TELEDYNE
JUDSON TECHNOLOGIES
A Teledyne Technologies Company

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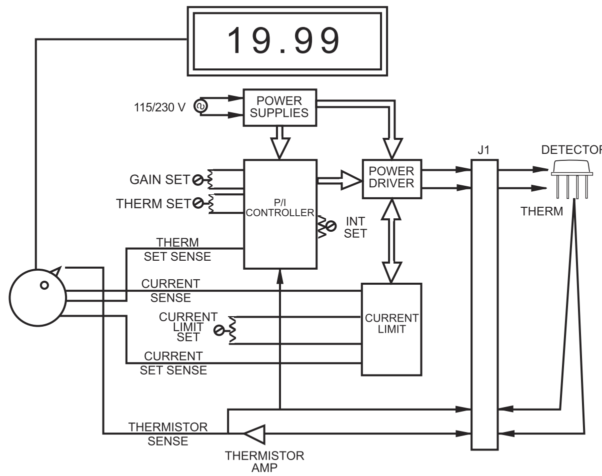

Figure 1
TC5 Block Diagram

GENERAL

The TC5 Controller is one of several models of controllers manufactured by Teledyne Judson designed to provide high stability temperature control with a design approach that is user friendly. Figure 1 is a block diagram that illustrates the major components of this controller.

PRINCIPLE OF OPERATION

Please refer to Figure 1 as the following section is reviewed. The Controller is powered by standard AC input voltages (115 or 230). Incoming AC voltage is converted to low voltage DC for use by the control circuitry. These low power voltages are available on the rear panel connector J1 and can be used to power low voltage external circuitry. Also included in the controller is a separate DC voltage power source for driving the thermoelectric cooler (TC).

The resistance of the thermistor used to measure the temperature of the TC is converted to a DC voltage and compared to the voltage used to establish the set point. The difference between the set point voltage and the voltage resulting from the conversion of the thermistor resistance is amplified and applied to a power driver. The power driver controls the current flowing in the TC to bring the thermistor resistance equal to the set point. While this is occurring, an integral term is developed to maintain the required current flow to the TC when there is no difference between the set point and the thermistor resistance.

The current limit control prevents TC currents from exceeding the preset value ($I_{maximum}$ for thermoelectric cooler). This feature helps to prevent damage or reduced performance of the TC.

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TC5
TEMPERATURE CONTROLLERS
Operating Instructions

PREPARATION FOR OPERATION

CAUTION!

OPERATION

Before operating the controller, please check that it is wired for the proper AC input power and is fused properly. Fuse values are as follows:

115VAC 50/60Hz
Fuse Value 1.5 Ampere SB
Littlefuse 31301.5 or Equivalent (1/4 x 1-1/4)

230VAC 50/60Hz
Fuse Value 3/4 Ampere SB
Littlefuse 313.750 or Equivalent (1/4 x 1-1/4)

Jumpers within the controller determine the AC input voltage to be used. If the instrument is shipped from the factory with a North American 3 prong plug, it is configured for 115VAC operation and contains a 1.5 ampere slow blow fuse. If the controller is received from the factory with the AC input plug removed from the end of the power cord, it is configured for 230VAC operation and contains a 3/4 ampere slow blow fuse.

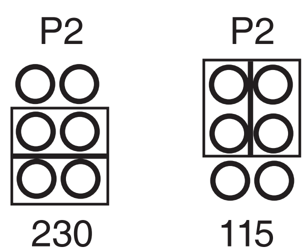
INTERNAL JUMPERS FOR AC INPUT SELECTION

Changing the AC input can be done as follows:

1. Disconnect the controller from any AC power source.

2. Remove the cover from the controller as detailed in the Section entitled "Disassembling the Instrument" on page 6.

3. Examine the jumpers on the main circuit board. Shown below are the two ways of installing the AC input selection jumpers.



4. To change the AC configuration, remover the jumpers and place them according to the diagram above.

5. Remove the fuse located in the AC input receptacle and replace it with one of the proper value for the AC input voltage selected.

6. Reassemble the instrument and proceed with the next section.

SELECTING THE OPERATING CONDITIONS

This instrument has been shipped after being set up and tested for the inputs anticipated to be required by the user. Normally, it is not necessary to open the instrument enclosure except for AC input selection as described above. All other operating conditions are available on the front panel. These include the following:

• Range select (L or H)
• TC Current Max Set
• TC Temperature Set
• Loop Gain Set
• Integral Term Set (I)

The selection and conditions of use of each of these features is discussed below.

TC5 SETUP

The digital panel meter (DPM) in the TC5 should be used to set the instrument up for proper operation. Once accomplished, there is no requirement to change the settings unless the user desires to change the control parameters. It is recommended that the instrument first be set up for operation without the TC attached to it in order to reduce the chance of damaging the TC from the initial current settings that may be in excess of its rated capacity.

TC5
TEMPERATURE CONTROLLERS
Operating Instructions

1. Selecting the range.
Before turning on the instrument, first select the range you will be operating within. On the front panel just to the left of the **DISPLAY SELECT** knob, there is a switch labeled **L** (Lo) and **H** (Hi). Select one of these ranges based on the maximum resistance of the thermistor at the control point.

RANGE SELECTED	MAXIMUM KOHMS
Lo	0 to 20
Hi	0 to 200

Figure 2
Detector Temperature vs Cooler Current
TE1, TE2 and TE3

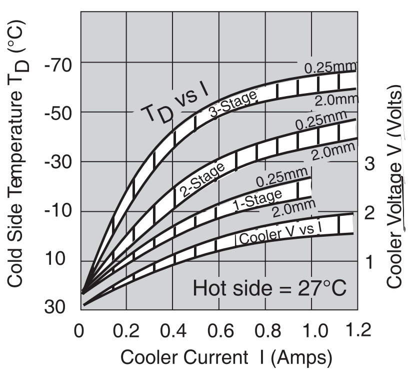
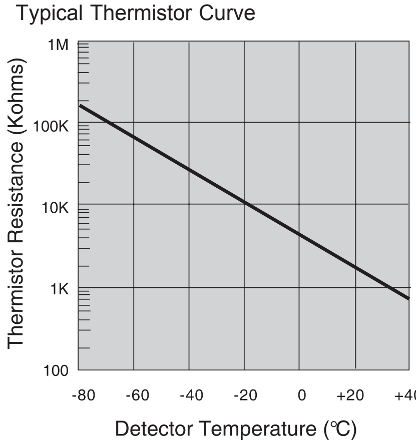


Figure 3
Typical Thermistor Curve



2. Thermoelectric cooler operation.
Figure 2 shows typical power requirements for the TE1, TE2 and TE3 coolers. The built-in thermistor can be used to monitor or control the temperature. Figure 3 shows typical thermistor resistance vs. temperature values. Sensitivity, cutoff wavelength and response uniformity are all functions of temperature. Detector temperature should be optimized for a particular application.

3. Setting the maximum allowable TC current.
With the TC disconnected at the rear panel, turn the instrument on and position the front panel display select switch to **TC CURRENT MAX SET**. The (DPM) will display the maximum current (amperes) to be supplied to the TC in either the heating or cooling mode. If the value shown is inadequate, adjust the corresponding potentiometer with a small blade screwdriver until the value on the DPM equals the maximum TC DC current desired.

As an example, the maximum current desired for heating or cooling a J15TE3 is 1.3 amperes, then adjust the right hand potentiometer until the DPM indicates 1.3. In this case, the maximum DC current for heating or cooling the TC will not exceed 1.3 amperes. The value can be changed at any time, even during normal operation of the controller.

4. Setting the required operating temperature.
To set the operating temperature of the TC, first look up the desired operating temperature on the TEMPERATURE VS. RESISTANCE chart for the negative coefficient thermistor chosen. Determine the resistance value of the thermistor at the required control temperature. For instance, if an operating point of 0°C is desired and the temperature to resistance chart indicates that the corresponding resistance equals 2.71 Kohms, move the front panel select switch to the **TC TEMPERATURE SET** position. Adjust the corresponding potentiometer until the DPM reads 2.71.

Other thermistor values may be used up to a maximum of 20 Kohms when the instrument is set to its normal Lo range. It is possible to extend the range to 200 Kohms for use with higher resistance thermistors. To accomplish this, change the position of the range switch, located on the lower left side of the front panel, from the 20 Kohm position **(L)** to the 200 Kohm position **(H)**. Under the conditions described in the previous paragraph, the same set point would indicate 2.7 on the DPM.

After the settings for maximum TC current and desired operating temperature set point have been established, **turn the instrument off** and connect the TC and thermistor to the rear panel connector, **J1**. When power is placed on, the instrument will operate to control the TC to the selected temperature without exceeding the established maximum TC current value.

Adjustments may be made to all front panel controls while the instrument is operating. However, if the range switch is to be changed and the TC is connected, power to the instrument should be off.

The **DISPLAY SELECT** switch may be positioned at either the **TC TEMPERATURE SET** or the **TC CURRENT SET** position any time in order to monitor the respective values.

There are two positions associated with the **DISPLAY SELECT** switch that are not labeled. These positions are used for factory diagnostic purposes and are to be ignored.

5. Setting the loop again. Normally, the **LOOP GAIN SET** adjustment located on the front panel can be left at the factory setting. The purpose of this adjustment is to change the **rate** at which the instrument responds to changes in thermistor resistance or a change of the temperature set point. If there is a long thermal delay in the temperature feedback path, it is possible that the instrument may over compensate for changes in temperature and begin to oscillate. If these conditions exist, it may be better to operate with less gain. Conversely, if thermal coupling is fast due to a light thermal load, additional gain may result in faster response to an input change without oscillation. Turning the **LOOP GAIN SET** potentiometer located on the front panel clockwise increases the gain. It is recommended to experiment with various settings of both the **LOOP GAIN SET** control and the integral term **I** set (discussed below) to obtain the optimum combination of response and stability.

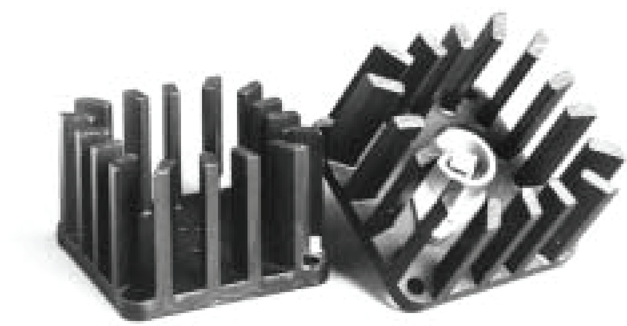
For applications where there is a large thermal mass, this may result in very long thermal response times. In such cases, it may be necessary to slow the response of the instrument beyond that which can be accomplished by the **LOOP GAIN SET** control alone. Insituations like this, a change in the integral term should bemade.

6. Setting the integral term. The integral term of the proportional/integral loop control circuit can be adjusted via a potentiometer on the front panel marked **I**. Trimming this adjustment clockwise will increase the time constant and slow the rate at which the integral term is developed. This is particularly important when the thermal coupling from the TC to the thermistor may be delayed due to the mass of the device being cooled or any other factor that may contribute to a slow thermal response. The adjustment to the integral term should be made in conjunction with the loop gain adjustment to trim the loop for the fastest response to a step change in load or set point while also attempting to minimize the overshoot of the instrument.

7. Heat sinking the thermoelectric cooler.

Teledyne Judson thermoelectric coolersdissipate up to 5 watts of power.

Heat sinking is necessary to dissipate this power. Teledyne Judson offers the following heat sinks to accomplish this task.



• HS1 Heat Sink for Teledyne Judson 66S/66G Packages

The HS1 Heat Sink is available for Teledyne Judson Ge, InAs and HgCdTe TE cooled detectors mounted in the 66S and 66G packages. The heat sink is designed to provide easy heat sinking to the customer's bench top or optical system.

• HSA2 Heat Sink Assembly for Teledyne Judson Thermoelectrically Cooled Detectors

The HSA2 Two-Stage Thermoelectric Cooler and Heat Sink Assembly is available for Teledyne Judson TE cooled detectors. The assembly consists of the specified detector, a thermistor and a twostage thermoelectric cooler mounted in a hermetic package with heat sink and detachable cables. The Model TC5 Temperature Controller is specifically designed for use with the HSA2.

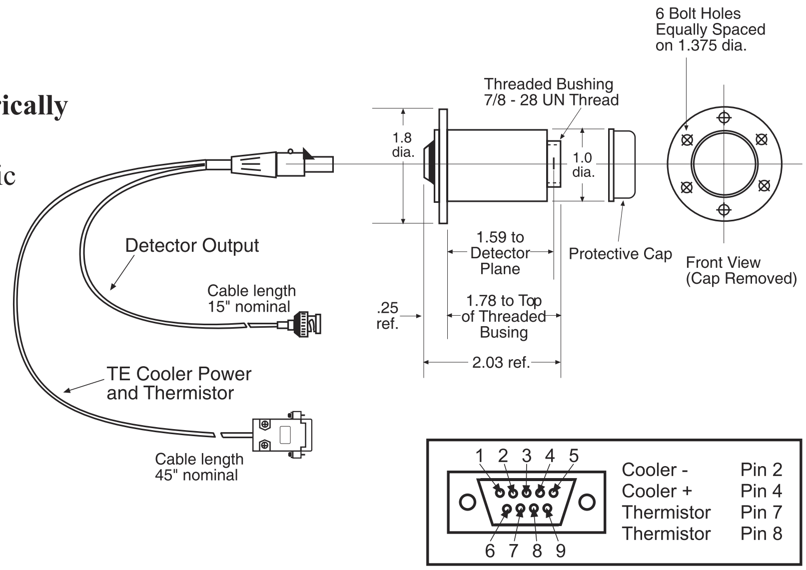


Figure 4
HSA2 Heat Sink Assembly

EXTERNAL CONNECTIONS

Connections to the TC5 are made at rear panel connect **J1**. The mating connector to **J1** is provided along with a cable hood. The mating connector is a 9-pin DE09P "D" connector with pin assignments as follows:

DE09P "D" CONNECTOR P1
1. Thermistor amplifier output (for external monitoring)
2. (-) TC Terminal
3. (-) 15VDC for external use (10mA max)
4. (+) TC Terminal
5. (+) 15VDC for external use (10mA max)
6. External set point input (optional)
7. Thermistor terminal 1
8. Thermistor terminal 2
9. Instrument ground

CAUTION!

Be extremely careful to observe polarity when wiring the thermoelectric cooler to the mating connector. Incorrect polarity may cause thermal runaway and possible damage to the TC.

CAUTION!

Be sure that the power to the instrument is off before connecting the cable to the rear panel connector. When first getting started, it is good practice to set the desired temperature and maximum TC current with the TC disconnected. With power off to the instrument, attach the TC. At this point, power to the instrument can be applied.

DISASSEMBLING THE INSTRUMENT

If it becomes necessary to remove the cover of the instrument, disconnect the instrument from **any** source of AC power. Do not simply turn off the power switch! Remove the front panel knob with an allen wrench. Next, remove the 2 front panel #4-40 screws holding the front panel to the instrument base plate and pull the front bezel and front panel forward until it is clear of the base plate. Set the front panel and bezel to one side until ready for reassembling.

Slide the cover of the instrument forward until it is free of the instrument base plate, making note of the grooves in the base plate extrusion for reassembly. Set the cover to one side until ready for reassembling. Remove the #4-40 screw on the bottom of the instrument base plate that secures the standoff in the location of the 10 pin connector **JP1**.

Unplug **JP1** by gripping the connector firmly and working it back and forth slightly while exerting an upward force to cause it to disconnect from its mating half on the main circuit board. Slide the main printed circuit board forward until it is free of the instrument base plate, making note of the grooves in the base plate extrusion that the board slides into for reassembling purposes. It is now possible to make the necessary changes to the AC input select jumper(s).

Reassembling is simply the reverse of disassembly. One note of caution is that it is extremely important that the #4-40 screw that secures the main printed circuit board to the instrument base plate be reassembled as it serves a dual purpose of providing a chassis ground in addition to providing a mechanical fastening point.

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