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Proposed Elementary Surveillance and Enhanced Surveillance text in chapter 3

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SUMMARY

This Working Paper proposes to combine generic and specific requirements for ELS and EHS in ED73 chapter 3.29 and 3.30.

Approach and general comments

- a) The text of this WP is based on the text proposed within DO181D v1.1.
- b) The approach used was to adopt a common approach and structure for describing the requirements. The approach is those used in proposed DO text for EHS, i.e., a presentation per register. This approach has been kept for EHS and has also been used for ELS.

In order to keep the possible reference to the requirements as a per register basis and to keep the same testing approach there is, at the end of each register used for ELS, a section pointing to what need to be done to report servicing of the register and any actions required when there is a change (eg broadcast of register 10).

The following structure has been adopted between the different registers:

- Purpose and definition,
- Data requirements
- Update
- Servicing (make reference to servicing and capability reporting in register 10,17,18,...)
- Change protocol when applicable

SC209 is invited to consider such common approach which facilitates the verification of the completeness of the requirements while keeping also a reading per function/register to keep the same testing approach.

- c) When a requirement is defined in ELS and in EHS it is described in ELS and referenced in EHS section. This is proposed because EHS transponders are ELS and not vice versa.
- d) When there is a list of requirements SC 209 is asked to consider to add a summary at the beginning to have quick understanding of for example which bits are managed in a register.
- e) The text contains reference to DO181 rev1.1 with hyperlink for easier comparison.

Summary of main differences between Do proposed text and ED proposed text

Main differences between DO181 and ED73 proposed ELS requirements

	Subject	Level of importance for discussion with SC209
ELS1	Introductory text under 3.29	Low, only presentation issue to facilitate quick understanding of requirements
ELS2	<p>Add a paragraph to cover requirements about content of register 10 to cover:</p> <ul style="list-style-type: none"> + BDS code (To be added) Mode S subnetwork version (may be only a pointer to the last paragraph in DO ELS) + Bit25 (minimum requirement to not set it when only register 20 is supported to be added) Bit33 (May be just a pointer as already covered in Do 2.2.24.3.5.1) + Bit 35 (important to be described here rather than to point to EHS as currently done in Do 2.2.24.2.2) +Bit 36 + Update rate + Change reporting <p>(see ED proposal)</p>	<p>Important content to be discussed:</p> <p>1- to agree that requirements shall be first described in ELS and EHS sections to make reference to ELS for requirements already covered in ELS</p> <p>2- to agree where to put these requirements</p> <ul style="list-style-type: none"> - To cover missing requirements within already existing section DO 2.2.24.3.5.1 under Flight Id and ac registration -Create new section to only cover missing requirements - Create new section covering all register 10 requirements and replace text under Flight Id and ac registration by pointers to register 18 paragraphs (see ED73 proposed text 3.29.3)
ELS3	Remove reference to 24 bit aircraft address when speaking about aircraft registration for bits in register 17 (DO 2.2.24.3.5.2.1)	low, only improvement to avoid confusion
ELS4	Add a section to cover requirements on register 18-1c which are not covered under Flight identification and aircraft registration requirements	<p>To discuss different options to cover missing register 18 requirements:</p> <ul style="list-style-type: none"> - To cover missing requirements within already existing section DO 2.2.24.3.5.3 under Flight Id and ac registration -Create new section to only cover missing requirements - Create new section covering all register 18 requirements and replace text under Flight Id and ac registration by pointers to register 18 paragraphs (see ED73 proposed text 3.29.5)
ELS4	<p>Addition of a section listing all requirements about register 18-1C:</p> <ul style="list-style-type: none"> + bit 41 for register 10 + bit 34 for register 17 + bit 33 for register 18 	<p>To be discussed as bits 41 ,34 and 33 are not covered within current version of DO181</p> <p>To discuss where to put these requirement in DO (a specific section or witin section related to aircraft id)</p>
ELS5	Rewording of "power-on cycle" which is confusing for some people	Low but recommended
ELS6	Introductory text on Aircraft identification (see ED 3.29.6.1 red text)	To be discussed and improved to avoid confusion (see long discussion in WG49)
ELS2	<p>General presentation</p> <p>ED73 has followed the same approach than DO181 EHS section i.e., per register</p>	To be discussed

Main differences between DO181 and ED73 proposed EHS requirements

	Subject	Level of importance for discussion with SC209
EHS1	Introductory text under 3.30	Low, only presentation issue to facilitate quick understanding of requirements
EHS2	Add paragraphs in declaration of capability in Register 10 to cover: + BDS code + Mode S subnetwork version + Bit 35 + Bit 36 All only pointing to corresponding ELS sections)	to be discussed (see ED 3.30.1.2)
ELS3	Remove status bit management in register 10 (see EHS 2.2.25.1.4)	To be removed as it is confusing
EHS4	Incorporate a summary of which bits are to be managed in register 17 and 18-1C	Low, only presentation issue to facilitate quick understanding of requirements
EHS5	Use servicing in place of receiving for bits in register 17	to be discussed to avoid confusion and wrong implementation
EHS6	Add a paragraph at the end of register 17 to point to bit 36 management when register 17 changes	to be discussed
EHS7	In register 18: add bit corresponding to Register 10 (pointer to ELS); replace text for register 18 by a pointer to corresponding section as it is already a requirement for ELS	to be discussed
EHS8	In register 18: To remove bullet c) in Minimum update interval and possibly to replace it by proposed text in ED	To be taken into account as it is misleading
EHS9	DO 2.2.25 (register 1d...) after register 18-1C to get register described in numerical order	Low, only presentation issue
EHS10	Correct title register 40 to be compliant with latest version of ICAO document	To be taken into account (easy)
EHS11	Add requirement about 2's complement coding in signed field in register 50 and 60	To be taken into account (I have already received several times questions on this subject)
EHS12	Change title of register 60 replace rate by velocity to be in line with ICAO	To be taken into account (easy)
EHS13	Small proposed wording changes in all sections	Low
EHS14	To clarify requirement on register 5F Optional or implicitly required (see note in DO181 2.2.25.6)	Important
EHS14	To consider generic requirement (3.30.9) for any other implemented registers	To be discussed

ED MOPS section 3

3 Minimum performance specification standard test conditions

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- 3.22 LEVEL 1 TRANSPONDER**
- 3.23 LEVEL2 TRANSPONDER (DATA LINK)**
- 3.24 LEVEL3 TRANSPONDER (UPLINK ELM CAPABILITY)**
- 3.25 LEVEL4 TRANSPONDER (DOWNLINK ELM CAPABILITY)**
- 3.26 LEVEL5 TRANSPONDER (ENHANCED DATA LINK CAPABILITY)**
- 3.27 ACAS-COMPATIBLE MODE S TRANSPONDER**
- 3.28 EXTENDED SQUITTER COMPLIANT TRANSPONDER**

3.29 ELEMENTARY SURVEILLANCE (ELS) COMPLIANT TRANSPONDER {DO 2.2.24}

{ 3.29.1 general paragraph heading removed from ED to keep equivalent numbering to DO181}

Elementary Surveillance has been defined as a capability to support airspace operations in European airspace. The following section contains the data requirements to support the capability. {DO 2.2.24}

{SC209 to consider addition of the following requirement summary}

{WG49 and SC209 to consider whether to use 'shall' in the following sentences}

The Mode S transponder has to be at minimum a data link (level 2) transponder (see section 3.23).

The Mode S transponder is supporting:

- (1) Flight status reporting (FS) as described in 3.18.4.12. The Mode S transponder is capable of automatically acquiring the on-the-ground status as described in 3.20.2.7
- (2) Barometric pressure altitude reporting as described in xxx.
- (3) CA as specified in 3.18.4.5 and 3.23 (ie. Greater than 3)
- (4) II and SI code as defined in section 3.21a and further details in section 3.29.2.
- (5) Declaration of capability in register 10₁₆ as described in section 3.21 and further detailed in 3.29.3
- (6) Aircraft register 17₁₆ as defined in 3.29.4
- (7) Aircraft registers 18₁₆{through 1C₁₆} as defined in 3.29.5
- (8) Flight identification reporting in register 20₁₆ as detailed in section 3.21 and further detailed in 3.29.6.
- (9) As an option, Aircraft register 21₁₆.

In addition Mode S transponder capable to support ACAS operation fulfils all requirements defined in 3.27. In particular it reports ACAS capability and version in register 10₁₆ and the RA Report in register 30₁₆.

Note: In the rest of this section, servicing a field in a register means that valid data have been received at a sufficient rate to fulfil requirement associated to the register. {TBD and further refined}

3.29.1 Ground Initiated Comm B {DO 2.2.24.1}

{SC 209 to consider to remove Commentary as it is not MOPS for ground station}

Mode S Transponder **shall** support extraction of registers 10₁₆, 17₁₆, 18₁₆ through 1C₁₆, and 20₁₆ using the GICB protocol in accordance with 3.21.1.12b.

Note: servicing register 21₁₆ is optional.

Note: As a level 2 transponder an ELS transponder reply to all aircraft register extraction requests (see). When an aircraft register is not implemented the content of MB is all 0. {DO 2.2.24.1}To be checked. Shall a level 2 xpder reply to all extraction requests ? check also crosslink capability for TCAS.

3.29.2 Surveillance Identifier (“SI”) Code Requirements {DO181-2.2.24.2}

Mode S Transponders support the requirements of Interrogator codes (II and SI) in accordance with all the following sections of this document.

- §3.18.4.9 “DI” Designator, Identification Field,
- §3.18.4.15, “II” Interrogator Identification Field
- §3.18.4.27, “PI” Parity / Interrogator Identity
- §3.18.4.33, “SD” Special Designator and “IIS”, Subfield in “SD”
- §3.18.4.7, “CL” Code Label
- §3.18.4.13, “IC” Interrogator Code

- §3.18.4.34, “SI” Surveillance Identifier
- §3.20.2.1, Basic Mode-S Error Protection
- §3.20.3.5, “Multisite Lockout Protocol”
- §3.20.2.1., “All-Call Reply Protocol”

{SC209 to check why squitters are covered, not currently covered in ED73}

{DO 2.2.24.2.2 not covered here but in register 10₁₆, pointer to EHS not a good option, EHS transponder is ELS but not vice versa}

3.29.3 Declaration of capability in Register 10₁₆ - Data link capability report {DO181-2.2.24.2.2; DO181-2.2.25.1.1}

{SC 209 to consider insertion of a section describing register 10 as already done in EHS. not clear what shall be supported in register for an ELS transponder; need to introduce what need to be managed by ELS transponder, furthermore reference to EHS in ELS is confusing as ELS is not necessarily EHS but EHS is ELS therefore it seems better to make reference to ELS in EHS as necessary }

{for clarity the text of 3.29.3 is not all in red although is does not exist in Do181}

3.29.3.1.1 Purpose and definition

Register 10₁₆ shall be formatted as specified in Appendix B table B-3-16.

Note: The following paragraphs detail the minimum requirement for Elementary Surveillance. The other fields need to be managed according to the additional capabilities supported by the transponder.

3.29.3.1.2 Data requirements

3.29.3.1.2.1 Bit 1 to 8 - BDS code {SC 209 to consider to add this paragraph – the text has not been put in red as it is the same text than the text in 2.2.25.1}

Bits 1 –through- 8 of register 10₁₆ shall be encoded with 1,0 (the BDS code).

Note: The setting of the BDS code by the transponder ensures that a broadcast change of the capability report will contain the BDS code for all cases of data link failure (e.g., the loss of the transponder data link interface)

3.29.3.1.2.2 Bit 17 to 23 - Declaration of Mode-S Subnetwork Version Number in BDS Code 1,0 {DO 2.2.24.4}

Bits 17 –through- 23 of register 10₁₆ shall be encoded with the Mode-S Subnetwork Version Number.

Note: Mode-S Subnetwork Version matches with the edition of ICAO Annex 10 Amendment.

To be consistent with Elementary (and Enhanced) surveillance requirements the Mode-S Subnetwork version shall be “3” or higher.

{note: bits and format of registers used for Elementary Surveillance have not changed between the different versions. 0 or above could be acceptable TBC??}

3.29.3.1.2.3 Bit 25 – {DO 2.2.25.1.1} {SC 209 to consider to add this paragraph and check associated test}

Bit 25 shall not be set by reporting only aircraft Identification in register 20₁₆ when no other Mode S specific services are supported.

Note: When bit 25 is set to 1, it indicates that at least one Mode S specific service (other than GICB services related to registers 02₁₆, 03₁₆, 04₁₆, 10₁₆, 17₁₆ to 1C₁₆, 20₁₆ and 30₁₆) is supported and the particular capability reports must be checked.

3.29.3.1.2.4 Bit 33 – Aircraft identification reporting capability

Bit 33 shall be set as stated in 3.21.1.12 e.

Note: This bit actually indicates whether the aircraft installation supports an interface to load the aircraft identification in the transponder register 20₁₆. It does not take into account the consistency of the data loaded into the register.

{DO 2.2.24.3.5.1}

Servicing of Register 20₁₆ requires the updating of Register 10₁₆ as follows:

- a) Register 10₁₆ (Data Link Capability Report) bit 33 shall be set to ONE (1) if the transponder is receiving any data from the Aircraft installation with which to service Register 20₁₆ with Flight Identification or Aircraft Registration data. {as provided in the respective sections for each BDS register in the subsequent sections of this document}.

Note: This requirement is not established by the transponder LRU own capability to service Register 20₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 20₁₆.

- b) Register 10₁₆ (Data Link Capability Report) bit 33 **shall** be set to ZERO (0) if the transponder is receiving no data from the Aircraft installation that could be used to properly service Register 20₁₆.

{Note: This bit is equivalent to bit7 of register 17₁₆. TBC ???}

3.29.3.1.2.5 Bit 35 – Surveillance Identifier Code (SIC)

The bit **35** of register **10₁₆** shall be set to **1** to indicate that the transponder support SI code.

Note: SI code support is a mandatory capability for all transponders.

3.29.3.1.2.6 Bit 36 - Bit 36 - Common usage GICB capability report {DO 2.2.25.1.2}

- a) Register 10₁₆ (Data Link Capability Report) bit 36 **shall** be toggled (i.e., changed from “0” to “1”, or from “1” to “0”) each time that the Common Usage GICB Capability Report (Register 17₁₆) is changed.
- b) To avoid the generation of too many broadcast capability report changes, Register 17₁₆ **shall** be sampled at approximately one minute intervals to check for changes that may require the toggling of bit 36 as discussed in subparagraph “a.”

3.29.3.2 Minimum Update interval {DO2.2.25.1.4}

- a) The minimum update interval at which Register 10₁₆ **shall** be reloaded with valid data is ≤4.0 seconds.

Note: Effectively, Register 10₁₆ must be updated every 4.0 seconds or sooner.

- b) Register 10₁₆ **shall** be updated within one second of the data changing and at least every four seconds thereafter.
- c) If particular data field in Register 10₁₆ cannot be updated within 8.0 seconds (e.g., twice the specified minimum update interval of ≤4.0 seconds), then {not applicable to register 10!!!! **SC 209 to consider to remove**: the status bit (if specified for that field) **shall** indicate that the data in that field is invalid and} the data field **shall** be ZEROed.

3.29.3.3 Change reporting

When Register **10₁₆** changes it shall be broadcast as described in 3.21.1.12 e 3).

3.29.4 Register 17₁₆

{SC209 to consider addition of a section on register 17₁₆ to allow quick access to the different requirements on the different bits and to follow same structure than EHS in DO181 }

3.29.4.1 Purpose and definition

The format of register 17₁₆ shall be formatted as specified in Appendix B table B-3-23

Note: the purpose of register 17₁₆ is to indicate which registers are currently supported by the aircraft installation i.e currently contained data useable for operational use.

Elementary Surveillance transponder manages the following bits of register 1716:

- a) Bit7 to indicate servicing of Register 2016,
- b) Bit8 to indicate servicing of Optional Register 2116.

3.29.4.2 Data requirements

3.29.4.2.1 Required Servicing of Register 17₁₆ Associated with Register 20₁₆ [{DO 2.2.24.3.5.2.1}](#)

- a) Register 17₁₆ bit 7 shall be set to ONE (1) if the transponder is {receiving} servicing Aircraft Identification (either Flight Identification as specified in the Flight Plan or Aircraft Registration, refer to 3.23.1.13) {introduction of 24 bit AA is confusing, SC 209 to consider to remove (which should be assigned based on the Mode-S 24-bit Address)} data in the Aircraft installation.

Note: This requirement is not established by the transponder LRU own capability to service Register 20₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 20₁₆.

- b) Register 17₁₆ bit 7 shall be set to ZERO (0) if the transponder is receiving no Aircraft identification data from the Aircraft installation that could be used to service Register 20₁₆.

Note: Guidance is given in appendix B ref Cxxxxx.

3.29.4.2.2 Required Servicing of Register 17₁₆ Associated with optional Register 21₁₆

Note: Elementary Surveillance does not require that Register 21₁₆ be serviced. However, if Register 21₁₆ is serviced, the following subparagraphs need to be complied with.

- a) Register 17₁₆ bit 8 shall be set to ONE (1) if the transponder is receiving Aircraft Registration {introduction of 24 bit AA is confusing, SC 209 to consider to remove (which should be assigned based on the Mode-S 24-bit Address)} data in the Aircraft installation.

Note: This requirement is not established by the transponder LRU own capability to service Register 21₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 21₁₆.

- b) Register 17₁₆ bit 8 shall be set to ZERO (0) if the transponder is receiving no data from the Aircraft installation that could be used to properly service Register 21₁₆

3.29.4.3 Change reporting

When BDS code 1,7 changes bit 36 of BDS 1,0 shall be toggled as defined in 3.29.3.1.2.6.

3.29.5 Register 18₁₆ to 1C₁₆ { WG49 and SC209 to decide whether to keep only 18 as the other are not used in ELS}

{SC209 to consider addition of a section on register 18₁₆ to 1C₁₆ to allow quick access to the different requirements on the different bits and to follow same structure than EHS in DO181 and in ED73}

3.29.5.1 Purpose and definition {DO 2.2.24.3.5.3}

Register 18₁₆ to 1C₁₆ bits **shall** be formatted as specified in Appendix B table B-3-24 to B2-28.

Note 1: Registers 18₁₆ to 1C₁₆ are used to indicate the capability of the aircraft installation to provide data for each register i.e. the register or a part of the register is managed by the transponder and it is known that data can be received from the installation to fill this field.

Note 2: This is not established by the Transponder LRU own capability. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to service the corresponding register. Once this capability is established it remains set until power off of the transponder.

Transponder supporting Elementary Surveillance manages:

- Register 18₁₆ bit 41 to indicate the capability to provide data in Register 10₁₆,
- Register 18₁₆ bit 34 to indicate the capability to provide data in Register 17₁₆,
- Register 18₁₆ bit 33 to indicate the capability to provide data in Register 18₁₆,
- Register 18₁₆ bit 25 to indicate the capability to provide data in Register 20₁₆,
- Optionally Register 18₁₆ bit 24 to indicate the capability to provide data in Register 21₁₆.

Bit 9 of register 18₁₆ is set when transponder is connected to an ACAS to indicate that ACAS RA report register 30₁₆ is supported (see section 3.27).

3.29.5.2 Data requirements

3.29.5.2.1 Required Servicing of Register 18₁₆ Associated with Register 10₁₆ {Not in DO181 SC 209 to consider addition of this requirement to ELS}

- a) Register 18₁₆ bit 41 **shall** be set to ONE (1) as the transponder is required to service any part of Register 10₁₆.

Note: This requirement is not established by the Transponder LRU own capability to service Register 17₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update Register 17₁₆.

- b) Once Register 18₁₆ bit 41 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) **until power-off of the transponder**. {SC209 to consider to replace: for the duration of the power-on cycle. }

3.29.5.2.2 Required Servicing of Register 18₁₆ Associated with Register 17₁₆ {Not in ELS but in DO

2.2.25.3.2.1 - SC 209 to consider addition of this requirement to ELS}

- a) Register 18₁₆ bit 34 **shall** be set to ONE (1) if the transponder is required to service any part of Register 17₁₆ as provided in 3.29.4.

Note: This requirement is not established by the Transponder LRU own capability to service Register 17₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update Register 17₁₆.

- b) Once Register 18₁₆ bit 34 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) **until power-off of the transponder**. {SC209 to consider to replace: for the duration of the power-on cycle. }

- c) Register 18₁₆ bit 34 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could result in the need to service Register 17₁₆ as provided in §3.29.4.

3.29.5.2.3 Required Servicing of Register 18₁₆ Associated with Register 18₁₆ {Not in ELS but in DO

2.2.25.3.2.2- SC 209 to consider addition of this requirement to ELS}

- a) Register 18₁₆ bit 33 **shall** be set to ONE (1) { **As always true, SC 209 to consider to remove:** if the transponder is required to service any part of Register 18₁₆ as provided in §.}

***Note:** This requirement is not established by the Transponder LRU own capability to service Register 18₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update Register 18₁₆.*

- b) Once Register 18₁₆ bit 33 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) **until power-off of the transponder.** {SC209 to consider to replace: for the duration of the power-on cycle.}
- c) {SC209 to consider to remove bullet c as it is not possible. Register 10 is always supported!}: Register 18₁₆ bit 33 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could result in the need to service Register 18₁₆ as provided in §. }

3.29.5.2.4 Required Servicing of Register 18₁₆ Associated with Register 20₁₆ {DO2.24.3.5.3.1}

- a) Register 18₁₆ bit 25 **shall** be set to ONE (1) if the transponder has received either Aircraft Identification (also referred to as Flight Identification as specified in the Flight Plan) or Aircraft Registration { SC 209 to consider to replace : (which should be assigned based on the Mode-S 24-bit Address)} data since the power-on of the transponder. {SC209 to consider to replace : during the power-on cycle.}
- b) Once Register 18₁₆ bit 25 has been set to ONE (1) { to be removed: during a particular power-on cycle}, then it shall remain set to ONE (1) **until power-off of the transponder.** {SC209 to consider to replace: for the duration of the power-on cycle.}
- c) Register 18₁₆ bit 25 shall be set to ZERO (0) if the transponder **has** received no data from the Aircraft installation that could be used to properly service Register 20₁₆ **since the power-on of the transponder** {SC209 to consider to replace: for the duration of the power-on cycle.}.

Note 1: It is accepted to set bit 25 in register 18₁₆ whatever the validity of the received data.

3.29.5.2.5 Required Servicing of Register 18₁₆ Associated with optional Register 21₁₆

{DO2.24.3.5.3.2}

***Note:** Elementary Surveillance does not require that Register 21₁₆ be serviced. However, if Register 21₁₆ is serviced, the following subparagraphs need to be complied with.*

- a) Register 18₁₆ bit 24 **shall** be set to ONE (1) if the transponder receives Aircraft Registration { SC 209 to consider to remove : (which should be assigned based on the Mode-S 24-bit Address)} data in the Aircraft Installation since the power-on of the transponder. {SC209 to consider to replace : during the power-on cycle.}

***Note:** This requirement is not established by the Transponder LRU own capability to service Register 21₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 21₁₆.*

- b) Once Register 18₁₆ bit 24 has been set to ONE (1) {during a particular power-on cycle}, then it **shall** remain set to ONE (1) until power-off of the transponder. {SC209 to consider to replace: for the duration of the power-on cycle.}
- c) Register 18₁₆ bit 24 **shall** be set to ZERO (0) if the transponder **has** received no data from the Aircraft installation that could be used to properly service Register 21₁₆ **since the power-on of the transponder** {SC209 to consider to replace: for the duration of the power-on cycle.}.

3.29.5.3 Minimum Update Interval

- a) The minimum update interval at which Register 18₁₆ { to 1C₁₆} **shall** be reloaded with valid data is **5.0** seconds i.e., Register 18₁₆ {to 1C₁₆} **shall** be updated at least once every **5.0**

seconds.

- b) The time between availability of data that causes a change in BDS Code **1,8** and the time that the change is made to Register 18₁₆ {SC209 to consider to replace: BDS Code 1,8 by register 18₁₆} **shall** be less than the minimum update interval specified as **5.0** seconds.
- c) The setting of these bits are static and shall not change during the operation of the transponder when the inputs disappear, i.e., Registers 18₁₆ to 1C₁₆ are static; once a bit is set it remains set to 1 until the power-off of the transponder.

3.29.6 Register 20₁₆ - Aircraft Identification and Data Sources {DO181-2.2.24.3.3}

3.29.6.1 Purpose and definition {DO 2.2.24.3.1.1}

The Mode-S transponder **shall** format register 20₁₆ as defined in Appendix B, Table B-3-32 and associated notes.

{WG49 and SC209 to consider adding following explanation}

Note: ICAO requires that the aircraft identification to be used is that employed in the flight plan. When no flight plan is available, the registration marking is used.

Note: On aircraft it is possible to have access to data coming from an interface where the pilot can enter the data that is employed in the flight plan. This could be the telephony designator of the aircraft operating agency, followed by the flight identification or the registration marking of the aircraft. This piece of information is considered as variable data and the transponder cannot know what is really entered by the pilot (depending on operational procedure). This piece of information is named "Flight Identification" within the rest of this section. In ARINC, it is normally provided via ARINC Labels 233 through 237 or by Label 360 for block transfer data.

In addition on some platforms it is also possible to receive another piece of data which is the registration marking (tail number). This is considered as a fixed data which does not vary during the flight. This piece of information can only be used when there is no data coming from the interface delivering the variable data. This is referenced as "Aircraft Registration" within the rest of this section.

{see 3.17.1 a3 + b5 here + check 3.21.1.13 if it is not duplicated and put indication here to point to 3.21.1.13 TBC}

3.29.6.2 Data requirements

3.29.6.2.1 Data Selection Priority {DO181 – 2.2.24.3.4.1}

Use of **Flight Identification** (3.17.1.b.5) or **Aircraft Registration** Data (3.17.1.a.3) in register 20₁₆ **shall** comply with the following:

- a) If Flight Identification data is available at anytime during unit operation, then flight identification data **shall** be inserted into the character subfields of Register 20₁₆.

Note: Flight Identification data is normally provided via ARINC Labels 233 through 237 or by Label 360 for block transfer data.

- b) If Flight Identification data is **NOT** available then Aircraft Registration, **if available**, **shall** be inserted into the character subfields of Register 20₁₆.

Note: if the transponder has no input from the Aircraft installation that could be used to service Register 20₁₆, Register 20₁₆ character subfield is set to 0 and Register 10₁₆ (Data Link Capability Report) bit 33 is set to ZERO (0) {modified DO2.2.24.3.5.1 but could be requirement}

- c) If Flight Identification data has been entered into Register 20₁₆ and then becomes NOT available, then the character subfields of the registers **shall** be set to all **ZERO**'s

- d) In all of the above cases, encoding of the character subfields in Register 20₁₆ **shall** conform to the following:

- (1) All characters will be left justified prior to encoding the Character fields.
- (2) Characters will be coded consecutively without intervening SPACE codes.
- (3) Any unused character spaces at the end of the subfield should contain a SPACE character code.
- (4) Any extra characters shall be truncated.

3.29.6.3 Flight Identification Update Rates {DO181 -2.2.24.3.6}

{Note: this paragraph applies only when Register 20₁₆ is filled with variable data (Flight Identification) and not with fixed data (Aircraft registration).} If reference not found: to be removed.

- a) The minimum update rate at which Register 20₁₆ shall be reloaded with valid data is 5.0 seconds.

Note: (Effectively, Register 20₁₆ must be updated every 5.0 seconds or sooner).

- b) If Register 20₁₆ cannot be updated within a 10.0 second timeframe (i.e., twice the specified minimum update rate of 5.0 seconds), then: {presentation change}

(1) the contents of the character field of the Register 20₁₆ shall be set to ZERO and:

(2) Bit 7 of register 17₁₆ shall be set to ZERO. {no req on bit 33 of register 10₁₆ ???}

{SC209 to consider to remove or replace by text in 3.29.3.1.2.3: Bit 25 of BDS Code 1,8 shall not change state if Register 20₁₆ has been properly serviced during the power-on cycle. If Register 20₁₆ has not been properly serviced during the power-on cycle, then bit 25 of BDS Code 1,8 must be verified as being set to ZERO (see §2.2.24.5.3.1).}

Note: Bit 25 of register 18₁₆ is not impacted see 3.29.3.1.2.3.

- c) The time between availability of data that causes a change in Register 20₁₆ and the time that the change is made to Register 20₁₆ shall be less than the minimum update rate specified as 5.0 seconds.

Note: The time between establishing availability of data and the time of updating Register 20₁₆ should be minimized (e.g., data latency should be minimized).

3.29.6.4 Aircraft Identification declaration of capability {added to keep DO approach per function - Do 2.2.24.3.5}

3.29.6.4.1 In Register 10₁₆ – Data Link Capability Report {Do 2.2.24.3.5.1}

The correct servicing of the character field of Register 20₁₆ is reported in Register 10₁₆ bit 33 as defined in §3.29.3.1.2.4. {DO 2.2.24.3.5.1}

3.29.6.4.2 In Register 17₁₆ – Common Usage GICB Capability Report {DO 2.2.24.3.5.2}

The correct servicing of the character field of Register 20₁₆ is reported in Register 17₁₆ bit 33 as defined in § 3.29.4.2.1 . {DO 2.2.24.3.5.2.1}

3.29.6.4.3 In Register 18₁₆ – Common Usage GICB Capability Report {Do 2.2.24.3.5.3}

The capability to report aircraft identification in the character field of Register 20₁₆ is reported in Register 18₁₆ bit 33 as defined in §.3.29.5.2 {DO 2.2.24.3.5.3.1}

3.29.6.5 Change reporting {DO 2.2.24.3.2}

If the aircraft identification reported in the “AIS” subfield is changed {to avoid confusion, SC 209 to consider to remove : in flight} the transponder shall report the new aircraft identification in accordance with §3.23.1.13 by use of the Comm-B Broadcast Message protocol (see §3.23.1.12.d).

3.29.7 Register 21₁₆ - Aircraft Registration (Optional) {DO181-2.2.24.3.3}

Note: Elementary Surveillance does not require that Register 21₁₆ be serviced. However, if Register 21₁₆ is serviced, the following subparagraphs need to be complied with.

3.29.7.1 Purpose and definition

The Mode-S transponder shall format register 21₁₆ as defined in Appendix B, Table B-3-33 and associated notes.

3.29.7.2 Register 21₁₆ - Data requirements {Do 2.2.24.3.4.2}

- a) If valid Aircraft Registration data is available, then the data shall be used to fill the Characters of bits 1 through 43 field in Register 21₁₆, "Aircraft and Airline Registration Markings" {as shown in Appendix B, Table B-3-33} :

Note: Aircraft Registration data is normally provided via ARINC Labels 301 through 303 or by Label 360 for block transfer data. Available data means that the status of the data is not set to No Computed Data (NCD).

- b) There is currently no method to provide the transponder with ICAO Airline Registration marking. Therefore, bits 44 through 56 of Register 21₁₆ shall be set to zero.
- c) {SC209 to consider to remove bullet c as it is a basic requirement for level 2 transponders: c. When Register 21₁₆ is being serviced with Aircraft Registration data, then Register 21₁₆ shall be available for GICB Extraction as per §Error! Reference source not found..}

3.29.7.3 Register 21₁₆ – Update Rates { DO 2.2.24.3.4.2.1}

- a. The minimum update interval at which Register 21₁₆ shall be reloaded with valid data is 15.0 seconds.

Note: Effectively, Register 21₁₆ must be updated every 15.0 seconds or sooner).

- b. If Register 21₁₆ cannot be updated within a 30.0 second timeframe (e.g., twice the specified minimum update interval of 15.0 seconds), then the contents of Register 21₁₆ shall be set to ZERO and:

(1). Note : Bit 24 of Register 18₁₆ shall not change state if Register 21₁₆ has been properly serviced during the power-on cycle. If Register 21₁₆ has not been properly serviced during the power-on cycle, then bit 24 of Register 18₁₆ must be verified as being set to ZERO.

- c. The time between availability of data that causes a change in Register 21₁₆ and the time that the change is made to Register 21₁₆ shall be less than the minimum update interval specified as 15.0 seconds.

Note: The time between establishing availability of data and the time of updating Register 21₁₆ should be minimized (e.g., data latency should be minimized).

3.29.7.4 Register 21₁₆- declaration of capability

3.29.7.4.1 In Register 17₁₆ {DO 2.2.24.3.5.2.1}

The correct servicing of at least one field in Register 21₁₆ is reported in Register 17₁₆ bit 8 as defined in § 3.29.4.2.2.

3.29.7.4.2 In Register 18₁₆ {DO 2.2.24.3.5.2.1}

The capability to service at least one field in Register 21₁₆ is reported in Register 18₁₆ bit 24 as defined in § 3.29.5.2.5 .

3.30 ENHANCED SURVEILLANCE (EHS) COMPLIANT TRANSPONDER {DO 2.2.25}

{General removed to try to keep same numbering than Do181}

The EUROCONTROL ATM 2000+ Strategy confirmed that Enhanced Surveillance (EHS) was essential to safely enable additional traffic growth.

This section contains requirements on Mode S transponders required to support EHS.

The Enhanced Surveillance application entails the use of eight Downlink Aircraft Parameters (DAPs) for initial implementation, as follows:

- Magnetic Heading
- Indicated Airspeed and/or Mach No.
- Vertical Rate (climb/descend)
- FCU/MCP Selected Altitude
- Ground Speed
- Roll Angle
- Track Angle Rate (or True Airspeed if Track Angle Rate is not available)
- True Track Angle

These DAPS are embedded in three transponder registers (40₁₆, 50₁₆, 60₁₆).

In addition to those three registers, the Enhanced Surveillance application uses a number of capability report registers to assess the real time ability of the aircraft to transmit DAPs. The format requirements related to the Enhanced Surveillance application for these capability registers are defined in sections 3.30.1 through 3.30.4.

The Enhanced Surveillance application presents the following benefits:

- The provision of actual aircraft derived data, such as Magnetic Heading, Air Speed, Selected Altitude and Vertical Rate, enables controllers to reduce the radio telephony (RT) workload and better assess the separation situations.
- EHS enables Monitoring Tools and Safety Nets, which work on actual data, to be implemented or improved (eg. Short Term Conflict Alert) which, in turn, will allow safety levels to be maintained or improved despite the increase in traffic levels.

Transponder capable to support EHS must:

- a) support ELS as defined in 3.29.
- b) at least be able to provide data in register 40₁₆, 50₁₆, 60₁₆.
- c) support capability reporting in CA and register 10₁₆ to 1F₁₆.

Note: servicing register 5F₁₆ is not mandatory. {DO 2.2.25.1.1 Not}

Note: In the rest of this section, servicing a field in a register means that valid data have been received at a sufficient rate to fulfil requirement associated to the register. {TBD and further refined}

3.30.1 Register 10₁₆ - Data link capability report

3.30.1.1 Purpose and definition

Register 10₁₆ shall be formatted as specified in Appendix B table B-3-16. {DO 2.2.25.1.3}

Note: The following paragraphs detail the minimum requirement for Enhanced Surveillance. The other fields need to be managed according to the additional capabilities supported by the transponder.

3.30.1.2 Data requirements

3.30.1.2.1 Bit 1 to 8 - BDS code

Bits 1 –through- 8 of register 10₁₆ are defined in Elementary Surveillance Mode S transponder § 3.29.3.1.2.1 .

{SC209 to consider to make reference to ELS transponder section}

3.30.1.2.2 Bit 17-23- Mode S subnetwork version number

Bit 17-23 (Mode S subnetwork version) is defined in Elementary Surveillance Mode S transponder § 3.29.3.1.2.2 .

Mode S Subnetwork version shall be ≥ 3 for EHS transponder as EHS has been standardized with ICAO amendment 77.

3.30.1.2.3 Bit 25 - Mode S specific services capability {DO 2.2.25.1.1 a}

a) Register 10₁₆ (Data Link Capability Report) bit 25 **shall** be set to ONE (1) if the transponder is receiving any data from the Aircraft installation with which to service Registers 1D₁₆ - 1F₁₆ / 40₁₆ / 50₁₆ or 60₁₆ (or other registers) as provided in the respective sections for each register in this document.

Notes:

1. Register 1D₁₆ – 1F₁₆ are included above in order to provide for possible declaration of capability to provide Dataflash or other Mode Specific Protocol capability.

2. This requirement is not established by the transponder LRU own capability to service Register 1D₁₆ - 1F₁₆ / 40₁₆ / 50₁₆ / 5F₁₆ or 60₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service these registers.

b) Register 10₁₆ (Data Link Capability Report) bit 25 **shall** be set to ZERO (0) if the transponder is receiving no data from the Aircraft installation that could be used to properly service either Registers 1D₁₆ through 1F₁₆, 40₁₆, 50₁₆ , 5F₁₆ (Optional) , 60₁₆ **or any other registers other than 02₁₆, 03₁₆, 04₁₆, 10₁₆, 17₁₆ through 1C₁₆, 20₁₆ and 30₁₆.**

c) When bit 25 is set to ONE (1), it **shall** indicate that at least one Mode S Specific Service is supported.

Note: Mode S Specific Service refers to the servicing of registers other than GICB services related to Registers 02₁₆, 03₁₆, 04₁₆, 10₁₆, 17₁₆ through 1C₁₆, 20₁₆ and 30₁₆.

3.30.1.2.4 Bit 35 – Surveillance Identifier Code (SIC)

a) The bit 35 of register 10₁₆ is set to 1 as defined in Elementary Surveillance Mode S transponder § 3.29.3.1.2.5 .

3.30.1.2.5 Bit 36 - Common usage GICB capability report {DO 2.2.25.1.2}

a) Register 10₁₆ (Data Link Capability Report) bit 36 is managed as specified in Elementary Surveillance Mode S transponder § 3.29.3.1.2.6.

3.30.1.3 Minimum Update Interval of Register 10₁₆ { DO181- 2.25.1.4}

a) The minimum update interval at which Register 10₁₆ **shall** be reloaded with valid data is ≤ 4.0 seconds.

Note: Effectively, Register 10₁₆ must be updated every 4.0 seconds or sooner).

b) Register 10₁₆ **shall** be updated within one second of the data changing and at least every four

seconds thereafter.

- c) If a particular data field in Register 10₁₆ cannot be updated within **8.0** seconds (e.g., twice the specified minimum update interval of **≤4.0** seconds, then the data field **shall** be ZEROED.

3.30.1.4 Change reporting

When register 10₁₆ changes, it is broadcast as described in 3.21.1.12 e 3).

3.30.2 Register 17₁₆- Common usage GICB capability report {DO 2.2.25.2}

3.30.2.1 Purpose and definition

The format of Register 17₁₆ shall be as specified in Appendix B table B-3-23 and associated notes. {DO 2.2.25.2.1}

{SC209 to consider to include foolowing summary of bits managed by EHS transponder}

A system supporting the European Enhanced Surveillance application is managing the following bits in register 17₁₆ :

- a) Bit 7 to indicate servicing of register 20₁₆ aircraft identification as defined for Elementary Surveillance,
- b) Bit 8 to indicate servicing of the optional register 21₁₆ aircraft identification as defined for Elementary Surveillance,
- c) Bit 9 to indicate whether the aircraft installation is servicing a part of register 40₁₆.
- d) Bit 16 to indicate whether the aircraft installation is servicing a part of register 50₁₆.
- e) Bit 24 to indicate whether the aircraft installation is servicing a part of register 60₁₆.

3.30.2.2 Enhanced Surveillance Servicing requirements {DO 2.2.25.2.2}

3.30.2.2.1 Required Servicing of Register 17₁₆ Associated with Register 20₁₆

Refer to §3.29.4.2.1, where requirements have previously been provided as servicing of Register 20₁₆ as a part of Elementary Surveillance.

3.30.2.2.2 Required Servicing of Register 17₁₆ Associated with optional Register 21₁₆

Refer to §3.29.4.2.2, where requirements have previously been provided as servicing of Register 21₁₆ may optionally be implemented as a part of Elementary Surveillance.

3.30.2.2.3 Required Servicing of Register 17₁₆ Associated with Register 40₁₆

- a) Register 17₁₆ bit 9 shall be set to ONE (1) if the transponder is servicing {SC209 to consider to replace receiving by servicing as receiving is not sufficient for setting bits in 17} either Selected Altitude, FMS Selected Altitude, Barometric Pressure Setting, FMS Vertical Mode, or Target Altitude Source data in Register 40₁₆ {remove the Aircraft installation}.

{ SC209 to consider to remove (Refer to Appendix B, Table B-3-64 for full definition of Register 40₁₆).}

Notes:

- 1. This requirement is not established by the transponder LRU own capability to service Register 4016. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 4016.
 - 2. FMS Vertical Mode data refers to data used to establish bits 48 through 51 of Register 4016.
 - 3. Target Altitude Source data refers to data used to establish bits 54 through 56 of Register 4016.
- b) Register 17₁₆ bit 9 shall be set to ZERO (0) if the transponder is receiving no data from the Aircraft installation that could be used to properly service Register 40₁₆.

3.30.2.2.4 Required Servicing of Register 17₁₆ Associated with Register 50₁₆

- a) Register 17₁₆ bit 16 shall be set to ONE (1) if the transponder is servicing {SC209 to consider to replace receiving by servicing as receiving is not sufficient for setting bits in 17} either Roll Angle, True Track Angle, Ground Speed, Track Angle Rate, or True Airspeed data in Register 50₁₆ {the Aircraft installation}.

{SC209 to consider to remove (Refer to Appendix B, Table B-3-80 for full definition of Register 50₁₆)}

Note: This requirement is not established by the transponder LRU own capability to service Register 50₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 50₁₆.

- b) Register 17₁₆ bit 16 **shall** be set to ZERO (0) if the transponder is receiving no data from the Aircraft installation that could be used to properly service Register 50₁₆.

3.30.2.2.5 Required Servicing of Register 17₁₆ Associated with optional Register 5F₁₆

Note: Enhanced Surveillance does not require that Register 5F₁₆ be serviced. However, servicing of Register 5F₁₆ is **implicitly required** {SC209 to clarify a register cannot be optional and impliwhen servicing Register 40₁₆ in ICAO Doc. 9871 and Appendix B. Therefore, if Register 5F₁₆ is serviced, the following subparagraphs need to be complied with.

- a) Register 17₁₆ bit 23 **shall** be set to ONE (1) if the transponder is receiving {SC209 to consider to clarify} either MCP/FCU Selected Altitude, FMS selected altitude, barometric pressure setting or FMS vertical mode (MCP/FCU mode bits) necessary to update Register 40₁₆ (see §3.30.5) which then requires that Register 5F₁₆ be updated in accordance with §3.30.7.

Note: This requirement is not established by the transponder LRU own capability to service Register 5F₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 5F₁₆.

- b) Register 17₁₆ bit 23 **shall** be set to ZERO (0) if the transponder is receiving no data from the Aircraft installation that could be used to properly service Register 5F₁₆.

3.30.2.2.6 Required Servicing of Register 17₁₆ Associated with Register 60₁₆ {DO 2.2.25.2.2.6}

- a) Register 17₁₆ bit 24 **shall** be set to ONE (1) if the transponder is servicing {SC209 to consider to replace receiving by servicing as receiving is not sufficient for setting bits in 17} either Magnetic Heading, Indicated Airspeed, Mach, Barometric Altitude Rate, or Inertial Vertical Velocity data in the Aircraft installation.

{SC209 to consider to remove (Refer to Appendix B, Table B-3-96 for full definition of Register 60₁₆) }

Note: This requirement is not established by the transponder LRU own capability to service Register 60₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 60₁₆.

- b) Register 17₁₆ bit 24 **shall** be set to ZERO (0) if the transponder is receiving no data from the Aircraft installation that could be used to properly service Register 60₁₆.

3.30.2.2.7 Minimum Update Interval

- a) The minimum update interval at which Register 17₁₆ shall be reloaded with valid data is 5.0 seconds (i.e., Register 17₁₆ is be updated at least once every 5.0 seconds).
- b) The time between availability of data that causes a change in Register 17₁₆ and the time that the change is made to Register 17₁₆ **shall** be less than the minimum update interval specified as 5.0 seconds.
- c) If a particular bit in Register 17₁₆ cannot be updated within 10.0 seconds (e.g., twice the specified minimum update interval of 5.0 seconds, then the bit **shall** be Zeroed.

3.30.2.3 Change reporting {SC209 to consider to add this paragraph}

When Register 17₁₆ changes, bit 36 of Register 10₁₆ is to be toggled as defined in § 3.29.3.1.2.6.

3.30.3 Register 18₁₆ through 1C₁₆ Mode S Specific Services GICB Capability {DO 2.2.25.3 similar}

3.30.3.1 Purpose and definition

Register 18₁₆ to 1C₁₆ bits shall be formatted as specified in Appendix B table B-3-24 to B2-28.

A system supporting the European Enhanced Surveillance application is managing the following bits in register 18₁₆ to 1C₁₆ :

- a) Register 18₁₆ bit 41 to indicate that the installation has the capability to provide data in Register 10₁₆,
- b) Register 18₁₆ bit 34 to indicate that the installation has the capability to provide data in Register 17₁₆,
- c) Register 18₁₆ bit 33 to indicate that the installation has the capability to provide data in Register 18₁₆,
- d) Register 18₁₆ bit 32 to indicate that the installation has the capability to provide data in Register 19₁₆,
- e) Register 18₁₆ bit 25 to indicate that the installation has the capability to provide data in Register 20₁₆,
- f) Register 18₁₆ bit 21 to indicate that the installation has the capability to provide data in Register 20₁₆ (OPTIONAL),
- g) Register 19₁₆ bit 49 to indicate that the installation has the capability to provide data in Register 40₁₆,
- h) Register 19₁₆ bit 33 to indicate that the installation has the capability to provide data in Register 50₁₆,
- i) Register 19₁₆ bit 18 to indicate that the installation has the capability to provide data in Register 5F₁₆ (OPTIONAL),
- j) Register 19₁₆ bit 17 to indicate that the installation has the capability to provide data in Register 60₁₆,

Note: Bit 9 of register 18₁₆ is set when transponder is connected to an ACAS to indicate that ACAS RA report register 30₁₆ is supported (see section 3.27).

Note: This is not established by the Transponder LRU own capability. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to service the corresponding register. Once this capability is established it remains set until power off of the transponder.

3.30.3.2 Enhanced Surveillance Capability requirements {2.2.25.3.2}

3.30.3.2.1 Required Servicing of Register 18₁₆ Associated with Register 10₁₆

Refer to § 3.29.5.2.1 as servicing of Register 10₁₆ is a part of Elementary Surveillance.

3.30.3.2.2 Required Servicing of Register 18₁₆ Associated with Register 17₁₆

Refer to § 3.29.5.2.2 as servicing of Register 17₁₆ is a part of Elementary Surveillance.

{SC 209 to consider to remove and make reference to ELS paragraph:

- a. Register 18₁₆ bit 34 **shall** be set to ONE (1) if the transponder is required to service any part of Register 17₁₆ as provided in §**Error! Reference source not found.**

Note: This requirement is not established by the Transponder LRU own capability to service Register 17₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update Register 17₁₆.

- b. Once Register 18₁₆ bit 34 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) for the duration of the power-on cycle.

c. Register 18₁₆ bit 34 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could result in the need to service Register 17₁₆ as provided in §**Error! Reference source not found.** }

3.30.3.2.3 Required Servicing of Register 18₁₆ Associated with Register 18₁₆

Refer to § 3.29.5.2.3 as servicing of Register 18₁₆ is a part of Elementary Surveillance.

{ SC 209 to consider to remove and make reference to ELS paragraph:

Register 18₁₆ bit 33 **shall** be set to ONE (1) if the transponder is required to service any part of Register 18₁₆ as provided in §**Error! Reference source not found.**

***Note:** This requirement is not established by the Transponder LRU own capability to service Register 18₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update Register 18₁₆.*

- b. Once Register 18₁₆ bit 33 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) for the duration of the power-on cycle.
- c. Register 18₁₆ bit 33 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could result in the need to service Register 18₁₆ as provided in §**Error! Reference source not found.** }

3.30.3.2.4 Required Servicing of Register 18₁₆ Associated with Register 19₁₆

a) Register 18₁₆ bit 32 **shall** be set to ONE (1) if the transponder is required to service any part of Register 19₁₆ as provided in §3.30.3.2.7 through §3.30.3.2.10.

***Note:** This requirement is not established by the Transponder LRU own capability to service Register 19₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update Register 19₁₆.*

- b) Once Register 18₁₆ bit 32 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) for the duration of the power-on cycle.
- c) Register 18₁₆ bit 32 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could result in the need to service Register 19₁₆ as provided in §3.30.3.2.7 through §3.30.3.2.10.

3.30.3.2.5 Required Servicing of Register 18₁₆ Associated with Register 20₁₆

Refer to §3.29.5.2.4 as servicing of Register 20₁₆ is a part of Elementary Surveillance.

3.30.3.2.6 Required Servicing of Register 18₁₆ Associated with Register 21₁₆ (Optional)

Refer to §3.29.5.2.5 as servicing of Register 21₁₆ is an Optional part of Elementary Surveillance.

3.30.3.2.7 Required Servicing of Register 19₁₆ Associated with Register 40₁₆

a) Register 19₁₆ bit 49 **shall** be set to ONE (1) if the transponder has received either Selected Altitude, FMS Selected Altitude, Barometric Pressure Setting, FMS Vertical Mode, or Target Altitude Source data in the Aircraft Installation during the power-on cycle.

(Refer to Appendix B, Table B-3-64 for full definition of Register 40₁₆).

Notes:

1. *This requirement is not established by the Transponder LRU own capability to service Register 40₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 40₁₆.*
2. *FMS Vertical Mode data refers to data used to establish bits 48 through 51 of Register 40₁₆.*

3. Target Altitude Source data refers to data used to establish bits 54 through 56 of Register 40₁₆.

- b) Once Register 19₁₆ bit 49 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) for the duration of the power-on cycle.
- c) Register 19₁₆ bit 49 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could be used to properly service Register 40₁₆ during the power-on cycle.

3.30.3.2.8 Required Servicing of Register 19₁₆ Associated with Register 50₁₆

- a) Register 19₁₆ bit 33 **shall** be set to ONE (1) if the transponder has received either Roll Angle, True Track Angle, Ground Speed, Track Angle Rate, or True Airspeed data in the Aircraft installation since during the power-on cycle.

(Refer to Appendix B, Table B-3-80 for full definition of Register 50₁₆)

Note: This requirement is not established by the Transponder LRU own capability to service Register 50₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 50₁₆.

- b) Once Register 19₁₆ bit 33 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) for the duration of the power-on cycle.
- c) Register 19₁₆ bit 33 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could be used to properly service Register 50₁₆ during the power-on cycle.

3.30.3.2.9 Required Servicing of Register 19₁₆ Associated with Register 5F₁₆

Note: Enhanced Surveillance does not require that Register 5F₁₆ be serviced. However, servicing of Register 5F₁₆ is *implicitly required* {WG49 and SC209 to clarify whether it is mandatory or not} when servicing Register 40₁₆ in ICAO Doc. 9871 and Appendix B. Therefore, if Register 5F₁₆ is serviced, the following subparagraphs need to be complied with.

- a) Register 19₁₆ bit 18 **shall** be set to ONE (1) if the transponder is required to service any part of Register 5F₁₆ as provided in §a).

Note: This requirement is not established by the Transponder LRU own capability to service Register 5F₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update Register 5F₁₆.

- b) Once Register 19₁₆ bit 18 has been set to ONE (1) during a particular power-on cycle, then it **shall** remain set to ONE (1) for the duration of the power-on cycle.
- c) Register 19₁₆ bit 18 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could result in the need to service Register 5F₁₆ as provided in §a).

3.30.3.2.10 Required Servicing of Register 19₁₆ Associated with Register 60₁₆

- a) Register 19₁₆ bit 17 **shall** be set to ONE (1) if the transponder has received either Magnetic Heading, Indicated Airspeed, Mach, Barometric Altitude Rate, or Inertial Vertical Velocity data in the Aircraft installation during the power-on cycle.

(Refer to Appendix B, Table B-3-96 for full definition of Register 60₁₆)

Note: This requirement is not established by the Transponder LRU own capability to service Register 60₁₆. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service Register 60₁₆.

- b) Once Register 19₁₆ bit 17 has been set to ONE (1) during a particular power-on cycle, then it shall remain set to ONE (1) for the duration of the power-on cycle.
- c) Register 19₁₆ bit 17 **shall** be set to ZERO (0) if the transponder receives no data from the Aircraft installation that could be used to properly service Register 60₁₆ during the power-on cycle.

3.30.3.3 Minimum Update Interval of registers 18₁₆ to 1C₁₆

- a) The minimum update interval at which Register 18₁₆ and register 19₁₆ **shall** be reloaded with valid data is **5.0** seconds.

{SC209 to consider to change into a note: That is, that Register 18₁₆ and/or Register 19₁₆ **shall** be updated at least once every 5.0 seconds.}

Note: Register 18₁₆ and 19₁₆ are updated at least once every 5.0 seconds.

- b) The time between availability of data that causes a change in Register 18₁₆ and/or Register 19₁₆ and the time that the change is made to Register 18₁₆ and/or Register 19₁₆ **shall** be less than the minimum update interval specified as 5.0 seconds.

{SC209 to consider to remove c as it is not applicable to register 18₁₆, 19₁₆. c If a particular data field in Register 19₁₆ cannot be updated within 10.0 seconds (e.g., twice the specified minimum update interval of 5.0 seconds), then the status bit (if specified for that field) shall indicate that the data in that field is invalid and the data field shall be ZEROed. and to replace by proposed new c hereafter}

- c) The setting of these bits are static and shall not change during the operation of the transponder when the inputs disappear, i.e., Registers 18₁₆ to 1C₁₆ are static; once a bit is set it remains set to 1 until the power-off of the transponder.

{SC209 to consider moving 2.2.25.8 here to have all registers defined in numerical order}

3.30.4 Register 1D₁₆ to 1F₁₆ Mode S Specific Services MSP Capability [\(DO 2.2.25.8\)](#)

- a) Register 1D₁₆ to 1F₁₆ **shall** be formatted as specified in Appendix B table B-3-24 to B2-28.
- b) Although, servicing of Register 1D₁₆ through 1F₁₆ is not required by Enhanced Surveillance, the “MB” field of these registers **shall** be set to ALL ZEROS.

Note: There is no formal requirement to implement data-flash however Mode S ground station may systematically extract register 1D₁₆ to decide to extract a register using GICB protocol or using the data-flash application.

3.30.5 Register 40₁₆ – Selected vertical intention {SC209 to change the title to be in line with latest version of ICAO document} {2.2.25.4}

3.30.5.1 Purpose and definition

- a) Transponder shall format Register 40₁₆ as defined in Appendix B, Table B-3-64 .
- b) The transponder **shall** comply with all constraints and requirements for servicing Register 40₁₆ that are provided with Table B-3-64 in Appendix B,.

3.30.5.2 Data requirements

3.30.5.2.1 Selected Altitude from Altitude Control Panel {DO 2.2.25.4.2.1 identical }

- a) The transponder **shall** process Selected Altitude From Altitude Control Panel (Mode Control Panel/Flight Control Unit or equivalent equipment) data from on-board aircraft data sources as provided in Appendix B, Table B-3-64 of the Register 40₁₆ definition table and format the data into bits 2 through 13 of the Register 40₁₆ “MB” field as shown in that table.
- b) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm\frac{1}{2}$ LSB.
- c) Status Bit 1 **shall** be set to ONE (1) whenever valid data is available in bits 2 through 13.
- d) Status Bit 1 **shall** be set to ZERO (0) whenever there is no valid data with which to fill bits 2 through 13.
- e) Bits 2 through 13 **shall** be set to ZERO (0) whenever there is no valid data with which to fill the bits.

3.30.5.2.2 FMS Selected Altitude {DO 2.2.25.4.2.2 identical }

- a) The transponder **shall** process FMS Selected Altitude data from on-board aircraft data sources as provided in Appendix B, Table B-3-64 of the Register 40₁₆ definition table and format the data into bits 15 through 26 of the Register 40₁₆ “MB” field as shown in that table.
- b) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm\frac{1}{2}$ LSB.
- c) Status Bit 14 **shall** be set to ONE (1) whenever valid FMS Selected Altitude data is available in bits 15 through 26.
- d) If FMS Selected Altitude data is not available for insertion into bits 15 through 26, Status Bit 14 **shall** be set to ZERO (0).
- e) If FMS Selected Altitude data is not available for insertion into bits 15 through 26, bits 15 through 26 **shall** be set to ZERO (0).

3.30.5.2.3 Barometric Pressure Setting {DO 2.2.25.4.2.3 identical }

- a) The transponder **shall** process Barometric Pressure Setting data from on-board aircraft data sources as provided in Appendix B, Table B-3-64 of the Register 40₁₆ definition table. Further processing of the input Barometric Pressure Setting data is needed as follows:
 - (1) Note that the Barometric Pressure Setting data received may be in BCD format and must be converted to Binary format prior to encoding data into Register 40₁₆. Tentative information regarding BCD to Binary Conversion and final mapping of the data into Register 40₁₆ is provided in the following Note:

Note: Barometric Pressure Setting BCD –to- BINARY Conversion Method Consider an input of 1085.9 millibars in BCD data.

Multiply by 10 to give the BCD count of 0.1 increments needed to represent the input data.

Yields: 10859

10859/2	=	5429	-	1
5429/2	=	2714	-	1
2714/2	=	1357	-	0
1357/2	=	678	-	1
678/2	=	339	-	0
339/2	=	¹⁶ 9	-	1
¹⁶ 9/2	=	84	-	1

- (2) Note that the encoding that is provided in Appendix B, Table B-3-64 Register 40₁₆ for Barometric Pressure Setting represents the input Barometric Pressure Setting data MINUS 800 millibars (mb). See Appendix B, Table B-3-64, Register 40₁₆ definition. Also, note that this 800 millibar correction has been taken into account in the BCD to BINARY conversion performed in the Note given in §**Error! Reference source not found.**.a.(1).
- b) The data loaded into the “MB” field **shall** be the Barometric Pressure Setting MINUS 800 millibars (mb) that has been converted to BINARY data in a manner that is consistent and equivalent with the BCD –to- BINARY conversion performed in the Note given in §**Error! Reference source not found.**.a.(1).
- c) Status Bit 27 **shall** be set to ONE (1) whenever valid data is available in bits 28 through 39, and the conditions given in §**Error! Reference source not found.**d are not applicable.
- d) Status Bit 27 **shall** be set to ZERO (0) whenever:
- (1). There is no valid data with which to fill bits 28 through 39.
 - (2). The input Barometric Pressure Setting data is less than 800 millibars (mb).
***Note:** This would result in a negative Barometric Pressure Setting after subtracting 800 millibars (mb) and doing the BCD to BINARY conversion.*
 - (3). The input Barometric Pressure Setting data is greater than 1209.5 millibars (mb).
- e) Bits 28 through 39 **shall** be set to ZERO (0) whenever there is no valid data with which to fill the bits.

3.30.5.2.4 FMS Vertical Mode Bits

Note: FMS Vertical Mode bits refer to bits 48 –through- 51 of Register 40₁₆.

3.30.5.2.4.1 Status of MCP / FCU Mode Bits (Bit 48)

Bit 48 **shall** indicate whether the mode bits (49, 50, and 51) are actively being populated (e.g., set) in Register 40₁₆ in accordance with the following table:

Table 2.2.25.4.2.4.1: Status of MCP/FCU Mode Bots (Bit 48) Encoding

<i>Bit 48</i>	<i>Meaning</i>
<i>0</i>	<i>No Mode Information Provided</i>
<i>1</i>	<i>Mode Information Deliberately Provided</i>

Essentially, if information is provided to the transponder to set either bit 49, 50, or 51 to either “0” or “1,” then Bit 48 **shall** be set to ONE (1) Otherwise, Bit 48 **shall** be set to ZERO (0).

3.30.5.2.4.2 Vertical Navigation Mode (Bit 49)

- a) The transponder **shall** accept information from an appropriate interface that indicates whether or not the Vertical Navigation Mode is active.
- b) The transponder **shall** set Bit 49 in accordance with the following table:

Table 2.2.25.4.2.4.2: Vertical Navigation Mode (Bit 49) Encoding

<i>Bit 49</i>	<i>Meaning</i>
<i>0</i>	<i>VNAV Not Active</i>
<i>1</i>	<i>VNAV Active</i>

- c) If appropriate information is not available to indicate whether or not the Vertical Navigation Mode is active, then the transponder **shall** set Bit 49 to ZERO (0).

3.30.5.2.4.3 Altitude Hold Bit

- a) The transponder **shall** accept information from an appropriate interface that indicates whether or not the Altitude Hold Mode is active.
- b) The transponder **shall** set Bit 50 in accordance with the following table:

Table 2.2.25.4.2.4.3: Altitude Hold Mode (Bit 50) Encoding

<i>Bit 50</i>	<i>Meaning</i>
<i>0</i>	<i>Altitude Hold Not Active</i>
<i>1</i>	<i>Altitude Hold Active</i>

- c) If appropriate information is not available to indicate whether or not the Altitude Hold Mode is active, then the transponder **shall** set Bit 50 to ZERO (0).

3.30.5.2.4.4 Approach Mode Bit

- a) The transponder **shall** accept information from an appropriate interface that indicates whether or not the Approach Mode is active.
- b) The transponder **shall** set Bit 51 in accordance to the following:

Table 2.2.25.4.2.4.4: Approach Mode (Bit 51) Encoding

<i>Bit 51</i>	<i>Meaning</i>
<i>0</i>	<i>Approach Mode Not Active</i>
<i>1</i>	<i>Approach Mode Active</i>

- c) If appropriate information is not available to indicate whether or not the Approach Mode is active, then the transponder **shall** set Bit 51 to ZERO (0).

3.30.5.2.5 Reserved Bits

Bits 52 and 53 of Register 40₁₆ “MB” field **shall** be set to ZERO (0).

3.30.5.2.6 Target Altitude Bits

3.30.5.2.6.1 Status of Target Altitude Source Bits (Bit 54)

Bit 54 **shall** indicate whether the Target Altitude Source bits (55 and 56) are actively being populated (e.g., set) in Register 40₁₆ in accordance with the following table:

Table 2.2.25.4.2.6.1: Status of Target Altitude Source Bits (Bit 54) Encoding

<i>Bit 48</i>	<i>Meaning</i>
<i>0</i>	<i>No Source Information Provided</i>
<i>1</i>	<i>Source Information Deliberately Provided</i>

{SC 209 to remove essentially – such word not expected in a requirement} If information is provided to the transponder to set either bit 55 or 56 (or both) to either “0” or “1”, then Bit 54 **shall** be set to ONE (1). Otherwise, Bit 54 **shall** be set to ZERO (0).

3.30.5.2.6.2 Target Altitude Source Bits

- a) The transponder **shall** accept information from an appropriate interface that indicates the origin of the intended aircraft target altitude in accordance with the following table:

Table 2.2.25.4.2.6.2: Target Altitude Source (Bit 55, 56) Encoding

<i>Bit 55, 56</i>	<i>Meaning</i>
<i>0 0</i>	<i>Unknown</i>
<i>0 1</i>	<i>Aircraft Altitude</i>
<i>1 0</i>	<i>FCU / MCP Selected Altitude</i>
<i>1 1</i>	<i>FMS Selected Altitude</i>

- b) Alternatively, the transponder may accept information from an appropriate interface or source and use such information to determine the encoding of bits 55, 56 in accordance with the table provided in §3.30.5.2.6.2.a.
- c) If appropriate information is not available to establish the encoding given in either §3.30.5.2.6.2.a or §3.30.5.2.6.2.b, then bits 55 and 56 of Register 40₁₆ “MB” field **shall** be set to ZERO (0).

3.30.5.3 Minimum Update Interval of Register 40₁₆

- a) The minimum update interval at which Register 40₁₆ **shall** be reloaded with valid data is 1.0 second.

{SC209 to consider turning the second shall into a note}

Note: Register 40₁₆ is updated at least once every 1.0 second.

- b) The time between availability of data that causes a change in Register 40₁₆ and the time that the change is made to Register 40₁₆ **shall** be less than the minimum update interval specified as 1.0 seconds.
- c) If Altitude Control Panel (MCP /FCU) Selected Altitude in Register 40₁₆ “MB” field bits 2 through 13 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds), then Status Bit 1 **shall** be set to ZERO (0) and bits 2 through 13 **shall** be set to ZERO (0).
- d) If FMS Selected Altitude in Register 40₁₆ “MB” field bits 15 through 26 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds), then Status Bit 14 **shall** be set to ZERO (0) and bits 15 through 26 **shall** be set to ZERO (0).
- e) If Barometric Pressure Setting in Register 40₁₆ “MB” field bits 28 through 39 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds) then Status Bit 27 **shall** be set to ZERO (0) and bits 28 through 39 **shall** be set to ZERO (0).
- f) If the FMS Vertical Mode Bits in Register 40₁₆ “MB” field bits 48 through 51 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds), then bits 48 through 51 **shall** be set to ZERO (0).
- g) If the Target Altitude Bits in Register 40₁₆ “MB” field bits 54 through 56 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds), then bits 54 through 56 **shall** be set to ZERO (0).

{WG49-Sc209 to consider whether it is required to add a section servicing including reference to bits in register 17 and 18}

3.30.6 Register 50₁₆ – track and turn report {DO [2.2.25.5](#)}

3.30.6.1 Purpose and definition

- a) Transponder **shall** format Register 50₁₆ as defined in Appendix B, Table B-3-80 .
- b) The transponder **shall** comply with all constraints and requirements for servicing Register 5016 that are provided with Table B-3-80 in Appendix B,.

3.30.6.2 Data requirements

3.30.6.2.1 Roll Angle {DO181 – 2.2.25.5.2.1}

- a) The transponder **shall** process Roll Angle data from on-board aircraft data sources as provided in Appendix B, Table B-3-80 of the Register 5016 definition table and format the data into bits 2 through 11 of the Register 5016 “MB” field as shown in that table.

{SC209 to consider adding requirement on two's complement coding}

- b) Bits 2 through 11 **shall** be encoded using two's complement coding.
- c) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- d) Status Bit 1 **shall** be set to “1” whenever valid up-to-date data is available in bits 2 through 11.
- e) Status Bit 1 **shall** be set to “0” whenever there is no up-to-date valid data with which to fill bits 2 through 11.
- f) Bits 2 through 11 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.6.2.2 True Track Angle

- a) The transponder **shall** process True Track Angle data from on-board aircraft data sources as provided in Appendix B, Table B-3-80 of the Register 5016 definition table and format the data into bits 13 through 23 of the Register 5016 “MB” field as shown in that table.

{SC209 to consider adding requirement on two's complement coding}

- b) Bits 13 through 23 **shall** be encoded using two's complement coding.
- c) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- d) Status Bit 12 **shall** be set to “1” whenever valid data is available in bits 13 through 23.
- e) Status Bit 12 **shall** be set to “0” whenever there is no valid data with which to fill bits 13 through 23.
- f) Bits 13 through 23 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.6.2.3 Ground Speed

- a) The transponder **shall** process valid Ground Speed data from on-board aircraft data sources as provided in Appendix B, Table B-3-80 of the Register 5016 definition table and format the data into bits 25 through 34 of the Register 5016 “MB” field as shown in that table.
- b) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- c) Status Bit 24 **shall** be set to “1” whenever valid data is available in bits 25 through 34.
- d) Status Bit 24 **shall** be set to “0” whenever there is no valid data with which to fill bits 25 through 34.
- e) Bits 25 through 34 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.6.2.4 Track Angle Rate

- a) The transponder **shall** process Track Angle Rate data from on-board aircraft data sources as provided in Appendix B, Table B-3-80 of the Register 5016 definition table and format the data into bits 36 through 45 of the Register 5016 “MB” field as shown in that table.

{SC209 to consider adding requirement on two's complement coding}

- b) Bits 36 through 45 **shall** be encoded using two's complement coding.

- c) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- d) Status Bit 35 **shall** be set to “1” whenever valid data is available in bits 36 through 45.
- e) Status Bit 35 **shall** be set to “0” whenever there is no valid data with which to fill bits 36 through 45.
- f) Bits 36 through 45 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.6.2.5 True Airspeed (TAS)

- a) The transponder **shall** process valid True Airspeed (TAS) data from on-board aircraft data sources as provided in Appendix B, Table B-3-80 of the Register 5016 definition table and format the data into bits 47 through 56 of the Register 5016 “MB” field as shown in that table.
- b) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- c) Status Bit 46 **shall** be set to “1” whenever valid data is available in bits 47 through 56.
- d) Status Bit 46 **shall** be set to “0” whenever there is no valid data with which to fill bits 47 through 56.
- e) Bits 47 through 56 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.6.3 Minimum Update Interval

- a) The minimum update interval at which Register 50₁₆ **shall** be reloaded with valid data is 1.3 seconds.

Note: Register 50₁₆ shall be updated at least once every 1.3 seconds.

- b) The time between availability of data that causes a change in Register 50₁₆ and the time that the change is made to Register 50₁₆ **shall** be less than the minimum update interval specified as 1.3 seconds.
- c) If Roll Angle data in Register 50₁₆ “MB” field bits 2 through 11 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified minimum update interval of 1.3 seconds) then Status Bit 1 **shall** be set to ZERO (0) and bits 2 through 11 **shall** be set to ZERO (0).
- d) If True Track Angle data in Register 50₁₆ “MB” field bits 13 through 23 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified minimum update interval of 1.3 seconds), then Status Bit 12 **shall** be set to ZERO (0) and bits 13 through 23 **shall** be set to ZERO (0).
- e) If Ground Speed data in Register 50₁₆ “MB” field bits 25 through 34 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified minimum update interval of 1.3 seconds) then Status Bit 24 **shall** be set to ZERO (0) and bits 25 through 34 **shall** be set to ZERO (0).
- f) If Track Angle Rate data in Register 50₁₆ “MB” field bits 36 through 45 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified minimum update interval of 1.3 seconds) then Status Bit 35 **shall** be set to ZERO (0) and bits 36 through 45 **shall** be set to ZERO (0).
- g) If True Airspeed (TAS) data in Register 50₁₆ “MB” field bits 47 through 56 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified minimum update interval of 1.3 seconds) then Status Bit 46 **shall** be set to ZERO (0) and bits 47 through 56 **shall** be set to ZERO (0).

{WG49-Sc209 to consider whether it is required to add a section servicing including reference to bits in register 17 and 18}

3.30.7 Register 5F₁₆ – Quasi-Static Parameter Monitoring [{DO 2.2.25.6}](#)

Note: Enhanced Surveillance does not require that Register 5F₁₆ be serviced. However, servicing of Register 5F₁₆ is **implicitly required** {WG49 – SC209 to clarify this point} when servicing Register 40₁₆ in ICAO Doc. 9871 and Appendix B. Therefore, if Register 5F₁₆ is serviced, the following subparagraphs need to be complied with.

3.30.7.1 Purpose and Definition

- a) Register 5F₁₆ **shall** be formatted as specified in Appendix B, Table B-3-95.
- b) The transponder **shall** comply with all constraints and requirements for servicing Register 5F₁₆ that are provided in Appendix B, Table B-3-95.

3.30.7.2 Enhanced Surveillance Servicing Requirements Associated with Register 5F₁₆

3.30.7.2.1 Due to MCP / FCU Selected Altitude

- a) Register 5F₁₆ bits 1 – 2 **shall** be set to “00” whenever MCP / FCU Selected Altitude data is not available to set bits 1 through 13 of Register 40₁₆.
- b) Whenever a change is detected in the MCP / FCU Selected Altitude data used to set bits 1 through 13 of Register 40₁₆, the Register 5F₁₆ bits 1 – 2 **shall** be incremented by one.

Note 1: Effectively, the decimal count is as follows: 1, 2, 3, -- 1, 2, 3, etc.

Note 2: The binary equivalent setting bits 1,2 is as follows: 01, 10, 11, -- 01, 10, 11, etc.

3.30.7.2.2 Due to FMS Selected Altitude

- a) Register 5F₁₆ bits 23 – 24 **shall** be set to “00” whenever FMS Selected Altitude data is not available to set bits 14 through 26 of Register 40₁₆.
- b) Whenever a change is detected in the FMS Selected Altitude data used to set bits 14 through 26 of Register 40₁₆, the Register 5F₁₆ bits 23 – 24 **shall** be incremented by one.

Note 1: Effectively, the decimal count is as follows: 1, 2, 3, -- 1, 2, 3, etc.

Note 2: The binary equivalent setting bits 23 – 24 is as follows: 01, 10, 11, -- 01, 10, 11, etc.

3.30.7.2.3 Due to Barometric Pressure Setting

- a) Register 5F₁₆ bits 25 – 26 **shall** be set to “00” whenever Barometric Pressure Setting data is not available to set bits 27 through 39 of Register 40₁₆.
- b) Whenever a change is detected in the Barometric Pressure Setting data used to set bits 27 through 39 of Register 40₁₆, the Register 5F₁₆ bits 25 – 26 **shall** be incremented by one.

Note 1: Effectively, the decimal count is as follows: 1, 2, 3, -- 1, 2, 3, etc.

Note 2: The binary equivalent setting bits 25 – 26 is as follows: 01, 10, 11, -- 01, 10, 11, etc.

3.30.7.2.4 Due to FMS Vertical Mode

- a) Register 5F₁₆ bits 17 – 18 **shall** be set to “00” whenever Barometric Pressure Setting data is not available to set bits 48 through 51 of Register 40₁₆.
- b) Whenever a change is detected in the FMS Vertical Mode data used to set bits 48 through 51 of Register 40₁₆, the Register 5F₁₆ bits 17 – 18 **shall** be incremented by one.

Note 1: Effectively, the decimal count is as follows: 1, 2, 3, -- 1, 2, 3, etc.

Note 2: The binary equivalent setting bits 17 – 18 is as follows: 01, 10, 11, -- 01, 10, 11, etc.

3.30.7.2.5 Other Register 5F₁₆ Bits

Register 5F₁₆ bits 3 through 16, 19 through 22, and 27 through 56 **shall** be set to ZERO (0) until such time that the respective parameters identified in Appendix B, Table B-3-95 are being monitored.

3.30.7.3 Minimum Update Interval of Register 5F₁₆

- a) The minimum update interval at which Register 5F₁₆ **shall** be reloaded with valid data is 0.5 seconds.

*Note: That is, that Register 5F₁₆ **shall** be updated at least once every 0.5 seconds.*

- b) The time between availability of data that causes a change in Register 5F₁₆ and the time that the change is made to Register 5F₁₆ **shall** be less than the minimum update interval specified as 0.5 seconds.
- c) If a particular data field in Register 5F₁₆ cannot be updated within 1.0 seconds (e.g., twice the specified minimum update interval of 0.5 seconds), then {Sc209 to consider to remove as not applicable to this register: the status bit (if specified for that field) **shall** indicate that the data in that field is invalid and} the data field **shall** be ZEROed (i.e., binary 00).

3.30.8 Register 60₁₆- Heading and Speed Report {DO [2.2.25.7](#).}

3.30.8.1 Purpose and definition

- a) Transponder shall format Register 60₁₆ as defined in Appendix B, Table B-3-96 .
- b) The transponder **shall** comply with all constraints and requirements for servicing Register 60₁₆ that are provided with Table B-3-96 in Appendix B,.

3.30.8.2 Data Requirements

3.30.8.2.1 Magnetic Heading

- a) The transponder **shall** process Magnetic Heading data from on-board aircraft data sources as provided in Appendix B, Table **B-3-96** of Register **60₁₆** definition table and format the data into bits **2** through **12** of the Register **60₁₆** “**MB**” field as shown in that table.

{SC209 to consider adding requirement on two's complement coding}

- b) Bits 2 through 12 shall be encoded using two's complement coding.
- c) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- d) Status Bit 1 **shall** be set to “1” whenever valid data is available in bits 2 through 12.
- e) Status Bit 1 **shall** be set to “0” whenever there is no valid data with which to fill bits 2 through 12.
- f) Bits 2 through 12 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.8.2.2 Indicated Airspeed

- a) The transponder **shall** process Indicated Airspeed data from on-board aircraft data sources as provided in Appendix B, Table B-3-96 of the Register 60₁₆ definition table and format the data into bits 14 through 23 of the Register 60₁₆ “MB” field as shown in that table.
- b) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- c) Status Bit 13 **shall** be set to ONE (1) whenever valid data is available in bits 14 through 23.
- d) Status Bit 13 **shall** be set to ZERO (0) whenever there is no valid data with which to fill bits 14 through 23.
- e) Bits 14 through 23 **shall** be set to ZERO (0) whenever there is no valid data with which to fill the bits.

3.30.8.2.3 Mach

- a) The transponder **shall** process Mach data from on-board aircraft data sources as provided in Appendix B, Table B-3-96 of the Register 60₁₆ definition table and format the data into bits 25 through 34 of the Register 60₁₆ “MB” field as shown in that table.
- b) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- c) Status Bit 24 **shall** be set to ONE (1) whenever valid data is available in bits 25 through 34.
- d) Status Bit 24 **shall** be set to ZERO (0) whenever there is no valid data with which to fill bits 25 through 34.
- e) Bits 25 through 34 **shall** be set to ZERO (0) whenever there is no valid data with which to fill the bits.

3.30.8.2.4 Barometric Altitude Rate

- a) The transponder **shall** process Barometric Altitude Rate data from on-board aircraft data sources as provided in Appendix B, Table B-3-96 of the Register 60₁₆ definition table and format the data into bits 36 through 45 of the Register 60₁₆ “MB” field as shown in that table.

{SC209 to consider adding requirement on two's complement coding}

- b) Bits 36 through 45 shall be encoded using two's complement coding.
- c) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source

data within $\pm 1/2$ LSB.

- d) Status Bit **35 shall** be set to “1” whenever valid data is available in bits 36 through 45.
- e) Status Bit **35 shall** be set to “0” whenever there is no valid data with which to fill bits 36 through 45.
- f) Bits 36 through 45 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.8.2.5 Inertial Vertical Velocity {SC209 to change rate by Velocity}

- a) The transponder **shall** process Inertial Vertical Rate data from on-board aircraft data sources as provided in Appendix B, Table B-3-96 of the Register 60₁₆ definition table and format the data into bits 47 through 56 of the Register 60₁₆ “MB” field as shown in that table.

{SC209 to consider adding requirement on two's complement coding}

- b) Bits **47 through 56 shall be encoded using two's complement coding.**
- c) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- d) Status Bit **46 shall** be set to “1” whenever valid data is available in bits 47 through 56.
- e) Status Bit **46 shall** be set to “0” whenever there is no valid data with which to fill bits 47 through 56.
- f) Bits 47 through 56 **shall** be set to “0” whenever there is no valid data with which to fill the bits.

3.30.8.3 Minimum Update Interval of register 60₁₆

- a) The minimum update interval at which Register **60₁₆ shall** be reloaded with valid data is **1.0** second.

Note: Register 60₁₆ is updated at least once every 1.0 second.

- b) The time between availability of data that causes a change in Register 60₁₆ and the time that the change is made to Register 60₁₆ **shall** be less than the minimum update interval specified as 1.0 seconds.
- c) If Magnetic Heading data in Register 60₁₆ “MB” field bits 2 through 12 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds) then Status Bit **1 shall** be set to “0” and bits 2 –through- 12 shall be set to “0”.
- d) If Indicated Airspeed data in Register 60₁₆ “MB” field bits 14 through 23 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds) then Status Bit **13 shall** be set to “0” and bits 14 through 23 shall be set to “0”.
- e) If Mach data in Register 60₁₆ “MB” field bits 25 through 34 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds) then Status Bit **24 shall** be set to “0” and bits 25 through 34 shall be set to “0”.
- f) If Barometric Altitude Rate data in Register 60₁₆ “MB” field bits 36 through 45 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds) then Status Bit **35 shall** be set to “0” and bits 36 through 45 shall be set to “0”.
- g) If Inertial Vertical Rate data in Register 60₁₆ “MB” field bits 47 through 56 cannot be updated with valid data within 2.0 seconds (e.g., twice the specified minimum update interval of 1.0 seconds) then Status Bit **46 shall** be set to “0” and bits 47 through 56 shall be set to “0”.

{WG49-Sc209 to consider whether it is required to add a section servicing including reference to bits in register 17 and 18}

3.30.9 Register XX₁₆ data format – Generic requirement

The requirements described in this section shall be verified for all implemented registers (other than those already detailed in this document).

3.30.9.1 Purpose and definition

- a) Transponder shall format Register XX₁₆ as defined in Appendix B, Table B-3-ddd .
- b) The transponder **shall** comply with all constraints and requirements for servicing Register XX₁₆ that are provided with Table B-3-ddd in Appendix B,.

3.30.9.2 Data requirement

3.30.9.2.1.1 Data-field « y »

- a) The transponder **shall** process data from on-board aircraft data sources as provided in Appendix B, Table B-3-ddd of Register XX16 definition table and format the data into field “y” of the Register XX16 “MB” field as shown in that table.
- b) Field “y” shall be encoded using two’s complement coding if it is a signed field and if it is not otherwise specified.
- c) The data loaded into the “MB” field **shall** be rounded so as to preserve accuracy of the source data within $\pm 1/2$ LSB.
- d) Status Bit of field “y” **shall** be set to “1” whenever valid and up to date data (data not older than twice the maximum update interval specified in table B1-1 in Appendix B) is available in field “y”.
- e) Status Bit b0 **shall** be set to “0” whenever there is no valid up to date data with which to fill field “y”.

Note: On an ARINC platform, when data is available in BCD and in binary, transponder will preferably use binary data rather than BCD data.

*{Note: **the transponder shaSelected** : When different sources of data are available the transponder will use data from the sources used to flight the aircraft.*

of highest priority and when data are no more available from this source the transponder may use data from an alternative source.}

3.30.9.3 Update rate

- a) The minimum update interval at which a data field in a register **shall** be reloaded with valid data is defined for each register in table B-1 in Appendix B.
- b) The transponder **shall** load valid data into the related transponder register as soon as it becomes available at the Mode S Specific Services entity.
- c) The time between availability of data that causes a change in a data-field of a register and the time that the change is made to the register **shall** be less than the minimum update interval specified in table B-1 in Appendix B.
- d) If a data-field field cannot be updated with valid data within twice the specified minimum update interval defined for the register with a minimum of 2s then Status Bit of the field **shall** be set to “0” (INVALID) and that data field shall be zeroed.

3.30.9.4 Servicing reporting

- a) The transponder **shall** report Mode-S Specific Services Capability Reports (installation capability) in transponder registers 18₁₆ to1C₁₆.
- b) The transponder **shall** update the common usage GICB Capability Report (transponder register 17₁₆) checking periodically the availability of the related data.
- c) The transponder **shall** repeatedly update the Data Link Capability Report (transponder register 10₁₆ bit 25 and bit 36 and broadcast register 10 in case of change in register 10₁₆).