

K190. 4 Channel Temperature Monitor & Controller

Documentation updated March 4th, 2009

This kit is an 'extension' of our popular K145 Temperature Logger kit. Like K145 it features four (4) temperature inputs using the DS1820 digital sensor. We have also added four (4) relays to provide output control.

Commands for reading temperatures or controlling relays are sent via the RS232 interface using simple text strings.

The kit can be controlled by a simple terminal or communications program (such as Hyperterminal) or via the free Windows application (see page 4).

FEATURES & SPECIFICATIONS

Operating Voltage	12VDC (nominal) 2.5mm DC jack, center positive
Operating Current	30mA (no relays operated) 120mA (all relays operated)
Inputs	4 x DS18S20 or DS18B20 Digital Temperature Sensors Range: -55°C to +125°C
Outputs	4 x SPDT relays, dry contacts 240VAC/24VDC @ 5A (resistive)
Connectors	2.5mm DC power jack DB9 female connector (RS232) 4 x 3-way pluggable screw terminals for relay contacts 4 x 3-way pluggable screw terminals for temperature sensors
Cable Length	Up to 7.5 metres (~25 feet). See text (page 2) for longer lengths
Visual Indicators	POWER LED DATA LED - OFF when idle ON while processing commands
Case size	13cm (W) x 10cm (D) x 3cm (H) (5.1" x 4" x 1.3")

KIT ASSEMBLY

Before starting, check the components supplied in the kit against the parts list.

NOTE: Please set aside the extra 4 x 1K resistors and 4 x 10uF tantalum capacitors for now. These are only required if using 'long' cables to connect sensors to the kit. See the section '**CABLE LENGTHS**' on page 2 for details.

It is recommended that components be inserted and soldered in the following order:

1. All the resistors.
2. Diodes D1 & D2. Match up the bar on the diodes with the bar on the overlay. **Note:** When installing D2 use the two outer holes. The 'middle' hole is actually a pin through – do not use that.
3. All the 100nF mono capacitors
4. The crystal and 27pF ceramic capacitors
5. All the IC sockets

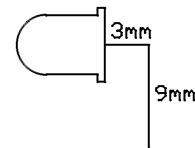
6. Resistor network RP1. The 'dot' at one end is to the right towards the 'K190' PCB designation.
7. The 78L05 regulator and 2-pin header J1
8. The 12 way connectors X3 & X4. Make sure they are sitting right down flat on the PCB before soldering.
9. 7805 voltage regulator. Measure and bend the leads at 90 degrees and fit to the PCB. Fix to the PCB using the supplied 3mm nut and bolt before soldering.
10. Electrolytic capacitors C2, C4 and C6. These are polarized - the positive lead is marked on the overlay, the negative is marked on the body of the capacitor.
NOTE: Capacitor C6 is laid down flat on the PCB. Bend the leads at 90 degrees close to the body using needle nose pliers before inserting. Make sure
11. DC power jack X2 and DB9 connector X1
12. The four (4) relays
13. **Pre-test.** Do not insert any ICs into their sockets yet. Connect a 12VDC supply the DC jack X2 and measure the voltage across pin 20 (+) and pin 10 (-) of IC1. It should read approximately 5 volts.

If OK then remove power and insert the ICs. Take care not to bend any of the IC pins when doing so.

14. **Now comes assembly of the front panel.** Start by inserting a LED clip into each hole, pushing it in from the front. Now insert a LED into each clip **from the rear**. The LED should "click" into place.

The long LED lead is the positive lead – the flat edge on the LED body indicates the negative lead. This flat edge is indicated on the PCB overlay.

Turn the LEDs in the clip so that the long lead is to the left (as viewed from the front). **This is very important so make sure it is right.** Now bend the leads down at right angles, about 3mm from the LED body, as shown below. Use a pair of long nose pliers to hold the leads while bending. Cut the leads off to a length of about 9mm from the bend.



15. **We are now going to fit the assembled PCB into the plastic case.** Before that check all your work carefully. Look for unsoldered joints and any solder bridges or splashes that may be shorting out adjacent pins.

Fit the front panel to the PCB. Be sure that the LED leads are inserted into their matching holes on the PCB. This can be a bit awkward – you may need to use long nose pliers to position the leads into the holes.

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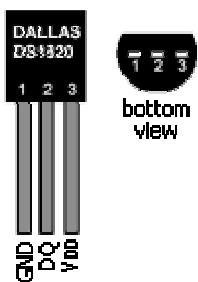
Now fit the rear panel and, while holding the panels in place, slowly position the PCB into the base of the plastic case. Make sure the front and rear panels slide into the slots provided. Secure the PCB to the case using the self-tapping screws then solder the LED leads **from the top of the PCB**.

TESTING

1. Insert the shorting plug on header J1. This sets the communications rate to 9600 baud.
2. Connect the kit to a PC serial port using a straight-through 9-way cable. The cable should have a male DB9 connector at one end and a female DB9 connector at the other.
3. Connect a 12VDC supply to the kit – the POWER LED should be **on** and the DATA LED **off**.
4. On the PC start a terminal or communications program. Most Windows PCs (up to XP) have a program called ‘Hyperterminal’ which can be found under ‘Start – Programs – Accessories – Communications’.
5. Configure the selected COM port for 9600 baud, 8 data bits, 1 stop bit, no parity, no handshaking.
6. Enable connection to the COM port. Some programs such as Hyperterminal require this step.
7. Press the ‘Enter’ key – the kit will respond with a ‘?’ character.
8. If all is well, press the ‘?’ key. The kit will respond with a banner message which includes the firmware version.

If steps 7 and 8 did not work then proceed to the ‘TROUBLESHOOTING’ section.

CONNECTING SENSORS



The diagram at left shows the pinout of the DS1820 sensor. The sensor pins connect to the kit’s screw terminals as follows:

Sensor	Screw Terminal
1 GND	-
2 DQ	D
3 VDD	+

CABLE LENGTHS

Cables have inherent capacitance between conductors which tend to degrade digital signals. The longer the length of cable the greater the capacitance and the more the signal is degraded.

Some types of cable have lower capacitance than others. It **is recommended to use CAT5 cable** when connecting sensors over long cable lengths. Flat telephone type cable is not quite as good as CAT5 but is better than twin-shielded audio cable.

For cable lengths up to 7.5 metres (25 feet), sensors can be simply connected at the end of the cable, as described. However for longer cables we need to add an extra resistor and capacitor **at the sensor end of the cable**.

The resistor provides a ‘harder’ pullup which helps overcome the cable capacitance and ‘squares up’ the digital signal enough to allow the sensor to operate. The capacitor provides power supply filtering and removes voltage fluctuations as the sensor outputs data.

These extra resistors and capacitors are provided in the parts list to be used for this purpose.

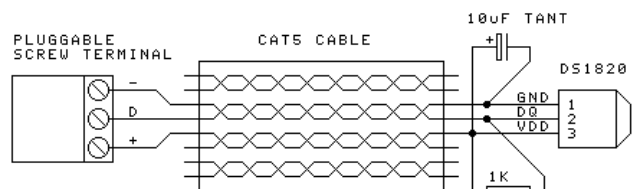
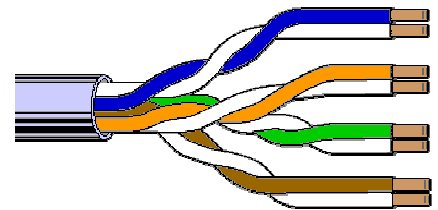
The 1K resistors are soldered across the DQ (pin 2) and VDD (pin 3) pins of the sensor. The 10uF tantalum capacitors are soldered across the VDD (pin 3) and GND(pin 1) pins of the sensor.

With the resistors and capacitors added the following cable lengths were used successfully:

Twin-shielded audio cable	- 15 metres (~50 feet)
Flat telephone type cable	- 75 metres (~245 feet)
CAT5 cable	- 100 metres (~325 feet)

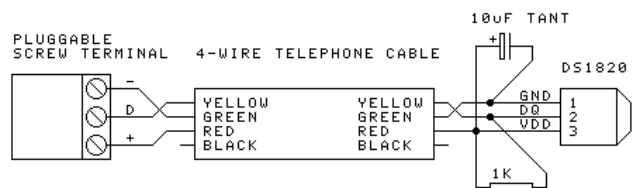
CABLE WIRING – CAT 5 CABLE

CAT5 cable has eight (8) wires consisting of four (4) twisted pairs. Only three (3) wires are used as per the following diagram:



CABLE WIRING – 4-WIRE TELEPHONE CABLE

As the name suggests this cable has only four (4) wires coloured black, red, green and yellow. Only three (3) wires are used as per the following diagram:



Note: The GND wire runs between the VDD and DQ wires. This reduces the potential of noise being induced into the data line from the power supply.

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TROUBLESHOOTING

Most faults are due to assembly or soldering errors. Verify that you have the right components in the right place.

Inspect your work carefully under a bright light. The solder joints should have a 'shiny' look about them. Check that there are no solder bridges between adjacent pads.

Check that no IC pins are bent up under the body of the ICs. This can sometimes happen when inserting ICs into sockets.

Is the POWER LED on? If not then check that diode D1 is inserted correctly. Also the DC power plug should be center positive.

Does the DATA LED blink on when you press the 'Enter' key? If not then this indicates a problem with the microcontroller IC1. The microcontroller turns this LED on in software. Either the microcontroller is not running, there is a comms problem (see below) or there was a programming error at the factory.

Have you inserted the link on J1? Have you configured the other comms parameters correctly? Have you enabled the program to connect to the selected COM port?

If the hardware assembly seems OK and the 5V test was OK (as described in the **ASSEMBLY** section) then there could be a communication problem between the kit and the PC.

Are you using a straight-through serial cable rather than a crossover cable? **You must use a straight-through cable.** You can test your cable – pin 2 at each end should be connected to each other. Same for pin 3.

If the cable is OK then we can test the communications link. Plug the cable into the PC serial port and short pins 2 and 3 together at the other end (not connected to kit). Run your comms program and press some keys on the keyboard. They should appear on the screen. If not then there is a problem with either the cable itself or the comms program configuration.

KIT OPERATION AND COMMANDS

The kit is controlled via the serial port using a set of simple text commands. The serial communication rate can be set to either 2400 or 9600 baud via jumper J1.

Commands are not terminated by an 'enter' key – they are processed character by character as they are received. This means the kit will immediately abort the command if an incorrect or invalid character is received.

The kit will output a response to **all** commands. In the case of an invalid or incorrect command the response will be a '?' character to indicate an error condition.

The kit also features a two second command timeout.

This means that once a valid command sequence is started, each subsequent character must be received within 2 seconds of the previous one. If not the command sequence will be aborted and the kit will output a '?' character. This helps to prevent a command 'lock up' if the kit receives a spurious character.

Note:

- Commands can be in upper or lower case.
- Each character received is echoed back.
- Relays are numbered 1 to 4. Relay number '0' (zero) indicates **all** relays.
- Temperature sensors are numbered 1 to 4. Sensor number '0' (zero) indicates **all** sensors.

? – Prints banner and firmware version number

Nx – Turn ON relay 'x' (where x = 0,1,2,3,4)

Eg. N3 – turn on relay 3
N0 – turn on **all** relays

Fx – Turn OFF relay 'x' (where x = 0,1,2,3,4)

Eg. F3 – turn off relay 3
F0 – turn off **all** relays

Note: The 'N' and 'F' commands do not need to return any data so the kit will output a '#' character to indicate that the command executed correctly.

Sx – Get status of relay 'x' (where x = 0,1,2,3,4)

Eg. S3 – returns the status of relay 3
S0 – returns the status of **all** relays

Returns '1' if operated – '0' if released

The **S0** command returns the status of **all** relays. In this case a hex byte is returned. Each bit within the byte indicates the status of the corresponding relay as follows:

Bit	7	6	5	4	3	2	1	0
Relay	-	-	-	-	4	3	2	1

Bits 4-7 are unused and always return '0'.

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Tx – Get temperature from sensor ‘x’ (where x = 0,1,2,3,4)

Temperatures are returned in degrees Centigrade (°C) to one decimal place.

Eg. T3 – read temperature from sensor 3
T0 – read temperature from **all** sensors

If a sensor is not present a ‘?’ is returned instead.

For the T0 command the temperatures are returned as a comma separated string.

WINDOWS CONTROL SOFTWARE

A free Windows application for controlling the kit is available for downloading from:

The software provides 4 channels of temperature monitoring (deg C or deg F), with the option to enable/disable thermostat (relay) control individually for each channel. SetPoint and Dropout (hysteresis) are configured separately for each channel. Thermostat action can be set for Heat or Cool mode. Manual override of thermostat action as well as manual operation of the relays is possible. A logging function is included

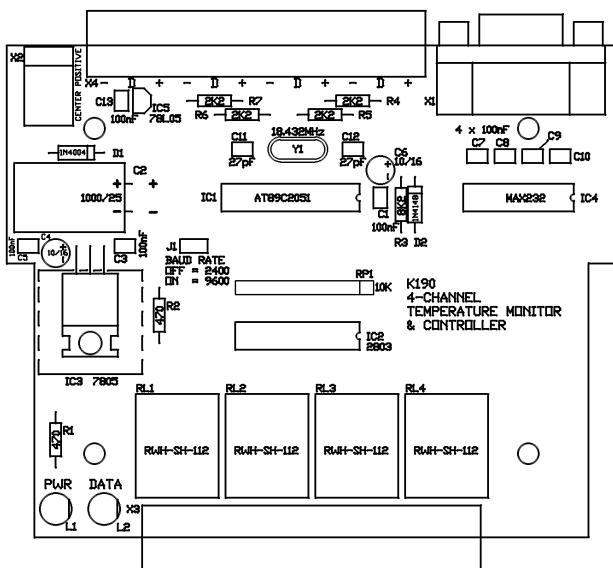
The software was written for DIY Electronics by John Gray. For more detailed software visit his website at www.108relays.ca

CONTACT DETAILS

For full range of kits see our website at www.kitsrus.com

Kit developer: www.ozitronics.com

Windows software: www.kitsrus.com



PARTS LIST – K190

Resistors (0.25W carbon film unless specified)

470R.....	R1,2.....	6
2K2.....	R4,5,6,7.....	4
10K.....	R3.....	1
1K.....	extra – see text.....	4

10K Resistor Network.....	RP1.....	1
SIL 10P9R		

Capacitors

27pF ceramic, 0.1”.....	C11,12.....	2
100nF mono, 0.1”.....	C1,3,5,7,8,9,10,13.....	8
10uF 16V electrolytic.....	C4,6.....	2
1000uF electrolytic.....	C2.....	1
25V or 35V		
10uF 16V tantalum.....	extra – see text.....	4

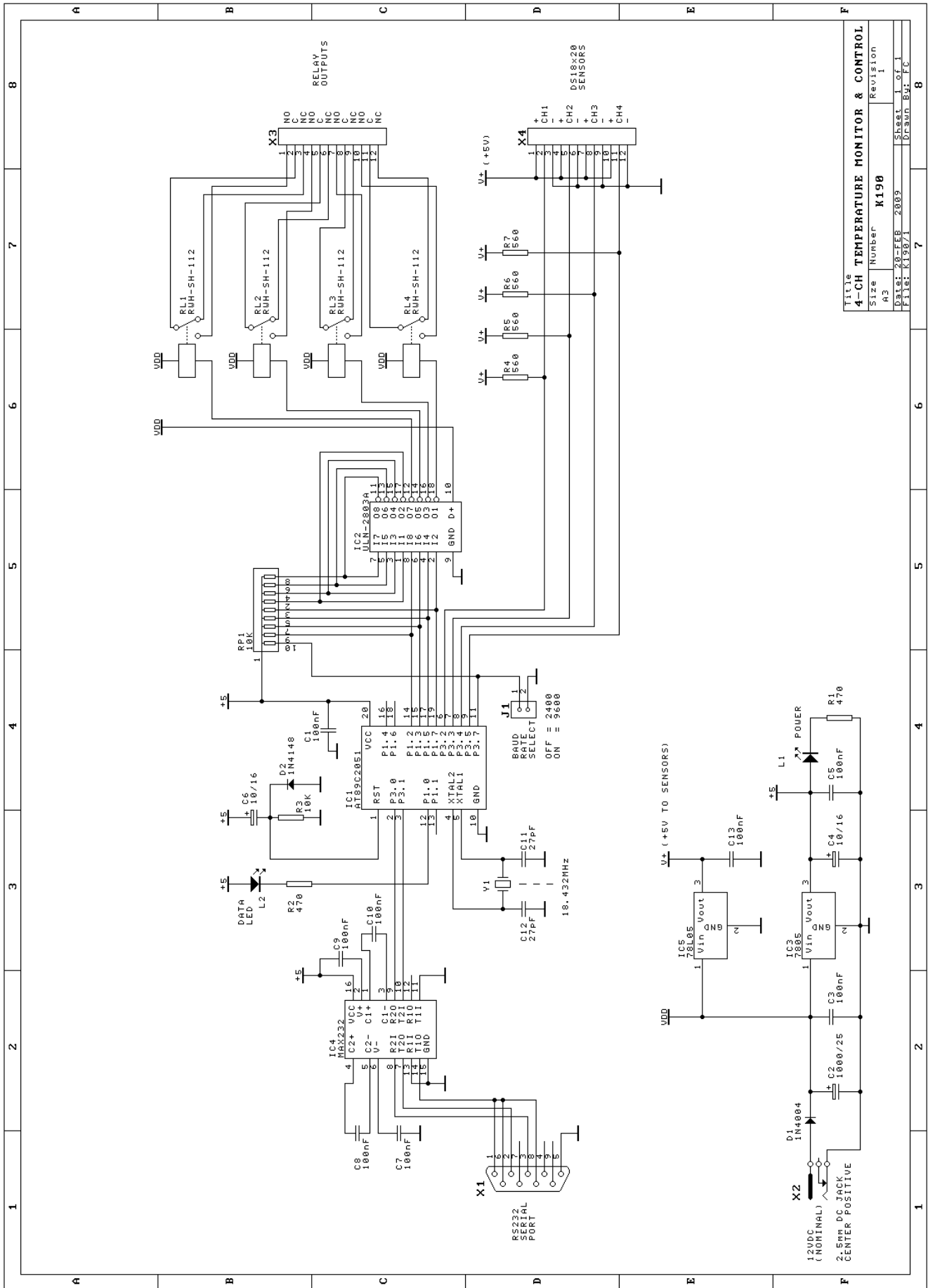
Semiconductors

LED, 5mm, red.....	L1,2.....	2
1N4004.....	D1.....	1
1N4148.....	D2.....	1
AT89C2051 MCU.....	IC1.....	1
With K190 firmware		
ULN-2803A.....	IC2.....	1
Relay driver		
MAX232, RS232 driver ...	IC4.....	1
7805, 5V regulator.....	IC3.....	1
78L05, 5V regulator.....	IC5.....	1
DS1820 sensor.....	IC2.....	1

Miscellaneous

Crystal, 20.2752MHz.....	Y1.....	1
Header, 2 pin.....	J1.....	1
Shorting plug.....	for J1.....	1
LED holder, panel mtg.....	for L1,2.....	2
DB9 connector, PCB mtg. X1.....		1
Right angle, female		
DC jack, 2.5mm.....	X2.....	1
PCB mtg		
Pluggable header.....	X3,4.....	2
12 way, ‘Dinkle’ 2EHDRC-12P or similar		
Pluggable screw socket.....	for X3,4.....	8
3 way, ‘Dinkle’ 2ESDV-03P or similar		
Relay, DPDT.....	RL1,2,3,4.....	4
‘Goodsky’ RWH-SH-112 or similar		
IC socket, 16 pin.....	for IC4.....	1
IC socket, 18 pin.....	for IC2.....	1
IC socket, 20 pin.....	for IC1.....	1
Screw, 3mm x 8mm.....	for IC3.....	1
Nut, 3mm.....	for IC3.....	1
PCB K190.....		
Set of front & rear panels, K190P.....		
Plastic case, 130(W) x 100(D) x 30(H)mm.....		

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Title		4-CH TEMPERATURE MONITOR & CONTROL	
Size	Number	Revision	
A3	K190	1	
Date:	20-FEB-2005	Sheet	1 of 1
File:	K190/1	Drawn	By: FC