

SECTION 6: DUAL DIFFERENTIAL SYSTEMS WITH SOLAR HEATED DHW STORAGE.

The Model C35-1S-2S(DHW)-3T is designed for use with dual differential having a solar heated DHW or DHW pre-heat storage. The C35 Output 1 differential channel "Temperature Adjust" range is scaled for use with solar heated pools, spas, hot tubs etc. The output 2 differential channel "Storage Temp Limit" control has an extended range (110°F-230°F OUT) for use with solar heated DHW or space heating storage systems. The Output 2 differential temperature thresholds are 8°F ON and 3°F OFF (as shipped) and may be field modified to 20°F ON and 5°F OFF. See section 9, Installation.

Figure 6-1 is a plumbing schematic for typical POOL/DHW solar system. The pool and DHW, Output 1 and Output 2 differential channels respectively, operate independently and the same as the pool/hot tub system described in section 4.

Figure 6-2 is a typical plumbing system for a POOL/DHW combination system having one (1) collector array to solar heat both the pool and DHW storage. For this system configuration the Model C35-1S-2S(DHW)-3T must be field modified by installing printed circuit board jumpers J1 and J2. See section 5 for a description of control operation.

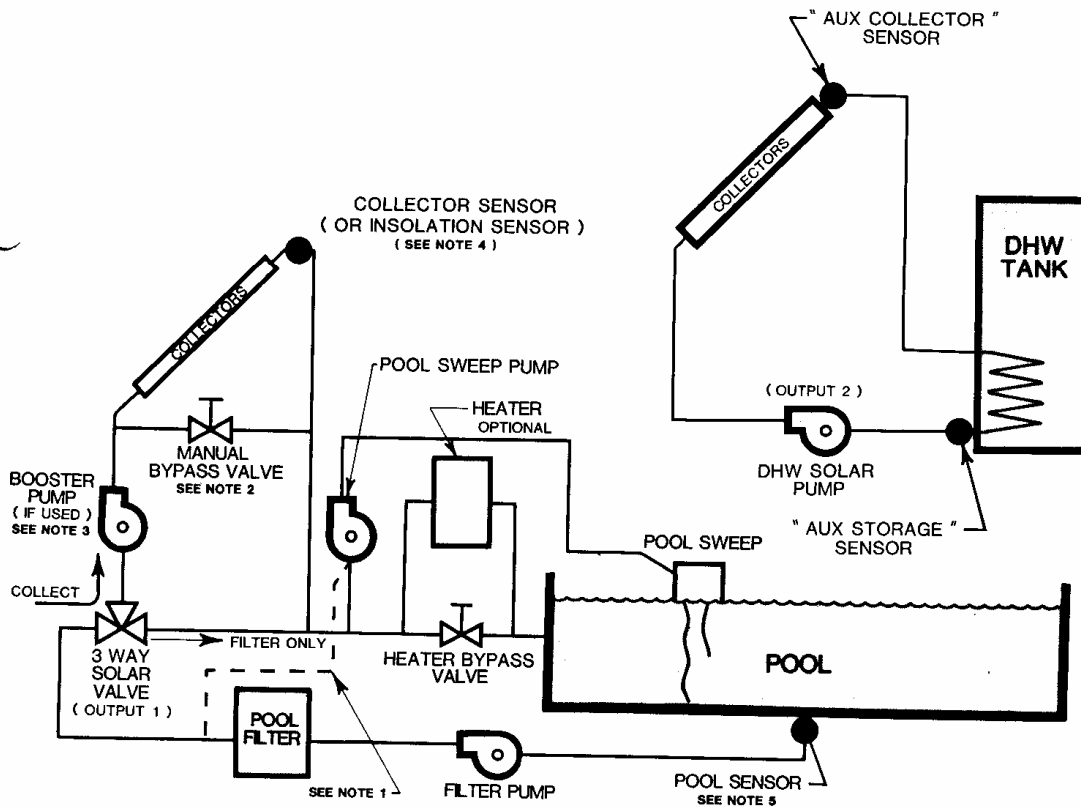


FIGURE 6-1, PLUMBING SCHEMATIC, INDEPENDENT POOL/DHW SYSTEM WITH TWO COLLECTOR ARRAYS

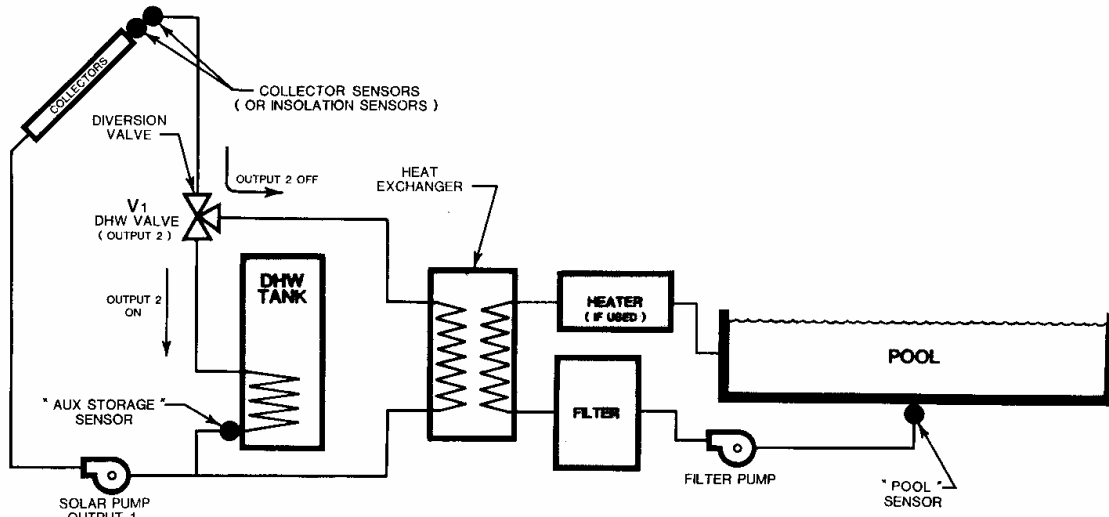


FIGURE 6-2, PLUMBING SCHEMATIC, POOL/DHW COMBINATION SYSTEM WITH ONE COLLECTOR ARRAY.

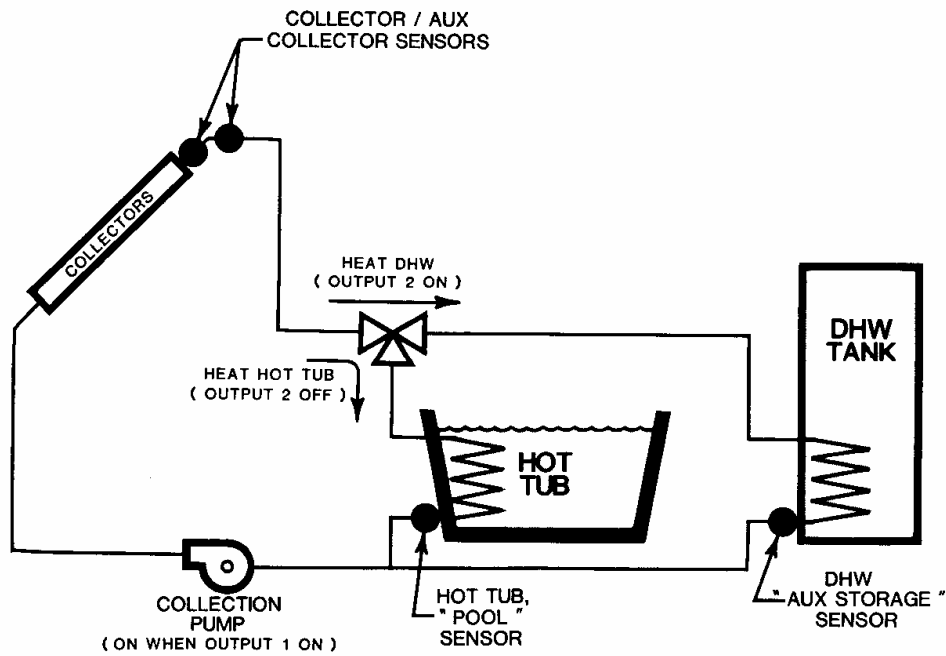


FIGURE 6-3, PLUMBING SCHEMATIC, HOT TUB/DHW CLOSED LOOP SYSTEM WITH ONE COLLECTOR ARRAY

APPLICATION NOTES

1. Typical pool sweep plumbing is as shown. This may require the pool sweep interlock to prevent air pockets from the open collector loop entering sweep plumbing. If your system is plumbed per the dashed line, then the interlock may not be required.
2. Collector bypass valve may be used to throttle collector flow rate and provide for drainback freeze protection.
3. If booster pump is used, operate pump by output 1.
4. Insolation sensor should be located near and at the same angle as the collector array to achieve the same exposure.
5. Pool sensor may be located in filter pump return loop or at pump itself.
6. If Recirculate Freeze Protection is selected it must override the pool system timer. Wire as shown in Figure 3-3 and refer to Section 8, Freeze Protection.
7. Total combined Output 1 and Output 2 LV module output power must **NOT** exceed 20VA continuous, 40VA intermittent duty, 10% duty cycle, 1 Minute ON time maximum. LV modules may be used to power one or more solenoid type valves instead of, or in addition to motorized valves. Ensure that the C35 maximum output rating is not exceeded.

SECTION 7: SINGLE DIFFERENTIAL SYSTEMS WITH DRAINDOWN FREEZE PROTECTION

The Model C35-1S-2F-3T utilizes Output 2 for control of Draindown Freeze Protection. Output 1 differential temperature channel solar collection, pool sweep interlock, and "Temperature Adjust" control operate as described in Section 3. The Output 1 differential channel may be used for a variety of solar collection applications (ie. pool, spa, hot tub etc.).

Draindown freeze protection (not to be confused with "Gravity Drainback" freeze protection) provides freeze protection by draining the collector array and associated plumbing when near freezing temperatures are sensed by any of the collection system freeze sensors.

When near freezing temperatures are reached at any of the freeze sensor locations, Output 2 (Normally ON) turns OFF and de-energizes the drain valve(s) to drain and protect the collector array and associated plumbing from freezing. The collector system is refilled (Output 2 turns ON) when all of the freeze sensors are well above freezing temperatures or if the collector/storage temperature difference reaches the differential temperature TURN ON threshold (see differential temperature override).

DRAINDOWN FREEZE THRESHOLDS

The collector and collector plumbing system temperatures are sensed both by a thermistor (Model SB, SC, ST, SW) sensor and one or more Freeze Snap switches (Model GC-1) for backup). The C35 starts freeze protection (Output 2 OFF) when the thermistor sensor temperature drops to 44°F and stops freeze protection (Output 2 ON) when the sensor temperature rises to 64°F.

The freeze snap switch(es) is wired in series with the thermistor type sensor and its contacts open to start draindown freeze protection (Output 2 OFF) when the snap switch temperature drops to 44°F. Freeze protection is stopped (Output 2 ON) when the snap switch temperature rises to 54°F.

DIFFERENTIAL TEMPERATURE OVERRIDE (freeze sensor wiring shown in fig. 8-1)

The Output 1 differential Turn On overrides Output 2 draindown freeze protection. When the system is drained (Output 2 OFF) and the collector/storage temperature differential reaches the Turn ON threshold (Output 1 ON), Output 2 is forced ON to refill the collector array and allow solar collection. This control function is often desirable for systems that are used in climates where ONLY mild freezes occur (**NEVER BELOW 20°F**). To enable this control function, the freeze sensors must be wired as shown in Figure 8-1.

NO DIFFERENTIAL TEMPERATURE OVERRIDE (see Figure 8-2)

For systems that are installed in regions which experience "Hard" freezes (below 20°F) or that have long exposed piping runs the differential temperature override function is not recommended. To disable the differential temperature override function, wire the freeze sensors as shown in figure 8-2.

DRAIN WHEN STORAGE REACHES HIGH LIMIT

This control function is often desirable for systems to prevent collection fluid from boiling or causing collector corrosion during collector stagnation.

To enable this control function, install printed circuit board jumper J3. The jumper is shipped with each C35-1S-2F-3T control. When J3 is installed, Output 2 turns OFF to drain the collector array when the storage temperature reaches the "Temperature Adjust" setpoint. The collector system refills when the storage temperature falls below the "temperature Adjust" setpoint.

SOLAR COLLECTION

Collection starts (Output 1 ON) when the collector/storage temperature difference increases to the "TURN ON" threshold

Collection stops when the temperature difference decreases to the "TURN OFF" threshold or when the storage temperature rises to the "Temperature Adjust" setpoint. The C35 is shipped with 4°F ON and 1.5°F OFF thresholds. These thresholds may be field modified to 8° ON and 3° OFF. See Section 9, Installation.

MODE SWITCH

"AUTO" This is the normal operating mode for your system. Both auto positions identical, select either. In the Auto mode, solar collection, sweep interlock, and Draindown freeze protection operate automatically.

"OUT/DRAIN" This is a test mode to check valve and/or pump operation. In this mode, OUTPUT 1 is forced OFF to de-activate Solar collection and Output 2 is forced OFF to Drain the collection system.

CAUTION: ALWAYS DISCONNECT AC POWER AT PANELBOARD BEFORE SERVICING ANY PART OF CONTROL SYSTEM.

"ON" This is another test mode to check valve and/or pump operation. In this mode, OUTPUT 1 is forced ON regardless of differential temperature. This mode also cycles the six (6) minute pool sweep interlock.

CAUTION: The ON mode inhibits freeze protection by keeping the drain valve on continuously regardless of freeze sensor temperatures.

"TEMPERATURE ADJUST"

The "Temperature Adjust" control sets the maximum storage temperature. Controls are shipped with a safe operating range of 65-104°F. Some storages contain a large volume of water and respond slowly to temperature adjustments. One recommended adjustment procedure is to set the "Temperature Adjust" control to its warmest setting allowing the storage to be heated until the desired temperature is attained. At this point, wait until collection begins, (Output 1 ON) then slowly move the temperature control toward a cooler setting until Output 1 just turns OFF. The storage temperature is now set. Make note of the control setting for future reference.

INDICATORS

The C35 L.E.D. indicators are recessed to enhance readability in sunlight. The indicators operate as follows:

- "POWER ON":** Illuminates when AC power is applied to the C35.
- "SWEEP ENABLE":** When illuminated, the pool sweep pump operates normally. When off, the pool sweep is disabled.
- "OUTPUT 1":** Is on when solar collection is in progress.
- "DRAIN VALVE"** Is normally ON, Turns OFF in Draindown mode.

MODE CHART FOR C35-1S-2F-3T

C35 SWITCH POSITION	SOLAR COLLECTION	DRAINDOWN FREEZE	POOL SWEEP
OUT/DRAIN	DISABLED	DRAIN	AUTO
AUTO	AUTO	AUTO	AUTO
ON	ON	ON	AUTO

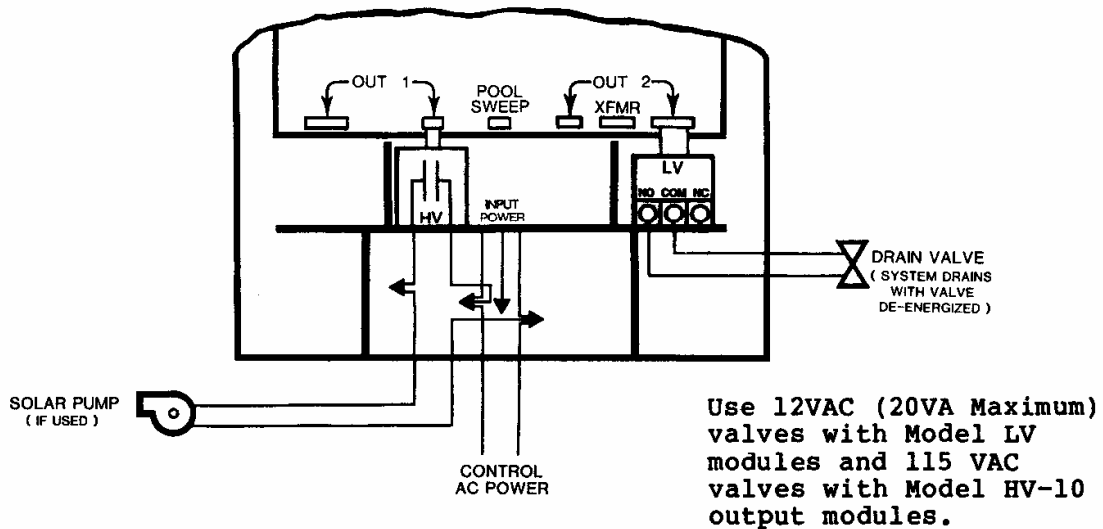


FIGURE 7-1, ELECTRICAL SCHEMATIC, TYPICAL DRAIN VALVE WIRING.

SECTION 8: FREEZE PROTECTION

GENERAL

All C35 models except Model C35-1S-2F-3T are provided with field selectable Recirculate Freeze Protection. Model C35-1S-2F-3T is available for systems with Draindown Freeze Protection.

IMPORTANT INFORMATION REGARDING CALIFORNIA FULL ONE YEAR WARRANTY COMPLIANCE

1. For compliance with California full one year Warranty, C35 controls used with systems that utilize Recirculate or Drain-down freeze protection must incorporate a minimum of TWO (2) freeze sensors. This must be accomplished by using ONE (1) thermistor sensor (Type SB, ST, SC or SW), and a minimum of at least ONE (1) type GC-1 Snap switch freeze sensor. This requirement is effective for controls installed on, or after 3/24/81.
2. Warranties on any Independent Energy controls are VOID if other than Independent Energy Inc. sensors are used.
3. For compliance with California Energy Commission warranty requirements consult IE factory or Manufacturers Representative for details.

It is the installers responsibility to identify all susceptible freeze points and protect these points with properly installed freeze sensors. Factors for determining susceptible freeze points are:

- * Length and position of exposed piping runs
- * Effectiveness of piping insulation
- * Shading of the array
- * Amount of insulation
- * Wind direction and velocity
- * Sun angles
- * Temperature difference between top and bottom of array
- * Emissivity of the absorber plate
- * Temperature of collector plate vs. water passages

Due to the difficulty in determining these freeze points, Independent Energy requires that a minimum of two (2) sensors be used. The installer should be very conservative when locating and installing sensors on susceptible freeze points.

RECIRCULATE FREEZE PROTECTION

CAUTION

Both the installer and system owner should be aware that Recirculate Freeze Protection **will NOT operate during a power outage**. For this reason, a means for manual draining should be provided and the owner instructed how to use it should a long power outage occur when freezing temperatures are experienced.

CAUTION

Sensors should be located to ensure that once recirculation is started, the entire array and plumbing is warmed above any danger of freezing before the sensors react to de-activate freeze protection.

For operation of Recirculate Freeze Protection refer to the operation section for your control model.

DRAINDOWN FREEZE PROTECTION

For operation of Draindown Freeze Protection refer to Section 7. See Sensor Wiring, Figure 8-1 and 8-2.

FREEZE SENSOR WIRING FOR RECIRCULATE AND DRAINDOWN FREEZE PROTECTION

The C35 may be wired using either the "collector" sensor (except if INS-1 Insulation sensor used) or a "separate" freeze sensor. In either case a minimum of one (1) GC-1 Snap Switch Thermostat must be wired "in series" with the selected thermistor sensor. See Figure 8-1 and 8-2.

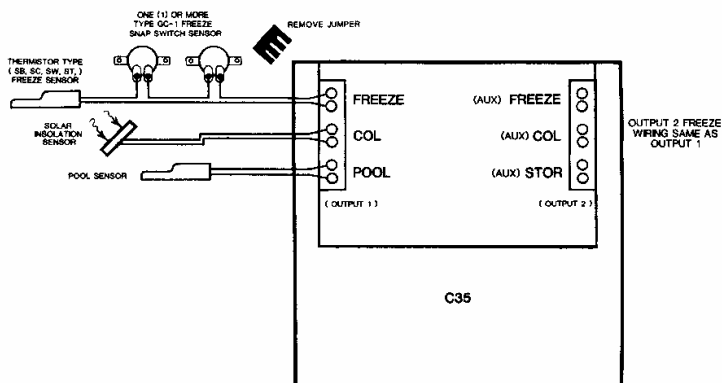


FIGURE 8-1, FREEZE SENSOR WIRING USING SEPARATE FREEZE SENSOR

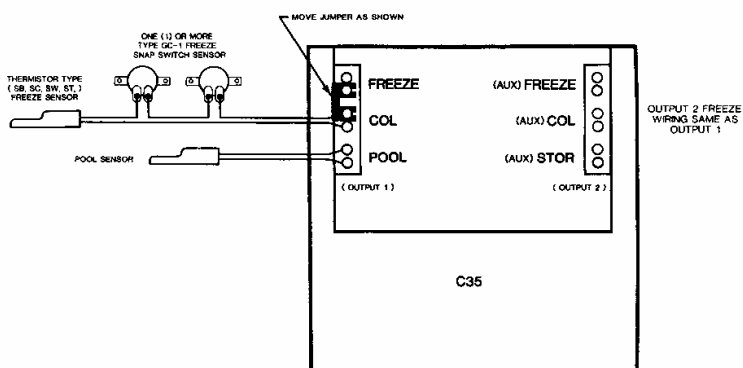


FIGURE 8-2, FREEZE SENSOR WIRING USING COLLECTOR SENSOR

SECTION 9: INSTALLATION

CAUTION: DISCONNECT ALL AC POWER DURING C35 INSTALLATION.

Before starting installation read this entire section. Installation must be performed by trained service personnel and in accordance with Local and NEC codes.

1. LOCATION AND MOUNTING

The C35 is provided with a raintight enclosure that is suitable for direct exposure to weather. To further reduce the risk of water entering the enclosure, mount the control in a sheltered location. The enclosure must be mounted vertically with the knockouts facing downward. A selected location should be out of reach from the pool, spa or hot tub (5 ft. minimum horizontal distance), and should be centrally located to minimize wiring runs. Allow for cover swing clearance and conduit/wire routing. In crowded locations it may be helpful to remove selected knockouts before mounting the control.

When a location has been selected. Hold the C35 firmly against the mounting surface, being careful not to drop the control, mark each mounting hole with a pencil. Now, set the control to one side, start all four (4) mounting screws, then hang the control. Finish by securely tightening the mounting screws.

2. REMOVING THE C35 FRONT PANEL

After the control is mounted at the desired location remove the front panel to gain access to the wiring compartment and to install output modules. Panel removal is as follows:

1. Remove the bottom panel screw completely.
2. Loosen the top panel screw almost completely out.
3. Press thumb on upper left or right corner of panel to lift bottom edge of panel out over enclosure of side walls.
4. Lift bottom of panel up to clear the slide control actuators and indicators and slide panel out toward bottom side of box.

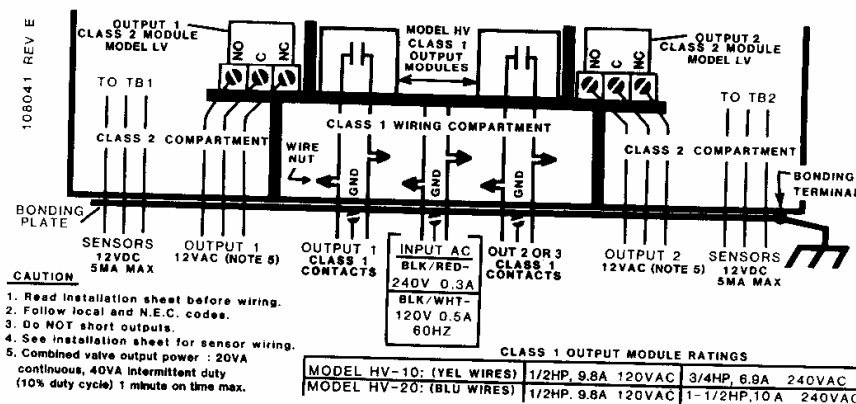


FIGURE 9-1, C35 WIRING DIAGRAM

3. INPUT AC WIRING

The C35 has an internal transformer to step down primary AC power for control circuitry and valve output power. The transformer primary is tapped for 120 and 240 VAC 60 HZ input power. The control is shipped with a wire nut installed on the 120V tap. (WHITE WIRE) Connect **240 VAC** input power to the **RED** and **BLACK** leads. If 120 VAC power is used, move the wire nut to the RED wire and connect 120 VAC input power to the **BLACK** and **WHITE** leads.

Select a wire size large enough to handle all valve and pump loads. Large pumps and/or long wiring runs from the panel board to the C35 may cause severe line voltage droop which may interfere with C35 control operation. Size input power wiring conservatively or run a separate circuit for large pump loads. Be sure to follow local and N.E.C. electrical codes for all wiring.

4. GROUNDING AND BONDING CAUTION: READ THIS SECTION CAREFULLY

To provide safe operation, the C35 must be properly grounded and bonded. Follow these guidelines and local/NEC Codes for Swimming Pool wiring. Refer to NEC article 680.

1. The C35 must be grounded at the pool service panel board even if metal conduit is used. A separate ground conductor sized in accordance with control power requirements and a minimum size of 12 AWG must be used.

2. Even if metal conduit is used, each pump or other CLASS I load connected C35 must grounded to the C35 ground plate via a separate ground conductor sized in accordance with load size and a minimum size of 12 AWG.

3. All CLASS 1 loads and the C35 ground plate must be bonded with a 8 AWG copper wire to the pool bonding system at the pool system panel board. See figure 9-2.

4. All pumps and valves used should be UL listed for use with swimming pools, hot tubs and spas.

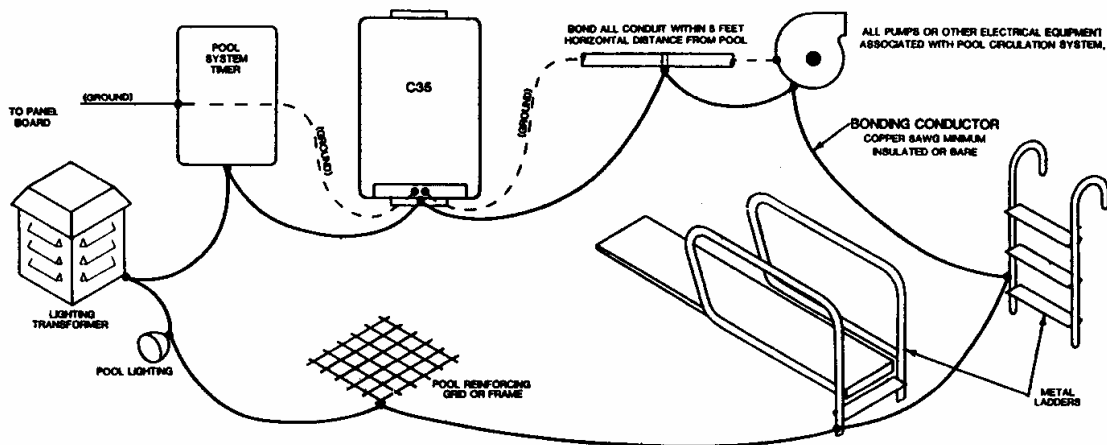
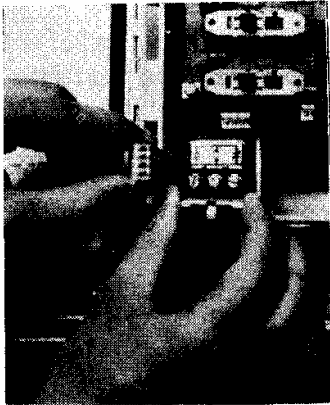


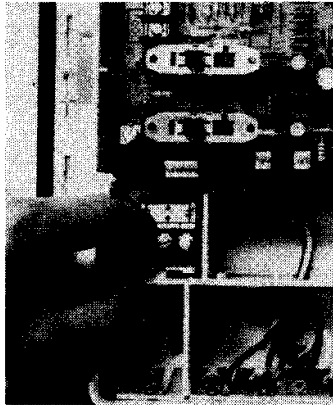
FIGURE 9-2, TYPICAL SCHEMATIC FOR BONDING POOL SYSTEM COMPONENTS

5. INSTALLING OUTPUT MODULES

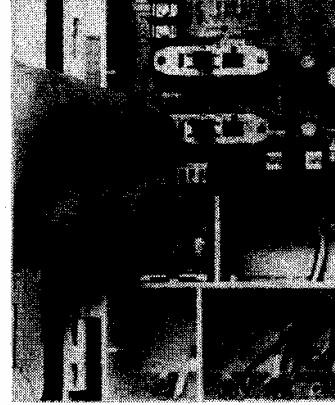
The C35 has provisions for adding up to 4 output modules: Two Model LV CLASS II valve output modules and two Model HV CLASS I pump output modules. The two Model LV valve modules may be operated by Output 1 and/or Output 2. The two HV modules may be operated by Output 1, Output 2 or the Pool Sweep Interlock output. The Model HV modules plug into the two center CLASS I module receptacles. **IMPORTANT: MAKE CERTAIN THAT THE MODULE PLUG IS PROPERLY ALIGNED WITH THE C35 CIRCUIT BOARD CONNECTOR.** See Figures 9-3 and 9-4 for module installation.



Holding connector to one side, insert module into slot in bottom of enclosure.

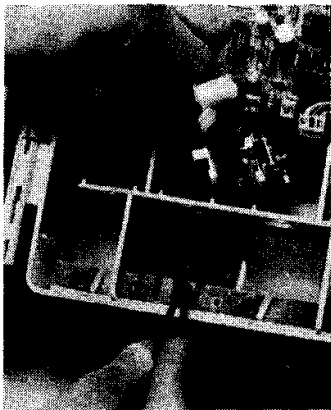


Align module snap catch into wiring divider and snap module into place.

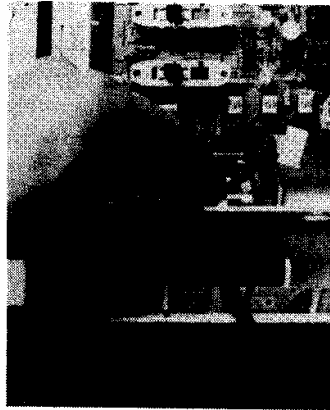


Align module plug with C35 circuit board connector. Plug in module.

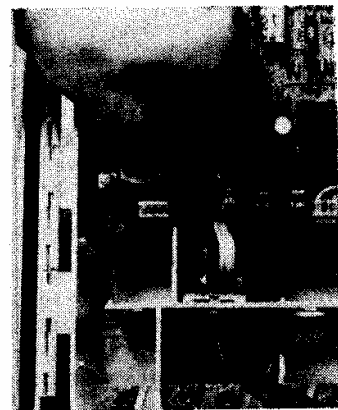
FIGURE 9-3, INSTALLING MODEL LV OUTPUT MODULES



Feed module pigtails through wiring divider. Twist module at angle shown and insert it into base slot.



Align module snap catch into wiring divider and snap module into place.



Align module plug with C35 circuit board connector. Plug in module.

FIGURE 9-4, INSTALLING HV OUTPUT MODULES

6. WIRING MODEL LV OUTPUT MODULES

CAUTION

N.E.C. and local codes consider 12 VAC or 24 VAC Class II wiring within a horizontal distance of 5 feet of Pool, Spa or Hot Tub to be unsafe and requires that this wiring be in conduit.

LV modules have screw clamp type terminals that allow good electrical connection to plain stripped wire ends. (No terminal lugs are required).

The output modules have 12 VAC normally ON and normally OFF outputs, each module is rated for 40VA maximum. If two LV output modules are connected to the C35 the total combined valve output load **MUST NOT** exceed:

20 VA continuous duty.

40 VA intermittent duty, 10% duty cycle, 1 minute ON time maximum.

IMPORTANT

Do **NOT** short valve output wiring. LV Output modules have fuses to protect internal C35 transformer from damage. Do **NOT** replace fuse with larger rating.

Check valve ratings and wiring diagram for proper connection.

IMPORTANT

When two, 3-way diverter valves are connected to one output module, valve internal limit switches can cause continuous valve cycling if the 2 valves lose mechanical synchronization. To avoid this: Use 2 valves of the same type and manufacturer, and start the valves together from the same normal operating position (one position or the other). When operating the C35 mode switch to test valve operation, allow ample time for the valves to completely cycle before switching to a new mode.

7. WIRING MODEL HV OUTPUT MODULES

Model HV modules provide contacts only and do **NOT** supply AC power to the loads. The isolated contacts may be wired to either 120 or 240 VAC pump loads. Check the pump or other load rating and select the correct output module for the application. See wiring label (FIG.9-1) or the reverse side of the control front panel.

8. MOUNTING SENSORS

Sensors should always be securely mounted by bolting, strapping with hose clamp or by screwing them into place. Never solder a sensor into place as the heat will permanently damage the sensor. Good thermal contact is a must. To enhance sensor accuracy, use a thermal grease such as GE Insulgrease type #640 or Wakefield #120-2 (available at electronic distributors, Radio Shack, etc.).

Do **NOT** expose sensors or sensor connections directly to rain.

Do **NOT** expose sensors to temperatures above 400°F or test sensors with an open flame, this type of thermal shock or high heat may permanently damage the sensor.

9. WIRING SENSORS

For sensor wiring refer to the applicable operation section system electrical schematic for your control model. Make certain that all sensor connections are tight at both the sensor and the C35 wiring terminals.

All sensor wiring is Class II low voltage. Consult local codes for specific wiring requirements. Typically, 18 AWG "Bellwire" is used for short runs (less than 100 feet). For longer runs up to 1000 feet or those that travel near other electrical equipment, wiring to other electrical equipment, Ham/CB radio gear, or other sources of electrical "noise", use shielded wire (eg. Belden 8760 for indoor use or 8428 for outdoor use or equivalent)

If shielded wire is used, ground the shield(s) at the C35 ground plate in the applicable sensor wiring compartment.

Wire exposed to weather must be suitable for outdoor use. All wiring connections must be well twisted with wire nuts and sheltered from direct weather contact. This may be accomplished by applying a Silicon Caulking compound into the installed wire nuts.

Provide some type of strain relief for sensor wiring at the sensor end. This may be accomplished with a "cable tie" or by tying an overhand knot in the wire.

SENSOR GROUNDING AND BONDING

The C35 sensor terminals supply less than 15VDC @ 5MA (0.005A) MAX to each sensor. This allows use of CLASS II wiring for the sensor circuits and eliminates any need for sensor grounding or bonding. Check with LOCAL codes for special requirements concerning CLASS II wiring around Pools, Spas Etc.

10. WIRING FREEZE SENSORS

Follow the same previously discussed procedure for both mounting and wiring freeze sensors. Refer to Section 8 (Freeze Protection) and Section 7 (Operation for Draindown Systems using Model C35-1S-2F-3T).

11. MODIFICATION OF DIFFERENTIAL THRESHOLDS

IMPORTANT

Before attempting to modify differential thresholds the installer should be certain that the selected thresholds are what is needed. Threshold modifications are made by cutting resistors, once this is accomplished the process is **NOT** reversible. Use the chart (page 9-6) to select differential thresholds.

If your control model number is not listed in the chart it may have custom features that include special differential thresholds. Do **NOT** attempt modification of thresholds unless the actual threshold values are determined.

CONTROL MODEL	MAIN CHANNEL			AUX CHANNEL		
	STANDARD	MODIFY TO	CUT RESISTORS	STANDARD	MODIFY TO	CUT RESISTORS
C35-1S-3T C35-1SN-3T C35-1S-2F-3T	4/1.5	8/3	R113 R116	4/1.5	8/3	R213 R216
C35-1S-2S-3T	4/1.5	8/3	R113 R116	4/1.5	8/3	R213 R216
C35-1S-2S(DHW)-3T	4/1.5	8/3	R113 R116	8/3	20/5	R213 R216

MODIFICATION PROCEDURE

1. Remove Power from the C35
2. Remove front panel
3. Locate the resistors to be cut
R113 and R116 for the Main channel (Output 1)
R213 and R216 for the Auxiliary channel (Output 2)
4. Cut resistor lead on each resistor about 1/8 inch ^{one} from the resistor body and separate the resistor body and lead to prevent contact after cover is installed. Cutting the resistor as indicated in figure 9-5 will allow a qualified distributor or IE factory to re-solder the connection should the modification later become undesirable.

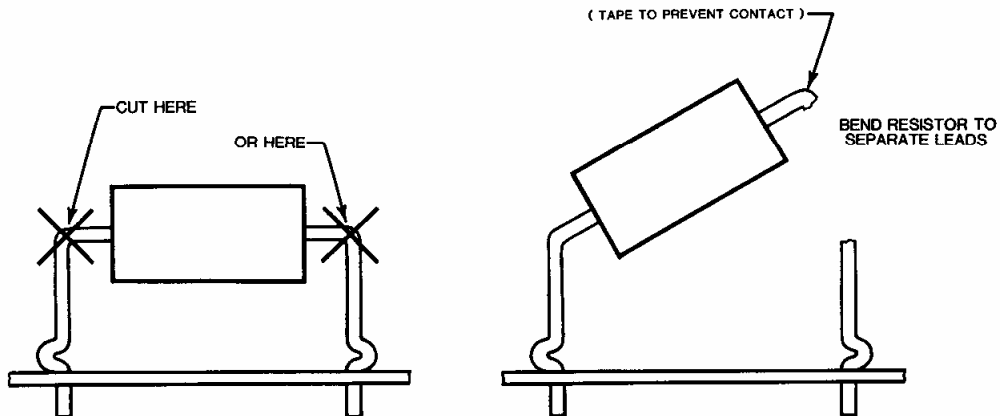


FIGURE 9-5, MODIFICATION OF DIFFERENTIAL TEMPERATURE THRESHOLDS