

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for building automation controllers including:
    - .1 Master Control Unit (MCU).
    - .2 Terminal Control Unit (TCU).

**1.2**      **RELATED SECTIONS**

- .1 Section 25 05 01 - EMCS: General Requirements.
- .2 Section 25 30 02 - EMCS: Field Control Devices.
- .3 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

**1.3**      **REFERENCES**

- .1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE, Applications Handbook, SI Edition.
  - .2 ASHRAE Standard 135 – BAC net – A Data Communications Protocol for Building Automation and Control Networks.
  - .3 ASHRAE Standard 135.1 Method of Test Conformance to BAC net.
- .2 Canadian Standards Association (CSA)
  - .1 C22.2 No.205, Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE)
  - .1 IEEE C37.90.1, Surge Withstand Capabilities Test for Protective Relays and Relays Systems.

**1.4**      **DEFINITIONS**

- .1 Acronyms used in this section include: see Section 25 05 01 - EMCS: General Requirements.

**1.5**      **SYSTEM DESCRIPTION**

- .1 General: Network of controllers comprising of MCU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these

specifications.

- .1 Provide sufficient controllers to meet intents and requirements of this section.
- .2 Controllers quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units:
  - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
  - .2 Incorporate communication interface ports for communication LANs to exchange information with other Controllers.
  - .3 Capable of interfacing with operator interface device.
  - .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need with other controllers. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

## 1.6

### DESIGN REQUIREMENTS

- .1 To include:
  - .1 Scanning of AI and DI connected inputs for detection of change of value and processing the detection of alarm conditions.
  - .2 Perform On-Off digital control of connected points, including the resulting required states generated through programmable logic output.
  - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
  - .4 Control of systems as described in sequence of operations.
  - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs: at least 25% of each point type distributed throughout the MCUs.
- .3 Field Termination and Interface Devices.
  - .1 To conform to CSA C22.2 No. 205.
  - .2 Electronically interface sensors and control devices to processor unit.
  - .3 Include, but not be limited to, following:
    - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
    - .2 Power supplies for operation of logic devices and associated field equipment.
    - .3 Lockable wall cabinet.
    - .4 Required communications equipment and wiring.
    - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

- .6 Input/Output interface to accept as minimum AI, AO, DI, DO functions as specified.
- .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
- .4 AI interface equipment to:
  - .1 Convert analog signals to digital format with 12 bit analog-to-digital resolution.
  - .2 Provide for following input signal types and ranges:
    - .1 4 - 20 mA;
    - .2 0-10V DC
    - .3 10 K ohm.
    - .3 Meet IEEE C37.90.1 surge withstand capability.
    - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
    - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
  - .1 Convert digital data from controller processor to acceptable analog output signals using 12 bit digital-to-analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 4 - 20 mA.
    - .2 0 - 10 V DC.
    - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
  - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
  - .2 Meet IEEE C37.90.1 surge withstand capability.
  - .3 Accept pulsed inputs up to 2 kHz.
- .7 DO interface equipment:
  - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
  - .2 Switch up to 5 amps at 220 V AC using optional interface relay.
- .4 Controller's and associated hardware and software: operate in conditions of 0C to 44C and 20% to 90% non-condensing RH.
- .5 Controllers (MCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
  - .1 Provide for conduit entrance from top, bottom or sides of panel.
  - .2 ECUs to be mounted in equipment enclosures or separate enclosures.

- .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

## 1.7 SUBMITTALS

- .1 Make Submittals in accordance with Section 01 33 00 – Submittal Procedures.
  - .1 Submit product data sheets for each product item proposed for this project.

## PART 2 PRODUCTS

### 2.1 MASTER CONTROL UNIT (MCU)

- .1 Primary function of MCU is to provide co-ordination and supervision of subordinate devices. Supervisory role shall include coordination of subordinate devices in the execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices. Include support for Open System Protocols, BACnet.
- .3 MCU shall have local I/O capacity as follows;
  - .1 To have at least 16 I/O points of which minimum to be 2AO, 6AI, 4DI, 4DO.
- .4 Central Processor Unit (CPU)
  - .1 Processor to consist of at minimum a 16-bit microprocessor capable of supporting software to meet specified requirements.
  - .2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.
  - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least all performance and technical specifications. Memory to include:
    - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
    - .2 Battery backed (72 hr minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) RAM to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and

CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS, CAB-Gateway, or locally installed floppy disk.

- .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving month/day/hour/minute/second, with rechargeable batteries for minimum 72 hr operation in event of power failure.

## 2.2 TERMINAL CONTROL UNIT (TCU)

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
  - .1 The TCU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.
- .3 Evaporator Terminal Controller
  - .1 Bi-directional thermostat-main control board of the system communication. Remote zone control, temperature sensor with configurable offset. Sequence of operation to ASHRAE HVAC Applications Handbook.
  - .2 Controller to support point definition; in accordance with section 25 05 01 – EMCS: General Requirements.
  - .3 Controller to operate independent of network in case of communication failure.
- .4 Controller to include damper actuator and terminations for input and output sensors and devices.

## 2.3 SOFTWARE

- .1 General:
  - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
  - .2 To include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
  - .3 Include initial programming of all Controllers, for entire system.
- .2 Program and data storage:
  - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
  - .2 Maintain CDL and operating data such as setpoints, operating constants,

alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

- .3 Programming languages:
  - .1 Control Description Logic software to be programmed using English like or graphical, high level, general control language.
  - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed.
- .4 Operator terminal interface:
  - .1 MCU to perform operating and control functions including:
    - .1 Multi-level password access protection to allow user/manager to limit workstation control.
    - .2 Alarm management: processing and messages.
    - .3 Operator commands.
    - .4 Reports.
    - .5 Displays.
    - .6 Point identification.
- .5 Pseudo or calculated points:
  - .1 Software to have access to any value or status in controller or other networked controller so as to define and calculate pseudo point from other values/status of controller. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
  - .2 Inputs and outputs for any process to be able to include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to any number of other processes (eg. cascading).
- .6 Control Description Logic (CDL):
  - .1 Capable of generating on-line project-specific control loop algorithms (CDLs). CDLs to be software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
  - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (eg. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS or BC(s) and to tune control loops.
  - .3 Perform changes to CDL on-line.
  - .4 Control logic to have access to values or status of all points available to controller including global or common values, allowing cascading or inter-locking control.

- .5 Energy optimization routines such as supply temperature reset, etc. to be MCU resident functions and form part of CDL.
- .6 MCU to be able to perform following pre-tested control algorithms:
  - .1 Two position control.
  - .2 Proportional Integral and Derivative (PID) control.
  - .3 Automatic control loop tuning.
- .7 Control software to provide the ability to define the time between successive starts for each piece of equipment to reduce cycling of motors.
- .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- .9 Power Fail Restart: Upon detection of power failure system to verify availability of emergency power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
- .7 Event and Alarm management: The system to use a management by exception concept for Alarm Reporting. This is a system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as a direct result of the primary event to be suppressed by the system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when fans stopped, or General Fire condition shuts fans down, only Fire alarm status shall be reported. The exception is, when a fan which is supposed to stop or start fails to do so under the event condition.
- .8 Energy management programs: The following programs shall include specific summarizing reports, to include the date stamp indicating sensor details which activated and or terminated the feature.
  - .1 MCU in coordination with subordinate TCU to provide for the following energy management routines:
    - .1 Time of day scheduling.
    - .2 Calendar based scheduling.
    - .3 Holiday scheduling.
    - .4 Temporary schedule overrides.
    - .5 Optimal start stop.
    - .6 Night setback control.
    - .7 Peak demand limiting.
    - .8 Temperature compensated load rolling.

- .9 Fan speed/flow rate control.
- .10 Hot water reset.
- .11 Refrigerant reset.
- .12 Condenser reset.
- .13 Night purge.
- .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
- .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.
- .9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
  - .1 MCUs to accumulate and store automatically run-time for binary input and output points.
  - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.
  - .3 MCU to automatically count events daily, weekly or monthly basis.
  - .4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.
  - .5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWh, litres, tonnes, etc.).
  - .6 Store event totalization records with minimum of 9,999,999 events before reset.
  - .7 User to be able to define warning limit and generate user-specified messages when limit reached.

## 2.4 LEVELS OF ADDRESS

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
  - .1 Display analog values digitally to 1 place of decimals with negative sign as required.
  - .2 Update displayed analog values and status when new values received.
  - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
  - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

## 2.5 POINT NAME SUPPORT

- .1 Controllers (MCU) to support point naming convention as defined in Section 25 05 01 – EMCS: General Requirements.

**PART 3**      **EXECUTION**

**3.1**            **LOCATION**

- .1            Location of Controllers to be approved by Departmental Representative.

**3.2**            **INSTALLATION**

- .1            Install Controllers in secure enclosures as indicated.
- .2            Provide necessary power from local 240 V branch circuit panel for equipment.
- .3            Install tamper locks on breakers of circuit breaker panel.
- .4            Use Uninterruptible Power Supply (UPS) and emergency power when equipment must operate in an emergency and co-ordinating mode.

**END OF SECTION**