VWDSP

Vibrating Wire Interface

USER'S GUIDE

Disclaimer: The following document is provided to assist users with the installation, operation and training in the use of our products. This document and our products are intended to be used by technically qualified personnel. Contained herein is information that is proprietary to Canary Systems and may not be reproduced or copied in any form, nor disclosed to outside parties by any means whether directly or indirectly, without the written consent of Canary Systems. This document is subject to change without notice and Canary Systems assumes no responsibility for errors, omissions or misinterpretation. Furthermore Canary Systems makes no warranty as to the suitability of this information and/or products for any given application or use.

VWDSP_usersguide.doc Revision D, 03/08

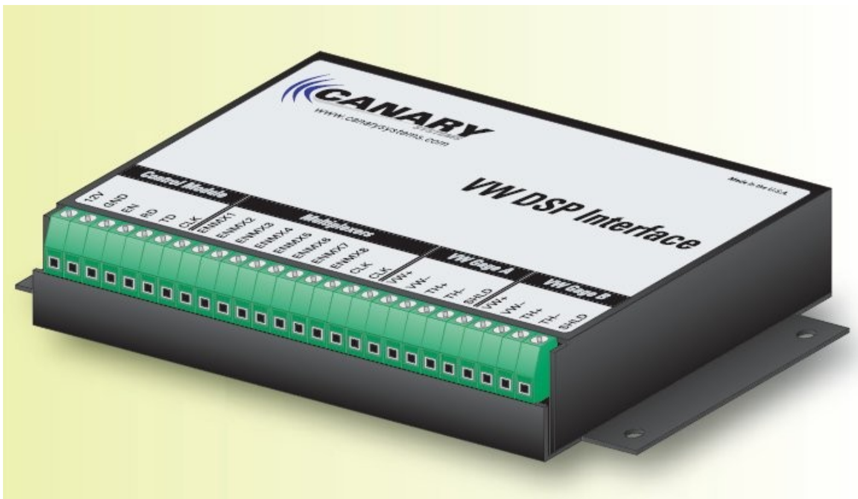
Canary Systems, Inc.
75 Newport Road, Suite 211
New London, NH 03257 USA
Voice: (603) 526-9800
Fax: (603) 526-9004
e-mail: support@canarysystems.com
web: www.canarysystems.com

Table of Contents

1.1 Overview

The VWDSP Interface provides the necessary excitation and signal processing to read 2 vibrating wire gages with their temperature devices. It uses analog and digital filtering techniques to insure a highly reliable vibrating wire measurement output. The temperature input is compatible with a wide range of thermistors and similar temperature sensors.

In addition, the VWDSP includes multiplexer expansion capabilities, up to 8 multiplexers may be enabled through the Interface. The VWDSP can also clock multiplexers using its CLK output. The default mode is for the attached Control Module to provide the clocking signal to advance the multiplexer channels.



Control of the VWDSP is performed using simple ASCII based commands, transmitted using a serial data interface at 1200 bps.

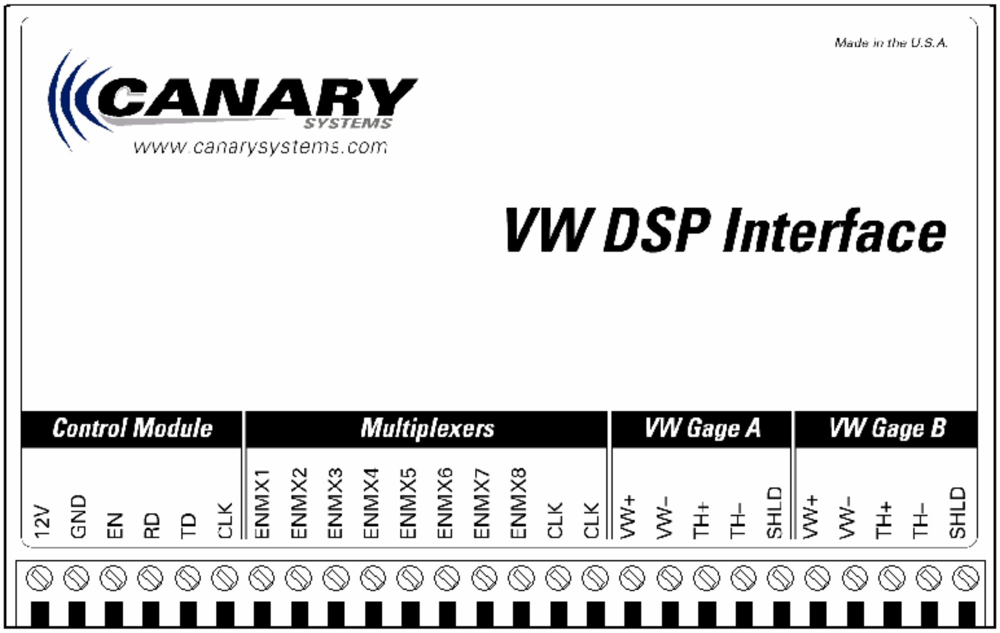
1.2 Specifications

General
Power requirements: 11-16 VDC (unregulated), nominal 12 VDC
Quiescent current (with serial port disconnected): < 500 µA
Quiescent current (with serial port connected): < 2.9 mA*
VWDSP activated current: < 40 mA
VWDSP (during VW Ping on Chan B) current: < 90 mA
Control line input impedance: 100 kilohms
Control line input levels: TTL (5V logic) or RS-232 (+/-12V NRZ logic)
Mux Enable Output levels (including CLK): TTL (5V logic) (< 6mA each)
Power input transient protection: 17.1 VDC, 1500W Transzorbs
with reverse polarity protection
Control signal input transient protection: 18 VDC, 1500W Transzorbs
Operating temperature: -40 to +70° C (-40 to +160° F)
* Radio connected to serial port can disconnect during sleep mode.

Vibrating Wire Sensor
Channels: 2 (each with thermistor input)
Sweep Range:
VW Coil resistance: 20 ohms minimum
Thermistor Input: YSI 44005

2.1 Terminal Connections

The connections for the VWDSP are shown as follows:



The following table explains the connections.

Terminal	Group	Description
12V	Control Module	Nominal 12V power input (11-16VDC range)
GND	Control Module	Ground connection
EN	Control Module	Enable input
RD	Control Module	Receive data input (output from MCU)
TD	Control Module	Transmit data output (input to MCU)
CLK	Control Module	Clock input from MCU (redirected to Multiplexers CLK terminals)
ENMX1-ENMX8	Multiplexers	Multiplexer enable outputs
CLK, CLK	Multiplexers	Clock outputs, whether from MCU (if connected) or generated internally. Two outputs provide 2 parallel TTL drive capability.
VW+	VW Gage A	Vibrating Wire + connection for channel A.
VW-	VW Gage A	Vibrating Wire - connection for channel A.
TH+	VW Gage A	Temperature + connection for channel A.
TH-	VW Gage A	Temperature - connection for channel A.
SHLD	VW Gage A	Shield connection for channel A.
VW+	VW Gage B	Vibrating Wire + connection for channel B.
VW-	VW Gage B	Vibrating Wire - connection for channel B.
TH+	VW Gage B	Temperature + connection for channel B.
TH-	VW Gage B	Temperature - connection for channel B.
SHLD	VW Gage B	Shield connection for channel B.

2.2 Controller Wiring

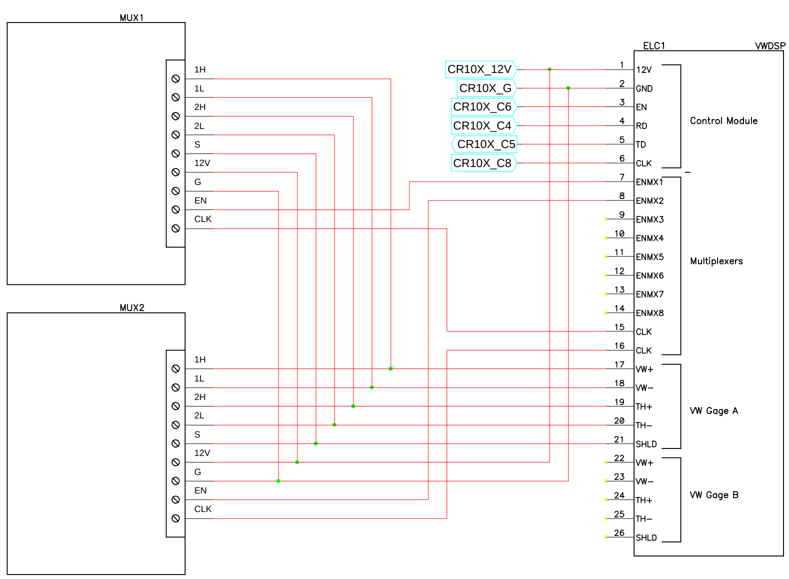
The VWDSP Interface provides a TTL or RS-232 level interface for connecting to the host device. The default interface is RS-232, contact Canary Systems or your product vendor to configure the interface for TTL. The VWDSP does not have data storage capability so it must be used in conjunction with other devices to deploy a data acquisition system. Typically it is used in conjunction with control modules such as the Campbell Scientific CR10X, CR800 or CR1000.

The following table lists the **Control Module** and **RS-232** connections, brief descriptions and connection destinations for use with a PC, and for the Control Modules, in both Non-MultiSensor Interface and MultiSensor Interface configurations. The MultiSensor Interface is a device manufactured by Canary Systems which facilitates connecting various types of instruments to a single multiplexer.

Label	Description	CR10X Non-MultiSensor	CR10X MultiSensor	CR800/ CR850	CR1000	RS-232 Female DB-9
12V	Power supply input. Nominal voltage is 12V DC, range is 6V to 16V.	12V	12V	12V	12V	
GND	Power supply ground.	G	G	G	G	5 (Black)
EN	Enable input. If the VWDSP must be powered continuously then connect to 12V, otherwise connect to a digital control port to activate. Input range is 4V to VCC (power supply). DO NOT APPLY A HIGHER VOLTAGE THAN THE POWER SUPPLY!	C6	C8	C3	C7	4 (Red)
RD	Receive data input to the VWDSP. Default is RS-232 type, 1200bps, 8 data bits, 1 stop bit, no parity.	C4	C2	C1	C5	3 (White)
TD	Transmit data output to the VWDSP. Default is RS-232 type, 1200bps, 8 data bits, 1 stop bit, no parity.	C5	C3	C2	C6	2 (Green)
CLK	Multiplexer clock input. This connection is common to the Multiplexers CLK outputs. It is designed to facilitate expanding the CLK output to multiple multiplexers.	C8 (Note: The VWDSP can also generate the clocking signal to avoid using C8.)	NA	C4 (Note: The VWDSP can also generate the clocking signal to avoid using C4.)	C8 (Note: The VWDSP can also generate the clocking signal to avoid using C8.)	

2.3 Multiplexer Wiring

The schematic illustrates wiring of the VWDSP in a non-MultiSensor system with 2 multiplexers.



2.4 Command Interface

The VWDSP supports a simple ASCII based command set to configure, read and output measurements from the 2 vibrating wire channels. All commands are followed by a carriage return. The commands, with parameters, are as follows:

Cnnnn – Clock multiplexer, where n = 0001-0256. Alternately the C command can be issued without a 4 digit value to send a single clock pulse. The clock pulse width is 10ms.

Mn – Enable multiplexer n, where n = 1-8. The respective ENMX1-ENMX8 output port is activated. If there is an existing port enabled it will be disabled prior to enabling the new port.

Pssss pppp cccc mmmm ttttt – Configure the vibrating wire measurement.

Where;
ssss = Start frequency of excitation, in Hertz. Range is 0001-9999.
pppp = Stop frequency of excitation, in Hertz. Range is 0001-9999.
cccc = Number of frequency cycles. Range is 0001-9999. Recommended default is 500.
mmmm = Duration of sampling period in 0.01 seconds. Range is 0001-9999. Recommended default is 100 for a 1 second sampling period.
tttt = Width of frequency swath. Range is 0001-9999. Recommended default is 100.

For example, the following command configures the vibrating wire measurement for a start frequency of 400 Hertz, stop of 3500 Hertz, 500 excitation cycles, a 1 second sampling period and a swath of 100.

```
P0400 3500 0500 0100 0100
```

If the command is received properly then the VWDSP will respond with **OK**, otherwise **NG** will display.

VA – Output the vibrating wire measurement from Channel A. The output is in a raw data format, it must be converted to “digits” or period using simple math functions. The output consists of 4 values, separated by the space character and followed by a checksum. For example, consider the following example output:

```
*VA<CR>
VA734 733 112 60579 3A
*
```

The first value, 734, is the total of available counts.
The second value, 733, is the useable counts.
The third value, 112, is the Sum MSW, followed by the Sum LSW, 60579.

To convert these values to period multiply the Sum MSW (112) by 65536 and add to this result the Sum LSW (60579). Then divide the number of counts used into the Sum to derive counts per cycle, then multiply by the clock period, or 0.1356µs, for count period. For example, using the figures in the example above, the vibrating wire period is (((112*65536)+60579)/733)*0.1356 or 1369µs. Invert this to derive frequency, square and then multiply by 0.001 to derive digits. For example, $(1/.001369)^2$*0.001 = 533 digits. Divide useable counts into available counts to derive reading quality.

See the CR10X and CR1000 program examples later in this section

VB – Output the vibrating wire measurement from Channel B. See above for conversion to period or digits.

TA – Output the temperature device measurement from Channel A. The output is in a raw data format, it must be converted to resistance or temperature using simple math functions. The output consists of 2 values, separated by the space character and followed by a checksum.

Note: The VWDSP Firmware was updated beginning with version 8 (use the S command to verify the version of your unit) to output different units for the TA command. The following 2 sections will clarify the different output units.

Pre Version 8 Firmware

Consider the following example output:

```
*TA<CR>
TA511 1014 94
*
```

The first value, 511, is the excitation voltage, expressed in terms of the 10-bit (0-1023) range of the A/D converter. The second value, 1014, is the output voltage, expressed in terms of the 10-bit (0-1023) range of the A/D converter.

To convert these values to temperature first calculate the current used to power the temperature device. Divide the voltage input by 1023, multiply by the reference voltage and then divide by 1000 to derive the current. For example, ((511/1023)*4.775)/1000 = 0.002385A. To derive the temperature device resistance subtract the input voltage from the output and divide by the current. For example, (((1014/1023)*4.775) - ((511/1023)*4.775))) /0.002385 = 984 ohms.

Version 8 and Higher

```
*TA<CR> or TAnnnn<CR>
TA00000 63800 B1
*
```

The 2 values represent a MSW and LSW of the 10-bit A/D result of the voltage measurement. By default the VWDSP acquires 100 samples and sums the results. Use TAnnnn to specify alternate averaging, nnnn=number of samples to sum. The MSW represents the number of 65536 results, the LSW represents the remainder.

To convert these values to temperature first calculate the resistance of the thermistor. This requires 4 steps. First, calculate the voltage across the termination resistor (6040). Vtr = ((((0*65536)+63800) /100)/1023)*2.5 = 1.559 Second, calculate the current through the thermistor by dividing Vtr into the resistor value (6040). Ir = 1.559/6040 = .000258 Third, calculate the voltage across the current limiting resistor by multiplying the resistance (499) by the current (Ir). Vr = 499 * .000258 = .1288 Fourth, calculate the thermistor resistance by subtracting Vtr and Vr from the excitation voltage and then dividing by the current (Ir). R = (2.5 – Vtr – Vr)/.000258 = (2.5 – 1.559 - .1288)/.000258 = 3148 ohms.

These formulas can be simplified but in their expanded form help explain the calculations performed.

The next step for either output is to convert the resistance values to temperature.

Conversion Resistance to Temperature

The conversion from resistance to temperature will depend on the model of the temperature device. For example, a YSI44005 device would be converted to temperature using the following log equation:

$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.2$$

Where; T = Temperature in °C.
LnR = Natural Log of Thermistor Resistance
$A = 1.4051 \times 10^{-3}$
$B = 2.369 \times 10^{-4}$
$C = 1.019 \times 10^{-7}$

Using the example above the temperature is approximately 52.5°C for the <rev 8 firmware and approximately 24.0°C for the >= rev 8 firmware.

TB – Output the temperature device measurement from Channel B. See above for conversion to resistance or temperature.

2.5 MultiLogger Software Configuration

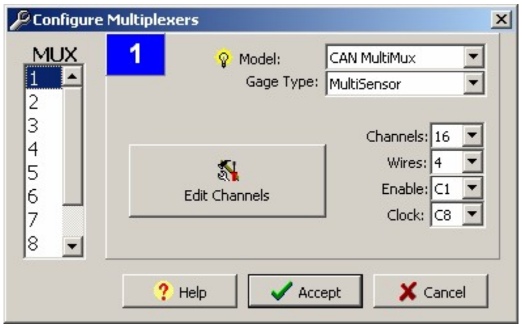
Support for the VWDSP is included in MultiLogger beginning in version 2.0.12. Contact Canary Systems or your software vendor to obtain an update. You can find the version of your software by selecting the menu item **Help | About**.

NOTE: There have been important updates to MultiLogger in regards the functionality of the VWDSP, contact Canary Systems or your software vendor to obtain the current version.

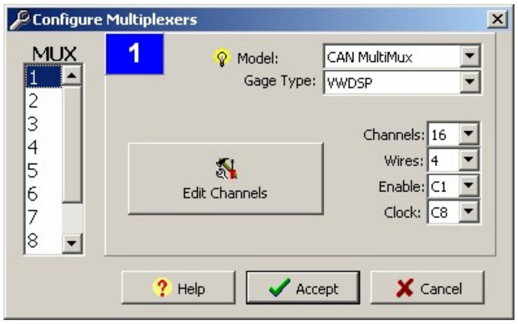
There are 3 steps to the configuration of your system to use the VWDSP.

1.Configure the multiplexer Gage Type

If using the MultiSensor Interface then select **MultiSensor**, as shown.



If NOT using the MultiSensor Interface then select **VWDSP**, as shown.



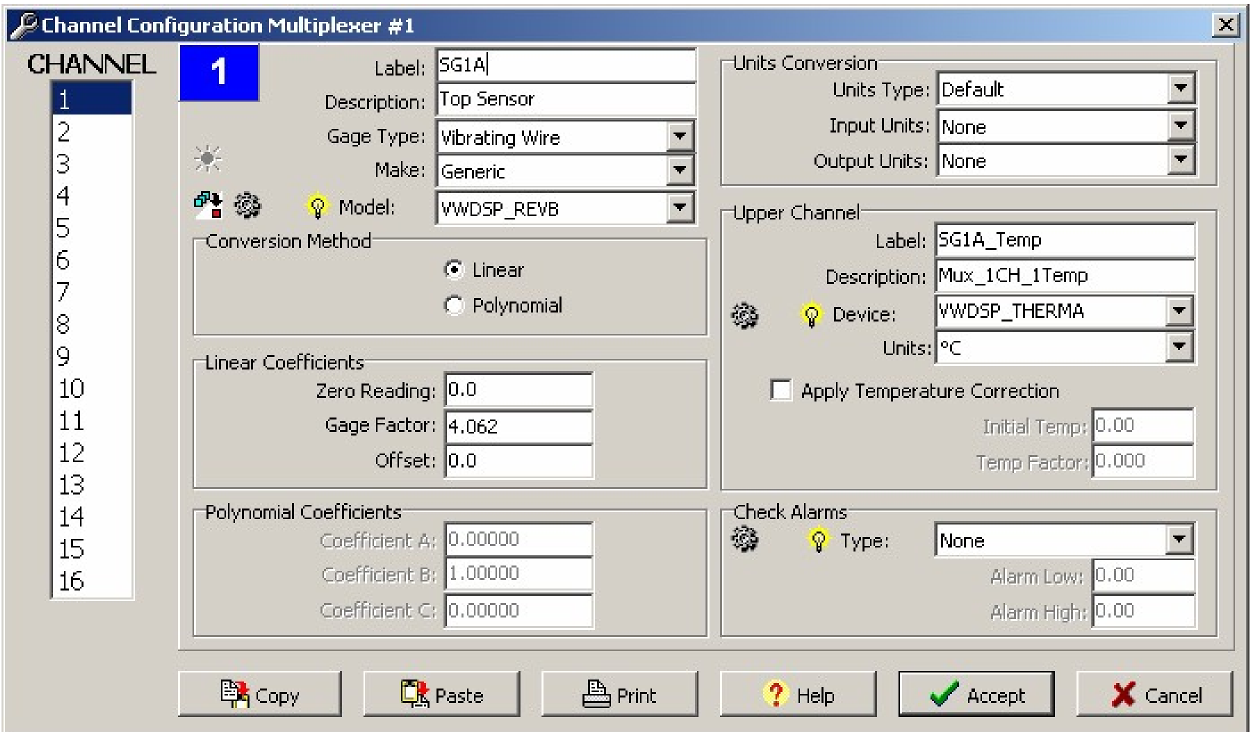
The Gage Type settings shown relate to the wiring of your system. If you are not sure of the system wiring, or whether the system includes the MultiSensor Interface, then contact your hardware vendor for further direction.

2. Configure the Channel Gage Type

There are generic VWDSP gage types as well as model specific VWDSP gage types. It is highly recommended to use the model specific gage types wherever possible. Note how the selections are organized by **Gage Type | Make | Model**. The VWDSP types will have VWDSP in the Model name.

Contact Canary Systems or your software vendor for information regarding gages not listed.

The generic types are explained below.



The generic models available include:

VWDSP_REVB – Frequency range is 400 to 3500 Hz, digits output, uses channel A of the VWDSP.
VWDSP_REVB_B – Frequency range is 400 to 3500 Hz, digits output, uses channel B of the VWDSP.
VWDSP_REVBP – Frequency range is 400 to 3500 Hz, period output (in microseconds), uses channel A of the VWDSP.
VWDSP_REVB_BP – Frequency range is 400 to 3500 Hz, period output (in microseconds), uses channel B of the VWDSP.

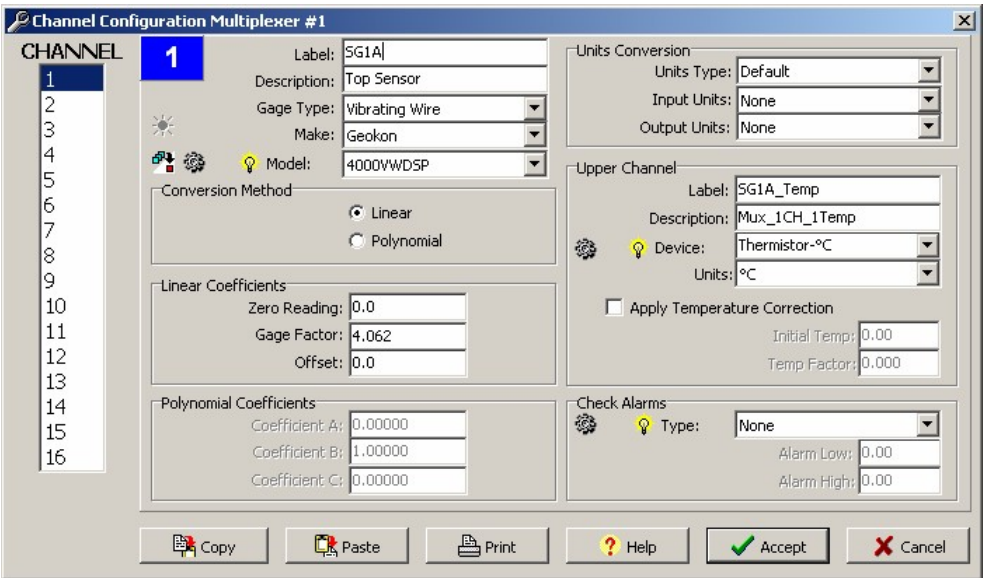
Note: The model specific gage types were added to MultiLogger beginning with version 2.1.2, it is highly recommended that you upgrade your version of MultiLogger if it pre-dates this version. Contact Canary Systems or your software vendor to obtain the current version.

IMPORTANT NOTE: All of the Canary Systems VWDSP gage types utilize UserLoc1 (Check your Input Storage list for the exact location number) to report the measurement Quality. This value expressed as a percentage, represents the amount of data that was used, compared to the amount of data available, in the calculation of digits or period. The Canary Systems VWDSP selections use a threshold of 50% to determine validity of a measurement. Be aware that other Application Notes may describe using this location to store various parameters related to alarm monitoring or other uses, please select an alternate location when utilizing the Canary Systems VWDSP gage types.

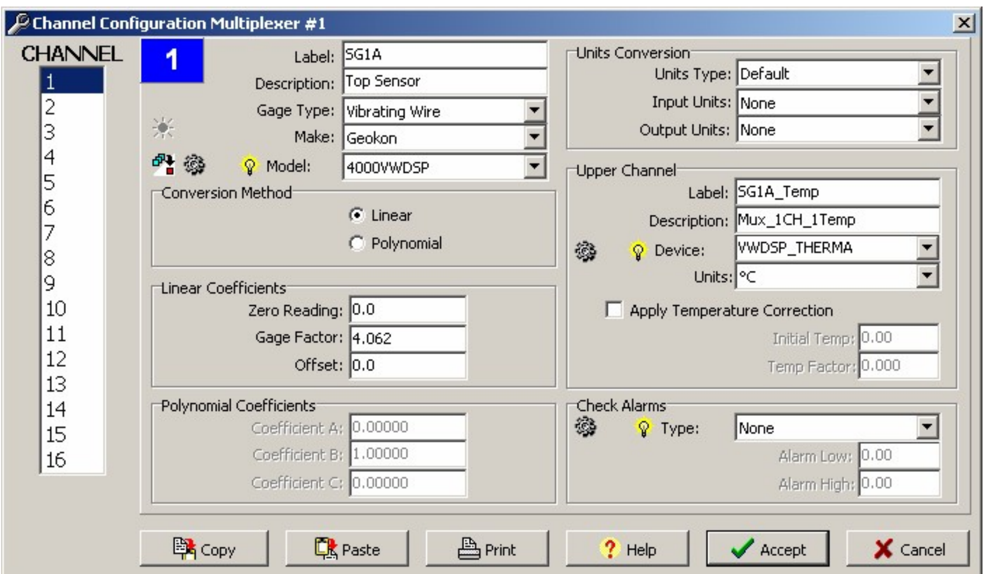
3. Configure the Upper Channel (if 16 Channel multiplexer)

If the multiplexer Channels is set to 16 then a temperature may also be read by making the appropriate selection from the Upper Channel **Device** list. If the multiplexer Channels is set to 32 or 48 then the Upper Channel options will be disabled.

If using the MultiSensor Interface then select the appropriate Thermistor device, as shown below.



If NOT using the MultiSensor Interface then select the appropriate VWDSP Device, as shown below.



<u>There are 4 VWDSP devices available:</u>

VWDSP_THERMA – YSI44005 thermistor connected to the A channel with output in °C.
VWDSP_ THERMA°F – YSI44005 thermistor connected to the A channel with output in °F.
VWDSP_THERMB - YSI44005 thermistor connected to the B channel with output in °C.
VWDSP_THERMB°F – YSI44005 thermistor connected to the B channel with output in °F.

2.6 CR10X Programming Examples

If you are writing your own Campbell program instead of using MultiLogger the following code example, extracted from MultiLogger, serves to illustrate how to utilize the VWDSP. This example uses the non-MultiSensor system wiring and assumes the multiplexers are wired to use the A Channel. Output is in digits.

Some of the nomenclature that follows in this program example is unique to the MultiLogger construct of programming files. For example, the Loc references (Tdbyte1, Tdbyte2, etc.) should be converted to Input Storage location numbers (with an appropriate matching label) when using this code in a Campbell program.

The P command that is sent matches the example shown in the section **Command Interface**.

Consult the **Campbell CR10X Operators Manual** for additional information on the P15 instruction.

NOTE: This instruction example is broken into 3 sections, the first section describes the multiplexer activation and looping instructions, the second describes the vibrating wire measurement, the third describes the temperature measurement.

Turn On VWDSP and Clock Multiplexer Loop

```
;Sample VWDSP loop instructions

;Configure PORTS and turn on VWDSP
P20     Set Port(s)    ;
1:[4919                ]      C8,C7,C6,C5 Options    ;
2:[9999                ]      C4,C3,C2,C1 Options    ;
P22     Excitation with Delay ;
1:[01                  ]      Ex Channel     ;
2:[0000                ]      Delay W/Ex (units = 0.01 sec) ;
3:[0010                ]      Delay After Ex (units = 0.01 sec)     ;
4:[0000                ]      mV Excitation  ;

;Load M command
P30     Z=F     ;
1:[77.000              ]      F      ;
2:[00                  ]      Exponent of 10 ;
3:[TDbyte1             ]      Z Loc                            ]       ;
P30     Z=F     ;
1:[49.000              ]      F      ;
2:[00                  ]      Exponent of 10 ;
3:[TDbyte2             ]      Z Loc                            ]       ;
P30     Z=F     ;
1:[13.000              ]      F      ;
2:[00                  ]      Exponent of 10 ;
3:[TDbyte3             ]      Z Loc                            ]       ;

;Send M Command
P15     Port Serial I/O       ;
1:[01                  ]      Reps    ;
2:[01                  ]      P15 SERIAL I/O (ASCII/RS-232, 1200 Baud)     ;
3:[0001                ]      P15 Serial I/O (Delay (units = 0.01 sec))    ;
4:[03                  ]      First Control Port     ;
5:[TDbyte1             ]      Output Loc                      ]       ;
6:[0003                ]      No. of Locs to Send    ;
7:[0000                ]      Termination Character  ;
8:[0000                ]      Maximum Characters     ;
9:[0000                ]      CTS/Input Wait (units = 0.01 sec)     ;
10:[TDbyte1             ]     Loc                      ]      ;
11:[1.0000              ]     Mult    ;
12:[0.0000              ]     Offset  ;

P22     Excitation with Delay ;
1:[01                  ]      Ex Channel     ;
2:[0000                ]      Delay W/Ex (units = 0.01 sec) ;
3:[0010                ]      Delay After Ex (units = 0.01 sec)     ;
4:[0000                ]      mV Excitation  ;
```

```
;Mux read loop
P87     Beginning of Loop        ;
1:[0                       ]       Delay   ;
2:[16                      ]       Loop Count     ;

;Advance the channel
P86     Do      ;
1:[78                      ]       Command Code Option (Pulse Port 8)    ;

;*********************************************************************
;    CR10X Programming - Vibrating Wire Channel A Instructions Here
;*********************************************************************

P31     Z=X     ;
1:[ReadingLoc              ]       X Loc   ;
2:[Mux1Loc--               ]       Z Loc   ;

P95     End     ;

;Turn off VWDSP
P86     Do      ;
1:[56                      ]       Command Code Option (Set Port 6 Low)  ;
```

Vibrating Wire Channel A

```
;Load P Command
P30     Z=F     ;
1:[80                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte1                 ]       Z Loc   ;

;Start
P30     Z=F     ;
1:[48                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte2                 ]       Z Loc   ;

P30     Z=F     ;
1:[52                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte3                 ]       Z Loc   ;

P30     Z=F     ;
1:[48                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte4                 ]       Z Loc   ;

P30     Z=F     ;
1:[48                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte5                 ]       Z Loc   ;

P30     Z=F     ;
1:[32                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte6                 ]       Z Loc   ;

;Stop
P30     Z=F     ;
1:[51                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte7                 ]       Z Loc   ;
P30     Z=F     ;
1:[53                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte8                 ]       Z Loc   ;
P30     Z=F     ;
1:[48                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte9                 ]       Z Loc   ;
P30     Z=F     ;
1:[48                      ]       F       ;
2:[0                       ]       Exponent of 10 ;
3:[TDbyte10                ]       Z Loc   ;
```

```
P30     Z=F     ;
1:[32                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte11             ]      Z Loc   ;

;Cycles
P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte12             ]      Z Loc   ;

P30     Z=F     ;
1:[54                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte13             ]      Z Loc   ;

P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte14             ]      Z Loc   ;

P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte15             ]      Z Loc   ;

P30     Z=F     ;
1:[32                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte16             ]      Z Loc   ;

;Sampling
P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte17             ]      Z Loc   ;

P30     Z=F     ;
1:[49                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte18             ]      Z Loc   ;

P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte19             ]      Z Loc   ;

P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte20             ]      Z Loc   ;

P30     Z=F     ;
1:[32                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte21             ]      Z Loc   ;

;Swath
P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte22             ]      Z Loc   ;
```

```
P30     Z=F     ;
1:[49                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte23             ]      Z Loc   ;

P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte24             ]      Z Loc   ;

P30     Z=F     ;
1:[48                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte25             ]      Z Loc   ;

;Terminator
P30     Z=F     ;
1:[13                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte26             ]      Z Loc   ;

;Load Read Command
P30     Z=F     ;
1:[86                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte27             ]      Z Loc   ;

P30     Z=F     ;
1:[65                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte28             ]      Z Loc   ;

P30     Z=F     ;
1:[13                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte29             ]      Z Loc   ;

;Load S command
P30     Z=F     ;
1:[83                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte30             ]      Z Loc   ;

P30     Z=F     ;
1:[13                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte31             ]      Z Loc   ;

;Send S command and get results
P15     Port Serial I/O        ;
1:[1                    ]      Reps    ;
2:[1                    ]      P15:2 Serial I/O (8-Bit, RS-232 ASCII, 1200 Baud)    ;
3:[1                    ]      P15:3 Serial I/O (Delay (0.01 sec units) before TX)  ;
4:[3                    ]      First (RTS/DTR) of Control Ports Used ;
5:[TDbyte30             ]      Start Loc for TX        ;
6:[2                    ]      Number of Locs to TX    ;
7:[42                   ]      Termination Character for RX  ;
8:[5                    ]      Max Characters to RX    ;
9:[100                  ]      P15:9 Serial I/O (Time Out for CTS (TX) and/or RX (0.01 sec
units));
10:[ScratchLoc1          ]     Start Loc for RX        ;
11:[1                    ]     Mult for RX     ;
12:[0                    ]     Offset for RX   ;

P63     Extended Parameters    ;
1:[83                   ]      Option  ;
2:[0                    ]      Option  ;
3:[0                    ]      Option  ;
4:[0                    ]      Option  ;
5:[0                    ]      Option  ;
6:[0                    ]      Option  ;
7:[0                    ]      Option  ;
8:[0                    ]      Option  ;
```

```
;Make sure VWDSP responded before proceeding
P89     If (X<=>F)      ;
1:[ScratchLoc1          ]      X Loc   ;
2:[3                    ]      Comparison Code Option (>=)   ;
3:[0                    ]      F       ;
4:[30                   ]      Command Code Option (Then Do) ;

;Short delay before P command
P22     Excitation with Delay ;
1:[1                    ]      Ex Channel     ;
2:[0                    ]      Delay W/Ex (units = 0.01 sec) ;
3:[10                   ]      Delay After Ex (units = 0.01 sec)     ;
4:[0                    ]      mV Excitation  ;

;Send P command
P15     Port Serial I/O        ;
1:[1                    ]      Reps    ;
2:[1                    ]      P15:2 Serial I/O (8-Bit, RS-232 ASCII, 1200 Baud)    ;
3:[1                    ]      P15:3 Serial I/O (Delay (0.01 sec units) before TX)  ;
4:[3                    ]      First (RTS/DTR) of Control Ports Used ;
5:[TDbyte1              ]      Start Loc for TX       ;
6:[26                   ]      Number of Locs to TX   ;
7:[0                    ]      Termination Character for RX  ;
8:[0                    ]      Max Characters to RX   ;
9:[0                    ]      P15:9 Serial I/O       ;
10:[TDbyte1              ]     Start Loc for RX       ;
11:[1                    ]     Mult for RX    ;
12:[0                    ]     Offset for RX  ;

P22     Excitation with Delay ;
1:[1                    ]      Ex Channel     ;
2:[0                    ]      Delay W/Ex (units = 0.01 sec) ;
3:[10                   ]      Delay After Ex (units = 0.01 sec)     ;
4:[0                    ]      mV Excitation  ;

;Send VA command and get results
P15     Port Serial I/O        ;
1:[1                    ]      Reps    ;
2:[1                    ]      P15:2 Serial I/O (8-Bit, RS-232 ASCII, 1200 Baud)    ;
3:[10                   ]      P15:3 Serial I/O (Delay (0.01 sec units) before TX)  ;
4:[3                    ]      First (RTS/DTR) of Control Ports Used ;
5:[TDbyte27             ]      Start Loc for TX       ;
6:[3                    ]      Number of Locs to TX   ;
7:[42                   ]      Termination Character for RX  ;
8:[32                   ]      Max Characters to RX   ;
9:[1500                 ]      P15:9 Serial I/O (Time Out for CTS (TX) and/or RX (0.01 sec units))
        ;
10:[ScratchLoc1          ]     Start Loc for RX       ;
11:[1                    ]     Mult for RX    ;
12:[0                    ]     Offset for RX  ;

P63     Extended Parameters    ;
1:[86                   ]      Option  ;
2:[65                   ]      Option  ;
3:[0                    ]      Option  ;
4:[0                    ]      Option  ;
5:[0                    ]      Option  ;
6:[0                    ]      Option  ;
7:[0                    ]      Option  ;
8:[0                    ]      Option  ;

;Make sure we have data from unit
P89     If (X<=>F)      ;
1:[ScratchLoc1          ]      X Loc   ;
2:[1                    ]      Comparison Code Option (=)    ;
3:[-99999               ]      F       ;
4:[30                   ]      Command Code Option (Then Do) ;

P31     Z=X     ;
1:[ScratchLoc1          ]      X Loc   ;
2:[ReadingLoc           ]      Z Loc   ;

P94     Else    ;
```

```
;Calculate Result
P37     Z=X*F   ;
1:[ScratchLoc3          ]      X Loc   ;
2:[65536                ]      F       ;
3:[ScratchLoc5          ]      Z Loc   ;

P33     Z=X+Y   ;
1:[ScratchLoc4          ]      X Loc   ;
2:[ScratchLoc5          ]      Y Loc   ;
3:[ScratchLoc5          ]      Z Loc   ;

P38     Z=X/Y   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[ScratchLoc2          ]      Y Loc   ;
3:[ScratchLoc5          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[0.1356               ]      F       ;
3:[ScratchLoc5          ]      Z Loc   ;

P42     Z=1/X   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[ScratchLoc5          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[1000                 ]      F       ;
3:[ScratchLoc5          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[1000                 ]      F       ;
3:[ScratchLoc5          ]      Z Loc   ;

P36     Z=X*Y   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[ScratchLoc5          ]      Y Loc   ;
3:[ScratchLoc5          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[0.001                ]      F       ;
3:[ScratchLoc5          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[0.001                ]      F       ;
3:[ReadingLoc           ]      Z Loc   ;

;Calculate Goodness
P38     Z=X/Y   ;
1:[ScratchLoc2          ]      X Loc   ;
2:[ScratchLoc1          ]      Y Loc   ;
3:[ScratchLoc6          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc6          ]      X Loc   ;
2:[100                  ]      F       ;
3:[UserLoc1             ]      Z Loc   ;
```

```
;Check Quality
P89     If (X<=>F)      ;
1:[UserLoc1             ]      X Loc   ;
2:[4                    ]      Comparison Code Option (<)    ;
3:[50                   ]      F       ;
4:[30                   ]      Command Code Option (Then Do) ;

P30     Z=F     ;
1:[-99998               ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[ReadingLoc           ]      Z Loc   ;

P94     Else    ;

P89     If (X<=>F)      ;
1:[ScratchLoc2          ]      X Loc   ;
2:[4                    ]      Comparison Code Option (<)    ;
3:[100                  ]      F       ;
4:[30                   ]      Command Code Option (Then Do) ;

P30     Z=F     ;
1:[-99997               ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[ReadingLoc           ]      Z Loc   ;

P95     End     ;

P95     End     ;

P95     End     ;

;Else VWDSP is not responding
P94     Else    ;

P31     Z=X     ;
1:[ScratchLoc1          ]      X Loc   ;
2:[ReadingLoc           ]      Z Loc   ;

P95     End     ;
```

<u>CR10X Temperature</u>

The following code example illustrates how to read a YSI44005 type thermistor using the A channel of the VWDSP, with output in °C.

```
P30     Z=F     ;
1:[83                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte1              ]      Z Loc   ;
P30     Z=F     ;
1:[13                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte2              ]      Z Loc   ;

;Load Read Command
P30     Z=F     ;
1:[84                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte3              ]      Z Loc   ;
P30     Z=F     ;
1:[65                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte4              ]      Z Loc   ;
P30     Z=F     ;
1:[13                   ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[TDbyte5              ]      Z Loc   ;

;Send S command and get results
P15     Port Serial I/O        ;
1:[1                    ]      Reps    ;
2:[1                    ]      P15:2 Serial I/O (8-Bit, RS-232 ASCII, 1200 Baud)    ;
3:[10                   ]      P15:3 Serial I/O (Delay (0.01 sec units) before TX)  ;
4:[3                    ]      First (RTS/DTR) of Control Ports Used ;
5:[TDbyte1              ]      Start Loc for TX        ;
6:[2                    ]      Number of Locs to TX    ;
7:[42                   ]      Termination Character for RX   ;
8:[8                    ]      Max Characters to RX    ;
9:[50                   ]      P15:9 Serial I/O (Time Out for CTS (TX) and/or RX (0.01 sec units))
10:[ScratchLoc10         ]     Start Loc for RX        ;
11:[1                    ]     Mult for RX     ;
12:[0                    ]     Offset for RX   ;

;Use S filter string
P63     Extended Parameters    ;
1:[83                   ]      Option  ;
2:[0                    ]      Option  ;
3:[0                    ]      Option  ;
4:[0                    ]      Option  ;
5:[0                    ]      Option  ;
6:[0                    ]      Option  ;
7:[0                    ]      Option  ;
8:[0                    ]      Option  ;

;Check for S command received before proceeding
P89     If (X<=>F)     ;
1:[ScratchLoc10         ]      X Loc   ;
2:[3                    ]      Comparison Code Option (>=)    ;
3:[0                    ]      F       ;
4:[30                   ]      Command Code Option (Then Do) ;

;Send TA command and get results
P15     Port Serial I/O        ;
1:[1                    ]      Reps    ;
2:[1                    ]      P15:2 Serial I/O (8-Bit, RS-232 ASCII, 1200 Baud)    ;
3:[10                   ]      P15:3 Serial I/O (Delay (0.01 sec units) before TX)  ;
4:[3                    ]      First (RTS/DTR) of Control Ports Used ;
5:[TDbyte3              ]      Start Loc for TX        ;
6:[3                    ]      Number of Locs to TX    ;
7:[42                   ]      Termination Character for RX   ;
8:[20                   ]      Max Characters to RX    ;
9:[200                  ]      P15:9 Serial I/O (Time Out for CTS (TX) and/or RX (0.01 sec units))
10:[ScratchLoc1          ]     Start Loc for RX        ;
11:[1                    ]     Mult for RX     ;
12:[0                    ]     Offset for RX   ;
```

```
;Use TA filter string
P63     Extended Parameters    ;
1:[84                  ]      Option  ;
2:[65                  ]      Option  ;
3:[0                   ]      Option  ;
4:[0                   ]      Option  ;
5:[0                   ]      Option  ;
6:[0                   ]      Option  ;
7:[0                   ]      Option  ;
8:[0                   ]      Option  ;

;Make sure we have a result from VWDSP
P89     If (X<=>F)     ;
1:[ScratchLoc1         ]      X Loc   ;
2:[4                   ]      Comparison Code Option (<)    ;
3:[0                   ]      F       ;
4:[30                  ]      Command Code Option (Then Do) ;

P30     Z=F     ;
1:[-99.99              ]      F       ;
2:[0                   ]      Exponent of 10 ;
3:[ReadingLoc          ]      Z Loc   ;

P94     Else    ;

;Calculate Result for < v7 FW
P89     If (X<=>F)     ;
1:[ScratchLoc10        ]      X Loc   ;
2:[4                   ]      Comparison Code Option (<)    ;
3:[8                   ]      F       ;
4:[30                  ]      Command Code Option (Then Do) ;

P30     Z=F     ;
1:[1023                ]      F       ;
2:[0                   ]      Exponent of 10 ;
3:[ScratchLoc3         ]      Z Loc   ;

P38     Z=X/Y   ;
1:[ScratchLoc1         ]      X Loc   ;
2:[ScratchLoc3         ]      Y Loc   ;
3:[ScratchLoc4         ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc4         ]      X Loc   ;
2:[4.700               ]      F       ;
3:[ScratchLoc4         ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc4         ]      X Loc   ;
2:[0.001               ]      F       ;
3:[ScratchLoc5         ]      Z Loc   ;

P38     Z=X/Y   ;
1:[ScratchLoc2         ]      X Loc   ;
2:[ScratchLoc3         ]      Y Loc   ;
3:[ScratchLoc6         ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc6         ]      X Loc   ;
2:[4.700               ]      F       ;
3:[ScratchLoc6         ]      Z Loc   ;

P35     Z=X-Y   ;
1:[ScratchLoc6         ]      X Loc   ;
2:[ScratchLoc4         ]      Y Loc   ;
3:[ScratchLoc7         ]      Z Loc   ;

P38     Z=X/Y   ;
1:[ScratchLoc7         ]      X Loc   ;
2:[ScratchLoc5         ]      Y Loc   ;
3:[ScratchLoc7         ]      Z Loc   ;

;Else calculate result for > v8 FW
P94     Else    ;
```

```
;Multiple MSW
P37     Z=X*F   ;
1:[ScratchLoc1          ]      X Loc   ;
2:[65536                ]      F       ;
3:[ScratchLoc1          ]      Z Loc   ;

;Add our LSW
P33     Z=X+Y   ;
1:[ScratchLoc1          ]      X Loc   ;
2:[ScratchLoc2          ]      Y Loc   ;
3:[ScratchLoc3          ]      Z Loc   ;

;Divide for our averaging
P37     Z=X*F   ;
1:[ScratchLoc3          ]      X Loc   ;
2:[0.01                 ]      F       ;
3:[ScratchLoc3          ]      Z Loc   ;

P30     Z=F     ;
1:[1023                 ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[ScratchLoc4          ]      Z Loc   ;

P38     Z=X/Y   ;
1:[ScratchLoc3          ]      X Loc   ;
2:[ScratchLoc4          ]      Y Loc   ;
3:[ScratchLoc4          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc4          ]      X Loc   ;
2:[2.5                  ]      F       ;
3:[ScratchLoc4          ]      Z Loc   ;

P30     Z=F     ;
1:[6040                 ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[ScratchLoc5          ]      Z Loc   ;

P38     Z=X/Y   ;
1:[ScratchLoc4          ]      X Loc   ;
2:[ScratchLoc5          ]      Y Loc   ;
3:[ScratchLoc5          ]      Z Loc   ;

P37     Z=X*F   ;
1:[ScratchLoc5          ]      X Loc   ;
2:[499                  ]      F       ;
3:[ScratchLoc6          ]      Z Loc   ;

P30     Z=F     ;
1:[2.5                  ]      F       ;
2:[0                    ]      Exponent of 10 ;
3:[ScratchLoc7          ]      Z Loc   ;

P35     Z=X-Y   ;
1:[ScratchLoc7          ]      X Loc   ;
2:[ScratchLoc4          ]      Y Loc   ;
3:[ScratchLoc7          ]      Z Loc   ;

P35     Z=X-Y   ;
1:[ScratchLoc7          ]      X Loc   ;
2:[ScratchLoc6          ]      Y Loc   ;
3:[ScratchLoc7          ]      Z Loc   ;

P38     Z=X/Y   ;
1:[ScratchLoc7          ]      X Loc   ;
2:[ScratchLoc5          ]      Y Loc   ;
3:[ScratchLoc7          ]      Z Loc   ;

P95     End     ;

;Resistance should be in ScratchLoc7
P40     Z=LN(X) ;
1:[ScratchLoc7          ]      X Loc   ;
2:[ScratchLoc8          ]      Z Loc   ;
```

```
P30     Z=F     ;
1:[2.369               ]      F       ;
2:[4--                 ]      Exponent of 10 ;
3:[ScratchLoc9         ]      Z Loc   ;

P36     Z=X*Y   ;
1:[ScratchLoc8         ]      X Loc   ;
2:[ScratchLoc9         ]      Y Loc   ;
3:[ScratchLoc8         ]      Z Loc   ;

P40     Z=LN(X) ;
1:[ScratchLoc7         ]      X Loc   ;
2:[ScratchLoc9         ]      Z Loc   ;

P36     Z=X*Y   ;
1:[ScratchLoc9         ]      X Loc   ;
2:[ScratchLoc9         ]      Y Loc   ;
3:[ScratchLoc10        ]      Z Loc   ;

P36     Z=X*Y   ;
1:[ScratchLoc9         ]      X Loc   ;
2:[ScratchLoc10        ]      Y Loc   ;
3:[ScratchLoc9         ]      Z Loc   ;

P30     Z=F     ;
1:[1.019               ]      F       ;
2:[7--                 ]      Exponent of 10 ;
3:[ScratchLoc10        ]      Z Loc   ;

P36     Z=X*Y   ;
1:[ScratchLoc9         ]      X Loc   ;
2:[ScratchLoc10        ]      Y Loc   ;
3:[ScratchLoc9         ]      Z Loc   ;

P30     Z=F     ;
1:[1.4051              ]      F       ;
2:[3--                 ]      Exponent of 10 ;
3:[ScratchLoc10        ]      Z Loc   ;

P33     Z=X+Y   ;
1:[ScratchLoc9         ]      X Loc   ;
2:[ScratchLoc10        ]      Y Loc   ;
3:[ScratchLoc10        ]      Z Loc   ;

P33     Z=X+Y   ;
1:[ScratchLoc8         ]      X Loc   ;
2:[ScratchLoc10        ]      Y Loc   ;
3:[ScratchLoc10        ]      Z Loc   ;

P42     Z=1/X   ;
1:[ScratchLoc10        ]      X Loc   ;
2:[ScratchLoc10        ]      Z Loc   ;

P34     Z=X+F   ;
1:[ScratchLoc10        ]      X Loc   ;
2:[273.2--             ]      F       ;
3:[ReadingLoc          ]      Z Loc   ;

P95     End     ;

;No S command received - no VWDSP connected?
P94     Else    ;

P31     Z=X     ;
1:[ScratchLoc10        ]      X Loc   ;
2:[ReadingLoc          ]      Z Loc   ;

P95     End     ;
```

2.7 CR1000 Programming Examples

If you are writing your own Campbell program instead of using MultiLogger the following code example, extracted from MultiLogger, serves to illustrate how to utilize the VWDSP. Output is in digits.

Some of the nomenclature that follows in this program example is unique to the MultiLogger construct of programming files. You will need to DIM ScratchLoc(10) as well as define a string buffer, sInBuf, to store the response string from the VWDSP.

```
'Turn on VWDSP Power
PortSet (7,1)
'Wait for power up
Delay(0,100,MSEC)
'Open our serial port
SerialOpen (8,1200,0,1000,255)

'Check that the VWDSP is present by sending S command
Delay (0,10,mSec)
ScratchLoc(1) = SerialOut (8,"S"+CHR(13),"*",2,50)

'Check for valid response
if ScratchLoc(1) <> 0 then

        'Short delay
        Delay (0,100,mSec)
        'Send P command
        SerialOut (8,"P0400 3500 0600 0040 0300"+CHR(13),"",0,0)
        'Short delay
        Delay (0,350,mSec)
        'Make sure buffer is clear
        SerialFlush(8)
        'Send VA command
        SerialOut (8,"VA"+CHR(13),"",0,0)
        'Receive response
        SerialIn(sInBuf,8,1500,-1,30)

        if Len(sInBuf) >= 30 then
                'Split out response values
                Splitstr(ScratchLoc(),sInBuf," ",4,0)

                'Convert to reading
                ScratchLoc(5) = 1/((((ScratchLoc(3)*65536)+ScratchLoc(4))/ScratchLoc(2))*0.1356)
                ScratchLoc(5) = (ScratchLoc(5) * 1000000)^2
                ScratchLoc(5) = ScratchLoc(5) * 0.001 'Convert to Digits otherwise f^2x10-9
                Reading_Loc = ScratchLoc(5)  * 0.001

                'Calculate quality
                mlUser1 = (ScratchLoc(2) / ScratchLoc(1)) * 100

                'Error - poor quality
                if mlUser1 < 50 then Reading_Loc = -99.998

                'Error - not enough data
                if ScratchLoc(2) < 50 then Reading_Loc = -99.997

        'No valid response
        Else
                Reading_Loc = -99.999
        EndIf

'No valid response
Else
        Reading_Loc = -99.999
EndIf
'Turn off VWDSP Power
PortSet (7,0)
'Close our serial port
SerialClose (8)
```

CR1000 Temperature

The following code example illustrates how to program a CR1000 to read a YSI44005 type thermistor connected to the input channel A of the VWDSP. The firmware revision is checked for temperature conversion method.

```
'Read a YSI44005 thermistor with the VWDSP Channel A - output C

'Turn on VWDSP Power
PortSet (7,1)
'Wait for power up
Delay(0,100,MSEC)
'Open our serial port
SerialOpen (8,1200,0,1000,255)
'Short delay before commands
Delay (0,50,mSec)

'Check our VWDSP version to determine results processing
SerialFlush(8)
SerialOut(8,"S"+CHR(13),"",0,0)
SerialIn(sInBuf,8,50,"*",12)
SplitStr(ScratchLoc(10),sInBuf," ",2,0)

'Make sure we have version before proceeding
if ScratchLoc(10) > 0 then

        SerialFlush(8)
        SerialOut (8,"TA"+CHR(13),"",0,0)
        SerialIn(sInBuf,8,100,-1,18)

        if Len(sInBuf) > 16 then

                SplitStr(ScratchLoc(),sInBuf," ",2,0)

                'Check FW to determine how to convert results
                if ScratchLoc(10) < 8 then
                        'Convert to resistance
                        ScratchLoc(4) = (ScratchLoc(1) / 1023) * 4.775
                        ScratchLoc(5) = ScratchLoc(4) * 0.001
                        ScratchLoc(6) = (ScratchLoc(2) / 1023) * 4.775
                        ScratchLoc(7) = (ScratchLoc(6) - ScratchLoc(4))/ScratchLoc(5)
                        else
                        ScratchLoc(3) = ((ScratchLoc(1) * 65536) + ScratchLoc(2)) / 100

                        ScratchLoc(4) = ((ScratchLoc(3)/1023)*2.5)
                        ScratchLoc(5) = ScratchLoc(4) / 6040
                        ScratchLoc(6) = ScratchLoc(5) * 499
                        ScratchLoc(7) = (2.5 - ScratchLoc(4) - ScratchLoc(6)) / ScratchLoc(5)
                        endif

                'Use Steinhart/Hart to convert resistance to temperature
                mlReading = 1/(.0014051+(.0002369*Log(ScratchLoc(7))) +
(.0000001019*(Log(ScratchLoc(7))^3))) - 273.2

                'Check range before finishing
                if mlReading > 100 then mlReading = -99.8

                else
                mlReading = -99.9
                endif

        else
        mlReading = -99999
        endif

'Turn off VWDSP Power
PortSet (7,0)
'Close our serial port
SerialClose (8)
```

3.1 Troubleshooting Flowchart

If you cannot obtain readings using the VWDSP or the readings are unstable then see the troubleshooting flowchart below for help in determining the nature of the problem. If all fails contact Canary Systems by phone, fax or e-mail for further assistance.