

**EngA**<sup>®</sup>

**ENGINEERED AIR**<sup>®</sup>

**INSTALLATION, OPERATION  
AND MAINTENANCE MANUAL  
FOR  
C-TRAC2**

**COOLING CONTROLLER**

RECOGNIZED  
COMPONENT



**Intertek**

RECOGNIZED  
COMPONENT



**Intertek**

UNIT MODEL NO. \_\_\_\_\_  
UNIT SERIAL NO. \_\_\_\_\_  
SERVICED BY: \_\_\_\_\_  
TEL. NO: \_\_\_\_\_

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

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## C-TRAC2.1

### COOLING, ECONOMIZER, HEAT RAMP CONTROL

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

Any reference to C-TRAC or to C-TRAC2 in the following text applies to Model C-TRAC2.1. The Model 2.1 is similar to previous versions with the following changes:

- “HD” terminal added (0-10 VDC heat output)
- “ED” terminal added (0-10 VDC economizer output)
- Removal of pot 6

#### I. APPLICATION

The C-TRAC is designed to control cooling and economizer functions on Engineered Air cooling units. It also includes a heat output control signal.

#### II. SERVICE

To ensure warranty is honoured, only a qualified HVAC service person, who has received training on the C-TRAC2.1, should be employed for service and troubleshooting. If information is required please contact the nearest Engineered Air Office.

#### III. GENERAL

The C-TRAC2.1 is a discharge air temperature control that includes the option of connecting a reset control of some type to electronically modify the discharge temperature set point.

The C-TRAC2.1 is a general purpose, multi-function controller. The C-TRAC2.1 performs the following functions:

- Modulating heat output 8.5 VDC (from HT (+) and B (□) terminals)
- Modulating heat output 10 VDC (from HD (+) and B (□) terminals)
- Modulating economizer output (from R, B, W terminals) for 3 wire signal to series 90 damper actuators
- Modulating economizer output 10 VDC (from ED (+) and B (□) terminals) – 2 wire signal
- Switching for 5 stages of mechanical cooling

The C-TRAC2.1 always starts in heat mode. If cooling is required it switches to economizer to satisfy demand. If this is not adequate to satisfy demand, it switches to mechanical cooling.

The heating output supplies a DC voltage signal to operate the Engineered Air heating controllers. (*G-TRAC, G-TRAC2, DJM2, DJT-2, H-TRAC, 109 interface, 3 way mixing valves for hot water or steam heating.*)

The economizer has four choices of control thereby giving maximum operational flexibility.

The mechanical cooling switching has minimum run time, minimum off time, and inter-stage timing.

Each time the C-TRAC2.1 is first powered on the H and N terminals it begins its cycle in the heat mode. How quickly the C-TRAC2.1 will react, depends on how far the temperature at the discharge sensor is from the calculated set point. If the call is for cooling the C-TRAC2.1 will go to the economizer operation and try to satisfy the cooling demand. If that is not possible then the C-TRAC2.1 will bring on the mechanical cooling if the outdoor ambient is warm enough. This process could take as much as 20 minutes to switch from the heating mode through the economizer mode to the mechanical cooling mode.

## IV. WIRING

Power supply = 24 VAC @ 0.9 amps.

The C-TRAC2.1 terminals "H and N" require a separate 24 VAC, 20 VA class 2 isolation transformer supplying power to **only** "H and N". Often this is best to not have a grounded neutral as side stray voltages can interfere with C-TRAC operation and create strange operating situations.

Terminal "N" should be wired to the neutral which is common to the same power source supplying power to terminals ("E, A, K"). All remote wiring less than 50 feet long should be installed in clean electrical environments and attached to terminals "Q, U, X, Y, V, Z". Wire should be a minimum of 22 ga twisted pair wire. (*Shielded wire is best.*) For longer runs and electrically noisy installations, the use of a minimum 20 gauge-shielded wire is recommended. (*Shield should be grounded at unit end only, other end taped.*)

**NOTE:** *If there is to be an interruption of only the C-TRAC2.1 power such as by a time clock shutdown at night, there cannot be any other load connected to the C-TRAC terminals H, A, E, or K. If this wiring is not correct there may be about 18 volts on any components attached incorrectly when the C-TRAC2.1 has power turned off. This is the result of a feedback voltage which may cause certain output signals to stay energized. (E.g. It may keep a fan delay relay energized to keep fan running when not required.)*

## V. HEAT OUTPUT

The C-TRAC2.1 has a 0-10 VDC output ramp from terminals "HD and B", which can be used to control gas heat controls (*DJM2, DJT2, G-TRAC, G-TRAC2, 109 Interface*), electric heat (*H-TRAC*) or water coils, etc.

## VI. SYSTEM TIMINGS

The C-TRAC2.1 has two built in timing circuits.

1. Timing from heat to economizer to mechanical cooling modes varies depending on the error between calculated set point and actual discharge temperatures.
2. Inter-stage minimum run and minimum off time for compressors is 4 minutes.

## VII. DIP SWITCHES AND POTS

The C-TRAC2.1 uses a number of dipswitches and pots to set the parameters it will look at to set its control set point at. They are set at the factory to "customize" the control for its particular application on each unit. Changing any of these settings can destroy the control capability for your particular system.

- Option 1. Discharge air control. (*Only dipswitch 1 on.*)
- Option 2. Not used – for test purposes only. (*Only dipswitch 2 on.*)
- Option 3. Discharge air control with room or return air reset. (*As the room warms up the discharge temperature falls. Dipswitch 1 and 3 on, reset wired to "V, X, Y and Z"*).
- Option 4. Discharge air control with ambient and/or VAV reset. As the airflow increases or the ambient temperature increases the discharge temperature will be set downwards. (*Dipswitch 1 and 4 on, resistor network wired to "V, X, Y, and Z"*).
- Option 5. Discharge air control with the BMS reset signal of 4-20 ma or 0-10 VDC modifying the discharge temperature. (*As the signal strength increases above 12 MA or 5.5 VDC the discharge temperature is driven warmer; as the BMS signal falls below 12 MA, 5.5 VDC the discharge temperature is driven colder. Dipswitch 1 and 5 on, BMS reset wired to + and -.*)

**NOTE:** *At approximately 5.5 VDC or 12 ma input from the BMS there would be no reset occurring. As the BMS input voltage deviates from this voltage, the C-TRAC2.1 will reset the discharge up or down.*

The C-TRAC2.1 dipswitches will be set for operation as per the following table:

Option	SW1	SW2	SW3	SW4	SW5	REMARKS
1	On	Off	Off	Off	Off	Discharge control
2	Off	On	Off	Off	Off	Room control ( <i>not recommended</i> )
3	On	Off	On	Off	Off	Discharge control c/w room or return reset
4	On	Off	Off	On	Off	Discharge control c/w ambient reset
5	On	Off	Off	Off	On	Discharge control c/w 4-20 ma, 0-10 VDC BMS reset or inlet vane position reset on supply fans

The above systems that have a room sensor/set-point can have a night setback to lock off the mechanical cooling and economizer and reduce the heating set point at night. The setback is activated when C-TRAC2.1 terminal K has 24 VAC applied to it. During the time terminal K is powered, the discharge sensor is locked off so the C-TRAC control is just from the space sensor/set point. If the sensor is in the return air the supply fan must be turned on for the sensor to be able to sense space temperature.

To repeat, the pre-selected options are set at the factory by setting the dipswitches and pots. If the settings are not correct the C-TRAC2.1 will not be able to function as designed due to the logic chip receiving incorrect information.

On the following page is a list of adjustment pots on the C-TRAC.

First, note the newer C-TRAC2.1 does not have a P6 pot. Refer to page 6 for more information.

Second, in addition to the pots under the cover on the front of the C-TRAC, there are additional pots located on the back of the C-TRAC. The control needs to be moved off the back wall to access these pots.

- P8 Room or ambient reset deadband (refer to page 19 for more information).
- P9 BMS or valve reset (refer to page 19 for more information).
- P10 BMS calibration (refer to page 19 for more information).
- P11 Heating control band setting (refer to page 19 for more information).

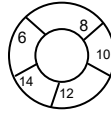


**VIII. POTS AND DIP SWITCH CHART**

**P1 NIGHT SETBACK**

To adjust the amount of heat for night below the room dial set point, first terminal "k" must be powered with 24 VAC on it. This locks off mech. cooling, econo and lowers the room heat by the temp set on pot.

**NOTE:** You need room sensor.



**SWITCHES**

1 to 5 selects option set point and sensors.

To test Discharge Air Control only switch 1=on, switches 2 through 5=off.

To test Room Control only

Switch 1 = off

Switch 2 = on

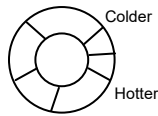
Switches 3 through 5 = off

Switches 6 and 7 are for economizer set up.

**SWITCH 8 IS TO SHORTEN MECH. COOLING TIMERS ENSURE ITS LEFT IN THE OFF POSITION WHEN YOU FINISH SERVICING.**

**P2 DISCHARGE CALIBRATION**

To calibrate the set point dial on the front of the C-TRAC2.1. To use this, "S" and "SP" must be jumped. If an external set point is wired to U, S, and M this is still the calibration pot. There will be no "S-SP" jumper with external set point.



**LED LIGHTS**

C-TRAC2.1 always starts in heat mode.

**HEATING** – light on, in heat mode.

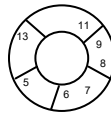
**NO HEAT OF COOL LIGHT** – Economizer operation.

**COOLING** – light on, in cool mode.

**INT. TIME DELAY LIGHT ON** – The discharge temp is not satisfied and the microprocessor is going to switch mode or adjust an output.

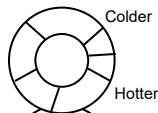
**P3 COOLING DEADBAND**

To adjust range in which discharge temp. will not switch cool stages.



**P4 CALIBRATION FOR ROOM RESET**

If the optional control is wired to terminals V, Y, X, Z.

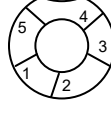


**P5 ROOM RESET FACTOR**

Adjusts amount of control the room thermostat has.

1 = maximum reset

5 = minimum reset



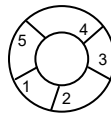
**P6 HEAT OFFSET FACTOR**

N/A on C-TRAC2.1.

On older C-TRAC's this pot sets deadband between heat and cool set point (heat output terminal HT and B). This ramped output is also affected by cooling deadband and type of heat control in use.

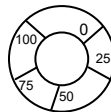
5 = min. offset

1 = max. offset



**P7 DAMPER MIN. POS. POT**

**Note:** Some units may use external pot.



## IX. STATUS LIGHTS

The C-TRAC2.1 has 4 status lights.

### **Heating Control Mode**

This light is on whenever the C-TRAC is in the heat mode (*the C-TRAC2.1 always starts in heat mode*).

### **Cooling Control Mode**

This light is on whenever the C-TRAC is in mechanical cooling mode.

**NOTE:** *If neither the heat nor cool light is on, the C-TRAC is in economizer mode.*

### **Compressor Ambient Closed**

This light is on whenever an externally mounted ambient control places 24 VAC on terminal "A".

### **Internal Timer**

If this light is off when the C-TRAC was power, the control is satisfied and the C-TRAC calculated set point and discharge temperatures are very close to each other. If it is on, the error between calculated set point and discharge temperature sensor is such that the control is timing to either change mode or increase/decrease the heat/economizer/mechanical cooling output.

## X. FAN CONTROL AND LOW LIMIT

These functions are **not** controlled by the C-TRAC2.1. Other devices, external to the C-TRAC2.1, supervise fan control and low limit.

## XI. CONTROL START-UP AND OPERATING STRATEGIES

The C-TRAC2.1 will always try to satisfy the discharge temperature. If the C-TRAC2.1 is unable to satisfy the discharge temperature in its current operating mode (*heating, economizer or mechanical cooling*) then it will switch into the next operating mode. Depending as to how far the discharge temperature is from the calculated desired discharge temperature determines how quickly the C-TRAC2.1 will switch to a different operating mode or adjust the output in the mode it is presently in. There are three operating modes:

- Heating (*heat light is on*)
- Economizer (*usually neither heat or cool light is on, the exception being constant economizer dipswitches 6 and 7 are off*)
- Mechanical cooling (*cool light is on*)

**NOTE:** *Remember the C-TRAC2.1 will always power up in the heating mode.*

When the C-TRAC is in mechanical cooling mode and the compressors are in operation, if the ambient control removes power from terminal A then the C-TRAC will go directly to heating mode. If there is no call for heat and the calculated set point wants cooling, it will return to economizer mode in a few minutes, then mechanical cooling.

### **Heat Output**

The C-TRAC2.1 always powers up in the heat mode. There are two possible heat output ramps to wire to depending on the application.

### **Heat Ramp Used on the Original C-TRAC**

The heat output control voltage is across terminals HT and B. The voltage varies from 0 VDC for no heat call, 0.75 for low heat call, modulating through to 8.5 VDC for high heat call. Note that certain older controls require a resistor network to reduce control voltage (*such as the original DJM which, if not for the resistor network, would be at high fire when there is greater than 4 VDC from the C-TRAC HT and B terminals*).

## Heat Ramp Used on the Revised C-TRAC2.1

This revision was made to Model C-TRAC2.1 in the spring of 1996. It has a 0 to 10-volt heat output ramp to modulate different heating controls (*G-TRAC, G-TRAC2, DJM2.1, H-TRAC, etc.*) The 0 to 10 VDC modulating output signal comes from the C-TRAC2.1 new terminal "HD" (*Positive*) and the existing "B" terminal (*negative*).

## Hot Water and Steam Heating

The heat output ramp can also be used to drive 2-way or 3-way mixing valves on hot water or steam coils on air handling units. These can be reverse or direct acting depending on piping and wiring of the mixing valves. Note that the output of the C-TRAC is not reverse acting. A resistor bridge network is required for actuators, which drive the above valves. Actuators can be 3 wire or 2-wire type.

## Simulate a Call for Maximum Heat

To simulate a call for maximum heat jump the discharge sensor connections Q and M and place the C-TRAC2.1 dip switches in the following positions. If the C-TRAC2.1 is in any other mode than heat at the time you perform this function, turn the power to the C-TRAC2.1 "off" for 10 seconds, then turn it back on. This will enable a faster response, as you will not need to wait for as many internal mode time delays.

- 1 - on
- 2 - off
- 3 - off
- 4 - off
- 5 - off

This has the C-TRAC2.1 operating strictly as a discharge air controller and the jumper forces the control to call for full heat, as its sensor input is now always cold.

Pots that affect the heat control on the original C-TRAC are pots 3, 6, and 11. The proper settings depend on the type of heating controller in use and the set point of the cooling deadband pot 3. **Pot 6 does not exist on the newer C-TRAC2.1 (it is a fixed value).**

Pot 11 (*on both original and new C-TRAC*) is the heat envelope pot. It is set to suit the type of heat exchanger and heat control being used.

*(On the original C-TRAC, pot 6 is the heat offset pot. This acts similar to the Honeywell T872 room thermostat as it sets up a deadband between the two levers. The C-TRAC pot 6 setting is from 5 to 0. When it's set at 5 there is very little offset and when its at 0 the heat set-point is at its furthest below the cooling set-point [the set-point on the knob].)*

## Economizer Control

Many units today use multiple 0 – 10 VDC direct acting motors. Most of these do not require shunt resistors.

The original C-TRAC had one economizer signal. It operates Honeywell series 90 motors from the "R, B", and "W" terminals on the C-TRAC and modulates the dampers by placing a slightly unbalanced voltage on the damper motor terminals "R, B", and "W".

The C-TRAC2.1 has added a 0 to 10 VDC economizer ramp. This will usually be operating the newer direct drive motors on the market today. There is a modulating output from terminals "ED" (*positive*) and "B" (*negative*). Zero volts is minimum position, ten volts is full fresh air.

If the discharge temperature is too hot the C-TRAC2.1 will energize the economizer after passing through the heating mode time delay. The length of time depends on the urgency of the overheating call. Typically this delay will be from 4 to 10 minutes.

The damper motor is normally on its own ungrounded isolated transformer.

The C-TRAC2.1 will use the economizer as another device to maintain the calculated discharge temperature.

## Minimum Pot Position

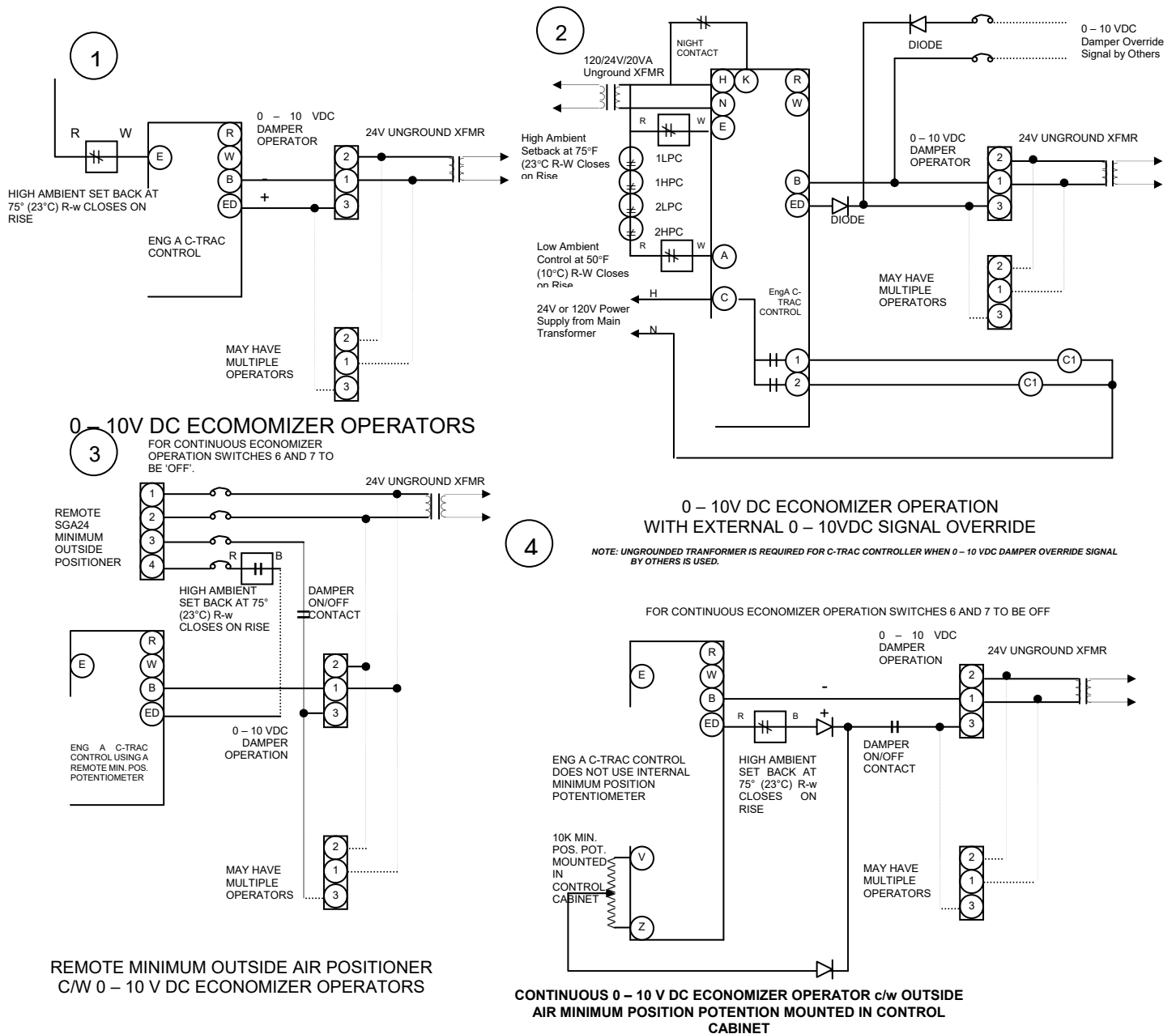
Pot 7 is the minimum position pot. When it is used it can be adjusted from 0 to 100% opening. The usual setting is in the 10% area if no other set point is specified. Note that the minimum position pot on the C-TRAC2.1 is not always in use. There are instances where a separate minimum position pot is being used. If a separate minimum position pot is being used it is usually located in the damper motor and pot 7 should be left at 0 position.

**BMS Minimum Position Reset**

Some applications require that BMS systems take control of the minimum OA position for smoke control or to maintain building static by supplying a 0 – 10 VDC signal to the C-TRAC 2.1. This method would require a diode to be placed on 'ED' terminal and another diode on remote signal wire to eliminate feedback problem. (See drawings).

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

**SAMPLE WIRING FOR 0 – 10 VDC MOTORS**



**The economizer is to be configured** to one of the following operation modes:

1. Dampers go to minimum fresh air position whenever the first compressor starts. (*Dipswitch 6 OFF and dipswitch 7 ON.*)
2. Dampers go to minimum fresh air position whenever the outside enthalpy or the outside temperature is high. (*Dipswitch 6 is ON and dipswitch 7 is OFF with a 24-volt ac input to terminal E.*)

**NOTE:** *The power applied to terminal E must be from the same source as the power supply to the C-TRAC2.1 terminal H.*

3. A combination of 1 and 2 (*dip switches 6 and 7 are both ON*).
4. Constant compressor load (*dip switches 6 and 7 are both OFF*). In this mode of operation the C-TRAC2.1 will try to operate with maximum outside air. If the cooling demand drops off, instead of shutting off a compressor, it will first throttle back the inlet air damper. If there is still not enough load in the return air the compressor will be cycled off. This will maintain a more constant compressor load and keep the discharge temperature satisfied while minimizing compressor cycles. Operation in this mode will require an external economizer ambient lockout and separate minimum position pot. For the 0 – 10 VDC 2 wire damper motor signal a 10K OHM pot is used externally or the SGA24 **remote** minimum pot can be used externally. When a 10K OHM pot is used ensure that the diodes are placed in proper 'bias'. (*See drawing for various options*). For the 3 wire Honeywell damper motors wired to RBW a minimum position pot such as Q209 or S9638 is used.

## Cooling

### Compressor Ambient Lockout

The mechanical cooling cannot operate unless the outside ambient is above a pre-selected limit. The ambient control is a separate control that is wired to the C-TRAC2.1 terminal A. When the outside temperature is above the set-point of the ambient control then a 24 VAC signal is applied to terminal A. The C-TRAC2.1 is able to cycle on the cooling stages.

**NOTE:** *Use the same 24 V power on terminal A as is being used to power the C-TRAC2.1 terminal H.*

The discharge air set point is the same for both the economizer and the mechanical cooling.

### Cooling Delays

The C-TRAC2.1 contains time delays for minimum run, minimum off, and inter-stage timing. These delays are all a non-adjustable 4 minutes. For service purposes turning on dip switch 8 can shorten the above delays.

**NOTE:** *This switch must be left in the off position during normal operation. If it is left 'on' it may result in compressor failure or lack of control stability.*

In addition to the above delays there may also be a cooling integral demand delay. This delay is calculated by the C-TRAC2.1 based on time and demand. This delay is non-removable and ranges in time from 1 to 8 minutes.

If the compressor ambient control is switched while compressors operating, the C-TRAC 2.1 will switch to heating mode as it thinks that the ambient was too cold for compressors to run!

### To Simulate a Call for Full Cooling

To simulate a call for full cooling open circuit the discharge air sensor by removing the wires from either "Q" or "M".

## XII. BURNER OPERATION

Burner operation is supervised by controls outside the C-TRAC2.1. In many applications the C-TRAC2.1 will supply a modulating 0-10 VDC signal to control the burner control module (*i.e. DJM, G-TRAC, etc.*) which in turn modulates the burner.

### XIII. TEMPERATURE CONTROL – GENERAL OVERVIEW

#### *Discharge Temperature Calculation*

**NOTE:** *If any resets are not connected but the switch is on, the discharge temperature will be affected. This is especially true of BMS systems that have not been wired in but the control was specified for it.*

The C-TRAC2.1 is designed primarily as a discharge air control. However, the discharge temperature can be reset up or down if a reset control is connected to the system. The C-TRAC2.1 has the ability to modify the discharge temperature by any of the following:

- The temperature at the optional room sensor.
- The temperature at the optional return air sensor.
- The temperature at the optional outside air sensor.
- The position of an optional VAV damper sensor.
- An input signal from a Building Management System (*BMS*).

If any optional reset controls are used, a calculation is done by the C-TRAC2.1 to select the corrected discharge temperature to satisfy the conditions of all the sensors and set points.

**NOTE:** *The reset can drive discharge temperatures up more than down in all applications (e.g. up 20 or down 7) except BMS (which will reset equally up 20, down 20).*

#### **Example:**

In all applications there is a discharge sensor and a discharge set point. We will assume a 55°F discharge set point. If no other control were activated on the C-TRAC2.1 it would maintain a 55° discharge. If, however, there were an optional room sensor at 69° and a remote room set point at 72°, then the space needs less cooling. The calculated discharge temperature would be adjusted up to a higher temperature to conserve energy and avoid overcooling the space.

If the room sensor temperature rose to 75° and the remote room set point is at 72° then the C-TRAC2.1 will bring on more cooling to cool the space.

If the C-TRAC has any reset option enabled, the discharge set point should not be set below 60°F as the reset could drive the discharge temperature very low.

The amount and rate of the reset depends on the authority given to the room control by the room reset factor pot (*pot 5*) and how far the room and discharge temperatures are from their respective set-points.

### XIV. SENSORS AND SET-POINTS

The C-TRAC2.1 is designed to operate with **JOHNSON CONTROLS TE 6000-960** sensors and **TE 6100-960** sensor/set-point dial or equivalent. This is nearly linear from □40 to +140°F. Following is a resistance temperature graph (*Page 15*).

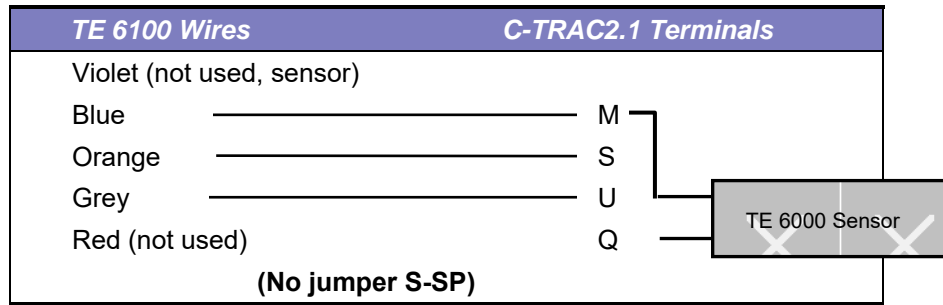
If a **JOHNSON CONTROLS TE 6100-960** combination sensor set point is used, it is not necessary to use both functions at the same time. In fact many applications use only the sensor or the set-point function in a "remote" application.

#### ***The Master Set-Points***

The master discharge air set point is the same for both the economizer and the mechanical cooling. The heating set point is offset below the cooling set point. (*This is similar to the offset between the levers on a T874 thermostat, which allows a deadband between the two set points. The deadband will not allow the control to cycle between the heating and cooling.*) This procedure is covered in the **HEAT OUTPUT** section.

As a MASTER SET POINT, the C-TRAC2.1 is designed to use either:

- The set point mounted on the face of the C-TRAC2.1 (*range of 10-35°C or 52-95°F*). If the C-TRAC2.1 face mounted set-point is used, terminals "SP and S" must be jumped, or;
- The Johnson TE 6100-960 set point (*range of 50-85°F and usually remote mounted*). If the TE 6100-960 is used as a set-point, "S to SP" are not jumpered and the TE 6100 must be wired to U, S and M:



**The Optional Reset Inputs**

May be controlled from room temperature, ambient temperature, voltage, or current input. The BMS voltage/current, room and ambient temperature resets will reset SPC in both directions.

The resets permit electronically changing the “calculated set-point” if external reset devices are wired correctly and the appropriate dipswitches are configured correctly. The “calculated or operating discharge air set-point” is the mathematical addition of the master set point and **one** optional reset signal.

If an ambient room override set point is used it is wired to the “Z, X, Y”, and “V” terminals. This is used on any override except the BMS control or a VAV system.

The BMS reset does not have a set point on the C-TRAC2.1. It is controlled from the BMS system. Refer to Section XVII.

**Night Heat**

In addition the control can be activated for night heat if configured and wired correctly. See below for details. Night heat operates best on units with return air. Night heat is not as compatible with units designed to operate as 100% "make-up air" because at night the unit will have to open the outside air dampers and heat outside air, which is not truly cost effective. If there is a modulating or single stage room thermostat connected to terminals “X, V, Y, and Z” the night heat function will be activated when terminal “K” is powered.

The only exception to “discharge air control” is when the C-TRAC2.1 is wired to provide space temperature control at night (*OPTIONAL*). During this night time operation the discharge sensor acts as a modulating high limit and controls discharge air temperature to approximately 110°F to 140°F.

**XV. INDUCED VOLTAGE ON REMOTE CONTROL WIRING**

Following are a number of discharge temperature reset methods. This also applies to remote set points, sensors, etc. When any of these are ordered at the time the unit is manufactured the control is calibrated at the factory and this calibration will satisfy most applications unless resistance from long wiring runs or induced voltage on the remote wiring cause it to be out of calibration. (*To check for induced voltages, disconnect all of the field wiring in question from the C-TRAC2.1 while the unit is operating, and check for AC volts across each questionable wire and ground.*)

**XVI. NIGHT HEAT THERMOSTATS**

Requires TE 6100-960-room thermostat c/w dipswitch 3 to be “on”. When terminal “K” is powered, cooling functions are disabled (*i.e. no economizer or mechanical cooling*). The TE 6100-960 set point is then set back a number of degrees as selected by pot 1 NSB (*night setback*). Heat is fired and maintained around a point between 110°F to 140°F as the TE 6000-960 discharge air sensor starts to conduct and operate as a modulating high limit.

**Night Setback**

Night setback is initiated by energizing terminal K with 24 VAC.

**NOTE:** Use the same 24 VAC power that is used to power the C-TRAC2.1. This terminal will lock off the mechanical cooling and the economizer when it is activated.

During night setback the room temperature will be lowered by an adjustable amount as set on the C-

TRAC2.1 pot 1 (NSB). The discharge sensor is locked off at night and control is from the room sensor/set-point only.

**NOTE:** *The room sensor must be present for this option to operate. (It also requires that dipswitch 3 is on for night setback to operate.)*

If there is a call for heat at night the discharge sensor will act as a discharge air modulating high limit. This is not field adjustable and will vary between 120 and 150°F. Due to heat lag at the sensor it may be possible that the control high limit may cycle the heater on and off.

## XVII. ROOM RESET THERMOSTAT OPTIONS

### Options

#### Reset of the Discharge Set-Point from Other Controls

- Room Reset
- Return Air Reset
- Outside Ambient Reset
- VAV Reset
- 0 to 10 VDC or 4 to 20 ma Reset

#### TE 6100-960 Set-Point Controller Connections

When using the numbers TE 6100 and TE 6000 note that they are a Johnson Controls part number. There are controls from other suppliers with different part numbers that may be substituted. The values must be equivalent to the Johnson line.

The TE 6100-960 can be used for two functions. The first is as a discharge temperature set point, for which it will be wired to terminals "M, S", and "U". The second use is to reset the discharge temperature from either space or outdoor ambient temperatures. In this application it will be wired to terminals "V, Z, X" and "Y". Refer to the unit-wiring diagram to determine the usage of any TE 6100-960.

A discharge set-point knob on the front of the C-TRAC2.1 is usually used as the set point. If it is in use the C-TRAC2.1 terminals "S" and "SP" will have a jumper across them.

**NOTE:** *If a TE 6100-960 is being used as a remote discharge set-point, the "S" and "SP" terminals on the C-TRAC2.1 will not be jumpered.*

#### Option 1 – Combination Sensor/Set-Point

If the TE 6100-960 is being used as a room reset device it is usually used as a combination sensor/set-point.

TE 6100 WIRE COLOUR	C-TRAC2.1 TERMINAL	PURPOSE
<b>Room reset sensor/set-point</b>		
<b>Blue</b>	_____ V	Room reset set point +
<b>Grey</b>	_____ Z	Room reset set point □
<b>Orange</b>	_____ Y	Room reset centre tap
<b>Violet</b>	_____ X	Room sensor

#### Option 2 – Remote Discharge Set-Point with Separate Discharge Sensor

Although two separate controls can be employed (*one as the sensor in the space and one as a reset set point located in a room where it cannot be tampered with*).

TE 6100 WIRE COLOUR	C-TRAC2.1 TERMINAL	PURPOSE
---------------------	--------------------	---------



Discharge sensor/set-point		
Blue	_____ M	Discharge set-point +
Grey	_____ U	Discharge set point □
Orange	_____ S	Dis. S.P. centre tap

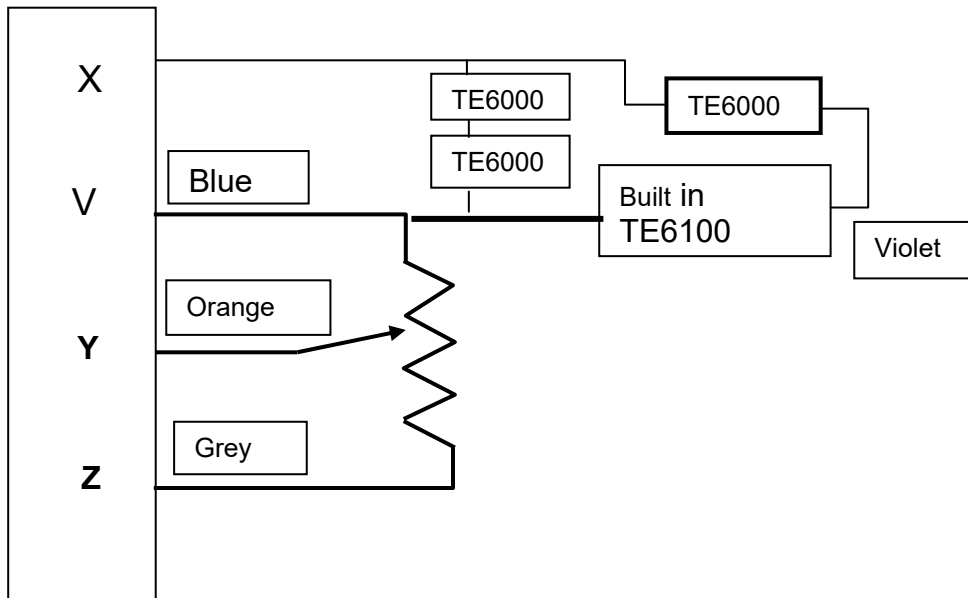
**NOTE:** Do not use the sensor (violet wire) on the TE 6100-960 if it is being used only as a remote discharge set point.

Use a separate TE 6000-960 sensor for a discharge sensor

Violet	_____ M	Discharge sensor +
Violet	_____ Q	Discharge sensor □

**Option 3 – Room Sensor Only**

If the TE 6100-960 is being used as a room sensor only use the violet and blue wires.

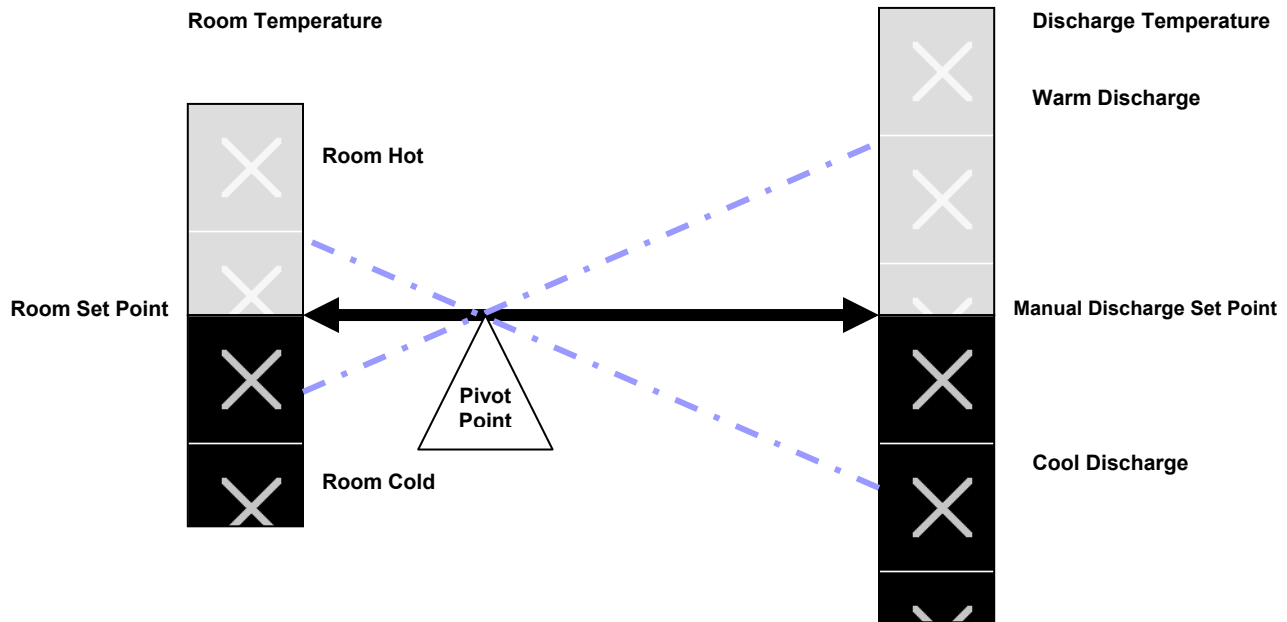


**Multiple Room Sensors**

Four sensors can be wired to give an average reading of room temperatures to the TRAC control. They must be wired in a series/parallel arrangement. The drawing above drawing shows a circuit making use of the built in sensor in the TE6100 Johnson Sensor/Setpoint assembly and using TE6000 sensors for the other three. (The other three could also be TE6100, just using the sensor wires .)

**TE 6100-960 Room or R/A Set-Point/Sensor c/w Dipswitch 3 “on”.**

**RESET CONTROL**



<i>Room stat satisfied</i>	<i>Unit controls discharge temperature as per discharge set point.</i>
<b>Room temp. colder than set-point</b>	Unit controls discharge temperature as per discharge set point plus selectable amount on pot 5 ( <i>room-reset factor</i> ).
<b>Room temp. hotter than set-point</b>	Unit controls discharge temperature as per discharge set point minus selectable amount on pot 5 ( <i>room-reset factor</i> ).

**4-20 ma or 0-10 VDC BMS Reset Signal**

Discharge air control with the BMS reset signal of 4-20 ma or 0-10 VDC modifying the discharge temperature. (As the signal strength increases above 12 MA or 5.5 VDC the discharge temperature is driven warmer; as the BMS signal falls below 12 MA, 5.5 VDC the discharge temperature is driven colder.)

**NOTE:** At approximately 5.5 VDC or 12 ma input from the BMS there would be no reset occurring. As the BMS input voltage deviates from this voltage, the C-TRAC2.1 will reset the discharge up or down.

**NOTE:** If the control is set up for a BMS signal and that signal is not connected, the C-TRAC will interpret the lack of voltage as a full call for reset downwards. If the BMS signal is not connected the BMS dipswitch should be off.

The BMS signal is wired to the optically isolated “+” and “□” terminals.

Pots 9 and 10 relate to BMS reset. As described below, pot 10 is the calibration pot.

Pot 9 determines the amount of authority being given to the BMS reset. Setting "2" allows ±4° and setting "5" allows as much as ±25°F on a 0 to 10 VDC system (±20° on a 4 to 20 ma system).

**Calibration for BMS Configuration**

- Set dipswitch 1 "on", and dip switches 2, 3, 4 and 5 "off".
- Calibrate the discharge sensor first **using the method below**.

Approximate relationship between 0-10 VDC and 4-20 ma signal is:

VDC	Ma	
0	0	<b>Note:</b> Zero reset considered to be about 5.5 VDC or 12 ma less is resetting down to cooler discharge greater is resetting up to warmer discharge
2	3	
4	8	
5	10	
6	12	
8	16	
10	20	

**Calibration Method 1**

Remove the discharge sensor and install a 1000-ohm 1% ¼ watt resistor in place of the sensor. Adjust the discharge set point until the internal time delay activated light goes off, and is mid way between the two on points. Set the incoming signal to either 12 ma or 5.5 VDC. Turn on dipswitch 5. Gradually adjust pot 10 (*mounted on the underside of the board*) until the internal time delay activated light goes off, and is mid way between the two on points.

**Calibration Method 2**

Install the temperature simulator pot and adjust the simulator temperature pot until the internal time delay activated light goes off, and is mid way between the two on points. Set the incoming signal to either 12 ma or 5.5 VDC. Turn on dipswitch 5. Gradually adjust pot 10 (*mounted on the underside of the board*) until the internal time delay activated light goes off, and is mid way between the two on points.

**XVIII. CALCULATED SET-POINT**

The calculated set point is an internal calculation of the C-TRAC electronics. If no reset devices are activated (*dipswitches 2, 3, 4, 5 are off*). The calculated set point and set point knob are the same value. If, however, one of the reset functions is activated, the calculated set point also includes the affect of that reset devices desire to adjust the set point up or down.

**XIX. DISCHARGE TEMPERATURE SENSING**

A duct sensor senses discharge temperature. There are often two discharge sensors on the C-TRAC, one for heat control and one for cool control. A relay will switch between them. This is to avoid hunting problems introduced by the thermal mass of the cooling coil.

**XX. SET-POINT CALIBRATION**

Set point calibration should not need to be done as it was set at the factory. The Johnson Control TE 6000-960 and the TE 6100-960 combination set point and sensor is pre-calibrated at Johnson's factory. The Engineered Air C-TRAC2.1 has been calibrated at the Engineered Air factory.

1. To determine what control options this C-TRAC is configured to operate with check the wiring diagram, control function, or C-TRAC dipswitch settings. The types of control are listed below.
2. Locate the dipswitches under the removable cover. Write down their present settings. After calibration **return the switches to their original settings.**

SW1	SW2	SW3	SW4	SW5	REMARKS
On	Off	Off	Off	Off	Discharge control
Off	On	Off	Off	Off	Room control ( <i>not recommended</i> )
On	Off	On	Off	Off	Discharge control c/w room or return reset
On	Off	Off	On	Off	Discharge control c/w ambient reset
On	Off	Off	Off	On	Discharge control c/w 4-20 ma, 0-10 VDC or vane position reset

Calibrate the required individual sensor and set points combination in the following order. Do not attempt to calibrate any application listed below that is not part of your application.

1. Discharge (*first*).
2. Room, return, or ambient (*second*).
3. Current, voltage, or vane position (*last*).

**TE 6100-960 Johnson Controls Set-Point/Sensor Approximate Resistance**

SENSOR (purple and blue)		Same resistance as TE 6000-960	
		Set-Point Dialed To	
		60 degrees	90 degrees
POT	(orange and grey)	2.725 K Ω	3.272 K Ω
	(orange and blue)	3.184 K Ω	2.702 K Ω
	(blue and grey) 970 Ω		
OTHER	(purple and orange)	4.19 K Ω	3.71 K Ω
	(purple and grey)	About 1.981 K Ω ( <i>varies with element temp.</i> )	

**Sensor Resistance Chart for TE 6100-960 and TE 6000-960**

°C	°F	Resistance Ω	°C	°F	Resistance Ω	°C	°F	Resistance Ω
-40	-40	602-605	18.3	65	983	48.9	120	1234
-34.4	-30	633	20	68	996	54.4	130	1269
-28.9	-20	665	20.6	69	1000.7	60	140	1333
-23.3	-10	698	21.1	70	1005	65.5	150	1365
-17.8	0	732	23.9	75	1026.5	71.1	160	1437
-12.2	10	768	26.7	80	1048	76.7	170	1491
-8.7	20	804	29.4	85	1070	82.2	180	1546
-1.1	30	842	32.2	90	1092	87.7	190	1602
4.4	40	881	35.6	95	1116	93.3	200	1659
10	50	921	37.8	100	1139	98.8	210	1718
12.8	55	941.5	43.3	110	1186	100	212	1778

*Reference resistance is 1035 ohms at 77°F. Resistance tolerances are ±0.05 to 0.15% at 77°F. Temperature range +32 to +104°F. (TE 6100-960 pot is 53C3, 500R, 7/8 by ¼ shaft.)*

**NOTE:** Engineered Air's design discharge temperature range is 30 to 140°F.

**Discharge Temperature Calibration Methods**

Where the following text calls for a resistor to be substituted into the circuit it must be a 1% tolerance resistor.

**Discharge Calibration Method 1**

- Ensure dipswitch 1 is "on".
- Set dipswitches "2, 3, 4", and "5" to the "off" position. This disables all set-point resets. You are now in discharge control mode only.
- Ensure no signal (24 VAC) is on the night setback terminal K.
- If there is no heating control connected to C-TRAC2.1 terminals HT and B, place a 10,000-ohm resistor across them.
- Ensure the C-TRAC2.1 is in the heat mode. If it is the heat light will be on. If the light is not on disconnect power to the C-TRAC2.1 and reenergize it. This will place it in the heat mode for a while.

- Measure the temperature at the discharge sensor (*TE 6000-960*). This must be an accurate measurement taken right at the sensor. On some units there are two TE 6000-960 sensors that get switched by a relay depending on what function the C-TRAC2.1 is in. The D/A sensor before the cooling coil is for heating, the one after for cooling.

**NOTE:** *If there is not a stable discharge temperature it will not be possible to calibrate accurately. It may be necessary to stabilize the discharge temperature in some way during this procedure.*

- Adjust the discharge set point to read the same as the temperature at the sensor.
- Adjust pot 2 until the output voltage across terminals HT and B just falls to 0 VDC.

## Discharge Calibration Method 2

SET DIP SWITCHES AS IN 1

- Accurately measure the discharge temperature (*average of multiple readings*). Adjust pot 2 until the discharge temperature average matches the setting of the discharge set point. This process may require several sets of readings and adjustments.

## Discharge Calibration Method 3

SET DIP SWITCHES AS IN 1

- Accurately (*average of multiple readings*) measure the discharge temperature. Quickly (*10 seconds max.*) set the discharge set-point to the read average discharge temperature, and quickly adjust pot 2 until the time delay activated light goes off, and is in the middle of the light off deadband.

## Discharge Calibration Method 4

SET DIP SWITCHES AS IN 1

- Set the discharge set point to the required set point. Connect the discharge temperature simulator and set the simulator temperature dial to the required set point. Adjust pot 2 until the internal time delay activated light goes off, and is midway between the two on points. This method does not compensate for sensor calibration or sensing location errors.

## Room or Return Air Temperature Calibration Methods

Room sensors can be a single sensor located in the centre of the space, or can consist of a number of sensors wired in a series/parallel configuration. If an average condition is being measured and you only measured the temperature at one sensor, your calibration will not reflect the average condition.

### Room Calibration Method 1

SET DIP SWITCH 1 ON AND 2, 3, 4, 5 OFF

- Measure the temperature at the room or return sensor. Set the room or return set point to the measured value. Set the discharge set point (*usually knob on C-TRAC*) to a point that the internal time delay light is off. Turn on dipswitch 3. If the internal TD light comes on, gradually adjust pot 4 until the internal time delay activated light goes off, and is mid way between the two on points.

### Room Calibration Method 2

SET DIP SWITCHES AS IN 1

- Attach the temperature simulator pot in place of the room or return sensor and set the temperature simulator pot to the desired calibration temperature. Set the room or return set-point pot to the same temperature. Gradually adjust pot 4 until the internal time delay activated light goes off, and is mid way between the two points. This method does not compensate for sensor calibration or sensing location errors.

## Ambient Reset Calibration

- First check discharge calibration by turning dipswitches “2, 3, 4” and “5” OFF. Ensure dipswitch 1 is ON

and calibrate discharge set point by connecting 1000Ω resistor across terminals “Q” and “M”. Set the discharge air set point to 70°F and adjust pot 2 (*discharge calibration*) until the internal time delay light is off.

- Next, turn dipswitch 4 ON to activate ambient reset feature. Disconnect the ambient sensor leads at the ambient sensor (*usually TE 6000-960*) and wire an 881 Ω resistor across the leads in place of the TE 6000.
- Adjust pot 4 until the internal time delay light shuts off. This completes the actual calibration. (*881Ω resistor, above, equates to 39°F at which point no reset is to occur.*) This checkout procedure is for a C-TRAC2.1 wiring diagram with resistor value of 324Ω wired between C-TRAC2.1 terminal V and the ambient sensor. If this resistor is not a 324Ω (*the most common version*), but is either a 402 or 365 ohm, this calibration will be slightly off.

This calibration results in the discharge temperature calculated set point being warmer at 80°F outside air temp and maximum downward reset occurring at 20°F outside air temp. The bandwidth of the reset is adjustable on pot 8. (*See C-TRAC2.1 set up sheets on Page 19 for values.*)

**Suggested Settings Re Hunting Problems**

C-TRAC2.1 with DJM may modulate through 20 degrees.

DJM-2 This control has a different response time and should give reduced temperature swings.

Refer to DJM2 Manual.

C-TRAC2.1 with G-TRAC with TE 6000-960 discharge sensor – may modulate through 20 degrees.

Set C-TRAC Pots	Set G-TRAC Pots
<b>P3 = 6 min. as high as 9</b>	P5 = 2
<b>P6 = 5 ***</b>	P6 = 4
<b>P11 = 2</b>	P8 = 4

C-TRAC2.1 with G-TRAC and hyper sensor – may modulate through 10 degrees.

Set C-TRAC Pots	Set G-TRAC Pots
<b>P3 = 6 min. as high as 9</b>	P5 = 2
<b>P6 = 5 ***</b>	P6 = 4
<b>P11 = 2</b>	P8 = 4

\*\*\*On C-TRAC2.1 pot 6 does not exist.

### ***LOCK-UP – Radio Frequency Interference***

When all regular troubleshooting items have been addressed about possible lock-up problems, look at this possible problem.

There have been some chips manufactured about mid 1995 that may lock up, often very shortly after a spark starts. This is often an intermittent problem and if the unit is equipped with a DJM2 it may also lock up without any lights "on". (*However, in some cases, some lights may be "on"*). If you witness this problem you will note that just after the combustion fan goes to light off speed the lockup will occur within a fraction of a second of the spark ignition beginning. Usually a pilot does not get time to light. The unit will reset if power is turned off for 30 seconds and then restored.

The spark creates radio frequency noise or radio frequency from some other source interferes with the electronics. This problem can also occur on units that have no spark but some other radio frequency source is nearby.

Installation of a radio frequency filter will resolve the problem. Disconnect the wires from "H" and "N" on the C-TRAC2. Connect them to the RFI filter. Connect the outlet of the filter to the "H" and "N" terminals with wires no longer than six inches in length if possible. Ensure the RFI filter is well grounded.

A filter that will resolve this problem is available at most electronics wholesalers. One we have used successfully is the CORCOM model 1VK1 EMI filter:

L-2X1.86 MH  
C-2X.1UHF (x2) SH  
2X.0055UF (Y)  
R-1.5 megohms

**XXI. C-TRAC2.1 SET UP SHEET**

<b>C-TRAC2.1</b>		JOB # _____	TAG # _____	DATE _____					
	DISCHARGE ONLY	DISCHARGE C/W ROOM RESET	DISCHARGE C/W 4-20 / 0-10 RESET	DISCHARGE C/W AMBIENT RESET	DISCHARGE C/W VAV POS RESET	ROOM ONLY			
Dip Switch 1 _____	ON	ON	ON	ON	ON	OFF			
Dip Switch 2 _____	OFF	OFF	OFF	OFF	OFF	ON			
Dip Switch 3 _____	OFF	ON	OFF	OFF	OFF	OFF			
Dip Switch 4 _____	OFF	OFF	OFF	ON	OFF	OFF			
Dip Switch 5 _____	OFF	OFF	ON	OFF	ON	OFF			
Dip Switch 6 _____	ON – WHEN TERMINAL E IS POWERED, THE DAMPERS GO TO MINIMUM POSITION								
Dip Switch 7 _____	ON – WHEN COMPRESSOR NUMBER ONE IS ON, THE DAMPERS GO TO MINIMUM POSITION								
If switches 6 and 7 are both off, the damper locks out and min. pos. must be external to C-TRAC. The C-TRAC will continuously modulate the damper during mechanical cooling. If there is an economizer, set switches 6 and 7 to the ON position.									
Dip Switch 8 _____	ALWAYS OFF _____ (Service Switch)		FOR ALL APPLICATIONS ALWAYS OFF						
POT NUMBER (The actual Pot labeling is shown in brackets.)									
1. NIGHT SETBACK (NSB) _____	Not Used	5,7,10,12,14°F	Not Used	Not Used	Not Used	5,7,10,12,14°F			
(Use only if terminal K is powered during night operation and C-TRAC is fitted with a room sensor.)									
2. DISCHARGE CALIBRATION (DIS CAL) _____ will be set by PRODUCTION, as required.									
3. COOLING DEADBAND (COOL DB) _____									
		0 or 1 COOLING STAGE = 8°F	2 COOLING STAGES = 7°F						
		3 COOLING STAGES = 6°F	4 or 5 COOLING STAGES = 5°F						
4. ROOM CALIBRATION (ROOM CAL) _____ will be set by PRODUCTION, as required.									
5. ROOM RESET RATIO FACTOR (enter pot pos. #) (ROOM RESET FACTOR)	Not Used	Reset Range	Not Used	Not Used	Not Used	Not Used			
Normal – Heat/Cool = 1		1 = +32/-10°F							
– Cool Only = 3		2 = +18/-6							
		3 = +12/-4							
		4 = +9/-3							
		5 = +7/-2							
6. POT NOT USED									
7. DAMPER MIN. POS. _____ Adjustable from 0-100% in all cases except when dip switches 6 and 7 are off. (enter value)									
8. ROOM DEADBAND _____ (enter pot pos#)	Not Used	SET TO POSITION 5	Not Used	1.0 = -15/+7°F	Not Used	1 = 0.75°F			
OR AMBIENT RESET RATIO (Ambient Reset Factor)				1.5 = -9/+4		2 = 3 (normal pos. = 2.5)			
				2.0 = -5/+3		3 = 6			
				3.0 = -2/+1 (normal = 1.5)		4 = 8			
						5 = 10			
9. 4-20 ma / 0-10 V or VAV VANE POSITION RESET _____ pos#. Normal = 4.5 for V/ma, 3.5 for vanes. Vane reset also needs the following position info. MAX. TEMP AT _____% OPEN MIN. TEMP AT _____% OPEN (VAV BMS RESET FACTOR)	Not Used	POSSIBLE WITH SPECIAL SET UP SPECS	°F °F POS# F/V F/ma	POSSIBLE WITH SPECIAL SET UP SPECS	POS# RESET(°F)	Not Used			
			5 = ±25 ±20		5 = ±20				
			4.5 = ±15 ±12		4.5 = ±12				
			4 = ±9 ±6		4 = ±6				
			3 = ±5 ±4		3 = ±4				
			2 = ±4 ±2.5		2 = ±2.5				
10. 0-10 V / 4-20 ma CALIBRATION BMS VAV CAL.:		PRODUCTION TO POSITION AS REQUIRED DURING INITIAL SET UP							
11. HEATING CONTROL BAND SETTING _____ (HEAT ENVEL) (enter pot pos#)		1. Select the column corresponding to the selected cooling deadband.							
For NO HEAT applications set to 5.		2. Select the row corresponding to the required heating controller.							
(NOTE: If sensor is downstream of the cooling coil subtract 0.5 from the required setting.)		3. Find the intersect COOLING DEADBAND (°F as per pot #3).							
			4	5	6	7	8	10	pot #11
		HEATING CONTROL SELECTION	109/DJM	2.5	3.0	3.5	3.5	4.0	4.0
			G-TRAC/H-TRAC	3.0	3.5	4.0	4.5	5.0	5.0
			HEATING COIL	2.0	2.0	2.5	2.5	3.0	3.5
<b>SETPOINTS</b>									
DISCHARGE SETPOINT VALUE _____	DISCHARGE SETPOINT LOCATION (circle)			INTERNAL PANEL MOUNTED	PANEL MOUNTED REMOTE		REMOTE IN ROOM		
ROOM SETPOINT VALUE _____	ROOM SETPOINT LOCATION (circle)								



**XXII. TROUBLE SHOOTING****NOTE:**

- *If there is to be an interruption of only the C-TRAC2.1 power such as by a time clock shutdown at night, there cannot be any other load connected to the C-TRAC terminals "H, A, E", or "K". If this wiring is not correct there may be about 18 volts on any components attached incorrectly (when the C-TRAC2.1 has power turned off.) This is the result of a feedback voltage which may cause certain output signals to stay latched (i.e. it may keep a fan delay relay energized to keep fan running).*
- *It will be necessary to allow time for the C-TRAC2.1 internal timers to complete their timing steps if your simulation requires a change of modes or stages.*

**To Simulate a Full Call for Cooling**

Set the switches to a discharge only control, and then open circuit the discharge sensor terminals "Q" and "U".

**To Simulate a Full Call for Heat**

Set the switches to a discharge only control, and then jump the discharge sensor terminals "Q" and "U".

**C-TRAC2.1 Internal Operating Rules**

1. Always satisfy the discharge temperature set point.
2. All reset signals only affect the discharge set point.
3. The control automatically selects the correct operating method to satisfy rule 1.
4. Selection of the operating method must follow these steps. Heat <> Economizer <> Mechanical Cooling or Mechanical Cool/Econo.
5. The control must obey all time delays - minimum on, minimum off, inter-stage, operating mode, etc.

**C-TRAC2.1 Set-Point Calculation**

Only one option should be used at a time. If more than one option is used, the amount of total reset is additive. This can push the calculated set point too far, make the room uncomfortable and can damage equipment. (*Discharge control dipswitch 1 should be "on" in all applications.*)

1. Initial set point (*as determined by the set-point dial*).  
+ PLUS
2. Optional calculated room reset demand as per set point.  
+ PLUS
3. Optional calculated ambient reset demand (*as per set point*).  
+ PLUS
4. Optional calculated BMS reset demand (*4-20 ma. or 0-10 VDC*) as per set point.  
+ PLUS
5. Any other operating demand reset set point (*e.g. night setback*).

**Example:**

A room thermostat is trying to maintain the space temperature as per its set point. If the room temperature is not as per the set point, the thermostat adjusts the discharge temperature up or down to satisfy the condition. The amount of reset is proportional as to

how close the room temperature is from being correct. There is an adjustable amount of authority for these overrides. The amount is selected at the factory and should not be field adjusted without authority from the factory. A room reset will have reached the limit of its reset authority if the space is 3.5° above or below the room thermostat set point.

The output to satisfy the calculated discharge temperature can be heating (*modulated or staged*), economizer, or staged cooling. The heating source can be provided by hot water, steam, electric heat, or gas heat (*DG, DJ, HE style units*).

### ***Is the C-TRAC2.1 Properly Configured?***

In order to perform properly the C-TRAC2.1 must be configured to the job specifications. Ensure all switches and pots are set to the proper settings. It may be necessary to contact the factory for these set points if the correct values are not known.

### ***Does Control Cycle through an Excessive Number of Operating Modes?***

1. Is the control properly configured?
2. Has switch 8 been left on? If so turn it off.
3. Consult factory. (*Have unit serial, model and tag available*).

## ***Voltage Noise***

Firstly it is possible for an AC signal to have an effect on any of the wiring to the C-TRAC2.1 sensors and set points. The use of shielded cable with a grounded shield at one end only for these purposes may be a necessity if there is an induced voltage on the C-TRAC2.1 wiring. It is usually possible to detect if an induced voltage is present by measuring for an AC voltage across ground and each suspect wire when the source of the induced voltage is active. The suspect wires to each device must be disconnected as a pair from the C-TRAC2.1 for this test. If possible, the test should be done with supply/return fans, compressors and condenser fan motors running, as each of these devices put out electrical noise.

## ***Heating Trouble Shooting***

### ***Overheating***

**NOTE:** *There are two heat ramps (HD or HT) on the C-TRAC2.1. Ensure wiring to the correct heat ramp as per the wiring diagram for the unit.*

It should be standard practice to set the control as a discharge only control if trying to trouble shoot it. This practice will remove any possibility of "reset" creating a situation that may appear to be a control problem. After setting the switches to a discharge only control, troubleshoot the system and then when satisfied it is operating correctly, switch in the resets one at a time to determine which if any may be the cause of overheating.

If the heating control is the 109 interface, there may be some overheating at the low fire position due to the delay off timer that operates the 109 contacts 8 and 9.

### ***Is there any problem with the discharge sensors resistance?***

Note that there may be a short or a low resistance path in the discharge sensor circuit.

### ***Is the sensor located in a good sensing location?***

A good sensing location is where there is a high volume of non stratified air, which is a good representation of the average temperature.

### ***Are the controls calibrated?***

The C-TRAC2.1 discharge control is calibrated using pot 2 (*dis cal*). You must ensure that there is no override before adjusting the discharge calibration pot. The room set point is calibrated using pot 4 (*room cal*). Refer to the calibration section for instructions on calibration.

**No Heat**

Note the comments in the overheating section above about setting the control as a discharge only control before proceeding.

Ensure switch 8 is in the off position.

*Is the C-TRAC2.1 in the heating mode?*

The heat light should be on. If it isn't, de-energize power to the C-TRAC2.1 and then replenish it. This will cause the C-TRAC2.1 to quickly go into heating mode.

*Is there heat output from the C-TRAC2.1?*

Measure the DC volts between C-TRAC2 terminals HT and B (*and/or HD and B on the C-TRAC2.1*). If there is over 0.75 vdc, the C-TRAC2.1 is in the heat mode. This test requires a load to be connected to C-TRAC2.1 if measuring on terminals "HT" and "B". If there is no heating controller connected then substitute a 10,000-ohm resistor.

*Is the discharge sensor good?*

First disconnect the discharge sensor and measure the resistance across it. Refer to the table (*Page 15*) for approximate resistance values. Next measure the resistance from each leg to ground with the fan off and then while the fan is running (*because some sensors check out ok when the fan is not running*). Resistance to ground on the sensors should be infinite. If these readings are good, turn off the power to the C-TRAC2.1, jumper the discharge sensor and reenergize it. This will place the C-TRAC2.1 into a heat mode with maximum heat call. If the voltage output across C-TRAC2.1 terminals "HT" and "B" goes to about 8.5 VDC (*or terminals "HD" to "B" are above 9.7 VDC on the C-TRAC2.1*) then the C-TRAC2.1 is okay. The sensor and/or set point may be faulty. The above test requires a load to be connected to C-TRAC2.1 terminals "HT" and "B". If there is no heating controller connected then substitute a 10,000-ohm resistor across "HT" and "B".

**Discharge Too Cool**

Note the primary comments in the overheating section above, about setting the control as a discharge only control before proceeding.

*Is the sensor located in a good sensing location?*

A good sensing location is where there is a high volume of non stratified air, which is a good representation of the average temperature.

*Is the system calibrated properly?*

**Hunting (External Causes)**

**H-TRAC**

If the C-TRAC2.1 is controlling a H-TRAC, ensure that the H-TRAC deadband pot is set to a maximum. (*Set H-TRAC cal pot to 9.*)

**G-TRAC, DJM2.1**

If the C-TRAC2.1 is controlling a DG or a DJ unit that is operating below the low fire range there will be some hunting as the burner cycles on and off. Reduction of the hunting may not be possible without optimum burner set up. (*Proper low fire rate.*)

G-TRAC	Set C-TRAC Pots	Set G-TRAC Pots
	<b>P3 = 6 min. as high as 9</b>	P5 = 2
	<b>P6 = 5 ***</b>	P6 = 4
	<b>P11 = 2</b>	P8 = 4

\*\*\* On C-TRAC2.1 pot 6 does not exist. ( See Page 15 – Suggested Settings Re Hunting Problems)

### ***DJM2 Slaving From C-TRAC***

Occasionally reports are received where a C-TRAC, acting as the main temperature control (*with the DJM2 its slave*) cycles from heat mode to free cool mode (*neither heat nor cool light on*) then back to heat mode. This results in excessive temperature swings due to the time delays as the C-TRAC changes modes. To reduce this occurrence:

Firstly, ensure the CONT, BMSS and BMSZ pots are correct as described in the DJM2 manual section X.

Secondly, if the above does not resolve the problem, adjust the C-TRAC COOLING DEADBAND Pot #3 to number value eleven. Also access the C-TRAC Pot eleven on the back of the C-TRAC and set it to number 2.

Thirdly, if the above steps do not resolve the issue, use an open sensor (*contact the factory for details*).

Fourth, if after doing the above and reasonable control cannot be attained, contact the factory about "Splitting" the C-TRAC and DJM2 apart.

### **G-TRAC2**

The **G-TRAC2** has special electronic circuitry designed to reduce hunting. As the **G-TRAC2** has a slow operating ramp, hunting should be very little after the initial 15 minute start-up cycle.

### **For Direct C-TRAC Control of the G-TRAC-2**

The G-TRAC, model 2.2 gives better control than previous versions.

- Set C-TRAC cooling deadband pot 3 to 4 degrees higher than normal value.
- Set C-TRAC heat envelope pot to position 1.5 (*pot 11*)
- Heat may stay on due to G-TRAC2 integral timing, if the G-TRAC2 heat switch is left on when the C-TRAC switches to mechanical cooling. Stage 1 mechanical cooling call should turn power off to the G-TRAC2 terminal "HS" by opening relay contacts.

### **Sensor Location**

Is the sensor located in a good sensing location? A good sensing location is where there is a high volume of non stratified air, which is a good representation of the average temperature.

### **Mixed Air Dampers**

If dampers are hunting excessively, adjust pot 3 (*cooling deadband*) to a wider dead band as per set up sheet. (*Adjust it towards 13.*) Adjust the travel of "linkage" style actuators to maximum stroke (*160°F*).

### **Possible C-TRAC2.1 Adjustments to Reduce Hunting**

Lastly, select the next lower setting for the heat envelope pot (*11*). Do not set pot 11 below 1.5. Pot 11 works in conjunction with pot 3. The purpose of pot 11 is to allow an adjustment to compensate for the "heat envelope" which is a characteristic of each heat exchanger and allows time for the heat exchanger mass to gain or loose heat. Pot 11 is just a randomly selected number system and the design selection is to set for a 5 to 6 degree deadband on the heating system. Set at 2 gives a wider band; set at 5 gives a narrower band. Setting a wider band slows the control valve speed by opening the centre band wider. Note that pot 3, the cooling deadband pot is marked in degrees. It should then be slowly opened to a wider band (*higher number*) until the best control is achieved.

**Economizer Trouble Shooting**

**0 to 10 VDC Motors**

Check the voltage at the ED and B terminals when the C-TRAC2.1 is in the economizer mode. Zero volts are closed to minimum position, 10 VDC is fully open and any voltage in between is in the modulating range. If the dampers stay in the full fresh air position with 10 VDC on them all of the time, check the minimum position pot setting. There is no shunt resistor required for multiple motors.

If the economizer is not opening refer to the section a few inches below about this topic.

**Motors wired to R, B, and W terminals**

There is a maximum of three damper motors allowed to be connected to the damper output terminals "R, B", and "W". A shunt resistor must be placed across terminals "R" and "B" of the C-TRAC2.1 when more than one damper motor is used (*2 motors 1500 ohms resistance, 3 motors 909 ohms*).

**NOTE:** *When multiple damper motors are connected to the same circuit they must maintain polarity on all connections on the 24 VAC side and DC neutrals.*

Note comments in overheating section above re operating as a discharge only control before proceeding.

Ensure the damper motor pot and cam switch are configured to the same setting. The C-TRAC2.1 will control best if these are set for the motor to stroke to the full 160-degree stroke.

**IMPORTANT** *Is the economizer properly configured? See the information in the economizer section.*

**SWITCH 7 "ON"** forces economizer to minimum when compressor starts, **SWITCH 6 "ON"** forces it to minimum when the enthalpy/ODT makes terminal E go high (*24 VAC applied to it*).

**Economizer Not Opening**

Is the economizer locked out because the high ambient terminal E has 24 VAC on it? When terminal "E" has 24 VAC on it the dampers go to minimum position if the damper configuration dipswitch is on.

***Is the C-TRAC2.1 in the economizer mode?***

If it is, both the heat and cool lights will usually be off (*depending on dipswitch configuration*). The economizer operates with the cool light on if the dipswitches 6 and 7 are set "off". Forcing C-TRAC2.1 into economizer mode, de-energize the C-TRAC2.1 and replace discharge sensor with 1000-ohm resistor. Adjust the amount of call using set-point dial. Reenergize C-TRAC2 and after a delay up to 10 minutes while internal timers go from heat to economizer the DC voltage across R and B should go from 2.8 (*closed*) to about 1.8 volts DC as the economizer opens. Volts also changes 0 to 10 VDC on terminals ED and B.

On units equipped with motors attached to the "R, B", and "W" terminals, if the mechanical cooling starts before the economizer moves (*based on the DC voltage measured at terminals "R" and "B"*) and you wish to verify if the damper motor will stroke, disconnect the damper motor wires "R, B", and "W", then jumper the motor terminals "R" and "B". If the motor does not drive and there is 24 AC volts applied to terminals T1 and T2 then the motor is faulty.

**NOTE:** *If dipswitch 6 is "on" and terminal "E" is hot, the dampers will not open.*

If there is a damper motor connected to the C-TRAC2.1 terminals "R, B" and "W", the voltage at C-TRAC2.1 terminals "R" and "B" will be:

<b>Fully closed with min. pos. pot at 0</b>	<b>= approx. 2.8 VDC</b>
<b>Fully open dampers</b>	<b>= approx. 1.8 VDC</b>

If there is no motor connected to the C-TRAC2.1 the voltage at terminals R and B is:

<b>Fully closed with min. pos. pot at 0</b>	<b>= approx. 0 VDC</b>
<b>Fully open dampers</b>	<b>= approx. 1.24 VDC</b>

If the operator is wired to C-TRAC2.1 terminals "ED" and "B" the control voltage will ramp closed (0 VDC) to open (10 VDC).

**NOTE:**

- *If an economizer is in use and a control motor is being operated from the "HT" and "B" heat ramp output (such as a hot water valve), it must not be on the same power supply as the econo motor.*
- *The dampers will go to minimum position for 4 minutes each time that the C-TRAC2.1 loses power to terminal "A". This will also cause the C-TRAC2.1 to resume its heating mode.*

**Minimum Position is Open Too Much**

If the internal minimum position pot is in use the minimum position is adjusted on pot 7 (*see diagram*). Note that some applications use a minimum position pot that is external to the C-TRAC2.1. If an auxiliary pot is used the internal pot will usually be set to minimum. Note that if it is not at minimum, the setting will be the total of the two pot settings.

**Mechanical Cooling Trouble Shooting**

Note the comments in the overheating section above about setting the control as a discharge only control before proceeding.

**Cooling Not Running**

For the mechanical cooling to operate three things from the C-TRAC2.1 must be satisfied (*as well as all external items relating to the cooling being in proper working order*):

1. The economizer signal must have gone to full open.
2. C-TRAC2.1 terminal "A" must be powered.
3. The internal timing circuits must have timed out.

Measure the AC voltage across the C-TRAC2.1 terminals "A" and "N". This is the ambient lockout terminal and it must have 24 VAC on it for the mechanical cooling to run. A caution should be noted if a digital meter is being used to measure these points. Due to floating voltages being read by high impedance digital meters, it may be possible to misinterpret a reading. Analogue meters put a load on a circuit and will draw down trace voltages. This will be true of other terminal voltage readings also.

***Is the C-TRAC2.1 in the cooling mode?******Is the cooling light on?***

Remove one of the discharge sensor wires. With the discharge sensor open circuited the C-TRAC2.1 will call for maximum cooling. Due to internal timers allow up to 15 minutes for the mechanical cooling to cycle on.

**NOTE:** *If you turn dipswitch pot 8 "on" you'll bypass much of the timing. However, you must remember to reset the switch to "off" when you're finished or it may result in loss of compressors or control cycling problems. This bypass switch will greatly reduce compressor staging times may have a small affect on the mode timing (heat, economizer, to cooling). If this allows the cooling to run then check the sensor and/or set point calibration as per the attached values.*

***Is the cooling being held off on a control external to the C-TRAC2.1?***

Consult the wiring diagram in the unit and trouble shoot accordingly.

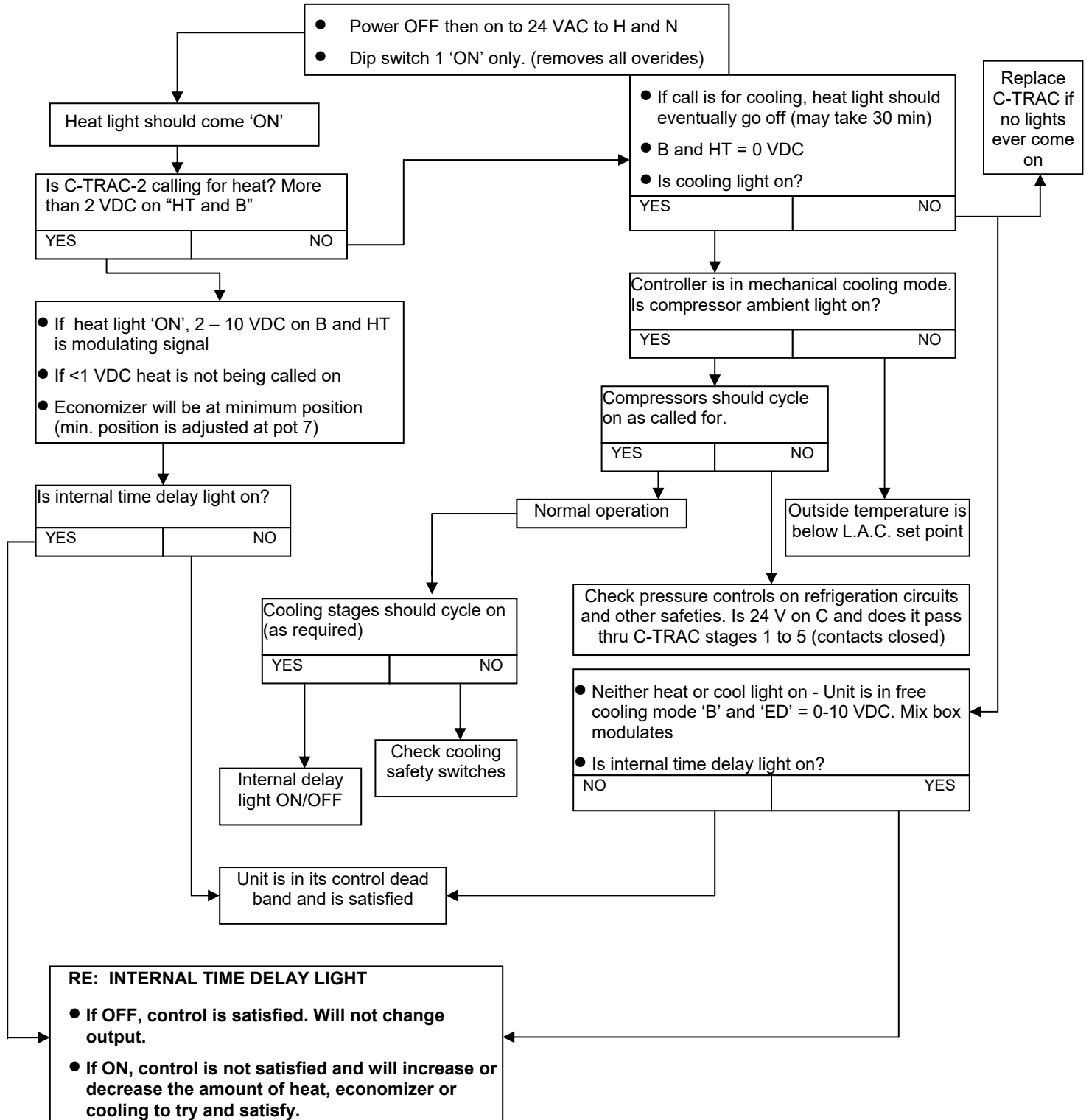
**Ambient Light stays On, Terminal “A” Has No Power**

The ambient light comes on when terminal “A” is powered with 24 VAC. If there is also an induced voltage on the wire to terminal “A” after the ambient light is turned on, and the light does not go off when the 24 VAC is removed, it may be necessary to use a relay on this terminal to isolate the induced voltage. Reports suggest that the mechanical cooling is locked off when terminal “A” loses the 24 VAC power, it is just the ambient light itself that is latched on.

**NOTE:** *When finished ensure all pots and dipswitches are in the correct operating positions. This is especially true for dipswitch 8.*

**QUICK CHECK FOR C-TRAC-2.1 NORMAL OPERATING SEQUENCE**

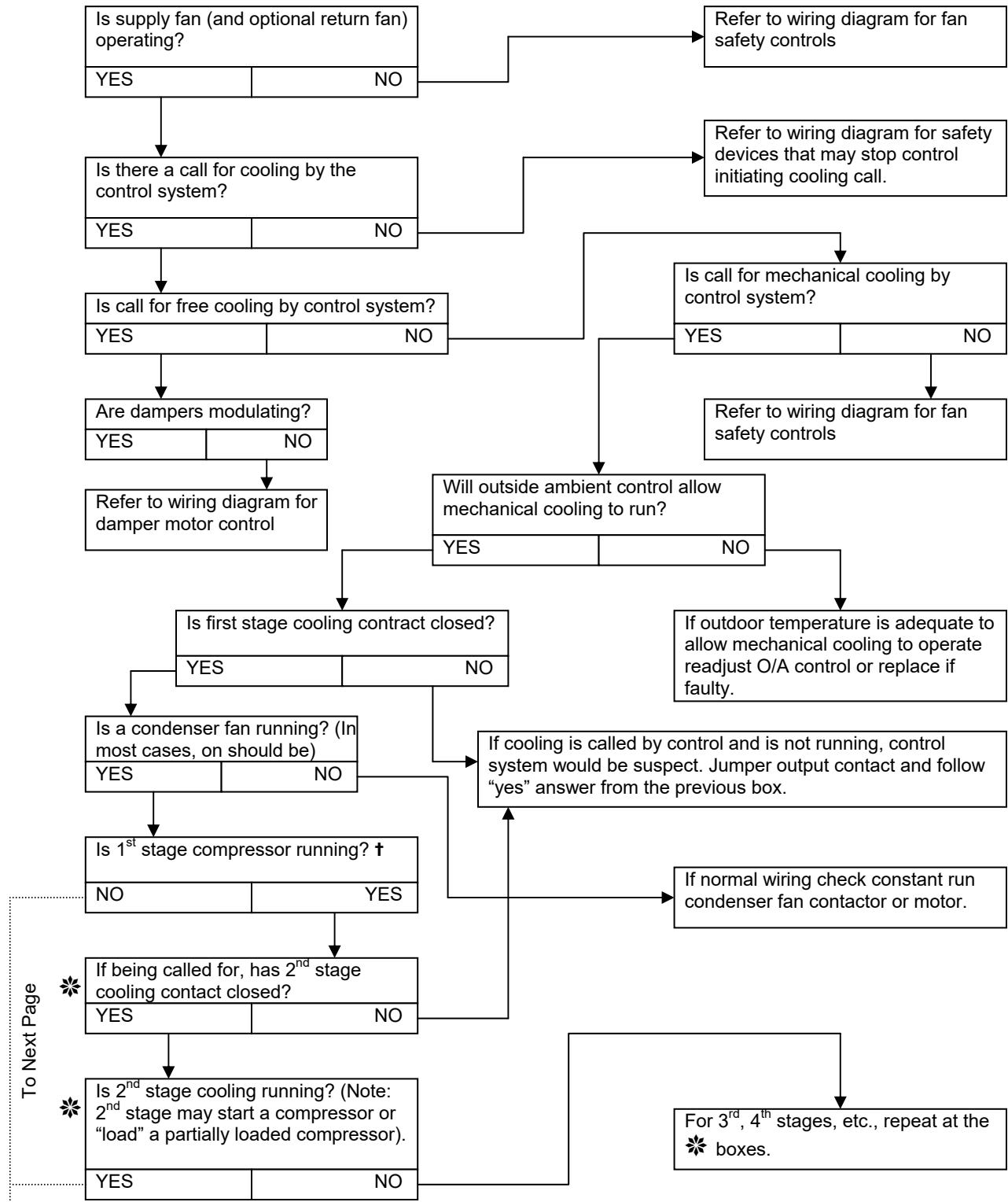
*The following is a flowchart covering many general operating/troubleshooting situations.  
If a more detailed manual is needed, contact the nearest EngA factory.*





**AIR CONDITIONING (Air Cooled Condenser)**

The following is a flowchart covering many general operating/troubleshooting situations.  
If a more detailed manual is needed, contact the nearest EngA factory.



To Next Page

**Determine type of compressor – Hermetic (welded) or Semi-Hermetic (bolted)**

**1. Hermetic Compressors**

- Most hermetically sealed compressors have internal pressure relief valves. If so equipped, there is usually no external high-pressure switch (usually open above 360#).
  - Some hermetic compressors have compressor protection modules.
  - Some hermetic compressors have auto reset low pressure switches (open 20#, close 65#).
  - Very few hermetic compressors have oil pressure switches.

**2. Semi-Hermetic Compressors**

- All semi-hermetic compressors have high, low, and oil pressure switches that operate at pressures noted in 1 above.

**3. Compressor Protection Modules**

- Some compressors have compressor protection modules (CPM), many CPM's have internal anti-cycle 3-minute timers.

**4. If compressor doesn't run:**

A. Ensure there is power to contactor coil:

- If not, check above-noted switches to ensure they are not tripped.
- Check system for refrigerant gas.

B. If contactor coil has power and contactor is pulled in, but compressor doesn't run;

- Does power pass through contacts of contactor?
- Is power at compressor terminals?
- If power is present ⇔

*Semi-Hermetic Compressor*

- Turn off power, measure motor winding resistance leg to leg and leg to ground. If open circuit or shorted – replace compressor.

*Hermetic Compressor*

- Turn off power, measure winding resistance leg to leg and leg to ground. If open circuited and compressor shell is hot – disconnect power, leave for 24 hours and recheck when cool. (Why? Internal line break protection may open circuit when hot). If shorted – replace compressor.

**† Extra Controls Which May be on Unit**

**Condenser Fans**

Some run constantly with any call for cooling. Others cycle to maintain head pressure. (Stage 1 on/off, 240/180 normal max.; Stage 2 on/off, 260/200 normal max.)

**Hot Gas Bypass**

Opens as load falls. Should begin opening about 63#, fully open 53#.

**Cylinder Unloading**

To reduce compressor capacity unload below 67#. Return to full capacity about 77# suction.

**ENGA C-TRAC 2.1**

