DART PROJECT

Downstream Terminator Module

Assembly and Test Directions

Manual

Tuesday, August 22, 1995

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Document # ESE-DART-950822

INTRODUCTION

This document is the manual on how to assemble the Downstream Terminator Network module from start to finish. It provides an outline, a tool list, and the procedures that I followed to complete the assembly of a module. There are many parts towards completion of each module; and to give an estimate, start to finish requires about 8 hours of work. If there are any questions or problems, consult a technician or an engineer for assistance. Good Luck!!

OUTLINE

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      F. Put Kapton tape on the Heat Shields of the Power Supply
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IV. Complete Module Assembly
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      A. Attach side panels
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      C. Connect Status Indicator LED's to DTN Board
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      A. Notch Out the Spot Where The Middle DTN

Standoff Goes
B. Insert AC Fuse/Socket Assembly into the Back Panel
C. Connect The Ground Cable of Cable #1 to the AC Fuse/Socket Assembly
D. Connect The 3 Pin Center Crimp Terminal Housing of Cable #1 to the Power Supply
3. Finishing Touches
A. Connect Cable #2 to both the Power Supply and the DTN Board
B. Insert One 1/2 Amp 250 Volt Fuse into the AC Fuse/Socket Assembly
C. Power Up DTN Module

V. The Temperature Cycle Chamber Test

VI. The Portable Hand Held Battery Powered Terminator Tester Test

VII. Troubleshooting

Tool List For
The Downstream Terminator Network
Module Assembly

1. One Soldering Iron
2. One Spool of Solder
3. One pair of Crimpers
4. Two pairs of Wire Strippers/Cutters (that can strip 16 to 30 gauge wire)
5. One Nibbler (to notch out Panels)
6. One Phillips Screwdriver
7. One Flathead Screwdriver
8. One Razor Blade
9. One Deburring Tool
10. One Desoldering Tool
11. One Roll of Masking Tape
12. One Roll of Kapton Tape
13. One Drill (with a drill bit of 0.152 in. in diameter)
14. Two Center Punches (one for the Power Supply, one for the DTN Board)
15. One Nut Driver
16. Plenty of Medium Sized Cable Ties

SECTION I: Board Assembly

1.1. Soldering the Connectors. The first step toward completion is to solder the 10 pin, the 34 pin and the 50 pin connectors to the board. The easiest way to handle this situation is to solder each connector separately onto the board. Starting off with any of them, manually fit the connector pins into their respective holes so that the connector points to the outer boundaries of the board. The leads on these connectors may be small and awfully short; so secure the connector onto the board by taping the connector onto the surface with masking tape. Then, turning the board over, solder each pin to the board, making sure the connection is with a good solderflow and high quality. After this is finished, move on to the next connector until all of them are finished.

1.2. Soldering the Sips (Single Inline Resistor Packages). The next step is to solder the Sips onto the board. This part is somewhat tricky because you must follow a certain rule to successfully connect these parts. If you look onto the board where the Sips are to be placed, you will see that there is a string of eight holes that the SIP will fit into. However, one of the holes (on the end) has a white border that is square around it (it also has a square pad). This pin hole is known as pin #1. If you look at the SIP itself, you will see that, on the label side, the first pin has a square or a line above it. This is pin #1 and you MUST insert this pin in the hole where pin #1 is supposed to go. The leads on the Sips may be short as well; so tape the SIP onto the board with masking tape if necessary. Then, solder the SIP onto the board. Repeat this procedure until all of the Sips are soldered into the board.

1.3. Soldering the Remaining Resistors. The next step is to solder the discrete resistors onto the board. If you are not sure of what value of resistor you are putting in, you can check the value by either using a digital multimeter or referring to the resistor color code chart. The way that I did this part would be to bend one of the leads of the resistor so that it would point in the same direction as the other lead would. Then, from left to right in each row, insert the resistor into the first two holes of the row and secure the placement. Repeat this until a row is filled (4 resistors). Then, solder both ends of the resistor to the board. After doing so, cut the leads so that on the solder side of the board, the points where the soldering took place are small in height. Repeat this procedure until all of the resistors are in place

and connected properly. For the resistors on the rest of the board, simply bend both of the leads, insert, and solder accordingly.

1.4. Soldering the Bypass Capacitors. On the DTN board where the bypass capacitors are to be soldered, there is not specific legend as to how they are to be placed. Just simply insert the capacitor into its spot and solder it to the board. However, there are two kinds of bypass caps used. The first one used is a .1 μF capacitor, which will have a *104K5* label on top of it. These go in the spots where there is not a *.001* inside the white border. In the spots where there is a *.001* inside the white border, it is necessary to solder in a 0.001 μF capacitor, which will have a *102K5* label on top of it. Solder in each type of capacitor until all of the spots are filled. The leads are short enough so that it will not be necessary to shorten the leads on the solder side of the board when you are finished.

1.5. Soldering the Remaining Capacitors. For this part, there is a specific way to connect these parts to the board. If you look at the board, you will see that where it is necessary to solder the capacitors onto the board, there is a plus sign (+) on one side and a negative sign (-) on the other side. This is because the capacitors being used are polarized. As expected, a certain polarity must be satisfied; therefore these capacitors cannot be inserted carelessly. If you look on the capacitor itself, you will see that there is a little bubble on one side of the capacitor. This is the positive (+) side of the capacitor. Place this lead in the + hole and correspondingly place the other lead into the - hole. Solder the part onto the board and clip the leads. Most of the capacitors look the same; so keep capacitors of one value separate from the other capacitors. The value of the capacitor (6.8 μF for example) is located inside each white border for reference. Repeat this procedure for all capacitors.

1.6. Soldering the Chips. Now, this step involves soldering the 74LS123, the 74LS08, and the 96F173 chips onto the board. The first thing to do is to place the 74LS123 and the 74LS08 chips into their respective locations and solder the chips onto the board. Then, place the 96F173 above the sockets where the chip should go. Press down on the chip with care and precaution; the chip should fit snugly into the sockets. If necessary, bend the leads of the chip so that they fit the socket terminals.

1.7. Soldering the Fuse Sockets and Other Miscellaneous Components.

For all of the places where there is an f-number, place two of the sockets into the holes and tape them to the board (on the component side). Then, solder them onto the board with plenty of solder. Do not clip anything. Then, insert the LEMOs into its location with the connector pointing out from the board. Solder the middle pin first, then solder the remaining four. Please pay careful attention to the connections on the outer four pins. From my experience, they do not cooperate very well. After that, place the Molex 4-pin right angle connector (with the pins facing out from the board) into its location and solder it in. Next, bend the leads of the LM1086 regulator so that the leads form a right angle. Insert the regulator into the board, solder it in, and clip the leads on the solder side of the board. Lastly, bend the leads on the Transorb (the part that looks like a silicon diode) so that it can fit into the holes provided. On the board itself, you will see that on one side on the transorb, the terminal is marked with a + and a "gnd". This is the side where the lead of the black end of the transorb is to be placed. After the transorb has been properly inserted, solder it to the board and clip the leads.

1.8. Inserting the Fuses. On the board, locate the places where F1 and F5 are (F1 should be right under the Molex connector and F2 should be under the LM1086 regulator). Using a lot of care, insert one 2 Amp miniature pico fuse into the F1 fuse location (clipping the leads to a sufficient length first) and press each lead so that it locks into the socket. Following this same procedure, insert one 1 Amp miniature pico fuse into the F2 fuse into that respective fuse location. At this stage, the DTN board is completely assembled from the component side.

SECTION 2: The Cable Assembly

2.1 Cable from the AC Fuse/Socket Assembly to the Power Supply. Assembling this cable requires making use of three different 18 or 20 gauge wires (that are in different colors for discrimination), an AC Fuse Socket, a 3 pin Center Crimp Terminal Housing, and a female disconnector terminal. Using the colors white, green, and black, cut about 4 inches of wire and strip both ends. For all intensive purposes, green will symbolize the ground cable; black will symbolize the neutral cable, and white will represent the line cable. With the Ground cable, one end will be soldered to the underside of the AC Fuse Socket, while the other end goes to the Power Supply. The end that goes to the Power Supply will be crimped inside a female disconnector terminal. This side of the green cable will go to the male ground terminal of the Power Supply (which will be in the bottom right hand corner if looking from the back panel forward). Concerning the white and black cables, one end of the cables will be soldered to the AC Fuse/Socket at the line and the neutral terminals respectively. The other ends will be crimped to 0.156 inch center crimp terminals. These terminals will now be inserted into the housing. If you look carefully on the housing, you will see that there are two ridges on one side of the housing. These are known as Polarizing Ribs. To properly insert the cables into the housing, it is necessary to place the black cable on the right most terminal and the white cable on the left most terminal. The housing should be sitting right side up and if done correctly, there should be an open terminal in the center of the housing. Also, to make sure that the cables are inserted correctly, they should click when they are pushed all the way into the housing. Then, the other end of the terminal housing should be inserted into the Power Supply with the Polarizing Ribs closest to the clip. The male terminals for the terminal housing are located to the left of the male ground terminal (using the same frame of reference). When all of this is complete, cable tie the three wires in two spots for neatness.

2.2 Cable from the Power Supply to the DTN Board. For this cable, we need four wires (two sets of two) made from 18 or 20 gauge wires, a female 4 pin Molex connector, 4 0.156 inch Crimp terminals, 4 0.100 inch Crimp Terminals, and a 6 pin Center Crimp Terminal Housing. This cable will take the ground and the Vcc (which is +5 volts) from the Power Supply and supply this to the DTN board. For all intensive purposes, red will symbolize the Vcc and the gray will symbolize the ground. For this cable, each wire needs to be about 5 inches in length with the wires stripped on

both ends. On one end of the cables, the four 0.156 inch Crimp terminals need to be applied via a crimper tool. On the other end, the four 0.100 inch Crimp terminals need to be applied. Once this is finished, the ends of the cable that have 0.100 inch crimp terminals need to be inserted into the Molex connector; while the other ends need to be inserted into the 6 pin Center Crimp Terminal Housing. Pertaining to the Molex connector, the cables need to be connected to the connector so that they click when fully inserted. From left to right, the order of insertion goes gray, red, red, and gray. In case you forget, look on the component side of the DTN board where the male part of the Molex connector is located and you can see the order in which the wires need to be connected in. On the Molex connector, you will see that there are two ridges on one of the sides. These ridges tell you to insert the female connector into the male connector (on the DTN board) right side up. Concerning the 6 pin Center Crimp Terminal Housing, the other ends of the wires need to be inserted here. Since there are six terminals and only four wires, skip the outermost terminals when you insert the wires into the housing. Just like the housing for the previous cable, there are Polarizing Ribs on one side of the housing. From left to right, insert the ground wires (gray wires) then the Vcc wires (red wires). Following the previous cable procedure, to make sure that the cables are inserted correctly, they should click when they are pushed all the way into the housing. Then, the housing end of the cable should be inserted into the Power Supply with the Polarizing Ribs closest to the clip. The male terminal for this housing should be in the bottom center of the Power Supply (looking from the front panel). The female Molex Connector should be connected to the male Molex connector on the DTN board also. When this is completed, cable tie the wires in two spots for neatness.

SECTION 3: Connections To The Bottom Panel

3.1 Drilling the Holes for the DTN Board and the Power Supply. In order to insure that both the DTN Board and the power supply fit correctly onto the bottom panel, it is necessary to measure out where the drill holes are to be made. Using the template for the DTN board, place the template onto the bottom panel, pressing it against the lip. Be sure to allow room for the side panels. Using one of the Center Punches, mark the points where the drill holes should be. Also, take one of the power supplies and place it onto the bottom panel adjacent to the template (allotting room for the Molex Connection). Using the other Center Punch, mark the points where the holes should be. Remove both the Power Supply and the template from the bottom panel. After this, take the drill and using the 0.152 inch (#24) drill bit, drill the holes into the bottom panel carefully and precisely.

3.2. Connect the Power Supply. One of the primary parts to completing the assembly the DTN module requires the successful installation of the DC Power Supply. Since the holes for the Power supply have already been done (section 3.1), the first step is to apply Kapton tape to the bottom panel where the Power Supply will sit. The Kapton tape should be applied to the entire area where the Power Supply sits.

The next step is to screw the 1/8 inch standoffs to the Bottom Panel. This will allow the Power Supply to occupy the same space, but the power supply will not sit right on the panel itself. Insert 1/2 inch Binding screws through the drilled holes and screw the standoffs onto the screws. The screws should be placed upside down so that the head is on the outside surface of the panel.

After this, manually fit the power supply onto the bottom panel so that the ends of the screws fit through the holes of the power supply board. Now, put the washers on the screws so that the washers are on top of the power supply board. When that is taken care of, screw on the Nylon insert nuts onto the screws so that the Power supply is secure. This will require the use of a screwdriver and the nut driver. Lastly, put Kapton tape onto the metal heat shields of the Power Supply. The tape should cover the top edges and overlap slightly on both sides.

3.3 Connect the DTN Board. The procedure for this is very similar to the installation of the power supply, but a lot simpler. Insert the 4-40 1/4 inch Phillips head machine screws into the outermost holes on the edges of the board. However, there is one screw that should not be placed in a hole

though. This screw is located in the corner where the 50 pin connector is located. The reason for this is because the screw (when tightened) will rest directly on top of a trace. This will cause a short on the board and alter the output of the module. Leave this hole empty. After all of the other screws are in place, screw on the 1/2 inch standoffs. Following this, position the DTN board over the drilled holes so that the standoffs sit right above them. Using the same screws, screw the DTN Board to the bottom panel so that the Board is secure and tightly connected to the panel.

SECTION 4: Complete Module Assembly

4.1 Assemble Front Panel. The first thing to do is to attach the side panels to the front panel. Using the silver screws and one package of U-shaped handles, thread one screw through the side panel clearance hole and through the front panel hole into the threaded hole in the handle. Repeat this for the other three screws. Then, tighten the screws so that everything is secure. Be sure not to strip the screws or the threaded holes. Secondly, insert the Status Indicator LED's into the front panel. On the DTN Board, you will see what light goes to what label (for example, the red light goes to the +3.3 V power label etc). After all of the LED's have been inserted into the front panel, trim the leads to about 4 inches in length and strip the ends. Thirdly, connect the Status Indicator LED's to the DTN Board by soldering the leads to the terminals provided. In case of confusion, the red leads get soldered to the left terminals of each LED; the black leads should be soldered to the right terminals. After this is complete, cable tie the leads in three spots for neatness. Lastly, connect the front panel to the bottom panel. Using the black screws provided, attach the front panel to the bottom panel by inserting and tightening the screws on the underside of the bottom panel. These screws should go through the bottom panel in four spots and through each of the side panels in two spots.

4.2. Back Panel Work. If you slide a back panel onto the chassis, you will see that the middle standoff on the DTN board will not allow the back panel to make a clean fit onto the chassis. Therefore, it is necessary to notch out the spot on the back panel where the middle standoff is. This is done with the use of the nibbler tool. After the notch is made, insert the AC Fuse/Socket assembly into the back panel so that it clicks into the panel. Connect the ground cable to the male ground terminal of the power supply. Then, connect the three pin Center Crimp Terminal Housing to the male connector of the power supply. Finally, insert and tighten seven black screws on the underside of the bottom panel and on the back panel. Three screws should go on the underside of the bottom panel; two should go on either side of the back panel.

4.3. Finishing Touches. For the final stages of assembling the DTN module, three things must be done. One, connect the cable discussed in

section 2.2 to both the Power Supply and the DTN Board at their respective terminals. Two, insert one 1/2 Amp 250 Volt Fuse into the AC Fuse/Socket assembly. Three, power up the DTN module by connecting the power cord to the module and inserting the plug into an AC outlet. At this point in the game, two lights should come on. These lights are the +5.0 Volt power LED and the +3.3 Volt power LED. If there are any problems, please refer to the troubleshooting section of this manual.

SECTION 5: The Temperature Cycle Chamber Test

At this point in the DTN Module Assembly, it is necessary to run each and every module through a temperature chamber test. This test determines if the module will maintain successful operation while undergoing serious (and some extreme) temperature conditions. The temperature chamber is located in the Northeast corner of the 13th floor, in the lab. Once all of the previous tasks are accomplished, it is necessary to place the modules (no more than 13 at a time) into the temperature chamber. It is possible to power up these modules by feeding the power cords through one of the chamber ports (on the left hand side). After this is completed, connect all of the power cords to the power strips found in the crate next to the temperature chamber. Before closing the temperature chamber, make sure that all of the modules power up when power is supplied to the strips. Then and only then can the temperature chamber be closed and sealed for the test. Thinh Pham and other authorized members of the group handle the temperature chamber controls, but it is essential that a cycle is provided for them to base the settings on. For the purposes of the DTN modules, the temperature cycle is as follows:

1. Start at Room Temperature.
2. Bring the Temperature from 23 °C down to 0 °C. This should be accomplished in a period of 5 minutes.
3. Let the modules "soak" at 0 °C for 30 minutes.
4. Bring the Temperature from 0 °C up to 40 °C. This should be accomplished in a period of 5 minutes.
5. Let the modules "soak" at 40 °C for 30 minutes.
6. Bring the Temperature from 40 °C up to 50 °C. This should be accomplished in a period of 5 minutes.
7. Let the modules "soak" at 50 °C for 10 minutes.
8. Bring the Temperature from 50 °C down to 0 °C. This should be accomplished in a period of 5 minutes.
9. Let the modules "soak" at 0 °C for 10 minutes.
10. Bring the Temperature from 0 °C up to 23 °C. This should be accomplished in a period of 5 minutes.
11. Let the modules "soak" at 23 °C for 2 minutes.
12. Steps 1 through 11 represent one cycle. Perform two cycles.

At this point, the modules have finished the temperature chamber test and can be removed from the chamber. From previous experiences, removing the modules (or at least opening the temperature chamber door) as soon as the test is finished will yield the best results.

SECTION 6: The Portable Hand Held Battery Powered Terminator Tester Test

At this stage in the project, it is necessary to use the Portable Hand Held Battery Powered Terminator Tester Box (P.H.H.B.P.T.T.) to wrap up the testing and the assembly of the DTN modules. Designed by Jamieson Olsen and John Anderson, this box will indicate whether or not each module's status indicators are functioning correctly. Each module is connected to the P.H.H.B.P.T.T. Box using 10 pin, 34 pin, and 50 pin ribbon cables. It is important to connect the cables correctly, or else the readings will be incorrect. To do so, look at the ribbon cable connectors (on the cable) and find the arrow on each connector. The arrow points to pin #1 of the connector. On each of the modules, there are three different connectors (10 pin, 34 pin, and 50 pin) on the back panel. Locate the arrows on each of these connectors. After this has been done, line up the connector arrow from the cable to the connector arrow from the module. Insert the cable into the module. Repeat this procedure for all of three cables. Then, connect the other ends of these three cables to the P.H.H.B.P.T.T. Box. The three connectors on the left hand side of the box are to be used here. After supplying power to the module and using the legend on the box, properly functioning modules are determined by studying and analyzing the corresponding light sequence. For the DTN module, the *strobe* LED and the five LED's marked "DTN only" should *not* be dimly lit for a properly functioning module. *Every other* LED on the box should be dimly lit. Now, disconnect both the 10 pin and the 50 pin connectors from the box and reconnect them to the right hand side connectors. This test will analyze the Status Indicator LED's on the front panel of the module. When the switch is turned on, the bottom LED on the box flashes brightly. Also, the status indicators on the DTN front panel should be flashing (except for the +5 volt and the +3.3 volt Power LED's). If all of these actions occur, then the module has passed the P.H.H.B.P.T.T. Box test.

SECTION 7: Troubleshooting

Problem	Solution
1. One or both of the Power LED's (that is the +5.0 V and the +3.3 V) don't light up.	1. There are four possible explanations for this problem: A: There may be a short that is caused by the leads touching either on top or on the bottom of the board. Simply trim the leads on the bottom. Or, space the leads on the top. Make sure that the insulation is completely covering each wire. B: A bad solder connection could be the case here too. C: A fuse may be blown. D: The existing power supply could be bad.
2. Power is not supplied to the DTN Board.	2. There may be a multitude of avenues to solve this problem. Here are a few: A: Check to see if the fuse on the AC Fuse/Socket Assembly works. If not, replace it. B: Check the AC voltages on the 3 pin Center Crimp male Terminal (with a multimeter) to see if power goes from the AC Fuse/Socket Assembly to the Power Supply. If not, there may be a bad cable connection. C: If A and B do not solve the problem, check to see if there are DC voltage readings on any of the pins of the power supply's 5 pin Center Crimp male Terminal. If not, the power supply may be bad. D: If A, B, or C do not fix the problem, the cable from the power supply to the

	DTN Board is bad.
3. The cables don't work properly.	3. This can be a direct result of bad crimping. Also, the crimp terminals may not be completely inserted into the housing. Check out both scenarios.
4. Other Status Indicator LED's (such as the Data Strobe LED and the EOR LED) light up.	4. Connect a DTN module with a UTN module via the 10 pin, 34 pin, and the 50 pin ribbon cable connectors. Remember to power up both modules separately. The problem should go away.
5. The light sequence on the Portable Hand Held Battery Powered Terminator Tester Box (P.H.H.B.P.T.T.) was incorrect.	5. Check the ribbon cable connectors to make sure that they have not been partially inserted nor upside down.
6. An LED on the P.H.H.B.P.T.T. box that is marked 'dim' is glowing brightly.	6. An open circuit exists between the 240Ω resistor and either of the 120Ω resistors. Check the part as well as the solder connection.
7. An LED on the P.H.H.B.P.T.T. box that is marked 'dim' is not lit.	7. There is an open circuit between either of the 120Ω resistors and +3.3V or ground. Also, the resistor may be inserted incorrectly (backwards for example). Check the colder connection and make adjustments if necessary.

As always, please remember to check the module for bad solder connections, broken resistors, loose connections, shorts, and bad crimping to eliminate testing problems during operation.