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Software, firmware, hardware design
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ESTechnical Reflow Oven Controller

Packing list:

1x ESTechnical reflow oven controller PCB with LCD display

4x 8mm M3 standoffs – male to female threads

1x 25A surface mounting Solid State Relay (SSR)

2x M4 x 16mm bolts with nuts

1x 50cm two pole signal cable with 2.54mm pitch header connector to bare ends

1 x 50mm 3mm dia. heat shrink sleeve

1x 75mm 6mm dia. high temperature sleeve

1x Installation manual (see below)

1x Operation manual (see below)

Thank you for your purchase of the ESTechnical T962(A) Reflow oven controller upgrade. If you have any questions or comments please let us know, we are always keen to hear feedback about our products.

Send messages to customerservices@estechnical.co.uk

SAFETY WARNING – the earthing of the T962(A) ovens is sometimes poor due to the paint on the case. Also, the earthing connection is mounted onto a screw that holds the plastic mains connector to the case. This is a weakness in the earthing – if the plastic connector cracks, the screw tension may slacken, causing the earth connection to degrade. We recommend that for your own safety, you drill a new hole in the back panel (near the mains inlet) specially for fitting the earth connection. On the inside of the panel, scrape away the paint around the new hole so that there is bare metal showing, then fit the earth wire from the mains connector to this new screw hole using an M3 bolt and nut, fasten securely.

It is essential to confirm that there is a very low resistance path from the metal case to the ground pin in the mains connector. We recommend testing between a screw head on the case and the mains inlet earth pin with a continuity meter. The resistance should be very low, 1 ohm or less. If the resistance is greater than 1 ohm, you must fix this for your own safety, and the safety of others.

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Fitting instructions for ESTechnical Reflow Oven Controller

IMPORTANT – mains electrical wiring is involved in the installation of this controller, but no mains voltages are connected directly to the controller. If you are in any doubt please consult a qualified electrician.

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What you will need (not supplied):

- Screwdrivers (a small flat-head terminal screwdriver and a cross-head for the controller mounting screws)
- Wire cutters
- Wire strippers
- Small pliers to help grip the nut when fitting the Solid State Relay (SSR)
- Electric drill and 5mm drill bit suitable for drilling steel panel
- Centre punch and hammer (for marking where to drill)
- A container for screws

Installation procedure:

1. Unplug the power cable from the unit
2. Remove the drawer from the unit (pull forwards until it stops, then carefully undo the clips (gently move the plastic levers) that keep the drawer in the runners, then slide the drawer out from the runners. Set the drawer aside.
3. Remove the screws that are under the front edge of the lid, there are two or three screws in the drawer opening, keep these safe.
4. Turn the unit around so you are looking at the back, remove the screws that hold the lid on the case, keep these safe.
5. Being very careful not to pull on any cables, carefully lift the back of the lid a little, then gently slide the lid forwards a little, lift off the oven, turn over and place it next to the bottom half of the oven.
6. Gently pick off the hot glue that's covering the connectors on the control board. A small screwdriver is helpful here, only try to remove a small amount at a time.
7. Disconnect all the cables that attach to the control board. Do not pull on cables, pull the connector apart gently and without twisting it.
8. Completely remove the control board and display and set aside the screws and washers.

9. **At this point, take a moment to familiarise yourself with the wiring that is present. You should have the following cables unplugged:**
    - Low voltage AC power cable from the small tranformer, has a plug that fits onto two pins.
    - Small signal cable to the heater solid state relay, fitted with two pin JST connector.
    - Mains cable that was used to supply the power for the oven cooling fan to the controller, this has a three pin connector with only two terminals populated.
    - One cable that goes into the back of the oven, this is the oven cooling fan cable and has a two pin connector fitted.
    - 2x thermocouples with coloured crimp ferrules to indicate polarity.
    - Keypad ribbon cable.
    - One cable that goes to the two panel LEDs, this has a 4 pole JST connector.
    - One cable that goes to the small DC cooling fan, with a 2 pole JST connector.

    You need to be able to identify each of these cables in order to proceed with the installation.

10. Screw the supplied stand-off posts into the four screw posts at the corners of the display window.
11. Place the new Reflow control board on the mounting posts for the display, making sure you have it the correct way round. The Keypad ribbon cable should curl round and line up with the keypad connector on the new control board.
12. Screw down the new control board using one screw and washer (the same screws and washers that were used to hold in the original display) – do not over tighten these screws.
13. Plug in the thin ribbon cable for the keypad, the connector is labelled 'Keypad'
14. Identify the cable that connects to the panel LEDs, plug this onto the pins labelled 'LEDs' on the ESTechnical reflow controller. NB – the wiring of this cable in the ovens we have seen has the polarity reversed. The black leads are used as the positive supply to the LEDs. You should fix this when installing the controller – do this by desoldering the connectoions on the back of the LEDs, then re-connecting the LEDs paying attention to get the right LED wired to the right pair of wires.
15. Find the cable for the small cooling fan, plug this into CONN5, being careful to observe the polarity marked on the board. The red wire is positive.
    At this point your reflow controller board should look like photo 1.

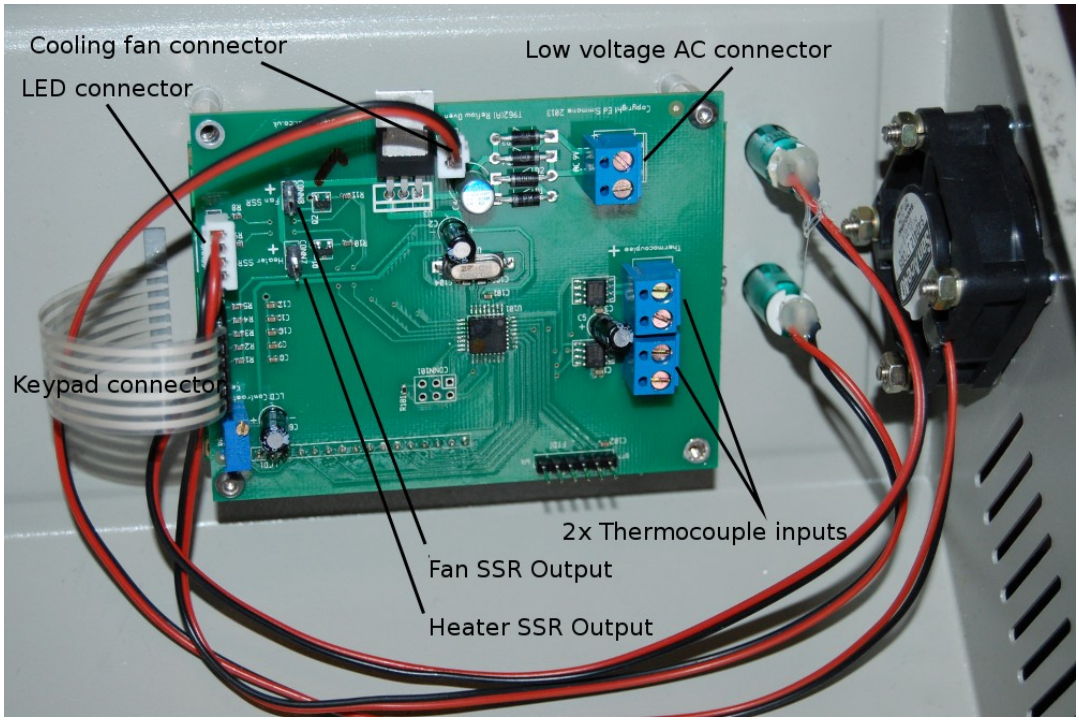

Photo 1 – The ESTechnical controller mounted in the T962A oven lid

16. To mount the supplied Solid State Relay (SSR) into the case, you must first unbolt the heater SSR, then drill two extra holes so that the two SSRs mount together as shown in photo 2 & 3 (below). Mark where you will drill first with a marker pen, check the position of the marks by offering up the solid state relays to their new mounting sites. Once you are happy with the location of the pen marks, gently make a punch mark (the oven contains quartz heater elements) on each pen mark.

Photo 2 – Drilling locations on the back panel, required for mounting the solid state relays

17. Before drilling, move all the cables out of the path of the drill. Be careful to remove all drilling swarf and to clean up any sharp edges on the holes you drill (a counter-sink or larger drill bit turned by hand in the hole is good for cleaning the edges). Do not allow any small bits of metal to remain inside the oven housing!
18. Mount both SSRs into the case firmly and ensure they are oriented as shown in photo 3, this will make the wiring easier later. Bolts for mounting the supplied SSR are also included.

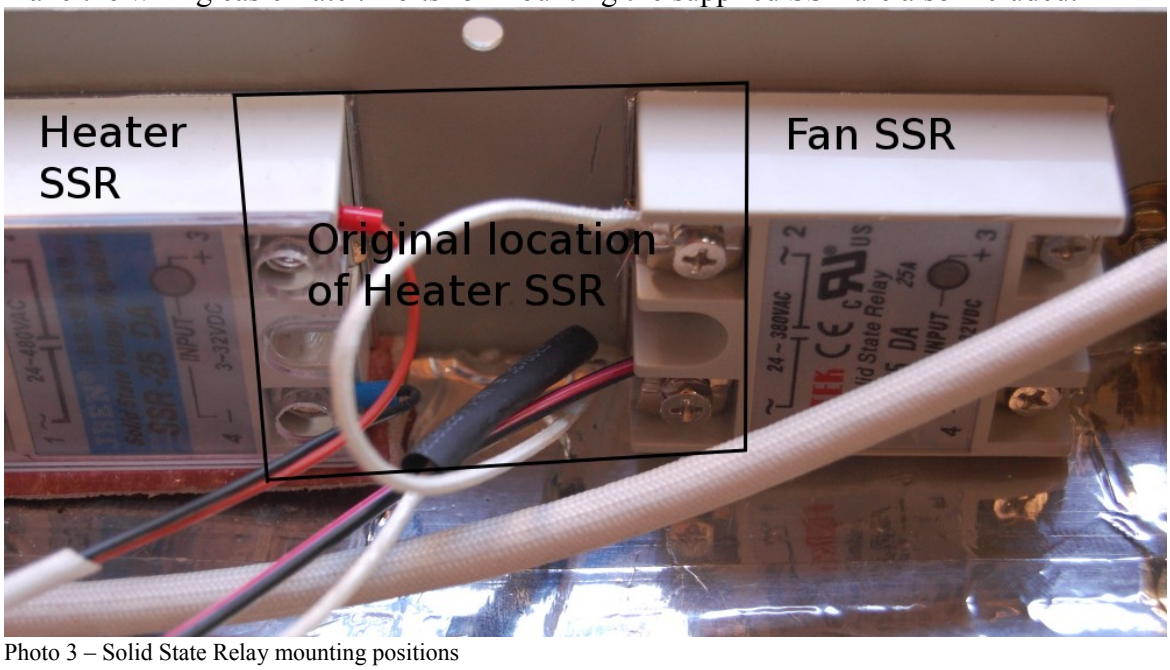

Photo 3 – Solid State Relay mounting positions

19. On the heater SSR, check the polarity of the connections of the signal input, in the ovens we have worked with so far, the red wire goes to the negative terminal. For the sake of completeness, we suggest you correct this if your oven is wired this way. The red wire should go to the + terminal and the black wire to the -.

20. Identify the mains cable that goes to the exhaust fan at the back of the oven. Cut the two wires at the base of the plug. Connect one of these wires to the fan Solid State Relay terminal labelled '**2 ~**'.
21. Identify the cable that previously supplied mains to the fan driver on the original controller board. You can follow this cable back to the mains switch mounted on the back panel of the oven. Cut off the connector and wire the NEUTRAL conductor into the SSR relay terminal labeled **'1 ~'**. You can shorten this cable to suit the new location.
22. Place both the heat shrink sleeve (provided) and the high temperature sleeve (provided) over the remaining lead of the fan. This needs to be connected to the live lead of the mains cable we identified in the previous step. These wires should be joined by soldering together to form an overlap of at least 6mm and covering with the 3mm diameter heat shrink insulation (provided). Shrink the heat shrink sleeve with a hot air gun. Although the inside of the lid does not get very hot, it is advisable to cover the heat-shrink sleeving with the high temperature sleeve for extra thermal protection.
23. Connect the supplied 50cm signal cable to the two input terminals of the fan SSR (red lead +).
24. Identify the output cable from the small mains transformer.
    If your ESTechnical reflow controller is equipped with the same pin header connector as the original controller, simply plug this lead in.
    Alternatively, if the ESTechnical controller is fitted with a screw terminal for the AC power, cut off the plug, strip the insulataion off the end of the cable for about 5mm, then clamp this into the screw terminal. The two wires can go in either way round, as this is low voltage AC.
25. Identify the thermocouple cables, there are two fitted to the oven. The thermocouple nearest the front of the oven drawer needs to be connected to the thermocouple connector closest to the controller's power connector – this is important for the correct function of the controller. Make sure you observe the polarity of the thermocouple, it has one lead marked red (this is positive, marked + on the board) and the other is blue (-).
26. Plug in the signal cable that goes to the Heater SSR, this fits to the two pins labelled 'Heater SSR' on the ESTechnical controller PCB. Observe the polarity marked on the board.
27. Plug the cable that goes to the Fan SSR onto the connector on the ESTechnical reflow controller labelled Fan SSR. Observe the polarity.
28. Carefully inspect the wiring of the oven, there should be no loose strands of wire sticking out from connectors, if there are any, redo the connection being careful to correctly insert all the strands into the screw terminal before tightening the screw. There should also be no plugs that are not plugged in and no remaining cables – if there are, go back and check.
29. If you are unsure of the mains wiring please consult a qualified electrician.
30. **Have a coffee break!**
31. Inspect all wiring again before reassembly!
32. Being very careful not to pull on or trap any of the cables, reassemble the oven by carefully placing the lid on (slightly forwards of where it needs to end up) and then slide it towards the back of the oven.
33. Fit the screws at the front of the oven in the drawer opening.
34. Fit the screws on the rear panel of the oven.
35. Now the oven is ready for testing.
    Plug in the power and switch on the oven, the display should illuminate and the controller will display the main item of the menu. (If the display does not illuminate, switch off the power immediately and go back and check connections.)
36. Check the small cooling fan is running, if not, go back and check the connections.
37. Press OK to start a reflow cycle, the main fan should begin to gently idle and the heater should begin to heat up. Press the 'S' key to stop the cycle. The controller will go into cool-down mode. The fan will stop when the oven returns to room temperature. The cooling down display can be interrupted without interrupting the cooling of the oven to get to the menu, just press the 'S' key again.
    If the fan does not start or heater does not start up, switch off the oven immediately to prevent any possible damage and go back to checking all connections.
38. Proceed to the operating instructions.

It is strongly advised to test your reflow profile settings with a data logger such as this:
http://www.lascarelectronics.com/temperaturedatalogger.php?datalogger=364
The thermocouple should be affixed to a test PCB so that it is in good contact with the PCB surface. A tiny amount of heat sink paste should be applied to the thermocouple to ensure that the temperature recorded accurately reflects the temperature of the test PCB.

ESTechnical accept no respsonsibility or liability for personal injury or damage to property – it is the user's responsibility to carry out installation and confirm the correct operation of the oven once installed. Perform testing on waste boards until you are confident the settings are correct for your oven, boards and parts density etc.

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Reflow controller operating instructions

Important notes:

We have noticed that our T962A oven works much better than any other configuration controlled from a single thermocouple in the front most mounting tube in the oven. This appears to be a cooler spot within the oven. All R&D has been monitored using a temperature datalogger and a carefully mounted thermocouple on a PCB. The board temperature can be as much as 20 degrees celcius higher than the reading from the thermocouple built into the oven. Take note of this when setting up profile temperatures, as the discrepancy is largest at the peak of the cycle. It is possible that other ovens will have a different behaviour and because of this we strongly recommend you carry out some testing with scrap board before reflowing important boards.

It is strongly advised to test your reflow profiles with a data logger such as this:
http://www.lascarelectronics.com/temperaturedatalogger.php?datalogger=364

ESTechnical accept no respsonsibility or liability for damage to boards or the oven – it is the user's responsibility to confirm the correct operation of the controller once installed. Perform testing on waste boards until you are confident the settings are correct for your oven, boards and parts density etc.

To start a reflow cycle:

Navigate to 'Cycle start' in the menu and press OK. The controller will perform the cycle using the current settings.

Stopping a cycle:

Should you need to abort a reflow cycle, press the 'S' key. The oven will move into the cooling down mode. Observe the temperature on the display before attempting to open the drawer or remove boards.

To load a saved reflow profile:

Navigate to 'Save/Load profile' and press OK, then navigate to 'Profile number' and press OK. Choose a profile number to load (by default all 32 profiles are the same, the user can save to these profiles) and then press OK. Then navigate to 'Load profile' and press OK. The controller will briefly show a loading display and then return to the menu. If you now navigate up to the top of the menu again (by pressing the Back key) and start a reflow cycle, the cycle will be performed using the newly loaded settings. These settings can be edited as per the steps below.

To edit the active profile:

Navigate to 'Edit profile' and press OK, then navigate to the parameter you wish to edit. The options are Ramp up rate, soak temperature, soak duration, peak temperature, peak duration, ramp down rate. Press OK once you have selected the option to edit, the controller will display the value and allow editing using the < and > keys. Press OK to confirm your changes, or to cancel press back. Repeat these steps to edit each parameter you wish to adjust.
This process edits the variables stored in RAM and does not save the changes permanently until you save the profile to EEPROM (see below).
When running a reflow cycle, the controller will use the settings as per your adjustment until a power cycle of the oven. If you wish to save the profile settings permanently see the steps below.

To save an edited profile:

Once you have edited a profile and wish to save it to the controller EEPROM memory, follow these steps to save the profile. Navigate to 'Save/Load profile' and press OK, then navigate to 'Profile number' and press OK. Choose a profile number to save (by default all 32 profiles are the same, the user can save to these profiles) and then press OK. Now navigate to 'Save Profile' and press OK.

Please note that any previous settings in the profile number you save to will be overwritten with the new settings.

Profile tuning tips:

To get the best from your reflow oven, it is advisable to perform a series of tests to determine the settings required to properly reflow each design of board you work with. Boards of different masses will behave differently and may require different soak duration, temperatures etc. to properly reflow all solder joints on the board.

Refer to the datasheets for all the parts you use to determine the allowable reflow profile for the design. Once the peak temperature of the most sensitive part is known, this must not be exceeded anywhere on the board.

Important: The board's temperature lags behind the heat of the oven, the oven is not controlling the board temperature directly, but the air temperature inside the oven. Towards the end of the peak phase of the controller cycle, the board will reach its own peak temperature. During cooling, the air temperature needs to drop quickly below the melting point of the solder and continue to decrease to remove the heat from the board.

Start with small changes, for example if the test shows the board is too cool, you should try one of the following options one at a time:

- Increase the soak time
- Increase the soak temperature
- Increase the peak temperature
- Decrease the ramp up rate

Any of these changes alone can be enough to alter the profile to be suitable for your needs, take small steps to avoid large unexpected changes. A small change to the soak duration goes a long way! The board temperature does not level off during soak, it continues to climb slowly.