

**PARKER HANNIFIN
REFRIGERATING SPECIALTIES DIVISION**

DF-00 SERIES

DEFROST CONTROLLER OPERATING MANUAL

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FEATURES AND SPECIFICATIONS

Features

The Refrigerating Specialties Defrost Controller is a powerful yet user-friendly device for controlling the sequence of events that occur during system defrost cycles. The Controller may be applied to both industrial and commercial refrigeration systems, and is suitable for use on hot gas, electric, or water defrost applications. The focus of this manual is on hot gas defrost, however the information here can easily be adapted to one of the other defrost methods.

In regular operation, status of the refrigeration system is continuously displayed on an LCD screen that is rated for operation at 32°F (0°C). The Status Screen, shown in figure 1, contains enough information to quickly show the system status as well as the defrost settings.

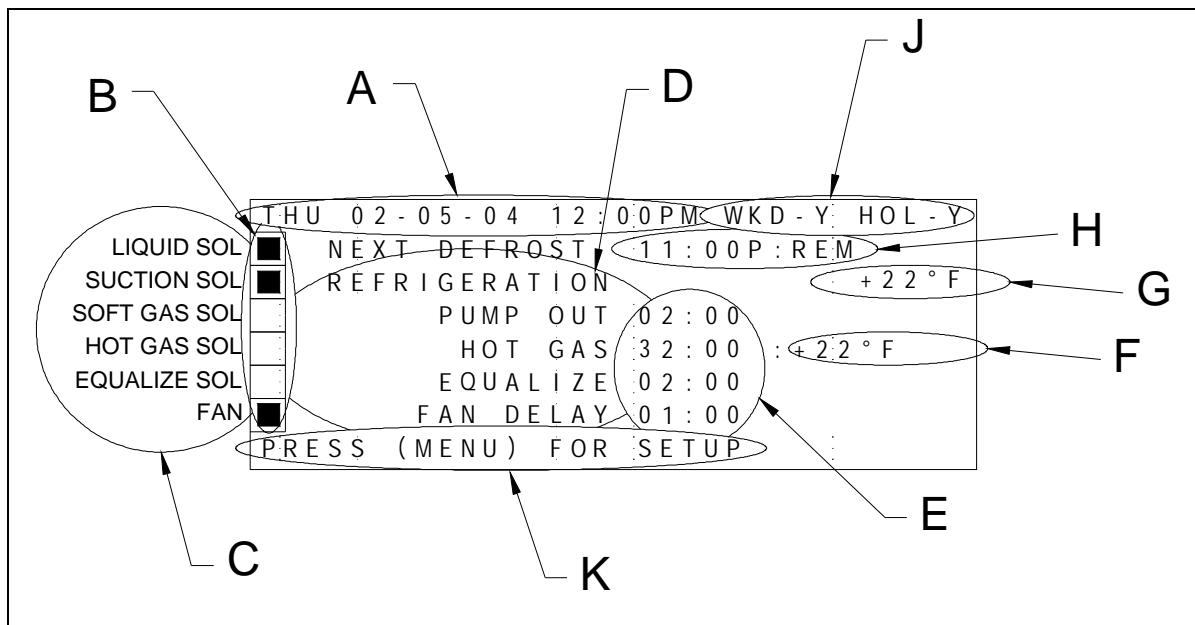


Figure 1: Status Screen

- **Item A** is the current day, date and time.
- **Item B** is a group of indicators that correspond with markings on the controller front panel (**Item C**). These indicators show which of the controller relays is currently energized.
- **Item D** lists the steps in the defrost cycle. At any given time, one of these items will be highlighted.
- **Item E** shows the time duration programmed for each defrost step. When one of the steps is active, the time counts-down to zero and resets. (The time shown for HOT GAS is actually the sum of the soft and hot gas times. During the soft gas phase, the words HOT GAS are replaced by SOFT GAS along with the set time for soft gas.)
- **Item F** shows either a temperature set point at which the hot gas step ends (e.g., "+22 DEGF"), or identifies that a remote contact is being used to terminate the hot gas (e.g., "REM2").
- **Item G** shows the temperature actually measured by an analog sensor, this measurement is compared to the set point (**Item F**) to determine when defrost is complete, or is simply an indication of room temperature.
- **Item H** shows the time of the next scheduled defrost cycle. If the defrost cycle occurs based on time and a remote contact closure, the message "REM" will also be displayed. If defrost is initiated by a remote contact only, then only the message "REM" will be displayed.
- **Item J** shows whether or not a weekend and holiday schedule will be applied to the normal defrost times.
- All screens give the user a one or two line prompt (**ITEM K**) for optional actions.

The Controller is programmed using on-screen prompts and four clearly marked push buttons (arrow up, arrow down, ENTER and MENU) on the front panel of the unit. (See figure 2.) There are two additional buttons on the front panel for immediately initiating or terminating a defrost cycle (DEF INIT, DEF TERM).

The DEF INIT and DEF TERM buttons are only active when the Status Screen (Figure 1) appears in the LCD display. Before a defrost cycle is manually begun or ended, the user is prompted to confirm that this action is really desired.

Detailed programming information is given later in this manual. The program for controlling defrost cycles is stored in the non-volatile memory of the electronic processor (EPROM). This memory is virtually unaffected by power outages. The included NiMH batteries for powering the internal clock are continuously charged while power is applied to the Controller. In the event of a power failure, the batteries have a life of up to thirty (30) days. The nuisance of resetting the unit after either short or long term power loss is therefore eliminated.

Defrost cycles are initiated or terminated based on criteria that can be easily tailored to a specific system.

The flexibility of the Controller gives the user a means to customize the defrost cycle for maximum energy efficiency.

Basic Operating Modes

The RS Defrost Controller operates in any of the three basic modes listed in Table 1. Within each of these modes, the controller will initiate or terminate defrost cycles based on a variety of criteria, described below.

Defrost Initiation Criteria

The Controller can be programmed to consider several factors to determine when (and if) a defrost cycle should occur. These criteria are described briefly in Table 2.

The details of the events that must occur during a defrost cycle will vary somewhat, depending on the type of refrigeration system. The user is encouraged to read Appendix A: Hot Gas Defrost Cycle later in this manual for insight on how to best program the controller for his particular application. The basic steps of a hot gas defrost cycle should be modified appropriately for water or electric defrost.

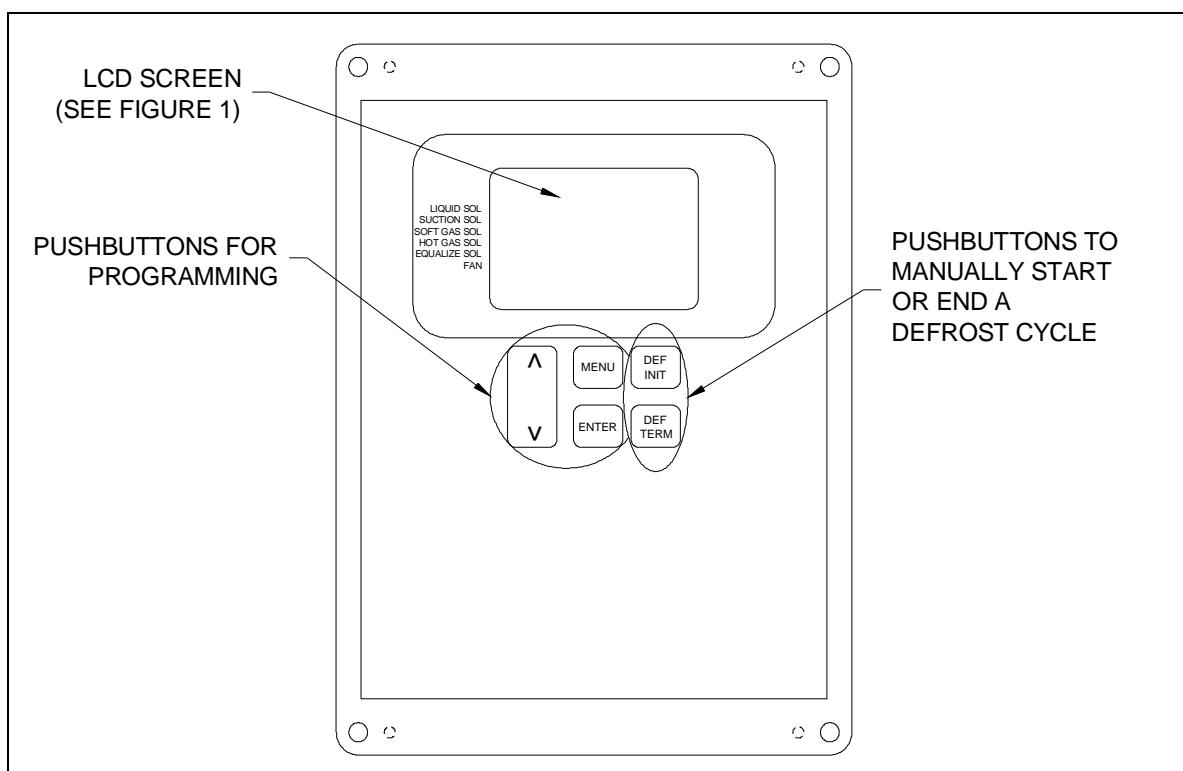


Figure 2: Controller Front Panel

Table 1: Operating Modes

MODE	DESCRIPTION
NORMAL OPERATION	Defrost cycles occur according to any of the Initiation and Termination Modes shown in Tables 2 & 3.
WEEKEND OPERATION	Allows the user to specify a special schedule to occur <u>once each week</u> for 1-3 days. At the end of the weekend, the normal schedule resumes. Weekend Operation only works in conjunction with 24 Hour / Constant Interval Initiation.
HOLIDAY OPERATION	Allows the user to specify a Weekend Schedule that occurs <u>one-time only</u> for a period of one to six days. At the end of the Holiday Schedule, either the Normal or Weekend Schedule will resume, depending on the day of the week. Holiday Operation observes the defrost frequency programmed for Weekend Operation.

Table 2: Initiation Criteria

CRITERIA	DESCRIPTION
24 HOUR / CONSTANT INTERVAL	Causes defrost cycles to begin every 2, 3, 4, 6, 8, or 12 hours. This is the default mode used in Quick Setup. Defrost cycles occur at the same time each day, unless a separate Weekend or Holiday Schedule is programmed.
CONSTANT INTERVAL	Allows the user to specify the time interval between the start of defrost cycles (from 15 minutes to 23 hours, 45 minutes in 15-minute increments). The interval is maintained indefinitely regardless of time of day or day of week.
EXACT TIME	Allows the user to specify the exact times of day (in 15 minute increments) when defrost cycles can occur. Up to 12 defrost start-times can be programmed. The schedule repeats every day, regardless of day of week.
LIQUID FEED TIME	Allows the user to specify the length of time that liquid can be fed to the evaporator before a defrost is warranted. In this mode, the Defrost Controller is able to open and close the liquid feed solenoid based on a signal from either a temperature sensor or a temperature switch.
REMOTE	Allows defrost cycle to be triggered by remote contact closure.
24 HR / CONST / REMOTE:	Causes defrost cycles to occur according to the 24 Hour Constant Interval Schedule <i>only if a remote contact is closed</i> . If the contact is not closed at the scheduled defrost time, the controller will check for contact closure again at the next scheduled defrost time.
CONST / REMOTE:	Causes defrost cycles to occur according to the Constant Interval Schedule <i>only if a remote contact is closed</i> . If the contact is not closed at the scheduled defrost time, the controller will check for contact closure again at the next scheduled defrost time.
EXACT / REMOTE:	Causes defrost cycles to occur according to the Exact Time Schedule <i>only if a remote contact is closed</i> . If the contact is not closed at the scheduled defrost time, the controller will check for contact closure again at the next scheduled defrost time.

Defrost Termination Criteria

The Controller signals the end of a defrost cycle by one of the three criteria listed in Table 3. The Cycle Steps (Table 4) are described in detail in Appendix A. Detailed programming steps are given later in this manual.

Table 3: Termination Criteria

Criteria	Description
TIME	Causes a defrost cycle to terminate at the conclusion of the Defrost Cycle Steps (Table 4).
TIME/TEMPERATURE	Causes Defrost Cycle to terminate when an analog temperature measurement reaches a pre-set limit, unless the Hot Gas Time (Table 4) expires first.
TIME/REMOTE	Causes Defrost Cycle to terminate when a remote contact closes, unless the Hot Gas Time (Table 4) expires first.

Table 4: Cycle Steps

	Available Range	Quick-Setup Default Value
PUMP OUT	1 to 30 minutes	1 minutes
SOFT GAS	0 to 5 minutes	0 Minutes
HOT GAS	1 to 45 minutes	20 minutes
EQUALIZE	1 to 60 minutes	1 Minute
FAN DELAY	1 to 5 minutes	1 minutes
FIRST DEFROST	12:00AM –11:45 PM (15-minute increments)	See Note ¹

¹ The unit is shipped without a First Defrost Time programmed. No defrost cycle can occur until a specific time is entered.

Manual Defrost Modes

DEF INIT: When the system is in normal refrigeration mode, pressing the DEF INIT button on the Controller panel will cause the Pump Out step of a defrost cycle to begin immediately after verifying that this is the desired action. The defrost cycle will proceed through the steps in Table 4, and terminate according to the criteria from Table 3 already programmed into the controller.

Note that if the Time/Temperature or Time/Remote termination criteria (Table 3) have been programmed, pushing DEF INIT may cause the unit to immediately step to the Equalize phase. This will occur either if the temperature measured by the sensor exceeds the pre-set limit, or if the remote contact is closed.

The DEF INIT button is only active when the System Status screen (Figure 1) is displayed. If the system is already in a defrost cycle, the DEF INIT button has no effect.

DEF TERM: When the system is in either the Pump Out, Soft Gas, or Hot Gas steps of a defrost cycle, pushing the DEF TERM button will cause the Equalize step of the defrost cycle to begin immediately after verifying that this is the desired action.

The DEF TERM button is only active when the System Status screen (Figure 1) is displayed. If the system is already in the Equalize or Fan Delay steps, the DEF TERM button has no effect.

Specifications and Installation

Installation of the Controller should be guided by the specifications summarized in Table 5. The Controller should be mounted in an indoor location having an ambient temperature between 32°F (0°C) and 120°F (50°C). Proper mounting position is shown in figure 3 of this manual. The Controller should not be subject to severe vibration, as this could cause sporadic electrical contacts and fatigue in the connections of any device. As shown on the wiring diagram (figure 4), the Controller should be protected with a 5A external fuse. The Controller is not to be connected to rigid metallic conduit.

Table 5: Specifications

Power	85 – 265 VAC, 50/60 Hz
Ambient Temperature Range	32°F to 120°F (0°C to 50°C)
Enclosure	IP65/NEMA 4 (Watertight) CAUTION: Non-metallic enclosures do not provide grounding between conduit connections. Use grounding bushings and jumper wires when connecting to metal conduit or equivalent.
Relays ²	Sealed Enclosure Contact: SPDT Rating: 10A/125VAC, 7A/250VAC, 7A/30VDC Contact Resistance: 100mW Max init. Operate/Release Time: 10 ms / 5 ms Temperature Range: -20°F to +160°F (-30°C to +70°C)
Terminal Strip	Accepts 14-22 AWG Maximum allowable torque on field wiring terminals is 3.5 in.-lb.
Approvals	UL, CSA, FCC ³ , CE

² **Note:** Solenoid and Fan control relay common terminals are to be connected to the line voltage of the device.

³ **Note:** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Power Interruption

In the event that power to the controller is interrupted, either during normal refrigeration operations or during defrost; the Controller will perform in a manner for maximum safety and reliability.

- Ø When power is interrupted, all relays will move to their de-energized positions (indicated on the wiring diagram, figure 4).
- Ø If the system was in defrost mode when power was interrupted, then when power is restored the Controller will immediately enter the "Equalization Phase" of the defrost cycle.
- Ø If the system was in refrigeration mode when power was interrupted, then when power is restored the Controller will return to the refrigeration mode.

The programmed defrost sequence and schedule is stored in non-volatile memory, and the internal clock is powered by a battery, which will last up to 30 days. The battery is continually charged while power is provided to the Controller.

Spare Parts

Contact Refrigerating Specialties if replacements are needed for any of the following components.

PN 107960	DEFROST CONTROLLER
PN 207225	BOARD ASSEMBLY (POWER), DEFROST CONTROLLER
PN 207226	BOARD ASSEMBLY (DISPLAY), DEFROST CONTROLLER
PN 310731	ENCLOSURE, DEFROST CONTROLLER
PN 310780	RELAY, SPDT, DEFROST CONTROLLER

Internal Fuse: 250V, 3.5A

Internal Batteries: Non-replaceable

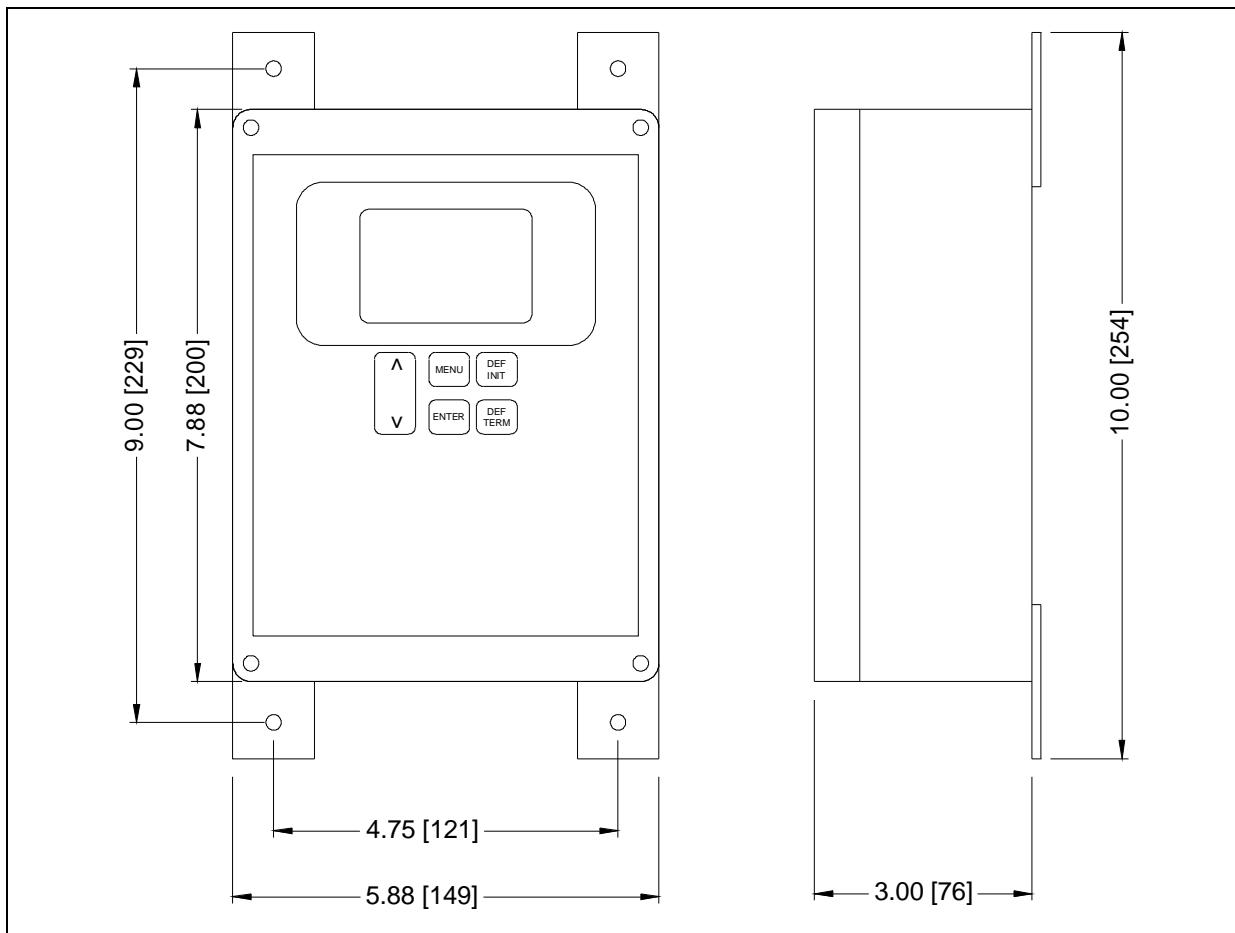


Figure 3: Controller Enclosure

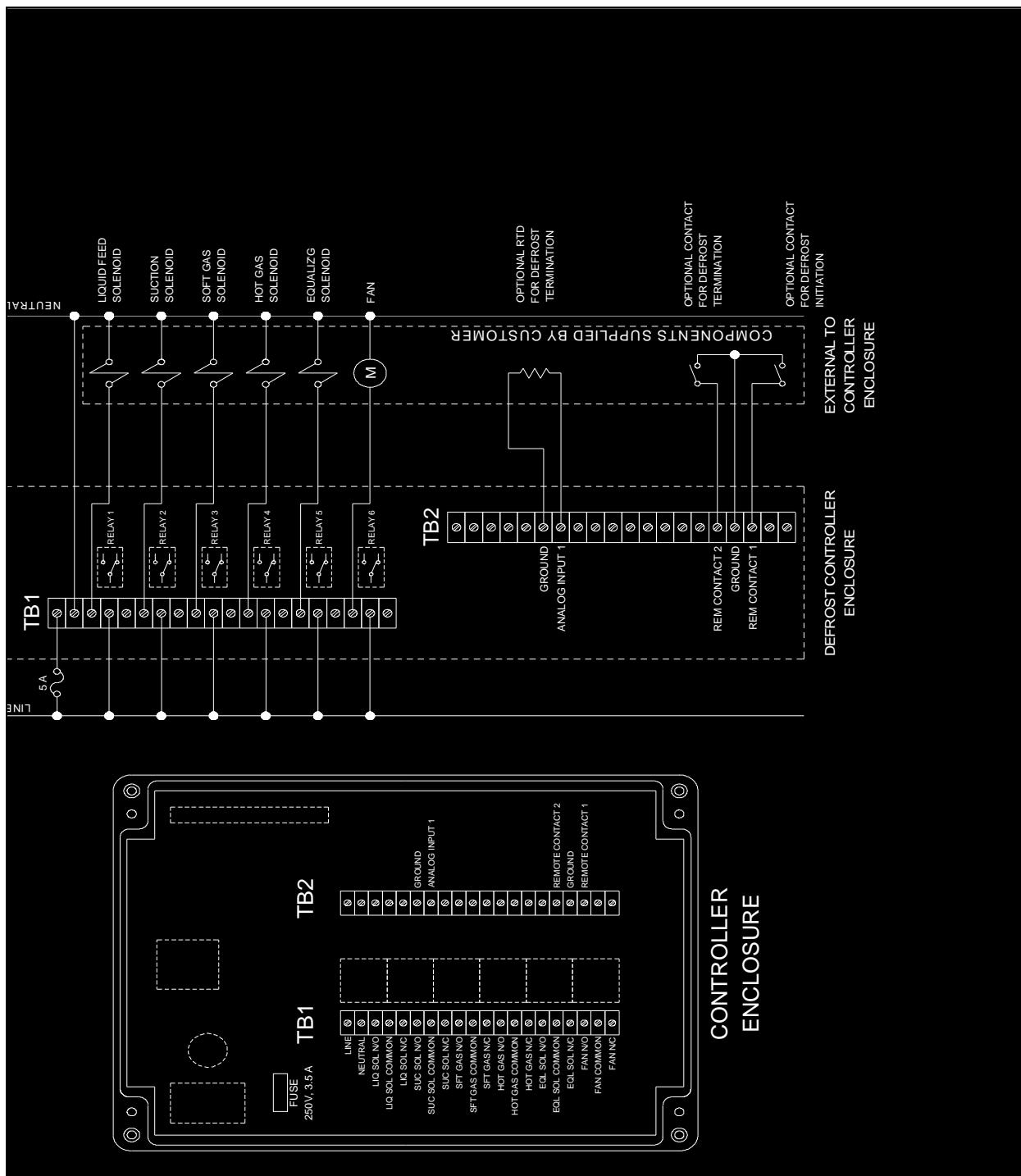


Figure 4: Basic Controller Wiring Diagram

Note: Low voltage sensor wiring shall be through a wire routing device in a manner which maintains 1/4 inch separation from line voltage field wiring.

QUICK SETUP

In its most basic operating mode, the Controller will cause defrost cycles to occur at regular intervals each day, according to the 24-Hour Constant Interval Mode, described in Table 1. The default duration of each step in the defrost cycle are given in Table 4.

The first time power is applied to the Controller, this System Status screen will appear:

SUN 01-01-01	12:00 AM	WKD-N HOL-N
n		
n REFRIGERATION		+20°F
o	4:00	
o HOT GAS:	20:00	
o EQUALIZE:	1:00	
n FAN DELAY:	2:00	
PRESS (MENU) FOR SETUP / OPTIONS		

Press the MENU button on the front panel, and the Main Menu will appear. Use the **▲▼** keys to highlight SET TIME / DAY then, press ENTER.

MAIN MENU:
SET TIME / DAY
SET TIMERS
SET DEFROST OPTIONS
SET ROOM TEMPERATURE
INITIATE/DISABLE HOLIDAY
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

Use the **▲▼** keys, to set month, and press ENTER.
Use the **▲▼** keys, to set day, and press ENTER.
Use the **▲▼** keys, to set year, and press ENTER.

WHAT IS THE DATE? <u>00/00/00</u>
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

Use the **▲▼** keys, to set the day, and press ENTER.

WHAT IS THE DAY? <u>SUN</u>
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

Use the **▲▼** keys, to set hour, and press ENTER.
Use the **▲▼** keys, to set minutes, and press ENTER.
Use the **▲▼** keys, to set AM/PM, and press ENTER.

WHAT IS THE TIME? 11:54 AM

PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

After entering the time, the Main Menu reappears. Select SET TIMERS with the **▲▼** keys, and press ENTER.

MAIN MENU:
SET TIME / DAY
SET TIMERS
SET DEFROST OPTIONS
VIEW SCHEDULE
INITIATE/DISABLE HOLIDAY
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

Use the **▲▼** keys, to set Pump Out duration, and press ENTER.

SET PUMP OUT DURATION:
<u>04</u> MINUTES
30 MAX
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

If there is no soft gas valve, enter zero for Soft Gas Duration; otherwise use the **▲▼** keys, to set Soft Gas Time, and press ENTER.

SET SOFT GAS DURATION:
<u>00</u> MINUTES
15 MAX
00 TO SKIP SOFT GAS
SELECT WITH ▲▼ PRESS (ENTER)

Use the **▲▼** keys, to set Hot Gas duration, and press ENTER.

SET HOT GAS DURATION:

20 MINUTES
45 MAX

SELECT WITH **▲▼** PRESS (ENTER)

Use the **▲▼** keys, to set Equalization time, and press ENTER.

SET HOT GAS EQUALIZATION:

01 MINUTES
60 MAX

SELECT WITH **▲▼** PRESS (ENTER)

Use the **▲▼** keys, to set Fan Delay, and press ENTER.

SET FAN DELAY DURATION:

02 MINUTES
05 MAX

SELECT WITH **▲▼** PRESS (ENTER)

To choose the times when defrost should occur, select SET DEFROST OPTIONS with the **▲▼** keys, and press ENTER.

MAIN MENU:

SET TIME / DAY
SET TIMERS
SET DEFROST OPTIONS
SET ROOM TEMPERATURE
INITIATE/DISABLE HOLIDAY
PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

Select DEFROST INITIATION OPTIONS with the **▲▼** keys, and press ENTER.

SET DEFROST OPTIONS:

DEFROST INITIATION OPTIONS
DEFROST TERMINATION OPTIONS
WEEKEND/HOLIDAY
VIEW SCHEDULE

PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

Each of the defrost initiation options was described in Table 2. For each of the first three modes listed, you will be given the option of selecting whether a remote contact needs to be closed at the scheduled time for a defrost to occur.

DEFROST INITIATION MODES:

24HOUR CONST INTERVAL

CONSTANT INTERVAL
EXACT TIME
TOTALIZED LIQUID
REMOTE CONTACT ONLY

PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

The most straightforward method for initiating defrost is the 24 HOUR CONSTANT INTERVAL mode. In this mode, defrost will occur at the same time each day as long as the remote contact (if selected) is closed. The 24 Hour Constant Interval Mode is also the only mode that can be used with a separate weekend or holiday schedule.

After selecting 24HOUR CONST INTERVAL, the following screen appears.

DEFROST FREQUENCY:

0 HOURS
2 HOURS
3 HOURS
4 HOURS
6 HOURS
8 HOURS
12 HOURS

PRESS (MENU) TO CANCEL
SFI ECT WITH **▲▼** PRFSS (FNTFR)

By selecting 0 HOURS for defrost frequency, the Controller is prevented from initiating a defrost sequence.

Selecting 2 HOURS will result in 12 defrost sequences every day at 2-hour intervals. Selecting 3 HOURS will result in 8 defrost sequences every day at 3-hour intervals, and so on.

If REMOTE CONTACT 1 is selected, no defrost will occur at the scheduled time if this contact is open. (More detailed instructions are given later in this manual.)

REMOTE CONTACT FOR DEFROST INIT

NO CONTACT
REMOTE CONTACT 1

SELECT WITH **▲▼** PRESS (ENTER)

Time can be entered in 15 minute increments. After entering the time for the first defrost to occur, the Defrost Initiation screen will reappear.

SET TIME FOR FIRST DEFROST

6:00 AM

SELECT WITH ▲▼ PRESS (ENTER)

Press MENU to return to the Main Menu. Then select SET DEFROST OPTIONS. When the following menu appears, select DEFROST TERMINATION OPTIONS.

SET DEFROST OPTIONS:

DEFROST INITIATION OPTIONS
DEFROST TERMINATION OPTIONS

WEEKEND/HOLIDAY
VIEW SCHEDULE

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

The most straightforward way to terminate a defrost cycle is the Time Only mode. Selecting this option will cause defrost cycle to end after time duration for each phase (Pump Out through Fan Delay) has expired.

DEFROST TERMINATION MODES:

TIME ONLY

TIME OR TEMPERATURE
TIME OR REMOTE CONTACT 2

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

More detailed instructions are given later in this manual for the Time/Temperature and Time/Remote Contact Modes.

ADVANCED PROGRAMMING

Set the time between defrosts to be as long as possible. Remember, although defrost cycles save energy by allowing the evaporators to operate at maximum efficiency, the defrost cycle itself costs energy. The 24-Hour Constant Interval Mode allows defrost cycles to occur every 2, 3, 4, 6, 8, or 12 hours. These frequencies allow defrost cycles to occur at the same time every day. If your system needs to be defrosted at a different frequency, this can be accomplished by employing the Constant Interval Mode. In this mode, defrosts occur at evenly spaced intervals, but the time of defrost will differ from one day to the next. Another option is to use the Exact Time Mode, and set the exact times of day (up to 12) when defrost cycles should begin. The Exact Time mode permits different time intervals between defrost cycles.

Defrost Schedule Worksheet

The Refrigerating Specialties Defrost Controller permits flexibility in setting defrost schedules for energy efficiency while accommodating the realities of the business day. In more complex situations, this flexibility can lead to unnecessarily long or short periods between defrost cycles. This can especially occur when using the Weekend or Holiday Modes, or Exact Time Initiation. The Worksheet on the following page may be useful in avoiding inappropriate periods between defrost cycles.

If you are using multiple Defrost Controllers on numerous cooling units, it may be helpful to make copies of the worksheet for each controller. Remember, in general only a maximum of one-third of the units should be defrosted at the same time.

To use the worksheet, first determine the defrost frequency that best suits your system. Then determine the best time of day for the first defrost to occur, taking into consideration such factors as shift-changes and times when the load on the system is heaviest, such as during daily delivery of new product into the refrigerated space.

With this preliminary information, put marks on the worksheet to indicate the start time of each defrost cycle throughout the day.

As an example, consider a refrigerated warehouse that receives deliveries throughout the day but is relatively inactive during the evenings. It may be advantageous to defrost the cooling unit once before deliveries start, say at 4:00AM. By noon, however, the coil is usually covered with a significant amount of frost. A second defrost could be scheduled to begin after the lunch break has begun, say 12:15. Shift-change might be the best time to schedule the next defrost, say 5:00PM. In the evening, when activity is low, only one defrost cycle may be necessary before the first daily 4:00AM defrost. A 10:30PM defrost cycle could be scheduled.

If a defrost cycle typically lasts 30 minutes (1 minute pump-out, 1 minute soft gas, 25 minute hot gas, 2 minute equalize, and 1 minute fan delay), the worksheet would look

something like this. This schedule could easily be programmed using the Exact Time Initiation Mode.

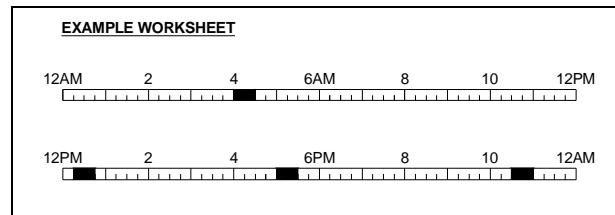
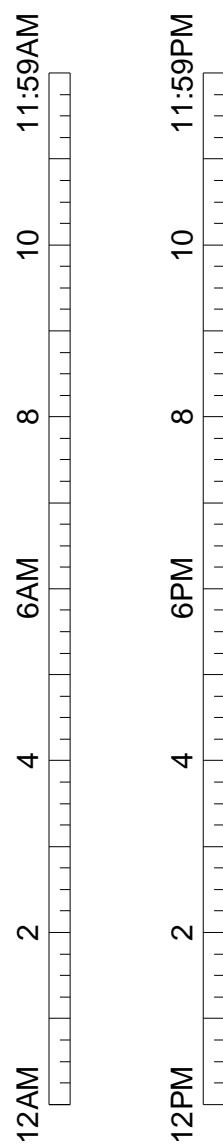


Figure 5: Example

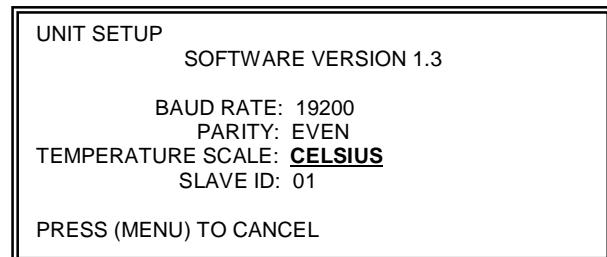


WEEKEND/HOLIDAY DEFROST SCHEDULE



Changing Temperature Units

The temperature units displayed on the Status Screen (Figure 1), can be changed between °F and °C. The units are changed by **simultaneously** pressing the ▲▼ keys on the front panel, and then releasing them. The Unit Setup Screen will appear.

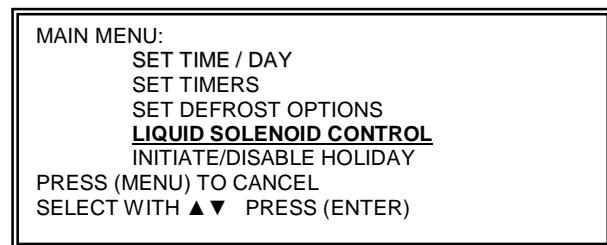


"BAUD RATE", "PARITY", and "SLAVE ID" are not used at this time.

With the Unit Setup Screen displayed, press ENTER twice and the temperature units will appear (either CELCIUS or FAHRENHEIT). Use the ▲▼ keys to switch to the desired temperature units. Press ENTER two more times to return to the Status Screen. The desired temperature units should be displayed.

Liquid Solenoid Control

Liquid Solenoid Control can be accessed through the main menu, shown below:



Following the selection of Liquid Solenoid Control, the following menu should appear

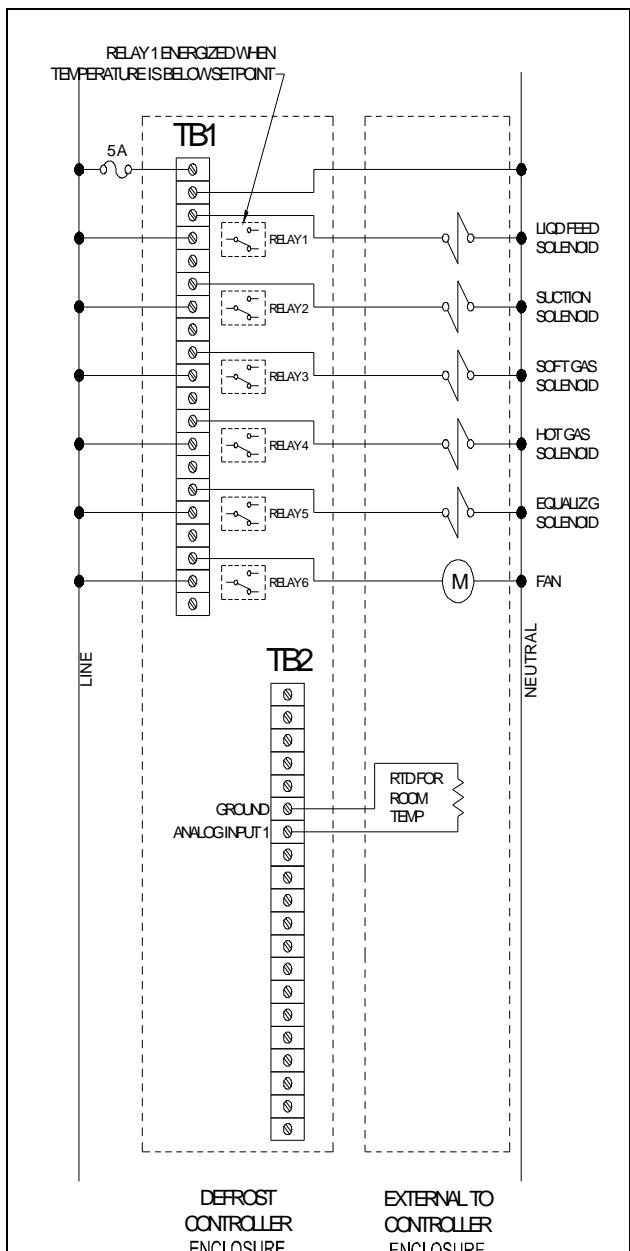


LSC SETPOINTS:

ON TEMPERATURE SETPOINT: **+25°F**
OFF TEMPERATURE SETPOINT: **+20°F**

PRESS (MENU) TO CANCEL

To use LSC with an RTD, the wiring diagram below applies.



The liquid solenoid status LED will show the current status of the liquid solenoid valve. Liquid solenoid control will be indicated on the Status screen immediately after "Refrigeration" as LSC.

SUN 01-01-01	12:06 AM	WKD-N HOL-N
o	NEXT DEFROST: 03:00AM	
n	REFRIGERATION LSC	+20°F
o	PUMP OUT: 4:00	
o	HOT GAS: 20:00	
o	EQUALIZE: 1:00	
n	FAN DELAY: 2:00	

PRESS (MENU) FOR SETUP / OPTIONS

Defrost Initiation Based on Totalized Liquid

Time can only be used if LSC is active. This mode is accessed through the following menu and can only be used when using Liquid Solenoid Control (LSC).

DEFROST INITIATION MODES:

24HOUR CONSTANT INTERVAL
CONSTANT INTERVAL
EXACT TIME
TOTALIZED LIQUID TIME
REMOTE CONTACT ONLY

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

If TOTALIZED LIQUID TIME (TLT) is selected, the following menu should appear:

SET TOTAL LIQUID TIME

03:45
12HR MAX

PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

Once TLT is set, the following indicator should appear on the Status Screen:

SUN 01-01-01	12:06 AM	WKD-N HOL-N
o	NEXT DEFROST: 03:00AM : TLT	
n	REFRIGERATION LSC	+20°F
o	PUMP OUT: 4:00	
o	HOT GAS: 20:00	
o	EQUALIZE: 1:00	
n	FAN DELAY: 2:00	

PRESS (MENU) FOR SETUP / OPTIONS

The NEXT DEFROST TIME is "dynamic", changing based on whether the liquid solenoid is open or closed.

Using Time and Remote Contact to Start Defrost

A remote contact may be used either alone or in conjunction with time to start a defrost cycle. The remote contact used to start a defrost cycle should be a normally open device connected to the REMOTE CONTACT 1 terminal. (See wiring diagram, figure 4.)

The device should have an electrical contact that closes under conditions normally associated with a frosted evaporator coil. For example, a temperature switch installed in the evaporator air stream may sense a high temperature indicating frost has blocked the airflow.

This device can be used in any of the modes shown on the Defrost Initiation Mode screen, except TOTALIZED LIQUID. In TOTALIZED LIQUID MODE, REMOTE CONTACT 1 is used as a signal to open and close the liquid feed solenoid.

DEFROST INITIATION MODES:

24HOUR CONST INTERVAL
CONSTANT INTERVAL
EXACT TIME
TOTALIZED LIQUID
REMOTE CONTACT ONLY

PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

If either 24HOUR CONST INTERVAL, CONSTANT INTERVAL, or EXACT TIME mode is selected, the following screen will appear later to permit REMOTE CONTACT 1 to be selected.

REMOTE CONTACT FOR DEFROST INIT

NO CONTACT
REMOTE CONTACT 1

SELECT WITH **▲▼** PRESS (ENTER)

After selecting REMOTE CONTACT 1, the "REM" indicator will appear on the Status Screen.

TUE 01-01-01 12:00 AM WKD-Y HOL-Y
n NEXT DEFROST: 06:00 AM : REM
n REFRIGERATION +20°F
o PUMP OUT: 1:00
o HOT GAS: 20:00
o EQUALIZE: 1:00
n FAN DELAY: 1:00
 PRESS (MENU) FOR SETUP OR OPTIONS

NOTE: In the Time/Contact modes, the Controller uses an "AND" criteria to determine if a defrost cycle should begin. Consider the events that will occur if defrosts are scheduled for 1AM and 7AM in

conjunction with REMOTE CONTACT 1. If the contact is open at 1:00 AM, no defrost will occur. If the contact closes at 1:01 AM, the next defrost will occur 7:00 AM (provided the contact remains closed). It may be adviseable, therefore, to schedule defrost cycles at shorter intervals. The user is responsible for ensuring the reliability of the device connected to REMOTE CONTACT 1.

Using Time or Remote Contact to Stop Defrost

A remote contact may be used in conjunction with time to stop a defrost cycle. The remote contact used to stop a defrost cycle should be a normally open device connected to the REMOTE CONTACT 2 terminal. (See wiring diagram, figure 4.)

The device should have an electrical contact that closes under conditions normally associated with a defrosted evaporator coil. For example, a temperature switch installed in the refrigerated space or on the coil may sense a high temperature indicating frost has been cleared from the coil.

DEFROST TERMINATION MODES:

TIME ONLY
TIME OR TEMPERATURE
TIME OR REMOTE CONTACT 2

PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

After selecting TIME OR REMOTE CONTACT 2, the Status Screen will reappear with the "REM" indicator showing.

TUE 01-01-01 12:00 AM WKD-Y HOL-Y
n NEXT DEFROST: 06:00 AM : REM
n REFRIGERATION +20°F
o PUMP OUT: 1:00
o HOT GAS: 20:00
o EQUALIZE: 1:00
n FAN DELAY: 1:00
 PRESS (MENU) FOR SETUP OR OPTIONS

NOTE: In the Time/Contact mode, the Controller uses an "OR" criteria to determine if a defrost cycle should be terminated. If the contact device closes at any phase during the defrost cycle (Pump Out through Hot Gas), the controller will immediately switch to the



Equalization phase regardless of how much time remains. The user is responsible for ensuring the reliability of the device connected to REMOTE CONTACT 2.

Using a Temperature Sensor to Stop Defrost

A PT100 type RTD (100Ω at 0°C) may be used in conjunction with time to stop a defrost cycle. The RTD should be connected to the ANALOG INPUT 1 terminal. (See wiring diagram, figure 4.)

The RTD may be installed in the refrigerated space or on the coil to sense a high temperature, indicating frost has been cleared from the coil. The measured temperature is shown on the Status Screen.

TUE 01-01-01	12:00 AM	WKD-Y HOL-Y
n NEXT DEFROST:	06:00 AM	REM
n REFRIGERATION		+20°F
o PUMP OUT:	1:00	
o HOT GAS:	20:00	
o EQUALIZE:	1:00	
n FAN DELAY:	1:00	
PRESS (MENU) FOR SETUP OR OPTIONS		

To create a setpoint, go to the Defrost Termination options screen and select TIME OR TEMPERATURE.

DEFROST TERMINATION MODES:
TIME ONLY
<u>TIME OR TEMPERATURE</u>
TIME OR REMOTE CONTACT 2
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

The Setpoint Screen will appear. Use the ▲▼ keys to change to the desired temperature setpoint.

CHOOSE TEMPERATURE SETPOINT:
<u>+25°F</u>
(-50° F TO +99°F)
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

After entering the setpoint, the Status Screen will reappear with the setpoint, as shown below.

TUE 01-01-01	12:00 AM	WKD-Y HOL-Y
n NEXT DEFROST:	06:00 AM	
n REFRIGERATION		+20°F
o PUMP OUT:	1:00	
o HOT GAS:	20:00	+25°F
o EQUALIZE:	1:00	
n FAN DELAY:	1:00	
PRESS (MENU) FOR SETUP OR OPTIONS		

NOTE: In the Time/Temperature mode, the Controller uses an "OR" criteria to determine if a defrost cycle should be terminated. If the temperature sensed by the RTD rises above the set-point at any phase during the defrost cycle (Pump Out through Hot Gas), the controller will immediately switch to the Equalization phase regardless of how much time remains. The user is responsible for ensuring the reliability of the RTD.

Weekend and Holiday Schedules

The Controller can be programmed for reduced defrost frequency on weekends and holidays. This mode is very similar to the 24 Hour Constant Interval mode discussed under Quick Setup. Holiday defrost frequency is the same as programmed for the weekend schedule. The only difference between holiday and weekend schedules is that weekend schedules repeat every week for the days specified (one to three consecutive days), the holiday schedule occurs only once (one to six consecutive days). A weekend schedule must be entered into the Controller before a holiday can be scheduled.

To program a weekend schedule, go to the Main Menu and select Set Defrost Options. From the Defrost Options Screen, select Weekend/Holiday.

SET DEFROST OPTIONS:
DEFROST INITIATION OPTIONS
DEFROST TERMINATION OPTIONS
<u>WEEKEND/HOLIDAY</u>
PRESS (MENU) TO CANCEL
SELECT WITH ▲▼ PRESS (ENTER)

The following screen will appear. Selecting zero hours will disable both weekend and holiday schedules. The controller will follow the normal schedule.

WEEKEND/HOLIDAY DEFROST FREQUENCY:	0 HOURS
	2 HOURS
	3 HOURS
	4 HOURS
	6 HOURS
	<u>8 HOURS</u>
	12 HOURS
PRESS (MENU) TO CANCEL	
WEEKEND STARTS ON	
SAT	
DAYS ARE FROM	
12:00 AM TO 11:59 PM	
SELECT WITH ▲▼ PRESS (ENTER)	



Next, select the day that the weekend ends on (for example Sunday).

WEEKEND ENDS ON

SUN
DAYS ARE FROM
12:00 AM TO 11:59 PM

SELECT WITH **▲▼** PRESS (ENTER)

Next set the time for first weekend defrost to occur (for example 6:00 PM)

SET TIME FOR FIRST
DEFROST

6:00 AM

SELECT WITH **▲▼** PRESS (ENTER)

When the following menu appears, push MENU twice to return to the Status Screen. The weekend indicator should have changed to "Y".

TUE 01-01-01	12:00 AM	WKD-Y	HOL-N
n	NEXT DEFROST: 06:00 AM		
n	REFRIGERATION		
o	PUMP OUT: 1:00		
o	HOT GAS: 20:00		
o	EQUALIZE: 1:00		
n	FAN DELAY: 1:00		

PRESS (MENU) FOR SETUP OR OPTIONS

To initiate a holiday schedule, return to the Main Menu and select Initiate/Disable Holiday.

MAIN MENU:
SET TIME / DAY
SET TIMERS
SET DEFROST OPTIONS
SET ROOM TEMPERATURE
INITIATE/DISABLE HOLIDAY
PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

Select Enable Holiday from the menu shown below.

ENABLE HOLIDAY
DISABLE HOLIDAY

PRESS (MENU) TO CANCEL
SELECT WITH **▲▼** PRESS (ENTER)

Select the day that the holiday is to begin (for example THU).

HOLIDAY STARTS ON

THU
DAYS ARE FROM
12:00 AM TO 11:59 AM

SELECT WITH **▲▼** PRESS (ENTER)

FRI).

HOLIDAY ENDS ON

FRI
DAYS ARE FROM
12:00 AM TO 11:59 AM

SELECT WITH **▲▼** PRESS (ENTER)

When the Main Menu reappears, push MENU to return to the Status Screen. The holiday indicator should have changed to "Y".

TUE 01-01-01	12:00 AM	WKD-Y	HOL-Y
n	NEXT DEFROST: 06:00 AM		
n	REFRIGERATION		
o	PUMP OUT: 1:00		
o	HOT GAS: 20:00		
o	EQUALIZE: 1:00		
n	FAN DELAY: 1:00		

PRESS (MENU) FOR SETUP OR OPTIONS

In the example given, defrost will occur the following Thursday at 6:00AM, 2:00PM, 10:00PM, and Friday at 6:00AM, 2:00PM, and 10:00PM (using the weekend frequency of eight-hours). The next defrost will occur at 6:00AM on Saturday, and follow the weekend schedule. The following Thursday, the Controller will follow the normal weekday schedule.

APPENDIX 1: THE HOT GAS DEFROST CYCLE

The means for melting the ice accumulated on evaporator coil surfaces will vary greatly from one system to another. Most typically, hot gas is employed. However, other methods such as the use of electric heaters or a warm water spray can also be used. The hot gas method will be discussed because it is the most common on large systems, and because of its complexity. The sequence of events described below can easily be adapted to either electric or warm water defrost.

In a Hot Gas Defrost Cycle, the heat for melting the ice is provided by hot gas taken from the compressor discharge⁴. As described below, the hot gas enters the evaporator and melts the ice as it cools and condenses to a liquid. The condensate then flows to some other part of the system, such as a suction accumulator.

While the exact details of the defrost cycle will vary according to the details of the system, there are a few general considerations which should always be observed:

- Ø **Be sure the refrigerated space does not get too warm during defrost.** When some coils are in defrost, the remaining evaporators must handle their refrigeration load, as well as the additional load from the defrost heat. For this reason (as well as for the reason given later) never more than 1/3 of the evaporators in a system should be in defrost mode at any given time. Typically, the defrost cycle is terminated based on a pre-set time limit. However, there may also be a temperature sensor (located either in the refrigerated space or on the evaporator coil itself) which terminates the defrost cycle if the temperature rises too high before the pre-set time has expired.
- Ø **Be sure there is an adequate supply of hot gas.** Remember, the hot gas is generated by compression of low temperature gas from operating evaporators. When one or more evaporators are being defrosted, they are no longer supplying cold vapor to the compressor so the supply of hot gas is reduced. (This is the other reason why the number of units in defrost should be limited to a maximum of 1/3 the total.)
- Ø **Be sure the hot gas upstream of the hot gas solenoid is supplied at sufficient pressure.** While it is possible to defrost a system with hot gas at a pressure of 90 psig⁵, such a low pressure will result in longer defrost time. Best results are obtained if the gas supplied throughout the defrost cycle is kept between 100 and 125 psig.
- Ø **Keep the pressure inside the evaporator from rising too high.** This function is generally served by a defrost pressure regulator that is set to open when the coil temperature is between about 40°F and 55°F (60-80 psig for ammonia, 70-90 psig for R22). Besides raising the temperature of the refrigerated space, higher defrost temperatures cause more of the melt water to evaporate back into the air instead of draining out.
- Ø **Arrange to warm drain pans and drain pipes in rooms below 32°F with either hot gas or electric heaters.** Melt water should be prevented from falling onto the floor or the products/processes in the refrigerated space. So to ensure that the water is removed, drain pans and associated piping should be pre-warmed so the water does not freeze and block them.

The types and arrangement of components will vary greatly from one refrigeration system to another. It is important that the valves and pipes for these systems be sized properly for safe, energy-efficient defrost. There are many resources available from both from Refrigerating Specialties and from industry groups such as IIAR, which will assist in properly sizing system components.

Figure 7 shows the valves typically found on a hot gas defrost arrangement. The sequence of events that occurs during hot gas defrost are similar for liquid recirculation, gravity flooded, and direct expansion systems.

1. **REFRIGERATION PHASE:** During normal refrigeration, liquid refrigerant flows through a Liquid Feed Solenoid Valve and into the evaporator. Here, heat is absorbed from the air that the Fan moves over the coil. This causes some (or all) of the refrigerant to vaporize. The liquid/vapor mixture (or vapor only) exits through the Normally Open Suction Stop Solenoid Valve and flows to an accumulator (or the compressor). When the evaporator coil temperature is below 32°F (0°C), water vapor in the air will freeze onto the coil surface and block the free flow of air.
2. **PUMP OUT PHASE (1 to 30 minutes):** During the pump out phase, the Liquid Feed Solenoid is de-energized, shutting off the supply of liquid refrigerant to the evaporator. The fan(s) continue to run, and the liquid inside the coil vaporizes and exits through the Suction Stop Solenoid. (When the suction main is located below the evaporator, liquid will exit the coil by gravity.) By either draining or evaporating the liquid out of the coil, heat from the hot gas will be applied directly to the frost instead of being wasted on vaporizing liquid refrigerant.

⁴ In the case of Warm or Cool Gas Defrost, the gas is taken from the high-pressure receiver at a temperature lower than the compressor discharge.

⁵ Ammonia Refrigeration Piping Handbook, © IIAR 2000

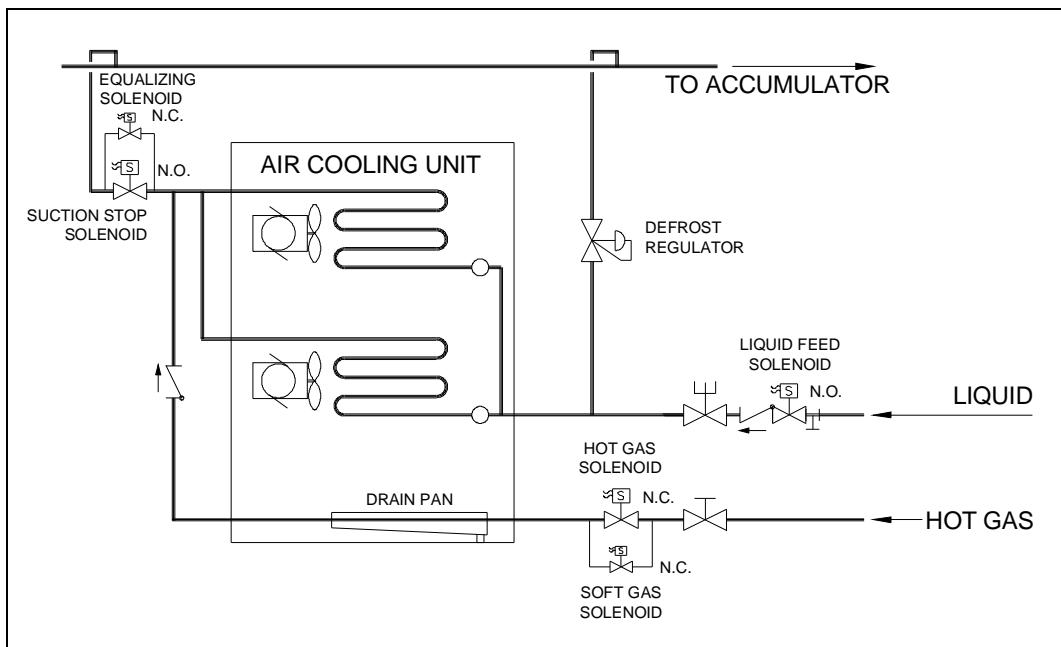


Figure 6: Typical Evaporator Configuration

3. **SOFT GAS PHASE** (0 to 10 Minutes): On many systems, a small Soft Gas Solenoid Valve is installed in parallel with the Hot Gas Solenoid Valve. At the beginning of the soft gas phase, the fan is shut down, the Suction Stop Valve is closed, and the Soft Gas Solenoid is energized, allowing hot gas from the compressor discharge to slowly enter the coil. The purpose of the Soft Gas Solenoid is to more gradually raise the pressure inside the coil when some residual liquid remains. Too rapid an introduction of hot gas can cause residual liquid to flash suddenly into vapor, resulting in potentially damaging pressure shocks. In addition, if there is any condensate in the hot gas line, the lower flow associated with the Soft Gas Valve greatly reduces the potential for harmful liquid slugging. Notice that the hot gas enters the tops of the coils after warming the drain pan. Doing so allows liquid inside the coil to drain downward, giving a more efficient defrost process.

Notice the two check valves in the system. One prevents liquid from flowing down into the drain pan during normal refrigeration. The second is mounted directly to the outlet of the Liquid Feed Valve. Liquid Feed Valve can only block flow moving *into* the evaporator. Without the second check valve, high pressure gas inside the coil during defrost would force the solenoid valve open and flow into the liquid line.

4. **HOT GAS PHASE** (1 to 45 minutes): If there was a Soft Gas Phase, then during the Hot Gas Phase the Hot Gas Solenoid is energized and the Soft Gas Solenoid is de-energized. If there is no Soft Gas Phase, the fan is shut down and the Hot Gas Solenoid is energized. Hot gas now flows more quickly into the coil and begins condensing as it gives up heat to melt the frost. Pressure inside the coil gradually rises high enough for Defrost Regulator to open. (The pressure setting of the Defrost Regulator should be between 60 and 80 psig in order to maintain the temperature in the coil between 40° and 55°F (5° - 15°C).) The liquid, or vapor/liquid mixture, flows through the Defrost Regulator and is typically routed to a suction accumulator. Hot gas continues to flow into the evaporator until either the pre-set time limit is reached or until a temperature sensor terminates the hot gas phase.
5. **EQUALIZATION PHASE** (1 to 60 minutes): After the time limit of the hot gas phase has been reached, the equalization phase begins. In this phase, the pressure inside the coil is permitted to decrease, either by allowing the warm liquid inside the coil to cool naturally or by energizing a small Equalizing Solenoid Valve that is installed in parallel with the Suction Stop Valve. The equalization phase reduces or eliminates the system shock, which would occur if (for example) warm 90 psig liquid was released into the 10 psig (or lower) suction piping. In addition to the pressure-related forces, the high-pressure liquid would generate a great deal of vapor inside the suction accumulator, resulting in sudden compressor loading.
6. **FAN DELAY PHASE** (1 to 5 minutes): At the conclusion of the equalization phase, the Equalizing Valve is closed, the Suction Stop Valve is opened and the Liquid Feed Solenoid is opened. However, the Fan is not yet energized. Instead, the coil temperature is allowed to drop, thereby freezing any water droplets that remain on the coil surface from the hot gas phase. After the fan delay has elapsed, the fan motor can be energized without water droplets being blown into the refrigerated space. The refrigeration phase has resumed, and will continue until the next scheduled defrost cycle.