

# APPLICATION NOTE - 1012

*Topic:* A NEW METHOD FOR CONTROLLING LARGE  
ELECTRIC FURNACE LOADS

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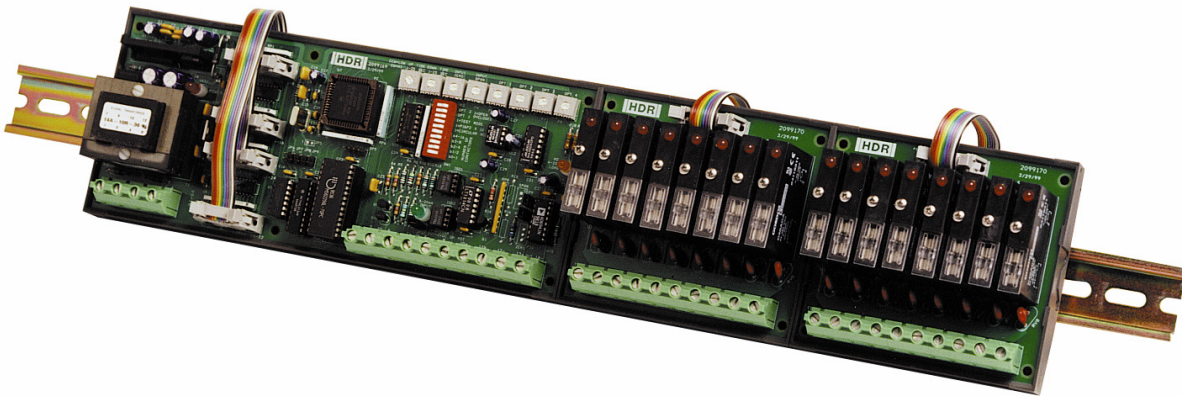
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## INTRODUCTION

As we all know, most large single zone heating systems requiring higher kilowatts have multiple banks of smaller heating elements. These heater banks can be controlled by any of these methods:

1. A single large electro-mechanical contactor
2. A large SCR Power Controller
3. Several smaller electro-mechanical contactors
4. Several smaller SCR Power Controllers
5. Combination of several small contactors and one SCR Power Controller

The last method is easily made possible by AMETEK HDR's Base-Load-Controller (BLC).



**Figure 1 - AMETEK HDR's Base-Load-Controller with 16  
Base Load outputs and one SCR Power Controller output**

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Have you ever had a heating zone rated for 1000 amperes using Zero-Fired SCR Power Control or a large contactor for temperature control that caused light flicker. Imagine the resultant harmonic currents and the low Power Factor if the same application used a Phase-Fired SCR Power Controller. Have you ever thought about the maintenance cost associated with large electro-mechanical contactors providing all of the control. AMETEK HDR's Base-Load-Controller can help minimize or eliminate many of these problems.

## **WHAT IS A BASE-LOAD-CONTROLLER**

A Base-Load-Controller is similar to Stepper Controls that have been used for many years in the heating industry with one significant improvement. AMETEK HDR's BLC is designed to operate directly with SCR Power Controls. It can control from one to 31 base loads plus one (SCR load) final heating stage (a total of 32). It is microprocessor based, easily programmed in the field (without additional equipment such as a computer terminal), has two control methods, up/down or circular - both usable with or without an SCR Power Controller connected.

For definition purposes, a "Base Load" is a number of heating elements that are connected in either single or three-phase configuration.

AMETEK HDR's Base-Load-Controller consists of two main assemblies:

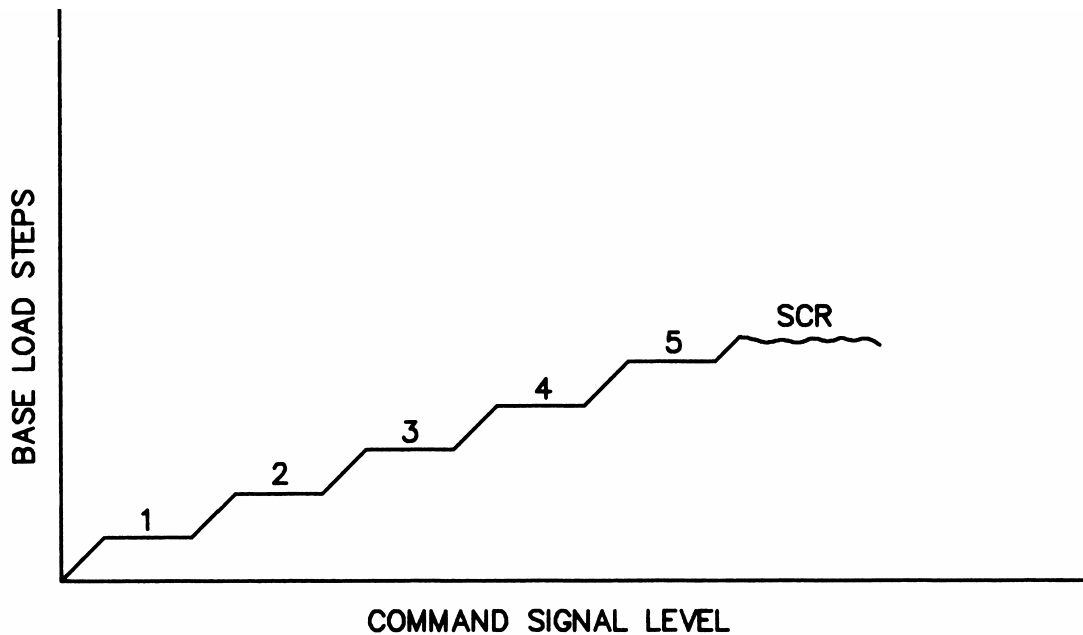
- Controller Module (only one per BLC)
- Eight-Channel Output Module (maximum four per BLC)

A complete Base-Load-Controller system requires not only the Base-Load-Controller assembly but also one contactor for each controlled step plus an SCR Power Controller.

## **HOW IT WORKS**

A command signal input - either a 4-20ma signal or a slide wire is required to set the desired output. The BLC turns on the number of heating base loads required and the desired SCR output level. The number of heating base loads increases in one step increments until the total base load requirement is reached. The SCR controller then regulates the temperature via the final heating stage (SCR load). Between steps the SCR increases power until the next step is

needed, it then resets to zero and ramps up to the next step. Refer to Figure 2. The ramp time (per each step) is adjustable from 1 to 25 seconds or 10 to 250 seconds.

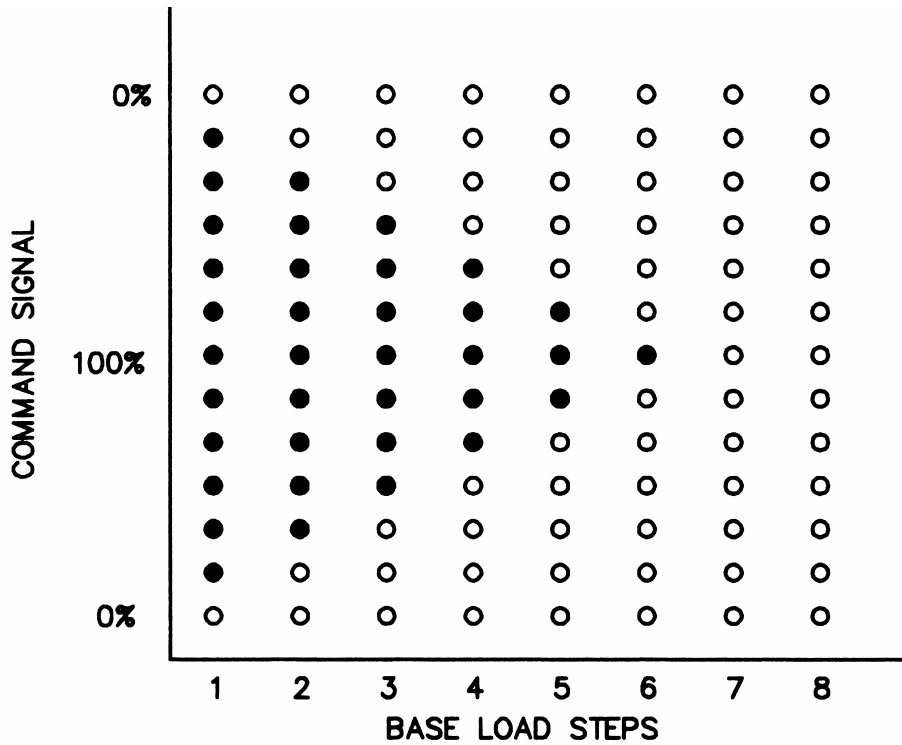


**Figure 2 - Typical Base-Load-Controller's output stages**  
 (Notice the ramp between the Base Loads)

### **CONTROL MODES**

The BLC has two modes of operation for managing and improving heater element life - up/down or circular.

**UP/DOWN** - The up/down mode initially and always starts with base load 1 and increases one step at a time until the required number of base loads is reached. The SCR's output regulates between steps and provides the final stage of temperature regulation. As the power requirement decreases the number of base loads decreases one step at a time until the new desired level is reached (First on - last off). A shortcoming of this method causes uneven operation time on each step of heating elements which can result in decreased element life. See Figure 3.



**Figure 3 - Example of UP/DOWN Mode**

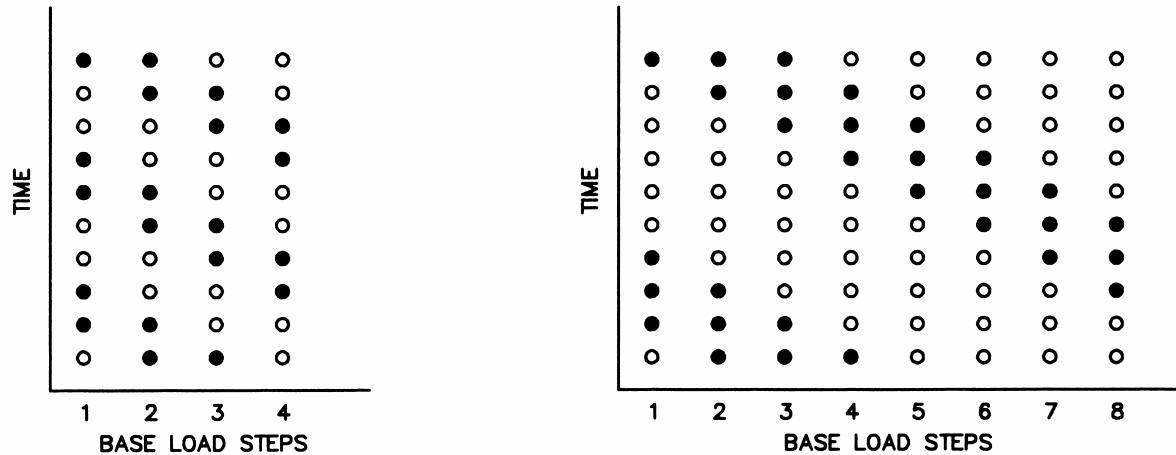
(The shaded circles indicate which Base Loads are turned on)

The shaded circles in Figure 3 indicate the loads were added one step at a time until the desired level was reached (6 out of 8). At this point the SCR Power Controller would regulate the temperature. When a lower temperature is required, the Base-Load-Controller reduces the number of connected loads one step at a time until the new required level is reached. Notice the first load "on" is also the last load "off".

Because the SCR Power Controller increases the power between load steps there are no major surges to the incoming power lines. During the time that 6 steps are turned on continuously, the SCR Power Controller is only controlling about 12% of the total load. If a Zero-Fired controller is being used, light flicker should not occur because it is controlling only a small portion of the total load.

If a Phase-Fired controller is being used, a large portion of the load is fixed and the SCR is only controlling a small portion allowing the Power Factor to remain high during any operating point. In addition, since the SCR is only switching a small portion of the total power, the line harmonics will be greatly reduced.

**CIRCULAR** - This method is similar to the up/down mode except once the desired number of base loads is reached, the BLC will time-share the base loads by adding and deleting steps simultaneously in a circular mode (First on - First off).



**Figure 4 - Two examples of Circular Mode**

(The shaded circles indicate which Base Loads are turned on)

Refer to Figure 4. The number of base loads required in the first example is 2 out of 4 (50% power requirement). In the second example the required number of base loads is 3 out of 8 (37.5% power requirement). The current process requirement in each example time-shares in a circular mode. The overall time interval is adjustable. This circular method evens the operation time of the heater elements which should help increase heater life.

#### **HOW THE BASE-LOAD-CONTROLLER HELPS**

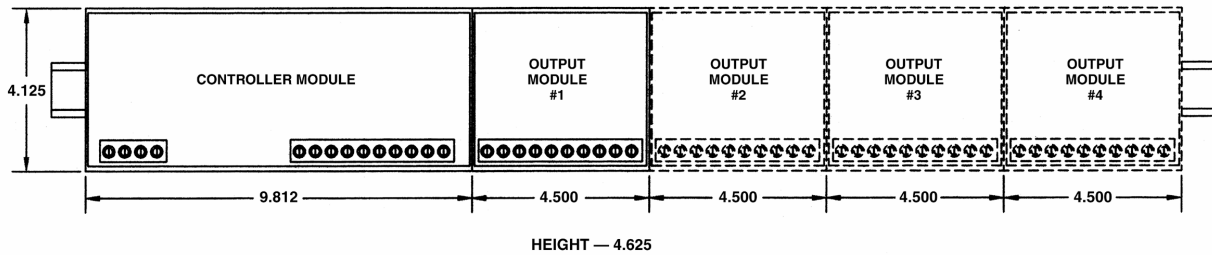
As an example, consider a heating system with ten heater loads that would include - 9 base loads and one Zero-Fired SCR controlled load. The process requires 75% heater load. The BLC turns on seven base loads and regulates the temperature using the final SCR stage. The power draw from the utility is stable with less than 10% of the power being turned on and off by the Zero-Fired Power Controller.

Using the same example except the SCR Power Controller is Phase-Fired. The process requires 75% heater load. Using only a large Phase-Fired SCR Power Controller the utility would record a Power Factor of about .75 and the system would produce high harmonics. Using the BLC with 7 elements turned on and a Phase-Fired SCR Power Controller regulating, the Power-Factor would be approximately .9

and the system would have reduced harmonics.

## SUMMARY

The Base-Load-Controller can help provide economical temperature regulation of large systems. In addition, it can eliminate light flicker associated with Zero-Fired loads. It will also improve Power-Factor and reduce the harmonics normally associated with Phase-Fired SCR Power Controls. The modular design allows for flexibility in the installation and requires the user to purchase only the amount of stages the process requires (see Figure 5).



**Figure 5 - AMETEK HDR's Base-Load-Controllers dimensions**  
(Shown mounted on a Din rail)

Note: The Base-Load-Controller's output modules can be mounted on a separate DIN rail above or below the Controller Module. Specify when ordering.