Commercial Refrigeration Basics
UNI-LINE® PRODUCT KNOWLEDGE
Subjects We Will Cover In This Session

- Refrigeration Overview
- Refrigerant Thermodynamics
- Refrigeration System Basics
- Defrost Controls
- Condenser Fan Controls
- Discharge Temperature Controls
- Termination Contacts

- Discharge Pressure Alarms
- Dripping Time
- Differential, Cut-In and Cut-outs
- Short Cycle Delay
- Liquid Vapor Capillary Element
- Existing Product Features
- Troubleshooting
- Q&A
What Is The Difference Between A/C And Commercial Refrigeration?

- Scientific principals are same, however refrigeration systems:
  - Operation Time 24 / 7
  - Defrost Cycles
  - Load Changes

- Energy Conservation Important on A/C Systems
  - However, more critical on Commercial Refrigeration Applications
Technical Terms and Definitions

- **PSIG**  Pounds per Square Inch Gauge
- **PSIA**  Pounds per Square Inch Absolute
- **BTU**  British Thermal Unit
- **Conduction**  Flow of heat with solids
- **Convection**  Flow of heat with fluids (or gas)
- **Radiation**  Flow of heat with air (or space)
- **Superheat**  Heat added to a refrigerant in the evaporator just after it changes from *liquid to gas* up to the compressor
- **Sub Cooling**  The difference in temperature in the condenser just after it changes from *gas to liquid* up to the expansion device
- **TXV**  Thermal Expansion Valve
- **Compressor**  A pump or mechanical device that increases the pressure of gases
Acronyms

- **AC** = Alternating Current voltage
- **DI** = Digital Input
- **FLA** = Full Load Amps for motors
- **IP67** = Enclosure rating for dust and water exposure
- **LED** = Light Emitting Diode
- **LRA** = Lock Rotor Amps
- **NTC** = Negative Temperature Coefficient
- **Pb1** = Probe 1
- **POS** = Point of Sale
- **SPST** = Single Pole Single Throw
- **SPDT** = Single Pole Double Throw
- **TEV** = Thermal Expansion Valve (Electronic)
- **USB** = Universal Serial Bus
Technical Terms and Concepts

- **Refrigerant Thermodynamics** - The transfer of heat from a place where it’s not wanted to a place where it’s not objectionable.

- **Hot Gas Defrost System** – Hot refrigerant is pumped directly to the evaporator tubing. Defrost time is usually 5 to 10 minutes.

- **Rules of Heat**
  - Heat always moves from a warmer to a cooler surface
  - Heat always moves in three ways;
    - conduction, convection, or radiation
  - When a refrigerant substance boils, it absorbs heat
  - When a refrigerant substance condenses, it rejects heat
Refrigeration System

Pressure Control

Defrost Control

Temperature Control

©2000 Simatech Systems, Inc
Defrost Control Concept

- **Defrost Control**
  - Prevents build of frost or ice
  - Heat output is provided by electric or hot gas defrosts
- Defrost can occur manually or automatically
- Defrost include time, temperature, and/or pressure setpoints
- Setpoints control initiation start time and termination end times
- Initiated defrost heats coil while disabling fans until termination setpoint is met
- While in defrost mode, safety interlock prevents compressor and heat output from being energized at the same time
Condenser Fan Concept

- Each condenser fan has following features:
  - Cut-on and cut-off setpoints
  - Cut-on and cut-off time delays
  - Controlled by discharge pressure or discharge temperature sensor

- Problems occur if head pressure is too low:
  - Frost on evaporator
  - Low flow of refrigerant
  - Short cycling
Technical Terms and Concepts

- **Defrost Termination Options**
  - Time
  - Temperature
  - Pressure
  - Digital

- **Termination Contacts** - When a digital (dry contact) device is used for defrost termination, the user may choose to terminate defrost when the input is closed or open depending on the digital input device used.

- **Discharge Pressure Alarms** - High and low discharge pressure alarms are available with an optional cutoff function for the high alarm to shut off the compressors. The restart function enables the compressor if the discharge pressure drops 50 lbs. below the cut-out target.
Technical Terms and Concepts

- **Dripping Time** - Allow excess moisture to drip off of evaporator coil after defrost melts ice or frost.

- **Discharge Temperature Control** - When fans are being controlled by discharge temperature, the high discharge pressure cut-out option can be used to shut off the compressors. Each fan may be set up so that the output relay will be energized when the fan is on. Usually set 20% above normal head pressure (R22: 260 psi).
Cut-In and Cut-Out Cooling Applications

- **Cut-out mode**: Differential is above setpoint
  - Output relay energizes when temperature rises to setpoint *plus* the differential value
  - When temperature drops to setpoint, the relay de-energizes

- **Cut-in mode**: Differential is below setpoint
  - The output relay energizes when the temperature rises to setpoint
  - When the temperature drops to setpoint *minus* the differential value, the relay de-energizes
Differentials

- Narrow Differential (10°F or less)
- When a narrow differential is desired
- Closely maintain within 5 to 6°F
- Wide Differential (10°F or more)
- Required due to swing in evaporator temperature between compressor ON and OFF
- Household refrigerators and room air conditioners
- Differential between 8 to 14°F
Cut-In and Cut-Cut Cooling Example

Desired Temp (Cut-Out Mode)

Relay energizes

Desired Temp (Cut-In Mode)
Terms and Concepts Continued

- Two Types of Cold Control
  - Constant Differential
  - Constant Cut-in

- Applications
  - Water coolers
  - Beverage dispensers
  - Display cases

- Constant Differential also called “straight range controls”

- Designed for household refrigerators and freezers
Constant Cut-In With Dial

Constant Cut-In, Variable Differential Thermostat Cycle Defrost Cycling Characteristics

- Cut-In ("ON")
- "Warm" Setting Off
- "Mid" Setting Off
- "Cold" Setting Off

Temperature Colder

Time

32°F (0°C)

DIFF

A

B

C

Colder
Terms And Definitions Continued

- Constant Cut-in type controls
  - Designed for frost free refrigerators
  - Used in coolers and display cases

- Operation of Cut-in controls
  - This type of control offers an *adjustable differential*
  - Rotating the dial indicator to the colder position changes the cut-out temperature only and widens the differential

- Capillary tube
  - The gas within the capillary tube reacts to temperature changes
  - Actuates the power element diaphragm to trip the toggle mechanism
Concepts – Short Cycle Delay

- Call for Cooling
- Equipment Response
- Time
- Load Demand
- Output Status
- Anti-short Cycle Delay

Call for Cooling ignored due to short cycle delay
Terms And Concepts Continued

- **Liquid Vapor Capillary Power Element**
  - Liquid is located at the coldest point due to condensation
  - Thermostat switching gets signal from temp at liquid vapor point
  - Temperature at coldest point of the sensing system controls the thermostat switching
  - Temperature at the point on the capillary to be sensed must always be colder than the remaining parts of the power element system
  - If it is not, then a condition known as a cross ambient condition exists, and the control point of the system will not be at the desired sensing point
Commercial Refrigeration Categories

- Temperature Controls
- Pressure Controls
- Defrost Controls
Temperature Controls

- Ice Machines
- Reach-In Refrigerator/Freezers
- Walk-In Refrigerator/Freezers
- Beverage Coolers
- Condensing Units
- Display Cases
Application For Cold Controls

- Ice Bin Level Control
- Ice Harvest
- Commercial Refrigeration
- Household
- Water Coolers

- A and CC Series
- K and RC Series
- 9500 Series Cold controls
- 3030 Series are Uni-Kits
Temperature Controls

- The Capillary-only bellows sense from the coldest exposure point
- The Capillary with bulb senses from the bulb only
- The bulb portion of the A22 & A30 capillaries must be mounted with tip end pointing upward within 65° of vertical
- Sensing elements of A22 & A30 contain saturated vapor liquid refrigerant and are sensitive to barometric pressure changes
- Sensing elements C12 & C17 contain liquid filled bulbs for accurate temperature control
- C12 & C17 bulbs may be oriented in any position
Capillary Tube Mechanics

THE SENSOR

SENSES A CONDITION AND RESPONDS WITH SOME PHYSICAL CHANGE.
Capillary Tube Electronics

ALL CONTROLS SHARE THESE SAME THREE ELEMENTS

SENSOR

LINKAGE

OUTPUT

RELAY
Capillary Only Temperature Control

- Limited vapor-fill sensing element
- Sense directly by the capillary
- May be used where the desired sensing is at the coldest point along the capillary (including the control body itself)
- Entire control located where it will sense fixture temperature
Electronic Temperature Controller (ETC)

- Electronic Accuracy
- Wide Range (-30° to 220°F)
- Wide Differential Selection
- Easy Installation
- Easy Programming
- Clear Temperature Display
- No Jumpers
- Contractor Preferred
- Sensor up to 400 Feet
- Averages Multiple Sensors
ETC Applications

- Retail store display freezers and reach-in coolers
- Supermarket display cases for produce/meats
- Retail store walk-in coolers and freezers
- Boiler operating control (used as a thermostat)
- Condenser fan cycling or staging
- Cooling tower pump and fan control
- Space and return air temperature control
- Bulk milk coolers
- Poultry houses and livestock barns
Installation for ETC Control

- Mount unit to wall or flat surface
- Review typical line voltage wiring diagram
- Determine location of sensor
- Program 4 simple steps
Troubleshooting Error Messages

- **E1** appears when up or down keys are pressed
  - If E1 appears when no keys are being pressed, replace the control
- **E2** appears if control settings are not properly stored in memory
  - Check all settings and correct if necessary
- **EP** appears when the probe is open, shorted or sensing a temperature that is out of range
  - Check if the sensed temp is out of range.
  - If not, check for probe damage by comparing it to a known ambient temp between -30° F and 220° F. Replace the probe if necessary.
- **EE** appears if the EEPROM data has been corrupted
  - This condition cannot be field repaired. Replace control
- **CL** appears if calibration mode has been entered.
  - Remove power to the control for at least five seconds. Reapply power.
  - If CL message still appears, replace control
Temperature Control Manufacturers

- Johnson Controls – Penn
- White-Rodgers
- Saganomia (Danfoss)
- G.E. - Art series
- Asian knock-offs
- Sunne Peco
- Ranco®
Commercial Refrigeration Categories

Temperature Controls
Pressure Controls
Defrost Controls
Pressure Controls

- “O” series
- “G” series
- “P” series for Oil Pressure
- 3321 Series Oil Protection
- Additional Controls
- Accessories
Pressure Controls – O Series

- Over 36 Million “O” controls have been produced since 1936
- Multiple pressure ranges for most refrigerant types
- Unique Lexan cover and captive set screw
- Offers super cap for vibration protection
- Ranco® O Series can also be temperature controls

Be careful to not confuse the following:
- O10-1402 (Pressure Control)
- O10-1409 (Temperature Control)
# Single Pressure Controls Replacements

<table>
<thead>
<tr>
<th>SKU #</th>
<th>Description</th>
<th>Reset</th>
<th>Range</th>
<th>Differential</th>
<th>Switch</th>
<th>Pressure Connection</th>
<th>Cap. Length</th>
<th>Replaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>010-1401</td>
<td>Low Pressure Controls</td>
<td>Auto</td>
<td>12” to 50</td>
<td>5 to 35</td>
<td>SPST-Opens Low</td>
<td>1/4” SAE male flare</td>
<td></td>
<td>Honeywell: L414A, Johnson: P70AN-8, P70AA-157, P70AN-9, P70AA-64</td>
</tr>
<tr>
<td>010-1402</td>
<td>Low Pressure Controls</td>
<td>Auto</td>
<td>12” to 50</td>
<td>5 to 35</td>
<td>SPST-Opens Low</td>
<td>1/4” SAE flare nut</td>
<td>36”</td>
<td>Honeywell: P420B, Johnson: 970AB-29, P70AA-123, P70AC-9, P70AB-12, P70AB-40, P70AA-47, P70AB-44</td>
</tr>
</tbody>
</table>
Commercial Refrigeration Super Cap

Super Cap® Capillary Protection System

- Provides 10 times more vibration protection
- Uses unique vibration-dampening cone
- Light weight copper alloy tubing
- Available on single and dual pressure controls
Dual Pressure controls

- Combines high and low pressure limit control into one unit
- Low pressure cycles compressor depends on suction pressure
- High pressure controls high pressure shutdown
## Dual Pressure Parts

- Common parts include **O12-1549** and **O12-4834**

<table>
<thead>
<tr>
<th>SKU #</th>
<th>Description</th>
<th>Low Press. (Open Low) Reset</th>
<th>Low Press. (Open Low) Cut-In PSI</th>
<th>Low Press. (Open Low) Diff. PSI</th>
<th>High Press. (Open High) Reset</th>
<th>High Press. (Open High) Cut-Out PSI</th>
<th>High Press. (Open High) Diff. PSI</th>
<th>Capillary Length</th>
<th>Replaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>O12-1505</td>
<td>O12 Series-SPST Switch</td>
<td>Auto</td>
<td>12&quot; to 50</td>
<td>5 to 35</td>
<td>Auto</td>
<td>100 to 250</td>
<td>50 Fixed</td>
<td>Has 1/4&quot; SAE male flare.</td>
<td>Honeywell: L413A</td>
</tr>
<tr>
<td>O12-1506</td>
<td>O12 Series-SPST Switch</td>
<td>Auto</td>
<td>12&quot; to 50</td>
<td>5 to 35</td>
<td>Auto</td>
<td>100 to 250</td>
<td>50 Fixed</td>
<td>36&quot; Has 1/4&quot; SAE flare nut.</td>
<td>Honeywell: P421B, Johnson: P70LA-88</td>
</tr>
<tr>
<td>O12-1502</td>
<td>O12 Series-SPST Switch</td>
<td>Auto</td>
<td>12&quot; to 50</td>
<td>5 to 35</td>
<td>Auto</td>
<td>150 to 450</td>
<td>70 Fixed</td>
<td>36&quot; Has 1/4&quot; SAE flare nut.</td>
<td>JOHNSON: P70LA-87, P70LA-96</td>
</tr>
<tr>
<td>O12-4842</td>
<td>O12 Series-SPST Switch</td>
<td>Auto</td>
<td>12&quot; to 50</td>
<td>5 to 35</td>
<td>Convertible</td>
<td>150 to 450</td>
<td>70 Fixed</td>
<td>Has 1/4&quot; SAE male flare.</td>
<td></td>
</tr>
</tbody>
</table>
G Series for Refrigeration Compressors

Applications (Pressure and Temperature Control)

- G20 used to protect against loss of charge
  - Evaporator freeze-up
  - Low pressure
- G23 provides high head pressure protection
  - High pressure

To Determine Part:

- Determine Current and Voltage settings
- Determine Pounds Per Square Inch (PSI) Pressure settings
- Determine Auto or Manual
- Determine Temperature Setpoints
**P30 Series for Lube Oil Protection**

- Guards pressure-lubricated refrigeration compressors

<table>
<thead>
<tr>
<th>SKU #</th>
<th>Pressure Range P.S.I.D.</th>
<th>Time Delay (SEC)</th>
<th>Repl. Module</th>
<th>Press Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>P30-5826</td>
<td>9</td>
<td>120</td>
<td>S30-1302</td>
<td>36&quot; Cap W/Nut</td>
</tr>
<tr>
<td>P30-5827</td>
<td>120</td>
<td>S30-1302</td>
<td>Male Flare</td>
<td></td>
</tr>
<tr>
<td>P30-5629</td>
<td>5</td>
<td>60</td>
<td>S30-1307</td>
<td>36&quot; Cap W/Nut</td>
</tr>
<tr>
<td>P30-3801</td>
<td>8 to 60 Adjustable</td>
<td>120</td>
<td>S30-1302</td>
<td>36&quot; Cap W/Nut</td>
</tr>
<tr>
<td>P30-3701</td>
<td>8 to 60 Adjustable</td>
<td>90</td>
<td>S30-1200</td>
<td>36&quot; Cap W/Nut</td>
</tr>
<tr>
<td>P30-3803H</td>
<td>8 to 60 Adjustable</td>
<td>120</td>
<td>S30-1302</td>
<td>Male Flare w/24&quot; Refrigeration Hose</td>
</tr>
<tr>
<td>P30-5827H</td>
<td>9</td>
<td>120</td>
<td>S30-1302</td>
<td>Male Flare w/24&quot; Refrigeration Hose</td>
</tr>
<tr>
<td>P30-5628H</td>
<td>5</td>
<td>60</td>
<td>S30-1307</td>
<td>Male Flare w/24&quot; Refrigeration Hose</td>
</tr>
</tbody>
</table>
Additional Controls and Accessories

- Solid State Lube Oil Protector 3321
- Lube Oil Protection for 2nd Compressor 3311
  - Time Delays include 45, 60, 90 or 120

- Refrigerant Hose 1290132-A18 Straight 18”
- Available with 90° Elbow & multiple lengths
Manufacturers of Pressure Controls

- Johnson Controls – Penn
- Danfoss
- Ranco®
- Robertshaw®

Ranco Advantages Include:
- Lexan Cover
- Super Cap®
- Application Specific
Commercial Refrigeration Categories

- Temperature Controls
- Pressure Controls
- Defrost Controls
How To Get Rid of Frost and Ice?

- Manual Defrost
- Off Cycle Defrost
- Timed Off Cycle Defrost
- Heat Defrost
  - Electrical
  - Hot Gas
Why Paragon® Defrost Timers?

- Paragon Electrical Products are high quality time switches with sealed synchronous motors and metal gears
- Commercial Refrigerators store valuable products
- Refrigeration failures are costly in terms of lost product and business
- Paragon Defrost Timers are UL certified as refrigeration controls, not as time switches
8000 Series Timers (D80)

- 40 Amps
- Time Initiated, Time Terminated
- All are 60 Hz, some 50 Hz units available

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Volts / 60 Hz</th>
<th>Contact 2-4</th>
<th>Contact 3-N</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>8041-00</td>
<td>120</td>
<td>Closed</td>
<td>Closed</td>
<td>Electric Heat Defrosting</td>
</tr>
<tr>
<td>8041-20</td>
<td>208-240</td>
<td>Closed</td>
<td>Closed</td>
<td>Electric Heat Defrosting</td>
</tr>
<tr>
<td>8045-00</td>
<td>120</td>
<td>Closed</td>
<td>None</td>
<td>Electric, Hot Gas, Compressor</td>
</tr>
<tr>
<td>8045-20</td>
<td>208-240</td>
<td>Closed</td>
<td>None</td>
<td>Electric, Hot Gas, Compressor</td>
</tr>
<tr>
<td>8047-00</td>
<td>120</td>
<td>Open</td>
<td>Closed</td>
<td>Electric Heat Defrosting</td>
</tr>
<tr>
<td>8047-20</td>
<td>208-240</td>
<td>Open</td>
<td>Closed</td>
<td>Electric Heat Defrosting</td>
</tr>
</tbody>
</table>
8100 Series (D81)

- 40 Amp switches
- Time Initiated, Temperature or Pressure Terminated
- Provides three defrost cycles with mechanical timer
- Pump-down, defrost, and fan delay

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Volts / 60 Hz</th>
<th>Contact 3-N</th>
<th>Contact 1-3</th>
<th>Content 2-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>8141-00</td>
<td>120</td>
<td>Closed</td>
<td>Open</td>
<td>Closed</td>
</tr>
<tr>
<td>8141-20</td>
<td>208-240</td>
<td>Closed</td>
<td>Open</td>
<td>Closed</td>
</tr>
<tr>
<td>8143-00</td>
<td>120</td>
<td>Open</td>
<td>Closed</td>
<td>Open</td>
</tr>
<tr>
<td>8143-20</td>
<td>208-240</td>
<td>Open</td>
<td>Closed</td>
<td>Open</td>
</tr>
<tr>
<td>8145-00</td>
<td>120</td>
<td>None</td>
<td>Open</td>
<td>Closed</td>
</tr>
<tr>
<td>8145-20</td>
<td>208-240</td>
<td>None</td>
<td>Open</td>
<td>Closed</td>
</tr>
</tbody>
</table>
Top Five Paragon® Defrost Timers

1. 8145-20
2. 8141-00
3. 8145-00
4. 8045-20
5. 8045-00
The Latest Paragon® Defrost Timer

- Universal Defrost Timers (UDT)
- Works with multiple voltages
- Removes built up of ice and frost
- Easy to install
- Simple to program
- Part 9145-00 temp terminated
- Part 9045-00 time terminated
- Available as mechanism only without case
  - Add “M” to end of part number
Universal Defrost Timer (UDT) Features

- Simple Programming
- Certified to UL873
- Switches rated at 30,000 cycles
- Last 16 years longer at 4 defrost per day
- Initiate 15 minute manual defrost
- Lighted display
- 100 hours of power loss protection
- Easy Installation
- Designed to fit Paragon® enclosures
- Withstands most rigorous applications
- Wires to 120V AC, 208V AC or 230V AC
- Display has defrost time and duration
- System status indicators
- Real-time clock
Feature Set Brochure

- Brochure highlights major features of the Universal Defrost Timer

- Real time clock
- 100 hours of power loss protection for both time and defrost schedule
- Mechanism only versions designed to fit in the standard Paragon enclosures
- Made in the USA

- Certified to UL300 Standard for Temperature-Indicating and Registering Equipment, as Refrigeration Controllers
- Switches rated to 30,000 cycles
- Competitive offerings are certified to UL410 Standard for Safety for Clock Operated Switches with switches rated to 5,000 cycles. At 4 defrost per day, the Paragon Universal Defrost timer switches last 16 years longer.

Universal Defrost Timer Models 9145 / 9045
Universal Defrost Timer – Wiring

Convert to 9145

Convert 8141 to 9145

8141
N 3 1 2 4 X

9145
A B C D E F G

Convert 8143 to 9145

8143
1 N 3 4 2 X

9145
A B C D E F G

Convert 8145 to 9145

8145
3 4 X 1 2 N

9145
A B C D E F G

Convert to 9045

Convert 8045 to 9045

8045
2 4 3 1 X

9045
A B C D E F
Conversion exercise - Converting 8145 to 9145
Air vs. Electric Defrost Terminations

- Time or Temperature Terminated in Electric Defrost
Installation Steps for 9045 Defrost

1. Turn off AC power
2. Open metal case to access control connectors
3. Connect wires from compressor to terminal A
4. Connect heater or hot gas solenoid to Terminal E
5. Connect wire to Terminal C from
   - L1 – 120 VAC or 208-240 VAC line
6. Jumper Terminal C to Terminals B and D
7. Connect wire from L2/N to Terminal F
Installation of Enclosure

- Universal Defrost Timer mounts in previous legacy boxes
- Perfect for aftermarket applications
Flashes at 12:00 Noon
Refrigerate LED is on
The Easy Part: Set Defrost

1. Scroll cursor to desired defrost start time

2. Press “Defrost Start/Stop” once
Still Easy Part: Clear Defrost

1. Rotate cursor to the first segment in the defrost

2. Press “Clear”
Reset Program, your CTRL-ALT-DEL!

Press, hold and release all four buttons to clear the program. The Defrost Timer will return to its original power up state.
## Troubleshooting UDT Defrost Timer

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backlight is not on.</td>
<td>The display backlight will turn on when the ADJUST knob is turned and will remain on for 10 seconds after the last activity.</td>
</tr>
</tbody>
</table>
| The display segments and backlight are not on.     | 1. Verify proper voltage is applied to the correct terminals.  
2. Perform PROGRAM RESET.  
3. Replace timer.                                     |
| All the display segments and LEDs are flashing.    | The control has detected a catastrophic or programming failure. If possible the UDT will return to refrigerate.  
1. Verify proper voltage is applied to the correct terminals.  
2. Verify wiring of the device.  
3. Perform PROGRAM RESET.  
4. If problem clears, reprogram the device.  
5. If indication remains, replace the timer.           |
| The display is flashing a G during normal operation. | Indicates a shorted defrost termination switch on Terminal G. The control will default to its timed termination point.  
1. Verify wiring of defrost termination switch.  
2. Verify switch operation, and replace defrost termination switch if necessary.  
3. Once the defrost termination switch is operating normally, the flashing G will reset automatically.  
(This may take one defrost cycle to reset.) |
Manufacturers of Electro-Mechanical Defrost Timers

- Old Manufacturers
  - Precision Timer Co. Inc
- Existing Manufacturers
  - Grässlin® / Intermatic®
  - Inexpensive time switches
  - Tork®
  - Paragon®
## Manufacturer Analysis

<table>
<thead>
<tr>
<th>Feature</th>
<th>Paragon® UDT</th>
<th>Grasslin DTMV40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Voltage (120/208-230)</td>
<td><strong>Yes</strong> - direct wire to terminals</td>
<td><strong>Yes</strong> - requires switch setting</td>
</tr>
<tr>
<td>UL Listed</td>
<td>**Yes - as a Defrost Controller. UL873 Temperature Regulating Device. Requires life test to 30,000 cycles at temperature extremes.</td>
<td><strong>Yes - as a light switch</strong> UL917 Clock Operated Switch. Requires life test to 6,000 cycles at room temperature.</td>
</tr>
<tr>
<td>System Status Indicators</td>
<td><strong>Yes</strong></td>
<td><strong>Yes</strong></td>
</tr>
<tr>
<td>Backlit</td>
<td><strong>Yes</strong> - Electronic</td>
<td>No</td>
</tr>
<tr>
<td>Real Time Clock</td>
<td>**Yes - clock maintained by capacitor for 100 hours of lost power. Schedule stored in flash memory</td>
<td><strong>Yes - Electromechanical</strong></td>
</tr>
<tr>
<td>Power loss protection</td>
<td><strong>Yes</strong> - time and defrost schedule easy to understand</td>
<td>Optional, can order battery backup which requires replacement</td>
</tr>
<tr>
<td>Manual Defrost Initiation</td>
<td><strong>Yes</strong></td>
<td>No</td>
</tr>
<tr>
<td>Intuitive Display</td>
<td><strong>Yes - Time and defrost schedule easy to understand</strong></td>
<td>No - Defrost duration is CCW</td>
</tr>
<tr>
<td>Switch Ratings</td>
<td>Compressor - 1hp@120V, 2hp@240V Defrost Htr - 30 Amps Resistive Fan - 1/4hp @120V, 1/2hp @240V 15 Amps resistive</td>
<td>Compressor - 1hp@120V, 2hp@240V Defrost Htr - 40 Amps Resistive Fan - 1 hp@120V, 2 hp@240V 30 Amps Resistive</td>
</tr>
<tr>
<td>Warning of DT failure</td>
<td><strong>Yes - see Terminal G error code</strong></td>
<td>No</td>
</tr>
</tbody>
</table>
Counter Mat for Universal Defrost Timers

- Visit website to order at [www.invensyscontrols.com](http://www.invensyscontrols.com)
- Part Number **150-2147** in Publication Zone
Electronic Digital Controllers

- Digital refrigeration and defrost controllers
- Self-contained refrigerated cases
- Low or med temperature applications
Eliwell™ Digital Controllers

- 6 LEDs for Functions
- Front Panel Protection IP65
- 3 ½ Digits, 12 mm (or 2 dig.)
- 4 Buttons
- Flush-panel
- Standard size, template
Applications

- Refrigeration Temperature Control
  - Compressor or solenoid valve control
- Thermostat functionality
- Defrost Control
- Optional Evaporator Fan Control
- Optional Alarm Relay Output
- Optional Evaporator Temperature Sensor for Defrost Termination and Fan Control
- Optional third Temperature Sensor
- Optional configurable Digital Input(s)
Eliwell™ Features

- Easy installation and configuration
- 12V AC/DC, 24V AC/DC, 120V AC or 230V AC power supply versions
- Copy Card accessory – Copies configuration from one controller to another
- Configurable PTC/NTC temperature sensor input
- Front protection rate IP65 (NEMA5 to NEMA6)
- Versions for direct drive of compressor, up to 2HP
- Remote communication capability – Optional through Televis System, HACCP management
Manufacturers of Digital Controllers

- Eliwell™
- Dixell
- Carel
- Danfoss - EKC series
- Technologic
- Love Controls
- Full Gauge Controls
- LAE
- Alreha
Troubleshooting Defrost Timers

**Purpose of the Timer**

- Shut off the refrigerator's compressor and evaporator fan motor
- Turn on the defrost system at regular intervals to rid the evaporator of frost.

**How They Fail**

- Timer motor, motor bearing, or reduction gears wear out
- Occasional or constant noise comes from the part
- Runs sometimes but not others, causes occasional frost to build up gears jam or bearing piles up, timer stops rotating
- Motor coil burns out and becomes an open circuit, timer stops rotating
- Burnt out contacts stick together causing: run and defrost
Troubleshooting Defrost Timer

- If timer stops in run cycle
  - Refrigerator fails to automatically defrost
  - Evaporator builds up with frost
  - Restricts air flow

- If timers stops in defrost part of the cycle
  - Food in the freezer thaws
  - Refrigerator components do not operate
Troubleshooting Exercise - Electrical
Unit Cooler Troubleshooting Tips

- Observe unit cooler conditions and collect current operation information.
- Correct unrestricted airflow is mandatory with all evaporators.
- Suction pressure at the evaporator is necessary in order to correctly calculate superheat at the Thermostatic Expansion Value (TXV).
- Check feeding supplied to the evaporator by the TXV and distributor assembly.
- The ability of the evaporator to efficiently exchange heat is totally dependent on having a fully active coil as near to saturated suction temperature of the refrigerant as possible.
- Remember superheat can be correct with incorrect refrigerant distribution.
Unit Cooler Troubleshooting Tips

- Check electrical compartment for proper operation.
- Ice accumulations inside the compartment resulting in moisture to flow into the compartment condensing on all cold components.
- This can result in large ice or frost accumulation inside the compartment or conduit.
- This condition can affect defrost termination and fan control operations, which can leave defrost heaters operating longer than needed, resulting in heaters creeping or coming out of heater slots.
- Defrost heaters can suffer damage resulting from ice or frost which can damage electrical wiring.
Troubleshooting Tips Continued

- Suction pressure, suction line temperature, liquid line pressure, liquid line temperature, and correct operating charge at the condensing unit are necessary to properly make a complete system diagnosis.

- Correct superheat range at the compressor is the only crucial superheat that really matters in refrigeration.

- Superheat at discussed compressor should be between 15° and 35° F in order to protect the compressor from flooding or possibly more importantly overheating.

- Superheat for scroll compressors should be between 10° to 20° F.

- Serious compressor damage can result from operating outside the above conditions.

- Frost at the compressor does not necessarily mean low superheat, and no frost at the compressor certainly does not mean there is sufficient superheat.
Find Refrigeration Products on Website

1. Go to www.Uni-Line.com
2. Click on Refrigeration
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