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1 Introduction and overview

This protocol specification specifies the format, message sequences and semantics of the AUTOSAR Protocol VDP.

VDP aims at addressing the need for distributing data collection tasks from a central data collection unit on an HPC to remote ECUs (in particular Classic Platform ECUs) as depicted in figure 1.1. The remote ECUs are assumed to have local access to the required data.

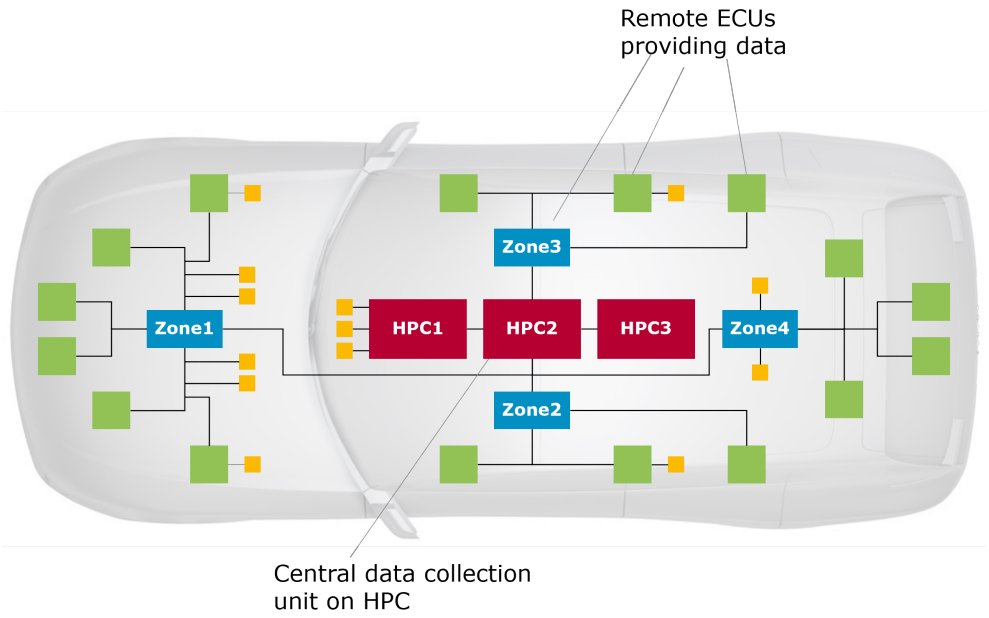


Figure 1.1: Representative vehicle architecture with the central data collection unit in an HPC and remote ECUs providing data.

1.1 Protocol purpose and objectives

To achieve this, VDP introduces a technical realization of four different sampling modes in a remote ECU controlled from a central collection unit. The different sampling modes are listed below.

- Cyclic: A data point is sampled cyclically at a remote ECU.
- On-change: A data point is sampled only when the value has changed (a 'change' can defined per data point type, i.e. per DCA Remote, and is not limited by the protocol. Exemplarily, it could be either a "≠" or the entering or leaving of a numerical range).
- Cyclic and on-change: A data point is sampled cyclically or additionally when it has changed.

- On-request: A data point is sampled only when a specific request (the trigger request, c.f. subsection 6.3.5) is received at the remote ECU.

VDP also provides error reporting mechanisms for the cases when specific data points do not support all modes.

One essential enabler for the practicability of the different sampling strategies is the systematic decoupling of sampling and transmission. For this, data point samples are buffered in a component in the remote ECU and potentially transmitted decoupled in time. Similarly to the sampling modes, VDP allows for the usage of three different transmission modes

- Cyclic: The remote ECU transmits all buffered data point samples periodically.
- On-sampling: The remote ECU transmits all buffered data point samples when a specific data point was sampled.
- On-request: The remote ECU transmits all buffered data point samples when the remote ECU receives a trigger request (c.f. subsection 6.3.5).
- Default: The remote ECU transmits all buffered data point samples when a specific buffer condition is fulfilled.

For both, sampling and transmission, VDP defines countermeasures that prevent the blocking of the remote ECU due to excessive sampling or the blocking the bus due to too many transmitted data messages.

1.2 Applicability of the protocol

1.2.1 Constraints and assumptions

VDP is relying on an underlying transport protocol in case VDP messages are longer than the frame size of the underlying bus protocol.

1.2.2 Limitations

The protocol can be applied on bus systems (including TPs) with appropriate message size and it should especially not be used in case the messages are too small to encompass multiple data point dynamic configurations or multiple data point samples (see chapter 4 for descriptions and definitions of these terms).

1.3 Dependencies

1.3.1 Dependencies to other protocol layers

VDP has one dependency on other protocol layers, which is described in the requirements in chapter 4 but additionally listed here.

Transport protocol IPDU length VDP messages are limited in length by the maximum length of the underlying IPDUs (c.f. [FO_PRS_VDP_00040])

2 Use Cases

ID	*Name*	*Description*
UC_VDP_00001	Dynamic In-Vehicle Data Collection	The dynamic collection of data from ECUs in the vehicle. Therein it shall support both data following a push semantic (notifications, event-based) as well as data following a pull semantic (get-APIs). The transmission may happen immediately after sampling, but it may also be delayed until a transmission trigger condition is fulfilled.

Table 2.1: VDP Use Cases

3 Related documentation

3.1 Input documents & related standards and norms

[1] Glossary
AUTOSAR_FO_TR_Glossary

[2] Specification of Synchronized Time-Base Manager
AUTOSAR_CP_SWS_SynchronizedTimeBaseManager

3.2 Related specification

The protocol requirements covered in this PRS are addressing the requirements imposed on this solution by the

- AUTOSAR Requirements Specification VDP (FO_RS_VDP.pdf)

4 Protocol Requirements

4.1 Requirements Traceability

Requirement	Description	Satisfied by
[FO_RS_VDP_00001]	Multi-Version Support	[FO_PRS_VDP_00020] [FO_PRS_VDP_00021] [FO_PRS_VDP_00023]
[FO_RS_VDP_00002]	VDP Dynamic Configuration of Data Points	[FO_PRS_VDP_00001] [FO_PRS_VDP_00002] [FO_PRS_VDP_00007] [FO_PRS_VDP_00008] [FO_PRS_VDP_00009] [FO_PRS_VDP_00024] [FO_PRS_VDP_00026] [FO_PRS_VDP_00030] [FO_PRS_VDP_00031] [FO_PRS_VDP_00032] [FO_PRS_VDP_00035] [FO_PRS_VDP_00036] [FO_PRS_VDP_00037] [FO_PRS_VDP_00038] [FO_PRS_VDP_00039] [FO_PRS_VDP_00040] [FO_PRS_VDP_00041] [FO_PRS_VDP_00042] [FO_PRS_VDP_00043] [FO_PRS_VDP_00044] [FO_PRS_VDP_00045] [FO_PRS_VDP_00046] [FO_PRS_VDP_00047] [FO_PRS_VDP_00048] [FO_PRS_VDP_00051] [FO_PRS_VDP_00052] [FO_PRS_VDP_00053] [FO_PRS_VDP_00054] [FO_PRS_VDP_00055] [FO_PRS_VDP_00056] [FO_PRS_VDP_00057] [FO_PRS_VDP_00058] [FO_PRS_VDP_00059] [FO_PRS_VDP_00060] [FO_PRS_VDP_00061] [FO_PRS_VDP_00062] [FO_PRS_VDP_00063] [FO_PRS_VDP_00064] [FO_PRS_VDP_00065] [FO_PRS_VDP_00066] [FO_PRS_VDP_00069] [FO_PRS_VDP_00100] [FO_PRS_VDP_00127] [FO_PRS_VDP_00128] [FO_PRS_VDP_00129] [FO_PRS_VDP_00130] [FO_PRS_VDP_00131] [FO_PRS_VDP_00132] [FO_PRS_VDP_00136] [FO_PRS_VDP_00137] [FO_PRS_VDP_00138] [FO_PRS_VDP_00139] [FO_PRS_VDP_00140] [FO_PRS_VDP_00141] [FO_PRS_VDP_00142] [FO_PRS_VDP_00143] [FO_PRS_VDP_00144] [FO_PRS_VDP_00146]
[FO_RS_VDP_00003]	VDP Different Modes for Data Sampling	[FO_PRS_VDP_00001] [FO_PRS_VDP_00002] [FO_PRS_VDP_00007] [FO_PRS_VDP_00008] [FO_PRS_VDP_00009] [FO_PRS_VDP_00040] [FO_PRS_VDP_00047] [FO_PRS_VDP_00048] [FO_PRS_VDP_00056] [FO_PRS_VDP_00057] [FO_PRS_VDP_00058] [FO_PRS_VDP_00059] [FO_PRS_VDP_00060] [FO_PRS_VDP_00061] [FO_PRS_VDP_00062] [FO_PRS_VDP_00081] [FO_PRS_VDP_00082] [FO_PRS_VDP_00083] [FO_PRS_VDP_00084] [FO_PRS_VDP_00085] [FO_PRS_VDP_00086] [FO_PRS_VDP_00087] [FO_PRS_VDP_00088] [FO_PRS_VDP_00089] [FO_PRS_VDP_00090] [FO_PRS_VDP_00119] [FO_PRS_VDP_00134] [FO_PRS_VDP_00135] [FO_PRS_VDP_00138]

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Requirement	Description	Satisfied by
[FO_RS_VDP_00004]	VDP Different Modes for Data Transmission	[FO_PRS_VDP_00001] [FO_PRS_VDP_00002] [FO_PRS_VDP_00007] [FO_PRS_VDP_00008] [FO_PRS_VDP_00009] [FO_PRS_VDP_00024] [FO_PRS_VDP_00025] [FO_PRS_VDP_00027] [FO_PRS_VDP_00028] [FO_PRS_VDP_00029] [FO_PRS_VDP_00040] [FO_PRS_VDP_00041] [FO_PRS_VDP_00047] [FO_PRS_VDP_00048] [FO_PRS_VDP_00053] [FO_PRS_VDP_00091] [FO_PRS_VDP_00096] [FO_PRS_VDP_00097] [FO_PRS_VDP_00098] [FO_PRS_VDP_00099] [FO_PRS_VDP_00100] [FO_PRS_VDP_00101] [FO_PRS_VDP_00102] [FO_PRS_VDP_00103] [FO_PRS_VDP_00104] [FO_PRS_VDP_00138] [FO_PRS_VDP_00141] [FO_PRS_VDP_00145]
[FO_RS_VDP_00005]	Detection of Missing Data on the Central ECU	[FO_PRS_VDP_00001] [FO_PRS_VDP_00002] [FO_PRS_VDP_00040] [FO_PRS_VDP_00092] [FO_PRS_VDP_00093] [FO_PRS_VDP_00094] [FO_PRS_VDP_00095] [FO_PRS_VDP_00138]
[FO_RS_VDP_00006]	VDP Temporary Interruption of Data Sampling	[FO_PRS_VDP_00001] [FO_PRS_VDP_00002] [FO_PRS_VDP_00007] [FO_PRS_VDP_00008] [FO_PRS_VDP_00009] [FO_PRS_VDP_00040] [FO_PRS_VDP_00041] [FO_PRS_VDP_00047] [FO_PRS_VDP_00048] [FO_PRS_VDP_00054] [FO_PRS_VDP_00055] [FO_PRS_VDP_00067] [FO_PRS_VDP_00068] [FO_PRS_VDP_00070] [FO_PRS_VDP_00071] [FO_PRS_VDP_00072] [FO_PRS_VDP_00073] [FO_PRS_VDP_00074] [FO_PRS_VDP_00075] [FO_PRS_VDP_00076] [FO_PRS_VDP_00077] [FO_PRS_VDP_00078] [FO_PRS_VDP_00079] [FO_PRS_VDP_00080] [FO_PRS_VDP_00138]
[FO_RS_VDP_00009]	VDP Efficient Representation of Meta Data	[FO_PRS_VDP_00001] [FO_PRS_VDP_00002] [FO_PRS_VDP_00003] [FO_PRS_VDP_00004] [FO_PRS_VDP_00039] [FO_PRS_VDP_00040] [FO_PRS_VDP_00099] [FO_PRS_VDP_00101] [FO_PRS_VDP_00102] [FO_PRS_VDP_00138]
[FO_RS_VDP_00010]	VDP Error Handling	[FO_PRS_VDP_00001] [FO_PRS_VDP_00002] [FO_PRS_VDP_00005] [FO_PRS_VDP_00006] [FO_PRS_VDP_00015] [FO_PRS_VDP_00016] [FO_PRS_VDP_00017] [FO_PRS_VDP_00018] [FO_PRS_VDP_00019] [FO_PRS_VDP_00036] [FO_PRS_VDP_00039] [FO_PRS_VDP_00040] [FO_PRS_VDP_00041] [FO_PRS_VDP_00052] [FO_PRS_VDP_00062] [FO_PRS_VDP_00065] [FO_PRS_VDP_00066] [FO_PRS_VDP_00070] [FO_PRS_VDP_00074] [FO_PRS_VDP_00079] [FO_PRS_VDP_00080] [FO_PRS_VDP_00088] [FO_PRS_VDP_00090] [FO_PRS_VDP_00098] [FO_PRS_VDP_00105] [FO_PRS_VDP_00106] [FO_PRS_VDP_00107] [FO_PRS_VDP_00108] [FO_PRS_VDP_00109] [FO_PRS_VDP_00110] [FO_PRS_VDP_00111] [FO_PRS_VDP_00112] [FO_PRS_VDP_00113] [FO_PRS_VDP_00114] [FO_PRS_VDP_00115] [FO_PRS_VDP_00116] [FO_PRS_VDP_00117] [FO_PRS_VDP_00118] [FO_PRS_VDP_00120] [FO_PRS_VDP_00121] [FO_PRS_VDP_00122] [FO_PRS_VDP_00123] [FO_PRS_VDP_00125] [FO_PRS_VDP_00126] [FO_PRS_VDP_00127] [FO_PRS_VDP_00128] [FO_PRS_VDP_00129] [FO_PRS_VDP_00130] [FO_PRS_VDP_00131] [FO_PRS_VDP_00132] ▽

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Requirement	Description	Satisfied by
		△ [FO_PRS_VDP_00133] [FO_PRS_VDP_00134] [FO_PRS_VDP_00135] [FO_PRS_VDP_00136] [FO_PRS_VDP_00137] [FO_PRS_VDP_00138] [FO_PRS_VDP_00144]
[FO_RS_VDP_00011]	VDP Control Sequence Enforcement	[FO_PRS_VDP_00010] [FO_PRS_VDP_00011] [FO_PRS_VDP_00012] [FO_PRS_VDP_00013] [FO_PRS_VDP_00014]

Table 4.1: Requirements Tracing

5 Definition of terms and acronyms

5.1 Acronyms and abbreviations

The glossary below includes acronyms and abbreviations relevant to the Vehicle Data Protocol that are not included in the [1].

Abbreviation / Acronym:	Description:
VDP	Vehicle Data Protocol
DCA	Data Class Adapter
CM	Communication Module
DP	Data point

Table 5.1: Acronyms and abbreviations used in the scope of this Document

5.2 Definition of terms

Terms:	Description:
Remote ECU	A remote ECU is the owner of the data resource wherein a functional cluster can have local access for retrieving this data.
Central ECU	A central ECU is the location of a vehicle central data collection unit, which aggregates all data from the remote ECUs provided with VDP.
Data point	A data point refers to a data resource inside the vehicle with a well-defined semantic that can be collected (e.g. vehicle speed).
Data point sample	A data point sample refers to the value of a data point acquired at a specific point in time (e.g. vehicle speed at 12 am).
VDP-CM Proxy	The VDP communication module proxy (VDP-CM Proxy) is the implementation of VDP in the data requesting software component residing in an HPC. Most probably it is directly attached to a vehicle data collector.
VDP-CM Remote	The VDP communication module remote (VDP-CM Remote) is the implementation of the VDP in the ECU which either owns the data resources or has direct access to it.
DCA Remote	A DCA Remote refers to a Data Class Adapter Remote. The Data Class Adapter Remotes are directly connected to a CM Remote and can directly access data points on the other side. They can be realized e.g. by integrator code, AUTOSAR Complex Device Drivers or a specific SWC.
VDP Slot ID	The VDP Slot ID refers to a dynamically associated ID to an abstract data point during the lifetime of a data collection task. The dynamic association is part of the protocol VDP and is established using the add dynamic configuration command (c.f. subsection 6.3.1)

Table 5.2: Definition of terms in the scope of this Document

6 Protocol specification

6.1 Message format

For both, data and control information, the same VDP message format is used, it consists of a header and a payload segment, c.f. figure 6.1.



Figure 6.1: VDP message format.

[FO_PRS_VDP_00001] Endianness

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003, FO_RS_VDP_00004, FO_RS_VDP_00005, FO_RS_VDP_00006, FO_RS_VDP_00009, FO_RS_VDP_00010

⌈All VDP specific fields shall be encoded in little-endian byte order.⌋

[FO_PRS_VDP_00138] Reserved bits

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003, FO_RS_VDP_00004, FO_RS_VDP_00005, FO_RS_VDP_00006, FO_RS_VDP_00009, FO_RS_VDP_00010

⌈All reserved bits shall be set to 0.⌋

[FO_PRS_VDP_00040] VDP maximum message size

Replaces: FO_PRS_VDP_CONSTR_00001

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004, FO_RS_VDP_00005, FO_RS_VDP_00006, FO_RS_VDP_00003, FO_RS_VDP_00009, FO_RS_VDP_00010

⌈When transport protocols denoted by $TP_1, ..., TP_n$ are used on which the VDP messages shall be routed, the maximally allowed VDP message size (VDP.maxMessageSize) shall fulfill the following condition dependent on the maximum IPDU size of the underlying transport protocols (TP_i.maxIPDUSize) in the following manner

$$VDP.maxMessageSize \leq \min_{i \in [0,...,n]}(TP_i.maxIPDUSize)$$

All transmitted VDP messages shall be shorter than or as long as VDP.maxMessageSize.

If no transport protocol is used all transmitted VDP messages shall be shorter than or as long as the maximum frame length.⌋

This means in particular, that VDP does not implement any additional segmentation or routing logic of either control or data messages.

6.1.1 Header format

The header format is specified in the following requirement and illustrated in figure 6.2.

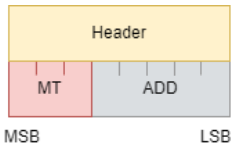


Figure 6.2: Header format.

[FO_PRS_VDP_00002] Header format

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003, FO_RS_VDP_00004, FO_RS_VDP_00005, FO_RS_VDP_00006, FO_RS_VDP_00009, FO_RS_VDP_00010

⌈The VDP header shall contain the following fields

Bit 7-5: (MT) message type, and

Bit 4-0: (ADD) message type specific additional information.

⌋

6.1.2 Payload format

Please refer to section 6.2 for further description.

6.1.3 Data types

The following introduces two VDP specific data types, the dynamic data length encoded UINT and the VDP relative timestamp.

[FO_PRS_VDP_00003] Dynamic data length encoded uint (DDLE[UINT])

Upstream requirements: FO_RS_VDP_00009

⌈VDP implementations shall support the encoding of unsigned integers of AUTOSAR type uint8_least as dynamic data length encoding as described in the following for an uint8_least VAL.

The encoding reserves the most significant bit of each byte for the indication whether another byte encoding VAL follows. MSB = 1 indicates that another byte follows, MSB = 0 indicates that this is the last byte.

The remaining 7 bit of each bytes contain the bits of VAL. The first byte contains the 7 first bits of VAL. The n^{th} byte then contains the n^{th} 7 bit of VAL.

In case the k·7 most significant bits of VAL are 0, the k first bytes are not transmitted.⌋

The dynamic data length encoding is illustrated in figure 6.3. In the bottom of the aforementioned figure, a uint16 with value '87' is encoded in DDLE[UINT]. The number '87' in uint16 is depicted there, highlighting that the most significant byte is 0 and the most significant bit of the lower byte as well. DDLE[UINT] then does not encode the byte with value 0. This is possible because the highest bit of the lower byte is as well 0 and can be used to encode that there is no second byte following.

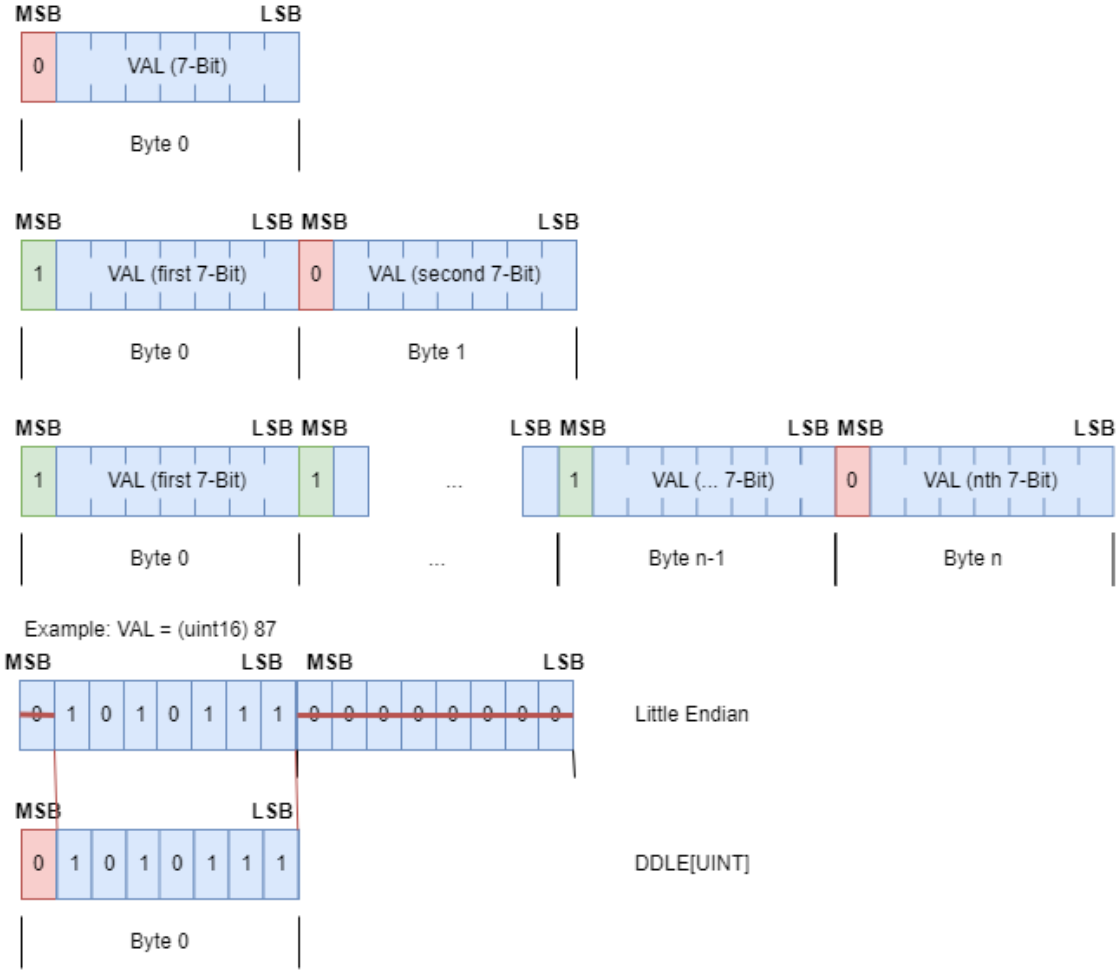


Figure 6.3: Uint8_least encoded with dynamic data length encoding. The indicated "first, second,.." seven bits are counted from the LSB of the to be encoded value.

[FO_PRS_VDP_00004] VDP relative timestamp

Upstream requirements: FO_RS_VDP_00009

⌈A VDP implementation shall compute a relative timestamp (DDLE encoded) with fixed resolution a between two timepoints t_1 and t_2 (unit: μs) as follows:

(i) Calculate the difference $\delta_{\mu s} = (t_2 - t_1)$

(ii) Transfer the difference into the target resolution a: $\delta_a = \mathrm{floor}(\delta_{\mu s} \cdot \frac{a}{\mu s})$

(iii) Serialize the difference into DDLE: $\Delta_a = DDLE[UINT](\delta_a)$.

The VDP implementation shall reconstruct the timestamp $\tilde{t}_2$ in μs from timestamp t_1 coded with resolution a inside the data message as described in the following steps.

(i) Compute $\tilde{\delta}_a = DDLE^{-1}[UINT](\Delta_a)$

(ii) Transfer the difference into μs: $\tilde{\delta}_{\mu s} = \tilde{\delta}_a \cdot \frac{\mu s}{a}$

(iii) Calculate the reconstructed timestamp (unit: μs): $\tilde{t}_2 = t_1 + \tilde{\delta}_{\mu s}$

⌋

Here, the function floor() maps a floating point number to the largest integer less or equal than the input.

Exemplarily, the computation of the VDP relative timestamp of subsequent time points is illustrated in table 6.1.

Reference Time t_1	Resolution a	Sample Time t_2	Relative Time $\delta_{\mu s} = (t_2 - t_1)$	Relative Timestamp δ_a	µs Timestamp $\tilde{\delta}_{\mu s}$	Restored Time $\tilde{t}_2 = t_1 + \tilde{\delta}_{\mu s}$
$0[\mu s]$	μs	$458\ 132[\mu s]$	$458\ 132[\mu s]$	$458\ 132[\mu s]$	$458\ 132[\mu s]$	$458\ 132[\mu s]$
$458\ 132[\mu s]$	ms	$458\ 426[\mu s]$	$294[\mu s]$	$0[ms]$	$0[\mu s]$	$458\ 132[\mu s]$
$458\ 132[\mu s]$	μs	$458\ 793[\mu s]$	$661[\mu s]$	$661[\mu s]$	$661[\mu s]$	$458\ 793[\mu s]$

Table 6.1: Timestamp computation and reconstruction for datapoints with resolution a. The reconstructed time of one row $\tilde{t}_2$ is used as t_1 in the following row.

6.1.3.1 VDP Slot ID and DCA Remote ID

[FO_PRS_VDP_00146] Maximum VDP Slot ID

Upstream requirements: FO_RS_VDP_00002

⌈The maximum allowed VDP Slot ID (VDP.maxSlotID) shall be configurable at compile time and must be less or equal to 16382 (max 2 bytes when coded in DDLE).⌋

The value 16383 (DDLE encoded 0xFF 0x7F) is used for the identification of asynchronous errors, see also: [FO_PRS_VDP_00105]: *Asynchronous error information*

[FO_PRS_VDP_00036] VDP Slot ID

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00010

⌈The VDP Slot ID (VDP_SLOT_ID) shall be within the range [1 .. VDP.maxSlotID] and of type DDLE[UINT] in any VDP message.⌋

[FO_PRS_VDP_00031] DCA Remote ID

Upstream requirements: FO_RS_VDP_00002

⌈The DCA Remote ID (DCA_REM_ID) shall be within the range [1 .. 16383] and of type DDLE[UINT] (maximally 2 bytes) in any VDP message.⌋

6.1.3.2 Error codes

The error codes as listed in the following requirement can either occur synchronously in a control response or asynchronously in a data message. All error codes which can be sent from the VDP-CM Remote to the VDP-CM Proxy in either a control message response or in a data message are listed in [FO_PRS_VDP_00005][FO_PRS_VDP_00006]. The usage of these error codes require that the control message requests are in the correct format.

In case a control type independent description can be given for this error code, it is given here, in case it is specific for a control type, it is explained in the according subsection.

[FO_PRS_VDP_00005] Error codes

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) shall be one of the following values in case the origin of the error is the DCA Remote.

0x00: Generic error (DCA Remote) (sync): [FO_PRS_VDP_00018]; (async):[FO_PRS_VDP_00109]

0x01: Data source error (async): [FO_PRS_VDP_00110]

0x02: Data point sampling error (async): [FO_PRS_VDP_00111]; (sync): [FO_PRS_VDP_00134]

0x03: Data loss error (async): [FO_PRS_VDP_00112]

0x04: Invalid (DCA_REM_DP_DCFG) (sync): [FO_PRS_VDP_00127]

0x05: Duplicated (DCA_REM_DP_DCFG) (sync): [FO_PRS_VDP_00128]

0x06: Data point limit reached (sync): [FO_PRS_VDP_00129]

0x07: Sampling mode cyclic is not supported (sync): [FO_PRS_VDP_00062]

0x08: Sampling mode on-change is not supported (sync): [FO_PRS_VDP_00058]

0x09 - 0x3F: Reserved

0x40 - 0x6F: Custom errors (DCA Remote) (sync, async) Implementation specific.

In case the origin of the error is the VDP-CM Remote, the following error codes shall be used.

0x70: Generic error (VDP-CM Remote) (sync): [FO_PRS_VDP_00019]; (async): [FO_PRS_VDP_00114]

0x71: Timestamp encoding error (async): [FO_PRS_VDP_00115]

0x72: Timebase error (async): [FO_PRS_VDP_00116]

0x73: Sample too long (async): [FO_PRS_VDP_00117]

0x74: Data buffer full (async): [FO_PRS_VDP_00118]

0x75: VDP Slot ID unknown (sync): [FO_PRS_VDP_00135]

0x76: DCA Remote ID unknown (sync): [FO_PRS_VDP_00130]

0x77: VDP Slot ID out of range (sync): [FO_PRS_VDP_00131]

0x78: Persistency storage limit reached (sync): [FO_PRS_VDP_00052]

0x79: VDP Slot ID already in use (sync): [FO_PRS_VDP_00132]

0x7A: DCA Remote inconsistency error (sync): [FO_PRS_VDP_00133]

0x7B: Secured channel not supported (sync): [FO_PRS_VDP_00046]

0x7C: Transmission mode cyclic already in use / not set (sync): [FO_PRS_VDP_00145] [FO_PRS_VDP_00038]

0x7D: VDP slot ID reserved (sync): [FO_PRS_VDP_00136]

0x7E - 0xAF: Reserved

0xB0 - 0xFF: Custom error VDP-CM Remote (sync, async) Implementation specific.

⌋

In case, the format is not correct, an error message (as defined in section 6.5) is sent. The error types are encoded by protocol error codes as defined in the following requirement.

[FO_PRS_VDP_00006] Protocol error codes

Upstream requirements: FO_RS_VDP_00010

⌈The protocol error supported by VDP are 5-bit unsigned integers. The numerical protocol error codes (PEC)s are encoded as follows.

(PEC) = 0: Control message sequence counter error

(PEC) = 1: Invalid options

(PEC) = 2: Duplicated VDP Slot ID error

(PEC) = 3: Incorrect number of bytes error

(PEC) = 4: Unknown message type error

(PEC) = 5 ... 31 : Reserved and unused

⌋

6.2 Message Types

VDP shall support data messages and control messages, they are differentiated using the (MT) field of the header (c.f. subsection 6.1.1) which can be of the following values.

[FO_PRS_VDP_00007] Message types

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004, FO_RS_VDP_00006, FO_RS_VDP_00003

⌈The message type (MT) in the header can be selected to be

(MT) = 0 Protocol version message

(MT) = 1 Control message

(MT) = 2 Data message

(MT) = 3 Error message

(MT) = 4 - 7 [Reserved]

Data and error message shall be sent from VDP-CM Remote to VDP-CM Proxy only. Control and Protocol version shall be split into a request sent from VDP-CM Proxy to VDP-CM Remote and a response sent from VDP-CM Remote to VDP-CM Proxy.⌋

6.2.1 Protocol version

The protocol version can be requested by the VDP-CM Proxy at the VDP-CM Remote as depicted in fig. 6.4.

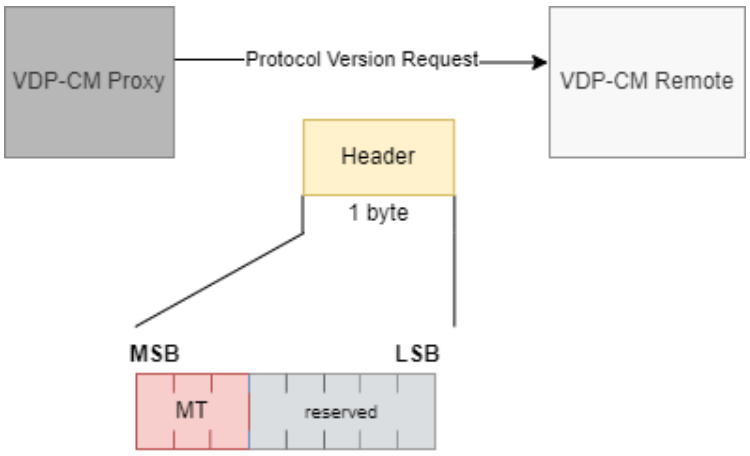


Figure 6.4: Protocol version request.

The VDP-CM Remote answers with a protocol version response as depicted in 6.5.

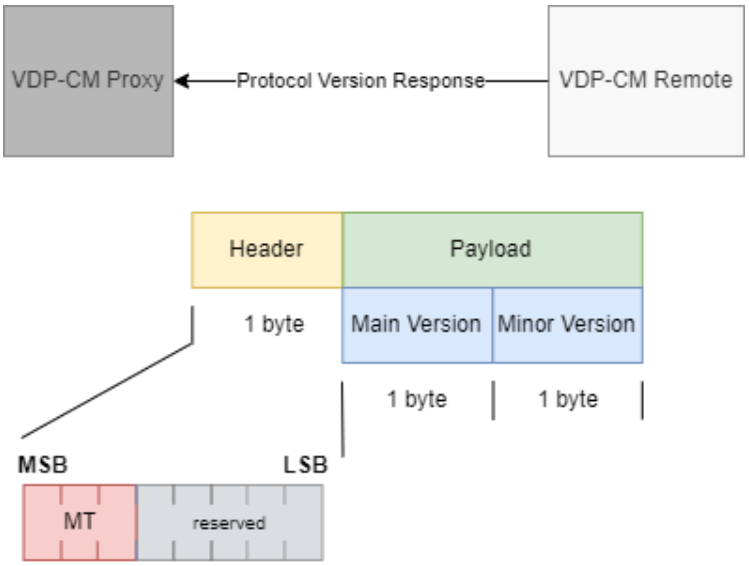


Figure 6.5: Protocol version response.

[FO_PRS_VDP_00020] Protocol version request header

Upstream requirements: FO_RS_VDP_00001

⌈For a protocol version request, the message type specific additional information (ADD) of the header shall be reserved.⌋

[FO_PRS_VDP_00021] Protocol version request

Upstream requirements: FO_RS_VDP_00001

⌈A protocol version request shall not contain any payload.⌋

[FO_PRS_VDP_00023] Protocol version response payload

Upstream requirements: FO_RS_VDP_00001

⌈The payload of the protocol version response shall be of two byte length and shall contain

Byte 0: Main version (uint8) set to 0x02, and

Byte 1: Minor version (uint8) set to 0x00.

⌋

6.2.2 Control Messages

The following requirements describe the common features and requirements imposed on all control messages. The specific instantiations in form of services/commands can be found in section 6.3.

Control message requests are sent from VDP-CM Proxy to VDP-CM Remote and control message responses are sent from VDP-CM Remote to VDP-CM Proxy as required

previously and depicted in figure 6.6. In case the control message was not in the correct format, the control message response is not sent but an error message.

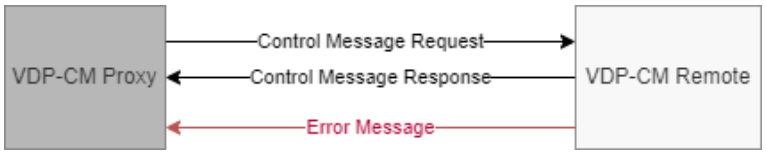


Figure 6.6: VDP control message request and response directions.

Because VDP control messages contain data that is security relevant (e.g., the SEC flag in the VDP settings), the authenticity of the VDP control messages need to be ensured. This can be done by using an appropriate protocol such as SecOC for transmission of VDP control messages.

[FO_PRS_VDP_00008] Control message request - header field (ADD)

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004, FO_RS_VDP_00006, FO_RS_VDP_00003

⌈For a control message, i.e. (MT) = 1, the field (ADD) of the VDP header shall contain the control message sequence counter (CON_SQ_CT).⌋

The header of a control message is depicted in figure 6.7.

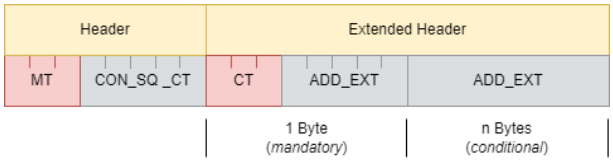


Figure 6.7: Control message header.

[FO_PRS_VDP_00009] Control message request - extended header

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004, FO_RS_VDP_00006, FO_RS_VDP_00003

⌈For a control message request, which is sent from the VDP-CM Proxy to the VDP-CM Remote, the header shall be followed by an extended header of at least one byte length. The mandatory byte shall contain

Bit 7-5: (CT) Command type, and

Bit 4-0: (ADD_EXT) Additional command specific flags in the extended header.

The conditional bytes are command specific.⌋

[FO_PRS_VDP_00047] Control message response - extended header

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004, FO_RS_VDP_00006, FO_RS_VDP_00003

⌈For a control message response, which is sent from the VDP-CM Remote to the VDP-CM Proxy, the header shall be followed by an extended header of one byte length. The mandatory byte shall contain

Bit 7-5: (CT) Command type, and

Bit 4-1: Reserved

Bit 0: (ACK) Acknowledge

⌋

6.2.2.1 Control message sequence counter

For all control messages (control acting from the VDP-CM Proxy to the VDP-CM Remote), a control message sequence counter is used to detect message loss and map responses to requests. Since the protocol is not stateless, this is essential to assure validity of the control sequences per remote ECU. Consequentially, if one VDP-CM Proxy is connected to multiple VDP-CM Remotes, it needs to handle as many control sequence counters.

[FO_PRS_VDP_00010] Control message sequence counter

Upstream requirements: FO_RS_VDP_00011

⌈The field (CON_SQ_CT) shall be a 5-bit unsigned integer (0..31).⌋

[FO_PRS_VDP_00011] Control message sequence counter initialization

Upstream requirements: FO_RS_VDP_00011

⌈During initialization, the control message sequence counter (CON_SQ_CT) shall be set to '1'.⌋

The previous requirement and the following incrementation and wrap around rules need to be realized by both, VDP-CM Proxy and Remote.

[FO_PRS_VDP_00012] Control message sequence counter incrementation

Upstream requirements: FO_RS_VDP_00011

⌈The control message sequence counter (CON_SQ_CT) shall be incremented by one for each VDP control request.⌋

[FO_PRS_VDP_00013] Control message sequence counter wrap around

Upstream requirements: FO_RS_VDP_00011

⌈If the control message sequence counter (CON_SQ_CT) reaches '31', it shall wrap around and start with the value '1' for the next VDP control message request to be transmitted from VDP-CM Proxy to VDP-CM Remote.⌋

[FO_PRS_VDP_00014] The control message sequence counter repeated in the response

Upstream requirements: FO_RS_VDP_00011

⌈The control message sequence counter (CON_SQ_CT) sent in the control message request shall be mirrored in the corresponding control message response.⌋

[FO_PRS_VDP_00015] Protocol error code - wrong control message sequence counter

Upstream requirements: FO_RS_VDP_00010

⌈In case that the control message sequence counter (CON_SQ_CT) is not the expected next (CON_SQ_CT) according to [FO_PRS_VDP_00012], an error message shall be sent from the VDP-CM Remote to the VDP-CM Proxy with (PEC) = 0.

The VDP-CM Remote must not send a control message response in this case.⌋

The previous error case may occur as well when an unexpected restart happened.

6.2.2.2 Acknowledge

Control message requests are sent from the VDP-CM Proxy to the VDP-CM Remote. The VDP-CM Remote indicates using an acknowledge bit whether the request was received and processed successfully. Requests which are partially erroneous are also responded to with (ACK) = 0, however the parts which can be successfully applied to the VDP-CM Remote are applied. The following subsections describe the specific realization per message type.

Beyond that, error messages can be sent asynchronously (c.f. section 6.5).

[FO_PRS_VDP_00016] Acknowledge bit

Upstream requirements: FO_RS_VDP_00010

⌈The acknowledge bit (ACK) of the control message response shall contain the following encoding.

- (ACK) = 1: Acknowledge
- (ACK) = 0: Not-acknowledge

⌋

6.2.2.3 NACK response payload

The control message response contains information about the erroneous parts of the control message requests.

[FO_PRS_VDP_00017] Not-acknowledge control message response payload

Upstream requirements: FO_RS_VDP_00010

⌈For a control message response with (ACK) = 0 (not-acknowledge), the payload of the control message response shall contain repeatedly

Byte 0: (EC) error code, and

Byte 1 - *: depending on (EC),

- (VDP_SLOT_ID) VDP Slot ID,
- (DCA_REM_ID) DCA Remote ID, or
- nothing.

It is described for each error code whether the VDP Slot ID or the DCA Remote ID follows.⌋

Not all error codes are allowed for every request. The specific allowed error codes per request are listed in the corresponding subsections. The following requirements specify the usage of error codes which are common for more than one control message type.

[FO_PRS_VDP_00018] Generic DCA Remote error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x00 shall be used in a control message response with (ACK) = 0, if a generic error occurred in the DCA Remote corresponding to the (VDP_SLOT_ID).⌋

[FO_PRS_VDP_00133] DCA Remote inconsistency error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x7A shall be used in a control message response with (ACK) = 0, if an unrecoverable synchronization error between DCA Remote and VDP-CM Remote occurred. It is followed by the (VDP_SLOT_ID) which caused the error.⌋

[FO_PRS_VDP_00019] Generic VDP-CM Remote error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x70 shall be used in a control message response with (ACK) = 0, if a generic error occurred in the VDP-CM Remote while processing the control request belonging to this (VDP_SLOT_ID).⌋

[FO_PRS_VDP_00135] Unknown VDP Slot ID

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00003

⌈In case the (VDP_SLOT_ID) for which triggering, activation or removal was requested is not known by the VDP-CM Remote, the trigger response shall contain this (VDP_SLOT_ID) with (EC) = 0x75.⌋

[FO_PRS_VDP_00131] VDP Slot ID out of range

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈In case a control request contains a (VDP_SLOT_ID) which lies within the range [(VDP.maxSlotID)+1 .. 16382], the control response shall contain in the payload the out of range (VDP_SLOT_ID) with (EC) = 0x77. This error shall be contained only once per response and reports the lowest (VDP_SLOT_ID) which is out of range, marking all (VDP_SLOT_ID)s higher than that implicitly out of range as well.⌋

[FO_PRS_VDP_00136] VDP Slot ID reserved

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈In case a control request contains a (VDP_SLOT_ID) which is either 0 or 16383, the control response shall contain in the payload the reserved (VDP_SLOT_ID) with (EC) = 0x7D. This error may be contained twice per response - once for 0 and once for 16383.⌋

The custom error codes are implementation specific.

6.2.3 Data messages

An overview of the data message can be found in figure 6.8.

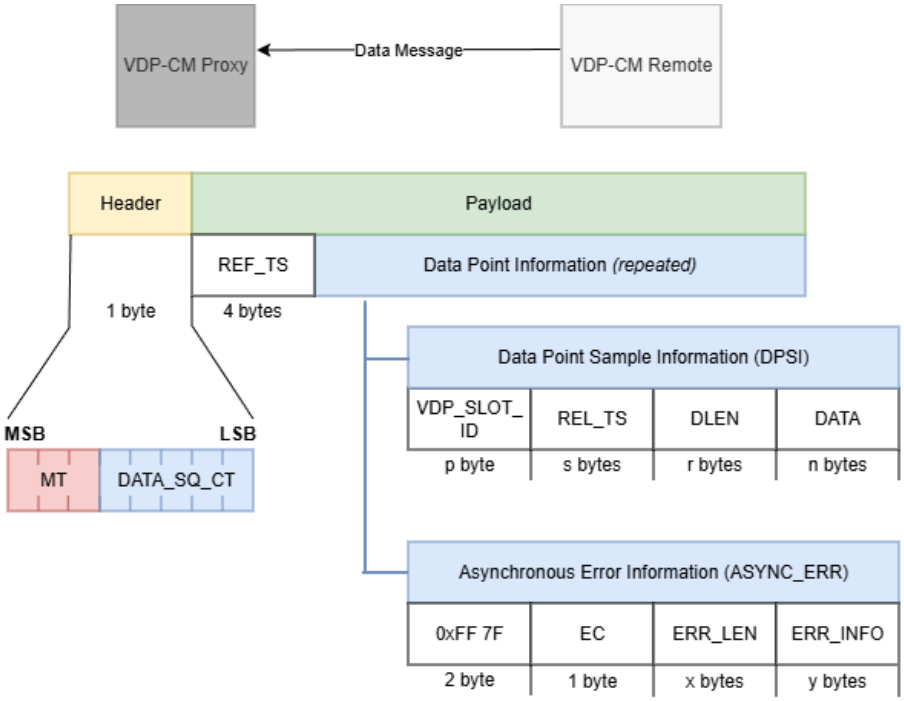


Figure 6.8: Data message.

Here, it is worth emphasizing, that the VDP-CM Remote responds (ideally) with one data message to all requests received. In this data message, all previously acquired data samples are aggregated and sent to the data consumer. An example with three different samples whereof one reported an asynchronous error for one sample is depicted in figure 6.9.

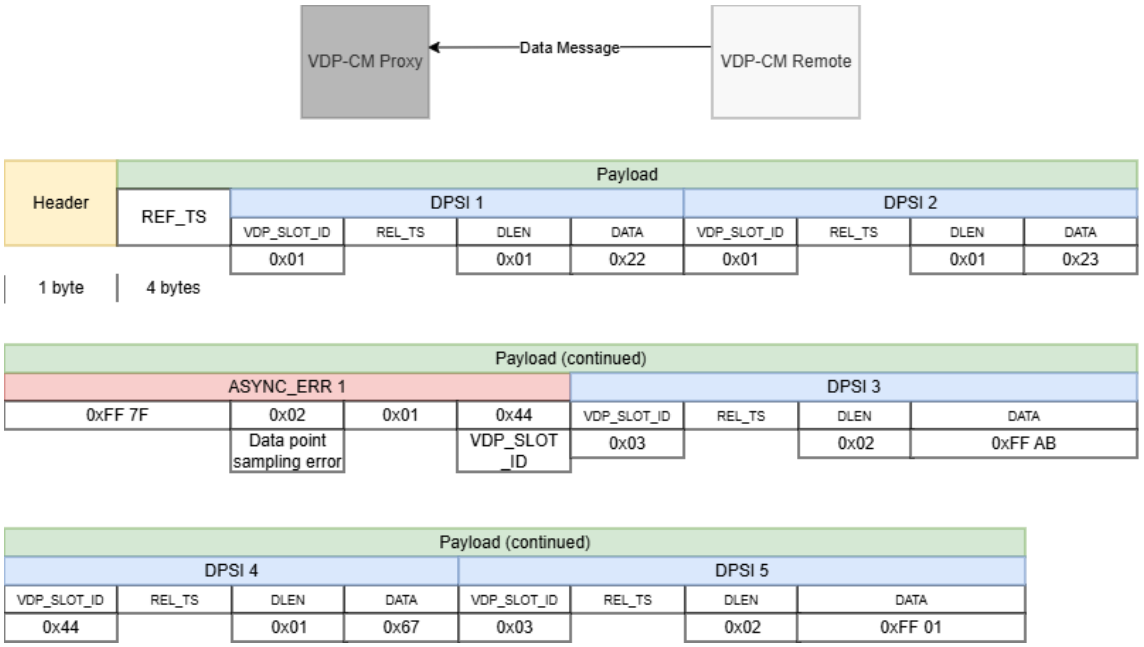


Figure 6.9: Example of a data message containing samples corresponding to multiple VDP_SLOT_IDs.

[FO_PRS_VDP_00091] Data message

Upstream requirements: FO_RS_VDP_00004

⌈A data message shall have (MT) = 2.⌋

[FO_PRS_VDP_00092] Data message header

Upstream requirements: FO_RS_VDP_00005

⌈The data message header field ADD shall contain a sequence counter (DATA_SQ_CT) which is an unsigned integer of 5 bit length.⌋

[FO_PRS_VDP_00093] Sequence counter initialization

Upstream requirements: FO_RS_VDP_00005

⌈The VDP-CM Remote shall initialize the sequence counter (DATA_SQ_CT) with 1 on startup.⌋

[FO_PRS_VDP_00094] Sequence counter increment

Upstream requirements: FO_RS_VDP_00005

⌈The sequence counter (DATA_SQ_CT) shall be increased by 1 with each data message sent by the VDP-CM Remote.⌋

[FO_PRS_VDP_00095] Sequence counter wrap around

Upstream requirements: FO_RS_VDP_00005

⌈When the sequence counter (DATA_SQ_CT) reaches 31, it shall wrap around and be set to 1 for the next data message.⌋

The data message payload is illustrated in figure 6.8, wherein repeated Data Point Information (DPI) is contained.

[FO_PRS_VDP_00096] Data message payload

Upstream requirements: FO_RS_VDP_00004

⌈The data message payload shall contain a reference timestamp (REF_TS) and repeated data point information (DPI).⌋

[FO_PRS_VDP_00097] Reference timestamp per data message

Upstream requirements: FO_RS_VDP_00004

⌈The reference timestamp (REF_TS) shall be a uint32 with the unit seconds.⌋

Hence, the reference timestamp can be set to be the seconds low field of a StbM timestamp (see [2]).

Due to the decoupling of sampling and transmission, there is the possibility of sampling errors occurring independent of the currently sent request, i.e. asynchronously. These errors are transmitted within the data frame as a specific type of the data point information.

[FO_PRS_VDP_00098] Data point information

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00004

⌈The data point information (DPI) shall be one of the two following types

Byte 0 = 0xFF AND Byte 1 = 0x7F: Asynchronous error information (ASYNC_ERR), or

Byte 0 $\neq$ 0xFF OR Byte 1 $\neq$ 0x7F: Data point sample information (DPSI).

⌋

6.2.3.1 Data point sampling information

[FO_PRS_VDP_00099] Data point sample information

Upstream requirements: FO_RS_VDP_00004, FO_RS_VDP_00009

⌈A data point sample information (DPSI) shall contain the following fields.

Byte 0 - p: (VDP_SLOT_ID)

Byte p+1 - k: (REL_TS) Relative timestamp

Byte k+1 - l: (DLEN) Data length

Byte l+1 - m: (DATA) Data

⌋

[FO_PRS_VDP_00100] VDP Slot IDs are used in data messages

Upstream requirements: FO_RS_VDP_00004, FO_RS_VDP_00002

⌈All samples acquired using the information from one data point dynamic configuration in the add dynamic configuration request shall be reported in the data message with the (VDP_SLOT_ID) of the data point dynamic configuration.⌋

[FO_PRS_VDP_00101] Relative timestamp

Upstream requirements: FO_RS_VDP_00004, FO_RS_VDP_00009

⌈The relative timestamp (REL_TS) shall be encoded according to [FO_PRS_VDP_00004] with a maximum length of 6 byte. If the DDLE encoded relative timestamp does not fit into 6 byte a timestamp encoding error according to [FO_PRS_VDP_00115] shall be raised.

If the (DPI) is the first one in the data message, the relative timestamp encodes VDP_REL_TS(REF_TS, <sample acquisition time>). Otherwise, it is VDP_REL_TS(reconstructed(<sample acquisition time of the previous sample>), <sample acquisition time>).⌋

[FO_PRS_VDP_00102] Data length encoding

Upstream requirements: FO_RS_VDP_00004, FO_RS_VDP_00009

⌈The data length (DLEN) shall be of type DDLE[UINT].⌋

[FO_PRS_VDP_00103] Data length maximum length

Upstream requirements: FO_RS_VDP_00004

⌈The data length (DLEN) shall be at most 2 byte long.⌋

[FO_PRS_VDP_00104] Length of data

Upstream requirements: FO_RS_VDP_00004

⌈The data (DATA) shall be a byte string of length (DLEN).⌋

The structure of the byte string (DATA) is not defined by the protocol VDP but is implementation specific.

6.2.3.2 Asynchronous error information

[FO_PRS_VDP_00105] Asynchronous error information

Upstream requirements: FO_RS_VDP_00010

⌈The asynchronous error information (ASYNC_ERR) shall contain the following fields

Byte 0 - 1: 0xFF 7F,

Byte 2: (EC) Error code,

Byte 3 - m: (ERR_LEN) Error information length,

Byte m+1 - n: (ERR_INFO) Error information.

⌋

[FO_PRS_VDP_00106] Error information length (ERR_LEN)

Upstream requirements: FO_RS_VDP_00010

⌈The error information length (ERR_LEN) shall be of type DDLE[UINT] and at most 2 byte long.⌋

[FO_PRS_VDP_00107] Error information (ERR_INFO)

Upstream requirements: FO_RS_VDP_00010

⌈The error information (ERR_INFO) shall be of length (ERR_LEN) and its content shall depend on (EC).⌋

[FO_PRS_VDP_00108] Allowed error codes for asynchronous errors

Upstream requirements: FO_RS_VDP_00010

⌈Only the following error codes (EC) from the total list given in [FO_PRS_VDP_00005] shall be allowed in [FO_PRS_VDP_00105].

0x00 [FO_PRS_VDP_00109]

0x01 [FO_PRS_VDP_00110]

0x02 [FO_PRS_VDP_00111]

0x03 [FO_PRS_VDP_00112]

0x40-0x6F [FO_PRS_VDP_00113]

0x70 [FO_PRS_VDP_00114]

0x71 [FO_PRS_VDP_00115]

0x72 [FO_PRS_VDP_00116]

0x73 [FO_PRS_VDP_00117]

0x74 [FO_PRS_VDP_00118]

0xB0-0xFF [FO_PRS_VDP_00114]

⌋

[FO_PRS_VDP_00109] Generic DCA Remote error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x00 *generic DCA Remote error* shall be used when a generic error occurred while sampling a data point.

If used, (ERR_LEN) $\geq$ 1, and (ERR_INFO) shall contain in the first byte(s) the DDLE[UINT] encoded VDP Slot ID of the data point causing this error.

The remainder of the (ERR_INFO) is implementation specific.⌋

[FO_PRS_VDP_00110] Data source error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x01 *data source error* shall be used in an asynchronous error information when the DCA Remote can not connect to the data source hence all data points from this DCA Remote are affected and can not be sampled.

For this error, (ERR_LEN) $\geq$ 1 and (ERR_INFO) shall contain the DDLE[UINT] encoded (DCA_REM_ID) of the affected DCA Remote.⌋

[FO_PRS_VDP_00111] Data point sampling error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x02 *data point sampling error* shall be used in an asynchronous error information when a data point was dynamically configured with (SCYCLIC) = 1 but the sampling failed once.

If this happens, the asynchronous error information (ASYNC_ERR) replaces the (DPSI). For this error, (ERR_LEN) $\geq$ 1 and (ERR_INFO) contains the DDLE[UINT] encoded VDP Slot ID of the data point for which the sampling failed.⌋

[FO_PRS_VDP_00112] Data loss error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x03 *data loss error* shall be used in an asynchronous error information when a data point sample was dropped. Exemplarily, it shall always be used when the data point sample was dropped because of an internal error.

If (EC) = 0x03 is set, (ERR_LEN) $\geq$ 1 and (ERR_INFO) contains the DDLE[UINT] encoded VDP Slot ID of the data point for which the sampling failed.⌋

The previously described error code shall not be used in case the internal error which caused the data loss was, that the buffer of the VDP-CM Remote was full. In this case, all data losses are reported in one asynchronous error code [FO_PRS_VDP_00118]. It indicates that at least one sample was lost.

[FO_PRS_VDP_00113] Error Code 0x40-0x6F

Upstream requirements: FO_RS_VDP_00010

⌈The error codes (EC) = 0x40 - 0x6F *custom DCA Remote errors* are implementation specific. If used, (ERR_LEN) $\geq$ 1, and (ERR_INFO) shall contain the DDLE[UINT] encoded VDP Slot ID of the data point causing this error.

The remainder of the (ERR_INFO) is implementation specific.⌋

[FO_PRS_VDP_00114] Error ID 0x70

Upstream requirements: FO_RS_VDP_00010

⌈In case (EC) = 0x70 or (EC) = 0xB0 - 0xFF is used, the (ERR_INFO) (and hence (ERR_LEN)) shall be implementation specific.⌋

[FO_PRS_VDP_00115] Timestamp encoding error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x71 *timestamp encoding error* shall be used when the encoding of the relative timestamp of a data sample according to [FO_PRS_VDP_00004] failed.

If (EC) = 0x71 is set, (ERR_LEN) = 0, and (ERR_INFO) is empty.⌋

When the error code (EC) = 0x71 is used in an asynchronous error information, the reconstructed timestamps of the following data point sample information may be fuzzy.

[FO_PRS_VDP_00116] Timebase error

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x72 *timebase error* shall be used in an asynchronous error information when the timebase of the remote ECU is out of synchronization.

If (EC) = 0x72 is set, (ERR_LEN) = 0, and (ERR_INFO) is empty.⌋

A potential cause for the previous error is, when the global time synchronization (GTS) of the remote ECU runs out of synchronization with the global time master.

When the error code (EC) = 0x72 is used in an asynchronous error information, the reconstructed timestamps of the following data point sample information may be fuzzy.

[FO_PRS_VDP_00117] Sample too long

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x73 *sample too long* shall be used in an asynchronous error information, when a DCA Remote attempted to push a too long data point sample to the VDP-CM Remote.

If (EC) = 0x73 is set, the (ERR_INFO) contains the (VDP_SLOT_ID) of the data point for which the too long sample was acquired and the (ERR_LEN) shall be set according to the length of the (VDP_SLOT_ID).⌋

[FO_PRS_VDP_00118] Data buffer full

Upstream requirements: FO_RS_VDP_00010

⌈The error code (EC) = 0x74 *data buffer full* shall be used in an asynchronous error information, when the internal buffer of the VDP-CM Remote is full and at least one data point sample was lost.

If (EC) = 0x74 is set, (ERR_LEN) = 0, and (ERR_INFO) is empty.⌋

6.3 Services / Commands

[FO_PRS_VDP_00048] Message types

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004, FO_RS_VDP_00006, FO_RS_VDP_00003

⌈The command type (CT) in the extended header shall be selected from the following.

(CT) = 0 Add dynamic configuration

(CT) = 1 Remove dynamic configuration

(CT) = 2 Activation

(CT) = 3 Trigger

(CT) = 4 - 7 [Reserved]

⌋

6.3.1 Add dynamic configuration

The full add dynamic configuration request as described in the following requirements is depicted in fig. 6.10.

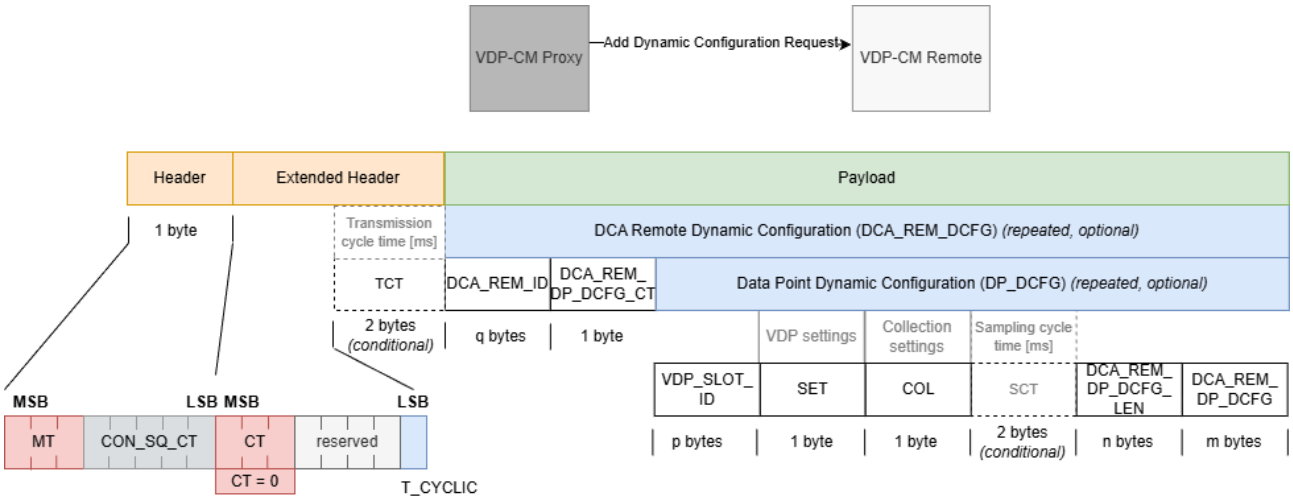


Figure 6.10: Add dynamic configuration request.

The add dynamic configuration request is answered with a add dynamic configuration response, c.f fig. 6.11.

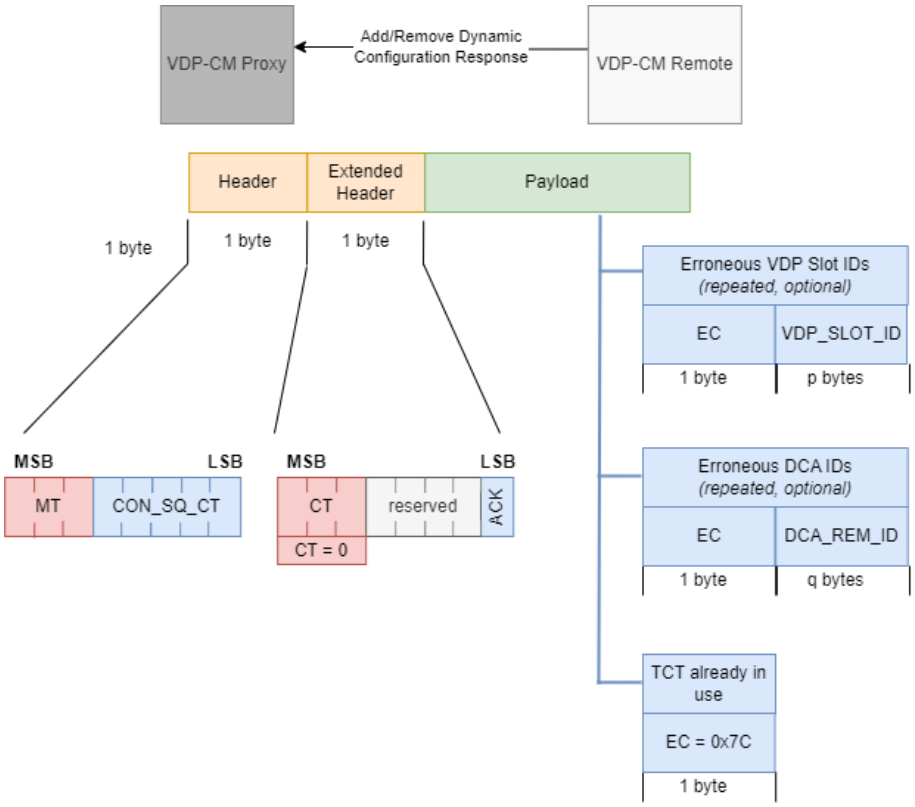


Figure 6.11: Add dynamic configuration response.

6.3.1.1 Request overview

[FO_PRS_VDP_00024] Add dynamic configuration request header

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004

⌈The control message extended header for an add dynamic configuration request shall contain

Byte 0, Bit 7-5: (CT) = 0 Command type: add dynamic configuration,

Byte 0, Bit 4-1: Reserved,

Byte 0, Bit 0: (TCYCLIC) Transmission mode cyclic, and

Byte 1-2: (conditional, TCT) Transmission cycle time.

⌋

[FO_PRS_VDP_00025] Add dynamic configuration request

Upstream requirements: FO_RS_VDP_00004

⌈The add dynamic configuration request payload shall contain optionally and repeatedly DCA Remote dynamic configuration (DCA_REM_DCFG, m_k byte).⌋

[FO_PRS_VDP_00027] Transmission mode cyclic flag

Upstream requirements: FO_RS_VDP_00004

⌈In case the flag (TCYCLIC) in the header of the add dynamic configuration request is set to '1', the transmission cycle time (TCT) shall be used.⌋

[FO_PRS_VDP_00145] Transmission cycle time already in use

Upstream requirements: FO_RS_VDP_00004

⌈In case the flag (TCYCLIC) in the header of the add dynamic configuration request is set to '1' but the VDP-CM Remote has a previously configured transmission cycle time (TCT), it shall respond with (EC) = 0x7C, transmission cycle time already in use.⌋

The error defined in [FO_PRS_VDP_00145] can be mitigated by removing the previous transmission cycle time (TCT) using a remove dynamic configuration request and then sending an add dynamic configuration request with the new cyclic transmission configuration.

[FO_PRS_VDP_00028] Extended dynamic configuration request header

Upstream requirements: FO_RS_VDP_00004

⌈The transmission cycle time (TCT) shall be of type uint16 given in milliseconds.⌋

[FO_PRS_VDP_00029] Transmission cycle time (TCT)

Upstream requirements: FO_RS_VDP_00004

⌈In case the flag (TCYCLIC) is set to '1', the VDP-CM Remote shall transmit data messages cyclically with the period set to a value which is at least the 'minimum transmission distance time' (MTDT) of the VDP-CM Remote. Furthermore, if $(TCT) \geq (MTDT)$, the VDP-CM Remote shall send the data messages with a period shorter or equal than (TCT) but as close as possible to (TCT).⌋

For explanation of the configuration parameter (MTDT), please refer to chapter 7.

The main aim of the previous requirement is to enable flexible configuration while still being restrained to main function periods in AUTOSAR classic platform ECUs. Including this restriction, the remote ECU can compute the actual transmission period by floor((TCT)/(VDP-CM Remote.MainFunctionPeriod)).

6.3.1.2 DCA Remote dynamic configuration (DCA_REM_DCFG)

The add dynamic configuration of the specific data points which shall be sampled is done per DCA Remote. The requested dynamic configuration contains a unique identifier, the VDP Slot ID, and the precise parametrization the respective data point.

[FO_PRS_VDP_00030] DCA Remote dynamic configuration

Upstream requirements: FO_RS_VDP_00002

⌈The DCA Remote dynamic configuration (DCA_REM_DCFG) shall contain

Byte 0 - q: (DCA_REM_ID) The DCA Remote ID ,

Byte q + 1: (DCA_REM_DCFG_CT) The number of DP_DCFG following , and

Byte q + 1 - n: (repeated) (DP_DCFG) Data point dynamic configuration

⌋

6.3.1.3 Data point dynamic configuration (DP_DCFG)

The data point dynamic configurations encode the mapping of the DCA Remote specific parametrization (given by the DCA Remote data point dynamic configuration) and the dynamically assigned identifier, the VDP Slot ID.

[FO_PRS_VDP_00035] Data point dynamic configuration

Upstream requirements: FO_RS_VDP_00002

⌈The data point dynamic configuration (DP_DCFG) shall contain

Byte 0 - p: (VDP_SLOT_ID) VDP Slot ID, [FO_PRS_VDP_00036]

Byte p + 1: (SET) VDP settings,

Byte p + 2: (COL) Collection settings ,

Byte p + 3 - p + 4: (SCT) Sampling cycle time, conditional field depending on (COL),

Byte l-k: (DCA_REM_DP_DCFG_LEN) DCA Remote data point dynamic configuration length,

Byte k+1-r: (DCA_REM_DP_DCFG) DCA Remote data point dynamic configuration.

(l is either p + 3 or p + 5 depending on (SCT).)⌋

[FO_PRS_VDP_00039] VDP Slot ID not unique error

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00009, FO_RS_VDP_00010

⌈If a VDP Slot ID is set multiple times in the same add dynamic configuration request or set even though it is already in use in the remote ECU, the VDP-CM Remote shall respond with a error message with (PEC) = 2.⌋

[FO_PRS_VDP_00137] Invalid length of (DP_DCFG)

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈If the field (DP_DCFG) is too short (e.g. less than 5 bytes), the VDP-CM Remote shall respond with an error message with (PEC) = 3, incorrect number of bytes.⌋

The previously described error condition can only be detected clearly for the last (DP_DCFG) in the add dynamic configuration request.

6.3.1.4 VDP settings

[FO_PRS_VDP_00041] VDP settings

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004, FO_RS_VDP_00010, FO_RS_VDP_00006

⌈The field VDP settings shall contain

Bit 7: Reserved

Bits 6-4: (TRES) Timestamp resolution

Bit 3: (SEC) Usage of secured channel

Bit 2: (PERSIST) Persistency

Bit 1: (TXMODE_ON_SAMPLING) Transmission mode 'on sampling'

Bit 0: (INIT_ACT) Initial activation state

⌋

[FO_PRS_VDP_00042] Timestamp resolution

Upstream requirements: FO_RS_VDP_00002

⌈The field (TRES) shall encode the following timestamp resolutions for the dynamically configured data point inside the data message

0: $1\,\mu$s,

1: $10\,\mu$s,

2: $100\,\mu$s,

3: 1 ms,

4: 10 ms,

5: 100 ms,

6: 1 s,

7: Reserved and unused.

⌋

The following requirements cover the protection of the communication by using a secured channel based on a secure communication protocol (like SecOC, TLS, IPsec, MACsec and so on). Which one to use is not specified.

[FO_PRS_VDP_00043] (SEC) Usage of secured channel bit

Upstream requirements: FO_RS_VDP_00002

⌈A data message containing at least one data point sample requiring with (SEC) = 1 shall be secured by usage of secured channel.⌋

[FO_PRS_VDP_00044] Data transmission without usage of secured channel

Upstream requirements: FO_RS_VDP_00002

⌈A data message which contains no data points samples requiring (SEC) = 1 shall not be secured by the usage of secured channel.⌋

[FO_PRS_VDP_00045] Data transmission without usage of secured channel always supported

Upstream requirements: FO_RS_VDP_00002

⌈All VDP-CM Remote shall support (SEC) = 0.⌋

[FO_PRS_VDP_00046] Data transmission with usage of secured channel not supported error

Upstream requirements: FO_RS_VDP_00002

⌈In case, the VDP-CM Remote can not transmit data messages with (SEC) = 1 but receive (DP_DCFG) with (SEC) = 1, the VDP-CM Remote shall respond with (ACK) = 0.

Furthermore, the response shall contain the (VDP_SLOT_ID) of the (DP_DCFG) and the error code 0x7B *secured channel not supported*.⌋

[FO_PRS_VDP_00051] Persistency of data point dynamic configurations

Upstream requirements: FO_RS_VDP_00002

⌈If (PERSIST) = 1, the full (DP_DCFG) shall be stored in NVM of the remote ECU. For (PERSIST) = 0, the (DP_DCFG) is stored in volatile memory only.⌋

In consequence of the previous requirement, unless (PERSIST) = 1, the add dynamic configurations are lost on ECU restart.

[FO_PRS_VDP_00052] Persistency storage limit reached

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00010

⌈If (PERSIST) = 1, but the remote ECU either does not support persisting (DP_DCFG)s or does not have sufficient memory to store the (DP_DCFG), the VDP-CM Remote shall respond with (ACK) = 0.

Furthermore, the response payload shall contain the (VDP_SLOT_ID) of the (DP_DCFG) and the error code 0x78 as listed in [FO_PRS_VDP_00005].⌋

[FO_PRS_VDP_00053] Transmission mode on sampling

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004

⌈When (TXMODE_ON_SAMPLING) = 1, the VDP-CM Remote shall transmit the data message as soon as possible when this data point is sampled.⌋

As soon as possible is written in the previous requirement, because the minimum transmission distance time (c.f. chapter 7) needs to be asserted by the VDP-CM Remote.

[FO_PRS_VDP_00054] Initial acitvation state - active

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00006

⌈When (INIT_ACT) = 1, the data point which is dynamically configured with this (DP_DCFG) shall be sampled according to (COL) as soon as possible after reception of the add dynamic configuration request.⌋

[FO_PRS_VDP_00055] Initial activation state - inactive

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00006

⌈When (INIT_ACT) = 0, the data point which is dynamically configured with this (DP_DCFG) must not be sampled (except due to a trigger request) until an activation request with this (VDP_SLOT_ID) and (ACT) = 1 is received by the remote ECU.⌋

6.3.1.5 Collection settings

[FO_PRS_VDP_00056] Collection settings

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003

⌈The field (COL) shall contain the following information

Bits 7-2: Reserved

Bit 1: (SCHANGE) Sampling mode 'on change'

Bit 0: (SCYCLIC) Sampling mode 'cyclic'

⌋

[FO_PRS_VDP_00057] Sampling mode on.change

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003

⌈When (SCHANGE) = 1, the data point shall be sampled each time a change has been identified by the DCA Remote.

The definition of change is implementation specific for the DCA Remote.⌋

[FO_PRS_VDP_00058] Sampling mode on-change is not supported

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003

⌈In case, a DCA Remote does not support (SCHANGE) = 1 for a specific (DP_DCFG), the add dynamic configuration response shall contain (ACK) = 0. The payload of the response shall then contain the (VDP_SLOT_ID) of the (DP_DCFG) and the error code 0x08.⌋

[FO_PRS_VDP_00059] Sampling mode cyclic and sampling cycle time

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003

⌈When (SCYCLIC) = 1, the sampling cycle time (SCT) of 2 bytes shall be set. In case it is not set, an error message shall be responded with (PEC)=3, incorrect number of bytes.⌋

[FO_PRS_VDP_00060] Sampling cycle time

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003

⌈The field (SCT) shall be of type uint16 and contains the sampling cycle time in milliseconds.⌋

[FO_PRS_VDP_00061] Sampling mode cyclic

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00003

⌈When (SCYCLIC) = 1 and (SCT) is given, the remote ECU shall sample the data cyclically with the period set to a value which is at least the 'minimum sampling distance time' (MSDT) of the DCA Remote. Furthermore, if $(SCT) \geq (MSDT)$, the DCA Remote shall sample data points with a period shorter or equal than (SCT).⌋

[FO_PRS_VDP_00062] Sampling mode cyclic is not supported

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00010, FO_RS_VDP_00003

⌈In case, a DCA Remote does not support (SCYCLIC) = 1 for a specific (DP_DCFG), the add dynamic configuration response shall contain (ACK) = 0. The payload of the response shall then contain the (VDP_SLOT_ID) of the (DP_DCFG) and the error code 0x07.⌋

[FO_PRS_VDP_00063] Encoding of DCA_REM_DP_DCFG_LEN

Upstream requirements: FO_RS_VDP_00002

⌈The field (DCA_REM_DP_DCFG_LEN) shall be of type DDLE[UINT] and maximum 2 byte long.⌋

[FO_PRS_VDP_00064] Length of DCA_REM_DP_DCFG

Upstream requirements: FO_RS_VDP_00002

⌈The field (DCA_REM_DP_DCFG) shall be a byte array.⌋

[FO_PRS_VDP_00065] Invalid length of DCA_REM_DP_DCFG error

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈If the field (DCA_REM_DP_DCFG) does not have the length (DCA_REM_DP_DCFG_LEN), the VDP-CM Remote shall respond with an error message with protocol error code (PEC) = 3, i.e. invalid number of bytes error.

In this case, the VDP-CM Remote must not respond with a control message response.⌋

[FO_PRS_VDP_00127] Invalid length DCA_REM_DP_DCFG

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈In case the (DCA_REM_DP_DCFG) has the wrong length, the corresponding (VDP_SLOT_ID) with (EC) = 0x04 shall be responded.⌋

[FO_PRS_VDP_00128] Duplicated DCA_REM_DP_DCFG

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈In case the (DCA_REM_DP_DCFG) belonging to (VDP_SLOT_ID) = n is a duplicate of another (DCA_REM_DP_DCFG) with a different (VDP_SLOT_ID)$\neq$ n, the corresponding (VDP_SLOT_ID) = n with (EC) = 0x05 shall be responded.

This holds as well for (DCA_REM_DP_DCFG)s which have been added in a previous add dynamic configuration requests.⌋

[FO_PRS_VDP_00129] Data point limit reached

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈In case the DCA Remote receives an additional (DCA_REM_DP_DCFG) with an add dynamic configuration request but runs out of buffer for dynamic configurations of data points, the corresponding (VDP_SLOT_ID) with (EC) = 0x06 shall be responded.⌋

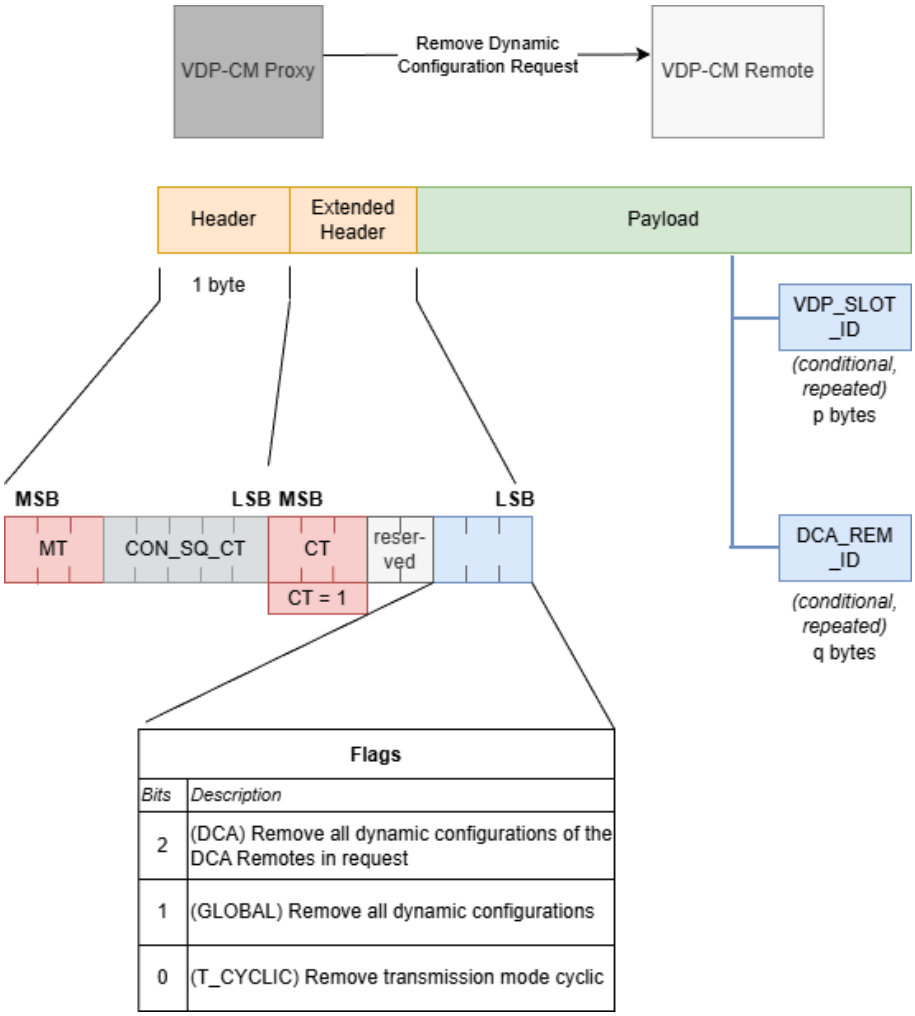
[FO_PRS_VDP_00132] VDP Slot ID already in use

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈In case the add dynamic configuration request contains a (DP_DCFG) with a (VDP_SLOT_ID) which has been used in either this add dynamic configuration request or is already in use in the VDP-CM Remote, the add dynamic configuration response shall contain the affected (VDP_SLOT_ID) with (EC) = 0x79.⌋

6.3.2 Remove dynamic configuration

The full remove dynamic configuration request as described in the following requirements is depicted in fig. 6.12.



Flags	
Bits	*Description*
2	(DCA) Remove all dynamic configurations of the DCA Remotes in request
1	(GLOBAL) Remove all dynamic configurations
0	(T_CYCLIC) Remove transmission mode cyclic

Figure 6.12: Remove dynamic configuration request.

The remove dynamic configuration request is answered with the same response as the add dynamic configuration request, c.f fig. 6.13.

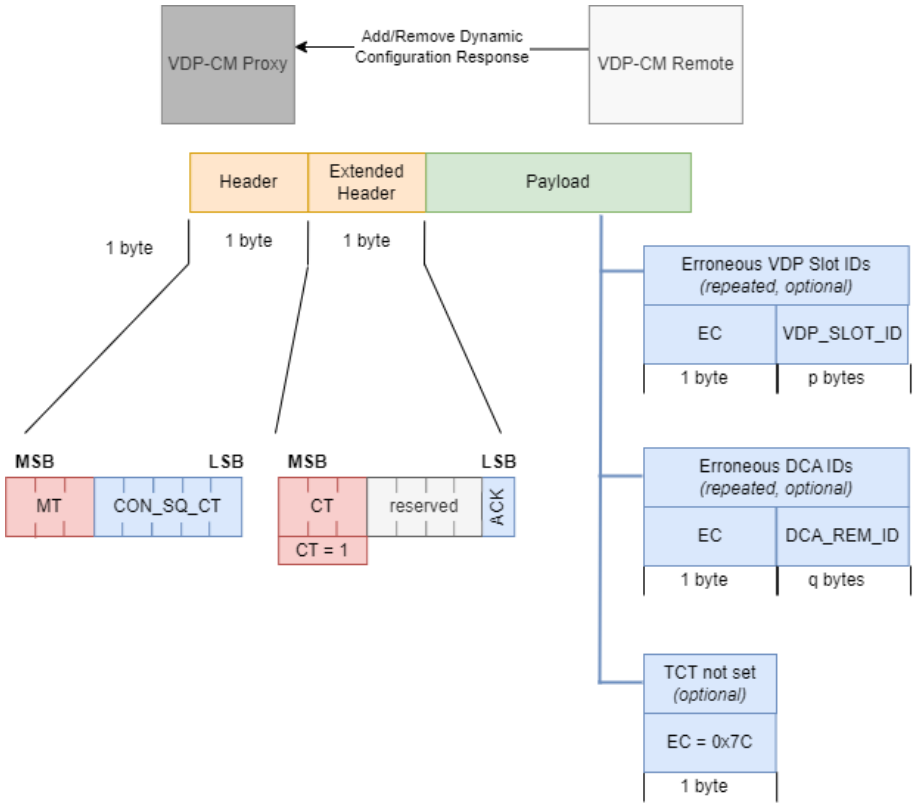


Figure 6.13: Remove dynamic configuration response.

[FO_PRS_VDP_00141] Remove dynamic configuration request header

Upstream requirements: FO_RS_VDP_00002, FO_RS_VDP_00004

⌈The control message extended header for a remove dynamic configuration request shall have one byte length and contain

Bit 7-5: (CT) = 1 Command type: remove dynamic configuration,

Bit 4-3: Reserved,

Bit 2: (DCA_REM),

Bit 1: (GLOBAL), and

Bit 0: (T_CYCLIC) Transmission mode cyclic.

⌋

[FO_PRS_VDP_00038] Remove cyclic transmission settings

Upstream requirements: FO_RS_VDP_00002

⌈When the flag (T_CYCLIC) in a remove dynamic configuration request is set, the VDP-CM Remote shall stop the cyclic transmission of data messages.

In case no cyclic transmission was set previously with an add dynamic configuration request, the VDP-CM Remote shall respond with error code (EC) = 0x7C, transmission cycle time not set.⌋

[FO_PRS_VDP_00140] Remove dynamic configuration incorrect number of bytes

Upstream requirements: FO_RS_VDP_00002

⌈When neither (T_CYCLIC), (GLOBAL), nor (DCA_REM) are set to '1' and the payload of the remove dynamic configuration request is empty, the VDP-CM Remote shall respond with an error message with (PEC) = 3, incorrect number of bytes.⌋

6.3.2.1 Remove all

A remove dynamic configuration request can conveniently remove all dynamic configurations from the VDP-CM Remote and attached DCA Remotes. This is encoded in bit 1 of the VDP extended header for the remove dynamic configuration request, i.e. the flag (GLOBAL).

[FO_PRS_VDP_00026] Global null configuration

Upstream requirements: FO_RS_VDP_00002

⌈When the flag (GLOBAL) is set to '1' the VDP-CM Remote shall remove all data point dynamic configurations and the transmission cyclic time (TCT) from the remote ECU.⌋

[FO_PRS_VDP_00037] Global null configuration payload length

Upstream requirements: FO_RS_VDP_00002

⌈When the flag (GLOBAL) is set to '1' the payload of the remove dynamic configuration request shall be empty.

If the request contains a payload, the VDP-CM Remote shall respond with an error message with (PEC) = 3, incorrect number of bytes.⌋

[FO_PRS_VDP_00139] Global null configuration invalid options

Upstream requirements: FO_RS_VDP_00002

⌈When the flag (GLOBAL) is set to '1', (TCYCLIC) and (DCA_REM) of the extended header must be set to '0'. Otherwise, the VDP-CM Remote shall respond with an error message with (PEC) = 5, invalid options.⌋

6.3.2.2 Remove per DCA

[FO_PRS_VDP_00032] DCA Remote null configuration

Upstream requirements: FO_RS_VDP_00002

⌈When the flag (DCA_REM) in a remove dynamic configuration request is set to '1' the payload must contain (DCA_REM_ID)s.

If the request does not contain a payload, the VDP-CM Remote shall respond with an error message with (PEC) = 3, incorrect number of bytes.⌋

[FO_PRS_VDP_00069] DCA Remote null configuration execution

Upstream requirements: FO_RS_VDP_00002

⌈When the flag (DCA_REM) in a remove dynamic configuration request, the VDP-CM Remote shall remove all dynamic data point configurations for the DCA Remotes specified by the (DCA_REM_ID)s in the payload of the remove dynamic configuration request.⌋

6.3.2.3 Remove per data point

[FO_PRS_VDP_00142] Remove VDP Slot ID

Upstream requirements: FO_RS_VDP_00002

⌈When the flags (DCA_REM) and (GLOBAL) are set to '0', the remove dynamic configuration request payload contains repeatedly (VDP_SLOT_ID)s in DDLE[UINT].

The VDP-CM Remote shall then remove all data point dynamic configurations which are identified by the (VDP_SLOT_ID)s in the payload.⌋

The requirements [FO_PRS_VDP_00142] and [FO_PRS_VDP_00038] allow explicitly for (VDP_SLOT_ID)s to be removed in the same request as a (TCT) and a (TCT) to be removed independently of any data point.

[FO_PRS_VDP_00143] Remove VDP Slot ID - no payload

Upstream requirements: FO_RS_VDP_00002

⌈When the flags (DCA_REM) and (GLOBAL) are set to '0' and the remove dynamic configuration request payload is empty, the VDP-CM Remote shall respond with an error message with (PEC) = 3, incorrect number of bytes.⌋

In consequence of [FO_PRS_VDP_00135] the VDP-CM Remote shall send a not-acknowledge when (VDP_SLOT_ID)s which are not known in the Remote ECU are required to be removed. However, effectively, this does not require further error handling at the requestors side.

6.3.3 Add/remove dynamic configuration response

[FO_PRS_VDP_00066] Add dynamic configuration response error codes

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈The following error codes from [FO_PRS_VDP_00005] shall be used in the add dynamic configuration response. Other error codes must not be used.

0x00 [FO_PRS_VDP_00018] Generic DCA Remote error

0x04 [FO_PRS_VDP_00127] Invalid length DCA_REM_DP_DCFG

0x05 [FO_PRS_VDP_00128] Duplicated DCA_REM_DP_DCFG

0x06 [FO_PRS_VDP_00129] Data point limit reached

0x07 [FO_PRS_VDP_00062] Sampling mode cyclic is not supported

0x08 [FO_PRS_VDP_00058] Sampling mode on-change is not supported

0x40 - 0x6F Implementation specific

0x70 [FO_PRS_VDP_00019] Generic VDP-CM Remote error

0x76 [FO_PRS_VDP_00130] DCA Remote ID unknown

0x77 [FO_PRS_VDP_00131] VDP Slot ID out of range

0x78 [FO_PRS_VDP_00052] Persistency storage limit reached

0x79 [FO_PRS_VDP_00132] VDP Slot ID already in use

0x7A [FO_PRS_VDP_00133] DCA Remote inconsistency error

0x7B [FO_PRS_VDP_00046] Secured channel not supported

0x7C [FO_PRS_VDP_00145] [FO_PRS_VDP_00038] Transmission cycle time already in use/ not set

0x7D [FO_PRS_VDP_00136] VDP Slot ID reserved

0xB0 - 0xFF Implementation specific

⌋

[FO_PRS_VDP_00144] Remove dynamic configuration response error codes

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈The following error codes from [FO_PRS_VDP_00005] shall be used in the remove dynamic configuration response. Other error codes must not be used.

0x00 [FO_PRS_VDP_00018] Generic DCA Remote error

0x40 - 0x6F Implementation specific

0x70 [FO_PRS_VDP_00019] Generic VDP-CM Remote error

0x75 [FO_PRS_VDP_00135] VDP Slot ID unknown

0x76 [FO_PRS_VDP_00130] DCA Remote ID unknown

0x77 [FO_PRS_VDP_00131] VDP Slot ID out of range

0x7A [FO_PRS_VDP_00133] DCA Remote inconsistency error

0x7D [FO_PRS_VDP_00136] VDP Slot ID reserved

0xB0 - 0xFF Implementation specific

⌋

[FO_PRS_VDP_00130] DCA Remote ID unknown

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00002

⌈In case the add dynamic configuration request contains a (DCA_REM_DCFG) with a (DCA_REM_ID) which is not known by the VDP-CM Remote, the add dynamic configuration response shall contain in the payload all affected (DCA_REM_ID)s with (EC) = 0x76 each.⌋

6.3.4 Activation

The activation request can activate or deactivate the sampling of data points. The message is designed in a way that it can either activate a set of data points or deactivate a set of data points but can not activate one set and deactivate another set. The request is illustrated in fig. 6.14.

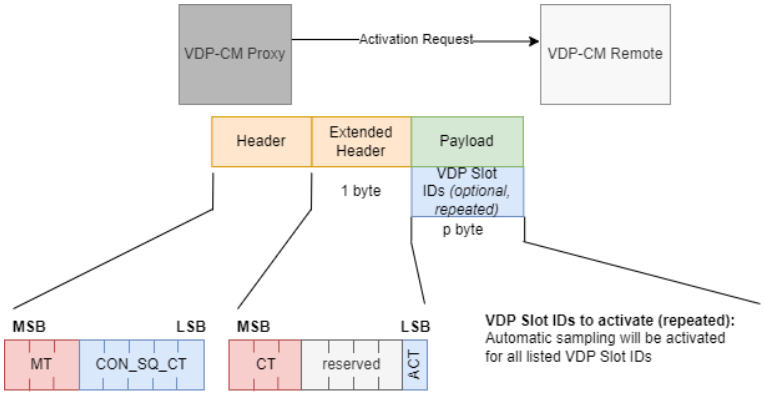


Figure 6.14: Activation request.

The VDP-CM Remote answers to a valid activation request with an activation response (c.f. fig. 6.15).

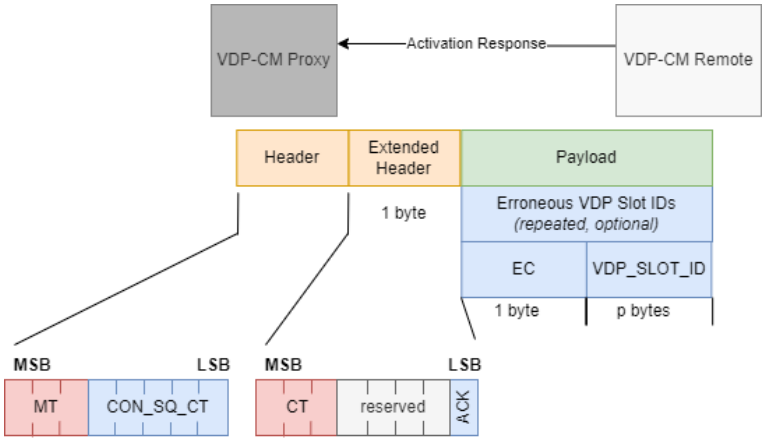


Figure 6.15: Activation response.

[FO_PRS_VDP_00067] Activation request service specific flags

Upstream requirements: FO_RS_VDP_00006

⌈For an activation request, i.e., (CT) = 2, the five command specific flags (ADD_EXT) of the extended header shall contain the following fields

Bit 4-1: Reserved

Bit 0: (ACT) Activation/Deactivation flag

⌋

[FO_PRS_VDP_00068] Activation/deactivation flag

Upstream requirements: FO_RS_VDP_00006

⌈The flag (ACT) from the activation request shall be set to

0: to indicate that it shall deactivate the sampling, or

1: to indicate that it shall activate the sampling.

⌋

[FO_PRS_VDP_00070] No VDP Slot ID given in the activation request payload

Upstream requirements: FO_RS_VDP_00006, FO_RS_VDP_00010

⌈In case the payload of an activation request is empty, i.e. no VDP Slot ID appended, the VDP-CM Remote shall respond with an error message with (PEC) = 3, incorrect number of bytes.⌋

[FO_PRS_VDP_00071] Activation request handling - activation

Upstream requirements: FO_RS_VDP_00006

⌈Upon reception of an activation request with (ACT) = 1, the VDP-CM Remote shall activate the sampling the data points corresponding to the VDP Slot IDs given in the payload at the according DCA Remotes.⌋

[FO_PRS_VDP_00072] Activation request handling - deactivations

Upstream requirements: FO_RS_VDP_00006

⌈Upon reception of an activation request with (ACT) = 0, the VDP-CM Remote shall deactivate the sampling the data points corresponding to the VDP Slot IDs given in the payload at the according DCA Remotes.⌋

[FO_PRS_VDP_00073] Activation request handling - ignore duplicated VDP Slot ID

Upstream requirements: FO_RS_VDP_00006

⌈When an activation request with (ACT) = 0 or (ACT) = 1 is received with a payload which contains one VDP Slot ID multiply, the VDP-CM Remote shall ignore the duplicated ID and may not send an error.⌋

[FO_PRS_VDP_00074] Activation request handling - partially erroneous request

Upstream requirements: FO_RS_VDP_00006, FO_RS_VDP_00010

⌈When an activation request with (ACT) = 0 or (ACT) = 1 is received and the activation or deactivation of specific VDP Slot ID can not be executed, all other activations or deactivations of VDP Slot IDs shall be performed anyways by the VDP-CM Remote .⌋

[FO_PRS_VDP_00075] Activation response

Upstream requirements: FO_RS_VDP_00006

⌈The VDP-CM Remote shall respond with an activation response when receiving a valid activation request.⌋

[FO_PRS_VDP_00076] Activation response header

Upstream requirements: FO_RS_VDP_00006

⌈The service specific bit of the activation response header is reserved.⌋

[FO_PRS_VDP_00077] Activation response acknowledge

Upstream requirements: FO_RS_VDP_00006

⌈In case, the sampling of all VDP Slot IDs listed in the request was (de)activated successfully, the activation response shall contain (ACK) = 1.⌋

[FO_PRS_VDP_00078] Activation response acknowledge payload

Upstream requirements: FO_RS_VDP_00006

⌈When the (ACK) bit of the activation response header is set to 1 (i.e. the request was acknowledged) the payload shall be empty.⌋

[FO_PRS_VDP_00079] Activation response not-acknowledge payload

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00006

⌈In case, the sampling of some VDP Slot IDs listed in the request could not be (de)activated successfully, the activation response shall contain (ACK) = 0.⌋

[FO_PRS_VDP_00080] Activation response error codes

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00006

⌈The following error codes according to [FO_PRS_VDP_00005] shall be used in activation responses. Other error codes must not be used.

0x00 [FO_PRS_VDP_00018]

0x40 - 0x6F Implementation specific

0x70 [FO_PRS_VDP_00019]

0x75 [FO_PRS_VDP_00135]

0x77 [FO_PRS_VDP_00131]

0x7A [FO_PRS_VDP_00133]

0x7D [FO_PRS_VDP_00136]

0xB0 - 0xFF Implementation specific

⌋

6.3.5 Trigger

The following requirements describe the trigger message. For a better understanding of the following requirements the trigger request is depicted in figure 6.16.

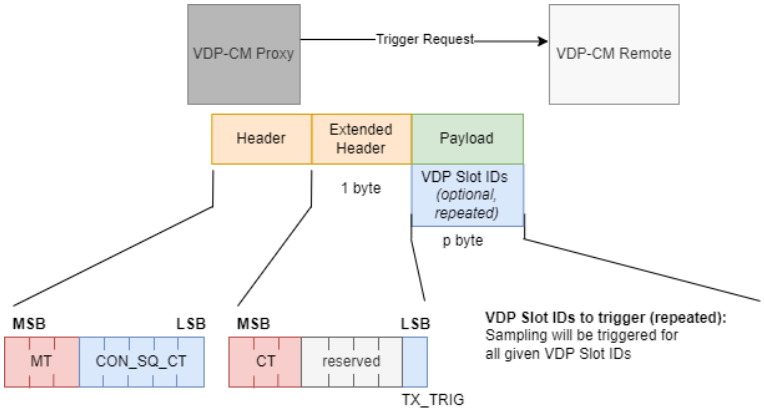


Figure 6.16: Trigger request.

The VDP-CM Remote answers to a correctly serialized trigger request with an trigger response (c.f. fig. 6.15).

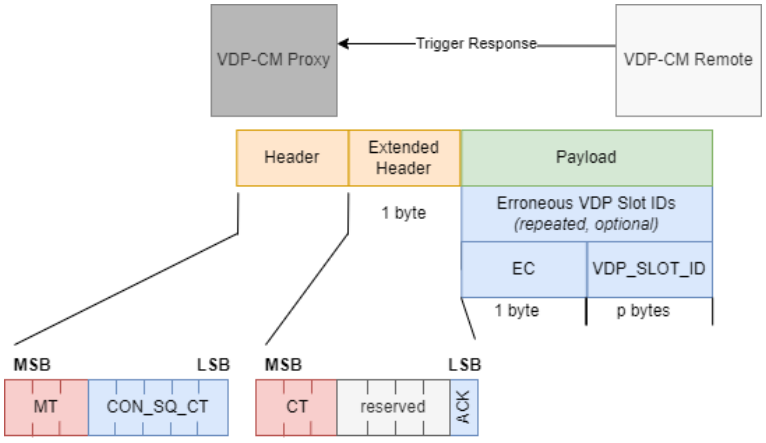


Figure 6.17: Trigger response.

[FO_PRS_VDP_00081] Trigger request header flags

Upstream requirements: FO_RS_VDP_00003

⌈The command specific flags (ADD_EXT) of the trigger request shall be set as follows

Bit 4-1: Reserved

Bit 0: (TX_TRIG) Transmission Trigger

⌋

[FO_PRS_VDP_00082] Transmission trigger

Upstream requirements: FO_RS_VDP_00003

⌈In case th field (TX_TRIG) of the trigger request is set to 1, the VDP-CM Remote shall transmit the data point samples which have been buffered currently in a data message to the VDP-CM Proxy as soon as possible.⌋

As soon as possible refers to the next point in time where the VDP-CM Remote can and is allowed to transmit data, i.e.according to the configuration parameter (MTDT), c.f. chapter 7, and according to the involved main function periods in case of an AUTOSAR Classic Platform implementation.

[FO_PRS_VDP_00083] Trigger request payload

Upstream requirements: FO_RS_VDP_00003

⌈The trigger request payload shall be conditional, i.e. mandatory when (TX_TRIG) = 0 and optional when (TX_TRIG) = 1, and shall contain repeated VDP Slot IDs of type uint8.⌋

[FO_PRS_VDP_00084] Trigger request - ignore duplicated VDP Slot IDs

Upstream requirements: FO_RS_VDP_00003

⌈In case the trigger request payload contains the same VDP Slot ID multiple times, the VDP-CM Remote shall ignore this and must not report an error.⌋

[FO_PRS_VDP_00085] Trigger sampling

Upstream requirements: FO_RS_VDP_00003

⌈The VDP-CM Remote shall trigger the sampling of the VDP Slot IDs given in a trigger request at the corresponding DCA Remotes.⌋

In case, the flag (TX_TRIG) is set to 1 and VDP Slot IDs are given in the payload, the data point samples acquired due to the sampling trigger must not necessarily be contained in the transmitted data message. It is valid behavior of the VDP-CM Remote, if the new samples are then contained in the subsequent data messages. This is elucidated further in the sequences in subsection 6.4.4.

[FO_PRS_VDP_00086] Trigger response

Upstream requirements: FO_RS_VDP_00003

⌈The VDP-CM Remote shall respond to a correctly serialized trigger request with a trigger response.⌋

[FO_PRS_VDP_00087] Trigger response header

Upstream requirements: FO_RS_VDP_00003

⌈The VDP-CM Remote shall set the field (ACK) of the trigger response to 1 (Acknowledge) if all trigger actions were successfully executed. To be precise, this means that an (ACK) may only be sent if either (or both)

- for (TX_TRIG) = 1 the transmission was triggered successfully, or
- for the payload was not empty, it means that the sampling of all contained VDP Slot IDs was successfully triggered.

Otherwise, the request must be answered with (ACK) = 0.⌋

[FO_PRS_VDP_00119] Trigger response before data message

Upstream requirements: FO_RS_VDP_00003

⌈In case (TX_TRIG) = 1 was set, the trigger response shall be sent before the data message is sent.⌋

[FO_PRS_VDP_00088] No trigger error

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00003

⌈In case (TX_TRIG) = 0 and the trigger request payload was empty, the VDP-CM Remote shall send an error message with protocol error type (PEC) = 3 *(Incorrect Number of Bytes Error)*.⌋

[FO_PRS_VDP_00089] Trigger response acknowledge payload

Upstream requirements: FO_RS_VDP_00003

⌈The trigger response shall not contain any payload if in the trigger response header (ACK) = 1.⌋

[FO_PRS_VDP_00090] Trigger response error codes

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00003

⌈The following error codes of the list provided in [FO_PRS_VDP_00005] shall be used in the trigger response.

0x00 [FO_PRS_VDP_00018]

0x02 [FO_PRS_VDP_00134]

0x40 - 0x6F Implementation specific

0x70 [FO_PRS_VDP_00019]

0x75 [FO_PRS_VDP_00135]

0x77 [FO_PRS_VDP_00131]

0x7A [FO_PRS_VDP_00133]

0x7D [FO_PRS_VDP_00136]

0xB0 - 0xFF Implementation specific

Other error codes must not be used.⌋

[FO_PRS_VDP_00134] Triggering failed

Upstream requirements: FO_RS_VDP_00010, FO_RS_VDP_00003

⌈In case the sampling of a data point, which was requested in the trigger request with a fixed (VDP_SLOT_ID), could not be triggered, the trigger response shall contain this (VDP_SLOT_ID) with (EC) = 0x02.⌋

6.4 Sequences

In the following subsections, the control messages are illustrated in different flows including the expected outcome.

6.4.1 Adding data point dynamic configurations to one DCA

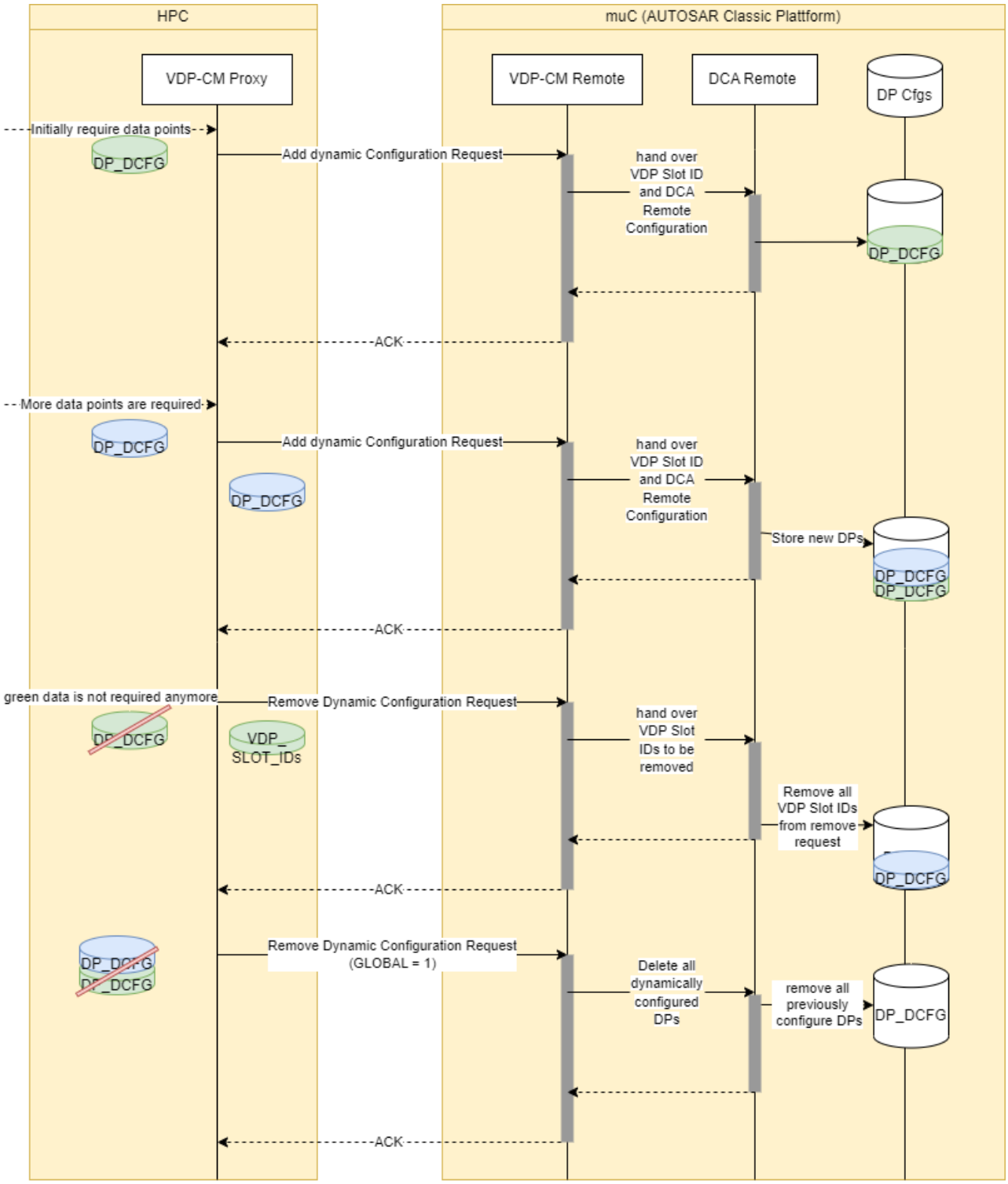


Figure 6.18: Adding additional data point configurations (blue) after issuing a data point dynamic configuration of a set of data point configurations (green). In the lower part, (DP_DCFG)s are removed from from the remote ECU.

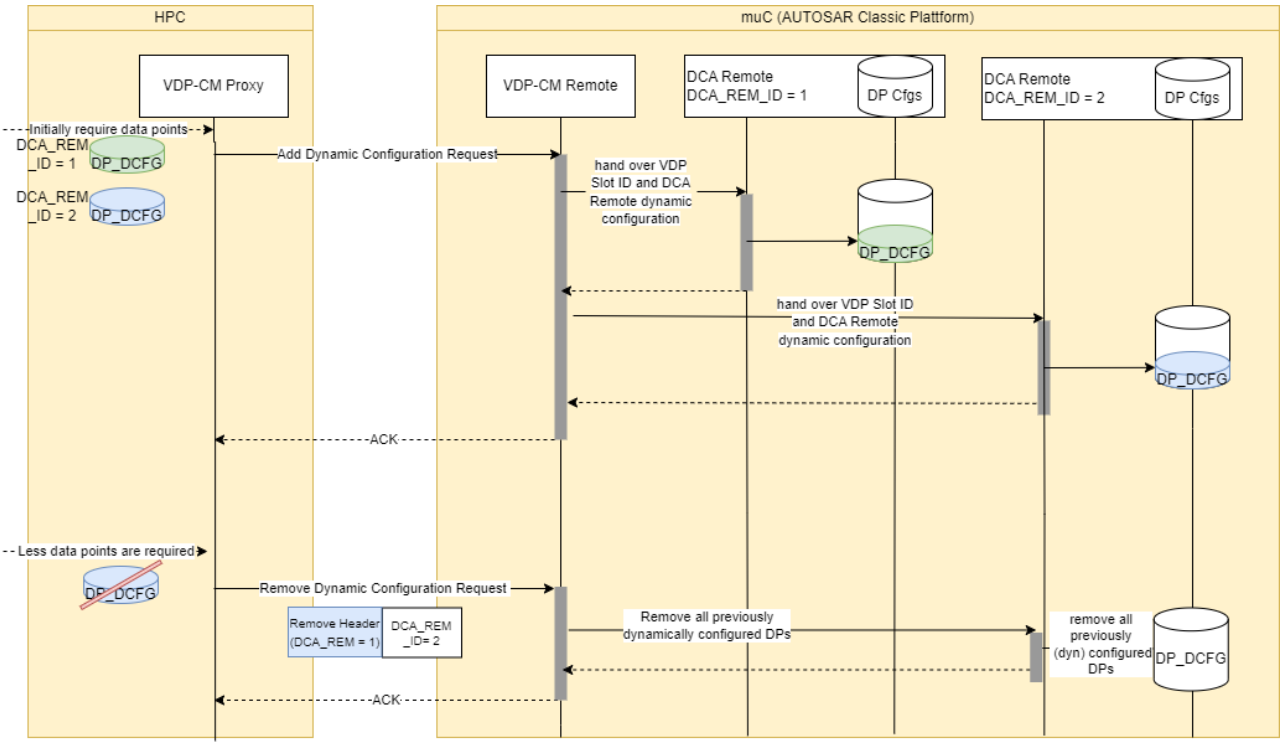


Figure 6.19: Adding (DP_DCFG)s to two DCAs and then removing the (DP_DCFG)s from one DCA.

6.4.2 Sampling mode cyclic

When (SCYCLIC) = 1 and (SCT) is set, the data points are sampled from the data resource by the DCA Remote independently of the incoming VDP control messages. In fig. 6.20, this is illustrated. Furthermore, in the same figure, the effect of the activation request with (ACT) = 0 is shown. After receiving this request, the automatic cyclic sampling is not performed anymore by the DCA Remote.

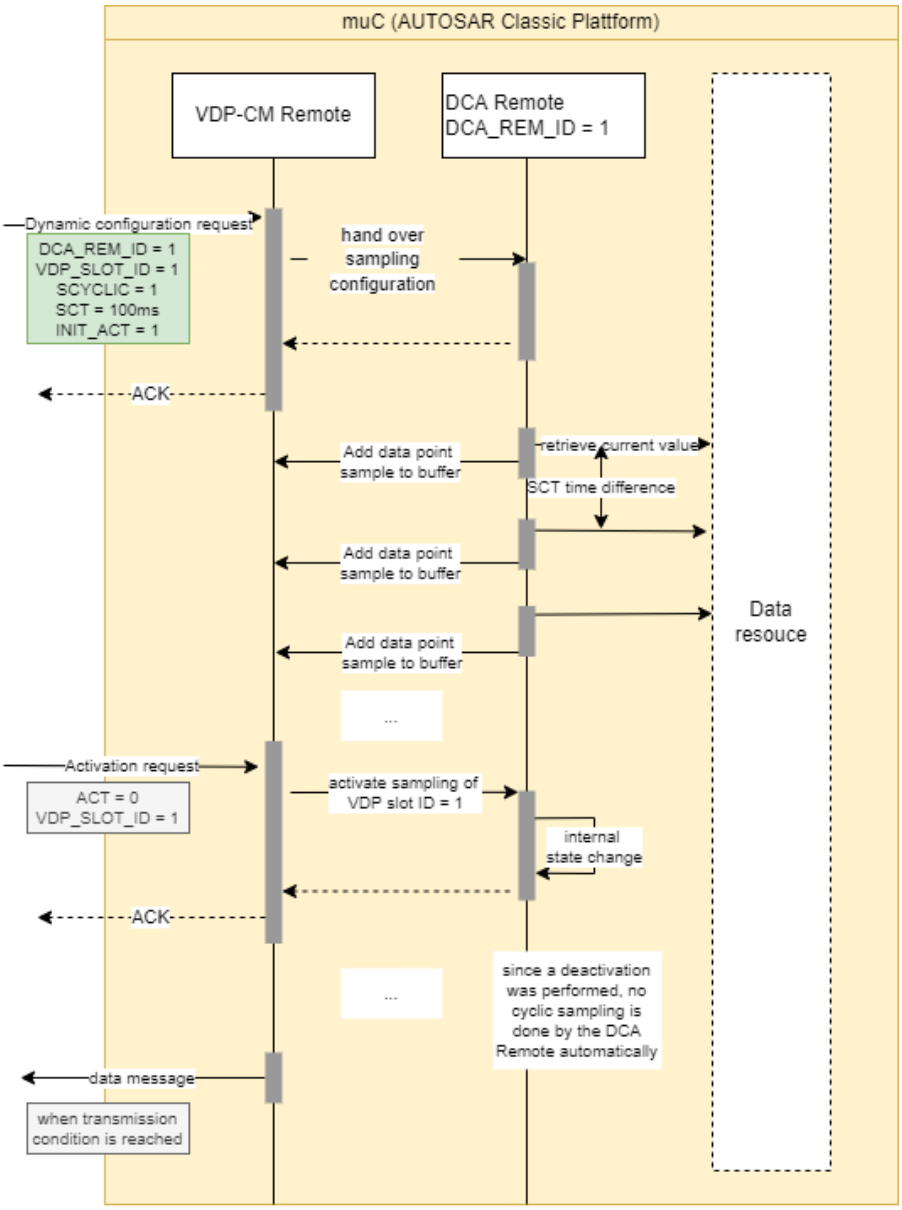


Figure 6.20: Cyclic sampling mode in combination with the initial activation state being on. The automatic sampling is activated directly after reception of the add dynamic configuration request and deactivated after the reception of a (de)activation request.

Vice versa, when the add dynamic configuration request has set (INIT_ACT) = 0, then the cyclic sampling is deactivated in the beginning and the DCA Remote does not perform regular sampling until an activation request with (ACT) = 1 with the corresponding VDP Slot ID is received (c.f. fig. 6.21).

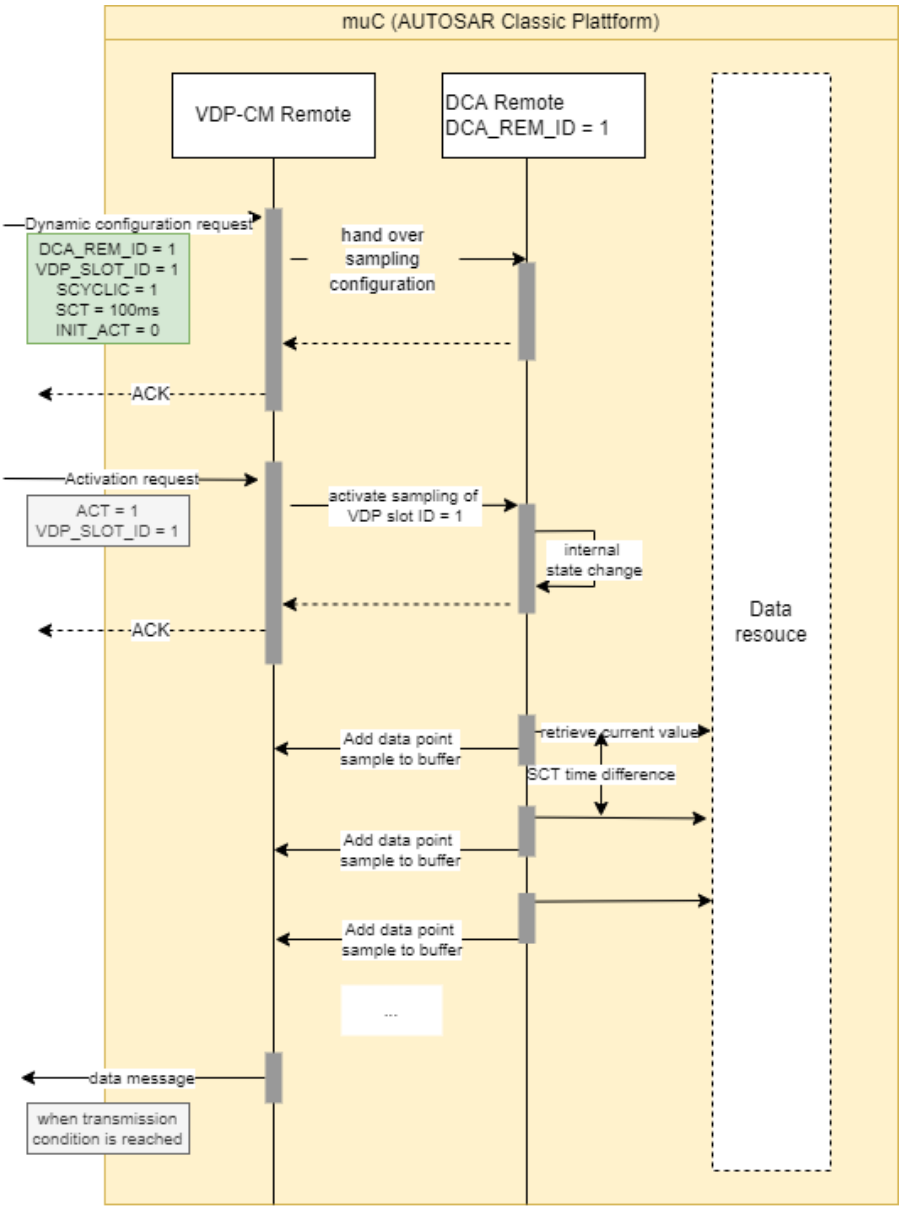


Figure 6.21: Cyclic sampling mode in combination with the initial activation state being off. The automatic sampling is started only after the reception of an activation request.

6.4.3 Sampling mode on request

In case both, (SCYCLIC) and (SCHANGE), are set to ’0’, no automatic sampling of the data point is performed by the DCA Remote independently of the activation state. The data point is sampled only when a trigger request with the corresponding VDP Slot ID is received. See fig. 6.22 for illustration.

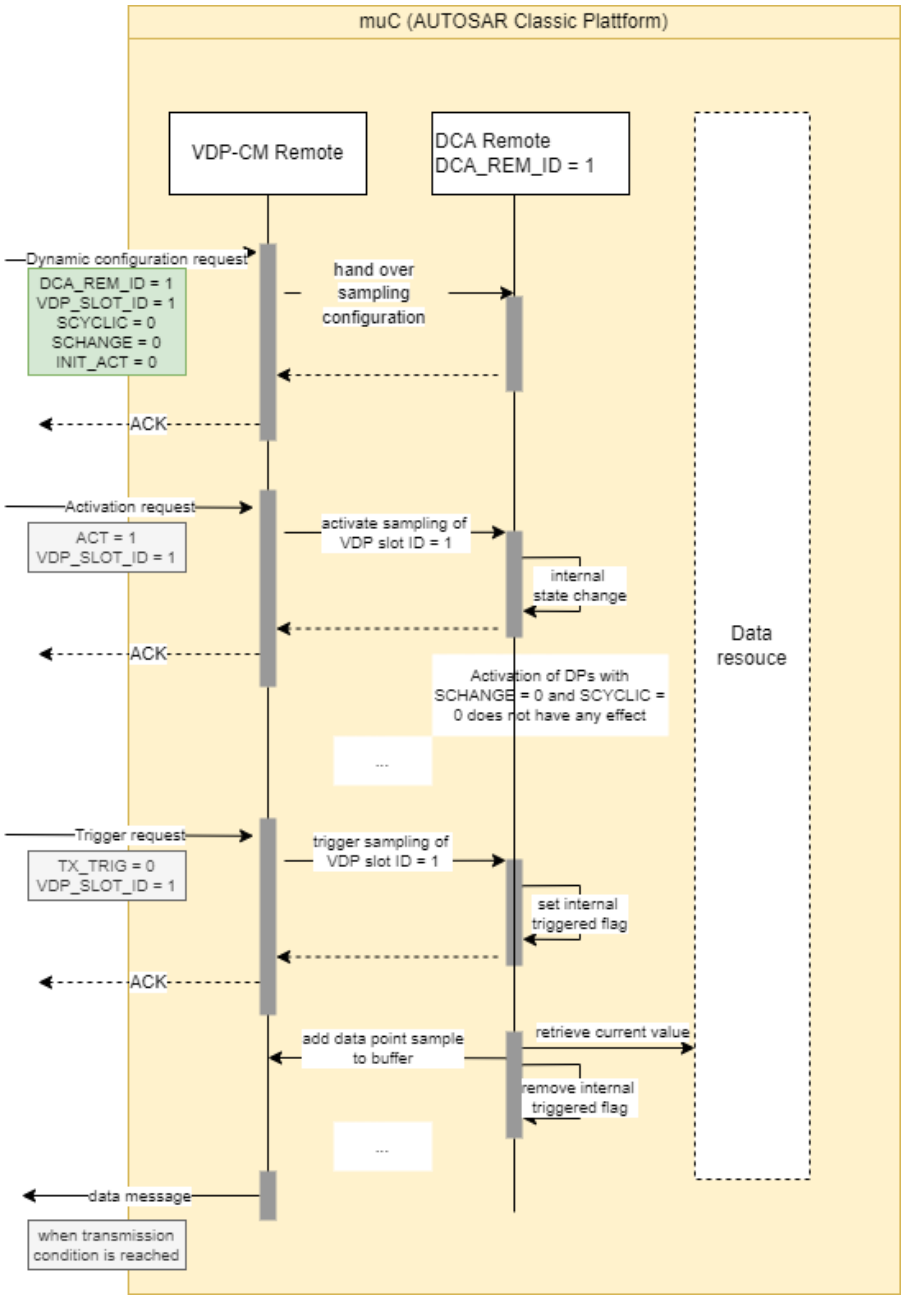


Figure 6.22: Sampling mode on-request in terms of the VDP protocol.

6.4.4 Transmission and sampling on request

In case a trigger request contains both, a transmission trigger and a sampling trigger, VDP does not require to have the data point samples acquired due to the trigger request in the data message which was triggered to be transmitted. This would be infeasible especially in the case, when the data point samples which were collected on trigger exceed the available buffer size in the remote ECU. Hence, allowing the remote ECU to split this in multiple data messages reduces the failure probability.

Exemplarily, two scenarios are depicted in fig. 6.23 and fig. 6.24.

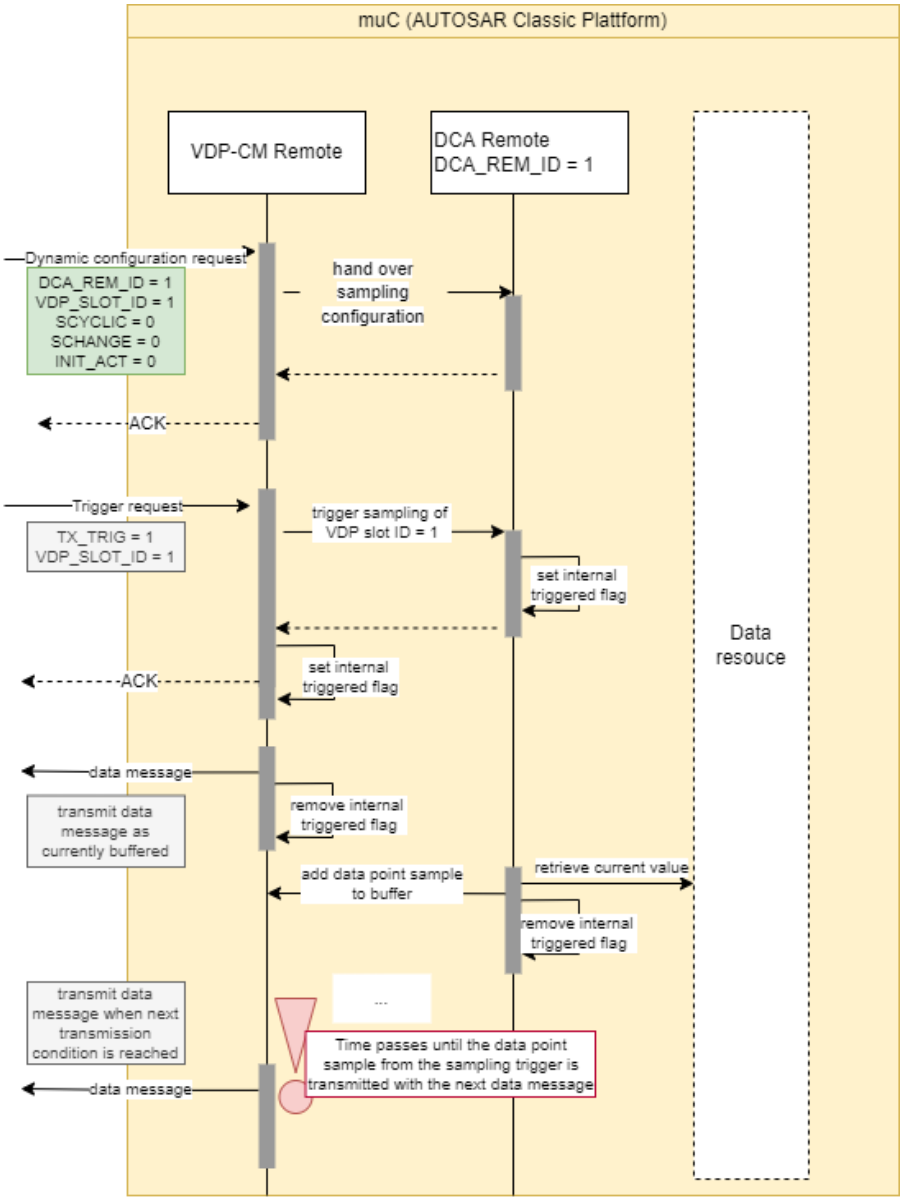


Figure 6.23: One allowed sequence of transmission trigger execution and sampling trigger execution. Here, transmission of the data message is executed before the sampling of the data point.

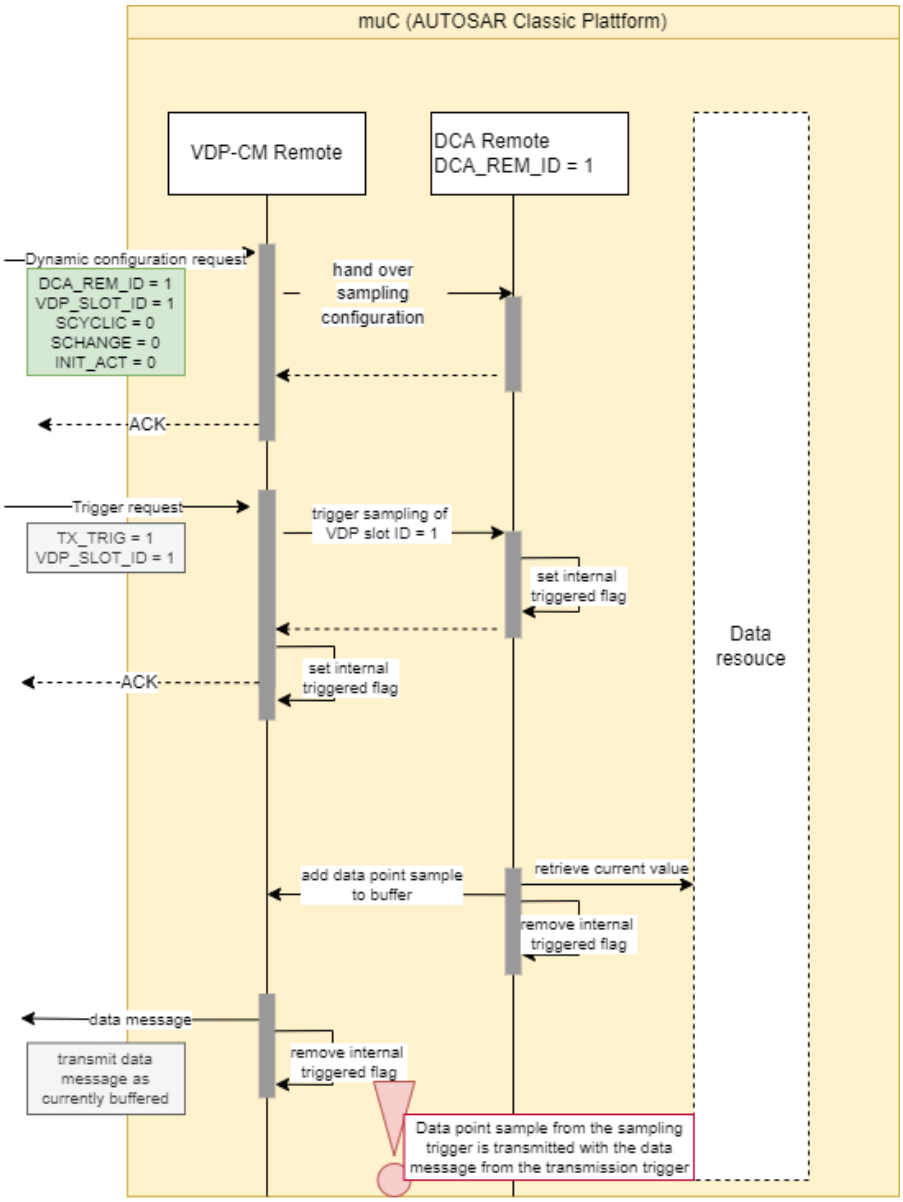


Figure 6.24: Another allowed sequence of transmission trigger execution and sampling trigger execution. Here, transmission of the data message is executed after the sampling of the data point.

6.4.5 Transmission on sampling

In case a (DP_DCFG) has configured (TX_MODE_ON_SAMPLING), the data message shall be sent from the remote ECU as soon as possible after the corresponding data point sample was acquired by the DCA remote as illustrated in fig. 6.25.

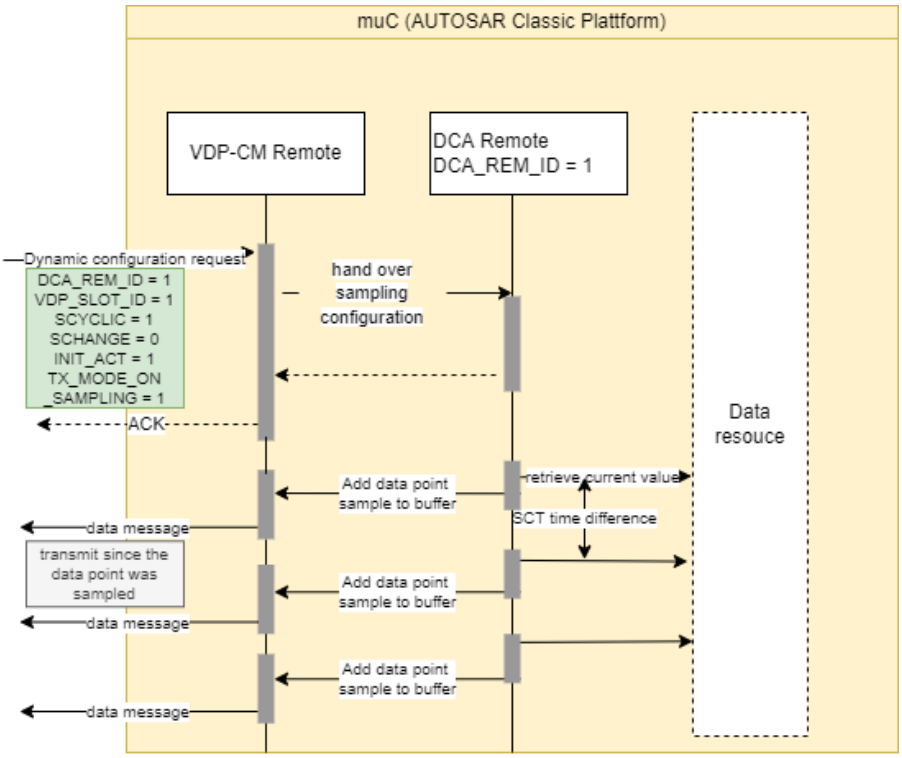


Figure 6.25: Transmission on sampling dynamic configuration and execution.

6.4.6 Transmission on request

In case a Trigger request with (TX_TRIG) = 1 is given, the VDP-CM Remote shall send all previously acquired data point samples in a data message to the HPC, the remote ECUs behavior is depicted in figure 6.26.

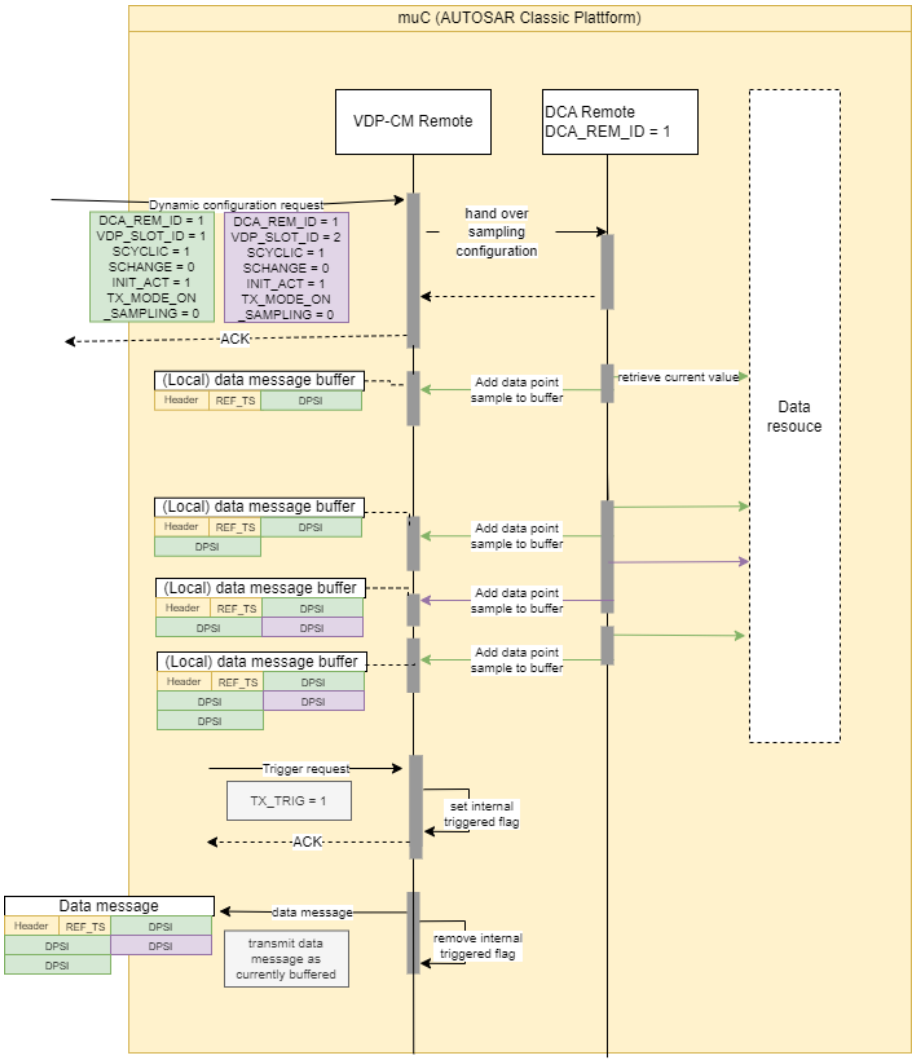


Figure 6.26: Transmission on request when no sampling is requested and five data point samples have been acquired previously.

6.5 Error messages

In case an incorrectly serialized control message request is sent, the remote ECU does not answer with a not-acknowledge but with an error message explicitely indicating the error which occured.

The error message is depiced in fig. 6.27.

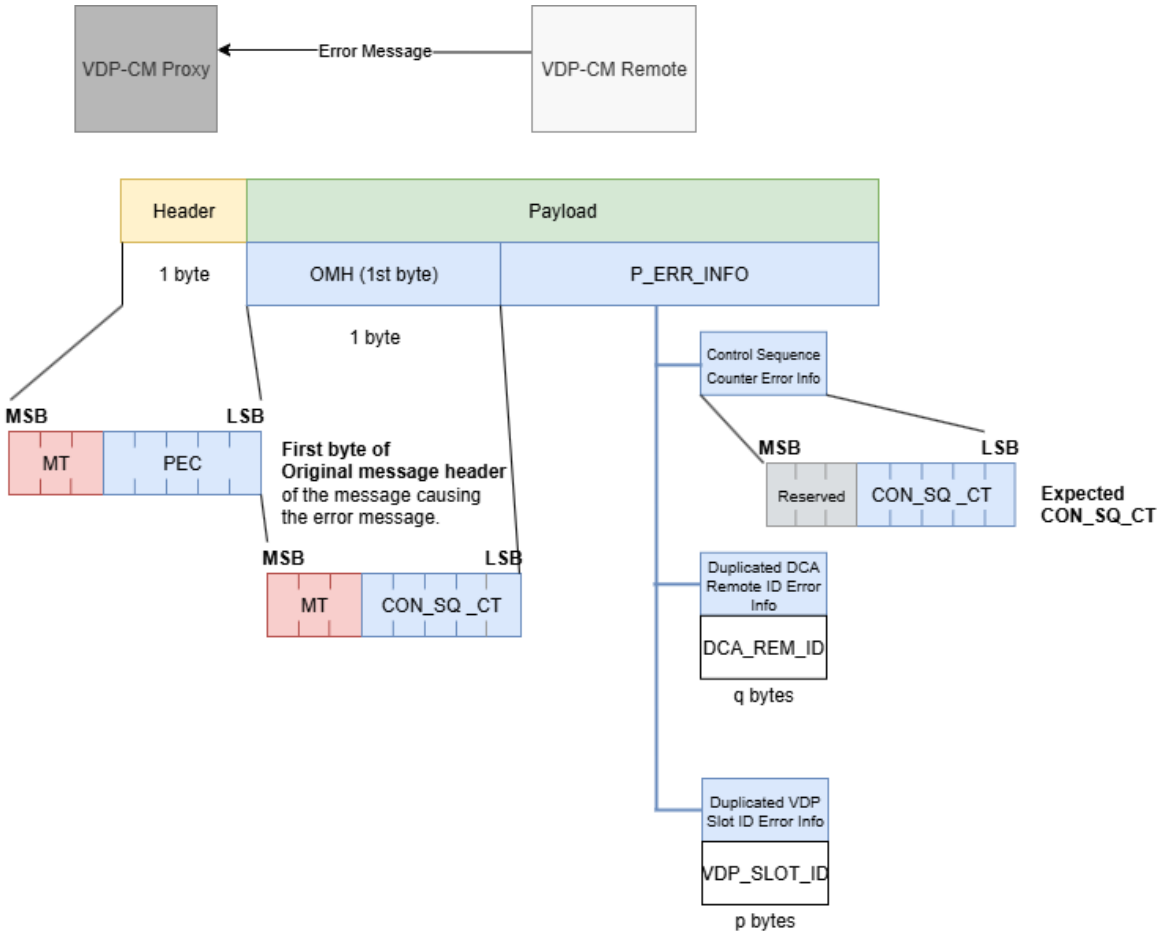


Figure 6.27: Error message.

[FO_PRS_VDP_00120] Error message

Upstream requirements: FO_RS_VDP_00010

⌈VDP shall support the error message with (MT) = 3. For this message, the field (ADD) shall contain the protocol error code (PEC) as specified in [FO_PRS_VDP_00006].⌋

[FO_PRS_VDP_00121] ErrorMessagePayload

Upstream requirements: FO_RS_VDP_00010

⌈The error message payload shall contain

Byte 0: (OMH) Original message header (first byte only, no extended header bytes)

Byte 1 - n: (P_ERR_INFO) Additional protocol error information (optional)

⌋

[FO_PRS_VDP_00122] Original message header (OMH)

Upstream requirements: FO_RS_VDP_00010

⌈When a control message request shall be responded to with a error message instead of a control message response, the header of this request shall be repeated in (OMH).⌋

[FO_PRS_VDP_00123] Error info unexpected control sequence counter

Upstream requirements: FO_RS_VDP_00010

⌈The field (P_ERR_INFO) for (PEC) = 0 shall be of 1 byte length and shall contain

Bit 7-5: Reserved , and

Bit 4-0: The expected (CON_SQ_CT) .

⌋

[FO_PRS_VDP_00125] Error info duplicated VDP Slot ID

Upstream requirements: FO_RS_VDP_00010

⌈The field (P_ERR_INFO) for (PEC) = 2 shall contain the duplicated VDP Slot ID in DDLE[UINT].⌋

[FO_PRS_VDP_00126] ErrorInfoOther

Upstream requirements: FO_RS_VDP_00010

⌈In case that (PEC)=1 or (PEC) > 2, (P_ERR_INFO) shall be empty.⌋

7 Configuration parameters

Parameter Name	Parameter Abbreviation	Description
Minimum Transmission Distance Time	(MTDT)	The minimum time which has to pass between two data messages transmitted by the VDP-CM Remote. Aim: Prevent (accidental) bus-flooding by VDP data messages.
Minimum Sampling Distance Time	(MTST)	The minimum time which has to pass between two data point samples acquired by the DCA Remote. Aim: Prevent (accidental) blocking of the CPU due to data sampling.

Table 7.1: Configuration parameters of the VDP-CM Remote and the DCA Remotes

8 Protocol usage and guidelines

We refer the reader to section 6.4 for control sequences of data collection tasks performed using VDP. Here, it is worth noting, that the assumption of implementation here is that the conceptual split between sampling and transmission is not only reflected in the protocol itself but also in the architectural split of the implementation on the remote ECU. This means in particular that

- the **VDP-CM Remote** is implementing the protocol and handling the **transmission modes**, and that
- the **DCA Remotes** are not implementing the protocol but only the **sampling modes**. This means in particular, as also illustrated in 6.4, that the DCA Remotes hold all sampling relevant information and execute the assignment of sampling independent of the VDP-CM Remote.

A Change history of AUTOSAR traceable items

A.1 Traceable item history of this document according to AUTOSAR Release R26-11

A.1.1 Added Specification Items in R26-11

none

A.1.2 Changed Specification Items in R26-11

Number	Heading
[FO_PRS_VDP_00004]	VDP relative timestamp
[FO_PRS_VDP_00023]	Protocol version response payload
[FO_PRS_VDP_00063]	Encoding of DCA_REM_DP_DCFG_LEN
[FO_PRS_VDP_00092]	Data message header
[FO_PRS_VDP_00093]	Sequence counter initialization
[FO_PRS_VDP_00094]	Sequence counter increment
[FO_PRS_VDP_00095]	Sequence counter wrap around
[FO_PRS_VDP_00101]	Relative timestamp
[FO_PRS_VDP_00103]	Data length maximum length
[FO_PRS_VDP_00105]	Asynchronous error information
[FO_PRS_VDP_00106]	Error information length (ERR_LEN)
[FO_PRS_VDP_00121]	ErrorMessagePayload
[FO_PRS_VDP_00137]	Invalid length of (DP_DCFG)

Table A.1: Changed Specification Items in R26-11

A.1.3 Deleted Specification Items in R26-11

none

A.1.4 Added Constraints in R26-11

none

A.1.5 Changed Constraints in R26-11

none

A.1.6 Deleted Constraints in R26-11

none

A.2 Traceable item history of this document according to AUTOSAR Release R25-11

A.2.1 Added Specification Items in R25-11

Number	Heading
[FO_PRS_VDP_00040]	VDP maximum message size
[FO_PRS_VDP_00136]	VDP Slot ID reserved
[FO_PRS_VDP_00146]	Maximum VDP Slot ID

Table A.2: Added Specification Items in R25-11

A.2.2 Changed Specification Items in R25-11

Number	Heading
[FO_PRS_VDP_00005]	Error codes
[FO_PRS_VDP_00023]	Protocol version response payload
[FO_PRS_VDP_00031]	DCA Remote ID
[FO_PRS_VDP_00036]	VDP Slot ID
[FO_PRS_VDP_00041]	VDP settings

▽

△

Number	Heading
[FO_PRS_VDP_00043]	(SEC) Usage of secured channel bit
[FO_PRS_VDP_00044]	Data transmission without usage of secured channel
[FO_PRS_VDP_00045]	Data transmission without usage of secured channel always supported
[FO_PRS_VDP_00046]	Data transmission with usage of secured channel not supported error
[FO_PRS_VDP_00066]	Add dynamic configuration response error codes
[FO_PRS_VDP_00067]	Activation request service specific flags
[FO_PRS_VDP_00080]	Activation response error codes
[FO_PRS_VDP_00090]	Trigger response error codes
[FO_PRS_VDP_00098]	Data point information
[FO_PRS_VDP_00109]	Generic DCA Remote error
[FO_PRS_VDP_00110]	Data source error
[FO_PRS_VDP_00111]	Data point sampling error
[FO_PRS_VDP_00112]	Data loss error
[FO_PRS_VDP_00113]	Error Code 0x40-0x6F
[FO_PRS_VDP_00131]	VDP Slot ID out of range
[FO_PRS_VDP_00144]	Remove dynamic configuration response error codes

Table A.3: Changed Specification Items in R25-11

A.2.3 Deleted Specification Items in R25-11

none

A.2.4 Added Constraints in R25-11

none

A.2.5 Changed Constraints in R25-11

none

A.2.6 Deleted Constraints in R25-11

Number	Heading
[FO_PRS_VDP_CONSTR_00001]	VDP maximum message size

Table A.4: Deleted Constraints in R25-11

A.3 Traceable item history of this document according to AUTOSAR Release R24-11

A.3.1 Added Specification Items in R24-11

Number	Heading
[FO_PRS_VDP_00001]	Endianness
[FO_PRS_VDP_00002]	Header format
[FO_PRS_VDP_00003]	Dynamic data length encoded uint (DDLE[UINT])
[FO_PRS_VDP_00004]	VDP relative timestamp
[FO_PRS_VDP_00005]	Error codes
[FO_PRS_VDP_00006]	Protocol error codes
[FO_PRS_VDP_00007]	Message types
[FO_PRS_VDP_00008]	Control message request - header field (ADD)
[FO_PRS_VDP_00009]	Control message request - extended header
[FO_PRS_VDP_00010]	Control message sequence counter
[FO_PRS_VDP_00011]	Control message sequence counter initialization

▽

△

Number	Heading
[FO_PRS_VDP_00012]	Control message sequence counter incrementation
[FO_PRS_VDP_00013]	Control message sequence counter wrap around
[FO_PRS_VDP_00014]	The control message sequence counter repeated in the response
[FO_PRS_VDP_00015]	Protocol error code - wrong control message sequence counter
[FO_PRS_VDP_00016]	Acknowledge bit
[FO_PRS_VDP_00017]	Not-acknowledge control message response payload
[FO_PRS_VDP_00018]	Generic DCA Remote error
[FO_PRS_VDP_00019]	Generic VDP-CM Remote error
[FO_PRS_VDP_00020]	Protocol version request header
[FO_PRS_VDP_00021]	Protocol version request
[FO_PRS_VDP_00023]	Protocol version response payload
[FO_PRS_VDP_00024]	Add dynamic configuration request header
[FO_PRS_VDP_00025]	Add dynamic configuration request
[FO_PRS_VDP_00026]	Global null configuration
[FO_PRS_VDP_00027]	Transmission mode cyclic flag
[FO_PRS_VDP_00028]	Extended dynamic configuration request header
[FO_PRS_VDP_00029]	Transmission cycle time (TCT)
[FO_PRS_VDP_00030]	DCA Remote dynamic configuration
[FO_PRS_VDP_00031]	DCA Remote ID
[FO_PRS_VDP_00032]	DCA Remote null configuration
[FO_PRS_VDP_00035]	Data point dynamic configuration
[FO_PRS_VDP_00036]	VDP Slot ID

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Number	Heading
[FO_PRS_VDP_00037]	Global null configuration payload length
[FO_PRS_VDP_00038]	Remove cyclic transmission settings
[FO_PRS_VDP_00039]	VDP Slot ID not unique error
[FO_PRS_VDP_00041]	VDP settings
[FO_PRS_VDP_00042]	Timestamp resolution
[FO_PRS_VDP_00043]	SecOC Flag
[FO_PRS_VDP_00044]	Data transmission without SecOC
[FO_PRS_VDP_00045]	Data transmission without SecOC always supported
[FO_PRS_VDP_00046]	Data transmission with SecOC not supported error
[FO_PRS_VDP_00047]	Control message response - extended header
[FO_PRS_VDP_00048]	Message types
[FO_PRS_VDP_00051]	Persistency of data point dynamic configurations
[FO_PRS_VDP_00052]	Persistency storage limit reached
[FO_PRS_VDP_00053]	Transmission mode on sampling
[FO_PRS_VDP_00054]	Initial acitvation state - active
[FO_PRS_VDP_00055]	Initial activation state - inactive
[FO_PRS_VDP_00056]	Collection settings
[FO_PRS_VDP_00057]	Sampling mode on.change
[FO_PRS_VDP_00058]	Sampling mode on-change is not supported
[FO_PRS_VDP_00059]	Sampling mode cyclic and sampling cycle time
[FO_PRS_VDP_00060]	Sampling cycle time
[FO_PRS_VDP_00061]	Sampling mode cyclic

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Number	Heading
[FO_PRS_VDP_00062]	Sampling mode cyclic is not supported
[FO_PRS_VDP_00063]	Encoding of DCA_REM_DP_DCFG_LEN
[FO_PRS_VDP_00064]	Length of DCA_REM_DP_DCFG
[FO_PRS_VDP_00065]	Invalid length of DCA_REM_DP_DCFG error
[FO_PRS_VDP_00066]	Add dynamic configuration response error codes
[FO_PRS_VDP_00067]	Activation request service specific flags
[FO_PRS_VDP_00068]	Activation/deactivation flag
[FO_PRS_VDP_00069]	DCA Remote null configuration execution
[FO_PRS_VDP_00070]	No VDP Slot ID given in the activation request payload
[FO_PRS_VDP_00071]	Activation request handling - activation
[FO_PRS_VDP_00072]	Activation request handling - deactivations
[FO_PRS_VDP_00073]	Activation request handling - ignore duplicated VDP Slot ID
[FO_PRS_VDP_00074]	Activation request handling - partially erroneous request
[FO_PRS_VDP_00075]	Activation response
[FO_PRS_VDP_00076]	Activation response header
[FO_PRS_VDP_00077]	Activation response acknowledge
[FO_PRS_VDP_00078]	Activation response acknowledge payload
[FO_PRS_VDP_00079]	Activation response not-acknowledge payload
[FO_PRS_VDP_00080]	Activation response error codes
[FO_PRS_VDP_00081]	Trigger request header flags
[FO_PRS_VDP_00082]	Transmission trigger
[FO_PRS_VDP_00083]	Trigger request payload

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Number	Heading
[FO_PRS_VDP_00084]	Trigger request - ignore duplicated VDP Slot IDs
[FO_PRS_VDP_00085]	Trigger sampling
[FO_PRS_VDP_00086]	Trigger response
[FO_PRS_VDP_00087]	Trigger response header
[FO_PRS_VDP_00088]	No trigger error
[FO_PRS_VDP_00089]	Trigger response acknowledge payload
[FO_PRS_VDP_00090]	Trigger response error codes
[FO_PRS_VDP_00091]	Data message
[FO_PRS_VDP_00092]	Data message header
[FO_PRS_VDP_00093]	Sequence counter initialization
[FO_PRS_VDP_00094]	Sequence counter increment
[FO_PRS_VDP_00095]	Sequence counter wrap around
[FO_PRS_VDP_00096]	Data message payload
[FO_PRS_VDP_00097]	Reference timestamp per data message
[FO_PRS_VDP_00098]	Data point information
[FO_PRS_VDP_00099]	Data point sample information
[FO_PRS_VDP_00100]	VDP Slot IDs are used in data messages
[FO_PRS_VDP_00101]	Relative timestamp
[FO_PRS_VDP_00102]	Data length encoding
[FO_PRS_VDP_00103]	Data length maximum length
[FO_PRS_VDP_00104]	Length of data
[FO_PRS_VDP_00105]	Asynchronous error information

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Number	Heading
[FO_PRS_VDP_00106]	Error information length (ERR_LEN)
[FO_PRS_VDP_00107]	Error information (ERR_INFO)
[FO_PRS_VDP_00108]	Allowed error codes for asynchronous errors
[FO_PRS_VDP_00109]	Generic DCA Remote error
[FO_PRS_VDP_00110]	Data source error
[FO_PRS_VDP_00111]	Data point sampling error
[FO_PRS_VDP_00112]	Data loss error
[FO_PRS_VDP_00113]	Error Code 0x40-0x6F
[FO_PRS_VDP_00114]	Error ID 0x70
[FO_PRS_VDP_00115]	Timestamp encoding error
[FO_PRS_VDP_00116]	Timebase error
[FO_PRS_VDP_00117]	Sample too long
[FO_PRS_VDP_00118]	Data buffer full
[FO_PRS_VDP_00119]	Trigger response before data message
[FO_PRS_VDP_00120]	Error message
[FO_PRS_VDP_00121]	ErrorMessagePayload
[FO_PRS_VDP_00122]	Original message header (OMH)
[FO_PRS_VDP_00123]	Error info unexpected control sequence counter
[FO_PRS_VDP_00125]	Error info duplicated VDP Slot ID
[FO_PRS_VDP_00126]	ErrorInfoOther
[FO_PRS_VDP_00127]	Invalid length DCA_REM_DP_DCFG
[FO_PRS_VDP_00128]	Duplicated DCA_REM_DP_DCFG

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Number	Heading
[FO_PRS_VDP_00129]	Data point limit reached
[FO_PRS_VDP_00130]	DCA Remote ID unknown
[FO_PRS_VDP_00131]	VDP Slot ID out of range
[FO_PRS_VDP_00132]	VDP Slot ID already in use
[FO_PRS_VDP_00133]	DCA Remote inconsistency error
[FO_PRS_VDP_00134]	Triggering failed
[FO_PRS_VDP_00135]	Unknown VDP Slot ID
[FO_PRS_VDP_00137]	Invalid length of (DP_DCFG)
[FO_PRS_VDP_00138]	Reserved bits
[FO_PRS_VDP_00139]	Global null configuration invalid options
[FO_PRS_VDP_00140]	Remove dynamic configuration incorrect number of bytes
[FO_PRS_VDP_00141]	Remove dynamic configuration request header
[FO_PRS_VDP_00142]	Remove VDP Slot ID
[FO_PRS_VDP_00143]	Remove VDP Slot ID - no payload
[FO_PRS_VDP_00144]	Remove dynamic configuration response error codes
[FO_PRS_VDP_00145]	Transmission cycle time already in use

Table A.5: Added Specification Items in R24-11

A.3.2 Changed Specification Items in R24-11

none

A.3.3 Deleted Specification Items in R24-11

none

A.3.4 Added Constraints in R24-11

Number	Heading
[FO_PRS_VDP_CONSTR_00001]	VDP maximum message size

Table A.6: Added Constraints in R24-11

A.3.5 Changed Constraints in R24-11

none

A.3.6 Deleted Constraints in R24-11

none