AirTest Model CN9000 Series Sensor Controller

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THEORY OF OPERATION

A basic CN9000 configuration consists of Input/Process/Display combination modules, a 3 relay output module, a 12 slot interconnect board, and a power supply sized to system requirements. Refer to color image for component identification.

INPUT MODULE
An input module provides a connection for a sensors data signal and power requirements. Circuitry is provided to condition the sensor signal for processing. An input module can have any one of a variety of input specifications to accommodate any sensor signal output type including temperature, pressure etc. These signals are then output to other modules via the interconnect board. Because power requirements between sensors can also vary, input modules can be configured to supply virtually any low voltage power source. Custom input modules may interface with override switches or keypads.
The basic input module has connections for 4-20mA input signal using a 100 ohm current sensing load, 12 volt DC sensor power source and an AC power source (optional).

PROCESS MODULE
A process module can input signals on the interconnect board and perform some form of analysis or further conditioning to the signal and in turn generate and direct an output signal back to the interconnect board to be used by other modules. Processing can include generation of signals to trip relays, turn on status LED's or display comprehensive alphanumeric data on an LCD panel. The basic process module is part of the basic input module.

DISPLAY MODULE
A display module can take many forms with the common theme of providing visual information, the most common being simple LED's.

OUTPUT MODULE
An output module inputs signals from the interconnect board and directs them to output devices as required by the end user. An output module can provide the end user with a simple contact closure or a complex data stream that can be used by a building management system. The AirTest CN9000 controller is also not limited by the number and output types per system configuration. Typical output modules provide one or more dry contact relays, LED contact closure indicators and wiring terminals.

FEATURE MODULE
Feature modules allow intermediate logic processing of system signals. These signals can be any combination of inputs from the interconnect board or onboard user wiring terminals. Processed signals can then be output to the interconnect board for use by other modules and/or to user wiring terminals for connection to external devices.

One example would be a module that processes a high gas concentration level from an input/process module and makes a dry contact relay closure to power a horn. If a push button is pressed (input through wiring terminals) the horn is silenced for a user selectable time period.

INTERCONNECT BOARD
This board provides a connection path between modules as well a power. The base interconnect board allows connection for up to 12 modules of any type. Multiple interconnect boards can be wired together to expand the system beyond 12 modules.

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THEORY OF OPERATION continued

A TYPICAL SYSTEM WALK THROUGH

The external sensor's power and 4-20mA status signal wires are connected to the input modules wiring terminals. Processing of the 4-20mA takes the form of a comparator circuit where it's digital output signal changes state when the voltage across the 100 ohm current sensing resistor is greater than a reference voltage. The voltage at which the state change occurs is called the "trip point".

The trip point voltage can be a fixed value, as in the sensor fail detect (out of operating range) circuit or be variable through user adjustable trim potentiometers. The base input module incorporates four comparator outputs, 2 of which have user settable trip points and the remaining 2 are have fixed trip points for high and low sensor fault conditions. The 2 fault state comparator outputs are tied common to allow one fault condition signal. The resulting 3 digital signals are placed onto 1 of 16 available signal channels on the interconnect board through jumpers on the input module.

The signals available on the interconnect board are used by the output module. Channel selection is accomplished but setting the appropriate jumper on the output module. There are 3 channel selection blocks, 1 for each of the 5 amp relays.

Common controller configurations use 3 relays as the final output to external devices. A ventilation system is activated by the contact closure of a relay when a low gas level is detected, while a second relay activates an audible and/or visual alarm when the gas level reaches a higher level indicating a possible problem with the ventilation system. The third relay is used to signal a fault with the system such a sensor signal loss which may indicate a sensor fault or a break it sensor wiring. In any case it is important to incorporate basic fault detection into any safety system.

INSTALLATION

The controller is designed for wall mounting in a control room or working area. The enclosure incorporates a sub panel assembly and window.

1. CONTROLLER INSTALLATION/MOUNTING

Securely mount the controller to the wall using four (4) mounting screws with lock washers and nuts. Make sure there is room for the door to open.

2. INTERCONNECT WIRING

Interconnect wiring is identified in the customer wiring diagram drawings in this manual. It is recommended that all wiring is shielded and common shielding practices be used for installation to reduce the possibility of radio frequency interference.

Step 1: Connect sensor to the interconnect cable. Record wire colours and what terminals they are connected to. See sensor information as to number of wires used and their connection.

Step 2: Terminate the other end of the interconnect cable from sensors at the connectors located inside the controller on the upper right of the motherboard. Observe correct polarity between sensor and controller connections. Failure to do so may result in damage to amplifier circuits.
Interconnecting wiring between controller and sensors

3. ALARM RELAY OUTPUTS

Step 1: Terminate wiring to alarm output connectors as identified in customer wiring diagram drawing.

Step 2: Terminate power supply input wiring as identified in customer wiring diagram.

4. PREPARATION FOR OPERATION

Step 1: Check all wiring for correct polarity and good terminal connections.

Step 2: Apply power and observe visual indicators.
- Input Module indicator lights may cycle between off, green, red and yellow upon start up. Many sensors will require a stabilization period. Consult specification for the particular sensor

Step 3: Check voltage reading at each sensor.
This measurement will depend upon main power supply setting.
- +12 VDC to 14 VDC between (+) and (-) terminal connections.

5. INSTRUMENT START-UP

Step 1: Let the sensor settle after power has been applied. See sensor data for settling time.

Step 2: A zero air sample should be applied to each sensor to check absolute zero when a continuous gas background exists in the area where the sensor is installed.

NOTE: Airtest gas monitors are shipped calibrated and should not require any adjustment provided voltage reading and operational tests give correct indication. However, it is recommended that a calibration test be performed after installation.

Step 3: Testing of response to the presence of gas using a test sample or calibration sample of gas should be applied to each sensor.

CONTROLLER CALIBRATION

1. ALARM TRIP POINT ADJUSTMENT – By Voltage

To Set Alarm Trip Points

Step 1: Open the inner cabinet door of the Model 9000 controller to allow access to alarm adjustments.

Step 2: Using a voltmeter, connect to the black and the yellow (RTP1) testpoints.

Step 3: Adjust the RTP1 potentiometer until the DVM reads the desired value as recorded when calibration gas was applied to the sensor.

The Input Module is normally set to operate from 0.4 to 2.0 VDC which is a direct correlation to the 4 mA to 20 mA signal produced by a 4-20 transmitter. This allows for easy calculation of alarm set points. The 0.4 to 2.0 volts corresponds to 0 ppm to max range ppm or in the case of the TR2000 0 – 200ppm CO.

2. ALARM TRIP POINT ADJUSTMENT – By Calibration Gas

Step 1: Open the inner cabinet door of the Model 9000 controller to allow access to low and high alarm potentiometer adjustments.

Step 2: Apply to the sensor, calibration gas of a concentration desired for low alarm relay activation.

Step 3: Adjust applicable “RTP1” potentiometer until the low alarm relay activates. (listen for “click” or watch relay activation lights on the Output Module)

Step 4: Redo steps 2 & 3 for the high alarm using calibration gas of a concentration desired for high alarm relay activation.

Step 5: Repeat steps 2 through 4 for each channel.

CN9000 CONTROLLER SPECIFICATIONS

Channels: up to 17 inputs (and one Output Module) per Interface Board

Dimensions: 12.6" W x 14.2" L x 8" D
(dimensions are based on a controller assembled for 11 analog inputs and 3 relay outputs)

Weight: 24 lbs.

Input Power: 120vac 50/60hz 1 Amp
-optional 220v 50/60hz.
-optional 12VDC, and/or 24VDC operation or backup power.

Input Power Fuse: 1 Amp (FastBlo)

Sensor power: 12VDC. at 0.2 amps per input.
-optional 24-28VAC

Operating Temperature Range: -30 C to +65 C.

INPUT MODULE

Display: 3 colour LED per Input Module

Indicators: -One 3 colour LED.
-POWER "ON" LED (GREEN) normally "ON".
-Relay Trip Point 1 (yellow) normally "OFF".
-Relay Trip Point 2 (red) normally "OFF".
-SENSOR MALFUNCTION (fail) per channel (red) normally "OFF"
(fail relay normally energized.)

Input Impedance -100 ohms

OUTPUT MODULE

Display: -each relay contact has LED to indicate closure

Relay : -3 relays – each relay DPST 5 Amp non-latching
-All relays are configurable as RTP1 or RTP2.

WARRANTY

AirTest Technologies, Inc (the company) warrants the Model CN-9000, Controller to be free from defects in materials and workmanship under normal use and service for a period of one year. The company's obligation of this warranty shall be limited to the repair or replacement of any part found to be defective. The company shall not be obligated to repair or replace units that are found to be in need of repair because of damage, (other than normal wear and tear), tampering or modification. The controller must be returned to AirTest suitably packaged and with freight prepaid. Liability is limited to the replacement cost of a new unit. In no case shall the company be liable for any consequential or incidental damages however caused. No agent, dealer or employee of the company has the authority to increase or alter the obligations or limitations of this warranty.

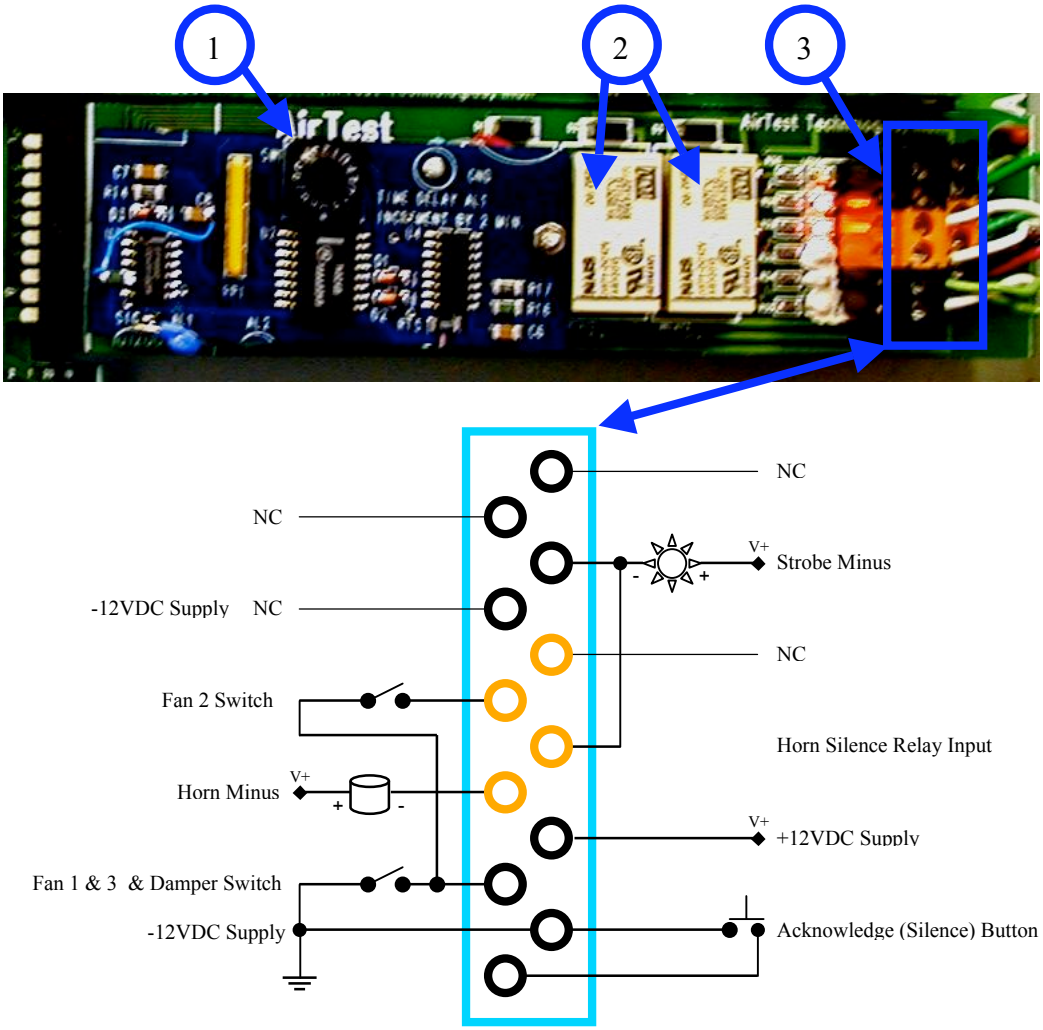
AirTest Model CN9000 Feature Module

This custom feature module incorporates a timing circuit, output relays and external input/output wiring terminal block.

1 – Timing Circuit (Time Select Switch)
If the front panel pushbutton marked “Audible Acknowledge” is pressed the timer circuit silences the audible horn for a period determined by the “Time Select Switch”. After the time period expires the audible alarm will be enabled and will sound if the system detects a high gas level state.
The Time Select Switch is marked 0 through 9 and A through F (10 through 15) for a total of 16 positions. Each position represents a 2 minute interval which is multiplied by the switch position value (0 through 15) to determine the audible silence time. If the switch is set to position A (value of 10) the silence time would be 2 minutes X 10 or 20 minutes The maximum time would be 30 minutes at switch position “F” (15 X 2 Min. = 30 Min.).

2 – Horn/Strobe Interlock Relays
Separate relays to drive the horn and strobe are provided to facilitate the audible silence function. When a high gas level is detected relay 3 (marked on module in white) will activate and provide a grounding (minus) signal to the horn and strobe. If the “Audible Acknowledge” button on the front panel is pressed relay 2 will disconnect the grounding signal to silence the horn for a period determined by the Time Selector Switch position.

3 – Input/Output Terminal Block
This terminal block provides connection points for the front panel switches, indicators, horn and strobe. Refer to diagram below for details.



Input/Output Wiring Identification and Simplified Schematic.

AirTest Model CN9000 Feature Module

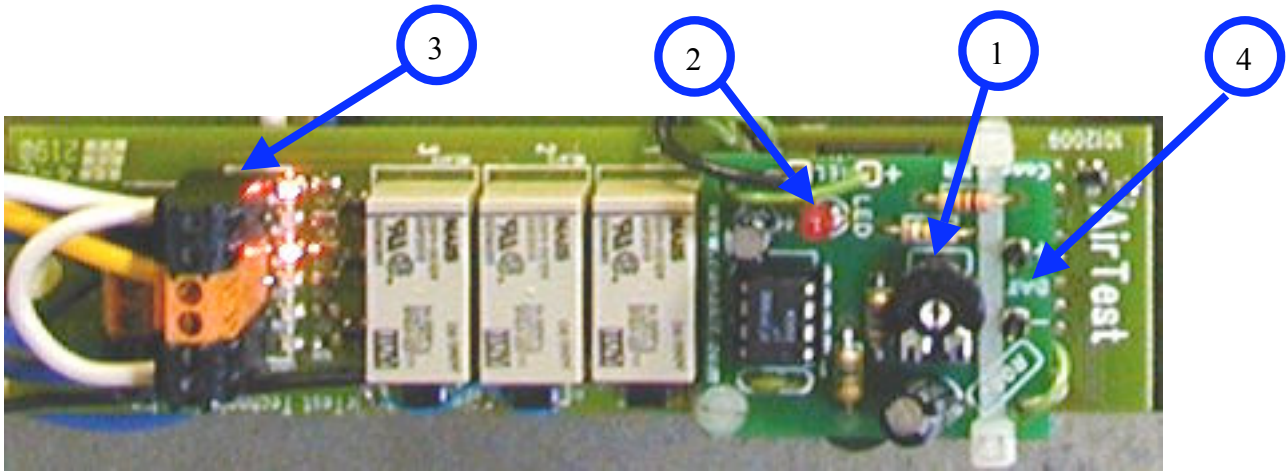
This custom feature module incorporates a timing circuit, output relays and external input/output wiring terminal block.

Silence Timing Circuit
When the front panel pushbutton marked “Silence” is pressed the timer circuit silences the audible horn for a period determined by the position of trim pot **(1)**. After the time period expires the audible circuit alarm will be enabled if the system detects a gas level above the Relay Trip Point (RTP). The timer is adjustable from 0 to approximately 20 minutes. The image below shows the trim pot set to offer a silence period of approximately 12 minutes.

LED **(2)** is illuminated during the silence period.

Terminal block **(3)** is custom wired and should not be modified unless instructed by AirTest or it’s an authorized representative.

The 2 header pins **(4)** are connected to the front panel push button via an IDC plug.



AirTest Model CN9000 Basic Input/Process Module Detail

This standard module incorporates a user wiring terminal block, trip point (TP) adjustment trimpots, TP output channel selectors, a multi-colored LED status indicator and test points for connecting a Digital Volt Meter (DVM).

(1) – Wiring Terminal Block

A screw-less wiring terminal block provides connections for sensor power and 4-20 mA input. Two power sources, typically 12-14 VDC and 24 VAC, are supplied for systems with mixed sensor types including loop powered electrochemical sensors, 3 wire DC powered MOS or Catalytic bead sensors and 24 VAC powered IR CO2 sensors. The power supplied to the terminals can be factory configured to many other standard or custom voltages. Refer to Input/Output wiring for system specific details.

(2) – Input Signal Test Points

The 4-20mA input is terminated with a 100 ohm, 1% precision, current sensing resistor. To read the signal current of the attached sensor connect the negative lead of a DVM (Digital Volt Meter) to the black ring terminal test point (common ground reference) and connect the positive lead to the bare lead on the top of the current sense resistor. The use of small alligator or flee clips is recommended. Multiply the voltage reading is by 10 to calculate the milliamp reading. For example a reading of 0.40 volts would be 4mA. (0.40 x 10 = 4). Twenty milliamps would read as 2 volts on the DVM. (2.00 x 10 = 20)

(3) – Relay Trip Point (RTP) adjustments and test points.

The standard input/process module incorporates 4 comparator circuits where 2 have user settable relay trip points or TP's for short. A TP is the point where a comparators single bit output changes to an active or inactive state when the rising or falling sensor signal level passes a threshold level.

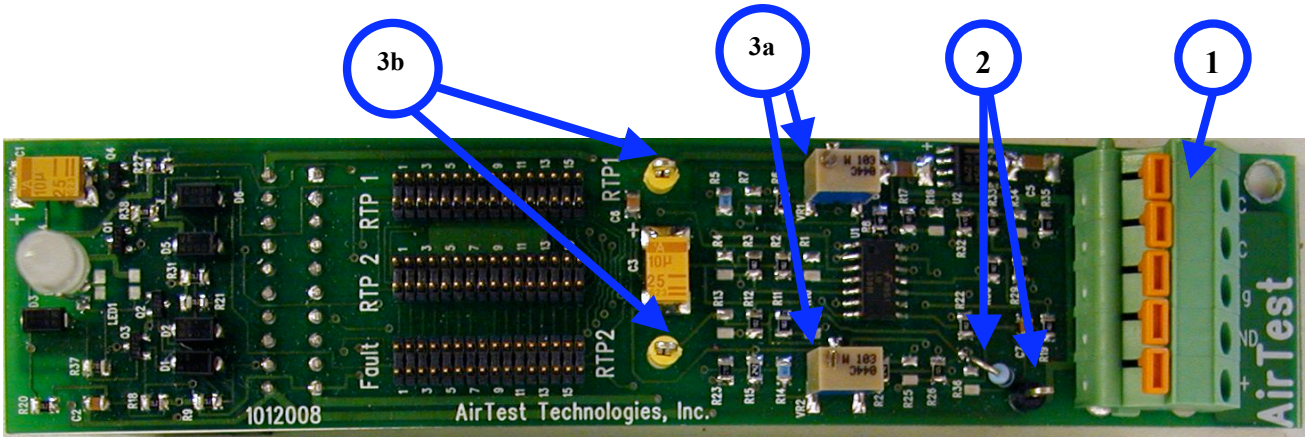
The voltage across the 100 ohm current sensing resistor is compared to a reference voltage. If the current sense voltage level is higher than the reference voltage, the output signal of the comparator circuit is activated and will be available on its' Output Channel selector jumper block. Two comparators are used for sensor fault detection and have factory set TP levels. See System specifications for more detail. These comparator outputs are combined and output to a single "FAIL" channel selector.

The 2 remaining comparators have user adjustable TP's through the turning of potentiometer screws (see 3a below). The TP level for TP1 and TP2 can be read at yellow test points (see 3b below). In the image below, TP1's yellow ring terminal test point and level adjust potentiometer is located at the top of the board and is identified by the white lettering printed on the circuit board, just to the left of the test terminal.

NOTE – Since a module can be plugged into the interconnect board on the left or right, the lettering and component positions will be inverted to the images shown.

A TP's voltage level can be read at it's corresponding test point and be converted to a current level as described above. To set a TP1 of 12mA connect the negative lead to the black common ground reference test point near the current sensing resistor and set the voltage read at TP1 test point to 1.20 volts. (12mA / 10 = 1.20 volts)

NOTE – For correct operation of status indicator TP1 voltage level must be set lower than TP2 voltage level.



AirTest Model CN9000 Basic Input/Process Module Detail

(4) – Output Channel Selector Block

~~Each comparators' digital (on/off, 1/0) output signal can be assigned to any one of 16 interconnect signal lines referred to as channels. A comparator output can use the same channel as another output to provide a logical "OR" configuration. This allows for a common signal to be present when any (1 OR 2 OR …etc.) sensor level is above a TP. A typical system will combine all Low level, all High level and all Fault TP's signals to drive 3 individual Low, High and Fault/Fail dry contact relays.~~

~~Each output channel selector block is identified by white lettering printed on the circuit board just to the left of each block.~~ ~~**NOTE –** Since a module can be plugged into the interconnect board on the left or right, the lettering and component positions will be inverted to the images shown.~~

~~Even though selection of a channel is totally arbitrary some logic should be applied to the decision. The factory default settings are jumpers placed on selector position 1 (channel 1) for TP1, on selector position 2 (channel 2) for TP2 and on selector position 16 (channel 16) for sensor Fail/Fault. These selector block pins are marked with white outlined rectangles in the image below. Jumper pin positions or channels are identified with white numbers printed on the circuit board.~~ ~~**NOTE** – Only the odd number pins are marked~~.

This feature is no longer available unless specified at order time. The channel selection is factory set (hard wired) as required be system specification.

(5) – Module Status Indicator.

A multi-colored LED is provided as status indication of the four output states of the module.

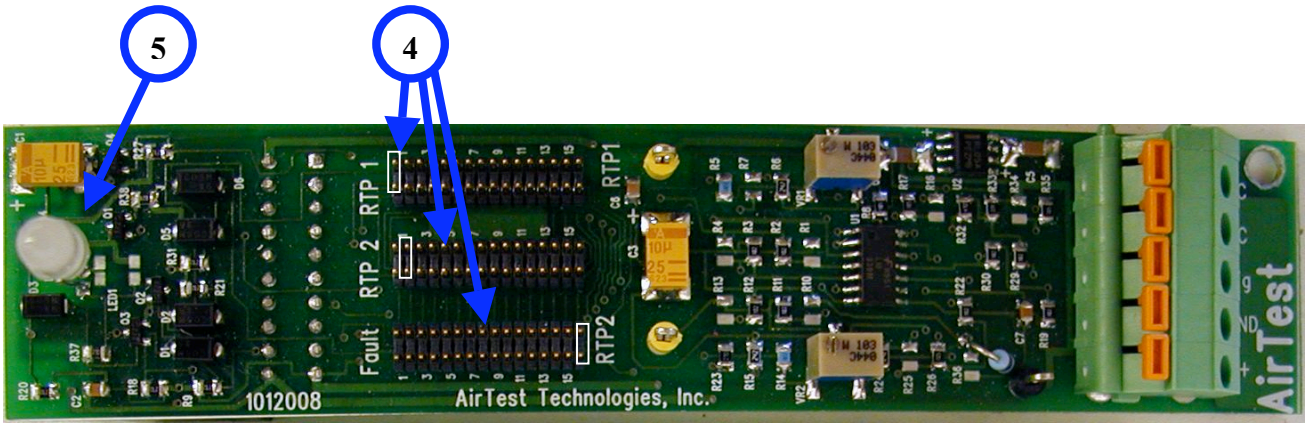
State	Color	Description
4	Red	Sensor signal level is at or above TP2 level.
3	Amber	Sensor signal level is at or above TP1 level.
2	Green	Sensor signal in range and below all TP's.
1	Off	Sensor signal is out of range or module has failed.

State 1 – An LED that is not lit is an indication of a fault in the system. An "ON" signal is generated and placed onto channel 16 (factory default) of the interconnect board. Refer to troubleshooting section on steps to resolve this abnormal condition.

State 2 – No output signals are generated in this state.

State 3 – An "ON" signal is generated and placed onto channel 1 (factory default) of the interconnect board. This is a normal condition as the long as it is expected that the sensor signal is at or above the TP1 level.

State 4 – An "ON" signal is generated and placed onto channel 2 (factory default) of the interconnect board. This is a normal condition as the long as it is expected that the sensor signal is at or above the TP2 level.



AirTest Model CN9000 Basic Output Module Detail

Output Module
This standard module consists of three relays, terminal blocks, input channel selectors and relay status indicators. Relays are Two Pole Single Throw type, with one pole NO (Normally Closed) and the other NC (Normally Closed).

This feature is no longer available unless specified at order time. The channel selection is factory set (hard wired) as required be system specification.

The state of each relay contact is indicated by LED's on board the Output Module. An illuminated LED indicates a closed contact.

Refer to Input/Output Wiring sheet for more detail.

Interconnect Board
The Interface Board provides the interconnection between the Input Modules, the Output Modules, custom circuit boards and any other future modules.

Power Supply
The Power Supply provided with the CN-9000 provides power for the CN-9000. Power supply size is determined by the requirements of the sensors and accessories that will be powered by the system.