ZooCADA - Log ™

Enclosure Climate Monitoring System

Version R01

Reference Manual

Breeding Labs
Treatment Rooms
Lab
Climate Control
Lighting Control
Monitoring

Exhibit Enclosures
Life
Climate Control
Lighting Control
Monitoring

Zoological Parks
ZooCADA
Control And
Data Acquisition
Network

Exhibit Enclosures
HVAC
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Food Storage Rooms
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Contents

Contents

Contents

Contents

System Overview

The ZooCADA-Log Enclosure Climate Monitoring System is a software program and hardware system designed to monitor the climate in wild animal enclosures at zoological facilities. The general design concept is to eliminate any need for staff to use manual instruments to collect climate data to monitor the enclosure environment; instead ZooCADA-Log does it automatically, allowing staff to focus on more productive activities.

Each ZooCADA-Log system comprises of a datalogger, it's peripherals and sensors, and is designed to monitor up to two enclosures. On the network, each datalogger is referred to as a station. The system is designed to monitor the enclosure temperature, relative humidity, soil moisture content, and soil temperature.

ZooCADA-Log continuously monitors the sensor measurements. The enclosure and, optionally the external, temperature and relative humidity measurements are logged every ten minutes. Soil moisture, averaged over the top 300mm of soil depth, and soil surface temperature are recorded hourly. Daily summaries containing the minimum, maximum, and average measurements of temperature, relative humidity, soil moisture and soil temperature are also recorded. This data can be used by staff to assist with research and animal welfare management. The electricity used by the exhibit is also recorded as this data can assist staff with energy management.

A table of high and low temperature setpoints for each month of the year, determined by the keepers based on the specific needs of the animal species housed in the enclosure, is entered into the ZooCADA-Log program. The setpoints define the acceptable temperature range within which the enclosure should operate. If the enclosure temperature becomes outside of the setpoint range by a preset number of degrees an alarm is triggered.

ZooCADA-Log provides automated alarms, via email messages, to alert staff of problems that require urgent attention. Alarms are provided for enclosure temperature too high or too low, electric power failures, sensor failures, and network communications failures. The alarm email messages are designed to be conspicuous in busy email inboxes, and self explanatory to the recipients. Each message states the current alarm, or list of current alarms if multiple alarms are active, and gives the current temperature of each enclosure so staff can make informed decisions in respect of how quickly they need to attend to the problem(s). The system also sends a reminder email message each morning to remind staff of any outstanding alarms that have not yet been cleared.

As with all of our datalogger based systems, staff can connect to the datalogger across the local area network to view the current conditions at each station and all of the operating parameters active in the datalogger. If the site's local area network is set up to allow remote access, dataloggers can also be configured to allow remote monitoring and support with password controlled access that can be unique to each datalogger in a zoo-wide system.

ZooCADA-Log Reference Manual

Program Features

Data Logging

- Enclosure and external temperature and RH values logged every 10 minutes.
- Enclosure and external max, min and average temperature and RH values logged daily.
- Enclosure soil moisture content and soil temperature logged every hour. (Optional)
- Enclosure min, max and average soil moisture content and soil temperature logged daily. (Optional)
- Barometric pressure sensor with hourly logging. (Optional)
- Electricity use in kWh logged as hourly and daily totals. (Optional)
- Event log of last 1000 alarm and system control events.
- Datalogging memory in excess of 1 year between downloads before memory overwrite.
- Data logged to ring memory so oldest data is overwritten first when memory full.
- Data files downloadable to Windows based PC using Campbell Scientific LoggerNet software.
- Data graphing from Windows based PC using Campbell Scientific LoggerNet software.

Alarms

- Power failure. (The electricity supply to the enclosure has failed)
- Communications failure. (The station can't obtain data from another station)
- External Sensor Failure. (For stations with external air temperature and RH sensors)
- Enclosure temperature too high.
- Enclosure temperature too low.
- Enclosure sensor failure.

General

- Battery backup of datalogger 12V power so system keeps logging data during power failure.
- Alarms sent via email to staff if power fails, or if communications to a remote station fails.
- Communications to stations via LAN enables staff to monitor system operation.
- Communications to stations via LAN enables automated or manual collection of logged data.
- System maintenance from Windows based PC using Campbell Scientific LoggerNet software.

ZooCADA-Log is a station of our modular control and data acquisition system. Each station can operate standalone or as an integral part of a fully networked, zoo-wide, system with various stations performing different tasks. Using our modular approach, up to 4000 stations, distributed over any geographic area, can be networked provided that network connectivity (typically the site's IP computer network) is available at each station.

Adena Scientific believes that accuracy and reliability are paramount requirements of any system used in animal welfare roles so we purpose designed our ZooCADA system to meet zoological needs and built it to run on dataloggers manufactured by Campbell Scientific in the USA and available worldwide.

Uninterruptible Power Supply

An uninterruptible power supply (UPS) ensures the datalogger continues to record data and transmit alarms during power failure events. The UPS is a DC-DC type, with an integral lithium-ion rechargeable battery. Its input is 12 Vdc, which comes from a mains powered power supply, and its output is 12 Vdc, which is used to power the datalogger and control system.

When the UPS input is receiving 12 Vdc from the mains power supply, the 12 Vdc is routed through the UPS to the UPS output to power the datalogger and control system. Up to approximately 0.6 Amp is simultaneously supplied to the battery charging circuit to keep the internal battery charged. If the input 12 Vdc power to the UPS is interrupted, the UPS battery automatically takes over supplying 12 Vdc to the UPS output to power the datalogger and its peripherals, and continues to do so until either the 12 Vdc input power is restored or the battery becomes fully discharged.

UPS Power Switch and LED Indicators

The UPS is fitted with an On/Off switch and four LED indicators as shown in the diagram below.
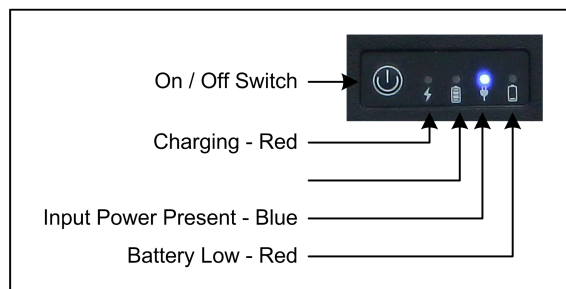
On / Off Switch

The On/Off switch only operates when there is no input power available to the UPS. As long as the UPS battery is charged and input power is available, the UPS output will automatically switch ON to provide output power.

When input power is not available the On/Off switch can be used to shutdown the UPS. One press switches ON the UPS and two presses switches OFF the UPS. This function is provided to allow the system to be powered down for maintenance without discharging the UPS battery.

Charging Indicator

The charging indicator is a Red LED next to the lightning bolt symbol.

The indicator is lit while the battery being charged.

The indicator is off when the battery is fully charged.

Battery Power Only Indicator

The battery power only indicator is a Blue LED next to the battery symbol.

The indicator is lit while the UPS output power is being supplied only from the battery.

The indicator is off when input power is available.

Input Power Present Indicator

The input power present indicator is a Blue LED next to the power plug symbol.

The indicator is lit while the UPS output power is being supplied from the input power.

The indicator is off when input power is not available.

Battery Low Indicator

The battery low indicator is a Red LED next to the low battery symbol.

The indicator is lit when the UPS battery is almost flat.

The indicator is off when the battery is charged.

UPS Run Time

The length of time the UPS will operate to power the datalogger depends on several variables including the number of sensors that are connected, the amount of data communications activity, the age and condition of the battery, and how charged the battery is when the UPS starts operating.

Testing with a new and fully charged UPS has shown that the UPS can power the datalogger, and several sensors for about 20-24 hours.

Storing the UPS

To shutdown the UPS for an extended period of time, such as when being placed into storage, first disconnect the input power so the UPS begins operating from its internal battery power, then immediately press the On/Off switch two times to switch the UPS OFF. All the LEDs will switch OFF. The UPS can now be safely stored.

When stored, the UPS battery will self-discharge at a rate that is greatly affected by the ambient temperature. The UPS should therefore be fully charged before being placed into storage and, if it is to be kept stored for an

extended period of time, the UPS should be periodically recharged to prevent the battery deteriorating and loosing its original capacity.

As a guide the UPS should not be stored for longer than the periods of time below without being recharged...

6 months at 20° C

3 months at 30° C

2 months at 35° C

UPS Specifications

Input: 12 Vdc, 3 Amps

Output: 12 Vdc, 2.5 Amps (Rated), 3 Amps (Max)

Input Connector: 2.1 mm DC Socket

Output Connector: 2.5 mm DC Plug

Over Current Protection: 3.5 Amps +/- 0.5 Amp

Battery Capacity: 7.4 V, 4000 mAh (29.6 Wh)

Alternative Sealed Lead Acid Battery UPS

The CR310 datalogger has a built-in charging system for Sealed Lead Acid batteries. A mains power supply with 24 Vdc output is connected to the CHG terminals on the datalogger and a 1.3 AH Sealed Lead Acid battery is connected to the BAT terminals. The datalogger draws it's power from the battery and, while mains power is available, the datalogger's charging system maintains the battery in a fully charged state. During a power failure the datalogger continues to draw its power from the battery until the battery becomes fully discharged.

WARNING: A fuse must always be installed, as close to the battery as possible, in the positive wire that runs from the datalogger to the battery to prevent risk of fire if a short circuit occurs. Do not bypass a blown fuse. Always replace fuses with the correct type.

The Sealed Lead Acid battery option offers a cost advantage over the lithium iron battery DC-DC UPS system but a Sealed Lead Acid battery is likely to need more frequent replacement, typically about once every three years. Lithium iron batteries can be discharged to about 85% of their capacity, whereas Sealed Lead Acid batteries can only be discharged to about 50% of their capacity, without causing damage to the battery. This may become a consideration in areas where mains power failures tend to be of a long duration, but in areas where mains power failures seldom extend over a prolonged period of time, Sealed Lead Acid batteries will provide a perfectly good UPS solution.

Datalogger CR310

This chapter is intended for maintenance and support purposes. There are no controls or adjustments on the datalogger, it's simply wired into the station and runs the software that is loaded into it.

The CR310 datalogger is the programmable heart of a ZooCADA-Log station. It has a range of inputs and outputs that send and receive sensor data and other control signals, and provides network connectivity so users can interrogate the control system from a computer via the network. It also records the measurements obtained from the sensors and retains that data in memory from where it can be downloaded to a computer at a later date.

The datalogger can be powered down, if necessary, by withdrawing the combined battery and charger connector. Always download the data from the datalogger before powering it down. The datalogger has an internal battery to maintain it's memory if power is removed but, if that battery has become weak due to age, data loss may occur.

Computer and Network Connections

The 10/100 Ethernet connector is used to connect the datalogger to the local area network (LAN) so it can be accessed via other computers, either using the Campbell LoggerNet software or by using a web browser, and is able to transmit alarm email messages to recipients via the Internet.

Please refer to the section "Setting up Communications with the Datalogger" in the CR310 Product Manual, which can be downloaded from the Campbell Scientific web site, for full information on set up procedures.

After being connected to a LAN for about one minute, the LEDs on the connector will indicate the status of the network connection as follows...

> Orange LED - Off for no link, Solid for valid Ethernet link, Flashing for Ethernet activity.

> Green LED - Off for 10 Mbps link, Solid for 100 Mbps link.

The datalogger can obtain a dynamic IP address from the DHCP server on the LAN, but we strongly recommend that it be configured with a static IP address. When multiple stations are installed on a site, a static address makes it easier to set up stations to communicate with one another across the LAN and simplifies routing to the Internet for off-site access. These network settings are configured using the "Device Configuration Utility" in the LoggerNet software.

The USB connector allows direct connection, using a ordinary USB cable, to any Windows computer that has the Campbell LoggerNet software installed on it. This is used when carrying out the initial configuration of the datalogger, and for maintenance or data collection as an alternative to a LAN connection when desired.

Inputs and Outputs

Users need not be concerned with the datalogger inputs and outputs for the usual operation of the system. This information is provided to assist with diagnostic tests in case it is needed.

Analog Inputs

The datalogger has six single ended (SE) analog inputs, labelled 1 to 6 with blue numbers on the datalogger panel. The voltages measured on single ended inputs are measured with respect to datalogger ground. The datalogger measures the analog inputs once each time the program scans, which is every two seconds.

SE1 - Power Good Indication.

When the mains power is available and the power supply is producing 12 Vdc, this input will be steady at approximately 2000 mVdc. During a power failure it will return to 0 Vdc. The power failure alarm is triggered if this voltage falls below 1000 mVdc.

SE2 - Not Used.

SE3 - Not Used.

SE4 - Not Used.

SE5 - Not Used.

SE6 - Not Used.

Pulse Inputs

The datalogger has two pulse counter inputs labelled P_SW and P_LL.

P_SW - Kwh Meter Input.

The pulse input P_SW operates on pull-to-ground switch closure. The kWh meter produces one pulse for every 0.01 kWh of electricity that's consumed. These pulses are counted by the datalogger P_SW pulse input. Each time the datalogger program scans, the P_SW counter is read and reset. The datalogger program then accumulates the pulse count in kWh and logs an hourly total each hour and a daily total each day.

P_LL - Not Used.

The pulse input P_LL accepts low voltage (20 V max) AC signal.

This port is not currently used.

Excitation Outputs

The datalogger has two excitation outputs, labelled VX1 and VX2 on the datalogger panel. These excitation outputs are designed to be used to provide excitation voltage for various analog sensors that are typically used on the datalogger's analog measurement inputs.

VX1 - Provides 2400 mV pulse for optional scan indicator LED.

VX2 - Not Used.

Control Ports

The datalogger has two control ports labelled C1 and C2 on the datalogger panel. These are programmable ports that can be software configured for use as logic inputs, logic outputs, pulse counters, and data ports.

C1 - SDI-12 Sensor Data Bus.

> SDI-12 is an asynchronous serial data communications protocol designed for intelligent environmental monitoring sensors. It is possible to use up to sixty two SDI-12 sensors on a single SDI-12 bus using the addresses 0-9, A-Z, and a-z but using this many sensors on a single bus is not recommended. Each sensor must be set to its own unique address.
>
> **NOTE:** New sensors are set to a default address of "0" and, unless that is the required address, must be changed to the required address before use.
>
> The SDI-12 bus on control port C1 is used for the sensors that are permanently fixed in position for the enclosure air temperature and relative humidity and, if installed, the external (outside) air temperature and relative humidity. The address allocations normally used by the ZooCADA system are:
>
> Address 0 - Outside air temperature and relative humidity, or all-in-one weather sensor.
>
> Address 1 - Enclosure 1 air temperature and relative humidity sensor.
>
> Address 2 - Enclosure 2 air temperature and relative humidity sensor.
>
> Address 3 - Barometric pressure sensor. (Optional)
>
> Address a - Enclosure 1 soil moisture sensor. (Optional)
>
> Address b - Enclosure 2 soil moisture sensor. (Optional)

C2 - This port is not currently in use.

RS232 Port

The datalogger includes an 9-pin D-sub connector labelled RS-232. This is a standard RS-232 interface for communications between Campbell Scientific dataloggers and various external devices. This port is not currently used.

Data Storage Memory

Measurement data is normally stored in data tables within SRAM (Static Random Access Memory). During data table initialisation, memory is allocated to each data table according to parameters defined in the program.

An internal lithium battery retains the SRAM memory when primary power is removed.

> **WARNING:** Always download data from the datalogger before making any program changes. Depending upon settings, data may be erased from this memory area when a program is sent to the datalogger.

To preserve the existing data when sending a program update to the datalogger that does not affect the data tables, such as when changing temperature setpoints, simply select the Preserve data if no table changed radio button in the dialog box before clicking the [Send] button .

The data memory is organised as ring memory so that when the memory is full, oldest data is overwritten by newest data. To see the total number of records that can be stored in memory before data overwriting begins, or to reset the data tables, select Station Status > Table Fill Times from the Connect Screen in the LoggerNet software. The datalogger program sets the memory so that an equal number of days will be stored in the various data tables.

A CR310 datalogger can store several months of data before memory overwrite occurs. To prevent risk of data loss due to overwriting of the ring memory, or any other cause, download the data manually on a regular basis or set up LoggerNet to download it automatically on a regular time schedule.

Power Circuits

Users need not be concerned with the datalogger power circuits for the usual operation of the system. This information is provided to assist with diagnostic tests in case it is needed.

Datalogger 12 Vdc Power Input

The datalogger is powered by 12 Vdc, from the UPS, which is applied via the battery and charger connector which is the main power to the system. Unplugging this connector will power down the datalogger and its sensors. The battery/charger connector provides pins for + and - 12 Vdc . In this system all +12 Vdc power circuits into and out of the datalogger are RED wires.

Datalogger 12 Vdc Switched Power Output

The datalogger switched power output SW12V terminal is not used in this system.

Power Ground

The terminals on the datalogger panel marked G are the power ground terminals. Each device that is connected to the +12 Vdc power terminal must have its ground (-ve or common) wire connected to one of the G terminals. In this system all power ground circuits are BLACK wires.

Analog Ground

The terminals on the datalogger panel marked $\rightleftharpoons$ are analog ground for single ended analog inputs, excitation returns, and a ground for sensor shield wires. Do not connect power ground wires to the analog ground.

Station Setpoints File

```
'*****************************************************************************************
'* ZooCADA-Log Enclosure Climate Monitoring System                                      *
'* Station Setpoints File For:                                                           *
'* Copyright 2015-2023 Adena Scientific Limited                                          *
'* Datalogger: Campbell Scientific CR300 Series                                          *
'* File name: STATION_SETPOINTS_ZLOG_R01.CR300                                           *
'* Revision Date: 2024-12-07                                                             *
'*****************************************************************************************


'Enclosure Temperature Setpoints.
'WARNING: Must be at least 4 degrees C difference between HI and LO setpoints.
'Setpoints are only used for temperature alarms in ZooLog.
'

ConstTable(Setpoints)                           'Beginning of editable constants table
    '
    'Enclosure Monthly Temperature Setpoints.
    Const SET_JAN_HI = 18.5                     'January Day Hi Temperature deg C
    Const SET_JAN_LO = 13.5                     'January Night Lo Temperature deg C
    '
    Const SET_FEB_HI = 19.0                     'February Day Hi Temperature deg C
    Const SET_FEB_LO = 14.0                     'February Night Lo Temperature deg C
    '
    Const SET_MAR_HI = 18.0                     'March Day Hi Temperature deg C
    Const SET_MAR_LO = 13.0                     'March Night Lo Temperature deg C
    '
    Const SET_APR_HI = 17.0                     'April Day Hi Temperature deg C
    Const SET_APR_LO = 12.0                     'April Night Lo Temperature deg C
    '
    Const SET_MAY_HI = 16.0                     'May Day Hi Temperature deg C
    Const SET_MAY_LO = 11.0                     'May Night Lo Temperature deg C
    '
    Const SET_JUN_HI = 15.0                     'June Day Hi Temperature deg C
    Const SET_JUN_LO = 10.0                     'June Night Lo Temperature deg C
    '
    Const SET_JUL_HI = 15.0                     'July Day Hi Temperature deg C
    Const SET_JUL_LO = 10.0                     'July Night Lo Temperature deg C
    '
    Const SET_AUG_HI = 15.0                     'August Day Hi Temperature deg C
    Const SET_AUG_LO = 10.0                     'August Night Lo Temperature deg C
    '
    Const SET_SEP_HI = 15.5                     'September Day Hi Temperature deg C
    Const SET_SEP_LO = 10.5                     'September Night Lo Temperature deg C
    '
    Const SET_OCT_HI = 16.0                     'October Day Hi Temperature deg C
    Const SET_OCT_LO = 11.0                     'October Night Lo Temperature deg C
    '
    Const SET_NOV_HI = 17.0                     'November Day Hi Temperature deg C
    Const SET_NOV_LO = 12.0                     'November Night Lo Temperature deg C
    '
    Const SET_DEC_HI = 18.0                     'December Day Hi Temperature deg C
    Const SET_DEC_LO = 13.0                     'December Night Lo Temperature deg C
    '
EndConstTable                                   'End of editable constants table

'*****************************************************************************************
'*                                  END OF INCLUDE FILE                                  *
'*****************************************************************************************
```

The station setpoints are constants that determine the upper and lower air temperatures that define the temperature range within which the enclosure is required to operate. When the enclosure temperature moves outside of the setpoints range a temperature alarm is triggered. There is a separate pair of setpoints for each month of the year to enable the system to be set to accommodate seasonal variation across the year.

The station setpoints constants are programmed into a structure called a constants table which can be edited using the CRBasic Editor, or by using the datalogger's built-in web site while logged in with administrator level privileges, the later being the easier and recommended method. The setpoints table is stored in a separate program file named STATION_SETPOINTS_ZLOG_R01, hereinafter simply referred to as the STATION_SETPOINTS file, so they are not overwritten whenever an updated program is uploaded to the datalogger.

To change the station setpoints constants by editing the STATION_SETPOINTS file it is necessary to use the CRBasic editor, then load the updated file into the datalogger. To do so, users need to have access to the program code on a Windows computer that has the Campbell Scientific LoggerNet program suite installed on it.

For full information on using the LoggerNet software please refer to the LoggerNet Manual which is downloadable from the Campbell Scientific web site.

> **IMPORTANT:** When editing setpoints ensure that only the numeric value is changed. Do not change anything else, especially the constant name or the = sign otherwise compile errors will be the likely result.

To change the setpoint constants using the datalogger's built-in web site, first login to the web site as an administrator, then select the Setpoints data table from the list of available tables. Edit the desired value(s) by double clicking on the current value, typing in the new value, and pressing the [Enter] key.

Once the change(s) are complete move down to the ApplyAndRestart value, the last value in the table, and change it from false to true then press the [Enter] key. This will cause the datalogger to restart and put the newly entered values into effect.

If the STATION_SETPOINTS file is edited using the CRBasic editor, it is essential to manually stop the program running and then restart it so the datalogger will recompile the program and make the new setpoints operational.

Do not change the name of the STATION_SETPOINTS file. The datalogger expects this file to be present and cannot run the program without it.

Enclosure Temperature Setpoints

The upper and lower temperature setpoints, in degrees Celsius, for the enclosure for each month.

    Const SET_JAN_HI = 18.5

    Const SET_JAN_LO = 13.5

The constant pair for each month is identified with three characters JAN, FEB, MAR, and so on, representing the calendar month that the setpoints correspond to.

These temperatures are the highest and lowest temperatures that are desired inside the enclosure. There MUST be a minimum of four degrees Celsius between the high and low value in each pair. If a setpoints error is detected an error is displayed in the Public data table Month variable.

The enclosure temperature setpoints must be set within the range between 30 degrees Celsius and 2 degrees Celsius and the low temperature setpoints must be at least 4 degrees lower than the high setpoints.

Station Setpoints File

Temperature Setpoints Manual Override

Keepers can temporarily override the temperature setpoints whenever they need to.

IMPORTANT: Temporary setpoints overrides are automatically removed if the datalogger is restarted.

The temperature setpoints Set_E00AirTC_HI and Set_E00AirTC_LO normally get their values from the Setpoints data table for each month of the year based on the dataloggers realtime clock/calendar, but sometimes keepers will need to set different setpoints on a temporary basis.

At the bottom of the Public data table there are two variables ManualTC_HI and ManualTC_LO which can be used to override the automatic monthly setpoints.

Normally ManualTC_HI and ManualTC_LO are both set to zero, the default, which allows the automatic monthly setpoints to be active.   When one or both of these is set to a non-zero value the manual override becomes active. If the manual setpoint ManualTC_HI is non-zero its value replaces Set_E00AirTC_HI and if ManualTC_LO is non-zero its value replaces Set_E00AirTC_LO.   The Month variable changes to display MANUAL OVERRIDE and the variables Set_E00AirTC_HI and Set_E00AirTC_LO display the values that have been made active by the override.

If only one of the manual override setpoints is set to a non-zero value, the other setpoint continues operating with the existing monthly setpoint value.   For example if Set_E00AirTC_HI is set to 17 degrees and Set_E00AirTC_LO is set to 10 degrees, and then ManualTC_HI is set to 19 degrees, the result will be Set_E00AirTC_HI will change to 19 degrees while Set_E00AirTC_LO will remain set to 10 degrees.

To set a manual setpoint, logon to the datalogger web interface and select the Public data table. Scroll down to the two manual setpoints at the bottom of the variables list. Use the mouse to select the variable that is to be edited by clicking on the value beside the variable name. This will highlight the entire variable. Click on the variable again. This will highlight just the digits in the variable. Edit the digits to the desired new value then press the [Enter] key. The newly edited values are effective immediately and the Month variable will display MANUAL OVERRIDE if the setpoint(s) are now overridden or the correct month of the year if the manual setpoints were set back to zero to remove the override.

If incorrect manual setpoints are entered the Month variable will display SETPOINTS ERROR and the datalogger program defaults to operating over the range between 30 degrees Celsius and 2 degrees Celsius. Defaulting to these constants ensures that the alarm system continues to function relatively normally, albeit with a wider temperature range, if the system is left with erroneous setpoints entered.

To avoid an error, ensure the manual setpoints meet the following criteria:

The ManualTC_HI setpoint must be lower than the SET_TOO_HOT station constant, and it must be at least four degrees higher than the displayed Set_E00AirTC_LO value.

The ManualTC_LO setpoint must be higher than the SET_TOO_COLD station constant, and it must be at least 4 degrees lower than the displayed Set_E00AirTC_HI value.

NOTE: An error condition may occur while editing both manual setpoints, but is usually avoidable by making the edits in whatever order is necessary to maintain compliance with the above criteria as each manual setpoint is entered. If an error does occur, continue editing to complete the editing process making sure the final values entered meet the above criteria.

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Station Constants File

```
'*********************************************************************************
'* ZooCADA-Log Enclosure Climate Monitoring System                              *
'* Station Constants File For:                                                  *
'* Copyright 2015-2023 Adena Scientific Limited                                 *
'* Datalogger: Campbell Scientific CR300 Series                                 *
'* File name: STATION_CONSTANTS_ZLOG_R01.CR300                                  *
'* Revision Date: 2025-02-13                                                    *
'*********************************************************************************


'Declare General Station Constants.
Const ENCLOSURE As String = "NEW STATION"        'Enclosure name
Const CUSTOM_FILE = False                          'Customisation file enabled (True/False)
Const DUAL_ENCL = True                           'Dual enclosures (True/False)
Const KWH_INSTALLED = False                      'Electricity meter installed (True/False)


'Declare Alarms Module Constants.
Const ALARM_ENABLE = True                        'Alarm enable (True/False)
Const ALARM_DEGREES = 1.5                        'Alarm temperature triger over setpoint
Const ALARM_RESET = 1.5                          'Alarm temperature reset under setpoint


'Declare Email Module Constants.
Const EMAIL_ENABLE = True                        'Enable sending of alarm email messages (True/False)
Const EMAIL_TEST = True                          'Divert alarm email messages to test file (True/False)
Const EMAIL_RESEND = 300                         'Resend time for alarm emails time in seconds (min 10 seconds)
Const EMAIL_TRIES = 3                            'Number of times to resend new alarm states (Typically 3)
Const EMAIL_NAG = True                           'Resend email outstanding alarms daily at NAG_HOUR True, False
Const EMAIL_NAG_HOUR = 8                         'Hour of the day to resend outstanding alarms.
Const EMAIL_ATTACH = ""                          'Email attachment file name (if desired)


'Declare Email Module Email Recipient Email Addresses.
'(Separate multiple addresses with commas).
Const TO_ADDR = "my.name@mycompany.co.nz, manager@mycompany.co.nz"


'Declare Comms Module Station Address Constants.
Const EXT_TRH1_ENABLE = False                    'Ext T/RH primary remote station enable (True/False)
Const EXT_TRH1_PK = 91                           'Ext T/RH primary remote station pakbus address
Const EXT_TRH1_IP As String = "192.168.10.91"    'Ext T/RH primary remote station IP address
Const EXT_TRH2_ENABLE = False                    'Ext T/RH secondary remote station enable (True/False)
Const EXT_TRH2_PK = 92                           'Ext T/RH secondary remote station pakbus address
Const EXT_TRH2_IP As String = "192.168.10.92"    'Ext T/RH secondary remote station IP address
Const MAX_COMMS_FAILS = 6                        'Maximum Number of comms failures before alarm
Const COMMS_PRIORITY = 2                         'Comms priority. REFER TO MANUAL!


'Declare External Temp/RH Local Sensor Constants.
Const EXT_DATA_ENABLE = True                     'External temp & RH data use enabled (True/False )
Const EXT_TRH_LOCAL = True                       'Ext T/RH local sensor installed (True/False)
Const EXT_TRH_PRIMARY = False                    'Ext T/RH local sensor (True = primary, False = secondary)
Const EXT_SDI_ADDR As String = "0"               'Ext T/RH local sensor SDI-12 address (Normally "0")


'Declare Enclosure 1 Sensor Address Constants.
Const E01TRH_SDI_ADDR As String = "1"            'Enclosure 1 T/RH sensor SDI-12 address (Normally "1")
Const E01SOIL_SDI_ADDR As String = "a"           'Enclosure 1 Soil sensor SDI-12 address (Normally "a")


'Declare Enclosure 2 Sensor Address Constants.
Const E02TRH_SDI_ADDR As String = "2"            'Enclosure 2 T/RH sensor SDI-12 address (Normally "2")
Const E02SOIL_SDI_ADDR As String = "b"           'Enclosure 2 Soil sensor SDI-12 address (Normally "b")


'Declare Barometric Pressure Sensor Constants.
Const BARO_ENAB = True                           'Barometric pressure display and logging enable (True/False)
Const BARO_STN_ELEV = 47                         'Barometer sensor station elevation in metres above MSL
Const BARO_LOCAL = False                         'Barometric pressure local sensor installed (True/False)
Const BARO_SDI_ADDR = "3"                        'Barometric sensor, SDI-12 address (Normally "3")


'*********************************************************************************
'*                          END OF INCLUDE FILE                                 *
'*********************************************************************************
```

ZooCADA-Log Reference Manual

The station constants determine various operating parameters for the station. They are intended to be configured during system commissioning and usually don't need changing later.

The station constants are stored in a separate program file named STATION_CONSTANTS_ZLOG_R01, hereinafter simply referred to as the STATION_CONSTANTS file, so they are not overwritten whenever an updated program is uploaded to the datalogger.

To change the station constants it is necessary to edit the STATION_CONSTANTS file, then load the updated file into the datalogger. To do so, users need to have access to the program code on a Windows computer that has the Campbell Scientific LoggerNet program suite installed on it.

For full information on using the LoggerNet software please refer to the LoggerNet Manual which is downloadable from the Campbell Scientific web site.

If the STATION_CONSTANTS file is edited using the CRBasic editor, it is essential to manually stop the program running and then restart it so the datalogger will recompile the program and make the new setpoints operational.

Do not change the name of the STATION_CONSTANTS file. The datalogger expects this file to be present and cannot run the program without it.

IMPORTANT: When editing constants ensure that only the numeric value is changed. Do not change anything else, especially the constant name or the = sign otherwise compile errors will be the likely result.

Enclosure Name

The name that is used to identify the enclosure for the web interface and in alarm email messages.

    Const ENCLOSURE As String = "KIWI CONSERVATION"

Set the text between the "" marks to a suitable name. The maximum length is 25 characters including spaces.

Customisation File

Flag determines whether or not the station has a customisation file.

    Const CUSTOM_FILE = False

Logical True or False. Normally set to False unless a customisation file has been created for the station.

Customisation files enable code for additional sensors and/or special processing to be added to the station program without changing the standard station program file.

Dual Enclosures Enable

Flag determines whether or not the station is monitoring two enclosures.

    Const DUAL_ENCLOSURES = False

Logical True or False. Normally set to False unless the installation has two enclosures. Setting this flag to True instructs the program compiler to include the necessary program code for the second enclosure.

Electricity Meter Installed

Flag determines whether or not the station is monitoring two enclosures.

    Const KWH_INSTALLED = False

Logical True or False. Set to True when a kWh meter is installed, otherwise set to False. Setting this flag to True instructs the program compiler to include the necessary program code for logging electricity use.

Station Constants File

Alarm Enable

Flag determines whether or not the alarm system should be operational.

    Const ALARM_ENABLE = True

Logical True or False. Normally set to True unless an ongoing maintenance problem is causing excessive nuisance alarms, in which case it can be set to False until the problem can be resolved. The alarms must be enabled in order for alarm events to be written to the Event Log data table.

Alarm Trigger Level

The number of degrees beyond the enclosure temperature setpoint at which an alarm is triggered.

    Const ALARM_DEGREES = 4

A decimal value. Typically about 4 degrees. This value MUST not be less than 1.0 degree Celsius. If the enclosure temperature either rises above the high setpoint or falls below the low setpoint by ALARM_DEGREES, it will trigger a temperature alarm. For example, if the enclosure high setpoint is 16 degrees and ALARM_DEGREES is set to 4, the high temperature alarm will be triggered at 20 degrees.

NOTE: In stations with HVAC control functions, this value must not be less than 2.0 degrees, to allow for air conditioner operation. For consistency it's best set this value the same for all stations on the same site.

Alarm Reset Level

The number of degrees beyond the enclosure temperature setpoint at which to reset the alarm.

    Const ALARM_RESET = 2

A decimal value. Typically about 2 degrees. A temperature alarm is reset when the enclosure temperature returns to less than ALARM_RESET past the high or low temperature setpoint. For example, if the enclosure low setpoint is 10 degrees and ALARM_RESET is set to 2, the low temperature alarm will reset at 8 degrees Celsius.

Email Enable

Flag determines whether or not the email system should be operational.

    Const EMAIL_ENABLE = True

Logical True or False. Normally set to True unless there is no internet connectivity available, or an ongoing maintenance problem is causing excessive nuisance emails, in which case it can be set to False until the problem can be resolved.

NOTE: The Campbell Scientific Email Relay server has a limit of 100 emails per day (USA time) from any given datalogger which, if exceeded, results in the Email Relay server rejecting further emails from that datalogger until the next day.

Email Test

Flag determines whether or not the email system is to operate in test mode and divert email messages to a file.

    Const EMAIL_TEST = False

Logical True or False. Normally set to False unless email messages are to be diverted to a file for test purposes. The file name is EmailTest.txt and is stored in the datalogger. This function allows extensive testing of the alarms and email messaging systems without actually sending the email messages via the Email Relay server.

Email Resend

The number of seconds between retry attempts when an email message fails to send.

    Const EMAIL_RESEND = 300

An integer value. Normally set in the range of 60 seconds to 300 seconds (1 to 5 minutes). This value MUST be a multiple of the program scan rate (normally 2 seconds) or the timer will malfunction.

Email Tries

The number of times the email system attempts to send an email message.

    Const EMAIL_TRIES = 3

An integer value. Normally set in the range of 1 to 4. A value of 1 means the system will only attempt to send an email message once, if it fails to send there are no retries. A value greater than 1 enables the email system to retry sending an email message that failed to send on the first attempt. Retries are at the interval determined by the constant EMAIL_RESEND, see above.

Email Daily Resend Enable

Flag indicates if an alarm email reminder message should be sent once each day for outstanding alarms.

    Const EMAIL_NAG = True

Logical True or False. Normally set to True unless users prefer to not have an alarms email message sent to them daily as a reminder of any alarms that have not yet been cleared.

Email Daily Resend Time

The hour of the day at which the daily alarm resend is to occur.

    Const EMAIL_NAG_HOUR = 8

Set to a number between 0 and 23, zero being midnight and 1 to 23 being the hour of the current day. Normally set to 8 for 08:00am so emails arrive among the first inbox deliveries for the day so staff have the opportunity to schedule whatever response they consider appropriate into their day. These email messages will be sent an hour earlier during Daylight Savings time as the datalogger is always operating on Standard Time.

Email Attachment File Name

The filename of a file to be sent as an attachment with each alarm email message.

    Const ATTACH = ""

Not currently used. The filename is entered between the quotes and must be present in the datalogger's file storage space. If no attachment is desired, empty quotes must be defined.

Email Message Recipients

The email addresses of the staff who are to receive alarm email messages.

    Const TO_ADDR = staff1.name@domain, staff2.name@domain, staff3.name@domain

A comma separated list of the email addresses for all the staff who are to receive the alarm messages from this station. Each station can have a different email recipient list so alarms can be sent to the staff member(s) usually responsible for each specific animal enclosure.

Station Constants File

Primary Remote Station Communications

Flag enables or disables network communications to the primary remote station.

Const EXT_TRH1_ENABLE = False

Logical True or False. Normally set to True unless this station has the only external temperature and RH sensor on the network. If this station has an external temperature and RH sensor installed, a remote station can provide a second pair of external sensor values. If this station has no external sensor installed, the primary remote station provides the external temperature and RH sensor values for use by this station.

Primary Remote Station PakBus Address

The PakBus address of the primary remote station.

Const EXT_TRH1_PK = 91

An integer value. Each station on the network has a unique PakBus address in the range from 1 to 3999. PakBus addresses from 4000 to 4094 are reserved for software such as LoggerNet. By convention we use the same number for the PakBus address as the last octet of the dataloggers IPv4 network address when IPv4 network addressing is in use.

Primary Remote Station IP Address

The static IP address of the primary remote station.

Const EXT_TRH1_IP = 192.168.10.91

An integer value. Each station on the network has a unique IPv4 or IPv6 address. If possible, use the number of the last octet of the station IPv4 network address for the PakBus address when IPv4 addressing is in use.

Secondary Remote Station Communications

Flag enables or disables network communications to the secondary remote station.

Const EXT_TRH2_ENABLE = False

Logical True or False. Set to True if a secondary remote station is available on the network that can provide the external sensor values. This is a fall back in case the communications to the primary remote station fails or if the primary remote station constant EXT_TRH1_ENABLE is set to False.

Secondary Remote Station PakBus Address

The PakBus address of the secondary remote station.

Const EXT_TRH2_PK = 82

An integer value. Each station on the network has a unique PakBus address in the range from 1 to 3999. PakBus addresses from 4000 to 4094 are reserved for software such as LoggerNet. By convention we use the same number for the PakBus address as the last octet of the dataloggers IPv4 network address when IPv4 network addressing is in use.

Secondary Remote Station IP Address

The static IP address of the secondary remote station.

Const EXT_TRH2_IP = 192.168.10.82

An integer value. Each station on the network has a unique IPv4 or IPv6 address. If possible, we use the number of the last octet of the station IPv4 network address for the PakBus address when IPv4 addressing is in use.

Maximum Communications Failures Before Alarm

The number of times communications to the remote station(s) can fail before an alarm is triggered.

Const MAX_COMMS_FAILS = 6

An integer value normally set between 3 and 9. The communications module will attempt to obtain the comms array from the designated remote station(s) every three minutes. If a remote station cannot be reached within the set number of tries an alarm is triggered.

NOTE: The alarm is always logged but depending upon the cause of the comms failure it may not be possible to send the alarms email message.

Communications Priority

The communications priority for communications by this station.

Const COMMS_PRIORITY = 2

An integer value set between 0 and 2. All stations MUST be set to 2 except for stations serving the external data to the network. On stations configured as Primary and Secondary external data providers the priority should be set to zero, COMMS_PRIORITY = 0. On stations configured to obtain external data from Primary or Secondary data providers and then provide that data to a number of other dataloggers on the same network switch the priority should be set to one, COMMS_PRIORITY = 1.

External (Outside) Temperature and Relative Humidity Enable

Flag determines whether or not external temperature and RH measurements should be operational.

Const EXT_DATA_ENABLE = False

Logical True or False. Normally set to True unless the system is operating as a standalone datalogger without an external temperature sensor installed on the local station or at a remote station. Setting this to False removes the external sensor code from the program operation so the ExtAirTC, ExtAirRH, and ExtAirVPD variables are removed from the Public data table instead of being always displayed with NAN values. It also prevents logging of those external measurements.

NOTE: When EXT_DATA_ENABLE is set to False, EXT_TRH_LOCAL should also be set to false.

Station Constants File

External (Outside)Temperature and Relative Humidity Sensor Installed

Flag indicates if an external air SDI-12 Temperature and RH sensor is installed on this datalogger.

    Const EXT_TRH_LOCAL = False

Logical True or False. Normally set to False unless the station has an external temperature and relative humidity sensor installed. Setting this flag to True instructs the program compiler to include the necessary program code for the external sensor.

NOTE: When EXT_TRH_LOCAL is set to True, ensure EXT_DATA_ENABLE is also set to True so measurements from the sensor can be viewed in the datalogger Public table and logged.

External Temperature and Relative Humidity Installed Is Primary Sensor

Flag indicates if the external air Temperature and RH sensor is installed on this datalogger is the primary sensor.

    Const EXT_TRH_PRIMARY = False

Logical True or False. Always set to False unless this station is has an external Temperature and RH sensor installed and it is to be the primary external temperature and RH station on the network. When set True the external temperature and RH sensor installed at this station is the primary external sensor for the network. When set False it is the secondary external sensor for the network.

The primary sensor provides the values CommsEx1TC and CommsEx1RH while the secondary sensor provides the values CommsEx2TC and CommsEx2RH into the communication array for sharing across the network.

External Temperature and Relative Humidity Sensor SDI-12 Address

The SDI-12 address for the local external temperature & relative humidity sensor, if Installed.

    Const EXT_SDI_ADDR = "0"

An integer value. Normally set to "0" with sensor wired to port C1. May be any other valid SDI-12 address value provided that it is unique for all sensors wired to the same port. If a local external temperature and RH sensor is installed on the local datalogger an address must be set. If no local external sensor is installed the constant is ignored. The SDI-12 address must be unique for each sensor installed on the same port.

Enclosure Temperature and Relative Humidity Sensor(s) SDI-12 Address

The SDI-12 addresses for the enclosure temperature & relative humidity sensor.

    Const E01TRH_SDI_ADDR = "1"

    Const E02TRH_SDI_ADDR = "2"

Integer values. Normally set to "1" for the temperature and RH sensor in enclosure 1, and "2" for the temperature and RH sensor in enclosure 2, with all sensors wired to port C1. Sensors for enclosure 2 are optional. An address must be set for each installed sensor. If there is only one enclosure, the constants for enclosure 2 sensors are ignored. The SDI-12 address must be unique for each sensor installed on the same port.

Enclosure Soil Moisture and Temperature Sensor(s) SDI-12 Addresses

The SDI-12 addresses for the enclosure soil moisture & soil temperature sensor.

Const E01SOIL_SDI_ADDR = "a"

Const E02SOIL_SDI_ADDR = "b"

Character values. Normally set to "a" for the soil moisture sensor in enclosure 1, and "b" for the soil moisture sensor in enclosure 2, with all sensors wired to port C1. Sensors for enclosure 2 are optional. An address must be set for each installed sensor. If there is only one enclosure, the constants for enclosure 2 sensors are ignored. The SDI-12 address must be unique for each sensor installed on the same port.

Barometric Pressure Enable

Flag determines whether or not the Barometric Pressure is displayed and logged.

Const BARO_ENAB = True

Logical True or False. Normally set to False unless a Barometric Pressure sensor is installed. The sensor may be installed on the local station or on a remote station. The station barometric pressure is retrieved from the communications array and corrected to Mean Sea Level for display.

Barometric Pressure Station Elevation

The elevation of the barometric pressure sensor station above Mean Sea Level.

Const BARO_STN_ELEV = 47

An integer value. The elevation above Mean Sea Level, in metres, of the station with the Barometric Pressure sensor installed. This value is used to calculate the correction of the station pressure to Mean Sea Level barometric pressure for display and logging. This value is ignored if BARO_ENAB is set to False.

Barometric Pressure Sensor Installed

Flag indicates if an external SDI-12 Barometric Pressure sensor is installed on this datalogger.

Const BARO_LOCAL = True

Logical True or False. Normally set to False unless a Barometric Pressure sensor is installed on this datalogger. This optional sensor measures the atmospheric pressure at the station, referred to as the station pressure. The measurement value is placed into the communications array so it is available to all stations on the network.

Barometric Pressure Sensor SDI-12 Address

The SDI-12 address for the local Barometric Pressure sensor, if Installed.

Const BARO_SDI_ADDR = "3"

An integer value. Normally set to "3" with the sensor wired to port C5. May be any other valid SDI-12 address value provided the sensor is wired to port C5 and the address is unique for all sensors wired to that port. If a barometric pressure sensor is installed on the local datalogger an address must be set.

Station Sensors File

```
'*******************************************************************************
'* ZooCADA-HVAC Enclosure Climate Control & Monitoring System                  *
'* Station Sensors Configuration File For:                                     *
'* Copyright 2015-2025 Adena Scientific Limited                                *
'* Datalogger: Campbell Scientific CR300 Series                                *
'* File name: STATION_SENSORS_ZSTORE_R01.CR300                                 *
'* Revision Date: 2025-02-03                                                    *
'*******************************************************************************
'
'NOTE: Leave sections unchanged for Optional Sensors if not installed.
'      Temperatures must be calibrated to degrees Celsius (deg C).
'      Relative Humidity must be calibrated to percent (%)
'      Barometric pressure must be calibrated to hectopascals (hPa).


'DECLARE SENSOR VARIABLES AND ARRAYS
'-----------------------------------
'
'Leave this section empty if no sensor variables are needed.
#If Section = "SensorVars" Then
  '
  'Declare External Sensor Arrays.
  #If EXT_TRH_LOCAL = True Then          'Compiler Directive - If local T&RH sensor installed
    Dim ExtTRHData(2)                    'External temperature & relative humidity sensor
    #If BARO_LOCAL = True Then           'Compiler Directive - If local barometric sensor installed
      Dim ExBaroData(3)                  'External barometric pressure sensor
    #EndIf                               'End Compiler Directive
  #EndIf                                 'End Compiler Directive
  '
  'Declare Enclosure 1 Sensor Arrays
  Dim E01TRHData(2)                      'Enclosure 1 temperature & relative humidity sensor
  Dim E01SoilData(6)                     'Enclosure 1 soil moisture sensor
  '
  'Declare Enclosure 2 Sensor Arrays
  #If DUAL_ENCL = True Then              'Compiler Directive - If dual enclosures enabled
    Dim E02TRHData(2)                    'Enclosure 2 temperature & relative humidity sensor
    Dim E02SoilData(6)                   'Enclosure 2 soil moisture sensor
  #EndIf                                 'End Compiler Directive
  '
#EndIf


'MEASURE EXTERNAL TEMPERATURE & RELATIVE HUMIDITY SENSOR (OPTIONAL)
'-----------------------------------------------------------------
'
#If Section = "SlowScanExtTRH" Then
  '
  'Measure Campbell Scientific HygroVue 5 SDI-12 Sensor.
  SDI12Recorder(ExtTRHData(),C1,EXT_SDI_ADDR,"M!",1,0,-1)
  '
  'Patch sensor measurement array values to program inputs.
  RawExtAirTC = ExtTRHData(1)
  RawExtAirRH = ExtTRHData(2)
  '
#EndIf


'MEASURE ENCLOSURE 1 TEMPERATURE & RELATIVE HUMIDITY SENSOR
'---------------------------------------------------------
'
#If Section = "SlowScanE01TRH" Then
  '
  'Measure Campbell Scientific HygroVue 5 SDI-12 Sensor.
  'Measurements Temperature, Relative Humidity
  SDI12Recorder(E01TRHData(),C1,E01TRH_SDI_ADDR,"M!",1,0,-1)
  '
  'Patch sensor measurement array values to program inputs.
  RawE01AirTC = E01TRHData(1)
  RawE01AirRH = E01TRHData(2)
  '
#EndIf
```

```
'MEASURE ENCLOSURE 2 TEMPERATURE & RELATIVE HUMIDITY SENSOR (OPTIONAL)
'--------------------------------------------------------------------
'
#If Section = "SlowScanE02TRH" Then
  '
  'Measure Campbell Scientific HygroVue 5 SDI-12 Sensor.
  'Measurements Temperature, Relative Humidity
  SDI12Recorder(E02TRHData(),C1,E02TRH_SDI_ADDR,"M!",1,0,-1)
  '
  'Patch sensor measurement array values to program inputs.
  RawE02AirTC = E02TRHData(1)
  RawE02AirRH = E02TRHData(2)
  '
#EndIf


'MEASURE BAROMETRIC PRESSURE SENSOR (OPTIONAL)
'---------------------------------------------
'
#If Section = "SlowScanBaro" Then
  '
  'Measure Campbell Scientific BaroVue 10 Barometric Pressure sensor.
  SDI12Recorder(ExBaroData(),C1,BARO_SDI_ADDR,"M!",1,0,-1)
  '
  'Patch sensor measurement array values to program inputs.
  RawBaroPres = ExBaroData(1)
  RawBaroQM = ExBaroData(3)
  'Set RawBaroQM=NAN if barometer model doesn't produce a QM value.
  '
#EndIf


'MEASURE ENCLOSURE 1 SOIL SENSOR
'-------------------------------
'
#If Section = "SlowScanE01Soil" Then
  '
  'Measure Enclosure 1 Water Content Reflectometer Sensor on Port C1.
  'Measurements 'VWC', 'EC', 'T', 'Pm', 'Pd' & 'Vr'
  'Optionally use "M4!" instruction for probes with OS2 - see CS650 Users Manual.
  SDI12Recorder(E01SoilData(),C1,E01SOIL_SDI_ADDR,"M3!",1,0)
  '
  RawE01Soil1VWC = E01SoilData(1)
  RawE01Soil1EC = E01SoilData(2)
  RawE01Soil1TC = E01SoilData(3)
  '
#EndIf


'MEASURE ENCLOSURE 2 SOIL SENSOR (OPTIONAL)
'------------------------------------------
'
#If Section = "SlowScanE02Soil" Then
  '
  'Measure Enclosure 2 Water Content Reflectometer Sensor on Port C1.
  'Measurements 'VWC', 'EC', 'T', 'Pm', 'Pd' & 'Vr'
  'Optionally use "M4!" instruction for probes with OS2 - see CS650 Users Manual.
  SDI12Recorder(E02SoilData(),C1,E02SOIL_SDI_ADDR,"M3!",1,0)
  '
  RawE02Soil1VWC = E02SoilData(1)
  RawE02Soil1EC = E02SoilData(2)
  RawE02Soil1TC = E02SoilData(3)
  '
#EndIf

'*******************************************************************************
'*                              END OF INCLUDE FILE                            *
'*******************************************************************************
```

Station Sensors File

The CRBasic code required to obtain the measurements from the station's sensors, and calibrate them into the standard units used within the ZooCADA system, is contained in a file named STATION_SENSORS_ZLOG_R01, hereinafter simply referred to as the STATION_SENSORS file.

Keeping the sensors configuration in its own file enables different sensor types to be installed at different stations, as needed, without necessitating changes to the main station program. This enables stations to be installed with the optimum sensors types for the site during initial installation and, if necessary, a sensor can be replaced with a different sensor type in the future if it fails and has been superseded by a new type.

The CRBasic code for optional sensors must be retained in the STATION_SENSORS file even if the optional sensors are not installed at the station. Optional sensors are enabled or disabled by settings in the STATION_CONSTANTS file and the necessary code changes are automatically made by the compiler when the system is installed.

IMPORTANT: The STATION_SENSORS file is determined during installation of the station sensors and is critical to the correct operation of the station.

Users should NOT change this file unless requested by Technical Support.

To change the station sensor configuration it is necessary to edit the STATION_SENSORS file, then load the updated file into the datalogger. To do so, users need to have access to the program code on a Windows computer that has the Campbell Scientific LoggerNet program suite installed on it.

For full information on using the LoggerNet software please refer to the LoggerNet Manual which is downloadable from the Campbell Scientific web site.

If the STATION_SENSORS file is edited using the CRBasic editor, it is essential to manually stop the station program running and then restart it so the datalogger will recompile the program and make the new sensor configuration operational.

Do not change the name of the STATION_SENSORS file. The datalogger expects this file to be present and cannot run the program without it.

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Data Tables

The datalogger stores all data in files called data tables. Data tables are made up of records and fields. Each row in a table represents a record and each column represents a field. The datalogger program determines the number of tables and the number of fields in each record. The image above shows a typical data table's contents and this is explained below; all other tables follow the same general format but will contain different information. Data files are typically stored as CSV text files with a .dat extension which can be imported and formatted into a spreadsheet, as has been done in the above example, or directly accessed by tools in Campbell Scientific LoggerNet software.

Data Table Header Rows

The data table contains four header rows providing information about the datalogger, the table, and its fields, with each field surrounded by double quotes which we have not shown in the diagram above for clarity.

First Row

The first header row of the data table is the environment line consisting of eight fields. The example image shown above contains the following:

TOA5 - Table output format. Can be changed using LoggerNet.

OKH_NH2_DL01 - The datalogger station name in LoggerNet. Can be changed using LoggerNet.

CR300 - The datalogger model range.

4206 - The datalogger serial number.

CR310.Std.09.02 - The datalogger operating system version.

CPU:OKH_NH2_DL01_R14.CR300 - Datalogger program name. Can change by sending new program.

1367 - Datalogger program signature. Changed by revising program or sending a new program.

E01_T_RH_10M - The data table name as defined in the datalogger program.

Second Row

The second header row of the data table contains the field names. The default field names are either a combination of the variable names (or aliases) from which the data is derived with an underscore and a three letter suffix, or a specified field name. The suffix is an abbreviation of the data process that outputs the data to final storage. The example image shown above contains the following field names:

TIMESTAMP - The date and time field showing when the record was created.

RECORD - A numerical record number field. Resets to zero when data tables are reset.

EnAirTC - Enclosure air temperature field.

EnAirRH - Enclosure air relative humidity field.

EnAirVpd - Enclosure air vapour pressure deficit field.

ExAirTC - External air temperature field.

ExAirRH - External air relative humidity field.

ExAirVpd - External air vapour pressure deficit field.

Third Row

The third header row of the data table contains the engineering units for the fields. These units are defined at the beginning of the datalogger program. The example image shown above contains the following units information:

TS - Time stamp for the time stamp field.

RN - Record Number for the record number field.

deg C - Degrees C for the enclosure temperature field.

% - Percentage for the enclosure relative humidity field.

kPa - Kilopascals for the enclosure vapour pressure deficit field.

deg C - Degrees C for the external temperature field.

% - Percentage for the external relative humidity field.

kPa - Kilopascals for the external vapour pressure deficit field.

Fourth Row

The fourth header row of the data table contains the abbreviations for the data process used to produce the field data. The example image shown above contains the following units information:

Blank - No special data processing is used for the time stamp field.

Blank - No special data processing is used for the record number field.

Avg - Average used for the enclosure temperature field.

Avg - Average used for the enclosure relative humidity field.

Avg - Average used for the enclosure vapour pressure deficit field.

Avg - Average used for the external temperature field.

Avg - Average used for the external relative humidity field.

Avg - Average used for the external vapour pressure deficit field.

Data Tables

Data Processing Abbreviations

Data processing instructions, such as average, maximum, minimum, or instantaneous sample, are used in the datalogger program to determine the type of data that is stored in the data tables. The following list contains all the abbreviations that can be used in the fourth row of the data tables and conditionally as field name suffixes on the first row. Not all of these are used in the ZooCADA system programs but are shown here for completeness.

Data Processing Abbreviations	
Data Processing Name	Abbreviation
Totalize	Tot
Average	Avg
Maximum	Max
Minimum	Min
Sample at Max or Min	SMM
Standard Deviation	Std
Moment	MMT
Sample	No abbreviation
Histogram1	Hst
Histogram4D	H4D
FFT	FFT
Covariance	Cov
Level Crossing	LCr
WindVector	WVc
Median	Med
ET	ETsz
Solar Radiation (from ET)	RSo
Time of Max	TMx
Time of Min	TMn

It is important to understand how the output data processing operates. All fields, except for instantaneous samples, are processed to produce the logged value. The example table shown in the image at the beginning of this chapter shows records that are logged at a ten minute interval, and at 02:40:00 the enclosure temperature average (EnAirTC) for record 4403 was logged as 16.85 degrees Celsius. Therefore 16.85 degrees Celsius is the average of all the measurements made by the datalogger over the ten minute interval from 02:30:01 to 02:40:00. The enclosure temperature sensors are measured every minute so this logged average is therefore the average of ten sensor measurements.

Data Table Data Record Rows

All rows after the fourth header row are called data records.

Data records are normally created at programmed regular intervals such as every ten minutes, hourly, or daily as shown by their time stamps. Event records are created whenever specified events occur, such as alarms or system errors, so the time stamp will show irregular record times.

The time stamp always indicates the time at the beginning of the datalogger program scan in which the record was written to the table. In the example table, shown in the image above, record number 4403 was written at 02:40:00 (2:40 am) on January 1, 2023.

Default Data Table Definitions

The datalogger includes three default data tables which are always present. Each of these data tables only contains the most recent measurements and information.

The default data tables are not downloaded when the logged data is downloaded from the datalogger as doing so is unnecessary, however they are available for viewing on a computer while it is connected to the datalogger with the LoggerNet software, or via a web browser.

DataTableInfo

The DataTableInfo data table is automatically created when a datalogger program produces other data tables. It reports statistics related to the data tables and is only updated when viewed.

Viewing this data table enables staff to determine the amount of data record storage used and available.

Table Name - DataTableInfo

TIMESTAMP - Record Date and Time (DateTime).

RECORD - Record Number (Integer).

DataTableName(1) - Name of the first data table created by the program (Text).

DataTableName(2) - Name of the second data table created by the program (Text).

SkippedRecord(1) - Number of skipped records in the first data table (Integer).

SkippedRecord(2) - Number of skipped records in the second data table (Integer).

DataRecordSize(1) - Number of records allocated to the first data table (Integer).

DataRecordSize(1) - Number of records allocated to the first data table (Integer).

DataRecordSize(2) - Number of records allocated to the second data table (Integer).

DataRecordSize(2) - Number of records allocated to the second data table (Integer).

SecsPerRecord(1) - Data output interval for the first data table (Integer).

SecsPerRecord(2) - Data output interval for the second data table (Integer).

DataFillDays(1) - Number of days required to fill the first data table (Decimal).

DataFillDays(1) - Number of days required to fill the first data table (Decimal).

DataFillDays(2) - Number of days required to fill the second data table (Decimal).

DataFillDays(2) - Number of days required to fill the second data table (Decimal).

DataFilled(1) - Percent of first data table filled (Decimal + Text).

DataFilled(1) - Percent of first data table filled (Decimal + Text).

DataFilled(2) - Percent of second data table filled (Decimal + Text).

DataFilled(2) - Percent of second data table filled (Decimal + Text).

NOTE: The example above is for a datalogger program that produces two data tables. The first or only number in brackets is the table number and increments for each new data table that is produced. A second number in the brackets, if present, indicates 1 for storage in on board memory or 2 for storage in an SD card and is only present for datalogger models such as the CR1000X that support multiple storage options.

Data Tables

Status

The Status data table includes information about the health of the datalogger and is updated only when viewed. The information in this data table is primarily intended to assist technical staff to verify that the datalogger and its program are functioning correctly and can be helpful if diagnosing problems.

Users do not normally need to view this table. For full details of the fields in this data table, please refer to the section "Status Table System Information" in the CR310 Product Manual.

Public

The Public data table is configured by the datalogger program and updated at the scan interval set within the datalogger program. It shows measurement and calculation results as they are made. This data table is for the ZooCADA-Log program and is an extremely useful tool for monitoring the station.

We recommend that users view this table as a daily check that everything is operating as expected.

Table Name - Public

>   TIMESTAMP - Record date and time (DateTime).
>
>   RECORD - Record number (Integer).
>
>   Platform - The software platform, in this case ZooCADA-Log.
>
>   Station - The name of the station (Text).
>
>   BattV - Battery voltage in Volts (Decimal).
>
>   E01AirTC - Enclosure 1 air temperature in degrees C (Decimal).
>
>   E01AirRH - Enclosure 1 air relative humidity in percent (Decimal).
>
>   E01AirDP - Enclosure 1 air dew point in degrees C (Decimal).
>
>   E01AirVp - Enclosure 1 air vapour pressure in kilopascals (Decimal).
>
>   E01AirVpd - Enclosure 1 air vapour pressure deficit in kilopascals (Decimal).
>
>   E01SoilTC - Enclosure 1 soil temperature in degrees C (Decimal).
>
>   E01SoilVWC - Enclosure 1 soil volumetric water content in cubic metres per cubic metre (Decimal).

>   **Second enclosure section if dual enclosures enabled.**
>
>   E02AirTC - Enclosure 2 air temperature in degrees C (Decimal).
>
>   E02AirRH - Enclosure 2 air relative humidity in percent (Decimal).
>
>   E02AirDP - Enclosure 2 air dew point in degrees C (Decimal).
>
>   E02AirVp - Enclosure 2 air vapour pressure in kilopascals (Decimal).
>
>   E02AirVpd - Enclosure 2 air vapour pressure deficit in kilopascals (Decimal).
>
>   E02SoilTC - Enclosure 2 soil temperature in degrees C (Decimal).
>
>   E02SoilVWC - Enclosure 2 soil volumetric water content in cubic metres per cubic metre (Decimal).
>
>   **End of second enclosure section.**

>   **External section if external sensors are in use on site.**
>
>   ExtAirTC - External (Outside) air temperature in degrees Celsius (Decimal).
>
>   ExtAirRH - External (Outside) air relative humidity in percent (Decimal).
>
>   ExtAirDP - External (Outside) air dew point in degrees C (Decimal).

ExtAirVp - External (outside) air vapour pressure in kilopascals (Decimal).

ExtAirVpd - External (outside) air vapour pressure deficit in kilopascals (Decimal).

End of external section.

Optional Barometric Pressure Sensor Display

BaroStn - Barometric pressure at the station in hectopascals.

BaroMSL - Barometric pressure calibrated to Mean Sea Level in hectopascals.

BaroTend - Barometric pressure tendency and amount of change in hectopascals.

End of Optional Barometric Pressure Sensor Display

Optional Electricity Usage Display

PowerCurHr - Electricity used in enclosure(s) in current hour in kWh (Decimal).

PowerCurDay - Electricity used in enclosure(s) in current day in kWh (Decimal).

End of Optional Electricity Usage Display

CurMonth - The current month of the year for which the setpoints are selected (Text).

Set_E00AirTC_HI - The high temperature setpoint for the current month in degrees Celsius (Decimal).

Set_E00AirTC_LO - The low temperature setpoint for the current month in degrees Celsius (Decimal).

E01SensState - The current state of the enclosure 1 temperature and relative humidity sensors (Text).

   TC OK, RH OK - The temperature and relative humidity sensors are both ok.

   TC OK, RH FAIL - The temperature sensor is ok and the relative humidity sensor has failed.

   TC FAIL, RH OK - The temperature sensor has failed and the relative humidity sensor is ok.

   TC FAIL, RH FAIL - The temperature sensor and the relative humidity sensor have both failed.

Second enclosure section if dual enclosures enabled.

E02SensState - The current state of the enclosure 2 temperature and relative humidity sensors (Text).

   TC OK, RH OK - The temperature and relative humidity sensors are both ok.

   TC OK, RH FAIL - The temperature sensor is ok and the relative humidity sensor has failed.

   TC FAIL, RH OK - The temperature sensor has failed and the relative humidity sensor is ok.

   TC FAIL, RH FAIL - The temperature sensor and the relative humidity sensor have both failed.

End of second enclosure section.

External sensor if external sensor is installed on this station.

ExtSensState - The current state of the external temperature and relative humidity sensors (Text).

   TC OK, RH OK - The temperature and relative humidity sensors are both ok.

   TC OK, RH FAIL - The temperature sensor is ok and the relative humidity sensor has failed.

   TC FAIL, RH OK - The temperature sensor has failed and the relative humidity sensor is ok.

   TC FAIL, RH FAIL - The temperature sensor and the relative humidity sensor have both failed.

End of external sensor section.

Optional Local Barometric Pressure Sensor

BaroSensState - The current state of the local external barometric pressure sensor (Text).

OK (QM n.nn) - The barometric pressure sensor is working normally.

RECALIB SOON - The sensor will need recalibrating in two to three months.

FAIL (QM n.nn) - The barometric pressure sensor needs recalibrating or has failed.

End of Optional Local Barometric Pressure Sensor

PowerState - The current state of mains electricity supply (Text).

OK - Mains power supply s OK.

POWER FAIL - Mains power supply has failed.

AlarmState - The current state of the alarm system (Text).

DISABLED - The alarm system has been disabled, no alarms will be detected.

INITIALISING - The alarm system is starting up and determining if any alarms are active.

NO ALARMS - All alarms are cleared.

>> ALARMS << - One or more alarms have been triggered.

EmailState - The current state of the email system (Text).

DISABLED - The email messaging system is set to disabled, email messages will not be sent.

TEST MODE - The email messages are diverted to a file for test purposes.

SYSTEM READY - The email system is ready to begin sending email messages.

SEND ATTEMPT - The email system is attempting to send a message.

SENT OK - The Email Relay server has received the message and relayed it to the recipients.

COMMS FAIL - Connection to the Email Relay server failed, the message was not sent.

DATA ERROR - The EmailRelay() function was called but not executed, the message was not sent.

COMMS ERROR - Error in communication to the Email Relay server, the message was not sent.

CommsState - The current state of the remote station (datalogger) communications (Text).

DISABLED - Remote station communications is not in use and has been disabled.

INITIALISING - The communications system is starting up.

COMMS ATTEMPT - The communications system is attempting to contact a remote station.

COMMS RETRY - The last attempt to contact a remote station failed and is now being tried again.

COMMS OK - Communications with the primary remote station succeeded.

COMMS SEC OK - Communications with the secondary remote station succeeded.

COMMS FAIL*, code1, code2* - All attempts to contact a remote station have failed.

CommsEx1TC - The communications array primary external temperature in degrees C (Decimal).

CommsEx1RH - The communications array primary external relative humidity in % (Decimal).

CommsEx2TC - The communications array secondary external temperature in degrees C (Decimal).

CommsEx2RH - The communications array secondary external relative humidity in % (Decimal).

CommsExBaro - The communications array barometric (station) pressure in hPa (Decimal).

CommsExSolar - The communications array solar radiation in W/m2 (Decimal).

CommsExRainHr - The communications array rainfall rolling 60 minute total in mm (Decimal).

CommsExRainDay - The communications array rainfall daily total in mm (Decimal).

CommsExWindSpd - The communications array wind vector speed in m/s (Decimal).

CommsExWindDir - The communications array wind vector direction in degrees (Int).

CommsExGustSpd - The communications array wind gust speed current hour in m/s (Decimal).

CommsExGustDir - The communications array wind gust direction current hour in degrees (Int).

Manual Setpoints Override section.

ManualTC_HI - User entry of manual override for the Set_E00AirTC_HI month setting (Decimal).

ManualTC_LO - User entry of manual override for the Set_E00AirTC_LO month setting (Decimal).

End of Manual Setpoints Override section.

Customisation Variables section.

CustomVar1 - Variable defined in customisation file, can be whatever variable name is appropriate.

CustomVar2 - Variable defined in customisation file, can be whatever variable name is appropriate.

NOTE: Customisation variables may or may not be present for any given station and are always placed at the bottom of the Public data table.

ZooCADA-Log Data Table Definitions

The format of the data tables for each type of dataset are identical across all ZooCADA systems.

All records in data tables, except for the Event Log, are generated at predetermined time intervals, 10 Minutes, Hourly, or Daily and provide what is called time-series data. Time series data can be easily plotted on a graph. The Event Log is event driven so its records are generated at whatever time the event occurs.

Enclosure number E00 is for functions common to all areas of the building whilst EXT is for external (outside) measurements common to all buildings.

Event Log

The EVENT_LOG data table contains a descriptive indication of each event that occurs. Events are logged at the time they occur. This table is limited to 1000 events before its ring memory overwrites.

Table Name - E00_EVENT_LOG

TIMESTAMP - Record date and time (DateTime).

RECORD - Record number (Integer).

EventDetected - Event description (Text).

Enclosure(s) Hourly Energy Use (Optional)

This data table provides an hourly accumulated total of the energy used within the enclosure. It enables a profile of the energy consumption across any given day to be analysed for energy management purposes. This can help identify daily peaks and troughs in energy use.

Table Name - E00_KWH_60M

TIMESTAMP - Record date and time (DateTime).

RECORD - Record number (Integer).

PowerCurHr - Energy consumption for the past hour in kilowatt hours (Decimal).

Data Tables

Enclosure(s) Daily Energy Use (Optional)

This data table provides a daily accumulated total of the energy used within the enclosure. It enables a profile of the energy consumption across any number of days or months to be analysed for energy management purposes. This can help identify seasonal peaks and troughs in energy use.

Table Name - E00_KWH_DAY

> TIMESTAMP - Record date and time (DateTime).
>
> RECORD - Record number (Integer).
>
> PowerCurDay - Energy consumption for the past day in kilowatt hours (Decimal).

Enclosure 1 Ten Minute Temperature, Relative Humidity, Dew Point, and Vapour Pressures

This data table provides high resolution monitoring of the climate in the enclosure and is ideal for graphing to ensure the enclosure climate is being maintained within the desired range. This data table also records the external (outside) temperature and relative humidity data which, when plotted on a graph against the enclosure data, helps with analysis of the HVAC performance.

Table Name - E01_T_RH_10M

> TIMESTAMP - Record date and time (DateTime).
>
> RECORD - Record number (Integer).
>
> EnAirTC - Enclosure air temperature in degrees Celsius (Decimal).
>
> EnAirRH - Enclosure air relative humidity in percent (Decimal).
>
> EnAirDP - Enclosure air dew point in degrees C (Decimal).
>
> EnAirVp - Enclosure air vapour pressure in kilopascals (Decimal).
>
> EnAirVPD - Enclosure air vapour pressure deficit in kilopascals (Decimal).
>
> ExAirTC - External (outside) air temperature in degrees Celsius (Decimal).
>
> ExAirRH - External (outside) air relative humidity in percent (Decimal).
>
> ExAirDP - External (outside) air dew point in degrees C (Decimal).
>
> ExAirVp - External (outside) air vapour pressure in kilopascals (Decimal).
>
> ExAirVPD - External (outside) air vapour pressure deficit in kilopascals (Decimal).

Enclosure 2 Ten Minute Temperature, Relative Humidity, Dew Point, and Vapour Pressures

Table Name - E02_T_RH_10M

> The format of this file is the same as "Enclosure 1 - 10 Minute Temperature and Relative Humidity".

Enclosure 1 Daily Temperature and Relative Humidity Summary

This data table provides a daily summary, logged at midnight (00:00), of the enclosure temperature and relative humidity over the previous day. The table records the average temperature along with the minimum and maximum temperatures and relative humidities, and the times they occurred.

Table Name - E01_T_RH_DAY

TIMESTAMP - Record date and time (DateTime).

RECORD - Record number (Integer).

EnAirTC_Avg - Average enclosure air temperature in degrees Celsius (Decimal).

EnAirTC_Max - Maximum enclosure air temperature in degrees Celsius (Decimal).

EnAirTC_TMx - Time of maximum enclosure air temperature (DateTime).

EnAirTC_Min - Minimum enclosure air temperature in degrees Celsius (Decimal).

EnAirTC_TMn - Time of minimum enclosure air temperature (DateTime).

EnAirRH_Max - Maximum enclosure air relative humidity in percent (Decimal).

EnAirRH_TMx - Time of maximum enclosure air relative humidity (DateTime).

EnAirRH_Min - Minimum enclosure air relative humidity in percent (Decimal).

EnAirRH_TMn - Time of minimum enclosure air relative humidity (DateTime).

Enclosure 2 Daily Temperature and Relative Humidity Summary

Table Name - E02_T_RH_DAY

The format of this file is the same as "Enclosure 1 - Daily Temperature and Relative Humidity Summary".

Enclosure 1 Hourly Soil Moisture and Temperature

This data table provides hourly soil moisture measurements for enclosures such as nocturnal houses with a soil floor to help with managing irrigation for the plants in the enclosure.

Table Name - E01_SOIL_60M

TIMESTAMP - Record date and time (DateTime).

RECORD - Record number (Integer).

EnSoilTC - Enclosure soil temperature in degrees Celsius (Decimal).

EnSoilVWC - Enclosure soil volumetric water content in cubic metres per cubic metre (Decimal).

EnSoilEC - Enclosure soil electrical conductivity in decisiemens per meter (Decimal).

Enclosure 2 Hourly Soil Moisture and Temperature

Table Name - E02_SOIL_60M

The format of this file is the same as "Enclosure 1 - Hourly Soil Moisture and Temperature".

Data Tables

Enclosure 1 Daily Soil Moisture and Temperature Summary

This data table provides a daily summary, logged at midnight (00:00), of the soil conditions in the enclosure over the previous day.

Table Name - E01_SOIL_DAY

TIMESTAMP - Record date and time (DateTime).

RECORD - Record number (Integer).

EnSoilTC_Avg - Average soil temperature in degrees Celsius (Decimal).

EnSoilTC_Max - Maximum soil temperature in degrees Celsius (Decimal).

EnSoilTC_TMx - Time of maximum soil temperature (DateTime).

EnSoilTC_Min - Minimum soil temperature in degrees Celsius (Decimal).

EnSoilTC_TMn - Time of minimum soil temperature (DateTime).

EnSoilVWC_Avg - Average soil volumetric water content in cubic metres per cubic metre (Decimal).

EnSoilVWC_Max - Maximum soil volumetric water content in cubic metres per cubic metre (Decimal).

EnSoilVWC_TMx - Time of maximum soil volumetric water content (DateTime).

EnSoilVWC_Min - Minimum soil volumetric water content in cubic metres per cubic metre (Decimal).

EnSoilVWC_TMn - Time of minimum soil volumetric water content (DateTime).

Enclosure 2 Daily Soil Moisture and Temperature Summary

Table Name - E02_SOIL_DAY

The format of this file is the same as "Enclosure 1 - Daily Soil Moisture and Temperature Summary".

External Daily Temperature and Relative Humidity Summary

This data table provides a daily summary, logged at midnight (00:00), of the external (outside) temperature and relative humidity over the previous day. The table records the average temperature along with the minimum and maximum temperatures and relative humidities, the times they occurred.

Table Name - EXT_T_RH_Day

TIMESTAMP - Record Date and Time (DateTime).

RECORD - Record Number (Integer).

ExAir TC_Avg - Average external (outside) air temperature for the day in Degrees Celsius (Decimal).

ExAir TC_Max - Maximum external (outside) air temperature for the day in Degrees Celsius (Decimal).

ExAir TC_TMx - Time of maximum external (outside) air temperature (DateTime).

ExAirTC_Min - Minimum external (outside) air temperature for the day in Degrees Celsius (Decimal).

ExAirTC_TMn - Time of minimum external (outside) air temperature (DateTime).

ExAirRH_Max - Maximum external (outside) air relative humidity for the day in Percent (Decimal).

ExAirRH_TMx - Time of maximum external (outside) air relative humidity (DateTime).

ExAirRH_Min - Minimum external (outside) air relative humidity for the day in Degrees Celsius (Decimal).

ExAirRH_TMn - Time of minimum external (outside) air relative humidity (DateTime).

External Hourly Barometric Pressure, Temperature and Humidity (Optional)

This data table provides an hourly record of the barometric pressure measurements, external (outside) temperature and relative humidity. It enables analysis of atmospheric conditions on an hourly basis and can be easily correlated with enclosure conditions for research purposes.

Table Name - EXT_BARO_60M

> TIMESTAMP - Record date and time (DateTime).
>
> RECORD - Record number (Integer).
>
> ExBaroStn - Barometric pressure at the station in hectopascals (Decimal).
>
> ExBaroMSL - Barometric pressure, corrected to Mean Sea Level, in hectopascals (Decimal).
>
> ExAirTC - External (outside) temperature in degrees Celsius (Decimal).
>
> ExAirRH - External (outside) relative humidity in percent (Decimal).

Using The Web Interface

The datalogger has a built-in web interface which enables easy viewing of the station status and data using a web browser from any network connected computer. No additional software is needed.

The web interface allows users to view the data without being logged on and offers several administrative functions that can be accessed by logging on to the datalogger with an administrator level logon.

We recommend using the web interface for viewing data, and LoggerNet software for administrative tasks.

The web interface makes day to day station checks quick and easy for users, whereas LoggerNet enables all the functionality of the entire datalogger network to be efficiently configured, utilised and maintained.

Connecting To A Station

1. Open the web browser on the computer

2. Enter the IP address of the station, in the format 192.168.5.92, into the browser's address and press [Enter].

3. The Status page will be displayed.

Status Page

The Status page gives key information about the datalogger and the program that is running in the datalogger. It can be selected by clicking on Status on the header/menu bar at the top of the page.

ZooCADA-Log Reference Manual

Click the [Refresh] button anytime it is desired to refresh the information on the page.

The web interface Status page displays a subset of the information in the dataloggers Status data table, which is an automatically generated default table. The complete Status data table can be viewed using the LoggerNet software. Most fields in the Status table are read only, and of a numeric data type unless otherwise noted.

Full details of all the fields in the Status table can be found in the section "Status Table System Information" in the CR310 Product Manual.

The fields displayed on the web interface Status page are described below in the order they are displayed.

Datalogger Information

Name - Datalogger station name stored in flash memory. Defaults to serial number. This is not the same name as that is entered into the LoggerNet software for the stations network name. This station name can be sampled into a data table, but it is not the name that appears in data file headers. Updated at startup or when the name is changed using the Device Configuration Utility in LoggerNet.

Timestamp - Datalogger date and time.

OS - Datalogger operating system version, release date and signature. Updates at startup.

Panel Temperature - Datalogger wiring panel temperature in degrees Celsius. Updates once per minute, when viewing the Status table, or programmatically.

Battery - Voltage of the 12V battery powering the system. Updates once per minute, when viewing the Status table, or programmatically.

Memory - Total final-data memory size (bytes) in the datalogger. Updated at startup.

Errors - Datalogger watchdog errors that have occurred while running this program, the count increments each time datalogger restarts due to error and resets automatically when a new program is compiled. Can be reset by entering 0. Updated at startup and on each error occurrence.

Program Information

Current - Program file that is currently running in the datalogger. Updates at startup.

Start Time - Date and time the CRBasic program was started. Updates at beginning of program compile.

Run Signature - Signature of the running binary (compiled) program. Value is independent of comments or non-functional changes. Often changes with operating system changes. Updates after compiling and before running the program.

Program Signature - Signature of the CRBasic program file including comments. Does not change with operating system changes. Updates after compiling the program.

Results for Last Program Compiled - Contains messages generated at compilation or during runtime. Updated after compile and for runtime errors such as variable out of bounds.

Memory Free - Unallocated final-data memory in the datalogger (bytes). Free memory is not necessarily available for data tables. As memory is allocated and freed, small sections of unallocated memory, which are unusable for data tables, may be created. Updated after compile completes.

Errors - Skipped Scans is the number of program scans that have been skipped while the CRBasic program is running. Does not include scans intentionally skipped as a result of program instructions Do/Loop and ExitScan instructions. Updated as skipped scans occur. Can be reset by entering 0.

Variables Out of Bounds is the number of attempts to write to an array outside of the declared size. The write does not occur. Indicates a CRBasic program error. Updated at runtime when the error occurs. Can be reset by entering 0.

Data Page

The Data page enables data tables stored in the datalogger to be viewed and downloaded. On some datalogger models this page also allows selected variables to be graphed in realtime. It can be selected by clicking on Data on the header/menu bar at the top of the page.

When selecting this page, if you are not logged on, the logon dialog box is displayed. Click the [Cancel] button to continue as an anonymous user without a logon, if this option is allowed by datalogger security settings, or enter your logon credentials to continue. You must logon to be able to make administrative changes.

The Table List on the left hand side of the page shows the available data tables. The Public data table is selected by default when the page is opened. Choose the desired table by clicking on the table name in the Table List.

The grey header displays the name of the selected data table. Check the Live checkbox to allow the display to update automatically as new data arrives. Click the [Save] button to save the data table to the computer.

The button on the right of the [Save] button toggles between [Table View] and [Record View] display modes.

[Table View] - Selects the table view mode when the page is currently in record view mode.

[Record View] - Selects the record view mode when the page is currently in table view mode.

ZooCADA-Log Reference Manual

File Control Page

The File Control page enables management of the datalogger files. Files can be sent, deleted, activated, and deactivated. The files page can be selected by clicking on Files on the header/menu bar at the top of the page.

When selecting this page, if you are not logged on, the logon dialog box is displayed. Click the [Cancel] button to continue as an anonymous user without a logon, if this option is allowed by datalogger security settings, or enter your logon credentials to continue. You must logon to be able to make administrative changes.

> **IMPORTANT:** Changes using this page should not be made unless requested by technical support.

The available devices are listed in the Device List on the left hand side of the page. Normally there will only be the one device, the datalogger CPU, and it will be automatically selected.

The files loaded onto the selected device are displayed below the grey header/toolbar which provides the buttons for each task. A checkbox beside each file allows the files to be selected.

Send - Click to send a file to the datalogger. A dialog box opens to allow selection of the desired file. Double click the desired file to send it to the datalogger.

Delete - Click to delete the selected file. A confirmation dialog box appears. Click [Yes] to delete the file [No] to keep the file and cancel the delete operation.

Stop Program - Click to stop the program running in the datalogger. A confirmation dialog box appears. Click [Yes] to stop the program [No] to cancel the operation. The information shown under Run Options will change to indicate the program has stopped.

There should always be at least one program file in the list, this being the program currently running in the datalogger. Under the Run Options heading it will show running, power up next to the file name.

When a program is upgraded to a new version, the datalogger will automatically set the new program to run on datalogger startup and retain the previous version. This is useful if an unexpected problem occurs with the new program version as it's easy to set the new program version to stop and then set the previous version to run.

Using The Web Interface
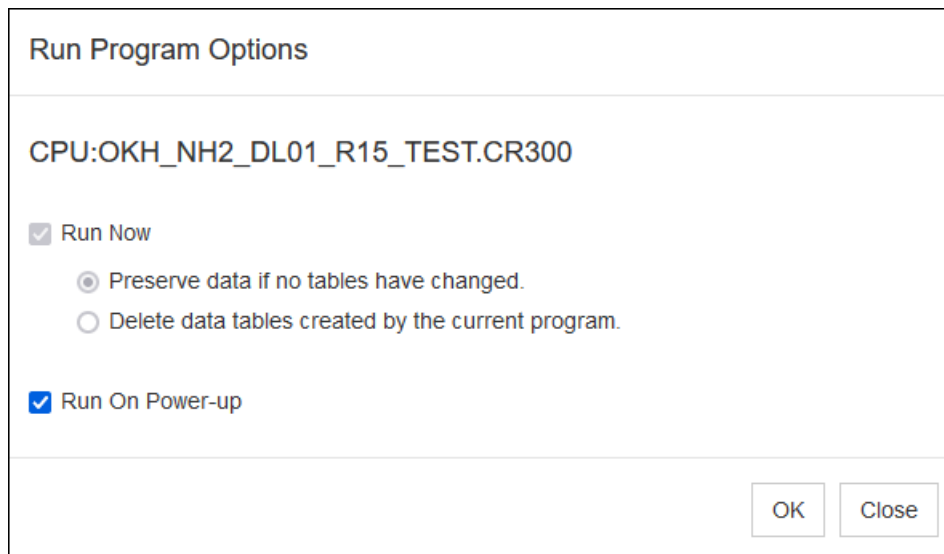
File Name Click

Clicking on the file name opens a Windows dialog box that allows the file to be saved to the computer or opened with a program on the computer. The save option is selected by default. Save the file as desired.

> **IMPORTANT**: LoggerNet is required on the computer if the program file is to be edited.

Run Options Click

The Run Options shown next to the file name indicate if the datalogger program is running and whether or not it is set to start on power up. Clicking the Run Options opens the Run Options Dialog Box.

If the datalogger program is running the dialog box will look like the example above with the Run Now options greyed out as they are not available.

If the program is stopped the Run Now options will be available.

Run Now Checkbox - Select to start the datalogger program, then choose the desired data table option.

  Preserve data if no tables have changed - Datalogger will attempt to preserve the data tables.

  Delete data tables created by the current program - The data tables will be deleted.

Run On Power-up - Select to enable the program to start automatically when the datalogger is powered up.

> **WARNING:** Failure to select Run On Power-up will cause the system to remain stopped after a power failure. It will then have to be manually started using the Run Options Dialog box every time there is a power failure to the datalogger until this setting is corrected.

Once the correct Run Options have been selected, click the [OK] button to start the datalogger program. The Run Options shown next to the file name will update to indicate the current status.

Utilities Page

The Utilities page enables setting the datalogger realtime clock and it provides a terminal function. It can be selected by clicking on Utilities on the header/menu bar at the top of the page.

The available utilities are listed on the left hand side of the page. Click to select the desired utility.

Clock Setting

When the page opens the Clock Setting utility is immediately available. It shows the current date and time from the computer, the station (datalogger) date and time, and the difference between the two.

The Date/Time Source drop down pick list offers two options for setting the time...

Sync With Computer - Click to set the station to the computer's time. Beware of daylight savings!
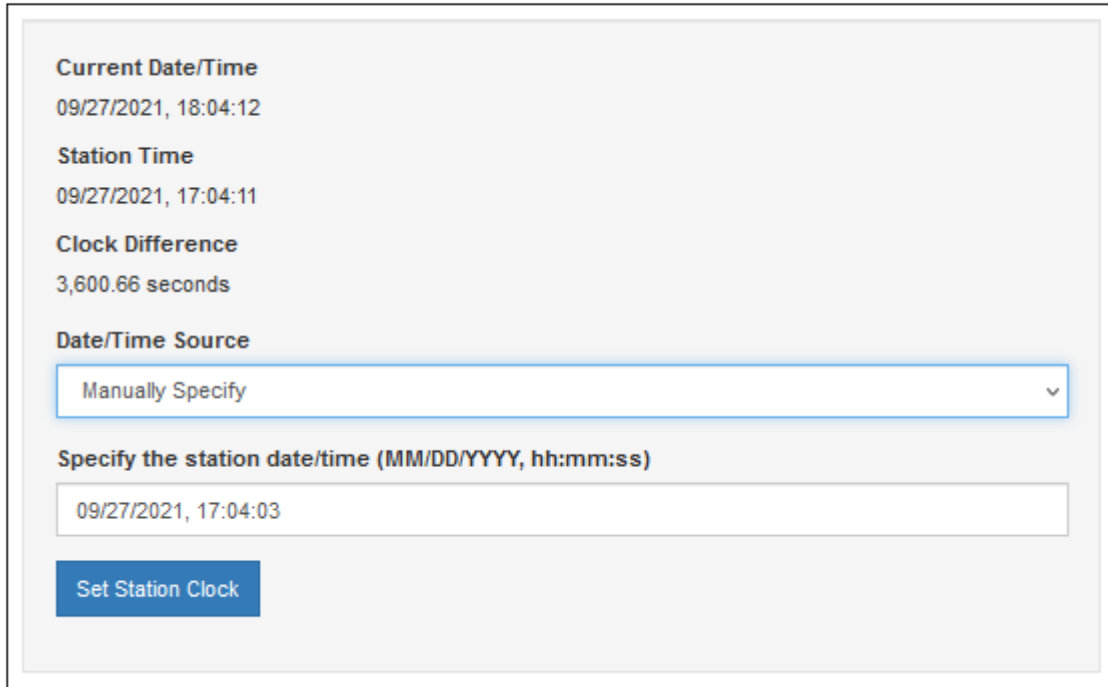
Manually Specify - Manually enter the correct time and date. This is the safest option.

IMPORTANT: Always use the Manually Specify option when setting the station (datalogger) clock to avoid inadvertently setting the station to the computer's Daylight Savings Time, which may cause data loss.

Using The Web Interface

To reset the datalogger date and time to the correct date and time...

1. Choose the Manually Specify option from the Date/Time Source drop down pick list. The page will update and a text box Specify the station date/time (MM/DD/YYYY,hh:mm:ss) will be displayed as shown below.
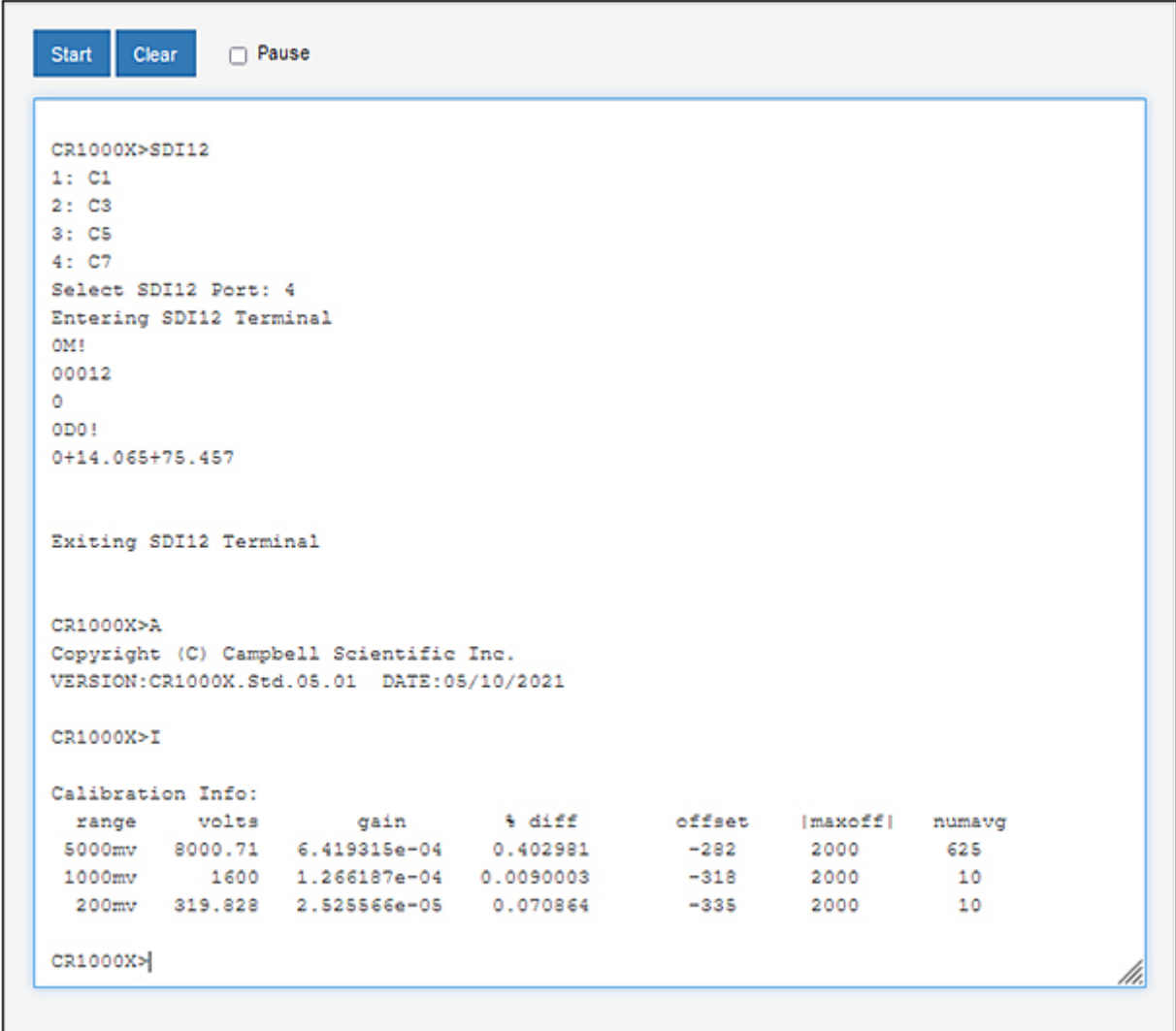
Current Date/Time
09/27/2021, 18:04:12

Station Time
09/27/2021, 17:04:11

Clock Difference
3,600.66 seconds

Date/Time Source

Manually Specify   ⌄

Specify the station date/time (MM/DD/YYYY, hh:mm:ss)

09/27/2021, 17:04:03

[Set Station Clock]

2. Edit the displayed date and/or time as necessary so the correct date and time is displayed.

3. Click the [Set Station Clock] button. A confirmation dialog box appears.

4. Click the [Yes] button to immediately update the station clock, or [No] to cancel the operation.

Tip: When editing the station time, enter a new time that is about thirty seconds ahead of the current time of day, then click the [Set Station Clock] button. Hover the mouse pointer over the [Yes] button on the confirmation dialog box and watch the Current Date/Time display approach the new time you entered for the station, then click the [Yes] button when the current time is one second before the time you have set.

IMPORTANT: DO NOT adjust the station (datalogger) clock for daylight savings time as doing so creates data anomalies that cannot be easily corrected and may result in loss of data.

Terminal

```
CR1000X>SDI12
1: C1
2: C3
3: C5
4: C7
Select SDI12 Port: 4
Entering SDI12 Terminal
0M!
00012
0
0D0!
0+14.065+75.457


Exiting SDI12 Terminal


CR1000X>A
Copyright (C) Campbell Scientific Inc.
VERSION:CR1000X.Std.05.01  DATE:05/10/2021

CR1000X>I

Calibration Info:
   range     volts        gain       % diff        offset    |maxoff|    numavg
  5000mv    8000.71   6.419315e-04   0.402981       -282       2000        625
  1000mv       1600   1.266187e-04   0.0090003      -318       2000         10
   200mv    319.828   2.525566e-05   0.070864       -335       2000         10

CR1000X>
```

The terminal function is primarily an engineering tool. It is not necessary to use it for routine datalogger operations other than configuring SDI-12 sensors. A sample Terminal session is shown above.

In this example the datalogger was placed into SDI-12 Transparent mode using the SDI12 command, then selecting SDI-12 port C7 by entering the selection 4 from the choices given.

NOTE: Only one sensor can be connected to the datalogger SDI-12 port when Transparent mode is used.

The SDI-12 command 0M! was issued to request the sensor initiate measurement. The 0 is the sensor SDI-12 address, M is the measurement instruction, and ! is the command terminator.

The SDI-12 command 0D0! was then issued to retrieve the measurement values from the sensor. The 0 is the sensor SDI-12 address, D0 is the measurement instruction, and ! is the command terminator.

The sensor responded with the values +14.065 and +75.457 which for the sensor used is the air temperature in degrees Celsius and the relative humidity in percent.

The SDI-12 Transparent mode was then exited and two commands issued to the datalogger.

Command A requested the datalogger operating system information, and command I requested the datalogger calibration information.

Sensor Measurements

This chapter provides information about how the datalogger program obtains the various climate measurements that are used to monitor the enclosure climate. The measurements also provide information that can assist users with managing the enclosure and caring for the animals held in it. All sensors are read and processed automatically by the datalogger program.

Enclosure Temperature and Relative Humidity Measurements

A temperature and relative humidity (RH) sensor is installed in the enclosure, or each enclosure if it's a dual enclosure installation, and is wired back to the datalogger which measures the sensors once every minute. The recommended sensor type is a Campbell Scientific HygroVue 5 SDI-12 combined temperature and RH sensor.

Each time the sensors are measured, the program carries out a test to ensure the measurement values obtained from the sensors are within the manufacturers specified operating range. If a sensor fails, it typically returns a measurement value that is out of range such as -9999 or NAN (Not A Number) so detecting such values enables the program to automatically disregard a sensor that is obviously defective.

The test criteria for the enclosure temperature and RH sensor measurement values are:

T^o C greater than -40 and T^o C less than 70 and T^o C is not NAN

RH % greater than 5 and RH % less than or equal to 100 and RH % is not NAN

NOTE: This check cannot verify that functioning sensors are also accurately calibrated, periodic calibration tests are recommended for this purpose.

The enclosure sensor states E01SensState, and E02SensState if dual enclosures is enabled, are displayed in the Public data table. If a sensor measurement fails the above test, the state for that sensor changes to indicate the nature of the fault. The state "TC OK, RH FAIL" indicates the RH sensor has failed, "TC FAIL, RH OK" indicates the temperature sensor has failed, and "TC FAIL, RH FAIL" indicates that both sensors have failed. Normally the sensor states will display "TC OK, RH OK" to indicate that the sensors are working normally.

The enclosure temperature and relative humidity measurements, E01AirTC and E01AirRH for enclosure 1, and E02AirTC and E02AirRH for enclosure 2 if dual enclosures are enabled, are displayed in the Public data table and logged every ten minutes. NAN (Not A Number) is displayed and logged in place of the measurement value in the event that no valid measurement value can be obtained from the sensors, which may be the result of sensor failure or if the sensors have yet to be measured after a program restart.

External Temperature and Relative Humidity Measurements

An external sensor is not required for a standalone ZooCADA-Log installation although it is recommended as it can provide helpful information. An external sensor can be installed and configured to enable this station to operate as a primary or secondary external sensor data provider to other networked stations.   If installed, the external sensor is measured once every minute. The recommended sensor type is a Campbell Scientific HygroVue 5 SDI-12 combined temperature and relative humidity sensor.

When a site has multiple network connected stations, one or more remote stations can provide external sensor measurement values which the local station then obtains via network communications every three minutes.

Each time the external sensors are measured, the program carries out a test to ensure the measurement values obtained from the sensors are within the manufacturers specified operating range. If a sensor fails, it typically returns a measurement value that is out of range such as -9999 or NAN (Not A Number) so detecting such values enables the program to automatically disregard a sensor that is obviously defective.

The test criteria for the external temperature and RH sensor measurement values are:

T° C greater than -40 and T° C less than 70 and T° C is not NAN

RH % greater than 5 and RH % less than or equal to 100 and RH % is not NAN

NOTE: This check cannot verify that functioning sensors are also accurately calibrated, periodic calibration tests are recommended for this purpose.

If an external sensor is installed on the datalogger, the external sensor state ExtSensState is displayed in the Public data table. Normally the sensor state displays "TC OK, RH OK" to indicate that the sensors are working normally. If a sensor measurement fails the above test, the state for the sensor changes to indicate the nature of the fault. The state "TC OK, RH FAIL" indicates the RH sensor has failed, "TC FAIL, RH OK" indicates the temperature sensor has failed, and "Tx FAIL, RHx FAIL" indicates that both sensors have failed.

NOTE: When external sensor values are acquired from remote stations via the comms array, a sensor failure does not raise an external sensor failure alarm on the local station. External sensor failure alarms are only generated by stations that have an external sensor installed on them.

The external air temperature and RH measurement values from the sensors, regardless of whether the sensors are local or remote, are placed into the Public data table variables CommsEx1TC, CommsEx1RH, CommsEx2TC, and CommsEx2RH (the communications array), so they are available to all dataloggers across the network.

For fail-safe redundancy two temperature and RH sensor measurements can be used, either with one sensor on the local station and one at a remote station, or with both at remote stations. If two measurements are available they are averaged and if one sensor fails the station continues operating using the remaining good sensor.

The following logic is applied to error check and average the external Temperature and RH sensors:

Test Sensor 1 and if Sensor 1 is Ok then

　　Test Sensor 2 and if Sensor 2 is Ok Then

　　　　Set Result to the Calculated average of Sensor 1 Value and Sensor 2 Value

　　Otherwise Sensor 2 is Defective so

　　　　Set Result to the Sensor 1 Value.

Otherwise Sensor 1 is Defective so Test Sensor 2 and if Sensor 2 is Ok then

　　Set Result to the Sensor 2 Value.

Otherwise Sensor 1 and Sensor 2 are Both Defective so

　　Set Result to NAN

If two external sensors are in use, the average measurements are determined using the following equation:

$$Average = (Value1 + Value\,2) \div 2$$

The resultant external temperature and relative humidity measurements, ExtAirTC and ExtAirRH are displayed in the Public data table and logged every ten minutes. NAN (Not A Number) is displayed and logged in place of the measurement value in the event that no valid measurement value can be obtained from the sensors, which may be the result of sensor failure or if the sensors have yet to be measured after a program restart.

Sensor Measurements

Vapour Pressure Measurements

The vapour pressure, saturation vapour pressure, and vapour pressure deficit values are all calculated by the program from the temperature and relative humidity values measured by the sensors.

It is important to understand that relative humidity (RH), is actually a ratio between the amount of water vapour currently in an air sample, called the vapour pressure, and the maximum amount of water vapour that air sample can "hold" at its current temperature, called the saturation vapour pressure.

The RH is determined using the following equation:

$$RH \% = \left(\frac{Vapour\ Pressue}{Saturation\ Vapour\ Pressure} \right) \times 100$$

The saturation vapour pressure value increases with increasing temperature, so if the air in an enclosure has a RH of 60 % at 15 degrees Celsius, and that same air is then warmed to 20 degrees Celsius it will have a RH of about 44 %, or if cooled to 10 degrees Celsius it will have a RH of about 83 %. The enclosure and external air are usually at different temperatures so RH cannot be used to compare their water vapour content for HVAC control purposes, their vapour pressures must be used instead.

The saturation vapour pressure for air at a given temperature can be derived using the following polynomial (reference Lowe, Paul R.: 1977, "An approximating polynomial for computation of saturation vapour pressure," Journal of Applied Meteorology, 16, 100-103), adjusted from units of millibars to kilopascals:

$$SatVP = (A0 + A1 \times T + A2 \times T^2 + A3 \times T^3 + A4 \times T^4 + A5 \times T^5 + A6 \times T^6) \times 0.1$$

$Where:$
$T = Temperature$
$A0 = 6.107799961$
$A1 = 4.436518521E-01$
$A2 = 1.428945805E-02$
$A3 = 2.650648471E-04$
$A4 = 3.031240396E-06$
$A5 = 2.034080948E-08$
$A6 = 6.136820929E-11$

When the relative humidity and the saturation vapour pressure are known, the vapour pressure can be determined using the following equation:

$$VP = RH \times SatVP \div 100$$

The vapour pressure deficit is then determined by the following equation:

$$VPD = SatVP - VP$$

The vapour pressure deficit determines how much plants can transpire so it's useful for horticultural purposes, such as managing plants in a nocturnal house. The enclosure vapour pressure deficit E01AirVpd, and optionally, the external vapour pressure deficit ExtAirVpd values are displayed in the Public data table and logged every ten minutes.

Dew Point Temperature Measurements

The dew point temperature is derived from the vapour pressure, relative humidity, and the saturation vapour pressure. The saturation vapour pressure is derived from the dry bulb temperature, and the vapour pressure from saturation vapour pressure and relative humidity.

The dew point is calculated using Tetens' equation solved for dew point with coefficients optimized for the temperature range of -35 to +50 degrees C as follows...

$$Td = \frac{a3 \times Ln\left(\dfrac{Vp}{a1}\right)}{a2 - Ln\left(\dfrac{Vp}{a1}\right)}$$

$Where:$
$Td = Dew\ Point\ Temperature$
$Vp = Vapour\ Pressure$
$a1 = 0.61078$
$a2 = 17.558$
$a3 = 241.88$

Soil Moisture and Temperature Measurements

A Campbell Scientific CS650 soil moisture reflectometer is used to measure the soil volumetric water content, the bulk electrical conductivity, and the soil temperature. This sensor comprises of an epoxy block that contains the electronics and holds two parallel, 300mm long, stainless steel rods that are inserted into the soil. A thermistor in the bottom of the epoxy block senses the soil temperature. Using a technique known as time domain reflectometry, the CS650 sends a signal along the stainless steel rods and measures the propagation time, signal attenuation, and temperature. Dielectric permittivity, volumetric water content, and bulk electrical conductivity are then derived from these values by the sensors microprocessor and sent to the datalogger.

Electricity kWh Meter Measurement (Optional)

A kWh meter can be installed in the switchboard to monitor the building's electricity use.

These meters have a pulse output that produces 1 pulse for every 0.01 kWh of electricity used. The pulse output from the kWh meter is applied to a pulse counter input on the datalogger which counts the number of pulses that occur between each program scan. The datalogger program reads each pulse counter and accumulates the count as hourly and daily kWh totals.

Recommended Maintenance Procedure

During maintenance when the datalogger program is not running, such as program updates, any pulses applied to the datalogger pulse counter input will not be counted and pulse counts not yet logged will be lost. To avoid logging inaccurate kWh data when the datalogger is restarted, it is necessary to enter the correct kWh totals into the Public data table PowerCurDay and PowerCurHr variables after restarting the datalogger.

When commencing maintenance, write down the kWh reading from the meter, and the PowerCurDay and PowerCurHr values from the variables in the datalogger Public data table. At the conclusion of maintenance, write down the kWh reading from the meter and subtract the start reading from the end reading to obtain the kWh used during maintenance. Add the kWh used during maintenance to the PowerCurDay and PowerCurHr values you wrote down at the start then enter those new values into the PowerCurDay and PowerCurHr variables in the datalogger Public data table using the LoggerNet software or the Web Interface.

Barometric Pressure Measurements (Optional)

To display and log barometric pressure measurements, a barometric pressure sensor must be installed on the ZooCADA network. The recommended sensor type is Campbell Scientific BaroVue 10. If a barometric pressure sensor is present on the network its value is displayed in the CommsExBaro variable in the Public data table.

To enable the barometer display on a station, the station constant BARO_ENAB must be set to True and the station's elevation above Mean Sea Level, in metres, must be entered into the BARO_STN_ELEV station constant. If the barometer display is enabled the station pressure is displayed in the BaroStn variable in the Public data table and the pressure corrected to Mean Sea Level is calculated and displayed in the BaroMSL variable in the Public data table. The station pressure is useful in situations where a measure of the actual pressure is required, whilst the barometric pressure is consistent with the pressure shown on meteorological charts intended to indicate the prevailing atmospheric conditions.

A barometric pressure sensor must only be installed on one station on the ZooCADA network. If installed, the sensor is measured every six minutes. The resulting station pressure measurement (the pressure at that station's elevation) is placed into the communications array where it can be accessed by all stations on the network.

On the station where the barometric pressure sensor is installed , the station constant BARO_SDI_ADDR is set to the sensor's SDI-12 address and the station constant BARO_LOCAL is set to True to enable the datalogger program to obtain the measurement values from the sensor.

The barometric pressure measurement, at Mean Sea Level, is derived from the station pressure measurement by calculating the difference pressure dP using the station elevation E above Mean Sea Level, in metres, then adding that difference pressure to the station pressure.

The difference pressure is determined using the following equation:

$$dP = 1013.25 \left\{ 1 - \left(1 - \frac{E}{44307.69231} \right)^{5.25328} \right\}$$

This equation assumes U. S. Standard Atmosphere and dry air (Atmospheric Science, Wallace and Hobbs 1977), and is as given in the Campbell Scientific BaroVue 10 Product Manual.

The datalogger logs the station pressure, barometric pressure, external (outside) temperature, and relative humidity every hour. These pressure measurements are recorded to assist zoo personnel with research activities and are not used by the datalogger program HVAC and lighting control functions.

Barometric Pressure Tendency Indication (Optional)

If the barometric pressure is available on the network and the station is configured to display it, the barometric pressure tendency, measured over the previous three hours, is also displayed in the Public data table variable BaroTend. The variable will display one of the following indications:

RISING x hPa	-	The pressure has increased by x HectoPascals
FALLING x hPa	-	The pressure has decreased by x HectoPascals
STEADY	-	The pressure has not changed
ERROR	-	An error was detected in the pressure measurement.

In order to be considered as RISING or FALLING the current barometric pressure must be at least 3.0 hPa different from the barometric pressure recorded three hours ago. A pressure change of less than 3.0 hPa over three hours is considered to be STEADY barometric pressure.

SDI-12 Sensor Address Settings

The SDI addresses should be set on the external and enclosure sensors as follows...

External (Ext) Temperature & Relative Humidity	-	Port C1 - Address 0
Enclosure (E01) Temperature & Relative Humidity	-	Port C1 - Address 1
Enclosure (E02) Temperature & Relative Humidity	-	Port C1 - Address 2
External (Ext) Barometric Pressure		Port C1 - Address 3
Enclosure (E01) Soil Moisture & Temperature	-	Port C1 - Address a
Enclosure (E02) Soil Moisture & Temperature	-	Port C1 - Address b

Communications to Remote Stations

All stations (dataloggers) in the ZooCADA system are designed to operate either as a single standalone station, or as one station in a network of stations where one or more of the external sensors may be located at remote stations with communications between stations achieved across a conventional IP computer network. The values required to be retrieved via network communications must be present in the Public data table and are placed into an array. The datalogger program uses a designated communications array for this purpose. The measurement values stored in the communications array of any given station are available, via network communications, to all other stations across the network.

The station that a user can currently "touch" is referred to as the local station, all other stations are remote stations.

Up to two remote stations with can be configured as sources for remote sensor measurement values, one is designated as the primary remote station and the other is the secondary remote station. The primary remote station is normally the first that the communications attempts to retrieve the desired values from. If communications to the primary remote station fails, the communications will automatically try to retrieve the values from the secondary remote station.

Normally in a wired IP network the communications are very reliable and the secondary remote station is unlikely to be called, but in a wireless network where the link quality may vary the secondary remote station can provide an alternative path by which the desired values can be obtained when necessary.

External Temperature and Humidity Sensor Configuration Options

Correct configuration of external temperature and humidity sensors is critical to the proper functioning of the ZooCADA system. Only one external temperature and humidity sensor can be installed on any one datalogger and is referred to as the local external sensor. When two external sensors are available on the network one of them must be assigned as the primary external sensor, the other becomes the secondary external sensor.

All ZooCADA stations that provide climate control functions require at least one external air temperature and RH sensor, installed as either a local sensor or a remote sensor, to provide the external air reference used by the control system. ZooCADA monitoring only stations do not need an external air reference but can be configured to log data from a remote external sensor, or to provide a local external sensor to the network.

Single Primary Local Sensor Only

In this configuration the primary external sensor is connected to the local station and there are no remote sensors available. The local external sensor should be configured as the primary sensor when it is the only external sensor on the network. This is also the configuration for a single standalone datalogger installation.

The station constants settings are:

EXT_TRH_LOCAL = True

EXT_TRH_PRIMARY = True

Primary Local Sensor with a Remote Sensor

In this configuration the primary external sensor is connected to the local station and a secondary remote sensor is available. The local sensor is configured as the primary external sensor and the local station obtains the secondary external sensor measurement values from another station on the network.

The station constants settings are:

EXT_TRH_LOCAL = True

EXT_TRH_PRIMARY = True

Secondary Local Sensor with a Remote Sensor

In this configuration the secondary external sensor is connected to the local station and a primary remote sensor is available. The local sensor is configured as the secondary sensor and the local station obtains the primary external sensor measurement values from another station on the network.

The station constants settings are:

EXT_TRH_LOCAL = True

EXT_TRH_PRIMARY = False

Single Remote Sensor Only

In this configuration there is no external sensor connected to the local station. The local station obtains the external sensor values from another station on the network.

The station constants settings are:

EXT_TRH_LOCAL = False

EXT_TRH_PRIMARY = False

Two Remote Sensors

In this configuration there is no external sensor connected to the local station. The local station obtains the external sensor values for both external sensors from another station on the network.

The station constants settings are:

EXT_TRH_LOCAL = False

EXT_TRH_PRIMARY = False

The Communications Array

A communications array is maintained by the datalogger program in the Public data table of the datalogger. This array contains the temperature and relative humidity values from the primary and, if installed, secondary external sensors, and may contain additional sensor values as well. Any station on the network can retrieve the array with all its values from any other station on the network. All values in the communications array are in the format "CommsValue" where the "Comms" prefix indicates it is a communications array value.

Communications array values are:

CommsEx1TC - Primary external temperature in degrees C (Decimal).

CommsEx1RH - Primary external relative humidity in % (Decimal).

CommsEx2TC - Secondary external temperature in degrees C (Decimal).

CommsEx2RH - Secondary external relative humidity in % (Decimal).

CommsExBaro - Barometric (station) pressure in hPa (Decimal).

CommsExSolar - Solar radiation in W/m2 (Decimal).

CommsExRainHr - Rainfall rolling 60 minute total in mm (Decimal).

CommsExRainDay - Rainfall daily total in mm (Decimal).

CommsExWindSpd - Wind vector speed in m/s (Decimal).

CommsExWindDir - Wind vector direction in degrees (Int).

CommsExGustSpd - Wind gust speed current hour in m/s (Decimal).

CommsExGustDir - Wind gust direction current hour in degrees (Int).

If a sensor is not present, or the sensor measurement returns an error, the corresponding communications array variables are loaded with "NAN" which means Not A Number. The program in each datalogger interprets that NAN as a sensor error and responds accordingly.

For the primary and secondary external air temperature and relative humidity measurements, the datalogger program reads the measurement values from the communications array, checks for obvious errors, averages the values if the values from two sensors are available, then uses the resultant external temperature and relative humidity values for HVAC control purposes as well as logging those values.

Remote Station Communication Configuration Options

Each station must be allocated its own static IP address and its own PakBus address, both of which must be unique on the network. These addresses are used to communicate with the station over the network and are set using the Device Configuration Utility in the LoggerNet software.

The datalogger program for each station must also be configured with the IP address and PakBus address of each remote station it is to communicate with, and the communications to each designated address must be enabled. These settings are made in the STATION_CONSTANTS file.

The examples below assume a private IP network (192.168.x.x) with the subnet 192.168.1.x. These IP address numbers may be different depending upon your specific network. Please consult your network administrator for IP address allocation information. The PakBus addresses are specific to the dataloggers on the network and will have been defined during datalogger installation.

A page is provided at the back of this manual that can be used to record the station names, IP addresses and PakBus addresses during installation for future reference.

Primary Remote Station

This is the remote station from which the local station will normally retrieve the desired values.

The station constants settings are:

> EXT_TRH1_ENABLE = True
>
> EXT_TRH1_PK = 82
>
> EXT_TRH1_IP = 192.168.1.82

To disable the primary remote station, set:

> EXT_TRH1_ENABLE = False

Secondary Remote Station

This is the remote station from which the local station will attempt to retrieve the desired values if the communications to the primary remote station fails or is disabled.

The station constants settings are:

> EXT_TRH2_ENABLE = True
>
> EXT_TRH2_PK = 92
>
> EXT_TRH2_IP = 192.168.1.92

To disable the secondary remote station, set:

> EXT_TRH2_ENABLE = False

Small Network Example

The diagram below is an example of a small network. Station 1 has the primary external sensor and there is no secondary external sensor. All other stations retrieve the primary external sensor measurement values from Station 1. This solution doesn't offer failsafe redundancy for the external sensor but is perfectly adequate for a small network.
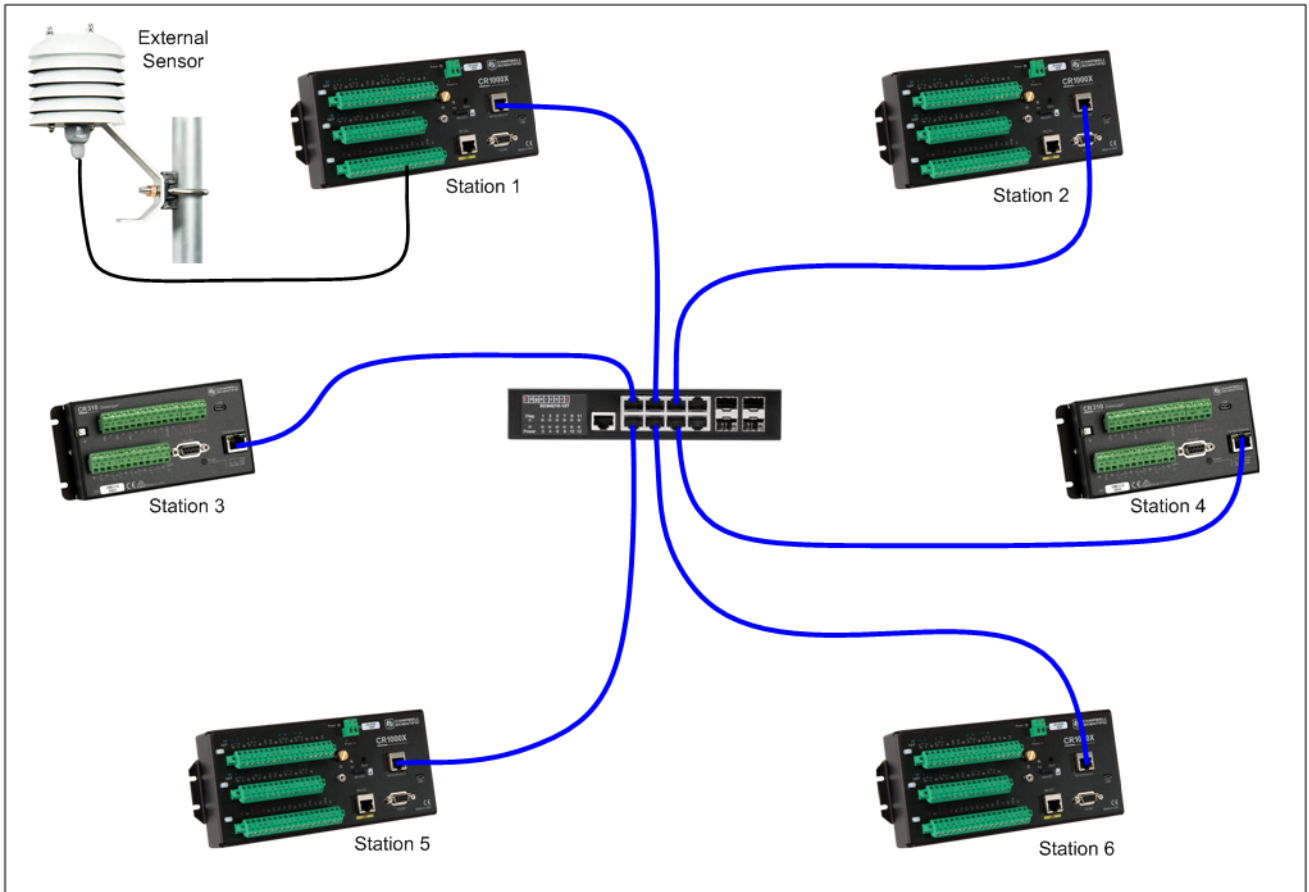
In this example, assuming the PakBus address and the IP address for each station is the station number in the diagram above, the configuration settings would be:

Station 1	All Other Stations
EXT_TRH_LOCAL = True	EXT_TRH_LOCAL = False
EXT_TRH_PRIMARY = True	EXT_TRH_PRIMARY = False
EXT_TRH1_ENABLE = False	EXT_TRH1_ENABLE =True
EXT_TRH1_PK = 1 (ignored)	EXT_TRH1_PK = 1
EXT_TRH1_IP = 192.168.1.1 (ignored)	EXT_TRH1_IP = 192.168.1.1
EXT_TRH2_ENABLE = False	EXT_TRH2_ENABLE = False
EXT_TRH2_PK = 2 (ignored)	EXT_TRH2_PK = 2 (ignored)
EXT_TRH2_IP = 192.168.1.2 (ignored)	EXT_TRH2_IP = 192.168.1.2 (ignored)

Large Network Example

The diagram below is an example of a large network that includes failsafe redundancy for the external sensors. In this example, the stations are also configured so the communications that retrieves the external sensor measurement values is distributed across the network to improve network traffic management.
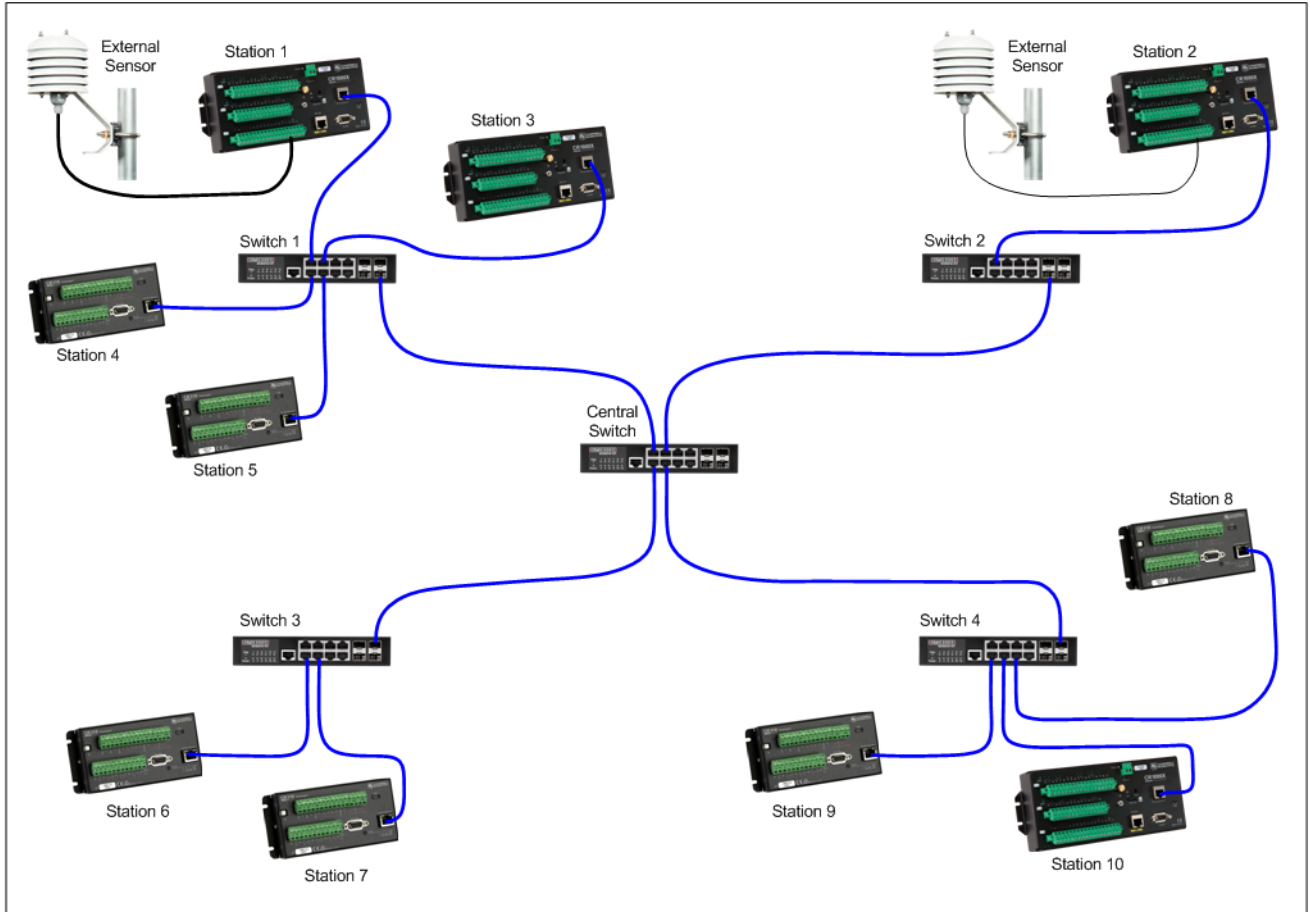
A good design technique is to keep communications between stations localised, as much as possible, to the network switches they are directly connected to.

Station 1 has the primary external sensor and retrieves the secondary external sensor measurement values from Station 2, while Station 2 has the secondary external sensor and retrieves the primary external sensor measurement values from Station 1. These two stations traverse the Central Switch to exchange the two values.

The other stations on Switch 1 all retrieve both external sensor measurement values from Station 1. Stations 6 and 8 traverse the central switch to retrieve both external sensor measurement values from Station 2. All other stations on Switch 2 (in this case none) would retrieve both external sensor measurement values from Station 2. All other stations on Switch 3 (in this case just Station 7) would retrieve both external sensor measurement values from Station 6. All other stations on Switch 4 (in this case Stations 9 and 10) would retrieve both external sensor measurement values from Station 8. This distributes the network traffic to avoid potential bottlenecks.

If a communications failure to the designated primary remote occurs for any station, except Stations 1 and 2 with local sensors installed, the station is able to retrieve the array of external sensor measurement values from a secondary remote station. All stations normally have the measurement values from both external sensors in its communications array so if the communications fails to a station with an external sensor installed on it, all stations can continue to operate using just the values from the remaining good external sensor station. This provides a high level of reliability of the shared external sensor values.

In this example, assuming the PakBus address and the IP address for each station is the station number in the diagram above, the configuration settings would be:

<u>Station 1</u>

    EXT_TRH_LOCAL = True

    EXT_TRH_PRIMARY = True

    EXT_TRH1_ENABLE = True

    EXT_TRH1_PK = 2

    EXT_TRH1_IP = 192.168.1.2

    EXT_TRH2_ENABLE = False

    EXT_TRH2_PK = 10 (ignored)

   EXT_TRH2_IP = 192.168.1.10 (ignored)

<u>Station 2</u>

    EXT_TRH_LOCAL = True

    EXT_TRH_PRIMARY = False

    EXT_TRH1_ENABLE =True

    EXT_TRH1_PK = 1

    EXT_TRH1_IP = 192.168.1.1

    EXT_TRH2_ENABLE = False

    EXT_TRH2_PK = 8 (ignored)

    EXT_TRH2_IP = 192.168.1.8 (ignored)

<u>Stations 3, 4 and 5</u>

    EXT_TRH_LOCAL = False

    EXT_TRH_PRIMARY = False

    EXT_TRH1_ENABLE = True

    EXT_TRH1_PK = 1

    EXT_TRH1_IP = 192.168.1.1

    EXT_TRH2_ENABLE = True

    EXT_TRH2_PK = 2

    EXT_TRH2_IP = 192.168.1.2

<u>Stations 6 and 8</u>

    EXT_TRH_LOCAL = False

    EXT_TRH_PRIMARY = False

    EXT_TRH1_ENABLE =True

    EXT_TRH1_PK = 2

    EXT_TRH1_IP = 192.168.1.2

    EXT_TRH2_ENABLE = True

    EXT_TRH2_PK = 1

    EXT_TRH2_IP = 192.168.1.1

<u>Station 7</u>

    EXT_TRH_LOCAL = False

    EXT_TRH_PRIMARY = False

    EXT_TRH1_ENABLE = True

    EXT_TRH1_PK = 6

    EXT_TRH1_IP = 192.168.1.6

    EXT_TRH2_ENABLE =True

    EXT_TRH2_PK = 2

    EXT_TRH2_IP = 192.168.1.2

<u>Stations 9 and 10</u>

    EXT_TRH_LOCAL = False

    EXT_TRH_PRIMARY = False

    EXT_TRH1_ENABLE = True

    EXT_TRH1_PK = 8

    EXT_TRH1_IP = 192.168.1.8

    EXT_TRH2_ENABLE =True

    EXT_TRH2_PK = 2

    EXT_TRH2_IP = 192.168.1.2

Communications States

The datalogger program displays the current communications state CommsState in the Public data table so users can easily check on the communications operation.

The possible communication states are:

COMMS ATTEMPT X - Attempting to contact a remote station.

This state is displayed while the local station is attempting to communicate with a remote station. The number "X" is the attempt number which increments for each successive attempt if communications is not established on the first attempt.

COMMS OK - Primary remote station contacted successfully.

This state is displayed after the local station has successfully completed communications with the primary remote station and collected the data in its communications array. This is the normal state.

COMMS SEC OK - Secondary remote station contacted successfully.

This state is displayed after the local station has successfully completed communications with the secondary remote station and collected the data from its communications array. This is the normal state that is expected when the primary remote station is either disabled or communications to it fails.

COMMS FAIL, *code1, code*2 - Communications failure, remote stations cannot be contacted.

This state is displayed when communications to the remote station(s) has been unsuccessful and the maximum number of retries has been reached. This state triggers a Comms Failure alarm and is written to the Event Log.

The COMMS FAIL message is followed by two error codes, *code1* and *code2*. The first, code1, is for communications to the primary remote station and the second, code2, is for communications to the secondary remote station. These codes point to failures of, or incompatibilities between, the station program requesting data and/or the station program providing the data, or possible network problems.

The codes that can be returned are as follows:

-1   -   A response was received but permission denied.

-16   -   The table name and/or field name is not present in the source datalogger, or the field is read only in the destination datalogger.

-17   -   The data type is not supported.

-18   -   The array in the source datalogger is not dimensioned large enough to hold the values to be sent or the array in the destination datalogger is not large enough to receive them.

-20   -   Out of Comms memory.

-21   -   Failed to route the packet when routing is set to auto-discover and the route isn't yet known.

-22   -   Communication port buffer exceeded.

-27   -   The DialSequence/EndDialSequence returned False so communication did not occur.

-99   -   The the remote station could not be contacted.

1, 2...n -   A positive number is the number of timeouts while waiting for a response. The value increments with each successive failure. After a 0 or negative response, the value will reset and start over at 1.

COMMS RETRY X - Communications retry needed after initial attempt failed.

This state is displayed after the local station failed an attempt to communicate with a remote station. The number "X" is the number of the pending retry and increments for each successive retry until either the maximum number of retries is reached or the communications succeeds.

DISABLED - Communications to remote stations is switched off and isn't used.

This state is displayed when communications is set to disabled because there are no remote stations to communicate with, or there is an unresolved communications problem and it was desirable to prevent a recurring communications alarm until repair work can be carried out.

INITIALISING - Communications state is undetermined while control system program is starting up.

This state is displayed when the datalogger program is starting up and the communications system has not yet made an attempt to communicate with a remote station. It represents a temporary indeterminate state that will resolve itself to one of the above states.

Functional States

The datalogger program uses state switches to keep track of all the operation of all functions. The current setting of each state switch is displayed in the Public data table variables so system users can see what state each program function is in. Each of the state switches is detailed below.

Enclosure 1 Air Temperature State

The enclosure 1 air temperature state is displayed in the Public data table E01TcState variable. This gives a visual indication of whether or not the enclosure is currently operating withing the setpoint range.

The possible enclosure temperature states are:

HIGH - The enclosure air temperature is above the high temperature setpoint.

OK - The enclosure air temperature is in the normal range.

LOW - The enclosure air temperature is below the low temperature setpoint.

ERROR - The enclosure air temperature is in an indeterminate state.

Enclosure 2 Air Temperature State (Optional)

The enclosure 2 air temperature state is displayed in the Public data table E02TcState variable when dual enclosures are installed. The states are the same as for "Enclosure 1 Sensor State" above. This gives a visual indication of whether or not the enclosure is currently operating withing the setpoint range.

Enclosure 1 Sensor State

The enclosure 1 sensor state is displayed in the Public data table E01SensState variable. A sensor 1 failure alarm is triggered if the sensor state indicates that the temperature or relative humidity sensor, or both have failed.

The possible enclosure sensor states are:

TC OK, RH OK - External sensor is installed, Temperature sensor is OK, RH sensor is OK.

TC FAIL, RH OK - External sensor is installed, Temperature sensor has failed, RH sensor is OK.

TC OK, RH FAIL - External sensor is installed, Temperature sensor is OK, RH sensor has failed.

TC FAIL, RH FAIL - External sensor is installed, Temperature sensor has failed, RH sensor has failed.

Enclosure 2 Sensor State (Optional)

The enclosure 2 sensor state is displayed in the Public data table E02SensState variable when dual enclosures are installed. The states are the same as for "Enclosure 1 Sensor State" above. A sensor 2 failure alarm is triggered if the sensor state indicates that the temperature or relative humidity sensor, or both have failed.

Power State

The mains power state is displayed in the Public data table PowerState variable. A prolonged power outage may result in the enclosure temperature reaching unacceptably high or low levels so any power outage triggers an alarm to alert staff. The datalogger is battery backed and is able to send alarm email messages while the UPS systems on the LAN are operating (typically 5-10 minutes after a power outage).

The possible power states are:

OK - Mains power is available, either from the electricity supply company or an on site generator set.

POWER FAIL - The mains power supply has failed, no mains power is available. Alarm triggered.

ZooCADA-Log Reference Manual

Alarm State

The alarm state is displayed in the Public data table AlarmState variable. The alarm system is designed record all alarm events into an Event Log data table so users can check on the recent system events, including any alarms. In addition to recording alarms in the Event Log, the alarms state is used to trigger the sending of alarms email messages via the email messaging system.

The possible alarms states are:

DISABLED - The alarm system has been disabled, no alarms will be detected.

INITIALISING - The alarm system is starting up and determining if any alarms are active.

NO ALARMS - All alarms are cleared.

>> ALARMS << - One or more alarms have been triggered.

NOTE: The alarms state displays >> ALARMS << with the chevrons when alarms are active to make this item more conspicuous in the displayed list of Public data table variables. The alarms state is not intended to provide details on the various alarms, this information is available via the other state switch indications, the Event Log, and the email messages.

Barometric Pressure Sensor State (Optional)

The barometric pressure sensor state is displayed in the Public data table BaroSensState variable. This state switch is only displayed if the optional barometric pressure sensor is installed, either on the local station or a remote station, and the station constant BARO_ENAB is set to True. A barometric pressure sensor failure alarm is triggered if the sensor state indicates that the sensor has failed.

The current QM (Quality Metric) value, if available, is reported in the BaroSensState variable to provide a visible indication of the current calibration accuracy of the barometric pressure sensor card. A QM value of 6 or higher indicates a freshly calibrated sensor, 5 or higher indicates the calibration is OK, 4 to 4.99 indicates that recalibration is needed most likely in the next two to three months, and less than 4 indicates the sensor needs recalibration.

If the sensor state indicates FAIL with a QM value of 4 or higher, the fault may be in the instrument electronics or elsewhere, not necessarily in the sensor card.

The possible barometric pressure sensor states (systems with QM value) are:

OK (QM n.nn) - The barometric pressure sensor is working normally.

RECALIB SOON - The sensor will need recalibrating in two to three months.

FAIL (QM n.nn) - The barometric pressure sensor needs recalibrating or has failed.

The possible barometric pressure sensor states (systems without QM value) are:

OK - The barometric pressure sensor is working normally.

FAIL - The barometric pressure sensor needs recalibrating or has failed.

Other State Switches

For information on the communications state CommsState and the email message send state EmailState please see the "Communications to Remote Stations" and "Email Messaging System" chapters respectively.

Event Log

TOA5, OKH_NH2_DL01, CR300, 15614, CR310.Std.10.07, CPU:OKH_NH2_DL01_R15.CR300, 685, E00_EVENT_LOG		
TIMESTAMP	RECORD	EventDetected
TS	RN	
		Smp
2024-01-11 18:28:18	0	Datalogger Program Started
2024-01-11 18:29:48	1	Alarm Power Failure
2024-01-11 18:29:48	2	Email Alarms
2024-01-11 18:29:48	3	EMAIL TEST MODE
2024-01-11 18:31:20	4	Power Failure Cleared
2024-01-11 18:31:20	5	Email Alarms Cleared
2024-01-11 18:31:20	6	EMAIL TEST MODE

The EVENT_LOG data table contains a descriptive indication of each event that occurs. This data table holds the most recent 1000 events, normally sufficient for several weeks of routine events, before its ring memory overwrites the oldest records with the newest records. The event log records all alarms and various other system events.

NOTE: Many of the event messages are also used to build the content of alarm email messages or appear in the various state variables displayed in the datalogger Public data table. Logging these events in the EVENT_LOG data table provides significant insights into the system operation and assists with problem resolution.

Viewing The Event Log

The Event log can be viewed two ways:

1. By collecting the data from the datalogger using LoggerNet, then opening the EVENT_LOG file with the View Pro utility which is part of LoggerNet. The data table is displayed in an easily readable format.

2. By viewing the data table in the dataloggers built-in web site.

Please see the Using The Web Interface chapter in this document for details on using the dataloggers built-in web site or the LoggerNet Product Manual, which can be downloaded from the Campbell Scientific web site, for details on using the various LoggerNet tools.

Event Messages

This section lists all the events that may be logged in the EVENT_LOG data table, for the ZooCADA-Log program, and provides an explanation of their meaning.

Enclosure 1

Alarm E01: Temp Too High - The enclosure 1 high temperature alarm was triggered.

E01: Temp Too High Cleared - The enclosure 1 high temperature alarm was cleared.

These events occur when the enclosure 1 temperature becomes too high and when it is subsequently cleared. The high temperature alarm is triggered when the enclosure 1 temperature E01AirTC rises to or above the enclosure high temperature setpoint Set_E00AirTC_HI plus the station constant ALARM_DEGREES. The alarm resets when the enclosure 1 temperature E01AirTC falls below the enclosure high temperature setpoint Set_E00AirTC_HI plus the station constant ALARM_RESET.

Alarm E01: Temp Too Low - The enclosure 1 low temperature alarm was triggered.

E01: Temp Too Low Cleared - The enclosure 1 low temperature alarm was cleared.

These events occur when the enclosure 1 temperature becomes too low and when it is subsequently cleared. The low temperature alarm is triggered when the enclosure 1 temperature E01AirTC falls to or below the enclosure low temperature setpoint Set_E00AirTC_LO minus the station constant ALARM_DEGREES. The alarm resets when the enclosure 1 temperature E01AirTC rises above the enclosure low temperature setpoint Set_E00AirTC_LO minus the station constant ALARM_RESET.

Alarm E01: Sensor Failure - The enclosure 1 temperature and RH sensor failure alarm was triggered.

E01: Sensor Failure Cleared - The enclosure 1 temperature and RH sensor failure alarm was cleared.

These events occur when the enclosure 1 temperature and relative humidity sensor fails and when it is subsequently restored to normal operation. Sensor failures usually require repair or replacement of the sensor by a service technician to clear the alarm.

Enclosure 2 (Optional)

Alarm E02: Temp Too High - The enclosure 2 high temperature alarm was triggered.

E02: Temp Too High Cleared - The enclosure 2 high temperature alarm was cleared.

These events occur when the enclosure 2 temperature becomes too high and when it is subsequently cleared. The high temperature alarm is triggered when the enclosure 2 temperature E02AirTC rises to or above the enclosure high temperature setpoint Set_E00AirTC_HI plus the station constant ALARM_DEGREES. The alarm resets when the enclosure 2 temperature E02AirTC falls below the enclosure high temperature setpoint Set_E00AirTC_HI plus the station constant ALARM_RESET.

Alarm E02: Temp Too Low - The enclosure 2 low temperature alarm was triggered.

E02: Temp Too Low Cleared - The enclosure 2 low temperature alarm was cleared.

These events occur when the enclosure 2 temperature becomes too low and when it is subsequently cleared. The low temperature alarm is triggered when the enclosure 2 temperature E02AirTC falls to or below the enclosure low temperature setpoint Set_E00AirTC_LO minus the station constant ALARM_DEGREES. The alarm resets when the enclosure 2 temperature E02AirTC rises above the enclosure low temperature setpoint Set_E00AirTC_LO minus the station constant ALARM_RESET.

Alarm E02: Sensor Failure - The enclosure 2 temperature and RH sensor failure alarm was triggered.

E02: Sensor Failure Cleared - The enclosure 2 temperature and RH sensor failure alarm was cleared.

These events occur when the enclosure 2 temperature and relative humidity sensor fails and when it is subsequently restored to normal operation. Sensor failures usually require repair or replacement of the sensor by a service technician to clear the alarm.

External Sensor

Alarm EXT: Sensor Failure - The external temperature and RH sensor failure alarm was triggered.

EXT: Sensor Failure Cleared - The external temperature and RH sensor failure alarm was cleared.

These events occur when an optional external temperature and relative humidity sensor connected to the local station fails and when it is subsequently restored to normal operation. Sensor failures usually require repair or replacement of the sensor by a service technician to clear the alarm.

Event Log

Barometric Pressure Sensor (Optional)

Systems with QM reporting:

Barometric Sensor OK (QM n.nn) - The barometric pressure sensor is working normally.

Barometric Sensor RECALIB SOON - The sensor will require recalibration in two to three months.

Barometric Sensor FAIL (QM n.nn) - The barometric pressure sensor needs recalibrating or has failed.

Systems without QM reporting:

Barometric Sensor OK - The barometric pressure sensor is working normally. (systems without QM value)

Barometric Sensor FAIL (QM n.nn) - The barometric pressure sensor needs recalibrating or has failed.

> These events indicate a change of the barometric pressure sensor's state switch BaroSensState and are based on the sensor's QM (Quality Metric) output. A QM of 5 or higher indicates the OK state, 4 to 4.99 indicates recalibration is needed soon, less than 4 indicates the sensor needs recalibration or has failed.

Alarm Barometric Sensor Failure - The barometric pressure sensor failure alarm was triggered.

Barometric Sensor Failure Cleared - The barometric pressure sensor failure alarm was cleared.

> These events occur when the barometric pressure sensor fails and when it is subsequently restored to normal operation. Sensor failures usually require replacement of the sensor card to clear the alarm.

Datalogger Program Restarts

Datalogger Program Started - Logged each time the datalogger program is started.

This event is logged to provide an indication of when the datalogger program was restarted. Restarts usually occur when a program update is loaded or the Setpoints table is edited but it can also happen if the datalogger detects an internal error (watchdog error) and automatically restarts itself. An occasional watchdog error is acceptable but frequent watchdog errors should be investigated.

Power Failure

Alarm Power Failure - The mains power failure alarm was triggered.

Power Failure Cleared - The mains power failure alarm was cleared.

> These events occur when a mains power failure occurs and when the power is subsequently restored.

Remote Station Communications

COMMS FAIL*, code1, code2* - The communications to the remote stations has failed.

> This event occurs when the local station cannot communicate with the remote station(s) to retrieve the external sensor data. It may correct itself before becoming an alarm event. Successful communications attempts are not logged. Excessive or continuous communications failures are usually the result of network problems, datalogger configuration errors, or hardware failures.

> For more information on the failure codes see the "Communications To Remote Stations" chapter.

Alarm Comms Failure - The data network communications failure alarm was triggered.

Comms Failure Cleared - The data network communications alarm has been cleared.

These events occur when a network failure occurs and when the network is subsequently restored to normal operation. Communications failures generally point to network problems, a configuration or hardware problem with a remote station, or a configuration or hardware problem with the local station. On sites where radio communications form part of the network the radio links may cause random intermittent communications failures that come right on their own.

Email System

Email Alarms - An email message advising of the alarms for this station has been sent.

This event occurs when the datalogger sends an email message advising staff of the station's alarms and is a normal function of the system. The event is generated every time the alarms system for the station changes state (either a new alarm occurs or an existing alarm is cleared).

Email Alarms Re-Send - The daily outstanding alarms email message for this station has been sent.

This event occurs when the datalogger sends the outstanding alarms reminder email message. This is a normal function of the system that is intended to remind staff each day of all outstanding alarms that have not yet been resolved. This message is not sent unless it is enabled in the system settings and unresolved alarms are present.

Email Alarms Cleared - An email message advising all the alarms for this station have been cleared.

This event occurs when the datalogger sends an email message advising staff that all the station's alarms have been cleared. It is a normal function of the system.

EMAIL SENT OK - The Email Relay server has received the message and relayed it to the recipients.

This event occurs when the datalogger successfully sends an email message. It is a normal function and the event is logged simply to enable confirmation that the email system is working.

EMAIL COMMS FAIL - The connection to the Email Relay server failed.

This event occurs when an email message cannot be sent because the datalogger is unable to connect to the Email Relay server. The error could be due to the Email Relay server being down in which case the system will return to normal operation when the Email Relay server administrator restores their server to operation. Other causes could be a network communications problem, a hardware fault, or a datalogger configuration error.

EMAIL DATA ERROR - The EmailRelay() function was called but not executed, the message was not sent.

This event occurs when an email message cannot be sent because execution of the EmailRelay() function did not occur due to lack of data records or not enough time. Possible causes include a network problem, a hardware fault, or a datalogger program error.

EMAIL COMMS ERROR - Error in communication to the Email Relay server, the message was not sent.

This event occurs when a connection to the Email Relay server was made but there was an error in communication, or the Email Relay server dropped the connection. Possible causes include a network problem, a datalogger program error, or a hardware fault.

This error also occurs if the datalogger has exceeded the maximum of 100 email messages sent via the Campbell Scientific Email Relay server in one day. If this limit is reached the Email Relay server terminates all further email send attempts by that datalogger until the next day (USA Time). A potential cause is an intermittent sensor fault that causes its measurement value to flip-flop between normal and an alarm state hundreds of time a day. This error will be obvious to staff as their email inbox will have been flooded with alarm email messages from the affected station.

Event Log

EMAIL DISABLED - The email messaging system is set to disabled, email messages will not be sent.

This event occurs when an email message would have been sent but the email system was set to disabled as it is not required. This is an informative diagnostic message, not a fault in the system.

EMAIL TEST MODE - The email messages are diverted to a file for test purposes.

This event occurs when an email message would have been sent but the email system was set to Test Mode which diverts the messages to a file for test purposes. and is an advisory message only.

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Alarms Module

The datalogger program monitors the temperatures of the enclosures, the functioning of the temperature sensors, and various other parameters to determine the alarms. An alarm is triggered whenever an abnormal event is detected. An alarm reset occurs when the trigger event has returned to normal. No user intervention is required to reset the alarms, this process is fully automated, although staff may well need to take action to either remedy the cause of the alarm, or arrange for a service technician to repair the fault that caused the alarm.

The alarms control module must be enabled in the STATION_CONSTANTS file for the alarms detection to operate.

Enabling The Alarms

The alarms module is enabled, or disabled, by setting the ALARM_ENABLE station constant in the datalogger program as follows:

ALARM_ENABLE = True   (The alarms are enabled), or

ALARM_ENABLE = False (The alarms are disabled).

NOTE: Enabling the alarms module enables alarms and alarm resets to be detected and then recorded in the EVENT_LOG data table. The email module must also be enabled in order for the datalogger program to send alarms email messages to staff. Please see the Email Messaging System chapter for further information.

Alarms Delay

The alarm delay time AL_DELAY (typically 10 seconds) is set in the program constants and is applied to all alarms to prevent nuisance alarms that would otherwise occur if an alarm condition is triggered and then immediately returns to normal. This delay time can be changed if necessary but is not intended to be user adjustable.

Alarms Event Logging

When the alarms module is enabled, each change of state of the alarms (alarms triggered and/or reset) will result in the alarm event being written to the event log. Please refer to the event log chapter for detailed information on all event messages and their meaning. Once an alarm is reset it is logged as being cleared as it no longer appears in the list of active alarms.

Alarms Module States

The datalogger program displays the current alarms state AlarmState in the Public data table so users can easily check on the overall state of the alarm system.

The possible alarm states displayed in the Public data table variable are:

DISABLED - The alarm system is not in use and has been disabled.

INITIALISING - The alarm system is starting up and determining if any alarms are active.

NO ALARMS - All alarms are cleared.

>> ALARMS << - One or more alarms have been triggered.

The alarm state only indicates the state of the alarm system, not the state of each individual alarm. The state of the individual alarms is indicated via the state variables displayed in the Public data table, the event log, and the alarm email messages.

Temperature Alarms Operation

The temperature alarms process is entirely automatic, once the cause of the temperature alarm has been remedied and the temperatures return to normal, the alarms will automatically reset. Each enclosure has its own high and low temperature alarms.

The desired operating temperature range for the enclosure(s) is determined by the high temperature and low temperature setpoints, Set_E00AirTC_HI and Set_E00AirTC_LO respectively. When the temperature in an enclosure moves too far beyond one of these setpoints a temperature alarm is triggered.

NOTE: When dual enclosures are installed, the temperature setpoints, are common to both enclosures. Multiple dataloggers can be networked together to provide individual enclosures with their own setpoints, datalogging, and control functions as needed.

The temperature setpoints are contained in the Setpoints data table in the datalogger and can be changed by users. There are temperature setpoints for each month of the year to enable keepers to configure the system so the alarms automatically follow seasonal temperature variation in the enclosure.

The temperature sensors are measured once every minute and a temperature alarm is triggered if the enclosure temperature E01AirTC, and/or E02AirTC if dual enclosures are installed, becomes higher than the high setpoint Set_E00AirTC_HI, or lower than the low setpoint Set_E00AirTC_LO, by the station constant ALARM_DEGREES amount.

Once an alarm is triggered it remains in that state until that alarm's reset conditions are met. Temperature alarms reset when the enclosure temperature becomes lower than the station constant ALARM_RESET amount below the high temperature setpoint Set_E00AirTC_HI or higher than the ALARM_RESET amount above the low temperature setpoint Set_E00AirTC_LO.

The alarm trigger station constant ALARM_DEGREES is normally set to about 4 degrees and the alarm reset station constant ALARM_RESET is normally set to about 2 degrees. The difference between these two values becomes the temperature alarm hysteresis value and must be at least one degree.

The following logic is applied to determine the state of the temperature alarm for each enclosure:

If Temperature >= Set_E00AirTC_HI + ALARM_DEGREES

    Set AlarmState to HighAlarm

Otherwise if Temperature <= Set_E00AirTC_LO - ALARM_DEGREES

    Set AlarmState to LowAlarm

Otherwise if Temperature > Set_E00AirTC_LO - ALARM_RESET and Temperature < Set_E00AirTC_HI + ALARM_RESET

    Set AlarmState to OK

The nature of the alarm is logged in the EVENT_LOG data table and sent to staff in the alarms email messages.

Temperature & RH Sensor Failure Alarms Operation

Each of the enclosures its own temperature sensor. An external temperature sensor may also be installed. These are normally very reliable and require little maintenance.

In the event that a sensor does fail, it is likely to produce a value that is outside of its specified operating range, such as -9999, or perhaps NAN which means Not A Number. Each time the sensors are read by the datalogger program, the program tests the measurement value for any out of range values. If an out of range value is detected the program sets the applicable sensors state variable, E01SensState, E02SensState, or ExtSensState for enclosure 1, enclosure 2, or the external sensor respectively, to indicate the failure.

The ZooCADA system uses combined temperature and relative humidity sensors for the enclosures and the external sensors.

The possible sensor fault states are:

TC OK, RH OK - External sensor is installed, Temperature sensor is OK, RH sensor is OK.

TC FAIL, RH OK - External sensor is installed, Temperature sensor has failed, RH sensor is OK.

TC OK, RH FAIL - External sensor is installed, Temperature sensor is OK, RH sensor has failed.

TC FAIL, RH FAIL - External sensor is installed, Temperature sensor has failed, RH sensor has failed.

The nature of the alarm is logged in the EVENT_LOG data table and sent to staff in the alarms email messages.

Barometric Pressure Sensor Failure Alarms Operation (Optional)

The barometric pressure sensor failure alarm process is entirely automatic, so once the faulty sensor has been repaired, the alarms will automatically reset. A sensor failure alarm can occur if the sensor card requires recalibration or if the sensor returns a pressure measurement value that is out of the manufacturers specified operating range. The sensor state is displayed in the Public table BaroSensState variable.

The possible states, with QM value, are:

OK (QM n.nn) - The barometric pressure sensor is working normally.

RECALIB SOON - The sensor will need recalibrating in two to three months.

FAIL (QM n.nn) - The barometric pressure sensor needs recalibrating or has failed.

The possible states, without QM value, are:

OK - The barometric pressure sensor is working normally.

FAIL - The barometric pressure sensor needs recalibrating or has failed.

NOTE: Barometric pressure sensors require periodic recalibration, typically every one to two years. Please see the manufacturers Product Manual for more information on recalibration procedures.

The QM (Quality Metric) value, if available, is displayed in the Public table BaroSensState variable. A newly calibrated sensor has a QM typically greater than 6 and its state is set to OK. As the sensor ages it's QM value diminishes. When the QM value drops below 4 the sensor needs recalibration and its state is set to FAIL. A warning that sensor recalibration will be needed in the next two to three months is produced while the QM value is in the range 4 to 4.99 during which time the state is set to RECALIB SOON.

If a sensor failure is displayed, check the QM value first. If the QM value is greater than 3.99 the failure may not be due to the sensor card, it could be a fault in the instrument electronics or elsewhere.

Power Failure Alarm Operation

The power failure alarm is automatic. It triggers when the power fails and resets when power is restored.

Mains electric power failures are usually the result of a failure somewhere in the power distribution system off site, rather than a problem with the electrical system in the building that is monitored by the datalogger, and power will be restored as soon as the electricity supply company is able to remedy the fault. The alarm is provided so that staff are informed and have the opportunity to take action should it be required.

A "power good" signal of about 2.6 Vdc from the datalogger's power supply is applied to the datalogger analog input port SE1. The PowerState variable in the Public data table indicates the presence or absence of that signal with two possible states as follows:

OK - Mains power is available, either from the electricity supply company or an on site generator set.

POWER FAIL - The mains power supply has failed, no mains power is available. Alarm triggered.

The nature of the alarm is logged in the EVENT_LOG data table and sent to staff in the alarms email messages.

WARNING: ALWAYS TREAT POWER LINES AS LIVE. Failures on the electricity supply network are normally restored without warning when the lines company has repaired the fault. **ELECTRIC SHOCK CAN BE FATAL!**

Communications Failure Alarm Operation

Although the ZooCADA-Log system itself does not require external temperature and relative humidity measurement values, it can fully participate in the sharing of external sensor measurement data across the network. Any station can be installed and configured to provide external sensor measurements to the network. Typically there is one or two stations installed with external sensors on a site and all the stations then communicate with one another to share that, and other data.

Occasionally, particularly in wireless links, communications errors result in a loss of a communication link between stations. The datalogger handles communications failures with multiple retries and use of a secondary station if the communications to the primary station fails, so normally the required data values are retrieved. If communications cannot be achieved within the MAX_COMMS_FAILS station constant number of retries, a communications failure alarm is triggered. The alarm automatically resets when communications is restored.

If the cause of the failure is due to a fault in the local station or its network connection, emailed alarm messages cannot be sent, but all communications failure are logged in the EVENT_LOG and the current state of the communications is displayed in the CommsState variable in the Public data table.

The possible communications states are:

COMMS ATTEMPT X - Attempting to contact a remote station.

COMMS OK - Primary remote station contacted successfully.

COMMS SEC OK - Secondary remote station contacted successfully.

COMMS RETRY X - Communications retry needed after initial attempt failed.

COMMS FAIL, *code1, code2* - Communications failure, remote stations cannot be contacted.
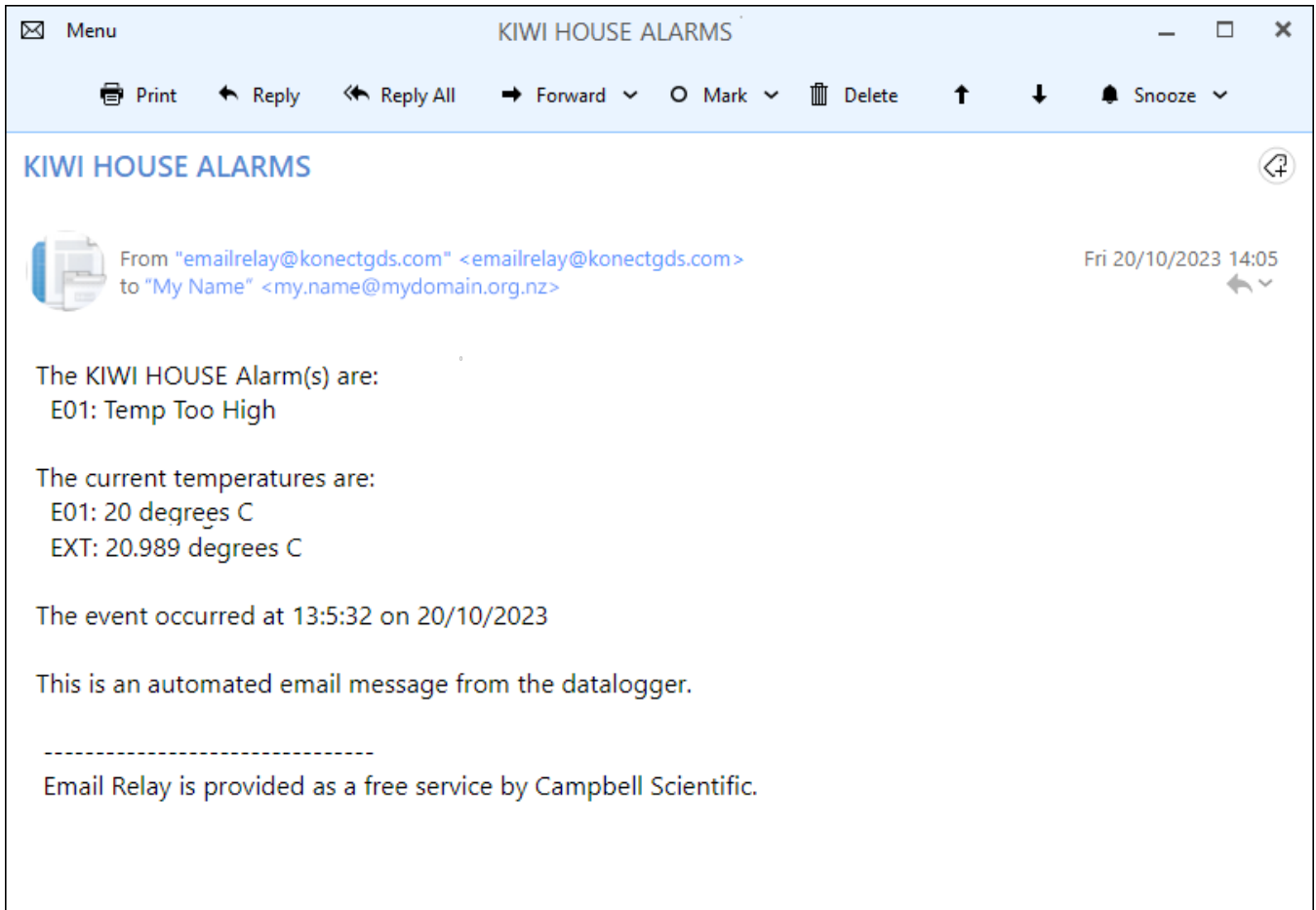
DISABLED - Communications to remote stations is switched off and isn't used.

INITIALISING - Communications state is undetermined while control system program is starting up.

The nature of the alarm is logged in the EVENT_LOG data table and sent to staff in the alarms email messages.

Email Messaging System

The datalogger can send alarm email messages advising users of events occurring at the station that need prompt attention. All messages are in the same format which is designed to alert users by the subject line alone, with more information contained in the message body. The format is designed to ensure messages are readily identified in a users email In-Box even on the smaller screens of mobile phones. A sample email message is shown above.

Alarms State Changed Email Messages

The operation of the email messaging system is completely automated.

The current state (active or inactive) of each alarm is stored in an array as a simple True or False, alarm active or alarm inactive respectively. Every two seconds the datalogger program checks the array to determine if the array contents have changed. If nothing has changed the alarms system does nothing further.

If the array contents have changed, the datalogger program creates a list of the alarms that are active and uses that list to build the body of a new email message. If no alarms are active (all previous alarms have been cleared) the list of alarms simply becomes a single "All Alarms Cleared" line instead of a list of current alarms. The current enclosure temperature measurements are added to the email message body along with the date and time the event occurred.

In this way, each alarm email message contains an up to date list of all the currently active alarms for the station. If there were two alarms listed on the previous email message and one of those has subsequently been cleared, the new email will simply list the remaining active alarm. This keeps the email message as concise as possible.

The email message is then sent via Campbell Scientific's Email Relay server to all the email recipients in the recipients list which is stored in the STATION_CONSTANTS file.

If the email message is not successfully sent to the Email Relay server, the datalogger program will try to send it again. The number of tries and the time between each try is set in the STATION_CONSTANTS file, typically three tries five minutes apart. Usually email messages are sent successfully on the first try but this technique helps ensure email messages will be sent successfully if the first try fails.

Alarms Daily Reminder Email Messages

Once each day the datalogger program can check the alarms array to determine if there are any outstanding alarms for the station that might have been overlooked. If outstanding alarms are present, it can then send a reminder email message to advise staff of the current situation.

The daily reminder email message function is enabled by default. If necessary, it can be disabled by setting the station constant ALARM_NAG = False in the datalogger program.

The reminder email message is normally sent at the beginning of the day so staff can schedule whatever remedial actions they consider appropriate into their day. The time at which the reminder email is sent is determined by the EMAIL_NAG_HOUR station constant. This setting, as with all ZooCADA system times, always operates in Standard Time. The default daily reminder email message send time setting is 8 for 08:00 hours.

If there are no outstanding alarms for the station, the reminder email message is not sent. This is to prevent cluttering up staff email inboxes with "All Alarms Cleared" messages on large sites with a number of stations.

Email Messaging System States

The datalogger program displays the current alarm email state EmailState in the Public data table so users can easily check on the messaging system operation.

The possible email message states are:

SENT OK - The Email Relay server has received the message and relayed it to the recipients.

> This state is displayed after the datalogger successfully sends an email message. It indicates that the email message was sent normally.

COMMS FAIL - The connection to the Email Relay server failed.

> This state is displayed when an email message cannot be sent because the datalogger is unable to connect to the Email Relay server. The error could be due to the Email Relay server being down in which case the system will return to normal operation when the Email Relay server comes back online. Other causes could be a network problem, a hardware fault, or a datalogger configuration error.

COMMS ERROR - Error in communication to the Email Relay server, the message was not sent.

> This state is displayed when a connection to the Email Relay server was made but there was an error in communication, or the Email Relay server dropped the connection. Possible causes include a network problem, a datalogger program error, or a hardware fault.

> This error also occurs if the datalogger has exceeded the maximum of 100 email messages sent via the Campbell Scientific Email Relay server in one day. If this limit is reached the Email Relay server terminates all further email send attempts by that datalogger until the next day (USA Time).

DISABLED - The email messaging system is set to disabled, email messages will not be sent.

> This state is displayed when the email messaging system is set to disabled because it is not required. This is an informative indication, not a fault in the system.

Email Messaging System

DATA ERROR - The EmailRelay() function was called but not executed, the message was not sent.

This state is displayed when an email message cannot be sent because execution of the EmailRelay() function did not occur due to lack of data records or not enough time. Possible causes include a network problem, a hardware fault, or a datalogger program error.

TEST MODE - The email messages are diverted to a file for test purposes.

This state is displayed when an email message would normally have been sent but the email system is set to Test Mode so the message was diverted to a file for test purposes. This is an informative diagnostic message, not a fault in the system.

Email Message Format

The email message subject is set as follows:

New Alarms - The ENCLOSURE plus the word "ALARMS".

Daily Re-sent Alarms - The ENCLOSURE plus the words "ALARMS (RE-SENT)".

Alarms Cleared - The ENCLOSURE plus the words "ALARMS CLEARED".

The first line in the message body "The ENCLOSURE Alarm(s) are:" identifies the station and provides a heading for the list of alarms.

Under the first line, the message body lists all of the current active alarms for the station. To avoid clutter any cleared alarms are not listed. If there were multiple alarms listed on the previous email and one of those alarms has subsequently been cleared, the newly cleared alarm is simply removed from the list.

When all alarms are cleared, an email message is sent stating "All Alarms Cleared" in place of the previous list of active alarms. This confirms to staff that there are no alarms outstanding.

A blank line follows the alarms list to separate it from the second list.

The second list has the heading "The current temperatures are:"

Following the second list heading the current temperatures for each enclosure at the station and the external temperature are listed. These temperatures are listed on every alarms email message, and the alarms cleared message, to give staff an immediate indication of the current situation and assist them with making decisions on their alarm response. The temperatures are updated before each email message send retry if the message is not successfully sent on the first try.

A blank line follows the temperatures list to separate it from the remainder of the message body.

The subsequent lines in the message body indicate the time the event occurred and identify the message as being an automated message from the datalogger.

NOTE: The time the event occurred is retained for subsequent email message send retries if the initial email message fails to send. This helps provides staff with an indication of how much time has elapsed since the alarm actually occurred.

Each email message ends with a footer stating "Email Relay is provided as a free service by Campbell Scientific" which is automatically applied by Campbell Scientific's Email Relay server.

Alarms Email Messages

The following information details the various alarms that can be sent by the datalogger as email messages to the recipients listed in the TO_ADDR station constant. All email messages are designed to provide a consistent format and concise content.

Enclosure 1 Alarms Messages

E01: Temp Too High - The enclosure high temperature alarm was triggered.

This alarm is triggered when the temperature in the enclosure rises above the Set_E00AirTC_HI setpoint by the station constant ALARM_DEGREES amount. Enclosure high temperature alarms typically result from an issue with the air conditioner that is preventing it maintaining the desired upper temperature limit.

E01: Temp Too Low - The enclosure low temperature alarm was triggered.

This alarm is triggered when the temperature in the enclosure falls below the Set_E00AirTC_LO setpoint by the station constant ALARM_DEGREES amount. Enclosure low temperature alarms typically result from an issue with the air conditioner that is preventing it maintaining the desired lower temperature limit.

E01: Sensor Failure - The enclosure temperature and RH sensor failure alarm was triggered.

This alarm is triggered when the temperature and RH sensor in the enclosure fails. Sensor failures will most likely require replacement of the sensor.

Enclosure 2 Alarms Messages

E02: Temp Too High - The enclosure high temperature alarm was triggered.

This alarm is triggered when the temperature in the enclosure rises above the Set_E00AirTC_HI setpoint by the station constant ALARM_DEGREES amount. Enclosure high temperature alarms typically result from an issue with the air conditioner that is preventing it maintaining the desired upper temperature limit.

E02: Temp Too Low - The enclosure low temperature alarm was triggered.

This alarm is triggered when the temperature in the enclosure falls below the Set_E00AirTC_LO setpoint by the station constant ALARM_DEGREES amount. Enclosure low temperature alarms typically result from an issue with the air conditioner that is preventing it maintaining the desired lower temperature limit.

E02: Sensor Failure - The enclosure temperature and RH sensor failure alarm was triggered.

This alarm is triggered when the temperature and RH sensor in the enclosure fails. Sensor failures will most likely require replacement of the sensor.

Barometric Pressure Sensor Alarm Message (Optional)

Barometric Sensor Failure - The barometric pressure sensor failure alarm was triggered.

This alarm is triggered when the measurement value returned by the sensor is outside of the expected operating range, or if available, the sensor's Quality Metric value falls below 4. If its available, the QM value is displayed next to the state in the Public table BaroSensState variable. If the QM values are greater than 3.99 the failure may not be due to the sensor card, it could be in the instrument electronics or elsewhere. If the QM values are less than 4 the sensor card requires recalibration.

External Sensor Alarm Message (Optional)

Ext: Sensor Failure - The external temperature and RH sensor failure alarm was triggered.

This alarm is triggered when the external temperature and RH sensor fails. Sensor failures will most likely require replacement of the sensor.

Email Messaging System

General Fault Alarms Messages

Comms Failure - The data network communications failure alarm was triggered.

This alarm is triggered when a network failure occurs. Communications failures usually point to network problems or a configuration or hardware problem at either a remote station or the local station. On sites where radio communications form part of the network the radio links may cause random intermittent communications failures that come right on their own.

Power Failure - The mains power failure alarm was triggered.

This alarm is triggered when a mains power failure occurs. Staff may need to respond to outages of extended duration to prevent spoilage of refrigerated food, such as by installing a temporary generator to supply the building.

Email Messages Daily Limit

The maximum number of email messages that can be sent by a datalogger in any one day is 100. This is a function of the Email Relay server provided by Campbell Scientific and is designed to ensure the system is not open to abuse. It is highly unlikely this will be exceeded by a station operating with ZooCADA system software.

If a station does exceed the limit, the email server will respond with an error which is displayed in the Public data table EmailState variable as "EMAIL COMMS ERROR". The Email Relay server will automatically reset at the end of the day, the time of which is determined by the server time (USA time).

Enabling The Email Messaging

The email messaging system is enabled, or disabled, by setting the EMAIL_ENABLE station constant in the STATION_CONSTANTS file as follows:

EMAIL_ENABLE = True - Sending email is enabled.

EMAIL_ENABLE = False - Sending of email is disabled, messages sent to test file instead.

Ensure there is at least one email address defined in the TO_ADDR station constant before enabling the email messaging system.

IMPORTANT: The alarms must also be enabled for email messaging to operate. If the alarms are set to disabled the email messaging is also automatically disabled.

Recipient Email Addresses

The automated alarm email messages are sent to the list of recipients whose email addresses are set in the TO_ADDR station constant. There must be at least one email recipient address if the alarms are enabled.

The format is:

TO_ADDR = keeper1@myisp.co.nz, keeper2@myisp.co.nz, manager@myisp.co.nz

Each address in the list must be separated from the next address with a comma.

It is best to send the email messages to at least two staff members to ensure the alarms have the best chance of being received by someone who can respond in a timely manner.

Email Test Function

The email module has a test function that enables the alarms and email system to be tested, without actually sending email messages, by diverting the messages to a file in the datalogger memory. This test function is enabled, or disabled, by setting the EMAIL_TEST station constant in the STATION_CONSTANTS file as follows:

EMAIL_TEST = True - Email messages are diverted to a file.

EMAIL_TEST = False - Email messages are sent to the email recipients.

The EMAIL_ENABLE constant must also be set to True.

When in the email test mode each email message is sent to a text file named EmailTest.txt in the datalogger. This file stores the exact text of every email message that is "sent" while the test mode is operating, including the email send retries because there is no confirmation from an Email Relay server. The file can be accessed using the Campbell Scientific LoggerNet software and a text editor or by using the File Control Page from the datalogger's built-in web interface.

Installation Notes

Use these pages to record any important notes specific to the site installation or operation.

Templates for Record Keeping

The following pages are intended to assist users with record keeping.

Good records are essential for audit, research and maintenance purposes. We recommend that users keep an ongoing file of all system settings in a manner that is appropriate to their business operations.

Each time settings are changed, a new record of the settings should be created and added to the file. Previous records should be retained when new records are added. This will provide an auditable trail of all setting changes that can assist research with site specific records of what works well for the animal species on display at that site.

These records also assist with maintenance. In the event that system settings have to be reinstated after maintenance work, the correct set of documented settings can be used to complete the reinstatement.

Please photocopy the following pages as needed and use them to create your own record keeping system.

This Page Intentionally Left Blank

ZooCADA-Log Station Configuration Record (Page 1 of 2)

Station Name: .... Site ID: .... Date: ..../.........../.................

Datalogger Settings

Datalogger Model:	Serial Number:
PakBus Address:	IP Address:
Subnet mask:	Gateway:
Program name:	

Station Setpoints

SET_JAN_HI =	SET_SEP_HI =
SET_JAN_LO =	SET_SEP_LO =
SET_FEB_HI =	SET_OCT_HI =
SET_FEB_LO =	SET_OCT_LO =
SET_MAR_HI =	SET_NOV_HI =
SET_MAR_LO =	SET_NOV_LO =
SET_APR_HI =	SET_DEC_HI =
SET_APR_LO =	SET_DEC_LO =
SET_MAY_HI =	SET_TOO_HOT =
SET_MAY_LO =	SET_TOO_COLD =
SET_JUN_HI =	SET_RH_HI =
SET_JUN_LO =	SET_RH_LO =
SET_JUL_HI =	
SET_JUL_LO =	
SET_AUG_HI =	
SET_AUG_LO	

Complete a new page each time the configuration is changed so an auditable record of changes is created.

ZooCADA-Log Station Configuration Record (Page 2 of 2)

Station Constants - General

ENCLOSURE =	EMAIL_ATTACH =
CUSTOM_FILE =	EXT_DATA_ENABLE =
DUAL_ENCL =	EXT_TRH_LOCAL =
KWH_INSTALLED =	EXT_TRH_PRIMARY =
ALARM_ENABLE =	EXT_SDI_ADDR =
ALARM_DEGREES =	E01TRH_SDI_ADDR =
ALARM_RESET =	E01SOIL_SDI_ADDR =
EMAIL_ENABLE =	E02TRH_SDI_ADDR =
EMAIL_TEST =	E02SOIL_SDI_ADDR =
EMAIL_RESEND =	BARO_ENAB =
EMAIL_TRIES =	BARO_STN_ELEV =
EMAIL_NAG =	BARO_LOCAL =
EMAIL_NAG_HOUR =	BARO_SDI_ADDR =

Station Constants - Email Addresses

TO_ADDR =

Station Constants - Comms Module

EXT_TRH1_ENABLE =	EXT_TRH2_ENABLE =
EXT_TRH1_PK =	EXT_TRH2_PK =
EXT_TRH1_IP =	EXT_TRH2_IP =
MAX_COMMS_FAILS =	COMMS_PRIORITY =

Complete a new page each time the configuration is changed so an auditable record of changes is created.

Station Change Log

Station Name: .... Site ID: ....

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Station Change Log

Station Name: .... Site ID: ....

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	

Date of Change:	Change(s) made:
Changed By:	