SDM-CD16D 16 CHANNEL DIGITAL CONTROL PORT EXPANSION MODULE INSTRUCTION MANUAL

9/01

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SDM-CD16D 16 Channel Digital Control Port Expansion Module

The SDM-CD16D (see Figure 1) is a synchronously addressed peripheral. It has 16 control ports and is compatible with Campbell Scientific's CR10/10X, CR23X, CR7 and 21X dataloggers.

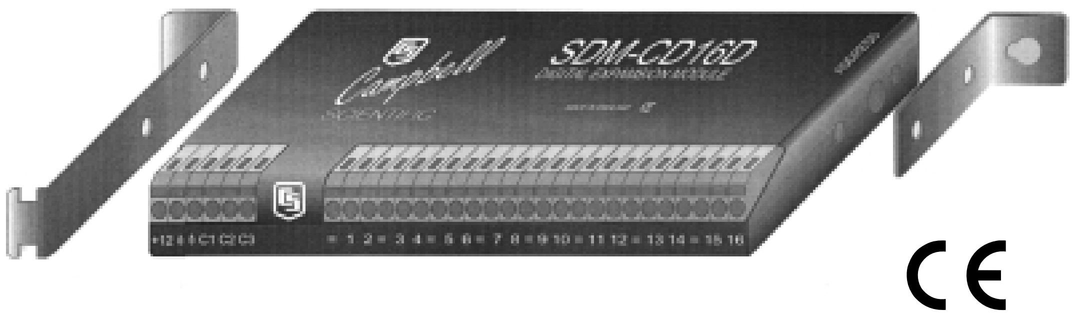

FIGURE 1. SDM-CD16D

1. Introduction

The SDM-CD16D expands the digital output capability of Campbell Scientific dataloggers. The outputs can be set to 0 or 5V by the datalogger. In addition to being able to drive normal logic level inputs, when an output is set HI a 'boost' circuit allows it to source a current of up to 100mA, allowing direct control of low voltage valves, relays etc.

The SDM-CD16D is a synchronously addressed datalogger peripheral. Datalogger control ports 1, 2 and 3 are used to address the SDM-CD16D then clock out the desired state of each of the 16 control ports. Up to sixteen SDM-CD16Ds may be addressed, making it possible to control a maximum of 256 ports from the first three datalogger control ports.

NOTE CR10/10X, CR23X, CR7 and 21X dataloggers use I/O Instruction 104 to control the SDM-CD16D.

Older dataloggers with pre-OS7.1 software may not have the necessary instruction, or may use Instruction 29. Ensure that your datalogger contains the appropriate instruction before using.

2. Control Specifications

2.1 General

Compatible dataloggers:	CR10/10X, CR23X, CR7 and 21X
Operating voltage:	12V DC nominal (9 to 18V)
Current drain at 12V DC:	100µA typical (All ports HI, no load)
Total cable length:	6m (CR10/10X, CR23X, 21X), 180m (CR7)

2.2 Output Specifications

Output Voltage (no load):	Output ON/HI, Nominal 5V (Minimum 4.5V) Output OFF/LO, Nominal 0V (Maximum 0.1V)
Output Sink Current:	Output will sink 8.6mA from a 5V source*
Output Source Current:	Output will source 36mA @ 3V, 115mA short-circuited to ground*
Max. Output Current: **(total all outputs)**	400mA at 50°C and 12V supply (see NOTE below)

NOTE The maximum current should be derated under the following conditions: 50mA for every 10°C above 50°C and/or 50mA for every volt above 12V.

Operating temp.:	-25°C to +70°C standard
Size:	230mm wide x 100mm high x 24mm deep
Weight:	350g
EMC Status:	Complies with EN55022-1:1998 and EN50082-1:1998

* If more detailed output characteristics are required, experienced users should consult the equivalent circuit diagrams shown in Figure 2, below.

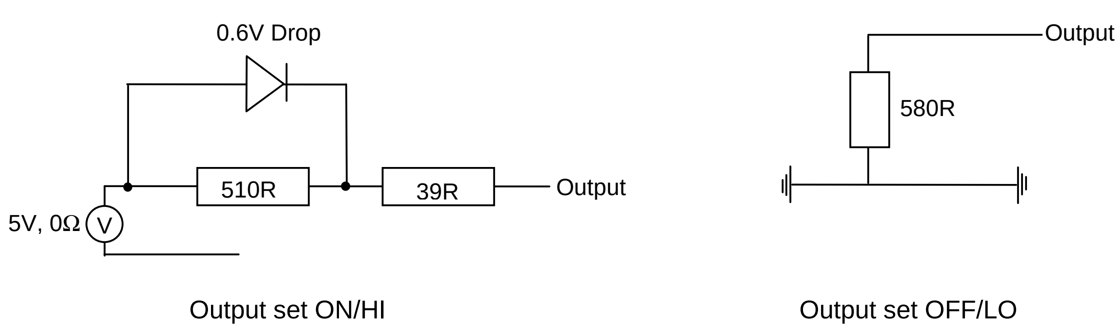

FIGURE 2. Equivalent Output Driver Circuit

3. Power Considerations

The SDM-CD16D power requirements are large compared to most Campbell Scientific products when driving significant loads. For many applications an external power supply, as shown in Figure 3, is recommended to power the SDM-CD16D.

For some applications it may be convenient to use the datalogger supply to power the SDM-CD16D, as shown in Figure 3. For long-term applications, the lead-acid power supply available with Campbell Scientific dataloggers should be used, allowing the batteries to be float charged. Alkaline batteries are not recommended for long term applications.

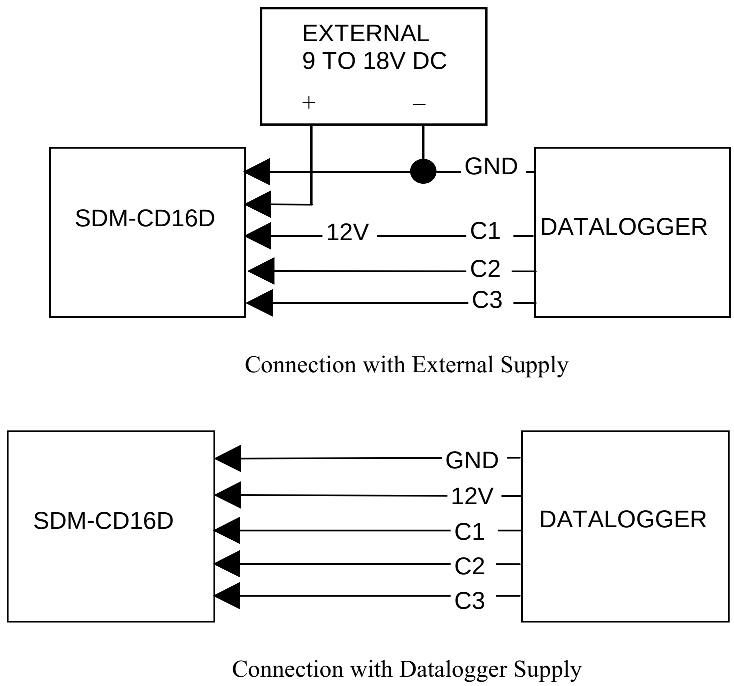

FIGURE 3. Connection Block Diagrams

NOTE If the 21X power supply is used to power the SDM-CD16D, 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 12V supply is used to power peripherals. This limitation reduces the number of available analog input channels and may make an external supply for the SDM-CD16D essential.

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4. Installation

For correct operation the SDM-CD16D must be installed where there is no risk of water ingress or condensation.

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

For datalogger connections, see Table 1, below. Please refer to Figure 4 for details of how to use the spring-loaded terminals.

TABLE 1. Datalogger to SDM-CD16D Connections

Connection Order	SDM-CD16D	Datalogger	Function
First	12V	12V on datalogger or external supply	Power
Second	⏚ C1 C2 C3	⏚ or G C1 (Control Port 1) C2 (Control Port 2) C3 (Control Port 3)	Common Ground Data Clock Enable

Multiple SDM-CD16Ds may be wired in parallel by connecting the datalogger side of one SDM-CD16D to the next.

The transient protection of the SDM-CD16D relies on a low resistance path to earth. Ensure that the ground return wire has as low a resistance as possible. Where long cable runs are likely, or where lightning damage is a possibility, the SDM-CD16D can be fitted with gas discharge tubes. Please contact Campbell Scientific for details.

NOTE For CR10/10X, CR23X and 21X dataloggers, the total cable length connecting SDM-CD16Ds to SDM-CD16Ds and the datalogger should not exceed 6m. Total cable lengths in excess of 6m will adversely affect communication performance. For CR7 dataloggers, the total cable length can be up to 180m.

4.1 Controlled Device Connections

The SDM-CD16D uses spring-loaded terminal blocks, which provide quick, vibration resistant, connections. The output terminals are labeled 1 to 16. A common ground connector is provided between each pair of terminals.

Use a screwdriver in either the top or front slot, as appropriate, to open the terminal spring. Strip any insulation from the wire to give 7 to 9mm bare wire. Push the wire into the opening, and, while holding it in position, withdraw the screwdriver to release the spring. The wire will now be firmly held in place. See Figure 4, below.

NOTE You cannot reliably insert more than one solid-core wire into one terminal connector unless the wires are soldered or clamped together. When inserting more than one stranded wire, twist the bare ends together before insertion.

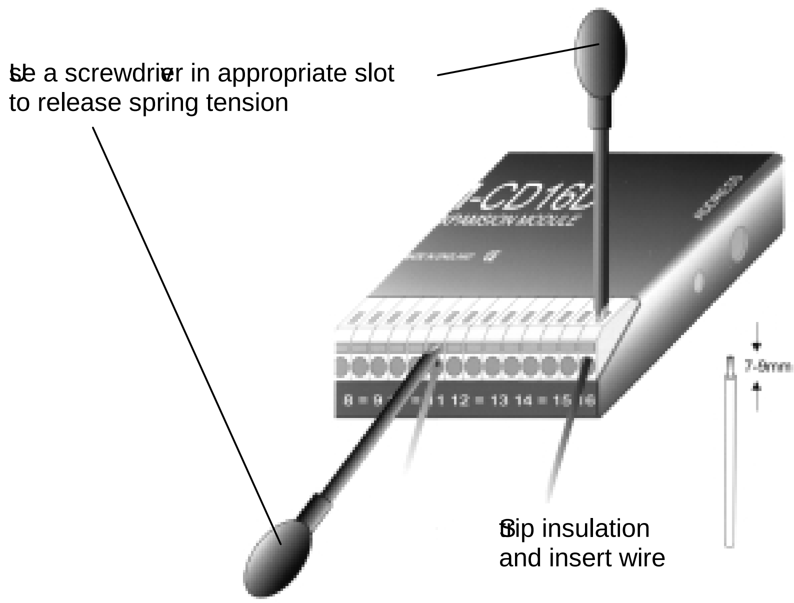

FIGURE 4. Use of Terminal Blocks

5. Address Selection Switches

Each SDM-CD16D can have 1 of 16 addresses. The factory-set address is 00. Table 2 shows switch position and the corresponding address. Figures 1 and 5 shows the position of the switch. Note that you will have to remove the mounting bracket to gain access to this switch.

TABLE 2. Switch Position and Addresses

Switch Setting	Base 4 Address
0	00
1	01
2	02
3	03
4	10
5	11
6	12
7	13
8	20
9	21
A	22
B	23
C	30
D	31
E	32
F	33

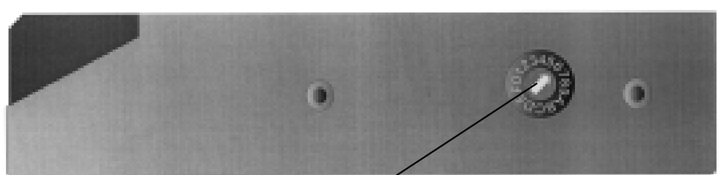

FIGURE 5. Address Selection Switch

6. Datalogger Instructions 104 (CR10/10X, CR23X, 21X, CR7) and 29 (older CR7s)

Instruction 104 is used by the CR10/10X, CR23X, CR7 and 21X to control the SDM-CD16D, and Instruction 29 is used by older CR7s. The Instruction descriptions are shown below.

Instruction 104 – SDM-CD16D used with CR10/10X, CR23X, CR7and 21X dataloggers

Parameter	Type	Description
1	2	Reps (No. of modules sequentially addressed)
2	2	Starting Address (base 4: 00..33)
3	4	Starting Input Location

Execution Time = 2ms per Rep for the CR10/10X and CR23X
3.5ms per Rep for the 21X and CR7

Instruction 29 – SDM-CD16D used with older CR7s

Parameter	Type	Description
1	2	Reps (No. of modules sequentially addressed)
2	2	Device (2 = SDM-CD16D)
3	2	Starting Address (base 4: 00..33)
4	2	Card (Excitation card No.)
5	4	Starting Input Location

Execution Time = 150ms to 190ms per Rep

The number of SDM-CD16Ds to be addressed is defined by the Reps (repetitions) parameter. Each Rep sequentially addresses (00, 01, 02,...32, 33) SDM-CD16Ds, starting with the address specified in parameter 2 (parameter 3 for Instruction 29).

For each repetition, the 16 ports of the addressed SDM-CD16D are set according to 16 sequential input locations starting at the input location specified in parameter 3 (parameter 5 for Instruction 29). Any non-zero value stored in an input location activates (sets HI 5V) the associated SDM-CD16D port. A value of zero (0) de-activates the port (sets LO 0V). For example, assuming two repetitions and a starting input location of 33, outputs 1 to 16 of the first SDM-CD16D are set according to input locations 33 to 48, and outputs 1 to 16 of the second SDM-CD16D are set according to input locations 49 to 64.

For older CR7s with Instruction 29, the Device (parameter 2) specifies what type of synchronously addressed peripheral is to be addressed. The Device code for an SDM-CD16D is 2.

For Instruction 29 only (older CR7s), the Card parameter (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

On power-up, all SDM-CD16D outputs are off /LO.

The SDM-CD16D 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-CD16D shifts in the C1 data bit on the rising edge of the C2 clock.

The first eight bits clocked out represent the SDM-CD16D address. If the address matches the SDM-CD16D's address, the SDM-CD16D is enabled. If enabled, the next 16 bits are shifted into the SDM-CD16D, each bit controlling one port, the first of which controls output 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 datalogger then lowers both C3 and C2 to complete the cycle.

8. Program Example

The example is written for the CR10/10X Measurement and Control Module. The program concepts presented are the same for the CR23X, 21X and CR7 dataloggers with minor changes in the program code.

In this example, the SDM-CD16D is used to control the temperature between 23°C and 28°C in each of five greenhouses. In each greenhouse the SDM-CD16D 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 that the temperature measurements have been made, and that the average temperature for each greenhouse is computed and stored in input locations 1 to 5. For further information on loops and input location indexing, please refer to your datalogger manual.

Input location assignments are as follows:

Input Location	**Input Location Label**	**Description**
1..5	Temp #1..#5	Avg. temp. greenhouse 1..5
10..14	Heat #1..#5	Heater control, greenhouse 1..5 SDM-CD16D Port 1..5
15..19	Cool #1..#5	Cooler control, greenhouse 1..5 SDM-CD16D Port 6..10
20..24	Fan #1..#5	Fan control, greenhouse 1..5 SDM-CD16D Port 11..15

```
;{CR10X}
;
*Table 1 Program
  01:          5         Execution Interval (seconds)

1: Beginning of Loop (P87)                      Master loop: end
  1:           0         Delay                  loop at step 30
  2:           5         Loop Count

Start heater control logic

2: If (X<=>F) (P89)                             if temperature is below
  1:           1         -- X Loc [ Temp_1 ]    heater threshold
  2:           4         <
  3:          23.5       F
  4:          30         Then Do                then

3: Z=F (P30)                                    put a '1' into heater control
  1:           1         F                      location
  2:           0         Exponent of 10
  3:          10         -- Z Loc [ Heat_1 ]

4: End (P95)                                    end 'then do'

5: If (X<=>F) (P89)                             if the heater is on (heater
  1:          10         -- X Loc [ Heat_1 ]    control location <>0)
  2:           2         <>
  3:           0         F
  4:          30         Then Do                then

6: If (X<=>F) (P89)                             check upper threshold
  1:           1         -- X Loc [ Temp_1 ]    to see if heater should
  2:           3         >=                     be turned off
  3:          25.5       F
  4:          30         Then Do

7: Z=F (P30)                                    if heater should be turned
  1:           0         F                      off, enter a '0' into
  2:           0         Exponent of 10         heater control location
  3:          10         -- Z Loc [ Heat_1 ]

8: End (P95)                                    end 'then do'
```

```
9: Else (P94)                                   else, if the heater is off

10: Z=F (P30)                                   enter a '0' into heater
  1:          0       F                         control location
  2:          0       Exponent of 10
  3:         10       -- Z Loc [ Heat_1 ]

11: End (P95)                                   end 'then do/else'

End heater control logic

Start cooler control logic

12: If (X<=>F) (P89)                            if 'cooler on' threshold
  1:          1       -- X Loc [ Temp_1 ]       is exceeded
  2:          3       >=
  3:         27.5     F
  4:         30       Then Do                   then

13: Z=F (P30)                                   put a '1' into cooler
  1:          1       F                         control location
  2:          0       Exponent of 10
  3:         15       -- Z Loc [ Cool_1 ]

14: End (P95)                                   end 'then do'

15: If (X<=>F) (P89)                            if cooler is on (cooler
  1:         15       -- X Loc [ Cool_1 ]       control location <>0)
  2:          2       <>
  3:          0       F
  4:         30       Then Do                   then

16: If (X<=>F) (P89)                            check lower threshold to
  1:          1       -- X Loc [ Temp_1 ]       see if cooler should be
  2:          4       <                         turned off
  3:         24.5     F
  4:         30       Then Do

17: Z=F (P30)                                   if cooler should be turned off
  1:          0       F                         put a '0' into cooler control
  2:          0       Exponent of 1             location
  3:         15       -- Z Loc [ Cool_1 ]

18: End (P95)                                   end 'then do'

19: Else (P94)                                  else, if cooler is off

20: Z=F (P30)                                   put a '0' into cooler
  1:          0       F                         control location
  2:          0       Exponent of 10
  3:         15       -- Z Loc [ Cool_1 ]

21: End (P95)                                   end 'then do/else'

End cooler control logic
```

```
Start fan control logic based on heater/cooler

22: If (X<=>F) (P89)                               if heater is on
  1:        10        -- X Loc [ Heat_1 ]
  2:         2        <>
  3:         0        F
  4:        11        Set Flag 1 High              set flag 1

23: If (X<=>F) (P89)                               if cooler is on
  1:        15         -- X Loc [ Cool_1 ]
  2:         2        <>
  3:         0        F
  4:        11        Set Flag 1 High              set flag 1

24: If Flag/Port (P91)                             if flag 1 is set
  1:        11        Do if Flag 1 is High
  2:        30        Then Do                      then

25: Z=F (P30)                                      put a '1' into fan control
  1:         1        F                            location
  2:         0        Exponent of 10
  3:        20        -- Z Loc [ Fan_1 ]

26: Else (P94)                                     else, if flag 1 is reset

27: Z=F (P30)                                      put a '0' into fan control
  1:         0        F                            location
  2:         0        Exponent of 10
  3:        20        -- Z Loc [ Fan_1 ]

28: End (P95)                                      end 'then do/else'

29: Do (P86)                                       reset flag 1
  1:        21        Set Flag 1 Low

30: End (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
  1:        10        Minutes (Seconds --) into a             out of 15 minute
  2:        15        Interval (same units as above)          interval
  3:        12        Set Flag 2 High                         set flag 2

32: If Flag/Port (P91)                             if flag 2 is set
  1:        12        Do if Flag 2 is High
  2:        30        Then Do                      then

33: Beginning of Loop (P87)                        start fan loop
  1:         0        Delay
  2:         5        Loop Count

34: Z=F (P30)                                      put a '1' into fan control
  1:         1        F                            location
  2:         0        Exponent of 10
  3:        20        -- Z Loc [ Fan_1 ]
```

```
35: End (P95)                                   end fan loop

36: End (P95)                                   end' then do'

37: If time is (P92)                                 reset flag 2 at the
   1:          0      Minutes (Seconds --) into a    end of the 15 minutes
   2:         15      Interval (same units as above)
   3:         22      Set Flag 2 Low

End fan control logic based on time

Input locations 10 to 24 are now loaded with a '1' or '0' to set ports on the SDM-CD16D

38: SDM-CD16 / SDM-CD16D (P104)                 send instructions to the
   1:          1      Reps                      SDM-CD16D with address 00
   2:         00      Address
   3:         10      Loc [ Heat_1 ]

*Table 2 Program
   02:         0.0000   Execution Interval (seconds)

*Table 3 Subroutines

End Program

-Input Locations-1
Temp_1 7 4 0
2 Temp_2 10 0 0
3 Temp_3 10 0 0
4 Temp_4 10 0 0
5 Temp_5 18 0 0
6 _________ 0 0 0
7 _________ 0 0 0
8 _________ 0 0 0
9 _________ 0 0 0
10 Heat_1 7 3 3
11 Heat_2 11 1 0
12 Heat_3 11 1 0
13 Heat_4 11 1 0
14 Heat_5 19 1 0
15 Cool_1 7 3 3
16 Cool_2 11 1 0
17 Cool_3 11 1 0
18 Cool_4 11 1 0
19 Cool_5 19 1 0
20 Fan_1 7 1 3
21 Fan_2 11 1 0
22 Fan_3 11 1 0
23 Fan_4 11 1 0
24 Fan_5 19 1 0
25 _________ 1 1 0
26 _________ 0 0 0
27 _________ 0 0 0
28 _________ 0 0 0
29 _________ 0 0 0
```