Four Things You Need To Know About Modulation Technologies

Bart Powelson
Director – Commercial Air Conditioning Marketing
Emerson Climate Technologies

Ken Monnier
Vice President – Air Conditioning Engineering, Technology Business
Leader Emerson Climate Technologies
Today’s Presenters

Bart Powelson

- Director - Commercial Air Conditioning Marketing
- 20+ Years Experience in HVACR Industry
- Responsible for Monitoring Industry Trends/Standards And Specifying and Launching New Compressor and Compressor Electronics Products for Commercial Air Conditioning Applications

Ken Monnier

- Vice President - Air Conditioning, Engineering, Technology Business Leader
- 30+ Years Experience in HVACR Industry
- Responsible for New Product Engineering and Engineering Management; Instrumental in Design and Technical Leadership of Various Fixed Capacity and Modulating Scroll Platforms and Compressor Electronics
The Role Of Modulation Technologies

The Benefits Of Modulation Technologies

The Applications Best Suited For Modulation Technologies

The Types Of Modulation Technologies
The Role Of Modulation Technologies

It’s Not Just A Want—It’s A Need

The Benefits Of Modulation Technologies

The Applications Best Suited For Modulation Technologies

The Types Of Modulation Technologies
Role Of Modulation Technologies

Changing Regulatory Landscape

• 2015 Regional Standards
• ASHRAE 90.1-2013
• Department of Energy Proposals
• Voluntary Standards
  (Energy Star, CEE, DOE Challenge)

Customer Preferences

• Enhanced Comfort
• Reduced Energy Costs
• Premium Technology
• Overall System Value
Impact Of 2015 Residential Regional Standards

- Growing Mid-Tier & Premium Tier
- Modulation Technologies Prevalent Above 14 SEER
- Enables Higher Efficiency And Differentiation
## ASHRAE 90.1-2010/13 vs. DOE Proposed Levels
### IEER For Commercial Air Cooled Packaged/Split Systems

<table>
<thead>
<tr>
<th>Efficiency Standards</th>
<th>6 – 10 Ton</th>
<th>11 – 20 Ton</th>
<th>21 – 60 Ton</th>
<th>&gt;60 Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 90.1-2010</td>
<td>11.2 IEER</td>
<td>11.0 IEER</td>
<td>9.9 IEER</td>
<td>9.6 IEER</td>
</tr>
<tr>
<td>ASHRAE 90.1-2013</td>
<td>12.7 IEER</td>
<td>12.2 IEER</td>
<td>11.4 IEER</td>
<td>11.0 IEER</td>
</tr>
<tr>
<td>(As Of 1/1/2016)</td>
<td>+13% IEER</td>
<td>+11% IEER</td>
<td>+15% IEER</td>
<td>+15%</td>
</tr>
<tr>
<td>DOE Proposed IEER</td>
<td>14.6 IEER</td>
<td>14.0 IEER</td>
<td>13.3 IEER</td>
<td>N/A</td>
</tr>
<tr>
<td>Levels (9/18/14)</td>
<td>~Effective Dec. 2018</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td>+30% Avg. IEER</td>
<td>+27% Avg. IEER</td>
<td>+34% Avg. IEER</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: Add +0.2 EER/IEER For Electric Resistance Heating
Agenda

1. The Role Of Modulation Technologies
2. The Benefits Of Modulation Technologies
   *It’s Not Just About Comfort*
3. The Applications Best Suited For Modulation Technologies
4. The Types Of Modulation Technologies
Enhanced Comfort
Precise Climate Control

Temperature Control

- Maintain More Even Temperature
  - Variable speed compressor
  - Standard Air Cond./Heat pump

Humidity Control

- Decrease Relative Humidity With Systems That Can Achieve Longer Run Cycles
Cooling Efficiency Definitions

Energy Efficiency Ratio (EER)
- Measure of Full Load System Efficiency calculated as Cooling Capacity (Btu/h) divided by Energy Consumption (Watts) at a given operating condition, usually Full Load or 95°F.

Integrated Energy Efficiency Ratio (IEER)
- Measure of Part Load Efficiency using a weighted average of efficiencies at various System Capacities and Conditions.

\[
IEER = (0.02A) + (0.617B) + (0.238C) + (0.125D)
\]

Where As:
A = EER at 100% Net Capacity at AHRI Standard Condition (95 deg F)
B = EER at 75% Net Capacity and Reduced Ambient (81.5 deg F)
C = EER at 50% Net Capacity and Reduced Ambient (68 deg F)
D = EER at 25% Net Capacity and Reduced Ambient (65 deg F)
Enhanced Energy Efficiency

**ENERGY EFFICIENT**

**SAVE UP TO 40%**
by upgrading to systems with variable speed technology

**REDUCE ENERGY CONSUMPTION BY 30-40%**
with systems using digital technology
Proven Reliability

• Reduced Compressor Cycling Improves Reliability

• CoreSense Technology Integrated Into Drives And Controls Optimizes Operation And Enhances Reliability

• Multiples Offer Greater Degree Of Redundancy
Agenda

1. The Role Of Modulation Technologies
2. The Benefits Of Modulation Technologies
3. The Applications Best Suited For Modulation Technologies
   *It’s Not Just For Premium Systems*
4. The Types Of Modulation Technologies
Ideal Applications For Modulation Technologies

**Residential**
- Mid-Tier And Premium Systems

**Commercial**
- Load Matching And Varying Loads
- Precise Temperature/Humidity Control
Applications for Modulation Technologies

Residential

• Mid-Tier Systems (14 SEER Featured And Above)

• Premium Efficiency Systems

• High Comfort Applications

• Geothermal
Applications for Modulation Technologies

Commercial

• Need For Load Matching
  – Restaurant Kitchens And Dining Rooms
  – Classrooms
  – Retail Stores
  – Conference Rooms
  – Theaters

• Need For Precise Temperature/Humidity Control
  – Data Centers
  – Hospitals And Healthcare Facilities
  – Museums
Agenda

1. The Role Of Modulation Technologies
2. The Benefits Of Modulation Technologies
3. The Applications Best Suited For Modulation Technologies
4. The Types Of Modulation Technologies
   *It’s Not “One Size Fits All”*
Types Of Modulation Technologies

**Mechanical Modulation**
- Multiple Compressors → Tandems/Trios
- Stepped/Two-Step → UltraTech
- Continuous → Digital

**Speed Control**
- Variable Speed
- Tandems With Variable Speed + Fixed

Images:
- Tandem / Trio
- Copeland Scroll UltraTech
- Copeland Scroll Digital
- Copeland Scroll Variable Speed
Multiple Modulation Technologies Available

- UltraTech
- Variable Speed
- Digital
- Multiples

Emerson Unique Technologies
Multiple Modulation Technologies Available

- UltraTech
- Variable Speed
- Digital
- Multiples

Emerson Unique Technologies
Copeland Scroll Ultratech™

**Two-Step Modulation**

- By Mechanically Unloading, Compressor Operates At 67% And 100%
- Optimized For High Part-Load Efficiency
- Offers Improved Temperature And Humidity Control
- 2-5HP Range
- Ideal For 14+ SEER Residential And Light Commercial Split And Package Applications

[Image of Copeland Scroll Ultratech™ with Part-Load and Full-Load Capacity illustrations]
Copeland Scroll Digital™

Continuous Modulation

• Separation Of Scroll Elements Alternately Loads And Unloads Compressor

• By Controlling Separation Times, Compressor Is Precisely Operated Between 10-100%

• Power Linearly Related To Capacity

• Precise Temperature & Humidity Control

• 3-15HP Range (Tandems Up to 30HP)

• Ideal For Light Commercial Split, Package And Chiller Applications
Tandems And Trios

Multiple Compressors
- Multiple Steps Of Capacity
- Independent Operation – No Lead/Lag
- Extensive Reliability Testing In Every Design
- Over 150 Even And Uneven Combinations
- High Part-Load And Full-Load Efficiency
- 3-120HP Range
- Ideal For Commercial Splits, Rooftops And Chillers
Copeland Scroll™ Variable Speed

Next Generation Variable Speed

• Variable Frequency Drive Dynamically Controls Compressor Motor Speed

• High Efficiency Embedded Magnet Motor Delivers Breakthrough Part-Load Efficiency

• Wide 20-120% Speed Range Provides Superior Temperature And Humidity Control

• Proven Reliability Enhanced With CoreSense™ Technology In Drive

• 2-10T Range

• Ideal For Premium Residential A/C & Heat Pump, Geothermal, Light Commercial Rooftop And Chiller Applications
# Compressor Modulation Technology Comparison

<table>
<thead>
<tr>
<th>Modulation Technology</th>
<th>Products</th>
<th>Range</th>
<th>Part Load Efficiency</th>
<th>Full Load Efficiency</th>
<th>Comfort</th>
<th>Applied Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>UltraTech (Two-Step)</td>
<td>2-5HP</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Best</td>
</tr>
<tr>
<td>Digital (Continuous)</td>
<td>3-15HP</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Better</td>
</tr>
<tr>
<td>Variable Speed</td>
<td>2-10HP</td>
<td>Highest</td>
<td>Low</td>
<td>Highest</td>
<td>Highest</td>
<td>Good</td>
</tr>
<tr>
<td>Multiples</td>
<td>3-120HP</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Best</td>
</tr>
</tbody>
</table>
Summary

1. The Role Of Modulation Technologies
   *It’s Not Just A Want—It’s A Need*

2. The Benefits Of Modulation Technologies
   *It’s Not Just About Comfort*

3. The Applications Best Suited For Modulation Technologies
   *It’s Not Just For Premium Systems*

4. The Types Of Modulation Technologies
   *It’s Not “One Size Fits All”*
Summary

Understand Efficiency Standards And Tiering Options
- Impact Of SEER/IEER Requirements

Consider How Modulation Benefits Can Satisfy Customer Needs
- Comfort, Energy Efficiency, Reliability

Identify Applications Best Suited For Modulation Solutions
- Mid-Tier/Premium Residential, Commercial Load Matching, High Or Precise Comfort Applications

Understand Technology Options Available To You
- Variable Speed Systems Deliver Excellent Efficiency At High Applied Cost
- Mechanical Modulation Can Affordably Provide Significant IEER Improvement
Thank You For Attending!

Join Us For Our Second Webinar In The “Getting Comfortable With Designer Air” Webinar Series

Modulation Technologies: Designing Great Commercial Atmospheres

May 26th 2:00PM EST