



P3010
Los Angeles LRV

AUXILIARY INVERTER



Section 0900 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Insert latest changed pages; dispose of superseded pages in accordance with applicable regulations.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 (0900) is **236** consisting of the following:

Draft.....	Draft	December 2014
Draft.....	Final Draft.....	April 2015
Draft.....	Final Draft-A	July 2015
Draft.....	Final Draft-B	December 2015
Draft.....	Final Draft-C	March 2016
Draft.....	Final Draft-D	September 2016
Draft.....	Final Draft-E	December 2016
Draft.....	Final Draft-F	December 2019
Draft.....	Final Draft-G.....	June 2020

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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. 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.

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.

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. Personnel's failure to heed these warnings could result in severe injury and or damage to the equipment.

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 provides step by step instructions covering the scheduled maintenance.

1.2 Safety

1.2.1 Warnings, Cautions and Notes

Warnings, Cautions, and Notes emphasize dangerous or important points in the associated text. For the purpose of this document, the use of Warnings Cautions and Notes are defined as follows:

- | | |
|----------------|---|
| Warning | A Warning is used to highlight an essential operating maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in injury or death to personnel. |
| Caution | A Caution is used to highlight an essential operating maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in damage to the equipment. |
| Note | A Note is used to highlight an essential operating or maintenance procedure, condition or statement which otherwise would result in misinterpretation or loss of time/accuracy. |

1.3 General Safety

At all times be aware that the APS (Auxiliary Power Supply) is a power conversion device operating on High Voltage, is composed of Heavy Equipment with parts that operate at High Temperatures. Ultimately, it is the responsibility of the individual to safely perform his/her duties.

1.3.1 Personal Safety

WARNING

BEFORE PERFORMING ANY WORK ON THE AUXILIARY POWER SUPPLY (APS), ENSURE THAT THE KNIFE SWITCH IS OPEN. THIS REMOVES THE 750 VDC INPUT FROM THE APS.

WARNING

ELECTROCUTION HAZARD. TO MINIMIZE THE RISK OF INJURY OR DEATH FROM ELECTROCUTION, FOLLOW THESE GENERAL SAFETY RULES WHEN WORKING ON OR AROUND THE APS:

- **DEENERGIZE**
- **SECURE AGAINST REACTIVATION**
- **VERIFY EQUIPMENT IS UNPOWERED**
- **GROUND AND SHORT**
- **COVER OR BARRICADE OFF ADJACENT PARTS THAT ARE LIVE**

WARNING

DANGEROUS RESIDUAL VOLTAGES ARE PRESENT. THE APS CONTAINS CAPACITORS THAT CAN RETAIN LETHAL VOLTAGES AFTER POWER HAS BEEN REMOVED FOR UP TO 3 MINUTES. PRIOR TO PERFORMING ANY SERVICE OR MAINTENANCE, REMOVE POWER AND WAIT 3 MINUTES TO ALLOW CAPACITORS TO DISCHARGE TO BELOW 50 VOLTS BEFORE PROCEEDING. ALWAYS MEASURE VOLTAGES BEFORE STARTING WORK.

WARNING

DC SHORT CIRCUIT HAZARD. TO MINIMIZE THE RISK OF INJURY OR DAMAGE CAUSED BY ARCING DUE TO SHORT CIRCUIT BETWEEN BATTERY PLUS AND MINUS LINE, FOLLOW THESE GENERAL SAFETY RULES WHEN WORKING ON OR AROUND THE APS:

- **DISCONNECT BATTERY VOLTAGE FROM THE APS**
- **SECURE AGAINST REACTIVATION**
- **VERIFY EQUIPMENT IS UNPOWERED**

WARNING

HOT SURFACES. PARTS OF THE APS SUCH AS HEAT SINKS, CHOKES, TRANSFORMERS OR POWER SEMICONDUCTORS SUCH AS DIODES, THYRISTORS AND TRANSISTORS (IGBTs) CAN BE HOT. DEPENDING ON THE MASS OF THE HOT COMPONENTS MORE OR LESS TIME IS NEEDED TO HAVE THOSE COMPONENTS TO COOL TO A SAFE CONDITION FOR SERVICING.

WARNING

HEAVY OBJECTS. MANY OF THE COMPONENTS IN THE APS HAVE CONSIDERABLE WEIGHT. ALWAYS TAKE APPROPRIATE PRECAUTIONS WHEN LIFTING, ATTACHING, DETACHING OR MOVING COMPONENTS OR FASTENERS.

1.3.2 Equipment Safety

A large number of components in the APS are sensitive to Electrostatic Discharge (ESD). Practice ESD Safety whenever handling Printed Circuit Boards (PCBs). Additionally, a number of components and their fasteners are mounted on vertical surfaces or inverted. As a result, fasteners and components can fall when detached from the mounting anchor points and damage themselves or other equipment. Be aware of the potential of falling objects when working on the APS.

CAUTION

ELECTROSTATIC SENSITIVE DEVICES. OBSERVE THE FOLLOWING PRECAUTIONS WHEN HANDLING ESDS.

- MOUNT PRINTED CIRCUITS AND ELECTRONIC COMPONENTS ONLY IF THE APS IS NOT UNDER VOLTAGE.
- TO AVOID DAMAGE TO THE PRINTED CIRCUITS, DO NOT TOUCH THE SURFACE OR THE PINS. TOUCH THE ELECTRONIC BOARDS ONLY AT THE EDGES.
- USE ANTISTATIC PACKING MATERIAL FOR TRANSPORTATION AND STORAGE.
- TO AVOID STATIC LOAD OF CMOS COMPONENTS AND THEIR DESTRUCTION, TOUCH GROUNDED PARTS TO DISCHARGE ELECTROSTATIC POTENTIAL OF YOUR BODY. EXAMPLES OF GROUNDED PARTS ARE THE GROUND CONTACTS OF SHUTTERED SOCKETS OR SWITCHBOARDS.
- COMPONENTS, WHICH ARE SENSITIVE FOR ELECTROSTATIC POTENTIAL, MUST NOT COME IN CONTACT WITH HIGH INSULATING MATERIALS LIKE PLASTIC FILMS, TABLETOPS OR ARTIFICIAL FIBER. THEY MUST BE PLACED ON CONDUCTIVE GROUNDSHEETS.

- IF SOLDERING IS REQUIRED, THE TIP OF THE SOLDERING IRON MUST BE GROUNDED.
- FOR SHIPPING AND STORAGE, ALL ELECTRONIC COMPONENTS MUST BE COVERED WITH CONDUCTIVE PACKING MATERIAL LIKE METALLIZED BOXES OR BAGS.
- WHEN MOUNTING ELECTRONIC BOARDS, ENSURE THE BOARDS ARE MOUNTED IN THE CORRECT ORIENTATION.

CAUTION

FALLING OBJECT DAMAGE. OBJECTS MOUNTED VERTICALLY OR IN AN INVERTED POSITION MAY FALL AND DAMAGE THEMSELVES OR OTHER COMPONENTS WHEN DETACHED. TO PREVENT DAMAGE FROM FALLING OBJECTS, TAKE APPROPRIATE MEASURES TO SUPPORT THESE OBJECTS WHEN WORKING.

1.3.3 Safety Labels

Visual displays are posted in the APS to draw attention to safety precautions. These displays are in the form of decals and are shown as follows:

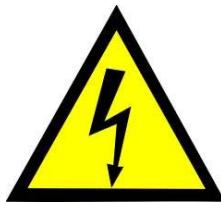


Figure 1-1: High Voltage Warning Decal

This decal is attached inside the APS near points (for example input and output terminals) where dangerous voltages are present under normal operating conditions.



Figure 1-2: Residual Voltage Warning Decal

This label is attached to the outside of the APS enclosure.

After cut-off of the APS from the line, the filter capacitors in the APS need time to discharge by means of the discharge resistor switched in parallel to the capacitors.



Figure 1-3: Electrostatic Discharge Precaution Decal

This decal is mounted in the vicinity of ESD sensitive devices. Observe established ESD precautions when handling ESD sensitive equipment.

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CHAPTER 2.0

FUNCTIONAL DESCRIPTION

2.1 Introduction

The Auxiliary Power Supply (APS) is a multiple voltage APS for high power rates. The APS is fed with DC voltage. Inside the APS this voltage is converted to commercial 3AC with neutral and DC standard voltages to supply the electric and electronic train equipment with electrical power.

Transtechnik's type key of the APS is U750DC/208AC3-28DC/P65-10/F60.

APS input voltage	750 Vdc
Output voltages	<p><u>Three Phase Output</u> with neutral for fan motor, air compressors and HVAC system supply. Nominal output values:</p> <ul style="list-style-type: none">– 3 x 208 Vac phase-to-phase, frequency 60 Hz, max. power: 65 kVA– Neutral for convenience outlet supply Nominal output value phase to neutral: 1 x 120 Vac, frequency 60 Hz, max. neutral power: 2.4 kVA <p>to supply the low-voltage DC loads and charge the battery.</p> <p>Nominal output voltage: 28.5 Vdc Max. total output power: 10 kW</p>

Galvanic insulation between primary power from the Overhead Catenary Supply (OCS) and APS output is provided by the internal high frequency transformer within the Series Resonance Chopper module.

2.2 Technical Design

Overview

The APS consists of:

- Intelligent Input filter
- IVPS section with
 - Buck/Boost Converter Module (BBCM)
 - Series Resonance Chopper Module (SRCM)
- Three phase AC section with
 - Three-phase PWM inverter module
 - AC and EMI filters
 - Three-AC phase output
 - Neutral conductor output
- DC section with
 - Chopper and rectifier module with HF transformer
 - DC and EMI filters
 - Separate output for battery charging
 - Cooling fan
- Control System with
 - Converter Control Unit (CCU)
 - Local IVPS, inverter, and LVPS control units
 - ± 15 V electronics power supply
 - Dead Battery Start Module (DBS)

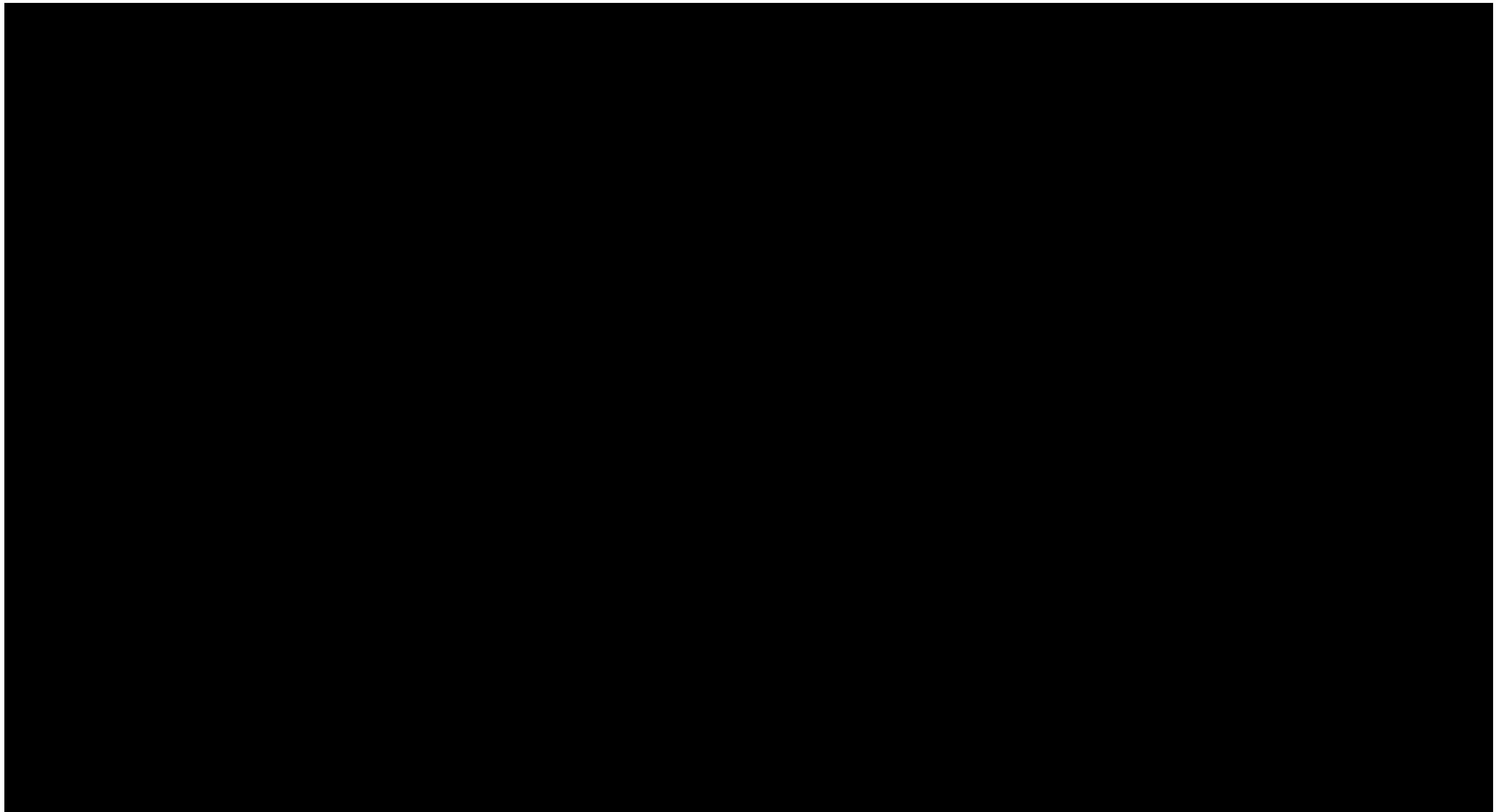


Figure 2-1: LACMTA P3010 Block Diagram Rev E, Aug 17, 2015

2.4 Functional Description

2.4.1 APS States

APS standby	Power modules are NOT running
APS OFF	Power modules are NOT running & APS internal electronic not running
APS ON	Power modules & internal electronic running
DBS	Power modules & internal electronic running

Input					Output	
DC Input [750 V _{DC}]	Battery [28.5 V _{DC}]	HW Enable/Reset [open – L = disable closed – H = enable]	Shut down (Panto down) [H = Panto down]	APS ON	State	Comment
L	L	L	L	L	APS OFF	APS OFF - power supply disabled
L	L	L	L	H	APS OFF	APS OFF - power supply disabled
L	L	L	H	L	APS OFF	APS OFF - power supply disabled
L	L	L	H	H	APS OFF	APS OFF - power supply disabled
L	L	H	L	L	APS OFF	Aps OFF – waiting for 750 VDC or battery
L	L	H	L	H	APS OFF	Aps OFF – waiting for 750 VDC or battery
L	L	H	H	L	APS OFF	Aps OFF – waiting for 750 VDC or battery
L	L	H	H	H	APS OFF	Aps OFF – waiting for 750 VDC or battery
L	H	L	L	L	APS OFF	APS OFF - power supply disabled
L	H	L	L	H	APS OFF	APS OFF - power supply disabled
L	H	L	H	L	APS OFF	APS OFF - power supply disabled
L	H	H	L	H	APS OFF	APS OFF - power supply disabled
L	H	H	L	L	APS standby	APS waiting for APS ON signal & 750 VDC
L	H	H	L	H	APS standby	APS waiting for 750 VDC
L	H	H	H	L	APS standby	APS waiting for shut down = L & APS ON signal & 750 VDC

Input					Output	
DC Input [750 V _{DC}]	Battery [28.5 V _{DC}]	HW Enable/Reset [open – L = disable closed – H = enable]	Shut down (Panto down) [H = Panto down]	APS ON	State	Comment
L	H	H	H	H	APS standby	APS waiting for shut down = L & 750 VDC
H	L	L	L	L	APS OFF	APS OFF - power supply disabled
H	L	L	L	H	APS OFF	APS OFF - power supply disabled
H	L	L	H	L	APS OFF	APS OFF - power supply disabled
H	L	L	H	H	APS OFF	APS OFF - power supply disabled
H	L	H	L	L	DBS	APS DBS mode active – APS ON signal will be ignored
H	L	H	L	H	DBS	APS DBS mode activated
H	L	H	H	L	APS OFF	APS starting in DBS mode & Reacting to shut down signal
H	L	H	H	H	DBS	APS DBS mode activated
H	H	L	L	L	APS OFF	APS OFF - power supply disabled
H	H	L	L	H	APS OFF	APS OFF - power supply disabled
H	H	L	H	L	APS OFF	APS OFF - power supply disabled
H	H	H	L	L	APS standby	APS waiting for APS ON signal
H	H	H	L	H	APS ON	Normal operation
H	H	H	H	L	APS standby	APS Reacting to shut down signal
H	H	H	H	H	APS standby	APS Reacting to shut down signal

L = Low

H = High

2.4.2 Additional Outputs: Relay K1 and Relay K2

The SW-controlled output relays are triggered by software event conditions, which are separate from the input conditions shown in the APS Inputs/Output table above.

- K1 is the APS OK relay (labeled *Load Shed* on the schematic and block diagram). It is energized when the input voltage exceeds 570 VDC and de-energized when input voltage falls below 550 VDC for 5 seconds.
K1 is used by the vehicle as an AC Enable: when energized, it's NO contacts are closed to energize the vehicle's APSOKA & APSOKB relays (when closed, the NO contacts of the APSOKA & APSOKB relays power the cab heaters and defroster and also enable the input APS OK signal to the HVAC).
- K2 is the APS FL Relay (labeled *APS Fault-Lighting* on the block diagram). It is energized when any sub-system (CCU, LVPS, LVPS or Inverter) is in ERROR State. It is also energized after thirty (30) seconds if:
 - The pantograph is up and the input voltage is less than 470 VDC
 - 750 VDC is available but there is no LVPS output as the LVPS is not in the RUN state
 - The pantograph is lowered

K2 is used by the vehicle as a DC Disable: when energized, it's NO contacts are closed to energize the vehicle's APSFLRA & APSFLRB relays (when opened, the NC contacts of the APSFLRA & APSFLRB relays remove power from main interior lights, destination signs, articulation display, passenger information display controller and cab display).

Energize and de-energize conditions for output relays K1 and K2, including associated logic, events and parameters, are described in detail within the document 60200_SRS_CCU_Rnn_yymmdd.pdf.

2.4.3 Input Section

NOTE: All given settable thresholds in the following chapters are the default values. They are changeable by service staff only (password protected).

2.4.3.1 Overview

The Input Section acts to protect the downstream converter components from overvoltage, suppresses line voltage of transients and converter reactions back to the line and protects the converter in case of severe component defects.

2.4.3.2 Function

DC Input for the converter is 750 VDC. This is picked up from the overhead catenary and transferred by the pantograph to the car wiring which in turn delivers the input voltage to the converter at X101.

The EMI Choke L107 improves of the converter's electromagnetic compatibility by suppressing conductive electromagnetic disturbances. L107 is located directly downstream the Input Connector, X101. L107 consists of a series of ferrite rings, through which the plus and minus input cables are passed.

Intelligent Input Filter

The intelligent input filter consists of Filter Choke L101, Capacitor C101 and Input Module A101. Resistors R104.1 and R104.2 are connected to the A101.

When input voltage is applied to the APS, input capacitor C101 is charged either via resistors R104.1/2 or via the IGBT V02.

During operation, IGBT V02 remains closed. If input current or voltage at filter capacitor C101 exceeds certain HW-coded limits, the IGBT will open. The current will flow through resistors R104 and thus will be limited.

- If capacitor voltage at C101 exceeds a HW-coded limit of 1045 V, the IGBT V02 will open. The current will flow through resistors R104 and thus will be limited.
- If capacitor voltage at C101 falls below a HW-coded limit of 1000 V, the IGBT V02 will close again.
- If input current exceeds a HW-coded limit of 272 A, the IGBT V02 will open. The current will flow through resistors R104 and thus will be limited.
- If input current falls below a HW-coded limit of 142 A, the IGBT V02 will close again.

Thus, input current and capacitor voltage will be limited, even during transient over voltages (active transient control).

The temperature of Input Module A101 is monitored by switch S01 mounted on the module's heat sink. Protective circuits and temperature monitoring prevents IGBT damage.

Diode V01 on A101 Input Module protects the converter against damage due to reversed input polarity. In case of grounded input lines, V01 blocks the energy stored in capacitor C101 at the DC input. Voltage dependent resistor (varistor) R01, which is connected in parallel to V01, protects the diode.

The Input Filter (L101 and C101) removes disturbances from the DC catenary to the converter and vice versa. Furthermore, the filter provides an energy resource when the train is passing gaps. The resonance frequency is above 184 Hz.

EMI protection is accomplished through measurement of the input filter capacitance during each shutdown discharge cycle of the filter capacitor. When the capacitance of the filter capacitor decreases below a critical value (where the margin between calculated emission and admissible limits is too low), a signal to vehicle control is set.

Capacitance evaluation is carried out by measuring the capacitor discharge time between two voltage thresholds [Start_FilterAgeControl = 150 V until Stop_FilterAgeControl = 100 V]. If the discharge time falls below "CapacityLossPreWarnTime" = 6460 ms, a pre-warning is set, if the discharge time falls below "CapacityLossCriticalTime" = 5900 ms, an according signal "Event_CapacityLoss_Error" to vehicle control is set.]

2.4.4.2 Function

The Buck/Boost Converter Module (BBCM) A221 receives the filtered Input Voltage from the Input Section, refer to Section 2.4.1. The Specified Input Voltage range is 490 VDC to 1000 VDC with the Nominal Input Voltage at 750 VDC. The BBCM is a combination Buck Converter and Boost Converter consisting of two circuits in series and is clocked at approximately 9 kHz. The BBCM compensates for deviations from the nominal Input Voltage. When Actual Input Voltage differs from Nominal Input Voltage, either the Buck Converter or the Boost Converter is activated in response.

If the Actual Input Voltage is above the Nominal Input Voltage value (750 VDC), then the system compensates by activating the Buck Converter while the Boost Converter remains inactive.

If the Actual Input Voltage is below the Nominal Input Voltage value (750 VDC), then the system compensates by activating the Boost Converter while the Buck Converter remains inactive.

In this way, Actual Input Voltage is stabilized to a steady Input Voltage which is delivered to the A222 Series Resonance Chopper Module (SRCM).

The Series Resonance Chopper Module A222 is connected directly to the BBCM output. The SRCM generates the Intermediate Circuit Voltage from the Input Voltage and ensures galvanic insulation.

The chopper on the SRCM consists of two full-bridge circuits (a chopper and a rectifier electrically separated by a transformer) with integrated LC resonance circuits. The chopper chops the DC Input Voltage into voltage pulses with a high switching frequency (approx. 28 kHz). The pulse length is constant.

The high switching frequency (approx. 28 kHz) allows for the using of particularly compact and lightweight ferrite transformers. Two high-frequency transformers T223.1/2 are arranged in the air duct (for cooling purposes). The transformers provide galvanic insulation and transform the AC voltage coming from the chopper to the required output value needed for use by the AC Section, refer to Section 2.4.3.

Two center-tap rectifiers on the SRCM rectify the AC voltage supplied by transformers T223.1/2. The secondary windings of the transformers each supply two diodes in bridge configuration. The resulting output is a constant DC voltage of nominal 350 VDC on the Intermediate Circuit. Additionally, at the midpoint of the IVPS Transformers is the natural neutral connection which is connected to the three AC Output phases, refer to Section 2.4.3.

The SRCM output is connected to the Inverter Module input. Two parallel capacitors, C01.1 and C01.2 and discharging resistor R01 on the Inverter Module form the Intermediate Circuit. The permanently connected discharging resistor ensures controlled capacitor discharge after the APS has been turned off.

IVPS control unit A70 consists of power module control board TT 3000 and mother board TT 3001. The control board is mounted as a piggy-back board on the mother board. The complete control unit is integrated directly on the BBCM module A221.

The IVPS control unit controls and monitors functions and operation of both sections of the IVPS stage including generating the switching pulses for the IGBTs on the BBCM and for SRCM.

Two thermistor pairs (R71/R72 & R74/R75) are placed on different locations (one pair each) of the heat sinks of modules A221 and A222. The measured temperature levels are evaluated by the IVPS control unit to identify over-temperature warnings [Jheatsink_Warn = 80° C] and faults [Jheatsink_Max = 90° C].

2.4.5 AC Section

2.4.5.1 Overview

The AC Section converts Intermediate Voltage from the IVPS Section to three-phase AC Output Voltage, refer to Section 2.4.2.

2.4.5.2 Function

The IVPS Section delivers Intermediate Voltage (350 VDC) to the A301 Inverter Module. Capacitors A222/C02.1-4 at the SRCM output and A301/C01.1-2 at the Inverter input are connected in parallel to the Intermediate Circuit and stabilize the Intermediate Circuit Voltage.

The A301 transforms the associated Intermediate Circuit DC Voltage in a pulse width modulated (PWM) rectangular voltage. The output frequency is 4.5 kHz and the duty cycles (relation of on-to-off times) of the Inverter's rectangular output pulses are modulated to create sinusoidal varying 3-phase outputs at the required 60 Hz output frequency.

Six IGBT modules V01 to V06, each equipped with a reverse current diode, are mounted on the A301 heat sink. The six-channel IGBT Driver Board, A02, processes the switching pulses from the A70 Inverter Control Unit and generates the actual pulses that drive the IGBT devices.

Downstream from the Inverter, the AC Filter consists of three chokes L301.1 to .3 in the current paths and three capacitors C301.1, C301.2 and C301.3, each between the phases L1-L2, L1-L3, L2-L3 respectively. The filter transforms the Inverter Module's PWM pulse output waveforms into the smoothed 3-phase sinusoidal AC Output Voltages. For specifics on the generation of 3-Phase AC Voltage using PWM, see section 2.5.1.

The midpoint of IVPS transformers T223.1/2 is the natural neutral connection. It is connected to the three AC Output Phases by Capacitors C302.1 to .3 and includes Filter Choke L302. The maximum neutral load is 2.4 kVA.

AC EMI Filter, A307, with four HF LC circuits, improves the electromagnetic compatibility of the three phase outputs and the neutral as well. A307 is located directly at the AC Output Terminals X301. So the three-phase AC Output Voltage is available at bolt terminals L1, L2, L3, and N. Maximum three-phase power is 65 kVA at $\cos\phi = 0.8$.

The Inverter Control Unit, A70, consists of Power Module Control Board, TT 3000, and Mother Board, TT 3001. The Control Board is mounted as a piggy-back board on the Mother Board. The complete Control Unit is integrated directly on the A301 Inverter Module.

The Inverter Control Unit controls and monitors functions and operation of the Inverter including generating the switching pulses for the IGBTs on the Inverter Module.

After inverter or APS shut down, discharge of the intermediate circuit capacitors is ensured by discharge resistor R311.

Thermistor R71 is placed on the heat sink of module A301. The cooling vanes of the heat sink are mounted in the air ducting for cooling purposes. The measured temperature level is constantly evaluated by the Inverter Control Unit to identify over-temperature warnings and faults.

2.4.6 LVPS Section

2.4.6.1 Overview

The Low Voltage Power Supply (LVPS) section supplies the low voltage DC Output for the train's LVDN loads and the battery charging voltage.

The A401 Combined Module consists of a Chopper and Rectifier mounted on the same heat sink. The radiating vanes of the heat sink are mounted in the forced air cooling ducting. The A401 performs three main tasks:

The Chopper Function transforms the high voltage input DC power into a medium to high voltage AC pulses which are applied to the primary windings of T402. The chopper consists of the A01 Chopper Board, A02 4-channel IGBT Driver Board and dual IGBT devices V11 and V12. Chopper unit A01 is mounted on the V11 and V12 devices and the four IGBTs (with their integrated reverse current diodes) are connected in an H-bridge connection.

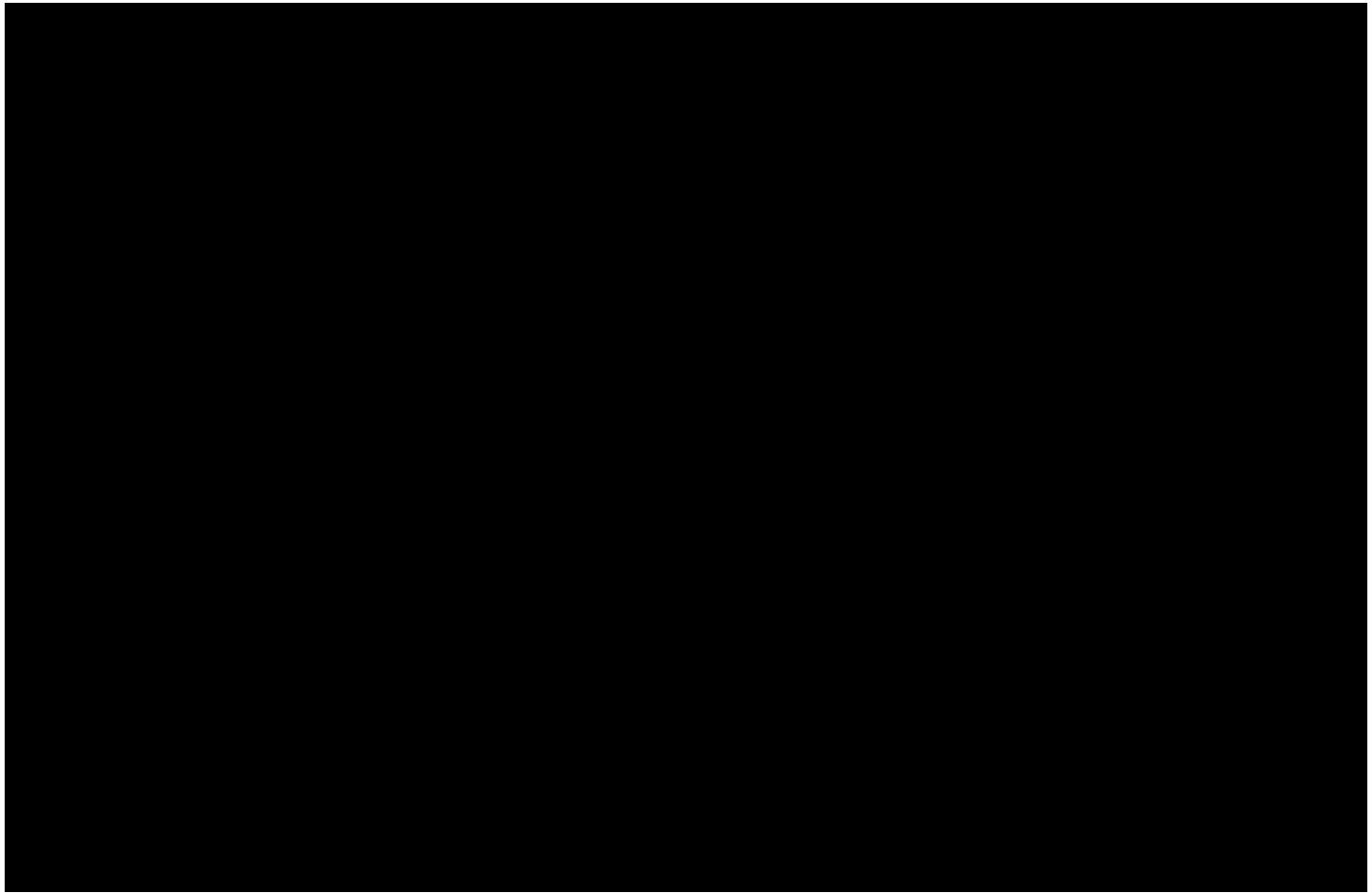


Figure 2-5: LVPS Section

The A02 Driver Board is mounted on top of the A01 board. The A02 is a 4-channel IGBT Driver Board and processes the switching pulses generated by the LVPS Control Unit into the actual pulses that drive the IGBT devices, refer to Section 2.5.2 for details.

The LVPS Controller Function monitors the input and output currents and voltages in order to regulate the output voltage and current according to the unit specifications. The IGBTs are switched at a fixed frequency of 20 kHz and regulation of the output is performed by modulation of the duty cycles of the IGBT drive pulses (relation of on-to-off times). This pulse width modulation (PWM) is used to vary the energy passed through Transformer T402 (which is then rectified and filtered into the DC output).

T402 steps down the higher AC voltage generated by the chopper module into a lower AC voltage; conversely, the inputs current is lower and the output current is higher. T402 is mounted in the air duct of the APS for cooling. Two thermistors, R71 and R72, are placed on different locations of the heat sink the A401. The measured temperature levels are evaluated by the LVPS Control Unit to identify over-temperature warnings [Heatsink_warn = 80° C] and faults [Heatsink_max = 90° C].

The Rectifier Function rectifies the low voltage AC pulses from T402's secondary windings into unfiltered DC pulses. The rectifier consists of Rectifier Boards A03.1 and A03.2 which are connected to T402's multiple secondary center tap-windings. Each rectifier board consists of two rectifier devices VD1 and VD2. The outputs of all four rectifier devices are connected in parallel.

The DC Output Voltage of the rectifier is filtered by the LC Filter which is made up of the L401 Choke and C401 Film Capacitor. Choke L401 and Capacitor C401 smooth the rectified voltage and reduce the voltage ripple.

Current Sensor U416 measures the total DC Output Current. Current sensor U426 measures the battery charging current. The current signals are wired to the LVPS control unit.

The DC Output Voltage is measured redundantly at two points and fed to the LVPS Control Unit via Processing Board A76. If both measured values match, the values are used for LVPS control. If the two measurements differ by more than a specific value [Vout_Diff_Max ≥ 8 V], the LVPS will be shut down.

DC EMI Filter A407, an LC circuit, improves the electromagnetic compatibility by attenuation of any higher frequency noise conducting into or out of the DC Output. A407 is located directly at the DC Output Terminals X401.

LVPS Control Unit A70 consists of a Power Module Control Board TT 3000 and Mother Board TT 3001. The Control Board is mounted as a piggy-back board on the Mother Board. The complete Control Unit is integrated directly on the A401 LVPS Combined Module.

The LVPS Control Unit controls and monitors functions and operation of the LVPS section including generating the switching pulses for the IGBTs on the LVPS module.

2.4.7 Electronics Section

2.4.7.1 Control Regulation Overview

The APS Control and Regulation System is composed of the Central Control Unit A701 (type TT 3300) and one Local Control Unit A70 (type TT 3000 / TT 3001) on each power module. As the APS is equipped with three power stages (IVPS, Inverter, and LVPS), there are three Local Module Control Units.

Main component of the control system is the A701 central Converter Control Unit (CCU), which is equipped with the main processor, flash memory and RAM chips, and various digital inputs and outputs as well as various communication interfaces.

The local power module control boards (type TT 3000) are also equipped with a Digital Signal Processor (DSP) with flash memory and RAM chips, Field Programmable Gate Array (FPGA) for programmable logics, and communication interfaces.

The CCU and Local Control Units communicate via CAN bus. The communication protocol is CANopen.

Data relevant for diagnosis are collected and processed by the CCU for evaluation by the diagnostic software. There are status and fault signals and also real-time recordings which are transferred from the Local Control Boards to the CCU.

All measured values are digitalized directly at the source and digitally fed to the Local Control Boards. The Local Control Boards condition the signals for further processing. All functions are controlled by software. Complete parameterization and project-specific adaptation of control boards TT 3300 and TT 3000 are done by uploaded software.

2.4.7.2 Control and Regulation Equipment

The A701 TT 3300 Control Board is the Converter Control Unit (CCU) and is used for central APS control and as external communication interfaces to the vehicle control as well as for connection to the portable Test Equipment (PTE) for diagnostics through the external connection ports X701 and X702. The following interfaces are located on the TT 3300 board:

Ethernet port – 2 channels; for connection to the vehicle control or the PTE for diagnostics

RS-232 ports – 2 channels; for connection to the MVB A751 board, etc...

The Converter Control Unit (CCU) has the following tasks:

Control of basic APS functions such as start-up and shut down

Data communication with the vehicle control,

Storing status data of the power modules and the entire APS.

The CCU includes also has a status / event log and a diagnostic interface for connecting a diagnosis PC/notebook. To that end, the Converter Control Unit provides external communication for the APS with regard to:

Data exchange with the diagnosis software on PTE via Ethernet

Data exchange with the vehicle via Ethernet or via CAN-connected MVB board A751

Receiving digital input signals (On / shut down) via CAN-connected I/O card A721

Generating digital status relay outputs via CAN-connected I/O card A721

Receiving battery temperature signal over CAN-connected I/O card A721.

2.4.7.3 CAN Bus

The A721 TT 3007 CAN Open I/O Board is powered by the +15 VDC from the A720 Electronics Power Supply and performs the following interfaces and functions:

CAN Open port – 2 connections; for connection to CAN Open network or bus terminating resistor, i.e. communicating with the A701 control board and power modules.

Isolated digital inputs – 3 channels w/ individual high speed inputs, for inputs from the vehicle such as enable, pantograph down or layover, etc.

Isolated digital inputs – 4 channels w/ common +15V power, e.g. temperature switches, Intelligent Input Filter status, DBS status, contactor status signals, etc.

Relay outputs – 2 NO/NC, e.g. for isolated relay outputs to the vehicle.

Isolated power FET outputs – 2 channels w/ individual power connections, e.g. for driving high power contactors.

Isolated low power FET outputs – 4 channels w/ common power connections, e.g. for enabling the intelligent input filter or DBS board or for driving low power annunciating relays.

Fan control and monitoring – 1 channel

2.4.7.4 MVB Interface

The A751 Multi-Vehicle Bus Interface Board provides an interface for communication with the Multi-Vehicle Bus (MVB).

2.4.7.5 Power Module Local Control Units (LCU)

Local Control Units for power modules are composed of a TT 3000 Control Board and is mounted as a piggyback board on the TT 3001 Mother Board. The Control Board is used for stand-alone module regulation. The Control Board is responsible for the evaluation of digitalized current and voltage measurement values and for the generation of pulse pattern for power module control.

The Control Board TT 3000 is located directly on the individual power module, together with Mother Board TT 3001 and runs on +15V power input provided by the Electronics Power Supply A720.

The TT 3000 Mother board is the interface for the Control Board. All of the following control-external connectors and interfaces are located on the TT 3001 board:

- IGBT driver interface, pulse and feedback
- CAN Open communication between control boards
- Contactors and relays, control and feedback
- Monitoring of digitalized Current and Voltage values
- Temperature monitoring

Each power module, IVPS, Inverter, and LVPS, has its own control unit. The main tasks are:

- Closed loop control of the power stage
- Pulse generation for the IGBT switches of the power module
- Monitoring the operating states of the power stage
- Protective measures in order to protect the module in case of malfunction.

2.4.7.6 Control Power

The Control and Regulation system is powered by the A720 Internal Power Supply. The A720 is a DC/DC converter which generates the ± 15 VDC supply voltage for the control boards. In normal operation, the power supply module is fed from the vehicle battery or from the 28.5 VDC LVPS output voltage. A727 is an EMI filter board reducing EMI on the inputs and outputs of the A720 power supply.

2.4.7.7 Dead Battery Start (DBS)

The Dead Battery Start Module A103 (DBS) is powered directly from the 750 VDC line voltage and converts this high voltage input into a low voltage DC power required to power the APS control electronics when the battery of the train is too low or disconnected. Also, receiving the external APS Enable signal is ensured as the supply voltage for this signal is also buffered by the DBS.

The DBS's output, regulated to 24 V / 100 W when enabled, is not needed when the train battery is adequately charged and connected. Therefore, when the train battery has its nominal voltage, the DBS converter is in a disabled mode, waiting for the battery voltage to fall below the DBS start up threshold [BatteryVoltageLow = 22 V].

To ensure operational capability, the DBS includes a diagnostic function to test its functionality. The diagnosis works as follows:

Always when running, the DBS sends out the signal "RUN". At each APS start, the DBS will be forced started by the CCU. The CCU reads back the "RUN" signal of the DBS.

When the forced start is initiated, high voltage is available and the "RUN" Signal of the DBS is active, then the DBS is detected as "GOOD".

Otherwise, the DBS functionality is determined as faulted.

2.4.8 Cooling

The converter is cooled by a blower unit (forced cooling). The blower (M901) is supplied internally by the DC voltage either generated by the APS or supplied by the vehicle battery.

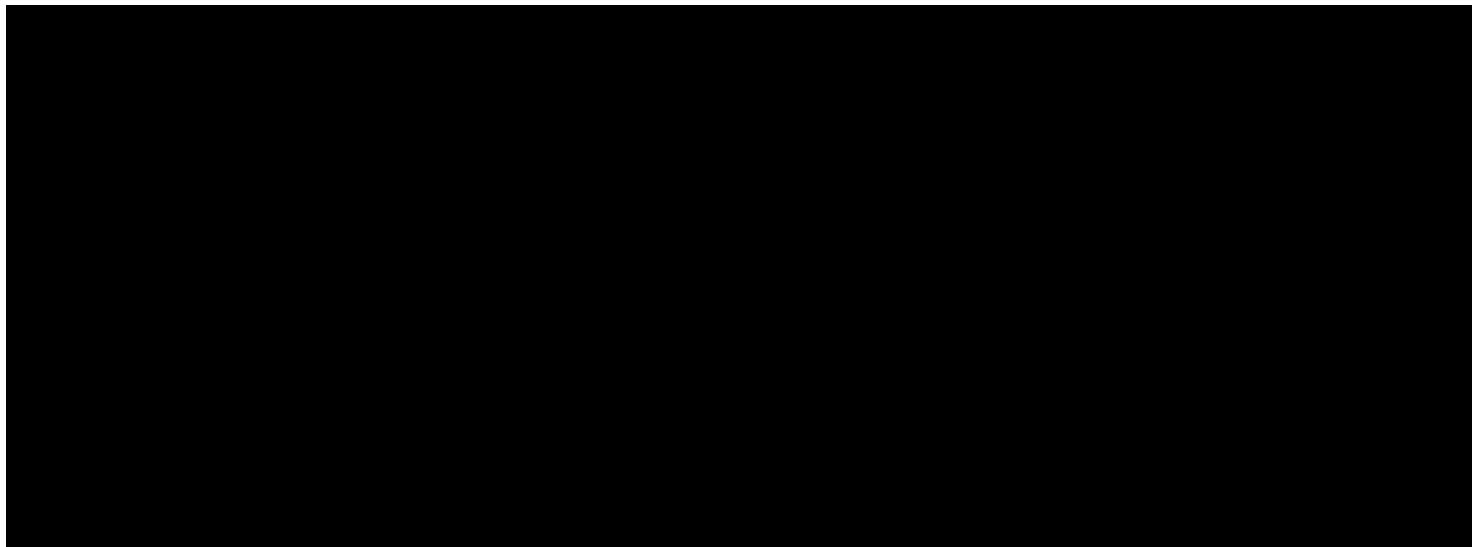
Power modules and other higher power components are arranged on heat sinks. The cooling vanes (or fins) protrude into the air duct, the magnetic components are also arranged in the air duct. All other electronics, power modules and control are mounted in a hermetically sealed compartment and thus are permanently protected against pollution.

The air inlet is located at the APS side. A cyclone-type filter cleans the aspirated air. The air outlets are arranged at the bottom of the unit.

DC cooling blower M901 is connected to the LVPS output and controlled by the A701 Converter Control Unit via the A721 I/O Board.

2.5 Conversion Theory

This section covers the theory on the generation of 3-phase AC from DC input using Pulse Width Modulation and LC Filtering.



A PWM voltage before the AC filter.

B Sinusoidal voltage after the AC filter.

Figure 2-6: Generation of the Sinusoidal Alternating Voltage

The inverter module consists of three identical bridge branches each formed by one pair of IGBT modules. Each of the branches chops the input voltage V_{DC} into pulses of constant amplitude but varying pulse width. The following description refers to the inverter circuit in Figure 2-6 and explains how the AC voltage of phase L1 is generated:

When IGBT2 is switched off and IGBT1 switches on, phase L1 is pulled up to $+V_{DC}$. Then when IGBT1 is switched off and IGBT2 switches on, phase L1 is pulled down to $-V_{DC}$. This pattern is repeated at a fixed frequency (the IGBTs are switched the same number of times each second) so that phase L1 is like a square wave. However, the pulse widths, i.e. the on-times (shaded areas) and off-times (non-shaded areas), of both IGBTs are constantly being changed. When the IGBT1 is on longer than IGBT2, the “average” output is higher and when the IGBT2 is on longer than IGBT1, the “average” output is lower. Figure 2-6 shows the pulse width modulation:

wide $+V_{DC}$ pulses & narrow $-V_{DC}$ pulses: Amplitude of output voltage is closer to $+V_{DC}$

narrow $+V_{DC}$ pulses & wide $-V_{DC}$ pulses: Amplitude of output voltage is closer to $-V_{DC}$

same width for $+V_{DC}$ and $-V_{DC}$ pulses: Amplitude of output voltage is 0 V.

In this manner, instantaneous value of the "average" output is defined by the ratio of the pulse width on-time to total on & off-time; this ratio is called the duty cycle, and varying (or modulating) the duty cycle allows the "average" output voltage to be changed up and down. Thus the software referencing a "sine table" (which consists of a list of ratios which have a sinusoidal pattern), uses pulse width modulation (PWM) to generate a sinusoidal output. IGBT 1 switches potential +Vic to phase L1, then IGBT 2 switches potential -Vic to L1. Both IGBTs are triggered alternately, switching the intermediate circuit potential intermittently with alternating polarity to phase L1. The pulse width is varied.

The downstream inductor/capacitor (LC) filter is used to transform the high frequency PWM voltage (A) to an AC voltage of low frequency (B). It effectively averages the high voltage pulses into the lower voltage sinusoidal waveforms. The LC filter has been designed to filter out the higher switching frequencies and pass the lower 60 Hz output.

The high switching frequency of 4.5 kHz combined with a "minimum loss space vector PWM" switching method contributes to a reduction in required choke size and thus reduction of weight and cost.

2.5.2 IGBT Driver Boards

The IGBT Driver Boards generates the IGBT driving signals from the Control Board pulses and includes four or six separate drivers for driving either the four semiconductor switches of a chopper or the six semiconductor switches of an inverter.

The design of the board ensures galvanic isolation between high voltage and converter electronics.

Each driver channel includes three functional blocks described hereafter:

A free-oscillating multivibrator feeds small internal transformers with an AC drive voltage (two transformers per driver channel). The resulting voltages on the secondary side of the transformers are rectified to produce +15 volts for logic, Vce comparison circuit and the actual drive on voltage and -6.2 volts for the actual drive off voltage level

Generation of type-specific sized and shaped IGBT switching pulses from the control signals of the control board, at the same time change-over between negative gate voltage during the off-period and positive voltage during the on-period. There is no galvanic connection between board signals and IGBT switching pulses.

Measurement and evaluation of the collector-emitter voltage VCE is performed in order to detect Vce faults caused by over current or a damaged IGBT.

If a Vce fault is detected, the IGBT switching pulses are interrupted immediately by the driver circuit for a short period of time. This gives the power module's control unit time to stop or modify its switching pulses if deemed necessary.

On the driver board, the signal from the high voltage Vce fault detection circuit is sent through a galvanic isolated barrier and then transmitted back to the control board.

CHAPTER 3.0

SCHEDULED MAINTENANCE TASKS

3.1 Task List for Scheduled Maintenance

The maintenance schedule shows the maintenance tasks to be performed and the associated mileage intervals for each task.

The longer maintenance intervals include the tasks of the shorter intervals. For instance, after 776,000 km / 480,000 miles, the tasks from all columns of the maintenance task list have to be also performed.

The maintenance intervals are based on an annual mileage of 161,000 km / 100,000 miles (Section 02.01 of the P3010 Technical Specification).

Scheduled activities during the 16,100 km (10,000 miles) cycle [this means round about 10 times a year in accordance to the estimated annual mileage] are limited to inspections, filter cleaning (or replacement if required), and replacement of approved consumables (Section 02.22.06 of the P3010 Technical Specification).

Table 3-1. Auxiliary Inverter Scheduled Maintenance

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 0900, Auxiliary Inverter Running Maintenance Manual Section Reference
	Warning Before removing the dry section service cover: <ul style="list-style-type: none"> • Isolate the APS from the catenary system and wait three minutes (discharge time of the high-voltage capacitors including factor for safety) • Ensure that the APS cannot become live: Pantograph must be in the down position and must be disabled from being raised and engaged. • Check that the APS is dead. Measure the residual capacitor voltage. Do not start working as long as the residual capacitor voltage is above 50 V. See Section 3.3.2 Residual Capacitor Voltage Check. Verify that battery voltage is disconnected from the APS by opening the Battery Circuit Breaker (BCB) which is located under the car. See Section 3.3.3 Battery Voltage Measurement.		

Table 3-1. Auxiliary Inverter Scheduled Maintenance (cont'd.)

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 0900, Auxiliary Inverter Running Maintenance Manual Section Reference
10,000 miles	Auxiliary Power Supply	Visually inspect the APS.	3.3.4
10,000 miles	Cyclone Type Filter	Clean Cyclone Type Filter (air filter assembly)	3.3.5
60,000 miles	Auxiliary Power Supply	Clean fan blades, air duct and power module heat sinks	3.3.6 through 3.3.8
120,000 miles	Warning Labels	Check warning labels on the APS enclosure for legibility	3.3.9
		Clean if necessary. Warning labels must always be recognizable and legible	3.3.9
120,000 miles	Ground Bolts	Check connection of ground bolts at APS outside. Fix any loose connections	3.3.10
120,000 miles	Dry Section Service Cover	Check gasket of dry section service cover. Replace damaged or worn gasket	3.3.11
		Check fasteners. Lock fasteners. Replace damaged parts	3.3.12
480,000 miles	Cooling Fan	Replace cooling fan M901	5.3.6.2
800,000 miles	Electrolytic Capacitors	Replace all stand-alone electrolytic capacitors. Replace electrolytic capacitors on PCBs.	3.3.15
800,000 miles	Gasket Replacement	Replace all Gaskets.	3.3.16
800,000 miles	Fuses	Replace fuses and spare fuses.	3.3.18
800,000 miles	Relays	Replace Relays on A721 PCB	3.3.19
1,600,000 miles	AC Filter Capacitors	Replace all capacitors in the AC Filter.	3.3.17
Always when opening a cover	Ground Cables	Check ground cables of covers for fit and damage. Fix loose connections	3.3.13
When necessary	Consumables	Replace approved consumables (not applicable)	N/A

3.2 General Instructions

NOTE: Threads of nuts and bolts are metric and named with M and a following figure that means the size in mm. Thread M6 for example means metric thread 6 mm. Thread pitch is normal unless otherwise specified.

Certain fastening devices such as lock washers or cable ties are not intended for reuse and should be replaced whenever removed.

3.2.1 Special Tools and Equipment

Use following tools and materials for removal and installation:

Table 3-2. Special Tools and Equipment

- Soldering gun
- Hex wrench set
- Nut driver set
- Drive socket set
- Screw driver set
(slotted-head and Phillips)
- Wire cutting pliers for cable ties
- Cable ties
- Cable tie pliers
- Pliers for small cable lugs
- Thread locker (e. g. Loctite®)
- Mounting tool no. 1: Southco 29-TB1A4
- Mounting tool no. 2: Southco 29-TFRS4
- Mounting tool no. 1: Southco 29-TB1A5
- Mounting tool no. 2: Southco 29-TFRS5

3.2.2 Maximum Torques

To tighten screws, do not exceed maximum allowed torque. The torques in the table below is valid for simple mechanical screw connections. Unless otherwise specified the following maximum torques are to be observed for simple mechanical screw connections:

Table 3-3. Maximum Torques

Thread	Max. Torque (Strength Class 8.8)
M5	4.9 Nm
M6	8.5 Nm
M8	20.6 Nm
M10	41.0 Nm

The above given values refer to a smooth-running thread. Usually 8.8-class screws are used in Transtechnik APSs. The strength class is embossed onto the screw head.

NOTE: For special purposes (e. g.: fixing cable lugs on terminals, fixing module heat sinks in the converter) the maximum allowed torques are considerably lower than for simple mechanical screw connections.

3.3 Maintenance Instructions

3.3.1 Remove Dry Section Cover

WARNING

ELECTROCUTION HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

WARNING

DC SHORT CIRCUIT HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

- Before removing any cover, wait at least three minutes for discharge of the capacitors inside the APS.
 - When the dry section service cover has been removed, measure at first the residual capacitor voltage on the input capacitor terminals. Additionally, check the residual voltage at the AC Output terminals (AC filter capacitors). For detailed instruction, see Section 3.3.2 Residual Capacitor Voltage Check.
 - Measure the DC voltage between the MINUS terminal and the BATT terminal of the battery line by use of a digital multi meter (DMM). For detailed instruction, see Section 3.3.3 Battery Voltage Measurement.
1. Unscrew 2 x hex socket screws M6 x 15 mm (1). See Figure 3-1.
 2. Remove screws and washers.
 3. Open all four compression latches (2) using an 8-mm hexagon key.

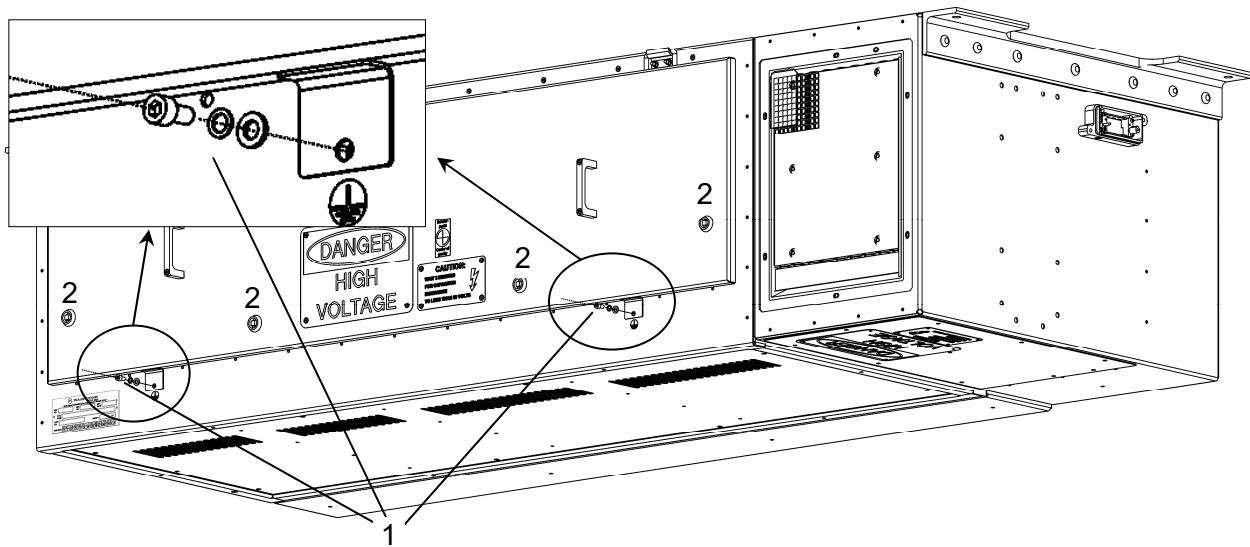


Figure 3-1: Remove Dry Section Cover (1)

4. Lift up dry section service cover (3) about 0.5 in so that the cover can be moved away from the enclosure – see detail drawing (4). See Figure 3-2.

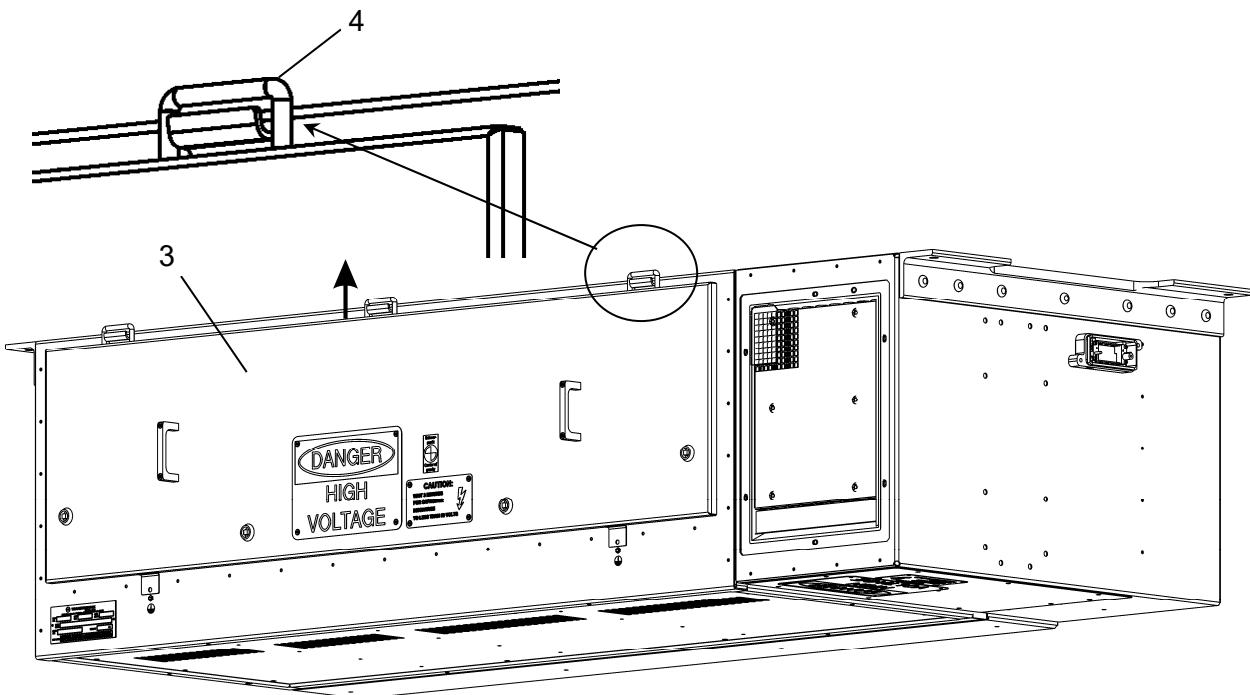


Figure 3-2: Remove Dry Section Cover (2)

5. Remove the dry section service cover from the support brackets and store it on a safe place. See Figure 3-3.

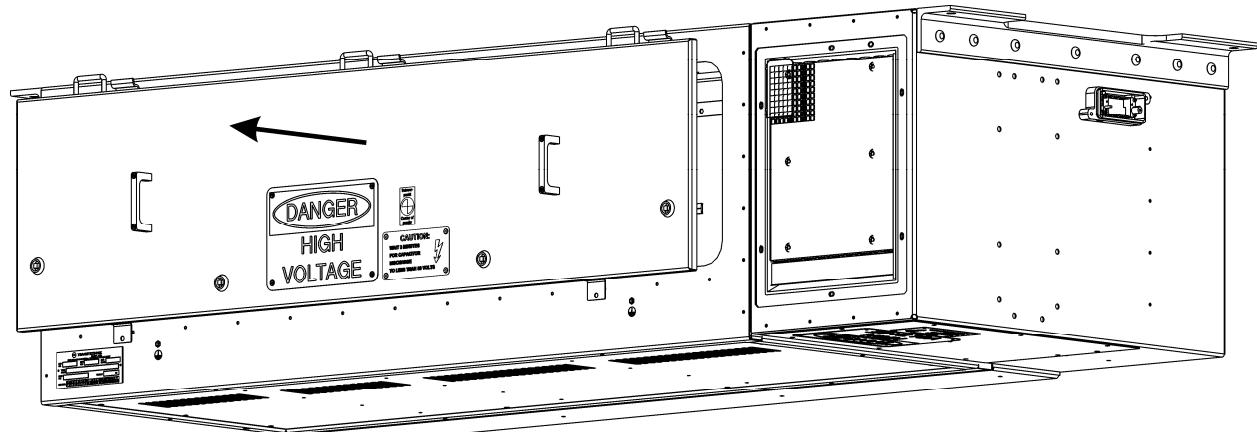


Figure 3-3: Remove Dry Section Cover (3)

3.3.2 Residual Capacitor Voltage Check

WARNING

BEFORE WORKING ON THE APS, ENSURE THAT THE MAIN-BREAKER BETWEEN APS AND TRAIN IS OPEN, TO AVOID CONNECTION (AND BACKFLOW) BETWEEN TRAIN BATTERY AND APS.

BEFORE WORKING ON THE APS, CONFIRM THAT THE HIGH VOLTAGE CAPACITOR C101 HAS DISCHARGED.

1. Remove dry section service cover. See Section 3.3.1.
2. Measure the DC voltage between the terminals (1) and (2) of capacitor C101 by use of a DMM). See Figure 3-4. See also the detailed view. The amount of voltage is important, polarity need not be considered.

If the amount of voltage between capacitor terminals (1) and (2) is less than 50 VDC, it is safe to proceed with work on the unit.

To be sure, that the AC capacitors have also discharged, check additionally the voltage between the AC output terminals (L1), (L2) and (L3). If no load is connected to the output terminals and the internal discharge resistor is damaged (concatenated fault conditions), the discharge time can be much longer than expected. If the voltage between the AC output terminals (L1), (L2) and (L3) is less than 50 VDC, it is safe to proceed with work on the unit.

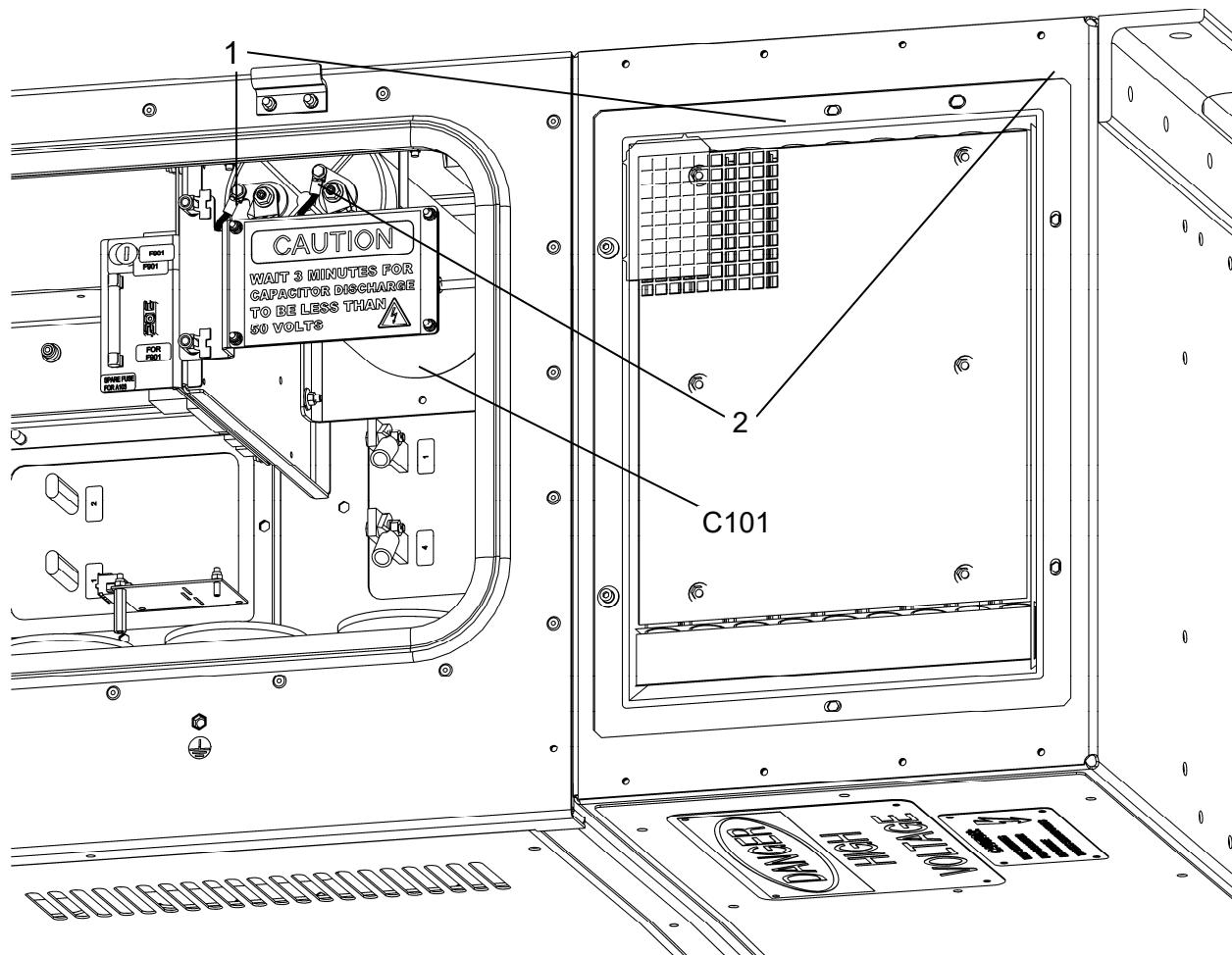


Figure 3-4: Residual C101 Capacitor Voltage Measurement

3.3.3 Battery Voltage Measurement

WARNING

BEFORE WORKING ON THE APS, CONFIRM THAT THE BATTERY VOLTAGE IS DISCONNECTED FROM THE APS.

Separating the battery DC voltage from the APS

Although the DC battery voltage (24 V nominal) is not dangerous, it is absolutely required to separate the battery lines from the APS. This is done to avoid dangerous situations or damage caused by short circuits between plus and minus DC lines.

To check if the APS is free of battery DC voltage, do the following:

1. Remove dry section service cover. Refer to Section 3.3.1.
2. Measure the DC voltage between the MINUS terminal (1) and the BATT terminal (2) of the battery line by use of a DMM. See Figure 3-7.

If the amount of voltage between terminals (1) and (2) is zero, it is safe to proceed with work on the unit.

WARNING

MAKE SURE THAT UNINTENTIONAL RE-CONNECTION OF THE BATTERY VOLTAGE TO THE APS IS IMPOSSIBLE!

3.3.4 Visual inspection of the APS

The inspection of the APS can be done without removing the APS from the train and without opening any service cover.

1. Check the APS for any damage, loose parts or unusual debris at the air grids. See Figure 3-5.
2. If you find any mechanical damage or loose parts, further maintenance actions may be required. (Repairing mechanical damages or fixing loose parts).
3. Remove any contaminants from the air grids which may affect the air flow through the filter. If necessary, use soft brush or vacuum cleaner. Small dust deposit need not be removed. Also a thin film of dirt on the air grids is normal and does not require further action.

3.3.5 Clean Cyclone Type Filter

- Cleaning is only required for particularly high levels of usage. Small dust deposit has not to be removed. Also a thin film of dirt on the Cyclone Type Filter is no reason for cleaning.
- The Air Filter assembly (Cyclone Type Filter) is mounted at the air intake on the right of the Dry Area Service Door (cover). The Air Filter is fixed with six sets of M5 bolts and one set of M6 grounding connection.
- Removal and Installation of the Air Filter assembly is described in Section 3.3.14.

1. Remove the Air Filter assembly.
2. To clean the Air Filter assembly use soft brush or vacuum cleaner.
3. Insert the cleaned Air Filter assembly again.

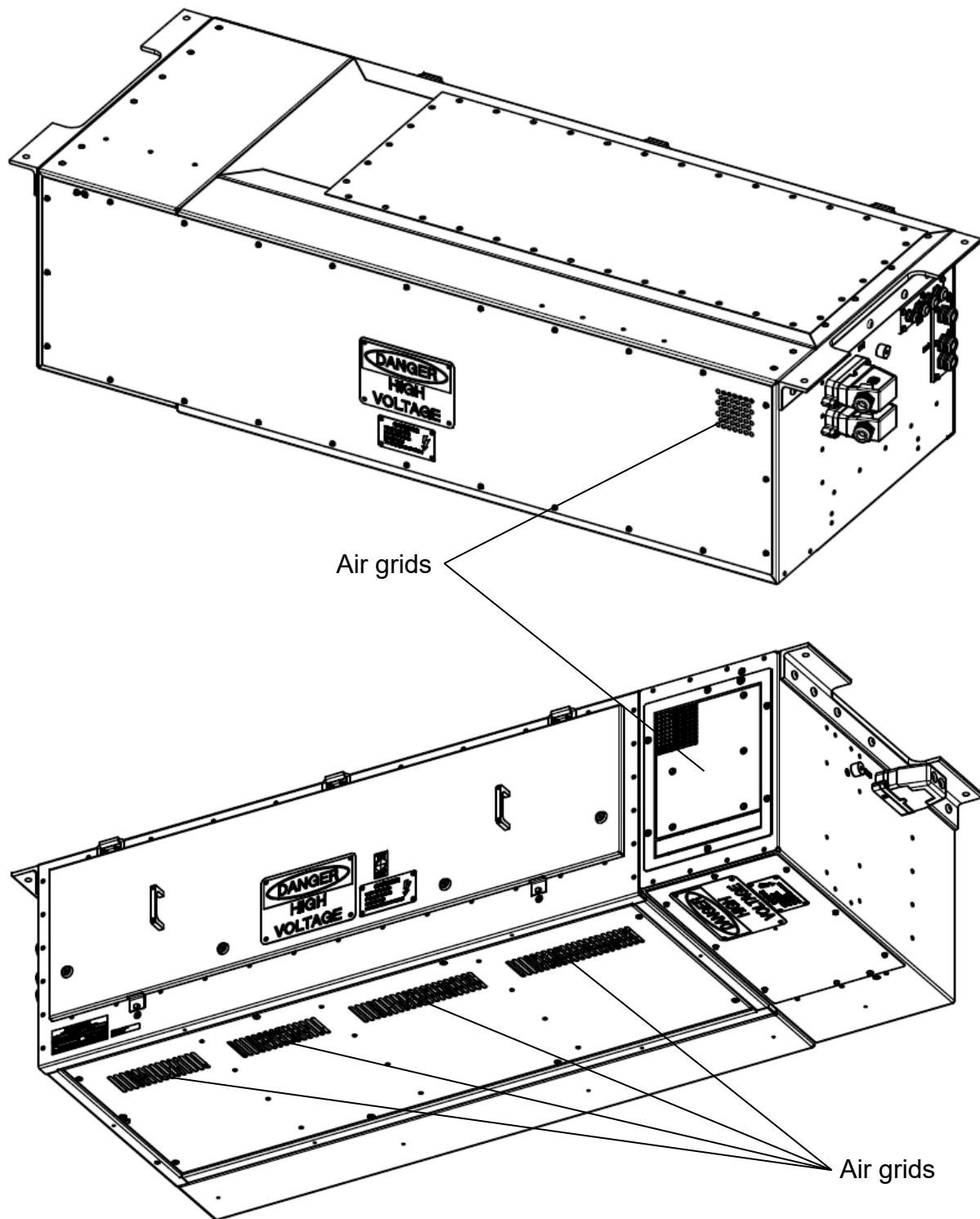


Figure 3-5: Air Grids of the APS

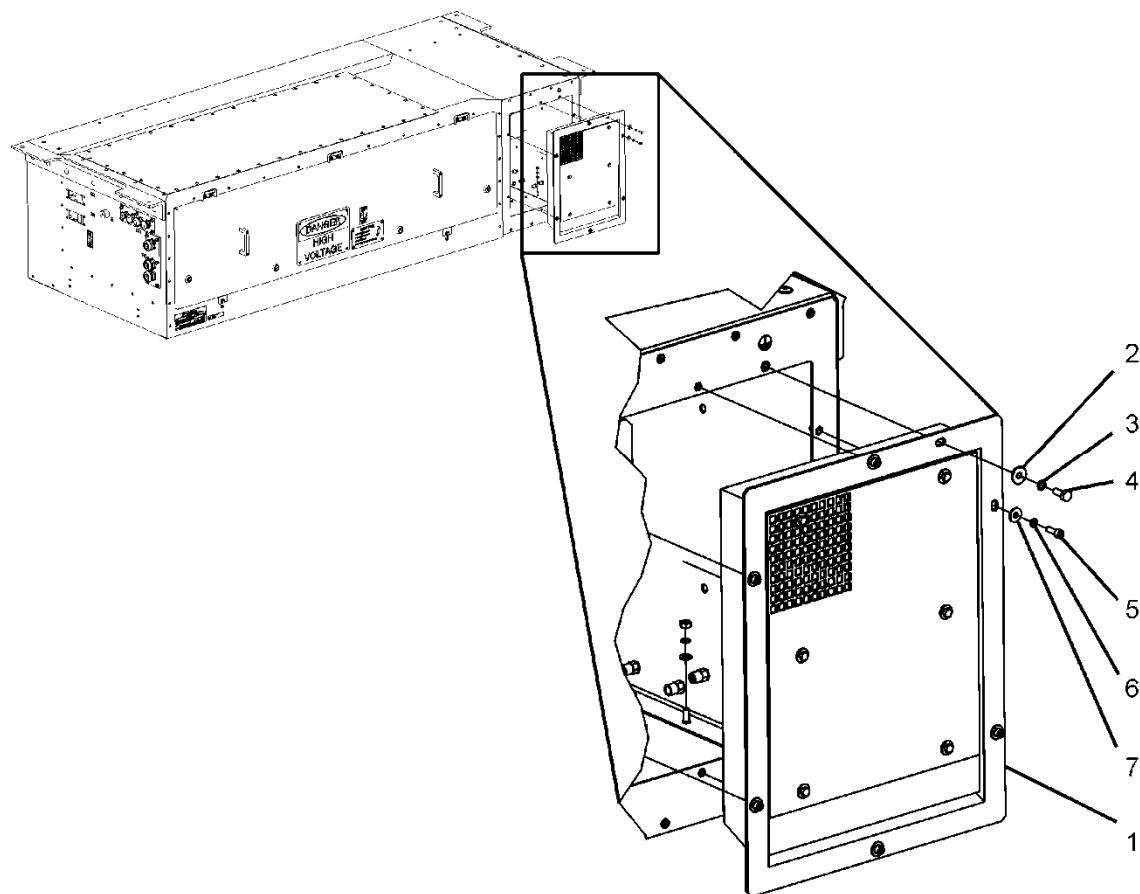


Figure 3-6: Cyclone Type Filter

3.3.6 Cleaning Power Module Heat Sinks

WARNING

ELECTROCUTION HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

WARNING

DC SHORT CIRCUIT HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

- Before removing any cover, wait at least three minutes for discharge of the capacitors inside the APS.
- When the dry section service cover has been removed, measure at first the residual capacitor voltage on the capacitor terminals. Voltage must be below 50 V. For detailed instruction, see Section 3.3.2 Residual Capacitor Voltage Check.
- Measure the DC voltage between the MINUS terminal and the BATT terminal of the battery line by use of a DMM. Voltage must be 0 V. For detailed instruction, see Section 3.3.3 Battery Voltage Measurement.

Callouts in brackets in the following refer to Figure 3-8.

Access to the heat sinks is given after removal of bottom service covers (1) and (2).

- Visually inspect heat sinks (5 to 10) for pollution.
- Cleaning is necessary if the cooling effect may be affected in any way, e.g. by crusts of dirt. A thin film of dirt on the cooling fins is no reason for cleaning.

Remove bottom service covers (1) and (2):

1. On the large bottom service cover (2): Open all eight quarter-turn fasteners.
2. Unscrew captive ground screw (3) and remove the service cover. Key size for (3): 10 mm
3. On the small bottom service cover (1): Unscrew all 8 hex socket screws M5 x 14 mm as well as the ground screw (4) (hex head screw M6 x 15 mm). Remove screws and washers. Hex socket key size for the 8 fasteners M5: 4 mm. Hex socket key size for the ground screw M6: 5 mm
4. Clean cooling fins of six heat sinks (5 to 10) using water with detergent and a brush. Remove foreign objects between cooling fins. Do not damage surfaces. Do not twist cooling fins.

After finishing work, install small bottom service cover.

1. Place small bottom service cover to the mounting location. Mind the correct alignment: One of the short edges has two holes – one for the fastener and one for the ground screw.
2. Attach eight fastening screws M5 x 14 mm, each with washer and lock washer.
3. Fasten screws hand-tight.
4. Attach ground screw with washer and lock washer and fasten it hand-tight.

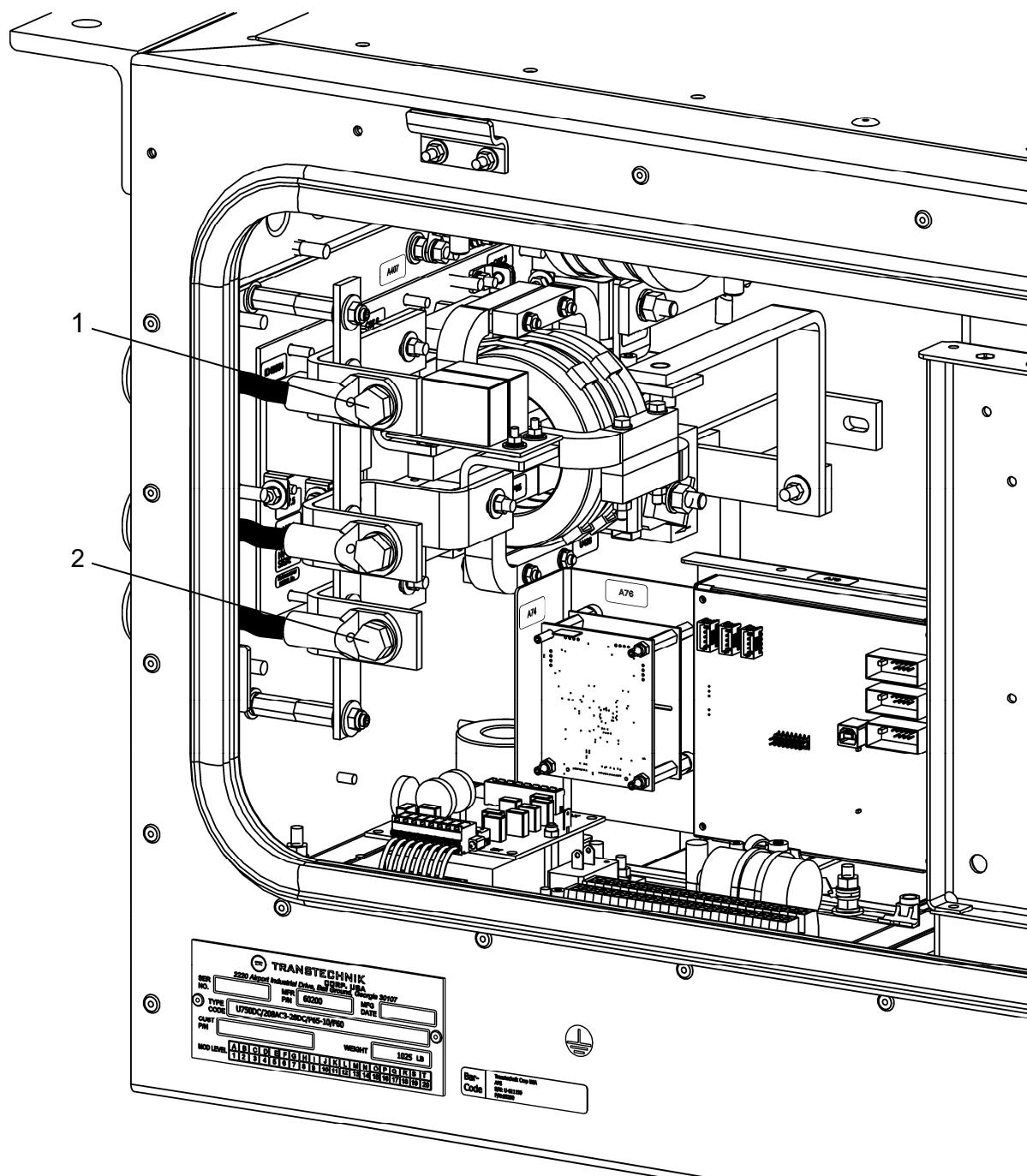


Figure 3-7: Battery Voltage Check

5. Fasten all eight fastening screws with hex socket wrench 4 mm.
6. Fasten ground screw with hex socket wrench 5 mm.
7. Attach the large bottom service cover: Mind the correct alignment: Cooling air slots to the air filter side.
8. Close all eight quarter turn fasteners.
9. Fasten captive ground screw M6 using a socket wrench with 10 mm insert.

3.3.7 Cleaning Air Duct

WARNING

ELECTROCUTION HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

WARNING

DC SHORT CIRCUIT HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

- Before removing any cover wait at least three minutes for discharge of the capacitors inside the APS.
- When the dry section service cover has been removed measure at first the residual capacitor voltage on the capacitor terminals. Voltage must be below 50 V. For detailed instruction, see Section 3.3.2 Residual Capacitor Voltage Check.
- Measure the DC voltage between the MINUS terminal and the BATT terminal of the battery line by use of a DMM. Voltage must be 0 V. For detailed instruction, see Section 3.3.3 Battery Voltage Measurement.

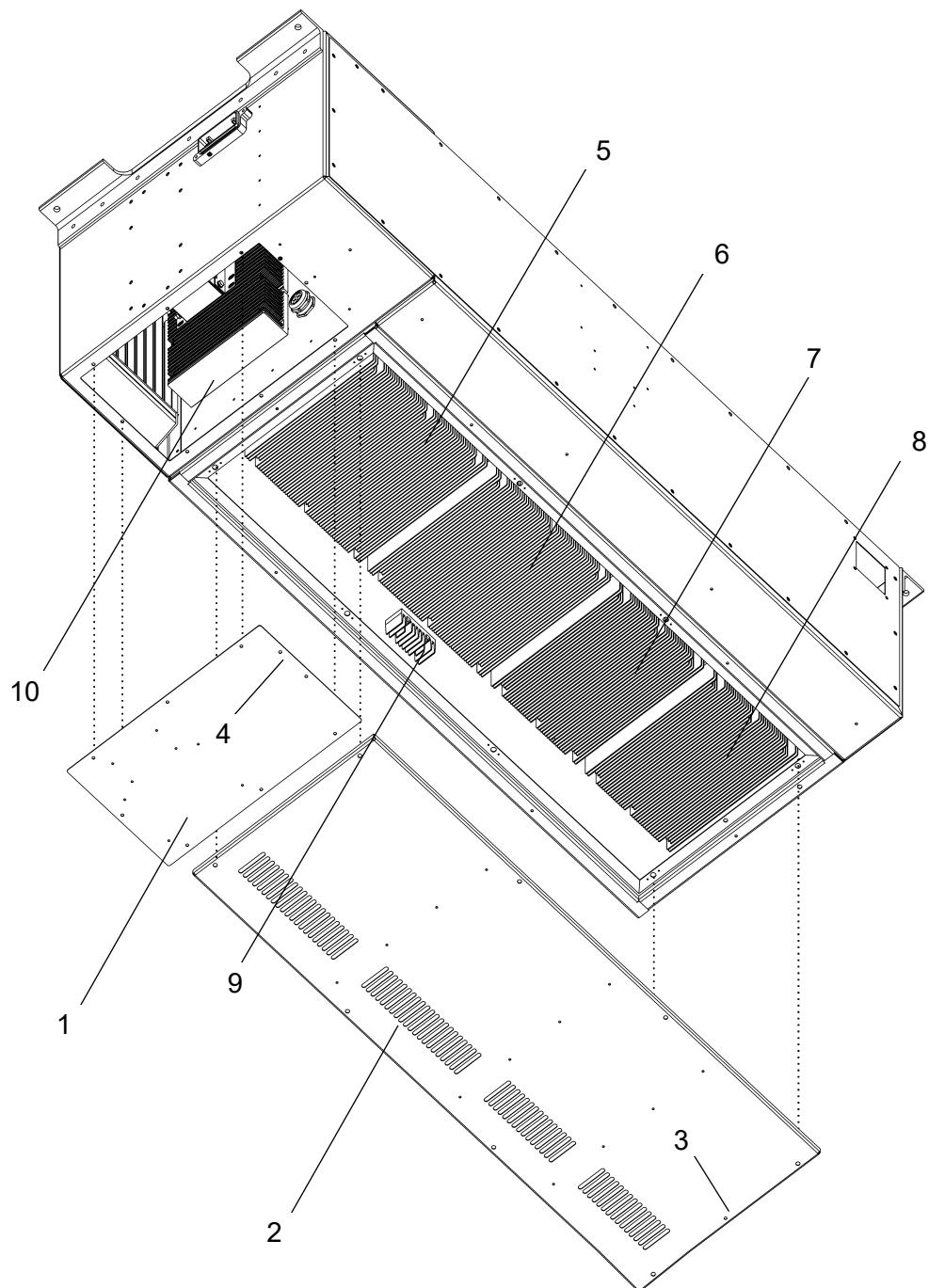


Figure 3-8: Heat Sinks and Access to Heat Sinks

Callouts in brackets in the following refer to Figure 3-7.

1. Unscrew 18 x hex socket screws M5 (2), using a hex socket key 4 mm.
2. Remove mounting hardware (screws and washers).
3. Remove air duct cover (1).
4. Clean all surfaces and components using compressed air and vacuum cleaner.

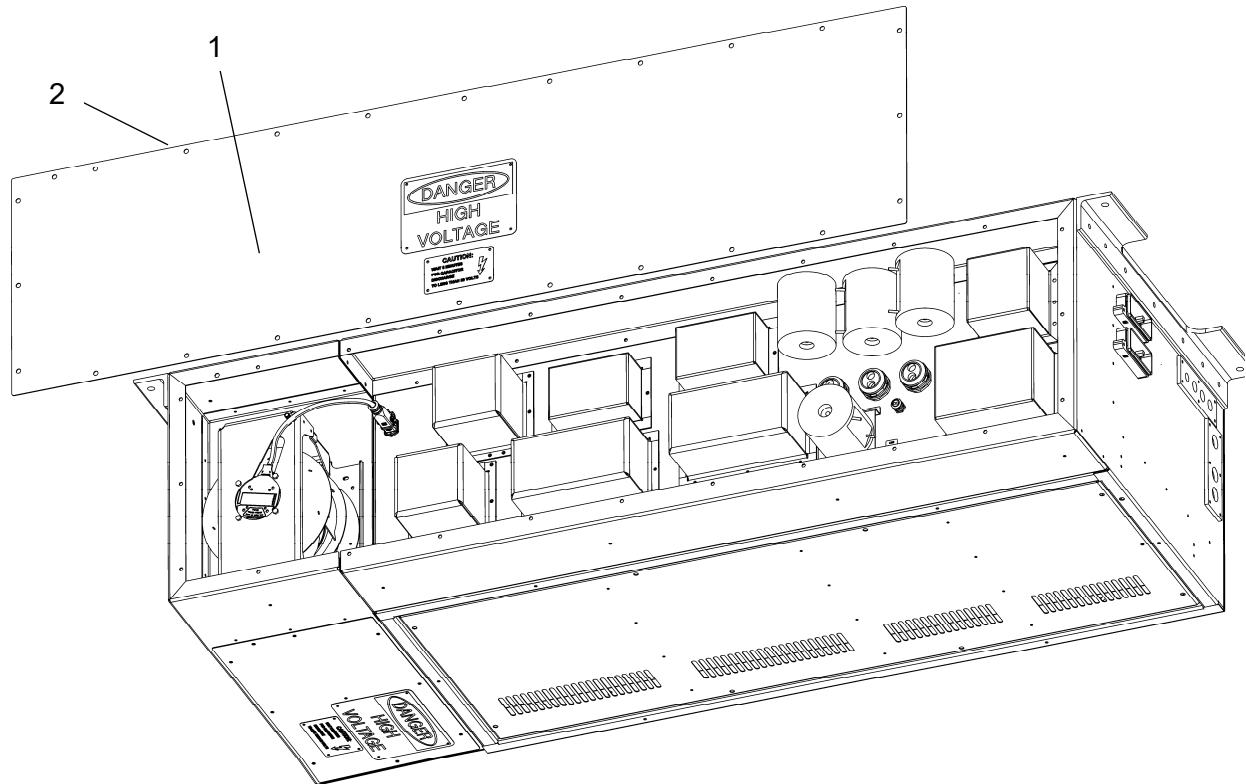


Figure 3-9: Cleaning Air Duct Overview

3.3.8 Cleaning Fan Blades

WARNING

ELECTROCUTION HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

WARNING

DC SHORT CIRCUIT HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

- Before removing any cover, wait at least three minutes for discharge of the capacitors inside the APS.

- When the dry section service cover has been removed, measure at first the residual capacitor voltage on the capacitor terminals. Voltage must be below 50 V. For detailed instruction, see Section 3.3.2 Residual Capacitor Voltage Check.
- Measure the DC voltage between the MINUS terminal and the BATT terminal of the battery line by use of a DMM. Voltage must be 0 V. For detailed instruction, see Section 3.3.3 Battery Voltage Measurement.

Callouts in brackets in the following refer to Figure 3-10.

Removing air duct cover

1. Unscrew 18 x hex socket screws M5 (2), using a hex socket key 4 mm.
2. Remove mounting hardware (screws and washers).
3. Remove air duct cover (1).

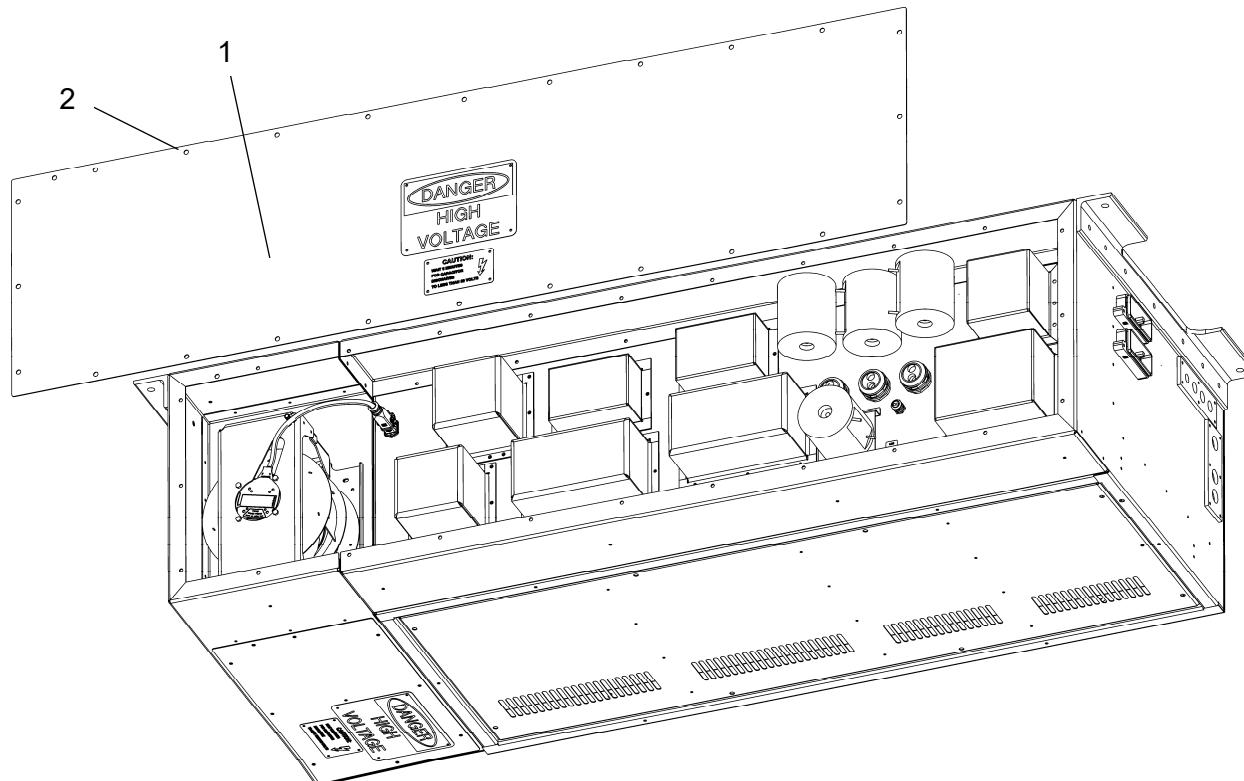


Figure 3-10: Removing Air Duct Cover

Callouts in brackets in the following refer to Figure 3-11.

Cleaning fan blades

1. Check the fan blades (3) for damage. If fan blades are damaged, the fan has to be replaced, see Section 3.3.11 Replace Cooling Fan M901.
2. Clean the fan blades (3) if necessary
 - with pressure air to loosen dirt from the blades and, at the same time
 - with vacuum-cleaner to remove dirt

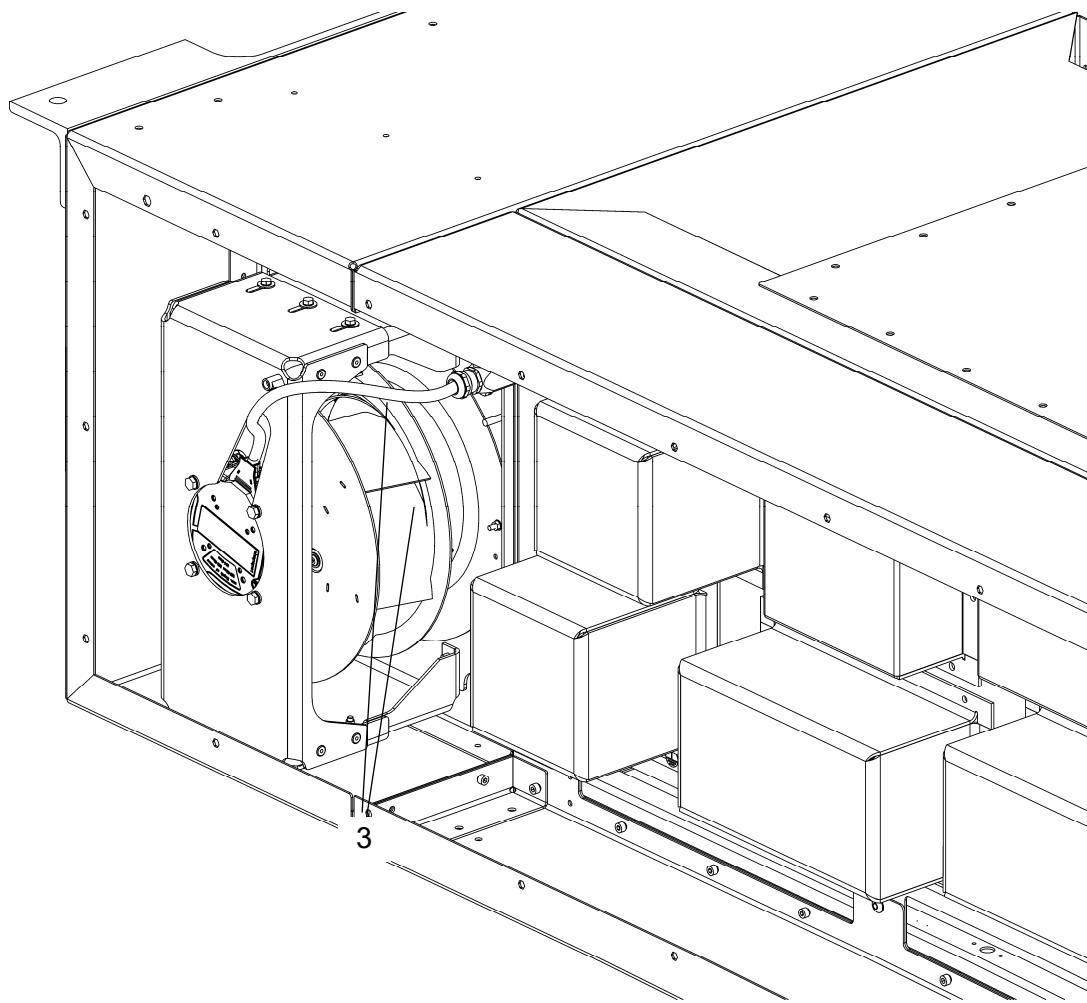


Figure 3-11: Fan Blades Overview

3.3.9 Inspecting and Cleaning Warning Labels

- Clean warning labels (1), (2), (3) and (4) on the dry section service cover as well as the small bottom service cover. See Figure 3-12.

Use water with detergent and a piece of cloth or a brush. Do not damage decals.

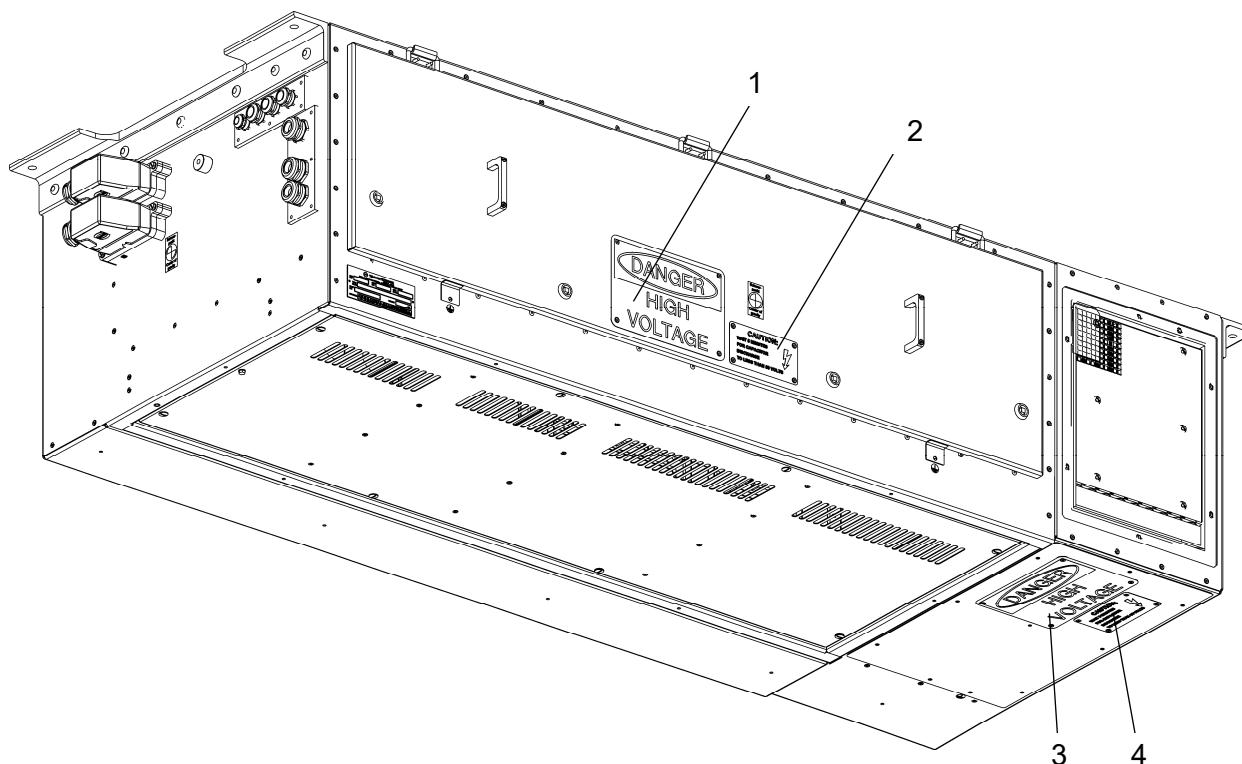


Figure 3-12: Warning Decals

- Clean warning decals (5) and (6) on the air duct cover. See Figure 3-13.

Use water with detergent and a piece of cloth or a brush. Do not damage decals.

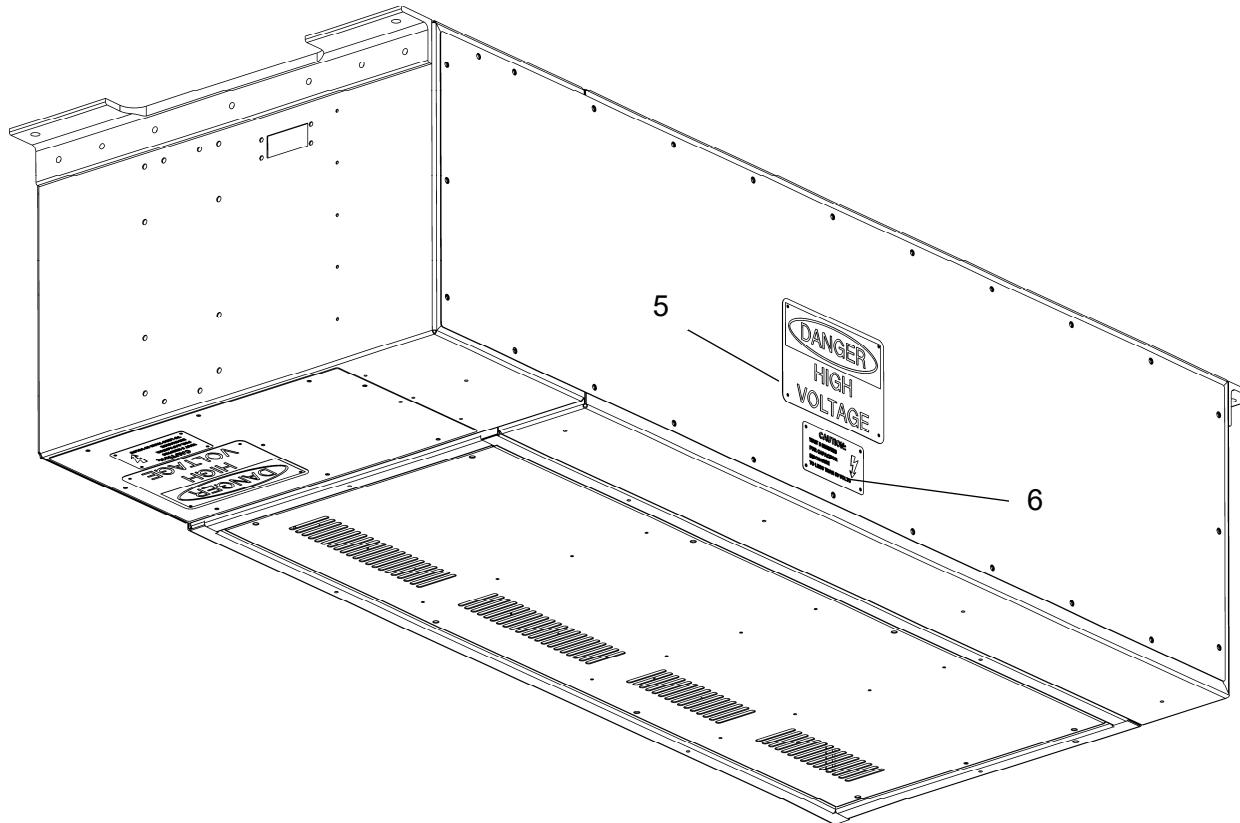


Figure 3-13: Warning Decals, Air Duct Service Cover

3.3.10 Check Connection of Ground Bolts at APS Outside

1. Check ground connection (metric bolt M10 x 20 mm) at primary APS ground socket (1) for firm fit. Use torque wrench. See Figure 3-14.
2. Torque ground connection to 10 Nm. If connection is damaged in any way or if attaching elements are missing, repair grounding connection.

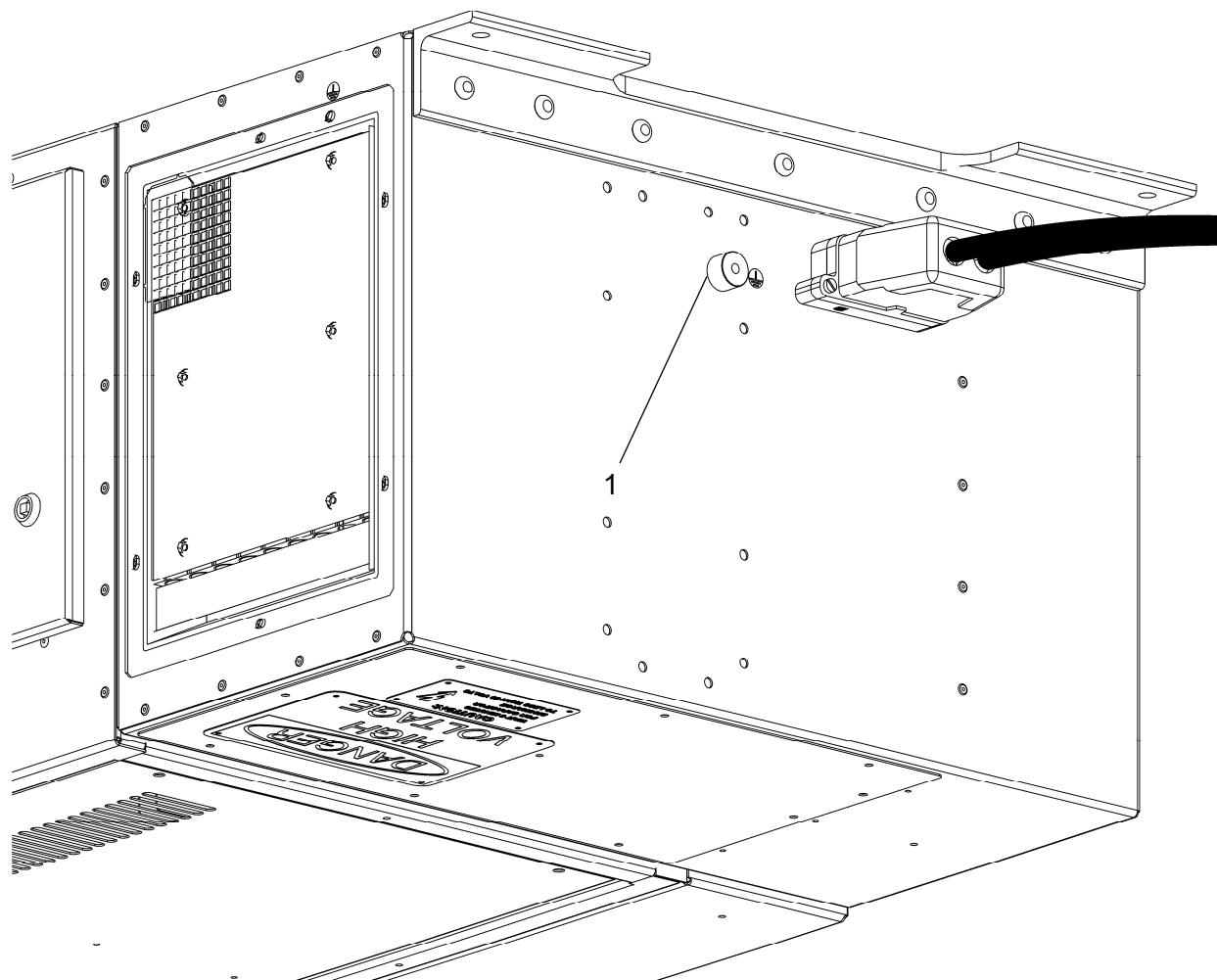


Figure 3-14: Ground Bolt 1

3. Check ground connection (metric bolt M10 x 20 mm) at secondary APS ground socket (1) for firm fit. Use torque wrench. See Figure 3-15.
4. Torque ground connection to 10 Nm. If connection is damaged in any way or if attaching elements are missing, repair grounding connection.

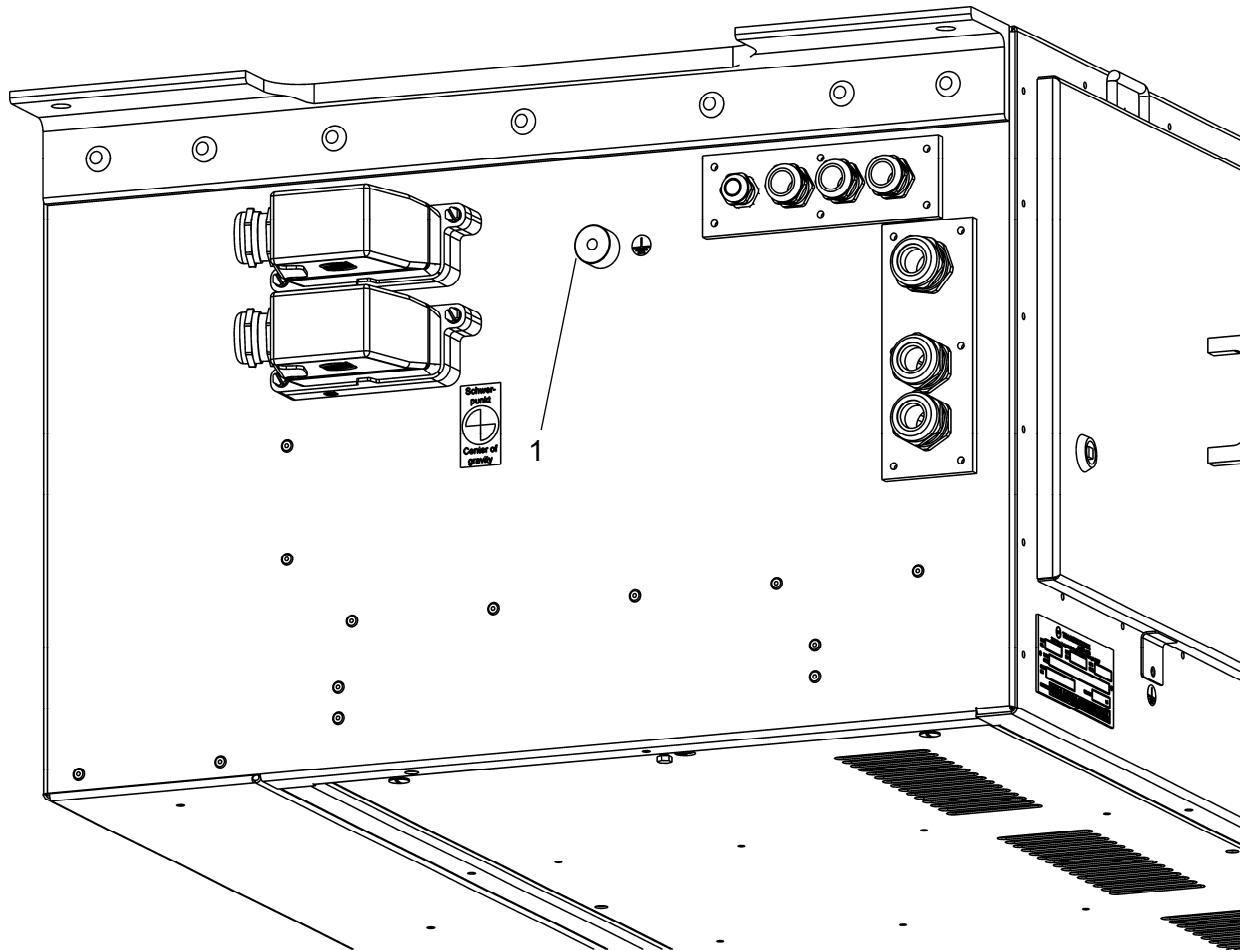


Figure 3-15: Ground Bolt 2

3.3.11 Check / Replace Gasket of Service Cover

WARNING

ELECTROCUTION HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

WARNING

DC SHORT CIRCUIT HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

- Before removing any cover, wait at least three minutes for discharge of the capacitors inside the APS.
- When the dry section service cover has been removed, measure at first the residual capacitor voltage on the capacitor terminals. Voltage must be below 50 V. For detailed instruction, see Section 3.3.2 Residual Capacitor Voltage Check.
- Measure the DC voltage between the MINUS terminal and the BATT terminal of the battery line by use of a DMM. Voltage must be 0 V. For detailed instruction, see Section 3.3.3 Battery Voltage Measurement.

Callouts in brackets in the following refer to figure 3-16.

1. Remove dry section service cover (see section 3.3.1).
2. Visually inspect gasket (1) around service opening.
3. If there is any damage which could affect tightness of the gasket, replace gasket.
4. If dry section service cover is leaking or if there are any symptoms of leaks, replace gasket.

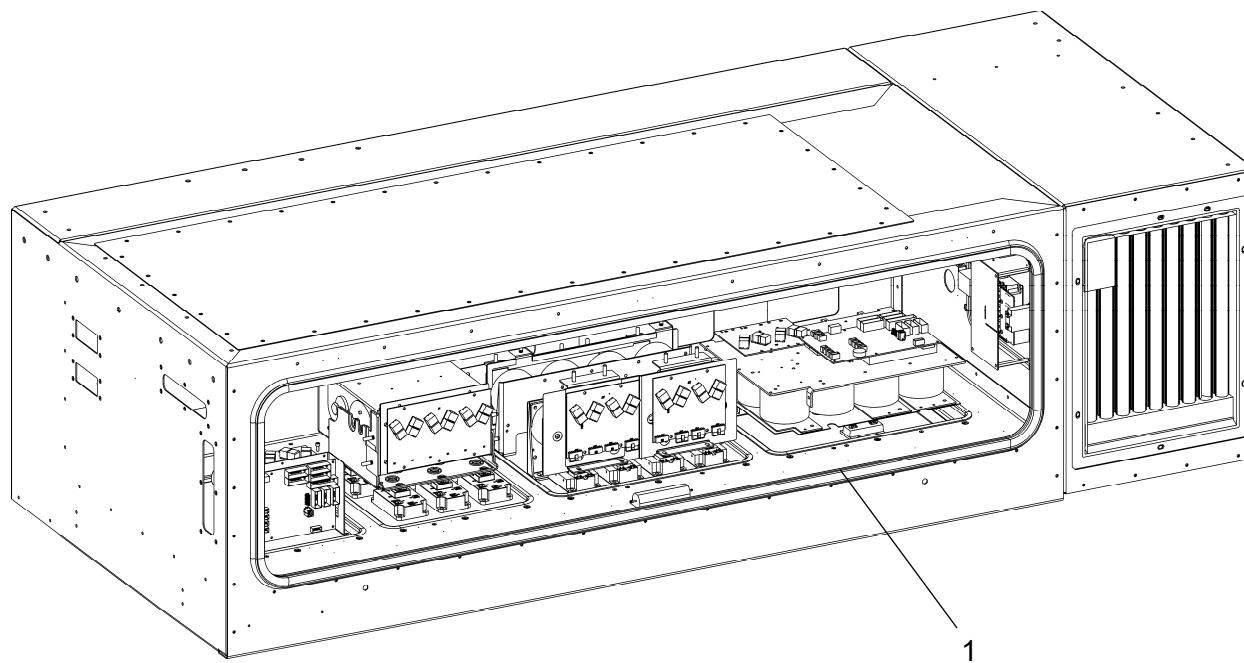


Figure 3-16: Dry Section Service Cover Gasket

5. Remove defective gasket (1) from service opening by pulling it off. See Figure 3-17. Remove any sealant reminders. If necessary, clean the edge of the service opening.

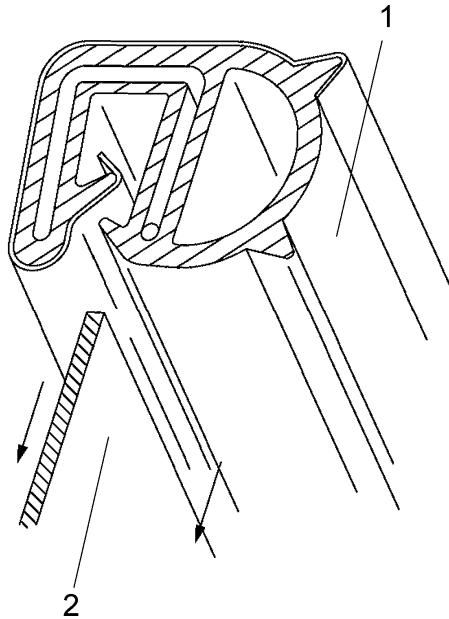


Figure 3-17: Gasket Detail

Required length of gasket material: 3.50 m

6. Attach the gasket (1) to the edge of the service opening (2) as shown in Figure 3-17.
 - Start with one end at the center of the service opening's lower edge.
 - Install the gasket progressively around perimeter.
 - Do not overstretch gasket while installing.
7. When gasket is fitted to the service opening edge,
 - carefully apply UV-resistant silicone sealant (for example Sikaflex-222UV) to the mating surfaces at both ends. Press the ends together until sealant has set.
 - Apply a bead of sealant on the seam and wipe off excess.
 - When sealant is dry, install service cover and fasten the compression latches.
8. Install and close dry section service cover.

3.3.12 Check Fasteners on the Dry Section Service Cover

There are two fastener types:

- 4 x compression latch (1) on the service cover (3).
 - 8 x quarter turn fastener (2) on the bottom cover (4).
1. Check each compression latch (1) for proper function. See Figure 3-18. If the latch does not close tightly, replace it. For replacing see section 3.3.12.1.
 2. Inspect all eight quarter-turn fasteners (2) of the bottom cover (4). If the latch does not close tightly, replace it. For replacing see section 3.3.12.2.

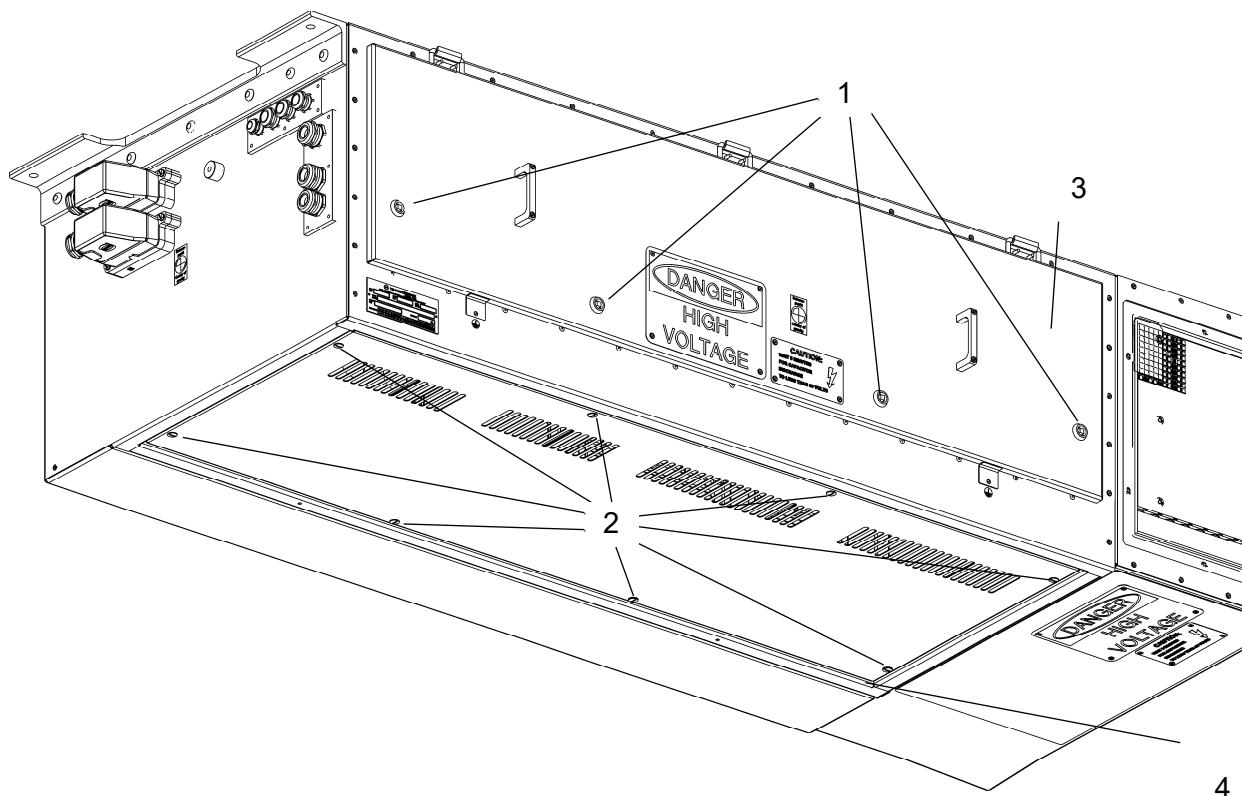


Figure 3-18: Dry Section Service Cover Fasteners

3.3.12.1 Replacing Compression Latches of Dry Section Service Covers

WARNING

ELECTROCUTION HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

WARNING

DC SHORT CIRCUIT HAZARD. REVIEW ALL SAFETY INFORMATION AND TAKE APPROPRIATE ACTIONS BEFORE OPENING ANY PART OF THE APS.

- Before removing any cover, wait at least three minutes for discharge of the capacitors inside the APS.
- When the dry section service cover has been removed, measure at first the residual capacitor voltage on the capacitor terminals. Voltage must be below 50 V. For detailed instruction, see Section 3.3.2 Residual Capacitor Voltage Check.
- Measure the DC voltage between the MINUS terminal and the BATT terminal of the battery line by use of a DMM. Voltage must be 0 V. For detailed instruction, see Section 3.3.3 Battery Voltage Measurement.

Special Tools

- Metric box wrench, size 10 mm
- Metric box wrench, size 27 mm
- Special detergent Sika 205, TT 36355
- Sealant Sikaflex-222UV, TT 36353
- Torque wrench (20 Nm)

Removal

1. Loosen screw M6 (5) and remove pawl (6). See Figure 3-19.
2. Loosen and remove ring nut (3).
3. Press fastener (4) out of service cover (1). If required, use rubber mallet.
4. Clean area of fastener hole in the service cover using special detergent Sika 205.

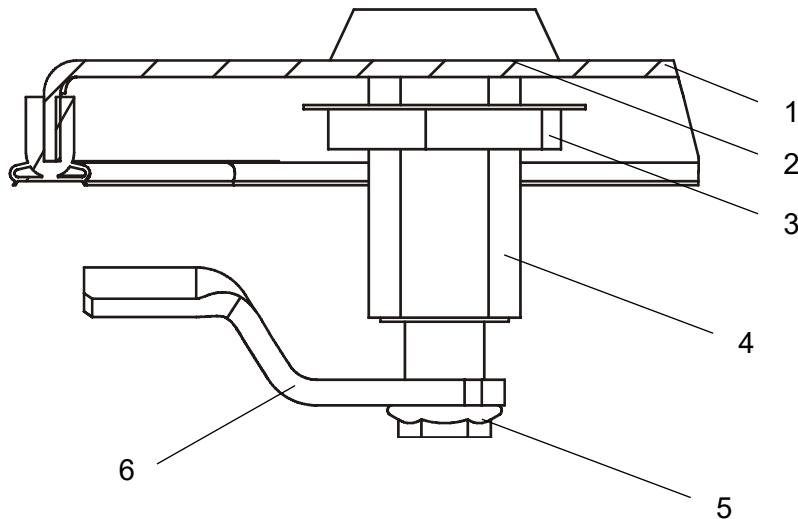


Figure 3-19: Compression Latch

Installation

1. Clean contact surface (2) of fastener (4) using special detergent Sika 205.
2. Apply a thin film of sealant Sikaflex-222UV to contact surface (2) of fastener (4).
3. Insert fastener (4) into service cover (1) and fix it using ring nut (3). Torque ring nut to 20 Nm.
4. Put pawl (6) on fastener (4) and fix it using screw (5). Torque screw to 10 Nm.
5. After hardening of sealant, again torque ring nut (3) to 20 Nm.

3.3.12.2 Replacing Quarter-Turn Fastener

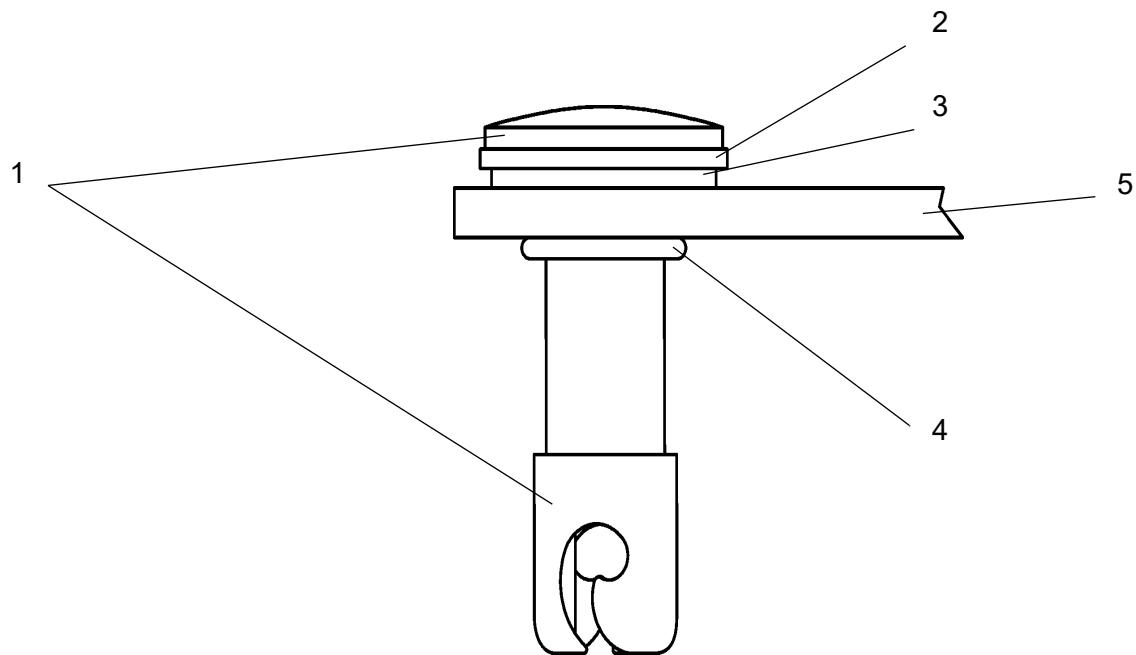


Figure 3-20: Quarter-Turn Fastener

Part

1	Quarter-turn fastener
2	Plastic circlip
3	Sealing ring
4	Circlip
5	Service cover sheet
6	Mounting tool no 1: Southco 29-TB1A4
7	Mounting tool no 2: Southco 29-TFRS4

Other tool: Side cutter

Remove quarter-turn fastener:

1. Cut open circlip (4) using side-cutter. See Figure 3-20.
2. Remove fastener (1) including plastic circlip (2) and sealing ring (3).

Install quarter-turn fastener

To slide the plastic circlip onto the fastener, mounting tool no. 1 is required.

1. Insert plastic circlip (2) into mounting tool no. 1 (6). See Figure 3-21.
2. Set fastener (1) on mounting tool no. 1 and press fastener into mounting tool. The plastic circlip will be slid onto the fastener.
3. Attach sealing ring (3) to fastener.

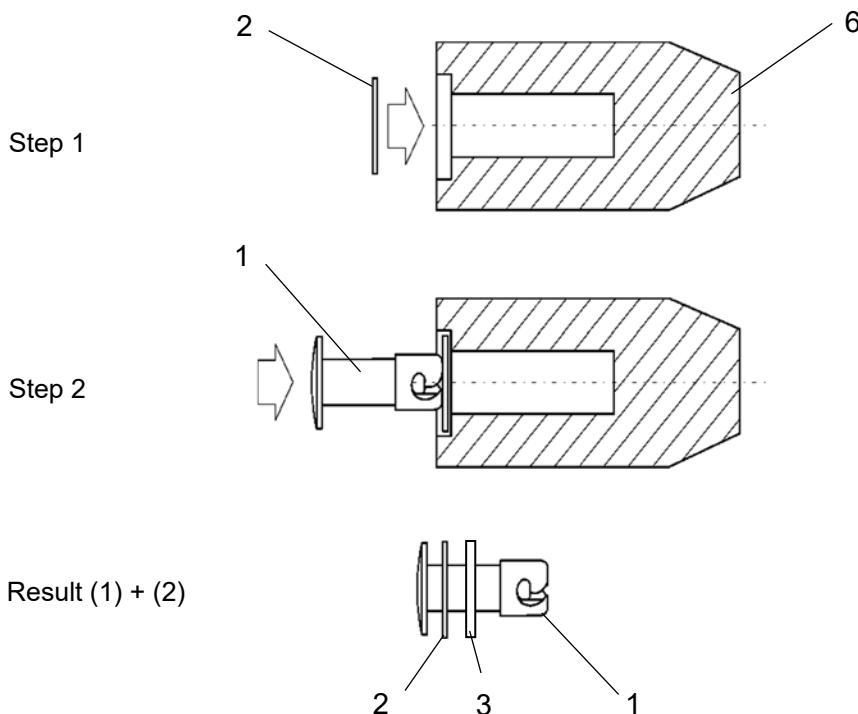


Figure 3-21: Install Quarter-Turn Fastener (1)

To mount the fastener on the dry section service cover, mounting tool no. 2 (7) + (8) is required. Do not damage circlip. It is imperative to use the mounting tool.

4. Set circlip (4) on mounting tool 2 insert (7). See Figure 3-22.
5. Attach mounting tool insert to mounting tool (8).
6. From the outside of the dry section service cover: Put fastener assembly (1), (2), (3) through hole of service cover (5).
7. From the inside of the dry section service cover: Insert complete mounting tool no. 2 into fastener.
8. Slide circlip (4) on fastener shaft by pressing mounting tool no. 2 towards the fastener. Hold up fastener from the cover outside.

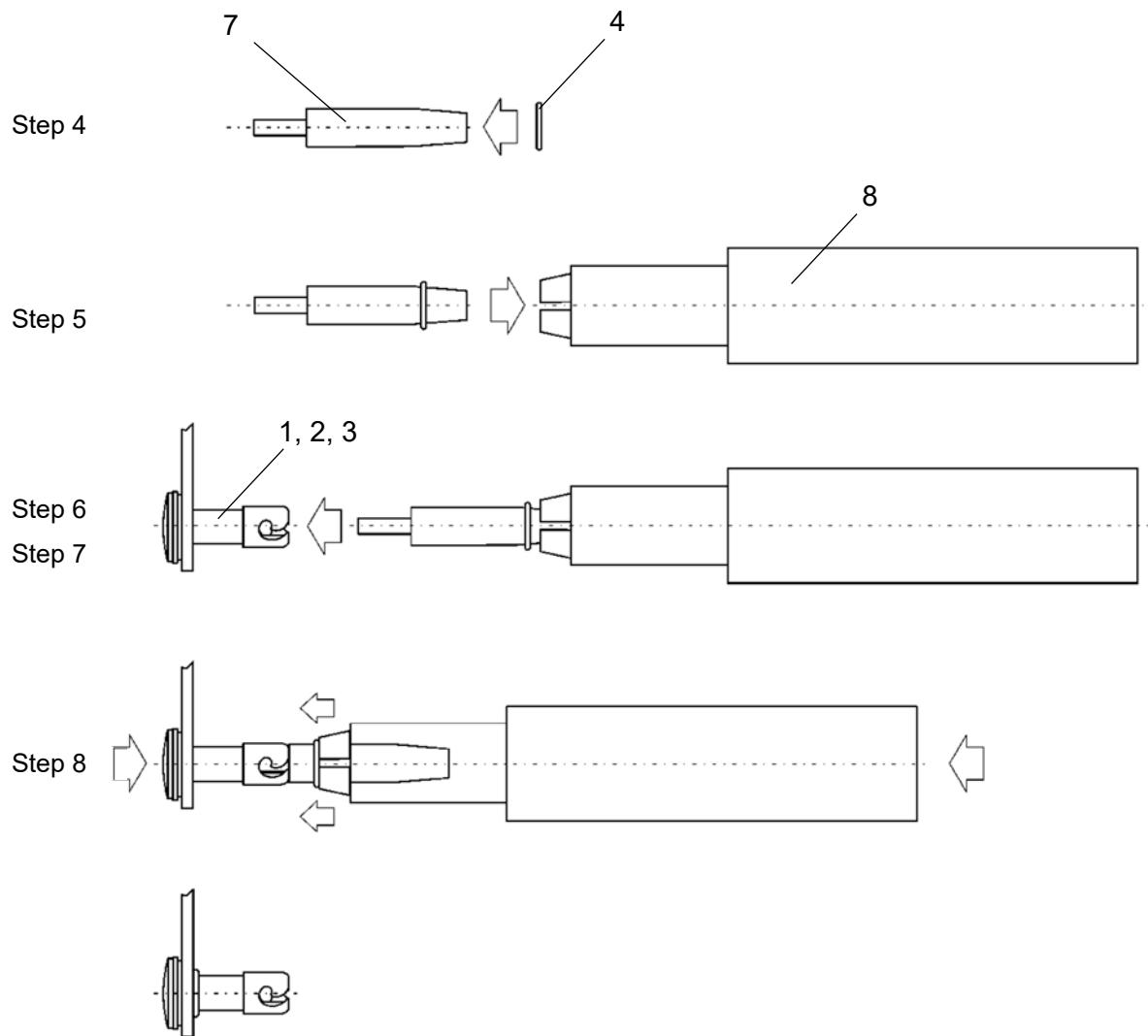


Figure 3-22: Install Quarter-Turn Fastener (2)

3.3.13 Check Ground Cables of Covers for Fit and Damage

Fix loose connections.

3.3.14 Removal and Replacement of Air Filter

The Air Filter assembly is mounted at the air intake point on the right of the Dry Area Service Door (cover). The Air Filter is held in place with six sets of M5 fasteners and one set of M6 grounding fasteners.

Removal

Callouts in brackets refer to Figure 3-23.

1. Remove the hex headed M6x16 screw (4) and the accompanying M6 Schnorr (3) and flat (2) washer.
2. Starting at the bottom and proceeding up both sides, remove the M5x16 screws (5) and accompanying M5 Schnorr (6) and flat (7) washers.
3. Support the weight of the Air Filter (1).

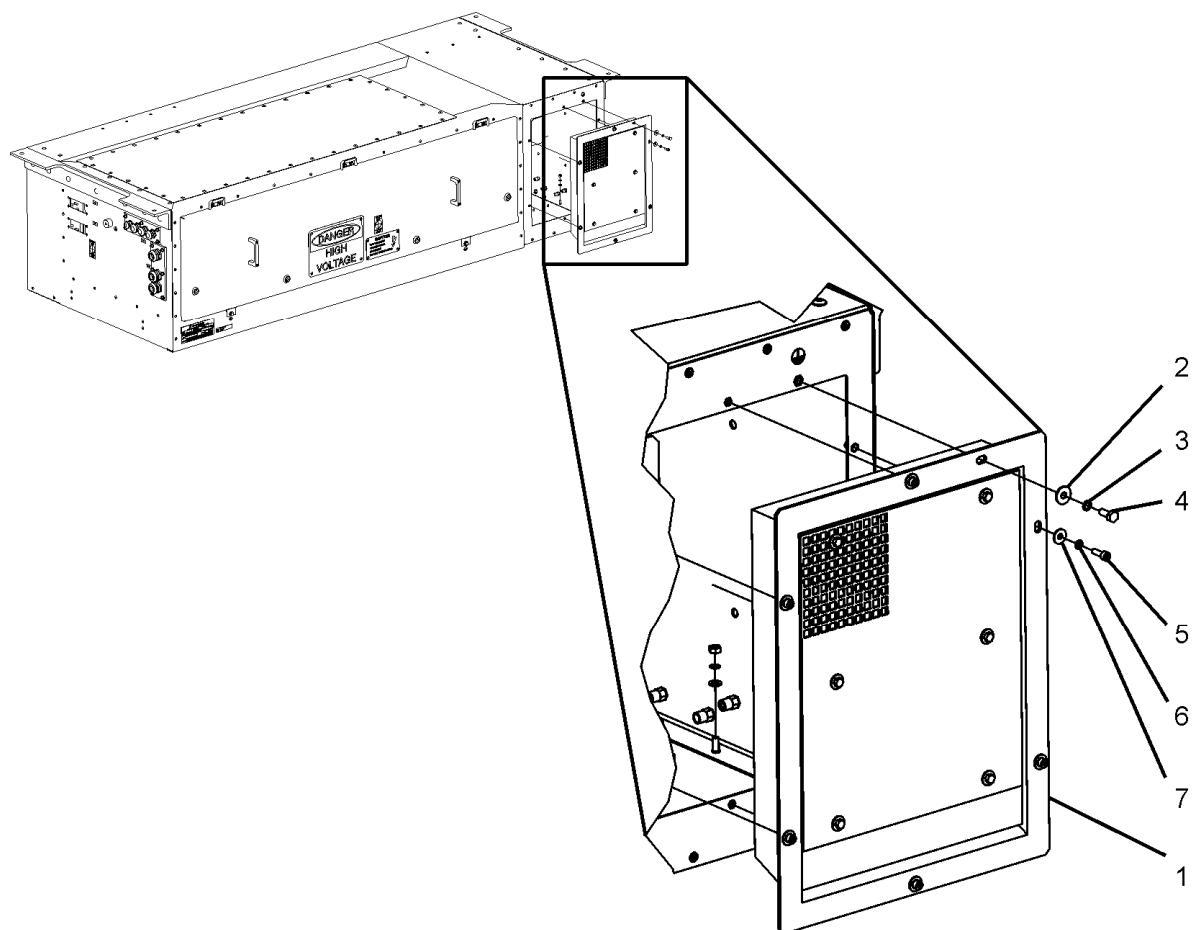


Figure 3-23: Removing Air Filter.

4. Remove the top M5x16 screw (5) and accompanying M5 Schnorr (6) and flat (7) washer. See Figure 3-23.
5. Lean the Air Filter (1) forward and allow it to pull away from the APS.
6. Remove the Air Filter (1) and store in a safe place.

Installation

1. Insert the Air Filter (1) with the beveled edge on the bottom.
2. Starting with the top and working down each side, insert the M5x16 screws (5) and accompanying M5 Schnorr (6) and flat (7) washers. Tighten to 43.37 lb-in (4.9 Nm) of torque.
3. Install the M5x16 screw (5) and accompanying M5 Schnorr (6) and flat (7) washer at the bottom. Tighten to 43.37 lb-in (4.9 Nm) of torque.
4. Insert the grounding hex headed M6x16 screw (4) and the accompanying M6 Schnorr (3) and flat (2) washer. Tighten to 75.23 lb-in (8.5 Nm) of torque to tighten.

3.3.15 Replacement of Electrolytic Capacitors

Electrolytic capacitors are considered at the end of their expected life at eight years. Replace the electrolytic capacitors at eight-year intervals.

Table 3-4. Electrolytic Capacitors

Item	Assembly	Subassembly
A103/C18	A100	A103
A103/C19	A100	A103
A301/C01.1	A300	A301
A301/C01.2	A300	A301
A701/C24	A700	A701
C411	A400	N/A
C720	A700	N/A

Table 3-4 identifies all electrolytic capacitors in the APS either stand-alone or as a sub component on a PCB.

Removal

1. Consult the Heavy Repair Manual to remove the expired component or PCB to be serviced from the APS.
2. Refer any PCBs to be serviced to the applicable department. Details on PCB components are provided in the BTE documentation.

Installation

1. Consult the Heavy Repair Manual to install the replacement component or serviced PCB into the APS.

3.3.16 Replacement of Gaskets

The prescribed lifetime of gaskets is eight years. Regardless of condition, replace the gaskets after 800,000 miles. Refer to section 3.3.11 for instructions on removal and replacement of gaskets.

3.3.17 Replacement of AC Filter Capacitors

The prescribed lifetime of the AC Filter Capacitors (C301.1, C301.2, C301.3, C302.1, C302.2 & C302.3) is sixteen years. Regardless of condition, replace the AC Filter Capacitors after 1,600,000 miles. Refer to the applicable section of the Heavy Repair Manual for instructions on the removal and replacement of the capacitors.

3.3.18 Replacement of Fuses

Fuses (whether in use or spare) should be replaced at eight-year intervals.

Table 3-5. Fuses

Item	Assembly	Subassembly
A103/F1	A100	A103
A727/F1	A700	A727
F901	F900	F901

Table 3-5 identifies all fuses in the APS either stand-alone or as a sub component on a PCB.

NOTE: The locations of the spare fuses can be found in the IPC.

There are a total of six fuses, three that are in use and three spares. Fuses are installed in a manner to facilitate their removal and replacement without the need for specialized tools or removal of the assembly for which the fuse is used.

3.3.19 Replacement of Relays

Relays are considered at the end of their expected life at eight years. Replace the relays at eight-year intervals.

Table 3-6. Relays

Item	Assembly	Subassembly
A721/K1	A700	A721
A721/K2	A700	A721

Table 3-6 identifies all relays on the A721 PCB.

Removal

1. Consult the Heavy Repair Manual to remove the PCB from the APS.
2. Refer the PCBs to be serviced to the applicable department. Details on PCB components are provided in the BTE documentation.

Installation

1. Consult the Heavy Repair Manual to install the serviced PCB into the APS.

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CHAPTER 4.0

DIAGNOSTICS AND TROUBLESHOOTING

4.1 Introduction

Monitoring

Performance and status of the APS can be monitored in real time via the Train Operator Display (TOD).

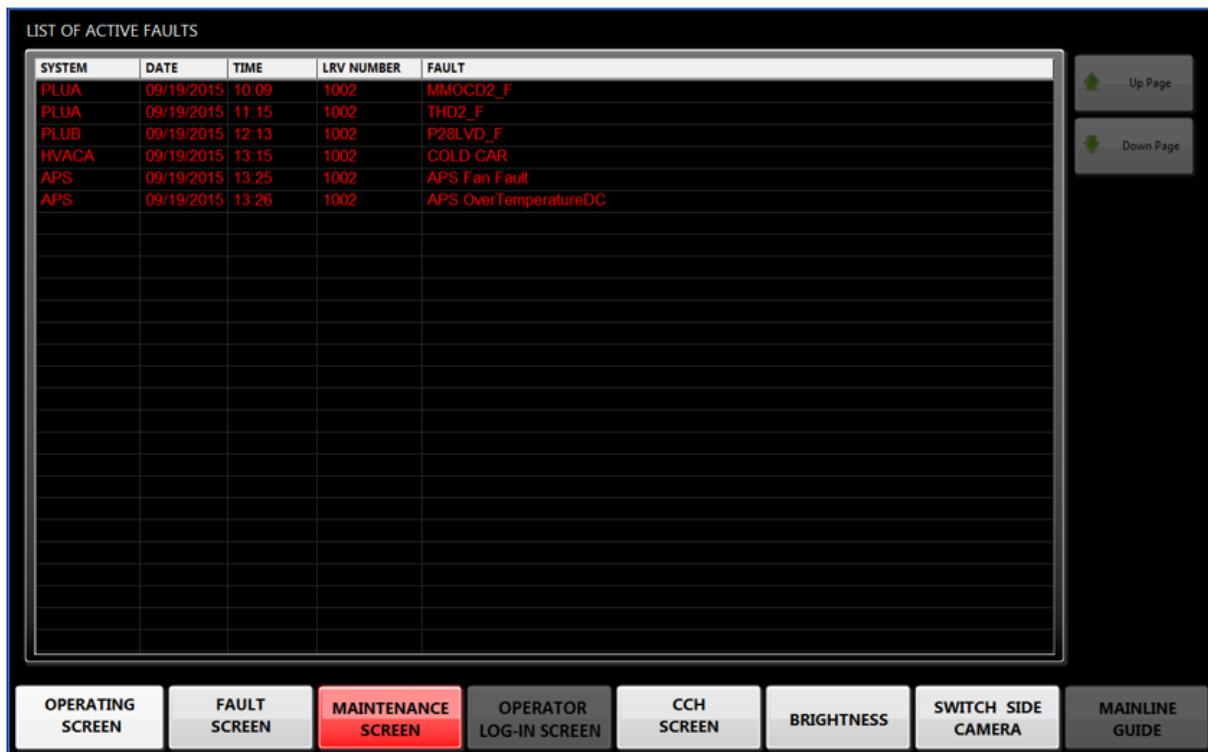


Figure 4-1: TOD Messages for faults (passed via the vehicle Ethernet network)

For details on the faults shown in the above figure, see Appendix.

Maintenance	
MVB-1537	
APS_Health_Status	OVERVOLTAGE_VIN_MAX2
NO FAULTS	OK
APS_RUN	OVERVOLTAGE_VIN_MAX1
RUN-MODE	OK
APS_ERROR	UNDERVOLTAGE_VIN_MIN2
OK	OK
APS_DC_INPUT_LOAD_SHED	UNDERVOLTAGE_VIN_MIN1
OK	OK
APS_DC_INPUT_OUT_OF_RANGE	HEATSINK_JMAX
OK	OK
APS_ACTUAL_LVDC_OUTPUT_VOLTAGE	APS_INPUT_VOLTAGE
28	799
APS_ACTUAL_INVERTER_AC_OUTPUT_VOLTAGE	APS_CALCULATED_INPUT_CURRENT
120	21
OVERVOLTAGE_VIN_MAX3	APS_ACTUAL_LVDC_OUTPUT_CURRENT
OK	95
APS_ACTUAL_INVERTER_AC_OUTPUT_CURRENT	ChkAPS_Status_Signals
40	VALID
OPERATING SCREEN	FAULT SCREEN
MAINTENANCE SCREEN	OPERATOR LOG-IN SCREEN
CCH SCREEN	BRIGHTNESS
SWITCH SIDE CAMERA	MAINLINE GUIDE

Figure 4-2: TOD Messages for Status (Passed Via The Vehicle MVB Network)

Diagnostics

Diagnostics is performed using a portable test unit (PTU0) with Transtechnik's diagnostic software ProDiag3000.

**Transtechnik
diagnostic software
ProDiag3000**

ProDiag3000 is a Windows software used to:

- Monitor operation of Transtechnik's auxiliary power converters
- Change operational parameters of the APS
- Store data of operational events for diagnostic purpose

**Installed on
portable test unit
(PTU)**

ProDiag3000 runs under Windows 7 on PCs, for example notebooks or other PCs



For detailed descriptions as well as instructions please refer to document "ProDiag3000_Manual".

4.2 Connecting and Launching ProDiag3000

The figure below is a simplified block diagram of the converter and its communication interfaces (including the connection between the computer and the converter's CCU).

It should be noted that the PTU can be connected to the CCU through the vehicle wiring or directly to the APS. In the latter case, the APS will have to be disconnected from the vehicle to make the Ethernet port available for direct connection.

The connection between the PTU and the CCU uses Ethernet protocol via a DHCP router in between the PTU and the CCU **or** directly via Ethernet cable.

Direct Connection via Ethernet Cable

For connections on site to the APS, you can connect directly to the APS. To initiate a ProDiag3000 session, take the following steps:

NOTE: The first time ProDiag3000 is launched on the PTU, some setup and configuration may be required. See the ProDiag3000 manual for further details.

WARNING

DO NOT TOUCH ANY ENERGIZED PARTS INSIDE THE APS WHILE SERVICE COVERS ARE REMOVED AND THE APS IS UNDER VOLTAGE! CAREFULLY KEEP TOOLS AND OTHER OBJECTS FROM FALLING INTO THE APS!

1. Connect the PTU to the Ethernet-Connector ETH1 in X6 directly on the CCU within the APS. See Figure 4-4, solid line.

Using Submin D socket X6 (ETH1) at the CCU, the PTU has to be configured to a static IP address in the range 100.0.0.2 ... 100.0.0.15 (subnet mask 255.255.255.240). Converter's IP address will be 100.0.0.1.

2. On the PTU, launch the ProDiag3000 software.

Connection via DHCP Router

For remote connections to the APS, you can use the path via a DHCP-router to the APS. It is assumed, that the DHCP router is a part of the train network. To initiate a ProDiag3000 session, take the following steps:

NOTE: The first time ProDiag3000 is launched on the PTU, some setup and configuration may be required. See the ProDiag3000 manual for further details.

1. Connect the PTU to the DHCP router.
2. If not already established, connect the DHCP router via Ethernet Interface Cable connector to X702 of the APS. See Figure 4-4, dashed line.
3. On the PTU, launch the ProDiag3000 software.

4.3 Troubleshooting Help System

The picture below shows the event log of ProDiag3000.

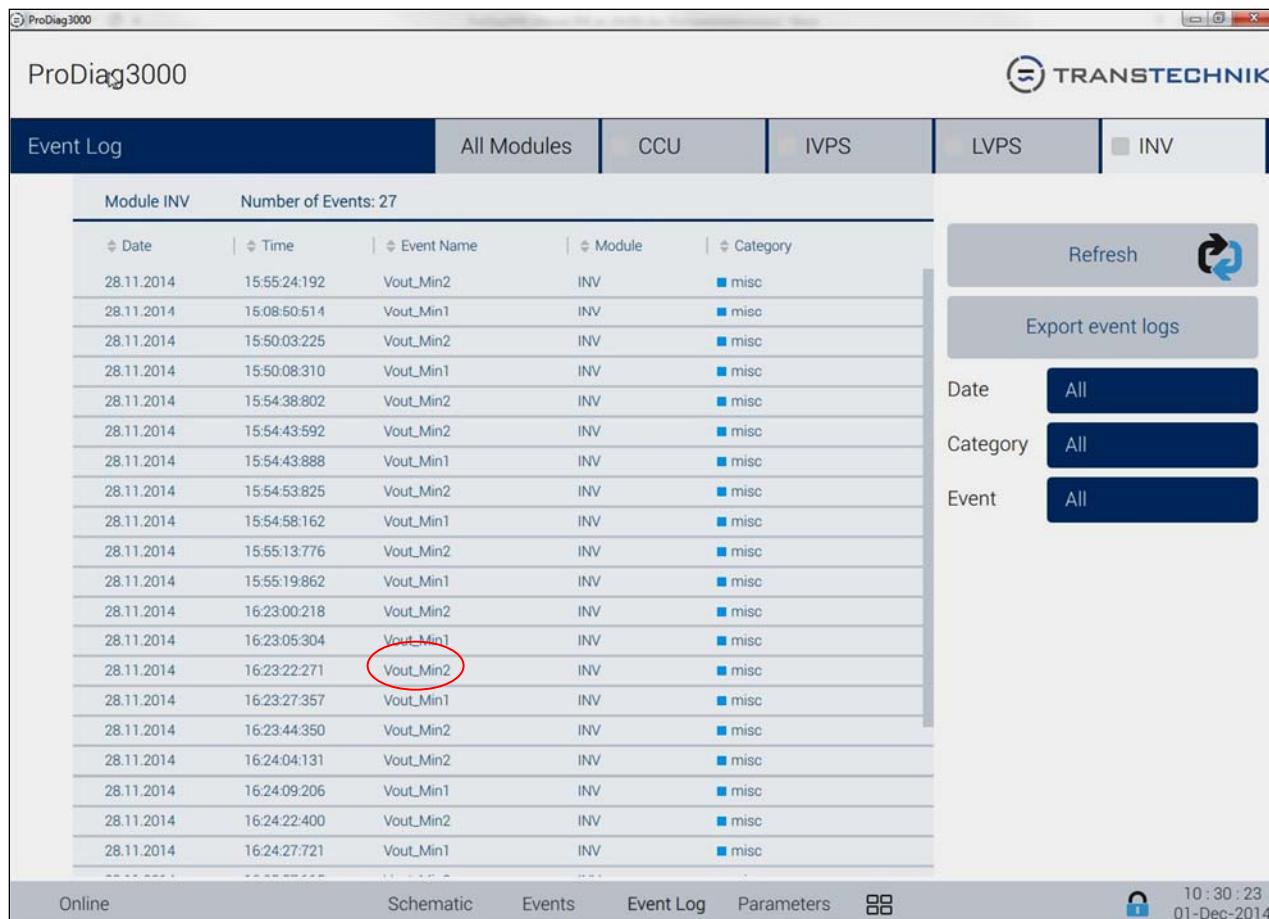


Figure 4-5: ProDiag3000, Event Log View

The troubleshooting Help System (see Figure 4-6) provides troubleshooting help information to support corrective actions on the APS after an error has occurred.

- Clicking on the event name (see red marker) starts the browser based ProDiag3000 Troubleshooting Help System.
- The Help System shows then a description associated to the just clicked event as well as possible causes for the event.
- Additionally, corrective action proposals are available after clicking a button.

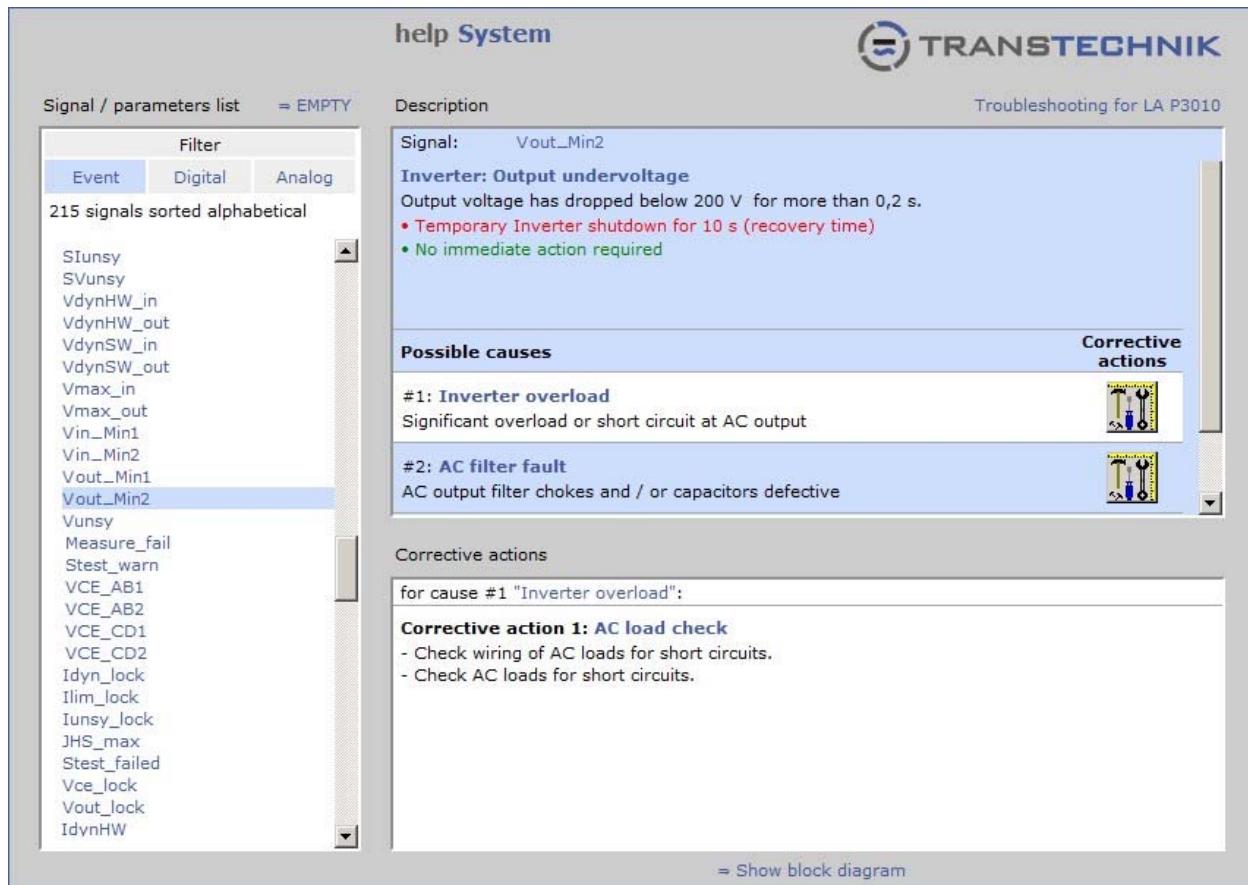


Figure 4-6: Troubleshooting Help System

For detailed description of the Help System, refer to ProDiag3000 manual "ProDiag3000 Diagnostic Software for Auxiliary Power Converters".

4.4 Troubleshooting without Help System

The table below is not intended to be a replacement for the detailed Help System of the ProDiag3000 software. Troubleshooting without using the Help System is described.

It is expected that a qualified technician will be able to perform additional recommended trouble analysis steps without instruction.

The following table presents a listing of critical conditions along with an explanation, a list of probable causes and recommended actions for correction or further trouble analysis.

Table 4-1. Description of Fault Conditions

Condition	Probable Cause	Recommended Action
No LED inside the APS is on, i.e. APS is not supported by power supply. (In this case also no Help System utility will work.)	<ul style="list-style-type: none"> • No input voltage available and battery is deeply discharged or disconnected. 	<p>Corrective action 1: Check the input voltage.</p> <p>Corrective action 2: Connect the train battery to the APS.</p>
Mechanical damage of the enclosure.	<ul style="list-style-type: none"> • Heavy physical impact, e.g. after a crash. 	<p>Corrective action: Check the APS in shop for proper function. Replace damaged housing elements. If necessary replace damaged modules as well.</p>
No output voltage available	<ul style="list-style-type: none"> • No input voltage available. • Input voltage out of range (< 490 V). 	<p>Corrective action 1: Check the input voltage</p> <p>Corrective action 2: Reset the APS by depressing the Reset pushbutton on the Upper Control Panel.</p>
No input voltage available	<ul style="list-style-type: none"> • Input fuse blown (AUX FUSE) (refer to Section 0700, Propulsion of the Running Maintenance and Servicing Manual) • Input connection to APS broken. 	<p>Corrective action 1: Check the input fuse/connection. Refer to Section 0700, Propulsion of the Running Maintenance and Servicing Manual.</p>
		<p>Corrective action 2: Check the input voltage of the APS.</p>
Short circuit at the output	<ul style="list-style-type: none"> • Faulty consumers. 	<p>Corrective action 1: Check the consumers. Remove the short circuit at the output.</p>
		<p>Corrective action 2: Reset the APS by depressing the Reset pushbutton on the Upper Control Panel.</p>
No communication between the APS and PTU possible.	<ul style="list-style-type: none"> • Wrong IP address or port; • (if connected via train network) DHCP-server out of service. 	<p>Corrective action 1: Check used IP address and port on PTU. Check DHCP-server for proper working.</p>
		<p>Corrective action 2: Reset PTU and start ProDiag3000 again.</p>
APS event log is empty, but the equipment will still not operate.	<ul style="list-style-type: none"> • Input conditions not met; • Faulty CCU; • CAN Communication error; • + 15 V Power supply (A720) faulty -> error on the power modules. 	<p>Corrective action 1: Check the input conditions (see chap. 2.4 Functional Description).</p>
		<p>Corrective action 2: Replace the Converter Control Unit (A701).</p>
		<p>Corrective action 3: Check CAN wiring (get support via Knorr Bremse Powertech.)</p>
		<p>Corrective action 4: Check A720.</p>
		<p>Corrective action 5: Check + 15 V wiring X711 to the power modules.</p>
Fault indication in train control shows an error within the APS.	<ul style="list-style-type: none"> • Any error inside the APS. 	<p>Connect the Help System utility ProDiag3000 and enter the diagnostics (see CHAPTER 4.0.)</p>

Whenever the proposed measures do not solve the problem, please get support via Knorr Bremse Powertech.

Evaluating the LED indications of the regulation boards only works with the APS remaining on voltage. If service covers have been removed, it is possible to get contact to dangerously high voltage.

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CHAPTER 5.0

LINE REPLACEABLE UNITS REMOVAL & REPLACEMENT PROCEDURES

5.1 General Information

5.1.1 Safety

5.1.1.1 General Safety

At all times be aware that the APS is a power conversion device operating on high voltage, is composed of heavy equipment with parts that operate at high temperatures. Ultimately it is the responsibility of the individual to safely perform his/her duties.

5.1.1.2 Personal Safety

WARNING

ELECTROCUTION HAZARD. THE CONVERTER CONTAINS EXPOSED CIRCUITRY THAT CARRIES HIGH VOLTAGES AND CURRENT. DO NOT PERFORM REMOVAL OR REPLACEMENT MAINTENANCE ON THE CONVERTER IN AN ACTIVE AND OPERATING STATE. REMOVE ALL POWER FROM THE CONVERTER BEFORE BEGINNING WORK.

WARNING

DANGEROUS RESIDUAL VOLTAGES ARE PRESENT. THE CONVERTER CONTAINS CAPACITORS THAT CAN RETAIN LETHAL VOLTAGES AFTER POWER HAS BEEN REMOVED FOR UP TO 5 MINUTES. PRIOR TO PERFORMING ANY SERVICE OR MAINTENANCE, REMOVE POWER AND ALLOW 5 MINUTES FOR CAPACITORS TO DISCHARGE TO BELOW 50 VOLTS BEFORE PROCEEDING. ALWAYS MEASURE VOLTAGES BEFORE STARTING WORK.

WARNING

HOT SURFACES. PARTS OF THE CONVERTER SUCH AS HEAT SINKS, CHOKES, TRANSFORMERS OR POWER SEMICONDUCTORS SUCH AS DIODES, THYRISTORS AND TRANSISTORS (IGBTS) CAN BE HOT. DEPENDING ON THE MASS OF THE HOT COMPONENTS MORE OR LESS TIME IS NEEDED TO HAVE THOSE COMPONENTS TO COOL TO A SAFE CONDITION FOR SERVICING.

WARNING

HEAVY OBJECTS. SOME OF THE COMPONENTS IN THE CONVERTER HAVE CONSIDERABLE WEIGHT. ALWAYS TAKE APPROPRIATE PRECAUTIONS WHEN LIFTING, ATTACHING, DETACHING OR MOVING COMPONENTS OR FASTENERS.

To minimize the risk of injury or death from electrocution, follow these general safety rules when working on or around the converter:

1. De-energize
2. Secure against reactivation
3. Verify equipment is unpowered
4. Ground and short
5. Cover or barricade off adjacent parts that are live

5.1.1.3 Equipment Safety

A large number of components in the APS are sensitive to Electrostatic Discharge (ESD). Practice ESD Safety whenever handling Printed Circuit Boards (PCBs). Additionally, a number of components and their fasteners are mounted on vertical surfaces or inverted. As a result, fasteners and components can fall when detached from the mounting anchor points and damage themselves or other equipment. Be aware of the potential of falling objects when working on the APS.

CAUTION

FALLING OBJECT DAMAGE. OBJECTS MOUNTED VERTICALLY OR IN AN INVERTED POSITION MAY FALL AND DAMAGE THEMSELVES OR OTHER COMPONENTS WHEN DETACHED. TO PREVENT DAMAGE FROM FALLING OBJECTS, TAKE APPROPRIATE MEASURES TO SUPPORT THESE OBJECTS WHEN WORKING.

CAUTION

POTENTIAL FOR CROSS CIRCUIT DAMAGE. SOME COMPONENTS SUFFER SIGNIFICANT DAMAGE IF CONNECTED INCORRECTLY. ALWAYS CONSULT CABLE LABELS AND TERMINAL MARKINGS WHEN MAKING ELECTRICAL CONNECTIONS.

CAUTION

POTENTIAL FOR SHORT CIRCUIT DAMAGE. METAL FASTENERS AND OTHER DEBRIS RESULTING FROM MAINTENANCE ACTIVITIES CAN CAUSE ELECTRICAL SHORTS AND SHOULD BE ACCOUNTED FOR FOLLOWING ANY PROCEDURE. THESE ITEMS SHOULD BE REMOVED FROM THE CONVERTER IF NOT IN USE. WHILE WORKING AT THE APS DO NOT WEAR METAL ATTIRE OR WATCH.

CAUTION

POTENTIAL FOR DAMAGE DUE TO ELECTROSTATIC DISCHARGE. EXERCISE ESD PRACTICES WHEN HANDLING ANY PRINTED CIRCUIT BOARD OR SEMICONDUCTOR.

Observe the following precautions when handling ESDs.

1. Mount printed circuits and electronic components only if the converter is not under voltage.
2. To avoid damage to the printed circuits, do not touch the surface or the pins. Touch the electronic boards only at the edges.
3. Use antistatic packing material for transportation and storage.
4. To avoid static load of CMOS components and their destruction, touch grounded parts to discharge electrostatic potential of your body. Examples of grounded parts are the ground contacts of shuttered sockets or switchboards.
5. Components, which are sensitive for electrostatic potential, must not come in contact with high insulating materials like plastic films, tabletops or artificial fiber. They must be placed on conductive groundsheets.
6. If soldering is required, the tip of the soldering iron must be grounded.
7. For shipping and storage, all electronic components must be covered with conductive packing material like metallized boxes or bags.
8. When mounting electronic boards, ensure the boards are mounted in the correct orientation.

CAUTION

POTENTIAL FOR EQUIPMENT DAMAGE. DO NOT INTERCHANGE THE PARTS OF THIS UNIT WITH ANY OTHER POWERTECH UNIT WITHOUT CONFIRMING INTERCHANGABILITY. COMPONENTS IN THE ILLUSTRATED PARTS CATALOG WITH MATCHING PART NUMBERS ARE INTERCHANGEABLE. THOSE WITH DIFFERENT PART NUMBERS ARE NOT.

5.1.2 Tools and Equipment

In general, no custom tools are required in the removal or replacement of components of the APS. The following list indicates tools most frequently used for removal and installation:

- Soldering gun
- Hex wrench set
- Nut driver set
- Drive socket set
- Screw driver set (slotted-head and Phillips)
- Wire cutting pliers for cable ties
- Cable ties
- Pliers/tongs for small cable lugs
- Thread locking compound (recommended type: Loctite 242)
- Torque wrench

5.1.3 Part Details

Each procedure highlights various parts which are encountered during the procedure and provides a brief description for each part. For specific details on any given part, refer to the applicable section of the Illustrated Parts Catalog (IPC).

5.1.4 Procedure Sequence

The design and construction of the APS has been carried out to balance weight and space with access and serviceability. In order to make servicing the components of the APS as efficient and risk-free of damage as possible, a standard sequence for the removal and installation of modules and components should be followed.

NOTE: Disconnect only those cables that are connected to the modules/components to be removed separately. Internal cables from one point of the module to another point of the same module need not to be removed if the whole module is to be extracted.

NOTE: All cabling is initially installed with labels identifying the connection point for the cable ends. Any time servicing is performed on the APS, inspect cable labels and if necessary, replace illegible or missing cable labels before the cable is disconnected. In this way, accidentally connecting cables to the wrong terminals is minimized and damage to equipment is avoided.

NOTE: Any time that the APS covers are opened/removed, an inspection of the latches, hinges, grounding cables and sealing gaskets should be performed to verify serviceability. If defects are detected, refer to the appropriate section of this manual or the companion manuals for corrective action.

5.1.4.1 General Sequence of Removal Steps

1. Review Safety Precautions. Review all safety precautions pertaining to the converter.
2. Prepare Converter. Remove power and verify converter is physically secure.
3. Access Work Area. Open the service door or remove panels as needed.
4. Identify Component. Locate the component to be serviced. Each procedure will have a figure showing the component in question and its location within the converter.
5. Inspection Connections and Attachments. Each procedure will indicate all electrical connections and all physical attachments (Anchor Points) and the associated hardware.
6. Disconnect Electrical Connections.
7. Detach Mechanical Connections.
8. Remove Component
9. Secure Work Area. If component will not be replaced or if replacement will be delayed, secure loose wiring and fasteners. Clean debris and cover all openings.

5.1.4.2 General Sequence of Installation Steps

1. Review Safety Precautions. Review all safety precautions pertaining to the converter.
2. Prepare Converter. Remove power and verify converter is physically secure.
3. Access Work Area. Open the service door or remove panels as needed.
4. Inspect Mounting Area. Check for obstructions or sign of previous damage and take action if required.
5. Prepare Component for Insertion. If the component requires special preparation, do so before installation.
6. Insert Component. Seat the component with attention to orientation and alignment with anchor points.
7. Attach Mechanical Connections.
8. Make Electrical Connections.
9. Secure Work Area. Secure loose wiring and fasteners and debris.
10. Close Converter. Reinstall any removed service panels and close the service door.

5.1.5 Mechanical and Electrical Fasteners

5.1.5.1 Fastener Torque Values

Procedures directing the tightening of fasteners will specify torque values where applicable. For situations in which no torque value is specified, see Table 3-3.

5.1.5.2 Fastener Reuse

While most fasteners, nuts, screws and flat washers can be reused without compromising the integrity of the anchor point, certain fasteners are intended for one time use or are compromised by sealing compounds. Any time the following fasteners are removed, they must be replaced with a new fastener.

- Schnorr Washer,
- Lock Washer,
- Nyloc or Locknut (Self-Locking Nut),
- Set Screw to which Loctite has been applied.

5.1.5.3 Electrical Connections

In various places throughout the converter, multiple conductors will connect at the same location. Whenever this is the case, the figure below illustrates how multiple connections should be ordered.

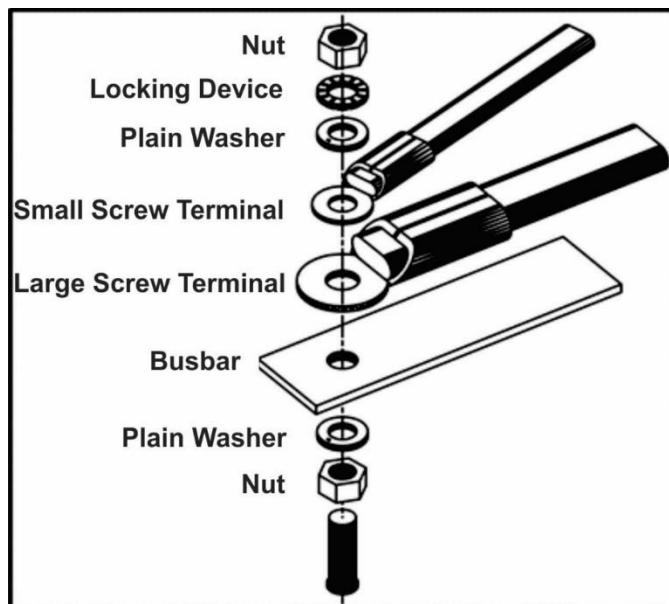


Figure 5-1: Multiple Electrical Connections at a Single Terminal

5.2 Line Replaceable Unit (LRU) Matrix and Power Modules

5.2.1 LRUs

The defining criterion in designating a component as a Line Replaceable Unit (LRU) is based on a reasonable expectation of serviceability on the inspection line with regard to accessibility. In general, any component accessible through the service door, which does not require removing infrastructure (e.g. lifting table) for removal, is considered a LRU.

All LRUs may be removed by one person. So no further staff is required. Only exception is the "Active Input Filter Module A101" with its heat sink).

The following table provides a listing of all components that have been defined as Line Replaceable Units (LRUs).

Table 5-1. LRU Removal and Replacement Procedures

LRU	Description	Weight		Procedure
		kg	lbs.	
A101	Active Input Filter Module	10	22	5.3.1.1
A103	Dead Battery Start Board	0.65	1.45	5.3.1.2
C101	Input Filter Capacitor	3.3	7.26	5.3.1.3
L107	Input EMI Choke	2.7	5.94	5.3.1.4
R104	Precharge Resistor	0.36	0.8	5.3.1.5
L202	IVPS Filter Choke	~0.7	~1.54	5.3.2.1
A307	AC Output EMI Module	4.55	10	5.3.3.1
R311	Discharge Resistor	0.15	0.32	5.3.3.2
U326	AC Current Sensor	0.13	0.275	5.3.3.3
C411	LVPS Capacitor	0.52	1.144	5.3.4.1
L402	LVPS Choke	0.23	0.503	5.3.4.2
A701	Converter Control Unit	0.3	0.66	5.3.5.1
A720	Converter Electronics Power Supply	0.34	0.754	5.3.5.2
A721	CAN Bus I/O Board	0.08	0.176	5.3.5.3
A727	Converter Electronics EMI Filter	0.12	0.264	5.3.5.4
A751	Multiple Vehicle Bus Interface	0.49	1.078	5.3.5.5
C720	Converter Electronics Filter Capacitor	0.07	0.151	5.3.5.6
R720	Discharge Resistor	~0.003	~0.005	5.3.5.7
V720	Blocking Diode	0.04	0.091	5.3.5.8
V721	Rectifier Diode	~0.003	~0.005	5.3.5.9
F901	Blower Fuse	~0.003	~0.005	5.3.6.1
M901	Blower Assembly	2.95	6.5	5.3.6.2

5.2.2 Power modules

Additionally are listed here in the following all power modules, which are mounted on heatsinks within the APS. These power modules can only be replaced through the bottom opening of the APS. According to their considerable weight, the replacement of these modules requires appropriate lifting equipment.

CAUTION

CONSIDER RISK FOR EQUIPMENT DAMAGE. IT IS RECOMMENDED THAT A SECOND PERSON BE USED TO SUPPORT THE MODULE AND MAINTAIN BALANCE/STABILITY WHEN BEING MANIPULATED INTO OR OUT OF THE CONVERTER.

The detailed replacement procedures for all power modules are described within the Heavy Repair Maintenance Manual. Consider also the general instructions for replacing of the power modules there!

Within the HRMM are then also described the detailed procedures for executing repair measurements within the power modules itself (e.g. exchange of IGBTs).

The following table provides a listing of all power modules that that can be exchanged through the bottom side of the APS.

Table 5-2. Power Module Removal and Replacement Procedures

Power Module	Description	Weight		Procedure in HRMM
		kg	lbs.	
A401	LVPS	16.2	35.7	Replace LVPS Module A401
A301	Inverter	22.0	48.5	Replace Inverter Module A301
A221	Buck-boost converter	24.2	53.4	Replace Buck-Boost Converter Module A221
A222	Series resonant chopper	24.8	54.7	Replace Series Resonance Chopper Module A222

5.3 LRU Removal and Replacement Procedures

5.3.1 Input Circuit (A100)

5.3.1.1 A101, Active Input Filter Module

This procedure covers the removal and installation of the A101 Active Input Filter Module from the APS.

WARNING

HEAVY OBJECTS: THIS COMPONENT IN THE AUXILIARY POWER SUPPLY HAS CONSIDERABLE WEIGHT. ALWAYS TAKE APPROPRIATE PRECAUTIONS WHEN LIFTING, ATTACHING, DETACHING OR MOVING COMPONENTS OR FASTENERS.

Required Materials:

- Cable Ties
- Labels
- Locktite

Special Equipment: None

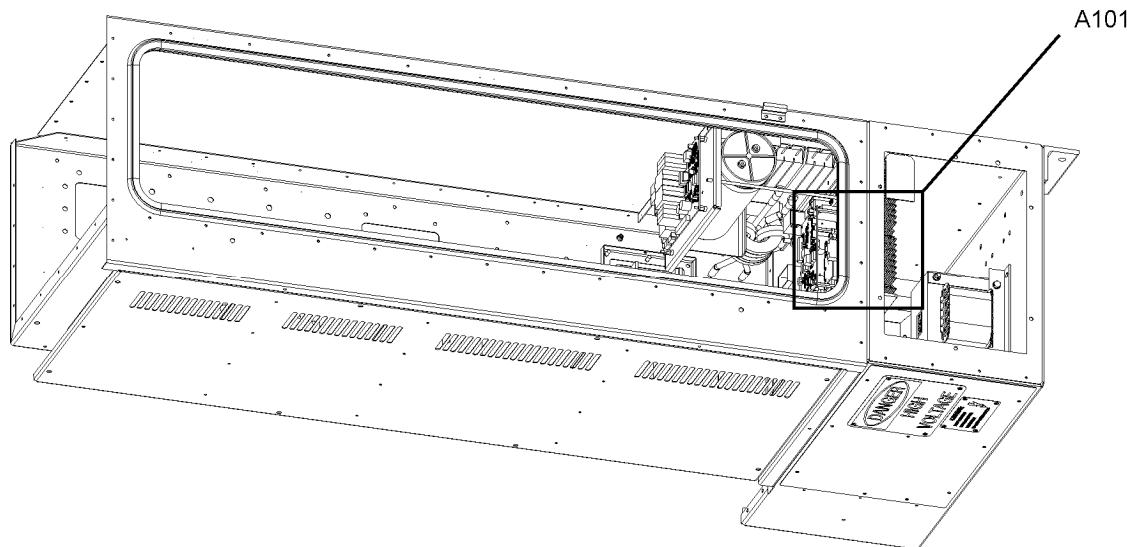


Figure 5-2: Location of A101

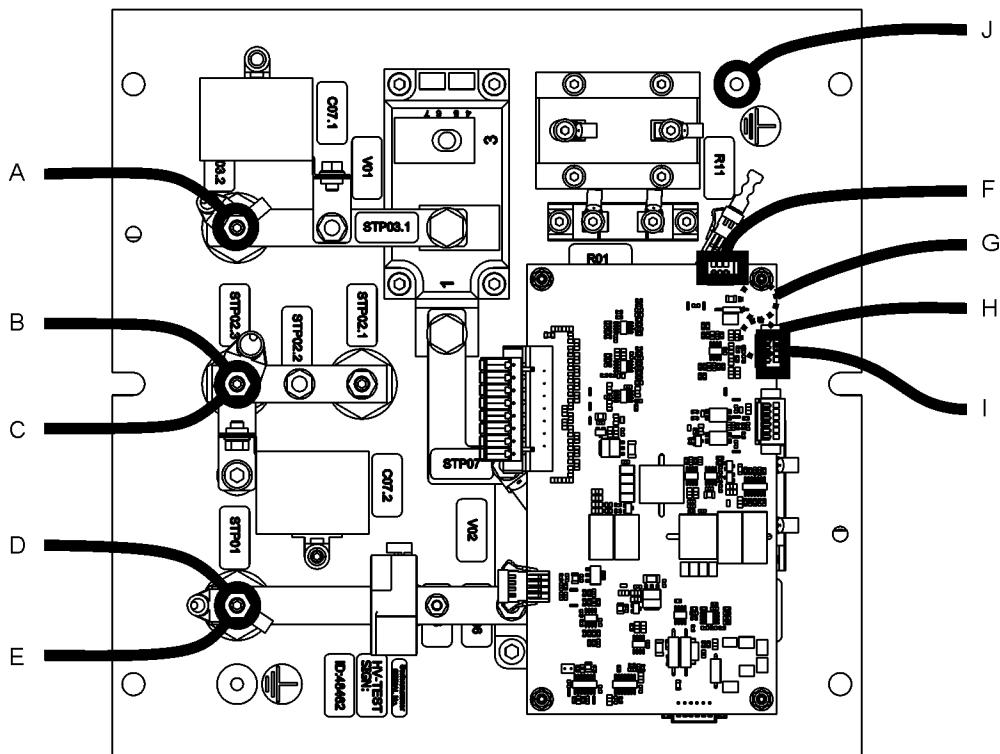


Figure 5-3: A101 Electrical Connections

A101 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	STP03.2	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
B	STP02.3	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
C	STP02.3	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
D	STP01	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
E	STP01	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
F	X1	Plug	None	
G	STP04	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
H	STP05	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
I	X2	Plug	None	
J	Ground	Ring	M6x10 Screw, M6 Schnorr Washer, M6 Flat Washer	53.1 lb-in (6 Nm)

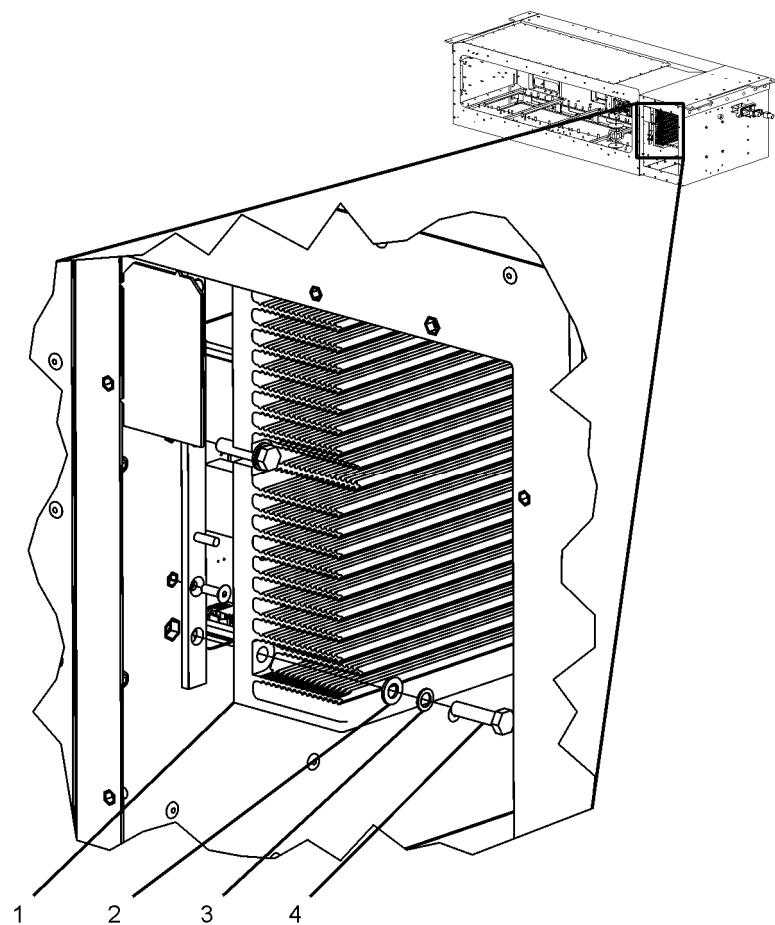


Figure 5-4: A101 Anchor Points

A101 Anchor Points Legend

Index	Description	Part Number
1	A101 Active Input Filter Module	48462
2	Flat Washer, M8	13134
3	Schnorr Washer, M8	39273
4	Screw, M8x35	17492

Removal

This procedure has to be used to remove the A101 Active Input Filter Module from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Remove Air Filter. Remove the air filter from the APS. See Section 3.3.14.
4. Locate A101. See Figure 5-2 for the location of A101. A101 is mounted in the Air Intake chamber of the APS.
5. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
6. Disconnect A101.
 - a. Disconnect External Cables. There are nine cables which connect to the A101. These connections are identified as A through I and are shown in Figure 5-3. Remove the fasteners and disconnect the cables.
 - b. Disconnect Ground. The A101 is grounded by a short jumper which attaches to the base of the module using an M6 flat washer, M6 Schnorr washer and M6x10 screw. Remove these fasteners to disconnect the ground cable.
 - c. Detach Cable Anchors. Cut cable ties as necessary to ensure extraction of the A101.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DANGER OF FALLING OBJECT. A101 IS MOUNTED ON A VERTICAL SURFACE AND WHEN DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN DETACHING THE A101, SUPPORT ITS WEIGHT UNTIL IT IS COMPLETELY REMOVED FROM THE APS.

7. Detach A101 (see Figure 5-4). A101 (1) is mounted to the bulkhead separating the air intake chamber from the dry area of the APS and is anchored to the bulkhead at six anchor points using M8x35 screws (4), M8 flat washers (2) and M8 Schnorr washers (3) at each point.
 - a. Remove the bottom four sets (two sets on each side) of fasteners on the A101 module and store in a safe place.
 - b. Support the weight of the module!
 - c. Remove the top two sets of fasteners on the module and store in a safe place.

CAUTION

POTENTIAL DAMAGE TO MODULE. WHEN MANIPULATING THE A101, BE CAREFUL TO AVOID DAMAGE TO THE VANES OF THE HEAT SINK. BREAKING OR BENDING THE VANES (FINS) WILL AFFECT THE HEAT DISSIPATION PROPERTIES OF THE HEAT SINK.

8. Remove A101 Module. Extract the A101 module from the APS.
9. Inspect Gasket. The A101 cavity is bordered by a gasket which isolates the dry area of the APS from the air intake chamber. Inspect the gasket for signs of wear or deterioration.
10. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A101 Module.

Installation

This procedure has to be used to install the A101 Active Input Filter Module into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Gasket. The A101 cavity is bordered by a gasket which isolates the dry area of the APS from the air intake chamber. Inspect the gasket for signs of wear or deterioration.

CAUTION

POTENTIAL DAMAGE TO MODULE. WHEN MANIPULATING THE A101, BE CAREFUL TO AVOID DAMAGE TO THE VANES OF THE HEAT SINK. BREAKING OR BENDING THE VANES (FINS) WILL AFFECT THE HEAT DISSIPATION PROPERTIES OF THE HEAT SINK.

CAUTION

DANGER OF FALLING OBJECT. A101 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN ATTACHING THE A101, SUPPORT ITS WEIGHT UNTIL IT IS FULLY MOUNTED IN THE APS.

2. Insert A101 Module (see Figure 5-4). Orient the A101 module (1) so that it is seen as shown in Figure 5-3.
3. Attach A101. A101 (1) is mounted to the bulkhead separating the air intake chamber from the dry area of the APS and is anchored to the bulkhead at six anchor points using M8x35 screws (4), M8 flat washers (2) and M8 Schnorr washers (3) at each point.
 - a. Install the top two sets of fasteners on the module and finger tighten.
 - b. Install the bottom four sets (two sets on each side) of fasteners on the A101 module.
 - c. Tighten all fasteners to 53.1 lb-in (6 Nm).
4. Connect A101.
 - a. Connect Ground. The A101 is grounded by a short jumper which attaches to the base of the module (see item J in Figure 5-3) using an M6 flat washer, M6 Schnorr washer and M6x10 screw. Affix these fasteners to connect the ground cable.
 - b. Connect External Cables. There are nine cables which connect to the A101. These connections are identified as A through I and are shown in Figure 5-3. Affix the fasteners and connect the cables.
 - c. Attach Cable Anchors. Replace cut cable ties as necessary to ensure cables do not move freely.
5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Replace Air Filter Cover and Air Filter from the APS. See Section 3.3.14.
7. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.1.2 A103, Dead Battery Start Module

This procedure covers the removal and installation of the A103 Dead Battery Start Module from the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

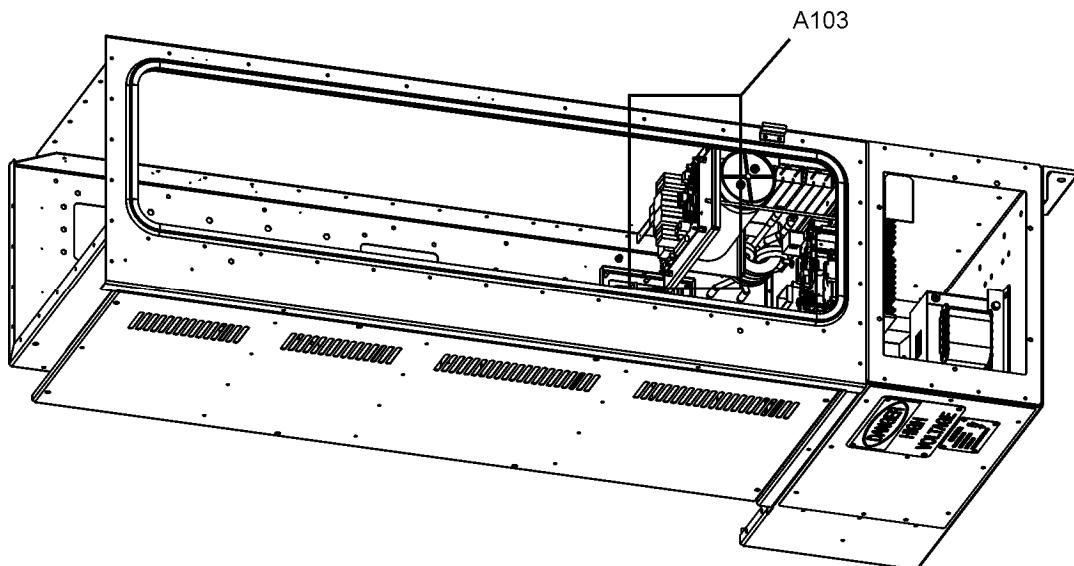


Figure 5-5: Location of A103

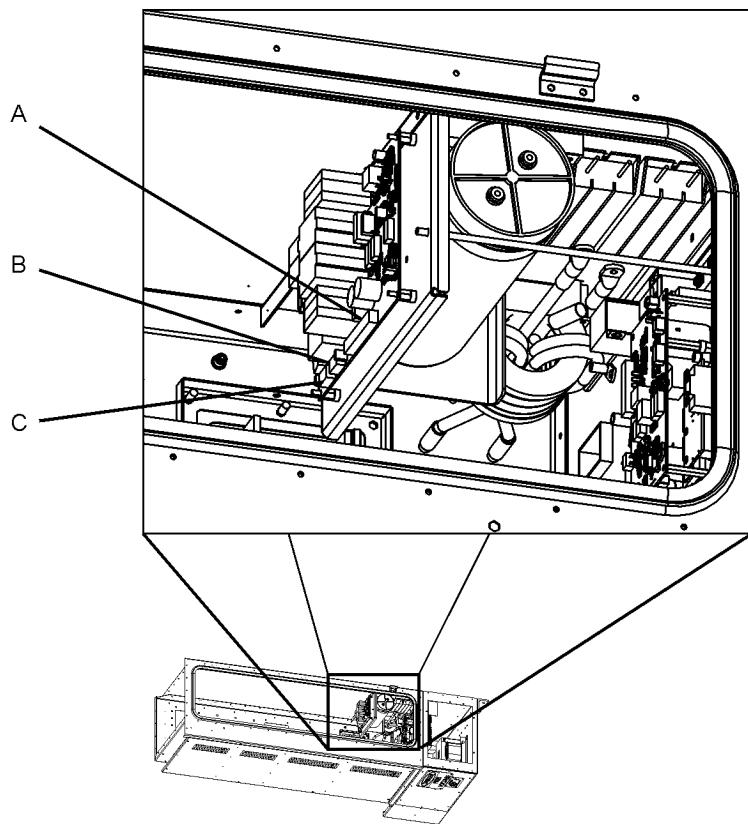


Figure 5-6: A103 Electrical Connections

A103 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	X5	Plug	None	N/A
B	X4	Plug	None	N/A
C	X2	Plug	None	N/A

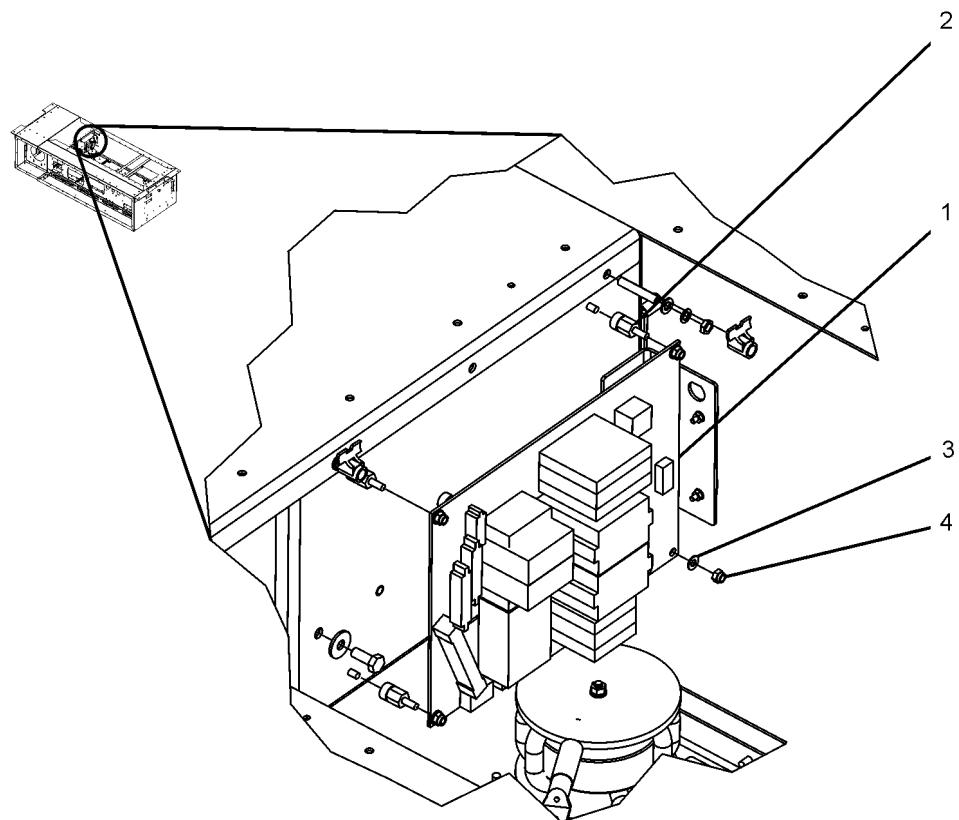


Figure 5-7: A103 Anchor Points

A103 Anchor Points Legend

Index	Description	Part Number
1	A103 Dead Battery Start PCB	48470
2	Standoff, M4x15	18592
3	Washer, M4	13132
4	Locking Nut, M4	47525

Removal

This procedure has to be used to remove the A103 Dead Battery Start Module from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate A103. See Figure 5-5 for the location of the A103. A103 is mounted on a panel next to the C101 Capacitor which is near the roof of the structure in the dry area of the APS.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect A103.
 - a. Disconnect External Cables. There are three cables which connect to the A103. These connections are identified as A, B & C and are shown in Figure 5-6. Unplug the cables.
 - b. Detach Cable Anchors. Cut cable ties as necessary to ensure extraction of the A103.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DANGER OF FALLING OBJECT. A103 IS MOUNTED ON A VERTICAL SURFACE AND WHEN DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN DETACHING THE A103, SUPPORT ITS WEIGHT UNTIL IT IS COMPLETELY REMOVED FROM THE APS.

6. Detach A103 (see Figure 5-7). A103 (1) is mounted atop M4x15 Standoffs (2) at four anchor points using M4 locking nuts (4) and M8 washers (3) at each point. Remove these fasteners to detach the A103.
7. Remove A103 Module. Extract the A103 module from the APS.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A103 Module.

Installation

This procedure has to be used to install the A103 Dead Battery Start Module into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DANGER OF FALLING OBJECT. A103 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN ATTACHING THE A103, SUPPORT ITS WEIGHT UNTIL IT IS FULLY MOUNTED IN THE APS.

2. Insert A103 Module (see Figure 5-7). Orient the A103 module (1) so that it is seen as shown.
3. Attach A103. A103 (1) is mounted atop M4x15 Standoffs (2) at four anchor points using M4 locking nuts (4) and M4 washers (3) at each point. Affix these fasteners to attach the A103. Tighten the locking nut to fit.
4. Connect A103.
 - a. Connect External Cables. There are three cables which connect to the A103. These connections are identified as A, B & C and are shown in Figure 5-6. Insert the plugs for the cables.
 - b. Attach Cable Anchors. Install cable ties as necessary to ensure cables will not move during operation of the APS.
5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.1.3 C101, Input Filter Capacitor

This procedure covers the removal and installation of the C101 Input Filter Capacitor from the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

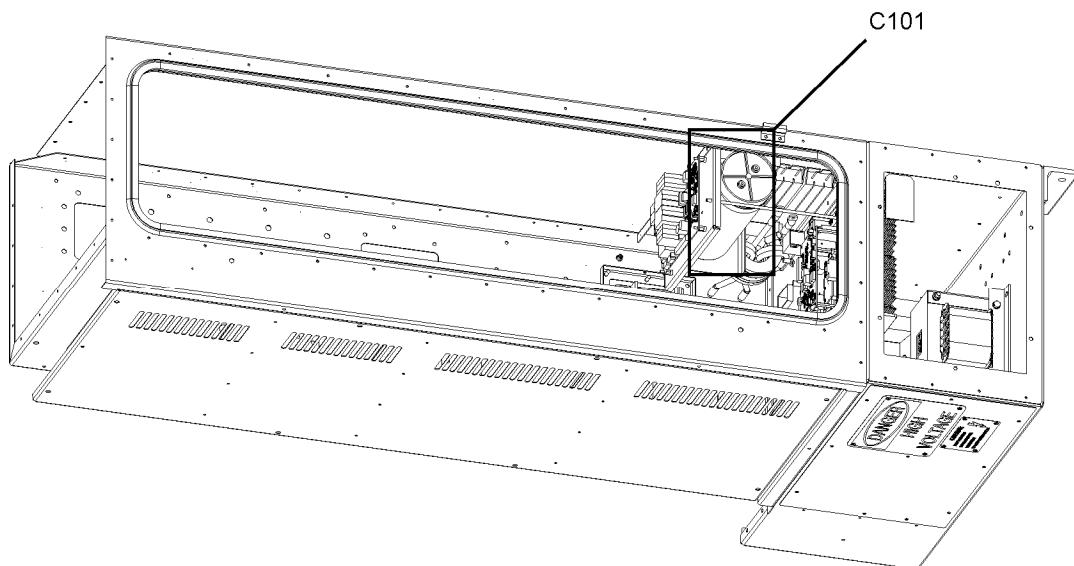


Figure 5-8: Location of C101

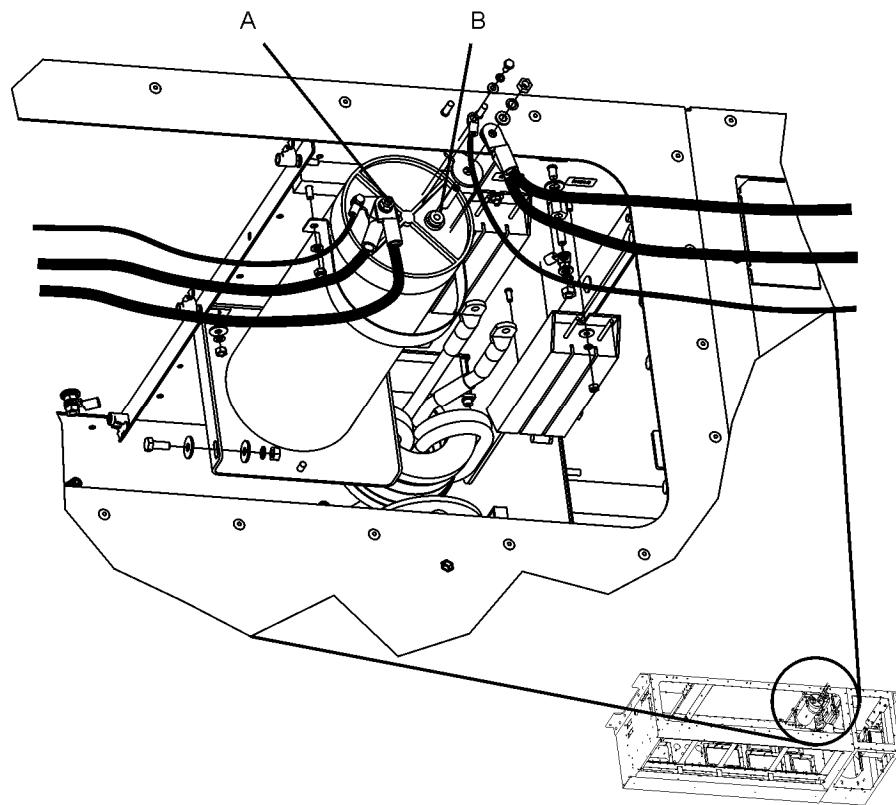


Figure 5-9: C101 Electrical Connections

C101 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	C101.1	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	77 lb-in (8.7 Nm)
B	C101.2	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	77 lb-in (8.7 Nm)

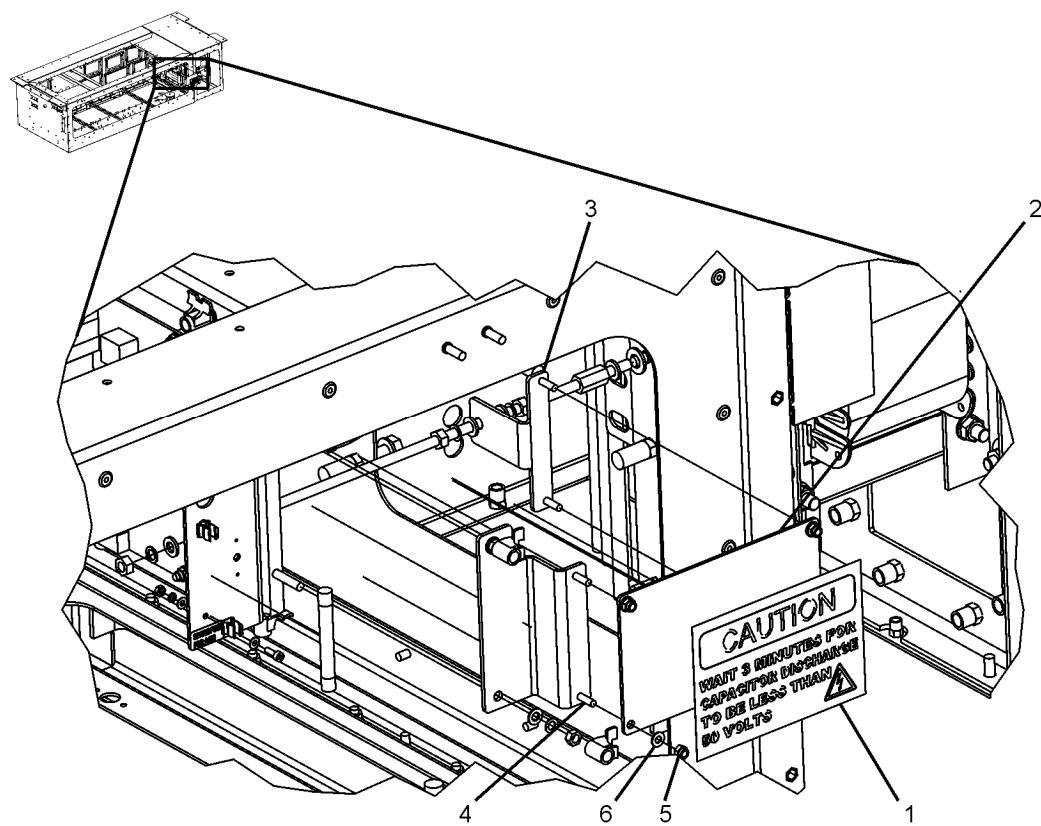


Figure 5-10: C101 Capacitor Shield

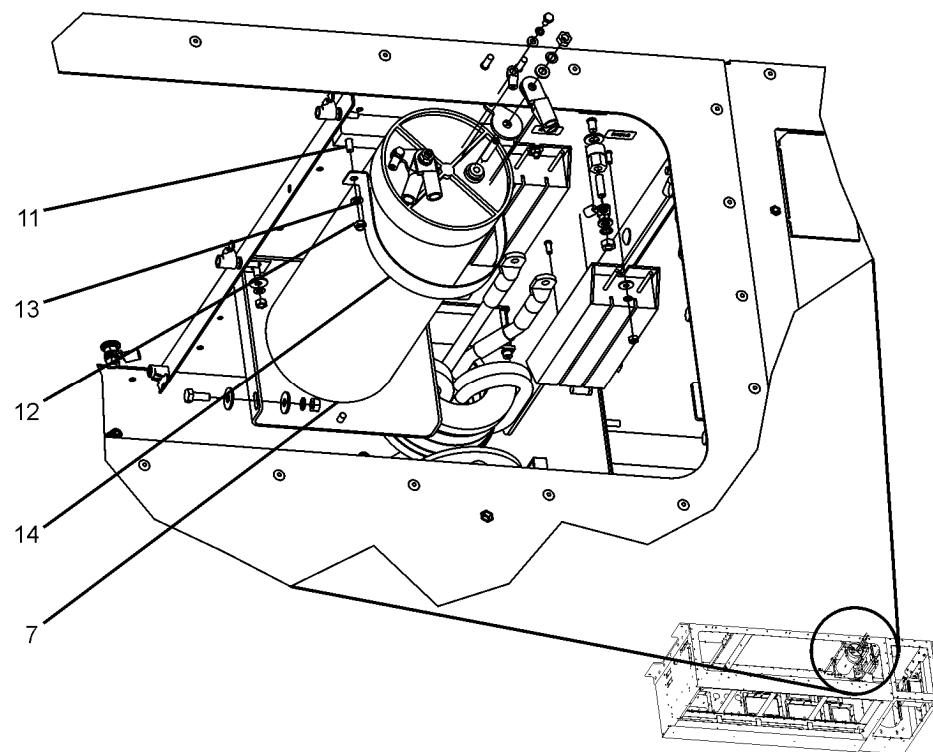


Figure 5-11: C101 Capacitor Mechanical Connections (Part 1)

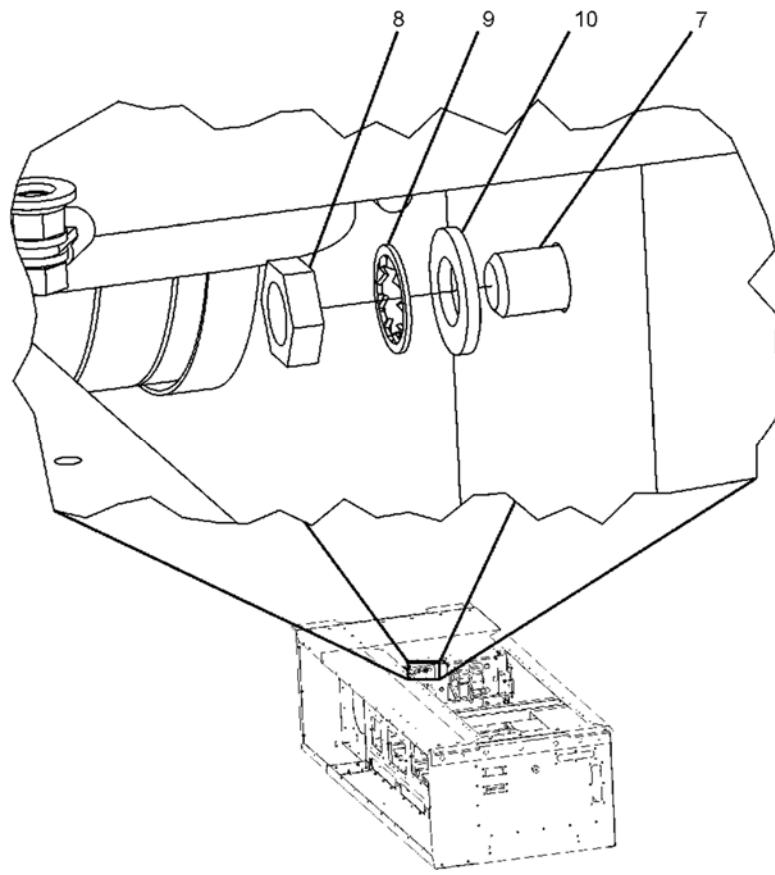


Figure 5-12: C101 Capacitor Mechanical Connections (Part 2)

C101 Capacitor Shield and Mechanical Connections Legend

Index	Description	Part Number
1	Caution Label	25836
2	Mounting Plate	71121
3	Holding Device A	71125
4	Holding Device B	71123
5	Locking Nut, M4	47525
6	Washer, M4	13132
7	Capacitor, C101	37477
8	Nut, Low Profile, M12	55464
9	Schnorr Washer, Star, M12	60134
10	Washer, M12	43252
11	Holding Device C	40808
12	Locking Nut, M5	47563
13	Washer, M5	12142
14	Holding Device D	40811

Removal

This procedure has to be used to remove the C101 Input Filter Capacitor from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate C101. See Figure 5-8 for the location of the C101. The C101 is mounted in a recess behind a panel displaying a caution message.
4. Remove C101 Shield (see Figure 5-10). A shield (2) adorned with a caution message (1) regarding residual voltage in C101 acts as both signage and a safety device and blocks access to the C101. This shield is mounted on two holding devices (3 & 4) at two anchor points on each. The shield is held in place using M4 locking nuts (5) and M4 washers (6).
 - a. Remove Fasteners. Remove the four M4 locking nuts (5) and four M4 washers (6).
 - b. Remove Shield. Pull the shield (2) off the anchor points on the two holding devices (3 & 4).
 - c. Inspect Caution Label. Inspect the caution sign (1) for damage and readability. Replace if needed.
5. Inspect Cables and Connections. Verify the labels on all cables connecting to the C101 (see Figure 5-9) and on the connection terminals are clear and legible. Replace these labels if necessary.
6. Disconnect C101.
 - a. Disconnect External Cables. There are six cables which connect to the C101 at two connection points. These connection points are identified as A & B and are shown in Figure 5-9. The cables are connected in groups of three on the poles of the C101 Capacitor and are fastened in place with M6 nut, washer and Schnorr washer sets. Remove these fasteners and disconnect the cables on both poles of the capacitor.
 - b. Detach Cable Anchors. Cut cable ties as necessary to ensure extraction of the C101.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DANGER OF FALLING OBJECT. C101 IS MOUNTED ON AN OVERHEAD SURFACE AND WHEN DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN DETACHING THE C101, SUPPORT ITS WEIGHT UNTIL IT IS COMPLETELY REMOVED FROM THE APS.

7. Detach C101 (see Figure 5-12). C101 (7) is mounted at the rear to a holding device using an M12 nut (8), M12 Schnorr washer (9) and M12 washer (10). Remove these fasteners to detach the C101.
8. Loosen C101 (see Figure 5-11). The C101 (7) is held in place against one holding device (11) by another holding device (14). Loosen the fasteners, an M5 locking nut (12) and an M5 washer (13) to loosen the C101.
9. Remove C101 Module. Extract the C101 by pulling horizontally straight out of the APS.
10. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the C101 Module.

Installation

This procedure has to be used to install the C101 Input Filter Capacitor into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DANGER OF FALLING OBJECT. C101 IS MOUNTED ON AN OVERHEAD SURFACE AND WHILE DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN ATTACHING THE C101, SUPPORT ITS WEIGHT UNTIL IT IS FULLY MOUNTED IN THE APS.

2. Install C101.

- a. Insert C101 Capacitor (see Figure 5-11). Be sure the body of the capacitor (7) is within the holding devices (11 & 14) and that the threaded stud is firmly seated through the mounting plate as shown in Figure 5-12.
- b. Secure C101 (see Figure 5-11). The C101 (7) is held in place against one holding device (11) by another holding device (14). Tighten the fasteners, an M5 locking nut (12) and an M5 washer (13) to secure the C101.
- c. Attach C101 (see Figure 5-12). C101 (7) is mounted at the rear to a holding device using an M12 nut (8), M12 Schnorr washer (9) and M12 washer (10). Affix these fasteners to attach the C101. Tighten the nut to fit.

3. Connect C101.

- a. Connect External Cables. There are six cables which connect to the C101 at two connection points. These connection points are identified as A & B and are shown in Figure 5-9. The cables are connected in groups of three on the poles of the C101 Capacitor and are fastened in place with M6 nut, washer and Schnorr washer sets. Connect the cables and affix these fasteners.
 - b. Attach Cable Anchors. Add cable ties as necessary to ensure cables do not move during APS operation.
4. Replace C101 Shield (see Figure 5-10). A shield (2) adorned with a caution message (1) regarding residual voltage in C101 acts as both signage and a safety device and blocks access to the C101. This shield is mounted on two holding devices (3 & 4) at two anchor points on each. The shield is held in place using M4 locking nuts (5) and M4 washers (6).
- a. Inspect Caution Label. Inspect the caution sign (1) for damage and readability. Replace if needed.
 - b. Install Shield. Position the shield (2) on the anchor points on the two holding devices (3 & 4) with the writing on the sign (1) upright and facing forward.
 - c. Affix Fasteners. Add the four M4 locking nuts (5) and four M4 washers (6). Tighten the nuts to fit.
5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.1.4 L107, Input EMI Choke

This procedure covers the removal and installation of the L107 EMI Choke from the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

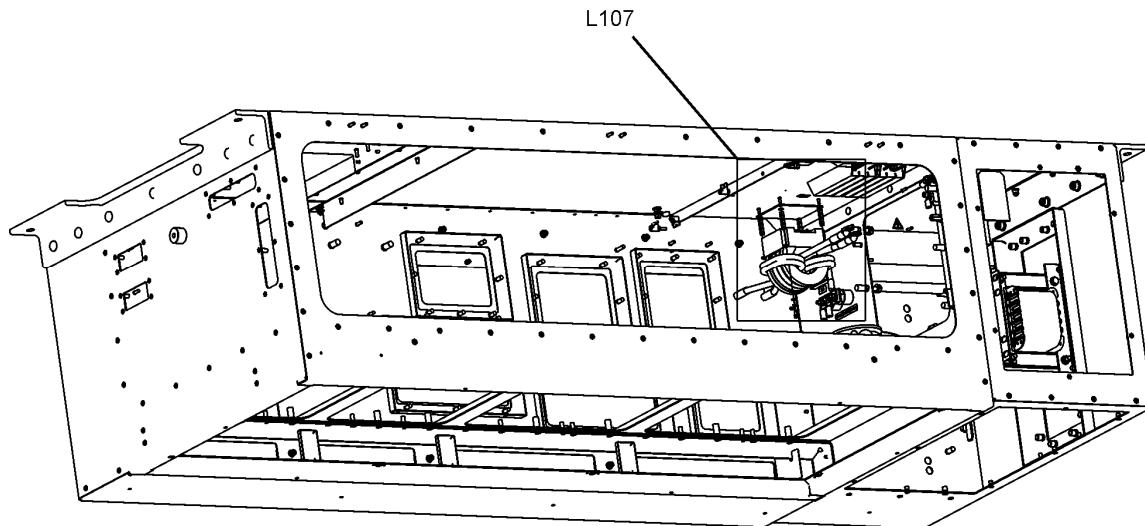


Figure 5-13: Location of L107

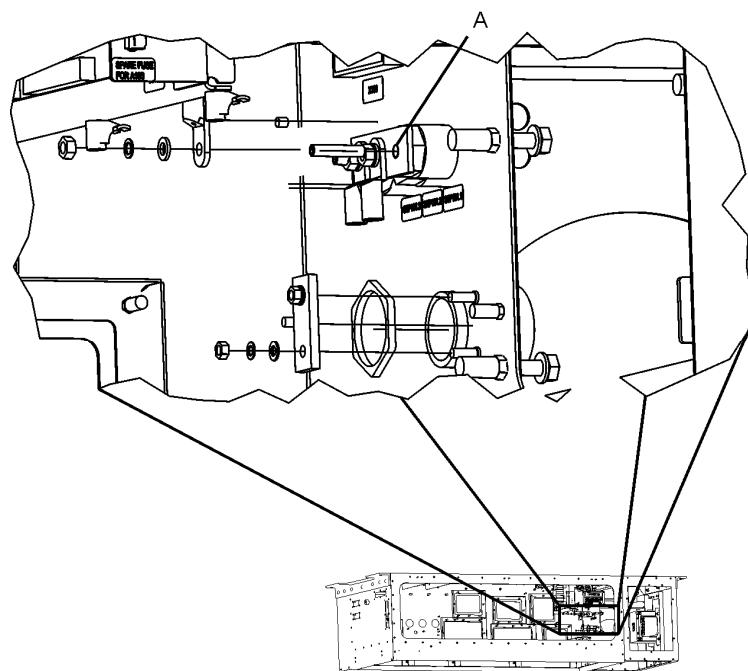


Figure 5-14: L107 Electrical Connections on STP101.1

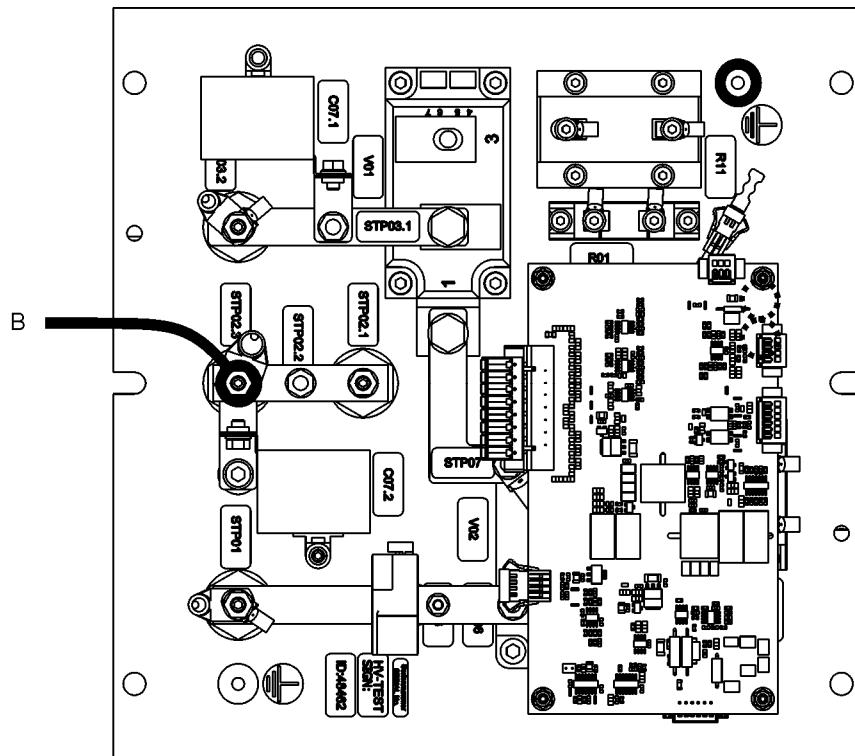


Figure 5-15: L107 Electrical Connections on A101

L107 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	STP101.1	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
B	A101/STP02.3	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)

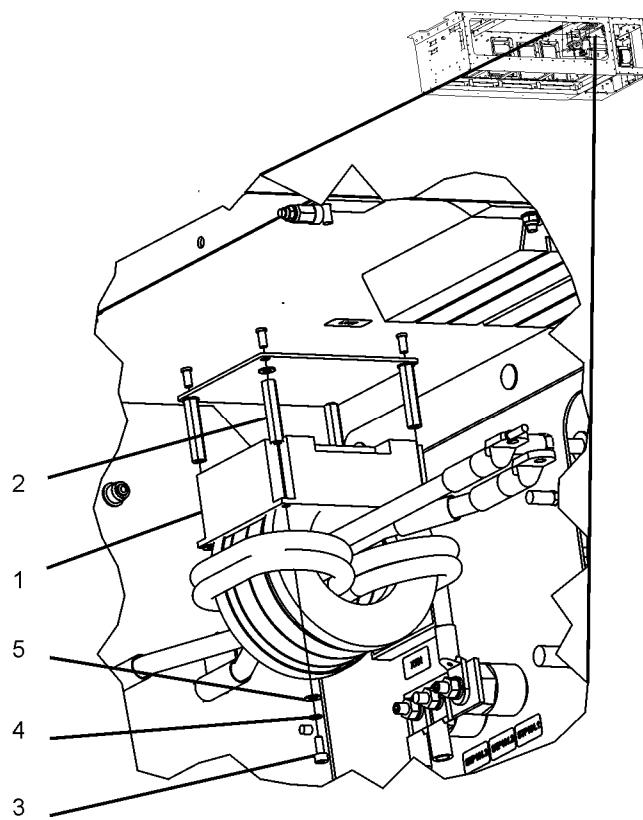


Figure 5-16: L107 Anchor Points

L107 Anchor Points Legend

Index	Description	Part Number
1	Choke, L107	48464
2	Standoff, M4x35	31711
3	Screw, M4x10	54146
4	Schnorr Washer, M4	39272
5	Washer, M4	13132

Removal

This procedure has to be used to remove the L107 EMI Choke from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate L107. See Figure 5-13 for the location of the L107. L107 is mounted on the ceiling, behind the C101 Capacitor.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect L107.

NOTE: The electrical cables which are wound around chokes and transformers are generally continuous and terminate at other points in the converter. As such it is usually necessary to disconnect chokes and transformers from the remote location.

The cabling for L107 emerges from the Input connector, X101, winds through the L107 Choke and then connects to two remote locations, STP101.1 and STP02.3 on the A101 module.

- a. Disconnect cable at STP101.1 (see Figure 5-14). Two cables lead in from the X101 Input Terminal and make a total of three turns through the L107 Choke before leading to their termination points. One cable terminates at STP101.1 (A) and is fastened with M6 nut, M6 Schnorr washer and M6 washer. Remove these fasteners and disconnect the choke from STP101.1.
- b. Disconnect cable at STP02.3 on the A101 module (see Figure 5-15). Two cables lead in from the X101 Input Terminal and make a total of three turns through the L107 Choke before leading to their termination points. One cable terminates at STP02.3 (B) on the A101 module and is fastened with M6 nut, M6 Schnorr washer and M6 washer. Remove these fasteners and disconnect the choke from the A101 module.
- c. Disengage cables from L107. Clip the cable ties and unwrap the cables from the L107 Choke.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DANGER OF FALLING OBJECT. L107 IS MOUNTED INVERTED ON AN OVERHEAD SURFACE AND WHEN DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN DETACHING THE L107, SUPPORT ITS WEIGHT UNTIL IT IS COMPLETELY REMOVED FROM THE APS.

6. Detach L107 (see Figure 5-16). The L107 (1) is suspended from four M4x35 Standoffs (2) at four anchor points and is held in place by M4 screws (3), M4 Schnorr washers (4) and M4 flat washers (5) at each point. Remove these fasteners to detach the L107.
7. Remove L107 Choke. To extract the L107, pull straight down on the component (1) until it clears the standoffs (2). Then manipulate the component sideways behind the C101 Capacitor and A103 Dead Battery Start module. After then extract the choke from the unit.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the L107 Module.

Installation

This procedure has to be used to install the L107 EMI Choke into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DANGER OF FALLING OBJECT. L107 IS MOUNTED INVERTED ON AN OVERHEAD SURFACE AND WHILE DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN ATTACHING THE L107, SUPPORT ITS WEIGHT UNTIL IT IS FULLY MOUNTED IN THE APS.

2. Insert L107 Choke (see Figure 5-16). Manipulate the choke into the converter above the SRC Module and then around behind the A103 and C101. Orient the L107 Choke (1) so that it is seen as shown in the figure.
3. Attach L107 (see Figure 5-16). The L107 (1) is suspended from four M4x35 Standoffs (2) at four anchor points and is held in place by M4 screws (3), M4 Schnorr washers (4) and M4 flat washers (5) at each point. Affix these fasteners to attach the L107. Tighten the screws to 23 lb-in (2.6 Nm) of torque.
4. Disconnect L107.

NOTE: The electrical cables which are wound around chokes and transformers are generally continuous and terminate at other points in the converter. As such it is usually necessary to disconnect chokes and transformers from the remote location.

The cabling for L107 emerges from the Input connector, X101, winds through the L107 Choke and then connects to two remote locations, STP101.1 and STP02.3 on the A101 module.

- a. Engage cables to L107. Pass the cables from back to front through the L107 rings and wrap the cables around the choke twice to emerge from the choke's front. The cables must pass through the choke a total of three times.
- b. Connect cable at STP101.1 (see Figure 5-14). Two cables lead in from the X101 Input Terminal and make a total of three turns through the L107 Choke before leading to their termination points. One cable terminates at STP101.1 (A) and is fastened with M6 nut, M6 Schnorr washer and M6 washer. Connect the cable and affix these fasteners to STP101.1.
- c. Connect cable at STP02.3 on the A101 module (see Figure 5-15). Two cables lead in from the X101 Input Terminal and make a total of three turns through the L107 Choke before leading to their termination points. One cable terminates at STP02.3 (B) on the A101 module and is fastened with M6 nut, M6 Schnorr washer and M6 washer. Connect the cable and affix these fasteners to the A101 module.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES SO THAT THEY WILL NOT MOVE WHILE THE TRAIN IS MOVING.

5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.1.5 R104.1 & R104.2, Precharge Resistors

This procedure covers the removal and installation of the R104 Precharge Resistors from the APS. There are two resistors labeled R104.1 and R104.2. Facing the APS, R104.1 is on the left and R104.2 is on the right.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

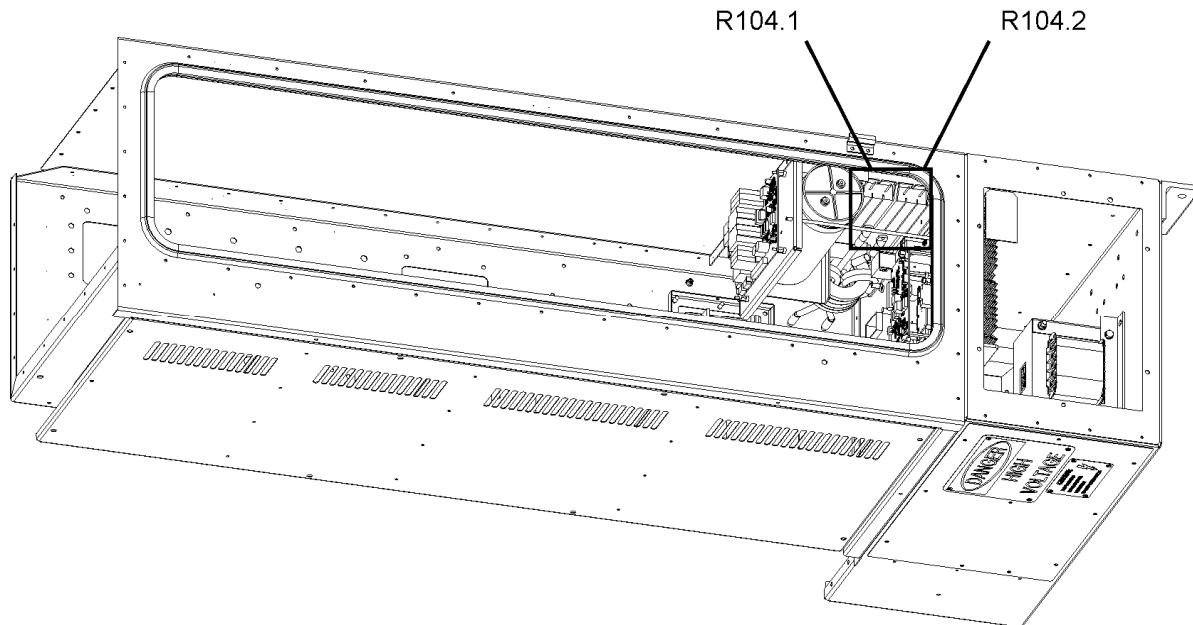


Figure 5-17: Location of R104.1 & R104.2

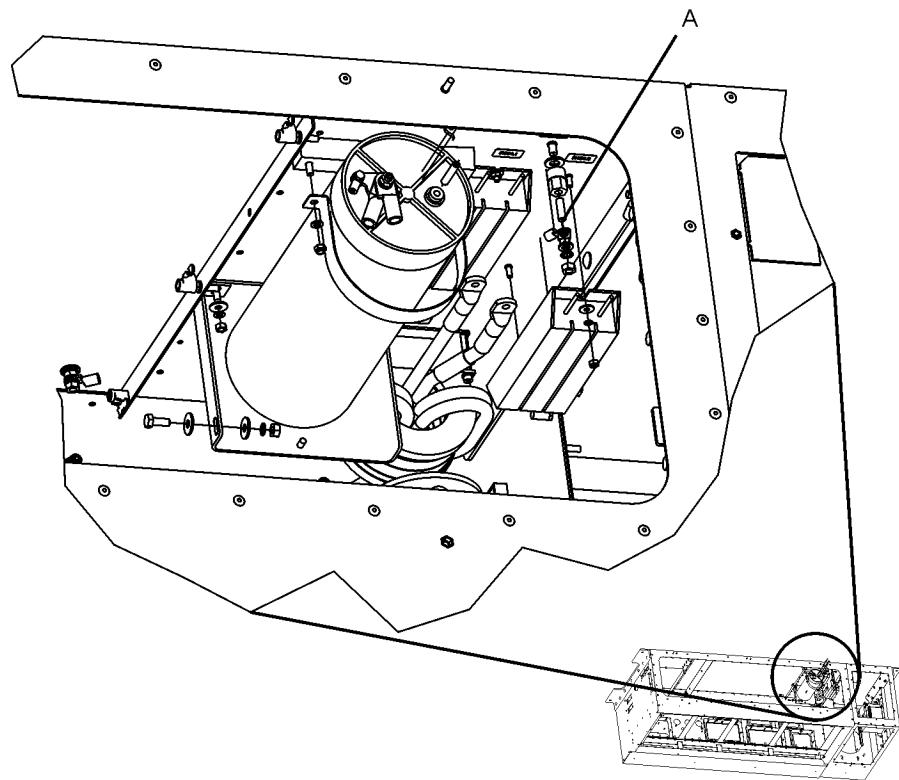


Figure 5-18: R104.1-2 Electrical Connections on STP-R104

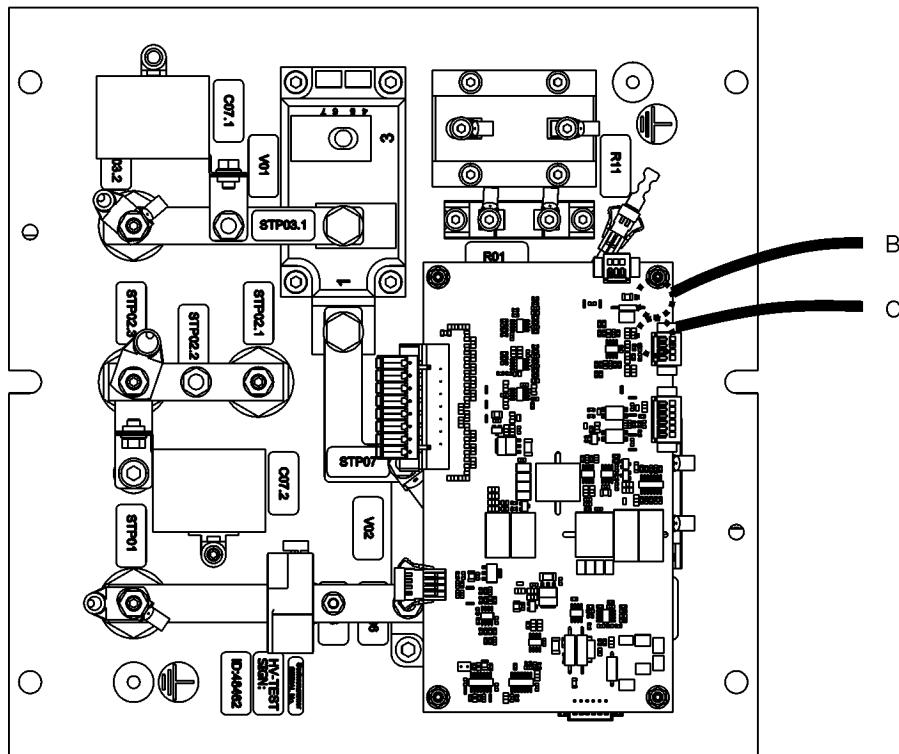


Figure 5-19: R104.1-2 Electrical Connections on A101

R104 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	STP-R104	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
B	A101/STP04	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)
C	A101/STP05	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)

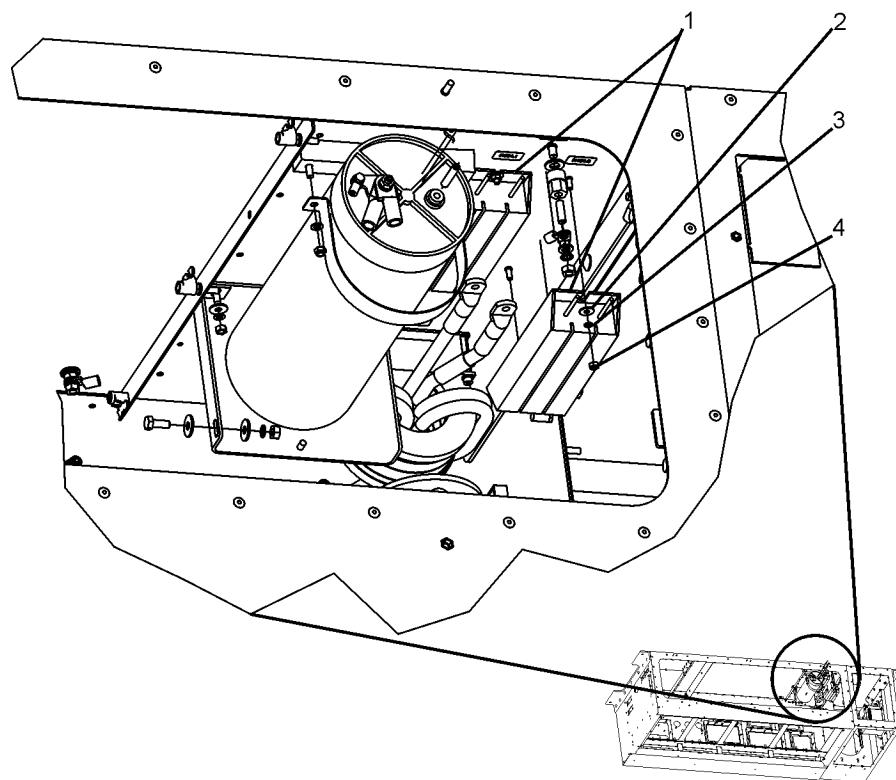


Figure 5-20: R104.1 & R104.2 Anchor Points

R104 Anchor Points Legend

Index	Description	Part Number
1	Resistor R104.1 or R104.2	48680
2	Flat Washer, M4	17324
3	Schnorr Washer, M4	39272
4	Nut, M4	13109

Removal

This procedure has to be used to remove the R104.1 and/or R104.2 Precharge Resistors from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate R104.1 and or R104.2. See Figure 5-17 for the location of the resistor(s) to be removed.
4. The R104.1 is on the side closer to the C101 and the R104.2 is on the side closer to the A101.
5. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.

NOTE: There are two R104 resistors. Repeat the applicable steps of this procedure for each resistor as needed.

6. Disconnect R104.

NOTE: The electrical cables are part of the resistors themselves and terminate at other points in the converter. As such it is necessary to disconnect these resistors at the remote location.

- a. Disconnect cable at STP-R104 (see Figure 5-18). Both resistors have one cable terminating at this junction and fastened with an M6 nut, M6 Schnorr washer and M6 washer. Remove these fasteners and disconnect the resistor from STP-R104.
- b. Disconnect cable on the A101 module (see Figure 5-19). Each resistor has a lead that is terminated on the A101 module. Consult the figure and legend for the applicable STP point on the A101 to disconnect. The cables are fastened with M6 nut, M6 Schnorr washer and M6 washer. Remove these fasteners and disconnect the resistor from the A101 module.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DANGER OF FALLING OBJECT. R104.1 & R104.2 ARE MOUNTED INVERTED ON AN OVERHEAD SURFACE AND WHEN DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN DETACHING THE R104, SUPPORT THEIR WEIGHT UNTIL THEY ARE COMPLETELY REMOVED FROM THE APS.

7. Detach R104 (see Figure 5-20). The R104 (1) is suspended from two anchor points and is held in place by M4 nuts (4), M4 Schnorr washers (3) and M4 flat washers (2) at each point. Remove these fasteners to detach the R104.
8. Remove R104. To extract the R104, pull straight down until the resistor clears the mounting points, then extract the resistor from the unit.
9. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the R104.

Installation

This procedure has to be used to install the R104.1 and/or R104.2 Precharge Resistor into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DANGER OF FALLING OBJECT. R104 IS MOUNTED INVERTED ON AN OVERHEAD SURFACE AND WHILE DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN ATTACHING THE R104, SUPPORT ITS WEIGHT UNTIL IT IS FULLY MOUNTED IN THE APS.

2. Insert R104 (see Figure 5-20). Insert the resistor by aligning the mounting slots on the resistor casing with the anchor points. Orient the resistor with the integrated leads toward the front of the APS, as shown in the figure.
3. Attach R104 (see Figure 5-20). The R104 (1) is suspended from two anchor points and is held in place by M4 nuts (4), M4 Schnorr washers (3) and M4 flat washers (2) at each point. Affix these fasteners to attach the R104. Tighten the nuts to 23 lb-in (2.6 Nm) of torque.

4. Connect L107.

NOTE: The electrical cables are part of the resistors themselves and terminate at other points in the converter. As such it is necessary to connect these resistors at the remote location.

- a. Connect cable at STP-R104 (see Figure 5-18). Both resistors have one cable terminating at this junction and fastened with an M6 nut, M6 Schnorr washer and M6 washer. Connect the cable and affix these fasteners to connect the resistor to STP-R104.
- b. Connect cable on the A101 module (see Figure 5-19). Each resistor has a lead that is terminated on the A101 module. Consult the figure and legend for the applicable STP point on the A101 to connect. The cables are fastened with M6 nut, M6 Schnorr washer and M6 washer. Connect the cable and affix these fasteners to connect the resistor to the A101 module.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES SO THAT THEY WILL NOT MOVE WHILE THE TRAIN IS MOVING.

5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.2 Intermediate Circuit (A200)

5.3.2.1 L202.1 & L202.2, IVPS Chokes

This procedure covers the removal and installation of the L202 IVPS Chokes, L202.1 is on the left and L202.2 is on the right.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

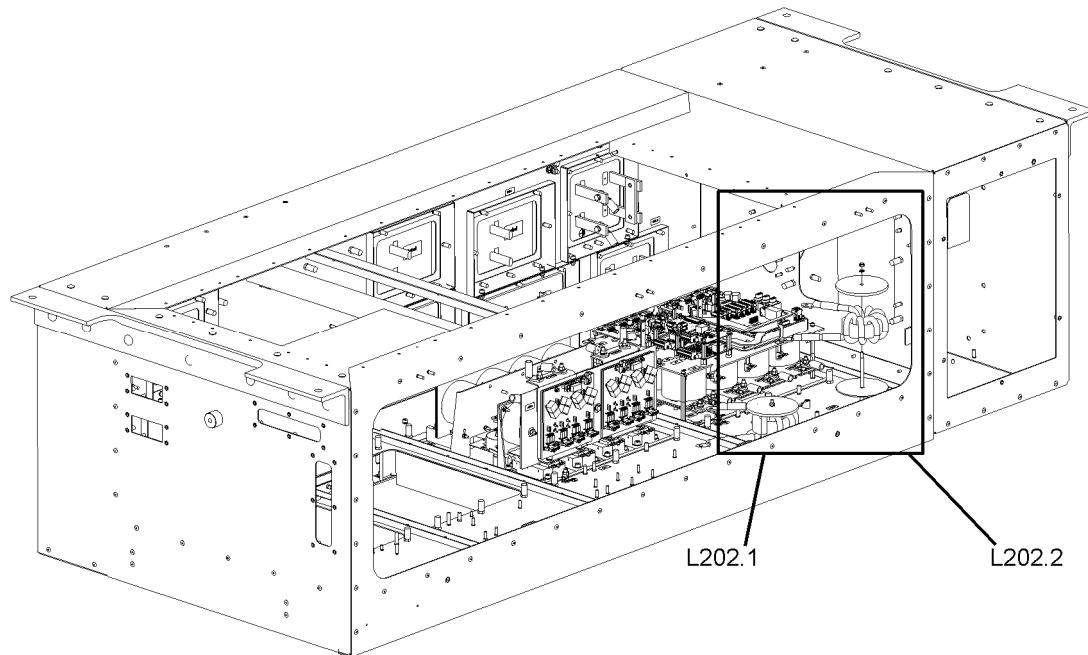


Figure 5-21: Location of L202.1 & L202.2

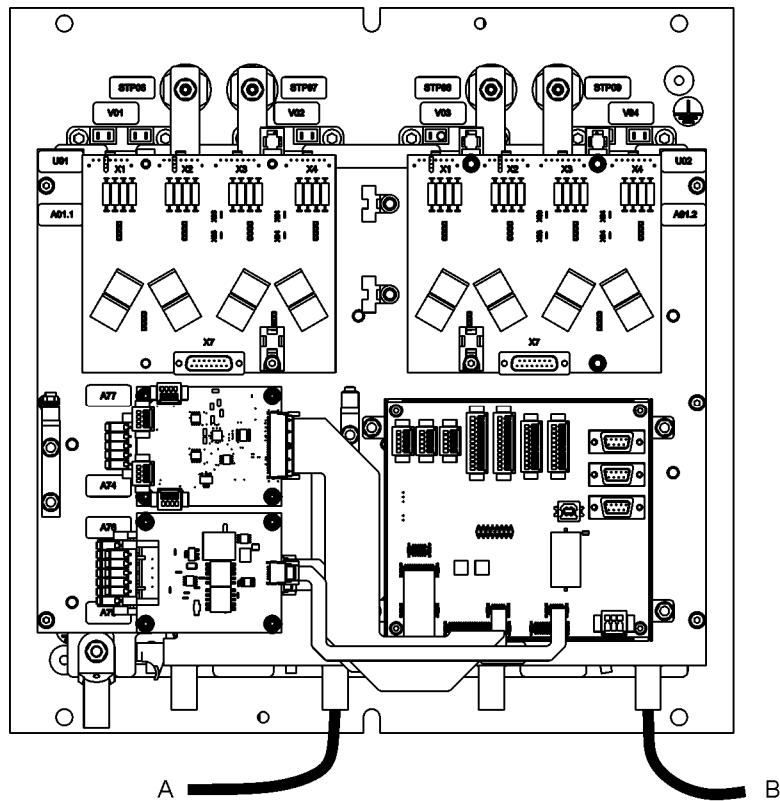


Figure 5-22: L202.1.-2 Electrical Connections on BBC Module A221

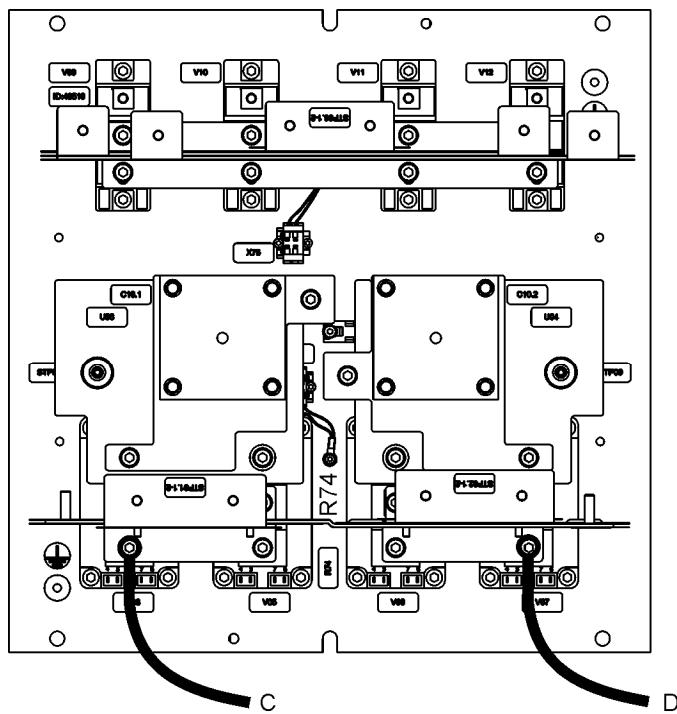


Figure 5-23: L202.1-2 Electrical Connections on SRC Module A222

L202 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A221/STP03.1	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	53 lb-in (6 Nm)
B	A221/STP04.1	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	53 lb-in (6 Nm)
C	A222/STP01.2	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	53 lb-in (6 Nm)
D	A222/STP02.2	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	53 lb-in (6 Nm)

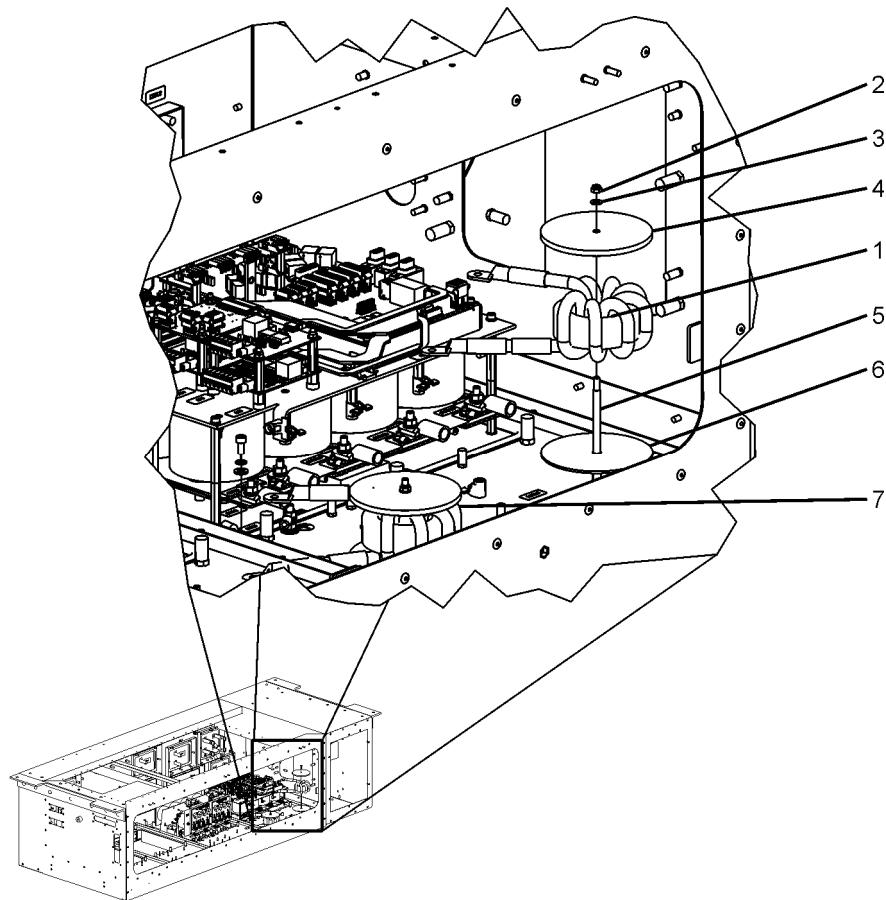


Figure 5-24: L202.1 & L202.2 Anchor Points

L202 Anchor Points Legend

Index	Description	Part Number
1	Ring Core Choke, L202.2	70150
2	Locking Nut, M5	47563
3	Washer, M5	12142
4	Plate	28930
5	Rod, M5x65	29787
6	Base	28932
7	Ring Core Choke, L202.1	70149

Removal

This procedure has to be used to remove the L202.1 and/or L202.2 IVPS Chokes from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate L202.1 and or L202.2. See Figure 5-21 for the location of the choke(s) to be removed. The L202.1 is on the side closer to the SRC module and the L202.2 is on the side farther from to the SRC module.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.

NOTE: There are two L202 Chokes. Repeat the applicable steps of this procedure for each Choke as needed.

5. Disconnect L202. In Figure 5-22 and in Figure 5-23, the electrical connections for L202.1 are labeled A and C and the electrical connections for L202.2 are labeled B and D.

NOTE: The electrical cables are part of the chokes themselves and terminate at other points in the converter. As such it is necessary to disconnect these chokes at the remote location.

- a. Disconnect cables on the BBCM (see Figure 5-22). Each choke has a lead that is terminated on the A221 module. Consult the figure and legend for the applicable STP point on the A221 to disconnect. The cables are fastened with M6 nut, M6 Schnorr washer and M6 washer. Remove these fasteners and disconnect the resistor from the A221 module.
- b. Disconnect cable on the SRC module (see Figure 5-23). Each choke has a lead that is terminated on the A222 module. Consult the figure and legend for the applicable STP point on the A222 to disconnect. The cables are fastened with M6 nut, M6 Schnorr washer and M6 washer. Remove these fasteners and disconnect the resistor from the A222 module.
6. Detach L202 (see Figure 5-24). L202 (1 or 7) is mounted on a threaded rod and secured with a holding plate (4). The holding plate is fastened down by a M5 washer (3) and M5 locking nut (2). Remove these fasteners and remove the plate.
7. Remove L202. To extract the L202, pull straight up until the choke clears the threaded rod spindle (5), then extract the choke from the unit.

8. Disengage Cabling. Unwind the cable from the ring core.

NOTE: The Ring Cores for the L202.1 and L202.2 are very similar in appearance and weight. If the choke is to be reinstalled, mark the choke with its designation so that they are not confused when the time comes to reinstall.

9. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the L202.

Installation

This procedure has to be used to install the L202.1 and/or L202.2 IVPS Chokes into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.
2. Prepare L202 Choke. Insert the cable through the center of the ring and wrap around the ring for a total of 8 turns.
3. Install L201.1 and or L202.2.

NOTE: The chokes look very similar. If new, differentiate the chokes by part number. If being reinstalled, consult the markings on the choke.

- a. Insert L202.1 and/or L202.2 (Figure 5-24). Insert the choke (1 or 7) by lowering the ring core onto the spindle (5) until the choke comes to rest on the base (6).
 - b. Secure L202 (see Figure 5-24). The L202 (1 or 7) is held in place by a plate (4) which is held in place by an M5 locking nut (2) and m5 washer (3). Install the plate and fasten down with the washer and nut. Tighten the nuts to 45 lb-in (5.1 Nm) of torque.
4. Connect L202. In Figure 5-22 and in Figure 5-23, the electrical connections for L202.1 are labeled A and C and the electrical connections for L202.2 are labeled B and D.

NOTE: The electrical cables are part of the chokes themselves and terminate at other points in the converter. As such it is necessary to connect these chokes at the remote location.

- a. Connect cables on the BBCM (see Figure 5-22). Each choke has a lead that is terminated on the A221 module. Consult the figure and legend for the applicable STP point on the A221 to disconnect. The cables are fastened with M6 nut, M6 Schnorr washer and M6 washer. Connect the cables and affix these fasteners and connect the coke to the A221 module.

- b. Connect cable on the SRC module (see Figure 5-23). Each choke has a lead that is terminated on the A222 module. Consult the figure and legend for the applicable STP point on the A222 to disconnect. The cables are fastened with M6 nut, M6 Schnorr washer and M6 washer. Connect the cables and affix these fasteners and connect the choke to the A222 module.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES SO THAT THEY WILL NOT MOVE WHILE THE TRAIN IS MOVING.

5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.3 AC Circuit (A300)

5.3.3.1 A307 AC Output EMI Module

This procedure covers the removal and installation of the A307 AC Output EMI Module from the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

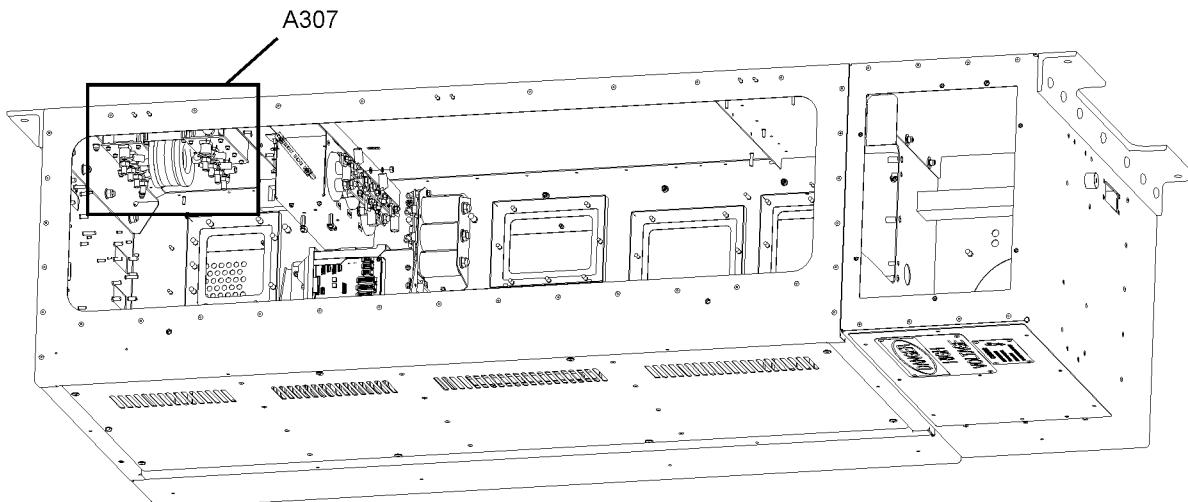


Figure 5-25: Location of A307

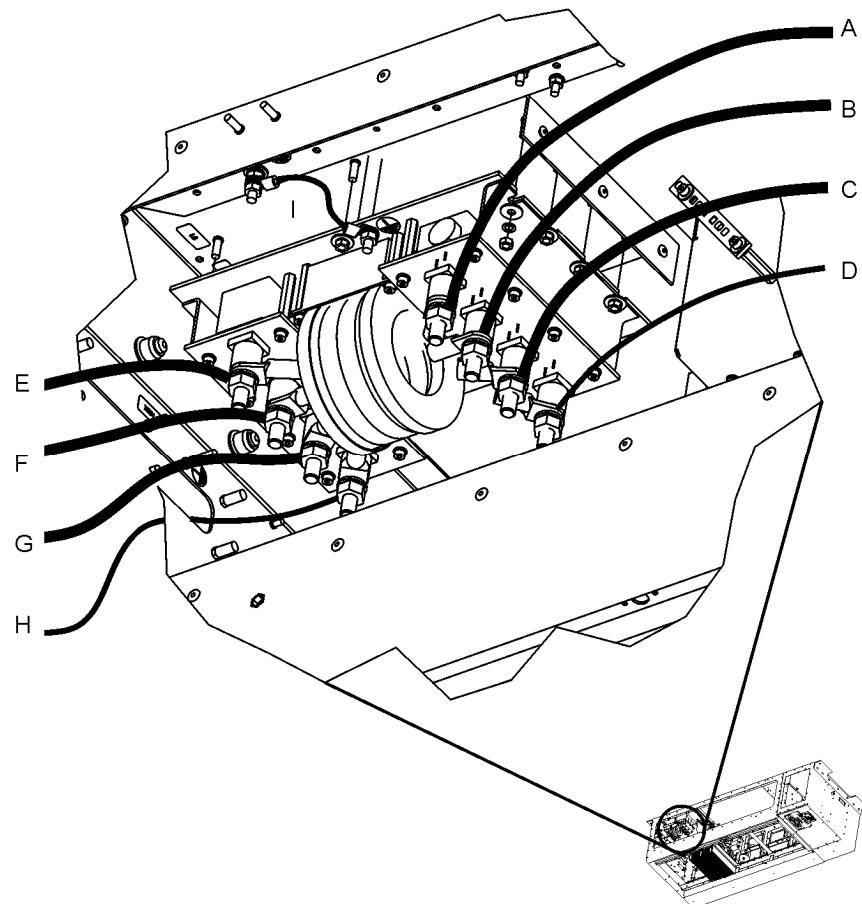


Figure 5-26: A307 Electrical Connections

A307 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A307/A07.1X1	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
B	A307/A07.1X2	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
C	A307/A07.1X3	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
D	A307/A07.1X4	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
E	A307/A07.2X1	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
F	A307/A07.2X2	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
G	A307/A07.2X3	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
H	A307/A07.2X4	Ring	M10 Nut, M10 Schnorr Washer, M10 Flat Washer	170 lb-in (19 Nm)
I	Ground	Ring	M6 Nut, M6 Schnorr Washer, M6 Flat Washer	88 lb-in (10 Nm)

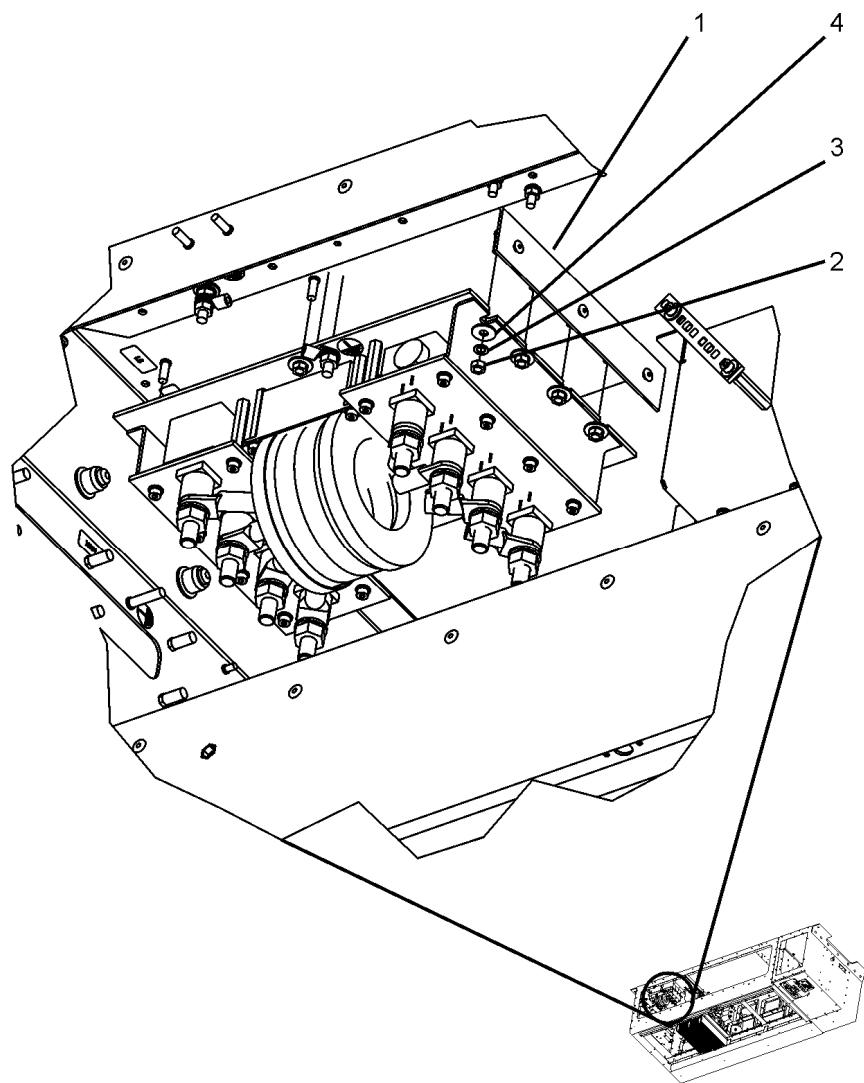


Figure 5-27: A307 Anchor Points

A307 Anchor Points Legend

Index	Description	Part Number
1	AC Output EMI Module, A307	71039
2	Nut, M5	20072
3	Schnorr washer, M5	15777
4	Flat washer, M5	20075

Removal

This procedure has to be used to remove the A307 AC Output EMI Module from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate A307. See Figure 5-25 for the location of the A307.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect A307.
 - a. Disconnect cables labeled A-D (see Figure 5-26). There are four posts onto which 3 large gage cables and 1 medium gage cable are connected and fastened with an M10 nut, M10 Schnorr washer and M10 washer. Remove these fasteners and disconnect the cables.
 - b. Disconnect cables labeled E-H (see Figure 5-26). There are four posts onto which user cables are connected and fastened with an M10 nut, M10 Schnorr washer and M10 washer. Remove these fasteners and disconnect the cables.
 - c. Disconnect ground cable labeled I (see Figure 5-26). This is a single cable connected to the base of the module and held in place with an M6 nut, M6 Schnorr washer and M6 washer. Remove these fasteners and disconnect the cable.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DANGER OF FALLING OBJECT. A307 IS MOUNTED INVERTED ON AN OVERHEAD SURFACE AND WHEN DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN DETACHING THE A307, SUPPORT ITS WEIGHT UNTIL IT IS COMPLETELY REMOVED FROM THE APS.

6. Detach A307 (see Figure 5-27). The A307 (1) is suspended from ten anchor points (four on each end and one on each side, in the middle) and is held in place by M5 nuts (2), M5 Schnorr washers (3) and M4 flat washers (4) at each point. Remove these fasteners to detach the A307.
7. Remove A307. To extract the A307, pull straight down until the module clears the mounting points, then extract the module from the unit.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A307.

Installation

This procedure has to be used to install the A307 AC Output EMI Module into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DANGER OF FALLING OBJECT. A307 IS MOUNTED INVERTED ON AN OVERHEAD SURFACE AND WHILE DETACHED WILL BE SUBJECT TO GRAVITY AND MAY FALL DAMAGING ITSELF OR OTHER EQUIPMENT. WHEN ATTACHING THE A307, SUPPORT ITS WEIGHT UNTIL IT IS FULLY MOUNTED IN THE APS.

2. Insert A301 (see Figure 5-27). Insert the resistor by aligning the mounting slots on the module base with the anchor points. Orient the module with the grounding post toward the front of the APS, as shown in the figure.
3. Attach A307 (see Figure 5-27). The A307 (1) is suspended from ten anchor points (four on each end and one on each side, in the middle) and is held in place by M5 nuts (2), M5 Schnorr washers (3) and M4 flat washers (4) at each point. Affix these fasteners and tighten to 31 lb-in (3.5 Nm) of torque.

4. Connect A307.

- a. Connect cables labeled A-D (see Figure 5-26). There are four posts onto which 3 large gage cables and 1 medium gage cable are connected and fastened with an M10 nut, M10 Schnorr washer and M10 washer. Connect the cables and affix these fasteners.
 - b. Connect cables labeled E-H (see Figure 5-26). There are four posts onto which user cables are connected and fastened with an M10 nut, M10 Schnorr washer and M10 washer. Connect the cables and affix these fasteners.
 - c. Connect ground cable labeled I (see Figure 5-26). This is a single cable connected to the base of the module and held in place with an M6 nut, M6 Schnorr washer and M6 washer. Connect the cable and affix these fasteners.
 - d. Secure Loose Cables. Add cable ties to secure the cables so that they will not move while the train is moving.
5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.3.2 R311 Resistor

This procedure covers the removal and installation of the R311 Resistor from the APS. R311 is mounted on the floor of the APS directly in front of the SRC Module A222.

Required Materials:

- Cable Ties
- Labels
- Heat conductive paste

Special Equipment: None

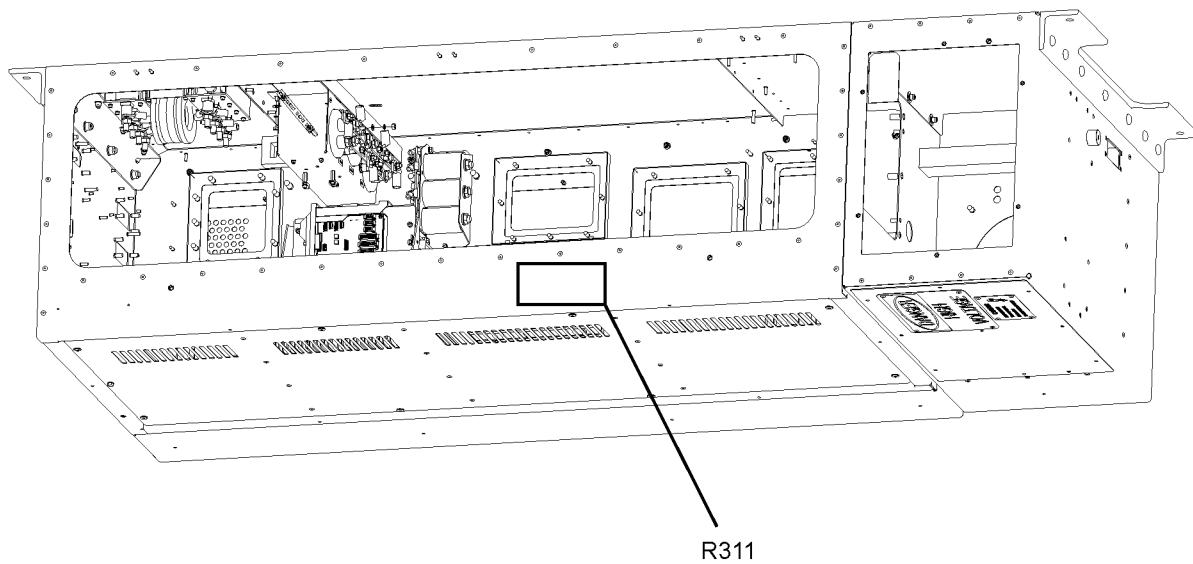


Figure 5-28: Location of R311

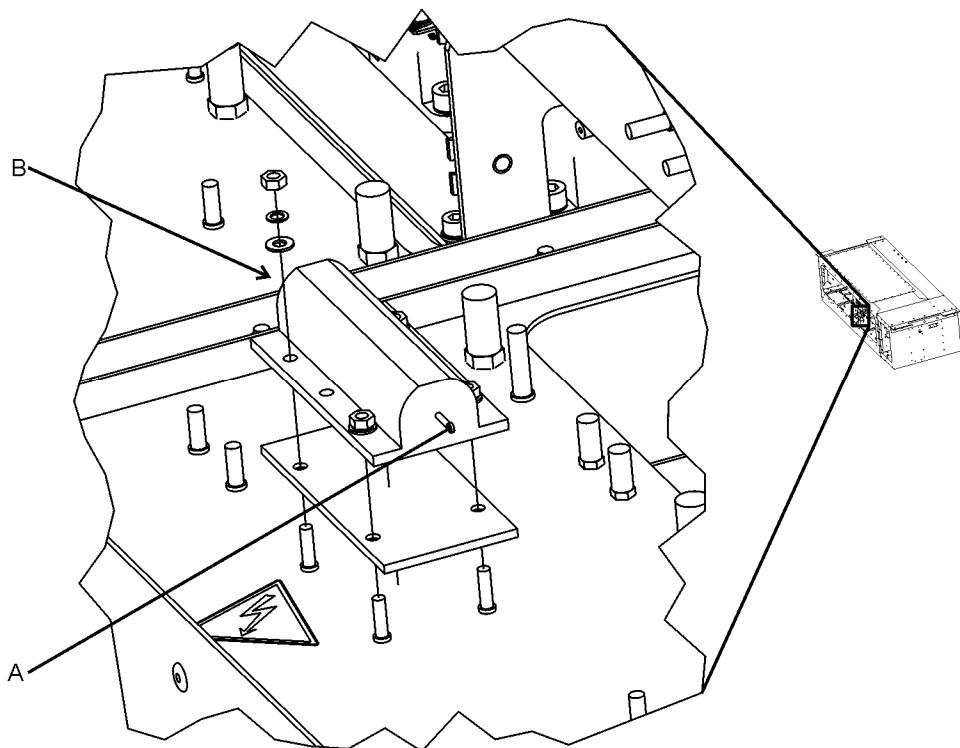


Figure 5-29: R311 Electrical Connections

R311 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	R311.1	Ring	M3 Nut, M3 Schnorr Washer, M3 Flat Washer	14 lb-in (1.6 Nm)
B	R311.2	Ring	M3 Nut, M3 Schnorr Washer, M3 Flat Washer	14 lb-in (1.6 Nm)

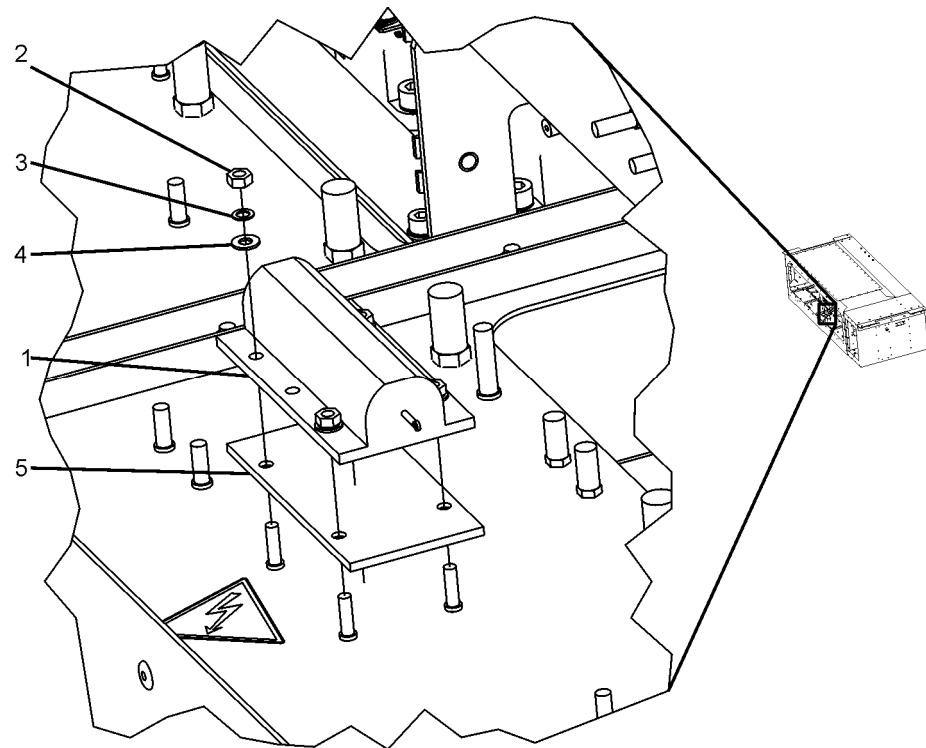


Figure 5-30: R311 Anchor Points

R311 Anchor Points Legend

Index	Description	Part Number
1	Resistor R311	07945
2	Nut, M4	13109
3	Schnorr washer, M4	39272
4	Flat washer, M4	13132
5	Mounting Plate	22818

Removal

This procedure has to be used to remove the R311 Resistor from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate R311. See Figure 5-28 for the location of the R311.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect R311.
 - a. Disconnect cables labeled A & B (see Figure 5-29). There are two cables which are connected and fastened with an M3 nut, M3 Schnorr washer and M3 washer sets. Remove these fasteners and disconnect the cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Detach R311 (see Figure 5-30). R311 (1) is mounted atop a mounting plate at four anchor points and is held in place with four M4 nut, M4 Schnorr washer and M4 flat washer sets. Remove these fasteners to detach R311.

NOTE: The R311 has a layer of heat conductive paste beneath it. While not adhesive, it may be necessary to wiggle or gently pry the R311 to loosen the resistor from the plate below.

7. Remove R311. To extract the R311, pull straight up until the resistor clears the mounting points, then extract the module from the unit.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the R311.

Installation

This procedure has to be used to install the R311 Resistor into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.
2. Prepare R311. Evenly apply a 100 μm layer of heat conductive paste to the bottom of the resistor.
3. Insert R311 (see Figure 5-30). Insert the resistor by aligning the mounting holes on the base with the anchor points.
4. Attach R311 (see Figure 5-30). R311 (1) is mounted atop a mounting plate at four anchor points and is held in place with four M4 nut, M4 Schnorr washer and M4 flat washer sets. Affix these fasteners and tighten to 20 lb-in (2.3 Nm) of torque.
5. Connect R311.
 - a. Connect cables labeled A & B (see Figure 5-29). There are two cable which are connected and fastened with an M3 nut, M3 Schnorr washer and M3 washer sets. Connect the cables and affix these fasteners.
 - b. Secure Loose Cables. Add cable ties to secure the cables so that they will not move WHILE THE TRAIN IS MOVING.
6. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
7. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.3.3 U326 Current Sensor

This procedure covers the removal and installation of the U326 Current Sensor from the APS. U326 is mounted on the back panel of the C301 Assembly of the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

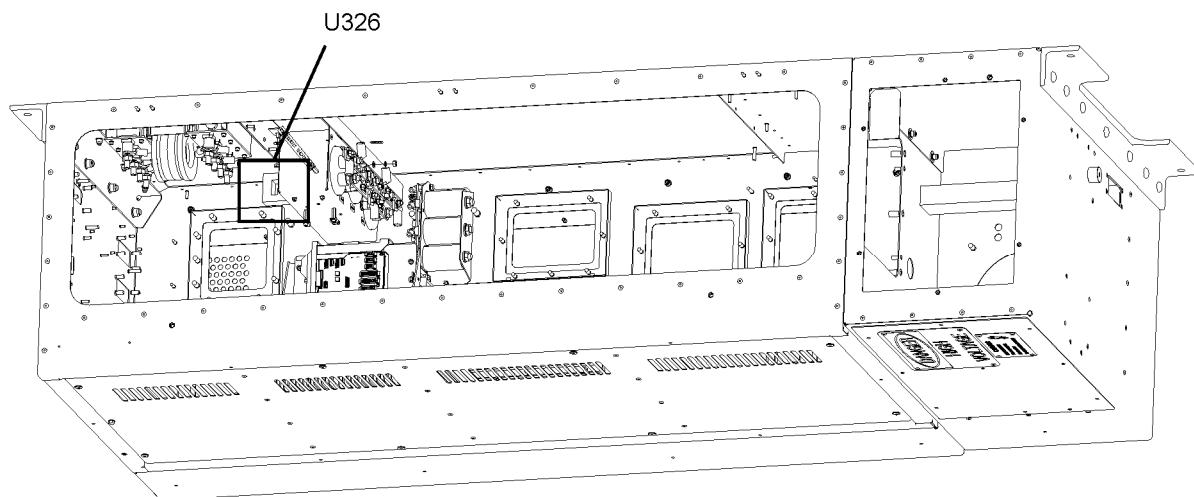


Figure 5-31: Location of U326

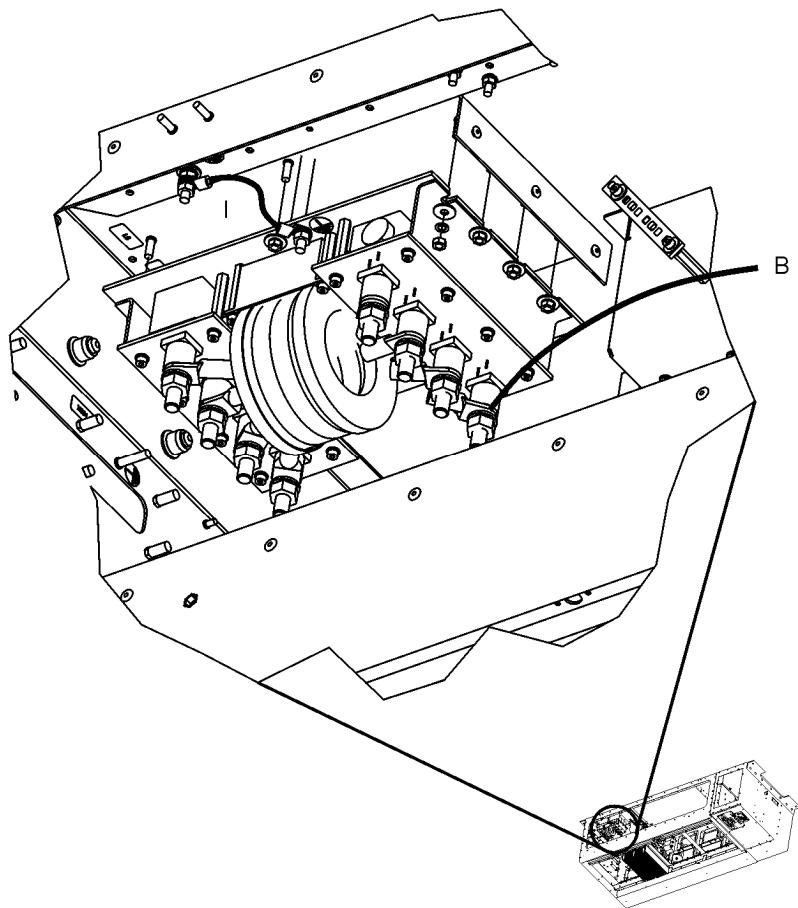


Figure 5-32: U326 Electrical Connections on A307

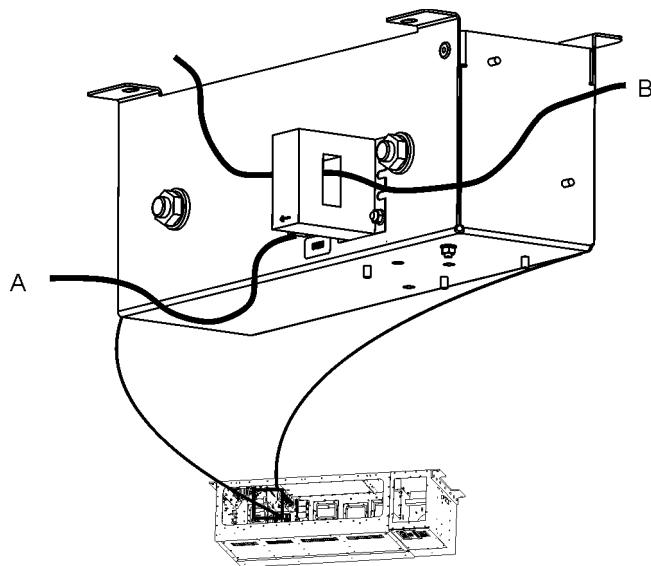


Figure 5-33: U326 Electrical Connections on U326

U326 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	U326X1	Plug	N/A	N/A
B	A307/A07.1X4	Ring	M10 Nut, M10 Schnorr washer, M10 Flat washer	170 lb-in (19 Nm)

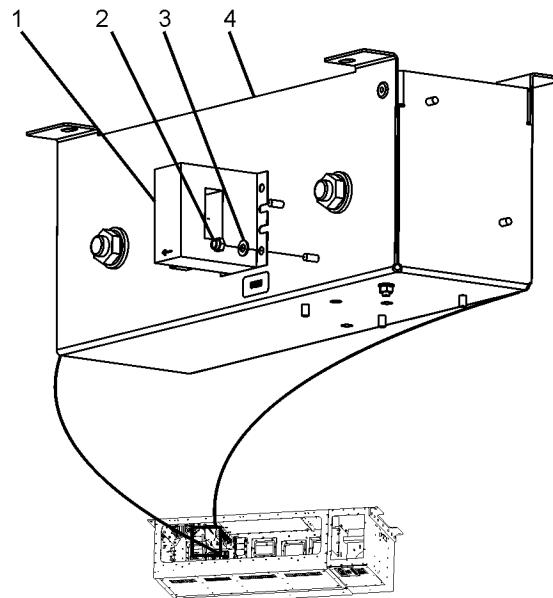


Figure 5-34: U326 Anchor Points

R311 Anchor Points Legend

Index	Description	Part Number
1	Current Sensor, U326	18347
2	Locking Nut, M4	47525
3	Flat washer, M4	13132
4	C301 Assembly	49144

Removal

This procedure has to be used to remove the U326 Current Sensor from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate U326. See Figure 5-31 for the location of the U326.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect U326.
 - a. Disconnect cable A (see Figure 5-33). There is one cable which is connected to the U326. Unplug this cable.
 - b. Disconnect cable B (see Figure 5-32). A second cable passes through the U326 and connects to the A307 and fastened with an M10 nut, M10 Schnorr washer and M10 washer. Remove these fasteners and disconnect the cable.
 - c. Draw cable B back through the current sensor to disengage from the current sensor. See Figure 5-33.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DAMAGE DUE TO FALLING OBJECT. U326 IS MOUNTED ON A VERTICAL SURFACE AND WHEN DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE U326 WHILE BEING DETACHED TO PREVENT FALLING.

6. Detach U326 (see Figure 5-34). U326 (1) is mounted to the back side of the C301 assembly (4) at two anchor points and is held in place with four M4 locking nut (2), and M4 flat washer (3) sets. Remove these fasteners to detach U326.
7. Remove U326. To extract the U326, pull straight off the mounting points, then extract the module from the unit.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the U326.

Installation

This procedure has to be used to install the U326 Resistor into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DAMAGE DUE TO FALLING OBJECT. U326 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE U326 WHILE BEING ATTACHED TO PREVENT FALLING.

2. Insert U326 (see Figure 5-34). Insert current sensor oriented with the plug facing the rear of the unit. An arrow is engraved on the top of the sensor. This should be facing the rear of the unit. The sensor should seat upon two diagonally located anchor points.
3. Attach U326 (see Figure 5-34). U326 (1) is mounted to the back side of the C301 assembly (4) at two anchor points and is held in place with four M4 locking nut (2), and M4 flat washer (3) sets. Tighten the nuts to fit.

4. Connect U326.

- a. Connect cable A (see Figure 5-33). There is one cable which is connected to the U326. Plug this cable in.
 - b. Connect cable B (see Figure 5-32). A second cable passes through the U326 and connects to the A307 and fastened with an M10 nut, M10 Schnorr washer and M10 washer. Thread this cable around the outside of the sensor, then through the sensor from back to front and then connect to the A307 as indicated. Affix the fasteners to connect the cable.
 - c. Secure Loose Cables. Add cable ties to secure the cables so that they will not move WHILE THE TRAIN IS MOVING.
5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.4 LVPS Circuit (A400)

5.3.4.1 C411 Filter Capacitor

This procedure covers the removal and installation of the C411 Capacitor from the APS. C411 is mounted on the back wall of the LVPS section of the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

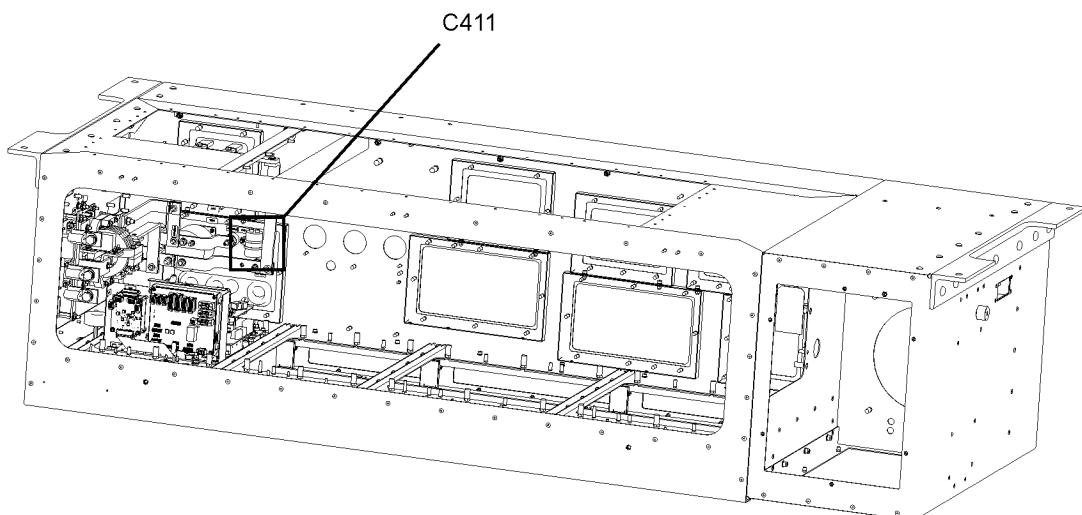


Figure 5-35: Location of C411

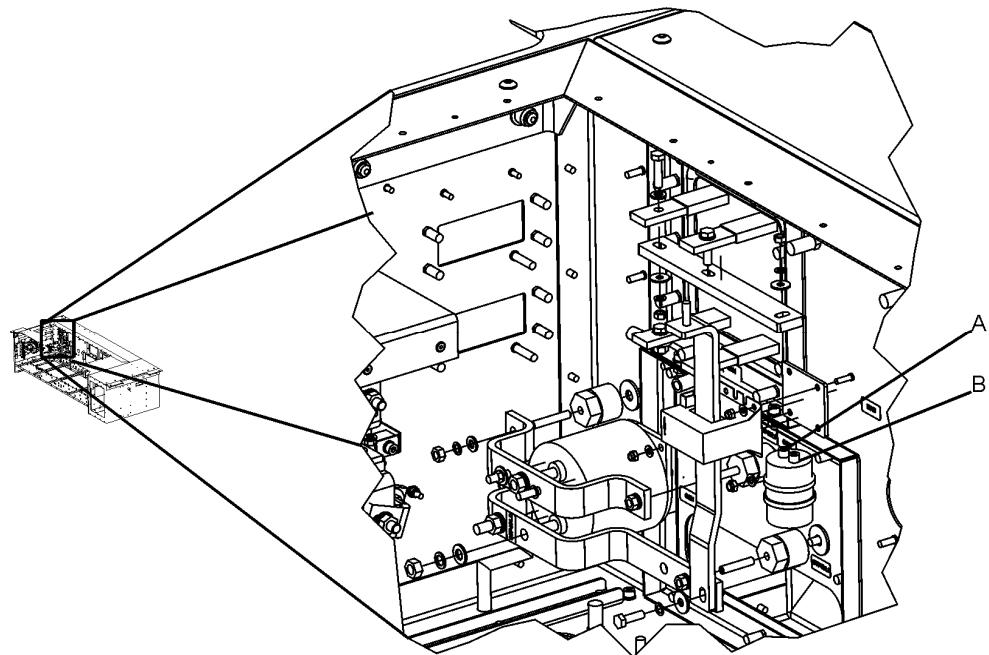


Figure 5-36: C411 Electrical Connections

C411 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	C411 +	Ring	M5x8 screw, M5 Schnorr washer, M5 flat washer	26.5 lb-in (3 Nm)
B	C411 -	Ring	M5x8 screw, M5 Schnorr washer, M5 flat washer	26.5 lb-in (3 Nm)

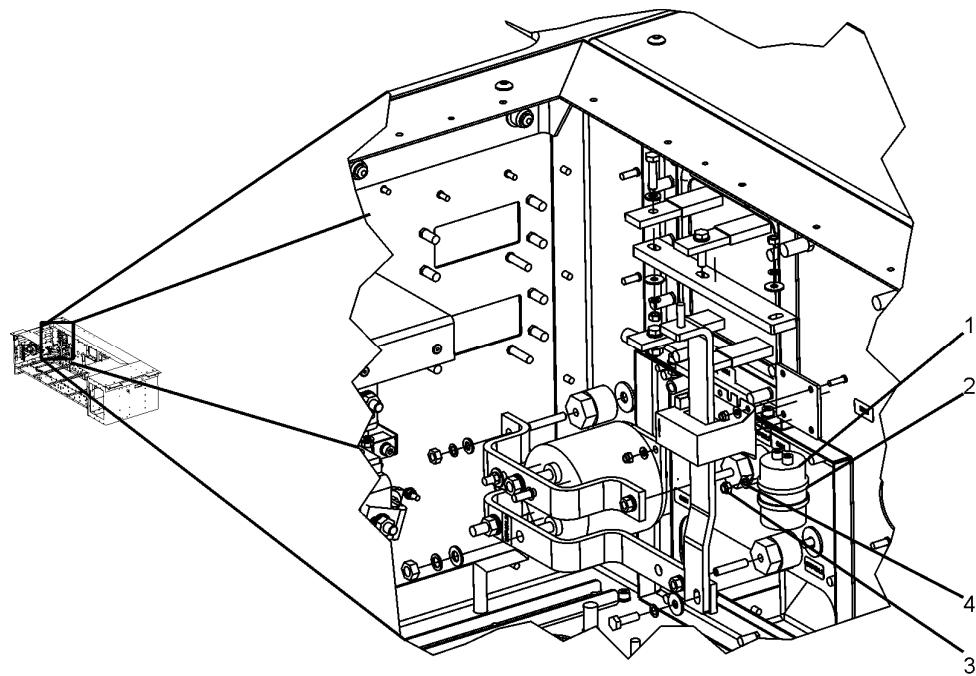


Figure 5-37: C411 Anchor Points

C411 Anchor Points Legend

Index	Description	Part Number
1	Capacitor, 411	07938
2	Holding Device	23029
3	Locking Nut, M5	47563
4	Washer, M5	12142

Removal

This procedure has to be used to remove the C411 Capacitor from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate C411. See Figure 5-35 for the location of the C411.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect C411.
 - a. Disconnect cables A & B (see Figure 5-36). These cables are connected at the top of the capacitor using M5 screw, Schnorr washer and flat washer sets. Remove the fasteners and disconnect the cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DAMAGE DUE TO FALLING OBJECT. C411 IS MOUNTED ON A VERTICAL SURFACE AND WHEN DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE C411 WHILE BEING DETACHED TO PREVENT FALLING.

6. Detach C411 (see Figure 5-37). C411 (1) is mounted to the back wall of the APS in the LVPS section and is held in place by a clamping device (2). The tension on the clamp is controlled by an M5 locking nut (3) and M5 washer (4). Loosen these fasteners to loosen the clamping device until the C411 can be rotated within the clamp.
7. Remove C411. To extract C411, push upward from beneath until the capacitor is clear of the clamping device, then extract the capacitor from the APS.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of C411.

Installation

This procedure has to be used to install the C411 capacitor into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DAMAGE DUE TO FALLING OBJECT. C411 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE C411 WHILE BEING ATTACHED TO PREVENT FALLING.

2. Prepare C411 Holding Device. The holding device for the C411 is a clamp. Ensure that the clamp has been loosened sufficiently for the C411 to slide easily into place.
3. Insert C411 (see Figure 5-37). Insert capacitor by placing it in the clamping device with the terminal labeled + on the left and the terminal labeled – on the right. Best practice is to insert the capacitor bottom first into the top of the clamp and slide downward until the clamp is at the middle of the capacitor.

CAUTION

DAMAGE DUE TO WRONG ELECTRICAL CONNECTION. WHILE CONNECTING CABLES TO THE CAPACITOR TERMINALS, NOTE LABELLING OF CABLE LUGS!

4. Attach C411 (see Figure 5-37). C411 (1) is mounted to the back wall of the APS in the LVPS section and is held in place by a clamping device (2). The tension on the clamp is controlled by an M5 locking nut (3) and M5 washer (4). Tighten these fasteners until the capacitor no longer rotates by hand within the clamp.

5. Connect C411.
 - a. Connect cables A & B (see Figure 5-36). These cables are connected at the top of the capacitor using M5 screw, M5 Schnorr washer and M5 flat washer sets. Connect the cables to the proper terminals and affix these fasteners.
 - b. Secure Loose Cables. Add cable ties to secure the cables so that they will not move WHILE THE TRAIN IS MOVING.
6. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
7. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.4.2 L402 Choke

This procedure covers the removal and installation of the C411 Capacitor from the APS. C411 is mounted on the back wall of the LVPS section of the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

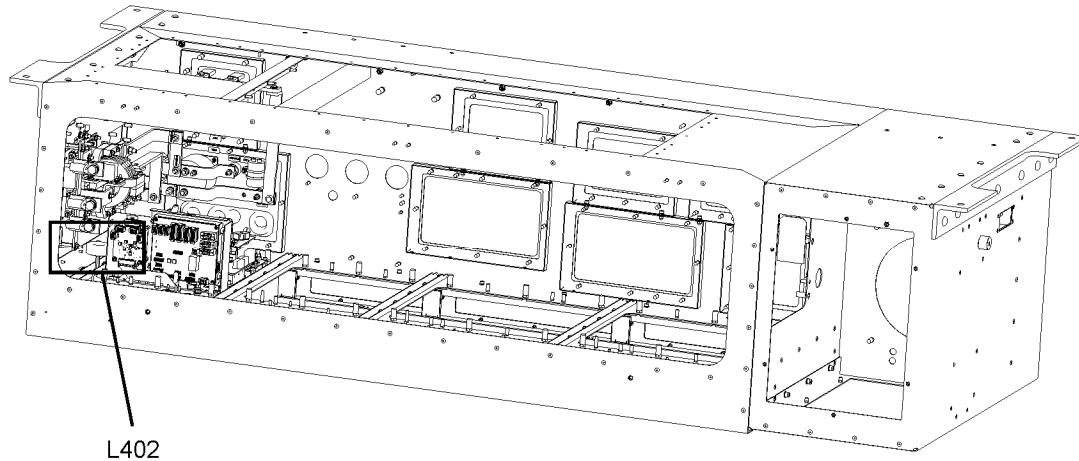


Figure 5-38: Location of L402

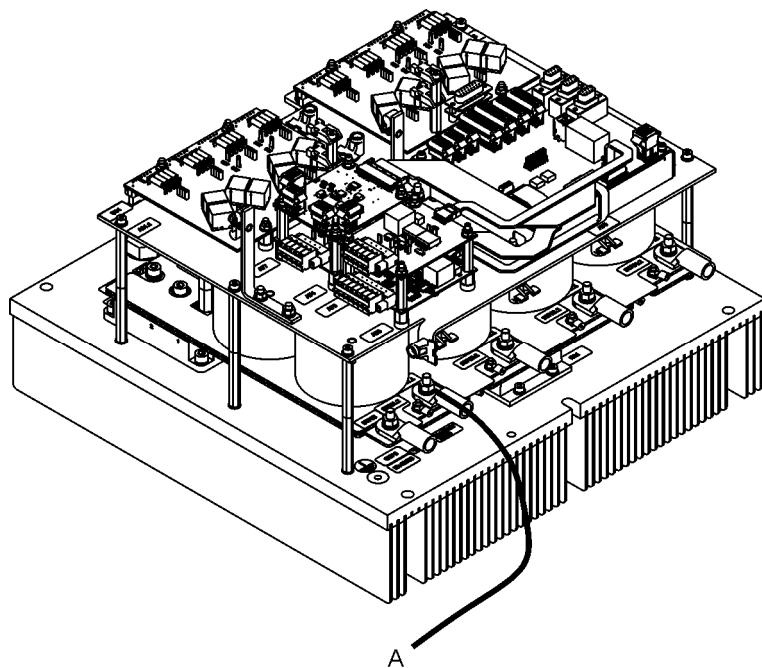


Figure 5-39: L402 Electrical Connections on A221

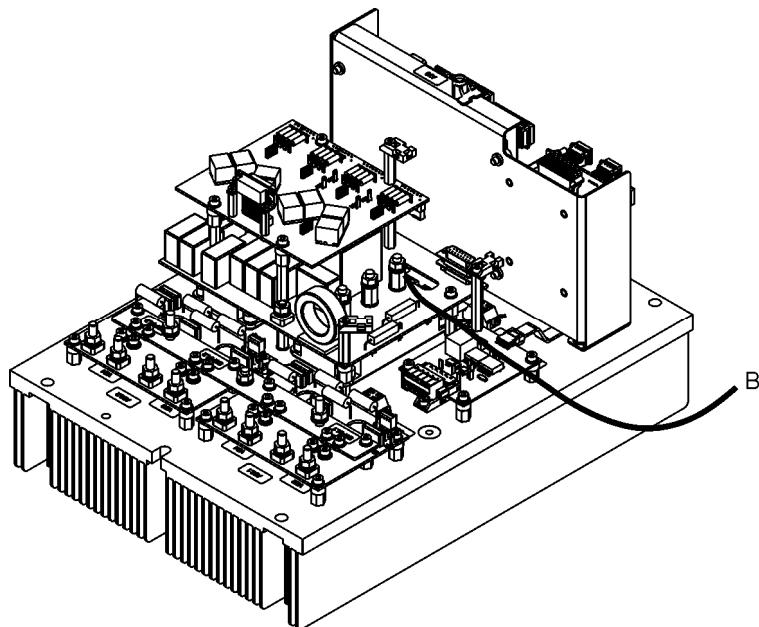


Figure 5-40: L402 Electrical Connections on A401

L402 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A221/STP01.1	Ring	M6 Nut. M6 Schnorr washer, M6 flat washer	53lb-in (6 Nm)
B	A401/A01C1	Ring	M6 Nut. M6 Schnorr washer, M6 flat washer	53lb-in (6 Nm)

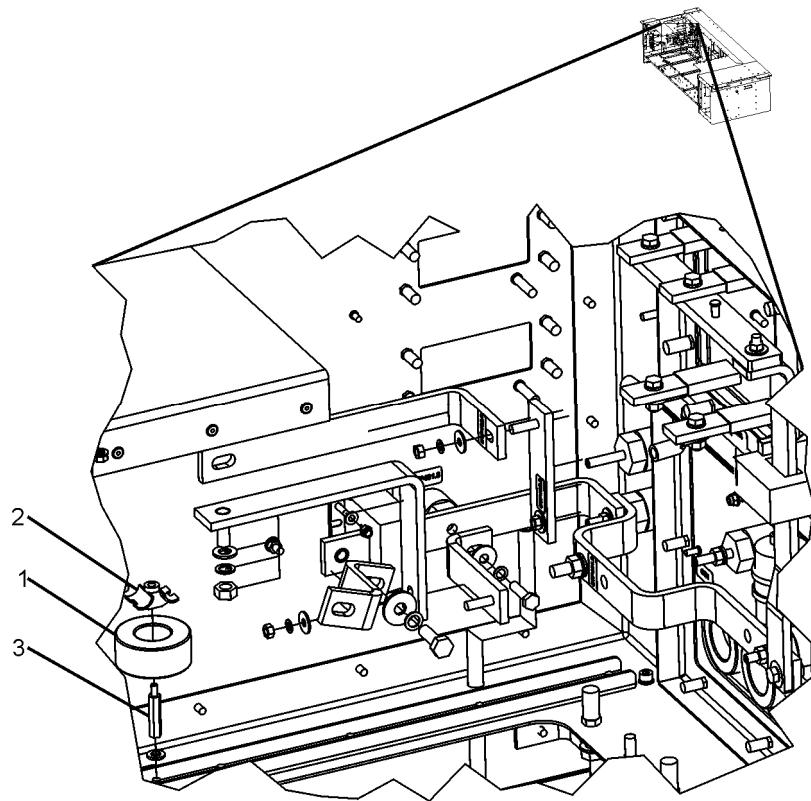


Figure 5-41: L402 Anchor Points

L402 Anchor Points Legend

Index	Description	Part Number
1	Ring Core Choke, L402	11343
2	Dual Cable Support	34724
3	Standoff, M4x30	51435

Removal

This procedure has to be used to remove the L402 Choke from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate L402. See Figure 5-38 for the location of the L402.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect L402.

NOTE: The cabling to and from the choke are continuous throughout the choke. As such, these cables must be disconnected at the remote terminals.

- a. Disconnect cable A (see Figure 5-39). This cable runs from the choke along the front of the APS to the A221 Buck Boost Converter. The cable terminates and is held in place with an M6 nut, M6 Schnorr washer and M6 flat washer. Remove these fasteners to disconnect the cable.
- b. Disconnect cable B (see Figure 5-40). This cable makes a short jump from the choke to the C1 terminal of the A01 board on the A401 LVPS Combined Module. The cable is held in place with an M6 nut, M6 Schnorr washer and M6 flat washer. Remove these fasteners to disconnect the cable.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Detach L402 (see Figure 5-41). L402 (1) is mounted to a standoff (3) and is held in place with a cable tie anchor (2). To detach, clip the cable ties which bind the choke to the cable tie anchor.
7. Remove L402. To extract the L402, lift upward and once clear of the cable tie anchor, pull carefully until the choke and cabling is free from the APS.

8. Disengage Choke. Unwrap the cabling from the choke.
9. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the L402.

Installation

This procedure has to be used to install the L402 choke into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.
2. Prepare L402 Holding Device. Engage the L402 by passing the cable through the center and then wrapping the cable around the ring core. There must be a total of eight turns.
3. Insert L420 (see Figure 5-41). Place the ring core atop the dual cable anchor. Orient the choke with the short lead toward the back and the long lead toward the front.
4. Attach L402 (see Figure 5-41). L402 (1) is mounted to a standoff (3) and is held in place with a cable tie anchor (2). Strap the L402 to the cable tie anchor with cable ties. Use as many as needed to ensure L402 will not move during APS operation.
5. Connect L402.

NOTE: The cabling to and from the choke are continuous throughout the choke. As such, these cables must be disconnected at the remote terminals.

- a. Connect cable A (see Figure 5-39). This cable runs from the choke along the front of the APS to the A221 Buck Boost Converter. The cable terminates and is held in place with an M6 nut, M6 Schnorr washer and M6 flat washer. Connect the cable and affix these fasteners to connect the cable.
- b. Connect cable B (see Figure 5-40). This cable makes a short jump from the choke to the C1 terminal of the A01 board on the A401 LVPS Combined Module. The cable is held in place with an M6 nut, M6 Schnorr washer and M6 flat washer. Connect this cable and affix these fasteners to connect the cable.
- c. Secure Loose Cables. Add cable ties to secure the cables so that they will not move WHILE THE TRAIN IS MOVING.
6. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
7. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5 Control Electronics (A700)

5.3.5.1 Converter Control Unit A701

This procedure covers the removal and installation of the A701 Converter Control Unit from the APS. A701 is mounted on the Electronics Panel in the front of the dry area the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

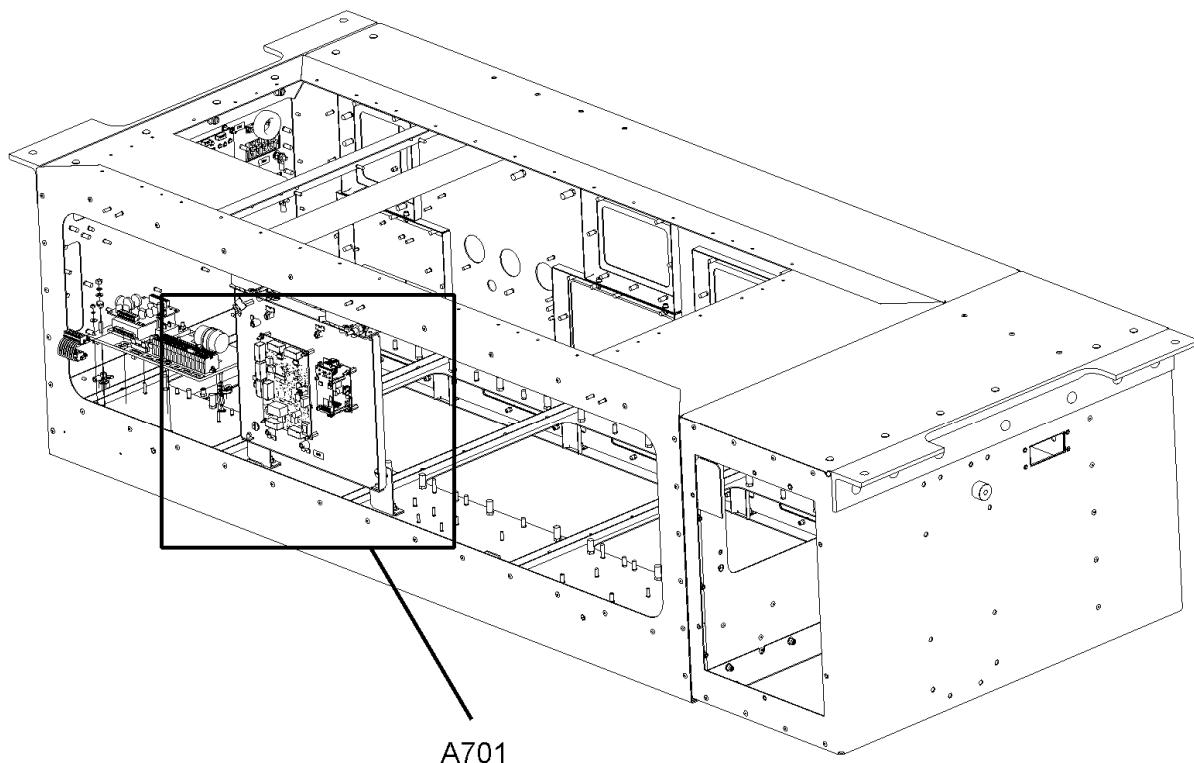


Figure 5-42: Location of A701

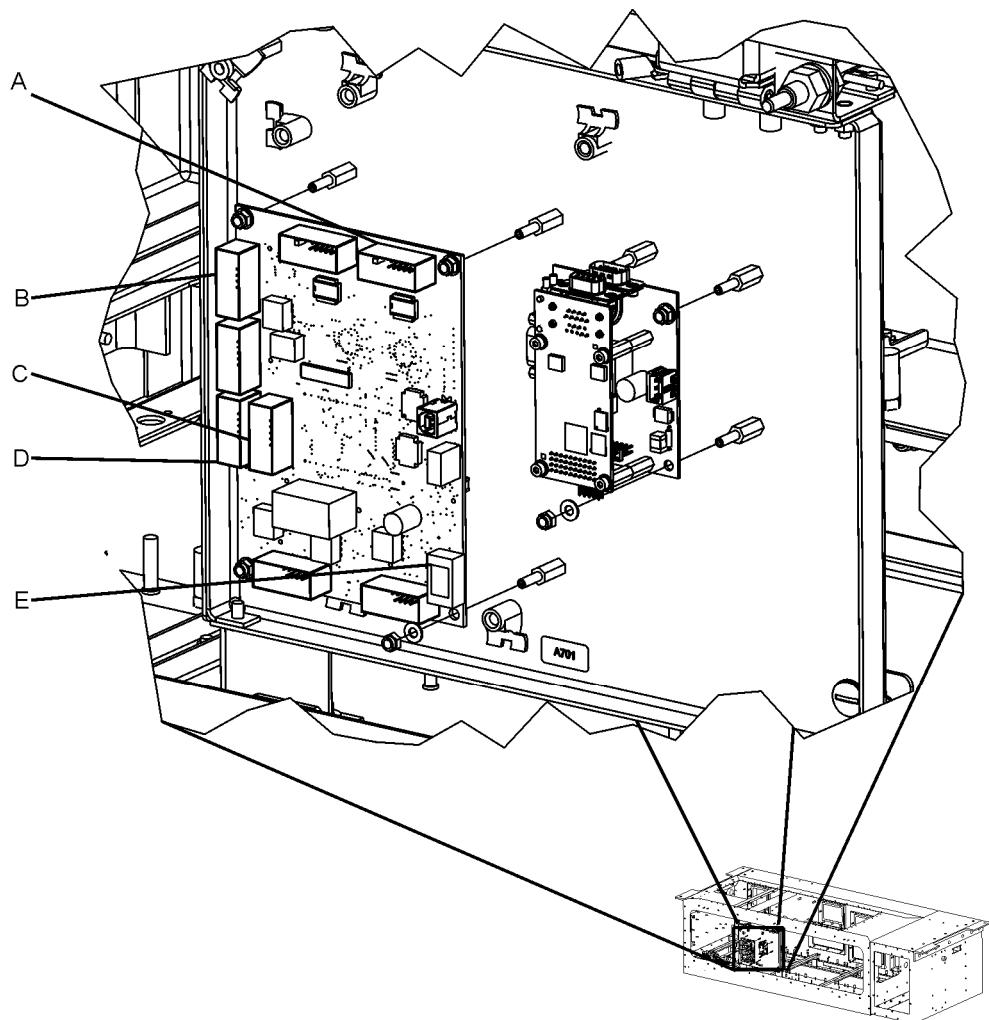


Figure 5-43: A701 Electrical Connections

A701 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A701 X7	D-Sub-9	N/A	N/A
B	A701 X12	Ribbon	N/A	N/A
C	A701 X18.1	D-Sub-9	N/A	N/A
D	A701 X18.2	D-Sub-9	N/A	N/A
E	A701 X1	Plug	N/A	N/A

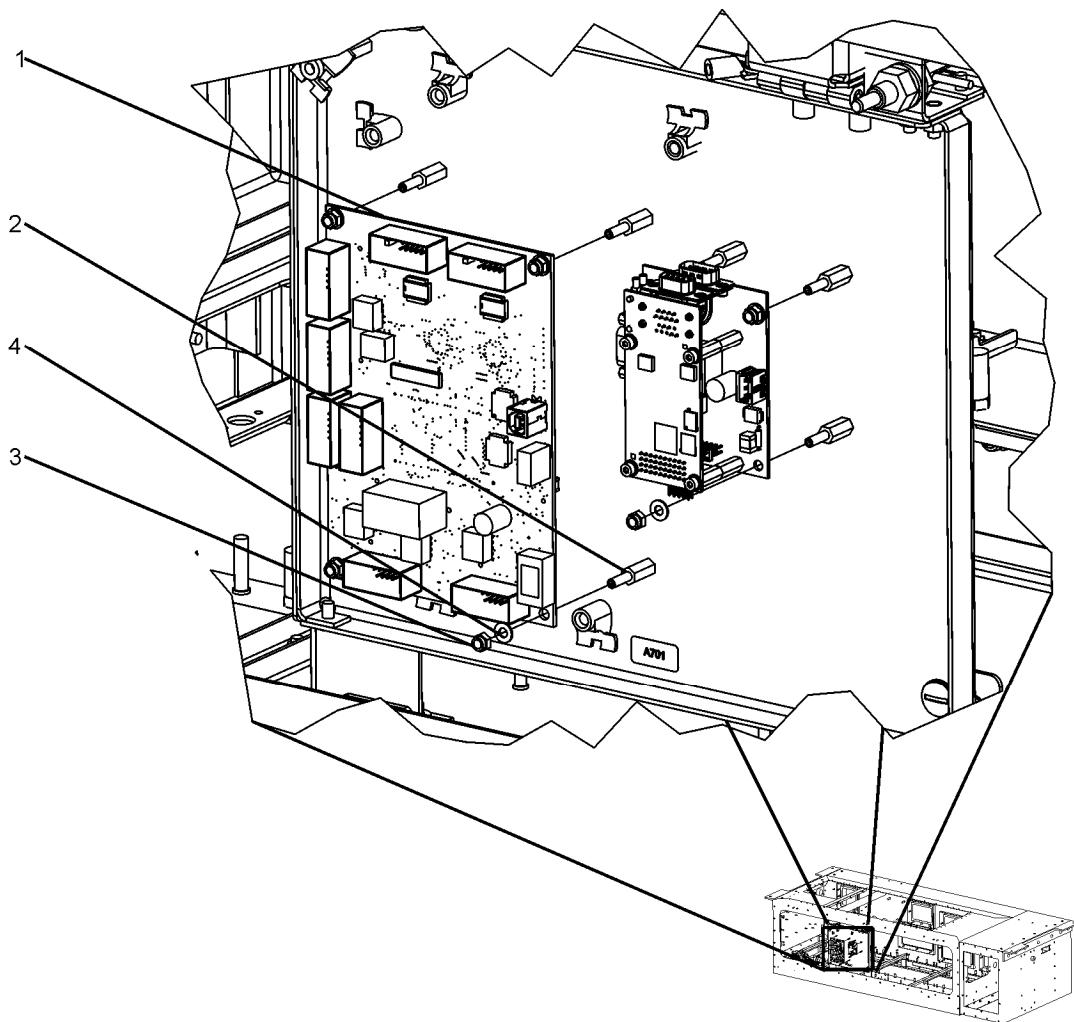


Figure 5-44: A701 Anchor Points

A701 Anchor Points Legend

Index	Description	Part Number
1	A701 PCB	70405
2	Set Screw, M4x20	09338
3	Locking Nut, M4	47525
4	Washer, M4	13132

Removal

This procedure has to be used to remove the A701 Converter Control Unit from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate A701. See Figure 5-42 for the location of the A701.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

5. Disconnect A701
 - a. There are four cable attachments (see Figure 5-43) labeled A-D which connect to the A701. Disconnect these cables.
 - b. The connection labeled E is a hardware key designated R790. There is no cable mated to the connector, but the connector contains internal circuitry. Disconnect this hardware key by removing it from the socket.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DAMAGE DUE TO FALLING OBJECT. A701 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE A701 WHILE BEING DETACHED TO PREVENT FALLING.

6. Detach A701 (see Figure 5-44). A701 (1) is mounted atop four setscrews (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Remove the fasteners to detach the A701.
7. Remove A701. To extract the A701, pull the board straight off the mounting setscrews. Store the A701 in a manner consistent with ESD practices.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A701.

Installation

This procedure has to be used to install the A701 Converter Control Unit into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

2. Insert A701 (see Figure 5-44). Place the board with the plugs labeled X6 and X7 on the top facing outward.

CAUTION

DAMAGE DUE TO FALLING OBJECT. A701 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE A701 WHILE BEING ATTACHED TO PREVENT FALLING.

3. Attach A701 (see Figure 5-44). A701 (1) is mounted atop four setscrews (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Affix the fasteners and tighten to 22 lb-in (2.5 Nm).
4. Connect A701.
 - a. There are four cable attachments (see Figure 5-43) labeled A-D which connect to the A701. Connect these cables.
 - b. The connection labeled E is a hardware key designated R790. There is no cable mated to the connector, but the connector contains internal circuitry. Install by connecting this hardware key to the socket.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.2 Control Electronics Power Supply A720

This procedure covers the removal and installation of the A720 Power Supply from the APS. A720 is mounted on the Electronics Power Panel in front of the LVPS in the front of the dry area the APS.

Required Materials:

- Cable Ties
- Heat Conductive Paste
- Labels

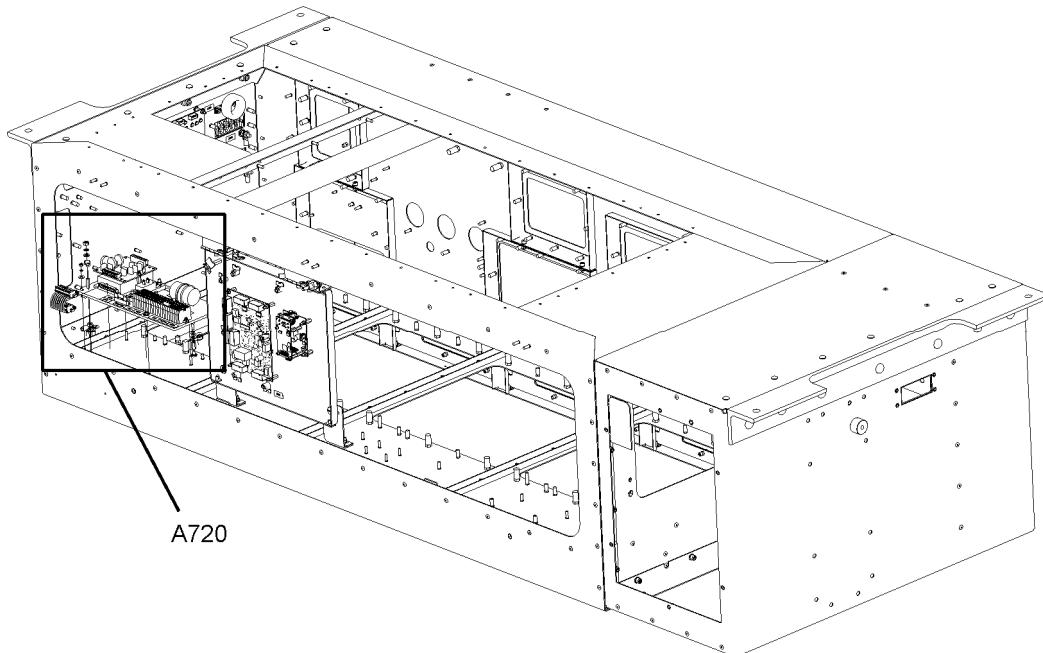
Special Equipment: None

Figure 5-45: Location of A720

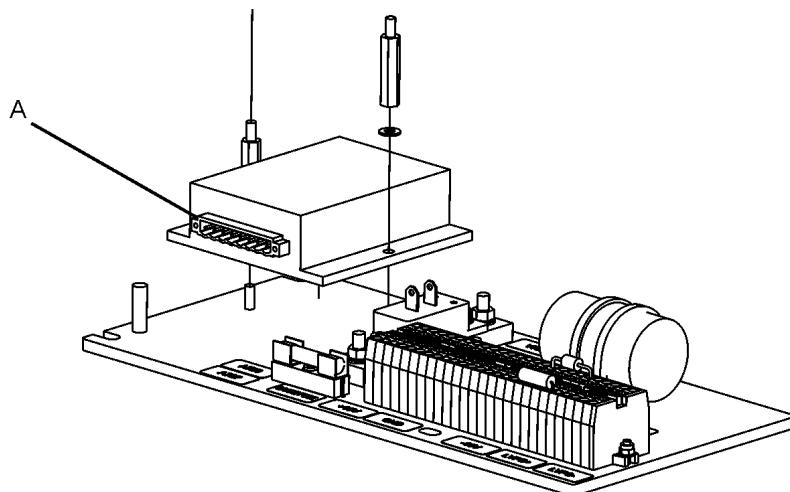


Figure 5-46: A720 Electrical Connections

A720 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A720 X1	Plug	N/A	N/A

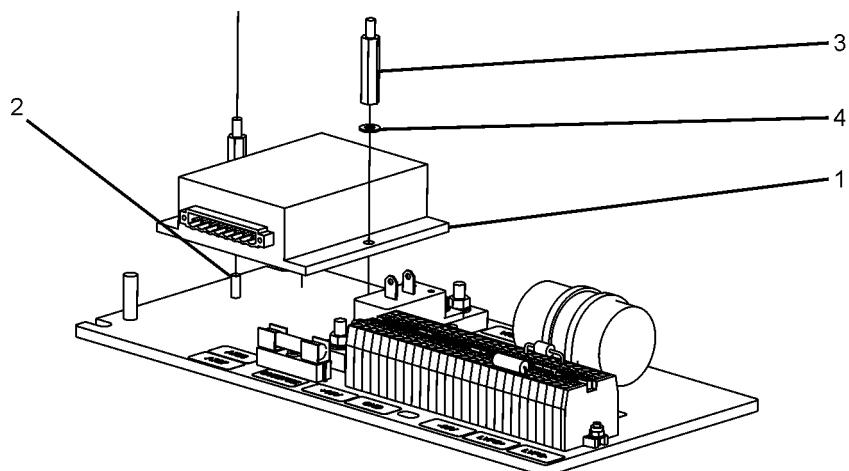


Figure 5-47: A720 Anchor Points

A720 Anchor Points Legend

Index	Description	Part Number
1	A720 Power Supply	41899
2	Base Plate	49524
3	Standoff, M4x30	33097
4	Washer, M4	13132

Removal

This procedure has to be used to remove the A720 Control Electronics Power Supply from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate A720. See Figure 5-45 for the location of the A720.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Remove A727 Control Electronics EMI Filter. See Section 5.3.5.4 for details on the removal of the A727.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

6. Disconnect A720.
 - a. There is one cable attachment (see Figure 5-46) labeled A which connects to the A720. Disconnect this cable.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

7. Detach A720 (see Figure 5-47). A720 (1) is mounted directly to the assembly base plate (2) at two points and is held in place with M4 standoff (3) and M4 washer (4) sets. Remove the fasteners to detach the A720.

NOTE: The underside of the A720 is coated with heat conductive paste. While not adhesive, it may be necessary to wiggle or pry the A720 loose.

8. Remove A720. To extract the A720, pull the board straight off the mounting studs. Store the A720 in a manner consistent with ESD practices.
9. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A720.

Installation

This procedure has to be used to install the A720 Converter Electronics Power Supply into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

2. Prepare A720. Evenly apply a 100 μm layer of heat conductive paste to the bottom of the A720.
3. Insert A720 (see Figure 5-46). Place the board with the plug facing outward.
4. Attach A720 (see Figure 5-47). A720 (1) is mounted directly to the assembly base plate (2) at two points and is held in place with M4 standoff (3) and M4 washer (4) sets. Affix the fasteners and tighten to 22 lb-in (2.5 Nm).
5. Connect A720.
 - a. There is one cable attachment (see Figure 5-46) labeled A which connects to the A720. Disconnect this cable.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Install A727 Control Electronics EMI Filter. See Section 5.3.5.4 for details on the installation of the A727.
7. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
8. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.3 CAN Bus I/O Board A721

This procedure covers the removal and installation of the A721 CAN I/O Board from the APS. A721 is mounted on the inside surface of the left (LVPS) side bulkhead above the A407 assembly in the dry area the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

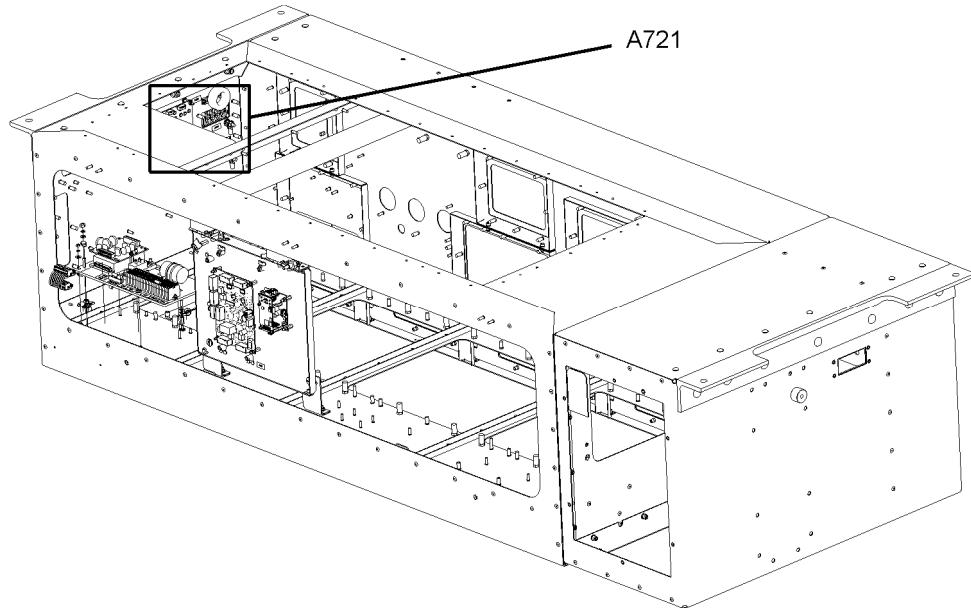


Figure 5-48: Location of A721

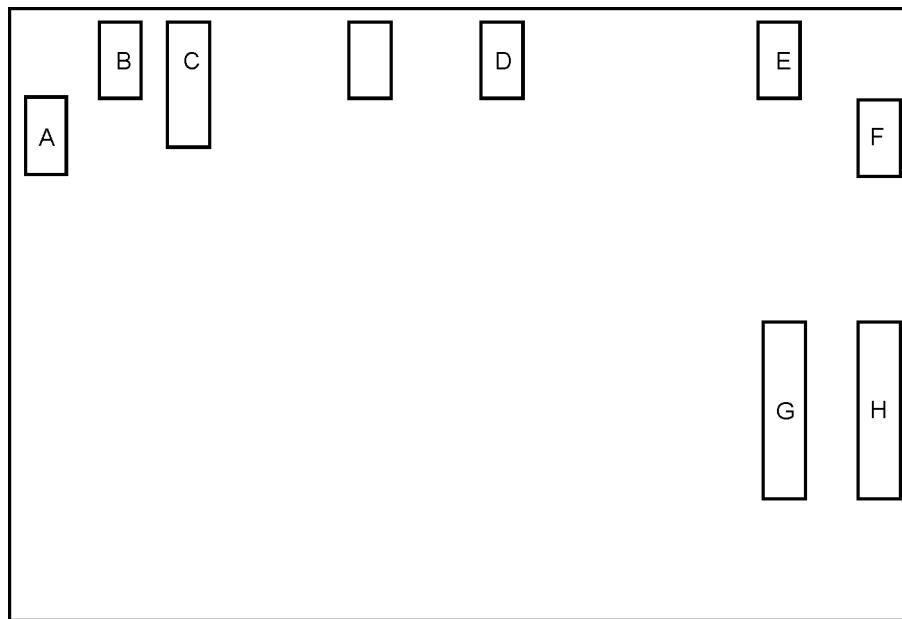


Figure 5-49: A721 Electrical Connections

A721 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A721 X8	Plug	N/A	N/A
B	A721 X7	Plug	N/A	N/A
C	A721 X10	Plug	N/A	N/A
D	A721 X6	Plug	N/A	N/A
E	A721 X5	Plug	N/A	N/A
F	A721 X1	Plug	N/A	N/A
G	A721 X3	D-sub 9	N/A	N/A
H	A721 X2	D-sub 9	N/A	N/A

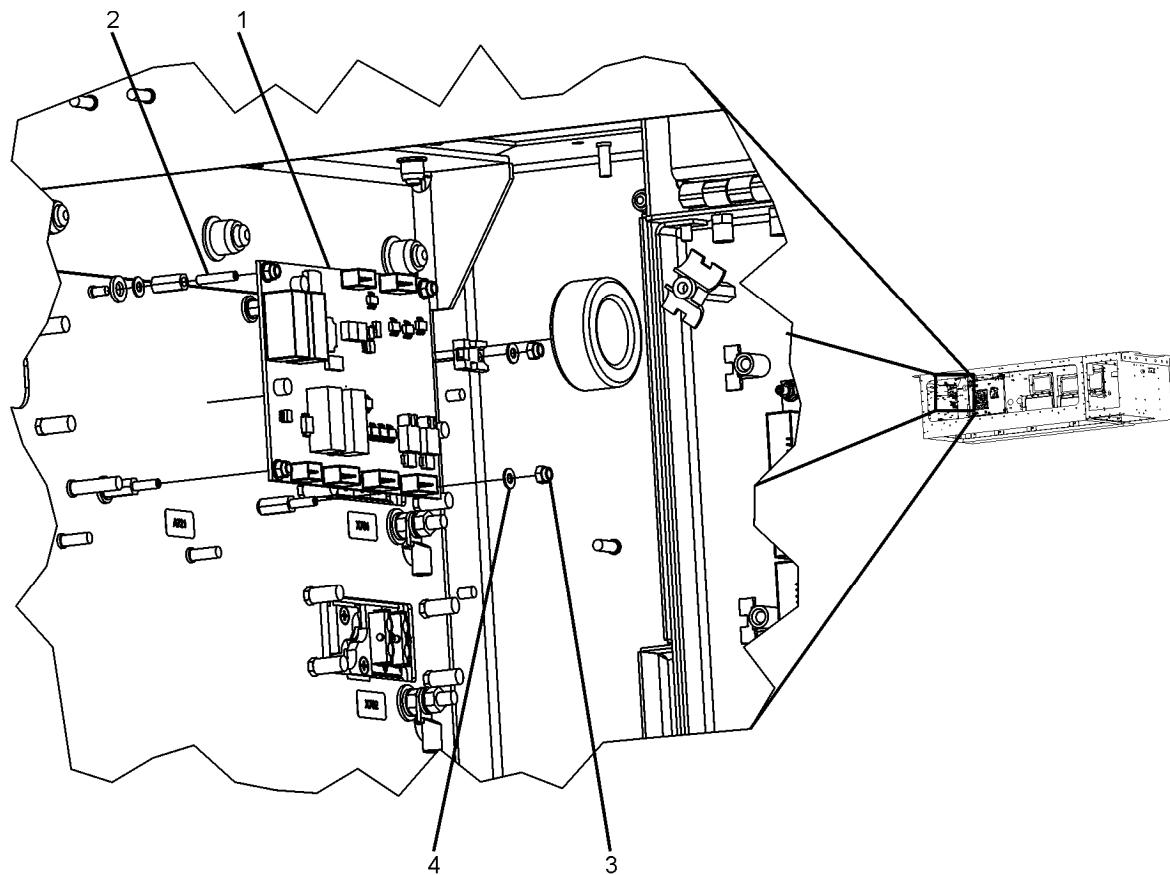


Figure 5-50: A721 Anchor Points

A721 Anchor Points Legend

Index	Description	Part Number
1	CAN Bus I/O Board ,A721	49020
2	Setscrew, M4x20	09338
3	Locking Nut, M4	47525
4	Washer, M4	13132

Removal

This procedure has to be used to remove the A721 CAN Bus I/O Board from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate A721. See Figure 5-48 for the location of the A721.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

5. Disconnect A721.
 - a. There are seven cable attachments (see Figure 5-49) labeled A-G which connect to the A721. Disconnect these cables.
 - b. The connection labeled H is a hardware key designated R791. There is no cable mated to the connector, but the connector contains internal circuitry. Disconnect this hardware key by removing it from the socket.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DAMAGE DUE TO FALLING OBJECT. A721 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE A721 WHILE BEING DETACHED TO PREVENT FALLING.

6. Detach A721 (see Figure 5-50). A721 (1) is mounted atop four setscrews (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Remove the fasteners to detach the A721.
7. Remove A721. To extract the A721, pull the board straight off the mounting setscrews. Store the A721 in a manner consistent with ESD practices.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A721.

Installation

This procedure has to be used to install the A721 CAN Bus I/O Board into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

2. Insert A721 (see Figure 5-49). Place the board with the plugs labeled G and H on the bottom right, nearer the back wall.

CAUTION

DAMAGE DUE TO FALLING OBJECT. A721 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE A721 WHILE BEING ATTACHED TO PREVENT FALLING.

3. Attach A721 (see Figure 5-50). A721 (1) is mounted atop four setscrews (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Affix the fasteners and tighten to 22 lb-in (2.5 Nm).
4. Connect A721.
 - a. There are eight cable attachments (Figure 5-49) labeled A-G which connect to the A721. Connect these cables.
 - b. The connection labeled H is a hardware key designated R791. There is no cable mated to the connector, but the connector contains internal circuitry. Install by connecting this hardware key to the socket.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.4 Electronics Filter Board A727

This procedure covers the removal and installation of the A727 Control Electronics EMI Filter from the APS. A727 is mounted on the Electronics Power Panel in front of the LVPS in the front of the dry area the APS.

Required Materials:

- Cable Ties
- Labels

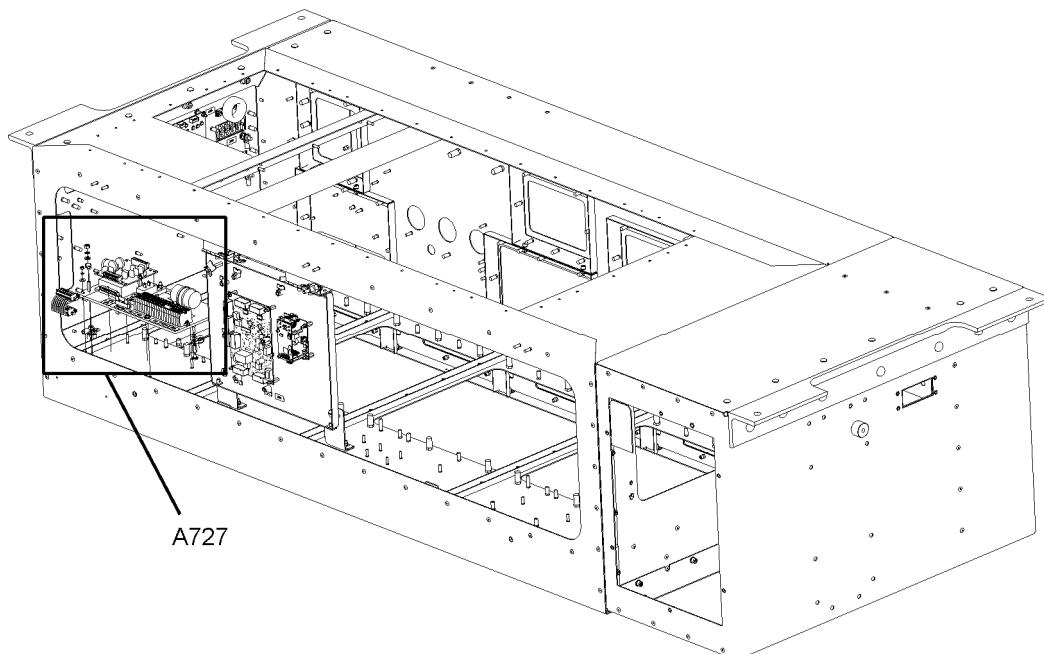
Special Equipment: None

Figure 5-51: Location of A727

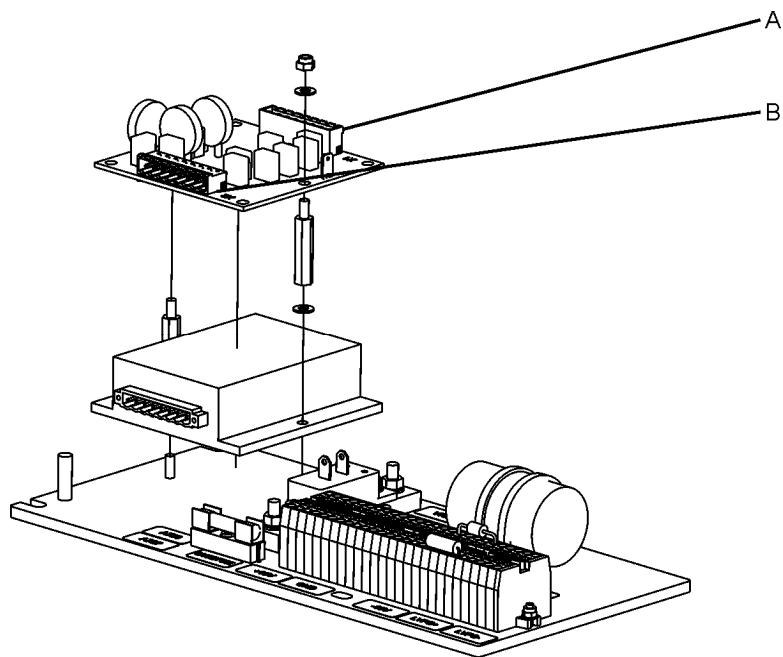


Figure 5-52: A727 Electrical Connections

A727 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A727 X1	Plug	N/A	N/A
B	A727 X2	Plug	N/A	N/A

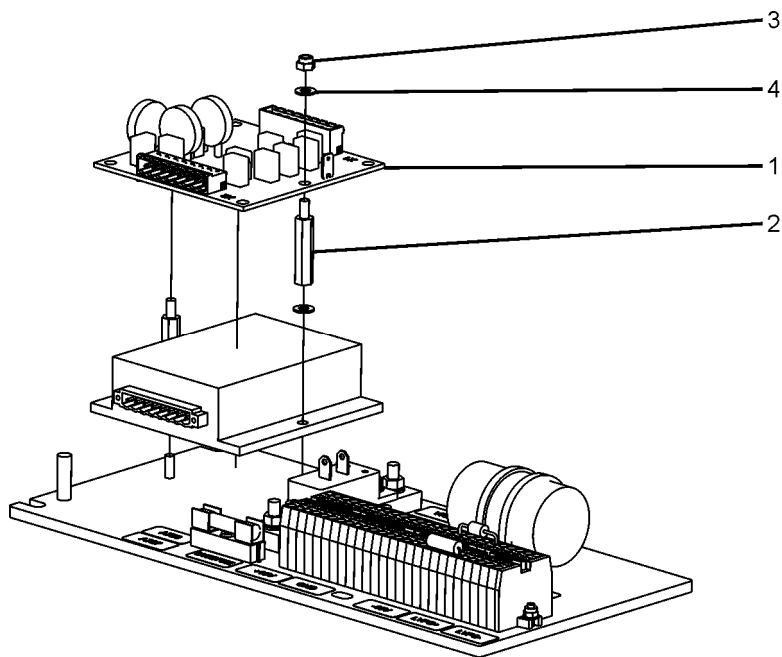


Figure 5-53: A727 Anchor Points

A727 Anchor Points Legend

Index	Description	Part Number
1	A727 Electronics EMI Filter	49507
2	Standoff, M4x30	33097
3	Locking Nut, M4	56049
4	Washer, M4	13132

Removal

This procedure has to be used to remove the A727 Control Electronics EMI Filter from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

NOTE: If this procedure is directed from Section 5.3.4.2, skip to step 3.

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate A727. See Figure 5-51 for the location of the A727.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

5. Disconnect A727.
 - a. There are four cable attachments (see Figure 5-52) labeled A & B which connect to the A727. Disconnect these cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Detach A727 (see Figure 5-53). A727 (1) is mounted atop two standoffs (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Remove the fasteners to detach the A727.
7. Remove A727. To extract the A727, lift the board straight up and off the mounting standoffs. Store the A727 in a manner consistent with ESD practices.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A727.

NOTE: If this procedure directed by Section 5.3.4.2, return to the next step of 5.3.4.2.

Installation

This procedure has to be used to install the A727 Converter Electronics EMI Filter into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

2. Insert A727 (see Figure 5-53). Place the board with the plug labeled X2 on the top facing outward.
3. Attach A727 (see Figure 5-53). A727 (1) is mounted atop two standoffs (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Affix the fasteners and tighten to 22 lb-in (2.5 Nm).
4. Connect A727.
 - a. There are two cable attachments (see Figure 5-52) labeled A & B which connect to the A727. Connect these cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

NOTE: If this procedure directed by Section 5.3.4.2, return to the next step of 5.3.5.2.

5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.5 MVB Interface Board A751

This procedure covers the removal and installation of the A751 MVB Interface from the APS. A751 is mounted on the Electronics Panel in the front of the dry area the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

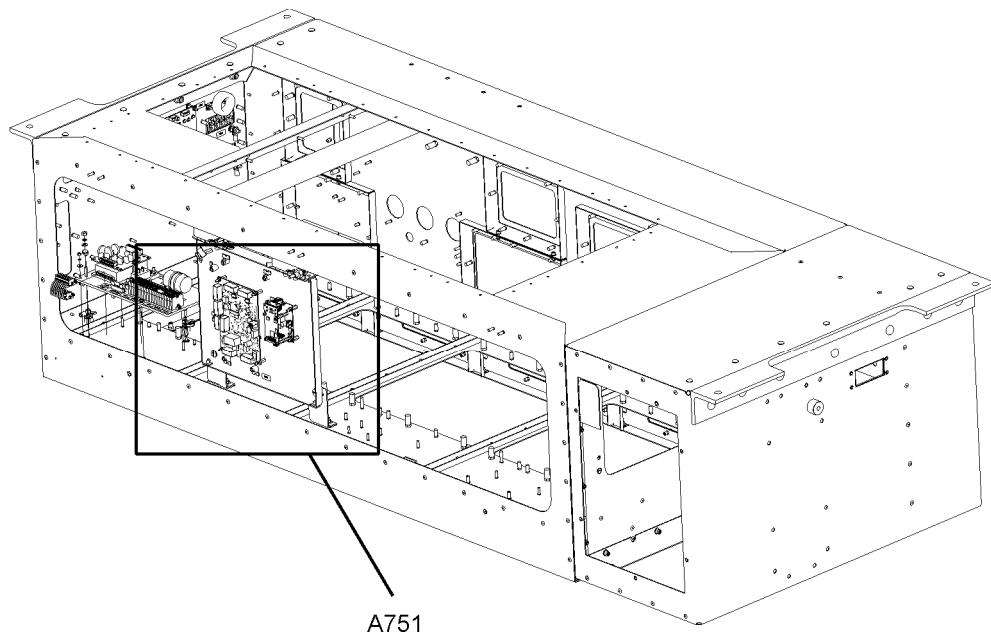


Figure 5-54: Location of A751

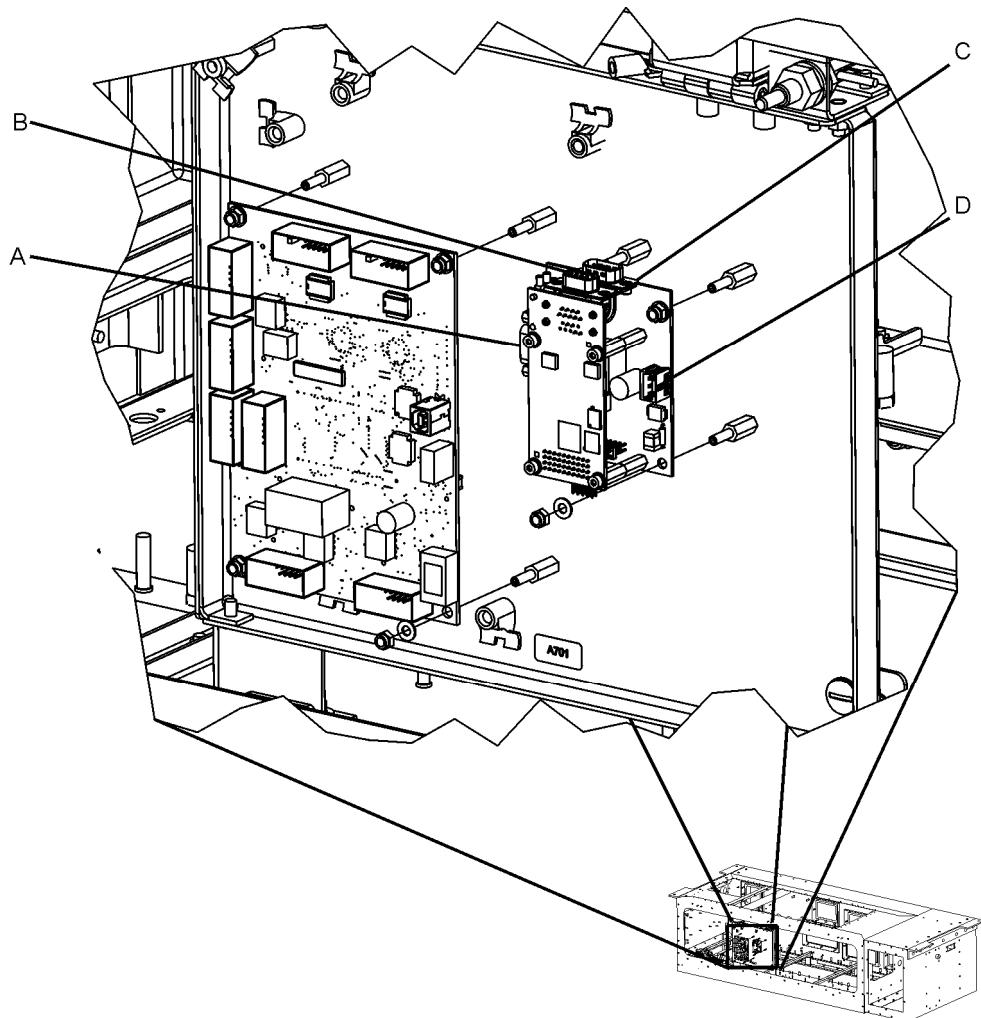


Figure 5-55: A751 Electrical Connections

A751 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	A751 X1	Ribbon Plug	N/A	N/A
B	A751 SK1	D-sub 9	N/A	N/A
C	A751 SK2	D-sub 9	N/A	N/A
D	A751 X2	Plug	N/A	N/A

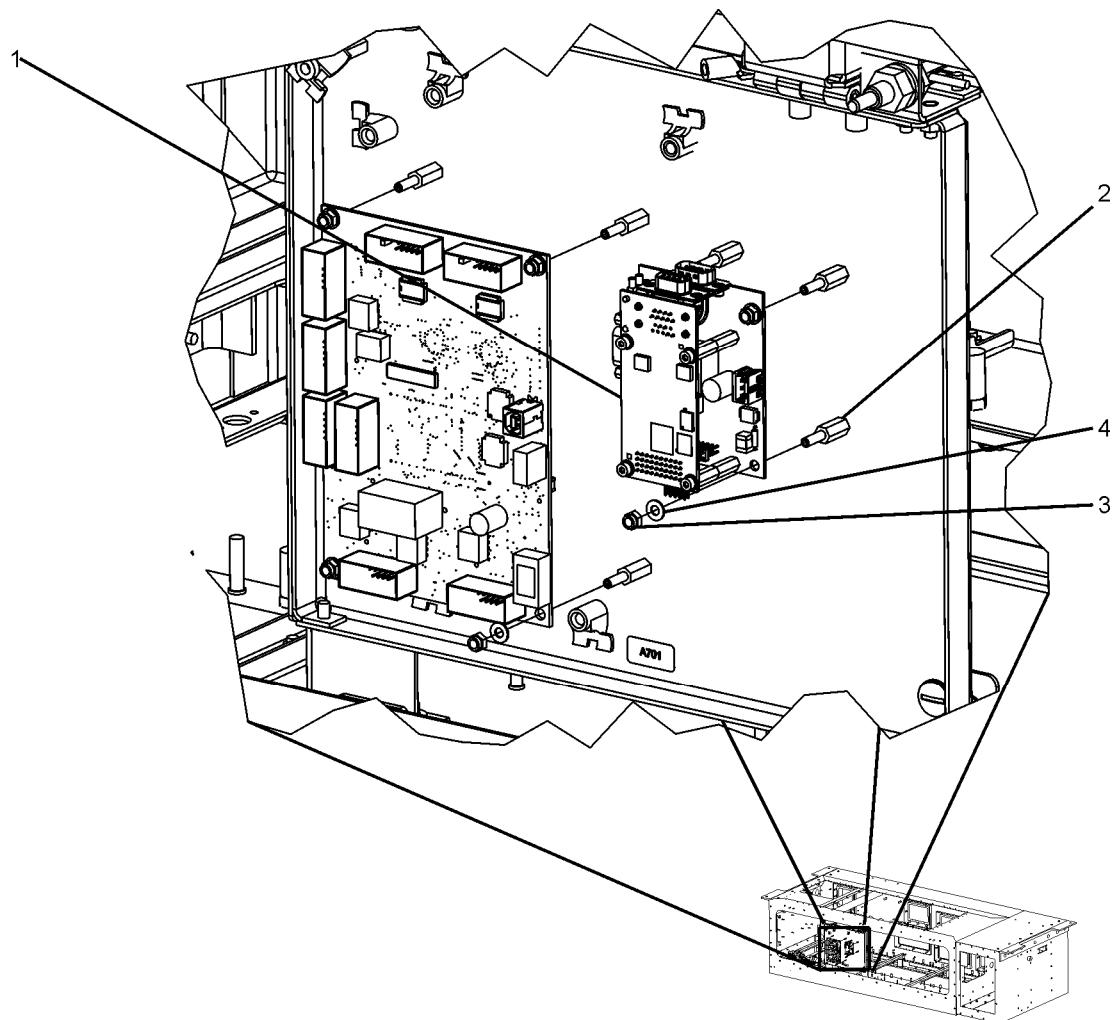


Figure 5-56: A751 Anchor Points

A751 Anchor Points Legend

Index	Description	Part Number
1	A751 MVB Interface	71016
2	Set Screw, M4x20	09338
3	Locking Nut, M4	47525
4	Washer, M4	13132

Removal

This procedure has to be used to remove the A751 MVB Interface Card from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate A751. See Figure 5-54 for the location of the A751.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

5. Disconnect A751.
 - a. There are four cable attachments (see Figure 5-55) labeled A-D which connect to the A751. Disconnect these cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DAMAGE DUE TO FALLING OBJECT. A751 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE A751 WHILE BEING DETACHED TO PREVENT FALLING.

6. Detach A751 (see Figure 5-56). A751 (1) is mounted atop four setscrews (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Remove the fasteners to detach the A751.

7. Remove A751. To extract the A751, pull the board straight off the mounting setscrews. Store the A751 in a manner consistent with ESD practices.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the A751.

Installation

This procedure has to be used to install the A751 Converter Control Unit into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

ESD SENSITIVE COMPONENT. PRACTICE ELECTROSTATIC DISCHARGE SAFETY MEASURES WHEN HANDLING PRINTED CIRCUIT BOARDS (PCBS).

2. Insert A751 (see Figure 5-56). Place the board with the plugs labeled B and C on the top facing outward.

CAUTION

DAMAGE DUE TO FALLING OBJECT. A751 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE A751 WHILE BEING ATTACHED TO PREVENT FALLING.

3. Attach A751 (see Figure 5-56). A751 (1) is mounted atop four setscrews (2) and is held in place with M4 locking nut (3) and M4 washer (4) sets. Affix the fasteners and tighten to 22 lb-in (2.5 Nm).
4. Connect A751.
 - a. There are four cable attachments (see Figure 5-55) labeled A-D which connect to the A751. Connect these cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

5. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.6 Electronics Filter Capacitor C720

This procedure covers the removal and installation of the C720 Capacitor from the APS. C720 is mounted on the Electronics Panel in the front of the dry area the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

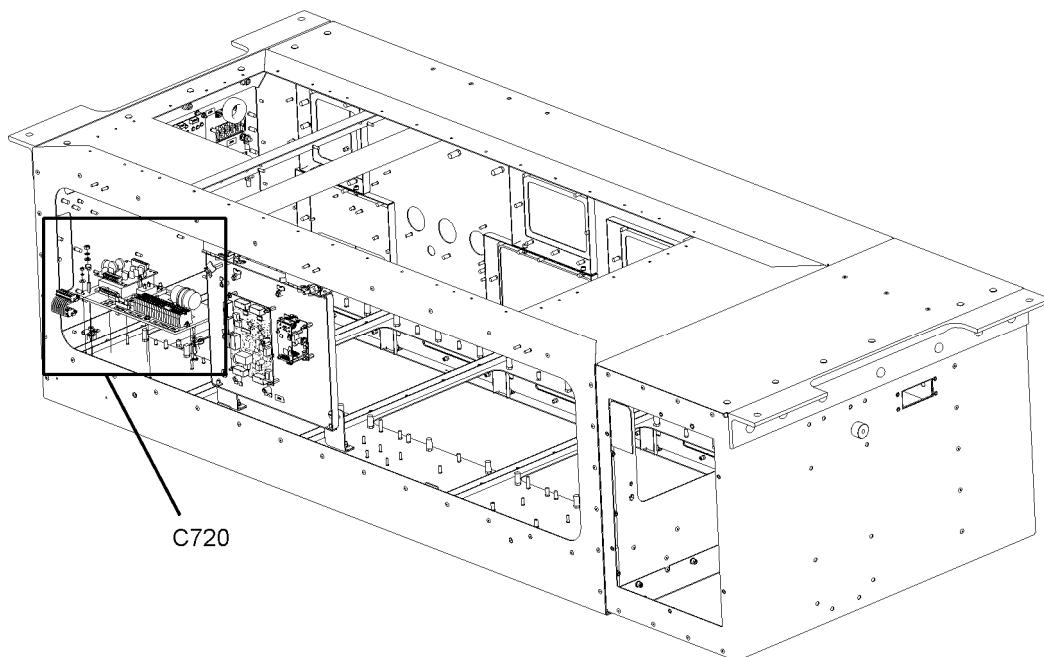


Figure 5-57: Location of C720

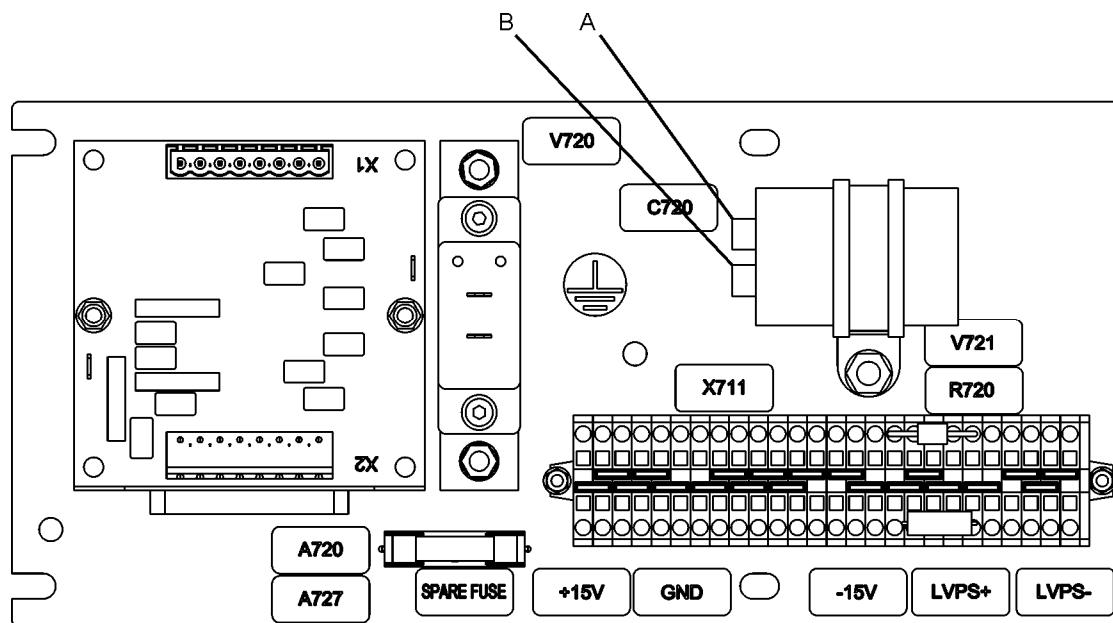


Figure 5-58: C720 Electrical Connections

C720 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	C720 +	Ring	M5x8 screw, M5 Schnorr washer, M5 flat washer	22 lb-in (2.5 Nm)
B	C720 -	Ring	M5x8 screw, M5 Schnorr washer, M5 flat washer	22 lb-in (2.5 Nm)

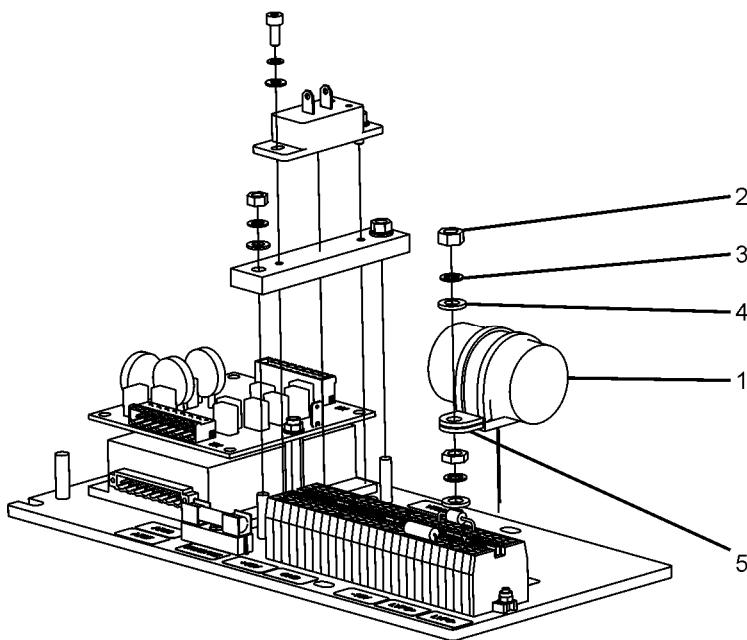


Figure 5-59: C720 Anchor Points

C720 Anchor Points Legend

Index	Description	Part Number
1	Capacitor, C720	07938
2	Nut, M6	03601
3	Schnorr washer, M6	17322
4	Flat washer, M6	13133
5	Clamp	23029

Removal

This procedure has to be used to remove the C720 Electronics Capacitor from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate C720. See Figure 5-57 for the location of the C720.

4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect C720.
 - a. There are two cable attachments (see Figure 5-58) labeled A & B which connect to the C720 using M5 crews, M5 washers and M5 Schnorr washers. Disconnect these cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Detach C720 (see Figure 5-59). C720 (1) is mounted in a clamping device (5) and is held in place with tension supplied by an M6 nut (2) M6 Schnorr washer (3) and M6 washer (4) sets. Loosen these fasteners to disengage the clamp from the C720.
7. Remove C720. To extract the C720, push on the left end of the capacitor and slide the capacitor to the right until it clears the clamp.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the C720.

Installation

This procedure has to be used to install the C720 Capacitor into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.
2. Prepare Clamp. Verify the clamp is sufficiently loosened to allow the capacitor to be inserted.
3. Insert C720 (see Figure 5-59). Slide the capacitor into the clamping device with the + terminal toward the inside of the converter.
4. Secure C720 (see Figure 5-59). C720 (1) is mounted in a clamping device (5) and is held in place with tension supplied by an M6 nut (2) M6 Schnorr washer (3) and M6 washer (4) sets. Tighten these fasteners to until C720 no longer turns freely by hand.

5. Connect C720.

- a. There are two cable attachments (see Figure 5-58) labeled A & B which connect to the C720 using M5 crews, M5 washers and M5 Schnorr washers. Connect these cables.

CAUTION

NOTE POLARITY. CORRECT CONNECTION OF THE CAPACITOR TERMINALS IS VERY IMPORTANT. FOLLOW THE LABELLING OF THE CABLES, A FOR C720"+" AND B FOR C720"-".

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
7. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.7 Resistor R720

This procedure covers the removal and installation of the R720 Resistor from the APS. R720 is mounted on the Electronics Power Supply Terminal Board X711 in the front of the LVPS area the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

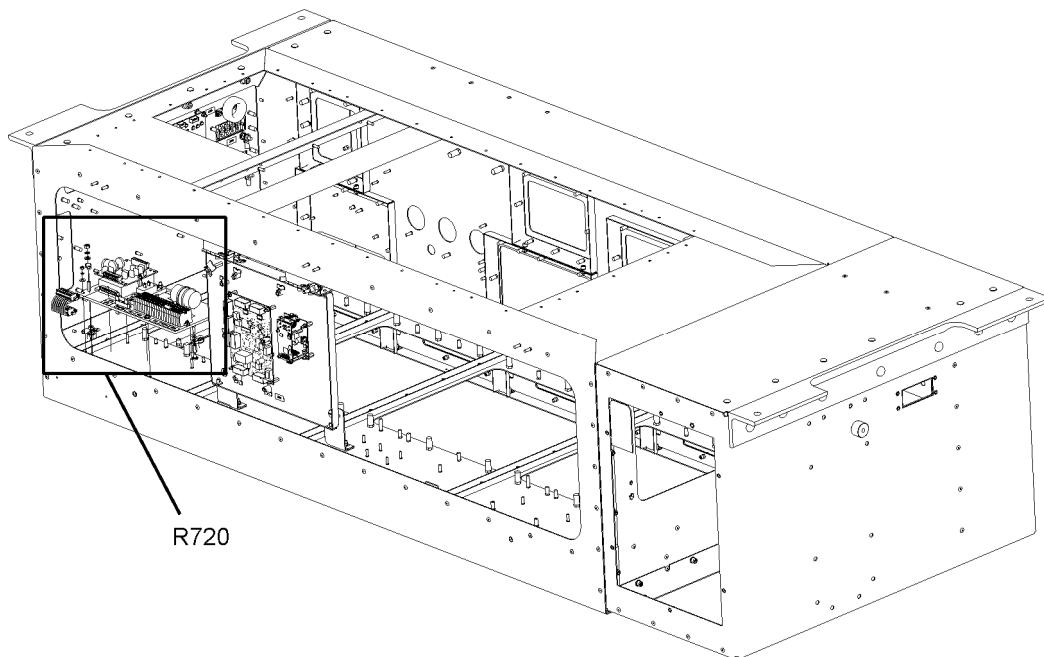


Figure 5-60: Location of R720

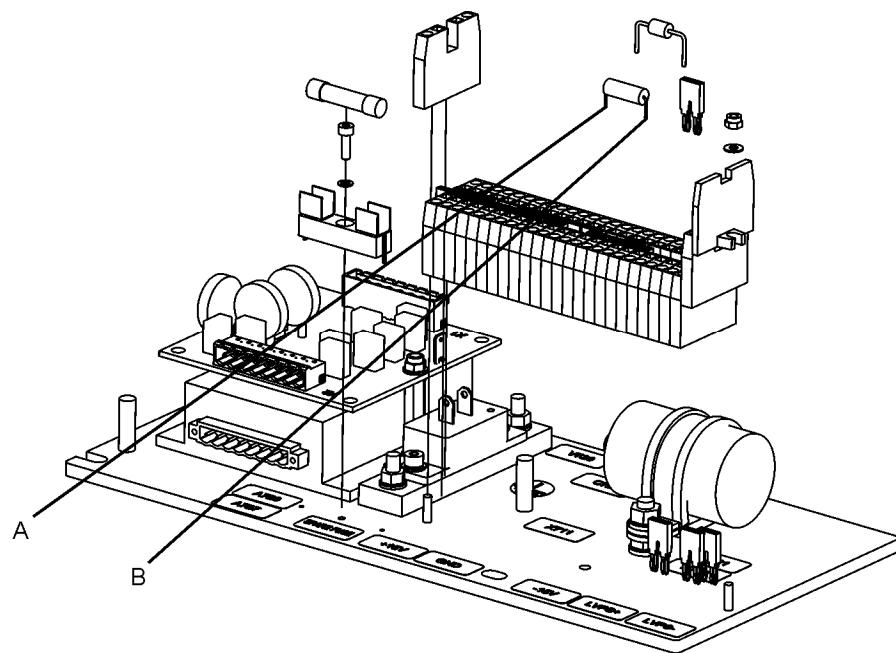


Figure 5-61: R720 Electrical Connections

R720 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	X711 Pin 20	Clamp	N/A	N/A
B	X711 Pin 21	Clamp	N/A	N/A

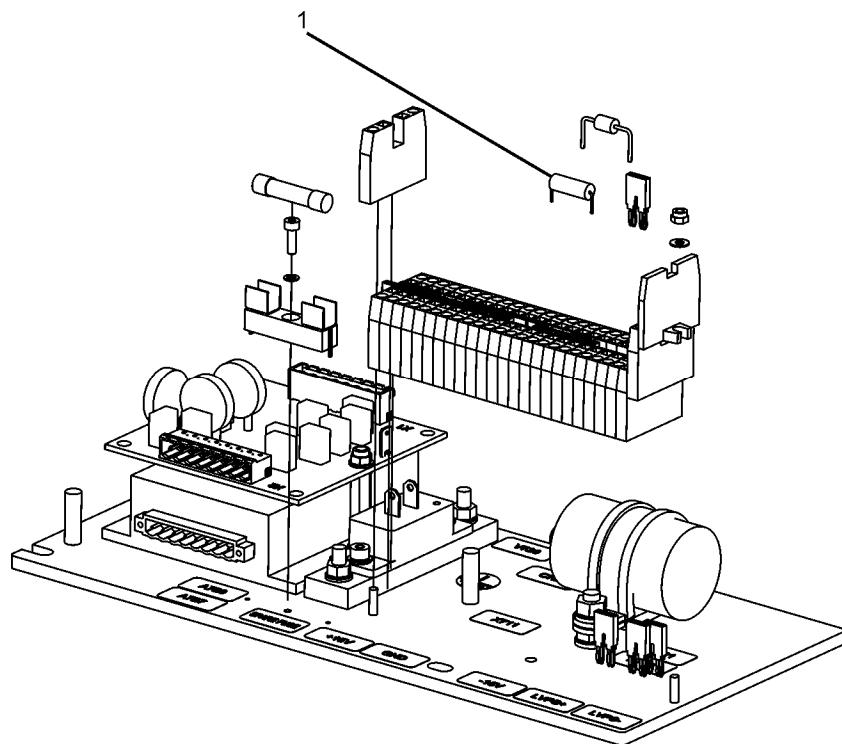


Figure 5-62: R720 Anchor Points

R720 Anchor Points Legend

Index	Description	Part Number
1	Resistor, R720	07167

Removal

This procedure has to be used to remove the R720 Resistor from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate R720. See Figure 5-60 for the location of the R720.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.

NOTE: The R720 Electrical Connection is also its Mechanical Connection.

5. Remove R720 (see Figure 5-61 and Figure 5-62). R720 (1) is mounted directly on the X711 terminal block between pins 20 and 21. To remove, use a small head screwdriver to push downward on the release catch next to each pin. It may be necessary to bend the resistor to remove it.
6. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the R720.

Installation

This procedure has to be used to install the R720 Resistor into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the pins 20 and 21 of terminal block X711 are undamaged and are serviceable.
2. Insert R720 (see Figure 5-61). Orient the resistor with the gold band on the left and press firmly down on the left leg of the resistor into the slot 20 until the latching mechanism is engaged. Do the same for the other end of the resistor in pin 21. It may be necessary to bend the resistor during insertion. If so, straighten the resistor once it is in place.
3. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
4. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.8 Blocking Diode, V720

This procedure covers the removal and installation of the V720 Blocking Diode from the APS. V720 is mounted on the Electronics Power Supply assembly in front of the LVPS section of the dry area the APS.

Required Materials:

- Cable Ties
- Labels
- Heat conductive paste

Special Equipment: None

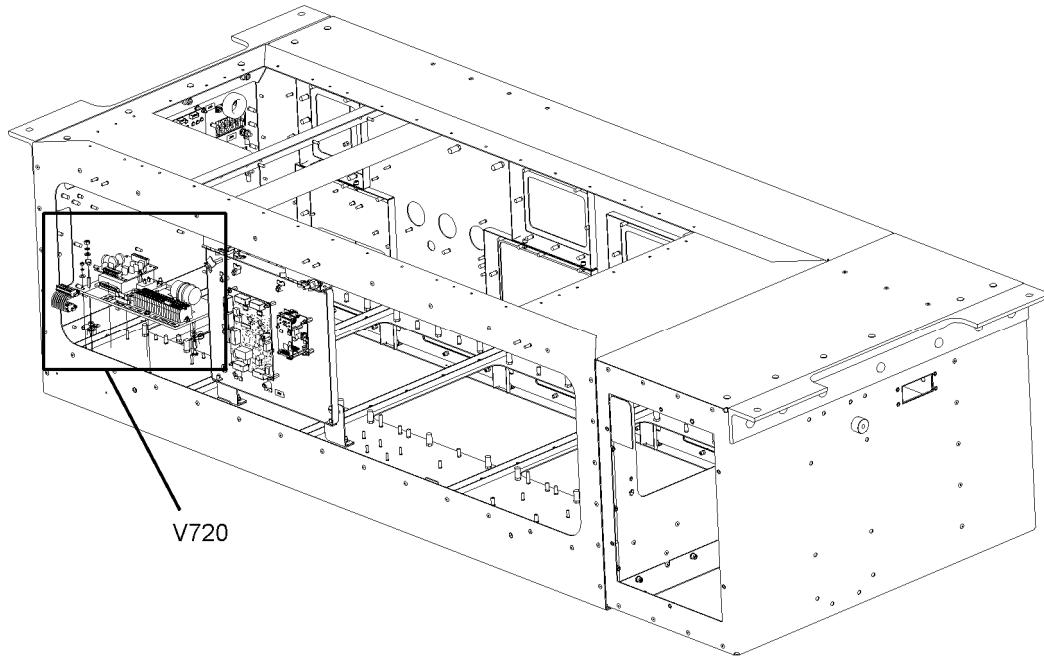


Figure 5-63: Location of V720

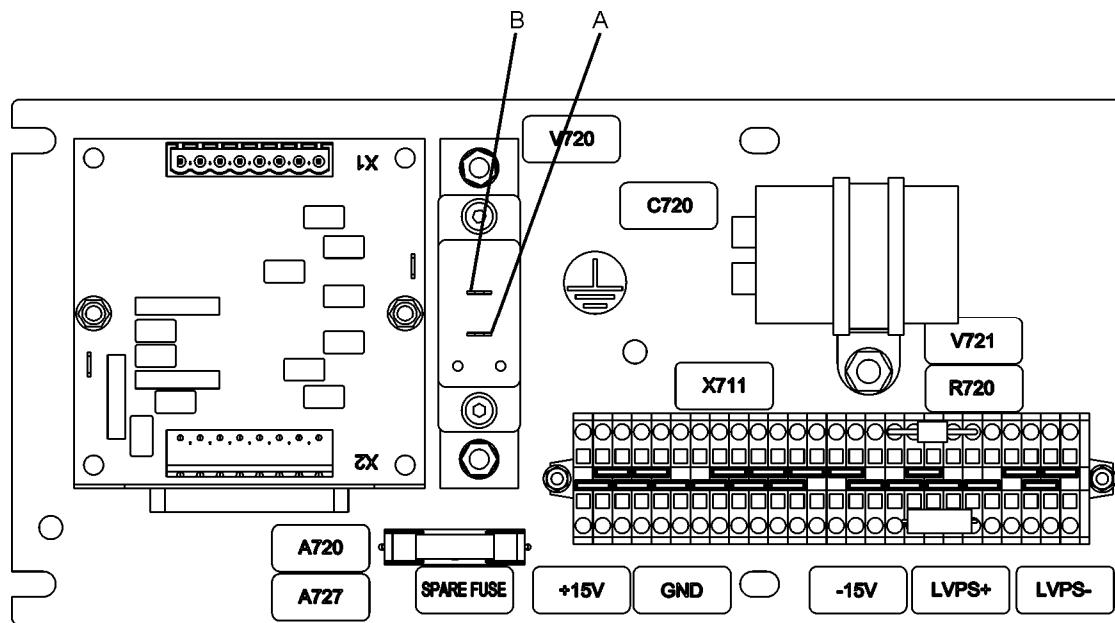


Figure 5-64: V720 Electrical Connections

V720 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	V720A	Fast-on	N/A	N/A
B	V720K	Fast-on	N/A	N/A

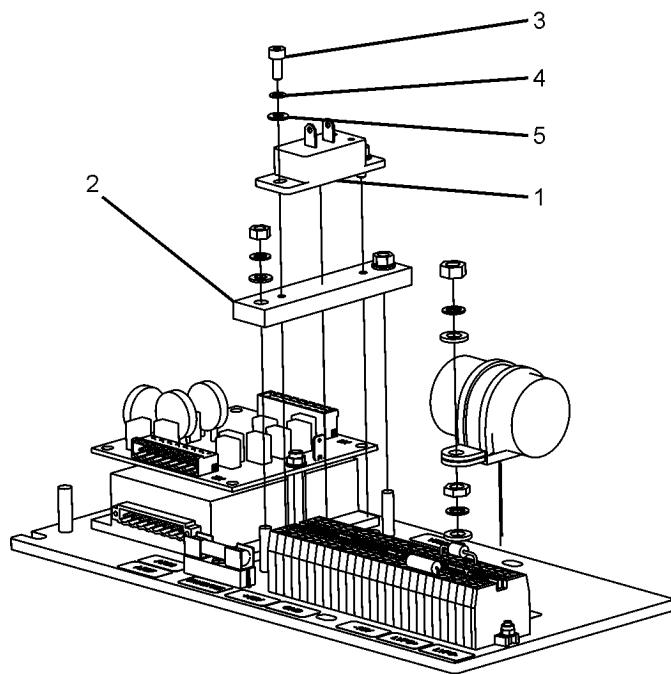


Figure 5-65: V720 Anchor Points

V720 Anchor Points Legend

Index	Description	Part Number
1	Diode, V720	12946
2	Mounting Plate	20723
3	Screw, M4x10	54146
4	Schnorr washer, M4	39272
5	Flat washer, M4	13132

Removal

This procedure has to be used to remove the V720 Blocking Diode from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate V720. See Figure 5-63 for the location of the V720.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect V720.
 - a. There are two cable attachments (see Figure 5-64) labeled A and B which connect to the V720 using Fast-on connectors. Disconnect these cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Detach V720 (see Figure 5-65). V720 (1) is mounted atop a mounting plate (2) and is held in place with two M4 locking nut (3) and M4 washer (4) sets. Remove the fasteners to detach the V720.

NOTE: The bottom of the V720 is coated with heat conductive paste. While not adhesive, it may be necessary to wiggle or pry the V720 up from the mount.

7. Remove V720.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the V720.

Installation

This procedure has to be used to install the V720 Blocking Diode into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.
2. Prepare the V720. Apply a 100 μm thick coating of heat conductive paste on the bottom of the diode.
3. Insert V720 (see Figure 5-64). Place the diode with the cathode toward the interior of the APS and the anode toward the door of the APS.
4. Attach V720 (see Figure 5-65). V720 (1) is mounted atop a mounting plate (2) and is held in place with two M4 locking nut (3) and M4 washer (4) sets. Affix the fasteners and tighten to 22 lb-in (2.5 Nm).
5. Connect V720.
 - a. There are two cable attachments (see Figure 5-64) labeled A and B which connect to the V720 using Fast-on connectors. Connect these cables.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

6. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
7. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.5.9 Rectifier Diode, V721

This procedure covers the removal and installation of the V721 Rectifier Diode from the APS. V721 is mounted on the X11 Terminal Block of the Electronics Power Supply Assembly in the front of the dry area of the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

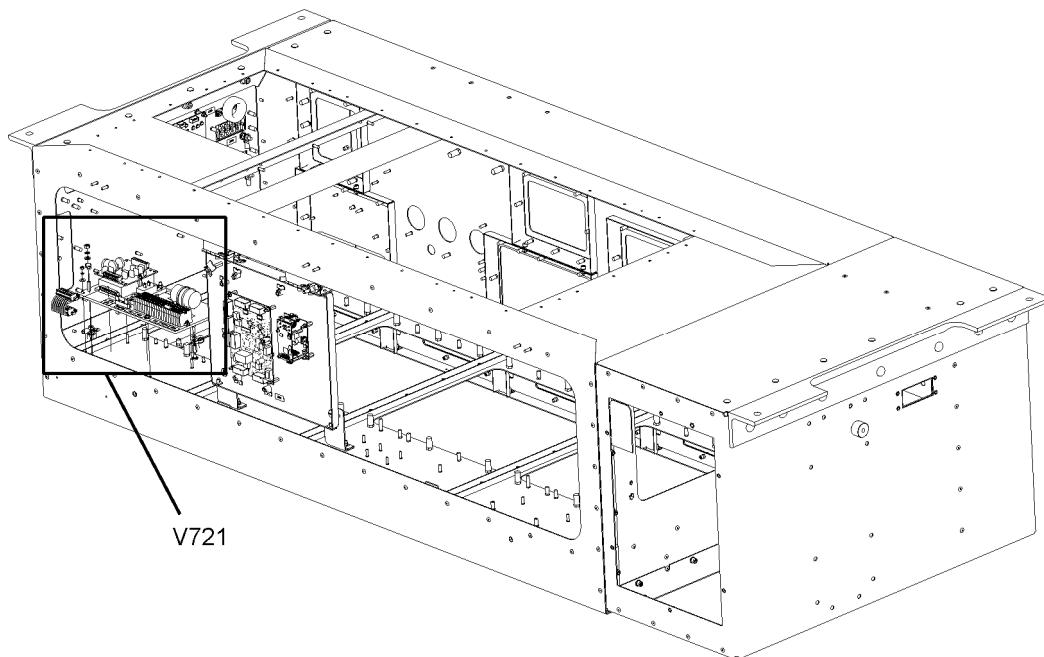


Figure 5-66: Location of V721

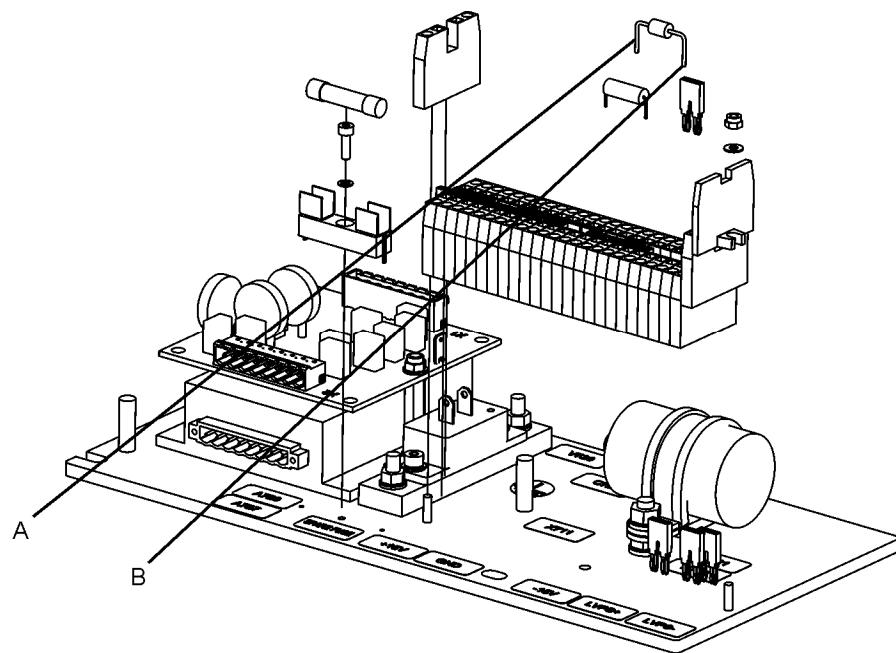


Figure 5-67: V721 Electrical Connections

V721 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	V721K	Clamp	N/A	N/A
B	V721A	Clamp	N/A	N/A

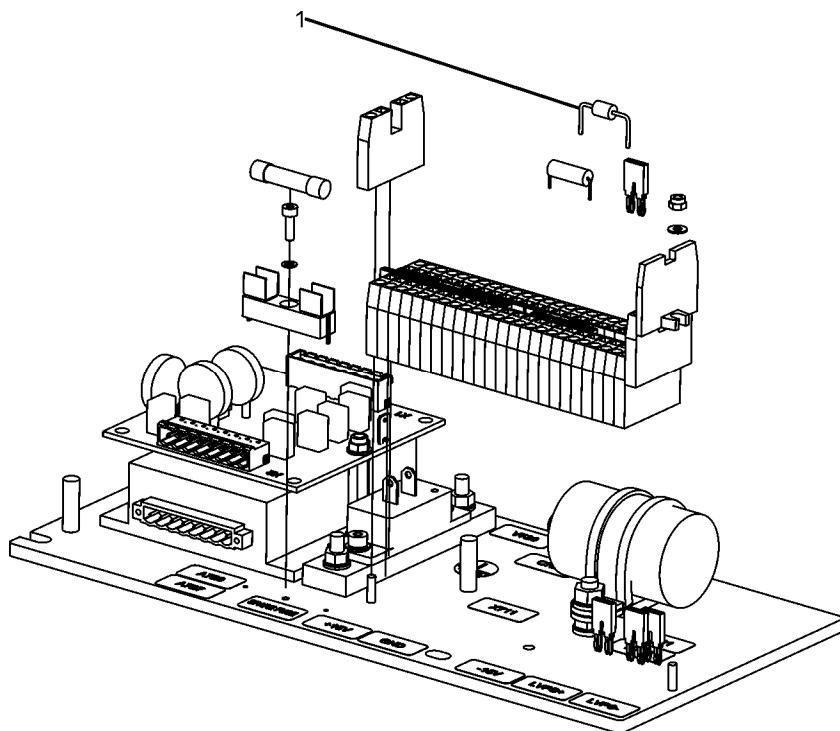


Figure 5-68: V721 Anchor Points

V721 Anchor Points Legend

Index	Description	Part Number
1	Diode, V721	00960

Removal

This procedure has to be used to remove the V721 Rectifier Diode from the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate V721. See Figure 5-66 for the location of V721.
4. Verify the labels on the connection block X711 terminals are clear and legible. Replace these labels if necessary.

NOTE: V721 Electrical Connection is also its Mechanical Connection.

5. Remove V721 (see Figure 5-67 and Figure 5-68). V721 (1) is mounted directly on the X711 terminal block between pins 20 and 21. To remove, use a small screwdriver to push downward on the release catch next to each pin. It may be necessary to bend the Rectifier Diode to remove it.
6. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of V721.

Installation

This procedure has to be used to install the V721 Rectifier Diode into the APS. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the pins 20 and 21 of terminal block X711 are undamaged and are serviceable.
2. Bend the Rectifier Diode for insertion. Insert V721 (see Figure 5-67). Note the correct polarity of the diode. Press firmly down the Rectifier Diode into the slot 20 and slot 21 until the latching mechanism is locked.
3. Close Service Door. Close the Dry Area Cover from the front of the APS. See Section 3.3.1.
4. Secure Area. Inspect the work area and secure any debris or loose parts.

5.3.6 Support Systems (A900)

5.3.6.1 Blower Fuse, F901

This procedure covers the replacement of the F901 Blower Fuse from the APS. The F901 receptacle is located on a panel next to the warning plate in front of C101 in the front of the dry area the APS.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

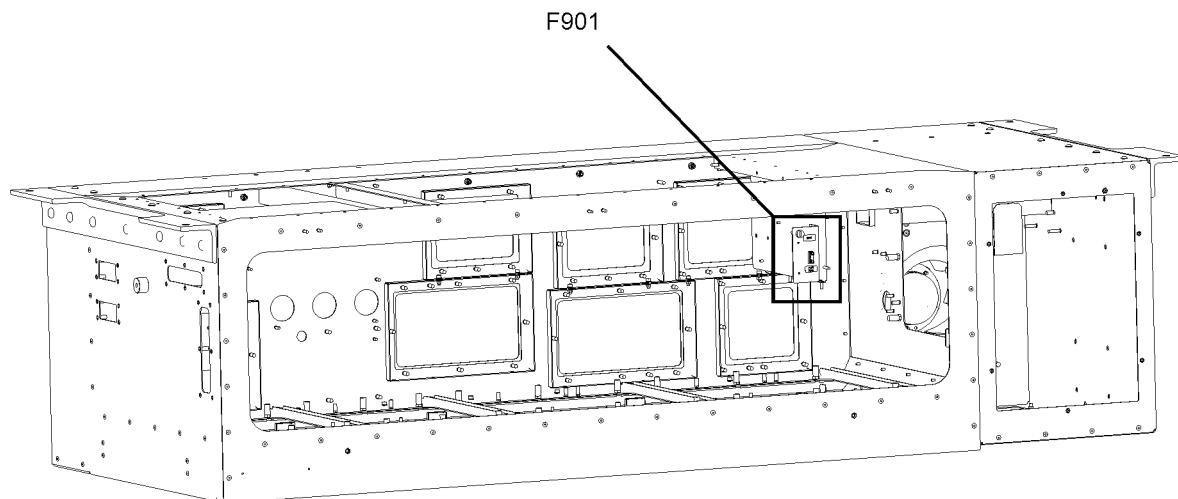


Figure 5-69: Location of F901

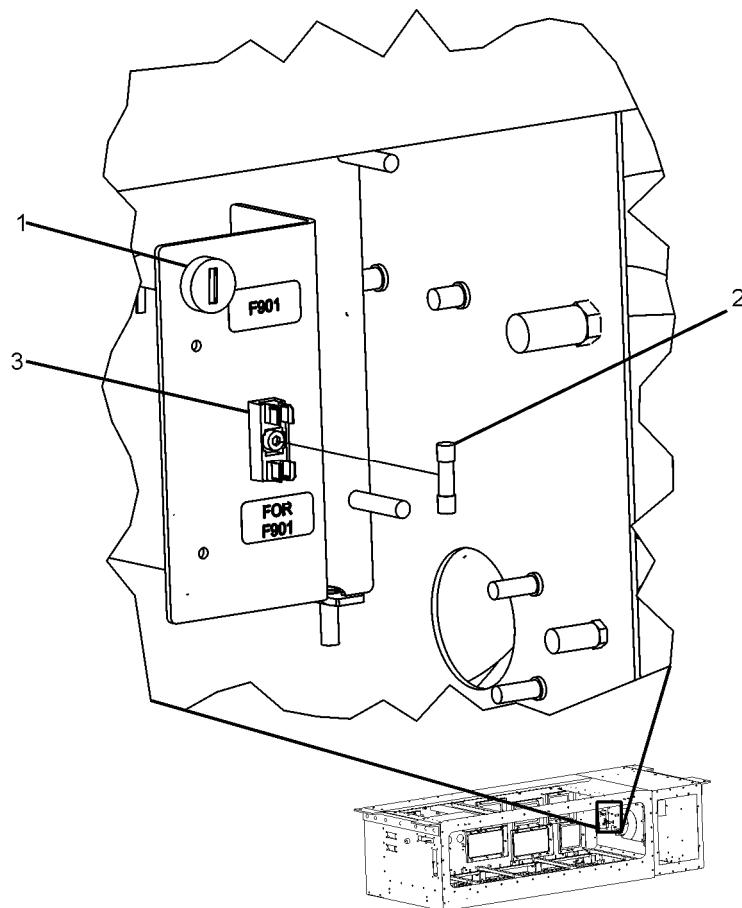


Figure 5-70: F901 Replacement

F901 Replacement Legend

Index	Description	Part Number
1	Fuse Receptacle	04617
2	Spare Fuse	16636
3	Spare Fuse Holder	03129

Fuse Replacement

This procedure has to be used to replace the F901 Fuse in the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.
2. Open Service Door. Open the Dry Area Cover from the front of the APS. See Section 3.3.1.
3. Locate F901. See Figure 5-69 for the location of the F901.
4. Disengage Fuse Receptacle. Push inward gently and rotate the receptacle cap approximately $\frac{1}{4}$ turn in the counterclockwise direction. Release pressure on the cap and pull the cap from the receptacle.
5. Remove Fuse. The fuse mounts in the receptacle cap and is held in place by tension between contact clips. Pull the fuse straight away from the cap to remove.
6. Insert Fuse. Insert the replacement fuse by sliding the fuse straight into the clips on the receptacle cap until the fuse is fully seated in the cap.
7. Engage Fuse Receptacle. Insert the cap with the mounted fuse into the fuse receptacle. Gently apply inward pressure and rotate the cap approximately $\frac{1}{4}$ turn in the clockwise direction until cap locks into place.

5.3.6.2 Blower Assembly, M901

This procedure covers the removal and installation of the M901 Blower Unit from the APS. M901 is mounted in the wet area the APS.

NOTE: Replacement of the blower falls under the category of Periodic Maintenance and must be performed every 776,000 km. However, due to its location, this procedure may require a heavy repair environment to facilitate access to the blower unit.

Required Materials:

- Cable Ties
- Labels

Special Equipment: None

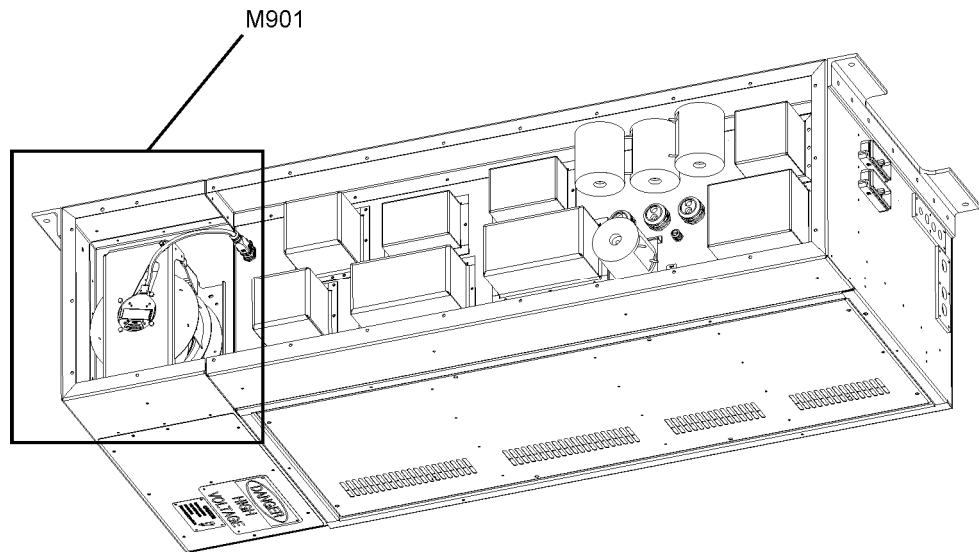


Figure 5-71: Location of M901

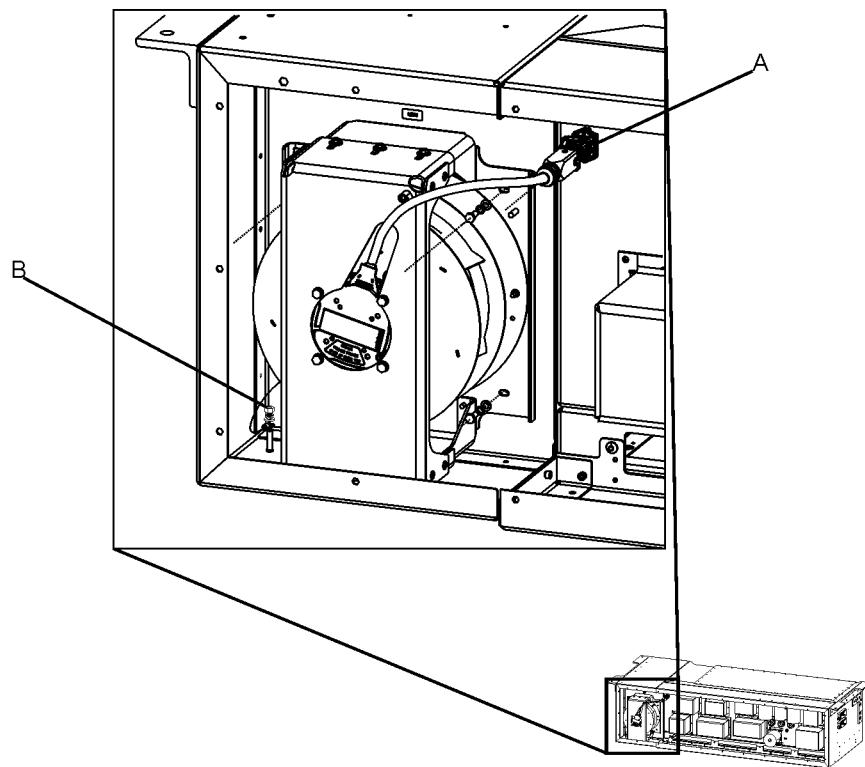


Figure 5-72: M901 Electrical Connections

M901 Electrical Connections Legend

Index	Connection	Termination	Hardware	Torque
A	X901	Latch Plug	N/A	N/A
B	Ground	Ring	M6 Nut, M6 Schnorr washer, M6 Flat washer	77 lb-in (8 Nm)

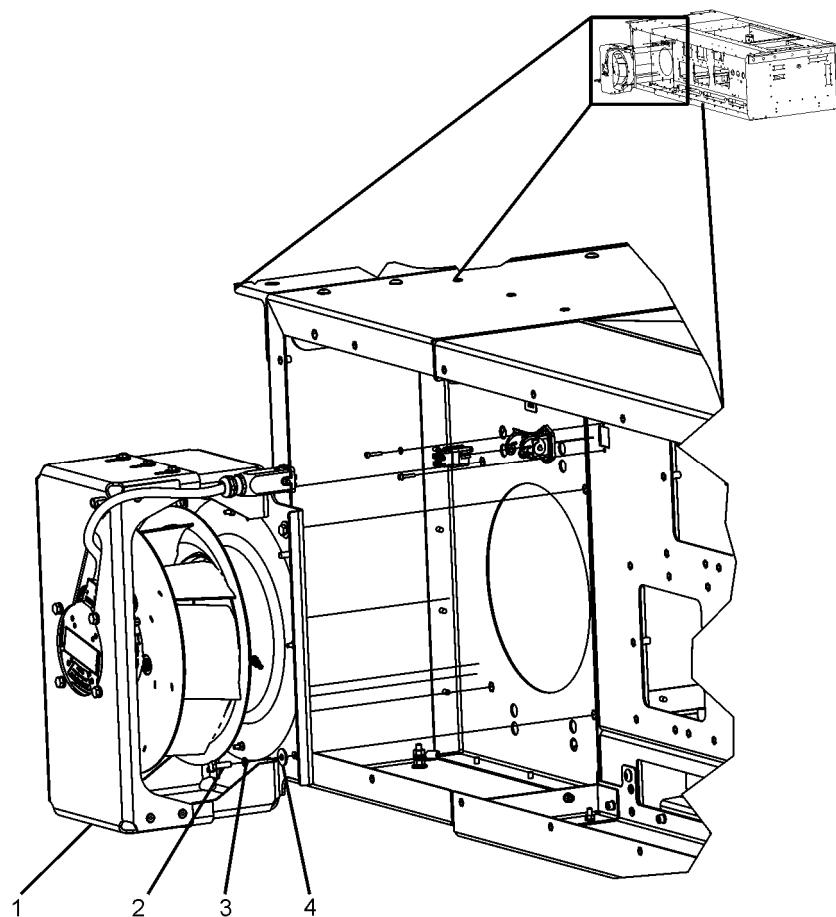


Figure 5-73: M901 Anchor Points

M901 Anchor Points Legend

Index	Description	Part Number
1	Blower Unit	47692
2	Screw, M6x20	13107
3	Schnorr washer, M6	17322
4	Flat washer, M6	20191

Removal

This procedure has to be used to remove the M901 Blower Unit. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Remove and Verify Removal of Power from APS. Refer to Section 3.3.2 for instruction on verification of capacitor discharge.

WARNING

MOVING PARTS. VERIFY THAT POWER HAS BEEN REMOVED FROM THE APS AND THAT THE FAN BLADES OF THE BLOWER HAVE STOPPED (AIR FLOW HAS CEASED) BEFORE PROCEEDING WITH THIS PROCEDURE.

2. Open Air Duct Service Panel. Open the Wet Area Cover from the APS. Refer to Section 3.3. for cover removal.
3. Locate M901. See Figure 5-71 for the location of the M901.
4. Inspect Cables and Connections. Verify the labels on all cables and on the connection terminals are clear and legible. Replace these labels if necessary.
5. Disconnect M901.
 - a. The M901 is connected to the converter at X901 by a single latching plug (see Figure 5-72). Unlatch the plug (A) and disconnect the M901.
 - b. The M901 is grounded at a grounding stud on the floor of the APS to the left of the blower unit at a single grounding point (B) using M6 nut, M6 Schnorr washer and M6 flat washer. Remove these fasteners and disconnect the grounding cable.

CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

CAUTION

DAMAGE DUE TO FALLING OBJECT. M901 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE M901 WHILE BEING DETACHED TO PREVENT FALLING.

6. Detach M901 (see Figure 5-73). M901 (1) is mounted at four points and is held in place with M6x20 screw (2), M6 Schnorr washer (3) and M6 flat washer (4) sets. Remove the fasteners to detach the M901.
7. Remove M901. To extract the M901, pull the assembly straight off the mounting points and then lift out and back to extract the blower from the APS.
8. Secure Area. Inspect the work area and secure any debris or loose parts. Place the latter in storage until reinstallation of the M901.

Installation

This procedure has to be used to install the M901 Blower Unit into the APS. The APS should be isolated from power before entering this procedure. Review all listed safety notices prior to starting this procedure. Effective technical competence of the technician is assumed.

For detailed information on parts, consult the applicable section of the (IPC).

1. Inspect Mounting Points. Verify the anchor points are undamaged and are serviceable.

CAUTION

DAMAGE DUE TO FALLING OBJECT. M901 IS MOUNTED ON A VERTICAL SURFACE AND WHILE DETACHED, WILL BE SUBJECT TO GRAVITY AND MAY FALL CAUSING DAMAGE TO ITSELF OR OTHER COMPONENTS. SUPPORT THE M901 WHILE BEING ATTACHED TO PREVENT FALLING.

2. Insert M901 (see Figure 5-73). Lower the blower unit (M901) into the wet area of the converter and then align the unit with the four mounting points and move the blower assembly forward until the blower intake rests snug against the circular port at the bulkhead leading to the air filter and L101 area.
3. Attach M901 (see Figure 5-73). M901 (1) is mounted at four points and is held in place with M6x20 screw (2), M6 Schnorr washer (3) and M6 flat washer (4) sets. Affix the fasteners and tighten to 77 lb-in (8.8 Nm) of torque.
4. Connect M901 (see Figure 5-72).
 - a. The M901 is grounded at a grounding stud on the floor of the APS to the left of the blower unit at a single grounding point (B) using M6 nut, M6 Schnorr washer and M6 flat washer. Connect the ground cable and affix these fasteners.
 - b. The M901 is connected to the converter at X901 by a single latching plug (A). Connect the plug and latch it into place.

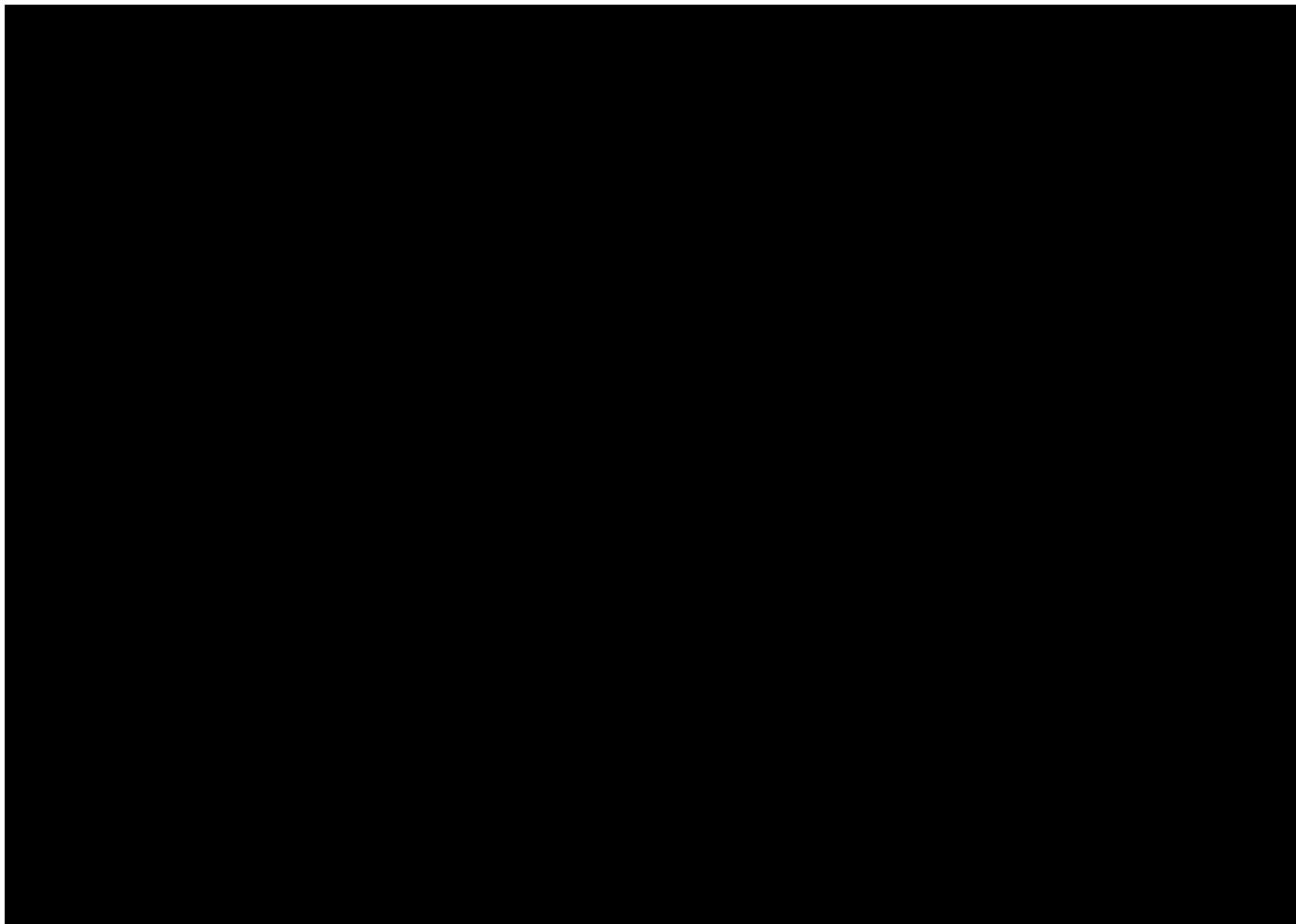
CAUTION

SECURE ALL CABLES. SECURE LOOSE CABLES TO PREVENT DAMAGE TO CABLES OR EQUIPMENT DURING REMOVAL. ADD CABLE TIES TO SECURE THE CABLES TO THE APS INFRASTRUCTURE TO PREVENT DAMAGE TO THE CABLES.

5. Close Air Duct Service Panel. Close the Wet Area Cover from the rear of the APS. Refer to Section 3.3.
6. Secure Area. Inspect the work area and secure any debris or loose parts.

5.4 APS Schematic, LA P3010

Within the following pages you will find the schematics of the APS. The cabling is spread over several pages. The schematics are technical drawings virtually divided into columns (1 to 10) and rows (A to G), see example below.



For navigation between the pages, page numbers and columns have to be considered.

Within the navigation marks the first number is a consecutive current path number to be also found on the target page. The second number (after the slash) indicates the target page (drawing-sheet). The last number indicates the virtual column on the target page where the current path will continue.

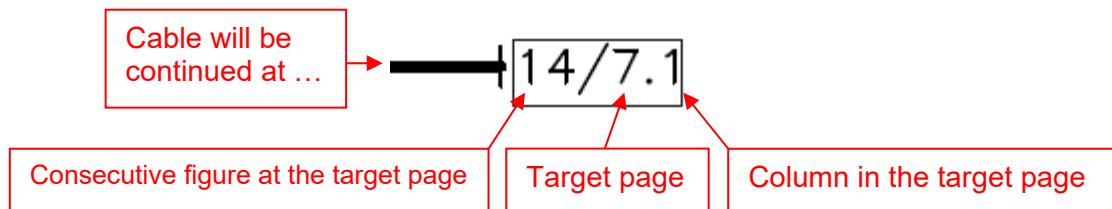
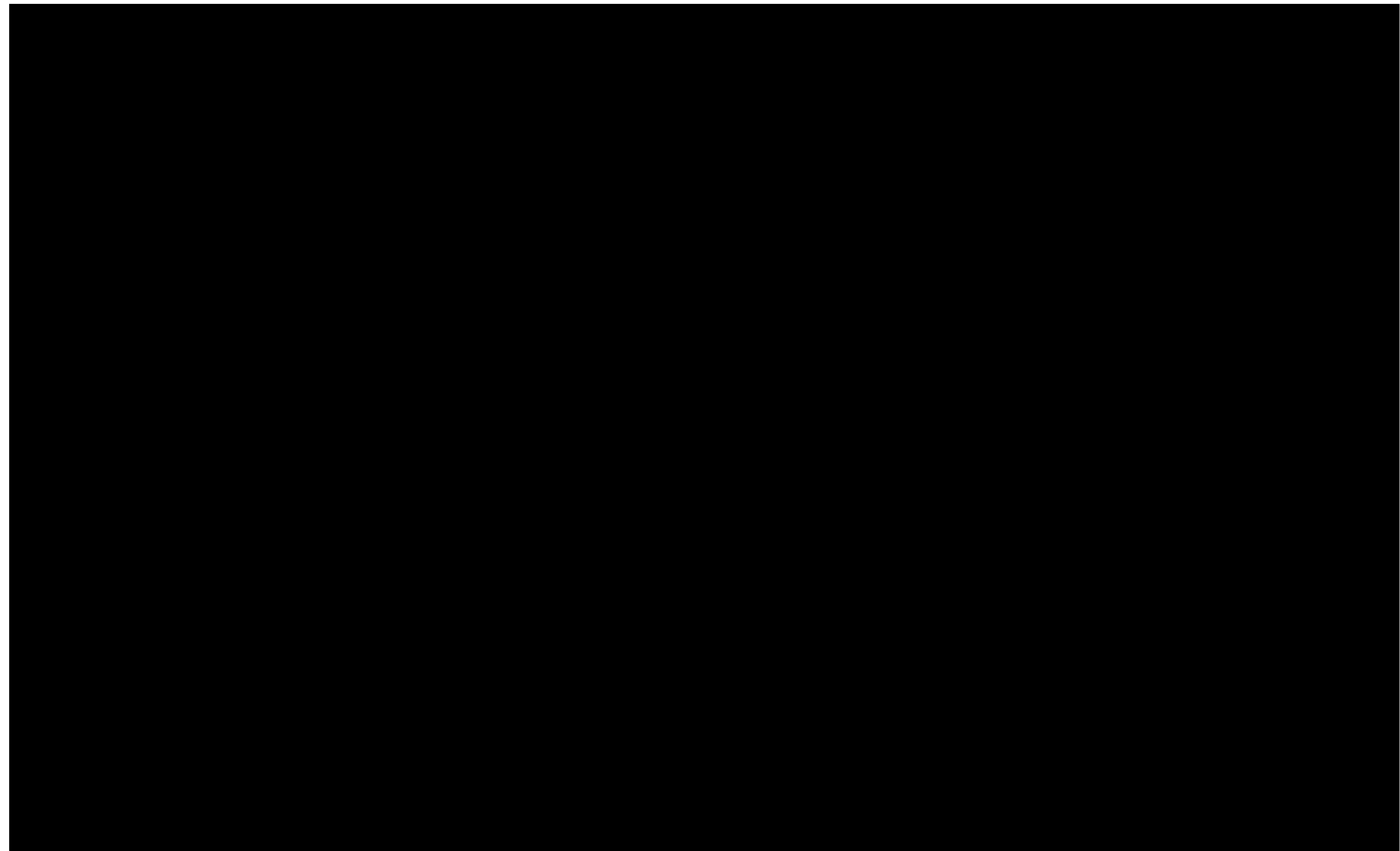
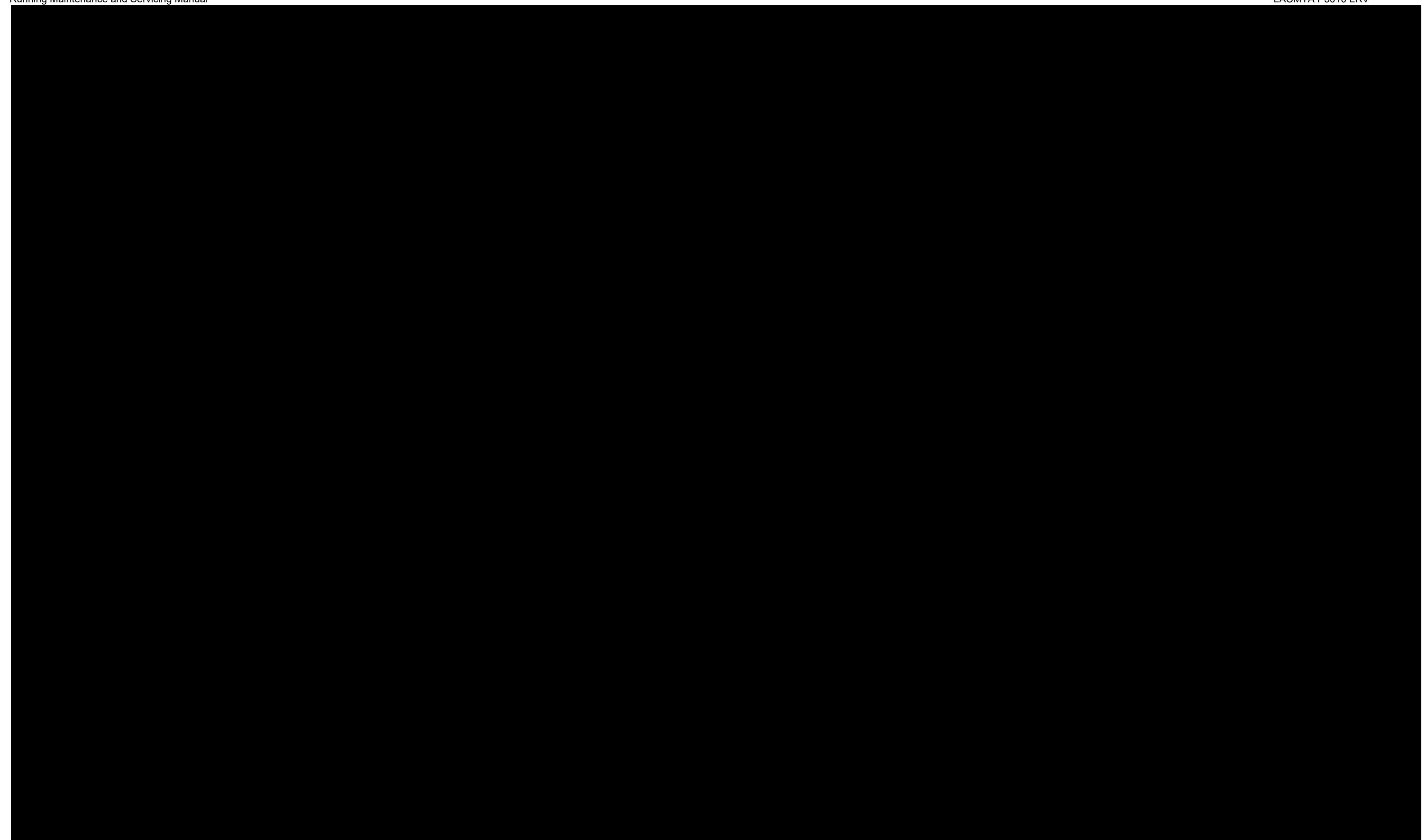
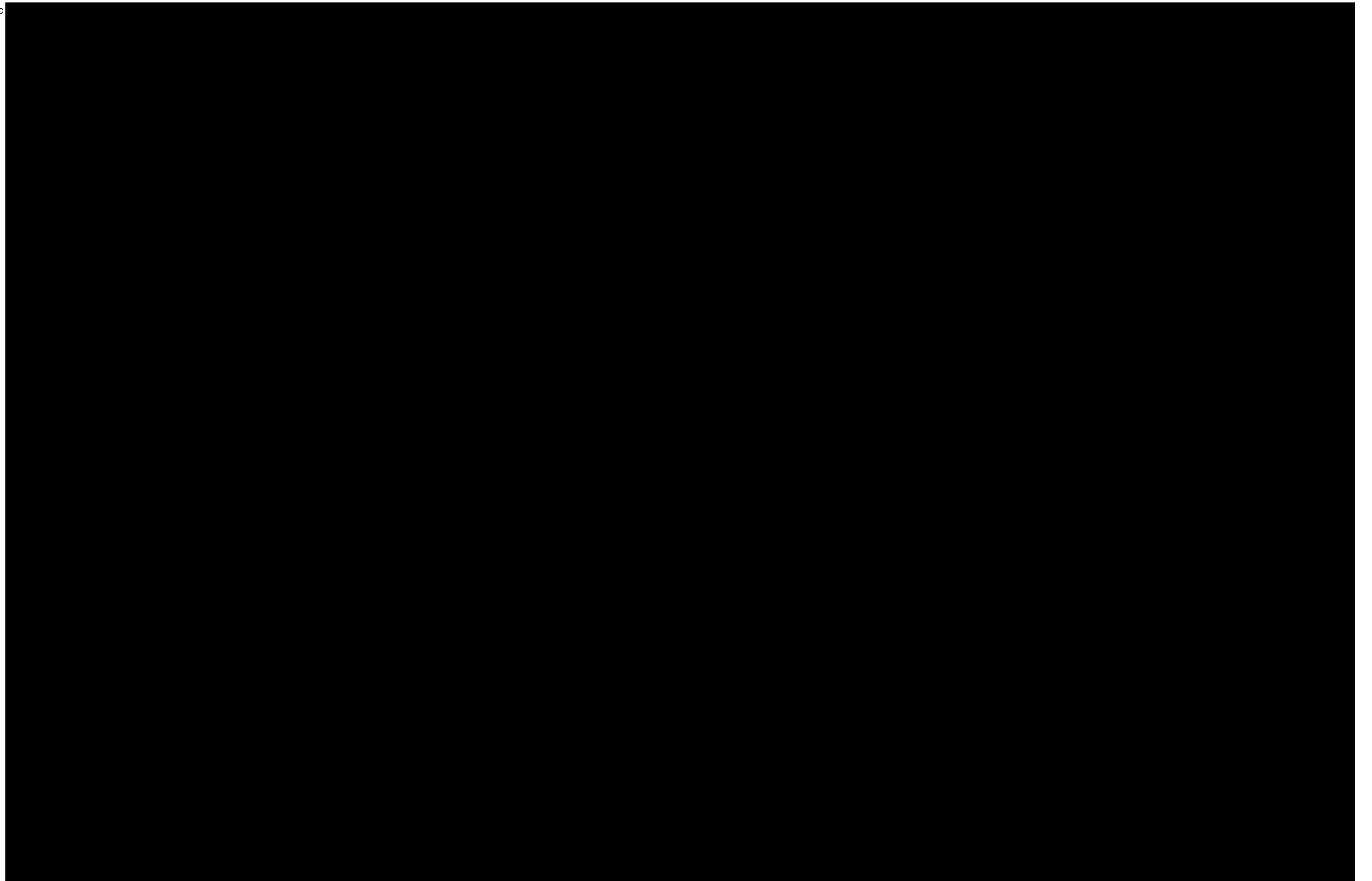
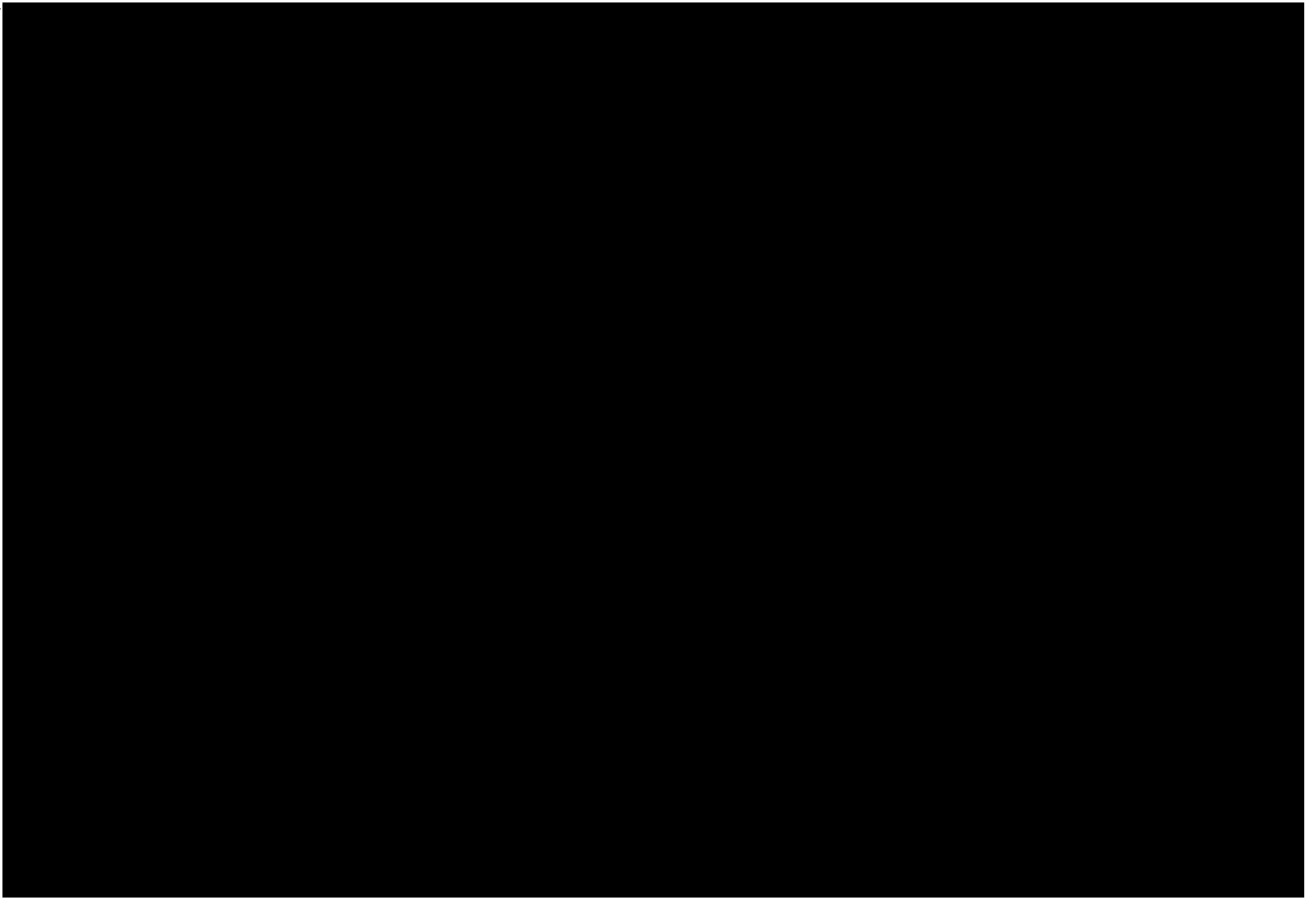


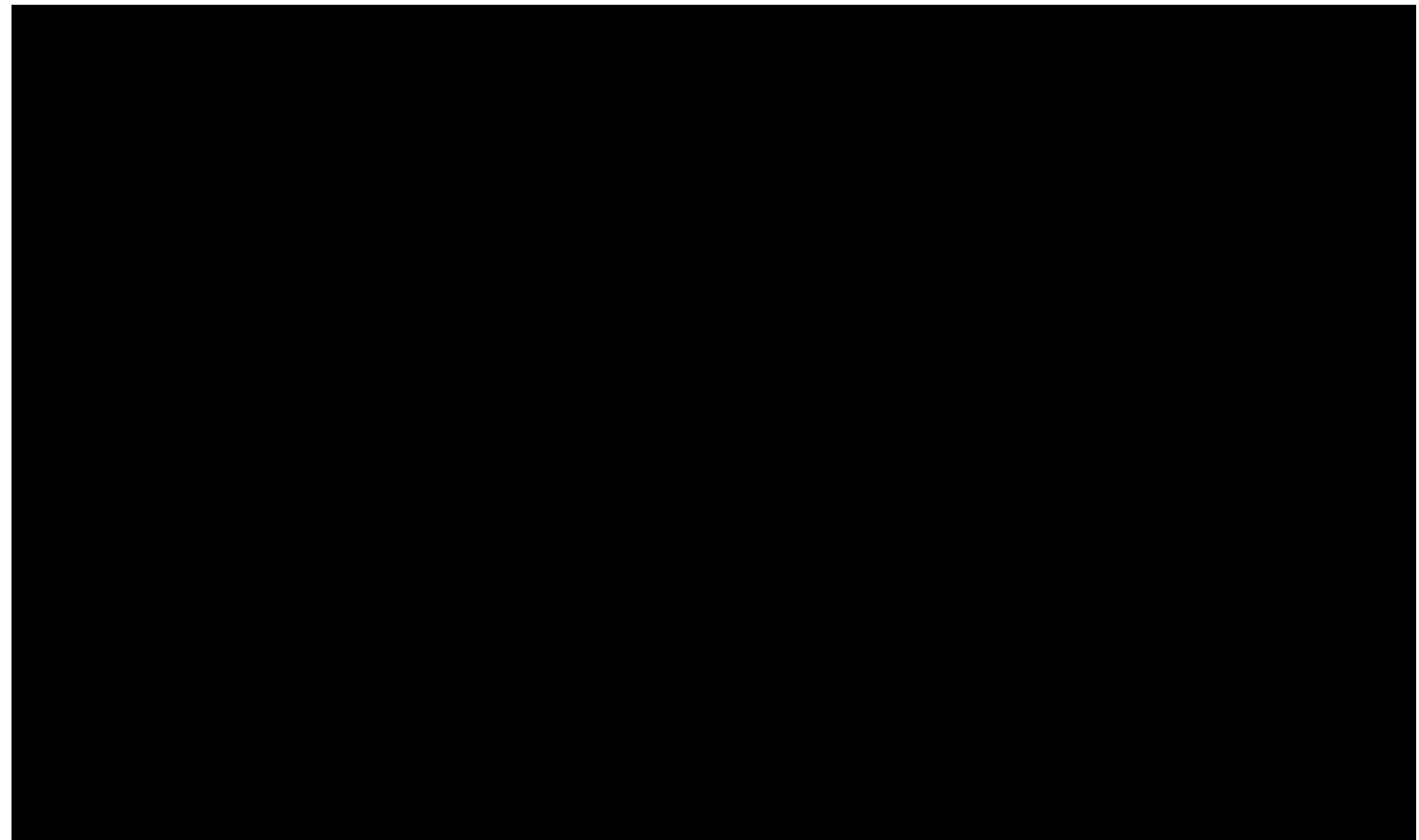
Figure 5-75: Navigation Marks

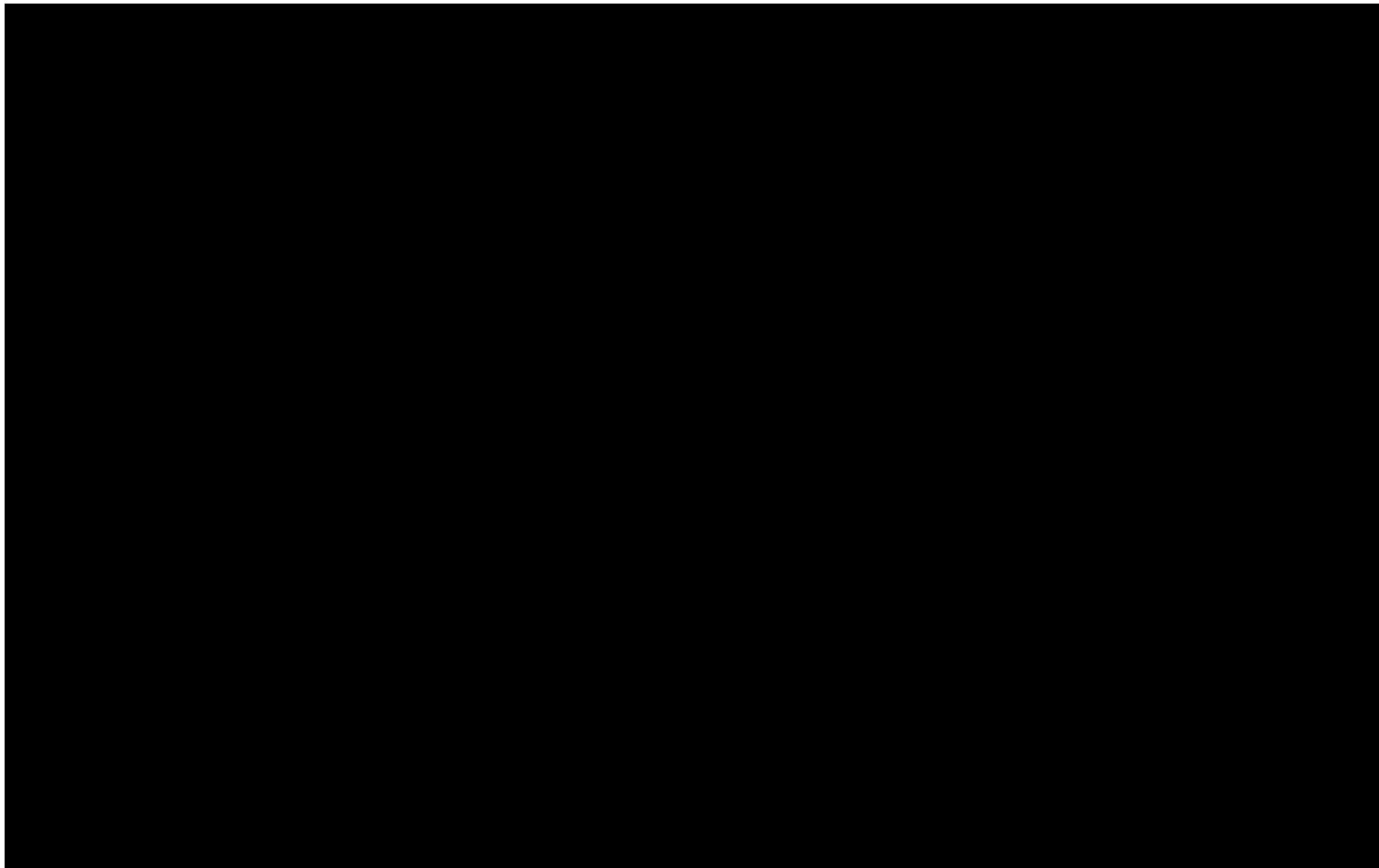


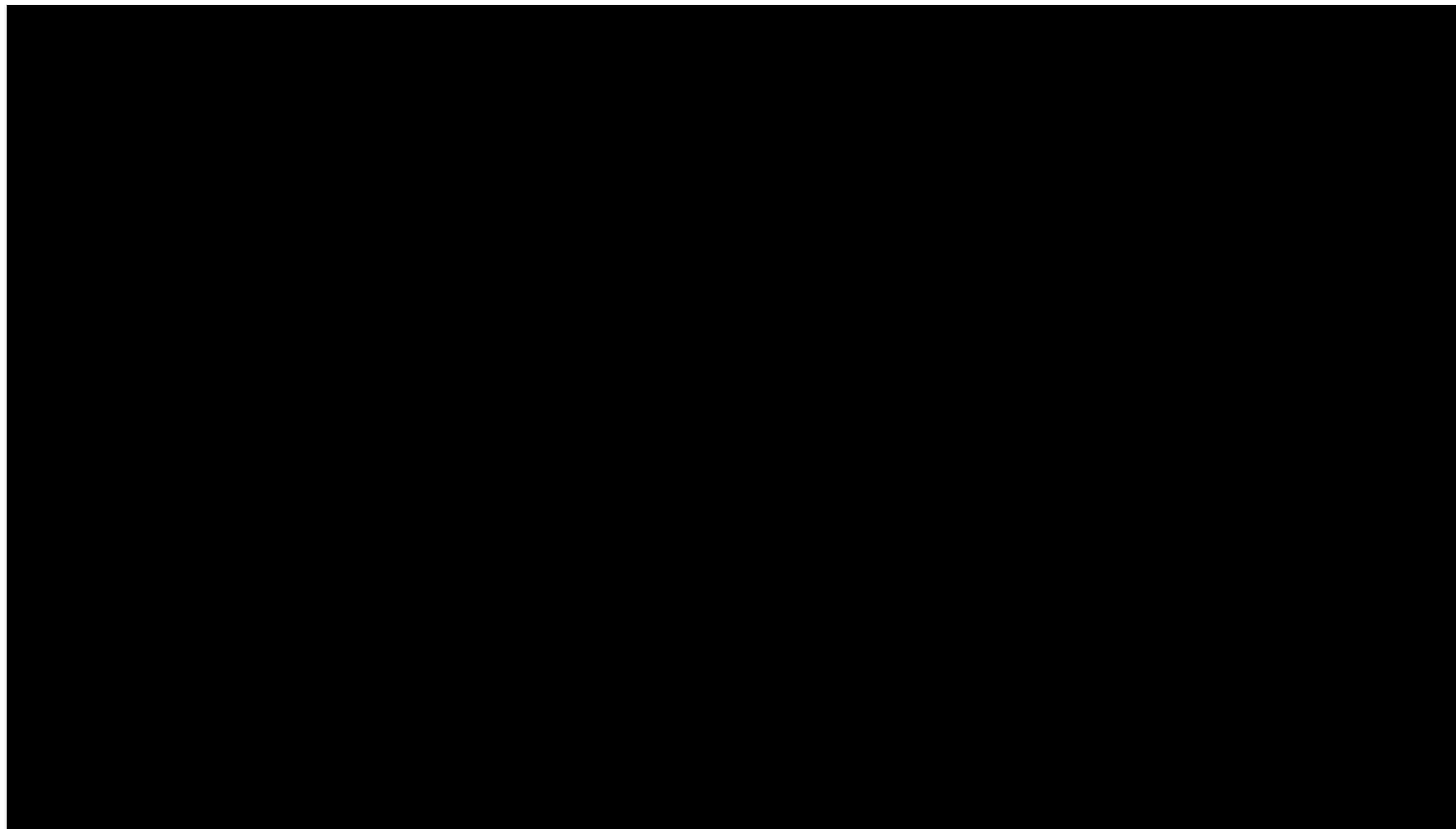












CHAPTER 6.0

APPENDIX: LACMTA P3010 TOD FAULTS FOR THE APS

This appendix provides reference to the faults that may appear on the TOD and the corresponding corrective action

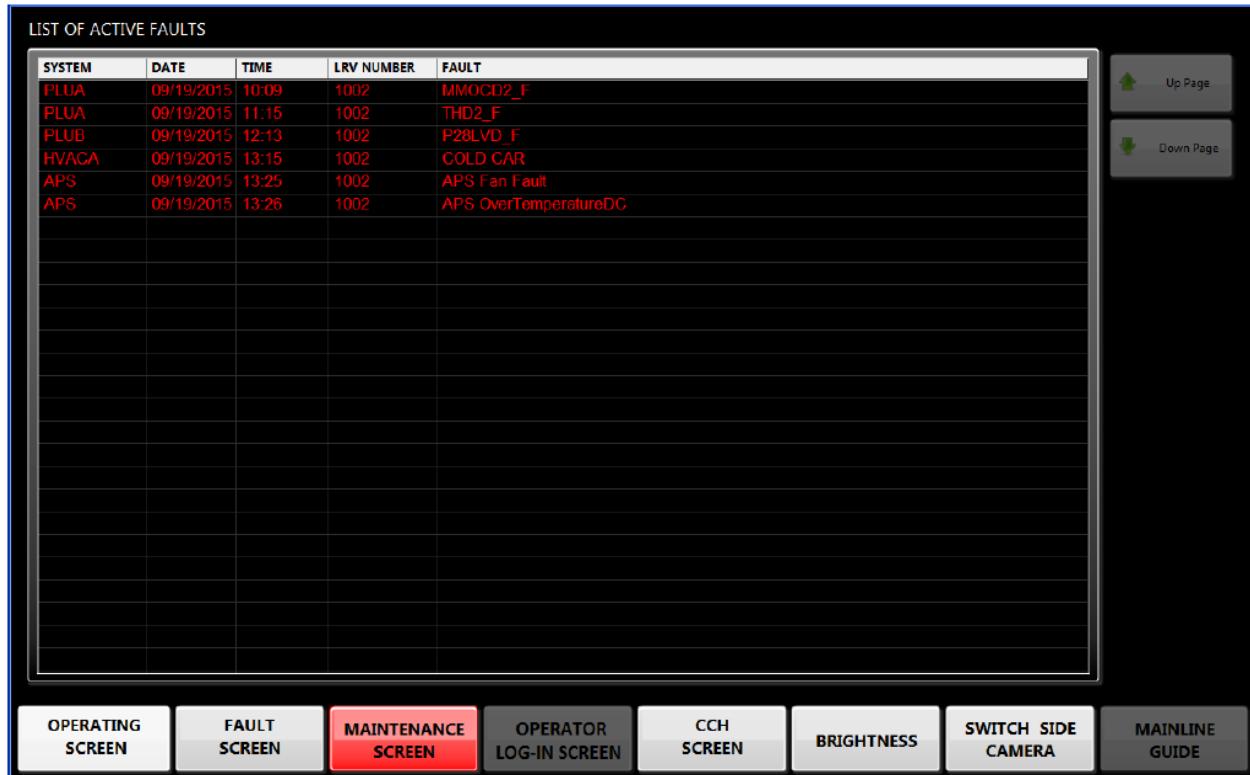


Figure 5-77: LACMTA P3010 TOD Faults for the APS

The following table provides the Description, Cause and Corrective Action for each APS Fault which can be displayed on the TOD Fault Screen.

Table 6-1. TOD Active Screen Faults (UER0617)

Active Fault	Description*	Cause*	Corrective Action*
APS_GeneralFaultAC	1. Firmware incorrect 2. CAN-Bus faulty 3. Power supply 15V faulty 4. Self-test failed	1) Software is incorrect 2) CAN-Bus cable defective; CAN-Bus plug is not correct connected. 3) Power 15V is below 13.5V 4) Self-test failed, Sensor check failed Etc.	1) New software upload is necessary 2) Check cable and plugs 3) Check wiring, replace power supply, etc. 4) Check APS w/ ProDiag3000
APS_VinOutOfRangeAC	Input voltage at IVPS too low or too high	1) Supply voltage too low or too high 2) Sensor defective 3) Input module (A101) defective	1) ----- 2) Replace voltage sensor 3) Replace module
APS_OverTemperatureAC	Over temperature at IVPS or INV detected	1) Ambient temperature too high 2) Over load, airflow blocked, heatsink dirty	1) ----- 2) Check loads, verify airflow, clean heatsink
APS_OverCurrentAC	Over current at IVPS or INV detected	1) Over load 2) Sensor defective	1) Check loads 2) Replace current sensor
APS_OutputUnderVoltageAC	Inverter output voltage too low	1) Cable break 2) IGBT control defect 3) Sensor defect	1) Check wiring and if necessary replace cables 2) Replace module 3) Replace voltage sensor
APS_OutputOverVoltageAC	Inverter output voltage too high	1) Voltage overshoot because of a big load shedding at the output 2) Output voltage sensor defective	1) Regulation too slow, resetting regulation parameter 2) replace voltage sensor
APS_InputOverVoltageAC	Input over voltage at IVPS too high	1) Supply voltage too high 2) Input voltage sensor defective 3) Input module (A101) defective	1) ----- 2) replace voltage sensor 3) replace module
APS_GeneralFaultDC	1. Firmware incorrect 2. CAN-Bus faulty 3. Power supply 15V faulty 4. Self-test failed	1. Software incorrect 2. CAN-Bus cable defect; CAN-Bus plug is not correct connected. 3. Power 15V is below 13.5V 4. Self-test failed, Sensor check failed etc.	1) New software upload is necessary 2) Check cable and plugs 3) Check wiring, replace power supply, etc. 4) Check APS w/ ProDiag3000
APS_VinOutOfRangeDC	Input voltage at LVPS too low or too high	1) Supply voltage too low or too high 2) Sensor defective 3) Input module (A101) defective	1) ----- 2) Replace voltage sensor 3) Replace module
APS_BattSensFault	Battery temperature sensor failure (cable break or shorted)	1) Sensor not connected 2) Sensor shorted	1) Check all connections 2) Replace sensor
APS_OverTemperatureDC	Heatsink over-temperature at LVPS section	1) Ambient temperature too high 2) Over load, airflow blocked, heatsink dirty	1) ----- 2) Check loads, verify airflow, clean heatsink
APS_OverCurrentDC	Overcurrent at LVPS detected	1) Over load 2) Sensor defect	1) Check loads 2) Replace current sensor
APS_OutputOverVoltageDC	LVPS output voltage too high	1) Voltage overshoot because of a big load shedding at the output 2) Output voltage sensor defective	1) Regulation too slow, resetting regulation parameter 2) Replace voltage sensor
APS_InputOverVoltageDC	LVPS input voltage too high	1) Supply voltage too high 2) Input voltage sensor defective 3) Input module (A101) defective	1) ----- 2) Replace voltage sensor 3) Replace module

Table 6-1. TOD Active Screen Faults (UER0617) (cont'd.)

Active Fault	Description*	Cause*	Corrective Action*
APS_GeneralFaultCCU	1. Firmware incorrect 2. CAN-Bus faulty 3. Power supply 15V faulty 4. Self-test failed 5. Active Input Filter module is faulty	1) Software incorrect 2) CAN-Bus cable defect; CAN-Bus plug is not correct connected. 3) Power 15V is below 13.5V 4) Self-test failed 5) Input module overload or is defect	1) New software upload is necessary 2) Check cable and plugs 3) Check wiring, replace power supply, etc. 4) Check APS w/ ProDiag3000 5) Check wiring, replace input module
APS_DBS_Fault	DBS is faulty	1) DBS is defective 2) Loose connection of the DBS run feedback contact 3) CAN IO-board is faulty	1) Replace DBS module 2) Check wiring 3) Replace board
APS_Fan_Fault	Internal fan is faulty	1) Fan is defect 2) Loose connection 3) CAN IO-board is faulty	1) Replace fan 2) Check wiring and connection 3) Replace IO-board
APS_CapacityLoss_Error	Capacity of the input capacitor is too low	1) Capacitor is defective or too old 2) Discharge resistor is defective	1) Replace input capacitor 2) Replace resistor
APS_CapacityLoss_Warning	Capacity of the input capacitor is too low	1) Capacitor is defective or too old 2) Discharge resistor is defective	1) Replace input capacitor 2) Replace resistor

* For additional fault analysis and repair guidance, connect a PTU to the APS via Ethernet and open KBPT's diagnostic software ProDiag3000.

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