**Rack Refrigeration Application Note**
**APP– 013**

## THEORY

The system this application note is written for is at the Hancock Research Center in Wisconsin. This system has 18 evaporators, each associated with a individual bin and XT panel. Each bin has an independent Setpoint and can require hot gas defrost at any time, depending on the temperature. A parallel compressor rack system, was the most logical way to go. Each of the evaporators, has a electronic expansion valve (EEV) and a electronic pressure regulator (EPR) on it. The XT panel sends a 0-20ma signal to a ER-110 control card. The ER-110 controls both the EEV and EPR, and also the defrost cycle. Each of the compressors have a CR-110 controlling it. The compressors are controlled on suction pressure, and the suction pressure Setpoint is set to be sufficient for the coldest Setpoint.

## OPERATION

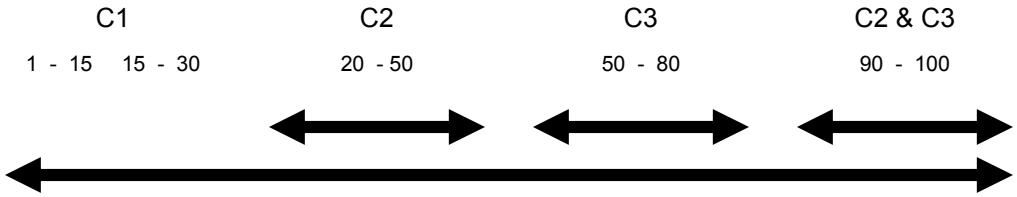
The system is composed of 3 compressors, C1 7hp, C2 10hp and C3 15hp.

C1 is the controlling compressor and sends a output percentage to C2 and C3. The system is dependent on C1 to run. It could run with C2 or C3 shut off. The suction Setpoint is set on the C1 compressor. A typical setting would be 35 psi, this would allow a room temperature of down to 30 degrees. With this setting the compressors will cycle on and off to maintain this suction pressure. C1 is the only compressor that will pump down. The suction pressure is maintained by a PID loop running in C1. The PID loop will calculate a output signal from 0 to 100 %. This will show up on each of the compressors as output. Each compressor will start or stop according to this output signal. The staging is set as follows:

C1 on at 15 % and off at 1 %
C1 unloader, loaded at 30% and unloaded at 15%
C2 on at 50% and off at 20%
C3 on at 80% and off at 50%
C3 and C2 on at 100% and off at 90%

**SPECIAL OPERATION**

When compressor C3 starts at 80 percent, C2 will shut of and not start until 100%. C2 and C3 will both run until the signal drops below 90 %, at which time C2 will shut off. When the signal drops below the C3 shut off point, C2 will then start.

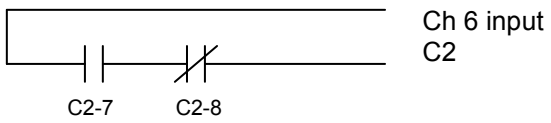


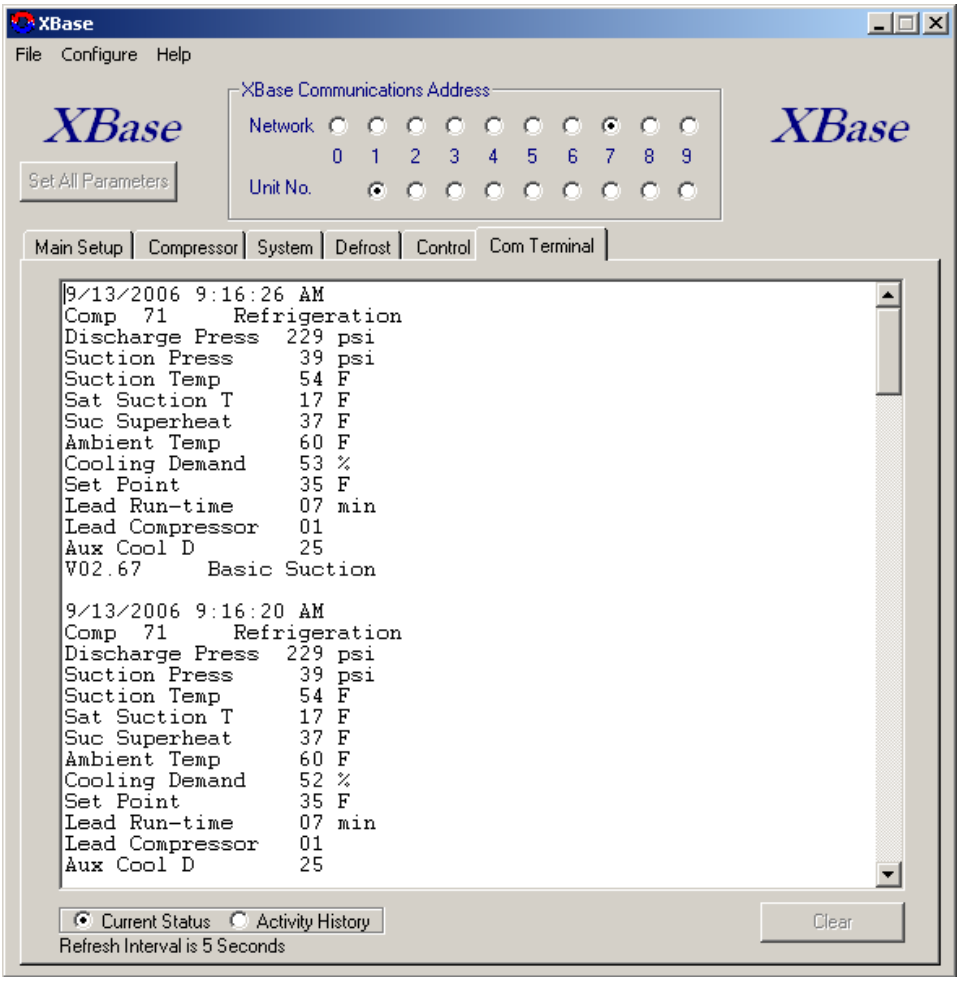

Compressor C1 is the only compressor that has a unloader on it and provides the most flexibility and has been designated as a floater. As a floater, it can float any where in the 0-100 % signal range. C1 as shown, has a 30% window. This window can be adjusted to what ever you want. This window includes the unloader. If the signal is 0 and starts to rise, C1 will be the first to start as the signal gets above 15%. If the signal were to continue to climb, C1 unloader would load up, and the nC2 would start at 50%. The high end of the C1 operating window, will stay with the signal as long as it continues to increase. Lets say that at 60%, the signal starts backing off and goes to 45 %. C2 would continue to run, but C1 rode the window up to 60% and with the 15% decrease it will now shut its unloader off and run at 1/2 capacity.

C1 will move its window with the signal, for the entire range. The top of the window will start to move when the signal is greater than the top value. If the signal were to drop more than the bottom of the window, then the window will start moving down.

C1 can then operate any where in the 0-100 % range in conjunction with any of the other compressors.

C2 and C3 both have a standby input on Ch 6. If you short Ch 6 the compressor will go into standby. This option is used only on the C2 compressor. C2 is currently set to start at any output greater than 50%. The standby input is used when C3 turns on at 80%. Any time C3 turns on, a relay contact is used to turn C2 off. If the output goes to 100%, then C3 will turn on another output that will lift the standby contact on Ch6 and allow both C3 and C2 to run. Two relays are used to accomplish this, C2-7 and C2-8. C2-7 picks up any time C3 is running and C2-8 is connected to out 7 on C2. C2-8 is on when the output gets to 100% and off when it drops to 90%.






This is some of the information for compressor C1. The cooling demand is the overall output percentage that all the compressors are being staged at.

The Aux cool d is the floating window for compressor C1. It is currently at 25 %.

## HOT GAS INJECTION

On a parallel rack system, it is very important that the last compressor does not shut off. With only one or two evaporators running, the small compressor running unloaded, would cycle on and off. To solve this problem a hot gas liquid injection system is used. A hot gas solenoid valve and mechanical TX valve is used to inject hot gas into the suction line. When the Hot gas injection is turned on the suction pressure will increase and the PID loop controlling the suction pressure will raise the output percentage. C1 uses output 8 to turn the Hot gas on and off. Under the system tab on Xbase, the parameter unloader 3 is used to set the percentage for the Hot Gas injection. This is set for 0 and 15 %. These setting would have the hot gas injection on, any time the output percentage goes below 15%. A relay contact from each of the evaporators are paralleled and then series with the output 8 from C1. The contact will shut of the hot gas and allow pump down if all evaporators are off. This hot gas injection works very well, and typically will be pulsed on for about 10 sec's. This is enough to raise the output, but the suction pressure remains very stable.

**CONDENSER FANS**

Each of the 4 condenser fan outputs are paralleled on C1, C2 and C3. Thus any of the cards can stage the fans on.

The condenser is a Split condenser with a control valve. The condenser valve only opens when C3 is running.