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INSTRUCTION MANUAL

ECU

Environmental Control unit

This manual applies to ECUs with a software revision of 3.0 and the STEV2 (or STEV2-B).

Serial No._____

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082318

CONTENTS

ABOUT THIS MANUAL

The following symbols are used in this guide:

This symbol indicates a CAUTION. Cautions warn against actions that can cause damage to equipment. Please read these carefully.

This symbol indicates a WARNING. Warnings alert you to actions that can cause personal injury or pose a physical threat. Please read these carefully.

NOTES and TIPS contain helpful information.

The **Environmental Control Unit (ECU)** can be used with either the **Stagetop Environment** incubator (**STEV-**Fig. 1) or with a full microscope enclosure system (large chamber-Fig. 2). For short term or long term studies of living cell cultures under a microscope or for time lapse video research, a microscope **Stagetop Environment** incubator (**STEV**) is essential. Perfect for Live Cell Imaging**, STEV** is a compact environmental incubation chamber that houses your culture wells and fits on a microscope stage.

Fig. 1—The Stagetop Environment (STEV) and ECU (Environmental Control Unit) comprise the basic incubator system for growing cells under controlled conditions.

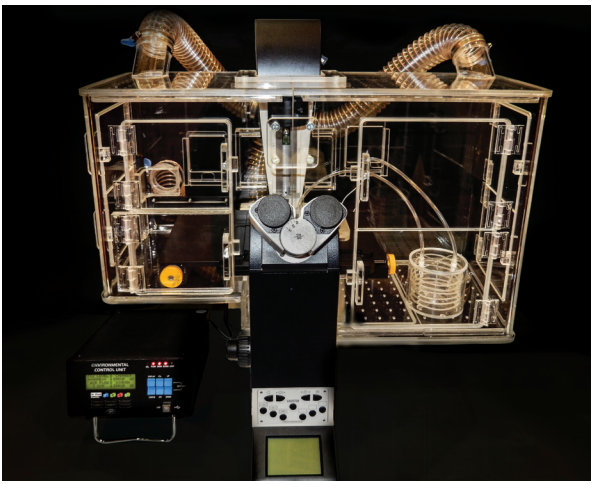


Fig. 2—A complete environmental control system includes the ECU (Environmental Control Unit and a microscope with chamber.

INTRODUCTION

This system offers precision control of both temperature and carbon dioxide, as well as remote control and data logging via a USB connection. The system is flexible and easy to configure for a variety of experimental conditions.

The carbon dioxide sensor is located in the incubator chamber (**STEV**) wall. Feedback from this sensor allows the **ECU** to control the concentration of CO_2 from 0–20%.This controller offers a background flow rate of 0–950 SCCM.

NOTE: THE **ECU-HCP** has an external CO_2 sensor.

The system includes the **Environmental Control Unit (ECU)** electronics which use four programmable loops to control the temperatures of the incubation chamber (base) and the lid, CO_2 within the environmental incubation chamber and airflow within the incubator.

The system comes in four configurations, and all four are discussed in this manual.

- **ECU-H5**–Pre-mixed CO_2 gas of the desired concentration is pumped into the system, and this **ECU** regulates the airflow at the desired level. It also controls the heating and monitors the stagetop environment chamber.
- **ECU-HC**–This control unit mixes the air and CO_2 gas to the desired concentration. An internal CO_2 sensor (inside the **ECU** controller) monitors the concentration of the gas. The **ECU-HC** regulates the airflow at the desired level, controls the heating of the system and monitors the stagetop environment chamber.
- **ECU-HCP**–This unit performs like the **ECU-HC**, except this unit comes with a remote CO_2 sensor that is positioned inside the stagetop environment chamber.
- **ECU-HOC**–This unit performs like the **ECU-HC**. In addition to controlling the temperature and CO_2, this unit also controls the O_2 level. Nitrogen is used to displace oxygen from the background air, which generally has about 20.7% oxygen. The O_2 level of the background gas can be regulated down to as low as 1%.

Features

- Up to five programmable digital control loops
  - Independent incubator base temperature PID control with ±0.1ºC precision
  - Independent incubator lid temperature PID control with ±0.1ºC precision
  - CO_2 digital PID control with ±0.1% precision
  - O_2 digital PID control with ±0.1% precision
  - Airflow digital PID control from 0–900 SCCM
- Probe tracking adaptive mode automatically adjusts the setpoints for both the chamber and the window to maintain the desired well temperature
- USB-based remote control and data logging
- Electronic flow meter

- Programmable alarm for out of tolerance condition on all four channels
- Compact and lightweight

Options

The standard environmental control unit has a heated incubator (with a heated glass lid) and CO_2 control. In the event that your application uses a heated microscope chamber, this system connects with an **AirTherm Satellite** heater.

Notes and Warnings

CAUTION: Always remove the lid on the Stagetop Environment (**STEV**) by using the thumb hold indentation in the bottom left corner of the incubation chamber.

Parts List

After unpacking, verify that there is no visible damage to the unit. Verify that all items are included:

(1) **STEV** – Stagetop environmental control unit with lid

(1) **ECU** – Environmental Control Unit electronics control

(1) Temperature sensor

(1) CO_2 Sensor Cable (orange) – This is ONLY provided with the **ECU-HCP** systems.

(1) Accessory Kit that includes a tubing kit with connectors, and a syringe kit

(1) Instruction Manual

Unpacking

Upon receipt of this instrument, make a thorough inspection of the contents and check for possible damage. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed damage should be reported at once to the carrier and an inspection requested. Please read the section entitled "Claims and Returns" on page 35 of this manual. Please contact WPI Customer Service if any parts are missing at 941-371-1003 or customerservice@wpiinc.com.

Returns: Do not return any goods to WPI without obtaining prior approval (RMA # required) and instructions from WPI's Returns Department. Goods returned (unauthorized) by collect freight may be refused. If a return shipment is necessary, use the original container, if possible. If the original container is not available, use a suitable substitute that is rigid and of adequate size. Wrap the instrument in paper or plastic surrounded with at least 100mm (four inches) of shock absorbing material. For further details, please read the section entitled "Claims and Returns" on page 35 of this manual.

INSTRUMENT DESCRIPTION

The **ECU** may be also be used with a full microscope enclosure, but for now we will look at the Stagetop Environment (**STEV2**) with the Environmental Control Unit (**ECU**) electronics. The **STEV2** (shown below) accepts a remote CO_2 probe and is designed for use with an **ECU-HCP**. If the remote probe is not required, a **STEV2B** may be used. The **STEVB** works with an **ECU-H5**, **ECU-HC** or **ECU-HOC**, and it does not accept a remote probe.

STEV2

The Stagetop Environment Incubator has an airtight lid that snaps into place. The second generation **STEV** is shown below, and it features the perfusion ports. All connections are on the left side of **STEV2**.

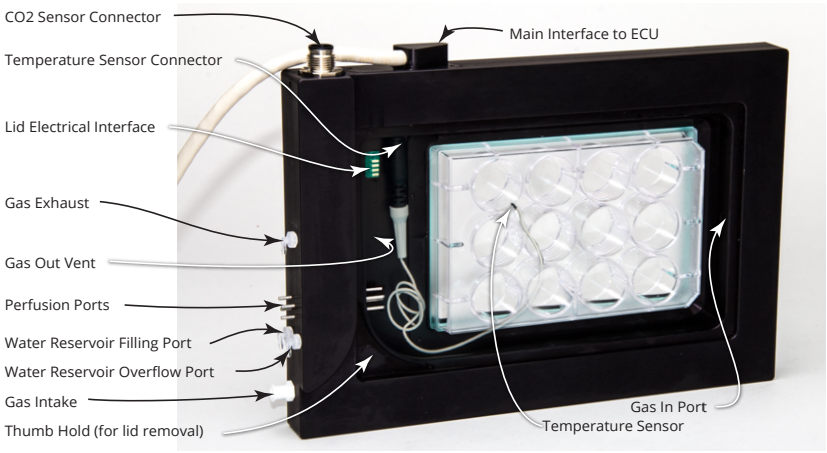


Fig. 3—The Stagetop Environment incubator for the **ECU-HCP** *is shown with the cover removed.*

CO_2 Sensor Connector–In most cases, the CO_2 sensor is housed inside the incubator wall. The CO_2 gas passes from the ***Gas Intake*** to the ***Gas In Port*** over the culture wells to the ***Gas Out Vent***. Then, it passes over the CO_2 sensor as it exits through the ***Gas Exhaust*** tube. Attach the orange CO_2 sensor cable from the **ECU** to this port.

Temperature Sensor Connector–Two ports are located on the inside of the chamber wall. The first (left) is for future use. Plug the temperature sensor into the second one. (right). The tip of the sensor can be positioned inside the chamber, as desired.

Lid Electrical Interface–When the lid is properly installed, this interface allows the **ECU** to control the lid temperature.

Gas Exhaust–Mixed gas travels through the system and exits through this exhaust port. It can be vented to the air or connected to an exhaust system, if desired.

Gas Out Vent–Mixed gas inside the incubation chamber exits the chamber through this vent hole.

Perfusion Ports–These ports can be used for microfluidic experiments and gas transfer.

Water Reservoir Ports–The water reservoir inside the incubator wall serves two purposes. When it is heated, it helps to maintain the temperature of the chamber. Second, it humidifies the mixed gas as the gas travels through water permeable tubing inside the water reservoir. Connect a syringe filled with distilled water to the luer fitting on the ***Water Reservoir Filling Port***. Fill the chamber until the water comes out of the ***Water Reservoir Overflow Port***.

Fig. 4—Use a large syringe filled with distilled water to fill the water reservoir. When it is full, water will come out the overflow port.

Gas Intake–The mixed gas enters the incubation chamber through this port. Use ¼˝ OD tubing to connect this port to the ***Mixture Out Port*** on the back of the **ECU**.

Thumb Hold–Insert your thumb or finger and gently lift the chamber lid when you need to remove the lid.

Main Interface to ECU–The cable allows the **STEV** to communicate with the **ECU** electronics.

Gas In Port–Mixed gas enters the incubator chamber through this hole.

Fig. 5—The STEV is shown with the chamber cover in position.

ECU

The **ECU** houses all the electronics for:

- Regulating the CO_2 flow and temperature of the incubation chamber
- Controlling the temperature of the chamber lid and an auxiliary heater
- Monitoring the air flow, CO_2 level, and four temperatures.
- **ECU-HOC** also regulates and monitors the O_2 level.

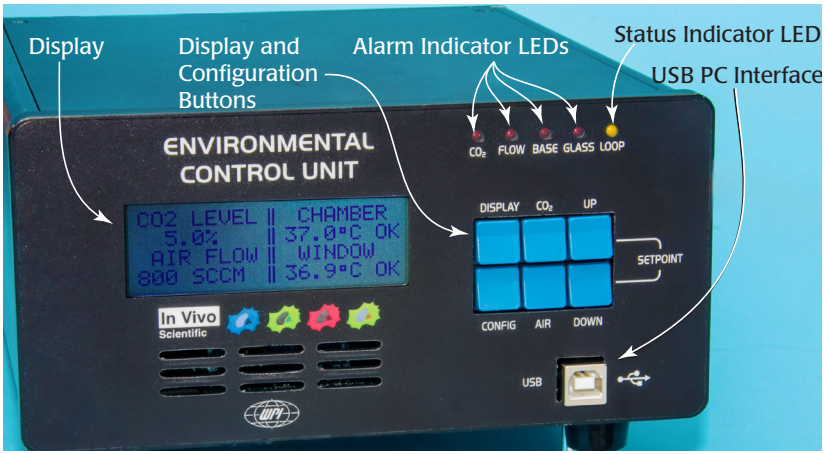


Fig. 6—The front panel of most ECUs displays four monitored parameter: CO_2 level, air flow, chamber temperature and temperature of the chamber's heated glass lid (window). The ECU-H5 does not display CO_2, because a pre-mixed gas of known concentration is used, and CO_2 is not monitored. The ECU-HOC also displays the oxygen level.

Display–The main display shows the CO_2 level in the incubator chamber, the O_2 level in the incubator chamber (**ECU-HOC** version only), the air flow (in standard cm^3), the temperature inside the chamber and the temperature of the heated glass lid (window).

Display and Configuration Buttons–

Display: Press this button to toggle between the main display and a set of individual temperatures, including the specimen temperature (positioned inside the chamber), the adaptive mode display and an optional auxiliary temperature which can be connected to the system using the ***Auxiliary Heater Port*** on the back of the **ECU**.

Config: This button toggles through a list of configuration parameters like setpoints and alarms.

CO_2: To quickly see the CO_2 level, press this button. On the **ECU-HOC,** this button displays both the CO_2 level and the O_2 level.

Air: To quickly see the air flow, press this button.

Up/**Down**: These two buttons are used to adjust configuration parameters.

Alarm Indicator LEDS–The red LEDs illuminate to indicate an alarm state.

CO_2: This red LED illuminates when the CO_2 level falls more than ±0.5% outside the high and low alarm limits set using the configuration menu.

Flow: This red LED illuminates when the measured air flow is more than 100 SCCM (Standard Cubic Centimeters/Minute) greater or less than the setpoint.

Base: This red LED illuminates when the incubation chamber (base) temperature falls outside the high and low alarm limits set using the configuration menu.

Glass: This red LED illuminates when the chamber lid (glass) temperature falls outside the high and low alarm limits set using the configuration menu.

Status Indicator LED–This yellow heartbeat LED blinks continuously to indicate that the unit is operational and the control loops are running.

USB PC Interface–Connect the **ECU** to a computer using a standard USB cable. This interface can be used to monitor and control the ECU. It is intended for integration with software packages like a microscope imaging software.

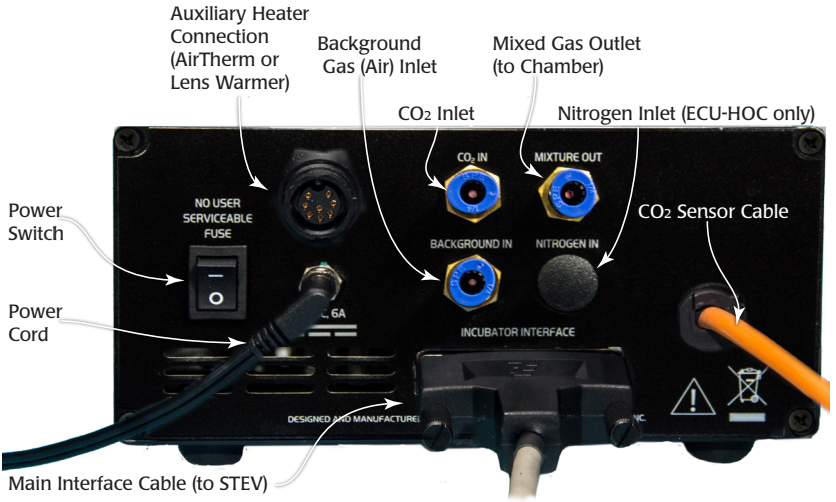


Fig. 7—The ECU-HCP back panel has the ports and connectors to connect the STEV chamber with the electronic controls. The ECU-H5 has no Gas Inlet port or CO_2 Sensor Cable. Because the ECU-HC has an internal sensor, it will not have a CO_2 Sensor Cable. The ECU-HOC has an additional port for nitrogen inlet.

Power Switch–This toggle button powers on the electronic controls.

Auxiliary Heater Connection–An auxiliary heater (like the **AirTherm** or a lens warmer) can be plugged into this port to allow the **ECU** to control it. For example, when used with a satellite heater, the **ECU** could be used to regulate the temperature

of a microscope enclosure chamber used in live cell imaging. Alternatively, it could be used to regulate a lens warmer.

Background Gas Inlet pressure fit connector–Connect the pressurized background gas to this port using 1/4″ OD tubing. If you are using the **ECU-H5**, connect the pre-mixed gas to this port. With the other **ECU**s, connect the background air tank to this port.

CO_2 Inlet pressure fit connector–Connect the CO_2 tank to this port using 1/4″ OD tubing. The **ECU-H5** does not have this port.

N_2 Inlet pressure fit connector–Connect the N_2 tank to this port using 1/4″ OD tubing. The **ECU-HOC** is the only unit with this port. The nitrogen is used to displace oxygen.

Mixed Gas Outlet–Connect this port to the *Gas Intake* on the **STEV** chamber using 1/4″ OD tubing.

CO_2 Sensor Cable (ECU-HCP only)– Connect this orange cable to the *CO_2 Sensor Connector* on the **STEV** chamber.

Tubing Kit

Fig. 8—The tubing kit contains all the tubing to connect the gas tanks, the ECU and the STEV. This kit will vary somewhat depending on which ECU you ordered.

Syringe Kit

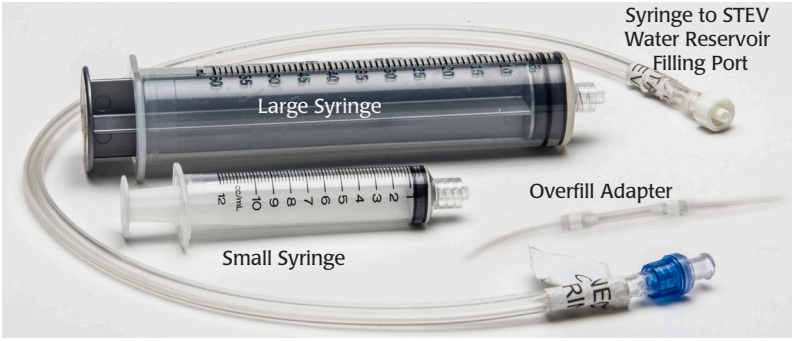


Fig. 9—The syringe kit is used for filling the STEV water reservoir.

OPERATING INSTRUCTIONS

System Setup

The basic setup of the environment control system is shown below. Gas connections can be made using ¼″ OD tubing. The **ECU** is optimized at the factory for 5% CO_2, however, a range of other control percentages may be used. During the initial setup, the setpoint should be set to 0% CO_2 concentration and allowed to settle for 15 minutes. For the **ECU-HCP**, the **CO_2 flow control should be fully open**,* and the background air should be running at 800CCM. The background gas for all the other configurations should be set at 400CCM. Once the system settles, adjust the setpoint to the desired concentration.

***NOTE**: For the system to operate correctly, it is important that the pressure for the CO_2 flow control and the back-ground air be set at 25 PSI. For the **ECU-HOC**, the pressure for the nitrogen flow must also be set to 25 PSI.

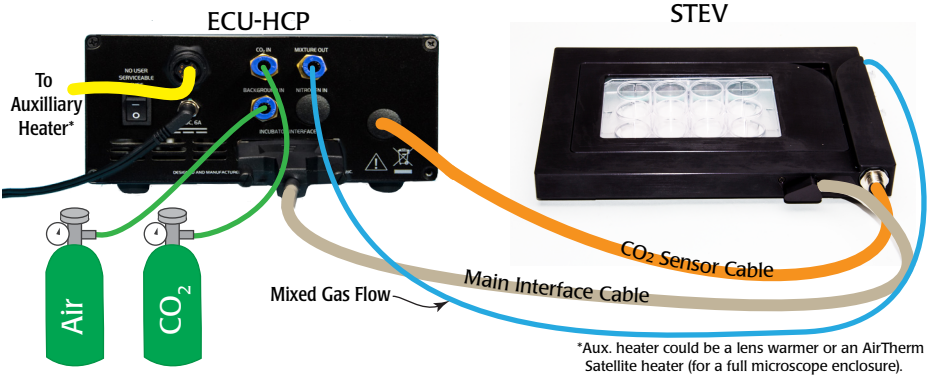


Fig. 10—The ECU-HCP connections

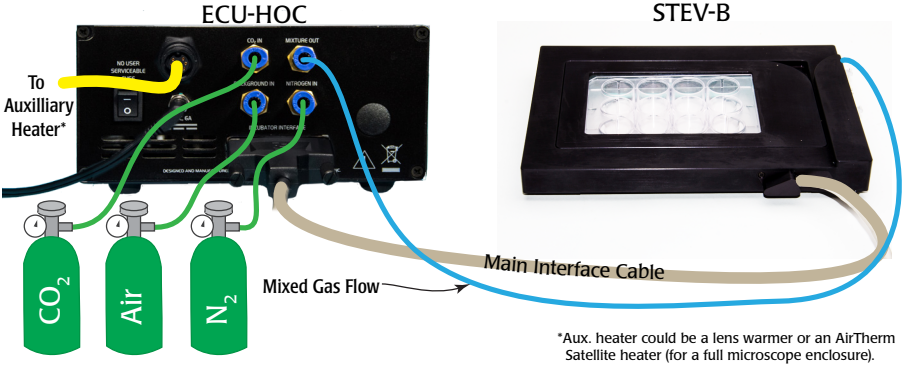


Fig. 11—The ECU-HOC connections

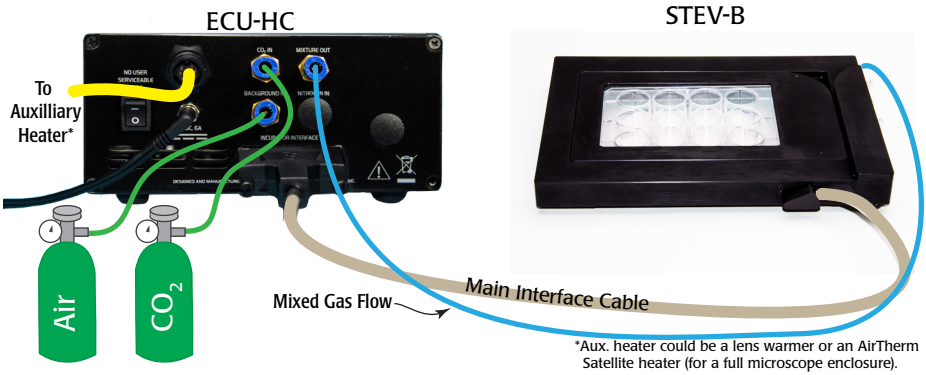


Fig. 12—The ECU-HC connections.

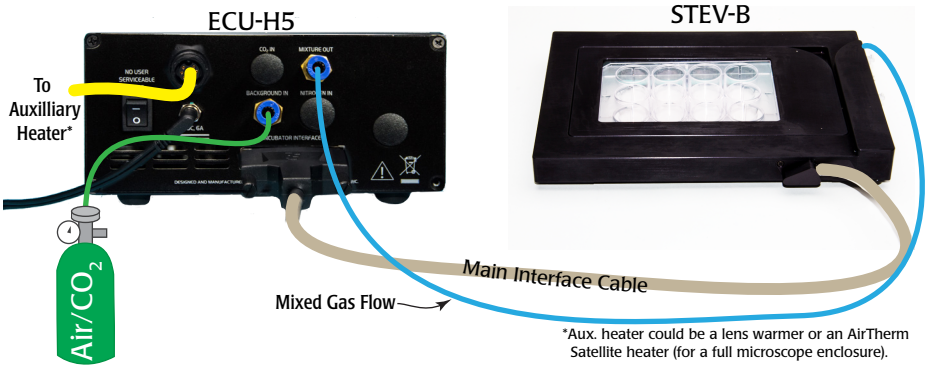


Fig. 13—The ECU-H5 connections

1. Connect one end of the overflow adapter to ***Water Reservoir Filling Port*** and the other end to the ***Overflow Port***. The overfill adapter allows the water in the reservoir to expand as it heats without spilling onto the microscope stage.

Fig. 14— The overflow adapter has two luer fittings used to connect to a syringe.

Fig. 15—The overfill adapter is connected to the STEV filling and overflow ports.

2. To fill the water reservoir:

- Disconnect the luer fitting on the overfill adapter in order to fill the reservoir.
- Attach the white fitting on the reservoir filling tubing to the water intake tubing.

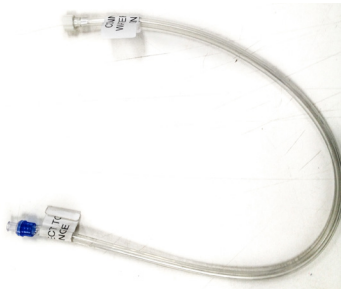


Fig. 16—The white end of the reservoir filling tube attaches to the STEV water intake tubing, and the blue end attaches to a syringe.

- Fill the 100CC syringe filled with warm, distilled water. Attach the blue luer lock on the filling tube to the syringe. Inject water into the ***Reservoir Filling Port*** until water without bubbles comes out of the ***Reservoir Overflow Port*** on the top of the stagetop environment.

Fig. 17—Connect the syringe to the blue connector on the filling tube.

- Disconnect the filling tube, and reconnect the overfill adapter.

TIP: If you prefer, cap the inlet port, and leave the outlet port open. Be sure to route the water away from the microscope. The water in the chamber may expand on initial heating and overflow the chamber. The moist air in the chamber transmits heat much better than dry air.

3. Using the labeled tubing kit, make the gas connections for the **ECU**:
   - (**ECU-HCP, ECU-HOC** and **ECU-HC** only.) Connect the CO_2 tank to the ***CO_2 In port***. Press the opaque Tygon tubing all the way into the port.
   - (**ECU-HOC** only.) Connect the nitrogen gas tank to the ***N2 In port***.
   - Connect the background gas tank to the ***Background In port***. For the **ECU-H5**, connect the pre-mixed gas to this port.
   - Connect the ***Mixture Out port*** to the ***Gas Input port*** on the **STEV** chamber.

4. Connect the **STEV** with the **ECU**:
   - (**ECU-HCP** only.) Line up the pins and notch on the sensor connector (on the **STEV**) with the holes on the sensor cable to connect the sensor.
   - Connect the ***Main Interface cable*** on the **STEV** chamber to the ***Incubator Interface port*** on the **ECU**.

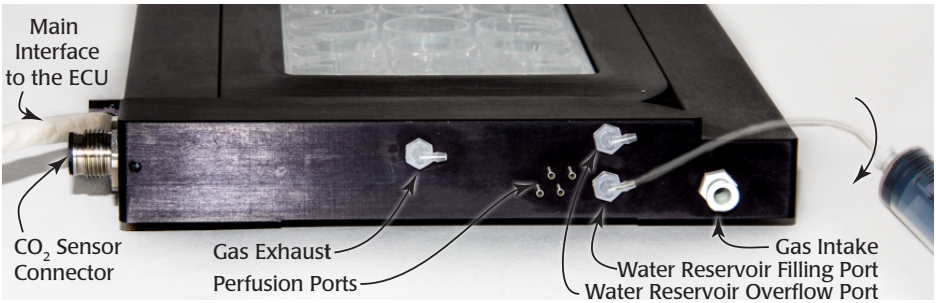


Fig. 18—The STEV2 (shown) has the connector for the ECU-HCP *external CO_2 sensor.*

5. If desired, connect an auxiliary heater to the ***Auxiliary Heat Connector*** on the back of the **ECU**. This could be an **AirTherm Satellite** unit for heating a microscope chamber, or it could be a lens warmer. If you are using a lens warmer, a dongle is required. See "Setting Up an Auxiliary Heater" on page 23.

Fig. 19—The AirTherm Satellite heater can be used as an auxiliary heater which can be controlled by the ECU.

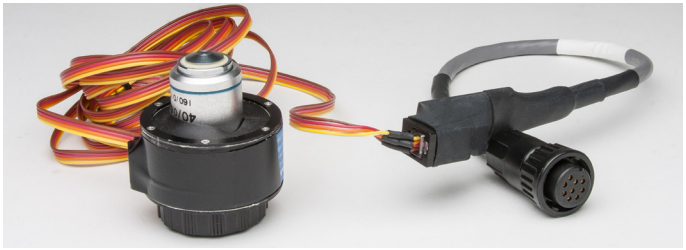
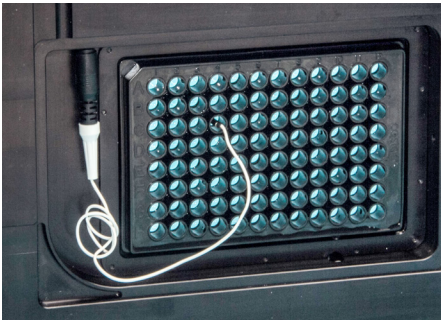


Fig. 20—A lens warmer is plugged into the ECU dongle.

6. Open the lid of the chamber by placing your thumb or index finger in the thumb hold and gently lifting the lid.

7. Position the culture well plate and the temperature sensor as desired inside the chamber. Usually the sensor is positioned near the center of the well plate. Fill the temperature sensor well with distilled water.



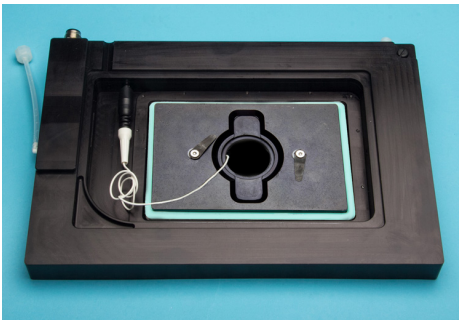


Fig. 21—(Left) Position the temperature sensor in one of the culture wells.
Fig. 22—(Right) This STEV has a 35mm well adapter plate.

NOTE: Adapters are available that allow you to use 35mm culture dishes inside a **STEV**. If you use an adapter, verify that the dish is placed inside the adapter so that it sits flat. Push it in place with enough force so that the gasket seals around it. Because it is a snug fit, press it straight down. If it is tilted, it is harder to install. It must sit flat on the bottom of the **STEV**.

8. Reposition the chamber lid and press it securely into place. The rubber gasket on the lid does not conduct heat. Most of the heat is transmitted through the moist air and the glass radiating onto the well plate.

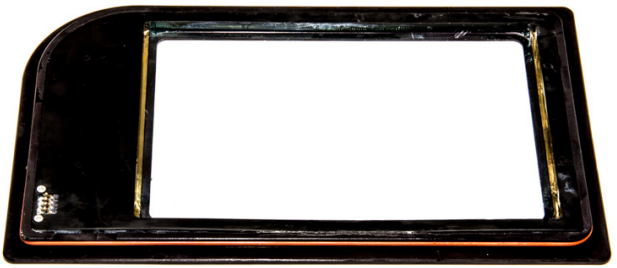


Fig. 23—The rounded corner of the lid fits into the thumb hold on the base of STEV. Notice the electronic interface connection in the bottom left corner of the image. This interface allows the controller to communicate with the lid and control the lid temperature.

CAUTION: Avoid touching the electronic interface connector on the underside of the lid and on the base. Keep moisture out of this interface, especially when you are cleaning the lid and base unit.

9. Plug the power cable from the **ECU** into an AC power outlet.

10. Turn the power switch on the back of the **ECU** unit on.
11. Select the incubator type (***STEV*** or ***Large Incubator***) by simultaneously press the ***Up*** and ***Down*** buttons to access the ***Hardware Setpoint*** menu (Fig. 24). Press the ***Config*** button to toggle through the options until ***Select Incubator*** displays (Fig. 25). Press the ***Down*** button to change the setting. Press the ***Display*** button to save your option. The main display and the parameters available from the ***Configuration*** menu change depending on which incubator option you choose.

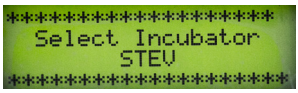


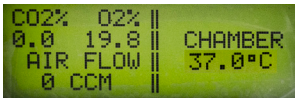
Fig. 24—Press the Up and Down buttons together to enter the Hardware Setpoint menu.
Fig. 25—The incubation chamber selection can be adjusted with the Up or Down button.

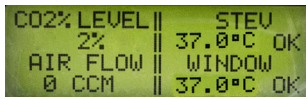
12. Set the configuration parameters, as needed. See "Setting Parameters Using the Configuration Menu" on page 16.
    NOTE: When the **STEV** is chosen as the incubator type, the setpoints for the **STEV** and the lid regulate the temperature at those structures. The temperature at the well plate is lower because of a temperature gradient between the plate and the body of the chamber. Setting the lid and chamber setpoints to 38.5ºC usually allows the **ECU** to maintain the well plate temperature around 37ºC. If you prefer, you can set the ***Probe Tracking Adaptive Mode*** to automatically adjust the setpoints for both the chamber and the window to maintain the desired well temperature.
13. Allow the system to run for 20 minutes so that the CO_2 level stabilizes.

Main Display Options

What appears on the main controller display of the **ECU** depends on the version of the **ECU** and which incubator it is configured for. The display always shows the current measured CO_2 level, air flow level and the incubation chamber temperature (Fig. 26). If the **ECU** is setup for use with a **STEV** (Fig. 27), the display also shows the temperature of the heated lid (window). In addition to all those parameters, the **ECU-HOC** also displays the O_2 level (Fig. 28).

NOTE: The ***STEV Temperature*** is monitored by a sensor mounted inside the **STEV** chamber wall. The ***Window Temperature*** registers the temperature of the heated glass lid of the **STEV**.





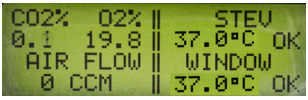


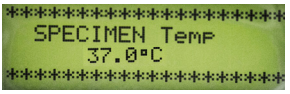
Fig. 26—(Left) The ECU-HOC configured for a large chamber shows only the chamber temperature on the right side of the display.
Fig. 27—(Center) The default display of the ECU controller (configured for a STEV) continuously updates to show four measured parameters. The ECU-H5 displays "None" for the CO_2 value, because a pre-mixed gas of known concentration is used, and CO_2 is not monitored.

Fig. 28—(Right) The ECU-HOC (configured for a STEV) also displays the oxygen level.

Press the **Display** button to toggle through the display options and monitor the current values of the system temperatures. If the **ECU** is configured for a stagetop environment, you may toggle through the following displays:

- Specimen Temperature (Fig. 29) is measured by the sensor positioned inside the **STEV** chamber. The free probe (specimen) temperature is not used as feedback for the temperature control circuit.
- Probe Tracking display (Fig. 30) shows the adaptive control mode status (enabled or disabled), and the chamber and window setpoint temperatures.
- If a lens warmer is enabled, the Lens Heater Temperature display (Fig. 31) may be viewed.

NOTE: If the **ECU** is configured for a large chamber, the only display available is the home screen.



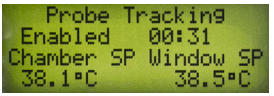
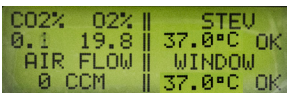


Fig. 29—(Left) Specimen Temperature Display
Fig. 30—(Center) Probe Tracking Display
Fig. 31—(Right) Lens Heater Temperature (optional)

Viewing the CO_2 Measurement

The CO_2 level measured inside the incubation chamber (***STEV*** or a ***Large Chamber***) is always available in the upper left corner of the main display (Fig. 32). To quickly view the CO_2 level alone, press the ***CO_2*** button on the **ECU** (Fig. 33). On an **ECU-HOC**, the O_2 level is also available (Fig. 34).



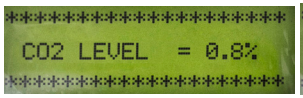
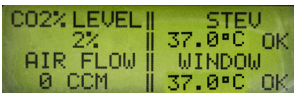


Fig. 32—(Left) The CO_2 level is shown in the upper left corner of the main display.
Fig. 33—(Center) Press the CO_2 button to display only the CO_2 level.
Fig. 34—(Right) When you press the CO_2 button on the ECU-HOC, you can view the O_2 level also.

Viewing the Air Flow

The air flow level of the mixed air entering the incubation chamber (***STEV*** or ***Large Chamber***) is always available in the lower left corner of the main display (Fig. 35). To quickly view the air flow alone, press the ***Air*** button on the **ECU** (Fig. 36).



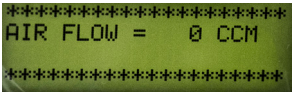


Fig. 35—(Left) The air flow is shown in the lower left corner of the main display.
Fig. 36—(Right) Press the Air button to display only the current air flow to the chamber.

Setting Parameters Using the Configuration Menu

Press the *Config* button on the **ECU** to access the *Configuration* menu. This menu varies depending on whether the system is setup for a **STEV** or a large chamber. When the system is configured for a **STEV**, you may use this menu to:

- Adjust parameters for the **STEV** chamber, including: *STEV Setpoint* (page 16), *STEV High Alarm* (page 16) and *STEV Low Alarm* (page 17)
- Adjust parameters for the glass lid of the **STEV** chamber, including: *Window Setpoint* (page 17), *Window High Alarm* (page 17) and *Window Low Alarm* (page 18)
- Enable/Disable *STEV Alarm* (page 18) and the *Window Alarm* (page 18)
- Enable *Adaptive Mode* and adjust the *Adaptive Mode Interval* (page 18)
- Set the *Lens Heater Setpoint* (if a lens heater is enabled, page 19)

When the system is configured for a large chamber, you may use this menu to adjust the *AirTherm Setpoint* (page 19) and the *Fan Air Flow Setpoint* (page 20).

1. To adjust configuration parameters, press the *Config* button on the **ECU** to access the *Configuration* menu. Press the *Config* button again until the parameter you want to adjust displays. All the available parameters are discussed on the next few pages.
2. Then, press the *Up* or *Down* button to change the parameter or toggle through its options.
3. Press the *Display* button to save the new parameters or press the *Config* button again to toggle through the rest of the parameters.

Adjusting STEV Setpoint

The *STEV Setpoint* is the temperature to be maintained inside the **STEV** incubation chamber. To adjust this parameter, see page 16.

NOTE: The setpoint for the chamber regulates the temperature of the **STEV** base. The temperature at the well plate is lower because of a temperature gradient between the plate and the body of the chamber. Setting the lid and STEV setpoints to 38.5ºC usually allows the **ECU** to maintain the well plate temperature around 37ºC.

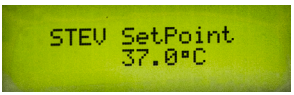


Fig. 37—The STEV chamber setpoint can be adjusted with the Up/Down buttons.

Adjusting STEV High Alarm

If the **STEV** chamber temperature climbs above the high alarm temperature, the *Base* LED illuminates. If the *STEV Alarm* is enabled, the **ECU** beeps continuously until the temperature falls back into the acceptable range. To enable the audible alarm, see "Enabling Audible STEV Alarm" on page 18. To adjust this parameter, see page 16.

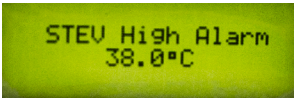


Fig. 38—The STEV high alarm parameter can be adjusted with the Up/Down buttons.

Adjusting STEV Low Alarm

If the **STEV** chamber temperature falls below the low alarm temperature, the ***Base*** LED illuminates. If the ***STEV Alarm*** is enabled, the **ECU** beeps continuously until the temperature returns to the acceptable range. To enable the audible alarm, see "Enabling Audible STEV Alarm" on page 18. To adjust this parameter, see page 16.

Fig. 39—The STEV low alarm parameter can be adjusted with the Up/Down buttons.

Adjusting Window Setpoint

The ***Window Setpoint*** is the target temperature of the glass lid of the **STEV** chamber. To adjust this parameter, see page 16.

NOTE: The setpoint for the window regulates the temperature of the **STEV** lid. The temperature at the well plate is lower because of a temperature gradient between the plate and the body of the chamber. Setting the ***Window*** and ***STEV Setpoints*** to 38.5°C usually allows the **ECU** to maintain the well plate temperature around 37°C.

Fig. 40—The setpoint can be adjusted with the Up/Down buttons.

Adjusting Window High Alarm

If the heated glass lid temperature climbs above the high alarm temperature, the ***Glass*** LED illuminates. If the ***Window Alarm*** is enabled, the **ECU** beeps continuously until the temperature falls back into the acceptable range. To enable the audible alarm, see "Enabling Audible Window Alarm" on page 18. To adjust this parameter, see page 16.

Fig. 41—The alarm parameter can be adjusted with the Up/Down buttons.

Adjusting Window Low Alarm

If the heated glass lid temperature falls below the low alarm temperature, the ***Glass*** LED illuminates. If the ***Window Alarm*** is enabled, the **ECU** beeps continuously until the temperature returns to the acceptable range. To enable the audible alarm, see "Enabling Audible Window Alarm" on page 18. To adjust this parameter, see page 16.

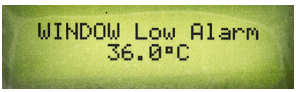


Fig. 42—The alarm parameter can be adjusted with the Up/Down buttons.

Enabling Audible STEV Alarm

By default alarms are disabled on startup, because they would beep continuously until the control loops stabilize the conditions in the environmental system. When the ***STEV Alarm*** is enabled, the controller beeps if the temperature inside the chamber is outside the range set by the high and low alarms. To adjust this parameter, see page 16.

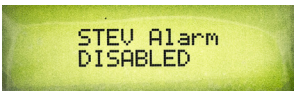


Fig. 43—Enable or disable the alarm using the Up/Down buttons.

Enabling Audible Window Alarm

By default alarms are disabled on startup, because they would beep continuously until the control loops stabilize the conditions in the environmental system. When the ***Window Alarm*** is enabled, the controller beeps if the temperature of the heated glass lid is outside the range set by the high and low alarms. To adjust this parameter, see page 16.

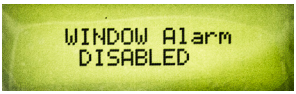


Fig. 44—Enable or disable the alarm using the Up/Down buttons.

Configuring Adaptive Mode

When enabled, the probe tracking adaptive mode automatically adjusts the setpoints for both the **STEV** chamber and the window to maintain the desired well temperature. By default the adaptive mode is disabled. Once the system stabilizes, the adaptive mode may be enabled. When it is enabled, the system samples the probe temperature periodically based on the configured adaptive interval. Each time it samples the probe temperature, the **ECU** automatically adjusts the window and lid setpoints to achieve (and then maintain) the desired well temperature.

1. ALLOW THE SYSTEM TO STABILIZE BEFORE YOU ENABLE ADAPTIVE MODE.
2. Press the ***Config*** button on the **ECU** to access the ***Configuration menu***. Press the

Config button again until the ***Adaptive Mode Enable*** parameter displays.

Fig. 45—Enable or disable the Adaptive Mode by pressing either the Up or Down button.

3. Press the **Up** or **Down** button to enable (or disable) the adaptive mode.
4. If necessary, modify the ***Adaptive Interval***. By default it is set to 10 minutes, but the range is from 1–20 minutes. Press the ***Config*** button again to display the Adaptive Interval parameter.

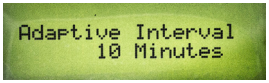


Fig. 46—The adaptive interval can be adjusted with the Up/Down buttons.

5. Press the ***Up*** or ***Down*** button to change the adaptive interval in one minute increments.
6. Press the ***Display*** button to save the new parameters or press the ***Config*** button to toggle through the rest of the parameters.

Adjusting Lens Heater Setpoint

If a lens heater is enabled, you can configure the target temperature (setpoint) that the lens warmer will maintain. If the lens heater is disabled, this menu option does not appear in the ***Configuration*** menu. Before the lens heater may be used, both the **ECU** hardware and software must be configured.

- See “Configuring the ECU for a Lens Warmer” on page 25.
- See “Enabling the Lens Heater” on page 23.

To adjust this parameter, see page 16.

Fig. 47—The lens heater setpoint can be adjusted with the Up/Down buttons.

Adjusting AirTherm Setpoint

If the system is setup for use with a large chamber, then the **ECU** requires an **AirTherm Satellite** heater to be connected to the ***Auxiliary Heater*** port on the back of the **ECU**. The ***AirTherm Setpoint*** is the target temperature for the environment inside the large chamber. This configuration parameter does not display when the **ECU** is setup for use with a **STEV** stagetop environment. To adjust this parameter, see page 16.

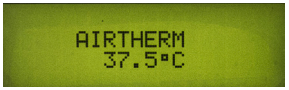


Fig. 48—The AirTherm Satellite’s setpoint can be adjusted with the Up/Down buttons.

Adjusting Fan Air Flow Setpoint

If the system is setup for use with a large chamber, then the **ECU** requires an **AirTherm Satellite** heater to be connected to the ***Auxiliary Heater*** port on the back of the **ECU**. Adjust the fan speed to control the air flow rate through the satellite heater. The default fan air flow speed setting is 50%. It can be adjusted up or down to move between 20–50 ft^3/min. (CFM). For safety reasons, the fan cannot be set below 10%. This configuration parameter does not display when the **ECU** is setup for use with a **STEV** stagetop environment. To adjust this parameter, see page 16.

TIP: A lower flow rate offers a quiet operation and is suitable for most applications. However, the higher flow rate can generate more turbulence, so that the temperature in the chamber is more uniform. The higher air flow speeds up the heating process and makes it possible to heat larger chambers.

CAUTION: Avoid blocking the airflow. Although the **AirTherm** has a built-in thermal cutoff switch which is designed to reduce the hazard, a fan failure or obstruction in the airflow has the potential for overheating the system and damaging the instrument or even causing a fire.

Fig. 49—The AirTherm Satellite's Fan Air Flow Setpoint can be adjusted with the Up/Down buttons.

Accessing the Hardware Setpoint Menu

Simultaneously press the ***Up*** and ***Down*** buttons to access the ***Hardware Setpoint*** menu. From this menu, you may:

- Adjust the CO_2 level setpoint (not available on the **ECU-HC**, page 21), O_2 level setpoint (for the **ECU-HOC** only, page 21) and flow level setpoint (page 22)
- Enable or disable the lens heater (page 23)
- Select the incubator type (**STEV** or large chamber, page 23)

1. To adjust any of the hardware options, simultaneously press the ***Up*** and ***Down*** buttons to access the ***Hardware Setpoint*** menu.

Fig. 50—Press the Up and Down buttons together to enter the Hardware Setpoint menu.

2. Press the ***Config*** button to toggle through the list of available setpoints and hardware choices. All the available options are discussed on the next few pages.
3. Then, Press the ***Up*** or ***Down*** button to change the setpoint or option.
4. Press the ***Display*** button to save your choice or press the ***Config*** button to toggle through the rest of the menu.

Adjusting CO_2 Level Setpoint (Not Available on the ECU-H5)

For the **ECU-HCP**, the carbon dioxide sensor is located in the incubator chamber (**STEV**) wall. For the **ECU-HC** and **ECU-HOC**, the sensor is located inside the **ECU** controller. Feedback from this sensor allows the **ECU** to control the concentration of CO_2 from 0–20%. It can be set in increments of 0.1%. The default is 5%. To adjust this option, see "Accessing the Hardware Setpoint Menu" on page 20.

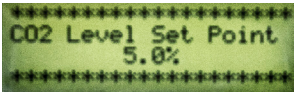


Fig. 51—The setpoint can be adjusted with the Up/Down buttons.

Adjusting O_2 Level Setpoint (ECU-HOC only)

The **ECU-HOC** controls the oxygen level down to 1% oxygen. This is accomplished by displacing the oxygen in the background gas with nitrogen. It can be set in increments of 0.1%. The default is 15%. To adjust this option, see "Accessing the Hardware Setpoint Menu" on page 20.

NOTE: For setpoint levels of 5% or less, reduce the background gas air flow to 100 CCM to improve system stability. See "Adjusting Flow Level Setpoint" on page 22.

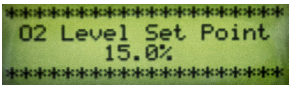


Fig. 52—The setpoint can be adjusted with the Up/Down buttons.

Oxygen Concentration versus Flow Considerations

The gas mixture out of the **ECU-HOC** consists of a mixture of air, nitrogen and carbon dioxide. The concentration of CO_2 is determined directly by adding CO_2 to the air. Therefore, a mixture of 5% CO_2 (with no N_2 added) is 95% air and 5% CO_2. The concentration of O_2 is determined by the amount of O_2 present in the air. The standard concentration of O_2 in air is 20.8%. Because of this, the maximum concentration of O_2 in a 5% CO_2 mixture is 19.76% (0.95 x 20.8 = 19.76). As the CO_2 increases, the maximum obtainable O_2 decreases.

To control the O_2 concentration in the gas mixture, we pump N_2 into the gas mixture to displace the air and consequently the O_2.

NOTE: During this process, the N_2 displaces CO_2, but the CO_2 control loop restores the balance by adding CO_2 until the desired concentration is achieved.

The **ECU**'s flow meter measures the input flow of air into the unit. The output flow rate on the **ECU** is the sum of the incoming air plus the required CO_2 to achieve the desired concentration of CO_2 plus the necessary N_2 to displace the required amount of air in order to regulate the oxygen content. The lower the required O_2 concentration, the greater the amount of N_2 required to displace the O_2. This

increases the volumetric flow into the incubation chamber. Since the incubation chamber opposes the air flow, pressure increases.

For example, let's say that our setup is as follows:

- Air flow is 400 CCM
- CO_2 concentration is 5%
- Desired O_2 concentration is 1%

To achieve this, we would need to configure the system as follows:

- 7200 CCM of N_2
- 400 CCM of CO_2

This would result in a total gas mixture flow rate of 8000 CCM (400 CCM air + 7200 CCM N_2 + 400 CCM CO_2). This volumetric flow significantly increases the pressure at the **STEV**. This volume is not achievable with the specified input gas pressures. In order to mitigate this problem, the input air flow must be reduced to keep the required gas volumes in an acceptable range. Fig. 53 shows the suggested air flow setting to achieve the oxygen concentrations shown for CO_2 levels of 5%,10% and 15%. Slight deviation from these values is acceptable.

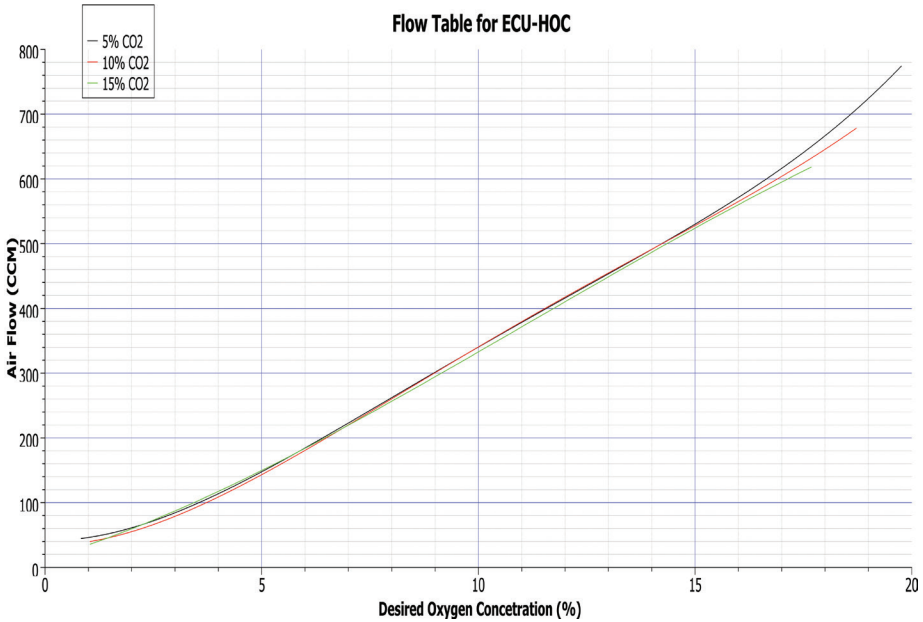


Fig. 53—This graph shows how to choose a Flow Setpoint based on the level of CO_2 and the desire concentration of O_2 in the air mix.

Adjusting Flow Level Setpoint

This controller offers a background flow rate of 0–950 SCCM. It can be set in increments of 10 CCM. The default is 800 SCCM for the **ECU-HCP,** and 400 SCCM for

the **ECU-HOC**, the **ECU-HC** and the **ECU-H5**. To adjust this option, see “Accessing the Hardware Setpoint Menu” on page 20.

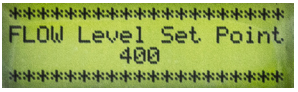


Fig. 54—The setpoint can be adjusted with the Up/Down buttons.

Enabling the Lens Heater

By default the **ECU** is configured for use with an **AirTherm**. If you are using the **ECU** with a stagetop environment and want to control a lens heater through the ***Auxiliary Heater*** connection instead, you must enable the lens heater in the software using this setting. You must also configure the controller. See “Configuring the ECU for a Lens Warmer” on page 25. To adjust this option, see “Accessing the Hardware Setpoint Menu” on page 20.

Fig. 55—Enable the lens heater by pressing the Up or Down button.

Selecting Incubator Type

The **ECU** can be setup to work with either a **STEV** Stagetop Environment or a large chamber. The ***Configuration*** menu options and the main display change depending on the selection made here. To adjust this option, see “Accessing the Hardware Setpoint Menu” on page 20.

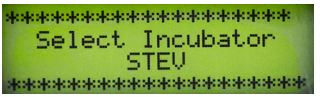


Fig. 56—Use the Up or Down button to select either STEV or Large Chamber.

Setting Up an Auxiliary Heater

The Auxiliary Heater connection on the back of the **ECU** may be used for either an **AirTherm Satellite** heater (page 23) or a lens warmer (page 25). The **AirTherm Satellite** is required when using a large microscope chamber. The lens warmer is an option that may be used with a **STEV** stagetop environment.

Setting Up an AirTherm Satellite Heater

When using the system with a large chamber, an **AirTherm Satellite** heater is plugged into the Auxiliary Heater port on the **ECU**, and the **ECU** can then be used to regulate the temperature of a microscope enclosure chamber (Large Chamber) used in live cell imaging.

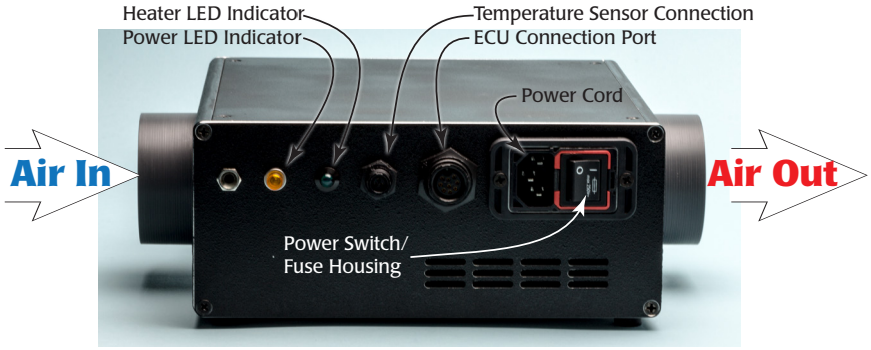


Fig. 57—All the AirTherm Satellite connections are on the same face of the unit.

1. Connect tubing with the included clamps as shown in Fig. 58.
2. To connect the **AirTherm Satellite** heater to the **ECU**, connect one end of the **ECU** cable supplied with the **AirTherm Satellite** to the *ECU Connection Port* on the **AirTherm Satellite**. Connect the other end to the *Auxiliary Heater Connection* on the **ECU**.
3. Connect the temperature sensor to the *Temperature Sensor Connection* on the **AirTherm Satellite**.

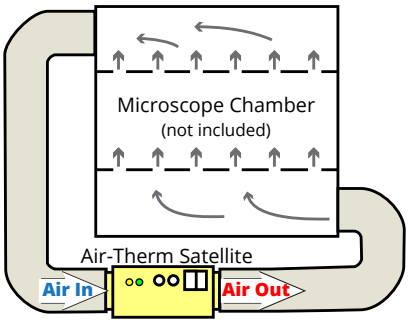


Fig. 58—Connect the tubing to the air inlet and outlet ports on the AirTherm Satellite to the air outlet and inlet ports on the microscope chamber.

4. Place the sensor inside the microscope chamber.
5. Connect the power cord to the **AirTherm Satellite**, and plug it into an AC wall outlet. Turn the power switch on. When the power is on, the yellow *Power LED Indicator* is illuminated.
6. Verify that the **ECU** is configure for a *Large Chamber*. See “Selecting Incubator Type” on page 23.
7. Adjust the temperature setpoint to the desired target value. See “Adjusting AirTherm Setpoint” on page 19. By default the temperature setpoint is set at

37ºC. If the temperature reading is below the setpoint, the heater turns on and the green ***Heater LED indicator*** begins to flash.

8. Adjust the fan speed to control the air flow rate. See "Adjusting Fan Air Flow Setpoint" on page 20. The airflow rate can be adjusted from 20–50 ft^3/minute (CFM). For safety reasons, the fan flow rate cannot be set at less than 10%.

TIP: A lower flow rate offers a quiet operation and is suitable for most applications. However, the higher flow rate can generate more turbulence, so that the temperature in the chamber is more uniform. The higher air flow speeds up the heating process and makes it possible to heat larger chambers.

CAUTION: Avoid blocking the airflow. Although a built-in thermal cutoff switch is designed to reduce the hazard, a fan failure or obstruction in the airflow has the potential for overheating the system and damaging the instrument or even causing a fire.

7. Allow the temperature to reach the setpoint and wait one hour.

Configuring the ECU for a Lens Warmer

1. Power down the **ECU** and unplug it from the AC power source.
2. Remove the four screws on the top of the **ECU** control box to remove the cover.
3. If your controller is newer than version 2.5, locate the ***J27*** jumper. By default it is set to ***Aux*** (covering the left and center pins) as shown in Fig. 59. To set the hardware to ***Lens Heater***, position the jumper over the center and left pins.

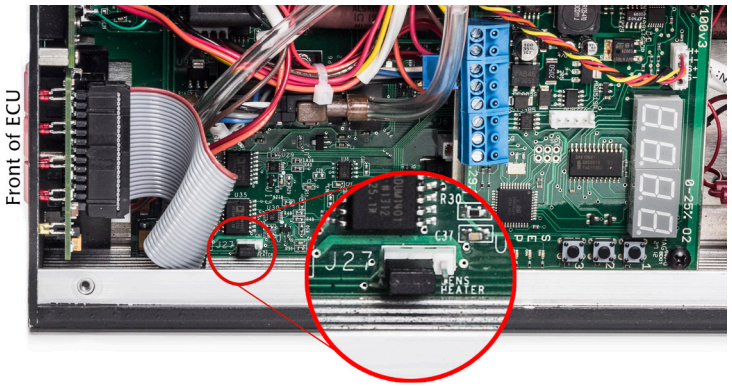


Fig. 59—On new ECUs (version 2.5 or newer, 2014) reposition the J27 jumper to configure the hardware for a lens heater. This board is configure for an AirTherm.

If your controller is older, locate and remove the ***J19*** and ***J20*** jumpers (Fig. 60).

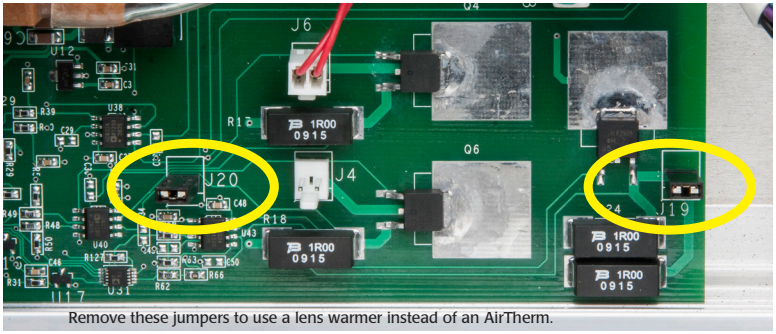


Fig. 60—Remove the J19 and J20 jumpers to use a lens warmer.

4. Reinstall the cover and secure it with the four screws.
5. Power up the controller and verify that the ***ECU*** is configured for a stagetop environment (***STEV***). See "Selecting Incubator Type" on page 23.
6. Enable the lens heater. See "Enabling the Lens Heater" on page 23.
7. Adjust the Lens Heater Setpoint, if necessary. See "Adjusting Lens Heater Setpoint" on page 19.

Resetting Factory Defaults

To restore the original factory settings on the **ECU**:

1. Power down the **ECU.**
2. Restart the system while depressing both the ***Up*** and ***Down*** buttons. The display indicates that the default settings have been restored.

ACCESSORIES

Part Number	Description
3245	Quick fit reducers ¼″ OD, 5/32″ ID
400195	0.156″ OD Tubing
AIRTHERM-SAT-1W	AirTherm Satellite Heater (110V)
AIRTHERM-SAT-2W	AirTherm Satellite Heater (230V)
97777	AirTherm Satellite ECU Interface cable
XXXXX	Microscope objective (lens) warmer
97799	Lens warmer dongle
3301	European power cord
3302	UK power cord
3006	US power cord
13208	Hose clamps
14088	Australian power cord
15590	Clear hose, 2.5" diameter, 4.5'
98727	Temperature probe for the AirTherm Satellite
802269	AirTherm Satellite 220V Fuse, slow blow, 250V, 4A
802270	AirTherm Satellite 110V Fuse, slow blow, 250V, 1.2A

TROUBLESHOOTING

Issue	Possible Cause	Solution
No Power	Power cord is improperly connected	Verify that the power cord is securely connected and plugged into a live wall socket.
Error on the display	The CO_2 Level display shows "ERROR" because the CO_2 sensor is not properly plugged in.	Check the CO_2 sensor connection on the **STEV**. This applies to the **ECU-HCP** only.
	The Probe Temperature display shows "ERROR" because the temperature sensor is improperly installed.	Check the temperature probe connection inside the **STEV**.
	CHAMBER ERROR appears on the display because the **AirTherm** is improperly connected.	Verify that the **AirTherm** is properly connected to the Auxiliary Heater connection on the back of the **ECU**.
Chamber never reaches setpoint	The factory default parameters may be corrupt	Reset the parameters to the factory settings. See "Resetting Factory Defaults" on page 26.
System does not stably regulate CO_2	Parameters have changed or the setup has changed.	Reset the parameters to the factory settings. See "Resetting Factory Defaults" on page 26.
	Incorrect pressure set for CO_2, background air or any other gas	Check the pressure. Then, check the connections on all the gas ports for leaks.

NOTE: If you have a problem/issue with that falls outside the definitions of this troubleshooting section, contact the WPI Technical Support team at 941-371-1003 or technicalsupport@wpiinc.com.

SPECIFICATIONS

This unit conforms to the following specifications:

Power	110/240V, 50/60Hz
Operating Temperature (ambient)	10 – 45°C (50 – 122°F)
Operating Humidity (ambient)	15 – 70% RH, non-condensing
Warm up Time	20 minutes
Computer Interface	USB via external USB/RS232 converter
Sensor	Non-dispersive infrared (NDIR), dual beam, 20s response time
Air-Therm SAT	
Air Flow Rate	20–50 CFM (0.55 to 1.4 m^3/min.)
Control Temperature Range	Ambient to 45ºC
Temperature Resolution	0.1ºC
AO for Chart Recorder	0.5ºC Resolution, 0–10 V represents 0–100ºC
Heating Volume	Min. volume 1.5 CF (42.5 L) to less than 50 CF (1400 L), re-circulating
Temperature Sensor Type	Platinum RTD 1000 Ω
Fuse	120 V: 4 A, slow 5 x 20 mm metric 230 V: 2.5 A, slow 5 x 20 mm metric
Power	450 W, 95–135 V or 220–240 V, 50/60 Hz
Dimensions	9.25 x 8.25 x 3.5" (23.5 x 21 x 9 cm)
CO_2 Sensor (ECU-HCP and ECU-HC only)	
Sensor Range	0 – 20% CO_2
Control Range	0 – 20%
Control Precision	0.1% CO_2
Control Accuracy	0.1 – 3% of reading
Drift	<2.5% reading/year
O_2 Sensor (ECU-HOC only)	
Sensor Type	Zirconium Dioxide, diffusion, 4s response time
Sensor Range	0–25%
Control Range	0–25%*
Control Precision	0.1% O2
Control Accuracy	±0.5% (2% of the full scale)

*The upper limit of the ECU-HOC oxygen control range is constrained by the oxygen content in the background gas. For example, if the background air has 20.7% oxygen, the ECU-HOC can only control up to 20.7% oxygen.

APPENDIX A: AIRTHERM SATELLITE HEATER

Changing a Fuse on the AirTherm Satellite 220V

1. Turn the main power switch off (I).
2. Unplug the power cord from the power cord socket on the back of the **AirTherm** (Fig. 61).

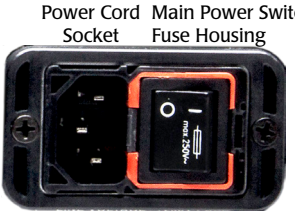


Fig. 61—Unplug the power cord to access the fuse housing release.

3. Insert a small flat blade screwdriver under the orange lip on the left side of the main power switch/fuse housing (Fig. 62). Gently pry upwards until the power switch slides out.

Fig. 62—(Left) Insert the screw driver under the fuse housing lip and pry the housing open.
Fig. 63—(Right) The fuse housing slides out.

4. Pull the fuse housing out of its socket (Fig. 64).

Fig. 64—Remove the fuse housing to access the fuses.

5. Remove the bad fuse.
6. Replace the bad fuse with another 5x20mm metric fuse, 4A, 250V.
7. Slide the power switch/fuse housing back into its socket until it snaps into place.
8. Reinstall the power cord.
9. Turn the power switch on to verify that the **AirTherm** has power again.

Changing a Fuse on the AirTherm Satellite 110V

A spare fuse is provided in the fuse housing (Fig. 65).

1. Turn the main power switch off (I).
2. Unplug the power cord from the power cord socket on the back of the **AirTherm** (Fig. 65).

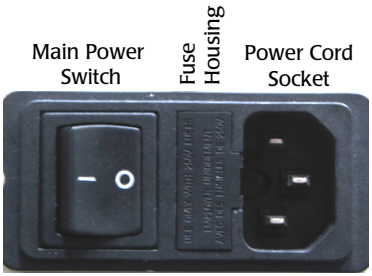


Fig. 65—Unplug the power cord to access the fuse housing release.

3. Insert a small flat blade screwdriver under the lip on the right side of the fuse housing cover (Fig. 66).

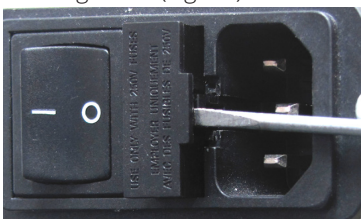


Fig. 66—Insert the screw driver under the fuse housing lip and pry the housing open.

4. Pull the fuse housing out as far as it will go and rotate it to the right. There is a catch to keep the housing from coming completely out (Fig. 67).

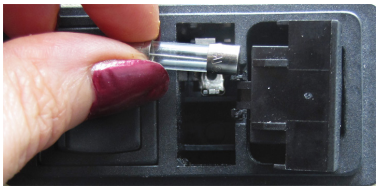


Fig. 67—Open the fuse housing and rotate it right to remove the fuse.

5. Remove the bad fuse. It is the one on the top. A spare fuse is stored in the bottom slot of the fuse housing.
6. Use the spare fuse provided to replace the bad fuse. Slide it into the top slot of the fuse housing.
7. Rotate the fuse housing and slide it back into position.
8. Reinstall the power cord.
9. Turn the power switch on to verify that the **AirTherm** has power again.

DECLARATION OF CONFORMITY

WORLD PRECISION INSTRUMENTS, LLC.
175 Sarasota Center Boulevard
Sarasota, FL 34240-9258 USA
Telephone: (941) 371-1003 Fax: (941) 377-5428
E-mail: wpi@wpiinc.com

DECLARATION OF CONFORMITY

We: World Precision Instruments, Inc.
175 Sarasota Center Boulevard
Sarasota, FL 34240-9258 USA

As the **manufacture/distributor** of the apparatus listed, declare under sole responsibility that the product(s):
ECU SERIES

To which this declaration relates is/are in conformity with the following standards or other normative documents:

Safety:
EN 61010-1:2010
EMC:
EN61326-2-3:2013, EN 61326-1:2013
EN 61000-3-2:2014, EN 61000-3-3:2013

And therefore conform(s) with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC relating to safety requirements:

Issued on: **Aug 15, 2018**

Quality Department Manager

F-QC-006 Rev B

WORLD PRECISION INSTRUMENTS, INC.
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Telephone: (941) 371-1003 Fax: (941) 377-5428
E-mail: wpi@wpiinc.com

DECLARATION OF CONFORMITY

We: World Precision Instruments, Inc.
175 Sarasota Center Boulevard
Sarasota, FL 34240-9258 USA

As the **manufacture/distributor** of the apparatus listed, declare under sole responsibility that the product(s):

AIRTHERM-SAT

To which this declaration relates is/are in conformity with the following standards or other normative documents:

Safety:
EN 61010-1:2010
EMC:
EN 61326-1:2013
EN 61326-2-3:2013
EN 61000-3-2:2014
EN 61000-3-3:2013

And therefore conform(s) with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC relating to safety requirements:

Issued on: **May 9, 2016**

Cliff Bredenberg
Chief Technology Officer

Glen Carlquist
Vice President of Manufacturing

F-QC-006 REV A

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E-mail: wpi@wpiinc.com

DECLARATION OF CONFORMITY

We: World Precision Instruments, Inc.
175 Sarasota Center Boulevard
Sarasota, FL 34240-9258 USA

As the **manufacture/distributor** of the apparatus listed, declare under sole responsibility that the product(s):

STEV-2

To which this declaration relates is/are in conformity with the following standards or other normative documents:

Safety:
EN 61010-1:2010
EMC:
EN 61326-1:2013
EN 61326-2-3:2013
EN 61000-3-2:2014
EN 61000-3-3:2013

And therefore conform(s) with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC relating to safety requirements:

Issued on: **May 9, 2016**

Cliff Bredenberg
Chief Technology Officer

Glen Carlquist
Vice President of Manufacturing

F-QC-006 REV A

INDEX

WARRANTY

WPI (World Precision Instruments, Inc.) warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of 30 days* from the date of receipt. WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than WPI, the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

WPI makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. WPI shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. WPI shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

Claims and Returns

Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within ten (10) days after receipt of shipment. Claims for lost shipments must be made within thirty (30) days of receipt of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim is settled. In some instances, photographic documentation may be required. Some items are time-sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container

Do not return any goods to us without obtaining prior approval and instructions from our Returns Department. Goods returned (unauthorized) by collect freight may be refused. Goods accepted for restocking will be exchanged or credited to your WPI account. Goods returned which were ordered by customers in error are subject to a 25% restocking charge. Equipment which was built as a special order cannot be returned.

Repairs

Contact our Customer Service Department for assistance in the repair of apparatus. Do not return goods until instructions have been received. Returned items must be securely packed to prevent further damage in transit. The Customer is responsible for paying shipping expenses, including adequate insurance on all items returned for repairs. Identification of the item(s) by model number, name, as well as complete description of the difficulties experienced should be written on the repair purchase order and on a tag attached to the item.

** Electrodes, batteries and other consumable parts are warranted for 30 days only from the date on which the customer receives these items.*

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