

### Introduction

The XR3000 Configurable Logic Controller (XR3000 Agent) exemplifies a new, more accessible form of automation controller. Its enabling technology allows users to implement and manage their own automation needs for many types of installations ranging from automated irrigation control, crop monitoring, reservoir management, and many other applications.



### Control Principles

The guiding principle behind the operation of the XR3000 is that of the Hysteresis Controller. A Hysteresis Controller monitors an input and controls an output based on threshold settings compared against the input. A simple example of this is a thermostat. A thermostat “turns on” at a set temperature, and then turns off after either a preset amount of time, or after a specific temperature delta has been achieved. While a thermostat uses a single threshold with an implied direction, the XR3000 uses both an explicit on and off threshold and these two settings imply the direction. For example, a thermostat used to turn on a furnace that is set at 60F, will turn on when the temperature sinks below 60F and will turn off at some higher temperature. In the XR3000 that would correspond to an On Threshold of 60F and an Off Threshold of 65F. Since the On Threshold is lower than the Off Threshold, the implication is that the “turn on” criterion is when the temperature/Input falls below 60F.

## *“Take Control”*

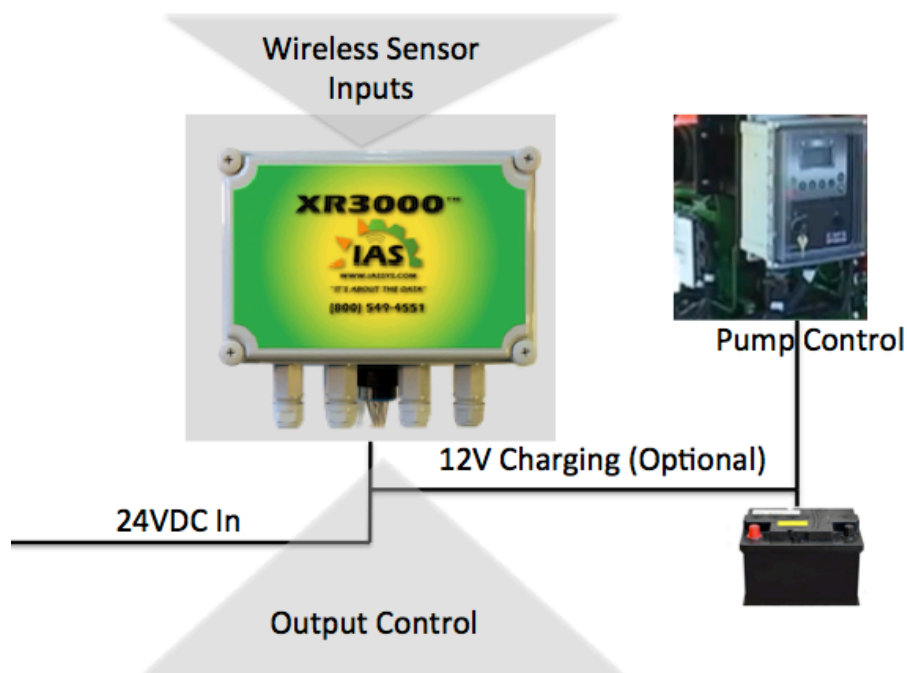
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The delta between the On Threshold and the Off Threshold provides the “Hysteresis” needed to allow the control to operate smoothly.

The XR3000 Agent can be thought of as an eight channel Hysteresis Controller, where each of the eight input channels can be used to turn on one of the eight outputs.

### System Overview

The XR3000™ can be operated independently, or integrated with a pump control system. The XR3000™ provides the Internet accessibility, remote sensor integration and simple control configuration necessary to fully automate any remote installation.



### Power Requirements

The XR3000™ can be powered from an optional solar panel, or can be hard-wired with 18-24VDC input. The XR3000™ comes with internal batteries to allow notification of power failure, and can be used to charge an external battery in engine-driven applications.

### Access



## *“Take Control”*

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Once installed, the XR3000™ can be accessed from any computer or mobile device with Internet access. The URL is [harvestwatch.iassys.com](http://harvestwatch.iassys.com)

### **Web Interface**

The XR3000™ has a web-interface that allows the device to be configured to match the required operation, and then once configured, viewed at a glance to see the overview of the resource being monitored and controlled.

This web-based GUI supports many different types of devices, but the portion that is specific to the XR3000™ is broken down into five tabs:

- **Control** – this tab is the default tab and displays all eight channel input reads, all eight output states, start schedule programming and optionally pump and engine status if being used in an engine-driven application.
- **Input** – this tab is used to configure the input On/Off Thresholds and to specify which Outputs are controlled by which Inputs.
- **Output** – this tab is used to configure output behavior. Start delays, on times, and output to output logical behavior are defined here. Outputs can be “triggered” from another channel, and configured to turn on after a delay. The buzzer can be configured here to buzz during the start delay of any configured output.
- **Wireless** – this tab is used to verify wireless sensor operation and to select which sensors are bound to which channels.
- **System** – this tab is used to check the system time, serial number, battery and solar panel currents and voltages. This tab is also used to configure integration with an external Modbus-capable Controller.

### **Control Tab Examples**

Below in Figure 1 is shown an example of an XR3000™ control tab, configured with an optional, external controller.

## “Take Control”

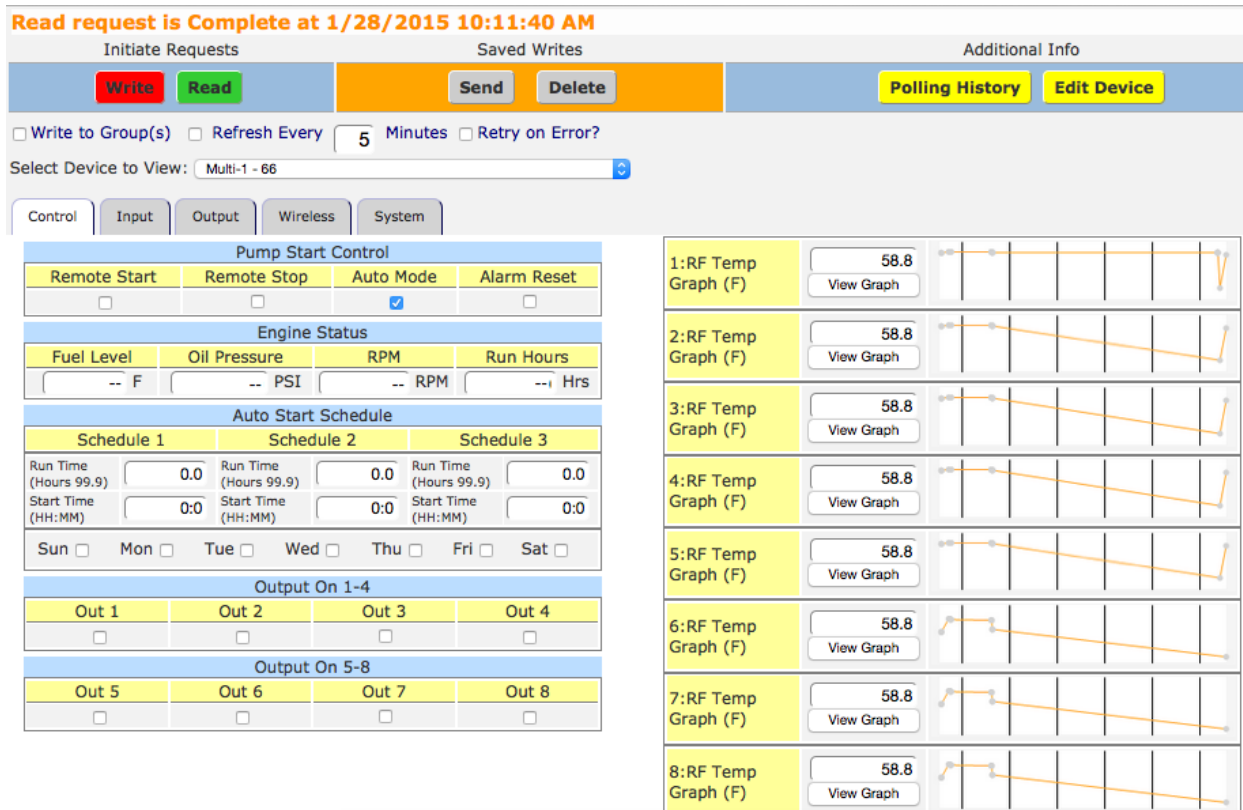


Figure 1: Control Tab with Pump Controller Information

In Figure 2, a generic Control Tab is shown for an example XR3000 unit. In this case, all eight channels are being used for wireless temperature sensors. In the example above, channel 1 has been set to turn on with a temperature below 70F and off again when the temperature reaches 80F. Note that the output “Out 1” is on for channel 1. The eight temperature sensors shown here can be used individually to turn on their respective outputs, or can be logically combined to turn on a single output when any one meets the threshold criteria.

## "Take Control"

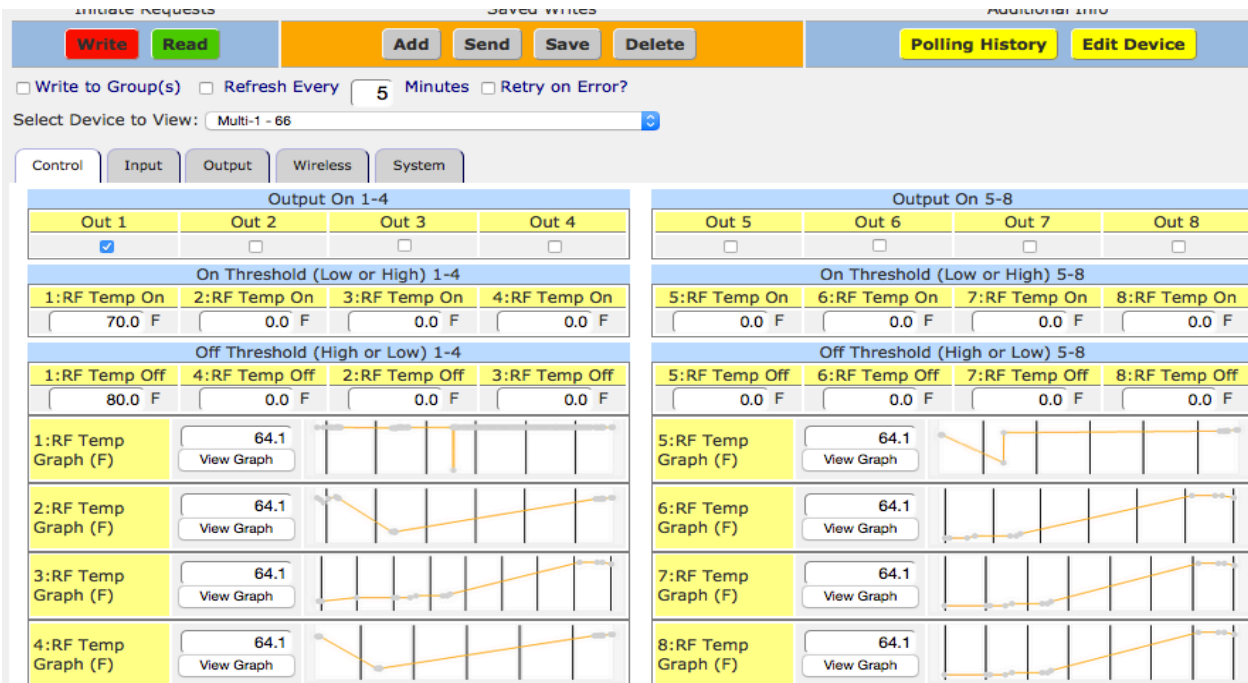


Figure 2 : Control Tab

### Input Tab Examples

Below in Figure 3, the Input Tab is shown. The Input Tab allows the matching of sensors to channels, and allows the outputs to be configured to determine which outputs are controlled by which input channels. In the example below, each output is defined to be controlled by its corresponding, individual input. If all the "CH Out" dialogs had the same 1-8 number defined, then any Input Channel 1-8 matching it's On/Off criteria would control the same output.

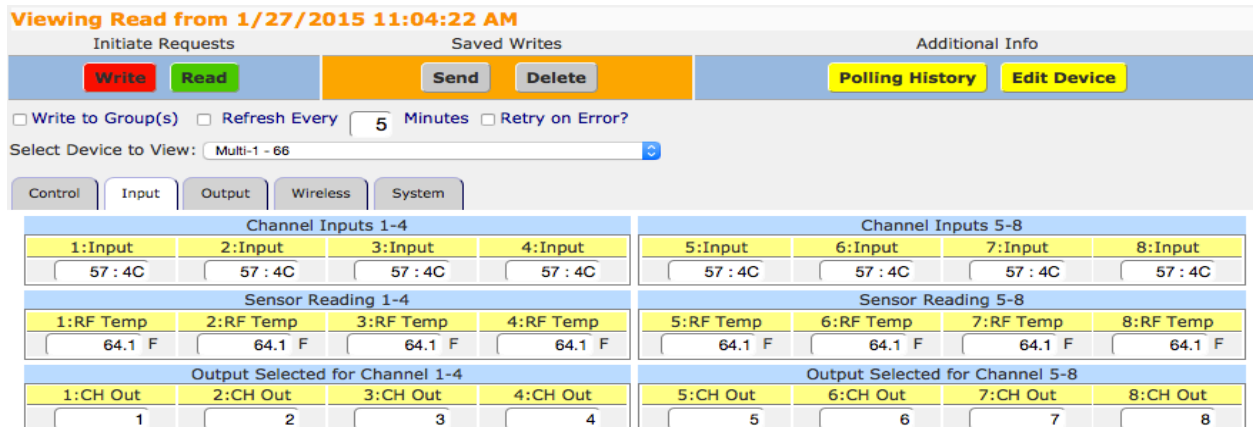


Figure 3: Input Tab

## *“Take Control”*

For example, in Figure 4 below, any temperature could trigger Output 1. This might be an example of turning on sprinklers for a frost-protection system. The Input channel that meets its temperature criteria first, will turn on Output 1.

Note that setting both On and Off Thresholds to the same value disables that input channel as far as output control.

Home << Back **BrettsFarm - Multi-1 - 66** Help Log Out

**Viewing Read from 1/27/2015 11:04:22 AM**

Initiate Requests      Saved Writes      Additional Info

**Write** **Read** **Send** **Delete** **Polling History** **Edit Device**

☐ Write to Group(s) ☐ Refresh Every  Minutes ☐ Retry on Error?

Select Device to View: Multi-1 - 66

Control Input Output Wireless System

Channel Inputs 1-4				Channel Inputs 5-8			
1:Input	2:Input	3:Input	4:Input	5:Input	6:Input	7:Input	8:Input
57 : 4C	57 : 4C	57 : 4C	57 : 4C	57 : 4C	57 : 4C	57 : 4C	57 : 4C

Sensor Reading 1-4				Sensor Reading 5-8			
1:RF Temp	2:RF Temp	3:RF Temp	4:RF Temp	5:RF Temp	6:RF Temp	7:RF Temp	8:RF Temp
64.1 F	64.1 F	64.1 F	64.1 F	64.1 F	64.1 F	64.1 F	64.1 F

Output Selected for Channel 1-4				Output Selected for Channel 5-8			
1:CH Out	2:CH Out	3:CH Out	4:CH Out	5:CH Out	6:CH Out	7:CH Out	8:CH Out
1	1	1	1	1	1	1	1

Figure 4

The hexadecimal number displayed in each X:Input dialog indicates which wireless sensor is bound to that channel. This number is also printed on each individual sensor. The sensors can be bound to specific channels by using the Wireless Tab, but the XR3000 system will also auto-populate these dialogs with the first eight wireless sensors found when it is initially installed.

### *Output Tab Examples*

In the example of Figure 5, Output 1 is being used to start a single device, which could be an irrigation pump or system. There is a 0.2 minute delay (12 seconds) during which time the buzzer will sound, before Output 1 will be enabled. Note that all three schedules are configured to turn on Output 1.

## “Take Control”

Select Device to View: Multi-1 - 66

Control Input **Output** Wireless System

Logically AND Output X				To this Channel			
AND To 1	AND To 2	AND To 3	AND To 4	AND To 5	AND To 6	AND To 7	AND To 8
0	--	--	--	0	0	0	0
Channel Trigger 1-4				Channel Trigger 5-8			
1:CH Trig	2: CH Trig	3:CH Trig	4:CH Trig	5:CH Trig	6:CH Trig	7:CH Trig	8:CH Trig
--	--	--	--	--	--	--	--
Output Start Delay 1-4				Output Start Delay 5-8			
1:Delay	2:Delay	3:Delay	4:Delay	5:Delay	6:Delay	7:Delay	8:Delay
0.2 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M
If Non-Zero Use On Time X				Instead of Off Threshold			
On Time 1	On Time 2	On Time 3	On Time 4	On Time 5	On Time 6	On Time 7	On Time 8
0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M	0.0 MM.M
Exclusive Output 1-4				Exclusive Output 5-8			
Excl 1	Excl 2	Excl 3	Excl 4	Excl 5	Excl 6	Excl 7	Excl 8
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Outputs for Buzzer and Schedule							
Buzzer Trigger	Sched A Out	Sched B Out	Sched C Out				
1	1	1	1				

Figure 5: Output Tab

The Output Tab contains the configuration options for logically combining Outputs and Channels. The top row allows an Output X to be logically dependent on a specific Input Channel in addition to the one that is configured to use Output X as its output.

### Channel Trigger

The Channel Trigger configuration can be used to configure an Output to turn on based on the state of another Output. If 2:CH Trig is set to '1', then Output 2 will turn on if Output 1 is on, and will turn on 2:Delay time after Output 1. In this manner outputs can be sequenced. If the Channel Trigger is set to '9' then that output will trigger on any other output being on.

### Wireless Tab

The Wireless Tab is used to configure and monitor the behavior of the wireless sensors. The top row shows the MAC Id for each sensor. The second row shows the time since the last update in seconds. The third row shows a percentage representing the quality of the signal from the sensor, and finally the “Found Radio” control allows assigning sensors to specific channels via the Bind # and Clear # dialogs.

Note that the battery voltage for each radio can also be seen. The battery should be above 3.3V to be considered fresh and any battery below 3.0V should be replaced.

### How the XR3000 “finds” Radios Initially



## *“Take Control”*

When the XR3000 is initially powered up, the Radio ‘X’ fields as shown below should all be 00:00. The XR3000 listens for any RF90 wireless sensor broadcasting sensor data. As radios are discovered, they are placed in the first Radio ‘X’ slot with a 00:00 as the MAC address. Once the radios are discovered, they will be remembered and displayed in the same slots.

### How to use the Bind Field

If a new radio is discovered, but there are no open Radio ‘X’ slots, the MAC will be displayed in the “Found Radio” control block. By entering a radio number 1 thru 8 into the Bind window and clicking on the ‘Write’ button, the newly discovered radio will be then placed into the Radio ‘X’ slot. For example, if a ‘1’ was written into the Bind window, the new radio will now be remembered as Radio 1. Any previously discovered radio in that slot will no longer be in the remembered list.

### How to use the Clear Field

By entering a 1 thru 8 into the Clear window, and then clicking the “Write” button, the radio number entered will be cleared from the remembered list. If a ‘1’ was written, then Radio 1 would display 00:01 as its MAC. Radio 1 now has no radio remembered for that slot, but a newly discovered radio will not automatically be placed into slot one, since the MAC number is not set to 00:00.

Control	Input	Output	Wireless	System	Local Sensors		
Radio 1	Radio 2	Radio 3	Radio 4	Radio 5	Radio 6	Radio 7	Radio 8
86 : 3D	57 : 38	00 : 00	00 : 00	00 : 00	00 : 00	00 : 00	00 : 00
Seconds Since Update 1-4				Seconds Since Update 5-8			
Time 1	Time 2	Time 3	Time 4	Time 5	Time 6	Time 7	Time 8
19 S	132 S	-- S	-- S	-- S	-- S	-- S	-- S
Radio Link Quality 1-4				Radio Link Quality 5-8			
Radio 1 LQ	Radio 2 LQ	Radio 3 LQ	Radio 4 LQ	Radio 5 LQ	Radio 6 LQ	Radio 7 LQ	Radio 8 LQ
63 %	70 %	-- %	-- %	-- %	-- %	-- %	-- %
RF Batt:1	RF Batt:2	RF Batt:3	RF Batt:4	RF Batt:5	RF Batt:6	RF Batt:7	RF Batt:8
3.45 V	3.37 V	-- V	-- V	-- V	-- V	-- V	-- V
Found Radio							
Bind (1-8)	Clear (1-8)	MAC #	Type				
--	--	00 : 00	--				

Figure 6: Wireless Tab

### How to Interpret the Time Field

The Time ‘X’ field in the “Seconds Since Update” control block show how long in seconds it has been since that Radio ‘X’ has been heard from with new sensor data. Typically this number will be less than 300 seconds, since the RF90 radios transmit sensor data roughly every 5 minutes or 300 seconds. If that number grows very large, then that specific radio is not functioning properly.

### How to Interpret the LQ% Field



## *“Take Control”*

The LQ% or Link Quality field can be used to roughly interpret the signal strength of the RF90 wireless sensor as the transmission is received at the XR3000. This is a 0 to 100% scale, which is a linearization of a logarithmic scale and so should only be used as a relative measurement.

### Setup To Turn On/Off by Threshold

Control	Input	Output	Wireless	System	Local Sensors
<b>Channel Inputs 1-4</b>					
1:Input	2:Input	3:Input	4:Input		
54 : 86	55 : 86	56 : 86	57 : 86		
<b>Sensor Reading 1-4</b>					
1:RF Soil Moisture	2:RF Soil Moisture	3:RF Temp	4:RF Temp		
10 %	10 %	59.6 F	60.2 F		
<b>On Threshold (Low or High) 1-4</b>					
1:RF On Percent	2:RF On Percent	3:RF Temp On	4:RF Temp On		
10 %	10 %	32.0 F	32.0 F		
<b>Off Threshold (High or Low) 1-4</b>					
1:RF Off Percent	2:RF Off Percent	3:RF Temp Off	4:RF Temp Off		
50 %	50 %	35.0 F	35.0 F		
<b>Output Selected for Channel 1-4</b>					
1:CH Out	2:CH Out	3:CH Out	4:CH Out		
1	1	1	1		
<b>Channel Inputs 5-8</b>					
5:Input	6:Input	7:Input	8:Input		
58 : 86	53 : 86	52 : 86	51 : 86		
<b>Sensor Reading 5-8</b>					
5:RF Soil Moisture	6:RF Soil Moisture	7:RF Temp	8:RF Temp		
10.1 %	13.0 %	58.7 F	59.0 F		
<b>On Threshold (Low or High) 5-8</b>					
5:RF Percent On	6:RF Percent On	7:RF Temp On	8:RF Temp On		
10 %	10 %	32.0 F	32.0 F		
<b>Off Threshold (High or Low) 5-8</b>					
5:RF Percent Off	6:RF Percent Off	7:RF Temp Off	8:RF Temp Off		
50 %	50 %	35.0 F	35.0 F		
<b>Output Selected for Channel 5-8</b>					
5:CH Out	6:CH Out	7:CH Out	8:CH Out		
5	5	5	5		

In the example above, there are two pumps being controlled. Pump 1 is controlled by Output 1, and Pump 2 is controlled by Output 2. In this example, both pumps are associated with Temperature and Soil Moisture sensors. The pumps are set to turn on when the temperature drops below 32F and to turn off when the temperature rises above 35F. Also the pumps will turn on when the soil moisture drops below 10% and back on when it rises to 50%. The state machine for each Channel Input is run independently, so any channel falling below its “On” threshold will turn the pump on in this example. By default, the Output will turn off based on any input channel crossing above its “Off” threshold. There is a Threshold Mode register on the System tab which can be set to non-zero so that all input channels mapped to the same Output must cross their “Off” threshold before the Output will be turned Off.

### Setup To On by Threshold and Off By Time

Using On/Off Threshold to establish On level, and direction of threshold, and if Time On is set to non-zero, the Output will stay on for Time specified.

### Wiring Harness

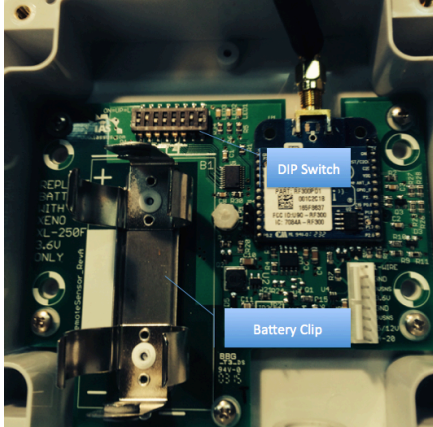
## *“Take Control”*

<b>Wiring Harness - Deutsch HDP26-24-21SE</b>				
<b>Pin # (letter)</b>	<b>Gauge</b>	<b>Function</b>	<b>Connected To</b>	<b>Alpha Wiring Scheme (All 18AWG)</b>
A to E on Socket	18AWG	Reserved	Internal Ground Loop - Common with PV- on socket.	Red/Black
B	12AWG to 16AWG (2 Wires on plug)	Battery+	External 12V Battery (+)	Red/Yellow
C	18AWG	RS485+ (A+)	External Modbus Device - Note IEM-2020 Terminal 13	White/Black
D	12AWG to 16AWG (2 Wires on plug)	PV+	Solar Panel (+)	Red
E	12AWG to 16AWG	PV-	Solar Panel (-) - A pin can loop and join in E pin.	Black
F	18AWG	RS485- (B-)	External Modbus Device - Note IEM-2020 Terminal 14	White/Green
G	12AWG to 16AWG	Battery-	External 12V Battery (-)	Brown
H	Relay 1 / 18AWG	Programmable Output 1/NO		Green
J	Relay 2 / 18 AWG	Programmable Output 2/NO		Blue
K	Relay 3 / 18AWG	Programmable Output 3/NO		Purple
L	Relay 4 / 18AWG	Programmable Output 4/NO		Gray
M	Relay 5 / 18AWG	Programmable Output 5/NO		White
N	Relay 6 / 18AWG	Programmable Output 6/NO		Beige
P	Relay 7 / 18AWG	Programmable Output 7/NO		Pink
R	Relay 8 / 18AWG	Programmable Output 8/NO		Yellow
S	Relay 1 Center / 16-18AWG	Center of Relay 1		Red/Green
T	Relays 2-8 Centers / 12-16AWG	Load for Relays 2-8		Red/White
U				
V				
W				
X				

### Radio Configuration

See the image of the RF90 Wireless Sensor below. The XR3000 accepts up to 8 wireless sensors.

## *“Take Control”*



The DIP switches are in the upper portion of the image, and the battery clip is shown to the left. There should be no reason to change a DIP switch unless to setup a device as a Repeater. Using a standard RF90 as a Repeater will consume battery life significantly faster, so that device should be monitored carefully to ensure proper function, and will require battery replacement more often.

The image to the right shows the battery installed in the correct orientation. Plus and Minus are marked on the PCB. The clips are very stiff to ensure good contact, but in order to ensure proper contact seating, rotate the battery once inserted. This will allow the battery to move vertically within the clips and ensure that the spring force is not holding the battery too low or too high.



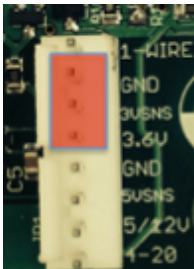
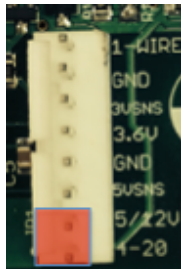
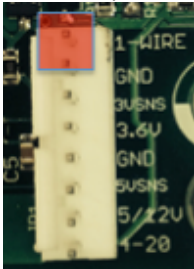
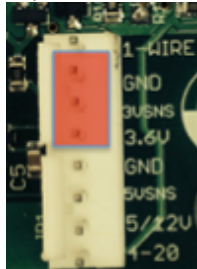
### Dip Switches

## *“Take Control”*

Switch	1 – 8, Left to Right, Up is On
1	On: Erase flash on Power-Cycle / Always leave Off
2	On: Repeater Behavior, Off Normal Behavior. Repeater takes more battery.
3	Reserved
4-8	Sensor type.

### Sensor Types

The table below shows the correct DIP switch setting and connector position for each sensor type.

<table><tr><td>X</td><td>X</td><td>X</td><td>Off</td><td>Off</td><td>Off</td><td>Off</td><td>On</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr></table> <p>VH400 Soil Moisture Sensor (33)</p> 	X	X	X	Off	Off	Off	Off	On	1	2	3	4	5	6	7	8	<table><tr><td>X</td><td>X</td><td>X</td><td>Off</td><td>Off</td><td>Off</td><td>On</td><td>On</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr></table> <p>Irrrometer LT Tensiometer (35)</p> 	X	X	X	Off	Off	Off	On	On	1	2	3	4	5	6	7	8
X	X	X	Off	Off	Off	Off	On																										
1	2	3	4	5	6	7	8																										
X	X	X	Off	Off	Off	On	On																										
1	2	3	4	5	6	7	8																										
<table><tr><td>X</td><td>X</td><td>X</td><td>Off</td><td>Off</td><td>Off</td><td>On</td><td>Off</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr></table> <p>RTD Temperature Sensor (34)</p> 	X	X	X	Off	Off	Off	On	Off	1	2	3	4	5	6	7	8	<table><tr><td>X</td><td>X</td><td>X</td><td>Off</td><td>Off</td><td>On</td><td>Off</td><td>Off</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr></table> <p>AquaPlumb Water Level Sensor (36)</p> 	X	X	X	Off	Off	On	Off	Off	1	2	3	4	5	6	7	8
X	X	X	Off	Off	Off	On	Off																										
1	2	3	4	5	6	7	8																										
X	X	X	Off	Off	On	Off	Off																										
1	2	3	4	5	6	7	8																										
<table><tr><td>X</td><td>X</td><td>X</td><td>Off</td><td>Off</td><td>On</td><td>Off</td><td>On</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr></table> <p>0-100PSI Pressure Transducer (37)</p>	X	X	X	Off	Off	On	Off	On	1	2	3	4	5	6	7	8																	
X	X	X	Off	Off	On	Off	On																										
1	2	3	4	5	6	7	8																										



<b>Account Admin</b>	
<a href="#">Account Users</a>	<a href="#">Select</a> SMS 1
<a href="#">Device Groups</a>	<a href="#">Select</a> Test AutoStart
<a href="#">Devices</a>	<a href="#">Select</a> XR3000 - Copy
<a href="#">Change Register Names</a>	<a href="#">Select</a> XR3000 - 198
<a href="#">Export Polling Data</a>	<a href="#">Select</a> XR3000 - 202
<a href="#">Define Alerts</a>	<a href="#">Select</a> XR3000 - 208
<a href="#">Login History</a>	<a href="#">Select</a> XR3000 - 209
	<a href="#">Select</a> XR3000 - 210
	<a href="#">Select</a> XR3000 - 216
	<a href="#">Select</a> XR3000 - 219
	<a href="#">Select</a> XR3000 - 219
	<a href="#">Select</a> XR3000 - 220
	<a href="#">Select</a> XR3000 - 236
	<a href="#">Select</a> XR3000 - 44 -
	<a href="#">Select</a> XR3000 - 53
	<a href="#">Select</a> XR3000 - 66

Make sure the device from which you want an alert is selected as shown on the right.

Dev

Select a Register to Edit

Add Alert

Copy Alerts

Alert History

Export to CSV File

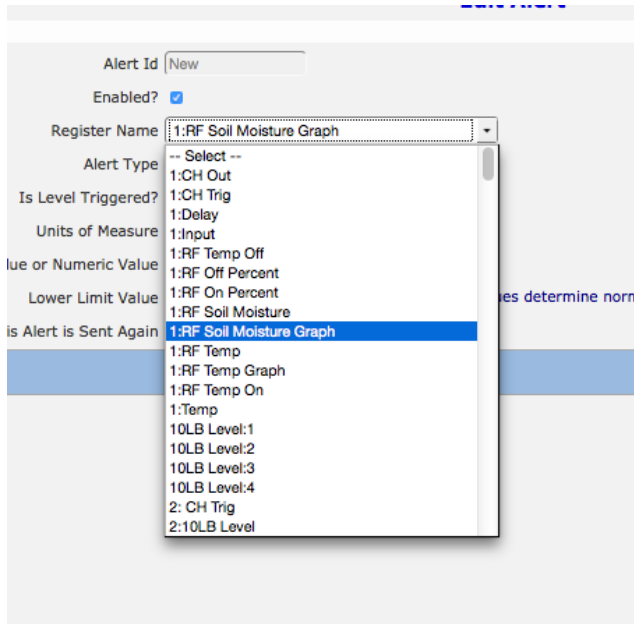
Select Device: 

XR3000 - 202 - MPC20

Id	Device Name	Register Name
No Alerts Defined for this Device		

## "Take Control"

Alerts can be set for any value that is displayed on any tab of HarvestWatch for a specific device.



Alert Id

Enabled? ☒

Register Name **1:RF Soil Moisture Graph**

Alert Type **-- Select --**

Is Level Triggered? **1:CH Trig**

Units of Measure **1:Input**

Value or Numeric Value **1:RF Temp Off**

Lower Limit Value **1:RF On Percent**

Is Alert is Sent Again **1:RF Soil Moisture**

**1:RF Soil Moisture Graph**

1:RF Temp

1:RF Temp Graph

1:RF Temp On

1:Temp

10LB Level:1

10LB Level:2

10LB Level:3

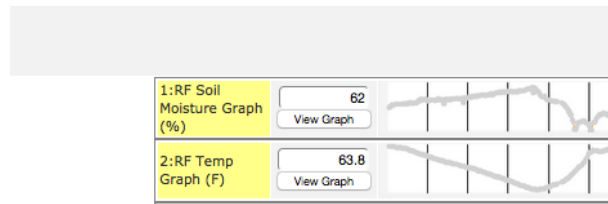
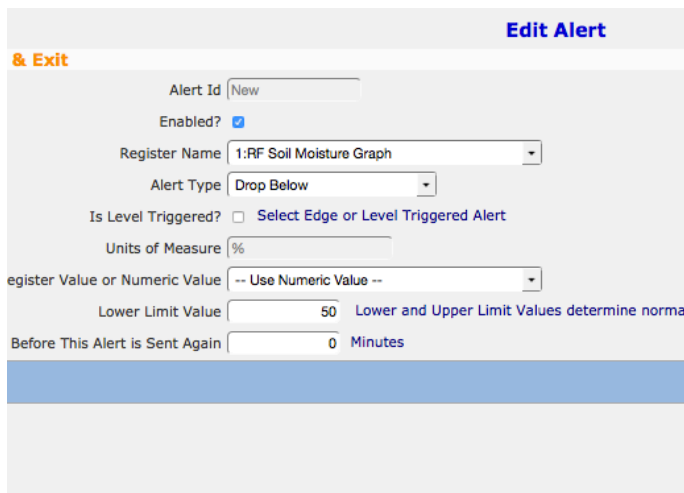
10LB Level:4

2: CH Trig

2:10LB Level

Let's assume that we want to set an alert for our soil moisture sensor on Radio 1. We need to choose the Register Name that matches the name displayed on the screen as shown below.

In this case, we want to set an Alert for 1:RF Soil Moisture Graph.

**Edit Alert**

**& Exit**

Alert Id

Enabled? ☒

Register Name **1:RF Soil Moisture Graph**

Alert Type **Drop Below**

Is Level Triggered? ☐ **Select Edge or Level Triggered Alert**

Units of Measure **%**

Register Value or Numeric Value **-- Use Numeric Value --**

Lower Limit Value  **Lower and Upper Limit Values determine normal range**

Before This Alert is Sent Again  **Minutes**

Here we define our alert to trigger when the 1:RF Soil Moisture Graph value drops below 50%.



## *“Take Control”*

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### Diagnostics

There are 3 LEDs on the upper right of the 4AChrg\_UART PCB.

Led1	Led2	Led3	Explanation
Off	Off	Off	Unit is sleeping or powered Off.
On	Off	Off	Reset – this LED is set when we initially start the code.
On	Blink	On	We have powered up the Modem and are trying to establish a cellular link.
Blink	Blink	On	We have established communications with Modem.
Blink	On	Off	Completed “Chat” with Modem, trying to establish PPP.
Off	Blink	Off	Have established the LCP Connection to network.
Blink	Blink	Off	Have established IPCP Connection to network.
Blink	Off	On	Have established IP Connection to network – normal “good” state.