

Door control units maintenance guideline

- What is door control units? (DCUs)

DCUs serve as the "brain" of train door systems, controlling and monitoring door operations to ensure safety and reliability. They handle various door types (sliding, plug sliding, single leaf, double leaf) and power systems (electric-motor driven, spindle driven, pneumatic-air cylinder, belt driven, arm). Key features include controlling door movement, detecting faults or malfunctions, preventing unsafe door operations (e.g., opening when the train is moving, closing when someone is in the doorway), logging faults/events, and compensating for environmental influences and mechanical wear.

- Installation, maintenance, testing, and troubleshooting of transport door systems for double glider door system.

1. Checks to be carried out upon initial service

- Release all air from the door system via the filter regulator before any checks.
- Manually open and close the doors to check free movement, ensuring no impediment from seals or flaps.
- Check that door guide rollers and tracks are dry and free from grease, and all fasteners/bolts are secure.
- Apply 5.5-6.0 bar (80-90psi) air pressure, then check reed switch positions, open/close speeds (2-3 seconds for opening, 3-3.5 seconds for closing), and pipe/fitting leaks.
- Check reed switch positions, with door(s) closed. Adjust if necessary.
- Check open / close speeds. Optimum speeds are: 2-3 seconds open ; 3-3.5 seconds closing. Adjust if necessary.
- Check nylon pipe and fittings for leaks or damage. Check security of all pipes.
- Check security of all electrical wiring and connections where applicable.
- Visually check all aperture seals / door nosing rubbers, doors, handrails, door-shafts etc for security and damage.
- Operate the doors to check alignment and satisfactory operation. Adjust if necessary.
- Operate the doors to check satisfactory operation of all open and close buttons located in the drivers console, above the doors, and those positioned externally.

2. Testing procedure

All tests should be undertaken with the door system correctly installed. The engine should be running to provide full electrical power and air pressure.

Conduct the following test and use the fault-finding charts where applicable if a fault is detected. Please note that all tests must be conducted on a stationary vehicle.

- Open and close the doors using the drivers controls (push buttons on console, footswitch on floor etc)
- Remove handbrake and try to open doors from the drivers controls. If a handbrake interlock is fitted, the doors should not open.
Re-apply the handbrake when the check is completed.
- Open the door by pressing the emergency open button mounted near the door. This will open the door by pneumatics only.
- Close the door by pressing the interior close button.
- Open the door by pressing the emergency open button mounted on the exterior of the vehicle. This will open the door by pneumatics only.
- If obstacle detection is fitted, close the door using the drivers control and obstruct on of the leading edge rubbers. Confirm the doors re-open automatically. Repeat the test, obstructing the other leading edge rubber.

3. Maintenance guideline

1) Daily schedule

- Operate the doors to check satisfactory operation of all open and close buttons located in the drivers console, above the doors and those positioned externally.
- Operate the doors to check alignment and satisfactory operation. Adjust if necessary.
- Test the sensitive edge system (if fitted).
- Check the air pressure at the filter regulator. Should be 5.5-6.0 Bar (80-90psi) as indicated on the gauge if fitted.

2) Monthly schedule

- Visually check all aperture seals / door nosing rubbers, doors, handrails, door-shafts etc for security and damage. Note that the nosing rubbers contain the sensitive edge components where fitted.
- After releasing all air from the door system, manually open and close the doors, checking that they are free running. Ensure top seal, aperture seal or door active flaps are not impeding movement.
- Check the pneumatic pipes running from the sensitive edge nosing rubber is free from damage, defects and is securely attached to the pressure switch. Check that the pipe is not twisted, distorted, crushed or trapped along its entire length.
- Check the filter regulator bowl for signs of excessive moisture or foreign matter. Excess moisture can be removed via the drain screw located on the bottom of the filter regulator bowl. Excessive foreign matter may be caused by potential failure or wear of other components within the pneumatic system on the vehicle not directly linked to the door system. Whilst not the responsibility of Transport Door Solutions, we consider it prudent to check the system according to the recommendations laid down in the appropriate service / inspection manuals.
- Check the general alignment of the door-leaves and check that all fasteners are tight.
- Operate the doors and check that they locate correctly when they are both open and closed. Adjust if necessary.
- Check that shelf-plate fasteners and fixings are tight.
- Check that reed-switches are secure and all fixings are tight.

- Check the condition of electrical wires and connections where applicable. Replace or refit as appropriate.
 - Check the condition of pneumatic pipes and fittings where applicable.
 - Check the pneumatic pipes and fittings for leaks. Replace or refit as appropriate.
 - Check open / close speeds. Optimum speeds are: 2-3 seconds open ; 3-3.5 seconds closing. Adjust if necessary.
 - Check the pneumatic actuators, valves, filter regulator and all control open / close buttons for damage or leaks.
 - Check the operation of all open / close buttons.
 - Check the aperture seals and active flaps for damage or deterioration. Replace as appropriate.
 - Clean (with warm soapy water) the door and shelf-plate components, inspecting at the same time for damage or loosening of components.
4. Typical tool requirements:
- Spanners: Open & Closed Ended (24, 23, 22, 19, 17, 16, 13, 12, 10, 8, 7, 4 mm A/F); Adjustable Spanner (up to 25mm opening S-M-L); Sockets
 - Allen Keys: Hex & Ball Nose Ends (1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0, 8.0, 12 mm A/F); Tee Bar Type (3.0, 4.0, 5.0, 6.0, 8.0)
 - Screw Drivers Bits: 4mm Flat Blade Screwdrivers (S-M-L); No.PZ2 Pozi-Drive Screwdriver; No.PZ2, No.PZ3 Pozi-Drive Bits
 - Miscellaneous: Internal & External Circlip Pliers; Pliers (flat & tapered ends); Stanley Knife; Scissors; small Combination type Hammer
5. Air-bleed door control system troubleshooting (key steps):
- For spontaneous closing/delayed opening/ failure to open: Check air pressure, pipes, valves, and buttons; replace faulty components as needed.
 - For failure to close/delayed closing/spontaneous opening: Inspect air supply, pipes, filter regulator, actuator, and valve; address leaks or replace parts.
 - For slamming (open/close): Adjust speed controls, piston-rod length, or crank position; replace actuator if issues persist.
 - For loose doors when closed/slow-erratic movement: Increase pressure, adjust piston-rod, check for resistance, or clean/adjust speed screws.
- Based on LUL's *1996 stock defect guide* and *defective in service instructions* referenced in the document, the operational guidelines for train operators when door system faults occur are as follows:
 - For doors failing to open
- 1) All doors on one car failing to open: Try door control buttons again, inform the controller, and check the TMS miniature circuit breaker in the affected car.

- 2) All doors on the whole train failing to open: Inform passengers of the delay, operate the ESDC (Emergency Saloon Door Control) switch, use back wall door-open buttons, then return the ESDC switch to normal. If doors still don't open, use outside door valves to detain passengers.
 - 3) One doorway failing to open on one car: The train can remain in service until reaching a depot.
 - 4) More than one doorway failing to open on the platform side: Withdraw the train from service.
- For doors failing to close
- 1) A single door failing to close: Check for obstructions, attempt to close the door again, and inform control if it remains open.
 - 2) All doors on one car failing to close: Use the porter's button (on the outside of each car) to close doors; if unsuccessful, check and reset relevant door miniature circuit breakers. If issues persist, inform control, operate the door isolating cock in the affected car, manually close the doors, and operate the TDIC (Train Door Interlock Cut-Out) switch.
 - 3) All doors on the train failing to close: Shut down the driving cab, trip and reset the TMS2 miniature circuit breaker. If the fault persists, try closing doors using buttons in another driving cab; if still unsuccessful, inform control and follow their instructions.
- General requirements
- 1) If doors cannot be closed at a station, operators must not move the train, inform the controller, detain passengers, and wait for assistance.
 - 2) If door close buttons are defective: A single faulty button allows the train to remain in service to a depot, but all buttons failing requires the train to be withdrawn.

Case study:

This is a Rail Accident Investigation Branch (RAIB) report investigating an incident on 1 September 2018, where a London Underground Jubilee line train (1996 tube stock) travelled between Finchley Road and West Hampstead stations with 10 out of 28 passenger doors open. The train reached a maximum speed of 62 km/h during the 56-second journey, with approximately 30 passengers on board, but no injuries occurred.

Key Details of the Incident

- The train was operating in Automatic Train Operation (ATO) mode. At Finchley Road station, some doors opened without being commanded by the train operator, and the operator couldn't control them via normal door buttons.

- The train operator bypassed the door interlock circuit using the Train Door Interlock Cut-Out (TDIC) switch (intended to prevent departure with open doors) while handling the issue. They failed to notice the open doors before departing and during the journey.
- The operator's actions were likely influenced by a sudden increase in workload (from low ATO-mode workload), fatigue (due to insufficient sleep), and/or low blood sugar (from prolonged fasting).

Causal and Underlying Factors

- **Technical issues:** Unusual door behavior resulted from train control system overload (due to excessive fault messages from defective ventilation fans and passenger information systems), causing train management components (TMCCs, TMRTs) to reboot. This left some doors in a "default passenger mode," allowing them to open via local buttons.
- **Operator actions:** The operator did not follow procedures, incorrectly used the TDIC switch instead of the Emergency Saloon Door Control (ESDC) switch, and failed to check door status (e.g., unlit Doors Closed Visual [DCV] lights).
- **System deficiencies:** The 1996 stock trains lacked an audible warning when the TDIC switch was activated, violating LUL standards. Operator training inadequately prepared them for handling faults under time pressure in ATO mode.

Recommendations

- Review safety systems (including TDIC switches) on 1995 and 1996 stock trains to align with current good practice.
- Enhance operator training for fault response in ATO mode, using simulators and quick-reference guides.
- Implement routine downloading/analysis of train management system data to predict/prevent safety-critical failures.
- Improve operator awareness of how insufficient sleep and poor eating affect performance.

● Fault Handling

- If a door by-pass device is activated (to override safety systems), the crew must:
 - 1) Conduct a safety briefing to assign passenger observation positions .
 - 2) Notify the railroad's designated authority and adhere to operating rules .

- 3) Obtain approval from a Qualified Maintenance Person (QMP) or qualified person (QP) to continue service, with documentation of safety determinations .

- Malfunctioning doors must be isolated using door isolation locks (securing doors closed, signaling “closed” to the summary circuit, and cutting power to the door motor) .
- Unsealed by-pass devices must be reported immediately; trains may continue to the next repair point only if the door summary indicator functions correctly .
- **Maintenance Requirements**
 - Crew must verify by-pass devices are sealed in non-by-pass mode when taking control of the train (visual inspection or functional tests for summary indicator validity) .
 - Records of by-pass activations, unintended door openings, and repairs must be maintained in the defect tracking system .
 - End-of-train circuit integrity must be maintained; switches used to establish the circuit must be secured against unauthorized access .
 - As part of daily inspections, all door safety system override devices must be verified as inactive and sealed .
 - By December 6, 2018, railroads must train crews to identify/ isolate malfunctioning doors and conduct periodic operational tests of crew proficiency .

- **Maintenance Steps for Door Control-Related Components**

- 1) **Door Controls**

- **Control Unit**
 - Inspect the control unit for physical damage and secure connections.
 - Test functionality using portable test equipment.
 - Download software, reprogram the door controller, and check for fault codes.
 - Replace the control unit if faults persist.
- **Door Cut-Out**
 - Test the door cut-out and individual door interlocks.
 - Adjust or repair faulty components; replace the door cut-out if necessary.

- **Relays/Solenoids**
 - Test the operation of relays and solenoids.
 - Replace faulty relays or solenoids.
- **Motors/Drive Mechanisms**
 - Test motor operation and check drive mechanism connections for wear.
 - Adjust motor parameters and repair repairable parts; replace motors or drive mechanisms for severe faults.
- **Limit, Proximity, and Micro Switches**
 - Test switch triggering functions and signal output.
 - Adjust switch positions; replace damaged switches.
- **Sensors**
 - Test sensor detection range and signal transmission.
 - Calibrate sensor positions; replace faulty sensors.
- **Sensitive Edges**
 - Test the triggering sensitivity of sensitive edges.
 - Adjust sensitive edge positions; replace damaged ones.
- **Emergency Release Mechanism**
 - Test manual operation of the emergency release mechanism.
 - Lubricate components, adjust the release device, and replace the entire mechanism if needed.
- 2) Door Panel and Track**
 - **Rollers/Hangers and Linkage**
 - Inspect rollers and hangers for wear or looseness; lubricate moving parts.
 - Adjust roller positions; replace worn rollers, hangers, or linkage.
 - **Door Guide**
 - Check for deformation or foreign objects in the guide; clean the guide.
 - Adjust guide alignment; replace damaged guides.

➤ **Gaskets/Seals**

- Inspect gaskets for aging, damage, or misalignment.
- Adjust gasket positions; replace damaged gaskets or seals.

3) Advanced Troubleshooting

➤ **Electrical/Electronic Faults**

- Troubleshoot electrical circuits for door operation using a multimeter to test voltage, current, and resistance.
- Inspect terminal connections; repair loose or corroded joints.

➤ **Mechanical Operation Faults**

- Manually operate door mechanisms to identify jams, abnormal noises, or other mechanical issues.
- Adjust door alignment, lubricate key moving parts, and replace excessively worn mechanical components.

➤ **Software-Related Faults**

- Connect to the door control system via a laptop to read fault logs and real-time data.
- Reload software programs and calibrate system parameters.

● **General Repair Framework**

- **Fault Identification:** Use the DCU's fault code display (e.g., dark screen, specific error codes) to identify the issue.
- **Root Cause Analysis:** Refer to the "Probable causes" for each fault to narrow down potential issues (e.g., wiring faults, component damage, incorrect settings).
- **Corrective Actions:** Follow step-by-step instructions to repair or replace faulty components, adjust settings, or rewire connections.

● **Key Repair Steps for Common Faults**

1. Power and Display Issues

- 1) **Fault:** Display is dark/no power.
- 2) **Causes:** Overloaded 24V control circuit, short circuit, water ingress, no input voltage, or

faulty DCU.

3) *Repair Steps:*

- Disconnect all electrical loads and measure current consumption to check for overloads; use a higher-capacity DCU if needed.
- Inspect for water damage; replace with a water-resistant DCU (e.g., TS in housing XL) if damaged.
- Verify input voltage; restore correct mains supply per technical data.
- If the DCU remains non-functional in delivery condition (all cables disconnected), replace the DCU.

2. Safety Circuit Faults

1) **Fault:** Safety circuit open (e.g., pass-door contact, slack-rope switch).

2) *Causes:* Open contacts, damaged spiral cables, incorrect wiring, faulty DIP switch settings.

3) *Repair Steps:*

- Check if pass-door closes flush; realign hinges or adjust contacts.
- Test spiral cables for continuity; replace if damaged.
- Verify wiring at terminals (e.g., X2.1-X2.2) and correct per diagrams.
- Adjust DIP switch positions in junction boxes or WSD modules per instructions.

3. Emergency Shutdown or Brake Issues

1) **Fault:** Emergency shutdown switch actuated or safety brake triggered.

2) *Causes:* Activated emergency switch, faulty brake contacts, overloaded drive unit.

3) *Repair Steps:*

- Reset the emergency shutdown switch and check for continuity in the circuit.
- Inspect brake connections; replace damaged brake components or wiring.
- Allow the motor to cool if overloaded; reduce door cycles if exceeding rated limits.

4. Communication/Network Faults

1) **Fault:** Radio transmission failure (WSD door module).

2) *Causes:* Obstacles in radio path, overlapping channels, low battery, misaligned antenna.

3) *Repair Steps:*

- Remove obstacles or relocate the DCU to ensure unobstructed radio links.
- Reassign radio channels to avoid overlaps (menu item 2.0).
- Replace WSD battery if voltage <3.2V under load; straighten or reposition the antenna.

5. Motor/Drive Unit Faults

- 1) **Fault:** Motor overload or thermal contact triggered.
- 2) *Causes:* Mechanical jams, excessive cycles, faulty thermal contacts.
- 3) *Repair Steps:*
 - Inspect door mechanism for damage (e.g., broken springs); repair or replace components.
 - Reduce door usage to stay within rated cycles; allow the motor to cool.
 - If thermal contact remains open after cooling, contact the manufacturer for replacement.

6. Sensor or Safety Edge Faults

- 1) **Fault:** Safety edge (8k2/1k2) or light curtain activation.
- 2) *Causes:* Obstacles, damaged sensors, loose wiring, water ingress.
- 3) *Repair Steps:*
 - Remove obstacles from the door area.
 - Test safety edges for continuity (8k2Ω or 1k2Ω resistance); replace if values are incorrect.
 - Dry or seal components if water-damaged; replace rubber profiles if deformed.

➤ Tools and Aids for Repair

- GfA-Stick: Use with GfA+ app to read fault logs, settings, and events via Bluetooth, aiding in diagnosis.
- Service Case: Includes reference DCU (TS 971), limit switches, and test components to isolate faults.