SDM-CD16AC 16 CHANNEL
AC/DC CONTROLLER

REVISION: 5/00

Warranty and Assistance

The **SDM-CD16AC 16 CHANNEL AC/DC CONTROLLER** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

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Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.

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SDM-CD16AC 16 Channel AC/DC Controller Table of Contents

Figures

Table

SDM-CD16AC 16 Channel AC/DC Controller

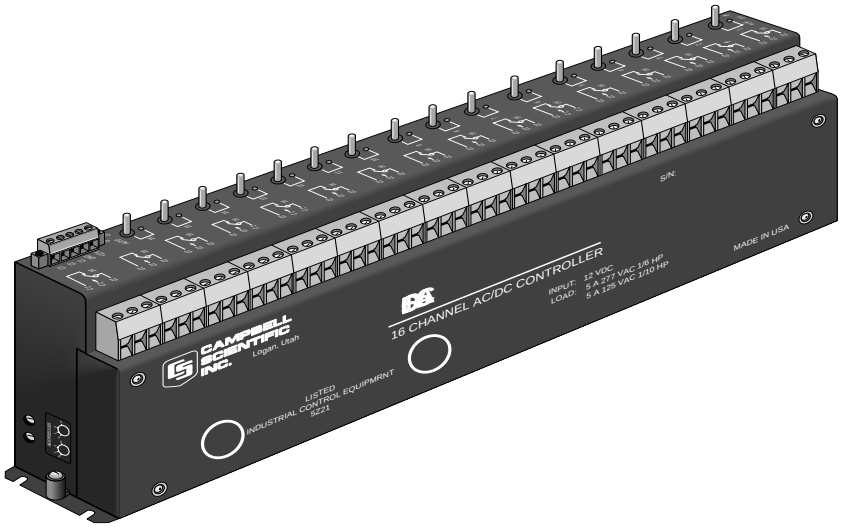


FIGURE 1. SDM-CD16AC Face Panel

1. Function

The SDM-CD16AC has 16 AC/DC relay control ports and is compatible with CSI's CR10, 21X and CR7 dataloggers (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. Datalogger control ports 1, 2, and 3 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 first three datalogger control ports.

I/O Instruction 104 is used by the 21X and CR10 to control the SDM-CD16AC. The CR7 uses Instruction 29.

NOTE Ensure that the datalogger contains the appropriate instruction prior to system deployment.

2. Control Specifications

Compatible dataloggers: CR10, 21X, CR7.

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 (CR10, 21X), 600 ft (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 10^7

Actuation/Release time: Approx. 4 ms

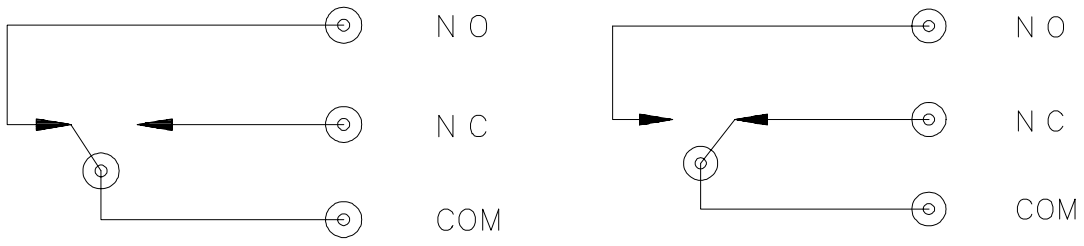
Operating temp.: -40° to 70°C

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.

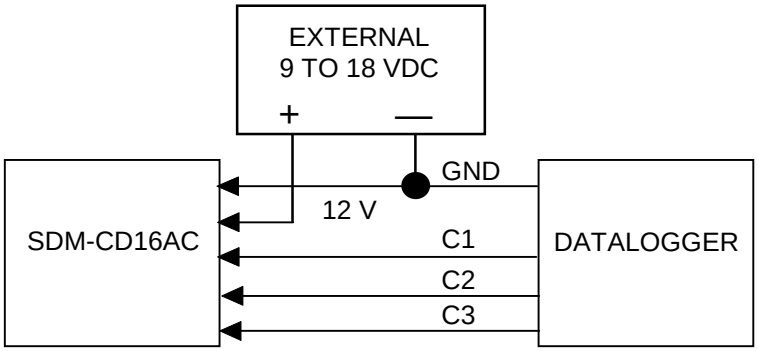
If the datalogger lead acid supply is used, the number of SDM-CD16AC's that can be powered is limited by the 300 mA current sourcing capability of the wall charger. With a continuous 6 mA current drain per SDM-CD16AC and 45 mA per active LED, a maximum of 6 LEDs may be powered by the datalogger, after 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.



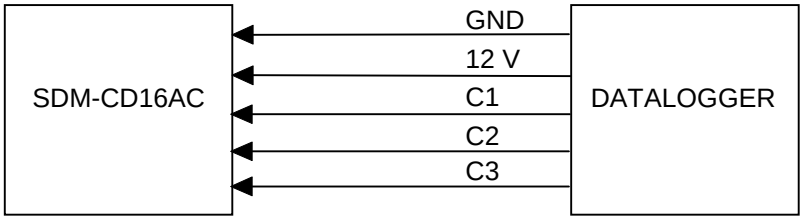
Position of Contacts When Coil is Energized (ON)

Position of Contacts When Coil Is Not Energized (OFF)

FIGURE 2. Switch Operation



Connection With External Supply



Connection with Datalogger Supply

FIGURE 3. Connection Block Diagrams

TABLE 1. Datalogger to SDM-CD16AC Connections			
Connection Order	**SDM-CD16AC**	**Datalogger**	**Function**
First	12 V	12 V on datalogger or external supply	Power
Second	Gnd	Gnd	Common ground
	C1	C1 (Control Port 1)	Data
	C2	C2 (Control Port 2)	Clock
	C3	C3 (Control Port 3)	Enable

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.

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

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.

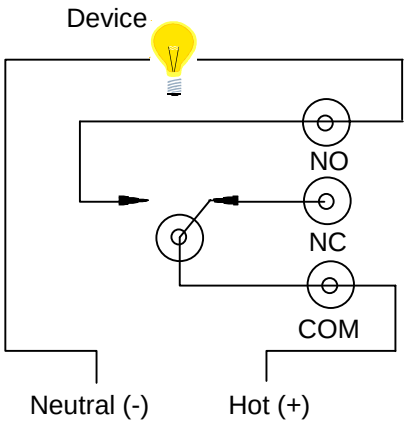


FIGURE 4. Typical Wiring Application

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.

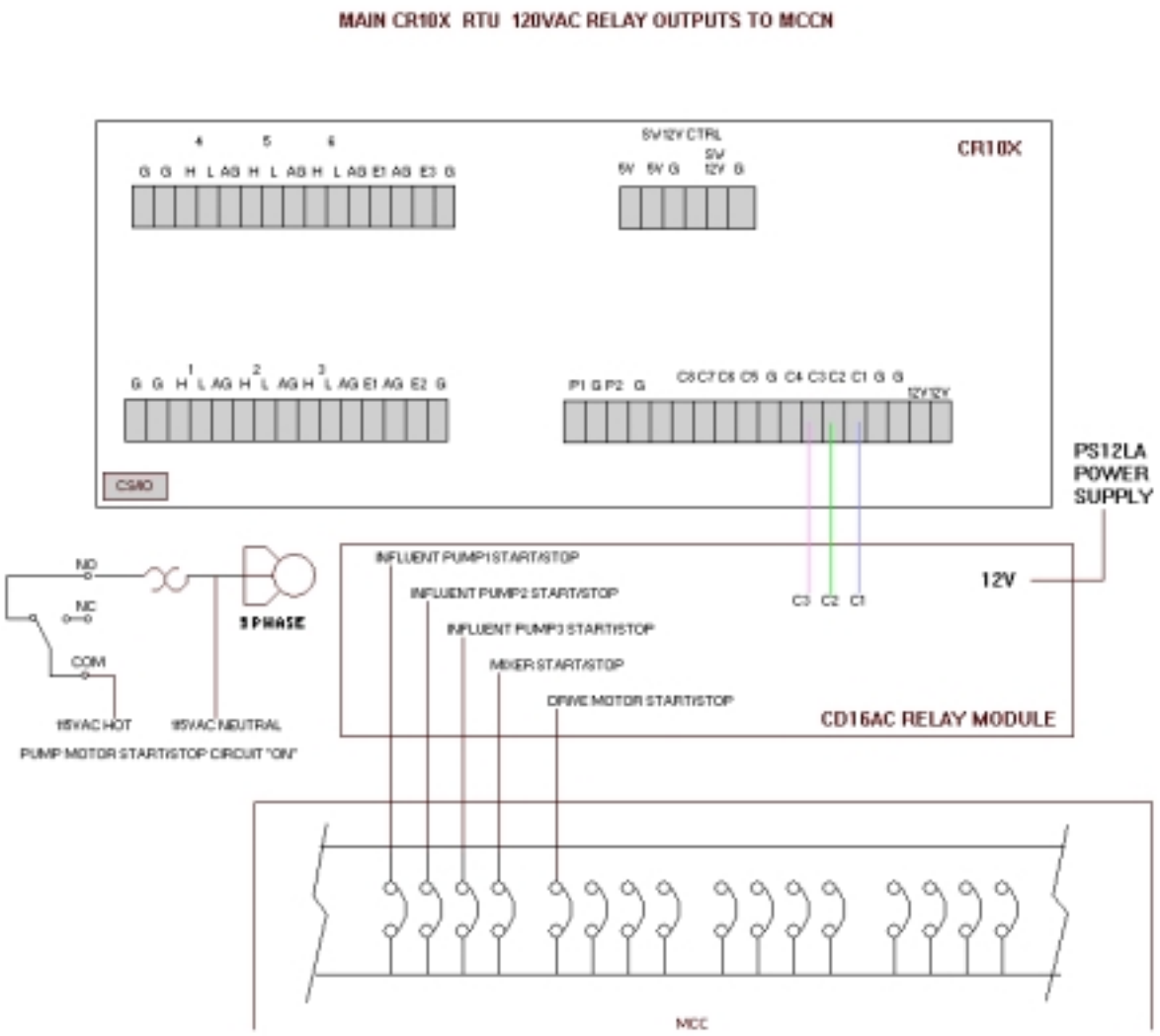


FIGURE 5. CD16AC Relay Outputs to MCC

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 A			
	0	1	2	3
Switch B				
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 Instruction—104 (21X, CR10) 29 (CR7)

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

Instruction 104—SDM-CD16AC use with CR10 and 21X

Param.	Type	Description
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 CR10, 3.5 ms per Rep for the 21X

Instruction 29 - SDM-CD16AC use with CR7

Param	Type	Description
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 Reps (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 Reps 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 Reps 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 Example

The example is written for the CR10 Measurement and Control Module. The program concepts presented are the same for the 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

```
01:  Beginning of Loop (P87)                    Master Loop, End
  01:          0        Delay                   Loop at Step 30
  02:          5        Loop Count

START HEATER CONTROL LOGIC

02:  If X<=>F (P89)                             If "Heater On"
  01:         1--       X Loc                   threshold is
  02:          4        <                       exceeded
  03:       23.5        F
  04:         30        Then Do                 Then

03:  Z=F (P30)                                  Put a "1" into Heater
  01:          1        F                       Control Location
  02:          0        Exponent of 10
  03:        10--       Z Loc :

04:  End (P95)                                  End Then Do/End

05:  If X<=>F (P89)                             If Heater
  01:        10--       X Loc                   #1 on (Heater Control
  02:          2        <>                      Location <> 0)
  03:          0        F
  04:         30        Then Do                 Then

06:  If X<=>F (P89)
  01:         1--       X Loc                   Temp #1 Check Upper Threshold
  02:          3        >=                      to see if heater should
  03:       25.5        F                       be turned off
  04:         30        Then Do
```

```
07:  Z=F (P30)                                  If heater should be turned
  01:            0        F                     off, enter a "0" into
  02:            0        Exponent of 10        heater control location
  03:          10--       Z Loc :

08:  End (P95)                                  Else Then Do/End

09:  Else (P94)                                 Else, If the heater is off,

10:  Z=F (P30)
  01:            0        F                     Enter a "0" into heater
  02:            0        Exponent of 10        control location
  03:          10--       Z Loc :

11: End (P95)                                   End Then Do/Else/End

END HEATER CONTROL LOGIC

START COOLER CONTROL LOGIC

12:  If X<=>F (P89)                             If "Cooler" on
  01:           1--       X Loc                 threshold is
  02:            3        >=                    exceeded
  03:         27.5        F
  04:           30        Then Do               Then

13:  Z=F (P30)                                  Put a "1" into cooler
  01:            1        F                     Control Location
  02:            0        Exponent of 10
  03:          15--       Z Loc :

14:  End (P95)                                  End Then Do/End

15:  If X<=>F (P89)                             If cooler is on
  01:          15--       X Loc                 (Cooler control
  02:            2        <>                    Location <>0)
  03:            0        F
  04:           30        Then Do               Then

16:  If X<=>F (P89)                             Check lower threshold to
  01:           1--       X Loc                 see if cooler should be
  02:            4        <                     turned off
  03:         24.5        F
  04:           30        Then Do

17:  Z=F (P30)                                  If cooler should be turned
  01:            0        F                     off, put a "0" into cooler
  02:            0        Exponent of 10        control location
  03:          15--       Z Loc :

18:  End (P95)                                  End Then Do/End

19:  Else (P94)                                 Else if cooler is off
```

```
20:  Z=F (P30)
  01:          0        F                      Put a "0" into cooler
  02:          0        Exponent of 10         control location
  03:        15--       Z Loc :

21:  End (P95)                                 End Then Do/Else/End

END COOLER CONTROL LOGIC

START FAN CONTROL LOGIC BASED ON HEATER/COOLER

22:  If X<=>F (P89)                            If heater is on
  01:        10--       X Loc
  02:          2        <>
  03:          0        F
  04:         11        Set high Flag 1        Set flag 1

23:  If X<=>F (P89)                            If cooler is on
  01:        15--       X Loc
  02:          2        <>
  03:          0        F
  04:         11        Set high Flag 1        Set flag 1

24:  If Flag/Port (P91)                        If flag 1 is set
  01:         11        Do if flag 1 is high
  02:         30        Then Do                Then

25:  Z=F (P30)                                 Put a "1" into fan
  01:          1        F                      control location
  02:          0        Exponent of 10
  03:        20--       Z Loc:

26:  Else (P94)                                Else, If flag 1 is reset

27:  Z=F (P30)                                 Put a "0" into fan
  01:          0        F                      control location
  02:          0        Exponent of 10
  03:        20--       Z Loc :

28:  End (P95)                                 End Then Do/Else/End

29:  Do (P86)                                  Reset flag 1
  01:         21        Set low Flag 1

30:  End Loop (P95)                            End Master Loop

END FAN CONTROL LOGIC BASED ON HEATER/COOLER

START FAN CONTROL LOGIC BASED ON TIME

31:  If time is (P92)                          If 5 minutes remain
  01:         10        minutes into a         out of 15 minute
  02:         15        minute interval        interval,
  03:         12        Set high Flag 2        set flag 2
```

```
32:  If Flag/Port (P91)                          If flag 2 is set
  01:          12          Do if flag 2 is high
  02:          30          Then Do               Then

33:  Beginning of Loop (P87)                     Start fan loop
  01:           0          Delay
  02:           5          Loop Count

34:  Z=F (P30)                                   PUT A "1" INTO FAN
  01:           1          F                     CONTROL LOCATION
  02:           0          Exponent of 10
  03:         20--         Z Loc :

35:  End (P95)                                   End fan loop

36:  End (P95)                                   End then do

37:  If time is (P92)
  01:           0          minutes into a        Reset flag 2 at the
  02:          15          minute interval       end of the 15 minute
  03:          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)                           Send instructions to the
  01:           1          Reps                  SDM-CD16AC with address 00
  02:          00          Address
  03:          10          Loc

39:  End Table 1 (P)
```