

The Unit Controller (an example of an Intelligent Responder) is located at or in the Heat / Cool Unit. It is hard wired to a wall-mounted Temperature Display/Control which measures the room temperature and allows control input from the user. Combined they completely control the the Heat / Cool Unit. The Unit Controller is assigned its own ID in the same manner as a Responder and its major operating parameters, including occupied / unoccupied status and set point, can be modified using PLC. During unoccupied status the deadband is opened to allow energy savings. The space temperature and the Unit Controller status can be reported via PLC to the Controller. From the perspective of the Controller it looks like a Responder with DO, DI, AI and AO.

The Unit Controller represents a major step toward distributed intelligence by combining local control of loads with PLC communication. This assures continued control of the Heat / Cool Units even if the Controller or the PLC equipment goes down. Typical uses are for controlling heat pumps and small packaged heater / air conditioner units. Other examples of Intelligent Responders are covered in A456.

## 2.6 LOADS, SENSORS & HEAT / COOL UNITS

The choice of which loads are to be controlled and which sensors are to be interrogated should be dictated by the manufacturer of the Controller or by the installer in order to achieve the proper control algorithm.

## ★ 2.7 LAYING OUT THE PLC JOB ★

In the use of power-line carrier equipment it is paramount to realize that the PLC signal amplitude is attenuated, or reduced, as it is propagated throughout a building's electrical system, as is normal with any form of communications. Just as the 60 Hz power-line voltage is attenuated over long runs of conductor, so is the PLC signal. To minimize the detrimental effects of signal reduction, proper layout is essential. To insure proper operation of PLC, the following rules must be followed:

1. The CTME or CTR absolutely must be installed within a maximum of 10 feet (wire run distance) of each of the building main electrical disconnects. The shortest possible distance is recommended. Connection must be through a 5- to 20-ampere fused disconnect (not time-lag or slow-blow and not a breaker) to all phases of the load side of each of the main electrical disconnects.
2. A good equipment ground must be connected to the CTME or CTR. A separate wire may have to be run to a known good ground.
3. The CTME or CTR absolutely must be installed downline from current transformers.
4. Installation of a CTR or CTME on the load side of a secondary (branch) disconnect close to a main disconnect may not be used to communicate with Responders or IRs that are fed from other secondary (branch) disconnects.
5. If there are voltage step-down transformers between the building main electrical disconnect and any Responder or IR then a Transformer Bypass (TB4) can be used to shunt the PLC around that step-down transformer but only under definite, limited conditions, which are the following:
  - a. The rating of the step-down transformer is no more than 100KVA.
  - b. Equipment Ground must be continuous throughout the facility including the ac service supplied by the step-down transformer.

- c. No more than 20 Responders or IRs are being fed from the secondary of the step-down transformer.
- d. The length of the ac wire run from the building main electrical disconnect to the step-down transformer is no more than 250 feet.
- e. The primary voltage of the step-down transformer is no more than 600 Vac.

If all of the above conditions are not fully met then an additional CTME or CTR must be installed at the load side of the step-down transformer and hard wired to the Command Synthesizer.

The layout of the ac lines in a building is typically in the shape of branches of a tree, which makes for short wire runs and little voltage drop from the starting point to the end points. By comparison, one long wire run, which would go from the starting point and attach to each electrical load in succession before ending at the last electrical load, would result in a substantial voltage loss at the last electrical load. That type of wire run would also result in poor PLC communication not only because of long wire runs but also because the PLC signal will be attenuated by all preceding Responders. Therefore, when a dedicated line (case L) is installed, the installer must make certain the line is installed as branches of a tree instead of one long run. There are legitimate reasons for using case L in PLC communication, such as when there are many electrical services in a shopping mall and the need for many signal couplers can be eliminated by the use of case L. Wiring of these installations **must** avoid one long wire run to eliminate possible communications problems.

In wiring the PLC signal from the Command Synthesizer to the CTME or CTR, use two-conductor jacketed cable. Use 22-gauge for up to 1,500 feet of cable, 20-gauge for up to 2,500 feet of cable, and 18-gauge for up to 4,000 feet of cable. Cable with shield is recommended but not absolutely necessary. Where other existing wire is available, the round-trip resistance of the wire should be limited to 50 ohms. The outgoing signal has an RF carrier and may cause interference with telephone lines sharing the same shield. The one cable handles signals going to and from the CTR.

## 2.8 FREE-STANDING vs INTEGRATED PLC

If a Command Synthesizer is not integrated into the Controller it is referred to as free-standing PLC. The Command Synthesizer is point-per-point wired to the Controller. It appears to the Controller as if it is directly wired to the various DO, DI, AO and AI points. Free-standing PLC can be used to add the cost saving advantages of PLC to energy management systems using almost any Controller. This type of system is also useful in expanding existing hard-wired energy management systems, particularly when the added points are remote from the Controller. Drawing 3 illustrates the head-end portion of a one-way free-standing PLC system and Drawing 4 illustrates the head-end portion of a two-way free-standing PLC system. Drawing 5 illustrates the head-end portion of a generic integrated two-way PLC system in which the Command Synthesizer is part of or integrated with the Controller.

## 3. COMPONENTS OF A PLC SYSTEM

The Data Sheets in the latter part of this manual describe and specify the components making up a PLC system.