

# OPEN TC8 Documentation

Realization of OPEN TC8 tests with CANoe, vTESTstudio  
and VT System

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## 1 Introduction

### 1.1 What is the OPEN Alliance and the TC8 test?

The One Pair Ethernet Alliance Special Interest Group (OPEN Alliance) plays an important role in the standardization of Automotive Ethernet. It includes many automotive OEMs, TIER1 and other suppliers as well as chip manufacturers. The OPEN Alliance develops documents in several committees (Technical Committee) to ensure the interoperability and compatibility of Automotive Ethernet. Technical Committee 8 (TC8) "Automotive Ethernet ECU Test Specification" develops documents to ensure interoperability and conformity with existing ECU standards.

#### 1.1.1 Definition of the TC8 test

The individual TC8 tests are based on the ISO/OSI layer model (Open Systems Interconnection Model) and can be assigned to individual layers. The tests cover all layers from layer 1 (physical layer) to layer 7 (application layer). A detailed list of all 850+ test cases and supported communication protocols can be found [1].

#### 1.1.2 Preparation of the DUT

The DUT (Device Under Test) must be prepared for the execution of the TC8 tests. This includes the possibility, depending on the test case, to ensure a defined behavior of the DUT. For example, for testing the ARP protocol (Address Resolution Protocol) required for IP communication, it must be possible to delete the ARP tables. Normally, this functionality is not explicitly available on an ECU.

These settings can be made manually, for example via a debugger. In addition, the TC8 test specification refers to mechanisms such as the AUTOSAR Testability Protocol defined in [2]. With their help, settings relevant for the TC8 test can be made via Ethernet communication. CANoe supports both options during test execution.

### 1.2 Where do I get the documents from?

The documents of the OPEN Alliance can be freely downloaded from the homepage ([www.OPENSIG.org](http://www.OPENSIG.org)) or via the member portal (<https://members.opensig.org>). The AUTOSAR documents are also freely available at (<https://www.autosar.org>). They cannot be obtained from Vector. For a successful implementation and execution of the TC8 tests it is necessary to understand the contents of the following documents:

- [1] OPEN Alliance Automotive Ethernet ECU Test Specification TC8 ECU Test, Version 2.0
- [2] Testability Protocol and Service Primitives, Version 1.2.0

## 2 Solution approach with Vector tools

### 2.1 Overview

With the CANoe Option .Ethernet Vector provides the TC8-ECU tests from version 12.0 as an example configuration. Figure 1 shows the interaction of the tools using a Vector standard Ethernet interface.

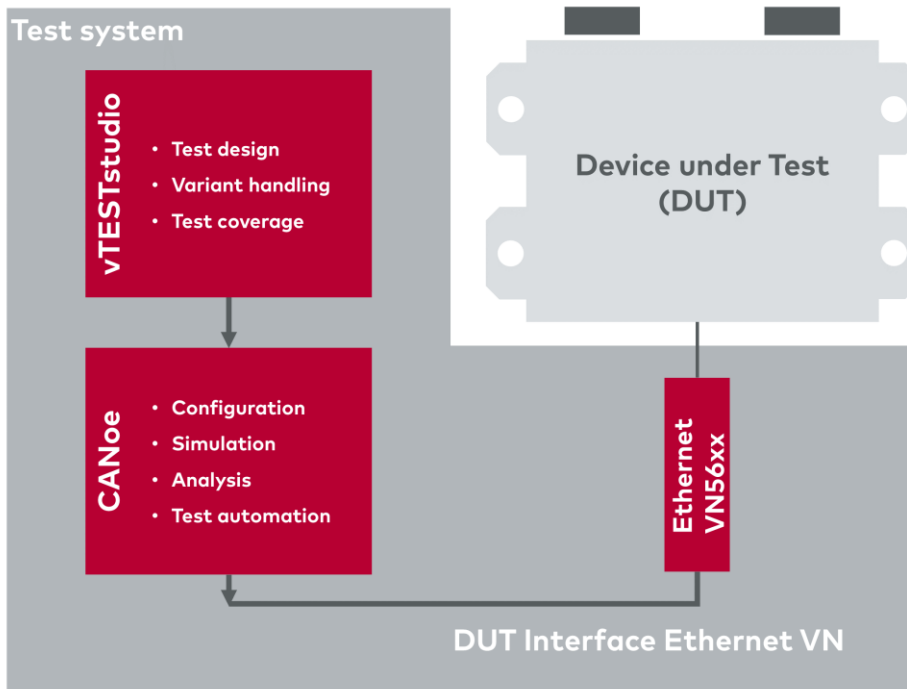


Figure 1 - Tool chain for executing TC8 tests based on vTESTstudio and CANoe

Figure 2 shows an example of how the degree of automation of the test execution can be increased by adding the VT system. In addition, it is possible to extend the test coverage to the physical layer with the help of the VT system.

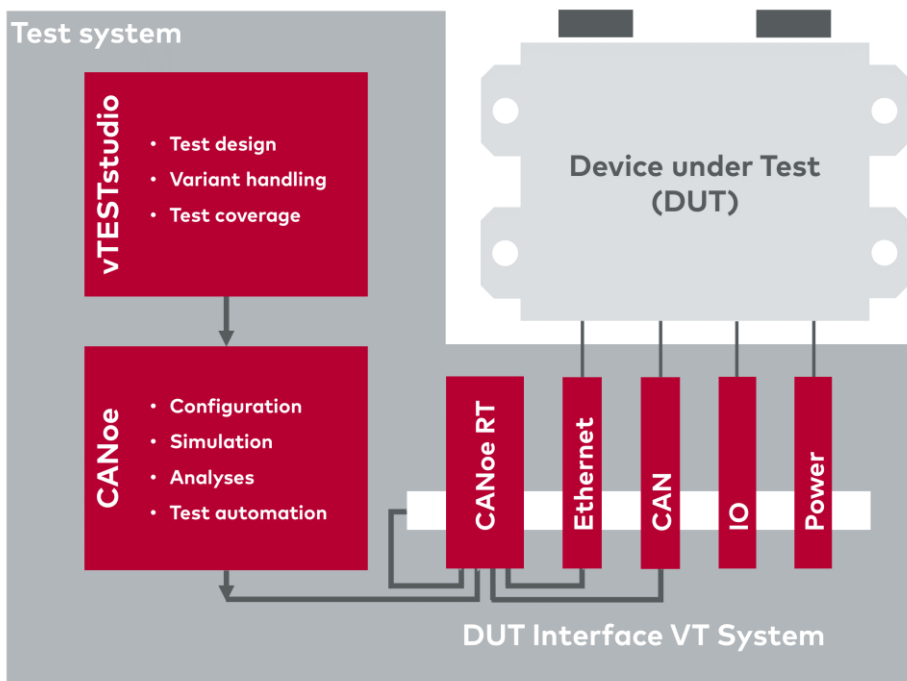


Figure 2 - Tool chain for the automated execution of TC8 tests based on vTESTstudio, CANoe and VT System.

## 2.2 Tasks in vTESTstudio

### 2.2.1 Definition of the test procedure

In vTESTstudio all implemented TC8 tests as well as the test procedure are transparently stored (see Figure 3). The TC8 tests and the test procedure can be changed here if necessary. In general, this is not necessary. With the help of vTESTstudio the test units are created which are later executed in CANoe.

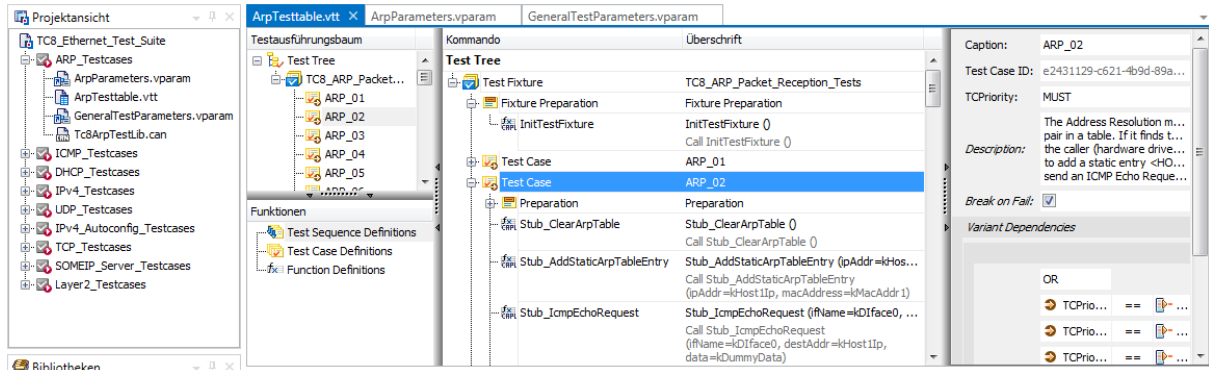


Figure 3 - Definition of test procedure in vTESTstudio using the example of ARP tests

### 2.2.2 Configuration of the Tests

For the successful execution of the TC8 tests some settings must be made. Without a correct configuration of the settings, the test results may be falsified or the successful execution of the TC8 tests may not be possible. The TC8 tests in vTESTstudio are basically structured in such a way that they only have to be configured in a few defined places. Each test group (e.g. ARP, ICMP, IPv4, ...) contains two parameter files:

- the global parameter file "GeneralTestParameters.vparam" as well as a
- parameter file with specific settings for the Test group to be executed

The global parameter file contains general settings for the DUT such as its IP address or MAC address (see Figure 4). The file exists once and is referenced in all test cases. The specific parameter file contains settings for the selected test group. For example, in the file "ArpParameters.vparam" all parameters of the ARP tests (Address Resolution Protocol) are described (see Figure 5).

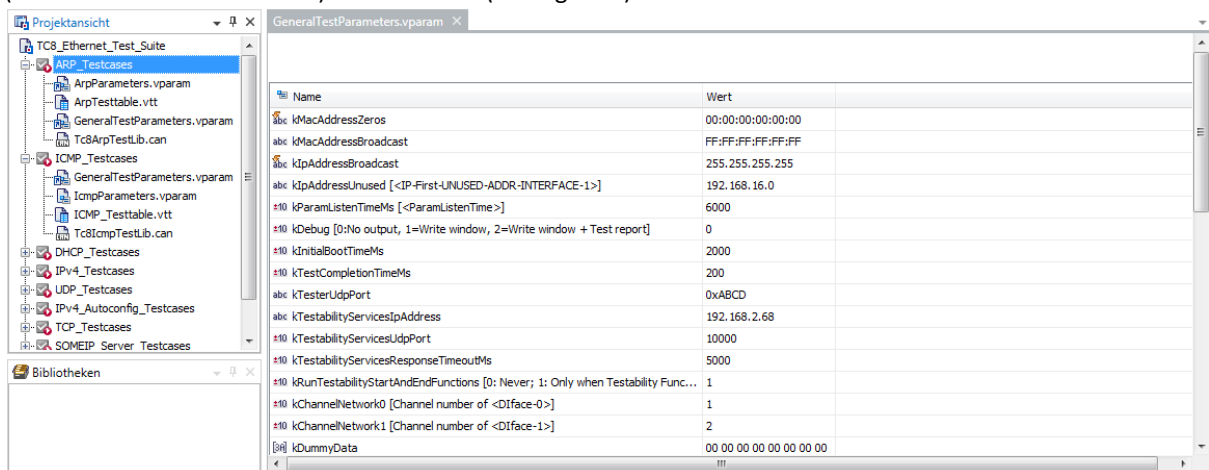


Figure 4 - vTESTstudio parameter file "GeneralTestParameter.vparam" for configuring general settings for the DUT

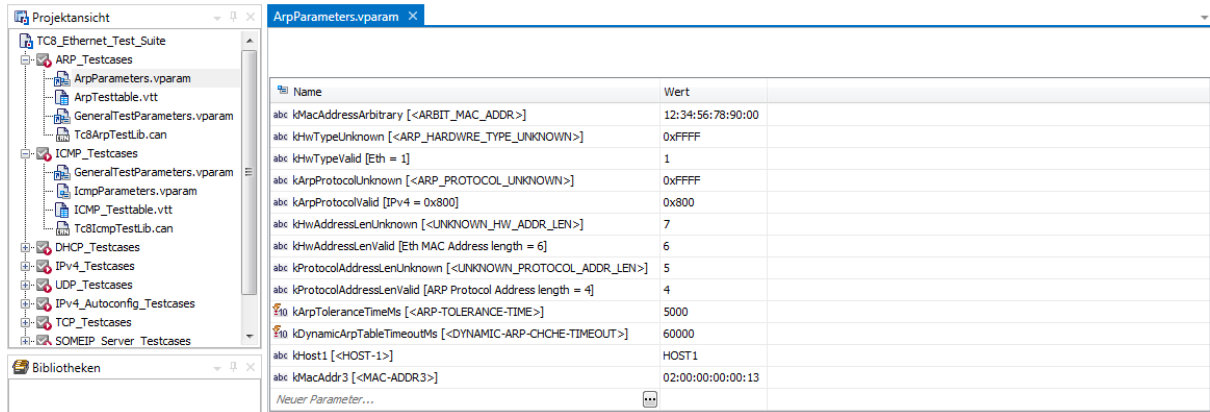


Figure 5 - Example of a vTESTstudio parameter file “ArpParameters.vparam” for configuring specific ARP test parameters

### 2.2.3 Stub-Functions

In addition to configuration using parameters, as described in Chapter 2.2.2, there are further options available for adapting the TC8 test. These are the stub functions. The stub functions are typically a CAPL code block that is executed in CANoe during the runtime of the TC8 test and usually also has an equivalent on the DUT in the form of a special test code. The stub function serves to prepare the DUT for the upcoming test. Figure 6 shows an example using the Address Resolution Protocol (ARP) test, where the stub function must be called in CANoe to delete the MAC address table before starting the test execution. The stub function must ensure that the table with the MAC addresses on the DUT is completely deleted after the call in CANoe.

The implementation of the TC8 tests in vTESTstudio defines a separate stub function for all necessary test steps. In general, this stub function must be adapted to the respective DUT before test execution.

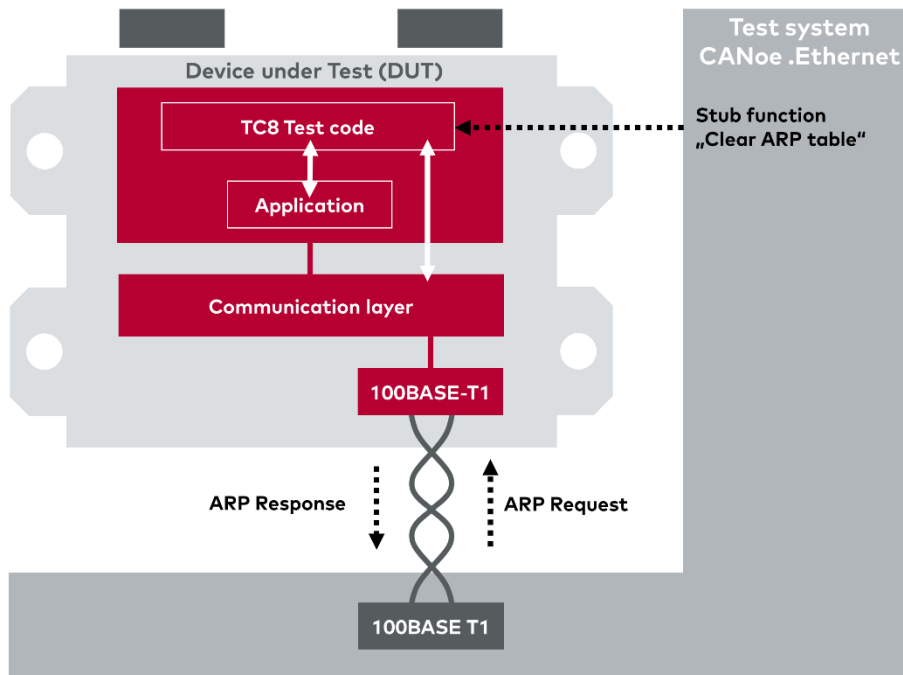


Figure 6 - Example of a stub function for deleting the ARP table on the DUT

In some cases, the implementation of stub functions is already based on the use of the AUTOSAR Testability Protocol - a communication protocol specified by AUTOSAR. This communication protocol is already supported by the Vector TC8 test implementation. In this case, only individual parameters must be changed when adapting the stub functions.

## 2.3 Tasks in CANoe

### 2.3.1 Runtime Environment

CANoe provides the runtime environment for the TC8 tests created with vTESTstudio. In CANoe, the tests to be executed can be selected and the test sequence started. No vTESTstudio is required for the execution of the tests.

#### 2.3.1.1 Which CANoe is required?

Any CANoe .Ethernet (PRO, PEX, FUN and RUN) from version 12.0 can be used to perform the TC8 test.

#### 2.3.1.2 Which Ethernet interface can be used

Basically, any Vector Ethernet interface that supports IEEE 100BASE-T1 can be used. There are no special requirements from CANoe's point of view. The functional scope of the Ethernet interfaces varies and can affect the tests to be performed. For example, the VT6306 also allows some tests to be performed on the physical layer. Most TC8 tests can be performed with one or two Ethernet channels. Some tests, such as switch tests, require three channels.

#### 2.3.1.3 What configuration does Vector provide?

All TC8 test configurations delivered as part of CANoe represent a proposal for implementation and serve to demonstrate the functionality. Further configurations can also be downloaded from the Vector Knowledge Base. Please note that the number and scope of configurations may change over time.

Please note that the demo and sample programs only show certain aspects of the software. As these programs are intended for demonstration purposes only, Vector Informatik GmbH hereby disclaims any liability for slight negligence, unless otherwise required by law.

### 2.3.2 Test report

#### 2.3.2.1 Preparation and presentation

CANoe automatically generates a comprehensive HTML test report that logs the executed test scopes as well as the results (see Figure 7).

##### Statistics

Executed test cases	49	
Test cases passed	49	100% of executed test cases
Test cases inconclusive	0	0% of executed test cases
Test cases failed	0	0% of executed test cases
Test cases with error in test system	0	0% of executed test cases
Number of failures outside of test cases		
Inconclusive	0	
Fail	0	
Error in test system	0	

Figure 7 - Summary of results

The report also contains a detailed summary of the procedure and content for each test step (see Figure 8). With the help of this information, problems during test execution or test configuration can be detected very quickly. In particular, the specified time stamps can be used to jump directly to the trace window to analyze the communication.

### [-] 1.1.1 ARP\_01: Passed

Static ARP entry (no ARP request). The Address Resolution module tries to find the <protocol type, target protocol address> pair in a table. If it finds the pair, it gives the corresponding 48 bit Ethernet address back to the caller (hardware driver) which then transmits the packet. (Note: Here DUT is configured to add a static entry <HOST-1-IP, MAC-ADDR1> in its ARP cache. TESTER then causes DUT to send an ICMP Echo Request and expects that DUT will NOT send any ARP Request. Relevance to xANVL Release 9.15: 1,1. Relevance to ANVL AUTOSAR Test 2,1)

Test case begin: 2019-04-04 09:47:16 (logging timestamp 2.000000)  
 Test case end: 2019-04-04 09:47:22 (logging timestamp 8.400121)

#### Attributes

TCPriority: MUST

#### Preparation of Test Case

Timestamp	Test Step	Description	Result
2.000038	Resume reason	Resumed on TextEvent 'ExpectedServicePrimitiveResponse' Elapsed time=0.0384ms (max=5000ms)	-
2.000038	Stub_GeneralStartTest Stubfunction for start test case succeeded		pass

#### Main Part of Test Case

Timestamp	Test Step	Description	Result
<b>1. Stub_ClearArpTable (): Passed</b>			
2.200038	SP_Arp_ClearArpTable	Clear Arp Table (ARP) with PID=0xFF.	-
2.200058	Resume reason	Resumed on TextEvent 'ExpectedServicePrimitiveResponse' Elapsed time=0.0192ms (max=5000ms)	-
2.200058	Stub_ClearArpTable	Clear ARP Table of DUT succeeded.	pass
<b>2. Stub_AddStaticArpTableEntry (ipAddr=kHost1Ip, macAddress=kMacAddr1): Passed</b>			
2.200058	SP_Arp_AddStaticArpTableEntry	Add Static Arp Table Entry (ARP) with PID=0xFD.	-
2.200079	Resume reason	Resumed on TextEvent 'ExpectedServicePrimitiveResponse' Elapsed time=0.02112ms (max=5000ms)	-
2.200079	Stub_AddStaticArpTableEntry	Add static ARP table entry to DUT succeeded.	pass
<b>3. Stub_IcmpEchoRequest (ifName=kDfiface0, destAddr=kHost1Ip, data=kDummyData): Passed</b>			
2.200079	Stub_IcmpEchoRequest	Send ICMP echo request from DUT succeeded.	pass
<b>4. WaitForUnexpectedArpRequest (timeout=kParamListenTimeMs, destMac=kWildcard, srcMac=kDfiface0MacAddr, senderHardwareAddress=kWildcard, senderProtocolAddress=kWildcard, targetHardwareAddress=kWildcard, targetProtocolAddress=kWildcard): Passed</b>			
8.200079	Resume reason	Elapsed time=6000ms (max=6000ms)	-
8.200079	WaitForUnexpectedArpRequest	DUT didn't send an ARP request.	pass
<b>5. Stub_DeleteStaticArpTableEntry (ipAddr=kHost1Ip, macAddress=kMacAddr1): Passed</b>			
8.200079	SP_Arp_DeleteStaticArpTableEntry	Delete Static Arp Table Entry (ARP) with PID=0xFC.	-
8.200100	Resume reason	Resumed on TextEvent 'ExpectedServicePrimitiveResponse' Elapsed time=0.02112ms (max=5000ms)	-
8.200100	Stub_DeleteStaticArpTableEntry	Delete static ARP entry from DUT succeeded.	pass

#### Completion of Test Case

Timestamp	Test Step	Description	Result
8.200121	Resume reason	Resumed on TextEvent 'ExpectedServicePrimitiveResponse' Elapsed time=0.02112ms (max=5000ms)	-
8.200121	Stub_GeneralEndTest Stubfunction for end test case succeeded		pass

Figure 8 - Excerpt test report from CANoe with time stamp

## 2.3.3 Simulated DUT as Reference Implementation

### 2.3.3.1 Objective of the reference implementation

The configuration of the TC8 test cases and the evaluation of the problems found is a complex process and requires some practice. To support the user, Vector provides a reference implementation of the DUT within a CANoe simulation with the "Golden Device". This ensures that TC8 tests can be executed error-free on the simulated Golden Device and a positive test result as well as logging files etc. are generated. The result based on the Golden Device can be used as a reference for the evaluation of the result based on the DUT. In case of an error, the direct comparison helps to assess whether the cause lies in the configuration of the TC8 test or at the DUT.

## 2.4 Integration of the VT-System

The VT system can basically perform the test in the same way as a PC with CANoe. The VT System offers more extensive possibilities for automated test execution. As shown in Figure 2, the various plug-in cards can also be used to influence the physical ports of the DUT. By controlling the supply voltage, it is possible, for example, to reset the DUT (RESET).

In addition, the VT6306 Ethernet interface card also provides the option of influencing the physical transmission channel. This makes it very easy to implement test cases for the physical layer, such as determining the time of link creation after an ECU start.



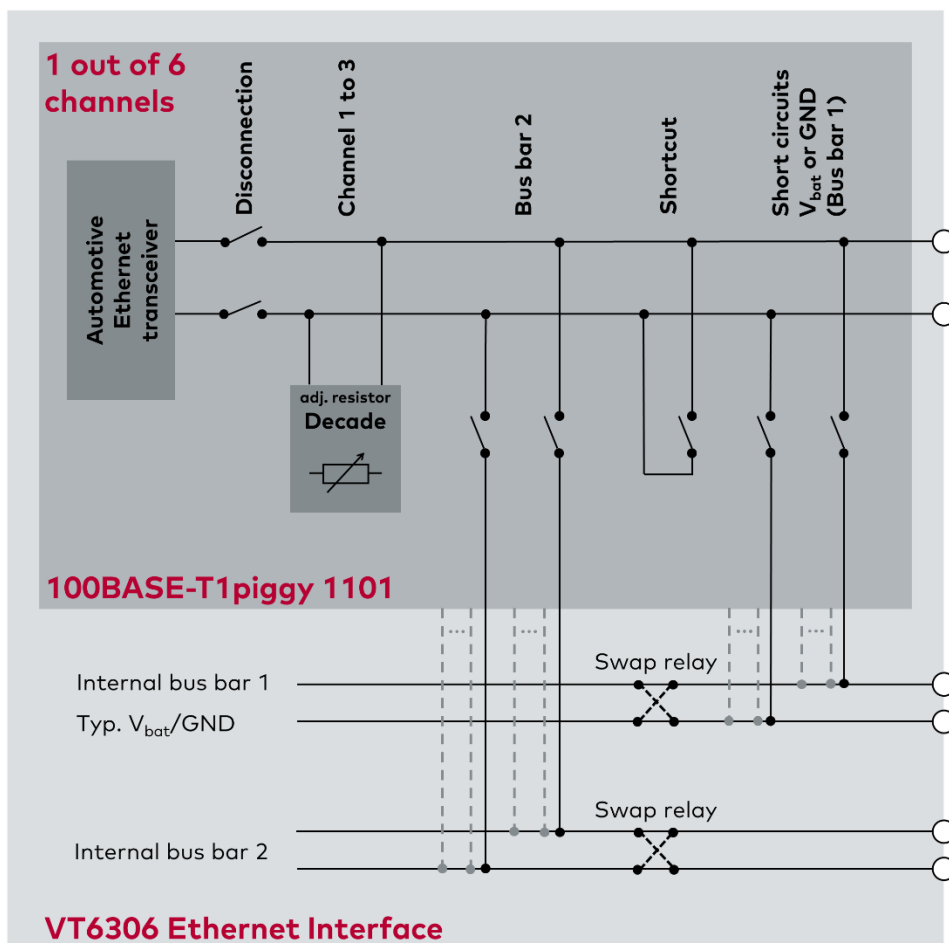


Figure 9 - Possibilities for influencing the physical transmission channel of the VT6306 Ethernet interface

### 3 Contacts

For a full list with all Vector locations and addresses worldwide, please visit <http://vector.com/contact/>.