
**Information technology — Data
protocol for radio frequency
identification (RFID) for item
management —**

**Part 1:
Application interface**

*Technologies de l'information — Protocole de données relatif à
l'identification par radiofréquence (RFID) pour la gestion d'objets —
Partie 1: Interface d'application*

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This second edition cancels and replaces the first edition (ISO/IEC 15961-1:2013), which has been technically revised.

The main changes are as follows:

- Clauses from ISO/IEC 15962 which had been reproduced in this document have been removed and replaced by references to these clauses.
- The requirement for backwards compatibility with the 2004 version of this document (ISO/IEC 15961:2004) has been clarified.
- The document was edited for clarity and conformity with ISO/IEC Directives Part 2 drafting rules.

A list of all parts in the ISO/IEC 15961 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The technology of radio frequency identification (RFID) is based on non-contact electronic communication across an air interface. The structure of the bits stored on the memory of the tag is invisible and accessible between the tag and the interrogator only using an air interface protocol, as specified in the appropriate part of ISO/IEC 18000. The result of the transfer of data between an application and an interrogator in open systems requires data to be encoded in a consistent manner on any tag that is part of that open system. This is not only to allow equipment to be interoperable, but in the special case of data carriers, for the data to be encoded on the tag in one system's implementation and to be read at a later time in a completely different and unknown system's implementation. The data bits stored on each tag must be formatted in such a way as to be reliably read at the point of use if the tag is to fulfil its basic objective. This reliability is achieved through the specification of a Data Protocol in this document and the data encoding rules of ISO/IEC 15962. Additionally, ISO/IEC 24791-1 specifies a software system infrastructure architecture that enables RFID system operations between business applications and RFID interrogators. Specific parts of the infrastructure standards address data management requirements (ISO/IEC 24791-2) and device interface requirements (ISO/IEC 24791-5). These support defined implementations that incorporate the encoding rules of ISO/IEC 15962 and the functional rules of the commands and responses in this document.

Manufacturers of RFID equipment (e.g. interrogators, tags) and users of RFID technology require standards-based Data Protocols for RFID for item management. This document, ISO/IEC 15962, ISO/IEC 24791-1, ISO/IEC 24791-2 and ISO/IEC 24791-5 specify these protocols, which are layered above the air interface standards defined in the ISO/IEC 18000 series.

The transfer of data to and from an application, supported by appropriate application commands, is the subject of this document. This document is intended to be used as a reference to develop software appropriate for RFID applications and equipment. ISO/IEC 15962, which is intended to be used with this document, specifies the overall process and the methodologies developed to format the application data into a structure to store on the tag.

NOTE ISO/IEC 15961:2004 is a withdrawn standard, replaced by ISO/IEC 15961-1, ISO/IEC 15961-2, ISO/IEC 15961-3 and ISO/IEC 15961-4. ISO/IEC 15961:2004 is referenced to point out the differences with this document because some systems still use the withdrawn version. All information pertaining to the use of the withdrawn ISO/IEC 15961:2004 is contained in this document. The intention is to remove reference to the withdrawn standard in the next version of this document.

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Information technology — Data protocol for radio frequency identification (RFID) for item management —

Part 1: Application interface

1 Scope

This document focuses on the abstract interface between an application and the data processor and includes the specification and definition of application commands and responses. It allows data and commands to be specified in a standardised way, independent of the ISO/IEC 18000 series air interfaces.

This document:

- provides guidelines on presenting data as objects;
- defines the structure of Object Identifiers, based on ISO/IEC 9834-1;
- specifies the commands that are supported for transferring data between an application and the radio frequency identification (RFID) tag;
- specifies the responses that are supported for transferring data between the tag and the application;
- does not specify any required transfer syntax with ISO/IEC 15962, but provides the non-normative information in [Annex A](#) for backward compatibility with the 2004 version of this document (ISO/IEC 15961:2004¹).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 15961-3, *Information technology — Data protocol for radio frequency identification (RFID) for item management — Part 3: RFID data constructs*

ISO/IEC 15962, *Information technology — Radio frequency identification (RFID) for item management — Data protocol: data encoding rules and logical memory functions*

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 and the following apply.

1) Withdrawn standard. Replaced by ISO/IEC 15961-1, ISO/IEC 15961-2, ISO/IEC 15961-3 and ISO/IEC 15961-4.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

application

software component that issues commands and receives responses to the commands within a system

3.1.2

data processor

implementation of the processes defined in ISO/IEC 15962, including the data compactor, formatter, logical memory, and command/response unit

Note 1 to entry: This was called "data protocol processor" in ISO/IEC 15961:2004²⁾.

3.2 Abbreviated terms and designations

URN uniform resource name

Since "TDS", "Type C" and "Type D" are commonly used in the industry to refer to the technology components as specified by these standards, the following designations are used in this document:

Type C ISO/IEC 18000-63

Type D ISO/IEC 18000-64

TDS GS1 EPC Tag Data Standard

4 Conformance

4.1 General

The commands and responses in this document are expressed in an abstract syntax; transfer encoding, as specified by ISO/IEC 15961 (the superseded 2004 version of this document) is no longer required. As such, conformance to this document is specifically indicated by the resultant proper encoding of tags according to ISO/IEC 15962.

The arguments and fields contained in individual commands and responses identify what needs to be considered for correct input to the Data Processor to achieve a valid encoding. Also, they identify what an application expects to have returned following access to a tag. Because of the way the Data Protocol is structured, the commands and responses specified in this document are, to a large extent, independent of particular tag types that are only known to the Data Processor through the Tag Driver. The result is that ISO/IEC 15962 can specify conformance requirements for valid encoding, which this document cannot.

This clause provides conformance best practice advice to achieve an integrated data communication channel between the application and the tag.

4.2 Application conformance

An application is expected to support the commands and responses that are meaningful to the application. For every command considered relevant for an application, all the constituent components shall be considered in transfers between the application and the Data Processor.

2) Withdrawn standard. Replaced by ISO/IEC 15961-1, ISO/IEC 15961-2, ISO/IEC 15961-3 and ISO/IEC 15961-4.

In particular, application standards shall take into consideration the various arguments in the command as defined in [Clause 7](#) (e.g. Object-Lock, Compact-Parameter). These determine the requirements of what is encoded on the tag, and the necessary processes that the Data Processor shall invoke to achieve a valid encoding.

4.3 Conformance of the Data Processor

The Data Processor is, effectively, the implementation of ISO/IEC 15962. Depending on the scope of the Data Processor (ranging from being specific to an industry, to being generic to the entire RFID Data Protocol) various arguments included in the commands can be processed in different manners (e.g. data can be identified with a full Object-Identifier or a Relative-OID). This document imposes no constraints on the design of the Data Processor, other than a requirement to support all the functionality specified by the arguments in the commands that are necessary to achieve proper encoding.

5 Protocol model

The ISO/IEC 15962 protocol model applies for this document.

6 Presentation conventions

6.1 Commands, responses, and arguments

6.1.1 General

Commands and responses are defined within a box format, such as is shown in [Figure 1](#).

Each command or response contains an ordered list of fields or arguments. When necessary, the field/argument name is followed by the data type and a brief description. Fields with values that are restricted to a subset of the range of their data types have their possible and legal values shown in *italics* below the field name.

NOTE None of this applies to the original commands and responses when presented in the ASN.1 abstract syntax as in ISO/IEC 15961:2004.



Figure 1 — Box format for commands, responses and complex arguments

6.1.2 Data types

The following data types are used in the commands and responses:

- BOOLEAN: An argument that can have the values TRUE or FALSE.
- BIT STRING: A sequence of bits.
- BYTE: An integer with the possible values 0 to 255, usually expressed as a hexadecimal value 00_{16} to FF_{16} .
- BYTE STRING: A sequence of bytes. (Equivalent to OCTET STRING).
- EBV-8: A binary method to encode variable size numbers in the same field by using a leading indicator bit preceding a 7-bit value. The final EBV-8 component begins with a 0, all preceding components begin with a 1. For example, $69_{10} = 01000101$, whereas $369_{10} = 101110001_2$ whose EBV-8 representation is **10000010 01110001** (i.e. separated into 7-bit strings and then the indicator

added as a prefix. The only requirement for using an EBV-8 code in a command is where this type of value is returned in an air interface response.

- HEXADECIMAL ADDRESS: A location (on the memory of a tag), expressed as a hexadecimal value.
- INTEGER: An integer can take any whole number. In the context of this document, the values are all positive.
- OBJECT IDENTIFIER: An Object Identifier as defined in [6.2.1](#).

6.2 Object Identifier presentation in the application interface

6.2.1 Object identifier structure to ISO/IEC 8824-1

This document uses the OBJECT IDENTIFIER type as defined in ISO/IEC 8824-1 with identifiers assigned as specified in ISO/IEC 9834-1. This uses a registration tree with a common implied root node (ISO/IEC 9834-1), a series of arcs from each node, with new arcs added as required to define a particular Object (see [Figure 2](#)). Thus, the body responsible for a particular node:

- has a defined set of arcs to identify itself;
- can manage the allocation of arcs under its node, independently of other bodies;
- is assured of uniqueness from all other arcs in the registration tree.

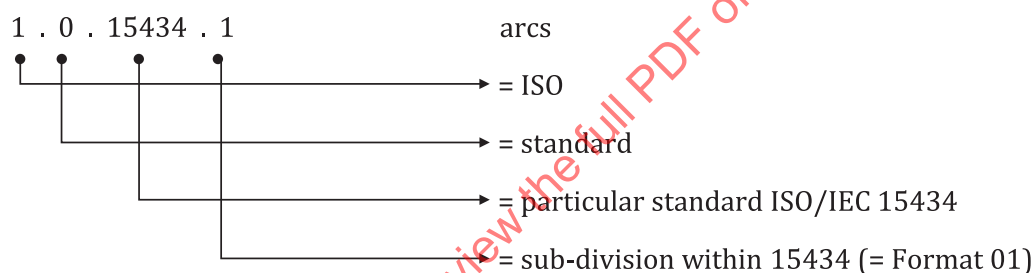


Figure 2 — Example object identifier arcs

The only top arcs permitted for all Object Identifiers are shown in [Table 1](#).

Table 1 — Object Identifier top arcs

Identifier arc name	Numerical value
itu-t	0
iso	1
joint-iso-itu-t	2

NOTE 1 Any ISO/IEC standard, e.g. this document, has Object Identifiers under the ISO top arc.

The second arc is administered by the relevant organisation named for the top arc. The current list of top and second arcs is given in ISO/IEC 15961-3.

The third arc is controlled by the system or body defined for the second arc; sometimes this is a registration authority. The hierarchical structure continues until the Object is identified uniquely. The procedure of naming Object Identifiers ensures that each Object is unique within its "parent" arc and that each parent arc is unique within its previous level, right back to the top three arcs.

NOTE 2 This structure enables Object Identifiers from different domains (e.g. open and closed systems) to be encoded unambiguously on a tag memory.

Three forms of Object Identifier are used with the RFID Data Protocol:

- Object-Identifier: This full structure is used for communications between the application and the Data Processor defined by the scope of this document.
- Root-OID: The Root-OID is the common part of a set of encoded Object Identifiers. It acts as a common prefix to the Relative-OID values encoded on the tag. This structure is particularly important in applications that require a variety of data from a common data dictionary to be encoded on a tag. The Root-OID is either explicitly encoded or declared according to the encoding rules of ISO/IEC 15962.
- Relative-OID: This structure is used in conjunction with the Root-OID (see below) for communication between the application and the Data Processor defined by this document. These structures are applied in situations where a common root applies to the set of Object Identifiers to be encoded on the tag. For example, if all the Object Identifiers have the common root 1 0 15961 12 encoding spaces can be saved on the tag if this common Root-OID does not have to be encoded for each Object Identifier. The Relative-OID is a suffix to a common RootOID, which is either encoded or declared in some other way.

NOTE 3 Except in the command and response abstract forms (see [Clause 10](#)) and places where the distinction is vital, the term Object-Identifier applies also to the Relative-OID.

6.2.2 Presenting the Object-Identifier in accordance with ISO/IEC 8824-1

When the Object-Identifier is presented in accordance with ISO/IEC 8824-1, spaces are inserted between each arc as follows:

1 0 15961 12 1

NOTE The more formal representation of this in ASN.1 is: {iso(1) standard(0) rfid-data-protocol(15961) iata(12) baggage-id (1)}.

6.2.3 Presenting the Object-Identifier as a Uniform Resource Name (URN)

The Object-Identifier may also be presented in the URN in the following format, based on IETF RFC 3061, with the decimal point character between each arc:

urn:oid:1.0.15961.12.1

6.3 Byte notation

6.3.1 Byte — Basic unit for 8-bit coding

This document supports binary, 6-bit, 7-bit, 8-bit, and user data that can exceed 8-bits per character. The common unit of coding is the 8-bit byte (also known as the octet).

Binary data shall be padded with leading zero bits until the binary value is octet aligned; 7-bit data shall be represented as bytes with bit 8 (see [6.3.2](#)) set to a zero value. Data exceeding 8-bits shall be encoded in multiple bytes.

An 8-bit byte is represented by two hexadecimal values, using the characters 0-9, and A-F.

6.3.2 Bit ordering

Within each byte, the most significant bit is bit 8 and the least significant is bit 1. Accordingly, the weight allocated to each bit is as shown in [Table 2](#).

Table 2 — Bit sequence in the 8-bit byte

Bit value	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1
Weight	128	64	32	16	8	4	2	1

6.3.3 Byte conversion

The 8-bit value is converted into the two hexadecimal characters with bit 8, bit 7, bit 6 and bit 5 having the weights 8, 4, 2 and 1 respectively to define the first hexadecimal character. Bit 4, bit 3, bit 2 and bit 1 retain the weights 8, 4, 2 and 1 respectively to define the second hexadecimal character.

7 Processing application commands and responses

7.1 General

Since the publication of the first edition of ISO/IEC 15961 (ISO/IEC 15961:2004) and ISO/IEC 15962, it has become clear that a number of device configurations do not require the transfer encoding to properly support the functions of the Data Protocol. These device configurations have similar characteristics in that they can support all processes internally (e.g. printer-encoders, hand-held RFID readers, and software packages), but other device configurations can have similar characteristics. These characteristics include a complete encoding process that supports the functionality of the application command and the encoding processes on the logical memory and/or the decoding processes from the logical memory to the application responses.

In these devices, transfer encoding would have to be created, and immediately be decoded and discarded, resulting in two unnecessary processes that add to the process time and complexity. As part of the revision of ISO/IEC 15961:2004 into a multi-part standard, this document now includes support for a "straight through" process.

There are two fundamentally different ways to implement support for the commands and responses defined in [Clause 10](#).

7.1.1 Option A: Straight through process

In devices or software that incorporate data input of commands compatible with this document and also support the encoding processes of ISO/IEC 15962, the transfer encoding is not required. It is therefore essential to ensure that the basic functionality of the commands and responses are followed. The rules defined for Object Identifiers (see [7.3.3](#)) and the command and response arguments (see [7.4](#)) shall be followed.

Various forms of implementation are possible for this straight through processing of the Data Protocol, including input from forms and more direct transfer from host systems. This document places no constraints on the process adopted.

7.1.2 Option B: Transfer encoding

If a device, or software only supports the processes of this document or only supports the encoding processes of ISO/IEC 15962, then the original transfer encoding may be used (see [Annex A](#)). Alternative transfer encoding including the binary encoding defined in ISO/IEC 24791-5 may be used for better integration with systems that support such interface mechanisms. In turn, this means that the command and response structures defined in [Clause 7](#) shall also be considered as abstract or functional definitions of the requirements to properly encoded data on a tag or read and interpret data from the tag.

7.2 Encoding system related information in commands

7.2.1 Singulation-Id

The Singulation-Id (previously defined as TagId in ISO/IEC 15961:2004) is provided by the Tag Driver. It identifies the tag unambiguously for at least the period of a data transaction.

In the Data Protocol, the Singulation-Id shall be up to 255 bytes long and acts as a file reference for the Logical Memory, and in turn provides a one-to-one link to the Logical Memory Map of the tag itself. Singulation-Id shall be based upon one of the following, the choice being determined by the design of the Tag Driver and the air interface protocol:

- a) A completely Unique Item Identifier programmed in the tag, as specified in the ISO/IEC 18000 series.
- b) A data related identifier, e.g. like a Unique Item Identifier (UII), that provides for uniqueness within the specific application domain of item management. This requires the UII to be read to establish the Singulation-Id.
- c) A virtual- or session-identifier based on a time slot or other feature managed by the air interface protocol.
- d) Combinations of (b) and (c), e.g. a virtual Singulation-Id across the air interface but requiring the data related identifier to be returned as a response.

7.2.2 AFI

The AFI (previously defined as ApplicationFamilyId in ISO/IEC 15961:2004) refers to specific identifiers that enable selective addressing of tags. This may be supported by a mechanism at the air interface. Because the AFI is supported by standards for smart card, the structure that follows is non-conflicting with those standards. The value of the AFI for RFID for Item Management shall be a single byte value specified in ISO/IEC 15961-3, as follows:

- If in the range 00_{16} to $0F_{16}$, the code applies to a closed system application, as defined in ISO/IEC 15961-3. The list of code values is updated in the associated RFID data constructs register.
- If in the range 90_{16} to CE_{16} , the code applies to an open system application as defined in ISO/IEC 15961-3. The list of code values is updated in the associated RFID data constructs register.
- The value CF_{16} is reserved as an extension code for multiple byte AFI code values.

The AFI should be stored on the tag in some form, or alternatively may be determined by the air interface services if these are sufficiently specific. If the AFI is not supported by a class of tag, and the services from the air interface do not provide this by other means, the value of this code in the system information for the tag shall be 00_{16} .

7.2.3 DSFID

The DSFID (previously defined as StorageFormat in ISO/IEC 15961:2004) refers to specific identifiers that enable efficient encoding on tags. The value of the DSFID for RFID for Item Management is a single byte, or multiple bytes. It encodes the Access-Method and Data-Format, both of which are defined below. The Access-Method is encoded in bits 8 and 7 of the DSFID, with the final five bits (bits 5 to 1) encoding the Data-Format. Bit 6 defines additional functionality supported by some types of tag.

If the Access-Method has a value between 4 and 15, extensions to the DSFID are implemented by the Data Processor.

NOTE None of these values has yet to be assigned, and such assignments will only be assigned by revision or amendment to this document.

If the Data-Format has a value between 32 and 287 as defined in ISO/IEC 15961-3, extensions to the DSFID are implemented by the Data Processor. As the Data-Format is registered as part of the ISO/IEC 15961-2 Data Constructs register, this extension occurs independently of changes to this document.

7.2.4 Access-Method

The Access-Method defines the way data can be mapped on the tag and be accessed from the tag. The value of Access-Method should be stored on the tag, or may be defined by the air interface services, if this can be done unambiguously. The Access-Method is defined as a bit value and the following codes shall apply:

- 0 No-Directory: This Access-Method provides the simplest set of encoding rules. The basic rule is to link a data Object to an Object-Identifier and support this with appropriate syntactical components to create a Data-Set. The Data-Sets are concatenated to produce a contiguous sequence of encoded bytes in the Logical Memory Map.
- 1 Directory: The Directory structure supports all the encoding rules of the No-Directory structure, but additionally supports the encoding of a directory at the higher address values within the Logical Memory Map on the tag. When the Directory structure is used, any command seeking to selectively read data can first access the directory to find the memory address of the beginning of the Data-Set, and then go to that location to read the bytes that represent the encoding of the Data-Set.

The Directory may be written to the RFID tag at a later time than the initial encoded data.
- 2 Packed-Objects: The Packed-Object structure was introduced at the first revision of ISO/IEC 15962 and this edition of this document. The encoding scheme is fundamentally different, because it takes a set of Object-Identifiers and their Objects and encodes them in an indexed structure that integrates compaction and encoding. The Packed-Object encoding scheme requires a rule-based table for each Data-Format, which calls up specific compaction schemes for the individual elements. The compaction schemes are standard, irrespective of the Data-Format. The Packed-Object scheme requires more complex encoding and decoding rules than the No-Directory and Directory Access-Methods, but offers significant encoding efficiency even over the basic No-Directory structure when a number of Object-Identifiers need to be encoded. This can reduce the amount of memory required on the tag and can reduce the size of message transferred across the air interface in response to a read command. Application domains need to define a table of indexed Relative-OIDs for this Access-Method to be implemented. It can only be applied as an alternative to the No-Directory or Directory Access-Methods on a particular tag; but tags with any of the Access-Methods may be intermixed in the same application.
- 3 Tag-Data-Profile: The Tag-Data-Profile scheme is intended to support fixed message structures, typically where several Object-Identifiers and their Objects need to be encoded. The fixed message structure is best suited for applications that are reasonably homogeneous and additionally have a consistent requirement for the same Object-Identifiers to be encoded on all tags in the application. Each Tag-Data-Profile requires registration.

- 4 Multiple-Records: The Multiple-Records encoding process overlays a structure onto the No-Directory, Packed-Objects, and Tag-Data-Profile Access-Methods for multiple instances of these, and even a mixture of these Access-Methods, to be encoded in the same Logical Memory. This is achieved through the introduction of an encoded MR-header and a preamble for each record. This allows the encoding of individual records to fully conform with the inherent Access-Method. This also enables the same Object-Identifier to be encoded in separate records, with one rule that supports a list of the same data element in one record. There are three main classes of application supported by the Access-Method and these can also be intermixed. One class enables different data formats and owners of data to share the same tag, but under the control of the original owner of the tag. Another supports a time sequence of history records of the same type to be repeated. The third major class is for the support of hierarchically related records, e.g. for supply chain delivery or bill of material types of structure.
- 5 to 15 Reserved for future encoding schemes to be defined in ISO/IEC 15962 and invoked under rules for a multiple byte DSFID. Some of the new Access-Methods can be inherent encoding schemes in Multiple-Records. This can only be determined as the encoding schemes are developed.

Where a choice can be made, the following guidelines can be of assistance:

- The No-Directory structure is better suited to tags with small memory capacity, because the directory itself is an overhead that needs to be encoded. It also is better suited where there are few Object-Identifiers to be encoded, so that a continuous read function will transfer all the encoding (or at least sufficient of the encoded bytes) to enable the bytes to be parsed to find the required Object-Identifier and associated Object.
- The Directory structure is obviously better suited where the conditions differ from those suited to the No-Directory structure. In addition, it is better suited to applications that call for selective reading, writing, or modifying one or few Object-Identifiers from among many. In this type of situation, the extra read processes to transfer the directory to the Data Processor are likely to be balanced by the shorter read time for the selected Object-Identifier.
- The Packed-Objects structure requires more complex encoding and decoding but offers a significant improvement in encoding efficiency over the basic No-Directory structure. As such, it is better suited to applications where the encoding requirements are relatively high compared to the memory capacity of the tags used in the application.
- The Tag-Data-Profile scheme is best suited to applications where the domain is homogeneous (e.g. a vertically integrated supply chain where all suppliers are known to all customers) and all parties agree that each Object-Identifier shall be encoded and agree to a common structure and format for each data Object.

As the Access-Method must be specified by the application, it should be possible to measure transfers of data that simulate a directory plus data structure with that of a No-Directory structure. Such a test can be used to determine a reasonable breakeven point between this and the other Access-Methods, considering the variety and length of data and the typical read/write implementations expected for an application.

Once an Access-Method has been specified for the tag, the application does not need to qualify how reading, writing, or the organisation of the bytes on the Logical Memory is to be achieved. This is the function of the Data Processor and the Tag Driver.

7.2.5 Data-Format

The Data-Format defines the Root-OID of the Object-Identifiers being stored on the tag. The Data-Format enables data Objects to be identified simply by a Relative-OID, making more efficient use of encoding space or to restrict data to one class.

Full Object-Identifiers (i.e. with a different Root-OID than that defined by the Data-Format) can still be encoded on the tag, enabling data from different application domains to be encoded, albeit without the same level of encoding efficiency.

The value of Data-Format should be stored on the tag or may be defined by the air interface services if this can be done unambiguously. When defined by the air interface protocol, there shall be a one-to-one relationship with the type of tag and the value of Data-Format. The value of the Data-Format for RFID for Item Management shall be an integer value in the range 0 to 287 specified in ISO/IEC 15961-3. The following are relevant to this document:

- | | |
|---|---|
| 0 | Not-Formatted: This is used for tags not formatted, or not yet formatted, to this document. |
| 1 | Full-Featured: This Data-Format supports any type of data format where the full Object-Identifier is used. Its prime purpose is to enable heterogeneous data (i.e. from different data dictionaries) to be encoded on the one tag. For example, it can be used to encode data from different closed system applications unambiguously, using the ISO/IEC 9834-1 registered Object Identifiers for each application. |
| 2 | Root-OID-Encoded: This Data-Format is used when all the data on the tag has a common RootOID, which does not conform with one of the specific Root-OIDs associated with a Data-Format registered under the rules of ISO/IEC 15961-2. |

The Root-OID for Data-Format 2 shall be directly encoded on the tag using the appropriate root arcs. Each Object is encoded on the tag using a Relative-OID, representing the remaining lower order arcs.

- | | |
|-----------|---|
| 3 to 28 | These code values apply to an open system application as registered under ISO/IEC 15961-2. The list of code values is updated in the associated RFID data constructs register. |
| 29 | This code applies to closed system data where the encoded data is in accordance with this document and ISO/IEC 15962. |
| 30 | This code applies to closed system data, where the encoding rules are not in accordance with ISO/IEC 15962. It is of use for applications that are migrating from other encoding rules, enabling data to be distinguished and properly encoded. It is also of use prior to the transition of tags from a closed system application to an open system application. |
| 31 | This value is not assigned to any application, because its binary equivalent is used to signal an extension to the Data-Format, in the range 32 to 287. |
| 32 to 287 | These values are reserved for open system applications as registered under ISO/IEC 15961-2, when an extension mechanism is invoked under ISO/IEC 15962 rules for a multiple byte DSFID. |

7.3 Preparing the basic Objects and other application-based arguments

7.3.1 General

This is an initial process to ensure that the data Objects are prepared in a format compatible with this document.

NOTE It is recognised that there are message-based protocols and syntax for existing AIDC application standards that differ from the Object-based protocol of this document. It is possible to achieve the benefits of the Object-based protocol and maintain compatibility with message-based systems by converting between the two formats (see [Annex B](#)).

The outputs described in the subclauses that follow shall be the format of inputs to the Data Processor. However, the mechanisms to achieve them on input and output are not specified in the subclauses. The requirement is to assign an Object-Identifier to each Object using the data dictionary relevant to the application standard.

7.3.2 General model

[Figure 3](#) provides a data flow model for preparing each Object-Identifier and associated data Object. Each type of application data, and particularly those covered by this document, has a data dictionary, or list of data Objects or data elements.

Any such data dictionary can evolve over time and maintenance of such a data dictionary shall be independent of this document. The data dictionary usually consists of a coded list (e.g. numeric, alphabetic, alphanumeric) of data Objects and their specification for use within the domain of the application standard. ISO/IEC 15961-3 and its associated RFID data constructs register defines Object-Identifiers that are relevant to applications.

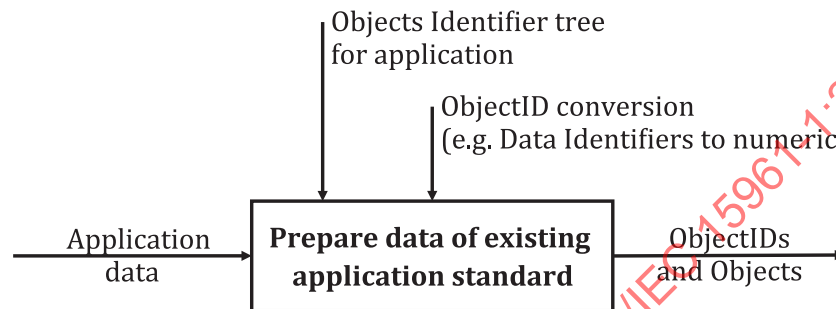


Figure 3 — Data flow model: Prepare basic Objects

7.3.3 Object-Identifier

The Object-Identifier shall be provided by the application system as a series of arcs as defined in [6.2](#) including all the Object-Identifiers associated with the established Data-Formats.

The Object-Identifier should be presented as a (full) Object-Identifier in the application commands unless an application-specific system supports all the relevant Relative-OIDs. Whenever possible, the Data Processor converts a (full) Object-Identifier to a Relative-OID for more efficient encoding on the tag, based on the Data-Format received from the tag.

7.3.4 Relating Object-Identifiers

Message-based syntax can use recursive or looping techniques to create repeated sequences of related data (e.g. individual quantity and batch numbers linked to different product codes). When the complete message is parsed, the syntax identifies boundary points so that the attributes are correctly linked to the primary code.

NOTE In an Object-based system (such as the Data Protocol of this document and ISO/IEC 15962) operating at a base level, there is a risk of creating false links (i.e. product code A can be linked to quantity of product B). The problem can be overcome using one of the techniques described in [Annex C](#).

7.3.5 Object

7.3.5.1 General

The application provides data in the form of an Object. This value is byte-based and associated with the definition of the Object-Identifier provided by the application data dictionary. Specific advice about interpretation is given in the following subclauses.

7.3.5.2 Basic 8-bit character set information

Many business applications make use of ISO/IEC 8859-1 or ISO/IEC 646. As such, the interpretation (or presentation) of the data is known to all participants in the system. This includes the specific sender

and recipient even if, as is common in an open AIDC system, they are not known directly to each other. If text file and browser application software are set up to handle the ISO/IEC 8859-1 character set, most of the data content can be displayed as intended. If the content has a specific interpretation, the RFID application shall establish between the participants exactly how particular data is to be interpreted. This can be achieved by publishing a data dictionary using the Object-Identifiers as a reference.

7.3.5.3 Support for ISO/IEC 10646

ISO/IEC 10646 supports the character glyphs of all character sets. One option to support data in any other specific character set is to pre-process this by converting to ISO/IEC 10646 using mapping tools, and then compacting this to UTF-8 encoding (as defined in ISO/IEC 10646). Any data directly defined by ISO/IEC 10646 should also be UTF-8 encoded, to reduce the number of bytes required to store the Object in the Logical Memory Map.

7.3.5.4 Support for secure or encrypted data

All forms of secure data, including encrypted data, shall be created by the application prior to being passed as an Object to the Data Processor. This is done for two reasons:

- It requires security of data to reside with the application and to be changed independently of the Data Processor.
- It allows the Data Processor to handle all data, whether encrypted or not, in a similar manner.

The fact that data is encrypted can be made known to the entire set of systems users, but the actual method of encryption can be restricted to the sender and intended recipient.

Further details are provided in [7.6](#).

7.3.6 Compact-Parameter

The inclusion of Compact-Parameter in a command shall determine whether the application data is to be compacted by the Data Processor. The Compact-Parameter is an integer value; the following codes apply:

- | | |
|---|---|
| 0 | Application-Defined: The Object shall not be processed through the data compaction rules of ISO/IEC 15962 and remains unaltered when stored in the Logical Memory Map of the tag. |
| 1 | Compact: This requires using the basic ISO/IEC 15962 compaction rules to compact the Object as efficiently as possible to reduce the number of bytes required on the Logical Memory Map. |
| 2 | UTF8-Data: This identifies that the Object has been externally transformed, using the ISO/IEC 10646 coded character set, to UTF-8 encoding. The Object shall not be processed through the data compaction rules of ISO/IEC 15962 and remains unaltered for transfer to the Logical Memory Map. |
| 3 | Pack-Objects: This identifies that a set of Objects is to be encoded using the Packed Object encoding scheme and identified with the associated Access-Method. The set of Objects shall not be compacted using the basic ISO/IEC 15962 compaction rules, but use the Packed Object encoding rules. |
| 4 | Tag-Data-Profile: This identifies that a set of Objects is to be encoded using the Tag Data Profile encoding scheme and identified with the associated Access-Method. Although the set of compaction schemes is identical to the basic ISO/IEC 15962 compaction rules, the Profile IDTable specifies a particular compaction scheme. The Profile IDTable specification shall be followed. |

- 5 Monomorphic-UII: This identifies that a single Object defining a UII is to be encoded using the compaction rules defined by the AFI. As this is applied to a UII, this Compact-Parameter shall only be applied to a single Object per memory bank.

This Compact-Parameter is explicitly defined because for some tags the encoding of Objects is independent of the encoding of the AFI, so the Data Processor shall access information about the Compact-Parameter from the Data Constructs register as defined by ISO/IEC 15961-2.

- 6 to 13 reserved for future definition

- 14 De-Compacted-Monomorphic-UII: This identifies that the Object in a response has been de-compacted using the rules defined by the AFI assigned for a particular Monomorphic-UII.

This Compact-Parameter is explicitly defined because the Monomorphic-UII does not have an associated Object-Identifier encoded on the tag. The Object-Identifier, as defined by the AFI, needs to be added to the response. The Data Processor shall access information about the Object-Identifier from the Data Constructs register as defined by ISO/IEC 15961-2.

- 15 De-Compacted-Data: This identifies that the Object in a response has been de-compacted using rules in ISO/IEC 15962 and restored to its original application input format.

Compaction is generally applied because it increases the encoding efficiency on the tag. Objects already encoded to UTF-8 encoding rules should be qualified with the Compact Parameter value (2) so that subsequent reading of the Object will clearly indicate that it will be processed through a UTF-8 decoder for final presentation to the application receiving the data. The Compact-Parameter value (0) should only be used if there is an over-riding reason not to compact the data. Reasons for this include prior compaction to application rules, or if the Object has been encrypted. In both these cases, although compaction can be possible and the decode process would fully restore the Object, the originally defined parameter value 0 or 2 would be lost and the receiving application can fail to undertake subsequent processing.

An alternative to the basic compaction is for a set of Objects to be encoded to the rules of Packed Objects. This can only be done if the application administrators choose to adopt the scheme by creating an index table, to which source references should be provided on the register of data constructs. Then for each tag to be encoded to the Packed Object rules the Compact-Parameter value (3) is applied to the entire set of Objects to be encoded.

Similarly, if data is to be encoded to the rules of Tag Data Profiles the Compact-Parameter value (4) is applied to the entire set of Objects to be encoded.

During the decode process, the following response codes are applied based on the input conditions:

- If the command argument was Application-Defined (0), a compliant Data Processor undertook no compaction and applied the relevant compact code to the encoding on the tag. As the decoder cannot interpret the encoded bytes, the response is Application-Defined (0).
- If the command argument was Compact (1) a compliant Data Processor applied the correct compact code to the encoding on the tag. As the decoder can interpret the encoded bytes, the response is De-Compacted-Data (15).
- If the command argument was UTF8-Data (2) a compliant Data Processor undertook no compaction and applied the relevant compact code to the encoding on the tag. As the decoder cannot interpret the encoded bytes, the response is UTF8-Data (2).
- If the command argument was Pack-Objects (3) a compliant Data Processor encoded to the rules as defined for the Object as defined by the ID Table specified. The decoder uses the same ID table to interpret the encoded byte and returns each data Object with the response De-Compacted-Data (15).

- If the command argument was Tag-data-Profile (4) a compliant Data Processor encoded to the rules as defined for the Object as defined by the ID Table specified. The decoder uses the same ID table to interpret the encoded byte and returns each data Object with the response De-Compacted-Data (15).
- If the command argument was Monomorphic-UII (5) a compliant Data Processor encoded to the rules as defined for the Object as defined by the AFI and the Data constructs register. The decoder, on recognition of the AFI uses the compaction rule declared on the Data Constructs register and returns the data Object with the response De-Compacted-Monomorphic-UII (14). It also returns the Object-Identifier as defined by the Data Constructs register.

NOTE Although the decoder is required to look up the compaction and de-compaction rules, as declared by the AFI from the Data Constructs register, responses from reading data do not include the AFI. This response argument is necessary to ensure that additional matching procedures are can be carried out.

7.3.7 Object-Lock

The command argument Object-Lock requires the Data Processor to arrange the encoded data set (encoded Object-Identifier or Relative-OID, Object, Precursor and other associated syntax components) in such a way that all of the associated bytes can be stored and locked in a block aligned manner in the Logical Memory Map. The locking process shall have the effect of making the bytes processed in this way, permanently encoded on the tag, or only capable of being unlocked in some types of tag with the use of relevant passwords.

7.4 Other command arguments

7.4.1 Access-Password

The command argument Access-Password requires the Data Processor to pass this to the interrogator so that the Access-Password in the command is matched with that on the tag. A match results in additional actions on the tag being permitted. A mismatch results in the air interface rejecting the command.

7.4.2 Additional-App-Bits

The command argument Additional-App-Bits is used to extend the search criteria of Object-Identifier data encoded in the UII memory of a segmented memory tag. The Additional-App-Bits are added as a suffix to the AFI and DSFID.

7.4.3 AFI-Lock

The command argument AFI-Lock is used to determine whether the AFI is to be locked or not. This is a BOOLEAN argument. If set to TRUE, the interrogator shall lock the AFI to ensure that the tag can only be used in the way prescribed. The locking process shall have the effect of making the bytes processed in this way, permanently encoded on the tag, or only capable of being unlocked in some types of tag with the use of relevant passwords.

NOTE In some tag types the AFI is part of a contiguous string with the encoded data sets. In such cases AFI-Lock does not apply.

7.4.4 Append-To-Existing-Multiple-Record

The command argument Append-To-Existing-Multiple-Record is a BOOLEAN argument. If TRUE, the data objects are to be appended to an existing multiple record, subject to various checks by the Data Processor. If FALSE, then a new multiple record shall be created.

7.4.5 Application-Defined-Record-Capacity

The command argument Application-Defined-Record-Capacity is a BOOLEAN argument that if FALSE determines that the Data Processor automatically determines that the capacity for the given multiple record is simply based on the encoded data and then increased to be block aligned. If set to TRUE, then the application needs to set the size of memory assigned to the record using the Record-Memory-Capacity argument.

7.4.6 Avoid-Duplicate

The command argument Avoid-Duplicate is used to ensure that the Object-Identifier is not already encoded in the Logical Memory Map. This is a BOOLEAN argument. If set to TRUE, the interrogator shall verify all Object-Identifiers in the Logical Memory Map. If the Object-Identifier already exists, the write command is aborted, and the Completion-Code value Duplicate-Object (10) is returned. If set to FALSE, the interrogator shall write the Object without any verification.

7.4.7 Battery-Assist-Indicator

The command argument Battery-Assist-Indicator is used by the application that the tag supports a battery assist feature. The argument is generally used when the air interface protocol does not have a feature to support such an indication.

7.4.8 Block-Align

The command argument Block-Align is used to define whether Objects written to a tag shall be aligned to the beginning of a block. This is a BOOLEAN argument. If set to TRUE, the interrogator shall align each Object written to a tag on a block boundary as determined by the specific tag architecture or manufacture.

7.4.9 Block-Align-Packed-Object

The command argument Block-Align-Packed-Object is used to define whether Packed-Objects written to a tag shall be aligned to the beginning of a block. This is a BOOLEAN argument. If set to TRUE, the interrogator shall align each Packed-Object written to a tag on a block boundary as determined by the specific tag architecture or manufacture.

7.4.10 Check-Duplicate

The command argument Check-Duplicate is used to invoke a particular process defined by the command (e.g. read or delete). This is a BOOLEAN argument.

If set to TRUE, the interrogator shall verify all Object-Identifiers in the Logical Memory Map. The command shall only be completed if there is no duplicate present. Otherwise, the Completion-Code value Duplicate-Object (10) is returned.

If the Check-Duplicate flag is set to FALSE, the interrogator shall act upon the first occurrence of the Object-Identifier, associated Object, and precursor. In this case, a duplicate Object-Identifier and associated Object (possibly with a different value) and precursor can be present.

7.4.11 Data-CRC-Indicator

The command argument Data-CRC-Indicator in a command instructs the Data Processor to add a CRC-16 either to each individual data set or to the entire encoded data, or to both. The argument Data-CRC-Indicator in a response indicates that the Data Processor validated the CRC-16, stripped this from the response and transferred the interpreted Object-Identifier and associated Object to the application.

7.4.12 Data-Length-Of-Record

This response argument provides the size of the encoded Multiple Record in terms of the write block size, as encoded in EBV-8 format in the record preamble.

7.4.13 Delete-MR-Method

The command argument Delete-MR-Method is used by the application to invoke one of two methods for the interrogator to delete a multiple record. This command argument is presented as an Integer value, and the following codes apply:

- 0 Mark record as deleted
- 1 Physically delete the record

The process details are defined in [10.28.1](#).

7.4.14 Directory-Length-EBV8-Indicator

The command argument Directory-Length-EBV8-Indicator is used by the application to ensure that sufficient space is available in the MR-header for the Data Processor to encode the actual length of the directory. This command argument is presented as an integer value and the following codes apply:

- 1 Single byte EBV-8, which can support a directory of up to 127 blocks.
- 2 Double byte EBV-8, which should be used when the Logical Memory is large and / or many records are expected to be encoded on it. This can support a directory size of up to 16383 blocks.

The value 2 is used for a directory that can originally be small in size, however, it is expected to increase in size at some future time.

7.4.15 DSFID-Lock

The command argument DSFID-Lock (previously storageFormatLock) is used to determine whether the DSFID is to be locked or not. This is a BOOLEAN argument. If set to TRUE, the interrogator shall lock the DSFID to ensure that the tag can only be used as prescribed. The locking process shall have the effect of making the bytes processed in this way permanently encoded on the tag, or only capable of being unlocked in some types of tag with the use of relevant passwords.

NOTE In some tag types the DSFID is part of a contiguous string with the encoded data sets. In such cases it cannot be locked independently.

7.4.16 DSFID-Pad-Bytes

The command argument DSFID-Pad-Bytes specifies the number of bytes that the application wants to provide in an Extended-DSFID in addition to those that are created by the Data Processor. For example, this can be to provide the encoding space for the length of encoded data to be added and updated in the future. When included in a response, additional pad bytes can be added by the Data Processor to align on a lock-block boundary if the Extended-DSFID is to be locked, or if the first Data-Set is to be locked.

7.4.17 Editable-Pointer-Size

The command argument Editable-Pointer-Size is used to specify that a Packed Object created explicitly or implicitly through a Write-Objects command shall allow subsequent modifications to its contents or structure. This command argument is presented as a non-zero integer value that indicates that the created Packed Object shall be made editable by adding an optional addendum subsection to the end of the Object Info section of the Packed Object. The pointer(s) to the Addendum Packed-Object shall be the number of bits specified in this command argument. The default value for this argument is zero, indicating that no addendum subsection is present, and that therefore the Packed Object is not editable.

7.4.18 Encoded-Memory-Capacity

This response argument provides the size reserved for a Multiple Record in terms of the write block size, as encoded in EBV-8 format in the record preamble.

7.4.19 EPC-Code

The command argument EPC-Code represents any of the unique codes defined by the TDS. The structure of each EPC-Code is self-declaring from the value of its 8-bit header. Although some of the codes do not align on an 8-bit boundary, these shall be rounded to 8-bit bytes for processing through the Data Processor and be rounded to 16-bit words for encoding on the associated tag.

7.4.20 Full-Function-Sensor-Indicator

The command argument Full-Function-Sensor-Indicator is used by the application that the tag supports a full-function sensor. The argument is generally used when the air interface protocol does not have a feature to support such an indication.

7.4.21 Hierarchical-Identifier-Arc

The response argument Hierarchical-Identifier-Arc is an integer value, converted from the EBV-8 value encoded in the Multiple Records preamble from a hierarchical record.

7.4.22 Identifier-Of-My-Parent

The command and response argument Identifier-Of-My-Parent is used for a multiple record that is part of a hierarchy and has the value of the hierarchical code of that record.

7.4.23 Identify-Method

The command argument identify-Method is used to define whether all, or some, of the tags belonging to the selected AFI in the operating area shall be identified. This command argument is presented as an integer value and the following codes apply:

- 0 Inventory-All-Tags
- 1 Inventory-At-Least
- 2 Inventory-No-More-Than
- 3 Inventory-Exactly
- 4 to 15 reserved for future definition

For every argument including Inventory-All-Tags, it is necessary to specify the number of tags to be read using the Number-Of-Tags (see [7.4.43](#)). More precise advice is provided in Inventory-Tags command (see [10.4](#)).

7.4.24 ID-Type

The command argument ID-Type is used to specify that a Packed-Object created explicitly or implicitly through a Write-Objects command shall be instantiated as type of ID List or ID Map. This command argument is presented as an integer value and the following codes apply:

- 0 ID List
- 1 ID Map

2 to 15 Reserved for future definition

7.4.25 Instance-Of-Arc

The response argument Instance-Of-Arc is an integer value, converted from the EBV-8 value encoded in the Multiple Records preamble.

7.4.26 Kill-Password

The command argument Kill-Password requires the Data Processor to pass this to the interrogator so that the Kill-Password in the command is matched with that on the tag. A match results in the tag function being permanently disabled. A mismatch results in the air interface rejecting the command.

7.4.27 Length-Of-Mask

The command argument Length-Of-Mask is used in conjunction with the command arguments Pointer and Tag-Mask to define the search criteria of TDS data encoded in the UII memory of a segmented memory tag.

7.4.28 Lock-Directory-Entry

The command argument Lock-Directory-Entry is BOOLEAN and if set to TRUE the interrogator shall lock the directory entry for the Multiple Record.

7.4.29 Lock-Multiple-Records-Header

The command argument Lock-Multiple-Records-Header is used to determine if all, some, or none of the MR-header is locked. This command argument is presented as an integer value and the following codes apply:

- 0 Not locked
- 1 Completely locked
- 2 Number-of-records field remains unlocked, the preceding fields are locked
- 3 Data Length of the Directory field remains unlocked, all other fields including the number-of-records field are locked
- 4 Data length of the directory field and the number-of-records field remain unlocked, all other fields are locked

7.4.30 Lock-Record-Preamble

The command argument Lock-Record-Preamble is BOOLEAN and if set to TRUE the interrogator shall lock the fields in the preamble.

7.4.31 Lock-UII-Segment-Arguments

The command argument Lock-UII-Segment-Arguments is used to define which component parts of the UII segment of a Type D tag shall be locked. The argument takes precedence over lock argument elsewhere in the associated command.

7.4.32 Max-App-Length

The command argument Max-App-Length is used to define the maximum compacted length of an encoded data set. It is used in commands that need to constrain air interface read commands for faster transactions, for example to read a UII encoded in the first data set on the tag.

7.4.33 Memory-Bank

The command argument Memory-Bank is used to define which part of a segmented memory tag on which data is to be encoded. The Data Processor then invokes rules that are specific to the Memory-Bank to achieve a correctly encoded tag.

7.4.34 Memory-Bank-Lock

The command argument Memory-Bank-Lock is used to define which part of a segmented memory tag is to be locked.

7.4.35 Memory-Length-Encoding

The command argument Memory-Length-Encoding in a command instructs the Data Processor to encode either memory capacity or the length of encoded data, or two both, in terms of the number of blocks. The argument Memory-Length-Encoding in a response indicates that the Data Processor calculated the relevant length and encoded this as part of the extended DSFIH.

7.4.36 Memory-Segment

The command argument Memory-Segment is used to define where on a segmented memory tag data is to be encoded. It is similar in function to the Memory-Bank argument (see 7.4.33), except that the tag for which this argument is appropriate can address multiple segments in the same air interface transaction.

7.4.37 Memory-Type

The command argument Memory-Type is used to define which memory structure is intended for encoding a Monomorphic-UII, effectively instructing the Data Processor which of the optional and conditional arguments and processes to apply to the encoding process.

7.4.38 Multiple-Records-Directory-Length

The response argument Multiple-Records-Directory-Length is an EBV-8 value.

7.4.39 Multiple-Records-Features-Indicator

The command and response argument Multiple-Records-Features-Indicator is a bit map with the following structure:

- Bit 8 with the value 1_2 indicates that all the records use the same Access-Method. If this bit = 0_2 then bits 7 to 4 = 0000_2
- Bits 7 to 4 identify the Access-Method if this is applied consistently. If bit 8 = 0_2 , the currently permissible string for bits 7 to 4 are:

0000_2	indicates that all records use the No-Directory Access-Method
0001_2	is not permitted
0010_2	indicates that all records use the Packed-Objects Access-Method
0011_2	indicates that all records use the Tag-Data-Profile Access-Method
0100_2	is not permitted

0101₂ to 1111₂ is currently reserved for additional Access-Methods

- Bit 3 with the value 1₂ indicates that some of the records are in a hierarchical relationship with other records.
- Bit 2 identifies whether the number-of-records field is fully maintained (e.g. updated each time a new record is added) or whether the number-of-records might not be the correct current value. The value 1 indicates that the number-of-records is correct, the value 0₂ indicates that the number-of-records field can be incorrect.
- Bit 1 with the value 1₂ indicates that there is an additional byte for indicating additional features. Currently this is RFU and therefore set to 0₂.

7.4.40 NSI-Bits

The command argument NSI-Bits defines a 9-bit code defined by TDS used as a prefix to the EPC-Code when encoded on the associated tag.

7.4.41 Number-In-Data-Element-List

The command argument Number-In-Data-Element-List is only used in a hierarchical record that is a data element list. The value is the count of the number of instances of the data element being encoded.

7.4.42 Number-Of-Records

The response argument Number-Of-Records is used in one of two ways. If bit 2 of the Multiple-Records-Features-Indicator equals:

- 0₂ then this field is not maintained and the value of Number-Of-Records should be zero, but any other value should be ignored, for example if some record count was initially maintained but later this function was decided to be stopped.
- 1₂ then this field is fully maintained as new records are added. A zero value for the Number-Of-Records is encoded when the MR-header is created.

7.4.43 Number-Of-Tags

The command argument Number-Of-Tags is used to define a limit on the Identify-Method specified. It is an integer value in the range 0 to 65535.

7.4.44 Objects-Offsets-Multiplier

The command argument Object-Offsets-Multiplier defines the size of the memory in bits that is requested for the storage of object offsets when the Directory-Type parameter in the Packed-Objects-Constructs argument is Packed-Object offset. The implementation shall use the parameter for proper sizing of the AuxMap structure in the Packed Object.

7.4.45 Packed-Object-Directory-Type

The command argument Packed-Object-Directory-Type defines whether the Packet Object is a directory, and in this case, which type of Packed Object directory has been constructed. A Presence/Absence directory provides a bit map of the ID Values encoded on any of the Packed Objects on the tag, but no indication of where the data is encoded. The index field directory adds the ordinal value of the Packed Object containing the specific ID Value. For example, a 3-bit index field identifies which of eight Packed Objects to access. An offset directory provides the starting address of the Packed Object containing a particular ID Value.

A null directory (i.e. the provision of space for a directory) is created by setting the pointer allocation in this argument by setting a non-zero value for the PO-Directory-Size argument.

If a Packed Object is not a directory, then a zero value is set for this argument.

7.4.46 Password

The command argument Password defines the byte string that represents a code value, qualified by the Password-Type, in a command that is required to be matched with the similarly defined code on the tag. A match provides permissions to carry out additional actions with the tag. A mismatch results in any associated command to be rejected.

7.4.47 Password-Type

The command argument Password-Type qualifies the value of the Password, used to provide permissions to carry out additional actions with the tag.

7.4.48 PO-Directory-Size

The command argument PO-Directory-Size defines the size of the (null) directory pointer created with the Packed Object. This command argument is presented as a non-zero integer value that shall be used for the size of the (null) directory pointer encoded in the Packed Object.

7.4.49 PO-Index-Length

The command argument PO-Index-Length is used to specify the size of the POindex Length for the AuxMap structure to be created when the Packed Object Directory-Type parameter is Packed-Object index field.

7.4.50 Pointer

The command argument Pointer is used in conjunction with the command arguments Length-Of-Mask and Tag-Mask to define the search criteria of TDS data encoded in the Ull memory of a segmented memory tag.

7.4.51 Pointer-To-Multiple-Records-Directory

The command and response argument Pointer-To-Multiple-Records-Directory is used to define the highest block number at the start address of the directory. This is defined as an EBV-8 value. If a directory is not initially encoded, then a fixed length EBV-8 string of the same length as required for the start point of the directory shall be encoded with a value of zero. The directory is encoded in reverse block sequence so that the next subsequent block of the directory is at the next lower address. The start of the directory is not necessarily the highest address in Logical Memory, because other hardware features of the tag may be specified to be located there. It will be necessary to invoke the air interface commands that define the memory mapping to determine the start address of the directory.

7.4.52 Read-Record-Type

The command argument Read-Record-Type is used to identify various logical structures from the tag. This command argument is presented as an integer value and the following codes apply:

- 0 Read-Multiple-Records-Header
- 1 Read-Multiple-Records-Header-Plus-1st-Preamble
- 2 Read-Multiple-Records-Directory

- 3 Read-Preamble-Specific-Multiple-Record
- 4 Read-All-Record-OIDs-Specific-Record-Type
- 5 Read-OIDs-Specific-Multiple-Record
- 6 Read-All-Objects-Specific-Multiple-Record
- 7 Read-Multiple-Objects-Specific-Multiple-Record
- 8 Read-1st-Objects-Specific-Multiple-Record
- 9 Read-Data-Element-List-Specific-Multiple-Record

If Read-Multiple-Records-Header is selected, the Data Processor returns the interpretation of the MR-header in the Multiple-Records-Header-Structure argument.

If Read-Multiple-Records-Header-Plus-1st-Preamble is selected, the Data Processor returns the interpretation of the MR-header in the Multiple-Records-Header-Structure argument and the interpretation of the first record's preamble in the Multiple-Records-Preamble-Structure argument.

If Read-Multiple-Records-Directory is selected, the Data Processor returns the interpretation of the multiple records directory in the Multiple-Records-Directory-Structure argument.

The Read-Record-Type codes 3 to 9 require the use of one or more Object-Identifiers in the command for the Data Processor to invoke the relevant processes. Three very specific formats of Object-Identifier are applied to multiple records:

- For a multiple record that is not part of a hierarchy, the structure is: 1.0.15961.401.{Data-Format}. {sector identifier}. {record type}. {instance-of}. {Relative-OID of data element}
- For a multiple record that is part of a hierarchy, but not a data element list, the structure is: 1.0.15961.402.{Data-Format}. {sector identifier}. {record type}. {hierarchical id}. {Relative-OID of element}
- For a multiple record that is a data element list, the structure is: 1.0.15961.403.{Data-Format}. {sector identifier}. {record type}. {hierarchical id}. {data element}

NOTE This object identifier calls for the response to include all the list element numbers.

The first two Object-Identifier structures apply to Read-Record-Type codes 3 to 8. The third listed Object-Identifier structure only applies to Read-Record-Type codes 3, 4 and 9.

If Read-Preamble-Specific-Multiple-Record is selected, the command shall include a single Object-Identifier in the Read-Objects List that is certainly defined down to the record type arc, and the instance-of arc (if applicable) or the hierarchical id arc (if applicable). The Data Processor returns the interpretation of the record's preamble in the Multiple-Records-Preamble-Structure argument.

Selecting the Read-All-Record-OIDs-Specific-Record-Type is useful for identifying a series of history records of the same type or a set of records in a hierarchy of the same type. In this case the command shall include a single Object-Identifier in the Read-Objects List that is only defined down to the record type arc. The Data Processor returns the list of Object-Identifiers one layer lower in the Read-OIDs-Response-List, i.e. either with the set of instance-of arcs or with the set of hierarchical id arcs.

If Read-OIDs-Specific-Multiple-Record is selected, the command shall include a single Object-Identifier in the Read-Objects List that is certainly defined down to the record type arc, and the instance-of arc (if applicable) or the hierarchical id arc (if applicable). The Data Processor returns the list of Object-Identifiers encoded within the record in the Read-OIDs-Response-List. This does not apply to Data Element lists.

If Read-All-Objects-Specific-Multiple-Record is selected, the command shall include a single Object-Identifier in the Read-Objects List that is certainly defined down to the record type arc, and the

instance-of arc (if applicable) or the hierarchical id arc (if applicable). The Data Processor returns the list of Object-Identifiers and Objects encoded within the record in the Read-Objects-Response-List. This does not apply to Data Element lists.

If Read-Multiple-Objects-Specific-Multiple-Record is selected, the command shall include the nominated Object-Identifiers that are defined down to the specific data element in the Read-Objects List. The Data Processor returns the list of nominated Object-Identifiers and Objects encoded within the record in the Read-Objects-Response-List. This does not apply to Data Element lists.

If Read-1st-Objects-Specific-Multiple-Record is selected, the command shall include the nominated Object-Identifier(s) that are defined down to the specific data element(s) in the Read-Objects List. The Data Processor returns the list of nominated Object-Identifiers and Objects encoded up to the Max-App-Length within the record in the Read-Objects-Response-List. This does not apply to Data Element lists.

If Read-Data-Element-List-Specific-Multiple-Record is selected, the command shall include a single Object-Identifier in the Read-Objects List that is defined down to the data element. The Data Processor first checks that the record is a Data Element list. If so, it uses the rules of the Access-Method to re-construct the Object-Identifier down to the list element number as encoded in the data element list and returns this and associated Objects encoded within the record in the Read-Objects-Response-List.

7.4.53 Read-Type

The Read-Type is a command argument used to identify the number and location of Object-Identifiers in a read command. This command argument is presented as an integer value and the following codes apply:

0	Read-1st-Objects
1	Read-Multiple-Objects
2	Read-All-Objects
3	Read-Monomorphic-UII
4 to 15	Reserved for future definition

If Read-1st-Objects is selected, then the command shall include the value for the Max-App-Length code, which is equivalent to the number of bytes intended to be read into the application. The argument is structured, and therefore differs from the superseded ISO/IEC 15961:2004, to read a sequence of Object-Identifiers, rather than the one only in the first position. If the Read-Type is set for Read-Multiple-Objects, this can apply to one or more Object-Identifiers.

If Read-Monomorphic-UII is selected, it instructs the Data Processor to carry out additional checks with the ISO/IEC Data constructs register to enable the proper process on the command.

7.4.54 Record-Memory-Capacity

The command argument Record-Memory-Capacity is used in commands to write a multiple record to indicate the amount of memory (in terms of write blocks) to assign, usually to enable the record to have additional data elements added. It is only used if the application needs to override the automatic sizing by the Data Processor when the Application-Defined-Record-Capacity argument is set to TRUE.

7.4.55 Record-Type-Arc

The response argument Record-Type-Arc is an integer value, converted from the EBY-8 value encoded in the Multiple Records preamble.

7.4.56 Record-Type-Classification

The command and response argument Record-Type-Classification is a binary bit string that identifies the class of record being encoded. The following codes apply:

000 ₂	stand-alone record, with an instance-of arc = 0
001 ₂	stand-alone record, with an instance-of arc >0
010 ₂	hierarchical record, top level
011 ₂	hierarchical record, has both parent and child(ren)
100 ₂	hierarchical record, data element list
101 ₂	other hierarchical record, no further children (never applies to a data element list)
110 ₂	Not relevant to this command (because it is associated with deleted records)
111 ₂	reserved

7.4.57 Sector-Identifier

The Sector-Identifier is used in the MR-header either to indicate the true Sector-Identifier for all records in the Logical Memory, or to signal that the true value varies between records and the true value is encoded in the record. This command and response argument is presented as an integer value and the following codes apply:

- 0 The true Sector-Identifier is encoded in each record and can vary between records.
- 1 This is used for closed system applications.
- 2 This indicates that the record type has a value equal to the Relative-OID of the first data element encoded on the record. For example, if the first data element has a Relative-OID = 7 for a product code, then the Record type = 7.
- >2 This is the Sector-Identifier assigned by the administrators of the data dictionary to a sector to manage its own allocation record types.

If all the records have the same Sector-Identifier, the non-zero value is part of the Object-Identifier structure in a command to write or read a record, shall be included separately for the Configure-Multiple-Records-Header command.

7.4.58 Simple-Sensor-Indicator

The command argument Simple-Sensor-Indicator is used by the application that the tag supports a simple sensor. The argument is generally used when the air interface protocol does not have a feature to support such an indication.

7.4.59 Start-Address-Of-Record

This response argument provides the address of the first byte of the encoded Multiple Record in terms of the write block size, as encoded in EBV-8 format in the multiple-records directory.

7.4.60 Tag-Data-Profile-ID-Table

The Tag-Data-Profile-ID-Table is a command argument used to identify the Tag-Data-Protocol that contains the compaction and formatting rules. The specific rules are essential to encode any data for a given application using this Access-Method.

7.4.61 Tag-Mask

The command argument Tag-Mask is used in conjunction with the command arguments Length-Of-Mask and Pointer to define the search criteria of TDS data encoded in the UII memory of a segmented memory tag.

7.4.62 Update-Multiple-Records-Directory

The command argument Update-Multiple-Records-Directory is BOOLEAN, but the processing on the Logical Memory by the Data Processor needs to consider whether a directory already exists. The following states and processes apply:

- If a directory pre-exists and the command argument is set to TRUE, the directory is fully updated, including any previously missed directory entries.
- If a directory pre-exists and the command argument is set to FALSE, the argument is ignored and the directory is fully updated, including any previously missed directory entries.
- If no directory exists and the command argument is set to TRUE, the directory is created and fully updated, including any previously missed directory entries.
- If no directory exists and the command argument is set to FALSE, no directory is created.

7.4.63 Word-Count

The command argument Word-Count is used in conjunction with Word-Pointer to define the number of encoded bytes to be read from a segmented memory tag, without any processing to be undertaken by the Data Processor.

7.4.64 Word-Pointer

The command argument Word-Pointer is used in conjunction with Word-Count and defines the start location of the memory of a segmented memory tag from which an encoded byte string is to be read.

7.5 Command-related field names

7.5.1 General

In addition to the command arguments (7.4), the following field names are used in the commands and responses.

7.5.2 Data-Set

The field name Data-Set refers to the contiguous byte string from the Precursor, the Object-Identifier to the final byte of the compacted Object on a tag.

7.5.3 Identities

The field name Identities is a command-response field that represents a list of the identified Singulation-Ids.

7.5.4 Length-Lock Byte

The field name Length-Lock Byte is a command-response field that identifies the length of the encoded data in an item-related segment and provides information about the lock status of pages on the tag.

7.5.5 Length-Of-Encoded-Data

The field name Length-Of-Encoded-Data is a command-response field that is part of the Extended DSFID and identifies the length of the encoded data in terms of blocks.

7.5.6 Lock-Status

The field name Lock-Status is a command-response field that identifies whether an encoding packet (e.g. a Data-Set) is locked or not locked.

7.5.7 Logical-Memory-Map

The field Logical-Memory-Map is a command-response field that represents the complete, but un-decoded, byte string that was read from the tag.

7.5.8 Memory-Capacity

The field name Memory-Capacity is a command-response field that is part of the Extended DSFID and identifies the length of the encoded data in terms of blocks.

7.5.9 Module-OID

The field Module-OID identifies an individual command or response module with a full Object-Identifier as defined in [7.3.3](#).

7.5.10 Number-Of-Tags-Found

The field name Number-Of-Tags-Found is a command-response field that returns the actual number of tags observed that met the criteria. If the Identify-Method argument is set to Inventory-No-More-Than, then the response value Number-Of-Tags-Found can be a lower number.

7.5.11 PO-ID-Table

The field name PO-ID-Table is a command field that identifies the specific table for the Data Processor to use as the source of detailed encoding rules.

7.5.12 Protocol-Control-Word

The field name Protocol-Control-Word is a command-response field that returns this 16-bit value in a response from the UII memory of a segmented memory tag. The Protocol-Control-Word contains bit-based data that identifies other features supported on the tag.

7.5.13 Read-Data

The field Read-Data returns an un-decoded byte string from segmented memory tags.

7.6 Data security

The data (Object) may be made secure using some form of encryption. This shall be applied prior to the Object being transferred to the Data Processor. The decryption process shall also be applied to the Object after it has been transferred to the application. As such, all the processes are transparent to this document and ISO/IEC 15962.

NOTE Additional guidance is provided in [Annex D](#).

8 Dataflows and processes to the air interface

8.1 General

Various processes are required to, e.g. format the tag, to write data to it, to read from it, to modify data. These are defined in the subclauses that follow. All of the processes to write and add data are described. Where the read process is the inverse of the write process, this is described briefly, otherwise a further description is provided.

8.2 Establishing communications between the application and the tag

8.2.1 General

The Data Processor does not communicate directly with the tag, but through the Tag Driver. The Data Processor requires specific system information based on the configuration of the tag (see [8.2.3](#)). This is to set parameters of the Logical Memory to correctly represent the tag memory and to enable communication to and from the Tag Driver. To achieve this, air interface services shall be provided to the Data Processor via the Tag Driver to establish communications (see [8.2.2](#)).

A number of these parameters need to be known to, or requested by, the Data Processor. Effectively, this procedure is used to configure the tag initially, to re-configure it if required, and to establish a communications link while the data transaction is open.

8.2.2 Air interface services

This document is open-ended with respect to the fact that new types of tag can be added to the ISO/IEC 18000 series and leave the Data Processor unaltered. To achieve this, some basic presumptions are made about the types of tag in the ISO/IEC 18000 series.

- Application memory is an integer number of bytes.

NOTE The term application memory is used in this subclause as a generic name for the area of tag memory available for user data (this is sometimes called "user memory" in the ISO/IEC 18000 series) and any separately addressable memory (e.g. for the UID).

- Application memory shall be organised in blocks. These shall be fixed size and be of one or more bytes.
- In addition to the requirements (above) relating to the memory, there shall be a reliable mechanism for writing and reading to and from the application memory.

The tag shall have a mechanism for storing the system information (see [8.2.3](#)), including the ability to write and read the component elements.

The technical details of the air interface services are provided in ISO/IEC 15962.

8.2.3 System information

The system information shall consist of the following elements that need to be transferred across the application interface and air interface, and are therefore part of this document and ISO/IEC 15962:

- Singulation-Id (see [7.2.1](#));
- AFI (see [7.2.2](#));
- DSFID (see [7.2.3](#)), which itself consists of:
 - Access-Method (see [7.2.4](#));
 - Data-Format (see [7.2.5](#)).

8.3 Application system services

The application system shall provide the following:

- Object Identifier (see [7.3.3](#));
- Object (see [7.3.5](#));
- Compact-Parameter (see [7.3.6](#));
- Object-Lock (see [7.3.7](#)).

These are incorporated into the definitions of application commands and responses, and never transferred without the supporting commands.

9 Command-Codes, Completion-Codes, and Execution-Codes

9.1 General

Application commands are used to instruct the Data Processor and the interrogator to execute specific functions. They are also applied to the processing of the application data to achieve efficient encoding. The responses from the Data Processor include requested data and information about actions undertaken and errors found. Each command/response pair has its abstract syntax presented as modules. Each module is defined in a manner that enables the command to be invoked independently of any other command.

So that the commands and responses can easily be incorporated into the transfer syntax, code values have been assigned in this document to the final arc of the command and response modules (see [9.2](#)). Completion-Codes (see [9.3](#)) and Execution-Codes (see [9.4](#)) are assigned to the responses. The sources of definitions of arguments and fields that apply to each command are given, including those that only apply to the command and response modules (see [7.4](#) and [7.5](#)).

In the processing of a command, an error can be detected. The command shall be aborted with no data transferred to or from the tag in which the error is detected. This is possible because processing is done in the Logical Memory. Although other error conditions can be present, the first problem identified is the only one reported. The appropriate Completion-Code or Execution-Code is returned. In the case where the command addresses multiple tags, all tags processed prior to the one with the detected error should be processed. The detection of the error aborts all subsequent processing.

The following subclauses define all the application commands and responses that are supported by this document. In addition to the basic syntax, these subclauses also describe the function and purpose of specific command arguments and responses. The commands and responses are grouped logically together. Within this subclause, the current appropriate abstract syntax is shown.

[Annex E](#) shows the original 16 modules using the ASN.1 abstract syntax and the terminology used in ISO/IEC 15961:2004. Some of these modules have direct equivalents in the current format, others have been merged to create new modules and this is described in the relevant subclauses. [Annex F](#) shows an example of the original transfer encoding of a command and response.

9.2 Final arc values of the command and response modules

Each command and response module shall be identified by an Object Identifier. The common root for commands is {iso(1) standard(0) rfid-data-protocol(15961) commandModules(126)}. The common root for responses is {iso(1) standard(0) rfid-data-protocol(15961) commandResponses(127)}. The final arc of each pair of command and response modules shall have the same value, effectively a Relative-OID. The final arc shall be specific to the command/response pair and the following final arcs are as specified:

- 1 Configure-AFI
- 2 Configure-DSFID
- 3 Inventory-Tags
- 4 Reserved (used by withdrawn ISO/IEC 15961:2004)
- 5 Delete-Object
- 6 Modify-Object
- 7 Reserved (used by withdrawn ISO/IEC 15961:2004)
- 8 ReadObject-Identifiers
- 9 Reserved (used by withdrawn ISO/IEC 15961:2004)
- 10 Read-Logical-Memory-Map
- 11 Reserved (used by withdrawn ISO/IEC 15961:2004)
- 12 Erase-Memory
- 13 Get-App-Based-System-Info
- 14 Reserved (used by withdrawn ISO/IEC 15961:2004)
- 15 Reserved (used by withdrawn ISO/IEC 15961:2004)
- 16 Reserved (used by withdrawn ISO/IEC 15961:2004)
- 17 Write-Objects
- 18 Read-Objects
- 19 Write-Objects-Segmented-Memory-Tag
- 20 Write EPC-UII
- 21 Inventory-ISO-UIImemory
- 22 Inventory-EPC-UIImemory
- 23 Write-Password-Segmented-Memory-Tag
- 24 Read-Words-Segmented-Memory-Tag
- 25 Kill-Segmented-Memory-Tag
- 26 Delete-Packed-Object
- 27 Modify-Packed-Object
- 28 Write-Segments-6TypeD-Tag
- 29 Read-Segments-6TypeD-Tag
- 30 Write-Monomorphic-UII
- 31 Configure-Extended-DSFID

- 32 Configure-Multiple-Records-Header
- 33 Read-Multiple-Records
- 34 Delete-Multiple-Record

Additional command and response modules, and their final arc values, will be added in numeric sequence, as required, to this document.

The complete module specifies the function that the interrogator shall perform. Each command specifies, as appropriate, processes to be undertaken by the Data Processor, the Tag Driver, and the interrogator in communications across the air interface. Each response specifies, as appropriate, processes to be undertaken by the Tag Driver, the Data Processor, and the communications across the application interface.

9.3 Completion-Code

The Completion-Code is part of the response to each command. The Completion-Code is an INTEGER value that reports specifically on how the command was processed and executed, successfully or not. It is returned in each response. If its value is 0 (00_{16}), the command has been successfully executed. If its value is 255 (FF_{16}), the command cannot be executed by the system for the reason specified in the Execution-Code (see 9.4). If its value is different from 0 and 255, it indicates that the command was not executed as instructed by the application for the reason mentioned.

NOTE The Completion-Code provides information on the basis that the command can be invoked for the particular tag in the communication chain, whereas the Execution-Code indicates a systems error or success.

The Completion-Codes as specified by ISO/IEC 15962 shall apply.

9.4 Execution-Code

The Execution-Code is part of the response to each command. The Execution-Code is an INTEGER value that reports on the way the command was processed and executed by the system, successfully or not. It is returned in each response. If its value is 0 (00_{16}), the command has been successfully processed, i.e. the protocol was executed. Other values indicate that a system error has occurred.

The Execution-Codes as specified by ISO/IEC 15962 shall apply.

10 Commands and responses

10.1 General

Each pair of command and response is specified in 10.2 to 10.22. Those arguments that require a separate specification are defined in 10.28.2.

10.2 Configure-AFI

10.2.1 Configure-AFI command

The AFI is a single byte code and is used as part of the selection process in an application. Details of the AFI codes assigned to applications are available on the Register of Data Constructs provided by the Registration Authority of ISO/IEC 15961-2:2019. If the air interface supports the AFI feature, only tags with a specific AFI will be returned for future processing.

This command is applicable for those air interface protocols where either of the following characteristics is true:

- A. The application command is directly related to an equivalent air interface command.
- B. The application command requires the AFI to be written to a particular memory location and nominally separated from item-related data by using a generic air interface write command.

The Configure-AFI command has the following arguments:

- AFI (see [7.2.2](#));
- AFI-Lock (see [7.4.3](#));
- Singulation-Id (see [7.2.1](#)).

The AFI-Lock argument applies to characteristic A above without constraint but can only apply to characteristic B above if the air interface protocol supports the locking of a single byte position defined for the AFI.

Configure-AFI command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 1

Singulation-Id: BYTE STRING (0..255)

AFI: BYTE

Possible Values:

<u>Value</u>	<u>Definition</u>
00 ₁₆ – 0F ₁₆	As defined in ISO/IEC 15961-3
90 ₁₆ – CE ₁₆	As published by the Registration Authority of ISO/IEC 15961-2:2019
CF ₁₆	Reserved as an extension code

AFI-Lock: BOOLEAN

If set to TRUE, the interrogator shall lock the AFI

10.2.2 Configure-AFI response

The Configure-AFI response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Configure-AFI response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 1

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
1	AFI-Not-Configured
2	AFI-Not-Configured-Locked
3	AFI-Configured-Lock-Failed
8	Singulation-Id-Not-Found
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.3 Configure-DSFID

10.3.1 General

Configure-Extended-DSFID (see [10.25](#)) is required when encoding indicators of other features in the tag, such as the use of a Data-CRC. That command can also be better to encode an Access-Method with a value greater than 3, or a Data-Format with a value greater than 31.

10.3.2 Configure-DSFID command

The DSFID is a single-byte code that is used to reduce the encoding of Object-Identifiers and to define particular encoding rules for ISO/IEC 15962 to follow. These encoding rules apply to the Access-Method. Details of the Data-Format (part of the DSFID) assigned to applications are available on the Register of Data Constructs provided by the Registration Authority of ISO/IEC 15961-2:2019.

The command is applicable for those air interface protocols where either of the following characteristics is true:

- The application command is directly related to an equivalent air interface command.
- The application command requires the DSFID to be written to a particular location and memory nominally separated from item-related data but using a generic air interface write command.

The Configure-DSFID command has the following arguments:

- DSFID-Constructs (see [11.2](#));
- DSFID-Lock (see [7.4.15](#));
- Singulation-Id (see [7.2.1](#)).

The DSFID-Lock argument applies to characteristic A above without constraint but can only apply to characteristic B if the air interface protocol supports the locking of a single byte position defined by the DSFID.

Configure-DSFID command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 2

Singulation-Id: BYTE STRING (0..255)

DSFID-Constructs-list: List of <DSFID-Constructs>

DSFID-Lock: BOOLEAN

If set to TRUE, the interrogator shall lock the DSFID

10.3.3 Configure-DSFID response

The Configure-DSFID response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Configure-DSFID response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 2

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error

4	DSFID-Not-Configured
5	DSFID-Not-Configured-Locked
6	DSFID-Configured-Lock-Failed
8	Singulation-Id-Not-Found
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.4 Inventory-Tags

10.4.1 Inventory-Tags command

The Inventory-Tags command requires that the value of the AFI is specified to select tags belonging to a particular class, typically containing tags belonging to a defined domain. The Inventory-Tags command is intended to read a set of Singulation-Ids from tags that have a particular AFI. It is only applicable where an air interface command supports an inventory process using the AFI as a named argument and, generally, where a unique chip identifier is used in the arbitration process.

An additional selection criterion (Identify-Method) determines how many tags, conforming with the specified AFI selection criterion, need to be identified before the response can be provided. A mechanism that can be used to detect any tag entering the operating area, is to set the Inventory-At-Least field to 1. Certain conditions can be confirmed by only undertaking a partial inventory, i.e. by using either the Inventory-At-Least, or the Inventory-No-More-Than field. A reconciliation of a known quantity of previous transactions (e.g. to identify that all items intended to be in a container are actually there) can be achieved by using the Inventory-Exactly field.

The Inventory-Tags command has the following arguments:

- AFI (see [7.2.2](#));
- Identify-Method (see [7.4.23](#));
- Number-Of-Tags (see [7.4.43](#)).

Inventory-Tags command	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 3	
AFI: BYTE	
Identify-Method: INTEGER (0..15)	
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	Inventory-All-Tags
1	Inventory-At-Least
2	Inventory-No-More-Than
3	Inventory-Exactly
4 – 15	Reserved
Number-Of-Tags: INTEGER (0..65535)	

If the Identify-Method is set to Inventory-All-Tags, the interrogator shall perform a complete inventory of all tags present in its field of operation. The value of Number-Of-Tags is irrelevant and should be set to zero by the application.

If the Identify-Method is set to Inventory-At-Least, the interrogator shall perform an inventory of the tags present in its field of operation and (possibly) continue waiting until it has identified a number of tags equal to Number-Of-Tags. If the Number-Of-Tags is set to 1, the Interrogator waits until the

first tag has been detected. This is a mechanism to wait for a tag to enter the interrogator field. If the Number-Of-Tags is set to more than 1, the Interrogator waits until the specified number of tags has been detected.

If the Identify-Method is set to Inventory-No-More-Than, the interrogator shall initiate an inventory of the tags present in its field of operation and shall return a response with a number of tags lower or equal to Number-Of-Tags. The interrogator may interrupt the inventory process when the Number-Of-Tags has been reached or may continue the inventory process until all tags have been read.

NOTE 1 This can be constrained by the air interface and anti-collision mechanism.

If the Identify-Method is set to Inventory-Exactly, the interrogator shall initiate an inventory of the tags present in its field of operation and shall return a response with the number of tags equal to Number-Of-Tags. This command parameter can be used to confirm the actual number of tagged items in a container. The Interrogator will wait until the specified number of tags has been detected. The interrogator may interrupt the inventory process when the Number-Of-Tags has been reached or may continue the inventory process until all tags have been read.

NOTE 2 This can be constrained by the air interface and anti-collision mechanism.

Execution of this command with the arguments Inventory-At-Least and Inventory-Exactly can cause the interrogator to wait until sufficient tags enter its field of operation; also, the command-response cannot be initiated until after this delay. It is the responsibility of the application to accommodate this potentiality.

10.4.2 Inventory-Tags response

The Inventory-Tags response has the following field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4);
- Identities (see 7.5.3);
- Number-Of-Tags-Found (see 7.5.10).

Inventory-Tags response	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 3	
Completion-Code: INTEGER	
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	No-Error
23	Failed-To-Read-Minimum-Number-Of-Tags
24	Failed-To-Read-Exact-Number-Of-Tags
255	Execution-Error
Execution-Code: INTEGER	
<i>Possible Values:</i> As defined in 9.4.	
Number-Of-Tags-Found: INTEGER (1..65535)	
Identities: List of <Singulation-Id>	

10.5 Delete-Object

10.5.1 Delete-Object command

The Delete-Object command instructs the interrogator to delete a defined Object-Identifier and its Object and associated parameters. Only one tag and only one Object-Identifier shall be programmed per command to ensure that the deletion process is robust. The delete function requires the removal of the Object-Identifier, the associated Object, precursor and other components of the data set from the Logical Memory Map, and then the re-writing of any data sets at higher address locations on the tag.

For the No-Directory and Directory Access-Methods, if other encoding follows the deleted Object-Identifier, the Data Processor may replace the deleted bytes with a null Data-Set. This procedure is invoked automatically by the Data Processor.

For the Packed-Objects Access-Method, the interrogator shall delete the Object from within the first Packed-Object in which the Object-Identifier exists. If the Packed-Object is editable, the Packed-Objects editing procedures shall be used so that the entire memory content does not need to be rewritten. Otherwise, the interrogator shall rewrite the content of the user memory appropriately recalculated with the Object-Identifier and its Object and associated parameters deleted. If any of the memory that is required to be rewritten during the execution of this command is locked, the response will return the appropriate Completion-Code.

If the Access-Method is Tag-Data-Profile, deletion is not possible because of the fixed structure of the encoding and the fact that there are no system-based null characters, and the appropriate completion code shall be returned.

For Multiple-Records the Object-Identifier shall identify a data element within an individual record. The rules for the inherent Access-Method shall apply. To delete the entire record, see [10.28](#).

The Delete-Object command instructs the interrogator to delete the data set specified by its Object-Identifier from the tag Logical Memory Map. There is a possibility that this procedure will not succeed if the data set is locked. If this is found to be the case, the response returns the appropriate Completion-Code. If the Check-Duplicate flag is set to TRUE, the interrogator shall verify, before deleting the requested Object, that there is only a single instance of the requested Object-Identifier. If the interrogator detects that the tag is encoding more than one instance of the referenced Object-Identifier, it shall not perform the Delete-Object function and shall return the appropriate Completion-Code.

If the Check-Duplicate flag is set to FALSE, the interrogator shall delete the first occurrence of the data set specified by its Object-Identifier.

This is an argument that effectively provides no protection against duplicate Object-Identifiers. It should only be used when there is a high expectation of no duplicates.

The Delete-Object command has the following arguments:

- Check-Duplicate (see [7.4.10](#));
- Object-Identifier (see [7.3.3](#));
- Singulation-Id (see [7.2.1](#)).

Delete Object command

Module OID: OBJECT IDENTIFIER = 1 0 15961 126 5

Singulation Id: BYTE STRING (0..255)

Object Identifier: OBJECT IDENTIFIER

Check Duplicate: BOOLEAN

If set is TRUE, the interrogator shall check that there is only one occurrence of the Identifier Object

10.5.2 Delete-Object response

The Delete-Object response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Delete-Object response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 5

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
10	Duplicate-Object
12	Object-Not-Deleted
13	Object-Identifier-Not-Found
14	Object-Locked-Could-Not-Delete
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.6 Modify-Object

10.6.1 Modify-Object command

The Modify-Object command is intended to change the value of a data Object associated with an Object-Identifier already encoded on the memory of the tag. The complete memory shall be read to ensure that the Object-Identifier is not duplicated. If so, the command is aborted. Invoking this command depends on the Access-Method declared for the tag. In addition, the procedure is different if the resultant encoding length of the modified Object is different from the original length. Each of the cases is discussed under the appropriate Access-Method.

This command shall not be used to modify a Monomorphic-UII. If the AFI on the tag declares that it is registered for a Monomorphic-UII, the appropriate error shall be returned, and the encoding process aborted. The correct command to use is defined in [10.24](#).

The Modify-Object command instructs the interrogator to carry out three related processes:

- a) Read the complete Logical Memory Map from the tag.
- b) Identify the encoded packet (e.g. Data-Set, or Packed-Object, or Tag-Data-Profile) specified by the Object-Identifier. If duplicated instances are found, the process is aborted.
- c) Over-write with the modified encoded packet:
 - including re-structuring the Precursor for a Data-Set,
 - including any Packed-Object structuring rules,
 - including any pad bytes for shorter data in a Tag-Data-Profile.

If the Object is already locked, it cannot be modified, and the appropriate completion code shall be returned.

If the Access-Method is Packed-Objects, and the Packed-Object is not editable, the Object cannot be modified, and the appropriate completion code shall be returned.

If the Access-Method is Tag-Data-Profile, three conditions can be presented:

- A. If the new compacted data is the same length, then this data is simply overwritten.
- B. If it is shorter, it is written to the tag with the necessary pad bytes.
- C. If it is longer, there is an error; the data cannot be modified, and the appropriate completion code shall be returned.

If the data object is part of a multiple record (identified with the basic root-OID of 1.0.15961.401) or a hierarchical multiple record (identified with the basic root-OID of 1.0.15961.402), then the process to modify a data object shall be that of the declared Access-Method. A data object cannot be modified on a data element list (identified with the basic root-OID of 1.0.15961.403).

The Modify-Object command has the following arguments:

- Compact-Parameter (see [7.3.6](#));
- Object (see [7.3.5](#));
- Object-Identifier (see [7.3.3](#));
- Object-Lock (see [7.3.7](#));
- Singulation-Id (see [7.2.1](#)).

Modify-Object command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 6

Singulation-Id: INTEGER (0..255)

Object-Identifier: OBJECT IDENTIFIER

Object: BYTE STRING

Compact-Parameter: INTEGER (0..15)

Possible Values:

Value	Definition (see 7.3.6 for further details)
0	Application-Defined
1	Compact
2	UTF8-Data
3	Packed-Objects
4	Tag-Data-Profile

Object-Lock: BOOLEAN

If TRUE the interrogator shall lock the relevant Data-Set

10.6.2 Modify-Object response

The Modify-Object response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Modify-Object response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 6

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
7	Object-Locked-Could-Not-Modify
8	Singulation-Id-Not-Found
10	Duplicate-Object
13	Object-Identifier-Not-Found
21	Object-Not-Modified
22	Object-Modified-But-Not-Locked
33	Insufficient-Tag-Memory
36	Command-Cannot-Process-Monomorphic-UII
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.7 Read-Object-Identifiers

10.7.1 Read-Object-Identifiers command

This command shall not be used with Multiple Records. Instead, the Read-Multiple-Records command shall be used (see [10.27](#)).

The Read-Object-Identifiers command instructs the interrogator to read all the Object-Identifiers from the tag. This module can be used in advance of a more selective command to read a specific Object, or to identify duplicate Object-Identifiers so that a housekeeping procedure can be invoked. A valid response, if the tag Logical Memory Map has no Object-Identifiers stored, is to return an empty Object-Identifiers list. Only one tag shall be programmed per command to ensure that the read process is robust.

The Read-Object-Identifiers command has the following argument:

- Singulation-Id (see [7.2.1](#)).

Read-Object-Identifiers command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 8

Singulation-Id: BYTE STRING (0..255)

10.7.2 Read-Object-Identifiers response

The Read-Object-Identifiers response has the following arguments:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#));
- Read-Olds-Response-List (see [11.15](#)).

Read-Object-Identifiers response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 8
 Read-OIDs-Response-List: List of <Read-OIDs-Response>
 Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.8 Read-Logical-Memory-Map

10.8.1 Read-Logical-Memory-Map command

The main function of this command is for diagnostic purposes, but it can also be used for other functions where reading the complete content of the Logical Memory Map is required. Only one tag should be programmed per command to ensure that the reading process is robust.

The Read-Logical-Memory-Map command instructs the interrogator to read the entire Logical Memory Map of the tag and respond with this without any decoding and interpretation (i.e. by returning the encoded byte values). No processing takes place through the Data Processor as part of this read command, so that individual Object-Identifiers, Objects, Compact-Parameter and Lock-Status cannot be directly identified.

The command applies equally to all Access-Methods, but if a Directory structure has been defined by the Access-Method, this shall be included in the response, but shall not be distinguished from other bytes in the Logical Memory Map.

The Read-Logical-Memory-Map command has the following argument:

- Singulation-Id (see [7.2.1](#))

Read-Logical-Memory-Map command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 10

Singulation-Id: BYTE STRING (0..255)

10.8.2 Read-Logical-Memory-Map response

The Read-Logical-Memory-Map response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#));
- Logical-Memory-Map (see [7.5.7](#)).

Read-Logical-Memory-Map response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 10

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error

8	Singulation-Id-Not-Found
19	Read-Incomplete
255	Execution-Error
Execution-Code: INTEGER	
<i>Possible Values:</i> As defined in 9.4 .	
Logical-Memory-Map: BYTE STRING	

10.9 Erase-Memory

10.9.1 Erase-Memory command

The Erase-Memory command instructs the interrogator to re-set to zero the entire Logical Memory Map of the specified tag. This includes the Directory when this is defined as the Access-Method. If none of the blocks is locked, this should result in a deletion of all Data-Sets or Packed-Objects. If any block is locked, then the Completion-Code: Blocks-Locked will be returned. Only one tag shall be programmed per command to ensure that the erasure process is robust.

Subsequent processing by the application, possibly by reading all the locked data, can be invoked to determine whether the tag is still useable. For example, the blocks that are locked can contain data permanently assigned to the item and the unlocked blocks containing transitory data.

The Erase-Memory command has the following argument:

- Singulation-Id (see [7.2.1](#)).

Erase Memory command
Module OID: OBJECT IDENTIFIER = 1 0 15961 126 12
Singulation Id: BYTE STRING (0..255)

10.9.2 Erase-Memory response

The Erase-Memory response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Erase-Memory response	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 12	
Completion-Code: INTEGER	
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
17	Blocks-Locked
18	Erase-Incomplete
255	Execution-Error
Execution-Code: INTEGER	
<i>Possible Values:</i> As defined in 9.4 .	

10.10 Get-App-Based-System-Info

10.10.1 Get-App-Based-System-Info command

The Get-App-Based-System-Info command instructs the interrogator to read the system information and return those arguments that are relevant to the application, namely the AFI and DSFID. This command is useful for tag types that do not return these codes as part of a response to other commands.

The Get-App-Based-System-Info command has the following argument:

- Singulation-Id (see [7.2.1](#)).

Get-App-Based-System-Info command
 Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 13
 Singulation-Id: BYTE STRING (0..255)

10.10.2 Get-App-Based-System-Info response

The Get-App-Based-System-Info response has the following arguments:

- AFI (see [7.2.2](#));
- Completion-Code (see [9.3](#));
- DSFID (see [7.2.3](#));
- Execution-Code (see [9.4](#)).

Get-App-Based-System-Info response
 Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 13
 AFI: BYTE
 DSFID: BYTE STRING
 Completion-Code: INTEGER
 Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
20	System-Info-Not-Read
255	Execution-Error

 Execution-Code: INTEGER
 Possible Values: As defined in [9.4](#).

10.11 Write-Objects

10.11.1 Write-Objects command

The Write-Objects command is used to write one or more Object-Identifiers and associated Objects to a tag. This command can be implemented to write the initial data to the tag, or to add data to the tag. The command is supported by a compound argument Add-Objects-List.

This command shall not be used to write a Monomorphic-UII. If the AFI on the tag declares that it is registered for a Monomorphic-UII, the appropriate error shall be returned, and the encoding process aborted. The correct command to use is defined in [10.24](#).

The DSFID-Constructs-list is used to specify the Access-Method and Data-Format. The Ext-DSFID-Constructs-list is used to set indicators on the Extended-DSFID and to instruct the Data Processor to carry out certain procedures, e.g. to apply a CRC to the data.

The DSFID-Constructs-list and the Ext-DSFID-Constructs-list are provided for use in one of the following ways:

- If data is being written to a blank tag, then they are provided as part of this command to minimise communications.
- If data is being added to the tag, then the DSFID in the command should match the DSFID already encoded on the tag, else there is an error and the encoding process can cease before significant amounts of data have been processed.
- Additionally, all the requirements declared by the arguments in the Ext-DSFID-Constructs-list shall be processed.

The DSFID-Lock argument, if set, is applied to the entire DSFID and Extended-DSFID byte string.

If the Access-Method is Packed-Objects, all Objects specified as arguments shall be included within the same new Packed-Object added after any existing Packed-Objects in memory. Several arguments only apply to Packed-Objects and these are defined in the Packed-Object-Constructs argument.

If the Access-Method is Tag-Data-Profile, all Objects specified as arguments shall be included within the same Tag-Data-Profile. Adding an Object that is not specified by the Tag-Data-Profile-ID-Table argument shall be treated as an error, and no encoding take place.

A Multiple-Record is declared by the Object-Identifiers in the Add-Objects-List all being in one of these three mandatory forms:

- 1.0.15961.401. {data format = dictionary}. {sector identifier}. {record type}. {instance-of}. {Relative-
OID of data element}
- 1.0.15961.402. {data format = dictionary}. {sector identifier}. {record type}. {hierarchical id}. {Relative-
OID of data element}
- 1.0.15961.403. {data format = dictionary}. {sector identifier}. {record type}. {hierarchical id}. {Relative-
OID of data element}. {list element number}

The Add-Objects-List argument applies to a single record in a multiple records structure. Therefore, in the OID structures listed above only the final arc values are permitted to differ in a single command.

Individual records shall be written only after the MR-header has been created.

The DSFID-Constructs-List argument shall be used to declare that the individual Multiple-Record is in accordance with the encoding rules of one of the following Access-Methods:

- 0 No-Directory
- 1 Not assigned
- 2 Packed-Objects
- 3 Tag-Data-Profile

For multiple records, the command requires the Multiple-Records-Constructs-List arguments (see [11.8](#)) to be defined. This includes instructions about reserving memory to enable the record to increase in size, to indicate whether a directory entry is required, and in some cases to identify whether there is a parent-child relationship between this record and others. There is also an argument to declare whether this record is defined as a data element list, in which case the Add-Objects-List contains multiple instances of the same Relative-OID. The command may also be used to add data elements to an existing multiple record by declaring this in the relevant argument in the Multiple-Records-Constructs-List.

The Ext-DSFID-Constructs-List is also required for defining all the encoded requirements for a Multiple-Record.

The MR-header defines rules for the Data-Format, Access-Method and sector identifier that govern the subsequent encoding of individual records. Depending on their individual settings, the rules either required the associated argument to be the same for all records or to be permitted to be different. Any variance with the MR-header shall cause the command to be aborted and the record not encoded.

The DSFID-Lock argument is not relevant for multiple records because this is part of the record preamble then needs to be considered as a unit for locking or not locking.

The Write-Objects command has the following arguments:

- Add-Objects-List (see [11.1](#));
- DSFID-Constructs (see [11.2](#));
- DSFID-Lock (see [7.4.15](#));
- Ext-DSFID-Constructs (see [11.4](#));
- Multiple-Records-Constructs (see [11.8](#));
- Packed-Object-Constructs (see [11.12](#));
- Tag-Data-Profile-ID-Table (see [7.4.60](#));
- Singulation-Id (see [7.2.1](#)).

Write-Objects command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 17

Singulation-Id: BYTE STRING (0..255)

DSFID-Constructs-list: [OPTIONAL] List of <DSFID-Constructs>

Ext-DSFID-Constructs-list: [OPTIONAL] List of <Ext-DSFID-Constructs>

DSFID-Lock: BOOLEAN

If set to TRUE, the interrogator shall lock the DSFID

Add-Objects-List: List of <Add-Objects>

Packed-Object-Constructs: [OPTIONAL] List of <Packed-Object-Constructs>

Tag-Data-Profile-ID-Table: INTEGER [OPTIONAL]

Multiple-Records-Constructs: [OPTIONAL] List of <Multiple-Records-Constructs>

10.11.2 Write-Objects response

The Write-Objects response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#));
- Write-Responses (see [11.18](#)).

Additional Completion-Codes apply to each Object-Identifier and are incorporated in the Write-Response argument.

Write-Objects response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 17

Write-Responses-List: List of <Write-Responses>

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
29	Object-Not-Editable
31	Packed-Object-ID-Table-Not-Recognised-No-Encoding
32	Tag-Data-Profile-ID-Table-Not-Recognised
33	Insufficient-Tag-Memory
36	Command-Cannot-Process-Monomorphic-UII
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
43	Data-Format-Not-Compatible-Multiple-Records-Header
44	Access-Method-Not-Compatible-Multiple-Records-Header
45	Sector-Identifer-Not-Compatible-Multiple-Records-Header
46	Record-Preamble-Not-Configured
47	Record-Preamble-Not-Locked
255	Execution-Error

Additional Completion-Codes apply to the Write-Response-List

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.12 Read-Objects

10.12.1 Read-Objects command

This command shall not be used to read any data object or other part of a multiple record. The relevant procedures are defined in [10.27](#).

The Read-Objects command instructs the interrogator to read a set of one or more Object-Identifiers and associated Objects from the tag. A command argument can be used to check that the Object-Identifier is not duplicated on the tag. Only one tag shall be programmed per command to ensure that the reading process is robust.

The command supports an argument that enables the application to prescribe an upper address point on the tag beyond which reading is discontinued. This argument incorporates the features of the original readFirstObject command but is no longer restricted to just one Object-Identifier. This command argument supports features across the air interface that can be faster than reading a named Object-Identifier(s). The application may therefore select to have the most often accessed Object(s) stored first in the tag. A value needs to be determined (in bytes) for the Max-App-Length argument, which can be achieved by simulating the encoding or by a short trial period, changing the value of this argument until the command achieves a high probability of reading the requested Object-Identifier(s) and Object(s).

This command may be used to read a Monomorphic-UII by declaring the relevant Object-Identifier as the single entry in the list of Read-Objects, combined with Read-Type 4. The Data Processor checks that the Object-Identifier is registered as part of a Monomorphic-UII entry on the ISO/IEC 15961-2 data constructs register.

- If it is registered, the encoded bytes are de-compacted to the rules defined on the register and included in the response.
- If it is not registered, the appropriate error is returned.

The Read-Objects command has the following arguments:

- Max-App-Length (see 7.4.32);
- Read-Objects (see 11.13);
- Read-Type (see 7.4.53);
- Singulation-Id (see 7.2.1).

Read-Objects command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 18

Singulation-Id: BYTE STRING (0..255)

Read-Type: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	Read-1st-Objects
1	Read-Multiple-Objects
2	Read-All-Objects
3	Read-Monomorphic-UII

Max-App-Length: INTEGER (1..65535)

This only applies to Read-Type (0) and is expressed in bytes

Read-Objects-List: List of <Read-Objects>

This does not apply to Read-All-Objects (2)

If the Check-Duplicate argument is set to FALSE in the Read-Object-List argument, having found the requested Object-Identifier the interrogator shall return the first Object found without checking for duplicates. If the Check-Duplicate argument is set to TRUE, the interrogator shall check for duplicate Object-Identifiers. If more than one instance of the requested Object-Identifier is found, the interrogator shall return the first found Object and indicate the presence of duplicates with the appropriate Completion-Code.

10.12.2 Read-Objects response

The Read-Objects response has the following arguments:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4);
- Read-Objects-Response-List (see 11.14).

Read-Objects response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 18

Read-Objects-Response-List: List of <Read-Objects-Response>

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
255	Execution-Error

Additional Completion-Codes apply to the Read-Objects-Response-List

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.13 Write-Objects-Segmented-Memory-Tag

10.13.1 Write-Objects-Segmented-Memory-Tag command

The Write-Objects-Segmented-Memory-Tag command is like the Write-Objects command except that it is intended to write data to a selected memory bank in a segmented memory tag. The command can be implemented to write initial data to the tag, or to add data to the tag. The command is supported by a compound argument Add-Objects-List.

This command shall not be used to write a Monomorphic-UII. If the AFI on the tag declares that it is registered for a Monomorphic-UII, the appropriate error shall be returned, and the encoding process aborted. The correct command to use is defined in [10.24](#).

The Access-Password in the command is used to match that on the tag to permit writing data to the tag.

The DSFID-Constructs-list is used to specify the Access-Method and Data-Format. The Ext-DSFID-Constructs-list is used to set indicators on the Extended-DSFID and to instruct the Data Processor to carry out certain procedures, e.g. to apply a CRC to the data.

The DSFID-Lock argument, if set, is applied to the entire DSFID and Extended-DSFID byte string.

The AFI and DSFID are provided as arguments for use in one of the following ways:

- If data is being written to a blank segmented memory tag, then these arguments are provided as part of this command to minimise communications.
- Depending on the memory bank concerned, if data is being added to the segmented memory tag, then the AFI and DSFID in the command should match the AFI and DSFID already encoded on the tag, else there is an error and the encoding process can cease before significant amounts of data have been processed.
- Additionally, all the requirements declared by the arguments in the Ext-DSFID-Constructs-list shall be processed.

If the Access-Method is Packed-Objects, all Objects specified as arguments shall be included within the same new Packed-Object added after any existing Packed-Objects in memory. Several arguments only apply to Packed-Objects and these are defined in the Packed-Object-Constructs argument.

If the Access-Method is Tag-Data-Profile, all Objects specified as arguments shall be included within the same Tag-Data-Profile. Adding an Object that is not specified by the Tag-Data-Profile-ID-Table argument shall be treated as an error, and no encoding take place.

Multiple records may be encoded only on Memory Bank 11. Individual records are written only after the MR-header has been created. The details defined in [10.11.1](#) for Multiple Records shall apply in constructing the command.

The Write-Objects-Segmented-Memory-Tag command has the following arguments:

- Access-Password (see [7.4.1](#));
- Add-Objects-List (see [11.1](#));
- AFI (see [7.2.2](#));
- DSFID-Constructs (see [11.2](#));
- DSFID-Lock (see [7.4.15](#));

- Ext-DSFID-Constructs (see 11.4);
- Memory-Bank (see 7.4.33);
- Multiple-Records-Constructs (see 11.8);
- Packed-Object-Constructs (see 11.12);
- Singulation-Id (see 7.2.1);
- Tag-Data-Profile-ID-Table (see 7.4.60).

Write-Objects-Segmented-Memory-Tag command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 19

Singulation-Id: BYTE STRING (0.255)

Memory-Bank: BIT STRING

Possible Values:

<u>Value</u>	<u>Definition</u>
01 ₂	UII-Memory
11 ₂	User-Memory

Access-Password: [Optional] BYTE STRING (4 bytes)

AFI: BYTE [only applies if Memory-Bank = 01]

DSFID-Constructs-list: List of <DSFID-Constructs>

Ext-DSFID-Constructs-list: [Optional] List of <Ext-DSFID-Constructs>

DSFID-Lock: BOOLEAN

If set to TRUE, the interrogator shall lock the DSFID

Add-Objects-List: List of <Add-Objects>

Packed-Object-Constructs: [OPTIONAL] List of <Packed-Object-Constructs>

Tag-Data-Profile-ID-Table: INTEGER [OPTIONAL]

Multiple-Records-Constructs: [OPTIONAL] List of <Multiple-Records-Constructs>

10.13.2 Write-Objects-Segmented-Memory-Tag response

The Write-Objects-Segmented-Memory-Tag response has the following field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4);
- Write-Responses (see 11.18).

Additional Completion-Codes apply to each Object-Identifier and are incorporated in the Write-Response argument.

Write-Objects-Segmented-Memory-Tag response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 19

Write-Response-List: List of <Write-Responses>

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found

25	Password-Mismatch
26	AFI-Mismatch
27	DSFID-Mismatch
33	Insufficient-Tag-Memory
36	Command-Cannot-Process-Monomorphic-UII
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
43	Data-Format-Not-Compatible-Multiple-Records-Header
44	Access-Method-Not-Compatible-Multiple-Records-Header
45	Sector-Identifier-Not-Compatible-Multiple-Records-Header
46	Record-Preamble-Not-Configured
47	Record-Preamble-Not-Locked
255	Execution Error

Additional Completion-Codes apply to the Write-Response-List

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.14 Write-EPC-UII

10.14.1 Write-EPC-UII command

The Write-EPC-UII command instructs the interrogator to write an EPC-Code into Memory Bank 01 of a segmented memory tag. The command supports various lengths of EPC-Codes specified by TDS.

The Access-Password in the command is used to match that on the tag to protect against unauthorised writing of data to the tag.

This command can be used to initially write the EPC-Code to the tag, or to overwrite the code value. If the new code is of a shorter length, the interrogator needs to ensure that bytes representing part of the older code are removed.

The Write-EPC-UII-Tag command has the following arguments:

- Access-Password (see [7.4.1](#));
- EPC-Code (see [7.4.19](#));
- Memory-Bank-Lock (see [7.4.34](#));
- NSI-Bits (see [7.4.40](#));
- Singulation-Id (see [7.2.1](#)).

Write-EPC-UII command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 20

Singulation-Id: BYTE STRING (0..255)

Access-Password: [Optional] BYTE STRING (4 bytes)

NSI-Bits: BIT STRING

EPC-Code: BYTE STRING

Memory-Bank-Lock: BOOLEAN

If TRUE the entire memory bank shall be locked.

10.14.2 Write-EPC-UII response

The Write-EPC-UII response has the following field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4).

Write-EPC-UII response	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 20	
Completion-Code: INTEGER	
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
25	Password-Mismatch
33	Insufficient-Tag-Memory
255	Execution-Error
Execution-Code: INTEGER	
<i>Possible Values:</i> As defined in 9.4.	

10.15 Inventory-ISO-UIImemory

10.15.1 Inventory-ISO-UIImemory command

The Inventory-ISO-UIImemory command is intended to return the contents of the UII memory from segmented memory tags, given the expectation that an Object-Identifier for a UII other than an EPC-Code is encoded. The response returns the content of the UII memory for all tags whose encoded bit string matches the arguments of the command.

The arguments provided in the command enable a bit mask to be incorporated into appropriate air interface protocol commands to select only tags that match the bit mask. The AFI is a required argument, and the other two arguments extend the bit string to increase the capability of selection.

This command may be used to read a Monomorphic-UII by declaring the relevant AFI as an argument. The Data Processor checks that the AFI is registered as part of a Monomorphic-UII entry on the ISO/IEC 15961-2 Data constructs register.

- If it is registered, the encoded bytes are de-compacted to the rules defined on the register and included in the response.
- If it is not registered, the appropriate error is returned.

NOTE A DSFID is not required when invoking this command to inventory Monomorphic-UIIs.

The Inventory-ISO-UIImemory command has the following arguments:

- Additional-App-Bits (see 7.4.2);
- AFI (see 7.2.2);
- DSFID-Constructs (see 11.2).

Inventory-ISO-UIImemory command	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 21	
AFI: BYTE	

DSFID-Constructs-list: [OPTIONAL] List of <DSFID-Constructs>
 Additional-App-Bits: BIT STRING [Optional]

10.15.2 Inventory-ISO-UIImemory response

The Inventory-ISO-UIImemory response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#));
- ISO-UIImemory (see [11.5](#)).

Inventory-ISO-UIImemory response
 Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 21
 ISO-UII Memory-List: List of <ISO-UIImemory>
 Completion-Code: INTEGER
 Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
255	Execution-Error

 Execution-Code: INTEGER
 Possible Values: As defined in [9.4](#).

10.16 Inventory-EPC-UIImemory

10.16.1 Inventory-EPC-UIImemory command

The Inventory-EPC-UIImemory command is intended to return the contents of the UII memory from segmented memory tags, given the expectation that an EPC-Code is encoded. The response returns the content of the UII memory for all tags whose encoded bit string matches the arguments of the command.

The arguments provided in the command enable a bit mask to be incorporated into appropriate air interface protocol commands to select only tags that match the bit mask. The Tag-Mask value consists of a bit string that should be determined by reference to relevant TDS standards. The same applies to the Pointer, which identifies the first bit of a continuous string on the tag that needs to be matched with the Tag-Mask.

The Inventory-EPC-UIImemory command has the following arguments:

- Length-Of-Mask (see [7.4.27](#));
- Pointer (see [7.4.50](#));
- Tag-Mask (see [7.4.61](#)).

Inventory-EPC-UIImemory command
 Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 22
 Pointer: HEXADECIMAL ADDRESS
 The address of the first (msb) bit against which to apply the Tag-Mask.
 Length-Of-Mask: INTEGER
 Tag-Mask: BIT STRING

10.16.2 Inventory-EPC-UIMemory response

The Inventory-EPC-UIMemory response has the following field names:

- Completion-Code (see 9.3);
- EPC-UIMemory (see 11.3);
- Execution-Code (see 9.4).

Inventory-EPC-UIMemory response	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 22	
EPC-UIMemory-List: List of <EPC-UIMemory>	
Completion Code:	INTEGER
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	No-Error
255	Execution-Error
Execution-Code:	INTEGER
<i>Possible Values:</i> As defined in 9.4.	

10.17 Write-Password-Segmented-Memory-Tag

10.17.1 Write-Password-Segmented-Memory-Tag command

The Write-Password-Segmented-Memory-Tag command instructs the interrogator to write one of the Passwords defined in the command to the appropriate memory of a segmented memory tag. Only one Password may be specified per command. The Password-Type identifies to the Data Processor the type of Password, and therefore its storage location on the tag.

The Write-Password-Segmented-Memory-Tag command has the following arguments:

- Password (see 7.4.46);
- Password-Type (see 7.4.47);
- Singulation-Id (see 7.2.1).

Write-Password-Segmented-Memory-Tag command	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 23	
Singulation-Id: BYTE STRING (0..255)	
Password-Type:	INTEGER
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	Kill-Password
1	Access-Password
Password:	BYTE STRING
For Password-Types 0 and 1, the length is 4 bytes	

10.17.2 Write-Password-Segmented-Memory-Tag response

The Write-Password-Segmented-Memory-Tag response has the following field names:

- Completion-Code (see 9.3);

— Execution-Code (see [9.4](#)).

Write-Password-Segmented-Memory-Tag response
Module-OID: OBJECT IDENTIFIER = 1 – 15961 127 23
Completion-Code: INTEGER
Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
26	Password-Not-Written
33	Insufficient-Tag-Memory
255	Execution-Error

Execution-Code: INTEGER
Possible Values: As defined in [9.4](#).

10.18 Read-Words-Segmented-Memory-Tag

10.18.1 Read-Words-Segmented-Memory-Tag command

The Read-Words-Segmented-Memory-Tag command instructs the interrogator to read a contiguous sequence of words from one of the memory banks of a segmented memory tag. This command can be used to extract encoded bytes, which are not necessarily Object-based, e.g. the unique Singulation-Id or a password. It can also be useful for diagnostic purposes.

The Read-Words-Segmented-Memory-Tag command has the following arguments:

- Access-Password (see [7.4.1](#));
- Memory-Bank (see [7.4.33](#));
- Singulation-Id (see [7.2.1](#));
- Word-Count (see [7.4.63](#));
- Word-Pointer (see [7.4.64](#)).

Read-Words-Segmented-Memory-Tag command
Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 24
Singulation-Id: BYTE STRING (0..255)
Memory-Bank: BIT STRING
Possible Values: (00..11)
Word-Pointer: HEXADECIMAL ADDRESS
Word-Count: INTEGER
Access-Password: [Optional] BYTE STRING (4 bytes)

10.18.2 Read-Words-Segmented-Memory-Tag response

The Read-Words-Segmented-Memory-Tag response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#));
- Read-Data (see [7.5.13](#)).

Read-Words-Segmented-Memory-Tag response
 Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 24
 Read-Data: BYTE STRING
 Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
25	Password-Mismatch
254	Undefined-Command-Error
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.19 Kill-Segmented-Memory-Tag

10.19.1 Kill-Segmented-Memory-Tag command

The Kill-Segmented-Memory-Tag command instructs the interrogator to apply appropriate air interface protocols to render the tag unreadable in future. The Kill-Password in the command shall match the Password encoded on the tag.

The Kill-Segmented-Memory-Tag command has the following arguments:

- Kill-Password (see [7.4.26](#));
- Singulation-Id (see [7.2.1](#)).

Kill-Segmented-Memory-Tag command
 Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 25
 Singulation-Id: BYTE STRING (0..255)
 Kill-Password: BYTE STRING (4 bytes)

10.19.2 Kill-Segmented-Memory-Tag response

The Kill-Segmented-Memory-Tag response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Kill-Segmented-Memory-Tag response
 Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 25
 Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
27	Zero-Kill-Password-Error
28	Kill-Failed
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.20 Delete-Packed-Object

10.20.1 Delete-Packed-Object command

The Delete-Packed-Object command instructs the interrogator to delete the Packed-Object in which the specified Object-Identifier is contained. The Object-Identifier simply acts as an alias to identify a specific Packed-Object. Only one tag and only one Object-Identifier shall be programmed per command to ensure that the deletion process is robust. The delete function requires the removal of the associated Packed-Object from the tag and replacing this with pad bytes.

It is possible that this procedure will not succeed if the Packed-Object is locked. If this is found to be the case, the response will return the appropriate Completion-Code.

If the Check-Duplicate flag is set to TRUE, the interrogator shall verify, before deleting the requested Packed-Object, that there is only a single instance of the requested Object-Identifier on the tag. If the interrogator detects that the tag is encoding more than one instance of the referenced Object-Identifier, it shall not perform the Delete-Packed-Object function and shall return the appropriate Completion-Code.

If the Check-Duplicate flag is set to FALSE, the interrogator shall delete the first occurrence of the Packed-Object that contains the specified by its Object-Identifier.

NOTE This is an argument that effectively provides no protection against duplicate Object-Identifiers. It can be effective when there is a high expectation of no duplicates.

The Delete-Packed-Object command has the following arguments:

- Check-Duplicate (see [7.4.10](#));
- Object-Identifier (see [7.3.3](#));
- Singulation-Id (see [7.2.1](#)).

Delete Packed Object command

Module OID: OBJECT IDENTIFIER = 1 0 15961 126 26

Singulation Id: BYTE STRING (0..255)

Object Identifier: OBJECT IDENTIFIER

Check Duplicate: BOOLEAN

If set is TRUE, the interrogator shall check that there is only one occurrence of the Object Identifier on the tag

10.20.2 Delete-Packed-Object response

The Delete-Packed-Object response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Delete-Packed-Object response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 26

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
10	Duplicate-Object
12	Object-Not-Deleted
13	Object-Identifier-Not-Found
14	Object-Locked-Could-Not-Delete
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.21 Modify-Packed-Object-Structure

10.21.1 Modify-Packed-Object-Structure command

The Modify-Packed-Object-Structure command is used to change the structure of a Packed-Object. The structure of a Packed-Object may be modified to define a specific directory type if the Packed-Object was created with the Packed-Object pointer allocation type as specified in [7.4.48](#). The command determines which type of directory shall be applied. The Object-Identifier simply acts as an alias to identify a specific Packed-Object. Only one tag and only one Object-Identifier shall be programmed per command to ensure that the modification process is robust.

It is possible that this procedure will not succeed if the Packed-Object is locked. If this is found to be the case, the response will return the appropriate Completion-Code.

A number of arguments are defined in the Packed-Object-Constructs argument. These arguments shall be used if included, but only if they are relevant for the type of Packed Object being modified by the command. If they are not relevant for the current Packed Object, the parameters shall be ignored.

If the Packed-Object already has a specific directory type defined, then the appropriate Completion-Code will be returned.

If the Check-Duplicate flag is set to TRUE, the interrogator shall verify, before modifying the requested Packed-Object, that there is only a single instance of the requested Object-Identifier on the tag. If the interrogator detects that the tag is encoding more than one instance of the referenced Object-Identifier, it shall not perform the Modify-Packed-Object-Structure function and shall return the appropriate Completion-Code.

If the Check-Duplicate flag is set to FALSE, the interrogator shall modify the first occurrence of the Packed-Object that contains the specified by its Object-Identifier.

This is an argument that effectively provides no protection against duplicate Object-Identifiers. It should only be used when there is a high expectation of no duplicates.

The Modify-Packed-Object-Structure command has the following arguments:

- Check-Duplicate (see [7.4.10](#));
- Object-Identifier (see [7.3.3](#));
- Packed-Object-Constructs (see [11.12](#));
- Singulation-Id (see [7.2.1](#)).

Modify Packed Object command

Module OID: OBJECT IDENTIFIER = 1 0 15961 126 27

Singulation Id: BYTE STRING (0..255)

Object Identifier: OBJECT IDENTIFIER

Check Duplicate: BOOLEAN

If set is TRUE, the interrogator shall check that there is only one occurrence of the Object Identifier

Packed Object Constructs List: [OPTIONAL] List of <Packed Object Constructs>

10.21.2 Modify-Packed-Object-Structure response

The Modify-Packed-Object response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Modify-Packed-Object-Structure response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 27

Completion-Code: INTEGER

Possible Values:

Value	Definition
0	No-Error
7	Object-Locked-Could-Not-Modify
8	Singulation-Id-Not-Found
10	Duplicate-Object
13	Object-Identifier-Not-Found
30	Directory-Already-Defined
33	Insufficient-Tag-Memory
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.22 Write-Segments-6TypeD-Tag

10.22.1 Write-Segments-6TypeD-Tag command

The Write-Segments-6TypeD-Tag command instructs the ISO/IEC 15962 Data Processor to write data to the UII segment, the item-related segment or both segments. The command can be implemented to write initial data to the tag, or to add data to the tag. The command is supported by a compound argument Add-Objects-List, which applies to the Item-related segment.

This command shall not be used to write a Monomorphic-UII. If the AFI on the tag declares that it is registered for a Monomorphic-UII, the appropriate error shall be returned, and the encoding process aborted. The correct command to use is defined in [10.24](#).

If data is being encoded on the tag for the first time, the AFI, UII-DSFID, and Item-Related-DSFID (if that segment is being encoded) shall be incorporated in the encoded byte string. If any of these three

is already encoded on the tag and there is a mismatch with the equivalent argument in the command, then the procedure shall be aborted

If the Access-Method is Packed-Objects, all Objects specified as arguments shall be included within the same new Packed-Object added after any existing Packed-Objects in memory. Several arguments only apply to Packed-Objects and these are defined in the Packed-Object-Constructs argument.

If the Access-Method is Tag-Data-Profile, all Objects specified as arguments shall be included within the same Tag-Data-Profile. Adding an Object that is not specified by the Tag-Data-Profile-ID-Table argument shall be treated as an error, and no encoding take place.

Multiple records may be encoded only on the item-related segment. Individual records are written only after the MR-header has been created. The details defined in [10.11.1](#) shall apply in constructing the command.

The Write-Segments-6TypeD-Tag command has the following arguments:

- AFI (see [7.2.2](#));
- Item-Related-Add-Objects-List (see [11.6](#));
- Item-Related-DSFID-Constructs (see [11.7](#));
- Lock-UII-Segment-Arguments (see [7.4.31](#));
- Memory-Segment (see [7.4.36](#));
- Multiple-Records-Constructs (see [11.8](#));
- Packed-Object-Constructs (see [11.12](#));
- Singulation-Id (see [7.2.1](#));
- Tag-Data-Profile-ID-Table (see [7.4.60](#));
- UII-Add-Objects-List (see [11.16](#));
- UII-DSFID-Constructs (see [11.17](#)).

Write-Segments-6TypeD-Tag command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 28

Singulation-Id: BYTE STRING (0.255)

Memory-Segment: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
1	UII segment
2	Item-related data segment
3	Both segments presented as objects

AFI: BYTE

Not required for Memory-Segment = 2 (Item-related data segment)

UII-DSFID-Constructs-list: [OPTIONAL] List of <DSFID-Constructs>

Not required for Memory-Segment = 2 (Item-related data segment)

UII-Add-Objects-List: List of <Add-Objects>

Only required for Memory-Segment = 1 (UII segment), and this shall only contain one Object-Identifier and Object

Lock-UII-Segment-Arguments: INTEGER

This argument takes precedence over lock argument elsewhere in the command.

Possible Values:

<u>Value</u>	<u>Definition</u>
1	Protocol Control word
2	DSFID
3	PC word + DSFID
4	UII Data-Set, but not PC word nor DSFID
5	PC word + UII Data-Set (this combination can be applied to a Monomorphic-UII)
6	DSFID + UII Data-Set
7	The complete UII segment, including the CRC-16

Item-Related-DSFID-Constructs-list: [OPTIONAL] List of <DSFID-Constructs>

Not required for Memory-Segment = 1 (UII segment)

Item-Related-Add-Objects-List: List of <Add-Objects>

Not required for Memory-Segment = 1 (UII segment)

Packed-Object-Constructs: [OPTIONAL] List of <Packed-Object-Constructs>

Not required for Memory-Segment = 1 (UII segment)

Tag-Data-Profile-ID-Table: INTEGER [OPTIONAL]

Not required for Memory-Segment = 1 (UII segment)

Multiple-Records-Constructs: [OPTIONAL] List of <Multiple-Records-Constructs>

10.22.2 Write-Segments-6TypeD-Tag response

The Write-Segments-6TypeD-Tag response has the following field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4).

Write-Segments-6TypeD-Tag response

Module-OID: OBJECT IDENTIFIER = 1 – 15961 127 28

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
26	API-Mismatch
27	DSFID-Mismatch
31	Packed-Object-ID-Table-Not-Recognised-No-Encoding
32	Tag-Data-Profile-ID-Table-Not-Recognised
33	Insufficient-Tag-Memory
36	Command-Cannot-Process-Monomorphic-UII
43	Data-Format-Not-Compatible-Multiple-Records-Header
44	Access-Method-Not-Compatible-Multiple-Records-Header
45	Sector-Identifier-Not-Compatible-Multiple-Records-Header
46	Record-Preamble-Not-Configured
47	Record-Preamble-Not-Locked
255	Execution-Error

Additional Completion-Codes apply to the Write-Response-List Execution-Code: INTEGER Possible Values: As defined in 9.4.

10.23 Read-Segments-6TypeD-Tag

10.23.1 Read-Segments-6TypeD-Tag command

This command shall not be used to read any data object or other part of a multiple record. The relevant procedures are defined in [10.27](#).

The Read-Segments-6TypeD-Tag command instructs the interrogator to read a contiguous sequence of words from all the memory segments of a Type D tag, and then to subdivide into the segments and other component parts. This command can also be useful for diagnostic purposes.

As the air interface protocol is capable of delivering the entire payload of the Type D tag, it is possible for the application to call for Object-Identifier(s) and Object(s) from either the UII segment and /or the Item-related data segment. A basic assumption of this command is that only one Object-Identifier and Object data set is encoded in the UII memory.

This command may be used to read a Monomorphic-UII by declaring the relevant AFI as an argument. The Data Processor checks that the AFI is registered as part of a Monomorphic-UII entry on the ISO/IEC 15961-2 data constructs register.

- If it is registered, the encoded bytes are de-compacted to the rules defined on the register and included in the response.
- If it is not registered, the appropriate error is returned.

NOTE A UII-DSFID is not required when invoking this command read a Monomorphic-UII.

The argument Read-Type is only applied if Objects are to be returned from the item-related segment. The argument enables the application to request selected and declared Object-Identifier(s) to be processed or to request that all Object-Identifier(s) be processed.

It is possible, setting Memory-Segment = 4 to call for all the bytes as encoded on the UII segment and the item-related segment, in effect the byte string defined in ISO/IEC 18000-64 as the output of the interrogator. As this by-pass any decode process by the ISO/IEC 15962 Data Processor the byte string in the response can be used for diagnostic purposes on the original encoding.

The Read-Segments-6TypeD-Tag command has the following arguments:

- AFI (see [7.2.2](#));
- Item-Related-DSFID-Constructs (see [11.7](#));
- Memory-Segment (see [7.4.36](#));
- Read-Objects (see [11.13](#));
- Read-Type (see [7.4.53](#));
- Singulation-Id (see [7.2.1](#));
- UII-DSFID-Constructs (see [11.17](#)).

Read-Segments-6TypeD-Tag command Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 29 Singulation-Id: BYTE STRING (0.255)
--

Memory-Segment: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
1	UII segment
2	Item-related data segment
3	Both segments presented as objects
4	Both segments as un-interpreted bytes

AFI: BYTE

UII-DSFID-Constructs-list: [OPTIONAL] List of <DSFID-Constructs>

Not required for Memory-Segment = 2 (Item-related data segment)

Not required if the AFI is for a monomorphic-UII

Item-Related-DSFID-Constructs-list: [OPTIONAL] List of <DSFID-Constructs>

Not required for Memory-Segment = 1 (UII segment)

Read-Type: INTEGER

Not required for Memory-Segment = 1 (UII segment)

Possible Values:

<u>Value</u>	<u>Definition</u>
1	Read-Multiple-Objects
2	Read-All-Objects

Read-Objects-List: List of <Read-Objects>

This does not apply to Read-All-Objects (2)

10.23.2 Read-Segments-6TypeD-Tag response

The Read-Segments-6TypeD-Tag response has the following arguments:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#));
- ISO-UIIMemory (see [11.5](#));
- Length-Lock Byte (see [7.5.4](#));
- Read-Data (see [7.5.13](#));
- Read-Objects-Response-List (see [11.14](#)).

Read-Segments-6TypeD-Tag response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 29

ISO-UII Memory-List: List of <ISO-UIIMemory>

This response argument is included when the content of the UII segment has been requested

Length-Lock Byte: BYTE

This response argument is included when the content of the item-related data segment has been requested

Read-Objects-Response-List: List of <Read-Objects-Response>

This response argument is included when the content of the item-related data segment has been requested

Read-Data: BYTE STRING

This response argument is included when the Memory-Segment = 4 (Both segments as un-interpreted bytes)	
Completion Code:	INTEGER
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
255	Execution-Error
Execution-Code:	INTEGER
<i>Possible Values:</i> As defined in 9.4 .	

10.24 Write-Monomorphic-UII

10.24.1 Write-Monomorphic-UII command

The Write-Monomorphic-UII command instructs the ISO/IEC 15962 Data Processor to write a Monomorphic-UII, either initially or to modify an existing Monomorphic-UII. Arguments are applied selectively depending on the type of tag being addressed.

A Monomorphic-UII is only supported by an encoded AFI, and no DSFID is encoded. The Object-Identifier is only required for communication purposes between the application and the Data Processor. It is not encoded on the tag. Only Compact-Parameter with the value 5 (Monomorphic-UII) shall be used in the command.

The generic encoding process calls for the Data Processor to check that the AFI in the command matches with one for a Monomorphic-UII on the ISO/IEC 15961-2 Data Constructs register. If a match is not possible either because the AFI is not registered for a Monomorphic-UII or that no matching AFI can be found on the register, then the encoding process is aborted.

If the AFI matches, the Object-Identifier is also checked for a match with that on the ISO/IEC 15961-2 Data Constructs register. A mismatch generates an appropriate Completion-Code, but this should only be treated as a warning about constructing the command. The process continues because the Object-Identifier is not encoded. The Data Processor uses the explicitly defined compaction scheme associated with the AFI on the ISO/IEC 15961-2 Data Constructs register to encode the Monomorphic-UII.

If the Memory-Type is 0 (Type C MB01) the first requirement is to read the content of MB 01 to establish any existing encoding. If this is locked, the process is aborted, otherwise the process continues. The encoding process compacts the Object, and if this results in an odd number of bytes appends the terminator byte 00₁₆. The Protocol Control word is constructed, incorporating the AFI and the length bits. If the Access-Password is in the command it is used to match that on the tag to protect against unauthorised writing of data to the tag. If this command is used to over-write MB01 with a new Monomorphic-UII, it is necessary to compare the length of the current and the new byte string. If the new code is of a shorter length, the interrogator shall ensure that bytes representing part of the older code are over-written with zero bytes.

If the Memory-Type is 1 (Type D UII segment), the first requirement is to read the content of the UII segment to establish any existing encoding. If this is locked, the process is aborted, otherwise the process continues. The encoding process compacts the Object, and if this results in an odd number of bytes appends the terminator byte 00₁₆. The Protocol Control word is constructed, incorporating the AFI and the length bits. If this command is used to over-write the UII segment with a new Monomorphic-UII, it is necessary to compare the length of the current and the new byte string. If the new code is of a different length (i.e. shorter or longer) to an existing Monomorphic-UII, the interrogator shall check if an item related segment is already encoded. The over-writing procedure, as defined in ISO/IEC 15962 shall consider whether there is item-related data on the RFID and whether any of this is locked. This is necessary because encoding on a Type D tag is contiguous between segments.

If the Memory-Type is 2 (single memory tag) the first requirement is to read the AFI on the tag (which can be encoded in a separate memory area) and at least 16 bytes from the content of the user memory to establish any existing encoding. If encoded bytes are found, then the process continues until a string of four zero bytes is found. If either the AFI or any part of the user memory is locked, the process is aborted, otherwise the process continues. The encoding process compacts the Object and adds the length of the compacted Monomorphic-UII as a prefix. If this command is used to over-write with a new Monomorphic-UII, it is necessary to compare the length of the current and the new byte string. If the new code is of a shorter length, the interrogator shall ensure that bytes representing part of the older code are over-written with zero bytes. If the correct AFI for the Monomorphic-UII is not already encoded on the tag, then this is encoded.

The Write-Monomorphic-UII command has the following arguments:

- Access-Password (see [7.4.1](#));
- AFI (see [7.2.2](#));
- AFI-Lock (see [7.4.3](#));
- Compact-Parameter (see [7.3.6](#));
- Memory-Bank-Lock (see [7.4.34](#));
- Memory-Type (see [7.4.37](#));
- Object (see [7.3.5](#));
- Object-Identifier (see [7.3.3](#));
- Object-Lock (see [7.3.7](#));
- Singulation-Id (see [7.2.1](#)).

Write-Monomorphic-UII command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 30

Singulation-Id: BYTE STRING (0..255)

Memory-Type: INTEGER (0..15)

Possible Values:

Value	Definition
0	Type C MB01
1	Type D UII segment
2	single memory tag

Access-Password: [OPTIONAL] BYTE STRING (4 bytes)

This may only be applied for Memory-Type 0 (Type C MB01). Additionally it is optional.

AFI: BYTE

AFI-Lock: BOOLEAN

This may only be applied for Memory-Type 2 (single memory tag)

If set to TRUE, the interrogator shall lock the AFI

Object-Identifier: OBJECT IDENTIFIER

This is the Object-Identifier associated with the AFI on the ISO/IEC 15961:2004 Data Constructs register.

Object: BYTE STRING

This is the Monomorphic-UII as presented by the application

Compact-Parameter: INTEGER

The only permitted value is 5 (Monomorphic-UII), which shall cause the Data Processor to call the explicitly defined compaction scheme associated with the AFI on the ISO/IEC 15961:2004 Data Constructs register.

Object-Lock: BOOLEAN

This may only be applied for Memory-Type 2 (single memory tag)

If TRUE the interrogator shall lock the relevant Data-Set

Memory-Bank-Lock: BOOLEAN

This may only be applied for Memory-Type 0 (Type C MB01)

If TRUE the entire memory bank shall be locked.

Lock-UII-Segment-Arguments: INTEGER

This may only be applied for Memory-Type 1 (Type D UII segment)

Possible Values:

<u>Value</u>	<u>Definition</u>
4	UII Data-Set, but not PC word nor DSFID
5	PC word + UII Data-Set (this combination can be applied to a Monomorphic-UII)
7	The complete UII segment, including the CRC-16

10.24.2 Write-Monomorphic-UII response

The Write-Monomorphic-UII response has the following field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4).

Write-Monomorphic-UII response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 30

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
7	Object-Locked-Could-Not-Modify
8	Singulation-Id-Not-Found
22	Object-Modified-But-Not-Locked
25	Password-Mismatch
26	AFI-Mismatch
33	Insufficient-Tag-Memory
34	AFI-Not-For-Monomorphic-UII
35	Monomorphic-UII-OID-Mismatch
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in 9.4.

10.25 Configure-Extended-DSFID

10.25.1 General

The Configure-DSFID command (see 10.3) is structure to support the encoding of an Access-Method and a Data-Format. Since the publication of the superseded ISO/IEC 15961:2004, additional features

have been added to create an Extended DSFID, for example, to signal the length of encoded data or whether error detection has been added to the data for data that is stored for a long period of time. The Configure-Extended-DSFID command is used to set various indicators that are encoded within the Extended DSFID. As the DSFID specifies which encoding rule to follow, the additional features declared by this command simply determine additional processes that are to be used when encoding data.

10.25.2 Configure-Extended-DSFID command

The Configure-Extended-DSFID command is used to instruct the Data Processor to encode all relevant DSFID features on the tag. The command needs to be invoked before any encoding takes place on the tag.

The DSFID-Constructs-list is used to specify the Access-Method and Data-Format. The Ext-DSFID-Constructs-list is used to set indicators on the Extended-DSFID and to instruct the Data Processor to carry out certain procedures, e.g. to apply a CRC to the data.

The DSFID-Lock argument, if set, is applied to the entire DSFID and Extended-DSFID byte string.

The Configure-DSFID command has the following arguments:

- DSFID-Constructs (see 11.2);
- DSFID-Lock (see 7.4.15);
- Ext-DSFID-Constructs (see 11.4);
- Singulation-Id (see 7.2.1).

The DSFID-Lock argument should only be applied once the user decides that all the features of the Extended DSFID can be permanently encoded.

Configure-Extended-DSFID command
Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 31
Singulation-Id: BYTE STRING (0..255)
DSFID-Constructs-list: List of <DSFID-Constructs>
Ext-DSFID-Constructs-list: [Optional] List of <Ext-DSFID-Constructs>
DSFID-Lock: BOOLEAN
If set to TRUE, the interrogator shall lock the DSFID

10.25.3 Configure-Extended-DSFID response

The Configure-Extended-DSFID response has the following field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4).

Configure-Extended-DSFID response
Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 31
Completion-Code: INTEGER
Possible Values:
Value Definition
0 No-Error
4 DSFID-Not-Configured
5 DSFID-Not-Configured-Locked

6	DSFID-Configured-Lock-Failed
8	Singulation-Id-Not-Found
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.26 Configure-Multiple-Records-Header

10.26.1 General

The Configure-Multiple-Records-Header command shall be the first command invoked to enable a tag to support multiple records. The command can be applied to any tag of sufficient memory capacity, but only applies to Memory Bank 11 of a segmented memory tag such as Type C.

10.26.2 Configure-Multiple-Records-Header command

The Configure-Multiple-Records-Header command is used to instruct the Data Processor to encode all relevant features of the MR-header on the tag. The command shall be invoked before any encoding of a record takes place on the tag.

The Access-Password in the command is used to match that on the tag to permit writing data to the tag. This only applies to the Type C tag and can only be applied to that tag if such a password had previously been encoded.

The DSFID-Constructs-list is used to specify the Access-Method (= 4) and Data-Format. If all the records are known to share the same Data-Format, defined as homogenous Multiple-Records encoding, then the value of that Data-Format shall be encoded. If any of the records are expected to have different Data-Formats, defined as a heterogeneous Multiple-Records encoding, then the Data-Format {00001} shall be used.

NOTE For the Multiple-Records Access-Method, the interpretation of Data-Format {00001} is that the records do not share a common Data-Format.

Because Access-Method {4} is required, the Ext-DSFID-Constructs-list argument (see [11.4](#)) is required to be used, but with these specific variants:

- Memory-Length-Encoding is optional and applies to the directory. The possible values for the bit string are 00 to indicate that no encoding is requested, and 10 to indicate that the current length of the directory shall be calculated by the Data Processor and encoded and encoded in the MR-header. If the MR-header is locked, then this cannot be used.
- Data-CRC-Indicator is optional and is applied to the entire directory component but is recommended if a directory is present. The only possible value for the bit string is 10.
- Simple-Sensor-Indicator is conditional and only required if other mechanisms are not available on the tag to declare the presence of simple sensors.
- Battery-Assist-Indicator is conditional and only required if other mechanisms are not available on the tag to declare the presence of a battery.
- Full-Function-Sensor-Indicator is conditional and only required if other mechanisms are not available on the tag to declare the presence of full function sensors.
- DSFID-Pad-Bytes shall not be used because of the facility to add pad bytes for the complete MR-header.

The Directory-Length-EBV8-Indicator (see 7.4.14) is mandatory and used to instruct the Data Processor to provide sufficient space in the MR-header to allow for the directory size to be encoded within the size limits set by the application.

The Multiple-Records-Feature-Indicator is mandatory and is a bit mapping to provide further information about the records encoded in the Logical Memory (see 7.4.39 for the details).

The Sector-Identifier (see 7.4.57) when included in this argument as a non-zero value represents the true sector identifier, but a zero value indicates that the true sector identifier is encoded in each of the individual records.

The Pointer-To-Multiple-Records-Directory (see 7.4.51) is an EBV-8 address to shows the start of the directory. The specific values are derived from air interface responses that provide details of the hardware memory mapping of the tag.

The Lock-Multiple-Records-Header argument (see 7.4.29) is used to determine whether the entire MR-header is locked or not. If it is not locked, the following options are possible:

- to leave only the data length of the directory field unlocked;
- to leave only the number-of-records field unlocked;
- to leave both the data length of the directory field and the Number-of-records field unlocked.

In the unlocked cases, the Data Processor shall ensure that necessary pad bytes are added after the preceding fields to achieve block alignment before they are locked. It shall also block align the unlocked field(s).

The Configure-Multiple-Records-Header command has the following arguments:

- Access-Password (see 7.4.1);
- Directory-Length-EBV8-Indicator (see 7.4.14);
- DSFID-Constructs (see 11.2);
- Ext-DSFID-Constructs (see 11.4);
- Lock-Multiple-Records-Header (see 7.4.29);
- Multiple-Records-Features-Indicator (see 7.4.39);
- Pointer-To-Multiple-Records-Directory (see 7.4.51);
- Sector-Identifier (see 7.4.57);
- Singulation-Id (see 7.2.1).

Configure-Multiple-Records-Header command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 32

Singulation-Id: BYTE STRING (0..255)

Access-Password: [OPTIONAL] BYTE STRING (4 bytes)

DSFID-Constructs-list: List of <DSFID-Constructs>

Ext-DSFID-Constructs-list: List of <Ext-DSFID-Constructs>

Directory-Length-EBV8-Indicator: [Optional] INTEGER

Possible Values:

Value	Definition
1	Single byte EBV-8
2	Double byte EBV-8, even if the length is less than 128 blocks

Multiple-Records-Features-Indicator: BYTE

This is a bit map that is set in this command that determines rules for the Data Processor to follow when encoding individual records.

Sector-Identifier: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	Indicates that the sector identifier varies between records, and that the true
≠0	Indicates the true value of the sector that applies to all records.

Pointer-To-Multiple-Records-Directory: EBV-8 VALUE

This value is based on responses from the interrogator on the memory mapping of the tag that is being addressed.

Lock-Multiple-Records-Header: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	Not locked
1	Completely locked
2	All components locked except for the Number-of-records field.

10.26.3 Configure-Multiple-Records-Header response

The Configure-Multiple-Records-Header response has the following field names:

- Completion-Code (see [9.3](#));
- Execution-Code (see [9.4](#)).

Configure-Multiple-Records-Header response

Module-OID: OBJECT IDENTIFIER = 1.0.15961.127.32

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
4	DSFID-Not-Configured
8	Singulation-Id-Not-Found
25	Password-Mismatch
37	Data-CRC-Not-Applied
38	Length-Not-Encoded-In-DSFID
39	Multiple-Records-Header-Not-Configured
40	Multiple-Records-Header-Not-Locked
41	File-Support-Indicators-Not-Configured
42	File-Support-Indicators-Not-Locked
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

10.27 Read-Multiple-Records

10.27.1 Read-Multiple-Records command

The Read-Multiple-Records command instructs the interrogator to read various logically structured components from a tag configured to encode multiple records. This includes reading a set of one or more Object-Identifiers and associated Objects from an individual record. Only one tag shall be programmed per command to ensure that the reading process is robust.

The command is applied to memory bank 11 of the Type C tag, and to the Item-related data segment of the Type D tag.

The Read-Record-Type argument (see [7.4.52](#)) provides a set of options for read data from the tag.

The Read-Multiple-Records command has the following arguments:

- Max-App-Length (see [7.4.32](#));
- Read-Objects (see [11.13](#));
- Read-Record-Type (see [7.4.52](#));
- Singulation-Id (see [7.2.1](#)).

Read-Multiple-Records command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 33

Singulation-Id: BYTE STRING (0..255)

Read-Record-Type: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	Read-Multiple-Records-Header
1	Read-Multiple-Records-Header-Plus-1st-Preamble
2	Read-Multiple-Records-Directory
3	Read-Preamble-Specific-Multiple-Record
4	Read-All-Record-OIDs-Specific-Record-Type
5	Read-OIDs-Specific-Multiple-Record
6	Read-All-Objects-Specific-Multiple-Record
7	Read-Multiple-Objects-Specific-Multiple-Record
8	Read-1st-Objects-Specific-Multiple-Record
9	Read-Data-Element-List-Specific-Multiple-Record

Read-Objects-List: List of <Read-Objects>

This only applies to:

- Read-Preamble-Specific-Multiple-Record (3),
- Read-All-Record-OIDs-Specific-Record-Type (4),
- Read-All-Objects-Specific-Multiple-Record (6),
- Read-Multiple-Objects-Specific-Multiple-Record (7),
- Read-1st-Objects-Specific-Multiple-Record (8), and
- Read-Data-Element-List-Specific-Multiple-Record (9)

See [7.4.52](#) for details of what Objects are relevant to each Read-Record-Type

Max-App-Length: INTEGER (1..65535)

This only applies to Read-Type (8) and is expressed in bytes

10.27.2 Read-Multiple-Records response

The Read-Multiple-Records response has the following argument and field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4);
- Multiple-Records-Directory-Structure-List (see 11.9);
- Multiple-Records-Header-Structure-List (see 11.10);
- Multiple-Records-Preamble-Structure (see 11.11);
- Read-Objects-Response-List (see 11.14);
- Read-oids-Response-List (see 11.15).

Read-Multiple-Records response	
Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 33	
Multiple-Records-Header-Structure-List: [Conditional]	List of <Multiple-Records-Header-Structure>
Multiple-Records-Preamble-Structure: [Conditional]	List of <Multiple-records>
Multiple-Records-Directory-Structure-List: [Conditional]	List of <Multiple-Records-Directory-Structure>
Read-oids-Response-List: [Conditional]	List of <Read-oids-Response>
Read-Objects-Response-List: [Conditional]	List of <Read-Objects-Response>
Completion-Code: INTEGER	
<i>Possible Values:</i>	
<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
48	Multiple-Records-Directory-Not-Present
255	Execution-Error
<i>Additional Completion-Codes apply to the:</i>	
<i>Read-Objects-Response-List</i>	
Execution-Code: INTEGER	
<i>Possible Values: As defined in 9.4.</i>	

10.28 Delete-Multiple-Record

10.28.1 Delete-Multiple-Record command

The Delete-Multiple-Record command instructs the interrogator to either mark a Multiple Record as deleted or to physically delete the record.

The Delete-MR-Method argument in the command instructs the interrogator as to which of these two methods is used.

If the method is mark record as deleted, the bytes that make up the record are not actually deleted, but the subject record and its entry in the directory (if present) have code values set to indicate that the record is no longer to be treated as valid. If either the record preamble or the directory is locked, then the command cannot be invoked. If the record is part of a hierarchical structure, then all the child(ren) records from the lowest level shall be deleted first. If any of these record preambles, or the associated directory entry, is locked, then none of the records can be deleted.

If the method is to physically delete the record, then all the encoding in the record is changed to make this part of the memory available for future encoding. This method cannot be used if any part of the record is locked, but if the preamble of the record is not locked, then the alternate method (mark record as deleted) may be attempted.

The Access-Password in the command is used to match that on the tag to permit writing data to the tag and deleting implies a write transaction. This only applies to the Type C tag and can only be applied to that tag if such a password had previously been encoded.

The Delete-Multiple-Record command has the following arguments:

- Access-Password (see 7.4.1);
- Object-Identifier (see 7.3.3);
- Singulation-Id (see 7.2.1).

Delete-Multiple-Record command

Module-OID: OBJECT IDENTIFIER = 1 0 15961 126 34

Singulation-Id: BYTE STRING (0..255)

Access-Password: [OPTIONAL] BYTE STRING (4 bytes)

Delete-MR-Method: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	Mark record as deleted
1	Physically delete to record

Object-Identifier: OBJECT IDENTIFIER

This is the Object-Identifier to the level where the final arc is that of the instance-of or hierarchical identifier

10.28.2 Delete-Multiple-Record response

The Read-Multiple-Records response has the following field names:

- Completion-Code (see 9.3);
- Execution-Code (see 9.4).

Delete-Multiple-Record response

Module-OID: OBJECT IDENTIFIER = 1 0 15961 127 34

Completion-Code: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
8	Singulation-Id-Not-Found
13	Object-Identifier-Not-Found
25	Password-Mismatch
49	Record-Not-Deleted-Preamble-Locked
50	Record-Not-Deleted-Directory-Locked
51	Record-Not-Deleted-Lower-Level-Preamble-Locked
52	Record-Not-Deleted-Encoding-Locked
255	Execution-Error

Execution-Code: INTEGER

Possible Values: As defined in [9.4](#).

11 Arguments

11.1 Add-Objects

This argument provides a list of Object-Identifiers and Objects to be written to the RFID, either to a "blank" tag or to append to data already encoded.

The Add-Objects argument has the following arguments:

- Avoid-Duplicate (see [7.4.6](#));
- Compact-Parameter (see [7.3.6](#));
- Object (see [7.3.5](#));
- Object-Identifier (see [7.3.3](#));
- Object-Lock (see [7.3.7](#)).

Add-Objects argument

Object-Identifier: OBJECT IDENTIFIER

Avoid-Duplicate: BOOLEAN

If TRUE, the interrogator shall check that the subject Object-Identifier is not already encoded on the tag.

Object: BYTE STRING

Compact-Parameter: INTEGER (0..15)

Possible Values:

Value	Definition (see 7.3.6 for further details)
0	Application-Defined
1	Compact
2	UTF8-Data
3	Packed-Objects
4	Tag-Data-Profile

Object-Lock: BOOLEAN

If TRUE the interrogator shall lock the relevant Data-Set.

If the Compact-Parameter is Packed-Objects, then this shall be the same for each component in the list; and the value of Object-Lock shall also be consistent throughout the list.

11.2 DSFID-Constructs

DSFID-Constructs argument

Access-Method: INTEGER

Possible Values

Value	Definition
0	No-Directory
1	Directory
2	Packed-Objects

3	Tag-Data-Profile
4	Multiple-Records
5 to 15	Reserved for extension when extensions to DSFID are implemented
Data-Format: INTEGER	
<i>Possible Values</i>	
<u>Value</u>	<u>Definition</u>
0	Not-Formatted
1	Full-Featured
2	Root-OID-Encoded
3 to 28	As published by the Registration Authority of ISO/IEC 15961-2:2019
29	For closed systems in accordance with ISO/IEC 15962
30	For closed systems with proprietary encoding
31	Not applicable as an assigned DSFID
32 to 287	Reserved as an extension for multiple byte Data-Format

11.3 EPC-UII memory

EPC UII Memory argument
Protocol Control Word: BYTE STRING (2)
EPC Code: BYTE STRING

11.4 Ext-DSFID-Constructs

This argument provides a list of additional arguments that are used to indicate additional features on the tag, or processes that the Data Processor shall use to complete the encoding on the tag. The argument is also used for some responses.

If either or both the Memory-Length-Encoding bits are = 1, the Data Processor shall calculate the relevant number of blocks and encode this on the tag conforming to the Extended DSFID syntax.

If either or both the Data-CRC-Indicator bits are = 1, the Data Processor shall calculate the relevant data CRC and encode this in the appropriate locations in the memory.

If the application specifies that the Battery-Assist-Indicator, and/or Full-Function-Sensor-Indicator, and/or Simple-Sensor-Indicator are to be set = 1 (TRUE), the Data Processor shall encode these settings whether or not the selected feature is actually supported by the tag.

Additional bytes can be encoded in the Extended-DSFID for future encoding on the tag by specifying the number of DSFID-Pad-Bytes.

The arguments Length-Of-Encoded-Data and Memory-Capacity are returned as arguments when the Ext-DSFID-Constructs is included in a response.

The Ext-DSFID-Constructs argument has the following arguments:

- Battery-Assist-Indicator (see [7.4.7](#));
- Data-CRC-Indicator (see [7.4.11](#));
- DSFID-Pad-Bytes (see [7.4.16](#));
- Full-Function-Sensor-Indicator (see [7.4.20](#));
- Length-Of-Encoded-Data (see [7.5.5](#));

- Memory-Capacity (see 7.5.8);
- Memory-Length-Encoding (see 7.4.35);
- Simple-Sensor-Indicator (see 7.4.58).

Ext-DSFID-Constructs argument

Memory-Length-Encoding: BIT STRING

Possible Values

<u>Value</u>	<u>Definition</u>
00 ₂	No encoded length or memory capacity is small (i.e. not more than 256 bits)
01 ₂	Memory capacity is defined
10 ₂	The length of encoded data is defined
11 ₂	Both memory capacity and length of encoding are defined

Data-CRC-Indicator: BIT STRING

Possible Values

<u>Value</u>	<u>Definition</u>
00 ₂	No data CRC
01 ₂	Data CRC applied to each individual data set
10 ₂	Data CRC applied only to the entire encoded data
11 ₂	Data CRC applied to each data set and to the entire encoded data

Simple-Sensor-Indicator: BOOLEAN

If a simple sensor is on the tag, this is set as TRUE.

Battery-Assist-Indicator: BOOLEAN

If this is a battery assisted tag, this is set as TRUE.

Full-Function-Sensor-Indicator: BOOLEAN

If a full-function sensor is on the tag, this is set as TRUE.

DSFID-Pad-Bytes: [Optional] INTEGER

This is the number of additional bytes requested by application to support additional arguments to be added at a later time, e.g. the Memory-Capacity and/or the Length-Of-Encoded-Data. In a response this can also include the number of pad bytes added to enable the extended DSFID to be locked on a lock-block boundary.

Memory-Capacity: INTEGER

This is only included in a response that included the Ext-DSFID-Constructs argument

Length-Of-Encoded-Data: INTEGER

This is only included in a response that included the Ext-DSFID-Constructs argument

11.5 ISO-UIImemory

ISO-UIImemory argument

Protocol-Control-Word: BYTE STRING (2)

DSFID: BYTE [OPTIONAL]

This is not returned when the AFI declares that that the Object is a Monomorphic-UII

Read-Objects-Response-List: List of <Read-Objects-Response>

11.6 Item-Related-Add-Objects

The command argument Item-Related-Add-Objects has the same function and structure as the Add-Objects command argument (see [11.1](#)), except that it is encoded in the item-related segment of a tag that can address multiple segments in the same air interface transactions. This specific argument enables it to be distinguished from the UII- Add-Objects (see [11.16](#)).

11.7 Item-Related-DSFID-Constructs

The command argument Item-Related-DSFID-Constructs has the same function and structure as the DSFID-Constructs command argument (see [11.2](#)), except that it is encoded in the item-related segment of a tag that can address multiple segments in the same air interface transactions. This specific argument enables it to be distinguished from the UII-DSFID-Constructs (see [11.17](#)).

11.8 Multiple-Records-Constructs

This argument provides a list of additional arguments that are used when writing a multiple record to the Logical Memory.

The BOOLEAN command argument Append-To-Existing-Multiple-Record (see [7.4.4](#)) is used to declare, if TRUE, whether the list of data objects is to be appended to a pre-existing record, subject to all the component arguments matching fields already encoded for the multiple record. If FALSE, this command shall be used to create a new record.

The command argument Application-Defined-Record-Capacity (see [7.4.5](#)) simply provides the application with the choice to set the memory capacity to a given size or to allow the Data Processor to block align the record. Allowing the Data Processor to control this is recommended unless there is a reason for the application to set a larger memory capacity, for example to enable additional data elements to be encoded at a later time. Therefore, the Record-Memory-Capacity is only required if the application needs to control this aspect of memory.

The Record-Type-Classification argument (see [7.4.56](#)) shall be aligned with the rules defined in the MR-header. If the wrong value is used, then the command shall be rejected by the Data Processor.

When constructing a command to encode a record that is part of a hierarchical structure, reference should be made to the application standard to ensure that the hierarchical relationships are correct. The Identifier-Of-My-Parent argument (see [7.4.22](#)) shall be based on a record that has already been the subject of a previous write command. If there is a mismatch, then the record is not encoded.

The Number-In-Data-Element-List argument (see [7.4.41](#)) only applies if the record is a data element list and is used to provide additional information to the Data Processor to ensure that the correct number of data elements with the same true Relative-OID is encoded. This can be particularly useful when the data varies in format and length between instances of the data element.

The arguments Lock-Record-Preamble (see [7.4.30](#)), Update-Multiple-Records-Directory (see [7.4.62](#)), and Lock-Directory-Entry (see [7.4.28](#)) all provide instructions to the Data Processor and are generally associated with the subject record. However, if the Update-Multiple-Records-Directory argument is set to TRUE and the directory does not yet exist, then a complete directory shall be created. Irrespective of the setting of the argument, if a directory is already encoded, then the Data Processor shall automatically fully update the directory.

Multiple-Records-Constructs argument

Append-To-Existing-Multiple-Record: BOOLEAN

If set to TRUE, the Data Processor shall check that all the arguments match with an existing multiple record and that none of the Relative-OID values already exist in the current version of the record. In the case that the existing record is defined as a data element list, then none of the list element number values in this command shall already be encoded in the current version of the record. If set to FALSE, the Data Processor shall encode the record as a new record.

Application-Defined-Record-Capacity: BOOLEAN

If set as TRUE, the application needs to define the Record-Memory-Capacity argument. If FALSE, the Data Processor shall simply block align the record and encode the record capacity as the minimum required to support the record.

Record-Memory-Capacity: [Optional] INTEGER

This is the total number of blocks that the application requires for the record, with any unused blocks to be set aside for additional encoding in this record in the future.

Record-Type-Classification: BIT STRING

Possible Values:

<u>Value</u>	<u>Definition</u>
000 ₂	stand-alone record, with an instance-of arc = 0
001 ₂	stand-alone record, with an instance-of arc >0
010 ₂	hierarchical record, top level
011 ₂	hierarchical record, has both parent and child(ren)
100 ₂	hierarchical record, data element list
101 ₂	other hierarchical record, no further children
110 ₂	Not relevant to this command (because it is associated with deleted records)
111 ₂	reserved

Identifier-Of-My-Parent: [Conditional] INTERGER

This value is the same as the hierarchical identifier of the parent record

Number-In-Data-Element-List: [Conditional] INTERGER (1..255)

This value is provided when the record classification is {100} to assist the data processor in encoding the associated Add-Objects argument

Lock-Record-Preamble: BOOLEAN

If this is set as TRUE, then the preamble shall be block aligned and locked

Update-Multiple-Records-Directory: BOOLEAN

If this is set as TRUE, then the directory is updated with this record, and any others not on the directory

Lock-Directory-Entry: BOOLEAN

If this is set as TRUE, then the directory entry for the record shall be block aligned and locked

11.9 Multiple-Records-Directory-Structure

This response argument provides a list of the content of the multiple records directories in a manner that the information can be used by the application to construct additional commands.

The Multiple-Records-Directory-Structure argument contains the following arguments and field names:

- DSFID-Constructs (see [11.2](#));
- Ext-DSFID-Constructs (see [11.4](#));
- Hierarchical-Identifier-Arc (see [7.4.21](#));
- Identifier-Of-My-Parent (see [7.4.22](#));
- Instance-Of-Arc (see [7.4.25](#));
- Record-Type-Arc (see [7.4.55](#));
- Record-Type-Classification (see [7.4.56](#));

- Sector-Identifier (see 7.4.57);
- Start-Address-Of-Record (see 7.4.59).

Multiple-Records-Directory-Structure argument

DSFID-Constructs-list: [Conditional] List of <DSFID-Constructs>

Ext-DSFID-Constructs-list: [Conditional] List of <Ext-DSFID-Constructs>

Sector-Identifier: [Conditional] INTEGER

If the sector identifier has not been provided by the MR-header, then the value in the record preamble is valid

Record-Type-Classification: BIT STRING

Possible Values:

<u>Value</u>	<u>Definition</u>
000 ₂	stand-alone record, with an instance-of arc = 0
001 ₂	stand-alone record, with an instance-of arc > 0
010 ₂	hierarchical record, top level
011 ₂	hierarchical record, has both parent and child(ren)
100 ₂	hierarchical record, data element list
101 ₂	other hierarchical record, no further children
110 ₂	Not relevant to this command (because it is associated with deleted records)
111 ₂	reserved

Record-Type-Arc: INTEGER

Instance-Of-Arc: [Conditional] INTEGER

Hierarchical-Identifier-Arc: [Conditional] INTEGER

Identifier-Of-My-Parent: [Conditional] INTEGER

This value is the same as the hierarchical identifier of the parent record

Start-Address-Of-Record: EBV-8

11.10 Multiple-Records-Header-Structure

This response argument provides a list of the content of the MR-header in a manner that the information can be used by the application to construct additional commands.

The Multiple-Records-Header-Structure argument contains the following arguments and field names:

- DSFID-Constructs (see 11.2);
- Ext-DSFID-Constructs (see 11.4);
- Multiple-Records-Directory-Length (see 7.4.38);
- Multiple-Records-Features-Indicator (see 7.4.39);
- Number-Of-Records (see 7.4.42);
- Pointer-To-Multiple-Records-Directory (see 7.4.51);
- Sector-Identifier (see 7.4.57).

Multiple-Records-Header-Structure argument

DSFID-Constructs-list: List of <DSFID-Constructs>

Ext-DSFID-Constructs-list: List of <Ext-DSFID-Constructs>

Multiple-Records-Directory-Length: [Optional] EBV-8

Multiple-Records-Features-Indicator: BYTE

This is a bit map that is set in this command that determines rules for the Data Processor to follow when encoding individual records.

Sector-Identifier: INTEGER

Possible Values:

Value	Definition
0	Indicates that the sector identifier varies between records, and that the true value is only obtainable for the individual record.
≠0	Indicates the true value of the sector that applies to all records.

Pointer-To-Multiple-Records-Directory: EBV-8

This value is based on responses from the interrogator on the memory mapping of the tag that is being addressed.

Number-Of-Records: EBV-8

If bit 2 of the Multiple-Records-Features-Indicator = 0, then the value of this field is probably invalid and shall be ignored.

11.11 Multiple-Records-Preamble-Structure

This response argument provides a list of the content of the record preamble in a manner that the information can be used by the application to construct additional commands.

The Multiple-Records-Preamble-Structure argument contains the following arguments and field names:

- Data-Length-Of-Record (see [7.4.12](#));
- DSFID-Constructs (see [11.2](#));
- Encoded-Memory-Capacity (see [7.4.18](#));
- Ext-DSFID-Constructs (see [11.4](#));
- Hierarchical-Identifier-Arc (see [7.4.21](#));
- Identifier-Of-My-Parent (see [7.4.22](#));
- Instance-Of-Arc (see [7.4.25](#));
- Record-Type-Arc (see [7.4.55](#));
- Record-Type-Classification (see [7.4.56](#));
- Sector-Identifier (see [7.4.57](#)).

Multiple-Records-Preamble-Structure argument

DSFID-Constructs-list: List of <DSFID-Constructs>

Ext-DSFID-Constructs-list: [Conditional] List of <Ext-DSFID-Constructs>

Encoded-Memory-Capacity: EBV-8

This is the size of the memory that has been reserved for the record, in terms of write blocks.

Data-Length-Of-Record: [Conditional] EBV-8

This is the size of the encoded record, in terms of write blocks.

Sector-Identifier: [Conditional] INTEGER

If the sector identifier has not been provided by the MR-header, then the value in the record preamble is valid

Record-Type-Classification: BIT STRING

Possible Values:

<u>Value</u>	<u>Definition</u>
000 ₂	stand-alone record, with an instance-of arc = 0
001 ₂	stand-alone record, with an instance-of arc >0
010 ₂	hierarchical record, top level
011 ₂	hierarchical record, has both parent and child(ren)
100 ₂	hierarchical record, data element list
101 ₂	other hierarchical record, no further children
110 ₂	Not relevant to this command (because it is associated with deleted records)
111 ₂	reserved

Record-Type-Arc: INTEGER

Instance-Of-Arc: [Conditional] INTEGER

Hierarchical-Identifier-Arc: [Conditional] INTEGER

Identifier-Of-My-Parent: [Conditional] INTEGER

This value is the same as the hierarchical identifier of the parent record.

11.12 Packed-Object-Constructs

The following arguments only apply to Packed-Objects and are ignored if the Access-Method is not Packed-Objects.

The Packed-Objects-Constructs argument has the following arguments:

- Block-Align-Packed-Objects (see [7.4.9](#));
- Editable-Pointer-Size (see [7.4.17](#));
- ID-Type (see [7.4.24](#));
- Object-Offsets-Multiplier (see [7.4.44](#));
- Packed-Object-Directory-Type (see [7.4.45](#));
- PO-Directory-Size (see [7.4.48](#));
- PO-ID-Table (see [7.5.11](#));
- PO-Index-Length (see [7.4.49](#)).

Packed-Objects-Constructs argument

PO-ID-Table: OCTET STRING

ID-Type: INTEGER (0..15)

Possible Values:

<u>Value</u>	<u>Definition</u> (see 7.4.24 for further details)
0	ID List
1	ID Map
2 to 15	Reserved for future definition

Packed-Object-Directory-Type: INTEGER (0..15)

Possible Values:

<u>Value</u>	<u>Definition</u> (see 7.4.45 for further details)
--------------	--

- | | |
|---------|--|
| 0 | This Packed-Object is not a directory and does not require one |
| 1 | Packed-Object Presence/Absence |
| 2 | Packed-Object index field |
| 3 | Packed-Object offset |
| 4 | Packed-Object pointer-allocation only expecting a future command to set the directory type |
| 5 to 15 | Reserved for future definition |

PO-Index-Length: INTEGER (1..7)

If this parameter is present and Packed-Object-Directory-Type is 2 (Packed-Object index field) then the implementation shall use this parameter in the POIndex Length parameter created for the POIndex Field for this Packed Object in a PO index directory. If the Directory-Type is not 2, this parameter shall be ignored.

Object-Offsets-Multiplier: INTEGER

If this parameter is present and Packed-Object-Directory-Type is 3 (Packed-Object offset) and PO-Index-Length is present, then the implementation shall use this parameter to reserve the number of bits of storage for object offsets in an AuxMap section of the directory Packed Object. If the Directory-Type is not 3 or a PO-Index-Length parameter is not present, this parameter shall be ignored. If the implementation is not able to allocate the input size number of bits for the AuxMap section of the directory Packed Object, the implementation shall return an Insufficient-Tag-Memory completion code.

PO-Directory-Size: INTEGER

If this parameter is present and Packed-Object-Directory-Type is 4 (Packed-Object pointer allocation only expecting a future command to set the directory type) then the implementation shall use this parameter for appropriate sizing of the (null) directory pointer created for this Packed-Object. If the Directory-Type is not 4, this parameter shall be ignored. If the implementation is not able to allocate the input size number of bits for the Addendum Packed Object, the implementation shall return an Insufficient-Tag-Memory completion code.

Block-Align-Packed-Objects: BOOLEAN

If set to TRUE, the interrogator shall ensure that this Packed-Object begins on a block boundary and that any necessary pad bytes are added after a previous Packed-Object (if present).

Editable-Pointer-Size: INTEGER

If set to a non-zero value, the interrogator shall mark the Packed Object as editable and create a pointer to an Addendum Packed Object of the size of the parameter in bits. If set to zero it indicates that the addendum subsection shall not be included.

11.13 Read-Objects

Read-Objects argument

Object-Identifier: OBJECT IDENTIFIER

Check-Duplicate: BOOLEAN

If set to TRUE, the interrogator shall check that there is only one occurrence of the OBJECT IDENTIFIER encoded on the tag.

11.14 Read-Objects-Response

Read-Objects-Response argument

Object-Identifier: OBJECT IDENTIFIER

Object: BYTE STRING

Compact-Parameter: INTEGER

Possible Values:

<u>Value</u>	<u>Definition</u>
0	Application-Defined
2	UTF8-Data
14	De-Compacted-Monomorphic-UII
15	De-Compacted-Data

Lock-Status: BOOLEAN

If TRUE, the Data-Set or Packed-Object containing the Object Identifier and Object is locked.

Completion-Code: INTEGER

These definitions are supplementary to those of the response that includes this argument.

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
10	Duplicate-Object
13	Object-Identifier-Not-found
15	Object-Not-Read
35	Monomorphic-UII-OID-Mismatch

11.15 Read-OIDs-Response

Read OIDs Response argument

Object Identifier: OBJECT IDENTIFIER

11.16 UII-Add-Objects

The command argument UII-Add-Objects has the same function and structure as the Add-Objects command argument (see [11.1](#)), except that it is encoded in the UII segment of a tag that can address multiple segments in the same air interface transactions. The argument shall only comprise on a single Object-Identifier and Object. This specific argument enables it to be distinguished from the Item-Related- Add-Objects argument (see [11.6](#)).

11.17 UII-DSFID-Constructs

The command argument UII-DSFID-Constructs has the same function and structure as the DSFID-Constructs command argument (see [11.2](#)), except that it is encoded in the UII segment of a tag that can address multiple segments in the same air interface transactions. This specific argument enables it to be distinguished from the Item-Related-DSFID-Constructs (see [11.7](#)).

11.18 Write-Responses

Write-Responses argument

Object-Identifier: OBJECT IDENTIFIER

Completion-Code: IN+++++TEGER

These definitions are supplementary to those of the response that includes this argument

Possible Values:

<u>Value</u>	<u>Definition</u>
0	No-Error
9	Object-Not-Added
10	Duplicate-Object

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Annex A (informative)

Abstract syntax and transfer encoding rules of ISO/IEC 15961:2004

A.1 Abstract syntax

A.1.1 General

This annex is included to ensure backwards compatibility of abstract syntax and encoding rules with the 2004 superseded version of this document (ISO/IEC 15961:2004). [Annex E](#) shows the original 16 commands using the abstract syntax of ISO/IEC 15961:2004. These can be used as a reference to compare with the present style of presenting the functional commands.

The abstract syntax is based on ASN.1 as defined in ISO/IEC 8824-1. The notation shall be as specified in that standard.

A.1.2 Character set

The character set used to define an ASN.1 item shall consist of:

- A to Z;
- a to z;
- 0 to 9;
- :=, { } < . @ () [] - ' " | & ^ * ; !

This character set is identical to that defined in ISO/IEC 8824-1.

A.1.3 Universal types

ASN.1 supports several Universal Types that are fundamental to the syntax, sometimes called "built-in types". Each has been assigned a class tag in ISO/IEC 8824-1 to unambiguously identify each type of data. Universal Types are shown in capital (uppercase) letters, e.g. UNIVERSAL. The Universal Types used in ISO/IEC 15961:2004, together with their Class Tags, are shown in [Table A.1](#).

Table A.1 — Universal types used in ISO/IEC 15961:2004

Universal type	Class tag
BOOLEAN	1
INTEGER	2
OBJECT IDENTIFIER	6
OCTET STRING	4
RELATIVE-OID	13
(reserved for future commands)	
SEQUENCE & SEQUENCE OF	16

A.1.4 Type references

In addition to the Universal Types, ASN.1 enables application specific types to be defined. When a type is defined, it is given a name to reference it in another type assignment. Type references begin with an uppercase letter and the complete name is shown without spaces. There are a few variants to the presentation of the subsequent characters. ISO/IEC 15961:2004 used the convention of mixed upper and lowercase characters, e.g. TypeReference.

The TypeReference name is followed by the three character sequence ": : =" to separate it from its definition.

Examples of TypeReference names that were used in ISO/IEC 15961:2004 are:

- ApplicationFamilyId;
- ObjectId;
- StorageFormat;
- TagId.

All the TypeReference names that were used in ISO/IEC 15961:2004 are defined in the appropriate subclause of this annex.

A.1.5 Element names

The components or elements of a TypeReference or enumerated list are named using a lowercase letter at the beginning, e.g. elementName. For some elements, further typing is required either to a TypeReference or a Universal Type.

Examples of elementNames that were used in ISO/IEC 15961:2004 are:

- accessMethod;
- applicationFamilyId;
- applicationSubFamily;
- commandCode;
- compactParameter;
- object;
- objectId;
- tagId.

NOTE In ISO/IEC 15961:2004, some elementNames and TypeReference names were often the same with the exception that the first letter is lowercase for the elementName and uppercase for the TypeReference.

All the elementNames that were used in ISO/IEC 15961:2004 are defined in the appropriate subclauses.

A.1.6 Other ASN.1 conventions illustrated

By using a simple example of ASN.1 syntax, unrelated to the purpose of, it is possible to illustrate the features of the syntax.

EXAMPLE

```
CustomerOrder : : = SEQUENCE {
```

```

orderNumber      INTEGER
name             OCTET STRING
address          CustomerAddress
productDetails SEQUENCE OF SEQUENCE {
    productCode   OBJECT IDENTIFIER
    quantity      INTEGER (1..999)
    },
urgency          ENUMERATED {
    nextDay (0),
    -- excludes Saturday and Sunday
    firstClass (1),
    roadTransport (2),
    -- typically three days
    }
}

```

In this example:

- The double colon and equal sign : : = separates the named TypeReference CustomerOrder from the definition.
- The curly brackets { } following SEQUENCE and the end, specify that orderNumber, name, address, productDetails and urgency are all elements of the CustomerOrder type reference.
- The element name address is further specified in the CustomerAddress type reference (excluded from the example for brevity).
- The element productDetails consists of two further elements productCode and quantity. This pair of elements is repeated n times, based on the SEQUENCE OF SEQUENCE. The { } define the boundary of the Type.
- The element urgency offers one of three codes: 0, 1 or 2 by the use of the ENUMERATED type. The { } define the boundary of the Type.
- Comments in this example "excludes Saturday and Sunday" and "typically three days" are preceded by the double dash "--".
- The INTEGER value for the element quantity is constrained by the "(1..999)" to be any value in the range 1 to 999, making it an error to order 1000 or more items of a productCode.

A.1.7 Modular structure of ASN.1 syntax

In keeping with the ASN.1 standards, the syntax that was used in ISO/IEC 15961:2004 is presented in a modular format. Separate modules are used for the commands and for the responses. Each module contains:

- A unique name.

- A unique Object Identifier that refers to this standard (in accordance with ISO/IEC 8824-1). The penultimate arc is either "commandModules (126)" or "responseModules (127)" to distinguish the dataflows. The final arc of each command/response pair has the same name and value to link these together.
- The key words DEFINITIONS, BEGIN and END to be in accordance with ISO/IEC 8824-1 and to allow the modules to be processed through compiler tools.
- A statement that this document uses "EXPLICIT TAGS", which indicates that all the elements ultimately encoded as UNIVERSAL TYPES.

The structure of a command module follows the following common format:

Module Name

{ISO(1) standard(0) rfid-data-protocol (15961) commandModules (126) moduleName(n)}

DEFINITIONS

EXPLICIT TAGS ::=

BEGIN

CommandName

-- assignments

END

The responseModule follows a similar format.

Within each module, all the elements are defined in such a way as to reduce these to UNIVERSAL TYPES. This avoids the need to implement any import function within the module.

A.2 Transfer syntax

A.2.1 Structure of the transfer encoding

The structure of the transfer encoding for the Data Protocol for RFID for Item Management as originally specified in ISO/IEC 15961:2004 is described below:

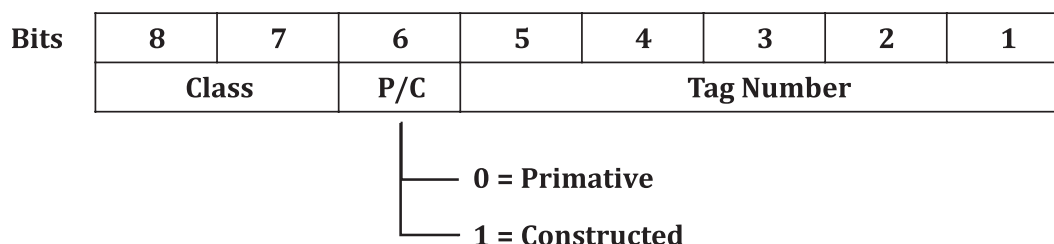
1. Type identifier octet(s) that encode the ASN.1 tag (class and number) of the Type used to qualify the data value.
2. Length bytes that define a count of the bytes that make up the contents.
3. Content (or value) bytes.

This is sometimes known as Type, Length, and Value (TLV). When the encoding is based on a sequence of TLV, it is known as Primitive encoding. The value V can be a triplet of TLV, and when this structure is used it is known as Constructed encoding, for example TL TLV TLV TLV. The choice between Primitive and Constructed encoding is largely determined by the Basic Encoding Rules of ISO/IEC 8825-1. The constructor types of SEQUENCE and SEQUENCE OF that shall use a Constructed encoding to be fully in accordance with the ASN.1 standards. Otherwise, the rules of ISO/IEC 8825-1 require that Primitive encoding be used or offer a choice, in which case only Primitive encoding were used in ISO/IEC 15961:2004. The option is clearly defined for each of the Universal Types that have their BER encoding rules defined in subsequent subclauses.

The module OBJECT IDENTIFIER shall be encoded in a TLV structure at the beginning of the transfer.

A.2.2 Encoding the ASN.1 type identifier

The ASN.1 type identifier shall be encoded as a single octet for the Types defined in ISO/IEC 15961:2004, as illustrated in [Figure A.1](#).



where: bits 8 and 7 encode the class of ASN.1 tag
 bit 6 encode whether this is a Primitive or Constructed tag
 bits 5 to 1 encode the number of the ASN.1 tag

Figure A.1 — Type Identifier octet structure

The 2-bit value for Class shall be one of the values defined in [Table A.2](#). For the Universal Types defined in ISO/IEC 15961:2004, the value shall be '00₂'.

Table A.2 — Encoding of ASN.1 class of tag

Class	Bit 8	Bit 7
Universal	0	0
Application	0	1
Context-specific	1	0
Private	1	1

The single bit value for the 'P/C' component shall be set to '0₂' to indicate Primitive encoding structures or shall be set to '1₂' to indicate constructed encoding structures.

The 5-bit value for the ASN.1 tag shall encode the Class tag number as a binary integer with bit 5 as the most significant bit. The Class tags that were specified for ISO/IEC 15961:2004 are defined in [Table A.1](#).

EXAMPLE

Universal Type = OBJECT IDENTIFIER

ASN.1 Type identifier = 00 0 00110

A.2.3 Length encoding

The length encoding of ISO/IEC 15961:2004 applied to both primitive and constructed encodings. The length bytes shall consist of one or more bytes, depending on the number of bytes in the contents. If the number of bytes in the contents is less than, or equal to, 127, then a single length octet shall be used. Bit 8 shall be '0₂' and bits 7 to 1 shall encode the number of bytes in the content (which may be zero) as an unsigned binary integer with bit 7 as the most significant bit.

NOTE ISO/IEC 15961:2004 limited the use of the length encodings of ISO/IEC 8825-1.

EXAMPLE

L = 38 is encoded as 00100110₂

If the number of bytes in the contents is more than 127, then two or more length bytes shall be used. The length shall be converted to an octet aligned value, for example, a length of 201 bytes converts to

$C9_{16}$ (or 11001001). This value is encoded in the second and subsequent bytes. The first octet shall be encoded as follows:

- Bit 8 shall be 1_2 .
- Bits 7 to 1 shall encode the number of subsequent bytes in the length bytes, as an unsigned binary integer with bit 7 as the most significant bit.
- The value 11111111_2 shall not be used to allow for future extension:

EXAMPLE

Length of content = 357

Convert to HEX = $01\ 65_{16}$

= $00000001_2\ 01100101_2$

As this is 2 bytes, the first octet = 100000010_2

The complete length encoding is:

	10000010	00000001	01100101 ₂
=	82	01	65_{16}

A.2.4 Contents octets

The contents octets encode the data value, which can be zero, one or more octets, depending on the Universal Type as specified in subsequent sub clauses.

A.2.5 Encoding of a BOOLEAN value

The encoding of a BOOLEAN value shall be primitive to be in accordance with ISO/IEC 8825-1. The BOOLEAN value shall be encoded in a single octet. If the BOOLEAN value is FALSE, the octet shall be zero. If the BOOLEAN value is TRUE, the octet shall have any non-zero value, at the sender's option.

A.2.6 Encoding an INTEGER value

The encoding of an INTEGER value shall be primitive to be in accordance with ISO/IEC 8825-1. The integer shall be encoded in one or more octets using the following procedures.

For positive integers and zero the steps are:

- The whole number is converted to a binary integer number in a bit field with the most significant bit first.
- The bit field is aligned to octet boundaries by adding leading zero bits.
- If the high order bit is 1_2 , add a pad octet 00_{16} as a prefix.

NOTE The high order bit of 0 denotes that the encodation is of a positive integer value.

EXAMPLE

Integer 128

Step 1: 10000000_2

Step 2: 10000000_2

Step 3: 00000000₂ 10000000₂

For negative integers, the encodation is to a twos-complement rule, the steps are:

- The whole number is converted to a binary integer number in a bit field with the most significant bit first.
- The bit field is aligned to octet boundaries by adding leading zero bits.
- The binary value from Step 2 is bit complemented (i.e. 02 to 12, 12 to 02).
- The twos-complement rule is applied adding 12 to the bit string of Step 2.
- If the high order bit is 0, add a pad octet FF16 as a prefix.

NOTE The high order bit of 1 denotes that the encodation is of a negative integer value.

EXAMPLE

Integer -27066

Step 1:	1101001 ₂	10111010 ₂
Step 2:	01101001 ₂	10111010 ₂
Step 3:	10010110 ₂	01000101 ₂
Step 4:	10010110 ₂	01000110 ₂

For decoding, the lead bit of the encoded integer value identifies whether the value is positive or negative.

If it is a positive value, conversion takes place on the remaining bits with the least significant bit being in position 0. The decimal integer value is the sum of the values 2^n , where n is the position number, or:

$$\sum_{n=0}^{p-1} 2^n$$

If it is a negative value, conversion takes place on the remaining bits with the least significant bit being in position 0. The first stage is to create a decimal integer value as the sum of the values of 2^n . The second stage takes this as a positive decimal integer from which is subtracted the value 2^p , where p is the position number of the lead bit that identifies this as a negative integer. As a formula, this is:

$$\sum_{n=0}^{p-1} 2^n - 2^p$$

EXAMPLE

10010110 ₂	01000110 ₂	
1 ₂		indicates -ve
0010110 ₂	01000110 ₂	= 5702
2 ^p	2 ¹⁵	32768
5702 - 32768 = -27066		

A.2.7 Encoding the OBJECT IDENTIFIER value

The encoding of an OBJECT IDENTIFIER value shall be primitive to be in accordance with ISO/IEC 8825-1. The Object Identifier value is encoded as a series of octet aligned values as follows:

1. The first two arcs of the registration tree are encoded as a single integer using the formula:

$$40f + s$$

where

f is the value of the first arc;

s is the value of the second arc.

2. The value "n" of each additional arc is encoded into an octet-aligned-bit-field. This is done as follows for values of "n":

- a. For $n < 128$:

the decimal value is converted to binary and encoded in a single octet; thus bit 8 is set to 0₂.

- b. For $128 \leq n < 16384$:

the decimal value is converted to binary and subdivided into two 7-bit strings: bit 7 to bit 1, bit 14 to bit 8. Each of these new bit strings is encoded in an octet; with bit 8 of the first octet set to 1₂, bit 8 of the last octet set to 0₂.

- c. For $n \geq 16384$:

the decimal value is converted to binary and subdivided into 7-bit strings: bit 7 to bit 1, bit 14 to bit 8, bit 21 to bit 15, and so on. Each of these new bit strings is encoded in an octet; with bit 8 of the first octet set to 1, bit 8 of the last octet set to 0 and bit 8 of the intervening octet(s) set to 1. The example below shows the process.

EXAMPLE

1. value = 91234_{10}
= $1\ 01100100\ 01100010_2$
2. Split into 7-bit strings
 $0000101_2\ 1001000_2\ 1100010_2$
3. Add prefix bits 0 for last octet
1 for preceding octet(s)
 $10000101_2\ 11001000_2\ 01100010_2$

Using this technique, the length of each component arc of the OBJECT IDENTIFIER is self-declaring. The first octet always defines the first two arcs. Each subsequent arc is defined by one octet if the lead bit of the next octet is 0; and multiple octets if the lead bit is 1, the group of octets ends with the octet with its lead bit equal 0. The arc value is encoded in the sequence of 7-bit values.

EXAMPLE

$[00101000]_2$	$1[1111000]_2\ 0[1001010]_2$	$0[0000001]_2$
$(1 \times 40) + 0$	15434	1
1 0	15434	1

Although the number of arcs allows for an OBJECT IDENTIFIER of any length, ISO/IEC 15961:2004 limited the length of the encoded value to be no more than 127 octets. This is a constraint placed to meet encoding requirements on the RF tag and the structure of the Logical Memory.

The constraint is on the encoded length of the OBJECT IDENTIFIER and not the number of arcs. It should be understood that an OBJECT IDENTIFIER encoded in 127 octets is highly unlikely.

A.2.8 Encoding an OCTET STRING value

Although the Basic Encoding Rules of ISO/IEC 8825-1 permit both forms of encoding, ISO/IEC 15961:2004 only supported primitive encoding of an OCTET STRING value.

The primitive encoding contains zero, one or more octets equal in value to the octets in the application data value. The encoded octets appear in the same order as they appear in the data value and with the most significant bit of an octet being aligned in both the encoded and data presentations.

For open systems application standards should ensure the octet sequence and bit ordering between receiving and sending systems.

A.2.9 Encoding a SEQUENCE value

The encoding of a SEQUENCE value shall be constructed to be in accordance with ISO/IEC 8825-1. The contents octets shall consist of the complete TLV encoding of one data value from each of the Types listed in the ASN.1 definition of the SEQUENCE Type. The data values shall be in the order of their appearance in the definition. Although ISO/IEC 8825-1 allows optional rules for Types with the keywords 'OPTIONAL' or 'DEFAULT' in the ASN.1 definition, ISO/IEC 15961:2004 required all Types in the SEQUENCE to appear in the constructed encoding.

EXAMPLE

ASN.1 definition

SEQUENCE {orderNumber OCTET STRING, product OCTET STRING, quantity INTEGER}

with the values:

{orderNumber "ABC1234", product "widget", quantity "12"}

is encoded as:

T = SEQUENCE	L		
30 ₁₆	14 ₁₆		
T = OCTET STRING	V	V	
04 ₁₆	07 ₁₆		"ABC1234"
T = OCTET STRING	V	V	
04 ₁₆	06 ₁₆		"widget"
T = INTEGER	V	V	
02 ₁₆	01 ₁₆		0C ₁₆

A.2.10 Encoding a SEQUENCE OF value

The SEQUENCE OF type has the same ASN.1 tag (UNIVERSAL 16) as the SEQUENCE type, therefore, adopting the same encoding rules. The encoding of a SEQUENCE OF value shall be constructed to be in

accordance with ISO/IEC 8825-1. The contents octets shall consist of the complete TLV encoding of each value, including the encoding of the repeated UNIVERSAL class tag of the encoded elements.

EXAMPLE

ASN.1 definition

sequence of {productCode OCTET STRING}

with the three values:

{productCode "ABC1234", "X6789Y", "PQR12345"}

is encoded as:

T = SEQUENCE L

30₁₆ 1B₁₆

T = OCTET STRING	V	V
04 ₁₆	07 ₁₆	"ABC1234"
T = OCTET STRING	V	V
04 ₁₆	06 ₁₆	"X6789Y"
T = OCTET STRING	V	V
02 ₁₆	08 ₁₆	"PQR12345"

Annex B (informative)

Accommodating established data formats

This document has been prepared on the basis that its Object-based protocol differs from the message-based protocols and syntax of some AIDC application standards. Therefore, basic data Objects shall be presented in a manner relevant to the application standard, for example in terms of:

- the data Object being supported in the data dictionary;
- the format of the data (e.g. numeric, alphanumeric), including its length;
- combinations of data Objects which are valid or illegal.

These features are outside the scope of this document and are the responsibility of the application.

Some conversion process is necessary until the application systems can handle data and identifiers in the format specified in this document. It is possible to have two independent implementation paths: one to write data, and one to read data.

For some major applications, some rigorous rules exist of what constitutes legitimate data. Software exists to ensure conformity to this format when using the existing message-based syntax. Users shall ensure that, as they implement an Object based method of writing data, the data itself follows the basic rules. [Figure B.1](#) illustrates this schematically.

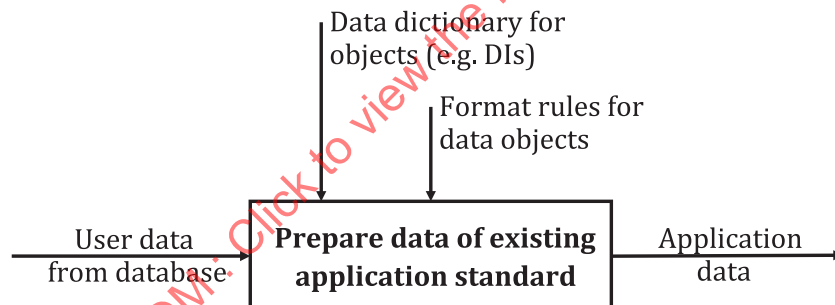


Figure B.1 — Data flow model: Prepare data of existing application standards

A similar process is required when data is read from a tag.

AIDC technologies based on write-once-read-many-times (WORM) technology can rely on the fact that data, as written, is what is read. This means the message syntax is encoded in the data carrier. The read-write capabilities of RFID, and the Object-based nature of the Data Protocol of this document, means that an established syntax has to be constructed based on the Object Identifier structure. While there is a requirement to output data with a particular data syntax (e.g. that of ISO/IEC 15434), then a conversion module is required to correctly map the set of Object Identifiers and data Objects to the message format required for the application of this document. This shall require the inversion of the conversion rules for some of the application data.

In addition, the message syntax of the established application standard needs to be created. This process generally requires all but the final arc of the Object Identifier to be discarded and for data separators (in accordance with the application standard) to be inserted correctly. Refer to the appropriate application standards for the precise rules.

A logical development step is for the application standard to develop procedures to accept output based on transfer syntax.

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Annex C (informative)

Relating data Objects

C.1 General

Message based syntax can use recursive or looping techniques to create repeated sequences of related data (e.g. individual quantity and batch numbers linked to different product codes). When the complete message is parsed, the syntax identifies boundary points so that the attributes are correctly linked to the primary code.

With an Object-based system (e.g. the Data Protocol of this document and ISO/IEC 15962) operating at a base level, there is a risk of creating false links (i.e. product code A can be linked to quantity of product B). The problem can be overcome using one of the techniques described below. The methods should only be adopted if incorporated into the application standard associated with the item being managed. The illustrations limit the number of constructed data elements to 255 per tag, but different rules can be developed if a greater number of constructions is required. Either rule is transparent to the complete Data Protocol of this document and ISO/IEC 15962, and so requires the processing to be implemented as part of the application. The options are included in this document to describe robust ways to preserve an Object-based data capture process using the Object Identifier tree structure.

C.2 Concatenation technique

Specific Object Identifiers can be created that link a defined set of attributes in a concatenated manner.

EXAMPLE

lowest arc 245 =

- sequence number 1 octet
- product code 8 octets
- quantity 1 octet
- batch number 4 octets

In this case the first byte of the Object, the sequence number, distinguishes one similar Object data from another.

Using this technique, each different arrangement of basic elements to create the concatenated construction would be given a different final node so the concatenation of product + quantity + expiry date would have its lowest arc value different from that for product + quantity + batch.

This method is more suitable when fixed combinations of elements must be created and the length of each Object is fixed.

C.3 Object identifier extension technique

The basic Object Identifier can be extended by the addition of a new final arc, with this as a 'linking' value.

EXAMPLE

The following three elements are to be linked:

- product code - final arc 48
- quantity - final arc 17
- batch - final arc 20

Assume that there are two different products whose details are encoded on the tag so the linking extensions 1 and 2 apply. Six individual Object-Identifiers are encoded:

...	48 1
...	48 2
...	17 1
...	17 2
...	20 1
...	20 2

The extension value is used to link the different Objects as a logical combination.

This method is more suitable when many different combinations of elements must be created and the length of, at least, one Object can vary between occurrences.

The Extension technique for relating Objects and their associated physical entities is similar to Scheme B for applying data security (see [C.2](#)). Therefore, for any one Object-Identifier, the technique shall only be applied to data security or to linking physical entities.

Annex D (informative)

Data security issues

D.1 General

Although data security is beyond the scope of this document and ISO/IEC 15962, the following guidance is provided to show how features of the Data Protocol can be used to achieve more secure data.

D.2 Object-Identifier issues

Encrypted data shall be associated with its own unique Object-Identifier. This ensures that authorised users can recognise encrypted data but does not declare to other users this fact. The Object itself simply appears with the Compact-Parameter set as Application-Defined (see [7.3.6](#)).

One method, called Scheme A for later reference, of creating the Object-Identifier is for this to have a final arc at the same level of all other final arcs in the application system. This is a systems level adoption of data security and requires all authorised users to know that the data is encrypted; however, the rules do not need to be publicly declared.

Another method, called Scheme B for later reference, for creating a unique Object-Identifier to identify the encrypted data is to extend the Object-Identifier of the plain (unencrypted) data and add an additional lower arc. This technique can be adopted bi-laterally between sender and authorised user(s), or at the systems levels for all authorised users. This technique can also be used to define the encryption type, selected keys and so on.

EXAMPLE

0 1 15961 nn nn	Plain Object
0 1 15961 nn nn 1	Encrypted Object
0 1 15961 nn nn 2	Encryption type
0 1 15961 nn nn 3	Key

Scheme B is similar to that proposed for relating Objects and their associated physical entities (see [C.3](#)). Therefore, for any one Object-Identifier, the technique shall only be applied to data security or to linking physical entities.

D.3 The data Object

The Object containing the application data shall have its Compact-Parameter set to Application-Defined after encryption.

The basic Object should be expanded to include a pre-defined data field or signature of the authorised writing party. This will help ensure data integrity as any unauthorised modification of the encrypted Object without access to the private key will most probably destroy the authorised signature. This will help identify that the Object has been changed without authority.

If a completely different Object-Identifier is assigned to the encrypted data (Scheme A above), then it is possible that it will need to be expanded to also contain additional unencrypted octets that define the encryption scheme and/or selection from a set of keys.

D.4 Using the Tag ID

It is possible to use the unique Tag ID, as defined for various types in the ISO/IEC 18000 series, as a component in a secure system. The Tag ID is intended to be unique to the tag, distinguishing it from all others. It is usually created at an early stage of manufacturing the tag using more robust techniques than can be used to write data into the Logical Memory Map. As such, it can be used to enhance data validity. Because of potential confusion with the Singulation-Id of the Data Protocol (which can use the Tag-ID), the Tag ID incorporated into the integrated circuit is referred to as the 18000 Tag ID, for the remainder of this annex.

Where the 18000 Tag ID also acts as the Singulation-Id as part of the systems information, the 18000 Tag ID is provided at an early stage of communication with the tag. Where the 18000 Tag ID is not provided as part of the systems information, additional commands are required to read it.

One method is to concatenate the 18000 Tag ID value to the basic Object data and encrypt the entire expanded Object. When decrypted by an authorised user, the 18000 Tag ID within the expanded Object can be compared with the real 18000 Tag ID to verify that they are identical. This may be applied to either Scheme A or B for creating the Object-Identifier, described above.

Another method is to use the 18000 Tag ID to modify the original key for encryption and decryption. This can be made to work for binary keys such as DES, where the 18000 Tag ID can be *exclusive or-ed* with the original key.

Before this approach is used, the implementers should verify that this type of modification of the key does not undermine the encryption method.

D.5 Advice on public key methods of encryption

Public key algorithms require longer keys to provide the same strength as symmetric keys. For example, a 512-bit public-key encryption cipher would have the equivalent strength of a 64-bit symmetric key cipher. This cipher length can preclude the use of public key ciphers in smaller capacity tags.

If a public key method of encryption is used, the data security will be compromised if the private key is used to encrypt the data and a public key is used to decrypt the data. Likewise, data integrity will be compromised if the public key is used to encrypt the data and the private key is used to decrypt the data. Double encryption or other means must be used to ensure data security and integrity.

The public key should not be encoded in the tag unless it is locked as an unauthorised party can violate the data integrity by overwriting the public key with another key and using another corresponding private key to encrypt altered data in the Object.

Annex E (informative)

Original commands and responses using ASN.1 abstract syntax

E.1 General

The following subclauses show the original 16 modules using the ASN.1 abstract syntax. Cross-references, sometimes with a name change, are provided to the normative subclauses that now replace those that were in the original modules.

E.2 ConfigureAfiModules

The ConfigureAfiModules consist of a commandModule and the associated responseModule that instruct the interrogator to write the applicationFamilyId (including the sub-family) into the tag. A fundamental requirement of this command is that only one tag shall be programmed per command. This is to ensure that the configuration process is robust, particularly in environments where more than one type of tag can be present.

The abstract syntax for ConfigureAfiModules is given in the following code:

```
-- Configure AFI
-- The ConfigureAfiCommand instructs the interrogator to write the AFI (Application
-- Family Identifier, including the sub-family) into the tag. The interrogator shall
-- lock the AFI if the Lock flag is set to true.

ConfigureAfiCommand
{iso(1) standard(0) rfid-data-protocol(15961) commandModules(126) configureAfi(1)}
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

ConfigureAfiCommand ::= SEQUENCE {
    tagId
        OCTET STRING(SIZE(0..255)),
        -- See Clause 7.2.1 (now renamed Singulation-Id) for detailed
        -- specification. TagId shall be provided by the Tag Driver for
        -- the
        -- purposes of identifying the tag unambiguously
        -- for at least the period of a transaction.
    applicationFamilyId
        ApplicationFamilyId,
    afiLock
        BOOLEAN
        -- If set to TRUE, the interrogator shall lock the AFI
}

ApplicationFamilyId ::= SEQUENCE {
```

```

applicationFamily      INTEGER {
                        all(0), -- address all families
                        -- values 1 - 8 reserved for definition by SC17
                        afiBlock9(9),
                        afiBlockA(10),
                        afiBlockB(11),
                        afiBlockC(12)
                        -- values 9 to 12 defined as per Annex B of this
                        -- International standard
                        -- values 13 to 15 reserved for definition by ISO/IEC
                        } (0..15),
applicationSubFamily    INTEGER {
                        all(0), -- This value shall not be encoded in the tag,
                        and
                        -- shall only be used in a command to signal that the
                        -- interrogator shall address all subfamilies within the
                        -- selected family.
                        -- NOTE This has little utility for this Data Protocol, but
                        -- is retained for compatibility with SC17 smart card commands
                        asf1-annex (1), -- values 1 to 15, for applicationFamily
                        9
                        -- to 12 defined as per Annex B of this part of ISO/IEC
                        15961
                        asf2-annex (2),
                        asf3-annex (3),
                        asf4-annex (4),
                        asf5-annex (5),
                        asf6-annex (6),
                        asf7-annex (7),
                        asf8-annex (8),
                        asf9-annex (9),
                        asfA-annex (10),
                        asfB-annex (11),
                        asfC-annex (12),
                        asfD-annex (13),
                        asfE-annex (14),
                        asfF-annex (15)
                        } (0..15)

```

```

-- ApplicationFamilyId is stored as a single OCTET within system information on the tag.
-- ApplicationFamilyId allows tags to be grouped according to specific families and
-- allows any such family of tags to be selectively addressed by the application. tag
-- vendors may implement mechanisms in the Tag Driver and air interface specifically for
-- selective addressing of tags by ApplicationFamilyId.

}
END

ConfigureAfiResponse
    {iso(1) standard(0) rfid-data-protocol(15961) responseModules(127) configureAfi(1)}
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

ConfigureAfiResponse ::= SEQUENCE {
    completionCode      INTEGER {
        noError(0),
        afiNotConfigured(1),
        afiNotConfiguredLocked(2),
        afiConfiguredLockFailed(3),
        tagIdNotFound(8),
        executionError(255)
    },
    executionCode        INTEGER
        -- See Clause 9.4 and notes in this syntax for a full list of
        -- executionCodes
    }
END

```

The following element names used in these modules are defined elsewhere in this document, as detailed:

- afiLock (see [7.4.3](#));
- applicationFamily (see [7.2.2](#));
- applicationFamilyId (see [7.2.2](#));
- applicationSubFamily (see [7.2.2](#));
- completionCode (see [9.3](#));
- executionCode (see [9.4](#));
- tagId (see [7.2.1](#)).

E.3 ConfigureStorageFormatModules

The ConfigureStorageFormatModule consists of a commandModule and the associated responseModule that instruct the interrogator to write the storageFormat (accessMethod and dataFormat) into the tag. The command also instructs the interrogator to initialise the tag Logical Memory Map by erasing any data already stored there. A fundamental requirement of this command is that only one tag shall be programmed per command. This is to ensure that the configuration process is robust, particularly in environments where more than one type of tag can be present.

If the accessMethod (incorporated in storageFormat) is specified as directory, the interrogator shall create the initial directory structure.

The ASN.1 Abstract Syntax for ConfigureStorageFormatModules is given in the following code:

```
-- Configure StorageFormat
-- The ConfigureStorageFormatCommand instructs the interrogator to write the
-- StorageFormat into the tag, and to initialise the tag logical memory
-- map. The interrogator shall erase all the application memory, and if the
-- directory format is specified by the StorageFormat, it shall create the
-- initial directory structure. The interrogator shall lock the
-- StorageFormat if the Lock flag is set to true

ConfigureStorageFormatCommand
{iso(1) standard(0) rfid-data-protocol(15961) commandModules(126)
configureStorageFormat(2) }
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

ConfigureStorageFormatCommand ::= SEQUENCE {
    tagId                OCTET STRING(SIZE(0..255)),
                        -- See Clause 7.2.1 (now renamed Singulation-Id) for
                        -- detailed
                        -- specification. TagId shall be provided by the Tag
                        -- Driver for the
                        -- purposes of identifying the tag unambiguously
                        -- for at least the period of a transaction.
    storageFormat         StorageFormat,
    storageFormatLock     BOOLEAN
                        -- If set to TRUE, the interrogator shall lock the
                        -- StorageFormat
}

StorageFormat ::= SEQUENCE {
    accessMethod          INTEGER {
                            noDirectory(0),
                            directory(1),
                            selfMappingTag(2)  -- Access to objects is via high
                            -- level commands to the tag and the internal
                            -- structure of the memory inside the tag is not
                            -- defined
                        } (0..3),
```

dataFormat

INTEGER {

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```

        notFormatted(0),    -- Not formatted according
            -- to this part of ISO/IEC 15961
        fullFeatured(1),    -- Supports any type of
            -- data based on full OID
        rootOidEncoded(2),  -- Supports any type of
            -- data with a common root-OID
        iso15434(3),        -- root-OID is defined as
            -- {1 0 15434}
        iso6523(4),        -- Supports data belonging to one or
            -- more International Code Designators compliant
            -- with ISO/IEC 6523-1, root-OID is defined as
            -- (1 0 6523)
        iso15459(5),       -- Supports unique item identifiers
            -- compliant with ISO/IEC 15459, root-OID is
            -- defined as (1 0 15459)
        iso15961Combined(8), -- Supports combinations of
            -- formats of ISO/IEC 15961, root-OID is defined
            -- as {1 0 15961}
        ean-ucc(9),        -- Supports data of the EAN-UCC system,
            -- root-OID is defined as {1 0 15961 9}
        di(10),            -- Supports Data Identifiers (as referred to
            -- in ISO/IEC 15418), root-OID is implied to be
            -- {1 0 15961 10}
        iata(12)           -- Supports IATA baggage handling data
            elements,
            -- root-OID is defined as {1 0 15961 11}
    } (0..31)
}
END

ConfigureStorageFormatResponse
{iso(1) standard(0) rfid-data-protocol(15961) responseModules(127)
configureStorageFormat(2) }
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

ConfigureStorageFormatResponse ::= SEQUENCE {
    completionCode      INTEGER {
        noError(0),
        storageFormatNotConfigured(4),
        storageFormatNotConfiguredLocked(5),
        storageFormatConfiguredLockFailed(6),
        tagIdNotFound(8),

```

```

                                executionError(255)
                                },
    executionCode      INTEGER
                                -- See Clause 9.4 and notes in this syntax
                                -- for a full list of executionCodes
}
END

```

The following elementNames used in these modules are defined elsewhere in this document, as detailed:

- accessMethod (see [7.2.4](#));
- completionCode (see [9.3](#));
- dataFormat (see [7.2.5](#));
- executionCode (see [9.4](#));
- storageFormat (see [7.2.3](#));
- storageFormatLock (see [7.4.15](#));
- tagId (see [7.2.1](#)).

E.4 InventoryTagsModules

The InventoryTagsModules consist of a commandModule and the associated responseModule that instruct the interrogator to identify a particular set of tags present in its operating field.

The ASN.1 Abstract Syntax for InventoryTagsModules is given in the code below.

The command requires that the value of the applicationFamilyId is specified to select tags belonging to a particular class, typically containing data belonging to a defined domain and / or containing a defined objectId.

The second, additional, selection criterion (identifyMethod) determines how many tags, in accordance with the specified applicationFamilyId selection criterion, need to be identified before the response can be provided. A mechanism that can be used to detect any tag entering the operating area, is to set the inventoryAtLeast argument to 1. Particular conditions can be confirmed by only undertaking a partial inventory, i.e. by using either the inventoryAtLeast, or the inventoryNoMoreThan arguments. A reconciliation of a known quantity of previous transactions (e.g. to identify that all items intended to be in a container are actually there) can be achieved by using the inventoryExactly argument. Details of the options are given in the module in the code below.

The response consists of the numberOfTagsFound and the identities of each tag by its tagId:

```
-- InventoryTags
-- The InventoryTagsCommand instructs the interrogator to inventory and to
-- identify all tags present in its operating area. Each tag is uniquely
-- identified by its TagId.

InventoryTagsCommand
{iso(1) standard(0) rfid-data-protocol(15961) commandModules(126) inventoryTags(3)}
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

InventoryTagsCommand ::= SEQUENCE {
    applicationFamilyId      ApplicationFamilyId,
    identifyMethod            INTEGER {
                                inventoryAllTags (0),
                                inventoryAtLeast (1),
                                inventoryNoMoreThan (2),
                                inventoryExactly (3)
                                } (0..15),
    numberOfTags              INTEGER (0..65535)
}

-- The ApplicationFamilyId separates fundamentally different types of application
-- data (see 7.2.2), and possibly particular objectIds. Specifying a
-- hex value xx (where x is a non-zero value) selects only the tags that have
-- the required data content.
-- Specifying a hex value 00 selects all the tags; this may be an appropriate
-- action to undertake a full inventory.
-- Specifying a hex value 0x, or x0, (where x is a non-zero value) might not be
-- logically sound because the tags are from different applications and the x
-- value has different meaning.

-- If the identifyMethod is set to inventoryAllTags, the interrogator shall perform
-- a complete inventory of all tags present in its field of operation. The value of
```

```
-- numberOfTags is irrelevant and should be set to zero by the application.

-- If the identifyMethod is set to inventoryAtLeast, the interrogator shall perform
-- an inventory of the tags present in its field of operation and (possibly)
-- continue waiting until it has identified a number of tags equal to numberOfTags.
-- If the numberOfTags is set to 1, the Interrogator will wait until the first tag
-- has been detected. This is a mechanism to wait for a tag to enter the
-- interrogator field.
-- If the numberOfTags is set to more than 1, the Interrogator will wait
-- until the specified number of tags has been detected.

-- If the identifyMethod is set to inventoryNoMoreThan, the interrogator shall
-- initiate an inventory of the tags present in its field of operation and shall
-- return a response with a number of tags lower or equal to numberOfTags.
-- The interrogator may interrupt the inventory process when the numberOfTags has
-- been reached or may continue the inventory process till all tags have been read.
-- NOTE This may be constrained by the air interface and anticollision
-- mechanism.

-- If the identifyMethod is set to inventoryExactly, the interrogator shall
-- initiate an inventory of the tags present in its field of operation and shall
-- return a response with the number of tags equal to numberOfTags. This command
-- parameter could be used to confirm the actual number of tagged items in a
-- container. The Interrogator will wait until the specified number of tags has
-- been detected. The interrogator may interrupt the inventory process when the
-- numberOfTags has been reached or may continue the inventory process till
-- all tags have been read.
-- NOTE This may be constrained by the air interface and anticollision
-- mechanism.

-- Execution of this command with the arguments inventoryAtLeast and
-- inventoryExactly can cause the interrogator to wait until sufficient tags
-- enter its field of operation; also the command-response cannot be initiated
-- until after this delay. It is the responsibility of the application to
-- accommodate this potentiality.
```

```

ApplicationFamilyId ::= SEQUENCE {
    applicationFamily          INTEGER(0..15),
    applicationSubFamily       INTEGER(0..15)
}

-- The code values are defined in the ConfigureAfiCommand.

TagId ::=
    OCTET STRING(SIZE(0..255))
    -- See Clause 7.2.1 for detailed specification

END

InventoryTagsResponse
{iso(1) standard(0) rfid-data-protocol(15961) responseModules(127) inventoryTags(3)}
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

InventoryTagsResponse ::= SEQUENCE {
    completionCode            INTEGER {
        noError(0),
        failedToReadMinimumNumberOfTags(23),
        -- for example, this could be due to a time-out
        failedToReadExactNumberOfTags(24),
        -- for example, this could be due to a time-out
        executionError(255)
    },
    executionCode              INTEGER,
        -- See Clause 9.4 and notes in this syntax
        -- for a full list of executionCodes
    numberOfTagsFound          INTEGER (1..65535),
    identities                  SEQUENCE OF TagId
}

TagId ::=
    OCTET STRING(SIZE(0..255))
    -- See Clause 7.2.1 for detailed specification

END

```

The following elementNames used in these modules are defined elsewhere in this document, as defined:

- applicationFamily (see [7.2.2](#));
- applicationFamilyId (see [7.2.2](#));
- applicationSubFamily (see [7.2.2](#));
- completionCode (see [9.3](#));

- executionCode (see 9.4);
- identifyMethod (see 7.4.23);
- identities (see 7.5.3);
- numberOfTags (see 7.4.43);
- numberOfTagsFound (see 7.5.10);
- tagId (see 7.2.1).

E.5 AddSingleObjectModules

The AddSingleObjectModules consist of a commandModule, and the associated responseModule, that instruct the interrogator to write an object, its objectId, and associated parameters into the tag Logical Memory Map. The command arguments can be used to lock the objectId, the object and associated parameters; and to check that the objectId is not already encoded on the tag. Only one tag shall be programmed per command to ensure that the writing process is robust.

The ASN.1 Abstract Syntax for AddSingleObjectModules is given in the following code:

```
-- Add Single Object
-- The AddSingleObjectCommand instructs the interrogator to write an object, its
-- OID and associated parameters into the tag logical memory map.
-- NOTE There is also an AddMultipleObjectsCommand.

-- If the checkDuplicate flag is set to TRUE, the interrogator shall verify, before
-- adding the object, that no object with the same OID already exists. If such
-- object exists, the interrogator shall not perform the Add Object function and
-- shall return the appropriate Completion Code.

-- If the Lock flag is set to TRUE, the interrogator shall lock the ObjectId, the
-- Object, its compaction scheme and associated parameters into the tag Logical
-- Memory Map

AddSingleObjectCommand
{iso(1) standard(0) rfid-data-protocol(15961) commandModules(126) addSingleObject(4)}
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

AddSingleObjectCommand ::= SEQUENCE {
    tagId          OCTET STRING(SIZE(0..255)),
                  -- See Clause 7.2.1 for detailed specification
    objectId       OBJECT IDENTIFIER, -- Full OID value
    avoidDuplicate  BOOLEAN,
                  -- If set to TRUE, check for duplicate objectId
    object         OCTET STRING,
    compactParameter INTEGER {
                        applicationDefined(0),
                        -- The object shall not be processed through the
```

```

        -- data compaction rules of 15962 and remains
        -- unaltered
        compact(1),
        -- Compact object as efficiently as possible
        -- using 15962 compaction rules
        utf8Data(2)
        -- Data has been externally transformed from a 16-bit
        -- coded character set to a UTF-8 string. The object
        -- shall not be processed through the data compaction
        -- rules of 15962 and remains unaltered
        } (0..15),
    BOOLEAN
    -- If TRUE the interrogator shall lock the ObjectId, the
    -- Object, its compaction scheme and other features in the
    -- Logical Memory Map
}

END

AddSingleObjectResponse
{iso(1) standard(0) rfid-data-protocol(15961) responseModules(127) addSingleObject(4)}
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

AddSingleObjectResponse ::= SEQUENCE {
    completionCode      INTEGER {
        noError(0),
        tagIdNotFound(8),
        objectNotAdded(9),
        duplicateObject(10),
        objectAddedButNotLocked(11),
        executionError(255)
    },
    executionCode        INTEGER
        -- See Clause 9.4 and notes in this syntax for a full list of
        -- executionCodes
    }

END

```

The following elementNames used in these modules are defined elsewhere in this document as defined:

— avoidDuplicate (see [7.4.6](#));

- compactParameter (see 7.3.6);
- completionCode (see 9.3);
- executionCode (see 9.4);
- object (see 7.3.5);
- objectId (see 7.3.3);
- objectLock (see 7.3.7);
- tagId (see 7.2.1).

E.6 DeleteObjectModules

The DeleteObjectModules consist of a commandModule and the associated responseModule that instruct the interrogator to delete a defined objectId and its object and associated parameters. Only one RF tag and only one objectId shall be programmed per command to ensure that the deletion process is robust. The delete function requires the removal of the objectId, the associated object, and precursor from the Logical Memory Map.

The ASN.1 Abstract Syntax for DeleteObjectModules is given in the following code:

```
-- Delete Object
-- The DeleteObjectCommand instructs the interrogator to delete the object
-- specified by its OID, from the tag Logical Memory Map. This means that a
-- subsequent command to read the object will return objectNotFound. This
-- procedure might not succeed if the object is locked, if this is found to be the
-- case, the response will return the appropriate completionCode. If the
-- checkDuplicate flag is set to TRUE, the interrogator shall verify, before
-- deleting the requested object, that there is only a single object with the
-- requested OID. If the interrogator detects that several objects have the same
-- OID it shall not perform the DeleteObject function and shall return the
-- appropriate completionCode

-- If the checkDuplicate flag is set to FALSE, the interrogator shall delete the
-- first occurrence of the object specified by its OID.
-- NOTE This is an argument that effectively provides no protection against
-- duplicate OIDs. It should only be used when there is a high expectation of
-- no duplicates.

DeleteObjectCommand
{iso(1) standard(0) rfid-data-protocol(15961) commandModules(126) deleteObject(5)}
DEFINITIONS
EXPLICIT TAGS ::=
BEGIN

DeleteObjectCommand ::= SEQUENCE {
    TagId          OCTET STRING(SIZE(0..255)),
                  -- See Clause 7.2.1 for detailed specification
    objectId       OBJECT IDENTIFIER, -- Full OID value
                  -- This initiates the deletion of the ObjectId and the
                  -- associated Object
```

checkDuplicate

BOOLEAN

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