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Introduction

About This Manual

This manual has been divided into several main sections to aid in locating specific information about the controller quickly. Sections such as Trouble Shooting on page 13, is where you would look as the name suggests, for information relating to any problems you may experience when firing.

A good way to understand the unit, once the controller has been installed as detailed in section Installation page 15, is simply to try it. Turn power on and follow the simple step by step procedure in the section called First Time Quick Programming Guide page 3.

As different questions arise refer to the appropriate section for a fuller understanding.

The following sections give a brief overview of what the controller can do.

Overview

Application

EMC 480S and EMC 481S three stage six segment Programmable Kiln Controllers, have been designed to control firing of kilns used for pottery work, ceramic work, and glass casting or wherever a temperature profile needs to be accurately controlled.
(Note that a six stage twelve segment controller is also available, refer to the EMC 483S data sheet BP482-11-0993).

Requirements

To avoid damaging the work when firing pottery, it is essential to raise the kiln temperature at a controlled rate. A good heat profile gives enough time for heat to uniformly spread throughout the work providing the following advantages:
- allows water vapour to escape slowly, particularly around 100°C.
- prevents excessive stress within the work at about 550°C.
- gives a controlled heat-time soak period at top firing temperatures.

How Does It Do It

To achieve a good heat profile the EMC Kiln Controllers use an automatic simmerstat to limit kiln heating power below 200°C. This prevents large temperature overshoot occurring at the lower temperature range. Above 200°C temperature is maintained by using on/off control, switching heat off at the profile temperature and switching heat back on when temperature falls 2°C below profile temperature. This has been proven to control the temperature very accurately.

Easy To Program

The kiln controller is very easy to program and use. Up to eight heat profile programs can be stored for use at any time. A program has three stages, each stage lets you
ramp the temperature up (or down) at a controlled rate and hold it at the desired
temperature for a fixed time, before moving on to the next stage.

**Easy To Start**

A firing is started by first selecting the required program, then either starting it instantly
or setting an in-built time clock to auto start the firing up to 24 hours after you set it. If
desired a firing can be started at any point within the program.

**Firing**

During a firing it is sometimes necessary to monitor progress and fine tune the
program. To allow you to do this the controller has six indicator lights to show progress
through the program and program settings can be viewed or changed with the display
and facia keys without interruption to the firing.

**Power Failure**

If firing is interrupted by a power failure, the controller can automatically resume firing
when power is restored, or it can stop the firing and indicate at which point in the
program this happened.

**Outputs**

The EMC 481S kiln controller has a Limit and a Run output in addition to the Heat
output of the EMC 480S. (All switch outputs are rugged long life relay contacts). The
Limit output switches when a set temperature is exceeded, and the Run output
remains switched on during the firing. These outputs are usually used as follows:

- The Limit output can be used as an alarm output if kiln temperature exceeds a
  maximum limit.
- Alternatively the Limit output can be used to automatically open a vent when firing is
  completed to rapidly cool the kiln.
- The Run output can be used on gas fired kilns to shut the main gas valve on
  completion of firing.

**Over Firing**

For added protection from over firing and kiln damage, heating is switched off if the
Thermocouple breaks, burns out or is reverse connected.
First Time Quick Programming Guide

General

This section describes how to program the controller for a typical Bisque firing, store it as program number Pr1, and then start it with or without the time clock. Follow the same procedure when programming the controller for other types of firings such as Gloss or Lustre etc.

Establish Firing Profile

First of all it is a good idea to draw the temperature profile you wish the firing to follow and write down the program values as shown on the diagram and chart below, then proceed to program the controller as described on the next page.

Please read HANDY HINTS at bottom of this page before programming.

<table>
<thead>
<tr>
<th>FIRING TYPE</th>
<th>PROGRAM NUMBER</th>
<th>Bisque</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAMP</td>
<td>TEMP</td>
<td>HOLD</td>
<td></td>
</tr>
<tr>
<td>STAGE 1</td>
<td>50</td>
<td>160</td>
<td>none</td>
</tr>
<tr>
<td>STAGE 2</td>
<td>100</td>
<td>650</td>
<td>none</td>
</tr>
<tr>
<td>STAGE 3</td>
<td>150</td>
<td>950</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Handy Hints

There are several points to remember when operating the keys

- If you do not press the SCROLL key or the UP and DOWN keys within five seconds of the last key press, the display will revert back to showing the kiln temperature. To get back to where you were in the program simply scroll through all program steps again.
- To avoid this five second time out either hold down the SCROLL key after a scroll key press or release any held key and hold down both the UP and DOWN keys until ready for the next key stroke.
Set A Bisque Firing Program And Store It As Pr1, (Program 1)

<table>
<thead>
<tr>
<th>KEY STROKES</th>
<th>DISPLAY SHOWING</th>
<th>INDICATOR LIGHTS ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press <strong>PROG SELECT</strong> key.</td>
<td>Display shows a program number</td>
<td><strong>Pr?</strong> START TIME flashes</td>
</tr>
<tr>
<td>Use <strong>UP</strong> or <strong>DOWN</strong> keys to set program number to 1.</td>
<td>Now shows</td>
<td><strong>Pr1</strong> START TIME flashes</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key twice and set Stage 1 Ramp to 50°C per hour.</td>
<td>Now shows</td>
<td>50.0 STAGE 1 and RAMP</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 1 Temp to 150°C.</td>
<td>Now shows</td>
<td>150 STAGE 1 and TEMP</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 1 Hold to 0:00 hr:min.</td>
<td>Now shows</td>
<td>0:00 STAGE 1 and HOLD</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 2 Ramp to 100°C per hour.</td>
<td>Now shows</td>
<td>100 STAGE 2 and RAMP</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 2 Temp to 650°C.</td>
<td>Now shows</td>
<td>650 STAGE 2 and TEMP</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 2 Hold to 0:00 hr:min.</td>
<td>Now shows</td>
<td>0:00 STAGE 2 and HOLD</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 3 Ramp to 150°C per hour.</td>
<td>Now shows</td>
<td>150 STAGE 1, STAGE 2 and RAMP</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 3 Temp to 950°C.</td>
<td>Now shows</td>
<td>950 STAGE 1, STAGE 2 and TEMP</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key and set Stage 3 Hold to 0:15 hr:min. (i.e. 15 minutes)</td>
<td>Now shows</td>
<td>0:15 STAGE 1, STAGE 2 and HOLD</td>
</tr>
<tr>
<td>Wait five seconds after last key press to return to normal operation.</td>
<td>Now shows current kiln temperature</td>
<td>?? ?? All off</td>
</tr>
</tbody>
</table>

Start The Bisque Firing Pr1 Instantly

<table>
<thead>
<tr>
<th>KEY STROKES</th>
<th>DISPLAY SHOWING</th>
<th>INDICATOR LIGHTS ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press <strong>SCROLL</strong>/<strong>PROG SELECT</strong> key.</td>
<td>Now shows a program number</td>
<td><strong>Pr?</strong> START TIME flashes</td>
</tr>
<tr>
<td>Use <strong>UP</strong> or <strong>DOWN</strong> keys to set program number to 1.</td>
<td>Now shows</td>
<td><strong>Pr1</strong> START TIME flashes</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key then press <strong>UP</strong> key until display reads <strong>Ins</strong>.</td>
<td>Now shows</td>
<td><strong>InSt</strong></td>
</tr>
<tr>
<td>IMPORTANT Wait five seconds after last key press to return to normal operation.</td>
<td>Now shows current kiln temperature</td>
<td>?? ?? STAGE 1 and RAMP on, HEAT light turns on and off and START TIME flashes</td>
</tr>
<tr>
<td>Press <strong>START/STOP</strong> key to start firing.</td>
<td>Now shows current kiln temperature</td>
<td>?? ??</td>
</tr>
</tbody>
</table>

Start The Bisque Firing Pr1 With The Time Clock

<table>
<thead>
<tr>
<th>KEY STROKES</th>
<th>DISPLAY SHOWING</th>
<th>INDICATOR LIGHTS ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press <strong>SCROLL</strong>/<strong>PROG SELECT</strong> key.</td>
<td>Now shows a program number</td>
<td><strong>Pr?</strong> START TIME flashes</td>
</tr>
<tr>
<td>Use <strong>UP</strong> or <strong>DOWN</strong> keys to set program number to 1.</td>
<td>Now shows</td>
<td><strong>Pr1</strong> START TIME flashes</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key then use <strong>UP</strong> or <strong>DOWN</strong> keys to set Start Time to 23:00 hr:min.</td>
<td>Now shows</td>
<td>23:00</td>
</tr>
<tr>
<td>Press <strong>SCROLL</strong> key ten times for an EMC-480S, or eleven times for an EMC-481S, then set present time. (Let's say time is 3:23pm)</td>
<td>Now shows today's time</td>
<td>15:23</td>
</tr>
<tr>
<td>IMPORTANT Wait five seconds after last key press to return to normal operation.</td>
<td>Now shows current kiln temperature</td>
<td>?? ?? All off</td>
</tr>
<tr>
<td>Press <strong>START/STOP</strong> key to start Time Clock. Firing will commence at 11pm.</td>
<td>Now shows current kiln temperature</td>
<td>?? ?? START TIME</td>
</tr>
</tbody>
</table>
Detailed Operation Of Controller

General

This section details what to look for when power is turned on and how to operate the controller, describes the function of the keys, indicator lights and the display, describes in detail all aspects of programming the controller and finally describes what can happen in the event of a power failure.

Power Up

When power is turned on to the controller, all display segments and indicator lights, except the HEAT light which will remain off for the first second, will turn on for about two seconds while the memory of the controller is auto checked.

If any segment or light does not turn on or the display shows “BAD”, the unit is faulty and should be returned for service.

If the power up test is okay the START TIME light will flash to indicate the clock requires setting. Refer to Set Clock on page 9.

Operation

The Kiln Controller is very easy to use. To commence a firing simply select one of eight pre-set programs, ensure the Start Time is set to OFF, then press the Start key. A program, (pre-set by the user), comprises of up to three stages, each stage has three settings, Ramp Rate, Temperature, and Hold Time. If a stage is not required it can be bypassed. When the firing is started the temperature climbs to the Hold temperature at the Ramp Rate and maintains the Hold temperature for the duration of the Hold period then advances, if not set to indefinite hold, onto the next Stage. Alternatively a firing can be started automatically at an unattended time. First ensure the internal clock is set to the correct time of day (refer to Set Clock on page 9), select a program, set the Start Time to the desired start time then press the Start key.

Keys

The keys are used for entering program settings and for starting or stopping a firing. Key graphics with plain background indicate their purpose when in normal operation and graphics with shaded background indicate their purpose when entering a program.

Handy Hints

There are several points to remember when operating the keys:

✦ If you do not press the SCROLL key or the UP and DOWN keys within five seconds of the last key press, the display will revert to showing the Kiln temperature. To get back to where you were in the program simply scroll through all program steps again.

✦ To avoid this time out either hold down the SCROLL key after a SCROLL key press or release any held key and hold down both the UP and DOWN keys until ready for the next key stroke.

Start/Stop Key

Either starts or stops a firing immediately when pressed or if a Start Time has been set, starts the time clock running so firing will commence at the pre-set Start Time.

Prog Select (Scroll) Key

First press will display current program number, subsequent presses steps through each setting of the program.
Control Temp (Up) Key

This key has two functions:
When programming, press to increase value of any program setting selected with the Scroll key.
When firing, press to display the Control Temperature, which is the temperature the kiln is controlled to. (If the kiln temperature is less than the Control Temperature, heating is switched on, if the kiln temperature is higher then heating is switched off.)

Note: As the program advances the Control Temperature follows a temperature profile calculated from the Ramp Rate, Temperature and Hold settings of each stage.

Elapsed Hold (Down) Key

This key performs two functions:
When programming, press to decrease value of any program setting selected with the Scroll key.
When Firing And In Hold, press to display how much time has elapsed since the start of the Hold period. If pressed while ramping to temperature the time shown will be 0.00.

Indicator Lights

All lights, except HEAT and START TIME, have two functions:
When Programming, they indicate which program setting is displayed and that its value can be altered with the UP or DOWN keys.
When Firing, they either indicate which program stage the firing is up to or, if a new value is being entered while firing, they indicate which program setting is displayed and that its value can be altered.

Heat Light

Indicates heat is being applied to the kiln.

Limit Light (481S Only)

When Programming, indicates display is showing the temperature at which the LIMIT output will switch, and that this value can be altered with the UP or DOWN keys.
When Firing, indicates the kiln temperature has exceeded the temperature LIMIT point.

Start Time Light

When Programming, has two functions.
1. After the second scroll key press, indicates display is showing the firing start time or "INST". (INST means the firing will begin instantly the START key is pressed).
2. After scrolling through all program stages to the end, it flashes to indicate display is showing the internal clock time.

When Firing, indicates START key has been pressed, the time clock is running, and firing will commence at the programmed start time.
If this light flashes other than when setting the clock, it indicates a power failure has stopped the clock.
A firing can be started instantly and run to completion whether this light is flashing or not. If a firing is to be auto started later in the day using the Time Clock, the clock must be reset to the current time of day.

Note: If power fails during a firing and base terminals 9 and 10 are linked for Auto Continue, firing will resume immediately power is restored.
If terminals 9 and 10 are not linked and power fails, firing will be stopped when power is restored, and the display will flash to indicate the firing has stopped. In this case firing must be either restarted by pressing the
START/STOP key or cancelled by either pressing any other key or the START/STOP key twice.

**Stage Light**

When **Programming**, indicates which program stage (1, 2 or 3) the Ramp, Temperature or Hold settings apply to. For instance, if STAGE light 2 and the RAMP light are both on, the display is showing the ramp rate value of stage 2.

When **Firing**, indicates the stage in the program the firing has got to. For instance, if both STAGE lights 1 and 2 and the HOLD light are on, the program has advanced to and is in the last hold stage, STAGE 3.

**Ramp Light**

When **Programming**, indicates display is showing the rate at which the kiln temperature will rise and that this value can be altered.

When **Firing**, indicates the firing is in the ramp part of a program stage.

**Temp Light**

When **Programming**, indicates display is showing the stage Holding temperature and that this value can be altered.

When **Firing**, indicates controller is waiting for the kiln temperature to be within ±5°C of holding temperature before proceeding into the hold period.

**Note** Temperature lag may occur, mainly at higher temperatures, if kiln heating cannot keep up with the set Ramp Rate. Commonly caused by one or more heating elements getting weak or failing.

**Hold Light**

When **Programming**, indicates display is showing the Hold period and that this value can be altered.

When **Firing**, indicates kiln temperature is being held at the stage temperature for the duration of the Hold period.

**Note** To see how much time has elapsed since the start of the Hold period, press the Elapsed Hold (Down) key.

**Display**

When **Programming**, shows selected program value.

When **Firing or Not Firing**, normally show's kiln temperature.

If Thermocouple burns out or wiring breaks display will show '11' on the extreme left of the display.

If Thermocouple is reverse connected, the temperature reading will decrease to -50°C. (The kiln temperature is actually rising to above +50°C), then that point the heating will be cut off and the display will show '11' on the extreme left of the display.

When **Power Fails During Firing**: on resumption of power, if base terminals 9 and 10 have not been linked for Auto continue, firing will not continue and the display will flash and show the current kiln temperature and the lights will indicate at which stage in the program the power failed.

To stop display flashing the firing must be either restarted by pressing the START/STOP key or cancelled by either pressing the SCROLL key or pressing the START/STOP key twice.

**Programming**

Selecting a program and setting a program are explained in the following sections.

**Note** If you do not press the SCROLL key or the UP and DOWN keys within five seconds of the last key press, the display will revert to showing the kiln temperature.
To get back to where you were in the program simply scroll through all program steps again.
To avoid this time out either hold down the SCROLL key after a SCROLL key press or release any held key and hold down both the UP and DOWN keys until ready for the next key stroke.

**Select A Program**

Press PROG SELECT key. Display shows current program number.
Use UP or DOWN keys to select program number.
Press SCROLL key to move onto START TIME setting or wait five seconds after last key press to return to normal operation or press START/STOP key to start firing.

**Set Start Time**

Press and release SCROLL key (2 times) until START TIME indicator light comes on. Display shows auto start time or shows the word "INSI". When the display shows "INSI", the Time Clock is turned off and firing will start instantly the START/STOP key is pressed.
Use UP or DOWN keys to set the time at which firing is to auto start, or set to "INSI" by holding down the UP key until display stops moving and shows "INSI".
Note: The 24 hour clock system is used for setting time, as an example, 3pm is set as 15:00, 1 minute to midnight as 23:59, 1 minute passed midnight as 00:01 etc.
Press SCROLL key to move onto RAMP setting of Stage 1 or wait five seconds after last key press to return to normal operation or press START/STOP key to either start the Time Clock, or if display shows "INSI", to start firing immediately.

**Set Ramp Stage 1**

Press and release SCROLL key (3 times) until both STAGE 1 and RAMP indicator lights come on. Display shows Ramp Rate for Stage 1 or shows the word "FAST". FAST means the kiln temperature will ramp as fast as possible to stage temperature.
Use UP or DOWN keys to set required ramp rate or set to "FAST" by holding down the UP key until display stops moving and shows "FAST".
Press SCROLL key to move onto TEMP setting of Stage 1 or wait five seconds after last key press to return to normal operation or press START/STOP key to start firing from this point (RAMP of STAGE 1) in the program.

**Set Temp Stage 1**

Press and release SCROLL key (4 times) until both STAGE 1 and TEMP indicator lights come on. Display shows either maximum temperature kiln will climb to during Stage 1 or shows the word "PASS". PASS means bypass stage 1 of the program completely.
Use UP or DOWN keys to set temperature to required maximum or to "PASS" by holding down the UP key until display stops moving and shows "PASS".
Press SCROLL key to move onto HCLD setting of Stage 1 or wait five seconds after last key press to return to normal operation or press START/STOP key to start firing from this point (TEMP of STAGE 1) in the program.

**Set Hold Stage 1**

Press and release SCROLL key (5 times) until both STAGE 1 and HOLD indicator lights come on. Display shows length of time kiln temperature will be held at TEMP STAGE 1 setting or shows the word "HLD". HLD means hold kiln temperature at STAGE 1 TEMP setting until firing is stopped by pressing the START/STOP key.
Use UP or DOWN keys to set required Hold period or set to "HLD" by holding down the UP key until display stops moving and shows "HLD".
Press SCROLL key to move onto RAMP setting of Stage 2 or wait five seconds after last key press to return to normal operation or press START/STOP key to start firing from this point (HOLD of STAGE 1) in the program.

Set Stage 2 And Stage 3

Programming Stage 2 and Stage 3 is identical to programming Stage 1 except more key presses are required to select a stage setting.

Set Limits (481S Only)

Press and release SCROLL key (12 times) until LIMIT indicator light comes on. Display shows either the temperature setting at which, if exceeded by the kiln temperature, the Limit light turns on and the Limit output relay contacts close or the display shows "OFF". OFF ensures the Limit output will not operate at any temperature.

Note: The Limit output can be used as an over firing cut-out or alternatively it can be used to automatically open a cooling vent when firing is completed. If further details are required please contact EMC or the kiln manufacturer.

Use UP or DOWN keys to set required Limit point or set to "OFF" by holding down the UP key until display stops moving and shows "OFF".

Press SCROLL key to move onto CLOCK setting or wait five seconds after last key press to return to normal operation.

Set Clock

Press and release SCROLL key (12 times for EMC 480S or 13 times for EMC 481S) until the START TIME indicator light flashes. Display shows the current time the clock is set to.

Use UP or DOWN keys to set clock to correct time of day.

CAUTION: The clock is used only for auto starting a firing and giving indication of a power failure, hence any time setting discrepancies will be reflected only when auto starting a firing.

Wait five seconds after last key press to return to normal operation.

Starting A Firing

Before starting a firing, select the program required for your firing. Refer to previous section Programming on page 7.

The kiln temperature will be displayed and all lights will be off, except possibly the START TIME light which may flash if the clock requires resetting.

There are three ways the firing can be started.

Instant Start Starts from the beginning of a program.

Stage Start Starts from any stage of the program.

Time Clock Start Starts automatically at the pre-programmed time.

Each section will be described in detail.

Note: When the firing has started, the HEAT light will turn on and off at different times to regulate the kiln heat.

If the kiln temperature is too low the HEAT light will turn on. This indicates power has been applied to the kiln's heating elements to increase the temperature.

If the kiln temperature is too high the heat light will turn off. This indicates power has been cut off to the kilns heating elements to allow the temperature to fall.

Instant Start

This is the simplest way of starting the firing.

First of all select the program number.
Then set the START TIME to "INSI". (Press and release SCROLL key (2 times) until START TIME indicator light comes on, then hold down the UP key until display stops moving and shows "INSI"). The firing will commence when the START/STOP key is pressed and will continue until the end of the program, or until the START/STOP key is pressed a second time stopping the firing.

**Stage Start**

The Stage Start allows you to start firing instantly from any point within the program. First of all select the program number.

Then use the SCROLL key to step through the program until the lights show the desired starting point.

The firing will commence when the START/STOP key is pressed and will continue until the end of the program, or until the START/STOP key is pressed a second time stopping the firing.

**Note** Make sure you press the START/STOP key within 5 seconds of operating the SCROLL key, otherwise you will have to scroll through to the starting point again.

**Time Clock Start**

The Time Clock start method allows the kiln firing to start automatically at a pre-programmed time.

First of all, if the START TIME light is flashing set the clock to the correct time. Refer to Set Clock on page 9.

**Note** This function uses the controllers internal clock which must be set to the correct time before starting. If the clock is incorrect, the firing will start at the wrong time. If the clock has not been set since the kiln controller was switched on, indicated by the START TIME light flashing, an Instant Start will occur when the START/STOP key is pressed.

Then select the program number.

Then set the START TIME to the time at which firing is to start. (Press and release SCROLL key (2 times) until START TIME indicator light comes on, then use the UP and DOWN keys to set the start time).

Finally, press the START/STOP key.

The START TIME light will turn on indicating the firing will start at the pre-set start time.

When the pre-set time is reached, the START TIME light will turn off and firing will commence.

**WARNING** If power fails during the period prior to the Time Clock Start time and after the Start key was pressed, the kiln will start firing immediately power is returned. To prevent this happening the Auto Continue feature must be disabled by removing the wire link between base terminals 9 and 10.

**Firing**

Once the firing is started, the kiln temperature will follow a temperature profile corresponding to your program.

The kiln controller generates an exact temperature profile, called the Control Temperature, and the Heat output is turned on and off to make the kiln temperature follow this profile.

You can see the Control Temperature at any time during a firing by pressing the UP key. Note the UP key is also labelled "CONTROL TEMP".

At lower temperatures, the kiln temperature will follow the control temperature very closely, but at higher temperatures the kiln temperature may fall behind the control
temperature, especially if the ramp rate is too high or the heating elements are getting old.

When the Temperature reaches the Hold Temp it will either be held at this temperature for the Hold period or if no Hold time has been set, the firing will move into the start of the next stage.

To avoid losing part of the heat soaking period, (that is if the kiln temperature falls behind the control temperature), the Hold time will not start until the kiln temperature is within 5°C of the Hold temperature.

While the controller is waiting for the kiln to reach the hold temperature, the TEMP light will be on. When the kiln temperature finally comes within 5°C of the hold temperature, the TEMP light will turn off and the HOLD light will turn on.

Accurate temperature control at low temperature is achieved by an automatic simmerstat which comes into action between 20°C and 200°C. Its purpose is to reduce power to the kiln over this range to prevent large temperature overshoot.

When the control temperature is about 20°C and heat is called for, the Heat output will cycle on for approximately 3 seconds and off for about 27 seconds. As the control temperature rises, the Heat output on time becomes longer, and the off time shorter.

At about 100°C the on and off times are both about 15 seconds, while just below 200°C the on time is about 27 seconds and the off time is about 3 seconds. Above 200°C the simmerstat action does not work at all and the Heat output will remain on when heat is called for.

Note: If the kiln temperature equals or is greater than the control temperature, the Heat output will turn off irrespective of the simmerstat action.

**Power Failure**

In the event of a power failure, the controller remembers what it was doing at the time power failed and retains all program values.

When power is restored, the controller will show that a power failure occurred. If a firing had been in progress, the firing can be manually started again to finish off the remainder of the firing, it can be cancelled or the controller can be set to auto continue from where it left off.

If the controller was stopped at the time power failed, the START TIME light will flash when power is restored. This indicates power has failed since the clock was last set to the correct time of day.

If firing was in progress when power failed, the START TIME light will flash only after the firing is either restarted or stopped. If restarted instantly, the remainder of the firing will not be affected by the incorrect clock setting. If restarted with the time clock, it is important to reset the clock to the correct time.

**Firing Does Not Resume When Power Returns**

For firing not to resume when power is restored, base terminals 9 and 10 must **not** be linked.

When power returns, from a failure, the display will flash to indicate that a failure has occurred and the lights will show at which step in the program it happened.

You can either continue on with the remainder of the firing by pressing the START/STOP key once, or you can cancel the firing by either pressing the SCROLL key once or the START/STOP key twice.

If the lights indicate firing was in a Hold period, the elapsed hold time prior to the failure can be seen on the display by pressing the DOWN key.

If the START TIME light is on, and the display is flashing, power failed while the controller was waiting to start the firing automatically. In this case you must either push the START/STOP key to start the firing immediately, or if you wish to start the firing automatically at a later time with the time clock, you must first cancel the
present firing by either pushing the SCROLL key once or the START/STOP key twice. Then you must set the clock to the correct time of day, adjust the START TIME if required, and finally restart the time clock by pressing the START/STOP key.

Firing Auto Continues When Power Returns

To automatically continue firing when power is restored, base terminals 9 and 10 must be linked.

When power returns, the START TIME light will flash to give a visual indication power failed at some point in the firing and to indicate the clock is incorrect. The firing will automatically restart and continue from where it left off.

Caution  If the controller was waiting to automatically time clock start the firing before power failed, the firing will start immediately power returns.
**Trouble Shooting**

The EMC480S and EMC481S kiln controllers have proved over a number of years to be very reliable. However there are times when things do go wrong.

To help sort out any problems you may have, a list has been compiled of common faults with separate columns for easy identification of the fault, the cause and the cure.

**Fault List**

<table>
<thead>
<tr>
<th>FAULT</th>
<th>CAUSE</th>
<th>CURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time clock light is flashing</td>
<td>1. Mains power has failed and the clock requires resetting.</td>
<td>Refer to <em>Set Clock</em> on page 9.</td>
</tr>
<tr>
<td></td>
<td>2. Electrical interference disrupted operation of controller.</td>
<td>Check Thermocouple is separated from power cabling as described in <em>Cable Separation</em> on page 15.</td>
</tr>
<tr>
<td>Firing stopped before end of program and controller is waiting to be restarted. Also the START TIME light is flashing.</td>
<td>Electrical interference disrupted operation of controller.</td>
<td>Check Thermocouple is separated from power cabling as described in <em>Cable Separation</em> on page 15.</td>
</tr>
<tr>
<td>Display and lights frozen and no response from any key press.</td>
<td>Electrical interference has locked out the controller.</td>
<td>Check Thermocouple is separated from power cabling as described in <em>Cable Separation</em> on page 15.</td>
</tr>
<tr>
<td>Kiln temperature rises faster than the set Ramp rate.</td>
<td>1. The probe is not fully inserted into the kiln. 2. START/STOP key was pushed immediately after setting the last Hold temperature when programming.</td>
<td>Push the probe fully into the kiln. Wait for five seconds after the last programming key stroke before pressing the START/STOP key. Refer to <em>Power Failure</em> on page 11.</td>
</tr>
<tr>
<td>Display is flashing.</td>
<td>Mains power failed during a firing and the firing has been halted. The lights show at what stage in the program the power failed.</td>
<td>Refer to <em>Power Failure</em> on page 11.</td>
</tr>
<tr>
<td>Kiln temperature fails to reach correct temperature.</td>
<td>1. Heating elements are weak or one or more sections of the heating element has failed. 2. Mains supply voltage is low.</td>
<td>Check and replace faulty elements.</td>
</tr>
<tr>
<td>Kiln over fires by up to 100°C.</td>
<td>Thermocouple compensating lead reverse connected.</td>
<td>Check Thermocouple lead. Refer to <em>Thermocouple</em> on page 17.</td>
</tr>
<tr>
<td><strong>FAULT</strong></td>
<td><strong>CAUSE</strong></td>
<td><strong>CURE</strong></td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>Heat light is on but kiln temperature is not increasing.</td>
<td>Mains power not connected to heating elements.</td>
<td>Check kiln door is closed properly, heating contactor has operated, main supply switch is on and the heater fuses are okay.</td>
</tr>
<tr>
<td>Display shows &quot;1&quot; on extreme left.</td>
<td>Thermocouple may have burnt out or its connecting leads may be faulty.</td>
<td>To determine if the Thermocouple is at fault, turn power off to the controller and remove from base. Strap base terminals 15 and 16 together with a wire link. Refit controller to base section and turn power on. If the display shows ambient temperature, i.e. approximately 20°C, the Thermocouple probe or its wiring is faulty. If the display still shows &quot;1&quot; the controller is faulty and should be returned to the supplier with a written description of the fault.</td>
</tr>
<tr>
<td>After the kiln has been firing for a short while, the display shows &quot;+1&quot; on extreme left.</td>
<td>Thermocouple is reverse connected.</td>
<td>Check Thermocouple connections as detailed in Thermocouple on page 17.</td>
</tr>
<tr>
<td>None of the indicator lights illuminate and the display remains blank after mains power is switched on.</td>
<td>Mains power is not connected to controller.</td>
<td>Check fuse which supplies power to the controller. If the fuse is not blown check for a power wiring fault. If power is checked to the base terminals okay the controller is faulty and should be returned to the supplier with description of fault.</td>
</tr>
<tr>
<td>On power up some of the display segments or some of the indicator lights do not turn on as described in Power Up on page 5.</td>
<td>Controller is faulty.</td>
<td>Return to supplier with a description of fault.</td>
</tr>
<tr>
<td>&quot;BAD&quot; is shown in the display.</td>
<td>Controller is faulty.</td>
<td>Return to supplier with a description of fault.</td>
</tr>
</tbody>
</table>
Installation

General

This section provides basic information on mounting the controller, details special wiring requirements to avoid the controller malfunctioning from electrical interference, and shows the wiring diagram of a typical installation.

Take particular note of the two WARNING paragraphs in the wiring section.

EMC recommends a qualified electrician install the unit to ensure all electrical safety requirements are met.

Dimensions

Mounting

Unplug the instrument from the base section by first ensuring the two locking screws, one at each end of case, are fully unscrewed, then with a slight end to end rocking motion gently pull the two sections apart.

The terminal base has two shrouded recesses spaced 100 mm apart for fitting mounting screws. These must be drilled through with a 3.2 mm diameter drill for M3 screws or a 4.2 mm diameter drill for M4 screws. The screws must be longer than 5 mm and have a head diameter less than 7.5 mm.

Attach the unit to a flat surface in a position where it is easy to read and operate, and where the case temperature will not rise above 45°C.

Wiring

Cable Separation

**WARNING** Power and Thermocouple cabling must be separated by at least 100mm. To avoid malfunction of the Controller it is most important that all power and control cabling exits the base section from cable entry's adjacent to terminals 1 and 2 and the Thermocouple cable exits the base from cable entry's adjacent to terminals 15 and 16. See diagram.

If the cabling cannot be separated sufficiently, it may be necessary to fit a suppressor capacitor, (RS Components Order number 238-299 or equivalent), directly across the contactor coil. Refer to Typical Wiring Schematic at end of this section.
Power Supply

Connect supply phase to terminal 1 and supply neutral to terminal 2.

Power requirement is 10VA maximum.

**WARNING** Before switching power on to controller, check supply voltage rating shown on the side label, is correct for your mains power supply.

Heat Output

Heat output contacts are on terminals 3 and 4 and are rated 240Vac, 4 amp load.
Link terminal 3 to terminal 1, and connect terminal 4 to the door switch/heating contactor wire.

When heat is called for the contact closes. This contact switches control power, through the kiln door interlock switch, to the heating contactor coil.

Note: The Heat contacts have a spark suppression circuit fitted across them. This comprises of a 22nF capacitor in series with a 470E resistor, paralleled with a 250Vac voltage limiting resistor.

If the switched load is a small slave relay, (3VA coil rating), the suppression circuit may allow sufficient leakage current to flow, when the Heat output is turned off, to keep the slave relay contacts held closed. To avoid this either the switched load must be increased or the suppression circuit removed.

Limit Output (481S Only)

Limit output contacts are on terminals 5 and 6 and are rated at 240Vac, 4 amp load.

When the kiln temperature exceeds the limit value the contacts open.

These can be used several ways for over temperature cut-out, as shown in the circuit diagrams below.
Run Output (481S Only)

Run output contacts are on terminals 7 and 8 and are rated at 240Vac, 4 amp load.
When firing starts, the contacts close and remain closed, (except during a power failure), for the duration of the firing. At the end of firing the contacts open.
This output may be used as the master cut-off control switch in gas fired kilns.

Auto Continue And Remote Start/Stop Input

Auto Continue and Remote Start/Stop input connects to terminals 9 and 10.
To activate this input a low voltage clean contact is required which must remain closed for a minimum time of 150ms. The voltage potential across these terminals is 5Vdc. The input can also be activated by a 5 volt logic pulse.
This input is used to select whether the firing will auto stop or auto continue on resumption of power, (following a power failure while firing), and also to start/stop the firing from a remote location.
There are four possible connections;
1. Firing auto starts on power resumption, no remote start/stop switch connected.
   Fit link between terminals 9 and 10.
2. Firing auto starts on power resumption, with remote start/stop switch connected.
   Terminals 9 and 10 wired to normally closed contact of remote start/stop switch.
3. Firing auto stops on power resumption, no remote start/stop switch connected.
   No connection to terminals 9 and 10.
4. Firing auto stops on power resumption, with remote start/stop switch connected.
   Terminals 9 and 10 wired to normally open contact of remote start/stop switch.

Thermocouple

Connect probe positive lead to terminal 15 and probe negative lead to terminal 16 and ensure the cable is separated from power cabling as described in Cable Separation at the beginning of this section.
When using compensating cable to extend the probe leads, ensure the correct compensating cable is used and polarised correctly. If the compensating cable is reversed, the kiln may over fire by as much as 100°C. Use the positive lead of the compensating cable to connect the positive terminal of the probe to the positive terminal of the controller.
If you are unsure of the compensating cable polarity, disconnect the compensation cable from probe and twist the ends together. Leave the other end connected to terminals 15 and 16. Apply a heated object, such as a lighted match, to the twisted end and observe the temperature reading on the display. If the reading increases, the cable is connected correctly to the controller. However if the reading decreases, the cable is reversed and should be rewired correctly.

Note
If Thermocouple burns out or wiring breaks display will show "1" on the extreme left of the display.
If Thermocouple is reverse connected, the temperature reading will decrease to -50°C, (the kiln temperature is actually rising to +50°C), then at that point the heating will be cut off and the display will show "-1" on the extreme left of the display.
Typical Kiln Wiring Schematic

Main Isolator - Fuses - Contactor - Heating Elements

230Vac Supply
L1
L2
L3
Neutral

4A

Door Switch

Suppressor Capacitor
Fitted across contactor coil if problems experienced with controller malfunctioning

Thermocouple Probe

Warning: Keep thermocouple leads separated from mains power cabling by 100mm or more
Adjustment Of Hold Temperature Setting Limits

General
When the EMC480S and EMC481S kiln controllers leave the factory the range that the Hold temperature can be adjusted over by the user has been pre-set to a low and a high limit of -100°C and 1300°C respectively. This prevents setting the Hold temperature to outside these limits which may damage the kiln.
Some kilns may still be damaged if fired to the factory set high limit. In these cases the limit should be reduced to suit the particular application. (Consult your kiln supplier for firing temperature limits.)
The following procedure details how these pre-set limits may be altered.

Procedure

Enter Group Selection Mode
Press the DOWN key, and while holding it down, press the SCROLL key. All indicator lights will turn on and the display will show "0".
Press the UP key once and number "14" will appear in the display.
Note
If a key is not pressed within five seconds of the previous key press, the controller will revert back to normal operation.
To avoid this time out either hold down the SCROLL key after a SCROLL key press or release any hold key and hold down both the UP and DOWN keys until ready for the next key stroke.

Set Maximum Hold Setting
Push the SCROLL key once. The HEAT light will turn on and the display will show the current maximum Hold temperature.
Alter display to the new value using the UP and DOWN keys.

Set Minimum Hold Setting
Press the SCROLL key once. If setting a 480S controller all indicator lights will be off, but if setting a 481S controller the LIMIT light will be on and in both cases the display will show the current minimum Hold temperature.
Alter display to the new value using the UP and DOWN keys.

Check New Settings
Press the SCROLL key once, the display goes back to showing the maximum Hold temperature, press the SCROLL key again and the display shows the minimum Hold temperature, etc.

Return To Normal Operation
Return to normal operation by either waiting five seconds without further key presses or press together both the SCROLL key and the START/STOP key.
Changing Thermocouple Type

General
It may be desirable to change the thermocouple from the factory set Type R to one of four others available, types J, K, N or T.
The following section describes how to do this.

Procedure
Check Controller Code Number
Only controllers supplied with one of the following type code numbers, located on its side label, can have the Thermocouple type changed by the user. Older models must be returned to the factory.

EMC480S-10-x-x-x
EMC481S-10-x-x-x
x indicates don't care

Reposition Jumper Plug
Remove unit from base section.
Remove bottom cover plate by flexing outwardly the container side opposite the PCB edge connector. Insert a screw driver in the gap and prise upwards.
WARNING: Do not remove cards from container when changing jumper plugs.
Reposition jumper plug on 8 pin wafer to align with appropriate thermocouple type.
Note: The jumper plug on the adjacent 4 pin wafer is normally set in the UP position. If the Thermocouple burns out or breaks when in this position, the temperature reading is forced over-scale and the heating will be cut off. If the plug is in the DOWN position when the Thermocouple burns out or breaks, the temperature reading will be forced underrange and the heat to the kiln again will be cut off.
Replace bottom cover plate ensuring the transistor clearance notch in the cover plate card slot is at the jumper plug end of the box.

Set Thermocouple Code Number
Plug unit into base and turn power on.
Press the DOWN key, and while holding it down, press the SCROLL key. The display will show "0".
Note: If a key is not pressed within five seconds of the previous key press, the controller will revert back to normal operation.
To avoid this time out either hold down the SCROLL key after a SCROLL key press or release any held key and hold down both the UP and DOWN keys until ready for the next key stroke.
Press the UP key twice, the display shows "102".
Press the SCROLL key, display shows currently selected thermocouple code number.
(Display shows "0004" for type R which is the factory setting.)
Use the UP and DOWN keys to adjust display to new code number selected from the list below.

<table>
<thead>
<tr>
<th>Thermocouple Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>0001</td>
</tr>
<tr>
<td>K</td>
<td>0002</td>
</tr>
<tr>
<td>N</td>
<td>0003</td>
</tr>
<tr>
<td>R</td>
<td>0004</td>
</tr>
<tr>
<td>T</td>
<td>0005</td>
</tr>
<tr>
<td></td>
<td>0006</td>
</tr>
</tbody>
</table>

Do not use this code

Return to normal operation by either waiting five seconds without further key presses or press together both the SCROLL key and the START/STOP key.
Specifications

Inputs
Thermocouples

Five types, (refer to Ordering Information at end of this section for details), are user selectable by changing a jumper plug and entering a software code. Usually supplied set to Type R.

- All types are ambient compensated.
- Measurement Accuracy: ±0.2% of full scale ±1°C.

Resistance Thermometer

Pt 100 to DIN 43760.
- Three or four wire connection.
- Measurement Accuracy: ±0.2% of full scale ±0.1°C.

Switch Input

Used for a remote Start/Stop input and to activate Auto Continue.

- To either start or stop the firing, use a pulsed, normally open or normally closed, low voltage clean contact, with a pulse duration longer than 120ms.
- If firing is to resume automatically after a power failure, use a normally closed switch or fit a link if remote Start/Stop is not required.
- Input is pulled high to +5V with an internal 22k ohm resistor.

Outputs

Heat

ON/OFF control action with a time proportioned, 30 second cycle time, automatic simmerstat power limit up to 200°C.

Gives 10% power at 20°C, 50% at 100°C, and 100% power above 200°C when heat is called for.

- Contacts close when kiln temperature is 2°C less than profile temperature, and open when kiln temperature is equal to or greater than profile temperature.
- Heating is cut off, and indicator displays '1', if Thermocouple breaks, burns out or is reverse connected.
- Contacts are rated to switch a 240 Vac, 4 Amp load.

Limit (481S Only)

Contacts open when kiln temperature exceeds the pre-set limit, and close 2°C below this limit.

- Limit setting range for Thermocouple inputs is -3200°C to 3200°C, and for RTD inputs, -320.0°C to 320.0°C.
- Contacts are rated to switch a 240 Vac, 4 Amp load.

Run (481S Only)

Contacts remain closed during firing, and open when firing is stopped.

- Contacts are rated to switch a 240 Vac, 4 Amp load.

Program Settings

Program Select

Up to eight programs can be stored and used repeatedly.
Specifications

Start Time
Firing starts instantly the Start/Stop key is pressed if Start Time is set to INST or starts automatically at the set Start Time.
- Adjustable from 0:00 hours, (midnight), to 23:59 hours (1 minute before midnight), and to INST.

Ramp Rate
Three ramps, one for each program stage, are adjustable in 0.1°C/hr steps up to 199.9°C/hr, and then in steps of 1°C/hr up to a maximum rate of 3200°C/hr.
- Can be set to FAST which takes kiln up to temperature as fast as possible.

Hold Temperature
Three hold temperatures, one for each stage, are adjustable between the pre set range limits or can be set to PASS which bypasses the stage.
- For Thermocouple inputs the pre-set range limits are adjustable from -3200°C to 3200°C and for an RTD input adjustable from -320.0°C to 320.0°C. Factory default settings are -100°C to 1300°C for Thermocouple ranges and -10.0°C to 130.0°C for the RTD range.

Hold Time
Three hold times, one for each stage, can be set from 0:00 to 54:00 (hr:min). Hold period starts when kiln temperature is within 5°C of hold temperature.

General

Clock
24 hour clock, can be set from 0:00 (midnight) to 23:59 (1 minute before midnight).
- Accuracy better than ±2 minutes per month.

Display
4½ digit liquid crystal, with 12mm high numbers.

Power Supply
240Vac ±10%, 10VA maximum, 115Vac and 24Vac optional.

Operating Temperature
0°C to 45°C.

Dimensions
150 x 75mm front panel, 110mm overall depth.

Shipping
Weight 0.95kg, Volume 4.7 litres. Accuracy better than ±2 minutes per month.

**Ordering Information**

To build the order code select one code from each of the five groups below as shown in the example.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat output only</td>
<td>480S</td>
</tr>
<tr>
<td>Heat, Limit and Run outputs</td>
<td>481S</td>
</tr>
</tbody>
</table>

**INPUT**

Thermocouples-user selected

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Range</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>Iron-Constantan</td>
<td>-100...1000 °C</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Chromal-Alumel</td>
<td>-100...1250 °C</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Nicrosil-Nisil</td>
<td>0...1300 °C</td>
<td>10</td>
</tr>
<tr>
<td>R</td>
<td>Platinum, 13%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Rhodium-Platinum</td>
<td>150...1750 °C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Copper-Constantan</td>
<td>-200...400 °C</td>
<td></td>
</tr>
</tbody>
</table>

Resistance Thermometer

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Range</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt100</td>
<td></td>
<td>-199.9...199.9 °C</td>
<td>20</td>
</tr>
</tbody>
</table>

**POWER SUPPLY**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>±10%</th>
<th>50/60Hz</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>240 Vac</td>
<td>±10%</td>
<td>50/60Hz</td>
<td>A</td>
</tr>
<tr>
<td>115 Vac</td>
<td>±10%</td>
<td>50/60Hz</td>
<td>B</td>
</tr>
<tr>
<td>24 Vac</td>
<td>±10%</td>
<td>50/60Hz</td>
<td>C</td>
</tr>
</tbody>
</table>

**SPECIALS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Unit</td>
<td>0</td>
</tr>
<tr>
<td>Specials, specified when ordering</td>
<td>X</td>
</tr>
</tbody>
</table>

**SCALE**

<table>
<thead>
<tr>
<th>Description</th>
<th>°C</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees Celsius</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Degrees Fahrenheit</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**EXAMPLE OF ORDER CODE**

480S-10-A-0-0