted and duct-mounted cases used. The AirTest design, using a similar sized case, provides over double the path length of any other CO_2 sensor (4.8") by bouncing the light around the small oval sensor element. Longer path length means that a larger sample of air is measured. In technical terms this results in an increased signal-to-noise ratio. This means that the AirTest sensor performs better at long-term sensor stability and accuracy than other devices. Greater dependability is the ultimate result.

Further Reference: www.AirTest.com/support/reference/lengthmatters.pdf

✓ **Background Calibration Algorithm:** Most drift of CO_2 sensors occurs because the infrared light source in the sensor tends to change over time. With the extended path length described above, this change is minimized because of the high signal to noise ratio provided by the extended path length. The sensor is also designed to regularly monitor the concentrations that occur when the monitored space goes unoccupied. During these unoccupied periods, CO_2 levels will typically be very similar to outside or ambient conditions. The AirTest CO_2 sensor monitors these background levels and for the purpose of maintaining a consistent control strategy, the sensor calibrates this background level to 400 ppm. If the baseline level measured over many days increases or decreases, the sensor makes small adjustment in calibration. By continually checking this background level, the sensor is able to maintain an ongoing calibration. CO_2 ventilation control in buildings is achieved by controlling ventilation based on the difference between inside and outside concentrations of CO_2. Because the self calibration feature automatically adjusts itself to outside levels, the TR9290 family of transmitters virtually eliminates the need for a separate and expensive outside air CO_2 sensor.

Further Reference: www.AirTest.com/support/reference/autocalpaper.pdf

4. Installation Considerations

✦ **Location:** Wall mount sensors should be placed in each major occupied zone. Wall mount sensors should be 4'-6' above the ground and mounted away from doors, windows and supply air streams. Also avoid areas where people may regularly gather, as that will tend to produce a high reading of CO_2 levels that is not representative of the full space being monitored. Duct mount sensors are typically mounted in the return air ducts. Be aware that return air streams may register a lower CO_2 concentration than is occurring in the target space because of averaging with other spaces. Also, dilution that can sometimes result from leaky supply air ducts located in return air plenums. For this reason, wall mounted sensors are often preferred. The TR9291 is to be placed inside the return air duct of ventilation equipment or directly inside return air grill.

✦ **Control Considerations:** The typical sequence of operation used for CO_2 ventilation control involves modulating outside air delivery to the space as CO_2 levels rise. It is recommended that some low level of ventilation be provided to the space during all occupied hours to control non-occupant related sources and to maintain building pressurization. When inside levels are a few hundred ppm over outside levels (established by the AirTest controller at 400 ppm), the outside air delivery should be increased as CO_2 levels rise using a proportional or PID control strategy. The upper control point of the control strategy should be equal to the design ventilation rate of the space in terms of air volume. For 15 cfm per person in a space, the upper control point should be 1100 ppm, and similarly, for 20 cfm per person in the space, the upper control point should be 930 ppm.

✦ Outside CO_2 Levels: As mentioned in the background calibration section, the AirTest sensor considers outside concentrations as part of its self calibration routine. As a result no outside air measurement is needed. For the control strategy to work properly, the building operator should assume for control purposes that the outside level is 400 ppm. While the actual outside level may

- be different from this, the purpose of CO_2 control is to control based on the differential between inside and outside levels.

- Self Calibration Consideration: For the self calibration algorithm in the CO_2 sensor to work best, inside concentrations should drop to outside concentrations at least every 2 to three weeks. In many buildings this will occur naturally. However in tight buildings or buildings that have an occupancy schedule that is highly irregular, CO_2 levels may not have a chance to reach background outside levels. As a result it is recommended that the building control strategy include a periodic purge mode that will bring inside levels to outside concentrations. This type of periodic purge mode is also recommended by ASHRAE as a way to clear out accumulated contaminants that may be given off by building furnishings and other materials.

- Sensor Commissioning: In some cases handling and shipping of the CO_2 sensor may have affected the original factory calibration. As a result, sensors should be installed and operating in the space for at least 3 weeks before the CO_2 sensors are commissioned. This will provide time for the self-calibration feature of the sensor to adjust for any offset in calibration that has occurred as a result of handling. The chart below shows how 20 sensors that were intentionally calibrated with an error up to 150 ppm drifted into a low error zone as the sensors calibrated themselves to the space. Many sensors will be calibrated properly out of the box, but handling may shift the units. This does not mean they are defective, but it does mean they will take time to stabilizewith the self calibration feature.

- For commissioning purposes it is recommended that the sensor be compared to a recently calibrated handheld unit such as the PT9250 from AirTest Technologies Inc. This device can be calibrated to outside background levels much like the AirTest Transmitter.

  The hand held unit should be turned on for at least 15 minutes before the measurement. Ideally the space should have minimal occupancy prior to and during the commissioning process (to avoid transitions and spikes in CO_2 readings). Place or hold the hand held CO_2 monitor near the sensor for a period of 10 minutes or until the readings on the hand held have appeared to stabilized. Be careful not to breathe in the vicinity of the sensor. Compare readings of the Hand Held and transmitter. Taking into consideration the accuracy of the AirTest transmitter and hand held device, acceptable readings should be within 100 to 150 ppm of each other.

  Further Reference:

  http://www.airtest.com/product/portable-data-logging/pt9250.htm

- **Continuous Commissioning & CO_2:** A good ongoing check of CO_2 sensor accuracy is to monitor readings through the building control system and determine if relatively consistent baseline levels are occurring on nights and weekends. For the self-calibration mode AirTest CO_2 sensors to work properly, CO_2 levels inside should drop to outside levels at lease once per week. Some building owners will also check their CO_2 readings during an intentional purge or economizer cycle where it can be assured that inside levels will be similar to outside levels. Although significant changes in baseline levels may indicate a fault with one or more CO2 sensors, it is also important to note that these changes may be an indication that an economizer or air handler may not be operating

5.1 Installation TR9290 Wall Mount

Dimensions
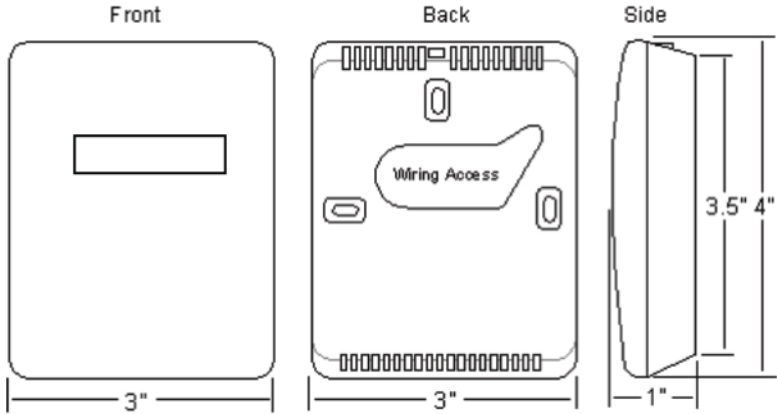
Closing Enclosure
▸ Hinge front cover on bottom of rear case
▸ Swing top cover into place until it snaps

Opening Enclosure
▸ Press tab on top of rear case
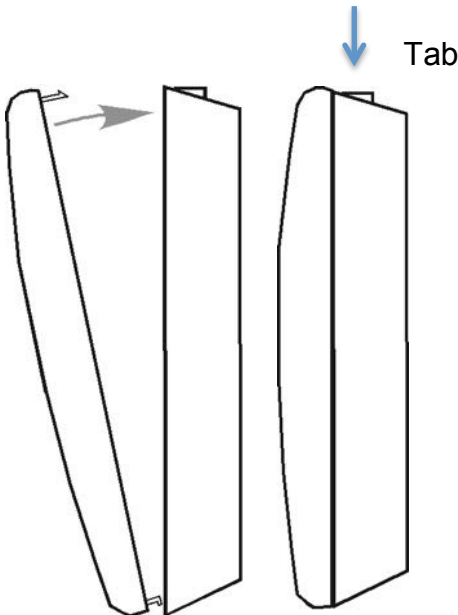▸ Swing top cover open from top.

TR9290 Wiring

TR9290-A	TR9290-B
+ Positive Power	**+** Positive Power
G Ground	**G** Ground
1 Out 1: 0-5V	**1** Out 1: 0-10V
2 Out 2: 4-20mA	**2** Out 2: 4-20mA

+ G 1 2

Tab

5.2 Installation TR9291 In-Duct Mount

Front   **Back**   **Side**

3.5"
4"

2.5"   2.5"   1"
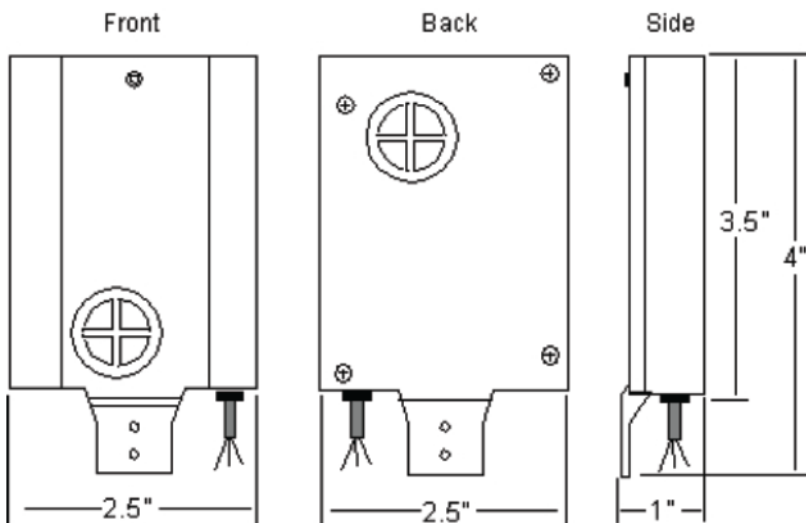
TR9291 Wiring

TR9291-A
+ Positive Power
G Ground
1 Out 1: 0-5V
2 Out 2: 4-20mA

TR9291-B
+ Positive Power
G Ground
1 Out 1: 0-10V
2 Out 2: 4-20mA

12"

Out 1 (*)
Out 2 (*)
Common (B)
Power+ (R)
* wire color will be on unit label
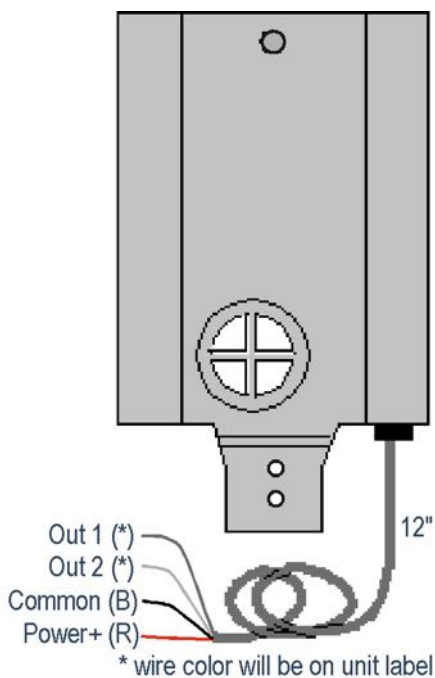
5.3 Installation: TR9292 Aspiration Duct Mount

Dimensions
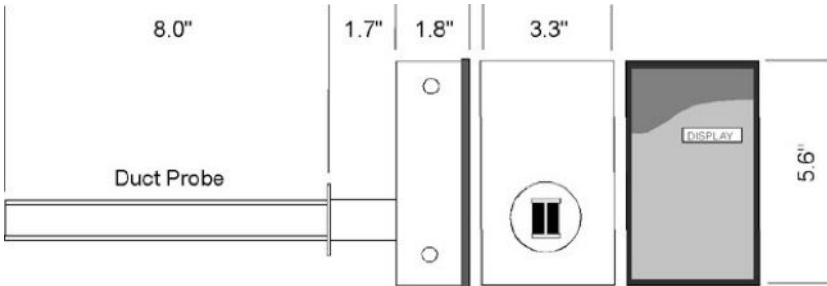
Mounting
‣ Drill 1/2" (25mm) Hole in duct for probe
‣ Attach mounting flange
‣ Connect flange to sensor

10   Hole with 25 mm diameter

Important
‣ Once wired, tighten outside flange around wire opening. For better seal use a small amount of calk in the flange.
‣ Make sure cover is firmly sealed to the box.
‣ To work properly box must be completely air tight so air from the duct can circulate between the sensor housing and the duct.

TR9292 Wiring
Note: 24VDC only!
TR9292-A
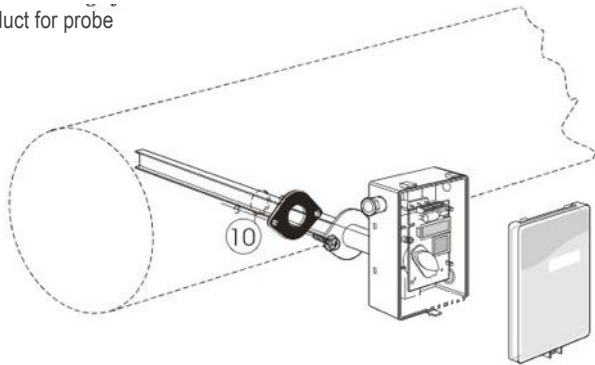**+** Positive Power
G Ground
1 Out 1: 0-5V
2 Out 2: 4-20mA

TR9292-B
+ Positive Power
G Ground
1 Out 1: 0-10V
2 Out 2: 4-20mA

5.4 Installation: TR9294 Wall Mount

Dimensions
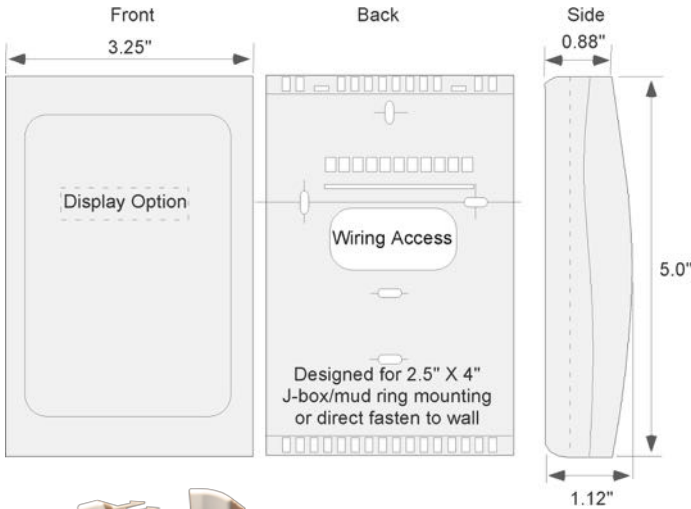
Side View
▸ Case hinges at bottom with clips that snap-in at the top of the case
▸ Case is much easier to open

Top View
▸ Press two tabs down and pull off cover

TR9294-A
+ Positive Power
G Ground
1 Out 1: 0-5V
2 Out 2: 4-20mA

TR9292-B
+ Positive Power
G Ground
1 Out 1: 0-10V
2 Out 2: 4-20mA
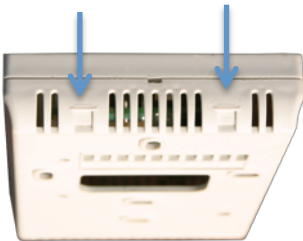
TR9294-Lon
+ Positive Power
G Ground
1 Lon
2 Lon

TR9294-BAC
+ 24 VAC/DC
- 24 VAC/DC
1 D+/A
2 D-/B
3 GND
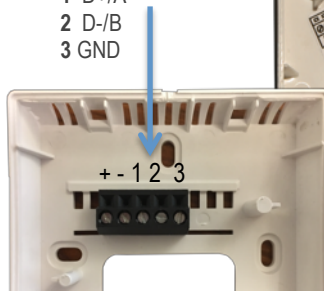
6.1 Product Specifications

General
CO_2 Detection Method: Gold Plated Non-Dispersive Infrared Optical Sensor with Automatic Baseline Correction for Self-Calibration, 4.8" optical path length, diffusion sampling.
Certification: CE, EMC89/336/EEC, CA Energy Commission, NYSERDA, LonMark® Certifed (V3.4).
Transmitter Rated Life: 15 years
Operating Conditions: 32 to 122º F (0 to 50ºC), 0 to 95% RH
Storage Conditions: -40 to 158º F (-40 to 70º C)

Performance
CO_2 Measurement Range: 0-2000 ppm (factory adjustable to 10,000 ppm upon request),
CO_2 Accuracy: +/- 1% of measurement range +/- 3% of measured value.
Calibration: Self Calibrating, Calibration Not Required
Response Time: T90 = <2 minutes (diffusion), < 15 seconds for flow through.

Power
Input: 24 VAC/VDC ±20%, 50-60 hz (half-wave rectified).
Note: The TR9292-Lon is 24VDC only!
Average Power Consumption: < 1 Watt average
Ground: Analog output transmitters must share common ground with control system.

Outputs
Linear Analog Output: Two simultaneous dual output options available: A) 0-5V & 4-20mA, B) 0-10V & 4-20mA
LonWorks®: CO_2 ppm & % SNVT

6.2 Lonworks® Specification

AirTest Models: TR9294-L-Lon, TR9294-Lon
Category: Sensor
Measurement Range: 0-2000 ppm (factory adjustable to 10,000 ppm)
Standard Program ID: 80:00:E5:05:46:06:04:01
LonMark® Version: 3.4
Manufacturer ID: 229
Device Class: CO2 Sensor (10.70)
Usage: 06 – Residential/Commercial
XIF/DRF Download:
   www.airtest.ca/support/sw/AirTestLon.zip
Transceiver: 04-TPFT-10
Model: 2
XIF Available: True
DRF available: True
LonMark Objects: 0000 Node object (1), 1070 CO2 Sensor (1)
Clock Rate: 10 MHz
Power Requirement: 18-30VAC/VDC (1/2 wave rectified) < 1 W average
Object Details: See diagram

6.3 BACnet® Specification

Description:

This BACnet® output is only available for the AirTest Model TR9294 wall Mount CO_2 Transmitter. These sensors are all self-calibrating and will not require any maintenance for the life for the sensor (typically 15 years). These sensors provide a CO_2 ppm output object for 0-2000 ppm CO_2. Evaluated by the BACnet® Interoperability Testing Service (BITS), BACnet® Testing Laboratory (BTL) Certification in progress.

BACnet® Overview

The BACnet® objects associated with the TR9294 permits display of current values of the CO_2 transmitter. The BACnet® objects associated with the TR9294 are described below.

BACnet® Device Object

The device object allows the configuration of the TR9294. Object properties can be specified as follows.

BACnet® Device Object	Description
TR9294	This allows the operator to specify the following:
	Device name
	Device location
	Time and Date
	Universal Time Coordinates Offset
	APDU properties
	MS/TP properties
	Object Identifer

Other BACnet® Objects

BACnet® Objects	Default Present-Value	Range	Description
Analog Input Objects			
CO2 Level (AI1)	Display Only	NA	Displays present CO2 value
Temperature (AI2)	Display Only	NA	Displays present temperature value
Analog Value Objects			
None			
Binary Input Objects			
Pushbutton ID,(BI1)	Inactive	Active/Inactive	Pushbutton on sensor module to facilitate identifying and locating
Sensor Error (BI2)	Active	Active/Inactive	Output from raw sensor indicating an error condition
Binary Output Objects			
Remote Calibration Request (BO1)	Inactive	Active/Inactive	optional remote calibration request
ID LED (BO2)	Inactive	Active/Inactive	LED for ID purpose

**Sensor Address Selection Overview:**

The TR9294 with BACnet® has two settings to allow for unique device identification on a BACnet® network.
1. A DIP switch selection for the MS/TP MAC Address. Valid addresses are in binary format using the DIP switch position 1 through 7. See table below.
2. A Device Instance property of the device that can be set using BACnet® tools.

Setting the MS/TP Address:

Device address and options selection DIP Switch.
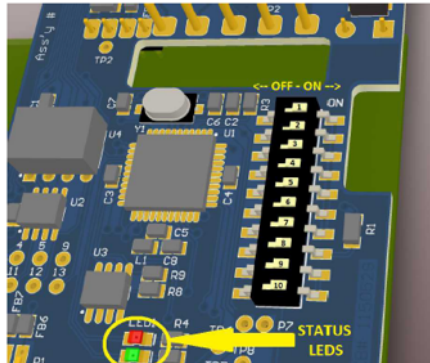
SW1 Switch Position	Function
1	A0 – LSB of device address. ON = binary 1. OFF = binary 0
2	A1
3	A2
4	A3
5	A4
6	A5
7	A6 – MSB of device address
8	Termination Resistor (0N = Connected: OFF = Disconnected)
9	Reserved – **Leave in ON position** or unexpected response may result.
10	Reserved – **Leave in OFF position** or unexpected response may result.
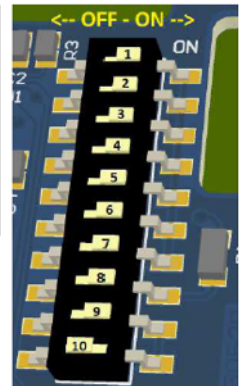
Note: When in the ON position, switch position 8 connects a 120 Ohm termination resistor across the RS-485 DATA+ and DATA- communication lines. Be sure to leave switch positions 9 and 10 as indicated above – unless instructed by AirTest support.

Factory Default Switch Positions

The AirTest TR9294-BACnet CO2 sensor is shipped with the MS/TP MAC address and options selector DIP switches set as above.
The MS/TP MAC address is set to 127 decimal (111 1111 binary & 7F hex), termination is connected and switch positions 9 & 10 are set as recommended.

Communication Status LEDs

Communication Status LEDs are provided for troubleshooting purposes and are not visible during normal use.
Received network signals is indicated by the illumination of the RED LED and sent network signals is indicated by the illumination of the GREEN LED.

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7. Product Liability & Limitations of Liability

AirTest Technologies Inc. (hereinafter referred to as AIRTEST) warrants that the Product shall conform to and perform in accordance with published technical specifications and the accompanying written materials, and shall be free of defects in material and workmanship for a period of one year, such Warranty period commencing on receipt of the product by the Customer.

This Warranty is limited to the repair and or replacement, at AIRTEST's sole discretion, of defective or non-conforming Product, and AIRTEST shall not be responsible for failure of the Product to perform specific functions, or any other non-conformance caused by or attributable to: a) any misapplication or misuse of the Product; b) failure of the Customer to adhere to any of AIRTEST's specifications or instructions; c) neglect of, abuse of, modification to, or accident to, the Product; or d) any associated or complimentary equipment or software not furnished by AIRTEST.

If this unit should malfunction, it must be returned to the factory for evaluation. Contact AIRTEST to determine if a product problem is a Warranty or repair issue (1-888-855-8880 or 604-517-3888). Prior to sending any Product back to AIRTEST the Customer must contact AIRTEST to receive a Return Materials Authorization Number (RMA #). This number must be marked clearly on the outside of the package you are sending. Packages without RMA #'s may be returned to sender unopened. Customer agrees to insure the Product or assume the risk of loss or damage in transit, to prepay shipping charges to AIRTEST, and to use the original shipping container or equivalent. Upon examination by AIRTEST, if the unit is found to be defective and therefore qualifies for Warranty, it will be repaired or replaced at no charge to the Customer. If the product is found not to qualify for Warranty, the Customer will be offered the opportunity to pay for repair of the damaged unit, and the Customer will be responsible for all shipping charges.

Limitations Of Liability

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