

EngA[®]

ENGINEERED AIR[®]

**INSTALLATION, OPERATION
AND MAINTENANCE MANUAL
FOR
H-TRAC**

Electric Heat (or staging) Control

INDOOR AND OUTDOOR MODELS



UNIT MODEL NO.

UNIT SERIAL NO.

SERVICED BY: _____

TEL. NO: _____

**CANADIAN
HEAD OFFICE
AND FACTORY**

1401 HASTINGS CRES. SE
CALGARY, ALBERTA
T2G 4C8
Ph: (403) 287-4774
Fx: 888-364-2727

**USA
HEAD OFFICE
AND FACTORY**

32050 W. 83rd STREET
DESOTO, KANSAS
66018
Ph: (913) 583-3181
Fx: (913) 583-1406

**CANADIAN
EASTERN FACTORY**

1175 TWINNEY DRIVE
NEWMARKET, ONTARIO
L3Y 5V7
Ph: (905) 898-1114
Fx: (905) 898-7244

SALES OFFICES ACROSS CANADA AND USA

Retain instructions with unit and maintain in a legible condition.
Please give model number and serial number when contacting
factory for information and/or parts.

www.engineeredair.com

TABLE OF CONTENTS

GENERAL	i
OPERATION	i
<i>Voltage or Current Operation</i>	<i>ii</i>
ADJUSTMENT POT LAYOUT	iii
HONEYWELL T991A SENSOR	iii
<i>Normal Operation Setting</i>	<i>iii</i>
H-TRAC Temp. Rise Calculation.....	iii
<i>Adjustment Pot Settings</i>	<i>iv</i>
MAXITROL SOLID STATE SENSOR/SET-POINT	iv
<i>Normal Operation Setting Deadband and Time Delay Pots</i>	<i>iv</i>
H-TRAC Temp. Rise Calculation.....	iv
<i>Adjustment Pot Settings</i>	<i>iv</i>
CALIBRATION POT	iv
<i>Initial Set Up (Factory)</i>	<i>iv</i>
<i>Field Calibration (Maxitrol Sensor, Set point Only TD114 and TS114 Systems)</i>	<i>v</i>
<i>Voltage or Current Interface</i>	<i>v</i>
<i>Normal Operational Settings Calibration (CAL) Pot</i>	<i>v</i>
<i>Span Pot</i>	<i>v</i>
<i>OIC Pot Adjustments</i>	<i>vi</i>
<i>Deadband and Time Delay Pot Adjustments</i>	<i>vi</i>
<i>Room Control</i>	<i>vi</i>
Room Set Up	vi
Set Up Procedure.....	vii
TROUBLESHOOTING	viii
T991A	viii
Control Cycles Properly but Not at Set-Point	viii
No Heat	viii
Sensor Check Out.....	viii
<i>Maxitrol</i>	<i>viii</i>
T991A	viii
Voltage or Current Control.....	viii
Overheating	ix
All Stages Continuously On	ix
<i>Sensor Check Out</i>	<i>ix</i>
<i>Maxitrol</i>	<i>ix</i>
<i>T991A</i>	<i>ix</i>
<i>Voltage or Current Control</i>	<i>ix</i>
<i>Calibration Problem</i>	<i>ix</i>
<i>Hunting (Large Stages)</i>	<i>ix</i>
<i>Hunting (Stage 1 and 2)</i>	<i>ix</i>

Some Stages Do Not Switch On ix

ENGINEERED AIR ELECTRIC HEAT CONTROLLER (*H-TRAC*)

If any errors or omissions are noted please contact Wade Pascoe at (403) 287-4775 or Fax (403) 287-4799 or (243-5059).

To ensure warranty is honoured, only a qualified HVAC service person that has received training on the H-TRAC should be employed for service and troubleshooting. If information is required please contact the nearest Engineered Air office.

The Engineered Air electric heat controller (*H-TRAC*) is a five stage **modified** binary weighted controller. It is designed to operate with solid state, electro mechanical, 4 to 20 ma, or 1 to 10 volts DC input. The H-TRAC also incorporates separate P and PI control schemes.

I. GENERAL

There are 2 versions of H-TRAC. A standard version, which operates with 3-wire slide wire control (*e.g. T991A Discharge Air Control or T921 room control c/w TS114 and TD114, TS114 Discharge Air Control*). The other, H-TRAC-I, works with above plus 0-10 VDC, 4 to 20 ma c/w TS 114 (*e.g. BMS or DDC controls*), except for T921 room control c/w TS114.

The H-TRAC is designed to control electric heat systems. It is a special design, which works best with progressively larger kilowatt electric heat coil stages. The control has five steps (*stages*). They do not switch in sequence but are designed with a logic system to give a total of 15 stages by switching the 5 stages in relation to their different kilowatt ratings.

The first stage is the smallest stage. Stage two is larger. Stages one and two have no time delay on them. The third, fourth and fifth stages are of the same capacity and larger than stages one and two. They each have a time delay built into them. The time delay period varies due to how far the temperature is from the control set point. The time delay could vary between 30 and 120 seconds. Typically, stages 1 and 2 operate on (P) proportional control and stages 3 to 5 operate on (PI) proportional and integral control.

The H-TRAC output is a modified binary controller. It's designed to utilize 5 variable sized stages to give the equivalent control of 15 equal stages. The electric heat coil may have some stages not controlled by the H-TRAC. For example they may be turned on/off by an outdoor ambient control.

For those stages controlled by an H-TRAC, they are best sized as follows:

- Stages 3, 4, and 5 would be the same (*i.e. 100 kW each*).
- Stage 2 would be ½ that of above (*i.e. 50 kW*).
- Stage 1 would be ½ that of stage 2 (*i.e. 25 kW*).

The H-TRAC will energize various combinations of the above coils to obtain the 15 equal output stages.

All the above features combine together to form a controller with fine temperature control, good response time and little system temperature droop.

II. OPERATION

The H-TRAC is actually two controllers built into one package. The small stage 1 and 2 are operated by the proportional (P) only control section. These stages **DO NOT** have time delays between stages. An instantaneous maximum heat call will immediately bring on stages 1 and 2.

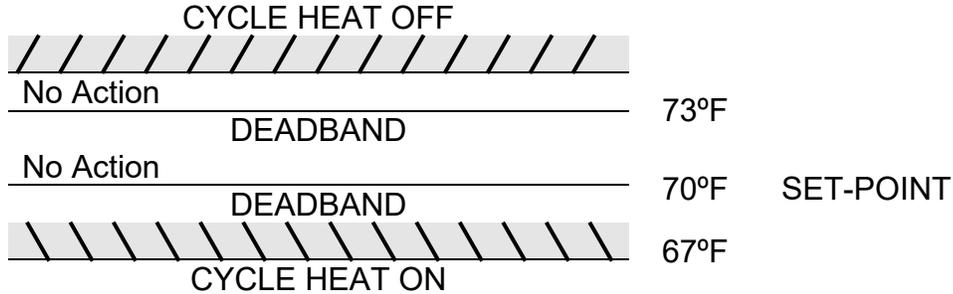
Stages 3, 4, and 5 are operated by the proportional integral (PI) control section. These stages **DO** have time delays between stages. The time delay is based on how far the temperature is from set point and the setting on the time delay pot (*TD*). The further the temperature is from set point, the shorter the time delay. The time delay numbers quoted in the set up procedures section are for maximum heat calls. If the temperature were close to set point the actual delay would be 3 to 8 times longer.

DEADBAND Defined as the temperature range in which the heat demand is satisfied and a PI controller takes no action.

Example: If the set-point is 70°F and the deadband is set for 6°, this means the temperature can range up to 3° in either direction before the PI controller will adjust the output.

$$3^\circ \text{ over} + 3^\circ \text{ under} = 6^\circ \text{ deadband}$$

A typical deadband example:



The **Proportional (P)** and **Proportional Integral (PI)** controllers inside the H-TRAC each have their own deadband. (A deadband within a deadband.) Each deadband will operate like the above example. Adjusting the main deadband pot will automatically adjust both deadbands. The inner deadband width is a non-adjustable percentage (%) of the outer value. The deadband width numbers quoted in the set up directions refer only to the outer deadband. Stages 2 through 5 use the outer deadband and stage 1 uses the inner deadband.

An LED indicating light is mounted on the back of the H-TRAC controller. During troubleshooting, the H-TRAC will have to be turned over to view the LED light. This light will come on whenever the temperature is outside the outer deadband. The light also indicates that the time delay between stages (*integral action*) is in operation. If this light is on long enough the H-TRAC will eventually cycle a stage on or off.

Stage 2 is synchronized to (*but not controlled by*) the indicating light. Therefore, under cycling loads the light and stage 2 will seem to operate together.

There is no indicating light for stage 1.

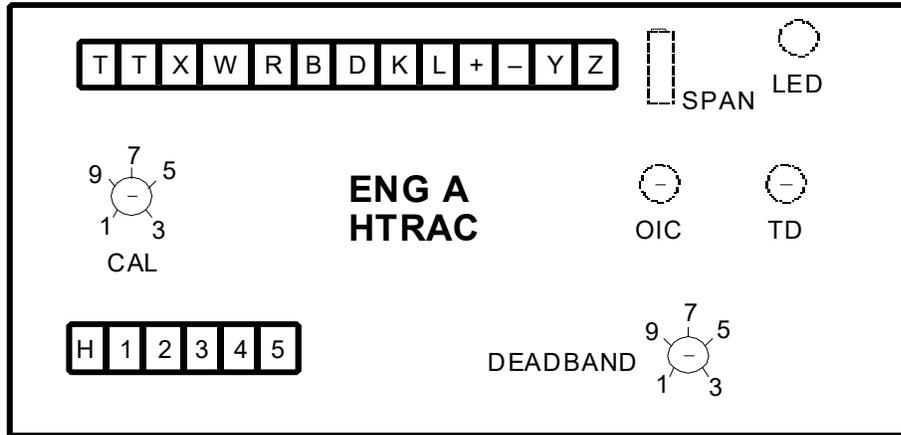
Voltage or Current Operation

The H-TRAC-I is designed to operate using a current or voltage signal from some external source (*often a building management computer*). This signal is interpreted by the H-TRAC as a reset signal. The adjustable reset amount is added to the minimum discharge temperature setting to give the required discharge set point. For this method of operation the H-TRAC requires a TS114 temperature sensor. The minimum set point is internally set on the CAL pot. For more information see the set up section.

NOTE: Field analog control inputs require signal isolation to prevent ground loop signal corruption and/or damage to the controller(s).

III. ADJUSTMENT POT LAYOUT

NOTE: Pots TD, SPAN, OIC and LED are accessible only from behind the H-TRAC.



SET UP

There are two potentiometers that are adjustable through the front of the control. Note that these are factory set. Adjusting these in the field may cause the control to operate in an unsatisfactory manner. We do not recommend adjusting these without accurately noting the settings so you can return to them.

The set up procedure will vary with the temperature sensing system connected to the H-TRAC.

NOTE: If the H-TRAC is being controlled by a CTRAC, adjust the deadband pot fully counter-clockwise. This sets the deadband to its maximum width (setting 9).

IV. HONEYWELL T991A SENSOR

A special T991A with last 4 digits 1756 (*fast response*) should be used.

There are **two** adjustment pots that must be set. These are the time delay (TD) and deadband (DB) pots. All the remaining pots are not used for the T991A operation.

Normal Operation Setting

H-TRAC Temp. Rise Calculation

No Ambient Stages

(i.e. unit does not have heating element controlled by ambient control. Refer to internal wiring diagram).

H-TRAC Temp. Rise = Unit Temperature Rise (*noted on unit nameplate*).

One Ambient Controlled Stage

H-TRAC Temp. Rise = Unit Temperature Rise x 0.6

Two Ambient Controlled Stages

H-TRAC Temp. Rise = Unit Temperature Rise x 0.43

Adjustment Pot Settings

H-TRAC TEMP. RISE	DEADBAND POT	TIME DELAY POT
10 - 50EF	3	7
51 - 75EF	4	6
76 - 100EF	5	5
Over 100EF	5	4

If excessive cycling or hunting of stages 3, 4 or 5 occurs, select the next lower time delay pot setting. Any temperature calibration required should be made on the T991A.

V. MAXITROL SOLID STATE SENSOR/SET-POINT

There are **three** adjustment pots that must be set for proper operation. These are TD (*time delay*), DB (*deadband*), and CAL (*calibration pots*). The remaining two pots are not used.

Normal Operation Setting Deadband and Time Delay Pots

The proper DB and TD settings must be based on the total temperature rise of the LMK heating unit.

H-TRAC Temp. Rise Calculation

No Heating Elements Controlled by Ambient Control

H-TRAC Temp. Rise = Unit Temperature Rise

One Ambient Controlled Stage

H-TRAC Temp. Rise = Unit Temperature Rise x 0.6

Two Ambient Controlled Stages

H-TRAC Temp. Rise = Unit Temperature Rise x 0.43

Adjustment Pot Settings

H-TRAC TEMP. RISE	DEADBAND POT	TIME DELAY POT
10 - 39EF	2	5
40 - 59EF	3	5
60 - 79EF	4	4
80 - 99EF	5	3
100 - 109EF	6	3
110 - 129EF	7	2

If stages **3, 4, 5** are hunting, the time delay pot setting should be set one number lower. If stages **1 and 2** are "**both**" hunting, the next larger deadband pot setting should be selected.

VI. CALIBRATION POT

Initial Set Up (Factory)

The CAL pot should be adjusted using the following procedure:

1. Set the DB pot to 1.
2. Connect a 10K resistor between terminals D and W.
3. Connect a 10K resistor between terminals D and B.
4. Observe the LED light. If the light is on adjust the CAL pot until the light goes out.

5. Reset the DB pot to its original position and remove 10K test resistors.

Field Calibration (Maxitrol Sensor, Set point Only TD114 and TS114 Systems)

NOTE: The calibration pot is very sensitive. One complete turn is the equivalent of 70°F calibration. Rotating the adjustment pot clockwise will decrease the output temperature.

Voltage or Current Interface

This method of control requires that all 5 adjustment pots be set. The voltage or current input signal acts like a reset signal to the internally adjusted minimum set point. Because of this, the H-TRAC requires a TS114 discharge air sensor. If the input signal is driven to 0 VDC or 4 ma, or disconnected from + and - terminals, the H-TRAC will discharge at the minimum set-point value. This adjustment is made on the CAL pot. The maximum discharge temperature is indirectly set and is calculated from the position of both the Span and the CAL pots. The term Span refers to the maximum amount of temperature reset that a full input signal will give.

MAX. DISCHARGE = MIN. DISCHARGE + SPAN

NOTE: On newer jobs where field wiring is incomplete, the unit will discharge cool temperatures.

Normal Operational Settings Calibration (CAL) Pot

In this mode of operation the calibration pot is used to set the minimum discharge temperature setting. This is the discharge temperature when either the input signal becomes 0 or the signal is lost.

<i>CAL Pot Setting</i>	<i>Default Temperature (EF)</i>
1	50
2	57
3	64

Span Pot

The span pot is used to set the sensitivity of the incoming voltage or current signal. The setting of the span pot added together with the minimum setting pot is the maximum allowable discharge temperature. The span pot is set by first de-energizing the H-TRAC controller and then by measuring the resistance (*ohms*) between terminals L and X. (*It is not necessary to disconnect the TS114 sensor.*) Adjust the multi-turn span pot according to the following table.

<i>L to X Resistance (ohms)</i>	<i>Span in EF (Max. Reset)</i>
130	10
150	20
164	30
175	40
182	50
190	60

Example: If the span pot was set for a 40 \square span and the minimum discharge temperature pot (*CAL*) was set to 55°F, the maximum discharge temperature would be 95°F.

OIC Pot Adjustments

The OIC pot is designed to calibrate the H-TRAC with respect to the incoming signal. The correct procedure for calibration is as follows:

1. Set the voltage or current signal to max. (*10 VDC or 20 ma*).
2. Measure the DC voltage from terminals Z to X.
3. Adjust the OIC pot until the voltage level from Z to X is equal to 6.0 VDC.

Deadband and Time Delay Pot Adjustments

As per Maxitrol adjustment procedure (*Page iv*).

Room Control

Room control requires both a T921 room sensor and a Maxitrol TS114 discharge sensor. This method of room control will not operate with H-TRAC-I models that are configured to operate with either 4-20 ma or 0 to 10 volts.

When the H-TRAC is controlling from the room it will use both the room and discharge sensors to modulate the discharge temperature. A room heat call will cause the H-TRAC to linearly increase the heat output. The amount of heat increase is dependent on both the linear response ratio and the throttling range of the T921 thermostat.

The TS114 discharge sensor will also act as a modulating high and low limit. This will prevent the discharge temperatures from operating outside of the designed operating range even if the filters are plugged or the fresh air dampers are open too much. These mod limits will automatically be selected when setting the OIC and CAL pots.

Room Set Up

The pots that will require set up are:

- Deadband (DB) set to position 1
- Time Delay (TD) set to position 2
- Calibrate (CAL)
- Linear Response Ratio (OIC)

The TD pot and the OIC pots are not accessible from the top of the H-TRAC. They must be adjusted from pots mounted on the back of the H-TRAC. Adjusting these pots will require moving the H-TRAC from the wiring panel. It may be possible to do so without removing the wires to the H-TRAC by removing mounting screws and carefully turning around.

The CAL and OIC pot settings are important and must be set according to the chart below and by carefully following the set up procedure.

REQUIRED TEMPERATURE OVERRIDE RANGE °F	OIC POT SETTING	CALIBRATION RESISTOR REQUIRED
50-90	1	10,000 ohms (0.25 watt)
50-95	2	"
47-97	3	"
44-100	4	"
38-104	5	"
46-122	6	9,530
38-129	7	"
42-145	8	9,090
37-149	9	"

If the proper resistors are not available a 10K pot or a Maxitrol TD114 temperature selector can be used. Connect to terminals 1 and 3 of TD114. Measure the resistance between 1 and 3 of TD114 and adjust the pot on back of TD114, not the pointer needle pot but the other one, which will have a seal on it, until the required resistance is read.

Before setting up the H-TRAC select the desired operating temperature range.

Set Up Procedure

1. The T921 room thermostat must be installed and connected to H-TRAC terminals W, B, L. (T921 terminal R is connected to H-TRAC terminal L, W to W, B to B.)

NOTE: If a pot is used instead of the T921 thermostat it **MUST** have 140 ohms resistance from terminals W and B. It does not matter what the T921 or pot is set for, the important thing is to have 140 ohms between W and B.

2. Disconnect the TS114 sensor.
3. Install the required calibration resistor in place of the TS114 sensor, from above.
4. Remove the jumper wire attached from H-TRAC terminal #Z to D.
5. Set the OIC pot to the values indicated in the above table.

NOTE: There are no markings on the OIC pot. The markings of the TD pot next to the OIC pot should be used as a reference.

6. For all cases, set the DB pot to position 1 and the TD pot to position 2.
7. Reinstall the H-TRAC and energize it.
8. The CAL pot must now be set. With the H-TRAC powered up and operating, adjust the CAL pot until the first stage cycles on or off.

NOTE: This pot is very sensitive and the accuracy of the temperature range calibration depends on this setting. Gradually rotate the CAL pot until stage 1 cycles again. The proper setting of the CAL pot is just between the point where the first stage cycles on and the point where it cycles off.

9. Remove the resistor and reinstall the TS114 sensor and the jumper wire from Z to D.
10. Check for the proper room operation. The throttling band on the T921 should be set. With the H-TRAC it will be possible to select a narrower throttling range than is normally selected. Recommend throttling range is 2-4 °F.

VII. TROUBLESHOOTING

NOTE: *If inlet air is warm disconnect the 3Ø or 1Ø, whichever is applicable, wiring to the electric heat coils. In this way, the contactors can be cycled without possible damage to the heat coil from overheating.*

T991A

Control Cycles Properly but Not at Set-Point

Adjust calibration set point after reading the paragraph about the "CAL" pot. Note that the "CAL" pot is not used with the 140-ohm control system. This system is calibrated at the 140-ohm control (*as per control manufacturers instructions*).

No Heat

1. Is there 24 VAC to terminals T + T? If not, check fuses, wiring, etc.
2. Measure the DC voltage from terminals Y to X. There should be 12 VDC present. If not, replace the H-TRAC.
3. Check the sensor and/or set point.

Sensor Check Out

Maxitrol

Measure the resistance of both the TS114 sensor and the TD114 set point. Both resistance readings should range between 9,000 and 11,000 ohms. If the resistance is out of range, replace the suspect control.

Note: *At 77°F (25°C) the reference resistance should be 10,000 ohms.*

T991A

Measure the resistance of T991A terminals B to W. It should measure 140 ohms. Measure the resistance from terminals R to B and the resistance from R to W. If you add both readings together the result should be 140 ohms. If the T991A resistance is okay connect terminals R and B to the H-TRAC controller or jump "R" to "B". (*Terminal W is not connected.*) If the heat starts to cycle on, replace the T991A controller. A Q209 manual pot may be connected to RBW terminals where R is the center tap of the pot. For a quick test a Q209 can be of any resistance range (*i.e. 135 ohms, 270 ohms, etc.*).

Voltage or Current Control

In both cases a Maxitrol TS114 sensor should be sensing the temperature. Remove it from the circuit and measure the resistance between terminals 1 and 2. The resistance should measure between 9,000 and 11,000 ohms. If not, replace sensor.

NOTE: *At 77°F (25°C) the reference resistance should be 10,000 ohms.*

If the sensor is okay check the DC voltage at the terminals marked + and -. If this signal is below 2 VDC the main building remote controller is not calling for heat. Adjust or repair field wiring or central control system.

If the integrating LED light is on, check for 24 VAC power from terminal H to ground. If there is not 24 VAC present, check the wiring and/or fuse.

Replace the H-TRAC controller.

Overheating

All Stages Continuously On

Check the sensor and/or set point.

Sensor Check Out

Maxitrol

Measure the resistance of both the TS114 sensor and the TD114 set point. Both resistance readings should range between 9,000 and 11,000 ohms. If the resistance is out of range, replace the suspect control.

Note: At 77°F (25°C) the reference resistance should be 10000 ohms.

T991A

Measure the resistance of T991A terminals B and W of T991A. It should measure 140 ohms. Measure the resistance from terminals R to B and the resistance from R to W. Add both readings together and the result should be 140 ohms. If the T991A resistance is okay, connect terminals R and W to the H-TRAC controller. (*Terminal B is not connected.*) If the heat starts to cycle off, replace the T991A controller.

Voltage or Current Control

Measure the resistance of the Maxitrol TS114 sensor. It should be between 9,000 and 11,000 ohms.

Note: At 77°F (25°C) the reference resistance should be 10,000 ohms.

Measure the DC voltage to terminals + and □. If this voltage is over 9 VDC the central building controller is calling for full heat. Adjust or repair field wiring or central control system.

Replace the H-TRAC controller.

Calibration Problem

Either overheating or underheating - refer to the set up section for your control method application.

NOTE: If the unit is being controlled by a central building controller it may be necessary to adjust or recalibrate the settings and/or sensing of the central system.

Hunting (*Large Stages*)

Decrease the setting on the TD pot by 1 setting.

Hunting (*Stage 1 and 2*)

Increase the setting on the DB pot by 1 setting.

Some Stages Do Not Switch On

Disconnect the temperature control device. Jumper "R" and "B". If all stages do not pull in, check and ensure that voltage is outputting from suspected faulty stage. If no voltage output is present, the H-TRAC is suspect. If voltage output is present the contactor is suspect.

NOTE: Substituting a 130 ohm pot as a temperature control on terminals "R", "B", and "W" should allow you to adjust to any desire point in stages of switching. Connect the centre terminal of the pot to "R".