



# Product Specification

## 1, Features

Type:	7 days programmable thermostat For heating and cooling, heat pump and non-heat pump system With Ecofactor communication
Equipment compatibility:	Heat pump: 3H2C Non-heat pump: 2H2C
System control:	Heating, Cooling, Off, Emergency heating and Auto season changeover
Fan control:	Auto and On
LCD:	Segmented, positive. Blue backlight
Input:	Capacitive sensing "Touch Dial"
Temperature measurement:	Internal temperature sensor, Fahrenheit or Celsius selectable.
Relative humidity measurement:	Internal humidity sensor (internal use only, user not accessible)
Clock:	12/24 hours with calendar. DST and Time zone selections.
Program:	7 days programmable, 6 programs per day, individual heating and cooling setpoints.
Program holds:	Temporary, Permanent, Vacation and Duration (Duration through network only)
Auto recovery	Yes, user selectable.
Filter warning:	Yes, user selectable.
HP Fault warning:	Yes, LCD.
AUX indicator:	Yes, LCD.
Key lock:	Yes, software.
Memory back up:	Yes, Flash or EEPROM.
Memory hold up time:	10 hours.
Power supply:	Dual power. Can operate on 2 AA cells or 24VAC, or both.
Battery life:	18 months.
Communication:	Ecofactor, iControl, OTA software upgrade through Zigbee gateway. Internet connectivity via gateway with iControl server and iControl smartphone apps/Webapps
Housing design:	107 x 107 x 28.5mm. Use wall mounting bracket. Thermostat can be removed from the bracket that the wires connected to. Material: PC241R. Texture: High glossy. Color: Optima white. IP30
Rohs	Yes.

## **2. Specification**

### **Equipment compatibility**

Heat pump system: 3 heating stages: Y1, Y2 and W1 (auxiliary heating)  
2 cooling stages: Y1 and Y2  
Emergency heating: W1  
Reverse valve type O or B selectable  
Emergency heating HE/HG type selectable  
Heat pump fault feedback (L) indication

Non heat pump system: 2 heating stages: W1 and W2  
2 cooling stages: Y1 and Y2  
HE/HG selectable  
Jumper for separated heating and cooling circuit

### **Terminals**

Number of terminals: 9 + 1 (reserved for future)  
Terminals for heat pump Y1, Y2, W1, G, O/B, L, Rc, C  
Terminals for non heat pump Y1, Y2, W1, W2, G, Rc, Rh, C

### **User interface**

Display: Segmented type LCD with blue backlight  
Input: Capacitive type "Touch Dial"  
Button: Hidden reset key

### **Clock and Calendar**

Clock synchronization: via Internet.  
Clock free run accuracy: +/- 2 seconds per day.  
Time display format: AM/PM / 24 hours format user selectable.  
DST: Enable / Disable user selectable. Clock automatically adjusted if DST is enabled.  
Time zone: -2 to +3 hours user selectable.  
Calendar: Valid through 2000 to 2099  
Calendar display format: MM-DD-YY. (Calendar is not displayed on home screen)

### **Temperature Measurement**

Temperature display format: Fahrenheit or Celsius user selectable.  
Temperature display range: Fahrenheit: 32°F ~ 99°F, 1°F display resolution  
Celsius: 0°C ~ 40°C, 1°C display resolution  
Temperature measurement accuracy: +/- 0.5°C (15°C to 25°C room temperature)  
+/- 1.0°C (full temperature measurement range)  
Calibration: Yes, via software, user adjustable.  
+/- 7°F in 1°F resolution.  
+/- 4°C in 0.5°C resolution.

## Relative humidity measurement

Humidity display format:	Percentage RH (Humidity data is only for thermostat internal use. It is displayed in test mode only. Humidity information is not available to end users.)
Display / measurement range	20% ~ 95% in 1% resolution
Humidity measurement accuracy:	+/-8% at 60%, 25°C +/-10% full measurement range.

## Temperature Control

Temperature setting range: (Program, Temporary hold and Permanent Hold)	Heating and cooling: Fahrenheit: 41°F ~ 95°F, 1°F setting resolution Celsius: 5°C ~ 35°C, 1°C setting resolution Heating setpoint cannot be set higher than cooling in the same program.
Temperature setting range: (Vacation hold)	Heating only Fahrenheit: 32°F ~ 60°F, 1°F setting resolution Celsius: 0°C ~ 15°C, 1°C setting resolution
Switching differential (span):	Stage 1: Fahrenheit: 0.5°F, 1.0°F and 2.0°F user selectable. Celsius: 0.2°C, 0.5°C and 1.0°C user selectable. Stage 2: Fahrenheit: 2.0°F (fixed). Celsius: 1.0°C (fixed). Stage 3: Fahrenheit: 2.0°F (fixed). Celsius: 1.0°C (fixed).
Auto season changeover deadband:	Fahrenheit: 5°F ~ 11°F, 1°F setting resolution Celsius: 2.5°C ~ 6°C, 0.5°C setting resolution
Temperature control accuracy:	Base on NEMA test result: Span set to minimum. Total loading 2.5A. After control is stabilized, the following should be achieved: Differential: less than 2°F Droop: less than +/-1°F

## Control protection

Compressor short cycle protection timer:	5 ~ 10 minutes, 1 minute setting resolution. Set through network.
Residual Cooling fan delay timer:	30 ~ 300 seconds, 30 seconds setting resolution. Set through network.
Auto heat cut-off:	When room temperature is higher than 99°F or 35°C.
Auto cool cut-off:	When room temperature is lower than 40°F or 5°C.
Temperature error cut-off:	When error is found in room temperature measurement.

## Filter counter

Filter counter:	Counts Y1 or G turn on time for up to 999 hours.
Filter change reminder:	300, 500 or 700 hours user selectable. Indication on LCD when Filter counter reached the reminder setting.

## Program

Program style:	7-day programmable 6 programs per day
Program time :	Resolution: 10 minutes difference Shared between heating and cooling
Program temperature:	Resolution: 1°F or 1°C Individual heating and cooling setpoints
Program override:	4 types: Temporary hold Permanent hold Vacation hold Duration hold (set through network only, no UI supports)

## Power Supply

Power source:	Dual power – Can be powered by Battery or 24VAC, or both. (For Heat pump mode, terminal C connection is required for L signal)
Battery power:	2 AA size alkaline batteries 2 stages battery voltage monitor (low battery indication and shut off) Low battery indication when battery is low Longer than 18 months of normal operation without low battery indication come out
AC power:	18 ~ 30VAC at RC – C terminals AC voltage monitor and back plate detection switch
Back up power	Super cap to maintain clock and user data for at least 10 hours after both the battery and AC power are removed. Conditions: at 25°C and the Supercap has been fully charged up.

## Memory backup

Non-volatile memory:	Flash backup. User's data are saved in flash after they are changed.
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## Control switch

Type:	Latching type relays
Switch rating:	2A, 30VAC
Number of switch	Total 6

## Heat pump L input

Logic:	Assert: 15~30VAC, De-assert: 0~10VAC
Indication:	“FAULT” is displayed on LCD when L is asserted.

### **Environmental Ratings**

	Min.	Typ.	Max.	Units
Operating Temperature	0		50	°C
Storage Temperature	-10		60	°C
Operating Humidity	5		95	%RH
Voltage AC	18	24	30	VAC
Frequency	57	60	63	Hz

### **Environmental test**

	Test Conditions	Pass/Fail
Hi Temperature / Hi Humidity	40°C / 90%RH 10 Day Duration	No functional failures after testing
Temperature Cycling	-20 to +60°C 12 cycles 15 minutes soak at each temp extreme	No functional failures after testing
Vibration	3G	No functional failures after testing

### **EMC**

	Standard	Pass/Fail
EFT Power Line	EN61000-4-4	4000 V <sub>p-p</sub> , no room temperature changes, no backlight activations, no lock-up, no reset, no lose of memory.
EFT Clamp (all outputs)	EN61000-4-4	4000 V <sub>p-p</sub> , no room temperature changes, no backlight activations, no lock-up, no reset, no lose of memory.
Line Interruptions	EN61000-4-11	No lock-up, no lose of memory, Reset OK
VCC Sag	EN61000-4-11	No lock-up, no lose of memory, Reset OK
Surge test	EN61000-4-11	1.0kV, No lock-up, no lose of memory, Reset OK although UL has no this requirement in 24V products.
Static Discharge	EN61000-4-2	±8kV for contact and ±12kV for air discharge. No reset, no system lock-up, no lose of memory; 16 KV, no damage to unit.

### **Product life**

Product life: 10 years design  
 2 years guarantee  
 Condition:  
 100,000 relay cycle  
 50,000 hours LCD half life  
 10000 hrs backlight (50% light reduce ratio)

### **Agency approval**

Agency approval: FCC, HA1.2

### **RF module characteristics**

Type: *CTL357 High Power Zigbee*  
*IEEE 802.15.4-compliant*

<i>Form factor:</i>	<i>Module</i>
<i>Function:</i>	<i>Communicate with Gateway and meet HA1.2 + EcoFactor 10 attribute</i>
<i>Operating frequency</i>	<i>2.4GHz ISM band</i>
<i>Channels scanned when forming network</i>	<i>15, 16, 21 and 22</i>
<i>Antenna</i>	<i>PCB antenna for ERT50 (SLGE5R1).</i>
<i>Communication</i>	<i>Two-way communication</i>
<i>Input/Output Impedance</i>	<i>50Ohm</i>
<i>Data Rate</i>	<i>250Kbits</i>
<i>DSSS Chip Rate</i>	<i>2Mc/s</i>
<i>Frequency Stability</i>	<i>+/-40ppm</i>
<i>Transmit Power</i>	<i>14dBm(equivalent isotropically radiated power)</i>
<i>Operating Voltage</i>	<i>2.1-3.6V</i>
<i>Current Consumption</i>	<i>140mA</i>
<i>Effective Distance</i>	<i>Outdoor <math>\geq 300m</math> open field and line of sight Indoor <math>\geq 30m</math> ( across 4 concrete 20cm thick walls, and 1 floor up/down)</i>
<i>Networking</i>	<i>Mesh Network</i>
<i>Conformity</i>	<i>Radio: ETSI EN300 328 V1.6 &amp; EN300 440 class 2 EMC: ETSI EN301 489-17 V1.2.1 EMC: ETSI EN301 489-1 V1.6.1 Safety: IEC/EN60950-1</i>

## **System reset, System options and Memory backup**

1. The thermostat is reset when the RESET key is pressed, or after power up from an empty Supercap.
2. There are three types of reset:
  - Type 1 reset is the reset after first power up since manufactured, or reset key pressed and user touches OK during the full screen. The hardware and all the memory are reset, including the System options. Users are requested to set the System options.
  - Type 2 reset is when the RESET key is pressed. The hardware and all the memory are reset. System options, however, are retrieved from Flash.
  - Type 3 reset is when power up from an empty Supercap. The hardware is reset. All the memory is retrieved from Flash.
3. During the reset process, the LCD will display full screen and then system information (firmware version, etc.) before going into Normal mode.
4. The following is the status after reset:

### **System states after reset:**

	Type 1 Reset	Type 2 Reset	Type 3 Reset
<b>System option setting mode after reset:</b>	Yes	No. System options retrieved from Flash	
<b>Operation mode:</b>	Normal mode / Home screen		
<b>Time:</b>	12:00 AM		From Flash
<b>Date:</b>	Jan 1st, 2013		From Flash
<b>Room temperature:</b>	Current room temperature		
<b>Programs:</b>	Reset to default		From Flash
<b>Set temperature:</b>	According to programs		
<b>Program number:</b>	According to programs		
<b>System:</b>	Heat		From Flash
<b>Fan:</b>	Auto		From Flash
<b>Program holds:</b>	Cleared		From Flash, revised
<b>Time format:</b>	12 hours		From Flash
<b>Day light saving time:</b>	On		From Flash
<b>Time zone:</b>	0		From Flash
<b>Span:</b>	0.5°F / 0.25°C		From Flash
<b>Auto season changeover deadband:</b>	8.0°F / 4.5°C		From Flash
<b>Auto recovery:</b>	Enabled		From Flash
<b>Room temperature offset:</b>	0°F / 0°C		From Flash
<b>Temperature scale:</b>	Fahrenheit		From Flash
<b>Filter counter:</b>	0 hours		From Flash
<b>Filter warning time:</b>	700 hours		From Flash
<b>Compressor short cycle protection:</b>	5 minutes		From Flash
<b>Residual cooling fan delay:</b>	60 seconds		From Flash
<b>Vacation start date:</b>	Jan 1st, 2013		From Flash
<b>Vacation end date:</b>	Jan 1st, 2013		From Flash
<b>Vacation temperature:</b>	41°F / 5°C		From Flash
<b>Low battery warning:</b>	Revised		
<b>Output status:</b>	All relays turned off during reset, then updated.		

<b>Key lock:</b>	Unlocked
<b>LCD backlight:</b>	Off

### **Default programs (all 7 days)**

Program	Program time	Heat set point	Cool set point
1	6:00AM	68°F (20°C)	79°F (26°C)
2	8:00AM	61°F (16°C)	84°F (29°C)
3	6:00PM	68°F (20°C)	79°F (26°C)
4	10:00PM	61°F (16°C)	82°F (28°C)
5	10:00PM	61°F (16°C)	82°F (28°C)
6	10:00PM	61°F (16°C)	82°F (28°C)

### **System options**

System options include:

1. Equipment type: Heat pump / Non heat pump
2. Fan control in heating: Electric / Gas or oil furnace
3. Reverse valve (for heat pump only): O / B

If Heat pump is selected for the equipment type, Fan control option and Reverse valve option will also need to set.

If Non heat pump is selected for the equipment type, only Fan control option will need to set.

System options are saved into the Flash and will not be changed by power lost or system reset. System options can be changed by calling up the System option setting mode during Type 1 reset, that is:

1. First power up after manufactured,
2. Press RESET key, and then touch OK during reset full screen.

### **Memory backup**

1. User's settings are saved in the Flash. They are saved whenever they are changed and user confirmed the change.
2. The clock and calendar are also saved in the Flash every 1 hour. So when start up from Type 3 reset the time and date would not be too much different from the correct one.

## **Outputs and Terminals**

1. Outputs are relay switched. Total 6 latching type relays.
2. There are all together 10 terminals, of which 1 ("X") is reserved for future expansion.
3. Heat pump and non heat pump share some of the terminals.
4. Heat pump system compatible to 3H2C systems: 2 stages of compressor and 1 stage of auxiliary heating. Emergency heating shared with auxiliary heating
5. Non heat pump system compatible to 2H2C systems: 2 stages of heating and 2 stages of cooling. Heating and cooling are of separated 24VAC circuits. Connect RC and RH with the supplied jumper for integrated 24VAC circuit.
6. Indication "FAULT" on LCD when L terminal is asserted in heat pump mode.
7. Rc and Rh must be put together on the PCB for the installation of the jumper.
8. Terminal X must be put at the either ends of the terminal block as it will not be installed in the current version.

Heat pump			Non heat pump		
Terminal	Type	Functions	Terminal	Type	Functions
<b>R</b>	Power	24VAC power input (Not used)	<b>RC</b>	Power	24VAC, cooling power input
<b>C</b>	Power	24VAC common	<b>RH</b>	Power	24VAC, heating power input
<b>L</b>	Input	Heat pump fault input (24VAC)	<b>C</b>	Power	24VAC common (Not used)
<b>Y1</b>	Output	Compressor 1 <sup>st</sup> stage	<b>Y1</b>	Output	1 <sup>st</sup> stage cooling
<b>Y2</b>	Output	Compressor 2 <sup>nd</sup> stage	<b>Y2</b>	Output	2 <sup>nd</sup> stage cooling
<b>W1</b>	Output	Auxiliary / Emergency heating	<b>W1</b>	Output	1 <sup>st</sup> stage heating
<b>O/B</b>	Output	Reverse valve	<b>W2</b>	Output	2 <sup>nd</sup> stage heating
<b>G</b>	Output	Fan	<b>G</b>	Output	Fan
<b>X</b>	Open	Reserved	<b>X</b>	Open	Reserved

## **Power supplies, Power monitor and management**

1. The thermostat is dual power – can be powered by batteries or 24VAC, or both.
2. The thermostat monitors: 1) Battery voltage, 2) AC voltage, 3) Back plate.
3. The thermostat operates in 3 power modes: Normal power mode, Low battery power mode and Shut off mode.
4. The thermostat has a Super cap back up power.

## **Power supplies**

### **Battery power**

1. 2 AA size alkaline batteries.
2. When battery is the only power source, provides 18 months or above under Standard operation condition. The Standard operation condition is:
  - i. Default heartbeat once every 7s and attribute once every 5 minutes with Zigbee gateway;
  - ii. 10 remote update and query once a day (TBC).
  - iii. Sending 10 attribute command 288 times every day(TBC).
  - iv. No OTA.

### **AC power**

1. 18 ~ 30VAC at RC – C terminals.
2. Some systems do not have C wire available so there is no AC power supply for these systems.

## **Power monitor and management**

### **Battery voltage detection**

1. Battery voltage is monitored periodically at least 10 times a minute. It can be skipped if the battery voltage may not be stable, say during high current operations. It can also be called whenever necessary, say after system reset so an updated battery condition is available.
2. The Battery voltage detection function should be able to detect 3 levels of battery voltage:
  - i. The first level denote the normal battery operation. For new batteries, this level should last for at least 18 months. This is called the Normal power mode.
  - ii. The second level denote the low battery operation. The thermostat functions normally except backlight is shut off and the low battery indicator comes on. First and second levels together should last for at least 24 months. This is called the Low battery power mode.
  - iii. The third level denote the minimum battery voltage range that can maintain minimum CPU functions, include time keeping and memory. All other thermostat functions stop and all relays shut off. User settings should have been properly saved in Flash. This is called the Shut off mode.

### **AC power monitor**

1. AC power monitor includes AC voltage detection and back plate detection switch.
2. AC voltage detection is to tell the thermostat if AC power is available. If AC power is present, the thermostat will always in Normal power mode and the battery condition will be ignored. i.e., If there is AC power, there will be no low battery indication or shut off even battery is not installed.
3. Back plate detection can be a simple detection switch. It is to tell the thermostat if it is removed from the back plate. This means two things: 1) there is no AC power, so battery is the only power source, if exists, and 2) the terminals are disconnected, have to prepare for the coming "rough" reconnection. The thermostat will do the followings upon Back plate removal:
  - i. Shut off all relays. This is to prevent sparking and power surge when reconnect.
  - ii. The thermostat operates on battery power only and so need to observe the battery voltage levels. There is no relay control since all relays must be shut off.

### **Summary of power availability and power mode**

Back plate detection	AC voltage detection	Battery voltage detection	Thermostat state
Back plate is On	AC present	Don't care	Normal power mode
	AC not present	Normal	Normal power mode
		Battery low	Low battery power mode
		Shut off	Shut off mode
Back plate is Off	Don't care	Normal	Normal power mode, but with all relays shut off
		Battery low	Low battery power mode, but with all relays shut off
		Shut off	Shut off mode

### **Super cap back up power**

1. The Super cap back up power kicks in whenever both the AC and battery power is removed.
2. The back up power will provide a minimum of 10 hours of Shut off mode operation after it is fully charged.

### **LCD backlight**

1. LCD backlight only works in Normal power mode.
2. In Normal power mode, Touch Dial works with the backlight. For other power modes, Touch Dial will ignore the back light..

3. Touch on the Touch Dial will turn on the LCD backlight for 10 seconds.
4. Touch Dial will accept input (except long input, see below) only when the backlight is on. i.e., if the backlight is off, touch on the Dial will only turn on the backlight. The input
5. Long press input does not require the backlight be turned on before. For example, press and hold OK 2 seconds to engage Permanent hold. The backlight will turn on when the Dial is touched, and the hold is activated after 2 seconds.

## **User Interface**

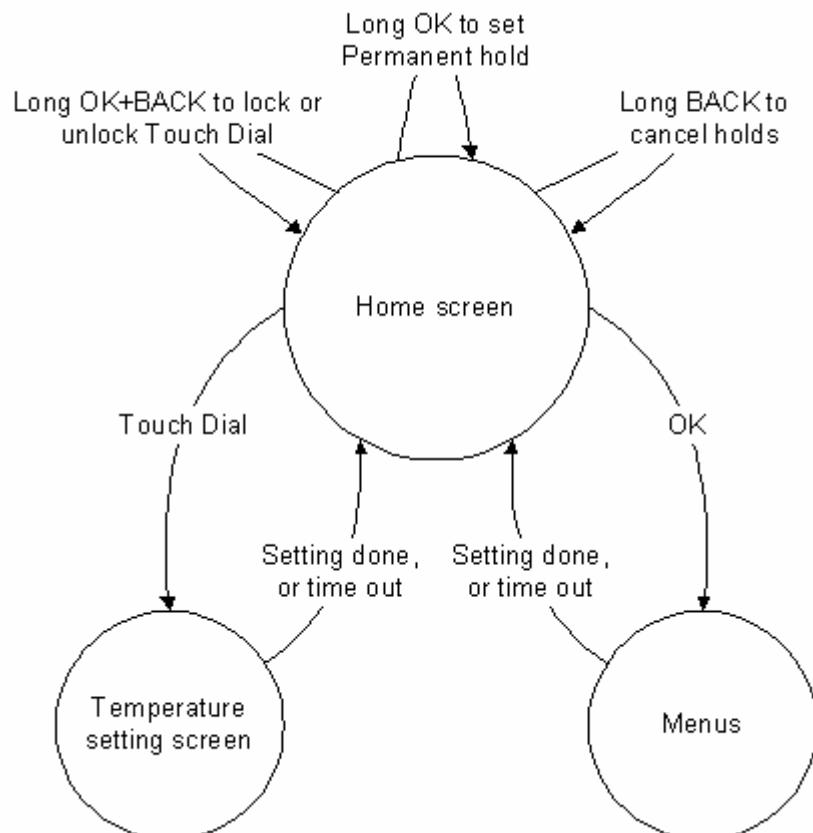
1. 3 main operation interfaces: The Home screen, Temperature setting screen and Menus.
2. 3 other special modes:
  - i. The Test mode is only used for factory testing.
  - ii. The Option setting mode only available during system reset.
  - iii. The Shut off mode is a safe mode when the battery is too low for normal operation.

## **The Home screen**

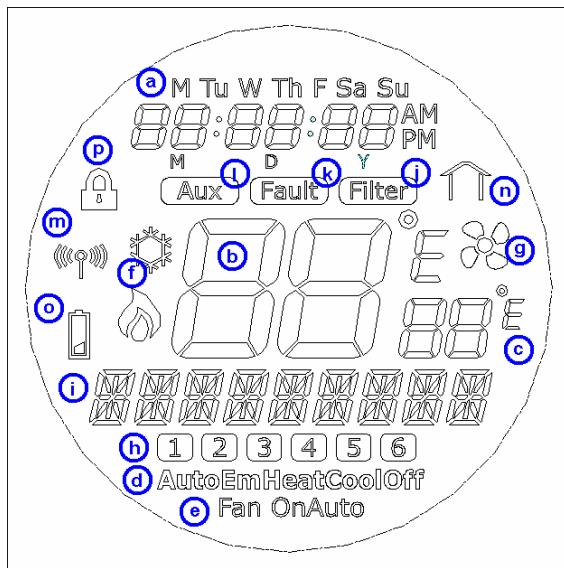
1. The Home screen is the basic display screen.
2. Temperature control and RF only conducted in the Home screen (except during pairing and firmware update).
3. Temperature setting mode and Menus, when no key is pressed, must return to the Home screen after certain period of time.
4. Touch on the Touch Dial to enter Temperature setting screen. Touch OK to enter Main menu.
5. Touch and hold OK for 2 seconds ("Long OK") will set the thermostat to Permanent hold. Touch and hold BACK for 2 seconds ("Long BACK") will cancel any Holds set before and return to Program mode.

## **Key lock**

1. Locked Touch Dial (key lock) will not response to input. The backlight is disabled too.
2. The Touch Dial can be locked by pressing and holding OK and BACK together for 2 seconds. The Key lock indicator will be displayed.
3. To unlock, press and hold OK and BACK together for 2 seconds again. The Key lock indicator will be cleared too.



## Home screen display



- a) The current day of week and time
- b) The current room temperature
- c) The current set temp
- d) System selection
- e) Fan selection
- f) System status
- g) Fan status
- h) Program number
- i) Information display
- j) Filter change reminder
- k) Heat pump fault warning
- l) Auxiliary heat indication
- m) RF indication
- n) Ecofactor indication
- o) Low battery indication
- p) Key lock indication

### a) Time display

1. Time can be displayed in 12 or 24 hours format.
2. Time is displayed on the first and second group of "88" from the right.
3. 12 hours format: 12:00AM to 11:59PM. Leading zero of the hour is not displayed.
4. 24 hours format: 00:00 to 23:59. Leading zeros of hour and minute are displayed.
5. Colon is flashing at 1Hz synchronized to the clock second.

### b) Room temperature display

1. Leading zero is not displayed.
2. °F or °C is displayed to indicate the temperature is Fahrenheit or Celsius.
3. If temperature is lower than the minimum displayable value, "Lo" is displayed.
4. If temperature is higher than the maximum displayable value, "Hi" is displayed.
5. If there is measurement error, " - " is displayed.

### c) Set temperature display

1. Leading zero is not displayed.
2. °F or °C is displayed to indicate the temperature is Fahrenheit or Celsius.

### d) System indicator

1. The possible display are:
  - i. Heat pump: Heat, Off, Cool, Auto Heat, Auto Cool and Em Heat
  - ii. Non heat pump: Heat, Off, Cool, Auto Heat and Auto Cool

### e) Fan indicator

The possible display are: Fan On and Fan Auto

### f) System status indicators

1. The flame icon is displayed if heating output is turned on. It flashes if heating output is deferred (e.g., by short cycle protection timer).
2. The snow icon is displayed if cooling output is turned on. It flashes if cooling output is deferred (e.g., by short cycle protection timer).

**g) Fan status indicator**

1. The fan icon is displayed if the fan output is turned on.

**h) Program number**

1. In Program mode or Temporary hold, it indicates the current program.

**i) Information display**

“PROG” – Program mode  
“TEMP HOLD” – Temporary hold  
“PERM HOLD” – Permanent hold  
“VACATION” – Vacation hold  
“SHUT OFF” – Shut off mode

**j) Filter change reminder**

1. Displays and flashes when the filter counter is expired.

**k) Heat pump fault warning**

1. Displays when 24VAC presents on “L” in Heat pump mode.

**l) Auxiliary heat indication**

1. Displays when W1 is turned on in Heat pump heating mode.

**m) RF indication**

1. Displays when the thermostat is connected to the server.

**n) Ecofactor indication**

<TBD>

**o) Low battery indication**

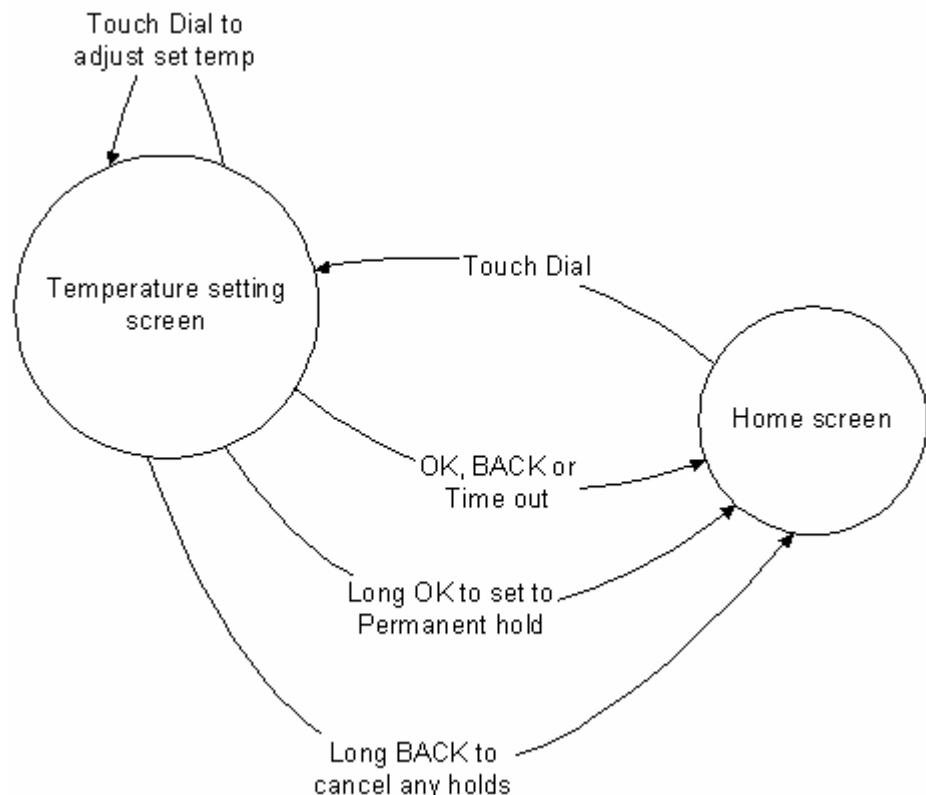
1. Displays and flashes in Low battery power mode.

**p) Key lock indication**

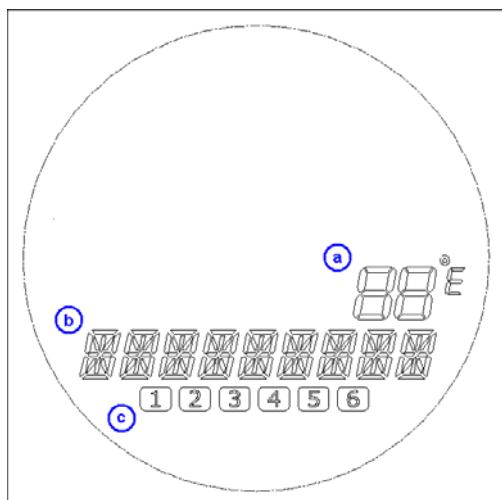
1. Displays when Touch Dial (key) is locked.

### **Temperature setting screen**

1. In Home screen, touch the dial will change to Temperature setting screen. The current set temp can be changed by sliding on the Touch Dial. Clockwise to increase and anti-clockwise to decrease. Depends on the holds, the following could happen:
  - i. If it is Program mode, change of the current set temp will activate Temporary Hold.
  - ii. If it is Temporary Hold, Permanent Hold or Vacation Hold, the hold will continue after changing the current set temp.
2. Long OK will set the thermostat to Permanent hold and back to the Home screen. Long BACK seconds will cancel any Holds set before, return to Program mode and back to the Home screen.
3. Return to Home screen automatically when no touching in 10 seconds



### **Temperature setting screen display**



#### **a) Set temp**

The set temp is flashing in the setting screen.

#### **b) Hold display**

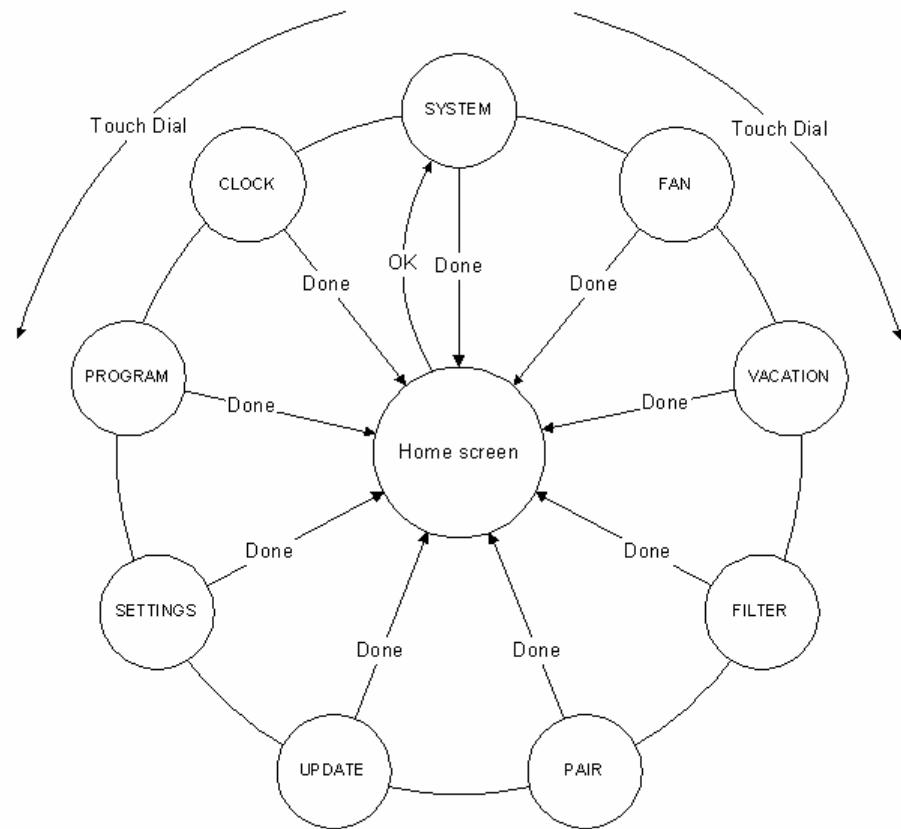
Indicates the current hold setting:  
 "PROG" – Program mode  
 "TEMP HOLD" – Temporary hold  
 "PERM HOLD" – Permanent hold  
 "VACATION" – Vacation hold

#### **c) Program number**

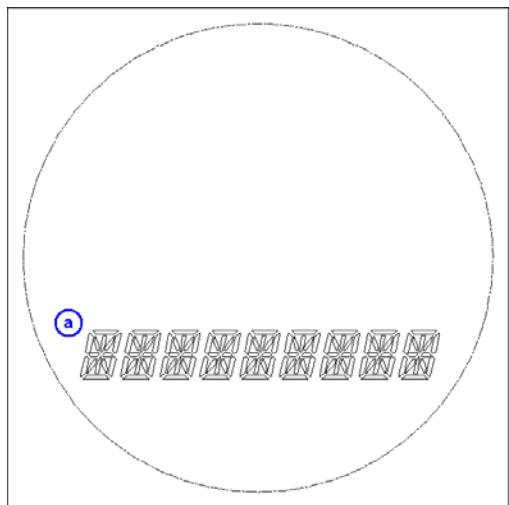
If it is program mode, the current program number is displayed.

## Menus

1. In Home screen, touch OK to enter Main menu. LCD cleared, menu item flashing. The first menu item is SYSTEM. Scroll through the Main menu by the Touch Dial.
2. Main menu includes: SYSTEM, FAN, VACATION, FILTER, PAIR, UPDATE, SETTINGS, PROGRAM and CLOCK (clockwise sequence, cycles).
3. Touch OK to select the menu item displayed.
4. Touch BACK or wait 15 seconds to go back to Home screen



## Display:



### Menu selection

- a) Display and flash "SYSTEM", "FAN", "VACATION", "FILTER", "PAIR", "UPDATE", "SETTINGS", "PROGRAM" or "CLOCK".

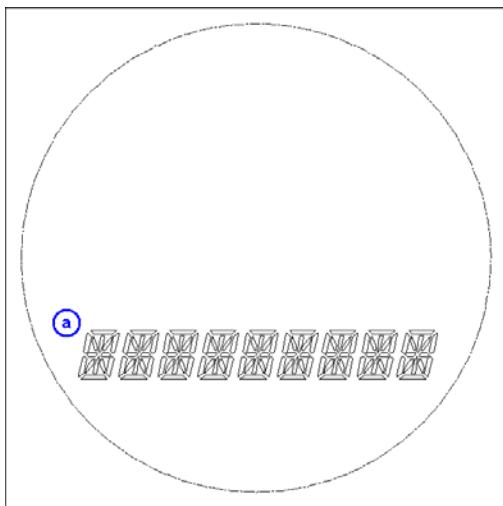
### **System menu**

1. When enter, The current system is displayed and flashing. Other segments cleared.
2. Scroll through the System menu by the Touch Dial.
3. System menu includes: HEAT, COOL, OFF, EMHEAT and AUTO (clockwise sequence, cycles). EMHEAT (Emergency heating) is only available in Heat pump system.
4. Press OK to accept the new system and go back to Main menu.
5. Long OK to accept the new system and go back to Home screen.
6. Press BACK will discard changes and go back to Main menu.
7. Long BACK or wait 15 seconds will discard changes and go back to Home screen.
8. System will be updated after going back to Home screen.

### **Fan menu**

1. When enter, the current fan setting is displayed and flashing. Other segments cleared.
2. Scroll through the Fan menu by the Touch Dial.
3. Fan menu includes: FAN AUTO and FAN ON (cycling).
4. Press OK to accept the new fan setting and go back to Main menu.
5. Long OK to accept the new fan setting and go back to Home screen.
6. Press BACK will discard changes and go back to Main menu.
7. Long BACK or wait 15 seconds will discard changes and go back to Home screen.
8. Actual fan update will be performed after going back to Home screen.

### **System and Fan menu display:**



#### **System menu**

a) Display and flash “HEAT”, “COOL”, “OFF”, “EMHEAT” or “AUTO”.

#### **Fan menu**

a) Display “FAN AUTO” or “FAN ON”. “AUTO” and “ON” are flashing.

### **Vacation hold menu**

Vacation hold menu includes three sub-screens:

#### **Setting the Vacation start day**

1. “START” and the Vacation start day with “M”, “D” and “Y” are displayed. Month is flashing. The default Vacation start day is the previous set Vacation start day.
2. Set the Month by the Touch Dial (cycling). Press OK to proceed to set Day. Day will be flashing.
3. Set the Day and Year with the similar procedure (day cycles but year does not).
4. When setting Month, press BACK will go back to Main menu. Any changes made (including end day and temperature) will be discarded.
5. When setting Year, press OK will proceed to set the Vacation end day.

### Setting the Vacation end day

1. "END" and the Vacation end day with "M", "D" and "Y" are displayed. Month is flashing. The default Vacation end day is the previous set Vacation end day.
2. Set the Month by the Touch Dial (cycling). Press OK to proceed to set Day. Day will be flashing.
3. Set the Day and Year with the similar procedure (day cycles but year does not).
4. When setting Month, press BACK will go back to set the Vacation start day.
5. When setting Year, if the dates were set correctly, press OK will proceed to set the Vacation temperature. Correct dates mean the end date is equal to or after the start date.

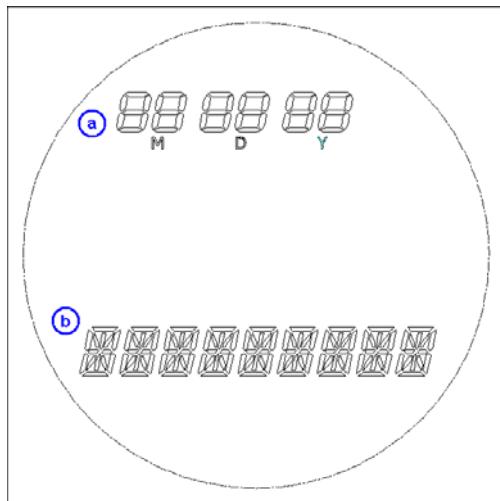
### Setting the Vacation temperature

1. "TEMP", "Heat" (system indicator) and the Vacation temperature are displayed. The vacation temperature is flashing. The default Vacation temperature is the previous set Vacation temperature.
2. Set the Vacation temperature by the Touch Dial (non-cycling).
3. When set to the minimum temperature, further counter-clockwise move on the Touch Dial will change the temperature to OFF. "Heat" indicator is cleared when "OFF" is displayed.
4. Press OK to confirm all the settings and go back to Main menu.
5. Press BACK will go back to set Vacation end day.

### Notes:

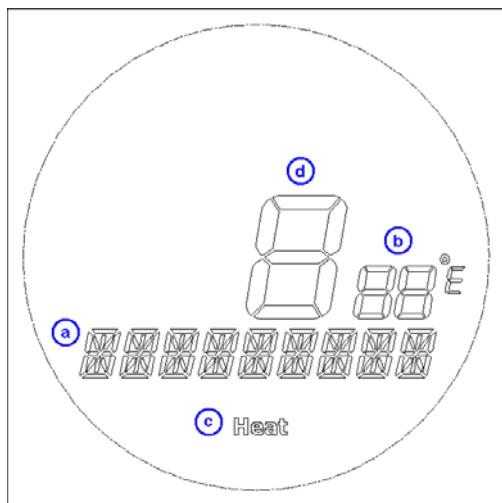
1. In any of the screens, Long OK to accept all the changes and go back to Home screen. However, if the end day was set before the start day, all the changes will be discarded and go back to Home screen.
2. In any of the screens, Long BACK or wait 30 seconds will discard all the changes and go back to Home screen.

### Vacation menu display:



### Vacation start day and end day menu

- a) Display the month, day, and year of the start or end date. The setting item is flashing.
- b) Display "START" when setting start day. Display "END" when setting the end day.



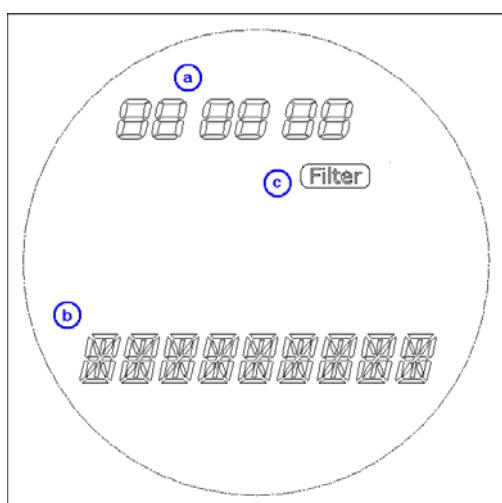
#### Vacation temperature menu

- Display "TEMP".
- Flash the vacation temperature, or "OFF" with d).
- Heat system indicator is displayed if b) is a temperature value. It turns off if d) and b) display "OFF".
- If vacation is set to off, flash "OFF" with b).

#### Filter menu

- The Filter warning time (e.g., "700 HRS") is displayed on the 14-segments with the digits flashing. The Filter counter (e.g., "234 hr") is displayed on the 7-segments of the clock. The Filter warning indicator will be displayed and flashes if the Filter counter is equal to or larger than the Warning time.
- Set the Filter warning time by the Touch Dial (non-cycling).
- Press OK to confirm the Filter warning time and go back to Main menu.
- Long OK to confirm the Filter warning time and go back to Home screen directly.
- When set to the smallest Warning time, further counter-clockwise move on the Touch Dial will change to display "RESET". If OK is pressed when "RESET" is displayed, the Filter counter will be reset to "000 hr" and briefly flash 3 times.
- Long OK when "RESET" is displayed will reset the Filter counter to "000 hr" and go back to Home screen. Filter warning time will not be affected.
- Press BACK to discard any changes made and go back to Main Menu. Long BACK or wait 15 seconds to discard any changes made and go back to Main Menu. Note that reset Filter counter cannot be reverted by BACK.

#### Filter menu display



- The filter counter. 3 digits with "hr" displayed on the right most digits. Example: "234hr".
- The flashing filter warning time. Example: "700 HRS".
- If filter counter is equal to or larger than filter warning, the filter reminder indicator will come out and flash.

#### Pair menu

<TBD>

## Update menu

Tbd

Note: Suggest to change "Upgrade" to "Update".

## Setting Menu

Setting menu includes five sub-menus.

Scroll through the sub-menus by the Touch Dial.

System menu includes: system configuration, TEMP UNIT, OFFSET, RECOVERY and CONTROL (clockwise sequence, cycle). Except system configuration, all the other four flash.

Press OK to enter the sub-menu (except system configuration, see below). Long OK has no function.

Press BACK will go back to Main menu

Long BACK or wait 15 seconds will go back to Home Screen.

### Setting – System configuration

System configuration is for review only. It has nothing to set so the title is not flashing. The title can be one of the following six:

HP–O–HE (Heat pump, reverse valve "O", fan option is HE)

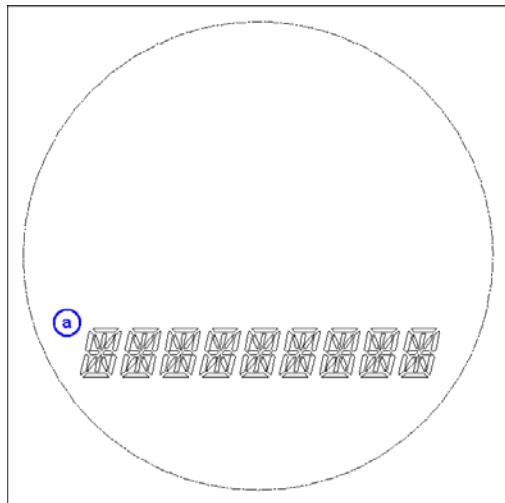
HP–O–HG (Heat pump, reverse valve "O", fan option is HG)

HP–B–HE (Heat pump, reverse valve "B", fan option is HE)

HP–B–HG (Heat pump, reverse valve "B", fan option is HG)

NHP – HE (Non heat pump, fan option is HE)

NHP – HG (Non heat pump, fan option is HG)



a) Display base on option setting:

"HP–O–HE" (Heat pump, reverse valve "O", fan option is HE)

"HP–O–HG" (Heat pump, reverse valve "O", fan option is HG)

"HP–B–HE" (Heat pump, reverse valve "B", fan option is HE)

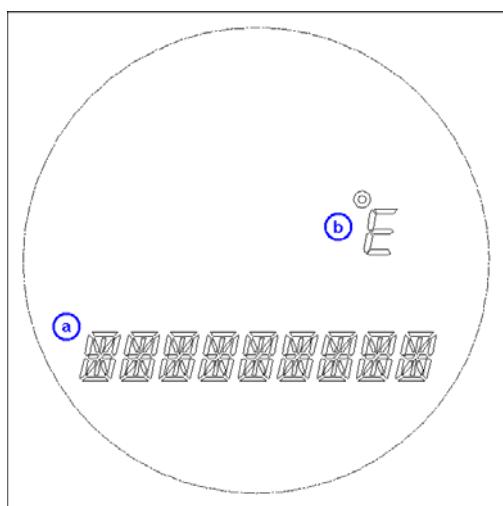
"HP–B–HG" (Heat pump, reverse valve "B", fan option is HG)

"NHP – HE" (Non heat pump, fan option is HE)

"NHP – HG" (Non heat pump, fan option is HG)

### Setting – Temperature unit (TEMP UNIT)

1. "TEMP UNIT" displayed with the current temperature unit (°F or °C) flashing.
2. Set Fahrenheit or Celsius by the Touch Dial (cycling).

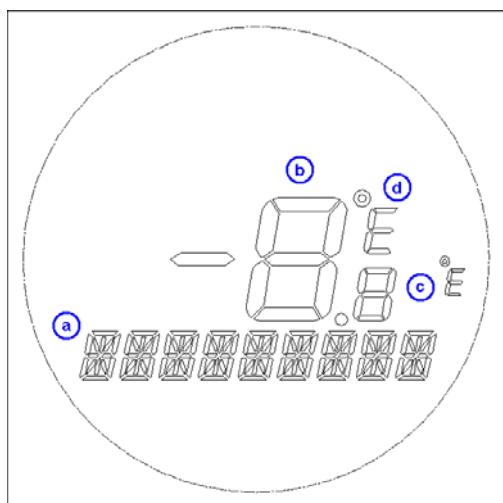


a) Display "TEMP UNIT".

b) "°F" or "°C" flashing.

#### Setting – Room temperature offset (OFFSET)

1. "OFFSET" displayed with the current temperature offset value flashing. "°F" or "°C" displayed according to the temperature unit.
2. Set the offset values by the Touch Dial (non-cycling).



a) Display "OFFSET".

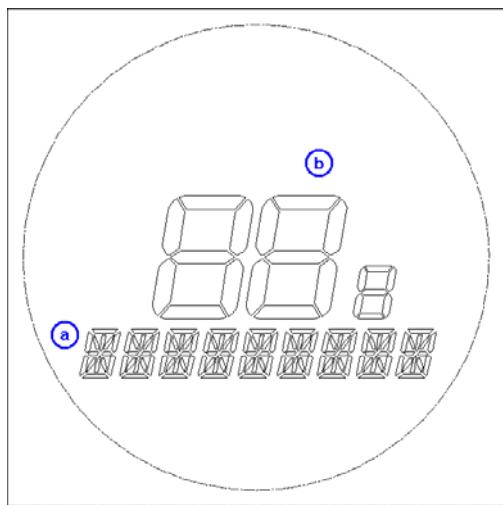
b) Flashing offset value.

c) Decimal point and F/C indicator for Celsius mode.

d) F/C indicator for Fahrenheit mode.

#### Setting – Auto recovery (RECOVERY)

1. "RECOVERY" displayed with the current recovery setting ("YES" or "NO") flashing.
2. Set the offset values by the Touch Dial (cycling).



a) Display "RECOVERY".

b) Flashing "YES" or "NO"

#### Setting – Control parameters (CONTROL)

Control menu sets the control span and auto season changeover deadband.

The first setting is span. "SPAN" is displayed and the current span setting is flashing. "°F" or "°C" displayed according to the temperature unit.

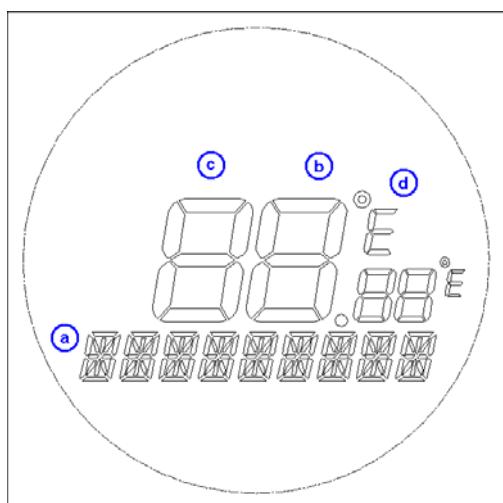
Set the span by the Touch Dial (non-cycling).

Press OK to confirm the span and go to deadband setting.

"DEADBAND" is displayed and the current deadband setting is flashing. "°F" or "°C" displayed according to the temperature unit.

Set the deadband by the Touch Dial (non-cycling).

Press BACK will return to set the span. Changes made will be discarded.



#### Setting Span

a) Display "SPAN".

b) Flashing span setting with 1 or 2 places decimal (F/C) and F/C indicator.

#### Setting Deadband

a) Display "DEADBAND".

b) Flashing deadband setting. Celsius has 1 place decimal and F/C indicator.

c) 10's digit of deadband setting for Fahrenheit.

d) F/C indicator for Fahrenheit deadband which does not have decimal place.

#### Notes:

1. In all the setting sub-menus (except configuration), press OK to confirm and go back to Setting menu (except when in setting Span in Control menu, press OK will confirm and go to set the deadband). Long OK to confirm and go back to Home screen directly.

2. Press BACK to discard any changes made and go back to Setting Menu (except when in setting deadband in Control menu, press BACK will discard the change and go back to span). Long BACK or wait 15 seconds to discard any changes made in that sub-menu and go back to Main Menu.

### **Program menu**

The program setting procedure is summarized as follow:

- a) Choose the day(s) to program (Weekday, Weekend, Whole week, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday).
- b) Set the hour, minute, heat and cool setpoints of program 1 of the day(s) chosen.
- c) Set the hour, minute, heat and cool setpoints of program 2 of the day(s) chosen.
- d) Set the hour, minute, heat and cool setpoints of program 3 of the day(s) chosen.
- e) Set the hour, minute, heat and cool setpoints of program 4 of the day(s) chosen.
- f) Set the hour, minute, heat and cool setpoints of program 5 of the day(s) chosen.
- g) Set the hour, minute, heat and cool setpoints of program 6 of the day(s) chosen.
- h) Go back to a) to choose another day(s) to program.

#### **Choose day(s) to program:**

1. Enter Program menu. "PROGRAM" is displayed and weekday flashing ("M Tu W Th F").
2. Set the days by the Touch Dial (cycling). The days in clockwise sequence are "M Tu W Th F", "Sa Su", "M Tu W Th F Sa Su", "M", "Tu", "W", "Th", "F", "Sa" and "Su".
3. Press OK to go to set the programs of the day(s) selected.
4. Press BACK will go back to Main menu. Long BACK, or wait 30 seconds to go back to the Home screen directly.

#### **Setting programs of the program day(s) chosen:**

1. The first program to set is program 1. "PROGRAM", program day(s) and program number ("1") are displayed. The time, the heating temperature of program 1 and "HEAT" indicator are displayed. The program hour is flashing.
2. Set the program hour by the Touch Dial (cycling)
3. Press OK to go to set the minute (cycling).
4. Press OK again to go to set the heat temperature (non-cycling).
5. Press OK again to go to set the cool temperature (non-cycling). The "HEAT" indicator will change to "COOL".
6. Press OK again will save the changes made in this screen and change to set the next program.
7. Repeat the above procedures to complete all the six programs. At program 6 it will go back to choose program day(s).
8. Press and hold OK will save the changes made in that screen and go back to Home screen directly.
9. Press BACK to go back one step. If it is setting the minute pressing BACK will discard the changes on the screen and go back to previous program. If it is Program 1 minute it will go back to choose program day(s).
10. Long BACK, or wait 30 seconds to go back to the Home screen directly. In either case any changes in that screen will be discarded.

#### **Notes:**

1. Programs time does not need to be programmed in sequence. However, when programming is done and back to the home screen, the thermostat will check and sort the programs to make sure all the programs are in sequence. i.e., program 1 must precede program 2, program 2 must precede program 3, and so on.
2. Programs with identical time is allowed, but only the program with the largest program number will take place.
3. Heat setpoint of a program cannot be set higher than the cool setpoint of that program. It is for proper automatic changeover between heating and cooling.

### **Clock menu**

Clock menu is to set: time format, time, date, DST and time zone.

#### **Setting of time format**

1. When enter, "CLOCK" and the current setting of time format ("12hr" or "24hr") are displayed. "12" or "24" is flashing.
2. Change the time format by the Touch Dial (cycling).

3. Press OK to confirm and go to time setting screen.
4. Press BACK to discard change in time format and go back to Main menu.

#### Setting of time

1. “CLOCK” and the current time are displayed with the hour flashing. Colon does not flash.
2. Set the hour by the Touch Dial (cycling).
3. Press OK to change to set minute. Press OK again will confirm the time and go to date setting screen. If minute has been changed the clock second will also be reset to zero.
4. Press BACK when setting minute will go back to set hour. Press BACK when setting hour will discard the changes in time setting screen and go back to set time format.

#### Setting of date

1. “DATE”, “M D Y” and the current date are displayed. Month is flashing.
2. Set the month by the Touch Dial (cycling).
3. Press OK to change to set day (cycling). Press OK again to set year (non-cycling). Press OK when setting year will confirm the date settings and go to DST setting screen.
4. Press BACK to go back one items. Press BACK when setting month will discard the changes in date setting screen and go back to set time.

#### Setting of DST

1. “DST ON” or “DST OFF” is displayed, depending on the current setting. “ON” or ‘off’ are flashing.
2. Set DST to on or off by the Touch Dial (cycling).
3. Press OK to confirm and go to time zone setting screen.
4. Press BACK to discard change in DST and go back to date setting screen.

#### Setting time zone

1. “TIME ZONE” and the current setting are displayed. The setting is flashing.
2. Set the time zone by the Touch Dial (non-cycling).
3. Press OK will confirm the time zone and go back to Main menu.
4. Press BACK will discard time zone changed and go back to DST setting.

#### Notes

1. Time and date are freezed on the display so that they do not change automatically during set up. If there is no change made, the original clock and calendar will not be affected.
2. Day, if not conform to the month or leap year, will be adjusted automatically to the largest day of the month. For example, 30 for January, 28 for February and non leap years.
3. In any of the screens, Long OK to accept all the changes and go back to Home screen.
4. In any of the screens, Long BACK or wait 30 seconds will discard the changes on that screen and go back to Home screen.

#### Special modes

##### Test mode (factory uses only)

Press RESET to reset the thermostat and then press and hold <TBD> will enter test mode.

##### System option setting mode

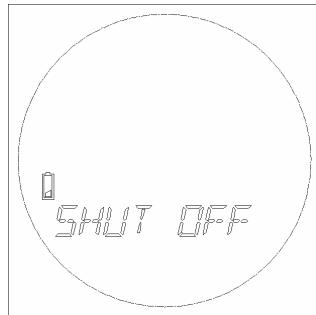
Press RESET to reset the thermostat and then press and hold OK will start System option setting mode.

1. The first option is the Equipment type: “EQUIP HP” or “EQUIP NHP” displayed. The previous set option is displayed and flashes (HP or NHP).
2. Select the Equipment type by the Touch Dial (cycling).
3. Press OK to proceed to the second option. Press BACK has no function (will not leave System option setting mode).

4. The second option is the Fan control option: "FAN HE" or "FAN HG". The previous set option is displayed and flashes (HE or HG).
5. Select the Fan control by the Touch Dial (cycling).
6. For the first option set to HP, press OK to proceed to the third option. For the first option set to NHP, press OK will confirm the settings, leave the setting mode and start normal operation. Press BACK will go back to the first option.
7. The third option is the Reverse valve option: "O/B O" or "O/B B". The previous set option is displayed and flashes (O or B).
8. Select the Reverse valve by the Touch Dial (cycling).
9. Press OK to confirm the settings, leave the setting mode and start normal operation. Press BACK will go back to the second option.
10. There is no time out in System options setting mode. The thermostat will stay in the mode forever if the user does not make selection.

### **Shut off mode**

1. Thermostat switch to Shut off mode automatically when AC power is not available and the battery is too low to support normal operation.
2. User's settings should have properly saved in Flash when entering Shut off mode.
3. In Shut off mode, all relays are switched off. All thermostat control functions and communication cease. All user interfaces stop. The thermostat should switch to a very low power consumption mode to maintain the clock and the memory for as long time as possible.
4. The thermostat will exit Shut off mode if replaced with good batteries or AC becomes present.
5. In Shut off mode, the thermostat will not switch back to Low battery power mode. It can only go directly to Normal power mode. This hysteresis is to prevent the thermostat from switching back and forth between shut off and operation. And thus, if the user changes the batteries in Shut off mode, the batteries must be fresh enough for Normal operation mode. Weak batteries will keep the thermostat in Shut off mode.
6. The LCD display "SHUT OFF" and the low battery indicator:



## **Program and Program overrides**

### **Program mode:**

Set temp is automatically changed according to the programs. "PROG" and program number are displayed.

### **Temporary Hold:**

Set temp is temporary changed and will return to program when the next program time comes, or manually reset. "TEMP HOLD" and program number are displayed.

### **Permanent Hold:**

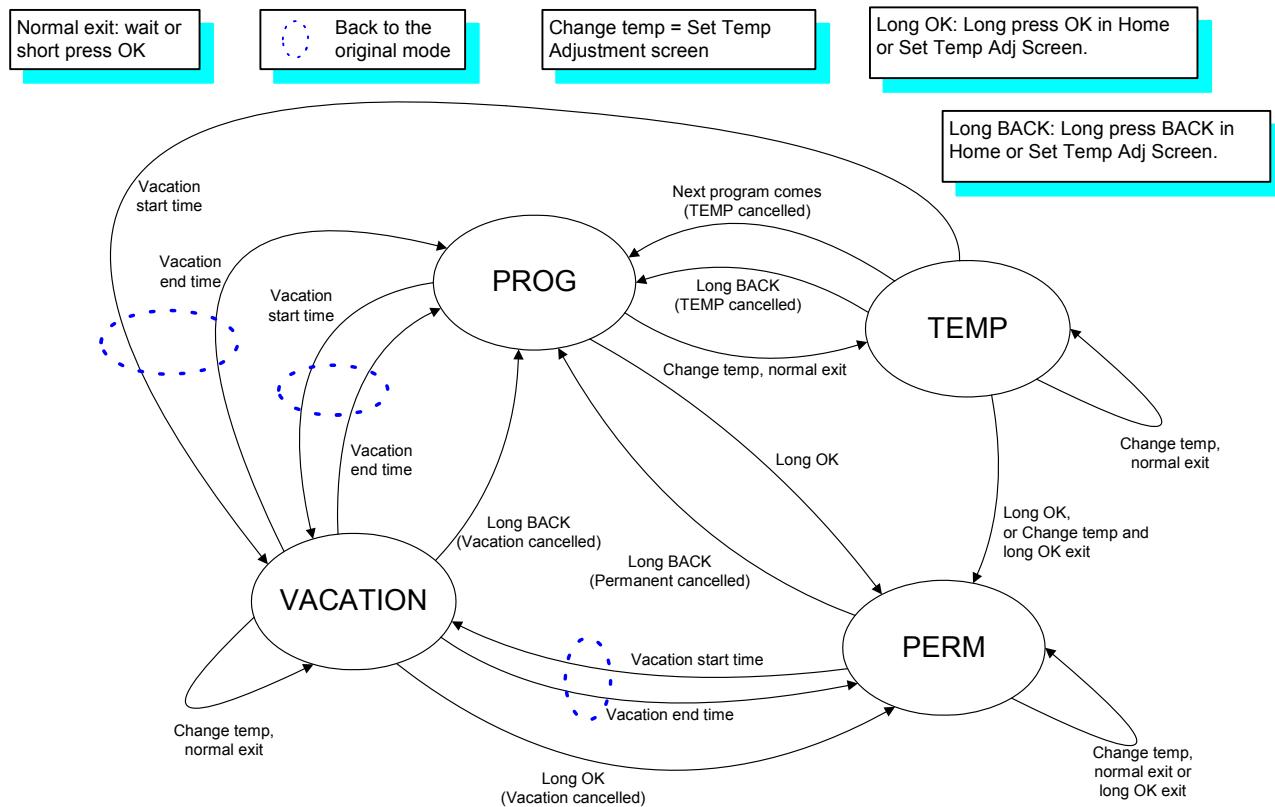
Set temp is permanently changed and will return to program only by manual reset. "PERM HOLD" is displayed but program number is cleared.

### **Vacation Hold:**

Set temp is temporary changed according to Vacation settings. "VACATION" is displayed, and program number is cleared. It will return to program mode or Permanent hold when Vacation ends. It will return to Program mode by manual reset.

1. Vacation hold set the thermostat to a preset temperature for a preset period of time. User sets the start date, end date and the temperature. The thermostat will set to that temperature in that period of time.
2. If the start day is set earlier than the current day, vacation will be activated immediately after returning to home screen.
3. End date equals to the start date means vacation is cancelled.
4. The vacation period is from 12:00am of start date to 12:00am of end time. (Note: Hour can be set through server, so in this case the vacation start and end times can be any other hours of the day).
5. Vacation always runs in heat mode. It will switch to heat mode in the period and back to the original mode after the vacation ends.
6. User can also select OFF mode in vacation. The thermostat will turn off the system in the vacation period. In this case the vacation temperature is no need to set.
7. If it is permanent hold when vacation starts, it will return to permanent hold after the vacation ends.
8. If it is temporary hold or program mode when vacation starts, it will return to program mode after the vacation ends.

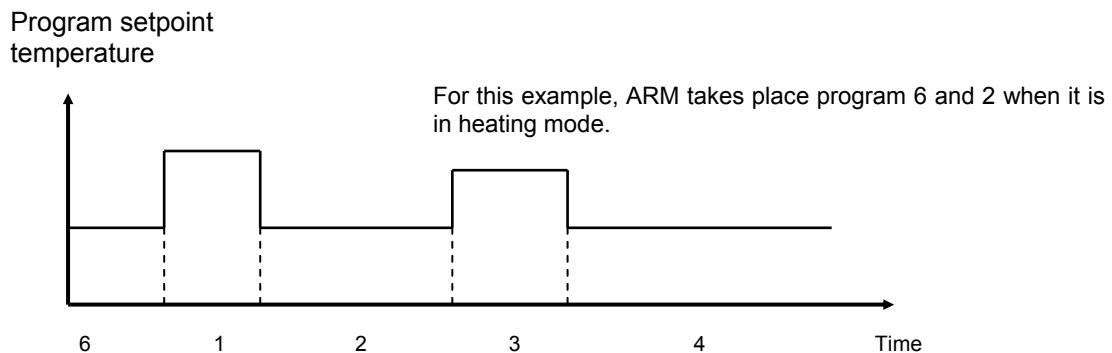
The following diagram summarize the flow between Program mode, Temporary Hold, Permanent Hold and Vacation Hold:



## Auto Recovery

### Advance Recovery Mode (ARM) for Non heat pump heating, cooling, and Heat pump cooling

1. Advance Recovery Mode (ARM) minimizes the time required to achieve a comfort setting after a set back program.
2. ARM is enabled when the Autorecovery is enabled.
3. ARM only operates in Program mode.
4. ARM activates when recovering room temperature from setback or setup programs to comfort programs. In heating mode ARM will only take place when the current program setpoint temperature is lower than the upcoming program setpoint temperature, and in cooling mode the current is higher than the upcoming.



5. During ARM, room temperature is recovered gradually by changing to the setpoint of the upcoming comfort program temperature, some time before its time step. The purpose is to minimize the time required to achieve a comfort setting after a set back program.
6. The start time of ARM is based on the difference between the current room temperature and the upcoming comfort program setpoint temperature. The larger the difference, the earlier the ARM starts. Following table is the cross reference between the temperature difference and the ARM start time:

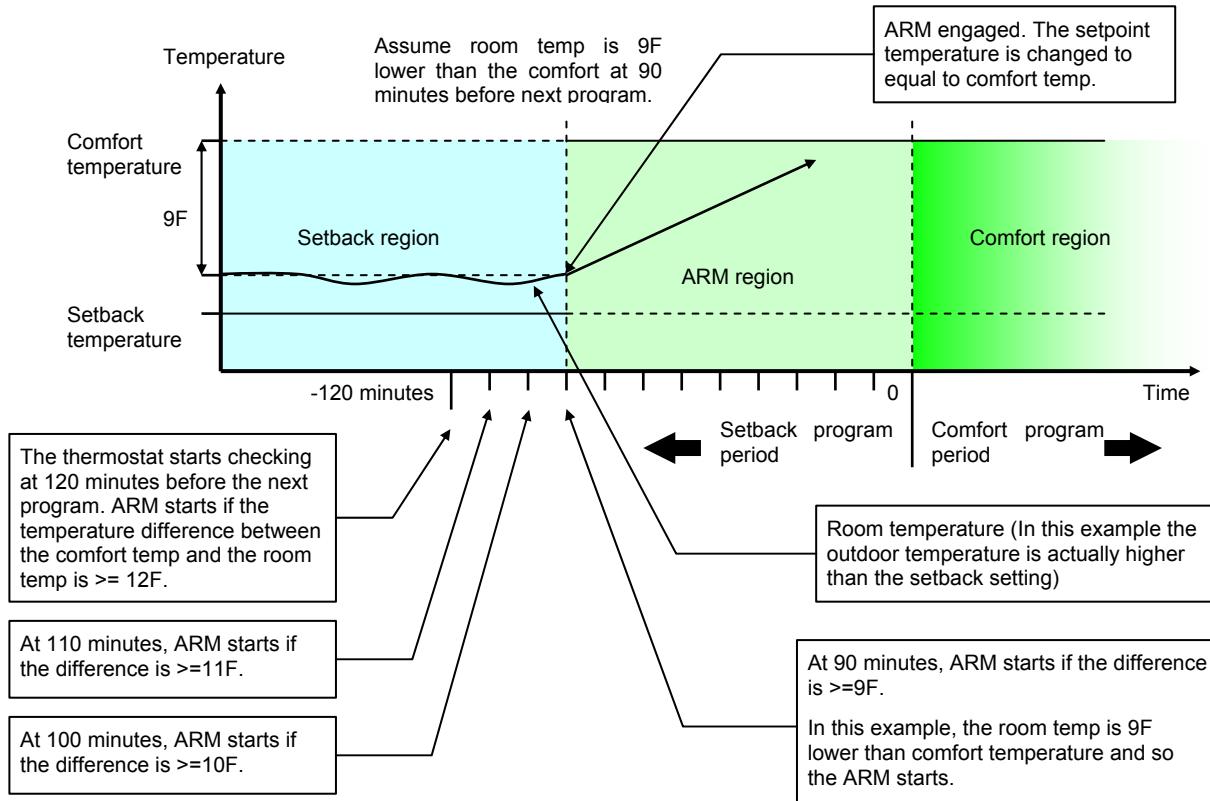
### Heating mode

Temperature difference: (Next program temp. – Current displayed room temp.)	ARM starts time (Time before start time of the next program)
Larger than or equal to 12°F (6.0°C)	120 minutes
11°F (5.5°C)	110 minutes
10°F (5.0°C)	100 minutes
9°F (4.5°C)	90 minutes
8°F (4.0°C)	80 minutes
7°F (3.5°C)	70 minutes
6°F (3.0°C)	60 minutes
5°F (2.5°C)	50 minutes
4°F (2.0°C)	40 minutes
3°F (1.5°C)	30 minutes
2°F (1.0°C)	20 minutes
1°F (0.5°C)	10 minutes
Less than or equal to 0°F (0°C)	ARM does not start

### Cooling mode

Temperature difference: (Next program temp. – Current displayed room temp.)	ARM starts time (Time before start time of the next program)
Larger than or equal to $-12^{\circ}\text{F}$ ( $-6.0^{\circ}\text{C}$ )	120 minutes
$-11^{\circ}\text{F}$ ( $-5.5^{\circ}\text{C}$ )	110 minutes
$-10^{\circ}\text{F}$ ( $-5.0^{\circ}\text{C}$ )	100 minutes
$-9^{\circ}\text{F}$ ( $-4.5^{\circ}\text{C}$ )	90 minutes
$-8^{\circ}\text{F}$ ( $-4.0^{\circ}\text{C}$ )	80 minutes
$-7^{\circ}\text{F}$ ( $-3.5^{\circ}\text{C}$ )	70 minutes
$-6^{\circ}\text{F}$ ( $-3.0^{\circ}\text{C}$ )	60 minutes
$-5^{\circ}\text{F}$ ( $-2.5^{\circ}\text{C}$ )	50 minutes
$-4^{\circ}\text{F}$ ( $-2.0^{\circ}\text{C}$ )	40 minutes
$-3^{\circ}\text{F}$ ( $-1.5^{\circ}\text{C}$ )	30 minutes
$-2^{\circ}\text{F}$ ( $-1.0^{\circ}\text{C}$ )	20 minutes
$-1^{\circ}\text{F}$ ( $-0.5^{\circ}\text{C}$ )	10 minutes
Less than or equal to $0^{\circ}\text{F}$ ( $0^{\circ}\text{C}$ )	ARM does not start

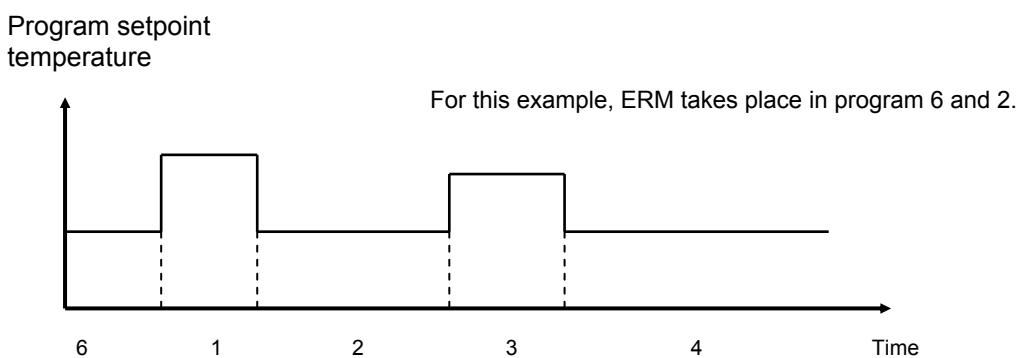
7. ARM operates exactly the same in heating and cooling mode except that the setpoint is different and the control logic is reversed. For simplicity, heating mode is assumed in the following discussion.
8. The maximum ARM period is 120 minutes. So starting from 120 minutes before the upcoming comfort program, the thermostat will check every ten minutes if the temperature difference meets the ERM starting criteria.



9. When temperature difference meets the ARM starting criteria, ARM starts. The set point temperature is changed to the upcoming comfort program temperature.
10. Control pattern is the same as normal non-HP heating, cooling and HP cooling control.
11. When the time setting is reached for the start of the comfort program, ARM is completed.
12. During ARM, the thermostat will show the set point temperature that the system is trying to achieve. i.e., the thermostat will show the set point temperature of the upcoming comfort program temperature.

## 2. Efficient Recovery Mode (ERM) for Heat Pump Heating

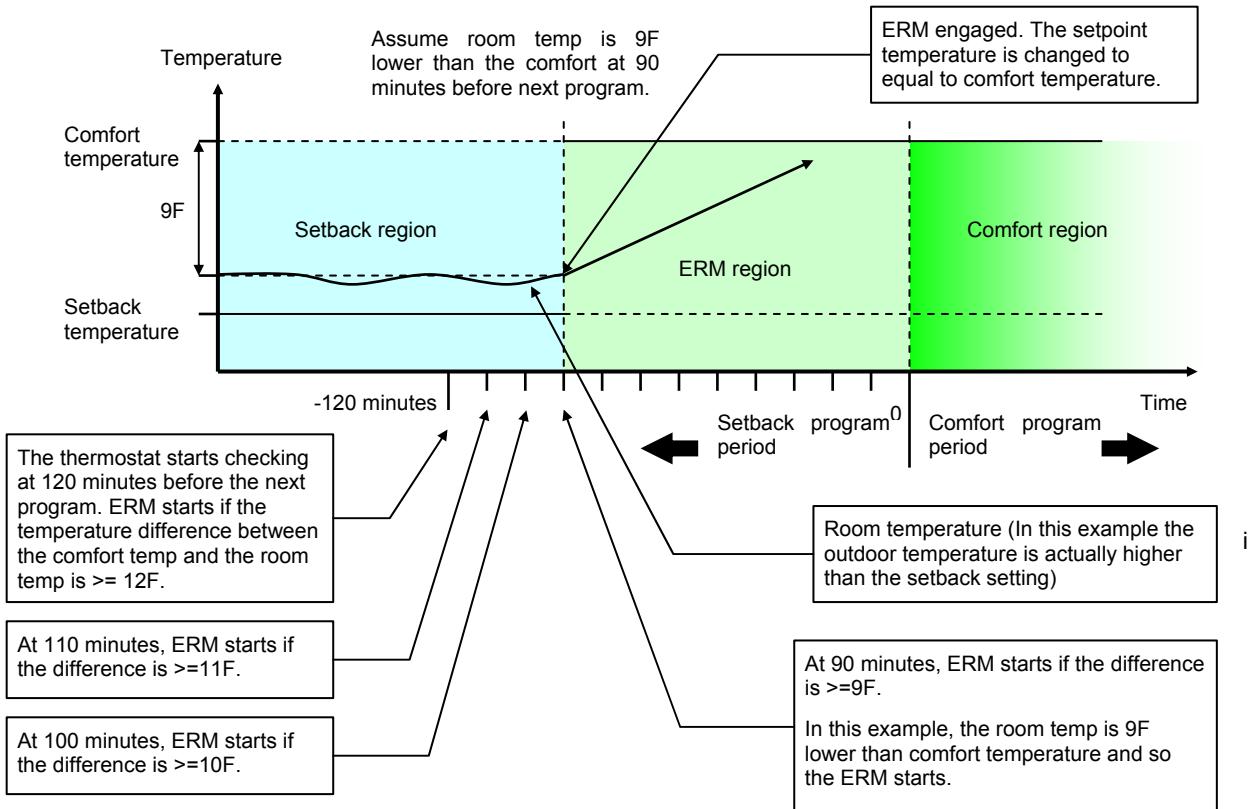
1. Efficient Recovery Mode (ERM) minimizes the use of W1 during recovery from setback program period.
2. ERM is enabled when the Autorecovery is enabled.
3. ERM only operates in program mode.
4. ERM does not operate when emergency heat is selected.
5. ERM activates when recovering room temperature from setback programs to comfort programs. So ERM will only take place when the current program setpoint temperature is lower than the upcoming program setpoint temperature.



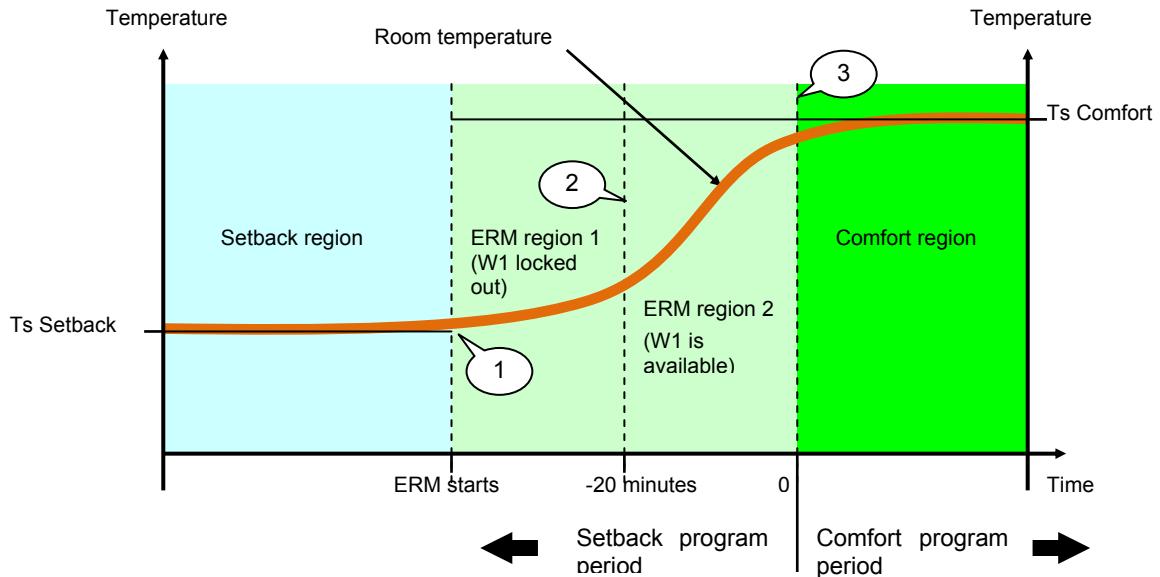
6. During ERM, room temperature is recovered gradually by using only Y1 and Y2 until the last 20 minutes. The setpoint temperature is changed to that of the upcoming comfort program temperature some times before the next program. The purpose is to minimize the use W1.
7. The start time of ERM bases on how much the difference between the current room temperature and the upcoming comfort program setpoint temperature. The larger the difference, the earlier the ERM starts. Following table is the cross reference between the temperature difference and the ERM start time:

Temperature difference: (Next program temp. – Current displayed room temp.)	ERM starts time (time before start time of the next program)
Larger than or equal to 12°F (6.0°C)	120 minutes
11°F (5.5°C)	110 minutes
10°F (5.0°C)	100 minutes
9°F (4.5°C)	90 minutes
8°F (4.0°C)	80 minutes
7°F (3.5°C)	70 minutes
6°F (3.0°C)	60 minutes
5°F (2.5°C)	50 minutes
4°F (2.0°C)	40 minutes
3°F (1.5°C)	30 minutes
2°F (1.0°C)	20 minutes
1°F (0.5°C)	10 minutes
Less than or equal to 0°F (0°C)	ERM does not start

8. The maximum ERM period is 120 minutes. So starting from 120 minutes before the upcoming comfort program, the thermostat will check every ten minutes if the temperature difference meets the ERM starting criteria.



9. ERM will lock out W1 until 20 minutes before the next program. In this period only Y1 and Y2 will be utilized for recovery.



- (1) When temperature difference meets the ERM starting criteria, ERM starts. The setpoint temperature is changed to the upcoming comfort program temperature. Note that W1 is locked out.
- (2) When it reached 20 minutes before the comfort program, W1 lock out is released and the thermostat can use it to complete the recovery.
- (3) ERM completed.

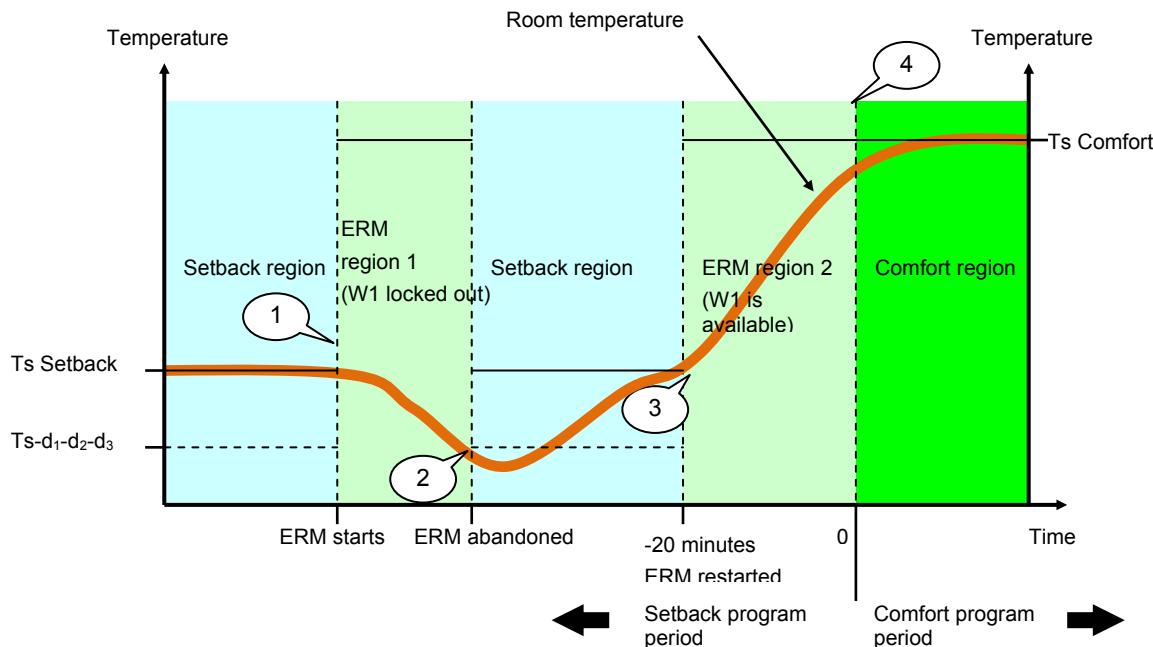
**Control pattern in ERM region 1:**

Room Temperature	Y1	Y2	W1
$T_s \leq T_r$	OFF	OFF	OFF
$T_s - d_1 \leq T_r < T_s$	NC	OFF	OFF
$T_s - d_1 - d_2 \leq T_r < T_s - d_1$	ON	NC	OFF
$T_r < T_s - d_1 - d_2$	ON	ON	OFF

**Control pattern in ERM region 2:**

Room Temperature	Y1	Y2	W1
$T_s \leq T_r$	OFF	OFF	OFF
$T_s - d_1 \leq T_r < T_s$	NC	OFF	OFF
$T_s - d_1 - d_2 \leq T_r < T_s - d_1$	ON	NC	NC
$T_s - d_1 - d_2 - d_3 \leq T_r < T_s - d_1 - d_2$	ON	ON	NC
$T_r < T_s - d_1 - d_2 - d_3$	ON	ON	ON

10. If, for example, in a very cold weather, Y1 and Y2 alone are not enough for recovery and the room temp starts to drop in ERM. Then if the room temperature drops lower than the W1 activation temperature ( $T_s - d_1 - d_2 - d_3$ ) ERM will be abandoned. The thermostat will return to normal setback control with W1 available. This will continue until 20 minutes before the upcoming comfort program and the thermostat will enter ERM again with the 3<sup>rd</sup> stage control.



- (1) When temperature difference meets the ERM starting criteria, ERM starts. The setpoint temperature is changed to the upcoming comfort program temperature. Note that W1 is locked out.
- (2) However, in this example the first two stages are not powerful enough to keep the room temperature. Eventually the room temperature drops too much ( $T_s - d_1 - d_2 - d_3$ ) and the thermostat stops the ERM and returns to normal setback control where setpoint =  $T_s$  (Setback) and W1 is available again.
- (3) When it reaches 20 minutes before the comfort program, ERM starts again. Settemp changed to  $T_s$  (Comfort). W1 is still available and the thermostat continues to complete the recovery.
- (4) ERM completed.

11. During ERM, the thermostat will show the setpoint temperature that it is trying to achieve. I.e., in both the ERM region 1 and 2, the thermostat will show the setpoint temperature of the upcoming comfort program temperature.

## Control

Control patterns describe the states when all delay timers are fulfilled. Please also refer to individual delay timers for the transient states.

### Control patterns

- Tr - Room Temperature
- Ts - Set Temperature
- d1 - First stage differential.(Span = 0.5°F, 1.0°F or 2.0°F / 0.2°C, 0.5°C or 1.0°C)
- d2 - Second stage differential (Fixed 2.0°F / 1.0°C)
- d3 - Third stage differential (Fixed 2.0°F / 1.0°C)

### Non Heat pump - Heating

Room Temperature	Output			
	Y1	Y2	W1	W2
Ts ≤ Tr	OFF	OFF	OFF	OFF
Ts - d1 ≤ Tr < Ts	OFF	OFF	NC	OFF
Ts - d1 - d2 ≤ Tr < Ts - d1	OFF	OFF	ON	NC
Tr < Ts - d1 - d2	OFF	OFF	ON	ON

### Non Heat pump - Cooling

Room Temperature	Output			
	Y1	Y2	W1	W2
Ts ≥ Tr	OFF	OFF	OFF	OFF
Ts + d1 ≥ Tr > Ts	NC	OFF	OFF	OFF
Ts + d1 + d2 ≥ Tr > Ts + d1	ON	NC	OFF	OFF
Tr > Ts + d1 + d2	ON	ON	OFF	OFF

### Non Heat pump – OFF

Room Temperature	Output			
	Y1	Y2	W1	W2
Don't care	OFF	OFF	OFF	OFF

### Non Heat Pump – Fan

Fan	System	Fan option	System output	Output G
On	Don't care	Don't care	Don't care	On
Auto	Heat	HE	On	On
			Off	Off
		HG	Don't care	Off
	Cool	Don't care	On	On
			Off	Off
	Off	Don't care	Off	Off

**Heat pump - Heating**

Room Temperature	Output		
	Y1	Y2	W1
$T_s \leq T_r$	OFF	OFF	OFF
$T_s - d1 \leq T_r < T_s$	NC	OFF	OFF
$T_s - d1 - d2 \leq T_r < T_s - d1$	ON	NC	NC
$T_s - d1 - d2 - d3 \leq T_r < T_s - d1 - d2$	ON	ON	NC
$T_r < T_s - d1 - d2 - d3$	ON	ON	ON

**Heat pump - Cooling**

Room Temperature	Output		
	Y1	Y2	W1
$T_s \geq T_r$	OFF	OFF	OFF
$T_s + d1 \geq T_r > T_s$	NC	OFF	OFF
$T_s + d1 + d2 \geq T_r > T_s + d1$	ON	NC	OFF
$T_r > T_s + d1 + d2$	ON	ON	OFF

**Heat pump – Emergency heating**

Room Temperature	Output		
	Y1	Y2	W1
$T_s \leq T_r$	OFF	OFF	OFF
$T_s - d1 \leq T_r < T_s$	OFF	OFF	NC
$T_r < T_s - d1$	OFF	OFF	ON

**Heat pump – OFF**

Room Temperature	Output		
	Y1	Y2	W1
Don't care	OFF	OFF	OFF

**Heat Pump – Fan**

Fan	System	Fan option	System output	Output G
On	Don't care	Don't care	Don't care	On
Auto	Heat	Don't care	On	On
			Off	Off
	Cool	Don't care	On	On
			Off	Off
	Em Heat	HE	On (W1 only)	On
			Off	Off
		HG	Don't care	Off
	Off	Don't care	Off	Off

**Heat pump – O/B terminal control**

Option	System	Output W2 / OB
O	Heat	OFF
	Cool	ON
	Emergency Heat	OFF
	Off	OFF
B	Heat	ON
	Cool	OFF
	Emergency Heat	ON
	Off	OFF

**Switching sequence****Heat pump**

1. Outputs are turned off in the following sequence: W1 ▶ Y2 ▶ Y1
2. Outputs are turned on in the following sequence: Y1 ▶ Y2 ▶ W1

To update the output, the thermostat will first follow (1) to turn off the relays that are required to turn off. It will then update G. Finally it will follow (2) to turn on the relays that are required to turn on.

**Non Heat pump**

1. Outputs are turned off in the following sequence: W2 ▶ W1 or Y2 ▶ Y1
2. Outputs are turned on in the following sequence: W1 ▶ W2 or Y1 ▶ Y2

To update the output, the thermostat will first follow (1) to turn off the relays that are required to turn off. It will then update G. Finally it will follow (2) to turn on the relays that are required to turn on.

**Note:**

1. For Heat pump, O/B is changed only when Y1 and Y2 are turned off.
2. For Non heat pump, Y1 or Y2 cannot be turned on if W1 or W2 is on. Likewise, W1 or W2 cannot be turned on if Y1 or Y2 is on.
3. For Heat pump emergency heating, Y1 and Y2 are lock out.
4. Short cycle protection is not necessary between the switching of Y1 and Y2.
5. When switching system and if G is on in both the old and new systems, do not turn it off during the switching sequence.

**Relay update**

1. Relays are only updated in the Home screen.
2. Relays will stay unchanged if there was touch operation in 2 seconds.
3. Changing to Shut off mode will ignore 1 and 2. Relays are switched off immediately.
4. Depends on power limitation, relay update may be deferred until backlight or RF is done.

**Delay timers****Compressor short cycle protection timer**

1. Y1 cannot be turned on if it has not been turned off for a specific period of time.

2. This should not be affected by system change. For example. If the mode is heat pump heating, changing to cooling mode will shut off the compressor and it will be locked out until after delay time.

### **Residual cooling fan delay**

1. After cooling is turned off, fan will continue to run for a specific period of time.
2. While the fan is operating in the extended period, if the user changes the system mode from COOL to others, the fan will turn off and the delay timer will be reset.

### **Auto season changeover**

1. If system is set to Auto, the thermostat will determine heating or cooling system automatically.
2. Auto season changeover will be temporarily disabled in Temporary hold and Vacation hold. For Temporary hold, the system when the hold is activated will be maintained. For Vacation hold, it is always the heat mode or off.
3. Auto season changeover will be temporary disabled during the recovery process,
4. For Program mode, if the room temperature is higher than or equal to the cool set temp, and also higher than or equal to the heat set temp + deadband, switch the system to cooling control. If the room temperature is lower than or equal to the heat set temp, and also lower than or equal to the cool set temp - deadband, switch the system to heating control.
5. For Program mode, it is assumed that the cool setpoint is always higher than or equal to the heat setpoint.
6. For Permanent hold, if the room temperature is higher than or equal to set temp + deadband, switch the system to cooling control. If the room temperature is lower than or equal to set temp - deadband, switch the system to heating control.
7. Otherwise, set the system to the same as the last controlled system.

### **Protection**

#### **Heat cut off at high temperature**

When room temperature is too high, all heating outputs will be turned off regardless of the control pattern and delay timers.

#### **Cool cut off at low temperature**

When room temperature is too low, all cooling outputs will be turned off regardless of the control pattern and delay timers.

#### **Relay state feedback**

Latching type relays are used which is susceptible to vibration. State of the relays is continuously monitored. It will be corrected if it does not match the correct state.

#### **Temperature sensing error**

If there is error in temperature measurement, “- -“ will be displayed on the room temperature and the thermostat will turn off all the relays.

### **Temperature sampling**

1. Temperature sampling rate should be 4 times per minute or faster.
2. Temperature sampling should be put on hold if there is possible instability in electrical or temperature. For example, during LCD backlight or RF is on (could affect the AD circuit?) or the user is setting the thermostat (could affect the surrounding temperature?). Final implementation will be decided base on the design and test result.
3. Moving average or other methods is required to reduce influence from temperature fluctuation or possible temperature reading error.

## **ZigBee Profile**

The thermostat is based on the Ember stack platform. It is the end device for the Zigbee Pro network. It supports Zigbee Home Automation Profile.

### **Supported clusters**

Server side	Client side
<b>Common</b>	
Basic	
Poll Control cluster	
Groups Cluster	
Scene Cluster	
Power Configuration Cluster	
Identify	
	Time
	OTA
<b>HVAC</b>	
Thermostat	
Thermostat User Interface Configuration	
Fan Control	
Relative Humidity Measurement Cluster	

**Note:**

About the attributes and commands of each cluster, please refer Attributes and Command List file for details.

## FCC STATEMENT

1. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference.
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

### RF warning statements:

This equipment must be installed and operated with a minimum distance of 20 cm between the equipment and its antenna and your body.