Honeywell

4111 Humidity Transmitter Operations Manual

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TotalPlant

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About This Document

Abstract

This manual provides technical description and installation and maintenance instructions for the Honeywell 4111 Humidity Transmitter

Included are all circuit adjustment instructions required to verify proper electrical functions of the instrument as well as system calibration for ambient temperature and moisture.

Revision Notes

The following list provides notes concerning all revisions of this document.

Rev. ID	Date	Notes
0	2/97	This document is the initial Honeywell release of the L&N manual 278158 Rev. B. This manual has been updated to reflect the Honeywell format as well as the changes to the product offering.
1	8/97	Corrections were made to Figures 1-1 and 1-2. The Model Selection Guide Tables were cleaned up, getting rid of the extra, unused column.

References

Honeywell Documents

The following list identifies all Honeywell documents that may be sources of reference for the material discussed in this publication.

Document Title	ID #	Binder Title	Binder ID #

Non-Honeywell Documents

The following list identifies select non-Honeywell documents that may be sources of reference for the material discussed in this publication.

Title	Author	Publisher	ID/ISDN #

Contacts

The following list identifies important contacts within Honeywell.

Organization	Telephone	Address
Honeywell TAC	1-800-423-9883 Voice	1100 Virginia Drive Fort Washington, PA 19034

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1. Introduction

1.1 Overview

Sensors

The Honeywell 4111 unit consists of a dual sensor, a full range (0-100% RH) ULTRA-H II Thin Film Capacitive Humidity Sensor and a thin film platinum RTD Sensor ULTRA 7 combined with a linearized 4 to 20 mA, two-wire current transmitter. The platinum RTD provides repeatable full range temperature compensation.

The sensors, ULTRA-H II with an Ultra-7 bonded to it, are plug-in replaceable mounted on the tip of a 3/8 inch diameter stainless steel probe and protected by a conductive reinforced polyester perforated shield. A stainless steel porous filter, that can be advantageous for some applications, is optional. The interchangeable shield or filter screws off for easy cleaning. Rugged corrosion-resistant construction allows the sensor to withstand the normal impact of environmental and chemical substances. Common solvents, dirt, oil and other pollutants do not affect stability or accuracy. Sensor connections are encapsulated in a custom molded plug to exclude contamination.

Transmitter

The transmitter is a low noise, low drift, constant current device that accepts the capacitive and resistive outputs from the sensors through circuit elements that provide sensor intrinsic safety. It produces a temperature-corrected 4-20 mA current output which can be converted into equivalent dc voltage output across an externally connected load resistor. This voltage can be observed with the help of a high input impedance digital voltmeter, recorder or controller. If a receiving instrument has an internal load resistor, then there is no need for the user to install one. The unit operates from 11.2-45 V dc with virtually no change in calibration accuracy. With a power supply voltage not near these limits, regulation is not required.

Packaging

The unit is packaged in a NEMA 4X housing(Fig. 1.1). Castings are low copper aluminum fully anodized with an aliphatic urethane finish.

Electrical connections are accessed by removing the housing cover and exposing a barrier strip with screw terminals. A label adjacent to the barrier strip screw terminals identifies connections.

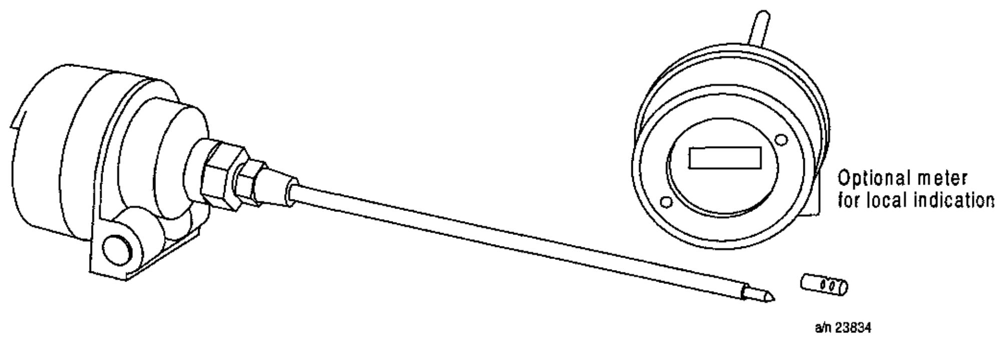

Figure 1-1 4111 Humidity Transmitter

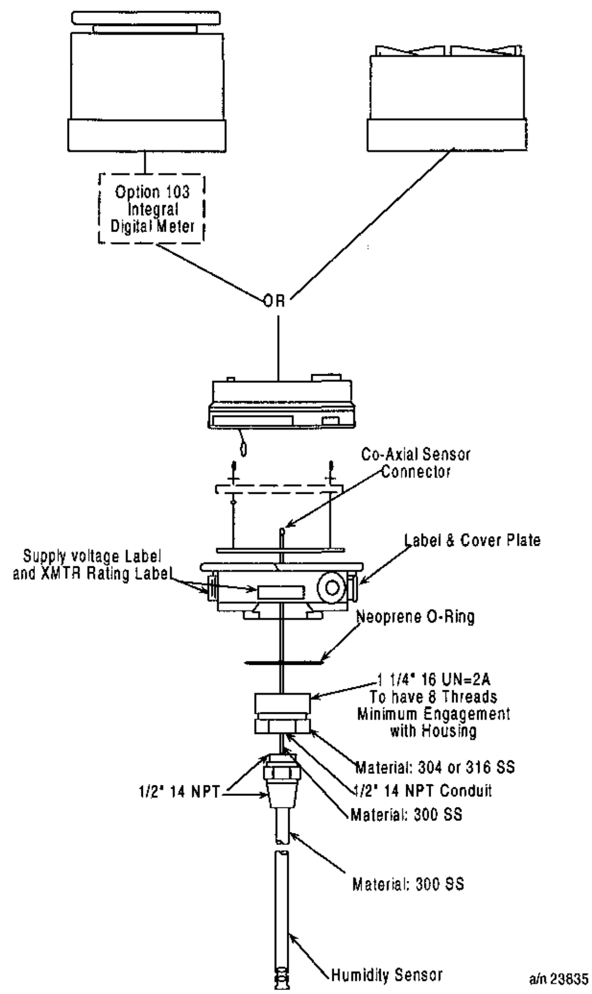

Figure 1-2 4111 Housing

2. Specifications and Model Selection Guide

2.1 General Specifications

Transmitter Output: 4-20 mA corresponding to 0 to 100% RH

Calibrated Humidity Range: 0 to 100% RH

Calibration: NIST traceable data available

Sensing Element: ULTRA-H II thin film capacitive element with an ULTRA-7 thin film platinum RTD for temperature compensation.

Accuracy: ±2.5% RH at 15°C to 40°C (59°F to 104°F) or ±3.5% RH at 10°C to 90°C (41°F to 194°F) +0.03% RH/°C

±1% RH from 90°C to 185°C; from 0 to 93.8% RH at 1 Atm; ±1% RH to user set point held ±10% RH and ±5°C (Includes temperature, linearity, hysteresis and repeatability)

Repeatability: ±0.5% RH

Linearity: ±1% RH

Hysteresis: ±1% of operating humidity span

Temperature Effect: ±0.03% RH/°C ±1% RH at 10°C to 90°C (41°F to 194°F); ±0.03% RH/°C ±1% RH from 90°C to 185°C (194°F to 365°F)

Operating Temperature: -40°C to 80°C

(-40°F to 176°F)

Storage Temperature: -55°C to +85°C

(-67°F to + 185°F)

Time Constant: 16 seconds in slow moving air at 25°C

Stability: Within 0.5% RH up to 80% RH; at 93.8% RH increases to +3% RH within 16 hours at 25°C

Washability: Washable in detergent solution with a water rinse

Sensor Interchangeability: Plug-in and re-calibrate transmitter to original specifications

RFI Susceptibility: Per SAMA PMC 33.1

Input Voltage Effect: ±0.002% RH/V from 12 V to 45 V

Power Requirement: 12 V dc + (R_{load} x 0.02 A) minimum to 45 V dc maximum, unregulated

Recommended R_{Load}:

250 Ohms ±0.1% max at 17 V dc min

500 Ohms ±0.1% max at 22 V dc min

750 Ohms ±0.1% max at 27 V dc min

Zero and Span Adjust: Adjustable for calibration, non-interacting

Break Indication: Upscale to 20 mA except shorted RTD sensor down scale to 4 mA

Polarity Protection: Diode protected

Pressure Rating: 0-50 psi

Sensor Housing: Stainless steel probe; fluted shield (standard); porous stainless steel filter (optional)

Transmitter Housing: NEMA 4X cast low copper aluminum, fully anodized with aliphatic urethane finish. Weight of standard unit: 3.2 lb. (1.5 kg). Weight with extended dome cover approximately 4.4 lb. (2.0 kg)

Sensor Connections: Coaxial jack and 2-pin connector; sensor cables plug into transmitter module; Cable allows sensor tip extension up to 36" from transmitter

Signal connection Power/Signal leads to terminals under outer cover

System Test: Disconnected humidity cable provides 4.0 ±0.01 mA output; Disconnected RTD cable or removed sensor provides 20 ± 0.01 mA output

2.2 Model Selection Guide

KEY NUMBER **Selection**

Description	
4111 Temperature Compensated Humidity Transmitter	04111

TABLE I - SENSOR TYPE

ULTRA H II ™ Thin Film Humidity/ULTRA 7 ™ RTD	H

TABLE II - PROBE LENGTHS

Standard Lengths 12 Inches	#
Non-Standard Lengths, Select any length from 02-11"	02
	03
	04
	05
	06
	07
	08
	09
	10
	11

Non-Standard Lengths, Select any length from 13-32"	13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

TABLE III - OPTIONS	Selection
None	000
Pipe/Wall Bracket Kit	100
Integral Digital Meter and Extended Dome	103
PVC Solar Shield for Outdoor Use	104
Sintered Stainless Steel FIlter	105
Sintered Stainless Steel Filter with Hydrophobic Coating	106
FM Approved Suitable for Class I & II, Div. 1, Applicable Groups B,C,D,E, F,G. *Explosion Proof Conduit Required*	110
Stainless Steel Tag, up to 22 Charact5ers on each of 3 lines	208

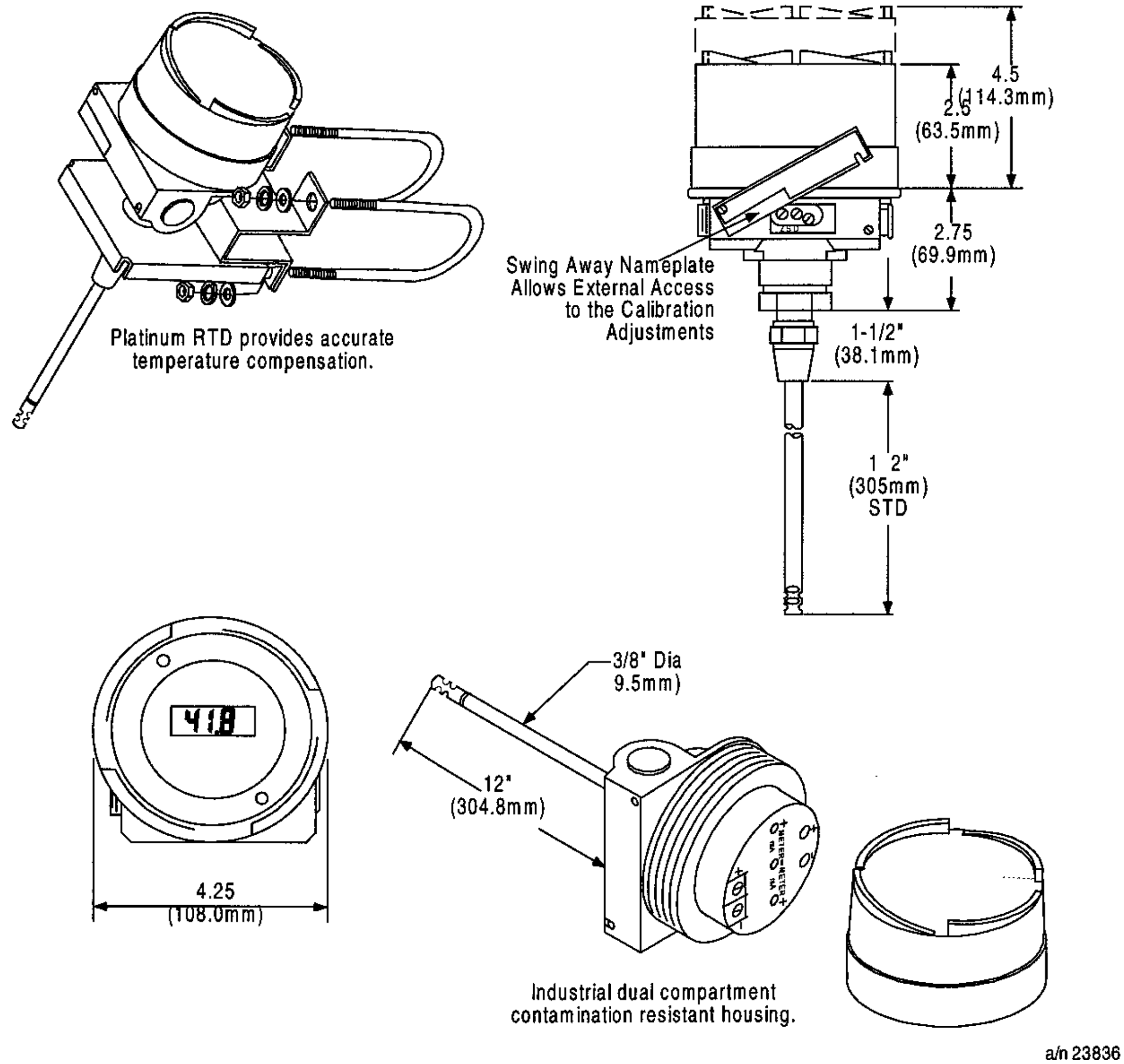

Figure 2-1 Dimensions

3. Installation

3.1 Storage and Shipment

CAUTION:

For prolonged storage or for shipment, the Transmitter should be kept in its shipping container do not remove clamps or covers. Store in a suitable environment with temperature between -55 and 85°C and relative humidity that excludes moisture condensation on the unit.

3.2 Unpacking

Table 3-1 Unpacking

Step	Action
1	If there are visible signs of damage, do not remove the transmitter from its packing material. Notify the carrier and Honeywell immediately.
2	If there is no visible damage, compare the contents with the packing list. Notify the carrier and Honeywell immediately if there is a or shortage.
3	Please do not return goods without contacting Honeywell.
4	Carefully remove the Transmitter from its packing case and then remove any shipping ties on packing material. Follow the instructions on any attached tags and then remove such tags.

3.3 Mounting Location

The 4111 Relative Humidity Transmitters can be mounted in virtually any position and in any convenient location which has a suitable environment (see Specifications) and which provides access for connections and adjustments. If hot objects are located nearby, provide shielding from radiant heat.

Be sure to allow at least 2-1/2 " above the Transmitter for removal of the threaded-on-top cover; allow 3-1/2" if the Transmitter is equipped with an optional meter. Also allow space for operator access to the zero and span adjustments behind the swing-away nameplate. If the Transmitter is equipped with an optional meter, position the Transmitter for easy viewing of the meter through the window on the top of the cover. The meter can be plugged in at 180 degree opposed positions for best viewing. The wiring access should be either at the top or bottom of the desired meter orientation.

Transmitters are equipped with integral sensors that provide direct 1/2 - 14 NPT process mounting per Figure 1-1.

CAUTION

Pipe mounting is not recommended if the pipe is subject to severe vibration.

3.4 Disassembly and Assembly for Separate Sensors and Remote Mounting

The 4111 housing and probe are normally shipped from the factory as an assembled unit. Should it become necessary to disassemble or assemble the unit for any reason, proceed carefully in accordance with the instructions in this section. The assembled unit will be similar to Figure 1.1

WARNING

It is imperative to disconnect power before disassembling any part of the transmitter.

CAUTION

This unit contains devices that can be damaged by electrostatic discharge (ESD). The damage incurred may not cause

3.4.1 Transmitters with Integral Probe and/or Digital Meter

Table 3-2 Disassembly/Re assembly

Step	Action
1	Unscrew and remove the Transmitter's top cover
2	If the Transmitter is equipped with the optional meter, remove it by pulling it straight out. The meter is plugged into a matching socket in the terminal module beneath it.
3	Remove three screws which attach the terminal module to the Transmitter housing,
4	Rock the can-shaped terminal housing slightly, if necessary, to free it from its sealing gasket underneath.
5	Lift the terminal housing carefully. The are leads attaching it via a connector to the circuit board below which you need to unplug. Lay the terminal housing to one side with all its wires attached.
6	Assemble the adapter bushing, part number 4113-451-0187 in Figure 2.1 to the probe assembly as shown in Figure 1.1 Use Teflon® tape to seal the threaded connection between the probe and bushing.
7	Pass the coaxial cable from the probe assembly through the bottom opening in the Transmitter housing and through the center hole in the signal processing board. Do not insert the sensor plug into the socket at this point.
8	Thread the bushing adapter and probe assembly onto the Transmitter housing with Teflon® tape applied to the threads to seal the connection. Tighten the fittings.
9	Plug the coaxial cable jack into the socket on the signal processing circuit board.
10	Plug the RTD connector into the receptacle on the signal processing circuit board.
11	Plug the terminal module connector into the signal processing board. Replace the terminal module carefully on its gasket. When the terminal module is properly seated on its gasket, tighten it in place with he three screws previously removed, Fig. 3.1
12	Replace the optional meter, if so equipped, by plugging it into the sockets on top of the terminal module. Screw on the transmitter's top cover.

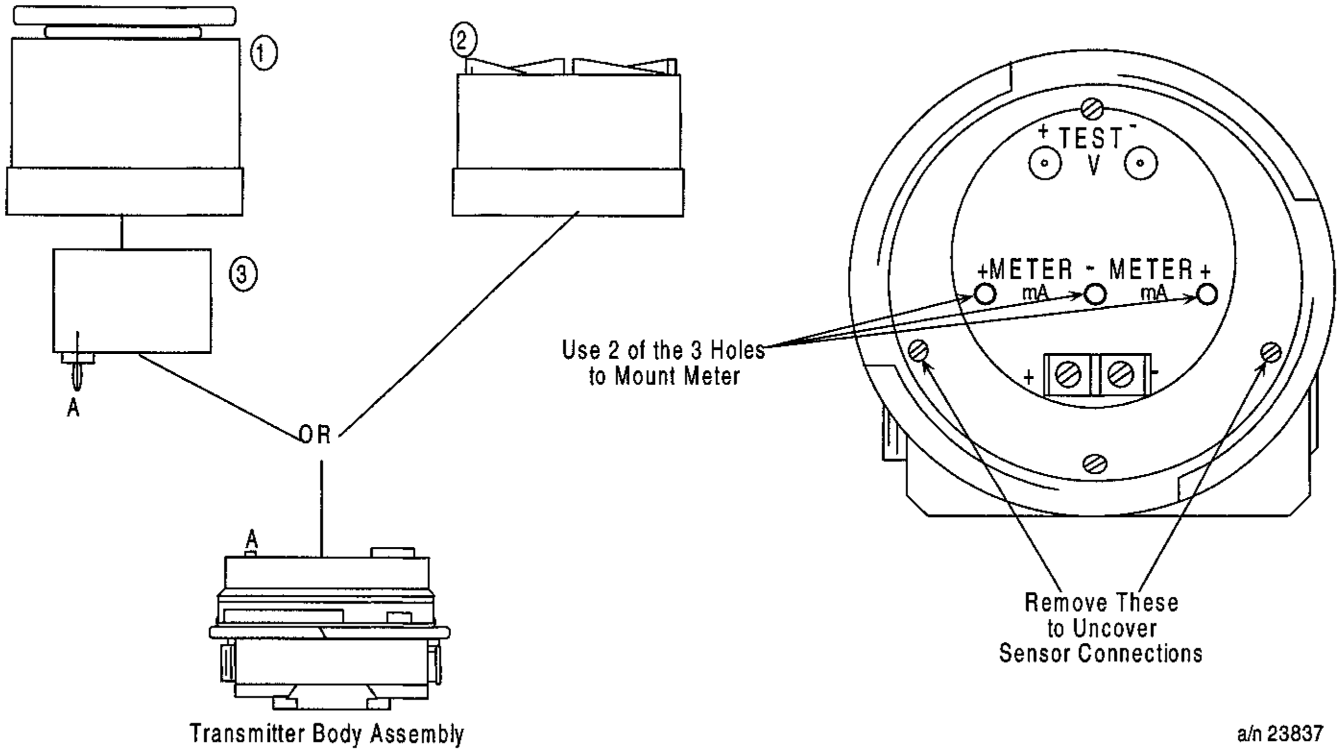

Figure 3-1 Disassembly Details

4. Wiring the 4111

4.1 General Wiring Recommendations

CAUTION

All wiring must be done by qualified technicians and must conform to national or local electrical codes.

In general, stranded wire should be used for wiring. Unless locally applicable codes dictate otherwise, the recommended minimum wire sizes in Table 1 should be observed. To avoid electrical interference with signals, do not run low level signal leads in close proximity to, or parallel with, line voltage leads or other power leads.

Table 4-1 Recommended Minimum Wire Size

Gage No.	Description
14	Earth ground wire to common power supply
18	Earth ground wire to single unit 120/240 V ac power supply, line leads +24 V dc and common leads
20	DC current and voltage field wiring
22	DC current and voltage wiring in control room

In all field mounted installations, it is important to avoid cable or conduit arrangements which might allow moisture to collect inside the housing of the unit. If the housing is mounted in such a position that one of the conduit openings is at the bottom, that opening should be used, if possible, in preference to the upper opening. The unused opening must be plugged securely to prevent the entrance of moisture; even an air leak could result in condensation forming inside the housing over a period of time. When conduit is used, "Y" fittings or drip legs should be installed.

4.2 Power and Output Signal Wiring

The humidity measuring system requires an 11.2-45 V dc power supply which is often located at the receiving device, e.g., data logger. For the connection to the receiving device, stranded copper wire with insulation rated at 600 volts minimum is recommended. If a fuse is not present at the receiving unit which powers the transmitter, install a 0.1 ampere fuse in the "+" line. Refer to local electrical codes before wiring.

Table 4-2 DC Power Supply Requirement vs Load

Voltage	Wiring and Load Resistance
45 Vdc	1650 Ohms
27 Vdc	790 Ohms
22 Vdc	540 Ohms
17 Vdc	290 Ohms

The above values are derived from the relationship 11.2 Vdc + (R_{load} x 0.02A) = Vdc loop min.

11.2 Vdc is required to keep the transmitter in regulation while the load(resistor + lead wires) creates the balance of the voltage drop incurred at the 20 mA level.

ATTENTION

Determine Load Resistor Values and mounting location per the requirements of your readout device(s)

To make connections to the standard unit terminals (with or without optional meter), remove the top cover and follow the circuit in Figure 4-1. Power and output signal wiring must be routed through one of the 1/2" NPT conduit openings.

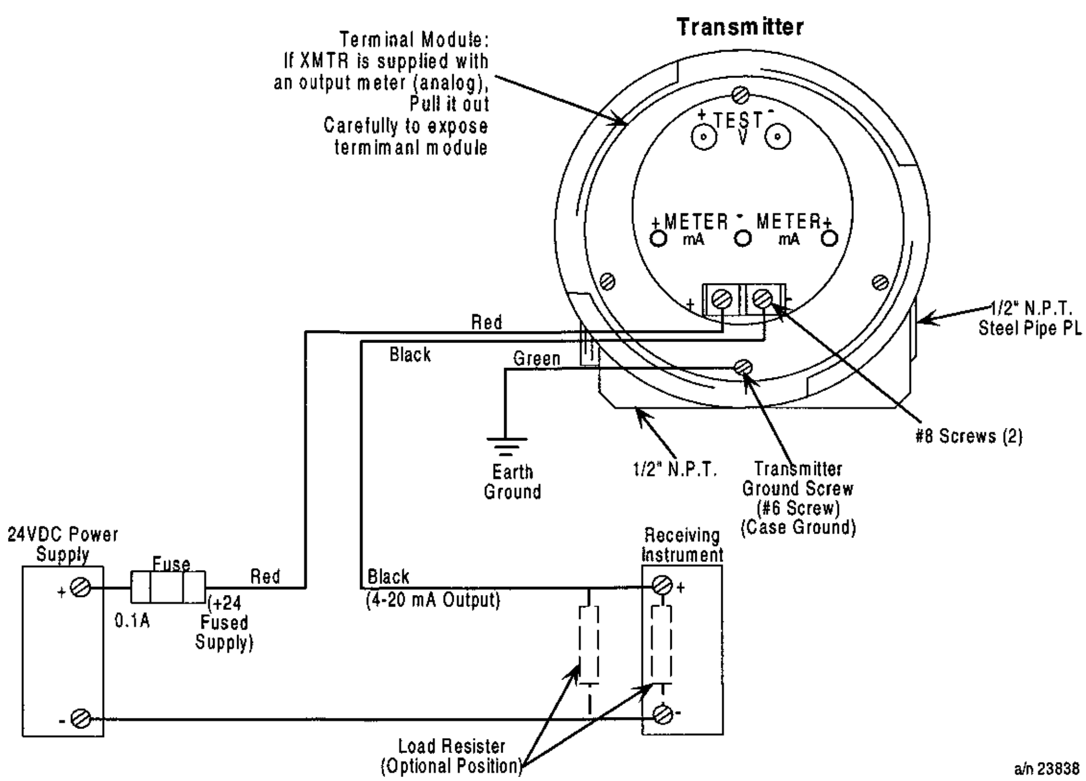

Figure 4-1 Wiring Diagram with External Power supply

Minimum power supply voltage is increased in the equation above from 11.2 V dc to 13.9 V dc with the optional digital meter. TIM requires 24 V dc and 50 mA current capacity from the power supply to accommodate all possible applications including differential measurements driving two transmitters .

4.3 Digital Meter Installation and Adjustments

If a digital meter is factory installed, it is supplied calibrated for the transmitter span ordered. This section describes the meter setup and calibration for maintenance. Upon installation the meter may be plugged in either of the two possible 180° alternate positions for readability through the window in the tall cap.

When retrofitting a digital meter in the field, remove the inner cap that the meter plugs into and cut out the diode mounted on the meter plug-in terminals underneath. Remove the meter faceplate for access to jumper and switch selections for setting up the meter. Zero and Span pots are accessible for later calibration without removing the faceplate.

The digital meter 4 mA zero may be set at any display indication from -1999 to +1999 with optional decimal point indication as described under "Meter Annunciator Selection."

4.3.1 Meter Zero Adjustment

Table 4-3 Meter Zero Adjustment

Step	Action
1	Locate the range selection pin jumpers on the round printed circuit board.
2.	Notice that the first 8 sets of pins, left to right, of the 10-pin double-row header are devoted to zero range adjustments Z1, Z2, Z3 and Z4. Important: Any time a zero range change is made, both jumpers must be moved to the new range as shown by the circuit board silkscreen; e.g., the zero range jumpers will always be side-by-side.
3.	At low span settings, zero ranges Z3 and Z4 allow a 4.00 mA signal to be displayed from -1999 to 000 (or several hundred counts above zero at higher span settings). This is the normal setting for 0% RH.
4.	At low span settings, ranges Z1 and Z2 allow a 4.00 mA signal to be displayed from 000 (or several hundred counts above zero at higher span settings) to +1999.
5.	With jumpers in place, a 4.0 mA transmitter output obtained by removing the terminal module and unplugging the sensor co-ax connector may be used to adjust the Zero Pot.

4.3.2 Meter Span Adjustment

The 20.0 mA span can be ranged for any quantity of counts above the 4.0 mA value. Normal setting would be 1000 counts equal to 100.0% RH.

Table 4-4 Meter Span Adjustment

Step	Action
1	The span range selection jumpers are the two sets of pins marked S1 and S2.
2	For spans from 0 to 2000 counts, place the jumper in position S2. This is the normal setting for 100% RH.
3	For spans from 2000 to 4000 counts, place the jumper in position S1.
4	With jumper in place, a 20.0 transmitter output obtained by wetting or immersing the sensor (chip portion only) in distilled water may be used to adjust the span pot.

4.3.3 Meter Annunciator Selection

Table 4-5 Meter Annunciator Selection

Step	Action
1	Locate the 8 position DIP switch on the printed circuit board.
2	Set swiches ON as desired per the following table:
3	After all zero and Span range jumper positioning and annunciator selections are made, the meter face plate may be reinstalled. ZERO and SPAN adjustment pots are easily accessible at the edge of the meter assembly

Table 4-6 DIP Switch Functions

Switch	Function
S1	Decimal point 1, XXX.X (normal humidity setting)
S2	Decimal point 2, XX.XX
S3	IN WC
S4	°C
S5	°F
S6	% RH (normal on humidity annunciator)
S7	PSI
S8	%

5. Operation

5.1 Introduction

Once the input/output connections have been completed, the unit will operate upon application of power. The unit has no operating controls and, as stated in the Specifications, was factory calibrated to provide 4-20 mA output over the whole 0 to 100% RH range. The ZERO and SPAN adjustments should not be disturbed unless calibration is performed.

5.2 Principles of Operation

The sensor is located on the tip of the probe. It consists of an alumina substrate with thin film gold plate deposited electrodes which are covered with a water-absorbing polymer coating, then a porous platinum layer that limits sensing to the first polymer layer, and finally a protective polymer coating layer. When the relative humidity in the atmosphere changes (increases), more water is absorbed by the inside coating layer. The polymer dielectric constant changes with the water absorption accordingly and, in turn, produces an increase or decrease in capacitance. These changes in capacitance are measured by circuits in the current transmitter and converted into regulated current signals from 4 to 20 mA. The 4 to 20 mA output can be measured as a voltage drop across the load resistor and corresponds to 0 to 100% of relative humidity, covering the full range.

5.3 Circuit Functional Description

Input power is applied in series with the selected load resistor to a Constant Current Source. See Functional Block Diagram, Figure 5. This circuit is a precision adjustable current regulator that provides power to the Capacitance-to-Frequency Converter, the Frequency-to-Current Converter and the Output Current Modulator. The voltages applied to these circuits are controlled by a Voltage Reference Source to obtain precise values. Relative Humidity is sensed by the ULTRA-H II Thin Film Sensor which changes its dielectric constant with humidity. The capacitive signal is routed through the Capacitance-to Frequency Converter at the output. This change in frequency signal is applied to the Frequency-to-Voltage Converter which in turn drives the 0 to 16 mA Output Current Modulator. The RTD Temperature Sensor is connected to the Frequency-to-Voltage Converter and provides correction to the RH sensor signal as temperature changes. The current flowing through the Current Modulator is then summed with the 4 mA current consumed by the circuit and produces an output current, independent of power supply fluctuations. This current varies between 4 and 20 mA, depending on the relative humidity sensed by the sensor. The linearization circuit linearizes the sensor performance to within ±1% of relative humidity. Adjustments can be made with the ZERO and SPAN trimpots. The ZERO trimpot establishes the zero reference point, whereas the SPAN trimpot adjusts the gain. These controls are factory preset.

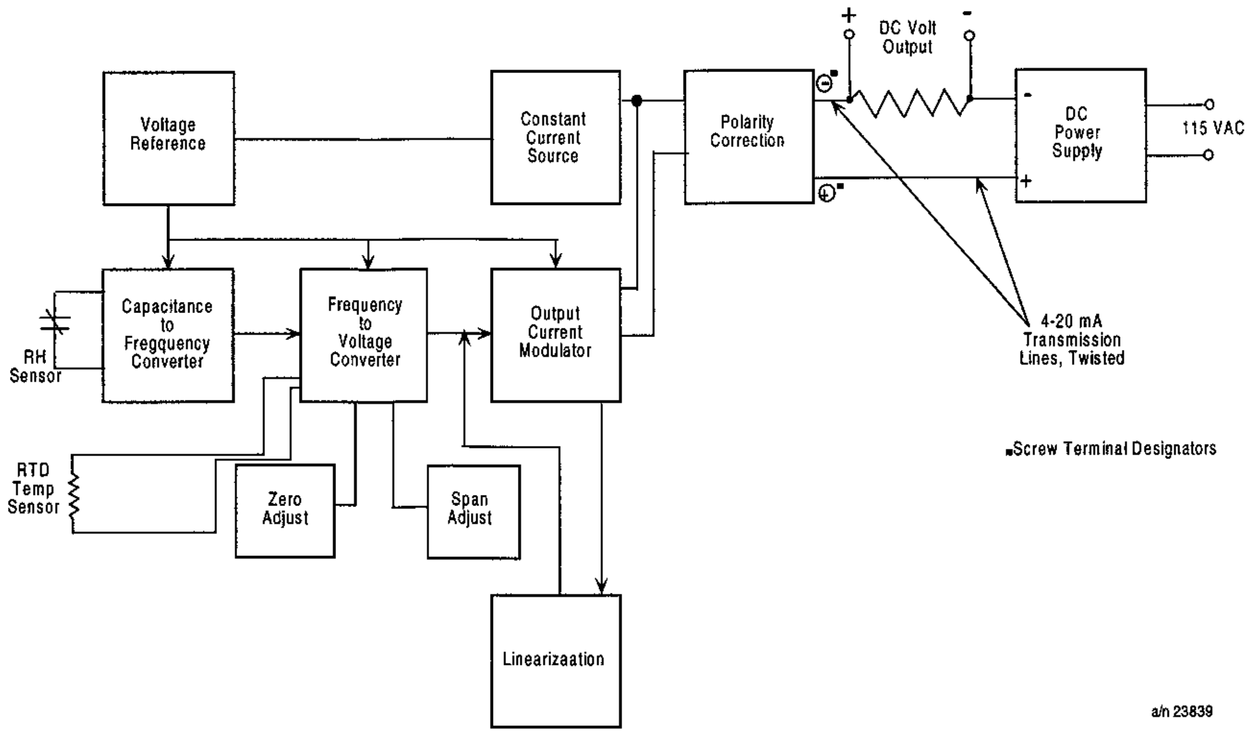

Figure 5-1 Functional Block Diagram for Model 4111

6. Troubleshooting

6.1 Moisture Condensation and Surface Contamination

In the case of moisture condensation which is especially typical for outdoor applications, or cooled ducts, the correct readings will restore after the water evaporates from the surface.

For duct applications, especially at high flow rates, condensation can often be avoided by removing the perforated cover, thereby reducing pressure recovery at the sensor. In the case of surface contamination, it might be necessary to clean the sensor. The cleaning procedure is described briefly in section 6.1.

If a stainless steel porous filter is required for protection, then similar problems may be brought about by the moisture condensation in the filter pores. it takes longer for moisture to evaporate from these pores than from the sensor surface, and condensation appears more readily in the pores than on the sensor. Contamination of the filter, especially with salts, can create an environment inside the filter that had relative humidity substantially different from that outside the filter that is to be measured. Filter washing with subsequent drying is recommended in these cases.

6.2 Sensor Cleaning

To clean the sensor assembly, carefully unscrew the black plastic cap so that the sensor will not be damaged. Immerse the sensor into some cleaning solution. Distilled water and detergent solutions, preferably dish detergent can be used. Gently agitate the sensor assembly in the solution to clean its surface. Do not touch the sensor chip surface except carefully with a soft watercolor brush, such as camel hair. Avoid abrasion on the thin film sensing surface. Deep scratches can destroy the sensor. Final rinsing in distilled water is recommended. After cleaning wait for 24 hours to allow the sensor to dry and then perform the system check which is described in the following section. Make zero and span adjustments if they are necessary. A dip in isopropyl alcohol 99N.F after rinsing will remove the water and speed drying.

6.3 Operational Tests

When a voltmeter is available, and access to the instrument is convenient, the following tests may be performed in situ. Otherwise, use a bench power supply and a 250 Ohm load resistor.

Table 6-1 Test Procedure

Step	Action	Result/Notes
1	Disconnect the moisture sensor	unplug the co-ax connector from the transmitter circuit.
2	Measure the output voltage across the load resistor	If the system output stage functions properly, then the output voltage signal must correspond to the current of 4.0 ±0.01 mA.
3	Disconnect the temperature sensor	unplug the 2-pin RTD connector from the transmitter circuit
4	Measure the output voltage across the load resistor.	The output voltage signal must correspond to the current of 20.0 ±0.01 mA.

6.4 Servicing

Before attempting to service or repair this product, please contact your Honeywell Regional Office in order to avoid possible voiding of your warranty.

7. Calibration

REFERENCE

(Table4-6, 8- 2), Fig. 1-1 , Fig. 4-1, Fig 5-1, and Fig. 7-1 for switches, zero and span controls and connections.

7.1 Introduction

Calibration of the unit is accomplished with humidity standards such as the Honeywell Model 4113-L60-00 Series Calibration Cells. Refer to Table 8.2 for the various types of calibration cells and their respective relative humidity values. Calibration should be performed once every six months. The calibration cells are designed for possible field use in constant temperature conditions.

For quick calibration, a single point calibration can be conducted using a mid range cell and ZERO adjust per steps (2) through (7). For single point calibration do not adjust SPAN.

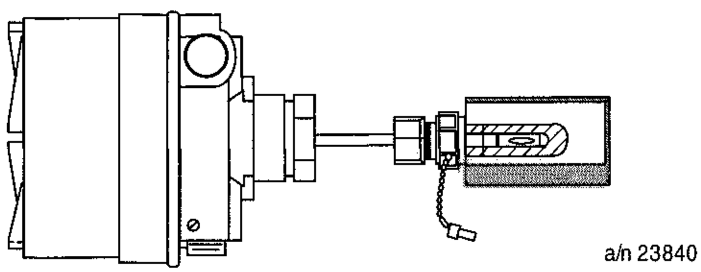

Figure 7-1 Installation of Probe in Calibration Cell

CAUTION

It is extremely important for the temperature of the humidity cell and the unit to be constant during these calibrations. To ensure that, it is recommended that calibration be conducted in a constant temperature room and that the humidity cell be immersed in a big thermal mass; for example: into a styrofoam container filled with sand. The humidity cell should be buried in the sand to the depth of 2-3 inches. Your local tropical fish store carries clean, coarse sand called aquarium gravel.

Table 7-1 Cal. Procedure

Step	Action	Result/Notes
1	Obtain a power supply, and select appropriate calibration cells per Table	Connections are shown in Fig. 8-1, electrical test set up
2	Select the low end cell first.	Gently shake the bottle allowing most crystals in the solution to flow to the side when placing the bottle on its side.
3	Remove the storage stopper from the gland nut.	Install the sensor into bottle with gland nut finger making tight contact. See Figure x.x
4	Allow the RH of the air above the solution to regain its RH equilibrium.	This may take up to 2 hours to occur and is independent of Rh probe response time, but determined by the time the cell needs to regain equilibrium relative humidity inside it.
5	When equilibrium has been reached (no further change in RH probe output), set the ZERO adjust trimpot ...	...to obtain an indication of the RH value as determined by the selected calibration cell.
6	Slide the calibration cell from the RH sensor probe and replace the storage stopper.	Stop calibration procedure here for single point calibration.
7	For two-point or multi-point calibration only, repeat steps (2) through (5) for the calibration cell with the RH value closest to the RH range upper limit of the unit to be calibrated.	
8	When equilibrium has been reached (no further change in RH probe output), set the SPAN adjust trimpot....	....to obtain an indication of the RH value as determined by the selected calibration cell.
9	Slide the calibration cell from the RH sensor probe and replace the storage stopper.	
10	Repeat steps (1) through (6) and check that the reading of the sensor still corresponds to the RH value of the calibration cell at the low limit of the calibration range. If necessary, make adjustments. There is no interaction between ZERO and SPAN adjustments due to the electronic circuits in the unit.	Repeat calibration is required only if large adjustments are made in order to account for the fact that the ZERO adjustment is not at real ZERO humidity when calibration cells are used.