CorpsLON
DDC Requirements
UFGS 23 09 23

Building Controls Requirements

- The following is a summary of the requirements in Unified Facilities Guide Specification (UFGS) 23 09 23:
  - Not all requirements are discussed here
  - Project specific requirements are specified in contract documents
  - The information provided is for informational purposes only
  - Where conflict exists, the contract specification provides the definitive requirement

1.4.1 System Requirements
"Give us an Open system"

- The control system shall be an open implementation of LonWorks technology using ANSI/CEA-709.1B as the communications protocol and using LonMark Standard Network Variable Types as defined in LonMark Master SNVT List exclusively for communication over the network
  - Ensures multiple vendors can interoperate
- LonWorks Network Services (LNS) shall be used for all network management including addressing and binding of network variables. A copy of the LNS database shall be submitted to the project site as specified
  - Ensures 3rd party can integrate to the UMCS

1.4.1 System Requirements
"Give us an Open system"

- The hardware shall be installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality
  - Ensures we're not 'locked in' to specific vendors at the controller level

1.4.1 System Requirements "We Own the System"

- All necessary documentation, configuration information, configuration tools, programs, drivers, and other software shall be licensed to and otherwise remain with the Government…
- The Contractor shall provide sufficient documentation and data, including rights to documentation and data…

  such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor

1.4.1 System Requirements "We Own the System"

- Hardware shall be installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor
  - Ensures that no contractor has 'leverage' over the government

Sensors and Instrumentation

- Accuracy of sensors and instrumentation includes transmitter and is checked at controller input
- Specified ranges are minimum ranges – document actual range on Point Schedule
- Except temperature sensors, output shall be:
  - 0-10Vdc
  - 4-10 mAdc
  - SNVT (these sensors become ASCs)
  - For temperature sensors, we'll accept thermistors, RTDs, etc.
- Similar requirements for actuators (0-10, 4-20 or SNVT)

DDC Hardware -General Requirements-

- Locally powered (not link power) TP/FT-10 device
- Configurable via SNVT, SCPT, UCPT or hardware setting (can't use proprietary tools for ***configuration***)
  - programming can be via proprietary tools
- Communicate only using ANSI/CEA-709.1 and SNVTs
- SNVT inputs/outputs as required and shown
- SNVTs must have meaningful names identifying value they represent
- Submit XIF with controller documentation
- Expected revision adds hardware override (HOA) option

DDC Hardware
NO Gateways

- "Everything" must talk ANSI/CEA-709.1
- Gateways permitted for a single, packaged controller that doesn't talk ANSI/CEA-709.1
  - e.g. a chiller with packaged (factory installed) controls without a 709.1 network
  - May provide gateway with that specific mechanical equipment to get it on the 709.1 network
  - May NOT use for built-up (non-packaged) controls or equipment; they must be "native" 709.1
  - May NOT extend non-709.1 network beyond a single packaged equipment

DDC Hardware
-Application Specific Controller-

A controller with a fixed built-in application which is configured for the control application.

- LonMark certification required
- Must be fully configurable via LNS plug-in.
- Submit (and license) plug-in

DDC Hardware
-General Purpose Programmable Controller-

A controller with no fixed built-in application or XIF file.

- Must be configurable for the application via SNVT, SCPT, UCPT or hardware setting
  - Requires programmer to include configuration
  - Document configuration on Points Schedule
- Must provide licensed programming software/tool
- Must provide controller program source code (in a file format that the government can load into the programming tool, modify, and download to the controller)

DDC Hardware
-Application Generic Controller (AGC)-

A controller with a “limited” fixed built-in application and XIF file

- Considered a GPPC in current released specs
- Anticipated requirements in revised spec:
  - Must be programmable and configurable via LNS plug-in
  - Provide licensed programming software (usually LNS Plug-in)
  - Must provide controller program/configuration information source code (as with GPPC)

DDC Hardware
-Local Display Panel (LDP)-

DDC Hardware with a limited user interface for monitoring and control

- Current spec considers LDPs to be ASCs
- Revised spec will consider LDP a separate type
- LDPs are required at each air handler or as shown (designer option)
- Points to be viewed/overridden by LDP shown on Points Schedule (beware conflicting overrides)
- LDPs generally poll for SNVT values and need to be reconfigured after a database merge

DDC Hardware Output
Manual Overrides (HOA)

- Not in current specification
- Revised specs include HOA column on Points Schedule
- Allows integral or external HOA switches for outputs
  - Binary outputs manual ON or OFF
  - External HOA for analog outputs allow adjustment through entire range (0-100%)
  - Integral HOA for analog output allow (designer option) either:
    - Full open / full closed or
    - Adjustment through entire range

Building Control Network (BCN)
-Current Specs-

- *Backbone* with 1 or more *local control busses*
- *Backbone:*
  - Contractor performs bandwidth usage calculations
  - TP/FT-10 or IP depending on bandwidth calcs
  - No control devices connected – routers only
  - Must be available at BPOC Location
- *Local Control Bus:*
  - TP/FT-10
  - All DDC hardware connected to a *local control bus*
  - Max 2 routers/repeaters between controller & backbone

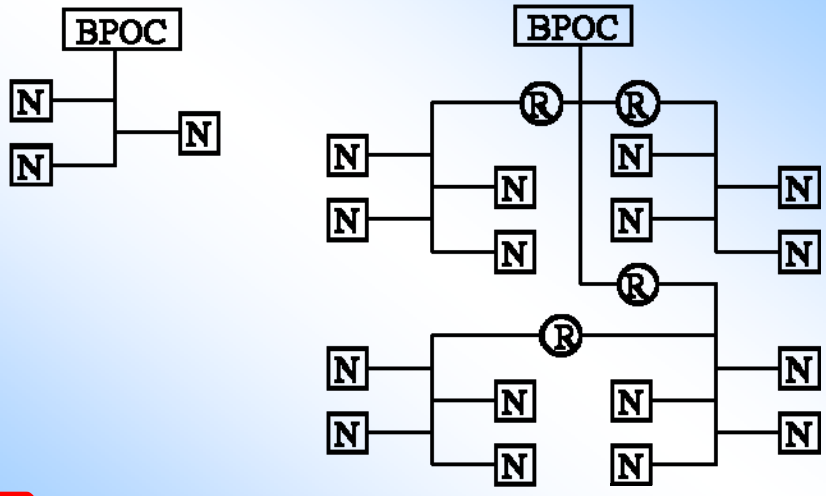
Building Control Network (BCN)
-Revised Specs-

- One or more *local control networks*
- **If more than one *local control network* provide a *backbone***
- *Building Control Network Backbone:*
  - **No more bandwidth calculations**
  - **TP/FT-10 only**
  - No control devices connected – routers only
  - Must be available at BPOC Location
  - **Only traffic allowed on backbone is to/from the UMCS/BPOC, to/from system schedulers, and shared sensors (such as outside air temp). No "control" over the backbone**

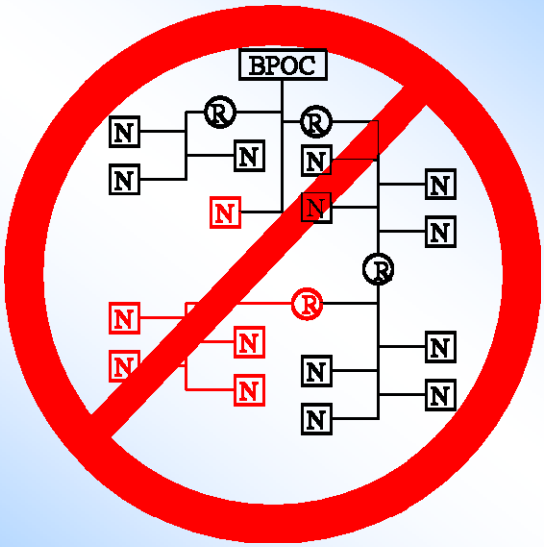
Building Control Network (BCN) -Revised Specs-

- *Local Control Network:*
  - TP/FT-10
  - All DDC hardware connected to one or more *local control networks*
  - Max 2 routers/repeaters between controller and backbone
  - **Max 40 nodes per segment**
  - **Max expected bandwidth usage of 50 packets per second**

Building Control Network Examples



Building Control Network Examples (cont.)



Network Parameters in revised spec

(not addressed in current spec)

- To ensure TP/FT-10 provides adequate bandwidth
- Use bindings with “send on change” (aka COV)
  - 1 degree F for zone temperatures
  - 0.5 degrees F for all other temperatures
  - 0.02 inches water gauge for duct pressures
  - 0.01 inches water gauge for zone pressures
  - 5% of the design maximum for flows
- Min send time: 5 sec (2 sec for pressure control)
- Max send time: 20 minutes
- Use Acknowledged Send

Network Configuration Tool must use LNS

- Building network configuration may be performed with tool of vendor's choice ***as long as it can export LNS***
- Vendor must provide valid (i.e. can be opened in any LNS-based tools) LNS database as project submittal
- LNS database must provide accurate, complete, up-to-date definition of all nodes, devices, network bindings, traffic, and communication
- LNS database must include LNS credits for all nodes/devices in the LNS database
  - Building contractor is responsible for purchasing these credits and transferring them to the government

Control Sequence Implementation

- Current spec:
  - No requirements for controller selection
  - If using multiple controllers for 1 sequence isolate with a router or repeater (provides "network surge protection")
- Expected revisions:
  - Use ASC whenever a suitable ASC exists.
  - If no suitable ASC (designer option):
    - use programmable controller(s)
    - use multiple application specific controllers
    - let contractor decide
  - If using multiple controllers isolate with a router ("network surge protection" & ensure network congestion elsewhere doesn't interfere with the sequence)

Network Overrides in revised spec

(not addressed in current spec)

- ***Override with same SNVT Type as overriden point***
  - Provide input on controller with same SNVT type as point to be overridden
  - Point is *not* overridden if input is NUL value and is overridden otherwise
- ***Override with SNVT of type HVAC_Override***
  - Provide SNVT input of type SNVT_HVAC_overrid
  - Controller may support multiple modes
  - Controller must support HVO_FLOW_PERCENT mode (permits override to 0 – 100%)
  - Document how to use override

Network Overrides
-Revised Spec-

- Other methods allowed only for ASCs (ASCs may not support the “preferred” method on previous slide)
  - Override must still be via SNVT
  - Provide 1 or more SNVT inputs and document fully how to accomplish override:
    - Values of inputs for to override point
    - Values of inputs for to NOT override point

Alarms
-Current Spec-

- Alarm SNVT generated by the building DDC system
  - Building contractor responsible for alarms
- May be generated by controller performing application or separate “alarm generator” hardware.
- Alarm SNVT bound to UMCS
- Designer option to include “redundant alarm handler”
  - For really critical alarms

- Not supported to bind alarm to UMCS
- Didn’t allow standardization of “alarm configuration” process
  - Every vendor’s alarm generator is different

Alarms
-Revised Spec-

- UMCS polls building control system and generates alarms.
- Building controls contractor must provide SNVT to poll for alarms per the Points Schedule.
- Building designer and/or contractor defines alarm conditions on points schedule for implementation by UMCS contractor
- Provides standard way of setting up alarms
  - Whatever method M&C software uses
- Redundant alarm handler removed from specification
  - Was **NEVER** used (as far as we know)

Trending

- Trending performed by UMCS
- Building contractor must provide SNVTs for trending per the Point Schedule

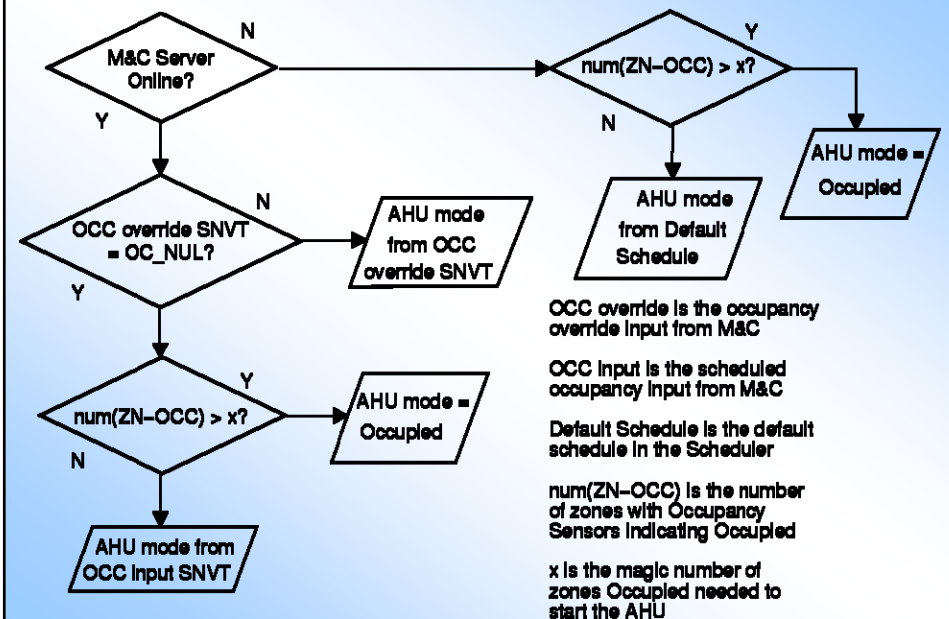
Scheduling

- Scheduling performed by UMCS with backup in building
- System Schedule Sequence of Operations specifies scheduling
- Inputs:
  - Scheduled from UMCS (SNVT_occupancy)
  - Override from UMCS (SNVT_occupancy)
  - Space occupancy from zone sensors
- Outputs:
  - Air handler occupancy output
  - Terminal unit occupancy output

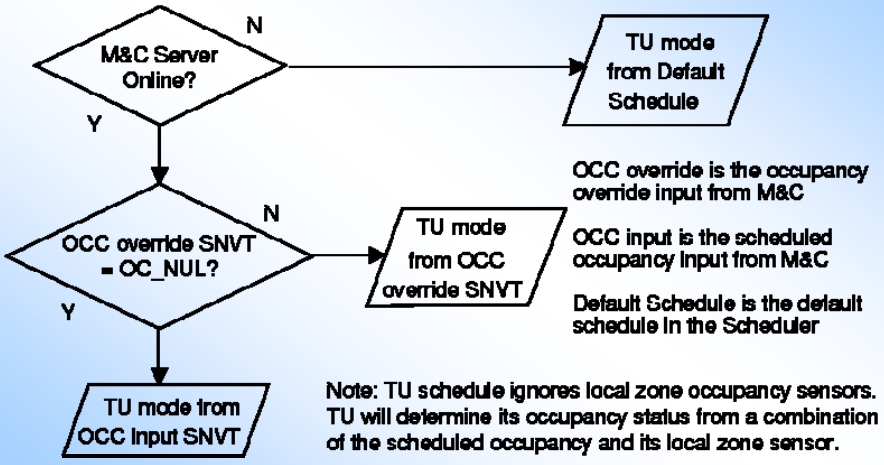
Scheduling

- Priority (high to low)
  - Override occupancy input
  - Space occupancy inputs
  - Scheduled occupancy inputs
- If more than 95 minutes has elapsed since last scheduled occupancy input, assume M&C server is offline or dead and use default schedule (and space occupancy inputs)

AHU Scheduling



Terminal Unit Scheduling



Testing / Training

- Performance Verification Test (PVT)
  - Show that the system is working as specified
  - Updated UFGS will add 1 week “endurance test”
  - Use NCT or hook up GUI temporarily if needed to demonstrate that system is functioning
- Training
  - Location/layout of controls
  - Troubleshooting controls
  - LNS Plug-ins
  - Programming tools

Project Sequencing

- (Submittal) Existing conditions report, design drawings, cut sheets, pre-construction QC checklist
- *(Execute)* Install controls
  - This is where most of the work occurs!
- *(Execute)* Startup and startup testing
- *(Submittal)* Startup report, construction QC checklist, programming software, LNS plug-ins, XIF files, draft as-built drawings

Project Sequencing

- *(Submittal)* Proposed PVT procedures
- *(Execute)* PVT
- *(Submittal)* PVT report, GPPC and AGC programs, LNS database, final as-builts
- *(Submittal)* O&M instructions
- *(Submittal)* Training plan and materials
- *(Execute)* Training
- *(Submittal)* Close-out/final QC checklist

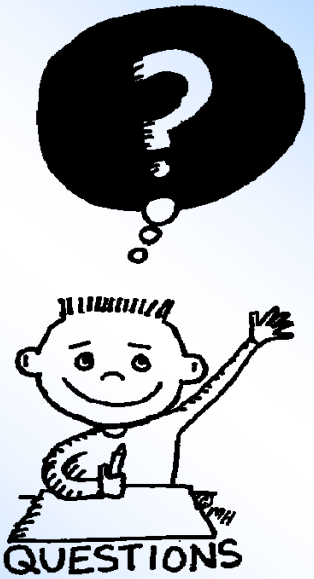
QC Checklists

(combined pre-, construction-, and final-)

- DDC hardware numbered/listed on control drawings
- Signals on control drawings labeled with name/type
- Local Display Panel locations shown on drawings
- Points Schedules broken out by DDC hardware
- All DDC hardware is on TP/FT-10 network
- All ASCs are LM certified
- All communication is via 709.1 and SNVTS
  - No explicit messaging
- All systems have schedulers and default schedules

QC Checklist

- Sequences performed as specified with DDC hardware
- Training schedule and attendees coordinated with DPW
- Accurate as-builts including Points Schedule
- LNS database is up-to-date and accurate
- LNS plug-ins for ASCs
- Programming software for GPPCs and AGCs
- Software licensed to government
- O&M instructions / manual complete and submitted
- Training completed



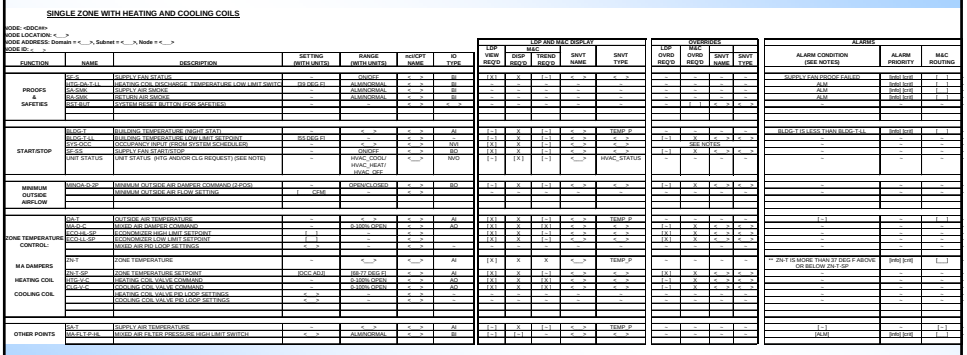
Building Control System Requirements

- Building Control Network (BCN) shall be:
  - TP/FT-10 per ANSI/CEA-709.3
  - doubly-terminated bus topology only
  - “logically flat” and peer-to-peer
  - with backbone (only routers, no devices)
- Communication via ANSI/CEA-709.1b using SNVTs only
- Gateway use is restricted:
  - Only for packaged equipment
  - One gateway per piece of packaged equipment

Building Control System Requirements

- Submit valid, accurate as-built LNS database
  - Does not specify what tool to use, but database must be “good”
- Submit all software including licenses:
  - LNS Plug-ins
  - Programming software for GPPCs and AGCs
  - Source code for GPPCs and AGCs
  - Any other software the government needs to operate, maintain, expand the system
- Submit accurate, as-built Points Schedule
  - Vital submittal required for system integration

SINGLE ZONE WITH HEATING AND COOLING COILS



FUNCTION	NAME	DESCRIPTION	SETTING (WITH UNITS)	RANGE (WITH UNITS)	In/OPT NAME	ID TYPE	LDP VIEW REQ'D	M&C DISP REQ'D	M&C TREND REQ'D	SNVT NAME	SNVT TYPE	LDP OVRD REQ'D	M&C OVRD REQ'D	SNVT NAME	SNVT TYPE	ALARM CONDITION (SEE NOTES)	ALARM PRIORITY	M&C ROUTING
PROOFS & SAFETIES	SF-S	SUPPLY FAN STATUS		ON/OFF	< >	BI	[X]	X	[-]	< >	< >	–	–	–	–	SUPPLY FAN PROOF FAILED	[today] [cri/l]	[X]
	HTG-DA-T-LL	HEATING COIL DISCHARGE TEMPERATURE LOW LIMIT SWITCH	720 DEG F	ALM/NORMAL	< >	BI	–	–	–	–	–	–	–	–	–	ALM	[today] [cri/l]	[X]
	SA-SMK	SUPPLY AIR SMOKE	–	ALM/NORMAL	< >	BI	–	–	–	–	–	–	–	–	–	ALM	[today] [cri/l]	[X]
	RA-SMK	RETURN AIR SMOKE	–	ALM/NORMAL	< >	BI	–	–	–	–	–	–	–	–	–	ALM	[today] [cri/l]	[X]
	RST-BUT	SYSTEM RESET BUTTON (FOR SAFETIES)	–	–	< >	< >	–	–	–	–	–	–	[X]	< >	< >	–	–	–
START/STOP	BLDG-T	BUILDING TEMPERATURE (NIGHT STAT)		< >	< >	AI	[–]	X	[–]	< >	TEMP_P	–	–	–	–	BLDG-T IS LESS THAN BLDG-T-LL	[today] [cri/l]	[–]
	BLDG-T-LL	BUILDING TEMPERATURE LOW LIMIT SETPOINT	750 DEG F	–	< >	< >	[–]	X	[–]	< >	< >	[–]	X	< >	< >	–	–	–
	SYS-OCC	OCCUPANCY INPUT (FROM SYSTEM SCHEDULER)	–	< >	< >	NVI	[X]	X	[–]	< >	< >		SEE NOTES			–	–	–
	SF-SS	SUPPLY FAN START/STOP		ON/OFF	< >	BO	[X]	X	[–]	< >	< >	[–]	X	< >	< >	–	–	–
	UNIT STATUS	UNIT STATUS (HTG AND/OR CLG REQUEST) (SEE NOTE)	–	HVAC_COOL/ HVAC_HEAT/ HVAC_OFF	<___>	NVO	[–]	[X]	[–]	<___>	HVAC_STATUS	–	–	–	–	–	–	–
MINIMUM OUTSIDE AIRFLOW	MNDA-D-3P	MINIMUM OUTSIDE AIR DAMPER COMMAND (2-POS)		OPEN/CLOSED	< >	BO	[–]	X	[–]	< >	< >	[–]	X	< >	< >	–	–	–
		MINIMUM OUTSIDE AIR FLOW SETTING	1 CFM	–	< >	< >	–	–	–	–	–	–	–	–	–	–	–	–
ZONE TEMPERATURE CONTROL:	OA-T	OUTSIDE AIR TEMPERATURE	–	< >	< >	AI	[X]	X	[–]	< >	TEMP_P	[–]	–	< >	< >	[–]	–	[–]
	MA-D-C	MIXED AIR DAMPER COMMAND	–	0-100% OPEN	< >	AO	[X]	X	[X]	< >	< >	[X]	X	< >	< >	–	–	–
	ECO-HL-SP	ECONOMIZER HIGH LIMIT SETPOINT	[–]	–	< >	< >	[X]	X	[–]	< >	< >	[X]	X	< >	< >	–	–	–
	ECO-LL-SP	ECONOMIZER LOW LIMIT SETPOINT	[–]	–	< >	< >	[X]	X	[–]	< >	< >	[X]	X	< >	< >	–	–	–
		MIXED AIR PID LOOP SETTINGS	< >	–	< >	–	–	–	–	–	–	–	–	–	–	–	–	–
M A DAMPERS	ZN-T	ZONE TEMPERATURE	–	<___>	<___>	AI	[X]	X	X	<___>	TEMP_P	–	–	–	–	** ZN-T IS MORE THAN 37 DEG F ABOVE OR BELOW ZN-T-SP	[today] [cri/l]	[___]
HEATING COIL	ZN-T-SP	ZONE TEMPERATURE SETPOINT	(OCC ADJ)	RB-TT (DEG F)	< >	AI	[X]	X	[–]	< >	< >	[X]	X	< >	< >	–	–	–
	HTG-V-C	HEATING COIL VALVE COMMAND	–	0-100% OPEN	< >	AO	[X]	X	[X]	< >	< >	[–]	X	< >	< >	–	–	–
COOLING COIL	CHG-V-C	COOLING COIL VALVE COMMAND	–	0-100% OPEN	< >	AO	[X]	X	[X]	< >	< >	[–]	X	< >	< >	–	–	–
		HEATING COIL VALVE PID LOOP SETTINGS	< – – >	–	< >	–	–	–	–	–	–	–	–	–	–	–	–	–
		COOLING COIL VALVE PID LOOP SETTINGS	< – – >	–	< >	–	–	–	–	–	–	–	–	–	–	–	–	–
OTHER POINTS	SA-T	SUPPLY AIR TEMPERATURE	–	< >	< >	AI	[–]	X	[–]	< >	TEMP_P	–	–	–	–	[–]		[–]
	MA-FLT-P-HL	MIXED AIR FILTER PRESSURE HIGH LIMIT SWITCH	< >	ALM/NORMAL	< >	BI	[–]	[–]	–	< >	< >	–	–	–	–	[ALM]	[today] [cri/l]	[–]

Example Points Schedule

SINGLE ZONE WITH HEATING AND COOLING COILS

NODE: <DDC##>
NODE LOCATION: <___>
NODE ADDRESS: Domain = <___>, Subnet = <___>, Node = <___>
NODE ID: <___>

FUNCTION	NAME	DESCRIPTION	SETTING (WITH UNITS)	RANGE (WITH UNITS)	nci/CPT NAME	IO TYPE
PROOFS & SAFETIES	SF-S	SUPPLY FAN STATUS	–	ON/OFF	<___>	BI
	HTG-DA-T-LL	HEATING COIL DISCHARGE TEMPERATURE LOW LIMIT SWITC	[39 DEG F]	ALM/NORMAL	<___>	BI
	SA-SMK	SUPPLY AIR SMOKE	–	ALM/NORMAL	<___>	BI
	RA-SMK	RETURN AIR SMOKE	–	ALM/NORMAL	<___>	BI
	RST-BUT	SYSTEM RESET BUTTON (FOR SAFETIES)	–	–	<___>	<___>
START/STOP	BLDG-T	BUILDING TEMPERATURE (NIGHT STAT)	–	<___>	<___>	AI
	BLDG-T-LL	BUILDING TEMPERATURE LOW LIMIT SETPOINT	[55 DEG F]	–	<___>	–
	SYS-OCC	OCCUPANCY INPUT (FROM SYSTEM SCHEDULER)	–	<___>	<___>	NVI
	SF-SS	SUPPLY FAN START/STOP	–	ON/OFF	<___>	BO
	UNIT STATUS	UNIT STATUS (HTG AND/OR CLG REQUEST) (SEE NOTE)	–	HVAC_COOL/ HVAC_HEAT/ HVAC_OFF	<___>	NVO
MINIMUM OUTSIDE AIRFLOW	MINOA-D-2P	MINIMUM OUTSIDE AIR DAMPER COMMAND (2-POS)	–	OPEN/CLOSED	<___>	BO
		MINIMUM OUTSIDE AIR FLOW SETTING	[____CFM]	–	<___>	
ZONE TEMPERATURE CONTROL:	OA-T	OUTSIDE AIR TEMPERATURE	–	<___>	<___>	AI
	MA-D-C	MIXED AIR DAMPER COMMAND	–	0-100% OPEN	<___>	AO
	ECO-HL-SP	ECONOMIZER HIGH LIMIT SETPOINT	[___]	–	<___>	
	ECO-LL-SP	ECONOMIZER LOW LIMIT SETPOINT	[___]	–	<___>	
		MIXED AIR PID LOOP SETTINGS	<___>	–	<___>	–
MA DAMPERS	ZN-T	ZONE TEMPERATURE	–	<___>	<___>	AI
	ZN-T-SP	ZONE TEMPERATURE SETPOINT	[OCC ADJ]	[68-77 DEG F]	<___>	AI
HEATING COIL	HTG-V-C	HEATING COIL VALVE COMMAND	–	0-100% OPEN	<___>	AO
COOLING COIL	CLG-V-C	COOLING COIL VALVE COMMAND	–	0-100% OPEN	<___>	AO
		HEATING COIL VALVE PID LOOP SETTINGS	<___>	–	<___>	–
		COOLING COIL VALVE PID LOOP SETTINGS	<___>	–	<___>	–
OTHER POINTS	SA-T	SUPPLY AIR TEMPERATURE	–	<___>	<___>	AI
	MA-FLT-P-HL	MIXED AIR FILTER PRESSURE HIGH LIMIT SWITCH	<___>	ALM/NORMAL	<___>	BI

Example Points Schedule (left side)

LDP AND M&C DISPLAY					OVERRIDES				ALARMS		
LDP VIEW REQ'D	M&C DISP REQ'D	M&C TREND REQ'D	SNVT NAME	SNVT TYPE	LDP OVRD REQ'D	M&C OVRD REQ'D	SNVT NAME	SNVT TYPE	ALARM CONDITION (SEE NOTES)	ALARM PRIORITY	M&C ROUTING
[X]	X	[–]	<___>	<___>	–	–	–	–	SUPPLY FAN PROOF FAILED	[info] [crit]	[___]
–	–	–	–	–	–	–	–	–	ALM	[info] [crit]	[___]
–	–	–	–	–	–	–	–	–	ALM	[info] [crit]	[___]
–	–	–	–	–	–	–	–	–	ALM	[info] [crit]	[___]
–	–	–	–	–	–	[___]	<___>	<___>	–	–	–
[–]	X	[–]	<___>	TEMP_P	–	–	–	–	BLDG-T IS LESS THAN BLDG-T-LL	[info] [crit]	[___]
[–]	X	[–]	<___>	<___>	[–]	X	<___>	<___>	–	–	–
[X]	X	[–]	<___>	<___>	SEE NOTES				–	–	–
[X]	X	[–]	<___>	<___>	[–]	X	<___>	<___>	–	–	–
[–]	[X]	[–]	<___>	HVAC_STATUS	–	–	–	–	–	–	–
[–]	X	[–]	<___>	<___>	[–]	X	<___>	<___>	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
[X]	X	[–]	<___>	TEMP_P	–	–	–	–	[–]	–	[___]
[X]	X	[X]	<___>	<___>	[–]	X	<___>	<___>	–	–	–
[X]	X	[–]	<___>	<___>	[X]	X	<___>	<___>	–	–	–
[X]	X	[–]	<___>	<___>	[X]	X	<___>	<___>	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
[X]	X	X	<___>	TEMP_P	–	–	–	–	** ZN-T IS MORE THAN 37 DEG F ABOVE OR BELOW ZN-T-SP	[info] [crit]	[___]
[X]	X	[–]	<___>	<___>	[X]	X	<___>	<___>	–	–	–
[X]	X	[X]	<___>	<___>	[–]	X	<___>	<___>	–	–	–
[X]	X	[X]	<___>	<___>	[–]	X	<___>	<___>	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
[–]	X	[–]	<___>	TEMP_P	–	–	–	–	[–]	–	[–]
[–]	[–]	–	<___>	<___>	–	–	–	–	[ALM]	[info] [crit]	[___]

Example Points Schedule (right side)