TechData Sheet

Naval Facilities Engineering Service Center
Port Hueneme, California 93043-4370

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Direct Digital Control Technology

Definitions and Policy

Direct digital control (DDC) is a term used by industry to identify digital control systems for heating, ventilating, and air-conditioning (HVAC) systems.

DDC is replacing pneumatic and electric control systems traditionally used in the HVAC industry. More than 90 percent of new construction in the U. S. today uses DDC. Its advantages over the older systems include:

- Lower maintenance
- More accurate and reliable temperature control
- Built-in energy and maintenance management functions

DDC uses standalone and distributed control technology. ***Standalone controllers*** do not require information from other controllers or computers to maintain control. A failure of one controller will not directly affect the operation of another controller. ***Distributed DDC controllers*** are usually located near the equipment they control (e.g., one controller for an air handling unit (AHU) or one controller for a variable air volume (VAV) box).

The Government has used numerous acronyms for energy management systems over the years including, BAS, EMS, EMCS, UMCS, UCS, CMCS, and CMS. Since DDC combines both the function of conventional controls (automatic temperature control) and energy management systems into one, the Navy is using the industry standard acronym DDC to describe this technology.

Building level DDC systems may be accessed remotely from workstations over local area networks (LANs) or telephone lines. This allows the maintenance department to remotely troubleshoot HVAC problems. This also allows engineering and energy departments to oversee operation and management of building conditions and energy efficiency.

Within a building, the following are usually controlled and/or monitored by standalone digital controllers: ***HVAC systems, lighting systems***, and ***energy consumption and demand***.

Many other building systems may be automated with DDC technology. Building automation refers to the integration of building systems and the DDC system. Common building systems with microprocessors include:

- Fire
- Security
- Building power systems
- Chillers and computer room air-conditioning units

However, we generally recommend minimizing building automation until the technology of integrating these systems matures. Currently, we recommend integrating larger chillers (>150 tons) with DDC systems for all projects.

Technology

Figure 1 outlines a typical building level DDC system. The DDC system contains two levels of controllers. ***Level I*** controllers, sometimes called system controllers, have more programming flexibility and provide communications routing and supervisory control of the Level II controllers. System controllers are linked together on a high speed network often operating at over 1,000,000 bits per second (BPS). The two most common Level I LANs used in the industry are Ethernet and ARCnet. System controllers control larger HVAC equipment, such as central plants (chilled and hot water systems) and larger, more complex air handling units.

Level II controllers are used for smaller equipment such as small air handling units, and terminal equipment (VAV boxes, fan coil units, heat pumps, etc.). This equipment has less complex control strategies. Usually there is one controller for each piece of HVAC equipment. Level II controllers are connected together on lower speed networks (9,600 BPS and higher) and often use RS-485 communications.

Typical buildings will consist of one or more Level I controllers and numerous Level II controllers. A 100,000 square foot building may have over 100 controllers distributed throughout the facility.

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Wide area LANs are used to connect remote workstations and multiple building DDC systems. This allows more efficient monitoring and troubleshooting of the buildings' HVAC systems. The wide area network may be an existing basewide data communication LAN or a new dedicated LAN. A wide area LAN is shown in Figure 1.

Benefits

Major benefits of DDC include:

- Accurate and reliable HVAC control systems.
- Improved indoor air quality and temperature control.
- Built in energy management features to control temperature control strategies.
- Reduces controls calibration (digital controllers do not require calibration).
- Remote troubleshooting of HVAC temperature control problems (problems often are identified before occupants are aware of the problem).
- Remote alarming and reporting.
- Provides a tool to maintain facility HVAC systems and manage energy consumption.

DDC Design Guidance

We do not recommend the installation of DDC systems if it is used exclusively for energy management functions such as start/stop of mechanical equipment. Digital timeclocks/thermostats are better choices for these functions. The value of DDC lies in its superior performance in controlling and monitoring HVAC systems compared to conventional control systems.

Designers should use Naval Facilities Guide Specification (NFGS) 15910 (formally 15972) for all DDC design. A standard controls drawing format is provided in Figure 2. This drawing includes:

- Flow diagram of mechanical equipment.
- Sequence of operation.
- Simple points list (directly shown on the mechanical system's flow diagram).
- Simple electrical ladder diagram.

Design the DDC system to control the complete mechanical system. DDC should not be used for a timeclock only. Generally, in small buildings (10,000 to 20,000 square feet), the DDC controls can be reduced to very simple systems. If remote monitoring is not desired, a simple digital thermostat for small rooftop AHUs is adequate. Even if remote communications is desired, the DDC system should be designed as simple as possible.

When designing DDC systems, be sure to include utility meters. Specify the energy and maintenance management reports required by the customer.

Developing a Facility Wide DDC Program

We encourage the following long-term approach to developing functioning DDC systems and integrating multiple DDC system manufacturers into one DDC workstation.

The standard data communication protocol Building Automation and Control Network (BACnet™), ASHRAE/ ANSI Standard 135-1995, was developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and adopted by the American National Standards Institute (ANSI). Using this standard will provide some of the answers to compatibility problems caused by using multiple DDC manufacturers.

The following are our recommendations in developing a facility-wide DDC system:

- Use standalone DDC controls within the building.
- Provide workstation(s) in the same building with the manufacturer specific workstation software.
- Provide BACnet™ Gateway or Level I "Native" speaking BACnet controllers to link building proprietary DDC systems to the global BACnet™ maintenance workstation.
- Provide BACnet™ workstations at the maintenance shop and engineering/energy departments.
- Use an activity wide local area network (e.g., basewide Ethernet LAN) to link the BACnet™ workstation to the building's BACnet™ Gateway.
- Limit the competition of DDC system manufacturers to reduce the number of proprietary programming languages that must be learned.

The primary reasons for installing DDC are improved comfort, increased energy efficiency, and improved maintenance. When the activity takes an active role in the operation of DDC systems, these primary goals will be achieved. Installation of a PC workstation within the building will allow occupants to monitor conditions and allow maintenance personnel to troubleshoot the mechanical system. This workstation will operate the DDC system manufacturer's graphic software and include all software required to reprogram the controllers and modify graphics.

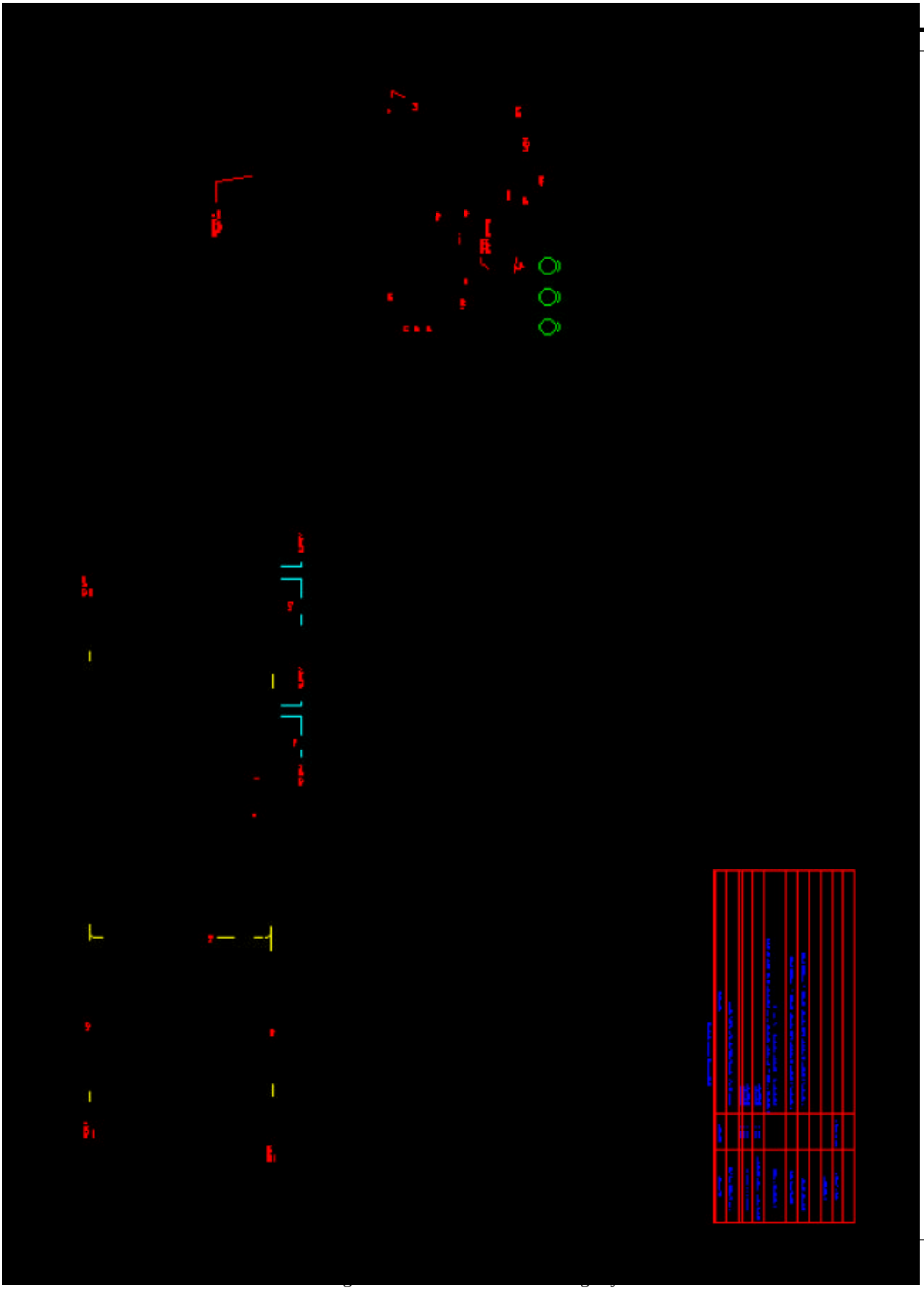
Use of BACnet™ will allow reading and writing of information (temperature, setpoints, schedules, etc.) between the building control system and global BACnet™ maintenance and engineering workstations.

The BACnet™ workstation allows maintenance and engineering departments remote monitoring and control of the different DDC systems. Ideally, the BACnet™ workstations will communicate with the different DDC systems using the basewide LAN. If a basewide or activity wide LAN does not exist, design the workstations to communicate over dedicated or dial up phone lines.

Even with BACnet™, we recommend continuing to limit the competition of DDC manufacturers. Small facilities should limit the competition to one or two manufacturers. For larger facilities, limit the competition to two to four manufacturers. Limiting the competition is not a requirement, however, each DDC manufacturer will continue to use their proprietary programming language(s). Limited competition eliminates the requirement to learn several programming languages and allows the staff to concentrate on mastering a manageable number of DDC systems.

Successful DDC installations provide an excellent tool to better manage and maintain our shore facilities. As the Navy's center of expertise for DDC, NFESC will continue to follow ASHRAE's and the industry's developments to update our criteria and guidance for the Navy's increasing procurement of DDC systems.

If you have questions about direct digital controls, call ***Karl Swanson***, ESC22, at (805) 982-3901, DSN: 551-3901, or through the Internet: kswanson@nfesc.navy.mil.



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