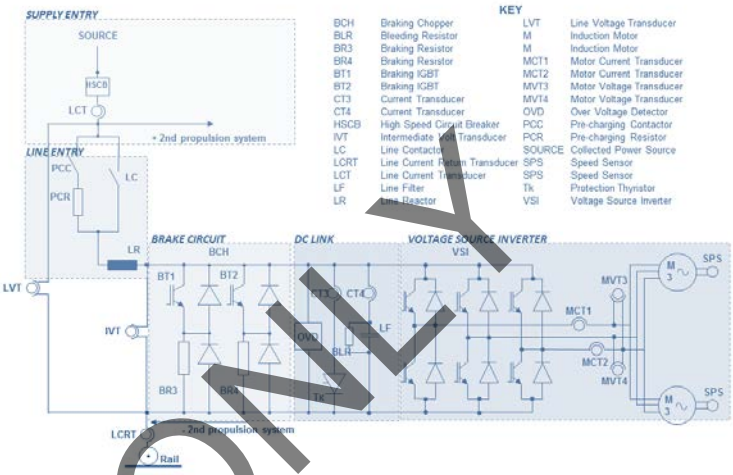
Inspection and Maintenance of Propulsion and Dynamic Braking Systems



Course 203






PARTICIPANT GUIDE

RAIL CAR TRAINING CONSORTIUM

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MODULE 1

GENERAL INSPECTION AND MAINTENANCE

Outline

Purpose and Objectives

The purpose of this module is to provide participants with an overview to the principles of maintenance when working on a rail vehicle's propulsion system.

Upon completing this module, the participant should be able to complete the following objectives with an accuracy of 75% or greater:

- Explain agency's schedule of inspection and maintenance for rail car's propulsion and dynamic braking system.
- Demonstrate ability to read electrical schematics of a rail car's propulsion system and dynamic braking system
- Demonstrate knowledge of three-phase motors
- Demonstrate knowledge of capacitor charge
- Demonstrate knowledge of electrostatic discharge
- Demonstrate proper use of thermal compound
- Demonstrate knowledge of pulse width modulation

Key Terms

- Preventive Maintenance (PM) Sheets
- Periodic Inspection (PI) Sheets
- Portable Test Equipment (PTE)
- Line Replaceable Unit (LRU)

Line Replaceable Units

A line replaceable unit (LRU) is a component on the rail vehicle that is designed to be replaced quickly by the maintainer. Sometimes these are called "modules" and are designed by OEMs so they can be easily removed and replaced with a similar part.

Depending on the configuration and OEM design, some common LRUs are located in the propulsion logic unit and in the high voltage assemblies. For example, on CTA's 5000 series cars the line reactor is a separate LRU shown in Figure 1.1.

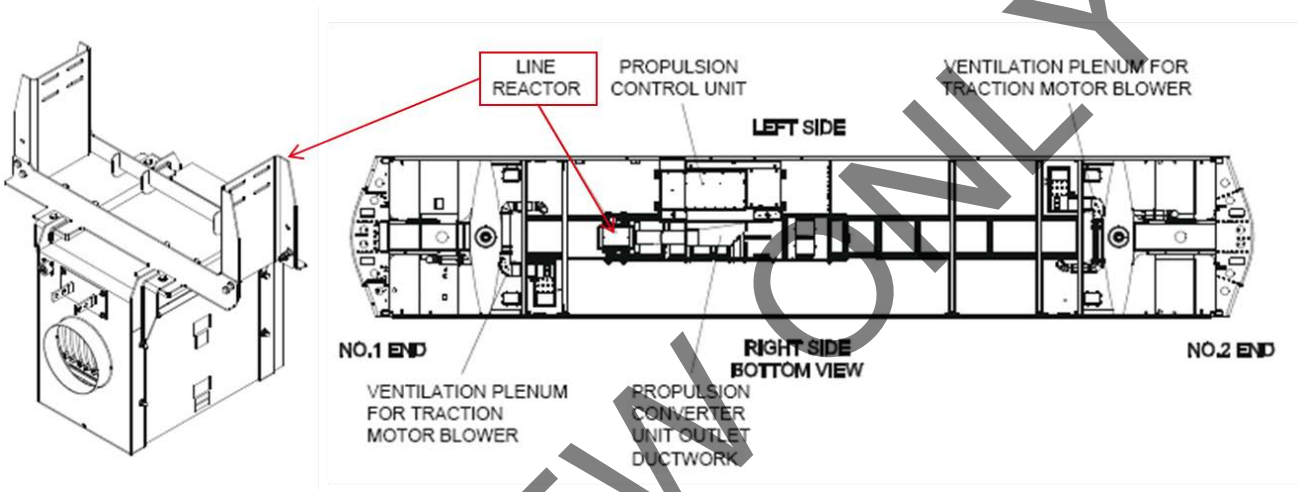


Figure 1.1 Line Reactor LRU –courtesy CTA

Diagnostic-based Maintenance

Diagnostic-based maintenance is facilitated by the rail vehicle's propulsion logic system. Recall from Course 103 that propulsion logic refers to the communication platform which manages and controls the flow of information both on board the rail vehicle and between the vehicle and ground. The propulsion logic system is housed in the propulsion control unit (PCU) which some technicians refer to as the "brain" of the train's propulsion system. Depending on OEM design, PCUs are housed in electrical enclosures located under the car, lockers inside the vehicle, or in other locations on the rail car. The propulsion logic system allows for efficient and reliable train operation and the car monitoring unit allows for computerized diagnostics-based maintenance. The basic functions of the propulsion logic system are therefore to execute, monitor, protect, annunciate, and communicate. Propulsion logic systems and related nomenclature vary across vehicle types, manufacturers, and rail transportation agencies. They also vary in location on the rail vehicle.

PCUs are designed with some kind of computer-based interface through which rail vehicle technicians can diagnose, test, and report faults on the operation of the propulsion system. The exact design, configuration, software, and diagnostic capabilities vary by OEM. Essentially,

diagnostic-based maintenance allows the rail car technician to connect **portable test equipment**[1] **(PTE)**, such as a notebook, to the car monitoring unit to gain status of the propulsion sub-systems. In order for this to happen there must be software which interprets sub-systems status and reports functionality and faults to the technician as well as a communication link between the PTE and the car monitoring unit. Diagnostic software allows the rail car technician to check the status of the propulsion system and to isolate particular faults. It typically includes the ability to download a snapshot and data of the propulsion system at time of inspection.

Figure 1.2 is a schematic representation of a propulsion diagnostic system in use at Denver RTD on their Siemens 0700 rail vehicles. Siemens diagnostic system on this type of rail car is SIBAS-32.

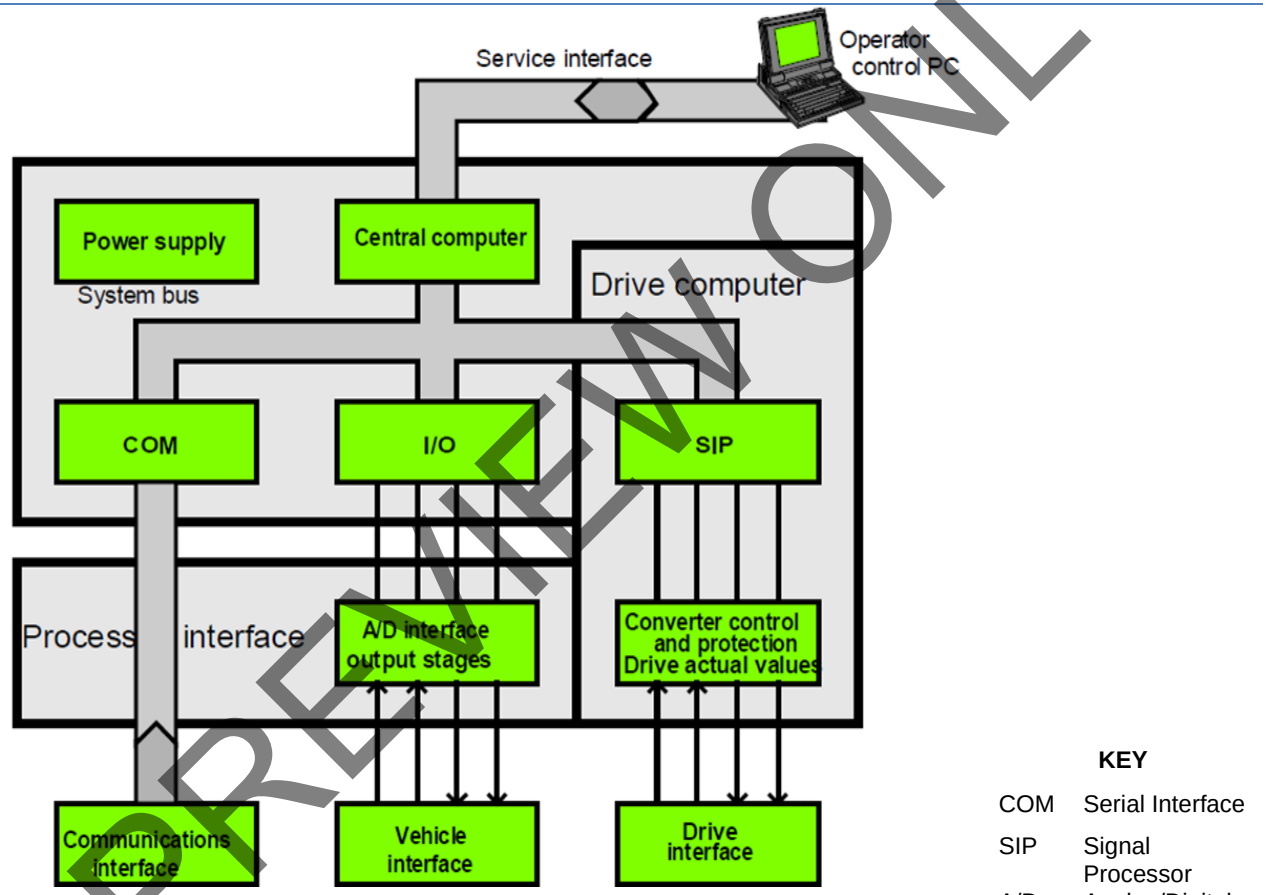


Figure 1.2 Propulsion System Connected to PTU –courtesy Denver

Rail car technicians are expected to check reports from the propulsion diagnostic system as part of their standard inspection and maintenance procedures. The participant should receive training on their agency-specific diagnostic system.

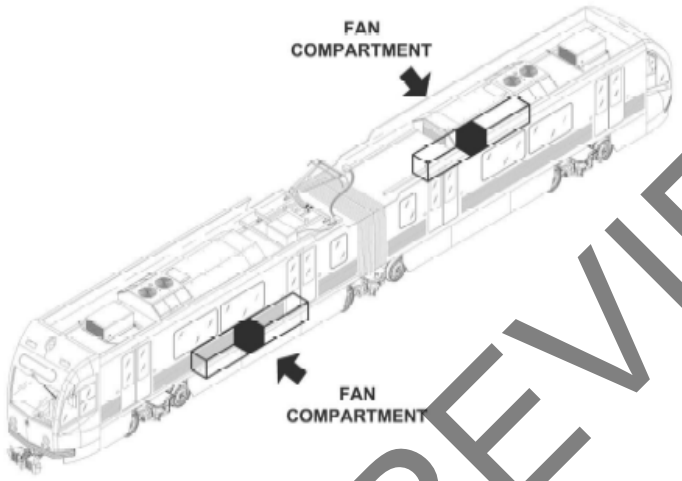
[1] Also known as portable test units or PTUs for short.

P2550 PREVENTIVE MAINTENANCE SHEET

Card Code: R-P-07-03-07-00/C-00

System:	Sheet:
PROPULSION	1/4
Subsystem/Assy: TRACTION INVERTER HV COMPONENTS	Unit: INVERTER COOLING MOTOR FAN
Component:	Man Hours: 0.3
Maintenance Task: CLEANING	Interval/Miles: 30,000

LOCATION:



P2550 PREVENTIVE MAINTENANCE SHEET

Card Code: R-P-07-03-07-00/C-00

System:	Sheet:
PROPULSION	2/4
Subsystem/Assy: TRACTION INVERTER HV COMPONENTS	Unit: INVERTER COOLING MOTOR FAN
Component:	Man Hours: 0.3
Maintenance Task: CLEANING	Interval/Miles: 30,000

SAFETY PRECAUTIONS:

WARNING: ALWAYS WEAR EYE PROTECTION AND GLOVES WHILE PERFORMING THIS MAINTENANCE TASK.

WARNING: ELECTRICAL HAZARD IS PRESENT THROUGHOUT THE PROPULSION SYSTEM AND CAUTION MUST BE TAKEN WHILE WORKING ON OR NEAR THE EQUIPMENT. REMOVE ALL ELECTRICAL POWER BEFORE PERFORMING MAINTENANCE TO THE SYSTEM.

WARNING: BEFORE PERFORMING MAINTENANCE PROCEDURES AND TOUCHING ANY COMPONENT, USE A RELIABLE HIGH VOLTAGE TEST PROBE TO VERIFY THAT NO VOLTAGE IS PRESENT.

WARNING: HIGH VOLTAGE IS PRESENT ON THE INVERTER GROUP. AFTER REMOVING ALL POWER FROM THE VEHICLE, WAIT A MINIMUM OF 1 MINUTE PRIOR TO REMOVE OR OPEN MAIN INVERTER GROUP,SINCE THE CAPACITORS DISCHARGE TIME IS 10 SECONDS
FAILURE TO COMPLY WITH SAFETY REGULATIONS COULD RESULT IN SERIOUS INJURY OR EVEN DEATH IF NOT FOLLOWED.

WARNING: WORKING AREAS MUST BE WELL VENTILATED, LIGHTED, AND CLEAR OF DEBRIS FOR OBVIOUS SAFETY REASONS.

WARNING: WHEN WORKING ON COMPONENTS ACCESSIBLE FROM THE UNDERFRAME, AND THE VEHICLE IS ON THE INSPECTION PIT, A WARNING SIGN MUST BE APPLIED EXTERNALLY FROM THE PIT TO WARN THAT MAINTENANCE PERSONNEL IS WORKING IN THE PIT.

TOOLS:
Air gun

CONSUMABLES:
Degreaser

SPARE PARTS:
N/A

Figure 1.6 OEM-prepared PM Sheet –courtesy LA Metro

P2550 PREVENTIVE MAINTENANCE SHEET

Card Code: R-P-07-03-07-00/C-00

System:	Sheet:
PROPULSION	3/4
Subsystem/Assy: TRACTION INVERTER HV COMPONENTS	Unit: INVERTER COOLING MOTOR FAN
Component:	Man Hours: 0.3
Maintenance Task: CLEANING	Interval/Miles: 30,000

PROCEDURE:

PRELIMINARY OPERATIONS

Set the Vehicle in safety conditions in accordance with LACMTA Maintenance Shop Regulations:

1. Remove Electrical Power from Vehicle by lowering the Pantograph and deenergizing the catenary.
2. Lock out and tag out the catenary in accordance with all LACMTA Safety Rules, Regulations, Policies, and Procedures

NOTE The tag must indicate the name of the person who removed Power.
That person knows why the Power was removed and when it safe to restore it.
Only the individual whose name appears on the tag or a person with his approval should remove the tag and restore Power.

3. Place both the CB 2F06 (Propulsion Motor Fan Circuit Breaker located on the LV Locker both cars) to OFF position.

INSPECTION

To perform the task proceed as follows (Refer to Figure 1):

1. Inspect Motor Fan Compartment for general condition visible damage, missing / loose hardware.
2. Clean the Motor Air inlet with air gun and clean the Fan Motor Cooling Fins with a degreaser.
3. Check the Motor Power Supply Terminal Board for missing /loose hardware, visible gasket damage / deformation and relevant Cable Bushing for correct tightness.
4. Check the Motor Power Supply Cable for visible damage / loose / missing clamp.
5. Check the Grounding Wire and relevant connections for missing / loose parts, signs of fraying / overheating.
6. Clean the Grill using the air gun, if needed.
7. Check Inverter Air Outlet Grille for damage / deformation, loose / missing hardware.
8. Note any areas / items requiring corrective maintenance.
9. Restore Electrical Power to Vehicle.

P2550 PREVENTIVE MAINTENANCE SHEET

Card Code: R-P-07-03-07-00/C-00

System:	Sheet:
PROPULSION	4/4
Subsystem/Assy: TRACTION INVERTER HV COMPONENTS	Unit: INVERTER COOLING MOTOR FAN
Component:	Man Hours: 0.3
Maintenance Task: CLEANING	Interval/Miles: 30,000

PROCEDURE (CONT'D):

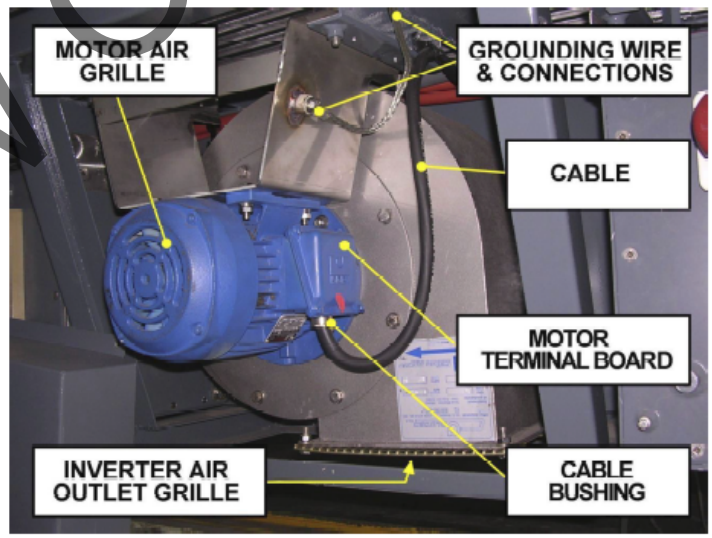


Figure 1 - TRACTION INVERTER - MOTOR FAN

Figure 1.7 OEM-prepared PM Sheet

Learning Application 1B

With the help of your instructor, examine the checklists for inspection and maintenance that you agency uses for the rail car's propulsion and dynamic braking system.

1. Attach a copy of a blank checklist to your class notes.

2. Check which areas of your checklist shows you how to perform tests following specific procedures provided by your agency.

3. Where are these procedures (or manuals) stored in your agency's maintenance shop?

4. While working on the rail car how will you access these procedures?

5. In the space below, write down other specific instructions regarding written procedures for completing the inspection and maintenance checklist.

MODULE 2

AC Propulsion

Outline

Purpose and Objectives

The purpose of this module is to provide participants with framework of the steps involved in inspecting, maintaining, and testing major components of an AC propulsion system on rail cars used in major U.S. transportation agencies.

Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Inspect and maintain propulsion inverter
- Inspect and maintain master controller
- Inspect and replace IGBTs
- Inspect and maintain propulsion blower
- Inspect and replace filter capacitors
- Inspect and clean choke/ line inductor
- Inspect and maintain high speed circuit breaker
- Inspect, test, replace ground fault sensor
- Inspect and maintain contactor/arc chutes
- Check resistance with multimeter
- Clean and lube knife switch
- Inspect and maintain DC link Inspect, clean, lube traction motor and traction motor blower
- Inspect and maintain speed sensors/tach sensors
- Inspect and maintain speed sensor cable
- Check contacts
- Inspect and clean braking resistors
- Inspect brake choppers

Key Terms

- Arc Chute
- Blowout Coil
- Car Monitoring Unit
- Contacts
- Line Breaker Shunt
- Master Controller
-
- Propulsion Logic
- Traction Container
- Trip Coil

2-4 BLOWER FOR PROPULSION CONTAINER

The propulsion blower provides cooling air for the propulsion container. Air is drawn in through screens and grilles on the sides of the vehicle and passed over the cooling fins of the IGBT modules and Line Reactor. This cooling air is necessary to maintain the temperature of the IGBTs. A rise in temperature outside of the IGBTs limits will result in a reduced performance and will directly affect the propulsion system.

If there is a failure of the propulsion blower while the train is in operation, the resulting increase in temperature in the propulsion system will cause the Traction Control Unit (TCU) to signal a restricted speed mode for the vehicle.

Propulsion Blower Inspection and Maintenance	
General Recommendations	Agency Requirements
• Check for voltage at the blower motor. • Check that blower and housing are secured to the OEM recommended tightness. • Check for dirt build up on the blower blades. • Check clearance between blower and housing and examine for bearing failure. • Check that motor shaft is not bent. Listen for excessive bearing noise. • Check and clear inlet and exhaust screens, ducts, and filters. • With power removed, check wiring with an ohm meter.	

High Speed Circuit Breaker (HSCB)

Newer rail vehicles rely on high speed circuit breakers to protect them from disastrous situations. HSCBs have two major functions:

1. Provide short circuit protection to the propulsion system.

2. Connect the power source (e.g. catenary, third rail) voltage to main voltage of the propulsion system and disconnects from that power source when faults that may cause currents in excess of line switch opening capacity to occur.

Figure 2.5 Side view of a High Speed Circuit Breaker –courtesy PATCO

At best, a faulty HSCB unit can cause the trains to stand still; at worst, a faulty unit can blow up parts of the rail vehicle's propulsion infrastructure potentially leading to human causalities.

Proper testing, regular inspection, and accurate maintenance of HSCBs are therefore critical functions of a rail car maintainer's duties.

With assistance from your instructor or in addition to hands-on lessons, list your agency's With assistance from your instructor or in addition to hands-on lessons, list your agency's requirements for inspection or maintenance of the HSCB next to the general recommendations in the following table.

High Speed Circuit Breaker (HSCB) Inspection and Maintenance	
General Recommendations	Agency Requirements
• Adjust high-speed circuit breaker • Check for and remove excessive dust and debris. • Inspect and clean arc chute • Ensure all components are secure and serviceable. • Check all small wiring and cable insulation for overheating and damage. • Inspect high-speed circuit breaker contactors. • If indicated, overhaul high-speed circuit breaker following recommendations by OEM and agency.	

2-6 DYNAMIC BRAKING

During dynamic braking, the traction motors act as generators, converting the energy of the rotating wheels into electrical current. The conversion of kinetic energy into electricity slows the rail car. This module has a section dedicated to the inspection and maintenance of AC motors and in this section the focus is on two major components: braking resistors and brake choppers.

Braking Resistors

Braking resistors dissipate dynamic braking energy and discharge the filter capacitors. The following lists separate steps for inspection, cleaning and testing braking resistors.

Braking Resistors Inspection	
General Recommendations	Agency Requirements
• Make sure components securing brake resistors such as cables, mechanical parts, or shields, are not loose or damaged. Repair or replace if necessary. • Make sure screws fastening braking resistor to car underframe are secure and torque mark is present. If not, torque to OEM-recommendations and apply torque seal as recommended. • Perform a megger test to ensure suitability of component. o Check for cracked or broken mounting insulators. Even if crack is suspected, in the insulator ceramic spacer for example, perform megger test. o Check braking resistor for abnormal overheating, burned open, distorted, or sagging elements. • Make sure wiring insulation is undamaged, i.e.: no cracks or abrasion damage are present. • Inspect resistor assembly grillwork and remove any objects (paper, plastic bags, etc.) that may restrict cooling air flow. • Make sure no excessive accumulation of dirt or contaminating materials are	

The following case study shows the application of an LED-indication system that indicates the condition of the brake chopper modules.

Case Study 2.7: Denver Regional Transportation District (RTD)

Configuration of brake chopper modules on RTD's SD-160 LRV manufactured by Siemens©

Brake Chopper Configuration: Each inverter has a brake chopper module. Each brake chopper has eight IGBTs which are mounted in two rows of 4 on each module board. The four IGBTs in each row are connected in parallel. The brake chopper board has 4 terminal posts.

LEDs indicate the condition of the IGBTs. Using a IGBT phase module tester which plugs directly into the brake chopper module's 15-pin test plug receptacle, the rail car technician can test the circuit.

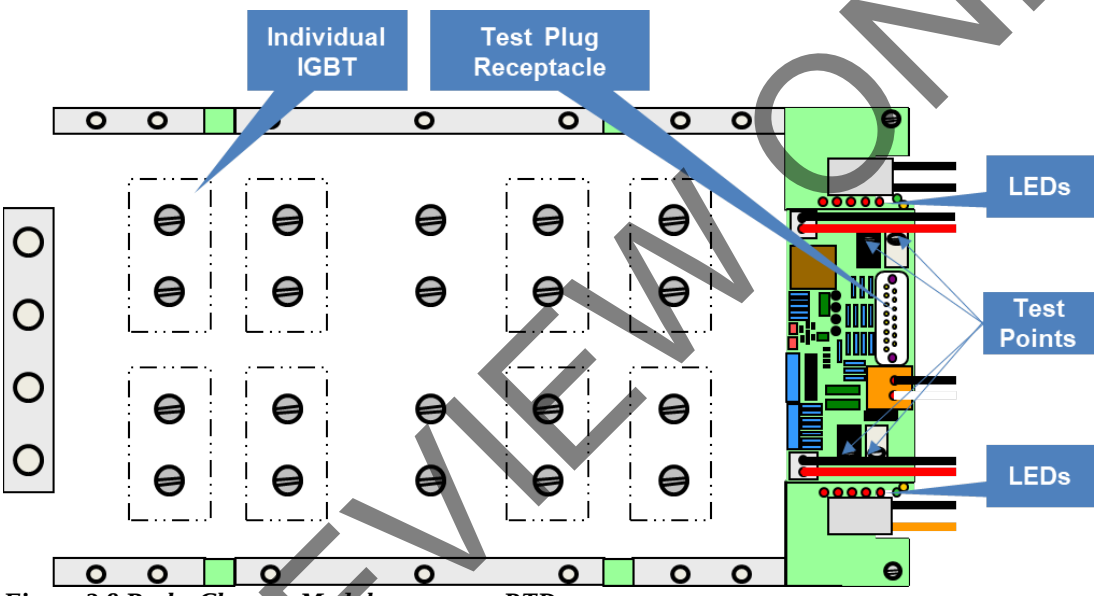


Figure 2.8 Brake Chopper Module –courtesy RTD

2-7 POWER INVERSION

The participant should recall from Course 103 that power inversion refers the capability of certain devices in the propulsion circuit that change the high speed DC input voltage to AC voltage for output to the AC motors. The two major components in power inversion are propulsion logic control unit and the propulsion inverter.

Propulsion Logic Control Unit

The propulsion control unit (PCU) is the housing for the propulsion logic controller.

Propulsion Logic Control Unit Inspection and Maintenance	
General Recommendations	Agency Requirements
• Remove connection to main power • Verify that all mounting and supporting hardware is firmly fastened. • Inspect all connectors and wires for wear, corrosion, or any other visible change. • Inspect for dirt or debris. • If necessary, clean with non-conductive cloths.	

Case Study 2.8: **Chicago Transit Authority (CTA)**
Procedures for inspecting the Logic Control Unit and components on CTA's 5000 Series Rapid Transit Cars. Numbers in parentheses refer to Figure 2.9

1. Verify all mounting screws (2) are firmly fastened on VCU-C unit (1), MIO1 unit (6), MIO2 unit (7), and battery holder (8).
2. Verify ground strap (3) is securely fastened to ground screw (4) on VCU-C (1), MIO1 unit (6), MIO2 unit (7), and to ground stud on mounting panel. Make sure that ground strap (3) is not abraded or corroded.
3. Verify battery holder cable is securely fastened to connectors on battery holder (8) and VCU-C (1) and that cable is not abraded or corroded.
4. Ensure that male and female Multifunction Vehicle Bus (MVB) termination plugs (5) are fastened securely to VCU-C (1) and MIO1 unit (6).
5. Inspect all connectors and wires for wear, corrosion, or any other visible damage.
6. Inspect for dirt or debris. Clean, if necessary, as follows:
    a. **Use soft cloth to wipe dust off unit, related components, and connecting** hardware.
    b. Verify air holes behind unit face are unobstructed.
    c. If necessary, use soft brush to remove dust buildup in air holes or between cooling fins of unit.

2-8 AC TRACTION MOTORS

AC traction motors convert the electrical energy produced by the propulsion inverter into mechanical energy which is then used to propel the train forward. The motors can also be used as generators which convert the kinetic energy of the train back into electrical energy to slow the train via dynamic braking.

AC Traction Motor Inspection and Maintenance	
General Recommendations	Agency Requirements
• Air inlet and outlets o Clean o Inspect for debris or damage • Speed senor o Clean • Traction Motor Assembly o Inspect for external damage o Check external connections o Inspect for signs of condensation o Overhaul per OEM and agency recommended procedures • Bearings o Re-lubricate o If indicated, replace per OEM and agency recommended procedures.	

Case Study 2.9: Bombardier 5000 Series A- and B- Cars, **Chicago Transportation Authority (CTA)**

Inspect Traction Motor

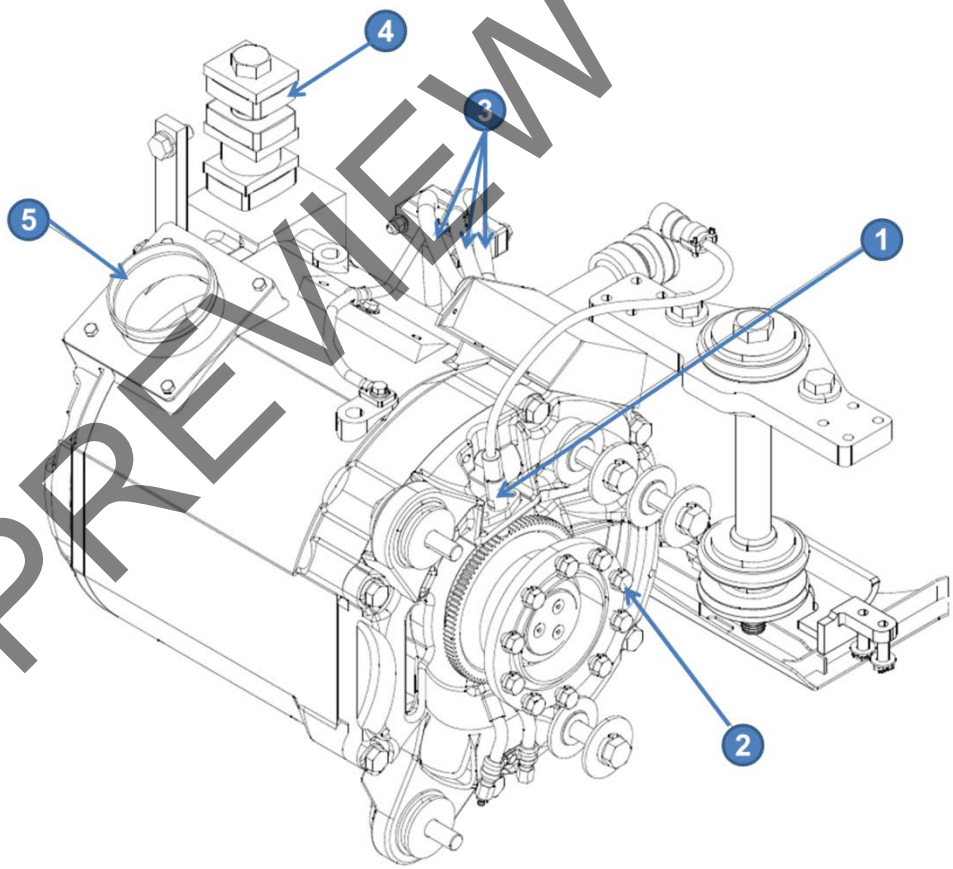
1. Inspect speed sensor (1) and cable for damage or signs of burning and overheating. Replace cables and/or speed sensor if necessary.

2. Inspect coupling flange bolts (2). Verify torque mark on fastener, washer and mounting surface is clearly visible and all segments are aligned. Replace any loose, missing, or damaged attaching hardware.

3. Inspect truck cable leads (3) for damage or signs of burning and overheating. Replace cables if necessary.

4. Inspect traction motor mounting assembly including motor mount hardware and motor mount bushings (4). Verify torque mark on each fastener, washer, and mounting surface is clearly visible and all segments are aligned. Replace any loose or missing hardware.

5. Check air inlet duct (5) for damage. Replace if required.



MODULE 3

DC Propulsion

Outline

Purpose and Objectives

The purpose of this module is to provide participants with an understanding of the steps involved in inspecting, maintaining, and testing major components of an DC propulsion system on rail cars used in major U.S. transportation agencies.

Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Inspect and maintain chopper
- Inspect and maintain cam control
- Inspect and maintain master controller
- Inspect and maintain propulsion logic control unit
- Inspect and maintain ventilation system
- Inspect and maintain high speed circuit breaker
- Inspect and maintain contactor/arc chutes
- Inspect and maintain resistance banks
- Inspect and maintain knife switch
- Inspect and maintain overcurrent protection

Key Terms

- Main chopper circuit
- Braking chopper circuit

3-1 OVERVIEW

A DC propulsion system is one that uses cam controllers or chopper circuits to supply power to direct current (DC) traction motors thereby providing the means to accelerate the rail car and provide dynamic braking. It is a complex system with many components.

This course has organized the DC propulsion system into four functional areas: switching, filtering, traction control and dynamic braking, and motors (Figure 3.1). Within each of the four areas, this module describes standard maintenance procedures of the main components as well as some of their sub-components. These procedures may not be specific to the rail cars the participant is expected to inspect and maintain at their rail transportation agency. This course should supplement further training either in the classroom or on the job on rail vehicles specific to participant's agency.

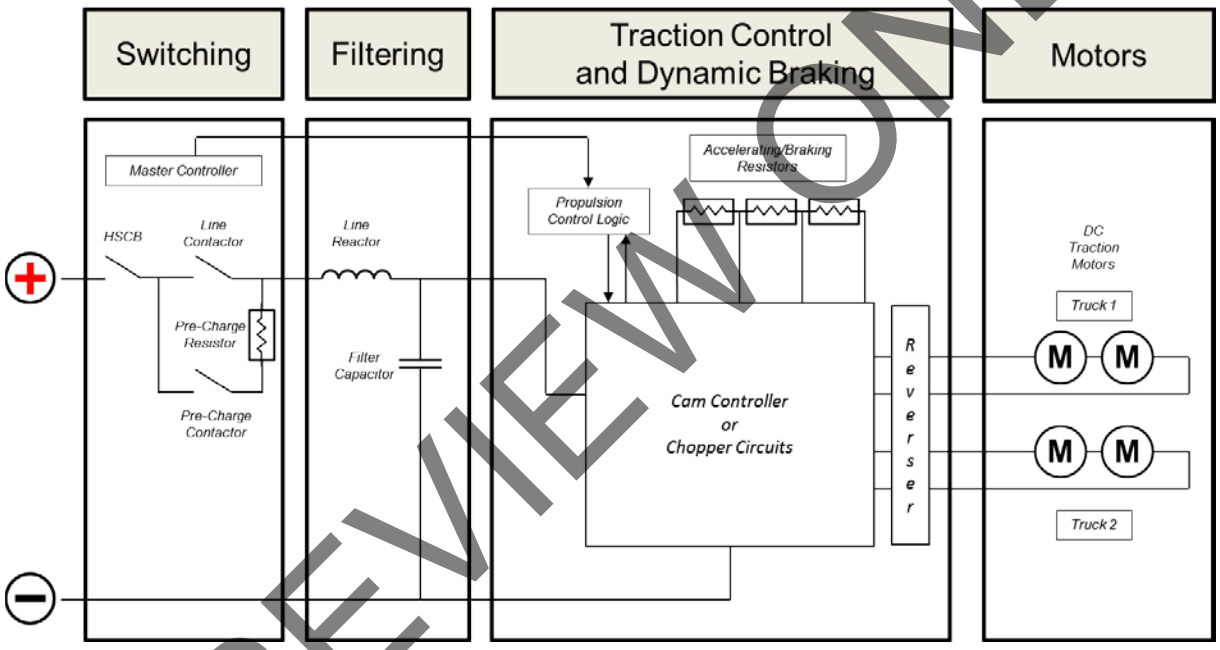


Figure 3.1 DC Propulsion Overview

This course helps the participant examine maintenance procedures that can be modeled in their approach to inspecting and maintaining major components of a rail vehicle's propulsion system.

In order to incorporate these variations in the rail car's propulsion system, this module uses a three-part approach in listing recommended practices for inspection and maintenance:

1. An overview of the propulsion component given a general layout as shown in Figure 3.1.
2. A guide showing general recommended inspection and maintenance of that component beside which the participant can note their agency-specific inspection and maintenance requirements for that component.
3. A case study from a Consortium rail agency listing the steps that agency follows for inspecting and maintaining that component.

3-2 MASTER CONTROLLER

During revenue service the master controller is operated by the train operator in the cab. The master controller requests drive and/or braking rates via manipulation of a p-signal evaluated by the propulsion logic control unit.

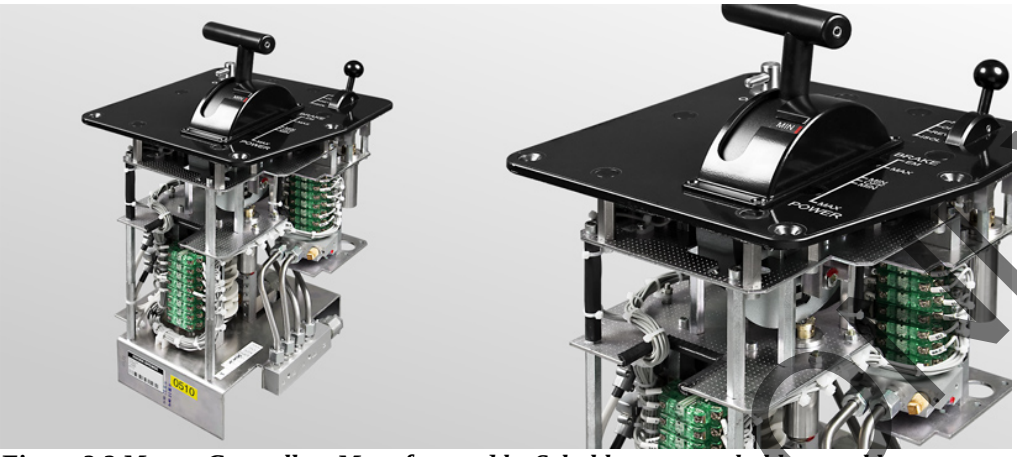


Figure 3.2 Master Controllers Manufactured by Schaltbau www.schaltbau-gmbh.com

Master Controller Inspection and Maintenance	
General Recommendations	Agency Requirements
• Remove connection to main power • Vacuum and clean surface components. • Test the handle mechanical interlocks. • Visually inspect movement steps to verify contact movements and connections. • Using PTE and software interface, verify signals received to the logic control unit. • Clean contacts using non-corrosive cleaner and non-conductive cloths. • Tighten connections as needed. • Inspect connection harness. • Replace Master Controller when all maintenance is exhausted and unit continues to fail (rare)	

Case Study 3.2: **Niagara Frontier Transportation Authority (NFTA)**

1. Seal all air leaks at the inlet and outlet sides of the blower to prevent the entrance of dirt or loss of air.
2. Change filters per OEM recommendations and agency guidelines.
3. Check motor brushes per OEM and agency recommendations.
4. Check for damage of wheel of the fan.
5. Check fan wheel balance. If vibration is noticed, check:
    a. Bearing and drive alignment
    b. Shaft straightness
    c. Wheel loose on shaft
    d. Loose or worn bearings
    e. Loose mounting bolts
    f. Motor out of balance
    g. Worn or corroded wheel
    h. Accumulation of material on wheel
6. Check for wear on fan blades. Replace or rebuild per agency recommendations.

The line input to the propulsion container consists of a line contactor, a pre-charging circuit, and the line reactor. The pre-charging circuit functions to slowly charge the DC link capacitor up to required voltage with the pre-charging resistor. Together with the DC link capacitor, the line reactor forms the line filter.

Line Contactor

The line contactor acts as the main high voltage connection for the propulsion container. Its task is to activate and deactivate the charge switch. With the line contactor open, the power flows through the pre-charging contactor and pre-charging resistor to charge the uncharged link capacitors. It can (and does) operate under load in order to shut off supply voltage, in both normal operation as well as some emergency situations.

Figure 2.4 Siemens™ Line Contactor with Arc Chute-courtesy SDMTS.

Line Contactor Inspection	
General Recommendations	Agency Requirements
• Visually inspect line contactor. • Check contact tips and arc chute.	

Case Study 3.4: Port Authority Transit Corporation (PATCO)

Inspect Line Contactor

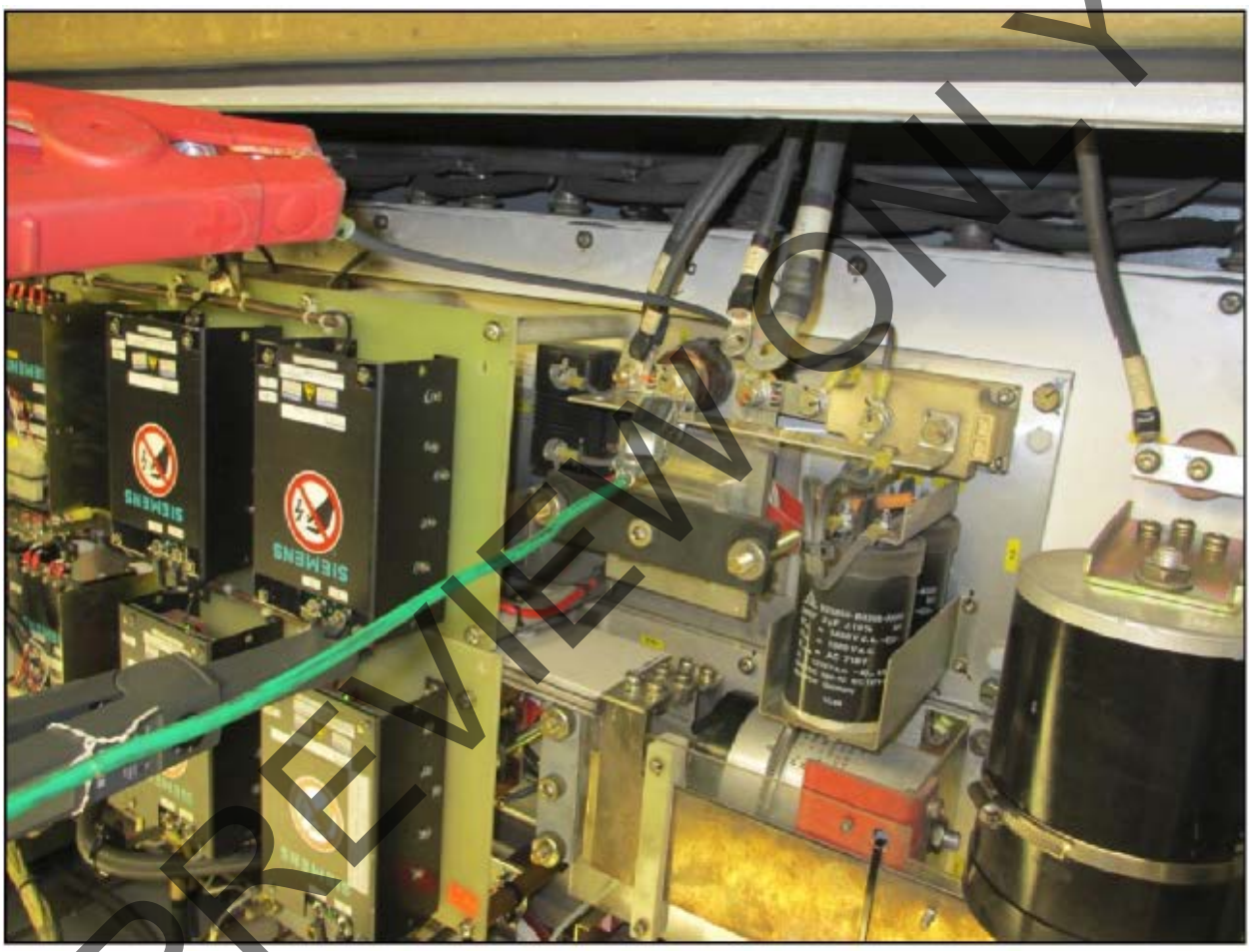
1. Unlock and open the circuit breaker panel behind the operator in the cab and turn off the PROPULSION BRAKE ELECTRONICS circuit breaker.
2. Open the covers of the high voltage cubicle.
3. Remove the arc chute.
4. Visually check the condition of the contacts.
    a. If the contacts are worn to their limit, replace the contacts per OEM recommendations.
    b. Re-install the arc chute.
    c. Re-install the high voltage cubicle.

8. The Field Module Testing lists four steps. On the photo below, circle and label the following as “a”, “b”, and “c”:

    a. The disconnected cable from terminal F11

    b. The jumper wire from the positive battery lead to terminal F11.

    c. Load resistor connection at terminal F12.



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Braking Resistors

Braking resistors dissipate dynamic braking energy and discharge the filter capacitors. The following lists separate steps for inspection, cleaning and testing braking resistors.

Braking Resistors Inspection	
General Recommendations	Agency Requirements
• Make sure components securing brake resistors such as cables, mechanical parts, or shields, are not loose or damaged. Repair or replace if necessary. • Make sure screws fastening braking resistor to car underframe are secure and torque mark is present. If not, torque to OEM-recommendations and apply torque seal as recommended. • Perform a megger test to ensure suitability of component. o Check for cracked or broken mounting insulators. Even if crack is suspected, in the insulator ceramic spacer for example, perform megger test. o Check braking resistor for abnormal overheating, burned open, distorted, or sagging elements. • Make sure wiring insulation is undamaged, i.e.: no cracks or abrasion damage are present. • Inspect resistor assembly grillwork and remove any objects (paper, plastic bags, etc.) that may restrict cooling air flow. • Make sure no excessive accumulation of dirt or contaminating materials are present. Steam clean, if necessary.	

Case Study 3.7: Denver Regional Transportation District (RTD)

Steps to Inspecting DC Motor Brush

Note: The surface of the commutator should be evenly colored, smooth, and clean.

1. Inspect condition of the copper segment edges. If necessary, deburr them with a copper brush. If undercutting between the copper segments is less than 0.8 mm deep, rescrape.
2. If the insulating slots are less than 0.8 mm deep, rescrape and break the edges with a deburring too.
3. Flashover tracks indicate poor brush contact. If flashover is present, commutator must be ground or skimmed.

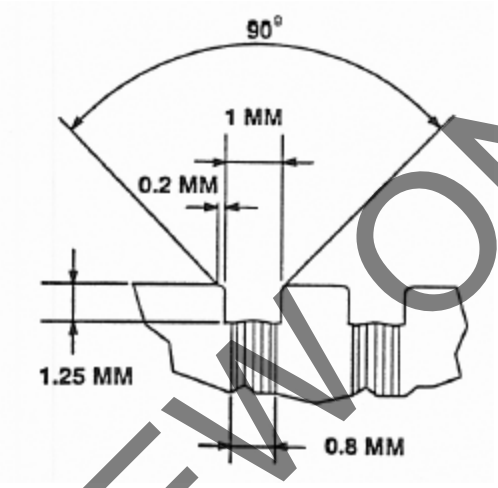

Figure 3.6 Commutator Segments -courtesy Denver RTD

Learning Application 3E

With direction from your instructor or workplace mentor, compare the illustration below to the type of DC traction motor you will be working on in the rail car maintenance facility at your agency. Circle which

1. What is the main objective of this bulletin?

2. List the six materials and tools needed during the maintenance procedures.

Reverser

The reverser changes the direction of rotation of the traction motors by reversing the direction of the current through the motor fields. Generally, the rail car technician is expected to test the reverser operation during a complete check of the other motorized driving direction switches. Reversers may require other inspection and maintenance procedures such as lubrication of its drum with OEM recommended lubricants.

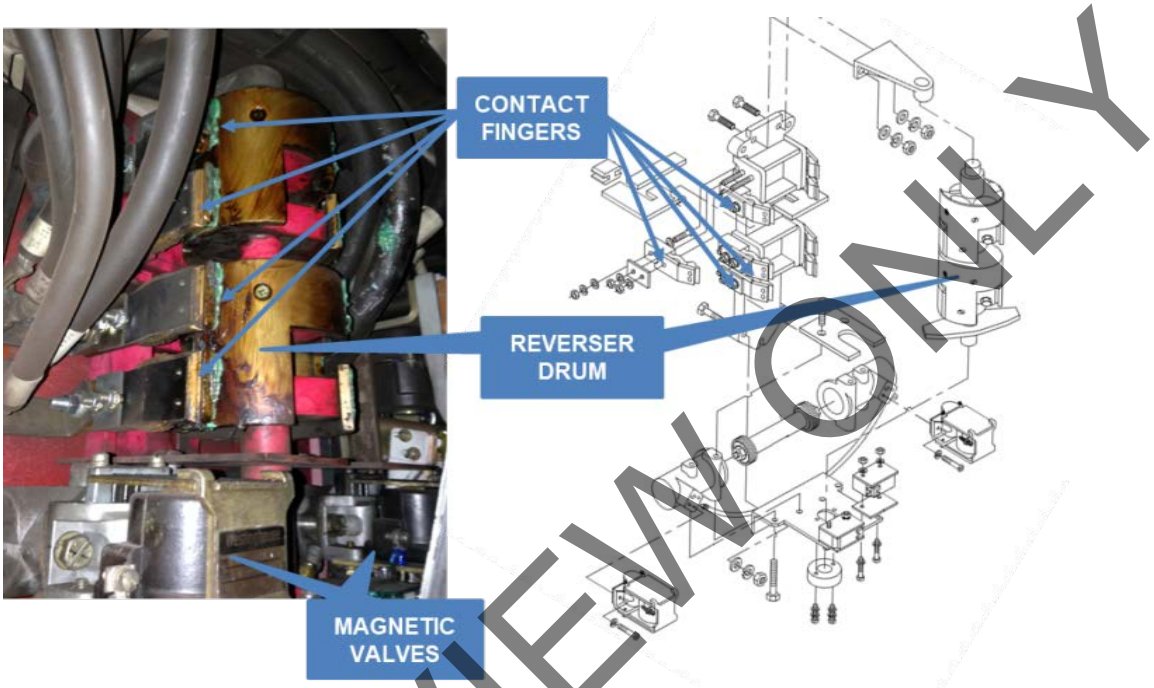

Figure 3.7 Reverser Components, Photo and Drawing –courtesy BART

Reverser Inspection and Maintenance	
General Recommendations	Agency Requirements
• Visually inspect reverser contacts for wear. • Clean if indicated. • Lubricate reverser drum following OEM and agency recommendations.	

Case Study 3.8: Bay Area Rapid Transit (BART)
Steps to Lubricating Reverser

1. Operate one magnetic valve to move drum.
2. Use acid brush to apply a light coat of lubricant to drum. Use only OEM-specific recommendations for acid brush and lubricant.