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23.06.2008	3.0.2	AUTOSAR Administration	Legal disclaimer revised
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Date	**Version**	**Changed by**	**Change Description**
13.12.2007	3.0.0	AUTOSAR Administration	• New API Adc_ReadGroup introduced • Removed API Adc_ValueReadGroup • Modified API Adc_GetStreamLastPointer • New configuration parameter added *AdcGroupReplacement *AdcPriorityImplementation *AdcResultBufferPointer *AdcEnableQueuing *AdcReadGroupApi • Cconfiguration parameter removed *ADC_GRP_PRIORITY_IMP_LEVEL *ADC_STREAMING_BUFFER_POINTER • Priority mechanism improved • Type definitions modified and extended • State diagrams added • New state transitions defined • New state ADC_STREAM_COMPLETED added • State based requirements added • Sequence charts modified and extended • ADC buffer access mode example added • New DET's defined *new DET ADC_E_ALREADY_INITIALIZED *new DET ADC_E_PARAM_CONFIG *new DET ADC_E_BUFFER_UNINIT • Part of existing requirments reformulated • Added new requirement ID's ADC321-ADC432 • Document meta information extended • Small layout adaptations made
24.01.2007	2.1.1	AUTOSAR Administration	• “Advice for users” revised • “Revision Information” added

Document Change History			
Date	**Version**	**Changed by**	**Change Description**
23.11.2006	2.1.0	AUTOSAR Administration	• Removed the "On Demand" functionality. Related services not available anymore. • Removed the "Gated Continuous" conversion mode. Related services not available anymore. • Removed the distinction between internal and external hardware trigger. • Introduced a priority mechanism for channel groups for allowing channel groups with higher priority to interrupt ongoing conversions (can cover also the "On demand" functionality). • Reworked the "Streaming Access Mode". A dedicated data structure for the returned values of a conversion is now clearly defined. • Conversion values access now allowed only through channel groups (no single channel value available. Related service not available anymore).
27.03.2006	2.0.0	AUTOSAR Administration	Document structure adapted to common Release 2.0 SWS Template.
30.06.2005	1.0.0	AUTOSAR Administration	Initial Release.

Disclaimer

Advice for users

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Table of Contents

1 Introduction and functional overview

This specification describes the functionality, API and the configuration of the AUTOSAR Basic Software module ADC Driver.

The ADC module initializes and controls the internal Analogue Digital Converter Unit(s) of the microcontroller. It provides services to start and stop a conversion respectively to enable and disable the trigger source for a conversion. Furthermore it provides services to enable and disable a notification mechanism and routines to query the status and result of a conversion.

The ADC module works on so called ADC Channel Groups, which are build from so called ADC Channels. An ADC Channel Group combines an analogue input pin (ADC Channel), the needed ADC circuitry itself and conversion result register into an entity that can be individually controlled and accessed via the ADC module.

2 Acronyms and abbreviations

Abbreviation / Acronym:	*Description:*
DEM	Diagnostic Event Manager
DET	Development Error Tracer
ADC	Analogue Digital Converter
MCU	Microcontroller Unit
API	Application Programming Interface
HW	Hardware
SW	Software
ADC HW Unit	Represents a microcontroller input electronic device that includes all parts necessary to perform an “analogue to digital conversion”.
ADC Module	ADC Basic Software module ADC Driver, abbreviated also with ADC Driver
ADC Channel	Represents a logical ADC entity bound to one port pin. Multiple ADC entities can be mapped to the same port pin.
ADC Channel Group	A group of ADC channels linked to the same ADC hardware unit (e.g. one Sample&Hold and one A/D converter). The conversion of the whole group is triggered by one trigger source.
ADC Result Buffer (ADC Streaming Buffer, ADC Stream Buffer)	The user of the ADC Driver has to provide a buffer for every group. This buffer can hold multiple samples of the same group channel if streaming access mode is selected. If single access mode is selected one sample of each group channel is held in the buffer.
Software Trigger	Software API call that starts the conversion of one ADC channel group or a continuous series of ADC channel group conversions.
Hardware Trigger	ADC internal trigger signal that starts one conversion of an ADC channel group. ADC hardware trigger are generated internally in the ADC hardware, e.g. based on an ADC timer or a trigger edge signal. The trigger hardware is tightly coupled or integrated in the ADC hardware. No software is required to start the ADC channel group conversion after the hardware trigger is detected. *Note: If the ADC hardware does not support hardware trigger, a similar behavior can be realized with software trigger in combination with the GPT/ICU driver. E.g. in a GPT timer notification function a software triggered ADC channel group conversion can be started.*
Conversion Mode	One-Shot: The conversion of an ADC channel group is performed once after a trigger and the results are written to the assigned result buffer. A trigger can be a software API call or a hardware event. Continuous: The conversions of an ADC channel group are performed continuously after a software API call (start) and the results are written to the assigned result buffer. The conversions themselves are running automatically (hardware/interrupt controlled). The Continuous conversions can be stopped by a software API call (stop).
Sampling Time, Sample Time	Time during which the analogue value is sampled (e.g. loading the capacitor, …)
Conversion Time	Time during which the sampled analogue value is converted into digital representation.
Acquisition Time	Sample Time + Conversion Time.

Table 1: Acronyms and abbreviations used in this document

3 Related documentation

3.1 Input documents

[1] General Requirements on Basic Software Modules,
AUTOSAR_SRS_BSWGeneral.pdf

[2] General Requirements on SPAL,
AUTOSAR_SRS_SPALGeneral.pdf

[3] Specification of Standard Types,
AUTOSAR_SWS_StandardTypes.pdf

[4] List of Basic Software Modules,
AUTOSAR_TR_BSWModuleList.pdf

[5] Specification of Diagnostic Event Manager,
AUTOSAR_SWS_DiagnosticEventManager.pdf

[6] Specification of Development Error Tracer,
AUTOSAR_SWS_DevelopmentErrorTracer.pdf

[7] Requirements on ADC Driver,
AUTOSAR_SRS_ADCDriver.pdf

[8] Specification of ECU Configuration,
AUTOSAR_TPS_ECUConfiguration.pdf

[9] Layered Software Architecture,
AUTOSAR_EXP_LayeredSoftwareArchitecture.pdf

[10] Specification of ECU State Manager,
AUTOSAR_SWS_ECUStateManager.pdf

[11] Specification of I/O Hardware Abstraction,
AUTOSAR_SWS_IOHardwareAbstraction.pdf

[12] Basic Software Module Description Template,
AUTOSAR_TPS_BSWModuleDescriptionTemplate.pdf

4 Constraints and assumptions

4.1 Limitations

No limitations.

4.2 Applicability to car domains

No restrictions.

5 Dependencies to other modules

Module DET
If development error detection for the ADC module is enabled: The ADC module shall raise errors to the Development Error Tracer (DET) whenever a development error is encountered by this module.

Module DEM
The ADC module shall report production errors to the Diagnostic Event Manager (DEM).

Module MCU Driver
The Microcontroller Unit Driver (MCU Driver) is primarily responsible for initializing and controlling the chip's internal clock sources and clock prescalers. The clock frequency may affect:

- Trigger frequency
- Conversion time
- Sampling time

Module PORT driver
The PORT module shall configure the port pins used by the ADC module. Both analogue input pins and external trigger pins have to be considered.

5.1 File structure

5.1.1 Code file structure

[ADC240] ⌈The code file structure shall not be defined within this specification completely. At this point it shall be pointed out that the code-file structure shall include the following file named:

- Adc_PBcfg.c – for post build time configurable parameters.

This file shall contain all post-build time configurable parameters.⌋ (BSW00380, BSW00419)

5.1.2 Header file structure

[ADC267] ⌈The file include structure shall be as follows.

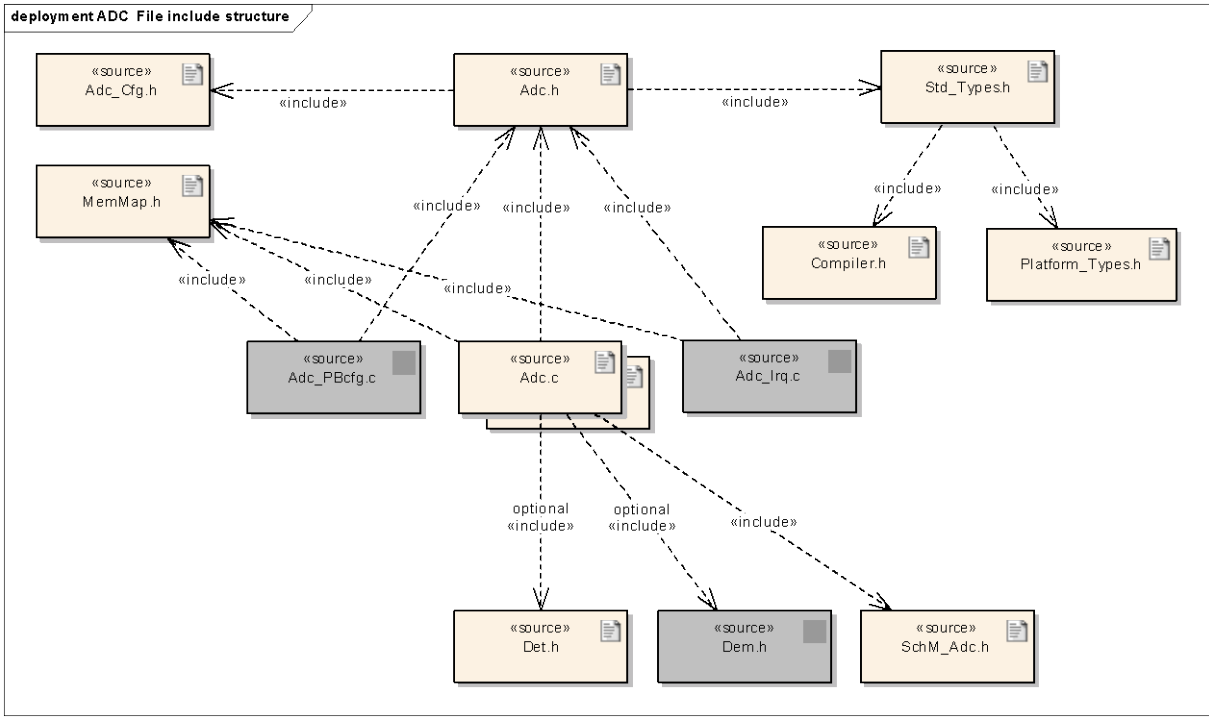


Figure 1: ADC Driver file include structure

⌋ (BSW00381, BSW00412, BSW00383, BSW00415, BSW00300, BSW00346, BSW158, BSW00314, BSW00370, BSW00348, BSW00353, BSW00361, BSW00435, BSW00436)

[ADC239] ⌈The module shall optionally include the Dem.h file if any production error will be issued by the implementation.⌋ (BSW00339, BSW00409)

Note:
By this inclusion the APIs to report errors as well as the required Event Id symbols are included. This specification defines the name of the Event Id symbols which are provided by XML to the DEM configuration tool. The DEM configuration tool assigns ECU dependent values to the Event Id symbols and publishes the symbols in Dem_IntErrId.h.

6 Requirements traceability

Requirement	Satisfied by
-	ADC442
-	ADC311
-	ADC426
-	ADC446
-	ADC457
-	ADC315
-	ADC349
-	ADC388
-	ADC368
-	ADC380
-	ADC429
-	ADC439
-	ADC448
-	ADC307
-	ADC421
-	ADC417
-	ADC432
-	ADC312
-	ADC348
-	ADC372
-	ADC361
-	ADC371
-	ADC431
-	ADC358
-	ADC345
-	ADC344
-	ADC433
-	ADC373
-	ADC428
-	ADC374
-	ADC367
-	ADC437
-	ADC332
-	ADC369
-	ADC339
-	ADC304

-	ADC415
-	ADC414
-	ADC387
-	ADC337
-	ADC445
-	ADC430
-	ADC425
-	ADC333
-	ADC370
-	ADC450
-	ADC236
-	ADC381
-	ADC359
-	ADC423
-	ADC438
-	ADC296
-	ADC365
-	ADC434
-	ADC384
-	ADC449
-	ADC338
-	ADC376
-	ADC075
-	ADC351
-	ADC375
-	ADC335
-	ADC419
-	ADC447
-	ADC451
-	ADC416
-	ADC366
-	ADC343
-	ADC346
-	ADC418
-	ADC436
-	ADC377
-	ADC420
-	ADC353
-	ADC424

-	ADC305
-	ADC422
-	ADC440
-	ADC360
-	ADC336
-	ADC413
-	ADC321
-	ADC441
-	ADC458
-	ADC364
-	ADC427
BSW00300	ADC267
BSW00301	ADC460
BSW00302	ADC460
BSW00306	ADC460
BSW00307	ADC460
BSW00308	ADC460
BSW00312	ADC460
BSW00314	ADC267
BSW00323	ADC152, ADC129, ADC269, ADC128, ADC125, ADC126, ADC065, ADC241, ADC131, ADC130, ADC225
BSW00325	ADC460
BSW00326	ADC460
BSW00327	ADC065
BSW00328	ADC460
BSW00329	ADC460
BSW00330	ADC460
BSW00331	ADC269, ADC065
BSW00334	ADC460
BSW00335	ADC222, ADC221, ADC224
BSW00336	ADC111
BSW00337	ADC069, ADC065, ADC230, ADC229
BSW00338	ADC067, ADC233, ADC234
BSW00339	ADC068, ADC069, ADC235, ADC239
BSW00341	ADC460
BSW00342	ADC460
BSW00343	ADC460
BSW00344	ADC460
BSW00345	ADC342
BSW00346	ADC267

BSW00347	ADC460
BSW00348	ADC267
BSW00350	ADC233
BSW00353	ADC267
BSW00355	ADC460
BSW00357	ADC460
BSW00359	ADC082
BSW00360	ADC082
BSW00361	ADC267
BSW00369	ADC067, ADC233, ADC234
BSW00370	ADC267
BSW00371	ADC460
BSW00373	ADC460
BSW00375	ADC460
BSW00376	ADC460
BSW00380	ADC240
BSW00381	ADC267
BSW00383	ADC267
BSW00385	ADC069, ADC065
BSW00386	ADC152, ADC154, ADC164, ADC166, ADC165, ADC129, ADC269, ADC128, ADC125, ADC126, ADC068, ADC069, ADC112, ADC241, ADC233, ADC133, ADC136, ADC137, ADC131, ADC130, ADC225, ADC218, ADC107
BSW00387	ADC460
BSW00398	ADC460
BSW004	ADC124
BSW00405	ADC054
BSW00406	ADC295, ADC294, ADC154, ADC299, ADC298, ADC297, ADC300, ADC301, ADC302, ADC068, ADC107
BSW00407	ADC237
BSW00409	ADC239
BSW00411	ADC237
BSW00412	ADC267
BSW00413	ADC460
BSW00414	ADC054, ADC342
BSW00415	ADC267
BSW00416	ADC460
BSW00417	ADC460
BSW00419	ADC240
BSW00423	ADC460
BSW00424	ADC460

BSW00425	ADC460
BSW00426	ADC460
BSW00427	ADC460
BSW00428	ADC460
BSW00429	ADC460
BSW00431	ADC460
BSW00432	ADC460
BSW00433	ADC460
BSW00434	ADC460
BSW00435	ADC267
BSW00436	ADC267
BSW005	ADC460
BSW006	ADC460
BSW007	ADC460
BSW009	ADC460
BSW010	ADC460
BSW101	ADC054
BSW12056	ADC080, ADC084, ADC085
BSW12057	ADC054
BSW12063	ADC113
BSW12064	ADC460
BSW12067	ADC460
BSW12068	ADC460
BSW12069	ADC460
BSW12077	ADC460
BSW12078	ADC460
BSW12092	ADC460
BSW12125	ADC056
BSW12129	ADC078
BSW12163	ADC110, ADC111
BSW12169	ADC460
BSW12265	ADC460
BSW12267	ADC460
BSW12280	ADC140, ADC383, ADC382
BSW12283	ADC122
BSW12291	ADC326, ADC325, ADC329, ADC328, ADC327, ADC331, ADC330, ADC222, ADC221, ADC220, ADC226, ADC224, ADC219
BSW12292	ADC113, ADC214
BSW12317	ADC157, ADC156, ADC155, ADC104
BSW12318	ADC157, ADC156, ADC057, ADC058, ADC077

BSW12364	ADC157, ADC061, ADC060, ADC145, ADC146, ADC356, ADC357, ADC385, ADC386
BSW12447	ADC277, ADC280, ADC090, ADC091, ADC101, ADC100, ADC104
BSW12448	ADC152, ADC154, ADC164, ADC166, ADC165, ADC129, ADC269, ADC128, ADC125, ADC126, ADC065, ADC112, ADC241, ADC133, ADC136, ADC137, ADC131, ADC130, ADC225, ADC107
BSW12461	ADC054, ADC250, ADC248, ADC249, ADC246, ADC247
BSW12463	ADC460
BSW12802	ADC219, ADC214, ADC216, ADC215
BSW12817	ADC279, ADC283, ADC146, ADC356, ADC357
BSW12818	ADC092
BSW12819	ADC122, ADC113, ADC318
BSW12820	ADC289, ADC288, ADC310, ADC340, ADC341
BSW12822	ADC320
BSW12823	ADC273, ADC281, ADC282, ADC114, ADC116, ADC144
BSW12824	ADC113
BSW12825	ADC319
BSW157	ADC057, ADC058, ADC104, ADC082, ADC083
BSW158	ADC267
BSW160	ADC460
BSW161	ADC460
BSW162	ADC460
BSW164	ADC460
BSW167	ADC460
BSW168	ADC460
BSW170	ADC460
BSW171	ADC266, ADC265, ADC121, ADC120, ADC260, ADC259, ADC237, ADC228

7 Functional specification

7.1 General behavior

7.1.1 Background & Rationale

The table below shows a list of possible desired functionalities of an ADC user and in which way they are provided by the ADC module. Furthermore the table also depicts a possible realization and the mapping of these functionalities to the capabilities of a commercial microcontroller (C16x).

Desired Functionality	*ADC Driver Function*	*Example: C16x Derivate Wording*
Just one conversion result of a single channel.	Software triggered one-shot conversion where the converted group consists of exactly one channel.	Fixed channel, single conversion, software trigger.
Cyclic conversion of a single channel.	Hardware triggered one-shot conversion where the converted group consists of exactly one channel.	Fixed channel, single conversion, hardware trigger.
Repeated conversion of a single channel.	Continuous conversion where the converted group consists of exactly one channel.	Fixed channel, continuous conversion.
Just one conversion result of each channel within a group.	Software triggered one-shot conversion where the converted group consists of more than one channel.	Auto scan, single conversion, software trigger.
Cyclic conversion of each channel within a group.	Hardware triggered one-shot conversion where the converted group consists of more than one channel.	Auto scan, single conversion, hardware trigger.
Repeated conversion of each channel within a group.	Continuous conversion where the converted group consists of more than one channel.	Auto scan, continuous conversion.

Table 2: Different possibilities of One-shot and Continuous conversions

7.1.2 Requirements

[ADC090] ⌈The ADC module shall allow grouping of one or more ADC channels into so called ADC Channel groups.⌋ (BSW12447)

[ADC091] ⌈The ADC module's configuration shall be such that an ADC Channel group contains at least one ADC Channel.⌋ (BSW12447)

[ADC451] ⌈The ADC module's configuration shall be such that an ADC Channel group contains exactly one ADC Channel if the global limit checking feature is enabled and the channel specific limit checking is enabled for the ADC Channel.⌋ ()

[ADC092] ⌈The ADC module shall allow the assignment of an ADC channel to more than one group.⌋ (BSW12818)

[ADC277] ⌈The ADC module's configuration shall be such that all channels contained in one ADC Channel group shall belong to the same ADC HW Unit.⌋ (BSW12447)

The ADC module supports the following conversion modes:

- **[ADC380]** ⌈The ADC module shall support the conversion mode "One-shot Conversion" for all ADC Channel groups. One-shot conversion means that exactly one conversion is executed for each channel configured for the group being converted.⌋ ()

- **[ADC381]** ⌈The ADC module shall support the conversion mode "Continuous Conversion[1]" for all ADC Channel groups with trigger source software. "Continuous Conversion" means that after the conversion has been completed, the conversion of the whole group is repeated. The conversions of the individual ADC channels within the group as well as the repetition of the whole group don't need any additional trigger events to be executed. Converting the individual channels within the group can be done sequentially or in parallel depending on hardware and/or software capabilities.⌋ ()

The ADC module supports the following start conditions or trigger sources:

- **[ADC356]** ⌈The ADC module shall support the start condition "Software API Call" for all conversion modes. The trigger source "Software API Call" means that the conversion of an ADC Channel group is started/stopped with a service provided by the ADC module.⌋ (BSW12817, BSW12364)

- **[ADC357]** ⌈The ADC module shall support the start condition "Hardware Event" for groups configured in One-Shot conversion mode. The trigger source "Hardware Event" means that the conversion of an ADC Channel group can be started by a hardware event, e.g. an expired timer or an edge detected on an input line.⌋ (BSW12817, BSW12364)

[ADC279] ⌈The ADC module shall allow configuring exactly one trigger source for each ADC Channel group.⌋ (BSW12817)

The ADC module supports the following result access modes:

- **[ADC382]** ⌈The ADC module shall support result access using the API function Adc_GetStreamLastPointer. Calling Adc_GetStreamLastPointer informs the user about the position of the group conversion results of the latest conversion round in the result buffer and about the number of valid conversion results in the result buffer. The result buffer is an external buffer provided from the application.⌋ (BSW12280)

[1] On some microcontroller also called „auto-scan mode".

Note: The function is used for both types of groups, configured in Streaming Access Mode and in Single Access Mode (Single Access Mode is handled equal to Streaming Access Mode with Streaming Counter equal to 1).

- **[ADC383]** ⌈The ADC module shall support result access using the API function Adc_ReadGroup, if the generation of this API function is statically configured. Calling Adc_ReadGroup copies the group conversion results of the latest conversion round to an application buffer which start address is specified as API parameter of Adc_ReadGroup.⌋(BSW12280)
  Note: The function is used for both types of groups, configured in Streaming Access Mode and in Single Access Mode.

[ADC140] ⌈The ADC module shall guarantee the consistency of the returned result value for each completed conversion.⌋(BSW12280)

Note:
The consistency of the group channel results can be obtained with the following methods on the application side:
- *Using group notification mechanism*
- *Polling via API function Adc_GetGroupStatus*

In any case, new result data must be read out from the result buffer (e.g. via Adc_ReadGroup) before they are overwritten. If the function Adc_GetGroupStatus reports state ADC_STREAM_COMPLETED and conversions for the same group are still ongoing (continuous conversion or hardware triggered conversion), the user is responsible to access the results in the result buffer, before the ADC driver overwrites the group result buffer.

[ADC384] ⌈The ADC module's environment shall ensure that a conversion has been completed for the requested group before requesting the conversion result.⌋()

Note: If no conversion has been completed for the requested channel group (e.g. because the conversion of the ADC Channel group has been stopped by the user) the value returned by the ADC module will be arbitrary (Adc_GetStreamLastPointer will return 0 and read NULL_PTR; Adc_ReadGroup will return E_NOT_OK).

[ADC288] ⌈The ADC module shall allow the configuration of a priority level for each channel group.⌋(BSW12820)

Note: This implies a prioritization mechanism, implemented in SW, or where available, supported by the HW. Groups with trigger source HW are prioritized always with the HW prioritization mechanism.

[ADC310] ⌈The ADC module's priority mechanism shall allow aborting and restarting of channel group conversions.⌋(BSW12820)

[ADC345] ⌈The ADC module's priority mechanism shall allow suspending and resuming of channel group conversions.⌋ ()

[ADC430] ⌈The ADC module shall allow a group specific configuration whether the abort/restart or suspend/resume mechanism is used for interrupted channel groups.⌋ ()

Note: In contrast to the software controlled abort/restart or suspend/resume mechanism on channel group level, the ADC hardware can support abort/restart and suspend/resume mechanism on ADC channel level. It is up to the implementation which of both mechanisms is implemented on channel level.

[ADC311] ⌈The ADC module's priority mechanism shall allow the queuing of requests for different groups.⌋ ()

Note: Higher priority groups can abort or suspend lower priority groups. In this case the priority handler should put the interrupted channel group conversion in the queue and this channel group conversion will be restarted or resumed later, transparently to the user.

[ADC312] ⌈In the ADC module's priority mechanism the lowest priority is 0.⌋ ()

[ADC289] ⌈The ADC module's priority mechanism shall allow the configuration of 256 priority levels (0...255).⌋ (BSW12820)

[ADC315] ⌈The ADC module shall support the static configuration option to disable the priority mechanism.⌋ ()

[ADC340] ⌈The ADC module shall support the static configuration option to enable the priority mechanism ADC_PRIORITY_HW_SW, using both hardware and software prioritization mechanism. If the hardware does not provide the hardware prioritization mechanism a pure software prioritization mechanism shall be implemented.⌋ (BSW12820)

[ADC341] ⌈If the priority mechanism is supported by the hardware: The ADC module shall support the static configuration option ADC_PRIORITY_HW to enable the priority mechanism using only the hardware priority mechanism.⌋ (BSW12820)

Note: If hardware priority mechanism is selected, also groups with software trigger source are prioritized from the hardware prioritization mechanism.

[ADC339] ⌈If hardware priority mechanism is supported and selected: The ADC module shall allow the mapping of the configured priority levels (0-255) to the available hardware priority levels.⌋ ()

Note: The specific implementation of the ADC module describes restrictions concerning the available hardware priority levels and the possible mapping of the available hardware priorities to the priorities of the ADC channel groups.

[ADC332] ⌈If the priority mechanism is active, the ADC module shall support a queuing of conversion requests. The conversion requsts shall be queued when, if channel group with higher priority is requested for conversion while lower priority channel group conversion is ongoing (here lower priority group shall be queued) OR channel group conversion requests can not immediately be handled, because a higher priority channel group conversion is ongoing.⌋ ()

[ADC417] ⌈If the priority mechanism is active, the ADC module shall handle channel group conversion requests for groups with the same priority level, in a 'first come first served' order.⌋ ()

[ADC333] ⌈If the priority mechanism is not active and if the static configuration parameter AdcEnableQueuing is set to ON, the ADC module shall support a queuing of conversion requests and shall service the software groups in a 'first come first served' order.⌋ ()

Note: Software conversion requests storage shall be supported in a software implemented queue or by the hardware.

[ADC335] ⌈If the queuing mechanism is active (priority mechanism active or queuing explicitly activated), the ADC module shall store each software conversion request per channel group at most one time in the software queue.⌋ ()

Note: The ADC module shall only store one conversion request per channel group, not multiple requests, which may occur if a high priority long-term conversion blocks the hardware.

[ADC336] ⌈ 'Enable hardware trigger requests', generated with API function Adc_EnableHardwareTrigger, shall not be stored in any queue.⌋ ()

[ADC337] ⌈The hardware prioritization mechanism shall be used in case of hardware triggered conversion requests.⌋ ()

[ADC338] ⌈The ADC module shall not store additional software conversion requests for the same group, whose group status is not equal to ADC_IDLE.⌋ ()

[ADC060] ⌈The ADC module shall call the group notification function, whenever a conversion of all channels of the requested group is completed and if the notification is configured and enabled.⌋(BSW12364)

[ADC413] ⌈The ADC module functions shall be reentrant, if the functions are called for different channel groups. This requirement shall be applicable for all API functions, except Adc_Init, Adc_DeInit and Adc_GetVersionInfo.⌋()

Note: The reentrancy of the API functions applies only if the caller takes care that there is no simultaneous usage of the same group.

[ADC414] ⌈The ADC module's environment shall check the integrity (see Note ADC413) if several calls for the same ADC group are used during runtime in different tasks or ISR's.⌋()

[ADC415] ⌈The ADC module shall not check the integrity (see Note ADC413) if several calls for the same ADC group are used during runtime in different tasks or ISRs.⌋()

[ADC445] ⌈The ADC module shall allow configuring limit checking for ADC Channels. ⌋()

[ADC446] ⌈If limit checking is active for an ADC Channel, only ADC conversion results, which are in the configured range, are taken into account for updating the user specified ADC result buffer.⌋()

[ADC447] ⌈If limit checking is active for an ADC Channel, only ADC conversion results, which are in the configured range, are take range, ar n into account for triggering state transitions of the ADC group status.⌋()

[ADC448] ⌈If continuous conversion mode with SW trigger source is selected: if limit checking is active for an ADC Channel, ADC conversion results, which are not in the configured e neglected from the ADC driver, and the conversion is reiterated.⌋()

[ADC449] ⌈If one-shot conversion mode with SW trigger source is selected: if limit checking is active for an ADC Channel, an ADC conversion result, which is not in the configured range, is neglected from the ADC driver, and the ADC group, containing the ADC channel, will stay in state ADC_BUSY.⌋()

Note: Before a new SW triggered one-shot conversion can be reissued, it is required to set the ADC group status to ADC_IDLE, using the API Adc_StopGroupConversion().

[ADC450] ⌈If one-shot conversion mode with HW trigger source is selected: if limit checking is active for an ADC Channel, ADC conversion results, which are not in the configured range, are neglected from the ADC driver, and the conversion is reissued, triggered by the next HW trigger.⌋ ()

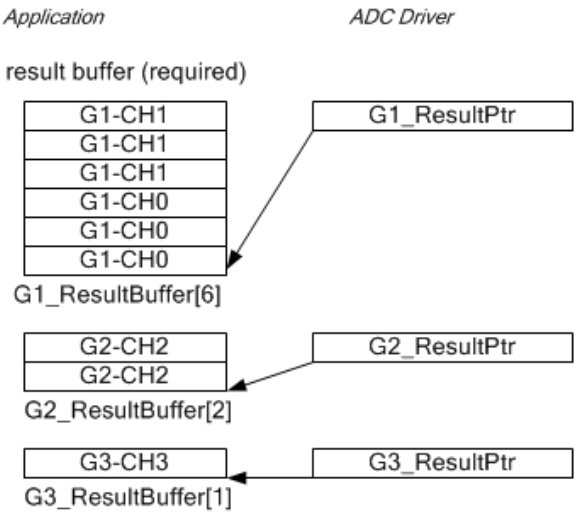
7.1.3 ADC Buffer Access Mode Example

1. Configuration

Group	ADC_GROUP_DEFINITION	ADC_RESULT_POINTER
group G1:	CH0, CH1	G1_ResultPtr
group G2:	CH2	G2_ResultPtr
group G3:	CH3	G3_ResultPtr

Group	ADC_GROUP_ACCESS_MODE	ADC_STREAMING_NUM_SAMPLES
group G1:	ADC_ACCESS_MODE_STREAMING	3
group G2:	ADC_ACCESS_MODE_STREAMING	2
group G3:	ADC_ACCESS_MODE_SINGLE	(1)

2. Result Pointer Initialization with Adc_SetupResultBuffer API function



3. Result access with Adc_GetStreamLastPointer API function

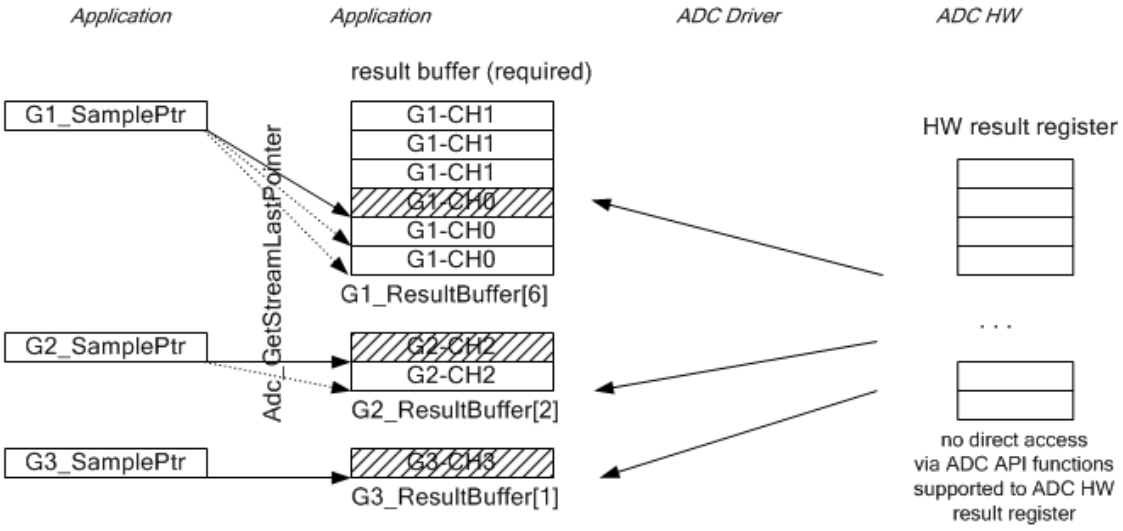


Figure 2: Example for Group and Result Buffer configuration – Result pointer initialization and calling Adc_GetStreamLastPointer for accessing results of latest conversion round in the Result Buffer

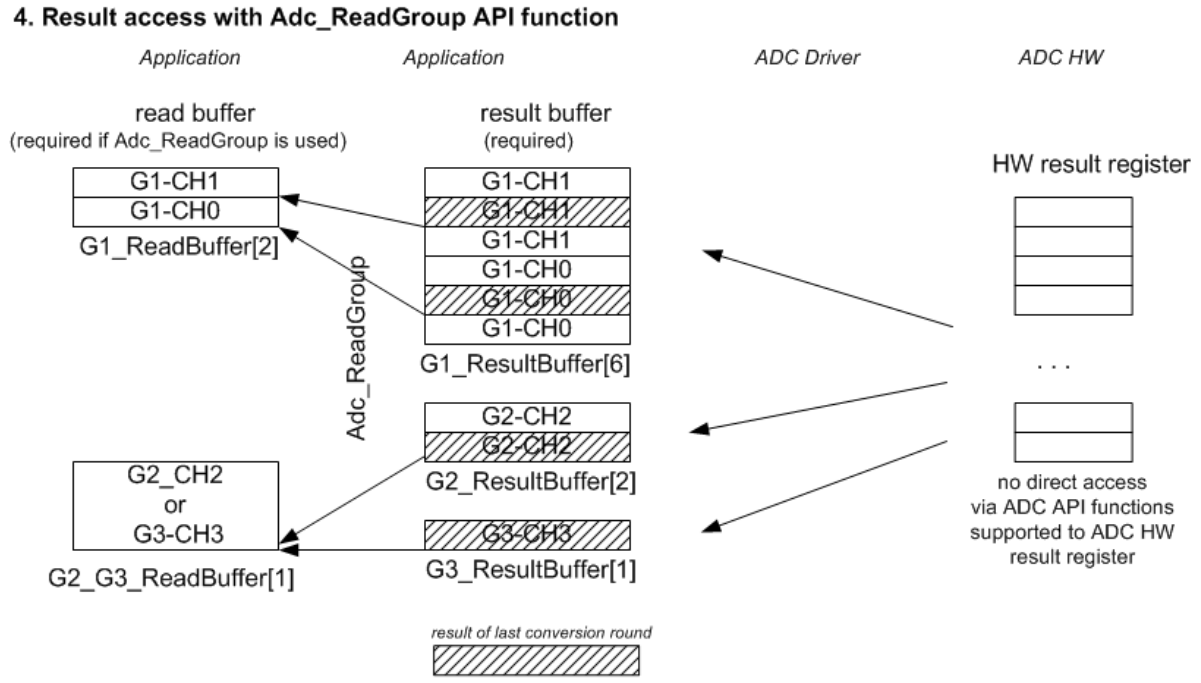


Figure 3: Example for calling Adc_ReadGroup which copies results from Result Buffer to optional Read Buffer

7.1.3.1 Example: Configuration

The example configuration consists of three ADC groups. Group 1 consists of 2 channels, group 2 and group 3 consist of one channel each. For group 1 and 2 the group access mode ADC_ACCESS_MODE_STREAMING is configured. The group access mode of group 3 is ADC_ACCESS_MODE_SINGLE. The ADC driver will store the conversion results of group 1-3 in three application buffers, accessed with three configured ADC_RESULT_POINTER :
G1_ResultPtr, G2_ResultPtr and G3_ResultPtr.

7.1.3.2 Example: Initialization

The user has to provide application result buffers for the ADC group results. One buffer is required for each group. The buffer size depends on the number of group channels, the group access mode and from the number of streaming samples, if streaming access mode is selected. Before starting a group conversion, the user has to initialize the group result pointer using API function Adc_SetupResultBuffer which initializes the group result pointer to point to the specified application result buffer.

7.1.3.3 Example: Adc_GetStreamLastPointer Usage

The ADC driver stores the conversion results of group G1, G2 and G3 in the according result buffer G1_ResultBuffer[], G2_ResultBuffer[] and G3_ResultBuffer[].

A direct access from the ADC API functions to the ADC hardware result register is not supported from the ADC driver.

The user provides three pointers G1_SamplePtr, G2_SamplePtr and G3_SamplePtr which will point to the ADC application result buffer after calling Adc_GetStreamLastPointer. Precisely pointer G1_SamplePtr points, after calling Adc_GetStreamLastPointer, to the latest G1_CH0 result of the latest completed conversion round (G1_CH0 is the first channel in G1 group definition).The application result buffer layout is shown in Figure 2. The application result buffer of group 1 holds three times the streaming results of G1_CH0 and then three times the streaming results of G1_CH1. Knowing the application result buffer layout, the user is able to access all group channel results of the latest conversion round. G2_SamplePtr and G3_SamplePtr are also aligned, after calling Adc_GetStreamLastPointer, to point to the latest result of the first group channel of the according group. Both groups have only one channel. G2_SamplePtr points to one of the G2_CH2 results (the latest result). Because group 3 is configured in single access mode, G3_SamplePtr points always to G3_CH3.

Adc_GetStreamLastPointer returns the number of valid samples per channel, stored in the application result buffer (number of complete group conversion rounds). If the return value is equal to the configured parameter 'number of streaming samples', all conversion results in the streaming buffer are valid. If the return value is 0, no conversion results are available in the streaming buffer (the sample pointer will be aligned to NULL).

To enable Adc_GetStreamLastPointer to align the sample pointer (G1_SamplePtr, G2_SamplePtr and G3_SamplePtr) to point to the latest channel result, the API is defined to pass a pointer to the result pointer instead the result pointer itself.

7.1.3.4 Example: Adc_ReadGroup Usage

If the optional API function Adc_ReadGroup is enabled, the user has to provide additional buffers for the selected groups, which can hold the results of one group conversion round. Calling Adc_ReadGroup copies the latest results from the application result buffer to the application read group buffer. In the example, one application read buffer (G2_G3_ReadBuffer) is used for group G2 and G3.

7.2 Conversion processing and interaction

7.2.1 Background & Rationale

The following examples specify the order of channel conversion depending on group and conversion type:

- **Example 1**: Channel group containing channels [CH0, CH1, CH2, CH3, and CH4] is configured in Continuous conversion mode. After finishing each scan, the notification (if enabled) is called. Then a new scan is started automatically.

- **Example 2**: Channel group containing channels [CH0, CH1, CH2, CH3, and CH4] is configured in One-Shot conversion mode. After finishing the scan the notification (if enabled) is called.
- **Example 3**: Channel group containing channel [CH3] is configured in Continuous conversion mode. After finishing each scan the notification (if enabled) is called. Then a new scan is started automatically.
- **Example 4**: Channel group containing channel [CH4] is configured in One-Shot conversion mode. After finishing the scan the notification (if enabled) is called.

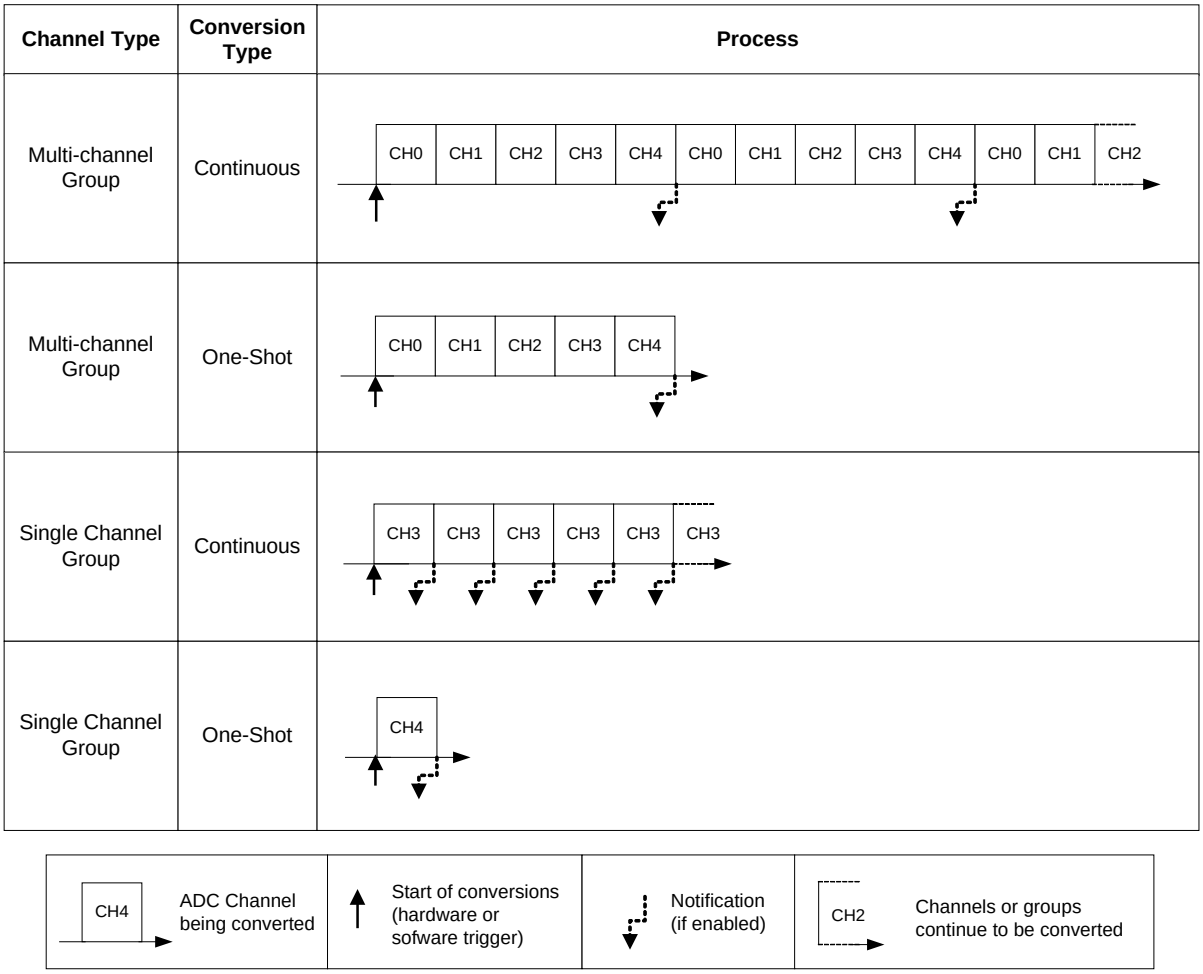


Figure 4: Conversion Mode behavior examples

7.2.2 Requirements

[ADC280] ⌈The ADC module shall convert only one ADC Channel group per ADC HW Unit at a time. The ADC module shall not support the concurrent conversion of different (even exclusive) ADC Channel groups on the same ADC HW Unit.⌋ (BSW12447)

Note: Concurrent conversion of ADC Channel groups on different ADC HW Units may be possible, depending on the capabilities of the hardware. Also concurrent conversion of individual channels within one channel group may be possible if supported by the hardware.

Note: If a channel shall be used in different conversion modes (e.g. continuous conversion mode during normal operation and one-shot conversion mode for a special conversion at a dedicated point in time), this channel shall be assigned to different groups configured with the respective conversion modes.

Note: In order to request the conversion of a channel shared between two groups, the ADC user has to stop the conversion of the first group containing the specified channel and then start the conversion of the second group containing the specified channel.

7.3 State Diagrams

The ADC module has a state machine that is shown in the following figures. The states are group specific and not module specific. The diagrams show all possible configuration options for ADC groups. The state transitions depend on the ADC group configuration.

7.3.1 ADC State Diagram for One-Shot/Continuous Group Conversion Mode

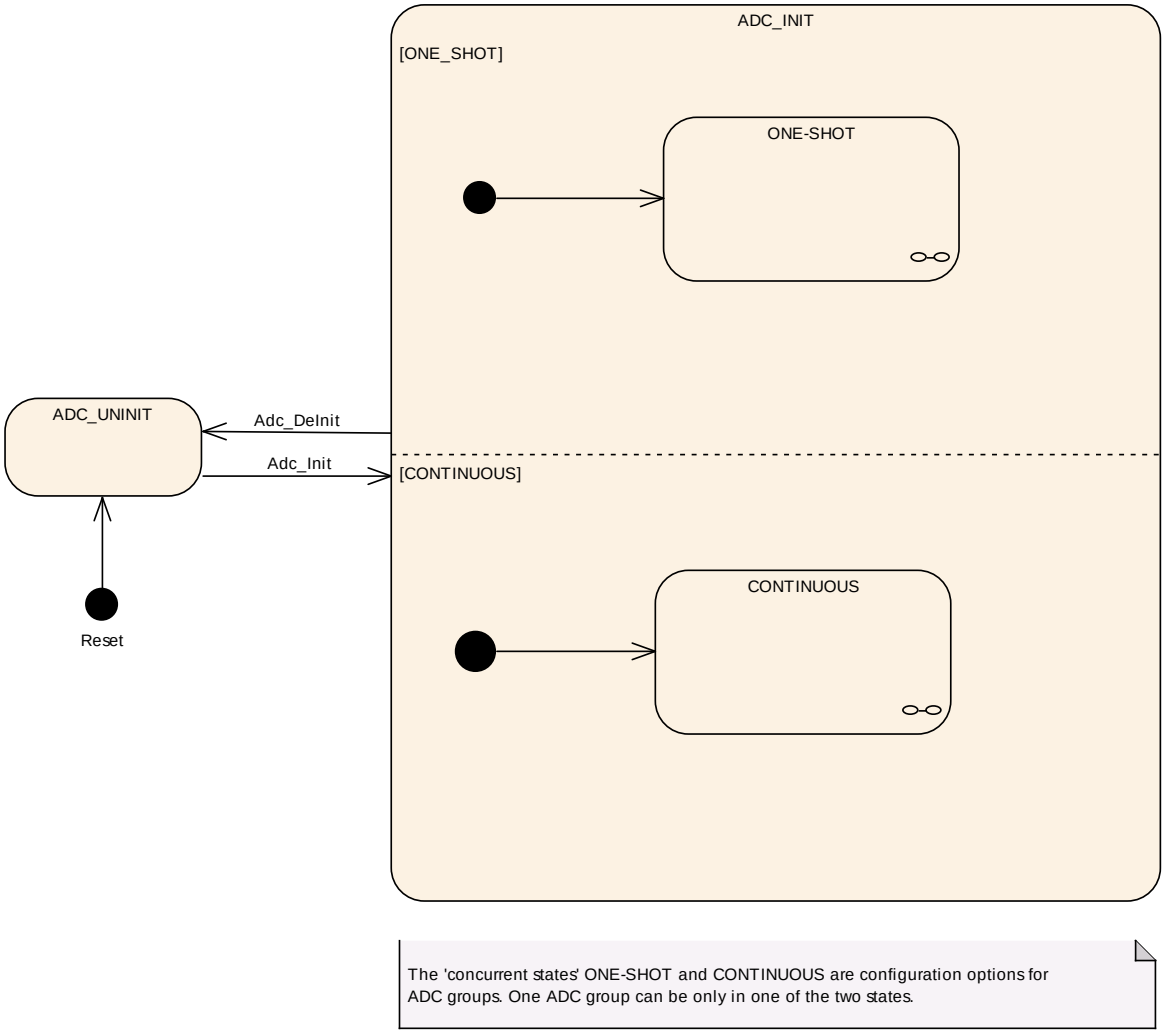


Figure 5: ADC State Diagram for One-Shot/Continuous Group Conversion Mode

7.3.2 ADC State Diagram for HW/SW Trigger in One-Shot Group Conversion Mode

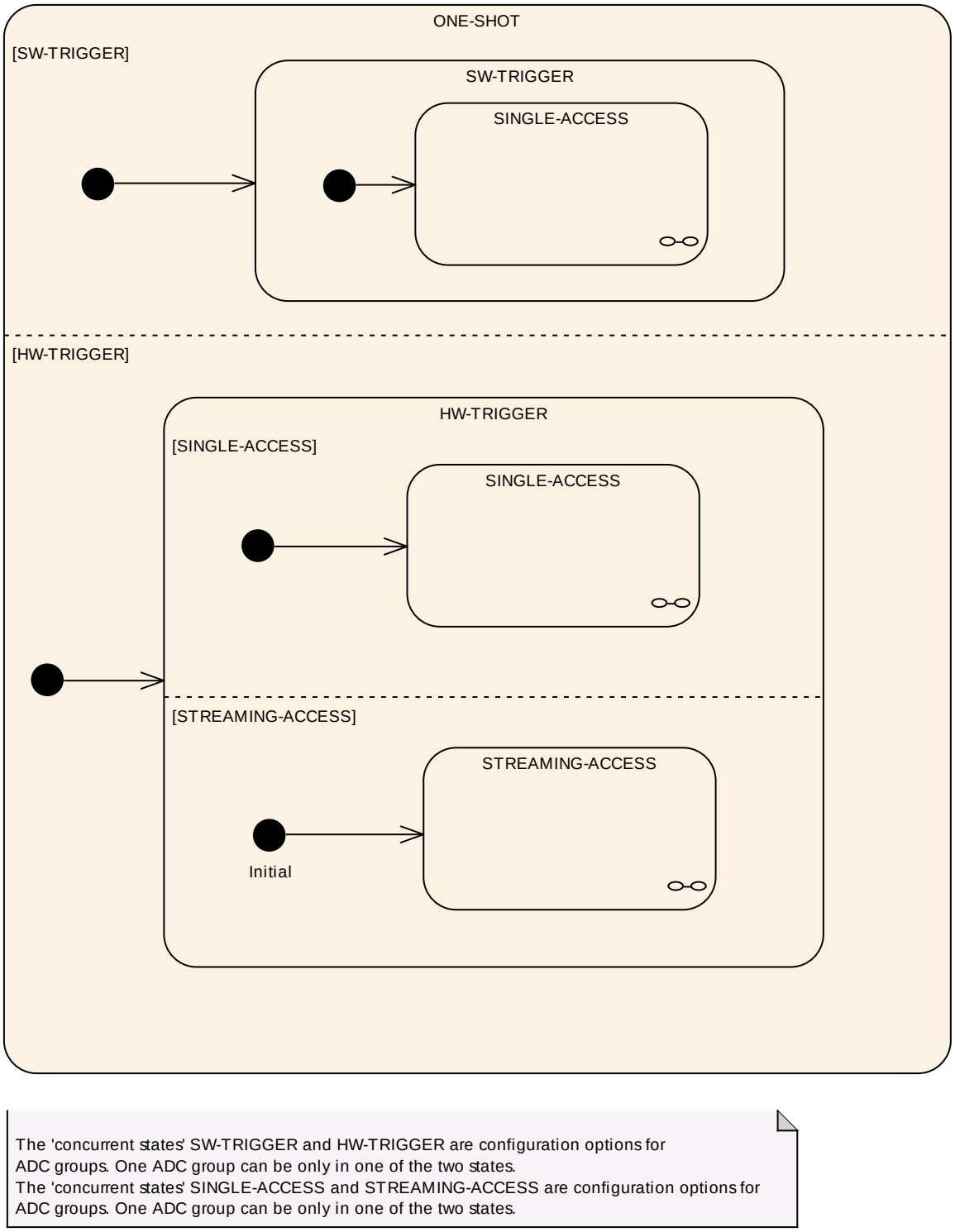


Figure 6: State Diagram HW/SW Trigger in One-Shot Group Conversion Mode

7.3.3 ADC State Diagram for SW Trigger in Continuous Conversion Mode

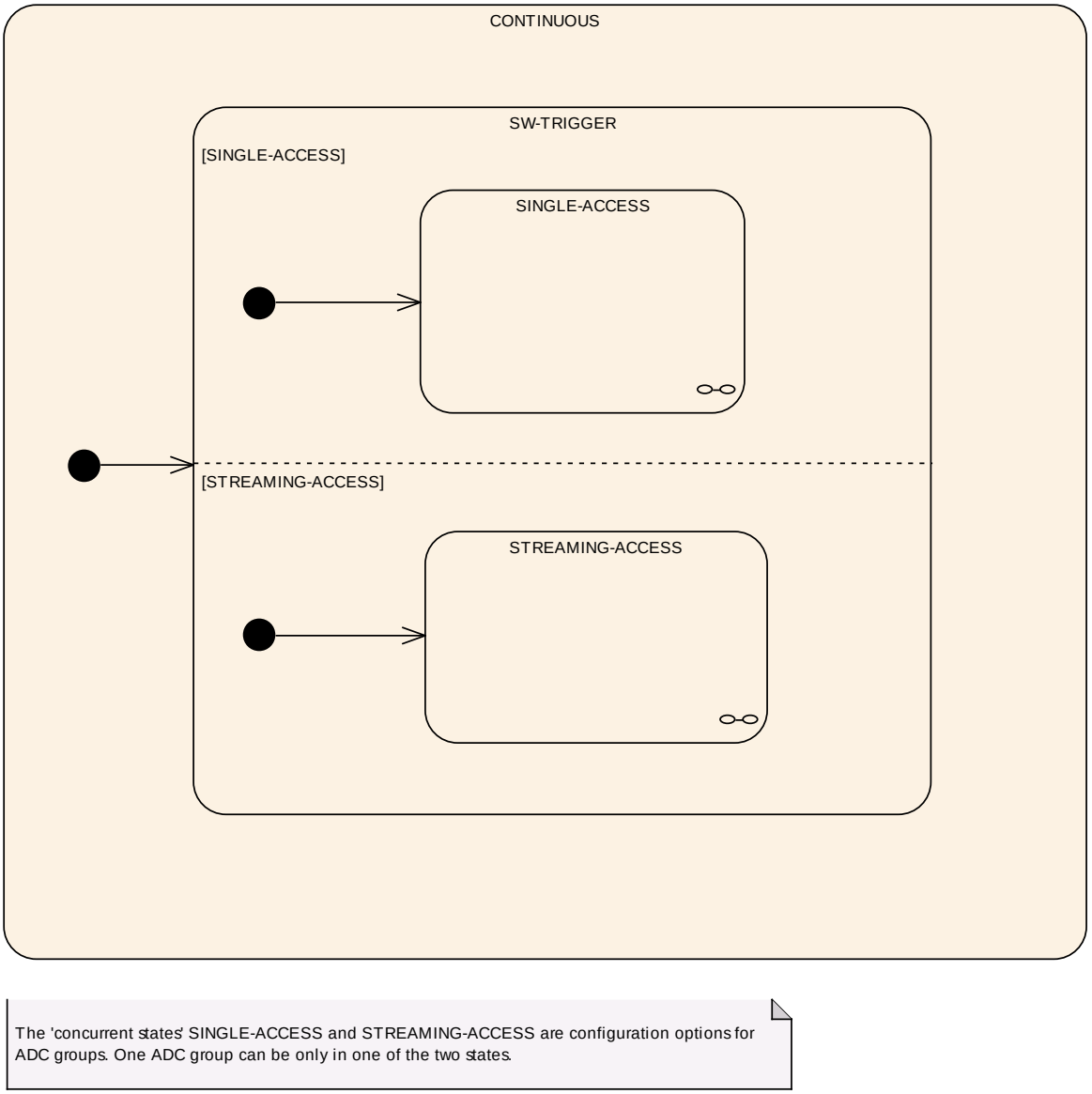


Figure 7: State Diagram SW Trigger in Continuous Conversion Mode

7.3.4 ADC State Diagram for One-Shot Conversion Mode, Software Trigger Source, Single Access Mode

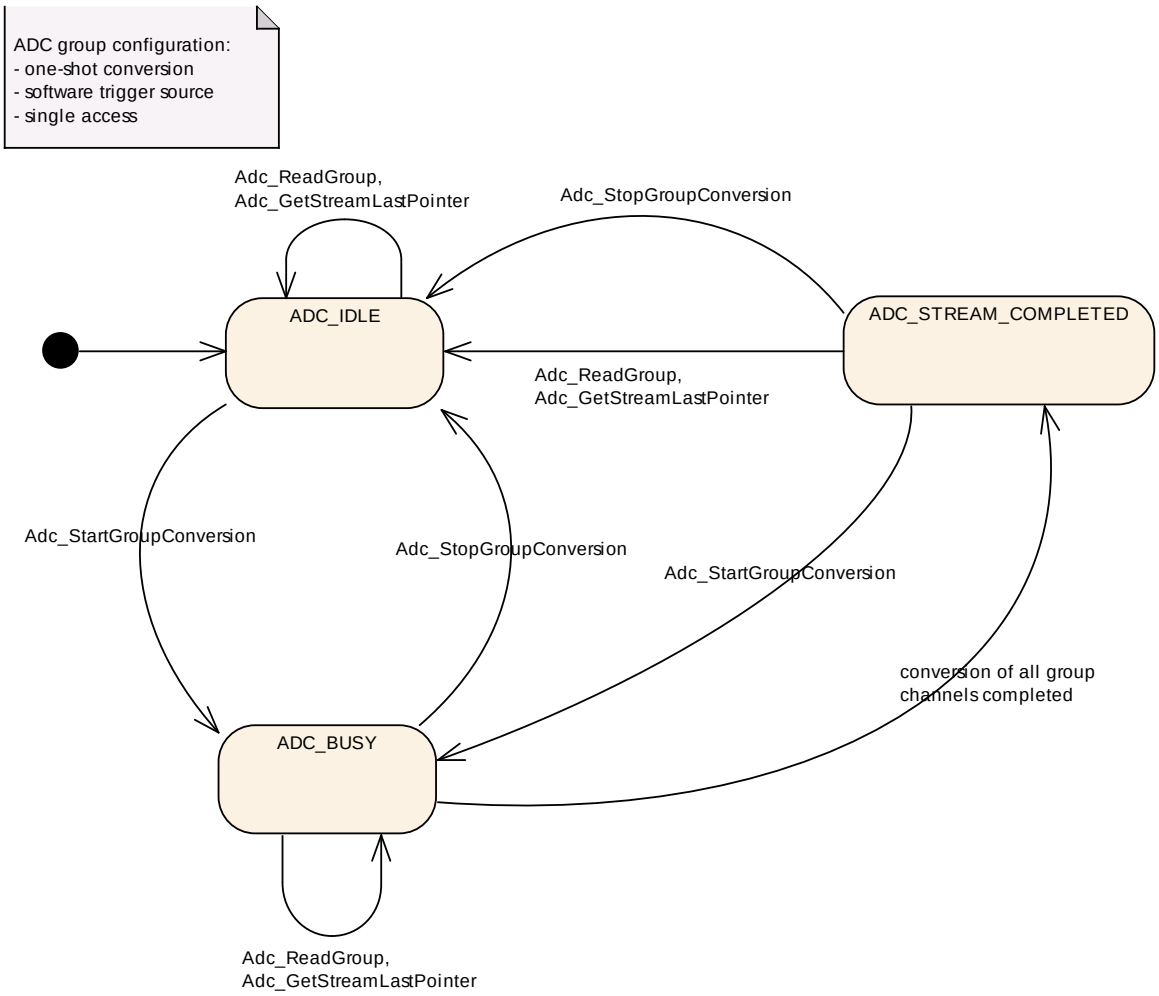


Figure 8: State Diagram On-Shot, SW Trigger, Single Access

7.3.5 ADC State Diagram for One-Shot Conversion, Hardware Trigger Source, Single Access Mode

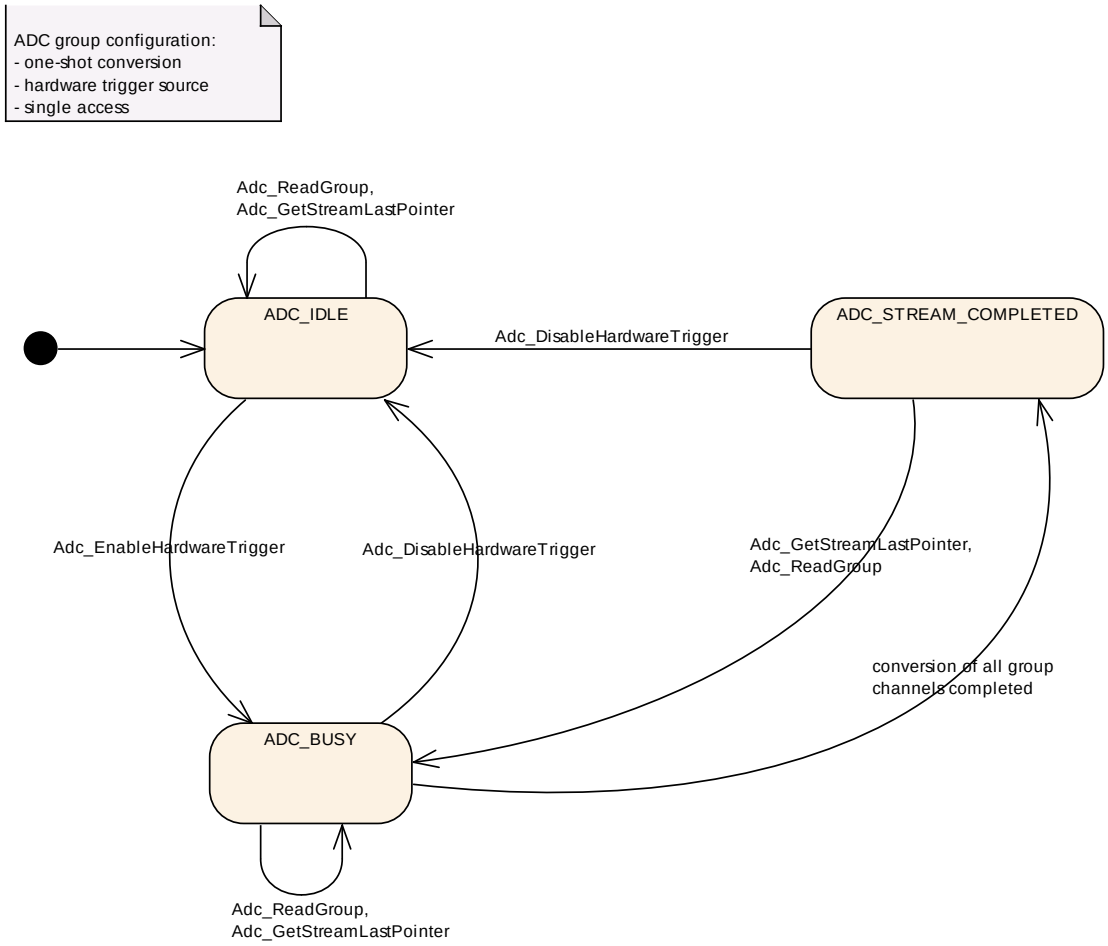


Figure 9: State Diagram One-Shot, HW Trigger, Single Access

7.3.6 ADC State Diagram for One-Shot Conversion Mode, Hardware Trigger Source, Linear and Circular Streaming Access Mode

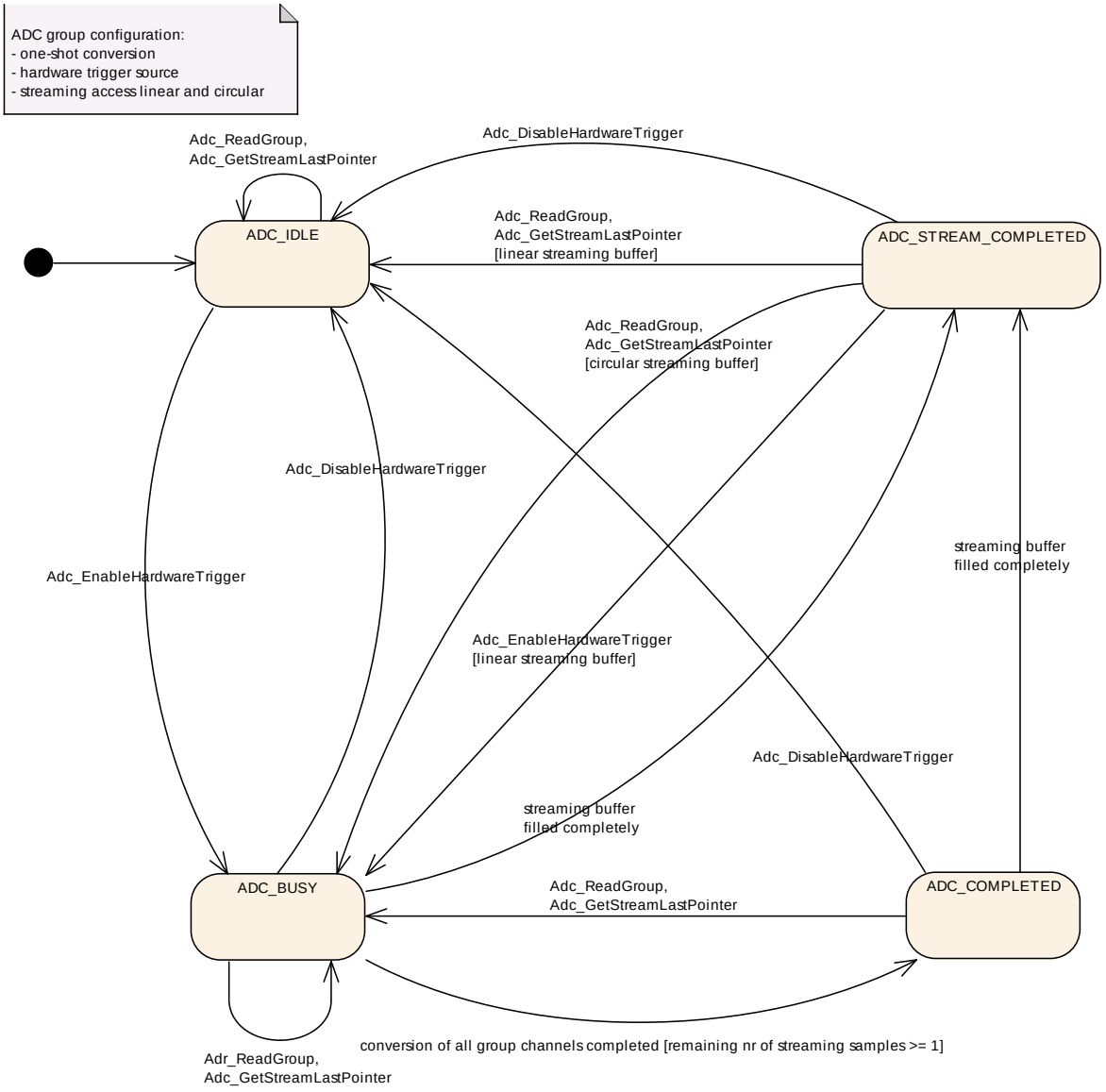


Figure 10: State Diagram One-Shot, HW Trigger, Streaming Access

7.3.7 ADC State Diagram for Continuous Conversion Mode, Software Trigger Source, Single Access Mode

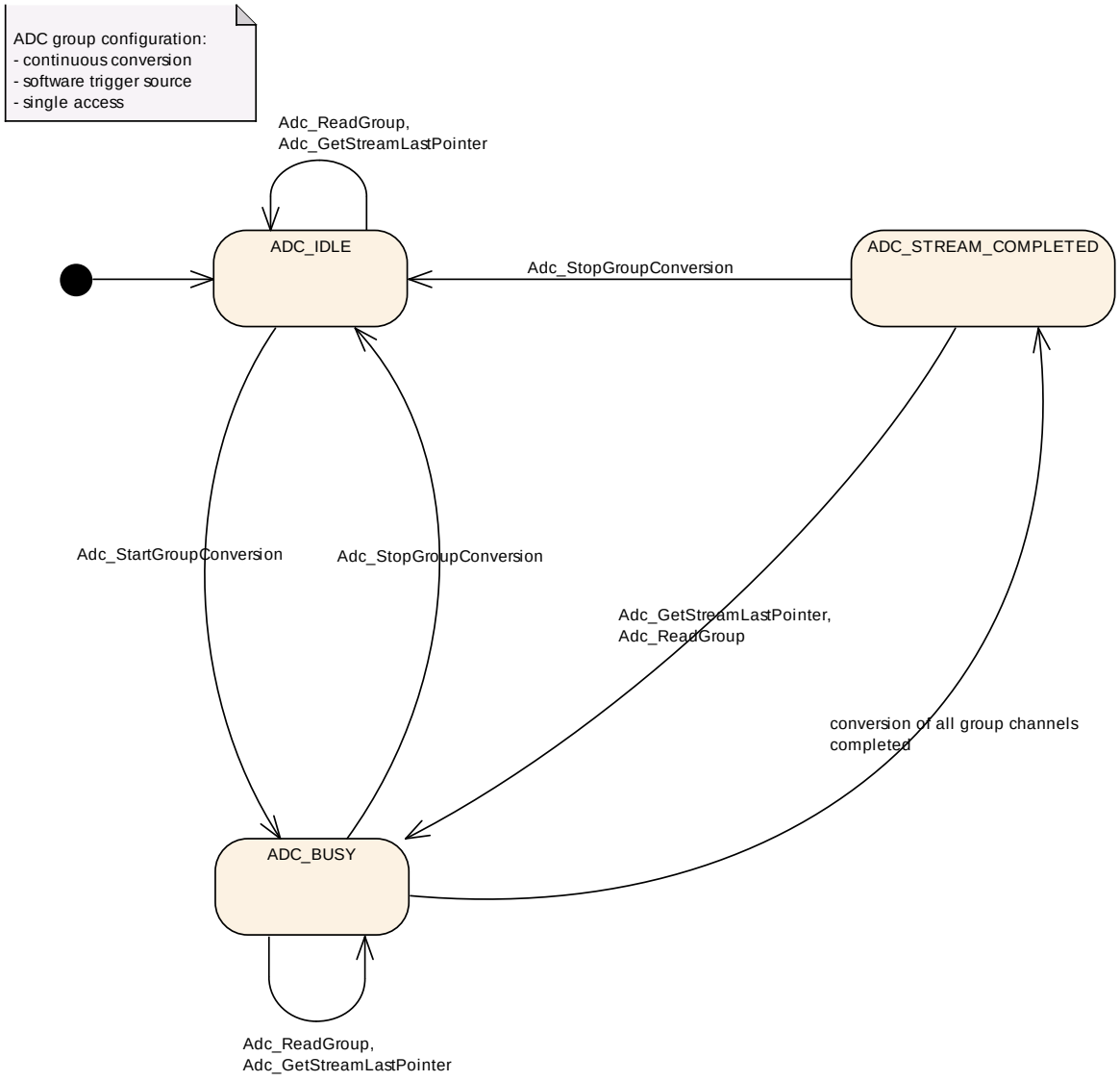


Figure 11: State Diagram Continuous, SW Trigger, Single Access

7.3.8 ADC State Diagram for Continuous Conversion Mode, Software Trigger Source, Linear and Circular Streaming Access Mode

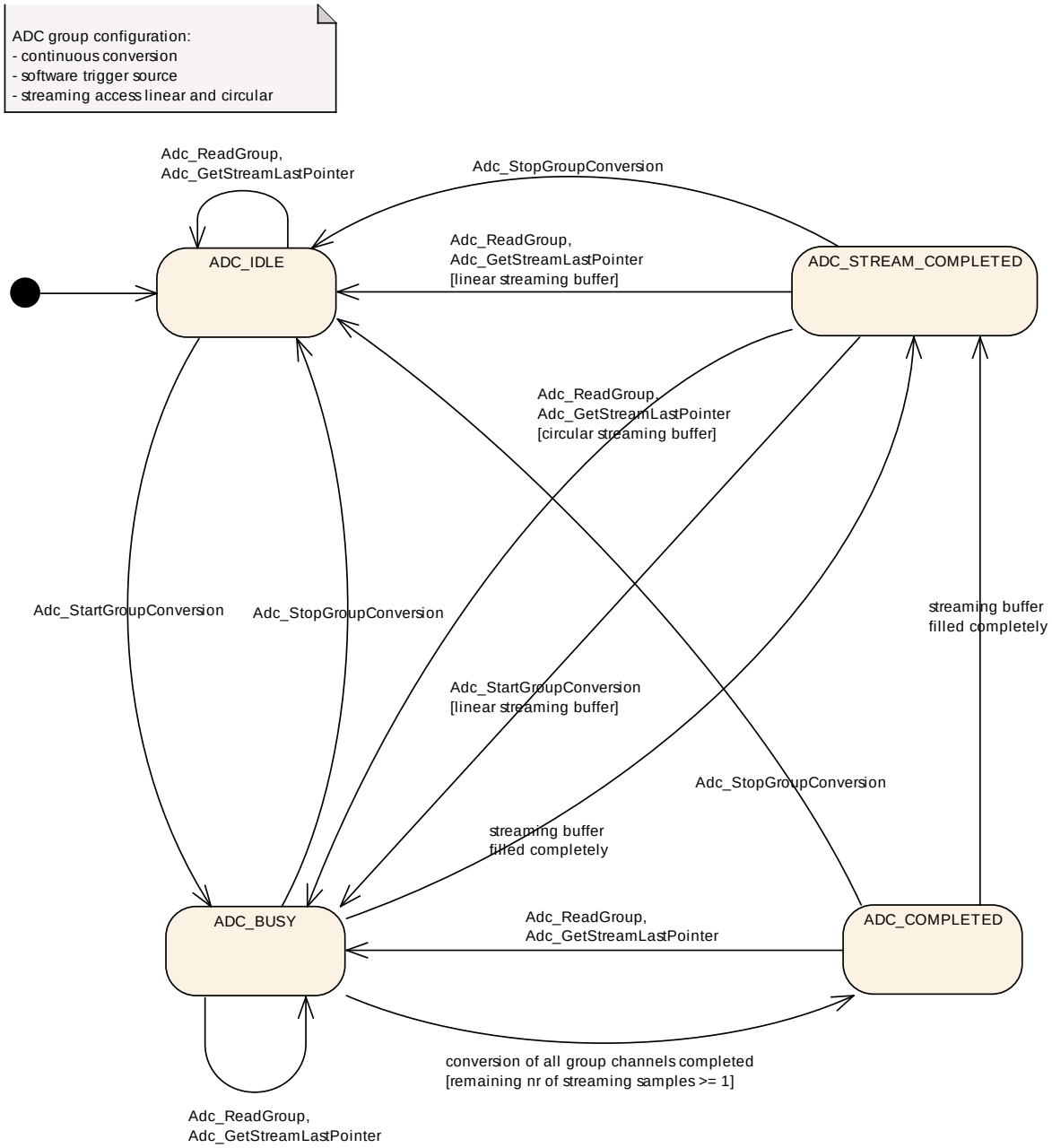


Figure 12: State Diagram Conversion, SW Trigger, Streaming Access

7.4 Version check

7.4.1 Background & Rationale

The integration of incompatible files is to be avoided. Minimum implementation is the version check of the header file inside the .c file (version numbers of .c and .h files must be identical).

7.4.2 Requirements

[ADC124] ⌈The ADC module shall perform Inter Module Checks to avoid integration of incompatible files.
The imported included files shall be checked by preprocessing directives.

The following version numbers shall be verified:
- <MODULENAME>_AR_RELEASE_MAJOR_VERSION
- <MODULENAME>_AR_RELEASE_MINOR_VERSION
.
Where <MODULENAME> is the module abbreviation of the other (external) modules which provide header files included by the ADC module.

If the values are not identical to the expected values, an error shall be reported.⌋ (BSW004)

7.5 Error classification

[ADC230] ⌈Values for production code Event Ids are assigned externally by the configuration of the Dem. They are published in the file Dem_IntErrId.h and included via Dem.h.⌋ (BSW00337)

[ADC229] ⌈Development error values are of type uint8.⌋ (BSW00337)

[ADC065] ⌈The following errors shall be detectable by the ADC module depending on its configuration (development / production mode).⌋ (BSW00337, BSW00323, BSW00385, BSW00327, BSW00331, BSW12448)

Type of error	*Relevance*	*Related error code*	*Value [hex]*
Adc_Init has not been called prior to another function call (see **ADC154**, **ADC294**, **ADC295**, **ADC296**, **ADC297**, **ADC298**, **ADC299**, **ADC300**, **ADC301**, **ADC302**,.	Development	ADC_E_UNINIT	0x0A
Adc_StartGroupConversion was called while another conversion is already running or a HW trigger is already enabled or a request is already stored in the queue (see **ADC346**, **ADC348**, **ADC350**, **ADC351**, **ADC352**). Adc_EnableHardwareTrigger was called while a conversion is ongoing or a HW trigger is already enabled or the maximum number of HW triggers is already enabled (see **ADC321**, **ADC349**, **ADC353)** Adc_DeInit was called while a conversion is still ongoing (see **ADC112**).	Development	ADC_E_BUSY	0x0B
Adc_StopGroupConversion was called while no conversion was running (see **ADC241**). Adc_DisableHardwareTrigger was called while group is not enabled (see **ADC304**)	Development	ADC_E_IDLE	0x0C
Adc_Init has been called while ADC is already initialized (see **ADC107**)	Development	ADC_E_ALREADY_INITIALIZED	0x0D
Adc_Init has been called with incorrect configuration parameter (configuration pointer is NULL_PTR for post-build configuration **ADC343** or configuration pointer is not equal NULL_PTR for pre-compile configuration **ADC344**)	Development	ADC_E_PARAM_CONFIG	0x0E
Adc_SetupResultBuffer or Adc_GetVersionInfo called with invalid data buffer pointer, NULL_PTR passed **ADC269**, **ADC458**	Development	ADC_E_PARAM_POINTER	0x14
Invalid group ID requested (see **ADC125**, **ADC126**, **ADC152**, **ADC128**, **ADC129**, **ADC130**, **ADC131**, **ADC225**, **ADC218**).	Development	ADC_E_PARAM_GROUP	0x15
Adc_EnableHardwareTrigger or Adc_DisableHardwareTrigger called on a group with conversion mode configured as continuous (see **ADC281**, **ADC282**).	Development	ADC_E_WRONG_CONV_MODE	0x16
Adc_StartGroupConversion or Adc_StopGroupConversion called on a group with trigger source configured as hardware (see **ADC133**, **ADC164**).	Development	ADC_E_WRONG_TRIGG_SRC	0x17

Adc_EnableHardwareTrigger or Adc_DisableHardwareTrigger called on a group with trigger source configured as software API (see **ADC136**, **ADC137**).			
Enable/disable notification function for a group whose configuration set has no notification available (see **ADC165**, **ADC166**).	Development	`ADC_E_NOTIF_CAPABILITY`	`0x18`
Conversion started and result buffer pointer is not initialized (see **ADC424**, **ADC425**).	Development	`ADC_E_BUFFER_UNINIT`	`0x19`
--	Production	`--`	`Assigned by DEM`

Table 3: Error classification

[ADC069] ⌈Additional errors that are detected because of specific implementation and/or specific hardware properties shall be added in the ADC device specific implementation specification. The classification and enumeration shall be compatible to the errors listed above.⌋ (BSW00337, BSW00339, BSW00385, BSW00386)

7.6 Error detection

[ADC233] ⌈The detection of development errors is configurable (ON/OFF) at pre-compile time. The switch `AdcDevErrorDetect` (see chapter 10.2) shall activate or deactivate the detection of all development errors.⌋ (BSW00338, BSW00369, BSW00386, BSW00350)

[ADC234] ⌈If the switch `AdcDevErrorDetect` is enabled, API parameter checking is enabled.⌋ (BSW00338, BSW00369)

Note: The detailed description of the detected errors can be found in chapter 7.5 and chapter 8.3.

[ADC235] ⌈The detection of production code errors cannot be switched off.⌋ (BSW00339)

[ADC269] ⌈If development error detection is enabled for the ADC module, the following API parameter checking shall be performed according to the respective functions (see table below). The error shall be reported to the Development Error Tracer.⌋ (BSW00323, BSW00386, BSW00331, BSW12448)

Note: For description and values of the error codes refer to chapter 7.5.

Note: For description of boundary conditions for the criteria of the development error detection refer to chapter 8.3.

Function	*Criteria of detection*	*Related error code*
Adc_Init	ADC driver and hardware already initialized.	ADC_E_ALREADY_INITIALIZED
	ADC initialization API called with incorrect configuration pointer	ADC_E_PARAM_CONFIG
Adc_DeInit	Function called prior to initialization.	ADC_E_UNINIT
	Function called while conversion is running.	ADC_E_BUSY
Adc_StartGroupConversion	Function called prior to initialization.	ADC_E_UNINIT
	Function called while any group is not in state ADC_IDLE.	ADC_E_BUSY
	Function called while conversion request already stored in queue.	
	Function called while conversion of same group is already running.	
	Function called with non existing group.	ADC_E_PARAM_GROUP
	Function called for a group configured for hardware trigger source.	ADC_E_WRONG_TRIGG_SRC
	Function called while result buffer pointer is not initialized	ADC_E_BUFFER_UNINIT
Adc_StopGroupConversion	Function called prior to initialization.	ADC_E_UNINIT
	Function called while group is in state ADC_IDLE.	ADC_E_IDLE
	Function called with non existing group.	ADC_E_PARAM_GROUP
	Function called for a group configured for hardware trigger source.	ADC_E_WRONG_TRIGG_SRC
Adc_GetGroupStatus	Function called prior to initialization.	ADC_E_UNINIT
	Function called with non existing group.	ADC_E_PARAM_GROUP
Adc_ReadGroup	Function called prior to initialization.	ADC_E_UNINIT
	Function called with non existing group.	ADC_E_PARAM_GROUP
	Function called while group status is ADC_IDLE	ADC_E_IDLE

Adc_EnableHardwareTrigger	Function called prior to initialization. Function called with non existing group. Function called for a group configured for software API trigger source. Function called for a group configured for Continuous conversion mode. Function called while any group is not in state ADC_IDLE. Function called while HW trigger for the group is already enabled. Function called while maximum number of available hardware triggers is already enabled. Function called while result buffer pointer is not initialized	ADC_E_UNINIT ADC_E_PARAM_GROUP ADC_E_WRONG_TRIGG_SRC ADC_E_WRONG_CONV_MODE ADC_E_BUSY ADC_E_BUFFER_UNINIT
Adc_DisableHardwareTrigger	Function called prior to initialization. Function called with non existing group. Function called for a group configured for software API trigger source. Function called for a group configured for Continuous conversion mode. Function called for a non enabled group.	ADC_E_UNINIT ADC_E_PARAM_GROUP ADC_E_WRONG_TRIGG_SRC ADC_E_WRONG_CONV_MODE ADC_E_IDLE
Adc_EnableGroupNotification	Function called prior to initialization. Function called with non existing group. Function called and notification function pointer is NULL.	ADC_E_UNINIT ADC_E_PARAM_GROUP ADC_E_NOTIF_CAPABILITY
Adc_DisableGroupNotification	Function called prior to initialization. Function called with non existing group. Function called and notification function pointer is NULL.	ADC_E_UNINIT ADC_E_PARAM_GROUP ADC_E_NOTIF_CAPABILITY
Adc_SetupResultBuffer	Function called prior to initialization. Function called with non existing group. Function called while any group is not in state ADC_IDLE. Function called and DataBufferPtr is NULL_PTR.	ADC_E_UNINIT ADC_E_PARAM_GROUP ADC_E_BUSY ADC_E_PARAM_POINTER
Adc_GetStreamLastPointer	Function called prior to initialization. Function called with non existing group. Function called while group status is	ADC_E_UNINIT ADC_E_PARAM_GROUP ADC_E_IDLE

	ADC_IDLE	
Adc_GetVersionInfo	Function called with NULL pointer.	ADC_E_PARAM_POINTER

Table 4: Error detection

7.7 Error notification

[ADC067] ⌈Detected development errors shall be reported to the *Det_ReportError* service of the Development Error Tracer (DET) if the pre-processor switch AdcDevErrorDetect is set (see chapter 10)⌋ (BSW00338, BSW00369)

[ADC068] ⌈Production errors shall be reported to the Diagnostic Event Manager (DEM).⌋ (BSW00406, BSW00339, BSW00386)

7.8 Debug Support

[ADC439] ⌈Each variable that shall be accessible by AUTOSAR Debugging, shall be
defined as global variable.⌋ ()

[ADC440] ⌈All type definitions of variables which shall be debugged, shall be accessible by the header file Adc.h.⌋ ()

[ADC441] ⌈The declaration of variables in the header file shall be such, that it is possible to calculate the size of the variables by C-"sizeof".⌋ ()

[ADC442] ⌈Variables available for debugging shall be described in the respective ADC Software Module Description.⌋ ()

8 API specification

8.1 Imported types

In this chapter all types included from the following files are listed:

[ADC364] ⌈

Module	*Imported Type*
Dem	Dem_EventIdType
	Dem_EventStatusType
Std_Types	Std_ReturnType
	Std_VersionInfoType

⌋ ()

8.2 Type definitions

8.2.1 Adc_ConfigType

Name:	`Adc_ConfigType`		
Type:	`Structure`		
Range:	`--`		Implementation specific configuration data structure.
Description:	Data structure containing the set of configuration parameters required for initializing the ADC Driver and ADC HW Unit(s).		

8.2.2 Adc_ChannelType

Name:	`Adc_ChannelType`		
Type:	`uint`		
Range:	`--`	`--`	The range of this type is µC specific and has to be described by the supplier.
Description:	Numeric ID of an ADC channel.		

8.2.3 Adc_GroupType

Name:	`Adc_GroupType`		
Type:	`uint`		
Range:	`--`	`--`	The range of this type is µC specific and has to be described by the supplier.
Description:	Numeric ID of an ADC channel group.		

8.2.4 Adc_ValueGroupType

Name:	`Adc_ValueGroupType`		
Type:	`int`		
Range:	`--`	`--`	Implementation specific.
Description:	Type for reading the converted values of a channel group (raw, without further scaling, alignment according precompile switch ADC_RESULT_ALIGNMENT).		

The result values shall be stored in an integer buffer, i.e. an array of integers.

The following rules shall apply to the driver implementation:

- **[ADC318]** ⌈In single value access mode the result buffer shall have as many elements as channels belonging to the group. In this way each buffer element corresponds to a channel, in the order the channels are defined in the group.⌋ (BSW12819)

- **[ADC319]** ⌈In streaming access mode the result buffer shall have `m*n` elements, where `n` is the number of channels belonging to the group, `m` the number of samples acquired per channel. In this way the first `m` elements belong to the first channel in the group, the second `m` elements to the second channel and so on.⌋ (BSW12825)

- **[ADC320]** ⌈The dimension (in number of bits) of each buffer element (of type integer) shall be uniform, tailored on the largest (in number of bits) channel belonging to any group.⌋ (BSW12822)

Note: Only if all ADC channels of all ADC groups have 8 bit resolution, Adc_ValueGroupType can be configured as 8 bit data type.

Note: The information about number of channels belonging to the group and number of samples acquired per channel can be derived from the group configuration data.

8.2.5 Adc_PrescaleType

Name:	`Adc_PrescaleType`		
Type:	`uint`		
Range:	`--`	`--`	The range of this type is µC specific and has to be described by the supplier.
Description:	Type of clock prescaler factor. (This is not an API type).		

8.2.6 Adc_ConversionTimeType

Name:	`Adc_ConversionTimeType`		
Type:	`uint`		
Range:	`--`	`--`	The range of this type is µC specific and has to be described by the supplier.
Description:	Type of conversion time, i.e. the time during which the sampled analogue value is converted into digital representation. (This is not an API type).		

8.2.7 Adc_SamplingTimeType

Name:	Adc_SamplingTimeType		
Type:	uint		
Range:	--	--	The range of this type is µC specific and has to be described by the supplier.
Description:	Type of sampling time, i.e. the time during which the value is sampled, (in clock-cycles). (This is not an API type).		

8.2.8 Adc_ResolutionType

Name:	Adc_ResolutionType		
Type:	uint8		
Range:	--	--	The range of this type is µC specific and has to be described by the supplier.
Description:	Type of channel resolution in number of bits. (This is not an API type).		

8.2.9 Adc_StatusType

Name:	Adc_StatusType	
Type:	Enumeration	
Range:	ADC_IDLE	- The conversion of the specified group has not been started. - No result is available.
	ADC_BUSY	- The conversion of the specified group has been started and is still going on. - So far no result is available.
	ADC_COMPLETED	- A conversion round (which is not the final one) of the specified group has been finished. - A result is available for all channels of the group.
	ADC_STREAM_COMPLETED	- The result buffer is completely filled - For each channel of the selected group the number of samples to be acquired is available
Description:	Current status of the conversion of the requested ADC Channel group.	

8.2.10 Adc_TriggerSourceType

Name:	Adc_TriggerSourceType	
Type:	Enumeration	
Range:	ADC_TRIGG_SRC_SW	Group is triggered by a software API call.
	ADC_TRIGG_SRC_HW	Group is triggered by a hardware event.
Description:	Type for configuring the trigger source for an ADC Channel group.	

8.2.11 Adc_GroupConvModeType

Name:	Adc_GroupConvModeType	
Type:	Enumeration	
Range:	ADC_CONV_MODE_ONESHOT	Exactly one conversion of each channel in an ADC channel group is performed after the configured trigger event. In case of 'group trigger source software', a started One-Shot conversion can be stopped by a software API call. In case of 'group trigger source hardware', a started One-Shot conversion can be stopped by disabling the trigger event (if supported by hardware).
	ADC_CONV_MODE_CONTINUOUS	Repeated conversions of each ADC channel in an ADC channel group are performed. 'Continuous conversion mode' is only available for 'group trigger source software'. A started 'Continuous conversion' can be stopped by a software API call.
Description:	Type for configuring the conversion mode of an ADC Channel group.	

8.2.12 Adc_GroupPriorityType

Name:	Adc_GroupPriorityType		
Type:	uint8		
Range:	0..255	--	--
Description:	Priority level of the channel. Lowest priority is 0.		

8.2.13 Adc_GroupDefType

Name:	Adc_GroupDefType
Type:	--
Description:	Type for assignment of channels to a channel group (this is not an API type).

8.2.14 Adc_StreamNumSampleType

Name:	Adc_StreamNumSampleType		
Type:	uint		
Range:	--	--	The range of this type is µC specific and has to be described by the supplier.
Description:	Type for configuring the number of group conversions in streaming access mode (in single access mode, parameter is 1).		

8.2.15 Adc_StreamBufferModeType

Name:	Adc_StreamBufferModeType	
Type:	Enumeration	
Range:	ADC_STREAM_BUFFER_LINEAR	The ADC Driver stops the conversion as soon as the stream buffer is full (number of samples reached).
	ADC_STREAM_BUFFER_CIRCULAR	The ADC Driver continues the conversion even if the stream buffer is full (number of samples reached) by wrapping around the stream buffer

		itself.
Description:	Type for configuring the streaming access mode buffer type.	

8.2.16 Adc_GroupAccessModeType

Name:	Adc_GroupAccessModeType	
Type:	Enumeration	
Range:	ADC_ACCESS_MODE_SINGLE	Single value access mode.
	ADC_ACCESS_MODE_STREAMING	Streaming access mode.
Description:	Type for configuring the access mode to group conversion results.	

8.2.17 Adc_HwTriggerSignalType

Name:	Adc_HwTriggerSignalType	
Type:	Enumeration	
Range:	ADC_HW_TRIG_RISING_EDGE	React on the rising edge of the hardware trigger signal (only if supported by the ADC hardware).
	ADC_HW_TRIG_FALLING_EDGE	React on the falling edge of the hardware trigger signal (only if supported by the ADC hardware).
	ADC_HW_TRIG_BOTH_EDGES	React on both edges of the hardware trigger signal (only if supported by the ADC hardware).
Description:	Type for configuring on which edge of the hardware trigger signal the driver should react, i.e. start the conversion (only if supported by the ADC hardware).	

8.2.18 Adc_HwTriggerTimerType

Name:	Adc_HwTriggerTimerType		
Type:	uint		
Range:	--	--	The range of this type is µC specific and has to be described by the supplier.
Description:	Type for the reload value of the ADC module embedded timer (only if supported by the ADC hardware).		

8.2.19 Adc_PriorityImplementationType

Name:	Adc_PriorityImplementationType	
Type:	Enumeration	
Range:	ADC_PRIORITY_NONE	priority mechanism is not available
	ADC_PRIORITY_HW	Hardware priority mechanism is available only
	ADC_PRIORITY_HW_SW	Hardware and software priority mechanism is available
Description:	Type for configuring the prioritization mechanism.	

8.2.20 Adc_GroupReplacementType

Name:	Adc_GroupReplacementType	
Type:	Enumeration	
Range:	ADC_GROUP_REPL_ABORT_RESTART	Abort/Restart mechanism is used on group level, if a group is interrupted by a higher

		priority group. The complete conversion round of the interrupted group (all group channels)is restarted after the higher priority group conversion is finished. If the group is configured in streaming access mode, only the results of the interrupted conversion round are discarded. Results of previous conversion rounds which are already written to the result buffer are not affected.
	ADC_GROUP_REPL_SUSPEND_RESUME	Suspend/Resume mechanism is used on group level, if a group is interrupted by a higher priority group. The conversion round of the interrupted group is completed after the higher priority group conversion is finished. Results of previous conversion rounds which are already written to the result buffer are not affected.
Description:	Replacement mechanism, which is used on ADC group level, if a group conversion is interrupted by a group which has a higher priority.	

8.2.21 Adc_ChannelRangeSelectType

Name:	Adc_ChannelRangeSelectType	
Type:	Enumeration	
Range:	ADC_RANGE_UNDER_LOW	Range below low limit - low limit value included
	ADC_RANGE_BETWEEN	Range between low limit and high limit - high limit value included
	ADC_RANGE_OVER_HIGH	Range above high limit
	ADC_RANGE_ALWAYS	Complete range - independent from channel limit settings
	ADC_RANGE_NOT_UNDER_LOW	Range above low limit
	ADC_RANGE_NOT_BETWEEN	Range above high limit or below low limit - low limit value included
	ADC_RANGE_NOT_OVER_HIGH	Range below high limit - high limit value included
Description:	In case of active limit checking: defines which conversion values are taken into account related to the boardes defineed with AdcChannelLowLimit and AdcChannelHighLimit.	

8.2.22 Adc_ResultAlignmentType

Name:	Adc_ResultAlignmentType	
Type:	Enumeration	
Range:	ADC_ALIGN_LEFT	left alignment
	ADC_ALIGN_RIGHT	right alignment
Description:	Type for alignment of ADC raw results in ADC result buffer (left/right alignment).	

8.3 Function definitions

8.3.1 Adc_Init

[ADC365] ⌈

Service name:	Adc_Init	

Syntax:	`void Adc_Init(`
	`  const Adc_ConfigType* ConfigPtr`
	`)`	

Service ID[hex]:	0x00	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	ConfigPtr	Pointer to configuration set in Variant PB (Variant PC requires a NULL_PTR).
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Initializes the ADC hardware units and driver.	

⌋ ()

[ADC054] ⌈In case of Variant PB: The function Adc_Init shall initialize the ADC hardware units and driver according to the configuration set referenced by ConfigPtr.⌋ (BSW00405, BSW101, BSW00414, BSW12057, BSW12461)

[ADC342] ⌈In case of Variant PC: The function Adc_Init shall initialize the ADC hardware units and driver according to the pre-compile configuration set. The configuration pointer which is passed to Adc_Init shall be a NULL pointer. The pointer is only evaluated, if development error detection is enabled (see ADC344).⌋ (BSW00345, BSW00414)

[ADC056] ⌈The function Adc_Init shall only initialize the configured resources. Resources that are not contained in the configuration file shall not be touched.⌋ (BSW12125)

The following rules regarding initialization of controller registers apply to this driver implementation:

- **[ADC246]** ⌈If the hardware allows for only one usage of the register, the driver module implementing that functionality is responsible for initializing the register.⌋ (BSW12461)
- **[ADC247]** ⌈If the register can affect several hardware modules and if it is an I/O register, it shall be initialized by the PORT driver.⌋ (BSW12461)
- **[ADC248]** ⌈If the register can affect several hardware modules and if it is not an I/O register, it shall be initialized by the MCU driver.⌋ (BSW12461)
- **[ADC249]** ⌈One-time writable registers that require initialization directly after reset shall be initialized by the startup code.⌋ (BSW12461)
- **[ADC250]** ⌈All other registers shall be initialized by the startup code.⌋ (BSW12461)

[ADC077] ⌈The function Adc_Init shall disable the notifications and hardware trigger capability (if statically configured as active).⌋ (BSW12318)

[ADC307] ⌈The function Adc_Init shall set all groups to ADC_IDLE state. ⌋ ()

[ADC343] ⌈In case of Variant PB and if development error detection for the ADC module is enabled: if called with a NULL_PTR as configuration parameter, the function Adc_Init shall raise development error ADC_E_PARAM_CONFIG and return without any action. ⌋ ()

[ADC344] ⌈In case of Variant PC and if development error detection for the ADC module is enabled: if called without a NULL_PTR as configuration parameter, the function Adc_Init shall raise development error ADC_E_PARAM_CONFIG and return without any action. ⌋ ()

[ADC107] ⌈If development error detection for the ADC module is enabled: if called when the ADC driver and hardware are already initialized, the function Adc_Init shall raise development error ADC_E_ALREADY_INITIALIZED and return without any action.⌋ (BSW00406, BSW00386, BSW12448)

8.3.2 Adc_SetupResultBuffer

[ADC419] ⌈

Service name:	Adc_SetupResultBuffer

Syntax:	`Std_ReturnType Adc_SetupResultBuffer(`
	`  Adc_GroupType Group,`
	`  Adc_ValueGroupType* DataBufferPtr`

	)	
Service ID[hex]:	0x0c	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC channel group.
	DataBufferPtr	pointer to result data buffer
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: result buffer pointer initialized correctly E_NOT_OK: operation failed or development error occured
Description:	Initializes ADC driver with the group specific result buffer start address where the conversion results will be stored. The application has to ensure that the application buffer, where DataBufferPtr points to, can hold all the conversion results of the specified group. The initialization with Adc_SetupResultBuffer is required after reset, before a group conversion can be started.	

」()

[ADC420] 「The function Adc_SetupResultBuffer shall initialize the result buffer pointer of the selected group with the address value passed as parameter.」()

[ADC421] 「The ADC module's environment shall ensure that no group conversions are started without prior initialization of the according result buffer pointer to point to a valid result buffer.」()

[ADC422] 「The ADC module's environment shall ensure that the application buffer, which address is passed as parameter in Adc_SetupResultBuffer, has the according size to hold all group channel conversion results and if streaming access is selected, hold these results multiple times as specified with streaming sample parameter (see ADC292).」()

[ADC423] 「If development error detection for the ADC module is enabled: if the channel group ID is non-existing, the function Adc_SetupResultBuffer shall raise development error ADC_E_PARAM_GROUP and return without any action.」()

[ADC433] 「If development error detection for the ADC module is enabled: if called while group is not in state ADC_IDLE, function Adc_SetupResultBuffer shall raise development error ADC_E_BUSY and return without any action.」()

[ADC434] 「If development error detection for the ADC module is enabled: when called prior to initializing the driver, the function Adc_SetupResultBuffer shall raise development error ADC_E_UNINIT.」()

[ADC457] 「If development error detection for the ADC module is enabled: when called with a NULL_PTR as DataBufferPtr, the function Adc_SetupResultBuffer shall raise development error ADC_E_PARAM_POINTER.」()

8.3.3 Adc_DeInit

[ADC366] ⌈

Service name:	Adc_DeInit

Syntax:	`void Adc_DeInit(`
	`  void`
	`)`

Service ID[hex]:	0x01
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	Returns all ADC HW Units to a state comparable to their power on reset state.

⌋ ()

[ADC110] ⌈The function Adc_DeInit shall return all ADC HW Units to a state comparable to their power on reset state. Values of registers which are not writeable are excluded. It's the responsibility of the hardware design that this state does not lead to undefined activities in the µC.⌋ (BSW12163)

[ADC111] ⌈The function Adc_DeInit shall disable all used interrupts and notifications. ⌋ (BSW00336, BSW12163)

[ADC358] ⌈The ADC module's environment shall not call the function Adc_DeInit while any group is not in state ADC_IDLE.⌋ ()

[ADC228] ⌈The function Adc_DeInit shall be pre compile time configurable On/Off by the configuration parameter: AdcDeInitApi.⌋ (BSW171)

[ADC112] ⌈If development error detection for the ADC module is enabled: if called while not all groups are either in state ADC_IDLE or state ADC_STREAM_COMPLETED, while no conversion is ongoing (ADC groups which are implicitly stopped), the function Adc_DeInit shall raise development error ADC_E_BUSY and return without any action.⌋ (BSW00386, BSW12448)

[ADC154] ⌈If development error detection for the ADC module is enabled: if called before the module has been initialized, the function Adc_DeInit shall raise development error ADC_E_UNINIT and return without any action.⌋ (BSW00406, BSW00386, BSW12448)

8.3.4 Adc_StartGroupConversion

[ADC367] ⌈

Service name:	Adc_StartGroupConversion	

Syntax:	`void Adc_StartGroupConversion(`
	`  Adc_GroupType Group`
	`)`	

Service ID[hex]:	0x02	
Sync/Async:	Asynchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Starts the conversion of all channels of the requested ADC Channel group.	

⌋ ()

[ADC061] ⌈The function Adc_StartGroupConversion shall start the conversion of all channels of the requested ADC Channel group. Depending on the group configuration, one-shot or continuous conversion is started.⌋ (BSW12364)

[ADC431] ⌈The function Adc_StartGroupConversion shall reset the internal result buffer pointer, that conversion result storage always starts, after calling Adc_StartGroupConversion, at the result buffer base address which was configured with Adc_SetupResultBuffer.⌋ ()

[ADC156] ⌈The function Adc_StartGroupConversion shall NOT automatically enable the notification mechanism for that group (this has to be done by a separate API call).⌋ (BSW12317, BSW12318)

[ADC146] ⌈The ADC module's environment shall only call Adc_StartGroupConversion for groups configured with software trigger source.⌋ (BSW12817, BSW12364)

[ADC259] ⌈The function Adc_StartGroupConversion shall be pre-compile time configurable On/Off by the configuration parameter AdcEnableStartStopGroupApi.⌋ (BSW171)

[ADC125] ⌈If development error detection for the ADC module is enabled: when called with a non-existing channel group ID, function Adc_StartGroupConversion shall raise development error ADC_E_PARAM_GROUP and return without any action.⌋ (BSW00323, BSW00386, BSW12448)

[ADC133] ⌈If development error detection for the ADC module is enabled: when called on a group with trigger source configured as hardware, function Adc_StartGroupConversion shall raise development error

ADC_E_WRONG_TRIGG_SRC and return without any action.⌋ (BSW00386, BSW12448)

[ADC346] ⌈If development error detection for the ADC module is enabled and the priority mechanism is disabled and the queuing is disabled : when called while any of the groups, which can not be implicitly stopped, is not in state ADC_IDLE , the function Adc_StartGroupConversion shall raise development error ADC_E_BUSY and return without any action.⌋ ()

Note: The condition that any group is not in state ADC_IDLE means in this context:

- *Any conversion is ongoing*
  or
- *Any HW trigger is enabled*

[ADC426] ⌈If development error detection for the ADC module is enabled and the priority mechanism is disabled and the queuing is disabled: when called while any of the groups, which can be implicitly stopped, is not in state ADC_IDLE and not in state ADC_STREAM_COMPLETED, the function Adc_StartGroupConversion shall raise development error ADC_E_BUSY and return without any action.⌋ ()

Note: Groups which can be implicitly stopped are:

- *Software triggered groups configured in one-shot, single-access mode*
- *Software triggered groups configured in continuous, linear streaming access mode*
- *Hardware triggered groups configured in one-shot, linear streaming access mode*

[ADC348] ⌈If development error detection for the ADC module is enabled and the priority mechanism is enabled: when called while a group, which can not be implicitly stopped, is not in state ADC_IDLE, the function Adc_StartGroupConversion shall raise development error ADC_E_BUSY and return without any action.⌋ ()

Note: The condition that the group is not in state ADC_IDLE means in this context:

- *The conversion of the same group is currently ongoing*
  or
- *A conversion request for the same group is already stored one time in the queue*

[ADC427] ⌈If development error detection for the ADC module is enabled and the priority mechanism is enabled: when called while a group, which can be implicitly stopped, is not in state ADC_IDLE and not in state ADC_STREAM_COMPLETED, the function Adc_StartGroupConversion shall raise development error ADC_E_BUSY and return without any action.⌋ ()

[ADC351] ⌈If development error detection for the ADC module is enabled and the priority mechanism is disabled and the queuing is enabled: when called while a group, which can not be implicitly stopped, is not in state ADC_IDLE, the function Adc_StartGroupConversion shall raise development error ADC_E_BUSY and return without any action.⌋ ()

[ADC428] ⌈If development error detection for the ADC module is enabled and the priority mechanism is disabled and the queuing is enabled: when called while a group, which can be implicitly stopped, is not in state ADC_IDLE and not in state ADC_STREAM_COMPLETED, the function Adc_StartGroupConversion shall raise development error ADC_E_BUSY and return without any action.⌋ ()

[ADC294] ⌈If development error detection for the ADC module is enabled: when called prior to initializing the driver, the function Adc_StartGroupConversion shall raise development error ADC_E_UNINIT.⌋ (BSW00406)

[ADC424] ⌈If development error detection for the ADC module is enabled: when called prior to initializing the result buffer pointer with function Adc_SetupResultBuffer, the function Adc_StartGroupConversion shall raise development error ADC_E_BUFFER_UNINIT.⌋ ()

8.3.5 Adc_StopGroupConversion

[ADC368] ⌈

Service name:	Adc_StopGroupConversion	

Syntax:	`void Adc_StopGroupConversion(`
	`  Adc_GroupType Group`
	`)`	

Service ID[hex]:	0x03	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Stops the conversion of the requested ADC Channel group.	

」()

[ADC385] ⌈When the ADC Channel Group is in one-shot and software-trigger mode, the function Adc_StopGroupConversion shall stop an ongoing conversion of the group.⌋ (BSW12364)

[ADC437] ⌈When the ADC Channel Group is in one-shot and software-trigger mode, the function Adc_StopGroupConversion shall remove a start/restart request of the group from the queue, if queuing is enabled and a start/restart request is stored in the queue.⌋ ()

[ADC386] ⌈When the ADC Channel Group is in continuous-conversion and software-trigger mode, the function Adc_StopGroupConversion shall stop an ongoing conversion of the group.⌋ (BSW12364)

[ADC438] ⌈When the ADC Channel Group is in continuous-conversion and software-trigger mode, the function Adc_StopGroupConversion shall remove a start/restart request of the group from the queue, if queuing is enabled and a start/restart request is stored in the queue.⌋ ()

[ADC155] ⌈The function Adc_StopGroupConversion shall automatically disable group notification for the requested group.⌋ (BSW12317)

Note:
Groups which are implicitly stopped shall not disable the group notification until Adc_StopGroupConversion is called.

[ADC360] ⌈The function Adc_StopGroupConversion shall set the group status to state ADC_IDLE.⌋ ()

[ADC283] ⌈The ADC module's environment shall only call the function Adc_StopGroupConversion for groups configured with trigger source software.⌋ (BSW12817)

[ADC260] ⌈The function Adc_StopGroupConversion shall be pre compile time configurable On/Off by the configuration parameter AdcEnableStartStopGroupApi.⌋ (BSW171)

[ADC126] ⌈If development error detection for the ADC module is enabled: if the group ID is non-existing, the function Adc_StopGroupConversion shall raise development error ADC_E_PARAM_GROUP and return without any action.⌋ (BSW00323, BSW00386, BSW12448)

[ADC164] ⌈If development error detection for the ADC module is enabled: if the group has a trigger source configured as hardware, function Adc_StopGroupConversion shall raise development error ADC_E_WRONG_TRIGG_SRC and return without any action.⌋ (BSW00386, BSW12448)

[ADC241] ⌈If development error detection for the ADC module is enabled: when called while the group is in state ADC_IDLE, the function Adc_StopGroupConversion shall raise development error ADC_E_IDLE and return without any action.⌋ (BSW00323, BSW00386, BSW12448)

Note: For groups which are implicitly stopped (groups with conversion mode one-shot or groups with linear streaming buffer mode), state is ADC_STREAM_COMPLETED until results are accessed with Adc_ReadGroup or Adc_GetStreamLastPointer API functions or until group is explicitly stopped by Adc_StopGroupConversion API.

[ADC295] ⌈If development error detection for the ADC module is enabled: if called prior to initializing the module, function Adc_StopGroupConversion shall raise development error ADC_E_UNINIT and return without any action.⌋ (BSW00406)

Note:
All groups which are started with Adc_StartGroupConversion should also be stopped with Adc_StopGroupConversion, before they are started again to reset the group status to ADC_IDLE. Exceptions to this rule are groups which are implicitly stopped because of the selected conversion mode (linear buffer with streaming access mode or one-shot conversion mode with single access). These groups can also be restarted while the group is in state ADC_STREAM_COMPLETED.

8.3.6 Adc_ReadGroup

[ADC369] ⌈

Service name:	Adc_ReadGroup	

Syntax:	`Std_ReturnType Adc_ReadGroup(`
	`  Adc_GroupType Group,`
	`  Adc_ValueGroupType* DataBufferPtr`
	`)`	

Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC channel group.

	DataBufferPtr	ADC results of all channels of the selected group are stored in the data buffer addressed with the pointer.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: results are available and written to the data buffer E_NOT_OK: no results are available or development error occured
Description:	Reads the group conversion result of the last completed conversion round of the requested group and stores the channel values starting at the DataBufferPtr address. The group channel values are stored in ascending channel number order (in contrast to the storage layout of the result buffer if streaming access is configured).	

⌋()

[ADC075] ⌈The function Adc_ReadGroup shall read the latest available conversion results of the requested group.⌋()

[ADC113] ⌈The function Adc_ReadGroup shall read the raw converted values without further scaling. The read values shall be aligned according the configuration parameter setting of ADC_RESULT_ALIGNMENT.⌋(BSW12063, BSW12819, BSW12292, BSW12824)

[ADC122] ⌈If applicable, the function Adc_ReadGroup shall mask out all information or diagnostic bits provided by the conversion but not belonging to the conversion results themselves.⌋(BSW12283, BSW12819)

[ADC329] ⌈Calling function Adc_ReadGroup while group status is ADC_STREAM_COMPLETED shall trigger a state transition to ADC_BUSY for continuous conversion modes (single access mode or circular streaming buffer mode) and hardware triggered groups in single access mode or circular streaming access mode.⌋(BSW12291)

[ADC330] ⌈Calling function Adc_ReadGroup while group status is ADC_STREAM_COMPLETED shall trigger a state transition to ADC_IDLE for software triggered conversion modes which automatically stop the conversion (streaming buffer with linear access mode or one-shot conversion mode with single access) and for the hardware triggered conversion mode in combination with linear streaming access mode.⌋(BSW12291)

[ADC331] ⌈Calling function Adc_ReadGroup while group status is ADC_COMPLETED shall trigger a state transition to ADC_BUSY.⌋(BSW12291)

[ADC359] ⌈The function Adc_ReadGroup shall be pre-compile configurable On/Off by the configuration parameter AdcReadGroupApi.⌋()

[ADC388] ⌈If development error detection for the ADC module is enabled: when called while the group status is ADC_IDLE and the group conversion was not started

(no results are available from previous conversions), the function Adc_ReadGroup shall raise development error ADC_E_IDLE, return E_NOT_OK and return without any action.」()

[ADC152] 「If development error detection for the ADC module is enabled: if the group ID is non-existing, the function Adc_ReadGroup shall raise development error ADC_E_PARAM_GROUP and return E_NOT_OK.」(BSW00323, BSW00386, BSW12448)

[ADC296] 「If development error detection for the ADC module is enabled: when called prior to initializing the driver, the function Adc_ReadGroup shall raise development error ADC_E_UNINIT and return E_NOT_OK.」()

8.3.7 Adc_EnableHardwareTrigger

[ADC370] 「

Service name:	Adc_EnableHardwareTrigger	

Syntax:	`void Adc_EnableHardwareTrigger(`
	`  Adc_GroupType Group`
	`)`	

Service ID[hex]:	0x05	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Enables the hardware trigger for the requested ADC Channel group.	

」()

[ADC114] 「The function Adc_EnableHardwareTrigger shall enable the hardware trigger for the requested ADC Channel group.」(BSW12823)

Note: Adc_EnableHardwareTrigger can only be used for ADC internal trigger sources controlled from the ADC hardware.

[ADC144] 「A group with trigger source hardware, whose trigger was enabled with Adc_EnableHardwareTrigger, shall execute the group channel conversions, whenever a trigger event occurs.」(BSW12823)

[ADC432] 「The function Adc_EnableHardwareTrigger shall reset the internal group result buffer pointer, that conversion result storage always starts, after calling Adc_EnableHardwareTrigger, at the result buffer base address which was configured with Adc_SetupResultBuffer.」()

[ADC273] 「The ADC module's environment shall guarantee that no concurrent conversions take place on the same HW Unit (happening of different hardware triggers at the same time).」(BSW12823)

Note: The reason for ADC273 is that the ADC module can only handle one group conversion request per HW Unit at the same time. In case of concurrent HW conversion requests, the HW prioritization mechanism controls the conversion order.

[ADC120] 「The ADC module's environment shall only call the function Adc_EnableHardwareTrigger for groups configured in hardware trigger mode (see AdcGroupTriggSrc).」(BSW171)

[ADC265] 「The function Adc_EnableHardwareTrigger shall be pre-compile time configurable On/Off by the configuration parameter AdcHwTriggerApi.」(BSW171)

[ADC321] 「If development error detection is enabled for the ADC driver and if the priority mechanism is disabled and queuing disabled: when called while any group with trigger source SW is not in state ADC_IDLE, the function Adc_EnableHardwareTrigger shall raise development error ADC_E_BUSY and return without any action.」()

[ADC349] 「If development error detection for the ADC module is enabled: if the HW trigger for the group is already enabled, the function Adc_EnableHardwareTrigger shall raise development error ADC_E_BUSY and return without any action.」()

[ADC353] ⌈If development error detection for the ADC module is enabled: if the maximum number of available hardware triggers is already enabled (device and implementation specific), the function Adc_EnableHardwareTrigger shall raise development error ADC_E_BUSY and return without any action.⌋ ()

[ADC128] ⌈If development error detection for the ADC module is enabled: if the channel group ID is invalid, the function Adc_EnableHardwareTrigger shall raise development error ADC_E_PARAM_GROUP and return without any action.⌋ (BSW00323, BSW00386, BSW12448)

[ADC136] ⌈If development error detection for the ADC module is enabled: if the group is configured for software API trigger mode, the function Adc_EnableHardwareTrigger shall raise development error ADC_E_WRONG_TRIGG_SRC and return without any action.⌋ (BSW00386, BSW12448)

[ADC281] ⌈If development error detection for the ADC module is enabled: if a HW group is erroneously configured for continuous conversion mode, the function Adc_EnableHardwareTrigger shall raise development error ADC_E_WRONG_CONV_MODE and return without any action.⌋ (BSW12823)

Note: SW groups configured in continuous conversion mode shall raise development error ADC_E_WRONG_TRIGG_SRC instead.

[ADC297] ⌈If development error detection for the ADC module is enabled: if called prior to initializing the driver, the function Adc_EnableHardwareTrigger shall raise development error ADC_E_UNINIT and return without any action. ⌋ (BSW00406)

[ADC425] ⌈If development error detection for the ADC module is enabled: when called prior to initializing the result buffer pointer with function Adc_SetupResultBuffer, the function Adc_EnableHardwareTrigger shall raise development error ADC_E_BUFFER_UNINIT.⌋ ()

8.3.8 Adc_DisableHardwareTrigger

[ADC371] ⌈

Service name:	Adc_DisableHardwareTrigger	

Syntax:	`void Adc_DisableHardwareTrigger(`
	`  Adc_GroupType Group`
	`)`	

Service ID[hex]:	0x06	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.

Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	Disables the hardware trigger for the requested ADC Channel group.

⌋()

[ADC116] ⌈The function Adc_DisableHardwareTrigger shall disable the hardware trigger for the requested ADC Channel group.⌋ (BSW12823)

[ADC429] ⌈The function Adc_DisableHardwareTrigger shall remove any queued start/restart request for the requested ADC Channel group if queuing is enabled.⌋()

[ADC145] ⌈The function Adc_DisableHardwareTrigger shall abort an ongoing conversion, if applicable (supported by the hardware).⌋ (BSW12364)

[ADC157] ⌈If enabled, the function Adc_DisableHardwareTrigger shall disable the notification mechanism for the requested group.⌋ (BSW12317, BSW12318, BSW12364)

[ADC361] ⌈The function Adc_DisableHardwareTrigger shall set the group status to state ADC_IDLE.⌋()

[ADC121] ⌈The ADC module's environment shall only call the function Adc_DisableHardwareTrigger for groups configured in hardware trigger mode (see AdcGroupTriggSrc).⌋ (BSW171)

[ADC266] ⌈The function Adc_DisableHardwareTrigger shall be pre-compile time configurable On/Off by the configuration parameter AdcHwTriggerApi.⌋ (BSW171)

[ADC129] ⌈If development error detection for the ADC module is enabled: if the channel group ID is non-existing, the function Adc_DisableHardwareTrigger shall raise development error ADC_E_PARAM_GROUP and return without any action.⌋ (BSW00323, BSW00386, BSW12448)

[ADC137] ⌈If development error detection for the ADC module is enabled: if the group is configured for software API trigger mode, the function Adc_DisableHardwareTrigger shall raise development error ADC_E_WRONG_TRIGG_SRC and return without any action.⌋ (BSW00386, BSW12448)

[ADC282] ⌈If development error detection for the ADC module is enabled: if a HW group is erroneously configured for continuous conversion mode, the function Adc_DisableHardwareTrigger shall raise development error ADC_E_WRONG_CONV_MODE and return without any action.⌋ (BSW12823)

Note: SW groups configured in continuous conversion mode shall raise development error ADC_E_WRONG_TRIGG_SRC instead.

[ADC304] ⌈If development error detection for the ADC module is enabled: if the group is not enabled (with a previous call of Adc_EnableHardwareTrigger), the function Adc_DisableHardwareTrigger shall raise development error ADC_E_IDLE and return without any action.⌋ ()

[ADC298] ⌈If development error detection for the ADC module is enabled: if called prior to initializing the ADC module, Adc_DisableHardwareTrigger shall raise development error ADC_E_UNINIT and return without any action.⌋ (BSW00406)

Note:
All groups which are enabled with Adc_EnableHardwareTrigger should also be disabled with Adc_DisableHardwareTrigger, before they are enabled again, even if they are implicitly stopped because of the selected conversion mode (streaming buffer with linear access mode).

8.3.9 Adc_EnableGroupNotification

[ADC372] ⌈

Service name:	Adc_EnableGroupNotification	

Syntax:	`void Adc_EnableGroupNotification(`
	`  Adc_GroupType Group`
	`)`	

Service ID[hex]:	0x07	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Enables the notification mechanism for the requested ADC Channel group.	

⌋ ()

[ADC057] ⌈The function Adc_EnableGroupNotification shall enable the notification mechanism for the requested ADC Channel group.⌋ (BSW157, BSW12318)

[ADC100] ⌈The function Adc_EnableGroupNotification shall be pre-compile time configurable On/Off by the configuration parameter AdcGrpNotifCapability.⌋ (BSW12447)

[ADC130] ⌈If development error detection for the ADC module is enabled: if the channel group ID is non-existing, the function Adc_EnableGroupNotification shall raise development error ADC_E_PARAM_GROUP and return without any action.⌋ (BSW00323, BSW00386, BSW12448,)

[ADC165] ⌈If development error detection for the ADC module is enabled: if the group notification function pointer is NULL, the function Adc_EnableGroupNotification shall raise development error ADC_E_NOTIF_CAPABILITY and return without any action.⌋ (BSW00386, BSW12448)

[ADC299] ⌈If development error detection for the ADC module is enabled: if called prior to initializing the ADC module, Adc_EnableGroupNotification shall raise development error ADC_E_UNINIT and return without any action.⌋ (BSW00406)

8.3.10 Adc_DisableGroupNotification

[ADC373] ⌈

Service name:	Adc_DisableGroupNotification	

Syntax:	`void Adc_DisableGroupNotification(`
	`  Adc_GroupType Group`
	`)`	

Service ID[hex]:	0x08	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Disables the notification mechanism for the requested ADC Channel group.	

⌋ ()

[ADC058] ⌈The function Adc_DisableGroupNotification shall disable the notification mechanism for the requested ADC Channel group.⌋ (BSW157, BSW12318)

[ADC101] ⌈The function Adc_DisableGroupNotification shall be pre-compile time configurable On/Off by the configuration parameter AdcGrpNotifCapability⌋ (BSW12447)

[ADC131] ⌈If development error detection for the ADC module is enabled: if the channel group ID is non-existing, the function Adc_DisableGroupNotification shall raise development error ADC_E_PARAM_GROUP and return without any action.⌋ (BSW00323, BSW00386, BSW12448)

[ADC166] ⌈If development error detection for the ADC module is enabled: if the group notification function pointer is NULL, the function Adc_DisableGroupNotification shall raise development error ADC_E_NOTIF_CAPABILITY and return without any action.⌋ (BSW00386, BSW12448)

[ADC300] ⌈If development error detection for the ADC module is enabled: if called prior to initializing the ADC module, Adc_DisableGroupNotification shall raise development error ADC_E_UNINIT and return without any action.⌋ (BSW00406)

8.3.11 Adc_GetGroupStatus

[ADC374] ⌈

Service name:	Adc_GetGroupStatus	

Syntax:	`Adc_StatusType Adc_GetGroupStatus(`
	`  Adc_GroupType Group`
	`)`	

Service ID[hex]:	0x09	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Adc_StatusType	Conversion status for the requested group.
Description:	Returns the conversion status of the requested ADC Channel group.	

」()

[ADC220] ⌈The function Adc_GetGroupStatus shall return the conversion status of the requested ADC Channel group.⌋ (BSW12291)

[ADC221] ⌈The function Adc_GetGroupStatus shall return ADC_IDLE:

- If Adc_GetGroupStatus is called before the conversion of the requested group has been started
- For groups with trigger source software: If Adc_GetGroupStatus is called after the conversion was stopped with Adc_StopGroupConversion
- In continuous group conversion mode with linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer (group was in state ADC_STREAM_COMPLETED while calling Adc_GetStreamLastPointer).
- In continuous group conversion mode with linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup (group was in state ADC_STREAM_COMPLETED while calling Adc_ReadGroup).
- In one-shot SW conversion mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer.
- In one-shot SW conversion mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup.
- For groups with trigger source hardware: If Adc_GetGroupStatus is called after calling Adc_DisableHardwareTrigger
- For groups with trigger source hardware and linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer (group was in state ADC_STREAM_COMPLETED while calling Adc_GetStreamLastPointer).
- For groups with trigger source hardware and linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup (group was in state ADC_STREAM_COMPLETED while calling Adc_ReadGroup). 」(BSW00335, BSW12291)

[ADC222] ⌈The function Adc_GetGroupStatus shall return ADC_BUSY:
- If it is called while the first conversion round of the requested group is still ongoing (continuous conversion mode).
- Once trigger is enabled for group with HW trigger source.
- Once Adc_StartGroupConversion is called for group with SW trigger source.
- In continuous group conversion mode with single access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer
- In continuous group conversion mode with single access mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup.
- In continuous group conversion mode with circular streaming access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer
- In continuous group conversion mode with circular streaming access mode If Adc_GetGroupStatus is called after calling Adc_ReadGroup.
- In continuous group conversion mode with linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer (group was in state ADC_COMPLETED while calling Adc_GetStreamLastPointer).
- In continuous group conversion mode with linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup (group was in state ADC_COMPLETED while calling Adc_ReadGroup).
- In one-shot HW conversion mode and single access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer.
- In one-shot HW conversion mode and single access mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup.
- In one-shot HW conversion mode and circular streaming access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer.
- In one-shot HW conversion mode and circular streaming access mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup.
- In one-shot HW conversion mode and linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_GetStreamLastPointer (group was in state ADC_COMPLETED while calling Adc_GetStreamLastPointer).
- In one-shot HW conversion mode and linear streaming access mode: If Adc_GetGroupStatus is called after calling Adc_ReadGroup (group was in state ADC_COMPLETED while calling Adc_ReadGroup).⌋ (BSW00335, BSW12291)

[ADC224] ⌈The function Adc_GetGroupStatus shall return ADC_COMPLETED:
- If it is called after a conversion round (not the final one) of the requested group has been finished.⌋ (BSW00335, BSW12291)

[ADC325] ⌈The function Adc_GetGroupStatus shall return ADC_STREAM_COMPLETED:
- If it is called in single access mode after one conversion round is completed.
- If it is called in streaming access mode after the number of conversion rounds of the requested group have been finished, to fill the streaming buffer completely.

⌋ (BSW12291)

[ADC226] ⌈The function Adc_GetGroupStatus shall provide atomic access to the status data by the use of atomic instructions.⌋ (BSW12291)

[ADC305] ⌈To guarantee consistent returned values, it is assumed that ADC group conversion is always started (or enabled in case of HW group) successfully by SW before status polling begins.⌋ ( )

[ADC225] ⌈If development error detection for the ADC module is enabled: if the channel group ID is non-existing, the function Adc_GetGroupStatus shall raise development error ADC_E_PARAM_GROUP and return ADC_IDLE without any action.⌋ (BSW00323, BSW00386, BSW12448)

.

[ADC301] ⌈If development error detection for the ADC module is enabled: if called prior to initializing the ADC module, Adc_GetGroupStatus shall raise development error ADC_E_UNINIT and return ADC_IDLE without any action.⌋ (BSW00406)

[ADC436] ⌈In case of an aborted/suspended group, the state of the queued group remains the same as it was before the group was aborted/suspended.⌋ ()

8.3.12 Adc_GetStreamLastPointer

[ADC375] ⌈

Service name:	Adc_GetStreamLastPointer	

Syntax:	`Adc_StreamNumSampleType Adc_GetStreamLastPointer(`
	`  Adc_GroupType Group,`
	`  Adc_ValueGroupType** PtrToSamplePtr`
	`)`	

Service ID[hex]:	0x0b	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	Group	Numeric ID of requested ADC Channel group.
Parameters (inout):	None	
Parameters (out):	PtrToSamplePtr	Pointer to result buffer pointer.
Return value:	Adc_StreamNumSampleType	Number of valid samples per channel.
Description:	Returns the number of valid samples per channel, stored in the result buffer. Reads a pointer, pointing to a position in the group result buffer. With the pointer position, the results of all group channels of the last completed conversion round can be accessed. With the pointer and the return value, all valid group conversion results can be accessed (the user has to take the layout of the result buffer into account).	

⌋ ()

[ADC214] ⌈The function Adc_GetStreamLastPointer shall set the pointer, passed as parameter (PtrToSamplePtr) to point in the ADC result buffer to the latest result of

the first group channel of the last completed conversion round.⌋ (BSW12292, BSW12802)

[ADC418] ⌈All values which the ADC driver stores in the ADC result buffer, are left without further scaling and shall be aligned according the configuration parameter setting of ADC_RESULT_ALIGNMENT.⌋ ()

[ADC387] ⌈The function Adc_GetStreamLastPointer shall return the number of valid samples per channel, stored in the ADC result buffer. ⌋ ()

Note: Valid samples are in the ADC result buffer when the group is in state ADC_COMPLETED or ADC_STREAM_COMPLETED. In state ADC_BUSY or ADC_IDLE the value 0 is returned.

Note: The return value is 1 for groups with single access mode configuration, if valid samples are stored in the ADC result buffer.

[ADC216] ⌈When called while the group status is ADC_BUSY (a conversion of the group is in progress), the function Adc_GetStreamLastPointer shall set the pointer, passed as parameter (PtrToSamplePtr), to NULL and return 0.⌋ (BSW12802)

[ADC219] ⌈The ADC module's environment shall guarantee the consistency of the data that has been read by checking the return value of Adc_GetGroupStatus.⌋ (BSW12291, BSW12802)

Note: See also ADC140.

[ADC326] ⌈Calling function Adc_GetStreamLastPointer while group status is ADC_STREAM_COMPLETED shall trigger a state transition to ADC_BUSY for continuous conversion modes (single access mode or circular streaming buffer mode) and hardware triggered groups in single access mode or circular streaming access mode.⌋ (BSW12291)

[ADC327] ⌈Calling function Adc_GetStreamLastPointer while group status is ADC_STREAM_COMPLETED shall trigger a state transition to ADC_IDLE for software conversion modes which automatically stop the conversion (streaming buffer with linear access mode or one-shot conversion mode with single access) and for the hardware triggered conversion mode in combination with linear streaming access mode.⌋ (BSW12291)

[ADC328] ⌈Calling function Adc_GetStreamLastPointer while group status is ADC_COMPLETED shall trigger a state transition to ADC_BUSY.⌋ (BSW12291)

[ADC215] ⌈If development error detection for the ADC module is enabled: when called while the group status is ADC_IDLE and the group conversion was not started (no results are available from previous conversions) , the function

Adc_GetStreamLastPointer shall raise development error ADC_E_IDLE, set the pointer, passed as parameter (PtrToSamplePtr), to NULL and return 0.⌋(BSW12802)

[ADC218] ⌈If development error detection for the ADC module is enabled: if the group ID is non-existent, the function Adc_GetStreamLastPointer shall raise development error ADC_E_PARAM_GROUP, set the pointer, passed as parameter (PtrToSamplePtr), to NULL and return 0 without any further action.⌋(BSW00386)

[ADC302] ⌈If development error detection for the ADC module is enabled: if called prior to initializing the driver, the function Adc_GetStreamLastPointer shall raise development error ADC_E_UNINIT, set the pointer, passed as parameter (PtrToSamplePtr), to NULL and return 0 without any further action.⌋(BSW00406)

8.3.13 Adc_GetVersionInfo

[ADC376] ⌈

Service name:	Adc_GetVersionInfo

Syntax:	`void Adc_GetVersionInfo(`
	`  Std_VersionInfoType* versioninfo`
	`)`

Service ID[hex]:	0x0a
Sync/Async:	Synchronous
Reentrancy:	Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	versioninfo ‖ Pointer to where to store the version information of this module.
Return value:	None
Description:	Returns the version information of this module.

⌋()

[ADC236] ⌈The function Adc_GetVersionInfo shall read the version information of the ADC module. The version information includes:

- Module Id.
- Vendor Id.
- Vendor specific version numbers (BSW00407). ⌋()

[ADC458] ⌈If development error detection for the ADC module is enabled: The function Adc_GetVersionInfo shall check the parameter versioninfo for not being NULL and shall raise the development error ADC_E_PARAM_POINTER if the check fails. ⌋()

[ADC237] ⌈The function Adc_GetVersionInfo shall be pre-compile time configurable On/Off by the configuration parameter AdcVersionInfoApi (see chapter 10.2).⌋(BSW171, BSW00407, BSW00411)

8.4 Call-back Notifications

Since the ADC Driver is a module on the lowest architectural layer it doesn't provide any call-back functions for lower layer modules.

8.5 Scheduled functions

None

8.6 Expected Interfaces

In this chapter all interfaces required from other modules are listed.

8.6.1 Mandatory Interfaces

This chapter defines all interfaces which are required to fulfill a core functionality of the module.

8.6.2 Optional Interfaces

This chapter defines all interfaces which are required to fulfill an optional functionality of the module.

[ADC377] ⌈

API function	*Description*
Dem_ReportErrorStatus	Queues the reported events from the BSW modules (API is only used by BSW modules). The interface has an asynchronous behavior, because the processing of the event is done within the Dem main function.
Det_ReportError	Service to report development errors.

⌋ ()

8.6.3 Configurable interfaces

In this chapter all interfaces are listed where the target function could be configured. The target function is usually a call-back function. The names of this kind of interfaces are not fixed because they are configurable.

[ADC078] ⌈The ADC module's ISR´s, providing the "conversion completed events", shall be responsible for resetting the interrupt flags (if needed by hardware) and calling the associated notification function.⌋ (BSW12129)

Note: The notification functions IoHwAb_Adc_Notification_<GroupID> run in interrupt context. It's the responsibility of the user to keep the code of these functions reasonably short. The names of the group notification functions are configurable (see ADC402).

[ADC082] ⌈

Service name:	IoHwAb_Adc_Notification_<GroupID>

Syntax:	`void IoHwAb_Adc_Notification_<GroupID>(`
	`  void`
	`)`

Sync/Async:	Synchronous

Reentrancy:	Re-entrancy of this API call depends on the users code.
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	--

」(BSW00359, BSW00360, BSW157)

[ADC104] 「The ADC Driver shall support an individual notification per ADC Channel group (if capability is configured) that is called whenever the conversion for all channels of that group is completed.」(BSW157, BSW12447, BSW12317)

[ADC083] 「When the notification mechanism is disabled, the ADC module shall send no notification.」(BSW157)

[ADC416] 「When the notifications are re-enabled, the ADC module shall not send notifications for events that occurred while notifications have been disabled. 」()

[ADC084] 「For every group, a particular notification call-back has to be configured. This can be a function pointer or a NULL pointer.」(BSW12056)

[ADC080] 「If for a notification call-back the NULL pointer is configured, no call-back shall be executed.」(BSW12056)

[ADC085] 「The call-back notifications shall be configurable as pointers to user defined functions within the configuration structure. For all available channel groups, call-back functions have to be declared during the configuration phase of the module. 」(BSW12056)

9 Sequence diagrams

9.1 Initialization of the ADC Driver

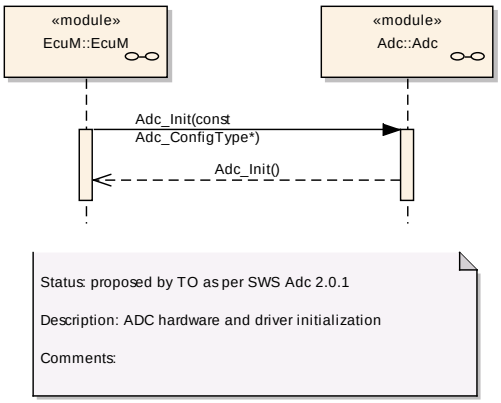


Figure 13: Initialization of the ADC Driver

9.2 De-Initialization of the ADC Driver

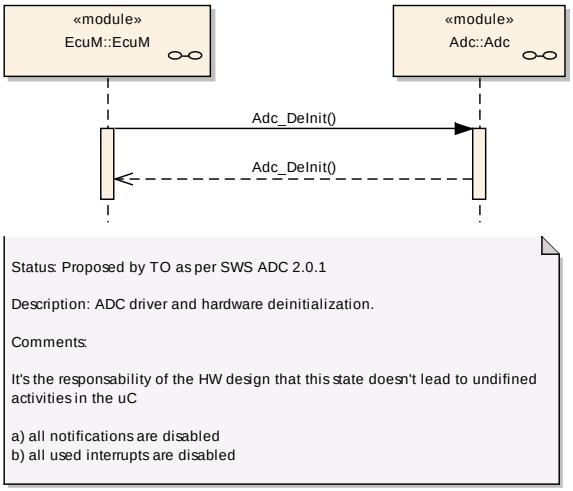


Figure 14: De-Initialization of the ADC Driver

9.3 Software triggered One-Shot conversion without notification

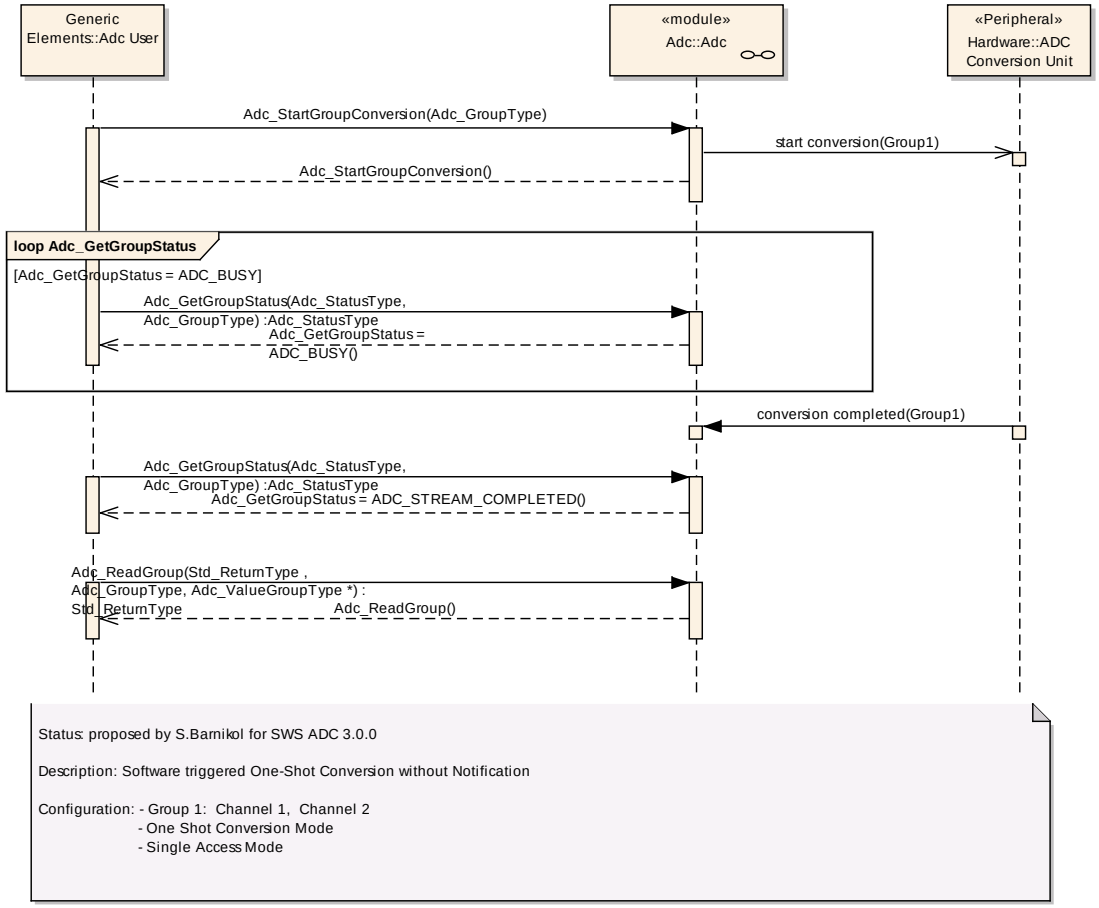


Figure 15: Software triggered one-shot conversion without notification

9.4 Software triggered continuous conversion with notification

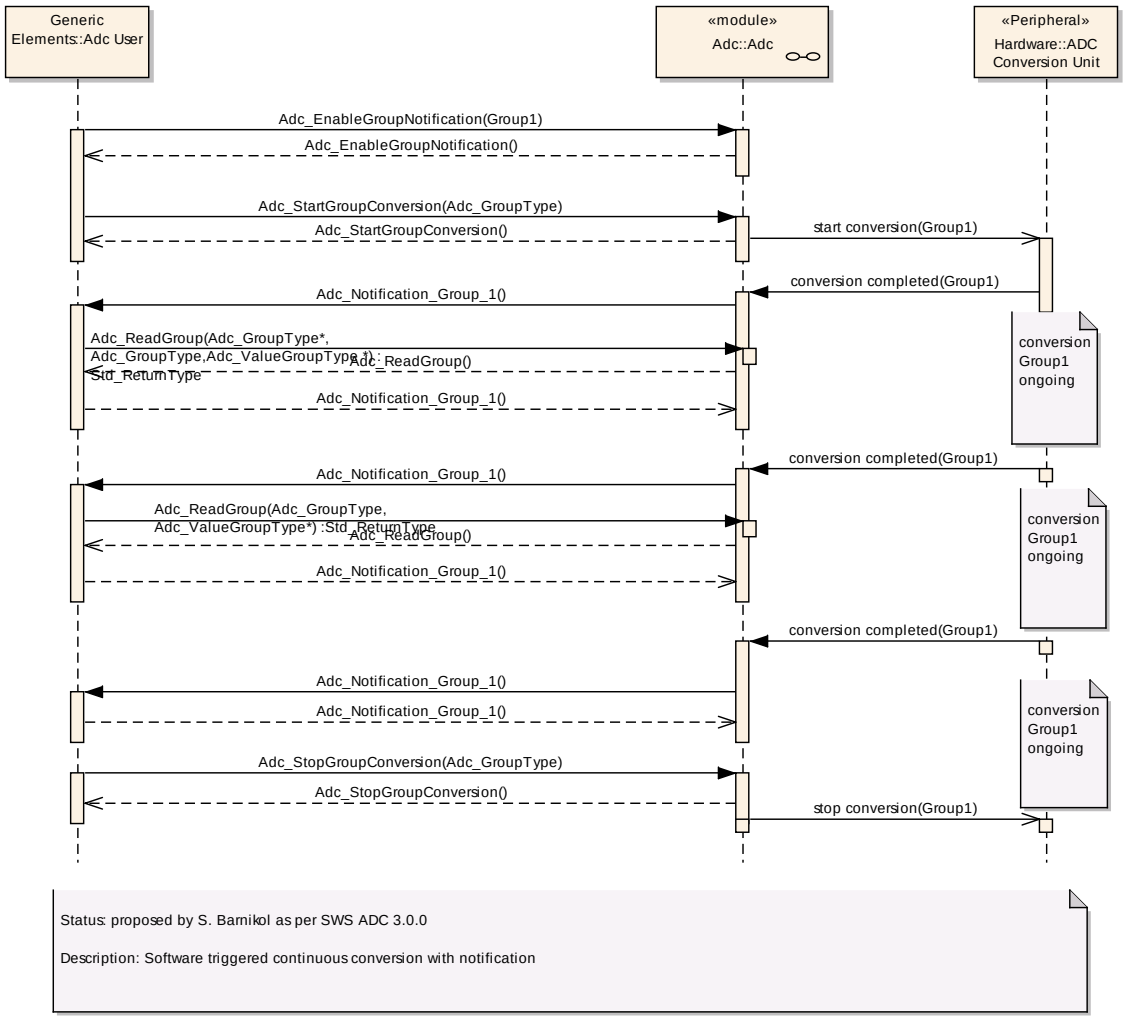


Figure 16: Software triggered continuous conversion with notification

9.5 Hardware triggered One-Shot conversion with notification

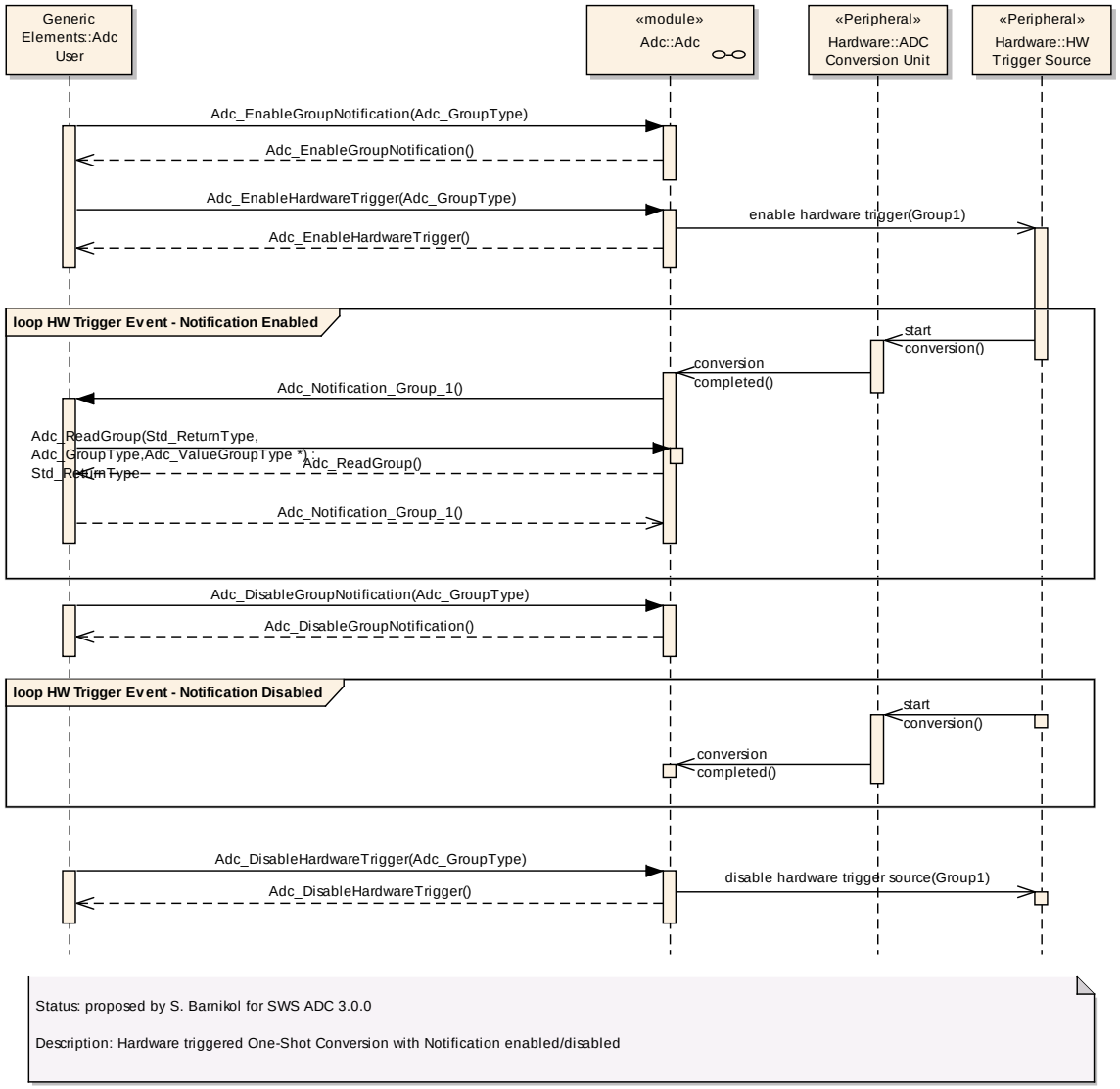


Figure 17: Hardware triggered one-shot conversion with notification

9.6 HW Trigger - One-Shot conversion - Linear Streaming

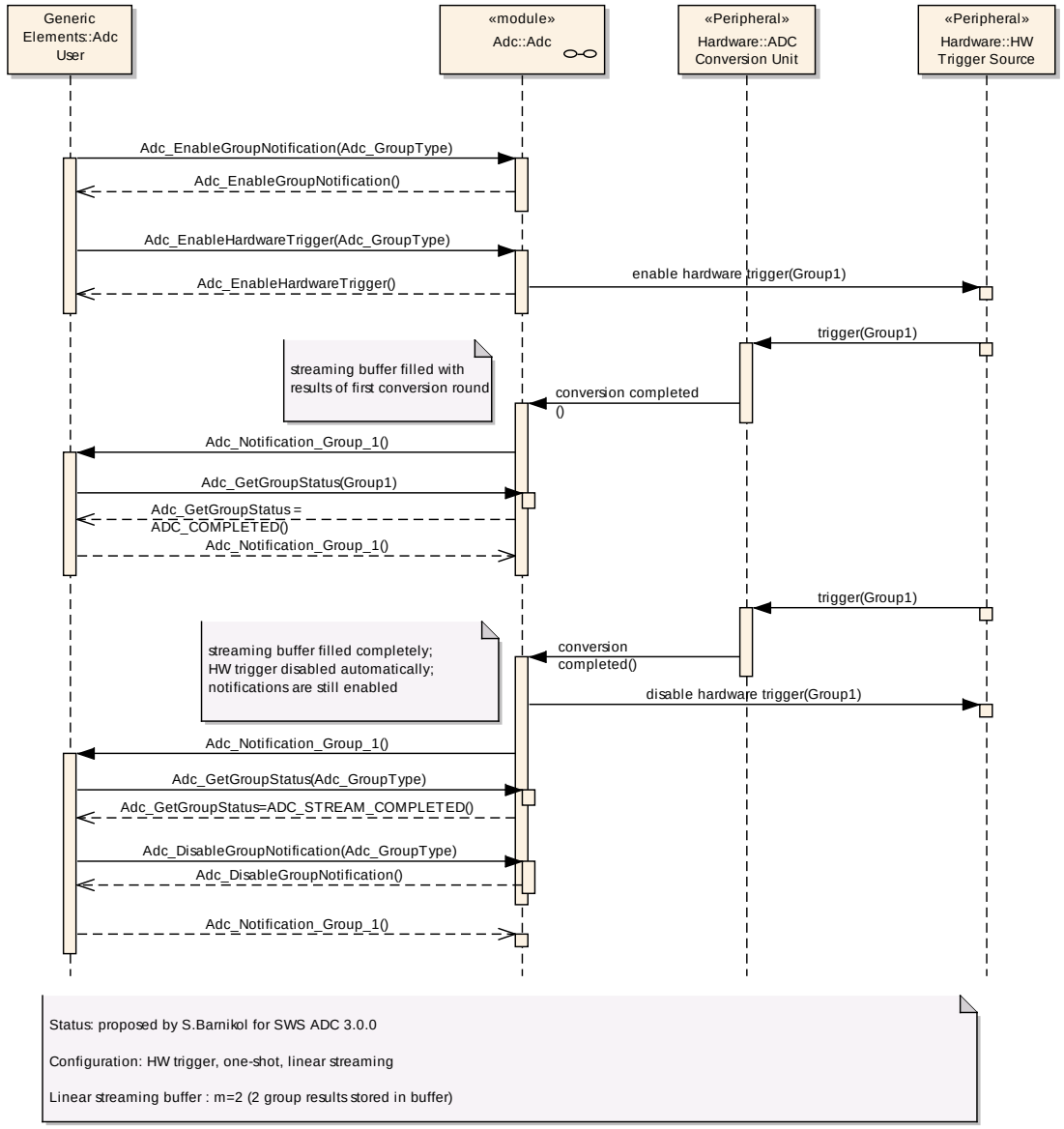


Figure 18: Hardware triggered one-shot conversion – linear streaming

9.7 No Priority Mechanism – No Queuing

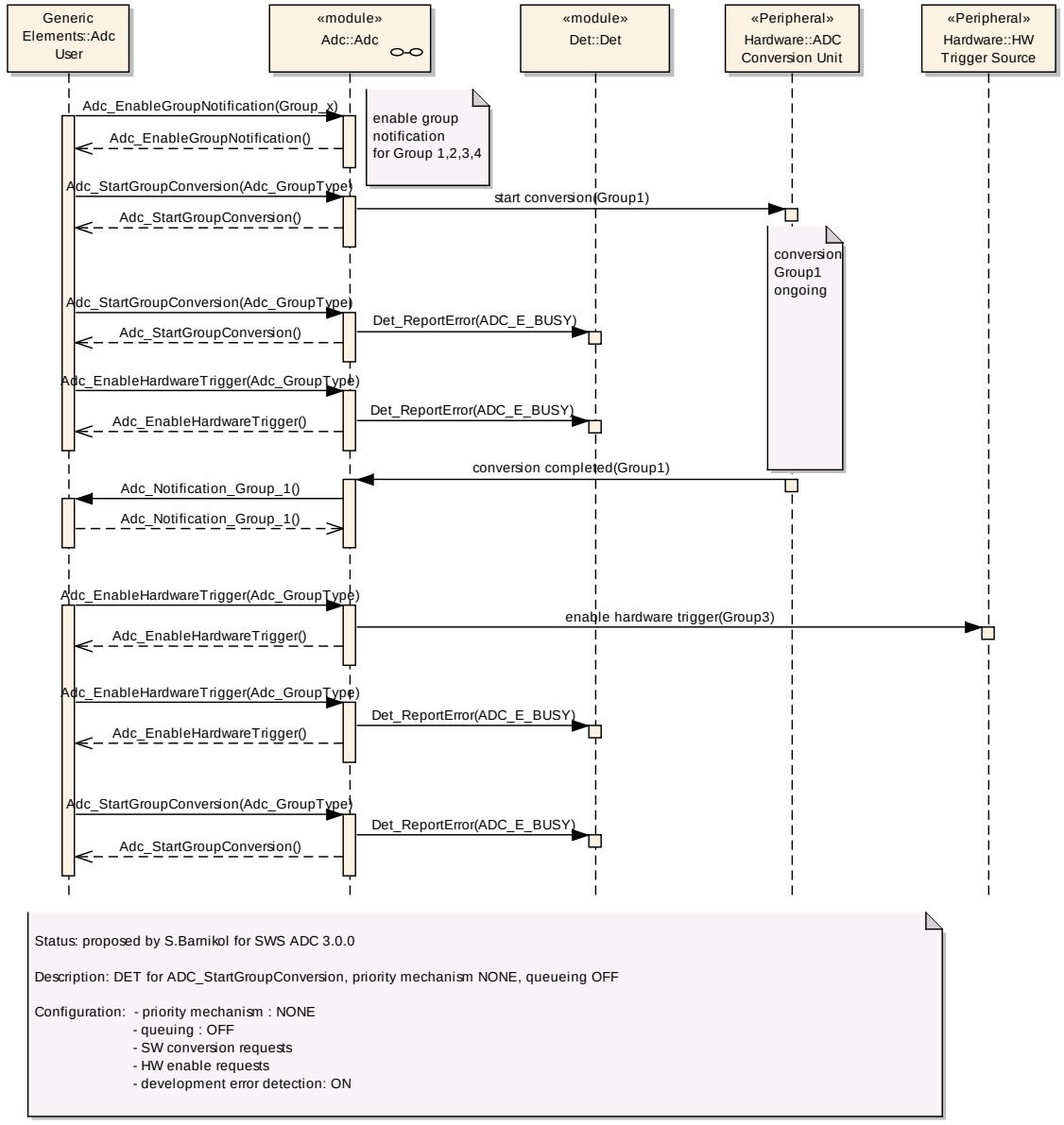


Figure 19: No priority mechanism – no queuing

9.8 No Priority Mechanism – SW Queuing

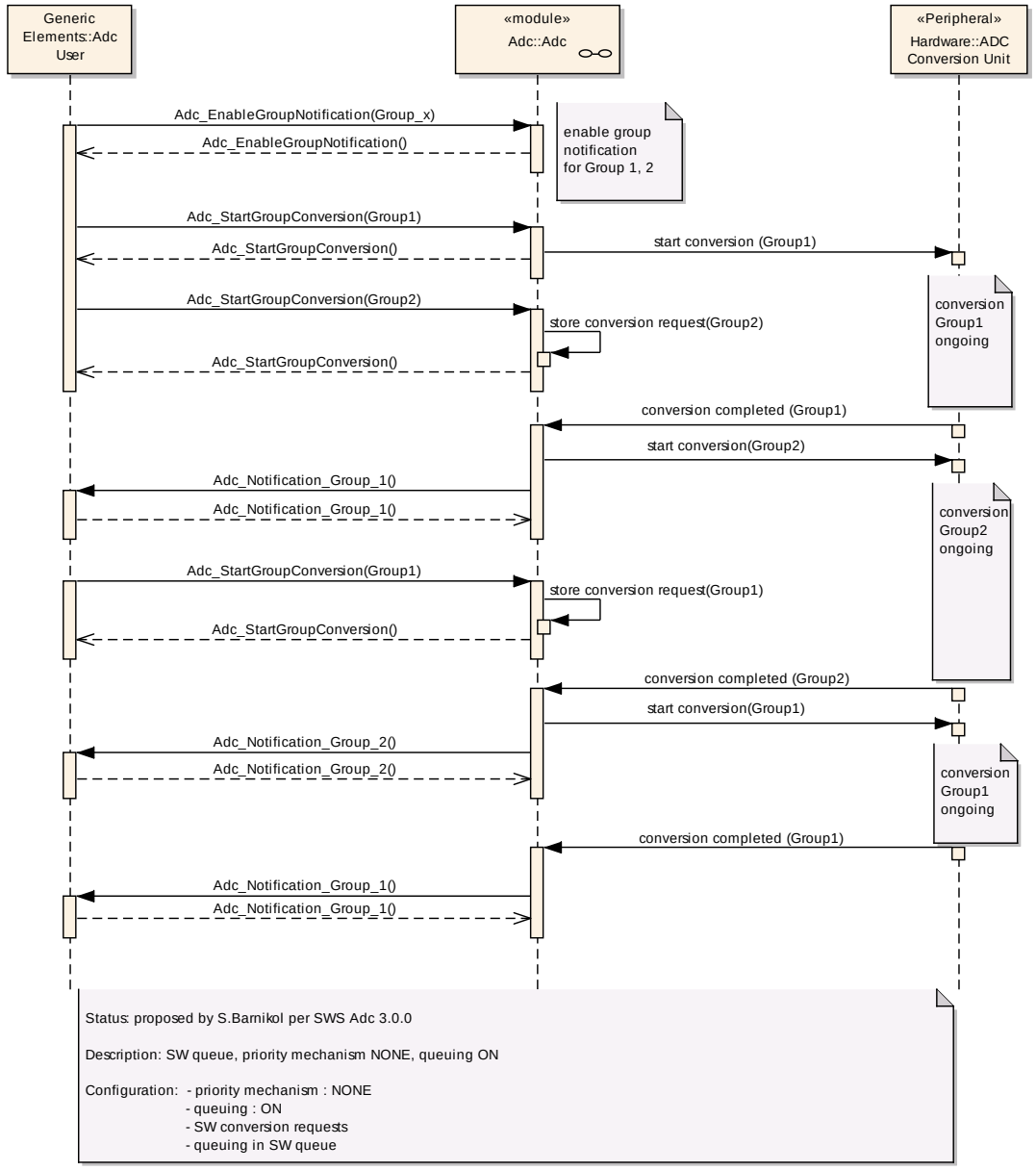


Figure 20: No priority mechanism – software queuing

9.9 HW_SW Priority Mechanism – SW Queuing

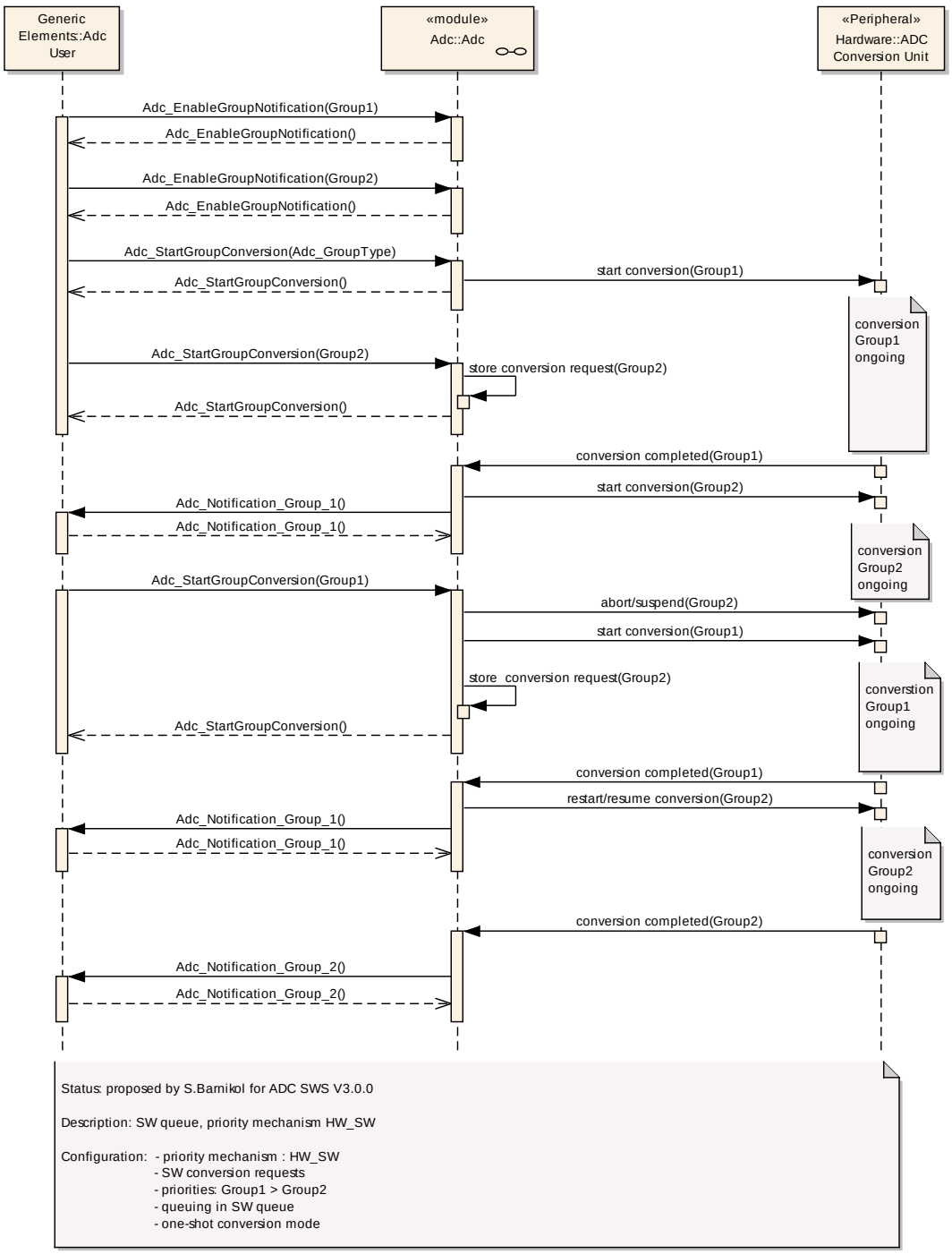


Figure 20: Hardware/software priority mechanism – SW queuing

9.10 HW Priority Mechanism – HW Queuing

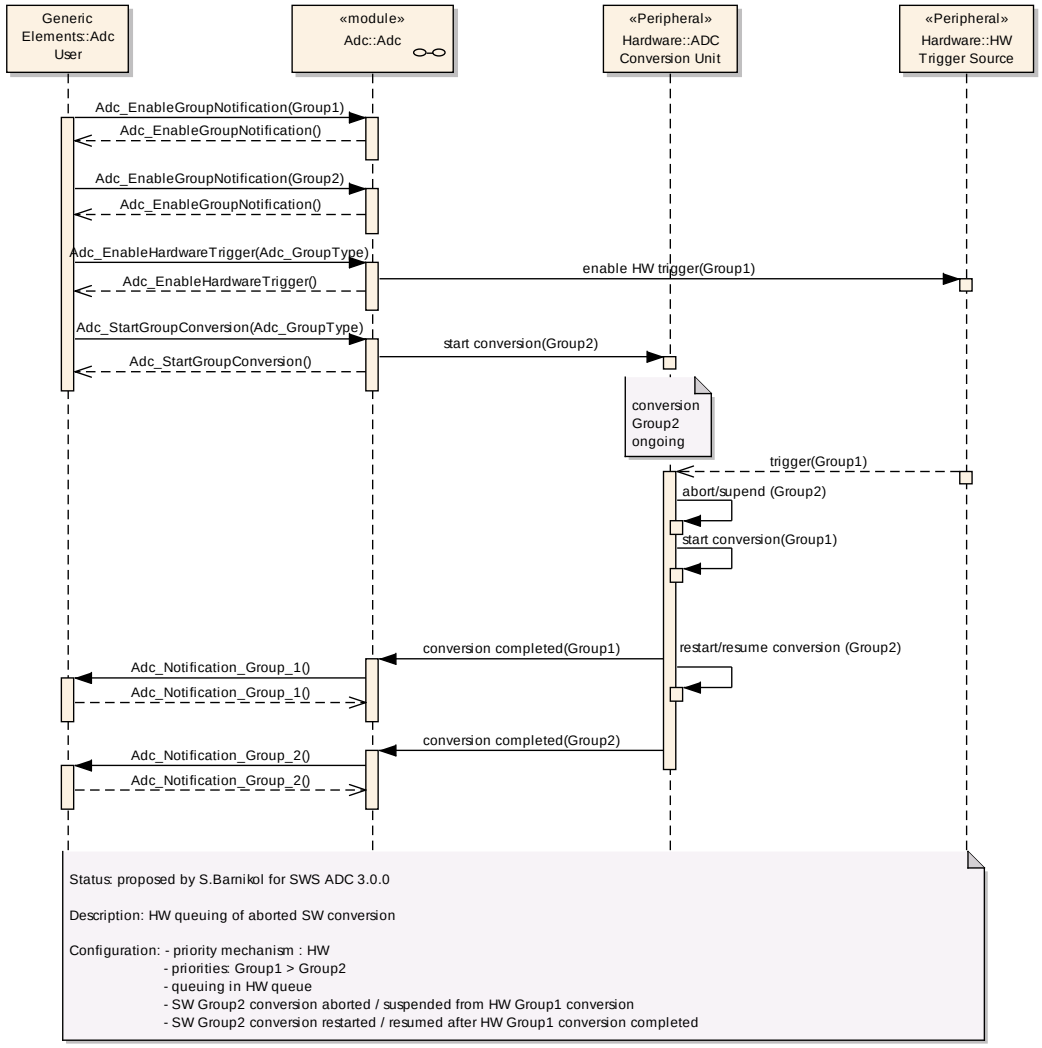


Figure 22: Hardware priority mechanism – HW queuing

9.11 HW_SW Priority Mechanism – HW/SW Queuing

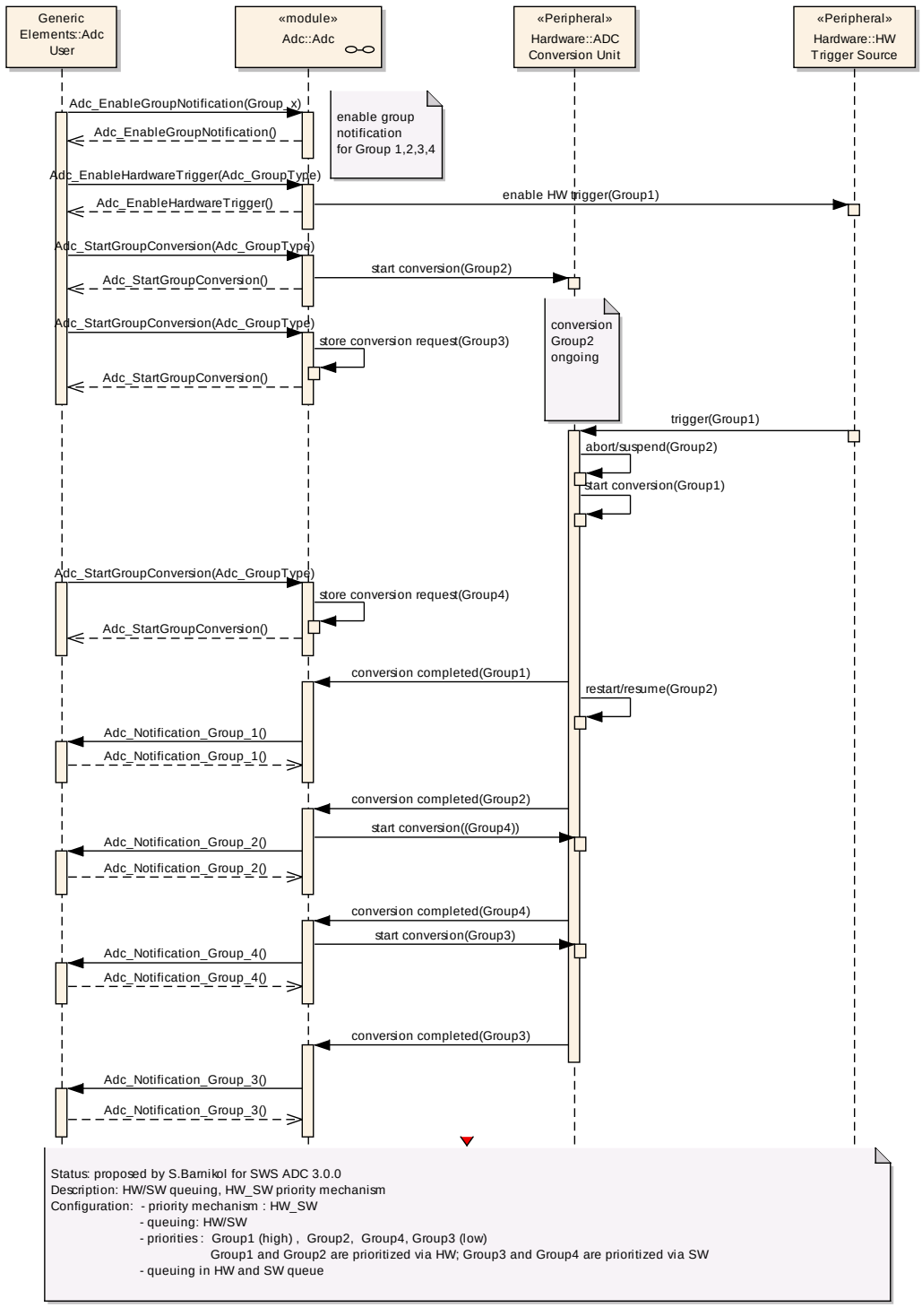


Figure 23: Hardware/software priority mechanism – hardware/software queuing

10 Configuration specification

In general, this chapter defines configuration parameters and their clustering into containers. In order to support the specification Chapter 10.1 describes fundamentals. It also specifies a template (table) you shall use for the parameter specification. We intend to leave Chapter 10.1 in the specification to guarantee comprehension.

Chapter 10.2 specifies the structure (containers) and the parameters of the module ADC Driver.

Chapter 10.2.3 specifies published information of the module ADC Driver.

10.1 How to read this chapter

In addition to this section, it is highly recommended to read the documents:

- AUTOSAR Layered Software Architecture
- AUTOSAR ECU Configuration Specification
  This document describes the AUTOSAR configuration methodology and the AUTOSAR configuration metamodel in detail.

The following is only a short survey of the topic and it will not replace the ECU Configuration Specification document.

10.1.1 Configuration and configuration parameters

Configuration parameters define the variability of the generic part(s) of an implementation of a module. This means that only generic or configurable module implementation can be adapted to the environment (software/hardware) in use during system and/or ECU configuration.

The configuration of parameters can be achieved at different times during the software process: before compile time, before link time or after build time. In the following, the term “configuration class” (of a parameter) shall be used in order to refer to a specific configuration point in time.

10.1.2 Containers

Containers structure the set of configuration parameters. This means:

- *all* configuration parameters are kept in containers.
- (sub-) containers can reference (sub-) containers. It is possible to assign a multiplicity to these references. The multiplicity then defines the possible number of instances of the contained parameters.

10.1.3 Specification template for configuration parameters

The following tables consist of three sections:
- the general section
- the configuration parameter section
- the section of included/referenced containers

Pre-compile time - specifies whether the configuration parameter shall be of configuration class *Pre-compile time* or not

Label	*Description*
x	The configuration parameter shall be of configuration class *Pre-compile time*.
--	The configuration parameter shall never be of configuration class *Pre-compile time*.

Link time - specifies whether the configuration parameter shall be of configuration class *Link time* or not

Label	*Description*
x	The configuration parameter shall be of configuration class *Link time*.
--	The configuration parameter shall never be of configuration class *Link time*.

Post Build - specifies whether the configuration parameter shall be of configuration class *Post Build* or not

Label	*Description*
x	The configuration parameter shall be of configuration class *Post Build* and no specific implementation is required.
L	*Loadable* – the configuration parameter shall be of configuration class *Post Build* and only one configuration parameter set resides in the ECU.
M	*Multiple* – the configuration parameter shall be of configuration class *Post Build* and is selected out of a set of multiple parameters by passing a dedicated pointer to the init function of the module.
--	The configuration parameter shall never be of configuration class *Post Build*.

10.2 Configuration and configuration parameters

The following chapters summarize all configuration parameters. The detailed meanings of the parameters describe Chapter 7 and Chapter 8.

10.2.1 Variants

[ADC362] ⌈**VARIANT-PRE-COMPILE:** Only parameters with “Pre-compile time” configuration are allowed in this variant.. ⌋()

[ADC363] ⌈**VARIANT-POST-BUILD:** Parameters with “Pre-compile time”, “Link time” and “Post-build time” are allowed in this variant. ⌋()

10.2.2 Adc

Module Name	*Adc*
Module Description	Configuration of the Adc (Analog Digital Conversion) module.

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
AdcConfigSet	1	This is the base container that contains the post-build selectable configuration parameters
AdcGeneral	1	General configuration (parameters) of the ADC Driver software module.
AdcPublishedInformation	1	Additional published parameters not covered by CommonPublishedInformation container. Note that these parameters do not have any configuration class setting, since they are published information.

10.2.3 AdcGeneral

SWS Item	**ADC027_Conf :**
Container Name	AdcGeneral{AdcDriverGeneralConfiguration}
Description	General configuration (parameters) of the ADC Driver software module.
Configuration Parameters	

SWS Item	**ADC404_Conf :**		
Name	AdcDeInitApi {ADC_DEINIT_API}		
Description	Adds / removes the service Adc_DeInit() from the code. true: Adc_DeInit() can be used. false: Adc_DeInit() can not be used.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC405_Conf :**		
Name	AdcDevErrorDetect {ADC_DEV_ERROR_DETECT}		
Description	Switches the Development Error Detection and Notification ON or OFF. true: Enabled. false: Disabled.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC452_Conf :**
Name	AdcEnableLimitCheck {ADC_ENABLE_LIMIT_CHECK}
Description	Enables or disables limit checking feature in the ADC driver.
Multiplicity	1

Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC391_Conf :**		
Name	AdcEnableQueuing {ADC_ENABLE_QUEUING}		
Description	Determines, if the queuing mechanism is active in case of priority mechanism disabled. Note: If priority mechanism is enabled, queuing mechanism is always active and the parameter ADC_ENABLE_QUEUING is not evaluated. true: Enabled. false: Disabled.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module dependency: AdcPriorityImplementation: parameter is only evaluated for priority implementation ADC_PRIORITY_NONE.		

SWS Item	**ADC406_Conf :**		
Name	AdcEnableStartStopGroupApi {ADC_ENABLE_START_STOP_GROUP_API}		
Description	Adds / removes the services Adc_StartGroupConversion() and Adc_StopGroupConversion() from the code. true: Adc_StartGroupConversion() and Adc_StopGroupConversion() can be used. false: Adc_StartGroupConversion() and Adc_StopGroupConversion() can not be used.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC105_Conf :**		
Name	AdcGrpNotifCapability {ADC_GRP_NOTIF_CAPABILITY}		
Description	Determines, if the group notification mechanism (the functions to enable and disable the notifications) is available at runtime. true: Enabled. false: Disabled.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC408_Conf :**
Name	AdcHwTriggerApi {ADC_HW_TRIGGER_API}
Description	Adds / removes the services Adc_EnableHardwareTrigger() and Adc_DisableHardwareTrigger() from the code. true:

	Adc_EnableHardwareTrigger() and Adc_DisableHardwareTrigger() can be used. false: Adc_EnableHardwareTrigger() and Adc_DisableHardwareTrigger() can not be used.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC393_Conf :**		
Name	AdcPriorityImplementation {ADC_PRIORITY_IMPLEMENTATION}		
Description	Determines whether a priority mechanism is available for prioritization of the conversion requests and if available, the type of prioritization mechanism. The selection applies for groups with trigger source software and trigger source hardware. Two types of prioritization mechanism can be selected. The hardware prioritization mechanism (AdcPriorityHw) uses the ADC hardware features for prioritization of the software conversion requests and hardware trigger signals for groups with trigger source hardware. The mixed hardware and software prioritization mechanism (AdcPriorityHwSw) uses the ADC hardware features for prioritization of ADC hardware trigger for groups with trigger source hardware and a software implemented prioritization mechanism for groups with trigger source software. The group priorities for software triggered groups are typically configured with lower priority levels than the group priorities for hardware triggered groups. ImplementationType: Adc_PriorityImplementationType		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	ADC_PRIORITY_HW	Hardware priority mechanism is available only	
	ADC_PRIORITY_HW_SW	Hardware and software priority mechanism is available	
	ADC_PRIORITY_NONE	priority mechanism is not available	
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC394_Conf :**		
Name	AdcReadGroupApi {ADC_READ_GROUP_API}		
Description	Adds / removes the service Adc_ReadGroup() and from the code. true: Adc_ReadGroup() can be used. false: Adc_ReadGroup() can not be used.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**ADC444_Conf :**	
Name	AdcResultAlignment {ADC_RESULT_ALIGNMENT}	
Description	Alignment of ADC raw results in ADC result buffer (left/right alignment). Implementation Type: Adc_ResultAlignmentType	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	ADC_ALIGN_LEFT	left alignment

	ADC_ALIGN_RIGHT	right alignment	
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: module		

SWS Item	**ADC409_Conf :**		
Name	AdcVersionInfoApi {ADC_VERSION_INFO_API}		
Description	Adds / removes the service Adc_GetVersionInfo() from the code. true: Adc_GetVersionInfo() can be used. false: Adc_GetVersionInfor() can not be used.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

No Included Containers

10.2.4 AdcConfigSet

SWS Item	**ADC390_Conf :**
Container Name	AdcConfigSet [Multi Config Container]
Description	This is the base container that contains the post-build selectable configuration parameters
Configuration Parameters	

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
AdcHwUnit	1..*	This container contains the Driver configuration (parameters) depending on grouping of channels This container could contain HW specific parameters which are not defined in the Standardized Module Definition. They must be added in the Vendor Specific Module Definition.

10.2.5 AdcChannel

SWS Item	**ADC268_Conf :**
Container Name	AdcChannel{AdcChannelConfiguration}
Description	This container contains the channel configuration (parameters) depending on the hardware capability. The organization of this data structure could contain dependencies to the microcontroller so this is left up to the implementer and its location is left up to the configuration. Note: Since a AdcChannel can be part of several AdcGroups, this container is not realized as a subcontainer of AdcGroup but instead as a subcontainer of AdcHwUnit.
Configuration Parameters	

SWS Item	**ADC011_Conf :**
Name	AdcChannelConvTime {ADC_CHANNEL_CONV_TIME}
Description	Configuration of conversion time, i.e. the time during which the analogue value is converted into digital representation, (in clock cycles) for each

	channel, if supported by hardware. ImplementationType: Adc_ConversionTimeType		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC455_Conf :**		
Name	AdcChannelHighLimit {ADC_CHANNEL_HIGH_LIMIT}		
Description	High limit - used for limit checking.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module dependency: AdcEnableLimitCheck: not available if limit checking is not globally enabled. AdcChannelLimitCheck: not available if channel specific limit check is not enabled. AdcChannelLowLimit: has to be greater or equal than AdcChannelLowLimit.		

SWS Item	**ADC392_Conf :**		
Name	AdcChannelId		
Description	This parameter defines the assignment of the channel to the physical ADC hardware channel. ImplementationType: Adc_ChannelType		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 1024		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC453_Conf :**		
Name	AdcChannelLimitCheck {ADC_CHANNEL_LIMIT_CHECK}		
Description	Enables or disables limit checking for an ADC channel.		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module dependency: AdcEnableLimitCheck: not available if limit checking is not globaly enabled.		

	AdcGroupDefinition: ADC channels with limit checking feature enabled have to be assigned to ADC groups which consist exactly of one limit checking enabled ADC channel.

SWS Item	**ADC454_Conf :**		
Name	AdcChannelLowLimit {ADC_CHANNEL_LOW_LIMIT}		
Description	Low limit - used for limit checking.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module dependency: AdcEnableLimitCheck: not available if limit checking is not globally enabled. AdcChannelLimitCheck: not available if channel specific limit check is not enabled. AdcChannelHighLimit: has to be less or equal than AdcChannelHighLimit.		

SWS Item	**ADC456_Conf :**		
Name	AdcChannelRangeSelect {ADC_CHANNEL_RANGE_SELECT}		
Description	In case of active limit checking: defines which conversion values are taken into account related to the boarders defined with AdcChannelLowLimit and AdcChannelHighLimit. Implementation Type: Adc_ChannelRangeSelectType		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	ADC_RANGE_ALWAYS	Complete range - independent from channel limit settings.	
	ADC_RANGE_BETWEEN	Range between low limit and high limit - high limit value included.	
	ADC_RANGE_NOT_BETWEEN	Range above high limit or below low limit - low limit value included.	
	ADC_RANGE_NOT_OVER_HIGH	Range below high limit - high limit value included.	
	ADC_RANGE_NOT_UNDER_LOW	Range above low limit.	
	ADC_RANGE_OVER_HIGH	Range above high limit.	
	ADC_RANGE_UNDER_LOW	Range below limit - low limit value included.	
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module dependency: AdcEnableLimitCheck: not available if limit checking is not globally enabled. AdcChannelLimitCheck: not available if channel specific limit check is not enabled.		

SWS Item	**ADC089_Conf :**
Name	AdcChannelRefVoltsrcHigh {ADC_CHANNEL_REF_VOLTSRC_HIGH}
Description	Upper reference voltage source for each channel. Enumeration literals are defined vendor specific.
Multiplicity	0..1

Type	EcucEnumerationParamDef		
Range	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC023_Conf :**		
Name	AdcChannelRefVoltsrcLow {ADC_CHANNEL_REF_VOLTSRC_LOW}		
Description	Lower reference voltage source for each channel. Enumeration literals are defined vendor specific.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC019_Conf :**		
Name	AdcChannelResolution {ADC_CHANNEL_RESOLUTION}		
Description	Channel resolution in bits. ImplementationType: Adc_ResolutionType		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	1 .. 63		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: AdcMaxChannelResolution: The actual resolution has to be less or equal than the maximum resolution.		

SWS Item	**ADC290_Conf :**		
Name	AdcChannelSampTime {ADC_CHANNEL_SAMP_TIME}		
Description	Configuration of sampling time, i.e. the time during which the value is sampled, (in clock cycles) for each channel, if supported by hardware. ImplementationType: Adc_SamplingTimeType		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

No Included Containers

10.2.6 AdcGroup

SWS Item	**ADC028_Conf :**
Container Name	AdcGroup{AdcGroupConfiguration}
Description	This container contains the Group configuration (parameters).
Configuration Parameters	

SWS Item	**ADC317_Conf :**		
Name	AdcGroupAccessMode {ADC_GROUP_ACCESS_MODE}		
Description	Type of access mode to group conversion results. ImplementationType: Adc_GroupAccessModeType		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	ADC_ACCESS_MODE_SINGLE	Single value access mode	
	ADC_ACCESS_MODE_STREAMING	Streaming access mode	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	dependency: AdcGroupTriggSrc / AdcGroupConvMode: streaming access mode is not available for one-shot conversion mode with software trigger source.		

SWS Item	**ADC397_Conf :**		
Name	AdcGroupConversionMode {ADC_GROUP_CONV_MODE}		
Description	Type of conversion mode supported by the driver. ImplementationType: Adc_GroupConvModeType		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	ADC_CONV_MODE_CONTINUOUS	Conversions of an ADC channel group are performed continuously after a software API call (start). The conversions itself are running automatically (no additional software or hardware trigger needed).	
	ADC_CONV_MODE_ONESHOT	The conversion of an ADC channel group is performed once after a trigger.	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: AdcGroupTriggSrc: Continuous conversion mode only available for software triggered groups.		

SWS Item	**ADC398_Conf :**		
Name	AdcGroupId {ADC_GROUP_ID}		
Description	Numeric ID of the group. This parameter is the symbolic name to be used on the API. This symbolic name allows accessing Channel Group data. This value will be assigned to the symbolic name derived of the AdcGroup container shortName. ImplementationType: Adc_GroupType		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 1023		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC287_Conf :**
Name	AdcGroupPriority {ADC_GROUP_PRIORITY}
Description	Priority level of the AdcGroup. ImplementationType: Adc_GroupPriorityType

Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	dependency: ADC_PRIORITY_IMPLEMENTATION		

SWS Item	**ADC435_Conf :**		
Name	AdcGroupReplacement {ADC_GROUP_REPLACEMENT}		
Description	Replacement mechanism, which is used on ADC group level, if a group conversion is interrupted by a group which has a higher priority. ImplementationType: Adc_GroupReplacementType		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	ADC_GROUP_REPL_ABORT_RESTART	Abort/Restart mechanism is used on group level, if a group is interrupted by a higher priority group. The complete conversion round of the interrupted group (all group channels) is restarted after the higher priority group conversion is finished. If the group is configured in streaming access mode, only the results of the interrupted conversion round are discarded. Results of previous conversion rounds which are already written to the result buffer are not affected.	
	ADC_GROUP_REPL_SUSPEND_RESUME	Suspend/Resume mechanism is used on group level, if a group is interrupted by a higher priority group. The converions round (conversion of all group channels) of the interrupted group is completed after the higher priority group conversion is finished. If the group is configured in streaming access mode, only the results of the interrupted conversion round are discarded. Results of previous conversion rounds which are already written to the result buffer are not affected.	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC399_Conf :**
Name	AdcGroupTriggSrc {ADC_GROUP_TRIGG_SRC}

Description	Type of source event that starts a group conversion. ImplementationType: Adc_TriggerSourceType		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	ADC_TRIGG_SRC_HW	Group is triggered by a hardware event.	
	ADC_TRIGG_SRC_SW	Group is triggered by a software API call.	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: AdcGroupConvMode: Trigger source HW is not available for continuous conversion mode.		

SWS Item	**ADC400_Conf :**		
Name	AdcHwTrigSignal {ADC_HW_TRIG_SIGNAL}		
Description	Configures on which edge of the hardware trigger signal the driver should react, i.e. start the conversion (only if supported by the ADC hardware). ImplementationType: Adc_HwTriggerSignalType		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	ADC_HW_TRIG_BOTH_EDGES	React on both edges of the hardware trigger signal (only if supported by the ADC hardware).	
	ADC_HW_TRIG_FALLING_EDGE	React on the falling edge of the hardware trigger signal (only if supported by the ADC hardware).	
	ADC_HW_TRIG_RISING_EDGE	React on the rising edge of the hardware trigger signal (only if supported by the ADC hardware).	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: AdcTriggSrcHw: Valid only if the group is configured to be triggered by a hardware event.		

SWS Item	**ADC401_Conf :**		
Name	AdcHwTrigTimer {ADC_HW_TRIG_TIMER}		
Description	Reload value of the ADC module embedded timer (only if supported by ADC hardware). ImplementationType: Adc_HwTriggerTimerType		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 18446744073709551615		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: AdcTriggSrcHw: Valid only if the group is configured to be triggered by a hardware event.		

SWS Item	**ADC402_Conf :**		
Name	AdcNotification {ADC_NOTIFICATION}		
Description	Callback function for each group		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default value	--		
maxLength	--		
minLength	--		
regularExpression	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: This parameter is only available, if notification capability is configured available by AdcGrpNotifCapability		

SWS Item	**ADC316_Conf :**		
Name	AdcStreamingBufferMode {ADC_STREAMING_BUFFER_MODE}		
Description	Configure streaming buffer as "linear buffer" (i.e. the ADC Driver stops the conversion as soon as the stream buffer is full) or as "ring buffer" (wraps around if the end of the stream buffer is reached). ImplementationType: Adc_StreamBufferModeType		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	ADC_STREAM_BUFFER_CIRCULAR		The ADC Driver continues the conversion even if the stream buffer is full (number of samples reached) by wrapping around the stream buffer itself.
	ADC_STREAM_BUFFER_LINEAR		The ADC Driver stops the conversion as soon as sthe stream buffer is full (number of samples reached).
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: AdcGroupAccessMode: Valid only for streaming access mode.		

SWS Item	**ADC292_Conf :**		
Name	AdcStreamingNumSamples {ADC_STREAMING_NUM_SAMPLES}		
Description	Number of ADC values to be acquired per channel in streaming access mode. Note: in single access mode this parameter assumes value 1, since only one sample per channel is processed. ImplementationType: Adc_StreamNumSampleType		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 255		
Default value	1		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: AdcGroupAccessMode: Valid only for streaming access mode. In single access mode this parameter assumes value 1, since only one sample per channel is processed.		

SWS Item	**ADC014_Conf :**		
Name	AdcGroupDefinition {ADC_GROUP_DEFINITION}		
Description	Assignment of AdcChannels to a AdcGroups. ImplementationType: Adc_GroupDefType		
Multiplicity	1..*		
Type	Reference to [AdcChannel]		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

No Included Containers

[ADC098] ⌈ **(refers to ADC396):** All channels of a group share the same group configuration (channel can have different channel specific configurations).⌋ (BSW12447)

10.2.7 AdcHwUnit

SWS Item	**ADC242_Conf :**
Container Name	AdcHwUnit{AdcHWUnitConfiguration}
Description	This container contains the Driver configuration (parameters) depending on grouping of channels This container could contain HW specific parameters which are not defined in the Standardized Module Definition. They must be added in the Vendor Specific Module Definition.
Configuration Parameters	

SWS Item	**ADC087_Conf :**		
Name	AdcClockSource {ADC_CLK_SRC}		
Description	The ADC module specific clock input for the conversion unit can statically be configured to select different clock sources if provided by hardware. Enumeration literals are defined vendor specific.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC389_Conf :**		
Name	AdcHwUnitId {ADC_HWUNIT_ID}		
Description	Description: Numeric ID of the HW Unit. This symbolic name allows accessing Hw Unit data. Enumeration literals are defined vendor specific.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**ADC088_Conf :**

Name	AdcPrescale {ADC_PRESCALE}		
Description	Optional ADC module specific clock prescale factor, if supported by hardware. ImplementationType: Adc_PrescaleType		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
AdcChannel	1..*	This container contains the channel configuration (parameters) depending on the hardware capability. The organization of this data structure could contain dependencies to the microcontroller so this is left up to the implementer and its location is left up to the configuration. Note: Since a AdcChannel can be part of several AdcGroups, this container is not realized as a subcontainer of AdcGroup but instead as a subcontainer of AdcHwUnit.
AdcGroup	1..*	This container contains the Group configuration (parameters).

[ADC138] ⌈ **(refers to ADC242):** The ADC Driver shall support one or several ADC HW Units of the same type. The selection of ADC HW Unit shall be done by the configuration container AdcHwUnit. ⌋ ()

10.3 Published information

[**ADC459**] ⌈The standardized common published parameters as required by BSW00402 in the General Requirements on Basic Software Modules [1] shall be published within the header file of this module and need to be provided in the BSW Module Description. The according module abbreviation can be found in the List of Basic Software Modules [4].

Additional module-specific published parameters are listed below if applicable.⌋ ()

10.3.1 AdcPublishedInformation

SWS Item	**ADC030_Conf :**
Container Name	AdcPublishedInformation
Description	Additional published parameters not covered by CommonPublishedInformation container. Note that these parameters do not have any configuration class setting, since they are published information.
Configuration Parameters	

SWS Item	**ADC410_Conf :**

Name	AdcChannelValueSigned {ADC_CHANNEL_VALUESIGNED}		
Description	Information whether the result value of the ADC driver has sign information (true) or not (false). If the result shall be interpreted as signed value it shall apply to C-language rules.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

SWS Item	**ADC411_Conf :**		
Name	AdcGroupFirstChannelFixed {ADC_GROUP_FIRST_CHANNEL_FIXED}		
Description	Information whether the first channel of an ADC Channel group can be configured (false) or is fixed (true) to a value determined by the ADC HW Unit.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

SWS Item	**ADC412_Conf :**		
Name	AdcMaxChannelResolution {ADC_MAX_CHANNEL_RESOLUTION}		
Description	Maximum Channel resolution in bits (does not specify accuracy).		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 63		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

No Included Containers

10.4 Configuration of symbolic names

[ADC099] ⌈The symbolic names of ADC channels and ADC channel groups for use by the upper layer shall be defined by the configurator. They are to be defined in the modules configuration header file.⌋ (BSW12307, BSW12447)

11 Changes to Release 3.x

11.1 Deleted SWS Items

SWS Item	*Rationale*
ADC291	Configuration parameter AdcResultBufferPointer removed
ADC379, ADC354, ADC355	requirement IDs removed

11.2 Replaced SWS Items

SWS Item of Release 1	*replaced by SWS Item*	*Rationale*

11.3 Changed SWS Item

SWS Item	*Rationale*
ADC384	'channel' changed to 'group'
ADC338	reformulated
ADC385	Split in ADC385 and new ADC437
ADC386	Split in ADC386 and new ADC438
ADC332	reformulated
ADC124	corrected
ADC362, ADC363	reformulated
ADC221, ADC222	extended
ADC418, ADC113	Alignment changed
ADC236	Instance ID added
ADC392	reincluded
ADC023, ADC087, ADC089, ADC389	enumeration introduced
ADC065, ADC269	New DET ADC_E_PARAM_POINTER
ADC019, ADC292, ADC398, ADC412	Min/max for configuration parameter
ADC386	corrected

11.4 Added SWS Items

SWS Item	*Rationale*
ADC433	DET ADC_E_BUSY if Adc_SetupResultBuffer is called and group is not in state ADC_IDLE
ADC434	DET ADC_E_UNINIT if Adc_SetupResultBuffer is called before Adc_Init was called
ADC435	Requirement ID changed from ADC431(already used) to ADC435
ADC436	Group status in case of aborted/suspended group
ADC437	ADC385 split
ADC438	ADC386 split
ADC439-ADC443	ADC debug support added
ADC444	ADC result buffer alignment configuration parameter
ADC445-ADC456	ADC limit checking feature
ADC457	DET ADC_E_PARAM_POINTER if Adc_SetupResultBuffer is called with NULL_PTR
ADC459	Rework of published information

12 Changes to Release 4.0 Rev1, Rev3

12.1 Deleted SWS Items

SWS Item	*Rationale*
ADC324	DET for Adc_GetVersionInfo
ADC443	Debug variables removed

12.2 Replaced SWS Items

SWS Item of Release 1	*replaced by SWS Item*	*Rationale*

12.3 Changed SWS Item

SWS Item	*Rationale*
ADC124	Version number check correction, module abbreviation used
ADC337	reformulated
ADC444	Adc_ResultAlignmentType introduced

12.4 Added SWS Items

SWS Item	*Rationale*
ADC458	DET for Adc_GetVersionInfo

13 Not applicable requirements

[ADC460] ⌈ These requirements are not applicable to this specification.⌋ (BSW00344, BSW167, BSW170, BSW00387, BSW00398, BSW00375, BSW00416, BSW168, BSW00423, BSW00424, BSW00425, BSW00426, BSW00427, BSW00428, BSW00429, BSW00431, BSW00432, BSW00433, BSW00434, BSW00417, BSW161, BSW162, BSW005, BSW164, BSW00325, BSW00326, BSW00342, BSW00343, BSW160, BSW007, BSW00413, BSW00347, BSW00307, BSW00373, BSW00301, BSW00302, BSW00328, BSW00312, BSW006, BSW00357, BSW00355, BSW00306, BSW00308, BSW00371, BSW00376, BSW00329, BSW00330, BSW009, BSW010, BSW00341, BSW00334, BSW12267, BSW12463, BSW12068, BSW12069, BSW12169, BSW12064, BSW12067, BSW12077, BSW12078, BSW12092, BSW12265)