



MCS-8 Chiller Algorithms



◆ MCS-8 Chiller Software Versions

- **6 Versions of the Chiller Software:**

- CHL R08.00-? - Supports Recips, Scrolls
- CHL S08.00-? - Supports Semi-Hermetic Screws
- CHL C08.00-? - Supports Centrifugal
- CHL O08.00-? - Supports Open-Drive Screws
- CHL M08.00-? - Supports Mitsubishi Screws
- CHL I08.00-? - Ice Machine - Estero High School

◆ MCS-8 Control Options

- Supports up to 8 compressors / refrigeration circuits
- Supports up to 4 stages per compressor
- Supports up to 48 Relay Outputs
- Supports up to 48 Sensors Inputs
- Supports up to 6 Analog Outputs
- Supports 120 setpoints
- Supports 60 Alarms
- Supports 144 History Samples for all inputs & outputs

◆ MCS-8 Control Options

- Types of Compressors - Reciprocating, Open Drive Screws, Scrolls, Hitachi Screws, Bitzer Screws, Hartford Screw, Hall Screws, Carlyle screws, Hanbell Screws
- Condenser Control - None, RO Step Common, RO Step Individual per circuit, RO Step Combined, Variable Speed, Modulating Valve
- Chiller Barrel Heater
- Hot Gas Bypass – Special control logic for Screws
- Chilled Water Reset
- Two Expansions Valves Option - Screws Only
- Oil Equalization Option - Screws Only

◆ MCS-8 Control Options

- Oil Cooler Option - Screws With Oil Only
- Flow switches
- Pump down switches
- Run/Stop switch
- Network Run/Stop switch
- Emergency Stop switch
- Low Suction Unloading & Holding
- High Discharge Pressure Unloading & Holding
- High Discharge Temperature Unloading & Holding
- High Ampere Unloading & Holding

◆ MCS-8 Control Options

- Low Water Temperature Unloading & Holding
- Energy Efficient Compressor Staging – Screw only
- Chilled Water Pump Control
- Control Power Relay –No Stop
- Part Wind, Star Delta Starter, or Across the Line
- Low & High Ambient Shutdown
- English or Metric sensor readings
- Compressor Auto Rotation

◆ **Standard Chiller Lockouts**

- Freeze Protection
- No Flow Protection
- Phase Loss Protection
- Emergency Stop

◆ Standard Compressor Safeties/ Lockouts

- Low Differential Oil Pressure
- Low Suction Pressure
- Unsafe Suction Pressure
- Low Discharge Pressure
- High Discharge Pressure
- High Discharge Temperature
- HI Motor Temp or Motor Fault
- Hi Oil Temp
- Hi Motor Amp
- Low Motor Amp
- No Compress Proof
- High Oil Seal Temperature (Screw Compressors only)

◆ Chiller control decision making (fuzzy logic)

- Control on entering or leaving liquid
- Setpoints establish target / dead band zone
- Slope of control temperature is calculated
- what is current control temperature
- How far from the control target
- How fast is it moving to or away from the control target
- The decision is then made to increase, decrease or maintain the cooling capacity

◆ **Control Terms**

◆ **Description**

Target - - - - -	<i>The desired value to maintain the controlling sensor at</i>
Control Zone (+ and -) - - - -	<i>Allowable range around the target</i>
Controlling Sensor - - - - -	<i>Leaving, Return, Suction</i>
Rate of Change (Slope) - - - - -	<i>(+ / -) direction of controlled output</i>
Step Delay (Accumulator) - - -	<i>The sum of the absolute difference from Actual temperature to target</i>
Sensitivity (step) - - - - -	<i>Speed of Change (Reaction divisor)</i>

◆ Capacity Control Logic

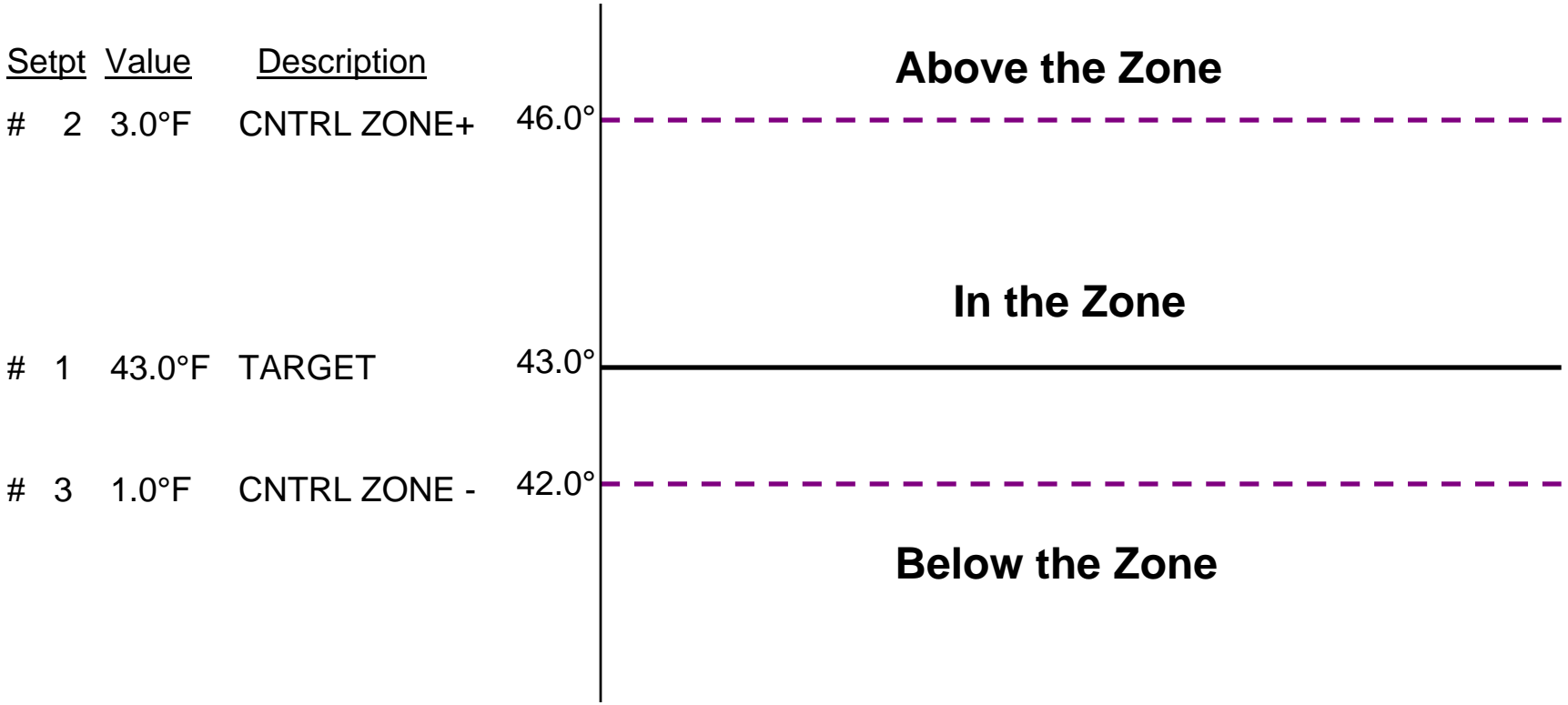
◆ Setpoints

- #1 Target
 - Leaving Liquid temperature target
- #2 Control Zone +
 - Allowable temperature above Target
- #3 Control Zone -
 - Allowable temperature below Target
- #25 Step Sensitivity
 - 1 = fast, 2 = medium, 3 = slow
- #26 Step Delay
 - Accumulator / Step Delay

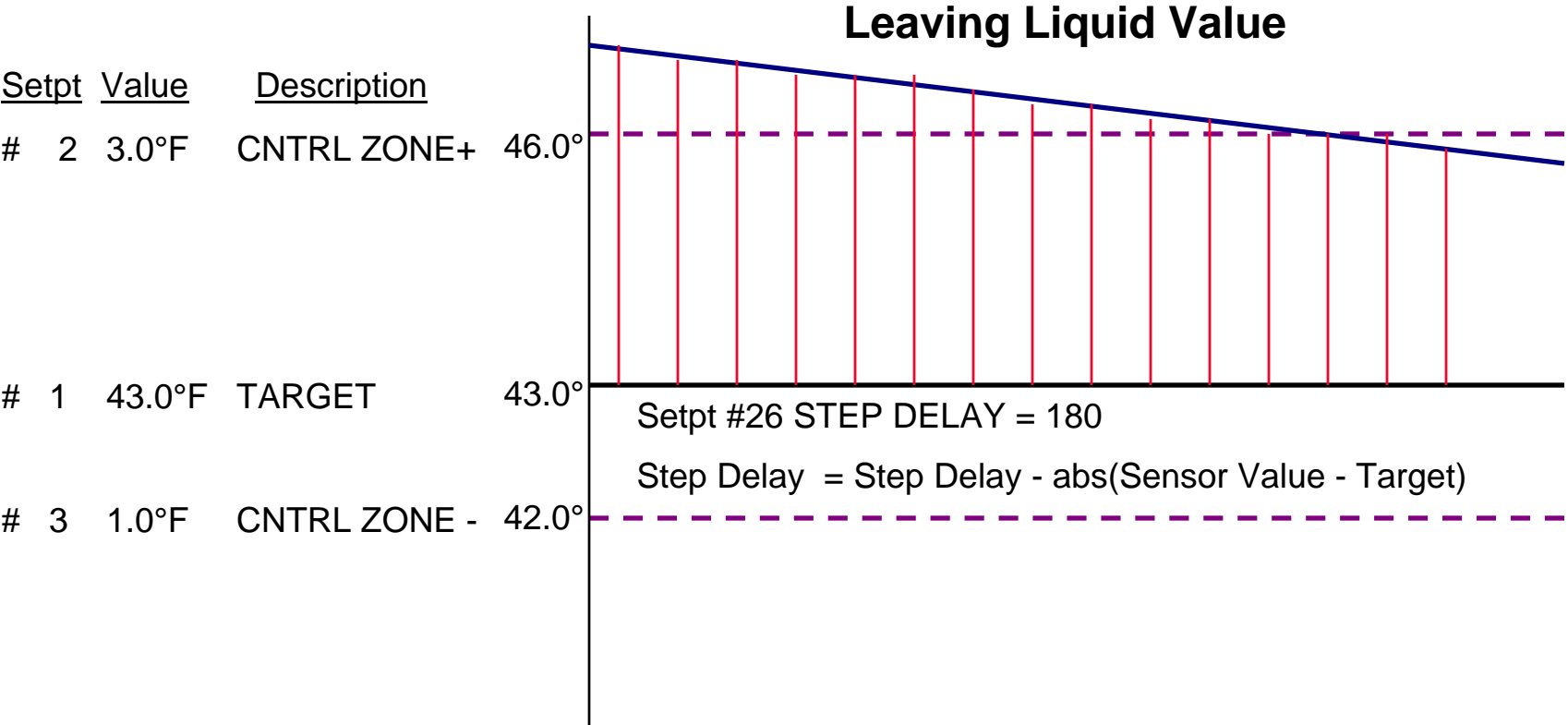
◆ Adjustment time is variable

- distance from target
- sensitivity
- accumulator / step delay

◆ Target, Control Zone +/- (Chilled Water Out Cntrl)



◆ Step Delay / Accumulator



◆ Rate Of Change-ROC (Slope)

- Setpoints
 - ◆ #27 Max ROC - - Max. neg. ROC above control zone.
 - ◆ #28 Max ROC+ - Max. pos. ROC below control zone
 - ◆ #29 ROC Interval - ROC time period (in seconds)

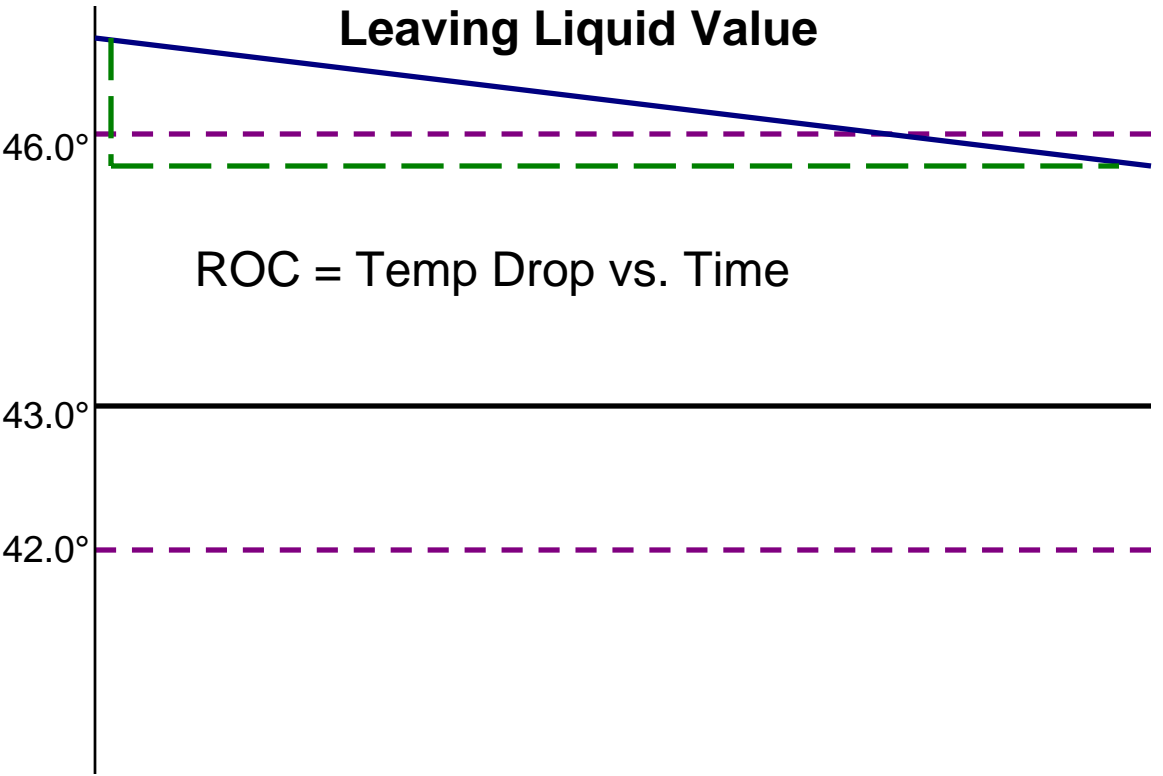
- Above Target=>LOADING unless ROC < MAX ROC- setpt
- Below Target=>UNLOADING unless ROC > MAX ROC+ setpt
- Control Zone>=HOLDING unless
 - ◆ ROC > MAX ROC+ then LOADING or
 - ◆ ROC < MAX ROC- then UNLOADING

◆ Rate of Change (Slope)

<u>Setpt</u>	<u>Value</u>	<u>Description</u>
# 2	3.0°F	CNTRL ZONE+

# 1	43.0°F	TARGET
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# 3	1.0°F	CNTRL ZONE -
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◆ Capacity Control States

- STARTUP** System Reset or Power Returned (delay of 60 seconds or set point value)
- OFF** System ready to run but no cooling capacity required
- HOLDING** No change in capacity.
- STEP -** Reducing chiller capacity - unloading.
- STEP +** Increasing chiller capacity - loading
- STOPPED** RUN STOP sensor input is OFF - chiller turned off.
- EVP FLW** FLOW SW sensor input is OFF - chiller turned off.
- SCH OFF** Operating schedule is false.
- AMB OFF** Low Ambient Temperature - chiller turned off.
- LOCKOUT** Chiller locked out, all points except alarm point are OFF
- LOST IO** Lost communication Chiller locked out

◆ Circuit Control States

- OFF** Compressor is off, not required to run.
- UNLDING** Compressor & LLS are ON and all three unloader are OFF - fully unloaded 25%.
- HG LOAD** Compressor & LLS are ON with two unloaders ON - 50% loaded.
- U1 LOAD** Compressor & LLS are ON with one unloader ON - 75% loaded.
- LOADED** Compressor & LLS are ON with all unloaders off - fully loaded 100%.
- DIS HLD** High Discharge Hold -Compressor & LLS are ON with one unloader ON - 75% loaded.
- SUC HLD** Low Suction Hold -Compressor & LLS are ON with one unloader ON - 75% loaded.
- PMP DWN** PUMP DOWN -Compressor is ON with all unloader & LLS OFF until pump down suction pressure or time delay is reached.
- ANITCYC** Anti-Cycle Delay after turning off compressor.
- SAFETY** A Safety trip has occurred - Compressor is held off for 10 minutes - Auto Reset.
- LOCKOUT** Two Safety trips have occurred with a two hour period - compressor is locked out- Manual Reset.
- LOST IO** Lost communication compressor is locked out.

◆ MCS-8 Safeties:

- ◆ The MCS-8 is designed to take corrective action to prevent a safety from occurring
- ◆ Safeties are checked every second
- ◆ Safeties can apply to the entire package or individual circuits
- ◆ If a safety does occur, the system will:
 - generate an alarm message
 - shut the circuit or package down
 - attempt to restart (after a period of time)
- ◆ If the same safety trips within a period of time a lockout will be created
- ◆ Note, time is unique to each safety

◆ Alarm Notification

- Most current alarms are displayed first
- Reason for the alarm, for example:
LOW SUCTION #1 (a low suction alarm for circuit #1 was generated)
- Each alarm is date & time stamped, for example:
MAY 30 13:17:33
- A lock out situation will not be created unless the same alarm occurs twice within a specified time