

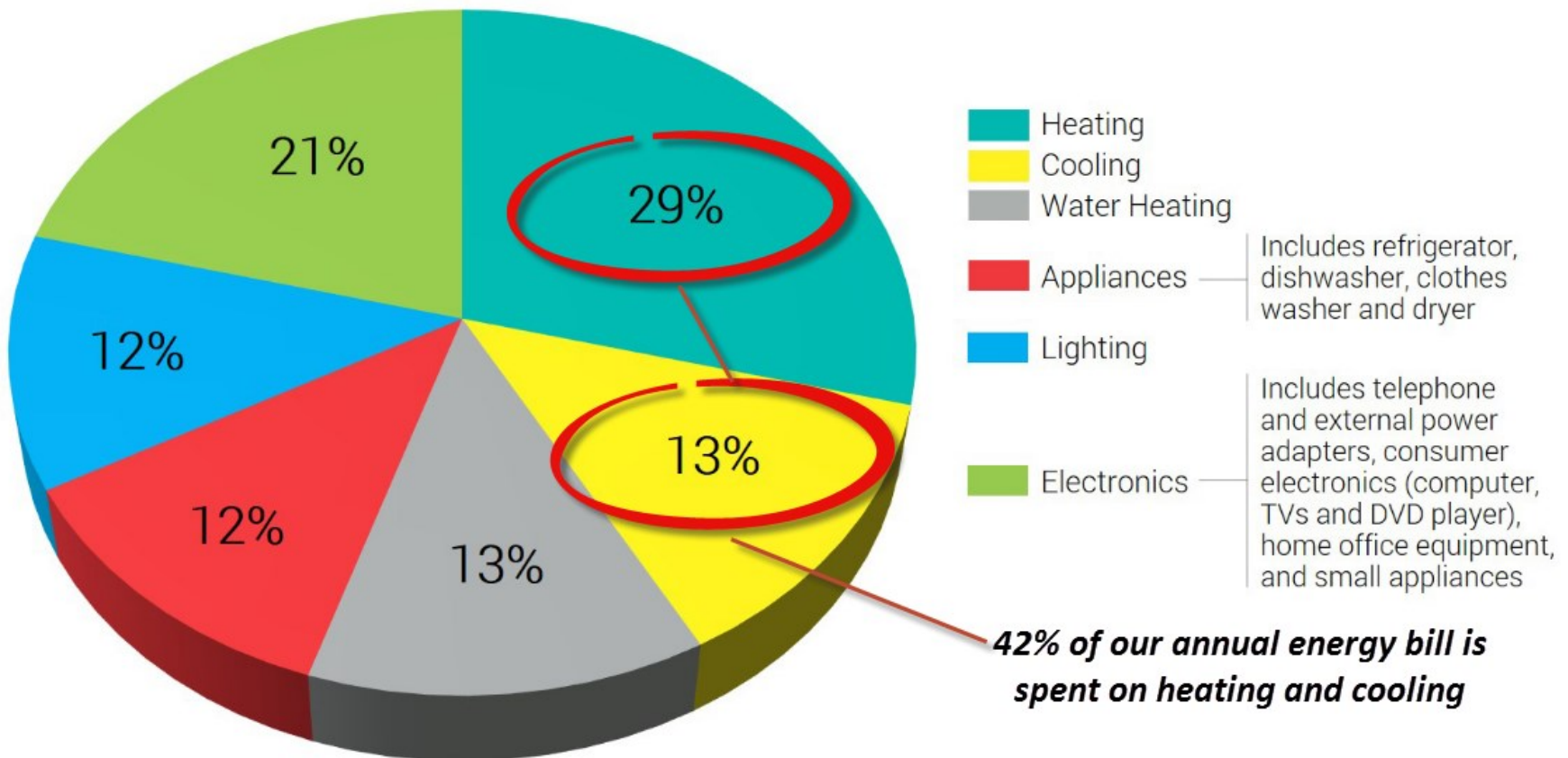
MCerberus®

The HVAC Monitoring “WatchDOG” System

RT Automation
Ron Roth, Ph.D.

Single Family Home Annual Energy Bill

Annual Energy Bill for a typical Single Family Home is \$2,060



Source: Typical House Factoid Memo. Lawrence Berkeley National Laboratory. April 2013.

Central HVAC Maintenance Guidelines

“The most common HVAC problems are attributable to improper operation due to faulty installation, poor service procedures, and inadequate maintenance...” www.energy.gov

“An air conditioner require regular maintenance for the unit to function effectively and efficiently throughout its years of service.” www.energy.gov

“Neglecting necessary maintenance ensures a steady decline in Central HVAC performance while energy use steadily increases.” www.energy.gov

“The Central HVAC owner has no idea how well their system is operating. Most individuals WAIT until their systems have issues before calling a repair person.” [Quote Ron Roth, Ph.D.]

Air Conditioner Repair Costs

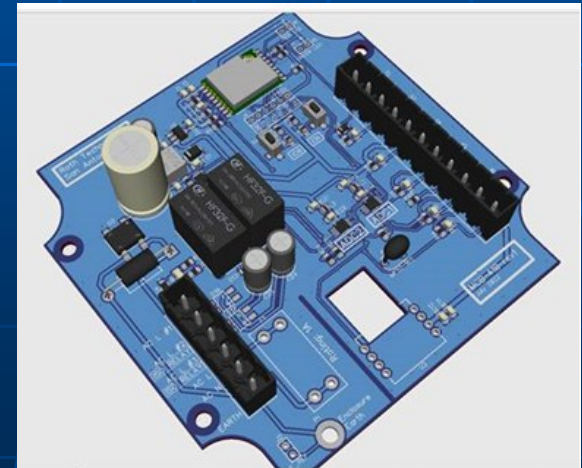
- Refrigerant leak detection and repair: **\$225-\$1600**
- AC refrigerant recharge: **\$160-\$400**
- Circuit board replacement: **\$120-\$600**
- Replace fuses, circuit breakers or relays: **\$15-\$300**
- Thermostat replacement: **\$60-\$250**
- A/C compressor repair hard start kit: **\$100-\$250**
- Capacitor or contactor replacement: **\$90-\$400**
- Home air compressor replacement: **\$1350-\$1800 (**)**
- Evaporator coil replacement: **\$650-\$1200**
- Condensing unit fan motor replacement: **\$100-\$300**
- Condensate pump replacement: **\$90-\$250**
- **Ceiling repair/replacement due to water damage: \$5,000+**

Reference: www.homeadvisor.com National Averages 2017

(**) “80 percent of AC Compressor Failures are preventable...” www.aristar.com

MCerberus[®] HVAC Monitoring System

- Continuous monitoring of Central HVAC Units in Residential and Roof Top Units
- Low Hardware and Installation Cost
- Determines real-time operational state of equipment via our Backoffice Software Solution
- Net Savings due to lower energy bills as well as minimizing repair costs
- Seven year plus installation history
- FCC Compliant: FCC CFR 47, Part 15, Subpart B, Class B Test

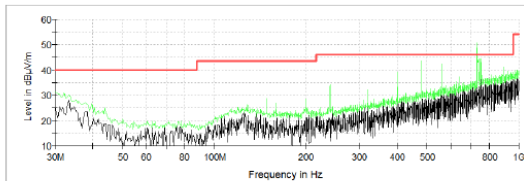


MCerberus® Application

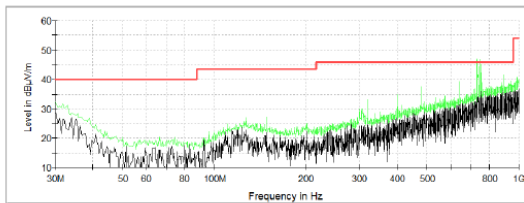
- The **Product Hardware** developed is a kit that can be installed on any Central HVAC system (residential and/or rooftop unit)
 - Microprocessor w/ WiFi capabilities
 - Two temperature sensors + optional room temp sensor
 - One current probe for blower fan
 - One water sensor w/ optional dual water sensor capability
 - Harness connection for 24VAC power input + connections to thermostat signal wires. Includes isolation circuitry that handles thermostat control relays with high leakage current
 - Optional delta P sensor for monitoring air filter quality
- The **Product Hardware** Unit takes a measurement every one minute and transmit the data to our server
- The **Product Software** Backoffice application analyzes the data and determines the current state of the equipment
- The data is evaluated with respect to established “rules” which determine the **Operational State** of the Central HVAC System
- Hardware based WatchDOG system ensures that monitoring system is running and will power cycle the system when and if necessary

FCC CFR 47, Part 15, Subpart B, Class B Test

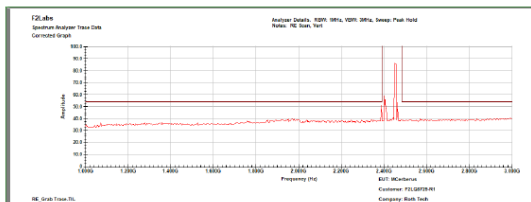
Characterization Scan: 30 MHz to 1000 MHz – Vertical



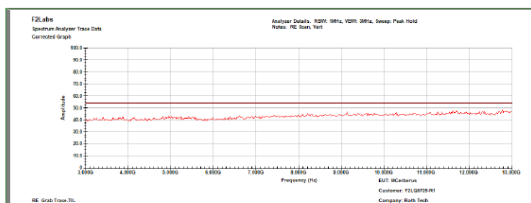
Characterization Scan: 30 MHz to 1000 MHz – Horizontal



Characterization Scan: 1 GHz to 3 GHz – Vertical



Characterization Scan: 3 GHz to 13 GHz – Vertical



CERTIFICATE OF TEST

Roth Technologies, LLC

14111 Bluff Grove Drive
San Antonio, Texas 78216 USA

Product Name: MCerberus® Condition Monitoring

Model(s): MCB-414*

*Denotes actual model tested as worst-case representative of product family that includes MCB-414, MCB-1XXX, MCB-2XXX, MCB-4XXX, MCB-5XXX, MCB-8XXX, and MCB-9XXX, where XXX represents various sensor inputs (temperature, current, etc).

Report No(s): F2LQ8729-R1-01E

The above-listed product(s) were tested and found to comply with the following standard(s)*:

Standard: Federal Register CFR 47, Part 15, subpart B, Class B

Standard: ICES-003, Issue 7:2020, Class B



Ben Coolbear
EMC Technical Manager
Issue Date: 2023-10-11

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*This Certificate is based on the evaluation of a representative sample(s) of the above-mentioned product(s) on a voluntary basis. This is to confirm that the tested sample(s) were tested to all or part of the standard(s) listed herein, as detailed in the applicable test report(s). It does not imply the assessment of the production of the product or approval of the manufacturing process or facility. The holder is authorized to use the Certificate to provide evidence of conformity as detailed above with the authority of F2 Labs.

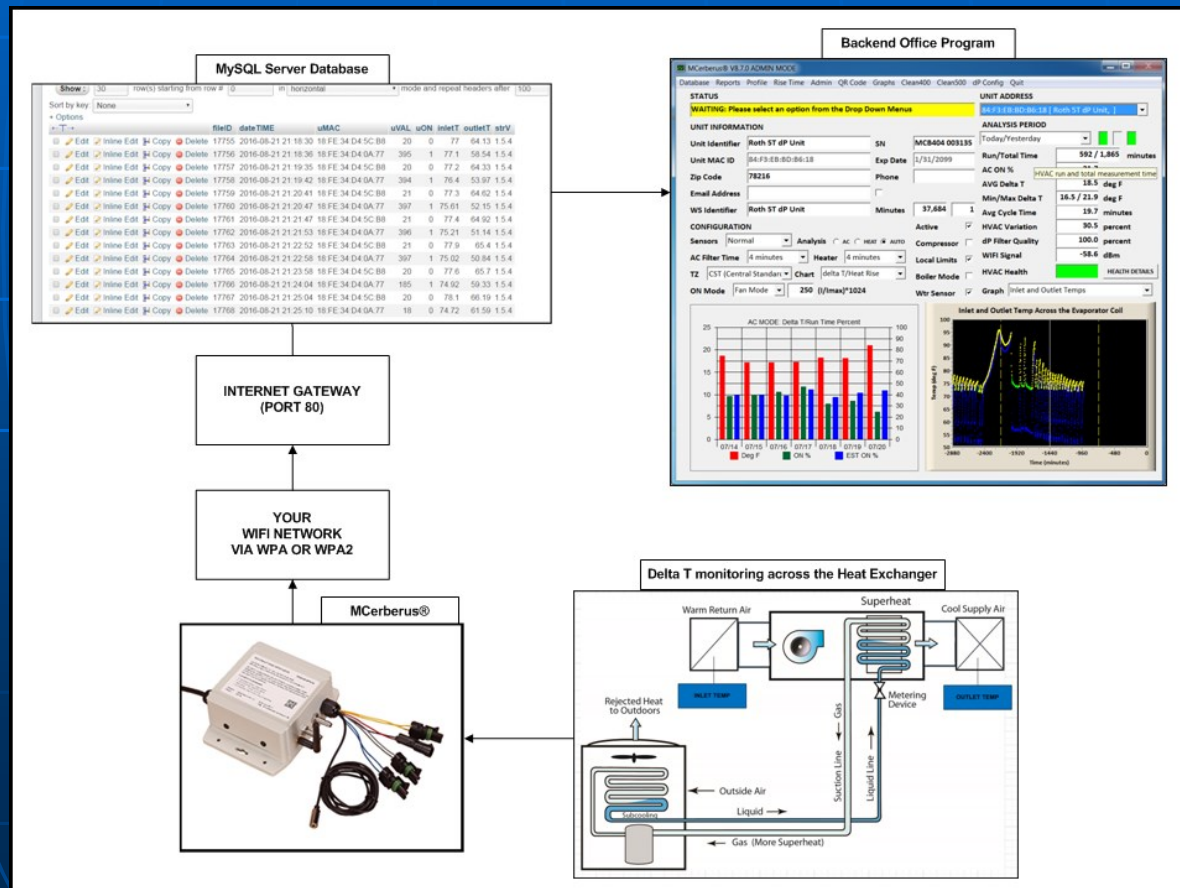
F2 Labs - Maryland
26501 Ridge Rd
Damascus, MD 20872
(301) 253-4500

F2 Labs - Ohio
16740 Peters Rd
Middlefield, OH 44062
(440) 632-5541

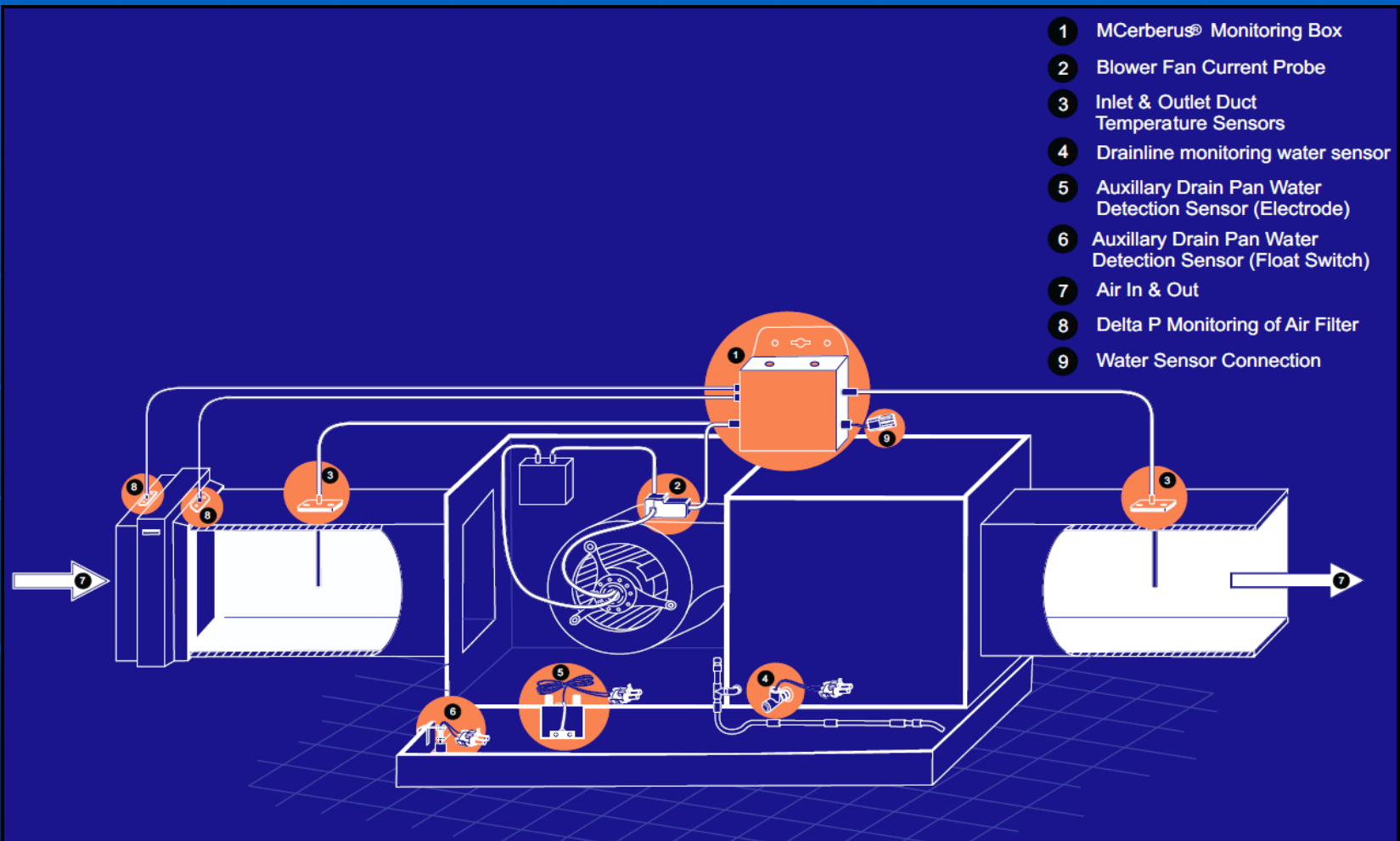
F2 Labs - Indiana
8583 Zionsville Rd
Indianapolis, IN 46268
(877) 405-1580

MCerberus® HVAC Monitoring Schematic

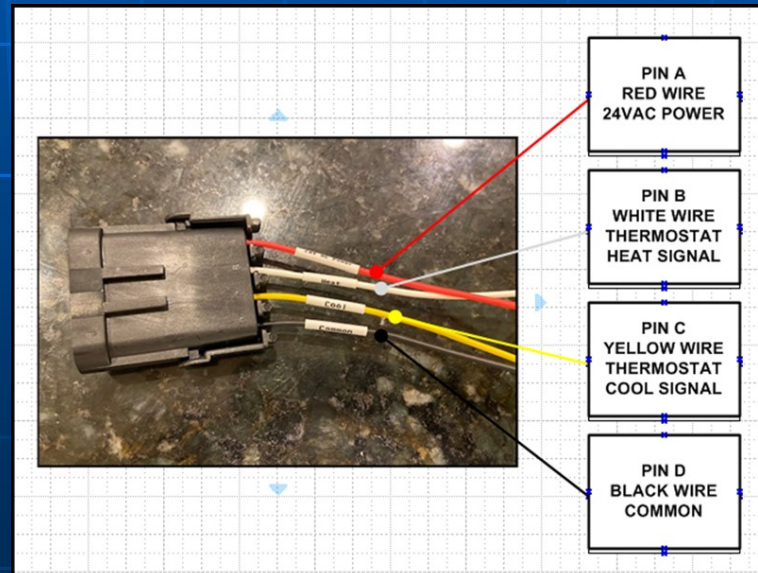
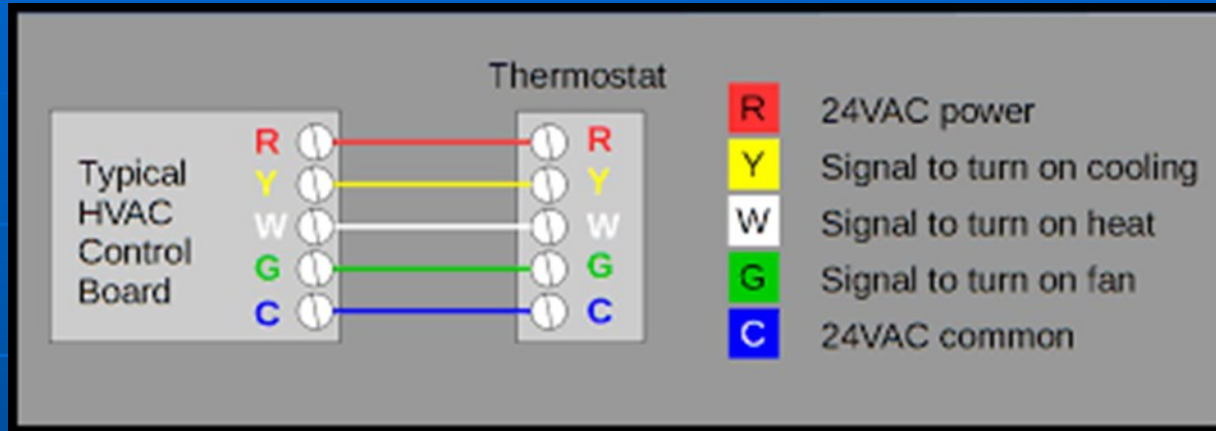
We control the whole interface including the backoffice software and server. We are capable of updating our system to support customers API requirements.



Complete Installation Method

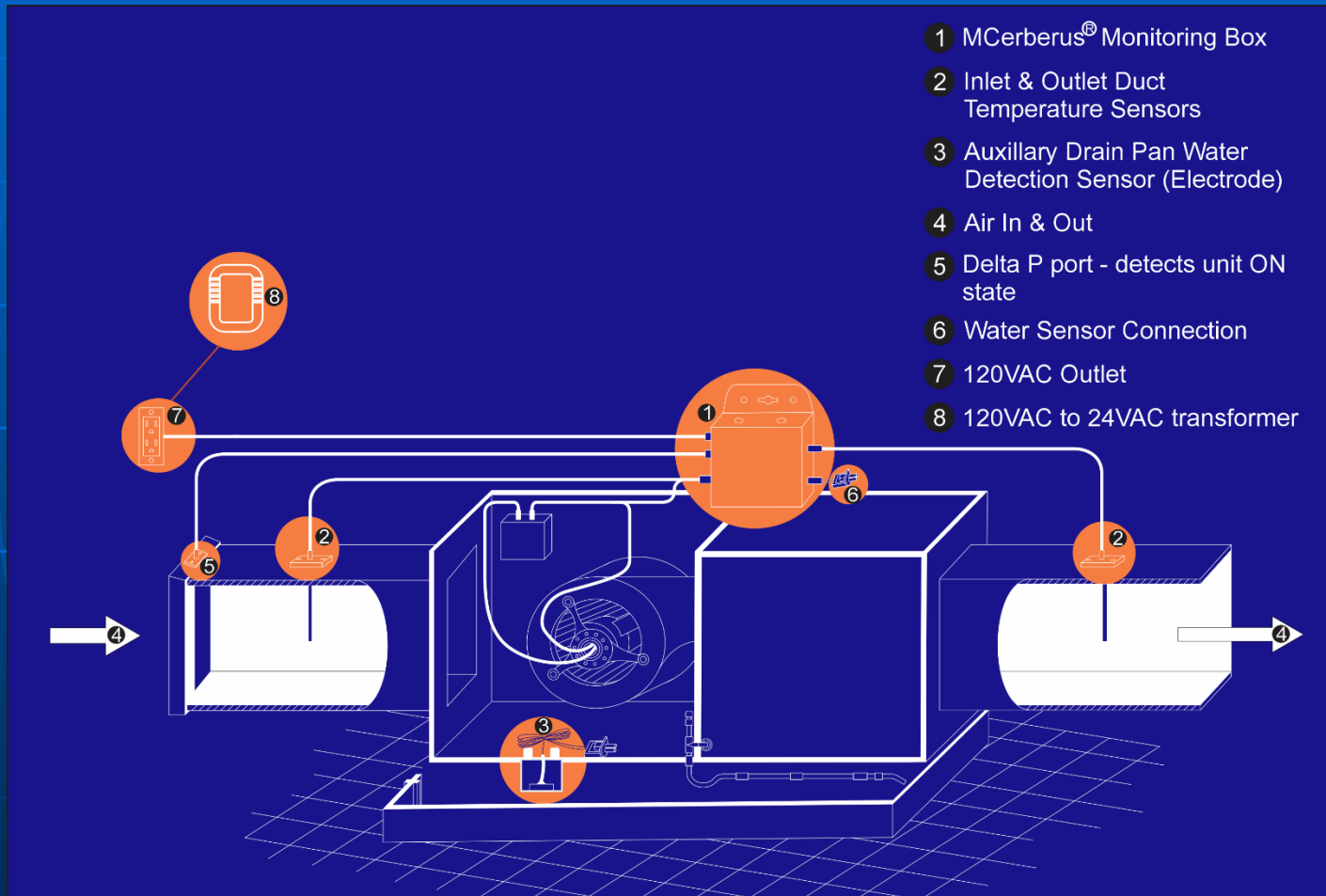


Thermostat Signal Connections



Simple Homeowner Installation Method

No need to open the unit – all connections external



Installation of Hardware



- Configure WiFi in a convenient location
 - Install Inlet and Outlet Temp Sensors (optional Room Temp Sensor)
 - Install Water Sensor
 - Connect Current Clamp to Power to Air Handler Blower Fan
 - Install optional delta P connections across air filter
 - Connect Power and Thermostat Control Signals
 - Turn system on – ensure that all signals are proper
-
- Our estimate for installation is 30 minutes not including transportation time for a well trained (seasoned) installer

MCerberus® Part Numbers

- MCB-410

<https://www.youtube.com/watch?v=1qcv2xgFRaM>

- MCB-414: Includes delta P capability

<https://www.youtube.com/watch?v=Ni14HxJ6GiE>

Back Office Software Package

Windows and MAC Windows emulator mode

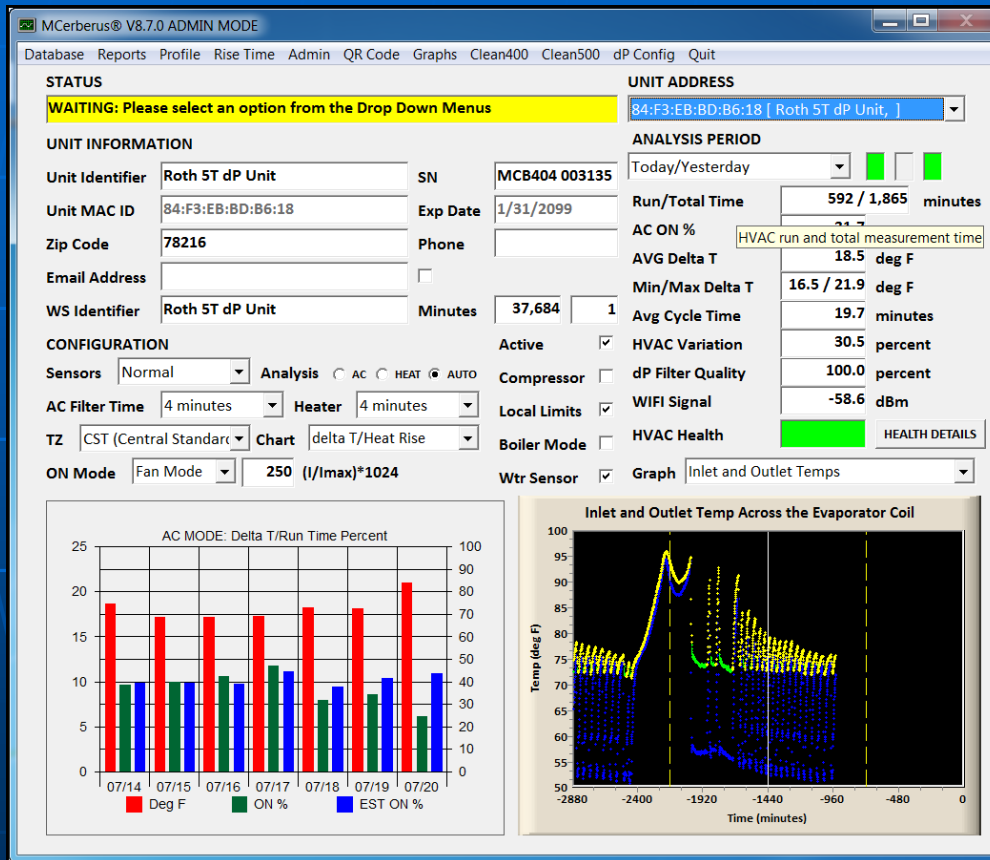
AC and Heater Analysis Modes

Computes delta T, Inlet/Outlet Temp, Run Time, and ON/OFF Cycles over the Selected Analysis Period

Optional Learning Algorithm used to detect expected run times as a function of outdoor temperature

Optional delta P sensor output used to detect filter quality

Monitoring Status Indicators provides summary



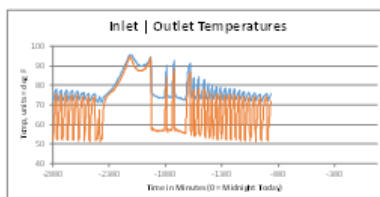
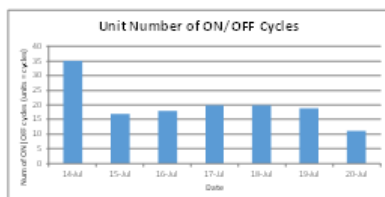
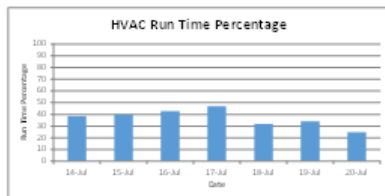
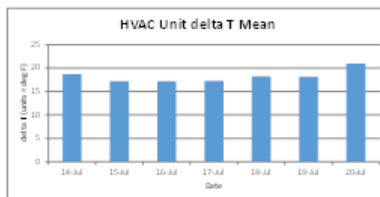
USA Patents Granted

- Continuous Monitoring for Early Failure Detection in Climate Control System, US 11320164 · Issued May 3, 2022
- Continuous Monitoring System for Early Failure Detection in HVAC Systems, US 11248817 · Issued Feb 15, 2022
- HVAC Monitoring Hardware, US D936492 · Issued Nov 23, 2021
- Drain pan mountable water sensor
Drain pan mountable water sensor. US D907175 · Issued Jan 5, 2021
- Water Proof Water Sensor, US D898598 · Issued Oct 13, 2020
- Fluid Dispensing System, US D869604S1 · Issued Dec 10, 2019

HVAC Health Monitoring

HVAC UNIT FAULT STATUS						
EXIT						
STATUS BAR						
WAITING: The following is a summary of the HVAC status. Please review - select EXIT when complete						
FAULT DESCRIPTION	RESULT	HVAC FAULT CONDITION				
Delta T is less than Min Limit		Measured Delta T	18.2	>=	14.0	deg F
Delta T is greater than Max Limit		Measured Delta T	18.2	<=	22.0	deg F
Delta T Fault occurred today (High and/or Low)						
Unit exhibits statistical change in performance		Delta T Variation	30.5	<=	100.0	percent
Unit is running too little		Measured Run Time		>=	0.0	percent
Unit is running too much		Measured Run Time		<=	90.0	percent
WiFi Fault: No Data Records recently						
WiFi Fault: System is not recording at reqd rate						
WiFi Signal Strength is too low		WiFi strength	-58.6	>=	-80.0	dBm
Inlet Temperature is too low		Measured Inlet T		>=	-30.0	deg F
Inlet Temp Sensor Fault						
Outlet Temp Sensor exceeds max limit		Measured Outlet T		<=	175.0	deg F
Outlet Temp Sensor Fault						
Room Temp is too low		Measured Room Temp		>=	43.6	deg F
Room Temp is too high		Measured Room Temp		<=	87.8	deg F
Room Temp Sensor Fault						
Water was detected by Water Sensor						
HVAC ON/OFF Cycle Limit (Short Cycling)		Number of Cycles	19	<=	120	cycles
Delta P exceeds max dP Limit		Measured Delta P		<=	0.30	inches H2O

UNIT MAC ID 84:F3:E8:8:D:66:18
UNIT SERIAL NUMBER MCB404 003133
UNIT IDENTIFIER Roth STD P Unit
DATE OF REPORT 7/20/2024 8:22
RUN | TOTAL TIME 592 / 1,865
ON PERCENT 31.7
DELTA T, MEAN (deg F) 18.5
delta T, MIN/MAX (deg F) 16.5 / 21.9
CYCLE TIME, MEAN (minutes) 19.7
delta P Filter Quality (percent) 100.0
WiFi Signal Mean (dBm) -58.6



FAULT RULE	FAULT STATUS	NOTES
Delta T is less than the Min Limit		Measured Delta T 18.2 >= 14.0 deg F Lower Limit
Delta T is greater than the Max Limit		Measured Delta T 18.2 <= 22.0 deg F Upper Limit
Short Term Delta T Fault (High and/or Low)		
Unit exhibits statistical change in behavior		Computed Delta T Variation 30.5 <= 100.0 percent
Unit is running too little		Measured Run Time >= 0.0 percent Lower Limit
Unit is running too much		Measured Run Time <= 90.0 percent Upper Limit
WiFi Fault: No Data Records Recently		
WiFi Fault: System not recording at req'd rate		
WiFi Signal Strength is too low		WiFi Strength -58.6 >= -60.0 dBm
Inlet Temperature is too low		Inlet Temp >= -30.0 deg F Lower Limit
Inlet Temp Sensor Fault		
Outlet Temp Sensor exceeds max limit		Outlet Temp <= 175.0 deg F Upper Limit
Outlet Temp Sensor Fault		
Room Temp is too low		Measured Room Temp >= 43.6 deg F Lower Limit
Room Temp is too high		Measured Room Temp <= 87.8 deg F Upper Limit
Room Temp Sensor Fault		
Water detected by Water Sensor		
HVAC ON/OFF Cycle Limit (Short Cycling)		Number of Cycles: 19 <= 120 ON/OFF cycles per day
delta P exceeds max dP limit		Measured delta P <= 0.30 inches of H2O

Unit Report Summary

Mobile Applications

- The MCerberus® HVAC Monitoring Application provides Daily Statistics regarding the state of their HVAC System being monitored by the MCB-4XX HVAC Monitoring Hardware.
- The application provides Delta T, Daily Run Times, ON/OFF Cycle Summary, Cycle Run Time Summary, and the Overall Operating Summary for their unit.
- The application also provides the status of the water detection sensor if the unit installed included one.



CONTACT INFORMATION

RT Automation

Website: www.mHVACmonitor.com

Email: sales@mcerberus.com