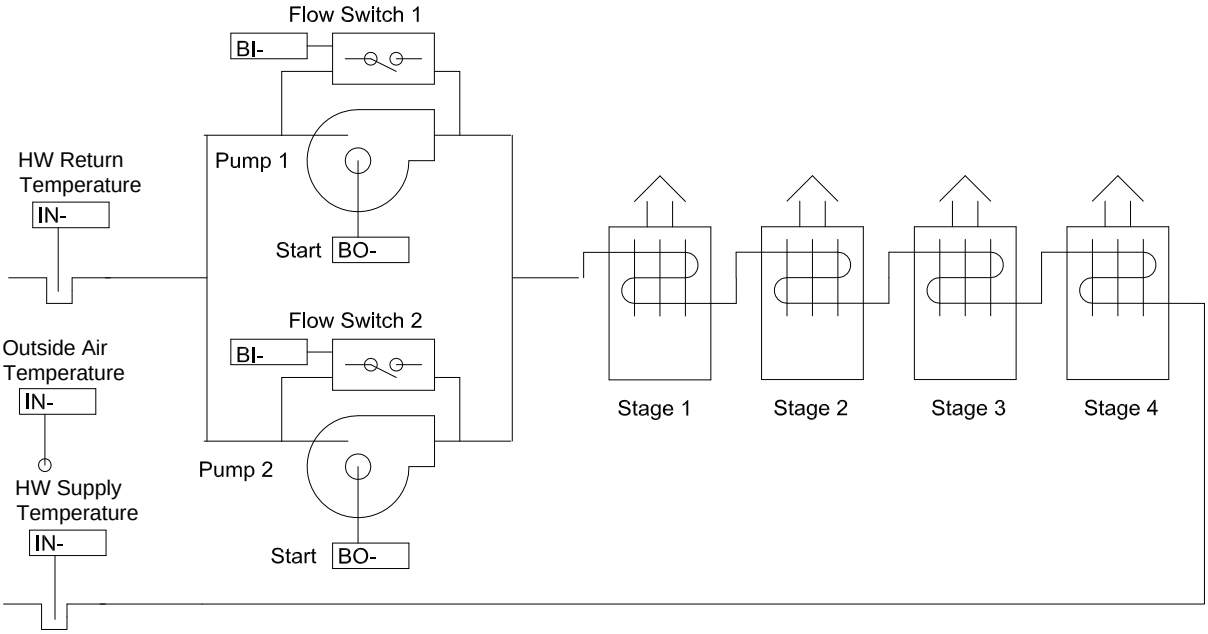
# Object 6 - Boiler

## Boiler Summary

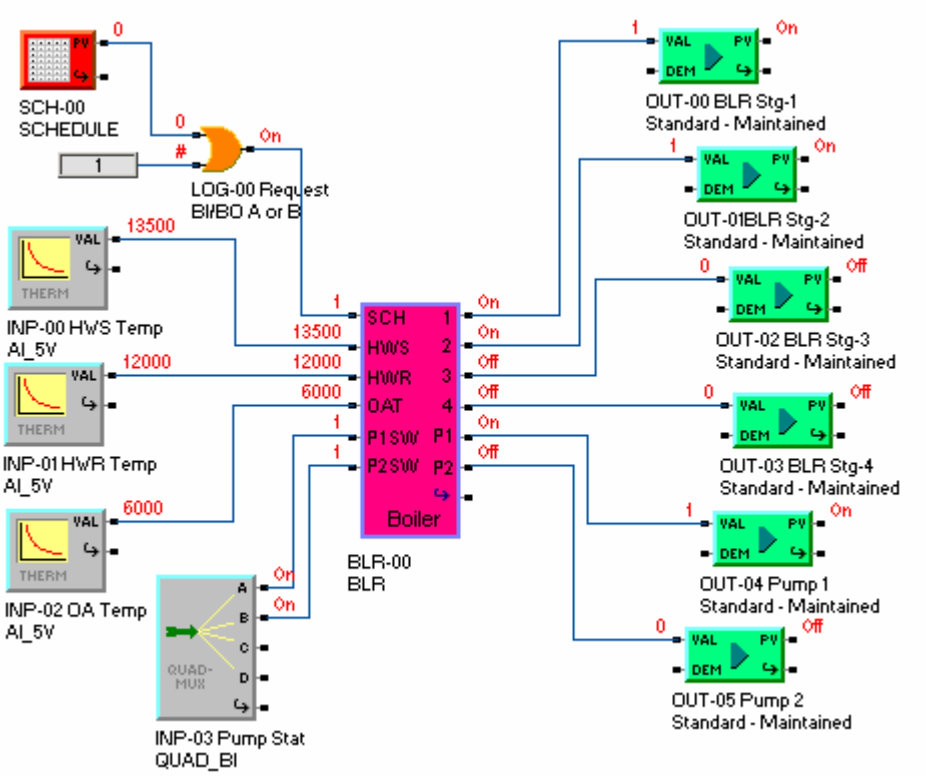



**Overview:** The boiler object is used to maintain a hot water supply at temperature setpoint. It utilizes a 4 stage boiler and 2 pumps.

**Inputs and Outputs:** The boiler object has input handles for hot water supply and return temperatures, proof of flow switches for each pump, on/off schedule, and outdoor air temperature. The boiler object's calculated outputs are the statuses, faults, and on/off control for boiler stages and pumps.

Note: The Boiler Object is restored in ASIC/2-7540. The Boiler Object is not used in ASIC/2-7040-C, FW740C 1.0 It was restored in FW740C Rev. 2.1. It is NOT included in FW740E and 840E.

**Boiler Operation:** The boiler object is typically tied to a schedule object which determines when it is operational (on) or non-operational (off). It may also be overriden on at any time by the logic in some other object.




**Supply Setpoint:** Typically, the boiler object maintains hot water supply temperature at supply setpoint based on the outdoor air temperature (OAT). If the OAT falls below the OAT minimum reset value, then the supply setpoint is reset to the maximum supply setpoint; if the OAT rises above the OAT maximum reset value, the supply setpoint is reset to the minimum supply setpoint. For OATs between the minimum and maximum reset values, the supply setpoint is determined using linear interpolation between the minimum and maximum setpoint values. If control based on outdoor air temperature is disabled, a default supply setpoint is used.

**Boiler Staging:** Each boiler stage must be enabled to be operational at all. Each stage has an associated temperature offset value and hysteresis value. If the hot water supply temperature is below the supply setpoint by at least the stage's offset value, the stage is turned on. It is turned off if the supply temperture rises back above this value by at least the hysteresis band. An interstage timer prevents 2 boiler stages from starting within too close a period of each other. A minimum-on timer prevents unnecessary on/off cycling of a boiler stage.

**Pumps:** Two pumps are available. Either one or both may be setup to be always on, or a lead pump/lag pump setup may be used. If the lead/lag configuration is used, the lead pump is on and the lag pump is off unless the lead pump fails, in which case the lag pump takes over. Either pump 1 or 2 may be permanently assigned to be the lead pump, or the pumps may be set up to trade roles. The boiler object may be configured so that the pumps trade roles at the beginning of every day or as function of how long the lead pump has been in the lead pump role.

**OAT Lockout:** If the outdoor air temperature rises above the OAT lockout setpoint, the boiler object is disabled and all boiler stages and the 2 pumps are turned off until the OAT falls below the OAT lockout setpoint by at least the hysteresis band. Lockouts supersede overrides on of the boiler.

**Pump Faults:** Proof of flow is monitored for each pump. If proof of flow is lost, the pump is immediately turned off and a proof of flow alarm in recorded. An attempt is made to turn the pump on again a limited number of times, but if proof of flow is not eventually obtained, the pump is locked out from operation and a pump fault alarm is set. The pump is locked out until user intervention. If the lead pump fails, the lag pump is started up and runs until the lead pump has been re-started. If both pumps fail, a double fault alarm is set and the boiler stages are locked out from operation.

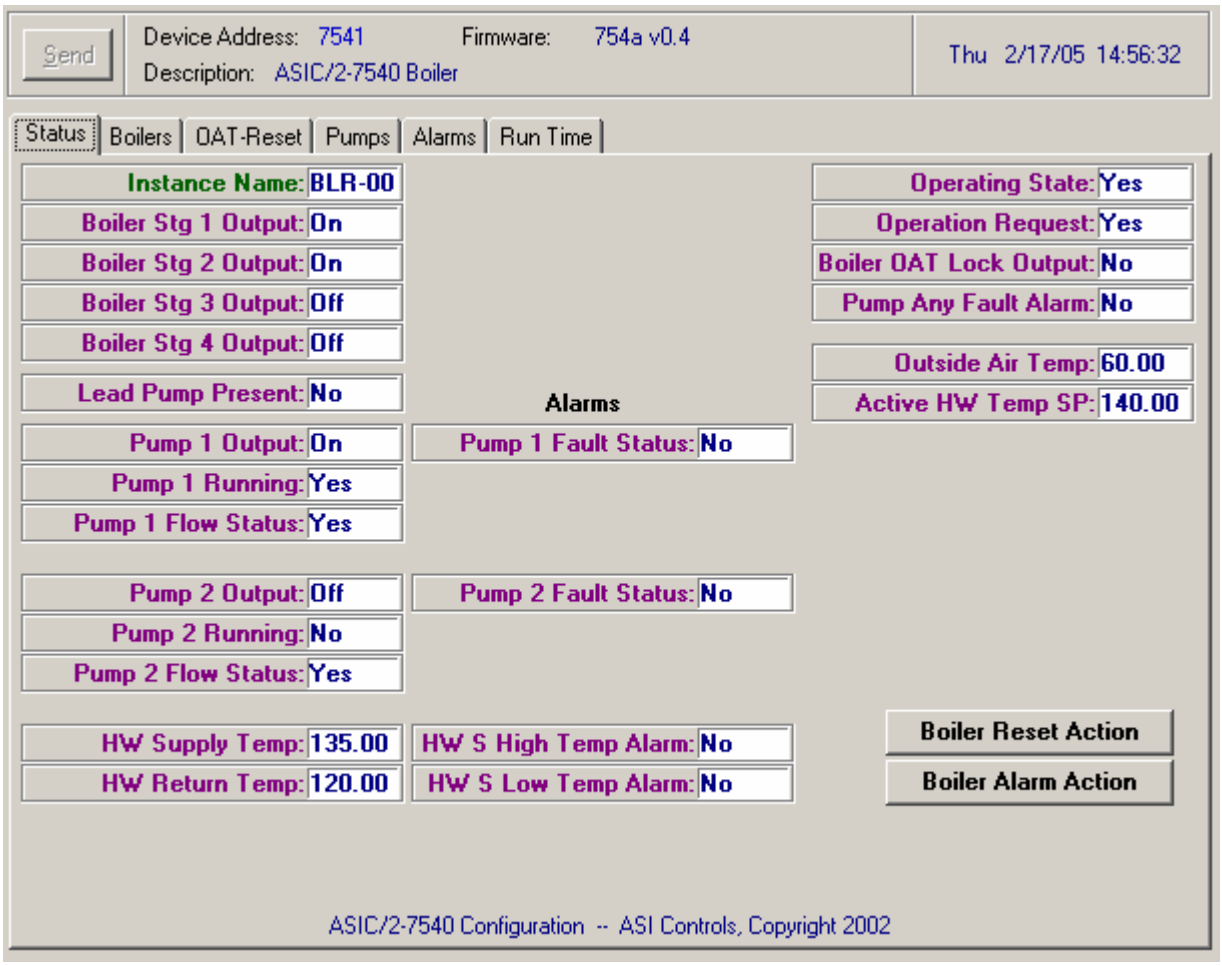
**Return/Supply Temperature Low/High Alarms**: The supply water temperature is monitored and periodically compared to the alarm setpoints. If supply temperature is above the high alarm setpoint, a high supply alarm is set; if below the low alarm setpoint, a low supply alarm is set. A similar sequence is performed for the return water temperature. For alarms to clear, the temperature must move back past the setpoint by a hysteresis value.

**Operational Monitoring:** For each pump, its starts today, hours today as lead, total hours on so far as lead, and total accumulated hours on (as lead or lag) are kept track of in memory.

# Boiler Operation

The up to 4 stages of hot water boilers are controlled to maintain hot water supply temperature. The outputs used for the pumps and stages are assignable. The inputs required for control are assignable.

4 Stages of Boiler
Lead/Lag Starting of 2 Pumps
TOD or continuous operation
Outside Air Temperature Lockout
Outside Air Temperature Reset




The boiler operates if the assigned operating schedule is ON, or if the boiler operation has been overridden ON unless locked out by the OAT Lock function.

One or two pumps operate whenever the Boiler operation is ON. When boiler operation is OFF, then both pumps are OFF.

If both pumps have been enabled and neither pump has been selected for use, then the operation of the pumps is in a lead/lag configuration with the lead pump determined by operator selection, selection by day of week, or selection by accumulated run time.

If only one pump has been enabled that pump is used for boiler operation.

If either pump has been enabled and selected for use, then one or both pumps run whenever operation of the boiler is ON.

When at least one pump is ON and proof of flow has been established, up to 4 stages of boiler is energized in sequence to maintain the Active HW Temperature SP. The Active HW Temperature SP is determined by a reset schedule based on outside air temperature if enabled, or the Default HW Temperature SP.

## Active HW Temperature SP

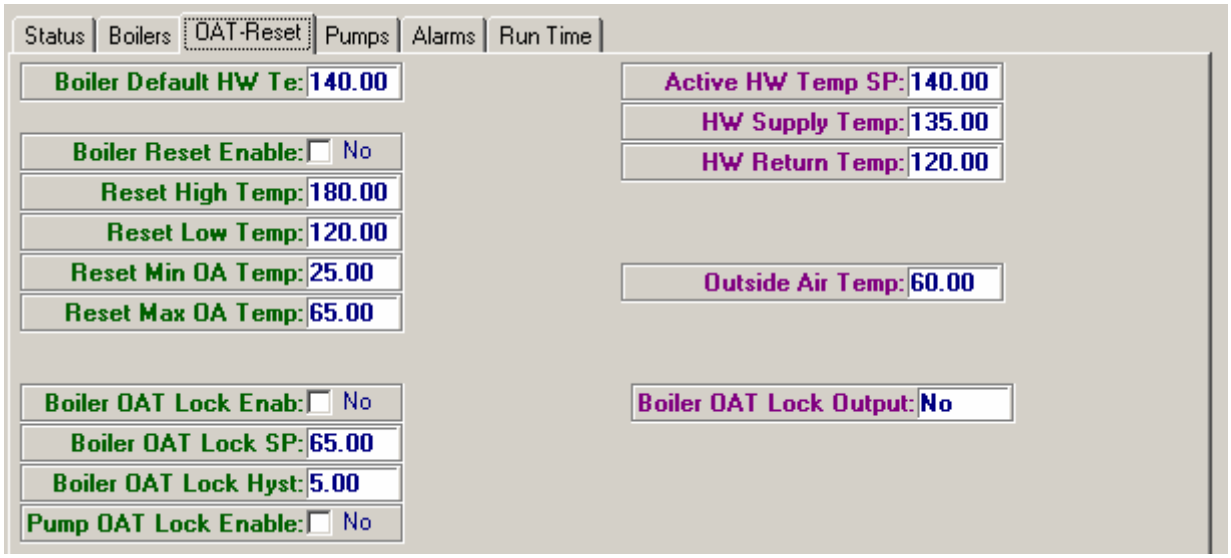
If the Reset feature has NOT been enabled, the Active HW Temp SP is equal to the Default HW Temp SP.

If the Reset feature has been enabled, the Active HW Temperature SP is calculated base on outside air temperature using linear interpolation of a reset schedule.

At an outside air temperature greater than or equal to the Boiler Min Reset OA Temp, the Active HW Temperature SP is equal to the Boiler Min Reset Temp SP.

At an outside air temperature less than or equal to the Boiler Max Reset OA Temp, the Active HW Temperature SP is equal to the Boiler Max Reset Temp SP.

At an outside air temperature less than the Boiler Max Reset OA Temp, and greater than the Boiler Min Reset OA Temp, the Active HW Temperature SP is between the Boiler Min Reset Temp SP and the Boiler Max Reset Temp SP using linear interpolation.




## Boiler Staging

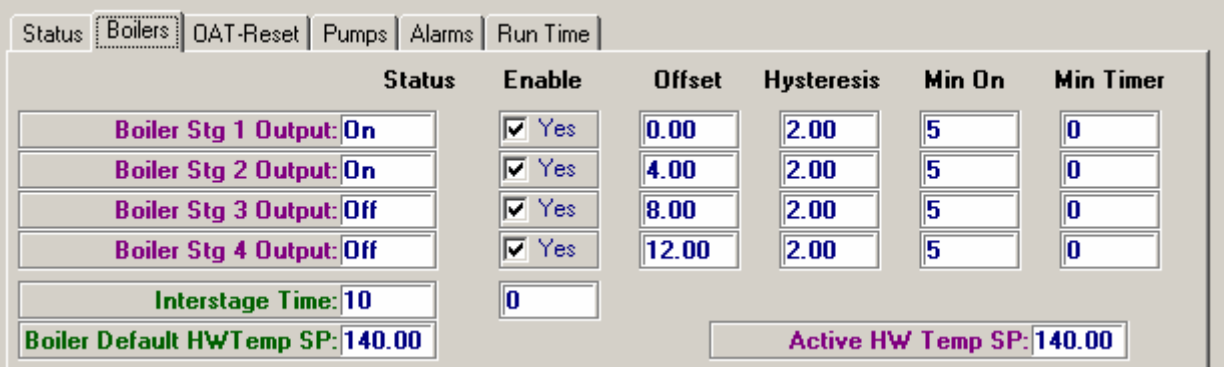
Boiler Stages are OFF when:

1) The Stage is NOT enabled.
2) The Boiler OAT Lock function has been enabled and is active.
3) There is no proof of flow.

If the Boiler OAT Lockout has been Enabled the stage will not come on if the outside air temperature lockout is active..

If the Boiler OAT Lock has been Enabled, the stage will not come on if the outside air temperature lockout is active.

An interstage timer [Default: 10 s] prevents more than one stage from coming on at the same time.




### *Boiler Stage 1 (ON/OFF)*

The boiler has up to four identical stages. If there is no proof of flow , or if the stage has not been enabled, the stage is OFF. An Interstage Timer [Default: 10 s] prevents more than one stage from coming on at the same time.

At a hot water supply temperature less than to the Active Hot Water SP minus the Boiler Stage 1 Offset Temp [Default: 0 F], the Boiler Stage 1 Output is energized. The Boiler Stage 1 remains energized until the hot water temperature reaches the Active Hot Water SP minus the Boiler Stage 1 Offset Temp plus the Boiler Stage 1 Hysteresis [Default: 2 F]. Once energized it remains on for a Boiler Stage 1 Min ON Time. [Default: 5 minutes]

### *Boiler Stage 2 (ON/OFF)*

The boiler Stage 2 is controlled in the same way as Stage 1. At a hot water supply temperature less than to the Active Hot Water SP minus the Boiler Stage 2 Offset Temp [Default: 4 F], Boiler Stage 2 Output is energized. The Boiler Stage 2 remains energized until the hot water temperature reaches the Active Hot Water SP minus the Boiler Stage 2 Offset Temp plus the Boiler Stage 2 Hysteresis [Default: 2 F] (Attr-36). Once energized it remains on for a Boiler Stage 2 Min ON Time. [Default: 5 minutes]

### *Boiler Stage 3 (ON/OFF)*

The boiler Stage 3 is controlled in the same way as Stage 1. At a hot water supply temperature less than to the Active Hot Water SP minus the Boiler Stage 3 Offset Temp [Default: 4 F], Boiler Stage 3 Output is energized The Boiler Stage 3 remains energized until the hot water temperature reaches the Active Hot Water SP minus the Boiler Stage 3 Offset Temp plus the Boiler Stage 3 Hysteresis [Default: 2 F]. Once energized it remains on for a Boiler Stage 3 Min ON Time. [Default: 5 minutes]

### *Boiler Stage 4 (ON/OFF)*

The boiler Stage 4 is controlled in the same way as Stage 1. At a hot water supply temperature less than to the Active Hot Water SP minus the Boiler Stage 4 Offset Temp [Default: 4 F], Boiler Stage 4 Output is energized. The Boiler Stage 4 remains energized until the hot water temperature reaches the Active Hot Water SP minus the Boiler Stage 4 Offset Temp plus the Boiler Stage 4 Hysteresis [Default: 2 F].Once energized it remains on for a Boiler Stage 4 Min ON Time. (Attr-40) [Default: 5 minutes]

## Boiler OAT Lock

If the Boiler OAT Lock function is enabled, the Boiler is locked out from operating if the outside air temperature exceeds the Boiler OAT Lock SP.

The Boiler OAT Lock function is used to lock out boiler and optionally pump operation when the outdoor temperature is above some setpoint.

If the outside air temperature, is greater than the Boiler OAT Lock SP [Default: 65 F], the OAT Lock function is active and the Boiler Lock Binary Output is energized.

The Boiler Lockout is active until the Outside Air Temperature falls to the Boiler OAT Lock SP minus the Boiler OAT Lock Hysteresis [Default: 5 F]

# Boiler Pump Operation

The pump or pumps operates whenever the boiler operation is ON. If Pump OAT Lock has been Enabled, the pumps is OFF whenever the OAT Lock function is active.

### *Single Pump*

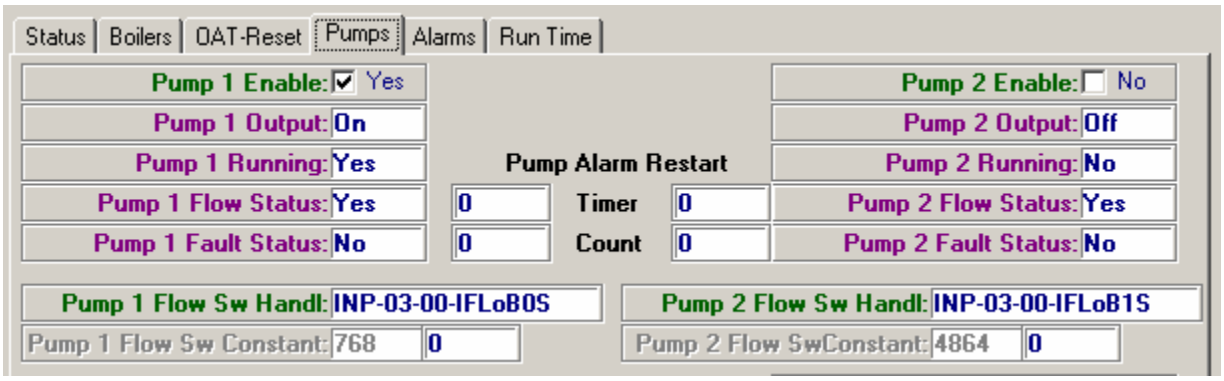
If only one pump has been enabled, that pump run whenever boiler operation is ON.

### *Pump Override ON*

If either pump has been enabled, and selected for use, then one or both pumps run whenever boiler operation is ON. Each pump will have its own proof of flow and restart.

If Pump 1 Enable and Pump 1 Override ON then Run Pump 1

If Pump 2 Enable and Pump 2 Override ON, then Run Pump 2




### *Lead/Lag Pump*

If both pumps are enabled, and neither pump is Overriden ON, then the operation of the pumps is in a lead/lag configuration.

The selection of Lead pump is based on Pump Lead Select, Day of Week, or Accumulated Pump Run Time.The other pump becomes the Lag Pump.

If Pump Lead Select is 1 or 2, then this is the lead pump.

If Lead Pump Select = 0, then look at Pump Flip/Flop. If Pump Flip/Flop on Day is yes, Change Lead Pump based on Day of Week. If Pump Flip/Flop on Day is No, and Pump Flip/Flop on Run Time is Yes, then the Lead Pump is changed based on Accumulated Run Time

If lead pump is changed, then both pumps are run for a Pump Crossover Delay before stopping the first pump. There is no interruption in flow during pump changeover.

### *Proof of Flow.*

Each pump may have its own proof of flow, or they may use a common proof of flow identified by the Pump 1 Flow Switch Handle and Pump 2 Flow Switch Handle.

If either proof of flow switch is closed, then proof of flow status (Attr-2, LO Bit 5) is verified for the hot water.

The Pump (1 or 2) Flow Status verifies that the pump (1 or 2) is running. If the requested pump is verified then the Proof of Flow Status is set to Yes.

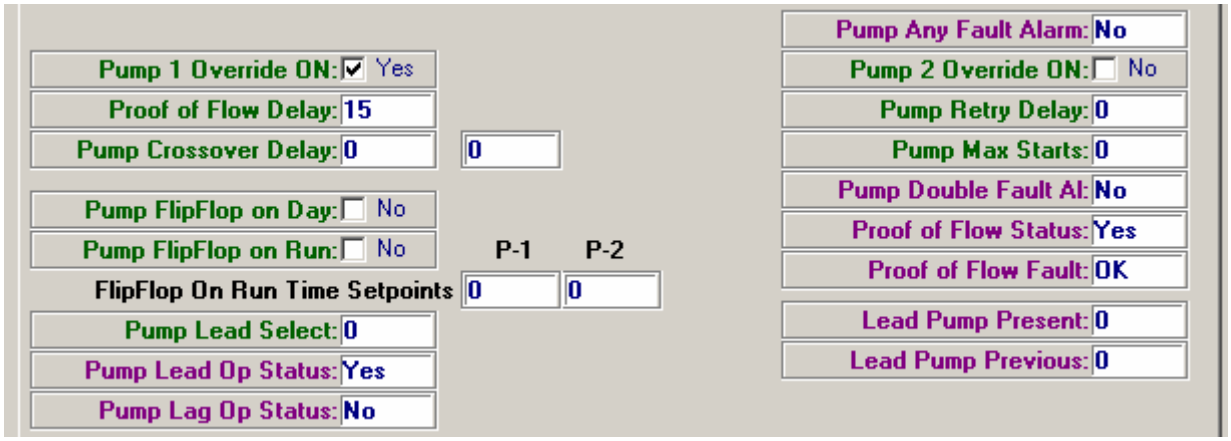
When boiler operation is requested, and the proof of flow fails to be established after a Proof of Flow Delay, a Proof of Flow Alarm is set. If proof of flow is re-established, the proof of flow alarm is cleared.

### *Proof of Flow Failure*

Upon failure of proof of flow of the lead pump after a Proof of Flow Delay, the controller turns OFF the lead pump, waits a Pump Retry Delay and retrys until the Pump Try Max has been reached. It then declares a Lead Pump Fault Alarm and turns OFF the lead pump.

In the event of failure of the lead pump, the controller starts the Lag Pump. Upon failure of proof of flow of the lag pump after a Proof of Flow Delay , the controller turns OFF the lag pump, waits a Pump Retry Delay and retries until the Pump Try Max has been

reached. It then declares a Lag Pump Fault Alarm (Attr-3, LO_BIT_1), and turn OFF the lag pump. If both the Lead Pump and Lag Pump are in fault, then the Double Pump Fault Alarm is set.




### *Pump 1 Run Time*

When Pump 1 is running, the Pump 1 Run Hours is accumulated in 1 hour increments. At the end of the day the total run hours is added to Pump 1 Accumulated Run Time and to Pump 1 Run Time. If Flip/Flop on Run Time is enabled and the pump is running, the sum of the Pump 1 Run Time and Pump 1 Run Hours is compared with the Pump 1 Flip/Flop SP. If greater than the Pump 1 Flip/Flop SP, the Lead Pump is switched, the Pump 1 Run Hours is added to Pump 1 Accumulated Run Time, and the Pump 1 Hours is zeroed.

### *Pump 2 Run Time*

When Pump 2 is running, the Pump 2 Run Hours is accumulated in 1 hour increments. At the end of the day the total run hours is added to Pump 2 Accumulated Run Time and to Pump 2 Run Time. If Flip/Flop on Run Time is enabled and the pump is running, the sum of the Pump 2 Run Time and Pump 2 Run Hours is compared with the Pump 2 Flip/Flop SP. If greater than the Pump 2 Flip/Flop SP, the Lead Pump is switched, the Pump 2 Run Hours is added to Pump 2 Accumulated Run Time, and the Pump 2 Run Hours is zeroed.

# Alarms

### *HWS Temperature Alarms*

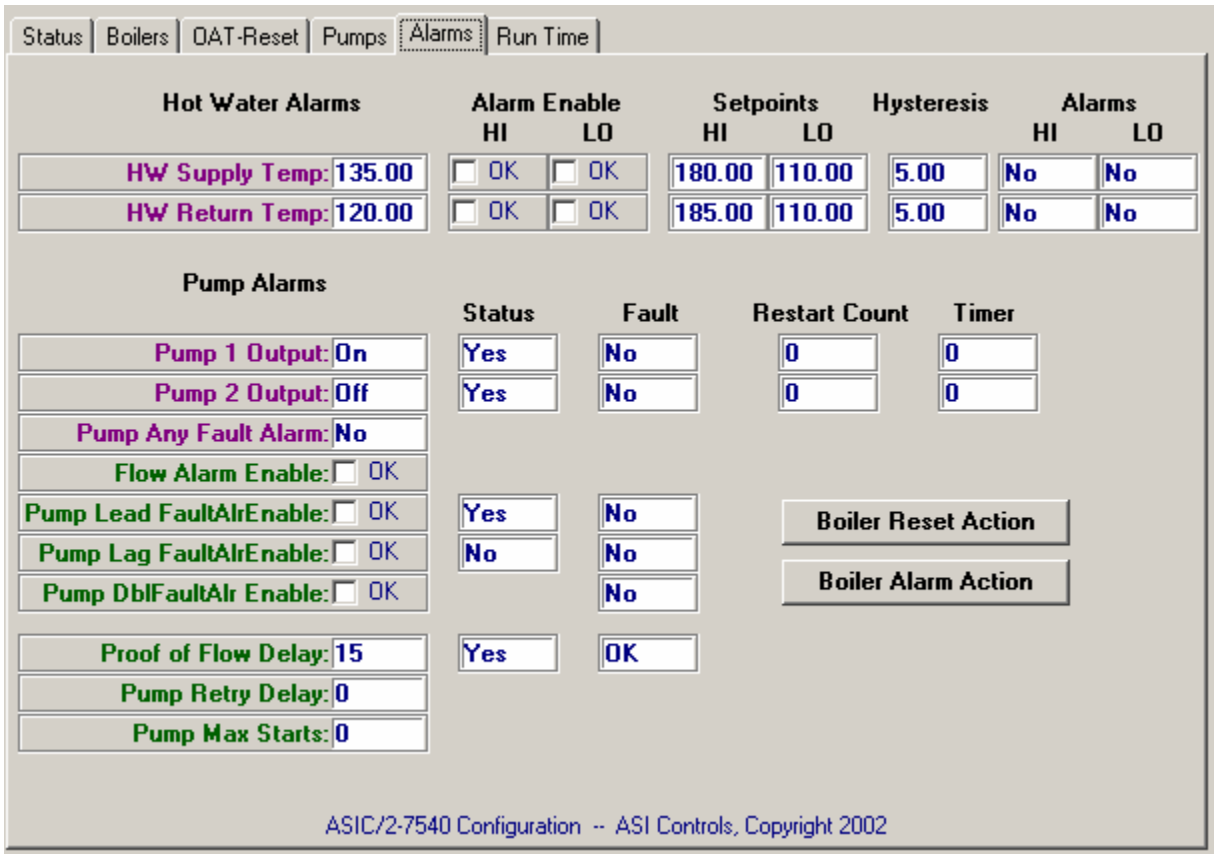
If the HW Supply Temperature exceeds the HWS High Temp Alarm SP [Default: 180 F], a HWS High Temp Alarm is set. The alarm remains active until the HW Supply Temperature falls below the HWS High Temp Alarm SP minus the HWS Temp Hysteresis [Default: 5 F].

If the HW Supply Temperature falls below the HWS Low Temp Alarm SP [Default: 180 F], a HWS High Temp Alarm is set. The alarm remains active until the HW Supply Temperature falls rises above the HWS Low Temp Alarm SP plus the HWS Temp Hysteresis [Default: 5 F]

### *HWR Temperature Alarms*

If the HW Return Temperature exceeds the HWR High Temp Alarm SP [Default: 180 F], a HWR High Temp Alarm is set. The alarm remains active until the HW Return Temperature falls below the HWR High Temp Alarm SP minus the HWR Temp Hysteresis [Default: 5 F]

If the HW Return Temperature falls below the HWR Low Temp Alarm SP [Default: 180 F], a HWR High Temp Alarm is set. The alarm remains active until the HW Return Temperature falls rises above the HWR Low Temp Alarm SP plus the HWR Temp Hysteresis [Default: 5 F].




### *Pump Alarms*

Pump fault alarms once set can only be cleared by an operator communication.

If the lead pump fails to start after Max Retries, a Lead Pump Fault Alarm is set.

If the lag pump fails to start after Max Retries, a Lag Pump Fault Alarm is set.

If both pumps fail to start after Max Retries, a Double Pump Fault Alarm is set.

If the Pump 1 fails to start after Max Retries, a Pump 1 Fault Status is set and a Pump 1 Fault Alarm is set.

If the Pump 2 fails to start after Max Retries, a Pump 2 Fault Status is set and a Pump 2 Fault Alarm is set.

#### *Proof of Flow Alarm*

If the proof of flow fails to be established after a proof of flow delay, a Proof of Flow Alarm is set. If proof of flow is re-established, the proof of flow alarm is cleared.

# Boiler Glossary

## Boiler Parameters

#### *Boiler Active Hot Water Supply Setpoint*

The current setpoint to which the boiler maintains its supply water output. May be determined using the boiler reset calculation based on outdoor air temperature. Otherwise equal to Default Setpoint or to a user-override value. In degrees F; user-configurable. (6,X,1,WORD)

#### *Boiler Default Hot Water Temperature Setpoint*

The value loaded into the Boiler Active Hot Water Supply Setpoint if the Boiler Reset feature is not enabled. In degrees F; user-configurable. (6,X,29,WORD)

#### *Boiler Interstage Time*

The delay which is enforced between the successive startings of any two boiler heating stages. In seconds; user-configurable. (6,X,30,WORD)

#### *Boiler Outdoor Air Temperature Lockout Enable*

This parameter must be set to "yes" for boiler OAT lockouts to occur. "Enabled", "Disabled"; user-configurable. (6,X,20,WORD)

#### *Boiler Outdoor Air Temperature Lockout Setpoint*

If boiler OAT lockouts are enabled, then an OAT above this setpoint disables all boiler heating stages from operation. In degrees F; user-configurable. (6,X,27,WORD)

#### *Boiler Outdoor Air Temperature Lockout Hysteresis*

For a disabled boiler to be re-enabled, the OAT must drop below Boiler OAT Setpoint by the hysteresis. In degrees F; user-configurable. (6,X,28,WORD)

#### *Boiler Operating Status*

Indicates whether the boiler is currently requested AND able to operate. (Able to operated is no Pump Faults or OAT Lockouts are in effect). "On","Off"; not user-configurable. (6,X,2,HI_BIT_0)

#### *Boiler Operation Requested*

Designates whether boiler operation is requested according to schedule or due to an override received via the communications line. "Yes","No"; not user-configurable. (6,X,2,HI_BIT_1)

#### *Boiler Override On*

If set to "yes" then the boiler is currently being overriden on by the user via the communications line. "Yes","No"; not user-configurable. (6,X,22,LO_BIT_0))

#### *Boiler Reset Enable*

If the boiler reset feature is enabled, then the Boiler Active Hot Water Supply Setpoint is determined based on the Outdoor Air Temperature. "Enable","Disable"; user-configurable. (6,X,20,LO_BIT_7)

#### *Boiler Reset High Temperature Setpoint*

If the boiler reset feature is enabled, Boiler Active Temperature Setpoint is reset to this value if OAT falls below Boiler Reset Minimum OAT. In degrees F; user-configurable. (6,X,23,WORD)

### *Boiler Reset Low Temperature Setpoint*

If the boiler reset feature is enabled, Boiler Active Temperature Setpoint is reset to this value if OAT rises above Boiler Reset Maximum OAT. In degrees F; user-configurable. (6,X,24,WORD)

### *Boiler Schedule Handle*

This handle points to the schedule which designates when the boiler object is to be operational (on) and when it is to be non-operational (off). User-configurable. (6,X,58,2 WORDS)

### *Boiler Stage X Enable*

Setting this parameter to "Yes" enables stage X (1 to 4) for duty. Setting it to "No" causes this stage to be skipped over when the boiler is performing its heating duties. "Yes", "No"; user-configurable. (6,X,20,LO_BIT_X)

### *Boiler Stage X Offset Temperature*

The HW Supply Temperature must fall below the Boiler Active Hot Water Supply Setpoint by this value for boiler stage X (1 to 6) to turn on. In degrees F; user-configurable. (6,X,31,WORD)

### *Boiler Stage X Hysteresis*

The HW Supply Temperature must rise above the Boiler Active Hot Water Supply Setpoint minus Boiler Stage X Offset Temperature for boiler stage X to turn off. In degrees F; user-configurable. (6,X,35,WORD)

### *Boiler Stage X Minimum On-Time*

Whenever boiler stage X is turned on, it must remain on for this amount of time at a minimum. In minutes; user-configurable. (6,X,39,WORD)

### *Boiler Stage X Minimum On Timer*

This timer records how long boiler stage X has been on. In minutes; user-configurable. (6,X,16,HI_BYTE)

### *Hot Water Return Temperature*

The temperature of the water incoming to the boiler after it has flowed through the heat pumps. In degrees F; user-configurable. (6,X,13,WORD)

### *Hot Water Return Temperature Handle*

This handle typically points to an index of an input object assigned to a temperature sensor positioned on the return pipe. User-configurable. (6,X,62,3 BYTES)

### *Hot Water Return High Temperature Alarm*

This alarm is set by the Hot Water Return Temperature exceeding the Hot Water Return High Temperature Alarm Setpoint. "OK","Alarm"; not user-changeable. (6,X,3,HI_BIT_4)

### *Hot Water Return High Temperature Alarm Enable*

Enables this alarm. "Enabled","Disabled"; user-configurable. (6,X,21,HI_BIT_4)

### *Hot Water Return High Temperature Alarm Setpoint*

Setpoint for this alarm. In degrees F; user-configurable. (6,X,55,WORD)

### *Hot Water Return Low Temperature Alarm*

This alarm is set by the Hot Water Return temperature falling below the Hot Water Return Low Temperature Alarm Setpoint. "Alarm", "OK"; not user-changeable. (6,X,3,HI_BIT_5)

### *Hot Water Return Low Temperature Alarm Enable*

Enables the above. "Enabled","Disabled"; user-configurable.

(6,X,21,HI_BIT_5)

### *Hot Water Return Low Temperature Alarm Setpoint*

Setpoint for this alarm. In degrees F; user-configurable. (6,X,56,WORD)

### *Hot Water Return Temperture Alarm Hysteresis*

If a High or Low Hot Water Return Temperature Alarm is in effect, the Hot Water Return temperature must pass back over the alarm setpoint by this hysteresis value for the alarm to clear. In degrees F; user-configurable. (6,X,57,WORD)

### *Hot Water Supply Temperature*

The temperature of the water supplied by the boiler to the heat pumps. In degrees F; user-configurable. (6,X,13,WORD)

### *Hot Water Supply Temperature Handle*

This handle typically points to an index of an input object assigned to a temperature sensor positioned on the supply pipe. User-configurable. (6,X,62,3 BYTES)

### *Hot Water Supply High Temperature Alarm*

This alarm is set by the Hot Water Supply Temperature exceeding the Hot Water Supply High Temperature Alarm Setpoint. "OK","Alarm"; not user-changeable. (6,X,3,HI_BIT_4)

### *Hot Water Supply High Temperature Alarm Enable*

Enables this alarm. "Enabled","Disabled"; user-configurable. (6,X,21,HI_BIT_4)

### *Hot Water Supply High Temperature Alarm Setpoint*

Setpoint for this alarm. In degrees F; user-configurable. (6,X,55,WORD)

### *Hot Water Supply Low Temperature Alarm*

This alarm is set by the Hot Water Supply Temperature falling below the Hot Water Supply Low Temperature Alarm Setpoint. "OK","Alarm" ;not user-changeable. (6,X,3,HI_BIT_5)

### *Hot Water Supply Low Temperature Alarm Enable*

Enables the above. "Enabled","Disabled"; user-configurable. (6,X,21,HI_BIT_5)

Hot Water Supply Low Temperature Alarm Setpoint

Setpoint for this alarm. In degrees F; user-configurable. (6,X,56,WORD)

### *Hot Water Supply Temperature Alarm Hysteresis*

If a High or Low Hot Water Supply Temperature Alarm is in effect, the Hot Water Supply Temperature must pass back over the alarm setpoint by this hysteresis value for the alarm to clear. In degrees F; user-configurable. (6,X,57,WORD)

### *Lag Pump Fault Alarm Enable*

Will read "Alarm" if the lag pump is currently in fault. (6,X,21,LO_BIT_2)

### *Lead Pump Present*

Specifies which pump is currently being used as the lead pump. "1","2"; not user-changeable. (6,X,2,LO_BIT_6)

### *Lead Pump Previous*

Specifies which pump was used as the lead pump prior to the current lead pump assuming the role. (6,X,2,LO_BIT_7)

### *Lead Pump Fault Alarm Enable*

Will read "Alarm" if the lead pump is currently in fault. (6,X,21,LO_BIT_1)

### *Outside Air Temperature*

Read by sensor for input index pointed at by Outside Air Temperature Handle. In degrees F; not user-changeable. (6,X,14,WORD)

### *Outside Air Temperature Handle*

Typically this points at an Input index which reads a temperature sensor on the outside of the building. User-configurable. (6,X,65,HI_BYTE)

### *Proof-of-Flow Status*

If either pump 1 or pump 2 has proof-of-flow then this will be set to "OK". "OK","No"; not user-configurable. (6,X,2,LO_BIT_5)

### *Proof-of-Flow Fault Alarm*

Will be equal to "Alarm" if neither pump 1 nor pump 2 has established proof-of-flow within the Proof-of-Flow Delay time following receipt of a request for boiler operation. "Alarm","OK"; not user-configurable. (6,X,3,HI_BIT_0)

### *Proof-of-Flow Fault Alarm Enable*

Enables the setting of this alarm. "Enabled","Disabled"; user-configurable. (6,X,21,HI_BIT_0)

### *Proof-of-Flow Delay*

The amount of time the proof-of-flow sensor must read positive for proof-of-flow to be considered to have been established. In seconds; user-configurable. (6,X,51,WORD)

### *Pump X Enable*

Enables pump X (1 or 2) for operation. "Enabled","Disabled"; user-configurable. Pump 1 (6,X,22,LO_BIT_4). Pump 2 (6,X,22,LO_BIT_5).

### *Pump X Output*

Read by the Output index for pump X (1 or 2) to determine whether the pump is to be on or off. "On","Off"; not user-changeable. Pump 1 (6,X,0,LO_BIT_4). Pump 2 (6,X,0,LO_BIT_5).

### *Pump X Run Requested*

Indicates that control logic wishes pump X (1 or 2) to be on. This parameter is not the same as Pump X Ouput because the interstage time requirement, an overriden Off, or a pump fault could force the pump output off. "Yes","No";

### *Pump X Override ON*

Indicates whether Pump X (1 or 2) is currently being overriden on. "Yes","No"; not user-changeable. Pump 1 (6,X,22,LO_BIT_6). Pump 2 (6,X,22,LO_BIT_7).

### *Pump X Flow Sensor Handle*

Points to the Input index which reads the pump X (1 or 2) low sensor. User-configurable. Pump 1 (6,X,66,WORD). Pump 2 (6,X,66,WORD).

### *Pump X Flow Status*

Indicates whether proof-of-flow has been attained for pump X (1 or 2). Proof-of-flow is attained when the flow sensor has continuously read positive for the proof-of-flow delay. Without proof-of-flow, a pump is forced off. "Yes","No"; not user-changeable. Pump 1 (6,X,2,LO_BIT_3). Pump 2 (6,X,2,LO_BIT_4).

### *Pump X Fault Status*

Indicates if pump X (1 or 2) is currently in fault. A pump fault is declared if proof-of-flow was not established and unsuccessful re-tries to establish it were made up to the maximum allowable limit (limit = Pump Maximum Restarts). "OK","Fault"; not user-changeable. Pump 1 (6,X,2,HI_BIT_6). Pump 2 (6,X,2,HI_BIT_7).

### *Pump Restart Delay*

The time to wait between failure to establish proof-of-flow for a pump and the making the next attempt to turn the pump on. In seconds; user-configurable. (6,X,44,WORD)

### *Pump Maximum Starts*

The maximum number of attempts which may be made to start either pump without establishing proof-of-flow. User-configurable. (6,X,22,HI_MS_NBL)

### *Pump X Restart Counter*

Keeps track of the number of re-starts which have been attempted so far. User-configurable. Pump 1 (6,X,5,LO_BYTE). Pump 2 (6,X,5,HI_BYTE).

### *Pump X Restart Timer*

This is used to track the proof-of-flow delay for Pump X (1 or 2). In seconds; not user-changeable. Pump 1 (6,X,6,LO_BYTE). Pump 2 (6,X,6,HI_BYTE).

### *Pump X Run Time Today*

The time that pump X (1 or 2) has been on so far today. In hours; not user-changeable. Pump 1 (6,X,10,WORD). Pump 2 (6,X,11,WORD).

### *Pump X Run Time Total*

The total time pump X (1 or 2) has been on since the last flip/flop occured. In hours; not user-changeable. Pump 1 (6,X,46,WORD). Pump 2 (6,X,49,WORD).

### *Pump X Run Time Accumulator*

The total time pump X (1 or 2) has been on since the user last cleared this parameter. Each time a flip/flop occurs, Pump Run Time Total is summed into this accumulator. In hours; may be cleared by user. Pump 1 (6,X,45,WORD). Pump 2 (6,X,48,WORD).

### *Pump X Starts Today*

The number of times pump X (1 or 2) has been successfully started today. Not user-changeable. Pump 1 (6,X,7,WORD). Pump 2 (6,X,8,WORD).

### *Pump Any Fault Alarm*

If either or both pumps are in fault, this will indicate "Alarm". "OK","Alarm"; not user-changeable. (6,X,3,LO_BIT_4)

### *Pump Double Fault Alarm*

Will read "Alarm" if both pumps 1 and 2 are in fault. "OK","Alarm"; not user-changeable. (6,X,3,LO_BIT_0)

### *Pump Double Fault Alarm Enable*

Enables the above alarm. "Enabled","Disabled"; user-configurable. (6,X,21,LO_BIT_0)

### *Pump Crossover Delay*

The time during which both the lead pump and the lag pump are forced on simultaneously when performing a pump flip/flop. In seconds; user-configurable. (6,X,43,LO_BYTE)

### *Pump Crossover Timer*

Used to enforce Pump Crossover Delay. (6,X,9,LO_BYTE)

### *Pump Flip/Flop on Day*

Enables switching of lead pump/lag pump roles for pumps 1 and 2 based day of the week. Switch occurs at beginning of each day. "Yes","No"; user-configurable. (6,X,22,LO_BIT_2)

### *Pump Flip/Flop on Run Time*

Enables switching of the lead pump/lag pump roles for pumps 1 and 2 based on the lead pump's run-time. "Yes","No"; user-configurable. (6,X,22,LO_BIT_3)

### *Pump X Flip/Flop Setpoint*

This setpoint only applies if Pump Flip/Flop on Run Time has been enabled. Once pump X Run Time Total plus Pump X Run Time Today has exceeded this setpoint, a pump flip/flop will be triggered. In hours; user-configurable. Pump 1 (6,X,47,WORD). Pump 2 (6,X,47,WORD).

### *Pump-Lead Operating Status*

Indicates whether the lead pump is currently on. "On","Off"; not user-changeable. (6,X,2,LO_BIT_1)

### *Pump-Lag Operating Status*

Indicates whether the lag pump is currently on. "On","Off"; not user-changeable. (6,X,2,LO_BIT_2)

### *Pump Lead Select*

Used to overrides the lead pump selection to pump 1 or pump 2, as chosen, unconditionally. Setting this to "0" disables the override. "0","1","2"; user-configurable. (6,X,22,HI_LS_NBL)

### *Pump Outdoor Air Temperature Lockout Enable*

If this parameter is set to "yes" then whenever a boiler OAT lockout is in effect, the boiler pumps are disabled in addition to the boiler heating stages. "Enabled","Disabled"; user-configurable. (6,X,20,WORD)

# Boiler Properties

The BOILER Object

BOILER (

| | |
|---|---|
| Object Number | = 6 |
| Data Type | = Word |
| Index | = 1 or as allocated |
| Attributes | = 74 (0..73) |
| DYNAMIC Attributes | = 20 (0..19) |
| STATIC Attributes | = 54 (20..73) |

## Boiler Firmware Revision

**ASIC/2-7540 FW754A Rev 1.0 Forthcoming 2005**

- Restores Boiler Object as in FW740C.

**ASIC/2-7040 FW740E Rev 1.7 Released 09/27/2000 CHK 0xE62A**
**ASIC/2-8040 FW840E Rev 1.7 Released 09/27/2000 CHK 0xCB80**

- Object 6 - Boiler is not supported in FW8/740E Rev 1.7 and later.

**ASIC/2-7040 FW740C Rev 2.1 Released 08/20/98 CHK F6CEh**
**ASIC/2-8040 FW840C Rev 1.1 Released 07/22/98 CHK F5F0h**

- Restores Tower and Boiler. They were deleted in 740C 2.0

**ASIC/2-7040 FW740C Rev 1.9 Released 04/15/98**

- Restores Tower and Boiler.

**ASIC/2-7040 FW740C Rev 1.0, Released 01/29/97**
The Boiler Not used in FW740C.

**ASIC/2-7040 FW740A Rev 1.0 03/31/94**
Fixed boiler turn off bug.

**ASIC/2-7000 FW700A.. Rev 1.0 Released 12/05/91**
SC/1-9040 FW907A Rev 1.0 Released 07/25/91
Boiler Never Turns off correctly.

## Boiler Dynamic Properties

Attr-0 Boiler Output Status
- LO BYTE
- LO Bit 0 - Boiler Stage 1 Output
- LO Bit 1 - Boiler Stage 2 Output
- LO Bit 2 - Boiler Stage 3 Output
- LO Bit 3 - Boiler Stage 4 Output
- LO Bit 4 - Pump 1 Output
- LO Bit 5 - Pump 2 Output
- LO Bit 6 -
- LO Bit 7 - Boiler OAT Lock Output
- HI BYTE - Spare

Attr-1 Boiler Active HW Temp SP

Attr-2 Boiler Status
- LO BYTE
- LO Bit 0 - Spare
- LO Bit 1 - Pump Lead Operating Status
- LO Bit 2 - Pump Lag Operating Status
- LO Bit 3 - Pump 1 Flow Status
- LO Bit 4 - Pump 2 Flow Status
- LO Bit 5 - Proof of Flow Status
- LO Bit 6 - Lead Pump Present
  (0 = Pump 1, 1 = Pump 2)
- LO Bit 7 - Lead Pump Previous
  (0 = Pump 1, 1 = Pump 2)
- HI BYTE
- HI Bit 0 - Boiler Operating Status
- HI Bit 1 - Boiler Operation Request
- HI Bit 2 - Boiler OAT Lock Status
- HI Bit 3 - Spare
- HI Bit 4 - Pump 1 Running
- HI Bit 5 - Pump 2 Running
- HI Bit 6 - Pump 1 Fault Status
- HI Bit 7 - Pump 2 Fault Status

Attr-3 Alarm Status
- LO BYTE
- LO Bit 0 - Pump Double Fault Alarm
- LO Bit 1 - Pump Lead Fault Alarm
- LO Bit 2 - Pump Lag Fault Alarm
- LO Bit 3 - Pump Any Fault Alarm
- LO Bit 4 - Spare
- LO Bit 5 - Spare
- LO Bit 6 - Spare
- LO Bit 7 - Spare
- HI Byte
- HI Bit 0 - Proof of Flow Fault Alarm
- HI Bit 1 - Spare
- HI Bit 2 - HW Supply High Temp Alarm
- HI Bit 3 - HW Supply Low Temp Alarm
- HI Bit 4 - HW Return High Temp Alarm
- HI Bit 5 - HW Return Low Temp Alarm
- HI Bit 6 -
- HI Bit 7 -

Attr-4 Action
0 - "Select" No Operation
01..16 - Clear Individual Alarms
Clear Attr-3 Alarm Bit 0 through Bit 15
01- "Clear Double Fault Alarm"
02 - "Clear Lead Fault Alarm"
03 - "Clear Lag Fault Alarm"
17 - "Reset Pumps", Clear Double, Lead, and Lag Alarms Attr-3 bits 0..2
18 - "Fresh Start", Reset All Attr-3 Alarm Bits 0..15
19 - "Force Boiler ON" (Attr-22, LO Bit 0 = 1)
20 - "Restore Auto" (Attr-22, LO Bit 0 = 0)
Pump Timers and Counters

Attr-5 Pump Start Counters
LO Byte - Pump 1 Restart Counter
HI Byte - Pump 2 Restart Counter

Attr-6 Pump Start Timers
LO Byte - Pump 1 Restart Timer
HI Byte - Pump 2 Restart Timer

Attr-7 Pump 1 Starts Today

Attr-8 Pump 2 Starts Today

Attr-9 Pump Crossover Timer
The timer for crossover to New Lead Pump from Old Lead Pump

Attr-10 Pump 1 Run Time Today
Pump 1 Run time Today in 1 hour increments.

Attr-11 Pump 2 Run Time Today
Current Temperatures

Attr-12 HW Supply Temp

Attr-13 HW Return Temp

Attr-14 Outside Air Temperature

Boiler Timers

Attr-15 Timers
LO Byte - Boiler Interstage Timer
HI Byte - Spare

Attr-16,17 Timers
Attr-16 LO Byte - Boiler Stage 1 Min ON Timer (min)
Attr-16 HI Byte - Boiler Stage 2 Min ON Timer (min)
Attr-17 LO Byte - Boiler Stage 3 Min ON Timer (min)
Attr-17 HI Byte - Boiler Stage 4 Min ON Timer (min)

Attr-18 Spare

Attr-19 Spare

## Boiler STATIC Properties

Attr-20 Enable Boiler
- LO BYTE
- LO Bit 0 - Boiler Stage 1 Enable
- LO Bit 1 - Boiler Stage 2 Enable
- LO Bit 2 - Boiler Stage 3 Enable
- LO Bit 3 - Boiler Stage 4 Enable
- LO Bit 4 - Spare
- LO Bit 5 - Pump OAT Lock Enable
- Also turns off the pumps if OAT Lock conditions exist.
- LO Bit 6 - Boiler OAT Lock Enable
- Enables OAT Lockout function Turns off Boiler if OAT> Boiler OAT Lock SP.
- LO Bit 7 - Boiler Reset Enable
- Enables OAT Reset function.
- HI BYTE - Spare

Attr-21 Enable Alarm
- LO BYTE
- LO Bit 0 - Pump Dbl Fault Alarm Enable
- Sets Alarm on Lead and Lag pump fault
- LO Bit 1 - Pump Lead Fault Alarm Enable
- Sets Alarm on Lead pump fault
- LO Bit 2 - Pump Lag Fault Alarm Enable
- Sets Alarm on Lag pump fault
- LO Bit 3 - Spare
- LO Bit 4 - Spare
- LO Bit 5 - Spare
- LO Bit 6 - Spare
- LO Bit 7 – Spare

Attr-21 HI BYTE
- HI Bit 0 - Proof of Flow Alarm Enable
- Sets Alarm on loss of proof of flow
- HI Bit 1 - Spare
- HI Bit 2 - HWS High Temp Alarm Enable
- Sets Alarm on High HW Supply Temp
- HI Bit 3 - HWS Low Temp Alarm Enable
- Sets Alarm on Low CWS Temp
- HI Bit 4 - HWR Temp High Alarm Enable
- Sets Alarm on High CWR Temp
- HI Bit 5 - HWR Temp Low Alarm Enable
- Sets Alarm on Low CWR Temp
- HI Bit 6 - Spare
- HI Bit 7 - Spare

Attr-22 Pump Setup
LO BYTE
LO Bit 0 - Boiler Override ON
Forces the Boiler ON and ignores TOD schedule. Pump or pumps turn on and boiler stages with HW supply temperature.
LO Bit 1 - Spare
LO Bit 2 - Pump Flip/Flop on Day
Change Lead Pump based on Day of Week if Pump Select = 0
LO Bit 3 - Pump Flip/Flop on Run Time
Change Lead Pump on Accumulated Run Time
if Pump Select = 0 and Flip/Flop on Day = 0
LO Bit 4 - Pump 1 Enable
LO Bit 5 - Pump 2 Enable
LO Bit 6 - Pump 1 Override ON
Force operation of Pump 1 if Pump 1 Enable = 1 and if boiler operation is ON.
Ignore Lead/Lag
LO Bit 7 - Pump 2 Override ON
Force operation of Pump 2 if Pump 2 Enable = 1 and if boiler operation is ON.
Ignore Lead/Lag
HI_LS_NBL - Pump Lead Select
0 = Use Day of Week
1 = Use Pump 1 for Lead
2 = Use Pump 2 for Lead
HI_MS_NBL - Pump Maximum Starts
Total number of start attempts before pump
fault is declared.

### *Boiler Reset Parameters*

Attr-23 Boiler Reset High Temperature SP [Typical 180 F]

Attr-24 Boiler Reset Low Temperature SP[Typical 120 F]

Attr-25 Boiler Reset Max OA Temp [Typical 65 F]

Attr-26 Boiler Reset Min OA Temp [Typical 25 F]

### *Boiler OAT Lock Parameters*

Attr-27 Boiler OAT Lock SP [Typical 65 F]

Attr-28 Boiler OAT Lock Hysteresis [Typical 4 F]

Attr-29 Boiler Default HW Temp SP [Typical 140 F]
This setpoint is used if the Reset has not been enabled, globally or for the stage.

### *Boiler Stage Parameters*

Attr-30 Boiler Interstage Time
Interstage time in seconds for adding a stage.

Temperature Offset from the Active HW Temp Setpoint for adding a Stage
Attr-31 Boiler Stage 1 Offset Temp [Typical 0 F]
Attr-32 Boiler Stage 2 Offset Temp [Typical 4 F]
Attr-33 Boiler Stage 3 Offset Temp [Typical 8 F]
Attr-34 Boiler Stage 4 Offset Temp [Typical 12 F]

Attr-35 Boiler Stage 1 Hysteresis [Typical 4 F]
Attr-36 Boiler Stage 2 Hysteresis [Typical 4 F]
Attr-37 Boiler Stage 3 Hysteresis [Typical 4 F]
Attr-38 Boiler Stage 4 Hysteresis [Typical 4 F]

Minimum ON Time in minutes for Stage 1.
Attr-39 Boiler Stage 1 Min ON Time [Typical 5 min]
Attr-40 Boiler Stage 2 Min ON Time [Typical 5 min]
Attr-41 Boiler Stage 3 Min ON Time [Typical 5 min]
Attr-42 Boiler Stage 4 Min ON Time [Typical 5 min]

### *Pump Control Parameters*

Attr-43 Pump Crossover Delay [Typical 30 s]
Delay in switching the lead pump. The new lead pump starts and runs for pump crossover Delay in seconds before the old lead pump is turned off.

Attr-44 Pump Retry Delay [Typical 20 s]
Delay in retrying a pump start. If the pump fails to start with in a Proof of Flow Delay, then the pump turns OFF and wait a Pump Retry Delay time before attempting to start again.

Attr-45 Pump 1 Accum Run Time
Accumulated Run time in Hours for Pump 1. This is accumulated at the end of the day from (Pump 1 Run Today). This is cleared by the operator. Fractional hours are carried over in Pump 1 Run Today to the next day.

Attr-46 Pump 1 Run Time
Accumulated Run time in Hours for Pump 1. This is accumulated at the end of the day from Pump 1 Run Today and is Cleared when a switch to Lead Pump 2 on Run Time is done.

Attr-47 Pump 1 Flip/Flop Setpoint
Setpoint in hours used to compare with Pump 1 Run Time Total + (Pump 1 Run Today) to determine if Flip/Flop to Lead Pump 2 is required.

Attr-48 Pump 2 Accum Run Time
Accumulated Run time in Hours for Pump 2. This is accumulated at the end of the day from (Pump 2 Run Today). This is cleared by the operator. Fractional hours are carried over in Pump 1 Run Today to the next day.

Attr-49 Pump 2 Run Time Total
Total Run time in Hours for Pump 2. This is accumulated at the end of the day from Pump 2 Run Time Today and is Cleared when a switch to Lead Pump 1 on is done when Run Time Total > Flip/Flop Setpoint.

Attr-50 Pump 2 Flip/Flop Setpoint

Attr-51 Proof of Flow Delay [Typical 15 s]
The time in seconds to wait after a change in the Proof of Flow Switch before declaring a change of state of the proof of flow switch.

### *Alarm Setpoints*

Attr-52 HWS High Temp Alarm Setpoint [Typical 180 F]
Attr-53 HWS Low Temp Alarm Setpoint [Typical 110 F]
Attr-54 HWS Temp Hysteresis [Typical 5 F]
Attr-55 HWR High Temp Alarm Setpoint [Typical 185 F]
Attr-56 HWR Low Temp Alarm Setpoint [Typical 110 F]
Attr-57 HWR Temp Hysteresis [Typical 5 F]

### *Input Handles*

Attr-58,59 Boiler Schedule Handle
Examines byte pointed to by handle. If non-zero then Boiler is ON.

Attr-60,61 HW Supply Temp Handle

Attr-62,63 HW Return Temp Handle

Attr-64,65 Outside Air Temp Handle

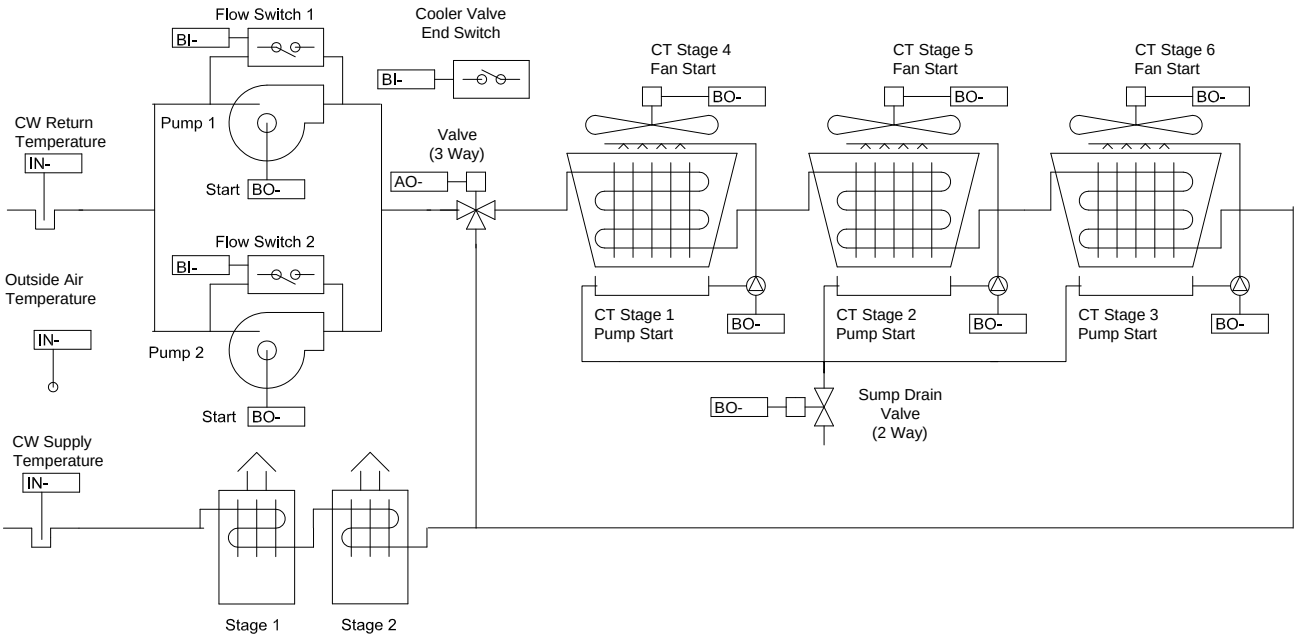
Attr-66,67 Pump 1 Flow Switch Handle

Attr-68,69 Pump 2 Flow Switch Handle

Attr-70 Spare
Attr-71 Spare
Attr-72 Spare
Attr-73 Spare

# Object 7 - Cooling Tower

## Cooling Tower Summary




**Overview:** The Cooling Tower object maintains the Supply Water Temperature at a Temperature Seetpoint for heat pumps or other applications. It utilizes 6 stages of tower cooling, 2 stages of boiler heating, 2 primary pumps, and 1 back-up pump

**Inputs and Outputs:** The cooling tower object has input handles for supply water temperature, return water temperature, outdoor air temperature, on/off schedule, bypass end switch, proof of flow switches for the supply pumps, and request for heat pump operation. Cooling tower outputs are: the cooling tower stages, the boiler stages, the 2 primary pumps and 1 auxiliary pump, the cooling tower lockout flag, the pump fault flag, the hp OK to operate flag, the cooling tower status, and the bypass end switch fault.

Note: The Cooling Tower Object is restored in ASIC/2-7540. The Tower Object is not used in ASIC/2-7040 FW740C 1.0 It was restored in FW740C Rev. 2.1. It is Not included in FW740E and 840E. It is included in ASIC/2-7540 FW754

**Cooling Tower Enable:** Whether the cooling tower is enabled or disabled is typically tied to a daily event schedule. Overrides on or off as determined by other objects are also recognized via the heat pump request input.

**Cooling Tower Operations:** The supply water temperature setpoint for each stage varies between user-configurable upper and lower setpoints. The cooling tower object maintains supply water at temperature setpoint in three fashions: by opening the

modulating cooler valve, by turning the 6 cooling stages on or off, and by turning the 2 heating stages on or off.

**Modulating Cooler Valve:** For supply water temperatures above the cooler valve temperature setpoint, the condenser bypass valve is modulated open to allow fluid to flow through the heat exchange surfaces of the cooling tower. The user-defined throttling range is the deviation from setpoint for which the valve moves from fully closed to fully open.

**Cooling Stages:** Six stages of cooling are available for use. Typically, each stage controls either a fan or a water spray. Stages are turned on and off based on the threshold-on setpoints and hysteresis bands assigned to each stage. If the supply water temperature rises above the threshold-on temperature, the stage is activated. No cooling stage is activated without proof of flow in the pump loop. A minimum-on timer prevents unnecessary cycling of the cooling stages. An interstage timer keeps more than one stage from coming on at once, preventing sudden power drains. The Cooling Tower object does not have the capability to change the actual fan speed; this must be done through external logic.

**Cooling Tower Spray Lockout:** Optionally, selected cooling stages (typically those using water sprays) may be disabled when both the outdoor air temperature has fallen below the cooling tower lockout setpoint and the supply water temperature has fallen below the lockout override setpoint. A cooling tower lockout binary output is available which may be used to trigger the sump drain to open. The conditions for lockout must be absent for a lockout restore delay period for the cooling tower lockout to be removed.

**Boiler Stages:** Two boiler stages are available for use. Each has a threshold-on setpoint and a hysteresis band. If supply temperature falls below the threshold-on value the stage is activated. No boiler stage is activated without proof of flow in the pump loop. A minimum-on timer prevents unnecessary cycling of the heating stages. The boiler stages may be configured to be locked-out from operation for outdoor air temperatures above a user-defined setpoint.

**Pump Operations:** Two primary pumps are available. Either one or both may be set-up to be always on, or a lead pump/lag pump setup may be used. If the lead/lag configuration is used, the lead pump is on and the lag pump is off unless the lead pump fails, in which case the lag pump is turned on. Either pump 1 or pump 2 may be permanently assigned to be the lead pump, or the pumps may be set up to trade roles periodically. The cooling tower object may be set up to have the pumps trade roles at the beginning of each day or as a function of how long the lead pump has been in the lead pump role.

**Lag Pump Add-In:** Optionally, for greater flow volume in high demand situations, the lag pump may be set up to operate simultaneously with the lead pump for supply water temperatures below a Lag Pump Add-In Heating Setpoint or above the Lag Pump Add-In Cooling Setpoint. Associated hystersis bands prevent unnecessary cycling of the lag pump due to this feature.

**Standby Pump Operation:** An standby pump output may be turned on whenever any or all of the primary pumps are in fault (see below).

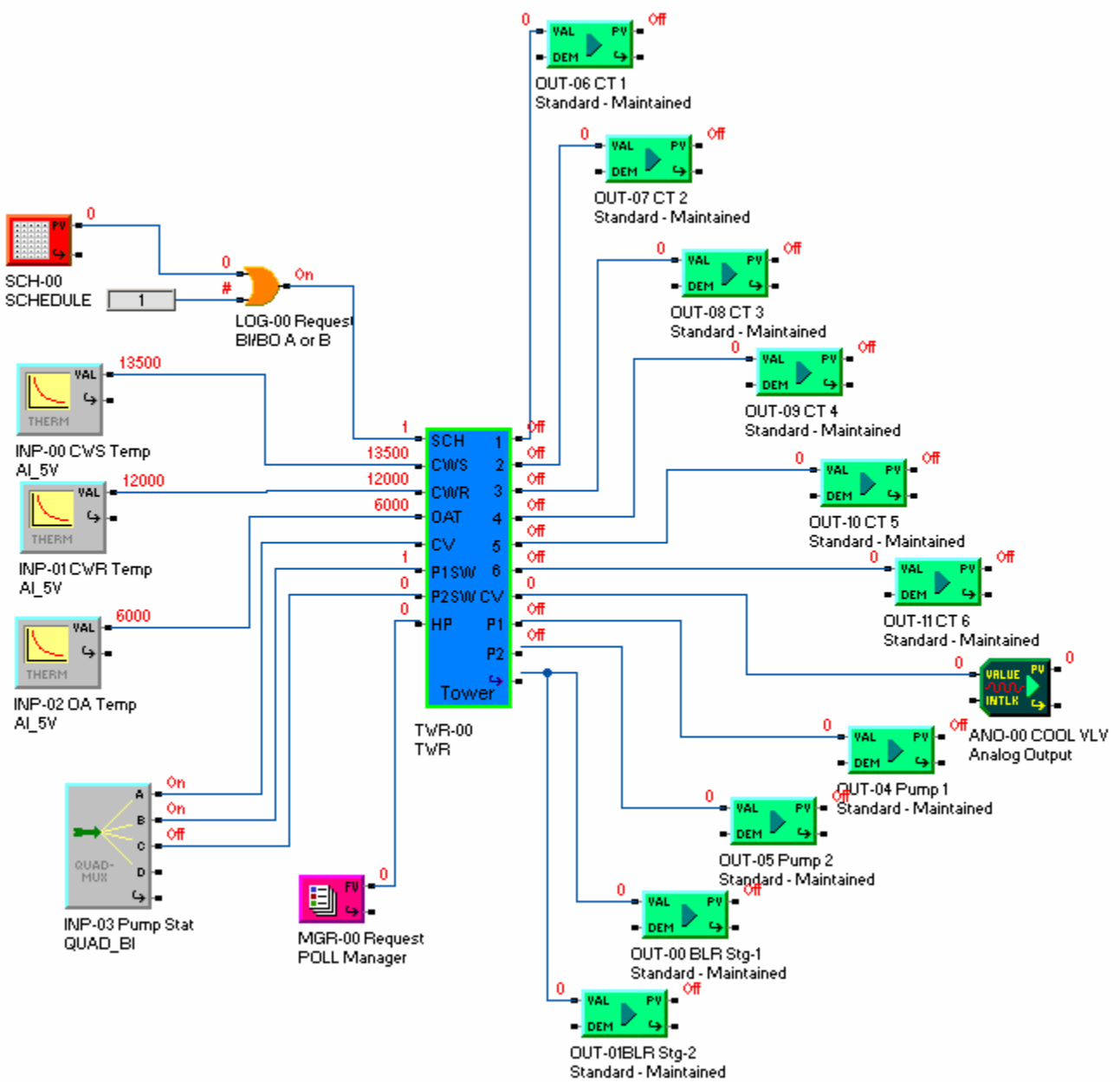
**Pump Faults:** Proof of flow switches for each pump are examined through input handles. If proof of flow is not established after a delay period, the pump is declared to be in fault, is turned off, and a pump alarm is registered. Re-starts of the pump are attempted up to a maximum number of tries; if unsuccessful, the pump is locked out from operation until re-enabled by the user. If both pumps fail, a double fault alarm is set and the cooling tower is locked-out from operations.

**Cooler Valve End Switch Fault:** The cooler valve end switch input detects when the modulating cooler valve has reached maximum position. If the switch is not closed after the user-defined drive time, a bypass end switch alarm is recorded. (The valve is closed by driving it from maximum open position towards closed position for the drive-time.)

**Supply and Return Temperature Alarms:** High and low alarm setpoints may be set up for both the supply water and the return water. High or low alarms are then triggered based on these setpoints.

**Heat Pump OK to Operate:** Other system controller objects may access the Heat Pump OK to Operate output to enable or disable heat pump operations in the building system. This output is set to OK when the cooling tower is not locked out and neither a high or low supply water temperature alarm is present. Typically, a broadcast object accesses this output and broadcasts heat pump disable or enable messages on the system bus at a periodic interval.

**Operational Monitoring:** The run time as lead today, the run time as lead total, and the accumulated run time as lag or lead is recorded in memory for both pumps 1 and 2.



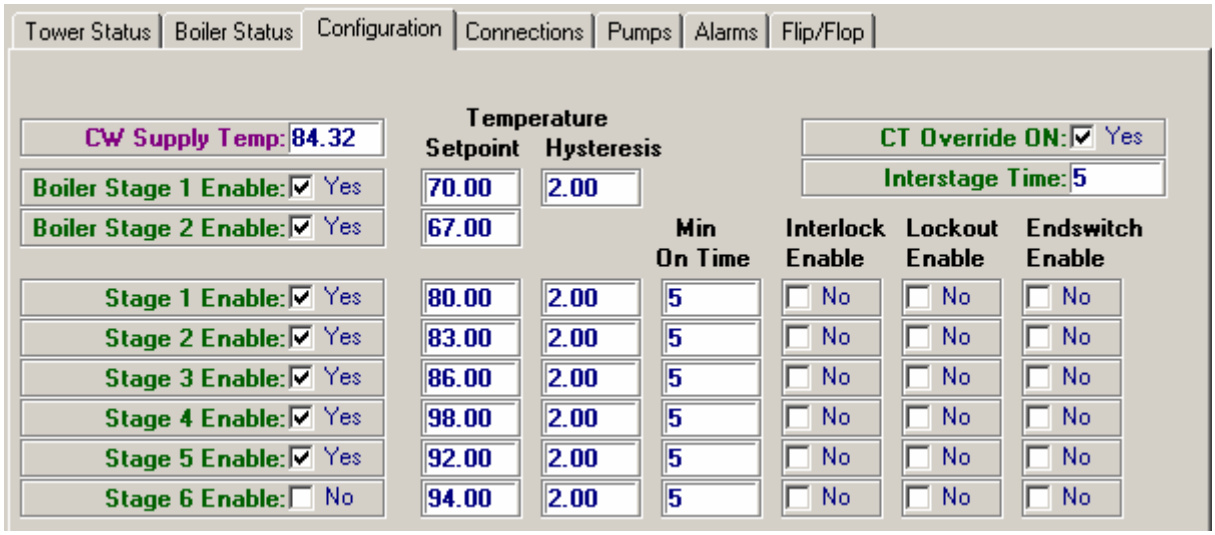
# Cooling Tower Operation

The condenser water is controlled against condenser water supply temperature with up to 6 stages for cooling and 2 stages for heating. The particular output used for each stage is assignable. The inputs required for control will also be assignable. The following features are supported:

6 Stages of Tower Cooling
Modulating Cooler Valve (Analog Output)
Modulating Cooler Valve (Tri-State)
Tower Spray Lockout
2 Stages of Boiler

## Tower Stage N (On/Off)

The cooling tower has up to six identical stages. Once the Cooler Valve End Switch (if enabled) has been satisfied, the cooling tower stages can be energized. If there is no proof of flow in the condenser water, all stages is off. A Tower Interstage Timer [Typical 10 s] prevents more than one stage from coming on at the same time.




At a condenser water temperature equal to the TWR Stage N Temperature Setpoint, the cooler stage is energized. The TWR Stage N will remain energized until the condenser water temperature reaches the TWR Stage N Temperature Setpoint minus the TWR Stage N Hysteresis. Once energized it will remain on for a TWR Stage N Min ON Time. [Typical 5 minutes]

TWR Stage N is OFF if:

1) The Stage is NOT enabled. .

2) The TWR Spray Lockout function has been enabled for this stage and is active.

3) There is no proof of flow.

4) The TWR Cooler Valve End Switch has been enabled for this stage and is not satisfied.

## Modulating Condenser Cooler Valve

If the modulating valve option is selected, the modulating cooler valve analog output (0..255 = 0..100%) begins to open at the Cooler Valve Temperature Setpoint.[Typical 75.00 F]. The valve will modulate from closed to full open over a Cooler Valve Throttling Range [Typical 5 F]. If there is no proof of flow the valve is Closed.

When the valve is fully open, Cooler Valve End Switch will close. Once the Cooler Valve End Switch is reached the Valve will not drive open further. If the end switch is enabled, has not been reached after driven its Cooler Valve Drive Time, then a Cooler Valve End Switch Alarm (if enabled) is set.

Note: This analog output may be used with Modulating Tri-state, or with Analog output.

The modulating valve uses tri-state output for Open and Close. The valve has a Cooler Valve Drive Time [Typical 25 s]. When the valve is closed, it will close for a Cooler Valve Drive Time and then stop.

## Tower Spray Lockout

If the outside temperature, is less than the TWR OAT Lockout Temperature Setpoint [Typical 35 F] and the CW supply temperature is less than the OAT Lock Override Setpoint [Typical 95 F], the Lockout function is active. This is used to lock out Cooler Stages and energize the TWR OAT Lockout Binary Output.

The TWR OAT Lockout is active until the outside temperature reaches the TWR OAT Lockout Temperature Setpoint plus the TWR OAT Lockout Hysteresis [Typical 5 F], or until the CWS Temperature exceeds the TWR OAT Lockout Override Setpoint plus the OAT Lockout Hysteresis for the TWR OAT Lockout-Clear Delay.


# CW Pump Operation

The lead pump shall be started based on operator command, TWR Operation Request from polling ASIC/2, or based on assignment to schedule. If the cooling tower runs 24 hours per day, it is permanently overridden ON..

### *Single Pump*

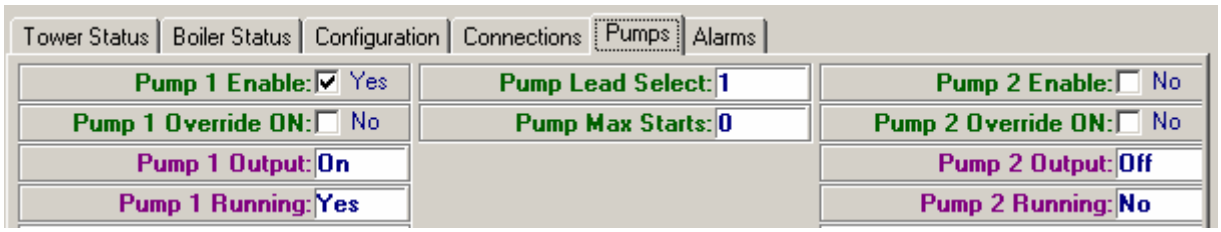
If only one pump has been enabled, that pump run whenever boiler operation is ON.

### *Pump Override ON*

If either pump has been enabled, and selected for use, then one or both pumps run whenever boiler operation is ON. Each pump will have its own proof of flow and restart.

If Pump 1 Enable and Pump 1 Override ON then Run Pump 1

If Pump 2 Enable and Pump 2 Override ON, then Run Pump 2




### *Lead/Lag Pump*

If both pumps are enabled, and neither pump is Overriden ON, then the operation of the pumps is in a lead/lag configuration.

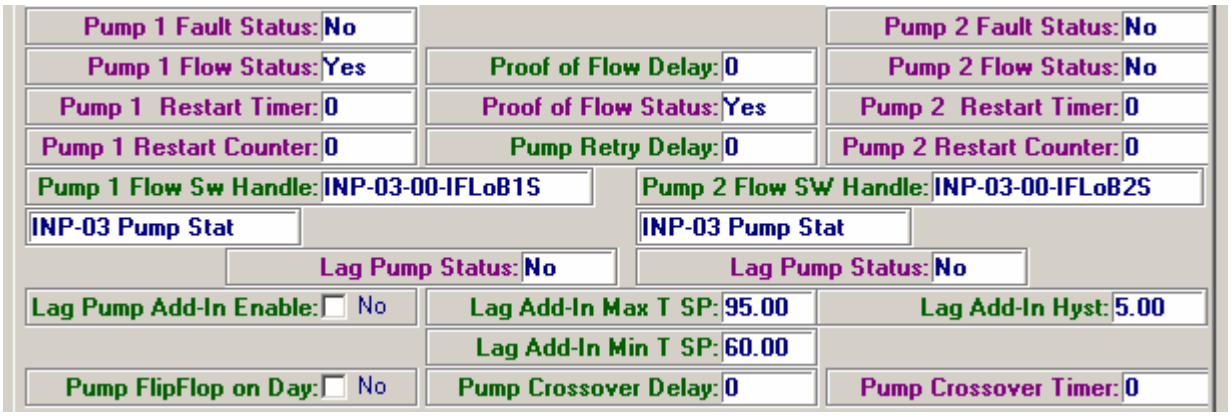
The selection of Lead pump is based on Pump Lead Select, Day of Week, or Accumulated Pump Run Time.The other pump becomes the Lag Pump.

If Pump Lead Select is 1 or 2, then this is the lead pump.

If Lead Pump Select = 0, then look at Pump Flip/Flop. If Pump Flip/Flop on Day is yes, Change Lead Pump based on Day of Week. If Pump Flip/Flop on Day is No, and Pump

Flip/Flop on Run Time is Yes, then the Lead Pump is changed based on Accumulated Run Time

If lead pump is changed, then both pumps are run for a Pump Crossover Delay before stopping the first pump. There is no interruption in flow during pump changeover.




### *Proof of Flow.*

Each pump may have its own proof of flow, or they may use a common proof of flow identified by the Pump 1 Flow Switch Handle and Pump 2 Flow Switch Handle.

If either proof of flow switch is closed, then proof of flow status (Attr-2, LO Bit 5) is verified for the hot water.

The Pump (1 or 2) Flow Status verifies that the pump (1 or 2) is running. If the requested pump is verified then the Proof of Flow Status is set to Yes.

When boiler operation is requested, and the proof of flow fails to be established after a Proof of Flow Delay, a Proof of Flow Alarm is set. If proof of flow is re-established, the proof of flow alarm is cleared.

### *Proof of Flow Failure*

Upon failure of proof of flow of the lead pump after a Proof of Flow Delay, the controller turns OFF the lead pump, waits a Pump Retry Delay and retrys until the Pump Try Max has been reached. It then declares a Lead Pump Fault Alarm and turns OFF the lead pump.

In the event of failure of the lead pump, the controller starts the Lag Pump. Upon failure of proof of flow of the lag pump after a Proof of Flow Delay , the controller turns OFF the lag pump, waits a Pump Retry Delay and retries until the Pump Try Max has been reached. It then declares a Lag Pump Fault Alarm, and turn OFF the lag pump. If both the Lead Pump and Lag Pump are in fault, then the Double Pump Fault Alarm is set.

### *Any Fault*

If either the Lead pump, or the lag pump is in fault, then the Pump Any Fault Alarm is set. This alarm can be used with external logic to bring on a standby pump.

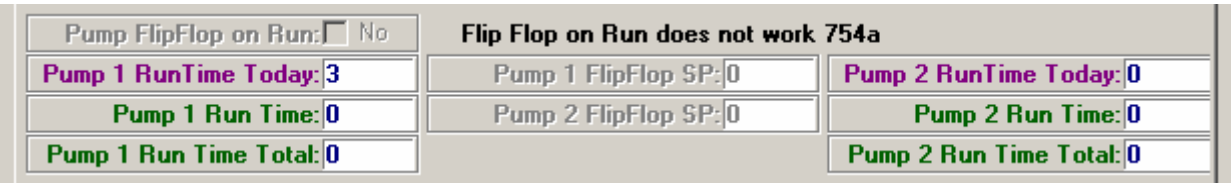
### *Lag Pump Add-In Min and Max Setpoints*

If the CW Supply Temperature exceeds the Lag Add-In Max Temperature Setpoint [Typical 95 F] , or if the CW Supply Temperature falls below the Lag Add-In Min Temperature Setpoint [Typical 60 F], the Pump Temperature Alarm is set and the Lag pump is turned on. A Lag Add-In Temperature Hysteresis [Typical 5 F] will determine when the lag pump turns off.

### *Flip Flop on Run Time*

> Note: Flip Flop on Run has a bug and does not currently work.

When Pump 1 is running, the Pump 1 Run Time Today is accumulated in 1 hour increments. At the end of the day the total Run Time is added to Pump 1 Accumulated Run Time and to Pump 1 Run Time Total . If Flip/Flop on Run Time is enabled) and the pump is running, the sum of the Pump 1 Run Time Total and Pump 1 Run Time Today in hours is compared with the Pump 1 Flip/Flop Setpoint. If greater than the Pump 1 Flip/Flop Setpoint, the Lead Pump is switched, the Pump 1 Run Time Today is added to Pump 1 Accumulated Run Time, and the Pump 1 Run Time Total is zeroed.




When Pump 2 is running, the Pump 2 Run Time Today is accumulated in 1 hour increments. At the end of the day the total Pump 2 Run Time Today is added to Pump 2 Accumulated Run Time and to Pump 2 Run Time Total. If Flip/Flop on Run Time is enabled and the pump is running, the sum of the Pump 2 Run Time Total and Pump 2 Run Time Today in hours is compared with the Pump 2 Flip/Flop Setpoint. If greater than the Pump 2 Flip/Flop Setpoint, the Lead Pump is switched, and the Pump 2 Run Time Today is zeroed.

# Boiler Operation

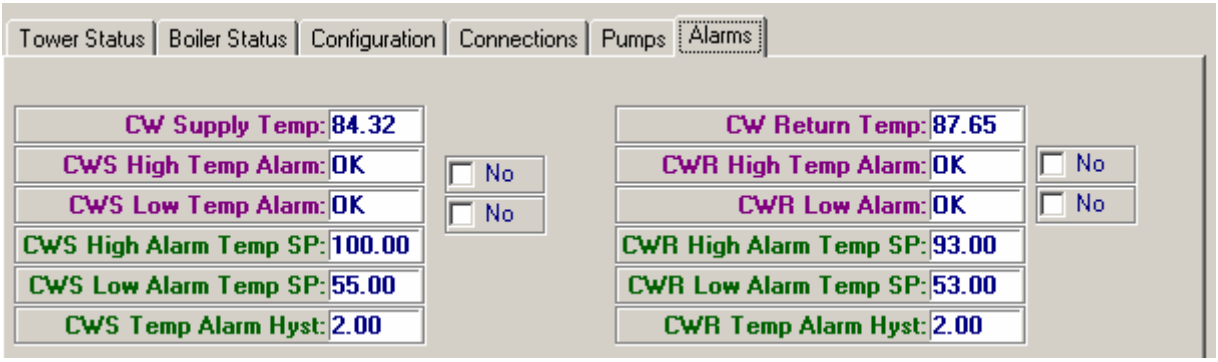
If the CW Supply Temperature is less than Boiler Stage 1 Setpoint [Typical 70 F] with proof of flow, the boiler stage 1 output is energized as the first boiler stage and will remain energized until the condenser water temperature reaches the Boiler Stage 1 Setpoint Plus the Boiler Temperature Hysteresis. [Typical 2 F]. If there is no proof of flow, or if the CW Supply Temperature is greater than the TWR Stage 1 Setpoint, the boiler is OFF.

If the CW supply temperature is less than Boiler Stage 2 Temperature Setpoint [Typical 68 F] with proof of flow, A, the boiler stage 2 is energized as the second boiler stage and will remain energized until the condenser water temperature reaches the Boiler Stage 2 Temperature Setpoint Plus the Boiler Temperature Hysteresis. If there is no proof of flow, or if the CW Supply Temperature is greater than the TWR Stage 1 Setpoint, the boiler is OFF.

# Alarms

## CWS/CWR Temperature Alarms

High and Low Temperature Alarms can be enabled for the Condenser Water Supply and Return.



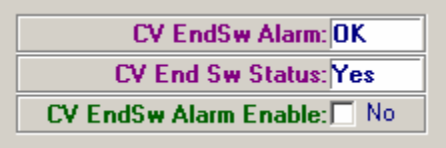

If the CW Supply Temperature exceeds the CWS High Temperature Alarm Setpoint, a CWS High Temperature Alarm should be set.

If the CWS Supply Temperature falls below the CWS Low Temperature Alarm Setpoint, a CW Low Temperature Alarm is set.

If the CW Return Temperature exceeds the CWR High Alarm Setpoint [Typical 96 F], a CWR High Temperature Alarm should be set.

If the CWS Supply Temperature falls below the CWS Low Limit Setpoint [Typical 58 F], a CWR Low Temperature Alarm should be set.

## Cooler Valve End Switch Alarm




If the end switch is enabled, has not been reached after driven its Cooler Valve Drive Time, then a Cooler Valve End Switch Alarm (if enabled) is set.

If the end switch is enabled and has been reached when or before driven its Cooler Valve Drive Time, then a Cooler Valve End Switch Alarm (if enabled) is cleared.

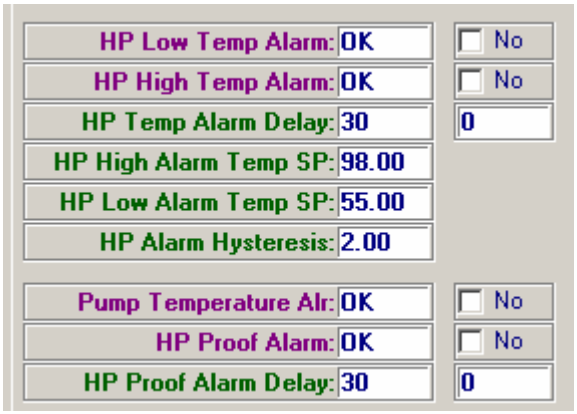
If the end switch is enabled, and the Cooler Valve Drive is less than the Cooler Valve Drive Time, then a Cooler Valve End Switch Alarm (if enabled) is cleared.

## Heat Pump OK to Operate


If proof of flow is established for a programmable Proof of Flow Delay [Default; 15 s], the HP OK to Operate bit is set.

If proof of flow is lost for a programmable Proof of Flow Delay[Default; 15 s, the HP OK to Operate bit is cleared.

If the CW Supply Temperature exceeds the HP High Temperature Setpoint, or falls below the HP Low Temperature Setpoint , the HP OK to Operate bit is cleared.


HP Low Temp Alarm: OK
No
HP High Temp Alarm: OK
No
HP Temp Alarm Delay: 30
0
HP High Alarm Temp SP: 98.00
HP Low Alarm Temp SP: 55.00
HP Alarm Hysteresis: 2.00
Pump Temperature Alr: OK
No
HP Proof Alarm: OK
No
HP Proof Alarm Delay: 30
0

# Cooling Tower Glossary

## Cooling Tower Parameters

### *Boiler Minimum On-Time*

The minimum time any boiler stage must remain on once it is turned on. In minutes; user-configurable. (7,X,13,HI_BYTE)

### *Boiler OAT (Outdoor Air Temperature) Alarm Status*

If enabled, this alarm is set by OAT rising above the OAT Lockout Setpoint. "Alarm", "OK"; not user-changeable. (7,X,3,HI_BIT_1)

### *Boiler OAT (Outdoor Air Temperature) Lockout Alarm Enable*

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_1)

### *Boiler OAT (Outdoor Air Temperature) Lockout Enable*

Enables the Boiler OAT Lockout feature. "Enable", "Disabled"; user-configurable. (7,X,20,HI_BIT_4)

### *Boiler OAT (Outdoor Air Temperature) Lockout Setpoint*

OAT rising above this setpoint causes Boiler OAT Lockout and sets Boiler OAT Lockout Alarm if these features are enabled. In degrees F; user-configurable. (7,X,56,LO_BYTE)

### *Boiler OAT (Outdoor Air Temperature) Lockout Status*

The Boiler OAT Lockout disables all boiler stages from operation if the OAT is above the OAT Lockout Setpoint. "On", "Off"; not user-changeable. (7,X,0,HI_BIT_2)

### *Boiler Stage Hysteresis*

Once a boiler stage is on, if the Outdoor Air Temperature rises above the Boiler Stage X Setpoint by this value, then Stage X (1 or 2) is turned off. In degrees F; user-configurable. (7,X,55,WORD)

### *Boiler Stage X Enable*

Enables boiler stage X (1 or 2) for operation. "Enabled", "Disabled"; user-configurable. Stage 1 (7,X,20,HI_BIT_1). Stage 2 (7,X,20,HI_BIT_2).

### *Boiler Stage X Output*

The output control for boiler stage X (1 or 2). This attribute is read by Output object. "On", "Off"; not user-changeable. Stage 1 (7,X,0,LO_BIT_0). Stage 2 (7,X,0,LO_BIT_1).

### *Boiler Stage X Temperature Setpoint*

If the Outdoor Air Temperature falls below this setpoint, Boiler Stage X (1 or 2) is triggered on. In degrees F; user-configurable. Stage 1 (7,X,53,WORD). Stage 2 (7,X,54,WORD).

### *Cooler Valve Drive Time*

Cooler Valve Drive Time indicates the value of the Cooler Valve Output for which the cooler valve should be at fully closed position. Cooler Valve End Switch Alarm uses this parameter. In seconds; user-configurable. (7,X,28,WORD)

### *Cooler Valve Enable*

This parameter should be set to "Enabled" if the system has a cooler valve. If set to "Enabled", the cooler valve output will be used as the 1st stage of cooling. "Enabled", "Disabled"; user-configurable. (7,X,20,LO_BIT_6)

### *Cooler Valve End Switch Alarm Enable*

Enables this alarm for operation. "Enabled", "Disabled"; user-configurable. (7,X,21,LO_BIT_7)

### *Cooler Valve End Switch Alarm Status*

This alarm will be set if Cooler Valve End Switch Status does not indicate that the switch is closed whenever Cooler Valve Output Status is greater than or equal to Cooler Valve Drive Time. "OK", "Alarm"; not user-changeable. (7,X,3,LO_BIT_7)

### *Cooler Valve End Switch Enable*

If a cooler valve end switch is installed on the cooler valve for this system, then it should be enabled through this parameter. It must be enabled for individual cooling stages to be locked-out on the basis of the cooler valve end switch. "Enabled", "Disabled"; user-configurable. (7,X,20,LO_BIT_7)

### *Cooler Valve End Switch Handle*

This handle points to the Input index which reads the cooler valve end switch. User adjustable. (7,X,95,WORD)

### *Cooler Valve End Switch Status*

Optionally, the cooler valve may be equipped with a cooler valve end switch. The end switch indicates if the cooler valve has reached maximum open position (if fully open, the valve directs all condenser water through the cooling stages - no water bypasses). Cooler Valve End Switch Status indicates if the cooler valve is completely open. "Yes", "No"; not user-changeable. (7,X,2,HI_BIT_3)

### *Cooler Valve Output*

When the cooler valve is closed, condenser water is bypassed around the cooling stages of the cooling tower. When the cooler valve is open, fluid flows through the cooling stages of the cooling tower. Not all systems will have a cooler valve; some systems just automatically direct condenser water through the cooling stages. For systems that have a cooler valve, opening the valve begins cooling operations. (Cooling stages do not have to be on for cooling to occur - condenser water will cool somewhat just by flowing through the tower.) For a tri-state output, the cooler Valve Output is expressed as a percentage of the time needed to drive the valve from fully closed to fully open position. For an analog output it is expressed as a percentage of the maximum open valve position. 0 to 100%; not user-changeable. (7,X,1,WORD)

### *Cooler Valve Temperature Setpoint*

Once the Condenser Water Supply Temperature rises above this setpoint, the cooler valve, if enabled, will begin to modulate open. In degree F; user-configurable. (7,X,26,WORD)

### *Cooler Valve Throttling Range*

The cooler valve modulates from fully closed to fully open as Condenser Water Supply Temperature moves over this throttling range above Cooler Valve Temperature Setpoint. In degrees F; user-configurable. (7,X,25,WORD)

### *Cooling Tower Action*

Writing the values listed below to this attribute (7,X,4,WORD) forces the specified action to occur.

0 "Select"
1 "Clear Double Fault Alarm"
2 "Clear Lead Pump Alarm"
3 "Clear Lag Pump Alarm"
4 "Clear Heat Pump Proof-of-Flow Alarm"
5 "Clear Pump Temperature Alarm"
6 "Clear Cooler Valve End Switch Alarm"
7 "Clear Proof-of-Flow Fault Alarm"
8 "Clear Boiler Lockout Alarm"
9 "Clear Condenser Water Supply High Temperature Alarm"
10 "Clear Condenser Water Supply Low Temperature Alarm"
11 "Clear Condenser Water Return High Temperature Alarm"
12 "Clear Condenser Water Return Low Temperature Alarm"
13 "Clear Heat Pump Disable Low Temperature Alarm"
14 "Clear Heat Pump Disable High Temperature Alarm"
17 "Clear Double, Lead, and Lag Alarms"
18 "Clear all above alarms"
19 "Override Cooling Tower On"
20 "Remove Override - Restore Automatic Operation"

### *Cooling Tower Alarm Status*

Indicates if any of the following alarms are set:

Heat Pump High Temperature Alarm
Heat Pump High Temperature Alarm
Heat Pump Proof of Flow Alarm
"Alarm", "OK"; not user-changeable. (7,X,2,LO_BIT_0)

### *Cooling Tower Interstage Time*

The time which must elapse between turning on any two cooling tower stages. In seconds; user-configurable. (7,X,32,WORD)

### *Cooling Tower Interstage Timer*

Keeps track of Cooling Tower Interstage Time. Reads in seconds; not user-changeable. (7,X,13,LO_BYTE)

### *Cooling Tower OAT Lockout Hysteresis*

To remove a Cooling Tower OAT Lockout, the OAT must remain above the Cooling Tower OAT Setpoint by this value for the Cooling Tower OAT Lockout Remove Delay time. In degrees F; user-configurable. (7,X,31,WORD)

### *Cooling Tower OAT Lockout Output*

If a Cooling Tower OAT Lockout is in effect, this output will come on. The user may use this output to trigger open a sump drain (if water sprays are used as Cooling Tower stages), or for some similar application. "On", "Off"; user-configurable. (7,X,0,HI_BIT_3)

### *Cooling Tower OAT Lockout Override Setpoint*

If the Condenser Water Supply Temperature rises above this setpoint then Cooling Tower OAT Lockout will be overridden off. In degrees F; user-configurable. (7,X,30,WORD)

### *Cooling Tower OAT Lockout Setpoint*

The setpoint used for Cooling Tower OAT Lockouts as described above. In degrees F; user-configurable. (7,X,29,WORD)

### *Cooling Tower OAT Lockout Status*

A Cooling Tower OAT Lockout is set by the Outdoor Air Temperature falling below the Cooling Tower OAT Lockout Setpoint - provided that the Condenser Supply Water Temperature is not above Cooling Tower OAT Override Setpoint. The lockout prevents operation of those Cooling Tower stages for which Cooling Tower Stage X Lockout Enable is set to "yes". Can be used to lockout spray pumps when freezing conditions are present. "OK", "Lock"; not user-changeable. (7,X,2,HI_BIT_2)

### *Cooling Tower OAT Lockout Timer*

This timer is used to time Cooling Tower OAT Lockout Remove Delay. Reads in seconds; user-configurable. (7,X,18,LO_BYTE)

### *Cooling Tower OAT Lockout-Clear Delay*

To remove a Cooling Tower OAT Lockout, the OAT must remain above the Cooling Tower OAT Setpoint by at least the Cooling Tower OAT Lockout Hysteresis for this delay time. In seconds; user-configurable. (7,X,51,LO_BYTE)

### *Cooling Tower Operating Status*

Indicates whether the cooling tower is currently able to operate. For it to be able to operate, at least one pump must have proof-of-flow. In addition to proof-of-flow, cooling tower operation must be requested with no Cooling Tower OAT Lockout in effect, or the cooling tower must be overridden On. "Fail", "Run"; user-configurable. (7,X,2,HI_BIT_0)

### *Cooling Tower Operation Requested*

Indicates that the Cooling Tower operation has been requested by the object pointed to by the Cooling Tower Schedule Handle. "Yes", "No"; user-configurable. (7,X,2,HI_BIT_1)

### *Cooling Tower Overridden On*

Indicates if the Cooling Tower has been overridden ON by the user. "Yes", "No"; user-configurable. (7,X,23,LO_BIT_0)

### *Cooling Tower Schedule Handle*

Points to the Schedule index used to enable and disable Cooling Tower operations during different periods of the day. User-configurable. (7,X,87,WORD)

### *Cooling Tower Stage X Cooler Valve End Switch Enable*

Each cooling stage may be locked out against the cooler valve end switch. If enabled, the flow valve end switch indicates complete closure of the valve. "Enabled", "Disabled"; user-configurable. (7,X,22,HI_BIT_0)

### *Cooling Tower Stage X Enable*

Enables Cooling Tower cooling stage X (1 to 6) for operation. One or more enabled cooling stages are used in meeting the tower's cooling requirement. "Enabled", "Disabled"; user-configurable. (7,X,20,LO_BIT_0)

### *Cooling Tower Stage X Hysteresis*

If Stage X (1 to 6) is currently on, the Condenser Water Supply Temperature must fall below Cooling Tower Stage X Temperature Setpoint by this hysteresis for Stage X to turn off. In degrees F; user-configurable. (7,X,39,WORD)

### *Cooling Tower Stage X Lockout Enable*

If this parameter is set to "Enabled" for Cooling Tower Stage X (1 to 6), and if a Cooling Tower OAT Lockout is in effect, then stage X will be locked-out from operating for as long as the Cooling Tower OAT Lockout is in effect. "Enabled", "Disabled"; user-configurable. (7,X,22,LO_BIT_0)

### *Cooling Tower Stage X Minimum On Time*

Once Cooling Tower Stage X (1 to 6) comes on, it must remain on for this amount of time at a minimum. In minutes; user-configurable. (7,X,45,WORD)

### *Cooling Tower Stage X Minimum On Timer*

Used to track the Minimum On-Time for Cooling Tower Stage X (1 to 6). Reads in minutes; not user-changeable. (7,X,14,LO_BYTE)

### *Cooling Tower Stage X Output*

Indicates the current output for Cooling Tower Stage X (1 to 6). "On", "Off"; not user-changeable. (7,X,20,LO_BIT_0)

### *Cooling Tower Stage X Temperature Setpoint*

If Cooling Tower Stage X is enabled and not locked-out, the stage will come on if Condenser Water Temperature rises above this setpoint. In degrees F; user-configurable. (7,X,33,WORD)

### *CWR High Temperature Alarm Enable*

Enables the Condenser Water Return High Temperature Alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_4)

### *CWR High Temperature Alarm Setpoint*

The trigger setpoint for this alarm. In degrees F; user-configurable. (7,X,79,WORD)

### *CWR High Temperature Alarm Status*

If this alarm is enabled then it will be set for Condenser Water Return Temperature above Condenser Water High Temperature Alarm Setpoint. Not user-changeable. (7,X,3,HI_BIT_4)

### *CWR Low Temperature Alarm Enable*

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_5)

### *CWR Low Temperature Alarm Setpoint*

The trigger setpoint for this alarm. In degrees F; user-configurable. (7,X,80,WORD)

### *CWR Low Temperature Alarm Status*

If this alarm is enabled then it will be set for Condenser Water Return Temperature below the Condenser Water Low Temperature Alarm Setpoint. Not user-changeable. (7,X,3,HI_BIT_5)

### *CWR Temperature*

The temperature of the condenser water as it enters the Cooling Tower cooling stages. In degrees F; user-configurable. (7,X,11,WORD)

### *CWR Temperature Alarm Hysteresis*

If a Condenser Water Return High or Low Temperature Alarm is in effect, then Condenser Water Return Temperature must pass back over the Condenser Water Return High or Low Temperature Alarm Setpoint by this hysteresis for the alarm to clear. In degrees F; user-configurable. (7,X,81,WORD)

### *CWR Temperature Handle*

Points to the Input index associated with the sensor which measures Condenser Water Return Temperature. User-configurable. (7,X,91,WORD)

### *CWS High Temperature Alarm Enable*

Enables the Condenser Water Supply High Temperature Alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_2)

### *CWS High Temperature Alarm Setpoint*

The trigger setpoint for Condenser Water Supply High Temperature Alarm. In degrees F; user-configurable. (7,X,76,WORD)

### *CWS High Temperature Alarm Status*

If this alarm is enabled then it will be set for Condenser Water Supply Temperatures above Condenser Water High Temperature Alarm Setpoint. Not user-changeable. (7,X,3,HI_BIT_2)

### *CWS Low Temperature Alarm Enable*

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_3)

### *CWS Low Temperature Alarm Setpoint*

The trigger setpoint for this alarm. In degrees F; user-configurable. (7,X,77,WORD)

### *CWS Low Temperature Alarm Status*

If this alarm is enabled then it will be set for Condenser Water Supply Temperature below Condenser Water Low Temperature Alarm Setpoint. Not user-changeable. (7,X,3,HI_BIT_3)

### *CWS Temperature*

The temperature of the condenser water as it enters the Cooling Tower. In degrees F; user-configurable. (7,X,10,WORD)

### *CWS Temperature Alarm Hysteresis*

If a Condenser Water Supply High or Low Temperature Alarm is in effect, then Condenser Water Supply Temperature must pass back over the Condenser Water Supply High Temperature Alarm Setpoint by this hysteresis for the alarm to clear. In degrees F; user-configurable. (7,X,78,WORD)

### *CWS Temperature Handle*

Points to the Condenser Water Supply Temperature Input index for the sensor which measures Condenser Water Supply Temperature. User-configurable. (7,X,89,WORD)

### *Heat Pump Alarm Hysteresis*

For a Heat Pump High (or Low) Temperature Alarm to be removed, the Condenser Water Supply Temperature must move back over the Heat Pump High (or Low) Temperature Alarm Setpoint by this hysteresis value. In degrees F; user-configurable. (7,X,84,WORD)

### *Heat Pump High Temperature Alarm*

If the Condenser Water Supply Temperature rises above the Heat Pump High Temperature Alarm Setpoint, then this alarm will be set (if it is enabled). "Alarm", "OK"; user-configurable. (7,X,3,HI_BIT_6)

### *Heat Pump High Temperature Alarm*

Indicates that a Heat Pump High Temperature Alarm has been present for at least Heat Pump Temperature Alarm Delay. "OK", "Alarm"; user-configurable. (7,X,19,LO_BIT_0)

### *Heat Pump High Temperature Alarm Enable*

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_6)

### *Heat Pump High Temperature Alarm Enable*

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,LO_BIT_4)

### *Heat Pump High Temperature Alarm Setpoint*

The trigger setpoint for this alarm. In degrees F; user-configurable. (7,X,82,WORD)

### *Heat Pump Low Temperature Alarm*

If the Condenser Water Supply Temperature falls below the Heat Pump Low Temperature Alarm Setpoint, then this alarm will be set (if it is enabled). "Alarm", "OK"; user-configurable. (7,X,3,HI_BIT_7)

### *Heat Pump Low Temperature Alarm*

Indicates that a Heat Pump Low Temperature Alarm has been present for at least Heat Pump Temperature Alarm Delay. "OK", "Alarm"; user-configurable. (7,X,19,LO_BIT_1)

Heat Pump Disable Low Temperature Alarm Enable

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,LO_BIT_5)

### *Heat Pump Low Temperature Alarm Enable*

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_7)

### *Heat Pump Low Temperature Alarm Setpoint*

The trigger setpoint for this alarm. In degrees F; user-configurable. (7,X,83,WORD)

### *Heat Pump OK to Operate*

This will be set to "Yes" only when is neither a Heat Pump Proof-of-Flow Alarm, nor a Heat Pump Disable High Temperature Alarm, nor a Heat Pump Disable Low Temperature Alarm present. This parameter is typically examined by a broadcast object, which uses the information to alert terminal unit controllers to either or disable their heat pump operations. "Yes", "No"; not user-changeable. (7,X,1,HI_BIT_7)

### *Heat Pump Proof-of-Flow Alarm*

If both pumps 1 and 2 have failed to attain proof-of-flow for the Heat Pump Proof-of-Flow Alarm Delay Time then this alarm will be set. If either or both pumps attain proof-of-flow for the delay time then this alarm will be cleared. "OK", "Alarm"; user-configurable. (7,X,3,LO_BIT_4)

### *Heat Pump Proof-of-Flow Alarm Delay Time*

The time for which proof-of-flow must be lost to set a Heat Pump Proof-of-Flow Alarm. Also equal to the time for which proof-of-flow must be present to clear a Heat Pump Proof-of-Flow Alarm. In seconds; user-configurable. (7,X,75,LO_BYTE)

### *Heat Pump Proof-of-Flow Alarm Delay Timer*

Used to measure Heat Pump Proof-of-Flow Alarm Delay Time. Not user-changeable. (7,X,7,LO_BYTE)

### *Heat Pump Proof-of-Flow Alarm Enable*

Enables this alarm for operation. "Enabled", "Disabled"; user-configurable. (7,X,21,LO_BIT_6)

### *Heat Pump Request Enable*

If this function is enabled, and if the heat pump request number (the number pointed at by the Heat Pump Request Handle) is greater than the Heat Pump Request Minimum Setpoint, then the cooling tower will be enabled. User-configurable. (7,X,23,LO_BIT_1)

### *Heat Pump Request Handle*

Points to the object, index, attribute which contains the heat pump request number. User-configurable. (7,X,101,WORD)

### *Heat Pump Request Minimum Setpoint*

The integer value pointed at by the Heat Pump Request Handle must be greater or equal to this setpoint for the cooling tower to be turned on due to a heat pump request. User-configurable. (7,X,73,WORD)

### *Heat Pump Temperature Alarm Delay*

If a Heat Pump High or Low Temperature Alarm is present for this delay time, then a Heat Pump Disable High or Low Temperature Alarm is set. In seconds; user-configurable. (7,X,75,HI_BYTE)

### *Lag Pump Add-In Alarm Enable*

Enables the Pump Temperature Alarm. "Yes", "No"; user-configurable. (7,X,20,HI_BIT_3)

### *Lag Pump Add-In Alarm Status*

Records an alarm whenever the lag pump has been turned on in addition to the lead due to the Condenser Water Supply Temperature moving outside the Lag Pump Add-In Minimum/Maximum Temperature Range. "OK", "Alarm"; not user-changeable. (7,X,3,LO_BIT_5)

### *Lag Pump Add-In Maximum Temperature Setpoint*

If the lag pump add-in feature is enabled, and if Condenser Water Supply Temperature rises above this setpoint, the lag pump will be turned on in addition to the lead. In degrees F; user-configurable. (7,X,59,WORD)

### *Lag Pump Add-In Minimum Temperature Setpoint*

If the lag pump add-in feature is enabled, and if Condenser Water Supply Temperature falls below this setpoint, the lag pump will be turned on in conjunction with the lead pump. In degrees F; user-configurable. (7,X,60,WORD)

### *Lag Pump Add-In Temperature Hysteresis*

Applies if the lag pump is on due to the lag pump add-in feature. The condenser water supply temperature must move back over the Lag Pump Add-In Minimum or Maximum Setpoint by this value for the lag pump to be shut off. In degrees F; user-configurable. (7,X,61,WORD)

### *Lag Pump Fault Alarm*

If enabled, then this alarm is set whenever the pump currently assigned to be the lag pump goes into fault. "OK", "Alarm"; not user-changeable. (7,X,3,LO_BIT_2)

### *Lag Pump Fault Alarm Enable*

Enables the Lag Pump Fault Alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,LO_BIT_2)

### *Lag Pump Operating Status*

Indicates whether the lag pump is currently on or off. "ON", "Off"; user-configurable. (7,X,2,LO_BIT_2)

### *Lead Pump Fault Alarm*

If enabled, then this alarm is set whenever the pump currently assigned to be the lead pump goes into fault. "OK", "Alarm"; not user-changeable. (7,X,3,LO_BIT_1)

### *Lead Pump Fault Alarm Enable*

Enables the Lead Pump Fault Alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,LO_BIT_1)

### *Lead Pump Operating Status*

Indicates whether the lead pump is currently on or off. "ON", "Off"; user-configurable. (7,X,2,LO_BIT_1)

### *Lead Pump Present*

A status parameter specifying which pump is currently in the lead role. Not user-changeable. 0 = Pump 1, 1= Pump 2. (7,X,2,LO_BIT_6)

### *Lead Pump Previous*

A status parameter specifying which pump was lead pump before the most recent flip-flop was performed. Not user-changeable. 0 = Pump 1, 1= Pump 2. (7,X,2,LO_BIT_7)

### *Lead Pump Select*

Designates which pump will be chosen as the lead upon resets, power-ups, etc. If this parameter is equal to "0", the selection will be based on the day of the week (i.e. Monday through Sunday are numbered 0 through 7. Even days use Pump 1, odd days use Pump 2). "0","1","2"; user-configurable. (7,X,23,HI_LS_NBL)

### *Outside Air Temperature*

The temperature as measured by a sensor located on the outside of the building. In degrees F; not user-changeable. (7,X,12,WORD)

### *Outside Air Temperature Handle*

Points to the Input index which reads the outside air temperature sensor. User-changeable. (7,X,93,WORD)

### *Proof of Flow Delay*

The delay time for which the proof-of-flow switch for a pump (1 or 2) must register positive for proof of flow to be established. In seconds; user-configurable. (7,X,68,WORD)

### *Proof of Flow Fault Alarm*

If enabled, this alarm will be set if both pump 1 and pump 2 have proof-of-flow faults. "OK", "Alarm"; not user-changeable. (7,X,3,HI_BIT_0)

### *Proof of Flow Fault Alarm Enable*

Enables this alarm for operation. "Enabled", "Disabled"; user-configurable. (7,X,21,HI_BIT_0)

### *Proof of Flow Status*

If either Pump 1 or Pump 2 has proof-of-flow, this parameter is set to "Yes". If neither has proof-of-flow, the cooling tower is disabled. "Yes", "No"; not user-changeable. (7,X,2,LO_BIT_5)

### *Pump Any Fault Alarm Status*

Will read as "Alarm" whenever either Pump 1 or Pump 2 has a fault alarm. "Alarm", "OK"; not user-changeable. (7,X,3,LO_BIT_3)

### *Pump Crossover Delay*

When performing a pump flip-flop, the old lag pump will be turned on and will assume the lead pump role. The old lead pump will remain on for Pump Crossover Delay and then will be turned off and assume the lag pump role; effectively, this delay is the time period for which both pumps must remain on simultaneously. In seconds; user-changeable. (7,X,57,LO_BYTE)

### *Pump Crossover Delay Timer*

Used to measure pump crossover delay. Reads in seconds; not user-changeable. (7,X,17,WORD)

### *Pump Double Fault Alarm Enable*

Enables this alarm. "Enabled", "Disabled"; user-configurable. (7,X,21,LO_BIT_0)

### *Pump Double Fault Alarm Status*

Will read as "Alarm" whenever both Pump1 and Pump 2 have fault alarms. "Alarm", "OK"; not user-changeable. (7,X,3,LO_BIT_0)

### *Pump Flip-Flop on Day*

This option forces a pump flip-flop to be performed at the beginning of each day. If Pump Flip-Flop on Run Time is also enabled, it takes precedence. "Yes", "No"; user-configurable. (7,X,23,LO_BIT_2)

### *Pump Flip-Flop on Run Time*

This option forces a pump flip-flop to be performed upon the lead pump having run for a time equal to its Flip-Flop Setpoint (see Pump X Flip-Flop Setpoint above). User-configurable. (7,X,23,LO_BIT_3)

### *Pump Maximum Starts Allowed*

The maximum number of starting attempts which fail which may be made before a pump fault is declared. User-configurable. (7,X,23,HI_MS_NBL)

### *Pump Restart Timer*

Used to time Pump Retry Delay. Reads in seconds; user-configurable. (7,X,6,WORD)

### *Pump Retry Delay*

The delay which must elapse between an unsuccessful starting of a pump and the next attempt to start the pump. In seconds; user-configurable. (7,X,58,WORD)

### *Pump Start Counter*

Keeps track of the number of unsuccessful pump starts that have been performed. Upon a successful pump start this parameter is zeroed. Not user-changeable. (7,X,5,WORD)

### *Pump X Accumulated Run Time*

The total time Pump X (1 or 2) has been on since the user last zeroed this parameter. Calculated by adding in Pump X Run Time Today at the end of each day. In hours; user-configurable. Pump 1 (7,X,62,WORD). Pump 2 (7,X,65,WORD)

### *Pump X Enable*

Enables pump X (1 or 2) for operation; if disabled, pump X may not turn on under any conditions. "Enabled", "Disabled"; user-configurable. Pump 1 (7,X,23,LO_BIT_4). Pump 2 (7,X,23,LO_BIT_5).

### *Pump X Fault Status*

If, at any time, the proof-of-flow switch for a pump reads negative for the Proof-of-Flow Delay time, then the pump is turned off and a re-start process is begun. After being off for Proof-of-Flow Delay, the pump is re-started; if the proof-of-flow switch does not read positive within Proof-of-Flow Delay, the pump is turned off again. A pump may be re-started until the counter equals Pump Maximum Starts; at this point, a pump fault is declared and the pump is locked-out from operation. A pump fault will not clear by itself; the user must clear it using the action parameter or the communications line. "Yes", "No"; user-configurable. Pump 1 (7,X,2,HI_BIT_6). Pump 2 (7,X,2,HI_BIT_7).

### *Pump X Flip/Flop Setpoint*

If lead/lag pump flip-flop is chosen to occur based on lead pump run-time, then the flip-flop is forced to occur when the run-time exceeds this setpoint. In hours; user-configurable. Pump 1 (7,X,64,WORD). Pump 2 (7,X,67,WORD).

### *Pump X Flow Status*

Indicates if pump X (1 or 2) has attained proof-of-flow. The pump X proof-of-flow switch must register positive for the Proof-Of-Flow Delay time for pump X to establish positive proof-of-flow. "ON", "Off"; user-configurable. Pump 1 (7,X,2,LO_BIT_3). Pump 2 (7,X,2,LO_BIT_3).

### *Pump X Flow Switch Handle*

Points to the Input index which reads the pump X (1 or 2) proof-of-flow switch. User-configurable. Pump 1 (7,X,97,WORD). Pump 2 (7,X,99,WORD).

### *Pump X Output*

Indicates the actual output for pump X (1 or 2). This parameter is examined by the Output index assigned to that pump when it controls the pumps output. "ON", "Off"; not user-changeable. Pump 1 (7,X,0,HI_BIT_0). Pump 2 (7,X,0,HI_BIT_1)

### *Pump X Override ON*

Forces pump X (1 or 2) on unconditionally. "Yes", "No"; user-configurable. Pump 1 (7,X,23,LO_BIT_6). Pump 2 (7,X,23,LO_BIT_7).

### *Pump X Run Time Today*

The time for which pump X (1 or 2) has been on so far today. In hours and minutes; not user-changeable. Pump 1 (7,X,8,WORD). Pump 2 (7,X,9,WORD)

### *Pump X Run Time Total*

The total time pump X (1 or 2) has been on since the last lead/lag pump flip-flop. In hours; not user-changeable. Pump 1 (7,X,63,WORD). Pump 2 (7,X,66,WORD).

### *Pump X Running*

This internal parameter indicates whether operation of pump X (1 or 2) is desired by control logic. It's value will not necessarily be the same as that for Pump X Output since pump faults could prevent the pump from actually turning on. "Yes", "No"; not user changeable. Pump 1 (7,X,2,HI_BIT_4). Pump 2 (7,X,2,HI_BIT_5).

# Cooling Tower Properties

COOLING TOWER Object

TOWER

| | |
|---|---|
| Object Number | =7 |
| Data Type | = Word |
| Index | = 1 or as allocated |
| Attribute | = 107 (0..106) |
| DYNAMIC Attributes | = 20 (0..19) |
| STATIC Attributes | = 87 (20..106) |

## Firmware Revision - Tower

**ASIC/2-7540 FW754A Rev 1.0 Forthcoming 2005**

- Restores Tower Object as in FW740C.

**ASIC/2-7040 FW740E Rev 1.7 Released 09/27/2000 CHK 0xE62A**
**ASIC/2-8040 FW840E Rev 1.7 Released 09/27/2000 CHK 0xCB80**

- Object 7 - Tower is not supported in this release.

**ASIC/2-7040 FW740C Rev 2.1 Released 08/20/98 CHK F6CEh**
**ASIC/2-8040 FW840C Rev 1.1 Released 07/22/98 CHK F5F0h**

- Restores Tower and Boiler. They were deleted in 740C 2.0

**ASIC/2-7040 FW740C Rev 2.1 Released 08/20/98**
**ASIC/2-8040 FW840C Rev 1.1 Released 07/22/98**

- Restores Tower . It deleted in 740C 2.0
- Flip Flop on Run Time does not work!

**ASIC/2-7040 FW740C Rev 1.9 Released 04/15/98**

- Restores Tower

**ASIC/2-7040 FW740C Rev 1.0, Released 01/29/97**

The Cooling Tower is Not used in FW740C.

**ASIC/2-8040 FW840A Rev 1.0, March 1996**.

**ASIC/2-7040 FW740A.. Rev 1.0 03/31/94**

Fixed Flip Flop on Run Hours

**ASIC/2-7000 FW700A.. Rev 1.0 Released 12/05/91**
**SC/1-9040 FW907A Rev 1.0 Released 07/25/91**

Flip Flop on Run does not work.

# Cooling Tower DYNAMIC Properties

Attr-0 LO BYTE Outputs

LO Bit 0 - **Boiler Stage 1 Output**
LO Bit 1 - **Boiler Stage 2 Output**
LO Bit 2 - **TWR Stage 1 Output**
LO Bit 3 - **TWR Stage 2 Output**
LO Bit 4 - **TWR Stage 3 Output**
LO Bit 5 - **TWR Stage 4 Output**
LO Bit 6 - **TWR Stage 5 Output**
LO Bit 7 - **TWR Stage 6 Output**

Attr-0 HI BYTE

HI Bit 0 - **Pump 1 Output**
HI Bit 1 - **Pump 2 Output**
HI Bit 2 - **Boiler OAT Lockout Output**
HI Bit 3 - **TWR OAT Lockout Output**
HI Bit 4 - Spare
HI Bit 5 - Spare
HI Bit 6 - Spare

Attr-0 HI Bit 7 - **HP OK to Operate**

This output is set if TWR Alarm Status is OK and if TWR Operating Status is Run.

Attr-1 **Cooler Valve Output**

Attr-2 Status

Attr-2 LO Bit 0 - **TWR Alarm Status**

This alarm is set if HP Delayed High or Low Temperature Alarms or Proof of Flow (delayed) are set.

Attr-2 LO Bit 1 - **Lead Pump Status**
Attr-2 LO Bit 2 - **Lag Pump Status**
Attr-2 LO Bit 3 - **Pump 1 Flow Status**
Attr-2 LO Bit 4 - **Pump 2 Flow Status**

Attr-2 LO Bit 5 - **Proof of Flow Status**

Attr-2 LO Bit 6 - **Lead Pump Present**
(0 = Pump 1, 1 = Pump 2)

Attr-2 LO Bit 7 - **Lead Pump Previous**
(0 = Pump 1, 1 = Pump 2)

Attr-2 HI Bit 0 - **TWR Operating Status**

This bit is set if C_OPS is true, and no double fault and if 1 pump is operating properly.

Attr-2 HI Bit 1 - **TWR Operation Requested**

This bit is set if
a) TWR is overridden ON; or
b) TWR Request is enabled and number from HP Request Handle Attr-101 is greater than HP Min Request ; or
c) Value from Schedule Handle is greater than zero.

Attr-2 HI Bit 2 - **TWR OAT Lockout Temperature Status**
Attr-2 HI Bit 3 - **Cooler Valve End Switch Status**
Attr-2 HI Bit 4 - **Pump 1 Running**
Attr-2 HI Bit 5 - **Pump 2 Running**
Attr-2 HI Bit 6 - **Pump 1 Fault Status**
Attr-2 HI Bit 7 - **Pump 2 Fault Status**

Attr-3 Alarm Status

LO BYTE

Attr-3 LO Bit 0 - **Pump Double Fault Alarm**
Attr-3 LO Bit 1 - **Lead Pump Fault Alarm**
Attr-3 LO Bit 2 - **Lag Pump Fault Alarm**
Attr-3 LO Bit 3 - **Pump Any Fault Alarm**

Attr-3 LO Bit 4 - **HP Proof Alarm** (Delayed)

HP Proof Alarm is set if the Proof of Flow Status is not set after a HP Proof Delay from it first going away.

Attr-3 LO Bit 5 - **Pump Temperature Alarm**

If Lag Pump Add-In Alarm Enable is yes and if the CW Supply Temperature exceeds the Lag Add-In Max Temperature Setpoint [Typical 95 F], or if the CW Supply Temperature falls below the Lag Add-In Min Temperature Setpoint [Typical 60 F], the Pump Temperature Alarm is set and the Lag pump is turned on.

Attr-3 LO Bit 6 - Spare

Attr-3 LO Bit 7 - **Cooler Valve End Switch Alarm**

HI Byte

Attr-3 HI Bit 0 - **Proof of Flow Fault Alarm**

Attr-3 HI Bit 1 - **Boiler OAT Lockout Alarm**

Attr-3 HI Bit 2 - **CWS High Temperature Alarm**

Attr-3 HI Bit 3 - **CWS Low Temperature Alarm**

Attr-3 HI Bit 4 - **CWR High Temperature Alarm**

Attr-3 HI Bit 5 - **CWR Low Temperature Alarm**

Attr-3 HI Bit 6 - **HP High Temperature Alarm**

Is set immediately if the CWS temperature exceeds the HP Disable High Temperature Alarm Setpoint

Attr-3 HI Bit 7 - **HP Low Temperature Alarm**

Attr-4 **Action**

0 - "Select" No Operation

1..16 - Clear Alarm Action, Reset Individual Alarms
Attr-3 Alarm Bit 0 through Bit 15

1 - Clear Alarm Action, "Clear Double Fault Alarm"

2 - Clear Alarm Action, "Clear Lead Pump Alarm"

3 - Clear Alarm Action, "Clear Lag Pump Alarm"

5 - Clear Alarm Action, "Clear Pump Temperature Alarm"

17 - Reset Pump Action, Clear Double, Lead, and Lag Alarms

18 - Fresh Start Action, Reset All Attr-3 Alarm Bits 0..15

19 - Override Action, Force ON (Attr-23, LO Bit 0 = 1)

20 - Override Action, Restore Auto (Attr-23, LO Bit 0 = 0)

### *Pump Timers and Counters*

Attr-5 Pump Restart Counters

LO Byte - **Pump 1 Restart Counter**

HI Byte - **Pump 2 Restart Counter**

Attr-6 Pump Restart Timers

LO Byte - **Pump 1 Restart Timer**

HI Byte - **Pump 2 Restart Timer**

Attr-7 Alarm Delays

LO Byte - HP Proof Alarm Delay Timer

HI Byte - HP Temperature Alarm Delay Timer

Attr-8 **Pump 1 Run Time Today**

Pump 1 Run time Today in 1 hour increments.

Attr-9 **Pump 2 Run Time Today**

### *Current Temperatures*

Attr-10 **CW Supply Temperature**

Attr-11 **CW Return Temperature**

Attr-12 **Outside Air Temperature**

### *Cooling Tower Timers*

Attr-13 Timers 1
- LO Byte - **TWR Interstage Timer** (s)
- HI Byte - **Boiler Minimum ON Timer** (min)

Attr-14 Timers 2
- LO Byte - **TWR Stage 1 Min ON Timer** (min)
- HI Byte - **TWR Stage 2 Min ON Timer** (min)

Attr-15 Timers 3
- LO Byte - **TWR Stage 3 Min ON Timer** (min)
- HI Byte - **TWR Stage 4 Min ON Timer** (min)

Attr-16 Timers 4
- LO Byte - **TWR Stage 5 Min ON Timer** (min)
- HI Byte - **TWR Stage 6 Min ON Timer** (min)

Attr-17 **Pump Crossover Delay Time**r
- The timer for changeover to New Lead Pump from Old Lead Pump

Attr-18 TWR Timers 5
- LO BYTE - **TWR OAT Lockout Timer**
- HI BYTE - Spare Timer

Attr-19 TWR Miscellaneous Flags
- LO bit 0 - **HP Disable High Temperature Alarm**
  - Is set if the HP High Temperature Alarm is set after a HP Temperature Alarm Delay from it first appearing.
- LO bit 1 - **HP Disable Low Temperature Alarm**

LO bit 2..7 - Spare

HI BYTE - Spare

## Cooling Tower STATIC Properties

Attr-20 Enable TWR

LO Bit 0 - **TWR Stage 1 Enable**
LO Bit 1 - **TWR Stage 2 Enable**
LO Bit 2 - **TWR Stage 3 Enable**
LO Bit 3 - **TWR Stage 4 Enable**
LO Bit 4 - **TWR Stage 5 Enable**
LO Bit 5 - **TWR Stage 6 Enable**
LO Bit 6 - **Cooler Valve Enable**
LO Bit 7 - **Cooler Valve End Switch Enable**

HI Bit 0 - **TWR OAT Lockout Enable**
Controls both Tower and Boiler
HI Bit 1 - **Boiler Stage 1 Enable**
HI Bit 2 - **Boiler Stage 2 Enable**
HI Bit 3 - **Lag Pump Add-In Enable**
HI Bit 4 - **Boiler OAT Lockout Enable**

Attr-21 Enable Alarm

LO Bit 0 - **Pump Double Fault Alarm Enable**
Sets Alarm on Lead and Lag pump fault

LO Bit 1 - **Lead Pump Fault Alarm Enable**
Sets Alarm on Lead pump fault

LO Bit 2 - **Lag Pump Fault Alarm Enable**
Sets Alarm on Lag pump fault

LO Bit 3 - Spare
LO Bit 4 - **HP Disable High Temperature Alarm Enable**
LO Bit 5 - **HP Disable Low Temperature Alarm Enable**
LO Bit 6 - **HP Proof Alarm Enable**

LO Bit 7 - **Cooler Valve End Switch Alarm Enable**
Sets Alarm on failure to reach end switch

HI Bit 0 - **Proof of Flow Enable**
Sets Alarm on loss of proof of flow

HI Bit 1 - **Boiler OAT Lockout Alarm Enable**

HI Bit 2 - **CWS High Temperature Alarm Enable**
Sets Alarm on High CWS Temp

HI Bit 3 - **CWS Low Temperature Alarm Enable**
Sets Alarm on Low CWS Temp

HI Bit 4 - **CWR High Temperature Alarm Enable**
Sets Alarm on High CWR Temp

HI Bit 5 - **CWR Low Temperature Alarm Enable**
Sets Alarm on Low CWR Temp

HI Bit 6 - **HP High Temperature Alarm Enable**
Sets alarm on High CWS Temp

HI Bit 7 - **HP Low Temperature Alarm Enable**
Sets alarm on Low CWS Temp.

Attr-22 Interlock Enable

LO BYTE- Enables Low OAT Lockout function for specific stage.

LO Bit 0 - **TWR Stage 1 Lockout Enable**
LO Bit 1 - **TWR Stage 2 Lockout Enable**
LO Bit 2 - **TWR Stage 3 Lockout Enable**
LO Bit 3 - **TWR Stage 4 Lockout Enable**
LO Bit 4 - **TWR Stage 5 Lockout Enable**
LO Bit 5 - **TWR Stage 6 Lockout Enable**
LO Bit 6 - Spare
LO Bit 7 - Spare

HI BYTE - Cooler Valve End Switch Enable

Enables Cooler Valve Interlock for specific stage.

HI Bit 0 - **TWR Stage 1 End Switch Enable**
HI Bit 1 - **TWR Stage 2 End Switch Enable**
HI Bit 2 - **TWR Stage 3 End Switch Enable**
HI Bit 3 - **TWR Stage 4 End Switch Enable**
HI Bit 4 - **TWR Stage 5 End Switch Enable**
HI Bit 5 - **TWR Stage 6 End Switch Enable**

Attr-23 Pump Setup

LO Bit 0 - **TWR Override ON**

Forces the Cooling Tower ON and ignores TOD schedule. Lead pump will turn on and tower will stage with supply temperature.

LO Bit 1 - **HP Request Enable**

Enables the HP Request Process. If enabled then the value indicated by the HP Request handle is compared with the HP Minimum Requests and if greater, then the TWR is turned on.

LO Bit 2 - **Pump Flip/Flop on Day**

Change Lead Pump based on Day of Week

LO Bit 3 - **Pump Flip/Flop on Run Time**

Change Lead Pump on Accumulated Run Time

LO Bit 4 - **Pump 1 Enable**

LO Bit 5 - **Pump 2 Enable**

LO Bit 6 - **Pump 1 Override ON**

Force operation of Pump 1 if Pump 1 Enable = 1 and if boiler operation is ON. Ignore Lead/Lag

LO Bit 7 - **Pump 2 Override ON**

Force operation of Pump 2 if Pump 2 Enable = 1 and if boiler operation is ON. Ignore Lead/Lag

HILSNBL - **Lead Pump Select**

0 = Use Day of Week
1 = Use Pump 1 for Lead
2 = Use Pump 2 for Lead

HIMSNBL - **Pump Max Starts** [Typical: 3]

Total number of starts attempted before pump fault is declared.

Attr-24 Interlock Enables

LO BYTE - TWR Stage Interlock Enable

If TWR Stage N Interlock Enable is set for a stage, it can not go off until TWR Stage N+1 is Off. For example Stage 1 cannot go off until stage 2 is off, etc.

LO Bit 0 - **TWR Stage 1 Interlock Enable**
LO Bit 1 - **TWR Stage 2 Interlock Enable**
LO Bit 2 - **TWR Stage 3 Interlock Enable**
LO Bit 3 - **TWR Stage 4 Interlock Enable**
LO Bit 4 - **TWR Stage 5 Interlock Enable**
LO Bit 5 - **TWR Stage 6 Interlock Enable**
LO Bit 6 - Spare
LO Bit 7 - Spare

HI BYTE - Spare

### *Condenser Water Cooler Valve Parameters*

Attr-25 **Cooler Valve Throttling Range** [Typical 5.00 F]

Attr-26 **Cooler Valve Temperature Setpoint** [Typical 75.00 F]

Attr-27 Spare

Attr-28 **Cooler Valve Drive Time** [Typical 25 s]

### *Cooling Tower Low OAT Lockout Parameters*

Attr-29 **TWR OAT Lockout Setpoint** [Typical 35.00 F]
Used to compare with OAT. IF OAT < TWR Lockout Temperature Setpoint for a TWR Lockout Delay, then TWR lockout function and output is active.

Attr-30 **TWR OAT Lockout Override Setpoint** [Typical 95.00 F]

Attr-31 **TWR OAT Lockout Hysteresis** [Typical 5.00 F]
This is used for both the TWR and Boiler Lockout comparisons.

### *Cooling Tower Stage Parameters*

Attr-32 **TWR Interstage Time** [Typical 10 s]
Interstage time in seconds for adding a stage.

Attr-33 **TWR Stage 1 Temperature Setpoint** [Typical 83.00 F]
Temperature Setpoint for adding Stage 1.

Attr-34 **TWR Stage 2 Temperature Setpoint** [Typical 83.00 F]
Attr-35 **TWR Stage 3 Temperature Setpoint** [Typical 86.00 F]
Attr-36 **TWR Stage 4 Temperature Setpoint** [Typical 89.00 F]
Attr-37 **TWR Stage 5 Temperature Setpoint** [Typical 92.00 F]
Attr-38 **TWR Stage 6 Temperature Setpoint** [Typical 94.00 F]

Attr-39 **TWR Stage 1 Hysteresis** [Typical 2.00 F]
Temperature Hysteresis for dropping Stage 1

Attr-40 **TWR Stage 2 Hysteresis** [Typical 2.00 F]
Attr-41 **TWR Stage 3 Hysteresis** [Typical 2.00 F]
Attr-42 **TWR Stage 4 Hysteresis** [Typical 2.00 F]
Attr-43 **TWR Stage 5 Hysteresis** [Typical 2.00 F]
Attr-44 **TWR Stage 6 Hysteresis** [Typical 2.00 F]

Attr-45 **TWR Stage 1 Min ON Time** [Typical 5 min]
Minimum ON Time in minutes for Stage 1.

Attr-46 **TWR Stage 2 Min ON Time** [Typical 5 min]
Attr-47 **TWR Stage 3 Min ON Time** [Typical 5 min]
Attr-48 **TWR Stage 4 Min ON Time** [Typical 5 min]
Attr-49 **TWR Stage 5 Min ON Time** [Typical 5 min]
Attr-50 **TWR Stage 6 Min ON Time** [Typical 5 min]

Attr-51 TWR Miscellaneous Delays
LO BYTE - **TWR OAT Lockout-Clear Delay** [Typical 30 sec]
(in seconds)
HI BYTE - Spare

Attr-52 Spare

### *Boiler Parameters*

Attr-53 **Boiler Stage 1 Temperature Setpoint** [Typical 70.00 F]
Temperature Setpoint for adding Boiler 1.

Attr-54 **Boiler Stage 2 Temperature Setpoint** [Typical 67.00 F]

Attr-55 **Boiler Stage Hysteresis** [Typical 2.00 F]
Temperature Hysteresis for dropping Boiler Stage

Attr-56 **Boiler OAT Lockout Temperature Setpoint** [Typical 68.00 F]
Used to compare with OAT. IF OAT > Boiler Lockout Temperature Setpoint for a Lockout Delay, then Boiler lockout function and output is active.

### *Pump Control Parameters*

Attr-57 **Pump Crossover Delay** [Typical 30 sec]
Delay in switching the lead pump. The new lead pump starts and runs for pump crossover Delay in seconds before the old lead pump is turned off.

Attr-58 **Pump Retry Delay** [Typical 30 sec]
Delay in retrying a pump start. If the pump fails to start with in a Proof of Flow Delay, then the pump will turn OFF and wait a Pump Retry Delay time before attempting to start again. (0..255 seconds)

Attr-59 **Lag Add-In Max Temperature Setpoint** [Typical 95.00 F]
Temperature at which Lag pump will turn ON to increase heat transfer for heat pump Cooling.

Attr-60 **Lag Add-In Min Temperature Setpoint** [Typical 60.00 F]
Temperature at which Lag pump will turn ON to increase heat transfer for Heat Pump heating.

Attr-61 **Lag Add-In Temperature Hysteresis** [Typical 5.00 F]
Hysteresis at which Lag pump will turn OFF for Heat Pump heating or Cooling.

Attr-62 **Pump 1 Accum Run Time**
Accumulated Run time in Hours for Pump 1. This is accumulated at the end of the day from (Pump 1 Run Today). This is cleared by the operator. Fractional hours are carried over in Pump 1 Run Today to the next day.

Attr-63 **Pump 1 Run Time Total**
Accumulated Run time in Hours. This is accumulated at the end of the day from Pump 1 Run Today and is Cleared when Flip/Flop to Lead Pump 2 is done based on Run Time.

Attr-64 **Pump 1 Flip/Flop Setpoint**
Setpoint in hours used to compare with Pump 1 Run Time + (Pump 1 Run Today) to determine if Flip/Flop to Lead Pump 2 is required.

Attr-65 **Pump 2 Accum Run Time**
Accumulated Run time in Hours for Pump 2.

Attr-66 **Pump 2 Run Time Total**

Attr-67 **Pump 2 Flip/Flop Setpoint**

Attr-68 **Proof of Flow Delay** [Typical 30 sec]
The time in seconds to wait after a change in the Proof of Flow Switch before declaring a change of state of the proof of flow switch.

Attr-69 Spare
Attr-70 Spare
Attr-71 Spare
Attr-72 Spare

### *HP Request Parameters*

Attr-73 **HP Request Minimum Setpoint**
This is used to compare with the value from the HP Request Handle to determine if the TWR should be ON.

Attr-74 Spare

**Attr-75 HP Request Alarm Delay**

LO BYTE - **HP Proof Alarm Delay (seconds)** [Typical 30 sec]
Delay for complement of Proof of Flow Status before setting Proof Alarm The time to wait after a change of state of proof of flow before changing transmit message to Enable HP Compressor, or to Disable HP Compressor. Loaded into HP Proof Delay Timer.

HI BYTE - **HP Temperature Alarm Delay (seconds)** [Typical 30 sec]
HP High Temperature Alarm (Delay) is set if the HP Disable High Temperature Alarm ) is set after a HP Temperature Alarm Delay from it first appearing. This can be used as the time to wait after a high or low loop temperature alarm before changing transmit message to Enable HP Compressor, or to Disable HP Compressor. Loaded into HP Temperature Alarm Timer

### *Alarm Setpoints*

Attr-76 **CWS High Alarm Temperature Setpoint** [Typical 100.00 F]

Attr-77 **CWS Low Alarm Temperature Setpoint** [Typical 55.00 F]

Attr-78 **CWS Temperature Hysteresis** [Typical 2.00 F]

Attr-79 **CWR High Alarm Temperature Setpoint** [Typical 93.00 F]

Attr-80 **CWR Low Alarm Temperature Setpoint** [Typical 53.00 F]

Attr-81 **CWR Temperature Hysteresis** [Typical 2.00 F]

Attr-82 **HP High Alarm Temp Setpoint** [Typical 98.00 F]

Attr-83 **HP Low Alarm Temp Setpoint** [Typical 55.00 F]

Attr-84 **HP Alarm Hysteresis** [Typical 2.00 F]

Attr-85 Spare

Attr-86 Spare

### *Input Handles*

Attr-87,88 **TWR Schedule Handle**
Examines byte pointed to by handle. If non-zero then Cooling Tower is ON.

Attr-89,90 **CW Supply Temperature Handle**

Attr-91,92 **CW Return Temperature Handle**

Attr-93,94 **Outside Air Temperature Handle**

Attr-95,96 **Cooler Valve End Switch Handle**

Attr-97,98 **Pump 1 Flow Switch Handle**

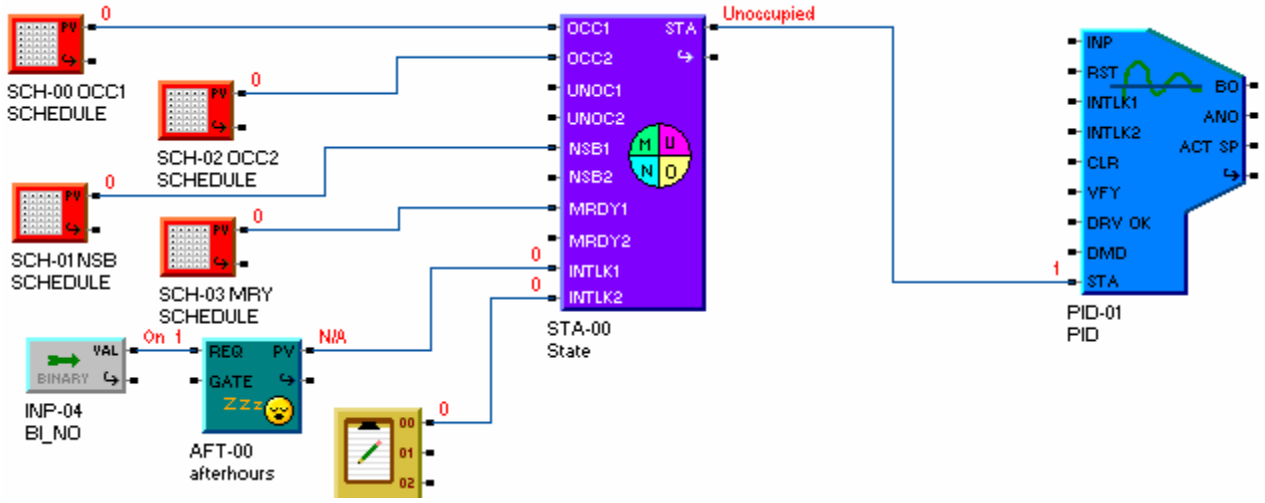
Attr-99,100 **Pump 2 Flow Switch Handle**

Attr-101,102 **HP Request Handle**
If HP Request Enable is set then the word pointed to by handle is compared with the HP Minimum Request Setpoint. If greater, then Cooling Tower is turned ON.

Attr-103 Spare
Attr-104 Spare
Attr-105 Spare
Attr-106 Spare

# Object 8 - State

## State Summary




**Overview:** The State object determines the present control state for the system controller. The four control states, Unoccupied, Occupied, Night Setback, and Morning Ready are used by the PID object to choose operating setpoints. The control state may also be broadcast to terminal unit controllers on the local bus of the ASIC/2.

**Inputs and Outputs:** The State object has schedule assignments for each of the 8 state events, and two interlock handles which may be used for the optimum start override, for the after-hours override, or for communication override of state from Utility index 0, Attr-0.. The output is the present control state.

**Determining Control State:** The four control states are Morning Ready, Occupied, Unoccupied and Night Setback. The eight state events are Morning Ready #1 and #2, Night Setback #1 and #2, Occupied #1 and #2, and Unoccupied #1 and #2. Up to two events are provided for each state so that each state may be scheduled to occur twice per day, if desired. Each event has an assigned Schedule index which gives the time the event should begin and the time it should end for each day of the week plus a holiday. Every 1 minute and 7.5 minutes each of the schedules is examined to see if the state event is on.

**State Precedence:** If more than one state is on at the same time, the control state is based on the following order of precedence:

Unoccupied > Occupied > Night Setback > Morning Ready.

**Default State:** Any one of the four states may be declared to be the default state. If no state is scheduled to be on, the default state is used.

**State Lockouts:** Lockouts may be set for any two of the four states. A lockout disables the state from being used, regardless of what its schedule says. In this way, a system

controller may enforce a two-state control system (Unoccupied or Occupied, only, for instance).

**Unsynchronized State:** Any one state may be declared to be the state to be used when the controller's clock is unsynchronized. A controller's clock is unsynchronized upon return from power outage.

**Interlock 1 Override:** Interlock 1 may be used to override the present state. For example Interlock 1 could read a value passed by Optimum Start, dictating that a Target State (such as Morning Ready) begin earlier than as specified in its schedule. The State object would examine Optimum Start periodically to see if the Target State has begun, overriding it into effect when it does begin.

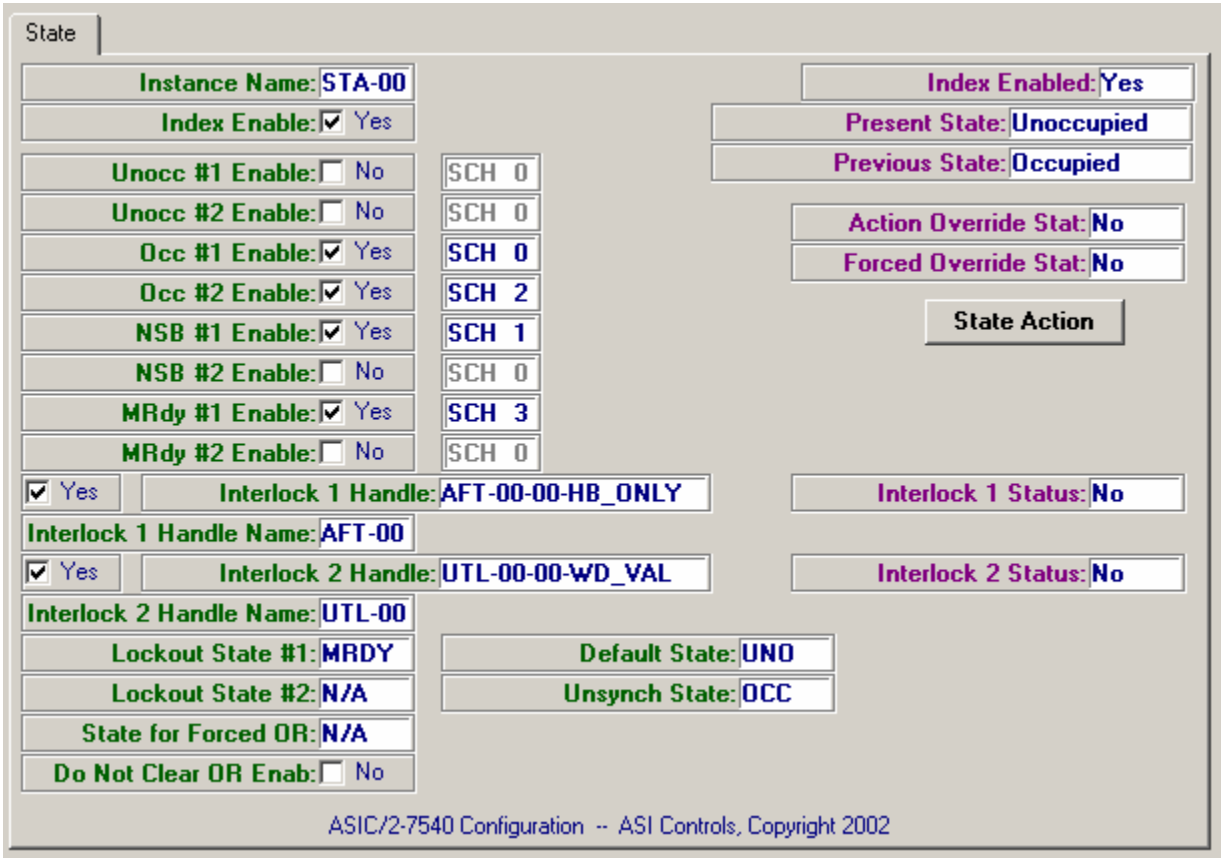
**Interlock 2 Override:** Interlock 1 may be used to override the present state. For example, Interlock 2 could be read the Present Value of the Afterhours Object. The State object would examine Interlock 2 periodically to see if an Afterhours override had come into effect. If so, the State object overrides the Control State to that dictated by the Afterhours object. Interlock 2 overrides take precedence over Interlock 1 overrides.

**Action Override of State:** Using communication the operator may force the control state to any state in one of two ways: An action message, or Forced Override. Writing an action message places the controller temporarily in the desired state. The action override does not survive a power-reset. The action state override will clear automatically on the next schedule event, or after 7.5 minutes have elapsed unless the Don't Clear Override Enable is set. The user may clear the override at any time.

The forced override writes the desired state into the static Forced Override State. The forced override survives a power-reset. The forced override will clear automatically on the next schedule event, or after 7.5 minutes have elapsed unless the Don't Clear Override Enable is set. The user may clear the override at any time.

The State object may be configured so that overrides never clear; the forced state may only be cleared by sending a clear override message over the communications line. In this situation, schedules would typically not be in use.

# State Operation




## Synchronized Operation

Only the current day's (Mon, .., Sun), Holiday, or Special Day schedule is examined.

If the controller is synchronized, upon the first synchronization and every second the time of day schedules are examined for an exact match. If an exact match is found, then the schedule turns ON or OFF. The output of each schedule is either 0 = OFF, or 1 = ON.

The state control block examines the assigned schedules to determine, if any of the assigned schedules are ON. The Default State is used if all assigned schedules are OFF. If any of the assigned schedules is ON then that determines the TOD State. If more than one schedule is ON then the following order of precedence is observed:

Forced OR > Action OR > Interlock 1 > Interlock 2 > UNOCC > OCC > NSB > MRDY > Default

### *Schedule Index*

Up to 2 schedules may be used for each state, Unoccupied, Occupied, Night Setback and Morning Ready. For the schedule to be used the appropriate Schedule Enable must be set. The index number of the schedule to be used for each state is identified in the State object.

**Note:** With FW700A..I the schedule assignment 1..15 indicates a schedule index 0..14.. With FW740A.. this is now the schedule index 0..63. There are separate enable flags for each schedule to be used.

## Unsynchronized Operation

If the controller is NOT synchronized, for example after reset or power up, the Unsynchronized State is used.

## Lockout

The high and low bytes of the Attr-7 Lockout indicate which states, e.g. Unoccupied, Morning Ready, are not to be used.

0 = none
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

## Possible States

The following states have been defined for the system controller based on bits 0,1,and 2 of the state byte.

0 = none, don't care,
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

## Default State

If the STATE has not been enabled , then the Attr-9 Default state is used.

Default State is also used if no assigned schedule is ON.

## State for Forced Override

The Force Override State has the highest priority and supersedes interlocks and the state requested by the Schedule Object. Force of State is done by writing to Attr-14 Force Override State.

If the Don't Clear flag is not set (Attr-6 Setup, LO bit 1 = 0), a forced state clears automatically after 7.5 to 15 minutes.

When entering the forced state, the Force Override Status (Attr-2-Status, LO bit 1) and Wait to Clear Override Status (Attr-2-Status, LO bit 7) are set and the forced state is used as the present value. After the second 7.5 minute increment is passed, the Attr-14 Force Override State is cleared to zero.

If the Don't Clear Override Enable is set (Attr-6 Setup, LO bit 1 = 1), the State force remains in effect until removed.

Action overrides have second priority.

## Interlock 1

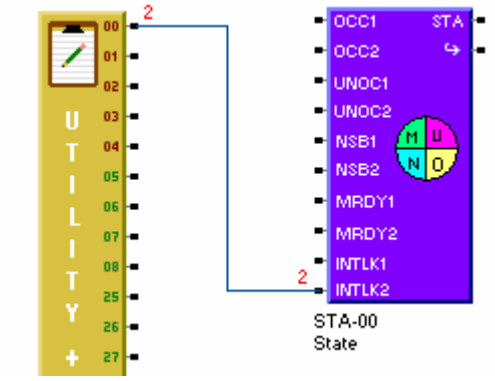
The Interlock 1 Handle points at the present value of an object which has the Interlock 1 Target State. If Interlock 1 is enabled (Attr-6 Setup, LO bit 2) and if the value is non-zero, then the Interlock 1 Status (Attr-2 Status, LO bit 2) is set and the Interlock 1 Target State is used for present value. If the value is 0, don't care, then Interlock 2 Handle is examined. Interlock 1 has higher priority than Interlock 2. For example, the present value of the Afterhours object will be set to 2 - Occupied, in response to a push-button. I

## Interlock 2

The Interlock 2 Handle points at the present value of an object which has the Interlock 2 Target State. If Interlock 2 is enabled (Attr-6 Setup, LO bit 3) and if the value is non-zero, then the Interlock 2 Status (Attr-2 Status, LO bit 3) is set and the Interlock 2 Target State is used for present value. If the value is 0, don't care, then Interlock 2 Handle is examined. Interlock 1 has higher priority than Interlock 2. If the value is 0, don't care, then the schedules are examined. For example, the present value of the Optimum Start object will be set to 2 - Morning Ready, in response to a calculated morning ready period.

### *State Override*

Index 0, Attr-0 is reserved for state override with message MT=0x10. It can be used as an override to the state object.




# State Glossary

## State Parameters

### *Action Override Status*

Indicates if Present State has been overridden via the Action parameter, attribute 4. "Yes, "No"; not user-changeable except via the Action parameter. (8,X,2,LO BYTE BIT 6)

### *Default State*

The control state to use on power-up if the State object has not been enabled (State Enable set to "No"). User-configurable; "Unoccupied", "Occupied", "Morning Ready", "Night Setback". (8,X,9,LO BYTE)

### *Don't Clear Overrides Enable*

If set to "Yes", then communications overrides are not automatically cleared. Normally, they are cleared after 7.5 minutes. "Yes", "No"; user-configurable. (8,X,6,LO BIT 1)

### *Forced Override Status*

Indicates if a forced override of state has been effected via the communications line. "Yes", "No"; not user-changeable. (8,X,2,LO BIT 1)

### *Interlock 1 Enable*

If set to "Yes", then the State object examines the Interlock 1 Override Handle for the occurrence of state overrides and, if one is present, what state to override to. "Yes", "No"; user-configurable. (8,X,6,LO BIT 2)

### *Interlock 1 Handle*

Points to the parameter which contains the state to use for Interlock 1 state overrides. User-configurable. (8,X,15,2 WORDS)

### *Interlock 1 Status*

Indicates if an Interlock 1 state override is currently in effect. If an override is in effect, then the current control state is based on the Interlock 1 Override Handle. "Yes", "No"; not user-changeable. (8,X,2,LO BIT 2)

### *Interlock 2 Enable*

If set to "Yes" then the State object examines the Interlock 2 Override Handle for the occurrence of state overrides and, if one is present, what state to override to. "Yes", "No"; user-configurable. (8,X,6,LO BIT 3)

### *Interlock 2 Handle*

Points to the parameter which contains the state to use for Interlock 2 state overrides. User-configurable. (8,X,16,2 WORDS)

### *Interlock 2 Status*

Indicates if an Interlock 2 state override is currently in effect. If one is, then the current control state is based on the Interlock 2 Override Handle. "Yes", "No"; not user-changeable. (8,X,2,LO BIT 3)

### *Lockout State #1, #2*

Designates one of the two total possible states which may be locked out from operation. User-configurable; "Unoccupied", "Occupied", "Morning Ready", "Night Setback". (8,X,7,LO BYTE, HI BYTE)

### *Morning Ready Schedule #1, #2*

Designates the schedule to be examined for the start and stop times for Morning Ready Event #1 or #2. User-configurable. (8,X,13,LO BYTE, HI BYTE)

### *Night Setback Schedule #1, #2*

Designates the schedule to be examined for the start and stop times for Night Setback Event #1 or #2. User-configurable. (8,X,12,LO BYTE, HI BYTE)

### *Occupied Schedule #1, #2*

Designates the schedule to be examined for the start and stop times for Occupied Event #1 or #2. User-configurable. (8,X,11,LO BYTE, HI BYTE)

### *Present State*

Indicates the control state currently in effect: 1 = "Unoccupied", 2 = "Occupied", 3 = "Night Setback", 4 = "Morning Ready". (8,X,0,WORD)

### *Previous State*

Indicates the control state which was in effect immediately prior to Present State going into effect. "Occupied", "Unoccupied", "Morning Ready", "Night Setback". (8,X,1,WORD)

### *Index Enable*

Enables this index of the State object for operation. User-configurable; "Yes", "No". (8,X,6,LO BIT 0)

### *State Action*

Writing to State Action overridesthe Active State value: 0 - No Action; 1 - Override to Unoccupied; 2 - Override to Occupied; 3 - Override to Night Setback ;4 - Override to Morning Ready; 5 - Restore to Schedule; 6. - No action. (8,X,4, WORD)

### *State Enabled*

Indicates if the State object is enabled for operation. Not User-configurable; "Yes", "No". (8,X,2,LO BIT 0)

### *State for Forced Override*

Designates the state to use when a "force state" message is received on the communications line. User-configurable; "Occupied", "Unoccupied", "Morning Ready", "Night Setback". (8,X,14,LO BYTE)

### *Unoccupied Schedule #1, #2*

Designates the schedule to be examined for the start and stop times for Unoccupied Event #1 or #2 User-configurable. (8,X,10,LO BYTE, HI BYTE)

### *Unsynchronized State*

Indicates the control state to be in effect if the system controller is not synchronized. User-configurable; "Occupied", "Unoccupied", "Morning Ready", "Night Setback". (8,X,8,LO BYTE)

### *Wait to Clear Overrides Status*

Indicates if controller is waiting to clear forced or action overrides. These are usually cleared automatically after the 2nd 7.5 minute tick (= 15 minutes). "Yes", "No"; not user-changeable. (8,X,2,LO BIT 4)

# State Properties

The STATE object defines the present values and setup parameters used by the controller to determine the present control state which is used by different control blocks.

| | |
|---|---|
| Object Name | STATE |
| Object Number | = 8 |
| Data Type | = Word |
| Index | = 1..8 as allocated. |
| Attribute | = 0..18 |
| DYNAMIC Attributes | = 6 (0..5) |
| STATIC Attributes | = 13 (6..18) |

The value assigned to State in all ASIC/2 objects is as follows:

0 = none, don't care,
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

This is in the same order as in the ASIC/1 controllers, but incremented by 1.

## State Firmware Revision

**ASIC/2-7540 FW754A Rev 1.0 Forthcoming 2005**
o as in FW740E.

**SINC/3-3000 FW300B Rev 1.0 Released 10/06/1999**
o State Not Supported

**ASIC/2-7040 FW740C Rev 2.2 Released 09/18/98 CHK 68E9h**
**ASIC/2-8040 FW840C Rev 1.2 Released 09/18/98 CHK**
o Fixes Synchronize Flag in System Object SYS-0,Attr-0,LObit0
Does not get set when clock is read on reset
in 740C 2.0, 2.1 and 840C 1.0,1.1
This keeps State from working. Schedules work fine.
740C 1.9 and earlier is OK, 840B 1.6 and earlier is OK

**ASIC/2-7040 FW740C Rev 1.0, Released 01/29/97**
. State correctly follows Special Days in Schedule if used.

**ASIC/2-7040 FW740D Rev 1.1 Released 25 June 1996**
o STATE increased to 64 Maximum

**ASIC/2-8040 FW840A Rev 1.0,March 1996**

**ASIC/2-7040 FW740A Rev 1.1 (05/27/94)**
Fixed Schedule Index Assignment

**ASIC/2-7040 FW740A Rev 1.0 Alpha Test (03/31/94)**
Add Schedule Enables
Assign Schedule Index Changed - does not work properly

**ASIC/2-7000 FW700A.. Rev 1.0 Released 12/05/91**
**SC/1-9040 FW907A Rev 1.0 Released 07/25/91**

## State DYNAMIC Properties

Attr-0 **Present State**

0 = none, don't care,
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

Attr-1 Previous State

Attr-2 Active Status (word)

LO Byte

Attr-2 LO bit 0 - **Index Enabled** (ST_ACTIVE)

1 = STATE Enabled; 0, STATE not enabled

Attr-2 LO bit 1 - **Forced Override Status**

0 = Not in Override
1 = Force override

If Force Override State is 1,2,3, or 4, then the present value will be forced to that value. If zero, then it is ignored.

Force OR > Action OR > Interlock 1

Attr-2 LO bit 2 - **Interlock 1 Status**

1 = Interlock 1 Active, forces Interlock 1 Target State
Interlock 2 > Interlock 1

Attr-2 LO bit 3 - **Interlock 2 Status**

1 = Interlock 2 Active, forces Interlock 2 Target State

Attr-2 LO bit 4 - Spare

Attr-2 LO bit 5 - Spare

Attr-2 LO bit 6 - **Action Override Status**

Overrides of Present Value may be accomplished by writing 1,2,3, or 4 to Attr-4, Action. If Present Value overridden to a new value, it is not updated until the Action Override is cleared. This will be clear on power reset or after the two 7.5 min ticks have occurred, unless Don't Clear Overrides is set to yes. If presently in a Forced Override, Action is not examined for overrides until the Force is cleared.

Force OR > Action OR > Interlock 1

Attr-2 LO bit 7 - **Wait to Clear Override**

(Internal flag)
provides 7.5 min minimum force time.

Attr-2 HI BYTE - Spare

Attr-3 Spare

Attr-4 **Action**

0 - No Action
1 - Override to Unoccupied
2 - Override to Occupied
3 - Override to Night Setback
4 - Override to Morning Ready
5 - Restore to Schedule
6. - No action

Attr-5 Spare

## State STATIC Properties

Attr-6 Setup State

LO Byte - Enable features

Attr-6 LO bit 0 - **Index Enable** (ST_ENABLE)

If the index is not enabled, the present value is set to Default State.

Attr-6 LO bit 1 - **Don't Clear Override Enable** (ST_DONT)
If set, Action Overrides or Forced Overrides are not cleared.

Attr-6 LO bit 2 - **Interlock 1 Enable**

Attr-6 LO bit 3 - **Interlock 2 Enable**

Attr-6 LO bit 4 - spare
Attr-6 LO bit 5 - spare
Attr-6 LO bit 6 - spare
Attr-6 LO bit 7 - spare

HI Byte - Spare (FW700A..)
Enable Schedules (FW740A)

Attr-6 HI bit 0 - **Unoccupied 1 Enable**
Attr-6 HI bit 1 - **Unoccupied 2 Enable**
Attr-6 HI bit 2 - **Occupied 1 Enable**
Attr-6 HI bit 3 - **Occupied 2 Enable**
Attr-6 HI bit 4 - **Night Setback 1 Enable**
Attr-6 HI bit 5 - **Night Setback 2 Enable**
Attr-6 HI bit 6 - **Morning Ready 1 Enable**
Attr-6 HI bit 7 - **Morning Ready 2 Enable**

Attr-7 Lockout States
Any two states may be locked out from consideration.
The value of state (0..5) (None, UNOCC, OCC, NSB, MRDY)
any other = none. If a state is locked out, it can not even be forced.
LO Byte - **Lockout State #1**
HI Byte - **Lockout State #2**

Attr-8 Unsynchronized State
LO - **Unsynchronized State**
HI - Spare

Attr-9 Default State
LO - **Default State**
HI - Spare

### *State Schedule Indexes*

Schedule AssignmentsFW700A.. , 1..15 have been changed to Schedule Index 0..255. in the ASIC/2-7040 FW740A.. A separate enable flag for each Schedule is included in Attr-6 HI Byte

Schedule Assignment 1..15 = Schedule index 0..14 (FW700)
0 means no schedule has been assigned.

Schedule Indexes (0..255) actual index of assigned schedule (FW740)

Attr-10 Unoccupied Schedules
LO BYTE - **Unoccupied 1 Schedule**
HI BYTE - **Unoccupied 2 Schedule**

Attr-11 Occupied Schedules
LO BYTE - - **Occupied 1 Schedule**
HI BYTE - - **Occupied 2 Schedule**

Attr-12 Night Setback Schedules
LO BYTE - **Night Setback 1 Schedule**
HI BYTE - **Night Setback 2 Schedule**

Attr-13 Morning Ready Schedules
LO BYTE - **Morning Ready 1 Schedule**
HI BYTE - **Morning Ready 2 Schedule**

Attr-14 Force Override State

LO BYTE - **State For Forced Override**

If the force override state is non-zero, the Present Value will be give by Force Override State. This will be reset to zero after the second 7.5 min tick, unless Don't Clear Overrides is set.

0 = none
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

HI - Spare

Attr-15,16 **Interlock 1 Handle**

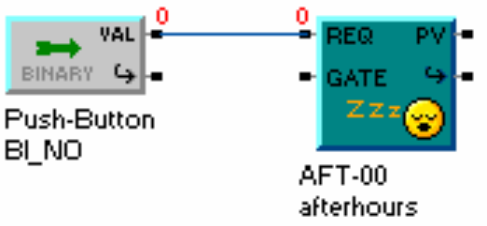
This points to the Interlock 1 Target State, for example generated by the Afterhours Object.

Attr-17,18 **Interlock 2 Handle**

This points to the Interlock 2 Target State, for example generated by the Optimum Start.

# Object 9 - Afterhours

## Afterhours Summary




**Overview:** The Afterhours object takes requests for afterhours operation from a binary input, determines when to begin and end afterhours periods, and outputs a target control state which is to be switched to during afterhours. The State object will typically examine the Afterhours Active Target State to determine whether to initiate the afterhours control state.

**Input:** Typically, afterhours mode is triggered via a momentary key switch or a maintained key switch located on each air handling unit. One system controller input is assigned to read these switches, and this SC's input is fed to the Afterhours object.

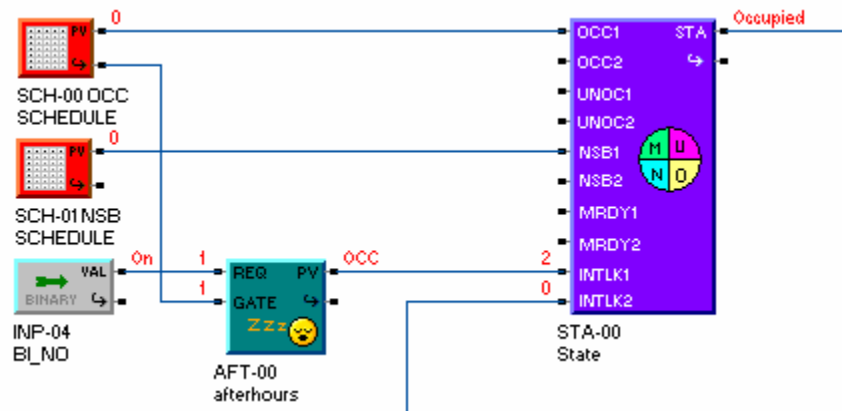
**Output:** The afterhours status (indicating whether currently in an afterhours period or not) is available in the Afterhours object's memory for examination by the State object. The State object is typically configured to examine the afterhours status whenever the State object is in Unoccupied, Night Setback, or Morning Ready; if an Afterhours period is in effect then the State object will override the control state to Occupied. This will not occur if the current state for the State object is the result of an override command sent via the communications line.

**Afterhours Sequence:** Closing the afterhours switch causes an afterhours request to be recorded. Opening the switch removes the request. When the request first appears, an afterhours period is initiated for at least the afterhours minimum on-time. Once minimum on-time has elapsed, if the request is no longer present then the afterhours period is ended. If the request is still present, the period extends until the Afterhours Time Allowed has elapsed. If, during the Afterhours period, a maintained contact is removed, or if a momentary contact occurs again, the Afterhours request is removed and the Afterhours period is ended before the Afterhours Time Allowed has elapsed.

**Afterhours Gate:** The availability of afterhours operation may be controlled by a Gate input. If the gate is enabled and true then afterhours functions normally. If the gate is enabled and false then the start of afterhours is prohibited. If the gate is true but goes false during afterhours operation then it is either canceled at the end of the minimum time or runs to the end of the afterhours time allowed depending on the option selected.

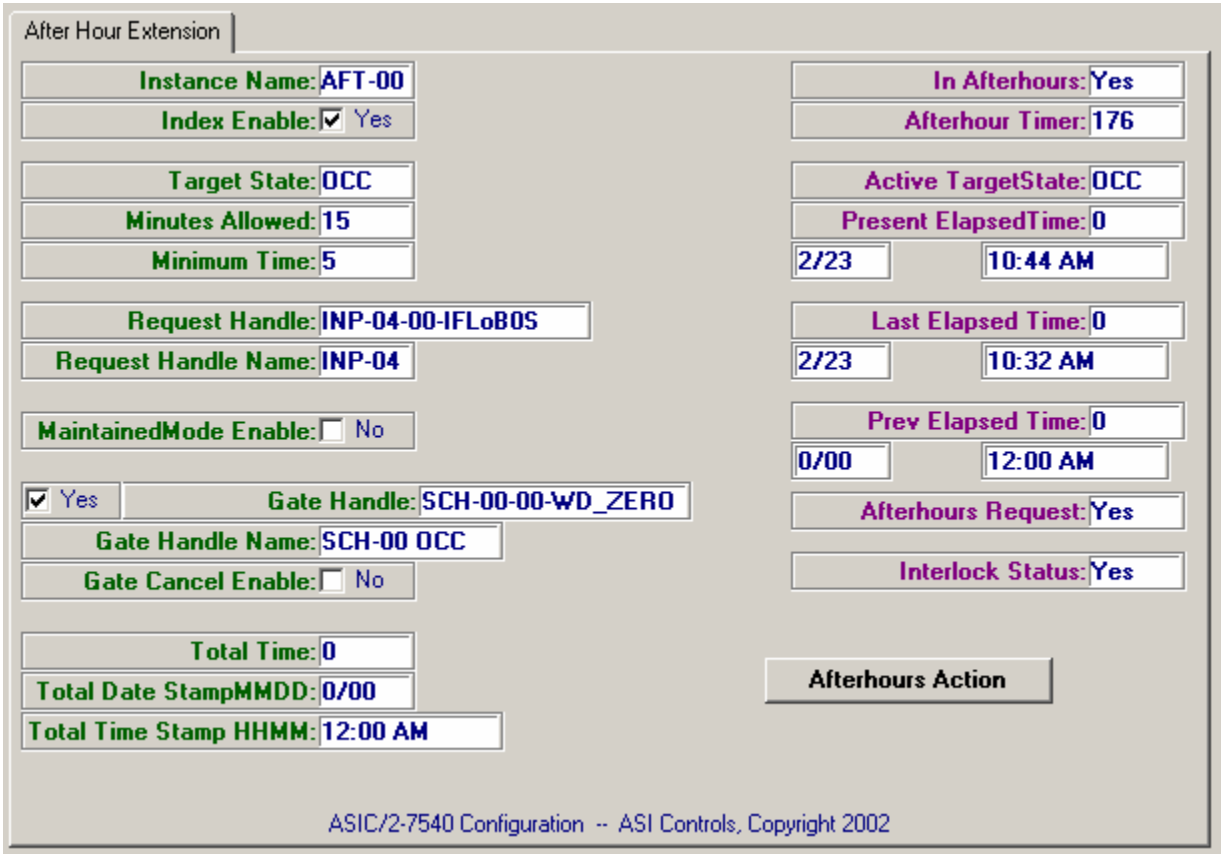
**Operational Monitoring:** Information on the three most previous afterhours sequences is saved in memory. The time and date each period was begun, and the minutes for which each period was in effect are all recorded. Additionally, a counter accumulates the total time spent in afterhours mode since the last time the counter was cleared. The date

and time the counter was last cleared are also recorded. Clearing is accomplished through ASI Setup Software or other building management system.




# Afterhours Operation

Afterhours monitors an input (typically a wall switch or push-button) and, in response to this input, issues an output indicating that an afterhours period has begun. The Afterhours output, Active Target State is typically monitored by the State object. Associated with the output is a Target State which is typically is used to designate the control state which State will override to during an afterhours period. An afterhours period has a configurable maximum time, Afterhours Time Allowed. The Afterhours Total Time is accumulated in non-volatile memory at the end of each afterhours period.



## Afterhours Request

A binary input monitored by Afterhours is pointed to by the Afterhours Request Handle. The input may be connected to either a momentary switch or to a maintained switch which generates an Afterhours Request.

If Maintained Mode Enable is No, the assigned binary input is closed for one second, then Request To Operate is set to "Yes".

Once an Afterhours Request to operate is made, if an afterhours period is not already occurring, then one is begun and In Afterhours is set to "Yes" and the Active Target State is loaded with the value in Target State.

While an afterhours period is in effect, if there is a second closure contact of a momentary-type binary input, then the Afterhours Request is removed. A third momentary closure, restores Afterhours Request, etc.

An afterhours period always remains in effect for at least Afterhours Minimum Time. If an Afterhours Request is not present after Afterhours Minimum Time has elapsed, then the current afterhours period is ended.

Once an afterhours period has ended for any reason, In Afterhours status and Afterhours Request are cleared. A new Afterhours Request to operate must be subsequently be made to begin another afterhours period.

### *Maintained Mode*

If Maintained Mode Enable is Yes, the Afterhours object looks for a maintained contact on the assigned input. If a the binary input remains closed for 1 second, then Request To Operate is set to "Yes".

While an afterhours period is in effect, if the maintained contact is removed on a, then the Afterhours Request is removed. A reinstatement of a maintained contact, restores Afterhours Request, etc.

> Note: For a maintained-type binary input, if the contact is still closed at the end of an afterhours period, then it must be opened and re-closed for at least 1 second to reinstate an Afterhours Request.

## Gate

Operation of the Afterhours object may be tied to a gate: If Gate Enable is set to "Yes" and the value pointed to by the Afterhours Gate Handle is not equal to "True", then Afterhours Requests will not be honored. One application would be to have Afterhours gated in some fashion to a Schedule index: Afterhours operation would then only be allowed during certain hours of the day.

If the gate is "True", then afterhours operation is started normally. Once in afterhours operation, if the gate goes away the operation depends on Gate Cancel Enable. If Gate Cancel Enable is No, then it will continue to run for the Afterhours Time Allowed, or until canceled by another push-button. If Gate Cancel Enable is Yes, then it will continue to run only until the Afterhours Minimum Time is reached after which afterhours operation will be canceled.

## Operational Monitoring

The date and time at which an afterhours request was made is saved in volatile memory for the current and two most recent afterhours periods in the parameters Present, Last, and Previous Start Date and Time. The time which has elapsed for the current afterhours period, as well as the lengths of the two most previous afterhours periods, are stored in Present Elapsed Time, and Last and Previous Elapsed Time. Upon the beginning of any new afterhours period, the previous values are lost, Last values are loaded into Previous, and Present values are loaded into Last.

At the end of every afterhours period, the number of minutes for which the period lasted is accumulated and stored in non-volatile memory in Afterhours Total Time. The

Afterhours Time and Date Stamp are updated to the PC's current date and time only upon a user-clearing of the Accumulated Minutes counter.

# Afterhours Glossary

## Afterhours Parameters

### *Afterhours Action*

The Afterhours Action is used to clear the Afterhours Total Time and Date Stamp: 0 = No Operation; 1 = Clear Afterhours Total Time, Attr-15, and Set Afterhours Time and Date Stamp, Attr-16,17 from internal clock; 2 = Clear Afterhours Total Time, Attr-15, only. (9, X, 11, WORD)

### *Afterhours Minimum Time*

The minimum time that an Afterhours override is active even though the user may terminate an Afterhours request once it has begun by re-pressing the request switch. User-configurable; in minutes. (9,X,14,LO BYTE)

### *Afterhours Request*

If the value pointed to by the Afterhours Request Handle indicates that a request for an Afterhours sequence has been made, then Afterhours Request is set to "Yes". Once the sequence is begun, Afterhours Request is set to "No". "Yes", "No"; user-configurable. (9,X,0,LO BIT 0)

### *Afterhours Time & Date Stamp*

Records the time at which the user last cleared the Afterhours Accumulated Minutes Counter using Afterhours Action = 1 (9,X,16,WORD)

### *Afterhours Time Allowed*

The maximum time that an Afterhours Request is active. User-configurable; in minutes. (9,X,14,HIGH BYTE)

### *Afterhours Timer*

Used to track the elapsed time occurring while in an Afterhours sequence in seconds; not user-changeable. (9,X,1,WORD)

### *Afterhours Total Time*

This counter accumulates the minutes spent in Afterhours mode as they occur. The end of a given Afterhours sequence does not clear this counter. The user may clear this parameter (set it equal to zero) at any time. User-configurable; reads in minutes. (9,X,15,WORD)

### *Gate Cancel Enable*

This parameter determines the action to take place if the Gate goes false during afterhours operation: 0 = continue running to end of Afterhours Time Allowed.\; 1 = cancel afterhours at or after Afterhours Minimum Time. User-configurable. (9,X,0,LO BIT 3)

### *Gate Enable*

If the Gate Enable is Yes, the value pointed to by Gate Handle is examined to determine whether Afterhours operations are to be available. "Yes" = non-zero, "No" = zero; user-configurable. (9,X,0,LO BIT 2)

### *Gate Handle*

Points to the Gate value. Typically, this is tied to the Occupied Schedule, so that Afterhours is in operation only during NOT Occupied times of the day. User-configurable. (9,X,0,20, 2 WORDS)

### *Gate Status*

Indicates the value read from Gate Handle. "True" = non-zero, "False" = zero; not user-changeable. (9,X,0,LO BIT 3)

### *In Afterhours*

Indicates that the Afterhours sequence is active. "Yes", "No";. (9,X,0,LO BIT 1)

### *In Afterhours*

If set to "Yes", if in Afterhours operation. User-configurable; "Yes", "No". (9,X,2,LO BIT 1)

### *Index Enable*

If set to "Yes", then Afterhours instance is enabled for operation. User-configurable; "Yes", "No". (9,X,13,LO BIT 0)

### *Last Elapsed Time*

The length in minutes of the second most recent Afterhours sequence. Not user-changeable. (9,X,5,WORD)

### *Last Start Date*

The date upon which the second most recent Afterhours sequence occurred. Not user-changeable. (9,X,7,WORD)

### *Last Start Time*

The time at which the second most recent Afterhours sequence occurred. Not user-changeable. (9,X,6,WORD)

### *Maintained Mode Enable*

If Maintained Mode is enabled, then afterhours Requests For Operation are triggered and remain in effect only so long as contact closure is maintained on the binary request input to the Afterhours object. If Maintained Mode is not enabled, then momentary mode is used. A contact closure need only be present for 1 second for a Request For Operation to be triggered under momentary mode. "Yes", "No"; user-configurable. (9,X,0,LO BYTE BIT 1)

### *Maintained Mode Status*

"Yes" indicates that maintained-type contact closures are used to trigger afterhours. "No" indicates that momentary-type contact closures are used to trigger afterhours. "Yes", "No"; not user-changeable. (9,X,0,LO BYTE BIT 2)

### *Present Elapsed Time*

Indicates the time the current or the most recent Afterhours period has lasted. In minutes;. (9,X,2,WORD)

### *Present Start Date*

The date upon which the most recent afterhours sequence occurred. If currently in an Afterhours sequence, then this indicates the date at which the sequence began. Not user-changeable. (9,X,4,WORD)

### *Present Start Time*

The time at which the most recent Afterhours sequence occurred. If currently in an Afterhours sequence, then this indicates the time at which the sequence began. Not user-changeable. (9,X,3,WORD)

### *Previous Elapsed Time*

The length in minutes of the third most recent Afterhours sequence. Not user-changeable. (9,X,8,WORD)

### *Previous Start Date & Time*

The date upon which the third most recent Afterhours sequence occurred. Not user-changeable. Date (9,X,10,WORD)Time (9,X,9,WORD)

### *Request Handle*

Points to the external parameter which indicates if Afterhours mode has been requested via a wall sensor or other device in the building. User-configurable. (9,X,18,2 WORDS)

***Target State***

The control state which is used in an Afterhours period: 0 = none; 1 = Unoccupied; 2 = Occupied; 3 = Night Setback;, or 4 = Morning Ready.. User-configurable. (9,X,13,HIGH BYTE)

# Afterhours Properties

The afterhours control block is used to generate an Target State for use by another object. For example, the Afterhours Active Target State can be read by STATE through a full handle and used as an override to force a new value to state.

The value assigned to Target State and State in all SC/1 objects is as follows:

0 = none, don't care,
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

The AFTERHOURS object defines the present values and setup parameters used by the controller to determine the Active Target State based on an Afterhours Request, such as a binary contact closure.

| | |
|---|---|
| Object Name | AFTERHOURS |
| Object Number | = 9 |
| Data Type | = Word |
| Index | = 1 or as allocated |
| Attribute | = 22 (0..21) |
| DYNAMIC Attributes | = 13 (0..12) |
| STATIC Attributes | = 9 (13..21) |

## Afterhours Firmware Revision

**ASIC/2-7540 FW754A Rev 1.0 Forthcoming 2005**
o as in FW740E.

**ASIC/2-7040 FW740C Rev 1.0, Released 01/29/97**

**ASIC/2-7040 FW740D Rev 1.1 Released 25 June 1996**
AFTERHOURS increased to 64 Maximum

**ASIC/2-8040 FW840A Rev 1.0 Released 22 March 1996**

**ASIC/2-7040 FW740A Rev 1.0 03/31/94**

**ASIC/2-7000 FW700A.. Rev 1.0 Released 12/05/91**

**SC/1-9040 FW907C Rev 1.0 Released 12/25/91**
Added Attr-13, LO Bit 3, Gate Cancel Enable

**SC/1-9040 FW907A Rev 1.0 Released 07/25/91**

## Afterhours DYNAMIC Properties

Attr-0 Afterhours Status

Attr-0 LO bit 0 - **Request to Operate**
Indicates the presence of a momentary or maintained input requesting operation.
1 = Afterhours operation requested
0 = No Afterhours request

Attr-0 LO bit 1 - **In Afterhours Status**
Indicates that unit should be in afterhours override.
1 = In Afterhours (Force to Target State)
0 = Not in Afterhours

Attr-0 LO bit 2 - **Maintained Mode Status** (Yes, No)
Shows type of contact
1 = Maintained Contact; 0 = Momentary Contact

Attr-0 LO bit 3 - **Gate Status**
1 = Gate on; 0 = Gate false, The interlock handle can point to an object such as schedule which permits afterhours operation only during specified periods. If the Gate is not enabled the gate status is always true.

Attr-0 LO bit 4 - Spare
Attr-0 LO bit 5 - Spare
Attr-0 LO bit 6 - Spare
Attr-0 LO bit 7 - Reserved

Attr-0 HI BYTE - **Active Target State**
When afterhours override is in effect it is loaded with Afterhours Target State (Attr-13,HI Byte) This byte is examined by State for override.
0 = none, don't care,
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

Attr-1 **Afterhours Timer**
(in seconds)

### *Present Time and Date Stamp*

Update when new request.

Attr-2 **Present Elapsed Time**
Present Afterhours Elapsed Time (in minutes) Updates at the end of the afterhours period.

Attr-3 **Present Start Time**
Present Afterhours Start Time
LO Byte - Present Start Time - Minute (0..59)
HI Byte - Present Start Time - Hour (0..23)

Attr-4 **Present Start Date**
Present Afterhours Start Date
LO Byte - Present Start Date - Day (1..31)
HI Byte - Present Start Date - Month (1..12)

### *Last Time and Date Stamp*

-Update from Present when new request.

Attr-5 **Last Elapsed Time** - minutes.

Attr-6 **Last Start Time**
LO Byte - Last Start Time - Minute (0..59)
HI Byte - Last Start Time - Hour (0..23)

Attr-7 **Last Start Date**
LO Byte - Last Start Date - Day (1..31)
HI Byte - Last Start Date - Month (1..12)

### *Previous Date Stamp*

- Update from Last when new request.

Attr-8 **Previous Elapsed Time** - minutes.

Attr-9 **Previous Start Time**
LO Byte - Previous Start Time - Minute (0..59)
HI Byte - Previous Start Time - Hour (0..23)

Attr-10 **Previous Start Date**
LO Byte - Previous Start Date - Day (1..31)
HI Byte - Previous Start Date - Month (1..12)

### *Action*

Attr-11 **Afterhours Action**
0 = No Operation
1 = Clear Afterhours Total Time, Attr-15, and
Set Afterhours Time and Date Stamp, Attr-16,17 from internal clock
2 = Clear Afterhours Total Time, Attr-15, only.

Attr-12 Spare

## Afterhours STATIC Properties

Attr-13 Afterhours Setup

Attr-13 LO bit 0 - **Index Enable**,
1 = Afterhours feature Enabled

Attr-13 LO bit 1 - **Maintained Mode Enable**
Shows type of contact
1 = Maintained Contact; 0 = Momentary Contact

Attr-13 LO bit 2 - **Gate Enable**
0 = Always Enabled
1 = Allow Afterhours override only if Gate is true. If Gate is false prevent start of afterhours override.

Attr-13 LO bit 3 - **Gate Cancel Enable** (FW 907C..,700A..,740A..)
Action to do if gate is enabled and goes false.
0 = continue running to end of Afterhours Time Allowed.
1 = cancel afterhours at or after Afterhours Minimum Time.

Attr-13 LO bit 4 - Spare
Attr-13 LO bit 5 - Spare
Attr-13 LO bit 6 - Spare
Attr-13 LO bit 7 - Spare

Attr-13 HI Byte - **Target State**
When Afterhours is active the output value will be set to the Target State.
0 = none, don't care,
1 = Unoccupied
2 = Occupied
3 = Night Setback
4 = Morning Ready

Attr-14 Afterhours Times ( minutes)
LO Byte - **Afterhours Minimum Time**
Minimum Length of Time in minutes once Afterhours request is made. [Typical 30 minutes]
HI Byte - **Afterhours Time Allowed**
Maximum Length of Time in minutes once Afterhours request is made [Typical 120 minutes]

### *Accumulated Total*

Attr-15 **Afterhours Total Time**
Accumulated total time in minutes that afterhours has been effect. If accumulated minutes is cleared using Attr-11, Action = 1, the Afterhours Total Time & Date Stamp will be updated from the controller software clock.

Attr-16 **Afterhours Total Time Stamp-** Accumulated Time
LO Byte - Accumulated Minutes Start Time - Minute (0..59)
HI Byte - Accumulated Minutes Start Time - Hour (0..23)

Attr-17 **Afterhours Total Date Stamp**
LO Byte - Accumulated Minutes Start Time - Day (1..31)
HI Byte - Accumulated Minutes Start Time - Month (1..12)

Attr-18,19 **Afterhours Request Handle**
Points at present value of Afterhours Request: for example, Object 5 Input, Index = 0..15, Attr = 0, present value, Select = 01h (FFFF if non zero).

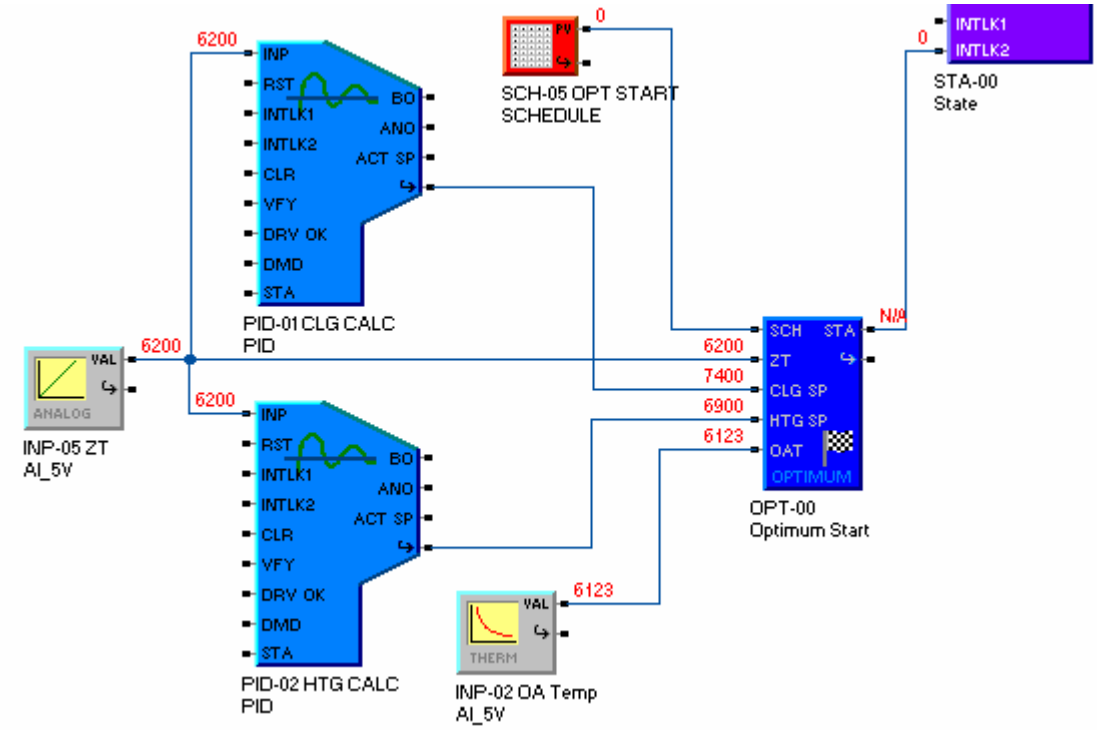
Attr-20,21 **Afterhours Gate Handle**
Points at present value of Gate: for example, Object 4 Schedule, Index = 0..15, Attr = 0, present value, Select = 01h (FFFFh if non zero). Afterhours request not available if gate enabled and zero.

# Object 10 - Optimum Start

## Optimum Start Summary

**Overview:** In temperature control applications, it is desirable to get a zone, or duct return air temperature within a certain temperature range prior to occupants arrival in the morning. The adaptive Optimum Start object is used to delay the start of heating or cooling to the last possible moment so that one can heat or cool a zone to a specified temperature by a specified time. Its purpose is to conserve energy.

**Application:** Typically the Optimum Start Target State is Morning Ready. The Optimum Start Schedule begins hours before the beginning of the Occupied period, and overlaps the Night Setback period.. At the beginning of the optimum start period the Optimum Start Interval is calculated and the Optimum Start Time is determined. The present value of optimum start remains at 0, until the Optimum Start Time is reached. At that time the Optimum Start present value goes to Morning Ready allowing the system to begin heating or cooling.




The Morning Ready period is usually sandwiched between Night Setback and Occupied and is used to warm or cool a building prior to daily occupancy. For Example, The Occupied Schedule begins at 8:00 am. The Night Setback schedule last until 8:00 am. The Optimum Start Schedule could be begin at 6:00 am and end at 8:00 am. If

Optimum Start calculates that the Start Interval should be 75 minutes, then it will keep the system in Night Setback until 6:45 am, 75 minutes before 8:00 am, at which time the present value of Optimum start goes to Morning Ready which can be used to override State. This would allow Morning Ready just enough time to bring building temperature within the Occupied setpoints by 8:00 am.

**Operation:** The Optimum Start object calculates an optimum start time based on either the zone temperature or the outdoor air temperature or both. Once configured and enabled the adaptive learning algorithm can modify the Start Intervals and Temperature Offsets based on actual experience with the building. Separate parameters are maintained for zone temperature and outdoor air temperature optimized start for both heating and cooling.

**Zone temperature optimized start** is typically used in the core of a large building, or in a well insulated or massive building where the time required to reach operating conditions depends primarily on the temperature of the zone at the beginning of the optimum start period.

**Outdoor Air Temperature optimized start** is typically used in perimeter zones of a light weight or uninsulated building where the time required reaching operating conditions depends primarily on the outdoor air temperature at the beginning of the optimum start period.

**Optimum Start Target State:** When it is time to start the system the Optimum Start target state, typically Morning Ready or Occupied is placed in the Present Value of the Optimum Start Object. This can be used to override the State Object to begin operation of the system.

**Optimum Start Schedule:** An index of the Schedule object is used as the Optimum Start schedule. Optimum start is only active when the Optimum Start Schedule is ON. The Optimum Start Schedule designates the earliest time at which Optimum Start may force override to the target state.

**Target Temperature Setpoints:** Optimum Start has handles which point to target cooling and heating zone temperature setpoints. Typically, these are the Occupied Temperature setpoints for the Zone Temperature. If the Zone Temperature is above the Cooling Target SP, then it is in the Cooling Mode. If the Zone Temperature is below the Heating Target SP, then it is in the Heating Mode.

**Balance Temperatures:** Optimum Start also has Heating and Cooling Balance Temperatures. Heating is usually not required if the Outdoor Air Temperature is above the Heating Balance Temperature because of internal heat generation in the building. Cooling is usually not required if the Outdoor Air Temperature is below the Cooling Balance Temperature because of heat loss to the outdoors. .

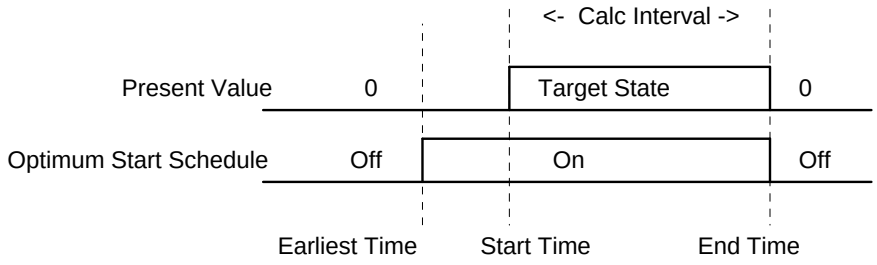
**Optimum Start-Time Calculation:** The Optimum Start Interval is the amount of time the system needs to run to reach the Target Temperature Setpoints. The Optimum Start Interval is the greater of either the sum of the calculated Zone and OAT Start Intervals or the Minimum Start Interval.

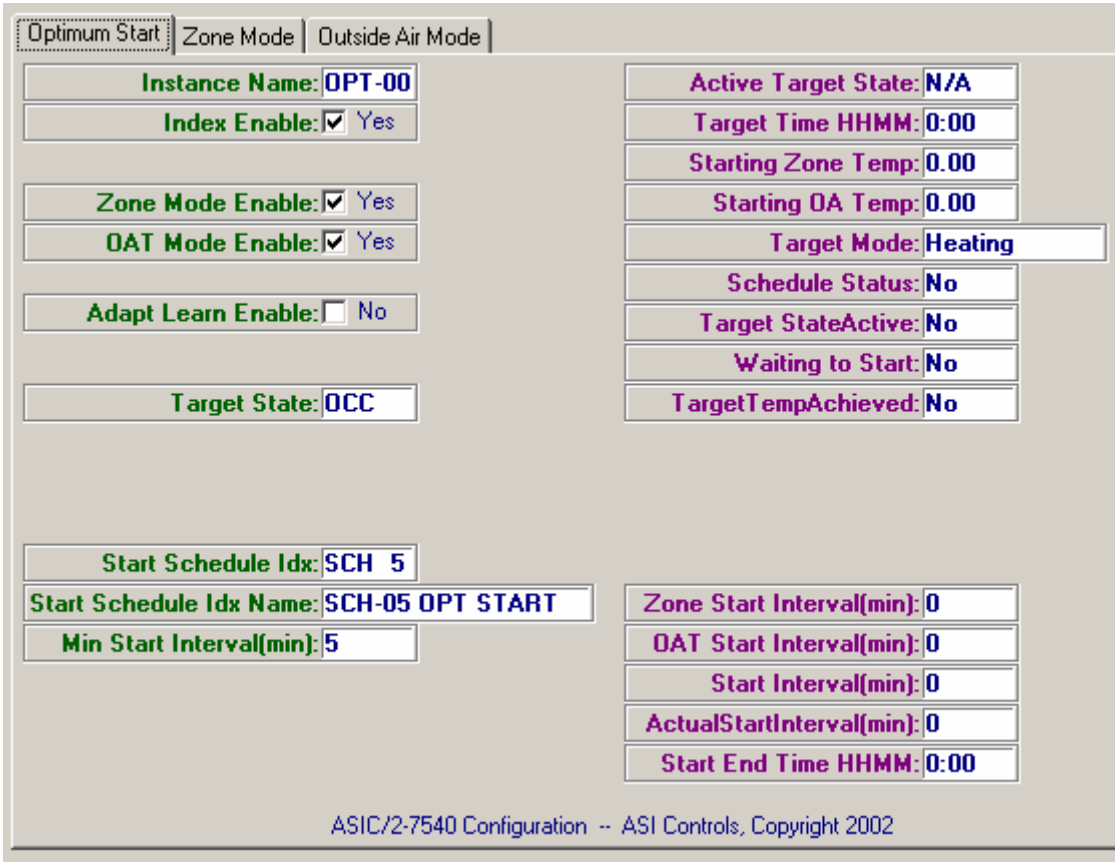
The Zone Start interval is proportional to the Heating or Cooling Zone Start Interval and the difference between Zone Temperate and the Target Temperature. The OAT Start Interval is proportional to the Heating or Cooling OAT Start Interval and the difference between OAT Temperature and the Balance Temperature. The Minimum Start Interval is adjustable by the user.

**Adaptive Learning :** The optimum start-time on time and temperature information is saved once the Target Zone Temperature Setpoint has been reached. The adaptive learning algorithm fine-tunes the configuration parameters so that optimum start-time becomes progressively more accurate.

# Optimum Start Operation

Optimum Start is used as an interlock to STATE or other object. The optimum start routine calculates an optimum time to begin operation. When the Optimum Start Schedule period begins the optimum start routine is used the outdoor temperature, initial zone temperature, are used to predict the Optimum Start Interval, and the Optimum Start Target Time. When the Optimum Start Target Time is reached it forces Attr-0 Optimum Start Override State to the Optimum Start Target State. It then monitors the zone temperature and the Actual Start Interval Today required to reach the desired temperature.




## Schedule Assignment

With FW740A and later, the Optimum Start Schedule Index is used to assign the schedule. An Optimum Start Schedule Index (0..255) and Optimum Start Target State (MRDY, OCC) are assigned. When the optimum start schedule ON time is matched, the control block examines the outdoor temperature, the zone temperature, and Target Heating and Cooling Setpoints and determines the Optimum Start Interval, the number of minutes before the Optimum Start End Time period to force the Optimum Start Present Value to the Optimum Start Target State. Another object, such as STATE, can then use this Present Value as an Override State.

The Optimum Start routine examines the Optimum Start Schedule for the current day to determine the Optimum Start ON and OFF times. The Optimum Start ON time is the earliest time that the routine can force the state to the Target State.

Optimum Start is only active while the Optimum Start schedule is ON. When the Optimum Start Schedule is OFF, then the Optimum Start Present Value is returned to zero.

## Zone Temperature Calculation

### *Zone Temperature Optimization*

The current Zone Temperature is compared with the Target Heating or Cooling Zone Setpoints which are identified by the Target Heating or Cooling Zone Setpoints Handles.

A predicted Zone Start Interval is calculated once, based on the conditions occurring when going into optimum start.

### *OAT Optimization*

The current Outdoor Air Temperature is compared with the Heating and Cooling Balance Temperatures. A predicted OAT Start Interval is calculated, based on the conditions occurring when going into optimum start.

### *Target Time*

The OAT Start Interval and the Zone Start Interval are added to give the Optimum Start Interval. If the Optimum Start Interval is less than the Minimum Start Interval, then the Optimum Start Interval is set equal to the Minimum Start Interval.

$$[\text{Optimum Start Interval}] = [\text{Zone Start Interval}] + [\text{OAT Start Interval}]$$

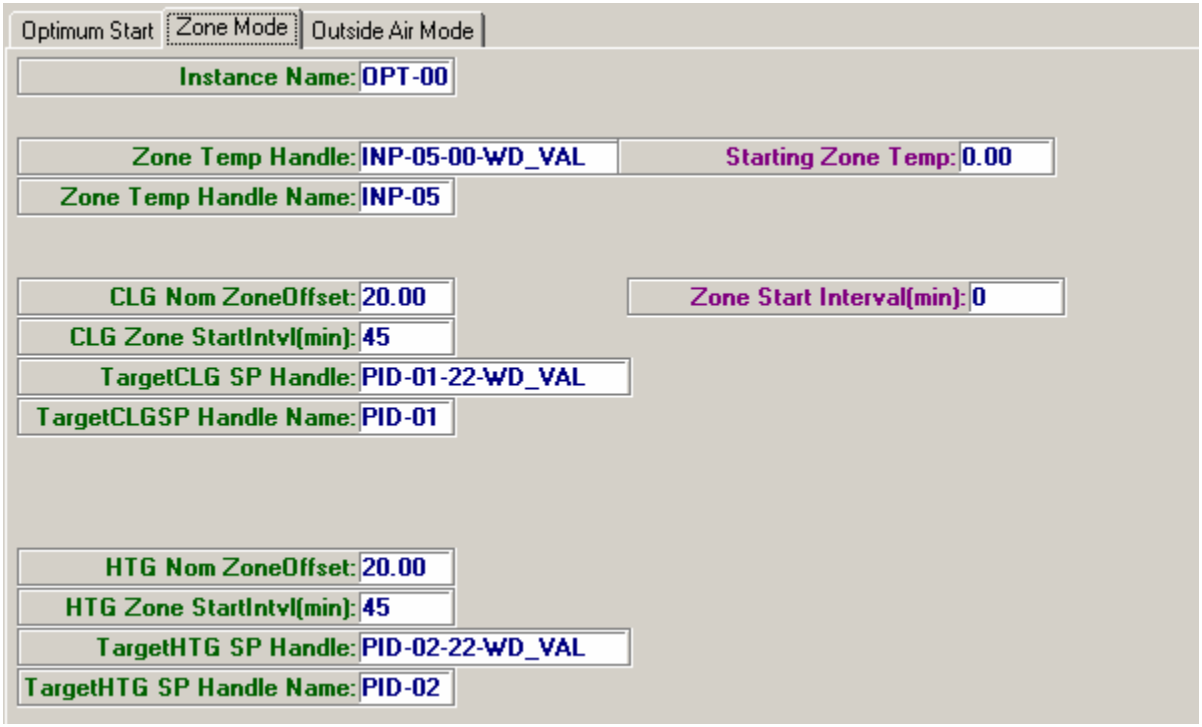
$$\text{If } [\text{Optimum Start Interval}] < [\text{Minimum Interval}],$$

$$\text{then } [\text{Optimum Start Interval}] = [\text{Minimum Interval}]$$

The Optimum Start Interval is subtracted from the Optimum Start End Time to give Optimum Start Time. The current time is examined and compared with the Optimum Start Target Time once each minute.

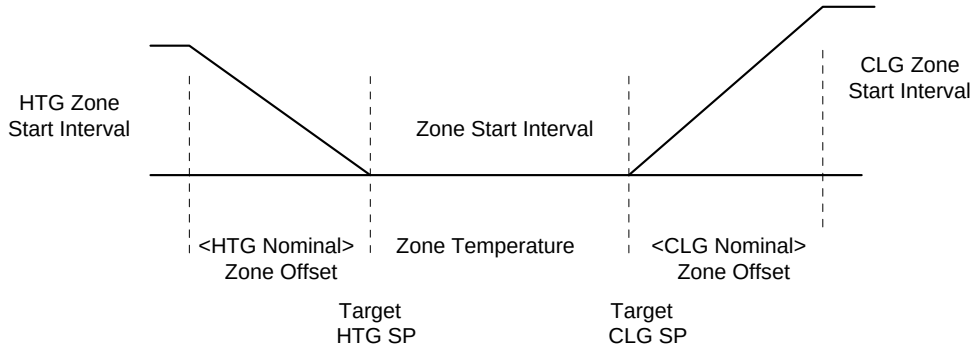
- If the current time is less than the Optimum Start Time, then the Optimum Start Override State is zero.
- If the current time is equal to or greater than the Optimum Start Time, then the Optimum Start is in the Override State and the Present Value is forced to the Target State.

In the Override State the Start Interval Today timer records the length of time before the zone temperature reaches the Target Heating or Cooling Zone Setpoint. The Start Interval Today timer continues to run until the zone temperature conditions are satisfied even after the end of the optimum start period.




## Zone Start Interval

The Zone Start Interval calculation is based on the Zone Offset, the offset of the zone temperature from the target (OCC or MRDY) heating or cooling setpoint  Note Temperatures are in units of 0.01 F.




### *Zone CLG Offset*

Zone CLG Offset = Zone Temp - Target CLG SP

If Zone Temp < Target CLG SP, or the  Zone Mode not enabled
then the Zone CLG Offset = 0

### *Zone HTG Offset*

Zone HTG Offset = Target HTG SP - Zone Temp

If Zone Temp > Target HTG SP, or the  Zone Mode not enabled
then the Zone HTG Offset = 0

### *Heating Mode*

If the zone temperature is below the target heating setpoint, then an optimum heating ready interval is calculated.  If the HTG Zone offset is greater than or equal to the Nominal HTG Zone Offset [Default: 20 F], then the Zone Start Interval is equal to the HTG Zone Start Interval [Default: 120 m]

Zone Start Interval
= [HTG Zone Start Interval] *[HTG Zone Offset/HTG Nominal Zone Offset].

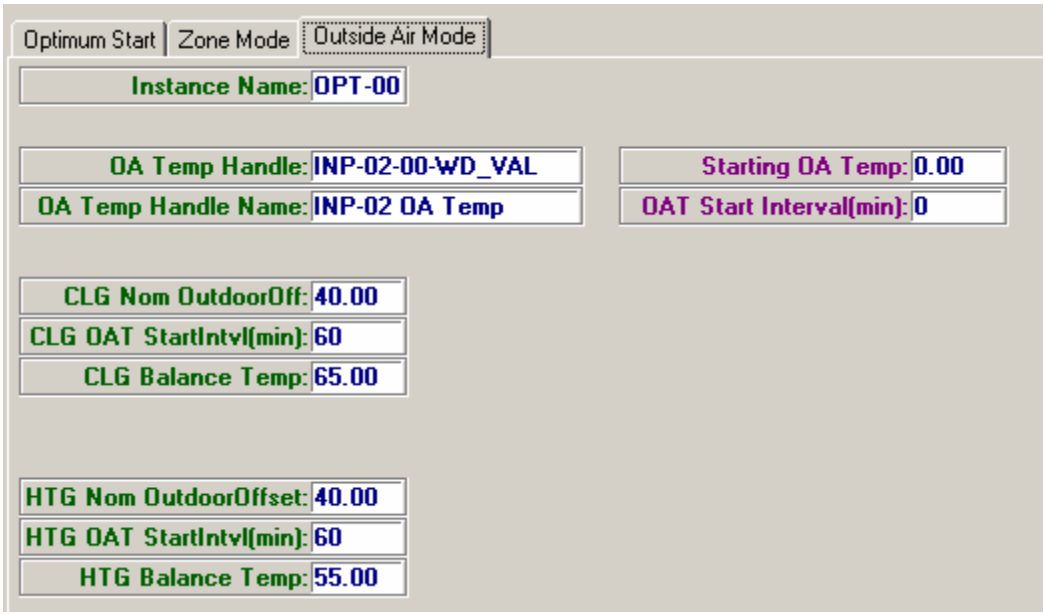
### *Deadband Mode*

If the zone temperature is below the Target Cooling Setpoint, but above the Target Heating Setpoint, then the controller is in Deadband in the target state and the HTG Zone Interval is zero.

### *Cooling Mode*

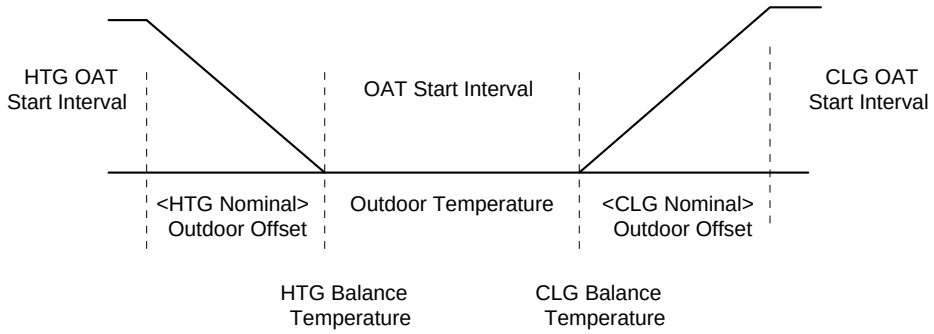
If the zone temperature is above the Target Cooling setpoint, then an optimum cooling Zone Start Interval is calculated. If the Cooling Zone Offset is greater than or equal to the CLG Nominal Zone Offset [Default: 20 F], then the Zone Start Interval is equal to the CLG Zone Interval [Default: 120 m].

Zone Start Interval
= [CLG Zone Start Interval] *[CLG Zone Offset/CLG Nominal Zone Offset].




## OAT Start Interval

The OAT Start Interval calculation is based on the Outdoor Offset, the offset of the outdoor temperature from the Heating or Cooling Balance Temperatures. The CLG Balance Temperate is the outdoor temperature at which Cooling will probably not be required and is typically 65 F. The HTG Balance Temperature is the outdoor temperature at which Heating will probably not be required and is typically 55 F. Note Temperatures are in units of 0.01 F.




### *Outdoor CLG Offset*

CLG OAT Offset = Outdoor Temp - CLG Balance Temp

If Outdoor Temp < CLG Balance Temp, or the OAT Mode not enabled
then the CLG OAT Offset = 0

### *Outdoor HTG Offset*

HTG OAT Offset = HTG Balance Temp - Outdoor Temp

If Outdoor Temp > HTG Balance Temp, or the OAT Mode not enabled
then the HTG OAT Offset = 0

### *Heating Mode*

If the zone temperature is below the target heating setpoint, then an OAT Start Interval is calculated in proportion to the HTG OAT Offset. If the Heating OAT Offset is equal to the Nominal Outdoor Heating Offset [Typical: 50 F]], then the OAT Start Interval is equal to the HTG OAT Start Interval [Typical: 120 m].

OAT Start Interval
= [HTG OAT Start Interval] *[HTG OAT Offset/HTG Nominal OAT Offset].

### *Deadband Mode*

If the zone temperature is below the Target Cooling Setpoint, but above the Target Heating Setpoint, then the controller is in Deadband in the target state and the OAT Start Interval is zero. The Optimum Start Interval is equal to the Minimum Start Interval.

### *Cooling Mode*

If the zone temperature is above the target cooling setpoint, then an OAT Start Interval is calculated in proportion to the CLG OAT Offset. If the CLG OAT Offset is greater than or equal to the Cooling Nominal OAT Offset [Typical: 50 F]], then the OAT Start Interval is equal to the CLG OAT Start Interval [Typical: 120 m].

OAT Start Interval
= [CLG OAT Start Interval] *[CLG OAT Offset/CLG Nominal OAT Offset].

## Operational Data

The following data is kept after the end of the optimum start period:

Optimum Start End Time
Starting Zone Temperature
Starting Outdoor Temperature
Calculated Start Interval Today
Actual Start Interval Today

This data can be periodically retrieved by the front end software and plotted. This data can then be used to determine: If Adaptive Learning is Enabled this data can be used to modify the following parameters:

| | |
|---|---|
| Cooling Nominal Zone Offset | [Typical, 10 deg F ] |
| Cooling Nominal OAT Offset | [Typical, 20 deg F ] |
| Cooling Zone Start Interval | [Typical, 120 min] |
| Cooling OAT Start Interval | [Typical, 120 min] |
| Heating Nominal Zone Offset | [Typical, 10 deg F ] |
| Heating Nominal OAT Offset | [Typical, 20 deg F ] |
| Heating Zone Start Interval. | [Typical, 120 min] |
| Heating OAT Start Interval. | [Typical, 120 min] |

The following parameters are set by the operator.

| | |
|---|---|
| Cooling Balance Temperature | [Typical, 65 deg F ] |
| Heating Balance Temperature | [Typical, 55 deg F ] |
| Minimum Start Interval | [Typical, 120 min] |

## Adaptive Optimal Start

Adaptive Optimal Start is achieved by changing key parameters when the predicted start time differs from the actual start time. Learning must be enabled for adaptive control to be used.


- If Zone Mode is Enabled, the high and low temperature limits for zone temperature may be modified.
- If Zone Mode is Enabled, the CLG/HTG Zone Start Interval may be modified based on the actual time to achieve setpoint.
- If OAT Mode is Enabled, the high and low temperature limits for outdoor air temperature may be modified.
- If OAT Mode is Enabled, the CLG/HTG OAT Start Interval may be modified based on the actual time to achieve setpoint.
- If both the Zone Mode is Enabled and the OAT Zone Mode is Enabled, either the CLG/HTG Zone Start Interval or the CLG/HTG OAT Start Interval may be modified.

The parameter is modified when the zone has achieved temperature setpoint. Only one parameter is modified at any one time. The start intervals are not modified by less than **5** minutes or more than **30** minutes at any one time.

### *Zone Temperature Limits*

If the Zone Mode of optimized start is enabled and if at the beginning of the optimum start period the zone temperature is outside the high and low zone temperature extremes by 2.0 degrees, then the CLG or HTG Nominal Zone Offset is increased. The corresponding Nominal Zone Interval is increased to maintain the same slope.

If the Zone Mode of optimized start is enabled, if learning is enabled, and if the Zone Temperature at the start of the optimum start period is greater than the CLG Target SP plus the CLG Nominal Zone Offset by 2.00 degrees, then a new CLG Nominal Zone Offset and Interval is calculated and saved in EEPROM.

If the Zone Mode of optimized start is enabled, if learning is enabled, and if the Zone Temperature at the start of the optimum start period is less than the HTG Target SP minus the HTG Nominal Zone Offset, by 2.00 degrees, then a new HTG Nominal Zone Offset and Interval is calculated and saved in EEPROM.

### *Outdoor Air Temperature Limits*

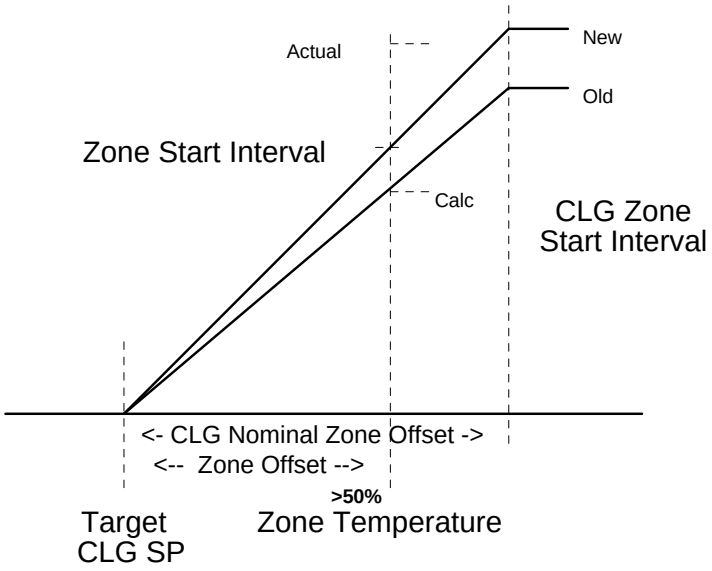
If OAT Mode of optimized start is enabled and if at the beginning of the optimum start period the outdoor air temperature is outside the high and low OA temperature extremes by 2.0 degrees, then the CLG or HTG Nominal OAT Offset is increased. The corresponding Nominal OAT Interval is increased to maintain the same slope.

If OAT Mode of optimized start is enabled, if learning is enabled, and if the OA Temperature at the start of the optimum start period is greater than the CLG Balance Temperature plus the CLG Nominal OA Offset by 2.00 degrees, then a new CLG Nominal OA Offset and Interval is calculated and saved in EEPROM.

If OA Temperature optimized start is enabled, and if learning is enabled, then if the OA Temperature at the start of the optimum start period is less than the HTG Balance Temperature minus the HTG Nominal OA Offset by 2.00 degrees, then a new HTG Nominal OA Offset and Interval is calculated and saved in EEPROM.

### *Zone Start Intervals*

No modification of the HTG or CLG Zone Start Interval is done unless Learning is enabled, the Zone Mode is enabled, and the Zone offset is greater than 50 % of the Nominal Offset., and if OAT Mode is enabled the fractional Zone offset is larger than the fractional OAT Offset. The CLG Zone Offset or Start Interval is modified only if in the Cooling Mode.




For Example in the Cooling Mode:

$$\text{CLG Start Interval is modified if}$$

$$\left[\frac{\text{CLG Zone Offset}}{\text{CLG Nominal Zone Offset}}\right] > 50\ \%$$

$$\text{and if OAT Mode Enabled}$$

$$\left[\frac{\text{CLG Zone Offset}}{\text{CLG Nominal Zone Offset}}\right] > \left[\frac{\text{CLG OAT Offset}}{\text{CLG Nominal OAT Offset}}\right]$$

Similar requirements are place on the Heating Mode.

If these conditions are satisfied a New CLG Zone Start Interval is calculated. It is assumed that all of change is attributed to the Zone Start Interval.

$$\left[\text{New CLG Zone Start Interval}\right] = \left[\text{Old CLG Zone Start Interval}\right] + \frac{\left[\text{Actual Start Interval - Calc Start Interval}\right]}{4} * \left[\frac{\text{CLG Nominal Zone Offset}}{\text{CLG Zone Offset}}\right]$$

The New CLG Zone Start Interval is saved only if the change is greater than 5 minutes.

### *OAT Start Intervals*

No modification of the HTG or CLG OAT Start Interval is done unless Learning is enabled, the OAT Mode is enabled, and the OAT offset is greater than 50 % of the Nominal Offset, and if Zone Mode is enabled the fractional OAT offset is larger than the fractional Zone Offset. The CLG OAT Offset or Start Interval is modified only if in the Cooling Mode.

If the fractional OAT Offset is greater than the fractional Zone Offset then it is assumed that all of the change is attributed to the OAT Interval.

For Example in the Cooling Mode:

$$\text{CLG OAT Start Interval is modified if}$$

$$\left[\frac{\text{CLG OAT Offset}}{\text{CLG Nominal OAT Offset}}\right] > 50\ \%$$

$$\text{and if Zone Mode Enabled}$$

$$\left[\frac{\text{CLG Zone Offset}}{\text{CLG Nominal Zone Offset}}\right] < \left[\frac{\text{CLG OAT Offset}}{\text{CLG Nominal OAT Offset}}\right]$$

If these conditions are satisfied a New CLG OAT Start Interval is calculated. It is assumed that all of  change is attributed to the OAT Start Interval.

$$[\text{New CLG OAT Start Interval}] = [\text{Old CLG OAT Start Interval}] + \frac{[\text{Actual Start Interval} - \text{Calc Start Interval}]}{4} * \left[\frac{\text{CLG Nominal OAT Offset}}{\text{CLG OAT Offset}}\right]$$

The New CLG OAT Start Interval is saved only if the change is greater than 5 minutes.

# Optimum Start Glossary

## Optimum Start Parameters

### *Actual Start Interval*

The actual amount of time it took to achieve the Target Cooling or Heating Setpoint. The interval is measured from the point at which Optimum Start initiated the Target State.  Not user-changeable; in minutes.  (10,X,8,WORD)

### *Adaptive Learning Enable*

Enables Optimum Start for updating parameters based on actual Start Intervals.  "Yes", "No"; user-configurable.  (10,X,12,LOW BIT 6)FW740A..

### *Cooling Balance Temperature*

Used in calculating the Optimum Start Interval.  This is a baseline value for Outdoor Air Temperature used in calculating the Cooling Nominal Outdoor Offset.  See the Object Definition for details. User-configurable; in degrees F.  (10,X,20,WORD)

### *Cooling Nominal Outdoor Offset*

Used in calculating the Optimum Start Interval.  Equal to the Starting Outdoor Air Temperature minus the Cooling Balance Temperature.  See the Object Definition for details.  Not user-changeable; in degrees F.  (10,X,21,WORD)

### *Cooling Nominal Zone Offset*

This is a baseline value for zone temperature variation from target setpoint used in calculating the Optimum Start Interval.  See the Object Definition for details.  User-configurable; in degrees F.  (10,X,22,WORD)

### *Cooling OAT Start Interval*

The baseline time used in calculating the OAT Start Interval in the Cooling Mode.  . User-configurable; in minutes.  (10,X,24,WORD)FW740A..

### *Cooling Zone Start Interval*

The baseline time used in calculating the Zone Start Interval in the Cooling Mode.  . User-configurable; in minutes.  (10,X,23,WORD)FW740A..

### *Heating Balance Temperature*

Used in calculating the Optimum Start Interval.  For Heating sequences, this is a base value for Outdoor Air Temperature used in calculating the Heating Nominal Outdoor Offset.  See the Object Definition for details. User-configurable; in degrees F.  (10,X,15,WORD)

### *Heating Nominal Outdoor Offset*

Used in calculating the Optimum Start Interval.  Equal to the Starting Outdoor Air Temperature minus the Heating Balance Temperature.  See the Object Definition for details.  Not user-changeable; in degrees F.  (10,X,16,WORD)

### *Heating Nominal Zone Offset*

This is a baseline value for zone temperature variation from target setpoint used in calculating the Optimum Start Interval.  See the Object Definition for details.  User-configurable; in degrees F.  (10,X,17,WORD)

### *Heating OAT Start Interval*

The baseline time used in calculating the OAT Start Interval in the Heating Mode. . User-configurable; in minutes. (10,X,19,WORD)

### *Heating Zone Start Interval*

The baseline time used in calculating the Zone Start Interval in the Heating Mode. . User-configurable; in minutes. (10,X,18,WORD)

### *Index Enable*

Enables index of the Optimum Start object for operation. "Yes", "No"; user-configurable. (10,X,12,LOW BIT 7)

### *Minimum Start Interval*

If the Optimum Start Interval calculated via algorithm is below this value, then it is reset to this value. User-configurable; in minutes. (10,X,13,WORD)

### *OAT Mode Enable*

Enables Optimum Start for calculating optimum start time based on Outdoor Air Temperature. "Yes", "No"; user-configurable. (10,X,12,LOW BIT 5) FW740A..

### *OAT Start Interval*

The calculated interval of time before the Optimum Start Schedule's off-time based on the offset of the Outside Air Temperature from the Balance Temperature. Not user-changeable; in minutes. (10,X,11,WORD). FW740A..

### *Optimum Start Action*

Writing the listed value to this parameter (10,X,4,WORD) causes the corresponding action to occur. No actions have been defined for this object.

### *Optimum Start End Time*

Designates the time at which the most recent optimum start period ended, as designated in the Optimum Start Schedule. (10,X,9,WORD)

### *Optimum Start Interval*

The calculated interval of time before the Optimum Start Schedule's off-time at which the Target State should be implemented. It is the sum of the Minimum, Zone, and OAT Start Intervals. In minutes. (10,X,7,WORD).

### *Optimum Start Override State*

see Present Value (10,X,0,WORD)

### *Optimum Start Schedule Status*

Designates whether the Optimum Start Schedule is currently in an on-period or in an off-period. Not user-changeable; "Yes", "No". (10,X,2,LOW BIT 6)

### *Optimum Start Schedule Assign*

Designates which index of the Schedule object that Optimum Start is to use for its on-time/off-time schedule 1 ..15 designates Schedule index 0..14, 0 designates not assigned. User-configurable; integer. (10,X,12,LOLSNBL)( FW700A..I, FW907A..) Obsolete.

### *Optimum Start Schedule Index*

Designates the Schedule object index (0..255) that Optimum Start is to use for its on-time/off-time schedule User-configurable; integer. (10,X,14,LOW BYTE )( FW740A..)

### *Optimum Start Target State*

The control state which an optimum start sequence activates to achieve the Target Cooling or Heating Setpoint. User-configurable; one of "Occupied", "Unoccupied", "Morning Ready", or "Night Setback". (10,X,12,LOW BITS 4-6)

### *Optimum Start Target Time*

The calculated time at which Optimum Start will activate the Target State. Equal to the Optimum Start Schedule's designated off-time minus the calculated Start Interval. ; (10,X,1,WORD)

### *Outdoor Air Temperature Handle*

Points to the external parameter from which the Outdoor Air Temperature is to be obtained. Typically points to an Input index. User-configurable. (10,X,27,2 WORDS)

### *Present Value*

Indicates the state which this Optimum Start index currently dictates should be in effect. Set to Target State when Optimum Start Target Time is arrived at. Not user-changeable; "Occupied", "Unoccupied", "Morning Ready", "Night Setback". (10,X,0,WORD)

### *Starting Outdoor Air Temperature*

Equal to the value of the Outdoor Air Temperature at the initiation of the Target State. Not user-changeable; in degrees F. (10,X,6,WORD)

### *Starting Zone Temperature*

Equal to the value of the Zone Temperature at the initiation of the Target State. Not user-changeable; in degrees F. (10,X,5,WORD)

### *Target Cooling Setpoint Handle*

Points to the external parameter which contains the Target Cooling Setpoint. User-configurable. (10,X,29,2 WORDS)

### *Target Heating Setpoint Handle*

Points to the external parameter which contains the Target Heating Setpoint. User-configurable. (10,X,31,2 WORDS)

### *Target Mode*

Indicates whether a cool-down sequence or a warm-up sequence is to be used to move the zone temperature to the target setpoint. 1= "Cool-down", 0 = "Warm-up"; not user-changeable. (10,X,2,LOW BIT 5)

### *Target State Activated*

Indicates whether the Target State has been initiated. "Yes", "No"; not user-changeable. (10,X,2,LOW BIT 3)

### *Target Temperature Achieved*

Indicates that the zone temperature has crossed over the Target Cooling or Heating Setpoint. Not user-changeable; "Yes", "No". (10,X,2,LOW BIT 4)

### *Waiting to Start*

Will be equal to "Yes" whenever the Optimum Start Schedule is on, but that the Target State has not been activated. Not user-changeable; "Yes", "No". (10,X,2,LOW BIT 0)

### *Zone Start Interval*

The calculated interval of time before the Optimum Start Schedule's off-time based on the offset of the Zone Temperature from the Target Temperature Setpoint. Not user-changeable; in minutes. (10,X,10,WORD).FW740A..

### *Zone Temperature Handle*

Points to the external parameter from which the zone temperature value is to be obtained. User-configurable. (10,X,25,2 WORDS)

### *Zone Mode Enable*

Enables Optimum Start for calculating optimum start time based on Zone Temperature. "Yes", "No"; user-configurable. (10,X,12,LOW BIT 4).FW740A..

# Optimum Start Properties

The OPTIMUM START object defines the present values and setup parameters used by the controller to determine the present control state which is used by different control blocks.

| | |
|---|---|
| Object Name | OPTIMUM START |
| Object Number | = 10 |
| Data Type | = Word |
| Index | = 1 or as allocated |
| Attributes | = 33 (0..32) |
| DYNAMIC Attributes | = 12 (0..11) |
| STATIC Attributes | = 21 (12..32) |

The optimum start routine monitors the zone temperature and the elapsed time required to reach the desired temperature. The outdoor temperature, initial zone temperature, the predicted optimum start interval, and the actual optimum start ready interval, is logged for each device using optimum start.

Optimum Start is used as an interlock to STATE. The present value of Optimum Start contains the target state for the override.

0 = Interlock Inactive
1 = Override to Unoccupied
2 = Override to Occupied
3 = Override to Night Setback
4 = Override to Morning Ready

The State object contains a full handle which can be used to point at this present value. If a value other than zero is found, and the Optimum Start is enabled in State, and Afterhours override is not active, then state will go to the value specified by Optimum start.

## Optimum Start Firmware Revision

**ASIC/2-7540 FW754A Rev 1.0 Forthcoming 2005**
o as in FW740E.

**ASIC/2-7040 FW740C Rev 1.0, Released 01/29/97**

**ASIC/2-8040 FW840A Rev 1.0 Released 22 March 1996**

**ASIC/2-7040 FW740A Rev 1.1 27 May 94**
o Object 10 Optimum Start has been fixed. It now correctly calculates the Zone and Start Intervals. It also adjusts the Intervals as needed when the Zone SP is reached.

**ASIC/2-7040 FW740A Rev 1.0 (03/31/94)**
This version does not work properly.
Separate Zone and OA Temp Calculations
Add Zone and OA Mode Enables
Add Adaptive Learning Enable
Optimum Start Schedule Assignment changed to Optimum Start Schedule Index

**ASIC/2-7000 FW700A Rev 1.0 Released 12/05/91**

**SC/1-9040 FW907A Rev 1.0 Released 07/25/91**

## Optimum Start DYNAMIC Properties

Attr-0 **Present Value**
Used for Optimum Start Override State is non-zero only during state override. Normally the State Interlock 2 Handle will look at this value.

Attr-1 **Optimum Start Target Time** - Time Stamp
LO Byte - Minute (0..59)
HI Byte - Hour (0..23)

Attr-2 Optimum Start Status

LO bit 0 - **Waiting To Start**
Set when Optimum Start Schedule is On but Target Time has not yet been reached.

LO bit 1 - Spare

LO bit 2 - Internal Use Only

LO bit 3 - **Target State Activated**
Set when Optimum Start Schedule is On and it is time to start. The Actual Start Interval timer is started. Target State Activated and the Optimum Start Target State is placed in Optimum Start Override State and remains until end of Optimum Start Schedule.

LO bit 4 - **Target Temp Achieved**
Set when Target State Activated and the Zone Temperature has reached the Target Setpoint. The Actual Start Interval timer is stopped.

LO bit 5 - **Target Mode**
1 = Cool-down, 0 = Warm-up

LO bit 6 - **Optimum Start Schedule Status**
1 = Schedule ON; 0 = Schedule OFF

LO bit 7 - Spare

HI Byte - Spare.

Attr-3 Spare

Attr-4 Action (None Defined)
0 = No Operation

### *Optimum Start Today*

Attr-5 **Starting Zone Temperature**
Note: temperatures in units of 0.01 F

Attr-6 **Starting Outdoor Temperature**
Note: temperatures in units of 0.01 F

Attr-7 **Calculated Start Interval Today**
This value is retained until the next calculation of new interval on the next day.

Attr-8 **Actual Start Interval Today**
This timer is started when the target State Activated is set, and runs until Target Temperature Achieved is Set. This timer is retained until the next day.

Attr-9- **Optimum Start End Time**
LO Byte - Minute Attr-0..59)
HI Byte - Hour (0..23)

Attr-10 **Zone Start Interval** (New!FW740)

Attr-11 **OAT Start Interval** (New!FW740)

## Optimum Start STATIC Properties

Attr-12 Optimum Start Setup

Attr-12 LOLSNBL (bits 0..3) - **Optimum Start Schedule Assign** (FW700A...)
Assigns the Schedule to be used to determine optimum start time.
1..15 = Schedule index 0..14 assigned
0 means no schedule has been assigned.

The Schedule Assignment is changed to Schedule Index and moved to Attr-14 .(FW740A.., FW840A)

Attr-12 LO bit 4 - **Zone Mode Enable**
(New! FW740A..,FW840A)
Enables Optimum Start to examine Zone Temperature to determine optimum start time. One or both may be enabled.

Attr-12 LO bit 5 - **OAT Mode Enable**
Enables Optimum Start to examine OAT Temperature to determine optimum start time. One or both may be enabled
(New! FW740A..)

Attr-12 LO bit 6 - **Adaptive Learning Enable**
(New! FW740A..)

Attr-12 LO bit 7 - **Index Enable**
1 = Enable Optimum Start

Attr-12 HI BYTE - **Optimum Start Target State**
This indicates which state to override to during optimum start period.

Attr-13 **Minimum Start Interval**
for HTG or CLG [Typical, 20 min]

Attr-14
LO Byte **Optimum Start Schedule Index** (FW740A...)
Not used if Index is not enabled.
HI Byte Spare

### *Heating Parameters*

Attr-15 **Heating Balance Temperature**
[Typical, 55 F]

Attr-16 **Heating Nominal Outdoor Offset**
[Typical, 40 F]

Attr-17 **Heating Nominal Zone Offset**
[Typical, 20 F]

Attr-18 **Heating Zone Start Interval**(Redefined FW740A..)
[Typical, 120 min]

Attr-19 **Heating OAT Start Interval** (New FW740A..)
[Typical, 120 min]

### *Cooling Parameters*

Attr-20 **Cooling Balance Temperature**
[Typical, 65 F]

Attr-21 **Cooling Nominal Outdoor Offset**
[Typical, 40 F]

Attr-22 **Cooling Nominal Zone Offset**
[Typical, 20 F]

Attr-23 **Cooling Zone Start Interval**(Redefined FW740A..)
[Typical, 120 min]

Attr-24 **Cooling OAT Start Interval**(New FW740A..)
[Typical, 120 min]

### *Input Handles*

Attr-25,26 **Zone Temperature Handle**

This points to the Zone Temperature, for example generated by the 5-INPUT, Index = 0, Attr-0 Present Value.

Attr-27,28 **Outdoor Air Temperature Handle**

This points to the Outdoor Air Temperature, for example generated by the 5-INPUT, Index = 1, Attr-0 Present Value.

Attr-29,30 **Target Cooling Setpoint Handle**

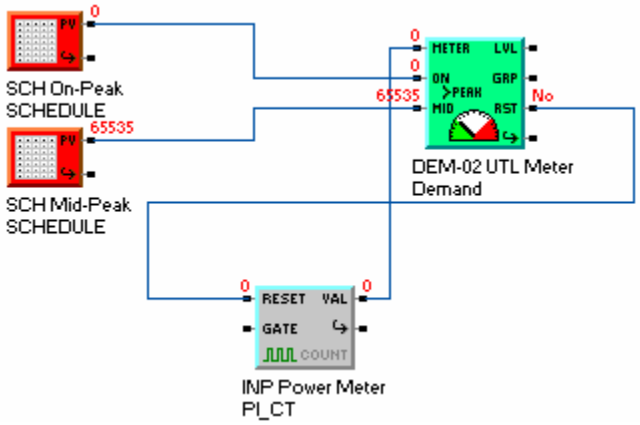
This points to the Target Cooling Setpoint, for example generated by the 18-PID, Index = 0, Attr-22, Control OCC SP.

Attr-31,32 **Target Heating Setpoint Handle**

This points to the Target Heating Setpoint, for example generated by the 18-PID, Index = 1, Attr-22, Control OCC SP.

# Object 11 - Demand Manager

## Demand Manager Summary




**Overview:** The Demand Manager object tracks the demand for electricity of the building, calculates what the projected kilowatt demand will be a short while into the future, and computes a demand level representative of the urgency to shed power loads. The demand manager may be used for monitoring and logging of electric power usage.

**Inputs and Outputs:** The demand limit object has an input handle for the kilowatt meter, and for the on-peak and mid-peak usage schedules. Its outputs consist of the current calculated demand level and the rotate group and a counter reset signal.

**Demand Level and Rotate Group:** The demand level represents the urgency to shed loads because of high electricity demand that may happen in the near future. Demand level is an integer between 1 and 6, where 6 indicates the highest urgency. Demand level is calculated periodically every sample period based on the current and recent power demand in the building, (see "Projected Demand" below). An excessive kilowatt demand which is constant and does not subside will cause demand level to increase. A non-zero demand level may be interpreted by controllers in the building to pare down operations so as to reduce electricity usage.

If the rotating demand group option is chosen, the demand level computes a demand rotate group number as well as the demand level. A demand group number is used to designate a certain group of controllers on the bus. The demand group number is incremented periodically from its minimum to maximum value; this allows demand limiting to be shared by groups of equipment and other controllers on a rotating basis.

**Remote Point:** The remote point object may be used to transmit the Demand Level and Rotate Group to other controllers on the Token Bus network.

**Broadcast:** The broadcast object of the ASIC/2 reads the demand level from the demand object and passes this information on to their designated controllers on the bus.

**Kilowatt Meter:** A counter records the total number of utility meter clicks that occur during each sample interval. Meter conversion constants are applied to obtain how many

kilowatt-hrs the reading represents. This value is placed in a 7 entry queue for use in the sliding window and projected demand calculations described below.

**Sliding Window Demand:** The sliding window demand is an average of previous kilowatt meter readings. The demand interval (not the same as the sample interval) represents the duration in time over which meter readings are averaged. It is divided by the sample interval to determine the number of previous meter readings to use, up to a maximum of 7. If any previous reading is 0, the sliding window demand is set to the current kilowatt meter reading.

**Projected Demand:** This is the value that is used to determine the broadcast demand level. The projected demand calculation uses a differential algorithm to calculate the demand that will exist one demand interval into the future if the current trend continues. The slope of kilowatt reading vs. time over the last 4 readings is calculated and used to extrapolate the current sliding window demand in determining the projected demand. The slope is smoothed to prevent against meter reading scatter.

**Demand Limit Setpoints:** The schedule assignment allows the user to identify On-peak and Mid-Peak schedules, so as to divide the day into regions representing on-peak, mid-peak and off-peak power usage. Alternately, on-peak usage may be designated to always be in effect. Associated with each of on-, mid-, and off-peak power usage period are demand limit setpoints in kilowatts. Each time the projected demand in kilowatts is calculated, the current demand level is updated based on the projected demand and active demand limit setpoint. The current demand level is available to the broadcast and remote point objects for relay to other controllers.

**Demand Limit Alarm:** The user may set alarm setpoints for on-peak, mid-peak, and off-peak usage periods. If the sliding window demand is greater than the appropriate setpoint, a demand limit alarm is recorded. No actions are taken by the demand limit object as a consequence of the alarm.

**Demand Level Alarm:** If the Active demand level is greater than the demand level alarm setpoint, a demand level alarm is recorded. No actions are taken by the demand limit object as a consequence of the alarm. The Demand Limit and Level Alarm flags may be used by the Alarm object to create system alarms.

**Operational Monitoring:** A variety of data is recorded in memory by the demand limit object for examination by the user:

- The minimum kilowatt demand seen and the time and date it occurred.

- The on-, mid-, and off-peak kilowatt readings for the current hour, the previous hour, today, and yesterday.

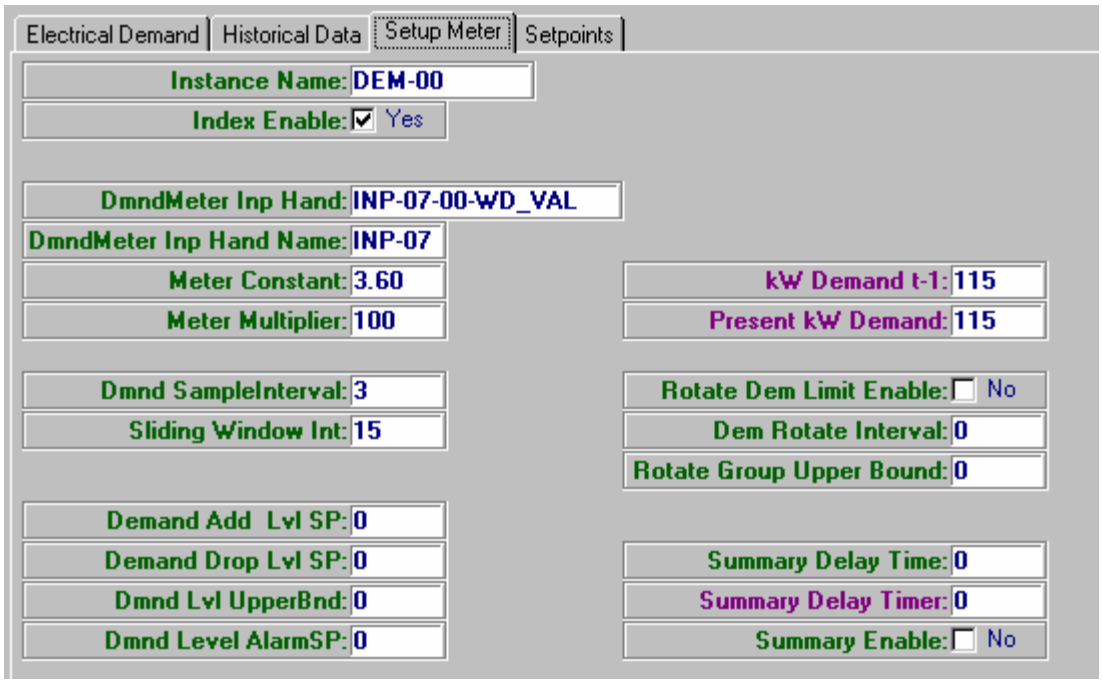
- The total kilowatts being billed by the meter for on-peak, mid-peak, and off-peak usage, and the billing time and date.

- The peak kilowatt meter reading for this month and for last month and the time and dates at which these occurred.

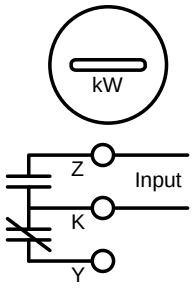
**Summary Demand Meter:** Delays calculation for up to 15 seconds to allow other objects, such as calculation Points, or other demand meters, to take place first.

## Demand Monitoring

The status of the kW-meter dry contacts are monitored. Typically one count is recorded for each open and close. The input is configured for pulse counting on rise of value. The electricity usage (counts) is monitored over a Demand Sample Interval at which time the demand manager will reset the counter.




### *Demand Meter Input*



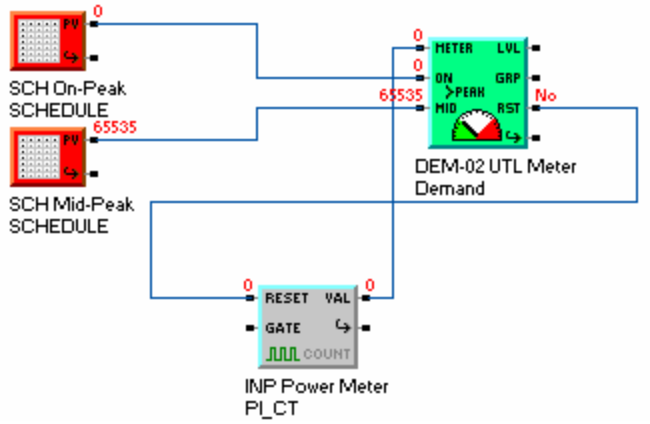

The pulse counting input accumulates counts for a Demand Sample Interval which is typically 3 minutes. Expected counts range from 24 to 420 counts/min. A count is a close-open cycle. At the end of the Demand sample interval the present number of counts at the input are retrieved, and the Meter Count Reset flag is set for 1 second.

Demand Meter Input Handle, identifies the input to be examined for counts. The Demand Meter Count Handle should point at object 5, index of the input, attribute 0, (Handle Select = 0).

### *Pulse Count Input Configuration*

The pulsed input must be configured as input type 33 (21h).).Prior to ASIC/2-8040 FW840C only inputs 5 thru 8 are available for pulse counting. Prior to ASIC/2-7040 FW740C only inputs 13 thru 16 are available for pulse counting. This input type looks for contact closures and accumulates the number of pulses received. The Input Scan Interval **must** be set to 1 second. The input present value is cleared after the demand manager has read the number of counts.

Note: The Demand Manger reads and resets the pulse input every minute. The counts are accumulated in the Demand Count which is reset every Demand Sample Interval.




The general rule is that each pulse (open, close cycle) represents one revolution of the demand meter. The input should be configured Count on Rise Enable = Yes, and Count on Fall Enable = No. If both are yes then one revolution will give two counts.

The Input has a Reset Handle which points at the Meter Count Reset flag and clears the counts to zero when the flag is set. The Count Reset Handle should point at Demand Meter Count Reset flag. The Input object is executed immediately after the Demand object, so that the probability of loosing a count is very small.

The Input has a Count Gate Handle which allows turning the counter on and off. This is generally not used so that the input Count Gate Enable will be NO. The Count Gate allows an outside signal to "gate" or turn off the input value, so that the input sees no counts. Even if a gate is used, it should be disabled until it is verified that counts are reaching the demand manager.

### *Meter Factor*

The calculation of electric power demand is based on 4 numbers: the Meter Constant, the Meter Multiplier, and the Counts per Sample Time.

where: Meter Constant, Kh ,is in 0.01W-hr/count
Multiplier, MULT is a number,
Counts is a number, and
Sample Periods, in minutes.

Typically the Meter Constant, Kh = 360 or 3.60 W-hr/count. The Multiplier is typically a current transformer multiplies the meter reading by 5, 20, 50, etc.

Electric power companies sometimes give a single number for the utility meter factor in W-hr/count. This must be converted into Meter Constant and Multiplier. The Meter Factor available as Attr-13 in FW740 is given by

Meter Factor = Kh/100*MULT (W-hr/count)

**Example:** A utility identifies a meter factor as giving 0.1250 kW-hr/count.

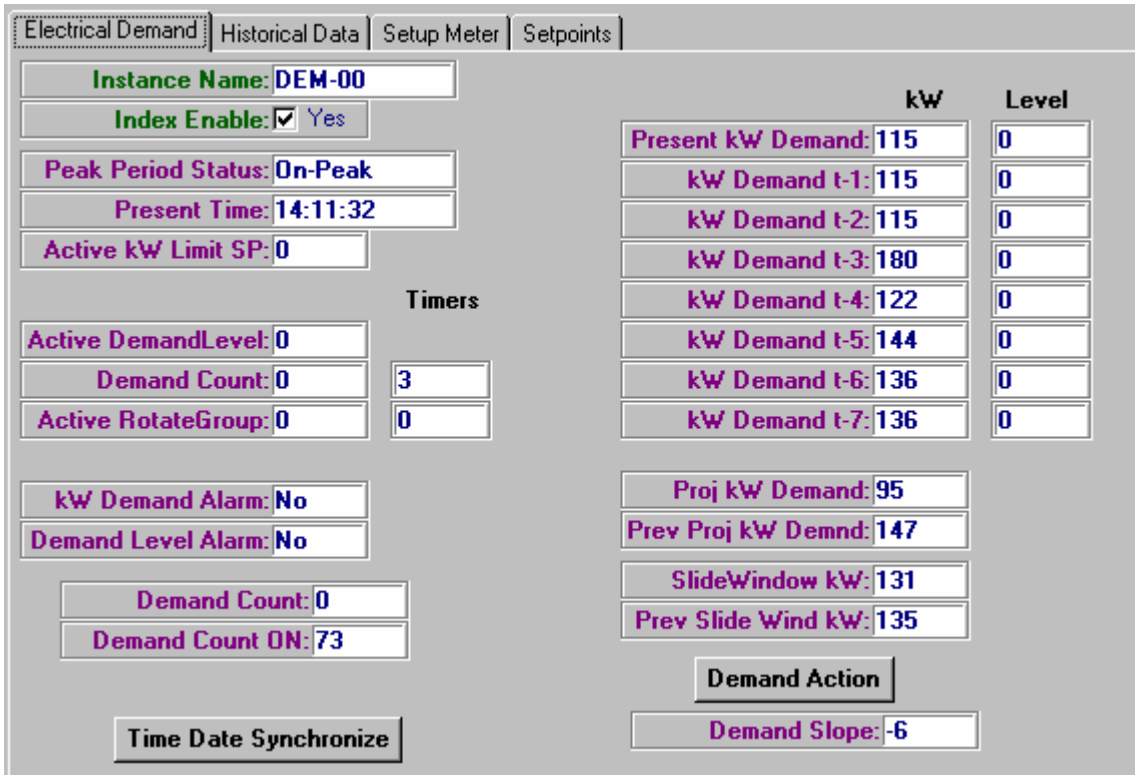
Meter Factor = Kh/100*MULT = 0.1250 kW-hr/count*1000 W/1 kW. = 125 W-hr/count.

Meter Factor = Kh/100*MULT = 125 W-hr/count

If we set

MULT = 1 then Kh = 12500
MULT = 10 then Kh = 1250
MULT = 100 then Kh = 125

***Present Demand (t)***




The counts are multiplied by the Meter Constant, Kh, and Meter Multiplier to determine the kW-hr during the N Minute period. The energy use over a total of 8 sample periods are saved for the purpose of computing the Sliding Window kW Demand.

Demand = (Kh/100)*MULT*Counts/Sample Period =Q <W-hr/minute>

where: Meter Constant, Kh ,is in 0.01W-hr/cnt
Multiplier, MULT is a number
Sample Periods, in minutes

Demand = Q <W-hr/minute>* 60 min/hr*1kW/1000W = P <kW-hr/hr>
Demand <kW> = (Kh<W-hr/cnt>/100)*MULT*Counts<cnt/period>
*(1 period/Sample Period< min>)* 60 min/hr*1kW/1000W

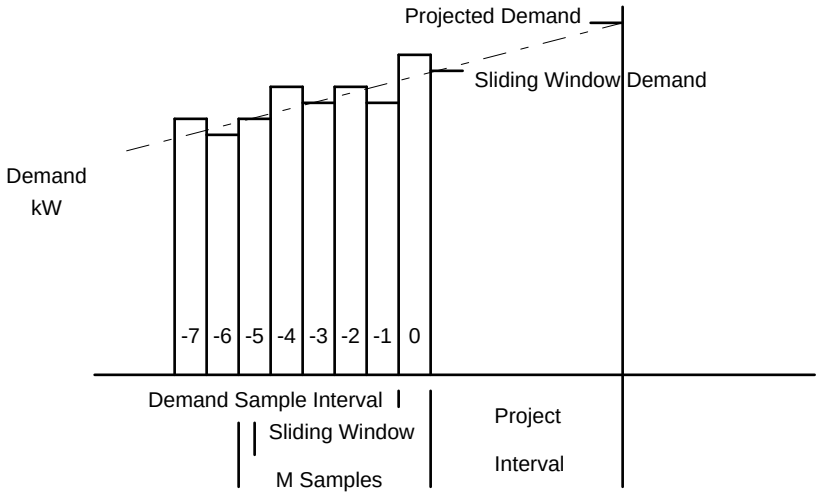
**For Example:** A utility meter has a Meter Constant of 3.60 W-hr/count and a Multiplier of 40. 240 counts are observed in a Sample Period of 3 minutes.

where: Meter Constant, Kh=360 ,is in 3.60 W-hr/cnt
Multiplier, MULT= 40 is a number
Sample Period = 3 minutes
Counts = 240

Power = (Kh/100)*MULT*Counts/Sample Period =Q <W-hr/minute>
Power = (360/100)*40*240/3 min = 11,520 <W-hr/minute> = 11.52 kW-hr/min
Power =11,520 <W-hr/minute>* 60 min/hr*1kW/1000W = 691.2 kW
The rate of power consumption kW Demand = 691 kW! .

In three minutes the energy consumption is
Energy = Power * Time =11,520 <W-hr/minute>* 3 min =34.5 kW-hr

### *Sliding Window Demand*




The Sliding Window Demand is based on the average of the latest Demand Samples over a Demand Window.

### *Sliding Window Interval*

The period of time over which the sliding window demand is calculated. [Typical: 15 minutes]. [Range: Sample Interval to 8* Sample Interval.

### *Number of Samples*

M is the Number of Samples to use in the Sliding Window Average. This is not an adjustable parameter.

M = INT(0.5 + Demand Window/Demand Sample Interval)

$$1 <= M <= 8$$

Sliding Window Demand Calculation

The Sliding Window Demand is the average over the Number of Samples over the demand window. If fewer than the Number of Samples has been collected since power reset, then the present demand is used.

### *Projected Demand*

Because of the scatter in the 3 minute demand data on a real building, the slope calculation must be smoothed.

SLOPE(t) = [SLOPE(t-1)*(SMOOTH-1) + Dy]/SMOOTH

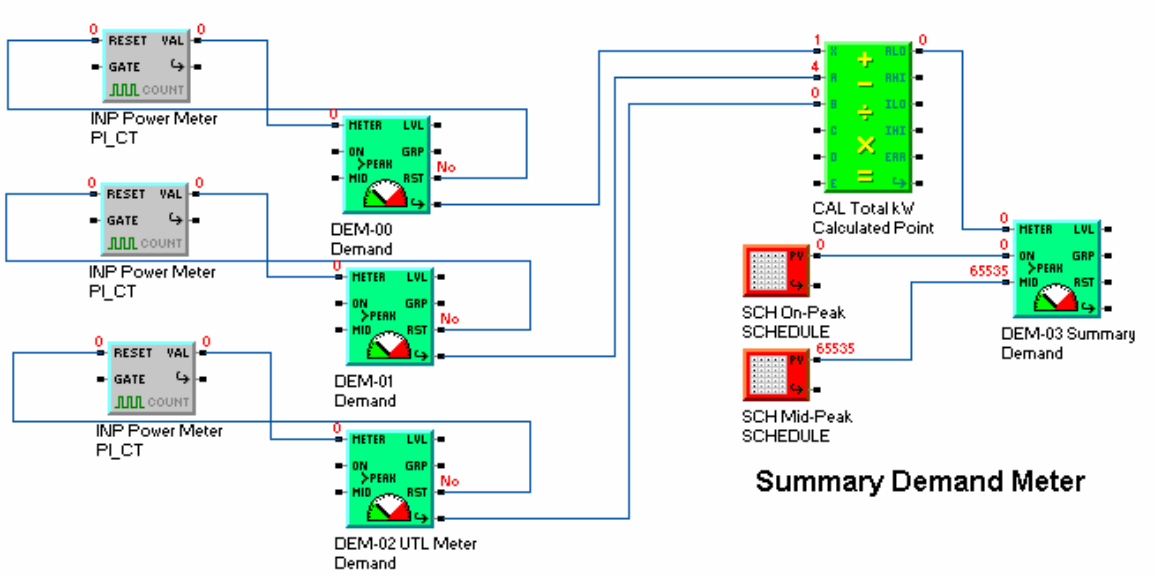
The SLOPE SMOOTH factor is hard coded at 4.

The projected demand is based on a smoothed linear extrapolation of the 4 most recent demand measurements. The present and previous projected demand is saved. The Demand is projected ahead for a Demand Window Time (M Demand Sample Intervals). M is the same value used in the Sliding Window Calculation. This calculation is done at each Demand Sample Interval. If fewer than the Number of Samples has been collected since power reset, then the present demand is used.

Proj_D(t) = SWD(t) + SLOPE*M

## Summary Demand Manager

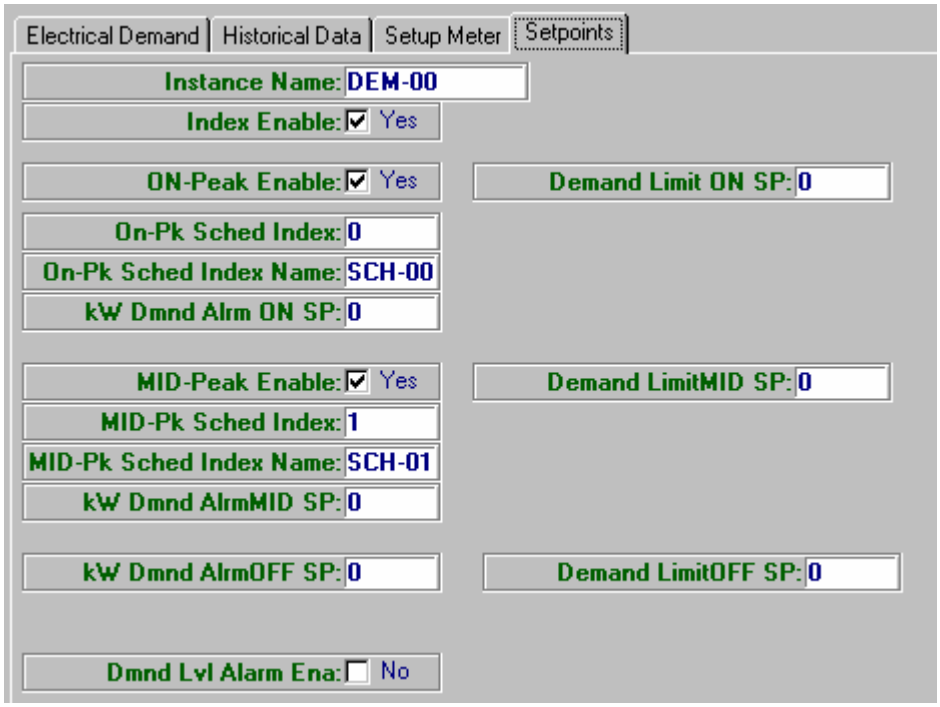
With FW740E 2.0, 840E 2.0, a Summary Demand Manger function has been added. If Summary Enable is yes, then it adds a delay of up to 15 seconds before making the calculation. This also delays the update of This Hour to Previous Hour, This Day to Previous Day, This Month to Previous Month.




The summary meter usually sees static values, which are sampled once a minute. These can be from a calculated point that totalizes several demand meters. Or it could be from Btu or other thermal power measurements. The Summary Demand manager can be used to accumulate Present kW-demand and make its own sliding window and summary totals which may include different scaling.

A Multiplier of 1 and a Meter Constant of 16.67 will make the kW-hr/hr equal to the input value.

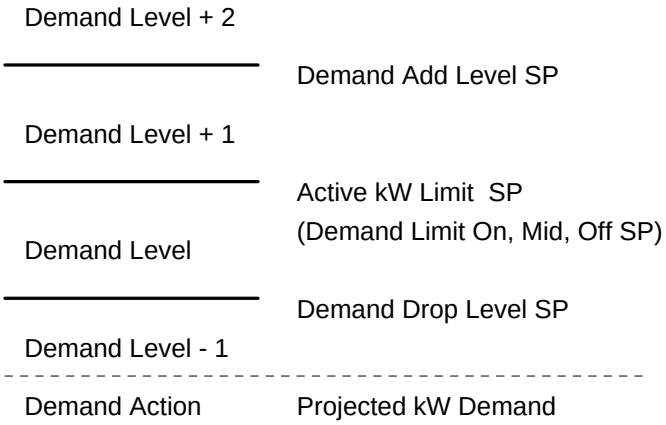
# Demand Limit




The Demand Limit Status is calculated each time the Demand, Sliding Window Demand, and Projected Demand is recalculated.

If the Projected Demand or Sliding Window Demand exceeds the Active Demand Setpoint, then the Demand Level is increased by 1. If the Projected Demand or Sliding Window Demand exceeds the Demand Setpoint by more than the Demand Add Level Setpoint, then the Demand Level is increased by 2.

If the Projected Demand and Sliding Window Demand falls below Active Demand Setpoint by more than the Demand Drop Level Setpoint, the Demand Level is reduced by 1.




***Active Demand Limit Setpoint***

The Demand Limit Setpoint may be a function of the On-, Mid-, and Off-peak period. The Demand Limit Setpoint has the same units as the Projected Demand or Sliding Window Demand. (word) [Range 0 to 65535 kW]

***Demand Add or Drop Level Setpoint***

The Demand Add or Drop Level Setpoints has the same units as the Projected Demand or Sliding Window Demand. (word) [Range 0 to 65535 kW]

### *Maximum Demand Level*

The maximum demand level reached during the present 15 minute period by the clock, is saved.

### *Maximum Demand Level Previous*

At the end of an even 15 minute interval by the clock. the Maximum Demand Level is saved in RAM and the Maximum Demand Level reset to 0.

### *Demand Level and Rotate Group*

Whenever the demand level changes, and at every Demand Broadcast Interval [Typical: 10 minutes] the controller broadcasts the present demand level. The demand manager simply calculates the current demand level and demand rotate group. The Broadcast object is used to transmit this information using a 16h message on the local bus. The Remote point is used to broadcast it to other system controllers on the system bus.

### *Demand Rotate Group*

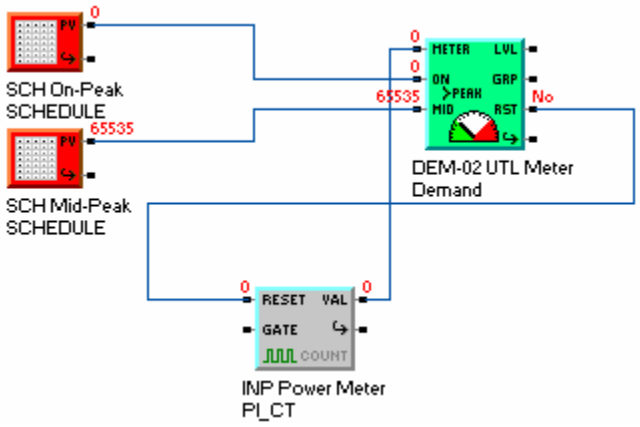
Each controller is assigned to a Demand Rotate Group.

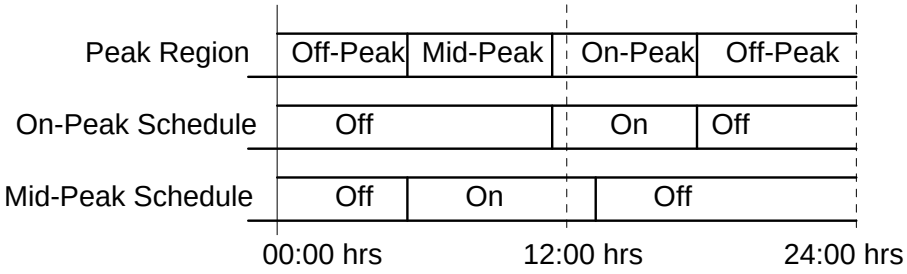
When the Active Demand Level is non-zero, the Demand Manager rotates the Active Demand Group through the range of assigned values from 1 to Rotate Group Upper Bound [Typical: 6] based on the Demand Rotation Interval. [Typical: 10 minutes]

## Peak Demand Schedule

On-Peak, Mid-Peak, and Off-peak periods can be defined by a schedule.

If On-Peak is not enabled, then it is ALWAYS On-peak independent of the schedule. If On-Peak is enabled, and a schedule is assigned, then the ON peak Schedule is examined.




Note: The Demand Manager is executed before the Schedules are evaluated. Totals for a sample period ending at the schedule change will be totaled with the previous peak period. The new peak period begins with the first sample interval after the schedule changes.

If ON, then it is On-Peak and values is assigned to appropriate ...-ON variable.

If Not ON, then it is Off-peak unless Mid-Peak schedule is assigned and Enabled.

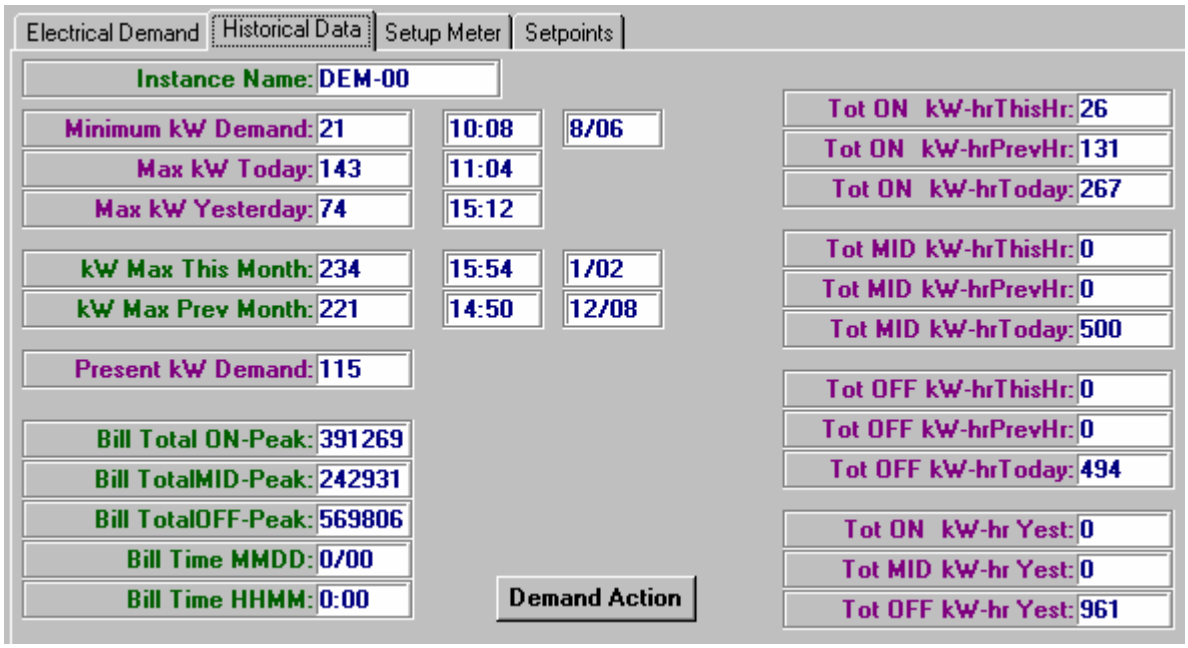
If Mid-Peak is enabled, and a schedule is assigned, then the MID peak Schedule is examined.

If ON, then it is Mid-Peak and values is assigned to appropriate ...-MID variable.

If Not ON then it is Off-peak

In FW740A.. the On-Peak and Mid-Peak Schedule Indexes are a Byte values.(0..63) = Schedule index 0..63. If the On-Peak Schedule is Enabled then the On-Peak Schedule Index (0..63) is used. If the Mid-Peak Schedule is Enabled, then the Mid-Peak Schedule Index (0..63) is used.

IN FW700A.. it was a Nibble. 1..15 = Schedule index 0..14




## kW-hr Usage

The kW-hr usage is totalized on an hourly and daily basis. The previous hour and previous day totals are retained in RAM.

At the end of the day the accumulated Total kW-hr Today usage for On-, Mid-, and Off-peak periods are transferred to the Total kW-hr Yesterday), and accumulated to the Billing Totals. Today's energy use is not saved through power outage.

The Total kW-hr Today for On-, Mid-, and Off-peak periods should be scaled so that they are less than a word value. 65,535 kW-hr/day. This would mean that the average hourly kW should be less than 2,730 kW-hr/hr!.

The Billing Total Date and Time is written when the data has been retrieved and the accumulated values are zeroed by the operator. The Billing values reflect only whole day accumulations.

In FW740A.. the billing totals accumulate to a double word values in new Attributes 78..83.

## Maximum kW Demand

If the current Sliding Window Demand is greater than the Maximum kW Demand - Today, then the Maximum kW Demand is updated and a date and time stamp recorded.

At the end of the day today's Maximum kW Demand and time is saved as Yesterday's Maximum kW Demand and Time. This value is also compared with the monthly Maximum kW Demand and if larger a new value of Value, Time, and Date is written to EEPROM.

At the end of the month the current monthly Maximum kW Demand is saved as the previous monthly Maximum kW Demand and the new value of 0 recorded, and the New

Month Time 00:00 and Date (MM DD) written to the current month peak. At the end of the first day that days peak then is automatically recorded as the monthly high.

## Demand Alarms

### *Demand Limit Alarm*

If the sliding window demand exceeds a predetermined kW Demand ON, MID, or OFF Alarm Setpoints for On-, Mid-, or OFF- peak times and the kW Demand Alarm Enable is set, Attr-51 LO Bit 2, then a kW Demand Alarm is set, Attr-2 LO bit 0.

### *Demand Level Alarm*

If the Active Demand Level exceeds a predetermined Demand Level Alarm Setpoint and the Demand Level Alarm Enable is set, Attr-55 HI Byte, then a Demand Level Alarm, Attr-2 LO bit 1, is set.

# Demand Manager Glossary

## Demand Manager Parameters

### *Active Demand Level*

This value is picked up by a Broadcast index and sent to terminal unit controllers or to the PID object. Based upon its value, they selectively shed loads or reduce target temperature setpoints. Active Demand Level represents more than just the Present kW Demand of the building, it is also representative of by how much and for how kW demand has exceeded the Active kW Limit Setpoint. Integer, 0 ... Demand Level Upper Bound; not user-changeable. (11,X,0,LO BYTE)

### *Active kW Limit Setpoint*

Each sampling period a calculation is made: if Projected kW Demand is greater than Active kW Limit Setpoint, then the Active Demand Level will incremented by 1. This setpoint is the trigger point for the beginning of energy conservation steps. In kW; user-configurable. (11,X,12,WORD)

### *Active Rotate Group*

Terminal unit controllers on the local bus enforce demand limit requirements in groups, on a rotating basis. The Active Rotate Group represents those controllers currently enforcing demand limit requirements. Used with the rotating demand limit feature only. Integer; not user-changeable. (11,X,0,HI BYTE)

### *Billing Date*

The date on which the power company bills for power usage. As far as the Demand Limit object is concerned, a new month begins at the Billing Date/Time. Integer, 1 ... 31; user-configurable. (11,X,68,WORD)

### *Billing Time*

The time of day at which the power company bills for power usage. As far as the Demand Limit object is concerned, a new month begins at the Billing Date/Time. High byte = hours, 1 ... 24; low byte = minutes 1 ... 60; user-configurable. (11,X,67,WORD)

### *Billing Total ON, MID, OFF*

The total kW-hrs of usage so far this month for power usage periods. In kW; user-configurable. On (11,X,69,WORD), Mid (11,X,70,WORD), Off (11,X,71,WORD)

### *Demand Add Level Setpoint*

For each Demand Add Level by which Projected kW Demand exceeds the Active kW Limit Setpoint, the Active Demand Level is incremented by 1 (up to a maximum of Demand Level Upper Bound). Note: Projected kW Demand in excess of the Active kW Limit Setpoint causes an increment in itself; Add Level increments are additional increments. In kW; user-changeable. (11,X,58,WORD)

### *Demand Count*

An internal parameter which keeps track of the number of counts (close/open cycles) on the kW meter input which have occurred so far in the current sample interval. Integer; not user-changeable. (11,X,4,WORD)

### *Demand Count ON, MID, OFF for Hour*

The number of counts recorded for the current hour during usage periods. Not user-configurable. On (11,X,5,WORD), Mid (11,X,6,WORD), Off (11,X,7,WORD)

### *Demand Drop Level Setpoint*

For each Demand Drop Level by which the Projected kW Demand is below the Active kW Limit Setpoint, the Active Demand Level is decremented by 1, down to zero. In kW; user-changeable. (11,X,57,WORD)

### *Demand Level Alarm*

Records an alarm if the Active Demand Level rises above the Demand Level Alarm Setpoint, (and the Demand Level Alarm is enabled.) "OK", "Alarm"; not user-changeable. (11,X,2,LO BIT 1)

### *Demand Level Alarm Enable*

Enables the Demand Level Alarm for operation. "Yes", "No"; user-configurable. (11,X,51,LO BIT 3)

### *Demand Level Alarm Setpoint*

The setpoint which triggers the Demand Level Alarm. Integer from 1 to Demand Level Upper Bound; user-configurable. (11,X,55,HI BYTE)

### *Demand Level t-X*

These parameters record the previous Active Demand Level which was in effect X sampling intervals ago. X may be from 0 to 7. Integer, 0 ... Demand Level Upper Bound; not user-changeable. (11,X,45 ... 48, alternating LO BYTE, HI BYTE)

### *Demand Level Upper Bound*

The maximum level up to which the Active Demand Level may be incremented. Integer; user-configurable. (11,X,56,HI BYTE)

### *Demand Limit ON, MID, OFF Setpoint*

Used as the Active kW Limit Setpoint for power usage periods. In kW; user-configurable. On (11,X,61,WORD), Mid (11,X,63,WORD), Off (11,X,65,WORD)

### *Demand Meter Input Handle*

Designates which physical input of the system controller is to read the kW meter. (11,X,59,2 WORDS)

### *Demand Rotate Interval*

The interval between successive increments of the Rotate Group number. Under the Rotating Demand Limit feature, the Rotate Group is broadcast by a Broadcast index to terminal unit controllers on the local bus. In minutes; user-configurable. (11,X,52,HI BYTE)

### *Demand Sample Interval*

Present kW Demand, Sliding Window kW Demand, Projected kW Demand and Active Demand Level are all recalculated each Demand Sample Interval. 1 to 15 minutes; user-configurable. (11,X,55,LO BYTE)

### *Demand Sample Interval*

Each Sample Interval, the Present kW demand is calculated based on the number of meter counts read during the Sample Interval. In minutes; user-configurable. (11,X,55,LO_BYTE)

### *Demand Slope*

This is the average rate of change of kW Demand over the last 4 sampling intervals. In kW; user-configurable. (11,X,17,WORD)

### *Index Enable*

Enables this index of the Demand Limit object for operation. "Yes", "No"; user-configurable. (11,X,50,LO BIT 4)

### *Interval Timer*

This timer is used to track the Sampling Interval. Reads in seconds; not user-changeable. (11,X,3,LO_BYTE)

### *kW Demand Alarm*

This alarm goes off if Present kW Demand exceeds the kW Demand Alarm MID, OFF, or ON Setpoint, depending on the current demand mode. OK, Alarm; not user-changeable. (11,X,2,LOBIT0)

### *kW Demand Alarm Enable*

Enables the Demand Alarm for operation. "Yes", "No"; user-configurable. (11,X,51,LO BIT 2)

### *kW Demand Alarm ON, MID, OFF Setpoint*

During power usage periods, if kW Demand rises above this setpoint then a Demand Alarm will be recorded (if the Demand Alarm is enabled). In kW; user-configurable. On (11,X,62,WORD), Mid (11,X,64,WORD), Off (11,X,66,WORD)

### *kW Demand t-X*

X is an integer from 1 to 7. This is the kW Demand reading taken X sampling periods ago. In kW; not user-changeable. (11,X,20 ... 26,WORD)

### *kW Maximum Current Month*

This is the maximum kW Demand for the building during the current billing month. In kW; not user-changeable. (11,X,72,WORD)

### *kW Maximum Current Month Date & Time*

This is the date of maximum kW Demand for the building during the current billing month. Used with kW Maximum Current Month Time. Integer 1 ... 31; not user-changeable. Date (11,X,74,WORD) ; Time - Low byte = minutes 0 ... 59; high byte = hours 0 ... 23; (11,X,73,WORD)

### *kW Maximum Previous Month*

This is maximum kW Demand for the building during the previous billing month. In kW; not user-changeable. (11,X,75,WORD)

### *kW Maximum Previous Month Date & Time*

This is the date of maximum kW Demand for the building during the previous billing month. Used with kW Maximum Previous Month Time. Integer 1 ... 31; not user-changeable. Date (11,X,77,WORD) ; Time - Low byte = minutes 0 ... 59; high byte = hours 0 ... 23; (11,X,76,WORD)

### *Maximum Demand Level*

The maximum Demand Level which occurred during any sampling interval which was part of the current Sliding Window Interval. Integer from 0 to Demand Level Upper Bound; user-configurable. (11,X,40,WORD)

### *Maximum kW Time Yesterday*

The time at which the building kW Demand was at its maximum yesterday. Low byte = minutes 0 ... 59, high byte = hours 0 ... 23; not user-changeable. (11,X,39,WORD)

### *Maximum kW Yesterday*

The maximum building kW Demand for yesterday. In kW; not user-changeable. (11,X,38,WORD)

### *Meter Constant*

Designates the number of watt-hours of power usage each rotation of the meter head represents. Watt-Hours/input count = Meter Constant * Meter Multiplier. Equipment dependent. Decimal, 0 to 655.35; user-configurable. (11,X,53,WORD)

### *Meter Count Reset*

This bit is set for one second following reading of the meter count input. The pulse input points at this bit to reset the counter. (11,X,2,LOW BIT 3)

### *Meter Factor*

Product of the Meter Constant and the Meter Multiplier in W-hr/count. Not user configurable. (11,X,13,WORD)

### *Meter Multiplier*

Because a current transformer is used in conjunction with the power monitor, the meter counts read by the system controller are not the same as the actual counts measured by the power meter. The measured counts must be multiplied by the Meter Multiplier to attain the actual counts. Integer; user-configurable. (11,X,54,WORD)

### *Mid-Peak Enable*

Enables the Mid-Peak schedule for examination. I "Yes", "No"; user-configurable. (11,X,50,LOBIT6)

### *Mid-Peak Schedule Assignment*

(FW700A..)The Schedule index which designates when Mid-Peak demand mode is to be in effect. Mid-Peak is a time of average power demand from the utility company; used for billing purposes. Integer; user-configurable.0 = Off, 1..15 = index 0..14 (11,X,50,HIMSNBL)

### *Mid-Peak Schedule Index*

(FW740A..) If Mid-Peak Enable is Set, then The Schedule index which designates when Mid-Peak demand mode is to be in effect. Mid-Peak is a time of average power demand from the utility company; used for billing purposes. Integer; user-configurable.0..63 (11,X,50,HI Byte)

### *Minimum kW Demand*

The minimum kW demand by the building during the current billing month. In kW; not user-changeable. (11,X,14,WORD)

### *Minimum kW Demand Date & Time*

The date at which building kW demand was at its minimum for the current billing month. Corresponds to Minimum Demand Time. Integer 1 to 31; user-configurable. (11,X,16,WORD) Time - Low byte is minutes 0 ... 59; high byte is hours 0 ... 23; user-configurable. (11,X,15,WORD)

### *Number of Samples*

The number of whole or fractional sampling intervals per Sliding Window Interval. Integer; not user-changeable. (11,X,49,HI BYTE)

### *On-Peak Schedule Assignment*

(FW700A.. Only) The Schedule index which designates when On-Peak demand mode is to be in effect. On-Peak is a time of highest power demand from the utility company; used for billing purposes. Integer; user-configurable. 0 = Off, 1..15 = index 0..14 (11,X,50,HIMSNBL)

### *On-Peak Schedule Index*

(FW740A..) If On-Peak Enable is Set, then the On-Peak Schedule index designates when On-Peak demand mode is to be in effect. On-Peak is a time of highest power demand from the utility company; used for billing purposes. Integer; user-configurable. 0..63 (11,X,51,HI Byte)

### *On-Peak Enable*

Enables examination of the On-Peak schedule to determine whether the current mode is On-Peak or not. On-Peak mode designates that power billing is currently being done at the highest rate. "Yes", "No"; user-configurable. (11,X,50,LOBIT5)

### *Peak Period Status*

Identifies current peak period of operation. 1 = On-Peak; 2 = Mid-Peak; 3 = Off-peak; 0 = On-Peak at all times. (11,X,2,HILSNBL)

### *Present kW Demand*

This is the current kW being used by the building, as measured by the power meter. Present kW Demand = (Meter Constant)*(Meter Multiplier)*(counts per sampling interval)/(sampling interval). In kW; not user-changeable. (11,X,19,WORD)

### *Previous Demand Level*

The value of Active Demand Level which was in effect one sampling period ago. Integer from 0 to Demand Level Limit; user-configurable. (11,X,1,LO BYTE)

### *Previous Maximum Demand Level*

The maximum value of Active Demand Level during the most recent quarter hour (either for minutes 0...15, 15...30, 30...45, or 45...60). Integer; user-configurable. (11,X,41,WORD)

### *Previous Projected Demand*

The value of Projected kW Demand Level which was in effect one sampling period ago. In kW; not user-changeable. (11,X,11,WORD)

### *Previous Rotate Group*

The Rotate Group in effect immediately prior to the current Rotate Group being in effect. Integer; user-configurable. (11,X,1,HI BYTE)

### *Previous Sliding Window kW Demand*

The value of Sliding Window kW Demand which was in effect one sampling period ago. In kW; not user-changeable. (11,X,9,WORD)

### *Projected kW Demand*

The kW Demand which the Demand Limit Object's algorithm predicts for one Sliding Window Interval into the future. Integer from 0 to Demand Level Limit. (11,X,10,WORD)

### *Rotate Group Timer*

Used to keep track of the amount of time which has elapsed since Rotate Group was last incremented. Used in conjunction with the Rotating Demand Limit feature. Reads in minutes; not user-changeable. FW700A.. (11,X,13,WORD) FW740A.. (11,X,3,HIBYTE)

### *Rotate Group Upper Bound*

Rotate Group is incremented each Rotate Interval, unless it is already equal to Rotate Group Upper Bound, in which case it is set equal to 1. Integer; user-configurable. (11,X,52,LOLSNBL)

### *Rotating Demand Limit Enable*

Enables the rotating demand limit feature for operation. Under this feature, the Rotate Group is incremented by 1 each Rotate Interval. Different Rotate Groups represent separate groups of terminal unit controllers which implement load shedding on a successive basis. "Yes", "No"; user-configurable. (11,X,52,LOBIT4)

### *Sliding Window Interval*

The length of the sliding window in minutes. All kW Demand readings taken during the current sliding window are averaged to determine the Sliding Window Demand. The number of whole or fractional Sample Intervals per Sliding Window Interval equals the number of readings which will be averaged together. In minutes; user-configurable. (11,X,56,LO BYTE)

### *Sliding Window kW Demand*

The average kW Demand during sampling intervals extending one sliding window interval into the past. Integer; user-configurable. (11,X,8,WORD)

### *Summary Delay Time*

When Summary Enable is Yes, this time is loaded into the Summary Delay Timer (1s...15s) Attr-51 LOMSNBL- - (FW740E2.0, 840E 2.0)

### *Summary Delay Timer*

When Summary Enable is Yes the Summary Delay Timer (1s...15s) counts down before the calculation is done. Attr-2 LOMSNBL - (FW740E2.0, 840E 2.0)

### *Summary Enable*

Enables the Summary Demand Feature. Attr-51 LO bit 0 - (FW740E2.0, 840E 2.0)

### *Today Maximum kW Demand*

The maximum kW Demand for the building so far today. In kW; user-configurable. (11,X,36,WORD)

### *Today Maximum kW Time*

The time at which maximum kW Demand occurred so far today. Low byte = minutes 0 ... 59; high byte = hours 0 ... 23; not user-changeable. (11,X,37,WORD)

### *Total ON kW Yesterday*

The total kW used by the building yesterday during usage periods. In kW; not user-changeable. On (11,X,42,WORD), Mid (11,X,43,WORD), Off (11,X,44,WORD)

### *Total On, Mid, Off kW This Hour*

The total kW used by the building during power usage periods over the previous hour. In kW; not user-changeable. On (11,X,27,WORD), Mid (11,X,28,WORD), Off (11,X,29,WORD)

### *Total On, Mid, Off kW Today*

The total kW used by the building during power usage periods today. In kW; not user-changeable. On (11,X,33,WORD), Mid (11,X,34,WORD), Off (11,X,35,WORD)

### *Total On, Mid, Off kW Previous Hour*

The total kW used by the building during power usage periods over the previous hour. In kW; not user-changeable. On (11,X,30,WORD),. Mid (11,X,31,WORD), Off (11,X,32,WORD)

# Demand Manager Properties

One controller with the kW demand monitor input is assigned the responsibility for demand limit management. The Demand Manager is responsible for periodically calculating the Demand Shed Level and Demand Rotate Group. All broadcasts to terminal units is accomplished by messages configured in the Broadcast Object. Terminal units on other system controllers will receive the Demand Shed Level and Demand Rotate Group as a Remote Point and initiate their own broadcast of messages on the local bus.

In the ASIC/2-8040 up to 4 pulse counting inputs are available that can support up to 4 separate demand managers. Note: Inputs 5 through 8 may be enabled for pulse counting.

In the ASIC/2-7540 and ASIC/2-7040 (FW740C and later) up to 16 pulse counting inputs are available that can support up to 16 separate demand managers. Earlier versions allowed only up to 4 pulse counting inputs on Inputs 12 through 16.

| | |
|---|---|
| Object Name | DEMAND MANAGER |
| Object Number | = 11 |
| Data Type | = Word |
| Index | = 0 |
| Attribute | = 78 (0..77) |
| DYNAMIC Attributes | = 50 (0..49) |
| STATIC Attributes | = 28 (50..77) (FW700A..,907A..) |
| STATIC Attributes | = 34 (50..83) (FW740A..,FW840A) |

## Demand Manager Firmware Revision

**ASIC/2-7540 FW754A Rev 1.0 Forthcoming 2005**

- As in FW740E .2.0.

**ASIC/2-8040 FW840E Rev 2.0 Released 12/15/2000 CHK 0xF6C1**
**ASIC/2-7040 FW740E Rev 2.0 Released 12/15/2000 CHK 0x181F**

- Adds Summary Demand Manager feature. Delays the calculation for up to 15 seconds to allow other calculations to take place first.
  Attr-2 LOMSNBL - Summary Delay Timer (FW740E2.0, 840E 2.0)
  Attr-51 LO bit 0 - Summary Enable (FW740E2.0, 840E 2.0)
  Attr-51 LOMSNBL- - Summary Delay Time (FW740E2.0, 840E 2.0)

**ASIC/2-7040 FW740C Rev 2.7 Released 12/11/2000 CHK 0x69A6**
**ASIC/2-8040 FW840C Rev 1.7 Released 12/11/2000 CHK 0x66F7**

- Fixes Problem with Demand Manager limiting number of counts.
- Fix Demand Manager accumulate daily totals.
- 11-Demand Manager fixed to eliminate truncation errors in calculation.

**ASIC/2-7040 FW740E Rev 1.8 Released 11/14/2000 CHK 0x2A80**
**ASIC/2-8040 FW840E Rev 1.8 Unreleased 11/14/2000**

- Fixes Problem with Demand Manager limiting number of counts.

**ASIC/2-7040 FW740E Rev 1.4 Released 02/15/2000 CHK 0x35DD**
**ASIC/2-8040 FW840E Rev 1.4 Released 02/15/2000 CHK 0x34BA**

- Fix Demand Manager accumulate daily totals.
  Was broken when fixed rounding problem.

**ASIC/2-7040 FW740E Rev 1.1 Preliminary 11/08/99 CHK 0x74B4**
**ASIC/2-8040 FW840E Rev 1.1 Preliminary 11/08/99 CHK 0x7166**

- 11-Demand Manager fixed to eliminate truncation errors in calculation.

**ASIC/2-7040 FW740C Rev 1.1 Preliminary 04/14/97 Chk F761h**

- Allows 16 pulse counting inputs
- Allows maximum of 16 Demand Manager

**ASIC/2-7040 FW740C Rev 1.1 Released 04/14/97**

- Allows maximum of 16 Demand Manager, and 96 Schedules

**ASIC/2-8040 FW840A Rev 1.0 Released March 1996**

**ASIC/2-7040 FW740b Rev 1.2 Released 08/18/95**
**ASIC/2-7040 FW740A Rev 2.1 Released 08/16/95**

o Demand Manager Peak Date Stamp now correct. It was off by one.
kW Max Month now in Attr-18 HI Byte
kW Max Day of Month is now in Attr-49 LO Byte

**ASIC/2-7040 FW740A Rev 1.9 Released 04/24/95**

o Allows up to 5 demand managers.

**ASIC/2-7040 FW740A Rev 1.1 27 May 94**

o Did not correctly access On-Peak and Mid-Peak
o Schedule Index.(fixed)
Now Accesses On-Peak and Mid-Peak Schedules correctly.
o Double Word kW-hr did not update high word.
Double Word now updates high word correctly.
Note: Demand Count is updated every minute,
and cleared at end of Sample Interval
o Added Rotate Group Timer in Attr-3 HI Byte
Deleted Rotate Group Timer in Attr-13
Added Meter Factor in Attr-13 (Kh*M/100)

**ASIC/2-7040 FW740A Rev 1.0 (03/31/94)**

Support up to 4 indices of demand manager.
Add Attr-18 Action New!(FW740A..)
Remove Attr-18 Demand Curvature
Remove Attr-50 HILSNBL- On-Peak Schedule Assignment
Remove Attr-50 HIMSNBL - Mid-Peak Schedule Assignment
Add Attr-50 HI Byte- On-Peak Schedule Index (FW740A..)
Add Attr-51 HI Byte- Mid-Peak Schedule Index (FW740A..)
Remove Attr-69,70,71 Billing Total On- ,Mid-, Off-Peak
Add Attr-78,79 Billing Total On-Peak
Add Attr-80,81 Billing Total Mid-Peak
Add Attr-82,83 Billing Total Off-Peak

**ASIC/2-7000 FW700A.. Rev 1.0 Released 12/05/91**
**SC/1-9040 FW907A Rev 1.0 Released 07/25/91**

## Demand Manager DYNAMIC Properties

Attr-0 Active Demand Status
LO - **Active Demand Level**
HI - **Active Rotate Group**

Attr-1 Previous Demand Status
LO - **Previous Demand Level**
HI - **Previous Rotate Group**

Attr-2 Demand Status

LO Byte - Demand Alarm Status
Attr-2 LO bit 0 - **kW Demand Alarm**; 1 = Alarm, 0 = OK
Attr-2 LO bit 1 - **Demand Level Alarm**; 1 = Alarm,0 OK
Attr-2 LO bit 2 - Spare

Attr-2 LO bit 3 - **Meter Count Reset**
Set for 1 second at end of Demand Sample Interval. This is used to reset the Demand Count Input after the Demand Counts have been retrieved.

Attr-2 LOMSNBL - **Summary Delay Timer** (FW740E2.0, 840E2.0)

Attr-2 HILSNBL - **Peak Period Status**
0 Not assigned, assumed to be On-Peak at all times.
1 ON Peak,
2 Mid Peak,
3 Off Peak

Attr-2 HI bit 4...7 - Spare

Attr-3 Timers
LO - **Interval Timer**, in seconds
HI - Spare(FW700A..)
**Rotate Group Timer** in minutes (FW740A..)

Attr-4 **Demand Count**
Counts per period 0 to 65535.
Expected counts range from 24 to 420 counts/min. A count is a close-open cycle.
At the end of each sample interval the Demand Count is retrieved from the input identified by the Demand Input Handle.

Attr-5 **Demand Count ON - This Hour**

Attr-6 **Demand Count MID - This Hour**

Attr-7 **Demand Count OFF - This Hour**
Counts per hour 0 to 65535. Expected counts range from 400 to 6000 in 15 minutes.
In each sample interval the counts are accumulated for the hour depending on the Peak Status

Attr-8 **Sliding Window kW Demand**
SWD(t) = (1/M)Sum(i=1 to M) Demand(t-M+1)
M = INT(0.5 + Demand Window/Demand Sample Interval)
1 <= M <= 5

Attr-9 **Previous Sliding Window kW Demand**
SWD(t-1)

Attr-10 **Projected kW Demand**
Proj_D(t) = SWD(t) +Dy* M

Attr-11 **Previous Projected kW Demand**
Proj_D(t-1)

Attr-12 **Active kW Limit Setpoint**
Current ON, MID, or OFF Peak Demand Setpoint

Attr-13 **Meter Factor** (FW740A..)
(Kh*MULT)/100 (W-hr/count)
Product of Meter Constant and Meter Multiplier.
Rotate Group Timer (FW700A..)

Attr-14 **Minimum kW Demand**
The smallest kW Demand in any sample interval. On power reset Minimum Demand kW is initialized at the end of the first complete sample interval.

Attr-15 **Minimum kW Demand - Time**
LO Byte - Minute (0..59)
HI Byte - Hour (0..23)

Attr-16 **Minimum kW Demand - Date**
LO Byte - Day (1..31)
HI Byte - Month (1..12)

Attr-17 **Demand Slope**
Current_Dy = dy/dt= {Demand(t)-Demand(t-1)+Demand(t-2)-Demand(t-3)}/2
This value is smoothed using a smoothing factor of 4.
Dy_Smooth = ((Current_Dy) + 3* (Smooth_Dy) )/4

Attr-18 **Action *New! (FW740A..)***
0 - No- op
1- Enable Index
2 - Disable Index
3 - Clear and Date Stamp Billing Totals

Attr-19 **Present kW Demand**
Demand for current minute is unsigned word 0 to 65535 kW
Demand =(Kh<W-hr/cnt>/100)*MULT*Counts<cnt/period>
*(1 period/Sample Period min)* 60min/hr*1kW/1000W
where Kh is the meter constant, see Attr-53.

### *Previous Demand Values*

Attr-20 **kW Demand t-1**
Attr-21 **kW Demand t-2**
Attr-22 **kW Demand t-3**
Attr-23 **kW Demand t-4**
Attr-24 **kW Demand t-5**
Attr-25 **kW Demand t-6**
Attr-26 **kW Demand t-7**

### *kW-hr Usage Today*

Attr-27 **Total ON kW-hr This Hour**
Attr-28 **Total MID kW-hr This Hour**
Attr-29 **Total OFF kW-hr This Hour**
(Kh/100)*MULT*(Counts OFF This Hour)*1kW/1000W
where Kh is the meter constant, see Attr-53.

Attr-30 **Total ON kW-hr Previous Hour**
Attr-31 **Total MID kW-hr Previous Hour**
Attr-32 **Total OFF kW-hr Previous Hour**
Total<kW-hr/hr> for previous hour.
Rolls over as HH:59:59 -> HH:00:00

Attr-33 **Total ON kW-hr Today**
Attr-34 **Total MID kW-hr Today**
Attr-35 **Total OFF kW-hr Today**

Accumulated at the end of each hour for the day. At the end of the day accumulated to Billing Total kW-hr. Attr-69,70,71(FW700A..)
Attr-78..83(FW740A..)

The Total kW-hr Today for On-, Mid-, and Off-peak periods should be scaled so that they are less than a word value. 65,535 kW-hr/day. This would mean that the average hourly kW should be less than 2,730 kW-hr/hr!.

### *Peak Demand*

Attr-36 **Maximum kW Today**

Attr-37 **Maximum kW Today - Time**
LO Byte - Minute (0..59)
HI Byte - Hour (0..23)

Attr-38 **Maximum kW Yesterday**

Attr-39 **Maximum kW Yesterday - Time**
LO Byte - Minute (0..59)
HI Byte - Hour (0..23)

Attr-40 **Maximum Demand Level - Current**
This is the maximum demand level of the M samples in the Demand Window Period.

Attr-41 **Maximum Demand Level - Previous**
- Previous 15 minute Period value
kW-hr Usage Today

Attr-42 **Total ON kW-hr Yesterday**
Attr-43 **Total ON kW-hr Yesterday**
Attr-44 **Total ON kW-hr Yesterday**
kW-hr/day for previous day. Rolls over as 23:59:59 -> 00:00:00

Attr-45..48 Demand Levels t-0, ..., t-7
Attr-45 LO - **Demand Level t-0**
Attr-45 HI - **Demand Level t-1**
Attr-46 LO - **Demand Level t-2**
Attr-46 HI - **Demand Level t-3**
Attr-47 LO - **Demand Level t-4**
Attr-47 HI - **Demand Level t-5**
Attr-48 LO - **Demand Level t-6**
Attr-48 HI - **Demand Level t-7**

Attr-49 Samples
LO - **kW Max Day**
HI - **Number of Samples**
The number of samples used to calculate Sliding Window kW Demand

## Demand Manager STATIC Properties

Attr-50 Demand Setup
If On-Peak is not enabled,
then it is ALWAYS ON peak independent of the schedule.
If On-Peak is enabled, then the assigned ON peak Schedule is examined.
If Not ON, then it is Off-peak
unless Mid-Peak is Enabled and Mid-Peak Schedule is ON.
IF ON=Peak or Mid-Peak is Enabled, but schedules are not assigned,
then it uses Off-peak.

LO Byte
Attr-50 LO bit 0 -
Attr-50 LO bit 1 -
Attr-50 LO bit 2 -
Attr-50 LO bit 3 -
Attr-50 LO bit 4 - **Index Enable**
Attr-50 LO bit 5 - **On-Peak Enable**
Attr-50 LO bit 6 - **Mid-Peak Enable**
Attr-50 LO bit 7 -

Attr-50 HILSNBL (bit 0..3) - **On-Peak Schedule Assignment** (FW700A..)
0 = Not Assigned, 1 = Schedule index 0, ... ,15 = Schedule index 14

Attr-50 HIMSNBL (bit 4..7) - **Mid-Peak Schedule Assignment** (FW700A..)
0 = Not Assigned, 1 = Schedule index 0, ... ,15 = Schedule index 14

Attr-50 HI Byte- **On-Peak Schedule Index** (FW740A.. )
0 = Schedule index 0. , etc.

If the On-Peak Schedule is Enabled, then the On-Peak Schedule Index (0..63) is used. If the Mid-Peak Schedule is Enabled, then the Mid-Peak Schedule Index (0..63) is used.

Attr-51 Demand Limit Enable
Attr-51 LO bit 0 - **Summary Enable** (FW740E2.0, 840E2.0)
Attr-51 LO bit 1 - Spare
Attr-51 LO bit 2 - **kW Demand Alarm Enable**
Attr-51 LO bit 3 - **Demand Level Alarm Enable**

Attr-51 LOMSNBL- - **Summary Delay Time** (FW740E2.0, 840E2.0)

Attr-51 HI Byte - - **Mid-Peak Schedule Index** (FW740A..)
Spare(FW700A..)

Attr-52 Enable Group
Attr-52 LOLSNBL (bit 0..3) - **Rotate Group Upper Bound**
The maximum rotate group number 1..15

Attr-52 LO bit 4 - **Rotating Demand Limit Enable**
Attr-52 LO bit 5 -
Attr-52 LO bit 6 -
Attr-52 LO bit 7 -

Attr-52 HI Byte - **Demand Rotate Interval** (minutes)
[Typical: 10 min]

Attr-53 **Meter Constant (Kh)**
The Meter Constant defines the energy usage per revolution of the utility meter which typically gives one count. It is in units of 0.01 W-hr/count. The meter constant and the meter multiplier can be found on the face plate of the watt-hour transducer. Unsigned word (0 to 655.35) [Typical: 360] 3.60

Attr-54 **Meter Multiplier (MULT)**

The Meter Multiplier depends on the current transformer used with the utility meter. The meter constant and the meter multiplier can be found on the face plate of the watt-hour transducer. Unsigned word (1 to 65535). [Typical: 800]

Attr-55

LO Byte - **Demand Sample Interval**
How frequently in minutes the demand is calculated.
N = 1 to 15. [Typical: 3 minutes]
HI Byte - **Demand Level Alarm Setpoint**
[Typical: 3]

Attr-56

LO Byte - **Sliding Window Interval**
Time in minutes over which the sliding window demand is calculated. N = 15 to 60.[Typical: 15 minutes] Demand Project Interval is the time in minutes over which the sliding window demand is projected. Demand Project Interval is the same as the Sliding Demand Window Interval

HI Byte - **Demand Level Upper Bound**

The maximum demand level to be reached under demand limit conditions. [Typical = 6]

Attr-57 **Demand Drop Level Setpoint**
[Range 0 to 65535 kW] [Typical: 100]

Attr-58 **Demand Add Level Setpoint**
[Range 0 to 65535 kW] [Typical: 100]

Attr-59,60 **Demand Meter Input Handle**

Note: The pulsed input must be configured as input type 33 (21h). This input type looks for contact closures and accumulates the number of pulses received. This value is then cleared after the demand manager has read the number of counts. The general rule is that each pulse (open, close cycle) represents one revolution of the demand meter. The input should be configured to count on rise.

Attr-61 **Demand Limit ON Setpoint**
[Range 0 to 65535 kW] [Typical: 50,000]

Attr-62 **kW Demand Alarm - ON Setpoint**
[Range 0 to 65535 kW] [Typical: 5000]

Attr-63 **Demand Limit MID Setpoint**
[Range 0 to 65535 kW] [Typical: 50,000]

Attr-64 **kW Demand Alarm - MID Setpoint**
[Range 0 to 65535 kW] [Typical: 5000]

Attr-65 **Demand Limit OFF Setpoint**
[Range 0 to 65535 kW] [Typical: 50,000]

Attr-66 **kW Demand Alarm - OFF Setpoint**
[Range 0 to 65535 kW] [Typical: 5000]

### *kW-hr History*

Attr-67 **Billing Time**
LO Byte - Minute (0..59)
HI Byte - Hour (0..23)

Attr-68 **Billing Date**
LO Byte - Day (1..31)
HI Byte - Month (1..12)

Attr-69 Spare (FW740A..)
Billing Total On-Peak kW-hr (FW700A..)

Attr-70 Spare (FW740A..)
Billing Total Mid-Peak kW-hr (FW700A..)

Attr-71 Spare (FW740A..)
Billing Total Off-peak kW-hr (FW700A..)

### *kW Maximum Demand*

Attr-72 **kW Maximum This Month** [Typical: 00 00h ]

Attr-73 **kW Maximum This Month - Time** [Typical: 00 00h ]
LO Byte - Minute (0..59)
HI Byte - Hour (0..23)

Attr-74 **kW Maximum This Month - Date** [Typical: 00 00h ]
LO Byte - Day (1..31)
HI Byte - Month (1..12)

Attr-75 **kW Maximum Previous Month**
Saved to EEPROM when time rolls over to next month.

Attr-76 **kW Maximum Previous Month - Time**
LO Byte - Minute (0..59)
HI Byte - Hour (0..23)

Attr-77 **kW Maximum Previous Month - Date**
LO Byte - Day (1..31)
HI Byte - Month (1..12)

### *Billing Totals*

The billing totals accumulate to a double word value. The Billing Time and Date are written by the host when the Billing Totals are read and cleared by the host software. Demand Action = 3 will zero the values and write a new date stamp from the clock.

Attr-78,79 **Billing Total On-Peak kW-hr** (FW740A..)
Unsigned Double Word Value

Attr-80,81 **Billing Total Mid-Peak kW-hr** (FW740A..)
Unsigned Double Word Value

Attr-82,83 **Billing Total Off-peak kW-hr** (FW740A..)
Unsigned Double Word Value