

Micro Control Systems

APPLICATION NOTE

APP-039

Heat Pump V9 Software Notes

Revision History

Date	Author	Description
10/24//06	Bob Toney	Created Application Note
10/30//06	Bob Toney	Correct name of set point #120

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1. Introduction

The standard CHL V8 software was used as base for the heat pump software. Both fixed capacity compressors, HMPM R, and variable capacity compressors, HMPM S, are supported.

The heat pump reserving valve that provides cooling and heating modes plus defrost function is supported in this software.

2. Heat Pump Set points.

The set point will apply to both HPMP R (Recip) and HPMP S (Screw) software unless noted.

2.1. Control Set points #1-12

#	NAME	DESCRIPTION
1	CHL OUT TRG	Control target. This value will be used to develop the Control Zone in conjunction with set points 2 and 3 when the system is in the COOLING mode. Refer to set point #120.
2	CNTRL ZONE +	Added to the CHL OUT TRG to create the top of the control zone.
3	CNTRL ZONE -	Subtracted from the CHL OUT TRG to create the bottom of the control zone.
4	HGS TEMP ON (HPMP S only)	This set point is used with compressors that have a hot gas by pass solenoid. When this set point is active and the control temperature is less than the CHL OUT TRG plus this value and the FLA % is within 7.0% of the MIN SLIDE% set point #31, the hot gas by pass solenoid for the compressor on this circuit will be turned on.
5	HGS TEMP OFF (HPMP S only)	This set point is used with compressors that have a hot gas by pass solenoid. When this set point is active and the control temperature is greater than the CHL OUT TRG plus this value or the FLA % is not within 7.0% of the MIN SLIDE% set point #31, the hot gas by pass solenoid for the compressor on this circuit will be turned off.
6	HGS PSI ON (HPMP S only)	This set point is used with compressors that have a hot gas by pass solenoid. When this set point is active and the suction pressure is less than this value and the FLA % is within 7.0% of the MIN SLIDE% set point #31, the hot gas by pass solenoid for the compressor on this circuit will be turned on.
7	HGS PSI OFF (HPMP S only)	This set point is used with compressors that have a hot gas by pass solenoid. When this set point is active and the suction pressure is greater than this value or the FLA % is not within 7.0% of the MIN SLIDE% set point #31, the hot gas by pass solenoid for the compressor on this circuit will be turned off.
8	L.INJECT.ON	Liquid injection is turned on when the discharge temperature is greater than this set point and turned off when the discharge temperature is less than this set point minus 5.0°F (or 2.5°C).
9	Not Used	
10	OIL COOLR ON	The oil cooler is turned on when the oil seal temperature is greater than this set point and turned off when the oil seal temperature is less than this set point minus 5.0°F (or 2.5°C).
11	Not Used	
12	Not Used	

2.2. Control Set points #18-24

#	NAME	DESCRIPTION
18	Not Used	Not Used
19	BARREL HEATER	The barrel heater to turned on when the ambient temperature is less than this value and turned off when the ambient temperature is greater than this value plus 5.0°F (or 2.5°C)
20	Not Used	Not Used

#	NAME	DESCRIPTION
21	MAX TRG RESET	This value is used to adjust the control CHL OUT TARG set point #1. The sensor input value will vary between 0 and 5 volts and the actual adjustment will be proportion from negative MAX TRG RESET value to positive MAX TRG RESET value.
22	LOW AMBIENT	If the ambient temperature is below this value the package will be disabled, unit state will be AMBIENT OFF. Once off on low ambient the unit will remain off until the ambient rises above this set point value by 5.0F (or 2.5C).
23	POWERUP DELAY	This is the time that the system will remain in the START UP state before moving to the next state.
24	HI AMBIENT	If the ambient temperature is above this value the package will be disabled, unit state will be AMBIENT OFF. Once off on high ambient the unit will remain off until the ambient drops below this set point value by 5.0F (or 2.5C).

2.3. Set points for Capacity Control Logic

#	NAME	DESCRIPTION
25	STEP SENSTIY	This value is used to adjust the speed of responding to changes in the control algorithm. 1= faster response HIGHER number's = slower response. Used only with the MCS-8 Control Zone control method.
26	STEP DELAY	This is the time delay before increasing or decreasing the number of refrigeration steps. Used only with the MCS-8 Control Zone control method.
27	MAX ROC -	Maximum negative Rate Of Change allowed before stopping the unit from loading. If the actual ROC is less than this value the capacity control state is placed in the HOLDING state. Used only with the MCS-8 Control Zone control method.
28	MAX ROC +	Maximum positive Rate Of Change allowed before stopping the unit from unloading. If the actual ROC is greater than this value the capacity control state is placed in the HOLDING state. Used only with the MCS-8 Control Zone control method.
29	ROC INTERV	Number of second between the samples used for calculating the actual Rate Of Change. Used only with the MCS-8 Control Zone control method.

2.4. Set points for controlling Variable Step Compressors

#	NAME	DESCRIPTION
30	MAX SLIDE % (HPMP S only)	Indicates the maximum slide or speed allowed. If speed limit it is usually set to 100%. In variable step control, it limits the slide load until all compressors are on or the number on is greater than set point #102, STEP CMP LIM, then they will all loaded to 100% of FLA.
31	MIN SLIDE % (HPMP S only)	Indicates the minimum slide or speed allowed. Usually 50%. This is where the slide valve or the inverter will be set when the compressor is turned on.
32	MAX ADJUST % (HPMP S only)	Indicates the maximum percentage change that can be made to the slide valve or the inverter when more cooling capability is needed.
33	MIN ADJUST % (HPMP S only)	Indicates the minimum percentage change that can be made to the slide valve or the inverter when less cooling capability is needed.
34	SLIDE SENSITY	This allows control of the adjustment made to slide wanted percentage. The adjustment is relative to the difference between current leaving liquid temperature and target. The larger the value the larger the adjustment.

#	NAME	DESCRIPTION
35	AMP DB HI (HPMP S only)	This set point is only used in the screw compressors. This value is the upper dead band limit to stop pulsing the slide valve. If the actual amps are within the dead band, the slide valve will not be moved.
36	AMP DB LO (HPMP S only)	This value is the lower dead band limit to stop pulsing the slide valve. If the actual amps are within the dead band, the slide valve will not be moved.
37	LOAD PULSE (HPMP S only)	Length of time to turn on the slide valve load solenoid. Time is expressed in 1/10 of a second.
38	UNLOAD PULSE (HPMP S only)	Length of time to turn on the slide valve unloader solenoid. Time is expressed in 1/10 of a second.
39-41	Not Used	

2.5. Set points for calculating FLA & % load for Variable Step Compressors

#	NAME	DESCRIPTION
42	SLIDE MULTI (HPMP S only)	Set point #42 = 80 for air-cooled machines, = 70 for water-cooled machines. (In CFG set points use 'DIGITAL/SW' for # decimals & print char.)
43	SLIDE DIVISOR (HPMP S only)	See set point #43 = 10. (In CFG set points use 'DIGITAL/SW' for # decimals & print char.)
44	SLIDE OFFSET (HPMP S only)	See set point #44 = 20. Field adjusts for offset if required. (In CFG set points use 'DIGITAL/SW' for # decimals & print char.)

2.6. Set points for Condenser Control

#	NAME	DESCRIPTION
45	CND STG1 ON	Air cooled- When the discharge pressure is above this value; turn on the first stage of the condenser fans.
46	CND STG1 OFF	Air cooled- If stage 1 is on and the discharge pressure drops below this value turn off the first stage of condenser fans.
47	CND DIFF ON	Air cooled- Differential PSI to turn on the remaining stages of condenser fans.
48	CND DIFF OFF	Air cooled- Differential PSI to turn off the remaining stages of condenser fans.
49	CND MIN RUN	Air cooled- Once a condenser fan stage has been turned on; it will remain on for at least the amount of minutes specified in this set point.
50-53	Not Used	
54	CND MIN SPD	Minimum speed percentage for variable speed condenser control.
55	CND MAX SPD	Maximum speed percentage for variable speed condenser control.
56-57	Not Used	Not Used

2.7. Set points for System Testing

#	NAME	DESCRIPTION
58	CFG TESTING	This MUST be setup as 'Not Used' or be set to '1', in a configurator running in the field, or the micro will not stop and alarm when an I/O communications signal is lost. (Available in Version 8.02-E and later.)

2.8. Set points for Compressor Control

#	NAME	DESCRIPTION
59	ANTI-CYC OFF	This is the anti cycle time delay (in seconds) based on when the compressor was turned off. This value is used in a calculation to determine how long a compressor should be in the anti-cycle state. Refer to the Standard Control Options section, Compressor Anti-Cycle Logic. (OFF to ON)
60	PMP DWN ON (HPMP R only)	When the continuous pump down option is specified and the compressor is off and the suction pressures exceed this value the compressor will go through a normal pump down sequence. Only used in CHL R08 software version.
61	PMP DWN OFF	This is the suction pressure value for turning off the compressor when in the PUMP DOWN state.
62	PMP DWN DELY	Maximum time delay (in seconds) that a compressor can remain in the PUMP DOWN state.
63	ANTI-CYC ON	This is the anti cycle time delay (in seconds) based on when the compressor was turned on. This value is used in a calculation to determine how long a compressor should be in the anti-cycle state. Refer to the Standard Control Options section, Compressor Anti-Cycle Logic. (ON to ON)
64	COMP MIN RUN	This is the minimum run time (in minutes) for a compressor once it is turned on. This minimum run time is bypass only for the safeties.
65	FLA COMP#1	Full Load Amps for the compressor on circuit 1. For screw compressors, the ampere when the compressor is fully loaded. This value is used to calculate the compressor current FLA %, which is used to control the loading and unloading of the slide valve. For fixed capacity compressors, the ampere is used to determine on/off status and safeties. This value is used to calculate the high and the low ampere safeties limits. Refer to set points 75 and 76.
66	FLA COMP#2	Full Load Amps for the compressor on circuit 2. Refer in set point 65 for definition.
67	FLA COMP#3	Full Load Amps for the compressor on circuit 3. Refer in set point 65 for definition.
68	FLA COMP#4	Full Load Amps for the compressor on circuit 4. Refer in set point 65 for definition.
69	FLA COMP#5	Full Load Amps for the compressor on circuit 5. Refer in set point 65 for definition.
70	FLA COMP#6	Full Load Amps for the compressor on circuit 6. Refer in set point 65 for definition.
71	FLA COMP#7	Full Load Amps for the compressor on circuit 7. Refer in set point 65 for definition.
72	FLA COMP#8	Full Load Amps for the compressor on circuit 8. Refer in set point 65 for definition.
73	STARTER DLAY	Time delay (in seconds) between the first and second relay being turned on. Used for part wind (typical value of 1) and star delta (typical value of 5) starter.

#	NAME	DESCRIPTION
74	OIL PUMP OFF	If oil pump is always on (specified in the PC-Config program), this set point is not used. If oil pump is not always on then this set point contains the PSI value when the oil pump is to be turned off.

2.9. Set points for Compressor Safeties

#	NAME	DESCRIPTION
75	HI AMPS	This set point is a percentage of the FLA; it is used to create the high amp draw limit. Depending on the circuit that is being tested: the value of this set point is multiplied by either the value in set points 65 through 72 to obtain the circuit's high limit. This value is tested in the high amp safety, if the amps exceed this value for the time specified in this set point the safety is tripped.
76	LO AMPS	This set point is a percentage of the FLA; it is used to create the low amp draw limit. Depending on the circuit that is being tested: the value of this set point is multiplied by either the value in set points 65 through 72 to obtain the circuit's low limit. This value is tested in the low amp draw safety, if the amps exceed this value for the time specified in this set point the safety is tripped.
77	LOW SUCTION	If active, the system checks for low suction pressure for each running compressor. The system will compare the suction pressure sensor reading to this value. It must be less than the value for the period of time specified in the set point before this set point will trip. <u>Digital or analog – Refers to 'Suction Pressure' column under circuits under Chiller V8 tab of PC-Config</u>
78	LO SUCT UNLD	The purpose of this set point is to take corrective action before a low suction pressure safety occurs. If a circuit has more than one step and it is fully loaded and if the suction pressure is less than the value of the safety set point (LOW SUCTION) plus the value of this set point, the system will turn off one step of capacity. An infinite step compressor will be forced to unload until the suction pressure rise above the calculated value. The circuit state will be changed to LO SUCT HOLD. The circuit will remain in this state for a minimum of 5 minutes. At that time, if the suction pressure has increased to a level greater than the value of set point LOW SUCTION plus the value of set point LOW SUCT RELD the compressor will return to normal control.
79	LOW SUCT RELD	See set point 78 description
80	UNSAFE SUCT	If active, the system checks for low suction pressure that is in an unsafe condition for each running compressor. The system will compare the suction pressure sensor reading to this value. It must be less than the value for the period of time specified in the set point before this set point will trip. Note the time period specified should be very short, 2-5 seconds. This safety set point trips the circuit to the LOCKOUT state immediately, no retry.
81	HI DISCH PSI	If active, the system checks for high discharge pressure condition for each running compressor. The system will compare the discharge pressure sensor reading to this value. It must be greater for the period of time specified in the set point before this safety will trip. <u>Digital or analog – Refers to 'Discharge Pressure' column under circuits under Chiller V8 tab of PC-Config</u>

#	NAME	DESCRIPTION
82	HI DISC UNLD	The purpose of this set point is to take corrective action before a high discharge pressure safety occurs. If a circuit has more than one step and it is fully loaded and its discharge pressure exceeds the value of the safety set point HI DISCH PSI (set point 81) minus this set point, the system will turn off one step of capacity. A screw compressor will be forced to unload until the discharge pressure falls below the calculated value. The circuit state will be changed to HI DISC HLD. The circuit will remain in this state for a minimum of 5 minutes. At that time if the discharge pressure has dropped below the value of the HI DISCH PSI minus the HI DISC RELD (set point 83) the compressor will return to normal control.
83	HI DISC RELD	This set point works in conjunction with set point 82. Refer to that set points description.
84	Not Used	
85	LO DISC PSI	If active, the system checks for low discharge pressure. The system will compare the sensor reading to this value. It must be less than the value for the period of time specified in the set point before a safety trip occurs.
86	HI WATER TEMP (HPMP R only)	The system will check for high temperature of the entering liquid. If this temperature is greater than the value in this set point, the system will move the circuit's state to HI WATER HOLD. This is similar to other holding states.
87	HI DISCH TMP	If active, the system checks for high discharge temperature condition for each circuit that has at least one step on. The system will compare the discharge temperature sensor reading to this value. It must be greater for the period of time specified in the set point before this safety will trip. <u>Digital or analog – Refers to 'Suction Temperature column under circuits under Chiller V8 tab of PC-Config</u>
88	HI DISC UNLD	The purpose of this set point is to take corrective action before a high discharge temperature safety occurs. If a circuit has more than one step and it is fully loaded and its discharge temperature exceeds the value of the safety set point HI DISCH TMP (set point 87) minus this set point, the system will turn off one step of capacity. A screw compressor will be force to unload until the discharge temperature falls below the calculated value. The circuit state will be changed to HI DISC HLD. The circuit will remain in this state for a minimum of 5 minutes. At that time if the discharge temperature has dropped below the value of the HI DISCH TMP minus the HI DISC RELD (set point 89) the compressor will return to normal control.
89	HDISC T RELD	This set point works in conjunction with set point 88. Refer to that set points description.
90	COND FAULT (HPMP S only)	If this set point is active and there are condenser faults; the system will check for the digital fault to be on. If on and the type of set point is LOCKOUT then the circuit with this condenser will be locked out. If not a LOCKOUT then only an alarm will be generated.
91	LOW OIL DIF	If active, the system checks for low differential oil pressure. The system will compare the calculated differential oil pressure to this value. It must be less than the value for the period of time specified in the set point before the safety will trip. <u>Digital or analog – Refers to 'Oil Pressure' column under circuits under Chiller V8 tab of PC-Config</u>
92	UNSAFE OIL	If active, the system checks for low differential oil pressure. The system will compare the calculated differential oil pressure to this value. It must be less than the value for the period of time specified in the set point before the safety will trip. The time delay for this set point should be very short 2-5 seconds. This safety trips to a lockout no retries are attempted. Manual intervention is required.

#	NAME	DESCRIPTION
93	HI OIL SEAL (HPMP S only)	Only used with a screw or centrifugal compressor. If the oil seal / or oil cooler temperature exceeds the value of this set point the system for the time specified, this safety will trip.
94	HI OIL TEMP	If active, the system checks for high oil temperature. The system will compare the oil temperature sensor reading to this value. It must be ON or greater for the period of time specified in the set point before this set point will trip. The sensor can be either an analog or digital input. <u>Digital or analog – Refers to ‘Oil Temp’ column under circuits under Chiller V8 tab of PC-Config</u>
95	HI MTR TEMP	If active, the system checks for high motor temperature. This can be either a digital input or an analog input, the system will compare the sensor reading to this value. It must be ON or greater for the period of time specified in the set point before this set point will trip. <u>Digital or analog – Refers to ‘Motor Temp’ column under circuits under Chiller V8 tab of PC-Config</u>
96	NO CMP PROOF	If this set point is active and there is a digital input indicated for compressor proof, when the compressor is on, the compressor proof will be checked for that circuit.
97	DIRTY FILTER (HPMP S only)	Only used for screw compressors. If the discharge pressure minus the oil filter pressure is greater than this value for the time specified a safety trip would occur.
98	DESIGN SUCT P (HPMP S only)	It is used to dynamically adjust the FLA comp (set point #66 through #72) set points when a screw compressor is running. If the actual suction PSI is less than the valve the FLA set point will be decreased. If greater it will be increased.
99	DESIGN DISC P (HPMP S only)	It is used to dynamically adjust the FLA comp (set point #66 through #72) set points when a screw compressor is running. If the actual discharge PSI is less than the valve the FLA set point will be decreased. If greater it will be increased.
100	Not Used	
101	SFTYHOLD DLY (HPMP S only)	Time in seconds to hold before trying to reload when the capacity has been decreased to avoid a safety, (Examples: high disc psi, high disc temp, low suct psi, etc.)
102	STEP CMP LIM (HPMP S only)	In the screw variable step control logic, the value of this set point if active limits the number of circuits that will be loaded to the value contained in set point #30, MAX SLIDE %. Once the number of compressors turned on equals this value, all compressors will be ramped up to 100% of their FLA.
103	LEAD COMP	Enables the user to specify the lead compressor. If a value is less than the maximum number of compressor the lead indicator is set to this value. If the value is zero then auto rotation is enabled.
104	COMP ROTATION	Specifies the number of days between rotation (set point #103 must be set to zero to enable auto rotation). If the value is zero then rotation will occur with every capacity cycle.

2.10. Set points for Chilled Water Pump Control

#	NAME	DESCRIPTION
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#	NAME	DESCRIPTION
105	PUMP FAILURE (NO FLOW)	If active and flow is lost and only one pump is present the system will move to a LOCK OUT state. If the system has two pumps and flow is lost the backup pump will start and the lead pump will be locked out. If the second pump is running and flow is lost then the entire system will be locked out. A lock out reset will be required to restart the system or to reactive a locked out pump. If inactive and the flow is lost, the system will move to the OFF- NO EVAP FLOW state. When flow is returned the system will automatically restart, no reset is required. This set point had been referred to as the NO FLOW.
106	LEAD PUMP	Enables the user to specify the lead pump.
107 108	Not Used	

2.11. Set points for Unit Safeties

#	NAME	DESCRIPTION
109	SERVICE MODE	The purpose of this set point is to aid in the servicing of the compressors. When this value is changed to 0, indicates that the system is in a service mode, the compressor will not be turned off.
110	Not Used	
111	FREEZE	If active, the system checks for freeze protection. The system will compare the chilled water out temperature to this value. It must be less than the value for the period of time specified in the set point before this safety will trip.
112	NO STOP	This set point is used to insure that a compressor is actually off when the system has called for it to be off. The value of the set point contains a percentage of the FLA COMP set points 65-72. If the compressor ampere is greater then this percentage of the FLA set point for the period specified the compressor is still running and the entire unit is locked out and a NO STOP alarm is generated. If a Control power relay is setup then it will be turned off when this safety trips.
113	Not Used	Not Used

2.12. Set points for heat pump control and defrost function

#	NAME	DESCRIPTION
114	LO SUCT ADJ	When the system is in the heating mode, the low suction safety test (based upon set point #77, LOW SUCTION, will be reduced by the value of this set point.
115	DEFR TRIGGER	This set point will trigger, determine when a defrost is needed. The system must be in the HEATING mode, the reversing valve on for the minimum time specified in set point #117, and if either coil 1 or 2 temperature sensors are less than this set point for the time specified in set point #116, TRIGGER DELAY, the system will enter defrost mode. If this set point is an ALARM type a message will be generated when the defrost mode is entered.
116	TRIGGER DELAY	This set point contains the time delay expressed in minutes that the defrost conditions must be true; refer to set point #115.
117	REV VLVE DLAY	This set point contains the time delay expressed in minutes for the reversing valve; refer to set point #115.

#	NAME	DESCRIPTION
118	DEFR END TEMP	When both coil temperatures if present are equal to or greater than this value the defrost cycle will end.
119	DEFR END TIME	This set point contains the maximum time expressed in minutes that the system will remain in the defrost mode.
120	HEAT TARGET	Control target. This value will be used to develop the Control Zone in conjunction with set points 2 and 3 when the system is in the HEATING mode. Refer to set point #1.

3. Relay Output Sequence

3.1. Relay Outputs for Fixed Capacity Compressor

COMP A
COMP B (only required if part. or split winding)
LIQUID LINE SOLONOID (optional)
REVERSING VALVE
UNLOADER SOLONOID 1 (optional)
UNLOADER SOLONOID 2 (optional)
HOT GAS BYPASS SOLONOID (optional)
LIQUID INJECTION (optional)

3.2. Relay Outputs for HARTFORD, BITZER, OR HANBEL Compressor

COMP A
COMP B (only required if part. or split winding)
SLIDE LOADER
SLIDE UNLOADER
LIQUID LINE SOLONOID (optional)
HOT GAS BYPASS SOLONOID (optional)
LIQUID INJECTION (optional)
FAST UNLOADER
SECOND LIQUID LINE SOLONOID (optional)
OIL EQUALIZATION SOLONOID (optional)
OIL COOLER SOLONOID (optional)
REVERSING VALVE

3.3. Relay Outputs for HITACHI Compressor

COMP A
COMP B (only required if part. or split winding)
SLIDE LOADER
SLIDE UNLOADER
FAST UNLOADER
LIQUID LINE SOLONOID (optional)
HOT GAS BYPASS SOLONOID (optional)
LIQUID INJECTION (optional)
SECOND LIQUID LINE SOLONOID (optional)
OIL EQUALIZATION SOLONOID (optional)
OIL COOLER SOLONOID (optional)
REVERSING VALVE