Series 4000 and 8000 Energy Controllers

Installation and Operation Manual

REVISION B 3/1/83

INSTALLATION AND OPERATION MANUAL
FOR
MODELS 4000, 4000A, 4000C, 4000AC
MODELS 8000, 8000A, 8000C, 8000AC

Alternate Designations: Above model numbers may have a "1" as the fourth digit (e.g. 4001, 8001, etc.)

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I — INTRODUCTION

1.1 SCOPE OF MANUAL

This instruction manual covers installation and operation of the Solidyne Models 4000 and 8000 Energy Management Controllers including those models with an "A" and /or "C" suffix designates a unit with the telephone communications option. Although installation and operation of some of the optional equipment is included herein, complete installation and operation instructions are shipped with the optional items. Specifications for the Models 4000 and 8000 with "A" and "C" options are listed in th appropriate sales literature. Any reference in this manual to the Models 4000 and 8000 will also apply to those models with the "A" and "C" suffixes unless otherwise noted.

II — INSTALLATION

2.1 UNPACKING

Open the carton and remove all packing material. Examine the unit for evidence of damage incurred during shipment. If such damage is noted, inform the carrier immediately. Do not return equipment to the factory for repair of shipment damage until the carrier has authorized repairs.

2.2 PHYSICAL INSTALLATION

Note: The Micromizer should not be installed in unheated buildings, on vibrating surfaces, or near process equipment that produces corrosive fumes or excess heat. Do not install the unit in rooms with synthetic carpeting that can produce static discharge to the unit by the operator.

Place the unit on a flat surface with the front panel facing upward. The cover of the Model 4000 is secured with a key lock. The front panel of the Model 8000 is secured with a key lock and a screw. Open the lock, if necessary (the cabinet is locked when the key is at its most clockwise position). Remove the screw adjacent to the lock on the Model 8000. The front panel will rotate 90^{o} around the hinge at its left side to expose the internal components. Remove the metal shield in the Model 8000 that covers the relay board, located in right half of unit. There is a hole at each

corner rear panel. These are to be used to mount the unit to a wall, using appropriately sized screws. After all electrical connections are made as described in the following paragraphs, remember to replace the metal shield if the unit is a Model 8000.

2.3 ELECTRICAL CONNECTIONS

When the unit has been securely mounted to a wall, the electrician should connect the appropriate conduit and wiring as specified by local building codes. The relays are single pole, double throw. Contacts are rated at 10 amperes into resistive loads at 120 volts AC, and 5 amperes into resistive loads at 240 volts AC. Normally closed contacts should be connected to any load that should remain in an operating condition if power to the controller is interrupted. However, inversion of the program for that switch is then required (see paragraph 3.10).

On the relay board note the location of the two output terminal blocks at the lower edge of the board. Make the required power and control wiring connections to these terminal blocks. Verify that the ground wire is securely connected to terminal marked "GND" on the Model 4000, or to any metal stud located near the bottom of the unit in the Model 8000. Remove the tape from the connector of the rechargeable battery and mate it with the battery connector on wires from the relay board. However battery must not be connected before the 120VAC power is applied to the unit. Apply 120VAC power first. See paragraph 5.2 regarding charging battery prior to installation.

2.3.1 FAIL-SAFE CONNECTIONS

Loads that must remain in a powered condition if power to the controller is interrupted, may be wired to the normally closed contacts of the respective switch output relays. The operator must then program those switches in accordance with paragraph 3.10.

2.3.2 CONNECTING EXTERNAL ON OR OFF OVERRIDES

The small 9 position terminal blocks on the left side of the relay board on the Model 4000, or at the top of the relay board on the Model 8000 are dedicated to the override functions. The terminals are labeled C, 1, 2, 3,

4, (plus 5, 6, 7 and 8 for 8000). Terminal C is the common connection. Each number refers to the number of the respective switch for which that terminal can be wired to provide an override. These terminals can be wired in any combination to override one or more of the switch circuits, forcing them to turn on or off in response to thermostats, CO monitors, manual switches or any other signalling source that has a contact closure as an output. Only dry contact closures should be used. No voltage should be applied to these terminals.

One thermostat (or other signalling device) can override a single output switch, any combination of switches, or all of the switches by connecting the desired override terminals to one side of the thermostat contacts and connecting the other side of the thermostat to the common (C) terminal. Also, different thermostats (or other devices with contact closure outputs) may be used to override different outputs. In those cases, the wire from one side of all thermostats are connected to the common terminal and the other wires connected to the respective desired override terminals.

Special Note: Note that the relays in the Model 4000 and four of the relays in the Model 8000 have special 4 pin connectors behind them each containing a small black loop of wire. These connectors may be removed and optional accessory boards plugged in as described in section 2.3.4. Activation of the on override for one of these four channels will energize any optional board plugged into the connector behind the relay for that channel. For example, if channel (switch) one had an 8064 duty cycler board plugged into its connector and also were to be overriden on, that channel would not come on totally but would come on under control of the 8064 duty cycler. Note, then that the on overrides do not completely turn on a channel that has function-plug-in boards installed---specifically the 8040, 8060, 8061, 8062, 8063, and 8064 boards, discussed in paragraphs 4.4 thru 4.9. The function-modifying board can be considered to take precedence over the "on" override. True and total on override can then only be accomplished by adding an additional override contact closure directly across the relay output terminals of that

channel.

This special interaction between the on override terminals and the function-modifying boards, 1) provides prevention of short-cycling problems when override thermostats are used and 2) provides the possibility of switching to a second level of duty cycling at a certain temperature level. The latter is accomplished with an 8064 plug-in board and a thermostat as described in paragraph 4.9.

2.3.2.1 CONNECTING ON OVERRIDES

For the Model 8000, the ON override terminal strip is at the top center of the relay board, on the left for the Model 4000. An ON override requires normally open switch contacts wired between a numbered terminal and the common terminal of this strip. Two or more of the numbered terminals may be connected together to provide simultaneous ON overrides for several of the internal switch circuits using a single contact closure.

2.3.2.2 CONNECTING OFF OVERRIDES

The OFF override terminal strip is at the top right of the Model 8000 relay board, and on the left for the Model 4000. An OFF override requires normally closed switch contacts wired between a numbered terminal and the common terminal. Two or more of the numbered terminals may be connected together to provide simultaneous OFF overrides for several of the internal switch circuits using a single contact opening. Note that the terminal for any circuit for which an OFF override is not provided must remain connected to the common terminal.

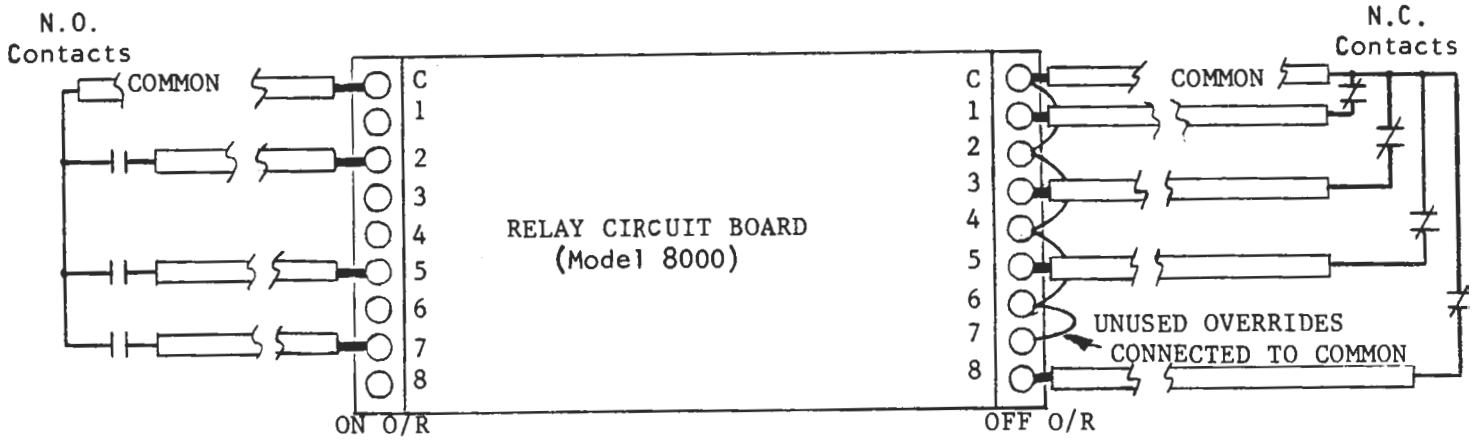

Illustration of Typical Override Connections.

2.3.3 CONNECTING OPTIONAL EQUIPMENT

There are a number of optional items of equipment that are available for use with either the Model 4000 or Model 8000. A description of each will be found in Section IV of this manual. Optional items are shipped with complete installation instructions. However, directions for connecting the temperature inputs to the Model 8020 Temperature Control Board and current inputs to the Model 8010 kW Demand Control Board are contained in the following paragraph.

2.3.3.1 CONNECTING TEMPERATURE OR CURRENT INPUTS

If the Model 4000 or Model 8000 is equipped with the optional Temperature Control Board (Model 8020) or kW Demand Board (Model 8010), connect the temperature sensing probe or the current transformers (CT's) to the terminals on the small board located inside the unit near the upper (or lower) left hand corner.

2.3.4 DELAY TIMER CONNECTORS

The connectors directly behind four of the output relays are provided for plug in of the Delay Timers described in Section V. The female connectors installed thereon are provided with jumpers to complete the connection from the relay contacts to the output terminals on the board. One of these must be in place behind each of the four relays, unless a Delay Timer or other accessory board using this connector is installed. An open connector will cause the respective output relay to be inactivated.

III — OPERATION

3.1 GENERAL

Operation of the Series 4000 and 8000 Energy Management Controllers is relatively simple and straight forward, although one will have to spend some time with the unit and this instruction manual to become proficient in its programming.

In preparing this section, we have attempted to present material in a logical manner. The simpler operations are initially covered. The more complex tasks that then follow are, for the most part, combinations of those that preceded them and will probably not seem complex at all. These programming instructions should be read in their entirety before permanent programs are stored. There are important points to consider near the end of this manual that will have influence on the permanent programming.

There are a number of functions that provide assistance during programming. Their explanations are contained in the paragraphs of 3.8. Please refer to them if the unit does not respond as you think it should, if you want to clear your entry and reprogram or if you simply need help.

While getting acquainted with the programming procedures, the loads should be disconnected so that they will not be activated by the data you enter. When you have mastered the programming procedures, write out the various set point programs that are to be permanently stored in the unit, connect the loads and proceed with programming. A programming worksheet is included in this manual from which working copies can be made.

"Set point" is the designator for program entries that turn a switch, or a group of switches, on or off. More is written about this later in this section. It is mentioned here since the "A" models will voice this term when power is first applied and when using the "help" and "examine" features.

It is prudent to examine the indicators on the front panel during and after

ENERGY CONTROL SCHEDULE

EQUIPMENT BEING CONTROLLED	CHANNEL NO	DAYS OF WEEK							TIME –OF–DAY SCHEDULE		DUTY CYCLE SCHEDULE				DATA SCHEDULE ☐ DEMAND (kW) ☐ TEMP (F°)				HOLIDAYS
		MON	TUE	WED	THU	FRI	SAT	SUN	TURN ON	TURN OFF	START TIME	MINUTES ON	MINUTES OFF	STOP TIME	START TIME	TURN ON POINT	TURN OFF POINT	STOP TIME	

completion of data entry. They provide visual verification that data entry was made in accordance with what you planned. As data is entered, the appropriate indicators are illuminated. The "A" models "replay" the entries, illuminating the displays in sequence and "voicing" the entries. Means of correcting erroneously entered data are covered in paragraphs 3.8 and 3.9.

3.2 FRONT PANEL CONTROLS AND SWITCHES

Examine the front panel controls and indicators. The clock display consists of the lighted digits in the window and the AM/PM indicators to its right. The appropriate AM or PM circle will blink each second to indicate clock operation. The upper row of circles are the day indicators. One or more of these will be illuminated to show which days have been selected during and after program entry and when examining previously programmed set points. When time of day is shown in the digital display, one circle will be illuminated to show the day of the week as a verification of correct clock time setting. The next row of circles are the switch indicators. They are illuminated as switches are selected by number during program entry and when examining previously programmed set points. They also light to show which switches are turned on during normal operation.

The two rows of gray colored rectangles are dual function keys used to make switch, day of week and time entries. They are pressure sensitive devices without perceptable motion when pressed. Since the keys are dual function, the computer must be told which function is being selected. This information is furnished by the AM, PM, DAY, SWITCH, ON, and OFF keys, one of which is pressed after numerical data is entered. This is shown in the programming examples that follow.

The bottom row contains the function keys. These are labeled ON, OFF, DATA, CLOCK, CYCLE, and HOLIDAY. The manner in which these keys are used in programming the unit is detailed in the examples that follow.

The time display will show the time of day except when programming is in progress. To enable the unit for programming requires that the key be

inserted in the lock and the lock rotated to its counterclockwise limit.

3.3 THE OPTIONAL "TALKING FEATURE" (Models 4000A, 4000AC, 8000A, 8000AC)

The "A" models are equipped with a voice synthesizer that responds with a vocal message as each key is pressed during programming and then "recaps" the program data when the last entry is made. If a key is pressed in the wrong sequence, "error" will be voiced by these units. In the examples of this section, the messages voiced by these units are shown in quotes on a seperate line. An error will occur if the operator attempts to continue with program entries while a message is being voiced. Wait until the unit is quiet before proceeding with the next program step. If you are programming a basic or "C" model, ignore the messages in quotes.

The voice volume control is located inside the unit behind the front panel. It is a small square blue potentiometer with a white center circle containing a screwdriver slot by which the volume adjustment may be made.

3.4 POWER UP

All commercial electrical systems are subject to voltage drops, interruptions and failures. These are caused by power station problems, weather, accidents, shutdowns for maintenance, etc. If the standby batteries are installed, program data in memory and correct time will be preserved during such power outages. However, as a battery power conservation measure, none of the panel indicators will be illuminated until the power is restored. Battery backup provides approximately 20 to 24 hours of memory protection.

Upon initial application of power, the unit is completely unprogrammed and the clock display shows "PF 1". Power interruption cause all data in memory to be lost and "PF 1" to appear in the display when power is restored if the unit is not equipped with a backup battery or the battery has been discharged or disconnected. With operating battery backup, the display will show "PF 2" when power is restored. In either case, programming should be checked per paragraph 3.8.3. The "A" models will voice the following message every 15 seconds until the cabinet is unlocked and the CLEAR key is pressed:

"Power failure has occured. Verify time and set points."

When the CLEAR key is pressed, the display is cleared and the unit may be reprogrammed, if necessary, or time and set points may be verified as explained in paragraph 3.8.3.

NOTE

The cabinet of the "A" (talking) versions must be locked in order for the verbal power failure alarm to function.

3.4.1 SEQUENTIAL STARTUP AFTER POWER FAILURE

If a power interruption occurs after the unit has been programmed and after standby battery has been given time to charge, the memory programming and correct time will be preserved for a length of time (up to one day) depending on the condition of and the charge on the battery. At the time power is restored, all loads normally scheduled to be on at that time will come on IN A STAGGERED FASHION --- 4 SECONDS APART.

3.5 SETTING THE CLOCK

The unit is equipped with a seven-day clock that must be set to the correct day of the week and time of day, since it controls all timing of switch set points over a seven-day period. The clock may be set to Saturday, 1:30 PM by pressing keys in the following order. (The messages voiced by the "A" models are shown in quotes below the key diagrams):

NOTE

If you have an "A" model and wish to be verbally guided by the Controller at this point, refer to paragraph 3.8.1

[CLEAR] "clear"	Clears clock display.
[SAT] [DAY] "six Saturday"	Set the day.

The keys with days of the week and numbers have dual functions. When the SAT key was pressed, a digit "6" was entered. When the DAY key was pressed, it told the controller that the "6" represented Saturday rather than a number. Continue as follows:

[1] [3] [0] [PM] "one three zero PM"	Sets the time of day. (Digits appear in clock display).

Pressing the PM keys told the controller that the numbers previously

entered (1, 3, 0), were time entries. The operation is terminated by pressing:

[CLOCK]	Terminate the operation.
"clock" "Saturday one-thirty PM"	

The "A" models terminate and verify the operation by voicing the day and time for which the clock is set.

To set the clock to Monday, 11:45 AM, press the keys in the following order:

[CLEAR]	Select clock. (Clears clock display).
"clear"	
[MON] [DAY]	Set the day.
"one Monday"	
[1] [1] [4] [5] [AM]	Set time of day.
"one one four five AM"	(Digits appear in clock display).
[CLOCK]	Terminate the operation.
"clock" "Monday eleven forty-five AM"	

If an error is made when entering the digits for the time of day and you have not yet pressed the AM or PM or DAY key, enter zeros until all zeros appear in the display. Then enter the correct digits. This applies to any time or number or day entry made in the course of programming a set point (or any enty involving numbered keys). An alternate method is to press the CLEAR key, which completely clears out that entry and allows you to renter from the beginning.

From the foregoing, the principles involved in setting the clock should be apparent. Practice setting the clock for different times. Remember, if you are setting the clock on an "A" model, wait for completion of the final message before taking the next step. Note that the lighted indicator in the upper row indicates the day of the week to which the clock is set. Also note that one of the two indicators to the right of the clock display blinks to show whether it is set to AM or PM. When you have completed the practice, set the clock to the present day and time of day.

3.6 DIRECT CONTROL OF SWITCHES

There are four programmable, electronically controlled switch circuits in the Series 4000 and eight in the Series 8000. The output of each of these circuits controls a single-pole, double-throw relay that has normally open and normally closed contacts. (The ON function of the controllers assumes closing of the normally open contacts). How these can be programmed is discussed in later paragraphs. Direct control can be used to check that the various controlled devices have been properly connected or to check the operation of any device at any time. Using the direct control will not, in any way, disturb the programs that are entered in accordance with the procedures provided in the other paragraphs of this section.

Use of direct switch control is shown in the following example where switch number 3 is turned on then off:

[3] [SWITCH] "three switch"	Select switch 3.
[ON] "on"	Select ON function.

Note that 3 in the SWITCH STATUS display illuminates to indicate that switch number 3 has been turned on.

[3] [SWITCH] "three switch"	Select switch 3.
[OFF] "off"	Select OFF function.

The 3 in the SWITCH STATUS display will be extinguished, indicating that the switch is now turned off.

NOTE

A switch that has been put into an ON or OFF status by direct control will remain in that status until the next point in the program is

reached that addresses that switch to change its status.

3.7 SETTING SWITCHES (LOADS)

Any of the switches may be individually programmed to close or open its relay contacts at specified times on various days of the week, independent of the others. Alternately, several switches may be programmed to operate simultaneously every day, or on all week days (Monday through Friday) or only on certain days of the week. Other combinations are possible as explained in paragaphs that follow in this section.

3.7.1 SETTING SWITCHES FOR TIME OF DAY.

Assume that there is a load that must be turned on at 10:00 AM on every day, Sunday through Saturday and it is connected to the normally open contacts of switch circuit number 3. It is programmed by pressing keys in the following order:

[CLEAR] "clear"	Clear display. Not necessary if present time is shown in display.
[3] [SWITCH] "three switch"	Select switch 3.
[EVERY] [DAY] "eight every day"	Select every day.
[1] [0] [0] [0] [AM] "one zero zero zero AM"	Set time.
[ON] "on""switch three Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, 10 AM, on"	Set ON function.

Note that the panel indicators show the switch number, days selected (MON through SAT), the time selected (10:00 AM) and the function (ON) as verification of the entries. (How to correct errors of entry is covered in paragraphs 3.8 and 3.9).

To set the time that this switch will open, first press the CLEAR key to clear the display (on the "A" models, wait for the vocal message to be completed before pressing the CLEAR key). Then follow the same procedure as above, inserting the appropriate time and terminating with the OFF key.

NOTE

Except when the present time of day is shown in the clock display, the CLEAR key must be pressed to clear the display before additional program data can be entered.

3.7.2 SETTING SWITCHES FOR SPECIFIED DAYS

Switches may be programmed to turn on or off on a specified day or specified days. For example, to set switch 3 to turn on Monday at 11:00 AM, press the keys in the following order:

[CLEAR] "clear"	Clear Display.
[3] [SWITCH] "three switch"	Select switch 3.
[MON] [DAY] "one Monday"	Set Monday.
[1] [1] [0] [0] [AM] "one one zero zero AM	Set time of day.
[ON] "on" "switch three Monday eleven AM, on"	Select ON function.

To set this same switch to turn off on a particular day and time, follow the above procedure, but insert the appropriate day and time and terminate the entry by pressing the OFF key. The switch will remain closed between the set on time and the set off time, even if several days elapse between these points.

3.7.3 SETTING SWITCHES FOR MULTIPLE DAYS

We have shown how to set switches for every day and for particular days. However, any number of switches may be set for the same time and for the same function (on or off) in one operation. Suppose there are three devices, connected to different switches, to be turned on at 8:00 AM on Monday, Tuesday and Thursday. They can be set simultaneously by pressing keys as follows:

[1] [SWITCH] [3] [SWITCH] [7] [SWITCH] Select switches 1, 3, 7.
"one switch three switch seven switch"

[MON] [DAY] [TUE] [DAY] [THUR] [DAY] Select Mon., Tues., Thurs.
"one Monday two Tuesday four Thursday"

[8] [0] [0] [AM] Set time.
"eight zero zero AM"

[ON] Set ON function.
"on" "switches 1, 3, 7, Monday, Tuesday, Thursday 8 AM, on"

.If all of these switches are to be turned off simultaneously, follow the same procedure (after pressing the CLEAR key), inserting the appropriate days and times, but terminate the operation by pressing the OFF key.

If any one of these three switches is to be turned off separately on different days or at different times, the turn-off time must be programmed separately in accordance with the procedures of paragraph 3.7.2. If the remaining switches are to be turned off simultaneously, they will be programmed in accordance with the above procedure, inserting only the appropriate switch numbers, appropriate days and time and terminating with the OFF key. For example, assume that switch 3 is to be turned off at 3:00 PM on each of those days and switches 1 and 7 are to be turned off at 5:00 PM. The keys would be pressed in the following order:

[CLEAR] Clear the display.
"clear"

[3] [SWITCH] Select switch 3.
"three switch"

[MON] [DAY] [TUE] [DAY] [THUR] [DAY] Set days.
"one Monday two Tuesday four Thursday"

[3] [0] [0] [PM] Set time.
"three zero zero PM"

[OFF] Select OFF function.
"off"
"switch three Monday, Tuesday, Thursday three PM off"

[CLEAR] Clear the display.
"clear"

[1] [SWITCH] [7] [SWITCH] "one switch seven switch"	Select switches 1 and 7.
[MON] [DAY] [TUE] [DAY] [THUR] [DAY] "one Monday two Tuesday four Thursday	Select Mon., Tue., and Thur.
[5] [0] [0] [PM] "five zero zero PM"	Set time.
[OFF] "off" "switches one and seven Monday, Tuesday, Thursday 5 PM off"	Select OFF function.

By pressing the WEEK key, rather than the MON, TUE, and THUR keys in the above examples, the on and off functions may be set for Monday through Friday only, as shown in the following example:

[1] [SWITCH] [3] [SWITCH] [7] [SWITCH] "one switch three switch seven switch"	Select switches 1, 3, 7.
[WEEK] [DAY] "seven weekdays"	Select Mon. through Fri.
[8] [0] [0] [AM] "eight zero zero AM"	Set time.
[ON] "on" "switches 1, 3, 7, Monday, Tuesday, Wednesday, Thursday, Friday, 8 AM on".	Set ON function.

3.7.4 SETTING SWITCHES FOR HOLIDAYS

The controllers are seven-day devices. That is, they can be programmed for seven day periods and, unless reprogrammed, will repeat the program every seven days.

The new series 4000 and 8000 controllers treat holidays as an eighth day. That is, every time-of-day, duty cycle or data value (temperature or demand) program that is to be obeyed on a holiday is designated as such at the time the program is initially entered. For example, refer back to the example in paragraph 3.7.1 where we turned on switch 3 at 10:00 AM Sunday thru Saturday. If this switch is also to turn on at 10:00 AM on <u>holidays</u>, the program entry would require an additional step as follows:

[3] [SWITCH] "three switch	Select switch 3.
[EVERY] [DAY] "eight every day"	Select every day.
[1] [0] [0] [0] [AM] "one zero zero zero AM"	Set time.
[ON] "on" "switch three Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, 10 AM, on"	Set ON function.

[HOLIDAY] "holiday"	Specify operation on holidays.

Note that the panel indicators will show Holiday light on along with the rest of the displayed information when this entry is made or when the entry is recalled in the EXAMINE procedure (to be discussed in 3.8.3).

All program entries that are to be active on holidays must have the [HOLIDAY] key pressed after the regular entry is completed, in the same manner as above.

Now, when a holiday approaches and any time within a week before the holiday, the operator simply programs the following: (assume next Tuesday is a holiday).

[TUE] [DAY] [HOLIDAY] "two Tuesday holiday"	"Tuesday holiday"	Set next Tue. as a holiday.

This will cause all program entries with a "holiday" designation to be obeyed next Tuesday and all program entries without a holiday designation to be ignored on that day. The regular schedule will resume for the following Tuesday.

Note that any combination or all of the days of the week can be entered together as holidays, accommodating long holidays and plant shutdowns up to a week in length.

Also take note that an entry can be programmed to be effective only on holidays by using a "contradictory" set point program. If this is a requirement for your application, call the factory for details.

3.7.5 HIERARCHY OF COMMAND WHEN PROGRAMS OVERLAP

Time-of day, duty cycling and temperature or demand programs may be entered for any switch and be in effect simultaneously. (Cycling and temperature or demand programming are covered in paragraphs 3.7.6, 3.7.7, 3.7.8 and 3.7.9). This is multiple or overlapping programming. When programs for a given output overlap, there appears what may be considered a heirarchy of command among the programs. Demand or temperature (data) programs come first, then duty cycling, then time-of-day. However, this apparent heirarchy is not entirely valid. Between the on and off levels of demand or temperature called the "dead band", duty cycling is allowed to take over. This creates some advantageous possibilities which are discussed in

paragraph 3.7.9.

Other than the fact that demand or temperature programming has absolute priority above and below the dead band, the remaining programming relationships that produce the apparent heirarchy of command are the result of the way the microprocessor works.

To understand the result of entering overlapping programs, you must understand how the microprocessor controls the outputs. Every minute the microprocessor reads through its programmed instructions to see if at that minute it is to make any changes in the state of its outputs. If any output is to be changed (turned on or off), the microprocessor will do so and cause that output to latch (or toggle) into its new on or off state (just like flipping a light switch on the wall). After it has done so, it forgets about that latched output until it reads another instruction in a future minute to change that output again. Therefore, at anytime, the state of an output is only dependent on the last toggle command it received, no matter how long ago it was. This allows duty cycling programs (discussed in following paragraph 3.7.6) to be inserted between the on and off setpoints of a time-of-day program making it appear as though duty cycling has precedence over the time-of-day schedule. However, at the end of every duty cycle program the output is toggled OFF and will remain so even though the time-of-day program has not yet reached its off set point. Therefore if this type of overlapped programming is done, you must insert, at the end of the program, another time-of-day ON set point for the same minute that you programmed the stop time for the duty cycling. This will assure that when duty cycling is over the output will be <u>on</u> until the programmed time-of-day <u>off</u> set point occurs.

The implications of this section will become more apparent as the referenced paragraphs are reviewed.

3.7.6 SETTING SWITCHES FOR DUTY CYCLING

Switches may be set to cycle on and off. For example, 15 minutes on and 5 minutes off. The period during which this cycling takes place may also have time limits such as between 10 AM and 3 PM. An example is presented below where switches 1 and 5 are set for duty cycles of 15 minutes on and 5 minutes off on Monday and Friday between the hours of 11:00 AM and 3:00 PM:

[1] [SWITCH] [5] [SWITCH] "one switch five switch"	Select switch #1 and #5.
[MON] [DAY] [FRI] [DAY] "one Monday five Friday"	Select Monday and Friday.
[1] [1] [0] [0] [AM] [CYCLE] "one one zero zero AM cycle"	Set time for beginning of cycle.
[1] [5] [ON] [5] [OFF] "one five on five off"	Set cycle on time. (15 minutes on, 5 minutes off.)
[MON] [DAY] [FRI] [DAY] [3] [0] [0] [PM] [OFF] "one Monday five Friday three zero zero PM off"	Set end of cycling period.

If duty cycling is to be continuous, that is start at 11:00 AM and continue indefinitely, then omit the last line above except for pressing OFF a second time. The maximum number of minutes for an on or off period is 255 The minimum is 1.

3.7.7 SETTING SWITCHES FOR RESPONSE TO TEMPERATURE OR DEMAND

If the unit is equipped with an optional Model 8020 temperature board, it may be programmed to respond to temperature. If it is equipped with an optional Model 8010 kW Demand Board, it may be programmed to respond to kW demand inputs. Note that only one or the other of these options may be installed. The DATA key is used for these types of programs as shown in the following example of temperature control entries. In this example, switches 3 and 4 are set to turn on at a temperature input of 92° and to turn off at 78° on weekdays between the hours of 10:30 AM and 4:00 PM.

[3] [SWITCH] [4] [SWITCH] "three switch four switch"	Select switches 3 and 4.
[WEEK] [DAY] [1] [0] [3] [0] [AM] [DATA] "seven weekdays one zero three zero AM data"	Set days and time.
[1] [9] [2] [ON] [1] [7] [8] [OFF] "one nine two on one seventy eight off"	Set temperature limits. (add 100 to temperature value).
[WEEK] [DAY] [4] [0] [0] [PM] [OFF] "seven weekdays four zero zero PM off"	Set days and time off. "switch three switch four Monday, Tuesday, Wednesday, Thursday, Friday 10:00 AM data one ninety two on one seventy eight off"

Note: Add 100 to temperature value desired. Temperature board is calibrated with a 100 degree offset to accommodate minus temperatures. Minus temperatures could not otherwise be entered into controller.

If response to the data input is to be continuous, then omit the last line in the above sequence, but do press the OFF key. Thus, you will have pressed the OFF key twice in a row. After 10:30 A.M. on the first weekday, switches 3 and 4 will respond to the temperature input. Where demand is to be the determining limit, the data entry is in KW. That is, the switch is programmed to turn ON at or below the low limit and turn OFF at or above the high limit. The maximum data value that can be programmed is 255. The minimum is 0.

Note that in the above discussion the temperature control OFF point was below the ON point. In a demand control strategy, however, the ON point is always below the OFF point. Don't let this worry you. The controller always knows that the "dead band" is between the ON and OFF points. It automatically knows in which state the load is on either side of the "dead band".

NOTE

Any data program entry may be called up and started immediately by first utilizing the EXAMINE feature explained in paragraph 3.8.3. When successive depressions of the examine key results in display of the desired entry, press the ON key. This initiates immediate response to the program data irrespective of the programmed start time. The switches will continue to respond to the programmed data until the programmed OFF time (if any). Response to the programmed data may be terminated using the same procedure as outlined in this note, except that the OFF switch, rather than the ON switch, is pressed.

The cautionary note of paragraph 3.7.9 also applies here.

3.7.8 ROTATING-LOAD DUTY CYCLING

Multiple loads can be duty cycled in a rotating fashion (called rotating-load duty cycling) as shown in the following example:

[1] [SWITCH] [EVERY] [DAY] Enter switch number and
"one switch eight everyday" days.

[8] [0] [0] [AM] [CYCLE] Enter start time and select
"eight zero zero AM cycle" cycle.

[1] [5] [ON] [5] [OFF] Enter ON and OFF times. .
"one five ON five off"

[EVERY] [DAY] [5] [0] [0] [PM] [OFF] Enter end of program time.
"eight everyday five zero zero PM off" "one switch everyday 8:00 AM cycle"

The "A" models messages will stop at this point and at other points during recap of the entry. Press the EXAMINE to continue the recap as shown in the example below:

(Press EXAMINE) "fifteen on" (Press EXAMINE) "five off" (Press EXAMINE) "every day 5:00 PM off"

Press the CLEAR key to allow continued programming.

[2] [SWITCH] [EVERY] [DAY] Enter switch number and day.
"two switch eight everyday"

[8] [0] [5] [AM] [CYCLE] Enter start time and select
"eight zero five AM cycle" cycle.

[1] [5] [ON] [5] [OFF] Enter ON and OFF times.
"one five on five off"

[EVERY] [DAY] [5] [0] [5] [PM] [OFF] Enter end of program time.
"eight everyday five zero five PM off" "two switch everyday 8:05 AM cycle (Press EXAMINE) "fifteen on" (Press EXAMINE) "five off" (Press EXAMINE) "every day 5:05 PM off"

Press The CLEAR key to allow continued programming.

[3] [SWITCH] [EVERY] [DAY] Enter switch number and
"three switch eight everyday" days.

[8] [1] [0] [AM] [CYCLE] Enter start time and select
"eight one zero AM cycle" cycle.

[1] [5] [ON] [5] [OFF] Enter ON and OFF times.
"one five on five off"

[EVERY] [DAY] [5] [1] [0] [PM] [OFF] Enter end of program time.
"eight everyday five one zero PM off" "two switch everyday 8:10 AM cycle (Press EXAMINE) "fifteen on" (Press EXAMINE) "five off" (Press EXAMINE) "every day 5:10 PM off"

Press the CLEAR key to allow continued programming.

[4] [SWITCH] [EVERY] [DAY] "four switch eight everyday"	Enter switch number and days.
[8] [1] [5] [AM] [CYCLE] "eight one five AM cycle"	Enter start time and select cycle.
[1] [5] [ON] [5] [OFF] "one five on five off"	Enter ON and OFF times.
[EVERY] [DAY] [5] [1] [5] [PM] [OFF] "eight everyday five one five PM off"	Enter end of program time.

"two switch everyday 8:15 AM cycle (Press EXAMINE) "fifteen on" (Press EXAMINE) "five off" (Press EXAMINE) "every day 5:15 PM off"

Press the CLEAR key to allow continued programming.

3.7.9 PROGRAMMING DUTY CYCLING CONTROLLED BY TEMPERATURE OR DEMAND

This paragraph is of concern only when programming a unit equipped with either the Model 8020 Temperature Control Board or the Model 8010 Demand Control Board.

When a demand or temperature program exists simultaneously with a cycling program, the two will interact. Duty cycling (time on/time off) will occur only between the ON and OFF data set points of the demand/temperature program. Thus a temperature program can be entered that will, for example, duty cycle an air conditioner when the outside temperature is between 75°F and 90°F while turning it on full when the temperature is above 90°F and off when it is below 75°F. A demand limiting program can be entered that will, for example, turn on a deferrable load below a demand of 90 KW, duty cycle the load when demand rises above 90 KW and turn it off completely when demand reaches 100 KW.

Also, if a particular load is critical and cannot be totally shed (turned off), then it can be limited to duty cycling only by programming its OFF level of demand at an unreasonably high number. For example, refer to the rotating duty

cycling program in paragraph 3.7.8. Assume that the requirements were that 1) the four loads are to turn on every day from 8:00 AM to 5:00 PM and not duty cycle until the KW demand reaches 90 KW, and 2) that all loads except No. 4 are to be completely turned off at a demand level of 140 KW and over, and 3) that load No. 4 would never be allowed to be totally off. Then the following program would be entered **in addition to the program for rotating-load duty cycling:**

```
  [1] [SWITCH] [2] [SWITCH] [3] [SWITCH]          Select switches 1,2,3.
"one  switch  two  switch three switch"

  [EVERY] [DAY]   [8]  [0]  [0] [AM] [DATA]       Set start time, select data.
"eight everyday eight zero zero am   data"

  [9] [0] [ON] [1]  [4] [0] [OFF]                 Set on/off data.
"nine zero on  one four zero off"

  [EVERY] [DAY] [5] [0] [0] [PM] [OFF]            Set end of program time.
  "eight everyday five zero zero PM off" "one switch, two switch, three
  switch, everyday eight AM data ninety on one-forty off everyday
  5:00 PM off"

  [CLEAR]                                         Clear for next entry.
  "clear"

  [4] [SWITCH] [EVERY] [DAY] [DATA]               Select switch 4 and days.
"four switch   eight everyday"                     and data

   [9] [0] [ON] [2] [5] [0] [OFF]                 Set on/off data.
"nine zero on  two five zero off"

  [EVERY] [DAY]   [5] [1] [0] [PM] [OFF]          Set stop time.
"eight everyday five one zero PM   off" "four switch everyday data ninety
 on two hundred fifty off everyday 5:10 PM off"
```

Observe in the next-to-last line of the above program that 250 is an unrealisticly high demand number. Thus, it is insured that whatever device is connected to switch No. 4 will never be totally turned off under demand control, but will be cycled.

Note: Whenever the above strategy is used, duty cycling program must always be entered before demand or temperature program.

CAUTION

When employing the above programming strategy, determine whether the air conditioner compressors have anti short cycling protection. If not,

then such protrection must be added since the possibility of a short off time exists. For example, if the load has just been turned off while in the demand "dead band" and the demand, shortly thereafter, drops below the dead band, the compressor will then be turned back on, causing a short cycle condition.

The plug-in time delay boards, Model 8060 and 8061, are available to provide such protection. Refer to the optional equipment descriptions of Section IV.

3.8 AIDS TO PROGRAMMING

As mentioned in paragraph 3.1, there are several features of the 4000 and 8000 series units that can be used as aids during programming. These are detailed in paragraphs 3.8.1 through 3.8.3.

3.8.1 HELP KEY ASSISTANCE (Models with "A" in suffix only)

In addition to the above detailed operating instructions the models with the talking feature (4000A, AC, 8000A, AC) have a unique "help" feature. Pressing the HELP key and then one of the specified function keys provides verbal instructions as to the method of programming that function. When the HELP key is pressed, the voice merely says "HELP". If you press the key again, the computer assumes you do not know how to use the help function, the following message will be voiced:

"For help on a specific function, press HELP key, then press desired function key"

The keys that may be used with the HELP key are the function keys (ON, OFF, DATA, CYCLE, CLOCK, HOLIDAY, MEMORY CLEAR), and the EXAMINE key. When any other key is pressed after the HELP key, the following message will be heard:

"No help available for this function"

After you follow the initial instruction given by the computer, press HELP key once again for the next instruction to follow. Repeat until all instructions are given.

Since the messages that the help feature generates are self explanatory, numerous and detailed they are not covered here.

The HELP key has another function that is covered in paragraph 3.8.3 describing the EXAMINE key.

Note: The HELP key has no function in units without the talking feature.

3.8.2 CORRECTING ERRORS

When programming errors occur, there are two methods of clearing the displays if the final key for the entry has not been pressed. These are described in the following paragraphs.

3.8.2.1 CLEARING WITH ZEROS

When numbered keys are pressed, the numbers appear in the digital display moving from right to left as additional numbered keys are pressed. Whenever a numbered key is pressed in error, and you have not pressed the AM, PM or function keys, the error can be corrected by pressing the zero key until all zeros appear in the display. The correct numbers may then be entered.

3.8.2.2 CLEAR KEY

The CLEAR key is one that is often used and which is very helpful. It must be pressed to clear the display and allow the next program to be entered. When you notice that you have made and entry error before pressing the final key in a programming sequence, press the CLEAR key. This clears all entries in that sequence, allowing you to start over. If an error has been made in the entry sequence, the unit may not respond to further key depressions. Press the clear key and start over. In neither case will previously completed programming sequences be affected. Note that the "A" models produce a verbal "error" message when an incorrect key is pressed.

3.8.2.3 THE MEMORY CLEAR KEY

If you have made an error and <u>have</u> pressed the final key in the programming sequence but have not yet pressed any other key, you may clear the entire sequence at this point by pressing the MEMORY CLEAR KEY. This key is activated only by pressing both circles on the key.

3.8.3 EXAMINE KEY

The EXAMINE key allows you to "play back" any program in memory using the SWITCH key. It allows you to examine the present value of the analog input data (temperature or demand) and any holidays using the DATA and HOLIDAY keys respectively.

The panel indicators will light to show the programming that is in memory. The "A" models will accompany the illuminated displays with a voice recap of the program.

When the SWITCH key has been pressed after the EXAMINE key, the data for the switch that was first programmed will be displayed. If it is a simple ON or OFF time of day entry, it will be displayed in its entirety. When a duty

cycle or temperature or demand program is examined, the first display shown is only the first part of the program. Successive depressions of the EXAMINE key are required to cause the remaining parts of the program to be displayed in sequence. The remaining switch program data will be displayed in the order in which it was entered with subsequent depressions of the EXAMINE key. When all switch programs have been examined, the next depression of the examine key will cause the displays to be extinguished.

On the 4000A and 8000A, the HELP key and EXAMINE keys can be used together to provide verbal instructions as to the examining procedure. Press HELP then EXAMINE. The verbal instructions tell how to examine set points. Press HELP again and it tells you how to examine for a HOLIDAY. Press HELP once more and it tells you how to examine analog data (present level of temperature or kW demand).

3.8.3.1 EXAMINING ANALOG INPUT DATA

To examine at any time the present temperature or kW demand reading (depending on which option is used), press the EXAMINE key then press the DATA key. This will cause the display to show and hold the value of the analog data as it existed at the time the DATA key was pressed. To get a continuously updating display of the analog data value, press DATA key twice after pressing EXAMINE key.

3.9 PROGRAMMING CHANGES/REPROGRAMMING WITH THE MEMORY CLEAR KEY

Any switch program may be erased using the EXAMINE and MEMORY CLEAR keys. First, use the EXAMINE key, as described in 3.8.3, to bring the desired program into display. Then press the MEMORY CLEAR key with two fingers, one on each circle of the key. (Requiring two fingers prevents accidental erasure of programs). Programs that require several depressions of the EXAMINE key to display program content will be completely erased if the MEMORY CEAR key is pressed when any part of that program is displayed. Programs can be erased only one at a time unless all power, including batteries, is removed from the unit. To delete a holiday entry, press the EXAMINE key, press the HOLIDAY key, then press the MEMORY CLEAR key.

A switch program cannot be changed by merely entering new data for that switch without first following the above procedure. Such changed entries are stored as completely new program in addition to those previously stored.

3.10 FAIL-SAFE PROGRAMMING

In the event that power to the controller is interrupted, the output relays that are programmed on at that time will open, turning off the loads connected to their normally open contacts. If the device connected to any switch of the controller must remain on under such conditions, the device can be wired to the normally closed contacts (see Section II) and the program inverted. Program inversion, under these circumstances, involves reversing the ON and OFF switch entries when programming. This includes reversing the minutes on and minutes off in duty cycling programs as well as reversing the on and off points for demand or temperature control.

3.11 MEMORY ALLOCATIONS

The memory of the controllers can accomodate 42 set points. Any program entry that terminates in an ON or OFF command, except those involving duty cycle and temperature or demand commands, uses only one set point. This is true even though several switches may be simultaneously turned on or off in that program entry. Duty cycle and temperature or demand program entries use 2-1/2 set points. When planning the final programming of the unit (you should write it out completely on a copy of the programming sheet shown on page 6), keep track of the number of set points you have used to be sure that you do not exceed the alloted forty-two. When several switches have common on times, you can combine them in a single program as shown in paragraph 3.7.3 Their common off times can also be combined. These combinations conserve memory. If memory capacity is exceeded, the Controller will display "FULL".

3.12 DAYLIGHT SAVINGS SWITCH

Use of the daylight saving switch eliminates the manual resetting of the clock at 2:00 AM on the affected Sunday morning. The switch is located inside the unit behind the front panel. If it is not so positioned, place it in its OFF position where it must remain for at least 24 hours prior to being set to SPRING or FALL. The clock will be automatically advanced one hour at 2:00 AM on the following Sunday when the switch is set to SPRING and retarded one hour when set to FALL. Leaving the switch in either of the off-center positions produces only a one-time effect. It may be returned to the center position any time after the time change has taken effect.

3.13 INITIAL PROGRAMMING

When starting up the installed controller for the first time, you must turn on whatever loads are supposed to be on at that time by direct entry into the keyboard as covered in paragraph 3.6.

This is necessary since the unit can only turn an output on or off as a transition point (toggle point) is passed in its program, as explained in section 3.7.5. Any duty cycling or data program that is supposed to be in progress at start up can be called up and started as explained in the note in paragraph 3.7.7.

3.14 HARD RESET

Some conditions may affect the unit's basic program, causing it to misoperate. In the case of the "A" models, the verbal ouput may be unintelligible. The display may lock up at a meaningless number or no number at all. The programs that were previously entered are destroyed. A "hard" reset is required before the unit can be reprogrammed. The following procedure should be followed to effect a hard reset:

1. Disconnect the battery.
2. Disconnect the 120VAC power.
3. Wait one minute.
4. Reconnect the 120VAC power.
5. Reconnect the battery.
6. Reprogram the unit.

SECTION IV -- OPTIONAL EQUIPMENT

4.1 GENERAL

There are a number of optional items for the Series 4000 and Series 8000 Energy Management Controllers that expand their capabilities. These are described briefly in this section. Specifications, installation and operating instructions are provided with the optional equipments.

4.2 DEMAND CONTROL BOARD MODEL 8010

The Demand Control Board interfaces the current transformers and the Controller to provide inputs for demand programming. The board is a plug-in unit that mounts on the rear interior surface of the Controller. A small cable and a connector provide the means for connection to the power supply board (left center) of the Controller. An analog output provides a signal for a chart recorder for continuous record of demand. The Model 8010 requires current transformers (Model 8011) to operate. Instructions for programming the Series 4000 and Series 8000 units with this option installed are contained in Section III of this manual.

Current transformers are not included with the Model 8010, but must be obtained separately.

Note that this circuit board cannot be installed if the unit is equipped with the Temperature Control Board option described in paragraph 4.3.

4.3 TEMPERATURE CONTROL BOARD MODEL 8020

The Temperature Control Board provides the interface between a temperature sensor, which is provided with the unit, and the Controller to provide inputs for temperature programming. The board is a plug-in unit that mounts on the rear interior surface of the Controller. A small cable and a connector provide the means for connection to the power supply circuit board of the Controller. The temperature sensor may be installed at considerable distances from the Controller. Accuracy of the unit is $\pm$ 1.5°F. Instructions for programming the Series 4000 and Series 8000 Controllers are contained in Section III of this manual.

Note that this circuit board cannot be installed if the unit is equipped with the Demand Control Board described in paragraph 4.2.

4.4 START TIME OPTIMIZER BOARD MODEL 8040

The Start Time Optimizer Board is similar in size to the Model 8020 Temperature Control Board. It delays the start time of heating or air conditioning equipment connected to one switch output of the Controller based on outside temperature. The Controller is initially programmed to turn on the equipment so as to bring the internal temperature of the building to a comfortable level at the time the occupants arrive, based on worse-case temperature and wind conditions. The Start Time Optimizer then delays the programmed start time by an amount determined by the actual temperatures when they are milder than worse case.

This optional board is a plug-in unit that mounts on the rear interior surface of the Controller. A small cable and a connector provide the means for connection to the relay board of the Controller behind any of the relays of channels 1 thru 4. The temperature sensor, which is included with the board, may be installed at considerable distance from the Controller. Instructions for programming the Series 4000 and Series 8000 Controllers with the Start Time Optimizer Board installed are included with the 8040.

4.5 TIME DELAY MODEL 8060

Adjustable delay-on-make plug-in board. Provides minimum off time (20 seconds to 30 minutes) to prevent compressor short cycling when demand limiting option is employed. Plugs directly into output board of Model 4000 or Model 8000 behind output relay of any of the channels 1 through 4. One 8060 board is recommended for each channel controlling a compressor that does not have its own anti-short cycling control.

4.6 TIME DELAY MODEL 8061

Adjustable delay-on-break plug-in board. Provides the same function as 8060 Time Delay except logic is reversed where fail-safe programming is employed (paragraph 3.10).

4.7 ONE-SHOT BOARD MODEL 8062

Plug-in board for on times of less than one minute. Used in applications such as signalling systems where output activation of only a few seconds is required. Plugs directly into output board of Model 4000 or Model 8000 behind the output relay of any of the channels 1 through 4.

4.8 OVERRIDE TIMER MODEL 8063

This plug-in board allows any output of the Controller to be overridden "on" by a remotely located switch connected via low-voltage wiring. Override time per depression of push-button adjustable from thirty minutes to two hours (approximately). Used to temporarily extend heating or air conditioning time before or after normal hours occupancy.

4.9 DUTY CYCLER MODEL 8064 --- TWO LEVEL TEMPERATURE DEPENDENT DUTY CYCLING

This plug-in board causes the channel into which it is connected to cycle on and off whenever that channel is supposed to be <u>on</u> as determined by the program in the microprocessor or by activation of the ON override. The on and off times are adjustable from 20 seconds to 30 minutes. Normally, duty cycling is programmed into the controller directly without the use of this board, as per paragraph 3.7.6. However, the 8064 board allows a second level of duty cycling to be called up on any channel that reuqires changing the duty cycle pattern when a certain temperature is reached. This is accomplished by programming the desired channel of the controller with the duty cycle pattern having the shorter on time and setting the cycle pattern with the longer on time into the 8064 board plugged into that channel. The 8064 board will have no effect while the channel is operating normally (not overridden). When the channel is overridden "on", such as with a thermostat, the 8064 board takes over and the duty cycle with the shorter on time goes into effect.

4.10 SEQUENCERS

There are several sequencing/cycling options available for the Series 4000 and Series 8000 Controllers. They are open frame units for mounting in a suitable enclosure. A simple two-wire plug-in cable connects the sequencing unit to the master relay board in the Controller. One Controller switch output is required to control one sequencer/cycler. All sequencers have SPST normally open relay contacts rated at 10 amperes. Installation and operating instructions are supplied with each unit.

4.10.1 SEQUENCER MODEL TCS-1

The Model TCS-1 Sequencer can sequence/cycle up to four independent loads or groups of loads. The number of loads is chosen by a programming jumper on the board. The loads are turned off sequentially with only one load off at any time. The sequencing continually repeats until terminated by the Controller. The status of the outputs is displayed by indicator lights on the board. Using the TCS-1, a peak demand reduction of 25%, 35% or 50% can be achieved, depending upon whether the energy consuming loads are connected to the board and sequenced in four, three or two equal sized groups, respectively. Each load off time is adjustable from twenty seconds to thirty minutes.

4.10.2 SEQUENCING CONTROLLER AND EXPANDER MODELS TCS-40 and TCS-40-E4

Similar to the TCS-1, the TCS-40 can control four independent loads or groups of loads. However, the TCS-40 is much more versatile and universal in its applications, and it has the capability of being expanded to an eight-load controller using the TCS-40-E4 Expander. The TCS-40 repetitively sequences though eight equal time steps, turning the loads ON or OFF at each step. The length of the individual time steps may be programmed from one minute or two hours in one minute increments. All programming can be easily accomplished or modified in the field via switches on the units. No power is required to maintain the program. All eight time steps are of equal duration and continually repeat their sequence until terminated by the Controller (or the OFF override). On and off overrides are provided for each load. These

may be connected to thermostats, limit switches, manual switches, etc. The ON overrides require a contact closure, the OFF overrides require a contact opening. Any number of outputs may be controlled by a single override.

Upon initial activation or after a power failure, the loads programmed to come on during the first time step do so in a staggered manner, one every thirty seconds.

NOTE: A four pin connector must be specified on one end of the interconnecting cable when TCS-1 or TCS-40 are to be used with the 4000 or 8000 series controllers.

4.11 POWER LINE CARRIER SYSTEM -- Transmitter Boards, Models 8030/4 and 8030/8; and Receivers Models DR-8

The Solidyne Power Line Carrier System components consist of four, eight and sixteen channel power line carrier transmitters and the Series DR-8 Receiver Relays which can be coded in the field to respond to any channel of the transmitter. The transmitters may be stand-alone units (Models 8030P-4, 8030P-8, and 8030P-16 respectively) requiring external switching contacts for activation, or the transmitter boards themselves, without enclosures, are available to be factory or field installed directly into the Series 4000 or 8000 Controllers. However, normally only the 4 channel board (Model 8030/4) or the 8 channel board (Model 8030/8) would be used in the controllers. The transmitters superimpose digitally coded radio frequency signals on the building's existing 120 volt AC power lines. Each channel transmits a different digital code. These signals are received by DR-8 Digital Receivers, each individually set to respond to one of 256 possible codes that are field selectable. These codes are set by internal switches according to a coding chart in the instructions. A DR-8 will respond only to its own digital address code. Up to 200 receivers can be set to respond to a particular address. The relay contacts of the receiver open when the digital signal is received and close when the signal is absent. When the contacts are closed the load will be turned on and off by its normal control (thermostat, wall switch, etc.).

The inputs of the transmitter are wired to the switch output relay

contacts of the Series 4000 or Series 8000 Controller. Upon application of power, the transmitter sequentially checks the status of the contacts connected to its inputs at a rate of one per second. When an open contact is encountered, the transmitter generates an 8-bit coded signal for that channel which is carried by the power lines to the DR-8 Receiver which responds by opening its relay contacts.

Receiver relay contacts are rated at 120 volts AC, 10 amperes. The transmitter requires 120 volts AC at 0.1 amperes. The receiver requires 90 to 277 volts AC to operate. 30 amp receivers available (208 to 277VAC).

Note: Only one transmitter may be installed in any given power distribution network from the utility company's transformer. If two Model 8000's with PLC are required, use two controllers without built-in PLC and field wire them to one 16 channel transmitter, Model 8030P-16.

5.1 GENERAL

Repair of the Controllers in the event of malfunction, except for the battery, should be referred to qualified factory personnel.

5.2 BATTERY

The rechargeable battery is kept on a constant trickle charge by the Controller power supply. Normally, this will keep the battery at full charge with the ability to maintain the program memory intact for approximately twenty to twenty-four hours. A power outage in excess of that time may fully discharge the battery. When this condition occurs, all programming in the controller memory will be lost. The battery must then be allowed to recharge after a "hard reset" procedure is followed as described in paragraph 3.14. A fully discharged battery will require at least two days to recharge to a useable level. Maximum charging current is approximately 30 ma. When fully charged, battery voltage should read 9.3 volts.

Charging prior to initial startup:

It is recommended that before initial start-up, prior to installation, electrical connection is made to the unit and battery as described in paragraph 2.3, and the battery is allowed to charge for one or two days. This will assure full battery charge at start up and will avoid power interruption problems during the first few days of operation.

VI -- WARRANTY

Solidyne Corp. warrants the Energy Management products of its manufacture to be free from defects in material and workmanship under normal use and service for a period of one year after delivery to the original retail purchaser. The obligation of Solidyne under this warranty is limited to repairing or replacing at its option without charge any product which shall be returned to Solidyne by the original purchaser, transportation charges prepaid, within one year after purchase and which upon examination shall disclose to Solidyne's satisfaction to be defective and under warranty. This warranty shall not apply to a product which has been subject to misuse, neglect, accident, incorrect wiring not of its own installation, or to use in violation of instructions furnished by Solidyne, or to a product which has been repaired or altered without the consent of Solidyne or to a product damaged by a lightning strike on the power line to which it was connected. After one year repairs will be made at a nominal fee based on time and material.

This warranty does not cover shipping damage sustained to the product due to improper packing by the purchaser when returning the unit to the factory.

SOLIDYNE SHALL NOT UNDER ANY CIRCUMSTANCES BE HELD LIABLE FOR LOSS, DAMAGE OR EXPENSE DIRECTLY OR INDIRECTLY RESULTING FROM THE USE OF ITS PRODUCTS OR FROM ANY OTHER CAUSE. IN NO EVENT WILL SOLIDYNE CORP. BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES; NOR SHALL SOLIDYNE CORP. BE LIABLE FOR TRANSPORTATION, LABOR OR OTHER CHARGES FOR ADJUSTMENTS, REPAIRS, REPLACEMENT OF PARTS, INSTALLATION OR OTHER WORK WHICH MAY BE DONE OR IN CONNECTION WITH ITS PRODUCTS. THE ABOVE WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, AND NO PERSON, AGENT, OR DEALER IS AUTHORIZED TO ASSUME FOR SOLIDYNE ANY OTHER LIABILITIES IN CONNECTION WITH ITS PRODUCTS.

SERVICE UNDER WARRANTY

To establish and receive warranty service, proof of purchase in the form of a dated sales invoice, showing serial number, is required. Also, a return authorization number must be obtained from the factory before returning any equipment. Obtain this number from Solidyne Corp., 2400 W. Hassell Road, Hoffman Estates, IL 60195. Telephone: 312-882-8444. When returning equipment, make sure packing is adequate to prevent shipping damage. Use double box with extra layer of cushioning.