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Industrial communication networks – Fieldbus specifications – Part 3-18: Data-link layer service definition – Type 18 elements

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 3-18: Data-link layer service definition – Type 18 elements

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International Standard IEC 61158-3-18 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This first edition and its companion parts of the IEC 61158-3 subseries cancel and replace IEC 61158-3:2003. This edition of this part constitutes a technical addition.

This edition includes the following significant changes with respect to the previous edition:

a) deletion of the former Type 6 fieldbus, and the placeholder for a Type 5 fieldbus data-link layer, for lack of market relevance;
b) addition of new types of fieldbuses;
c) division of this part into multiple parts numbered 3-1, 3-2, …, 3-19.

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/473/FDIS	65C/484/RVD

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

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under http://webstore.iec.ch in the data related to the specific publication. At this date, the publication will be:

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- withdrawn;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

NOTE The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

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

INTRODUCTION

This part of IEC 61158 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/TR 61158-1.

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 data-link layer service defined in this standard is a conceptual architectural service, independent of administrative and implementation divisions.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 3-18: Data-link layer service definition – Type 18 elements

1 Scope

1.1 Overview

This standard provides common elements for basic time-critical and non-time-critical messaging communications between devices in an automation environment and material specific to Type 18 fieldbus. The term “time-critical” is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This standard defines in an abstract way the externally visible service provided by the Type 18 fieldbus data-link layer in terms of

a) the primitive actions and events of the service;

b) the parameters associated with each primitive action and event, and the form which they take; and

c) the interrelationship between these actions and events, and their valid sequences.

This standard defines the services provided to

- the Type 18 fieldbus application layer at the boundary between the application and data-link layers of the fieldbus reference model, and
- system management at the boundary between the data-link layer and systems management of the fieldbus reference model.

1.2 Specifications

The principal objective of this standard is to specify the characteristics of conceptual data-link layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of data-link protocols for time-critical communications. A secondary objective is to provide migration paths from previously-existing industrial communications protocols.

This specification may be used as the basis for formal DL-Programming-Interfaces. Nevertheless, it is not a formal programming interface, and any such interface will need to address implementation issues not covered by this specification, including:

a) the sizes and octet ordering of various multi-octet service parameters, and

b) the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

This standard does not specify individual implementations or products, nor do they constrain the implementations of data-link entities within industrial automation systems.

There is no conformance of equipment to this data-link layer service definition standard. Instead, conformance is achieved through implementation of the corresponding data-link protocol that fulfills the Type 18 data-link layer services defined in this standard.

2 Normative references

The following referenced documents are indispensable for the application 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 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

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

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

3 Terms, definitions, symbols, abbreviations and conventions

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

3.1 Reference model terms and definitions

This standard is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein.

3.1.1 DL-address [ISO/IEC 7498-3]

3.1.2 DL-address-mapping [ISO/IEC 7498-1]

3.1.3 called-DL-address [ISO/IEC 7498-3]

3.1.4 calling-DL-address [ISO/IEC 7498-3]

3.1.5 centralized multi-end-point-connection [ISO/IEC 7498-1]

3.1.6 DL-connection [ISO/IEC 7498-1]

3.1.7 DL-connection-end-point [ISO/IEC 7498-1]

3.1.8 DL-connection-end-point-identifier [ISO/IEC 7498-1]

3.1.9 DL-connection-mode transmission [ISO/IEC 7498-1]

3.1.10 DL-connectionless-mode transmission [ISO/IEC 7498-1]

3.1.11 correspondent (N)-entities
correspondent DL-entities (N=2)
correspondent Ph-entities (N=1) [ISO/IEC 7498-1]

3.1.12 DL-duplex-transmission [ISO/IEC 7498-1]

3.1.13 (N)-entity
DL-entity (N=2)
Ph-entity (N=1) [ISO/IEC 7498-1]

3.1.14 DL-facility [ISO/IEC 7498-1]

3.1.15 flow control [ISO/IEC 7498-1]

3.1.16 (N)-layer
DL-layer (N=2)
Ph-layer (N=1) [ISO/IEC 7498-1]

3.1.17 layer-management [ISO/IEC 7498-1]

3.1.18 DL-local-view [ISO/IEC 7498-3]

3.1.19 DL-name [ISO/IEC 7498-3]

3.1.20 naming-(addressing)-domain [ISO/IEC 7498-3]

3.1.21 peer-entities [ISO/IEC 7498-1]

3.1.22 primitive name [ISO/IEC 7498-3]

3.1.23 DL-protocol [ISO/IEC 7498-1]

3.1.24 DL-protocol-connection-identifier [ISO/IEC 7498-1]

3.1.25 DL-protocol-data-unit [ISO/IEC 7498-1]

3.1.26 DL-relay [ISO/IEC 7498-1]

3.1.27 reset [ISO/IEC 7498-1]

3.1.28 responding-DL-address [ISO/IEC 7498-3]

3.1.29 routing [ISO/IEC 7498-1]

3.1.30 segmenting [ISO/IEC 7498-1]

3.1.31 (N)-service
DL-service (N=2)
Ph-service (N=1) [ISO/IEC 7498-1]

3.1.32 (N)-service-access-point
DL-service-access-point (N=2)
Ph-service-access-point (N=1) [ISO/IEC 7498-1]

3.1.33 DL-service-access-point-address [ISO/IEC 7498-3]

3.1.34 DL-service-connection-identifier [ISO/IEC 7498-1]

3.1.35 DL-service-data-unit [ISO/IEC 7498-1]

3.1.36 DL-simplex-transmission [ISO/IEC 7498-1]

3.1.37 DL-subsystem [ISO/IEC 7498-1]

3.1.38 systems-management [ISO/IEC 7498-1]

3.1.39 DLS-user-data [ISO/IEC 7498-1]

3.2 Service convention terms and definitions

This standard also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer:

3.2.1 acceptor

3.2.2 asymmetrical service

3.2.3 confirm (primitive); requestor.deliver (primitive)

3.2.4 deliver (primitive)

3.2.5 DL-confirmed-facility

3.2.6 DL-facility

3.2.7 DL-local-view

3.2.8 DL-mandatory-facility

3.2.9 DL-non-confirmed-facility

3.2.10 DL-provider-initiated-facility

3.2.11 DL-provider-optional-facility

3.2.12 DL-service-primitive; primitive

3.2.13 DL-service-provider

3.2.14 DL-service-user

3.2.15 DLS-user-optional-facility

3.2.16 indication (primitive); acceptor.deliver (primitive)

3.2.17 multi-peer

3.2.18 request (primitive); requestor.submit (primitive)

3.2.19 requestor

3.2.20 response (primitive); acceptor.submit (primitive)

3.2.21 submit (primitive)

3.2.22 symmetrical service

3.3 Data-link service terms and definitions

3.3.1
DLE station identifier
network address assigned to a DLE

3.3.2
DLE station slot
unit (granularity of one) of position dependent mapping (for cyclic data field) of which a DLE may occupy one or more, delineated by the range beginning at the DLE station identifier with a length equal to the configured number of occupied slots

3.3.3
DL-segment, link, local link
single DL-subnetwork in which any of the connected DLEs may communicate directly, without any intervening DL-relaying, whenever all of those DLEs that are participating in an instance of communication are simultaneously attentive to the DL-subnetwork during the period(s) of attempted communication

3.3.4
DLSAP
distinctive point at which DL-services are provided by a single DL-entity to a single higher-layer entity

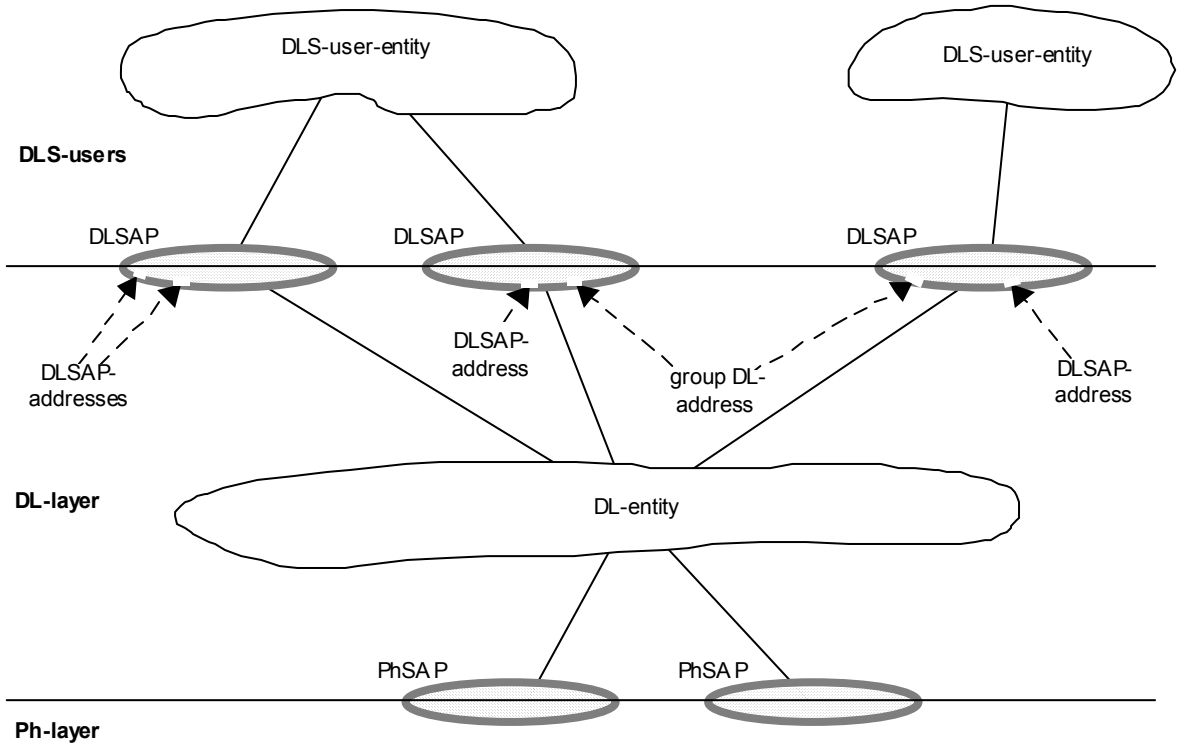
NOTE This definition, derived from ISO/IEC 7498-1, is repeated here to facilitate understanding of the critical distinction between DLSAPs and their DL-addresses.

3.3.5
DL(SAP)-address
either an individual DLSAP-address, designating a single DLSAP of a single DLS-user, or a group DL-address potentially designating multiple DLSAPs, each of a single DLS-user

NOTE This terminology is chosen because ISO/IEC 7498-3 does not permit the use of the term DLSAP-address to designate more than a single DLSAP at a single DLS-user.

3.3.6
(individual) DLSAP-address
DL-address that designates only one DLSAP within the extended link

NOTE A single DL-entity may have multiple DLSAP-addresses associated with a single DLSAP.



NOTE 1 DLSAPs and PhSAPs are depicted as ovals spanning the boundary between two adjacent layers.

NOTE 2 DL-addresses are depicted as designating small gaps (points of access) in the DLL portion of a DLSAP.

NOTE 3 A single DL-entity may have multiple DLSAP-addresses and group DL-addresses associated with a single DLSAP.

Figure 1 – Relationships of DLSAPs, DLSAP-addresses and group DL-addresses

3.3.7
extended link
DL-subnetwork, consisting of the maximal set of links interconnected by DL-relays, sharing a single DL-name (DL-address) space, in which any of the connected DL-entities may communicate, one with another, either directly or with the assistance of one or more of those intervening DL-relay entities

NOTE An extended link may be composed of just a single link.

3.3.8
frame
denigrated synonym for DLPDU

3.3.9
group DL-address
DL-address that potentially designates more than one DLSAP within the extended link

NOTE A single DL-entity may have multiple group DL-addresses associated with a single DLSAP. A single DL-entity also may have a single group DL-address associated with more than one DLSAP.

3.3.10
master DLE
DLE that performs the functions of network master

3.3.11
master-packed DLE
master DLE that uses the packed response access protocol

3.3.12
master-polled DLE
master DLE that uses the polled response access protocol

3.3.13
node
single DL-entity as it appears on one local link

3.3.14
packed response
transmission of data managed by the process of a master broadcasting a trigger message whereupon each slave waits a time period unique to its DLE station identifier then transmits its response resulting in a time-sliced packing of all slave responses triggered by a single master request

3.3.15
polled response
transmission of data managed by the process of a master individually interrogating each slave in a request/response paradigm

3.3.16
receiving DLS-user
DL-service user that acts as a recipient of DLS-user-data

NOTE A DL-service user can be concurrently both a sending and receiving DLS-user.

3.3.17
RWr
DLS-user visible register containing word-oriented cyclic data of type input data that is transmitted from a slave DLE to a master DLE

3.3.18
RWw
DLS-user visible register containing word-oriented cyclic data of type input data that is transmitted from a master DLE to a slave DLE

3.3.19
RX
DLS-user visible register containing bit-oriented cyclic data of type input data that is transmitted from a slave DLE to a master DLE

3.3.20
RY
DLS-user visible register containing bit-oriented cyclic data of type output data that is transmitted from a master DLE to a slave DLE

3.3.21
sending DLS-user
DL-service user that acts as a source of DLS-user-data

3.3.22
slave DLE
DLE that performs the functions of network slave

3.3.23
slave-packed DLE
slave DLE that uses the packed response access protocol

3.3.24
slave-polled DLE
slave DLE that uses the polled response access protocol

3.4 Common symbols and abbreviations

DL-	Data-link layer (as a prefix)
DLC	DL-connection
DLCEP	DL-connection-end-point
DLE	DL-entity (the local active instance of the data-link layer)
DLL	DL-layer
DLPCI	DL-protocol-control-information
DLPDU	DL-protocol-data-unit
DLM	DL-management
DLME	DL-management Entity (the local active instance of DL-management)
DLMS	DL-management Service
DLS	DL-service
DLSAP	DL-service-access-point
DLSDU	DL-service-data-unit
FIFO	First-in first-out (queuing method)
OSI	Open systems interconnection
Ph-	Physical layer (as a prefix)
PhE	Ph-entity (the local active instance of the physical layer)
PhL	Ph-layer
QoS	Quality of service

3.5 Conventions

3.5.1 Basic conventions

This standard uses the descriptive conventions given in ISO/IEC 10731.

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

Service primitives, used to represent service user/service provider interactions (see ISO/IEC 10731), convey parameters that indicate information available in the user/provider interaction.

This standard uses a tabular format to describe the component parameters of the DLS primitives. The parameters that apply to each group of DLS primitives are set out in tables throughout the remainder of this standard. Each table consists of up to six columns, containing the name of the service parameter, and a column each for those primitives and parameter-transfer directions used by the DLS:

— the request primitive's input parameters;

— the request primitive's output parameters;

— the indication primitive's output parameters;

— the response primitive's input parameters; and

— the confirm primitive's output parameters.

NOTE The request, indication, response and confirm primitives are also known as requestor.submit, acceptor.deliver, acceptor.submit, and requestor.deliver primitives, respectively (see ISO/IEC 10731).

One parameter (or part 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 and parameter direction specified in the column:

M — parameter is mandatory for the primitive.

U — parameter is a User option, and may or may not be provided depending on the dynamic usage of the DLS-user. When not provided, a default value for the parameter is assumed.

C — parameter is conditional upon other parameters or upon the environment of the DLS-user.

(blank) — parameter is never present.

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.

In any particular interface, not all parameters need be explicitly stated. Some may be implicitly associated with the DLSAP at which the primitive is issued.

In the diagrams which illustrate these interfaces, dashed lines indicate cause-and-effect or time-sequence relationships, and wavy lines indicate that events are roughly contemporaneous.

3.5.2 DLE support level

There are three levels of data transmission support for a DLE.

- Level A – supports only bit-oriented cyclic data transmission.
- Level B – includes level A as well as word-oriented cyclic data transmission.
- Level C – includes level B as well as acyclic data transmission.

3.5.3 DLE station identifiers

By convention, certain DLE station identifiers have implied reference to their DLE class as specified in Table 1.

Table 1 – DLE station identifiers

Value	DLE class
0	Master DLE
1 – 64	Slave DLE
128	Standby master DLE

4 Data link services

4.1 Overview

The Type 18 DL specifies a master/slave relationship for data transmission traffic management. DL-management services are provided to establish connections whereupon a DLE is instantiated as either a master DLE or a slave DLE.

Once connected, the master DLE scans all connected slave DLEs for cyclic, and for the polled class acyclic, data under the control of the DLS-user. Cyclic data is transmitted in the same format (bit-oriented and word-oriented) in every scan. Acyclic data is transmitted as required in a request/response message format. Only the master-polled DLE is able to generate acyclic data requests.

4.2 Primitives of the DLS

The DLS provides the following service primitives for data transmission and reception:

- CYCLIC-DATA-UPDATE
- ACYCLIC-DATA-TRANSMIT
- MASTER-TRANSMISSION-TRIGGER.

4.3 CYCLIC-DATA-UPDATE

4.3.1 Parameters

Parameters are listed in Table 2.

Table 2 – CYCLIC-DATA-UPDATE parameters

Parameter name	Request	Indication
Master status	C	
Maximum DLE station identifier	C	
Output data	M	
Slave status		M
Input data		M

4.3.2 Master-polled

4.3.2.1 Request

The master status, bit-oriented output register (RY) and, for DLE support level B, word-oriented output registers (RWw) are updated with the values specified in the DLSDU.

4.3.2.2 Indication

The slave status, bit-oriented input registers (RX) and, for DLE support level B, word-oriented input registers (RWr) have been updated with the values specified in the processed DLPDU.

4.3.3 Slave-polled

4.3.3.1 Request

The slave status, bit-oriented input registers (RX) and, for DLE support level B, word-oriented input registers (RWr) are updated with the values specified in the DLSDU.

4.3.3.2 Indication

The master status, bit-oriented output register (RY) and, for DLE support level B, word-oriented output registers (RWw) have been updated with the values specified in the processed DLPDU.

4.3.4 Master-packed

4.3.4.1 Request

The maximum DLE station identifier and the bit-oriented output register (RY) is updated with the values specified in the DLSDU.

4.3.4.2 Indication

The slave status and the bit-oriented input register (RX) have been updated with the values specified in the processed DLPDU.

4.3.5 Slave-packed

4.3.5.1 Request

The slave status and the bit-oriented input register (RX) is updated with the values specified in the DLSDU.

4.3.5.2 Indication

The maximum DLE station identifier and the bit-oriented output register (RY) have been updated with the values specified in the processed DLPDU.

4.4 ACYCLIC-DATA-TRANSMIT

4.4.1 Parameters

Parameters are listed in Table 3.

Table 3 – ACYCLIC-DATA-TRANSMIT parameters

Parameter name	Request	Indication	Response	Confirm
Acyclic message	M	M(=)	M	M(=)

4.4.2 Master-polled

4.4.2.1 Request

The master's acyclic message data is queued with the message from the DLSDU and will be transmitted upon execution of the next MASTER-TRANSMISSION-TRIGGER request.

4.4.2.2 Confirmation

A slave's acyclic message response data has been received.

4.4.3 Slave-polled

4.4.3.1 Indication

A master's acyclic message request data has been received.

4.4.3.2 Response

The slave's acyclic message response data is queued with the message from the DLSDU and will be transmitted along with the slave's next cyclic data transmission as specified by Type 18 DL-protocol.

4.5 MASTER-TRANSMISSION-TRIGGER

4.5.1 Parameters

There are no parameters defined for this service.

4.5.2 Request

The MASTER-TRANSMISSION-TRIGGER request is only supported by a master DLE. Receipt of the MASTER-TRANSMISSION-TRIGGER request causes the master DLE to initiate the master DLE transmission method defined by the Type 18 DL-protocol.

5 DL-management Services

5.1 Overview

The Type 18 DL specifies a master/slave relationship for data transmission traffic management. DL-management services are provided to establish connections whereupon a DLE is instantiated as either a master DLE or a slave DLE.

Once connected, DL-management services are provided to release, suspend and resume connections. Error indications and other more specialized services are also provided.

5.2 Required services

The DL provides the following service primitive for DL management:

- ESTABLISH-MASTER-POLLED
- ESTABLISH-SLAVE-POLLED
- ESTABLISH-MASTER-PACKED
- ESTABLISH-SLAVE-PACKED
- RELEASE-CONNECTION
- SUSPEND-CONNECTION
- RESUME-CONNECTION
- ACTIVATE-STANDBY-MASTER
- Error

5.3 ESTABLISH-MASTER-POLLED

5.3.1 Parameters

Parameters are listed in Table 4.

Table 4 – ESTABLISH-MASTER-POLLED parameters

Parameter name	Request	Confirm
Baud rate	M	
Master's status	M	
Slaves' status		M
Slave's configuration		M

5.3.2 Request

The DL executes the establish master-polled DLE procedure, as defined by the Type 18 DL-protocol.

The baud rate parameter values are specified in Table 5.

Table 5 – Baud rate parameter values

Value	Baud rate (kbit/s)
0	156
1	625
2	2 500
3	5 000
4	10 000

5.3.3 Confirmation

The DLE has been instantiated as a master-polled DLE. The DLSDU contains the slave's status fields collected from each slave discovered on the network. The slave's status parameter is a position mapped array of 64 elements corresponding to DLE station identifier. The slave's configuration parameter is a position mapped array of 65 elements corresponding to DLE station identifier.

NOTE Although the slave's configuration structure is a representation of all connected slaves, the one exception is that DLE station identifier 128 (the 65th element) specifies the configuration of a standby type master-polled DLE.

5.4 ESTABLISH-SLAVE-POLLED

5.4.1 Parameters

Parameters are listed in Table 6.

Table 6 – ESTABLISH-SLAVE-POLLED parameters

Parameter name	Request	Confirm
Master's status		M
Slaves' status	M	
Slave's configuration	M	

5.4.2 Request

The DL executes the establish slave-polled DLE procedure, as defined by the Type 18 DL-protocol.

5.4.3 Confirmation

The DLE has been instantiated as a slave-polled DLE. The DLSDU contains the master's status parameter that was received during the establish slave-polled DLE procedure.

5.5 ESTABLISH-MASTER-PACKED

5.5.1 Parameters

Parameters are listed in Table 7.

Table 7 – ESTABLISH-MASTER-PACKED parameters

Parameter name	Request	Confirm
Baud rate	M	
Maximum DLE station identifier	M	
Bit width	M	
Slave's configuration		M

5.5.2 Request

The DL executes the establish master-polled DLE procedure, as defined by the Type 18 DL-protocol.

The baud rate parameter values are specified in Table 8, the maximum DLE station identifier is in the range of 1 to 64 and the bit width parameter values are specified in Table 9 which configures the number of bits associated with each DLE station slot.

Table 8 – Baud rate parameter values

Value	Baud rate (kbit/s)
0	156
1	625
2	2 500

Table 9 – Bit width parameter values

Value	Bit width
1	4
2	8
3	16

5.5.3 Confirmation

The DLE has been instantiated as a master-packed DLE. The DLSDU contains the slave's configuration fields collected from each slave discovered on the network. The slave's configuration parameter is a position mapped array of 64 elements corresponding to DLE station identifier.

5.6 ESTABLISH-SLAVE-PACKED

5.6.1 Parameters

Parameters are listed in Table 10.

Table 10 – ESTABLISH-SLAVE-PACKED parameters

Parameter name	Request	Confirm
Maximum DLE station identifier		M
Bit width		M
Slave's configuration	M	

5.6.2 Request

The DL executes the establish slave-packed DLE procedure, as defined by the Type 18 DL-protocol.

5.6.3 Confirmation

The DLE has been instantiated as a slave-packed DLE. The DLSDU contains the maximum DLE station identifier and the configured bit width parameters that were received during the establish slave-packed DLE procedure.

5.7 RELEASE-CONNECTION

5.7.1 Parameters

Parameters are listed in Table 11.

Table 11 – RELEASE-CONNECTION parameters

Parameter name	Request
DLE station identifier	M

5.7.2 Request

The DLE executes the release connection procedure as defined by the Type 18 DL-protocol whereupon the connection to the requested DLE station is released.

5.8 SUSPEND-CONNECTION

5.8.1 Parameters

Parameters are listed in Table 12.

Table 12 – SUSPEND-CONNECTION parameters

Parameter name	Request
DLE station identifier	M

5.8.2 Request

The DLE executes the suspend connection procedure as defined by the Type 18 DL-protocol whereupon the connection to the requested DLE station is suspended.

5.9 RESUME-CONNECTION

5.9.1 Parameters

Parameters are listed in Table 13.

Table 13 – RESUME-CONNECTION parameters

Parameter name	Request
DLE station identifiers	M

5.9.2 Request

The DLE executes the resume connection procedure as defined by the Type 18 DL-protocol whereupon the connection to the requested DLE stations are resumed.

For the master DLE class, the DLE station identifier parameter is a list of DLE station identifiers. This service is only valid for DLE station identifiers that are in the suspended state.

For the slave DLE class, the DLE station identifier parameter is a single DLE station identifier. This service is only valid for a DLE station identifier that is in the suspended state.

5.10 ACTIVATE-STANDBY-MASTER

5.10.1 Parameters

There are no parameters defined for this service.

5.10.2 Request

This service is only supported by a master-polled DLE that has been configured as a master-polled DLE with the DLE master type set to standby. It is expected that the DLS-user performs the appropriate procedures for translating the values of input registers to the values for output registers and assuming the behavior of a master type DLS-user.

The DLE executes the activate standby master procedure as defined by the Type 18 DL-protocol and upon successful completion, the DLE becomes a master-polled DLE with the DLE master type set to active.

5.11 ERROR

5.11.1 Parameters

Parameters are listed in Table 14.

Table 14 – ERROR parameters

Parameter name	Indication
Error code	M

5.11.2 Indication

The Error indication is sent to the DLS-user in response to events as described in the Type 18 DL-protocol. The status parameter identifies a particular error as listed in the following list and explained in the Type 18 DL-protocol.

a) frame-error

b) crc-error

c) abort-error

d) buffer-overflow

e) invalid-address

f) master DLE-timeout – generated by the slave DLE class only

g) slave DLE-timeout – generated by the master DLE class only

h) all-slaves-suspended – generated by the master DLE class only.

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