



BSI Standards Publication

Industrial communication networks — Fieldbus specifications

Part 5-28: Application layer service definition — Type 28 elements

National foreword

This British Standard is the UK implementation of EN IEC 61158-5-28:2023. It is identical to IEC 61158-5-28:2023.

The UK participation in its preparation was entrusted to Technical Committee GEL/65, Measurement and control.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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(IEC 61158-5-28:2023)

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European foreword

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In the official version, for Bibliography, the following notes have to be added for the standard indicated:

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² To be published. Stage at time of publication: FprEN IEC 61784-2-X:2023.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61158-1	2023	Industrial communication networks - Fieldbus specifications - Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series	EN IEC 61158-1	2023
IEC 61158-4-28	2023	Industrial communication networks - Fieldbus specifications - Part 4-28: Data- link layer protocol specification - Type 28 elements	EN IEC 61158-4-28	2023
IEC 61158-6-28	2023	Industrial communication networks - Fieldbus specifications - Part 6-28: Application layer protocol specification - Type 28 elements	EN IEC 61158-6-28	2023
ISO/IEC 7498-1	1994	Information technology - Open Systems Interconnection - Basic reference model: The basic model	-	-
ISO/IEC 7498-3	1997	Information technology - Open Systems Interconnection - Basic reference model: Naming and addressing	-	-
ISO/IEC 8822	-	Information technology - Open Systems Interconnection - Presentation service definition	-	-
ISO/IEC 8824-1	-	Information technology - Abstract Syntax Notation One (ASN.1) - Part 1: Specification of basic notation	-	-
ISO/IEC 9545	-	Information technology - Open Systems Interconnection - Application layer structure	-	-
ISO/IEC 10731	1994	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services	-	-
IETF RFC 2460	1998	Internet Protocol - Version 6 (IPv6) - Specification	-	-

EN IEC 61158-5-28:2023 (E)

IETF RFC 791	1981	Internet Protocol	-	-
ISO/IEC/IEEE 8802-3	2021	Telecommunications and exchange between information technology systems - Requirements for local and metropolitan area networks - Part 3: Standard for Ethernet	-	-

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FIELDBUS SPECIFICATIONS –****Part 5-28: Application layer service definition –
Type 28 elements****FOREWORD**

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NOTE Combinations of protocol types are specified in the IEC 61784-1 series and the IEC 61784-2 series.

IEC 61158-5-28 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

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Draft	Report on voting
65C/1206/FDIS	65C/1235/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 61158 series, published under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC web site.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the "three-layer" fieldbus reference model described in IEC 61158-1.

The application service is provided by the application protocol making use of the services available from the data-link or other immediately lower layer. This document defines the application service characteristics that fieldbus applications and/or system management can exploit.

Throughout the set of fieldbus standards, the term "service" refers to the abstract capability provided by one layer of the OSI Basic Reference Model to the layer immediately above. Thus, the application layer service defined in this document is a conceptual architectural service, independent of administrative and implementation divisions.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-28: Application layer service definition – Type 28 elements

1 Scope

1.1 Overview

The fieldbus Application Layer (FAL) provides user programs with a means to access the fieldbus communication environment. In this respect, the FAL can be considered as a window between corresponding application programs.

This part of IEC 61158 provides common elements for basic time-critical and non-time-critical messaging communications between application programs in an automation environment and material specific to Type 28 fieldbus. The term "time-critical" is used to represent the presence of a time-window, in which one or more specified actions are required to be completed with some defined level of certainty.

This document defines in an abstract way the externally visible service provided by the different Types of the fieldbus Application Layer in terms of

- an abstract model for defining application resources (objects) capable of being manipulated by users via the use of the FAL service,
- the primitive actions and events of the service,
- the parameters associated with each primitive action and event, and the form which they take, and
- the interrelationship between these actions and events, and their valid sequences.

The purpose of this document is to define the services provided to

- the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
- Systems Management at the boundary between the Application Layer and Systems Management of the Fieldbus Reference Model.

This document specifies the structure and services of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498-1) and the OSI Application Layer Structure (ISO/IEC 9545).

FAL services and protocols are provided by FAL application-entities (AE) contained within the application processes. The FAL AE is composed of a set of object-oriented Application Service Elements (ASEs) and a Layer Management Entity (LME) that manages the AE. The ASEs provide communication services that operate on a set of related application process object (APO) classes. One of the FAL ASEs is a management ASE that provides a common set of services for the management of the instances of FAL classes.

Although these services specify, from the perspective of applications, how to request and response are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioural aspects of the applications are not specified; only a definition of what requests and responses they can send/receive is specified. This permits greater flexibility to the FAL users in standardizing such

object behaviour. In addition to these services, some supporting services are also defined in this document to provide access to the FAL to control certain aspects of its operation.

1.2 Specifications

The principal objective of this document is to specify the characteristics of conceptual application layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of application layer protocols for time-critical communications.

A secondary objective is to provide migration paths from previously existing industrial communications protocols. It is this latter objective which gives rise to the diversity of services standardized as the various types of IEC 61158, and the corresponding protocols standardized in the IEC 61158-6 series.

This document can be used as the basis for formal application programming-interfaces. Nevertheless, it is not a formal programming interface, and any such interface will address implementation issues not covered by this document, including

- the sizes and octet ordering of various multi-octet service parameters, and
- the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

This document does not specify individual implementations or products, nor does it constrain the implementations of application layer entities within industrial automation systems.

There is no conformance of equipment to this application layer service definition standard. Instead, conformance is achieved through implementation of conforming application layer protocols that fulfils the Type 28 application layer services as defined in this document.

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.

NOTE All parts of the IEC 61158 series, as well as the IEC 61784-1 series and the IEC 61784-2 series are maintained simultaneously. Cross -references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 61158-1:2023, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61158-4-28:2023, *Industrial communication networks – Fieldbus specifications – Part 4-28: Data-link layer protocol specification – Type 28 elements*

IEC 61158-6-28:2023, *Industrial communication networks – Fieldbus specifications – Part 6-28: Application layer protocol specification – Type 28 elements*

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 7498-3:1997, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*

ISO/IEC 8822, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8824-1, *Information technology – Abstract Syntax Notation One (ASN.1) – Part 1: Specification of basic notation*

ISO/IEC 9545, *Information technology – Open Systems Interconnection – Application Layer structure*

ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

ISO/IEC/IEEE 8802-3:2021, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

IETF RFC 791, J. Postel, *Internet Protocol*, September 1981, available at <https://www.rfc-editor.org/info/rfc791> [viewed 2022-02-18]

IETF RFC 2460, S. Deering and R. Hinden, *“Internet Protocol, Version 6 (IPv6) Specification”*, December 1998, available at <https://www.rfc-editor.org/info/rfc2460> [viewed 2022-02-18]

3 Terms, definitions, symbols, abbreviated terms and conventions

For the purposes of this document, the following terms, definitions, symbols, abbreviated terms and conventions apply.

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

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

3.1 Referenced terms and definitions

3.1.1 ISO/IEC 7498-1 terms

For the purposes of this document, the following terms given in ISO/IEC 7498-1 apply:

- application entity
- application process
- application protocol data unit
- application service element
- application entity invocation
- application process invocation
- application transaction
- real open system
- transfer syntax

3.1.2 ISO/IEC 8822 terms

For the purposes of this document, the following terms given in ISO/IEC 8822 apply:

- abstract syntax

- presentation context

3.1.3 ISO/IEC 9545 terms

For the purposes of this document, the following terms given in ISO/IEC 9545 apply:

- application-entity-invocation
- application-entity-type
- application-process-invocation
- application-process-type
- application-service-element

3.1.4 ISO/IEC 8824 terms

For the purposes of this document, the following terms given in ISO/IEC 8824 apply:

- object identifier
- type

3.2 Additional terms and definitions for this IEC 61158-5-28

The following terms and definitions apply to this document.

3.2.1

clock query

get clock information from the management node or terminal node device

3.2.2

clock synchronization

clock calibration of the terminal node device

3.2.3

control device

device that controls all field devices for logical operations, timing, calculations, etc.

3.2.4

cyclic

events which repeat in a regular and repetitive manner

3.2.5

cyclic time

time of cyclic processing of a device or module

3.2.6

field device

physical entity that is connected to the process or to factory equipment and has at least one signalling element that communicates with other signalling element(s) via a cable

3.2.7

management node

device for allocating and managing Type 28 network physical communication resources

3.2.8

non-RT Data

data insensitive to time deterministic requirements

3.2.9

RT Data

data sensitive to time deterministic requirements

3.2.10

terminal node

device in Type 28 network that communicates based on allocated physical communication resources

3.3 Abbreviations and symbols

AL	Application layer
ALCE	Application layer clock entity
ALDE	Application layer data entity
ALME	Application layer management entity
ALS	Application layer service
AE	Application entity
AP	Application process
APO	AP object
AR	Application relationship
ASE	Application service elements
C/S	Client/Server
DL-	Data-link layer (as a prefix)
DLCE	Data-link clock entity
DLDE	Data-link data entity
DLE	Data-link entity
DLL	Data-link layer
DLS	Data-link service
DLP	Data-link protocol
DLS-user	Data-link service user
DTC	Data transmission channel
DTS	Data transmission service
DTU	Data transmission unit
DLSDU	Data-link service data unit
DLPDU	Data-link protocol data unit
MAC	Medium access control
MN	Management node
NodeID	Node identifier
nRT	non-Real-Time
PhL	Physical layer
RT	Real-Time
RTA	Real-Time acyclic
RTC	Real-Time cyclic
TN	Terminal node

3.4 Conventions

3.4.1 Overview

The FAL is defined as a set of object-oriented ASEs. Each ASE is specified in a separate subclause. Each ASE specification is composed of two parts, including its class specification and its service specification.

The class specification defines the attributes of the class. The service specification defines the services that are provided by the ASE.

3.4.2 Conventions for class definitions

Class definitions are described using templates. Each template consists of a list of attributes for the class. The general form of the template is shown below:

FAL ASE:			ASE Name
CLASS:	Class Name		
CLASS ID	#		
PARENT CLASS:	Parent Class Name		
ATTRIBUTES:			
1	(o)	Key Attribute:	numeric identifier
2	(o)	Key Attribute:	Name
3	(m)	Attribute:	attribute name(values)
4	(m)	Attribute:	attribute name(values)
4.1	(s)	Attribute:	attribute name(values)
4.2	(s)	Attribute:	attribute name(values)
4.3	(s)	Attribute:	attribute name(values)
5	(c)	Constraint:	constraint expression
5.1	(m)	Attribute:	attribute name(values)
5.2	(o)	Attribute:	attribute name(values)
6	(m)	Attribute:	attribute name(values)
6.1	(s)	Attribute:	attribute name(values)
6.2	(s)	Attribute:	attribute name(values)
SERVICES:			
1	(o)	OpsService	service name
2	(c)	Constraint:	constraint expression
3.1	(o)	OpsService	service name
3	(m)	MgtService:	service name

- (1) The "FAL ASE:" entry is the name of the FAL ASE that provides the services for the class being specified.
- (2) The "CLASS:" entry is the name of the class being specified. All objects defined using this template will be an instance of this class. The class may be specified by this document, or by a user of this document.
- (3) The "CLASS ID:" entry is a number that identifies the class being specified. This number is unique within the FAL ASE that will provide the services for this class. When qualified by the identity of its FAL ASE, it unambiguously identifies the class within the scope of the FAL. The value "NULL" indicates that the class cannot be instantiated. Class IDs between 1 and 99, 240 and 767 are reserved by this document to identify standardized classes. CLASS IDs between 100 and 199, 768 and 1 279 are allocated for identifying user defined classes.

- (4) The "PARENT CLASS:" entry is the name of the parent class for the class being specified. All attributes defined for the parent class and inherited by it are inherited for the class being defined, and therefore do not have to be redefined in the template for this class.

NOTE The parent-class "TOP" indicates that the class being defined is an initial class definition. The parent class TOP is used as a starting point from which all other classes are defined. The use of TOP is reserved for classes defined by this document.

- (5) The "ATTRIBUTES" label indicate that the following entries are attributes defined for the class.
- a) Each of the attribute entries contains a line number in column 1; a mandatory (m) / optional (o) / conditional (c) / selector (s) indicator in column 2; an attribute type label in column 3; a name or a conditional expression in column 4; and optionally a list of enumerated values in column 5. In the column following the list of values, the default value for the attribute may be specified.
 - b) Objects are normally identified by a numeric identifier or by an object name, or by both. In the class templates, these key attributes are defined under the key attribute.
 - c) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting is used to specify:
 - i) fields of a structured attribute (4.1, 4.2, 4.3),
 - ii) attributes conditional on a constraint statement (5). Attributes may be mandatory (5.1) or optional (5.2) if the constraint is true. Not all optional attributes require constraint statements as does the attribute defined in (5.2),
 - iii) the selection fields of a choice type attribute (6.1 and 6.2).
- (6) The "SERVICES" label indicates that the following entries are services defined for the class.
- a) An (m) in column 2 indicates that the service is mandatory for the class, while an (o) indicates that it is optional. A (c) in this column indicates that the service is conditional. When all services defined for a class are defined as optional, at least one has to be selected when an instance of the class is defined.
 - b) The label "OpsService" designates an operational service (1).
 - c) The label "MgtService" designates a management service (2).
 - d) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting within the list of services is used to specify services conditional on a constraint statement.

3.4.3 Conventions for service definitions

3.4.3.1 General

The service model, service primitives and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

3.4.3.2 Service parameters

Service primitives are used to represent service user or service provider interactions (ISO/IEC 10731). They convey parameters which indicate information available in the user or provider interaction. In any particular interface, not all parameters shall be explicitly stated.

The service specifications of this document use a tabular format to describe the component parameters of the ASE service primitives. The parameters which apply to each group of service primitives are set out in tables. Each table consists of up to five columns for the

- a) parameter name,
- b) request primitive,
- c) indication primitive,
- d) response primitive, and

e) confirm primitive.

One parameter (or component of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive specified in the column:

M parameter is mandatory for the primitive

U parameter is a user option, and can be provided or not depending on dynamic usage of the service user. When not provided, a default value for the parameter is assumed.

— (blank) parameter is never present.

S parameter is a selected item.

Some entries are further qualified by items in brackets. These may be

a) a parameter-specific constraint:

"(=)" indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.

b) an indication that some note applies to the entry:

"(n)" indicates that the following note "n" contains additional information pertaining to the parameter and its use.

3.4.3.3 Service procedures

The procedures are defined in terms of

- the interactions between application entities through the exchange of fieldbus Application Protocol Data Units, and
- the interactions between an application layer service provider and an application layer service user in the same system through the invocation of application layer service primitives.

These procedures are applicable to instances of communication between systems which support time-constrained communications services within the fieldbus Application Layer.

4 Concepts

The fundamental concepts and templates used to describe the application layer service in this document follow IEC 61158-1, Clause 9.

5 Data type ASE

5.1 General

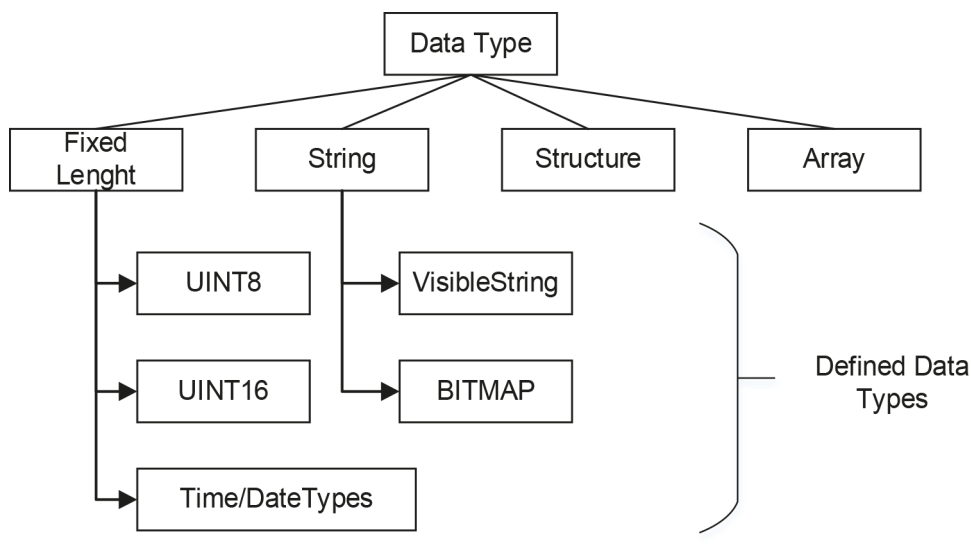
5.1.1 Overview

In the communication Type 28 FAL, Data type ASE complies with IEC 61158-1, Clause 10, and the other protocol-specific data types are not defined in this document.

Fieldbus data types specify the machine independent syntax for the data conveyed by each layer services. The fieldbus application supports the definition and transmission of basic and constructed data types.

Basic types are atomic data types that cannot be decomposed into more elemental types. Constructed data types are composed of basic types and other constructed types. Their complexity and the depth of nesting are not constrained by this document.

Data types are defined as instances of the data type class, as shown in Figure 1. Only a subset of the data types defined in Clause 5 are shown in Figure 1. Defining new types is accomplished by providing a new numeric ID and supplying values for the attributes defined for the data type class.



IEC

Figure 1 – Data type class hierarchy example

The data type definitions in Figure 1 are represented as a class/format/instance structure beginning with data type class entitled "Data Type". The formats for data types are defined by the data type class and represented in Figure 1.

The basic data classes are used to define fixed length and bit string data types. Standard types taken from ISO/IEC 8824 are referred to as simple data types. Other standard basic data types are defined specifically for fieldbus applications and are referred to as specific types.

The constructed types specified in this document are strings, arrays and structures. There are no standard types defined for arrays and structures.

5.1.2 Overview of basic types

Most basic types are defined from a set of ISO/IEC 8824 types (simple types). Some ISO/IEC 8824 types have been extended for fieldbus specific use (specific types).

Simple types are ISO/IEC 8824 universal types. They are defined in this document to provide them with fieldbus class identifiers.

Specific types are basic types defined specifically for use in the fieldbus environment. They are defined as simple class subtypes.

Basic types have a constant length. Two variations are defined, one for defining data types whose length is an integral number of octets, and one for defining data types whose length is a number of bits.

NOTE Boolean, Integer, OctetString, VisibleString, and UniversalTime are defined in this document for the purpose of assigning fieldbus class identifiers to them. This document does not change their definitions as specified in ISO/IEC 8824.

5.1.3 Overview of fixed-length types

The length of fixed-length types is an integral number of octets.

5.1.4 Overview of constructed types

5.1.4.1 Strings

A string is composed of an ordered set, variable in number, of homogeneously typed fixed-length elements.

5.1.4.2 Arrays

An array is composed of an ordered set of homogeneously typed elements. There are no restrictions on the data type of array elements placed, but each element shall be of the same type. Once defined, the number of elements in an array can be changed, or not.

5.1.4.3 Structures

A structure is made of an ordered set of heterogeneously-typed elements called fields. Like arrays, this document does not restrict the data type of fields. However, the fields within a structure do not have to be of the same type.

5.1.4.4 Nesting level

This document permits arrays and structures to contain other arrays and structures. It places no restriction on the number of nesting levels allowed.

When an array or structure contains constructed elements, access to a single element in its entirety is provided. Access to sub elements of the constructed element is also provided.

5.2 AL defined data types

5.2.1 Fixed length types

5.2.1.1 Date/Time types

5.2.1.1.1 Time type (TIMEV)

The time data type is an unsigned integer of 64 bits, which represents the time incremented with 1 ns. Table 1 shows the coding.

Table 1 – TIMEV type data coding

octet	bit							
	7	6	5	4	3	2	1	0
1	2^{63}	2^{62}	2^{61}	2^{60}	2^{59}	2^{58}	2^{57}	2^{56}
2	2^{55}	2^{54}	2^{53}	2^{52}	2^{51}	2^{50}	2^{49}	2^{48}
3	2^{47}	2^{46}	2^{45}	2^{44}	2^{43}	2^{42}	2^{41}	2^{40}
4	2^{39}	2^{38}	2^{37}	2^{36}	2^{35}	2^{34}	2^{33}	2^{32}
5	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}
6	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}
7	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8
8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

CLASS:

DATA TYPE

ATTRIBUTES:

- | | | |
|---|------------------------------|---------|
| 1 | Data Type Numeric Identifier | = 16 |
| 2 | Data Type Name | = TIMEV |