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Models
3546 and 3548

Water Jacketed Incubator

Operating Manual

Manual No. 7053546 Rev. 0

Read this Instruction Manual

Failure to read, understand and follow the instructions in this manual may result in damage to the unit, injury to operating personnel and poor equipment performance.

NOTE:

The material in this manual is for information purposes only. The contents and the product it describes are subject to change without notice. Forma Scientific, Inc. makes no representations or warranties with respect to this manual. In no event shall Forma Scientific, Inc. be held liable for any damages, direct or incidental, arising out of or related to the use of this manual. When contacting the factory regarding this unit, have the model, serial number and date of purchase available.

MANUAL NO. 7053546			
-	15817/IN-2210	12/18/96	Revised control panel wiring diagram rev 16 heg
-	IN-2186	12/17/96	Revised control panel wiring diagram rev 15 heg
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Section 1 - Receiving

1.1 Preliminary Inspection

This incubator was thoroughly inspected and carefully packed prior to shipment and all reasonable precautions were taken to ensure safe arrival of the merchandise at its destination. Immediately upon receipt, before the unit is moved from the receiving area, carefully examine the shipment for loss or damage. Unpack the shipment and inspect both interior and exterior for any in-transit damage.

1.2 Visible Loss or Damage

If any loss or damage is discovered, note any discrepancies on the delivery receipt. Failure to adequately describe such evidence of loss or damage may result in the carrier refusing to honor a damage claim. Immediately call the delivering carrier and request that their representative perform an inspection. Do not discard any of the packing material and under no circumstances move the shipment from the receiving area.

1.3 Responsibility for Shipping Damage

For products shipped F.O.B. Marietta, Ohio, the responsibility of Forma Scientific, Inc. ends when the merchandise is loaded onto the carrier's vehicle. On F.O.B. Destination shipments, Forma Scientific's and the carrier's responsibility ends when your Receiving Department personnel sign a free and clear delivery receipt.

Whenever possible, Forma Scientific, Inc. will assist in settling claims for loss or in-transit damage.

Section 2 - Unpacking List

2.1 Unpacking List

Remove packing box from incubator. If the unit is to be moved by fork lift, leave the incubator on the skid until it has been moved to its designated location. A plastic bag containing the following accessories is packed inside the incubator:

Qty.	Stock #	Description	Purpose
1	190247	Decontamination Kit	Maintenance
1	180001	Polypropylene Funnel	Fill & Drain
3'	246011	Vinyl Tubing 3/8" ID	Fill & Drain
6'	246010	Vinyl Tubing 3/16" ID	CO_2 Connection
1	285057	Extender Card	Maintenance & Calibration
20	55000	Stainless Steel Screws (Truss Head #10-32" x 5/8")	

Also packed with each incubator:

Qty.	Stock #	Description
24	23052	Stainless Steel Wing Nuts (#10-32)
1	121034	Cam Latch (Nylon)
1	127019	Stainless Steel Spacer (1/4" Diameter x 9/16")
1	550017	Stainless Steel Screw (Truss Head #8-32" x 1")
1	23051	Stainless Steel Wing Nut (#8-32)
5	224140	Stainless Steel Shelves
1	600034	Snapper Hose Clamp (.375")
4	3113234	Shelf Brackets
1	3113224	Stainless Duct Channel, Top
1	3113222	Stainless Duct Sheet, Left
1	3113223	Stainless Duct Sheet, Right
1	130038	#6 Neoprene Stopper
1	190388	Telephone Line Cord, 12'
1	190392	Modular RJ-11 Jack
1	7033546	Instruction Manual

Section 3 - Installation and Start-Up

3.1 Location

Locate the incubator on a firm, level surface capable of supporting the unit.

Approximate weight with water: 335 lbs (152 kg)

The incubator should be placed in an area of the laboratory away from any centrifuges, sonicators, doors, windows and air-conditioning or heating ductwork that might produce drafts. To help prevent microbial contamination, the incubator should not be located in areas of excessive personnel traffic.

Adequate room must be provided behind the incubator for connections of: electrical, gas, and other equipment. Also, since gases are emitted from the rear of the incubator, the unit should not be installed in an unvented recess or in a poorly ventilated room.

To prevent injury to personnel and/or damage to equipment, lock inner glass door and secure outer door before tipping unit to adjust the leveling feet. Do not attempt to tilt the incubator without assistance while adjusting the leveling feet.

3.2 Preliminary Disinfecting

Before installing the duct sheets and the shelves, remove the clear plastic film from the shelf brackets and duct sheets. Forma Scientific, Inc. recommends disinfecting all interior surfaces (including both door gaskets). Rinse the surfaces with sterile distilled water (50K Ohm to 1 Meg Ohm). Also disinfect the CO_2 sensor and the blower wheel, taking care not to saturate the sensor.

The duct sheets and shelves must be washed with the same disinfectant solution and rinsed with sterile distilled water prior to their installation in the chamber. Repeat rinsing until you are satisfied that all of the disinfectant-detergent has been removed. Proceed with the installation as noted.

For the complete disinfecting process, refer to Section 5.2 of this manual.

3.3 Installing the #6 Neoprene Stopper (Access Port)

Open the incubator outer door and inner glass door. Locate the opening in the top left corner of the interior chamber. Place the beveled end of the stopper in the opening.

3.4 Installing the Shelf Brackets and Cam Latch Assembly to the Duct Sheets (Refer to Figure 3-1)

A plastic coating has been applied on the duct sheets and shelf brackets to protect the finish during shipping and handling. This plastic coating must be peeled off before the protected parts are installed.

Shelf Brackets

- Locate the plastic bag containing the #10-32 x 5/8" truss head screws and wing nuts (20 each).

- With the duct sheet in a vertical position, align and mount the shelf brackets to the unflanged side of the duct sheets. Wing nuts go on the flanged side.

Cam Latch Assembly

- Locate the bag containing (2) #8-32 x 1" stainless steel truss head screws, (2) #8-32 wing nuts, (2) stainless steel spacers and (2) cam latches (nylon).

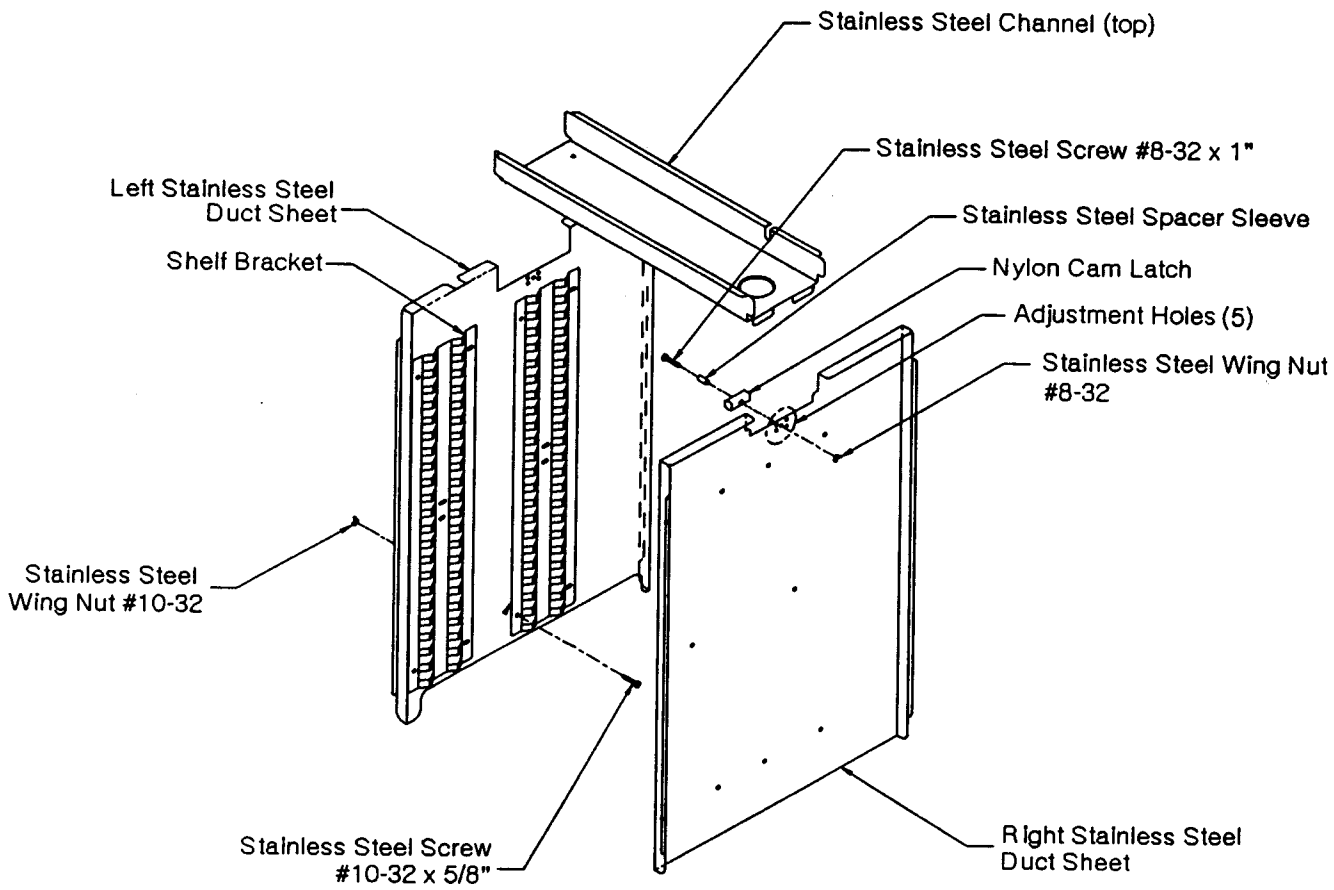
- Place stainless steel spacer (sleeve) over the #8-32 x 1" screw and insert it into the opening of the cam latch.

- Locate the five (5) small adjustment holes at the top of each duct sheet.

- Place the cam latch on the inside (or unflanged side) of duct sheet and insert screw with spacer sleeve through the middle hole of the five hole adjustment. If the duct sheets appear to be too tight or too loose, the cam latch assembly may be re-positioned up or down one hole for proper alignment.

- Secure screw on flanged side of duct sheet with #8-32 wing nut.

- Repeat these procedures for the other duct sheet.



Installing the Shelf Bracketrs and Duct Sheets
Figure 3-1

3.5 Installing the Duct Sheets (Refer to Figure 3-1)

Note: The left duct sheet has large notches in both top and bottom edges. The right duct sheet has a single notch in the top edge only.

- Carefully put the right duct sheet into the incubator chamber with the flanges toward the wall.

- Put the left duct sheet into the chamber, with the square notch at the top and the flanges toward the wall. Allow the top of the left-side duct sheet to lie diagonally across the chamber, resting upon the right-side duct sheet.

- Hook the top channel into the top opening of the right duct sheet. The top channel must be positioned so that the brass CO_2 sample tube (mounted in the ceiling of the incubator) is aligned with the notched out area on the right rear side of the top channel. The round opening will align with the blower wheel when it is slid into place.

- While supporting the blower channel, slide the left duct sheet up until it is vertical, making sure that the blower channel lines up into the slot on both duct sheets.

- Turn cam latch to a vertical position (up against bottom side of top channel) to secure. If duct sheets appear to be too tight or too loose, upon installation, the cam latch assembly may be re-positioned up or down one hole for proper alignment.

3.6 Installing the Shelves

The shelves may be placed at any level in the chamber. Slide the shelf into the shelf bracket at the desired level.

3.7 Leveling

Check the level of the unit by placing a bubble-type gauge on one of the shelves. Turn the hex nut located on the leveling leg clockwise to lengthen the leveling leg, or raise the unit. Turning the hex nut counterclockwise will shorten the leg, or lower the unit. Be sure to level the incubator before filling the water jacket.

To prevent injury to personnel and/or damage to equipment, lock inner glass door and secure outer door before tipping unit to adjust leveling feet. Do not attempt to tilt the incubator without assistance while adjusting the leveling feet.

3.8 Connecting the Incubator to a Power Source

With the incubator power switch OFF, plug the cord set into the receptacle on the back of the unit. *The cord set is the **mains disconnect** for the incubator*. Connect the other end of the cord set to an adequate power source. Refer to the serial tag located on the back of the unit or see the Specification section or Electrical Schematics in the back of this manual for specific power requirements.

Note: Forma Scientific, Inc. recommends that the incubator be connected to a separate electrical circuit.

3.9 Preparing the Incubator for Filling

450 ml of rust inhibitor was placed in the water jacket before the incubator was shipped. The rust inhibitor mixes with the distilled water during filling and provides a protective coating on the interior of the water jacket.

The fill fitting is used to fill the water jacket without having to move the incubator. The fill fitting is located on the center front of the unit, directly above the door.

The vent hole, located adjacent to the fill fitting allows the air displaced by water entering the jacket to escape. It also prevents distortion of the chamber by allowing air to escape as the unit expands and contracts during heating and cooling.

Do not plug this vent. A plugged vent will damage the water jacket chamber.

- Remove the plastic protective cap from the fill fitting. Check to see that the vent hole located adjacent to the fill fitting is not covered or plugged.

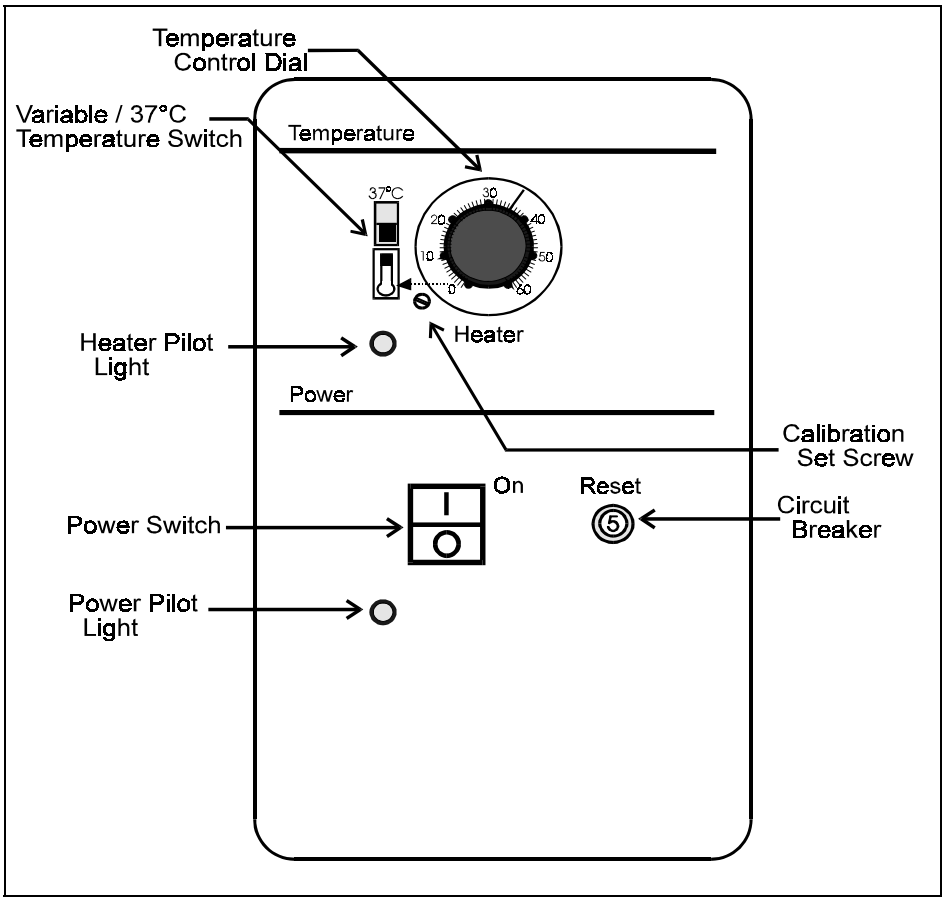
- Remove the protective metal cover from the drain fitting and valve and make sure the valve is closed (turned to the horizontal position). Refer to Figure 3-3 for drain and drain valve location.

- Set the TEMP SELECT switch to the variable position (down) and turn the temp control knob completely counterclockwise to keep the heater from coming on before the water jacket is filled. Refer to Figure 3-2 and Figure 3-4 for component locations.

- Turn the incubator power switch ON. The ADD WATER warning light and audible alarm will come on. Pressing the SET/SILENCE button on the alarm panel will silence the audible alarm

- Remove the adjusting screwdriver from the front of the control panel by pulling out the black knob beneath the Sample Port. The black knob is the handle of the adjusting screwdriver. Refer to Figure 4-2.

- Push the SET/SILENCE button on the Monitor Alarm Module, and adjust the over temp alarm setpoint to a setting 2° or 3° above the intended operating temperature. (Refer to Section 3.13)



Electric Power and Temperature Control Module
Figure 3-2

- Press the CO_2 SET/SILENCE button and rotate the CO_2 set screw until the display reads 00.0. (Refer to Figure 3-6 for locations of the SET/SILENCE button and set screw.)

3.10 Filling the Water Jacket

There are two methods of filling the water-jacket.

a. Funnel Fill

b. Tap Fill

Purity of the distilled water used in the water jacket and humidifier must be within the 50K ohm to 1 Meg ohm range to protect and prolong the life of the stainless steel water jacket. The use of tap water or distilled water outside of the specified range will decrease the operating life of the unit and will void the warranty.

a. Funnel Fill

A funnel and vinyl tubing are contained in the accessories bag included with each incubator.

- Verify that the water jacket drain valve on the bottom of the incubator frame is closed. The valve is located behind a protective metal cover and will require two screws to be removed. The valve is closed when the valve knob is turned vertical. Refer to the illustration in Figure 3-3.
- Attach the funnel into one end of the 3/8" I.D. vinyl tubing.
- Remove the plastic protective cap from the fill fitting.
- Attach the free end of the funnel tubing to the fill fitting.
- Hold funnel above the level of the fill fitting and pour the water into the funnel until the ADD WATER alarm light goes out. The water jacket holds about 13 gallons (49 liters) of water.

- Add one additional quart (one liter) of distilled water. The incubator is now properly filled.

- Remove the tubing from the fill fitting and replace the plastic protective cap.

Note: Water seepage may occur from vent hole when chamber temperature increases.

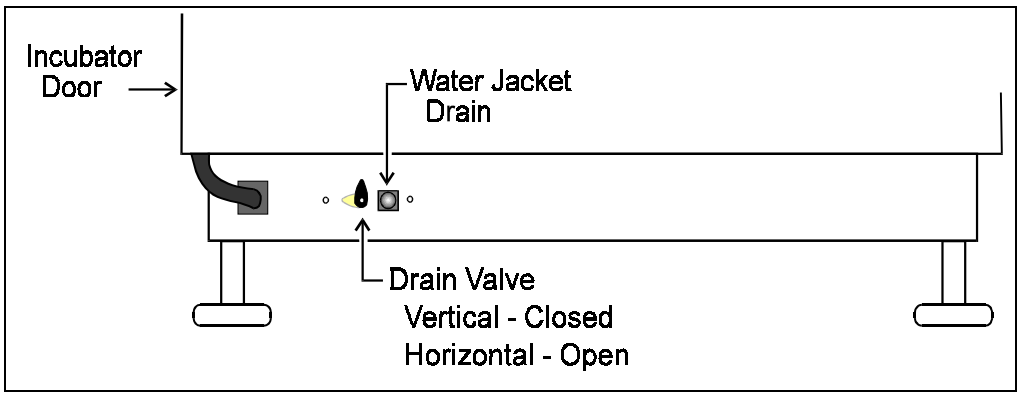


Figure 3-3
Incubator Base with Water Jacket Drain and Valve

b. Tap Fill Method

Three feet of 3/8" ID vinyl tubing is provided in the accessories bag included with each incubator. If the distilled water outlet is more than three feet from the incubator, more tubing and a connector will be required.

A high rate of flow and high pressure from the water tap can cause distortion to the incubator chamber walls.

- Verify that the water jacket drain valve on the bottom of the incubator frame is closed. The valve is located behind a protective metal cover and will require two screws to be removed. The valve is closed when the valve knob is turned vertical. Refer to the illustration in Figure 3-3.

- Remove the plastic protective cap from the fill fitting.

- Connect the 3/8" I.D. vinyl tubing between the fitting and the distilled water tap.

- Open the tap until water flows steadily into the water jacket.

- Turn the water off immediately when the ADD WATER alarm light goes out.
- Using the funnel, add an additional quart (one liter) of distilled water.
- Remove vinyl tubing and reinstall the plastic protective cap.

3.11 Filling the Humidity Reservoir or Pan

Do not use plastic pans for humidification as they will have an unpredictable effect on humidity and O_2/CO_2 levels in the incubator. Use only the floor of the unit or the optional stainless steel humidity pan.

Do not use de mineralized or de ionized water in the humidity reservoir or pan unless it has been boiled immediately prior to use as it may be contaminated with bacteria.

Listed below are two recommended methods of providing elevated humidity in the chamber.

Note: Frequent door openings will cause humidity loss from the chamber. Recovery time will also be affected.

1. Reservoir

The reservoir in the bottom of the incubator may be filled with at least 3/4" of sterile distilled (50K ohm to 1 Meg ohm) water.

2. Humidity Pan

The optional humidity pan (Forma Stock #237001) will hold about 6 quarts (5.8 liters) of sterile distilled (50K ohm to 1 Meg ohm) water. Note: This pan may be autoclaved. The best humidity and temperature response from the humidity pan is obtained when the pan is placed directly on the incubator floor.

The water level in the humidity reservoir should be checked frequently. If a disinfectant has been added to the water in the reservoir, it should be changed once a week to help prevent microbial contamination. If a disinfectant has not been added to the sterile distilled water, the water should be changed at least twice a week.

It is important that the water level in the reservoir or pan be kept relatively constant as fluctuations or "dry-outs" will have an adverse effect on the humidity level and CO_2 control in the chamber.

When installing the humidity pan, exercise care to avoid tearing the inner door gasket.

3.12 Setting the Chamber Temperature (Refer to Figure 3-4)

Before the initial temperature setting is made, push in on the PUSH TO SET button on the Alarm Monitor Module. Using the screwdriver on the control panel, turn the OVERTEMP set screw until the display shows a temperature that is two to three degrees above the desired operating setpoint. The overtemp safety may be reset after the chamber temperature has stabilized at setpoint.

If a chamber temperature of 37°C is desired, set the Variable/37°C switch on the Temperature Control panel to the 37°C (up) position. (Figure 3-2.)

If a value other than 37°C is desired, set the switch to the Variable position (down), and set the temperature control knob to the desired setpoint. Any temperature between 5°C above ambient to 50°C may be selected.

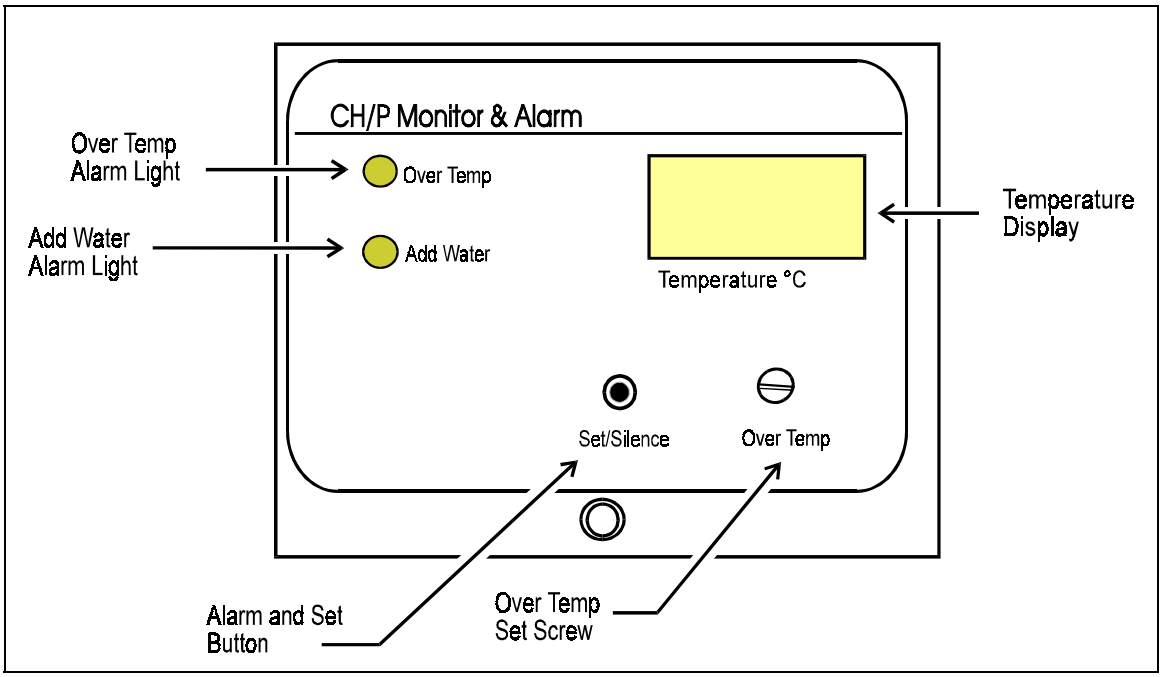
3.13 Setting the Overtemp Safety Thermostat (See Figure 3-4)

Once the chamber temperature has stabilized (as indicated by the digital display), the Over Temp Safety should be set as follows:

- Push the SET/SILENCE button on the Alarm Monitor Module.

- Using the screwdriver mounted on the control panel, turn the OVER TEMP set screw until the desired over temp alarm point is shown on the digital display. The over temp setpoint can be set within 0.1° of the operating setpoint, but it is recommended that it not be set within 0.5 of setpoint.

Note: The Over Temp Safety should be checked quarterly to insure proper operation. To check the over temp control, push the SET/SILENCE button on the Alarm Monitor Module and turn the Set screw counterclockwise until the over temp safety light is lit. Reset the Over Temp Safety after the test.



Temperature and Alarm Monitor Module
Figure 3-4

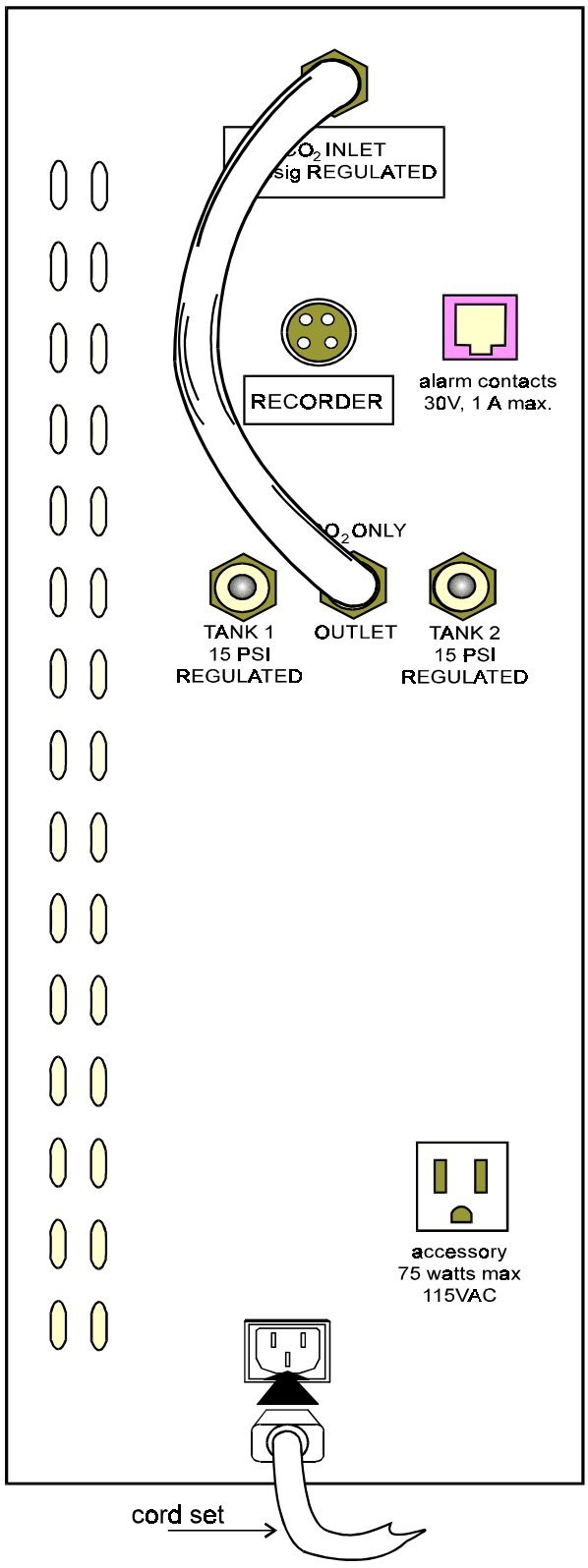


Figure 3-5
Rear view of control panel,
Using the gas guard

13.14 Connecting the Optional Gas Guard (Refer to Figure 3-5)

a. Connecting the Outlet of the Gas Guard to the Incubator's Gas Inlet

Before connecting the gas supply tanks, connect a piece of supply tubing between the outlet fitting and the gas inlet on the back of the incubator. The gas outlet is located between Tank 1 and Tank 2 inlet fittings. Check the connections for leaks.

b. Connecting The CO_2 Supply Tanks

Note: Output pressure from the tanks must be regulated with a dual stage pressure gauge set at 15 PSIG. Liquid substances must be supplied in tanks *without siphon tubes* to ensure that only gas enters the incubator.

The high pressure gauge should have an indicating range of 0 to 2000 PSIG to monitor tank pressure. The low pressure gauge should have an indicating range of 0 to 30 PSIG to monitor actual input pressure to the incubator injection system. A suitable two-stage pressure regulator is available from Forma Scientific, Inc., Stock #965010.

Supply pressure lower than 13.5 PSIG will cause improper operation of the gas guard and may cause nuisance alarms. Pressure higher than 15 PSI will damage the CO_2 control system.

Securely attach the gas lines from the supply tank to the barbed fittings located on the back of the unit. The fittings are labeled. Check the connections for leaks.

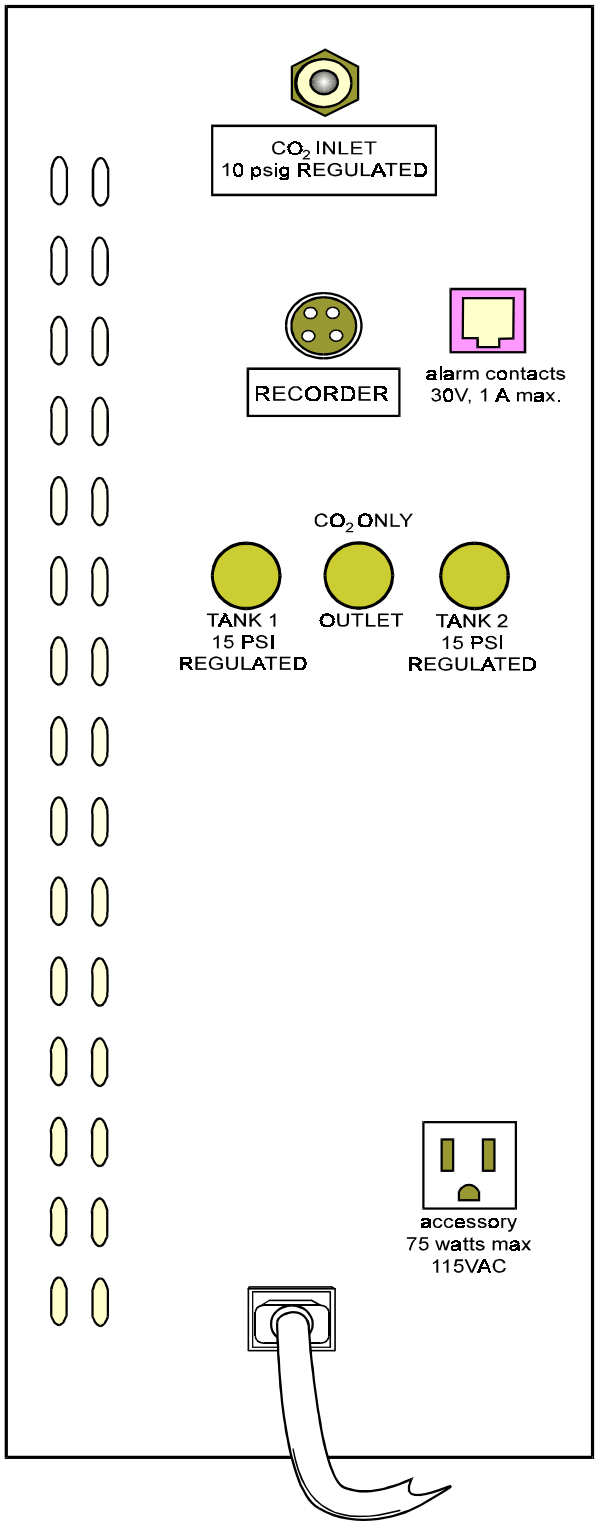


Figure 3-6
Rear view of control panel
Without the gas guard

3.15 Connecting the Gas Supply when not using the Gas Guard

(Refer to Figure 3-6)

If the gas guard is not to be used, the gas supply must be connected to the CO_2 inlet.

To provide for the most economical use of CO_2, a main supply of liquid CO_2 is recommended. The liquid CO_2 should be supplied from tanks ***without siphon tubes*** to ensure that only CO_2 gas enters the incubator injection system. It is also recommended that a two-stage pressure regulator with gauges be installed at the supply cylinder outlet.

The high pressure gauge should have an indicating range of 0 to 2000 PSIG to monitor tank pressure; the low pressure gauge should have an indicating range of 0 to 30 PSIG to monitor actual input pressure to the incubator injection system. A suitable two-stage pressure regulator is available from Forma Scientific, Inc., Stock #965010.

Note: Output pressure from the tanks must be regulated with a dual stage pressure gauge set at 10 PSIG. Liquid substances must be supplied in tanks *without siphon tubes* to ensure that only gas enters the incubator.

The CO_2 supply fitting is located on the upper left rear corner (as viewed from the back) of the incubator control panel. Securely attach the 3/16" I.D. vinyl CO_2 line to the barbed fitting and check the connection for leaks. If a metal line is used, the serrated fitting can be replaced and an 18 MPT fitting installed.

3.16 Zeroing the CO_2 Controller (See Figure 3-7)

This adjustment is made using the CO_2 gas content of ambient air (0.03%), the most accurate standard available.

Never use a FYRITE or other analyzer for this adjustment. The adjustment must be made on initial start-up, and it must also be made if a change in the humidification of the incubator is required.

Tools Required:

Calibration screwdriver (provided on the panel)
FYRITE CO_2 Analyzer (use only for checking) or other CO_2 measuring device.

Stabilize the Incubator

- Stabilize the incubator at the operating temperature and humidity level with no CO_2 in the interior chamber.
- Turn off the CO_2 at the supply.
- Fill the humidity reservoir or pan.
- Allow the incubator temperature and humidity to stabilize. This will take a minimum of eight hours. On initial start-up, however, allow three days to stabilize.

Adjust the Zero Set Pot (Refer to Figure 3-7)

- Using the small screwdriver mounted on the control panel, adjust the CO_2 control zero pot to read 00.0 on the digital display. Wait 5 minutes. Repeat if necessary until the display is stable.
- Turn on the CO_2 at the supply.
- Turn the CO_2 setpoint to the desired %.

Check the CO_2 at the Desired Setpoint

- Allow the incubator to reach setpoint and control (inject light will cycle) for a minimum of 30 minutes.

- Check the CO_2 level with a FYRITE until two consecutive readings agree. If the FYRITE and display are not within plus or minus 1.0%, consult the factory.

Note: After proper zeroing, the CO_2 display will be more accurate than the FYRITE, because the zero adjustment was accomplished using absolute.

3.17 Setting the CO_2 Content

The following conditions must be satisfied before the CO_2 percentage can be set:

Allow temperature and humidity in chamber to stabilize. For initial settings of CO_2, it is recommended that temperature and humidity be allowed to stabilize for three days.

Check the CO_2 control zero (See Section 3.16 for detailed instructions).

To set the CO_2 percentage, press the CO_2 SET/SILENCE button, and rotate the CO_2 set screw until the desired percentage is indicated on the digital display.

Note: If the unit is in overtemp and a CO_2 injection occurs, a brief, high CO_2 percentage will appear on the digital display due to the shut down of the internal fan during overtemp. The high CO_2 percentage occurs only at the sensor. CO_2 throughout the chamber will remain normal.

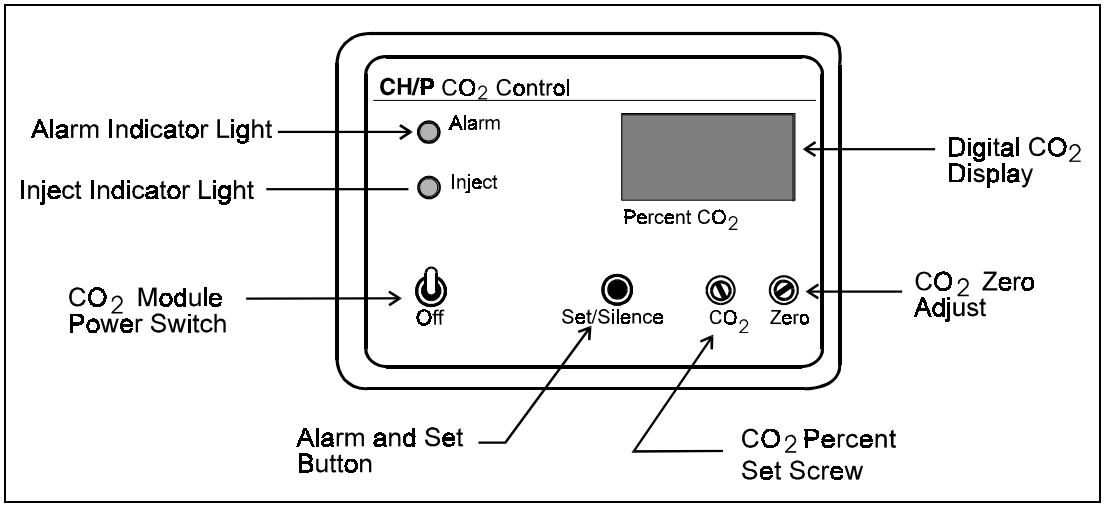


Figure 3-7
CO_2 Control Module

Section 4 - Operation

4.1 Operation

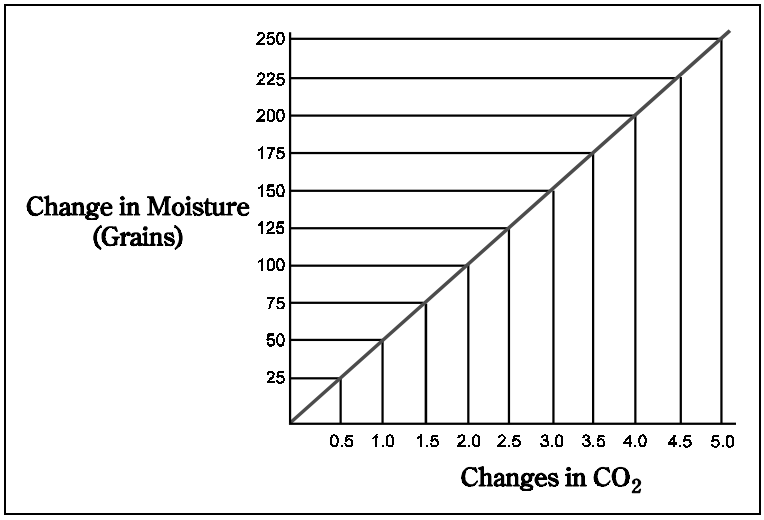
The water jacket is filled with 11.5 gallons (43.5 liters) of water through the fill fitting located on the front of the unit. The water is then warmed by the chamber heater, providing very stable heating of the incubator chamber. The water stays at a constant temperature with a minimum of heater on-time and also acts as insulation from ambient temperatures.

Temperature control is maintained by a proportional, zero-switching device which provides temperature uniformity throughout the chamber. A separate and independent over temperature controller assures product safety by assuming control at the over temp setpoint if the primary controller fails. Should an over temp condition develop, the monitor alarm system will alert the operator that a malfunction has occurred.

An internal blower gently circulates the air in the chamber to prevent CO_2 stratification and minimize culture desiccation.

4.2 Overview of Humidification and CO_2

Thermal conductivity of the air inside of the incubator is affected not only by the quantity of CO_2 present, but by the quantity of water vapor present in the incubator atmosphere. This effect is linearly related to the absolute humidity of the atmosphere (See figure below).



Moisture Effect on CO_2 Control Calibration
Figure 4-1

When monitoring the effects of CO_2, absolute humidity must be held constant so any change in thermal conductivity is caused only by a change in the CO_2 concentration. Under the worst circumstances, a change in absolute humidity could cause such a significant change in thermal conductivity that the controller could shift the CO_2 content by as much as 4%.

Maintaining the water level inside the incubator is a simple procedure, but an important one to keep the humidity in the incubator constant. Any water pan, used in lieu of flooding the incubator floor, must be stainless steel and at least 187 square inches of surface area. Tests indicate that smaller pans, bowls or non-metallic pans do not provide adequate humidification, which can lead to incubator humidity variations with ambient humidity shifts, resulting in CO_2 changes in the incubator.

When operating a dry incubator, as opposed to a humidified one, ambient humidity fluctuations will affect CO_2 calibrations. Since the fluctuations possible in extreme ambient changes have less effect on the total absolute humidity, the CO_2 calibration can be affected by as much as 1.5%.

When a change in humidity or temperature is needed, the CO_2 control can be easily zeroed for the new condition.

Temperature changes have little affect on CO_2 calibration, but do cause large changes in the absolute humidity which is reflected in changes in CO_2 calibration.

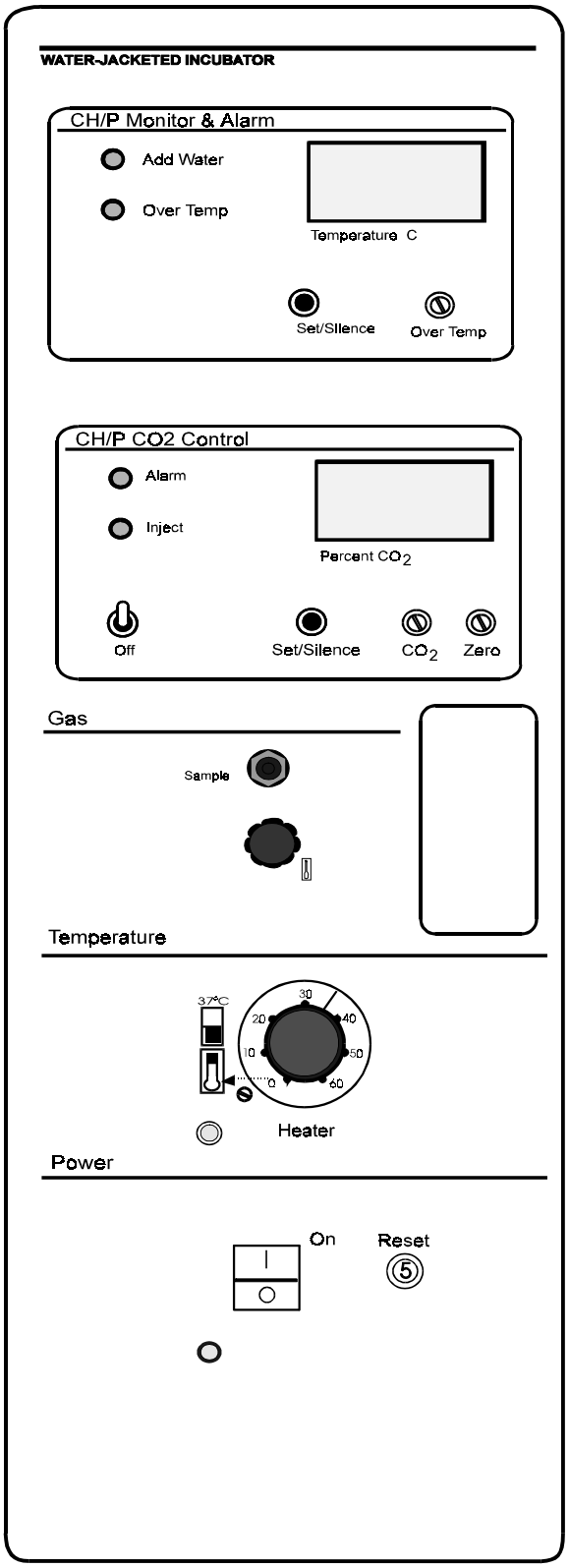


Figure 4-2
Control Panel

4.3 Control Panel (Figure 4-2)

Fill Fitting and Vent Hole

The fill fitting is located on the center front of the unit, directly above the door. This fitting is to facilitate filling of the water jacket without having to move the unit.

The vent hole, located adjacent to the fill fitting, above the front door, allows the air displaced by water entering the jacket to escape. It also prevents distortion of the chamber by allowing air to escape as the unit expands and contracts during heating and cooling. Under no circumstances should the vent be plugged.

Power Switch and Pilot Light

The main power switch controls the ON/OFF power to the unit. The power pilot light is activated when the power switch is on, and the unit is receiving power.

Circuit Breaker (Reset)

The 5 amp circuit breaker for the incubator (labeled Reset) can be pushed to reset the incubator power supply within a few seconds after the breaker has tripped. If it trips a second time, the unit should be checked by a qualified electrician.

Variable/37°C Switch, Temp Control and Heater Pilot Light

When the Variable/37°C switch is set to the 37°C (up) position, chamber temperature will automatically be maintained at +37°C. If necessary, the 37°C control can be calibrated using the calibration screw located at the lower left side of the temperature control dial. See Section 6.3 for calibration instructions for the 37°C setting.

When the Variable/37°C switch is set to the Variable (down) position, control is assumed by the temperature control potentiometer. The numbers (0 to 60) around the control knob indicate approximate setpoint values in degrees Centigrade. Any value between +5°C above ambient temperature and 50°C may be selected. The heater pilot light will be activated whenever the heater is energized.

Gas Sample Port

A sample port for checking CO_2 percentage by independent means (e.g. FYRITE or similar CO_2 measuring device).

The Sample Port should never be capped, as it serves as a vent for the incubator chamber.

Setpoint Adjustment Screwdriver

A small screwdriver, located directly above the sample port, has been provided for setting the CO_2 and overtemp setpoints. Pull out on the knob to release the screwdriver (the knob is the handle of the screwdriver).

4.4 CO_2 Module (Refer to Figure 4-3)

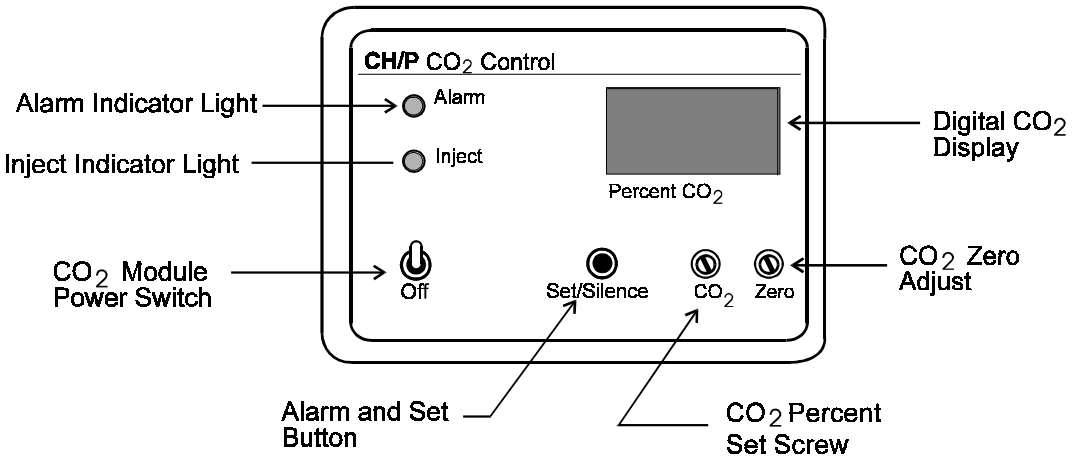
CO_2 Power Switch

The CO_2 power switch controls the electrical power to the CO_2 system, and it must be ON when the incubator is to be operated with CO_2. The switch should be turned on as soon as power is applied to the unit to allow the CO_2 system to warm up.

CO_2 Controller and Digital Display

The LCD digital readout on the CO_2 module continually displays the percent of CO_2 in the chamber. The setpoint is displayed when the CO_2 SET/SILENCE button is pushed.

The CO_2 setpoint is changed by pushing the CO_2 SET/SILENCE button and rotating the CO_2 set screw to the desired percentage.



CO_2 Control Module
Figure 4-3

Audible CO_2 Alarm and Pilot Light

The audible CO_2 alarm and pilot light are activated when the percent CO_2 deviates from setpoint by plus or minus 1% (nominal) for longer than approximately four minutes.

Set/Silence Push Button

When pushed, the SET/SILENCE button will silence the CO_2 alarm and de-energize the alarm light. The alarm will remain deactivated until another alarm condition occurs. This button must be pushed to set or display the CO_2 setpoint.

Alarm Disable Switch

Note: It is necessary to pull the CO_2 module out slightly to gain access to the alarm disable switch. Grasp the black plastic button on the bottom of the control module, directly beneath the Set/Silence push button. Pull on the button until the circuit board releases from its internal connector strip. The Alarm Disable Switch is located on the side of the module and is clearly marked. (See Figure 4-4.) To replace the module, push firmly until the connector strip is seated. Press the black plastic button until it snaps into place.

When the alarm switch is in the DISABLE position, the CO_2 alarm is completely disabled. When the switch is set to the NORMAL position, the alarm system is operative and can be silenced by pressing the SET/SILENCE button.

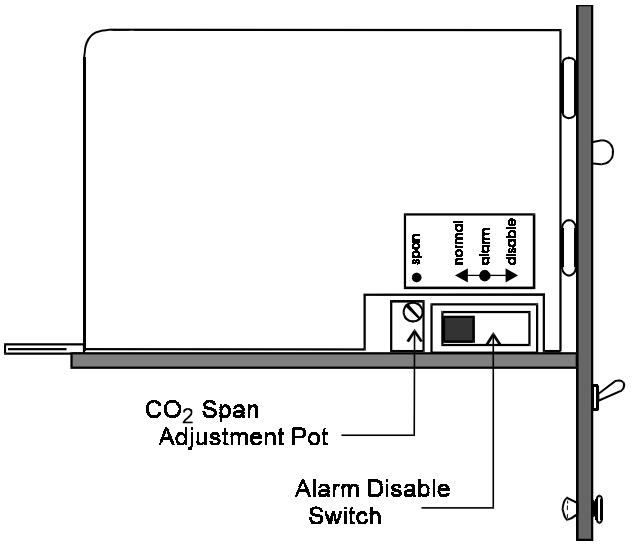
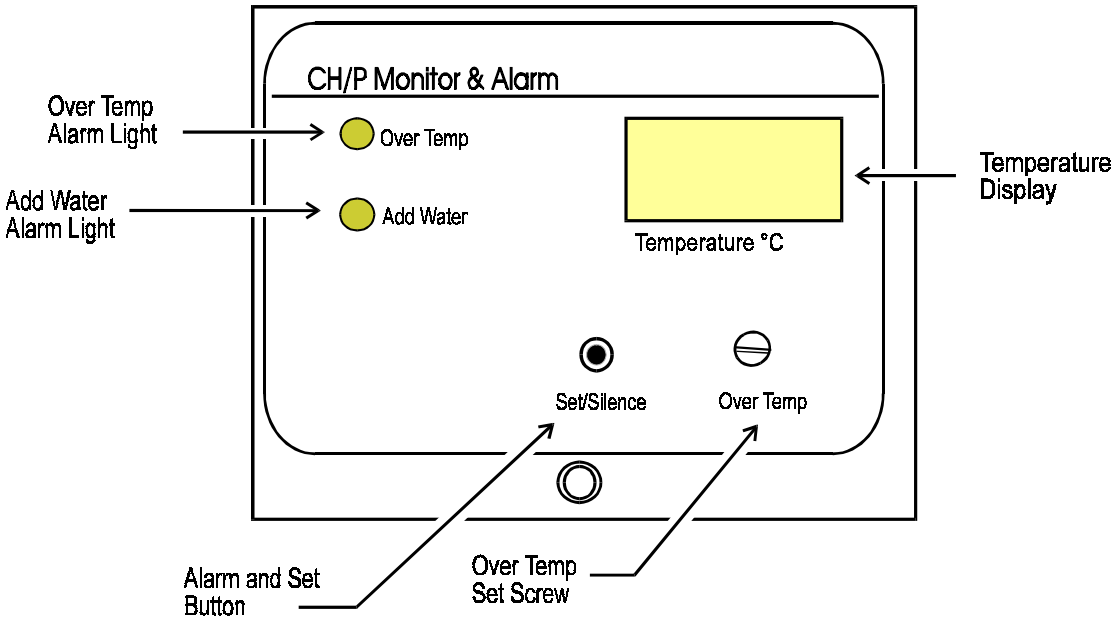


Figure 4-4
Alarm Disable Switch on the CO_2 Control Module

CO_2 Inject Light

The CO_2 inject light is activated whenever there is a demand for CO_2 to meet setpoint requirements. Since the CO_2 inject light is independent of the CO_2 alarm, it will continue to signal a need for CO_2 when the CO_2 alarm is set to either the defeat or silence position.

CO_2 Zero Adjustment



Temperature Monitor and Alarm Control Panel
Figure 4-5

The CO_2 zero adjustment is used for zeroing the CO_2 controller to specific control conditions. It is the *only* user calibration adjustment on the CO_2 module. ***All internal adjustments are for qualified service personnel only.***

4.5 Alarm/Monitor Module (Refer to Figure 4-5)

Overtemperature Controller and Push-to-Set Button

The overtemperature setpoint is displayed when the PUSH TO SET button on the module is pushed. Overtemp control point is adjusted by pushing the SET button and rotating the set screw on the module to the desired setpoint.

Overtemp Alarm and Pilot Light

The overtemperature audible alarm and pilot light are activated in the event of an overtemp condition. Once the alarm has been activated, it can only be silenced by the temperature in the chamber returning to normal or by readjusting the overtemp setpoint to a value above the chamber temperature.

Add Water Pilot Light and Audible Alarm

The ADD WATER audible alarm and pilot light are activated whenever the water level in the water jacket is low. The alarm will be deactivated only when approximately one quart (one liter) of water has been added through the fill fitting. (See Section 3.10).

4.6 Remote Alarm Relay System

IMPORTANT USER INFORMATION

Caution! Stored product should be protected by an activated alarm system capable of initiating a timely response 24 hours/day. Forma Alarms provide interconnect for centralized monitoring.

Alarm states and alarm conditions are listed on Table 4-1. When the relay is off it is in the alarm state.

Alarms and Indicators, Table 4-1

Alarm Condition	Visual Indicator	Audible Alarm	Reset Delay (Ringback)	Alarm Relay State
None	Off	Off		On
* Temp.> Over Temp Setpoint	Over Temp LED On	On	30 Minutes	Off
* Low Water in Water Jacket	Flash Add Water LED	On	30 Minutes	Off
** % CO_2 Dev Setpoint ± 1%	CO_2 Alarm LED On	On	17 Minutes	Off
*** Tank1 Low	Pressure Low #1	On		Off
*** Tank2 Low	Pressure Low #2	On		Off
Power Failure	Off	Off		Off

* Silenced audible alarm will ring back in 30 minutes if the alarm condition still exists. The Alarm LED will remain lit.

** Condition must exist for four minutes before alarm activates. Silenced alarm will extinguish the led alarm light, silence the audible alarm and change the alarm relay to the on state. the alarm system will ring back after 17 minutes if the alarm condition still exists.

REMOTE ALARM RELAY WIRING DIAGRAM *** When the CONTROL switch on the gas guard is turned off the indicator light will be extinguished and the audible alarm will be silenced. The built-in alarm relay on the Model 3546, however, remains active.

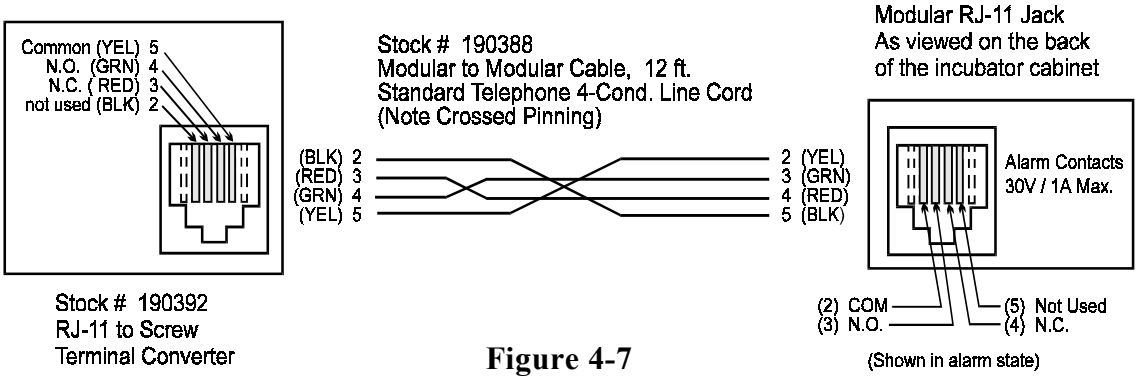
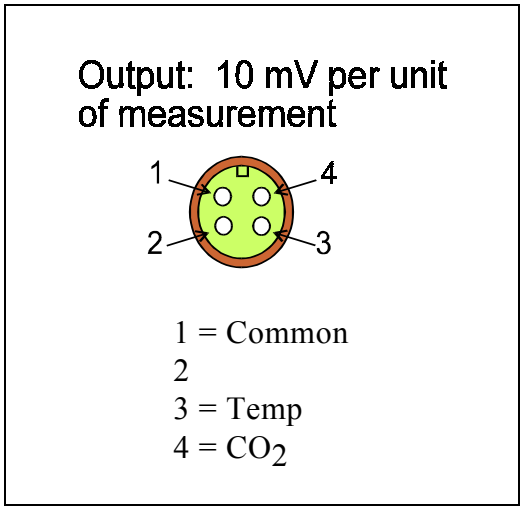


Figure 4-7

A SPDT relay is provided for monitoring alarm conditions on the incubator. Connections are made by means of an RJ-11, telephone style jack, located on the rear of the cabinet. Figure 4-7 shows the connector wiring diagram. Any of the incubator alarms will activate the relay.

4.7 Recorder Output



Incubator temperature and CO_2 information may be directed to a recorder or other data storage device from a four-pin connector located on the back of the control panel. The connector pin numbers are identified in Figure 4-8 and are arranged as they would be seen looking at the back of the cabinet.

Figure 4-8
Recorder Output Jack

4.8 (Optional) Gas Guard, Stock #190410 (Refer to Figure 4-9)

Forma Scientific's stock # 190410 built-in Gas Guard is a monitoring and switching device for incubator gas supplies.

The unit monitors a two cylinder gas supply. When the active supply tank is depleted, an audible alarm sounds and the gas guard automatically switches to the second tank.

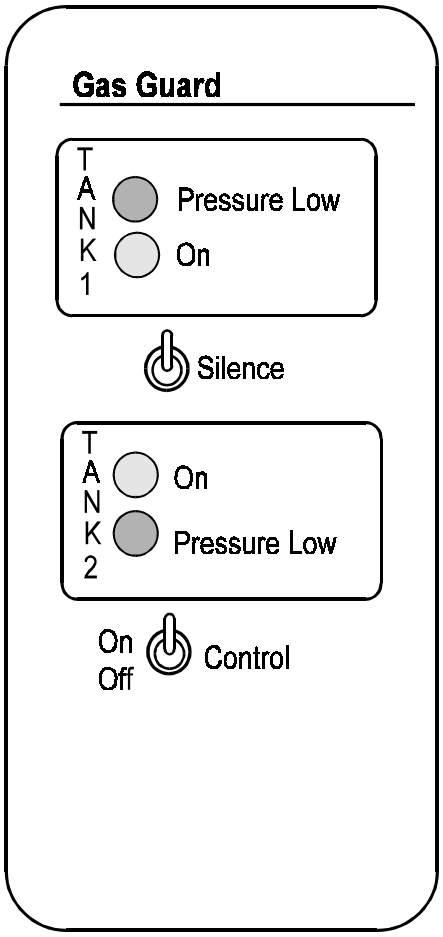


Figure 4-9
Built-in Gas Guard
(Factory Installed Option)

Control Switch

The CONTROL switch controls power to the gas guard control circuit board. The yellow LEDs on the front panel designate which tank is active and indicate the unit is receiving power.

Silence Switch

The SILENCE switch silences the alarm and selects the alternate tank. If the SILENCE switch fails to silence the alarm, it is an indication that both gas tanks are depleted or incapable of producing 15 PSIG.

Note: During initial start-up, the incubator should not be injecting gas.

Gas Depletion Alarm

The gas depletion alarm sounds automatically when the active supply tank becomes empty. The other tank becomes active with the sounding of the alarm.

Note: Should both supply tanks become depleted, the only way to silence the alarm is to turn the CONTROL switch Off.

Active Tank Indicating Lights

The two yellow indicating lights, labeled TANK1 On and TANK2 On, located on the front of the control panel indicate which of the gas tanks is active.

Pressure Low Indicating Lights

The two red indicating lights, labeled Pressure Low, indicate when a supply tank is depleted. If both tanks are depleted both red indicating lights will be lit.

Start-Up Procedure

- Turn the CONTROL switch on.
- Select the active tank using the SILENCE switch.

Section 5 - Routine Maintenance

5.1 Installing the Decontamination Kit

REVISED 8/91

INSTRUCTION SHEET #7190028

INSTRUCTIONS FOR INSTALLING DECONTAMINATION KIT# 190028

1) **DISCONNECT INCUBATOR FROM POWER SUPPLY.**

2) Remove shelves, duct sheets and blower channel from incubator interior.

3) Remove blower wheel. To remove the blower wheel, grasp it as shown in Figure #1 and pull down firmly.

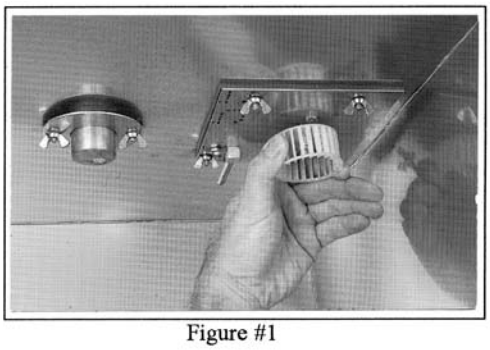


Figure #1

4) Match blower wheel from kit with blower wheel that was removed in Step #3. IMPORTANT! THE BLOWER WHEEL REPLACEMENT MUST BE AN IDENTICAL MATCH. Place new blower wheel over motor shaft and push blower wheel up against snap ring (if present). Confirm that blower wheel rotates freely.

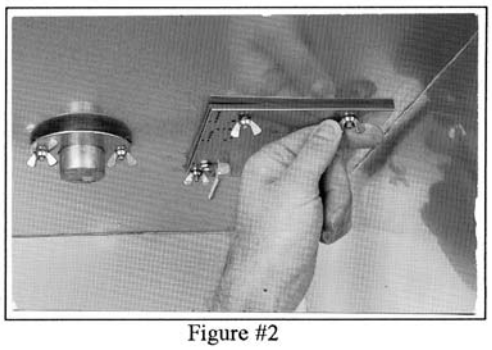


Figure #2

5) Next locate and remove the four wing nuts that secure the motor mounting plate to the incubator ceiling, shown in Figure #2.

6) Carefully pull blower motor assembly down into chamber area. NOTE: ON SOME MODELS, THE BLOWER MOTOR ASSEMBLY MAY DROP DOWN ONLY 1-1/2 TO 2 INCHES.

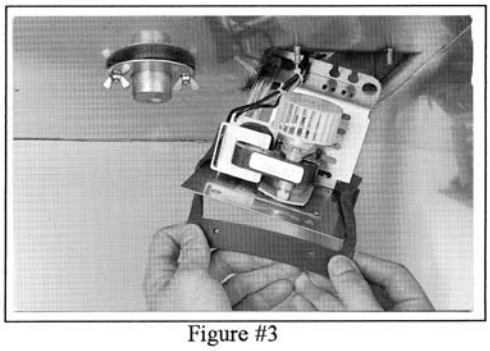


Figure #3

7) Slide the motor mounting gasket over the motor mounting plate, as shown in Figure #3. Discard gasket.

8) Install the new motor mounting gasket over the four studs, located on the incubator ceiling, as shown in Figure #4.

NOTE: THE MOTOR MOUNTING GASKET MUST LIE FLAT BETWEEN THE MOTOR MOUNTING PLATE AND THE INCUBATOR CEILING. TIGHTEN ALL FOUR WING NUTS FIRMLY TO ENSURE A GOOD SEAL.

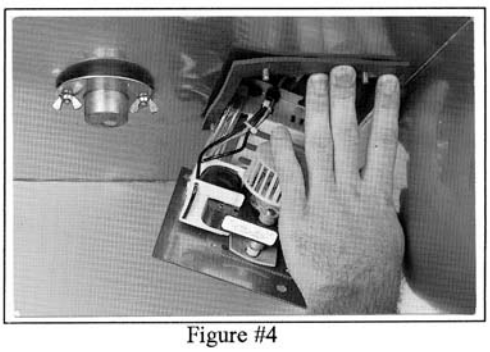


Figure #4

THE FOLLOWING STEPS APPLY TO AUTOMATIC CO_2 AND AUTOMATIC O_2/CO_2 INCUBATORS. FOR CONSTANT FLOW INCUBATORS, SKIP TO STEP #12.

9) Remove the two wing nuts and large flat washer that secures the CO_2 sensor, shown in Figures #5 & #6. Allow sensor to drop down into chamber area. Disconnect sensor at electrical connector.

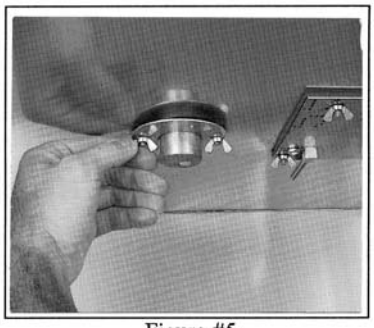


Figure #5

10) Peel o-ring off sensor and replace it with the new o-ring provided in kit, shown in Figure #7.

11) Electrically reconnect CO_2 sensor. Reinstall CO_2 sensor to original position. Tighten wing nuts firmly to ensure proper sealing.

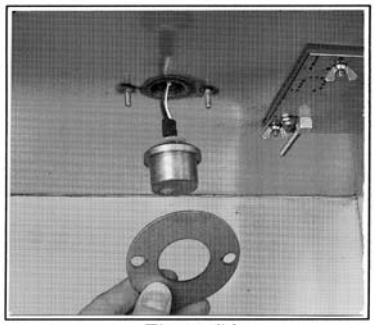


Figure #6

12) Reinstall blower channel, duct sheets and shelves. Reconnect incubator to power supply.

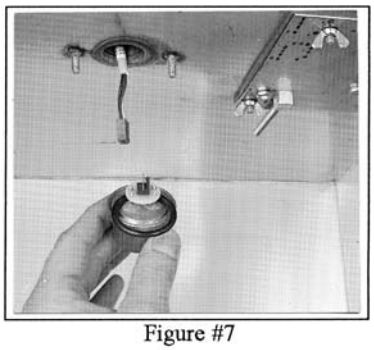


Figure #7

5.2 Disinfecting the Incubator Interior

Use an appropriate disinfectant. All articles and surfaces to be disinfected must be thoroughly cleaned and rough dried.

Danger: Alcohol, even a 70% solution, is volatile and flammable. Use it only in a well ventilated area that is free from open flame. If any component is cleaned with alcohol, do not expose the component to open flame or other possible hazard.

Caution: Do not use strong alkaline or caustic agents. Stainless steel is corrosion resistant, not corrosion proof.

Do not use solutions of sodium hypochlorite (Purex, Clorox, etc.), as they may also cause pitting and rust.

- Remove shelves and duct sheets, and clean all interior surfaces, taking care not to saturate the CO_2 sensor.
- Rinse the surfaces at least twice with sterile distilled water (50K Ohm to 1 Meg Ohm), or until you are satisfied that all of the disinfectant-detergent has been removed.
- Thoroughly clean the door gasket.
- Clean inside of glass door with solution, and rinse with sterile distilled water (50K Ohm to 1 Meg Ohm).
- Wash or autoclave the shelves and duct sheets with solution.
- Rinse with sterile distilled water.

Repeat rinsing until all of the disinfectant-detergent has been removed.

- If desired, all surfaces can then be rubbed or sprayed with 70% alcohol.
- Reinstall the duct sheets and shelves.
- Operate incubator for 24 hours to assure removal of trace vapors.

After complete decontamination, it is recommended that the incubator be run and tested before placing any valuable contents inside the incubator chamber.

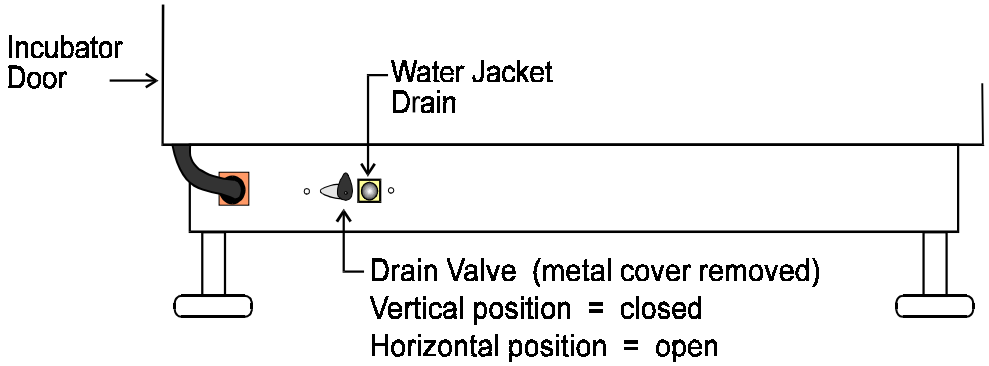
5.3 Cleaning the Cabinet Exterior

The incubator exterior may be cleaned with soap and water and a general use laboratory disinfectant.

5.4 Draining the Water Jacket (Refer to Figure 5-1)

For best results, the water in the water jacket should be changed annually.

- Turn off the incubator and disconnect its electric plug from the outlet.
- Remove the metal cover located below the door which protects the valve and drain fitting. Two knurled thumb screws hold it in place.
- Attach the 3/8" I.D. vinyl tubing to the drain fitting.
- Route the tubing to a drain or large bucket and turn the valve to the horizontal (valve open) position.
- If the water jacket is to be refilled, return the drain valve to the vertical (closed) position and review the filling instructions in Section 3.10.



Incubator Base with Water Jacket Drain Valve
Figure 5-1

5.5 Changing the CO_2 Filter (Qualified Service Personnel Only)

Note: Under conditions of normal use, and dependent upon the purity of gas being used, the CO_2 filter should be serviceable for about five years.

If the CO_2 filter becomes clogged, replace it with Forma stock #770001.

- Disconnect the unit from the power supply.
- Remove the screws securing the side service panel.
- Remove and replace the filter.

5.6 CO_2 Test Instruments

The best standard available for zeroing or calibrating the CO_2 controller is air, which typically contains 0.033% CO_2 by volume. Variations from this figure are insignificant.

It is very important that any Forma automatic CO_2 incubator be zeroed to air (See Section 3.16). *CO_2 test instruments should be used as a secondary check or to verify the CO_2 at operating levels.*

Because sampling technique is so important when using CO_2 test instruments, information is included in this manual on the use of the most commonly used test instrument, the FYRITE. The FYRITE should be used for checking purposes only; not for the actual zeroing of Forma equipment!

Section 6 - Service

6.1 General Troubleshooting

Symptom	Possible Cause
Problem 1: Pilot lights not on. Readouts are dark. CO_2 power switch is on.	• Unit unplugged, or main power switch *not on*. • Circuit breaker tripped. • Outlet overload protection has tripped. • No voltage at outlet. • Defective incubator wiring.
Problem 2: Pilot lights on but heat light and alarm monitor module lights out.	• 0.3 Amp fuse in control panel is blown.
Problem 3: CO_2 system indicator and readout are dark no control of CO_2 in chamber. Switch is on.	• Circuit breaker tripped. • Defective switch or wiring. • Defective CO_2 module.
Problem 4: CO_2 setpoint and display agree. FYRITE reads lower.	• FYRITE not zeroed. • Wool filter in FYRITE is dry. • FYRITE fluid need to be changed. • Chamber absolute humidity has decreased. • Control is incorrectly zeroed. • Defective CO_2 sensor or control.
Problem 5: Alarm sounds periodically, even with the alarm disabled. CO_2 alarm light not activated.	• Over temp control set too low. • Shorted heater. • Defective temp control or sensor.
Problem 6: CO_2 alarm and light are on. Alarm can be reset or disabled. If reset, alarm activates again.	• CO_2 level has deviated more than 1% from setpoint. • CO_2 supply has been interrupted. • CO_2 inject circuit is defective. • CO_2 solenoid is defective. • CO_2 sensor fan is defective.

Symptom	Possible Cause
Problem 7: Digital CO_2 display and FYRITE read more than 1% different from setpoint. CO_2 alarm not on.	• Alarm is disabled. • Defective alarm circuit. • Defective CO_2 sampler or control.
Problem 8: CO_2 display and FYRITE read 0% CO_2. Setpoint is OK. CO_2 alarm is activated. CO_2 inject light is on.	• Loss of CO_2 supply. • Defective CO_2 solenoid. • Clogged CO_2 in-line filter.
Problem 9: CO_2 display shows some random number or decimal point.	• Defective readout board. • Defective output to readout board from CO_2 control. • Faulty interconnecting wiring.
Problem 10: CO_2 display will not go to zero no matter how long the door is left open.	• Improper procedure. Close door and allow temperature and RH to stabilize eight hours. • Defective CO_2 sensor. • Defective CO_2 control.
Problem 11: Display flickers badly or counts up and down three or four digits.	• Defective readout board. • Excessive electrical interference near the cabinet. • Faulty grounding circuit. • Sampler blower is improperly installed or is defective.

Symptom	Possible Cause
Problem 12: CO_2 setpoint cannot be changed.	• Defective CO_2 control.
Problem 13: Unit cannot be zeroed.	• Defective CO_2 potentiometer. • Defective zero control. • Defective CO_2 Sensor.
Problem 14: CO_2 overshoots setpoint badly.	• Inoperative CO_2 sampler blower. • Defective CO_2 control. • CO_2 inlet pressure too high. • Unit is in over temp.
Problem 15: Actual CO_2 is higher than setpoint and readout. Re-zeroing helps for a time, then symptoms return.	• Defective CO_2 sensor. • Incorrect calibration of CO_2 control.
Problem 16: CO_2 alarm sounded while CO_2 level is controlling at setpoint.	• Excessive RFI or EMI near unit. • Faulty grounding circuit. • Defective CO_2 control.
Problem 17: CO_2 setpoint changes by itself.	• Faulty CO_2 potentiometer. • Defective CO_2 control.

6.2 CO_2 Control Module Calibration

These calibration procedures will be necessary only under the following conditions. DO NOT calibrate the incubator for any other reasons!

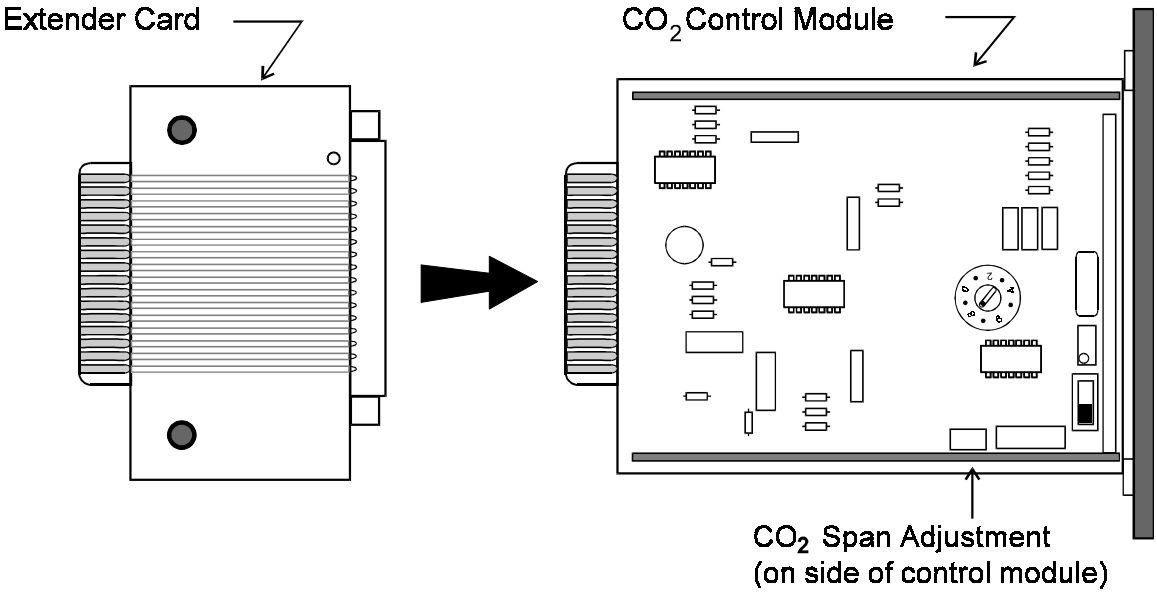
- After the CO_2 controller is replaced.
- After the CO_2 sensor is replaced.
- If there is reason to believe that the controller has previously been calibrated incorrectly.

Tools Needed:

Calibration screwdriver (provided).
Circuit board extender card (provided).
FYRITE CO_2 Analyzer.

The following procedures are to be carried out in the sequence given. To prepare the incubator for calibration:

- Turn off all electric power to the incubator.
- Remove the CO_2 Control Module by pulling out the black plastic button locking button on the bottom of the module. (Figure 6-2.)
- Firmly pull the button rearward until the circuit card releases from the internal connector strip.
- Attach the extender card to the back of the control module circuit board. (Refer to Figure 6-1.)
- Return the control module with extender card attached to the incubator control panel. Press the module firmly into the panel until the connector strip is seated. The control module will protrude a few inches from the incubator panel.



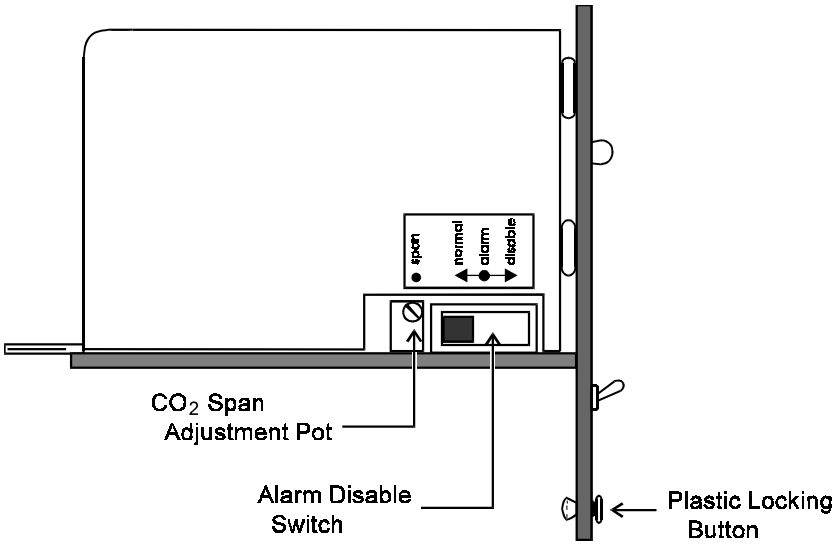
CO_2 Control Module showing the Extender Card and Span Adjustment Pot Location
Figure 6-1

a. Stabilizing the Incubator at operating temperature and humidity with no CO_2 in the chamber.

- Turn OFF the CO_2 supply at the source.
- Fill the humidity pan with sterile distilled water.
- Allow the chamber temperature and humidity to stabilize. This will take a minimum of eight hours if the temperature setpoint has been recently changed. Allow three days on initial start-up.
- Turn the span pot counterclockwise 10 turns. (Refer to Figures 6-1 and 6-2.)

b. Adjusting the Zero Pot

- Using the calibration screwdriver, adjust the CO_2 control zero pot to read 00.0 on the digital display.
- Wait 5 minutes, and repeat as necessary until the display is stable.



Side View of the CO_2 Control Module
Figure 6-2

c. Adjusting the Span Pot (Refer to Figure 6-2)

- Turn ON the CO_2 at the supply.
- Turn the CO_2 setpoint to 10%. Allow the CO_2 to stabilize at 10% on the readout and control (inject light will cycle) for a minimum of 15 minutes.
- Using a FYRITE or other measuring device, check the CO_2 level in the chamber until two consecutive readings agree.
- Turn the CO_2 setpoint to 0.0% to prevent CO_2 from being injected into the chamber during the adjustment.
- Adjust the span pot so the digital display agrees with the FYRITE reading.
- Turn the setpoint back to 10%, and allow the CO_2 to control and stabilize for a minimum of 15 minutes.
- Check the CO_2 in the chamber with a FYRITE or similar device until two consecutive readings agree. If the digital display is within plus or minus 1.0% of the FYRITE reading, proceed to the next step, "Recheck the Zero Adjustment." If the reading is not within plus or minus 1.0%, repeat Steps 3 through 6 of this procedure.

d. Re-checking the Zero Adjustment

- Turn OFF the CO_2 at the supply.
- Open both doors wide for 45 seconds. Close the doors, and allow a minimum of 15 minutes for the incubator to stabilize and assure a zero CO_2 condition in the chamber.
- If the readout is greater than 00.4, repeat the door opening for 15 seconds, and again allow the incubator to stabilize for a minimum of 15 minutes. If the display is not less than the previous reading, consult the factory. If the display now reads 00.4 or less, re-adjust the zero pot so the display reads 00.0.

e. Checking the CO_2 at the desired setpoint

- Turn ON the CO_2 at the supply.
- Turn the CO_2 setpoint to the desired level.
- Allow the incubator to reach setpoint and control for a minimum of 30 minutes.
- Check the CO_2 with a FYRITE or similar device until two consecutive readings agree. If the FYRITE and display are not within 1.0%, consult the factory.

Note: After proper calibration the CO_2 display will be more accurate than the FYRITE, because the zero adjustment was made using atmospheric conditions.

Once the module is calibrated, the Extender Card must be removed and the CO_2 Control Module returned to its proper position in the incubator panel.

- Turn off the incubator.
- Firmly pull the Control Module rearward until it releases from the internal connector strip.
- Remove the Extender Card.
- Replace the Control Module into its location in the incubator panel.

6.3 37°C Control Calibration

If the digital display indicates a temperature other than 37°C when the chamber temperature has stabilized and the temperature select switch is set to 37°C, it may be necessary to calibrate the adjustment.

To calibrate:

- Make a note of how much the display varies from 37°C.
- Locate the 37°C calibration adjustment on the control panel. (See Figure 3-2 in Section 3.)
- Using the calibration screwdriver, turn the calibration screw one turn clockwise for every half degree that the display is below 37°C. Turning the screw counterclockwise will lower the temperature.
- Allow the temperature to stabilize, and check the display again. If it still varies significantly, repeat Steps 1 through 3.

Servicing should be performed by qualified service personnel only. Disconnect the incubator from the power source before starting service procedures.

6.4 Replacing the CO_2 Sensor

- Turn the incubator off and disconnect it from the power source.
- Remove shelves, duct sheets, and blower channel from the chamber.
- Locate CO_2 sensor, and remove wing nuts. The sensor will drop down.
- There is a clip that connects sensor wiring to incubator wiring. To open the clip, pull out slightly on the clip tab to release the sensor.
- Remove the O-ring, and place it on the new sensor.
- Clip the new CO_2 sensor onto the incubator wiring and return the sensor to its original opening. Tighten the wing nuts securely to properly seal the O-ring.

- After the sensor has been replaced, calibrate the CO_2 controller according to the instructions in Section 6.2.

6.5 Replacing the Triac (Refer to Wiring Diagram 140179-71-0-D)

- Turn the incubator off and disconnect it from the power source.
- Remove the screws securing the right side access panel. Remove the panel and set aside.
- Open the incubator outer door to gain access to the triac mounting screws from underneath the control panel.
- Remove the two mounting screws which secure the triac.
- Carefully disconnect the wires to the triac and note their connections.
- Remove the triac from the unit. Note the thermal compound between the base of the triac and the floor of the control panel housing. If necessary, reapply more thermal compound before installing the new triac.
- Install the new triac by reversing the above procedure.

6.6 Replacing the CO_2 Solenoid (Refer to Wiring Diagram, 140179-71-0-D)

- Turn the incubator off and disconnect it from the power source.
- Remove the screws securing the right side access panel. Remove the panel and set aside.
- Locate the CO_2 solenoid and disconnect the tygon tubing attached to it. Note how tubing is installed so that it can be attached to new solenoid in same way.
- Remove the screws that hold the solenoid in place.
- Disconnect the wiring to the solenoid, making note of the connections.
- Remove the solenoid and install the new unit by reversing the above procedure. Note the flow direction marked on solenoid.

6.7 Replacing the Temperature Control

(Refer to Wiring Diagram, 140179-71-0-D)

- Turn the incubator off and disconnect it from the power source.
- Remove the screws securing the right side access panel. Remove the panel and set aside.
- Remove the temperature control knob by loosening the two Allen head screws recessed in the knob.
- Remove the nut on the shaft on the outside of the panel, then remove the nut on the back of the panel behind the control knob.
- Remove the wiring to the temperature control and note the connections.
- Remove the control and replace the new unit by reversing the above procedure.

6.8 Replacing Pilot Lights

- Turn the incubator off and disconnect it from the power source.
- Remove the screws securing the right side access panel. Remove the panel and set aside.
- Disconnect the wiring behind the defective light and break the retaining clip loose. Remove the pilot light.
- Insert the new pilot light from the front of the panel and install the new retaining clip.
- Reconnect the wiring.

6.9 Replacing the Circuit Breaker

- Turn the incubator off and disconnect it from the power source.
- Remove the screws securing the right side access panel. Remove the panel and set aside.
- Remove the two nuts securing the circuit breaker mounting plate to the control panel.
- Remove the nut securing the circuit breaker to its mounting plate.
- Remove the wiring and note the connections.
- Install the new circuit breaker by reversing the above procedure.

6.10 Replacing the Power Switch

- Turn the incubator off and disconnect it from the power source.
- Remove the screws securing the right side access panel. Remove the panel and set aside.
- Remove the two nuts securing the power switch to the mounting bracket.
- Remove the two screws and two nuts securing the power switch to the bracket.
- Remove the wiring and note the connections.
- Install the new power switch by reversing the above procedure.

6.11 Replacing the Thermistor

- Turn the incubator off and disconnect it from the power source.
- Remove the screws securing the right side access panel. Remove the panel and set aside.
- Locate the thermistors and remove the Silastic around the thermistor cable.
- Pull the defective thermistor out of the probe sheath.

- Cut the wires to the defective thermistor, making note of the connections.
- Attach the new thermistor using the electrical in-line connectors.
- Install the new thermistor by reversing the above procedure. Take care not to damage the probe tip and make sure that the probe is fully extended in the sheath. Reseal the port with Silastic or similar material.

6.12 Replacing the 0.3 Amp Fuse

The 0.3 amp fuse is located in the center of the control panel tray behind the CO_2 monitor module housing. (See the fuse replacement chart in Section 6.14)

To replace the fuse:

- Turn the incubator off and disconnect it from the power source.
- Remove the 10 screws securing the right side access panel. Remove the panel and set aside.
- Use a fuse puller or a small screwdriver to lift one end of the fuse. Remove the fuse and discard it.
- Insert a new 0.3 Amp fuse into the fuse holder.
- Re-secure the control panel.
- Connect power to incubator. Turn power switch ON and check operation of controls.

6.13 Replacing the Blower Motor

- Turn the incubator off and disconnect it from the power source.
- Remove the shelves, duct sheets and blower channel from the incubator interior.
- Remove and save the bottom blower wheel located inside the chamber by firmly pulling it down. Remove the snap ring (if present) from the motor shaft groove using needle-nose pliers.

- Remove the four wing nuts that secure the blower mounting plate to the incubator ceiling.
- Pull the blower motor assembly down into the chamber area.
- Remove and save the upper blower wheel/blower blade.
- Cut the tie wrap(s) securing the blower wires to the blower shield plate. *Note: An extra tie wrap has been provided for resecuring the electrical wiring.*
- Disconnect the blower motor electrical connectors and remove the bushing securing the blower motor wiring.
- Remove and save the two #6 nuts, washers and nylon spacers that secure the blower motor. Discard the old blower motor. S*ave the #6 nuts, nylon spacers and washers.*
- Remove the snap ring from the new blower motor shaft.
- Install new blower motor using the #6 nuts, nylon spacers and washers from step #9.
- Reconnect the wires to the blower motor.
- Install the snap bushing (located around the electrical wires from the blower motor) in the top of the blower shield plate.
- Reinstall the new snap ring on the motor shaft groove.
- Reinstall the lower blower wheel (inside the chamber) by pushing the blower wheel up against the snap ring.
- Reinstall the upper blower wheel/blower blade.
- Place the blower motor assembly into its original position.

Caution: Make sure that the vinyl tubing is not kinked and the wiring is not in contact with the top blower wheel.

6.14 Fuse Chart

Fuse	Manufacturer's Part No.	Amp Rating	Rupture Speed
Control	Buss MDL-3/10	0.3 Amp	Time Lag
230VAC (3548 only)	Buss MDL-3	3.0 Amp	Time Lag

Section 7 - Features, Specifications and Accessories

Models 3546/3548

7.1 Construction

- Fiberglass insulation combines with the water jacket to form triple-wall protection of the chamber.
- Smooth, seam-welded stainless steel interior provides a crevice-free chamber, reducing contamination.
- Fill and drain ports are located in front for easy access. through-wall access port in chamber is provided.
- Controlled heat in outer door prevents condensation on the inner glass door.

7.2 CO_2 Control Features

- CH/P® self-diagnostic electronics monitor and control CO_2 across the full 0-20% range. Tamper-resistant digital setpoint can be adjusted to within 0.1% and easily checked. Module also displays gas percentage on LCD readout.
- Audible and visual alarms indicate CO_2 deviations 1% above or below setpoint. Standard alarm delay avoids "nuisance alarms" during door openings. Audible alarm can be silenced. CO_2 alarm system will be reactivated when incubator returns to within 1% of setpoint.
- Automatic CO_2 control drastically reduces gas consumption.
- Forma's CO_2 sensor is a dependable, time-proven, solid-state thermal conductivity type which features sintered filter and glass bead, matched thermistors.
- If power fails, CO_2 is automatically disabled.
- CO_2 passes through an in-line micro biological filter.
- Optional built-in CO_2 Gas Guard ensures continuous gas supply.

7.3 Temperature Control

- Chamber temperature is constantly displayed on easy-to-read LCD.
- Independent, electronic, dual temperature controller maintains chamber temperature at a fixed +37°C or adjustable from +5°C above ambient to +60°C.
- CH/P module maintains overtemperature safety limit independent of temperature controller for true safety back-up. Limits are adjustable in 0.1°C increments. Audible and visual alarms warn of temperature deviations. Audible alarm can be silenced with 30 minute ringback.
- Tamper-resistant controls prevent alteration of overtemperature safety settings.

7.4 Specifications and Accessories

Temperature Control

Range: +5°C above ambient to +60°C (140°F)
Sensitivity: ±0.05°C
Uniformity: ±0.2°C @ +37°C (98.6°F)
Alarm Monitor: Audible and visual signals indicate deviation above selected setpoints

CO_2 Gas Control:

Self-diagnostic module, 0-20% CO_2 control: Better than ±0.1%

Relative Humidity

98% RH @ 37°C (98.6°F)

Dimensions

Interior 19.7"W x 26.8"H x 18.7"F-B (50.03 cm x 68.07 cm x 47.49 cm)
Exterior: 31.9"W x 37.5"H x 23.8"F-B (81.02 cm x 95.25 cm x 60.45 cm)

Capacity

5.7 cu.ft. (161.4 liters)

Shelves

5 electropolished, stainless steel

Electrical

3546: 90-130 VAC, 1 PH, 50/60 HZ, 4.2 FLA

3548: 180-260 VAC, 1 PH, 50/60 HZ, 2.6 FLA

Data Output: 10mv/unit temperature & CO_2

Accessory Outlet: 115V (75 Watts Max., 500uA Max. leakage)

Remote Alarm Contacts: Overtemperature, add water, power failure, CO_2 deviation

Weight

Net	233 lbs. (106 kg)
Net Operational	335 lbs. (152 kg)

Shipping:

Motor	300 lbs. (136 kg)
Air	350 lbs. (159 kg)
Ocean	400 lbs. (181 kg)

Construction

Interior 20 Gauge 304 2B Stainless Steel
Exterior 18 Gauge Cold Rolled Steel
Insulation 1-1/2" (3.8 cm) Fiberglass
Inner Door 1/4" (0.62 cm) Fully Tempered Safety Glass with Cam Action Latch

Finish: Powder coated for a durable, easily maintained surface.

Accessories

Description	Stock #
Blower Wheel Replacement Kit	90247
Electropolished Stainless Steel Shelf	224140
Stainless Steel Humidification Pan Kit	237001
Disposable Microbiological Filter	770001
Tissue Culture Shelf	500171
Stacking Adapter	190265
Floor Stand	505097

Temperature Recorders available upon request.

Accessories

Description	Stock #
Blower Wheel Replacement Kit	90247
Electropolished Stainless Steel Shelf	224140
Stainless Steel Humidification Pan Kit	237001
Disposable Microbiological Filter	770001
Tissue Culture Shelf	500171
Stacking Adapter	90265
Floor Stand	505097
Built-In Gas Guard	190410

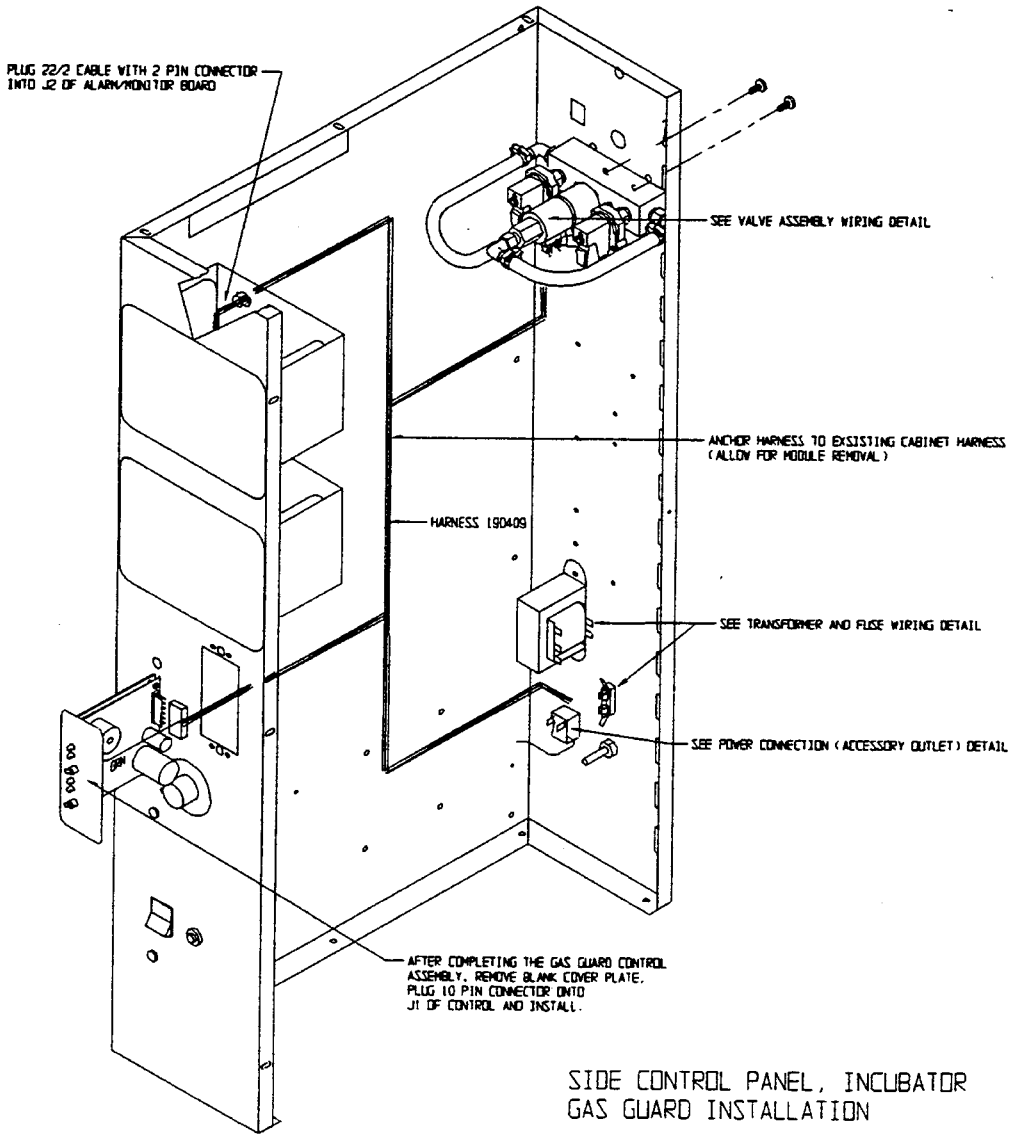
Section 8 - Parts List

Stock #	Description
770001	CO_2 Disposable Filter
250085	CO_2 Solenoid Valve 12VDC, 3W
300164	Over Temp Relay
431142	Four Sided Molded Magnetic Gasket
400296	Silicon Feather Gasket
230094	Glass Fuse .3A (Slow-Blow Type)
280004	#312 Green Pilot Light
280006	#312 Amber Pilot Light
285379	25A Triac
100071	Blower Wheel
156065	Blower Motor
231167	Alarm/Monitor Module
231142	CO_2 Control Module
231047	Temperature Control
290027	1K, Thermistor Cable
285057	Extender Card Module
132007	Heater, 120V, 6 Watt
230166	Fuse 3 Amp TD (3548 only)

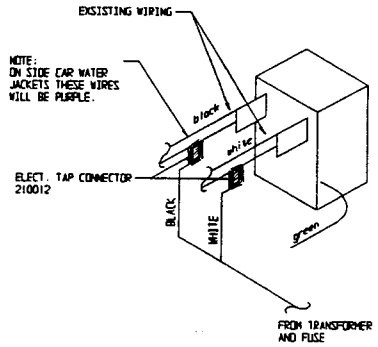
Factory Installed Gas Guard

230094	Fuse, .3A Time Delay
420081	Transformer, 20 VCT, 56VA
190411	Gas Guard Control

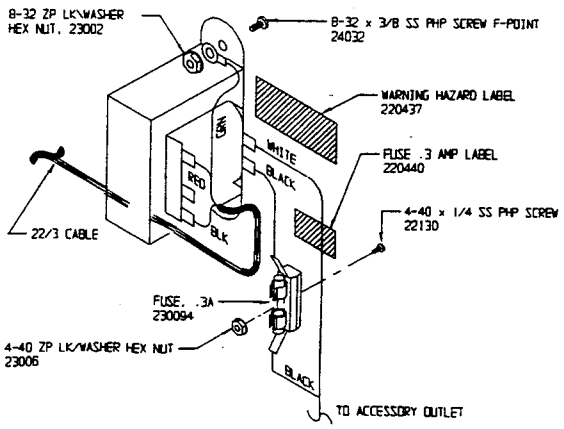
Section 9 - Schematics



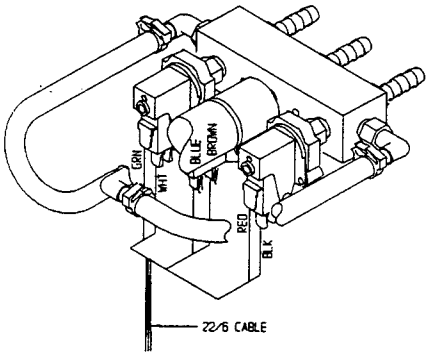
SIDE CONTROL PANEL, INCUBATOR
GAS GUARD INSTALLATION



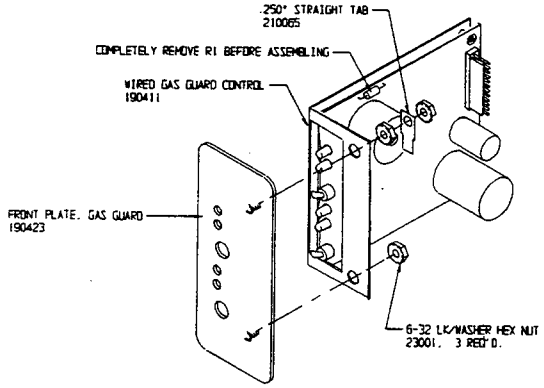
POWER CONNECTION (ACCESSORY OUTLET) DETAIL



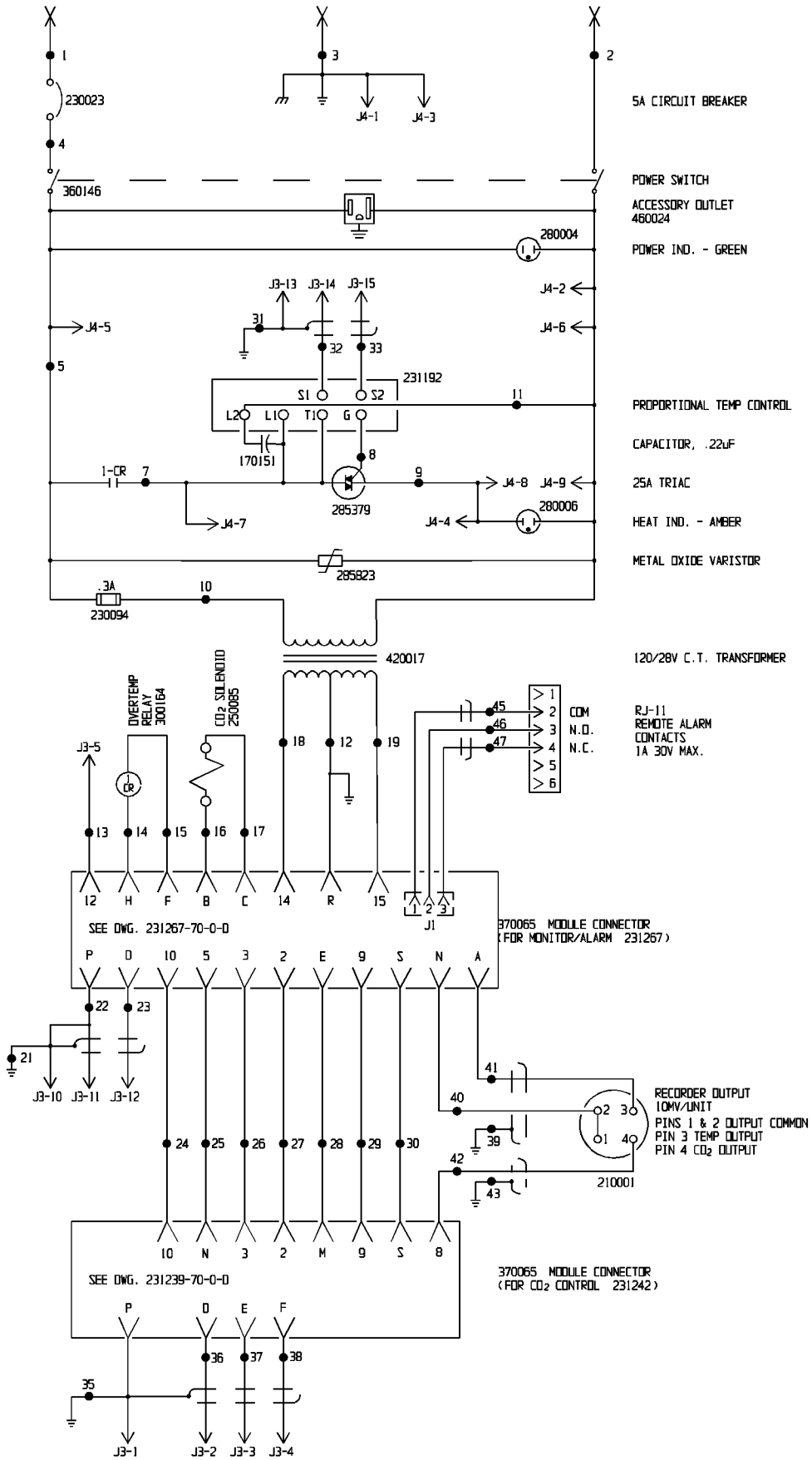
TRANSFORMER (420081) AND FUSE CLIP (230039)
WIRING DETAIL - SIDE CONTROL PANEL



VALVE ASSEMBLY (190422) WIRING DETAIL



GAS GUARD CONTROL ASSEMBLY DETAIL



Electrical Schematic
Forma Model:
3546
Water Jacket Incubator
Control Panel

140179-70-0-D Rev. 4
Page 1 of 3

EXTERNAL CONNECTIONS

J4-1 CABINET (GROUND)

J4-2 BLOWER MOTOR (NEUTRAL)

J4-3 BLOWER MOTOR (GROUND)

J4-4 MAIN CHAMBER HEATER, MAIN DOOR HEATER (120VAC CYCLED)

J4-5 BLOWER MOTOR (120VAC)

J4-6 MAIN CHAMBER HEATER, MAIN & SW DOOR HEATERS (NEUTRAL)

J4-7 SW DOOR HEATER (120VAC)

J4-8 6W CHAMBER HEATER (120VAC CYCLED)

J4-9 6W CHAMBER HEATER (NEUTRAL)

J3-1 CO_2 SENSOR, SHIELD

J3-2 CO_2 SENSOR, REFERENCE CELL

J3-3 CO_2 SENSOR, COMMON

J3-4 CO_2 SENSOR, CO_2 CELL

J3-5 ADD WATER SENSOR

J3-6 NOT USED

J3-7 NOT USED

J3-8 NOT USED

J3-9 NOT USED

J3-10 OVERTEMP SENSOR, SHIELD

J3-11 OVERTEMP SENSOR

J3-12 OVERTEMP SENSOR

J3-13 CONTROL SENSOR, SHIELD

J3-14 CONTROL SENSOR

J3-15 CONTROL SENSOR

WIRE REFERENCE CHART

WIRE #	GA.	COLOR	
1	16	BLK	
2	16	WHT	
3	16, 20	GRN	
4	20	BLK	
5	20	PUR	
6			
7	20	BLK	
8	20	YEL	
9	20	RED	
10	20	BLK	
11	20	WHT	
12	20	GRN	
13	20	BRN	
14	20	BLU	
15	20	BLU	
16	20	ORG	
17	20	ORG	
18	20	YEL	
19	20	YEL	
20			
21	24	SHLD	CABLE
22	24	BLK	
23	24	CLR	
24	20	BLK	
25	20	YEL	
26	20	RED	
27	20	BRN	
28	20	PUR	
29	20	ORG	
30	20	GRN	
31	24	SHLD	CABLE
32	24	BLK	
33	24	CLR	
34			
35	22	SHLD	CABLE
36	22	RED	
37	22	BLK	
38	22	WHT	
39	22	SHLD	CABLE
40	22	BLK	
41	22	RED	CABLE
42	22	WHT	
43	22	SHLD	
44			
45	22	GRN	CABLE
46	22	RED	
47	22	BLK	

CUSTOMER APPROVAL/REFERENCE
APPROVED BY _____
APPROVING FIRM _____
DATE OF APPROVAL _____

REV	ECR NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
4	IN-2402	06-23-98	JAS	PDK	HEG	REVISED RECORDER OUTPUT WIRING
3	SI-6866	03-12-98	RTB	KDG	LDN	TEMP. CONTROLLER BOARD CHG.
2	IN-2186	11-21-96	GLM	PDK	LDN	IEC-1010 UP-DATES
1	IN-2003	10-25-95	JAS	JAS	LDN	REV. MODULE NOS. - CE MARK
0	N/A	08-20-93	GLM	KDG	LDN	RELEASED FOR PRODUCTION

NOTES:

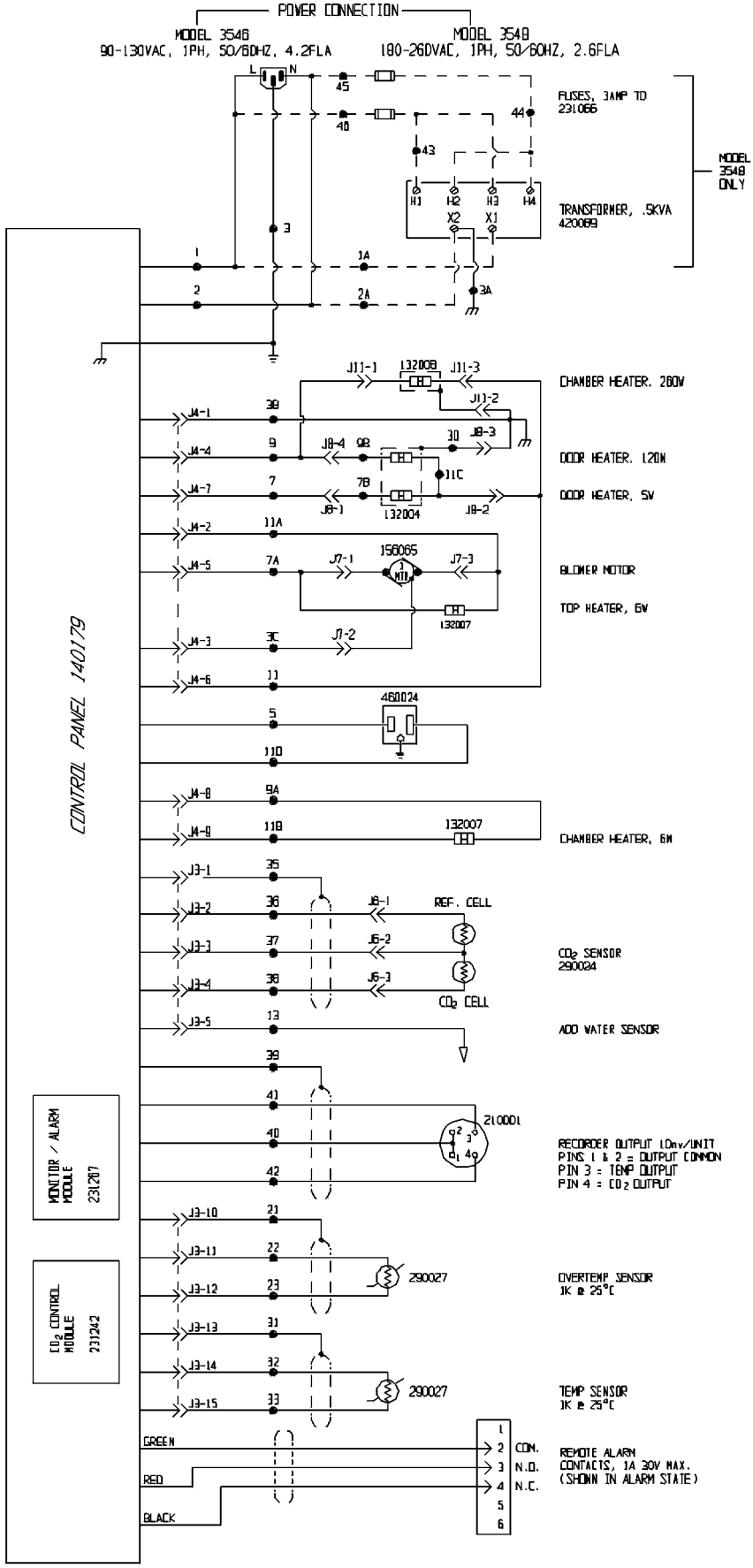
⊛	Denotes Terminal Strip Connection	Parts List Reference Number	
1-CR	Last Relay Number	○	Assembly
N/A	Last Terminal Number	⬠	Panel
47	Last Wire Number	⬡	Refrigeration
		□	Wiring

Forma Scientific
BOX 649 MARIETTA, OHIO 45750 TELEX 24-5394
TOLL FREE USA 800-848-3080, OHIO 614-373-4763

DATE 8-20-93	DWN JAS	CAD PDK	APPD LDN	SCALE NTS
CUSTOMER 140179				
JOB TITLE CONTROL PANEL (WIRED) 3546 W/J INC.				
DWG TITLE ELECTRICAL SCHEMATIC				
LOCATION STKNOS01	JOB NUMBER	DRAWING NUMBER 140179-70-0-D		

Electrical Schematic
Forma Model:
3546
Water Jacket Incubator
Control Panel

140179-70-0-D Rev. 4



Electrical Schematic
Model:
3546 and 3548
Incubators

3546-70-0-0 REV.13
Page 1 of 2

WIRE REFERENCE CHART

WIRE #	GAUGE	COLOR	
1	16	BLK	
1A	16	BLK	
2	16	WHT	
2A	16	WHT	
3	16	GRN/YEL	
3A	16	GRN/YEL	
3B	20	GRN	
3C	20	GRN	
3D	18	GRN	
5	20	PUR	
7	20	BLK	
7A	20	BLK	
7B	18	BLK	
9	20	RED	
9A	18	BLK	
9B	18	RED	
11	20	WHT	
11A	20	WHT	
11B	18	BLK	
11C	18	WHT	
11D	20	WHT	
13	20	GRN	
21	24	SHLD	CABLE
22	24	BLK	
23	24	CLR	
31	24	SHLD	CABLE
32	24	BLK	
33	24	CLR	
35	22	SHLD	CABLE
36	22	RED	
37	22	BLK	
38	22	WHT	
39	22	SHLD	CABLE
40	22	BLK	
41	22	RED	
42	22	WHT	
43	16	WHT	
44	16	RED	
45	16	GRN	
46	16	BLU	

REV	ECR NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
13	SI-7353	02-08-99	WLG	KDG	CCS	CHG'D TRANSFORMER WIRE COLORS
12	IN-2198	10-29-96	GLM	PDK	LON	IEC-1010 UP-DATES
11	IN-2003	10-25-95	JAS	JAS	LON	REV MODULE NOS - CE MARK
10	IN-1997	10-05-95	MSB	PDK	LON	ADDED 132007 TOP HEATER
9	SI-4877	01-24-95	PAR	KDG	LON	CHG. 275034 TRANSFORMER TO 420089

NOTES:
- ✳ Denotes Splice Connection
- N/A Last Relay Number
- 15 Last Terminal Number
- 46 Last Wire Number

Forma Scientific
BOX 649 MARIETTA, OHIO 45750 TELEX 24-5384
TOLL FREE USA (800)-848-3388, OHIO 614-373-4763

DATE 10-14-85 | DWN OWL | CAD OWL | APPD LON | SCALE NTS
CUSTOMER
JOB TITLE 3546/3548 W/J INCUBATOR W/SIDE CONTROL PANEL
DWG TITLE ELECTRICAL SCHEMATIC
LOCATION INCUBATR | JOB NUMBER | DRAWING NUMBER 3546-70-0-D

Electrical Schematic
Model:
3546 and 3548
Incubators