Industrial Product Training

August - 2009

CYPRESS
ENVIROSYSTEMS

Purpose

- Product training to support sales efforts
  - Product overview
  - High level installation overview
  - Common customer concerns

- We will not discuss detailed installation steps in this meeting. This will be scheduled as an in-person activity.

Agenda

- Wireless Infrastructure
- BBS
- WGR/WMR
- WTR
- WSTM
- WFM

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Agenda

- **Wireless Infrastructure**
  - Background
  - Common concerns
  - Setting up the wireless network
- BBS
- WGR/WMR
- WTR
- WSTM
- WFM

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Background on Cypress Wireless

- Products operate in the 2.4GHz spectrum
  - Approved by the FCC
  - Certified to operate internationally
- Wireless design evolved from the wireless keyboards and mice
  - Modified technology for robust industrial applications
  - Cypress Semi has deployed millions of units
- Thousands of industrial transmitters in the field in a variety of industrial facilities
  - Semiconductor manufacturing
  - Biopharma
  - Power plants
  - Food processing
  - Hospitals
  - Wastewater facilities
  - Commercial buildings
- Device testing performed at various customer sites – No known issues to date
  - Worked with equipment engineers and IT departments
  - No impact to manufacturing equipment
  - No impact to other wireless networks

Common Wireless Concerns

Three main concerns:

1. Emission
    - Will the Cypress products interfere with my existing equipment or wireless network?
2. Immunity
    - Will our equipment interfere with Cypress products?
3. Security
    - How secure is the wireless system?

Electromagnetic Compatibility (EMC) covers emission and immunity.

Emission and Immunity

Emission:

- Peak power transmission of 100mW
  - Mobile phones transmit 1-2W
  - Portable handset radios used in industrial plants transmit 1-5W
  - Cypress devices transmit 10x less power than mobile phones
- Cypress devices transmit on a very low duty cycle
  - Minimizes the chance of interference
  - Cypress protocol allows transmission for less than 1ms per sample period
  - Example: sample rate of 5 minutes translates to a duty ratio of 1:300,000

Immunity:

- Cypress devices have been installed in many different facilities
  - Power plants
  - Semiconductor processing fabs
  - Areas with high energy emitting RF devices
- No issues found to date

Security

- Cypress uses a proprietary wireless protocol
  - Results in low overhead (so we can transmit in under 1ms)
  - Less of a target for security breaks
  - Standard protocols are more typically broken because they are more common
- Blue Box Servers sit behind the company firewall
  - BBS is as secure as any other computer that the company is using
- Cypress software puts data in local database only if it recognizes the protocol
- Even if someone found the Cypress protocol, they could not gain any information from the computer network
  - No way to pull any information through Cypress wireless protocol
  - Not possible to embed an executable program/virus through Cypress wireless protocol
- Blue Box Servers may need antivirus protection
  - We can install McAfee out of the factory – possible corporate conflict
  - Customer can install their corporate anti-virus instead

Setting Up a Wireless Network

- **Wireless performance**
- Wireless site survey
- Wireless infrastructure
- Wireless channels

Wireless Performance

- Cypress wireless has been installed in many different types of sites
  - industrial plants
  - concrete bunkers
  - clean rooms
  - commercial high rises

- Typical wireless ranges for a single “hop” are:

Line of sight	300 ft (91m) open halls 150 ft (46m) in open office floor 100 ft (30m) in corridors
Sheet Rock / Dry wood	100 ft (30m), through five walls
Brick Walls	60 ft (18m), through three walls
Ceilings	25 ft (7.5m), through single ceiling

- Wireless Range Extenders (WREs) allow for multiple “hops” which extend the communications range of the system

Factors Reducing Wireless Range

- Wireless range is particularly affected when metal obstacles are in the line of transmission.

- A solid sheet of metal presents the greatest obstacle, while rebar reinforced concrete is less.

- Try to note the following objects and avoid in the line of transmission:
  - Elevator shafts and stairwells
  - Hollow lightweight walls filled with insulating metal foil
  - Metal reinforced concrete walls, pillars and columns
  - Plumbing and electrical risers

Bigger metal obstacles in transmission path = shorter wireless range

Wireless Range of Cypress Products

- WGR has shortest range - internal antenna
- WTR, WSTM, WFM, WRE and BBS have similar ranges - external antenna
- Best case, LOS, tested range:

  WGR = 1150 ft (350m)

  WRE = 1600 ft (488m)

Setting Up a Wireless Network

- Wireless performance
- **Wireless site survey**
- Wireless infrastructure
- Wireless channels

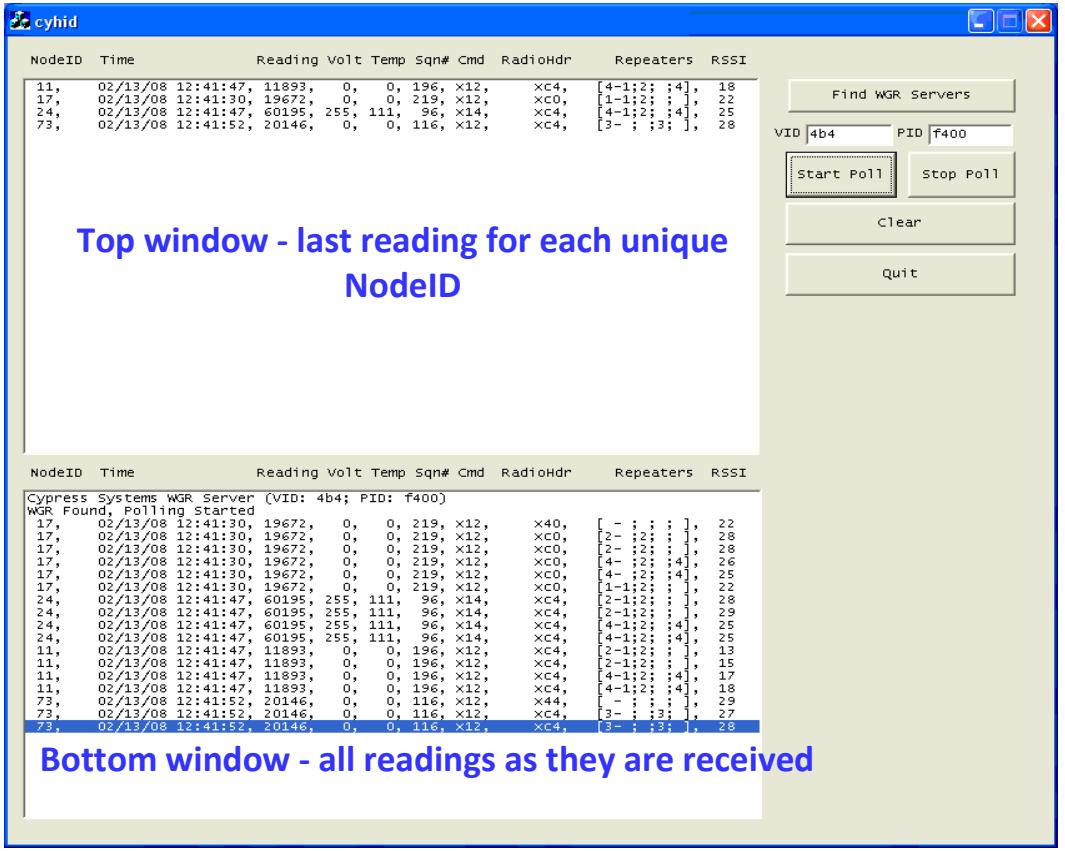
Wireless Survey Tool (IND-WST) Overview

- Used to capture signal strength on laptop
- 2 components to the wireless survey tool
  - Diagnostic receiver (hardware)
  - CYHid application (software)
- Use CYHid application to find spot where RSSI drops below 10 … that is a good spot for a WRE

Note: The application and receiver only records signal strength from the last "hop"

Setting up and use of the IND-WST

1. Connect Diagnostic Receiver to laptop with a USB cable
2. Launch CYHid (Cypress Human Interface Device)
3. Start with WGR at furthest location from BBS
4. Set the WGR to Medium mode
5. Click “Start Poll” to start receiving. RSSI maximum value is 31.
6. Survey each WGR or WTR device to insure that the RSSI level is ≥ 10 at the WRE or BBS location.
7. Click “Stop Poll” to stop receiving
8. Click “Close” to exit



Setting Up a Wireless Network

- Wireless performance
- Wireless site survey
- **Wireless infrastructure**
- Wireless channels

Installing the Wireless Network Infrastructure

- Wireless network infrastructure consists of WREs and BBS
- Environment and building layout may change the number of WREs required
- Complete site survey
  - Identify field device locations
  - Define WRE and BBS locations
  - Temporarily install WREs and BBS
- Verify wireless performance
- Permanently install WREs and BBS

Wireless Range Extender (WRE) Overview

- WREs to extend wireless range of field devices
- WREs require 5 VDC, provided by a 120/240 VAC adapter
- Multiple WREs in a system require different delays for each WRE (either 1, 2, 3, or 4 ms)
- Up to 4 WREs can be used to get a single field device reading to the BBS
- More than 4 WREs can be used in system, depending on layout.

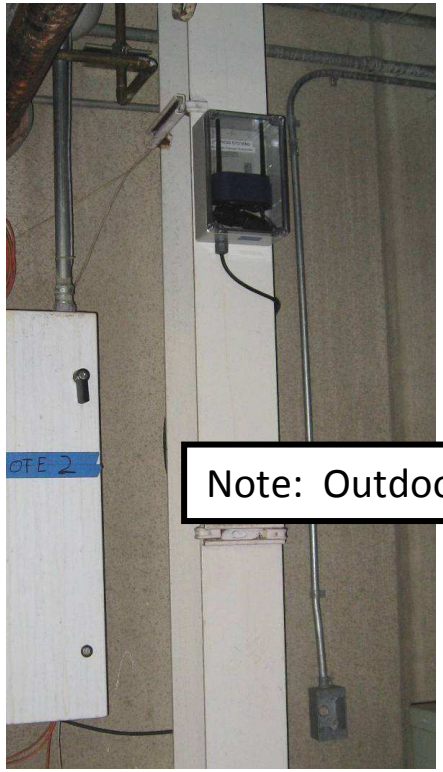
Short term:
- VARs order 1 PN and reprogram appropriate channel/delay using PSoC Programmer and applicable hex file.

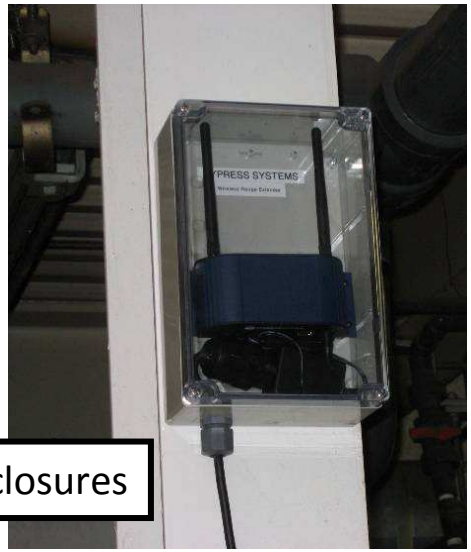
Long term:
- VARs order 1 PN and configure channel/delay with Hand Held (HH)Configuration Tool

WRE Installation Notes

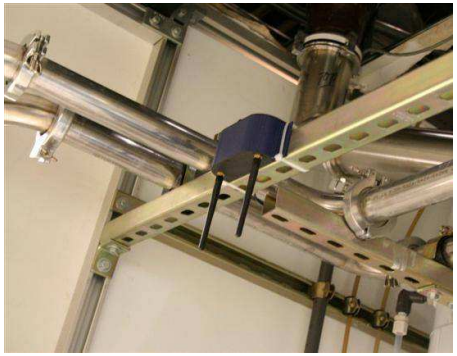
- WREs installed with the shortest delay (1ms) farthest away and longest delays (4ms) closest to the BBS
- WREs installed at eye level or above
- WREs securely attached, so it can't be moved
  - Prefer screws or cable ties, otherwise VHB (Very High Bond) tape
- Cords cable tied if possible
- Antennas screwed in all the way and vertical

WRE Field Installations





Note: Outdoor enclosures



Where to Place Receiver and Repeaters

Do

- Try to place the BBS in a central location on the site with power and LAN drop
- Mount WREs at eye-level or higher to avoid obstructions
- Use IND-WST to determine where signal is strongest

Don‘t

- Avoid solid metal obstacles in the line of transmission
- Don’t place WREs or BBS inside metal cabinets

WRE Common Questions

- How does the WRE work?
  - Always listening for packet data (why it needs continual power)
    - All field devices sleep, but transmitted data is asynchronous
  - Once the WRE receives packet, it sets a flag (WRE ID) and re-broadcasts
    - If the WRE ID is already set, it won't re-broadcast

- Why can't I have more than 4 WREs in a path?
  - Field devices transmit, then wait for an ACK from BBS. This is "listening time" and uses power.
  - Adding WREs increase listening time per transmission
  - Currently optimized for battery life
    - Devices listen for ~8ms (4 WREs), set in firmware
  - Will look at option on setting this in the field
    - Requires significant firmware change to wireless protocol

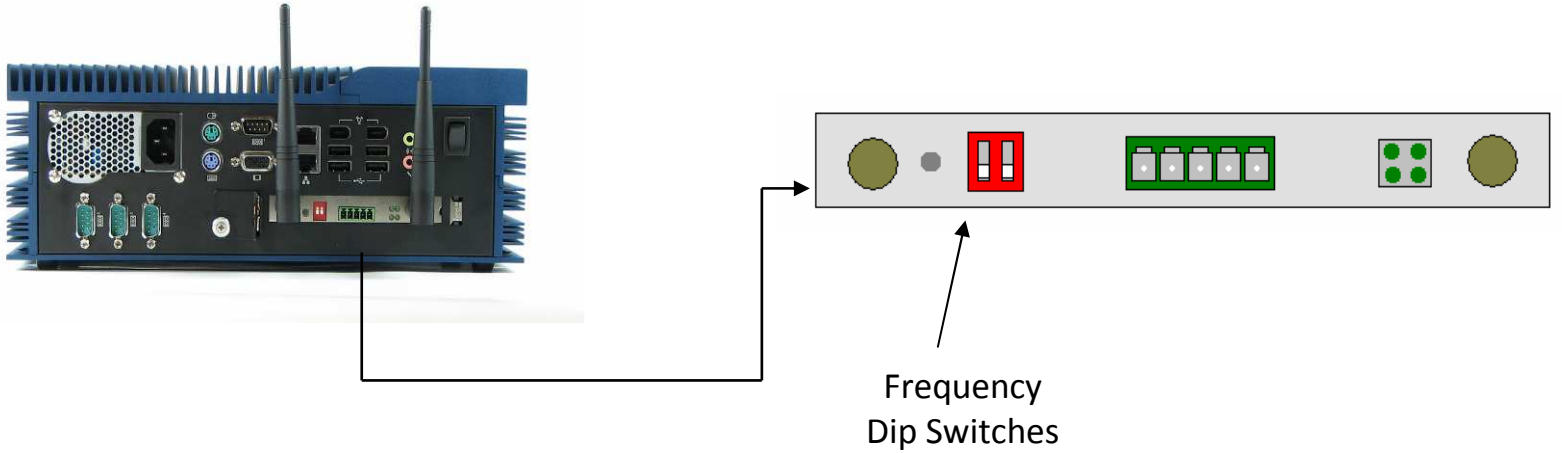
Setting Up a Wireless Network

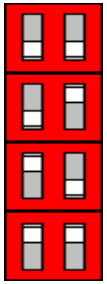
- Wireless performance
- Wireless site survey
- Wireless infrastructure
- **Wireless channels**

Configuring Channel Sets

- BBS, WREs, and all field device channel sets must match
- 4 common channel sets available – A, B, C, D
- Choose BBS channel set using dip switches on BBS
- WRE channel hard-coded onto unit
- Configure field device channel set using HHC

Wireless Blue Box Server Channels





- Channel Set A (2,74) or (74,2)
- Channel Set B (6,78) or (78,6)
- Channel Set C (24,50) or (50,24)
- Channel Set D (30,54) or (54,30)

4 common channel sets – BBS, WRE & field device channel sets must match

WRE Channel Set and Delay

- WREs labeled on bottom with channel set letter and delay
- A-1 means channel set A with a delay of 1ms
- Make sure channel set of the WREs match channel set of BBS and all field devices

Agenda

- Wireless Infrastructure
- **BBS**
  - Overview
  - Installation
  - Web Console
  - Common Questions
- WGR/WMR
- WTR
- WSTM
- WFM

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Blue Box Server (BBS) Overview

- Industrial computer
  - WinXP Pro
  - SQL database
- Simple Setup
  - Plug power cord
  - Connect to LAN
  - Provide static IP
- Blue Box Server receives field device readings and stores data in SQL database
- One receiver can handle 128 field devices (typical)
- Multiple servers can be installed at a single site

BBS Interfaces

- Web Server with Web Console App
- Currently supports the following standard protocols (requires license to be enabled)
  - OPC
  - BACnet
- SMS and email alarms available
- Future plans to support
  - Modbus
  - SCADA interface

BBS Installation Overview

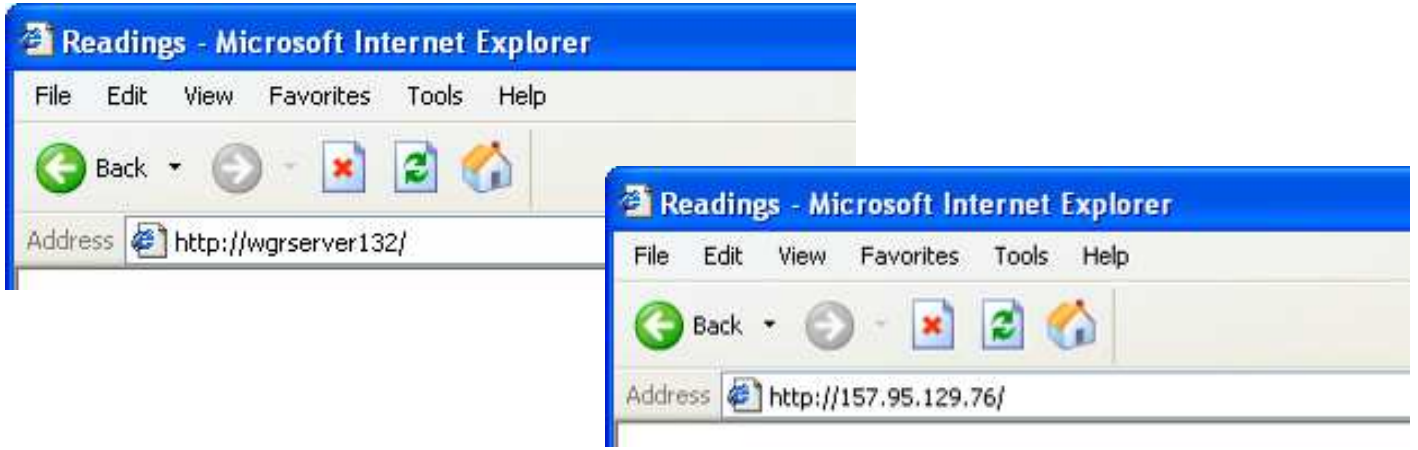
1. Determine location for BBS – need VAC and LAN
2. Choose the BBS channel set being used
3. Connect and power up BBS
4. Configure network settings
5. Connect to Ethernet port on customer LAN
6. Add installed nodes to database
7. Configure alarms, if needed
8. Verify wireless signal strength
9. Mount BBS, if needed

BBS Installation Notes

- Determine location for mounting
  - Must be installed indoors, in a temperature controlled environment
  - Can use optional wall-mount bracket
- Configure Internet Protocol (TCP/IP) Properties with the static IP address specified by customer's IT department
  - Option 1: USB mouse, keyboard, and monitor to access BBS
  - Option 2: Connect using VNC on laptop
  - Edit the Network Adapter settings to assign IP address

Connecting to the Web Console Application

- Option 1 (Connected to LAN)
  - From any PC web browser, enter the machine name or IP address
    Note: PC must be on the same LAN as BBS



- Option 2 (For standalone station)
  - Connect monitor, keyboard and mouse. Then start Internet Explorer.

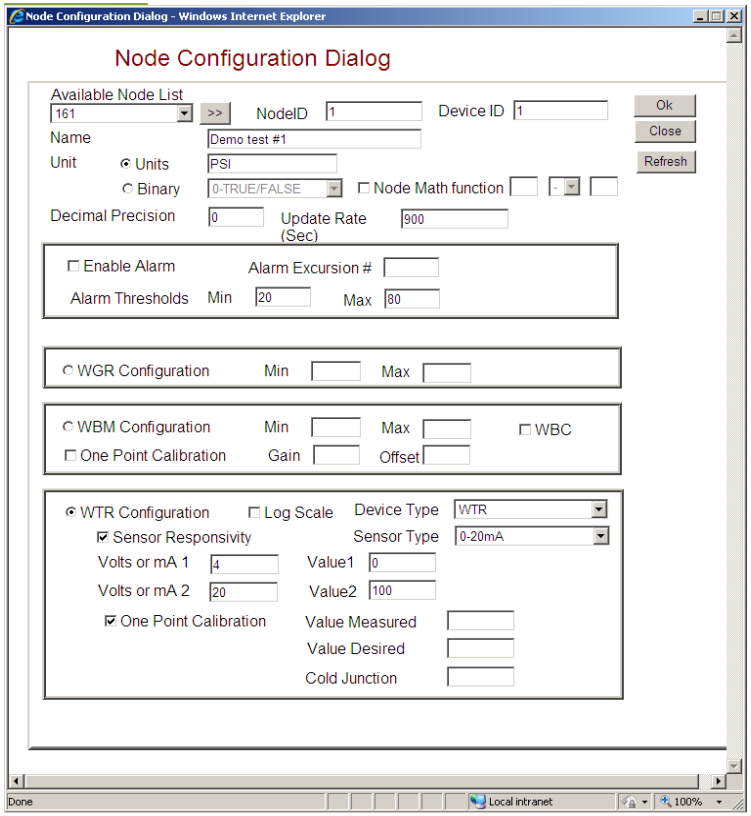
Adding Installed Nodes through Web Console

1. Click “Configuration” button on the Web Console. Enter:
   - Username: admin
   - Password: wgradmin

2. To add new node, enter NodeID number in text box and click “Add”

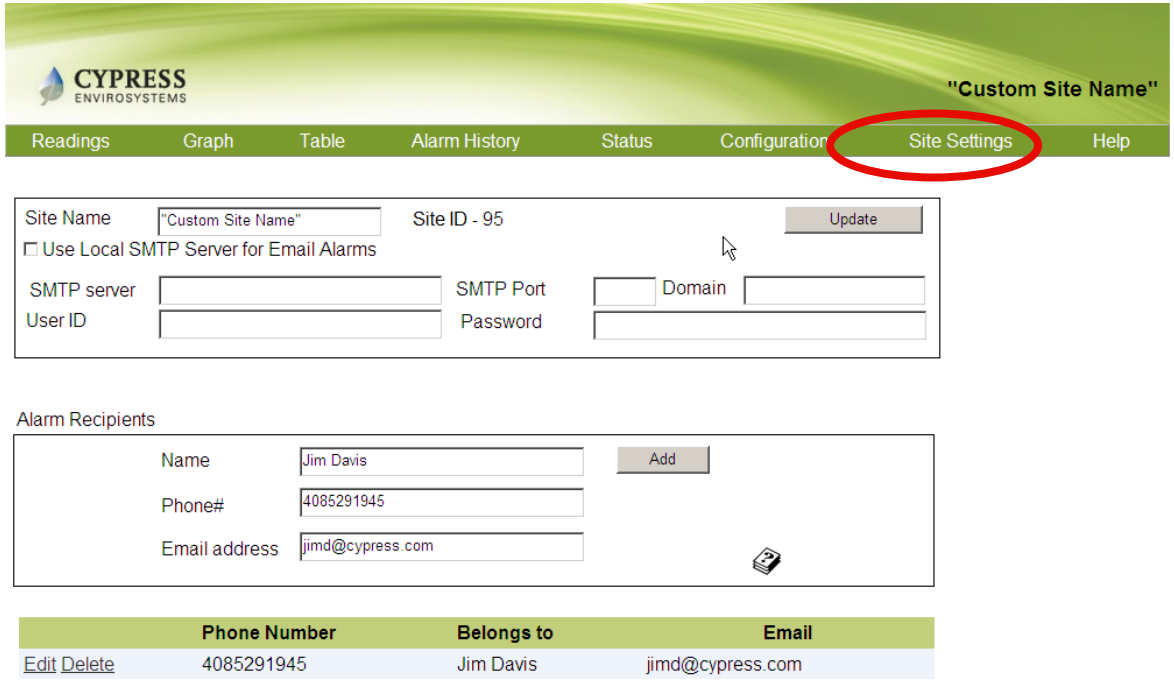
3. Enter node information in Node Configuration Dialog window, and click OK

   See Help file for details.



Configuring Alarms through Web Console

1. Go to Web Console, then click “Site Settings”
2. Enter same username and password as the Node Config page
3. Add Alarm Recipients



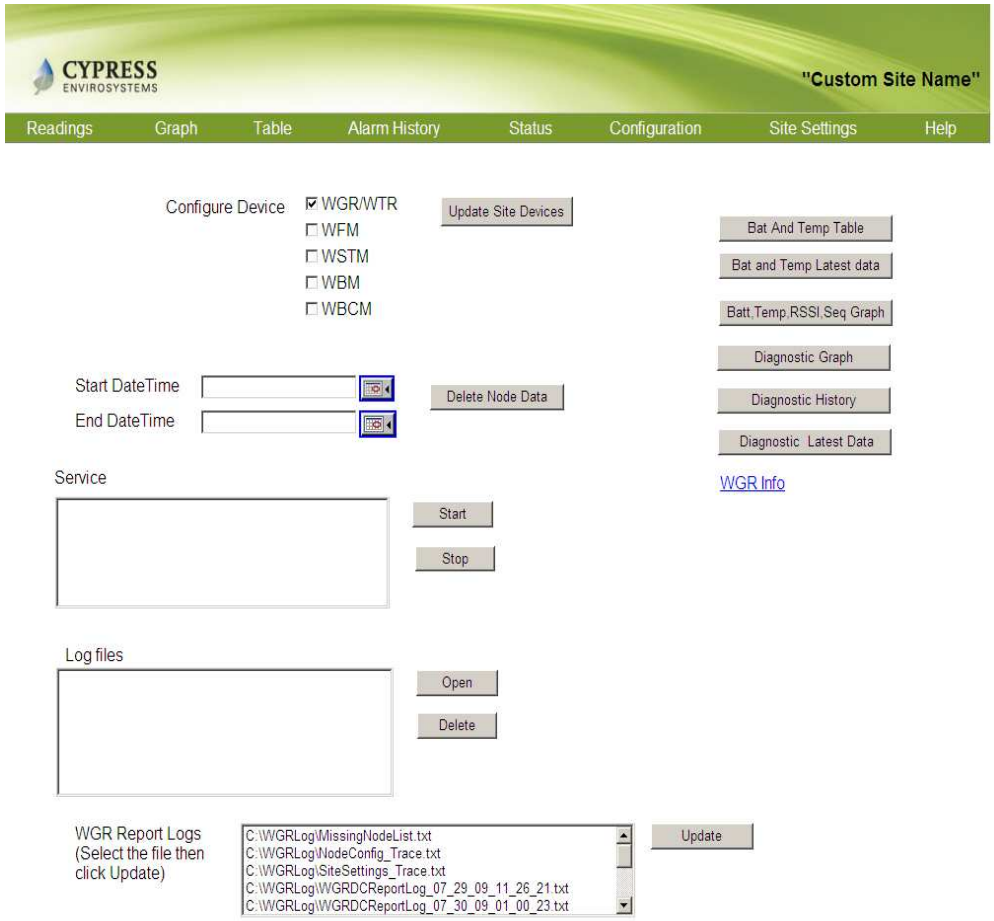
Note: If Enable Alarm checkbox is checked for a node, everyone in the alarm list will be notified via SMS text and/or email when the node goes into alarm state.

Verify Wireless Strength through Web Console

1. Access admin page by typing: http://WGRServerNNN/admin.aspx into web browser address bar. Enter
   - Username: master
   - Password: wgrmaster

2. Use Diagnostic History and Diagnostic Latest Data to see WGR data reception paths
   - Shows which WREs were used to get data to BBS

3. Verify all RSSI ≥ 10
   - If lower than 10, adjust WRE locations



BBS Common Questions

- What is the real number of devices that can talk to the BBS?
  - 128 field devices per BBS is a soft limit
  - Actual number depends on update rates and wireless range
- What happens with sites that have multiple BBS?
  - Set all field devices to different channels to match BBS
  - Currently, customer sees each BBS individually
  - Plans to have one centralized server for all BBS at customer site (target Q4)

Common General Product Questions

- Certifications
  - FCC
- ATEX
  - Product for hazardous locations
  - Planning on Class 1, Zone 2 certification for ATEX
  - Availability in Q4
- Wi-Fi
  - Currently developed units for OEM
  - Will have Cypress version available in Q4

Agenda

- Wireless Infrastructure
- BBS
- **WGR/WMR**
  - Overview
  - Details and Adapters
  - Installation Overview
  - HHC
  - Considerations
- WTR
- WSTM
- WFM

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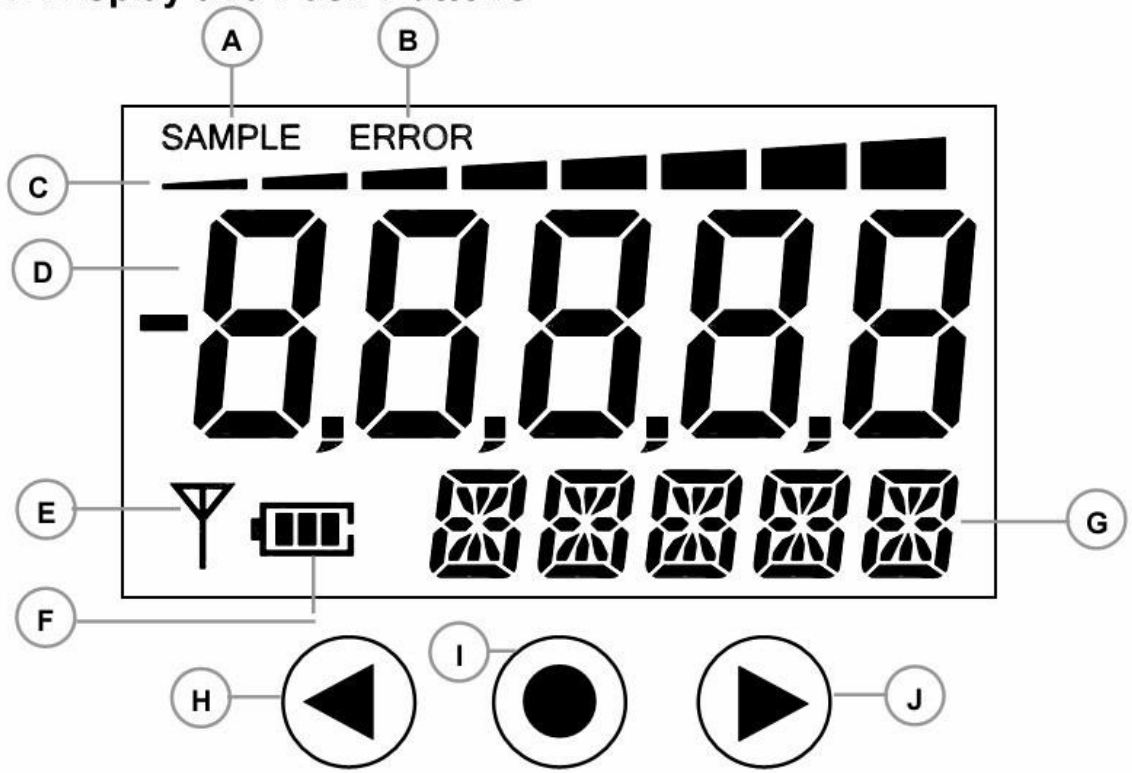
Wireless Gauge Reader (WGR) Overview

- System powers up from deep sleep
- Low power camera takes low-res image of gauge face
  - High light sensitivity, reduced processing load
- Image captured in two halves
  - Dual independent ultra-bright LEDs to cancel glare
- Image processing
  - Convert pointer orientation into an angle
  - Determine tip/tail
  - If image algorithm detects faults, then error code is sent with last good reading
- Displays updated result on LCD
- Wirelessly transmits result to BBS
  - Periodically transmits health status
- Deep sleep until next sample interval

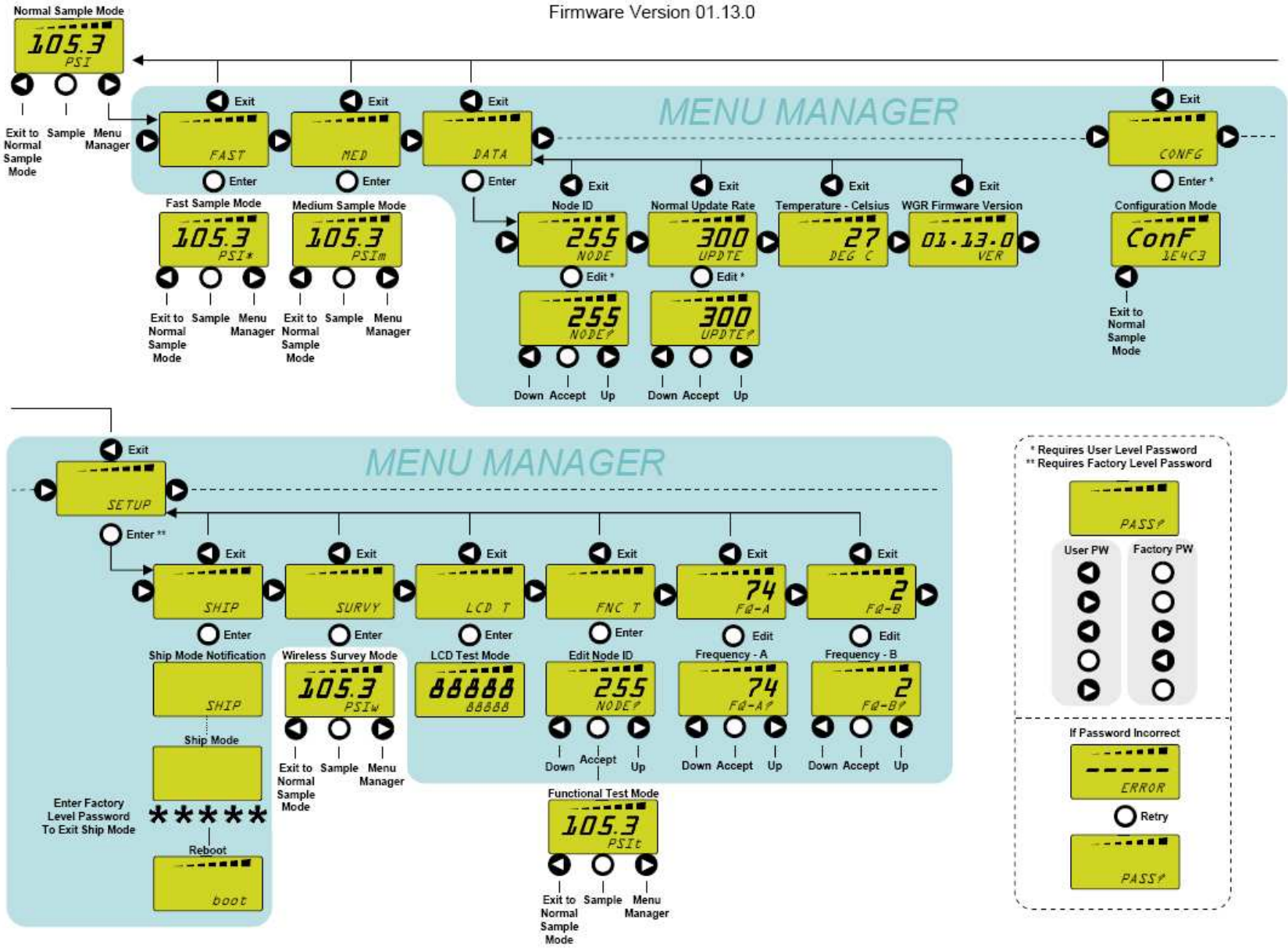
WGR LCD Display Details

LCD Display and Push Buttons

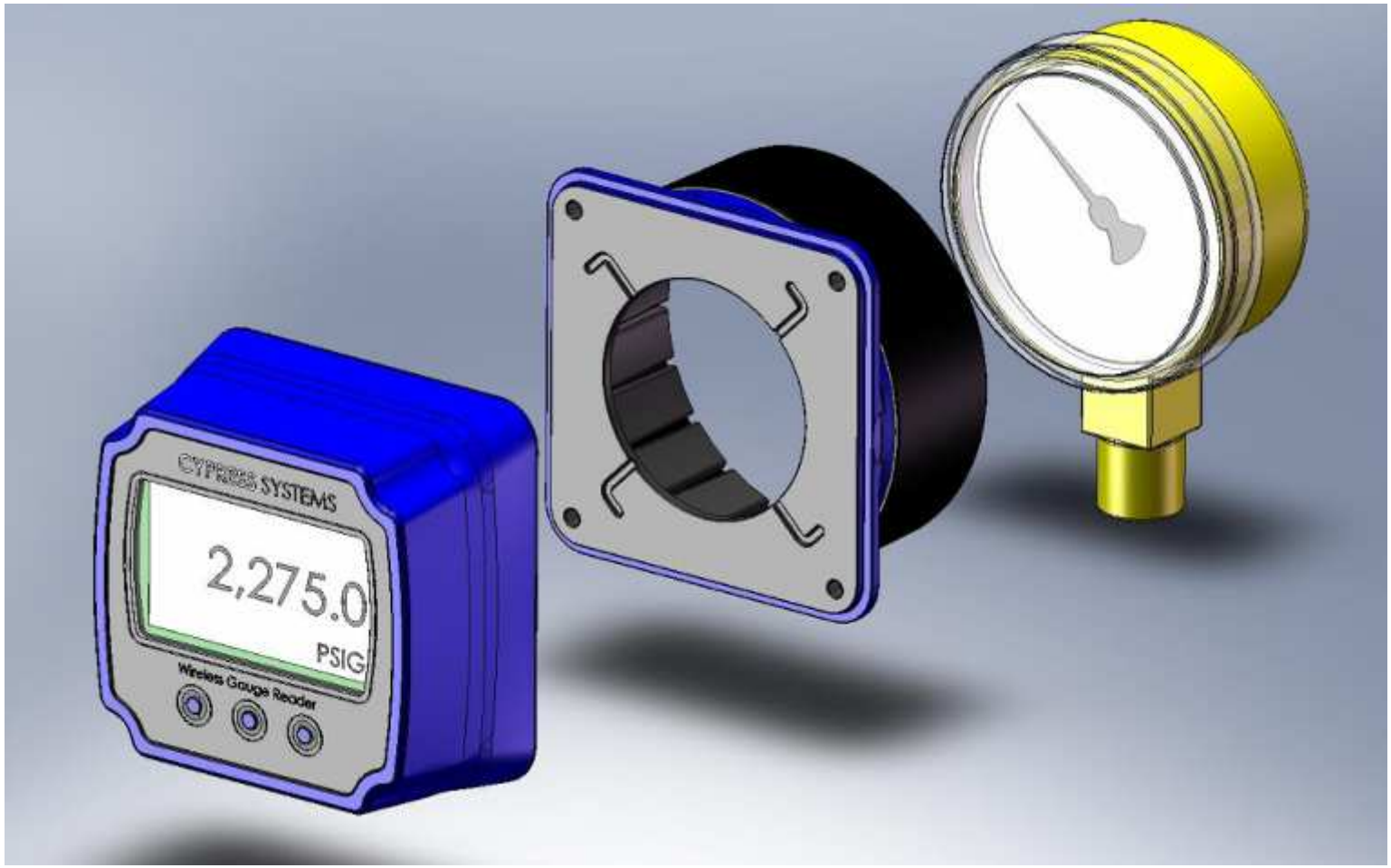


A.	**SAMPLE Icon**	Displayed when a new reading is being captured and converted
B.	**ERROR Icon:**	Displayed when an error condition is detected
C.	**Bar Graph**	Indicates percent of full-scale reading
D.	**Numeric Display**	Displays the converted reading value
E.	**Antenna Icon**	Displayed when wireless communication is successful
F.	**Battery Level**	Displays percentage of battery life remaining
G.	**Alpha-numeric Display**	Displays the reading units or diagnostic messages
H.	**Left Button**	Menu navigation and decrease values
I.	**Center Button**	Requests immediate updated reading and menu navigation
J.	**Right Button**	Menu navigation and increase values

WGR Menu Structure



WGR Exploded View



Common Gauge Types

Free-standing
(dry, liquid filled)

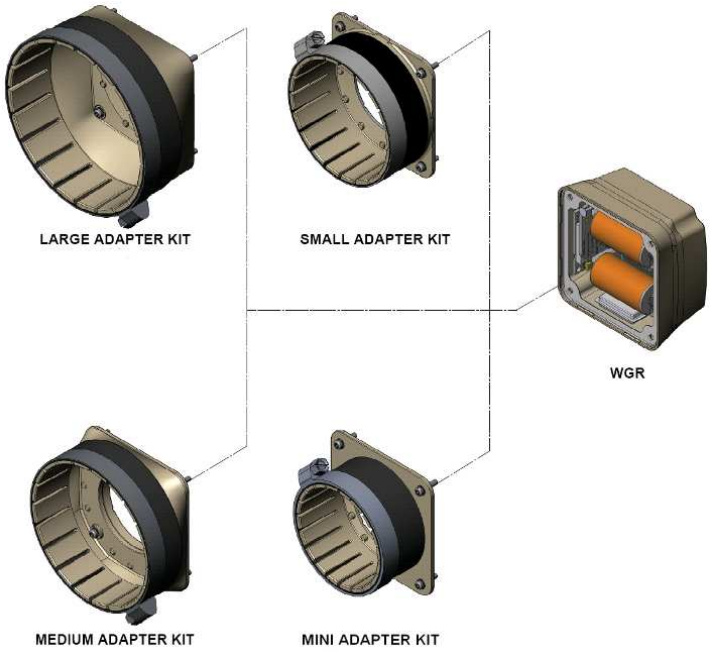
Process Gauge

Magnehelic

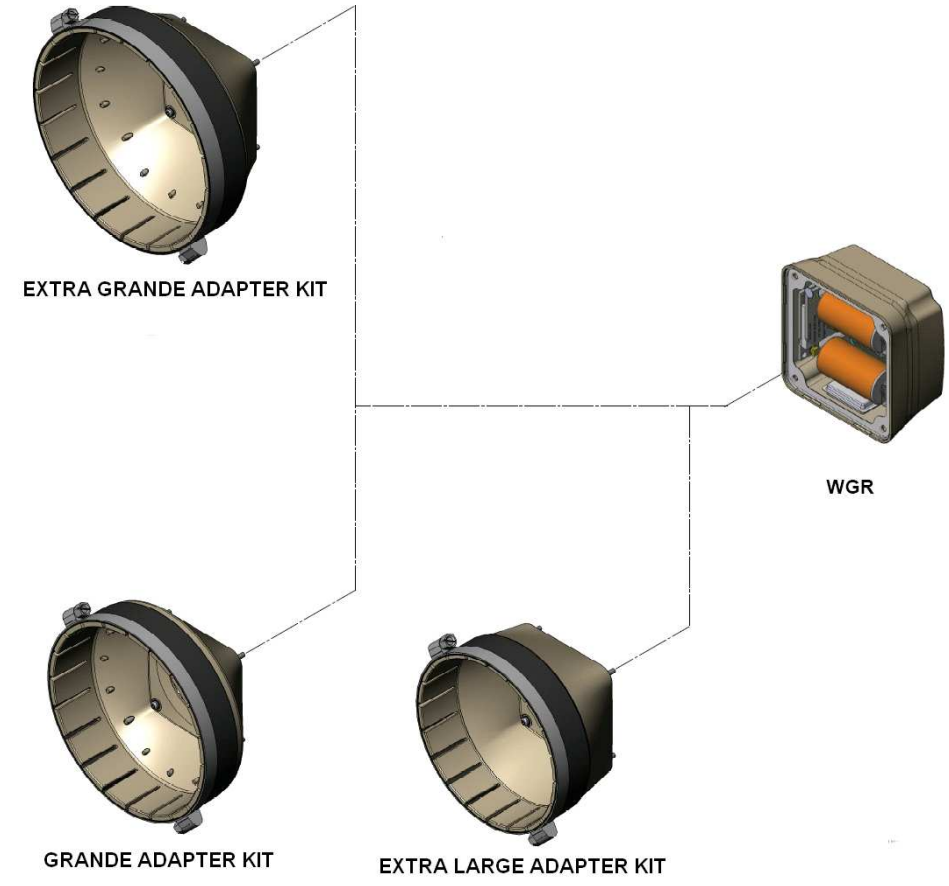
Panel Mounted

Photohelic

Standard Mounting Adapters



Near focus



Far focus

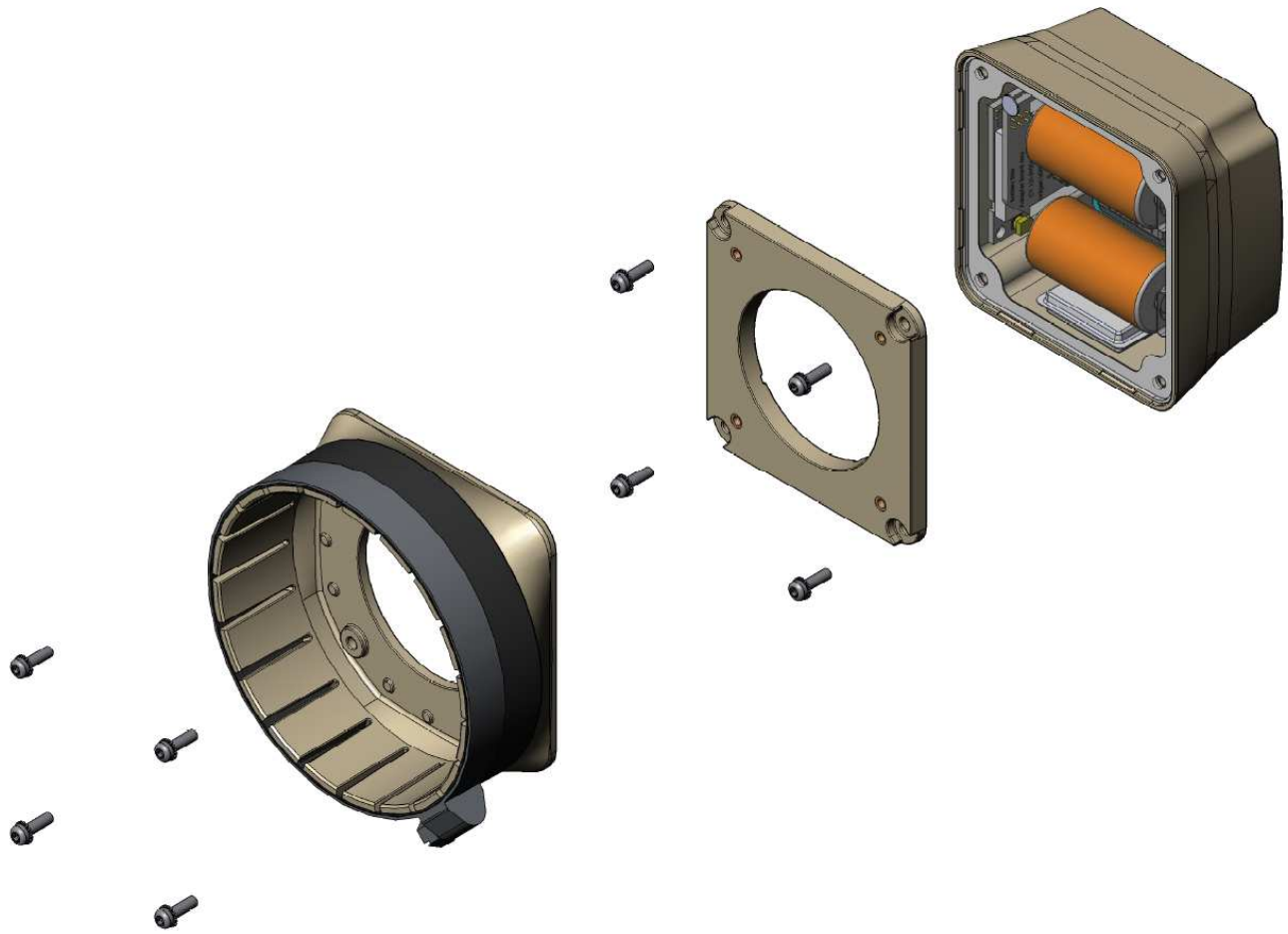
Mounting Adapter Sizes

Adapter size	Dimensions		
	ID @ Gauge Interface	Max OD of Gauge	Min OD of Gauge
Mini	1.955”	1.995”	1.600”
	[49.66mm]	[50.67mm]	[40.64mm]
Small	2.350”	2.390”	1.995”
	[59.69mm]	[60.71mm]	[50.67mm]
Medium	2.782”	2.822”	2.390”
	[70.66mm]	[71.68mm]	[60.71mm]
Large	3.245”	3.285”	2.820”
	[82.42mm]	[83.44mm]	[71.63mm]
Extra Large	3.675”	3.715”	3.285”
	[93.35mm]	[94.36mm]	[83.44mm]
Grande	4.083”	4.123”	3.715”
	[103.71mm]	[104.72mm]	[94.36mm]
Extra Grande	4.600”	4.680”	4.181”
	[116.84mm]	[118.87mm]	[106.20mm]

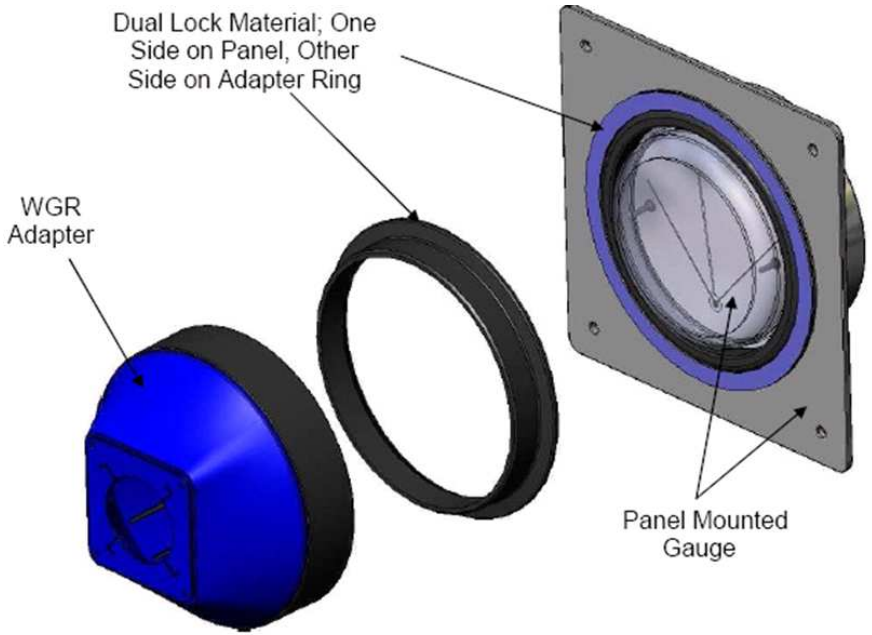
Also have special adapters for:

4.5” Process, Magnehelic, and Photohelic gauges

Adapter Assembly



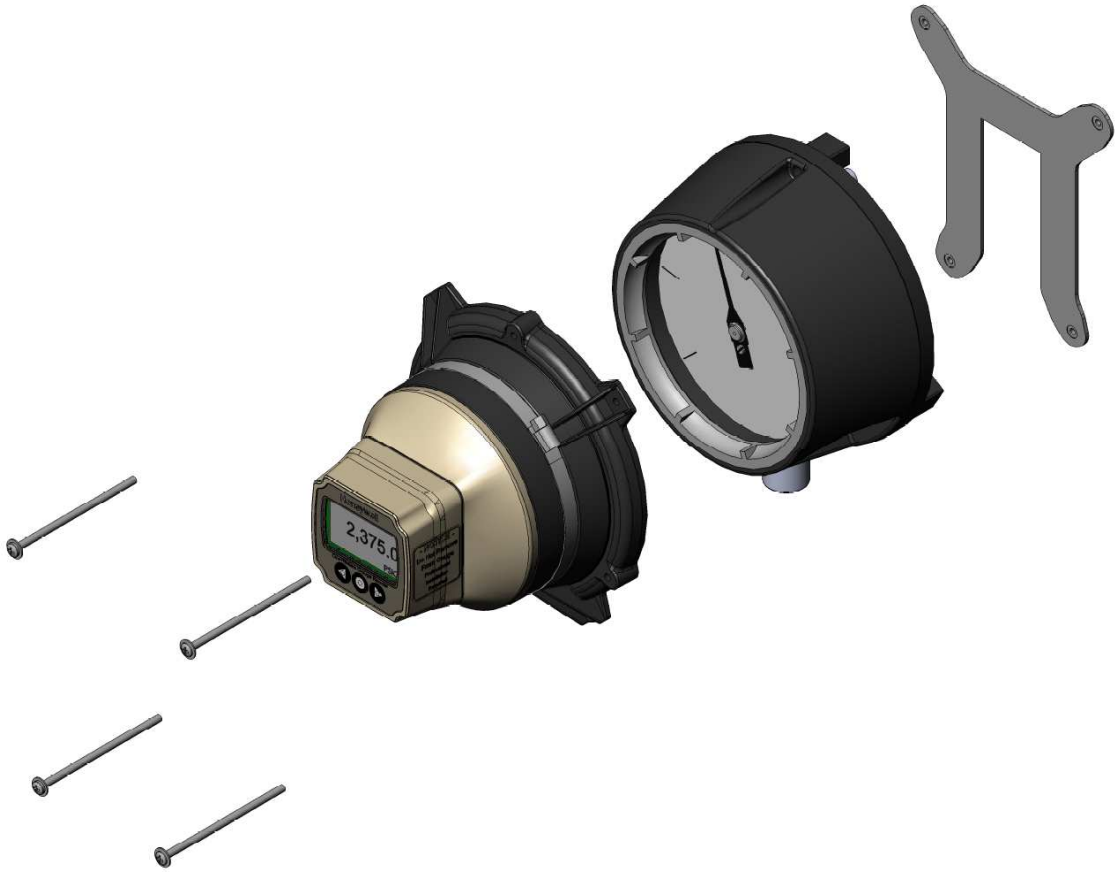
Panel Mount Adapters



Dual Lock Panel Mount

Special Adapters – Magnehelic/Photohelic

Special Adapter – Process Gauge



WGR Installation Overview

Site survey:

1. If possible, have paper copy of floor plan
2. Audit the gauge and mark location on floor plan
3. Take pictures of each gauge (close-up and surrounding area)
4. Note any possible issues (dirty gauge, tight mechanical area, etc.)
5. Look for BBS and WRE locations:
    - BBS location: Is there power and a LAN connection?
    - WRE location: Is there power?

Install preparation:

1. Summarize all gauges and determine required adapters
2. Determine initial wireless plan based on marked-up floor plan
    - Identify possible locations for repeaters (WREs)
    - Determine if more than 1 BBS is needed
3. Prepare install kit (HW, tools, materials etc.)

Installation:

1. Test wireless plan: Temporarily set up WGR system and test with Diagnostic Survey Tool
2. Install and calibrate WGRs
3. Train customer on how to look at data

WGR Mechanical Installation

1. Verify mechanical gauge functionality
2. Verify proper WGR mounting adapter
3. Monitor gauge pointer
   - Record current gauge reading
   - Monitor typical movement
   - Determine if excessive pointer vibration/flutte
4. Record gauge Information: Units, Min/Max Value
5. Prepare gauge
   - Clean front window with alcohol
   - Clean outside diameter
   - If there is excessive background writing, and front window is removable, install white tape to cover background writing
6. Install 1-3 shim bands
7. Mount WGR and align as desired
8. Tighten clamp

Handheld Configuration Tool (HHC) Basics

1. **Touch Screen:** Main display. Use stylus to navigate on screen.

2. **Navigation Arrows:** Up, down, left, and right navigation keys. Used to navigate to different text entry fields in application. Also, Left Arrow used to type negative symbol "-" into text entry field.

3. **[Enter/On] Key:** Used to power on HH and accept changes/entries.

4. **[FN] Key:** Has 2 functions
   - Off state: Press [FN] then [Enter/On]
   - Forced power down and full reboot: Hold [FN] + [Enter/On] for 5 sec

5. **[BKSP] Key:** Backspace key.

6. **Green LED:** Shows power and charge status

7. **Docking Station:** Docking station to charge HH and extra battery pack. Also used to connect HH to a PC via USB.

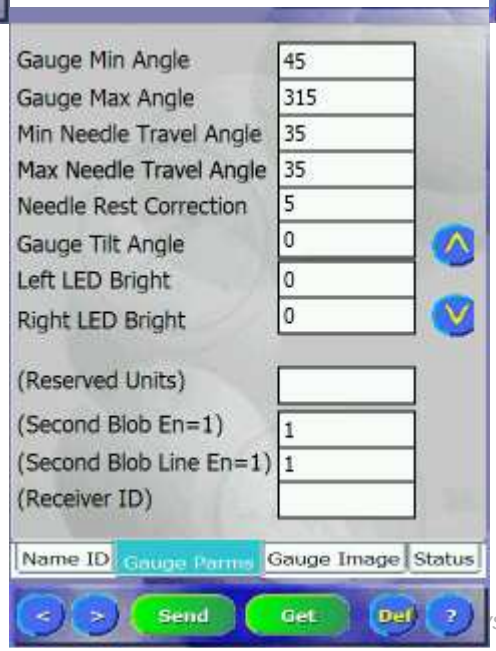
4 Menu Tabs of HHC Control Application

Name ID

- Default page
- Used to select device for configuration

Gauge Parameters

- Used to set gauge specific parameters

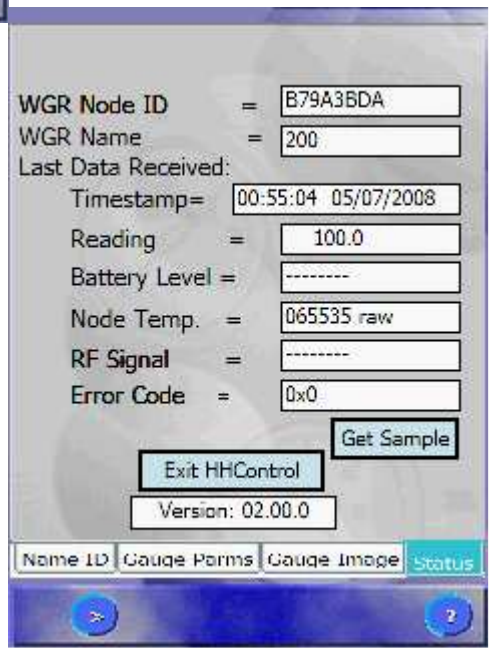


Gauge Image

- Displays gauge image and

Status

- Summary tab
- Used to verify proper configuration



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Considerations when Evaluating Customer Site

- WGR compatibility
  - Single pointer
  - Relatively clean gauge
  - Minimal background writing on gauge face
  - Liquid filled sufficiently
  - Range of gauge diameter for adapter fitting
  - Clearance for WGR in front of gauge

Agenda

- Wireless Infrastructure
- BBS
- WGR/WMR
- **WTR**
  - Overview
  - Details
  - Supported Connections
- WSTM
- WFM

CYPRESS ENVIROSYSTEMS

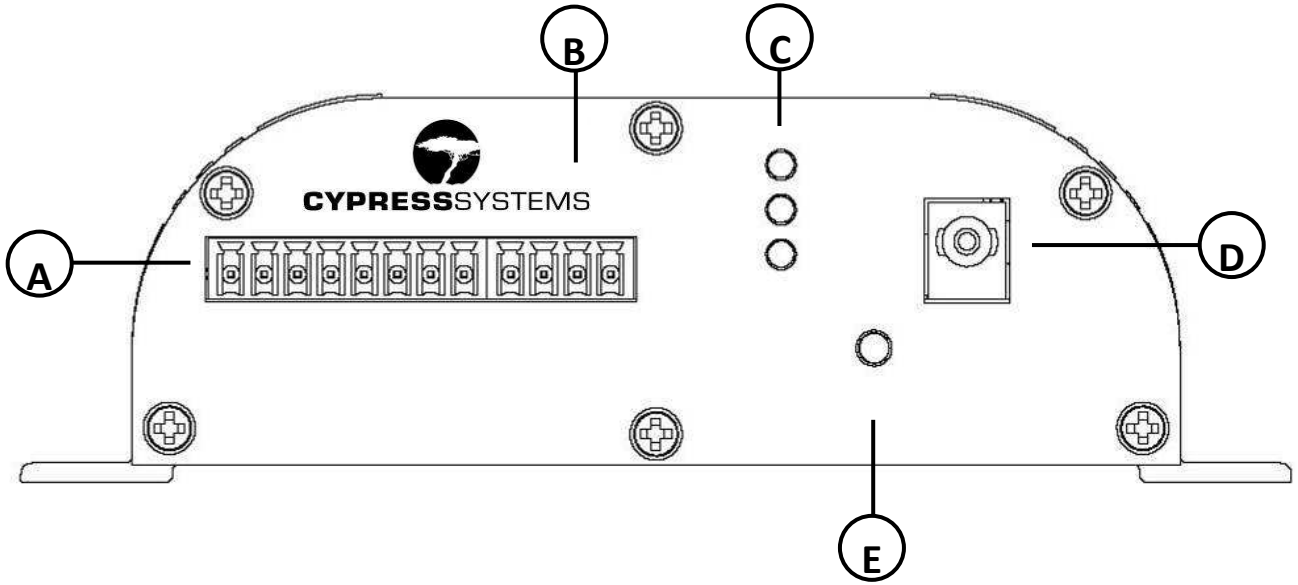
Wireless Transducer Reader (WTR) Overview

- Can remotely monitor outputs from wired sensors and transducers
  - voltage
  - current loop
  - RS232/485
- Two input channels
- Power options:
  - Wall powered
  - Internal battery powered
  - External power supply (5-24 VDC)

- Can be programmed to take readings at any given interval (in seconds)
  - Fastest supported sample rate is 1 second, which requires external power supply.

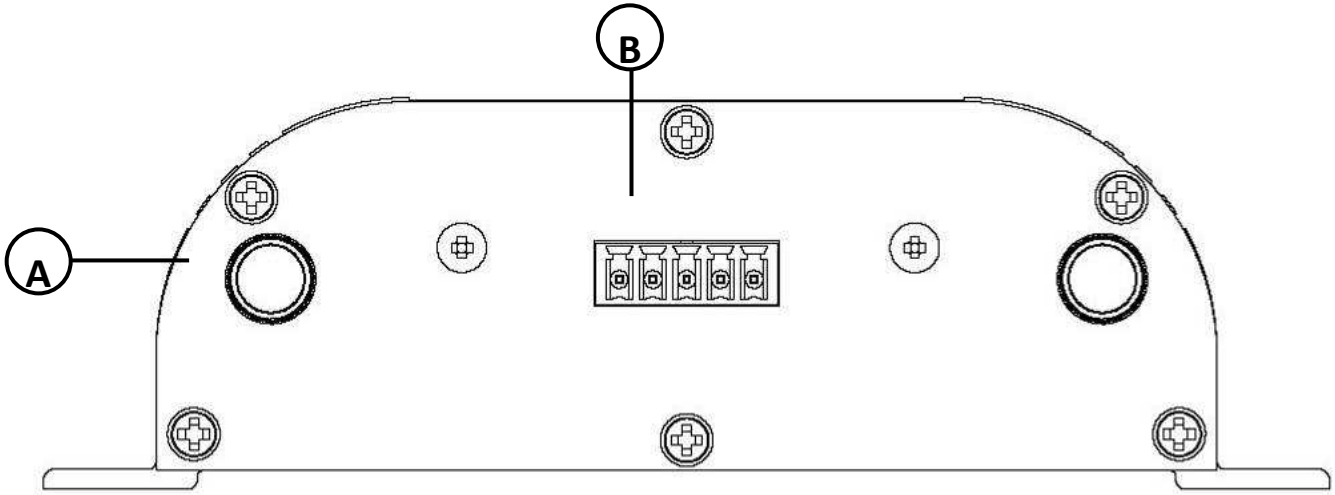
Note: If mounted outdoors, will need outdoor enclosure

WTR Front Panel



A. Sensor input terminal strip
B. External power terminal strip
C. LED Indicators
D. 5V-24V barrel jack input, 5.0mm x 2.1mm
E. Function Button: used to initiate a sample, set fast and medium update mode and for binding to the configuration tool

WTR Back Panel



A. Radio 1 antenna connector
B. Programming or Serial port (RS232/485)

WTR Power-on Sequence

When the WTR starts up, its normal boot sequence is as follows:

1. Turn on all LEDs for 2.5 sec
2. Turn off Red LED
3. Turn off Orange LED
4. Turn off Green LED

If the above sequence does not take place, something is wrong with the WTR (most likely the battery is not fully charged).

WTR Function Button and LED Lights

The function button can be used to

- take a sample
- put the unit into fast update mode
- put the unit into medium update mode
- put the unit into configuration mode

Hold Time	Indication	Function
< 2 sec	Green LED flash	Single sample on both RF channels
2 sec+	Yellow LED	Fast update mode (sample every 5sec for 5min)
4 sec+	Red LED	Medium update mode (sample every 30sec for 8hr)
> 5 Sec	Green, Yellow Red LED flash once, Green continuously flashing	WTR is in configuration mode. Use the HHC to configure Node ID, Channel set

WTR Supported Connections

- Transducers with the following analog outputs
  - 0-5V
  - 0-10V
  - 4-20mA

- Some digital signals, but additional WTR firmware customization may be needed
  - RS232
  - RS485

Agenda

- Wireless Infrastructure
- BBS
- WGR/WMR
- WTR
- **WSTM**
  - Overview of Steam Traps
  - Overview of WSTM
  - Installation Notes and Data Analysis
  - Considerations when Evaluating Customer Site
  - Common Customer Questions
- WFM

CYPRESS
ENVIROSYSTEMS

Principle of Operation of Steam Systems

- Types of steam:
  - Plant Steam
    - Generation from a boiler
    - General use steam for heating systems, heat exchangers, vessel jacket heating, etc.
  - Clean Steam / Pure Steam
    - Made using a generator
    - Typically have requirements for cleanliness
    - Used for sterilization or sanitization
- Traps placed strategically in steam systems to remove condensate
  - Maintain quantity and quality of steam
  - Improve efficiency of steam generation
  - Typically in low points of distribution system and at use points
    - Distribution piping is slightly sloped to move condensate in a specific direction toward a low point, where a steam trap can remove the condensate

Description of Steam Traps

- Steam trap function
  - Valve that is operated by a trigger
  - Trigger opens an orifice in trap to release condensate
  - Trigger resets when condensate has been removed - orifice is closed

- Various types of steam traps
  - Float (and Thermostatic)
  - Thermostatic
  - Inverted Bucket

Analysis of Steam Trap Function

- Failure modes of steam traps
  - Blocked
    - Orifice is blocked and no steam or condensate is removed through the trap
  - Blown
    - Orifice is always open and steam is released through the trap
- Three methods to analyze steam trap function
  - Visual inspection
    - Observation to see if steam is constantly flowing from the trap, or not at all
  - Temperature measurement
    - Measure temperature differential across trap and measure outlet temperature to determine if the trap is functioning
  - Ultrasonic measurement
    - Measure frequency of trap to indicate functionality (each trap operates at a specific frequency)
- Steam trap failure typically determined using two of the three methods

Wireless Steam Trap Monitor (WSTM) Overview

- Modified WTR with two thermocouple type K sensors
- Battery powered (typically lasts 3-5 years at sample rate of 15 min)
- Easy to install – just clamp on thermocouple sensors to the inlet and condensate out of the steam trap

Principle of Operation of the WSTM

- Thermocouples are placed at inlet and outlet of the steam trap to measure temperature
  - Type K thermocouples with a range of 32°F to 2012°F (0°C to 1100°C)
  - Per Steam Tables, ~ 150°C → 70 PSIA
- Expectations:
  - Inlet temperature approximately equivalent to the saturated steam temperature for operating pressure of steam system
  - Outlet temperature is just below boiling point of water
  - Differential temperature between inlet and outlet temperatures to show that there is steam on one side of the trap and condensate on the other side

    Note: Expected temp differential is function of steam pressure and condensate piping

WSTM Installation and Operation Notes

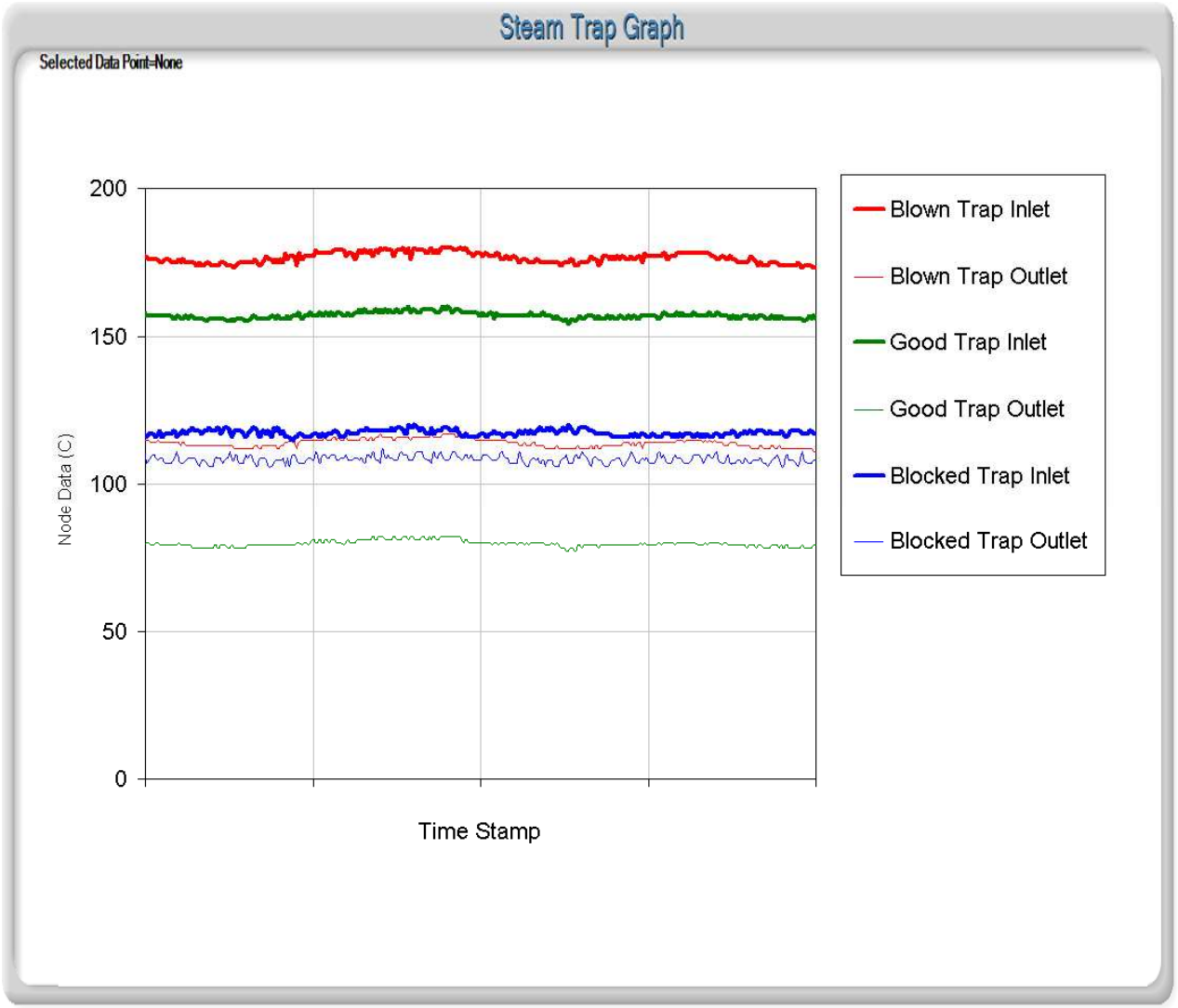
- WSTM is a WTR that uses thermocouples (TCs) as inputs
- Temperature limits on the TCs: 1100°C
- Installation: non-invasive. TCs clamp onto inlet and outlet pipe of steam trap
- Each WSTM has three nodes – inlet temperature, outlet temperature, differential temperature
- Readings page displays data on single line for steam trap: Inlet_Temp / Outlet_Temp / Delta_Temp
- Alarm set points may vary by steam trap
  - Dependent on steam pressure
  - May be dependent on steam trap type

WSTM Data Analysis

Scenario	Inlet Temperature	Outlet Temperature	Differential Temp > 20°C
Functioning Trap	At saturated steam temperature	Just below boiling point of water	Yes
Partially blown trap	At saturated steam temperature	Hovering at or above the boiling point of water	Yes
Blown trap	Above saturated steam temperature	Above boiling point of water	Yes
Blocked Trap	Below boiling point of water	Below boiling point of water	No
Off Trap or Bypassed Trap	Ambient temperature	Ambient temperature	No

Note: Expected temperature differential is a function of steam pressure and condensate piping

WSTM Sample Trend



Value of WSTM

- Predictive maintenance
  - Reduce manual inspection needs
  - Can identify potential failures before they occur
  - Can plan maintenance activities
- Energy savings
  - Typically only perform steam trap maintenance on an annual basis; losses go undetected until next maintenance
  - Can minimize steam loss by catching them as they occur

Considerations when Evaluating Customer Site

- Need to know approximate pipe sizes on inlet and outlet of steam traps
  - Helps installers size thermocouples
- Helpful to know:
  - Steam operating pressure – helps in analysis of data
  - Steam trap orifice sizes – helps to calculate losses and savings
  - Whether or not condensate goes to drain or goes to a condensate tank – may be some backpressure in the system, which might impact temperature
- If there is insulation around the trap, installers will need to pull it back – WSTM thermocouples must be installed directly on the pipe
- Smallest pipe diameter to get a TC around - ½”
- Installation time per steam trap:
  - Dependent on accessibility of trap
  - Dependent on insulation around trap
  - Dependent on knowing size of pipe around steam trap
  - Can take from 20 minutes to 1 hour

WSTM Common Questions

Reliability of temperature measurement over ultrasonic measurement?

- Somewhat of a religion – not easy to debate
- Both methods have issues:
  - Temperature method can be unreliable if:
    - Condensate system has a lot of back pressure (not vented)
    - Inlet steam pressure is low (less of a delta T to detect)
  - Ultrasonic method can be unreliable because:
    - Sonic device needs to be used correctly
    - Need to know what the sound profile is telling you. Automating the process is not easy. Plus, comparing real-world sound to a reference signature is not guaranteed either.
- Ultrasonic devices are much more expensive
- Ultimately, many people still use thermal guns to test steam traps → give good indication of problems

Note: Some traps may not have proper bypass and may not be easy to repair or replace except during shutdown. This impacts savings.

Agenda

- Wireless Infrastructure
- BBS
- WGR/WMR
- WTR
- WSTM
- **WFM**

CYPRESS
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Principle of Freezer Operation

- Freezers have compressors and a refrigerant loop that control the chamber temperature of the freezer
  - Ultra-low freezers typically have two compressors
  - 'Regular' freezers typically have one compressor
- Only "working" components are compressors
- Freezers typically monitored for temperature
- Temperature deviations are indications that failures have occurred, not potential failures
- Failure modes of freezers
  - Compressor failure
  - Power failure
  - Refrigerant loop leak
  - Chamber seal failure – door or gasket failure

Wireless Freezer Monitor (WFM) Overview

- WFM is a four-channel WTR
  - Channel 1: Low stage compressor amperage monitor
  - Channel 2: High stage compressor amperage monitor
    - This channel will not be used if the freezer only has one compressor
  - Channel 3: Chamber temperature monitor
  - Channel 4: Door switch monitor (open or close)
- All four channels record at the same time
  - Helps to correlate any deviations
- Door switch triggers an increased sampling rate
  - When the door switch is triggered, sample period reduced to every 30 seconds for a 2 minute duration
  - Intended to catch peak amperage draw of compressor at startup

How WFM Works to Prevent Failure

WFM monitors parameters that would indicate a potential failure

- Compressor Amperage Monitor
  - Compressor failure – compressors working too hard, or not working at all
  - Power failure – no amperage readings or constant amperage readings
  - Refrigerant loop failure – compressors working too hard, drawing too much amperage
- Door Status Monitor
  - Indication of the chamber seal failure mode
- Temperature Monitor
  - Indication that failure has occurred

Monitoring all points together correlates data to indicate imminent failure, cause of failure, or operator error

Value Add for the Customer

- Risk Mitigation
  - Minimizing risk of product loss within freezers by monitoring multiple parameters
- Predictive Maintenance
  - Indication of problems prior to equipment failure
  - Minimizing preventative maintenance activities
- Equipment Useful Life Extension
  - Resolving small problems before they result in equipment failure and replacement
- Flexibility of Monitoring
  - Some freezers are moved around. Hard wiring limits monitoring capabilities.

WFM Installation Overview

- Ammeters installed for each compressor
  - Ammeters connected in-line with existing wiring in freezer
  - Short downtime required for personnel safety during installation (approx. 5 minutes)
- Thermocouple installed inside chamber
  - Location of thermocouple consistent with existing chamber control thermocouple
  - Installation method will depend on customer
    - May be installed through door, if freezer cannot be defrosted
    - May have existing port for TC to be wired through
- Door switch connected to existing door switch
  - Most freezers have door alarms
  - Polarity of switch tested during installation
  - Output is 1 or 0 (0 is closed)

WFM Installation Overview

- WFM antenna is connected to rear of freezer
- WTR portion of WFM can be placed inside mechanical space of freezer
- Access Requirements for Installation
  - Installers have to open up the mechanical space of the refrigerator
  - Installers need to access the chamber in order to install the thermocouple
- Installation Time – Up to 1 hour
  - Wiring of compressors may take time to interpret
  - Accessibility of the mechanical space of freezers may be difficult

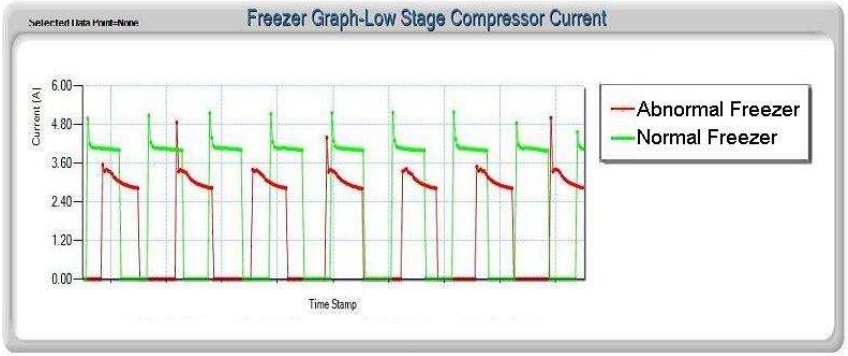
WFM Installation

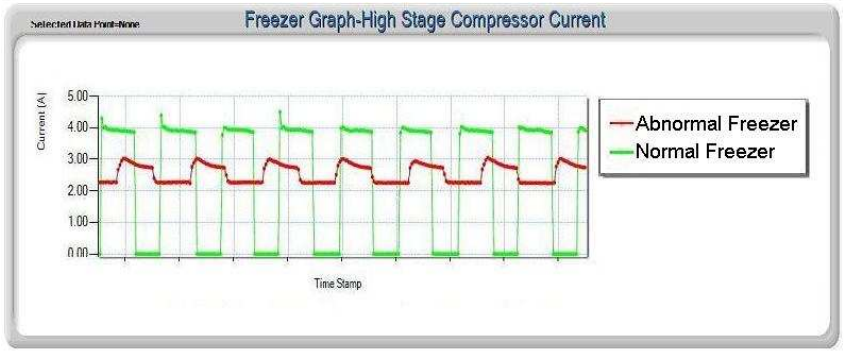
- Downtime required for installation is minimal
  - Most work can be done without downtime
  - A 5-minute downtime on a freezer that is maintaining temperature will have little/no impact
    - -70°C freezers can hold temperature for > 1 hr if functioning properly
    - Most freezers have battery backup to monitor temperature, even in a power failure
    - Installation team can monitor temperature while amperage points are installed

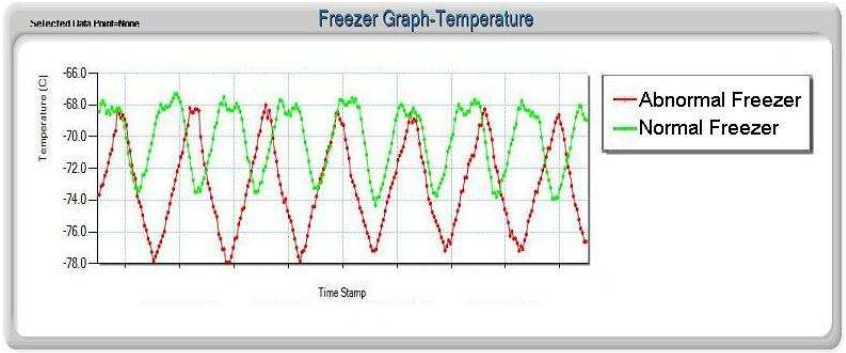
Things to Know about the WFM

- Power Options
  - The WFM is battery powered
  - The WFM can be plugged in, or powered by the freezer power
- Dual Chamber WFM
  - Freezers may have more than one chamber
  - Freezers may have more than one door, but a single chamber
  - Dual chamber freezers may require multiple WFMs to effectively monitor freezer
- Door Switch
  - Because door switch monitor ties into built-in door switch, monitoring methodology is dependent on the existing switch
    - May be a factor if freezer is an older unit with multiple doors, and door switch is only triggered by one of two doors
    - May be a factor if existing door switch is not functioning

Pictures and Trends







Appendix

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Glossary of Terms

BBS	Blue Box Server
HHC	Handheld Configuration Tool
IND-WST	Wireless Survey Tool
LOS	Line of Sight
RSSI	Received Signal Strength Indicator
WFM	Wireless Freezer Monitor
WGR	Wireless Gauge Reader
WRE	Wireless Range Extender
WSTM	Wireless Steam Trap Monitor
WTR	Wireless Transducer Reader
WMR	Wireless Magnehelic Reader