EL In-Place Inclinometer
56804199

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Slope Indicator Company
A Boart Longyear Group Company

3450 Monte Villa Parkway
Bothell, WA 98021-8906 USA
Tel: 425-806-2200 Fax: 425-806-2250
E-mail: solutions@slope.com
Website: www.slopeindicator.com

SLOPE INDICATOR

Contents

Introduction. 1
Components 3
Pre-Assembly 5
Installation 6
Manual Readings 10
Data Reduction. 11
Data Logging. 14

EL In-Place Inclinometer

Introduction

Inclinometer casing is typically installed in a near-vertical borehole or horizontal trench that passes through a zone of suspected movement. The string of in-place inclinometer sensors is positioned in the casing to span this zone.

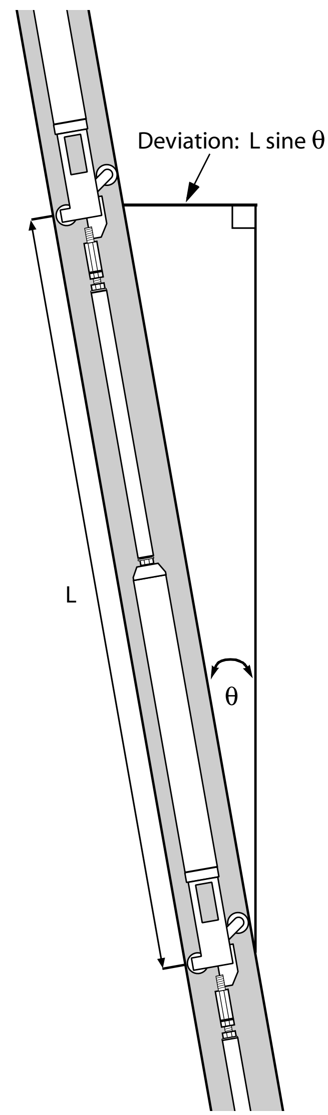
Ground movement displaces the casing, forcing it from its initial position to a new position. The inclinometer sensor does not measure this displacement directly. Instead, it measures its own inclination (tilt angle), which changes when the casing moves.

Deviation

The tilt angle is converted to a lateral distance, which is called deviation. Deviation is calculated by multiplying the sine of the angle by the gauge length of the sensor: L sine θ.

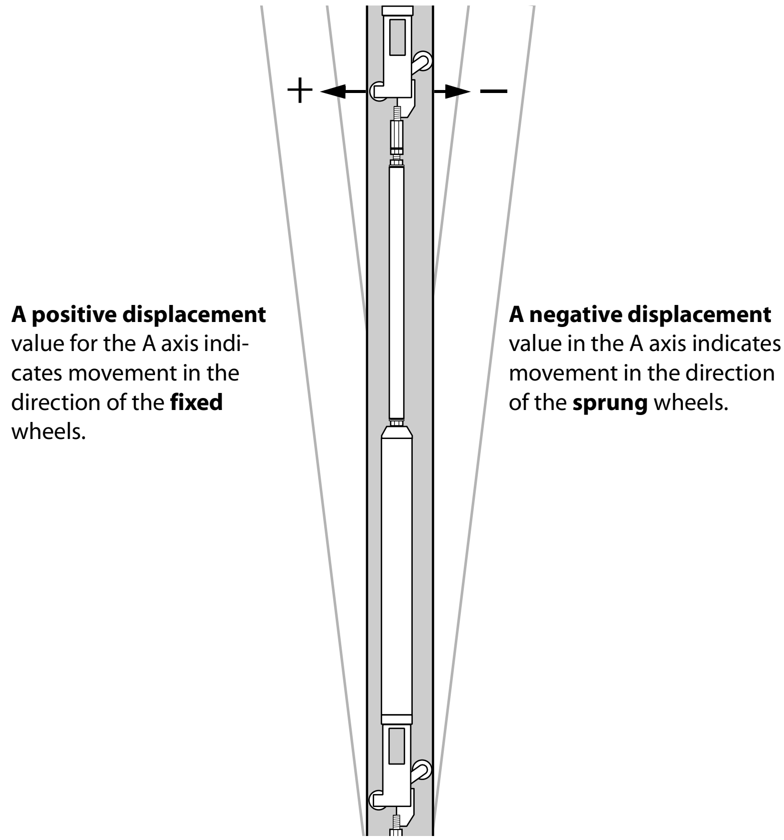
In the drawing at right, θ is the inclination of the casing, and L is the gauge length of the sensor, which extends from fixed wheel of one sensor to the fixed wheel of the next sensor.

A cumulative deviation plot is made by summing deviations from the bottom to each successive interval.



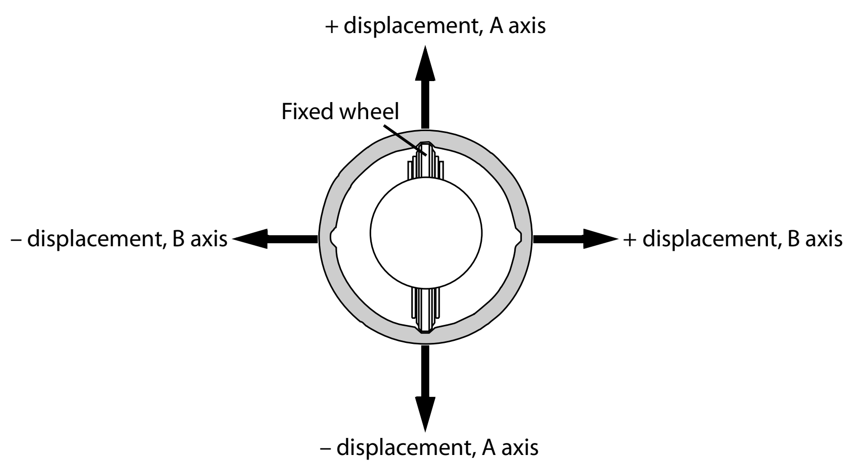
Displacement

Displacement, the distance the casing has moved, is calculated by subtracting the initial deviation from the current deviation. The displacement value will be negative or positive. This indicates the direction of movement, as shown below.



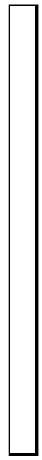
Direction of Movement

The displacement value shows the magnitude of movement. The sign (+ or –)shows the direction of movement.



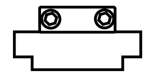
Components

Components of IPI Sensor



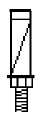
Gauge tubing: Completes gauge length of sensor.

Top clamp: Used to suspend sensors from top of casing.

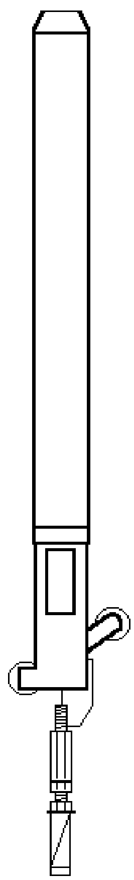


Coupling: Connects lengths of placement tubing.

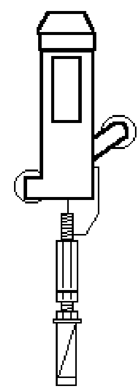
Placement tubing: (not shown) suspends sensors from top of inclinometer casing.



Tubing clamp: Connects gauge tubing to the sensor body.

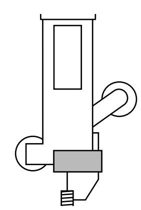


In-line wheel assembly: Used to terminate gauge length of top sensor.



IPI sensor: Includes wheel assembly and top and bottom tubing clamps. Tapered end of sensor is the top.

Swivel clamp: Locks the swivel on the bottom wheel assembly.



Tubing clamp: Connects the sensor to the gauge tubing of another sensor. Supplied with the sensor.

Gauge tubing

Gauge tubing may be pre-cut and supplied with the sensors. If gauge tubing is not supplied, check project specifications for required gauge length, and then follow the instructions below:

1. Choose stainless tubing that can accept tubing clamps. The standard tubing clamps have a minimum ID of 15.6 mm (0.615 inch) and expand to a maximum ID of 17.4 mm (0.685 inch).
2. Measure and mark the gauge tubing for the proper length: tubing length = total gauge length – 550 mm (21.625 inch). For example, you would cut tubing lengths of 1450 mm for a total gauge length of 2 meters.
3. Cut and deburr the gauge tubing. Check that tubing clamps fit inside.

Placement Tubing

Placement tubing is used to suspend the string of sensors from the top of the inclinometer casing. Use the coupling shown on previous page to join lengths of placement tubing. Use in-line wheel assembly if placement tubing must be articulated. If placement tubing is not supplied with the sensors, follow the instructions below:

1. Choose stainless tubing that can accept tubing clamps and couplings. The standard tubing clamps have a minimum ID of 15.6 mm (0.615 inch) and expand to a maximum ID of 17.4 mm (0.685 inch).
2. Deburr the gauge tubing and check that tubing clamps fit inside.

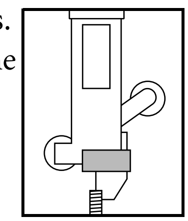
Pre-Assembly

Tools

- Vice-grips to hold gauge tubing.
- Wrench to tighten tubing clamps.

Identify and Check Sensors

1. Test each sensor. See “Manual Readings” for instructions.
2. Record the serial number and intended installation depth of each sensor.
3. Check that wheels are firmly attached to sensors. Also check that the swivel clamp is attached to the wheel assembly of the bottom sensor.

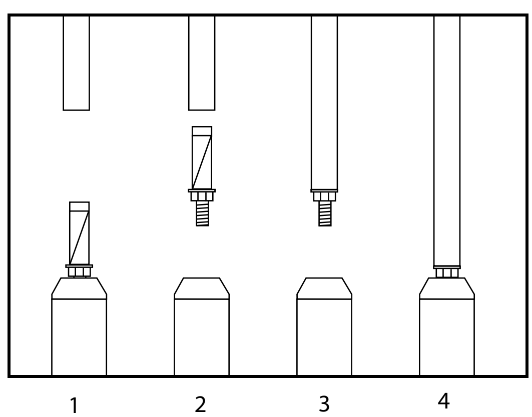


4. Check that cable lengths are correct.
5. Mark sensors for order of installation.
6. Attach sensor ID tags to ends of signal cables.

Attach Gauge Tubing to Each Sensor

As you work, be careful not to bend or damage the wheel assembly as you work.

1. Remove the tubing clamp from the top of the sensor body.
2. Insert clamp into gauge tubing
3. Hold tubing and tighten clamp well.
4. Screw gauge tubing onto sensor body until sensor body and gauge tubing form a rigid unit.



Installation

Overview

Installation involves connecting each sensor to the next as the sensors are lowered into the casing.

1. Align the fixed wheel of the first sensor in the preferred set of grooves.
2. Lower the sensor into the casing until the top of its gauge tubing is accessible.
3. Connect the next sensor to the gauge tubing of the downhole sensor. Then lower it into the casing.
4. Continue connecting sensors until the string is complete.
5. Connect the final wheel assembly and placement tubing.
6. Suspend the sensor string from the top clamp.

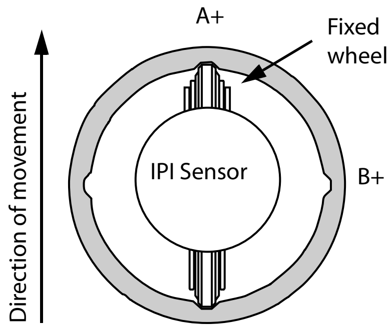
Required Tools

- Rope or cable attached to bottom sensor to (1) prevent loss of sensors down hole, and (2) control the position of the string during installation. A winch is useful when there are many sensors.
- Vice grips (clamping pliers) for holding gauge tubing while connecting adjacent sensors.
- Allen wrench for securing top clamp.
- Cable ties and vinyl tape for securing cable to gauge tubing.

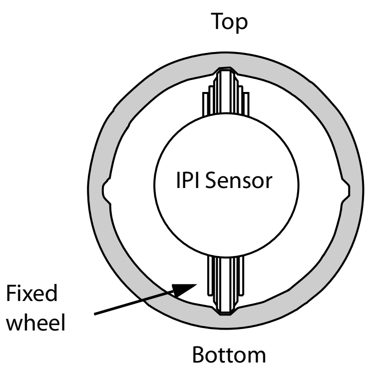
Preparations

1. Lay out sensors in order of installation.
2. Keep cables coiled until sensor is installed.

Install Bottom Sensor



Vertical Inclinometer Casing

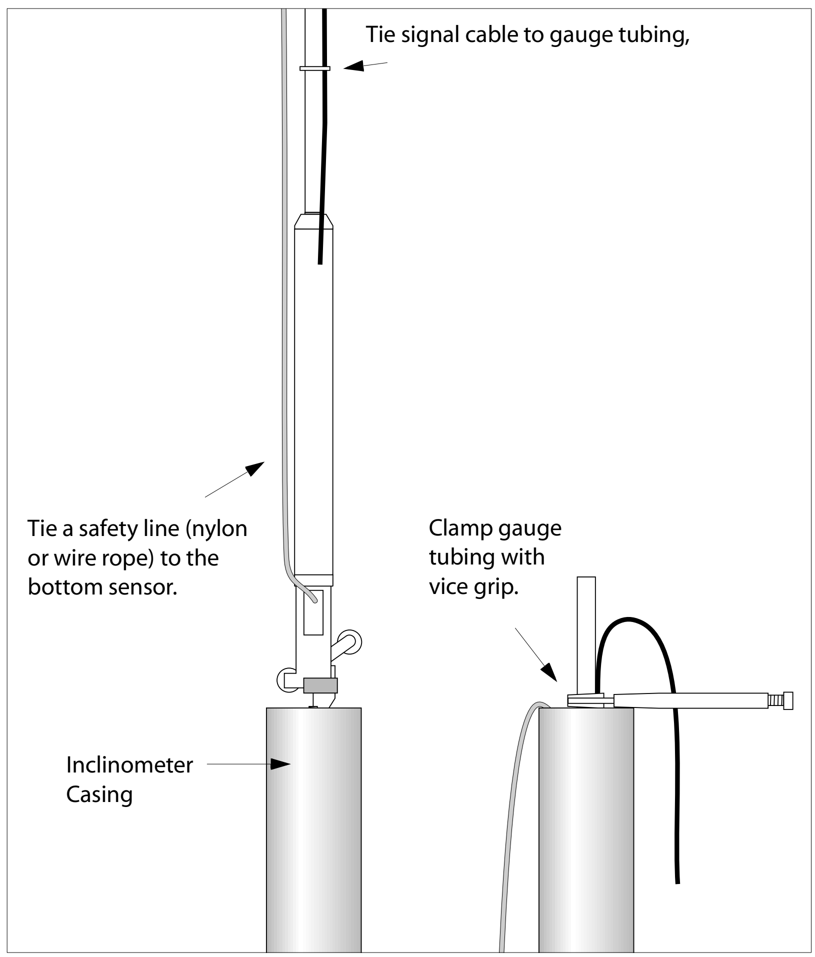


Horizontal Inclinometer Casing

1. Attach safety line (nylon or wire rope) to bottom sensor. Secure free end of line.
2. Align the fixed wheel of the first sensor with the preferred set of grooves:

- In vertical installations, casing is oriented so that one set of grooves is aligned in the direction of expected movement. Align the fixed wheel of the sensor toward the direction of movement, as shown in the drawing at left.
- In horizontal installations, casing is oriented so that one set of grooves is aligned to vertical. Insert the fixed wheel of the sensor in the bottom groove, as shown at left.

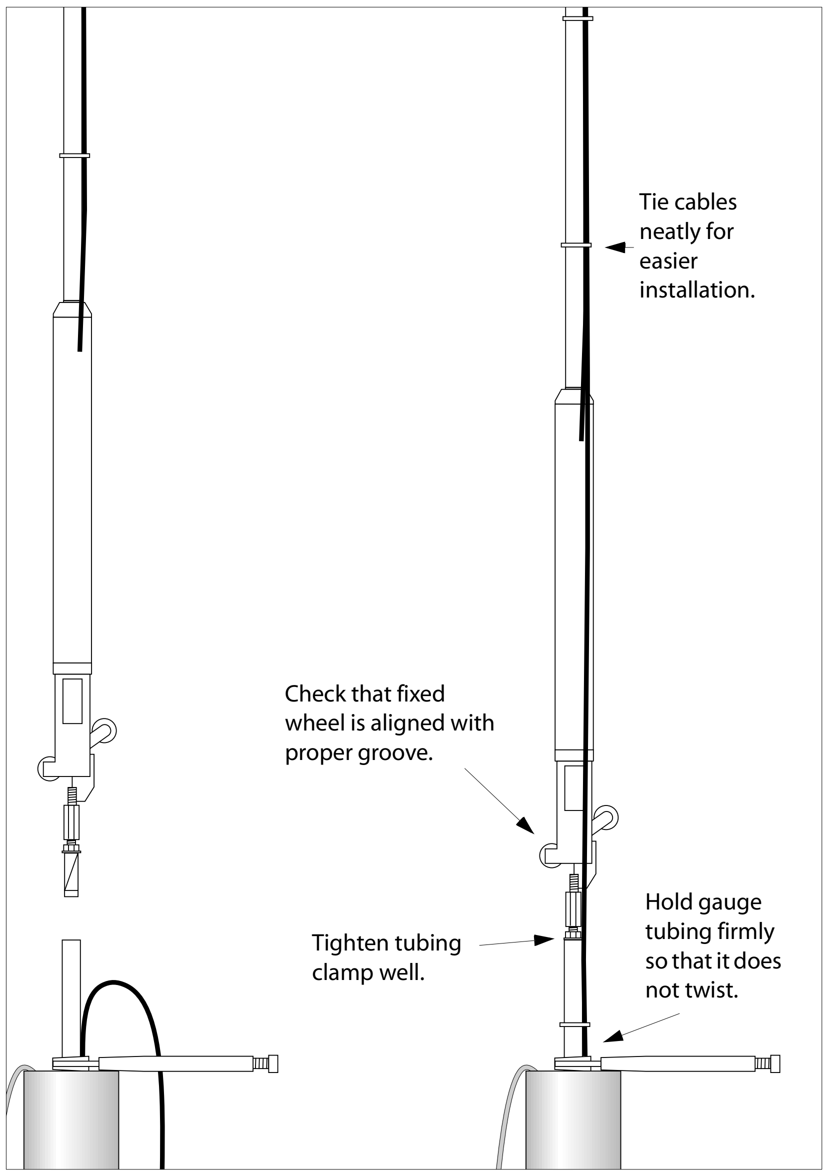
3. Lower sensor into casing. Tie signal cable to gauge tubing. Use vice grips to clamp top of gauge tubing. Now the next sensor can be installed.



Install Next Sensor

1. Connect next sensor to the gauge tubing of the sensor below, as shown in the drawing. Continue adding sensors until the sensor string is complete. Keep the following points in mind:

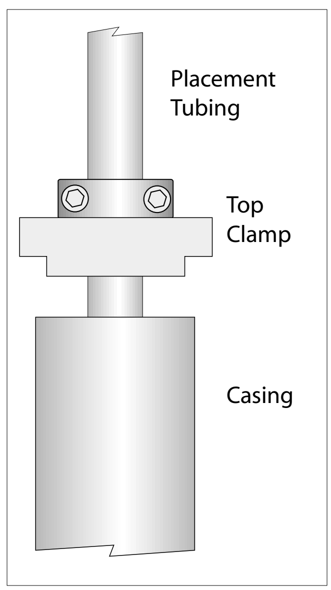
- Do not allow the installed sensor to twist in the casing when you tighten the connection. Twisting can damage the wheels or pop them out of the grooves.
- When you lower the sensor into the casing, check that the fixed wheel is aligned in the proper direction.
- Tie cables neatly, so that they do not cross each other.

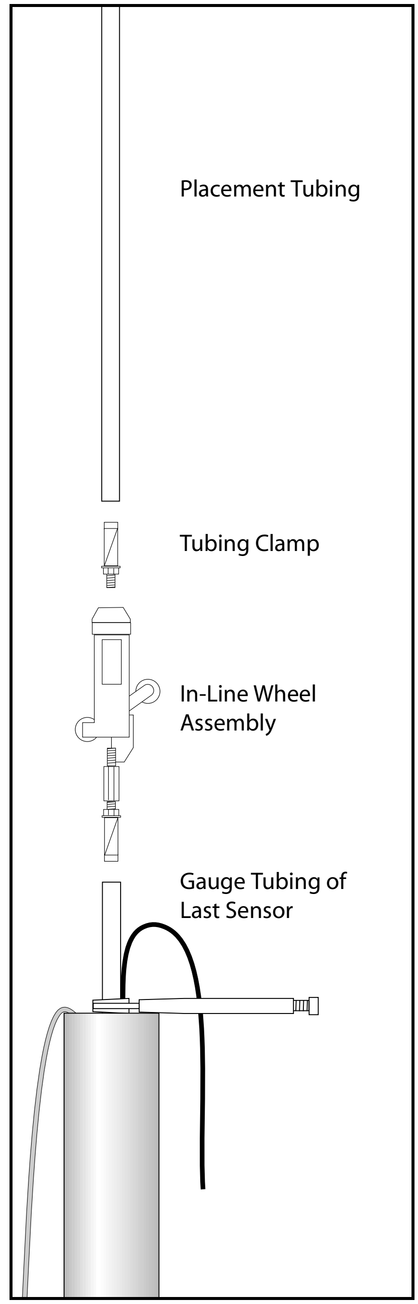


Install In-Line Wheel, Placement Tubing, and Top Clamp

.The in-line wheel assembly terminates the gauge length of the last sensor in the string. Placement tubing allows the string to be suspended deeper in the casing. The top clamp holds the placement tubing.

1. Attach wheel assembly to gauge tubing of last sensor.
2. Check that placement tubing is the right length. Then attach to wheel assembly.
3. Finally, suspend the entire sensor string from the top clamp. The top clamp has a split collar. Loosen the screws, slide the collar over the placement tubing or gauge tubing, and then tighten the screws





Manual Readings

Manual Readings

Manual readings are useful for testing the system before the data acquisition system is set up.

Equipment

Power Source: The power source must supply between 5.5 and 15 Vdc. An alkaline 9-volt transistor radio battery is suitable.

DC Voltmeter: The voltmeter should be capable of displaying values in the low millivolt dc range. Examples include a Beckman Industrial DM15B voltmeter or a Radio Shack Digital Multimeter (22-802).

Procedure

1. Connect the power source to the green (+) and black (-) wires.
2. To read the A-axis sensor, connect the voltmeter to the Orange wire (signal) and Yellow wire (reference).
3. To read the B-axis sensor, connect the voltmeter to the Blue wire (signal) and Violet wire (reference).
4. To read the thermistor, connect the voltmeter to the Red (+) and black (-) wires.

Test Readings

1. When the sensor body is vertical, you should see a reading of about 0.0 Vdc.
2. The A-axis sensor measures tilt in the plane of the wheels. Tilt the top of the sensor in the direction of the fixed wheel. The reading should be about 220 to 230 mV as the tilt nears 10 degrees. Tilt the top of the sensor in the direction of the sprung wheel. The reading should be -220 to -230 mV as the tilt nears 10 degrees.
3. The B-axis sensor (available with biaxial sensors only) is rotated 90 degrees from the A-axis sensor. Tilting the sensor to 10 degrees should provide a reading of ±220 to 230 mV.
4. See the next section, data reduction, to learn how to convert the reading in volts to deviation in mm.
5. At 25 degrees C, the thermistor reading should be about 1 Vdc.

Data Reduction

Introduction

Data reduction is usually automated because it involves a large number of readings and a large number of calculations.

Here, we explain how to use the sensor calibration record and provide an example of converting a single reading from voltage to mm of deviation.

Once you have deviations, you can calculate displacements (movements) by subtracting the initial deviation from the current deviation.

Calibration Record

A calibration record is provided with each EL IPI sensor. Note that calibrations are unique for each sensor, so use sensor serial numbers to match sensors with their calibrations.

The sensor calibration record lists three sets of factors for each axis of the sensor and one factor for the temperature sensor. The table at right shows factors for sensor serial number 10001. Your sensors will have different factors.

C0	-7.0311
C1	738.78
C2	-22.265
C3	-330.79
C4	194.26
C5	2022.1
S0	1
S1	0.00059828
S2	0.0000068117
F0	00012125
F1	0.016273
F2	0.00096919
Toffset	0.19
Tnom	12

C0 to C5: Use these factors to convert a reading in volts to mm per meter of gauge length.

S0 to S2: Use these factors to adjust the mm/m value above for temperature-related changes in sensor sensitivity.

F0 to F2: Use these factors to adjust the mm/meter value for temperature-related changes in the offset of the sensor.

Toffset: Use this factor in the equation to convert a thermistor reading in volts to degrees C.

Tnom: Tnom is normally 12 degrees C. However, the value shown on the sensor calibration record may be higher or lower if your sensors were calibrated over a custom range of temperatures.

Applying Calibration Factors

Suppose you obtain a reading of 57 millivolts (0.057V) from sensor 10001, which has a gauge length of 2 meters. How do you convert the voltage reading to mm of deviation? How do you correct for temperature effects? The temperature at the time of reading was 19.3 degrees C.

Converting sensor reading to mm per meter

Apply the C factors to the voltage reading as shown below. EL represents a reading in volts. C5 through C0 are factors that appear on the sensor calibration record. The result of the calculation is a value in mm per meter.

mm/meter = $\mathbf{C5 \cdot EL^5 + C4 \cdot EL^4 + C3 \cdot EL^3 + C2 \cdot EL^2 + C1 \cdot EL + C0}$

	C Factor	EL Reading	Value
C0	-7.0311		-70311
C1	738.78	0.057	42.11046
C2	-22.265	0.057^2	-0.07234
C3	-330.79	0.057^3	-0.06126
C4	194.26	0.057^4	0.002051
C5	2022.1	0.057^5	0.001217
mm per meter deviation =			34.94903

Calculating deviation in mm

To calculate deviation in mm, multiply the mm/meter value by the gauge length of the sensor.

deviation in mm = mm/meter value • gauge length of sensor

In this example, the gauge length is 2 meters, so the deviation would be about 70 mm. For higher accuracy, it is best to correct for changes in temperature.

Converting the thermistor reading to degrees C.

The calibration record provides an equation for converting the thermistor reading to degrees C. You need the Toffset value from the calibration record and a thermistor reading. In the equation below, ET represents the thermistor reading in volts.

$$\mathbf{DegC = (1264.9 \cdot ET^5 - 2836 \cdot ET^4 + 2587.6 \cdot ET^3 - 1194.2 \cdot ET^2 + 373.51 \cdot ET - 39.366) - Toffset}$$

To continue with the example, we will assume that the temperature was calculated to be 19.3 degree C.

Correcting for Temperature

Changes in temperature affect both the sensitivity and the offset of the sensor. In the instructions below, the sensitivity temperature correction is called SENSTC. The offset temperature correction is called OFFSTC.

Calculating the change in temperature

Temperature corrections are based on the change in temperature (DeltaT) from Tnom.

DeltaT = DegC - Tnom

In this example, DegC is 19.3 and Tnom is 12 degrees C, so DeltaT is 7.3 degrees C.

Calculating SENSTC

The sensitivity correction is calculated as follows:

SENSTC = S2•DeltaT^2 + S1•DeltaT + S0

	S Factor	DeltaT	Value
S0	1		1
S1	0.00059828	7.3	0.004367
S2	0.0000068117	7.3^2	0.000363
		SENSTC =	1.00473

Calculating OFFSTC

The offset correction is calculated as follows:

OFFSTC = F2•DeltaT^2 + F1•DeltaT + F0

	F Factor	DeltaT	Value
F0	0.00012125		.000121
F1	0.016273	7.3	0.118793
F2	0.00096919	7.3^2	0.051648
		OFFSTC =	0.170562

Calculating the corrected mm/meter value

Corrections are applied as follows:

corrected value = (mm/meter value • SENSTC) + OFFSTC
= (34.94903 • 1.00473) + 0.170562
= 35.28491

DataLogging

Requirements

The EL in-place inclinometer sensors has built-in signal conditioning board, so it can be read by most dataloggers.

Function	Wire Color	Electrical	Range
Power	Green	+Vdc power	5.5 to 15 Vdc, requires 3mA max at 12 Vdc
	Black	Ground	
A axis sensor	Orange	+Vdc output	±250 mV (differential)
	Yellow	- Vdc output	
B axis sensor	Blue	+Vdc output	±250 mV (differential)
	Violet	- Vdc output	
Thermistor	Red	+Vdc	160 to 1820 mV
	Shield	Make no connection	

Wiring Diagrams

Wiring diagrams on the following pages show how to connect uniaxial and biaxial IPIs to the Campbell Scientific CR10X datalogger system. The four diagrams show how to:

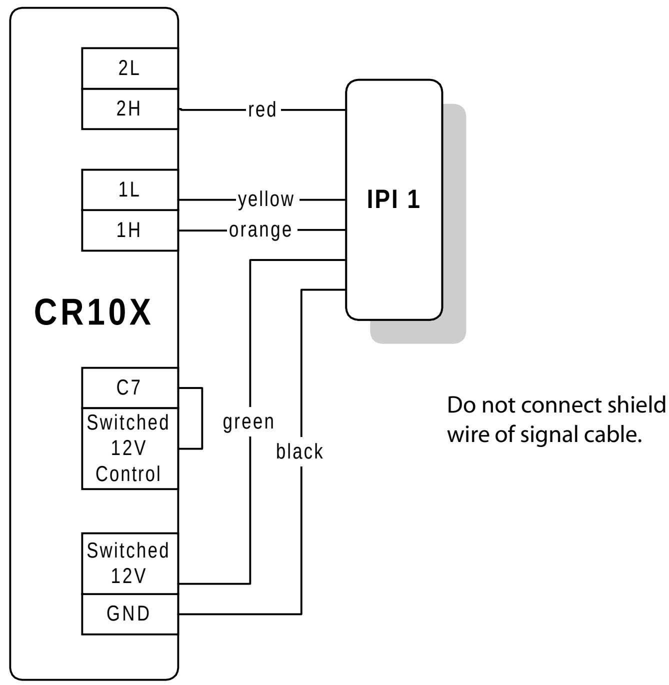
1. Connect uniaxial sensor directly to CR10.
2. Connect biaxial sensor directly to CR10.
3. Connect uniaxial sensor using AM416 multiplexer.
4. Connect biaxial sensor using AM416 multiplexer.

Sample Program

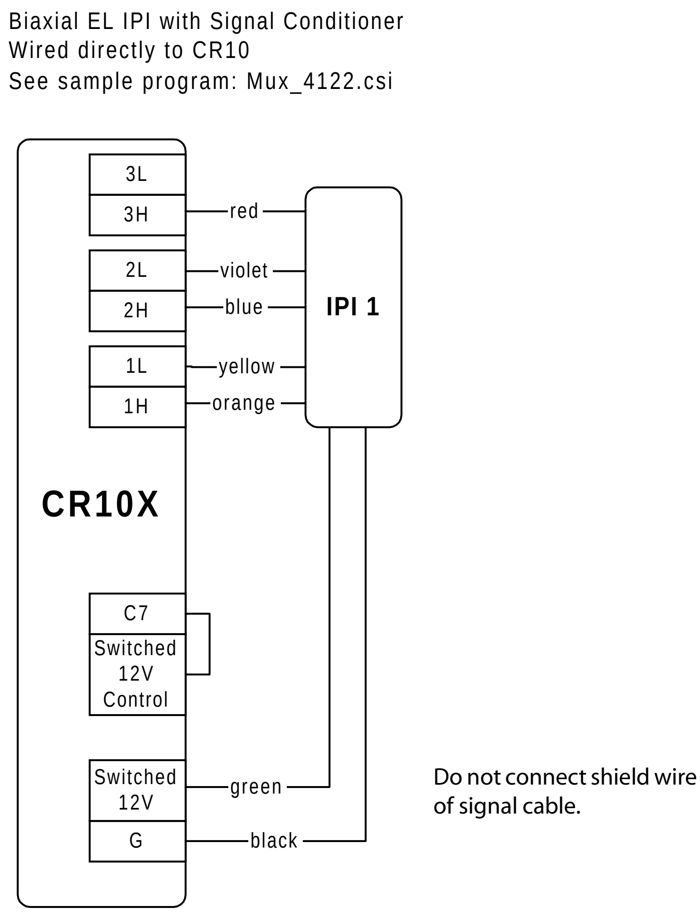
This is a typical program used to read IPI sensors that are connected to a multiplexer. The example shows two multiplexers.

Wiring Diagram 1 Connecting a uniaxial sensor directly to the CR10X

Uniaxial EL IPI with Signal Conditioner
Wired directly to CR10
See sample program: dir_4121.csi

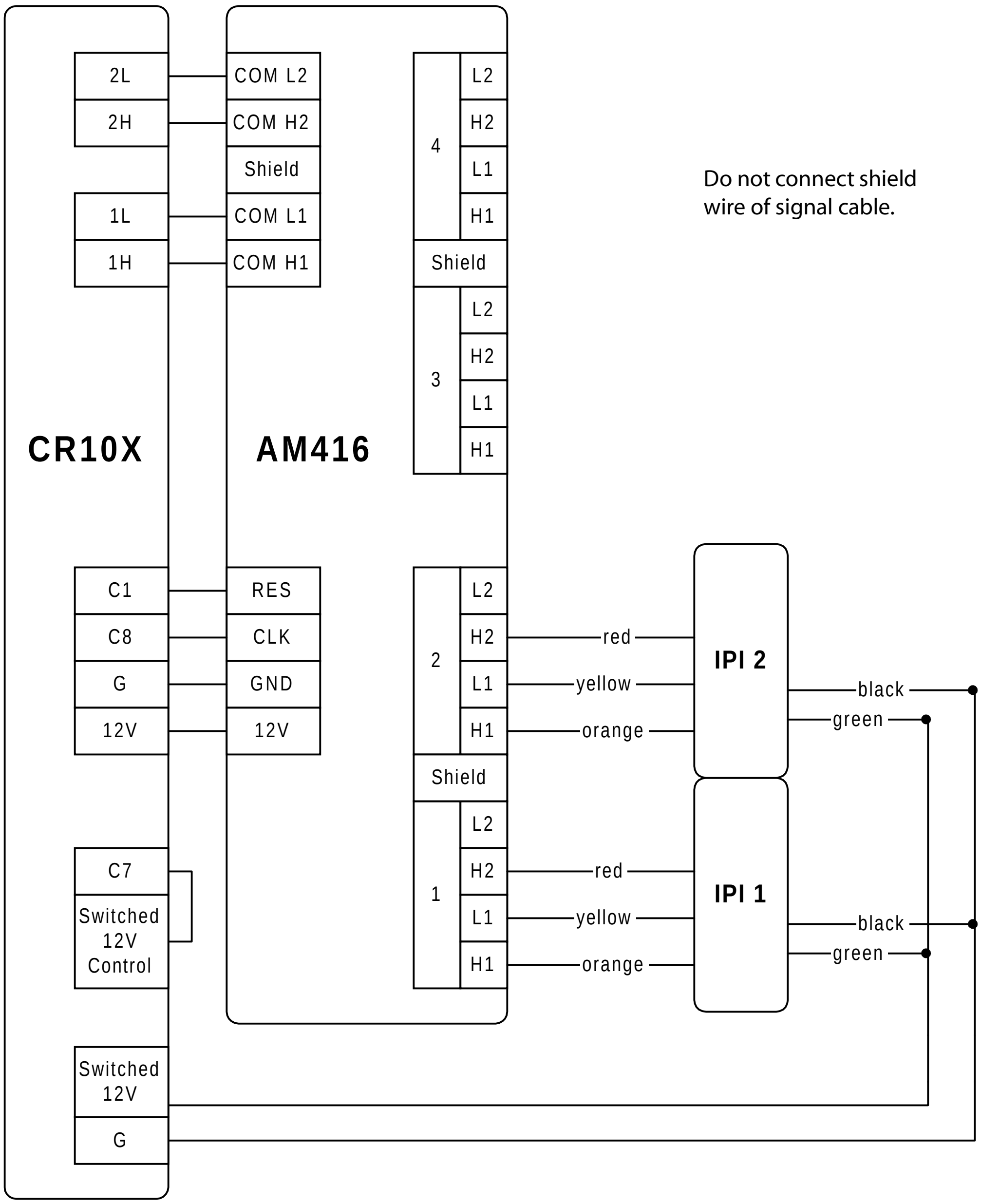


Wiring Diagram 2 Connecting a biaxial sensor directly to CR10X

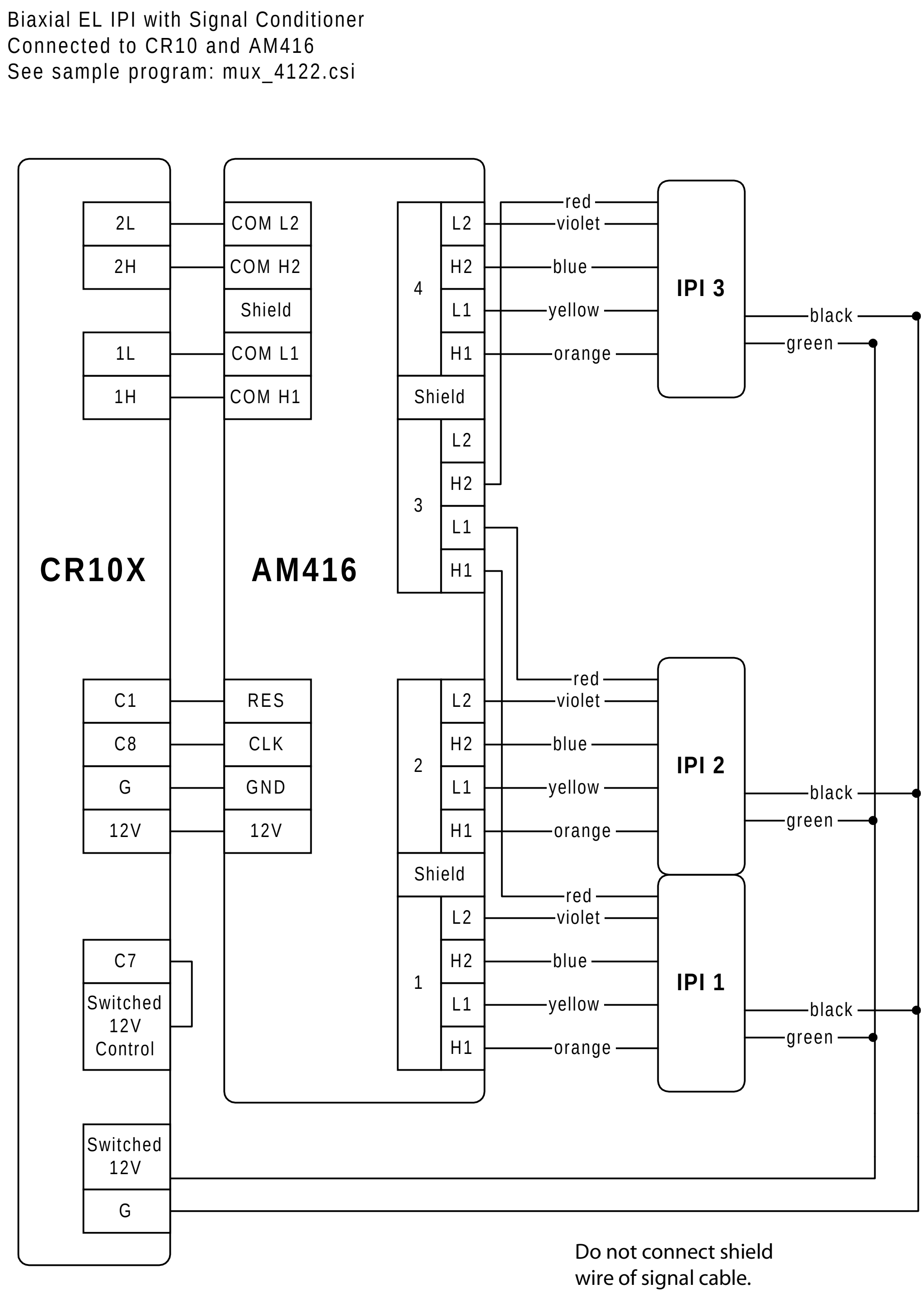


Wiring Diagram 3 Connecting uniaxial sensors to an AM416 multiplexer

Uniaxial EL IPI with Signal Conditioner
Connected to CR10 and AM416.
See sample program: mux_4121.csi



Wiring Diagram 4 Connecting biaxial sensors to the AM416 multiplexer



Sample Program

```
;{CR10X}
;Program: 24IPI.CSI
;         Date : 14-Feb-2000
;
;This program is provided as an example. It is the
;user’s responsibility to verify that the program meets
;the needs of the project.

; One CR10
; 2 x AM416, 12 biaxial EL IPI’s with temp to each Mux
; C1,2 to RES of MUX 1,2
; C7 used to switch 12 V power supply to IPI’s on/off
; C8 used to CLK from block to block

; Format of data stored:
; ID,YYYY,DDD,HHMM,1A-24A,1B-24B,1T-24T,BatteryV,CR10Temp
; IPI A and B in mV, IPI Temp in deg C


*Table 1 Program
  01: 300       Execution Interval (seconds) ;

1:  Batt Voltage (P10)
 1: 1        Loc [ Battery   ]

2:  Internal Temperature (P17)
 1: 2        Loc [ Temp      ]

3:  Do (P86) ;------------------------ Switch 12 V on
 1: 47       Set Port 7 High

4:  Excitation with Delay (P22) ;----- wait 5 seconds for power
to stabilise
 1: 3        Ex Channel
 2: 500      Delay W/Ex (units = 0.01 sec)
 3: 0        Delay After Ex (units = 0.01 sec)
 4: 0000     mV Excitation

5:  Do (P86)
 1: 81       Call Subroutine 81 ;-- read AM416#1

6:  Do (P86)
 1: 82       Call Subroutine 82 ;-- read AM416#2

7:  Do (P86) ;------------------------ Switch 12 V off
 1: 57       Set Port 7 Low

8:  If time is (P92) ;------------------- store data every 5
minutes
 1: 0000     Minutes (Seconds --) into a
 2: 5        Interval (same units as above)
 3: 30       Then Do

     9:  Do (P86)
      1: 10       Set Output Flag High (Flag 0)

     10:  Set Active Storage Area (P80)
      1: 1        Final Storage Area 1
      2: 101      Array ID

     11:  Do (P86)
      1: 5       Call Subroutine 5 ; Store readings from MUX #1
and #2

12:  End (P95)

*Table 2 Program
  02: 0         Execution Interval (seconds)

*Table 3 Subroutines

1:  Beginning of Subroutine (P85) ;---------------- 3 ---------
 1: 3        Subroutine 3

; Pulse and delay
```

```
     2:  Do (P86)
      1: 78       Pulse Port 8

     3:  Excitation with Delay (P22)
      1: 3        Ex Channel
      2: 1        Delay W/Ex (units = 0.01 sec)
      3: 4        Delay After Ex (units = 0.01 sec)
      4: 0000     mV Excitation

4:  End (P95)

5:  Beginning of Subroutine (P85); ---------------- 5 ----------
 1: 5        Subroutine 5

     6:  Real Time (P77)
      1: 1110     Year,Day,Hour/Minute

     7:  Resolution (P78)
      1: 1        High Resolution

     8:  Sample (P70)
      1: 12       Reps ;------------------- A (1-12)
      2: 4        Loc [ EL1_1     ]

     9:  Sample (P70)
      1: 12       Reps ;------------------- A (13-24)
      2: 40       Loc [ EL2_1     ]

     10:  Sample (P70)
      1: 12       Reps ;------------------- B (1-12)
      2: 16       Loc [ EL1_13    ]

     11:  Sample (P70)
      1: 12       Reps ;------------------- B (13-24)
      2: 52       Loc [ EL2_13    ]

     12:  Resolution (P78)
      1: 0        Low Resolution

     13:  Sample (P70)
      1: 12       Reps ;------------------- T (1-12)
      2: 28       Loc [ TP1_1     ]

     14:  Sample (P70)
      1: 12       Reps ;------------------- T (13-24)
      2: 64       Loc [ TP2_1     ]

     15:  Sample (P70)
      1: 2        Reps
      2: 1        Loc [ Battery   ]

16:  End (P95)

17:  Beginning of Subroutine (P85) ;---------------- 81 --------
---
 1: 81       Subroutine 81

     18:  Do (P86)
      1: 41       Set Port 1 High

     19:  Beginning of Loop (P87)
      1: 0000     Delay
      2: 4        Count(s)

          20:  Step Loop Index (P90)
           1: 3        Step

          21:  Do (P86)
           1: 88       Call Subroutine 88

          22:  Block Move (P54)
           1: 3        No. of Values
           2: 78       First Source Loc [ AvgEL_1   ]
           3: 2        Source Step
```

```
        4: 4     -- First Destination Loc [ EL1_1     ]
        5: 1        Destination Step

       23:  Block Move (P54)
        1: 3        No. of Values
        2: 79       First Source Loc [ AvgEL_2   ]
        3: 2        Source Step
        4: 16    -- First Destination Loc [ EL1_13    ]
        5: 1        Destination Step

       24:  Block Move (P54)
        1: 3        No. of Values
        2: 84       First Source Loc [ RawTP_1   ]
        3: 1        Source Step
        4: 28    -- First Destination Loc [ TP1_1     ]
        5: 1        Destination Step

  25:  End (P95)

  26:  Do (P86)
   1: 51       Set Port 1 Low

27:  End (P95)

28:  Beginning of Subroutine (P85) ;---------------- 82 --------
---
 1: 82       Subroutine 82

  29:  Do (P86)
   1: 42       Set Port 2 High

  30:  Beginning of Loop (P87)
   1: 0000     Delay
   2: 4        Count(s)

       31:  Step Loop Index (P90)
        1: 3        Step

       32:  Do (P86)
        1: 88       Call Subroutine 88

       33:  Block Move (P54)
        1: 3        No. of Values
        2: 78       First Source Loc [ AvgEL_1   ]
        3: 2        Source Step
        4: 40    -- First Destination Loc [ EL2_1     ]
        5: 1        Destination Step

       34:  Block Move (P54)
        1: 3        No. of Values
        2: 79       First Source Loc [ AvgEL_2   ]
        3: 2        Source Step
        4: 52    -- First Destination Loc [ EL2_13    ]
        5: 1        Destination Step

       35:  Block Move (P54)
        1: 3        No. of Values
        2: 84       First Source Loc [ RawTP_1   ]
        3: 1        Source Step
        4: 64    -- First Destination Loc [ TP2_1     ]
        5: 1        Destination Step

  36:  End (P95)

  37:  Do (P86)
   1: 52       Set Port 2 Low

38:  End (P95)

39:  Beginning of Subroutine (P85) ;-------------------- 88 ----
-----------------
 1: 88       Subroutine 88

  40:  Do (P86)
   1: 3        Call Subroutine 3 ;------------------ IPI#1
```

```
Sum=0

41:  Beginning of Loop (P87)
 1: 0000     Delay
 2: 50       Count(s)

     42:  Volt (Diff) (P2)
      1: 1        Reps
      2: 4        250 mV Slow Range
      3: 1        DIFF Channel
      4: 76       Loc [ Single    ]
      5: 1.0      Mult
      6: 0.0      Offset

     Sum=Sum+Single

43:  End (P95)

AvgEL_1=Sum/50

Sum=0

44:  Beginning of Loop (P87)
 1: 0000     Delay
 2: 50       Count(s)

     45:  Volt (Diff) (P2)
      1: 1        Reps
      2: 4        250 mV Slow Range
      3: 2        DIFF Channel
      4: 76       Loc [ Single    ]
      5: 1.0      Mult
      6: 0.0      Offset

     Sum=Sum+Single

46:  End (P95)

AvgEL_2=Sum/50

47:  Do (P86)
 1: 3        Call Subroutine 3 ;------------------- IPI#2

Sum=0

48:  Beginning of Loop (P87)
 1: 0000     Delay
 2: 50       Count(s)

     49:  Volt (Diff) (P2)
      1: 1        Reps
      2: 4        250 mV Slow Range
      3: 1        DIFF Channel
      4: 76       Loc [ Single    ]
      5: 1.0      Mult
      6: 0.0      Offset

     Sum=Sum+Single

50:  End (P95)

AvgEL_3=Sum/50

Sum=0

51:  Beginning of Loop (P87)
 1: 0000     Delay
 2: 50       Count(s)

     52:  Volt (Diff) (P2)
      1: 1        Reps
      2: 4        250 mV Slow Range
      3: 2        DIFF Channel
      4: 76       Loc [ Single    ]
```

```
         5: 1.0      Mult
         6: 0.0      Offset

        Sum=Sum+Single

   53:  End (P95)

   AvgEL_4=Sum/50

   54:  Do (P86) ;---------------------- 3 IPI temperatures
    1: 3        Call Subroutine 3

   55:  Volt (SE) (P1)
    1: 3        Reps
    2: 5        2500 mV Slow Range
    3: 1        SE Channel
    4: 84       Loc [ RawTP_1   ]
    5: 0.0004   Mult
    6: 0.0      Offset

   56:  Polynomial (P55)
    1: 3        Reps
    2: 84       X Loc [ RawTP_1   ]
    3: 84       F(X) Loc [ RawTP_1   ]
    4: -39.366  C0
    5: 373.51   C1
    6: -1194.2  C2
    7: 2587.6   C3
    8: -2836    C4
    9: 1264.9   C5

   57:  Do (P86) ;----------------------- IPI#3
    1: 3        Call Subroutine 3

   Sum=0

   58:  Beginning of Loop (P87)
    1: 0000     Delay
    2: 50       Count(s)

        59:  Volt (Diff) (P2)
         1: 1        Reps
         2: 34       250 mV 50 Hz Rejection Range
         3: 1        DIFF Channel
         4: 76       Loc [ Single    ]
         5: 1.0      Mult
         6: 0.0      Offset

        Sum=Sum+Single

   60:  End (P95)

   AvgEL_5=Sum/50

   Sum=0

   61:  Beginning of Loop (P87)
    1: 0000     Delay
    2: 50       Count(s)

        62:  Volt (Diff) (P2)
         1: 1        Reps
         2: 4        250 mV Slow Range
         3: 2        DIFF Channel
         4: 76       Loc [ Single    ]
         5: 1.0      Mult
         6: 0.0      Offset

        Sum=Sum+Single

   63:  End (P95)

   AvgEL_6=Sum/50

64:  End (P95)
```

```
End Program

-Input Locations-
1 Battery   1 1 1
2 Temp      1 1 1
3 _________ 0 0 0
4 EL1_1     7 1 1
5 EL1_2     11 1 1
6 EL1_3     11 1 1
7 EL1_4     11 1 0
8 EL1_5     11 1 0
9 EL1_6     11 1 0
10 EL1_7     11 1 1
11 EL1_8     27 1 1
12 EL1_9     11 1 0
13 EL1_10    11 1 0
14 EL1_11    11 1 0
15 EL1_12    27 1 0
16 EL1_13    11 1 1
17 EL1_14    11 1 1
18 EL1_15    11 1 1
19 EL1_16    11 1 0
20 EL1_17    11 1 0
21 EL1_18    11 1 0
22 EL1_19    11 1 0
23 EL1_20    11 1 0
24 EL1_21    11 1 0
25 EL1_22    11 1 0
26 EL1_23    11 1 0
27 EL1_24    27 1 0
28 TP1_1     11 1 1
29 TP1_2     3 1 1
30 TP1_3     3 1 1
31 TP1_4     3 1 0
32 TP1_5     3 1 0
33 TP1_6     3 1 0
34 TP1_7     3 1 0
35 TP1_8     3 1 0
36 TP1_9     3 1 0
37 TP1_10    3 1 0
38 TP1_11    3 1 0
39 TP1_12    19 1 0
40 EL2_1     7 1 1
41 EL2_2     19 1 1
42 EL2_3     19 0 1
43 EL2_4     3 0 0
44 EL2_5     3 0 0
45 EL2_6     3 0 0
46 EL2_7     3 0 0
47 EL2_8     3 0 0
48 EL2_9     3 0 0
49 EL2_10    3 0 0
50 EL2_11    3 0 0
51 EL2_12    3 0 0
52 EL2_13    7 1 1
53 EL2_14    3 1 1
54 EL2_15    19 0 1
55 EL2_16    3 0 0
56 EL2_17    3 0 0
57 EL2_18    3 0 0
58 EL2_19    3 0 0
59 EL2_20    3 0 0
60 EL2_21    3 0 0
61 EL2_22    3 0 0
62 EL2_23    3 0 0
63 EL2_24    3 0 0
64 TP2_1     7 1 1
65 TP2_2     11 1 1
66 TP2_3     19 0 1
67 TP2_4     3 0 0
68 TP2_5     3 0 0
69 TP2_6     3 0 0
70 TP2_7     3 0 0
71 TP2_8     3 0 0
```

```
72 TP2_9     3 0 0
73 TP2_10    3 0 0
74 TP2_11    3 0 0
75 TP2_12    3 0 0
76 Single    3 0 6
77 Sum       2 0 0
78 AvgEL_1   7 1 0
79 AvgEL_2   11 3 0
80 AvgEL_3   19 3 0
81 AvgEL_4   3 1 0
82 AvgEL_5   2 0 0
83 AvgEL_6   2 0 0
84 RawTP_1   7 2 2
85 RawTP_2   11 2 2
86 RawTP_3   19 2 2
87 CSI_R     0 0 0
88 CSI_1     0 0 0
-Program Security-
0
0
0
-Mode 4-
-Final Storage Area 2-
0
-CR10X ID-
0
-CR10X Power Up-
3
```