Product Manual

Measurement & Control Peripheral

SDM-CD16AC

16-Channel AC/DC Relay Controller

Revision: 9/19

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

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PLEASE READ FIRST

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area: 1 in^2 (square inch) = 645 mm^2

Length: 1 in. (inch) = 25.4 mm
1 ft (foot) = 304.8 mm
1 yard = 0.914 m
1 mile = 1.609 km

Mass: 1 oz. (ounce) = 28.35 g
1 lb (pound weight) = 0.454 kg

Pressure: 1 psi (lb/in^2) = 68.95 mb

Volume: 1 UK pint = 568.3 ml
1 UK gallon = 4.546 litres
1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a "#" symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

Recycling information

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Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.

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Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.eu or by telephoning +44(0) 1509 828 888 (UK). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, or 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

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SDM-CD16AC 16 Channel AC/DC Controller

1. Function

FIGURE 1-1. SDM-CD16AC face panel

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

The toggle switch has three positions: **ON** and **OFF** for manual override, and **AUTO** for data logger control. In the **ON** position, the common (**COM**) and normally open (**NO**) contacts are closed (see FIGURE 4-1). In the **AUTO** position, the state of the relays are controlled by the data logger control ports.

The SDM-CD16AC is a synchronously addressed data logger peripheral. Three ports on the data logger 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 data logger ports.

Compatible Campbell Scientific data loggers use the CRBasic instruction **SDMCD16AC()** to control the SDM-CD16AC.

2. Control Specifications

Operating temperature:	–25 to 50 °C
Operating voltage:	12 VDC nominal (11 to 18 VDC)
Current drain at 12 VDC:	6 mA quiescent; 45 mA per active LED (switch on or auto active)
Total cable length:	Cable lengths should be kept as short as possible; 6 m (20 ft) (for many applications); lengths longer than 6 m (20 ft) may be possible for CRBasic data loggers if the **SDMSpeed()** instruction is used
Toggle switch:	ON/OFF manual override; AUTO for data logger control
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:	11 to 18 VDC
Coil resistance:	360 Ohms ±10%
Expected life (contact closures):	Mechanical 10^7
Actuation/release time:	Approx. 4 ms
Standards:	Underwriters Laboratories (UL) listed product (E162021) Canadian Underwriters Laboratories (CUL) listed product (5Z21)

3. Power Considerations

The SDM-CD16AC power requirements are large compared to most Campbell Scientific products. For most applications, an external power supply (see FIGURE 3-1) is recommended to power the SDM-CD16AC.

For some applications, it may be convenient to use the data logger supply to power the SDM-CD16AC (see FIGURE 3-1). For long-term applications, the lead acid power supply available with Campbell Scientific data loggers should be used, allowing the batteries to be float charged. It is not recommended that the data logger alkaline supply be used to power the SDM-CD16AC for long-term applications due to its large power requirements.

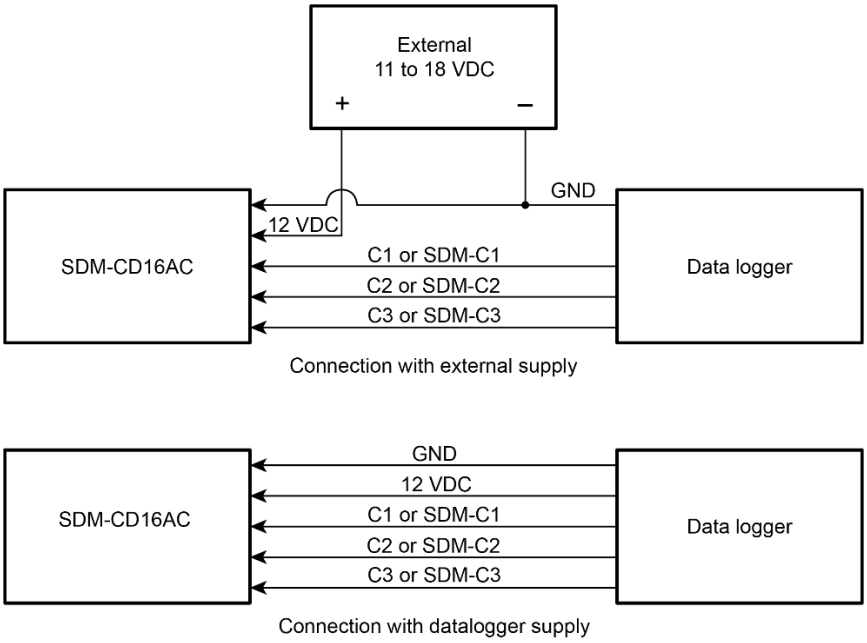


FIGURE 3-1. Connection block diagrams

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 °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 Cables connecting the terminals of the data logger 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, by touching them to the earth terminal.

For data logger connections, see TABLE 4-1.

Multiple SDM-CD16ACs may be wired in parallel by connecting the data logger side of one SDM-CD16AC to the next. The CABLE5CBL-L or an equivalent cable is used to connect the module to the data logger. A 0.3 m (1 ft) cable length should be sufficient when both data logger and SDM-CD16AC are housed within an ENC12/14; a 0.6 m (2 ft) length may be required if the data logger and SDM-CD16AC are housed at opposite ends of an EN16/18 enclosure.

CRBasic data loggers should use the **SDMSpeed()** instruction if the cable length is longer than 6 m (20 ft).

NOTE SDM cables in noisy environments need to be suitably shielded.

4.1 Wiring

4.1.1 SDM-CD16AC Power and Control Connections

Refer to FIGURE 3-1 and TABLE 4-1 for SDM-CD16AC operating power and control connections to the data logger.

TABLE 4-1. Data Logger to SDM-CD16AC Connections
(see caution)

Connection Order	SDM-CD16AC	Data Logger (see notes)	Function
First	**12V**	12 V on data logger or External supply	Power
Second	**G**	Gnd	Common ground
	C1	**SDM-C1** (CR3000, CR5000) or **C1** (other data loggers)	Data
	C2	**SDM-C2** (CR3000, CR5000) or **C2** (other data loggers)	Clock
	C3	**SDM-C3** (CR3000, CR5000) or **C3** (other data loggers)	Enable

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

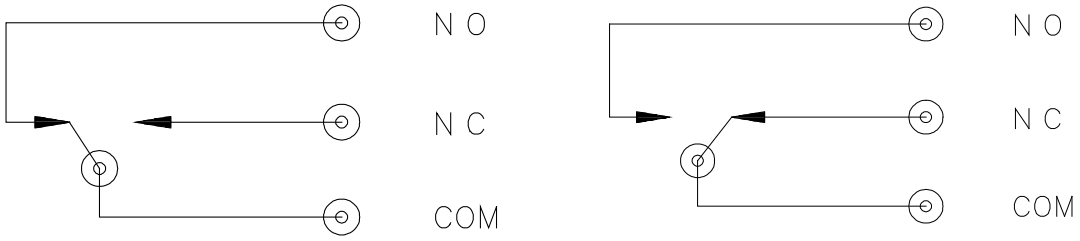
NOTE The CR6 allows SDM operation through control ports **C1**, **C2**, and **C3** as shown in TABLE 4-1. In addition, the **U** terminals on the CR6 may be used in the same manner. **U1**–**U3**, **U5**–**U8**, and **U9**–**U11** are usable in the same **Data**, **Clock**, **Enable** order as the **C** terminals.

NOTE 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.

4.1.2 Controlled Device to SDM-CD16AC Connections

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

FIGURE 4-1 shows how the switches in each channel operate. **NO** means "normally open", **NC** means "normally closed". **COM** means "common" to **NO** and **NC**.



Position of Contacts When Coil is Energized (ON)

Position of Contacts When Coil Is Not Energized (OFF)

FIGURE 4-1. Switch operation

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 4-2 shows an example.

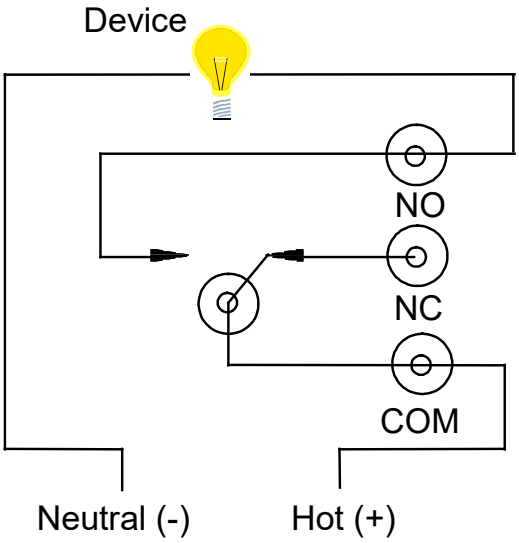


FIGURE 4-2. Typical wiring application

4.1.3 Motor Control

The SDM-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 data logger will automatically command the appropriate relay to energize the motor starter. The relay in the SDM-CD16AC will remain latched until the data logger 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 SDM-CD16AC can be used to control three phase pump motors, air blowers, and large control valves in the same fashion.

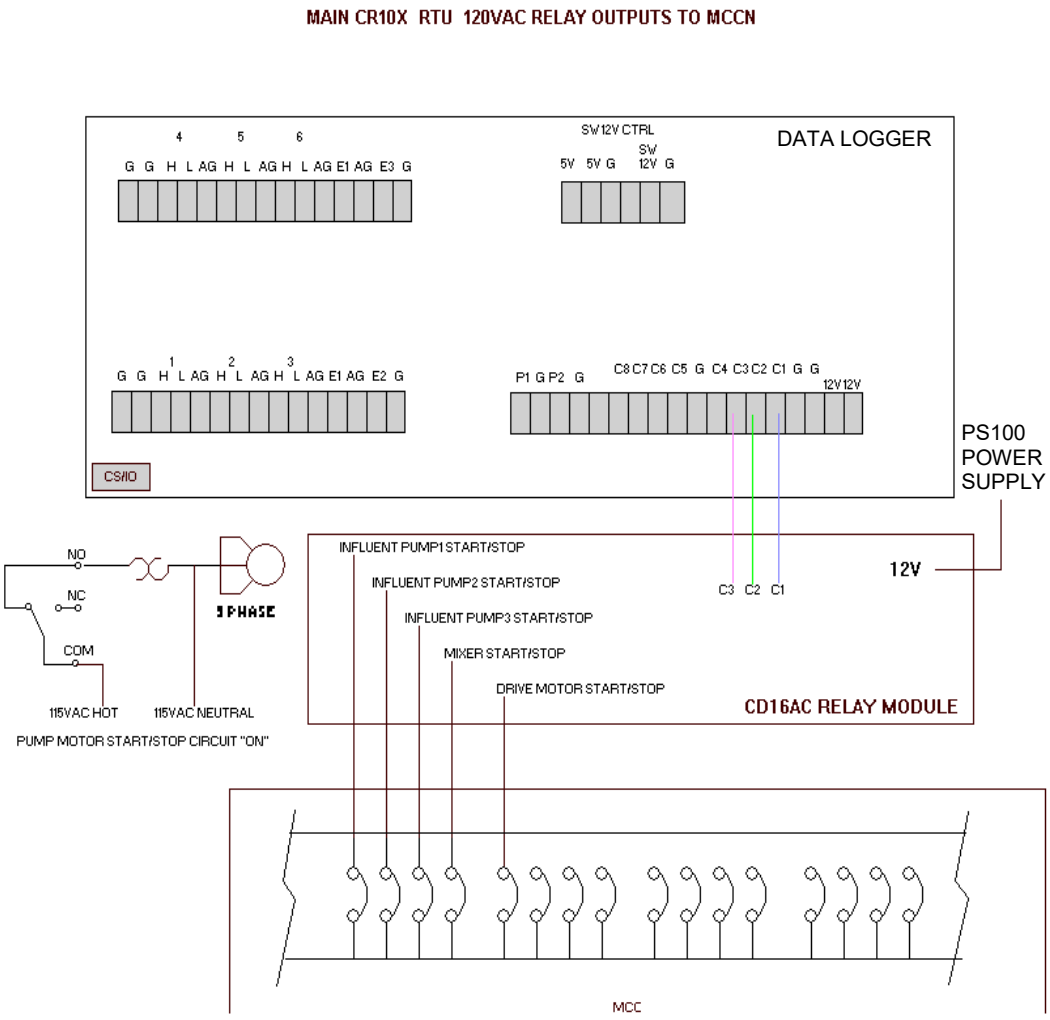


FIGURE 4-3. SDM-CD16AC relay outputs to MCC

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 5-1).

	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)

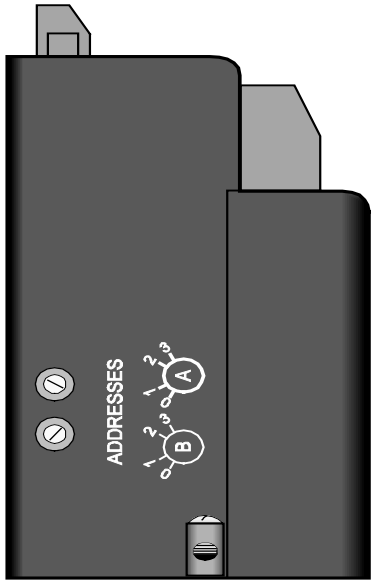


FIGURE 5-1. Addressing

6. Data Logger Programming

In CRBasic, the **SDMCD16AC()** instruction is used to control the SDM-CD16AC. Data loggers that are programmed with CRBasic include the CR6, CR800, CR850, CR1000X, CR1000, CR3000, CR5000, and CR9000(X). The **SDMSpeed()** instruction should also be used if the cable length is longer than 20 ft.

6.1 CRBasic Programming

6.1.1 SDMCD16AC() Instruction

Syntax

```
SDMCD16AC(Source, Reps, SDMAddress)
```

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.

If the ***Source*** parameter is defined as a Long variable, but it is dimensioned less than 16X Reps, ***Source*** will act as a binary control for the instruction whose bits 0…15 will specify control ports 1…16, respectively. In this situation, Source (1) will be used for the first Rep; Source (2) will be used for the second Rep, and so on.

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 data logger will increment the SDM address for each subsequent device that it communicates with.

6.1.2 SDMSpeed() Instruction

The **SDMSpeed()** instruction is used to change the speed at which data is clocked to and from attached SDM devices. Slowing down the clock rate may be necessary when many SDM devices are connected to the data logger, or even when a single SDM device is connected over a long cable.

- Many applications do not require the use of **SDMSpeed()**.
- If intermittent communications with several devices connected at once is experienced, or when using long cables, use **SDMSpeed()** to increase the bit period above the default. Try doubling the bit period until a stable link is achieved.
- To maximize communication speeds because of skipped scans, decrease the bit period.

Changing the clock rate is accomplished by changing the bit period of the clock signal. A short bit period equates to a faster clock rate and faster data transfer. A long bit period equates to a slower clock rate and a slower data transfer more suitable for long cable lengths or many connected devices.

The syntax of this instruction is as follows:

```
SDMSpeed(BitPeriod)
```

The ***BitPeriod*** argument can be a constant or variable integer. If the **SDMSpeed()** instruction is not included in the program, the default bit period for the clock line will be used. If the bit period specified is smaller than the minimum or larger than the maximum, the data logger will default to the minimum or maximum bit period, respectively. Refer to *CRBasic Editor Help* for the default, minimum, and maximum bit period for each data logger.

7. Theory of Operation

The SDM-CD16AC is a synchronously addressed peripheral. **C2** and **C3**, driven high by the data logger, initiate a cycle. While holding **C3** high, the data logger drives **C2** as a clock line and **C1** as a serial data line. The data logger

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 port 1.

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 data logger then lowers both **C3** and **C2** to complete the cycle.

8. Program Examples

8.1 CRBasic Example

8.1.1 Controlling Two SDM-CD16ACs

In the following CR1000X program example, a counter is used to fill an array called ***src***() that will control two SDM-CD16ACs.

CRBasic Example 8-1. Controlling 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
```

8.1.2 Control Temperature and Fans

In this example, the SDM-CD16AC is used to control the temperature between 23 and 28 °C in each of 5 greenhouses. In each greenhouse, 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 the appropriate variable

Input Location assignments are as follows:

Variable Array	Description
Temp(5)	Avg temp, greenhouse 1..5
Heat(5)	Heater control, greenhouse 1..5 SDM-CD16AC Port 1..5
Cool(5)	Cooler control, greenhouse 1..5 SDM-CD16AC Port 6..10
Fan(5)	Fan control, greenhouse 1..5 SDM-CD16AC Port 11..15
CD16_Output(16)	**EXAMPLE 1:** the actual values used to control the SDM-CD16: *CD16_Output(I), I = 1 to 5 are for Heat, I = 6 to 10 are for Cooling, I= 11 to 15 are for Fans*
CD16_Output as Long	**EXAMPLE 2:** the actual value used to control SDMCD the *CD16_Output bits set the SDM-CD16AC ports. bits 0 to 4 are for 'Heat, 5 to 9 are for Cooling, 10 to 14 are for Fans*

CRBasic Example 8-2 uses an array of values to set the SDM-CD16AC control outputs:

CRBasic Example 8-2. Using an Array to Set SDM-CD16AC Control Outputs

```
'Program name: SDMCD16Example1.CR1
'\\\\\\\\\\\\\\\\\\\\\\\\ DECLARATIONS /////////////////////////
Public Flag(8) as boolean
Public I
Public Temp(5)
Public Heat(5)
Public Cool(5)
Public Fan(5)
'CD16_Output(I), I = 1 to 5 are for Heat, I = 6 to 10 are for Cooling,
'I = 11 to 15 are for Fans
Dim CD16_Output(16)

'\\\\\\\\\\\\\\\\\\\\\\\\\\\ PROGRAM ///////////////////////////

BeginProg
  Scan(5,Sec, 3, 0)
    For I = 1 to 5
      If (Temp(I) < 23.5) Then
        Heat(I) = 1
      ElseIf (Temp(I) >= 25.5) Then
        Heat(I) = 0
      EndIf
      If (Temp(I) >= 27.5) Then
        Cool(I) = 1
      ElseIf (Temp(I) < 24.5) Then
        Cool(I) = 0
      EndIf
      If (Heat(I) <> 0) OR (Cool(I) <> 0) Then
        Fan(I) = 1
      Else
        Fan(I) = 0
```

```
      EndIf
    Next I
    If TimeInToInterval(10,15,Min) Then Flag(2) = True
    If TimeInToInterval(0,15,Min) Then Flag(2) = False
    If Flag(2) = True then
      For I = 1 to 5
        Fan(I) = 1
      Next I
    EndIf
    For I = 1 to 5
      CD16_Output(I) = Heat(I)
      CD16_Output(I+5) = Cool(I)
      CD16_Output(I+10) = Fan(I)
    Next I
    SDMCD16AC(CD16_Output(), 1, 0)
  NextScan
EndProg
```

CRBasic Example 8-3 uses an integer instead of an array to set the SDM-CD16AC control outputs:

CRBasic Example 8-3. Using an Integer to Set SDM-CD16AC Control Outputs

```
'Program name: SDMCD16Example2.CR1
'\\\\\\\\\\\\\\\\\\\\\\\\ DECLARATIONS /////////////////////
Public Temp(5)
Public TimedFanOn as Boolean
Dim I as Long
Dim CD16_Output as Long
'Note: CD16_Output bits set the SDM-CD16AC ports. bits 0 to 4 are for Heat,
'5 to 9 are for Cooling, 10 to 14 are for Fans

'\\\\\\\\\\\\\\\\\\\\\\\\\\ PROGRAM ///////////////////////////

BeginProg
  Scan(5,Sec, 3, 0)
    For I = 1 to 5
      If (Temp(I) < 23.5) Then  'Set appropriate Heater Bit High:
        CD16_Output = CD16_Output OR 2^(I-1)
      ElseIf (Temp(I) >= 25.5) Then  'Set appropriate Heater Bit Low:
        CD16_Output = CD16_Output AND (&H7FFF - 2^(I-1))
      EndIf
      If (Temp(I) >= 27.5) Then  'Set appropriate Cooler Bit High:
        CD16_Output = CD16_Output OR 2^(I+4)
      ElseIf (Temp(I) < 24.5) Then  'Set appropriate Cooler Bit Low:
        CD16_Output = CD16_Output AND (&H7FFF - 2^(I+4))
      EndIf
    Next I
    CD16_Output = (CD16_Output AND &H3FF)  'Set all Fan Bits Low
    'Turn on Fan Bits for active Heaters or Coolers:
    CD16_Output = CD16_Output OR ((((CD16_Output*2^5) OR (CD16_Output*2^10)) AND &H7C00)

    If TimeInToInterval(10,15,Min) Then TimedFanON = True
    If TimeInToInterval(0,15,Min) Then TimedFanON = False
    If TimedFanON = True Then   CD16_Output = CD16_Output OR &H7C00

    SDMCD16AC(CD16_Output(), 1, 0)
  NextScan
EndProg
```

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