High Efficiency Burner Controls – Beyond Efficiency

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GORDON SWANSON

FENWAL®

1999 – Present: Kidde-Fenwal, Ashland MA

Since 2002: General Manager, Fenwal Controls, division of UTC Climate Control and Security

1999-2002: Engineering Manager

Products – Gas burner controls, temperature controls, heat detectors

Prior to Fenwal: Climate Controls Division, Texas Instruments (now Sensata)

Fenwal Controls History

1923	Wilfred Turenne invents and patents a precise mechanical temperature controller device later trademarked: THERMOSWITCH®
1938	FENWAL, Inc. founded by T. L. Fenn and Dr. Carl Walter to manufacture and market THERMOSWITCH® Temperature Controllers
1960	FENWAL® introduces electronic AUTOMATIC GAS IGNITION CONTROLS All operations consolidate to a new plant in Ashland, Massachusetts
1966	FENWAL, Inc. acquired by Walter Kidde & Company, a leading manufacturer of fire protection equipment.
1975	FENWAL introduces12VDC gas ignition controls for the RV market. Well accepted and widely applied across the mobile equipment applications.
1989	FENWAL, Inc. acquired by Williams Holdings Ltd. (UK) along with other KIDDE fire protection companies.
1991	KIDDE-FENWAL, INC. forms by merger of Kidde's North Carolina operation into Fenwal's Ashland, MA facility
2000	KIDDE PLC created when Williams Holdings Ltd. de-merged into two separate companies: Chubb plc. and Kidde plc.
2005	UNITED TECHNOLOGIES. acquires Kidde plc to create a new UTC division: United Technologies Fire & Security. After several iterations, now part of UTC Climate, Controls and Security

GAS BURNER CONTROLS

Supplier to OEM's of agency-certified products that safely light & control gas burners

- 45 yrs in the industry
- Broad line of configurable "platform" products
- Strong technical & apps support
- Large installed base
- Quick-turn samples
- World-class Manufacturing
- Excellent Reputation
- Close industry relationships
- 98+% OTD

Certifications:

CSA® C US   CE EN298:2003   AGA

FENWAL IN THE MID 2000'S

Variety of platform controls in various voltages and ignition styles

For on/off type burners

Limited intelligence and communication

Still very popular today

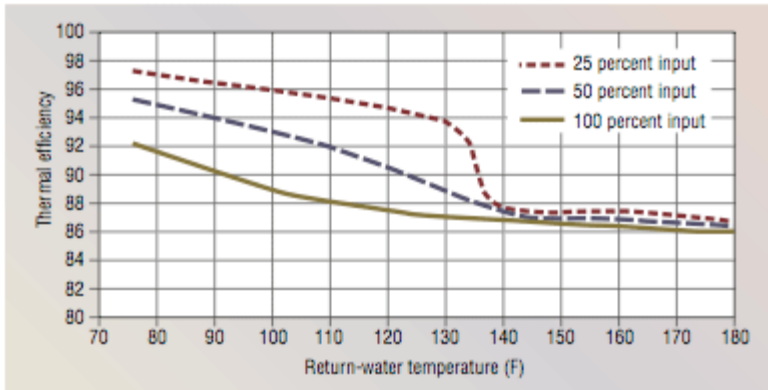Annual volume >1MM per year

ENERGY PRICES AND EFFICIENCY

FIGURE 1. Full- and part-load efficiencies.

2008 - According to the U.S. Department of Energy, almost 60% of boilers in the United States are more than 25 years old. Furthermore, it is widely accepted that these older-style, conventional boilers typically deliver less than 80% energy efficiency

July 2008 a gallon of gas hits $4.11

US Heating industry pivots to high efficiency boilers and water heaters

Most of the equipment – controls, heat exchangers – is imported from Europe

DOE and NRCAN efficiency regulations move in the direction driving high efficiency designs

Fenwal is behind the technology curve

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MARKET ACCEPTANCE OF HI-E MOD-CON

European experience with Mod-Con boilers dates back to the late 90's and has taken over the residential market segments
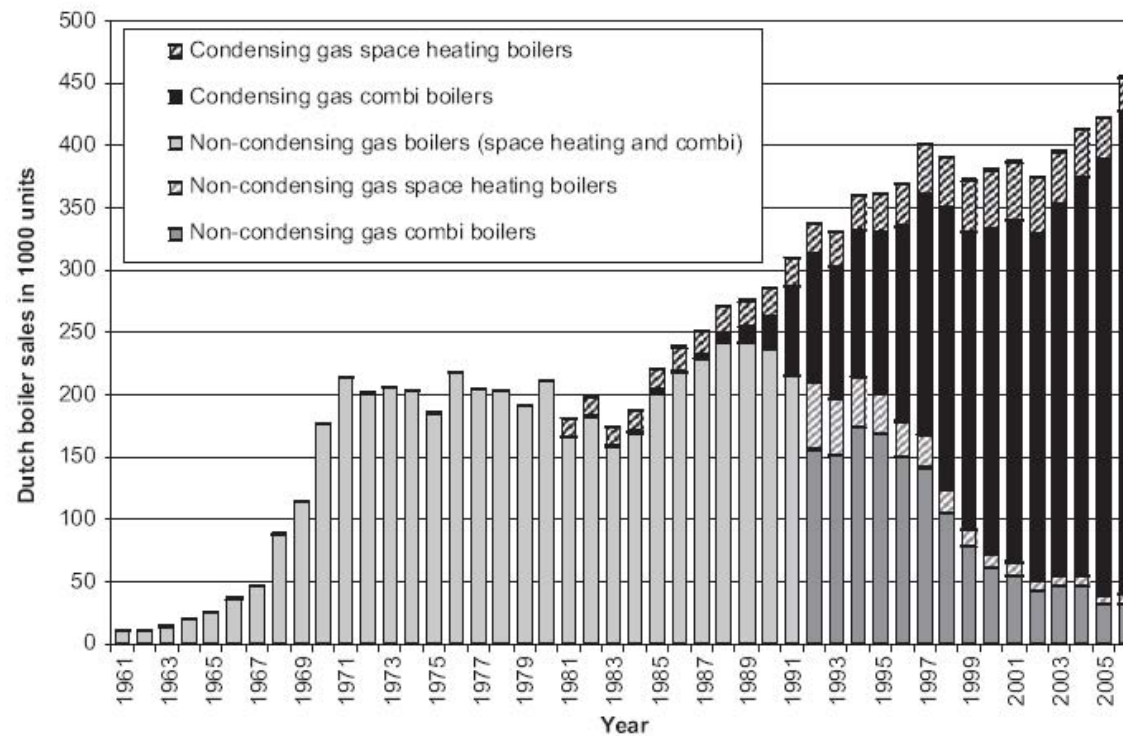
Fig. 1. Sales of condensing and non-condensing gas boilers in the Netherlands (In years prior to 1992, available data do not allow for differentiating between non-condensing gas space heating and combi boilers.) (data sources: CBS, 2007; Aptroot and Meijnen, 1993; Remeha, 2007; Sijbring, 2007).

THE FENWAL PIM®

Developed in response to the "European" controls dominating the US ModCon market

User interface/system control developed by tekmar®

Extensive VOC from more than twenty Boiler OEM's

Primarily envisioned as a boiler control for both residential and commercial applications

First OEM launch - 2012

PIM® CHALLENGES IN THE MARKET

Clearly PIM was not first to market

Many OEM's had already established a control partnership for ModCon
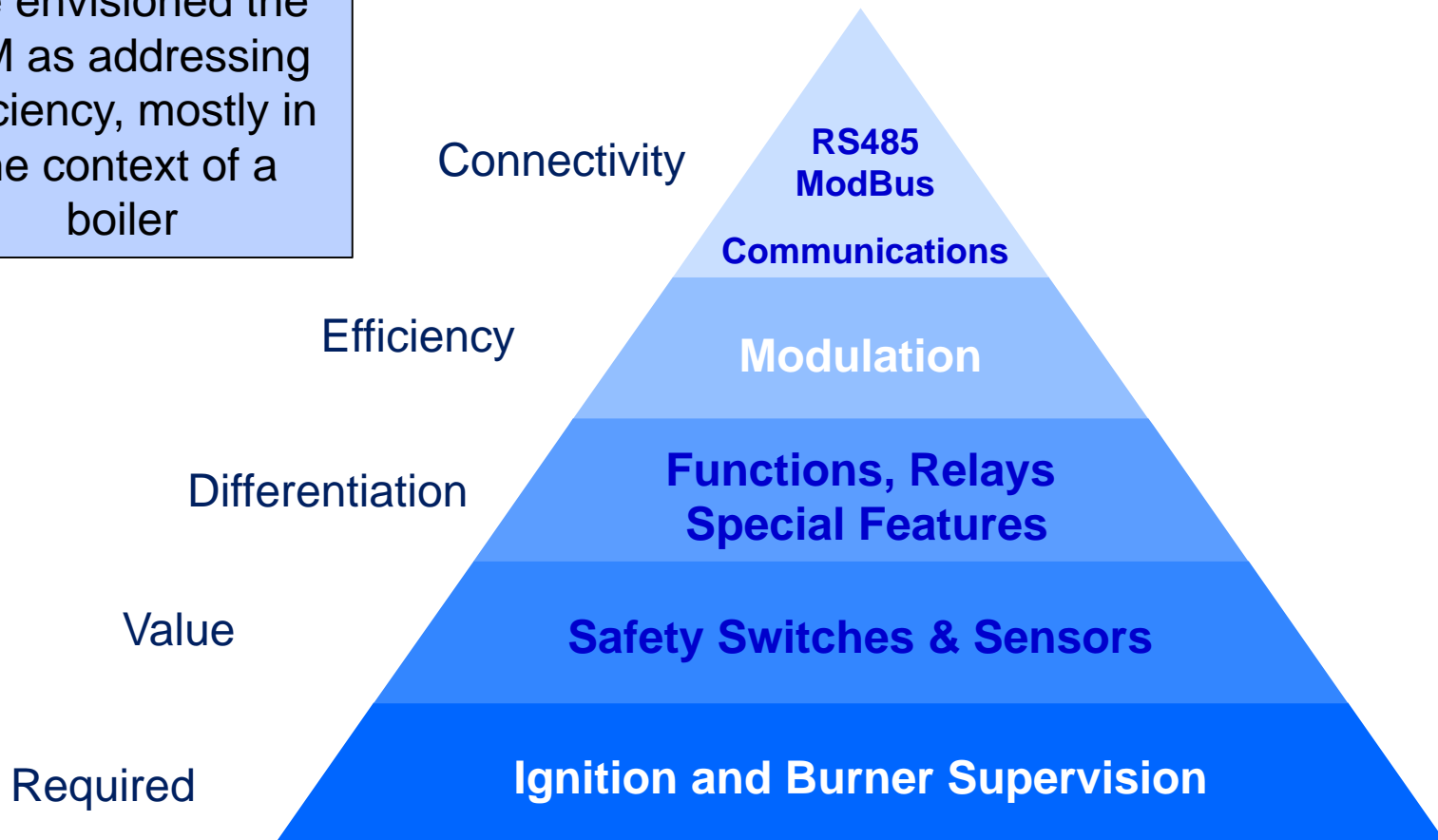
The PIM has compelling features and benefits

Gaining market share was proving to be difficult
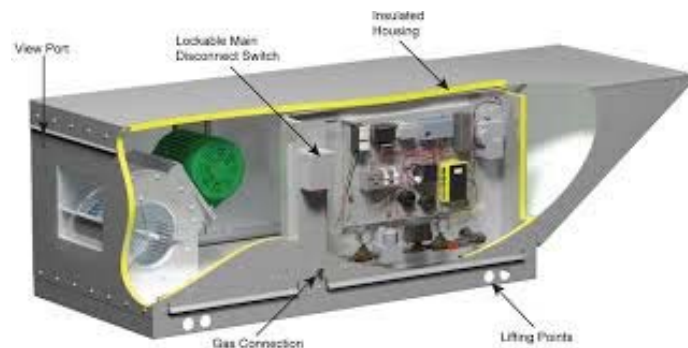
RE-IMAGINING THE PIM

Applications to alternate markets

BURNER CONTROL NEEDS HIERARCHY

We envisioned the PIM as addressing efficiency, mostly in the context of a boiler

Connectivity

Efficiency

Differentiation

Value

Required

RS485 ModBus

Communications

Modulation

Functions, Relays Special Features

Safety Switches & Sensors

Ignition and Burner Supervision
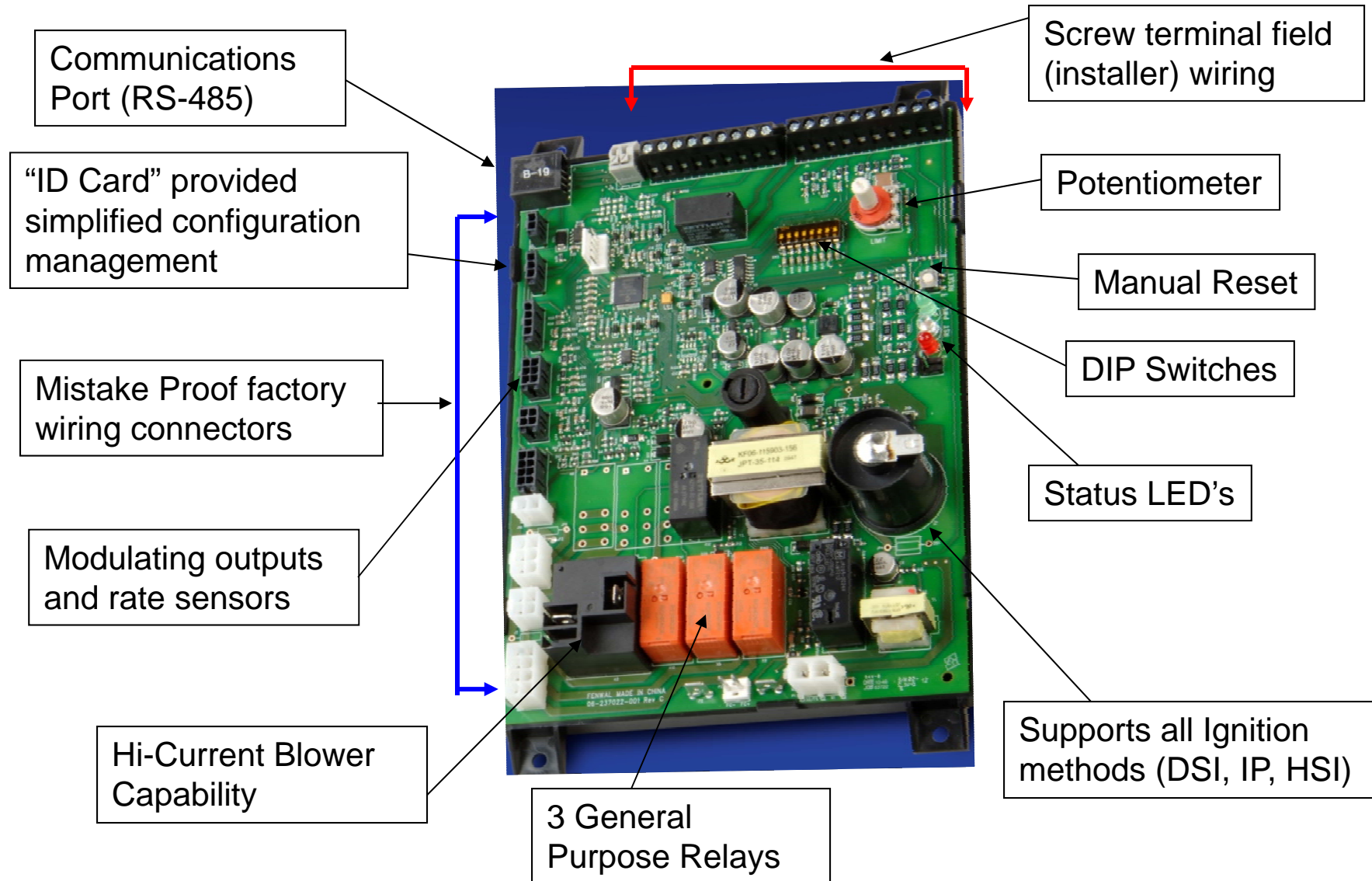
RE-IMAGINING THE PIM

We again embarked on gathering more VOC

Visited various industries, some core to Fenwal, others quite outside our usual "box"
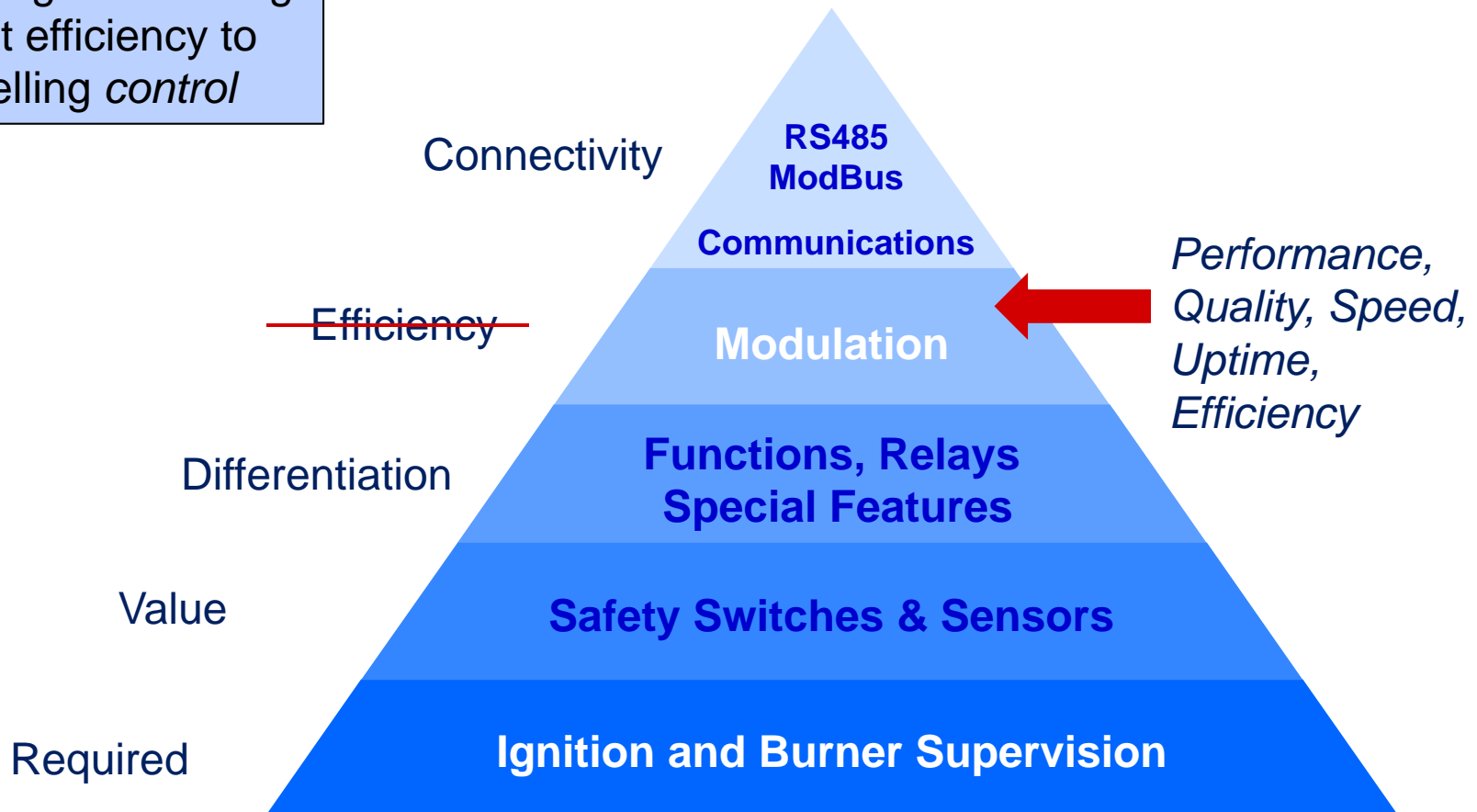
We were still focused on selling efficiency

But many markets were not receptive to a boiler-based value proposition

View Port

Lockable Main Disconnect Switch

Insulated Housing

Gas Connection

Lifting Points

PIM: BURNER SAFETY + I/O

Communications Port (RS-485)

"ID Card" provided simplified configuration management

Mistake Proof factory wiring connectors

Modulating outputs and rate sensors

Hi-Current Blower Capability

3 General Purpose Relays

Screw terminal field (installer) wiring

Potentiometer

Manual Reset

DIP Switches

Status LED's

Supports all Ignition methods (DSI, IP, HSI)

RE-IMAGED NEEDS HIERARCHY

Shifting from selling just efficiency to selling *control*

Connectivity

RS485 ModBus

Communications

~~Efficiency~~

Modulation

Performance, Quality, Speed, Uptime, Efficiency

Differentiation

Functions, Relays Special Features

Value

Safety Switches & Sensors

Required

Ignition and Burner Supervision

EXAMPLES AND CASE STUDIES

Applications to alternate markets

COMMERCIAL FRYER

Efficiency is important, but speed and food quality sell

Customer had developed a two-stage firing system, but using a collection of discrete components

High cost of install

Lacked capabilities for future performance enhancements

COMMERCIAL FRYER

Initial customer design

Individual components that did not communicate, needed end-of-line tweaking, complex wiring and installation

Fenwal

+

PWM

+

2 TDR's

=

COMMERCIAL FRYER

Using the PIM Solution

Precise speed control, lighting and firing

Low fire rate saves energy, responds quickly to load

Simple connections to cooking computer

Single board solution

Simplified installation

Consistent food quality

COMMERCIAL FRYER

Future options and improvements

Full modulation:

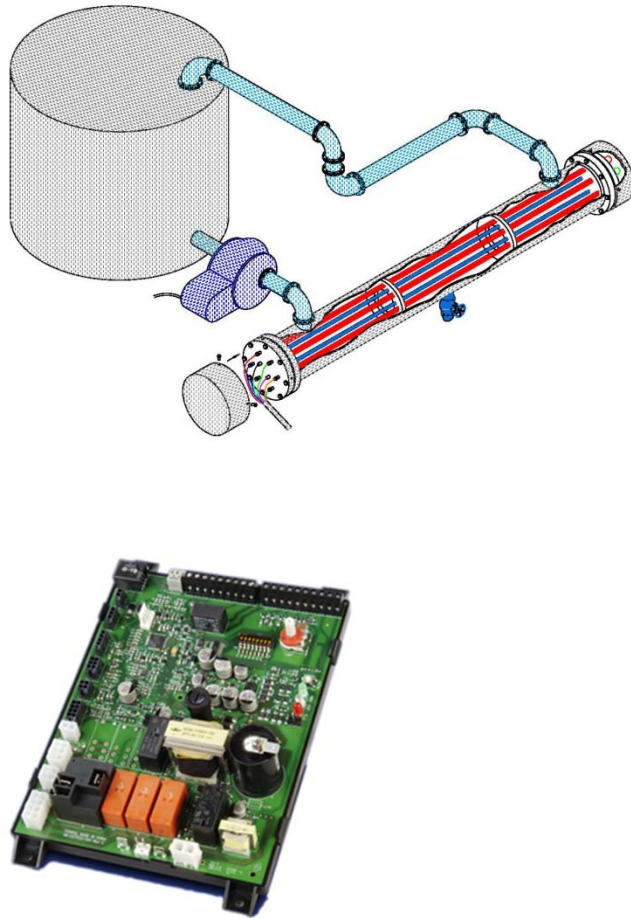Reduced overshoot, better cooking control

Better response to varying cooking loads

Improved food quality

Less cycling, longer oil life

Adaptive programs for fat melt, etc.

HEAVY OIL HEATING

Objective: Energy savings and better process control

Process heating application

Keeping crude flowing in the field or during processing

Non-sealed chamber uses modulating gas valve and inducer fan

Separate PWM "maps" developed for gas valve and blower
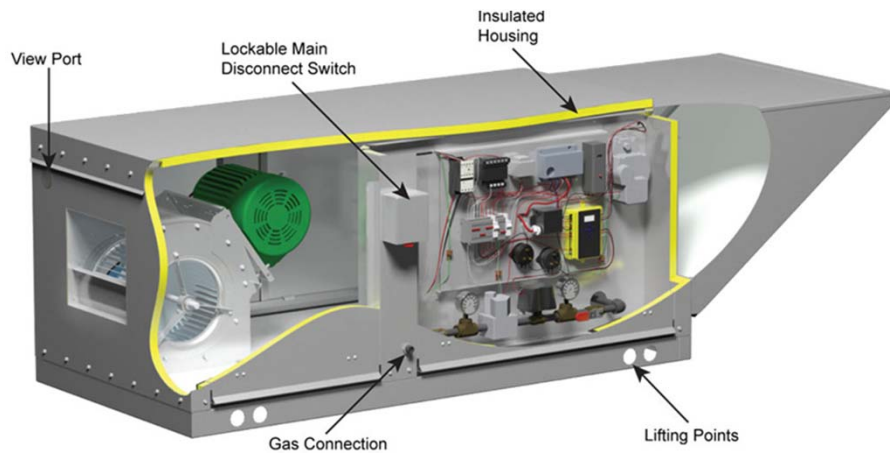
COMMERCIAL STEAMER

Objective: Better food quality and process time

Reduce variation in quality due to batch size

Simple on/off or staged control does not respond adequately

PIM configured to modulate based on steam pressure instead of temperature
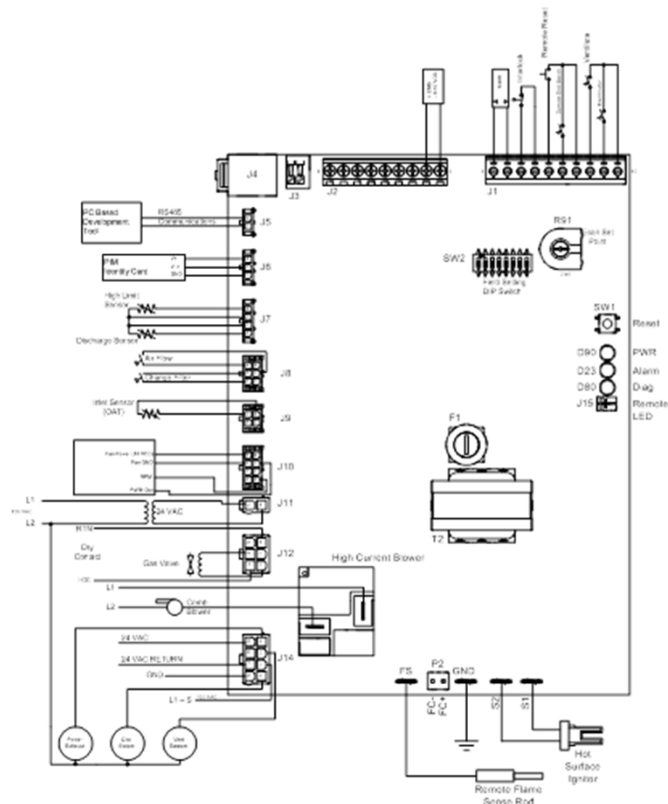
MAKE-UP AIR UNIT

Many make-up air units utilize an on/off gas heater

Discrete components are used to make up the control system

Several functions to control: Damper, economizer, combustion blower, circulation blower

MAKE-UP AIR UNIT

Control integration with the PIM

All Gas Ignition Control Functionality

PLUS

Control of discharge air temperature

Modulate combustion blower according to heating demand

Control Circulation blower

UL353 High Limit Control

Economizer and cold weather protection

Power Exhaust and Vent damper control

Adjustable purge times based on ducting

COMMERCIAL CONVECTION OVEN

Objective – Faster response, better food quality, energy savings

Concept already used in Europe for similar product

Simplified PIM control to manage modulating burner/blower assembly

0-10V control signal from cooking control

WHERE THE PIM IS NOT A NATURAL FIT

Radiant Heating

While on the market, modulating systems are a small segment

Typically requires modulating both gas and air

Higher product cost makes payback challenging

Two-stage systems meet comfort/efficiency goals at lower cost

Difficult to justify in price sensitive contractor markets

WRAP UP

LESSONS LEARNED WITH THE PIM

Benefits

Can improve control and consistency of many types of processes

Energy savings are usually realized, but there are almost always other benefits

Can consolidate multiple functions and reduce total installed cost

Scalable platform for future features and improvements

Diagnostics a plus during application development and in the field

Challenges

Almost no application is "off the shelf"

Higher initial R&D cost for both supplier and customer

Overall system cost is higher: Valve, blower, control

Payback a problem in cost sensitive product categories: Radiant Heat, Space Heaters, etc.

Difficult to "freeze" user interface and communications specs

QUESTIONS

Gordon Swanson
Fenwal Controls
gordon.swanson@fs.utc.com
508-231-2670

BACKUP INFORMATION

PIM Capabilities

PIM CAPABILITIES

- **PID Temperature Control**
  - Manual/Automatic Differential

- **Ignition Methods**
  - Direct Spark (DSI), Intermittent Pilot (IP)
  - Hot Surface (HSI), Proven HSI
  - External Ignition Transformer

- **DETECT-A-FLAME™ SENSING**
  - Sensitivity, Signal Processing, Full-Time Sensing

- **Combustion Blower Modulation**
  - Closed loop fan speed to control firing rate
  - Open loop PWM
  - 4-20 mA analog output

- **Gas Valve Options**
  - 1-Stage, 2-Stage, Isolated or
  - Modulating (4-20 mA; PWM)

PIM CAPABILITIES

- **24VAC Safety Inputs**
  High/Low Gas Pressure, Airflow Switch, LWCO,
  Waterflow Switch , Blocked Drain, Clean Filter

- **Temperature Sensors**
  UL353 Approved High Limit
  Six RTD/Thermistor Type inputs
  Ex: Inlet, Outlet, System, Outdoor, DHW, Vent

- **Rate-based Inputs**
  Blower speed feedback (RPM)
  Flow Rates (Water or Air)

- **Three Auxiliary Relay Outputs**
  Boiler, DHW, and System Pumps
  Vent dampers, Power exhaust, Circulating Fan

- **Commission Test Mode**
  High Limit Test, Field Test

PIM COMMUNICATIONS

PIM is able to communicate with a wide range of devices and systems

- **COMMUNICATIONS**
    Serial RS-485 (ex: OEM interface, cooking computer)

- **ENERGY MANAGEMENT SYSTEM (EMS)**
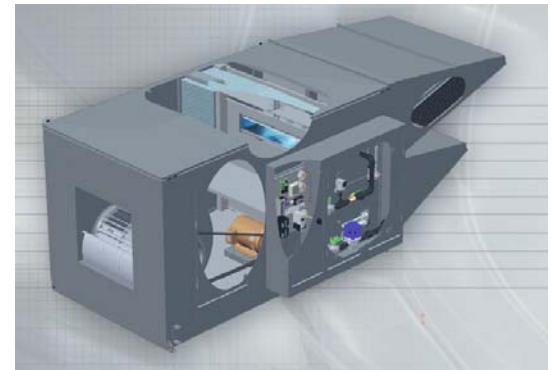   Analog Voltage 0-10 VDC or 4-20 mA
    Target Temperature / Direct Drive EMS input

- **PC INTERFACE**
    Development Tool or Monitoring Software

- **ADVANCED DIAGNOSTICS**
    LEDs, Alarm Relay, Messaging, Data Logging

PIM DEVELOPMENT TOOL