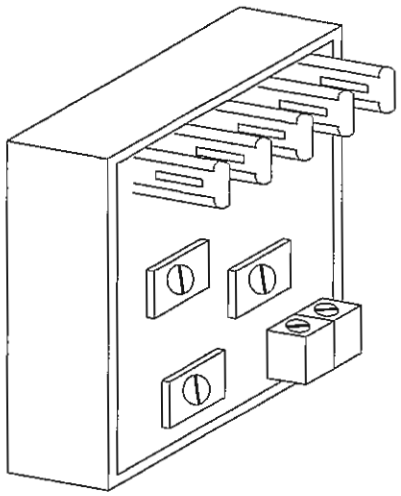
Solidyne

Multi-stage Interface Module



#M973

THE M973 ANALOG OUTPUT INTERFACE MODULE IS USED TO GENERATE HEATING AND COOLING DC VOLTAGE RAMPS FROM ANY OF THE SOLIDYNE CONTROLLERS WITH PWM CAPABILITY FOR INTERFACE TO HONEYWELL'S #W973 SINGLE ZONE LOGIC PANEL HEATING/COOLING MODULE.

- Inexpensive and effective method of controlling various types of staged gas, oil, electric heat, modulating gas, hot water or steam heat, and direct expansion or modulating chilled water cooling
- When used with the Solidyne Controllers with PWM capability, allows temperature control and energy management programs to be combined into one system
- Volts of response is remotely (via phone lines) or locally adjustable, which determines the number of stages of heating or cooling
- Excellent linearity between the deviation from Set Point vs DC Volts output
- Covers control applications for multi-stage HVAC units, heat pumps, economizers and heat reclaim units

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GENERAL

The #M973 analog output transmitter is an encapsulated, totally solid state electronic device designed to interface with the Honeywell #W973 zone logic panel. The Solidyne M973 module is extremely simple to install, as it plugs directly onto the existing 5 male spade terminals on the Honeywell W973 logic panel. No external power is required, as it is supplied by the W973 panel. The input and outputs are optically isolated for reliable and safe operation.

The M973 module utilizes advanced solid state circuit design which allows it to interface Solidyne Controllers with analog (PWM) output capability. Energy management strategies can then be incorporated with the Honeywell W973 relay panel, while maintaining all the functions and flexibility of the relay panel, such as:

- Multi-stage heating, cooling and economizer cycles as determined by the W973 relay panel.
- Control of up to 10 paralleled W973 relay panels.
- Up to 10 stages of heating/cooling via W973 satellite sequencers, using only one Clipper output.

When used with Solidyne Controllers with analog (PWM) output capability, the following building automation programs are possible:

- Programmable heating/cooling setpoints for occupied hours.
- Programmable setback of heating/cooling set points, without a need for any setback modules or wiring.
- Remote/local/averaged multizone temperature sensors can control the same output based on different time schedules.
- Analog DC ramp voltage can be RESET* by a secondary analog input (sensor), such as outside temperature, other zone temperature sensors, humidity, pressure, electrical demand in the building, etc.

* Available in controllers with Resettable and Floating PWM Setpoints.

SPECIFICATIONS

ELECTRICAL

SUPPLY: 20 VDC @ 20mA max., supplied by the Honeywell #W973 logic panel

INPUT SIGNAL LEVEL: 0 to 12 VDC PWM signal (pulse width modulated) @ 10mA max,. supplied by a Solidyne Controller

AMBIENT TEMP: -20°F to +140°F

SETPOINT ADJUSTMENT: Programmable from -25°F to +230°F

HEATING/COOLING DEADBAND: Fully adjustable, including different values at different times of the day. Adjustable from 0°F to 230°F in 1° increments

ANALOG OUTPUT SIGNALS: Two separate 1 to 16 VDC analog outputs (one each for cooling and heating)

PROTECTION: Outputs are short circuit protected

OUTPUT SIGNAL RATE OF CHANGE: Can be 16V/°F to 0.1V/°F via programming range temperatures in controller.

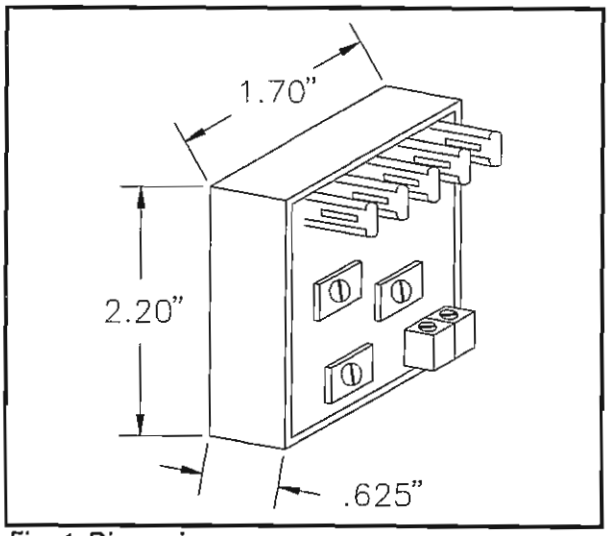

Fig. 1, Dimensions

MECHANICAL

DIMENSIONS: 1.70"L x 0.625"W x 2.20"H, See Fig. 1

BODY: Epoxy potted to protect the circuitry from extreme humidity environments and for uniform heat dissipation.

CONNECTIONS: Terminal strip for two-conductor cable conection to Clipper output. Molded-in .250" Spade terminals for connection to and mounting on the Honeywell #W973 relay module.

INSTALLATION

CAUTION

BEFORE INSTALLING OR REMOVING THE M973 MODULE, DISCONNECT POWER TO PREVENT EQUIPMENT DAMAGE OR PERSONAL INJURY.

1. Read the instructions very carefully. If these instructions are not followed damage or injury may result.

2. Discharge any static you may have accumulated by touching building ground before touching any components or terminals.

3. Check the ratings in the specifications and verify that this product will meet the requirements of your application.

4. This product should be installed by a trained, qualified service technician.

5. After the installation is complete, be sure to check the system out for proper operation.

MOUNTING / LOCATION

The Solidyne #M973 is designed to be mounted anywhere the Honeywell #W973 is mounted. Make sure that the W973 is not exposed to direct outside environment such as rain, direct sunlight, etc. Keep in mind that the DC voltage outputs generated by the M973 are controlled by the Solidyne controller where there is a specified, space-zone temperature sensor, which informs the controller of the present ambient temperature. Based on this sensor reading along with the programmed setpoints and parameters, the controller will send Pulse Width Modulated signals to the M973. According to this signal level a corresponding output DC voltage from the M973 will control multiple stages of heating or cooling loads.

It is important to note that the temperature sensor which is causing the modulated signals to be generated be installed according to industry accepted thermostat/sensor mounting guidelines. This includes locating the sensor at least 5 feet above the floor with good air circulation at average temperature. Do not mount these temperature sensors by drafts or dead spots, behind doors or in corners, near hot nor cold air ducts, in direct line with radiant heat from the sun or appliances, or on walls with concealed pipes, chimneys or unheated (uncooled) areas behind the sensors. Install one of the Solidyne #3282 family of temperature sensors and refer to its installation instructions for further details.

WIRING

All wiring must comply with local codes and ordinances. Two screw terminals are provided to connect the M973 to the Solidyne controller.

1. The Solidyne M973 mounts directly on the Honeywell #W973. The two-position terminal block must be wired to one of Solidyne's controller outputs. The COMMON (-) terminal is wired to the Controllers COMMON for outputs, and the SIGNAL (+) terminal is wired to an output ter-

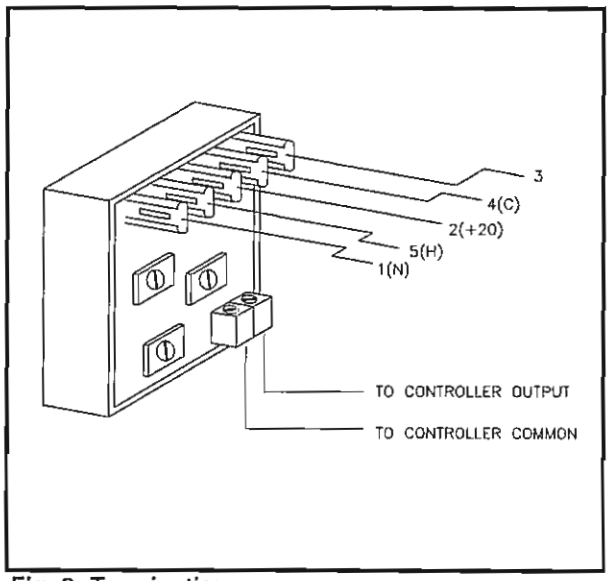

Fig. 2, Terminations

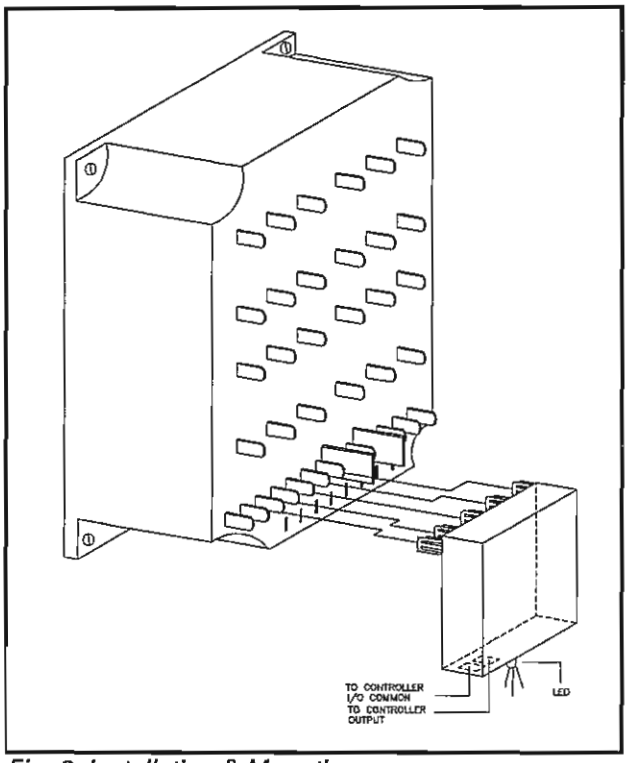

Fig. 3, Installation & Mounting

minal. Be certain to observe polarity. Typically, a twisted-pair of 18 AWG wires would be used. Shielding is not necessary under most conditions, and the wire need not be in conduit unless required by local code. The M973 can be located up to 3000 feet from the Solidyne Controller.

2. Note the 5 male spade connectors located in the bottom row, left hand side of the Honeywell W973 relay module. These connectors are designated below the quick connectors as "3-4-2-5-1", and designated above the 5 male quick connectors as " C +20 H N".

3. There is an LED located at the side of the M973 module. This LED is used for diagnostic purposes, and indicates the presence of the PWM signal form the Controller. Upon installation of the control to the M973, the LED will continuously flash if the output has been selected as PWM, even if the M973 is not attached to the W973 or a program entered.

4. Make certain the M973 is mounted snug onto the W973 male quick connectors for proper contact and connection.

OPERATION

The M973 is controlled by a PWM type setpoint programmed into Solidyne Controllers capable of analog outputs. Therefore, the Controller used must be capable of generating a PWM output. The programs used in the Clipper/XL or XL9600 typically would be Floating PWM setpoints preceded with an Analog Enable setpoint. In the Clipper/PLUS or other ClipperNet controllers capable of PWM, a "Hidden" PWM (modified Variable Analog Control) setpoint would be used.

The Solidyne M973 module receives a +20VDC supply from Honeywell W973 and generates two separate output voltage ramps, one each for cooling and heating. Zone temperature is monitored by one of the Solidyne #3282 family of temperature sensors, which is located anywhere in the building. As the zone temperature changes, the voltage output of the temperature sensor (#3282) changes directly. Refer to the Voltage vs Temperature chart for the #3282).

The change in the sensor output will cause a change in the modulated pulse-width output of the Solidyne controller, which is proportional to the zone temperature deviation from the heating or cooling set point. This signal is fed into the M973 which in turn generates a voltage output into the W973 causing it to switch ON or OFF the number of heating or cooling stages necessary to satisfy the zone demand. As the output DC voltage increases, the W973 switches more stages ON. The pulsating rate of the LED indicates the pulse-width modulation signal, and changes as the Controller output signal changes.

Figure 4 shows typical Output Voltage Ramp Values vs ^{o}F for a W973. Although Solidyne Controllers can be programmed to generate various DC voltages/^{o}F deviations, the manufacturer (Honeywell) recommends 2.5VDC/^{o}F.

Programming a dead band and proper temperature averaging techniques will insure stable system performance.

PROGRAMMING for the ClipperNet/XL or XL9600

A basic multi-stage heat/cool program would require the following information for programming:

a) the Target Temperature Deadband, ie, the value at which the M973 is satisfied and neither heat nor cool are required
b) the Maximum Cool Temperature, ie, the value at which all stages of cooling would be ON, and
c) the Maximum Heat Temperature, ie, the value at which all stages of heating would be ON.

When programming a ClipperNet/XL or XL9600, these values would then be entered into a program that would be made up of 3 setpoints; namely an Analog Enable setpoint to select between heating and cooling, a Floating PWM setpoint for the cooling control, and a Floating PWM setpoint for the heating control. These setpoints offer the most flexible and precise control of the M973.

NOTE: *Before programming, review the LOAD POLARITY status under the MISC DATA menu. For most applications, the status for this PWM output should be ON = ENERGIZED.*

In this example, a Clipper/XL or XL9600 (both are programmed similarly) is the controller, our heat target is 70° +/- 1°, our cool target is 74° +/- 1°, maximum heat occurs at 60°, and maximum cool occurs at 84°.

Start by programming the Analog Enable setpoint (#1). This setpoint will enable the following cooling Floating PWM setpoint (#2) at and above 74°, and enable the heating Floating PWM setpoint (#3) at and below 70°, with a deadband between 70° and 74°.

(#1) **ANALOG ENABLE SETPOINT**

Rate = Minutes:	ENTER (to accept minutes)
Start days?	As Appropriate
Start time?	As Appropriate
Master sensor #:	Sensor # to cause heat/cool changeover (3)
Master sensor HI value:	Value to enable Cool (74)
Master sensor LO value:	Value to enable Heat (70)
Stop days:	As Appropritate
Stop time:	As Appropriate

Next, enter the Floating PWM setpoint (#2) for cooling.

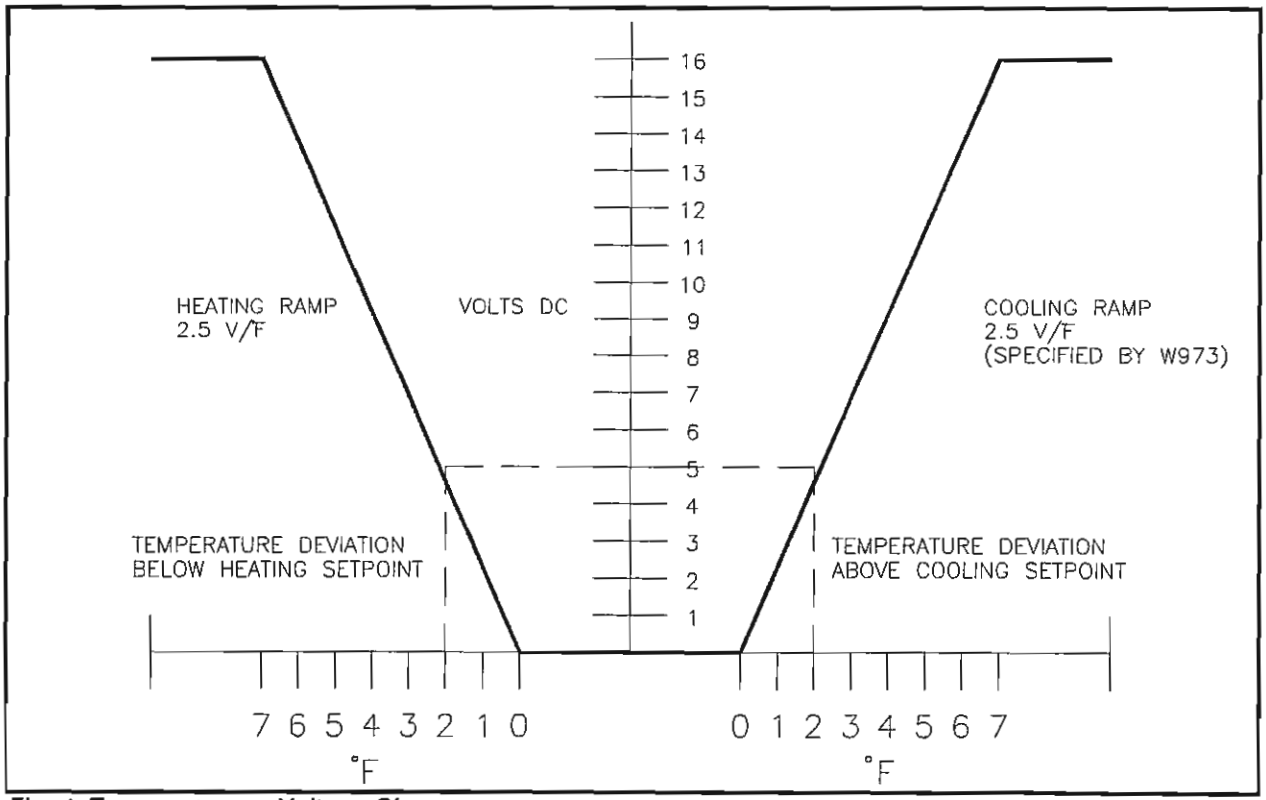

Fig. 4, Temperature vs Voltage Chart

(#2) **FLOATING PWM SETPOINT FOR COOL**

Which loads?	#4
ON load enables:	ENTER (to ignore)
OFF load enables:	ENTER (to ignore)
Start days?	As Appropriate
Start time?	As Appropriate
Master sensor #:	ENTER (to ignore)
Slave sensor #:	Space Sensor # (3)
Master sensor HI value:	ENTER (to ignore)
Master sensro LO value:	ENTER (to ignore)
Slave target @ Mstr HI:	Target Temp for Cool (74)
Slave target @ Mstr LO:	ENTER (to ignore)
Proportional band:	Degrees from target that requires Max Cool (10)
Max cycle change %:	Determines the response time, + = direct acting, - = indirect (10)
Max duty cycle %:	Determines the highest stage of cooling (96)
Min duty cycle %:	Determines the OFF or FAN output (50)
Update rate in seconds:	Determines the response time, along with Max Duty cycle change (60)
Stop Days:	As Appropriate
Stop Time	As Appropriate

Next, enter the Floating PWM setpoint (#3) for heat.

(#3) **FLOATING PWM SETPOINT FOR HEAT**

Which loads?	#4
ON load enables:	ENTER (to ignore)
OFF load enables:	ENTER (to ignore)
Start days?	As Appropriate
Start time?	As Appropriate
Master sensor #:	ENTER (to ignore)
Slave sensor #:	Space Sensor #, (3)
Master sensor HI value:	ENTER (to ignore)
Master sensro LO value:	ENTER (to ignore)
Slave target @ Mstr HI:	Target Temp for Heat (70)
Slave target @ Mstr LO:	ENTER (to ignore)
Proportional band:	Degrees from target that requires Max Heat (10)
Max cycle change %:	Determines the response time, "+" = direct acting, "-" = indirect (10), [use indirect for M974 program]
Max duty cycle %:	Determines the OFF or FAN output (50)
Min duty cycle %:	Determines the highest stage of heating(4)
Update rate in seconds:	Determines the response time, along with Max Duty cycle change (60)
Stop Days:	As Appropriate
Stop Time	As Appropriate

These basic programs can be "fine tuned" by changing the Update Rate, Maximum Change Rate, and entering the Reset Function if desired.

NOTE: *The permissable duty cycle range is from 4 to 96%. Values less than 4% will cause all stages to turn OFF.*

CHECK OUT PROCEDURE with the ClipperNet/XL or XL9600

1. Apply power to the Controller. The M973 should be wired to the appropriate output terminals of the Controller. The output should be selected under the Miscellaneous Menu as a FAST PWM OUTPUT, and the LOAD POLARITY under the same menu should be selected to be ON = ENERGIZED for most applications. Do <u>not</u> enter a PWM setpoint at this point. Refer to the Controller's Operations manual for details.

2. Verify that the PWM LED on the M973 is flashing at approximately 5 Hz.

3. If the Controller and M973 are mounted some distance from each other, an assistant would be helpful for this procedure.

Under the EXAMINE LOGGED DATA menu of the Controller, select the PWM OUTPUT DUTY CYCLE VALUE menu. Select the output to which the M973 is connected. This menu will allow you to see the PWM value of that output, as well as "override" it into a known test value. The display should now show 50%, which if no program was entered, would be the default value.

NOTE: *If a program were entered, this step would not be possible as the program would take control of the output and not allow an override value.*

With the PWM output at 50%, check the W973 loads for the correct operation. Enter test PWM values into the Controller and observe the W973 operation.

If the Honeywell W973 is not operating correctly, measure the voltages at the spade terminals connected to the Solidyne M973. There should be 20 VDC +/- 10% between terminals #1 (N) and #2

(+20). There should also be a DC voltage between 0.5 and about 16 volts on either terminals #1 (N) and #4 (C), or #1 (N) and #5 (H). This would depend on whether the PWM value you are generating is calling for HEAT or COOL.

4. Finally, enter the actual operating setpoint and observe the system for correct operation.

PROGRAMMING for ClipperNet PLUS Controller

1) Enter the Miscellaneous Data Entry Menu of the #8008 PLUS controller. One of the last items in the Miscellaneous Data Menu refers to "**FAST PWM?**" (Pulse Width Modulation?)

2) When display shows "**FAST PWM ?**", press the "*YES*" key.

3) The next display will be the question "**Which Outputs?**". Press the desired output number (or numbers) to dedicate these outputs to be PWM outputs. Then press the "*ENTER*" key to record this information. Under the Miscellaneous Menu, the LOAD POLARITY for the selected output should be ON = ENERGIZED for most applications. From now on these selected outputs will only generate PWM signals for control purposes, and cannot be used as outputs for other program strategies.

IMPORTANT NOTE: *Once an output is programmed to be a PWM output, none of the control programs, parameters or features applicable to ordinary digital load control outputs are valid. If no program exists internally to the #8008 PLUS, but an output is chosen to be PWM output, both ramp voltages outputs of the #M973 will be at zero volts, thus doing no control. This feature can be used to shut the system off if desired, which is similar to turning a digital load output off.*

4) The PWM output can be programmed via the "**Variable Analog Load Control**" function. Automatically none of the other control programs will be processed internally via the ClipperNet PLUS controller for an output selected as PWM.

5) Enter the "**Enter New Program?**" menu, and press the "*Yes*" key to select. Accept the location for the "**New Setpoint At ID#:**" by pressing "*Enter*", or select a different location as may be required. Then use the down arrows and select "**Variable Analog Load Control?**" as the program (setpoint) by answering "*Yes*".

6) Enter the load numbers when "**Which Loads?**" question is asked, then press the "*Enter*" key to record.

7) Enter the "**Start Days**" and "**Start Time**" when prompted to do so.

8) The "**Master Sensor #:**" has no meaning in this program, so press "*Enter*" to accept the default value.

9) The "**Slave Sensor #:**" is the active sensor for this program, so enter the correct sensor number and press "*Enter*".

10) The "**Master Sensor HI Value:**" will be the upper end of the proportional band. This value represents the temperature at which maximum cool is needed.

11) Next the "**@ Master HI, ON when slave =**" menu requests a value. This value is the cycle rate, in percent, that will be produced when the Slave sensor is at or above the upper end of the proportional band. Select 96% for Maximum Cool and press the "*Enter*" key.

12) Next the "**@ Master HI, OFF when slave =**" menu requests a value. This value is the cycle rate, in percent, that will be produced when the Slave sensor is at or below the lower end of the proportional band. Select 4% for MAximum Heat and press the "*Enter*" key.

13) The "**Master sensor LO value:**" will be the lower end of the proportional band. This value represents the temperature at which maximum heat is needed.

14) The "**@ Master LO, ON when slave =**" represents the maximum change, in percent, that can be made to the PWM cycle rate, per update, when the current PWM duty cycle rate is not equal to the calculated PWM cycle rate for the current Slave sensor reading. Range = 1% to 100%.

15) The "**@ Master LO, OFF when slave =**" value is the delay, in seconds, between PWM cycle rate updates. Range = 1 to 255 seconds.

16) The "**Maximum ON time**" is not used, press "*Enter*" to ignore.

17) Enter values for the **"Stop Days:"** and **"Stop Time:"** menus as required by your program, and press the *"Enter"* key after each entry.

18) The program is now entered and complete. Besides the start/stop days and time of day, the critical information that was entered are the data values for entries 10, 11, 12, and 13.

EXAMPLE: The output of the Solidyne #M973 module will be either 0-16 VDC on the HEAT terminals, or 0-16 VDC on the COOL terminals, or no output at all. These 3 conditions are determined by the parameters entered in entries 10-13, and the value of the temperature sensor input.

If in entry 10 ("Master Sensor HI Value:") a value of 80 was entered, at 80° or above the ClipperNet PLUS would output 96% as specified by entry 11. This would correspond to 16 VDC on the COOL terminals. If in entry 13 ("Master sensor LO value:") 65° was entered, at 65° or lower the ClipperNet PLUS would output 4% as specified by entry 12. This would correspond to 16 VDC on the HEAT terminals. At Slave temperature values between 65° and 80° the ClipperNet PLUS will calculate the PWM duty cycle rates via linear interpolation (See ClipperNet PLUS Operating Manual for detailed information).

PROGRAMMING for ClipperNet Controllers other than PLUS or XL

1) Enter the Miscellaneous Data Entry Menu of the #8008 controller. One of the last items in the Miscellaneous Data Menu refers to **"PWM?"** (Pulse Width Modulation?)

2) When display shows **"PWM ?"**, press the *"YES"* key.

3) The next display will be the question **"Which Outputs?"**. Press the desired output number (or numbers) to dedicate these outputs to be PWM outputs. Then press the *"ENTER"* key to record this information. From now on these selected outputs will only generate PWM signals for control purposes, and cannot be used as outputs for other program strategies.

IMPORTANT NOTE: *Once an output is programmed to be a PWM output, none of the control programs, parameters or features applicable to ordinary digital load control outputs are valid. If no program exists internally to the #8008, but an output is chosen to be PWM output, both ramp voltages outputs of the #M973 will be at zero volts, thus doing no control. This feature can be used to shut the system off if desired, which is similar to turning a digital load output off.*

4) The PWM output can be programmed via the **"Variable Analog Load Control"** function. Automatically none of the other control programs will be processed internally via the ClipperNet controller for an output selected as PWM.

5) Enter the **"Enter New Program?"** menu, and press the *"Yes"* key to select. Accept the location for the **"New Setpoint At ID#:"** by pressing *"Enter"*, or select a different location as may be required. Then use the down arrows and select **"Variable Analog Load Control?"** as the program (setpoint) by answering *"Yes"*.

6) Enter the load numbers when **"Which Loads?"** question is asked, then press the *"Enter"* key to record.

7) Enter the **"Start Days"** and **"Start Time"** when prompted to do so.

8) The **"Master Sensor #:"** has no meaning in this program, so press *"Enter"* to accept the default value.

9) The **"Slave Sensor #:"** is the active sensor for this program, so enter the correct sensor number and press *"Enter"*.

10) The **"Master Sensor HI Value:"** also has no meaning in this program, so press *"Enter"* to accept the default value.

11) Next the **"@ Master HI, ON when slave ="** menu requests a value. Let's call this value data *"A"*. This data *"A"* value must be either the highest or the lowest of the 4 setpoint values to be entered. The next 3 values *("B", "C" & "D")* must then be in either ascending or descending order, depending on the program strategy desired. Select a value for *"A"*, and press the *"Enter"* key.

12) At the **"@ Master HI, OFF when slave ="** menu, select the *"B"* value and press *"Enter"*.

13) The **"Master sensor LO value:"** menu has no meaning for this program, so press *"Enter"* key to accept the default value.

14) At the **"@ Master LO, ON when slave ="** menu, select the *"C"* value and press *"Enter"*.

15) At the **"@ Master LO, OFF when slave ="** menu, select the *"D"* value and press *"Enter"*.

16) Enter the **"Maximum ON time"** as *"1"*, and press *"Enter"* .

17) Enter values for the **"Stop Days:"** and **"Stop Time:"** menus as required by your program, and press the *"Enter"* key after each entry.

18) The program is now entered and complete. Besides the start/stop days and time of day, the critical information that was entered are the data values for *"A"*, *"B"*, *"C"*, and *"D"*. The *"A"* value must be the highest or the lowest data among the other data entries, and *"B"*, *"C"* and *"D"* must be datavalues in descending or ascending order as they are entered.

EXAMPLE: The output of the Solidyne #M973 module will be either 0-16 VDC on the HEAT terminals, or 0-16 VDC on the COOL terminals, or no output at all. These 3 conditions are determined by the programming of the *"A-B-C-D"* values, and the value of the temperature sensor input.

If the *"A"* value was chosen to be the highest value, the *"A"* and *"B"* values would then determine the COOL ramp. When the input signal from the temperature sensor reaches or exceeds the *"A"* value, the output on the COOL terminals will be 16 VDC. As the input signal from the temperature sensor decreases towards the *"B"* value, the voltage on the COOL terminals will decrease. When the signal value reaches the *"B"* value, the output on the COOL terminals will be 0 VDC. As the temperature as measured by the sensor varies between the *"A"* and *"B"* values, the output voltage of the Solidyne #M973 will vary between 0-16 VDC. When this voltage is applied to the Honeywell #W973 module, mutilple stages of COOLING will be turned ON or OFF as necessary to satisfy the setpoint.

When sensor reading falls between the *"B"* and *"C"* values, there is no DC voltage at either the COOL or HEAT outputs. The difference between the *"B"* and *"C"* values is the deadband which separates the COOLING and HEATING systems. The *"B"* value is the COOL setpoint. The *"C"* value is the HEAT setpoint.

As the sensor value decreases past the *"C"* value, a voltage will appear on the HEAT terminals. This voltage will continue to increase until the sensor value reaches or exceeds the *"D"* value, at which time the output voltage on the HEAT terminals will be 16 VDC. The *"C"* and *"D"* values determine the HEAT ramp.

CHECK OUT PROCEDURE with ClipperNet/PLUS and Others

1. Power the W973 and the ClipperNet controller. The Solidyne M973 should be installed on the Honeywell W973, and properly wired to the Clipper. The output channel of the Clipper being used for the M973 should be selected for PWM (FAST), and the Clipper should be programmed as outlined earlier.

2. Verify the 24 VAC supply to the Honeywell W973 panel.

Verify the 20 VDC signal from the Honeywell W973 to the Solidyne M973 as measures between terminals #1 (N) and #2 (+20).

3. Verify the "Signal" LED is continuously flashing.

4. Verify the programmed Temperature vs DC Output for HEAT (and/or COOL) on the M973, by checking the temperature at the sensor and measuring the voltage at the #M973, then comparing the values to the chart.

EXAMPLE: If a 2.5V/°F of ramp is used for the #W973 output to change state, then 4 stages of heat = 2.5V x 4 = 10V output to change from 1V to 11VDC within 4°F of the heating/cooling setpoint.

NOTE: *Two potentiometers are located on the Solidyne #M973 module which adjust the maximum voltage output at maximum HEAT and COOL, while a third potentiometer adjusts the deadband. Any attempts to recalibrate the #M973 should only be made by an experienced applications engineer familar with the functons of the Honeywell #W973, or other unique applications where the analog output has to be limited between 0 and some voltage level less than 16 VDC.*

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ORDERING KEY

Refer to your authorized Solidyne Wholesaler or Blue Sheet price list for ordering information.

If you have additional questions or need further information related to this product or any other Solidyne products, call (800) 648-3980 for order information, or call (708) 394-3333 for technical help and support.

1. Order Part #M973
2. For use with the Solidyne #8008LAN series controllers
3. For use with Solidyne XL9600 Controller (Part #STB required).
4. For interfacing to Honeywell's W973 series of multi-stage relay controllers.