



# HVCA Installation and Maintenance Manual - Generic

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## 1. INTRODUCTION

These instructions apply to the High Voltage Cable Assembly (HVCA) product for rail vehicles.

### 1.1. Abbreviations

EPR	Ethylene Propylene Rubber
EVA	Ethylene Vinyl Acetate
HV	High Voltage
HVCA	High Voltage Cable Assembly
HVEE	HVCA Downlead (two T-connectors)
HVTE	HVCA Downlead
HVTT	HVCA Rooflines
IPA	Isopropyl Alcohol
MRTC	Manufacturing Routine Test Certificate
PPE	Personal Protective Equipment
TE	TE Connectivity Ltd

### 1.2. Scope

This document provides guidance concerning the transportation, handling, storage, installation and maintenance of TE HVCA products (HVEE, HVTE and HVTT types)

The following subjects are covered:

- Transportation, Inspection, Handling and Storage
- Installation
- Routine Maintenance

### 1.3. Product Description

The HVCA product comprises an EPR insulated High Voltage cable with HV terminations built onto both ends. Cable length is customer specified and typically falls in the range 2 m to 25 m.

Two general types of termination are used:

- Bushing type termination
- T-connector screened separable connector

HVCAs are provided with an earth lead to connect the cable screen to the vehicle chassis earth. There will be an earth lead at one end or both ends of the HVCA according to customer need and TE recommended practice.

### 1.3.1. Bushing Termination

Bushing type terminations have a red or grey EVA housing and connect to HV equipment by means of an M16 or M20 threaded stud, or by a lug.

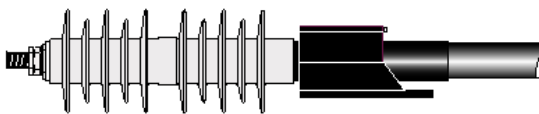
Outdoor (e.g. roof mounted) terminations always incorporate rain sheds whereas indoor terminations may not.



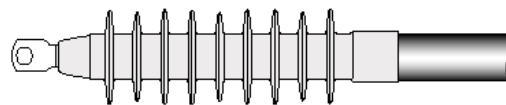
**Short Roofline HVCA with bushing terminations**

TE HVCA termination designs are classified as Flexible, Semi-Rigid (self-supporting) or Rigid (capable of bearing limited loads); these are specified for the HVCA according to customer requirements.

Semi-Rigid and Rigid terminations require special mounting arrangements and the HVCA is supplied with a suitable metal clamp fitted adjacent to the termination.



**Rigid Termination**



**Semi-Rigid Termination**

### 1.3.2. Screened Separable Connector (T-Connector)

T-connector screened separable connectors have a 'T' shaped rubber body (boot) made of silicone or EPDM rubber which encloses the high voltage connection. The boot has a black conductive outer surface that electrically screens the connection and provides an earthed surface that is safe to touch when the joint is energised.

T-connectors are typically used for connection to traction transformer bushings, hence are fitted to HVCA downleads; they can also provide a screened joint between HVCA's.



**Downlead HVCA with roof bushing and T-connector terminations**

## 2. INSPECTION, STORAGE, TRANSPORTATION AND HANDLING

### 2.1. Safety

Use of appropriate PPE (safety shoes, gloves, overalls etc) is advised when unpacking and handling the product.

 **WARNING** *Removal of the crate lid may expose the ends of sharp nails.*


### 2.2. Receiving the Product

TE HVCA products are shipped in palletised wooden crates designed for handling using suitable lifting/moving equipment such as hand pallet truck, fork lift truck, etc.

TE Connectivity must be notified of any crates received in a significantly damaged condition.

### 2.3. Packing Inspection

- Remove the crate lid using suitable tools, avoiding damage as its reuse may be required for storage or product return.
- Check that the packing list and MRTC are present in the cardboard carton.
- Check that the carton contents conform to the packing list and that the HVCA serial number matches that of the MRTC.
- HVCA bushing terminations are protected by cardboard tubing which is simply removed.
- HVCA T-connectors are protected by bubble wrap.

 **WARNING** *Do not use a knife to cut away the bubble wrap as this risks slicing into the rubber parts of the T-connector. Even light knife/bade scores will affect insulation performance, resulting in premature failure. Careful use of scissors is recommended to cut the bubble wrap adhesive tape to enable removal of the bubble wrap in one piece.*

### 2.4. HVCA Inspection

Inspect the terminations to check that no damage has occurred in transit or unpacking:

- Bushing termination: minor imperfections to the EVA housing/sheds (minor scuffing, surface blemishes, shed distortion, etc) will not affect the performance or life of the product and are not normally cause for concern.
- T-connector: check that there is no damage to the rubber boot or cable reducer. No cuts to the surface of either component is permissible. Also check that the boot is correctly positioned with respect to the cable lug per the boot position check criteria shown next page.

Contact TE if there is any doubt concerning the condition of received product.

**Boot position check:**



≤ 5 mm gap between top of lug and rubber.



> 5 mm gap between top of lug and rubber. Corrective action required prior to fitting to bushing – contact TE for advice.

**2.5. Storage**

Cable assemblies should be stored in their original packaging until required for installation in an indoor location. Crates must be stored horizontally, the correct way up, and stacked no more than two high (i.e. no more than one crate to be stacked on top of another).

The storage climatic conditions should comply with the specification of Class 1K21 in IEC 60721-3-1:2018.

The recommended storage temperature and humidity range are shown as:

Temperature	+5°C to +40°C.
Humidity	5% to 85%

Please consult with TE if requirement outside this range is anticipated.

**2.6. Transportation and Handling**

Cable assemblies' transportation and handling should be undertaken in their original packaging in a weather-protected place. Crates must be placed horizontally, the correct way up, and stacked no more than two layers (same as storage).

The transportation and handling climatic conditions should comply with the specification of Class 2K12 in IEC 60721-3-2:2018.

The recommended transportation and handling temperature and humidity range are shown as.

Temperature	-45°C to +70°C.
Humidity	4% to 100%

Please consult with TE if requirement outside this range is anticipated.

### 3. INSTALLATION

#### 3.1. HVCA Handling

Installation to be carried out by appropriately trained personnel. Care to be exercised to avoid damage during installation. Do not allow the cable to excessively bend during handling as this may damage the cable insulation or cable conductors.

Minimum bend radius is typically 10 x nominal cable diameter when laying and 6 x nominal cable diameter (or as specified on the customer drawing) when fixed in position.

**NOTE**

It is recommended HVCA installation be carried out between +5°C and +40°C.

#### 3.2. Bushing Termination Installation

Use only the fixings that have been supplied with the HVCA. Refer to the relevant TE customer drawing(s) for correct assembly and torque values of fixings.

Refer to the train installation drawings for correct orientation and placement of terminations and associated equipment such as inter-car jumper leads.

**⚠ WARNING** *Bushing terminations must not be modified from the original installation design without first consulting with TE. Such modifications include application of insulating tapes (e.g. to extend insulation onto connecting busbars) which can degrade the electrical performance of terminations and can cause early electrical failure. TE Warranty may be invalidated where modifications are carried out without the written consent of TE.*

#### 3.3. T-Connector Installation

The general rules for T-connectors during HVCA handling and installation are:

- Keep rubber boot protected (e.g. wrapped in bubble wrap) until final installation or connection has to be made.
- Ensure no dirt contamination to inside of rubber boot by keeping protective caps in place until final connection is to be made.
- Closely follow the installation instructions provided for the make/model of T-connector.
- In particular ensure complete and even greasing of all surfaces that require it as this forms a vital part of the electrical insulation mechanism, as well as providing a moisture barrier.
- Ensure that the screen earth lead connection is made.

#### 3.4. Post Installation Electrical Insulation Tests

Installations in accordance with EN 50343:2014 (Rules for installation of cabling on rolling stock) require a voltage withstand test to be performed on the cable following fitment to the vehicle. The following points apply:



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- AC withstand test voltage in accordance with Table 8 of EN 50343:2014 (e.g. 55 kVrms test voltage for 25 kV line voltage system).
- The withstand test shall be applied only once, and with the cable disconnected from other equipments according to the guidelines given in Section 7 of EN 50343:2014
- Transformer downleads shall have a 'dead-end' bushing installed to the T-connector where tested disconnected from the Traction Transformer.



## 4. ROUTINE MAINTENANCE

Maintenance requirements are minimal, typically being limited to:

- Jacket Inspection;
- Termination cleaning; and
- T-connector boot inspection

T-connector boots can be replaced if mechanically damaged, so long as no other damage to the cable assembly has occurred.

### 4.1. Cable Jacket Inspection

Six monthly visual inspection of exposed sections of cable jacket is recommended to check for possible abrasion damage due to foreign objects. The cable assembly must be replaced if any holes or splits are found in the cable jacket. Surface abrasions and scuffs are acceptable so long as the damage appears light with little risk of a split to the cable jacket developing.

NB: Temporary cable jacket repairs may be ineffective where water ingress has already occurred since water can wick along internal interfaces over time and cause eventual failure of a termination. The risk is dependent on several factors and TE advice should be sought where temporary cable repair is under consideration.

Immediate replacement of any cable assembly found to have damaged screen wires is advised.

Whitening of the cable jacket due to UV exposure is a natural phenomenon that affects red coloured cable jackets more so than the black coloured jacket, caused by small amounts of UV stabiliser material leaching out of the cable jacket due to the action of UV light. This is not a fault and it is recommended to leave such deposits in place for added UV protection.

Cable jacket cleaning is not normally needed; if required the agents specified for termination cleaning (Section 4.2) may be used.

### 4.2. Termination Cleaning

Yearly (or six monthly) cleaning of the housings is recommended to prevent excessive build-up of pollution deposits that can eventually lead to increased risk of electrical flashover.

The frequency of cleaning is dependent on general pollution conditions in service, also the proximity of the equipment to the train pantograph which emits black carbon particles due to pantograph collector head wear.

Acceptable cleaning agents are:

- Water with mild detergent – can be used warm (up to 45 °C) to assist with cleaning.
- Citrus based cleaning products. Recommended products:
  - TE EPPA-004 cable cleaning tissue.
  - 3M™ Novec™ Contact Cleaner.
- IPA (for removal of localised sticky residues).

In all cases a soft, lint free, cleaning cloth should be used and any residual cleaning deposits washed off the EVA using clean water. Abrasive cloths or cleaning materials must not be used. The EVA must not be coated in grease or paint for any reason.

### 4.3. T-Connector Boot Inspection

There are no preventative maintenance activities to undertake concerning the T-connector; the T-connector body is highly resistant to dirt and it is recommended not to clean T-connector boots unless necessary to do so (e.g. for inspection or replacement purposes), in which case light use of a non-abrasive cleaning cloth with warm water and mild detergent is the recommended cleaning method.

Visual inspections should be undertaken where there is risk of the T-connector boot being impacted by objects such as track ballast (NB installation design best practice should be to ensure adequate mechanical protection against this eventuality). A T-connector boot should be replaced if found to have tears or cuts to the rubber.

Occasional visual inspection is also recommended to check that the earth lead connection is intact.

EPDM rubber T-connector boots must be replaced if exposed to oil contamination from a leaking transformer bushing, for example.

### 4.4. T-Connector Boot Replacement

T-connector boot replacement is undertaken in accordance with product specific instructions included in the T-connector kit.

The following considerations apply:

- The task shall be undertaken by competent personnel who have received training in the handling/fitting of HVCA T-connectors.
- Check that all required components are present in the kit.
- Carefully ease off the old T-connector boot, taking care not to damage or move the cable adapter (see diagram next page) since correct positioning of the adaptor on the cable is critical.
- Only use grease that is supplied with the T-connector kit. On surfaces where grease needs to be applied ensure thin and even coverage with no dry areas.
- It is not necessary to undertake cable electrical insulation tests (section 3.4) following T-connector boot replacement.
- Following connection of a T-connector boot to a high voltage bushing it is recommended to wait 4-6 hours before energising at high voltage. This is a precaution in case of trapped air in the joint, to allow it to naturally leach out prior to first energisation.

