

# INSTRUCTION MANUAL



## SDM-CD16AC 16 Channel AC/DC Controller

Revision: 8/07



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# ***SDM-CD16AC 16 Channel AC/DC Controller***

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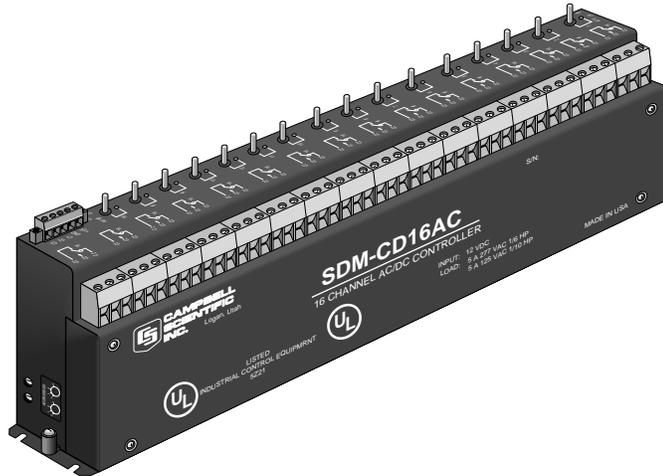


FIGURE 1. SDM-CD16AC Face Panel

## **1. Function**

The SDM-CD16AC has 16 AC/DC relay control ports (see Figure 1). Each relay port can be controlled by a datalogger or controlled manually with a manual override toggle switch.

The toggle switch has three positions; "ON" and "OFF" for manual override, and "AUTO" for datalogger control. In the "ON" position, the common (COM) and normally open (NO) contacts are closed (see Figure 2). In the "AUTO" position, the state of the relays are controlled by the datalogger control ports.

The SDM-CD16AC is a synchronously addressed datalogger peripheral. Three ports on the datalogger are used to address the SDM-CD16AC, then clock out the desired state of each of the 16 control ports. Up to 16 SDM-CD16ACs may be addressed, making it possible to control a maximum of 256 ports from the three datalogger ports.

In CRBasic, the SDMCD16AC instruction is used to control the SDM-CD16AC. In Edlog, either I/O Instruction 104 (CR10(X), CR23X, 21X) or Instruction 29 (CR7) is used.

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### **NOTE**

Ensure that the datalogger contains the appropriate instruction prior to system deployment. The SDM-CD16AC is not compatible with our CR200-series, CR500, or CR510 dataloggers.

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## 2. Control Specifications

Operating voltage: 12 VDC nominal (9 to 18).

Current drain at 12 VDC: 6 mA quiescent; 45 mA per active LED (switch on or auto active).

Total cable length: 20 ft (for most applications), 600 ft (possible for CR7)

Toggle switch: ON/OFF manual override; AUTO for datalogger control.

Underwriters Laboratories (UL) and Canadian Underwriters Laboratories (CUL) listed product. UL and CUL listing number is 5Z21.

### RELAY SPECIFICATIONS

Arrangement: Single pole double throw, Break before make

Contact material: Gold-clad silver

Individual contact rating: 5 A at 30 VDC, .3 A at 110 VDC, 5 A 1/10 HP at 125 VAC, 5 A 1/6 HP at 277 VAC

Coil voltage: 9 to 18 VDC

Coil resistance: 360 Ohms•±10%

Expected life (contact closures): Mechanical 10<sup>7</sup>

Actuation/Release time: Approx. 4 ms

Operating temp.: -40° to 70°C

## 3. Power Considerations

The SDM-CD16AC power requirements are large compared to most CSI products. For most applications an external power supply (see Figure 3) is recommended to power the SDM-CD16AC.

For some applications it may be convenient to use the datalogger supply to power the SDM-CD16AC (see Figure 3). For long-term applications, the lead acid power supply available with CSI dataloggers should be used, allowing the batteries to be float charged. It is not recommended that the datalogger alkaline supply be used to power the SDM-CD16AC for long term applications.

If the datalogger lead acid supply is used, the number of SDM-CD16AC's that can be powered is limited by the 300 mA current sourcing capability of the wall charger. With a continuous 6 mA current drain per SDM-CD16AC and 45 mA per active LED, a maximum of 6 LEDs may be powered by the datalogger, after which, more current is drawn than can be sourced by the wall charger. If this condition is maintained, it will ultimately lead to battery deep discharge, requiring new batteries.

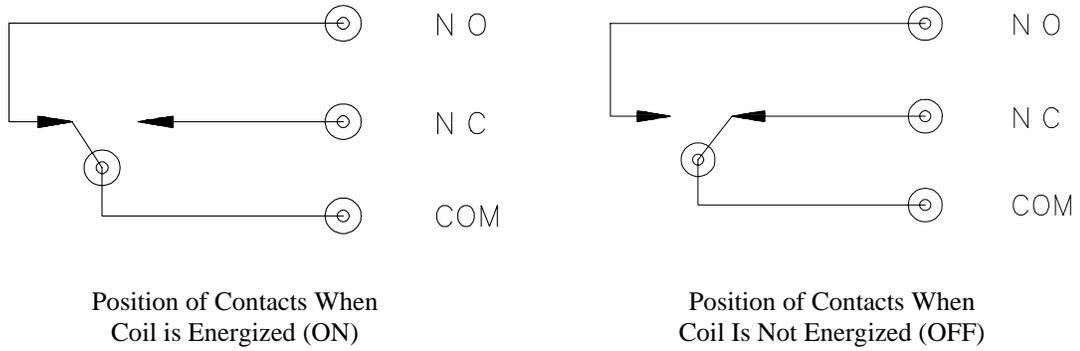
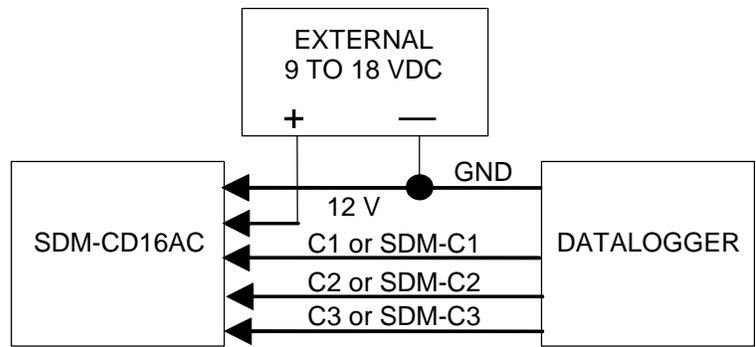
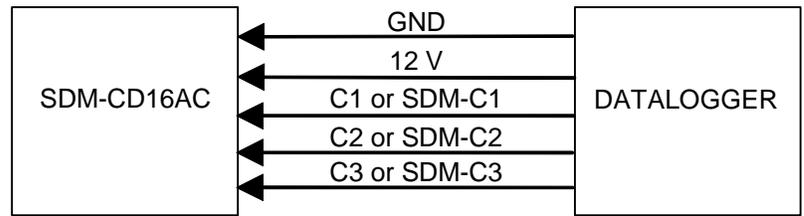


FIGURE 2. Switch Operation



Connection With External Supply (see note on next page)



Connection with Datalogger Supply (see note on next page)

FIGURE 3. Connection Block Diagrams

<b>Connection Order</b>	<b>SDM-CD16AC</b>	<b>Datalogger (see note)</b>	<b>Function</b>
First	12 V	12 V on datalogger or external supply	Power
Second	Gnd	Gnd	Common ground Data
	C1	SDM-C1 (CR3000, CR5000) or C1 (other dataloggers)	
	C2	SDM-C2 (CR3000, CR5000) or C2 (other dataloggers)	Clock
	C3	SDM-C3 (CR3000, CR5000) or C3 (other dataloggers)	Enable

**NOTE**

On a CR7, SDMs connect to the ports at the upper right corner of the 700X Control Module. On a CR9000X, SDMs connect to the ports on the CR9032 CPU Module, and on a CR9000, SDMs connect to the ports on the CR9080 PAM Module.

If the 21X power supply is used to power the SDM-CD16AC, all low level analog measurements (thermocouples, pyranometers, thermopiles, etc.) must be made differentially. This is a result of slight ground potentials created along the 21X analog terminal strip when the 12 V supply is used to power peripherals. This limitation reduces the number of available analog input channels and may mandate an external supply for the SDM-CD16AC.

## 4. Installation

- The SDM-CD16AC must be installed in an enclosure that provides a pollution degree 2 environment (normally, only nonconductive pollution. However, a temporary conductivity caused by condensation may be expected). All Campbell Scientific enclosures meet this requirement.
- Use copper conductors only.
- Wire Range: 30 – 14 AWG
- Tightening Torque: 5 – 7 in./lb.
- Use minimum 60/75 degree C wire.
- Input power must be connected to a class 2 supply only. All Campbell Scientific power supplies meet the class 2 supply requirements.

**CAUTION**

The order in which connections are made is critical. Always connect 12 V first, followed by ground, then Control Ports.

**CAUTION**


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Cables connecting the terminals of the datalogger and SDM device should be kept as short as possible to minimize the risk of corruption of the signals and damage from induced surges. Where long cable runs (>3 m) are unavoidable and the cables run outside, some extra protection may be required for the SDM control terminals. Please contact Campbell Scientific for further advice. When connecting wires to the SDM signal terminals please ensure they are at ground potential before making the connection, e.g. by touching them to the earth terminal.

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For datalogger connections, see Table 1.

Multiple SDM-CD16AC's may be wired in parallel by connecting the datalogger side of one SDM-CD16AC to the next. For CR10 and 21X dataloggers, the total length of the cables connecting the SDM-CD16AC's should not exceed 20 feet.

Total cable lengths in excess of 20 feet will adversely influence communication performance. For CR7 dataloggers, the total cable length should not exceed 600 feet.

## 4.1 Wiring

### 4.1.1 SDM-CD16AC Power and Control Connections

Refer to Figure 3 and Table 1 for SDM-CD16AC operating power and control connections to the datalogger.

### 4.1.2 Controlled Device Connections

**DANGER!**


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**ELECTROCUTION HAZARD! USE EXTREME CAUTION WHEN WORKING WITH HIGH VOLTAGE INPUTS. DO NOT COME IN CONTACT WITH HOT LEADS!**

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Figure 2 shows how the switches in each channel operate. NO means “normally open”, NC means “normally closed”. COM means “common” to NO and NC.

In most applications, the SDM-CD16AC acts as a switch (controllable break) in one wire of the circuit powering the controlled device. One side of this break may have power (hot). Figure 4 shows an example.

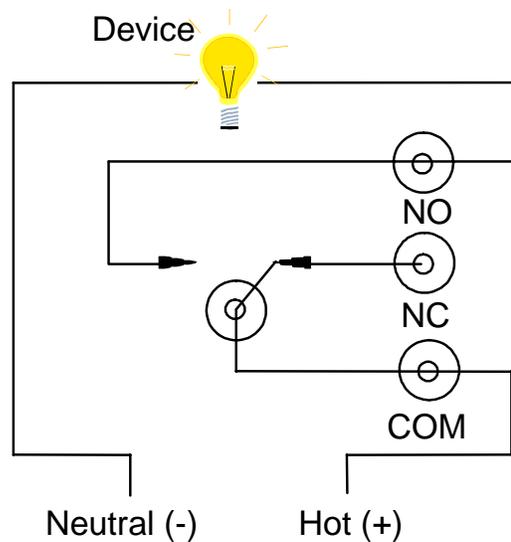


FIGURE 4. Typical Wiring Application

### 4.1.3 Motor Control

The CD16AC is a UL approved Start/Stop motor controller. In the figure below, a typical 5 Amp 115 VAC relay contact circuit shows how to control a three phase motor starter in a Motor Control Center (MCC). Typically, the CR10X will automatically command the appropriate relay to energize the motor starter. The relay in the CD16AC will remain latched until the CR10X program commands that the motor be turned off, at which time the relay will open the circuit to the motor starter and the motor will stop.

The CD16AC can be used to control three phase pump motors, air blowers, and large control valves in the same fashion.

MAIN CR10X RTU 120VAC RELAY OUTPUTS TO MCCN

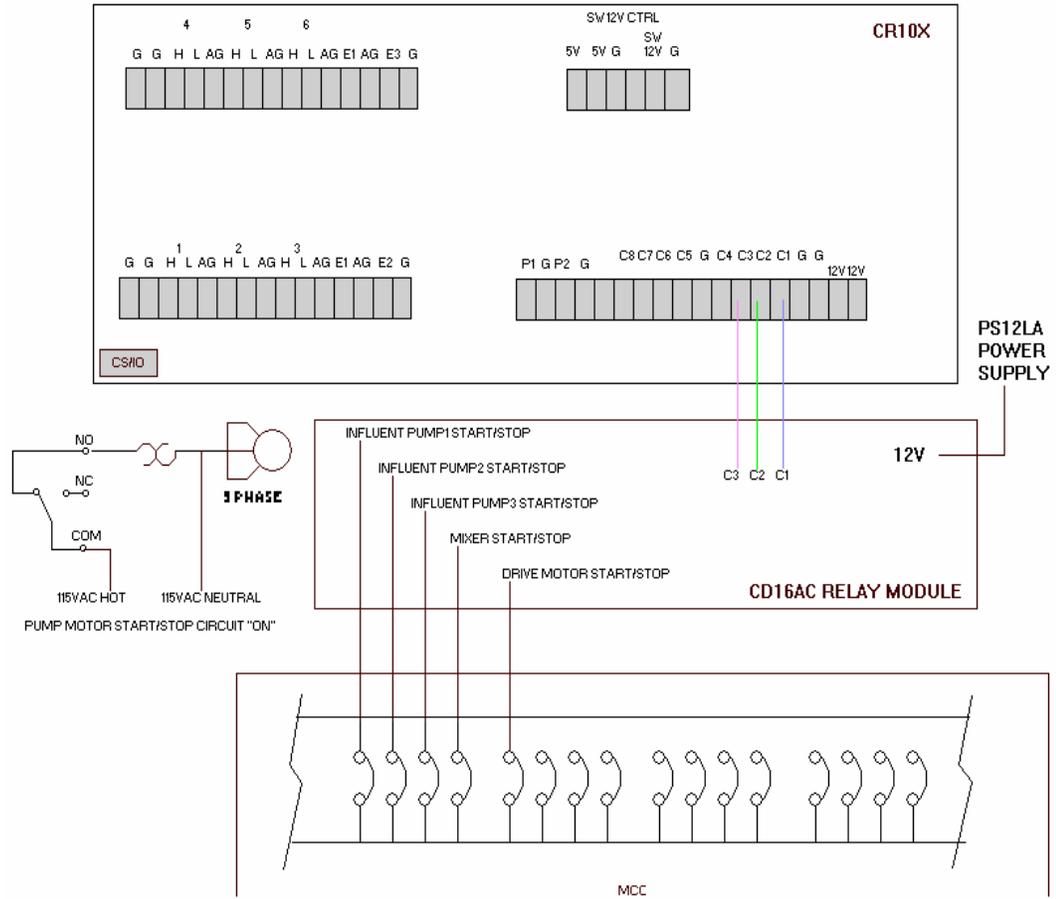


FIGURE 5. CD16AC Relay Outputs to MCC

## 5. Address Selection Switches

Each SDM-CD16AC can have 1 of 16 addresses. Shipped from the factory, the address is set at 00. The following table shows switch position and the corresponding address (see Figure 6).

Switch B	Switch A			
	0	1	2	3
0	00	01	02	03
1	10	11	12	13
2	20	21	22	23
3	30	31	32	33

Base 4 Address Matrix  
(00, 01, 02 . . . 32, 33)

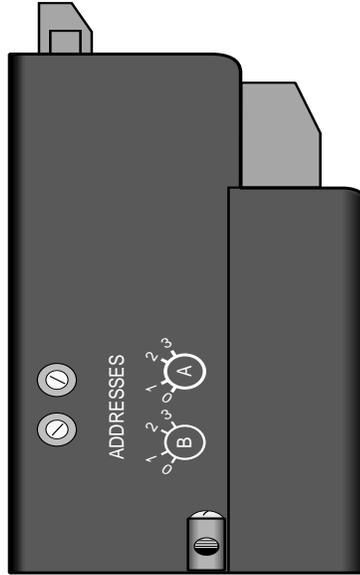


FIGURE 6. Addressing

## 6. Datalogger Programming

In CRBasic, the SDMCD16AC instruction is used to control the SDM-CD16AC. Dataloggers that are programmed with CRBasic include our CR800, CR850, CR1000, CR3000, and CR5000.

Edlog Instruction 104 is used by the CR23, 21X, and CR10(X) to control the SDM-CD16AC, and Edlog Instruction 29 is used by the CR7. SDM-CD16AC outputs that are to be controlled by the datalogger must have the toggle switch in the AUTO position.

### 6.1 CRBasic Programming

SDMCD16AC

#### Syntax

SDMCD16AC (Source, Repts, SDMAAddress)

#### Remarks

A port on an SDM-CD16AC is enabled/disabled (turned on or off) by sending a value to it using the SDMCD16AC instruction. A non-zero value will enable the port; a zero value disables it. The values to be sent to the CD16AC are held in the Source array.

The SDMCD16AC instruction has the following parameters:

**Source:** The Source parameter is an array which holds the values that will be sent to the SDM-CD16AC to enable/disable its ports. An SDM-CD16AC has 16 ports; therefore, the source array must be dimensioned to 16 times the number of Repetitions (the number of SDM-CD16AC devices to be controlled). As an example, with the array CDCtrl(32), the value held in

CDCtrl(1) will be sent to port 1, the value held in CDCtrl(2) will be sent to port 2, etc. The value held in CDCtrl(32) would be sent to port 16 on the second SDM-CD16AC.

**Reps:** The Reps parameter is the number of SDM-CD16AC devices that will be controlled with this instruction.

**SDMAddress:** The SDMAddress parameter is used to define the address of the CD16AC that will be controlled with this instruction. Valid SDM addresses are 0 through 14. Address 15 is reserved for the SDMTrigger instruction. If the Reps parameter is greater than 1, the datalogger will increment the SDM address for each subsequent device that it communicates with.

**NOTE**

CRBasic dataloggers use base 10 when addressing SDM devices. Edlog programmed dataloggers (e.g., CR10X, CR23X) used base 4 for addressing (see Table 2).

<b>Base 10</b>	<b>Base 4</b>	<b>Base 10</b>	<b>Base 4</b>
0	0	8	20
1	1	9	21
2	2	10	22
3	3	11	23
4	10	12	30
5	11	13	31
6	12	14	32
7	13	15	33 (reserved)

## 6.2 Edlog Programming

### Instruction 104—SDM-CD16AC use with CR23X, CR10(X), and 21X

<b>Param.</b>	<b>Type</b>	<b>Description</b>
1	2	Reps (# of modules sequentially addressed)
2	2	Starting Address (base 4: 00..33)
3	4	Starting Input Location

Execution Time = 2 ms per Rep for the CR10X, 3.5 ms per Rep for the 21X

### Instruction 29 - SDM-CD16AC use with CR7

<b>Param</b>	<b>Type</b>	<b>Description</b>
1	2	Reps (# of modules sequentially addressed)
2	2	Device (2 = SDM-CD16AC)
3	2	Starting Address (base 4: 00..33)
4	2	Card (Excitation card #)
5	4	Starting Input Location

Execution Time = 150 to 190 ms per Rep

The number of SDM-CD16ACs to be addressed is defined by the Repts (repetitions) parameter. Each Rep will sequentially address (00, 01, 02,...32, 33) SDM-CD16ACs starting with the address specified in parameter 2 (Instruction 29 parameter 3).

For each Rep, the 16 ports of the addressed SDM-CD16AC are set according to 16 sequential Input Locations starting at the Input Location specified in parameter 3 (Instruction 29 parameter 5). Any non-zero value stored in an input location activates the associated SDM-CD16AC port. A value of zero (0) deactivates the port. For example, assuming 2 Repts and a starting Input Location of 33, OUTPUT 1 through 16 of the first SDM-CD16AC are set according to Input Locations 33 through 48, and OUTPUT 1 through 16 of the second SDM-CD16AC are set according to Input Locations 49 through 64.

For Instruction 29, the Device (parameter 2) specifies what type of synchronously addressed peripheral is to be addressed. The Device code for an SDM-CD16AC is 2.

For Instruction 29 only (CR7), the Card parameter 4 specifies which 725 Excitation Card is being used for the Control Port signals. The Repts parameter does not advance beyond the specified Card, requiring another Instruction 29 for each 725 Excitation Card used.

## 7. Theory of Operation

The SDM-CD16AC is a synchronously addressed peripheral. C2 and C3, driven high by the datalogger, initiate a cycle. While holding C3 high, the datalogger drives C2 as a clock line and C1 as a serial data line. The datalogger shifts out a data bit on C1 (LSB first) on the falling edge of the C2 clock. The SDM-CD16AC shifts in the C1 data bit on the rising edge of the C2 clock.

The first 8 bits clocked out represent the SDM-CD16AC address. If the address matches the SDM-CD16AC's address, the SDM-CD16AC is enabled. If enabled, the next 16 bits are shifted into the SDM-CD16AC, each bit controlling one port, the first of which controls OUTPUT1.

When the 16 control bits are clocked in, C2 is held high while C3 is pulsed low then high to latch the control bits. The datalogger then lowers both C3 and C2 to complete the cycle.

## 8. Program Examples

### 8.1 CRBasic Example

In the following CR1000 program example, a counter is used to fill an array called Src( ) that will control two SDM-CD16ACs.

```

'Dimension Variables
Public src(32)
Dim i, count, mask(16)

'Program
BeginProg
for i=1 to 16
  mask(i) = 2^(i-1)
next i
Scan(20,msec,2,0)
  count = count + 1
  for i=1 to 32
    src(i) = count AND mask(((i-1) MOD 16) +1)
  next i
  SDMCD16AC(src(),2,1)
NextScan
EndProg

```

## 8.2 Edlog Example

The example is written for the CR10(X) Measurement and Control Module. The program concepts presented are the same for the CR23X, 21X, and CR7 dataloggers with minor program code changes.

In this example, the SDM-CD16AC is used to control the temperature between 23° and 28°C in each of 5 greenhouses. In each green house the SDM-CD16AC controls a heating unit, a refrigerating unit, and an air mixing fan according to the following conditions.

Heating unit: Activate when temperature < 23.5°C. Deactivate when temperature > 25.5°C

Cooling unit: Activate when temperature > 27.5°C. Deactivate when temperature < 24.5°C

Mixing fan: Activate whenever the heating or cooling units are activated. Activate for 5 minutes out of every 15 minutes.

The program assumes the temperature measurements have been made, and the average temperature for each greenhouse is computed and residing in Input Locations 1 through 5.

Input Location assignments are as follows:

Input Location	Location Label	Description
1..5	Temp #1..#5	Avg temp, greenhouse 1..5
10..14	Heat #1..#5	Heater control, greenhouse 1..5 SDM-CD16AC Port 1..5
15..19	Cool #1..#5	Cooler control, greenhouse 1..5 SDM-CD16AC Port 6..10
20..24	Fan #1..#5	Fan control, greenhouse 1..5 SDM-CD16AC Port 11..15

1: Beginning of Loop (P87)		<i>Master Loop, End</i>
1: 0	Delay	<i>Loop at Step 30</i>
2: 5	Loop Count	
<b>START HEATER CONTROL LOGIC</b>		
2: If X<=>F (P89)		<i>If "Heater On"</i>
1: 1--	X Loc	<i>threshold is</i>
2: 4	<	<i>exceeded</i>
3: 23.5	F	
4: 30	Then Do	<i>Then</i>
3: Z=F (P30)		<i>Put a "1" into Heater</i>
1: 1	F	<i>Control Location</i>
2: 0	Exponent of 10	
3: 10--	Z Loc :	
4: End (P95)		<i>End Then Do/End</i>
5: If X<=>F (P89)		<i>If Heater</i>
1: 10--	X Loc	<i>#1 on (Heater Control</i>
2: 2	<>	<i>Location &lt;&gt; 0)</i>
3: 0	F	
4: 30	Then Do	<i>Then</i>
6: If X<=>F (P89)		<i>Temp #1 Check Upper Threshold</i>
1: 1--	X Loc	<i>to see if heater should</i>
2: 3	>=	<i>be turned off</i>
3: 25.5	F	
4: 30	Then Do	
7: Z=F (P30)		<i>If heater should be turned</i>
1: 0	F	<i>off, enter a "0" into</i>
2: 0	Exponent of 10	<i>heater control location</i>
3: 10--	Z Loc :	
8: End (P95)		<i>Else Then Do/End</i>

9: Else (P94)		<i>Else, If the heater is off,</i>
10: Z=F (P30)		
1: 0	F	<i>Enter a "0" into heater</i>
2: 0	Exponent of 10	<i>control location</i>
3: 10--	Z Loc :	
11: End (P95)		<i>End Then Do/Else/End</i>
<b>END HEATER CONTROL LOGIC</b>		
<b>START COOLER CONTROL LOGIC</b>		
12: If X<=>F (P89)		<i>If "Cooler" on</i>
1: 1--	X Loc	<i>threshold is</i>
2: 3	>=	<i>exceeded</i>
3: 27.5	F	
4: 30	Then Do	<i>Then</i>
13: Z=F (P30)		<i>Put a "1" into cooler</i>
1: 1	F	<i>Control Location</i>
2: 0	Exponent of 10	
3: 15--	Z Loc :	
14: End (P95)		<i>End Then Do/End</i>
15: If X<=>F (P89)		<i>If cooler is on</i>
1: 15--	X Loc	<i>(Cooler control</i>
2: 2	<	<i>Location &lt;&gt;0)</i>
3: 0	F	
4: 30	Then Do	<i>Then</i>
16: If X<=>F (P89)		<i>Check lower threshold to</i>
1: 1--	X Loc	<i>see if cooler should be</i>
2: 4	<	<i>turned off</i>
3: 24.5	F	
4: 30	Then Do	
17: Z=F (P30)		<i>If cooler should be turned</i>
1: 0	F	<i>off, put a "0" into cooler</i>
2: 0	Exponent of 10	<i>control location</i>
3: 15--	Z Loc :	
18: End (P95)		<i>End Then Do/End</i>
19: Else (P94)		<i>Else if cooler is off</i>
20: Z=F (P30)		
1: 0	F	<i>Put a "0" into cooler</i>
2: 0	Exponent of 10	<i>control location</i>
0: 15--	Z Loc :	

21: End (P95)		<i>End Then Do/Else/End</i>
<b>END COOLER CONTROL LOGIC</b>		
<b>START FAN CONTROL LOGIC BASED ON HEATER/COOLER</b>		
22: If X<=>F (P89)		<i>If heater is on</i>
1: 10--	X Loc	
2: 2	<>	
3: 0	F	
4: 11	Set high Flag 1	<i>Set flag 1</i>
23: If X<=>F (P89)		<i>If cooler is on</i>
1: 15--	X Loc	
2: 2	<>	
3: 0	F	
4: 11	Set high Flag 1	<i>Set flag 1</i>
24: If Flag/Port (P91)		<i>If flag 1 is set</i>
1: 11	Do if flag 1 is high	
2: 30	Then Do	<i>Then</i>
25: Z=F (P30)		<i>Put a "1" into fan control location</i>
1: 1	F	
2: 0	Exponent of 10	
3: 20--	Z Loc:	
26: Else (P94)		<i>Else, If flag 1 is reset</i>
27: Z=F (P30)		<i>Put a "0" into fan control location</i>
1: 0	F	
2: 0	Exponent of 10	
3: 20--	Z Loc :	
28: End (P95)		<i>End Then Do/Else/End</i>
29: Do (P86)		<i>Reset flag 1</i>
1: 21	Set low Flag 1	
30: End Loop (P95)		<i>End Master Loop</i>
<b>END FAN CONTROL LOGIC BASED ON HEATER/COOLER</b>		
<b>START FAN CONTROL LOGIC BASED ON TIME</b>		
31: If time is (P92)		<i>If 5 minutes remain out of 15 minute interval,</i>
1: 10	minutes into a	
2: 15	minute interval	
3: 12	Set high Flag 2	<i>set flag 2</i>

32: If Flag/Port (P91)		<i>If flag 2 is set</i>
1: 12	Do if flag 2 is high	
2: 30	Then Do	<i>Then</i>
33: Beginning of Loop (P87)		<i>Start fan loop</i>
1: 0	Delay	
2: 5	Loop Count	
34: Z=F (P30)		<i>PUT A "1" INTO FAN CONTROL LOCATION</i>
1: 1	F	
2: 0	Exponent of 10	
3: 20--	Z Loc :	
35: End (P95)		<i>End fan loop</i>
36: End (P95)		<i>End then do</i>
37: If time is (P92)		
1: 0	minutes into a	<i>Reset flag 2 at the</i>
2: 15	minute interval	<i>end of the 15 minute</i>
3: 22	Set low Flag 2	

**END FAN CONTROL LOGIC BASED ON TIME**

**INPUT LOCATIONS 10 THROUGH 24 ARE NOW LOADED WITH "1" OR "0" TO SET PORTS ON THE SDM-CD16AC.**

38: SDM-CD16AC (P104)		<i>Send instructions to the SDM-CD16AC with address 00</i>
1: 1	Reps	
2: 00	Address	
3: 10	Loc	
39: End Table 1 (P)		





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