INSTRUCTION MANUAL

IRS21 Lufft Intelligent Road Surface Sensor

Revision: 2/09

Warranty and Assistance

The **IRS21 LUFFT INTELLIGENT ROAD SURFACE SENSOR** 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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IRS21 Lufft Intelligent Road Surface Sensor

1. Function

The IRS21 is a sensor that makes measurements of road surface. From measurements taken, the outputs are up to three temperatures, conductivity, percent salt, freezing temperature, road condition, and water film height. There is also an error status output from the sensor. The sensor is used for road weather stations.

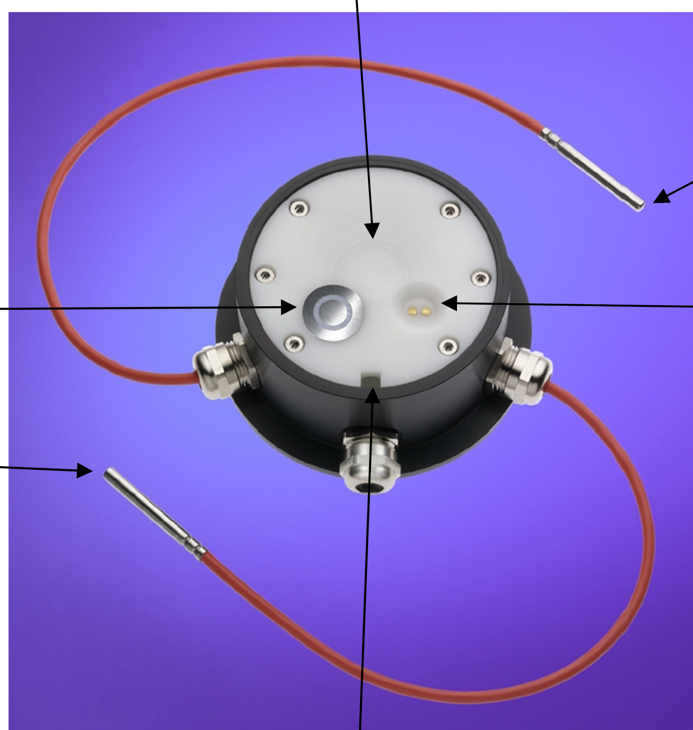


FIGURE 1-1. IRS21

2. Specifications

Dimensions:	5” in diameter, and 2” high
Weight:	2 pounds
Survival temperature:	-57° to 158°F (-50° to 70°C)
Rated current:	less than 200 ma
Interface:	RS485
Standard cable length:	75 feet (25m)
Optional cable length:	up to 300’ (100M)
Power supply:	9 to 14 Vdc
Operating temperature:	-40° to 158°F (-40° to 70°C)
Operating relative humidity:	100%

Outputs

Road condition:	dry, damp, wet, snow, freezing wetness, ice
Road temperature:	-40° to 158°F (-40° to 70°C)
Accuracy	±0.2°C (-10° to 10°C); ±0.5°C (-40° to 70°C)
Resolution	-.1°C
Freezing point:	-4° to 32°F (-20° to 0°C)
Accuracy	±.1°C
Resolution	-.1°C

Needed Accessories

RS485 to RS-232 adapter Lufft pn 8410.KON – Campbell part number 18080
SDM-SIO4

Warranty Exclusions

Due to important installation considerations, the following sensors will not be warranted.

1. Sensors that aren’t installed flush with the road surface.

   If the road sensor is installed above the road surface, damage to the sensor could result from equipment contacting the sensor.

   If the sensor is mounted below the road surface, incorrect measurements are possible due to the pooling effect of material on top of the sensor that is not representative of the road surface.

2. Sensors with exposed sensor cable in the road surface.

Equipment Needed for Installation

1. Drill and 5” core bit for the sensor hole.

2. Cement/concrete saw for the sensor lead saw cut with 1/2” saw blade.

3. Trencher for the sensor lead in the road shoulder.

4. Air nozzle to clean the cuts.

5. Hammer drill and 1/2” by 24” drill bit for the temperature sensors.

6. 115 VAC generator, 5 kW.

7. Portable compressor, 9 CFW.

Supplies Needed for Installation

1. Backer rod.

2. Epoxy.

3. PVC pipe for the sensor lead in the road shoulder. This isn’t required but adds protection for the cable.

4. Chalk line.

5. Duct tape.

6. Hammer and chisel.

3. Installation

FIGURE 3-1. Core cut for the road sensor.

Hole diameter = 6”
Hole depth = 3”
Saw cut depth = 2”
Saw cut width = 1/2”

Locate the place in the pavement for the sensor. Drill the sensor hole 3” deep, and clear the drilled hole of all excess material.

Saw cut the road surface for the sensor lead. The cut needs to be extended beyond the sensor hole to completely clear the sensor hole of excess material.

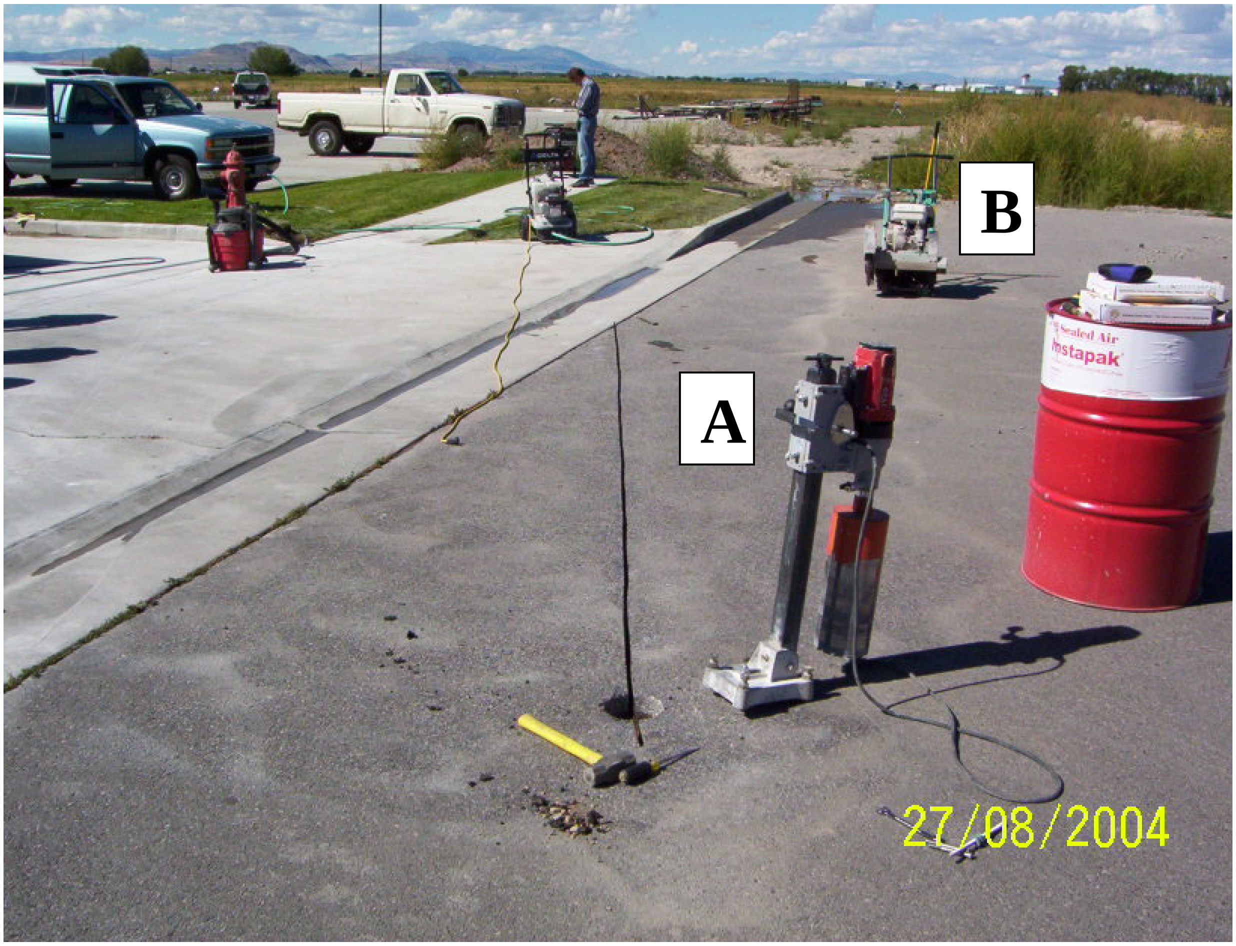
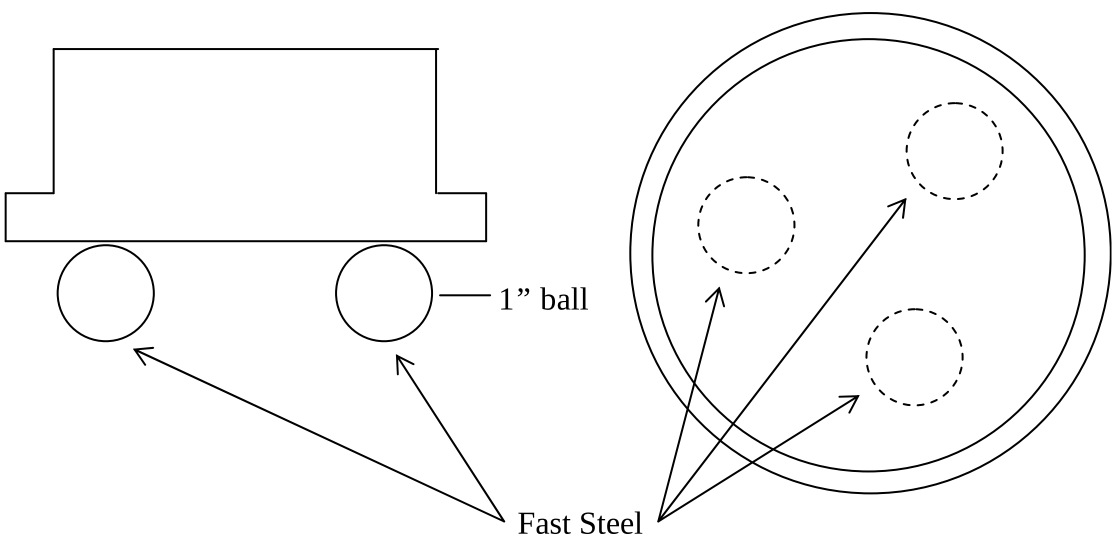


FIGURE 3-2. Core drill (A) and saw cutting (B) equipment.

FIGURE 3-3. Saw cut is masked with duct tape to control the epoxies.

FIGURE 3-4. View of fast steel which is placed under the sensor prior to epoxy application to provide a base for the sensor.



The fast steel is used to control the depth that the sensor fits into the sensor hole, and the limiting fixtures on the sensor make the sensor even with the road surface.

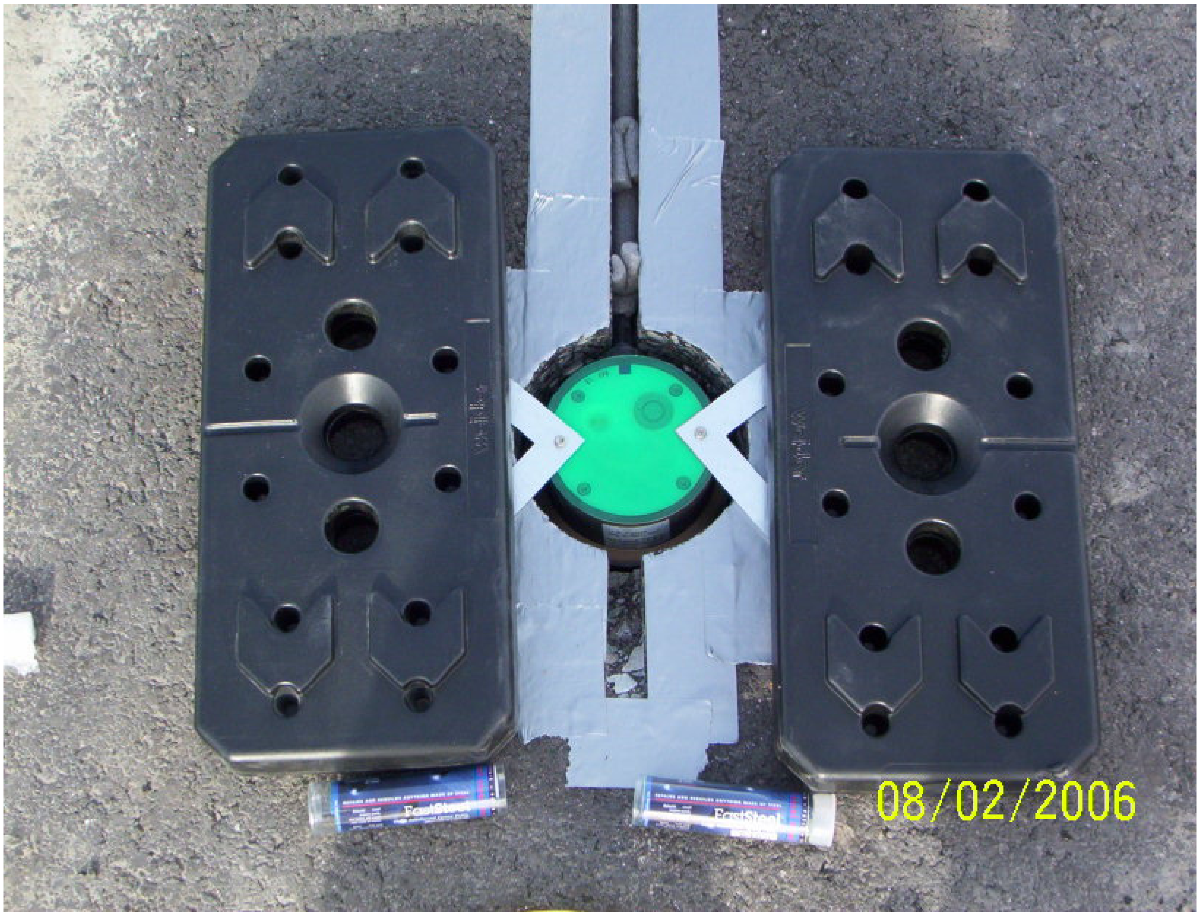


FIGURE 3-5. Weights are placed onto the leveling fixtures for the road sensor. One weight is placed on each leveling fixture.

FIGURE 3-6. First pour of Fabick epoxy, pn FJS (fast set), useable between 20° to 180°F.

An Excel worksheet is available on our web site to calculate the amount of epoxy needed. The file is located at www.campbellsci.com/downloads. The first pour of the epoxy fills and assures that there is complete coverage around the sensor and sensor cable. The second pour fills to the road surface.

FIGURE 3-7. Finished pour, with weights removed.

Above is the finished epoxy around the sensor. There is a dam of backer rod that prevents epoxy from draining from around the sensor while filling the sensor hole.

A dam of backer rod also can be used for the sensor cable fill. If there is any banking on the road, this is an effective way to fill the saw cut and the sensor hole to the required height.

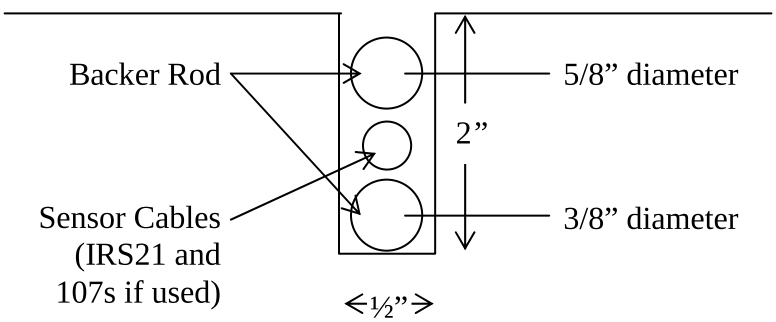
FIGURE 3-8. Second pour to bring the epoxy to grade.

After the first pour has hardened, the fixtures on sensor for making the sensor even with the road surface can be removed before adding more epoxy.

*FIGURE 3-9. Backer rod is used as a dam to control the epoxy.
Different epoxies can be used for directly around the sensor and along the cable.
Since the epoxy used is liquid, the backer rod is used to dam the epoxy until cured.*

FIGURE 3-10. Compressed air is used to dry and clean the saw cut.

FIGURE 3-11. Application of the sensor cable epoxy.
The saw cut is two inches deep. The backer rod is placed in the length of the saw cut below and above the sensor cable before epoxy application.

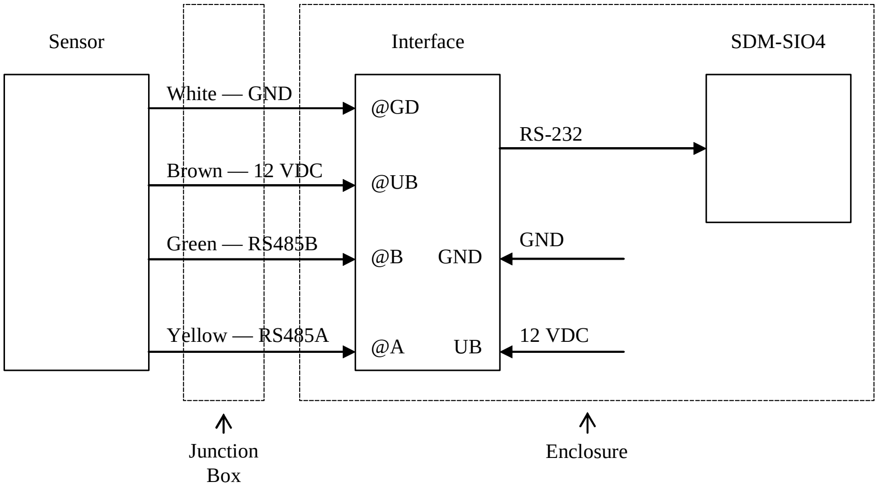


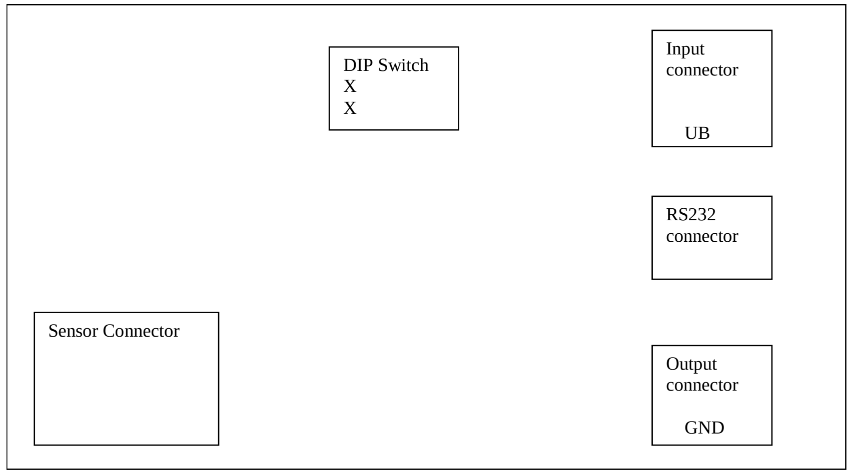
The backer rod in the saw cut should have a friction fit. When the epoxy fills the saw cut, if there is no friction fit, the backer rod tends to float to the road surface.

FIGURE 3-12. Finished epoxy application.

FIGURE 3-13. A junction box is used when cable splices are needed to extend the cable length.

4. Connections





The interface has a two position dip switch that can change the interface from master to slave operation. For operation with the RWIS station the interface is set to master and each interface takes a port on the SDM-SIO4.

The switches in the two left hand positions as indicated by the X's above make the interface a master.

The sensors can be daisy chained. This is done by writing the address of the sensor with software available only to the manufacturer at this time. The sensor connections are made to the sensor connector.

The input connector and output connectors are used for daisy chain operation, but are also used to supply the 12 volts to the interface and sensor.

In the figure above, power is applied to the input and output connectors.
12 volts is connected to the UB connection of the input connector from the power buss. Ground is connected from the power buss to the GND connection to the output connector.

5. Operation

The sensor is operated at two-minute intervals. This is done to prevent measurement errors from sensor heating that could happen if the sensor were powered too long. The sensor is polled with a command that asks for:

Temperature 1
Temperature 2
Temperature 3
Salt concentration
Freezing temperature
Water film height
Road condition
Error status

Sensors purchased for the Campbell Scientific RWIS station are not optioned with the first two temperature sensors. For these applications, 107 probes are used for sub surface temperature measurements. When these are used, one is placed at the bottom of the saw cut near the sensor. The other 107 is placed into the bottom of an 18" deep by 1/2" hole under the 107 probe placed into the saw cut near the IRS21.

The data returned consists of the polling command and ASCII data. Spaces separate the data points.

In typical operation the sensor is run in table two in mixed array loggers, and slow sequence in PakBus loggers. The interval for the sensor is two minutes.

6. Programming

The sensor is first powered with the DTR line set high. Then the RTS is set low to send data to the sensor. In this case the polling command will be sent to the sensor. As soon as the polling command is sent, RTS is set high to get data back from the sensor. In as short a time as is possible by the programming. RTS is set high to receive the data. Then the receive filter is sent to the SDM-SIO4, and data is retrieved by the logger.

In both programs below the SDM-SIO4 is set up with code at the start of the program. This ensures that if there is a reset or power is lost, the startup will configure the SDM-SIO4 without having to connect to the SDM-SIO4 to configure the device.

The calculations after reading the SDM-SIO4 are used to convert raw data measurements from the sensor to measurements such as degrees, and film thickness.

6.1 CR1000 Program

Although this example program is for the CR1000, other CRBasic dataloggers are programmed similarly.

```
'CR1000 Series Datalogger
'To create a different opening program template, type in new
'instructions and select Template | Save as Default Template
'date:
'program author:

'Declare Public Variables
'Example:
Public sio4result,counter,a
Public sensordata(8)
dim reqdata(17)
dim datafilter(18)
dim portset(22)
alias sensordata(1)=temperature1
alias sensordata(2)=temperature2
alias sensordata(3)=SurTmp0
alias sensordata(4)=SurSal0
alias sensordata(5)=SurFrePn0
alias sensordata(6)=SurWatDp0
alias sensordata(7)=SurSta0
alias sensordata(8)=PavSenEr0
```

```
'Declare Other Variables
'Example:
'Dim Counter

'Declare Constants
'Example:
'CONST PI = 3.141592654

DataTable (road,True,10)
      Sample (1,temperature1,FP2)
      Sample (1,temperature2,FP2)
      Sample (1,SurTmp0,FP2)
      Sample (1,SurSal0,FP2)
      Sample (1,SurFrePn0,FP2)
      Sample (1,SurWatDp0,FP2)
      Sample (1,SurSta0,FP2)
      Sample (1,PavSenEr0,FP2)
EndTable

'Define Subroutines
'Sub
Sub sio4setup

      'request data string    &&A^M^J      #1
      data 115,116,114,115,116,32,49,32,34,38,38,65,94,77,94,74,34
      for a=1 to 17 : read reqdata(a) : next a
      SDMSIO4 (reqdata(),1,0,4,321,0000,0000,17,1.0,0)

      Delay (1,2,Sec)

      'data fillter string    ffffffff     #2
      data 102,108,116,115,116,32,50,32,34,102,102,102,102,102,102,102,102,34
      for a=1 to 18 : read datafilter(a) : next a
      SDMSIO4 (datafilter(),1,0,4,321,0000,0000,18,1.0,0)

      Delay (1,2,Sec)

      'port setup  for port 4    4 13 3 0 0 9 0
      data 112,111,114,116,115,101,116,32,52,32,49,51,32,51,32,48,32,48,32,57,32,48
      for a=1 to 22 : read portset(a) : next a
      SDMSIO4 (portset(),1,0,4,321,0000,0000,22,1.0,0)

      Delay (1,2,Sec)

EndSub

'Main Program
BeginProg

            'Enter other measurement instructions
            'Call Output Tables
            'Example:

      SlowSequence
      Scan (120,Sec,3,0)      'irs21
```

```
        'rts hi to send polling string, dtr hi to power the road sensor
        SDMSIO4 (sio4result,1,0,4,1027,0022,0000,0,1.0,0)
        Delay (1,1,Sec)
        SDMSIO4 (sio4result,1,0,4,1027,0010,0,0,1.0,0)
        'rts lo to send data to the sensor
        SDMSIO4 (sio4result,1,0,4,1024,0001,0000,0,1.0,0)
        Delay (1,1,mSec)
        'rts hi to receive data from the sensor
        SDMSIO4 (sio4result,1,0,4,1027,0020,0000,0,1.0,0)
        Delay (1,1,Sec)
        'dtr lo to turn the sensor off
        SDMSIO4 (sio4result,1,0,4,1027,0001,0000,0,1.0,0)
        Delay (1,1,Sec)
        'send the filter
        SDMSIO4 (datafilter(),1,0,4,2054,9002,0000,18,1.0,0)
        'read the sio4
        SDMSIO4 (sensordata(),1,0,4,4,0000,0000,8,1.0,0)
        Delay (1,1,Sec)

        SurTmp0=(SurTmp0*.1)-50
        SurSal0=(SurSal0*.1)
        SurFrePn0=(SurFrePn0*.1)*-1
        SurWatDp0=((1560)-(16.55*SurWatDp0)+(.041*SurWatDp0^2))/1000

        CallTable road

    NextScan
EndProg
```

6.2 CR10X Program

```
;{CR10X-TD}
;
*Table 1 Program
  01:  60          Execution Interval (seconds)

;nosensor initialization

1:  If (X<=>F) (P89)
  1:   93          X Loc [ inp_init     ]
  2:   1           =
  3:   0           F
  4:   1           Call Subroutine 1

2:  Z=F x 10^n (P30)
  1:   1           F
  2:   0           n, Exponent of 10
  3: 93            Z Loc [ inp_init     ]

*Table 2 Program
  02:  120         Execution Interval (seconds)
```

```
;start irs21 sensor 1
;the polling string to send to the sensor for measurement is strst 1 "&26&41&0D&0A"
;the filter string for the sio4 is fltst 12 "n9Fn1Fn1fn3Fn1Fn3fff"
;the port setup is portset 3 13 3 0 0 9 0
;this sensor is set up for 19.2 kbaud, no parity, 8 data bits, 1 stop bit

;dtr hi to power the interface and puck and rts high for data to logger

1:  SDM-SIO4 (P113)
   1:   1           Reps
   2:   0           Address
   3:   3           Send/Receive Port 3
   4:   1027        Command
   5:   0022        1st Parameters
   6:   0000        2nd Parameters
   7:   0           Values per Rep
   8:   1           Loc [ dummy      ]
   9:   1.0         Mult
   10:  0.0         Offset

2:  Delay w/Opt Excitation (P22)
   1:   1           Ex Channel
   2:   0           Delay W/Ex (0.01 sec units)
   3:   250         Delay After Ex (0.01 sec units)
   4:   0           mV Excitation

;rts lo to send data to sensor

3:  SDM-SIO4 (P113)
   1:   1           Reps
   2:   0           Address
   3:   3           Send/Receive Port 3
   4:   1027        Command
   5:   0010        1st Parameters
   6:   0000        2nd Parameters
   7:   0000        Values per Rep
   8:   1           Loc [ dummy      ]
   9:   1.0         Mult
   10:  0.0         Offset

;&A<cr> to sensor

4:  SDM-SIO4 (P113)
   1:   1           Reps
   2:   0           Address
   3:   3           Send/Receive Port 3
   4:   1024        Command
   5:   0001        1st Parameters
   6:   0000        2nd Parameters
   7:   0           Values per Rep
   8:   1           Loc [ dummy      ]
   9:   1.0         Mult
   10:  0.0         Offset
```

```
5:  Delay w/Opt Excitation (P22)
   1:   1              Ex Channel
   2:   0              Delay W/Ex (0.01 sec units)
   3:   1              Delay After Ex (0.01 sec units)
   4:   0              mV Excitation

;rts hi to receive data from the sensor

6:  SDM-SIO4 (P113)
   1:   1              Reps
   2:   0              Address
   3:   3              Send/Receive Port 3
   4:   1027           Command
   5:   0020           1st Parameters
   6:   0000           2nd Parameters
   7:   0000           Values per Rep
   8:   1              Loc [ dummy      ]
   9:   1.0            Mult
   10:  0.0            Offset

7:  Delay w/Opt Excitation (P22)
   1:   1              Ex Channel
   2:   0              Delay W/Ex (0.01 sec units)
   3:   50             Delay After Ex (0.01 sec units)
   4:   0              mV Excitation

;dtr low to turn the interface and sensor off

8:  SDM-SIO4 (P113)
   1:   1              Reps
   2:   0              Address
   3:   3              Send/Receive Port 3
   4:   1027           Command
   5:   0001           1st Parameters
   6:   0              2nd Parameters
   7:   0              Values per Rep
   8:   1              Loc [ dummy      ]
   9:   1.0            Mult
   10:  0.0            Offset

;send filter to sio4

9:  SDM-SIO4 (P113)
   1:   1              Reps
   2:   0              Address
   3:   3              Send/Receive Port 3
   4:   2054           Command
   5:   9012           1st Parameters
   6:   0000           2nd Parameters
   7:   0000           Values per Rep
   8:   1              Loc [ dummy      ]
   9:   1.0            Mult
   10:  0.0            Offset
```

```
10:  Delay w/Opt Excitation (P22)
   1:    1                  Ex Channel
   2:    0                  Delay W/Ex (0.01 sec units)
   3:    1                  Delay After Ex (0.01 sec units)
   4:    0                  mV Excitation

;read the sio4

11:  SDM-SIO4 (P113)
   1:    1                  Reps
   2:    0                  Address
   3:    3                  Send/Receive Port 3
   4:    4                  Command
   5:    0000               1st Parameters
   6:    0000               2nd Parameters
   7:    8                  Values per Rep
   8:    2                  Loc [ pavt1_1      ]
   9:    1.0                Mult
   10:  0.0                 Offset

intemp=(pavt1_3*.1)-50
salt=pavt1_4*.1
freztemp=pavt1_5*.1
waterflm=(1560-(16.55*pavt1_6)+(.041*pavt1_6*pavt1_6))/1000


*Table 3 Subroutines
;start of sdm-sio4 setup

1:  Beginning of Subroutine (P85)
   1    1                  Subroutine 1

;data filter

      2:  Bulk Load (P65)
         1:    102                F ;f
         2:    108                F ;l
         3:    116                F ;t
         4:    115                F ;s
         5:    116                F ;t
         6:    32                 F ;space
         7:    49                 F ;1
         8:    50                 F ;2
         9:    10                 Loc [ flt1_1       ]

      3:  Bulk Load (P65)
         1:    32                 F ;space
         2:    34                 F ;"
         3:    110                F ;n
         4:    57                 F ;9
         5:    70                 F ;F
         6:    110                F ;n
         7:    49                 F ;1
         8:    70                 F ;F
         9:    18                 Loc [ flt9_1       ]
```

```
    4:  Bulk Load (P65)
      1:    110             F ;n
      2:    49              F ;1
      3:    102             F ;f
      4:    110             F ;n
      5:    51              F ;3
      6:    70              F ;F
      7:    110             F ;n
      8:    49              F ;1
      9:    26              Loc [ flt17_1       ]

    5:  Bulk Load (P65)
      1:    70              F ;F
      2:    110             F ;n
      3:    51              F ;3
      4:    102             F ;f
      5:    102             F ;f
      6:    102             F ;f
      7:    34              F    ;"
      8:    0               F ;
      9:    34              Loc [ flt25_1       ]

;request data string

    6:  Bulk Load (P65)
      1:    115             F ;s
      2:    116             F ;t
      3:    114             F ;r
      4:    115             F ;s
      5:    116             F ;t
      6:    32              F ;space
      7:    49              F ;1
      8:    32              F ;space
      9:    42              Loc [ st1_1         ]

    7:  Bulk Load (P65)
      1:    34              F ;"
      2:    38              F ;&
      3:    50              F ;2
      4:    54              F ;6
      5:    38              F ;&
      6:    52              F ;4
      7:    49              F ;1
      8:    38              F ;&
      9:    50              Loc [ st9_1         ]

    8:  Bulk Load (P65)
      1:    48              F ;0
      2:    68              F ;D
      3:    38              F ;&
      4:    48              F ;0
      5:    65              F ;A
      6:    34              F ;"
      7:    0               F
      8:    0               F
      9:    58              Loc [ st17_1        ]
```

```
;sdm-s014 portset

    9:  Bulk Load (P65)
      1:   112          F ;p
      2:   111          F ;o
      3:   114          F ;r
      4:   116          F ;t
      5:   115          F ;s
      6:   101          F ;e
      7:   116          F ;t
      8:   32           F ;space
      9:   66           Loc [ port1_1     ]

    10:  Bulk Load (P65)
      1:   51           F ;3
      2:   32           F ;space
      3:   49           F ;1
      4:   51           F ;3
      5:   32           F ;space
      6:   51           F ;3
      7:   32           F ;space
      8:   48           F ;0
      9:   74           Loc [ port9_1     ]

    11:  Bulk Load (P65)
      1:   32           F ;space
      2:   48           F ;0
      3:   32           F ;space
      4:   57           F ;9
      5:   32           F ;space
      6:   48           F ;0
      7:   0            F
      8:   0            F
      9:   82           Loc [ port17_1    ]

;portset

    12:  SDM-SIO4 (P113)
      1:   1            Reps
      2:   0            Address
      3:   5            Send to all four ports
      4:   321          Command
      5:   0            1st Parameters
      6:   0            2nd Parameters
      7:   22           Values per Rep
      8:   66           Loc [ port1_1     ]
      9:   1.0          Multiplier
      10:  0.0          Offset

;data filter
```

```
    13:  SDM-SIO4 (P113)
     1:  1            Reps
     2:  0            Address
     3:  1            Send/Receive Port 1
     4:  321          Command
     5:  0            1st Parameters
     6:  0            2nd Parameters
     7:  31           Values per Rep
     8:  10           Loc [ flt1_1      ]
     9:  1.0          Multiplier
     10: 0.0          Offset

;request data

    14:  SDM-SIO4 (P113)
     1:  1            Reps
     2:  0            Address
     3:  1            Send/Receive Port 1
     4:  321          Command
     5:  0            1st Parameters
     6:  0            2nd Parameters
     7:  22           Values per Rep
     8:  42           Loc [ st1_1       ]
     9:  1.0          Multiplier
     10: 0.0          Offset

15:  End (P95)

End Program
```

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