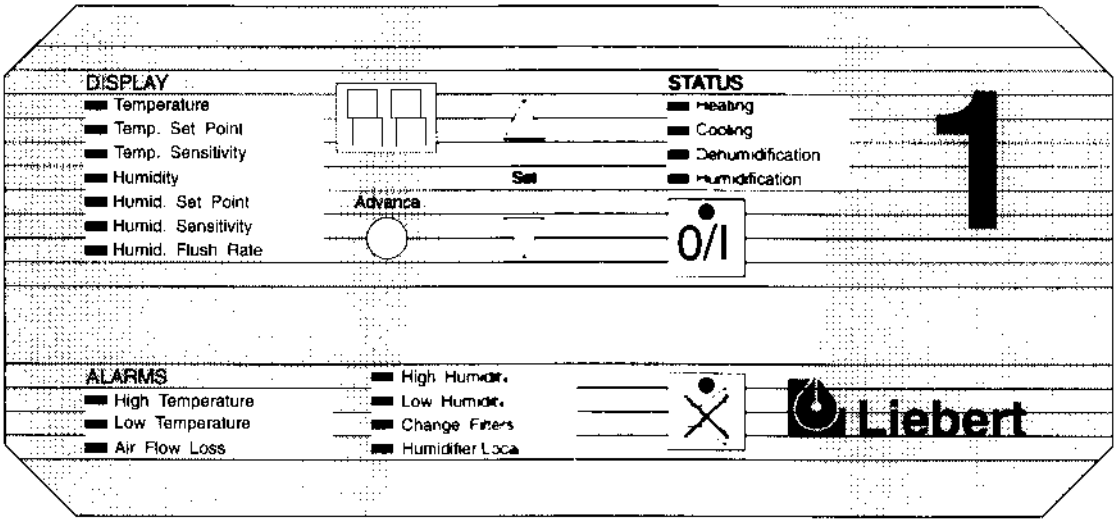
Operations Manual

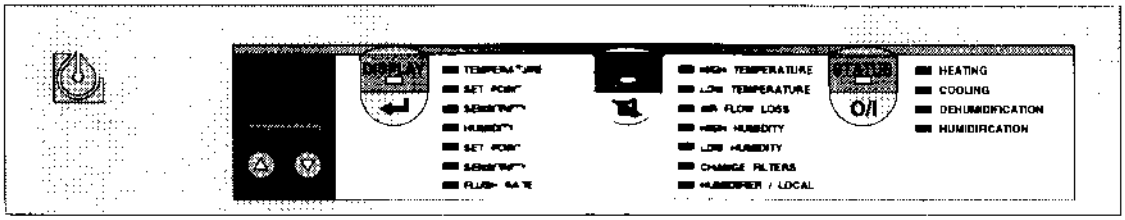
Level 5 Controller

SLC-ELV5-2E

ENVIRONMENTAL CONTROL

Level 5 Controller





Liebert

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Section 1 - Introduction

1.1 Scope

This manual describes the operation of the Level 05 controller for use in Liebert air conditioning systems. The control is an up-graded version of the familiar Level 0 control; it uses identical software, but has enhanced and additional features.

1.2 Components

The control system comprises a control board, together with panel-mounted display, interconnected by a single ribbon cable. Power to the control is provided by a dual-secondary, double wound transformer, complete with interwinding screen. Temperature and humidity sensing is achieved by the wide range (G2) sensor assembly.

1.3 Lithium battery

WARNING

This equipment contains a Lithium battery. There is a danger of explosion if the battery is incorrectly replaced (i.e. if connections are reversed). Replace only with the same or equivalent battery type recommended by the manufacturer. Discard used batteries in accordance with local regulations.

Section 2 - Display assembly

2.1 General

The display assembly consists of a printed circuit board, metal backing plate, label and plastic moulded bezel. A Challenger 4, Modular Plus and System 4 layout is shown in Figure 1A.

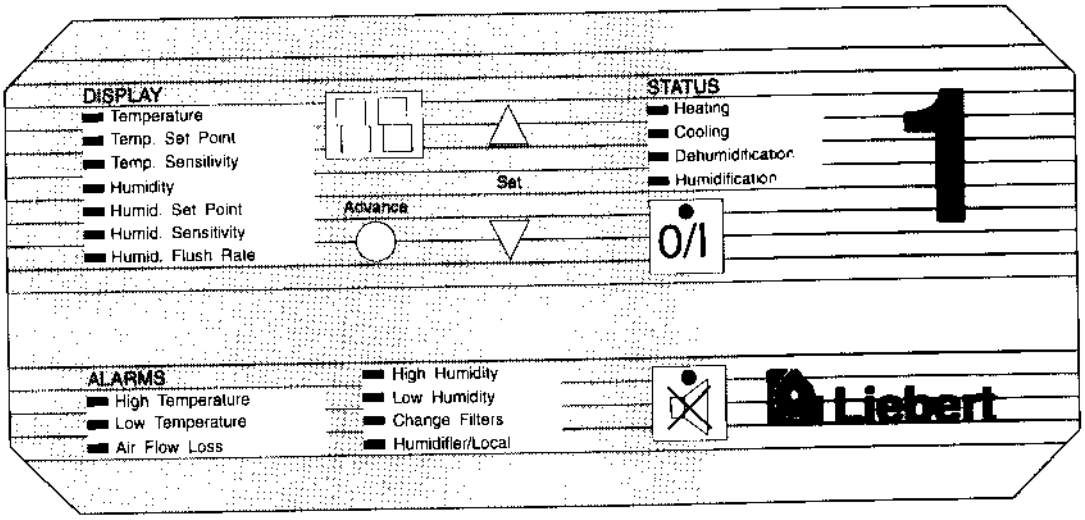


Figure 1A - Display assembly

A Mini Tower and LS400 layout is shown in Figure 1B.

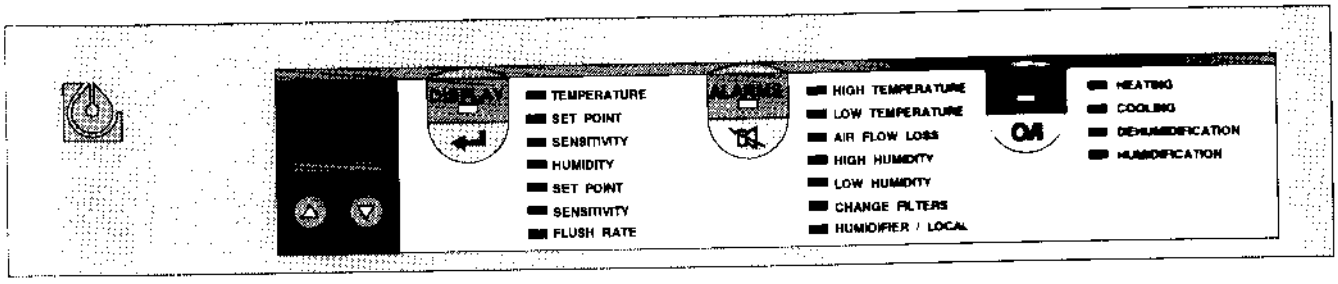


Figure 1B - Display assembly

2.2 Controls

2.2.1 *On/off switch*

The on/off switch is marked '0/1' and carries a red LED which is illuminated when the unit is turned on. The switch is of the maintained type so that automatic restart is built into the unit.

2.2.2 *Alarm present/silence switch*

The alarm silence switch is marked  and carries a yellow LED. If the controller senses an alarm condition, an audible warning device is sounded and the LED illuminated; pushing the switch cancels the audible alarm, but leaves the LED on. The visual indication disappears once all alarm conditions have been corrected.

2.2.3 *Advance button*

This button is used to scroll through the display LED's. The button is always active and may be operated at any time.

2.2.4 *Set buttons*

2.2.4.1 Change of set points

These buttons can be used to change set points when the following display LED's are illuminated:

- Temperature setpoint - from 40°F (4°C) to 85°F (29°C)
- Temperature sensitivity- from 1°F (1°C) to 5°F (3°C)
- Humidity setpoint- from 20% R.H. to 80% R.H.
- Humidity sensitivity- from 1% R.H. to 5% R.H.
- Humidifier flush rate - from 11 to 25. Adjusts the humidifier flush rate between 110% to 250% of the humidifier pan volume.

The set buttons are normally inactive (for security reasons) and will only respond from the front panel once the 'Set Point Enable' switch, located at the top of the control board (refer to Figure 2), has been depressed. A green LED, adjacent to the switch, signifies that the set buttons are active. After about three minutes, the buttons will revert to the non-active state.

2.2.4.2 Set mode 2

The set buttons may also be used to initiate 'Set Mode 2' in the following manner:

1. Ensure that the set point enable switch has been activated (green LED).
2. Select 'Temperature' or 'Humidity', as appropriate, with the advance button.
3. Simultaneously depress both 'Set' buttons.

After about 10 seconds, the temperature LED will flash, indicating that Set Mode 2 is in operation.

This mode can be employed to alter alarm trip points, select pan size or calibrate sensors, as described in the following sections. Once the desired adjustments have been effected, the display will revert to normal operation after about 30 seconds.

2.3 Indications

2.3.1 *Display*

A two segment LED display serves to show the various parameters under the control of the advance button, namely:

- Temperature
- Temperature setpoint
- Temperature sensitivity
- Humidity
- Humidity setpoint
- Humidity sensitivity
- Humidifier flush rate

2.3.2 *Status LED's*

Unit operation status is indicated by four green LED's showing heating, cooling, dehumidification and humidification. Cooling is indicated for DX or chilled water configurations, and heating for electric or hot water.

2.3.3 *Alarm LED's*

Alarm conditions are annunciated by seven yellow LED's. These conditions are:

- High temperature
- Low temperature
- Air flow loss
- High humidity
- Low humidity
- Change filters
- Humidifier/local

2.4 Alarms

2.4.1 *General*

Alarm conditions are annunciated by the seven yellow LED's. All alarms are auto-reset - the appropriate LED will remain lit as long as the alarm condition exists and will extinguish once it has been corrected.

The audible alarm will sound each time a new alarm condition arises; it may be silenced by the Alarm/Silence switch. If it is not silenced, it will stay active until all alarm conditions have disappeared.

2.4.2 *Alarm trip points (default values)*

The controller leaves the factory with the following set points:

Temperature setpoint - 75°F (nominal 24°C)

Temperature sensitivity - 3°F (nominal 2°C)

Humidity setpoint - 50% R.H.

Humidity sensitivity - 3% R.H.

2.4.2.1 High temperature

Trips at setpoint +7°F (82°F, 28°C)

Resets at setpoint +6°F (81°F, 27°C)

Indicated by high temperature LED.

2.4.2.2 Low temperature

Trips at setpoint -8°F (67°F, 19°C)

Resets at setpoint -7°F (68°F, 20°C)

Indicated by low temperature LED.

2.4.2.3 High humidity

Trips at setpoint +8% R.H. (58% R.H.)

Resets at setpoint +7% R.H. (57% R.H.)

Indicated by high humidity LED.

2.4.2.4 Low humidity

Trips at setpoint -8% R.H. (42% R.H.)

Resets at setpoint -7% R.H. (43% R.H.)

Indicated by low humidity LED.

2.4.3 *Alarm trip points (user defined)*

The temperature and humidity alarm trip points may be changed from the default values by use of the Set Mode 2 function (see 2.2.4.2 above).

2.4.3.1 High temperature

Engage Set Mode 2, advance to temperature set point and then use the set buttons. The trip point may be adjusted within the following limits:

Set point +1o up to 90°F (32°C)

Alarm reset will occur 1 degree below the trip point.

2.4.3.2 Low temperature

Engage Set Mode 2, advance to temperature sensitivity and then use the set buttons. The trip point may be adjusted within the following limits:

Set point -1° down to 35°F (2°C)

Alarm reset will occur 1° above the trip point.

2.4.3.3 High humidity

Engage Set Mode 2, advance to humidity set point and then use the set buttons. The trip point may be adjusted within the following limits:

Set point +1% R.H. up to 85% R.H.

Alarm reset will occur 1% below the trip point.

2.4.3.4 Low humidity

Engage Set Mode 2, advance to humidity sensitivity and then use the set buttons. The trip point may be adjusted within the following limits:

Set point -1% R.H. down to 15% R.H.

Alarm reset will occur 1% above the trip point.

2.4.4 Air flow loss

This alarm, driven by a diaphragm switch, indicates that the air flow within the unit has dropped to an unacceptable level. It disables the reheats and humidifier and forces the compressors (if running) into a pump-down cycle.

2.4.5 Change filters

This alarm, driven by a differential pressure switch, is activated when the pressure drop across the air filters rises to an unacceptable value. No other action is taken.

2.4.6 Humidifier/local

This alarm has a dual function:

a) It responds to a high water level in the humidifier pan, and

b) It reacts to a closure of contacts on the customer block (24, 50). The type of alarm function may be designated by the user.

Since a high water condition is also annunciated on the main control board, no ambiguity should arise.

When a humidifier high water condition is detected, the make-up valve is disabled, to avoid flooding.

2.4.7 Temperature sensing error

This is caused by an open/short circuit temperature sensor or damaged sensor board. It is distinguished by two horizontal display bars and simultaneous high and low temperature alarms.

2.4.8 Humidity sensing error

This is caused by an open circuit humidity sensor (when low humidity alarm enabled) or by a short circuit humidity sensor. It is indicated by two horizontal display bars and simultaneous high and low humidity alarms.

2.4.9 High head pressure (compressor 1 or 2)

This alarm responds to signals from the high pressure switches, sounds the audible alarm and lights the generic alarm LED.

2.5 Compressor sequencing

Often, in a DX unit, the lead compressor will have sufficient capacity to meet the cooling demand. Without sequencing, the lag compressor may run infrequently, resulting in uneven wear and a higher probability of compressor malfunction. To avoid this problem, the lead compressor may be selected and changed from time to time.

The control is factory set with compressor 1 as the lead. To alter this to compressor 2, proceed as follows:

1. Engage Set Mode 2
2. Advance to Humidifier Flush Rate
3. Use the set buttons to change from 1 to 2 (or vice versa).

2.6 Sensor calibration

2.6.1 *General*

When an air conditioning installation comprises more than one unit, it is reasonable to expect that the temperature and humidity sensors of units close together should agree: because of sensor tolerances, this is not always the case.

The software allows an offset to be applied to either sensor, as described below.

2.6.2 *Temperature sensor*

Engage Set Mode 2 (in temperature position) and use set buttons to increase or decrease the sensor reading. Maximum deviation from nominal setting is ±5°F (±3°C).

Note: In this mode, the temperature is displayed in °F. The user must make the necessary conversion if the normal display is set in Celsius.

2.6.3 *Humidity sensor*

Engage Set Mode 2, advance to the humidity position and use the set buttons to increase or decrease the sensor reading. Maximum deviation from nominal is ±5% R.H.

3.1 General details

3.1.1 *Mechanical*

The control board measures 145 x 350mm and is supported by seven 6.35mm quick-release plastic mounts. To minimize the effects of spurious noise and voltage transients, the board is of multi-layer construction: the upper inner layer is 0Vdc, whilst the lower inner layer is split between +5V and +12Vdc. General tracking is on both the outer layers.

3.1.2 *Layout*

The right hand side of the board is devoted to the microprocessor and low current circuitry, whilst the left hand side accommodates the power supplies, output relays, input terminal blocks and customer connection block. Headers for connecting to contactors, sensors and alike are positioned along the bottom edge of the board. Figure 2 overleaf illustrates the control board layout.

3.1.3 *Display harness*

The display assembly is connected to the control board by a 20-way ribbon cable from connector P1, positioned at the top right of the board.

3.1.4 *Back-up battery*

The on-board RAM is backed up by a lithium primary battery, to ensure that customer set points are retained during a power outage. Upon initial commissioning, the piece of card isolating the battery should be removed; if the unit is subsequently powered down for any length of time, the card should be re-inserted to avoid unnecessary battery discharge. Under normal operating conditions, the battery life is approximately 5 years.

The voltage of the battery should be checked at regular intervals and renewed if it drops below 2.5V (measured from top of battery to 0V on connector P10) or if the controller should lose customer set points. In this event, the set points will revert to the factory values.

3.1.5 *Fusing*

The incoming 24Vac supply is fused by a 20mm, 'Quick Blow' 8 Amp glass fuse, whilst the 17.5Vac supply, feeding the DC power supplies, is fused by a 3.15 Amp glass fuse. These fuses, located at the top left of the board, should be replaced only by direct equivalents.

3.1.6 *DC voltage adjustment*

Potentiometer RV1 is used to set the voltage on the 5V line - this is factory set at 5.1V and will not generally require resetting. The 12Vdc line is not adjustable.

3.1.7 *Software*

The operational characteristics of a given controller are defined by a single Eprom (U37), located to the right hand side of the board. Should there be a need to change this device, care should be exercised to ensure correct polarisation. The usual precautions associated with static sensitive integrated circuits should be observed.

3.1.8 *Output devices*

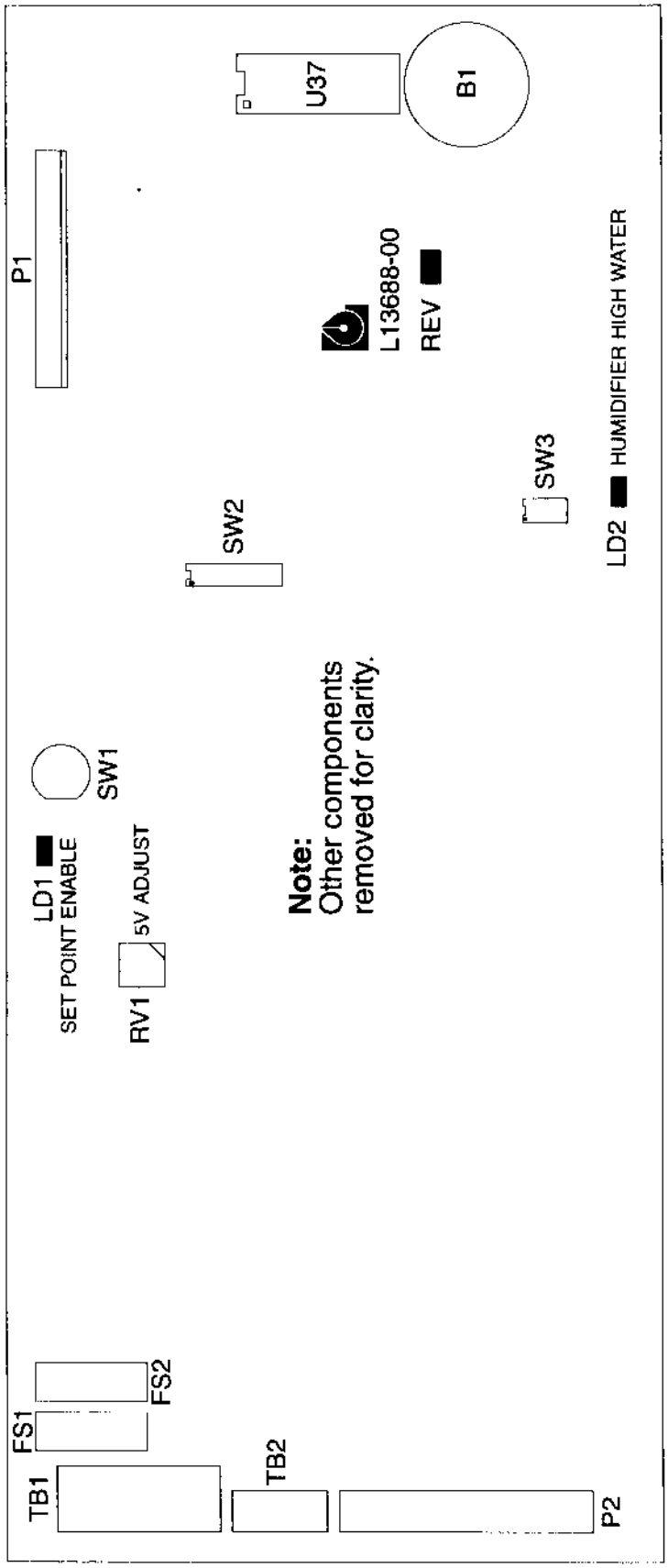
Output drives to associated contactors are via relays to pin headers on a 0.156 in. (3.96mm) pitch. These are arranged in a logical fashion, as specified in Section 5.

3.1.9 *Input signals*

All input signals to the controller are buffered by opto-couplers, to provide high noise immunity.

3.1.10 *Customer connections*

General customer connections are via a two-part terminal block (P2), as are the RS422 communications port.



Key	Description
B1	Battery
FS1	24V ac glass fuse
FS2	17.5V ac glass fuse
LD1	Set point enable LED
LD2	Humidifier high water LED
P1	Display harness connection
P2	Extended alarm board connections
RV1	DC voltage adjustment potentiometer
SW1	Set point enable switch
SW2	Dip switches
SW3	Modulating motor control
TB1	Input power to controller
TB2	2 x 24V ac supply points
U37	Software EPROM

Figure 2 - Microprocessor board layout

Section 4 - Control philosophy & software operations

4.1 Temperature control

Temperature control is achieved in Liebert units by means of staged or proportional control (or a mixture of both). These control modes are set out below.

Heating:	Staged	Electric, hot gas reheat
	Proportional	Hot water, steam reheat
Cooling:	Staged	Compressorised
	Proportional	Chilled water
	Mixed	Compressorised with free-cooling (Glycool)

Return air temperature, sensed by a thermistor, is generally the defining parameter for temperature control. The sensor measures temperature accurately over the range 35°F (2°C) to 90°F (32°C), although the working range is restricted to 40°F (4°C) to 85°F (29°C). The range of sensitivity adjustment (that is, the allowable deviation from set point) is 1°F (1°C) to 5°F (3°C).

It should be noted that the basic software always uses Fahrenheit and when a Celsius readout is selected, the conversions are approximate, owing to the restrictions imposed by the two digit display.

4.1.1 Staged heating

4.1.1.1 General

The controller can drive up to three discrete stages of reheat: the control energises relays which switch 24Vac to contactors that turn on heating elements.

Note: To achieve staged heating, the option switches must be set accordingly.

4.1.1.2 Mode of operation

Consider a system defined by a temperature (T), Set Point (SET) and Sensitivity (SENS), all in Fahrenheit.

As the room temperature starts to fall, heating stages are switched on according to the following algorithm.

If T (SET - SENS)	no action
If T = (SET - SENS)	1st stage ON
If T = (SET - SENS - 1)	2nd stage ON
If T = (SET - SENS - 2)	3rd stage ON

Conversely, if the temperature rises, then the heating stages are turned off as follows:

If T = (SET - SENS - 1.5)	3rd stage OFF
If T = (SET - SENS - 0.5)	2nd stage OFF
If T = (SET - SENS/2)	1st stage OFF

This procedure is shown diagrammatically in Figure 3 for a system defined by a Set Point of 70°F and Sensitivity of 3°F.

The hysteresis between 'on' and 'off' temperatures is to prevent rapid cycling of the reheat elements.

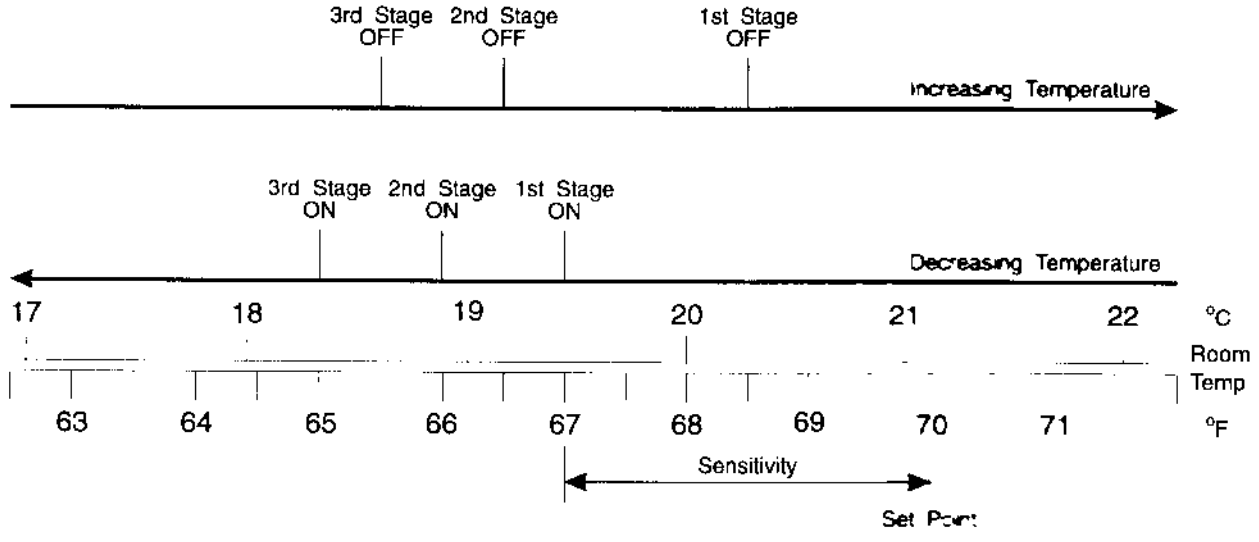


Figure 3 - Staged heating

4.1.2 *Staged cooling*

4.1.2.1 General

In this mode, the controller delivers signals that turn on either one or two compressors (2-step) and, by the addition of an auxiliary board, one or two compressors which may run unloaded or otherwise (4-step).

Since Liebert equipment usually features a pump-down cycle, the controller does not switch the compressor contactor directly. A call for cooling is effective in opening the liquid line solenoid which, in turn, causes the pressure in the suction line to increase so that the low pressure switch can operate, thereby completing the 24Vac circuit to the compressor contactor. Conversely, when the cooling demand has disappeared, the liquid line solenoid closes, but the compressor keeps running until the low pressure switch opens again and de-energises the compressor contactor.

Note: To achieve a particular staged cooling mode, the option switches must be set accordingly.

4.1.2.2 2-step cooling

As the temperature rises, cooling stages are turned on according to the following algorithm:

If T (SET + SENS)	no action
If T = (SET + SENS)	1st stage ON
If T = (SET + SENS + 1)	2nd stage ON

Conversely, when the temperature falls, cooling stages are turned off as follows:

If T = (SET + SENS + 0.5)	2nd stage OFF
If T = (SET + SENS/2)	1st stage OFF

This procedure is shown diagrammatically in Figure 4 for a system defined by a set point of 70°F and sensitivity of 3°F.

The hysteresis prevents excessive operation of the liquid line solenoids.

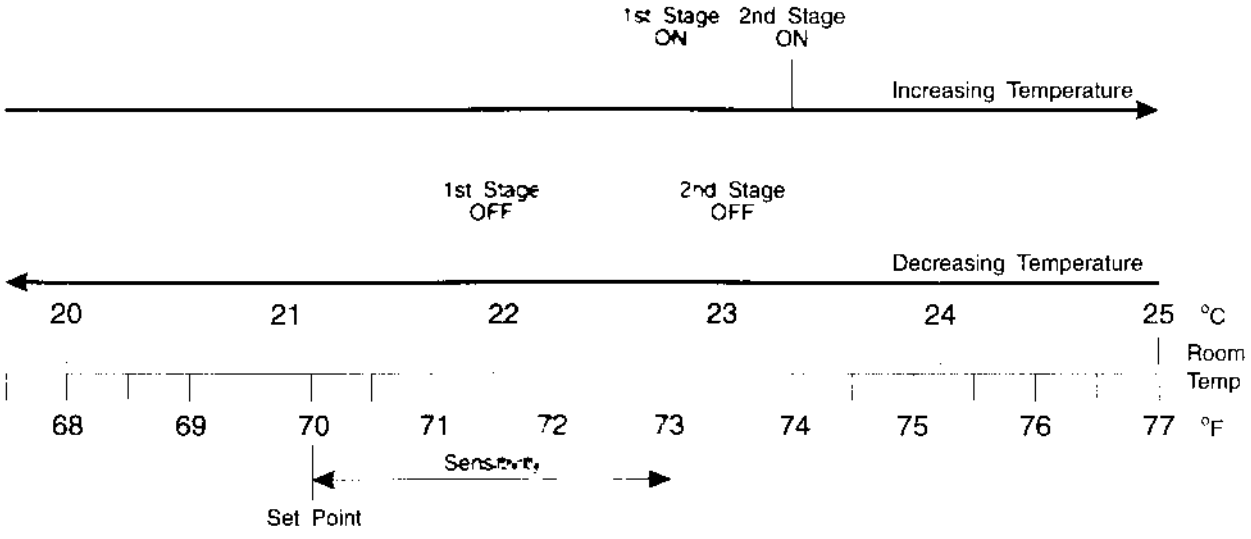


Figure 4 - 2-step cooling

4.1.2.3 4-step cooling

In this mode of operation, the various cooling stages are as follows:

Cooling Stage	Cooling Devices
1	Compressor 1 ON, unloaded
2	Compressors 1 & 2 ON, unloaded
3	Compressor 1 ON, compressor 2 unloaded
4	Compressors 1 & 2 ON

As the temperature rises, the cooling stages are brought on according to the following algorithm:

If T (SET + SENS)	no action
If T = (SET + SENS)	1st stage ON
If T = (SET + SENS + 0.7)	2nd stage ON
If T = (SET + SENS + 1.1)	3rd stage ON
If T = (SET + SENS + 1.5)	4th stage ON

Conversely, when the temperature falls, cooling stages are turned off as follows:

If T = (SET + SENS + 1.2)	4th stage OFF
If T = (SET + SENS + 0.9)	3rd stage OFF
If T = (SET + SENS + 0.4)	2nd stage OFF
If T = (SET + SENS/2)	1st stage OFF

The procedure is shown diagrammatically in Figure 5 for a system defined by a set point of 70°F and sensitivity of 3°F.

The hysteresis prevents excessive operation of the liquid line solenoids.

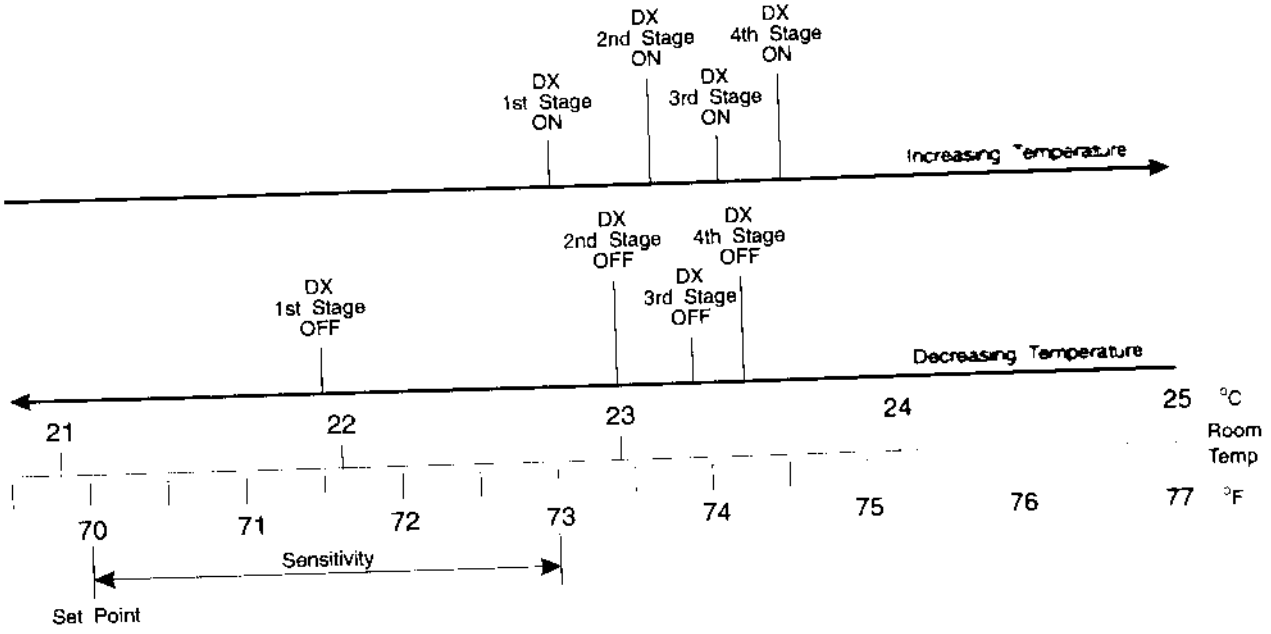


Figure 5 - 4-step cooling

4.1.3 *Proportional heating*

4.1.3.1 General

Proportional control is used to drive modulating valves in systems having hot water or steam reheats. The associated modulating motors can be of two types:

a) Liebert optional high pressure actuators react solely to a DC signal to define the valve position. Typically, this will be 0 -10V, although some American motors use 0 - 2.5V.

b) Liebert standard low pressure actuators employ a feedback potentiometer, the signal from which is indicative of valve position.

The controller has outputs to drive both motor types, for heating and cooling applications.

4.1.3.2 Mode of operation

When the room temperature is equal to (SET - SENS - 0.1), the valve will open by 10% and then by another 10% for each successive 0.1°F drop in temperature until it is fully open.

Conversely, as the temperature starts to rise, the valve will close by 10% when T = (SET - SENS - 0.9) and will close by another 10% for each successive 0.1°F rise in temperature until it is fully closed.

The procedure is illustrated in Figure 6 for a system having a set point of 70°F and a sensitivity of 3°F.

To select proportional heating, the option switches must be set accordingly.

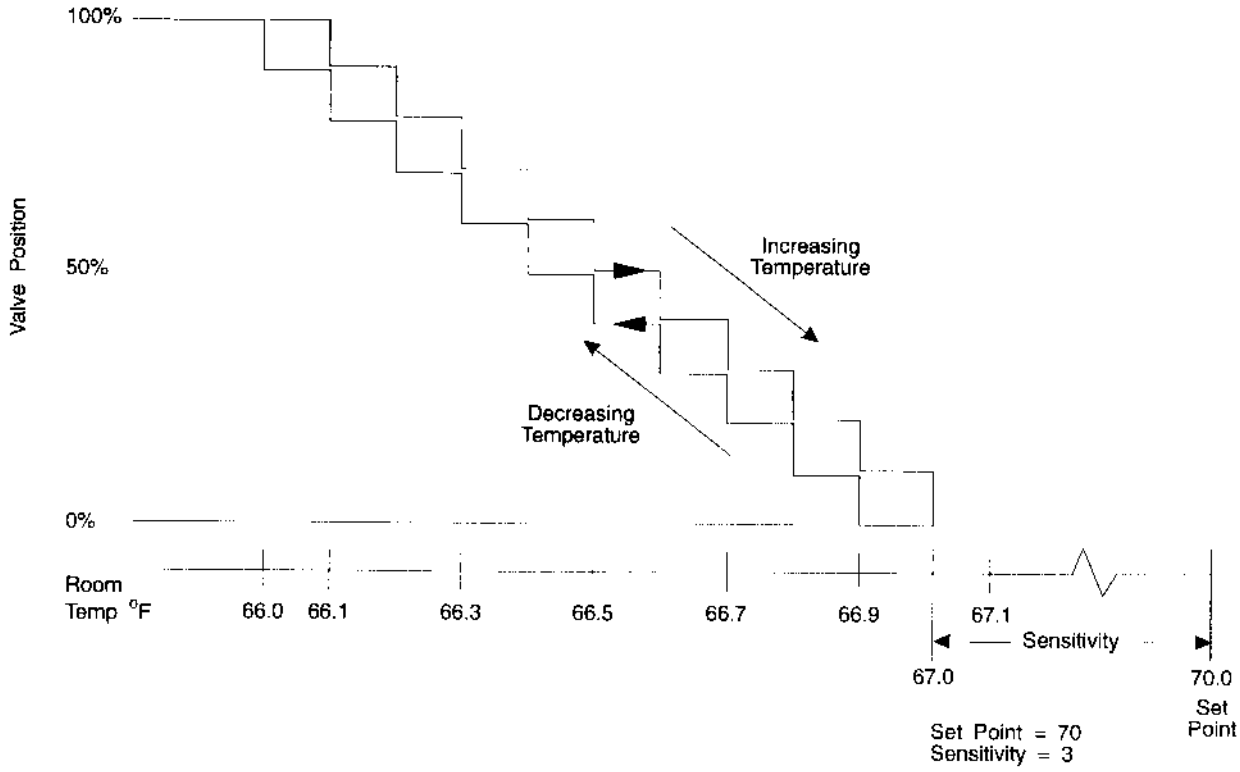


Figure 6 - Proportional heating

4.1.4 *Proportional cooling*

Proportional cooling is used for chilled water and free-cooling applications. The valves and modulating motors employed are as described for proportional heating.

4.1.4.1 Mode of operation

When the room temperature is equal to (SET + SENS/10), the valve will open by 10% and then by another 10% for each successive rise in temperature of SENS/10 until it is fully open. Conversely, as the temperature starts to fall, the valve will close by 10% when T = (SET + SENS - 0.1) and will close by another 10% for each successive fall in temperature of SENS/10 until it is fully closed.

The procedure is shown in Figure 7 for a system having a set point of 70°F and a sensitivity of 3°F.

To select proportional cooling the software and/or option switches must be chosen accordingly.

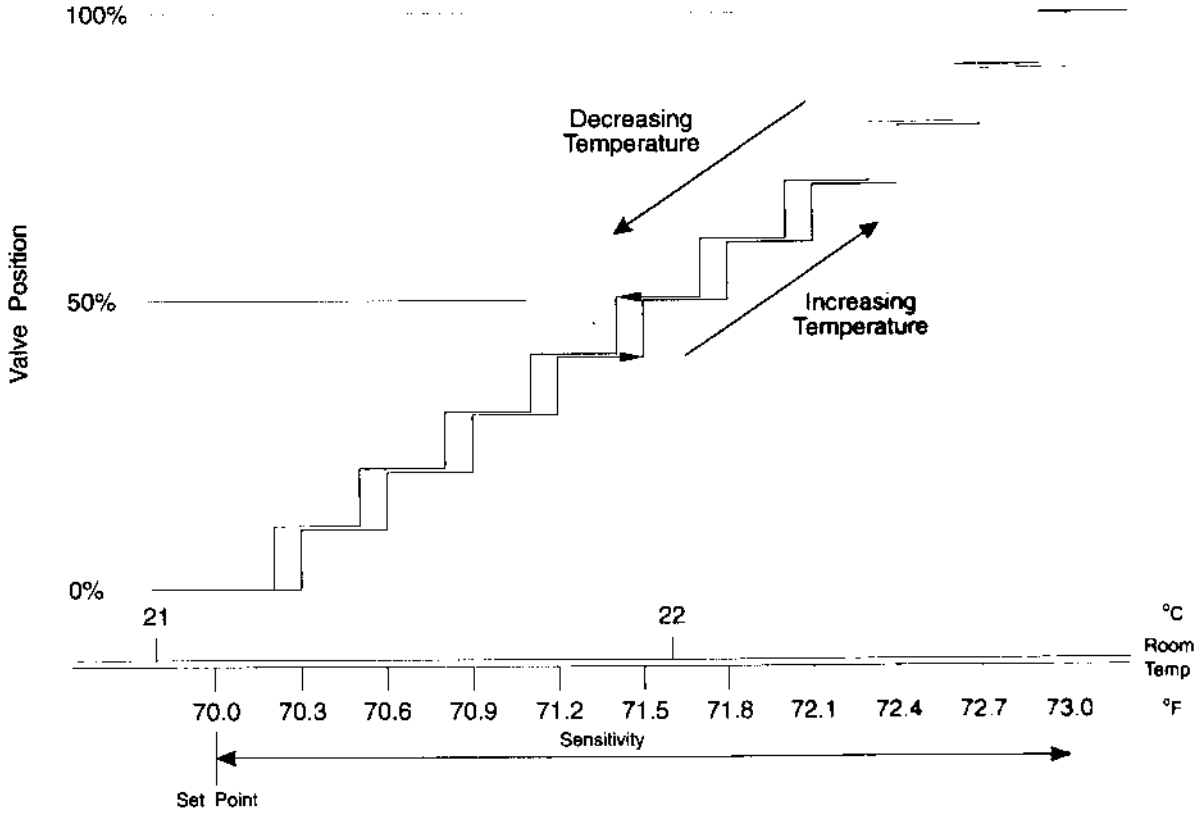


Figure 7 - Proportional cooling

4.1.5 *Mixed cooling (Direct Expansion (DX) with free-cooling)*

The free-cooling system utilises an extra coil (Econocoil) in a conventional DX machine. This coil is linked to a heat rejection device in the outside environment. Glycol, circulated through the coil, is controlled by a modulating valve. If the outside temperature is sufficiently low, the Econocoil may be adequate to supply the full room cooling requirements; if it is not, the DX stages can also be brought in, to give a mixed cooling regime. This is a more energy efficient system than normal DX cooling.

On a call for cooling, the control must first determine if the glycol is cold enough to cool the room directly. If it is not, the control operation proceeds as a standard DX unit (2-step or 4-step, as appropriate).

The glycol temperature is sensed and compared, by the controller, with the return air temperature. If it is found to be at least 3°F (1.66°C) below the return air temperature, the control changes its cooling strategy accordingly.

4.1.5.1 2-step system

When the glycol is cold enough and Glycool is available, the modulating motor is controlled in the same way as for chilled water cooling. Once the valve is fully open, the DX cooling stages start to turn on. The procedure is as follows:

If T = (SET)	no action
If T = (SET + SENS/10)	valve opens 10%

The valve then opens by 10% for each successive rise in T of SENS/10 until it is 100% open at (SET + SENS). Then,

If T = (SET + SENS + 1)	1st DX stage ON
If T = (SET + SENS + 2)	2nd DX stage ON

Conversely, when the temperature falls, the cooling devices are turned off as follows:

If T = (SET + SENS + 1.5)	2nd DX stage OFF
If T = (SET + SENS + 0.5)	1st DX stage OFF
If T = (SET + SENS - 0.1)	valve closes by 10%

The valve then closes by 10% for each successive drop in T of SENS/10 until it is fully closed. This procedure is demonstrated in Figure 8 for a system defined by a set point of 70°F and sensitivity of 3°F.

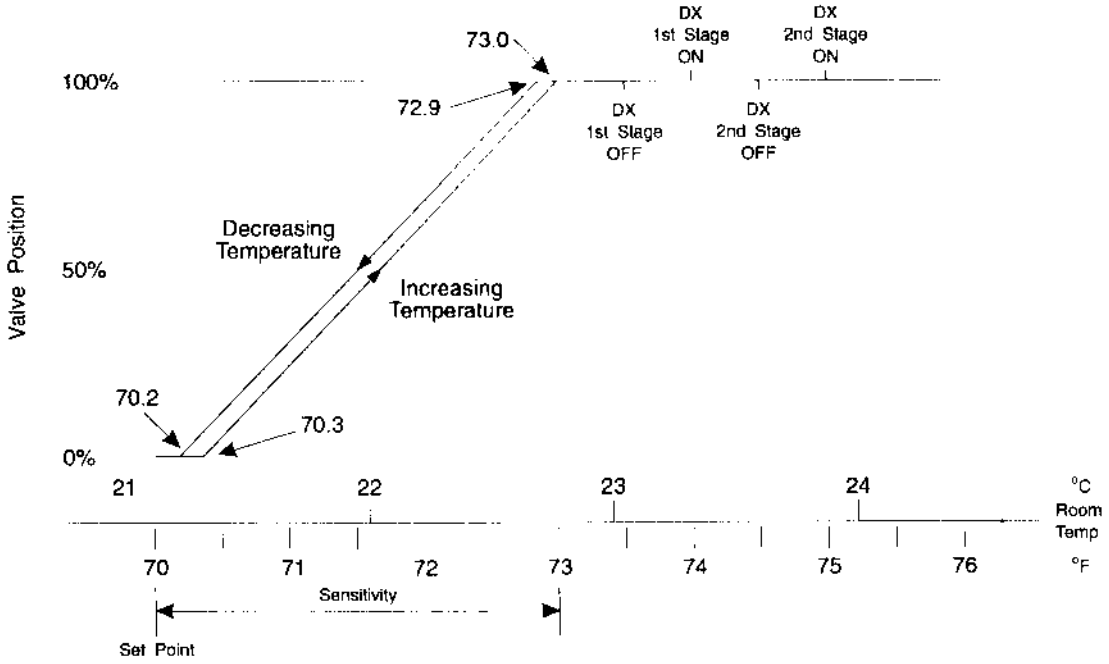


Figure 8 - 2-step Glycool

4.1.5.2 4-step system

In this system, as the temperature rises, the valve starts to open when T = (SET + SENS/10) and is 100% open at T = (SET + SENS). 1°F later the DX stages start to turn on. Using the same definition for the DX stages as in section 4.1.2.3, the procedure is as follows:

If T = (SET)	no action
If T = (SET + SENS/10)	valve opens 10%

The valve then opens by 10% for each successive rise in T of SENS/10 until it is 100% open at (SET + SENS). Then,

If T = (SET + SENS + 1)	DX stage 1 ON
If T = (SET + SENS + 1.7)	DX stage 2 ON
If T = (SET + SENS + 2.1)	DX stage 3 ON
If T = (SET + SENS + 2.5)	DX stage 4 on

Conversely, as the temperature starts to fall, the cooling devices are switched off according to the following algorithm:

If T = (SET + SENS + 2.2)	DX stage 4 OFF
If T = (SET + SENS + 1.9)	DX stage 3 OFF
If T = (SET + SENS + 1.4)	DX stage 2 OFF
If T = (SET + SENS + 0.5)	DX stage 1 OFF
If T = (SET + SENS - 0.1)	Valve closes by 10%

Then valve closes by another 10% for each successive fall in T of SENS/10 until it is fully closed.

The procedure is shown in Figure 9 for a system defined by a set point of 70°F and a sensitivity of 3°F.

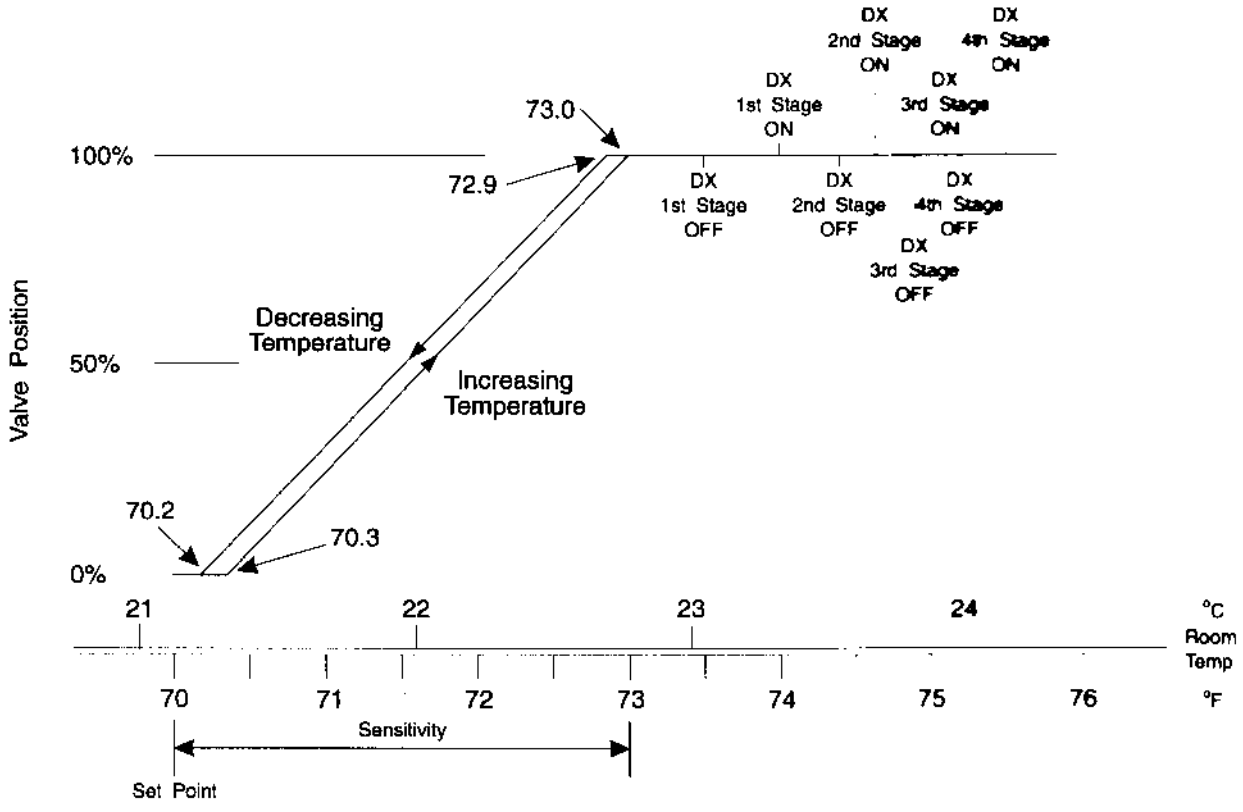


Figure 9 - 4-step Glycool

4.2 Humidity control

4.2.1 *Humidification*

Liebert environmental control units are offered with infrared or steam canister type steam humidifiers. On/off control only is employed.

Relative humidity is sensed by means of a resistive type sensor, designed for a working range of 20% to 80% R.H. The range of sensitivities is 1% to 5% R.H.

Consider a system characterised by a humidity (RH), set point (SET) and sensitivity (SENS). The humidification process is initiated when the room humidity falls to (SET - SENS). Water level control begins and humidification follows shortly afterwards. Humidification ceases when the room humidity reaches (SET - SENS x ¾). This is shown in Figure 10 for a system having a set point of 50% R.H. and a sensitivity of 4%.

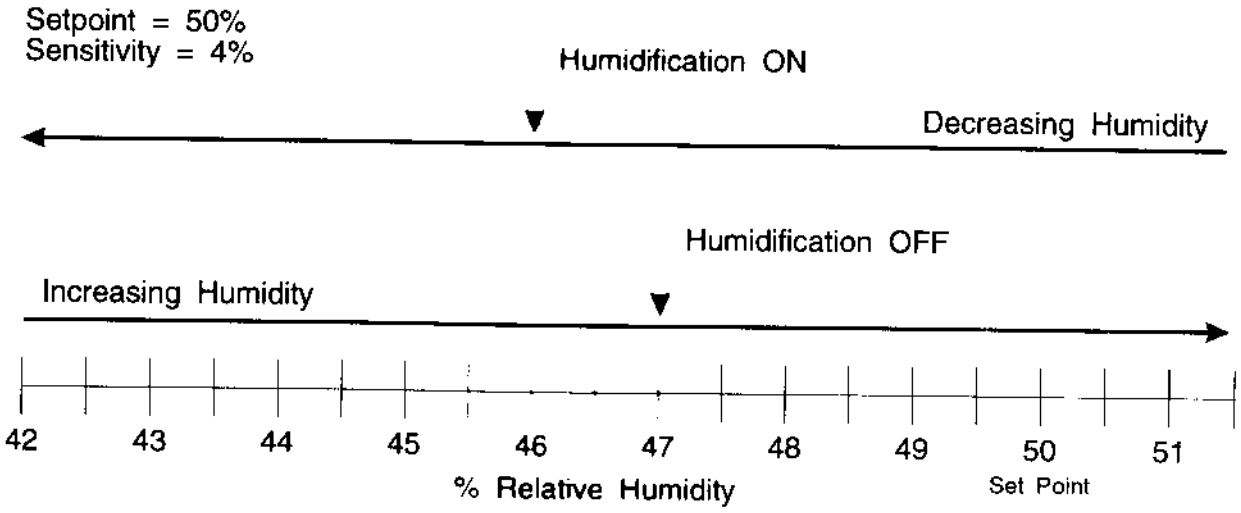


Figure 10 - Humidification control

4.2.2 *Dehumidification*

Note that the option switches must be set accordingly to provide dehumidification.

Dehumidification in Liebert units may be achieved by a variety of methods:

4.2.2.1 Proportional control

In chilled water units, the water control valve is opened by an amount proportional to the amount of dehumidification required. The valve is opened in 10% increments, but the total actuator travel occurs over a 2% R.H. range. The valve opening needed for dehumidification is added to that required for cooling. Figure 11 illustrates the principle.

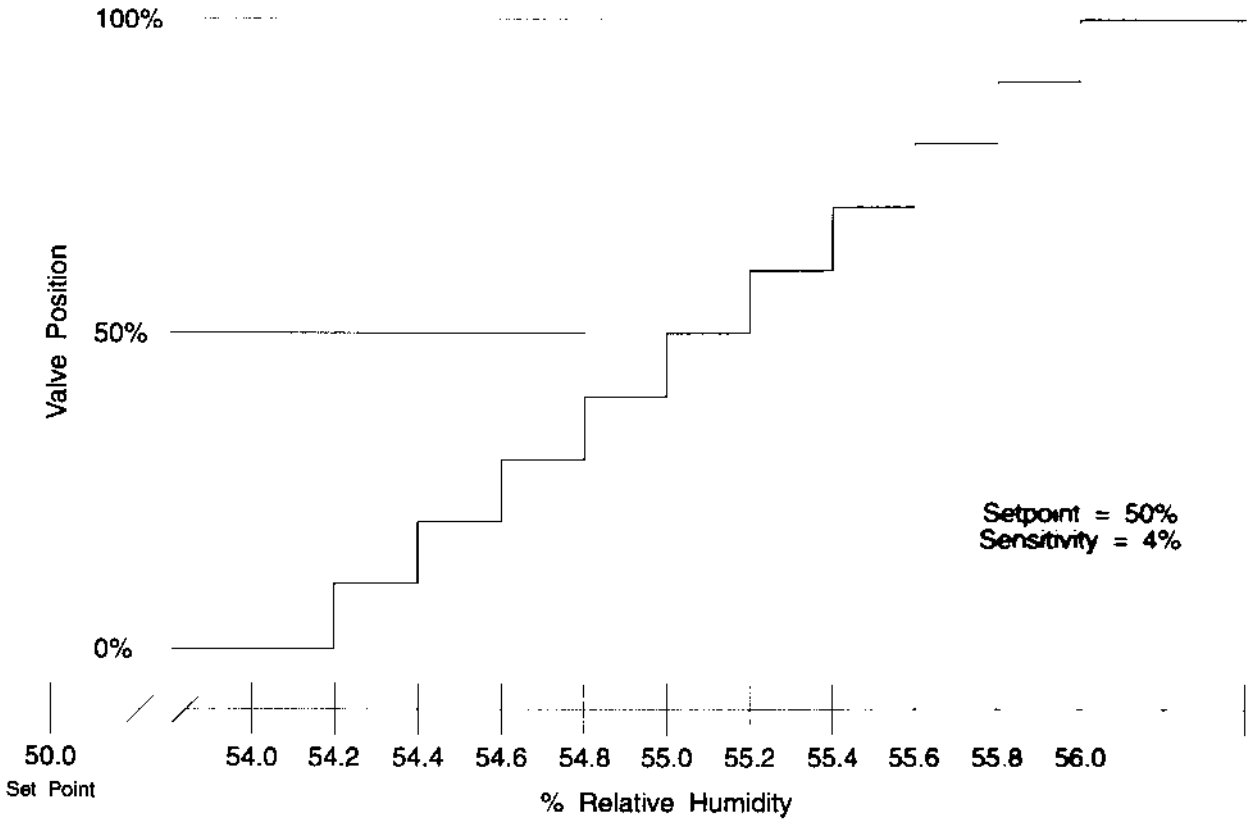


Figure 11 - Proportional dehumidification

4.2.2.2 Staged dehumidification

Note that the option switches must be set accordingly for staged dehumidification.

On some Liebert units, dehumidification is achieved via compressor control. Dehumidification will occur when the evaporator temperature falls below the dew point in the room, achieved by turning on an additional compressor.

The dehumidification process will be initiated when the room humidity rises to (SET + SENS) and will cease when it has decreased to (SET + SENS x ¾). This is shown in Figure 12.

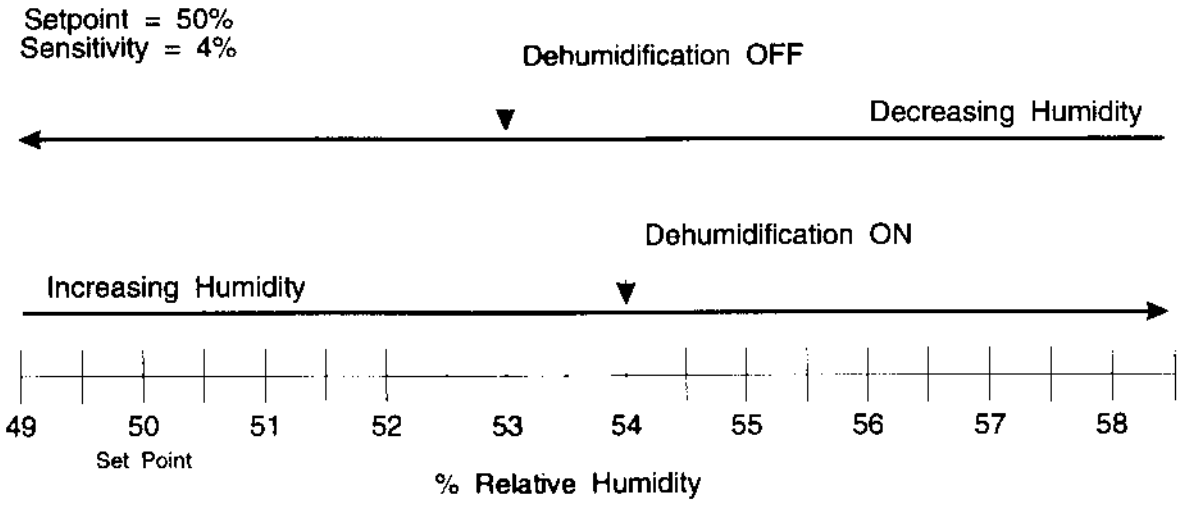


Figure 12 - Staged dehumidification

4.2.2.3 Other dehumidification methods

Other methods of achieving dehumidification are:

a) Split coil, whereby the refrigerant is forced through a fraction of the total coil area, leading to a drop in the evaporator temperature.

b) Bypass air damper, whereby part of the normal coil airflow is diverted, leading to a lowering of the sensible heat ratio.

c) Lowering the airflow by reducing the fan speed, leading to a lowering of the sensible heat ratio.

Such methods can be accommodated, either by means of the software, or by use of the dedicated dehumidification output, designed to provide the necessary signals to such devices.

4.2.3 *Autoflush control (infrared humidifier)*

The autoflush water level control system is an integral part of the humidity control of Liebert air conditioners.

If a need for humidification arises, the autoflush software checks how long humidification has been off (the off time). If the off time is greater than 30 hours, it assumes that the pan is dry and that a prefill period must take place, to ensure some water in the pan before the infrared lamps are switched on. If the off time is less than 30 hours, the prefill period is bypassed. At this point, the lamps are turned on, and the pan continues to fill to the proper water level.

The fill valve is now turned off and humidification proceeds; this is a timed cycle that allows 6.3mm of water to be evaporated from the pan.

The next process refills the pan with enough water to make up the drop in level, plus an amount extra. The refill amount (flush rate) is user programmable from 110% up to 250%. (see 4.2.3.1) and is effective in flushing away solid matter down the humidifier stand pipe.

The flow diagram in Figure 13 illustrates this process.

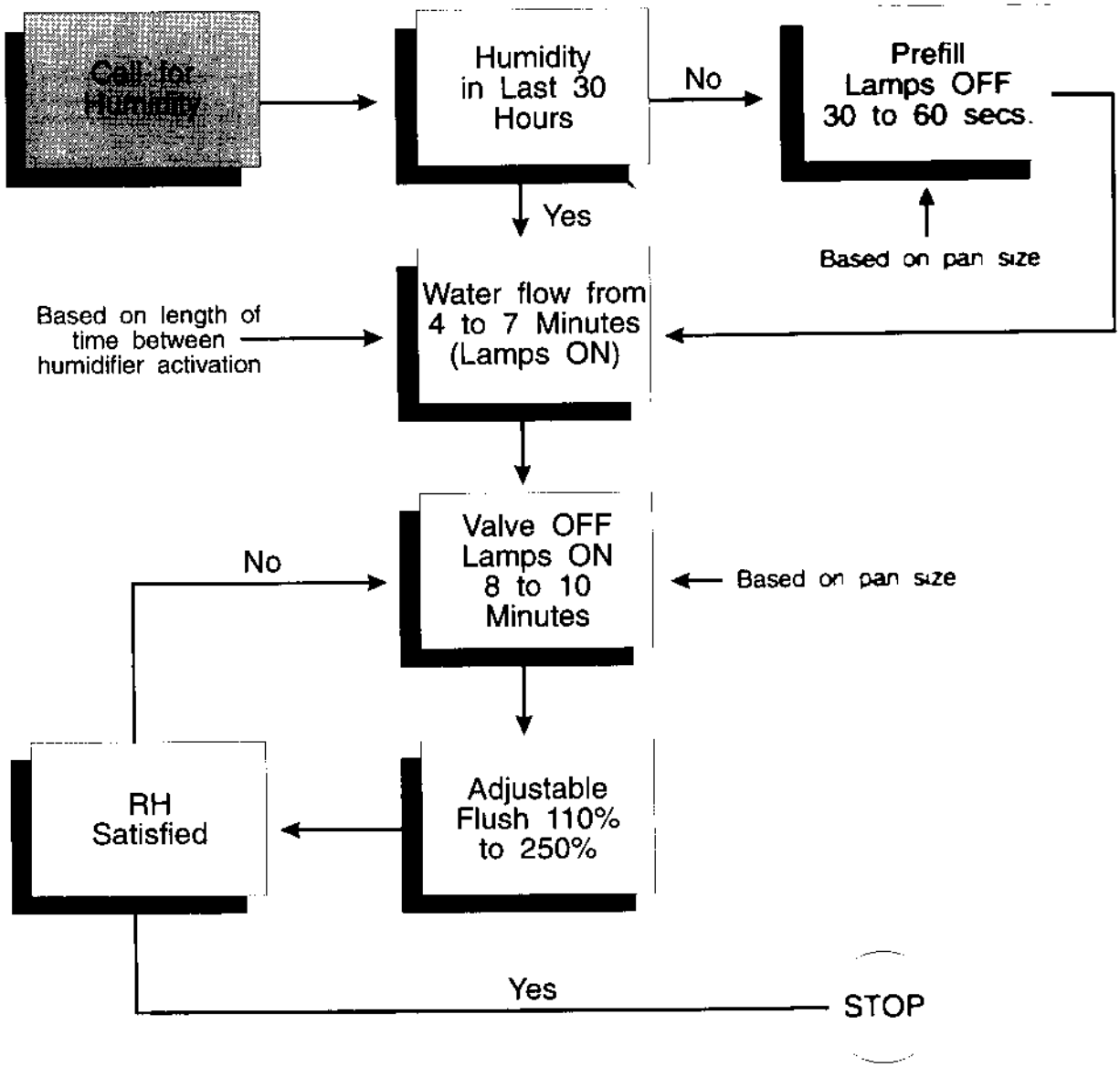


Figure 13 - Autoflush control (infrared humidifier)

4.2.3.1 Adjustment of flush rate

The flush rate may be varied as follows:

1. Press the set point enable button on the control board
2. Advance the display to Humidifier Flush Rate
3. Use up/down buttons to select value from 11 (110%) to 25 (250%)

Note: The default value is 11.

4.2.3.2 Pan size selection

There are two infrared humidifiers used in Liebert equipment, large (6 lamps) and small (3 lamps). The appropriate pan size should be selected in the following manner.

1. Advance to 'Humidity'.
2. Engage Set Mode 2.
3. Use the set buttons to change from 2 (large pan) to 1 (small pan), or vice versa.

4.3 Heat rejection output

The Level 05 provides a set of volt-free contacts that close on any call for cooling or on a call for dehumidification. These contacts should not be used with voltages greater than 24Vac. If a higher voltage is to be switched, this should be achieved by the use of a slave contactor.

4.4 Common alarm output

The control is provided with a set of volt-free, changeover contacts that respond to any alarm condition. These appear on the customer connection block, P2, and are rated at 5A, 24Vac.

Individual alarms may be annunciated remotely by means of an Extended Alarm Card, available for exclusive use with the Level 05 control. The Extended Alarm Card is available from Liebert, Cork.

4.5 Serial communications

Level 05 generates an RS422 output for communicating with Liebert SiteScan. The control system uses a two-wire, RS-422 channel to communicate with Liebert Site Products. This communications uses a proprietary protocol. A converter board (ECA2) is available to allow communications with a dumb terminal or computer using an RS-232 channel. More details are provided in the Site Products and ECA2 user manuals. This is on connector block P10.

An optional card is available (Environmental Communications Adapter - ECA2) from Liebert Cork to provide RS232 port with data output in ASCII code. This card converts the protocol from the Liebert SiteScan format to provide an open communications environment.

4.6 Option switches

4.6.1 Unit operating system

The eight way switch, S2, located in the middle of the control board, is used to select various operating options. These are shown in Figure 14.

It is important to note that only switch number 8 (Fahrenheit/Celsius selection) should be changed whilst the controller is powered up. If other switch positions are to be altered, the controller should be powered down first or the chosen option may not be accepted by the controller.

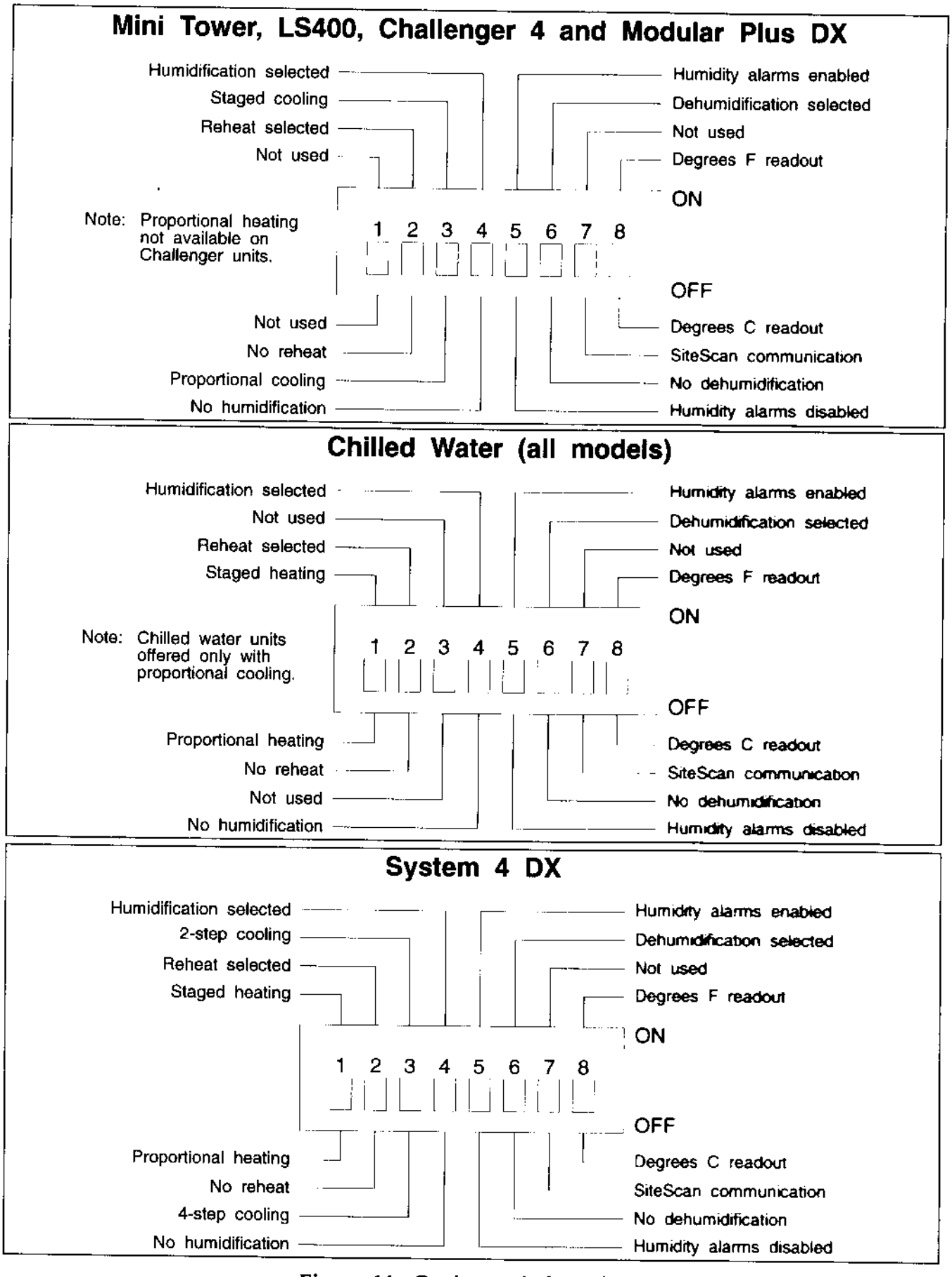


Figure 14 - Option switch settings

4.6.2 *Modulating motor outputs*

The four way switch, S3, located near the bottom of the control board, dictates the direction that a valve moves in response to a call for heating or cooling. This is important, since a particular valve can be connected in two different ways to suit the piping arrangement within a unit. These are shown in Figure 15.

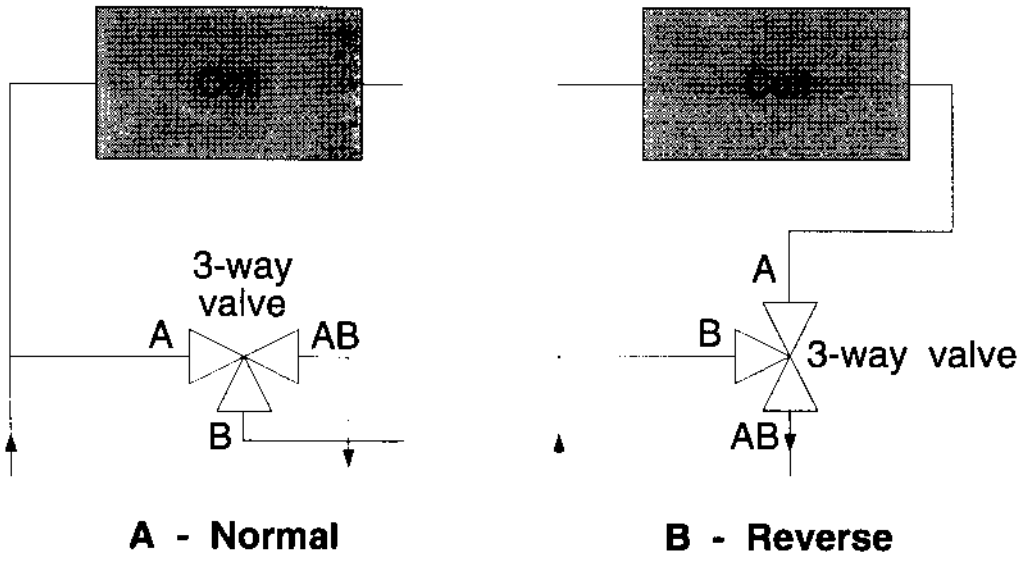


Figure 15 - Valve connections

A. 'Normal'	B. 'Reverse'
Valve stem up for coil flow.	Valve stem down for coil flow.
Valve stem down for bypass.	Valve stem up for bypass.

Switch settings are as follows.

Heating:	Normal operation	1 On, 2 Off
	Reverse operation	1 Off, 2 On
Cooling:	Normal operation	3 On, 4 Off
	Reverse operation	3 Off, 4 On

These switches may be changed without powering down the controller.

Section 5 - Terminal assignments

This section gives information on incoming and outgoing connections to the various headers and terminal blocks.

5.1 Terminal block TB1

Provides input power to controller.

TB1-1, TB1-2	17.5Vac to +5 and +12V power supplies
TB1-3	24Vac ground, contactor supply
TB1-4	24Vac ground and chassis earth
TB1-5	24Vac live (+ve)

5.2 Terminal block TB2

Provides fused 24Vac supply for sundry uses.

TB2-1, TB1-2	24Vac live (+ve), fused
TB2-3, TB2-4	24Vac ground

5.3 Header P1

Connects control to display assembly.

P1-1, P1-2	On/off switch
P1-3	Digital ground (0Vdc)
P1-4	+5Vdc supply
P1-5	Signal to heating LED
P1-6	Signal to humidification LED
P1-7, P1-8, P1-9	Data lines
P1-10	Clock line
P1-11	Signal to cooling LED
P1-12	Signal to dehumidification LED
P1-13	Audible alarm signal
P1-14	Set point enable line
P1-15	Signal from set button (up)
P1-16	Signal from set button (down)
P1-17	Signal from advance button
P1-18	Alarm/silence switch line
P1-19	Signal to alarm present LED
P1-20	+12Vdc supply

5.4 Terminal block P2

Extended alarm board / customer connection block (two part terminal block)

P2-1(38), P2-2(37)	Remote shutdown, open to activate
P2-3(37), P2-4(39)	Firestat input, open to activate
P2-5(75)	Normally open summary alarm output
P2-6(76)	Common summary alarm output
P2-7(77)	Normally closed alarm contact
P2-8(24), P2-9(50)	Remote alarm input, close to activate
P2-10(70), P2-11(71)	Heat rejection output, closes, 24Vac max.

5.5 Header P3

Main fan, air flow and filter clog switches.

P3-1, P3-2	Main fan contactor coil
P3-3, P3-4	Main fan overload, normally closed
P3-5	Air flow switch, normally open
P3-6	Air flow switch, normally closed
P3-7	Air flow switch, common
P3-8, P3-9	Filter clog switch, closes to activate

5.6 Header P4

Compressor no. 1 and associated pressure switches.

P4-1, P4-2	Compressor no. 1 contactor coil
P4-3, P4-4	Low pressure switch no. 1 + internal winter start
P4-5	High pressure switch no. 1, normally closed
P4-6	High pressure switch no. 1, normally open
P4-7	High pressure switch no. 1, common
P4-8, P4-9	Compressor no. 1 overload, normally closed

5.7 Header P5

Compressor no. 2 and associated pressure switches.

P5-1, P5-2	Compressor no. 2 contactor coil
P5-3, P5-4	Low pressure switch no. 2 + internal winter start
P5-5	High pressure switch no. 2, normally closed
P5-6	High pressure switch no. 2, normally open
P5-7	High pressure switch no. 2, common
P5-8, P5-9	Compressor no. 2 overload, normally closed

5.8 Header P6

Reheaters.

P6-1, P6-2	Reheat stat., normally closed
P6-3, P6-4	Reheat no. 1 contactor coil
P6-5, P6-6	Reheat no. 2 contactor coil
P6-7, P6-8	Reheat no. 3 contactor coil

5.9 Header P7

No. 1 liquid line solenoid, freezestat and hot gas bypass.

P7-1, P7-2	Hot gas bypass solenoid no. 1
P7-3, P7-4	Freezestat. no. 1, normally closed
P7-5, P7-6	Liquid line solenoid valve no. 1

5.10 Header P8

No. 2 liquid line solenoid, freezestat and hot gas bypass.

P8-1, P8-2	Hot gas bypass solenoid no. 2
P8-3, P8-4	Freezestat. no. 2, normally closed
P8-5, P8-6	Liquid line solenoid valve no. 2

5.11 Header P9

Humidifier.

P9-1, P9-2	Pan thermostat, normally closed
P9-3, P9-4	Humidifier contactor coil
P9-5, P9-6	Humidifier make-up valve
(P9-6), P9-7	Volt-free signal to steam humidifier when no link between P9-8, P9-9
P9-8, P9-9	Link, remove if contacts on P9-6, P9-7 are to be used
P9-10, P9-11	Humidifier high water detection probes

5.12 Terminal block P10

RS422 communications output to Liebert site products.

P10-1	T+
P10-2	T-
P10-3	+5Vdc
P10-4	Digital ground

5.13 Header P11

Dehumidification output.

P11-1	24Vac ground
P11-2	24Vac ground, opens on dehumidification
P11-3	Normally open, 24Vac ground on dehumidification
P11-4	24Vac

5.14 Header P12

Hot water reheat valve modulating motor (DC input type).

P12-1	24Vac
P12-2	24Vac ground
P12-3	0 - 2.5Vdc signal output
P12-4	Digital ground
P12-5	0 - 10Vdc signal output

5.15 Header P13

Hot water reheat valve modulating motor (feedback type).

P13-1	Negative power to motor - 'W'
P13-2	24Vac ground (DC return) - 'R'
P13-3	Positive power to motor - 'B'
P13-4	One end feedback potentiometer - 'G'
P13-5	Wiper arm of feedback potentiometer - 'T'
P13-6	Other end of feedback potentiometer - 'Y'

5.16 Header P14

Chilled water valve modulating motor (DC input type).

P14-1	24Vac
P14-2	24Vac ground
P14-3	0 - 2.5Vdc signal output
P14-4	Digital ground
P14-5	0 - 10Vdc signal output

5.17 Header P15

Chilled water valve modulating motor (feedback type).

P15-1	Negative power to motor - 'W'
P15-2	24Vac ground (DC return) - 'R'
P15-3	Positive power to motor - 'B'
P15-4	One end of feedback potentiometer - 'G'
P15-5	Wiper of feedback potentiometer - 'T'
P15-6	Other end of feedback potentiometer - 'Y'

5.18 Header P16

Receives output signals from temperature/humidity board.

P16-1	Temperature signal
P16-2	Humidity signal
P16-3	+5Vdc
P16-4	Digital ground

5.19 Header P17

Accepts temperature signals from glycol and return air sensors for free-cooling applications.

P17-1, P17-2	Glycol sensor input
P17-3, P17-4	Return air sensor input

Note: P17-1, P17-2 should be linked for DX operation.

Section 6 - Extended alarm board

6.1 General

This board is to be used in conjunction with the Level 5 control and is intended to provide volt-free changeover contacts for all individual alarm and status conditions. This allows an air conditioning unit to be hardwired into a building management system.

The board is connected into the Level 5 display bezel by a single 13-way ribbon cable. The board layout, showing terminal blocks etc. is shown in Figure 16.

6.2 System alarm outputs

Volt-free contacts for the various system alarm conditions are located on terminal block TB1 according to the schedule below.

Terminal	Function	Type
TB1-1	Humidifier high water	N/C
TB1-2		Common
TB1-3		N/O
TB1-4	Low temperature	N/C
TB1-5		Common
TB1-6		N/O
TB1-7	High temperature	N/C
TB1-8		Common
TB1-9		N/O
TB1-10	Loss of air flow	N/C
TB1-11		Common
TB1-12		N/O
TB1-13	Low humidity	N/C
TB1-14		Common
TB1-15		N/O
TB1-16	High humidity	N/C
TB1-17		Common
TB1-18		N/O
TB1-19	Change filters	N/C
TB1-20		Common
TB1-21		N/O
TB1-43	Summary alarm	N/C
TB1-44		Common
TB1-45		N/O

The summary alarm output is activated by any alarm selected by the user. Selection is made by the DIP switches SW1 and SW2, in accordance with the following table.

Switch	Function	Action
SW1/1	Humidifier high water/local	Close to activate summary alarm
SW1/2	Low temperature	
SW1/3	High temperature	
SW1/4	Loss of air flow	
SW1/5	Low humidity	
SW1/6	High humidity	
SW1/7	Change filters	
SW1/8	Dehumidification	
SW2/1	Cooling	Close to activate summary alarm
SW2/2	Humidification	
SW2/3	Heating	
SW2/4	Customer alarm 1	
SW2/5	Customer alarm 2	
SW2/6	Customer alarm 3	
SW2/7	Not used	
SW2/8	Not used	

6.3 Customer alarm outputs

The board provides for three customer-defined alarm outputs: these respond to volt-free contact closures on terminal block TB2, as laid out below.

Terminal	Function	Type	Input
TB1-34	Customer alarm no. 1	N/C	TB2-1 & TB2-2
TB1-35		Common	
TB1-36		N/O	
TB1-37	Customer alarm no. 2	N/C	TB2-3 & TB2-4
TB1-38		Common	
TB1-39		N/O	
TB1-40	Customer alarm no. 3	N/C	TB2-5 & TB2-6
TB1-41		Common	
TB1-42		N/O	

6.4 Status indications

The operational status of the air conditioning unit may be monitored remotely by volt-free changeover contacts, also located on terminal block TB1, as laid out below.

Terminal	Function	Type
TB1-22	Dehumidification	N/C
TB1-23		Common
TB1-24		N/O
TB1-25	Cooling	N/C
TB1-26		Common
TB1-27		N/O
TB1-28	Humidification	N/C
TB1-29		Common
TB1-30		N/O
TB1-31	Heating	N/C
TB1-32		Common
TB1-33		N/O

All relays are normally de-energised and only energise in the event of an alarm condition or status indication.

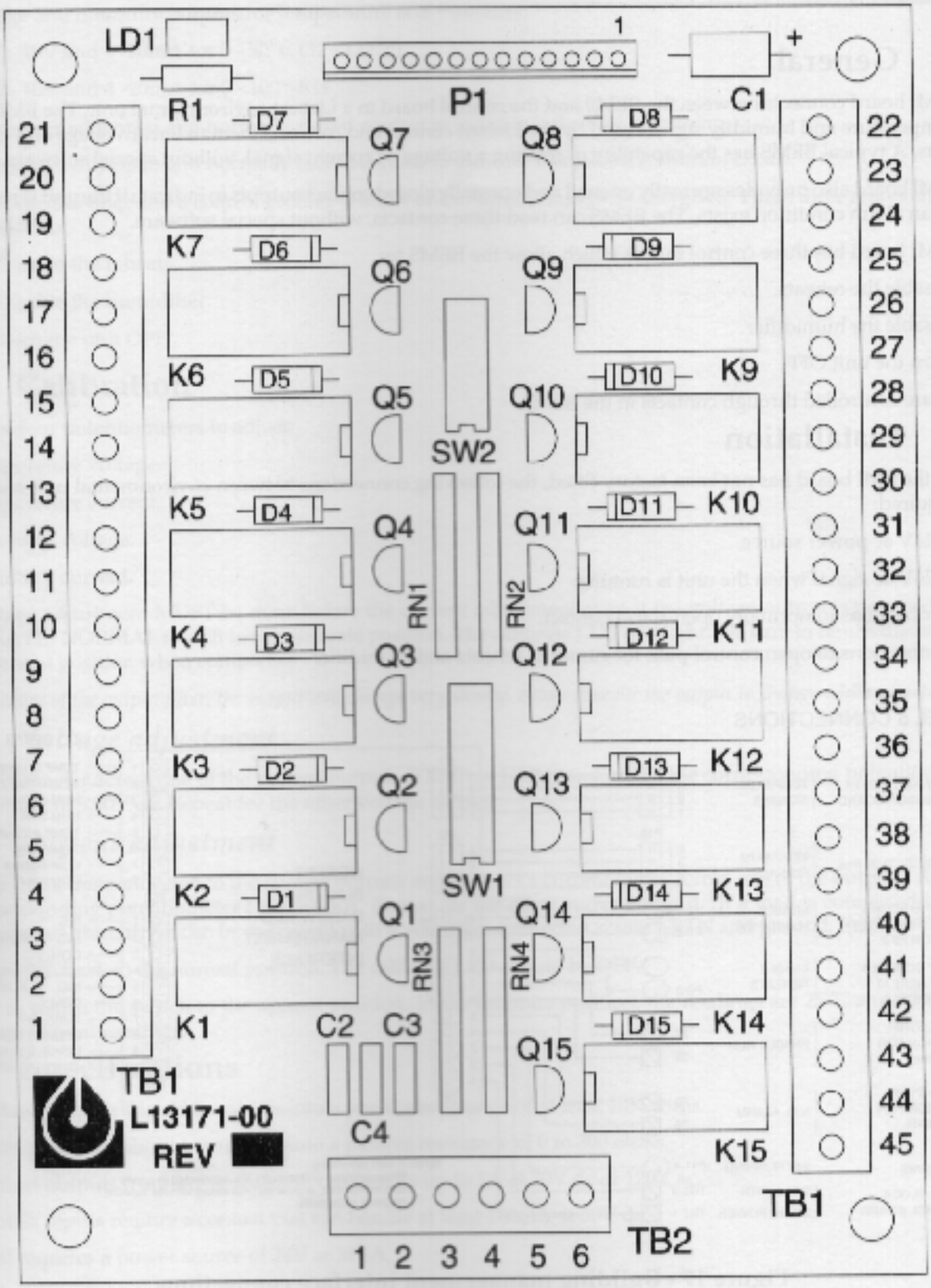


Figure 16 - Extended alarm board

Section 7 - Hard wired interface

7.1 General

The BMI board connects between the BEMS and the control board in a Liebert environmental unit. The BMI reads the temperature and humidity signals used by the Liebert control and converts them to linear voltage and current outputs. A typical BEMS has the capability of reading a voltage or current signal, without special software.

The BMI board also provides normally opened and normally closed contact outputs to indicate if the unit is running and if an alarm condition exists. The BEMS can read these contacts, without special software.

The BMI board has three control inputs which allow the BEMS to:

1. Disable the reheats.
2. Disable the humidifier.
3. Turn the unit OFF.

These are controlled through contacts in the BEMS.

7.2 Installation

When the BMI board has not been factory fitted, the following connections between environmental unit and BMI are required:

1. A 24V ac power source.
2. A 24V ac signal when the unit is running.
3. Connections to normally open alarm contact.
4. Connections to open control path for running, reheats and humidifier.

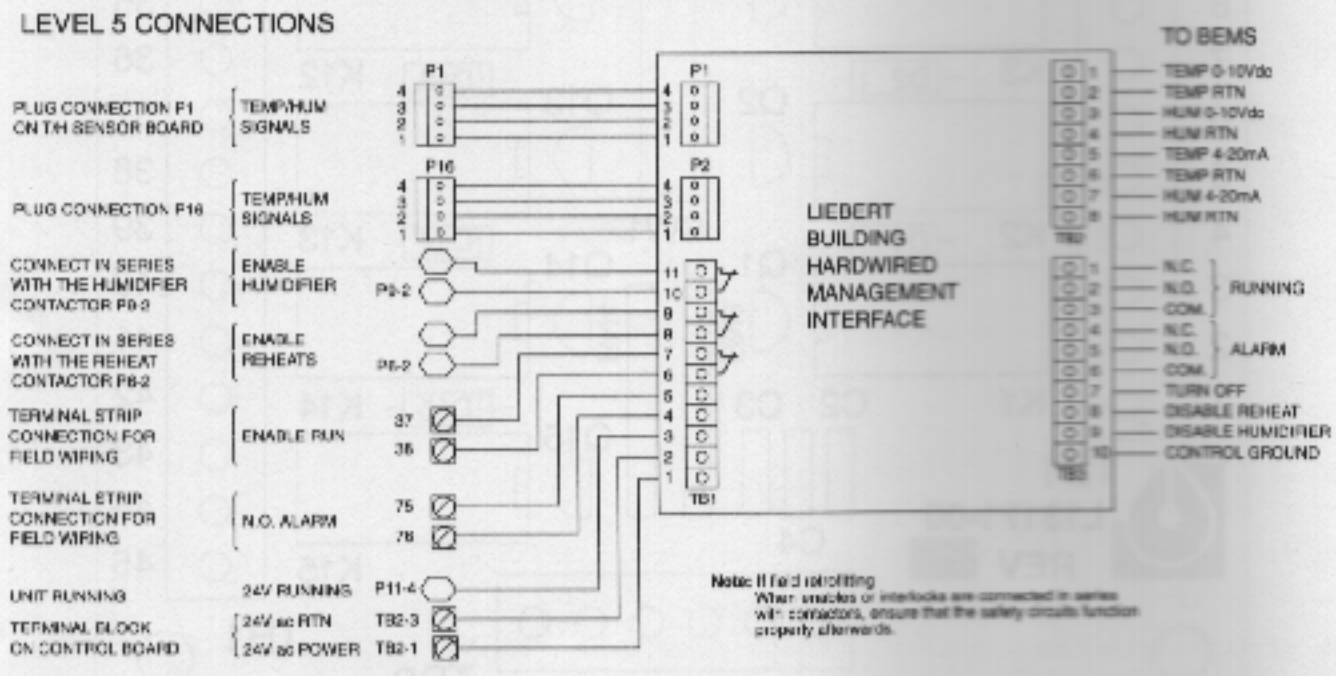


Figure 17 - Building management interface connections

Note: There is only one 24V ac return, therefore items 1 and 2 must have a common return.

Note: The specific locations for all these connections can be determined from the wiring diagram for the particular Liebert unit.

7.3 Connections between BMI and BEMS

1. Voltage and humidity outputs for temperature and humidity.

   0 - 10V and 4 -20mA for 0 - 50°C (32 - 122°F)

   0 - 10V and 4 -20mA for 0 - 100%RH

2. Both a normally open and normally closed contact to indicate if the unit is running.
3. Both a normally open and normally closed contact to indicate if an alarm condition exists.
4. Three control lines and a control ground to allow one of three relays to be energised. These three relays enable the BMS to:

   a) Disable the reheats.

   b) Disable the humidifier.

   c) Turn the unit OFF.

7.4 Calibration

There are four potentiometers to adjust:

1. Temperature voltage.
2. Temperature current.
3. Humidity voltage.
4. Humidity current.

The voltage adjustment MUST be done before the current adjustment even if the voltage output is not used. Set CALIBRATE/NORMAL switch to the calibrate position. The calibrate LED will light. (Be sure to return the switch to the normal position when complete.)

Note: Because of the output filter, the output will change very slowly. Allow time for the output to change while adjusting.

7.4.1 Voltage adjustment

Place a voltmeter across one of the voltage outputs (TEMP or HUM) and adjust the corresponding potentiometer for a reading of 5.00V dc. Repeat for the other voltage output.

7.4.2 Current adjustment

Remove any wires connected to the current outputs and connect a current meter across one of the outputs. Adjust the corresponding potentiometer for 12.00mA. Repeat for the other current output. (If a load is connected to the current output, the current can be measured with a voltmeter connected across I-RTN and ground. I(mA) = V x 10.

Set the switch back to the normal position. The calibrate LED should be OFF.

Be sure to return the switch to the normal position. In the calibrate position, the readings are 25°C and 50% RH, which are normal readings.

7.5 Specifications

The voltage outputs should terminate into a passive resistance of at least 10K ohms.

The current outputs should terminate into a passive resistance of 0 to 300 ohms.

The contact outputs (running and alarm) can handle up to 1A at 30V dc or 120V ac.

The control inputs require a contact that can handle at least 100mA at 30V dc.

The BMI requires a power source of 24V ac at 1A.

Section 8 - ECA2 card (RS232 interface)

8.1 General

This interface will allow a dumb terminal or an RS232 port of a computer to communicate with a Liebert Level 5 controller.

The standard version uses a 3-wire RS232 link (xmt data, rec data, gnd). The baud rate is dip switch selectable (300, 1200, 9600). The format is set at 8 databits, 1 stop and zero parity.

8.2 Communication with terminal

The terminal will receive a prompt character (>). The user can then enter a request followed by a carriage return. The requested data will be obtained from the unit and a message followed by a parameter will be sent to the terminal.

Example. user enters: > TEMPERATURE SETPOINT = 73

response: TEMP SETPT 73

The user can also change a setpoint by including an '=' in the message. If the new setpoint is valid, it will be changed. In any case the terminal will receive a response telling what the setpoint is.

Example. user enters: > TEMP SETPT = 72

response: TEMP SETPT 72

You may receive an 'INVALID REQUEST' or 'BAD PARAMETER' message back if you entered incorrect data.

Only the first three characters of each word are used so the user can enter the whole word (TEMPERATURE) or just TEM.

The user can obtain information about the setpoints, status (temp, humidity, cooling, heating, etc) and alarms.

The table on the following page lists the information you can request from the unit. Those marked with * are not available on Level 5.

You can enter 'HELP' to see a list of these requests (only shows the first 3 characters).

Miscellaneous notes:

Most data from the unit is translated by the interface, but a few messages are sent to the RS232 terminal exactly as they were received from the unit. These messages will have 'u:' preceding the message. The 'u:' indicates that this message is shown as it came back from the unit. For example, a COMMUNICATION CHECK request will return 'u: COMMUNICATION OK'. Also, an ALARM REVIEW will return alarm messages directly from the unit and these will have 'u:' in front.

An ALARM REVIEW request will return one alarm message for each request. If more than one alarm condition exists, it will step through all the alarms each time the ALARM REVIEW request is entered (this is a function of the unit, not the interface). An ALARM request reports all the present alarms at once.

While entering a request, the backspace (ctrl/h) can be used to correct typing mistakes.

You can reset the interface board by entering 'RESET IF'. After approximately 5 seconds the interface board will reset and display a message 'LIEBERT BMS INTERFACE' followed by a 4 digit hex number that identifies the software in this interface board.

You can enter 'OPTIONS' to see how the dip switches are set. Currently, this only shows how dip switch no. 7 is set, which selects Level 5.

To change degrees, enter 'DEGREE=' followed by 'F' or 'C'. All other setpoint changes require a numeric value.

There are 3 requests that do not return any messages so the interface prints 'OK'. These are ALARM ACKNOWLEDGE, ALARM RESET AND MIDNIGHT SYNC (which sets the time = 00.00).

If no response is received from the unit when one is expected, the interface outputs 'NO RESPONSE'. This will happen if the communication line is not connected.

To obtain		Enter
Block of summary data	*	SUM
Block of control setpoints		SET or CON
Block of status data		STA
All alarms (alarm block)		ALL ALA or ALA BLO or ALA
Temperature reading		TEM
Humidity reading		HUM
Temp and hum readings		TH or T H or TEM HUM
Temperature setpoint		TEM SET
Temperature tolerance		TEM TOL
Humidity setpoint		HUM SET
Humidity tolerance		HUM TOL
High temperature alarm	*	HI TEM ALA
Low temperature alarm	*	LO TEM ALA
High humidity alarm	*	HI HUM ALA
Low humidity alarm	*	LO HUM ALA
Winter start delay	*	WIN STA DEL or WSK
Restart delay	*	RES DEL
Humidifier flush rate		HUM FLU RAT or HUM WAT RAT
Chilled water flush cycle	*	CHI WAT FLU CYC or CW FLU CYC
Zero compressor run hours	*	ZER COM HOU
Time	*	TIM
Temperature calibration	*	TEM CAL
Humidifier calibration	*	HUM CAL
Percentage cooling/heating		PER or %
Humidifier/dehumidifier status		HUM STA or DEH STA
Compressor no. 1 run hours	*	COM 1 HOU
Compressor no. 2 run hours	*	COM 2 HOU
Glycool hours	*	GLY HOU
Communications check		COM CHE
Alarm reset		ALA RES
Alarm acknowledge		ALA ACK
Alarm review		ALA REV
Customer alarm 1	*	CUS ALA 1
Customer alarm 2	*	CUS ALA 2
Identify unit		ID
Midnight sync	*	MID SYN
Degrees		DEG or FC

* Not available on Level 5.

8.3 ASCII codes

Details of ASCII codes are given in the table applicable to the job.

8.4 Installation

The following instructions apply when the board is not factory fitted but requires to be retrofitted in the field.

1. Mount the board in a suitable location.
2. The interface board requires a 5V dc power supply at 1 amp. Connect +5V dc to P2-3 and ground to P2-4.
3. Connect a two wire line from the RS422 Sitescan port of a Level 5. The positive RS422 wire to P3-1 and the negative to P3-2.
4. Connect an RS232 cable from the dumb terminal or computer port to P1 of the interface board. P1 accepts a female 25 pin connector. The connections are:
   a) P1-2 data transmitted from the interface.
   b) P1-3 data received by the interface.
   c) P1-7 ground.

   Dip switch selections:

Baud rate	SW2	SW1
300	off	off
1200	off	on

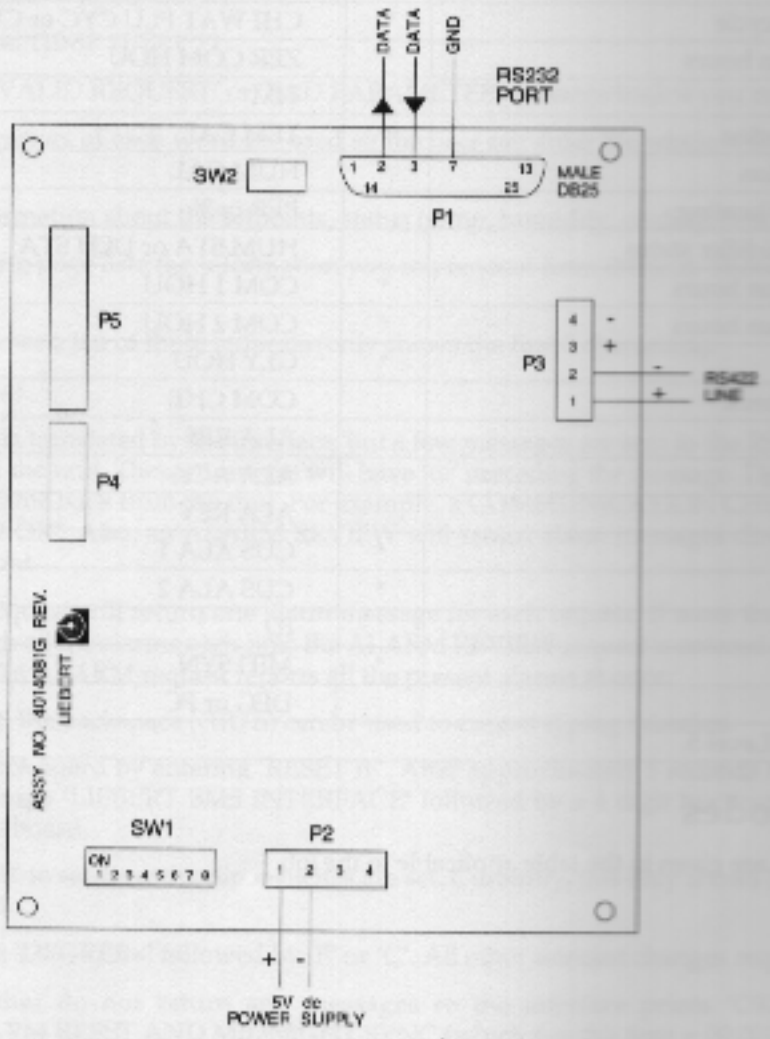


Figure 18 - ECA2 card connections

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