

AC/DC DLX

Installation Manual

DIGITAL DYNAMICS

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1 Overview

The AC/DC DLX was designed for easy installation into virtually any 3-Rail O Gauge engine equipped with either AC or DC motors. Its small size and versatility permits it to be installed into the smallest of engines with little or no difficulty.

The AC/DC DLX consists of two circuit boards that plug together. The smaller of the two is the Lionel R2LC Command Control Module. It contains a radio receiver, microprocessor, and drive circuits for your locomotive headlamps, electrocouplers, and smoke unit. It also has the capability to operate a Lionel Railsounds system. The microprocessor on this board receives and interprets digital commands from the TrainMaster system and operates the various features of your locomotive.

The slightly larger board contains the power circuitry necessary to drive the motors in your locomotive. Though small in physical size, the circuit can easily handle a load of 8 Amperes or more of AC or DC current, provided measures are taken to provide a proper heat sink to the engine chassis.

All of the required connections to your locomotive are brought out from the AC/DC DLX via two conveniently located connectors.

The board has an overall length of 2.25", a maximum height profile of approximately 1.625", and a width of 1.25".

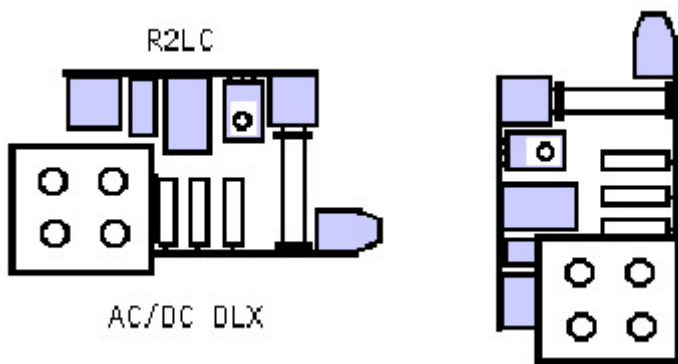


Fig. 1 AC/DC DLX Mechanical Configurations

If chassis space is limited, but there is ample height inside the engine, the AC/DC DLX can be re-configured to a smaller chassis footprint by mounting it vertically. Figure 1 illustrates this alternate configuration.

To reconfigure the board, remove the four screws and nuts that attach the heat sink to the board, then remove the heat sink. Avoid disturbing the thermal grease applied to the heatsink and the motor driver devices.

Rotate the heatsink ninety degrees as shown, line up the alternate mounting holes with the four upright power devices, and replace and tighten the screws and nuts.

1.1 Board Layout

While reading the product description that follows, refer to the accompanying diagrams to familiarize yourself with the boards and the connections to them.

The aluminum heatsink is designed to remove excess heat from the board's components and to provide a simple means to mount the board to virtually any chassis. A single self tapping screw included with the kit is all that is required to secure the unit to an engine chassis.

Primary electrical connections to the AC/DC DLX are made via four wires for the DC Version or five wires for the AC version, an 8-position terminal block, and a 4-pin Railsounds® connector. The wires are a special multi-stranded, highly flexible type, color coded for ease of identification.

The 8-position screw-down type terminal block allows convenient connection to the antenna, engine's headlamps, smoke unit, and electrocouplers. Connections to an optional Railsounds® system is made via the small 4-pin connector J2.

A small slide switch is attached to the unit. It is used to configure the AC/DC DLX in either the Program mode or Run mode.

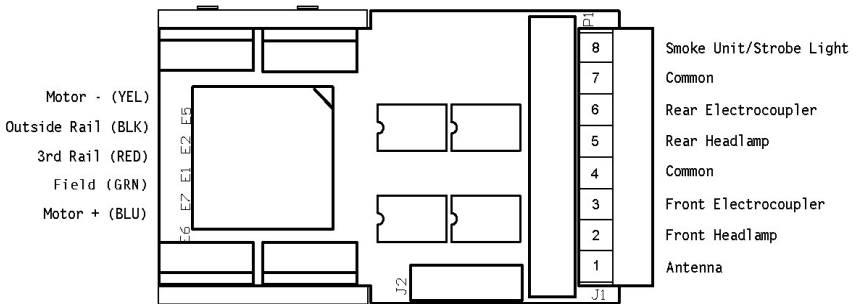


Figure 1 - AC/DC DLX Electrical Connections (component side view)

1.2 What's Required

A minimum amount of soldering skill is required to perform this installation correctly. If you feel that you do not possess the proper soldering equipment or the expertise, you should refer installation to your dealer or to Digital Dynamics.

If you think that the wiring of your particular engine is different from what is described in this manual, do not attempt installation unless you have some experience with electrical circuits. Instead, contact Digital Dynamics for assistance.

1.2.1 Tools Required for Installation

The tools listed below are required to complete a quick and reliable installation. Other tools and accessories may be used, but are not required.

- Low power soldering iron
- Rosin core solder
- Small wire cutters
- Small long-nosed pliers
- Small flat blade screwdriver
- Wire strippers
- Small Phillips screwdriver
- Electrical tape or shrink tubing
- Razor Blade or Exacto Knife

After completing your installation, you will need a CAB-1, and either a test track or layout equipped with the Lionel Trainmaster System in order to perform a complete test of your engine.

1.3 What's Supplied

Before beginning your installation, take a few minutes to familiarize yourself with the circuit board layout and the contents of the installation kit.

1.3.1 AC/DC DLX Kit Contents

The parts kit contains miscellaneous electrical and mechanical hardware to help you complete your installation. It includes:

- Lionel R2LC circuit board
- AC/DC DLX Circuit Board w/ Heatsink
- Antenna
- Four (4) 1uF non-polarized capacitors (AC version only)
- Plastic Ty-Wraps
- 1/4" Sheet Metal Screw
- Four (4) Wire Nuts

2 Detailed Installation Instructions

Please take the time to read and thoroughly understand the instructions in this manual. While it is unlikely that any damage may occur to your engine, improper installation of this product may cause permanent damage to its circuit components.

Since there are so many different types of engines available from at least a half dozen different manufacturers, it is impossible to describe an exact installation procedure for each case. For the most part, all engines are identical in that they have a motor, often two motors, one or two headlights, couplers, a smoke unit, and possibly a sound system. There will be differences or special cases among all of these features. However, the fundamental instructions remain the same, and special cases will be dealt with where appropriate. The installation procedure begins with the fundamental steps. As these steps are completed, proceed to the section that most closely matches the type of engine you are working on.

2.1 Engine Preparation

Remove the body from the locomotive and place it aside where it cannot be damaged. Remove all exposed headlamp bulbs from the chassis so they are not broken during the installation. Place the chassis on a clean, level work surface.

Examine the engine wiring and make notes or drawings of existing connections before removing components or disconnecting any wires. At the same time, determine the optimum location to mount the AC/DC DLX so that wire lengths can be kept to a minimum. In most cases, there will be plenty of room to mount the AC/DC DLX, even if a sound system is to be added. Generally, engines equipped with either single or dual DC can motors have plenty of space on the chassis to mount electronic components, especially after the existing reverse unit is removed. However, older Lionel engines, particularly those with die cast chassis, have additional hardware that may require removal before the AC/DC DLX can be installed.

Before settling on a final mounting location, check to be sure that the engine shell will fit on the chassis with the unit in place. Only after you are satisfied that there will be no clearance problems should you proceed with wiring.

2.2 Installation Instructions for Specific Engine Types

2.2.1 Diesel or Electric Type Locomotives With DC Can Motors

2.2.1.1 Circuit Board Mounting

Locomotives driven by DC can motors usually have ample space on the chassis to mount the AC/DC DLX. You may be able to make use of existing holes in the chassis to mount the AC/DC DLX. Before permanently mounting the unit, be sure there is sufficient clearance to accommodate the engine shell when the board is mounted to the chassis. Also check that the board and its wires do not interfere with any moving parts such as motor flywheels. If no suitable chassis holes are available, locate the AC/DC DLX in the most optimum location, mark its location, and drill a 1/8" hole in the

chassis. Use the 1/4" sheet metal screw to attach the heat sink to the chassis. **Be absolutely certain that the mounting screw does not protrude far enough through the heatsink to come in contact with the circuit board.** If necessary, use one or two small washers to reduce the length that the screw extends beyond the heatsink. Alternatively, use a Dremel tool with cutoff wheel to remove excess length from the screw after it has been tightened in place.

Thermal conduction of heat from the board to the chassis can be improved by applying a small amount of thermal grease to the heatsink surface that comes in contact with the chassis. If you like to run long, heavy trains, thermal grease will help to keep heat from building up within the engine by improving heat conduction to the chassis which is cooled by outside air. Small tubes of thermal heat compound are available at any Radio Shack store or other electronic component suppliers.

2.2.1.2 Wiring the Motors and Power

Refer to the diagram of figure 3 to wire the AC/DC DLX to engine power and the motors. Use the enclosed wire nuts to secure all connections, or, if you prefer, solder and insulate the connections with either electrical tape or heat shrink tubing.

1. Connect the RED wire to the engine pickup rollers.
2. Connect the BLK wire to the engine frame or other suitable ground.
3. Connect the BLU wire to the motor (+) terminal
4. Connect the YEL wire to the motor (-) terminal

If after completing the installation, the engine runs in the wrong direction, simply reverse the BLU and YEL wires at the motor terminals.

2.2.1.3 Additional Wiring

The remaining connections to the AC/DC DLX are made at the screw-down terminal block. These connections include lighting, electrocouplers, and antenna. Refer to the engine wiring diagrams, and proceed to section 2.3.

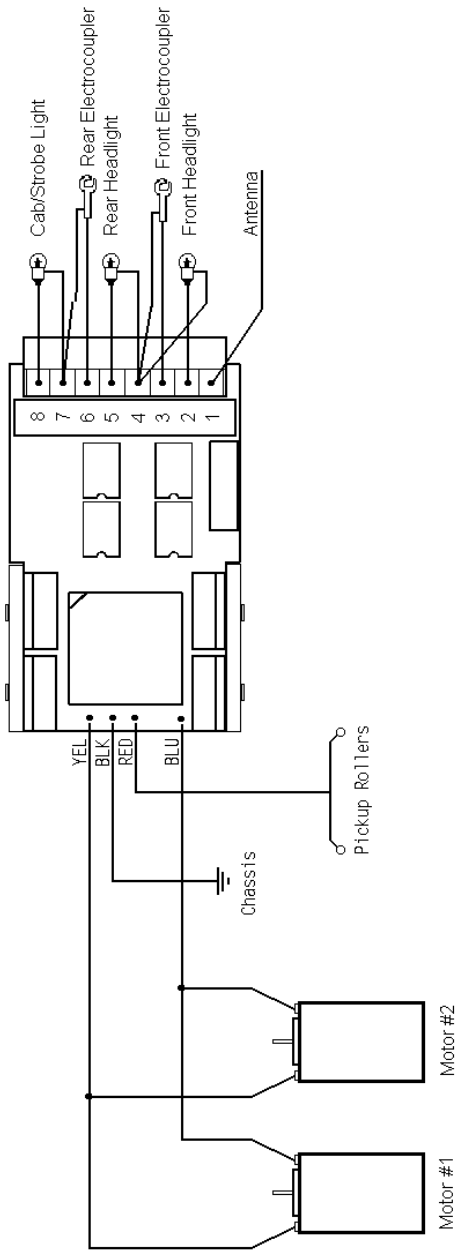


Figure 2 - Diesel DC Motor Wiring Diagram

2.2.2 Diecast Steam Locomotives With DC Can Motors

2.2.2.1 Circuit Board Mounting

For steam locomotive installations, the AC/DC DLX is mounted in the tender. Electrical connections from the tender mounted AC/DC DLX to the engine are made through a six or eight-pin connector assembly available from Digital Dynamics.

1. Remove the shell from the tender and place it aside where it cannot be damaged. Place the chassis on a clean, level work surface.
2. Unsolder or remove all electrical connections to the existing reverse unit and remove the reverse unit from the tender.
3. Clean any grease, oil, or loose rust from the chassis surface.
4. Attach the AC/DC DLX to the tender chassis using the 1/4" sheet metal screw. If you are planning to install a sound system, locate the AC/DC DLX so that it offers maximum available space to the sound system. Be absolutely certain that the **mounting screw does not protrude far enough through the heatsink to come in contact with the circuit board.** If necessary, use one or two small washers to reduce the length that the screw extends beyond the heatsink. Alternatively, use a Dremel tool with cutoff wheel to remove excess length from the screw after it has been tightened in place
5. Once the board is firmly mounted to the chassis by the heatsink, use the foam tape to secure the opposite end of the board underneath the terminal block.

2.2.2.2 Wiring the Tender and Tether

Refer to figure 4 for while performing the following steps. The wiring diagram illustrates how the various signals are routed through the tether. Begin with the tender. Note that the wiring is fairly straightforward. Bear in mind that the tender side of connector appears in the drawings as a mirror image of its mating connector. As you make each connection, verify that each one is correct and that it will mate properly with the engine. It is strongly suggested that you adhere to the same wiring convention for all your engines so that you can interchange tenders among them if desired.

1. Feed the wires from the 8-pin MALE connector through an opening in the engine side of the tender. The MALE connector is the one with male pins visible inside the connector shell. Most tenders have a suitable opening for this connector and wiring.
2. Make all connections to the headlamp, smoke unit, motor, power and chassis ground from the wires of the connector assembly to the AC/DC DLX. Use the wire nuts enclosed with the kit to make the motor and power connections. The remaining connections for headlamps, etc. will be to the AC/DC DLX terminal block.
3. If the tender is equipped with an electrocoupler, connect it to the appropriate position on the AC/DC DLX terminal block.

2.2.2.3 Wiring the Tether and Locomotive

1. Layout the 8-pin connector assembly over the engine chassis, noting the wires and their respective destinations. Make sure there is enough slack in the cable to make connection to the tender.
2. Referring to the Steam Wiring Diagram of figure 4, make all connections to the motor, headlamp, smoke unit, pickup rollers and chassis. Although soldering is the preferred method, you can use the wire nuts enclosed with the kit to make the motor and power connections.
3. Upon completion of these steps, go on to the next section.

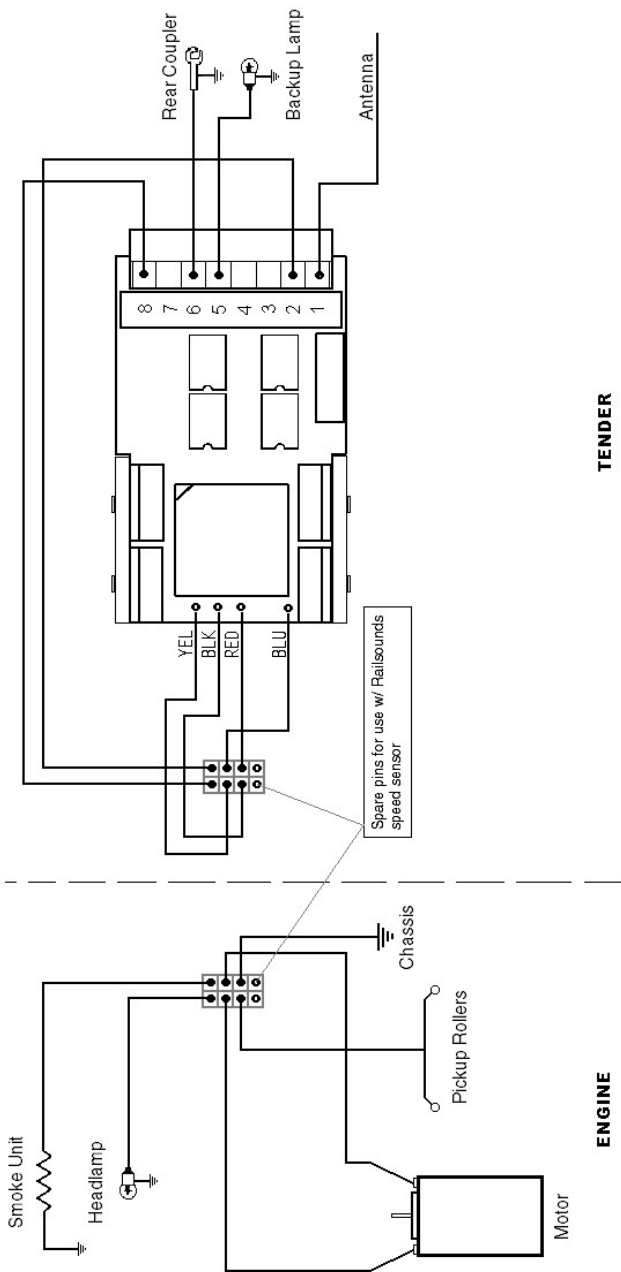


Figure 3 - Steam DC Motor Wiring Diagram

2.2.3 Lionel AC Diesel or Electric Type Locomotives

This section describes installation of the AC/DC DLX into diesel or electric type locomotives having either a single or dual AC motor. Refer to the wiring diagram of figure 5 while performing these steps.

Before proceeding, note that the wiring of modern era and Postwar diesel type locomotives differs slightly in the production methods used. For example, many modern era engines are assembled with prefabricated wiring harnesses that use 'fast-on' tabs rather than solder connections to make connection to the motors. Excess wire lengths are usually bundled up and held in place with wire ties. Older engines tend to have point-to-point type wiring. With this in mind, read through the following steps completely before cutting or removing any wires. This way, you can anticipate what needs to be done without needlessly cutting or removing any wires.

1. Remove the three wires that connect the E-unit to the motor(s) by unsoldering them at the motor. Usually, these wires are colored blue, green, and yellow. Postwar locomotives will have a mechanical E-unit, while more modern Lionel locomotives may be equipped with an electronic reverse controller. Make a note of all the connections before you remove them. In dual motor units, there will be an additional set of blue, green, and yellow wires that connect from the first to the second motor. In some instances, the wires may all be black.
2. Disconnect the E-unit connections to the pickup rollers. Depending upon the model of locomotive, there may be one or two of these wires. In either case, they are usually colored red and come directly from the truck mounted pickup roller and are soldered to a common point on the E-unit.
3. Unsolder the wire that leads to the headlamp socket from the E-unit. This wire is usually soldered to the same point as the pickup roller wires.
4. If you are installing the AC/DC DLX into a modern era Lionel locomotive, skip the next steps and go on to the next section.
5. Remove the red wire connecting the E-unit to the horn relay.
6. Loosen the single screw on the side of the E-unit and remove it from the chassis.
7. At the horn relay, unsolder the black wire connected to the horn.
8. Remove the two screws located at the base of the Relay Bracket.
9. Lift the Relay Bracket from the chassis. Be sure to save the insulator, screws, and shoulder washers should you ever desire to restore the engine to its original configuration.
10. If you will be installing a Railsounds system, you may remove the horn unit at this time.

2.2.3.1 Circuit Board Mounting

With these components removed from the engine, the next task is to mount the AC/DC DLX circuit board to the chassis.

1. If there are existing holes in the chassis, align one of them to one of the holes in the bottom of the heatsink, and fasten it in place with the supplied self-tapping sheet metal screw.
2. If no convenient holes exist, locate the AC/DC DLX in the most optimum location, mark its position, and drill a 1/8" hole in the chassis.
3. Attach the AC/DC DLX to the chassis using the 1/4" sheet metal screw. If you are planning to install a sound system, locate the AC/DC DLX so that it offers maximum available space to the sound system. Be absolutely certain that the **mounting screw does not protrude far enough through the heatsink to come in contact with the circuit board**. If necessary, use one or two small washers to reduce the length that the screw extends beyond the heatsink. Alternatively, use a Dremel tool with cutoff wheel to remove excess length from the screw after it has been tightened in place.
4. Once the board is firmly mounted to the chassis by the heatsink, use the foam tape to secure the opposite end of the board underneath the terminal block.

For the purpose of heat dissipation, particularly with dual motor engines, it is best to obtain metal-to-metal contact between the mounting bracket and the engine chassis. Single motor AC engines will not generally require a heat sink to the chassis, although it is good practice to do so whenever possible.

2.2.3.2 Wiring Lionel AC Motors

The open frame AC Universal motor is found in most Lionel engines, and is commonly referred to as a Pullmor motor. This motor has three connections, plus an additional connection from the negative side of the field winding that is soldered directly to the motor casing.

Pay special attention to the wiring instructions and wiring diagrams when connecting the AC/DC DLX to this type of motor, since the connections may be different to what you are accustomed to. Refer to the wiring diagram of Figure 5 while performing the following procedure.

1. Remove one of the screws that hold the brush cover to the motor. Slide one of the supplied terminal washers over the screw and replace it in the motor. Orient the arm of the terminal so that it is parallel to the brush springs. Repeat this procedure for the other motor screw. Then, if you are working on a dual motor locomotive, repeat the entire procedure for the remaining motor.
2. Solder a non-polarized 1uF capacitor from one of the motor brush terminals to the adjacent terminal washer you just installed. Wrap the capacitor leads through the hole in the washer and solder the connection. Keep the capacitor leads as short as possible.
3. Repeat this procedure, installing a second capacitor on the other motor brush terminal.
4. Refer to your notes to determine the colors of the wires that were removed from the motor. Connect the BLU wire from the AC/DC DLX to the brush terminal from which the old BLU wire was removed.

5. Solder the GRN wire from the AC/DC DLX to the motor field terminal. This terminal is located between the two brush terminals.
6. Solder the YEL lead from the AC/DC DLX to the remaining brush terminal.
7. Repeat this procedure for the second motor.
8. Connect the RED wire from the AC/DC DLX to the engine pickup rollers. Use a wire nut to secure the connection.
9. Connect the BLK wire from the AC/DC DLX to a solid engine ground. The best ground connection is made where the negative end of the field coil is soldered to a tab on the side of the motor. Solder to this point, if possible. If the engine has two motors, it is a good idea to solder a wire between the two motors, connecting their ground terminals together along with the BLK lead.

With the motor wiring completed, proceed to the next section of this manual to continue with the rest of the installation.

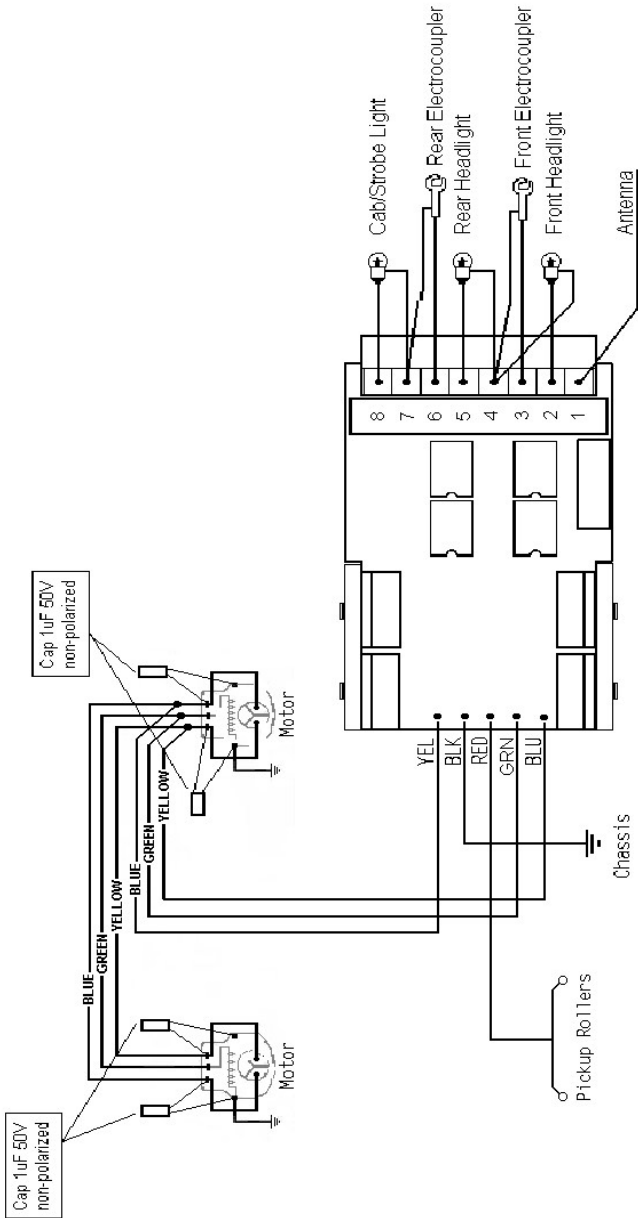


Figure 4 - Lionel Single or Dual AC Motor Wiring Diagram

2.2.4 Lionel AC Motor Steam Locomotives

Installation into steam locomotives is slightly more complicated than diesels, since space is generally limited inside the engine body. However, there is more than enough space in a tender to mount the AC/DC DLX. This will require the use of an 8-pin connector assembly to make the necessary connections from the locomotive to the tender. These connector sets are available from Digital Dynamics.

2.2.4.1 Circuit Board Mounting

The AC/DC DLX may be mounted directly to the tender frame using the heatsink mounting bracket.

1. Remove the shell from the tender and place it aside where it cannot be damaged. Place the chassis on a clean, level work surface.
2. Unsolder or remove all electrical connections to the existing reverse unit and remove the reverse unit from the tender.
3. Clean any grease, oil, or loose rust from the chassis surface.
4. Attach the AC/DC DLX to the tender chassis using the 1/4" sheet metal screw. If you are planning to install a sound system, locate the AC/DC DLX so that it offers maximum available space to the sound system. Be absolutely certain that the **mounting screw does not protrude far enough through the heatsink to come in contact with the circuit board**. If necessary, use one or two small washers to reduce the length that the screw extends beyond the heatsink. Alternatively, use a Dremel tool with cutoff wheel to remove excess length from the screw after it has been tightened in place.
5. Once the board is firmly mounted to the chassis by the heatsink, use the foam tape to secure the opposite end of the board underneath the terminal block.

2.2.4.2 Wiring the Engine and Tether

Pay special attention to the wiring instructions and wiring diagrams when connecting the AC/DC DLX to the motor, since the connections may be different to what you are accustomed to. The only wiring that will be done inside the locomotive body will be to the engine side of the 8-pin connector assembly. It is a good idea to wire all of your engines in a consistent manner so that engines and tenders can be interchanged. Refer to the wiring diagrams of Figures 6 and 7 while performing the following procedure.

1. With the body removed from the locomotive, remove the three wires that connect the E-unit to the motor(s) by unsoldering them at the motor. Usually, these wires are colored blue, green, and yellow. Make a note of the connections before you remove them. In some instances, the wires may all be black.
2. Disconnect the E-unit connections to the pickup rollers.
3. Unsolder the wire that leads to the headlamp socket from the E-unit. This wire is usually black and may be soldered to the same point as the pickup roller wires.
4. Unsolder the wire that leads to the smoke unit.
5. Loosen the single screw on the side of the E-unit and remove it from the chassis.

6. Identify the headlamp lead at the connector and attach it to the existing headlamp lead either by soldering it, or by using a wire nut. Consider removing the old lead and soldering the new wire directly to the fiber washer.
7. Identify the smoke unit lead at the connector and solder it to the smoke unit wire. Be sure to adequately insulate the connection.
8. Connect the pickup roller wire to the appropriate connector lead.
9. Connect the connector ground wire to a solid ground on the engine chassis. Either solder the wire directly to the motor case, or use one of the supplied solder washers and an existing screw in the chassis.
10. Remove one of the screws that hold the brush cover to the motor. Slide one of the supplied terminal washers over the screw and replace it in the motor. Repeat this procedure for the other motor screw.
11. Connect a non-polarized 1uF capacitor from one of the motor brush terminals to the adjacent terminal washer you just installed. Wrap the capacitor leads through the hole in the washer and solder the connection. Keep the capacitor leads as short as possible.
12. Wrap the other capacitor lead around the appropriate brush terminal, using a small pair of long-nosed pliers and then solder the connection.
13. Connect the appropriate wire from the 8-pin connector assembly to the motor brush terminal that formerly had a BLU wire soldered to it. Also connect the remaining lead of the capacitor adjacent to the brush terminal.
14. Strip approximately 1/2" of insulation from one of the GRN wires. Solder the wire to both the center motor field terminal and the remaining brush terminal, the one that originally had a YEL wire connected to it.
15. Connect the remaining capacitor lead to the adjacent brush and field terminals.
16. Unsolder the negative end of the bare field winding from the motor case. If your soldering iron is not hot enough to melt the solder, simply clip the wire as close to the solder joint as possible. Avoid flexing this wire any more than is necessary, since it is easily broken.
17. Connect the remaining GRN wire from the connector assembly to the bare motor field wire. Use a wire nut to secure the connection, or solder it if you prefer, but be sure to insulate the connection with electrical tape.
18. Wiring of the engine should now complete. However, there should be two remaining wires from the connector that have not been used. One of these, identified as CHUFF, is for synchronization of Railsounds® with the smoke unit. Refer to the Railsounds® installation manual for proper use of this connection.

2.2.4.3 Wiring the Tender and Tether

Wiring the tender side is fairly straightforward. Bear in mind that the tender side of the 8-pin connector appears in the drawings as a mirror image of its mating connector. As you make each connection, verify that each one is correct and that it will mate correctly with the engine.

1. Remove the shell from the tender and place it aside where it cannot be damaged. Place the chassis on a clean, level work surface.
2. Unsolder the connections from the existing reverse unit to the headlamp, smoke unit, and pickup rollers.
3. Remove the reverse unit completely from the tender.
4. Clean any grease, oil, or loose rust from the chassis surface.
5. Attach the AC/DC DLX to the tender chassis using the mounting bracket and screw.
6. Feed the wires from the 8-pin MALE connector through an opening in the engine side of the tender. The MALE connector is the one with the eight equal length wires attached. Most tenders have a suitable opening for this connector and wiring.
7. Make all connections to the headlamp, smoke unit, motor, power and chassis ground from the wires of the connector assembly to the AC/DC DLX. Use the wire nuts enclosed with the kit to make the motor and power connections. The remaining connections for headlamps, etc. will be to the AC/DC DLX terminal block.
8. Using the supplied wire nuts, connect the BLU and YEL armature wires from the AC/DC DLX to the appropriate wires of the tether. Again, refer to figure 6
9. Connect the GRN field wire to the tether.
10. Connect the AC/DC DLX BLK wire, along with the appropriate tether wire to a solid ground on the tender chassis.
11. Connect the AC/DC DLX RED wire to the tether.
12. Connect the tether headlamp wire to the appropriate connection on the Terminal Block J1. Refer to figure 6 for the terminal block connections.
13. Connect the tether smoke unit wire to the appropriate connection on the Terminal Block J1. Again, refer to figure 6 for the terminal block connections.
14. Proceed to section 2.3 to complete the installation.

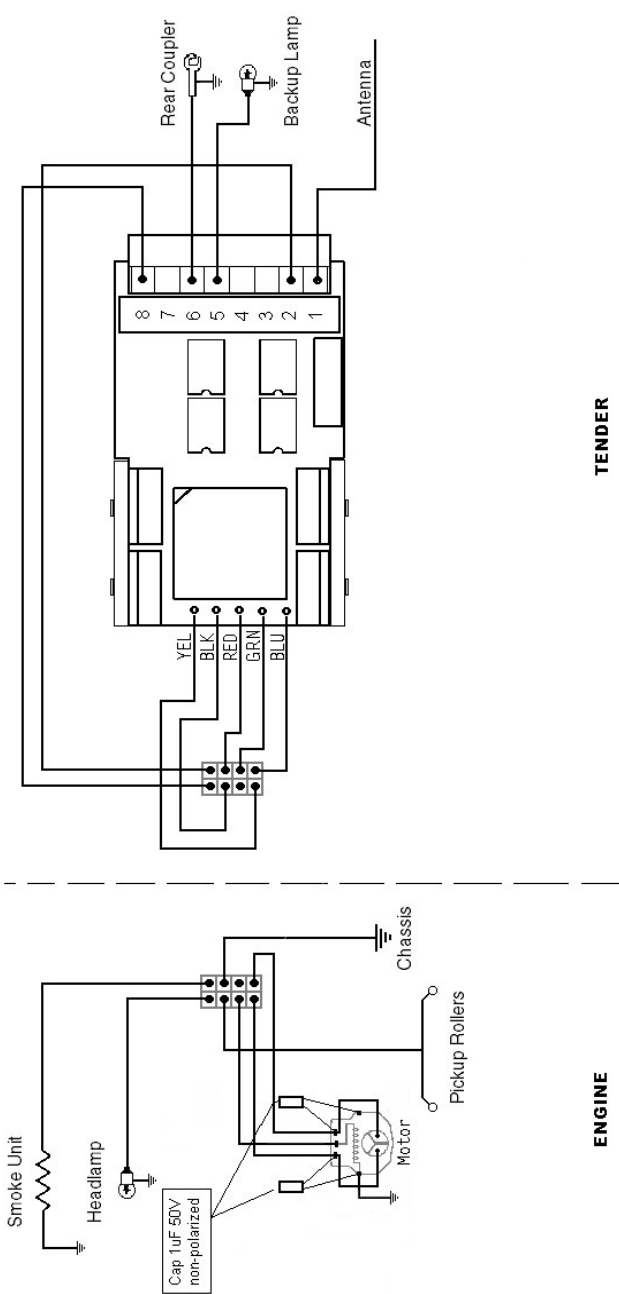


Figure 5 - Lionel Steam Locomotive Wiring Diagram

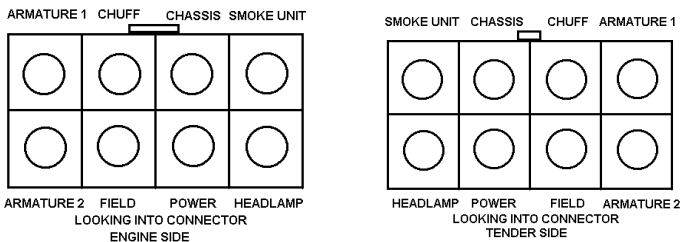


Figure 6 - Steam 8-pin Tether Connectors

2.3 **PROG/RUN Switch**

The PROG/RUN switch should be positioned in a convenient location where it can easily be changed if required. Some engines may have a similar switch already in place that was used by the original electronic reverse unit. In this case, simply remove the old switch and replace it with the switch from the AC/DC DLX.

Even if no switch is present, many engines have a pre-punched hole in the chassis to accommodate a switch. Otherwise, use a small piece of foam adhesive to attach the switch to a convenient location.

The switch is in the RUN position when it is open, with the slide lever over the unused terminal. Conversely, in the PROG position, the switch lever is directly over the two wired terminals.

2.4 **Headlights**

The Trainmaster system operates with a constant track voltage of 18 Volts. The AC/DC DLX takes advantage of this to efficiently power your locomotive's incandescent lamps. In Command Mode, the voltage applied to the lamps is half wave rectified 18 VAC, In this environment, the light bulbs will see an average voltage equal to approximately half the track voltage, or about 9V. In Conventional mode, the lamp voltage will be equal to the track voltage.

Lionel engines are usually equipped with either 12V or 14.5V bulbs. These may be directly connected to the AC/DC DLX. If your engine has factory installed directional lighting operated from a solid state reverse unit, it is likely that the bulbs are rated at 1.5V. If this is the case, you must either replace them with 12V bulbs, or add a series dropping resistor to the circuit. The value of this resistor depends on the bulb operating voltage, and the desired brightness. For a 1.5V bulb, install a 330 Ohm 1/2 Watt in series with each bulb before connecting to the AC/DC DLX. For other voltage bulbs, use the formula below to calculate the value of the resistor.

$$R = (18-V)/I$$

Where R = the value of the resistor in ohms, V = the lamp rated voltage, and I = lamp current. As a rule, lower voltage bulbs have large operating currents. For example 1.5V bulbs require 50mA for rated brightness. For a 6V bulb, the operating current is proportionally less - about 12mA. Bear this in mind when calculating the appropriate resistor value.

2.5 Constant Voltage Headlamps

A significant number of modern engines have factory installed constant voltage lighting. These engines use low voltage bulbs in conjunction with a voltage regulator circuit to provide steady lamp brightness regardless of track voltage. The Trainmaster system automatically provides constant brightness to headlights, since the track voltage is constant. However, if you would like the ability to control the engine's constant brightness headlamp from your CAB-1, you can connect the input of the voltage regulator circuit to the AC/DC DLX headlamp.

To do this, disconnect the wire from the engine's pickup roller to the regulator circuit and connect the regulator circuit to the headlamp output of the AC/DC DLX. Add the resistor to the circuit as shown in the diagram below:

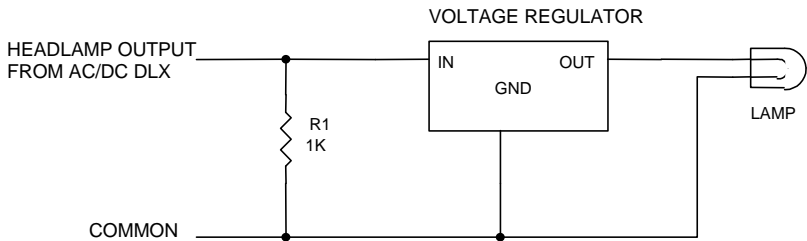


Figure 7 - Connection to Constant Voltage Lighting Circuit

2.5.1 Directional Lighting on Williams Engines

Some Williams engines use diodes in series with 14.5V headlamps which in turn, are powered from the motors to achieve directional lighting. The diodes are soldered directly to the motor case and wrapped in heat shrink tubing. They must be removed from the circuit before connecting the headlamp to the AC/DC DLX, or the headlamps will not operate. Pay special attention to the two wires coming from the headlamps. Be sure to observe which wire is connected to chassis ground. The chassis ground should be connected to one of the COMMON terminals on the AC/DC DLX terminal block. The other wire is connected to the appropriate headlamp output on the terminal block.

2.5.2 Marker Lamps

Some of the more detailed steam engines may have marker lamps lit by miniature LEDs. These cannot be driven directly by the AC/DC DLX without adding protective components to the circuit. You need to add resistor in series with the LED to limit its current and a series diode to protect it from damaging peak reverse voltage. The value of the resistor depends on the efficiency of the LEDs and the level of brightness desired. A value in the range of 470 Ohms to 510 Ohms is usually appropriate. Use the following circuit to connect the marker lights to the headlamp output of the AC/DC DLX.

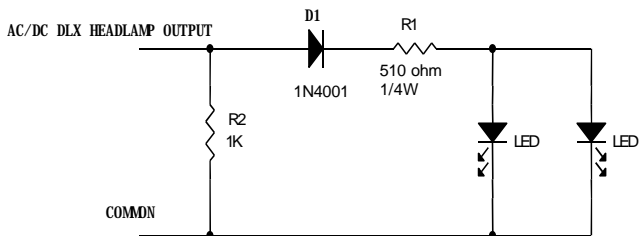


Figure 8 - Connection to LED Marker Lamps

2.6 Electromagnetic Coil Couplers

If your locomotive is equipped with electromagnetic coil couplers, you will want to connect them to the AC/DC DLX for remote CAB-1 controlled operation. This type of coupler has a coil of wire wrapped around the coupler arm. It may or may not also have the traditional 'thumbtack' for magnetic remote control track operation. All Premier MTH engines are equipped with 'Protocouplers', their trademark name for electrocouplers. MTH Railing engines without Protosounds, and engines from Weaver, Williams, or K-Line, as a rule, do not come standard with electrocouplers. Most Lionel engines, other than early Postwar types are not electrocoupler equipped, but most of them can easily be upgraded. Digital Dynamics stocks a number of different types of electrocouplers suitable for most applications. Please call for information.

When connecting the electrocouplers, you will find that some types, Postwar types in particular, have a single wire. The common connection is made through the coupler to the chassis. For electrocouplers with two wires, make connections as shown below:

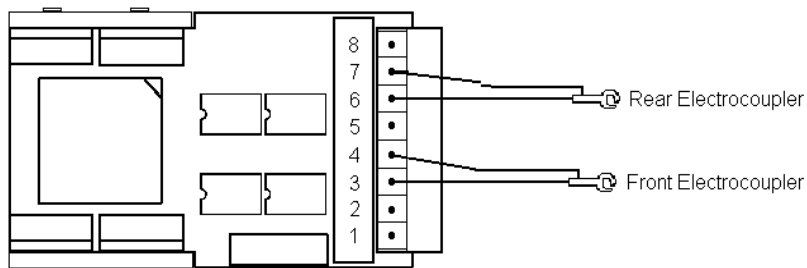


Figure 9 - Electrocoupler Connections

2.7 Smoke Units

If you would like the ability to turn your engines smoke unit on and off from the CAB-1, or control smoke boost, you can connect the smoke unit to the AC/DC DLX.

Locate the power lead to the smoke unit. Power may come directly from the engine pickup roller, or it may connect via an ON/OFF switch underneath the engine. Connect this lead to the appropriate location on the AC/DC DLX terminal block. Refer to figure 2 for the proper connection.

You may need to replace your older Postwar smoke unit with a newer liquid smoke type if you wish to connect it to the AC/DC DLX. The AC/DC DLX is capable of supplying only a little more than 400mA maximum, and if the resistance of the smoke unit is too low, or it is shorted internally, it will damage the smoke unit driver on the R2LC circuit board.

Postwar type smoke units designed for use with smoke pellets consist of a few turns of nichrome wire on a ceramic element. Usually, the resistance of these elements is very low. Measure the resistance with an ohmmeter. If it is significantly less than 30 ohms, you should replace it, preferably with a modern type designed for use with liquid smoke.

3 Sound Systems

The AC/DC DLX is compatible with the advanced state of the art Lionel Railsounds® system. A wide variety of Railsounds® boards are available from Digital Dynamics and come with complete installation instructions. Please call or write for further information.

The AC/DC DLX will operate all Lionel SignalSounds® and Railsounds® systems from version 2.5 to the present version. Connection to a Railsounds® system is made via a single 4-pin connector on the AC/DC DLX. The appropriate connection cable is supplied with all Railsounds® systems purchased from Digital Dynamics. Please see the Railsounds® Installation Manual for further instructions.

You may also use your AC/DC DLX to operate a SignalSounds unit to obtain a good quality horn and bell. While SignalSounds boards are not generally available for sale, they can be recycled from Lionel engines that have been upgraded to full Railsounds.

SignalSounds is a small plug-in type board that can be mounted to the engine chassis with a single screw. A special connector is needed to make electrical connections to the board. You can obtain a pre-wired connector, including loudspeaker, from Digital Dynamics. Please call for further information.

4 Antenna Installation

Antenna installation and location is critical to your engine functioning reliably under the TrainMaster system. The antenna must be located where it can best pick up the signal radiating from the track. As a general rule, antenna location is fairly forgiving in plastic bodied engines, as the plastic does not interfere with the radio signal. However, die-cast or brass locomotives will limit or completely block the signal from the antenna.

4.1 Plastic Body Locomotives

1. Remove the antenna from the parts kit. The antenna is the adhesive backed copper strip with a wire soldered to it.
2. Place the locomotive body upside down on a soft surface such as an old towel, or a piece of carpet.
3. Remove the adhesive backing from the copper strip.
4. Starting at the rear of the loco body, place the copper strip antenna lengthwise along the inside center of the roof.
5. Extend the antenna wire for as long a distance as possible inside the locomotive, then loop it back to where it will connect to the AC/DC DLX circuit board.
6. Under no circumstances should the antenna be attached to a metal chassis. Doing this will short-circuit signal reception.
7. Place the locomotive body along side the chassis and connect the antenna wire to the appropriate location on the terminal block. Refer to the diagram of figure 2 for the location of this connection.
8. Place the engine body on top of the chassis. Do not fasten it to the chassis until after tests are completed.

4.2 Die-Cast Locomotives

Metal engine and/or tender bodies present a special problem for the TrainMaster® system, since the radio signal cannot reach the circuit if the circuit and antenna are enclosed within.

If your tender has a plastic body, you may attach the antenna to the inside of the plastic shell anywhere it is convenient. The orientation of the antenna should be parallel with the track direction.

If you have a diecast tender shell, you will need to electrically isolate it from the chassis.

1. Using black electrical tape, cover the chassis at every location that comes in contact with the tender shell. Usually, you need only wrap a continuous piece of tape around the sides of the chassis with part of the tape overlapping on top. When the tender shell is installed, the tape should not be visible.
2. Place the shell on the chassis, and use an ohmmeter to test for continuity. If you do not have access to an ohmmeter, carefully inspect the chassis and tender shell for any areas that may be in contact with each other. Correct as necessary.

3. Attach the antenna to the inside of the diecast shell. Place it over an area where there is no paint. You may need to scrape away paint to make good electrical contact between the antenna and the tender shell. Alternatively, you can remove the copper strip from the antenna wire, and attach the exposed wire to any available hardware such as a nut, bolt, or screw within the tender shell.
4. Fasten the tender shell to the chassis using #4 nylon screws. These are available at many hardware stores or from your local hobby dealer.
5. After tightening the screws, make sure that there is still no electrical continuity between the shell and chassis.

5 Testing Your Installation

Do not place your engine on the track without first verifying that your transformer's circuit breaker is operating normally. The circuit breaker should immediately trip when a load or short circuit drawing 10 or more amperes is placed on the track. If there is a problem with the installation, the circuit breaker will prevent the AC/DC DLX from sustaining permanent damage.

Before placing the locomotive on the track and applying power, carefully inspect all solder connections for short circuits and loose connections. Make sure all wire nuts are tight. Pay particular attention to areas where the circuit board may potentially come in contact with metal parts of the engine. Also, it is important that any unused wires do not come in contact with any part of the circuit or any exposed metal parts. Either cut-off unused wires, or wrap their ends with electrical tape in order to prevent short circuits.

It is very important that you

1. Remove all other locomotives from the track, and make sure that track power is OFF.
2. Make sure your Trainmaster® system is properly connected. Refer to the instructions that came with your Lionel Trainmaster® system if you are not sure about the connections.
3. Verify that your system is operational by observing the indicators on the Command Base as buttons are pressed on the CAB-1.
4. Place the locomotive on the track.
5. Hold the locomotive firmly while you apply power to the track. This will prevent possible damage to your locomotive in the event it starts up unexpectedly due to a malfunction or improper installation.
6. Turn on power. Observe that the engine headlamp is lit steadily.
7. Make sure that none of the circuit components, including any wiring, are hot to the touch, and that no smoke or burning odor is present. Otherwise, shut down power immediately.
8. Using the CAB-1 controller, press [ENG][1], then slowly turn the red button clockwise. If the installation was performed properly, the engine will begin to move forward.
9. Use the Troubleshooting section to help you determine the problem if the engine does not respond as it should.

5.1 Programming the Engine

5.1.1 Engine ID#

The AC/DC DLX comes with its engine ID set to number '1'. If you want to change the engine ID, follow this procedure.

1. Make sure the Command Base or PowerMaster is connected to the track. The PowerMaster CMD/CONV switch must be set to the CMD position.
2. Set the engine PROG/RUN switch to PROG.
3. Place the engine on the track and apply power.
4. On the CAB-1, press [ENG] then the number (1 - 99) for the locomotive.

5. Press [SET]. The engine ID is saved forever, or until you decide to change it.
6. Continue to the next section to program the feature code for your engine.

5.1.2 Engine Features

The R2LC Command module is a very flexible device and can be programmed to operate all the features of different locomotives. For example, there are five (5) general purpose outputs that can be programmed to operate different functions such as directional headlamps, strobe light, cab lights, smoke unit, or electrocouplers. Use the table below to determine which features of your engine you need to operate from your CAB-1. Then, use the corresponding feature code to program your AC/DC DLX.

Code	Engine Type	Feature 1	Feature 2	Feature 3	Feature 4	Feature 5
0	Steam w/ Signalsounds	Headlamp	Rear Lamp	Front Coupler	Rear Coupler	Smoke Unit
1	Diesel w/ Signalsounds	Headlamp	Rear Lamp	Front Coupler	Rear Coupler	Strobe Light
2	Diesel w/ Signalsounds	Headlamp	Rear Lamp	Front Coupler	Rear Coupler	Cab Light
4	Steam w/ Railsounds	Headlamp	Rear Lamp	Front Coupler	Rear Coupler	Smoke Unit
5	Diesel w/ Railsounds	Headlamp	Rear Lamp	Front Coupler	Rear Coupler	Strobe Light
6	Diesel w/ Railsounds	Headlamp	Rear Lamp	Front Coupler	Rear Coupler	Cab Light
8	Diesel w/ Railsounds	Headlamp	Rear Lamp	Front Coupler	Rear Coupler	Smoke Unit

To program the engine features,

1. Set the engine PROG/RUN switch to PROG.
2. Place the engine on the track and apply power.
3. On the CAB-1, press [ENG] then the number (1 - 99) for the locomotive.
4. Press [SET].
5. Press [AUX1] [N], where N = the engine feature code.
6. Remove power from the track and place the switch back into the 'RUN' position.

5.2 Conventional Mode Operation

In the absence of the command environment, an AC/DC DLX equipped engine will operate like one equipped with a conventional E-unit, cycling from Neutral to Forward to Neutral to Reverse each time power is momentarily interrupted. Cycling of locomotive direction can be overridden by placing the Engine ID programming switch in the 'PROG' position. This will lock the engine direction into Forward. You must replace the switch back to the 'RUN' position if you wish to run the engine in Command mode.

To test the engine in Conventional Mode:

1. Remove power from the Command Base by unplugging the wall transformer. Or, if you have a Powermaster based system, set the PowerMaster switch to the CONV position.
2. Place the engine on the track and slowly increase the track voltage. The engine should begin to move in response to the transformer setting.
3. Cycle the engine through FWD-NEUTRAL-REVERSE using the direction button, or by briefly cycling power to the track. The engine should operate just like one equipped with a mechanical E-unit, except that the lighting will be directional.
4. If the engine fails to respond in Conventional Mode, make sure the TrainMaster signal is not present on an adjacent track, or anywhere else nearby. The only way to ensure this is to completely remove power to the Command Base by unplugging it.

5.3 Troubleshooting

When correctly installed, the AC/DC DLX will give years of reliable service. However, improper installation may cause permanent damage to the circuit or give less than optimum performance. First check all wires for solid, reliable connections, then be absolutely certain that there are no short circuits, or bare wires coming in contact with each other or the locomotive chassis. After this is done, use the accompanying chart to diagnose and any correct installation problems. If your specific problem is not listed, or the suggested solution does not work for you, contact Digital Dynamics for assistance.

Locomotive Starts Up in Conventional Mode Or Does Not Respond to CAB-1 Commands	<p>Check that the Trainmaster® System is operating properly using a known working engine. Verify that the proper Engine ID is being used at the CAB-1 Controller. Remember that the default engine ID # is set to '1'. See the instructions under the heading "Poor Signal Reception".</p> <p>Reset the Engine ID.</p>
Locomotive Direction Is Out Of Sync With Headlamps	<p>Either the headlamp wiring is reversed, or the motor armature wires (BLU or YEL) are reversed. If the default start-up direction in command mode is reverse, then the motor(s) are incorrectly wired. Reverse the BLU and YEL motor leads. Otherwise, simply reverse the front and rear headlamp wiring (applies to dual headlamp locos only).</p>
Locomotive Runs In One Direction Only	<p>One of the motor armature wires has been reversed with the field wire. Another possibility is that your Lionel locomotive was equipped with a two position E-unit, which is wired differently than the traditional scheme. Contact Digital Dynamics for instructions.</p>
Railsounds does not operate properly in Command Mode	<p>Engine feature code may be improperly programmed. Refer to section 5.1.2 and program engine for Railsounds operation.</p>
Smoke unit not operating, cab light blinking, or strobe light does not blink	<p>Engine feature code may be improperly programmed. Refer to section 5.1.2. The smoke unit may be connected through a manual switch. Make sure the switch is set to the ON position.</p>
Engine lurches forward when CAB-1 throttle is first turned up.	<p>Reset engine Stall Speed. If condition persists, lower track voltage to 16V or less.</p>
Locomotive stops for no apparent reason	<p>There are two possible causes for this, poor signal reception or excessive electrical noise. See following.</p>
Poor Signal Reception	<p>The microprocessor is programmed in such a way that if it loses contact with the Trainmaster® radio signal, even for a fraction of a second, it will immediately halt the engine. This safety precaution was included to prevent your train from suffering damage should it run out of control. Make sure that your Command Base is connected to the track properly and is receiving AC power from its wall transformer.</p> <p>Verify that the Command Base is receiving commands from your CAB-1 remote. The indicators on the CAB-1 will change from RED to GREEN as it receives a signal from the CAB-1 indicating that buttons are pressed.</p> <p>Ensure that the locomotive antenna is properly connected to the circuit board, and that the antenna wire is oriented correctly inside the locomotive body. For optimum reception of the radio control signal, the antenna should be directed parallel to the rails.</p>
Excessive Electrical Noise	<p>If the problem seems to be speed related, i.e. the locomotive seems to stop frequently when run at moderate to high speeds, but operates correctly at low speeds, then the problem is most likely due to excessive motor noise and/or arcing of the pickup rollers. Older dual-motor locomotives, particularly those with horizontal style motors, are more prone to generating excessive electrical noise than are single motor locomotives. There are some measures that can be taken to reduce noise, including replacement of the motor brushes with the newer style bonded wire brushes, available from Lionel, from Lionel Service Centers, or from any of the many suppliers of train repair parts.</p> <p>Other measures you can take to reduce electrical noise include thoroughly cleaning your track and engine pickup rollers, cleaning and resurfacing the motor brushes and armature, and replacing the pickup rollers if they show signs of excessive wear. If necessary, bend the pickup roller arm so that it exerts maximum pressure on the track</p>
Electrocouplers Open Randomly or Headlamps Flicker	<p>Trim excessive lead lengths wherever possible and dress the wires controlling lamps and couplers as far away as possible from motor and power pickup leads, and form a twisted wire pair with the power lead and ground lead wherever possible. Insert a 1/4W resistor in series with the board and the headlamp and/or electrocoupler. Use a value of 5.6 Ohms to 10 Ohms, whichever works best.</p>

Notes

Limited Warranty

Digital Dynamics warrants to the original consumer purchaser that this product will be free of defects in materials and workmanship for a period of one year from the date of original purchase. This warranty does not cover service, repair, or replacement to correct any damage caused by improper installation, improper connection, external electrical fault, accident, disaster, misuse, abuse, or modifications to the product. All other express or implied warranties, including the implied warranty of merchantability and fitness for a particular purpose, are hereby disclaimed.

If this product is not in good working order as warranted, the sole and exclusive remedy shall be repair or replacement. In no event shall Digital Dynamics, or any dealer, distributor, or authorized installation and/or repair service provider be liable for any damages in excess of the purchase price of the product. This limitation applies to damages of any kind, including but not limited to, direct or indirect damages, lost profits, lost savings or other special, incidental, exemplary or consequential damages whether for breach of contract, tort or otherwise, or whether arising out of the use of or inability to use the product, even if Digital Dynamics, or any dealer, distributor, or service provider has been advised of the possibility of such damages or any claim by any other party. Some states do not allow the exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you.

During this one year warranty period, the product will either be repaired or replaced (at our option) without charge to the purchaser, when returned either to the dealer with proof of the date of purchase or directly to Digital Dynamics when returned prepaid and insured with proof of date of purchase.

Some states do not allow limitations on how long an implied warranty lasts, so such limitations may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Repairs

Each and every Digital Dynamics product is thoroughly tested before it is shipped. The likelihood that it is not working when it reaches you is very small. However, if after troubleshooting it yourself you cannot get it to work properly, you should return it along with your engine to Digital Dynamics postage paid. Do not remove the board from the engine, and include a note indicating the problem. Enclose a check for \$20 to cover troubleshooting and return shipping. If you want the parcel insured beyond \$100, enclose the appropriate amount.

Should your product ever need repair, you should return it postpaid directly to Digital Dynamics. If the product is within the warranty period, it will be repaired and returned to you free of charge. Units out of Warranty will be repaired for a service charge of \$25. Do not send the entire locomotive unless you are instructed to do so. Please call or email for return authorization before returning anything.

To obtain return authorization call (203) 778-3599, 4PM to 8 PM (EST), or by email to info@digitynam.com.

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