Metro

P3010
Los Angeles LRV

DOORS

Section 0400
RUNNING MAINTENANCE & SERVICING MANUAL

LIST OF EFFECTIVE PAGES

Insert latest changed pages; dispose of superseded pages in accordance with applicable regulations.

NOTE: On a changed page, the portion of the text affected by the latest change is indicated by a vertical line.

Total number of pages in this section (0400) is **142** consisting of the following:

Original	0	October 2020
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Revision	2	October 2021
Revision	3	April 2022
Revision	4	October 2022

PAGE	CHANGE NO.	PAGE	CHANGE NO.
i	4		
ii through xiv	0		
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SAFETY SUMMARY

Some of the procedures in this section are preceded by warnings/cautions regarding potential hazards in handling this equipment. These warnings/cautions should be carefully read and understood before proceeding. Failure to observe these precautions may result in serious injury to personnel performing the work and/or bystanders and /or damage to equipment or property. The key warnings for this equipment are as follows:

Electrical – The electrical equipment described in this section operates at voltages and currents that are extremely dangerous to life. Personnel should closely observe all generally prescribed cautions and warnings before performing any work on the LRV. Failure to heed these cautions and warnings by personnel could result in severe injury or death.

Chemicals – Follow safety precautions for handling hazardous chemicals as provided by the manufacturer. The ***manufacturer's*** warnings should be closely heeded to avoid personal injury.

Location – Special caution should be taken when accessing or servicing equipment located on the roof and under the car. Personnel should wear personal protective equipment (PPE), e.g., a safety harness while accessing or serving equipment located on the roof.

Weight – To prevent possible personal injury when attempting to remove or install equipment on the vehicle, adequate support of a lifting device must be used to prevent the equipment from falling. Failure to heed these cautions and warnings by personnel could result in severe injury or death and/or damage to equipment and property.

Contact – Some components in this equipment attain temperatures that can cause severe burns. Closely follow all warnings and recommended procedures for handling these components.

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CHAPTER 1.0

GENERAL DESCRIPTION

1.1 Introduction

This chapter discusses the physical arrangement of the door entrances on the vehicle then provides a detailed description of the door entrance assembly and its major components.

Figure 1-1 shows the arrangement of the IFE-supplied door entrances on the vehicle. Cars A and B each have four double-leaf, pocket style door entrances. The door entrance assemblies are identical with one exception; an exterior emergency manual release is located outside entrances A1/A2, A7/A8, B1/B2 and B7/B8. Components not supplied by IFE are not shown.

Each door entrance assembly has an overhead door operator assembly controlled by a door control unit (DCU) with an internal microprocessor. The DCU drives an electric motor to transport the doors from open to close and back again in response to various signals. All DCUs perform diagnostics and develop fault codes that are shown locally at the DCU. MVB Master DCU at door entrance B5/B6 communicates the functional data to the train via Multi-Vehicle Bus (MVB) and ETH Master DCU at door entrance A3/A4 communicates the diagnostic data fault codes via Ethernet (ETH). Refer to Section 2.1 for further functional description of the Door Control Unit.

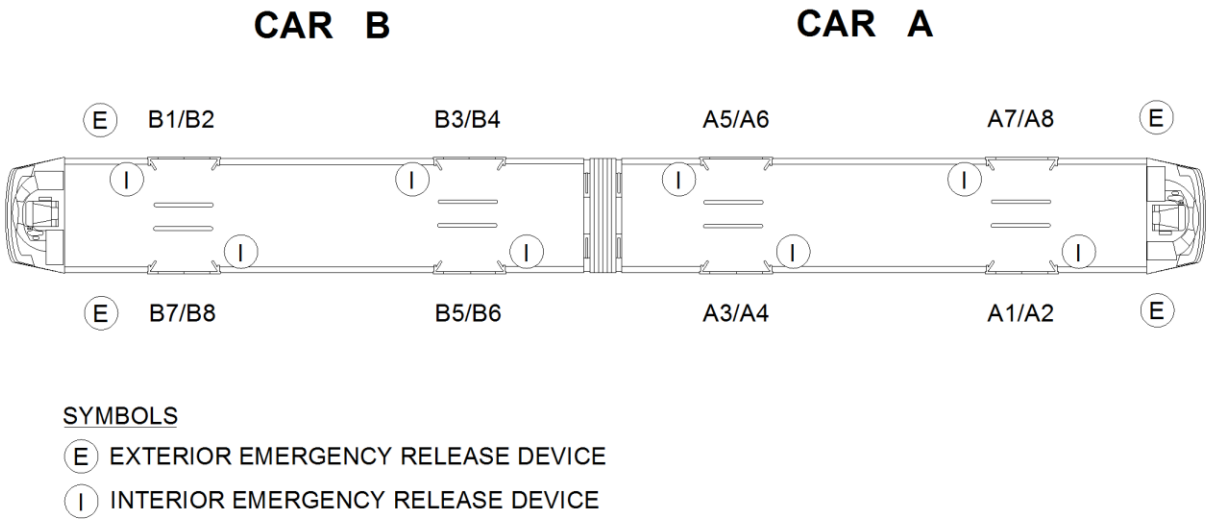


Figure 1-1: Arrangement of Doors on Car

Table 1-1. Door System Details

Door Entrance	IFE Part Number	DCU	Manual Release Location
A1/A2	4000721AR13	Common	Interior and Exterior
A3/A4	4000721AR12	Ethernet	Interior
A5/A6	4000721AR14	Common	Interior
A7/A8	4000721AR15	Common	Interior and Exterior
B1/B2	4000721AR13	Common	Interior and Exterior
B3/B4	4000721AR14	Common	Interior
B5/B6	4000721AR11	MVB	Interior
B7/B8	4000721AR12	Common	Interior and Exterior

Table 1-2. Reference Data

Characteristic	Specification
DOOR FREE OPENING WIDTH:	4 ft (48 in.)
DOOR OPENING TIME:	2.5 seconds +0.5 sec./-0 sec.
DOOR CLOSING TIME:	3.0 sec. +0.5 sec./-0 sec.
DOOR SQUEEZING FORCE: First closing attempt Further closing attempts Peak	 ≤ 22.5 $LBF_{effective}$ (100 $N_{effective}$) ≤ 33.7 $LBF_{effective}$ (150 $N_{effective}$) ≤ 44.9 LBF_{peak} (200 N_{peak})
TEST BAR SIZE: (The test bar is the smallest item detectable by the sensitive edge tape switch. The test bar has to be held rigidly and perpendicular between both closing door leaves except the uppermost 3 inches and lowermost 1 inch of the door leaves.)	Rectangle: 0.25 in. wide x 3 in. high Round: 3/8 in. diameter
TEMPERATURE RANGE:	- 22°F to 158°F (-30°C to 70°C)
VOLTAGE:	17 - 34 vdc (28.5 vdc nominal)
AVERAGE POWER CONSUMPTION:	<150 W (opening/closing sequence)
PEAK POWER CONSUMPTION:	500 W (<500 ms; locking, unlocking, obstruction)
SLEEP MODE POWER CONSUMPTION: (if door is in closed or open position)	< 25 W (depends on the activated outputs)
MAXIMUM AIR PRESSURE IN THE CAR:	50 Pa

Table 1-3. Abbreviations

Abbreviation	Description
CAN-Bus	Controller Area Network – Bus Field Bus System
DCU	Door Control Unit
DDD	Door Diagnostic Description
EPROM	Erasable Programmable Read Only Memory (Flash EPROM)
ETH	Ethernet Bus-System
ICD	Interface Control Document Bus Description
LED	Light Emitting Diode
LOM	Logic Module (Logic Module of the DCU)
MDC(U)	Modular Door Control (Unit)
MONIT ME	IFE Monitoring Me, IFE PC-software, for local modifying of parameters
MVB	Multifunction Vehicle Bus
NO Contact	Normally Open Contact
NC Contact	Normally Closed Contact
PC	Personal Computer
POM	Power Module (Power Module of the DCU)
RS232	Recommended Standard 232 (serial interface; EIA-232) Serial Interface
SFD	System Functional Description
ST03A	Application Software for Diagnosis of the IFE door system
TCN	Train Control Network
UPDATE	IFE Update, IFE PC-software, for local software-download
VAC	Volts, Alternating Current
VDC	Volts, Direct Current

1.2 Component Overview

Figure 1-2 shows the mechanical components and Figure 1-3 shows the electrical connections of a single door entrance assembly.

NOTE: The door leaves have a right hand (RH) and left hand (LH) configuration. When inside the car, facing the doors, a LH door opens to the left while a RH door opens to the right.

IFE-supplied equipment includes device labels that are the same as those used in the electrical diagrams. Each IFE door assembly consists of the following main components:

- Door Operator
- Door Control Unit (DCU)
- Finger Protection Rubber
- Interior Emergency Manual Release with Bowden Cable
- Exterior Emergency Manual Release with Bowden Cable

Non-IFE supplied door equipment consists of the following components:

- Exterior
  - Crew Switches (refer to Section 3.3.10 of HRM Section 0200)
  - Door Pushbutton (refer to Section 3.3.8 of HRM Section 0200)
  - Door Open Indicator (refer to Sections 2.2.12 and 7.3.12 of RMSM Section 0600)
- Interior
  - Door Closing Light (refer to Sections 2.2.4 & 7.3.7 of RMSM Section 0600)
  - Door Closing Chime (refer to Sections 2.2.3.7.2 & 7.4.3.7.2 of RMSM Section 0200)
  - Door Out-of-Service Sign (refer to Sections 2.2.3 & 7.3.6 of RMSM Section 0600)
  - Automatic Passenger Counter (APC) Sensor (refer to Sections 2.2.3.8 & 7.4.3.8 of RMSM Section 0200)
  - Passenger Door Pushbutton (refer to Sections 2.2.3.2 & 7.4.3.2 of RMSM Section 0200)

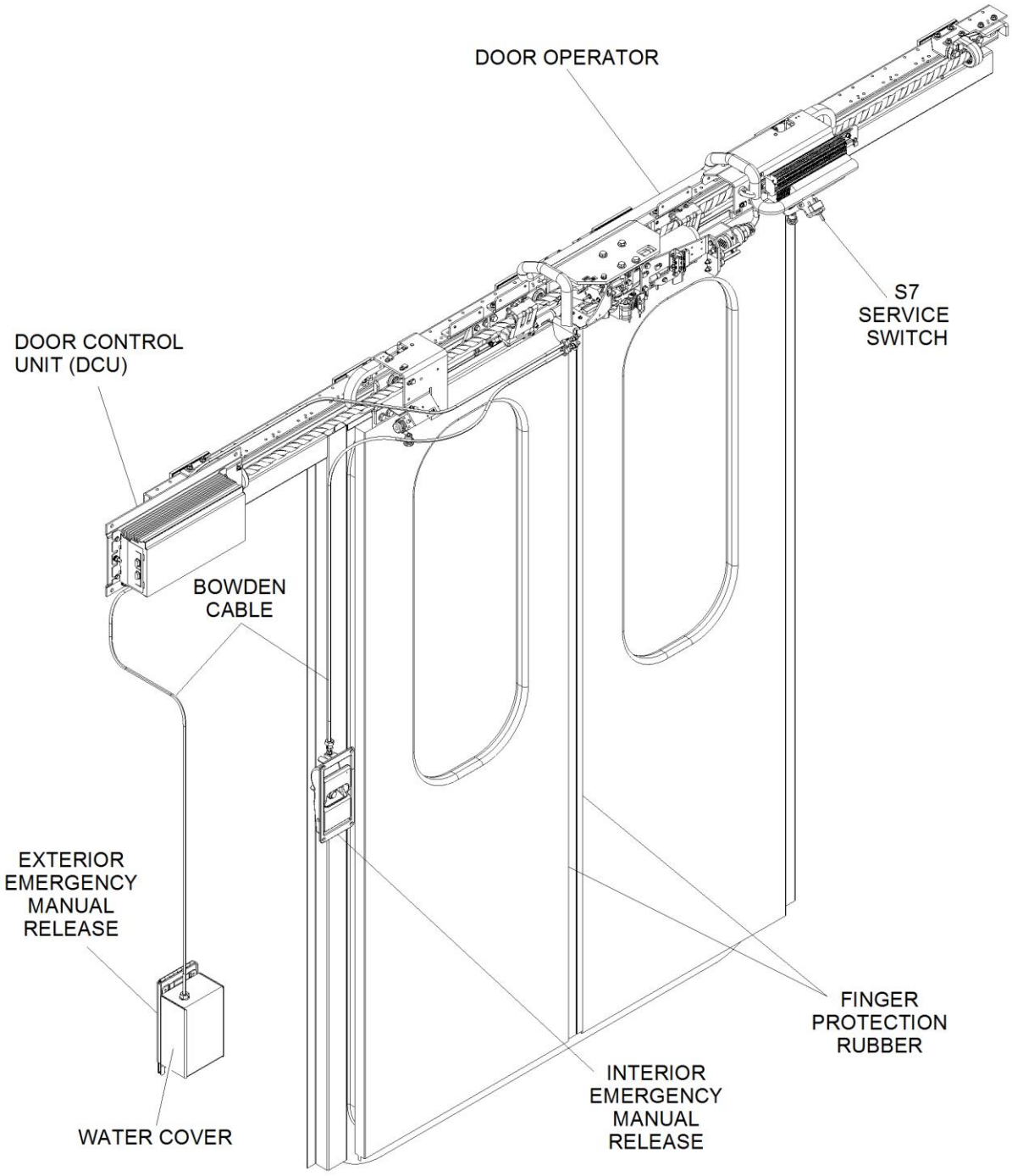


Figure 1-2: Mechanical Components of IFE Door Entrance

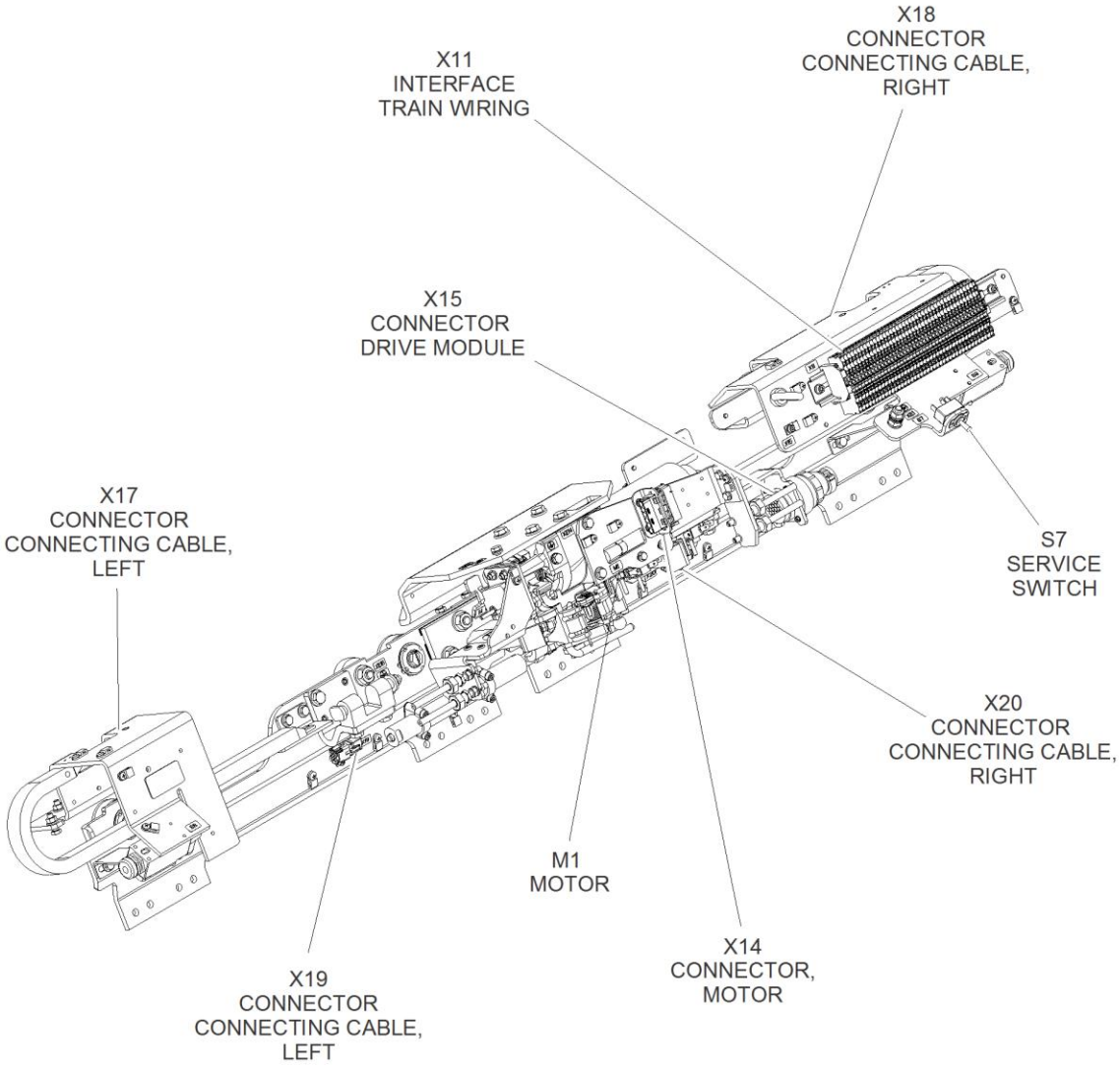


Figure 1-3: Electrical Connections of IFE Door Entrance

1.3 Door Operator

See Figure 1-4. The door operator is a car-mounted assembly containing the mechanical components used to open and close the doors. The operator has a rigid metal support bracket that mounts to the car structure. The support bracket has pre-drilled holes and threaded parts for attaching the other components of the door operator.

The operator consists of following components:

- Door Control Unit (DCU),
- Drive Motor including motor and position sensor,
- Spindle Assembly,
- Guide Rail / Doorhangers,
- Door locking and limit switches,
- Interior/ Exterior Manual releases,
- Wiring Assembly with Connecting cables and Service Switch.

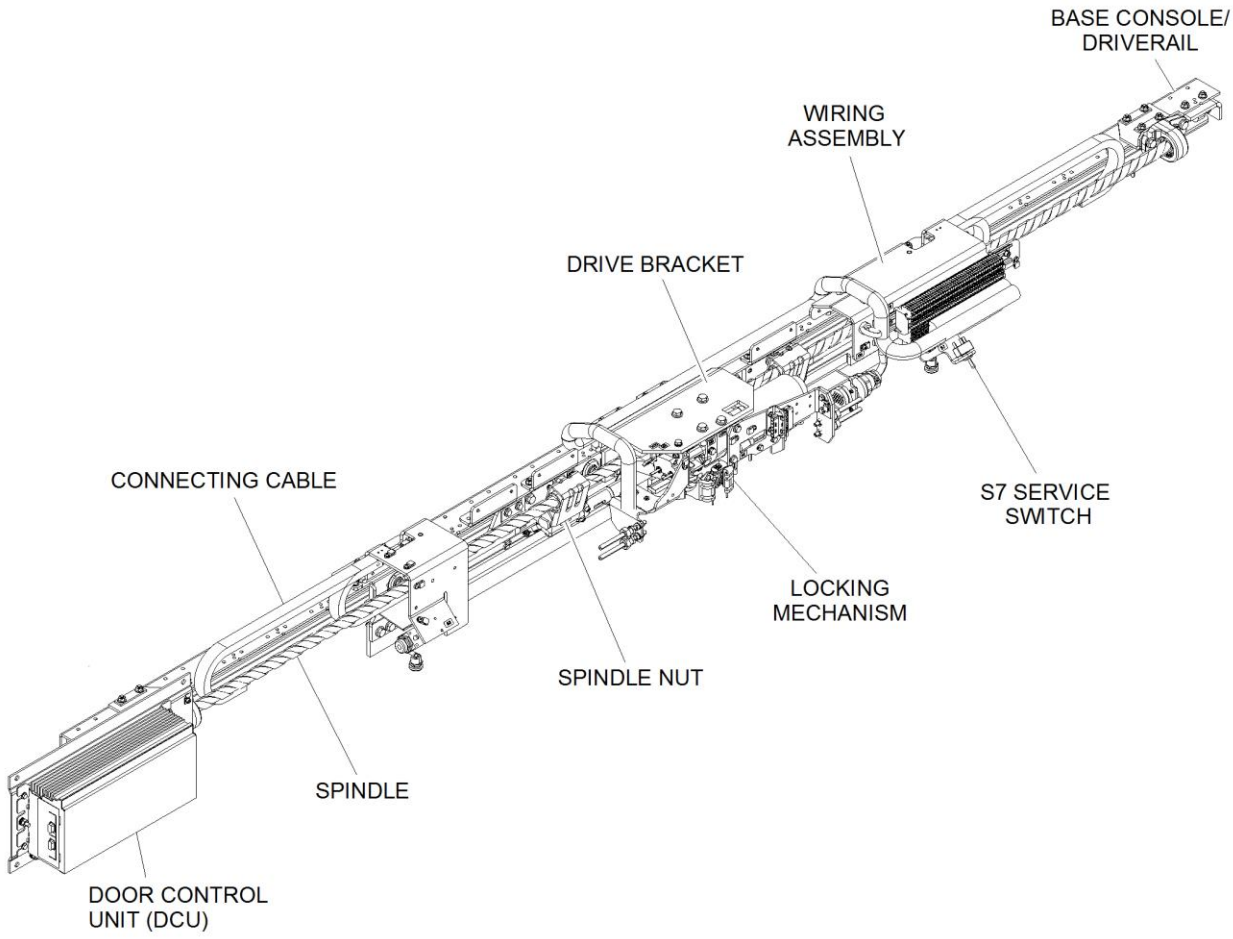


Figure 1-4: Door Operator

1.3.1 Drive Motor

See Figure 1-5. The S3 basic drive contains a permanent magnet, 24VDC reversible DC motor which controls opening and closing door movements. The motor drives the spindles and the associated trolley / nut assemblies via a planetary gearbox. The gearbox has two outputs; one to drive the spindle and one to actuate the locking mechanism.

The motor has a nominal 24VDC coil and provides the necessary force to open and close the doors. The motor is controlled by an electronic motor control circuit within the DCU. The motor drives the spindle either clockwise or counterclockwise via the gearbox.

The motor has an integral position sensor (Hall Effect sensor) for motor speed, door speed and position detection. The sensor detects movement of the motor and generates a 2-channel pulse signal which is used by the DCU to determine the door speed. By analyzing these pulses the DCU can detect the actual door position at any time.

The DCU also determines the direction of movement through the phase relationship of channel A and channel B sensor signal. The door position sensor is also used by the DCU for way/time monitoring and backup obstruction detection. The DCU supplies the sensor with 12 VDC power.

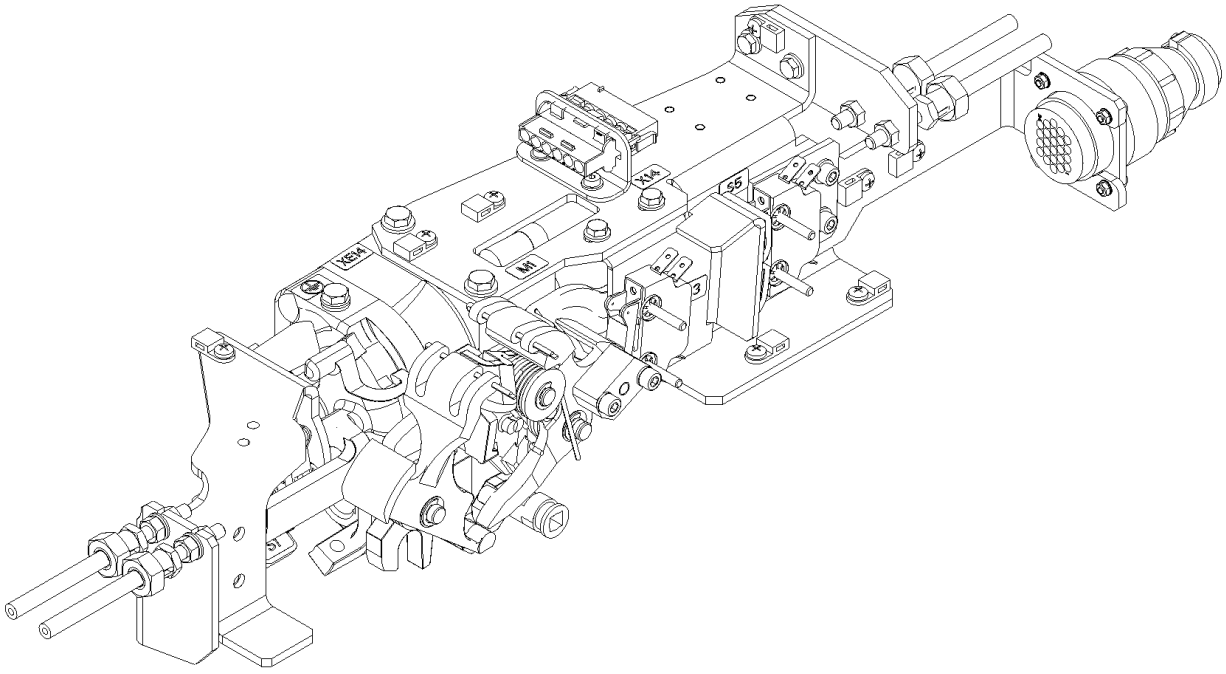


Figure 1-5: S3 Basic Drive

1.3.2 Spindle Assembly

See Figure 1-6. The spindle assembly is a motor-driven shaft that moves the doorhangers, and thereby the door leaves, in the open and closed directions. The spindle is an aluminum threaded shaft with bearing brackets on each end that attach to the support bracket of the door operator. The spindle also supported in the center by the S3 Drive. The section of the spindle that sits in the drive is not threaded (approximately 1 in.).

The spindle threads on the right and left sides have opposite pitch. Each spindle half has a single hinged spindle nut with matching threads. The opposing threads on each spindle half causes the spindle nuts to move in opposite directions when the spindle is turned. The spindle nuts convert the spindle rotation to linear movement. As the S3 drive motor turns the spindle, the spindle nuts move outwards on the spindle (door opening) or inwards (door closing) depending on motor direction.

The spindle nuts are attached to the doorhangers by pins secured with locknuts. The door leaves mount directly to the door carriers. Consequently, the doors open when the spindle rotates in one direction and close when the spindle rotates in the opposite direction.

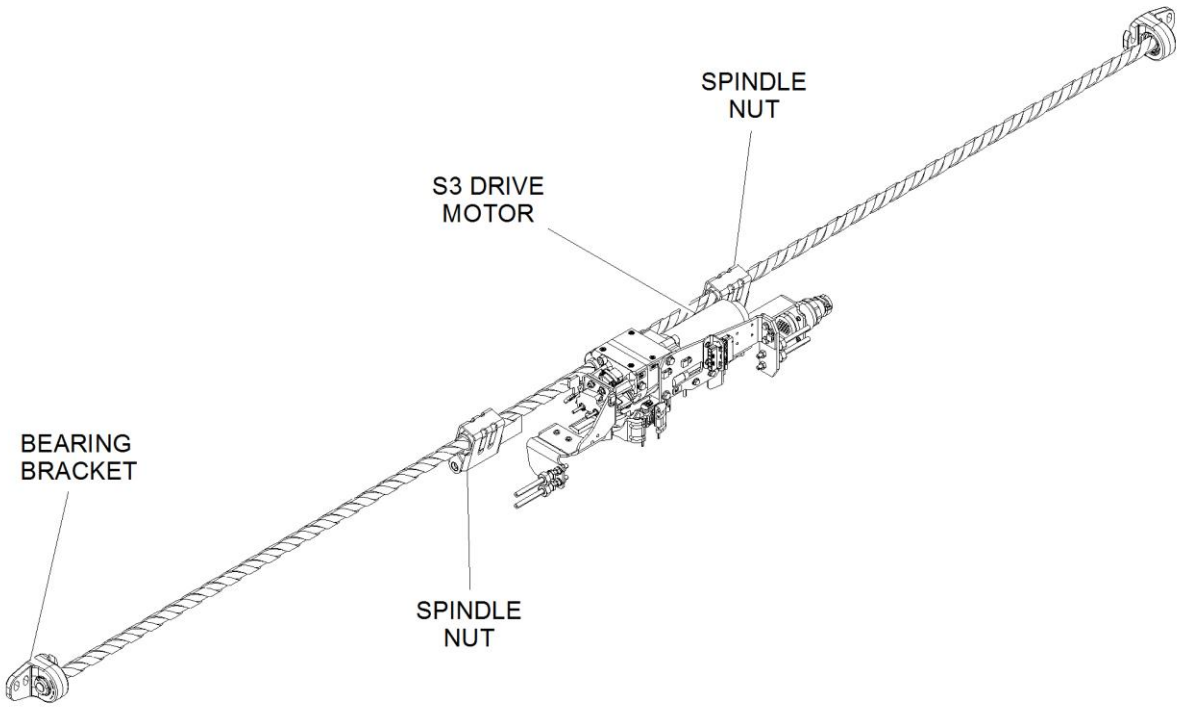


Figure 1-6: Spindle Assembly

1.3.3 Guide Rail and Doorhangers

See Figure 1-7. The guide rail, which is an integral part of the base console, is constructed of steel sheet metal. It provides both an upper and lower contact surface for the doorhanger rollers. The doorhanger is installed within the guide rail using counterstay rollers and supporting rollers to guide the panels in a linear motion. The combined support and guide rail takes all the weight of the door panel and provides the parallel position of the door leaf to the carbody during opening and closing cycles.

Two sets of rollers made of high performance nylon are installed to each doorhanger which in turn, is mounted to the upper section of each door leaf. These rollers run in the guide rail within the door operator. One of the two support rollers of the door hanger (trolley) assembly is eccentrically mounted to facilitate vertical adjustment of the door leaf within the trolley. Both counter rollers are eccentrically mounted, so the door leaf runs smooth in the guide rail and cannot jump off.

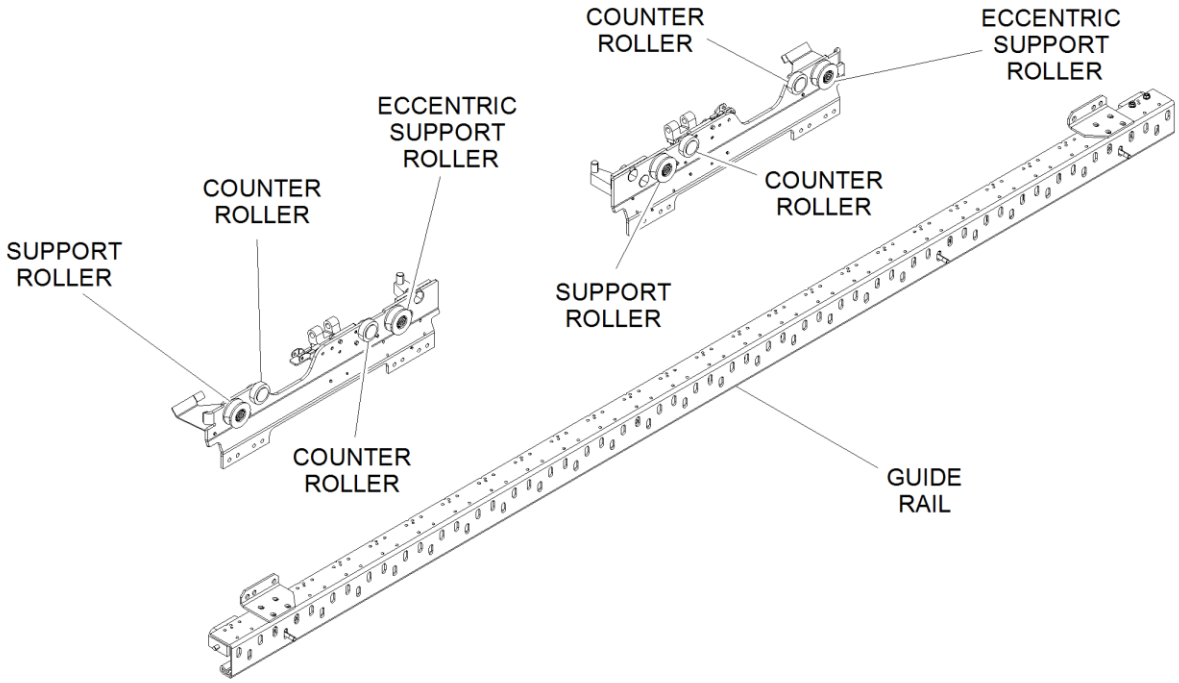


Figure 1-7: Guide Rails and Doorhangers

1.3.4 Door Locking and Limit Switches

See Figure 1-8. The door lock mechanism is located at the center of the operator. The locking pawls are spring loaded to the open positions and are engaged when the door moves to the closed position. A latch to block the pawls once engaged is applied via a separate shaft of the gear box of the same drive motor used for the door open/closing movement.

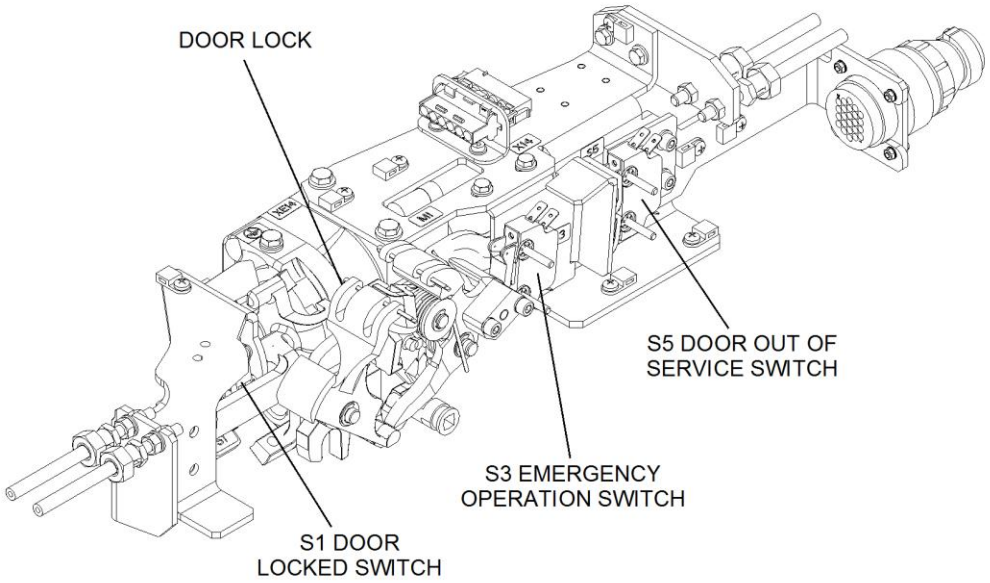


Figure 1-8: Door Lock and Limit Switches

The design of the system allows that even with the loss of power, the door panels can always be manually pushed into the closed and locked position. A relay located within the local Door Control Unit, cuts off the power for the DC-motor and opens the interlock circuit.

The emergency unlocking unit allows the train crew to manually open the doors from inside or outside the car for emergency exit or entry. The emergency unlocking unit is integrated with the operator and is controlled remotely from the interior and exterior emergency release devices via Bowden cable.

The cut out devices allows the train crew to manually isolate the door. Mechanical and electrical door isolation is achieved by actuation of the cut out lever. The cut out lever is integrated with the operator and is accessed via the door operator access panel.

The operator includes a door locked switch that identifies when the door operator is locked in position. The door locked switch is mounted within the locking mechanism. An additional limit switch identifies that the door is in the closed position. The door leaf closed switch is mounted on the operator close to the door panel separate from the locking mechanism.

Installed on the drive motor is a position sensor that identifies to the door control unit the position of the door panels in reference to the rotation of the motor and position sensor. This information aids in determining if the door has driven to an open or closed position or whether it has encountered an obstruction.

Table 1-4. Door Operator Switch Functions

Switch Number	Function
S1	Detects the door locked position.
S3	Detects the emergency release operation.
S5	Detects the cut out door operator.
S8/S9	Detects the door leaf in the fully closed position.

1.3.5 Wiring Assembly and Connecting Cables

See Figure 1-9 and Figure 1-10. The wiring assembly includes a mounting console, DIN rail with terminal block X11, and door system wiring with electrical connectors (not shown) to interconnect the components of the door system and provide an interface to the car. The mounting console attaches to the door operator support bracket and provides mounting for the wiring assembly components.

A service switch (S7) is provided to manually turn power to the DCU on and off. The service switch is used during maintenance activities to remove power to the local DCU, thereby removing power to the motor (M1), so maintenance can be performed without risk of door movement.

The connecting cables consist of flexible cables enclosed in protective plastic links. The connecting cables provide the electrical connections for the sensitive edge tape switches (S11/S12) and provide protection for the wiring during door movement. The cable connects to the X17/X18 connectors on the door carriers and the X19/X20 connectors on the door operators. The cable is grounded at the door carriers and at the door operator.

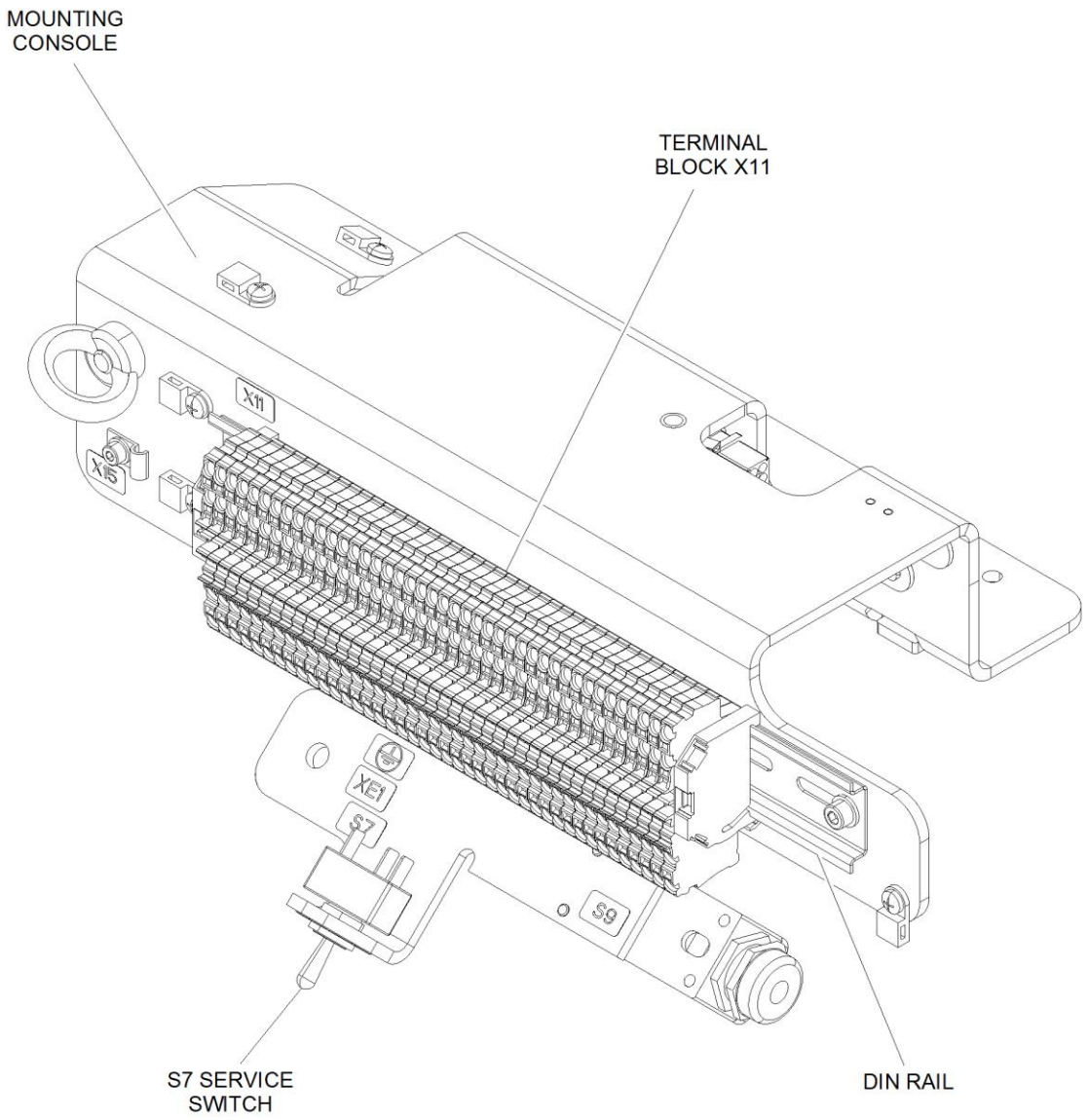


Figure 1-9: Wiring Assembly

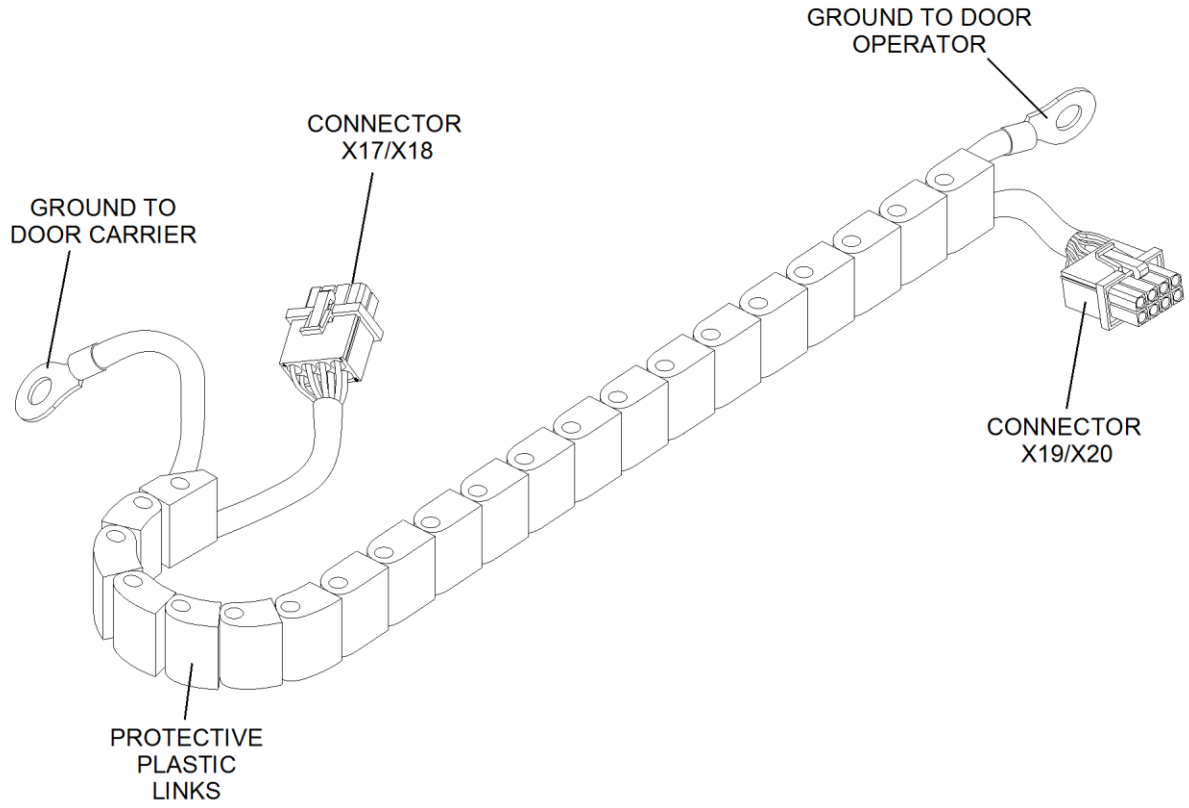


Figure 1-10: Connecting Cable

1.3.6 Door Control Unit (DCU)

See Figure 1-11. The Door Control Unit is mounted on the operator. The DCU is a microprocessor based device that controls the operation of a sliding pocket door system. There is one DCU per door operator. All eight DCUs on a car are connected via CAN-bus, allowing the seven common DCUs to communicate with the MVB Master DCU (door entrance B5/B6). The MVB Master DCU has MVB connectors to communicate with the Train Control Network (TCN).

The DCU controls the operation of the motor movement and locking functions based on inputs from trainlines, passenger door-open pushbuttons, crew switches, and limit switches. The DCU also controls operation of the door indicators including audible and visual warnings, door out-of-service indicator, and door open indicators.

The DCU includes an internal software diagnostic module that monitors door operation, and develops diagnostic codes that identify detected failures in the system. If a diagnostic code occurs, it is indicated on the red LED “Error” on the DCU by a flash code and sent to the TOD via ETH. Refer to Table 2-7 for detailed diagnostic flash code information. A read out of the DCU diagnostic memory can be obtained via the RS232 interface using a laptop and the IFE ST03A diagnostic software.

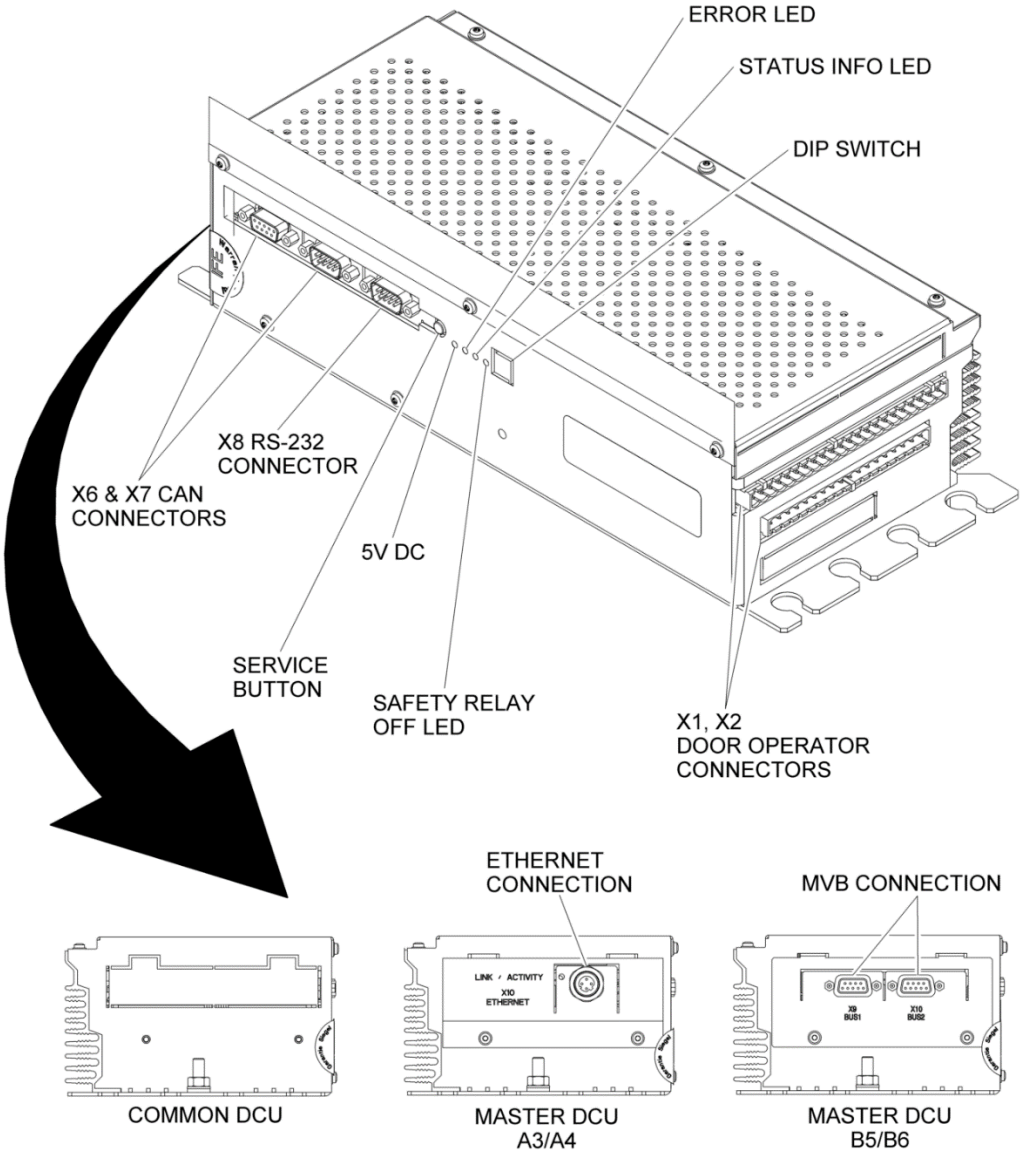


Figure 1-11: Door Control Unit

The front of DCU includes the following:

- CAN-bus connectors X6 and X7,
- RS232 connector X8 - For interface with the PTU,
- SERVICE BUTTON -For use by maintenance personnel,
- 5 VDC LED (Green LED) – Internal voltage supply available,
- ERROR LED(Red LED) – Failure of the DCU,
- STATUS INFO LED (Yellow LED) – Free programmable, not used,
- STATUS RELAY OFF LED (Green LED) – Illuminated when safety relay is switched off,
- A DIP switch - not used.

The SERVICE BUTTON at the DCU has the following functions:

- Closing of a not closed door. This button allows closing a not closed door. It is not possible to open a closed or closing door with this button,
- Initialization of the nominal motor current graph. Pushing of the button upon feeding voltage supply and keeping pushed until the red LED ERROR is extinguished enables initialization of the nominal motor current graph for door movement.

The left side of the MVB Master DCU at doors B5/B6 contains the X9 (BUS1) and X10 (BUS2) connectors for the MVB interface, and a grounding lug. The left sides of the ETH Master DCU at doors A3/A4 contains the X10 (ETH) connector for the Ethernet interface and a grounding lug. The left sides of common DCUs have a blank plate.

The right side of all DCUs includes the X1 and X2 connectors. Connector X1 is used for input signals from the car and door operator components. Connector X2 is used for:

- outputs signals to car and door operator components,
- power supply from car,
- power to door motor.

1.3.7 Interior/Exterior Manual Release Assembly

See Figure 1-12. The interior / exterior emergency manual release is a hand-operated flap-design mechanism that allows the doors to be unlocked and opened from inside or outside the vehicle; intended to allow personnel ingress to or egress from the car in an emergency situation or for use by technicians during maintenance activities. The interior and exterior manual release devices share the same configuration. The exterior manual release device is enclosed in a protective water cover.

The manual release is operated by pulling the flap outward 60-degrees A 16 foot Bowden cable (Figure 1-13) runs from the exterior emergency manual release to the door lock mechanism (Figure 1-8) on the door operator. When operated, the doors move from the closed and locked position to the open position, creating a small gap between the door leaves, allowing them to be physically pushed opened.

The flap is self-retracting and will reset automatically to its original position. The door status indicators are illuminated when the doors are in a manually released state. The exterior manual release is located on the exterior of the car at door entrances B1/B2, B7/B8 and A1/A2, A7/A8.

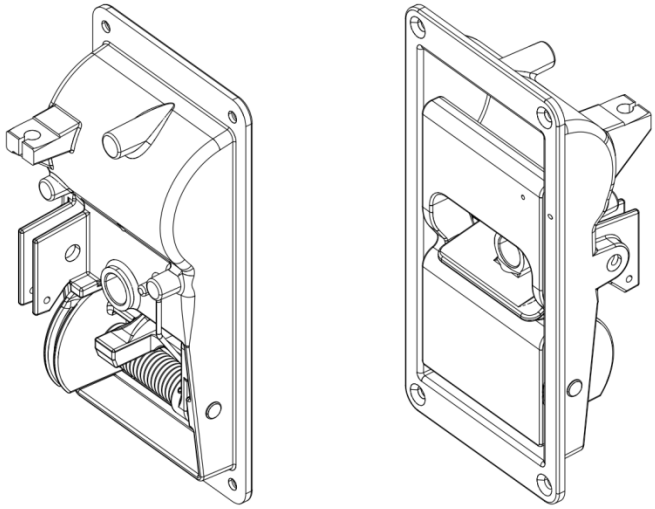
1.3.8 Finger Protection Rubber

See Figure 1-14. The finger protection profile on the front edge of the door leaves are each equipped with a sensitive edge switch. Pressure sensitive edge switches are touch-sensitive strips that sense changes in pressure. The safety edge activates when pressure causes the conductive plates to make contact and a signal is sent to the DCU.

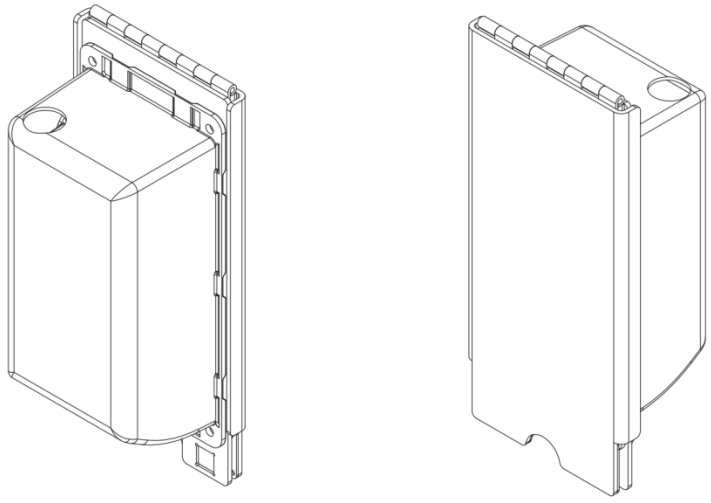
Switches S11 (Left) / S12 (Right) are the tape switches in the sensitive edges (finger protection rubber). If during the closing sequence the rubber profile is deformed in an encounter with an object, a signal is transmitted to the DCU that an obstruction is present and the obstruction sequence is activated.

The functionality of the sensitive edge is observed by the DCU. When a fault occurs (steady activation or interruption) a diagnostic code is generated.

The obstruction detection by the sensitive edge will be stopped as soon as the door reaches the closed and locked position.



INTERIOR EMERGENCY MANUAL RELEASE



EXTERIOR EMERGENCY MANUAL RELEASE

Figure 1-12: Emergency Manual Release

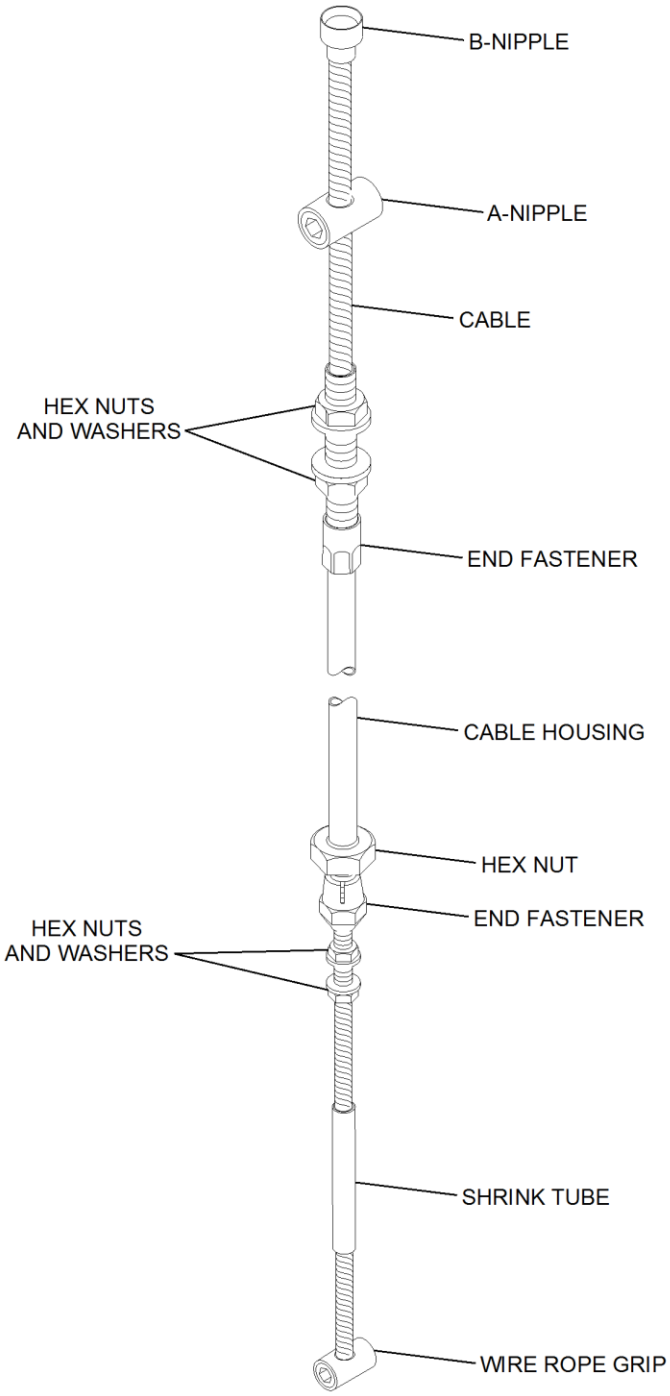


Figure 1-13: Bowden Cable

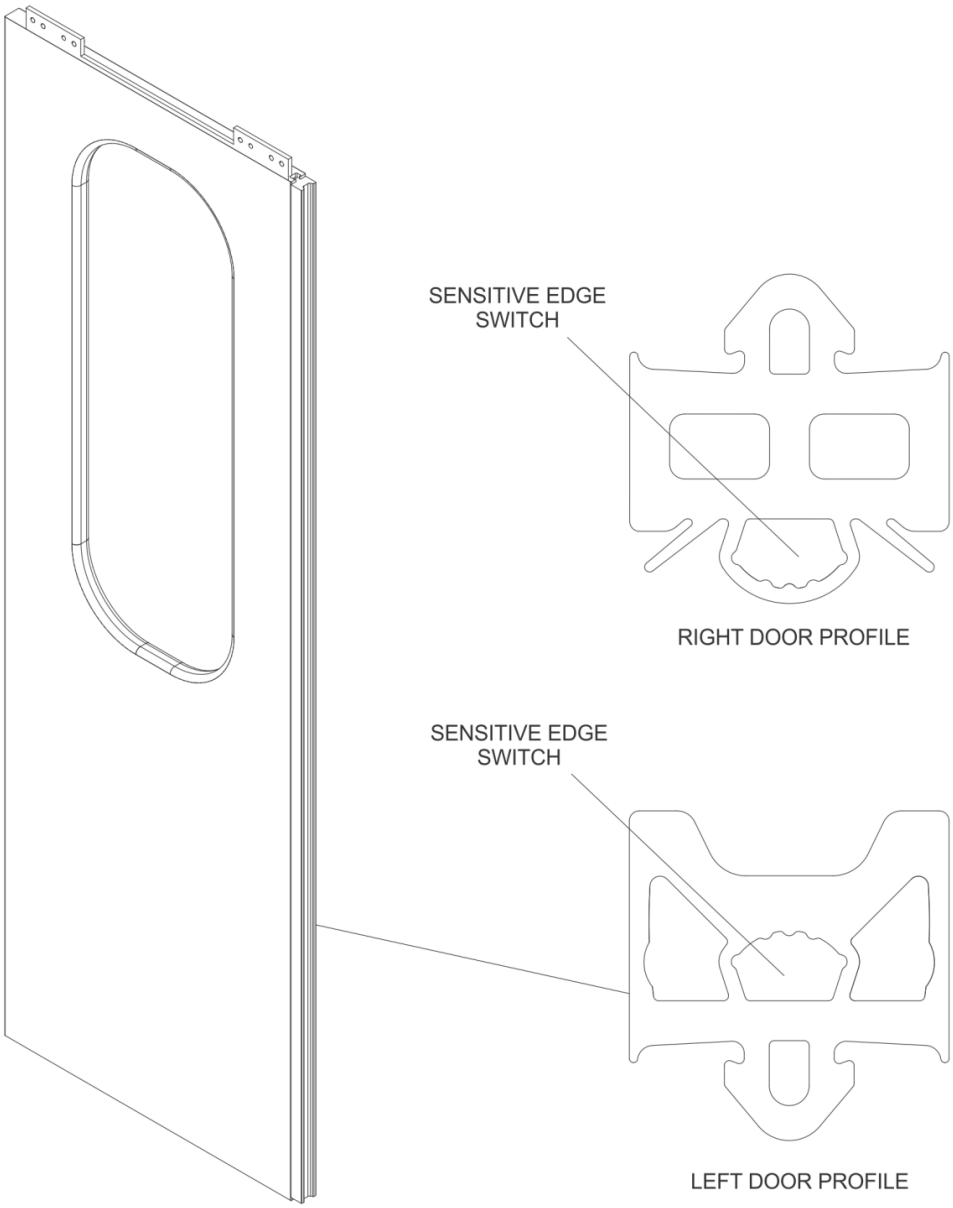


Figure 1-14: Finger Protection Rubber

CHAPTER 2.0

FUNCTIONAL DESCRIPTION

2.1 Introduction

This chapter describes the mechanical functions involved in door opening and closing as well as operation of the emergency manual releases and door cutout device. This chapter also describes the DCU, electrical connections, door operation, and diagnostics.

All eight door entrances function the same way. Each entrance has two door leaves attached to trolleys on the door operator. The door operator opens and closes the door leaves using an electric motor to drive the spindle assembly, causing the trolleys to traverse from closed to open and back again.

The door operator is controlled by the software program stored in the Door Control Unit's (DCU) Flash Memory (EPROM). The standard minimum data retention of flash EPROMs is 10 to 15 years, which prompts the EPROM to be a scheduled maintenance item. The interval and re-flash procedure is defined in the HRM.

Execution of this program produces the software logic to control the door operator based on inputs from the Multi-Function Vehicle Bus (MVB), trainlines, and limit switches and sensed outputs. In addition, the software logic controls the function of the audible and visual indicators associated with door opening and closing, and provides obstruction detection during door opening and closing. Program execution also determines any fault conditions that are then sent as messages via the MVB and communicated locally.

The DCU at door B5/B6 is the MVB Master DCU and connects to the train control network via the MVB bus by means of a PC104 bus interface (an industry computer standard that allows production of the customized embedded system). The 6 common DCUs are connected via CAN bus to the MVB Master DCU at door B5/B6. Functional data will be transmitted on the MVB bus-system.

The ETH Master DCU at door A3/A4 is connected to the TCN via ETH-Bus by means of an integrated Ethernet bus interface. Only diagnostic data from all DCU´s (respective door entrances) will be transmitted on the Ethernet bus.

2.2 Mechanical Operation

This section describes the mechanical operation of the door operator.

The door operator assembly contains the mechanical and electrical components necessary to physically transport the door leaves from closed to open and back again. The door operator also houses the DCU, the microprocessor-based electronic unit that controls the door operator components.

The major components of the door operator involved in door opening and closing are the DCU, motor and door lock (M1), spindle assembly and door hangers, and limit switches. The DCU is described in Section 2.5.

The reversible DC motor (M1) rotates in opposite directions for door opening and closing as commanded by the DCU. This is done by changing the polarity of the voltage applied to the motor. The position sensor contained in the motor returns pulses to the DCU while the motor is running. Using the frequency of the pulses, the DCU is able to determine the direction, speed, and position of the doors.

The permanent magnetic-type motor includes a planetary gear unit with two outputs; one to drive the spindle and one to actuate the locking mechanism. The spindle spans the full length of the door operator. The outboard ends of the spindle are supported by bearing assemblies while the centers are supported by the drive motor.

The spindle threads on the right and left sides have opposite pitch. Each spindle half has a single hinged spindle nut with matching threads. The opposing threads on each spindle half causes the spindle nuts to move in opposite directions when the spindle is turned. The spindle nuts convert the spindle rotation to linear movement. As the motor turns the spindle, the spindle nuts move outwards on the spindle (door opening) or inwards (door closing) depending on motor direction.

The spindle nuts are attached to the doorhangers by pins secured with locknuts. The door leaves mount directly to the doorhangers. Consequently, the doors open when the spindle rotates in one direction and close when the spindle rotates in the opposite direction.

The guide rail which is an integral part of the base console is constructed of steel sheet metal. The door hanger is installed within the guide rail using rollers to guide the panels in a linear motion.

The door closed switch assemblies are fixed to the support bracket of the motor assembly. The assemblies contain limit switches S1, S3 and S5 that are actuated/de-actuated by the movement of the trolleys. When the doors are closed, one set of contacts notifies the DCU that the doors are closed and locked. This information is used by the DCUs software logic for diagnostic purposes and as a means of knowing when the doors are first closed at power on. A second set of contacts is wired in series in the interlock loop. The interlock loop is complete only when all doors on both sides of the LRV are closed.

The door lock mechanism is located at the center of the operator attached to the motor. The pawls are spring loaded to the open positions which are engaged when the door moves to the closed position. A latch to block the pawls once engaged is applied via a separate shaft of the gear box attached to the drive motor.

The cut out lever on the door lock mechanism allows the train crew to manually isolate the door. Mechanical and electrical door isolation is achieved by actuation of the cut out lever. The cut out lever is integrated with the operator and is accessed via the door operator access panel.

The emergency interior/exterior manual release units allow personnel to manually open the doors from inside or outside the car for emergency exit or entrance. The emergency releases are integrated with the operator and are controlled remotely via Bowden cables.

Tape switches S11 and S12 are part of the sensitive edges on the right-hand and left-hand door leaf assemblies. If an object is encountered by the sensitive edge during a close door cycle, the tape switch is activated, signaling the DCU, and the doors are re-opened.

In addition, installed on the drive motor is a position sensor that identifies to the door control unit the position of the door panels in reference to the rotation of the motor and position sensor. This information aids in determining if the door has driven to an open or closed position or whether it has encountered an obstruction. In this case the DCU can measure and determine if the door panels encountered an obstruction during opening or closing process and activate the obstruction sequence. The amount of opening/closing force allowed before halting the process can be predetermined and programmed into the control software of the door control unit.

There are two types of passenger pushbuttons (S21) that are used on the Los Angeles vehicle; two interior passenger pushbuttons installed at each entrance, and two exterior passenger pushbuttons installed on each side of the portal. The switches signal the DCU when a passenger requests the doors to open, but only when the switches are enabled by the train operator.

OUT OF SERVICE indicators H13 (interior) and H14 (exterior) are also installed inside above the door portals. The indicators are illuminated when the door entrance is cutout.

2.2.1 Manual Door Movement

When the doors are unlocked by manual release, the spring loaded locking mechanism on the door operator manually unlocks and is held in the unlocked position by the manual release device. When manually released, the doors will open a minimum of 1 inch to allow full opening of the doors.

To close the doors manually the manual release device used must be reset back to its closed position. This will allow the spring loaded locking mechanism on the door operator to reset back to locked position when the doors are fully closed.

2.3 Electrical Wiring Diagrams

Refer to Appendix A, Document ED01139R01, for IFE door system wiring diagrams.

The IFE door wiring diagram consists of five sheets. The diagram uses a line continuation method. A slash (/) is a continuation symbol followed by a sheet number and grid location. For example, /2.A8 indicates a line continuation to or from sheet 2, grid location A8.

Sheet 1 shows the following:

- A list of device designations used in Sheets 2 through 5 of the wiring diagram in alphabetical order. Note that some if these may have different device designations in the car data. Refer to the integrated schematic data for the vehicle. IFE-supplied equipment includes device labels on the equipment,
- A list of the input and output signals for a single DCU, in numerical order of connector pin numbers. The 18 DCU digital inputs are prefixed with the letter “E” (E1 – E18) while the 8 DCU digital outputs are prefixed with the letter “A” (A1 – A8). (For example, “X1 pin 1 / logic module E1” means that E1 is the label of the digital input to connector X1, contact number 1. The status indication of the input is also shown. In this example, E1 is active when the NO MOTION trainline is active (1 = v < 1kph). The real-time states of the E-prefixed inputs and A-prefixed outputs are viewable in real-time using IFE ST03A software with a laptop PC. Refer to IFE ST03A manual in the Tools and Test Equipment Manual,
- A Train configuration diagram showing the locations of the doors and operating elements.

Sheet 2 shows the circuit diagram interface:

- Distribution of input power from the vehicle,
- Interlock loop and safety relay,
- DCU output to indicators H11, H12, H13, H14 and H15,
- Interface with trainlines,
- Interface with crew switches.

Sheet 3 shows the circuit diagram interface (door area):

- Power supply to limit switches and sensitive edges,
- Limit switches,
- Sensitive edges,
- Door motor and motor control.

Sheet 4 shows the DCU interface for the left and right sensitive edge switches in the door leaves.

Sheet 5 shows the CAN bus connections among the eight DCUs. The DCU at door B5/B6 is the MVB Master DCU and connects to the Train Control Network (TCN) via the MVB bus. Train communication with the other 6 common DCUs and ETH Master DCU at door A3/A4 is transmitted thru the MVB Master DCU at door B5/B6 via the CAN-bus. ETH Master DCU at door A3/A4 connects to the TCN thru the ETH-bus. Diagnostic data from all DCU's (6 common and MVB Master DCU) are transmitted thru the ETH Master DCU at door A3/A4 via the ETH-bus. Sheet 5 also shows the door coding established by wiring to identify the DCU location on the vehicle.

2.4 Interface Description

The interface descriptions are grouped by connection type: hard-wired and MVB.

NOTE: Explanation to the following signal tables:

E…Inputs of the Door Control Unit

A…Outputs of the Door Control Unit

TERMS:

In the signal tables below, the following terms are used to define the signal types:

Steady signal ... The signal is evaluated continuously by its state.

Pulse signal.... The signal is not evaluated by its state but by its state transition (edge) and whether the transition is positive or negative signed. A state transition from 0VDC to 24VDC is called a positive edge. A state transition from 24VDC to 0VDC is called a negative edge. To prevent the detection of faulty signals (random interferences) by mistake there is specified a minimum duration of the pulse signal. Within the durations defined for each signal, the signal state must not change. Otherwise, the signal event will not be detected and no function is carried out.

2.4.1 Power Supply

The operating power is nominal 24 Vdc from the car. Circuit breaker F1, per Appendix A, is a car breaker that protects the line from over-current.

The carbuilder has assigned a separate circuit breaker for each DCU. The F1 equivalent designation for each circuit breaker is as follows:

- DC1CBA – Door Control 1 Circuit Breaker A Unit
- DC1CBB – Door Control 1 Circuit Breaker B Unit
- DC2CBA – Door Control 2 Circuit Breaker A Unit
- DC2CBB – Door Control 2 Circuit Breaker B Unit

2.4.2 Hard Wired Signals

2.4.2.1 Train Control Signals to DCU

INPUTS

NO.	SIGNAL	SIGNAL LEVEL	TYPE
E1	No Motion	1 = standstill	steady
E2	Central Open	1 = open	steady
E3	Door Release	1 = released	steady
E4	Central Close	1 = closed	pulse *
E7	Open Front Door	1 = open	steady
E8	Close Front Door	1 = closed	steady
E10	Limp Home Mode	1 = limp home mode	steady

* Positive edge, pulse duration: min 200ms

2.4.2.2 Input Signals from Door Drive Mechanism to DCU

INPUTS

NO.	SIGNAL	SIGNAL LEVEL	TYPE
E5	Open Pushbutton S21	1 = open	pulse*
E6	Door Leaf Left Closed Switch S8	1 = open	steady
E9	Door Leaf Right Closed Switch S9	0 =closed	steady
E11	Door Out of Service Switch S5	0 = out of service	steady
E12	Emergency Operation Switch S3	1 = operated	steady
E13	Door Locked Switch S1	0 = door Locked	steady
E14	Crew Switch Open	1 = open	steady
E15	Sensitive Edge Left Door Leaf S11	1 = active	steady
E16	Sensitive Edge Right Door Leaf S12	1 = active	steady
E17	Door position sensor direction	0 = pulse	pulse**
E18	Door position sensor pulse	0 = pulse	pulse**

* Positive edge, pulse duration: min 200ms

** Negative edge, pulse duration > 1ms

2.4.2.3 Output Signals from DCU to Door Drive Mechanism

OUTPUTS

NO.	SIGNAL	SIGNAL LEVEL	TYPE
A1	Illumination Pushbuttons red LED's	1 = active	steady
A2	Illumination Pushbuttons green LED's	1 = active	steady
A3	Door Out Of Service Indication Elements	1 = active	steady
A4	ADA Door Closing Indication	1 = active	steady
A5	Power Supply Pushbuttons	1 = active	steady
A6	Door Open	1 = active	steady
A7	Door Open Indication	1 = active	steady
A8	Door Close Warning Chime	1 = active	steady

2.4.3 MVB Signals

2.4.3.1 MVB Input Signals to DCU

INPUTS

NO.	SIGNAL	SIGNAL LEVEL	TYPE
1	No Motion	1 = standstill	steady
2	Central Door Open command	1 = central opening	steady
3	Door Release	1 = released	steady
4	Central Door Close command	1 = close	pulse*
	* Pulse duration: min 2 sec.		

2.4.3.2 DCU Output Signals to MVB

OUTPUTS

NO.	SIGNAL	SIGNAL LEVEL
1	Door 4 Health Status (Doors A7/A8)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)
2	Door 3 Health Status (Doors A5/A6)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)
3	Door 2 Health Status (Doors A3/A4)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)
4	Door 1 Health Status (Doors A1/A2)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)
5	Door 8 Health Status (Doors B7/B8)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)

OUTPUTS (cont'd.)

NO.	SIGNAL	SIGNAL LEVEL
6	Door 7 Health Status (Doors B5/B6)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)
7	Door 6 Health Status (Doors B3/B4)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)
8	Door 5 Health Status (Doors B1/B2)	1 = Door System Healthy (no faults) 2 = Door System Not Healthy (faults detected)
9	Door A1/A2 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled
10	Door A3/A4 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled
11	Door A5/A6 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled
12	Door A7/A8 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled
13	Door B1/B2 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled
14	Door B3/B4 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled
15	Door B5/B6 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled
16	Door B7/B8 State	1 = Open 2 = Closed 3 = Cutout 4 = Enabled

OUTPUTS (cont'd.)

NO.	SIGNAL	SIGNAL LEVEL
17	Door Emergency/Release State	0 = No handles activated 1 = Door A1/A2 Emergency Open Handle Activated 2 = Door A3/A4 Emergency Open Handle Activated 4 = Door A5/A6 Emergency Open Handle Activated 8 = Door A7/A8 Emergency Open Handle Activated 16 = Door B1/B2 Emergency Open Handle Activated 32 = Door B3/B4 Emergency Open Handle Activated 64 = Door B5/B6 Emergency Open Handle Activated 128 = Door B7/B8 Emergency Open Handle Activated

2.4.3.3 Output Signals from DCU to Train Control Network via ETH

Outputs

SIGNAL	SIGNAL LEVEL	TYPE
Diagnostic codes defined in Table 2-7	1 = diagnostic code active	steady

2.4.3.4 MVB Communication Fault

All signals which are transmitted either hardwired or via MVB bus system are always checked for validity. Data-bus signals are evaluated for safety related functions, therefore the signals must be at the appropriate safety level.

If the signals do not match (hardwired and MVB signal) they are evaluated according to the information below and a diagnostic code is generated. Hardwired signal to DCU input E10 (Limp Home Mode) will also be evaluated.

If MVB-Bus is not available, Bus signals can neither be transmitted nor received.

Signal: No Motion

Status Hardwired	Status Bus-Signal	Limp Home Mode	Resulting Signal
0	0	0	No motion = 0
0	1	0	No motion = 0
1	0	0	No motion = 0
1	1	0	No motion = 1
0	Bus not available	0	No motion = 0
1	Bus not available	0	No motion = 0
0	0	1	No motion = 0
0	1	1	No motion = 0
1	0	1	No motion = 1
1	1	1	No motion = 1
0	Bus not available	1	No motion = 0
1	Bus not available	1	No motion = 1

Signal: Release

Status Hardwired	Status Bus-Signal	Limp Home Mode	Resulting Signal
0	0	0	Release = 0
0	1	0	Release = 0
1	0	0	Release = 0
1	1	0	Release = 1
0	Bus not available	0	Release = 0
1	Bus not available	0	Release = 0
0	0	1	Release = 0
0	1	1	Release = 0
1	0	1	Release = 1
1	1	1	Release = 1
0	Bus not available	1	Release = 0
1	Bus not available	1	Release = 1

Signal: Central Open

Status Hardwired	Status Bus-signal	Limp Home Mode	Resulting Signal
0	0	0	Central Open = 0
0	1	0	Central Open = 0
1	0	0	Central Open = 0
1	1	0	Central Open = 1
0	Bus not available	0	Central Open = 0
1	Bus not available	0	Central Open = 0
0	0	1	Central Open = 0
0	1	1	Central Open = 0
1	0	1	Central Open = 1
1	1	1	Central Open = 1
0	Bus not available	1	Central Open = 0
1	Bus not available	1	Central Open = 1

Signal: Central Close

Status Hardwired	Status Bus-signal	Limp Home Mode	Resulting Signal
0	0	0	Central Close = 0
0	1	0	Central Close = 0
1	0	0	Central Close = 0
1	1	0	Central Close = 1
0	Bus not available	0	Central Close = 0
1	Bus not available	0	Central Close = 0
0	0	1	Central Close = 0
0	1	1	Central Close = 0
1	0	1	Central Close = 1
1	1	1	Central Close = 1
0	Bus not available	1	Central Close = 0
1	Bus not available	1	Central Close = 1

2.5 Door Control Unit

In an individual door arrangement, the DCU functions to control operation of the door operator motor (M1) based on inputs from the trainlines, passenger door-open pushbuttons, crew switches, limit switches, MVB signals, and the door position sensor in the motor. The DCU also controls operation of the door-related indicators and warning devices.

The DCU receives 17 to 32 Vdc (nominal 28.5 Vdc) from the car's low voltage power supply.

All Door Control Units (DCUs) on a car are serially connected via CAN-bus. The DCU at door entrance B5/B6 is the MVB Master DCU connected via MVB-Bus to the Train Control Network (TCN). The ETH Master DCU at door A3/A4 is connected via ETH-bus to the TCN.

Diagnostic codes from all DCUs, MVB Master DCU at door B5/B6 and the 6 common DCUs are transmitted thru the ETH Master DCU at door A3/A4 via the Ethernet-bus system to the TCN.

A read-out of the diagnostic memory of all DCUs can be obtained using the RS232 interface on any DCU and connecting a portable laptop PC with the IFE diagnostic software ST03A installed. This can be done locally at a common DCU or at the ETH Master DCU at door A3/A4. Connecting to the ETH Master DCU allows access to the data on the 6 common DCUs as well as the MVB Master DCU at door B5/B6.

In accordance with train control signals (such as NO MOTION and DOOR RELEASE trainlines), signals from elements at the door drive mechanism (limit switches, position sensors) and signals from the door entrance area (pushbuttons), the DCU opens and closes the particular door.

The DCU has 18 input signals (E1–E18) and 8 output signals (A1-A8), which are governed by the software contained in the DCU memory. Software can be uploaded via the RS232 service interface using a laptop PC with the IFE software Update 5.3. Refer to Section 2.5.6.2.

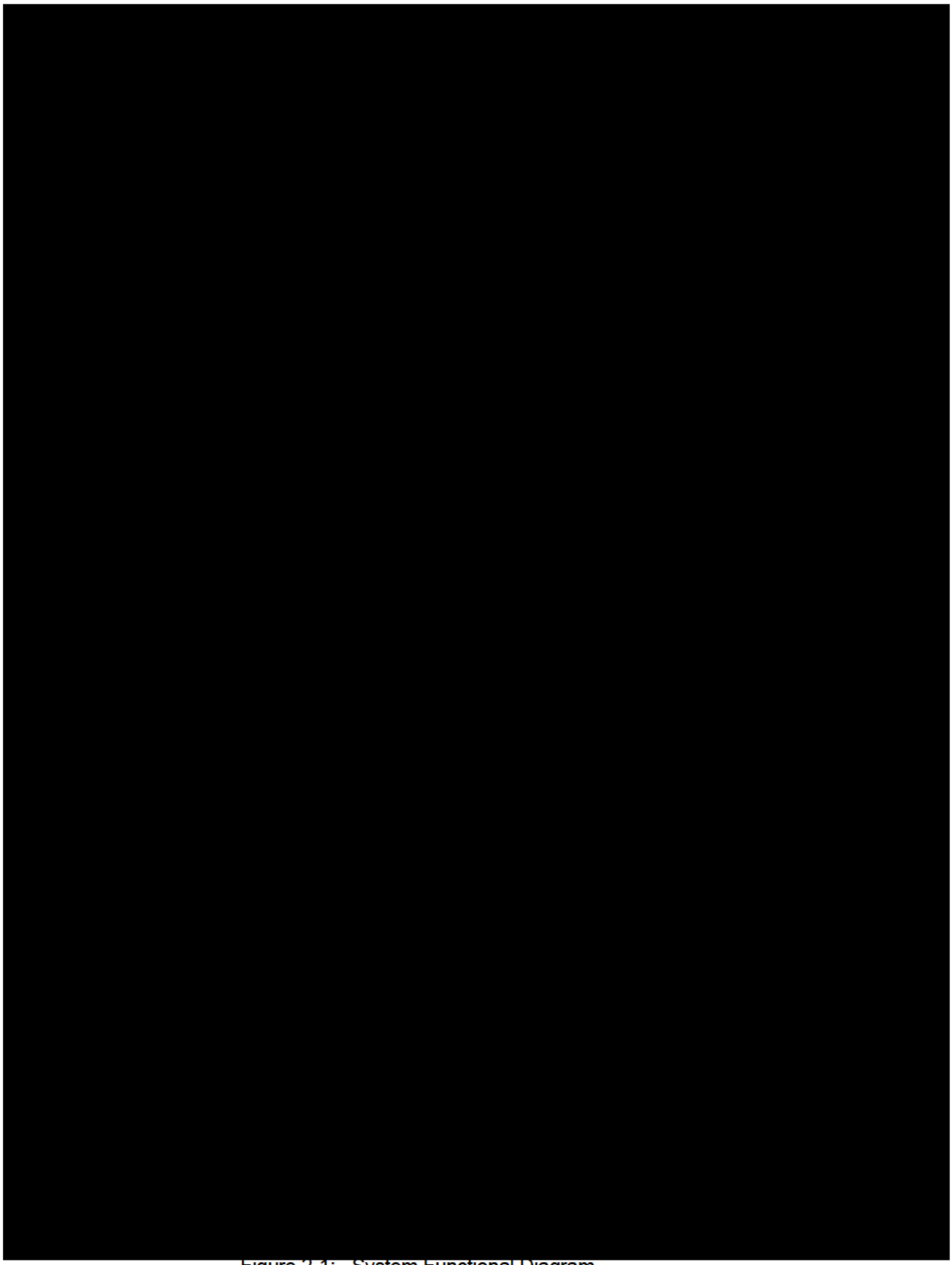


Figure 2-1: System Functional Diagram

2.5.1 Service, Indication, and Control Elements

Table 2-1. Service, Indication, and Control Elements

Element	Nomenclature	Location
DCU Type MDC-24(SMVB)	A1	Door Operator
Circuit Breaker	F1* DC1CBA/B ** DC2CBA/B **	Cabs
Door Closing Warning Buzzer	H1*	Interior – above door portal at each door entrance
ADA Door Closing Indication	H11*	Interior – above door portal at each door entrance
Door Open Indication	H12*	Exterior – above door portal at each door entrance
Door Out Of Service Indication, Interior	H13*	Interior – above door portal at each door entrance
Door Out Of Service Indicator, Exterior	H14/H15*	Exterior – both sides of portal at each door entrance
Contactor, Relay No Motion	K1*	Cab
Motor	M1	Door Operator
Door Locked Switch	S1	Door Operator
Emergency Operation Switch	S3	Door Operator
Door Out of Service Switch	S5	Door Operator
Service Switch	S7	Door Operator
Door Leaf Left Closed Switch	S8	Door Operator
Door Leaf Right Closed Switch	S9	Door Operator
Sensitive Edge Tape Switch	S11	Left Door Leaf Finger Protection Rubber
Sensitive Edge Tape Switch	S12	Right Door Leaf Finger Protection Rubber
Door Open Pushbutton	S21*	1 Interior - at each door entrance 2 Exterior - on each side of door portal
Exterior Crew Key Switch	S50*	2 Exterior – at each end door entrance
Connectors	X##	According To Circuit Diagram ED01139R01, Appendix A
* Carbuilder Scope Of Supply ** Car Nomenclature		

2.5.2 DCU Inputs & Outputs

Table 2-2. DCU Inputs

Input	Description	Status
E1	Signal “No Motion”	1 = standstill
E2	Central open	1 = open
E3	Door release	1 = released
E4	Central close/ Crew Switch closed	1 = closed
E5	Open Pushbutton	1 = open
E6	Door Leaf Left Closed Switch	0 = closed
E7	Open Front Door*	1 = operated
E8	Close Front Door*	1 = closed
E9	Door Leaf Right Closed Switch	0 = closed
E10	Limp Home Mode	1 = limp home mode
E11	Door Out of Service Switch	0 = door out of service
E12	Emergency Operation Switch	1 = emergency service
E13	Door Locked Switch	0 = door locked
E14	Crew Switch Door Opening	1 = open
E15	Sensitive Edge Door Leaf Left	1 = active
E16	Sensitive Edge Door Leaf Right	1 = active
E17	Door Position Sensor (direction)	0 = pulse
E18	Door Position Sensor (pulse)	0 = pulse
	*Doors A1/A2, A7/A8, B1/B2, B7/B8	

Table 2-3: DCU Outputs

Output	Description	Status
A1	Illumination Pushbutton red LED’s	1 = active
A2	Illumination Pushbutton green LED’s	1 = active
A3	Door Out Of Service indication elements	1 = active
A4	ADA Door Closing indication	1 = active
A5	Power Supply Pushbuttons	1 = active
A6	Door Open	1 = open
A7	Door Open indication	1 = active
A8	Door Closing Warning Chime	1 = active

2.5.3 DCU Status LEDS

Table 2-4. LED Indicators on DCU

5 VDC	Green	Indicates presence of internal supply voltage; Illuminates when internal AC-DC converter is producing 5 Vdc
ERROR	Red	Steady ON – Failure of DCU or no software installed Flashing – Active fault detected; LED flashing a flash code (number of flashes equals code number) when the diagnostic software detects an operational fault
STATUS INFO	Yellow	Not used
SAFETY RELAY OFF	Green	Indicates status of safety relay; Illuminates when safety relay de-energized

2.5.4 DCU Service Button

The SERVICE BUTTON is a pushbutton switch on the front of the DCU that can be used to close a not closed door and to re-initialize the DCU (reset the motor current curve and re-learn the mechanical door-open position).

To re-initialize the DCU:

1. Place S7 service switch, located on door operator, in off position “O” to remove power from local door and DCU.
2. Press and hold SERVICE BUTTON on DCU.
3. Place S7 service switch in on position “I” to restore power to local door and DCU.
4. When red ERROR LED turns off, release SERVICE BUTTON.
5. Cycle doors (open and close) ten times.

While the DCU is learning the full open position, the full mechanical open position must be reached and both rubber buffers must contact the portal simultaneously every time the doors open.

Re-initializing the DCU resets the motor current curve to nominal values. The door is then opened and closed to allow the DCU to learn the door open position. The DCU uses this as the position to reach when subsequently opening doors.

2.5.5 RS-232 Connector

RS-232 connector X8 of each DCU connects to the internal microcomputer. This provides a serial link to the microcomputer using RS-232 communication protocol. The serial link allows PTU (a laptop PC) to communicate with the microcomputer using IFE software. Refer to the ST03A manual in Tools and Test Equipment Manual for prerequisites of usage.

2.5.6 IFE Door System Software

The following is a description of each software tool.

2.5.6.1 ST03A

ST03A is a diagnostic program that displays real-time inputs and outputs of the DCU, downloads diagnostics codes, provides database functions such as reports and graphs (depending on the license), and allows downloaded data to be stored.

ST03A software is connected to the DCU through use of the PTU (laptop PC with IFE ST03A software installed) and a null modem USB cable equipped with an RS-232 adapter. The cable is connected to the laptop serial port and the DCU RS-232 (X8) connector.

The IP address of each DCU is specified by carbuilder IP access points based on individual car number. As an example, the IP address for car 1004 would be 10.0.4.87 where 87 is the address assigned for the DCU Ethernet gateway. The numbers 0.4 are the 2nd and 3rd octets of the car number identifier. The IP address is input into the ST03A Tools → Options→ Connection. Refer to the Tools and Test Equipment Manual for use of ST03A.

2.5.6.2 IFE Update

IFE Update is a program that downloads application software to the DCU. This can be done through use of the PTU (laptop PC with IFE ST03A software installed) and a null modem USB cable connected to the RS-232 (X8) connector of an individual DCU or the ETH connector of the Master DCU at door entrance A3/A4, which then allows access to the data of the MVB Master DCU at door entrance B5/B6 and the 6 common DCUs.

The main screen displays connection status and the installed version software. It has pull-down menu selections to establish connection, install new software, restart the DCU after programming, and exit the program. Context sensitive help screens explain use of the software. Refer to IFE Update 5.3 in the Tools and Test Equipment Manual.

2.5.7 CAN BUS Connectors

Connectors X6 and X7 are used to connect the eight DCUs on a CAN bus by car wiring. The DCU at door B5/B6 is the MVB Master on the CAN bus. Each DCU supplies all other DCUs on the CAN network with diagnostic data and the door cycle counter from the door system. Each DCU stores all diagnostic data and door cycle counters of the whole network. Connector X10 (ETH) on the ETH Master DCU at door A3/A4 is used to transmit diagnostic data on the CAN bus.

2.5.8 Door Coding

Each DCU receives a code that corresponds to its specific location (door entrance number) in the LRV on the CAN bus. The coding is set by LRV wiring from connector X6, pin 6 to pins 1, 5, 8, or 9 as listed in Table 2-5 below.

Table 2-5: Door Coding

Door	X6 Pin 1 (BIT 0/X6.1)	X6 Pin 8 (BIT 1/X6.8)	X6 Pin 9 (BIT 2/X6.9)	X6 Pin 5 (BIT 3/X6.5)
A1/A2	X			
A3/A4		X		
A5/A6			X	
A7/A8	X	X	X	
B1/B2				X
B3/B4	X	X		X
B5/B6	X		X	X
B7/B8		X	X	X
X = bridge to pin 6 (CAN ground) inside the D-Sub-connector X6				

2.5.9 MVB Connectors

Connectors X9 and X10 are used to connect the MVB Master DCU at door B5/B6 on a MVB bus by car wiring. The MVB Master DCU uses this bus to communicate with the TCN. MVB signals are listed in Section 2.4.3.

2.6 Door Operation

2.6.1 Power-Up

- The DCU door control logic initializes and begins operation when the power supply is switched on. The following operations occur:
- Door is closed:
  (1) The door is activated and remains closed.
  (2) No further operation occurs until the input signals change.
- Door is not closed:
  (1) The door is activated in the closing direction.
  (2) The obstruction detection system is operating using Motor Current Monitoring and Sensitive Edge Tape Switch according to Section 2.6.9.
  (3) Because the DCU does not know where the door is, a special software routine is used to close the doors at reduced speed until the doors reach the fully closed and locked position (reference position for the door position sensor).
  (4) The DCU now knows where the door is and normal speed is used for further operations.

2.6.2 Trainline No Motion

Opening of a door electrically is possible only if the trainline NO MOTION is active. The NO MOTION signal inhibits all open signals through software logic in order of highest priority. As long as trainline NO MOTION is deactivated, all other trainline signals will be ignored. Open or opening doors start to close immediately if the trainline NO MOTION is deactivated.

Trainline NO MOTION influences the pushbutton illumination. Refer to Section 2.6.7.

2.6.3 Trainline Door Release

Trainline DOOR RELEASE can be enabled for passenger activation by the operator either for the left or the right side of the vehicle via the operator control panel. When doors are released for passenger activation, the passenger can then open the door by pressing the interior or exterior door-open pushbutton (S21). The passenger pushbuttons illuminate as described in Section 2.6.7.

2.6.4 Safety Relay

Safety relay is located inside the DCU and is only activated by hardwired signal NO MOTION (input E1).

The safety relay provides three security features for door function:

- One, it maintains the door interlock loop open and under control of the DCU until the door closed and locked test is passed (refer to Section 2.6.14.2),
- Two, it acts as a hardware interlock between the DCU and the motor lock mechanism to prevent a program execution error from accidentally unlocking the door,
- Three, it keeps the door interlock loop open if a diagnostic code of Priority A is present (refer to Section 2.6.14.2).

2.6.4.1 Function of the Safety Relay

The safety relay has one N.O. contact and one N.C. contact, used as follows:

- The N.O. contact is connected to the activation circuit of the motor drive unit. This prevents the DCU from energizing the motor unless the safety relay is energized to complete the circuit,
- The N.C. contact is in series with the door closed and locked loop. The loop is closed only when all eight doors are closed and locked and all eight safety relays are switched off. The loop portion for a single door is bypassed by door out of service switch S5 when the door is cut-out.

The logic switching status of the internal safety relay is monitored in the DCU. If switching status does not correspond to the generated NO MOTION signal as defined in Section 2.6.4.2, a diagnostic code will be generated in the DCU and transmitted to the train control network via ETH bus-system.

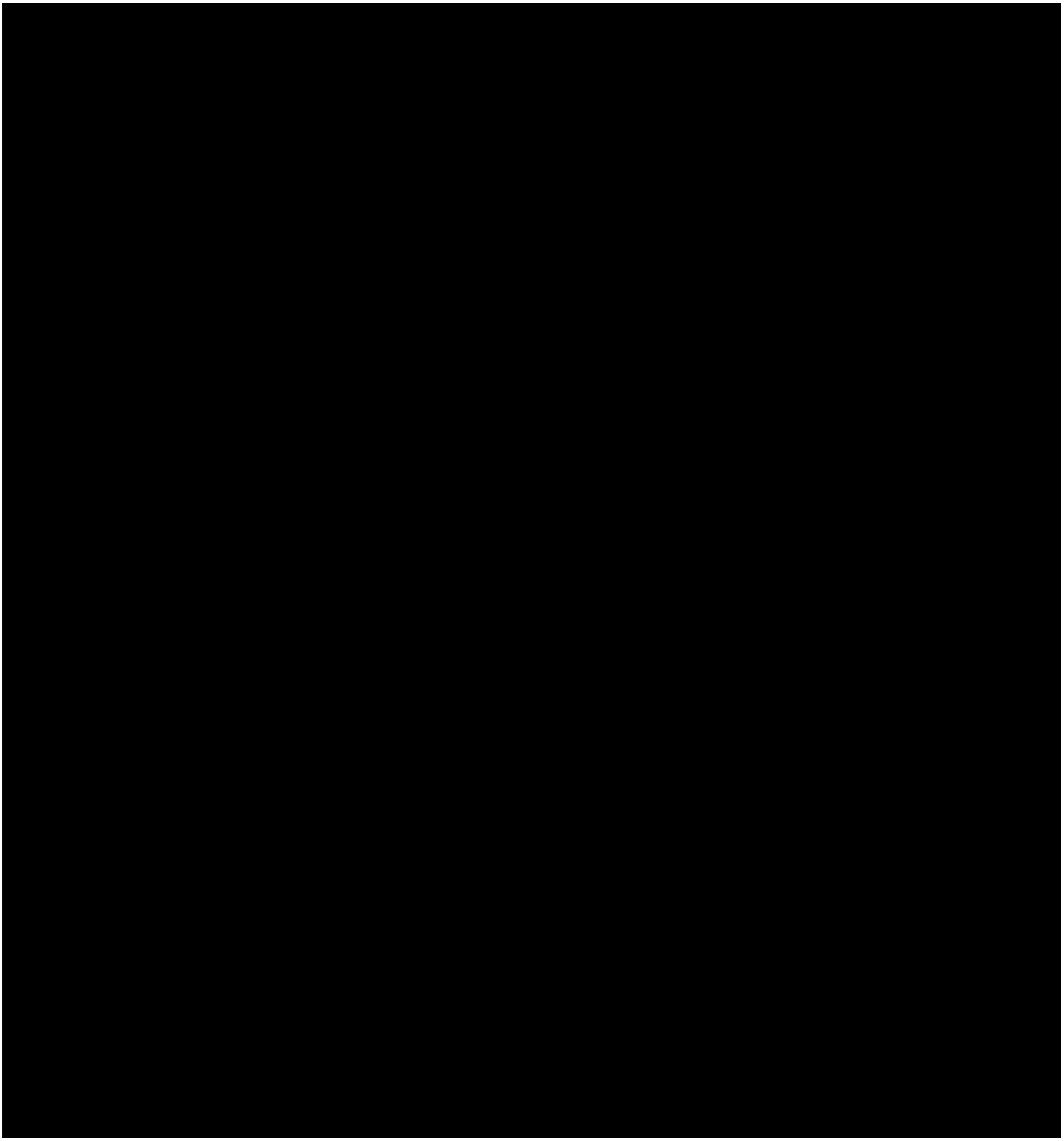


Figure 2-2: Safety Relay Control Circuitry

2.6.4.2 Activation of the Safety Relay

The safety relay within the DCU enables activation of the door drive motor.

As soon as the safety relay is activated, the normally closed (N.C.) contact of the safety relay within the door closed loop is opened.

In order to activate the safety relays, the following condition and signals must be present:

NO MOTION (E1) signal is active

Additionally, an internal enabling (transistor switch) by software for activation of the safety relay must be given per the following conditions:

RELEASE Signal is active, according to Section 2.4.3.4

OR

Door becomes unlocked as indicated by S1 door locked switch

OR

Door is or becomes emergency operated

AND

NO MOTION (E1) signal is available, according to Section 2.4.3.4

When opening with crew switch, the last condition (NO MOTION signal available) is not necessary.

2.6.4.3 Deactivation of the Safety Relays

In order to keep the switching cycles of the safety relay as low as possible, the deactivation of the safety relay (interruption of the self-latching by the switching transistor) will occur per the following conditions:

Door was closed and RELEASE signal deactivated

OR

Door was closed after emergency reset according to Section 2.6.8.3

AND

Door closed and locked

AND

No Priority A diagnostic codes exist

2.6.5 Door Opening Control Logic

This section describes the control logic for opening of the doors. When the doors leave the closed and locked position, the exterior door open indicator H12 illuminates and remains illuminated until the doors return to the closed and locked position.

For pushbutton illumination refer to Section 2.6.7.

For door opening with Crew Switch refer to Section 2.6.5.4.

2.6.5.1 Opening of Individual Doors by Passengers

A passenger can open a door by pressing the interior or exterior door-open pushbutton (S21) after the door has been released by the operator (refer to Section 2.6.3).

A door that has been opened by a passenger door-open pushbutton (S21) automatically closes after a time delay of T1 + T3. Refer to Figure 2-3, Door Timing and Table 2-6, Adjustable Door Parameters.

In addition, if a door is in the process of automatic closing, pressing a pushbutton causes the door to reopen as described in Section 2.6.6.2.

If a passenger presses a door open pushbutton (S21) while no doors are released, an open request command is sent from the DCU via MVB to the Train Control Network (TCN). The TCN then sends the open request command via MVB to the corresponding DCU on the other side of the vehicle. The open request is then memorized at both sides of the vehicle.

When the vehicle stops (NO MOTION signal goes high) at the next station and the doors of one vehicle side are released, the system responds as follows:

- The door opens automatically and the open request is cancelled. Door closing is per Section 2.6.6,
- Active open requests at non-released doors are cancelled via MVB (reset open request command).

For pushbutton illumination refer to Section 2.6.7.

For warning device activation refer to Section 2.6.13.

2.6.5.2 Opening via Central Door Open Command (MVB & Trainline Signal)

The Central Door Open command can be activated by the operator for the left side or the right side of the vehicle. A Central Door Open command causes the following:

- The DOOR RELEASE trainline is activated, which is a prerequisite for door opening,
- All doors on the selected side open to the fully open position,
- The illumination of pushbuttons according to Section 2.6.7,
- The doors remain open until the operator presses the Central Door Close pushbutton. This causes the DOOR RELEASE trainline signal to change from high to low and deactivates the Central Open MVB signal.

2.6.5.3 Opening by Crew Switch

The Crew Switch signal of the car is connected to input E14 (no activation of safety relay).

An opening by crew switch is possible only if signal NO MOTION on DCU input E1 is high activated (input E1 activates the safety relay).

2.6.5.4 Open Front Doors

Signal Open Front Doors is given from the Operator. One or more front doors can be opened. This is a local function and concerns only the activated door.

2.6.6 Door Closing Control Logic

This section describes the control logic for door closing.

Refer to Figure 2-3, Door Timing and Table 2.7, Adjustable Door Parameters, for more information on specific time delays (T1, T2, etc.) during the door closing process.

Refer to Section 2.6.13.1 for door open indicator H12 and Section 2.6.13.2 for ADA door closing indicator H11 operation during the door closing process.

Refer to Section 2.6.13.3 for operation of the audible and visual door closing warnings during the door closing process (time delay T3).

Refer to Section 2.6.7 for pushbutton illumination operation during door closing sequences.

During door closing the obstruction detection system operates according to Section 2.6.8.5.

For crew switch operation, and the effect on the door closing process, refer to Section 2.6.10.

2.6.6.1 Closing Process

The door closing process is only possible if the door is not out of service AND sensitive edge is not actuated.

The closing sequence of the door after a valid close command is as follows:

- Closing signal is received by DCU or open hold time for closing runs out,
- Pre-warning time for closing T3 is started,
- Warning indicators and warning sound module are activated,
- After pre-warning time, the DCU motor is started in closing direction of the door and warning sound stops,
- Door leaf closed switches S8 (left) and S9 (right) are mechanically activated,
- Door is closed, safety relay is deactivated, and the NC contact S1 within the door closed loop is closed.

2.6.6.2 Automatic Closing after Open Hold Time for Closing

Under specific conditions, an open hold time for closing (T1) is started as soon as the door reaches the open end position. After expiration of open hold time for closing, the door automatically starts the closing sequence.

The following conditions must be fulfilled to start open hold time for closing:

Sensitive edge not actuated

AND

No positive edge of open pushbutton

AND

No central open signal,

AND

Door is not emergency released

AND

S5 door out of service switch signal is inactive

AND

Door is in open end position

During Open hold time for closing, warning elements H1 and H11 are active.

As soon as open hold time for closing T1 is finished, the closing sequence starts according to Section 2.6.6.1.

If one of the above conditions is no longer fulfilled, the open hold time for closing is reset. Open hold time will restart once all conditions are fulfilled again.

During the closing sequence, obstruction detection is taken into account according to Section 2.6.9.1.

2.6.6.3 Central Door Close Command – Closing of Doors by Operator

A door which is opened by Central Door Open command will not close automatically and will only close by Central Close command. The Central Door Close command is initiated by the operator pressing the central door close pushbutton in the cab. This deactivates the DOOR RELEASE trainline and cancels an active Central Door Open command.

The operator can close the doors via the Central Door Close command if the doors were opened by passenger pushbutton or by the Central Door Open command.

2.6.6.4 Door Closing by Operator after Door Opened by Passenger

If the door was opened by a passenger and a Central Door Close command is given (DOOR RELEASE trainline deactivated), the closing response depends on the state of the door. The possibilities are as follows:

- If the door is in the process of opening, then the door will stop and the closing process will immediately start as described in 0,
- If the door is open, and the Central Door Close command is given during time delay T1, T3 time delay starts and doors close after T1 expires,
- If the door is already open, and the Central Door Close command is given during delay time T3, the closing process will continue uninterrupted,
- If the door is already closing, the closing process will continue uninterrupted.

2.6.6.5 Door Closing by Service Button

Located on the DCU is a service button by which the door can be closed by service staff for maintenance purposes. Closing by Service Button is only possible if door is not out of service and sensitive edge is not actuated. Once positive edge of service button signal is detected, the doors close according to the sequence defined in Section 2.6.6.1.

Closing by Service Button is a local function and will only close the adjacent door.

2.6.6.6 Closing of Doors via NO MOTION Signal

If the NO MOTION trainline is disabled, all open doors start to close immediately (except doors in the manual released state per 2.6.8.1). In this instance time delay T3 is not applicable and both audible and visual door closing warning indicators operate while the doors are closing and stop when the doors are closed.

In this instance obstruction detection operates during the door closing process according to Section 2.6.9.5.

2.6.7 Illumination of Pushbutton S21

The open push button illumination is activated by output A2, Illumination Pushbutton green LEDs. The pushbutton functions as follows:

- Steady as long as the door is released for opening under the following conditions:
  - No Motion AND Release
    AND
  - Door is not out of service
    AND
  - Door is not opened by emergency release device

- Flashing 2Hz during Pre-warning time for closing independent of the release signal

If signal release is further active during door closing movement, the steady illumination remains active.

2.6.8 Manual Release of Doors

This section describes operation of the emergency manual release devices. There is one interior manual release at all door entrances. Only front door entrances A1/A2, A7/A8, and B1/B2, B7/B8 have an exterior manual release. The exterior manual release is housed in a protective water cover.

2.6.8.1 Interior and Exterior Emergency Manual Release

The operation of the emergency manual release devices is purely mechanical and therefore can be used when power has been lost. The devices operate independent of the NO MOTION signal and can be used at any speed. The manual release can also be used to open a door that is cutout.

The Interior / Exterior emergency manual release is a hand-operated flap-design mechanism that allows the doors to be unlocked and opened from inside or outside the vehicle, intended to allow egress or emergency response personnel access to the car in an emergency situation or for use by technicians during maintenance activities.

The manual release is operated by pulling the flap outward 60-degrees. When operated, the doors move from the closed and locked position to the open position, creating a small gap between the door leaves, allowing them to be physically pushed opened. The flap is self-retracting and will reset automatically to its original position.

2.6.8.2 Mechanical Operation of the Manual Releases

When operated, the manual release pulls on the attached Bowden cable, causing the lock mechanism lever to actuate the emergency operation switch (S3), and mechanically disengage the lock.

Operating a manual release causes the following occur:

- The Emergency Operation Switch (S3) on the drive unit is actuated and interrupts the door closed loop,
- The signal Emergency Operation Switch (S3) is detected by the DCU,
- The door functions are switched off (except closing command for emergency reset),
- The door is unlocked and leaves the closed position; the door will open by spring device a minimum 1 inch,
- All closed limit switches (S1, S8, and S9) are mechanical deactivated,
- Flap handle returns itself to normal position (interior / exterior emergency device) if this is manual released,
- The door can be manually opened or closed,
- The door remains emergency released (DCU stores emergency release conditions).

2.6.8.3 Resetting of Manual Releases

Door closing can be done manually or by a door close command. The release mode is reset when the door reaches the closed position. All functions are available when:

- Emergency Operation Switch (S3) is reset (done automatically when the self-retracting flap handle is released),
- Door Locked Switch (S1) indicates a closed door,
- Door Leaf Left Closed Switch (S8) indicates a closed door,
- Door Leaf Right Closed Switch (S9) indicates a closed door.

NOTE: The closing command will be ignored if the emergency device flap is held open too long and not released for reset. Flap must be reset prior to manual closing of the door.

2.6.9 Obstruction Detection

The door system utilizes an obstruction detection system during door closing and opening sequences.

2.6.9.1 Obstruction Detection during Closing Sequence

The DCU door control logic detects obstacles during door closing using three different methods; motor current monitoring, way/time monitoring, and a sensitive edge tape switch (S11) on the right door leaf. The obstruction detection system is automatically disabled when the door reaches the closed and locked position.

2.6.9.2 Motor Current Monitoring

The normal curve of the motor current during the closing sequence is stored and automatically adjusted during each closing sequence. If the actual value of the motor current exceeds the nominal value, obstacle detection becomes active. The maximum current is not steady. It depends on the door position and on the current consumption of earlier closing sequences (self-learning maximum current curve). The value of the maximum current stays stored in the DCU even when the supply voltage of the DCU is switched off. If the DCU is moved to any other door, it is necessary to re-initialize it by pressing and holding the SERVICE BUTTON, turning on power, and continuing to press the SERVICE BUTTON until the red ERROR LED turns off.

2.6.9.3 Way-/time Monitoring

The DCU monitors and divides the door movement into small distances by using magnetic pulses from the door position sensor (Hall-effect device integral to motor M1). If the closing door does not pass the appropriate distance point within a fixed time, the obstruction detection subroutine will activate.

2.6.9.4 Sensitive Edge Tape Switch

The edge of the each door leaf is equipped with finger protection rubber and a sensitive edge tape switch (S11/S12). If the door meets a person or object while closing, the tape switch signals the DCU, which then activates the obstruction detection subroutine immediately. If there is a failure of the sensitive edge system (constant operation or interruption), the DCU generates a diagnostic code.

With the sensitive edge system operational, the door can detect a rectangle test bar (0.25” wide by 3.0” high), or round bar (3/8”) held rigidly and perpendicularly between the closing door leaves. Detection of the rectangle test bar is only possible when the sensitive edge is operational. If the sensitive edge is not operational, a round bar 1.18 inches in diameter can still be detected using the other two functions of the obstruction detection system. The obstruction detection system is automatically disabled when the door reaches the closed and locked position.

The sensitive edge method of obstruction detection is only applicable during door closing.

2.6.9.5 Obstruction Detection by Door Closing Method

If an obstruction is detected during the closing sequence, the following sequences can take place, depending on the way the door closing was initiated: (Refer to Figure 2-3 Door Timing and Table 2.7, Adjustable Door Parameters, for more information on specific time delays (T1, T2, T3.) during the door closing, or obstruction detection, process.)

A. Sequence 1 – applicable for automatic closing, Central Door Close command by the operator, or closing by crew switch: The door re-opens to the fully open position. The doors remain open for time delay T1 & T3. After these delays, the doors re-start the closing movement.

B. Sequence 2 – loss of NO MOTION signal: Door stops for 1 second (to remove trapped obstacles) and closes afterwards automatically. If the obstruction detection goes active again, the door stops once more for 1 second and closes afterwards automatically. This sequence is repeated 5 times.

C. Sequence 3 – The emergency manual release device was operated and reset while the vehicle was moving, or the door release signal is missing: The door does not reopen. It stops for 2 seconds then starts the closing process. This sequence is repeated 5 times.

If an obstruction is detected again, the door repeats the sequence. The number of closing attempts is non-adjustable. After 5 attempts to close, the door re-opens to the fully open position and remains open. At this time a diagnostic code is generated by the DCU and reported to the TCN.

During this sequence the operator can issue a Central Door-Open or Door-Close command and reset the obstruction detection circuitry. A new door-open command opens any door that is not fully open. With a new close command, the doors re-start the closing process as described in Section 2.6.6.3.

2.6.9.6 Obstruction Detection Logic on Opening

During the opening sequence the door control logic detects obstructions using motor current monitoring and way/time monitoring only. If the DCU detects an obstruction during the opening cycle, the door stops immediately in its current position for time delay T4. After the T4 time delay the door continues to open. If the obstruction is detected again, the door repeats this sequence up to C2 attempts. After C2 attempts, the door stops in its current position. The DCU then records this as the maximum reachable open position and generates a diagnostic code that is sent to the TCN.

2.6.10 Crew Switch Operation

There are two exterior door crew switches located at the end of each door entrance A1/A2, A7/A8, and B1/B2, B7/B8. Each door crew switch has three positions: OPEN, NEUTRAL and CLOSE with spring return to the NEUTRAL position. It can only be turned by using the crew key. The switches operate independently whether the vehicle is powered or not. Each crew switch only functions locally on the specific door. The door crew switches are interlocked with the NO MOTION signal to disable them while the car is in motion.

The command of a door crew switch overrides any other electrical open commands (trainline or MVB). For all scenarios, the NO MOTION signal must be high to allow the door to open.

When the door is opened by the crew key, the door will remain open for five seconds. The crew key can cancel time delay T1 of five seconds by placing the door crew switch in the CLOSE position or by using the door close pushbutton in the cab.

The crew switch will activate the Central Close command by energizing both the Door Right Close Relay and the Door Left Close Relay. All open doors will close according to the received Central Close commands according to Section 2.6.6.3.

2.6.10.1 Crew Person Enters Unpowered Vehicle

For a crew person to enter an un-powered vehicle, the exterior door crew switch must be placed in the OPEN position. When this occurs, the power up sequence will begin on the LRV. The DCU will boot up in less than four seconds and the NO MOTION circuitry will be ready in less than eight seconds. After this startup sequence occurs, the exterior door crew switch must then be placed in the OPEN position.

When the above sequence is complete, the door opens and remains open for time delay T1 of five seconds. After T1 time delay expires, the door closes automatically according to Section 2.6.6.2.

If parameter T1 of five seconds is set to 0, the door remains open until the crew switch is placed in the CLOSE position.

If the vehicle local mode is set to off while the door is open, the door will remain open due to lack of power.

2.6.10.2 Crew Person Enters Vehicle in Local Mode

If the vehicle is in local mode, the crew person must only place the exterior door crew switch in the OPEN position. The door then opens and remains open for time delay T1. After T1 time delay expires, the door closes automatically according to Section 2.6.6.2.

If parameter T1 of five seconds is set to 0, the door remains open until the crew switch is placed in the CLOSE position

2.6.10.3 Crew Person Leaves Vehicle and Vehicle Is To Be Powered Down (Cab)

When the vehicle is to be powered down and a crew person is leaving the vehicle, the front door control switch must be placed in the OPEN position. The door then opens and remains open for time delay T1. After T1 time delay expires, the door closes automatically according to Section 2.6.6.2.

If parameter T1 of five seconds is set to 0, the door remains open until the crew switch is placed in the CLOSE position.

2.6.11 Cutout Operation

Each door entrance is equipped with a mechanical cut-out system that includes the manually operated cutout lever located on the locking mechanism assembly on the door operator. This device will function to isolate the door mechanically.

2.6.11.1 Mechanical Cutout with Door Cutout Device

The cutout operation is initiated by moving the cutout lever counterclockwise 90-degrees, which will switch off the door functions. It will also cause the following functions:

- Illuminate the Door Out of Service Indication Elements,
- Send information to the operator control via the MVB Bus system,
- Bypass Door Locked Switch (S1), Door Leaf Closed Switch (S8/S9), and Safety Relay,
- Switch off the door drive motor (except for commanded door closing/ not allowed opening functions),
- The DCU disables door operation and activates the “door cutout” output A3 steadily.

If there is a failure in the locking mechanism (door opening not allowed), the door drive motor will close the door.

The Emergency manual releases are functional when the cutout is activated. When the manual releases are reset, the spring loaded lock mechanism will allow manual closing and locking of the door.

2.6.12 Electrical Door Isolation Using Service Switch S7

Service switch S7 is mounted on the door operator.

Operation of this switch initiates the following:

- Removal of power supply from the door drive unit,
- CAN-Bus Communications remains in service,
- If MDC-24SMVB (DCU at door entrance B3/B4) is cut out, no MVB communication is available,
- If MDC-24ETH (DCU at door entrance A5/A6) is cut out, no ETH communication is available,
- No new diagnostic codes are stored for the respective door system, active diagnostic codes remain stored,
- An open door must be closed manually. The door stays in the door closed loop until the door is closed.

The door can be emergency operated but an activation of the door drive motor in closing direction is not possible.

An electrical cut out is not recommended unless absolutely necessary ie: short circuit that influences train wiring, burned cables, or other major electrical failures.

Operation of service switch S7 does not bypass the interlock loop.

2.6.13 Audible and Visual Warnings

This section describes the operation of the visual and audible door closing warning indication. Figure 2-3, Door Timing shows the time line for the general activation process of the audible and visual door close warning devices.

2.6.13.1 Exterior Visual Door Opening Indicator (H12)

Door status open indicator H12 illuminates green and is located on the exterior of the train, above the center of each doorway. The DCU controls the indicator via output A7 as follows:

- Indicator H12 illuminates steadily when the door is released or unlocked, or when a manual release device is actuated and the door is in emergency condition,
- Indicator H12 flashes modulated with a frequency of 1 Hz if a failure of priority A (major fault) is active. The flashing overrides the steady illumination. For instance, if a door is open and a failure of priority A is active, then the door status indicator will flash,
- Indicator H12 is extinguished when the door becomes closed and locked, provided the door is not in emergency condition or a priority A fault exists.

2.6.13.2 Interior Visual ADA Door Closing Indicator (H11)

Visual interior ADA door closing indicator H11 illuminates red and is mounted in the interior of the train, above the center of each doorway. The DCU controls the light Illumination via output A4 as follows:

- Indicator H11 flashes (modulated with a frequency of 2 Hz) for an adjustable time delay T3 (Figure 2-3), before door closing movement. The light continues to flash until the door is closed and locked,
- Indicator H11 flashes (modulated with a frequency of 2 Hz) during re-opening if an obstruction detection occurs,
- Indicator H11 flashes (modulated with a frequency of 2 Hz) if a priority A fault is active. The light stops flashing when the priority A fault is removed or the door is cutout.

2.6.13.3 Audible Door Closing Warning Buzzer

The audible door closing warning buzzer H1 is located above the door portal at each door entrance. The buzzer has a frequency of 2.5 kHz ± 15%. The DCU activates buzzer H1 via output A8 as follows:

- Warning buzzer H1 sounds during pre-closing (T3, Figure 2-3),
- If door obstruction detection occurs, the device is deactivated during the reopening movement of the door.

2.6.14 Adjustable Door Parameters

Table 2-6 lists the adjustable parameters and gives the specified range and steps. Figure 2-3 illustrates the time periods. PTU (ST03A software and laptop PC) is used to change parameters via MVB bus system.

Table 2-6: Adjustable Door Parameters

Parameter	Default Value	Adjustable Range	Adjustable Interval	Description
T1	5 seconds	0; 2–30 sec. 0 = infinite	1 second	Automatic closing – door open dwell time (time doors stay open before closing automatically when opened by passenger pushbutton)
T2	1 second	0–10 seconds 0 = infinite	1 second	Open hold time after activation of obstruction detection at closing
T3	2 seconds	0–5 seconds	1 second	Pre-closing warning – time that audible and visual warnings are active before doors start closing movement

2.6.14.1 Door Closed Monitoring

The door control logic monitors the door closed and locked position. If a failure occurs and a door leaves the closed position without an opening command, the door control logic will close the door with nominal force. Obstruction detection is not functional in this case.

2.6.14.2 Interlock Loop (Door Summary) for Door Status Relay

The interlock loop for the car's Door Status Relay consists of a serial connection of the following items:

- Door Locked Switch S1,
- Emergency Operation Switch S3,
- Door Leaf Left Closed Switch S8,
- Door Leaf Right Closed Switch S9,
- N.C. contacts of safety relay (located internally in the DCU).

If a priority A diagnostic code exists, safety relay does not switch off. Therefore, the interlock loop for the Door Status Relay stays open. This inhibits operation of the vehicle via car circuits.

The condition is remedied by operating the respective cutout device to take the door out of service.

When a door is cut-out by using the door cutout lever, the interlock loop for the respective door is bypassed with the Door Out of Service Switch S5.

If the door is closed and locked and safety relay is switched off by the internal DCU circuit, then the Door System Is Safe signal is sent over the MVB bus.

2.7 Door Diagnostics

The door diagnostic system monitors door operation and automatically detects fail conditions. It is intended to alert train personnel when doors need to be set out of service for identification and repair of failure.

The system provides the following:

- diagnostic data transmitted to the vehicle control via the ETHERNET bus system,
- status LED's on the housing of the DCU that indicate red LED “Error” by a flash code. A failure in the hardware of the DCU or missing software in the system memory is indicated by a steady illuminated red LED “Error” and flashing green indicator H12 if priority A failure is detected,
- an RS-232 connector on the DCU to link with a PTU (laptop pc and IFE software ST03A) to read and memorize the DCU diagnostic data,
- a diagnostic software module that continuously monitors the door functions to find abnormal conditions by plausibility checks.

2.7.1 Fault Notification to Vehicle

The DCU maintains the door status summary in an open condition when the diagnostic software module finds a failure that compromises passenger safety (priority A), which may require taking the door out of service. This prevents propulsion. The DCU will flash the associated status indicators to indicate the door with the fault. Flash codes are defined in Table 2-7. At the same time, the DCU transmits the diagnostic code to the TCN.

2.7.2 Indication LEDS on the Housing of the DCU

The LEDs on the DCU indicate the status of various functional conditions to maintenance personnel to aid in locating faults. Refer to Section 2.5.3, Table 2-4 for the functional condition LEDs.

2.7.3 RS-232 Service Connector

The service connector provides a serial connection to a PC to connect to the DCU with a null modem cable. Two IFE applications can be run for the DCU as described in Section 2.5.6.

2.7.4 Diagnostic Software Module of DCU

2.7.4.1 General

The diagnostic software module runs continuously as part of the door control logic. The module does the following and logs results by assigning a diagnostic code (Table 2-7) to the failure:

1. Checks the internal hardware: EPROM (CRC checksum), RAM, NOVRAM, runtime watchdog timer, and oscillator watchdog timer.
2. Does plausibility checks by checking the movement of the door and the corresponding input signals coming from limit switches, pushbutton switches, etc. against required and known operating conditions, time outs, or failure conditions.
3. Monitors the output current of the motor for opens and all other outputs for short circuits.

When power is turned off, the software module stops logging the diagnostic data of the isolated door, but saves already recorded diagnostic data for the door.

The module finds failures and indicates them to operation personnel (to isolate the door) or to service people (to locate and repair the failure). The different failures are split into failures of priority A and B. A summary fault indication signal is transmitted to the TCN in the event of a current priority A failure.

A fail condition is automatically stored in the nonvolatile diagnostic memory (NOVRAM) of the DCU. A present failure will be cleared automatically and transmitted into background storage, if the previous present fail condition has been removed and the last operation operates normally.

Failures are coded by failure number and assigned priorities. High priority failures cause the DCU to stop door operation and require that the crew cut out the door. Failures are indicated by the ERROR LED on the DCU and can be read and stored for a history via the RS-232 Service Connector.

2.7.4.2 Structure of Diagnostic Memory

2.7.4.2.1 Quantitative Diagnostic System (QDS)

The diagnostic memory is subdivided into foreground memory (current fail conditions) and background memory (temporary fail conditions).

The foreground memory contains current diagnostic data, meaning diagnostic data that is currently in existence at the time of the inquiry.

The background memory contains temporary diagnostic data, meaning diagnostic data that were previously observed by the DCU, but are not active at the moment of data transmission from DCU to PC or have been changed into temporary diagnostic data by any circumstances (i.e. by itself or an action of train personnel).

Current diagnostic data becomes temporary diagnostic data:

- Automatically, if a previous faulty state clears and the door functions again,
- If the reason for the diagnostic code is repaired by the train personnel (however not by cutting out the door).

A change of current diagnostic data to temporary diagnostic data is done in order to preserve this diagnostic information for maintenance personnel.

2.7.4.2.2 Historical Diagnostic System (HDS)

The historical diagnostic system stores every change of diagnostic condition with date and time stamp. Every time a diagnostic condition becomes active (current fail condition) or a diagnostic condition becomes inactive (temporary fail condition), the diagnostic condition is stored with current time and date of occurrence.

Because there is no internal Real Time Clock (RTC) available in the DCU, it is necessary to get the date and time information from the train communication system via bus interface. This date and time are used as long as the communication network is operating. If the communication network was operating after power up of the DCU and then stopped operating, the time is calculated inside the DCU by using the synchronized date and time received earlier from the train communication network. In that case, the date and time corresponds to the real time, until the power supply of the DCU is switched off.

The different diagnostic conditions are memorized in a ring memory arrangement. If the limitation is exceeded, the oldest entry will be overwritten by the new one.

Each modular door control unit (MDC-24, MDC-24ETH, MDC-24SMVB) is integrated with a 128kByte-NOVRAM which will store the faults of the historical diagnostic system (HDS): maximum 500 entries. The HDS is a local system and is not transmitted to other door controllers. The NOVRAM is equipped with an internal battery and is responsible for battery backup of the diagnostic memory. The internal battery requires NOVRAM to be a scheduled maintenance item, replaced at the interval defined in the Heavy Repair Maintenance Manual.

All diagnostic data is available via the Ethernet and the RS232 service interface.

2.7.4.3 Diagnostic Code Parameters

Each diagnostic code is described by the following parameters:

- Internal diagnostic code number: 1 to 999 (Code used internal to DCU),
- Customer diagnostic code number: 1 to 99 (Code sent via MVB to TCN),
- Diagnostic code counter: 1 to 99 (increments if a diagnostic code occurs or change from the background to the foreground memory),
- Customer specific flash code: 1…30x flashing,
- Priority: A, B,
- Function: a, b, c, d.

The internal (IFE) diagnostic code numbers are standard, defined by IFE, and always refer to the same defined element. Due to the fact that the same internal code can be assigned to several of the same element types, the supplementary customer code number is provided to define each specific element.

For example, one internal (IFE) diagnostic code number (177) is defined for the door leaf detection switches. The external (customer) code (3 or 4) is provided to precisely define which limit switch is defective.

Both the internal and external (IFE and Customer) diagnostic codes can be viewed through use of a laptop and software ST03A.

2.7.4.4 Diagnostic Code Priority

The diagnostic software module assigns a priority A or priority B to each logged diagnostic code as shown in Table 2-7.

Priority A is high priority. The safety of the passengers or the operation of the door can be affected. The operator should fix the problem or cut out the door (remove from service). To inform the operator of a failure condition of priority A, the safety relay of the DCU does not switch off even if the door leaves are closed and locked. Therefore, the interlock loop for the Door Status Relay (door summary circuit) stays open. This prevents propulsion unless the door is cut out.

Priority B is low priority. The safety of the passengers or the operation of the door is not affected. The problem can be checked or repaired at the home depot.

2.7.4.5 Diagnostic Code Effect on Door Functions

Diagnostic codes of function “a” or “b”, as defined in Table 2-7, will cause an immediate stop of door movement. The short circuit of the door drive motor is interrupted setting the door free so that it can be manually locked / closed.

Due to one of the actions listed below, the DCU tries to continue door movement on diagnostic codes of function “b” without actions from train personnel e.g. repair or door isolation:

- Operation of open pushbutton
- Activation or deactivation of trainline NO MOTION
- Activation or deactivation of trainline DOOR RELEASE
- Activation or deactivation of trainline CENTRAL CLOSE

Failures with function “c” or “d” will generate a diagnostic code only. Door function will not be impacted.

2.7.4.6 Read Out of the Diagnostic Memory

The diagnostic memory software module communicates the logged diagnostic codes via the ERROR LED on the housing of the DCU and the RS-232 Service Connector. Diagnostic codes are also transmitted from the DCU to the TCN via ETH. The TCN relays selected diagnostic codes to the Train Operator Display (TOD). Table 2-7 defines which diagnostic codes are transmitted to the TOD.

2.7.4.6.1 Error LED on DCU

The diagnostic software module indicates each active diagnostic code with the ERROR LED. The possibilities are:

- The ERROR LED is not illuminated when no diagnostic code is active,
- The ERROR LED is steadily illuminated if there is a failure in the hardware of the DCU or if the software in the system memory is missing,
- The ERROR LED flashes a code if an active diagnostic code is present.

The flash code always shows the diagnostic code with the lowest number first. The lower the diagnostic code, the more important it is to correct operation. For example, refer to the codes in Table 2-7. If flash code 1 (broken wire in the circuit of the door drive motor) and flash code 10 (passenger door-open switch S1 failed) are both active, then flash code 1 is displayed by the ERROR LED. When the reason for this code is corrected, flash code 10 is displayed by the ERROR LED. The typical flash timing is 300ms on and 300ms off with a 2.5 second break before the next flash.

2.7.4.6.2 RS-232 Interface

On the DCU interface RS-232 on door 1. With the use of a laptop computer and the diagnostic software IFE ST03A, the diagnostic data of all DCUs can be read out on the DCU interface from door 1 and stored. The data can be managed with the use of a database. For detailed information, refer to IFE ST03A manual in the Tools and Test Equipment Manual.

With the use of a laptop computer and the diagnostic software IFE ST03A, the diagnostic data of the adjacent DCU connected with the RS-232 service interface can be read out and stored. The data can be managed with the use of a database.

2.7.4.6.3 Clearing of the Diagnostic Memory of DCU

Current diagnostic codes are automatically cleared and become temporary diagnostic data (background memory), if a previous fault state clears and the door works correctly, or if the reason for the diagnostic code is repaired by the train personnel. Cutting out a door does not change the current diagnostic data, which is retained until the actual reason is corrected.

The whole diagnostic memory can be deleted using a laptop computer and the diagnostic software IFE ST03A. For detailed information, refer to the IFE ST03A manual in the Tools and Test Equipment Manual.

An active diagnostic code is saved even if the supply voltage of the DCU is switched off.

2.7.4.7 Door Cycle Counter

The DCU includes an internal counter that counts the number of opening cycles. The counter is a 8-digit counter. Consequently, if the counter reading is higher than 99,999,999, it will start at zero again. The door cycle counter value is automatically transmitted during read out of the diagnostic memory.

2.7.4.8 Error LED Flash Codes, Priority, and Diagnostic Codes for DCU

The DCU will store 31 different diagnostic code types which are transmitted to the vehicle control unit via the ETHERNET bus system. Table 2-7 lists the flash codes in numerical order. Some faults have the same flash code but are distinguished by the customer code sent over the MVB. For example, Flash code 2 indicates four possible faults, but each fault has a different customer code.

Associated priorities, function effects, and diagnostic codes are also given.

Table 2-7. Listing of Flash Codes, Priority, and Diagnostic Codes

Flash Code	Priority	Effect	Name	Diagnostic Code IFE	Diagnostic Code, Vehicle MDS	Set	Reset	Comments	Available thru TOD
1	A	b	Open in the circuit of door drive motor M1.	1	1	0 sec.	0 sec.	-	Yes
2	A	a	Door Locked Switch S1 fails.	2	2	0 sec.	0 sec.	Switch S1	Yes
2	A	d	Door leaves the closed/ locked position without permission.	44	44	0 sec.	0 sec.	Door drive motor will be activated in closing direction.	Yes
2	A	d	Door out of service device fails.	226	66	2 sec.	2 sec.	Switch S5	No
3	A	b	Door Leaf Left Closed Switch fails.	177	3	2 sec.	0 sec	Switch S8	Yes
3	A	b	Door Leaf Right Closed Switch fails.	177	4	2 sec.	0 sec.	Switch S9	Yes
4	A	b	Door position sensor fails.	5	5	0 sec.	0 sec.	-	Yes
5	A	b	Obstruction detection at door closing sequence was activated on five successive closing sequences.	6	6	0 sec.	0 sec.	Number of closing sequences = 5	Yes
6	B	d	Motor current monitoring at door opening sequence was activated on three successive opening attempts.	7	7	0 sec.	0 sec.	Number of opening attempts = 3. The actual position will be used as substitute for the open position.	Yes
7	A	b	Internal safety relay of the DCU fails.	8	8	10 sec.	2 sec.	Not testable	Yes

Table 2-7. Listing of Flash Codes, Priority, and Diagnostic Codes (cont'd.)

Flash Code	Priority	Effect	Name	Diagnostic Code IFE	Diagnostic Code, Vehicle MDS	Set	Reset	Comments	Available thru TOD
8	B	c	Short circuit at the output A1 of the DCU.	13	13	2 sec.	2 sec.	Illumination Pushbutton red LEDs	Yes
8	B	c	Short circuit at the output A2 of the DCU.	14	14	2 sec.	2 sec.	Illumination Pushbutton green LEDs	Yes
8	B	c	Short circuit at the output A3 of the DCU.	15	15	2 sec.	2 sec.	Door out of service indicator elements	Yes
8	B	c	Short circuit at the output A4 of the DCU.	16	16	2 sec.	2 sec.	Warning lamp	Yes
8	B	c	Short circuit at the output A5 of the DCU.	17	17	2 sec.	2 sec.	Power supply pushbuttons	Yes
8	B	c	Short circuit at the output A6 of the DCU.	19	19	2 sec.	2 sec.	Door open (for passenger counter device)	Yes
8	B	c	Short circuit at the output A7 of the DCU.	20	20	2 sec.	2 sec.	Warning lamp outside door open	Yes
8	B	c	Short circuit at the output A8 of the DCU.	21	21	2 sec.	2 sec.	Audible warning device H1	Yes
9	A	b	Sensitive edge at left door leaf (inside view) fails	135	26	2 sec.	0 sec.	Sensitive edge S11	Yes
9	A	b	Sensitive edge steady activated	175	24	60 sec.	0 sec.	Time duration = 1 min. left sensitive edge	Yes
10	A	b	Sensitive edge at right door leaf (inside view) fails.	136	27	2 sec.	0 sec.	Sensitive edge S12	Yes
10	A	b	Sensitive edge steady activated.	176	25	60 sec.	0 sec.	Time duration = 1 min. right sensitive edge	Yes
11	B	c	Door open push button(s) fails.	48	32	60 sec.	0 sec.	Time duration = 1 minute	Yes
12	B	c	Crew Switch fails.	55	61	60 sec.	0 sec.	Time duration = 1 minute	Yes
13	B	c	Service push button on the DCU fails.	246	33	60 sec.	0 sec.	Time duration = 1 minute	Yes
14	B	d	Battery backup of diagnostic memory fails.	22	22	0 sec.	0 sec.	Not testable	No
15	B	d	Failure mode condition of signals: Central open, Locked	301	97	1 sec.	0 sec.	Delay time between signals = 5 seconds	Yes
15	B	d	Failure mode condition of signals: Release, Locked	302	98	1 sec.	0 sec.	Delay time between signals = 5 seconds	Yes
15	B	d	Failure mode condition of signals: Central open, Release, Locked	303	99	0 sec.	0 sec.	Delay time between signals = 5 seconds	Yes

Table 2-7. Listing of Flash Codes, Priority, and Diagnostic Codes (cont'd.)

Flash Code	Priority	Effect	Name	Diagnostic Code IFE	Diagnostic Code, Vehicle MDS	Set	Reset	Comments	Available thru TOD
17	A	a	Door coding faulty	138	48	0 sec.	0 sec.	-	No
18	B	c	Data bus communication fails	42	42	60 sec.	0 sec.	Signals and functions respectively via bus are no longer available	No
19	A	b	System does not detect opened position at 2.5 seconds opening time	257	90	1 sec.	1 sec.	S3T-e2	No
19	A	b	System does not detect closed position at 3.0 seconds closing time	258	90	1 sec.	1 sec.	S3T-e2	No

EFFECT DEFINITIONS

a) Deactivation of the DCU causes an immediate stop of the door movement. Reactivation is only possible by switching the supply voltage of the DCU OFF and ON again. A closed/locked door can only be opened by the emergency release device. Closing of door by loss of NO MOTION signal or not allowed opening (failure in the locking mechanism) is active.

b) Deactivation of the DCU causes an immediate stop of the door movement. Reactivation as defined in Section 2.7.4.5.

c) No change in function. For further functions, the component will not be used.

d) No change in function and no change in further functions.

2.7.4.9 IFE Diagnostic Code Description

The internal diagnostic codes of a DCU are listed below in numerical order. The DCU Internal Diagnostic Code is the IFE code generated by the diagnostic module of the DCU.

2.7.4.9.1 DCU Internal Diagnostic Code 1

Statement: Open circuit in the door drive motor M1.

Prerequisite: Door drive motor M1 activated (open or close direction).

Diagnostic criterion: Door drive motor M1 is activated, but no motor current is measured.

Diagnostic deletion: If door drive motor M1 is activated again and a motor current is measured.

Possible problem: Motor M1 circuit, wiring, output circuit of the DCU and motor M1.

2.7.4.9.2 DCU Internal Diagnostic Code 2

Statement: Door locked switch S1 fails.

Prerequisite: Door drive motor M1 activated (open or close direction) and door locked switch S1 indicates a closed door.

Diagnostic criterion: When door drive motor M1 is activated and door position sensor detects a door movement.

Diagnostic deletion: If door locked switch S1indicates a not closed door.

Possible problem: Adjustment and wiring of door locked switch S1 and input circuit of the DCU.

2.7.4.9.3 DCU Internal Diagnostic Code 5

Statement: Door position sensor fails.

Prerequisite: Door drive motor M1 activated (open or close direction).

Diagnostic criterion: On five successive door movements, no pulses from door position sensor are counted.

Diagnostic deletion: If at least 1 pulse from the door position sensor is counted again.

Possible problem: Door position sensor (internal to motor M1); and input circuit of the DCU.

2.7.4.9.4 DCU Internal Diagnostic Code 6

Statement: Obstruction detection at closing sequence was activated on five successive closing sequences.

Prerequisite: Door drive motor M1 activated (close direction) and the door locked switch S1 or S2 indicates a not closed door.

Diagnostic criterion: The motor current or way-/time monitoring was activated on a fixed number of successive closing sequences, and the door did not reach the closed position at any time.

Diagnostic deletion: If door locked switch S1 or S2 indicates a closed door.

Possible problem: Door operator, movement of the door, adjustment of the door, adjustment and wiring of the door locked switch S1 or S2, and input circuit of the DCU.

2.7.4.9.5 DCU Internal Diagnostic Code 7

Statement: Motor current monitoring at opening sequence was activated on three successive opening attempts.

Prerequisite: The door drive motor M1 activated (open direction) and the door locked switch S1 and S2 indicates a not closed door.

Diagnostic criterion: The motor current or way-time monitoring was activated on three successive opening attempts.

Diagnostic deletion: If an open command is given (at a closed door) and the door reaches the fully open position without interruption of the opening sequence.

Possible problem: Signal input of the door position sensor B1 at the DCU, door operator, door movement, adjustment of the door, adjustment and wiring of the door locked switch S1 and S2 and input circuit of the DCU.

2.7.4.9.6 DCU Internal Diagnostic Code 8

Statement: Internal safety relay of the DCU fails.

Prerequisite: None.

Diagnostic criterion: The state of the safety relay does not correspond to the activating signals of the relay (checked internally by the signal OBSERVATION SAFETY RELAY, which is internally hard wired to the microprocessor).

Diagnostic deletion: If the logical state of the safety relay corresponds to the activating signals.

Possible problem: The activation of the safety relay according to the wiring diagram has to be checked; otherwise, the DCU has to be replaced.

2.7.4.9.7 DCU Internal Diagnostic Code 13

Statement: Short circuit at the output A1 of the DCU.

Prerequisite: Output A1 is activated.

Diagnostic criterion: The output A1 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A1 is activated and the current does not exceed the nominal current and there is no short circuit detected by the DCU.

Possible problem: Component connected to output A1, wiring and output of the DCU.

2.7.4.9.8 DCU Internal Diagnostic Code 14

Statement: Short circuit at the output A2 of the DCU.

Prerequisite: Output A2 is activated.

Diagnostic criterion: The output A2 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A2 is activated and the current does not exceed the nominal current and there is no short circuit detected by the DCU.

Possible problem: Component connected to output A2, wiring and output of the

2.7.4.9.9 DCU Internal Diagnostic Code 15

Statement: Short circuit at the output A3 of the DCU.

Prerequisite: Output A3 is activated.

Diagnostic criterion: The output A3 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A3 is activated and the current does not exceed the nominal current and there is no short circuit is detected by the DCU.

Possible problem: Component connected to output A3, wiring and output of the DCU.

2.7.4.9.10 DCU Internal Diagnostic Code 16

Statement: Short circuit at the output A4 of the DCU.

Prerequisite: Output A4 is activated.

Diagnostic criterion: The output A4 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A4 is activated and the current does not exceed the nominal current and there is no short circuit detected by the DCU.

Possible problem: Component connected to output A4, wiring and output of the DCU.

2.7.4.9.11 DCU Internal Diagnostic Code 17

Statement: Short circuit at the output A5 of the DCU.

Prerequisite: Output A5 is activated.

Diagnostic criterion: The output A5 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A5 is activated and the current does not exceed the nominal current and there is no short circuit detected by the DCU.

Possible problem: Component connected to output A5, wiring and output of the DCU.

2.7.4.9.12 DCU Internal Diagnostic Code 19

Statement: Short circuit at the output A6 of the DCU.

Prerequisite: Output A6 is activated.

Diagnostic criterion: The output A6 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A6 is activated and the current does not exceed the nominal current and there is no short circuit detected by the DCU.

Possible problem: Component connected to output A6, wiring and output of the DCU.

2.7.4.9.13 DCU Internal Diagnostic Code 20

Statement: Short circuit at the output A7 of the DCU.

Prerequisite: Output A7 is activated.

Diagnostic criterion: The output A7 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A7 is activated and the current does not exceed the nominal current and there is no short circuit detected by the DCU.

Possible problem: Component connected to output A7, wiring and output of the DCU.

2.7.4.9.14 DCU Internal Diagnostic Code 21

Statement: Short circuit at the output A8 of the DCU.

Prerequisite: Output A8 is activated.

Diagnostic criterion: The output A8 is activated and the current exceeds the nominal value or a short circuit is detected by the DCU.

Diagnostic deletion: If the output A8 is activated and the current does not exceed the nominal current and there is no short circuit detected by the DCU.

Possible problem: Component connected to output A8, wiring and output of the DCU.

2.7.4.9.15 DCU Internal Diagnostic Code 22

Statement: Battery backup of the diagnostic memory fails.

Prerequisite: Supply voltage for the DCU is switched on.

Diagnostic criterion: At switch off of supply voltage of the DCU, the battery backup of the NOVRAM is not in function.

Diagnostic deletion: If the battery backup is, in function again when the supply voltage is activated.

Possible problem: Change the NOVRAM mounted in the DCU.

2.7.4.9.16 DCU Internal Diagnostic Code 42

Statement: Data bus communication fails.

Prerequisite: None.

Diagnostic criterion: The connection to the door data bus is interrupted.

Diagnostic deletion: If the connection to the data bus works again.

Possible problem: Door data bus cable, connectors and bus interface to be checked.

2.7.4.9.17 DCU Internal Diagnostic Code 44

Statement: Door leaves the closed and locked position without permission.

Prerequisite: Door has closed faultlessly and no open command is active.

Diagnostic criterion: The door locked switch S1 and S2 indicates a not closed door.

Diagnostic deletion: If the door locked switch S1 and S2 indicates a closed door again.

Possible problem: Mechanical adjustment of the emergency release devices, adjustment of emergency operation switch S3, door locking mechanism, door operator, adjustment and wiring of the door locked switches S1 and input circuit of the DCU.

2.7.4.9.18 DCU Internal Diagnostic Code 48

Statement: Door-open pushbutton switch S21 fails.

Prerequisite: Door-open pushbutton switch released to open the door.

Diagnostic criterion: The input signal at the DCU is activated longer than one minute.

Diagnostic deletion: If the DCU detects no activation of the door-open pushbutton switch.

Possible problem: Door-open pushbutton switches S21, input circuit of the DCU and wiring.

2.7.4.9.19 DCU Internal Diagnostic Code 55

Statement: Crew switch fails.

Prerequisite: None.

Diagnostic criterion: The input signal at the DCU is activated longer than one minute.

Diagnostic deletion: If the DCU detects no activation of the crew switch anymore.

Possible remedy: Crew switch, input circuit of the DCU and wiring to be checked.

2.7.4.9.20 DCU Internal Diagnostic Code 135

Statement: Sensitive edge at left door leaf (inside view) fails.

Prerequisite: None.

Diagnostic criterion: The electrical connection to the sensitive edge is interrupted.

Diagnostic deletion: If the DCU detects an electrical connection to the sensitive edge again.

Possible remedy: Sensitive edge switch S11, finger protection rubber, input circuit of the DCU and wiring to be checked.

2.7.4.9.21 DCU Internal Diagnostic Code 136

Statement: Sensitive edge at right door leaf (inside view) fails.

Prerequisite: None.

Diagnostic criterion: The electrical connection to the sensitive edge is interrupted.

Diagnostic deletion: If the DCU detects an electrical connection to the sensitive edge again.

Possible remedy: Sensitive edge switch S12, finger protection rubber, input circuit of the DCU and wiring to be checked.

2.7.4.9.22 DCU Internal Diagnostic Code 138

Statement: Door coding faulty.

Prerequisite: None.

Diagnostic criterion: The door coding is not correct.

Diagnostic deletion: If the door coding is correct.

Possible problem: Door coding has to be checked.

2.7.4.9.23 DCU Internal Diagnostic Code 175

Statement: Sensitive edge steady activated.

Prerequisite: Door/step not in closed/locked position.

Diagnostic criterion: The input signal at the DCU is activated longer than one minute.

Diagnostic deletion: If the DCU detects no activation of the sensitive edge anymore.

Possible remedy: Left sensitive edge switch, finger protection rubber, input circuit of the DCU and wiring to be checked.

2.7.4.9.24 DCU Internal Diagnostic Code 176

Statement: Sensitive edge steady activated.

Prerequisite: Door/step not in closed/locked position.

Diagnostic criterion: The input signal at the DCU is activated longer than one minute.

Diagnostic deletion: If the DCU detects no activation of the sensitive edge anymore.

Possible remedy: Right sensitive edge switch, finger protection rubber, input circuit of the DCU and wiring to be checked.

2.7.4.9.25 DCU Internal Diagnostic Code 177

Statement: Door leaf closed switch fails.

Prerequisite: Drive mechanism in closed/locked position.

Diagnostic criterion: The door locked switch S1 indicates a closed door and at least one door leaf closed switch indicates an open door.

Diagnostic deletion: If all door leaf closed switches indicate a closed status at a closed door.

Possible remedy: Door leaf closed switch S8 or S9.

2.7.4.9.26 DCU Internal Diagnostic Code 226

Statement: Door out of service device fails.

Prerequisite: Door is not closed/locked and way sensor indicates a not closed door.

Diagnostic criterion: The input signal at the DCU indicates a door locked out of service for T > 2 sec.

Diagnostic deletion: If input signal at DCU no longer indicates a door locked out service while door is not closed.

Possible remedy: Door out of service mechanism, input circuit at DCU, and wiring to be checked.

2.7.4.9.27 DCU Internal Diagnostic Code 246

Statement: Service push button on the DCU fails.

Prerequisite: None.

Diagnostic criterion: The input signal at the DCU is activated longer than one minute.

Diagnostic deletion: If the DCU detects no activation of the Service push button anymore.

Possible remedy: Service push button of the DCU to be checked.

2.7.4.9.28 DCU Internal Diagnostic Code 257

Statement: System does not detect opened position within 5 seconds.

Prerequisite: System is moving in opening direction without interruption.

Diagnostic criterion: System needs more than two times of 2.5 second opening time.

Diagnostic deletion: As soon as the system detects the opened position.

Possible remedy: Check of the whole gear.

2.7.4.9.29 DCU Internal Diagnostic Code 258

Statement: System does not detect closed position within 6 seconds.

Prerequisite: System is moving in closing direction without interruption.

Diagnostic criterion: System needs more than two times of 3 second closing time.

Diagnostic deletion: As soon as the system detects the closed position.

Possible remedy: Check of the whole gear.

2.7.4.9.30 DCU Internal Diagnostic Code 301

Statement: Failure mode condition of signals: Central open, Locked.

Prerequisite: None.

Diagnostic criterion: Central open = “1” AND Locked = “0”, delay time between signals 5s.

Diagnostic deletion: As soon as signal combination is no longer available.

Possible remedy: Check DCU inputs E2, E10, or wiring to these signals.

2.7.4.9.31 DCU Internal Diagnostic Code 302

Statement: Failure mode condition of signals: Release, Locked.

Prerequisite: None.

Diagnostic criterion: Release = “1” AND Locked = “0”, delay time between signals 5s.

Diagnostic deletion: As soon as signal combination is no longer available.

Possible remedy: Check DCU inputs E3, E10, or wiring to these signals.

2.7.4.9.32 DCU Internal Diagnostic Code 303

Statement: Failure mode condition of signals: Central open, Release, Locked.

Prerequisite: None.

Diagnostic criterion: Central open = “0” AND Release = “0” AND Locked = “1”, delay time between signals 5s.

Diagnostic deletion: As soon as signal combination is no longer available.

Possible remedy: Check DCU inputs E2, E3, E10, or wiring to these signals.

CHAPTER 3.0

SPECIAL TOOLS AND MATERIALS

Table 3-1. Special Tools

Description	Scope Of Supply	Usage	IFE Part Number	Application
Lifting Device	Customer	Recommended	-	Mounting of door operator/door leaf
Ruler	Customer	Recommended	-	Check of the door operator mounting surface to determine if shims are needed
Plumb Line/Water Level	Customer	Recommended	-	Check straightness of portal
Feeler Gauges	Customer	Recommended		Check of the Spindle nut gap
Stop Watch	Customer	Required		Measure door open/close times
Multimeter	Customer	Required		Used for checking of the specified voltage values
Laptop	Carbuilder	Required		Used for data transmission from/to IFE Door system
Portable Test Unit	Carbuilder	Recommended		Software maintenance
Assembly Jig	Carbuilder	Required	3T901156R96	Positioning of limit switch bracket
Lifting Column	Customer	Recommended		Lifting of S3 module
Screw M3	Customer	Required		Pulling out of the pins
Circlip Pliers	Customer	Required		Mounting and dismounting of circlips
EPROM Pliers	Customer	Required		Assembly and disassembly of EPROM
Wrist earth cable	Customer	Required		For earthing during NOVRAM exchange
Gauge “Seal Pressing”	Carbuilder	Required	3TD01549R07	Set up of door seal pressing: adjust lock bolt.
Obstruction Detection Tool	Carbuilder	Required	810965	Check finger protection obstruction detection

Table 3-2. List of Materials

Description	IFE Part Number	Application	Supplier
Klüber Isoflex LDS18 Spezial A	0UN300160R08	Greasing	www.klueber.com
Klüber Isoflex Topas NB 52	0UN300160R15	Greasing	www.klueber.com
TESAKREPP 4331	0V5602720	Taping	www.tesa.com
Loctite 2701	0V5605200	Gluing	www.loctite.com
Masking Tape TESA 4104	0VN401251R02	Taping	www.tesa.com
Masking Tape	0VN401251R06	Taping	www.tesa.com
Masking Tape TESA 4252	0VN401251RH1	Taping	www.tesa.com
Loctite 406	0VN401289R22	Gluing	www.loctite.com
Primer Loctite 770	0VN401289R28	Gluing	www.loctite.com
Loctite 243	0VN401289R47	Screw Securing	www.loctite.com
Optimol Paste White T	0VN401670R01	Greasing	www.castrol.com
MEK cleaning cloth	3N490050R01	Cleaning	www.socomor.com
Abrasive Paper (600)	WA472012	Gluing	www.3m.com
Sealing wax blue	3TD02927R01	Screw Securing	http://sicherungs-lack.de/
Sealing wax red	3TD02927R04	Screw Securing	http://sicherungs-lack.de/
Contactal HPG	3N401989R14	Preserve Grounding Points	IFE
Loctite 7063	0VN401289R91	Cleaning	www.loctite.com
Loctite 638	0VN401289R74	Gluing	www.loctite.com

CHAPTER 4.0

SCHEDULED MAINTENANCE

4.1 Introduction

This chapter details recommended inspection schedules for the doors. The following schedules should be followed during the initial service period and until the correct frequency of inspection can be determined based on actual use (mileage).

WARNING

WHEN INSPECTING THE DOORS FOLLOW ALL SAFETY PRECAUTIONS, RULES AND OPERATING PROCEDURES. USE CARE TO PREVENT PERSONAL INJURY.

CAUTION

MAINTENANCE INTERVALS ARE BASED ON NORMAL CONDITIONS. UNUSUAL OR EXTRAORDINARY CONDITIONS MAY REQUIRE MORE FREQUENT MAINTENANCE INTERVALS. IMPROPER MAINTENANCE CAN RESULT IN POOR PERFORMANCE

4.2 Scheduled Maintenance Action Index

Table 4-1 is a Scheduled Maintenance Action Index (SMAI). This index provides a list of all scheduled inspections, performance tests, and preventive maintenance procedures. The table has four columns: Maintenance Interval, Part Description, Scheduled Maintenance Task and Section Reference.

The Maintenance Interval column indicates the mileage between the maintenance tests and preventive maintenance procedures. The Part Description column lists the equipment, assembly, or subassembly that corresponds to the maintenance action. The Scheduled Maintenance Task column lists the maintenance task to be performed. The Section Reference column indicates the section number within this manual (or the HRM) that contains the procedure listed in the Maintenance Task column.

NOTE: The term “After two weeks in service” in the Maintenance Interval column means the maintenance action is required one time, after the doors have been in service for two weeks from first operation.

CAUTION

IN ADDITION TO 30,000 MILE INSPECTIONS, ALL MOUNTING HARDWARE MUST BE INSPECTED AFTER TWO WEEKS IN SERVICE.

Table 4-1. Scheduled Maintenance Periodicity

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 0400, Doors Running Maintenance Manual Section Reference
After two weeks in service of first operation	Safety Check	Inspect Mounting Hardware	4.3.1
30,000 miles or 3 Months (whichever comes first)	Safety Check	Inspect Mounting Hardware	4.3.1
30,000 miles or 3 Months (whichever comes first)	Door System Wiring	Inspect	4.3.1.2
30,000 miles or 3 Months (whichever comes first)	DCU Wiring	Inspect	4.3.1.3
30,000 miles or 3 Months (whichever comes first)	Torsion Springs	Inspect	4.3.1.4
30,000 miles or 3 Months (whichever comes first)	Lock Unit	Inspect	4.3.1.5
30,000 miles or 3 Months (whichever comes first)	Doorhanger Rollers	Inspect	4.3.1.6
30,000 miles or 3 Months (whichever comes first)	Door Hardware	Inspect	4.3.1.7
30,000 miles or 3 Months (whichever comes first)	DCU	Fault Check	4.3.2
30,000 miles or 3 Months (whichever comes first)	Emergency Manual Release	Function Check	4.3.3
30,000 miles or 3 Months (whichever comes first)	Emergency Manual Release	Function Check at Speed	4.3.3.1
30,000 miles or 3 Months (whichever comes first)	Pushbuttons and Indicators	Function Check	4.3.4
30,000 miles or 3 Months (whichever comes first)	Door Cutout Lever	Function Check	4.3.5
30,000 miles or 3 Months (whichever comes first)	Limit Switches	Function Check	4.3.6

Table 4-1. Scheduled Maintenance Periodicity (cont'd.)

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 0400, Doors Running Maintenance Manual Section Reference
30,000 miles or 3 Months (whichever comes first)	Door Obstruction Detection	Test	4.3.7
30,000 miles or 3 Months (whichever comes first)	Painted Components	Inspect	4.3.8
60,000 miles or 6 Months (whichever comes first)	Finger Protection Rubber	Clean and Grease	4.3.9
120,000 miles or 1 Year (whichever comes first)	Locking Unit	Inspect and Grease	4.3.10
120,000 miles or 1 Year (whichever comes first)	Locking Lever/Locking Pawl	Clean and Grease	4.3.11
120,000 miles or 1 Year (whichever comes first)	Spring Actuator	Inspect	4.3.12
120,000 miles or 1 Year (whichever comes first)	Rubber Buffer Assembly	Inspect	4.3.13
120,000 miles or 1 Year (whichever comes first)	Spindle	Inspect	4.3.14
120,000 miles or 1 Year (whichever comes first)	Spindle	Clean and Grease	4.3.15
120,000 miles or 1 Year (whichever comes first)	Release Lever	Clean and Grease	4.3.16
600,000 miles or 5 Years (whichever comes first)	Door Leaf Rollers	Inspect Wear	HRM
600,000 miles or 5 Years (whichever comes first)	Ring Gear	Inspect Wear	HRM
1,200,000 miles or 10 Years (whichever comes first)	NOVRAM	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Door Control Unit EPROM	Re-flash	HRM
1,800,000 miles or 15 Years (whichever comes first)	Geared Motor (M1)	Replace	HRM

Table 4-1. Scheduled Maintenance Periodicity (cont'd.)

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 0400, Doors Running Maintenance Manual Section Reference
1,800,000 miles or 15 Years (whichever comes first)	Ring Gear	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Door Locked Switch (S1)	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Emergency Operation Switch (S3)	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Door Out of Service Switch (S5)	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Door Leaf Left Closed Switch (S8)	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Door Leaf Right Closed Switch (S9)	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Spindle and Spindle Nuts	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Door Leaf Rollers	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Connecting Cable	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Springs in Spring Actuator	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Rubber Buffers	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Finger Protection Rubbers	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Bowden Cable -Interior Manual Release	Replace	HRM
1,800,000 miles or 15 Years (whichever comes first)	Bowden Cable - Exterior Manual Release	Replace	HRM

4.3 Preventive Maintenance Procedures

WARNING

WHEN INSPECTING OR SERVICING THE DOORS, ENSURE ALL OPERATING PROCEDURES REGARDING THE PREVENTION OF VEHICLE MOVEMENT ARE OBSERVED. USE CARE TO PREVENT PERSONAL INJURY.

BEFORE PERFORMING ANY MAINTENANCE PROCEDURE, ARRANGE FOR THE REMOVAL AND CONTINUOUS ISOLATION OF POWER IN ACCORDANCE WITH SAFETY RULES AND OPERATING PROCEDURES WHEN REQUIRED. ENSURE POWER IS OFF AND TAGGED TO ALERT MAINTENANCE PERSONNEL OF IN-PROGRESS TASK.

DANGER OF PERSONAL INJURY EXISTS DUE TO DOORS CLOSING WHEN ELECTRICAL POWER IS REQUIRED TO BE ON. TAKE CARE TO AVOID INJURY DUE TO MOVING PARTS.

CAUTION

DO NOT TURN SPINDLE BY HAND. TAKE CARE NOT TO DAMAGE FINISHED SURFACES. PROTECT FINISHED SURFACES WHEN PERFORMING MAINTENANCE. DO NOT USE MOTOR ASSEMBLY (M1) AS A HAND GRIP.

4.3.1 Safety Check of Mounting Hardware

Safety check Section 4.3.1 is used to verify the safety-related functions of the IFE door system.

The 28.5 VDC (range 17 to 34 VDC) operating supply must be available to permit checks to be carried out correctly.

WARNING

FOR MECHANICAL CHECKS, (S7) SERVICE SWITCH MUST BE SWITCHED OFF BEFORE PERFORMING ANY WORK ON DOORS.

USE CAUTION WHEN PERFORMING ELECTRICAL CHECKS AS THE ELECTRICAL SUPPLY REQUIRED FOR THIS WORK CANNOT BE SWITCHED OFF DURING THE CHECK.

4.3.1.1 Inspect Toothed Lock Washers

See Figure 4-1. Visually check all toothed lock washers (1) are present on limit switches S1, S3, and S5.

4.3.1.2 Inspect Door Operator Wiring

See Figure 4-1. Visually check wiring and electrical elements (limit switches (2), etc.) for correct connections and for any damages to wiring. Tighten loose connections and replace damaged wiring.

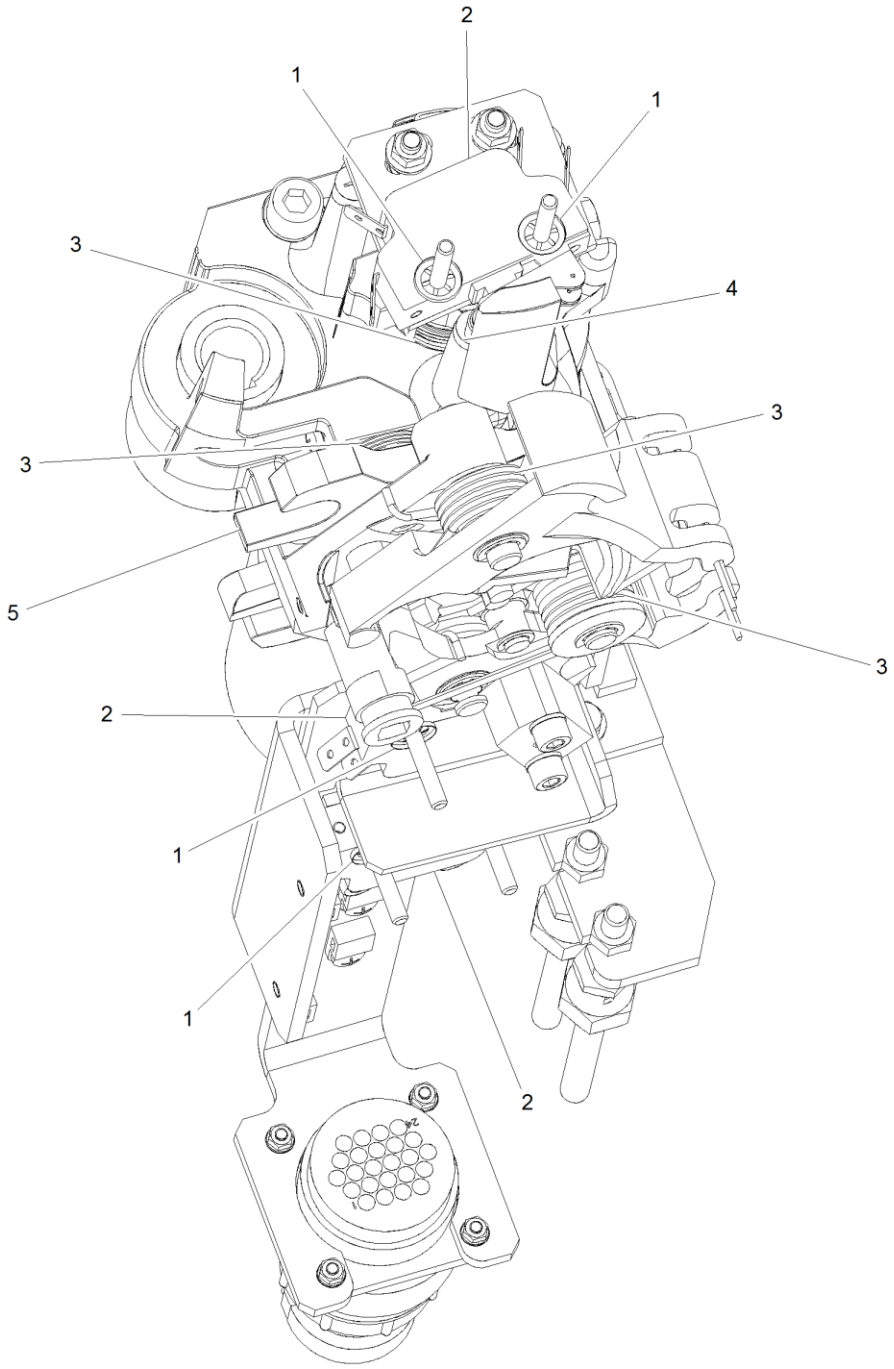


Figure 4-1: Visual Inspection

CAUTION

DO NOT PULL-ON WIRE HARNESS AT ANY TIME. IMPROPER INSPECTION OF DCU WIRING AND CONNECTORS MAY RESULT IN INCORRECT OPERATION.

4.3.1.3 Inspect DCU Wiring

See Figure 4-3. Check DCU wiring by manually inspecting top and bottom of DCU connectors X1 and X2 to ensure they are properly secured in place. Reseat connectors as needed.

4.3.1.4 Inspect Torsion Springs

See Figure 4-1. Check all torsion springs (3) to confirm they are not seized or broken.

4.3.1.5 Inspect Lock Unit

See Figure 4-1. Visually check locking lever (4) and locking pawls (5) of locking unit for any wear or damage.

4.3.1.6 Inspect Doorhanger Rollers

Inspect doorhanger rollers for free movement and any unusual wear.

4.3.1.7 Inspect Hardware

1. See Figure 4-2. Inspect all fixing hardware to ensure torque stripe is intact and not broken over fastening components (1-3).

2. If any hardware is found to be loose, or torque stripes are broken, correct as follows:

a. Remove screws (1), and washers (2) from the workspace (3) one at a time and clean threads and surfaces.

b. Apply Loctite to threads if indicated.

c. Install and torque hardware to values specified in relevant chapters.

d. Apply Torque Stripe (4).

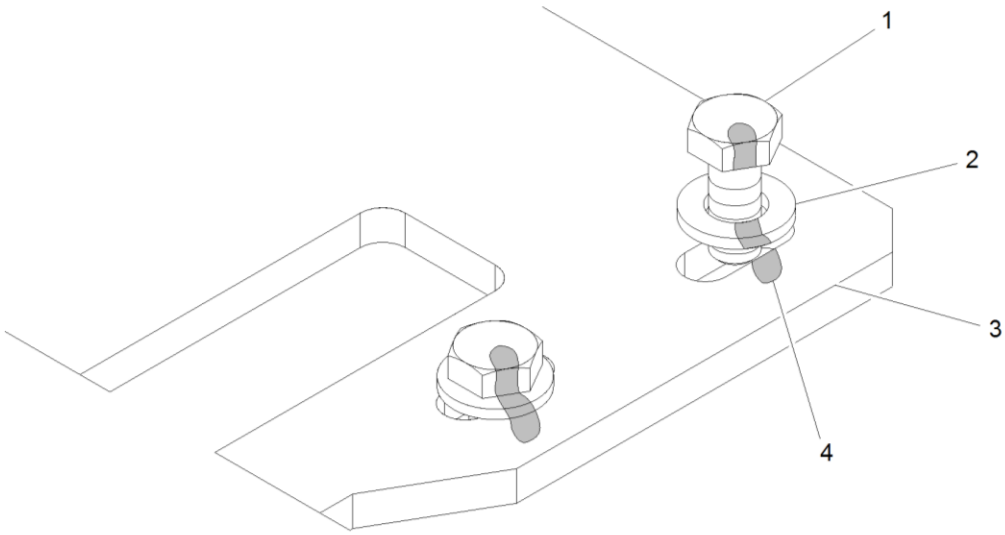


Figure 4-2: Torque Stripe (Typical)

4.3.2 DCU Fault Check

1. Access door operator.

2. See Figure 4-3. Check status of red ERROR LED (9) on front of DCU:

a. Steady illuminated red LED indicates failure of DCU. Remove DCU and return to IFE for further evaluation.

b. Flashing red LED indicates one or more active faults. To view faults, connect a null modem USB cable to the serial port of the PTU (laptop PC with IFE ST03A software installed) to the DCU RS-232 (X8) connector. Refer to diagnostic codes Table 2-7 to troubleshoot and clear faults.

4.3.3 Emergency Manual Release Function Check

1. See Figure 4-4. Pull Interior release handle (4) thru its full travel (140 degrees). Door handle will reset automatically when released.

2. Ensure the door is pressed open to leave a small gap (1) (Approx.1 in.).

3. Ensure door can be moved in the opening and closing directions.

4. Verify Emergency Operation Switch S3 (2) is operated when the manual release has been activated.

5. Verify Door Locked Switch S1 (3) is NOT activated when Emergency Operation Switch S3 is activated.

6. Repeat check for the exterior handle.

7. If the gap (a) is smaller than ½” (12.7 mm), then replace spring actuator per HRMM.

4.3.3.1 Emergency Manual Release Function Check at Speed

1. Simulate the speed signal using ST03 software. Activate each emergency egress and access device. It must be possible to open the door manually and the warning buzzer is activated.

2. Reset the speed signal.

4.3.4 Passenger Pushbutton and Indicator Function Check

1. Ensure vehicle is powered.

2. Release doors for passenger operation using cab release controls.

3. Check passenger pushbuttons and audible and visual indicators to ensure function as defined in Sections 2.6.7 and 2.6.13.

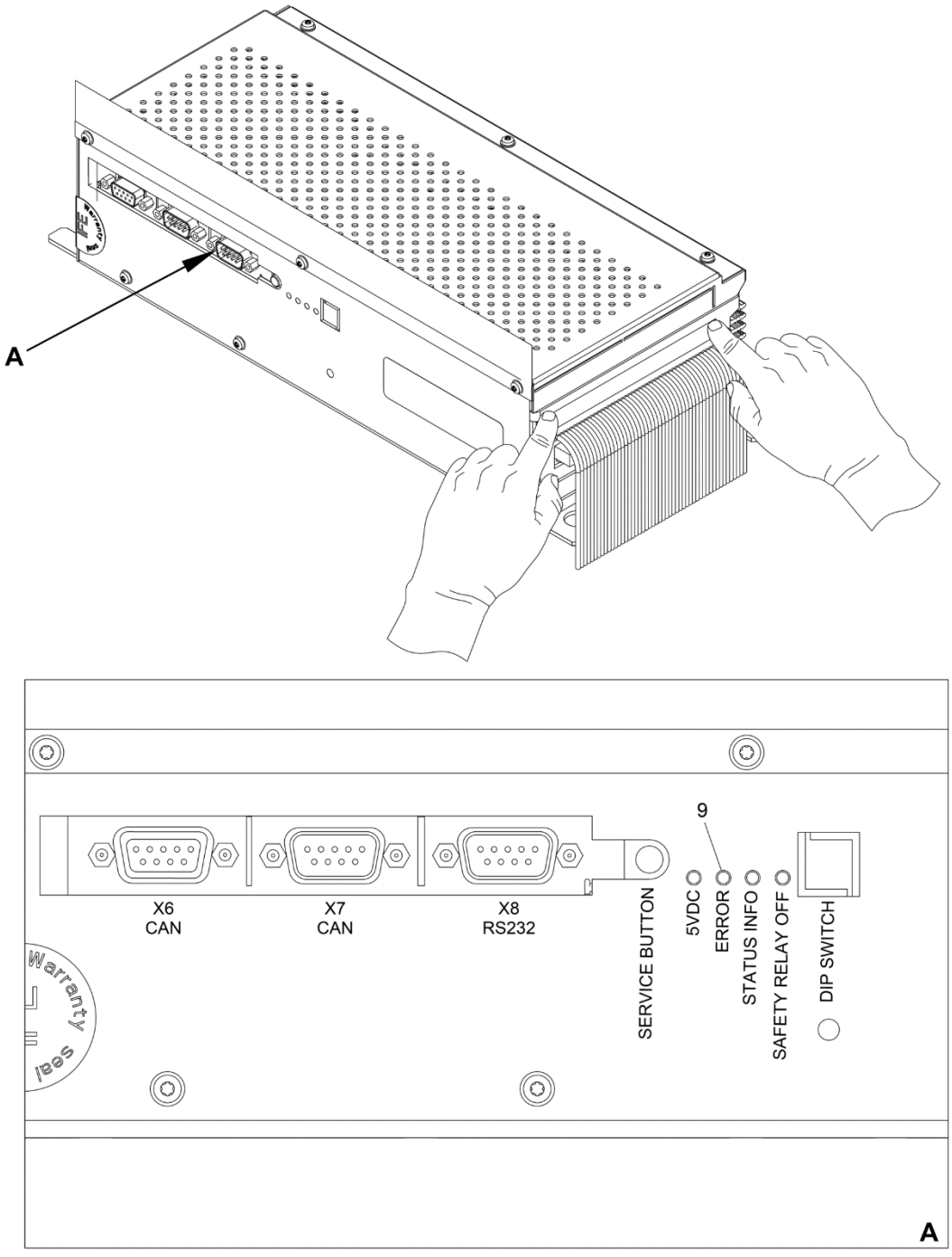


Figure 4-3: Check DCU for Faults

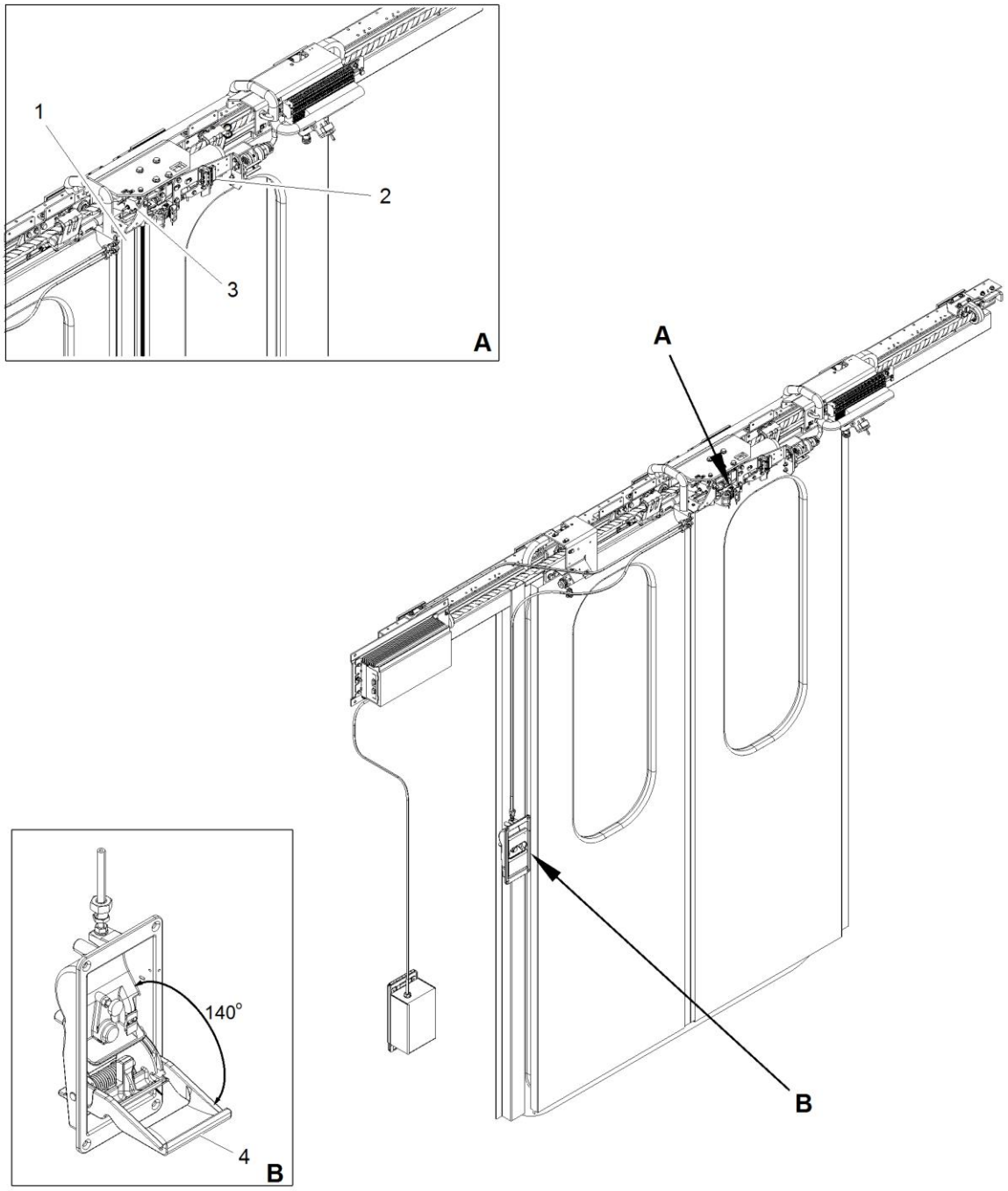


Figure 4-4: Emergency Manual Release

4.3.5 Cut Out Lever Function Check

1. See Figure 4-5. Ensure door leaves are in closed and locked position.
2. Remove the door operator cover. (See carbuilder instructions).
3. Activate the cut out lever by rotating up (counterclockwise) 90 degrees.
4. Ensure door is mechanically locked and cannot be opened manually by moving doors.
5. See Figure 4-6. Verify door out of service switch S5 (5) is activated by visual inspection and confirmation by the Door Out of Service signal lamp being lit.

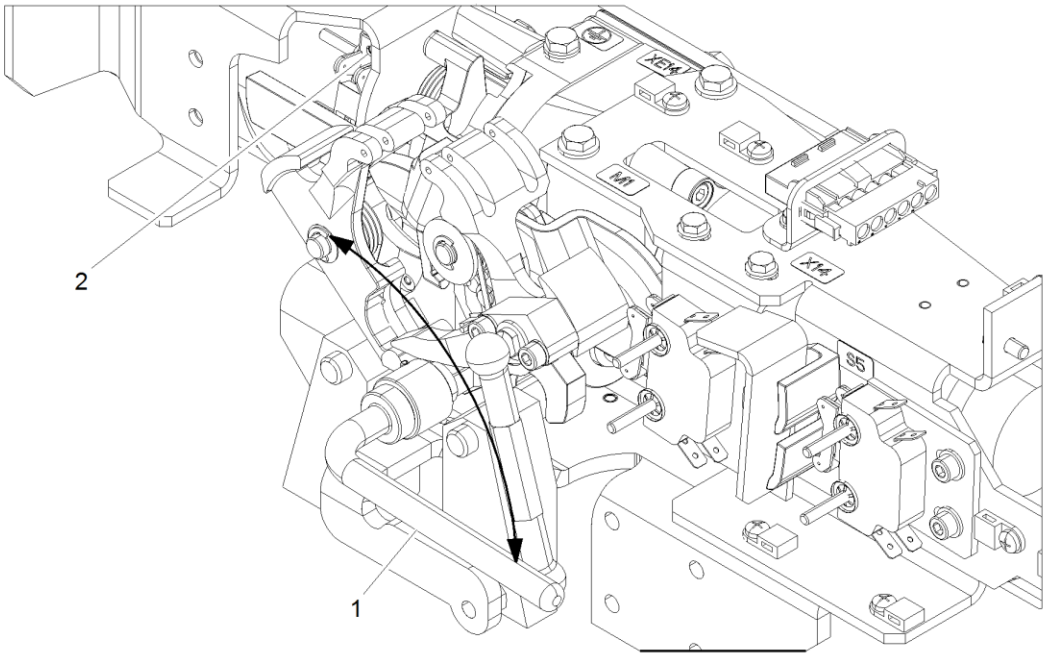


Figure 4-5: Cutout Lever

4.3.6 Limit Switch Function Check

4.3.6.1 Check S5 Door Out of Service Switch Adjustment

1. With electrical voltage supply present, use pushbuttons to bring door in open position.
2. See Figure 4-5. Activate cutout lever and check Door Out of Service lamps located at interior and exterior entrances.
3. See Figure 4-6. If door out of service lamps illuminate and switch is actuated, the door out of service switch S5 (4) is properly adjusted.
4. If door out of service lamps do not illuminate, verify rest stroke of limit switch according to Section 4.3.6.4.

5. If limit switch rest stroke is not within specification, adjust limit switch position as follows:

a. See Figure 4-5. Deactivate cutout lever by rotating down (clockwise) 90 degrees.

b. See Figure 4-6. Verify gap between pawl (6) and limit switch roller (8) measures at least 1 mm.

c. Verify gap between pawl (6) and limit switch hinge (7) measures at least 1 mm.

d. See Figure 4-5. Activate cutout lever by rotating up (counterclockwise) 90 degrees.

e. See Figure 4-6. Loosen two nuts (9) and slide S5 limit switch bracket (10) as necessary to actuate door out of service switch (4) against pawl (6) and tighten nuts, but do not torque.

f. Activate and deactivate cutout device at least three times to verify function of door out of service switch (4).

g. Torque two nuts (9) to 23 in-lb and apply torque stripe.

6. If limit switch adjustment is correct and signal lamp does not light, check signal lamp per carbuilder instructions.

4.3.6.2 Check S3 Emergency Operation Switch Adjustment

1. See Figure 4-6. Verify Emergency Operation Switch S3 (5) actuates when the emergency device is operated.

2. If emergency operation switch does not actuate, verify rest stroke of limit switch according to Section 4.3.6.4.

3. If limit switch rest stroke is not within specification, adjust limit switch position as follows:

a. Loosen two screws (3) and slide S3 limit switch bracket (2) as necessary to actuate emergency operation switch (5) against unlocking lever (1) and tighten screws, but do not torque.

b. Operate emergency device at least three times to verify emergency operation switch (5) actuates.

c. Torque two screws (3) to 23 in-lb and apply torque stripe.

4.3.6.3 Check S1 Door Locked Switch Adjustment

1. Electrically bring door to closed position.

2. See Figure 4-6. Verify Door Locked Switch S1 (12) is actuated.

3. If door closed switch does not actuate, verify rest stroke of limit switch according to Section 4.3.6.4.

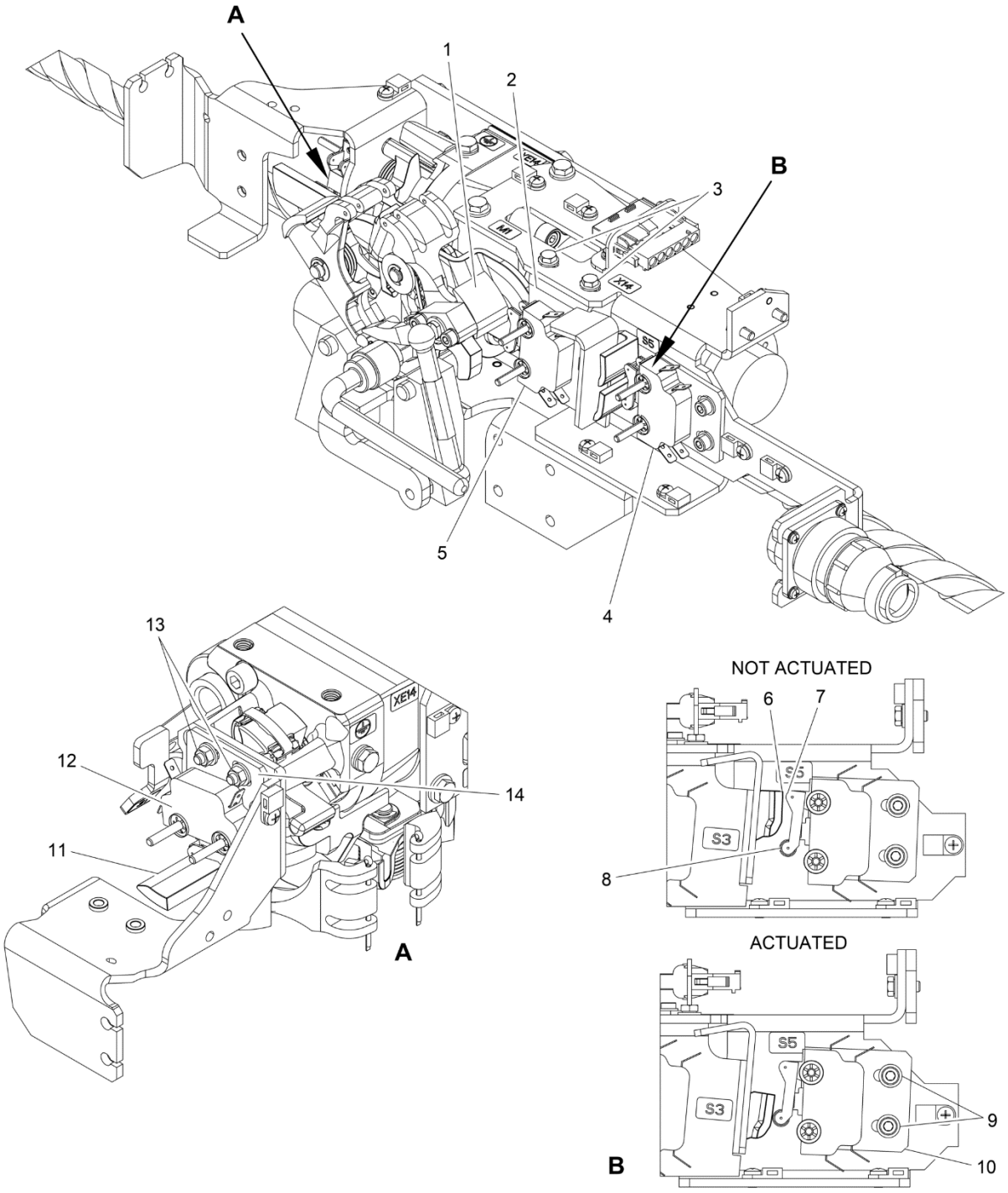


Figure 4-6: Cutout Device and Limit Switches

4. If limit switch rest stroke is not within specification, adjust limit switch position as follows:

a. Loosen two nuts (13) and slide limit switch bracket (14) as necessary to actuate door locked limit switch (12) against door lock (11) and tighten nuts, but do not torque.

b. Electrically open and close doors at least three times to verify door locked switch (12) actuates.

c. Torque two nuts (14) to 23 in-lb and apply torque stripe.

4.3.6.4 Check S5/S3/S1 Limit Switch Rest Stroke

1. Ensure (S7) service switch located on door operator is in off position.

CAUTION

TOO MUCH PRESSING FORCE ON ROLLER WILL DAMAGE LEVER

2. See Figure 4-7. To check adjustment, use the white indicator (2) shown in non-activated state (A).

3. To ensure correct activation, indicator (2) must reach into recess (1) of the limit switch housing and still be visible.

4. When limit switch is activated (B), a reserve stroke (C) of at least 1mm must exist between roller lever (3) and switch housing.

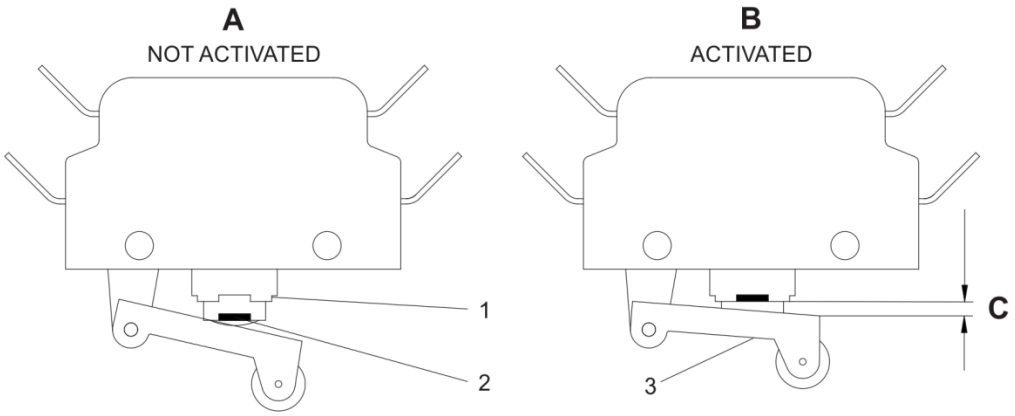


Figure 4-7: Limit Switch Rest Stroke

4.3.6.5 Adjust S8/S9 Door Leaf Closed Switch

1. See Figure 4-8. (Door Leaf Right Closed Switch S9 similar).
2. Verify door leaf closed switch (1) is actuated when door is in closed and locked position.
3. If adjustment is necessary, move door leaves to within 1 +0/-0.39 inches (25 +0/-10 mm) of fully closed position.
4. Loosen machine screws (2) with washers (3) and slide switching plate (4) until door leaf closed switch is just actuated.
5. Apply Loctite 243 to threads of machine screws (2) and torque to 84 in-lb.
6. Fully open and close door leaves to verify door leaf closed switch functionality. Repeat adjustment if necessary.
7. Apply torque stripe to machine screws (2).

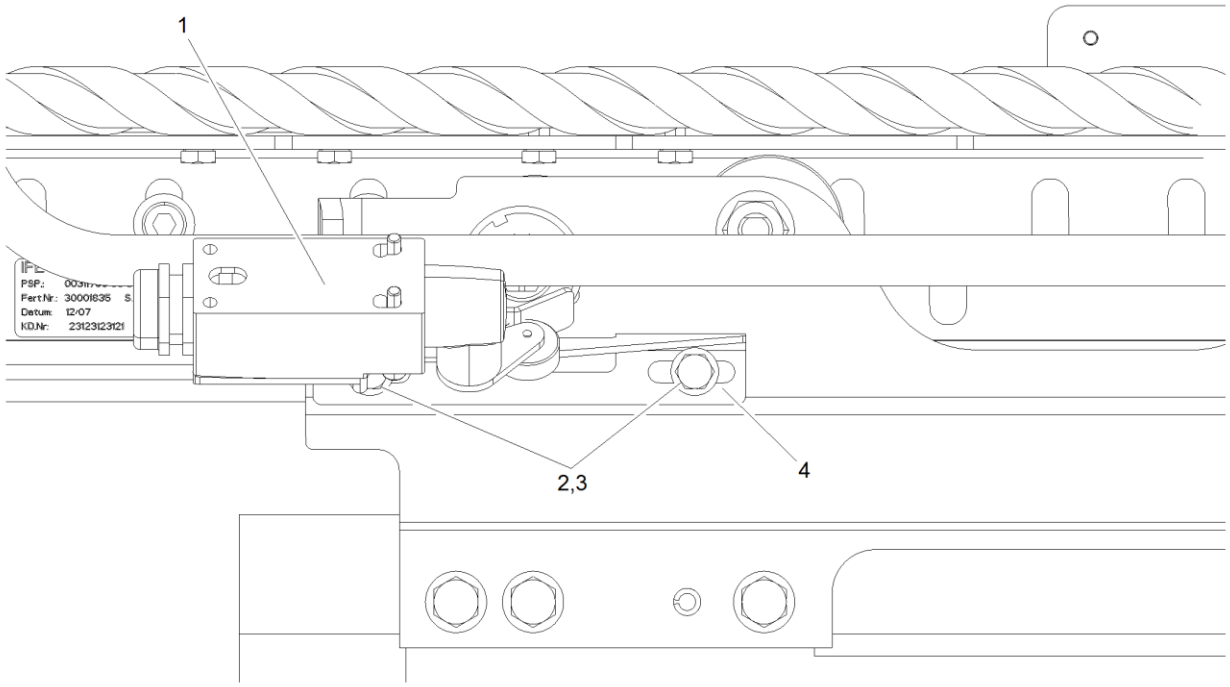


Figure 4-8: S8 Door Leaf Left Closed Switch

4.3.7 Obstruction Detection Test

Special Tools and Test Equipment Required:

- Gauge, Obstruction Detection IFE 810965

WARNING

USE CAUTION WHEN PERFORMING OBSTRUCTION DETECTION CHECK.

THE REQUIRED ELECTRICAL SUPPLY CANNOT BE SWITCHED OFF DURING THE TEST.

1. Open doors using cab controls.

NOTE: During test, ensure gauge is held firmly in parallel alignment and 90 degrees to the door leaves so it cannot tilt. This test requires two technicians.

2. See Figure 4-9. Position the square side of the obstruction gauge between the door leaves approximately halfway between top and bottom of the doors.

NOTE: As long as obstruction remains between doors the door will continue to attempt to close and to reopen. This setting can be changed so after a fixed number of times of reopening (between 1 and 99) the door will remain open for an operator to investigate and then clear door way or close and cut out doors.

3. Check no door closed signal is present.

4. Close doors using cab controls.

NOTE: As long as an obstruction exists the doors will attempt to open and close 5 times. Once the maximum number of closing attempts is reached the door will remain open until the operator investigates and clears the obstruction or places the door out-of-service using the door cutout device.

5. When doors encounter test bar, check the following events occur:
   - Doors must move to fully open position before attempting to re-close.
   - DCU input E15, Sensitive Edge Switch S11-lleft door leaf, must go active momentarily observed using IFE ST03 software. If input does not go active and doors do not open, replace sensitive edge in left door leaf.
   - DCU input E16, Sensitive Edge Switch S12- right door leaf, and DCU input E13, Door Locked Switch S1, must stay active as observed using ST03. If either input is inactive, replace associated limit switch.

6. Remove test bar and allow doors to fully close.

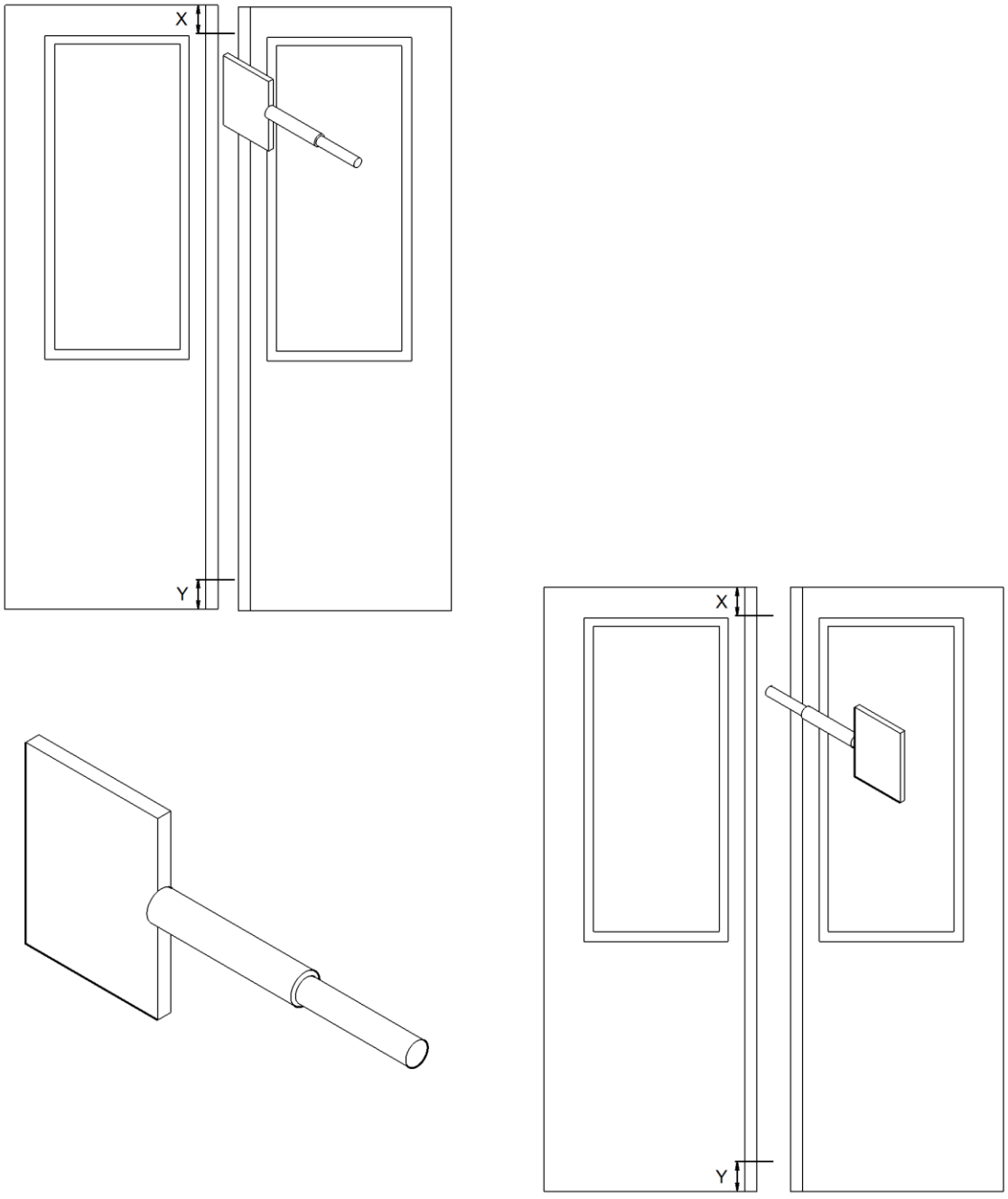


Figure 4-9: Obstruction Detection

CAUTION

REPEATED OBSTRUCTIONS CAN CAUSE THE DCU TO CLOSE THE DOORS WITH MORE FORCE (HIGHER MOTOR CURRENT) THAN NECESSARY. CYCLING THE DOORS BETWEEN OBSTRUCTION TESTS WILL PREVENT THIS.

7. Open and close doors once without test bar before performing next step. Doors must operate normally.
8. Repeat test twice more with test bar placed in the following location (refer to Figure 4-9):
    - 3.0 in. (75 mm) from top of door (dimension X),
    - 1.0 in. (50 mm) from bottom of door (dimension Y).
9. Open and close doors ten times using cab controls to reset the learned door profile on DCU.
10. Repeat full test using round test bar end of the obstruction gauge.

4.3.8 Inspect Painted Components

WARNING

DANGER OF PERSONAL INJURY EXISTS IF ELECTRICAL POWER IS ON. ENSURE POWER IS OFF AND TAGGED TO ALERT MAINTENANCE PERSONNEL OF IN-PROGRESS TASK.

1. Access Door Operator.

Place (S7) service switch, located on door operator, in off position “O” to remove power from local door.

NOTE: Cosmetic damage should be checked at a distance of 5 feet, without reflection.

2. Visually check doors for cosmetic damage such as dents, scrapes, and scratches. Bare metal surface should not visible.
3. Check all painted parts for damage showing bare metal surfaces.
4. Check all painted parts for other issues such as separation of the paint coating or corrosion not related to damage.
5. Report damage to supervision for logging and disposition.
    - Place (S7) service switch in on position “I” to restore power to local door.

4.3.9 Clean and Grease Finger Protection Rubber

Material Required:

- Silicone Paste P or Kluber Barrierta L25DL

WARNING

DANGER OF PERSONAL INJURY EXISTS DUE TO DOORS CLOSING IF ELECTRICAL POWER IS ON. USE LOCK OUT/TAG OUT PROCEDURES TO ALERT MAINTENANCE PERSONNEL.

OBSERVE MANUFACTURER'S SAFETY INSTRUCTIONS ON ALL PRODUCTS TO PREVENT RISK OF ILLNESS.

1. Ensure (S7) service switch (located on door operator) is in off position.
2. Access door drive assembly.
3. Manually release doors to access finger protection rubber.
4. Clean finger protection rubber surfaces and surrounding area with a clean cloth.
5. Lightly lubricate finger protection rubbers with Silicone Paste P.
6. Remove excess lubricant with clean dry cloth.

4.3.10 Inspect and Grease Locking Unit

WARNING

DANGER OF PERSONAL INJURY EXISTS DUE TO DOORS CLOSING IF ELECTRICAL POWER IS ON. ENSURE POWER IS OFF AND TAGGED TO ALERT MAINTENANCE PERSONNEL OF IN-PROGRESS TASK. SERVICE (S7) TOGGLE SWITCH MUST BE SWITCHED OFF BEFORE ANY WORK IS PERFORMED ON DOORS.

1. Ensure (S7) service switch (located on door operator) is in off position.
2. See Figure 4-10. Grease the sliding surfaces (A) of latches (1) and (2) and latch pins (3) and (4) with Isoflex Topas NB 52 using a brush.
3. Open and close the door leaves manually 2 or 3 times.
4. Wipe with clean dry cloth to remove any excess grease.

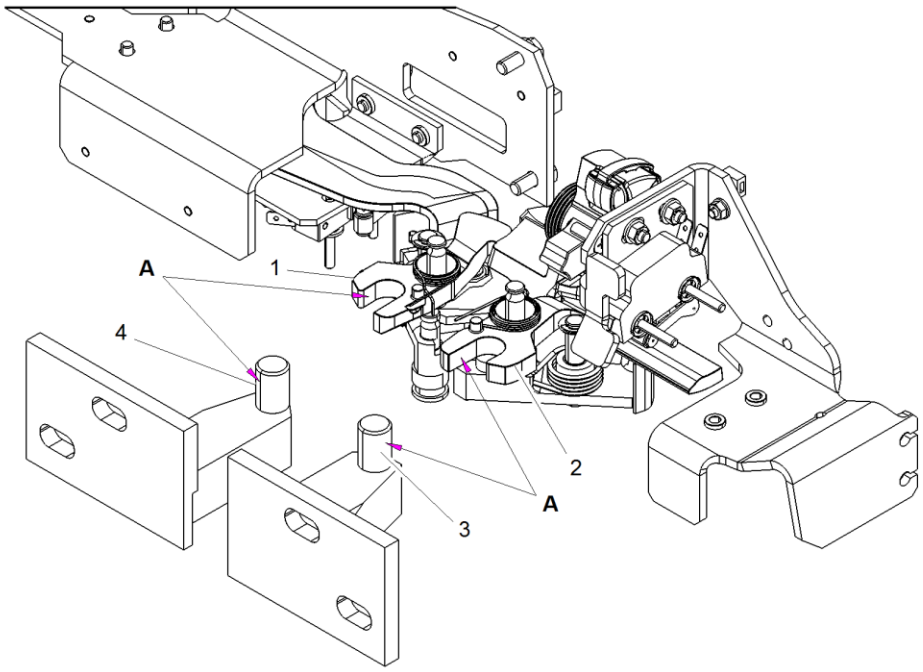


Figure 4-10: Locking Unit

4.3.11 Clean and Grease Locking Lever/Locking Pawl

WARNING

SERVICE SWITCH (S7) MUST BE SWITCHED OFF BEFORE ANY WORK IS PERFORMED ON DOORS.

1. Access door drive assembly.
2. See Figure 4-11. Clean area surrounding locking lever (1) with clean cloth.
3. Remove residual lubricant from locking lever (1) and associated parts with clean cloth.
4. Grease contact and rolling surfaces of locking lever (1) with Kluber Isoflex Topas NB 52.
5. Wipe up excess lubricant with clean cloth.

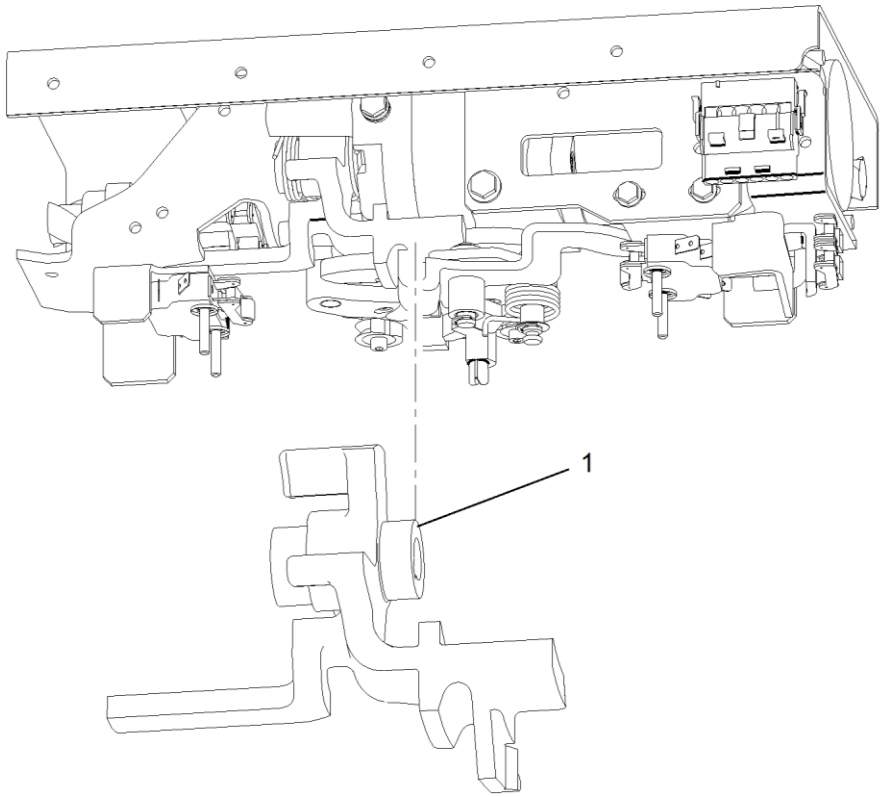


Figure 4-11: Locking Lever

4.3.12 Inspect Spring Actuator

1. Bring door leaves electrically in the closed and locked position.
2. Place (S7) service switch (located on door operator) in off position.
3. See Figure 4-4. Manually release door leaves by actuating manual release lever.
4. See Figure 4-12. Measure resulting gap (A) between the finger protection rubber (3) of one released door leaf (1) to the other door leaf (2).
5. If the gap (a) is smaller than 1” (25.4 mm), then rebuild spring actuator per Section 5.3.5.

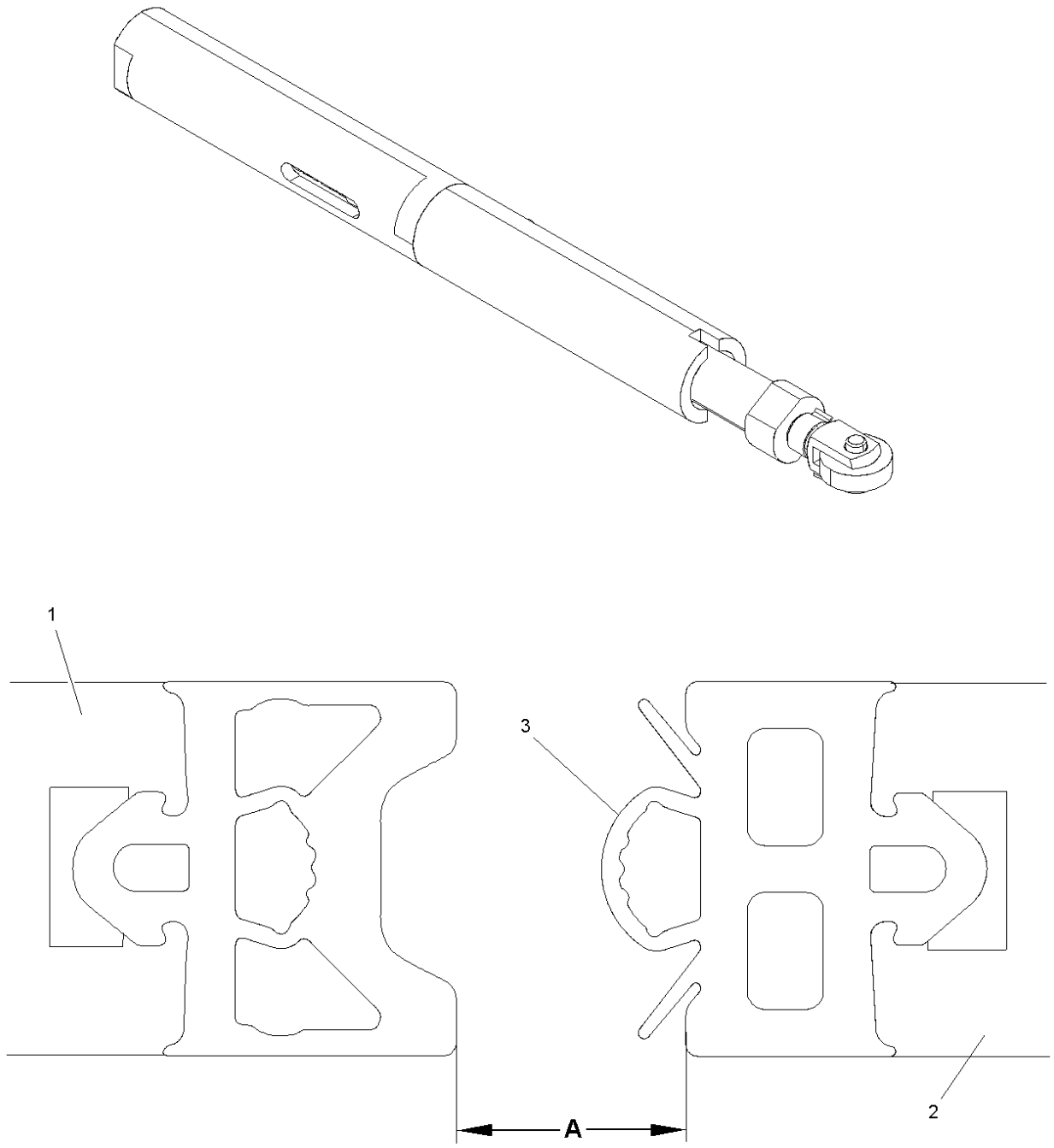


Figure 4-12: Spring Actuator

4.3.13 Inspect Rubber Buffer Assembly

WARNING

SERVICE SWITCH (S7) MUST BE SWITCHED OFF BEFORE ANY WORK IS PERFORMED ON DOORS.

1. See Figure 4-13. Check door open rubber buffers (1) on the door operator for cracks, excessive wear out, bending and so on.
2. Check the doorhanger buffer contact pads for bending or cracking.
3. Replace any damaged or bent parts.

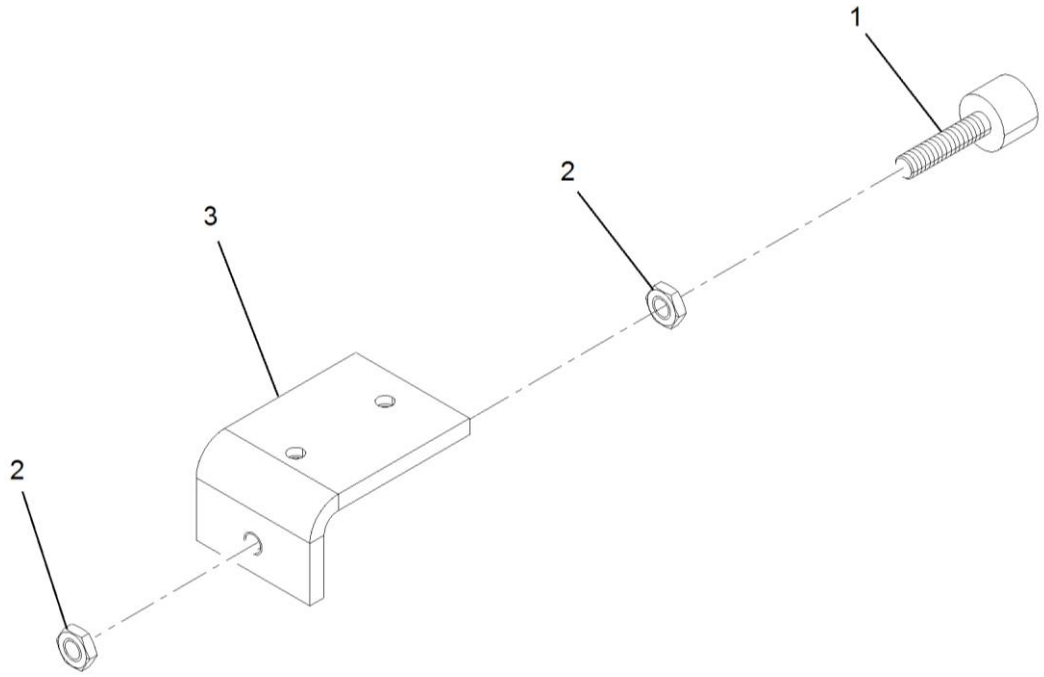


Figure 4-13: Rubber Buffer Assembly

4.3.14 Inspect Spindle Anodization

Check anodization of left and right spindle (1 and 2, Figure 4-13). If bright aluminum can be seen, spindle is damaged and should be replaced according to the HRM.

4.3.15 Clean and Grease Spindle

Material required:

- Kluber Isoflex 18 Special A

WARNING

SERVICE SWITCH (S7) MUST BE SWITCHED OFF BEFORE ANY WORK IS PERFORMED ON DOORS.

1. Clean area surrounding spindle with clean cloth.
2. Remove residual lubricant from spindle (1 and 2, Figure 4-14) and associated parts with clean cloth.
3. Brush on a light coating of Kluber Isoflex LDS 18 Special A, over the entire length of the spindle.
4. Open and close the doors manually two or three times to spread lubricant.
5. Wipe up excess lubricant with clean cloth.

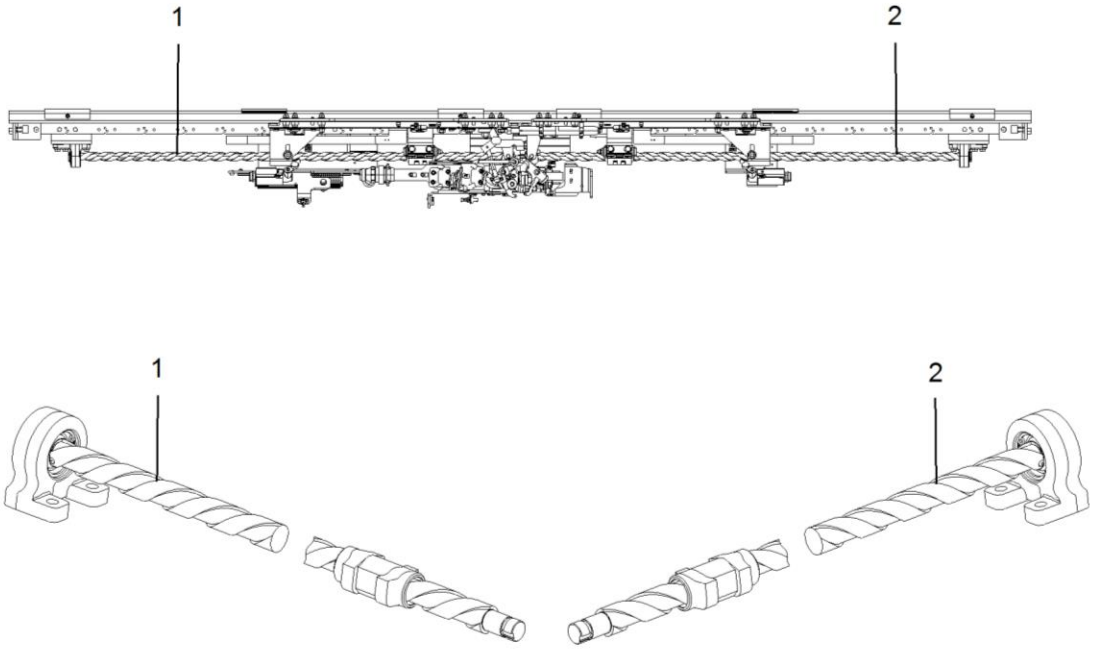


Figure 4-14: Spindle

4.3.16 Clean and Grease Release Lever

Material Required:

- Kluber Isoflex Topas NB 52

WARNING

SERVICE SWITCH (S7) MUST BE SWITCHED OFF BEFORE ANY WORK IS PERFORMED ON DOORS.

1. Access door drive assembly.
2. Clean area surrounding release lever (1, Figure 4-15) with clean cloth.
3. Remove residual lubricant from release lever (1) and associated parts with clean cloth.
4. Grease bolt of release lever (2) with Kluber Isoflex Topas NB 52.
5. Wipe up excess lubricant with clean cloth.

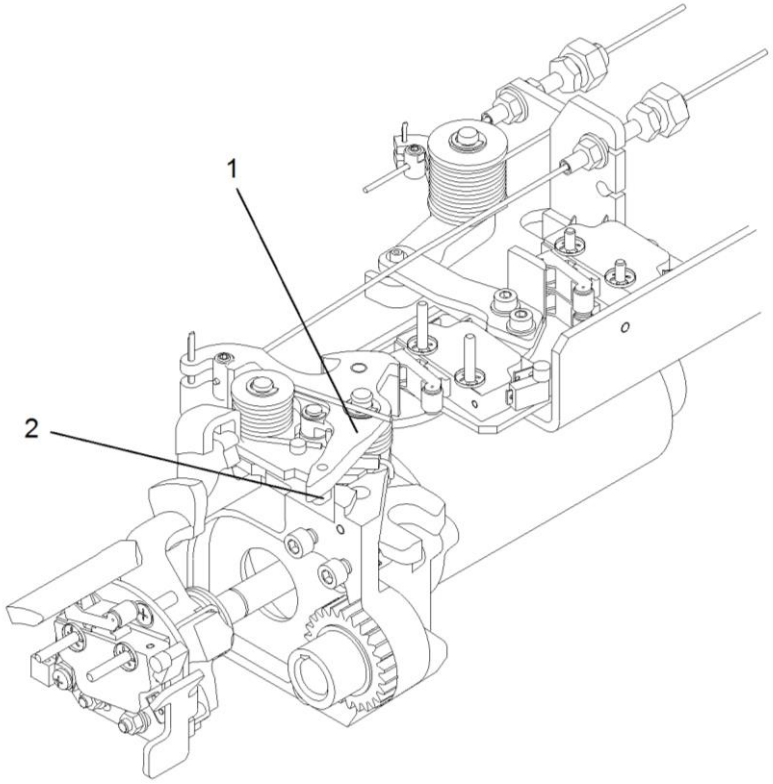


Figure 4-15: Release Lever

CHAPTER 5.0

CORRECTIVE MAINTENANCE

5.1 Introduction

This chapter provides the procedures to adjust, and to replace components of the IFE door entrance system.

5.2 Adjustments and Alignments

NOTE: Adjustments are performed on an as needed basis.

CAUTION

DO NOT TURN SPINDLE OF DOOR OPERATOR BY HAND.

DO NOT USE MOTOR (M1) AS A HAND GRIP.

TAKE CARE TO AVOID DAMAGING FINISHED DEVICES. AVOID USING METAL MEASURING TOOLS TO CHECK DIMENSIONS.

WARNING

WHEN INSPECTING OR SERVICING THE DOORS, ENSURE ALL OPERATING PROCEDURES REGARDING THE PREVENTION OF VEHICLE MOVEMENT ARE OBSERVED. USE CARE TO PREVENT PERSONAL INJURY.

BEFORE PERFORMING ANY MAINTENANCE PROCEDURE, ARRANGE FOR THE REMOVAL AND CONTINUOUS ISOLATION OF POWER IN ACCORDANCE WITH SAFETY RULES AND OPERATING PROCEDURES. ENSURE POWER IS OFF AND TAGGED TO ALERT MAINTENANCE PERSONNEL OF IN-PROGRESS TASK.

DANGER OF PERSONAL INJURY EXISTS DUE TO THE DOORS CLOSING WHEN ELECTRICAL POWER IS REQUIRED TO BE ON. TAKE CARE TO AVOID INJURY DUE TO MOVING PARTS.

WHEN USING OTHER MANUFACTURER'S PRODUCTS, OBSERVE THE MANUFACTURER'S SAFETY INSTRUCTIONS TO PRECLUDE DAMAGES TO OR IMPAIRMENT OF HEALTH.

5.2.1 Adjustment of Door Leaf Pre-load

1. Ensure (S7) service switch located on door operator is in the off position.
2. Activate interior emergency manual release according to Section 2.6.8.1 to create a small gap between door leaves.
3. See Figure 5-1. Manually push the door leaves in the open position (X=50mm).
4. Check parallelism: the preload at the top of both door leaves should be (X1= X ± 2mm).

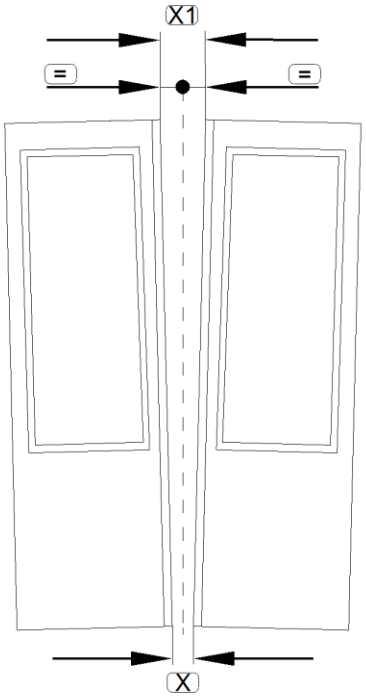


Figure 5-1: Door Leaf Pre-Load

5. See Figure 5-2. The door leaf must be pre-loaded by turning the eccentric support rollers (1) on the door hanger to apply constant pressure of the leading edge door seals in a closed position.
6. Recheck pre-load to ensure proper adjustment.
7. Torque slotted lock nut of eccentric support roller (2) to 11 ft-lbs. and bend tabs of locking washer (3) to lock door pre-load position.
8. Apply torque stripe to slotted locknut (2).

NOTE: Do not use Loctite to secure eccentric roller.

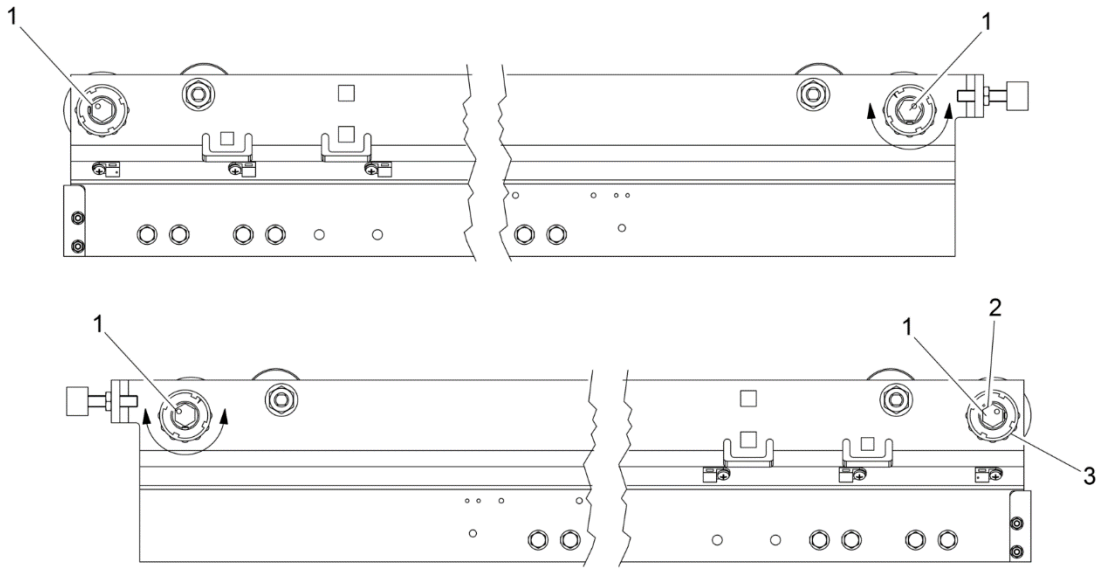


Figure 5-2: Doorhanger

5.2.2 Check Spindle Nut Gap

1. See Figure 5-3. Move door leaves manually into half open position.
2. While moving door leaves into closed position, check the gap (A) between plastic part of spindle nut (1) and housing of spindle nut (2). Gap A = 0.5mm ≤ a ≤ 5.5 mm.
3. While moving door leaves into open position, verify Gap A ≥ 0.5mm ≤ 5.5 mm.
4. If measurement (A) is not within defined value, re-adjust by adding or removing shims (4).
5. Apply a drop of Loctite 243 to threads of hexagon screws (3). Refer to manufacturer's guidelines for Loctite 243 dry time.
6. Torque hexagon screws (3) to 17 ft-lbs and apply torque stripe.

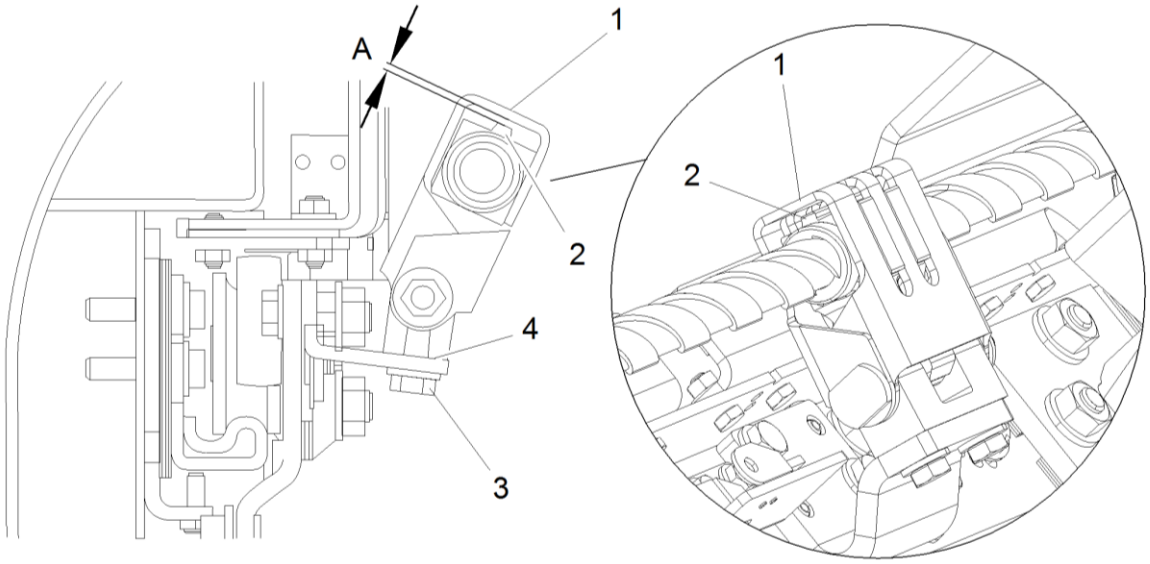


Figure 5-3: Spindle Nut Gap

5.2.3 Adjustment of Counterstay Rollers

1. See Figure 5-4. With an approximate 250mm gap between finger protection rubbers, turn eccentric (1) to adjust gap (A) (A=0.1 mm to 0.4 mm) between the upper edge of counterstay roller (3) and top of the upper guide rail (2).

2. Close and reopen doors manually to ensure doors run smoothly in the guide rail, visually confirming rollers rotate slightly.

3. After adjustment, apply a drop of Loctite to 243 to threads of counterstay roller bolt. Refer to manufacturer's guidelines for Loctite 243 dry time.

4. Torque bolt to 11 ft.-lbs and apply torque stripe.

5. Recheck Door Leaf Pre-Load according to Section 5.2.1.

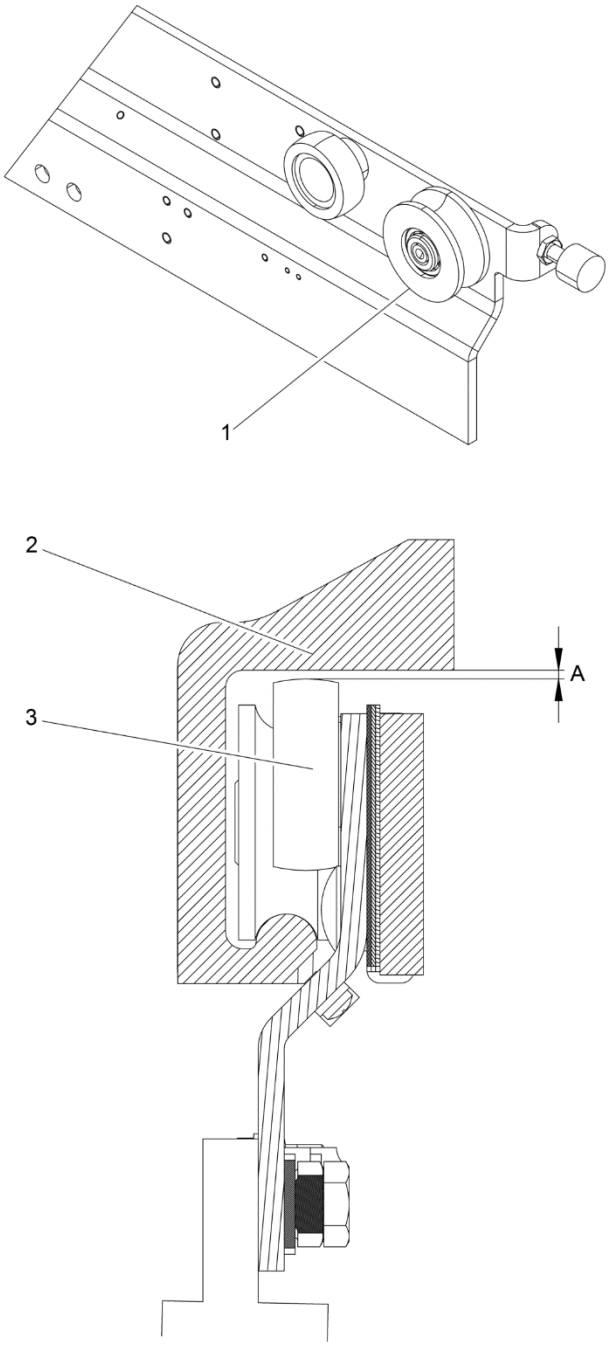
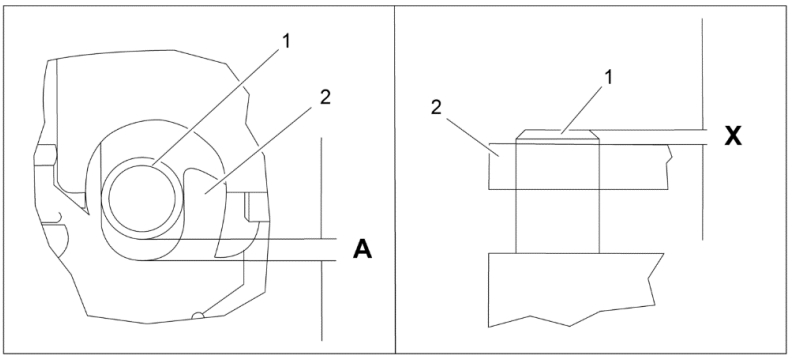


Figure 5-4: Counterstay Rollers

5.2.4 Check Lock Bolt Gap

1. See Figure 5-5. With doors in closed and locked position, check gap (A) (A= 3.7mm ± 0.8mm) between the lock bolt (1) and locking pawl (2) on right and left door leaf.
2. If necessary to adjust gap (A), release doors to open position and loosen hexagon nuts (3).
3. Adjust by adding or removing shims (4) until proper gap width is achieved.
4. Torque hexagon nuts (3) to 36 ft.-lbs. and apply torque stripe.
5. Verify measurement (X) (X= 2mm Min.) between lock bolt (1) and locking pawl (2).



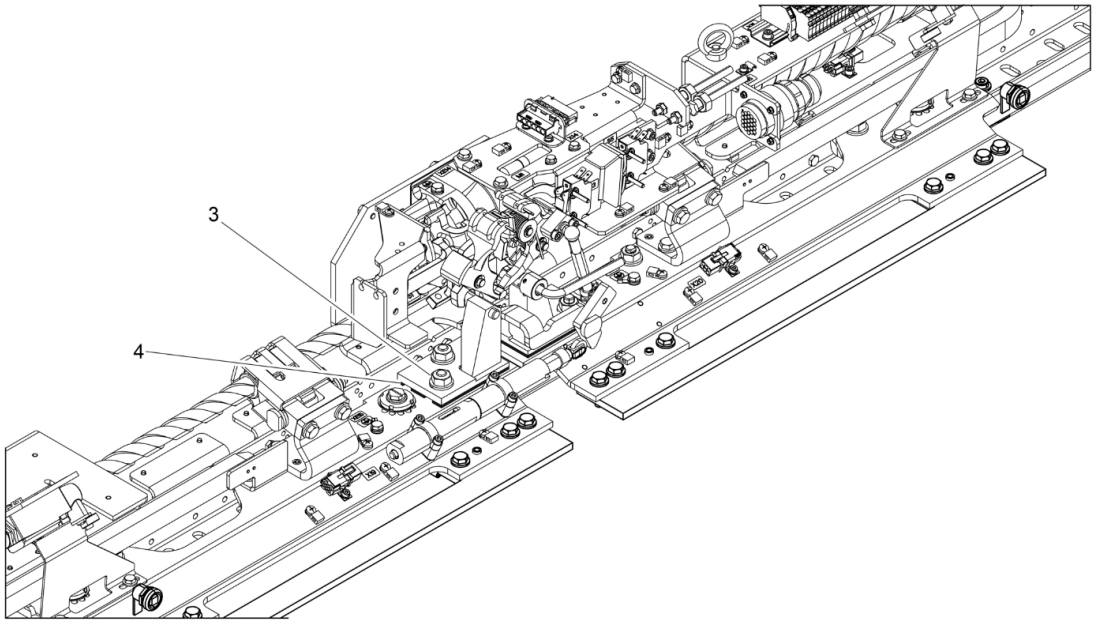


Figure 5-5: Lock Bolt Gap

5.2.4.1 Adjustment of Lock Bolt

1. Ensure (S7) service switch located on door operator is in the off position.

2. Manually push door leaves to closed position until finger protection rubbers touch slightly.

NOTE: End hooks of sealing press gauge must be inserted in recess of each spindle nut bracket to ensure proper engagement and alignment of sealing gauge brackets with outer surface edge of spindle nut brackets.

3. See Figure 5-6. Install sealing press gauge (1) by inserting end hooks (2) in recess of each spindle nut bracket (3).

4. See Figure 5-7. Adjust lock bolts by loosening hex nuts (4) and sliding two lock bolt brackets (3) until lock bolts (1) contact surface of locking pawls (2). Confirm measurement A = 0.

5. Once adjusted, hand-tighten hex nuts (4) for future torqueing.

6. Remove sealing gauge and manually open and close doors to ensure doors close and lock properly.

7. Upon confirmed adjustment, apply a drop of Loctite 243 to four hex nuts (4). Refer to manufacturer's guidelines for Loctite 243 dry time.

8. Torque four hex nuts to 36 ft.-lbs. and apply torque stripe.

9. Restore power with (S7) service switch and electrically open and close doors to ensure proper lock and unlock function.

5.2.5 Adjust Door Width Opening

1. See Figure 5-8. Move door leaves manually into open position.

2. Check measurement (B) (B = 1220 + 5mm).

3. If necessary, adjust the door opening width by loosening hex nut (2) and turning rubber buffer (1).

4. Secure the rubber buffers (1) in place with hex nuts (2).

5. Torque hex nuts (2) to 14-ft.-lbs.and apply torque stripe.

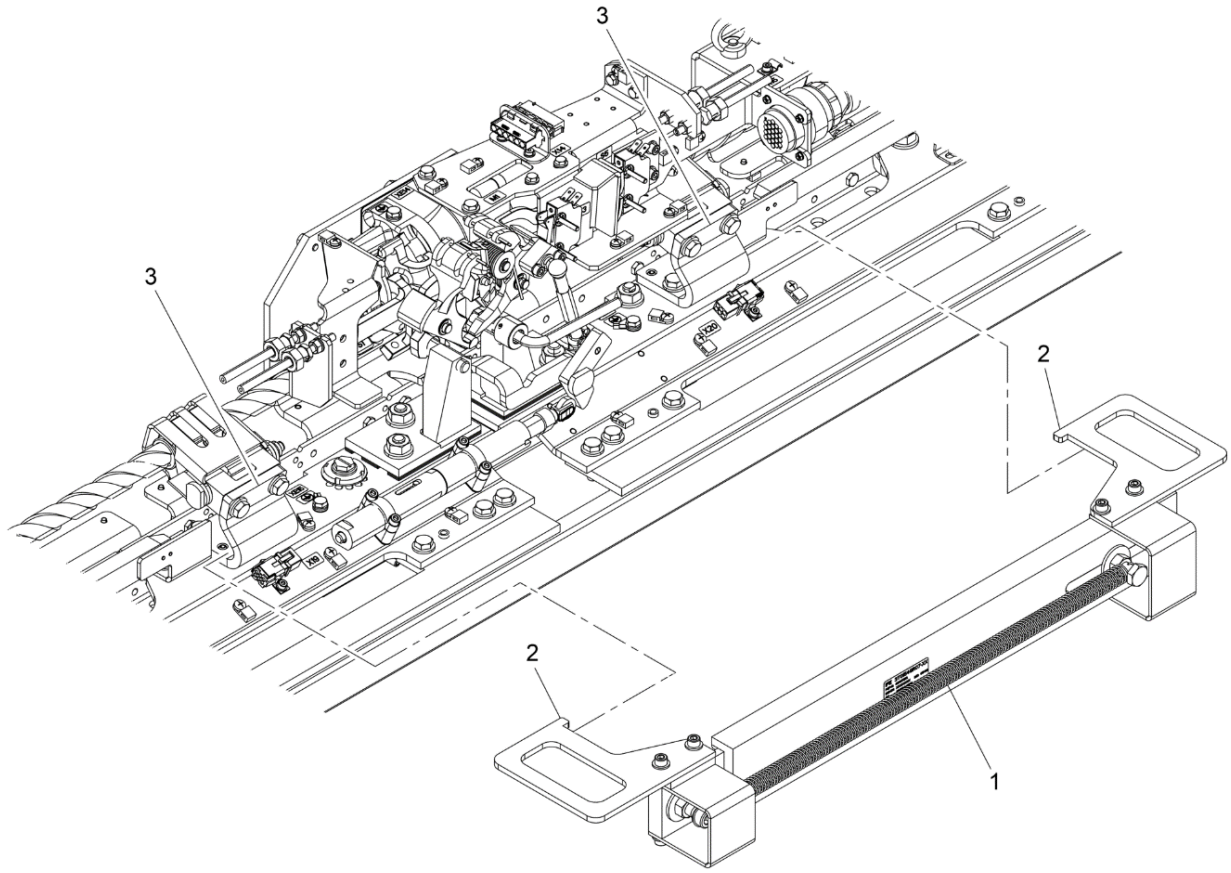


Figure 5-6: Install Sealing Press Gauge

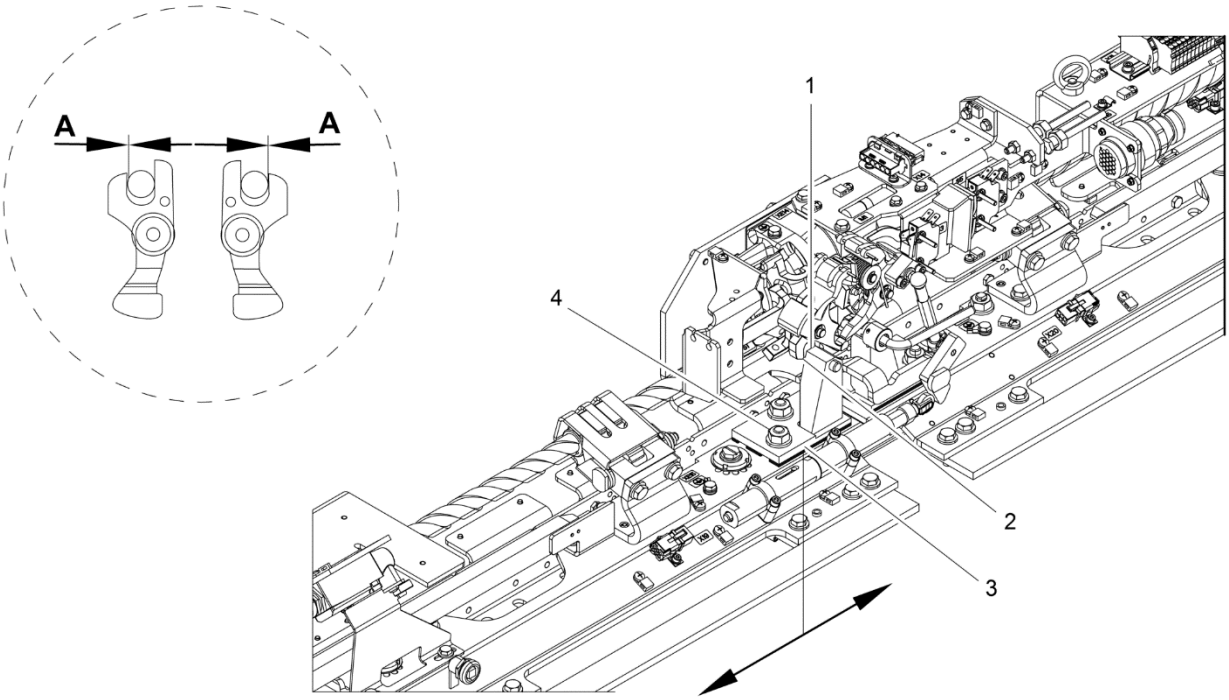


Figure 5-7: Adjust Lock Bolt

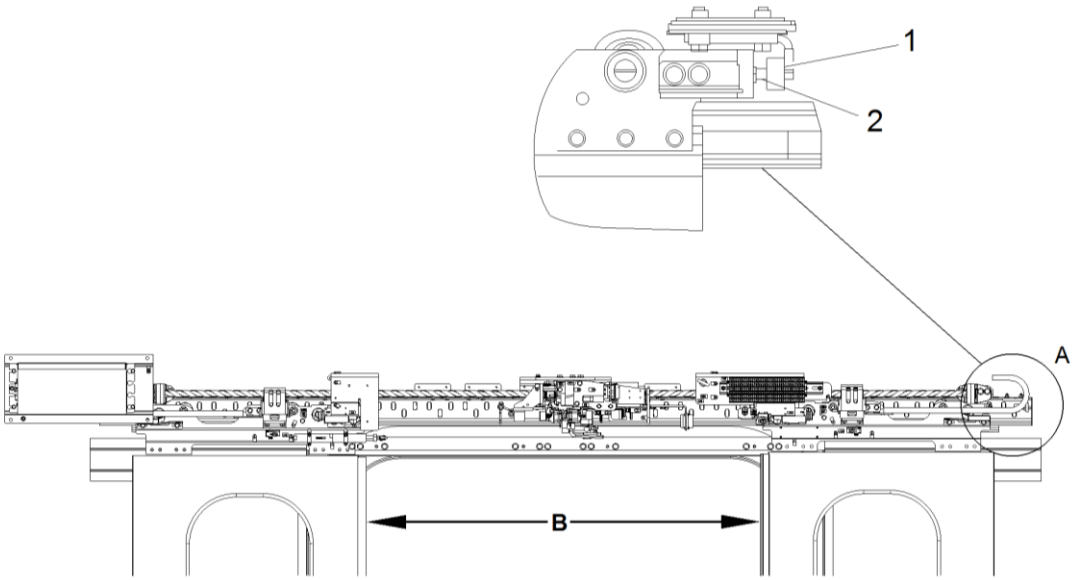


Figure 5-8: Door Width Opening

5.3 Component Removal and Installation

5.3.1 Replace Finger Protection Rubber

5.3.1.1 Removal

1. Ensure (S7) service switch located on the door operator is in the off position.
2. Disconnect the sensitive edge wiring (5) from the X19 connector on left door leaf (1). See Figure 5-9.
3. Disconnect the sensitive edge wiring (6) from the X20 connector on right door leaf (2).
4. Remove the thirteen M4 x 16 screws (7) from the left door leaf (1). Remove the sensitive edge retainer (8). Remove the finger protection rubber with sensitive edge S11 (3).
5. Remove the thirteen M4 x 16 screws (7) from the right door leaf (2). Remove the sensitive edge retainer (9). Remove the finger protection rubber with sensitive edge S12 (4).

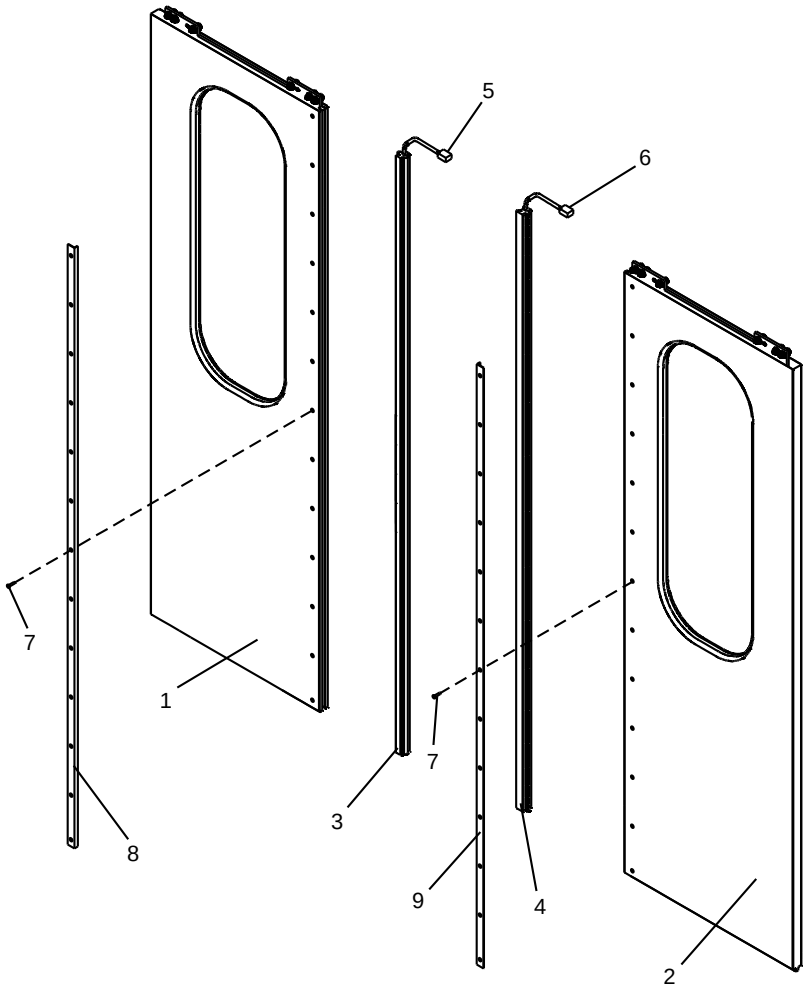


Figure 5-9: Finger Protection Rubber

5.3.1.2 Installation

1. Align the finger protection rubber with sensitive edge S11 (3) with the left door leaf (1). See Figure 5-9.
2. Align the sensitive edge retainer (8) with the left door leaf (1).
3. Install the thirteen M4 x 16 screws (7) with the left door leaf (1) and tighten.
4. Align the finger protection rubber with sensitive edge S12 (4) with the right door leaf (2).
5. Align the sensitive edge retainer (9) with the right door leaf (2).
6. Install the thirteen M4 x 16 screws (7) with the right door leaf (2) and tighten.
7. Connect the sensitive edge wiring (5) to the X19 connector on left door leaf (1).
8. Connect the sensitive edge wiring (6) to the X20 connector on right door leaf (2).
9. Turn (S7) service switch located on the door operator to the on position.
10. Check obstacle detection according to Section 4.3.7.

5.3.2 Replace Drive Unit

WARNING

SEAL OFF WORKING AREA AND USE SUITABLE LIFTING EQUIPMENT TO AVOID INJURY TO TRAIN PERSONNEL.

CAUTION

ENSURE PROPER DRIVE UNIT POSITIONING TO AVOID POSSIBLE COLLISION OF TRAIN COMPONENTS.

5.3.2.1 Remove Drive Unit

1. Ensure (S7) service switch located on door operator is in the off position.
2. Disassemble door leaves according to Section 5.3.5.
3. Disassemble EED and EAD Bowden cables from drive unit according to HRM.
4. Disconnect electrical wiring X11 and grounding point XE1.
5. Support drive unit with lifting column (customer supplied).
6. See Figure 5-10. Loosen hexagon nut (6) and set screw (7).
7. Loosen and remove eighteen socket head screws (4) (carbuilder scope) along with eighteen spring washers (5) (carbuilder scope).

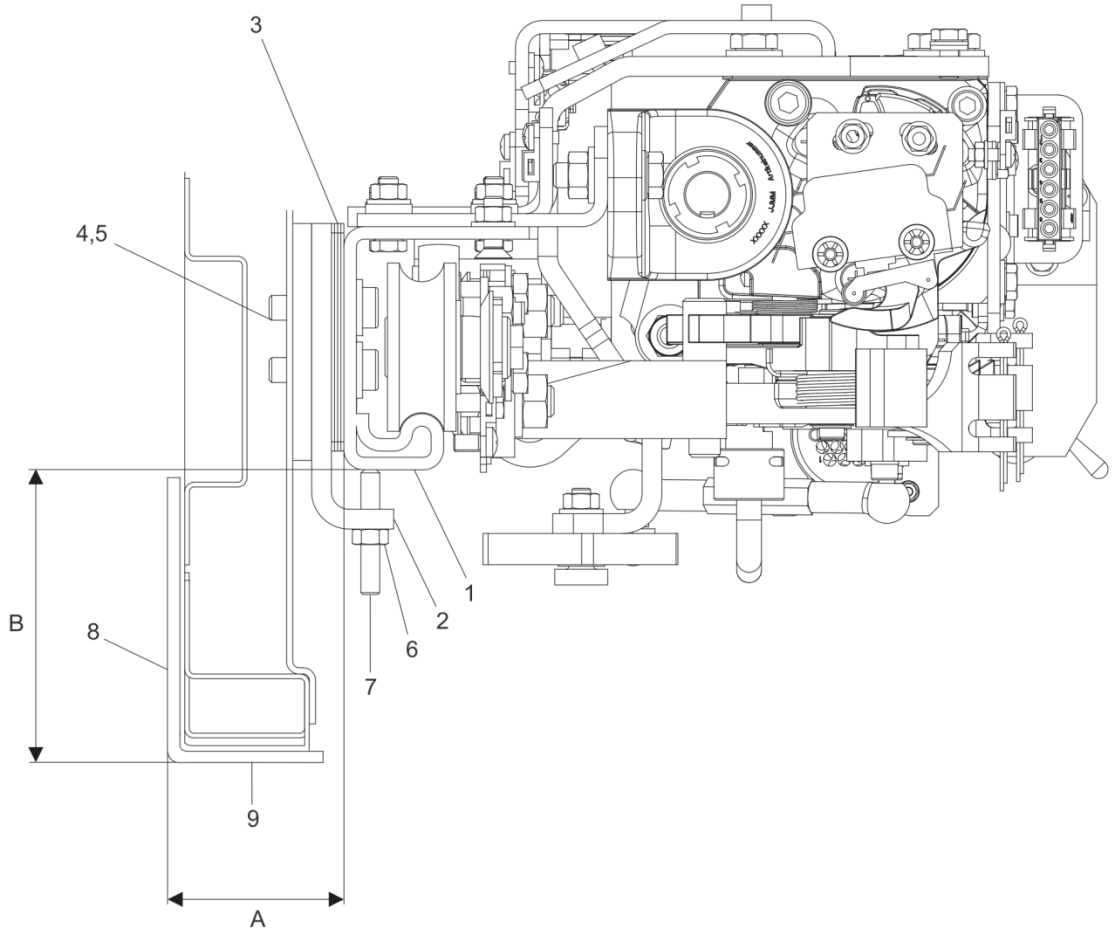


Figure 5-10: Drive Unit Replacement

8. Carefully remove drive unit from portal and place on a stable work surface.

9. See Figure 5-10. Remove mounting brackets (3), mounting consoles (4), and shims (4).

10. Group the brackets with shims and consoles with shims to ensure they are installed together in the same position on the new drive unit.

5.3.2.2 Install Drive Unit

1. See Figure 5-10. Position previously grouped brackets (3) with shims (4) and consoles (2) with shims (4) to the new drive unit (1), ensuring installment at the same location as removed.

2. See Figure 5-10. Loosen hex nut (6) and set screw (7).

3. Lift new drive unit with lifting column (customer supplied) and position to portal.

4. Fasten new drive unit to threaded plates of portal by inserting socket head screws (4) through spring washers (5), guide rail (1), mounting consoles/mounting brackets (2), and shims (3). Do not torque screws (4) at this time. See Figure 5-11.

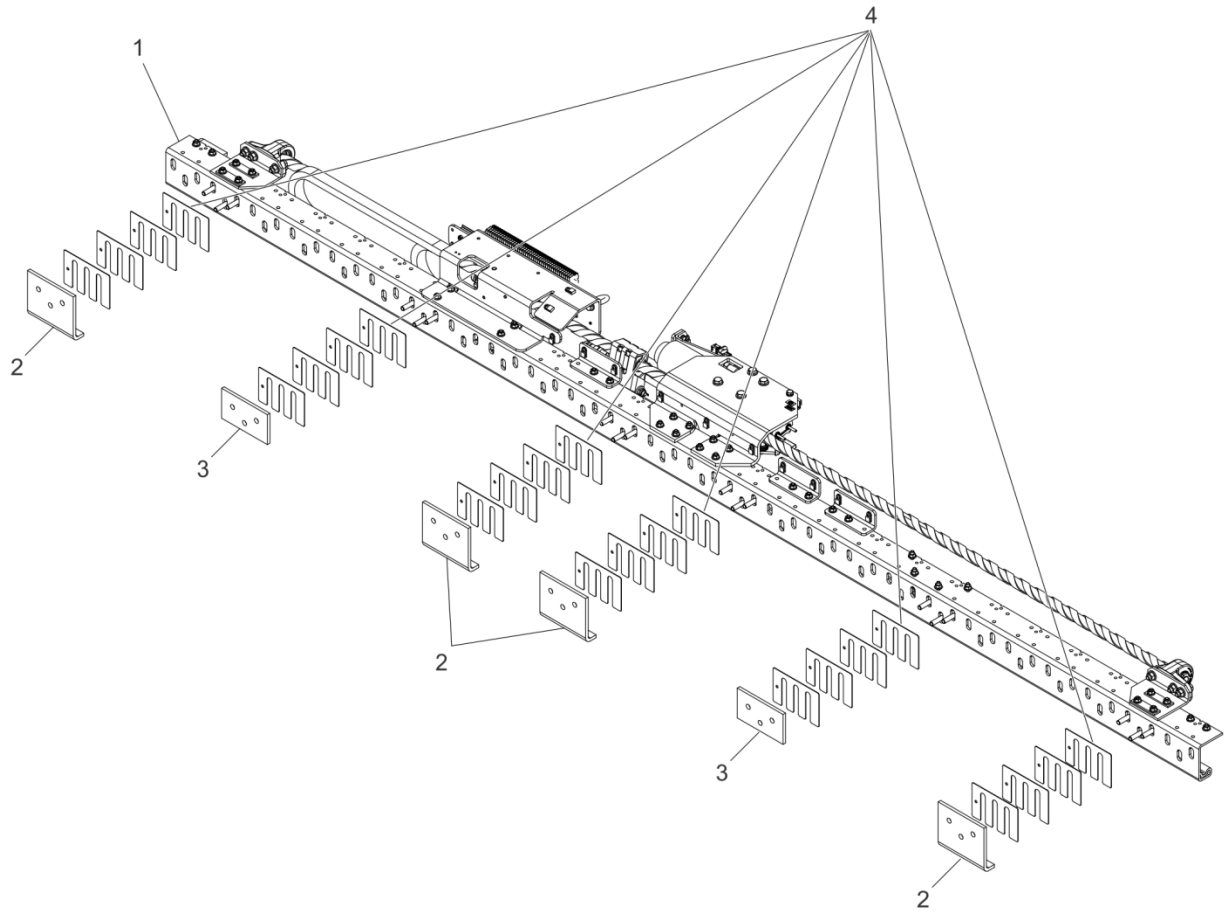


Figure 5-11: Drive Unit Console/Bracket Position

5. Ensure new drive unit is centered in portal.

6. Confirm measurement A (A= 56.7 ±0.3mm) between outside coach surface (8) and drive unit guide rail at both ends of drive unit.

7. Verify drive unit is seated straight with use of water level and ruler.

8. Adjust measurement B (B=92.5 ±1mm) between bottom surface of drive unit guide rail and upper edge of portal (9) with set screw (7). Measurement to be verified and adjusted as needed at both ends of drive unit.

9. Once drive unit is properly positioned, remove socket head screws (4) one at a time to apply a drop of Loctite 243 to end threads of each screw. Refer to manufacturer's guidelines for Loctite 243 dry time.

10. Torque three socket head screws (4) at a time at each position to 17 ft.-lbs. and apply torque stripe.

11. Apply a drop of Loctite 243 to threads of hexagon nut (6).

12. Torque hexagon nut (6) to 7 ft.-lbs. and apply torque stripe.

5.3.3 Replace Torsion Springs on Locking Pawls

5.3.3.1 Disassembly of Adapter

1. Ensure (S7) service switch located on door operator is in the off position.
2. Disassemble Bowden cable of emergency egress device and emergency access device according to HRM.
3. See Figure 5-12. Unscrew two machine screws (1) and remove them together with washers (2).
4. Remove the adapter (3).

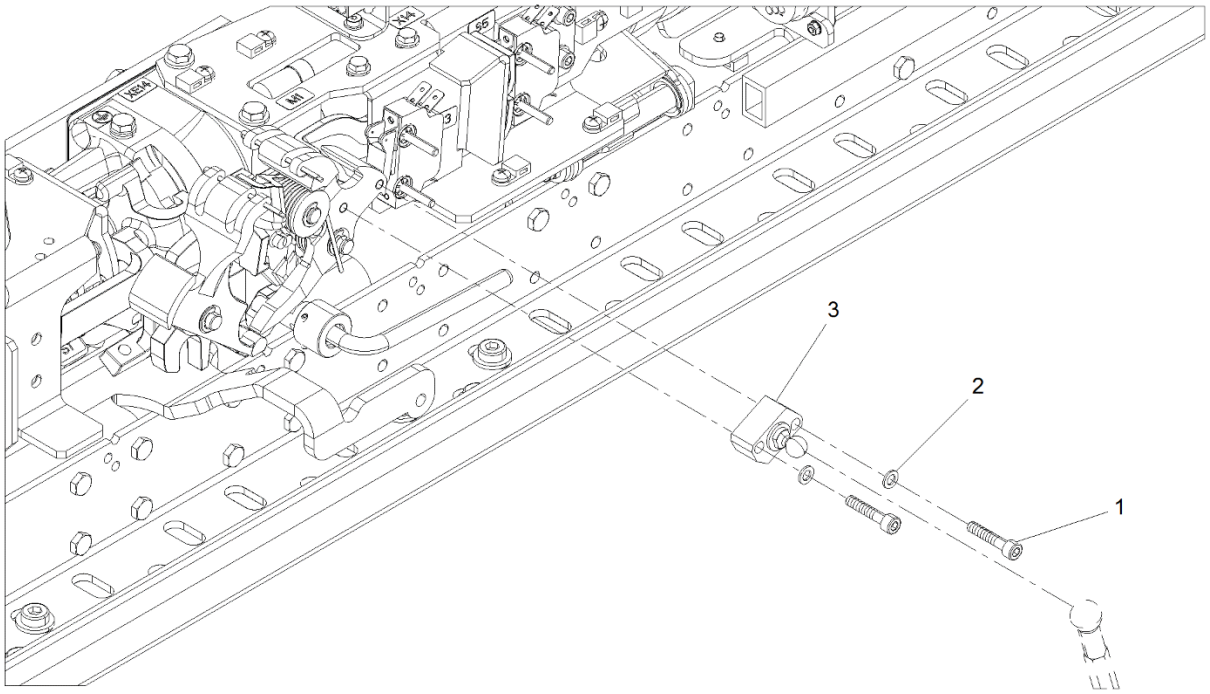


Figure 5-12: Remove S3 Adapter

5.3.3.2 Disassembly of Release Levers

1. See Figure 5-13. Remove securing ring (2) and washer (3).
2. Remove torsion spring (1).
3. Remove two securing rings (2) and two washers (5).
4. Remove release levers (6 and 8).
5. Remove torsion springs (4 and 7).

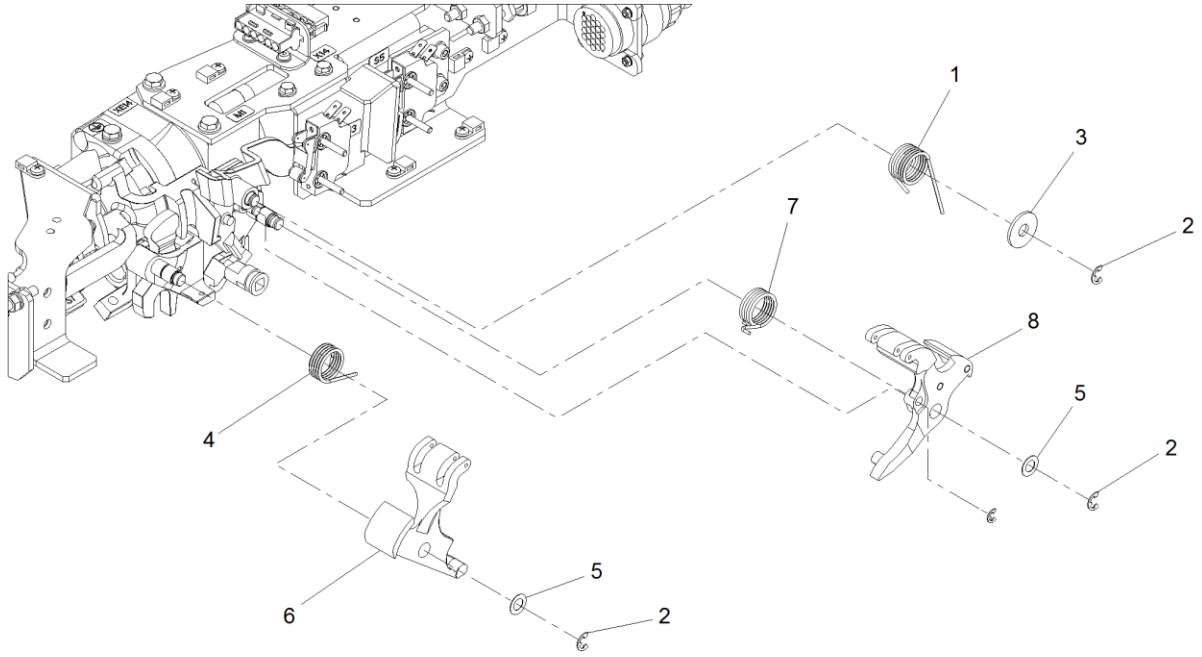


Figure 5-13: Remove Release Levers

5.3.3.3 Disassembly of Torsion Springs on Locking Pawls

1. See Figure 5-14. Unscrew and remove two pan head screws (1).
2. Screw in a M3 screw (customer supplied) to two pins (5).
3. Pull out two pins (5).
4. Remove locking pawls (3 and 6) together with springs (2 and 7) and two sliding washers (4).
5. Remove torsion springs (2 and 7) from locking pawls (3 and 6).

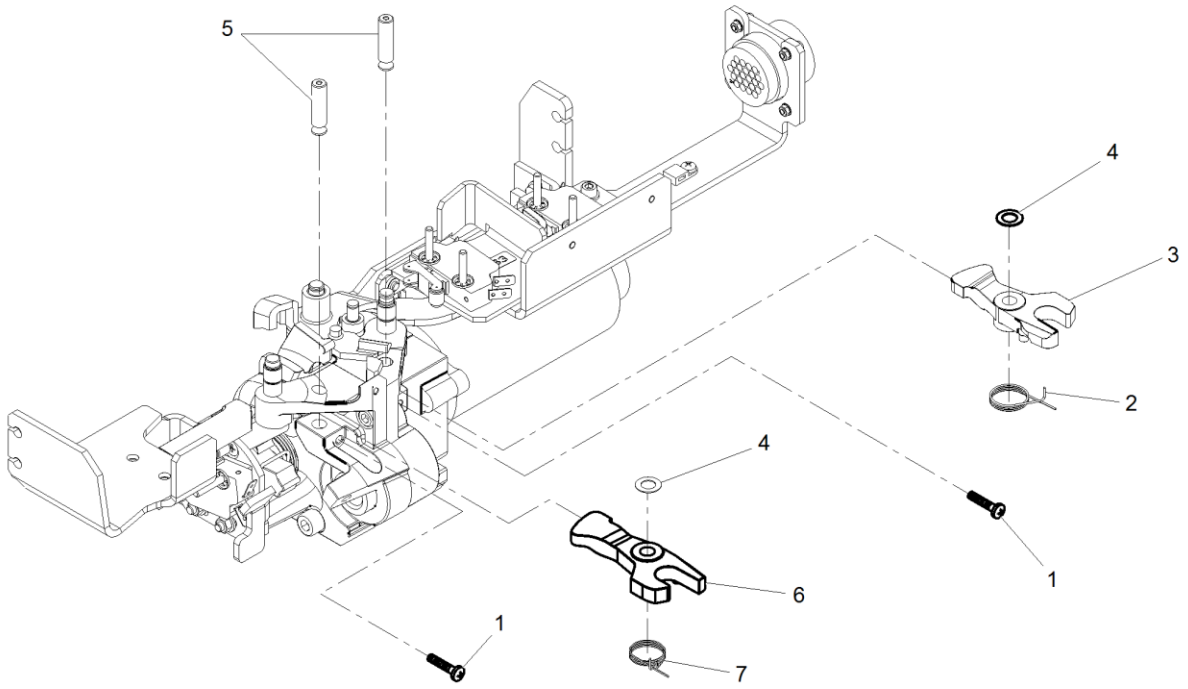


Figure 5-14: Remove Locking Pawl Torsion Springs

5.3.3.4 Assembly of Torsion Springs on Locking Pawls

1. See Figure 5-14. Lubricate two pins (5), locking pawls (3 and 6) and two sliding washers (4) with Isoflex Topas NB 52.
2. Attach new torsion springs (2 and 7) on locking pawls (3 and 6).
3. Push the locking pawls (3 and 6) together with two sliding washers (4) to position.
4. Insert two pins (5) to secure locking pawls (3 and 6).
5. See Figure 5-15. Check dimensions A and B to verify correct position of the pins (5). (A = 0.5 ± 0.5mm.) (B = 2.5 ± 0.5mm.).
6. See Figure 5-14. Apply a drop of Loctite 243 onto threads of two pan head screws (1). Refer to manufacturer's guidelines for Loctite 243 dry time.
7. Torque two pan head screws (1) to approximately 15 in-lb. It is possible that head of screws (1) do not touch surface of module upon proper installation.
8. See Figure 5-16. Manually press locking pawl (1) to closed position.
9. Using force gauge, press other locking pawl (2) to closed position. Sufficient force should not exceed 7.3 ft.-lbs.
10. Repeat the process for the other locking pawl.
11. If force exceeds 7.3 ft.-lbs., repeat process of greasing and mounting locking pawls.

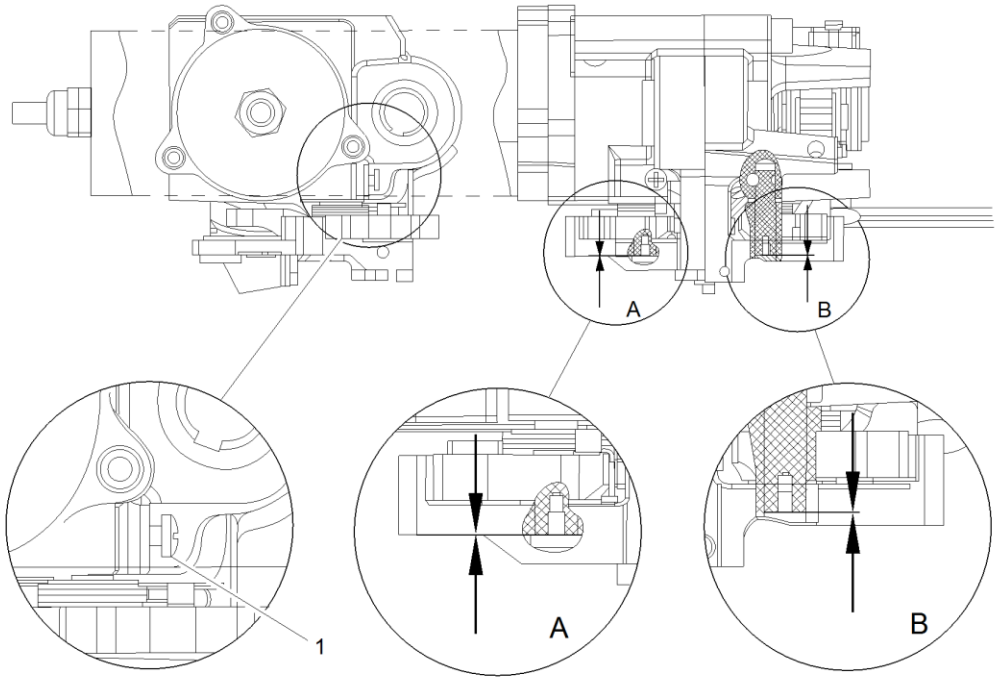


Figure 5-15: Locking Pawl Pin Position

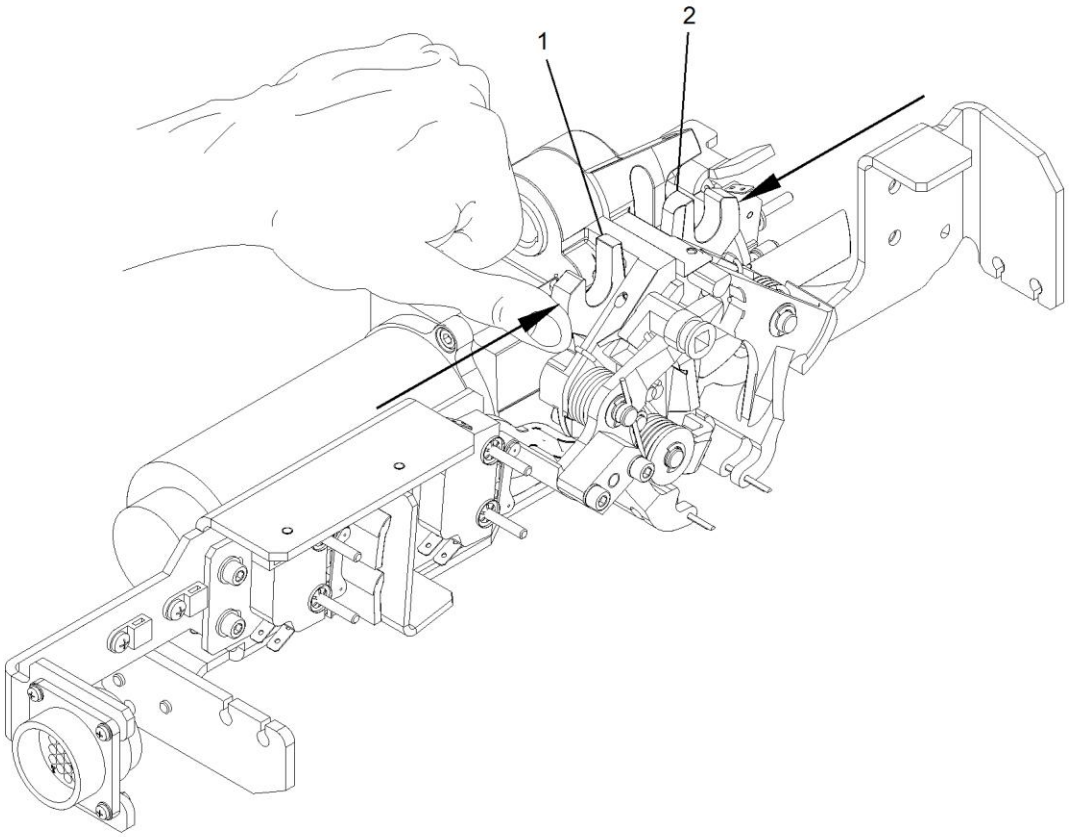


Figure 5-16: Locking Pawl Test

5.3.3.5 Assembly of Release Levers

1. See Figure 5-13. Place the torsion spring (1) into position.
2. Secure torsion spring (1) with washer (3) and securing clip (2).
3. Place torsion springs (4 and 7) into position.
4. Lubricate bolt of unlocking levers (6 and 8) with Isoflex Topas NB 52.
5. Attach unlocking levers (6 and 8) with two washers (5) and two securing clips (2) to S3 module mounting bolts.
6. See Figure 5-17. Check the gap “A” on both levers (A = 0.1-0.5mm)
7. Restore position of torsion springs (4 and 7).

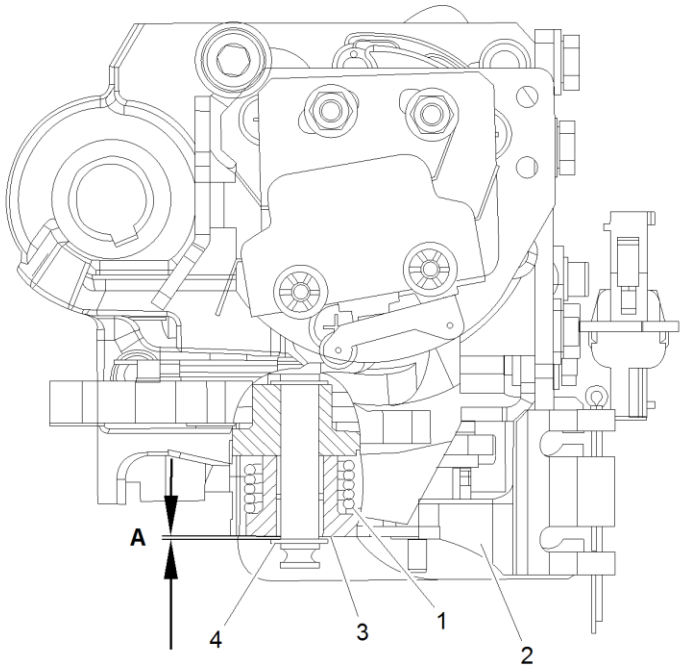


Figure 5-17: Assembly of Release Levers

5.3.3.6 Assembly of Adapter

1. See Figure 5-12. Apply Loctite 243 to threads of two machine screws (1). Refer to manufacturer’s guidelines for Loctite 243 dry time.
2. Fasten adapter (3) with two machine screws (1) and two washers (2).
3. Torque machine screws (1) to 5 ft.-lbs. and apply torque stripe.
4. Assemble Bowden cables according to HRM.
5. Turn on power supply for entrance system and perform function test.

5.3.4 Replace Torsion Spring on Locking Lever

5.3.4.1 Remove S1 Door Locked Switch Bracket

1. Ensure (S7) service switch is in off position.
2. Disconnect (S1) door locked switch wiring.
3. See Figure 5-18. Remove hexagon nuts (3), washers (2), and (S1) door locked switch bracket assembly (1) from S3 module.
4. See Figure 5-19. Loosen countersunk screws (2) and pull (S1) bracket from S3 module.

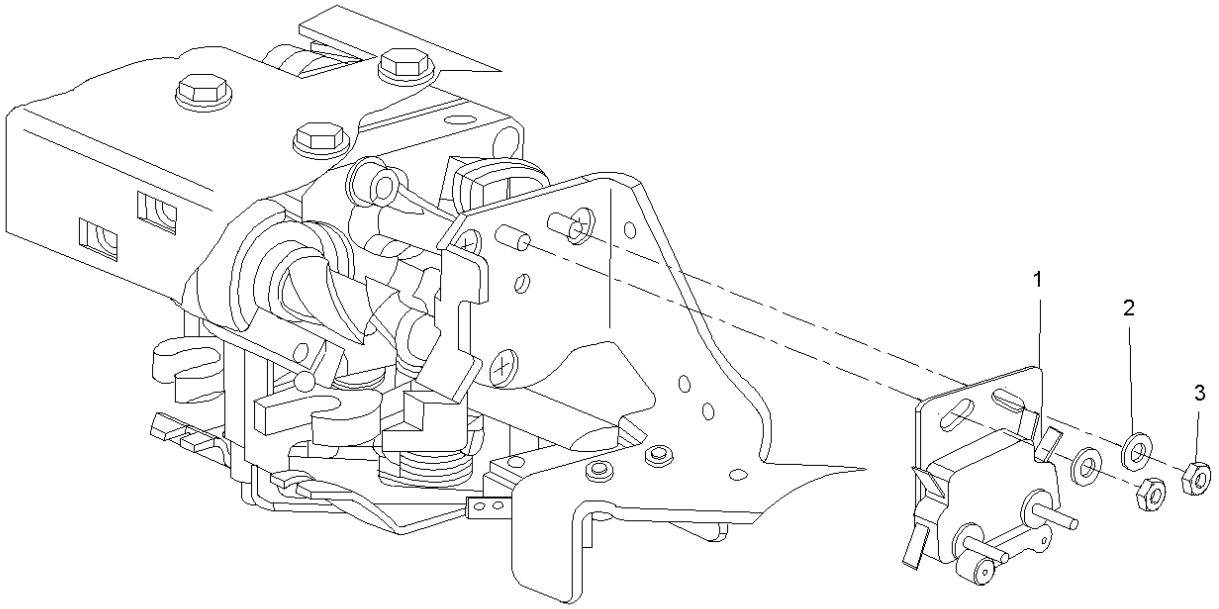


Figure 5-18: S1 Door Locked Switch Bracket

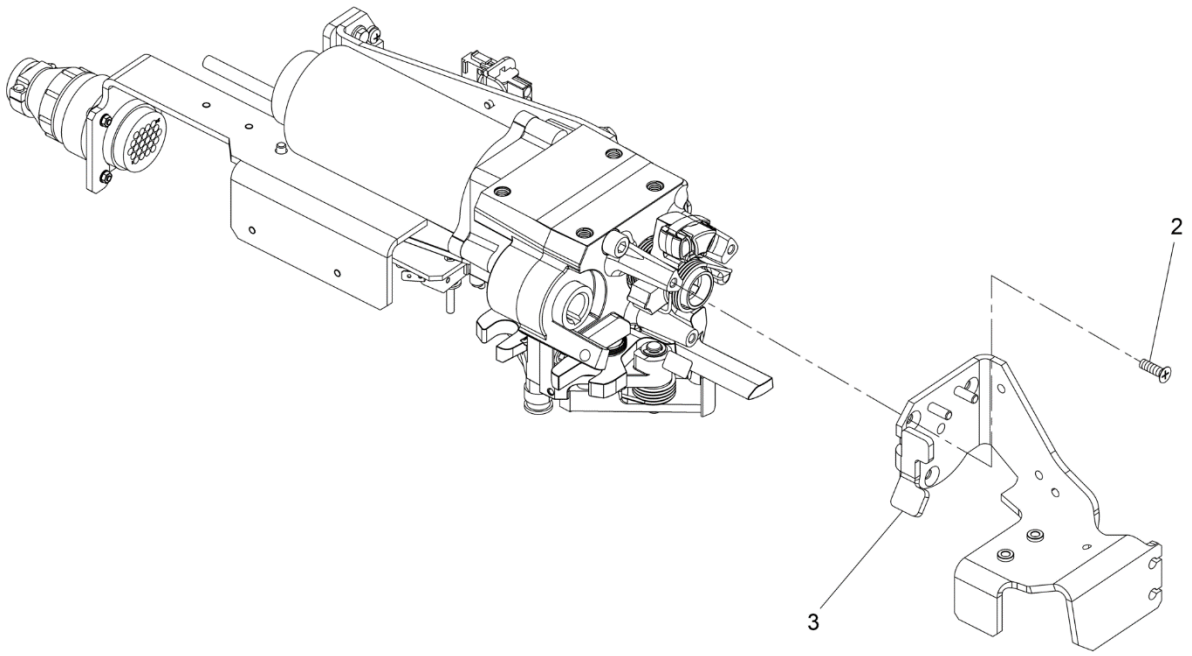


Figure 5-19: S1 Bracket

5.3.4.2 Remove Torsion Spring

1. See Figure 5-20. Remove locking lever (2) from the axle.
2. Remove torsion spring (1) from locking lever (2).

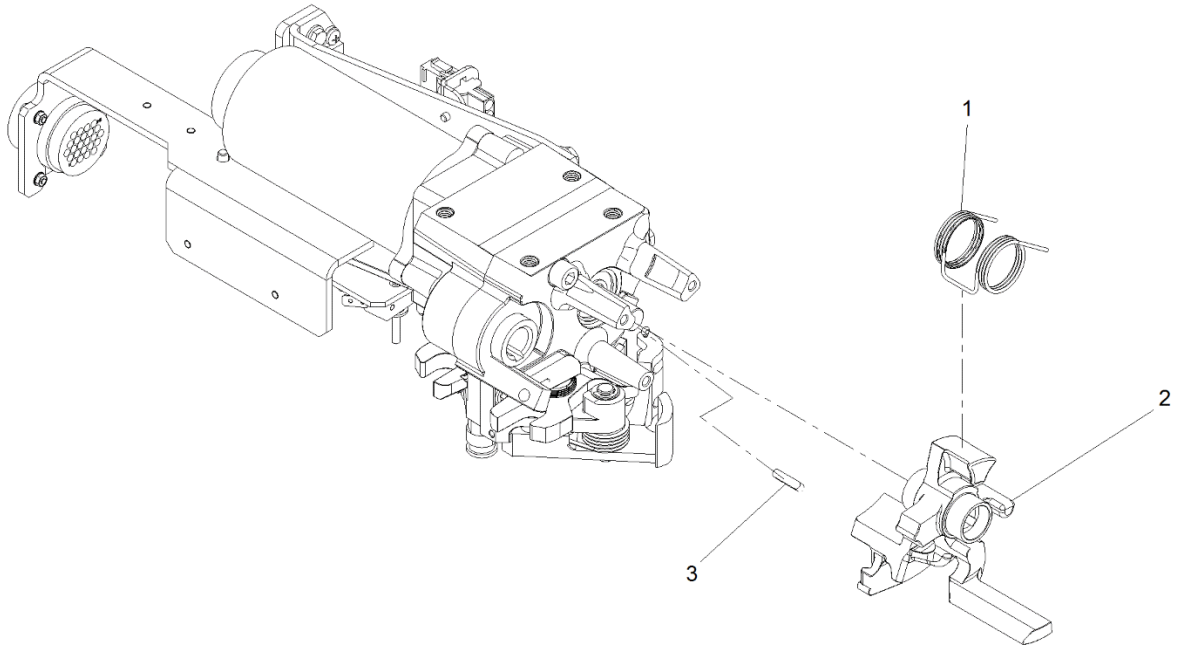


Figure 5-20: Torsion Spring on Locking Lever

5.3.4.3 Assemble Torsion Spring on Locking Lever

1. See Figure 5-20. Position new torsion spring (1) to locking lever (2).
2. Ensure feather key (3) is properly seated and install locking lever (2) to axle.
3. Grease all sliding surfaces of locking lever using Isoflex Topas NB 52.

5.3.4.4 Assemble S1 Door Locked Switch Bracket

1. See Figure 5-19. Install bracket (3) to S3 module gearbox.
2. Apply a drop of Loctite 243 to threads of three countersunk screws (2) and torque to 23 in-lb. Refer to manufacturer's guidelines for Loctite 243 dry time.
3. See Figure 5-18. Install (S1) door locked switch bracket (1) to S3 module with spring washers (2) and hex nuts (3).
4. Torque hex nuts (3) to 23 in-lb. Position new torsion spring (1) tab to locking lever (2).
5. Assemble the Bowden cable of emergency egress device and emergency access device according to the HRM.
6. Turn on power supply for entrance system and perform function test.

5.3.5 Replace Door Leaves

5.3.5.1 Remove Door Leaves

1. Turn off the power supply for the entrance system.
2. Disconnect grounding points XE17 from left door leaf and XE18 from right door leaf.
3. Secure door leaves against tipping or falling with suitable lifting equipment.
4. See Figure 5-21. Dismount two spring pins (3).
5. Remove six hexagon nuts (5) along with six hexagon head screws (4) and six spring washers (6).
6. Remove door leaf (2) from door hanger (1).
7. Place door leaf (2) on a workbench.
8. Repeat procedure for other door leaf.

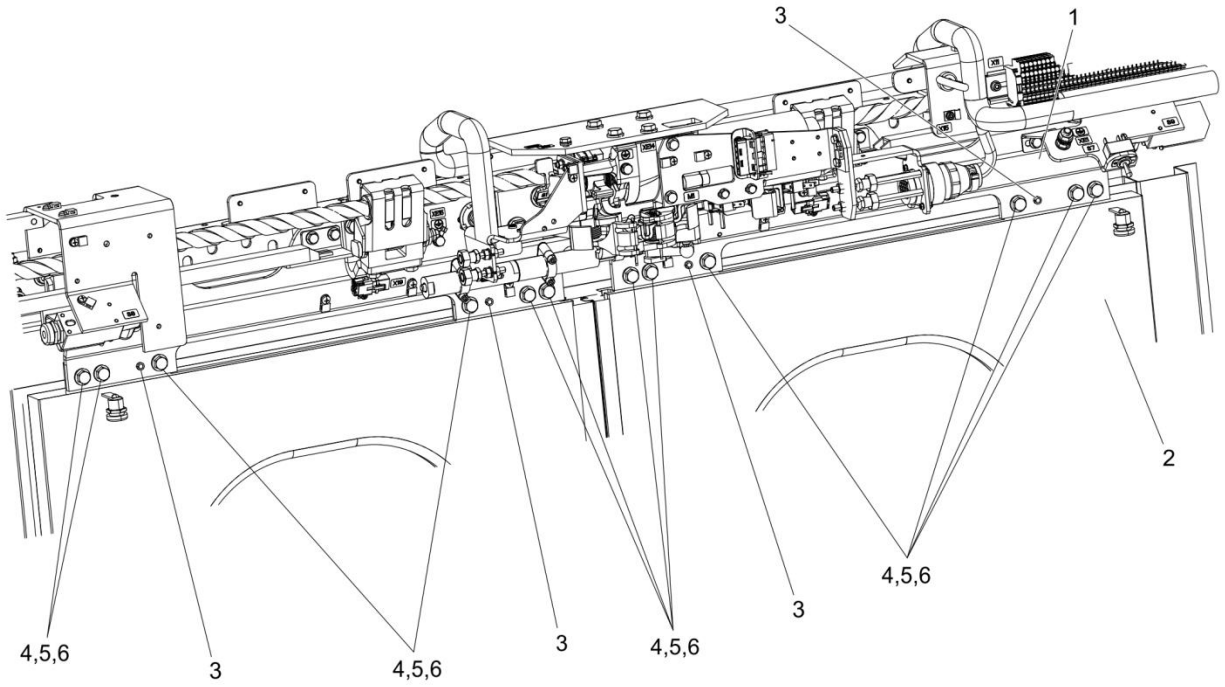


Figure 5-21: Replace Door Leaves

5.3.5.2 Install Door Leaves

1. Carefully lift door leaf with suitable lifting equipment and position between tread plates at bottom of door opening.
2. See Figure 5-21. Align door leaf (2) with corresponding mounting hardware holes on door hanger (1).
3. Insert two spring pins (3).
4. Apply a drop of Loctite 243 to end threads of six hexagon head screws (4). Refer to manufacturer's guidelines for Loctite 243 dry time.
5. Insert six hexagon screws (4) with six spring washers (6) and six hexagon nuts (5).
6. Torque six hexagon head screws (4) to 17 ft.-lbs. and apply torque stripe.
7. Repeat procedure for other door leaf.
8. Adjust door leaf pre-load according to Section 5.2.1.

5.3.6 Replace Door Control Unit (DCU)

5.3.6.1 Remove Door Control Unit

1. Turn off the power supply for the entrance system.
2. See Figure 5-22. Loosen grounding point XE11 (4).
3. Disconnect electrical wiring (connectors X1, X2, X6x, X7x, X9x and X10x).
4. Loosen all four locking screws (2).
5. Remove DCU.

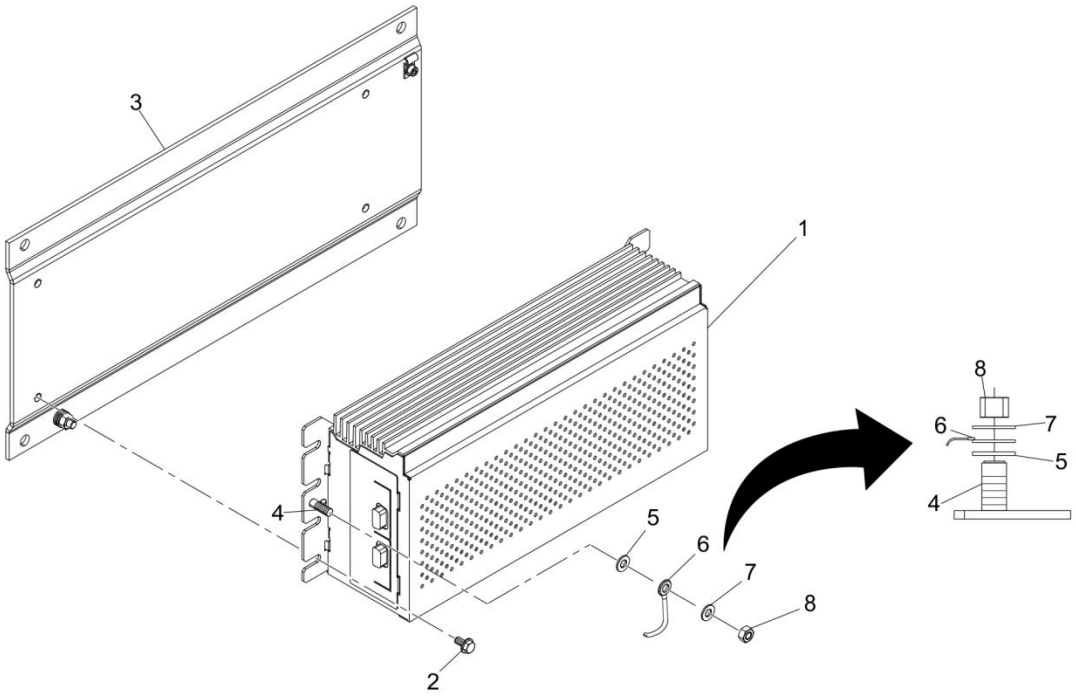


Figure 5-22: DCU Removal

5.3.6.2 Install Door Control Unit

1. Apply Loctite 243 onto fastening screws (2). Refer to manufacturer's guidelines for Loctite 243 dry time.
2. Fix door control unit (1) by fastening screws (2).
3. Torque fastening screws (2) to 49 in-lb and apply torque stripe.
4. Assemble grounding point XE11 (4) and preserve all connections with Contactal HPG.
5. Torque hexagonal nut (8) to 89 in-lb and apply torque stripe.
6. Once the sealing wax is fully cured, preserve all connection points with Contactal HPG.
7. Connect connectors X1, X2, X6x, X7x, X9x and X10x.
8. Initialize DCU according to Section 2.5.4.

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APPENDIX A

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CIRCUIT DIAGRAMS

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