Forma Scientific, Inc.

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Model: 310 Series*

Direct Heat
CO_2 Incubator

Operating and Maintenance Manual

Manual No: 7000310 Rev. 4

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.

CAUTION! All internal adjustments and maintenance must be performed by qualified service personnel.

Refer to the serial tag on the rear cover of this manual

Refer to listing of models on Page iii.

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Manual No. 7000310

REV	ECR/ECN	DATE	DESCRIPTION	By
4	18943/IN-2794	3/8/00	Updated 310-203 drawing, mounting hdwe & tubing – cntrl panel	ccs
--	18766/IN-2766	12/13/99	Removed RH SNSR ERR alarm	ccs
3	18675/IN-2755 18552/IN-2739	11/10/99	Updated illustated parts lists Blower motor seal change to 730068 & 730069	ccs
--	18457/IN-2721	8/13/99	Updated 310-203 for parts list change	ccp
--	18390/IN-2714	7/6/99	Updated elect. parts drawing -added outlet label P/N 220259	ccp
2	18117/IN-2701	5/25/99	Updated vinyl push rivets to nylon screws in door reverse	ccp
1	18121/IN-2678	3/8/99	Added cord p/n, decl. of conf. for copper, updated parts list	ccp
--	IN-2668	2/10/99	Parts list addition	deg
0		11/98	Original manual	ccp

Model	CO_2 Sensor*	Voltage**
310	T/C	115
311	T/C	230
320	IR	115
321	IR	230
350	T/C	115
351	T/C	230
360	IR	115
361	IR	230

*T/C is a thermal conductivity sensor. IR is an infrared sensor.

**All units are 50/60 HZ

If the incubator is not used in the manner specified in this operating manual, the protection provided by the equipment design may be impaired.

General Safety Notes used in this Manual

	Important operating and/or maintenance instructions. Read the accompanying text carefully. Ce symbole attire l'attention de l'utilisateur sur des instructions importantes de fonctionnement et/ou d'entretien. Il peut être utilisé seul ou avec d'autres symboles de sécurité. Lire attentivement le texte d'accompagnement. Wichtige Betriebs- und/oder Wartungshinweise. Lesen Sie den nachfolgenden Text sorgfältig. Importante instruccions de operacion y/o mantenimiento. Lea el texto acompanante cuidadosamente.

	Potential electrical hazards. Only qualified persons should perform procedures associated with this symbol. Ce symbole attire l'attention de l'utilisateur sur des risques électriques potentiels. Seules des personnes qualifiées doivent appliquer les instructions et les procédures associées à ce symbole. Gefahr von Stromschlägen. Nur qualifizierte Personen sollten die Tätigkeiten ausführen, die mit diesem Symbol bezeichnet sind. Potencial de riesgos electricos. Solo personas das capacitadadas deben ejecutar los procedimientos asociadas con este simbulo.

- √ Always use the proper protective equipment (clothing, gloves, goggles etc.).
- √ Always dissipate extreme cold or heat and wear protective clothing.
- √ Always follow good hygiene practices.
- √ Each individual is responsible for his or her own safety.

Do You Need Information or Assistance on Forma® Products?

If you do, please contact us 8:00 a.m. to 7:00 p.m. (Eastern Time) at:

1-740-373-4763	Direct
1-888-213-1790	Toll Free, U.S. and Canada
1-740-373-4189	FAX
http://www.forma.com	Internet Worldwide Web Home Page
fservice@forma.com	Service E-Mail Address

Our **Sales Support** staff can provide information on pricing and give you quotations. We can take your order and provide delivery information on major equipment items or make arrangements to have your local sales representative contact you. Our products are listed on the Internet and we can be contacted through our Internet home page.

Our **Service Support** staff can supply technical information about proper setup, operation or troubleshooting of your equipment. We can fill your needs for spare or replacement parts or provide you with on-site service. We can also provide you with a quotation on our Extended Warranty for your Forma products.

Whatever Forma® products you need or use, we will be happy to discuss your applications. If you are experiencing technical problems, working together, we will help you locate the problem and, chances are, correct it yourself...over the telephone without a service call.

When more extensive service is necessary, we will assist you with direct factory trained technicians or a qualified service organization for on-the-spot repair. If your service need is covered by the warranty, we will arrange for the unit to be repaired at our expense and to your satisfaction.

Regardless of your needs, our professional telephone technicians are available to assist you Monday through Friday from 8:00 a.m. to 7:00 p.m. Eastern Time. Please contact us by telephone or fax. If you wish to write, our mailing address is:

Forma Scientific, Inc.
Millcreek Road, PO Box 649
Marietta, OH 45750

International customers, please contact your local Forma Scientific, Inc. distributor.

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1.1 Incubator Components

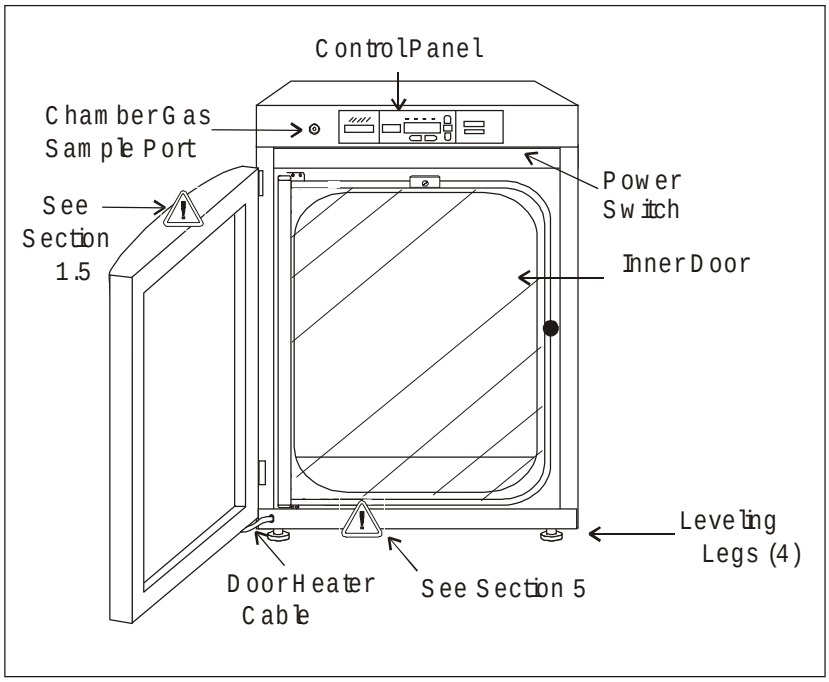


Figure 1-1
Forma® Model 310 Series Direct Heat Incubator

- Outer Door - Reversible to opposite swing, see Section 5.5
- Inner Door - Reversible to opposite swing, see Section 5.5
- Chamber Gas Sample Port - Used for sampling chamber CO_2 content using a FYRITE or similar instrument.
- Main Power Switch
- Control Panel - Keypad, Displays and indicators (See Figure 1-2)
- Leveling Legs - Used to level the unit

Note: The incubators are stackable. See Section 1.5.b.

1.2 Control Panel Keys, Displays and Indicators

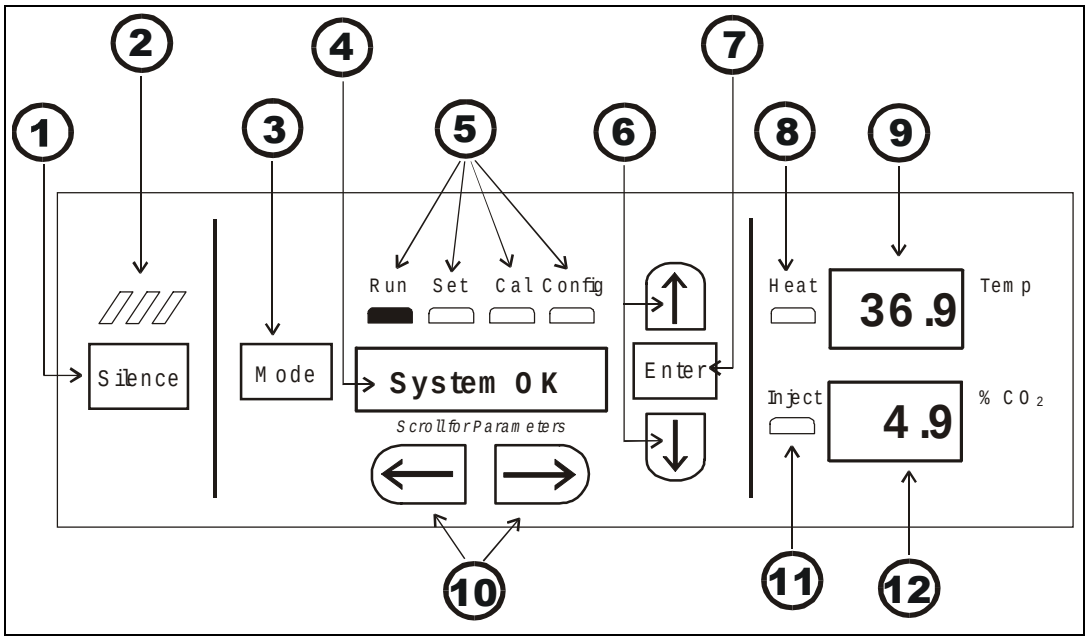


Figure 1-2
Control Panel

1. **Silence** - Silences the audible alarm.

2. Alarm Indicator - Light pulses on/off during an alarm condition in the cabinet.

3. **Mode** Select Switch - Used to select Run, Setpoints, Calibration and System Configuration Modes.

4. Message Center - Displays system status.

5. **Mode** Select Indicators -
   Run: Run Menu
   Set: Set Points Menu
   Cal: Calibrate Menu
   Config: Configuration Menu

6. Up and Down Arrows - Increases or decreases the number values, toggles between choices.

7. **Enter** - Stores the value into computer memory.

8. **Heat** Indicator - Lights when power is applied to the heaters.

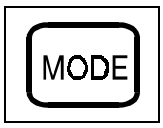
9. **Temp** Display - Program to display temperature continuously, RH continuously (with RH option), or toggle between temperature and humidity (with RH option). See Section 3.1, Configuration.

10. **Scroll for Parameters** Arrows - Moves the operator through the choices of the selected mode.

11. CO_2 **Inject** Indicator - Lights when CO_2 is being injected into the incubator.

12. **% CO_2** Display - Displays CO_2 percentage continuously.

1.3 Operation of the Keypad



The Model 310 Series direct heat incubator has four basic modes which allow incubator setup: Run, Setpoints, Calibration and System Configuration.

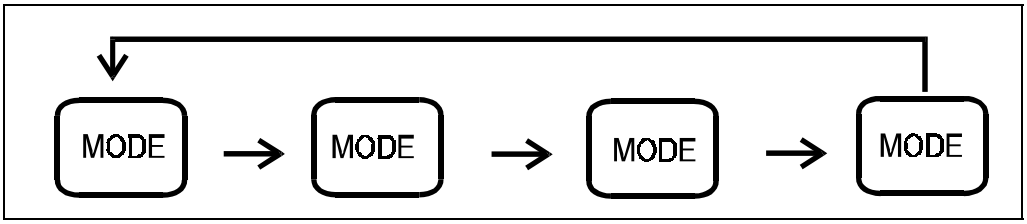
Run is the default mode which the incubator will normally be in during operation.

Set is used to enter system setpoints for incubator operation.

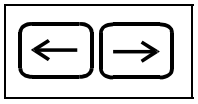
Calibration is used to calibrate various system parameters.

Configuration allows for custom setup of various options.

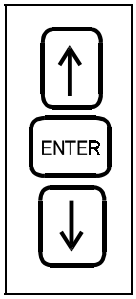
The chart below shows the selections under each of the modes.



RUN	SETPOINT	CALIBRATION	CONFIGURATION
Default Mode	**Temperature**	**Temp Offset**	**Audible**
	Overtemp	**CO_2 Cal**[1]	**Access Code**
	CO_2	**IR Cal**[2]	**Temp Lo Alarm**
		RH Cal	**Temp Relay**
			CO_2 Lo Alarm
			CO_2 Hi Alarm
			CO_2 Relay
			CO_2 Z & S #'s *
			RH Lo Alarm
			RH Relay
			Display Temp
			Display Rh
			Tank Select
			Gas Guard
			RS485 Address
		[1] T/C units only	**Base Unit Displays**
		[2] IR units only	*Option Displays*
			***T/C units only**



Scroll for Parameters Arrows: Steps the operator through the parameters of SET, CAL and CONFIG Modes. The right arrow goes to the next parameter, the left arrow returns to the previous parameter.



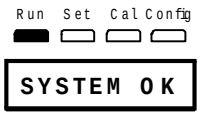
Up Arrow: Increases or toggles the parameter value that has been selected in the SET, CAL, and CONFIG Modes.

Enter: Must press Enter key to save to memory all changed values.

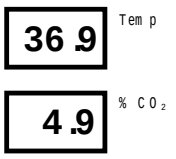
Down Arrow: Decreases or toggles the parameter values that have been selected in the SET, CAL and CONFIG Modes.

Silence Key: Press to silence the audible alarm. See Section 4 for alarm ringback times.

1.4 Displays



Message Center - Displays the system status (Mode) at all times. Displays **SYSTEM OK** during normal operation, or alarm messages if the system detects an alarm condition. See Section 4.1, Alarms.



Upper and Lower Displays - These 7 segment displays vary depending upon the options present and the configuration chosen. The upper display can display temp or RH, or toggle between them. The bottom display shows CO_2 continuously.

1.5 Installing the Incubator

a. Choosing the Location

Single and stacked units must be installed against a wall or similar structure. Maintain a three-inch clearance behind the incubator for electrical and gas hook-ups.

1. Locate the unit on a firm level surface capable of supporting the unit's weight of 205 lbs.
2. Locate the unit away from doors and windows and heating and air conditioning ducts.
3. Lift the unit only by the sides of the cabinet base . Do not attempt to lift it by the front and back . This places stress on the outer door hinges.

b. Stacking the Incubators

When stacking incubators, the direct heat incubator must be the top unit. Never stack a water-jacketed incubator on top of a 310 Series unit.

With incubators in a stacked configuration, do not leave both exterior doors open at the same time.

If the units have been in operation, shut them both off and pull the plugs before beginning any service work..

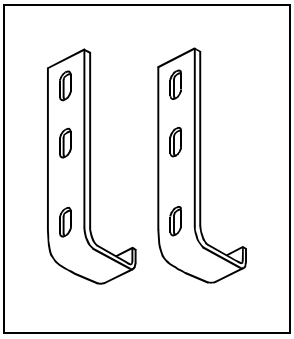


Figure 1-3

Note: Two stacking brackets (shown at left) are included in the parts bag included with each incubator.

1. Unscrew the slotted head screws on the top of the bottom incubator about an inch. Refer to Figure 1-4.

2. Unscrew and remove the leveling feet from the *top* unit and lift it onto the *bottom* unit, offsetting the base of the *top* unit approximately 2-3 inches behind the screws identified by the arrows in Figure 1-4.

3. Remove the kickplate from the top incubator. A Phillips screw on either end secures the plate. Note that the bottom of the incubator frame is notched.

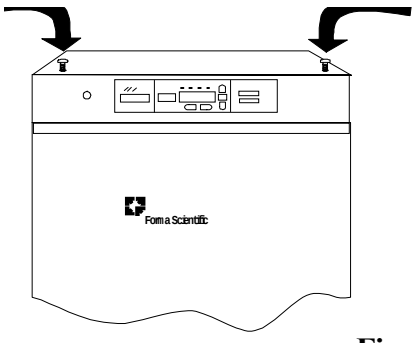


Figure 1-4

This incubator weighs 205 lbs. Have sufficient personnel when lifting.

Lift the unit only by the sides of the cabinet base. Do not attempt to lift it by the front and back as this places stress on the outer door hinge.

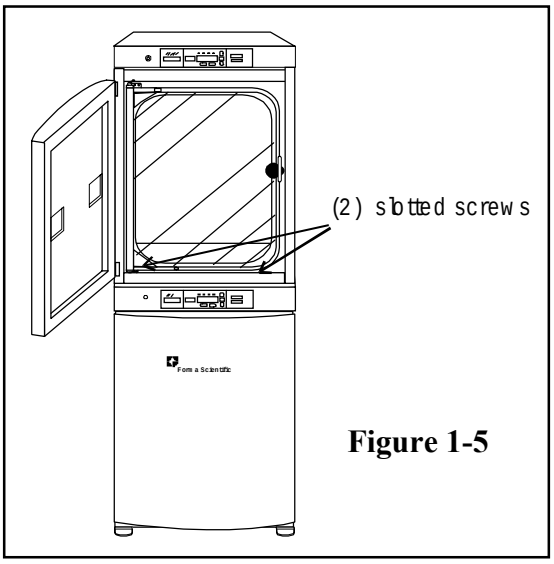


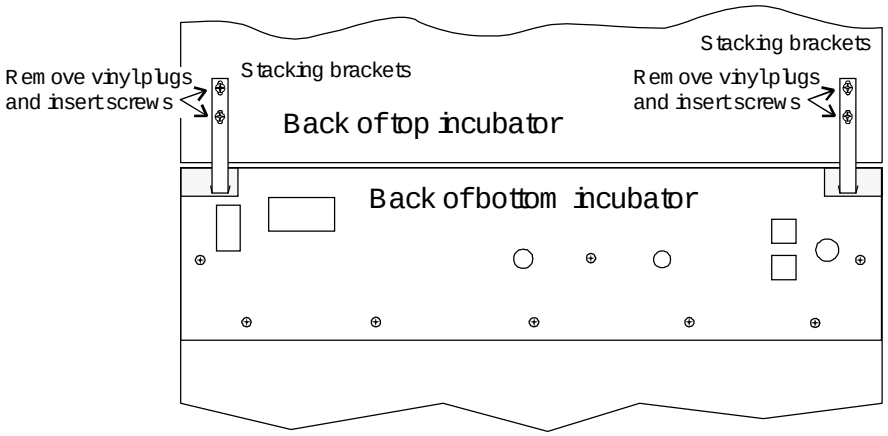
Figure 1-5

4. Align the sides of the *top* unit with the *bottom* unit and slide the *top* unit forward until the notches in the base of the *top* unit align with the (2) slotted screws in the top of the *bottom* unit. Refer to Figure 1-5.

5. Remove the four nylon plugs on the lower portion of the back of the upper incubator.

6. Insert the stacking brackets into the slots on the back of the control panel of the *bottom* unit as shown in Figure 1-6. Align the slots in the brackets with the mounting holes on the back of the top incubator. Secure the brackets with the screws provided in the stacking kit.

Figure 1-6



7. Replace the kick plate on the top unit, taking care not to crimp the door heater cable.
8. The stacked incubators are ready for service.

c. Preliminary Cleaning and Disinfecting

1. Remove the protective plastic coating on the shelf supports and air duct, if present.

2. Using a suitable laboratory disinfectant, disinfect all interior surfaces including shelves and shelf supports, door gaskets, blower wheel and CO_2 sensor. Refer to Section 5.1.

d. Installing the Shelves

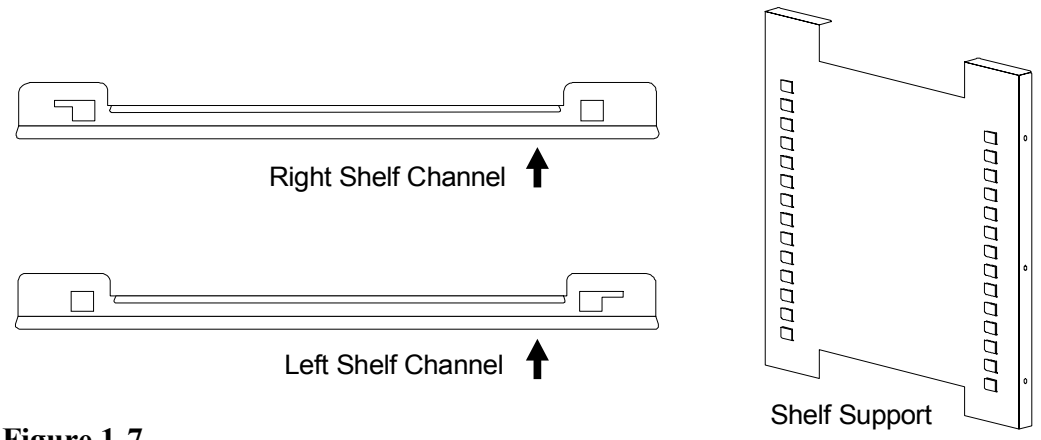


Figure 1-7

1. Install the large sheet metal shelf supports with the tabs facing into the center of the chamber with their slots up. There are no right side or left side supports, simply turn one of them to fit the opposite side. Tilt the shelf supports as they are placed in the chamber so the tops fit into the top air duct, then guide them into the vertical position. Figure 1-7 shows the support as it would be oriented for the right side of the chamber.

2. Referring to Figure 1-7, note that there *are* left side and right side shelf channels.

3. Install the shelf channels by placing the channel's rear slot over the appropriate rear tab on the shelf support. Pull the shelf channel forward and engage the channel's front slot into the shelf support's appropriate forward tab. Refer to Figure 1-8.

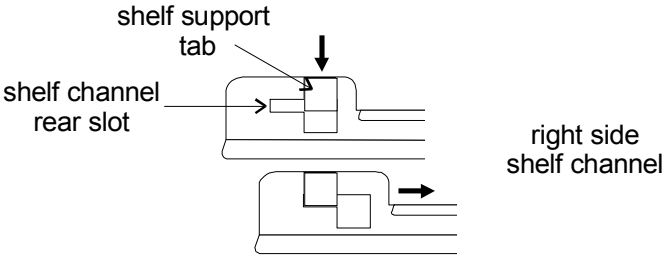


Figure 1-8

Figure 1-9 shows one of the channels installed on the right shelf support.

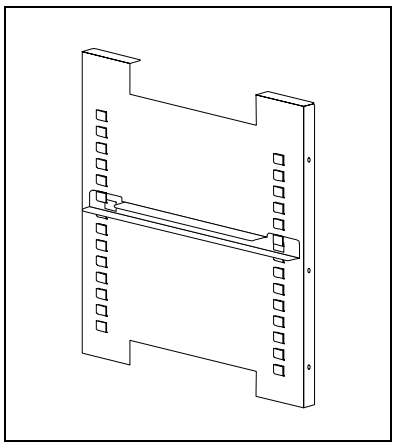


Figure 1-9

e. Installing the Access Port Filter

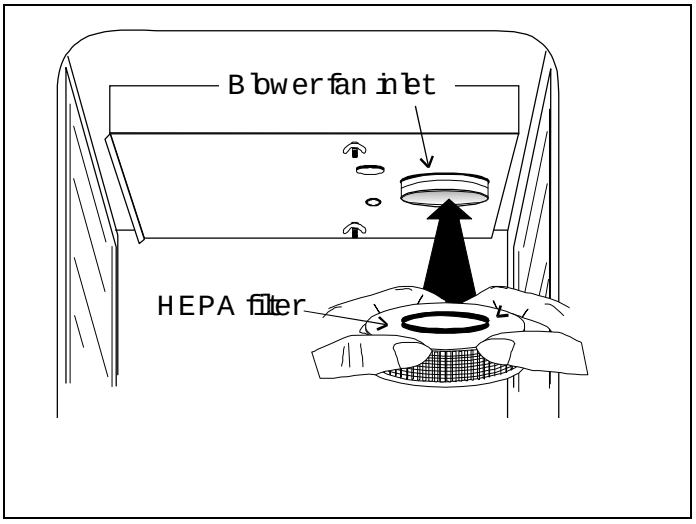
Locate the opening in the top left corner of the interior chamber. Install the smaller, beveled end of the stopper into the opening. See Figure 1-11.

f. Installing the (optional) HEPA Filter

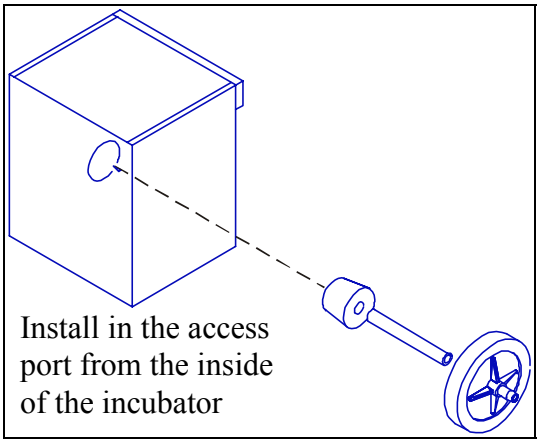
Use caution when handling the filter. The media can be damaged if it is mishandled.

To avoid damage to the incubator, do not operate the unit without the HEPA filter in place.

1. Remove the filter from the shipping box.
2. Remove the plastic coating from the filter, using caution not to touch the filter media.
3. Install the filter as shown in Figure 1-10. Refer to Section 5.6 for HEPA filter maintenance.



HEPA Filter **Figure 1-10**



Access Port Filter **Figure 1-11**

g. Leveling the Unit

Check for level by placing a bubble style level on one of the shelves. Turn the hex nut on the leveler counterclockwise to lengthen the leg or clockwise to shorten it. Level the unit front-to-back and left-to-right.

h. Connecting the Unit to Electrical Power

See the serial tag on the side of the unit for electrical specifications or refer to the electrical schematics at the end of this manual.

Connect the incubator to a grounded, dedicated circuit.

The power cord connector is the mains disconnect device for the incubator. Position the incubator so the unit can be easily disconnected.

Plug the provided power cord into the power inlet connector on the back of the cabinet (See Figure 1-12), then into the grounded, dedicated, electrical circuit.

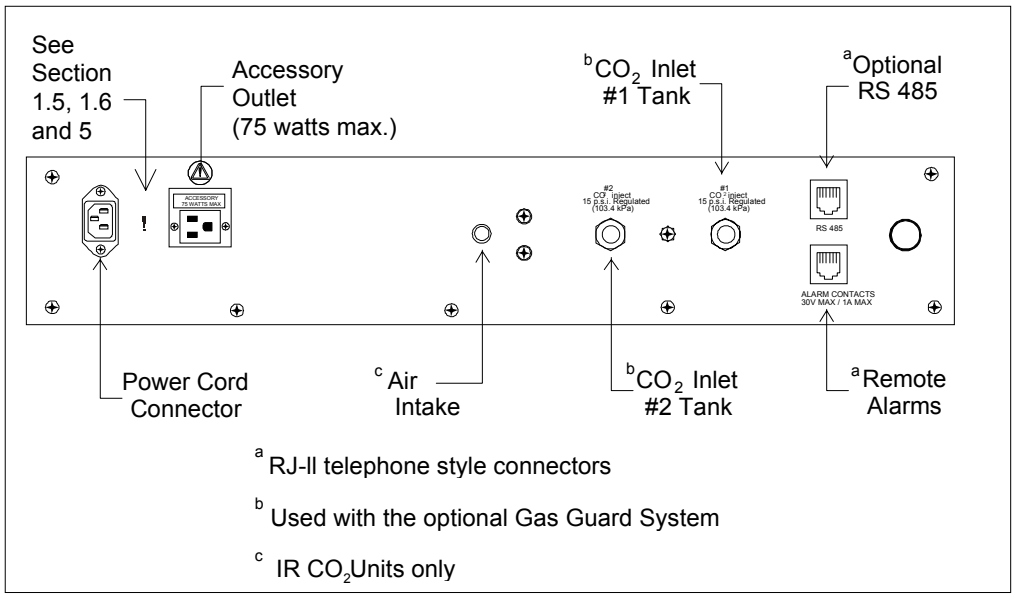


Figure 1-12

i. Filling the Humidity Pan

Fill the humidity pan with sterile distilled water to within 1/2" of the top. Place the pan directly in the center of the incubator floor to ensure best humidity and temperature response.

For applications requiring abnormally high humidity, the pan should be placed against the left side wall of the incubator. The ductwork has been modified to allow the pan to be placed against the wall of the incubator. In some ambient conditions, this may cause condensation to form in the chamber.

For best operation of the incubator, sterilized distilled, demineralized or de-ionized water should be used in the humidity pan. Water purity should be in the resistance range of 50K Ohm/cm to 1M Ohm/cm, or a conductivity range of 20.0 uS/cm to 1.0 uS/cm. Refer to ASTM Standard D5391-93 or D4195-88 for measuring water purity.

Distillation systems, as well as some types of reverse osmosis water purity systems, can produce water in the quality range specified. Tap water is not recommended as it may contain chlorine, which can deteriorate the stainless steel. Tap water may also have a high mineral content, which would produce a build-up of scale in the reservoir. High purity, ultra pure or milli-q water is not recommended as it is an extremely aggressive solvent and will deteriorate the stainless steel. High purity water has a resistance of above 1M Ohm to 18M Ohm. Even high purity water can contain bacteria and organic contaminants. Water should always be sterilized or treated with a decontaminant, safe for use with stainless steel as well as safe for the product, prior to being introduced into the humidity pan.

Check the level and change the water frequently to avoid contamination. Do not allow the water level to fluctuate significantly. "Dry-outs" will have an adverse effect on the humidity level and CO_2 calibration of the T/C units.

Distilled or de-ionized water used in the humidity pan must be within a water quality resistance range of 50K Ohm/cm to 1M Ohm/cm to protect and prolong the life of the stainless steel. Use of water outside the specified range will decrease the operating life of the unit and may void the warranty.

j. Connecting the CO_2 Gas Supply

High concentrations of CO_2 gas can cause asphyxiation!

OSHA Standards specify that employee exposure to carbon dioxide in any eight-hour shift of a 40-hour work week shall not exceed the eight-hour time weighted average of 5000 PPM (0.5% CO_2). The short term exposure limit for 15 minutes or less is 30,000 ppm (3% CO_2). Carbon dioxide monitors are recommended for confined areas where concentrations of carbon dioxide gas can accumulate.

This incubator is designed to be operated with CO_2 gas only. Connecting a flammable or toxic gas can result in a hazardous condition.

Gases other than CO_2 should not be connected to this equipment. CO_2 gas cylinders have a UN1016 label on the cylinder and are equipped with a CGA 320 outlet valve. Check the gas cylinder for the proper identification labels. The CO_2 gas supply being connected to the incubator should be industrial grade, 99.5% pure. Do not use CO_2 gas cylinders equipped with siphon tubes. A siphon tube is used to extract liquid CO_2 from the cylinder which can damage the pressure regulator. Consult with your gas supplier to ensure that the CO_2 cylinder does not contain a siphon tube. Gas cylinders should also be secured to a wall or other stationary object to prevent them from tipping.

A two-stage CO_2 pressure regulator is required to be installed on the outlet valve of the gas cylinder. Input pressure to the incubator must be maintained at 15 psig (103.4 kPa) for proper performance of the CO_2 control system. A single stage CO_2 pressure regulator will not maintain 15 psig (103.4 kPa) to the incubator as the pressure in the CO_2 cylinder decreases; therefore, a two stage regulator is recommended.

If higher purity CO_2 is desired inside the incubator (greater than 99.5% pure), the pressure regulator should be constructed with a stainless steel diaphragm, along with specifying the purity of the CO_2 from the gas supplier. Follow the manufacturer's instructions to ensure proper and safe installation of the pressure regulator on the gas cylinder.

Consult your facility safety officer to ensure that the equipment is installed in accordance with the codes and regulations that are applicable in your area.

The CO_2 gas supply being connected should be industrial grade 99.5% pure and should not contain siphon tubes. Install a two-stage pressure regulator at the cylinder outlet. The high pressure gauge at the tank should have 0-2000 psig range. The low pressure gauge, at the incubator inlet, should have a 0-30 psig range. Input pressure to the incubator must be maintained at 15 psig (103.4 kPa).

The incubator has serrated fittings on the back of the cabinet to connect the gas supply. Refer to Figure 1-12. The fitting is labeled CO_2 Inlet #1 Tank. Make sure that the connections are secured with clamps. Check all fittings for leaks.

For units having the CO_2 Gas Guard option, refer to Section 6.2.

1.6 Incubator Start-Up

With the incubator properly installed and connected to power, the humidity pan filled, and the unit connected to gas supplies, system setpoints can be entered. The following setpoints can be entered in Set mode: Temperature, Overtemperature and CO_2. To enter Set mode, press the Mode key until the Set indicator lights. Press the right and/or left arrow keys until the proper parameter appears in the message center. See Chart 1-1 for more detail.

a. Setting the Operating Temperature

All 310 Series incubators have an operating temperature range of 10°C to 50°C, depending on ambient temperature. The incubator is shipped from the factory with a temperature setpoint of 10°C. At this setting, all heaters and alarms are turned off. To change the operating temperature setpoint:

1. Press the Mode key until the Set indicator lights.
2. Press the right arrow until “Temp XX.X” is displayed in the message center.
3. Press the up/down arrow key until the desired temperature setpoint is displayed.
4. Press Enter to save the setpoint.
5. Press the Mode key until the Run indicator lights for Run mode or press the right/left arrow keys to go to next/previous parameter.

b. Setting the Overtemp Setpoint

The independent overtemp system is designed as a safety to protect the incubator only. It is not intended to protect or limit the maximum temperature of the cell cultures or customer's equipment inside the incubator if an overtemp condition occurs.

Forma 310 Series incubators are equipped with a secondary temperature monitoring system to monitor the air temperature inside the cabinet. This system is designed as a safety device to turn off all heaters in the event of a temperature control failure. Temperature control in the incubator will be +/- 1°C around the overtemp setpoint.

The overtemperature is set by the factory (default) at 40°C. However, the overtemp can be reset over a range from 0.5°C to 60°C above the temperature setpoint.

If the incubator's operating temperature setpoint is set above the overtemp setpoint, the overtemp setpoint will automatically update to 1°C above the temperature setpoint. It is recommended that the overtemp setpoint be maintained at 1°C over the operating temperature setpoint.

To set the Overtemp setpoint:

1. Press the Mode key until the Set indicator lights
2. Press the right arrow until Otemp XX.X is displayed in the message center
3. Press the up or down arrow key until the desired Overtemp setpoint is displayed
4. Press Enter to save the setting
5. Press the Mode key until the Run indicator lights or press the right or left arrow to go to the next or previous parameter.

c. Setting the CO_2 Setpoint

All T/C CO_2 cells are calibrated at the factory at 37°C, high humidity, and 10% CO_2. Therefore, if a temperature setpoint of 37° C has been entered, the humidity pan has been filled and the CO_2 control is to run between 0-10% with a T/C CO_2 sensor, the CO_2 setpoint may be entered immediately. Otherwise, it is important to allow the unit 12 hours to stabilize at the temperature setpoint before entering the CO_2 setpoint.

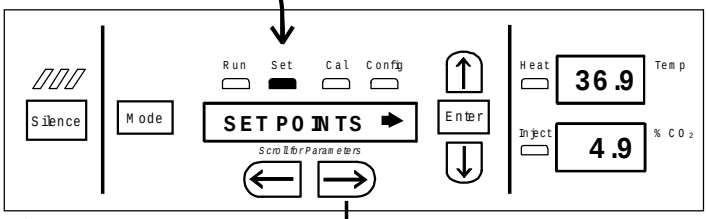
All models of the incubator have a CO_2 setpoint range of 0.0% to 20.0%. The incubator is shipped from the factory with a CO_2 setpoint of 0.0%. At this setting, all CO_2 control and alarms are turned off. To change the CO_2 setpoint:

1. Press the Mode key until the Set indicator lights.
2. Press the right arrow until "CO2 XX.X" is displayed in the message center.
3. Press the up/down arrows until the desired CO_2 setpoint is displayed.
4. Press Enter to save the setpoint.
5. Press the Mode key until the Run indicator lights to go to Run mode or press the right/left arrow keys to go to next/previous parameter.

Chart 1-1

Set Mode

Press MODE to light SET



To Set:

Operating Temperature

Press MODE to move to CALIBRATE mode

Mode

TEMP XX.X C

Scroll for Parameters

Press ← to return to previous parameter

Enter

Numbers increase

Press Enter to save setting

Numbers decrease

Over Temperature

Mode

OTEMP XX.X C

Scroll for Parameters

Press ← to return to previous parameter

Enter

Numbers increase

Press Enter to save setting

Numbers decrease

Percent CO_2

Mode

CO2 XX.X%

Scroll for Parameters

Press ← to return to previous parameter

Enter

Numbers increase

Press Enter to save setting

Numbers decrease

Section 2 - Calibration

2.1 Calibration Mode

After the unit has stabilized, several different systems can be calibrated. In the calibration mode, the air temperature, CO_2 and RH levels can be calibrated to reference instruments. To access the calibration mode, press the Mode key until the Cal indicator lights. Press the right and/or left arrow until the proper parameter appears in the message center. See Chart 2-1 at the end of this section for more detail.

Calibration frequency is dependent on use, ambient conditions and accuracy required. A good laboratory practice would require at least an annual calibration check. On new installations, all parameters should be checked after the stabilization period.

Prior to calibration, the user should be aware of the following system functions. While the unit is in the calibration mode, all system control functions are stopped so the unit remains stable. Readout of the system being calibrated will appear on the message center. If no keys are pressed for approximately five minutes while in calibration mode, the system will reset to Run mode so control functions are reactivated.

Before making any calibration or adjustments to the unit, it is imperative that all reference instruments be properly calibrated.

a. Calibrating the Temperature

Before calibration, allow the cabinet temperature to stabilize. Place the calibrated instrument in the center of the chamber. The instrument should be in the air flow, not against the shelf.

Temperature Stabilization Periods

Startup - Allow 12 hours for the temperature in the cabinet to stabilize before proceeding.

Already Operating - Allow at least 2 hours after the display reaches setpoint for temperature to stabilize before proceeding.

1. Press the Mode key until Cal indicator lights.
2. Press the right arrow until “TEMPCAL XX.X” appears in the message center.
3. Press up/down arrow to match display to calibrated instrument.
4. Press Enter to store calibration.
5. Press the Mode key to return to Run or the right/left arrow to go to next/previous parameter.

b. Calibrating the Thermal Conductivity CO_2 System

Models 310, 311, 350 and 351 have a thermal conductivity (T/C) CO_2 sensor. Thermal conductivity of the incubator atmosphere is not only effected by the quantity of CO_2 present but also by the air temperature and water vapor present in the incubator atmosphere. In monitoring the effects of CO_2 , air temperature and absolute humidity must be held constant so any change in thermal conductivity is caused by a change in CO_2 concentration.

Changing temperature or changing from elevated humidity to room ambient humidity levels will necessitate a re-calibration of the CO_2 control.

T/C CO_2 Sensor Stabilization Periods

Start -up - The CO_2 sensor has been calibrated at the factory for 37°C and elevated humidity. Allow the temperature, humidity, and CO_2 levels in the chamber to stabilize at least 12 hours before checking the CO_2 concentration with an independent instrument.

Presently operating - Make sure the chamber doors are closed. Allow at least 2 hours after the temperature and CO_2 displays reach their setpoints for chamber atmosphere stabilization.

1. Make sure the stabilization periods outlined above are followed.
2. Sample the chamber atmosphere through the sample port with an independent instrument. Sample the atmosphere at least 3 times to ensure accuracy of the instrument.
3. Press the Mode key until the Cal indicator lights.
4. Press the right arrow until "CO_2 CAL XX.X" is displayed in the message center.
5. Press the up /down arrows to change the display to match the independent instrument.
6. Press Enter to store the calibration.
7. Press the Mode key to return to Run or the right or left arrows to go to the next/ previous parameter.

c. Calibrating the Infrared CO_2 System

Models 320, 321, 360 and 361 have an infrared CO_2 sensor. Infrared CO_2 sensors are not effected by chamber atmosphere temperature or humidity. However, the light detector in the sensor is effected by wide temperature changes. *Therefore, changing temperature setpoints could necessitate a recalibration of the CO_2.* Chamber temperature should be allowed to stabilize before checking CO_2 concentrations with an independent instrument, especially on start-up.

All models equipped with an IR/CO_2 sensor have an automatic calibration which occurs every 24 hours and lasts for 5 to 6 minutes. During automatic calibration, the CO_2 display is blanked out and HEPA filtered room air is pumped through the CO_2 sensor. A new CO_2 calibration value is stored in memory for use as the 0.0% CO_2 reference point. The keypad/ control panel is locked during calibration, with the message center reading "CO2 AUTO CAL".

IR CO_2 Sensor Stabilization Times

Start up- Allow the temperature and the CO_2 of the cabinet to stabilize at least 12 hours before proceeding.

Presently operating - Allow CO_2 to stabilize at least 2 hours at setpoint before proceeding.

1. Measure the CO_2 concentration in the chamber through the gas sample port with a FYRITE or other independent instrument. Several readings should be taken to ensure accuracy.
2. Press the Mode key until the Cal indicator lights.
3. Press the right arrow until "IR CAL XX.X" appears in the message center.
4. Press the up/down arrow to adjust the display to match the independent instrument reading.
5. Press Enter to store the calibration.
6. Once Enter is pressed, the unit will go into a calibration cycle that will last 5 to 6 minutes. The control panel is locked during this cycle.
7. Press the Mode key to return to Run mode.

d. Calibrating Relative Humidity

All 310 Series incubators can be equipped with an optional direct read out relative humidity sensor. This is a readout only of the chamber relative humidity level. It does not provide any control of the relative humidity in the cabinet.

Relative Humidity Stabilization Times

Startup - Allow 12 hours for the relative humidity and temperature in the chamber to stabilize before proceeding.

Already Operating - Allow at least 2 hours after temperature display reaches setpoint for relative humidity to stabilize before proceeding.

1. Place an accurate independent instrument in the center of the chamber. Allow at least 30 minutes for RH to stabilize.
2. Press the Mode key until the Cal indicator lights.
3. Press the right arrow key until "RH CAL XX" appears in the message center.
4. Press the up/down arrow to match the display to the independent instrument.
5. Press Enter to store the calibration.
6. Press the Mode key to return to Run mode.

If a reliable RH measuring device is not available, you may calibrate the display to a typical level;

1. Follow the RH stabilization periods outlined above.
2. With a full humidity pan and stable temperature, the relative humidity in the chamber will be 95%.
3. Using Step 3-5 of the relative humidity sensor adjustment, adjust the display to 95%.
4. This calibration method should be accurate to within 5%.

Chart 2-1

Calibrate Mode

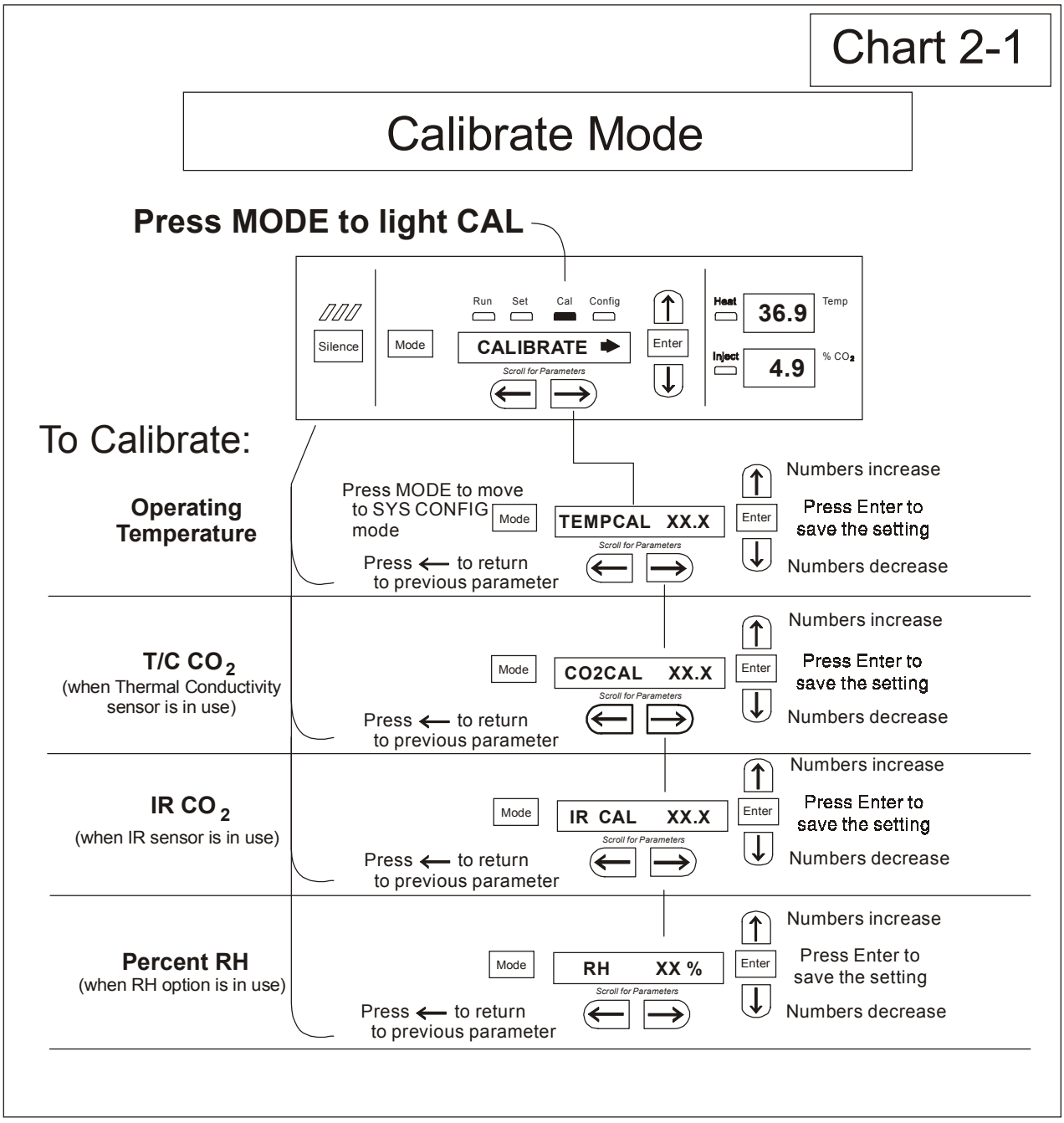


Chart 2-1.cdr

Section 3 - Configuration

3.1 Configuration Mode

Several features available in the Configuration Mode allow custom setup of the incubator. These features are listed and described below. All features may not be necessary in all applications, but are available if needed. To enter Configuration mode, press the Mode key until the Config indicator lights. Press the right and/or left arrow until the appropriate parameter appears in the message center. See Chart 3-1 for more detail.

a. Turning the Audible Alarm ON/OFF

The audible alarm can be turned on or off. The factory setting is ON.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until Audible XXX is displayed in the message center.
3. Press up/down arrow to toggle Audible ON/OFF.
4. Press Enter to save the setting.
5. Press the Mode key to return to run mode or right/left to go to next/previous parameter.

b. Setting an Access Code

A 3 digit Access Code can be entered to avoid unauthorized personnel from changing the setpoints, calibration, or configuration. A setting of 000 will bypass the access code. The factory setting is 000.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until Acc Code XXX is displayed in the message center.
3. Press up/down arrow to change the access code.
4. Press Enter to save the access code.
5. Press the Mode key to return to the Run mode or right/left to go to next/previous parameter.

c. Setting a Low Temp Alarm Limit (tracking alarm)

The low temp alarm limit is the deviation from the temperature setpoint which will cause a low temp alarm. The low temp alarm is variable from 0.5° below setpoint to 5° below setpoint. The factory setting is 1° below setpoint. A minus sign (-) in the display indicates that the alarm setting is below the setpoint.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until Temp Lo -X.X is displayed in the message center.
3. Press up/down arrow to change the low temp alarm limit.
4. Press Enter to save the low temp alarm limit.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

d. Enabling the Low Temperature Alarm to Trip Contacts

The low temperature alarm can be programmed to trip the remote alarm contacts. A setting of ON will cause this, a setting of OFF will not allow temp alarm to trip the contacts. The factory setting is ON.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until TMP RLY XXX is displayed.
3. Press the up/down key to toggle the setting ON/OFF.
4. Press Enter to save the setting
5. Press the Mode key to return to Run or the right/left arrow key to go to next/previous parameter.

e. Setting a Low CO_2 Alarm Limit (tracking alarm)

The low CO_2 alarm limit is the deviation from the CO_2 setpoint which will cause a low CO_2 alarm. The setpoint is variable from 0.5%CO_2 below setpoint to 5.0%CO_2 below setpoint. The factory setting is 1.0%CO_2 below setpoint. A minus sign (-) in the display indicates that the alarm setting is below the setpoint.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until CO_2 Lo -X.X is displayed in the message center.
3. Press up/down arrow to change the low CO_2 alarm limit.
4. Press Enter to save the low CO_2 alarm limit.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

f. Setting a High CO_2 Alarm Limit (tracking alarm)

The high CO_2 alarm limit is the deviation from the CO_2 setpoint which will cause a high CO_2 alarm. The setpoint is variable from 0.5 %CO_2 above setpoint to 5.0 %CO_2 above setpoint. The factory setting is 1.0 %CO_2 above setpoint.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until CO2 Hi X.X is displayed in the message center.
3. Press up/down arrow to change the high CO_2 alarm limit.
4. Press Enter to save the high CO_2 alarm limit.
5. Press the Mode key to return to run mode or right/left to go to next/previous parameter.

g. Enabling CO_2 Alarms to Trip Contacts

High and Low CO_2 alarms can be programmed to trip the remote alarm contacts. A setting of ON will cause this, a setting of OFF will not allow CO_2 alarms to trip the contacts. The factory setting is ON.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until CO2 Rly XXX is displayed in the message center.
3. Press up/down arrow to toggle the setting ON/OFF.
4. Press Enter to save the setting.
5. Press the Mode key to return to Run Mode or right/left to go to next/previous parameter.

h. Setting a New Zero Number for T/C CO_2 Sensors

If a new T/C CO_2 sensor is being installed, the two numbers on the factory installed sticker on the T/C cell must be entered to calibrate the CO_2 in the unit.

Note: For the technician's convenience, a label containing the two numbers on the T/C cell is affixed inside the electronics drawer.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until T/CZ# XXXX is displayed in the message center.
3. Press up/down arrow to change the zero number to match the sticker.
4. Press Enter to save the setting.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

i. Setting a New Span Number for T/C CO_2 Sensors

If a new T/C CO_2 sensor is being installed, the two numbers on the factory installed sticker on the T/C cell must be entered to calibrate the CO_2 in the unit.

Note: For the technician's convenience, a label containing the two numbers on the T/C cell is affixed inside the electronics drawer.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until T/CS# XXXX is displayed in the message center.
3. Press up/down arrow to change the span number to match the sticker.
4. Press Enter to save the setting.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

j. Setting a Low RH Alarm Limit

On units that have the RH option installed, a low RH alarm limit may be entered. The low RH alarm limit is the %RH in the cabinet which will cause a low RH alarm. The setpoint is variable from setpoint 0 to 90% RH The factory setting is 0% RH which will disable the alarm.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until RH Lo XX is displayed in the message center.
3. Press up/down arrow to change the RH low alarm limit.
4. Press Enter to save the RH low alarm limit.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

k. Enabling RH Alarms to Trip Contacts

The low RH alarm can be programmed to trip the remote alarm contacts. A setting of ON will cause this, a setting of OFF will not allow the RH alarm to trip the contacts. The factory setting is ON.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until RH Rly XXX is displayed in the message center.
3. Press up/down arrow to toggle the setting ON/OFF.
4. Press Enter to save the setting.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

l. Enabling Temp/RH to be Displayed

On units that are equipped with the RH option, the upper seven segment display on the control panel can be configured to display Temp continuously, RH continuously, or toggle between Temp and RH. If the units does not have RH the upper display will always display temperature. If temperature is set to ON, and the RH is set OFF temperature will be displayed continuously. If temperature is set to OFF and RH is set to ON, RH will be displayed continuously. If both are turned ON the display will toggle between the two. The factory setting will default to toggle mode if the RH option is present.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until Disp Tmp XXX or Disp RH XXX is displayed in the message center.
3. Press up/down arrow to toggle the setting ON/OFF.
4. Press Enter to save the setting.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

m. Selecting a Primary Tank with the Gas Guard Option

On units equipped with the Gas Guard option, a primary tank can be selected. The primary tank will be either Tank 1 or 2. The factory setting is Tank1 .

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until Tnk Sel X is displayed in the message center.
3. Press up/down arrow to toggle the setting between 1 and 2 .
4. Press Enter to save the setting.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

n. Enabling the Gas Guard System

On units equipped with the Gas Guard option, the Gas Guard system may be turned ON or OFF if it is not in use. The factory setting is OFF.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until Gas Grd XX is displayed in the message center.
3. Press up/down arrow to toggle the setting ON/OFF.
4. Press Enter to save the setting.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

o. Setting a RS485 Communications Address (1535 compatible only)

On units that have the RS485 option, direct communication with the Forma 1535 Model alarm system can be established. Each piece of equipment connected to the 1535 must have a unique address. An address of 0-24 can be entered for the incubator. A setting of 0 is an invalid address that the 1535 will ignore. The factory setting for the RS485 address is 0.

1. Press the Mode key until the Config indicator lights.
2. Press the right arrow until RS485 XX is displayed in the message center.
3. Press up/down arrow to move the RS485 address.
4. Press Enter to save the RS485 address.
5. Press the Mode key to return to Run mode or right/left to go to next/previous parameter.

Section 4 - Alarms

4.1 Alarms

The Model 310 Series incubator alarm system is shown in the table below. When an alarm is active, the message appears in the LED message center. Pressing Silence disables the audible alarm for the ringback period. However, the visual alarm continues until the incubator returns to a normal condition. The alarms are momentary alarms only. When an alarm condition occurs and then returns to normal, the incubator automatically clears the alarm condition and the message center.

Description	Message	Delay	Ringback	Relay
No alarm condition exists	SYSTEM OK	-----	-----	-----
CO2 System Auto Calibrating	CO2 AUTO CAL	-----	-----	-----
Temp > Otemp Set point	SYS IN OTEMP	0 min.	15 min.	Yes
Air Temp Sensor Fault (See Section 4.3)	TMP SENS ERR	0 min.	15 min.	No
Temperature Controller Failure (See Sect. 4.2)	TMP CTRL ERR	0 min.	15 min.	YES
CO2 Sensor Fault (See Section 4.4)	CO2 SENS ERR	0 min.	15 min.	No
CO2 Auto Zero Fault (IR option only, See Sect 4.5)	IR AUTOZ ERR	0 min.	15 min.	No
CO2 Sensor Cannot be Calibrated (IR option only, See Sect. 4.3)	REPL IR SNSR	0 min.	15 min.	No
Inner Door is Open	DOOR OPEN	15 min.	15 min.	No
CO2 > CO2 High Tracking Alarm	CO2 IS HIGH	15 min.	15 min.	Programmable
CO2 < CO2 Low Tracking Alarm	CO2 IS LOW	15 min.	15 min.	Programmable
TEMP < TEMP Low Tracking Alarm	TEMP IS LOW	15 min.	15 min.	Programmable
RH < RH Low Limit Alarm (RH option only)	RH IS LOW	30 min.	30 min.	Programmable
Tank 1 is low, switch to Tank 2 (Gas Guard only)	TANK1 LOW	0 min.	----	No
Tank 2 is low, switch to Tank 1 (Gas Guard only)	TANK2 LOW	0 min.	----	No
Both tanks are low (Gas Guard only)	TANK 1 and 2 LOW	0 min.	15 min.	No

- All alarm delays and ringback times are +/- 30 seconds -

When multiple alarm conditions occur, active messages are displayed in the message center one at a time, updating at 5 second intervals. Pressing Silence during multiple alarms causes all active alarms to be silenced and to ringback in 15 minutes.

The temperature alarms are disabled when the Temp set point is 10°C. The CO_2 alarms are disabled when the CO_2 set point is 0.0%.

4.2 Temperature Controller Failure TMP CNTR ERR (alarm)

In addition to other safety features designed into Forma 310 Series incubators, a thermostat is also provided to monitor the cabinet's temperature. In the unlikely event of a temperature control failure, the thermostat will turn off all heaters at a cabinet temperature of 65°C, +/-10%. This is intended to be a safety feature to protect the incubator, and is not intended to protect the cell cultures or the equipment inside the chamber should a temperature control failure occur.

4.3 Sensor Fault Alarms

The microprocessor in 310 Series incubators continually scans all available sensors to ensure that they are operating properly. Should an error be detected, the incubator will sound an alarm and display the appropriate message. If such an alarm occurs, contact your local distributor or the Forma Scientific Service department at 740-373-4763 or 1-888-213-1790 (USA and Canada) or fax 740-373-4189.

4.4 CO2 SENS ERR

If the cables or connectors between the main microprocessor board and the CO_2 sensor or between the CO_2 board and the sensor head on the I/R CO_2 units become loose or disconnected, the CO2 SENS ERR alarm will occur.

I/R Units -

On I/R incubators, the red light on the I/R module (Refer to Figure 5-8 for the location of the module circuit board) will be lit continuously if communication is lost between the CO_2 board and the sensor head. The CO_2 display will also be locked at 00.0 without injection. Turning the incubator off and on *will not* clear the alarm. Only proper connections of all the components will correct the alarm.

4.5 IR AUTOZ ERR

On incubators equipped with I/R CO_2 control, calibration is done automatically using an auto zero system. Auto zero occurs once every 24 hours. If, during the auto zero cycle, a CO_2 correction of more than .45% is detected, the IR AUTOZ ERR alarm will occur.

Possible problems which will cause this alarm are:

- Auto Zero pump, orifice, filter or tubing will not let air to the sensor.

  Possibilities are: Defective or electrically disconnected air pump
  Kinked auto zero vinyl tubing
  Disconnected tubing between the air pump and the sensor
  Plugged filter or orifice on the auto zero assembly
  Defective auto zero circuit

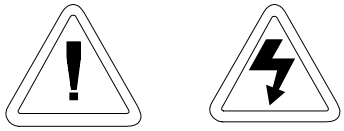
- Cabinet temperature has been increased significantly from a previous setpoint. (For example, the unit was calibrated and operating at 30°C and the setpoint is increased to 50°C) Here, calibrating the CO_2 will correct the alarm.

- High background CO_2 in the laboratory. This could be from leaks in the tank, regulator or vinyl CO_2 tubing.

- High CO_2 sensor calibration drift. This will require replacement of the sensor.

- Calibration of the CO_2 system to less than 3% actual CO_2. If this has occurred, contact the Forma Scientific Service Department.

Section 5: Routine Maintenance



If the unit has been in service, turn it off and disconnect the power cord connector before proceeding with any maintenance.

5.1 Disinfecting the Incubator Interior

Before using any cleaning or decontamination method except those recommended by the manufacturer, users must check with the manufacturer that the proposed method will not damage the equipment.

Use an appropriate disinfectant. All articles and surfaces to be disinfected must be thoroughly cleaned, rinsed with sterile water, 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.

Do not spray the T/C sensor with flammable solutions. The internal temperature of the CO2 sensor is approximately 150°C when the unit is in operation. Allow sufficient time for the sensor to cool before cleaning.

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 rusting.

1. Remove the shelves, HEPA filter (a factory installed option), access port filter, sample air filter, left and right duct sheets and the top duct. The top duct requires the two wing nuts to be removed.
2. Set the HEPA filter aside. Wash the shelves, ducts, wing nuts and stopper with disinfectant. Optional: The shelves, ducts and wing nuts may be autoclaved.
3. Remove the blower scroll held on by four screws. Remove the blower wheel and the access port filter. If a new blower wheel and scroll are going to be used, discard the old ones. If the old ones are being reused, wash and rinse all parts with disinfectant.
4. The CO_2 sensor may be lowered by unscrewing the retaining ring around the sensor. This will allow the sensor gasket to be removed, cleaned and replaced. WIPE the CO_2 sensor, do not spray or soak.
5. Wash the inner door gasket with disinfectant. The inner door gasket may be removed and/or replaced.
6. Wash the cabinet interior with disinfectant, starting at the top and working down. Refer to the disinfectant directions for length of time needed before rinsing. Wash the inner door both inside and out. The cabinet and door must be rinsed with sterile water until the disinfectant has been removed. After the cabinet has been rinsed, spray with 70% alcohol.
7. If the CO_2 sensor gasket was removed, spray it with 70% alcohol and install it. Install the sample filter.
8. Install the top duct, left and right ducts, inner door gasket, and access port stopper spraying each with 70% alcohol.
9. Install new HEPA Filter.
10. Install the shelves and spray with 70% alcohol.

5.2 Cleaning the Cabinet Exterior

Clean the incubator exterior with a damp sponge or soft, well-wrung cloth and mild detergent dissolved in water. Dry with a soft cloth.

5.3 Cleaning the Glass Doors

The chamber glass door and the optional independent inner glass doors may be cleaned using the same disinfectant as used on the incubator interior. It is imperative that they be rinsed with sterile distilled water to remove the disinfectant residue. The doors should then be dried with a soft cloth.

Some precautions in the cleaning and care of the incubator glass doors:

Moisture leaches alkaline materials (sodium, Na) from the surface of the glass. Evaporation of the moisture concentrates the alkaline and may produce a white staining or clouding of the glass surface. Cleaning chemicals with a pH above 9 and heat (autoclaving) accelerate the corrosion process. Therefore, it is very important to rinse and dry the glass doors after cleaning. Autoclaving the glass doors should be avoided.

There is no simple method for repairing corroded glass. In most cases, the glass must be replaced.

5.4 Cleaning the Humidity Pan

Clean the humidity pan with soap and water and a general use laboratory disinfectant. Rinse with sterile water and spray with 70% alcohol. The humidity pan may be autoclaved.

5.5 Reversing the Door Swing

For side-by-side operation or changing lab layouts, the inner and outer doors are field reversible. The procedure is written from the prospective of changing the door swing from a left-hand to a right-hand swing. All screw holes are pre-drilled for reversing the door. The tools required are a Phillips screwdriver, a 1/8" Allen wrench and a flatblade screwdriver.

The door reversing procedure takes about 30 minutes.

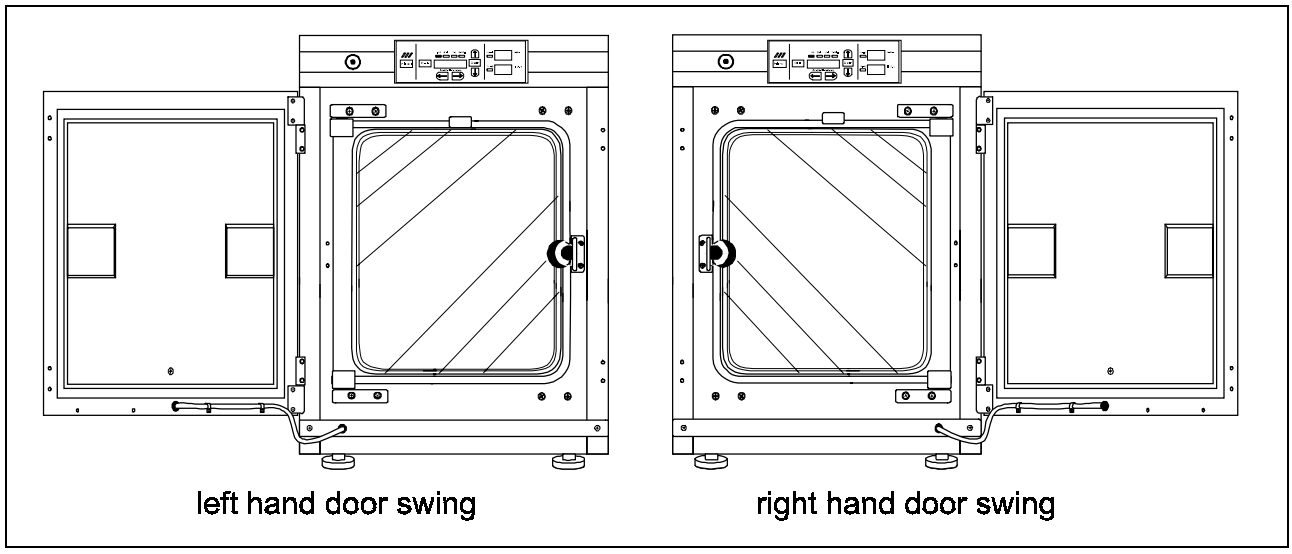
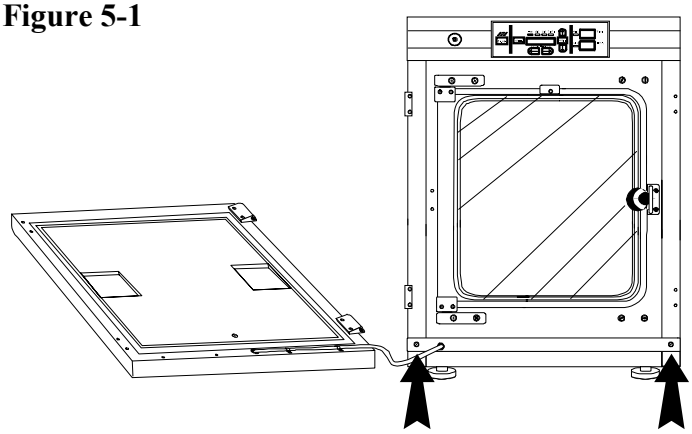
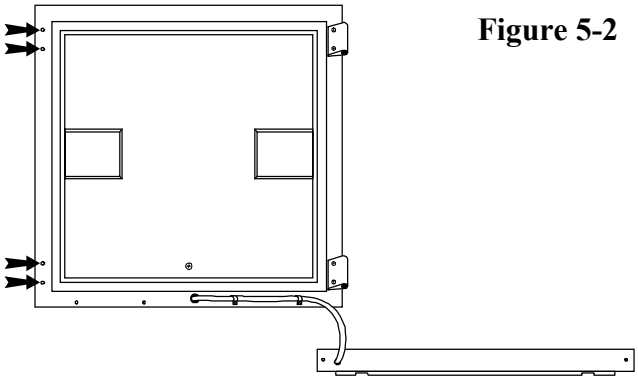


Figure 5-1



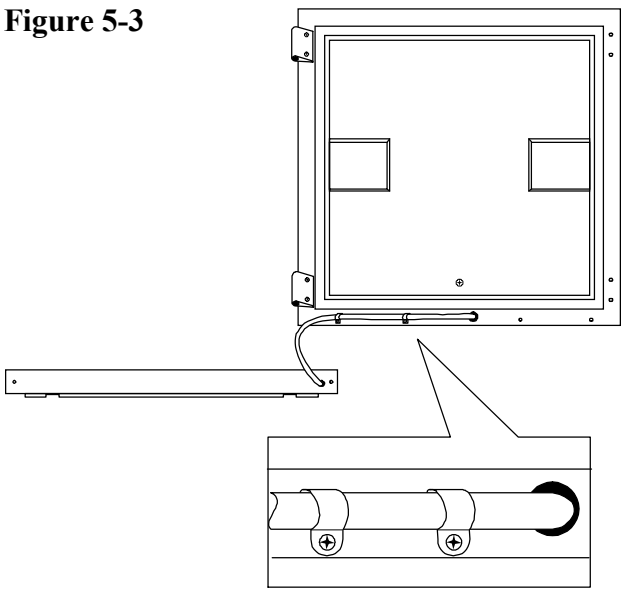
1. Remove the kick plate at the bottom of the cabinet by removing the two Phillips screws indicated by the black arrows in the illustration. Disconnect the cable inside the cabinet.
2. Open the outer door and remove it by lifting it off its hinge pins. Place the door on a padded surface to prevent scratches. (Figure 5-1) Note: The hinge pins are not connected to the brackets and may fall out when the door is lifted off.

Figure 5-2



3. Refer to the illustration of the outer door in Figure 5-2. With a Phillips screwdriver, remove and save the four nylon screws from the door hinge mounting holes. The black arrows identify the screw locations.
4. Remove the door hinges, rotate them 180° and secure them on the left side of the door. Install the nylon screws into the newly exposed holes.
5. Remove the two plastic clips securing the door heater cable. (These clips will be rotated 180° when installed on the left lower edge of the door frame.)

Figure 5-3



6. Rotate the kick plate and attach the door heater cable with the clips as shown in Figure 5-3. The insert in the illustration shows the proper positioning of the clips.
7. The incubator and door should look similar to the illustration in Figure 5-4 on the following page.

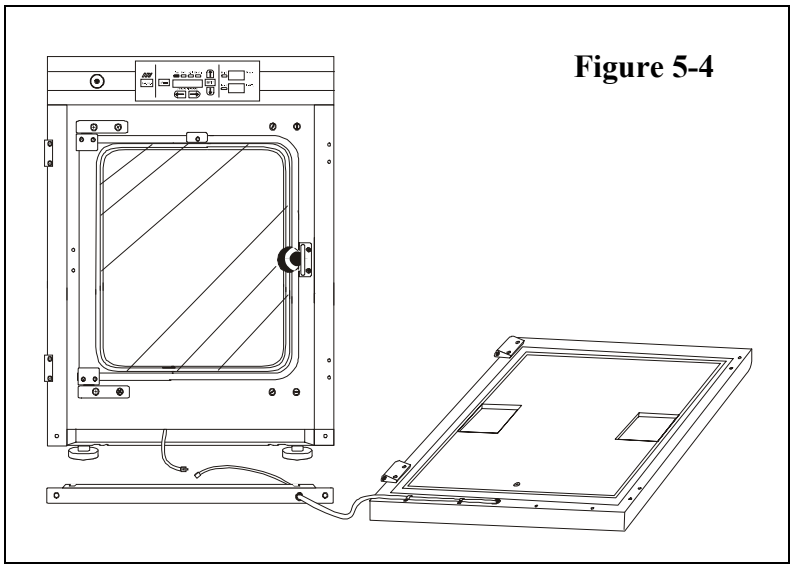


Figure 5-4

8. Remove the nylon screws along the right side of the cabinet. Remove the outer door hinges (Items 1 in Figure 5-5). Rotate them 180° and install them on the right side of the cabinet (Locations 2). Install the nylon screws in the holes vacated by the hinges.

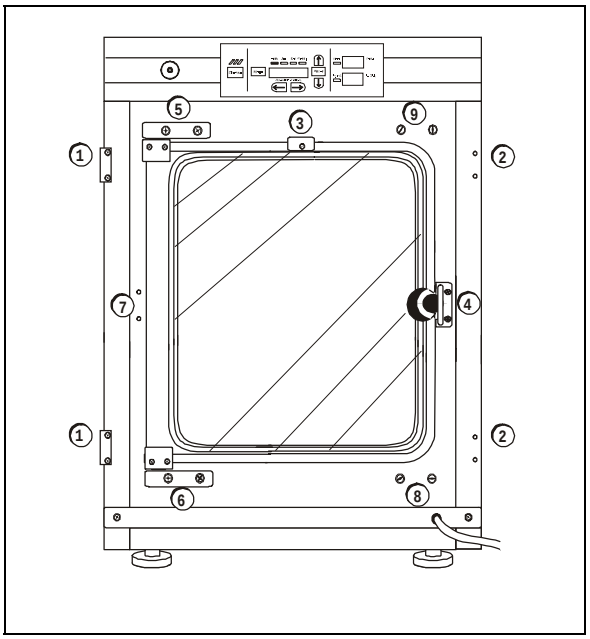


Figure 5-5

9. With a 1/8” Allen wrench, remove the door open switch target plate on the top of the inner door (Item 3).

10. Remove the door latch striker plate (Item 4).

11. Hold the door securely and remove the upper hinge bracket on the cabinet (Item 5). This hinge bracket will be rotated 180° and be placed in the lower right corner of the cabinet at Location 8.

12. Lift the glass door from the lower hinge and set it aside. Then remove the lower hinge from the cabinet (Item 6). This hinge bracket will be rotated 180° and be placed in the upper right corner of the cabinet at Location 9.

13. Remove the screws and washers from the new striker plate location (Item 7). These screws and washers can be threaded into the holes vacated by the striker plate at Location 4.

14. Rotate the striker plate 180° from its original position and attach it to the cabinet at Location 7.

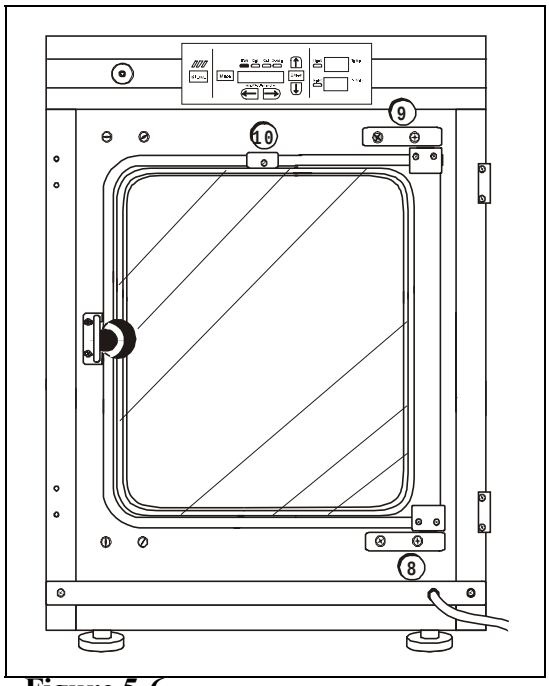


Figure 5-6

15. Using a flat blade screwdriver, remove the threaded nylon plugs from the new hinge bracket locations (Locations 8 and 9). Install the lower hinge bracket,(Item 5 removed earlier) at Location 8.

16. Rotate the door 180° and place it in the lower hinge bracket. Install the upper hinge bracket (Item 6 removed earlier) at Location 9.

17. Screw the threaded plugs into the holes vacated by the door hinge brackets at Locations 5 and 6 identified in Figure 5-5.

18. Install the door open switch target plate, Item 10. Refer to Figure 5-7. The plate must be positioned exactly 12.5 inches from the outside edge of the cabinet to the leading edge of the plate. Do not overtighten.

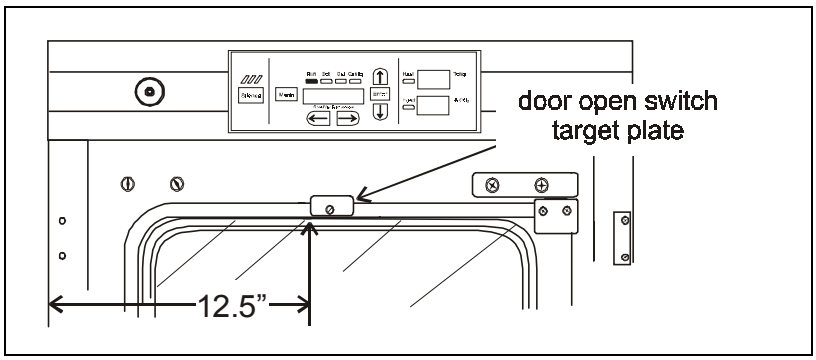


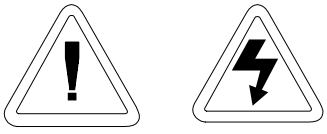
Figure 5-7

19. Connect the door heater cable and install the kick plate with the door heater cable on the right side.

20. Installing the outer door onto the hinge pins completes the door reversal procedure.

5.6 HEPA Filter Maintenance (factory installed option)

Replace the HEPA filter routinely on an annual basis, or sooner if it changes color. The filter should also be changed when the chamber is cleaned. See Section 5-1.



The electronics section contains hazardous voltages. Access to this area should only be by qualified service personnel.

5.7 Replacing the Power Fuses

There are only two replaceable fuses in the incubator. To access the fuses:

1. Turn off the incubator's power switch and unplug the power cord.
2. Open the outer door to the chamber.
3. Remove the two screws located below the control panel.
4. Lift up on the control panel, then pull it out.
5. Refer to Figure 5-8 for the location of the two fuses. (Items 21 in the illustration)
6. Slide the control panel back in, replace the screws and return the unit to service. If the fuse(s) blow after restoring power to the incubator, contact Forma's Service Department at the telephone number on the cover of this instruction manual.

Table 5-1, Fuse Replacement Chart

Fuse Voltage	Manufacturers Part #	Amperage Rating	Rupture Speed	IEC Letter Code
115 VAC ACC	BUSS GMC - 1.0A	1.0 Amp	Time-Lag	T
230 VAC ACC	BUSS BK-GMC-500ma	0.5 Amp	Time-Lag	T
24 VAC Door Heat	Schurter 034.3124	5.0 Amp	Time-Lag	T

5.8 The Electronics Section

1. Turn off the incubator's power switch and unplug the power cord.
2. Remove the two screws from the front of the cabinet top and the two screws in the uppermost corners of the back panel.
3. Slide the top about an inch to the rear and lift it off. Note: There are small locking tabs in the rear which will be bent if the top is lifted off without moving it first to the rear.

a. The major components

Refer to Figure 5-8. Some of the components shown in this illustration are factory installed options. They are identified as such in the descriptions below.

1. Power Switch - Located beneath the control panel. The outer door must be open to access the switch
2. RS 485 and Remote Alarm Contacts -Connectors and auxiliary wire through port
3. CO_2 manifold and supply tank connectors -Part of the Gas Guard system, a factory installed option.
4. CO_2 Gas solenoid
5. Accessory outlet, 75 watts maximum
6. Filtered line cord connector
7. CO_2 microbiological filter
8. Power transformer, export only
9. Main power transformer
10. Humidity sensor (optional)
11. Temperature probe
12. Sample port into the chamber
13. IR/T/C CO_2 sensor
14. Overtemperature thermostat
15. CO_2 injection port
16. Blower motor
17. IR CO_2 sensor board
18. Analog output board, 4-20 mA, 0-1 Volt, 0-5 Volt
19. Microprocessor board
20. Power supply board
21. Fuses

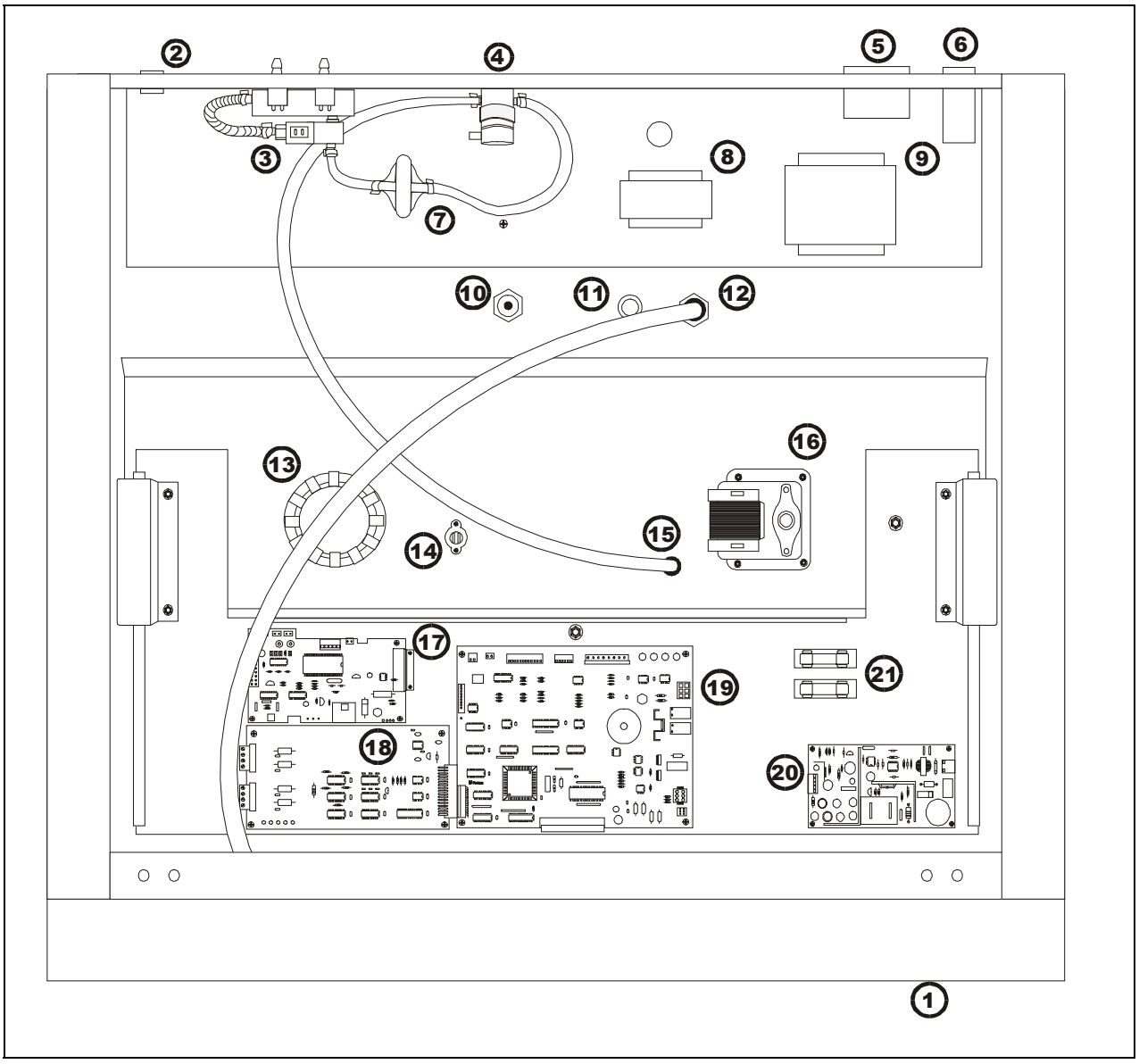


Figure 5-8

5.9 Replacing Sample Air Filter (Figure 5-9)

1. Connect one end of the sample port filter to the ceiling port.
2. Connect the other end of the filter to the back of the blower fan inlet.

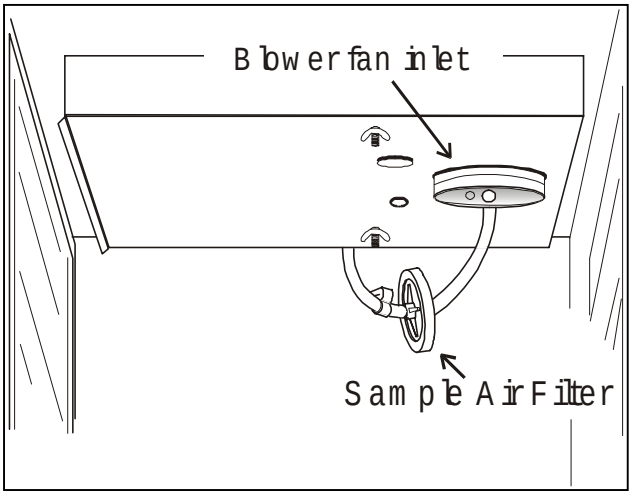


Figure 5-9

Section 6 - Factory Options

6.1 Connections to External Equipment

a. Connecting the Remote Alarm Contacts

A set of relay contacts is provided to monitor alarms through an RJ11 telephone style connector on the back of the cabinet. Refer to Figure 6-3 for the location of the alarm connector. The 12-foot telephone cord (P/N 190388) and RJ11-to-screw terminal conversion box (190392) are available through our service department.

The remote alarm provides a NO (normally open) output, an NC (normally closed) output and COM (common). Refer to Figure 6-1.

The contacts will trip on a power outage or an overtemperature condition. The contacts may also be programmed to trip or not trip on temperature alarms, CO_2 alarms, and RH alarms. See Section 3.1, Configuration Mode.

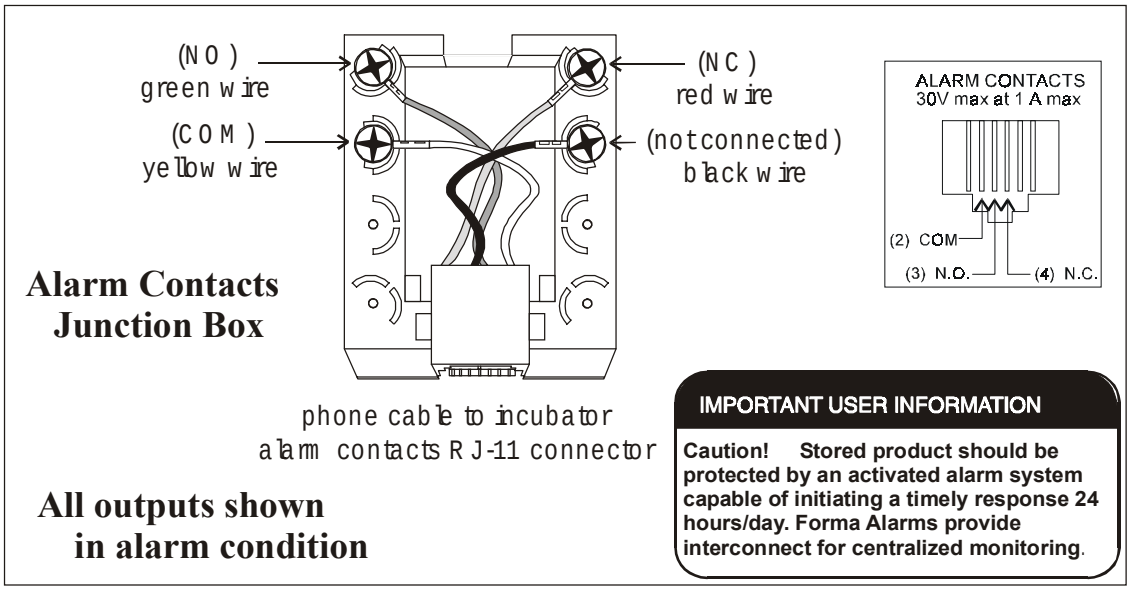


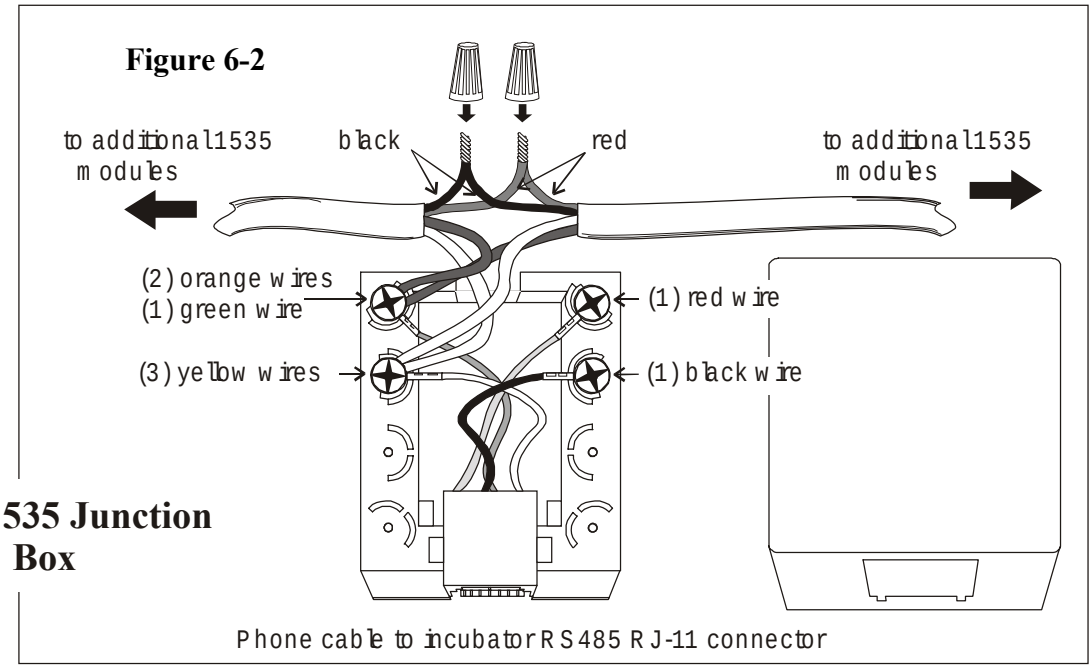
Figure 6-1

b. Connecting the RS485 Interface (190523)

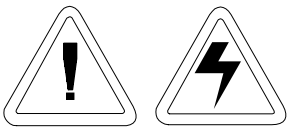
All incubator models can be purchased with the RS485 communications option. This option allows the incubator to be directly connected to a Forma Model 1535 alarm system without the use of a communications module. A junction box is provided with each RS485 option. Refer to Figure 6-2 for wiring details. Figure 6-3 shows the location of the RS485 connector on the back of the incubator cabinet

To allow the incubator and the 1535 to communicate, an address must be allocated on the 1535. Refer to Section 5.8 of the 1535 operating manual. The same address number must be assigned to the incubator. Refer to Section 3.1 of this manual, Configuration Mode.

Figure 6-2



c. Connecting the Analog Output Boards (190512, 190543, 190544)



The electronics section contains hazardous voltages. Only qualified personnel should access this area.

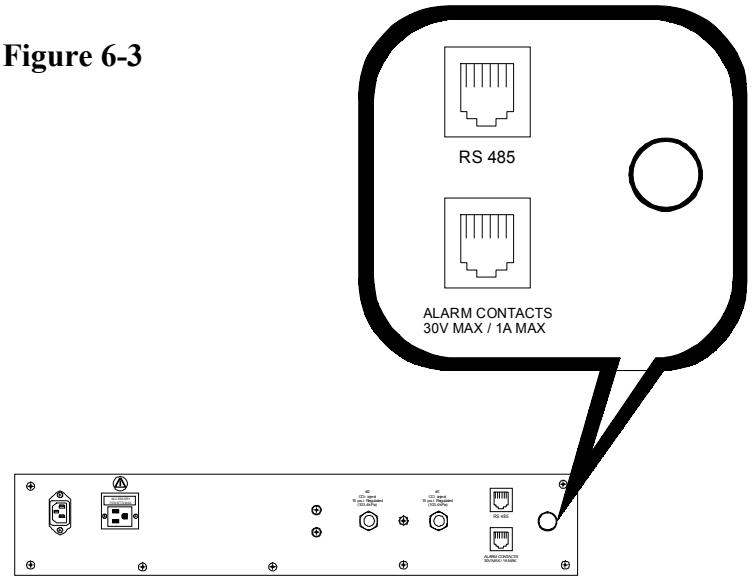
The analog output board is an option that allows the incubator to output analog signals representing the air temperature of the cabinet, CO_2 content, and relative humidity, depending upon which systems are in the incubator. There are three different analog output board options available : 0-1V, 0-5V, or 4-20mA signals. Negative display readings will output 0V. The outputs do not have isolated grounds. Refer to Table 6-1 for output specifications of the three boards.

Table 6-1 Analog Output Board Specifications

	190512 4-20 mA Output Scaling 4-20 mA Equals	**190544 0-1V** Output Scaling 0-1 V Equals	**190543 0-5V** Output Scaling 0-5V Equals
Temperature	0.0-100.0 °C	0.0-100.0 °C	0.0-100.0 °C
RH	0-100 %RH	0-100 %RH	0-100 %RH
CO_2	0.0-100.0 %CO_2	0-100.0 %CO_2	0-100.0 %CO_2

To wire in the analog output board, Forma recommends wire P/N 73041, which is a shielded 22 gauge, 3-conductor wire. This wire is readily available from other vendors including Alpha P/N 2403 and Deerborn P/N 972203.

Figure 6-3



To install the analog board:

1. Turn off the incubator and unplug it from the wall outlet.
2. Remove the top of the electronics section, refer to Section 5.8 of this manual.*
3. Locate the Analog Output board, Figure 6-4 and Item 18 of Figure 5-8.

* An alternate access to the electronics is to open the outer door and remove the two screws in the upper corners of the cabinet just under the display top. Lifting up on the top section, the electronics drawer can be pulled out to the limit of the internal wiring.

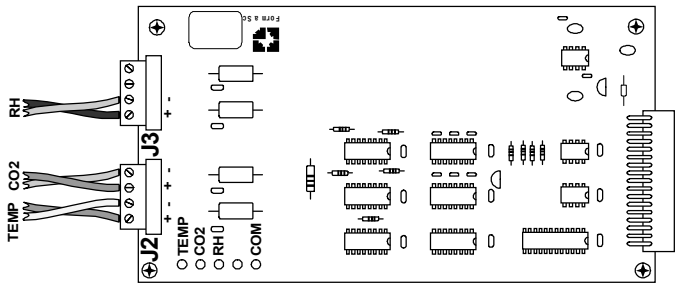
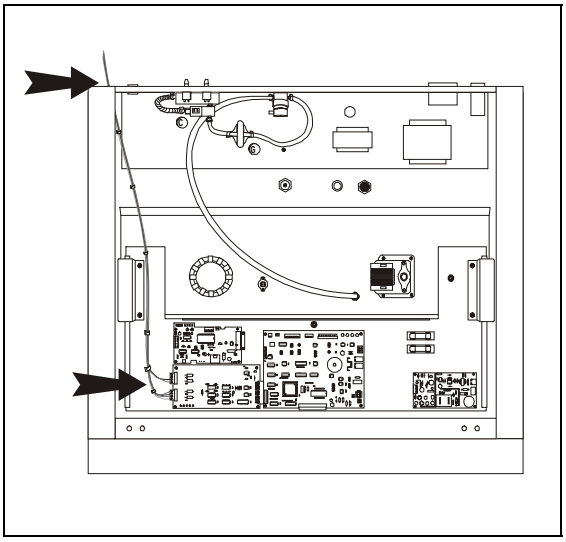


Figure 6-4

4. Each system monitored (Temp, CO_2, RH) requires two conductors (Refer to Figure 6-4). Feed the wires through the auxiliary wire through-port on the back panel. This port is a circular fitting adjacent to the remote alarm and RS485 connectors as illustrated in Figure 6-3. The wire routing is shown by the black arrows in Figure 6-5.



5. Strip the ends of each conductor and wire it to the appropriate terminals of connectors J2 and/or J3 on the analog board. (Refer to Figure 6-4)

6. When wiring is completed, slide in the electronics drawer or the replace the sheet metal cabinet top.

7. Replace the screws removed earlier and return the unit to service.

Figure 6-5

6.2 CO_2 Gas Guard (190640)

CO_2 can be lethal in high concentrations. Refer to warnings in Section 1.5.j of this manual.

The 310 Series incubators can be equipped with a built-in Gas Guard system that will operate with a CO_2 gas supply. The Gas Guard uses two pressure switches to continuously monitor the pressures of two independent CO_2 supplies and automatically switches from one supply to the other when the supply pressure drops below 10 psig (0.690 bar). The Gas Guard's design does not facilitate use by multiple incubators.

The CO_2 gas supplies must be equipped with two-stage pressure regulators with gauges. The high pressure gauge at the tank should have a 0-2000 psig range and the low pressure gauge should have a 0-30 psig range. The gas supply to the incubator must be maintained at 15 psig (1.034 bar). Gas pressures below 15 psig will cause nuisance alarms to occur on incubators equipped with the built-in Gas Guard.

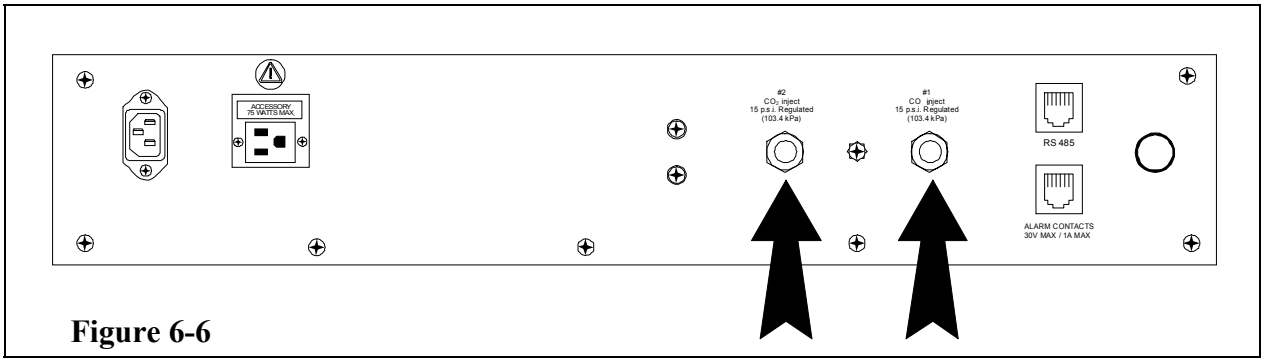


Figure 6-6

a. Connecting the CO_2 Gas Supplies

The CO_2 inlets for the Gas Guard are located on the rear of the cabinet. Using 1/4" ID tubing, connect one of the CO_2 supply tanks to the fitting labeled CO_2 Inlet #1 Tank. Connect the second CO_2 supply tank to the fitting labeled CO_2 Inlet #2 Tank. Install 3/8" hose clamps to secure the 1/4" ID tubing to the fittings on the rear of the drawer. (Refer to Figure 6-6)

b. Activating the Gas Guard

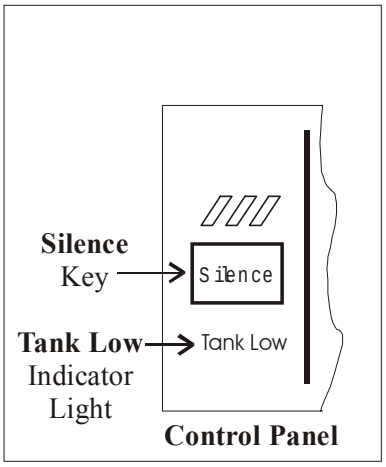
The built-in Gas Guard is not turned on when shipped from the factory. In addition, the Tank Sel for the Gas Guard is specified as Tank 1 when shipped. Refer to Section 3, Configure Mode, to activate the Gas Guard or change the Tank Sel from #1 to #2. If the Gas Guard system is not used, the incubator will function normally by supplying CO_2 from the supply tank connected to Inlet #1.

c. Operation of the CO_2 Gas Guard

With the Gas Guard in operation, the incubator will use the gas supplied by the tank connected to Inlet #1 until the pressure drops below 10 psig (0.690 bars). At this time, the Gas Guard automatically switches to the gas supplied through CO_2 Inlet #2.

In addition, the incubator automatically changes the Tank Sel in Configure Mode from 1 to 2 to indicate that the incubator is now using gas supplied through Inlet # 2. If the gas supply to Inlet #1 is replenished, the incubator will continue to operate using the gas supplied through Inlet #2 unless the operator changes the Tank Sel from #2 to #1 through Configure Mode. Refer to Section 3, Configuration.

Audible and visual alarms occur on the control panel when the gas guard switches from one supply to the other. The audible alarm sounds until the operator presses the **Silence** key on the control panel. The visual alarm in the Message Center will read *Tank 1 Low* while the audible alarm is sounding, but the message will be removed when the operator presses the **Silence** key. However, the 'Tank Low' indicator on the control panel will stay lighted until the condition is resolved. The unit will operate normally.



Both the audible and visual alarms described above do not ring back once the Silence key is pressed.

If the Gas Guard system does not detect an adequate gas supply at CO_2 Inlet #1 or Inlet #2, a visual and audible alarm will again occur on the control panel. The visual alarm in the Message Center will read ***Tank 1&2 Low.*** The audible alarm will continue to ring until the Silence key is pressed. The audible alarm will ring back every 15 minutes after the alarm is silenced if the Gas Guard continues to detect that both gas supply pressures are below 10 psig (0.690 bars).

6.3 Humidity Readout (190643)

The 310 Series incubators can be equipped with a humidity sensor to monitor the relative humidity inside the chamber. The sensor is mounted to the top air duct and provides a signal that is displayed in 1% increments on the control panel. The humidity readout can be displayed continuously or toggles with the temperature readout. In addition, a low alarm limit can be set on the humidity readout, which will detect when the humidity pan runs dry Refer to Section 3, Configuration.

a. Factors Affecting the Humidity Level in the Chamber

- Water level in the humidity pan
- Frequency of door openings
- The humidity pan is located on the bottom of the chamber versus on a shelf

Incubators equipped with a Thermal Conductivity CO_2 sensor rely on a constant level of relative humidity in order to accurately measure and control the CO_2 concentration in the incubator.

b. Accuracy of the Humidity Readout:

The sensor is capable of measuring relative humidity from 10% to 100% with an accuracy of ±5% above 90%. See Section 2, Calibration, for details on calibrating the humidity readout.

6.4 Connecting the Uninterruptable Power Supply (270078 and 270082)

The Uninterruptable Power Supply is not rated for life-support applications.

The optional Uninterruptable Power Supply (UPS) provides a back-up power source for the incubator. When the batteries are fully charged and the incubator operating at 37°C in an 18°C ambient temperature, the UPS provides approximately one hour of uninterrupted power during a power failure. A higher operating temperature decreases this back-up time, a higher ambient temperature increases it. This estimated time assumes that the incubator will be already at its operating temperature and that the incubator door will not be opened during the back-up period.

The remote alarm contacts will not trip during a power failure while connected to the UPS until battery power is exhausted. There is however, an audible and visual alarm when the unit switches to battery operation.

The UPS batteries are fully charged when the unit has been connected to utility power for a minimum of four hours. The UPS power switch does not have to be on for the batteries to charge. When battery replacement becomes necessary, refer to the UPS user's manual.

Use only factory recommended UPS units, 270078 or 270082, which produce a pure sine wave output. Other UPS units could damage the incubator and void the warranty. Typical facility back-up systems will not effect the efficiency of the incubator.

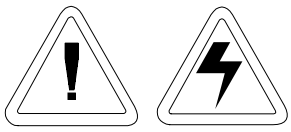
a. Connecting Uninterruptable Power Supply (P/N 270078, 115V, 50/60 Hz)

Plug the incubator line cord into one of the receptacles on the back of the UPS. Then plug the UPS line cord into a suitable wall outlet.

Turn the UPS power switch on.

b. Connecting Uninterruptable Power Supply (P/N 270082, 230V, 50/60 Hz)

Use the line cord supplied with the incubator to connect the UPS to a suitable wall outlet, and the UPS coupler to connect the incubator to the UPS.



The Uninterruptable Power Supply contains potentially hazardous voltages even when not connected to line voltage.

Do not attempt to disassemble the UPS as it contains no user-serviceable parts. Repairs must be performed only by factory trained service personnel.

Section 7 - Specifications*

*Specifications are based on nominal voltages of 115V or 230V in ambients of 22°C to 25°C.

Forma Models 310, 311, 320 and 321

Temperature

Control	±0.1°C Microprocessor PID Control
Setpoint	Digital - Touch pad, 0.1°C
Range	+5°C above ambient to 50°C
Uniformity	±0.2°C @ +37°C
Tracking alarm	User programmable (low) indicator
Overtemp	Tracking, user programmable, action, and indicator
Display	Digital, LED, 0.1°C increments

Temperature Safety

Type	Extreme temperature safety, action, and indicator
Sensor	Thermostat, independent of temperature control system
Indicator	Message center, audible and visual alarms

Relative Humidity

Control	Humidity pan - natural vaporization
Humidity with pan	95% RH at 37°C
Display	Optional in 1% increments
Alarm	Low RH with optional RH monitor

CO_2

Control	±0.1% microprocessor PID control
Sensor	T/C or IR
Readability	0.1%
Range	0 to 20%
Inlet pressure	15 psig
Display	Digital LED, 0.1% increments

Shelves

Dimensions	18.5” x 18.5”
Construction	Stainless Steel (belt sanded, both sides)
Surface area	2.4 sq. ft.
Max. per chamber	40.8 sq. ft.
Standard	4
Maximum	17

Construction

Interior volume	6.5 cu. ft.
Interior	Type 304 stainless steel shiny finish
Exterior	18 gauge cold roll steel
Outer door gasket	Four-sided molded, magnetic vinyl
Inner door gasket	Feather-edge, removable
Insulation	Fiberglass

Fittings

Access port	1-1/4 inch removable silicone plug
CO_2 inlet	1/4” barbed
Sample port	Front mounted barbed

Electrical

115 Volt models	90-125VAC, 50/60 Hz, 1PH, 2.4 FLA
230 Volt models	180-250, 50/60 Hz, 1 PH, 2.0 FLA
Power switch/circuit breaker	2 Pole, 6.0 Amp
Accessory outlet	Voltage equal to the cabinet input. 75 Watts maximum, 0.5ma leakage current
Alarm contacts	Deviation of temperature, CO_2, power, NO and NC

Unit BTU Output

115/230V	344 BTUH (100 watt)

Dimensions

Exterior	26.0” W x 38.5” H x 25.0” F-B
Interior	21.4” W x 26.8” H x 20.0” F-B

Weight

Net Weight Stainless Steel	205 lbs
Net Weight Copper	230 lbs.

Options/Accessories

HEPA filter	Factory installed: Stock no. 190858
Battery back-up	Free Standing: Stock no. 270078, 120VAC, 60Hz Stock no. 270082, 220VAC, 50Hz
Humidity	Factory installed: Stock no. 190463 - provides humidity readout and low alarm
Inner door kit	Customer installed: Stock no. 190650 - independent eight separate glass doors
Built-in Gas Guard	Factory installed: Stock no. 190640 - CO_2 only, automatically switches supply tanks
Recorders	Customer installed: Standard recorders used on Forma W/J incubators
Decontamination kits	HEPA filter, blower assembly, inner door gasket, etc. Stock no. 190868 (with HEPA filter) Stock no. 190869 (without HEPA filter)

Copper Options

Interior ductwork	Solid copper: Stock no. 190725
Perforated shelf	Customer Installed: Stock no. 224166 - solid copper
Humidity Pan	Customer Installed: Stock no. 237015 - solid copper
Copper interior kit	Factory installed: Replace stainless steel duct work, shelves, and humidity pan with solid copper Stock no. 190870

Optional Date Outputs

Analog	Factory installed: Stock no. 190544 - 0 - 1 volt
Analog	Factory installed: Stock no. 190543 - 0 - 5 volt
Analog	Factory installed: Stock no. 190512 - 4 - 20mA
Digital	Factory installed: Stock no. 190523 - RS-485 (Compatible with Forma Model 1535 Alarm Monitor only)

Certifications

Refer to the Declaration of Conformity at the back of this manual

Safety Specifications

Indoor Use Only
Altitude - 2,000 meters
Temperature - 5°C to 40°C
Humidity - 80% RH at or below 31°C, decreasing linearly to 50% RH at 40°C
Mains Supply Fluctuations - Mains supply voltage fluctuations not to exceed ±10% of the nominal voltage
Installation Category II [1]
Pollution Degree 2 [2]
Class of Equipment I

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[1] Installation category (overvoltage category) defines the level of transient overvoltage which the instrument is designed to withstand safely. It depends on the nature of the electricity supply and its overvoltage protection means. For example, in CAT II which is the category used for instruments in installations supplied from a supply comparable to public mains such as hospital and research laboratories and most industrial laboratories, the expected transient overvoltage is 2500 V for a 230 V supply and 1500 V for a 120 V supply.

[2] Pollution degree describes the amount of conductive pollution present in the operating environment. Pollution degree 2 assumes that normally only non-conductive pollution such as dust occurs with the exception of occasional conductivity caused by condensation.

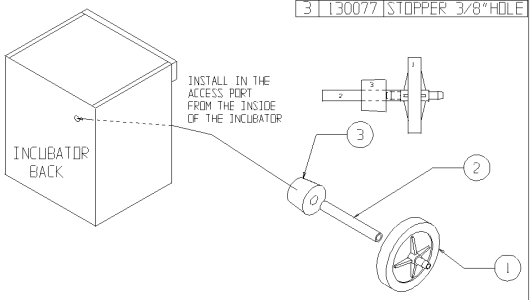
Section 8 - Spare Parts

Part Number	Description
190699	Removable feather gasket
190670	Duct sheet and shelf channel kit
190772	Micro board, (main control)
230135	Fuse, 1A, TD, 5 x 20mm
230120	0.5A fuse, TD, 5 x 20mm (accessory outlet)
230161	Fuse, 5A, 5 x 20mm
770001	Disposable filter, 99.97 (CO_2 line)
156098	Motor, 2-pole, 115VAC, 50/60 Hz
190793	Display board
290137	Probe, 2252 Ohm/25°C, 1/8 x2
760175	HEPA filter, 5.5” diameter
770005	Sample port filter
224175	Shelf
190868	Decontamination kit with HEPA filter
190869	Decontamination kit without HEPA filter
130077	Stopper with 3/8” hole
290090	Thermal conductivity type CO_2 sensor
190885	Infrared type CO_2 sensor w/ auto zero
250087	CO_2 valve with fittings
290154	RH sensor assembly (RH display option)
190883	Sample port filter assembly
190661	IR sensor filter
190985	Filtered air exchange assembly

Part Number	Description
230153	6A, DPDT circuit breaker switch (power)
400199	Switcher, 40W, 12, 5, -12V
420096	130VA transformer, int'l, 12/24V S
194021	34 position control to display ribbon cable
420097	43VA transformer (230VAC units only)
360213	Pressure switch (Gas Guard option)
250121	Gas valve (Gas Guard option)
190512	4-20mA output board
190543	0-5V output board
190544	0-1V output board

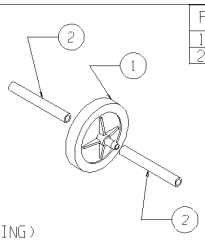
ID#	STK #	DESCRIPTION
1	310-201-0-D	IR/TC SENSOR ASSEMBLY
2	310-202-0-D	MOTOR/BLOWER ASSEMBLY
3	116022	HINGE, 1/4" GLASS
4	105058	DOOR, TEMPERED GLASS
5	180174	FACE FRAME, PVC
6	190611	HINGE PIN, STN STEEL
7	190612	HINGE BLOCK, ALUMINUM 2.0"
8	190643	TEMPERATURE PROBE ASSEMBLY
9	191534	REMOVEABLE FEATHER GASKET
10	113002	ADJUSTABLE FOOT
11	190788	OUTER DOOR W/ HEATER
12	190795	MAGNET MOUNT, DOOR
13	190833	LATCH MOUNT, INNER DOOR
14	180210	KNOB, BLACK
15	XXXXX	GAS INJECT PORT
16	360230	SWITCH, MAGNETIC ACTUATED
17	360231	MAGNET, DOOR
18	400133	THERMOSTAT, SNAP ACTION
19	990033	MAGNETIC GASKET, MOLDED
20	290137	"OPTIONAL" RH SENSOR
21	840020	SAMPLE PORT BULKHEAD FITTING
22	132054	LEFT HEATER, 13 WATTS
23	132050	BACK HEATER 30 WATTS
24	132051	BOTTOM HEATER, 24 WATTS
25	132055	RIGHT HEATER, 22 WATTS
26	132053	COLLAR HEATER, 9 WATTS
27	NA	DOOR HEATER, 69 WATTS
28	132056	FACE HEATER, 27 WATTS

PARTS LIST - DETAIL "A"		
1	770001	FILTER 50MM 1uM
2	950013	VINYL TUBE 3"
3	130077	STOPPER 3/8"HOLE

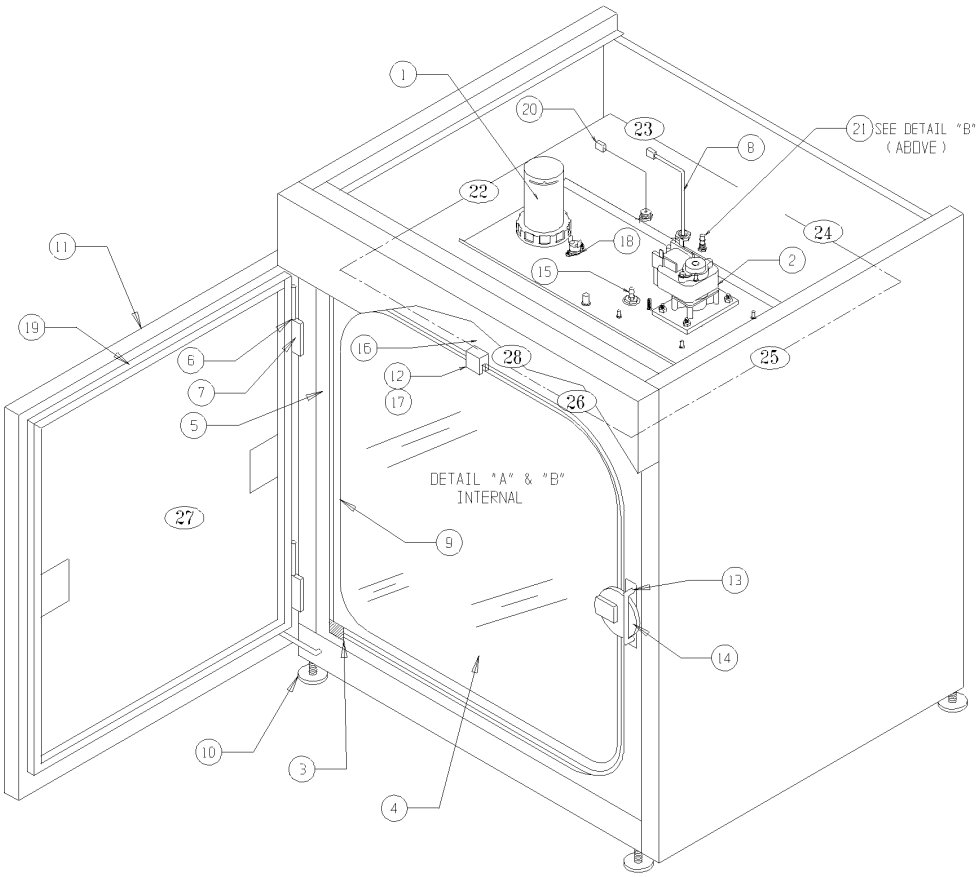


DETAIL "A"

PARTS LIST - DETAIL "B"		
1	770001	FILTER 50MM 1uM
2	244009	SILICONE TUBE 6"



DETAIL "B"
(INTERNAL TUBING)



310-200-0-D

ATTENTION
OBSERVE PRECAUTIONS
ELECTROSTATIC
SENSITIVE DEVICES

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

Forma Scientific

REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
2	DN-2755	07-24-00	G.G	G.G		REVISED PART NUMBERS.
1	DN-2755	11-02-98	G.G	K.G	DNF	CHG. 190689 GASKET TO 191534
0	N/A	11-8-98	G.G	G.G	M.H.	RELEASED FOR PRODUCTION

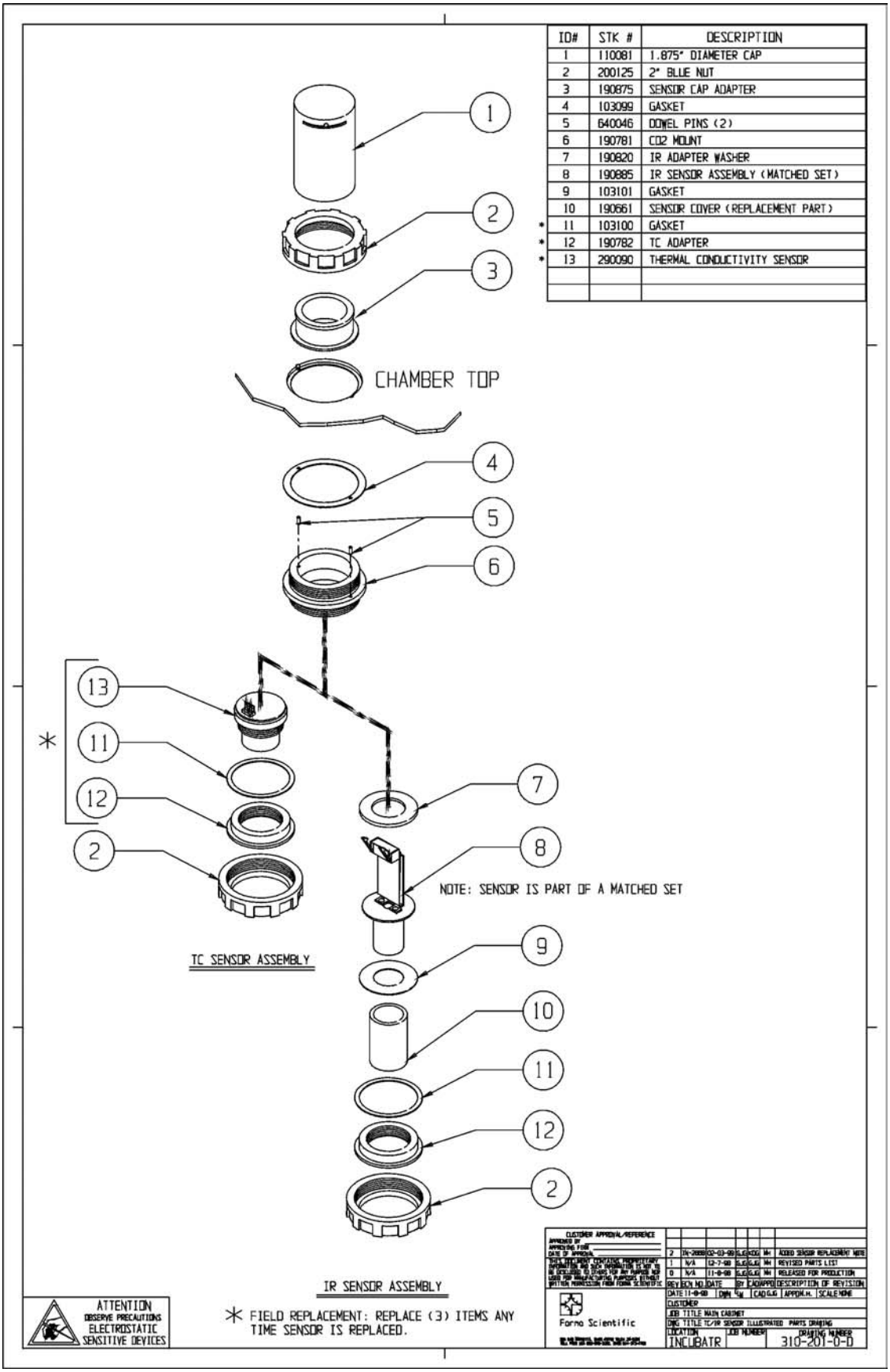
DATE 11-8-98 | DWN G.M | CAD GJG | APPD M.H. | SCALE NONE

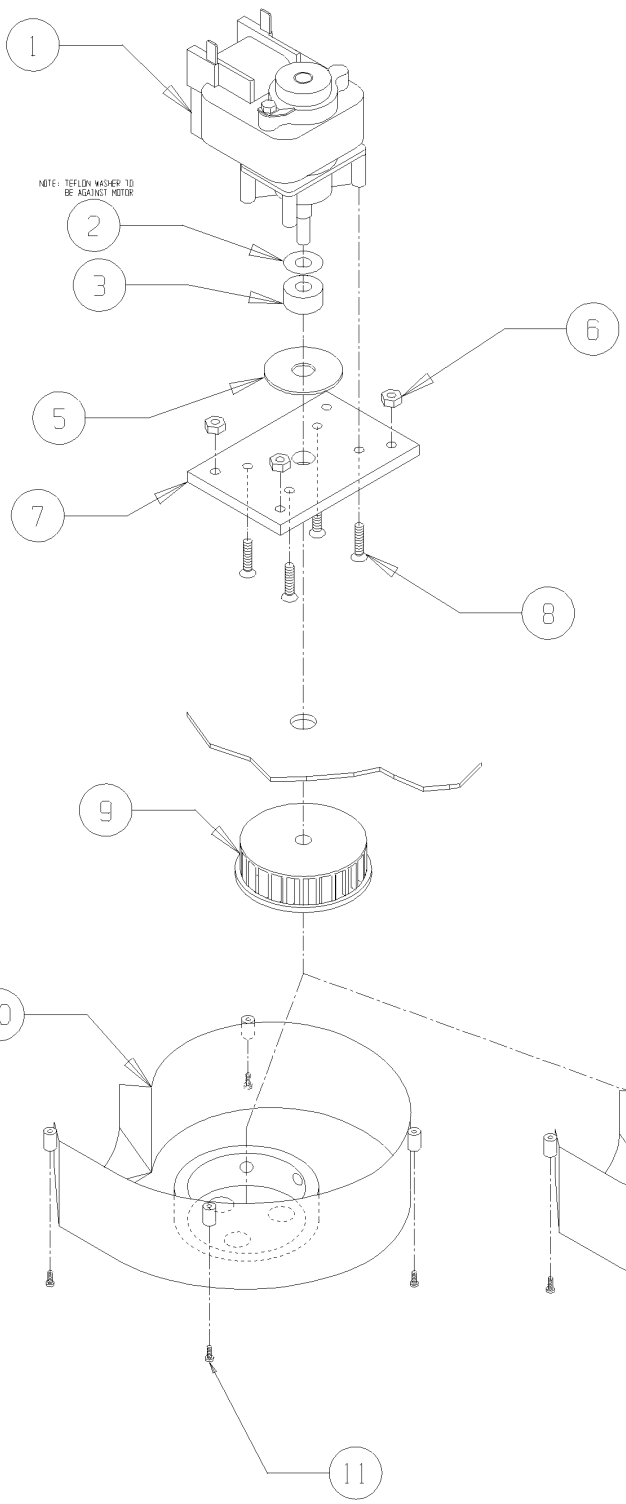
CUSTOMER

JOB TITLE MAIN CABINET

DWG TITLE ILLUSTRATED PARTS DRAWING

LOCATION INCUBATR | JOB NUMBER | DRAWING NUMBER 310-200-0-D


ID# | STK # | DESCRIPTION
1 | 110081 | 1.875" DIAMETER CAP
2 | 200125 | 2" BLUE NUT
3 | 190875 | SENSOR CAP ADAPTER
4 | 103099 | GASKET
5 | 640046 | DOWEL PINS (2)
6 | 190781 | CO2 MOUNT
7 | 190820 | IR ADAPTER WASHER
8 | 190885 | IR SENSOR ASSEMBLY (MATCHED SET)
9 | 103101 | GASKET
10 | 190661 | SENSOR COVER (REPLACEMENT PART)
* 11 | 103100 | GASKET
* 12 | 190782 | TC ADAPTER
* 13 | 290090 | THERMAL CONDUCTIVITY SENSOR
CHAMBER TOP
NOTE: SENSOR IS PART OF A MATCHED SET
TC SENSOR ASSEMBLY
IR SENSOR ASSEMBLY
* FIELD REPLACEMENT: REPLACE (3) ITEMS ANY TIME SENSOR IS REPLACED.
ATTENTION OBSERVE PRECAUTIONS ELECTROSTATIC SENSITIVE DEVICES
Forma Scientific
ADDED SENSOR REPLACEMENT NOTE
REVISED PARTS LIST
RELEASED FOR PRODUCTION
JOB TITLE MAIN CABINET
DWG TITLE TC/IR SENSOR ILLUSTRATED PARTS DRAWING
LOCATION INCUBATR
DRAWING NUMBER 310-201-0-D



ID#	STK #	DESCRIPTION
1	156098	MOTOR, 115 VAC 50/60 HZ
2	730068	TEFLON WASHER
3	730069	SILICONE WASHER 3/8" THICK
5	730034	NYLON WASHER 1 1/2" DIAMETER
6	23002	8-32 PLATED KEPS NUTS
7	190832	MOTOR SPACER
8	22142	8-32 x 3/4" FLAT HEAD SCREW
9	100097	BLOWER WHEEL
10	190831	BLOWER SCROLL
11	22002	#4-40 x 1/2 STN STL PHP SCREW
12	101013	O-RING, 3" SILICONE
13	190846	BLOWER SCROLL, W/HEPA FILTER

CUSTOMER APPROVAL/REFERENCE
APPROVED BY
APPROVING FIRM
DATE OF APPROVAL

REV	ECN NO	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
3	53-7667	06-28-00	G.G	G.G		REVISED BLOWER SCROLL #13
2	IN-2736	12-20-99	G.G	G.G	LDN	REVISED SEAL WASHER INFO
1	IN-2736	10-21-99	G.G	G.G	MSB	REVISED SEAL WASHER INFO
0	N/A	11-8-98	G.G	G.G	MH	RELEASED FOR PRODUCTION

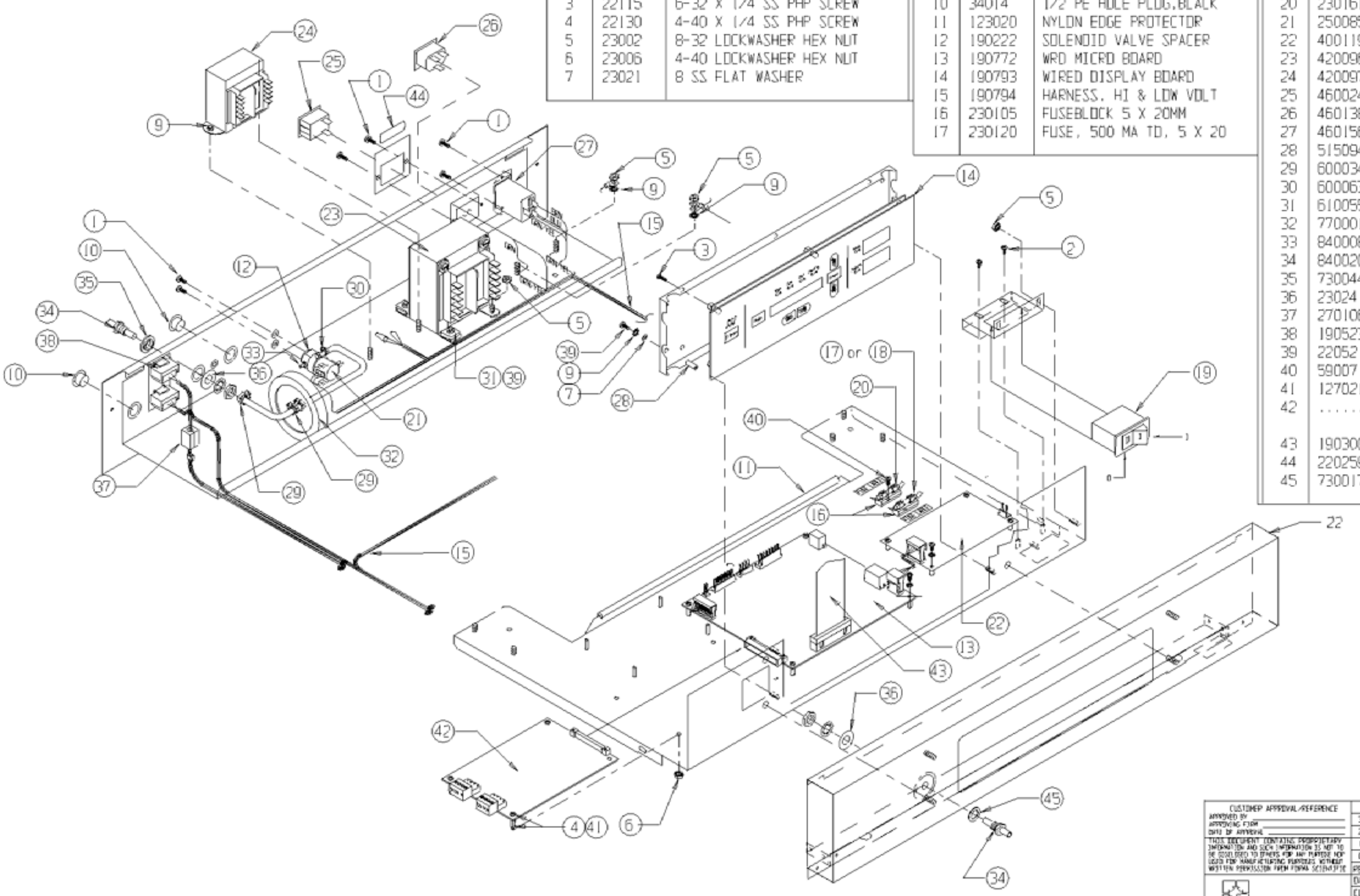
DATE 11-8-98 | DWN G.G | CAD G.G | APPD M.H. | SCALE NONE

Forma Scientific

CUSTOMER
JOB TITLE MAIN CABINET
DWG TITLE MOTOR/BLOWER ILLUSTRATED PARTS DRAWING
LOCATION INCUBATR | JOB NUMBER | DRAWING NUMBER 310-202-D-D

310-202-D-D

SYM	STK#	DESCRIPTION
1	22049	6-32 X 3/8 SS PHP SCREW
2	22051	8-32 X 1/4 SS PHP SCREW
3	22115	6-32 X 1/4 SS PHP SCREW
4	22130	4-40 X 1/4 SS PHP SCREW
5	23002	8-32 LOCKWASHER HEX NUT
6	23006	4-40 LOCKWASHER HEX NUT
7	23021	8 SS FLAT WASHER
8	23029	4 SS EXT TOOTH LKWASHER
9	23059	8 SS EXT TOOTH LK WASHER
10	34014	1/2 PE HOLE PLUG,BLACK
11	123020	NYLON EDGE PROTECTOR
12	190222	SOLENOID VALVE SPACER
13	190772	WRD MICRO BOARD
14	190793	WIRED DISPLAY BOARD
15	190794	HARNESS, HI & LOW VOLT
16	230105	FUSEBLOCK 5 X 20MM
17	230120	FUSE, 500 MA TD, 5 X 20
18	230135	FUSE, 1A TD, 5 X 20MM
19	230153	6A DPDT CKT BKR/SW,BLK
20	230161	FUSE, 5A, 5 X 20 MM
21	250085	SOLENOID VALVE, 12V
22	400119	SWITCHER 40W 12,5,-12V
23	420096	130VA XFMR, INT'L,12/24V
24	420097	43VA XFMR, INT'L 115
25	460024	SNAP-IN OUTLET
26	460138	PWR OUTLET,SNAP-IN RECEPT
27	460156	PWR ENTRY/RFI LINE FILTER
28	515094	1/4 X 9/16 THD STANDOFF
29	600034	.375" SNAPPER HOSE CLAMP
30	600063	.312 SNAPPER HOSE CLAMP
31	610055	CLIP-NUT 8-32 .02-.115
32	770001	DISPOSABLE FILTER 99.97
33	840008	10-32 X 5/32 HOSE FTG
34	840020	1/4 HOSE BRS BULKHEAD FTG
35	730044	NYLON WASHER
36	23024	3/8 SS FLAT WASHER
37	270106	FERRITE 1/400 CABLE
38	190523	OPTIONAL RS-485 CBLE
39	22052	8-32 X 3/8 SS PHP SCREW
40	59007	4-40 X 3/8 SS PHP SCREW
41	127021	4-40 M/F STANDOFF
42	....	OPTIONAL ANALOG BD 190512, 190543 OR 190544
43	190300	RIBBON CBLE ASSY, 34 POS
44	220259	ACCESSORY OUTLET LABEL
45	730017	3/8" BLACK FIBER WASHER



ATTENTION
OBSERVE PRECAUTIONS
ELECTROSTATIC SENSITIVE DEVICES

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

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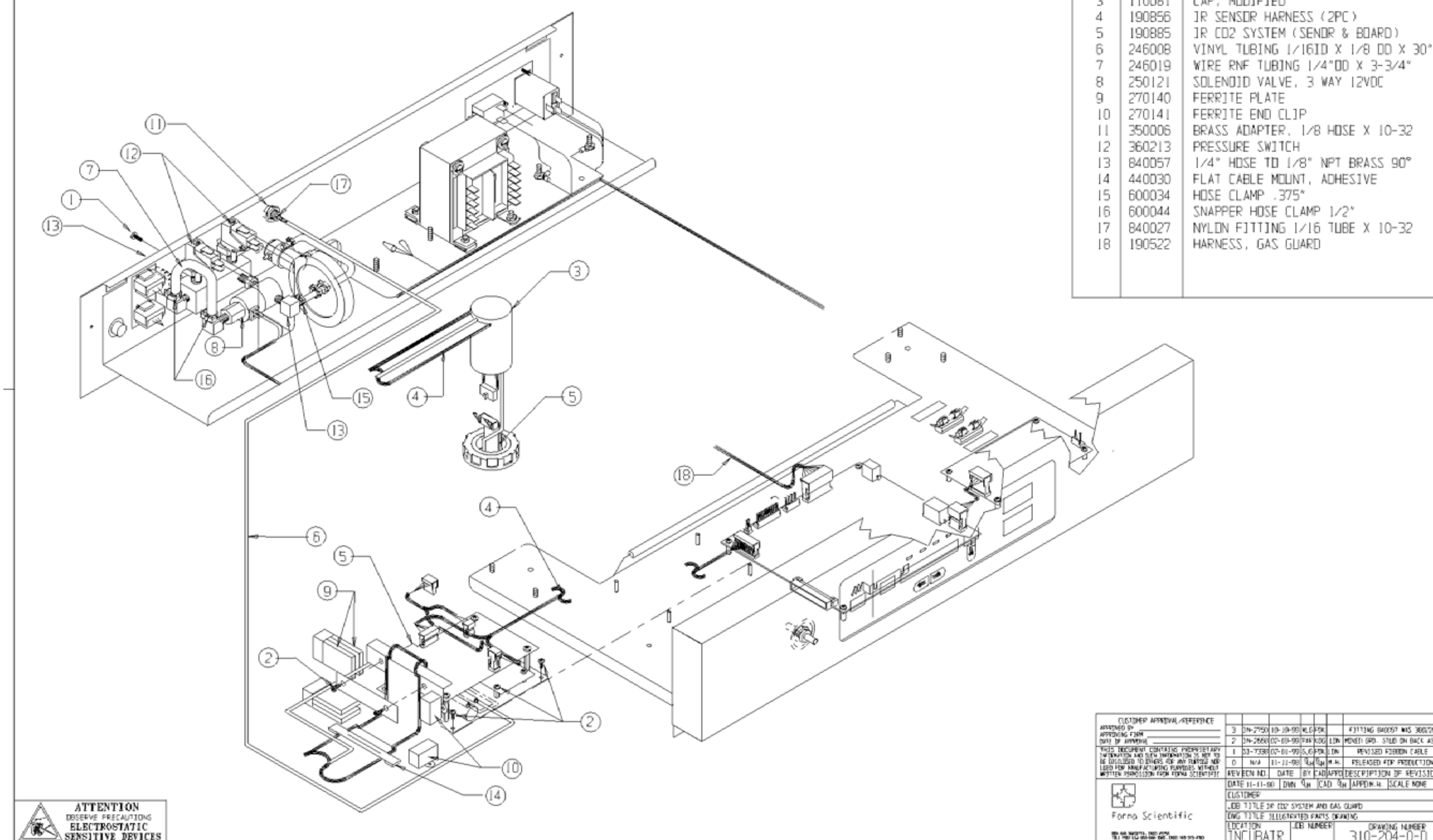
REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
3	IN-2704	02-24-00	DWL	KOG		ROTATED SOLENOID VALVE BODY
2	IN-2721	07-27-00	RAF	PDK	LON	CHANGE WASHER TO FIBER
1	IN-2714	06-25-00	RAF	PDK	LON	ADDED ACCESSORY OUTLET LABEL
0	N/A	10-20-98	GW	GW	LON	RELEASED FOR PRODUCTION

DATE 11-10-98 | DWN GW | CAD GW | APPD MH | SCALE NONE
CUSTOMER
JOB TITLE ELECTRICAL COMPARTMENT
DWG TITLE ILLUSTRATED PARTS DRAWING
LOCATION INCUBATR | JOB NUMBER | DRAWING NUMBER 310-203-0-D

Forma Scientific

SYM	STK#	DESCRIPTION
1	22052	8-32 X 3/8" SS PHP SCREW
2	22130	4-40 X 1/4" SS PHP SCREW
3	110081	CAP, MODIFIED
4	190856	IR SENSOR HARNESS (2PC)
5	190885	IR CO2 SYSTEM (SENOR & BOARD)
6	246008	VINYL TUBING 1/16ID X 1/8 OD X 30"
7	246019	WIRE RNF TUBING 1/4"OD X 3-3/4"
8	250121	SOLENOID VALVE, 3 WAY 12VDC
9	270140	FERRITE PLATE
10	270141	FERRITE END CLIP
11	350006	BRASS ADAPTER, 1/8 HOSE X 10-32
12	360213	PRESSURE SWITCH
13	840057	1/4" HOSE TO 1/8" NPT BRASS 90°
14	440030	FLAT CABLE MOUNT, ADHESIVE
15	600034	HOSE CLAMP .375"
16	600044	SNAPPER HOSE CLAMP 1/2"
17	840027	NYLON FITTING 1/16 TUBE X 10-32
18	190522	HARNESS, GAS GUARD



3	DN-2750	10-19-99	WLG	PDK		FITTING 840057 WAS 380220
2	DN-2668	02-09-99	FAR	KDG	LDN	MOVED GRD. STUD ON BACK ASSY
1	53-7338	07-01-99	S.G	PDK	LDN	REVISED RIBBON CABLE
0	N/A	11-11-98	GH	GH	M.H.	RELEASED FOR PRODUCTION
REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION

CUSTOMER APPROVAL/REFERENCE
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APPROVING FIRM
DATE OF APPROVAL

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DATE 11-11-98 | DWN GH | CAD GH | APPD M.H. | SCALE NONE

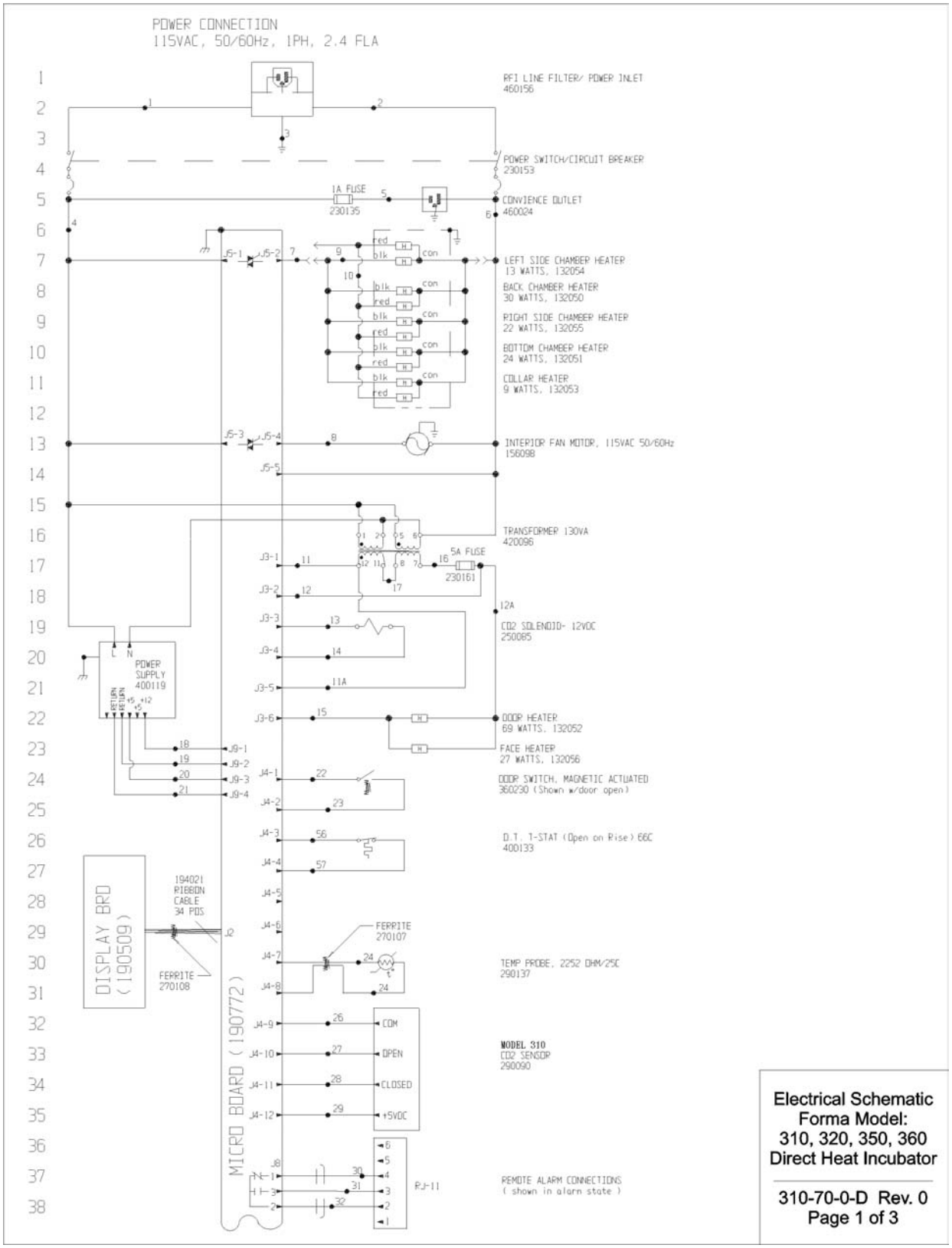
CUSTOMER

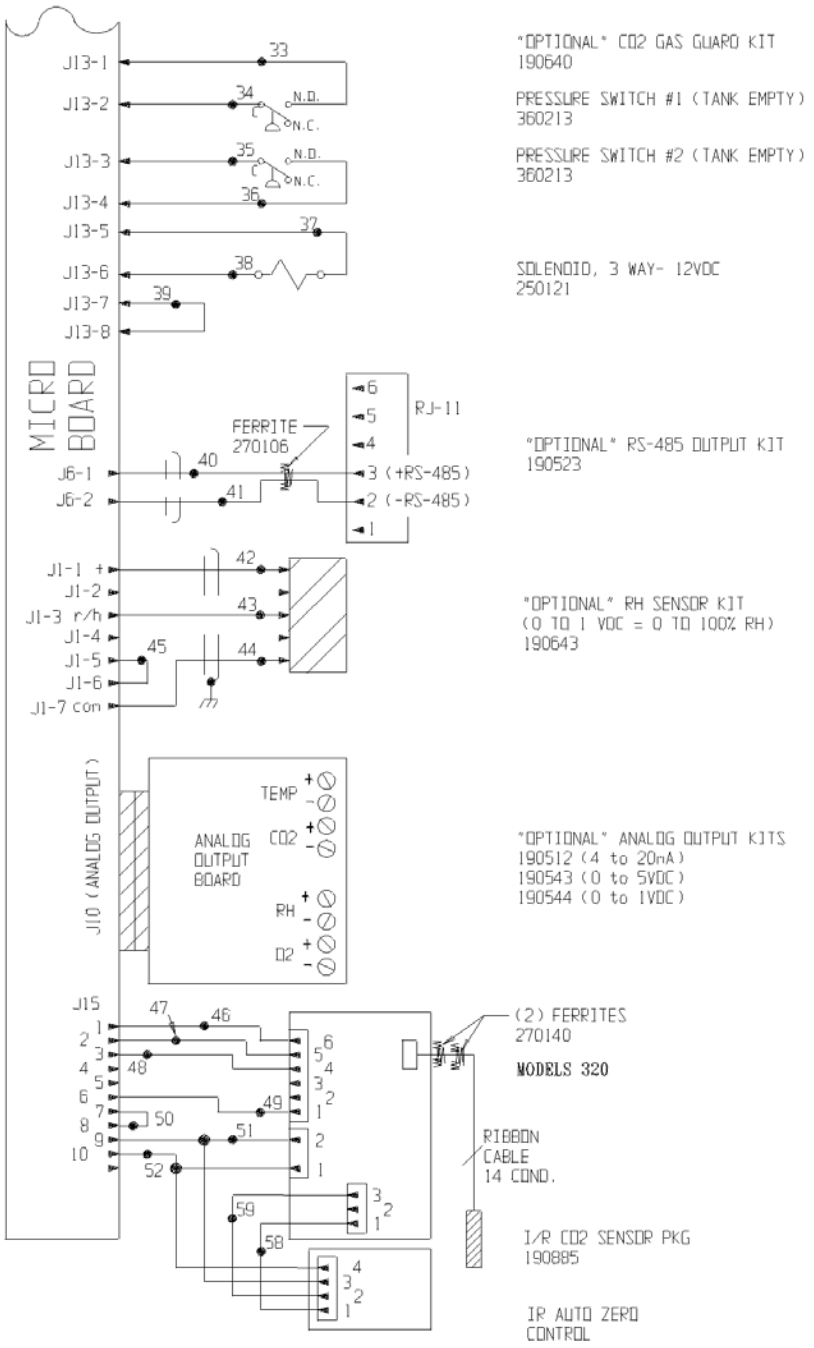
JOB TITLE IR CO2 SYSTEM AND GAS GUARD

DWG TITLE ILLUSTRATED PARTS DRAWING

LOCATION INCUBATR | JOB NUMBER | DRAWING NUMBER 310-204-0-D

Section 9 - Electrical Schematics





Electrical Schematic
Forma Model:
310, 320, 350, 360
Direct Heat Incubator

310-70-0-D Rev. 0
Page 2 of 3

WIRE REFERENCE CHART								
NO.	GA.	COLOR	NO.	GA.	COLOR	NO.	GA.	COLOR
1	16	BROWN	22	22	BLUE	47	22	ORANGE
2	16	BLUE	23	22	BLUE	48	22	YELLOW
3	16	GRN/YEL	24	22	RED	49	22	BROWN
3B	16	GREEN	25	22	RED	50	22	RED
4	18	BLACK	26	22	GREEN	51	22	GREEN
4A	18	BLACK	27	22	GRAY	52	22	BLACK
5	18	BLACK	28	22	PURPLE	53	18	RED
6	18	WHITE	29	22	ORANGE			
7	18	ORANGE	30	22/3	BLACK			
8	18	BLUE	31	22/3	RED	56	22	BROWN
9	18	BLACK	32	22/3	WHITE	57	22	BROWN
10	18	RED	33	20	RED	58	22	BROWN
11	18	BROWN	34	20	RED	59	22	WHITE
11A	18	BROWN	35	20	BLUE			
12	18	RED	36	20	BLUE			
12A	18	RED	37	20	ORANGE			
13	18	YELLOW	38	20	ORANGE			
14	18	YELLOW	39	20	BLACK			
15	18	BLUE	40	22/2	RED			
16	18	RED	41	22/2	BLACK			
17	18	ORANGE	42	22/3	BLACK			
18	18	RED	43	22/3	RED			
19	18	GREEN	44	22/3	GREEN			
20	18	ORANGE	45	22	BLACK			
21	22	GREEN	46	22	BLUE			

SENSOR REFERENCE VALUES

CO2 (2900SO)	DIFFERENCE VOLTAGE OF 3-6MV/%CO2 J4-9 & J4-10 TO J4-9 & J4-11
RH (1906431)	J1-7 & J1-1 = 12VDC J1-7 & J1-3 = 10MV/%RH

NOTES:

⊕	Denotes Terminal Strip Connection	Parts List Reference Number	
	Last Relay Number	○	Assembly
	Last Terminal Number	⬠	Panel
	Last Wire Number	⬡	Refrigeration
		□	Wiring

CUSTOMER APPROVAL/REFERENCE

APPROVED BY _____

APPROVING FIRM _____

DATE OF APPROVAL _____

REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
0	N/A	6/03/98				RELEASED FOR PRODUCTION

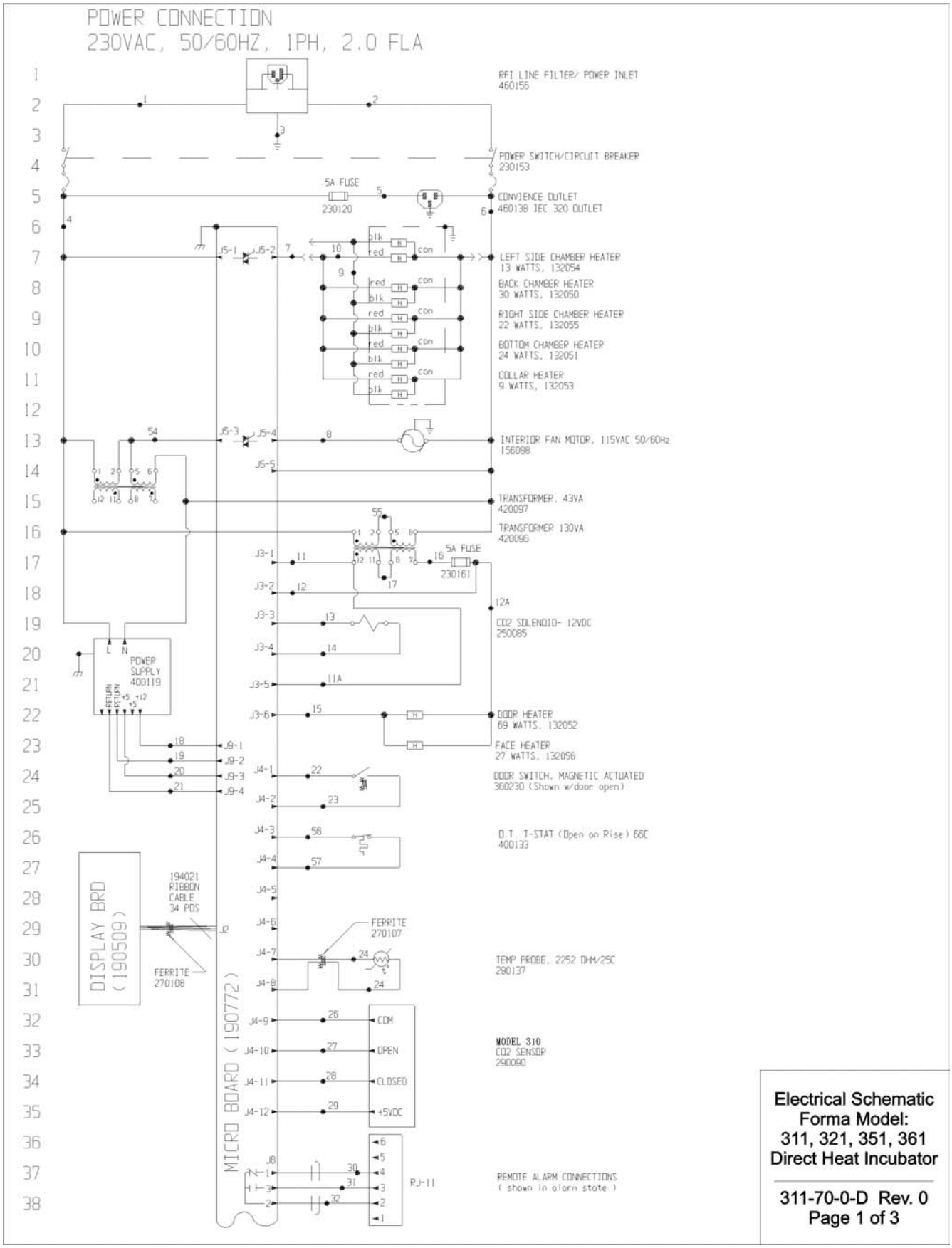
Forma Scientific

800 848 MARIETTA, OHIO 45750 TELEX 24-2304
TOLL FREE USA 800-848-3360, OHIO 614-373-4763

DATE 3-19-98	DWN	CAD	APPOM.H.	SCALE
CUSTOMER MODELS 310, 320				
JOB TITLE AIR JACKET INCUBATOR 115 VOLT (DOM.)				
DWG TITLE ELECTRICAL SCHEMATIC				
LOCATION INCUBATR	JOB NUMBER	DRAWING NUMBER 310-70-0-D		

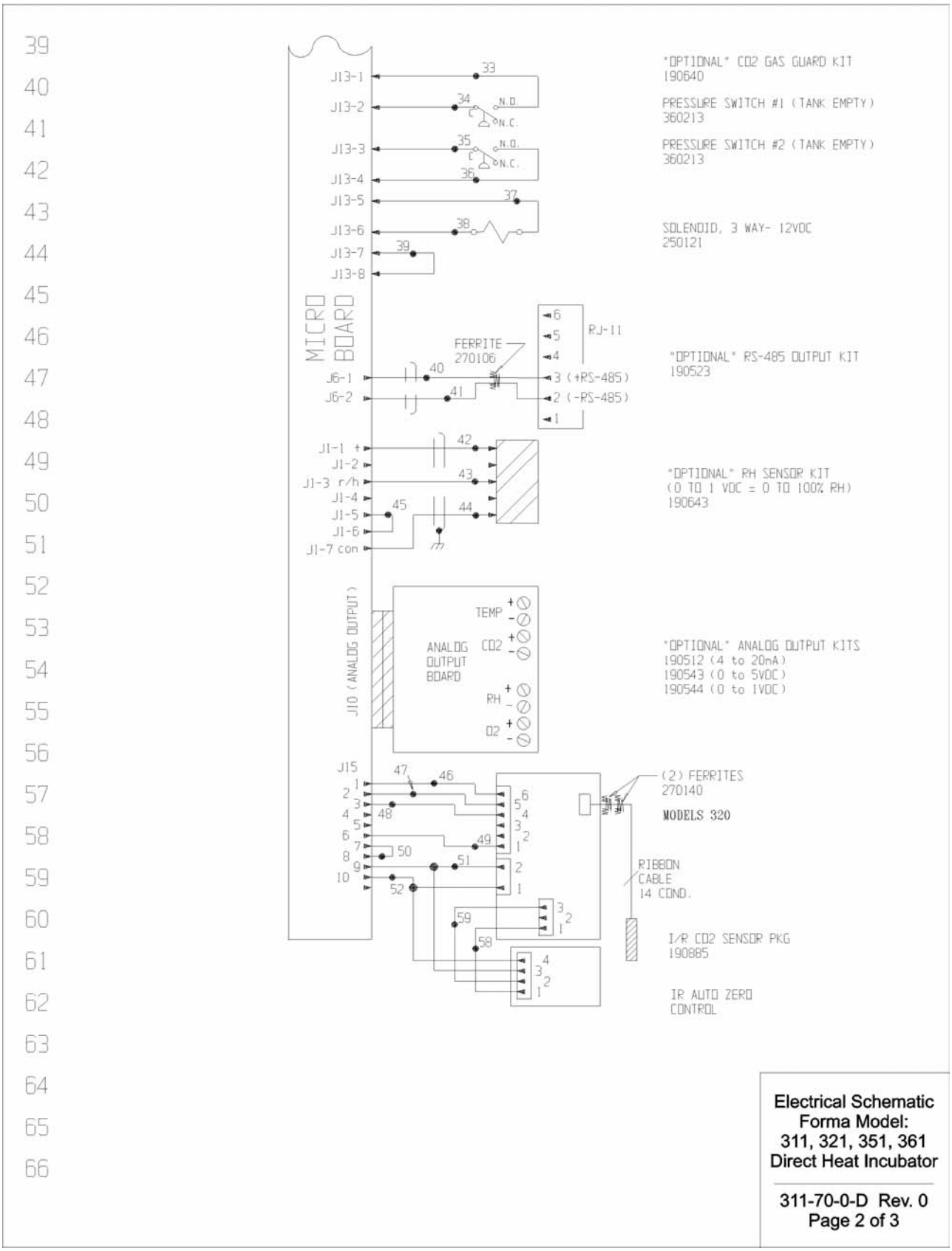
Electrical Schematic
Forma Model:
310, 320, 350, 360
Direct Heat Incubator

310-70-0-D Rev. 0
Page 3 of 3



Electrical Schematic
Forma Model:
311, 321, 351, 361
Direct Heat Incubator

311-70-0-D Rev. 0
Page 1 of 3


MICRO BOARD
J13-1
J13-2
J13-3
J13-4
J13-5
J13-6
J13-7
J13-8
33
34
35
36
37
38
39
N.O.
N.C.
"OPTIONAL" CO2 GAS GUARD KIT
190640
PRESSURE SWITCH #1 (TANK EMPTY)
360213
PRESSURE SWITCH #2 (TANK EMPTY)
360213
SOLENOID, 3 WAY- 12VDC
250121
FERRITE
270106
RJ-11
J6-1
J6-2
40
41
3 (+RS-485)
2 (-RS-485)
"OPTIONAL" RS-485 OUTPUT KIT
190523
J1-1 +
J1-2
J1-3 r/h
J1-4
J1-5
J1-6
J1-7 com
42
43
44
45
"OPTIONAL" RH SENSOR KIT
(0 TO 1 VDC = 0 TO 100% RH)
190643
J10 (ANALOG OUTPUT)
ANALOG OUTPUT BOARD
TEMP
CO2
RH
O2
"OPTIONAL" ANALOG OUTPUT KITS
190512 (4 to 20mA)
190543 (0 to 5VDC)
190544 (0 to 1VDC)
J15
46
47
48
49
50
51
52
59
58
(2) FERRITES
270140
MODELS 320
RIBBON CABLE
14 COND.
I/R CO2 SENSOR PKG
190885
IR AUTO ZERO CONTROL
Electrical Schematic
Forma Model:
311, 321, 351, 361
Direct Heat Incubator
311-70-0-D Rev. 0
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WIRE REFERENCE CHART

NO.	GA.	COLOR	NO.	GA.	COLOR	NO.	GA.	COLOR
1	16	BROWN	22	22	BLUE	47	22	ORANGE
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3B	16	GREEN	25	22	RED	50	22	RED
4	18	BLACK	26	22	GREEN	51	22	GREEN
4A	18	BLACK	27	22	GRAY	52	22	BLACK
5	18	BLACK	28	22	PURPLE	53	18	RED
6	18	WHITE	29	22	ORANGE	54	18	YELLOW
7	18	ORANGE	30	22/3	BLACK	55	18	YELLOW
8	18	BLUE	31	22/3	RED	56	22	BROWN
9	18	BLACK	32	22/3	WHITE	57	22	BROWN
10	18	RED	33	20	RED	58	22	BROWN
11	18	BROWN	34	20	RED	59	22	WHITE
11A	18	BROWN	35	20	BLUE			
12	18	RED	36	20	BLUE			
12A	18	RED	37	20	ORANGE			
13	18	YELLOW	38	20	ORANGE			
14	18	YELLOW	39	20	BLACK			
15	18	BLUE	40	22/2	RED			
16	18	RED	41	22/2	BLACK			
17	18	ORANGE	42	22/3	BLACK			
18	18	RED	43	22/3	RED			
19	18	GREEN	44	22/3	GREEN			
20	18	ORANGE	45	22	BLACK			
21	22	GREEN	46	22	BLUE			

SENSOR REFERENCE VALUES

CO2 (290090) DIFFERENCE VOLTAGE OF 3-6MV/%CO2
J4-9 & J4-10 TO J4-9 & J4-11

RH (190643) J1-7 & J1-1 = 12VDC
J1-7 & J1-3 = 10MV/%RH

NOTES:
⊕ Denotes Terminal Strip Connection
Last Relay Number
Last Terminal Number
Last Wire Number

Parts List Reference Number
○ Assembly
⬠ Panel
⬡ Refrigeration
□ Wiring

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

Forma Scientific

REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
0	N/A	6/03/98				RELEASED FOR PRODUCTION

DATE 3-18-98 | DWN | CAD | APPOM.H. | SCALE
CUSTOMER MODELS 311, 321
JOB TITLE AIR JACKET INCUBATOR 230 VOLT (EXP.)
DWG TITLE ELECTRICAL SCHEMATIC
LOCATION INCUBATR | JOB NUMBER | DRAWING NUMBER 311-70-0-D

Electrical Schematic
Forma Model:
311, 321, 351, 361
Direct Heat Incubator

311-70-0-D Rev. 0
Page 3 of 3