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CSS Microscope Incubator TCH882-G-COM Instructions for use



The CSS Microscope Incubator 882-G-COM is a multi-functional microscope incubation controller with close control of air temperature, humidity, oxygen content and carbon dioxide content. All are individually controlled via the front panel keypad or the computer interface.

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Safety Warning

The CSS Microscope Incubator TCH882-G is not intended for use with high oxygen content or flammable gases. To this end, the maximum oxygen or carbon dioxide concentrations are limited in software to 20%. The use of high oxygen content or flammable gases is wholly at the users risk and CSS will not accept any responsibility for loss, injury or damage as a consequence of its use.

Electro-magnetic compatibility statement

The CSS Microscope Incubator TCH882-G is classified as Class A under AS/NZS CISPR 11:2004 and is intended for use in an industrial environment. In a domestic environment this instrument may cause radio interference in which case the user may be required to take adequate measures.

Please note that the parameters noted below are only active if the relevant module has been installed. The CSS Microscope Incubator 882-G-COM has temperature measurement and control and humidity measurement as standard.

Humidity control, oxygen and CO₂ measurement and control are options

Introduction

All microscope incubation chambers are primarily intended to maintain a constant temperature on and around the region of the microscope stage where the sample is. They all have doors and access to various microscope controls with the result that they also have significant leakage, some worse than others. This is unavoidable but fortunately, as far as temperature control is concerned, can be compensated for in the design of the heater units.

Most heater units on the market these days use a proportional on/off control system. Some are particularly crude and as a result cannot maintain constant temperature better than 0.5C. Others use PID (proportional, integral ,differential) control and are capable of maintaining 0.1C. Unfortunately, all of these take in unregulated room air and attempt to heat it to the required temperature (typically 37C) or recycle air via an external heater unit. Both of these methods have three consequences:

1. They cannot cope with fast changes in the room air temperature such as happens when an air conditioner is present.
2. They use a lot of power with the consequence that parts of the chamber interior can reach temperatures as high as 70C. A potentially dangerous situation.
3. It is impossible to avoid vibration.

It is ironic that a standard incubation chamber, having a 6mm wall thickness is quite able to insulate against room air changes so if there was no air interchange between the inside and outside of the chamber, rapidly changing room air temperatures would be irrelevant.

The TCH882-G uses a very different approach. First, the heater unit is suspended inside the chamber, near the chamber top. Thus the air is recycled within the chamber, avoiding interchange with room air and maintaining a much more even flow of air within the chamber. This means that much more of the interior is kept at the desired temperature and the system is much faster in responding to outside influences, such as air conditioners turning on and off. Vibration is avoided

because the heater unit uses axial fan heaters and diffusion. The spring suspensions use the well known principle that vibration propagation along them is extremely poor. Because the heater units are internal in the chamber, they require much less power and internal temperatures are always close to the programmed value.

Secondly, the TCH882-G uses a fuzzy controller. In spite of its name, there is nothing "fuzzy" about the way these controllers work. The term "fuzzy" refers to the parameters that are being measured, not the control process. A fuzzy controller is similar in operation to a PID controller but has major differences.

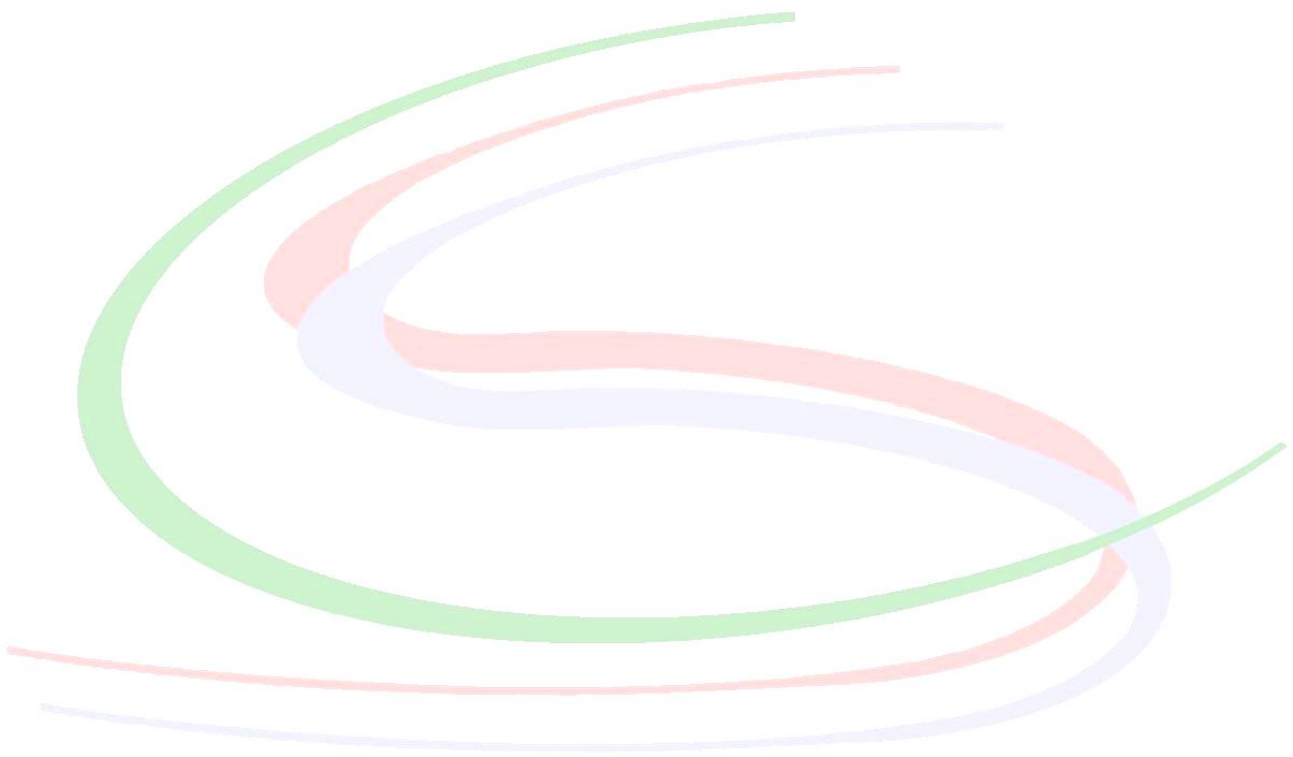
1. Fuzzy controllers are much simpler to design, modify and tune. Almost invariably, they are implemented in software. This has the advantage that adding options to a system is both quick and easy, without the need to add major hardware components.
2. They respond to input changes much more quickly and reduce overshoot.
3. Because the chamber itself is a part of the control system one normally cannot take the heater/probe of an on/off or PID controller from one chamber and place it in a second without the need to manually retune it first. The fuzzy controller has the "smarts" to automatically cope with the changes. Thus, they are self tuning.

It is virtually impossible to maintain a special atmosphere in an incubation chamber without the use of a sealed stage container of some sort. It appears at present that the best approach is to place a stage container inside a main chamber where the temperature is maintained by the main chamber and special atmospheres are maintained by the stage top container.

This is the approach taken with the TCH882-G with the addition that the stage container has gas input and output ports. This allows the possibility to recycle the sample atmosphere (future development) or to monitor, expel or trap exhaust gas. The TCH882-F can independently control two gasses. It also has a constant air (or other gas) input and so can effectively mix three gasses. Mixing occurs in a mixing chamber that precedes the gas sensors and humidification unit. Hence, gas mixing is accomplished using dry gasses. This helps to maintain the accuracy of the gas sensors.

Humidity is controlled independently of the gas mixing and is situated between a gas warming coil and the stage container inside the main chamber.

The intention of the oxygen measurement and control with the TCH882-G is to facilitate experiments that require hypoxic conditions. Measurement and control of oxygen (or CO₂) is confined to the stage container. The main chamber will not support high CO₂, hypoxic or high humidity conditions.



Operation

First connect at least one heater, the temperature/humidity probe and (possibly) the humidity control to the receptacles at the rear of the controller. If using only a single heater, it **must** be connected to the top drive outlet (Drive 1).

Connect gas supplies as necessary. All gas paths within the system are low pressure (1-2 psi with typical flow rates of 100 ml/min) so all gasses must be supplied via a gas regulator. The fittings accept a standard 6mm OD tubing.



To turn the instrument on, connect mains power to the mains IEC receptacle at the rear of the controller and switch the ON/OFF switch to "ON". The unit operates with a nominal 85 - 264VAC 50/60Hz supply. The unit will resume the function it was performing when it was last switched off. Full control of the unit is via two primary menus. The menus are called "*" and "*#"

To access the "*" menu:

Press *

You will be prompted to select a function.

The functions and associated keys for the * menu are:

- 0 display the clock/ timer
- 1 set the date/time clock
- 2 display the oxygen content
- 3 set the oxygen content target (0 - 20%)
- 4 display the CO₂ content
- 5 set the CO₂ content target (0 - 20%)
- 6 display the humidity
- 7 set the humidity target (0 - 100%)
- 8 display the temperature
- 9 set the temperature target (ambient - 50C)
- * Cycle through all the currently set parameters and display the settings.
- # this will display a sub menu where you can individually activate/deactivate/set the control of each parameter.

To access the *# menu:

Press *#

The functions and associated keys for the # menu are:

- 0 Calibration - ***Seek advice before using this feature.***
- 1 Purge a gas line. Choice is to purge CO₂, N₂ or both.
- 2 oxygen control ON/OFF
- 3 Store the currently set parameters to one of the four memory locations
- 4 CO₂ control ON/OFF
- 5 CO₂ and O₂ activation/deactivation
- 6 humidity control ON/OFF
- 7 -
- 8 temperature control ON/OFF
- 9 Select the number of fans (heater units) to be monitored.
- * -
- # -

At power off, all set target parameters and controls are saved and are automatically applied when next the instrument is turned on.

Entering new target parameters will overwrite previous settings unless they have been saved under one of the four memory buttons.

Parameter Activation and Deactivation

Temperature and humidity are always activated. Oxygen and CO₂ can be activated or deactivated in the "*#" menu (*#5). To display and/or control oxygen or CO₂, they MUST be activated. For each system, this function is performed in the factory so there is normally no need to change it. If a parameter is deactivated it is not monitored and cannot be displayed or controlled.

Setting the date/time clock:

To set the date/time clock press "* 1" then enter the year as four digits e.g., 2008. You will then be prompted to enter the month. Enter this as a number e.g. for June, enter "06". Next you will be prompted for the date, enter this as a number e.g. "17". Next enter the hour, this is a 24 hour clock e.g. 10PM is entered as "22" finally enter the minute e.g. "34" There is no feature for setting seconds, however, they are displayed, counting up from zero at the moment the final "minute" digit is entered.

In this example the date and time will be displayed as

17 Jun 2008 22:34:00

Once set, the clock continually updates regardless of whether or not it is displayed. The clock will automatically compensate for leap years.

At this time, the date/time clock is not battery backed (future development). All times are lost when power is removed from the system. If a date/time clock is required it must be reset every time the system is powered up. If no date/time clock is needed then an elapsed time timer will automatically start counting from the moment of power on. There is no need to set this timer.

Displaying the oxygen content:

To display oxygen content first activate it (if necessary) in the "*#" menu by typing "*#5". You will be prompted by the question:

Activate Oxygen? 1 = y 2 = n

Press 1 for yes. After you exit the activation menu press "*2" and the oxygen content will be displayed.

A typical display will appear as:

	Oxygen
OFF	1.5 %

Setting an oxygen content target:

To set an oxygen content target press "*3" You will be prompted to enter the oxygen concentration as a percentage with three digits. E.g. 5.2% is entered as "052" **Entering a value greater than 20% will result in the warning message "OUT OF RANGE" and the concentration will default to 20%.** At this stage the oxygen will (possibly) only be monitored, not controlled. To switch on control press "*#2" To switch off control, press "*#2" again. When oxygen control is switch on, oxygen content is controlled twice per minute. Because of the presence of the mixer and gas lines, the concentration of oxygen at the sample is constant.

Hint: The status of the control (On or Off) is continuously displayed in the lower left hand corner of the display. A "*" in the upper right corner indicates that the relevant controlling gas valve is open and that gas is being added to the mixture.

The measured parameter is repeatedly measured and updated even if control is not switched on.

Hint: You can set any target parameter regardless of whether it is activated or not.

Hint: When any parameter is activated and switched ON it is controlled regardless of whether or not it is being displayed.

To display CO₂ content

To display CO₂ content first activate it in the "#" menu by typing "*#5". You will be prompted by the question:

Activate CO2? 1 = y 2 = n

Press 1 for yes and 2 for no. After you exit the activation menu press "*4" and the CO₂ content will be displayed. To set CO₂ content target press "*5" then follow the same sequence as for oxygen above. **Entering a value greater than 20% will result in the warning message "OUT OF RANGE" and the concentration will default to 20%.** Similarly, to switch on/off CO₂ control press "*#4" When CO₂ control is switched on, CO₂ content is controlled twice per minute. Because of the presence of the mixer and gas lines, the concentration of CO₂ at the sample is constant.

To display the humidity

To display the humidity press "*6". To set a humidity target press "*7" then enter the desired humidity as a percentage with three (3) digits e.g. 50% is entered by pressing "050". **Entering a value greater than 100% will result in the warning message "OUT OF RANGE" and the humidity will default to 100%.** To switch on/off humidity control press "*#6". When switched on, humidity is measured then adjusted twice each minute. When humidity control is switched off, supply gasses to the sample bypass the humidification unit but still pass through all other parts of the gas system.

Displaying the temperature

To display the temperature press "*8". To set a temperature control target press "*9" then enter the temperature as three (3) digits. E.g. 37.0 °C is entered as "370". To switch on/off temperature control press "*#8".

Warning: The temperature probe is a semiconductor device and is very accurate. It is housed in a water proof jacket which will normally protect it. However, there always a risk that the protection can be damaged or inadvertently compromised.

DO NOT IMMERSE THE TEMPERATURE PROBE. THIS MAY DAMAGE THE SENSOR.

Displaying all set parameters

When you press "***" each of the parameter settings will be displayed in turn. e.g.

	Temperature
ON	37.0 °C

This indicates that temperature control is switched on and the target temperature is 37.0 °C.

With the exception of temperature which is measured continuously, any parameter which is **NOT** being displayed is measured twice each minute. If it is below the target value and ***it has its control activated and switched on*** it will be automatically controlled.

Heater units.

The fans are individually monitored. It is possible to have either one or two fans (heater units) operating. To use only one fan, connect it to the connector labelled "Drive 1" on the rear of the controller. Next, power the system and type "***". Among other parameters, you will be advised as to how many fans are being monitored. If you need to change the number type"*#9" You will be prompted to enter the number of fans being monitored (1 or 2). Select "1". The system will now automatically monitor the fan. *Normally there will be no need to do this as it will have been done for you in the factory.*

To use two heater units, connect one to each drive connector on the rear of the controller. The heaters are identical so it doesn't matter which way round they are connected. Now power the system and type "***". Among other parameters, you will be advised as to how many fans are being monitored. If you need to change the number type"*#9" You will be prompted to enter the number of fans being monitored (1 or 2). Select "2". The system will now automatically monitor both fans.

Note: Connecting a single fan to Drive 2 or selecting "2" fans to be monitored when there is only one present or attempting to select a number of fans other than 1 or 2 will result in an error message and the heating will be shut off.

This is a safe situation but of course, you run the grave risk of being mocked by your peers.

However, selecting "1" fan to be monitored when there are two present will result in the second fan NOT BEING MONITORED. This is quite safe provided the fan continues to function properly but can cause damage to the heater if it fails. There is virtually NO FIRE HAZARD as the heater is also monitored by an over temperature cut-out.

This action may void warranty.

To check how many fans are being monitored, press **

Should either fan fall below a critical speed, the system will display a warning message as well as an audible alarm. Temperature control ceases and heating stops. To clear the error, turn the unit off, check to ensure nothing is blocking the fan then turn the unit on again.

If the fault persists seek advice from the factory.

Each heater also has an internal over temperature monitor set to 70°C. If this activates, the power to the controller will be removed but power to the fans will continue. To clear the condition, turn the unit off, wait for it to cool, then turn on again.

Should the condition persist, seek advice from the factory.



To calibrate the system

The system is factory calibrated and should not need adjustment. In the event that it is necessary to recalibrate the instrument please first contact the factory for advice. Also please note that the calibration process is tedious and requires the availability of specialised instrumentation and gas standards.

The calibration for temperature and humidity are two point calibrations. The calibration for CO₂ and O₂ are single point calibrations. This is because the O₂ and CO₂ sensors give zero output when there is zero CO₂ or O₂ (as appropriate) present.

Each instrument is provided with a calibration certificate. This has on it, a number of parameters that can be programmed into the instrument memory via the keypad. To display the currently installed parameters, press "*#7". A set of four parameter lists will be displayed in turn, first temperature (four parameters), next humidity (four parameters), third is oxygen (two parameters) and finally carbon dioxide (two parameters).

When the temperature or humidity parameters are displayed, the left hand column contains the "low" parameters, first at the top, second below it. Similarly the right hand column contains the "high" parameters. The parameters for oxygen and CO₂ are displayed first to the left, second to the right.

If it is necessary to re-enter these parameters, press "*#01" You will be prompted to choose the parameter you wish to enter. Press:

"2" for oxygen

"4" for CO₂

"6" for humidity

"8" for temperature.

For temperature and humidity a second menu will open, it will ask if you wish to enter the low (1) or the high (2) parameter. Oxygen and CO₂ parameters skip this step and proceed directly to parameter entry.

Manual parameter entry:

You will be prompted to enter the first parameter. Always enter the parameters as three (3) digits. For example, 625 is simply entered as 625 whereas 52 is entered as 052, (*note the leading zero*). After the first three digits are entered, you will be prompted for the second parameter. Enter these in the same manner as for the first parameter. Once complete the system will return you to one of the main control menus. Press "*#7" to check that the parameters have been entered correctly.

If you need to calibrate the instrument to some other standard, follow the procedure below:

Setting parameters to known standards:

Temperature:

1. Have available an accurate temperature probe, preferably an electronic probe with continuous readout and a 0.1°C resolution. Closely couple the test probe to the probe of the TCH882-F. It is very important that this step is taken. Displacement of one probe from the other by as little as 1 cm can result in temperature errors of as much as several degrees. It is best to place both probes inside a small container and place this in the centre of the microscope stage. *This eliminates errors due to probe displacement and cooling due to air currents. Even the air current from the heater unit can cool a small probe.*
2. Place the probes inside the chamber and close all doors.
3. Select a low temperature, typically 28°C.
4. Warm the chamber for at least 1/2 hour and wait for it to stabilise properly. This is indicated when the temperature probe does not deviate for at least two minutes.
5. Note the reading on the test probe.

6. Press "*"#08" You will be prompted to select a high (2) or low (1) temperature. Select 1.
7. Type in the noted temperature as three digits. For example, if the noted temperature is 27.5°C, type in 275. The display will indicate this and then return to temperature control.
8. Now set a high temperature, typically 39°C.
9. Wait for the chamber to reach this temperature and stabilize. Do not alter the positions of the temperature probes or change the conditions inside the chamber by adding or subtracting items. This will alter the experimental conditions and invalidate the whole procedure.
10. Repeat steps 5 and 6 but this time select 2.
11. Repeat step 7 and type in the new (high) noted temperature.
12. Repeat steps 3 - 11.

At this stage the system will be calibrated for temperature (see? I warned you it was tedious!)

Humidity:

Calibrating humidity is the same procedure as calibrating temperature except for the following.

1. A source of dry gas is needed. It doesn't matter which gas but it is best to avoid oxygen for safety and of course, do not use flammable or similar gasses.
2. Set a temperature of 37°C and maintain this throughout the procedure.
3. You will need to set a dry (low) point and a wet (high) point. First set the dry point by purging the gas lines for at least 15 minutes with dry gas, humidity control set to OFF.
4. To enter the calibration routine select "*"#06"
5. When you are confident the gas is dry, type in a low humidity value of zero (000).
6. Next purge the gas lines for at least 5 minutes with humidity set to 100% and humidity control active.
7. Type in a high humidity value of 100% (100)
8. Repeat the above.

At this stage the system is calibrated for humidity.

Oxygen:

Calibrating oxygen is a simple process because we know the oxygen content of room air is 20.9% and because the sensor is a galvanic cell, it has zero output for zero oxygen.

To calibrate the oxygen sensor:

1. Connect a source of dry room air to the air inlet and purge for at least 15 minutes with a flow rate of around 100 ml/min.
2. Select a temperature of 37°C and maintain this throughout the procedure.
3. Ensure humidification, CO₂ and oxygen controls are turned off.
4. Enter the calibration routine by typing "*#02"
5. Type in a value of 20.9%, i.e. 209.

The procedure is complete.

Carbon Dioxide:

The procedure for calibrating CO₂ is the same as for oxygen with the following differences:

1. Use a calibrated CO₂ gas source. Typically this is a 5% CO₂ mix in air.
2. Connect the gas to the air inlet at the rear of the controller.
3. Select 37°C, humidity, CO₂ and oxygen control disabled.
4. Purge the system for at least 15 minutes with a flow rate of around 100ml/min.
5. Enter the calibration routine by typing "*#04"
6. Type in a value of 5% (050) or whatever the known CO₂ concentration is.

The system CO₂ calibration is now complete. There is no need for a zero input as the sensor is an IR sensor that gives zero output for zero CO₂.