USER GUIDE

XMTD-818GP
Programmable Temperature Controller

... When Used with Ceramic Kilns

Warner Instruments/FireRight Controls
www.fireright.com

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ABOUT THIS GUIDE

The XMTD-818GP is a programmable ramp/soak digital temperature controller. It can be used as an inexpensive replacement for aging FireRight Sr and Kilntronics 09VR kiln temperature controllers for less than US$50[1]. Wiring requirements are minimal, since it can very easily be interfaced with existing power control boxes; no need to rewire the kiln's control system.

This guide is provided as a courtesy to former FireRight/Kilntronics users. It applies only to the XMTD-818GP temperature controller, and is intended to be useful only for the application mentioned above. This is not intended as a general-purpose instruction manual for the controller itself. Warner Instruments is not involved in any way in the manufacture, sales, or service of these products.

DESCRIPTION

The XMTD-818GP is part of the XMT*-808 series of controllers, which are products of China. They are used world-wide in a wide assortment of applications.

This particular model accepts a variety of inputs, and can provide a variety of outputs. It can operate in either the simple ON-OFF mode, or the linear "PID" mode. It is also programmable, capable of performing firing schedules with as many as thirty temperature/time steps, with temperature being expressed in °C, and time in minutes. A simple Hi/Lo temperature alarm feature is also provided.

For this application, the selected temperature sensor input will be a Type K thermocouple, the selected control mode will be On/Off, and the output form will be a switched DC voltage compatible with most solid-state relay inputs. The controller's alarm feature isn't applicable to kiln firing, and will not be used.

The "XMTD-818GP" model number partially describes the controller:

XMT – the product series
D – case dimensions in cm: 72 x 72 x 110
8 – four keys, two-row LED display, PID capable

[1] When purchased online – April 2024

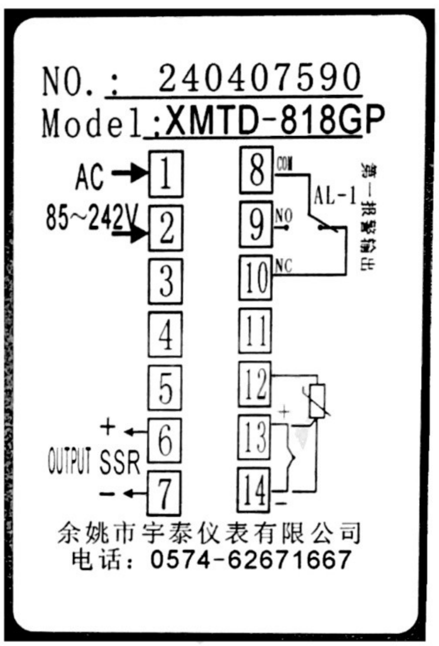
1 – one alarm
8 – six selectable inputs
G – two-bit SSR output
P – 30-segment programmable (ramp/soak)

INSTALLATION

The XMTD-818GP is designed for stationary mounting. Chose a convenient location within reach of the kiln's sensor cable, the modular control cable from the power controller or interface panel, and a 120vac wall receptacle.

A surface-mounted box or mounting bracket may be used. In either case, a 68mm (2.68") square cutout will be needed to mount the controller. Use the mounting clamps provided with the unit.

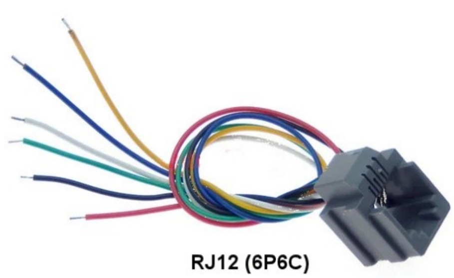
HOOK-UP



There are only three connections needed at the back of the controller: input power, the temperature sensor cable, and the cable going to the kiln's power control box or interface panel (the gray cable).

Referring to the wiring diagram provided on the side of the controller:

1. Connect 120vac input power to screw terminals 1 and 2. A common low-power 2-wire lamp cord may be used. Connect one wire to 1, and the other to 2, as shown.



2. An RJ-12 (6P6C) modular (telephone) receptacle is needed to connect the kiln's gray control cable to the controller. Connect its blue wire to 6, and its white wire

to 7. Snip off the stripped ends of the four remaining unused wires to ensure that the conductors cannot touch.

3. If your existing sensor cable is terminated with a modular plug, cut it off. Then remove an inch or two of the cable's outer jacket, and strip 6mm (1/4") of the insulation off the yellow and red wires. Connect the yellow (+)[2] wire to 13, and the red (-) wire to 14.

4. The "AL-1" alarm relay output is not used.

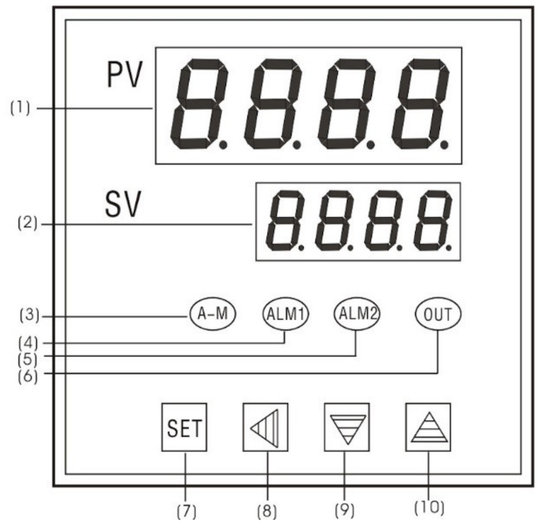
5. Devise a way to secure these three cords/cables to prevent they're possibly damaging the controller if jerked on (tripped over, etc.).

> Consider plastic strain-relief bushings for the power and sensor cables. The RJ12 connector is slotted, and can be slipped into a 12mm × 21mm (.440" × .825") slot in the edge of a mounting bracket or box. Alternatively, a short section of plastic "cord hider" raceway might suffice.

[2] The international color code is green (+) and white (-). In either case, the (-) wire is magnetic, and the (+) us not.

OPERATING INSTRUCTIONS

Front panel



The numeric displays, tell-tail indicators, and pushbutton switches on the controller's front panel have different functions, according to what's going on at any particular moment. It generally has two modes of operation; the "normal mode" and the "setup mode".

The normal mode is self-selected. Whenever the controller has been "hands free" for ten seconds, it will automatically switch back to the normal mode. In this mode:

1. "PV" displays the "process variable", which in this application is the measured temperature in °C.[3]
2. "SV", meaning "set value", is the present temperature setting °C.
3. The green "A-M" light will be on during "**run**", flashing during "**HoLd**", and off during "**StoP**".
4. The red "ALM1" light will be lit whenever the controlled temperature drops below the "ALM1" limit setting.
5. The red "ALM2" light will be lit whenever the controlled temperature exceeds the "ALM2" setting.
6. The green "OUT' light will be lit whenever the output is "ON" (i.e., calling for heat).

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[3] C-F Conversion: °F = (1.8×°C)+32; °C=(°F-32)/1.8

7. The multifunction **“SET”** key is used to …
    - switch the controller to its set-up mode
    - during set-up- it’s used to register the selection or setting for the current parameter and switch to the next item
    - select the StEP counter, permitting you to manually jump to whatever StEP you want

8. The “◀” key …
    - moves the decimal point (cursor) one digit to the left each time it’s pressed
    - when pressed in conjunction with **SET** during set-up, returns to the normal mode
    - momentarily switches the controller to the ramp/soak programming mode when pressed immediately following your having pressed either the “▼” or “▲” key

9./10. The “▼” and “▲” keys are used to …
    - adjust the value of a selected parameter, up or down
    - select a value for a non-adjustable parameter.

Holding **“SET”** depressed for two seconds switches the controller to the setup mode. In this mode …

1. “PV” displays the name of various set-up parameters.

2. “SV” displays the value of the parameters during setup procedures.

3. The green “A-M” light has no obvious function in the set-up mode and may be ignored.

4. The red “ALM1” light will be lit whenever the controlled temperature drops below the “ALM1” limit setting.

5. The red “ALM2” light will be lit whenever the controlled temperature exceeds the “ALM2” setting.

6. The green “OUT’ light will be lit whenever the output is “ON” (i.e., calling for heat).

7. The multifunction **“SET”** key is used to register the values you set or select for the various parameters, then switch to the next item.

8. The “◀” key …
   - changes the position of the decimal (cursor) in the “SV” window when entering values
   - momentarily changes the function of the “▼” and “▲” keys when used in combination with those keys

9./10. The “▼” and “▲” keys are used to …
   - adjust the value of a selected parameter, up or down
   - select a value for a non-adjustable parameter.

As a means of controlling costs, the user’s means of providing instructions to the controller is limited to just four pushbuttons at the bottom of its front panel. As a result, its operation is not very intuitive.

Its processor is programmed to interpret what the user is trying to do according to its current operating mode, and when, and in what sequence buttons are pushed. It has a very limited set of input patterns that it is able to understand, and will mostly ignore button pushing at times or in sequences that do not match something in its instruction set. But possibly even worse, by randomly pushing these buttons while attempting to guess how to do something, a user might inadvertently enter something that the processor can understand, and will then respond to … leading to even more confusion.

This means that prospective users must take the time to learn how the controller works before attempting to “go live” with it with actual kiln firings.

Initial Configuration

The XMTD-818GP controller is a highly capable instrument, capable of serving in many diverse applications. It has a set of some thirty-three functional characteristics that users can adjust in order to configure the controller for their particular use.

For our purposes … kiln firing … several of these do not apply, can be ignored. These are grayed-out on the following setup flow chart. Set the rest as instructed below the flow chart. This is generally a one-time, set-and-forget task.

To enter the setup mode, press **“SET”** for about two-seconds. The first parameter is “ALM1”. If you hold “**SET**” down, the controller will quickly slew through the parameter without changing anything, return to the normal mode, then begin again. Otherwise, to navigate through the parameter list …

- press **“SET”** to accept the value presently shown in the SV window and move to the next parameter
- press “◀” down and simultaneously press **“SET”** to escape from the setup mode and return to the normal mode.
- if no key is pressed within ten-seconds, the controller will automatically return to the normal mode.

- You can use ◀, the decimal point key, to quickly change set-up values. For example, with the display reading “9999” it would take about 90-minutes to change it to “15” by pressing and holding the ▼ key. But since the counter affects only the number to the left of the decimal point (cursor) …

  - ◀ to “9.999” and ▼ to “0.999”
  - ◀ to “9.99” and ▼ to “0.99”
  - ▼ to “9.9” and ▼ to “0.9”
  - ▼ to “9.” and ▲ to “15”

  You can also use this same method to quickly enter larger numbers.

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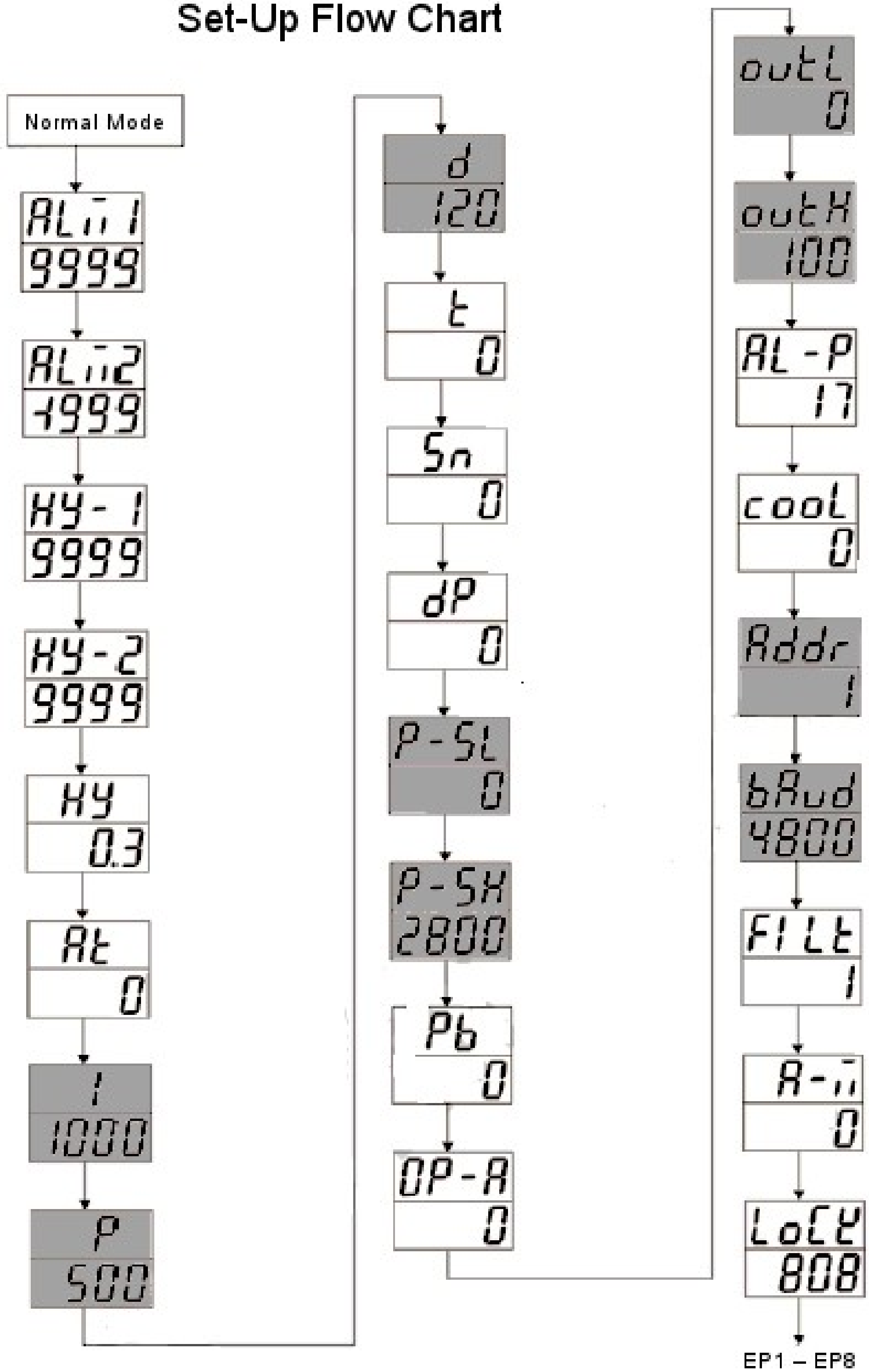
Set-Up Flow Chart



ALM-1: “High Limit Alarm” — Disable by setting at “9999”[4]
ALM-2: “Low Limit Alarm”: — Disable by setting at “-1999”[4]
Hy-1: “↑ Deviation Alarm” — Disable by setting at “9999”[4]
Hy-2: “↓ Deviation Alarm” — Disable by setting at “9999”[4]

Hy: “Dead Band” (aka: hysteresis”) — set at “3”

This setting establishes an On/Off switching differential at the set point, without which the controller’s output would likely chatter because of electrical interference, or “noise”, components imposed on the sensor input. For practical ceramic kilns, this can be set as high as “10” without degrading the firing process.

Example: Assuming an SV of 1800 with Hy set at 3, the controller output will switch to “OFF” when the temperature reaches 1803°C, switching back to “ON” when the temperature drops below 1797°C.

At: “Control Mode” — select mode “0”

At=0: On/Off control; a simple form of control that acts like a thermostat, turning the heat on when the temperature is less than the set point, and off when the temperature goes higher than the set point.

At=1: Manually tuned “Three-Mode” or “PID” control (Proportional-Integral-Derivative); a more precision form of control where the controller throttles the heating system when the temperature is anywhere near the set point, in an attempt to prevent overshooting, and keep the temperature exactly at the set point.

At=2: Automatically tuned PID control; where the initial P, I, and D parameters are determined by the controller, rather than being set by the user.

At=3: AI adjusted PID control; where the appropriate ongoing P, I, and D values are under AI control, After the auto-tuning process completes, the controller switches to this state automatically, and inhibits any further auto-tuning attempts.

[4] If interested, see “About Temp Limit and Deviation Alarms” in the Appendix.

P, I, & D: These parameters are ignored when the controller is operated in the On/Off mode.

t: “Control Period” (or “Cycle Time”) — set at “0”

Also part of the controller’s proportional control capabilities, enabling a “time proportioned” output, instead of a linear, continuously variable output. In “time proportioning”, the output is switched ON and OFF at regular intervals (the “cycle time”) with output proportioning accomplished by varying the “ON time vs the OFF time during each cycle. Time proportioning is quite adequate for systems with a very long “thermal time constant”, like ceramic kilns, and can be implemented with much less cost.

Sn: “Input Specification” — Select “0” (Type K thermocouple)

The XMTD-818GP supports several different types of thermocouple and resistance-type temperature sensors. Ceramic kilns always use Type K (“chromel vs alumel”) thermocouples because of their high temperature capability.

dP: “Decimal Point” — Select “0” (Whole numbers)

dP=0: temperature display resolution is 1°C

dP=1: temperature display resolution is 0.1°C up through “999.9, then 1°C from “1000” up.

This parameter only affects the display. It has no effect on controller performance, because the internal temperature resolution is always 0.1°C

P-SL & P-SH: “Linear Input Scale Factors” — Ignore

These parameters apply to linear analog inputs only; not to thermocouples or RTD sensors.

Pb: “Input Shift” — Set at “0”

This parameter can be used to compensate for sensor error and/or reference junction compensation error.

The controller itself is factory-calibrated, and after that its calibration is maintained digitally by the processor. *This attribute should be readjusted only when error-compensation is proven to be necessary.*

OP-A: "Output Form" — Select "0"

OP-A=0: binary "On/Off" output (e.g., SSR switching, mechanical relay contact, etc.)

OP-A=1: linear output (i.e., 4 to 20mA)

OP-A=2: time-proportional on/off output[5]

outL & outH: "Linear Output Limiting" — ignore

AL-P: "Alarm Definition" — select "17" …
"ALM1" is High Limit alarm
"ALM2" is Low Limit alarm
"Hy-1" is Plus Deviation" alarm
"Hy-2" is Minus Deviation" alarm

cooL: "Cooling Mode" — select "0"

cooL=0: for heating systems

cooL=1: for a/c or refrigeration systems

Used to reverse the controller's output logic for cooling applications, such that increases in temperature cause the output to increase.

Addr & bAud: "Comm Interface Settings" — Ignore

The XMTP-818GP does not have a communications interface, so these parameters have no function.

FILT: "Digital Input Filtering" — set at "1"

The thermocouple temperature sensor provides very low-level signals (only around 30µV/°C), so the input can be susceptible to electromagnetic interference, especially if the kiln is operating in an electrically "noisy" environment. A digital input filtering system is therefore provided.

The filter can be configured over a range of 0—20, "0" meaning "no filtering", and "20" being the maximum. Input filtering proportionately reduces the controller's response time so, although ceramic kilns naturally have a long "thermal time constant", **FILT**

[5] Time-proportioning is a scheme for adjusting the heating rate by establishing a fixed "cycle time", and then varying the "On" vs "Off" time within each cycle. For slow-responding systems, the heating pulses get nulled out, and the result is essentially linear.

should be set no higher than might be necessary to eliminate excessive output “chattering”. Begin with this low setting, and increase it gradually, as needed.

A-M: “Power Failure Safety” — Select “0”

This parameter determines what happens when the power is cut while the controller is operating in the ramp/soak mode …

A-M=0: the program is reset, and the controller automatically begins again at the first step when power is restored, no matter how many steps were previously completed.

A-M=1: the previous firing progress is saved; the controller automatically resets the running time for the step it was on when the power was cut, and resumes from that step when power is restored.

A-M=2: the controller will log its progress every one-minute up to the time the power was cut. When the power is restored, it will automatically resume in the last step saved, without having reset that step’s running time.

LoCk: “Operator Privileges” — select “808”

LoCk provides a way to prevent unauthorized user from tampering with the controller’s settings, by controlling access to them.

- When set to “808”, all set-up parameters and SV can be view and changed by the user.
- When set to any number other than “808”, user access will be limited to the parameters named in the “field parameter definition tables, EP1 through EP8.

EP1 – EP8: “Field Parameter Definitions”

When LoCk is enabled (any setting other than 808), users will be able to view and change only the parameters and settings named in these fields

The accessible parameters should be named in order, and “nonE” should be selected for the first unused EPn field.

Example: if operators needed to have access to the high and low limit alarm settings …

LocK=“0”, EP1=“ALM1”, EP2=“ALM2”, EP3=“nonE”

LoCk: “Operator Privileges” — select “0”

***

MANUAL OPERATION

The XMTP-818GP controller has no “Manual” mode, as such. To operate the controller manually (like a common thermostat), you can use one of the vacant StEP registers.

For example, to warm the kiln up to 90°C and let it set at that temperature indefinitely for “candling” purposes, do this …

1. Press **SET** once to bring up the StEP counter, then select “30”. (or any unused StEP) and press **SET** to register this choice and return to the normal mode.

2. Hold **SET** down for two seconds to enter the setup mode. Then toggle the **SET** button as necessary to get to “C-30” (or whatever StEP you selected.

3. Enter “90” for C-30, then press **SET**

4. Enter “0” for “t-30”, then press **SET**.

5. Allow the controller to return to its normal state (10-seconds), then press ▼ and select “**run**”

Electric kilns have excess heating capabilities at low temperatures, and are very likely to overshoot the 90°C set point when first fired up. If that’s a concern, and you have two empty StEP slots available, you could do this …

- C-29 = 20 and t-29 = 30
- C-30 = 90 and t-30 = 0

… set the StEP counter at “29” and “**run**” from there.

This will throttle the kiln’s heating system, ramping the temperature up to 90°C at a slow more linear rate, thus preventing overshoot.

***

AUTOMATIC OPERATION

The XMTP-181GP controller can perform firing schedules that include up to thirty ramp/soak steps. Some terms involved in automatic operations are …

ramp/soak: Ramp refers to the set point increasing or decreasing at a linear ratee. Soak means that the set point remains fixed at a certain temperature setting.

Program StEP: The number of the program StEP, from “1” to “30”

Current StEP: The StEP currently being performed

StEP Temperature: The set point designated for the end of the StEP. For ramp operations, this will be a higher or lower than the previous StEP temperature. For soak operations, it will be the same. StEP Temperature settings are labeled “C-01”, “C-02” … “C-30”

StEP Time: The set time of the StEP, in minutes, adjustable from “1” to “9999”. StEP Time settings are labeled as “t-01”, “t-02” … “t-30”

Running Time: The time that the current StEP has run, in minutes. When the Running Time reaches the StEP Time, the program will jump to the next StEP

run/HoLd: When the program status is “**run**”, the timer is enabled, and the set point changes as scheduled by the time designated for the **StEP**

When the program status is “**hoLd**”, the timer stops and SV stops changing

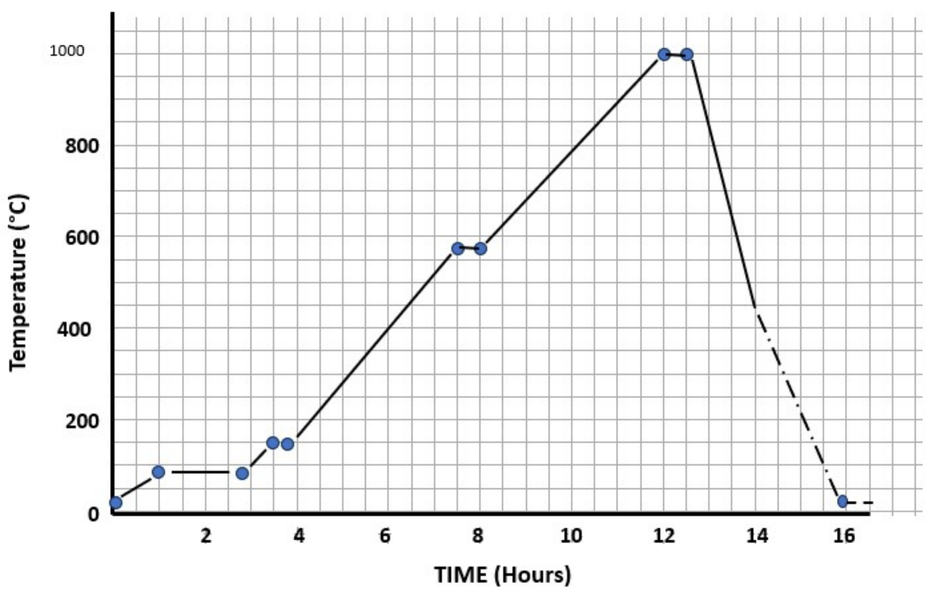
In the **run** state, when the program jumps to the next **StEP**, three variables are registered …

- the **StEP Temperature** from the previous StEP
- the **StEP Time** for this next StEP
- the **StEP Temperature** for this next StEP

The controller calculates the temperature transition rate by subtracting the former **StEP Temp** from the new **StEP Temp**, and dividing that by the new **StEP Time**, to come up with °C/Minute. SV is then incremented or decremented accordingly, until the **Running Time** equals the **StEP Time**. Then the program jumps to the next StEP. When the last StEP in encountered, signified by a “t-n = 0” setting, the controller is switched to the “hoLd” state.

Entering Firing Schedules

Firing ceramics kilns is more of an art than a science. Because there are so many variables involved, many of which cannot be precisely quantified, experience is a much better teacher than textbooks. So, deciding what the firing schedule is going to look like is the first step.



Here is one possibility for a “***Δ06***” bisque firing. Entering the firing profile time/temperature information in the controller can be somewhat confusing because of the way the controller seems to organize the input information. For example, in StEP 1 …

- C-01 is the initial temperature, and
- t-01 is the time ‘til the next StEP

Then, at StEP 2 …

- C-02 is actually the target temperature for the end of StEP 1, and the initial temperature for StEP 2.

One way to simplify the program entry task is to draw a graph of the planned firing schedule, as above, and then make a list of its segments, like this …

“20 — 60 — 94”

“94 — 120 — 94”

“94 — 30 — 149”

“149 — 30 — 149”

“149 — 270 … etc.”

…which, in tabular form, would look like this …

StEP	C-nn	T-nn	C-nn+1
1	C-01=20	t-01=60	94
2	C-02=94	t-02=120	94
3	C-03=94	t-03=30	149
4	C-04=149	t-04=30	149
5	C-05=149	t-05=270	571
6	C-06=571	t-06=30	571
7	C-07=571	t-07=240	1000
8	C-08=1000	t-08=30	1000
9	C-09=1000	t-09=240	20
10	C-10=20	t-10=0	

You can now enter this information quickly and accurately.

With the controller in its normal mode, press ▲ as necessary to switch to the **StoP** mode.

The press ◀ to switch to its programming mode, which will open with “C-01” in the upper display. Enter “20” in the bottom window, then press **SET**. The controller registers that value, then jumps to the next item, “t=-01”.

Press once again to dismiss that, and go on to “C-02”. Enter “94” and press twice again, to register that and jump to “C-03”.

In the same manner, enter the values for “C-03’ through “C-09”. After entering “20” for “C-10”, press **SET** only once. Then, while holding ◀ down, press **SET** to return the controller to the normal mode (or wait 10-seconds for the controller to return on its own).

Press ◀ again to return to the programming mode, then press **SET** once to jump from “C-01” to “t=01”. Enter “60”, then press **SET** twice to register that setting, and jump to "t=02".

At "t-02" enter "120", then press SET twice again to register that and get to "t-03".

In the same manner, enter the values for "t-03' through "t-09". After entering "0" for "t-10", press **SET** only once. Then, while holding ◀ down, press **SET** to return the controller to the normal mode (or wait 10-seconds for the controller to return on its own).

When ready to run the program, press ▼ until **run** appears in the lower window.

Entering a Second Firing Schedule

The controller's non-volatile memory will save its set-up and program data. Since its programming section has space for thirty program steps, you can input more than one firing profile, and select the one you need, when you need it.

The above example used only ten steps, and you might have some schedules with as few as three, such as this simple glaze firing profile …

Ceramics — Cone 04 Glaze			
Segment	Rate/hr	Temperature	Stage Time
1	83	121	1.20
2	222	924	3.61
3	67	1063	2.08
Total Firing Time:			6hrs 54min

20 — 72 —121
121 — 217 —924
924 — 125 — 1063
1063 — 209 — 20
20 — 0

The bisque, above, program occupies the first ten slots of the program memory, you can begin entering these five instructions at "C-11".

Press ◀ , and then press **SET** enough times to get to "C-11". Enter "20", press **SET** twice to register that and jump to "C-12". Enter "121" and press **SET** twice again, etc. … until having entered "20" for "C-15".

Let the controller switch itself back to its normal mode, then press ◀ to get back into the programming mode. Press **SET** enough times to get to "t-11", enter "72", then press **SET** twice to enter that and jump to "t-12". Continue in this manner until having entered “0” at “t-15”; press **SET** once to register that, then permit the controller to return itself to its normal mode.

You now have a bisque firing schedule and a glaze firing schedule stored in the controller’s memory …

Bisque: beginning on StEP 01
Glaze: begins ono StEP 11

To do a bisque firing, press ▲ until **StoP** appears in the display, which automatically resets the controller to “StEP 01” (aka, “T01”). When ready to begin, press ▼ to select “**run**”.

To do a glaze firing, you need to begin at ‘StEP 11”. press ▲ until **StoP** appears in the display, then press **SET** once to bring up the StEP counter. Adjust that to “11”, then press SET once to register your selection. When ready to begin, press ▼ to select “**run**”.

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APPENDIX A
About Temp Limit and Deviation Alarms

ALM1 and ALM2 are high/low limit alarms. They establish what will be considered a normal overall operating range.

HY-1 and HY-2 are deviation alarms. These are offsets referenced to the set point (SV), establishing what will be considered a tolerable difference between the set point and the controlled temperature.

These alarms need not necessarily be used. They are not generally needed when firing ceramic kilns, and are ordinarily disabled. Nevertheless, since the controller has this capability, the follow discussion is provided.

ALM-1: “High Limit Alarm”

> The “ALM1” alarm is set when the temperature rises above this setting, plus whatever “Hy” is. It will be reset when the temperature decreases to ALM-1 – Hy. This alarm actuates the controller’s “AL-1” alarm relay on terminals 8 and 10.
>
> > For example, with ALM-1=450 and Hy=5, ALM2 will set when PV rises above 455, and reset automatically when PV falls below 445.
>
> This is not generally applicable to kiln firing, so set this at “9999” to disable it.

ALM-2: “Low Limit Alarm”

> The “ALM2” alarm is set when the temperature drops below this setting, plus whatever “Hy” is. It will be reset when the temperature increases to ALM-2 – Hy.
>
> > For example, with ALM-2=450 and Hy=5, ALM2 will set when PV falls below 445, and reset automatically when PV rises above 455.
>
> This is not generally applicable to kiln firing, so set this at “–1999” to disable it.

Hy-1: “Plus Deviation Alarm”

The plus deviation alarm is set when the temperature is higher than the set value by an amount equal to this setting plus Hy.

- set when PV–SV ≧ Hy + Hy-1
- reset when PV–SV ≦ Hy – Hy1.

This is not generally applicable to kiln firing, so set this at “9999” to disable it.

Hy-2: “Minus Deviation Alarm”

The minus deviation alarm is set when the temperature is lower than the set value by an amount equal to this setting plus Hy.

- set when PV–SV ≧ Hy + Hy-2
- reset when PV–SV ≦ Hy – Hy2.

This is not generally applicable to kiln firing, so set this at “9999” to disable it.

orAL: Input Over-range or Under-range

This parameter is configured automatically according to the type of input selected at Sn. The designated range for the Type K sensor is –50°C to +1300°C. Whenever PV goes outside this range, a “orAL” alarm will be generated, the controller’s output will be disabled, and “orAL” will appear in the bottom display window.

A missing or disconnected temperature sensor will produce the “orAL” alarm condition. Type K thermocouples operating for prolonged periods at high temperature will eventually burn out, then also producing this alarm.

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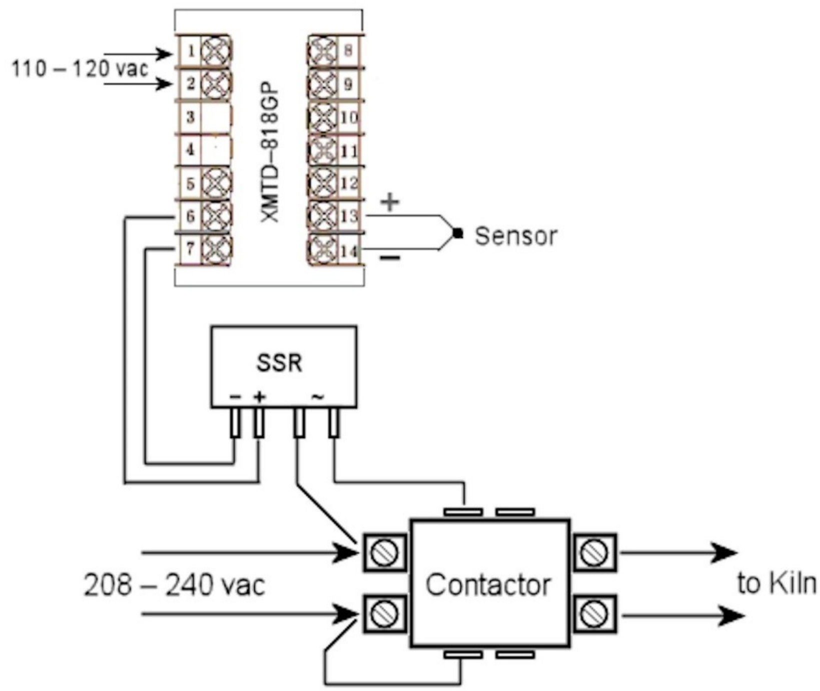
APPENDIX B
Non-Modular Hook-Up

No pre-existing KilnTronics or FireRight Power Controller or Interface Panel? No Problem. The XMTD–818GP can easily be hooked as shown here. Only two additional parts are needed; a discrete Solid-State Relay, and a Definite Purpose Contactor (see Appendix C).



The suggested contactor has a 208–240vac solenoid coil, and is capable of handling up to 50-amps. The wiring for the 208–240vac service connections must be sized according to the kiln's actual current rating and distance from the service entrance; generally, match the power cord that came with the kiln. The control wiring to/from the SSR can be as small as AWG#20.

APPENDIX C
Procurement Information

The following items were purchased for this project from online seller www.aliexpress.com …

Kiln Furnace Oven Programmable PID Temperature Controller 220V SSR Relay Output 72mm 30 Segment Program Controller — $48.22

10PCS RJ11 RJ12 RJ45 telephone FEMALE SOCKET connector with wire 4P4C 6P4C 6P6C 8P8C female jack connector 616E 623K 616M 641D — $2.58

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Parts needed for kilns with no pre-existing KilnTronics or FireRight modular Power Controller or Interface Panel (See Appendix B). These items are also available from www.aliexpress.com …

CG 1P 2P Air Conditioner Contactor Normally Open 24V 120V 240V Coil AC Definite Purpose Contactor for HVAC Motor Lighting … $9.89

PCB SSR-D3803HK D3805HK D3808HK Dedicated with Pins 3A 5A 8A DC-AC Solid State Relay … $2.20