Instruction Manual

Athena 6000/6200
Microprocessor-based Temperature Controller

- Dual 4-digit display
- Dual process/deviation alarms
- Touch key setup
- Compact–¼ DIN 3⅝" deep
- Internal lock-out switch to prevent unauthorized tampering

ATHENA

Athena 6000/6200
Microprocessor-based Temperature Controller

Designed for the user

Athena's unique new 6000 microprocessor-based controller was developed to satisfy the needs of actual end users, designers, and specifiers. Data was gathered on the temperature controller features, functions, and performance capabilities that they desired. Then Athena designed a controller to satisfy them.

Dual Indication

Now you can compare process temperature and setpoint at a glance - hands free. This dual digital display concept has formerly only been available in high priced multifunction process controls.

Microprocessors reduce size, add extras

By using microprocessor hardware and a highly sophisticated software package, Athena designers and engineers have included more features than have ever been available before in a controller this size. Incorporating two digital displays, touch-key operation, software linearized and stabilized thermocouple input with 3-mode PID action heat/cooling control and dual alarms, °F to °C conversion, alarms that can be energized for temp rise/fall and selectable as process or deviation type, and a program restart circuit that eliminates program lock-up due to transient voltage spikes or line voltage "brown out." Program automatically restarts within 2 milliseconds after condition passes.

PID Control

Three mode (Proportional, Integral, and Derivative) action eliminates offset (droop) as cooling and heating requirements change in the process, and provides fast output response to rate of change and reduces temperature overshoot and undershoot.

Thermocouple linearization

The 6000 has a program to linearize signal input from the thermocouple. Without it, temperature controllers have accurate temperature indication over only certain portions of the scale.

Contents

Specifications

Inputs:	
Line Voltage	**120/240 Vac $^{+10}_{-15\%}$ 50,60 Hz**
Sensor	**T, J or K thermocouple or Platinum 100Ω at 0°C**
Power consumption:	**Less than 6 VA (Instrument)**
Ranges available:	**J couple 0-1400°F (0-760%)** **K couple 0-2000°F (0-1093ºC)**
Accuracy:	**±1 digit of full scale**
Temperature stability:	**5 μV/ºC Max 3 μV/ºC typ.**
Cold end tracking:	**0.05ºC/°C ambient**
Operating ambient for rated accuracy:	**0 to 55%**
Maximum lead resistance for rated accuracy:	**Thermocouple: 100Ω** **RTD: 10Ω/lead**
Series mode noise rejection:	**60 dB**
Common mode noise rejection:	**120 dB**
T/C break protection:	**upscale standard**
Dual display:	**Process temp displayed continuously; setpoint or other parameters updated on lower display**
Display update rate and filtering	**Greater than 5 times per second.** **Analog and digital filtering techniques increase stability of process & display.**
ºF/ºC:	**Internal switch selection-process, setpoint and alarms affected.**
Alarm 1 & 2:	**Adjustable over full range of control. LED displays alarm status. 3 amp relay at 120 Vac normally open contact.** ***Reverse acting relay* by switch selecting or low alarms.** **Process/deviation mode selectable (internal switch).**
Outputs:	**Available heating only or heat/cool**
– B Relay (time proportioning)	**SPST relay 7 amps resistive at 120 Vac, 5 amp resistive at 240 Vac, 50 VA inductive**
-F Current proportional	**4-20 mAdc into 500 ohm max.**
-S Pulsed voltage	**0-20 Vdc pulsed time proportioning signal for driving solid state relays 500 ohms maximum input impedance**
-T Triac (time proportional	**Solid state plug-in triac output. Rated 1 amp holding & 10 amps inrush**
-E1 & E2 Auxiliary alarm relays (on/off)	**SPST relays, rated 3 amps at 120 Vac**
Filtered LED display:	**4 digits for process, 4 digits for parameters.**
T/C linearization:	**Continuously calculated and updated using rom based algorithm.**
Connections:	**Inputs and outputs vla barrier strips with U.L. approved locking sems terminals.**
Dimensions:	**Front panel: 96mm x 96mm x 22mm** **Case: 92mm x 92mm x 118mm** **Depth behind panel: 96mm (approx. minus panel thickness)**
Mounting:	**Channel slides and screws**
Weight:	**2 lb**
Recorder output: (RTD only)	**1 mV/ºC for degree reading unit** **0.1 mV/ºC for 1 10 degree reading unit**

Front Panel Adjustments

Touch Key

Index: Allows the following adjustments to be selected.

1) set point temperature	**0 to span**
2) alarm one temperature setting	**0 to span**
3) alarm two temperature setting	**0 to span**
4) rate with tracking reset (1:6ratio)	**** 0 to 120 sec**
5) heat gain	***** 1 to 400**
6) heat cycle time	*** 1 to 120 sec**
7) cool gain	***** 1 to 400**
6) cool cycle time	*** 1 to 120 sec**

up/down keys: increases/decreases values of above adjustments

Enter: writes selected values to nonvolatile memory

Internal switches/jumpers

A) 4 position dip switch
- **1) selects ºF/ºC display**
- **2) selects energized alarm two on hi/low (dev + / dev -) temperature**
- **3) selects energized alarm one on hi/low (dev + / dev -) temperature**
- **4) selects process or deviation alarm function**

B) 2 position dip switch
- **1) selects reduced rate gain**
- **2) locks out front panel parameter entry excepting set point**

NOTES: * setting to zero disables output**

*** setting to zero initiates 60 millisecond timebase for ultra fast cycling. Use with external solid state relays.**

****Setting to zero disables reset and rate actlon for proportional only control.**

To order see price sheet C-5-82

General

Congratulations on purchasing an outstanding temperature controller Ingenious use of microprocessor technology has given you an economical, compact controller that:

1. **Accurately measures, linearizes and displays temperature in °F and °C.**
2. **Digitally enters and displays control and alarm set points as well as heat and cool gains, cycle times, and user simplified rate and reset action.**
3. **Can be switched configured for high and low process alarms or deviation alarms.**
4. **Can be field converted from relay output "B", to solid state relay "T" to solid state relay driver "S" or to a 4-20 MA output SCR driver "F", with independent outputs for heat and cool.**
5. **Will remember its "entered" settings after power failure or shut-off and not "Go To Sleep".**

CAUTION: HIGH VOLTAGE AND HIGH TEMPERATURES CAN CAUSE INJURY AND ARE A FIRE HAZARD. PLEASE READ ALL INSTRUCTIONS, HAVE ONLY SKILLED PROFESSIONALS WIRE THE UNIT, AND USE AN APPROVED TEMPERATURE AND/OR PRESSURE SAFETY CONTROL. EVEN THE BEST COMPONENTS CAN BE DAMAGED OR MAY NOT FAIL SAFE.

Configuration

Depending on the model number of the unit you have ordered, you will find one or two of four basic modules available. The fifth and sixth digits of the code indicate the module type for heat and cool respectively:

B – Relay 7A/5A @ 120/240 Vac
F – 4-20 mA (Proportional)
T – Triac 1 AMP @ 240 Vac
S – Pulsed voltage for solid state relays to 24 Vdc

Example: 6000-F-B – Has proportional mA heat output to drive SCR control and a relay cool control for compressor cooling.

Alarms

The seventh and eighth digits in the ordering code number indicate number of alarms supplied. 6000-T-B-00 indicates none, E1 represents one, and E2 means two.

Installation Instructions

Unpacking

Unpack the instrument and inspect for shipping damage. Report any damage to the carrier immediately.

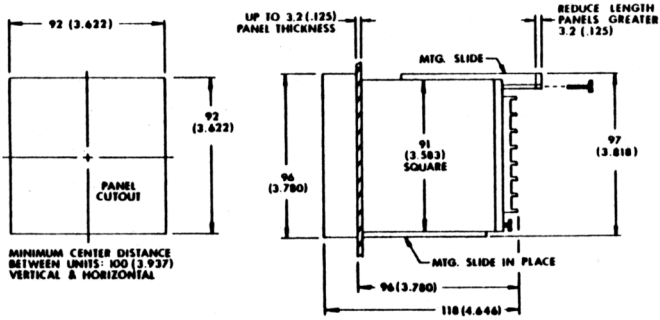
Locating

Select a location for the controller where it will not be subject to excessive shock, vibration, dirt, moisture or oil. The ambient temperature of the area should be between 30° and 130°F. (See Option 15 – dust, oil, water resistant cover available to protect from harsh environments).

Mounting

Mount the controller into a 92 mm (3⅝") square cutout. See figure below for the cutout and case dimensions. The plug-in controller does not have to be removed from its housing for mounting.

SERIES 6000 DIMENSIONS



NOTE: All Dimensions Are In Millimeters; Inches Are Shown In Parenthesis.

Installation Instructions

Remove two screws that hold the mounting slides, and then remove the slides. Insert case from front panel and re-install the two slides and two screws. Do not overtighten screws. The length of the slides must be reduced if the controller is to be mounted in an extra thick panel. If the controller has been unplugged from its housing, the top of the housing can be determined because it features the serial tag.
If buckling is observed in very thin panels, a slip-on steel yoke, B-60M5-1, can be ordered through our customer service department.

Terminal Designations

TERMINAL	
1 2	Thermocouple + (white for type J, yellow K) Thermocouple – (red for type J and K)
5 6 7	Option, #2 alarm, closes on alarm #1 and #2, alarm common Option, #1 alarm, closes on alarm
8 9 10	Instrument power line neutral Instrument power, 120V line or Instrument power, 240V line
11	"B" or "T" Power in for heat "F" or "S" + Output, heat, to power handler
12	"B" or "T" Power out to heater or contactor "F" or "S" – Output, heat, to power handler
13	"B" or "T" Power in for cool "F" or "S" + Output, cool, to cooling regulator
14	"B" or "T" Power out to cooling fan, valve, etc. "F" or "S" – Output, cool, to cooling regulator

Output Modules

The Athena 6000 offers users field interchangeable output modules. This unique feature makes it possible to fill output requirements for a variety of applications with a single controller model. Heating and cooling outputs may be selected independently.

Module Type B: This 7A/5A relay (at 120/240Vac) is used for driving resistive heaters and loads directly. Athena recommends a range of cycle times from 10 to 120 seconds for best relay life, set with consideration to the needs of the process to provide lowest ripple. Cycle

Output Modules

times less than ten seconds will drastically shorten relay life and in no case should the cycle time be set to zero (60 millisecond time base). Normally open contacts are provided for both heating or cooling use.

NOTE: Do not use this output module with mechanical contactors because they generate an excessive EMI field which can Interfere with other controllers. Instead we recommend "T" output modules for this applicatlon.

Module Type F:

This 4-20 mA output module can deliver full output to loads having an input Impedance of 500 OHMS or less. The cycle time setting must be ZERO for smooth current output.

A push-on terminal is utilized as a return for ground currents of the milliamp source. It is connected Internally to the mating lug on the heatsink. To avoid ground loops, drive floating (ungrounded) loads or use isolated thermocouples.

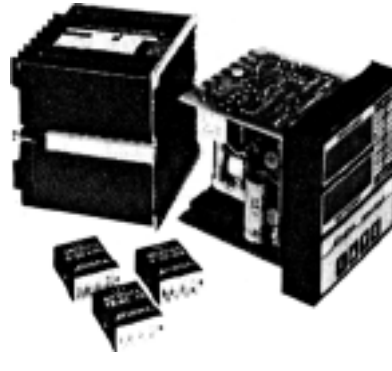
Module Type T:

This solid state relay is capable of 1 AMP at 120/240Vac. It is zero voltage switched and optically isolated from the drive signal. With it, resistive loads up to 120 watts at 120Vac and 240 watts at 240Vac may be controlled directly. Using direct control there is no lower limit on the cycle time setting (down to 60 milliseconds).

Larger loads may be controlled utilizing an external contactor. In this case, It is advisable to use cycle settings of ten seconds or greater to minimize contactor wear. External suppresslon of the contactor is advisable if EMI becomes a problem.

Module Type S:

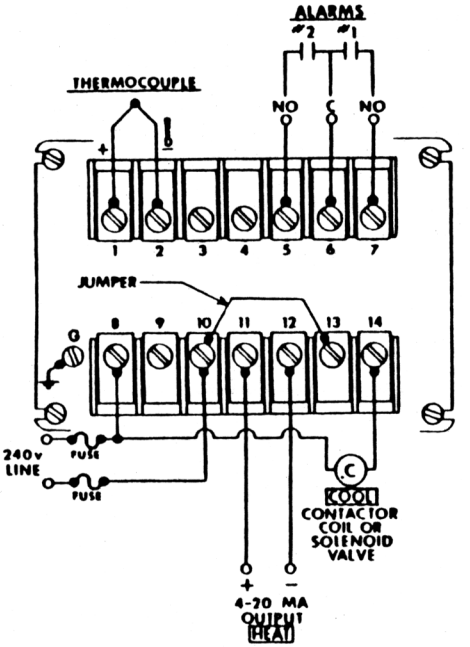
Similar to F, but pulsed 20V/20mA DC output for driving solid state relays. Up to 6 (series input connected) solid state relays can be used. Cycling time (HC) can be set to optimize the load response time requirements without sacrificing relay life.



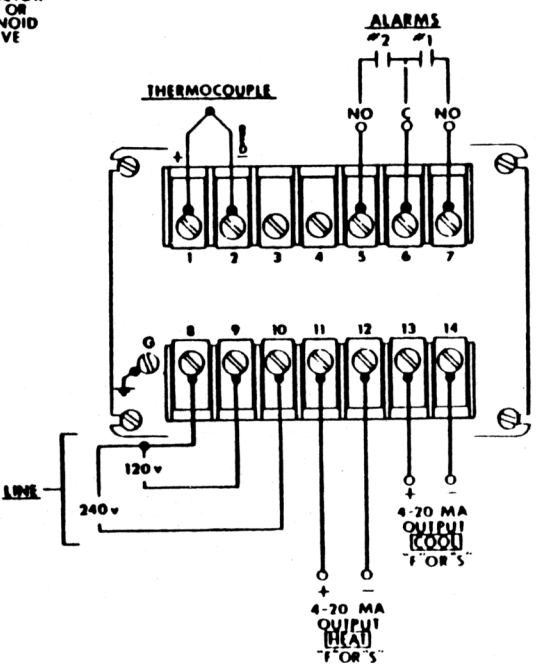
Installation Instructions

Wiring Examples

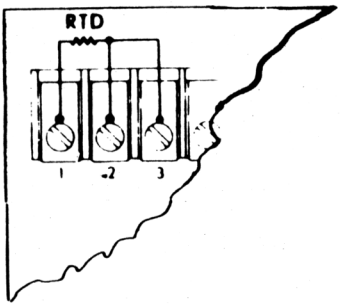
240V for FB and FT outputs



120/240V for FO and FF outputs

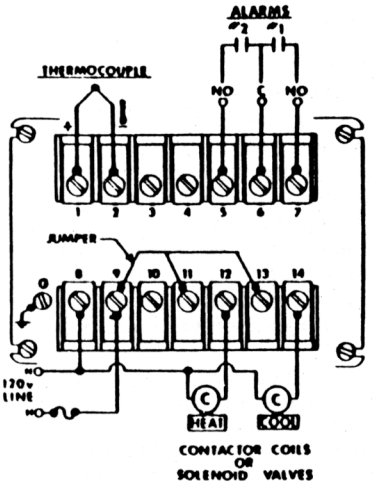


RTD input wiring for 6200

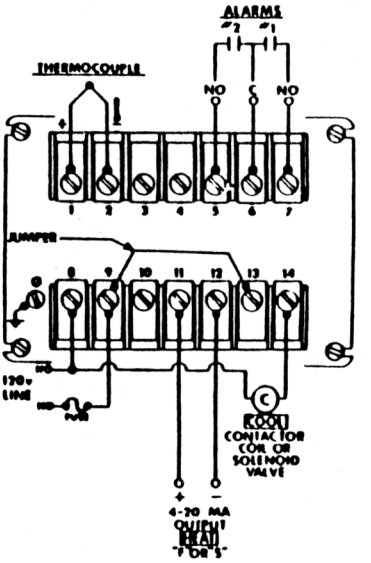


Installation Instructions

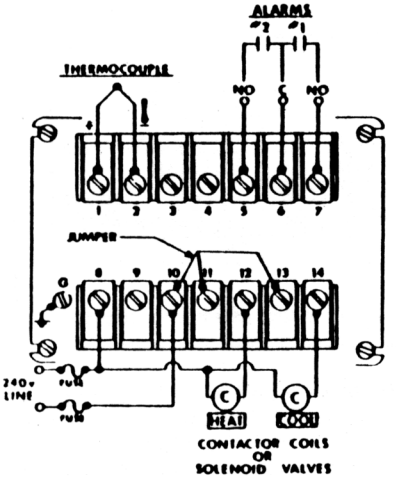
120V for TO, TT, BO, and BB



120V for FB and FT outputs



240V for TO, TT, BO and BB



NOTE: BO and BB relay outputs rated 7 Amp @120V and 5 Amp @240V, for resistive loads only.

Installation Instructions

Internal Switches

There are two switch modules inside the controller. One module controls alarm outputs and selects °C or °F. The other allows rate action reduction and front panel lock-out.

Alarms

If your unit is equipped with alarms (one or two) their functions can be selected with the four switch module inside the unit. (See drawing for location).

Switch Number Four changes both alarms from deviation (shown in actual degrees) to process (shows temperature) when depressed. (See section).

Switch Number Three changes alarm one from low to high when depressed (energies on temperature rise).

Switch Number Two changes alarm two from low to high when depressed (energizes on temperature rise).

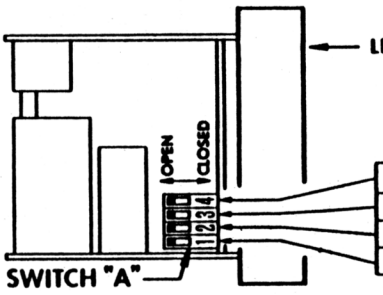
Switch Number One indicates °F depressed, °C open.

Instruments are shipped from the factory with the alarms in the "process" configuration with alarm one "high" and alarm two "low".

NOTE: When the alarms are configured as "process" alarms, the alarm will trip when the process temperature is greater than the alarm setpoint if it has been configured for high alarm. The alarm will trip when the process is less than the alarm setpoint if it has been configured for low alarm.

When the alarms are configured as deviation alarms, the alarms are triggered when the process varies from the process setpoint by whatever value has been set for the alarm. In the case of high alarms the value is above the process set point.

INTERNAL SWITCHES FOR ALTERNATE FUNCTIONS



SWITCH "A"		
	OPEN ←	→ CLOSED
4	DEVIATION	PROCESS
3	ALARM "1" LOW	ALARM "1" HIGH
2	ALARM "2" LOW	ALARM "2" HIGH
1	°C	°F

NOTES: In deviation mode, low alarms positions imply minus number in display.

°C/°F

Switch Position Number One (bottom) of the four pole switch configures the unit for degrees fahrenheit when depressed. It is shipped from the factory in this position. To change to degrees celsius, push the switch to the other position.

Installation Instructions

Reduced Rate Action

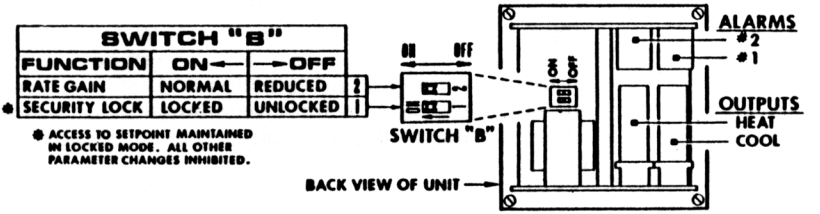
For the processes with noticeable transit dead time (when the head source upstream, and the temperature is downstream) or with inherent temperature fluctuations (such as air or fluid flow processes) an internal switch "B" enables reduced rate (derivative) gain. Slide switch B-2 to the right side for this function change.

Instruments are shipped from the factory in the normal rate gain mode.

Key Pad Security Lock

Switch B-1 disables operator access to all parameters (excepting set point). Pressing the index key does not advance the L.E.D. cursor in the index window. Changes to set point may still be effected and entered into non-volatile memory in the usual manner.

RATE GAIN SELECTOR, SECURITY LOCK FOR PARAMETERS
(expecting Set Point)



Wiring Thermocouple Circuits

Before wiring, check thermocouple and extension wire to make sure that they conform to the appropriate thermocouple type specified on the serial number tag. In thermocouple circuits, the negative lead is colored red. Extension wires must be the same alloy and polarity as the couple. The thermocouple circuit resistance should not exceed 100 OHMS.

Do not run thermocouple leads in the same conduit as the power lines. If shielded thermocouple is used, terminate the shield only at the controller end using the corner screw provided for that purpose.

Standard Thermocouples

I.S.A. TYPE	MATERIALS	COLOR CODE
J	Iron-Constantan (I/C)	White (+) / Red (−)
K	Chromel Alumel (C/A)	Yellow (+) / Red (−)

Thermocouple Placement

Proper thermocouple placement can eliminate many problems in the system. The probe should be placed so that it can detect any temperature change with minimal thermal lag. In a process that requires fairly constant heat output, the probe should be placed close to the heater. In processes where the heat demand is

Installation Instructions

variable, the probe should be close to the work area. Some experimenting with probe location is often needed to find its optimum position.

In a bath process, the addition of a stirrer will help to eliminate thermal lags. Since the thermocouple is basically a point measuring device, putting more than one thermocouple in parallel will provide an average temperature reading and produce better results In air heated processes.

NOTE: if controls with "F" or "S" outputs drive loads with grounded or hot input terminals (not floating), an isolated thermocouple must be used. Otherwise, when both input and output are grounded, severe ground loop currents will result, causing errors and permanent controller damage.

Standard thermocouple limits of error are ± 4ºF or 0.75% (half that for special) plus drift caused by improper protection or over temperature. This is far greater than controller error, but can not be corrected at the sensor except by selection and replacement. In extreme case, total system requirements can be met by offsetting the control to compensate for these outside errors.

Operating Instructions

Control Panel Description

Continuous Display Of Process Variable

Continuous Display Of Setpoint Or Indexed Parameter

Touch Key Group

Pressing The "I" Button Advances The Cursor In The "Index" Group

LED To indicate Output "Status"

Function Selected Indicated By LED "Cursor" Advanced By "I" Button

Enters The Selected Value To Nonvolatile Memory

Raises (Increases) The Selected Variable

Lowers (Decreases) The Selected

Operating Instructions

Start-Up

Before line voltage is applied, double check all items connected to controller: The correct type thermocouple (see section on thermocouples, p. 11) must be on terminals 1 and 2 (red on 2) with no AC or DC voltage leading or arcing to it. Proper terminals selected for line voltage (8 & 10 for 240V). No heater shorts or shorts to ground. No exposed bare wires or frayed insulation.

On very fast processes heaters should be temporarily disconnected to give operators familiarization time without exceeding safe temperature limits of the process.

Parameter Entry

Set point: Apply power. After allowing a few seconds for initialization, the upper display will indicate thermocouple temperature at the process, the lower display wil show set point temperature, and the index indicator illuminates set point (SP). The status (output) indicator will pulse with a greater "on" time as the difference between actual process temperature and set point widens, and at lesser "on" time as the difference narrows.

To establish a setpoint, first make sure the index light is still on (SP). Then depress the UP button to increase the value shown in the lower display, or the DOWN button to decrease it, until the desired setpoint is reached. To retain this parameter in the non-volatile memory, depress the "enter" key E. Display will blink.

Alarms: Depress index key (I) until index indicator lights at (AI). Now set alarm one trip point by up or down keys as before. Enter (E). If configured as deviation tracking alarm, the lower display shows difference between set point and the point where alarm is triggered. (See p. 10 to select alarm functions).

Depress index key (I) again and advance to alarm 2 (A2). Set as above.

Rate: Advance index to rate (RT). This is the rate (differential or anticipating) action adjustment, calibrated in seconds. It is software connected to automatic reset (integral or droop correcting) action, which automatically tracks rate.

This wide range, high resolution, single button entry greatly simplifies tuning the control to the process. Temporarily run it down to zero (proportional only) and enter (E).

Heat Gain: Heat gain (HG), the next index position, sets controller gain for heat control. It is the inverse of proportional band (P.B.) which can be calculated as ºP. B. = Full Scale º/Gain. At HG = 0, heat is off. Temporarily set HG = 400 or about 3.5º prop. band on "J" couple units, 5º on "K". Proceed to set the next parameter.

Heat cycling (HC) is next. It should be set to the longest possible cycling time in seconds (depending on the mass of process) for increased life expectancy of relays. 15 to 30 seconds for massive loads, 10 to 15 for fast loads when relay driven. "T" output solid state

Operating Instructions

relays directly connected to small heaters, 0-5 sec., but not faster than 10 sec. when driving mechanical contactors. "S" solid state contactor drivers can be used 0-10 sec. "F" mA output units must be set to HC = 0, less than 1 sec.

CG Is cooling gain. If no cooling is used, set it to 100, and enter. If cooling is employed, start at CG = 400 and follow procedure to set HG.

The final index position is used to set cooling cycling (CC) time. On all "T" output units, C = 0. Other outputs are dictated by the type of cooling method employed. Mechanical compressors may require 2 minutes, liquid pumps 30 seconds, solenoid valves 5-15 seconds, small fans 5 seconds, large ones 30. Decide, set and enter (E) to lock in value. Then move index back to "SP".

Connect power to heater and observe temp. rise. Run set polnt down to meet process. Heat output will start proportioning within a few degrees of process temperature, and cool will proportion once SP is below process.

Tuning Heat Gain

An ideal process would glve perfect results with highest controller gain. Practically speaking however, heaters are overpowered, have stored heat and poor coupling, loads have multiple delays, and the sensor reading lags behind the heating output status. A controller must be tuneable to process characteristics in order to compensate for the deficiencies of the rest of the system. The Model 6000 has been designed so that it does this and still remains easy to operate.

Heat Gain (HG) Setting

1. Fix set polnt (SP) at the desired process temperature. (If overshoot can not be tolerated durlng set-up, use 20-30% lower temp.)
2. Set heat gain (HG) at 400. Record the range of temperature oscillations around the set point. Note their durations.
3. Reduce gain by half (200). Observe and note oscllllatlon (if any).
4. Repeat this halving procedure until temperature is stable.
5. Push (E) to enter. You have now compensated for heater power and number of lags, but a droop between set polnt and process exists.

Rate (RT) Setting
(includes reset)

1. Set rate (RT) to 01 seconds for fast systems, 05 for slow, 10 seconds for massive.
2. Observe oscillation building up and record the range.
3. Double rate time. Observe oscillation.
4. Repeat the doubling procedure until the process stabilizes again.
5. Then enter (E).

You have now optimized rate and reset times for the frequency response of the process. If time permits, finer adjustment can be made. For faster start-up

(with some overshoot) reduce rate time 10-20%. For more anticipation (giving undershoot) increase rate slightly. Experiment with (HG) settings.

EXAMPLES OF PARAMETER SETTING ON TWO PROCESSES

Process A: Slow, 2 lag process, matched power, 200° set point.

HG	RT	TEMPERATURE	REMARKS
409	00	197°-199°	Process shows 2° oscillation, 2° average droop - cut gain setting in half.
200	00	196°	Process is stable, Gain O.K. but 4° droop-requires addition of rate-add 05 for slow process.
200	05	194°-206°	Process shows 8° slowing oscillation, reset is hunting, double RT to 10.
200	10	199°-201°	Almost -double RT value again.
200	20	200°	Good-process is stable. Double again to see if we can improve.
200	40	198°-202°	Now process is showing 4° faster (rate) "hunting". Back up again. RT = 20.

Process B: Fast, 3 lag, overpowered process, 400° set point.

HG	RT	TEMPERATURE	REMARKS
409	00	389°-435°	Process oscillates, wild, skip to much less gain.
25	00	375°-391	With 16° oscillation, 17° droop- galn should be cut
12	00	384°	Gain O.K., 36° droop- now add RT = 1 for fast process.
12	01	371°-435°	Need more rate tlme-double to 2.
12	02	396°-404°	Getting close-add a little more.
12	03	400° ±	Good-add a little more to see if we can improve.
12	04	400°	Optimum

Low gain requirement indicates poor thermal coupling or overpower. Special problems can be caused by very noisy turbulent flow processes or by systems havlng a pure dead time between heat application and temperature measurement. In both cases, rate is likely to continuously overreact. Unplug unit and set internal switch to reduced rate gain. (From back of case, your left, B-2, top position).

Cool Gain (CG) Setting

If cooling is to be controlled, first optimize the heat adjustments. Start heat generating mechanism (chemical reaction, mechanical, subambient set point, etc. that will require cooling action.

1. Set cool gain to 400 (maximum). If stable, enter. Most likely the temperature will oscillate. Record values used.
2. Reduce gain to 200. Compare temperature oscillations. If oscillations are reduced, continue lowering gain until process is stable.
3. If up and down temperature peaks get bigger, cool cycling (CC) may be too long or the cooling mechanism has too much lag or time delay. If possible, improve dynamics of cool transfer, If not, go to rate (RT) and double rate time.
4. Now optimize cooling gain as in step 2.
5. Since heat rate will now be too long, cut heat gain in half.

Trouble Shooting

Front dark - no instrument power, blown fuse or burned out transformer.

Process display shows CCCC– Open thermocouple. Short terminals 1 and 2, should indicate temperature at back of case. Repair or replace thermocouple.

About Half Or Twice Expected Reading- Check position of ºC or ºF switch. Short 1 and 2 to read room temperature. 22-30 is %, 70-85 is ºF

About 30% Error - Wrong thermocouple type. Disconnect couple. "J" units over range above 1400°F, "K" above 2000°F + .

No Heat - Heater wiring, wrong output module, blown fuses.

Heat Stays On- Welded relay contacts or shorted output module. Check for cause and correct the components.

Process Display Shows 0000 Or Initially Displays Room Temperature Then Counts Down Scale As Process Warms – Check for reversed thermocouple.

Unit Repairs

It is recommended that units requiring service be returned to an authorized service center. When a controller is returned for service, a note stating the problem should accompany the unit. To eliminate service delay, consult the factory prior to returning any unit.

A spare parts list can be supplied upon request if complete model number, serial number and temperature range is supplied.

Warranty

This equipment is warranted to be free from defects of material and workmanship. It is sold subject to our mutual agreement that the liability of Athena Controls, Inc. is to replace and/or repair at its factory, provided the equipment is returned, transportation prepaid within (2) years of its purchase.

The purchaser agrees that Athena Controls, Inc. shall assume no liability for consequential damages resulting from its use or packaging of shipments returned to the factory.

Components which wear or which are damaged by misuses are not warranted. These include contact points, fuses and triacs. Units which have been rewired by customer are not warranteed.

Specifications are subject to change without notice.

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