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INTERNATIONAL  
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**CEI  
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**60870-5-104**

Deuxième édition  
Second edition  
2006-06

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**Matériels et systèmes de téléconduite –**

**Partie 5-104:  
Protocoles de transmission –  
Accès aux réseaux utilisant des profils de  
transport normalisés pour la CEI 60870-5-101**

**Telecontrol equipment and systems –**

**Part 5-104:  
Transmission protocols –  
Network access for IEC 60870-5-101  
using standard transport profiles**



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Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: [inmail@iec.ch](mailto:inmail@iec.ch) Web: [www.iec.ch](http://www.iec.ch)

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**TELECONTROL EQUIPMENT AND SYSTEMS –****Part 5-104: Transmission protocols –  
Network access for IEC 60870-5-101 using  
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International Standard IEC 60870-5-104 Ed.2 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This second edition cancels and replaces the first edition published in 2000 and constitutes a technical revision. The main changes of this second edition with respect to the previous edition are as follows: improvement of the sequences and interoperability of the protocol and addition of new functions for the handling of redundant connections.

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

| FDIS        | Report on voting |
|-------------|------------------|
| 57/812/FDIS | 57/819/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 the ISO/IEC directives, Part 2.

IEC 60870-5 consists of the following parts, under the general title *Telecontrol equipment and systems – Part 5: Transmission protocols*

- Part 5: Transmission protocols – Section One: Transmission frame formats
- Part 5: Transmission protocols – Section 2: Link transmission procedures
- Part 5: Transmission protocols – Section 3: General structure of application data
- Part 5: Transmission protocols – Section 4: Definition and coding of application information elements
- Part 5: Transmission protocols – Section 5: Basic application functions
- Part 5-6: Guidelines for conformance testing for the IEC 60870-5 companion standards
- Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks
- Part 5: Transmission protocols – Section 102: Companion standard for the transmission of integrated totals in electric power systems
- Part 5-103: Transmission protocols – Companion standard for the informative interface of protection equipment
- Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles
- Part 5-601: Conformance test cases for the IEC 60870-5-101 companion standard

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.

## INTRODUCTION

IEC 60870-5-101 provides a communication profile for sending basic telecontrol messages between a central telecontrol station and telecontrol outstations, which uses permanent directly connected data circuits between the central station and individual outstations.

In some applications, it may be required to send the same types of application messages between telecontrol stations using a data network containing relay stations which store and forward the messages and provide only a virtual circuit between the telecontrol stations. This type of network delays messages by varying amounts of time depending on the network traffic load.

In general, the variable message delay times mean that it is not possible to use the link layer as defined in IEC 60870-5-101 between telecontrol stations. However, in some cases it is possible to connect telecontrol stations having all three layers of the companion standard IEC 60870-5-101 to suitable data networks using Packet Assembler Disassembler (PAD) type stations to provide access for balanced communication.

In all other cases this companion standard, which does not use the link functions of IEC 60870-5-101, may be used to provide balanced access via a suitable transport profile.

**TELECONTROL EQUIPMENT AND SYSTEMS –****Part 5-104: Transmission protocols –  
Network access for IEC 60870-5-101 using  
standard transport profiles****1 Scope and object**

This part of IEC 60870 applies to telecontrol equipment and systems with coded bit serial data transmission for monitoring and controlling geographically widespread processes. It defines a telecontrol companion standard that enables interoperability among compatible telecontrol equipment. The defined telecontrol companion standard utilizes standards of the IEC 60870-5 series. The specifications of this part present a combination of the application layer of IEC 60870-5-101 and the transport functions provided by a TCP/IP (Transmission Control Protocol/Internet Protocol). Within TCP/IP, various network types can be utilized, including X.25, FR (Frame Relay), ATM (Asynchronous Transfer Mode) and ISDN (Integrated Service Data Network). Using the same definitions, alternative ASDUs (Application Service Data Unit) as specified in other IEC 60870-5 companion standards (for example, IEC 60870-5-102) may be combined with TCP/IP, but this is not described further in this part.

NOTE Security mechanisms are outside the scope of 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.

IEC 60870-5-3:1992, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 3: General structure of application data*

IEC 60870-5-4:1993, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 4: Definition and coding of application information elements*

IEC 60870-5-5:1995, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 5: Basic application functions*

IEC 60870-5-101:2003, *Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks*

IEC 60870-5-102:1996, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 102: Companion standard for the transmission of integrated totals in electric power systems*

ITU-T Recommendation X.25:1996, *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit*

IEEE 802.3:1998, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

RFC 791, *Internet Protocol, Request for Comments 791 (MILSTD 1777) (September, 1981)*

RFC 793, *Transmission Control Protocol, Request for Comments 793 (MILSTD 1778) (September, 1981)*

RFC 894, *Internet Protocol on Ethernet Networks*

RFC 1661, *Point-to-Point Protocol (PPP)*

RFC 1662, *PPP in HDLC Framing*

RFC 1700, *Assigned Numbers, Request for Comments 1700 (STD 2) (October, 1994)*

RFC 2200, *Internet Official Protocol Standards, Request for Comments 2200 (June, 1997)*

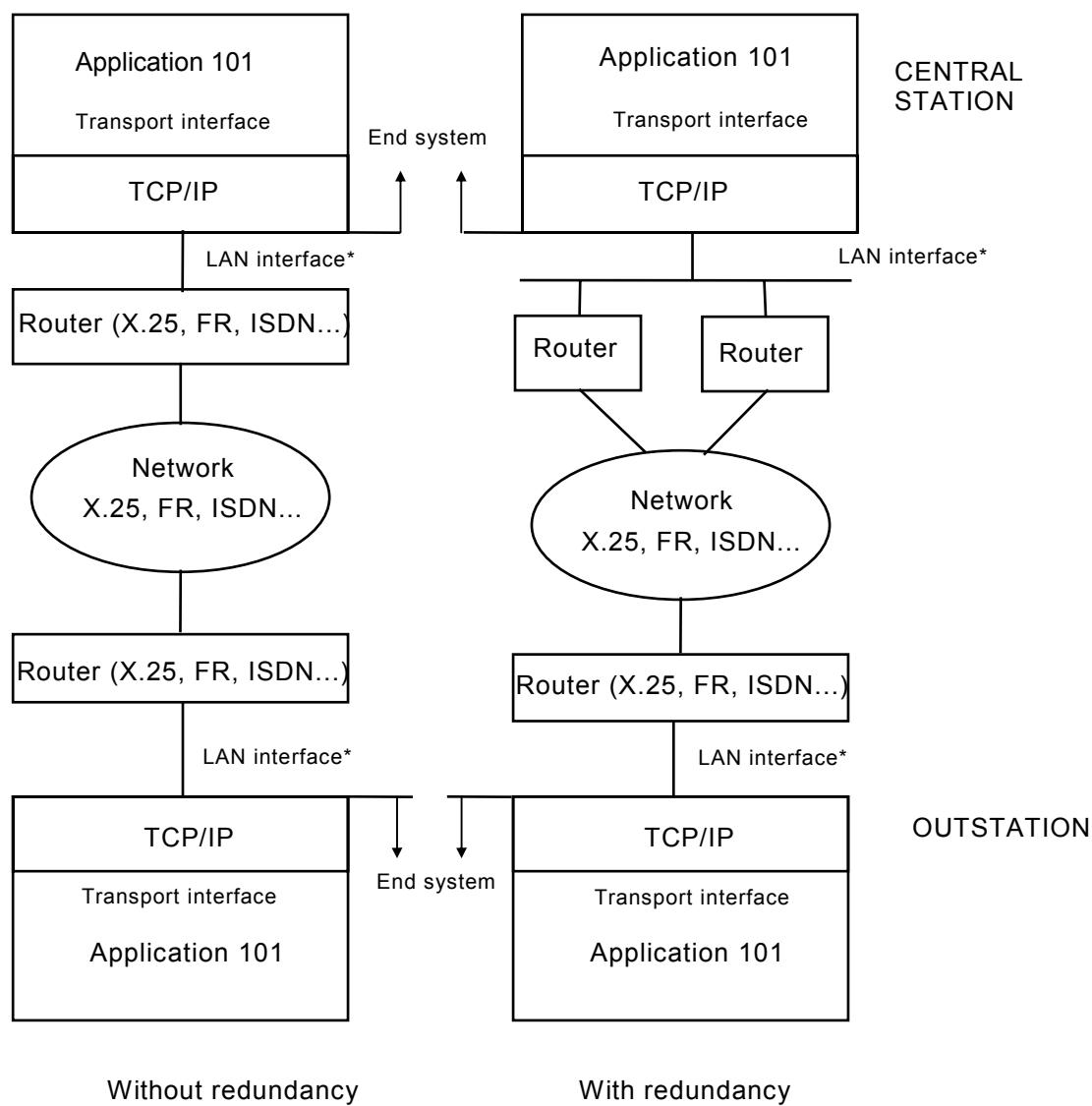
### 3 General architecture

This standard defines the use of an open TCP/IP-interface to a network, containing for example a LAN for telecontrol equipment, which transports IEC 60870-5-101 ASDUs. Routers which include the different WAN-types (for example, X.25, Frame Relay, ISDN, etc.) may be connected via a common TCP/IP-LAN-interface (see figure 1). Figure 1 shows a redundant configuration in the central station in addition to a non-redundant system.

Motivations:

The use of separate routers offers the following advantages.

- There is no need for network-specific software in end systems.
- There is no need for routing functionality in end systems.
- There is no need for network management in end systems.
- It facilitates obtaining end systems from manufacturers that specialize in telecontrol equipment.
- It facilitates obtaining individual separate routers, to suit a variety of networks from manufacturers specializing in this non-telecontrol specific field.
- It is possible to change the network type by replacing only the router type, without affecting the end systems.
- It is particularly suitable for converting existing end systems that conform to IEC 60870-5-101.
- It is suitable for present and future implementations.



IEC 2785/2000

**Figure 1 – General architecture (example)**

## 4 Protocol structure

Figure 2 shows the protocol structure of the end system.

|   |                |                              |
|---|----------------|------------------------------|
| Selection of application functions of IEC 60870-5-5 according to IEC 60870-5-101                      | Initialization | <b>User process</b>          |
| Selection of ASDUs from IEC 60870-5-101 and IEC 60870-5-104   |                | <b>Application (layer 7)</b> |
| APCI (Application Protocol Control Information)<br><b>Transport Interface (user to TCP interface)</b> |                |                              |
|   |                | <b>Transport (layer 4)</b>   |
| Selection of TCP/IP protocol suite (RFC 2200)   |                | <b>Network (layer 3)</b>     |
|   |                | <b>Link (layer 2)</b>        |
|   |                | <b>Physical (layer 1)</b>    |
| NOTE Layers 5 and 6 are not used.   |                |                              |

IEC 2786/2000

### Figure 2 – Selected standard provisions of the defined telecontrol companion standard

Figure 3 shows the recommended selection of the TCP/IP Protocol suite (RFC 2200) used in this standard. At the time of publication, the RFCs indicated were valid, but may have been replaced in the meantime by equivalent, relevant RFCs. The relevant RFCs are available at the Internet address <http://www.ietf.org>.

The Ethernet 802.3 stack shown may be used by a telecontrol station end system or DTE (Data Terminal Equipment) to drive a separate router as shown in the example in figure 1. If a redundant configuration is not required, a point-to-point interface (for example, X.21) to the separate router may be used instead of a LAN interface, thus retaining more of the original hardware when converting end systems originally conforming to IEC 60870-5-101.

Other compatible selections from RFC 2200 are also permitted.

This standard uses the TCP/IP transport profile as defined in other referenced standards, without alteration.

| Transport Interface (user to TCP interface) |   |                                |
|---|---|--------------------------------|
| RFC 793 (Transmission control protocol)     |   | <b>Transport<br/>(layer 4)</b> |
| RFC 791 (Internet protocol)                 |   | <b>Network<br/>(layer 3)</b>   |
| RFC 1661<br>(PPP)                           | RFC 894<br>(Transmission of<br>IP datagrams<br>over ethernet<br>networks) | <b>Data link<br/>(layer 2)</b> |
| Serial line                                 | Ethernet  | <b>Physical<br/>(layer 1)</b>  |

IEC 2787/2000

**Figure 3 – Selected standard provisions of the TCP/IP protocol suite RFC 2200 (example)**

## 5 Definition of Application Protocol Control Information (APCI)

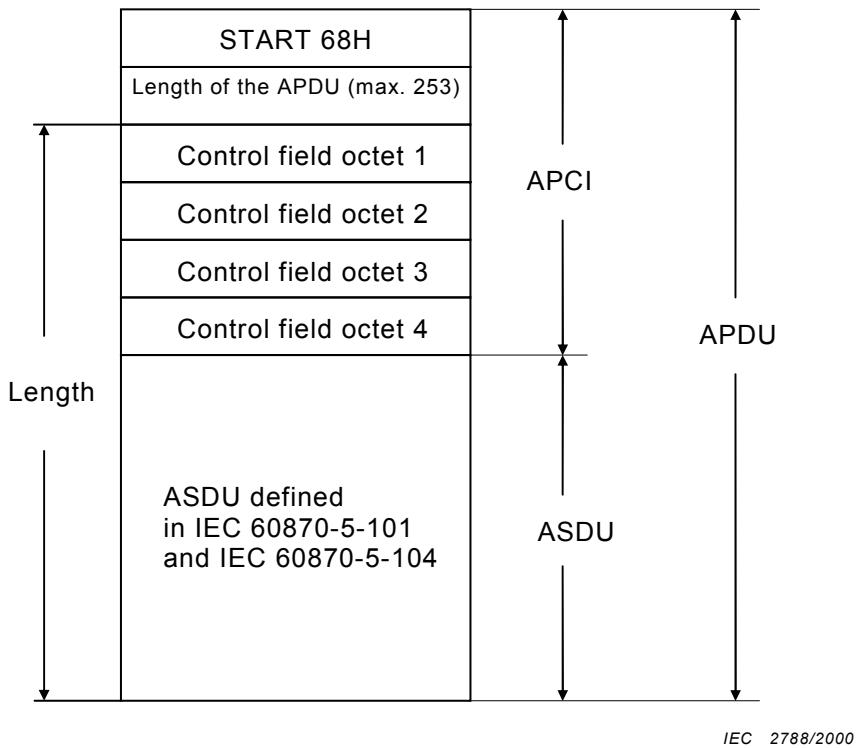
The transport interface (User to TCP interface) is a stream-oriented interface which does not define any start or stop mechanism for the ASDUs of IEC 60870-5-101. In order to detect the start and the end of the ASDUs, each APCI includes the following delimiting elements: a start character, the specification of the length of the ASDU, plus the control field (see figure 4). Either a complete APDU (or, for control purposes, only the APCI fields) may be transferred (see figure 5).

NOTE The abbreviations used above are taken from clause 5 of IEC 60870-5-3 as follows.

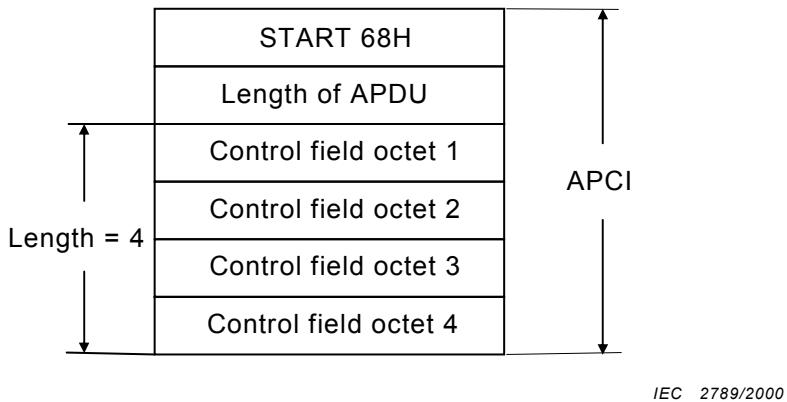
APCI Application Protocol Control Information

ASDU Application Service Data Unit

APDU Application Protocol Data Unit



**Figure 4 – APDU of the defined telecontrol companion standard**



**Figure 5 – APCI of the defined telecontrol companion standard**

START 68H defines the point of start within the data stream.

The length of the APDU defines the length of the body of the APDU, which consists of the four control field octets of the APCI plus the ASDU. The first counted octet is the first octet of the control field, the last counted octet is the last octet of the ASDU. The maximum length of the ASDU is limited to 249 because the maximum value of the field length of APDU is 253 ( $APDU_{max} = 255$  minus start and length octet) and the length of the control field is 4 octets.

The control field defines control information for the protection against loss and duplication of messages, start and stop of message transfers and the supervision of transport connections. The counter mechanism of the control field is defined according to 2.3.2.2.1 to 2.3.2.2.5 of the ITU-T X.25 recommendation.

Figures 6, 7 and 8 show the definition of the control field.

Three types of control field formats are used to perform numbered information transfer (I format), numbered supervisory functions (S format) and unnumbered control functions (U format).

Control field octet 1 bit 1 = 0 defines the I format. I format APDUs always contain an ASDU. The control information of an I format is shown in figure 6.

| Bit | 8                            | 7 | 6 | 5 | 4 | 3 | 2   | 1 |         |
|-----|------------------------------|---|---|---|---|---|-----|---|---------|
|     | Send Sequence Number N(S)    |   |   |   |   |   | LSB | 0 | octet 1 |
| MSB | Send Sequence Number N(S)    |   |   |   |   |   |     |   | octet 2 |
|     | Receive Sequence Number N(R) |   |   |   |   |   | LSB | 0 | octet 3 |
| MSB | Receive Sequence Number N(R) |   |   |   |   |   |     |   | octet 4 |

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**Figure 6 – Control field of type Information transfer format (I format)**

Control field octet 1 bit 1 = 1 and bit 2 = 0 defines the S format. S format APDUs consist of the APCI only. The control information of an S format is shown in figure 7.

| Bit | 8                            | 7 | 6 | 5 | 4 | 3 | 2   | 1 |         |
|-----|------------------------------|---|---|---|---|---|-----|---|---------|
|     | 0                            |   |   |   |   |   | 0   | 1 | octet 1 |
|     | 0                            |   |   |   |   |   |     |   | octet 2 |
|     | Receive Sequence Number N(R) |   |   |   |   |   | LSB | 0 | octet 3 |
| MSB | Receive Sequence Number N(R) |   |   |   |   |   |     |   | octet 4 |

IEC 2791/2000

**Figure 7 – Control field of type numbered supervisory functions (S format)**

Control field octet 1 bit 1 = 1 and bit 2 = 1 defines the U format. U format APDUs consist of the APCI only. The control information of a U format is shown in figure 8. Only one function – TESTFR, STOPDT or STARTDT – may be active at the same time.

| Bit | 8      | 7   | 6      | 5   | 4       | 3   | 2 | 1 |   |         |
|-----|--------|-----|--------|-----|---------|-----|---|---|---|---------|
|     | TESTFR |     | STOPDT |     | STARTDT |     |   | 1 | 1 | octet 1 |
|     | con    | act | con    | act | con     | act |   |   |   | octet 2 |
|     | 0      |     |        |     |         |     |   |   |   |         |
|     | 0      |     |        |     |         |     |   | 0 |   |         |
|     | 0      |     |        |     |         |     |   |   |   |         |

IEC 2792/2000

**Figure 8 – Control field of type unnumbered control functions (U format)**

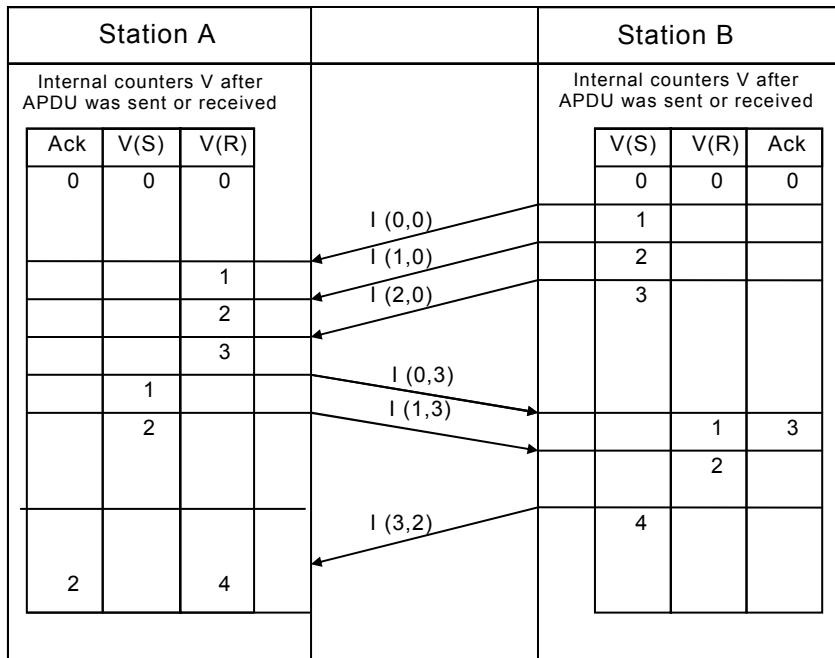
### 5.1 Protection against loss and duplication of messages

The use of the Send Sequence Number N(S) and the Receive Sequence Number N(R) is identical to the method defined in ITU-T X.25. For simplification purposes, the additional sequences are defined in figures 9 to 12.

Both sequence numbers are sequentially increased by one for each APDU and each direction. The transmitter increases the Send Sequence Number N(S) and the receiver increases the Receive Sequence Number N(R). The receiving station acknowledges each APDU or a number of APDUs when it returns the Receive Sequence Number up to the number whose APDUs are properly received. The sending station holds the APDU or APDUs in a buffer until it receives back its own Send Sequence Number as a Receive Sequence Number which is a valid acknowledge for all numbers  $\leq$  the received number. Then it may delete the correctly transmitted APDUs from the buffer. In case of longer data transmission in one direction only, an S format has to be sent in the other direction to acknowledge the APDUs before buffer overflow or time out. This method should be used in both directions. After the establishment of a TCP connection, the send and receive sequence numbers are set to zero.

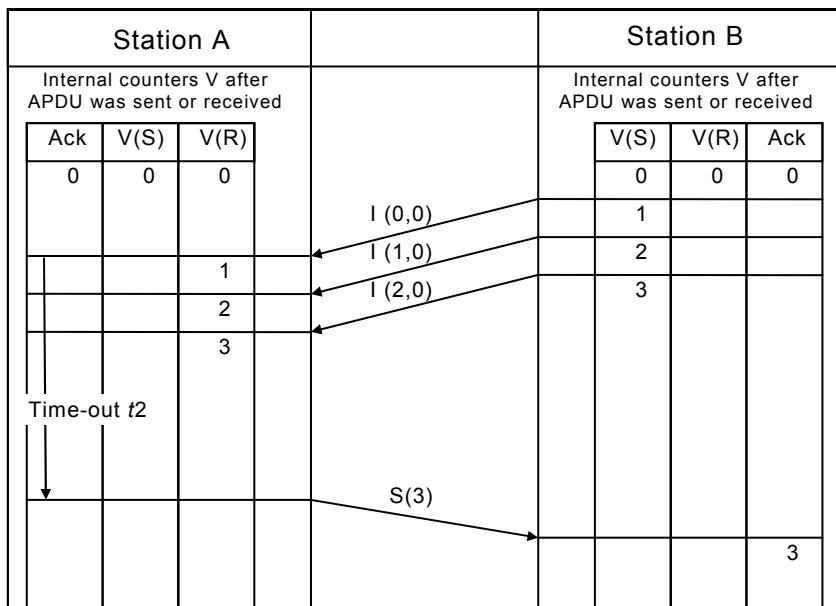
The following definitions are valid for figures 9 to 16:

- V(S) = Send state variable (see ITU-T X.25);
- V(R) = Receive state variable (see ITU-T X.25);
- Ack = Indicates that the DTE has received correctly all I format APDUs numbered up to and including this number;
- I(a,b) = Information format APDU with a = send sequence number and b = receive sequence number;
- S(b) = Supervisory format APDU with b = receive sequence number;
- U = Unnumbered control function APDU.



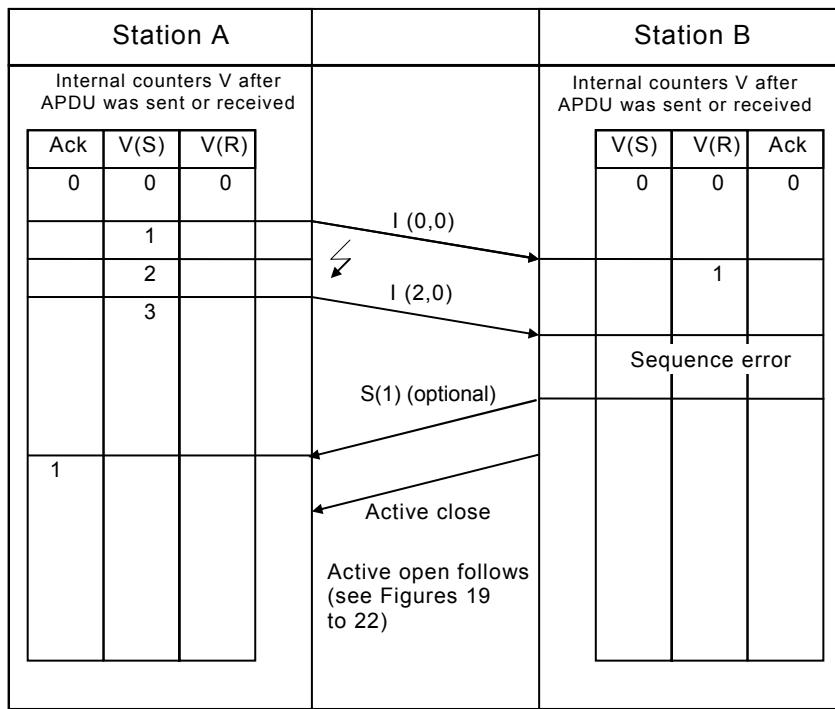
IEC 2793/2000

**Figure 9 – Undisturbed sequences of numbered I format APDUs**



IEC 929/06

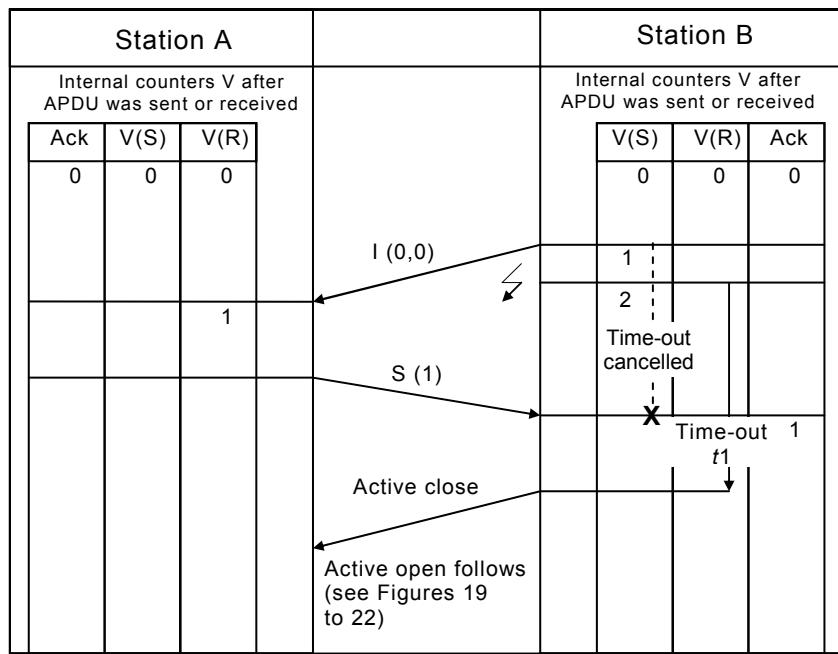
**Figure 10 – Undisturbed sequences of numbered I format APDUs acknowledged by an S format APDU**



IEC 930/06

NOTE To avoid retransmission of APDU's that have already been accepted, an S-frame should, if possible, be sent prior to the active close.

**Figure 11 – Disturbed sequence of numbered I format APDUs**



IEC 931/06

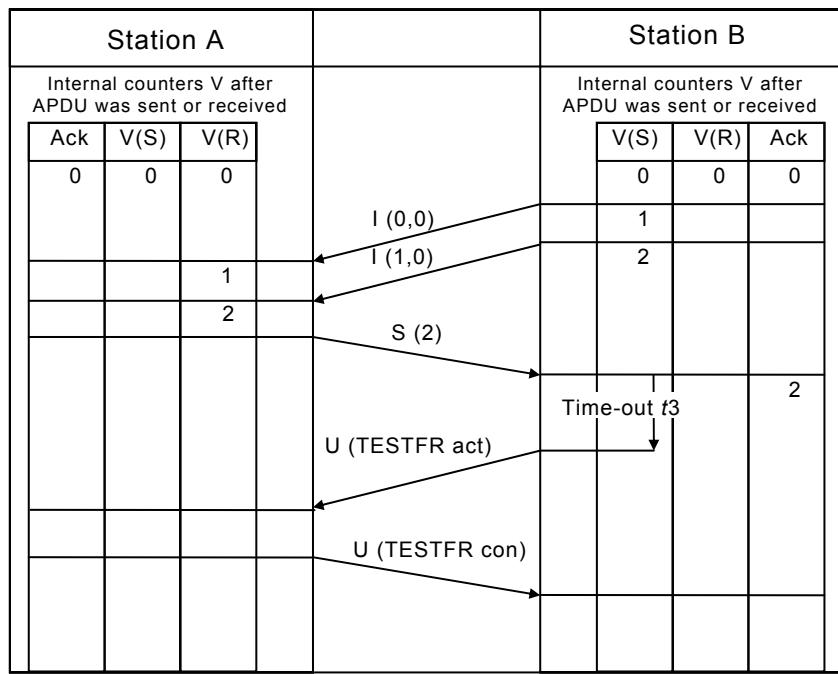
**Figure 12 – Time-out in case of a not acknowledged last I format APDU**

## 5.2 Test procedures

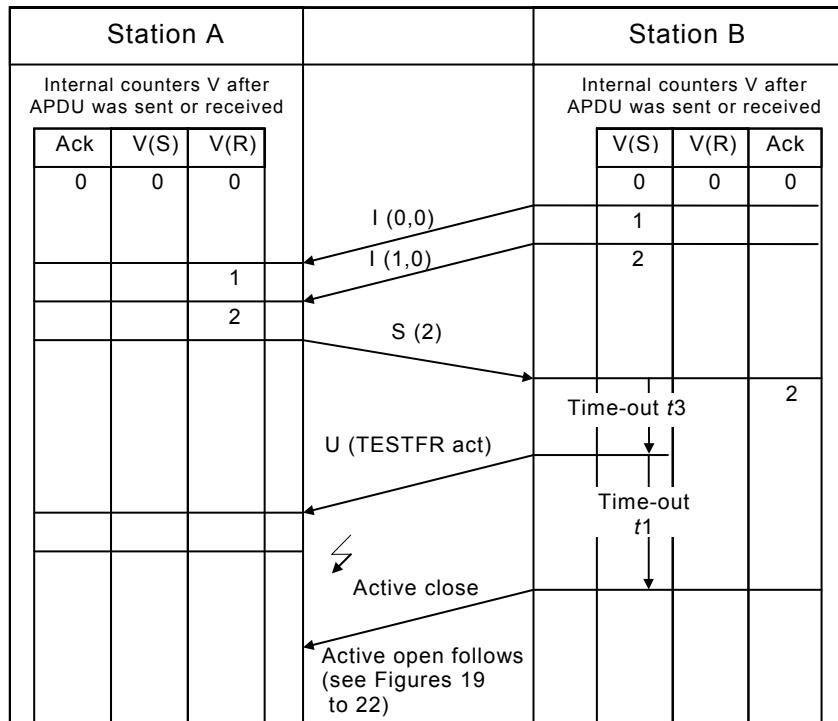
Unused, but open, connections may be periodically tested in both directions by sending test APDUs (TESTFR = act) which are confirmed by the receiving station sending TESTFR = con. Both stations may initiate the test procedure after a specified period of time in which no data transfers occur (time out). The reception of every frame – I frame, S frame or U frame – retriggers timer t3.

Station B has to supervise the connection independently. However, as long as it receives test frames from station A, it will not send test frames.

The test procedure can also be initiated on "active" connections where absence of activity is possible for extended times and connectivity needs to be assured.



IEC 932/06

**Figure 13 – Undisturbed test procedure**

IEC 933/06

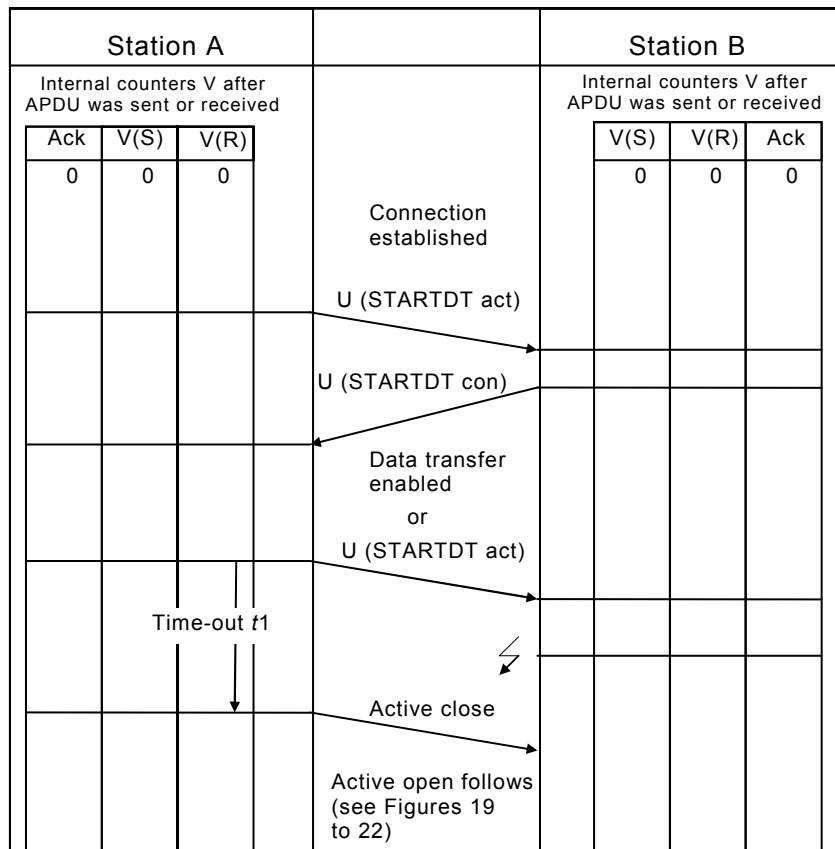
**Figure 14 – Unconfirmed test procedure**

### 5.3 Transmission control using Start/Stop

STARTDT (Start Data Transfer) and STOPDT (Stop Data Transfer) are used by the controlling station (for example, Station A), to control the data transfer from a controlled station (Station B). This is useful, for example, when more than one connection between the stations is open and therefore available, but only one connection at a time is used for the data transfer. The defined functionality for STARTDT and STOPDT avoids loss of data in the case of switchover from one connection to another. STARTDT and STOPDT are also used with single connections between the stations to control the traffic on the connection.

When the connection is established, user data transfer is not automatically enabled from the controlled station on that connection, i.e. STOPDT is the default state when a connection is established. In this state, the controlled station does not send any data via this connection, except unnumbered control functions and confirmations to such functions. The controlling station must activate the user data transfer on a connection by sending a STARTDT act via this connection. The controlled station responds to this command with a STARTDT con. If the STARTDT is not confirmed, the connection is closed by the controlling station. This implies that after station initialization (see 7.1) STARTDT must always be sent before any user data transfer from the controlled station (for example, general interrogated information) is initiated. Any pending user data in the controlled station is sent only after the STARTDT con.

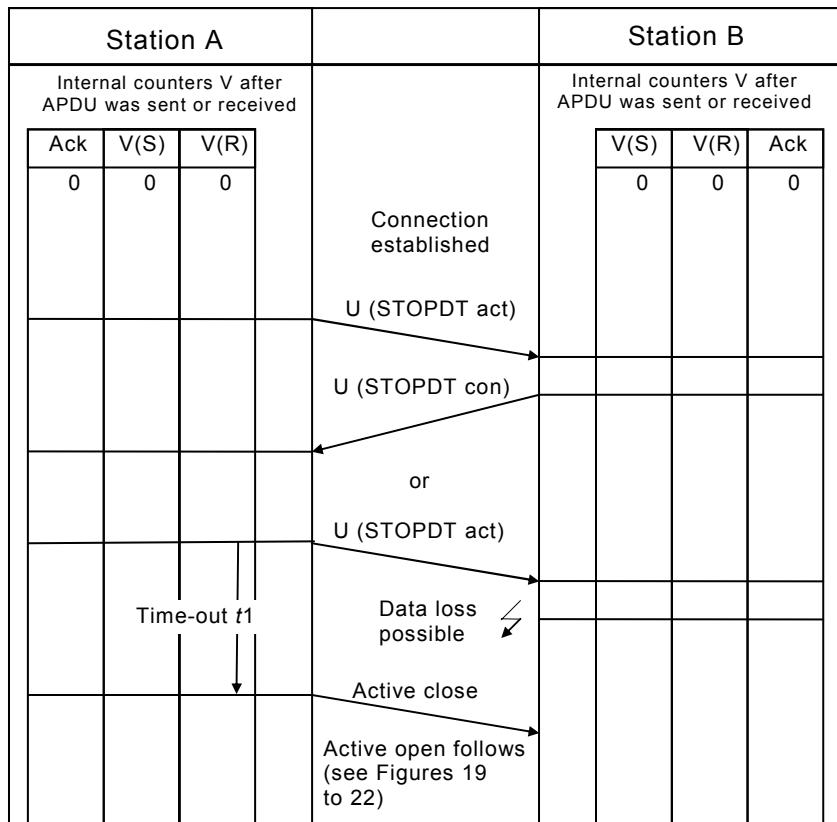
STARTDT/STOPDT is a mechanism for the controlling station to activate/deactivate the monitoring direction. The controlling station may send commands or setpoints even if it has not yet received the activation confirmation. Send and receive counters continue their functionality independent of the use of STARTDT/STOPDT.



IEC 934/06

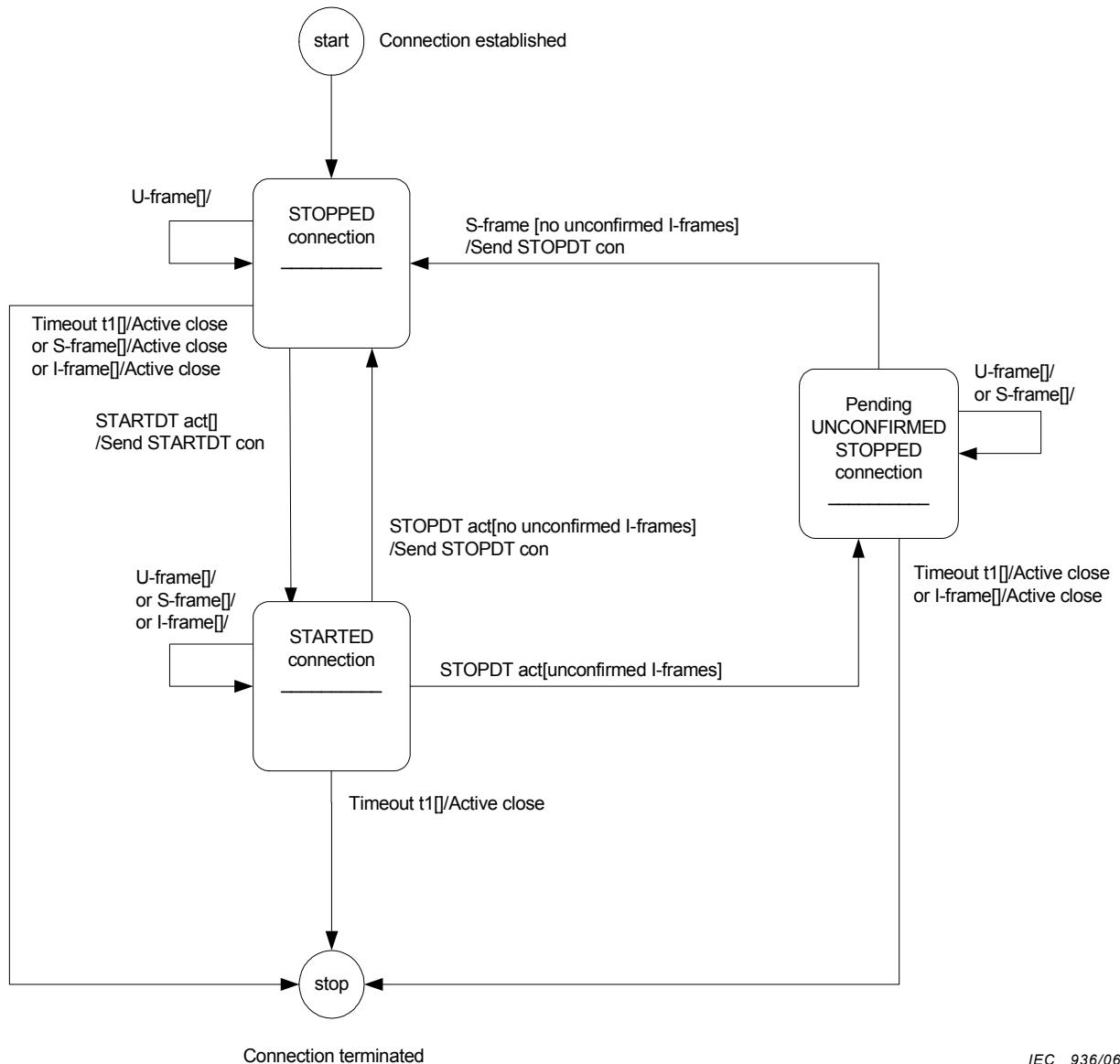
**Figure 15 – Start data transfer procedure**

In the case of, for example, a switchover from an active connection to another connection (for example, by an operator), the controlling station first transmits a STOPDT act on the active connection. The controlled station stops the user data transfer via this connection and returns a STOPDT con. Pending ACKs to user data can be sent from the point of time when the controlled station receives STOPDT act to the point of time when it returns STOPDT con. After receiving the STOPDT con, the controlling station may close the connection. A STARTDT on the other established connection is needed to start the data transfer from the controlled station on that connection (see figure 17).



IEC 935/06

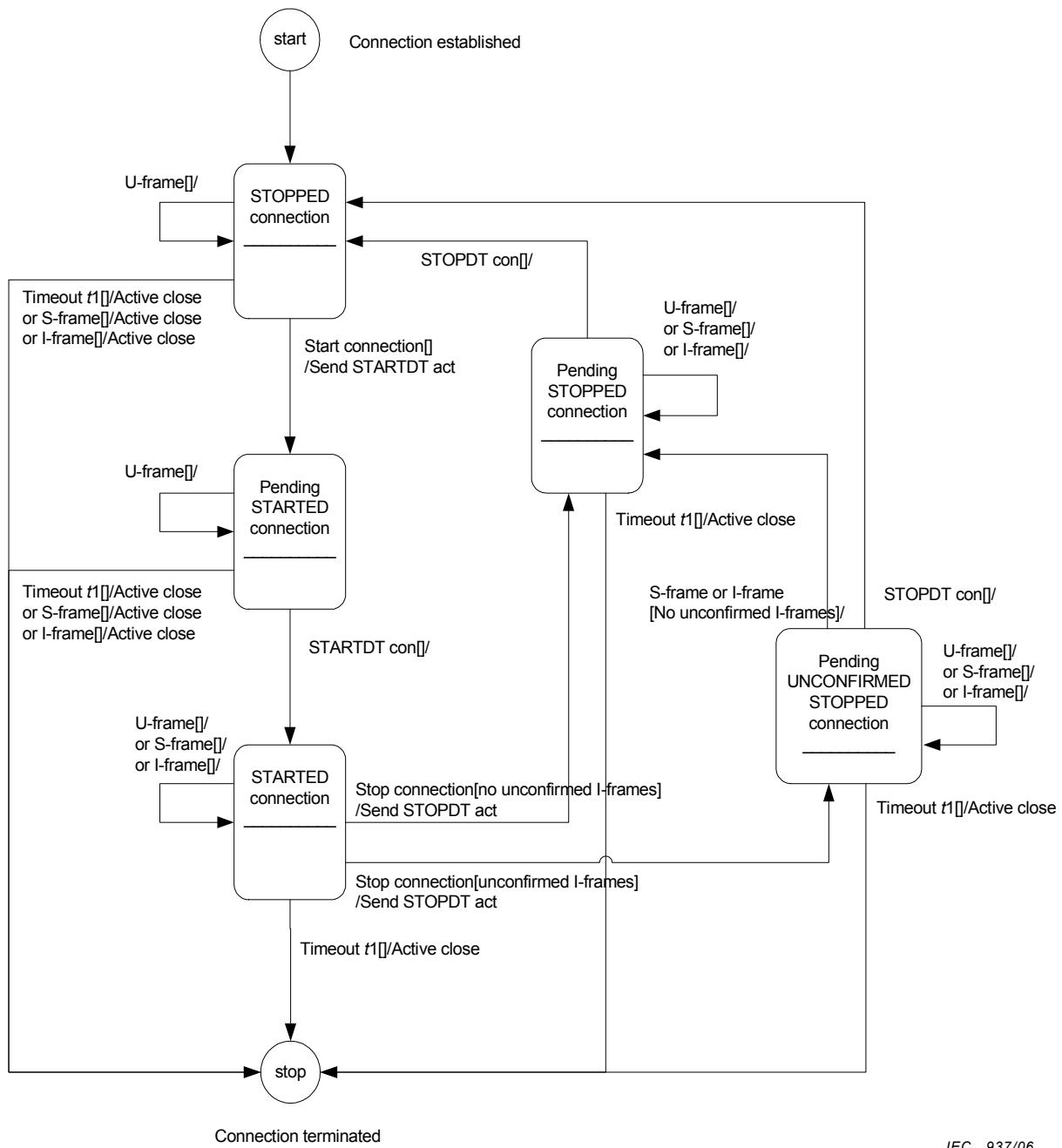
**Figure 16 – Stop data transfer procedure**



NOTE 1 Connection terminated means that there is no longer any data exchange between TCP and the application protocol (CS104).

NOTE 2  $t_1$  is the timeout of a sent U-frame or I-frame.

**Figure 17 – State transition diagram for Start/Stop procedure (controlled station)**



**NOTE 1** Connection terminated means that there is no longer any data exchange between TCP and the application protocol (CS104).

NOTE 2  $t_1$  is the timeout of a sent U-frame or I-frame.

**Figure 18 – State transition diagram for Start/Stop procedure (controlling station)**

STOPDT act stops the transmission of I-frames immediately.

The controlling station should, however, confirm all received messages before sending STOPDT act, and the controlled station should confirm all received messages before returning STOPDT con. This is similar to the case with the pending unconfirmed message at connection closure, see Figure 11.

The controlling station should also immediately send an S-frame upon receiving an I-frame while in the Pending STOPPED state or Pending UNCONFIRMED STOPPED state. This will allow the controlled station to send its STOPDT con sooner (see figure 18).

If unconfirmed messages exist in the controlling station, the controlled station must confirm these messages by sending an S-frame before sending out the STOPDT con. If unconfirmed messages exist in the controlled station, the controlled station must wait for an incoming S-frame confirming these messages before sending out the STOPDT con.

After any connection re-establishment, unconfirmed messages may be transmitted when the Start procedure is completed, if required by the user process.

#### **5.4 Portnumber**

Every TCP address consists of an IP address and a port number. Every equipment connected to the TCP-LAN has its individual IP address, while the standard port number for IEC 60870-5-104 is defined to be 2404, confirmed by IANA.

The server (controlled station) uses the port number 2404 in all cases, both for the listening port and the established connections. The client (controlling station) may use other port numbers, for example ephemeral port numbers, as allocated by the client's TCP implementation.

#### **5.5 Maximum number of outstanding I format APDUs (k)**

The value of  $k$  shall indicate the maximum number of sequentially numbered I format APDUs that the DTE may have outstanding (i.e. unacknowledged) at a given time. Each I frame is sequentially numbered and may have the value 0 through modulus  $n$  minus 1, where "modulus" is the modulus of the sequence numbers which is defined by the parameter  $n$ . The value of  $k$  shall never exceed  $n - 1$  for modulo  $n$  operation (see 2.3.2.2.1 and 2.4.8.6 of the ITU-T X.25 recommendation).

- The transmitter stops the transmission at  $k$  unacknowledged I format APDUs.
- The receiver acknowledges at the latest after receiving  $w = I$  format APDUs\*
- The maximum number of  $k$  is  $n - 1$  for modulo  $n$  operation.

Maximum range of values of  $k$ : 1 to 32767 ( $2^{15}-1$ ) APDUs, accuracy 1 APDU.

Maximum range of values of  $w$ : 1 to 32767 APDUs, accuracy 1 APDU (recommendation:  $w$  should not exceed two-thirds of  $k$ ).

### **6 Selection of ASDUs defined in IEC 60870-5-101 and additional ASDUs**

The following ASDUs defined in IEC 60870-5-101 and in clause 8 of this standard are valid:

---

\* Acknowledging before  $k$  is reached avoids a transmission stop.

**Table 1 – Process information in monitor direction**

|                     |   |           |
|---------------------|---|-----------|
| TYPE IDENTIFICATION | $:= \text{UI8}[1..8]<0..44>$  |           |
| <0>                 | $:=$ not defined  |           |
| <1>                 | $:=$ single-point information   | M_SP_NA_1 |
| <3>                 | $:=$ double-point information   | M_DP_NA_1 |
| <5>                 | $:=$ step position information  | M_ST_NA_1 |
| <7>                 | $:=$ bitstring of 32 bits   | M_BO_NA_1 |
| <9>                 | $:=$ measured value, normalized value   | M_ME_NA_1 |
| <11>                | $:=$ measured value, scaled value   | M_ME_NB_1 |
| <13>                | $:=$ measured value, short floating point number  | M_ME_NC_1 |
| <15>                | $:=$ integrated totals  | M_IT_NA_1 |
| <20>                | $:=$ packed single-point information with status change detection                               | M_PS_NA_1 |
| <21>                | $:=$ measured value, normalized value without quality descriptor                                | M_ME_ND_1 |
| <22..29>            | $:=$ reserved for further compatible definitions  |           |
| *                   | <30> $:=$ single-point information with time tag CP56Time2a                                     | M_SP_TB_1 |
| *                   | <31> $:=$ double-point information with time tag CP56Time2a                                     | M_DP_TB_1 |
| *                   | <32> $:=$ step position information with time tag CP56Time2a                                    | M_ST_TB_1 |
| *                   | <33> $:=$ bitstring of 32 bit with time tag CP56Time2a  | M_BO_TB_1 |
| *                   | <34> $:=$ measured value, normalized value with time tag CP56Time2a                             | M_ME_TD_1 |
| *                   | <35> $:=$ measured value, scaled value with time tag CP56Time2a                                 | M_ME_TE_1 |
| *                   | <36> $:=$ measured value, short floating point number<br>with time tag CP56Time2a               | M_ME_TF_1 |
| *                   | <37> $:=$ integrated totals with time tag CP56Time2a  | M_IT_TB_1 |
| *                   | <38> $:=$ event of protection equipment with time tag CP56Time2a                                | M_EP_TD_1 |
| *                   | <39> $:=$ packed start events of protection equipment<br>with time tag CP56Time2a               | M_EP_TE_1 |
| *                   | <40> $:=$ packed output circuit information of protection equipment<br>with time tag CP56Time2a | M_EP_TF_1 |
| <41..44>            | $:=$ reserved for further compatible definitions  |           |

\* These types are defined on IEC 60870-5-101.

**Table 2 – Process information in control direction**

|   |   |           |
|---|---|-----------|
| TYPE IDENTIFICATION := UI8[1..8]<45..69>                          |   |           |
| <b>CON&lt;45&gt;</b>  | := single command   | C_SC_NA_1 |
| <b>CON&lt;46&gt;</b>  | := double command   | C_DC_NA_1 |
| <b>CON&lt;47&gt;</b>  | := regulating step command  | C_RC_NA_1 |
| <b>CON&lt;48&gt;</b>  | := set point command, normalized value  | C_SE_NA_1 |
| <b>CON&lt;49&gt;</b>  | := set point command, scaled value  | C_SE_NB_1 |
| <b>CON&lt;50&gt;</b>  | := set point command, short floating point number                             | C_SE_NC_1 |
| <b>CON&lt;51&gt;</b>  | := bitstring of 32 bits   | C_BO_NA_1 |
| <52..57> := reserved for further compatible definitions           |   |           |
| ASDUs for process information in control direction with time tag: |   |           |
| <b>CON&lt;58&gt;</b>  | := single command with time tag CP56Time2a                                    | C_SC_TA_1 |
| <b>CON&lt;59&gt;</b>  | := double command with time tag CP56Time2a                                    | C_DC_TA_1 |
| <b>CON&lt;60&gt;</b>  | := regulating step command with time tag CP56Time2a                           | C_RC_TA_1 |
| <b>CON&lt;61&gt;</b>  | := set point command, normalized value with time tag CP56Time2a               | C_SE_TA_1 |
| <b>CON&lt;62&gt;</b>  | := set point command, scaled value with time tag CP56Time2a                   | C_SE_TB_1 |
| <b>CON&lt;63&gt;</b>  | := set point command, short floating-point number<br>with time tag CP56Time2a | C_SE_TC_1 |
| <b>CON&lt;64&gt;</b>  | := bitstring of 32 bits with time tag CP56Time2a                              | C_BO_TA_1 |
| <65..69> := reserved for further compatible definitions           |   |           |

Process information in control direction may be sent with or without a time tag but must not be mixed when sending to a given station.

NOTE ASDUs marked "CON" in the control direction are confirmed application services and may be mirrored in the monitor direction with different causes of transmission. These mirrored ASDUs are used for positive/negative acknowledgements (verifications).

**Table 3 – System information in monitor direction**

|   |  |           |
|---|--|-----------|
| TYPE IDENTIFICATION := UI8[1..8]<70..99>                |  |           |
| <70> := end of initialization                           |  | M_EI_NA_1 |
| <71..99> := reserved for further compatible definitions |  |           |

**Table 4 – System information in control direction**

|   |  |           |
|---|--|-----------|
| TYPE IDENTIFICATION := UI8[1..8]<100..109>                            |  |           |
| <b>CON</b> <100> := interrogation command                             |  | C_IC_NA_1 |
| <b>CON</b> <101> := counter interrogation command                     |  | C_CI_NA_1 |
| <102> := read command   |  | C_RD_NA_1 |
| <b>CON</b> <103> := clock synchronization command (optional, see 7.6) |  | C_CS_NA_1 |
| <b>CON</b> <105> := reset process command                             |  | C_RP_NA_1 |
| <b>CON</b> <107> := test command with time tag CP56Time2a             |  | C_TS_TA_1 |
| <108..109> := reserved for further compatible definitions             |  |           |

**Table 5 – Parameter in control direction**

|  |  |           |
|--|--|-----------|
| TYPE IDENTIFICATION := UI8[1..8]<110..119>                                   |  |           |
| <b>CON</b> <110> := parameter of measured value, normalized value            |  | P_ME_NA_1 |
| <b>CON</b> <111> := parameter of measured value, scaled value                |  | P_ME_NB_1 |
| <b>CON</b> <112> := parameter of measured value, short floating-point number |  | P_ME_NC_1 |
| <b>CON</b> <113> := parameter activation                                     |  | P_AC_NA_1 |
| <114..119> := reserved for further compatible definitions                    |  |           |

**Table 6 – File transfer**

|   |  |           |
|---|--|-----------|
| TYPE IDENTIFICATION := UI8[1..8]<120..127>                    |  |           |
| <120> := file ready   |  | F_FR_NA_1 |
| <121> := section ready  |  | F_SR_NA_1 |
| <122> := call directory, select file, call file, call section |  | F_SC_NA_1 |
| <123> := last section, last segment                           |  | F_LS_NA_1 |
| <124> := ack file, ack section                                |  | F_AF_NA_1 |
| <125> := segment  |  | F_SG_NA_1 |
| <126> := directory  |  | F_DR_TA_1 |
| <127> := Query Log – Request archive file                     |  | F_SC_NB_1 |

NOTE ASDUs marked **CON** in the control direction are confirmed application services and may be mirrored in the monitor direction with different causes of transmission. These mirrored ASDUs are used for positive/negative acknowledgements (verifications).

## 7 Mapping of selected application data units and functions to the TCP services

In this clause, the functions which are selected from IEC 60870-5-5 for use in this standard are specified. The application services defined in this standard are assigned to the suitable transport services defined in RFC 793. The ASDU labels specified are as defined in IEC 60870-5-5.

The controlling station is equivalent to the client (connector), the controlled station to the server (listener).

### 7.1 Station initialization (6.1.5 to 6.1.7 of IEC 60870-5-5)

Release of connections may be initiated by either the controlling or the controlled station. Connection establishment is performed by

- the controlling station in case of a controlled station as a partner;
- a fixed selection (parameter) in the case of two equivalent controlling stations or partners (see figure 1).

Figure 19 shows that an established connection may be closed by the controlling station giving an active close call to its TCP, followed by the controlled station giving a passive close to its TCP. The figure then shows the establishment of a new connection by the controlling station giving an active open call to its TCP after the controlled station has previously given a passive open call to its TCP. Finally, the figure shows the alternative active close of the connection by the controlled station.

Figure 20 shows that, during the initialization of the controlling station, a connection is established with each controlled station in turn. Starting with station 1 the controlling station gives an active open call to its TCP which results in connection establishment if the TCP of station 1 has the listen status (status not shown in the figure). This is then repeated for the remaining controlled stations.

Figure 21 shows the controlling station repeatedly attempting to establish a connection with a controlled station. These attempts fail until the controlled station has performed a local initialization and given a passive open call to its TCP which has then acquired the listen status (status not shown in the figure).

Figure 22 shows the controlling station establishing a connection by giving an active open call to its TCP. The controlling station then sends Reset\_Process to the connected controlled station, which confirms back the Reset\_Process and gives an active close call to its TCP. The connection then closes after the controlling station has given a passive close call to its TCP. Then the controlling station tries to connect the controlled station by giving cyclic active opens to its TCP. When the controlled station is again available, after its remote initialization, it returns a CLT=SYN, ACK. This results in the establishment of a new connection if the controlling station acknowledges the CLT=SYN, ACK.

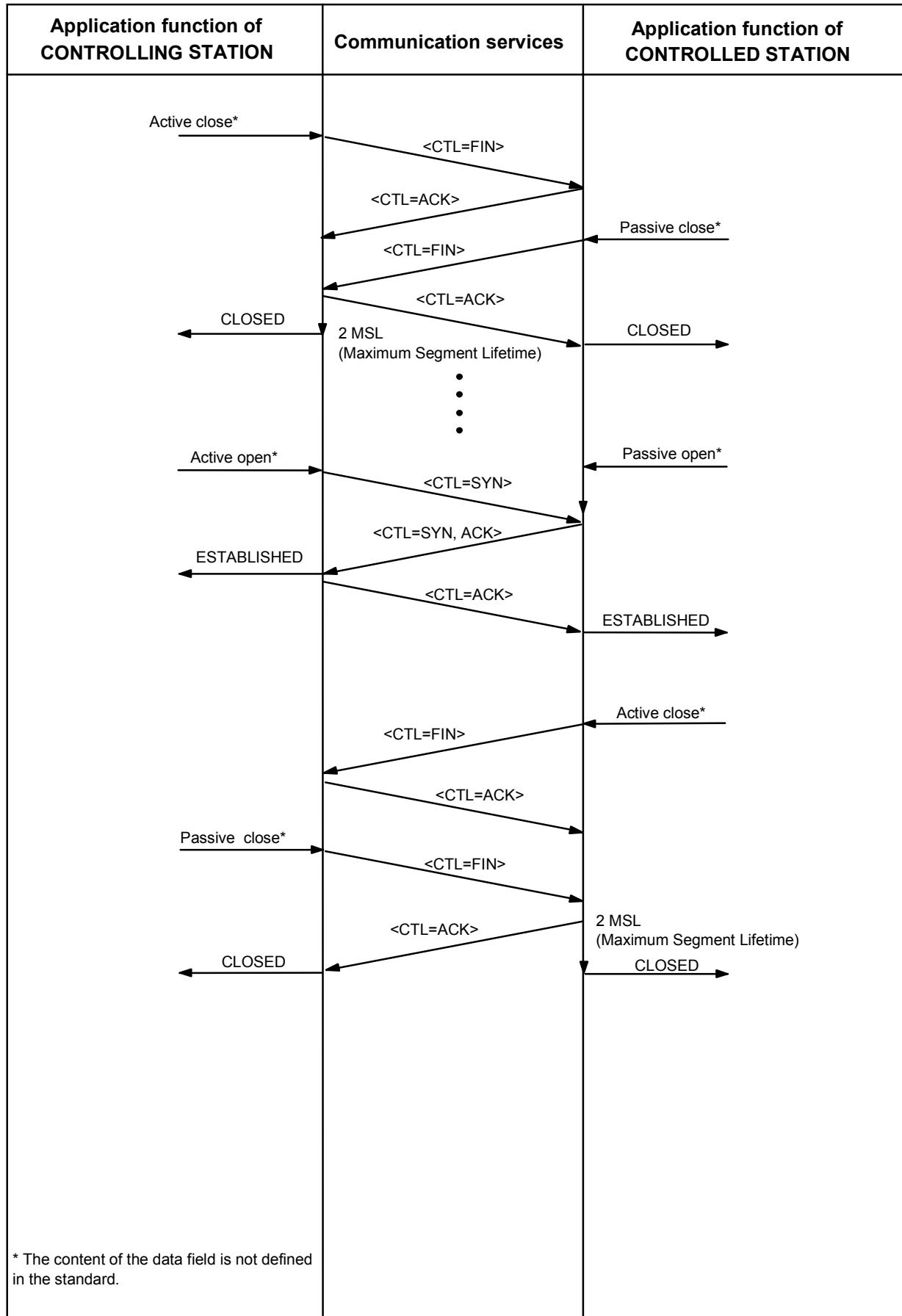
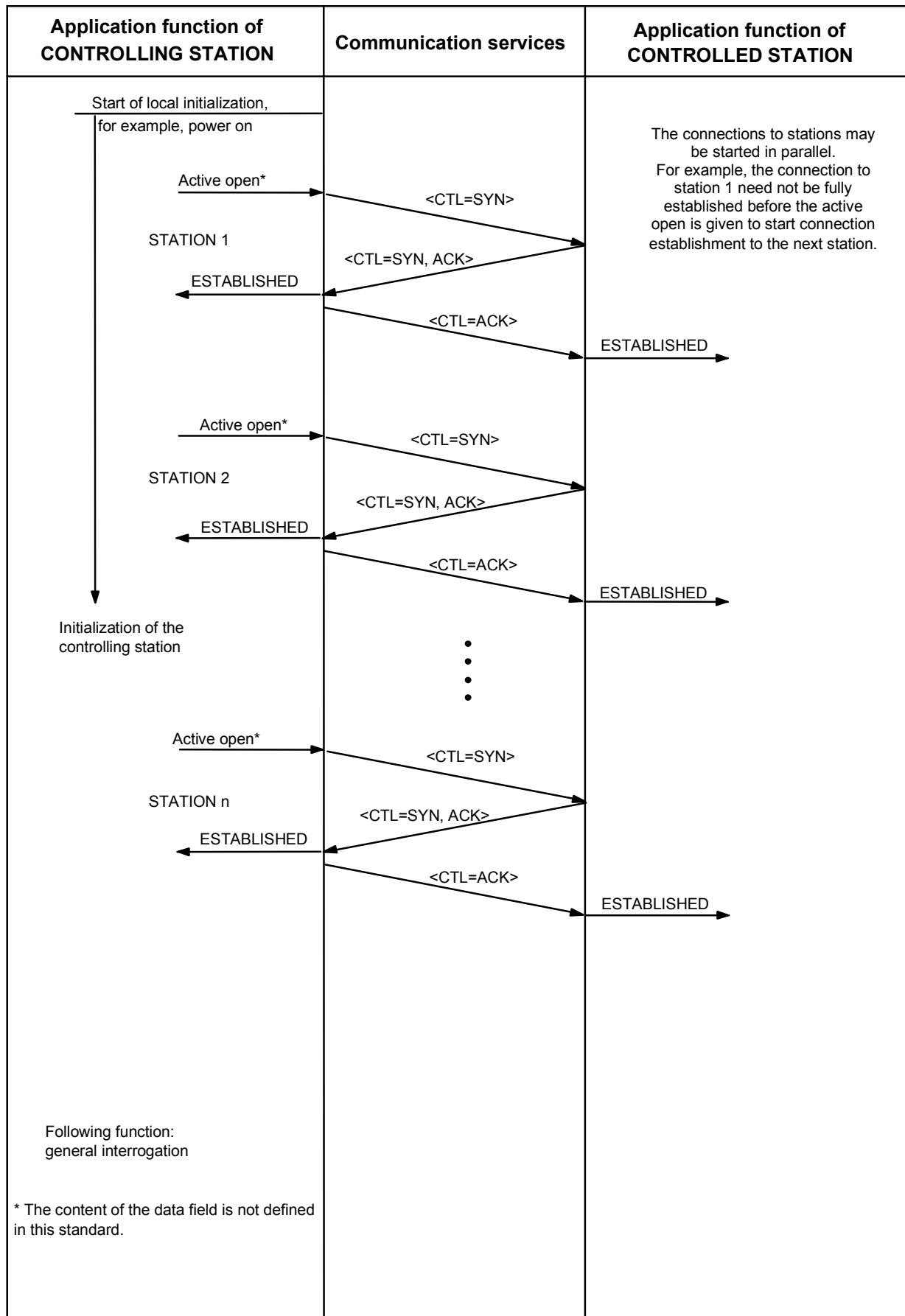


Figure 19 – TCP connection establishment and close



\* The content of the data field is not defined in this standard.

**Figure 20 – Initialization of the controlling station**

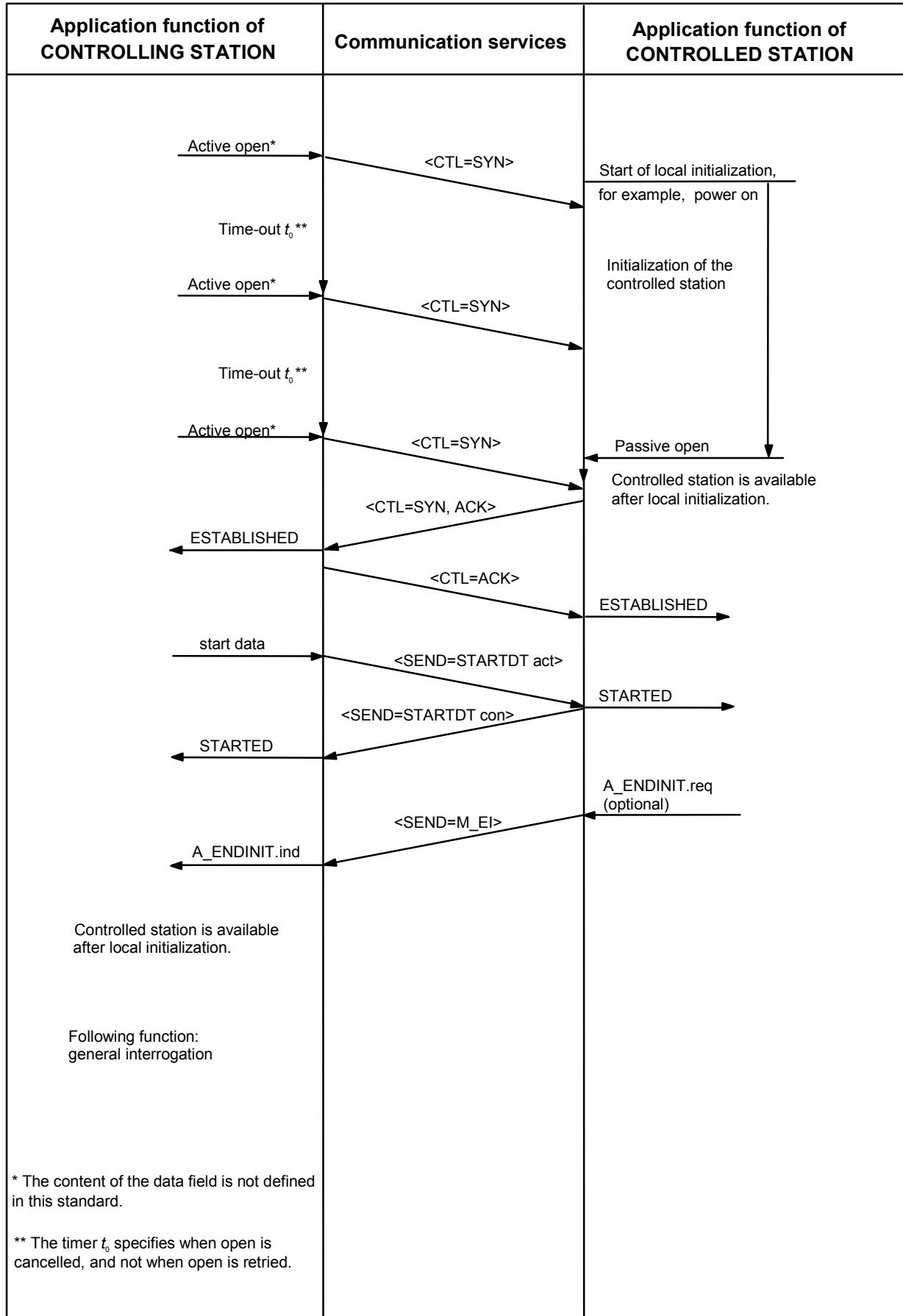


Figure 21 – Local initialization of the controlled station

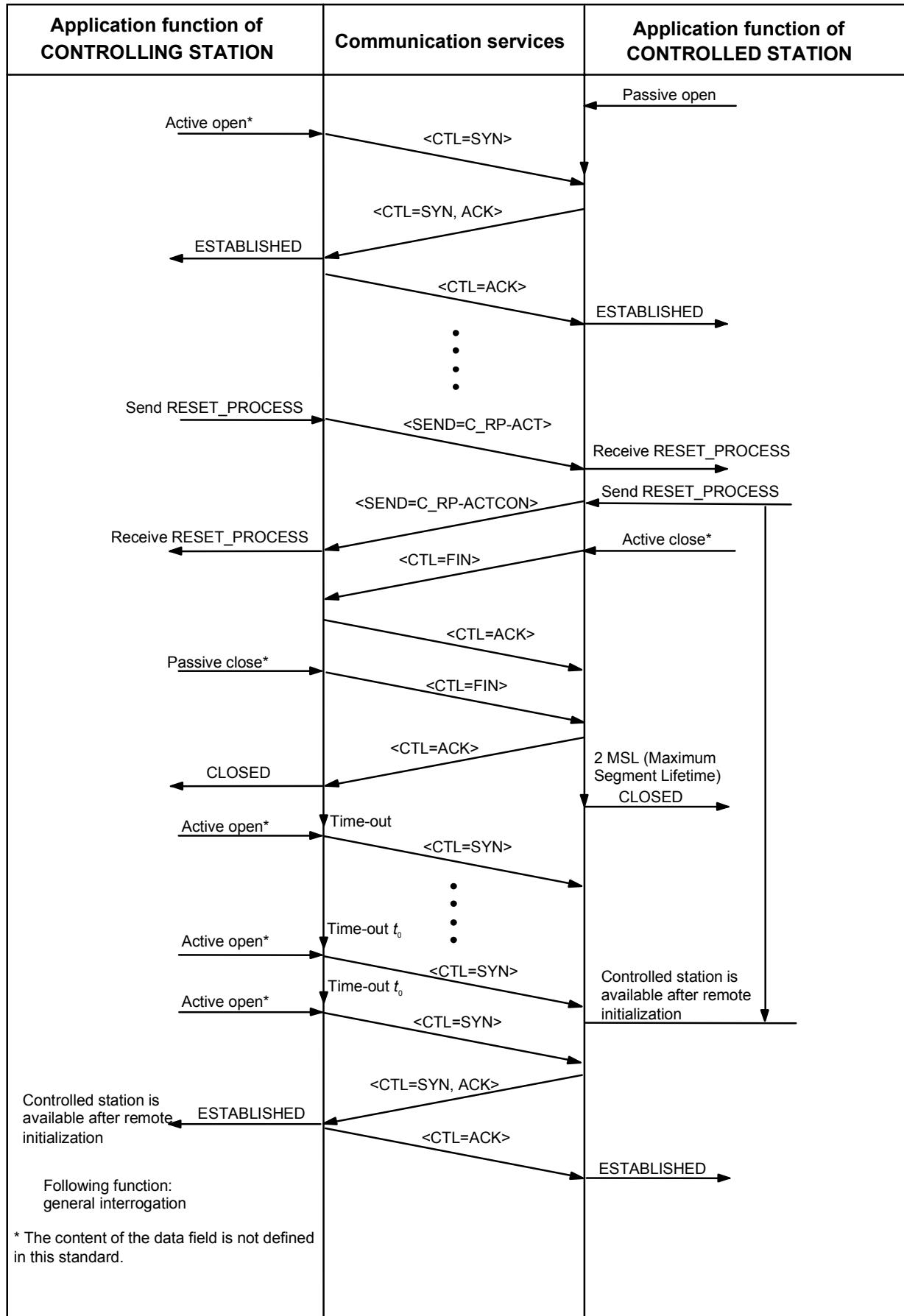


Figure 22 – Remote initialization of the controlled station

## 7.2 Data acquisition by polling (6.2 of IEC 60870-5-5)

Request of user data class 1 and 2 are link functions of IEC 60870-5-2 and therefore not available in this standard. However, data may be read (requested) as shown in the bottom part of figure 10 of IEC 60870-5-5. The requesting of data by cyclic requests is permitted, but should be avoided. Such cyclic requests burden the network with excess transmission traffic.

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>TCP Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b> |
|--|--------------------------------|-------------------------------------|
| A_RD_DATA.req                                | send                           | C_RD                                |
| A_RD_DATA.ind                                | receive                        | C_RD                                |
| A_M_DATA.req                                 | send                           | M                                   |
| A_M_DATA.ind                                 | receive                        | M                                   |

## 7.3 Cyclic data transmission (6.3 of IEC 60870-5-5)

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>TCP Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b> |
|--|--------------------------------|-------------------------------------|
| A_CYCLIC_DATA.req                            | send                           | M CYCLIC                            |
| A_CYCLIC_DATA.ind                            | receive                        | M CYCLIC                            |

## 7.4 Acquisition of events (6.4 of IEC 60870-5-5)

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>TCP Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b> |
|--|--------------------------------|-------------------------------------|
| A_EVENT.req                                  | send                           | M SPONT                             |
| A_EVENT.ind                                  | receive                        | M SPONT                             |

## 7.5 General interrogation (6.6 of IEC 60870-5-5)

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>TCP Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b> |
|--|--------------------------------|-------------------------------------|
| A_GENINCOM.req                               | send                           | C_IC ACT                            |
| A_GENINCOM.ind                               | receive                        | C_IC ACT                            |
| A_GENINACK.req                               | send                           | C_IC ACTCON                         |
| A_GENINACK.ind                               | receive                        | C_IC ACTCON                         |
| A_INTINF.req                                 | send                           | M                                   |
| A_INTINF.ind                                 | receive                        | M                                   |
| A_ENDINT.req                                 | send                           | C_IC ACTTERM                        |
| A_ENDINT.ind                                 | receive                        | C_IC ACTTERM                        |

## 7.6 Clock synchronization (6.7 of IEC 60870-5-5)

| Application Service<br>IEC 60870-5-5 | TCP Service<br>RFC 793 | ASDU Label<br>IEC 60870-5-5 |
|--------------------------------------|------------------------|-----------------------------|
| A_CLOCKSYN.req                       | send                   | C_CS ACT                    |
| A_CLOCKSYN.ind                       | receive                | C_CS ACT                    |
| A_TIMEMESS.req                       | send                   | C_CS ACTCON                 |
| A_TIMEMESS.ind                       | receive                | C_CS ACTCON                 |

The clock synchronization procedure defined in IEC 60870-5-5 cannot be used in this standard because the link layer according to IEC 60870-5-2, which provides the exact time of sending the clock command, is no longer available.

However, clock synchronization may be used in configurations where the *maximum network delay* is *less* than the required accuracy of the clock in the receiving station. For example, if the network provider guarantees that the delay in the network will never be more than 400 ms (a typical X.25 WAN value) and the required accuracy in the controlled station is 1 s, the clock synchronization procedure is useful. Use of this procedure avoids the necessity of installing clock synchronization receivers or similar equipment in potentially several hundreds or thousands of controlled stations.

The procedure is a copy of that of 6.7 of IEC 60870-5-5, with the "first bit" and "time correction" requirements and link layer options (SEND/NO REPLY or SEND/CONFIRM) removed.

Clocks in controlled stations have to be synchronized with the clock in the controlling station to provide correct chronological sets of time-tagged events or information objects, whether they are transmitted to the controlling station or logged locally. The clocks are initially synchronized by the controlling station after system initialization and then re-synchronized periodically by agreement by transmitting C\_CS ACT PDUs.

The C\_CS ACT PDU contains the whole (date and time) current clock time with the required time resolution at the instant when the message is generated by the application layer. After the execution of the clock sync internally the controlled station generates a C\_CS ACTCON PDU that contains the local time *before* it was synchronized. This message is transmitted after any buffered time-tagged PDUs, that may be waiting for transmission. Time-tagged events that occur *after* the internal clock synchronization are transmitted *after* the C\_CS ACTCON PDU.

Controlled stations expect the reception of clock synchronization messages within agreed time intervals. When the synchronization command does not arrive within this time interval, the controlled station sets all time-tagged information objects with a mark that the time tag may be inaccurate (invalid). This mark is also set after station initialization (warm and cold boot) of controlled stations before reception of a valid C\_CS ACT PDU. Time-tagged events that occur after the reception of valid C\_CS ACT PDU are transmitted without the mark.

### 7.6.1 Description of sequential procedure

(See figure 15 of IEC 60870-5-5.)

The application process in the controlling station sends the clock synchronization command as a CLOCKSYN.req primitive with the time as known in the application process and with the required accuracy to the communication services. The communication services transmit this request as a C\_CS ACT PDU and delivers this request as a A\_CLOCKSYN.ind primitive to the application process in the controlled station.

After the execution of the clock synchronization operation the application process of the controlled station produces the time message which is transmitted as a C\_CS ACTCON PDU initiated by an A\_TIMEMESS.req primitive. This request contains the time which is known in the application process in the controlled station *before* reception of the A\_CLOCKSYN.ind. This PDU is issued to the application process of the controlling station as an A\_TIMEMESS.ind primitive.

### 7.7 Command transmission (6.8 of IEC 60870-5-5)

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>TCP Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b>   |
|--|--------------------------------|---------------------------------------|
| A_SELECT.req                                 | send                           | C_SC, C_DC, C_SE, C_RC, C_BO ACT      |
| A_SELECT.ind                                 | receive                        | C_SC, C_DC, C_SE, C_RC, C_BO ACT      |
| A_SELECT.res                                 | send                           | C_SC, C_DC, C_SE, C_RC, C_BO ACTCON   |
| A_SELECT.con                                 | receive                        | C_SC, C_DC, C_SE, C_RC, C_BO ACTCON   |
| A_BREAK.req                                  | send                           | C_SC, C_DC, C_SE, C_RC, C_BO DEACT    |
| A_BREAK.ind                                  | receive                        | C_SC, C_DC, C_SE, C_RC, C_BO DEACT    |
| A_BREAK.res                                  | send                           | C_SC, C_DC, C_SE, C_RC, C_BO DEACTCON |
| A_BREAK.con                                  | receive                        | C_SC, C_DC, C_SE, C_RC, C_BO DEACTCON |
| A_EXCO.req                                   | send                           | C_SC, C_DC, C_SE, C_RC, C_BO ACT      |
| A_EXCO.ind                                   | receive                        | C_SC, C_DC, C_SE, C_RC, C_BO ACT      |
| A_EXCO.res                                   | send                           | C_SC, C_DC, C_SE, C_RC, C_BO ACTCON   |
| A_EXCO.con                                   | receive                        | C_SC, C_DC, C_SE, C_RC, C_BO ACTCON   |
| A_RETURN_INF.req                             | send                           | M_SP, M_DP, M_ST                      |
| A_RETURN_INF.ind                             | receive                        | M_SP, M_DP, M_ST                      |
| A_COTERM.req                                 | send                           | C_SC, C_DC, C_SE, C_RC, C_BO ACTTERM  |
| A_COTERM.ind                                 | receive                        | C_SC, C_DC, C_SE, C_RC, C_BO ACTTERM  |

### 7.8 Transmission of integrated totals (6.9 of IEC 60870-5-5)

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>TCP Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b> |
|--|--------------------------------|-------------------------------------|
| A_MEMCNT.req                                 | send                           | C_CI ACT                            |
| A_MEMCNT.ind                                 | receive                        | C_CI ACT                            |
| A_MEMCNT.res                                 | send                           | C_CI ACTCON                         |
| A_MEMCNT.con                                 | receive                        | C_CI ACTCON                         |
| A_MEWINCR.req                                | send                           | C_CI ACT                            |
| A_MEWINCR.ind                                | receive                        | C_CI ACT                            |
| A_MEWINCR.res                                | send                           | C_CI ACTCON                         |
| A_MEWINCR.con                                | receive                        | C_CI ACTCON                         |
| A_REQINTO.req                                | send                           | C_CI ACT                            |
| A_REQINTO.ind                                | receive                        | C_CI ACT                            |
| A_REQINTO.res                                | send                           | C_CI ACTCON                         |
| A_REQINTO.con                                | receive                        | C_CI ACTCON                         |
| A_INTO_INF.req                               | send                           | M_IT                                |
| A_INTO_INF.ind                               | receive                        | M_IT                                |
| A_ITERM.req                                  | send                           | C_CI ACTTERM                        |
| A_ITERM.ind                                  | receive                        | C_CI ACTTERM                        |

### 7.9 Parameter loading (6.10 of IEC 60870-5-5)

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>TCP Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b> |
|--|--------------------------------|-------------------------------------|
| A_PARAM.req                                  | send                           | P_ME ACT                            |
| A_PARAM.ind                                  | receive                        | P_ME ACT                            |
| A_PARAM.res                                  | send                           | P_ME ACTCON                         |
| A_PARAM.con                                  | receive                        | P_ME ACTCON                         |
| A_PACTIV.req                                 | send                           | P_AC ACT                            |
| A_PACTIV.ind                                 | receive                        | P_AC ACT                            |
| A_PACTIV.res                                 | send                           | P_AC ACTCON                         |
| A_PACTIV.con                                 | receive                        | P_AC ACTCON                         |
| A_LCPACH.req                                 | send                           | P_ME SPONT                          |
| A_LCPACH.ind                                 | receive                        | P_ME SPONT                          |

### 7.10 Test procedure (6.11 of IEC 60870-5-5)

| Application Service<br>IEC 60870-5-5 | TCP Service<br>RFC 793 | ASDU Label<br>IEC 60870-5-5 |
|--------------------------------------|------------------------|-----------------------------|
| A_TEST.req                           | send                   | C_TS ACT                    |
| A_TEST.ind                           | receive                | C_TS ACT                    |
| A_TEST.res                           | send                   | C_TS ACTCON                 |
| A_TEST.con                           | receive                | C_TS ACTCON                 |

### 7.11 File transfer (6.12 of IEC 60870-5-5)

#### Control and monitor direction

| Application Service<br>IEC 60870-5-5 | TCP Service<br>RFC 793 | ASDU Label<br>IEC 60870-5-5 |
|--------------------------------------|------------------------|-----------------------------|
| A_CALL_DIRECTORY.req                 | send                   | F_SC                        |
| A_CALL_DIRECTORY.ind                 | receive                | F_SC                        |
| A_CALL_DIRECTORY.res                 | send                   | F_DR                        |
| A_CALL_DIRECTORY.con                 | receive                | F_DR                        |
| A_SELECT_FILE.req                    | send                   | F_SC                        |
| A_SELECT_FILE.ind                    | receive                | F_SC                        |
| A_FILE_READY.req                     | send                   | F_FR                        |
| A_FILE_READY.ind                     | receive                | F_FR                        |
| A_CALL_FILE.req                      | send                   | F_SC                        |
| A_CALL_FILE.ind                      | receive                | F_SC                        |
| A_SECTION1_READY.req                 | send                   | F_SR                        |
| A_SECTION1_READY.ind                 | receive                | F_SR                        |
| A_CALL_SECTION1.req                  | send                   | F_SC                        |
| A_CALL_SECTION1.ind                  | receive                | F_SC                        |
| A_SEGMENT1.req                       | send                   | F_SG                        |
| A_SEGMENT1.ind                       | receive                | F_SG                        |
| A_SEGMENTn.req                       | send                   | F_SG                        |
| A_SEGMENTn.ind                       | receive                | F_SG                        |
| A_LAST_SEGMENT.req                   | send                   | F_LS                        |
| A_LAST_SEGMENT.ind                   | receive                | F_LS                        |
| A_ACK_SECTION1.req                   | send                   | F_AF                        |
| A_ACK_SECTION1.ind                   | receive                | F_AF                        |
| A_SECTIONm_READY.req                 | send                   | F_SR                        |
| A_SECTIONm_READY.ind                 | receive                | F_SR                        |

| <b>Application Service<br/>IEC 60870-5-5</b> | <b>Transport Service<br/>RFC 793</b> | <b>ASDU Label<br/>IEC 60870-5-5</b> |
|--|--------------------------------------|-------------------------------------|
| A_CALL_SECTIONm.req                          | send                                 | F_SC                                |
| A_CALL_SECTIONm.ind                          | receive                              | F_SC                                |
| A_ACK_SECTIONm.req                           | send                                 | F_AF                                |
| A_ACK_SECTIONm.ind                           | receive                              | F_AF                                |
| A_LAST_SECTION.req                           | send                                 | F_LS                                |
| A_LAST_SECTION.ind                           | receive                              | F_LS                                |
| A_ACK_FILE.req                               | send                                 | F_AF                                |
| A_ACK_FILE.ind                               | receive                              | F_AF                                |
| A_DIRECTORY.req                              | send                                 | F_DR                                |
| A_DIRECTORY.ind                              | receive                              | F_DR                                |

## 8 ASDUs for process information in control direction with time tag

This clause defines the additional ASDUs in the control direction which are extended with the time tag CP56Time2a. This time includes date and clock time in milliseconds up to years and is defined in IEC 60870-5-101. When using networks that might cause undesirable delays of commands, sending ASDUs with a time tag is recommended. A controlled station receiving a command or set point which has exceeded the maximum allowable delay (system-specific parameter) will not return a protocol response (i.e. the controlled station does not return a positive ACTCON nor a negative ACTCON). This is because the confirmation could be significantly delayed, and might not readily be associated with the original request. The command is passed to the controlled station application so that it can identify that the command was received “too late”, but must not perform any command action. The time tag contains the time at which the command is initiated in the controlling station.

**8.1 TYPE IDENT 58: C\_SC\_TA\_1**  
**Single command with time tag CP56Time2a**

**Single information object (SQ = 0)**

|  |  |  |
|--|--|--|
| 0   0   1   1   1   0   1   0          | TYPE IDENTIFICATION  |  |
| 0   0   0   0   0   0   0   1          | VARIABLE STRUCTURE QUALIFIER   |  |
| Defined in 7.2.3 of IEC 60870-5-101    | CAUSE OF TRANSMISSION  |  |
| Defined in 7.2.4 of IEC 60870-5-101    | COMMON ADDRESS OF ASDU   |  |
| Defined in 7.2.5 of IEC 60870-5-101    | INFORMATION OBJECT ADDRESS   |  |
| S/E     QU     0   SCS                 | SCO = Single command, defined in 7.2.6.15 of IEC 60870-5-101                     |  |
| CP56Time2a                             | INFORMATION OBJECT   |  |
| Defined in 7.2.6.18 of IEC 60870-5-101 | Seven-octet binary time<br><br>(Date and clock time in milliseconds up to years) |  |

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**Figure 23 – ASDU: C\_SC\_TA\_1**  
**Single command with time tag CP56Time2a**

C\_SC\_TA\_1 := CP{Data unit identifier,Information object address,SCO,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 58 := C\_SC\_TA\_1

CAUSE OF TRANSMISSION

In control direction:

<6> := activation  
 <8> := deactivation

In monitor direction:

<7> := activation confirmation  
 <9> := deactivation confirmation  
 <10> := activation termination  
 <44> := unknown type identification  
 <45> := unknown cause of transmission  
 <46> := unknown common address of ASDU  
 <47> := unknown information object address

**8.2 TYPE IDENT 59: C\_DC\_TA\_1**  
**Double command with time tag CP56Time2a**

**Single information object (SQ = 0)**

|   |  |                                      |
|---|--|--------------------------------------|
| 0   0   1   1   1   0   1   1                               | TYPE IDENTIFICATION  |                                      |
| 0   0   0   0   0   0   0   1                               | VARIABLE STRUCTURE QUALIFIER   |                                      |
| Defined in 7.2.3 of IEC 60870-5-101                         | CAUSE OF TRANSMISSION  | DATA UNIT<br>IDENTIFIER              |
| Defined in 7.2.4 of IEC 60870-5-101                         | COMMON ADDRESS OF ASDU   | Defined in 7.1<br>of IEC 60870-5-101 |
| Defined in 7.2.5 of IEC 60870-5-101                         | INFORMATION OBJECT ADDRESS   |                                      |
| S/E     QU     DCS  | DCO = Double command, defined in 7.2.6.16 of IEC 60870-5-101                     |                                      |
| CP56Time2a<br><br>Defined in 7.2.6.18<br>of IEC 60870-5-101 | Seven-octet binary time<br><br>(Date and clock time in milliseconds up to years) | INFORMATION<br>OBJECT                |

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**Figure 24 – ASDU: C\_DC\_TA\_1**  
**Double command with time tag CP56Time2a**

C\_DC\_TA\_1 := CP{Data unit identifier,Information object address,DCO,CP56Time2a }

CAUSES OF TRANSMISSION used with

TYPE IDENT 59 := C\_DC\_TA\_1

CAUSE OF TRANSMISSION

In control direction:

```
<6> := activation
<8> := deactivation
```

In monitor direction:

```
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination
<44> := unknown type identification
<45> := unknown cause of transmission
<46> := unknown common address of ASDU
<47> := unknown information object address
```

**8.3 TYPE IDENT 60: C\_RC\_TA\_1**  
**Regulating step command with time tag CP56Time2a**

**Single information object (SQ = 0)**

|   |  |                                      |
|---|--|--------------------------------------|
| 0   0   1   1   1   1   0   0                               | TYPE IDENTIFICATION  |                                      |
| 0   0   0   0   0   0   0   1                               | VARIABLE STRUCTURE QUALIFIER   |                                      |
| Defined in 7.2.3 of IEC 60870-5-101                         | CAUSE OF TRANSMISSION  | DATA UNIT<br>IDENTIFIER              |
| Defined in 7.2.4 of IEC 60870-5-101                         | COMMON ADDRESS OF ASDU   | Defined in 7.1<br>of IEC 60870-5-101 |
| Defined in 7.2.5 of IEC 60870-5-101                         | INFORMATION OBJECT ADDRESS   |                                      |
| S/E     QU     RCS  | RCO = Regulating step command, defined in 7.2.6.17 of IEC 60870-5-101            |                                      |
| CP56Time2a<br><br>Defined in 7.2.6.18<br>of IEC 60870-5-101 | Seven-octet binary time<br><br>(Date and clock time in milliseconds up to years) | INFORMATION<br>OBJECT                |

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**Figure 25 – ASDU: C\_RC\_TA\_1**  
**Regulating step command with time tag CP56Time2a**

C\_RC\_TA\_1 := CP{Data unit identifier,Information object address,RCO,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 60 := C\_RC\_TA\_1

CAUSE OF TRANSMISSION

In control direction:

```
<6> := activation
<8> := deactivation
```

In monitor direction:

```
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination
<44> := unknown type identification
<45> := unknown cause of transmission
<46> := unknown common address of ASDU
<47> := unknown information object address
```

**8.4 TYPE IDENT 61: C\_SE\_TA\_1**  
**Set-point command with time tag CP56Time2a, normalized value**

**Single information object (SQ = 0)**

|   |  |   |
|---|--|---|
| 0   0   1   1   1   1   0   1             | TYPE IDENTIFICATION  |   |
| 0   0   0   0   0   0   0   1             | VARIABLE STRUCTURE QUALIFIER   |   |
| Defined in 7.2.3 of IEC 60870-5-101       | CAUSE OF TRANSMISSION  |   |
| Defined in 7.2.4 of IEC 60870-5-101       | COMMON ADDRESS OF ASDU   | DATA UNIT<br>IDENTIFIER<br>Defined in 7.1<br>of IEC 60870-5-101 |
| Defined in 7.2.5 of IEC 60870-5-101       | INFORMATION OBJECT ADDRESS   |   |
| Value                                     | NVA = Normalized value, defined in 7.2.6.6 of IEC 60870-5-101                |   |
| S Value                                   |  |   |
| S/E QL                                    | QOS = Qualifier of set-point command, defined in 7.2.6.39 of IEC 60870-5-101 |   |
| CP56Time2a                                | Seven-octet binary time  | INFORMATION<br>OBJECT   |
| Defined in 7.2.6.18<br>of IEC 60870-5-101 | (Date and clock time in milliseconds up to years)                            |   |

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**Figure 26 – ASDU: C\_SE\_TA\_1**  
**Set-point command with time tag CP56Time2a, normalized value**

C\_SE\_TA\_1 := CP{Data unit identifier,Information object address,NVA,QOS,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 61 := C\_SE\_TA\_1

CAUSE OF TRANSMISSION

in control direction:

<6> := activation  
 <8> := deactivation

in monitor direction:

<7> := activation confirmation  
 <9> := deactivation confirmation  
 <10> := activation termination (opt)  
 <44> := unknown type identification  
 <45> := unknown cause of transmission  
 <46> := unknown common address of ASDU  
 <47> := unknown information object address

**8.5 TYPE IDENT 62: C\_SE\_TB\_1**  
**Set-point command with time tag CP56Time2a, scaled value**

**Single information object (SQ = 0)**

|   |   |
|---|---|
| 0 0 1 1 1 1 1 0   | TYPE IDENTIFICATION   |
| 0 0 0 0 0 0 0 1   | VARIABLE STRUCTURE QUALIFIER  |
| Defined in 7.2.3 of IEC 60870-5-101                         | CAUSE OF TRANSMISSION   |
| Defined in 7.2.4 of IEC 60870-5-101                         | COMMON ADDRESS OF ASDU  |
| Defined in 7.2.5 of IEC 60870-5-101                         | INFORMATION OBJECT ADDRESS  |
| Value<br>S Value<br>S/E QL                                  | SVA = Scaled value, defined in 7.2.6.7 of IEC 60870-5-101<br>QOS = Qualifier of set-point command, defined in 7.2.6.39 of IEC 60870-5-101 |
| CP56Time2a<br><br>Defined in 7.2.6.18<br>of IEC 60870-5-101 | INFORMATION OBJECT<br><br>Seven-octet binary time<br><br>(Date and clock time in milliseconds up to years)                                |

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**Figure 27 – ASDU: C\_SE\_TB\_1**  
**Set-point command with time tag CP56Time2a, scaled value**

C\_SE\_TB\_1 := CP{Data unit identifier,Information object address,SVA,QOS,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 62 := C\_SE\_TB\_1

CAUSE OF TRANSMISSION

In control direction:

<6> := activation  
 <8> := deactivation

In monitor direction:

<7> := activation confirmation  
 <9> := deactivation confirmation  
 <10> := activation termination (opt)  
 <44> := unknown type identification  
 <45> := unknown cause of transmission  
 <46> := unknown common address of ASDU  
 <47> := unknown information object address

**8.6 TYPE IDENT 63: C\_SE\_TC\_1**  
**Set-point command with time tag CP56Time2a, short floating point number**

**Single information object (SQ = 0)**

|   |  |
|---|--|
| 0 0 1 1 1 1 1 1                           | TYPE IDENTIFICATION  |
| 0 0 0 0 0 0 0 1                           | VARIABLE STRUCTURE QUALIFIER   |
| Defined in 7.2.3 of IEC 60870-5-101       | CAUSE OF TRANSMISSION  |
| Defined in 7.2.4 of IEC 60870-5-101       | COMMON ADDRESS OF ASDU   |
| Defined in 7.2.5 of IEC 60870-5-101       | INFORMATION OBJECT ADDRESS   |
| Fraction                                  | IEEE STD 754 = Short floating point number,<br>defined in 7.2.6.8 of IEC 60870-5-101 |
| Fraction                                  |  |
| E Fraction                                |  |
| S Exponent                                |  |
| S/E QL                                    | QOS = Qualifier of set-point command, defined in 7.2.6.39 of IEC 60870-5-101         |
| CP56Time2a                                | Seven-octet binary time<br>(Date and clock time in milliseconds up to years)         |
| Defined in 7.2.6.18<br>of IEC 60870-5-101 |  |

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**Figure 28 – ASDU: C\_SE\_TC\_1**  
**Set-point command with time tag CP56Time2a, short floating point number**

C\_SE\_TC\_1 := CP{Data unit identifier,Information object address,IEEE STD 754,QOS,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 63 := C\_SE\_TC\_1

CAUSE OF TRANSMISSION

In control direction:

<6> := activation  
 <8> := deactivation

In monitor direction:

<7> := activation confirmation  
 <9> := deactivation confirmation  
 <10> := activation termination (opt)  
 <44> := unknown type identification  
 <45> := unknown cause of transmission  
 <46> := unknown common address of ASDU  
 <47> := unknown information object address

**8.7 TYPE IDENT 64: C\_BO\_TA\_1**  
**Bitstring of 32 bit with time tag CP56Time2a**

**Single information object (SQ = 0)**

|   |   |                                      |
|---|---|--------------------------------------|
| 0   1   0   0   0   0   0   0             | TYPE IDENTIFICATION   |                                      |
| 0   0   0   0   0   0   0   1             | VARIABLE STRUCTURE QUALIFIER  |                                      |
| Defined in 7.2.3 of IEC 60870-5-101       | CAUSE OF TRANSMISSION   | DATA UNIT<br>IDENTIFIER              |
| Defined in 7.2.4 of IEC 60870-5-101       | COMMON ADDRESS OF ASDU  | Defined in 7.1<br>of IEC 60870-5-101 |
| Defined in 7.2.5 of IEC 60870-5-101       | INFORMATION OBJECT ADDRESS  |                                      |
| Bitstring                                 | BSI = Binary state information, 32 bit,<br>defined in 7.2.6.13 of IEC 60870-5-101 | INFORMATION<br>OBJECT                |
| Bitstring                                 |   |                                      |
| Bitstring                                 |   |                                      |
| Bitstring                                 |   |                                      |
| CP56Time2a                                | Seven-octet binary time<br><br>(Date and clock time in milliseconds up to years)  |                                      |
| Defined in 7.2.6.18<br>of IEC 60870-5-101 |   |                                      |

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**Figure 29 – ASDU: C\_BO\_TA\_1**  
**Bitstring of 32 bit with time tag CP56Time2a**

C\_BO\_TA\_1 := CP{Data unit identifier,Information object address,BSI,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 64 := C\_BO\_TA\_1

CAUSE OF TRANSMISSION

In control direction:

<6> := activation

In monitor direction:

|      |    |                                    |
|------|----|------------------------------------|
| <7>  | := | activation confirmation            |
| <10> | := | activation termination (opt)       |
| <44> | := | unknown type identification        |
| <45> | := | unknown cause of transmission      |
| <46> | := | unknown common address of ASDU     |
| <47> | := | unknown information object address |

**8.8 TYPE IDENT 107: C\_TS\_TA\_1**  
**Test command with time tag CP56Time2a**

**Single information object (SQ = 0)**

|   |  |                                      |
|---|--|--------------------------------------|
| 0   1   1   0   1   0   1   1                               | TYPE IDENTIFICATION  |                                      |
| 0   0   0   0   0   0   0   1                               | VARIABLE STRUCTURE QUALIFIER   |                                      |
| Defined in 7.2.3 of IEC 60870-5-101                         | CAUSE OF TRANSMISSION  | DATA UNIT<br>IDENTIFIER              |
| Defined in 7.2.4 of IEC 60870-5-101                         | COMMON ADDRESS OF ASDU   | Defined in 7.1<br>of IEC 60870-5-101 |
| Defined in 7.2.5 of IEC 60870-5-101                         | INFORMATION OBJECT ADDRESS   |                                      |
| TSC   | TSC = Test sequence counter, 16 bit  |                                      |
| CP56Time2a<br><br>Defined in 7.2.6.18<br>of IEC 60870-5-101 | Seven-octet binary time<br><br>(Date and clock time in milliseconds up to years) | INFORMATION<br>OBJECT                |

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**Figure 30 – ASDU: C\_TS\_TA\_1**  
**Test command with time tag CP56Time2a**

C\_TS\_TA\_1 := CP{Data unit identifier,Information object address,TSC,CP56Time2a}

TSC := UI16[1..16]<0..65535>

The requesting station may choose any value of TSC. The TSC in the response shall match the request, and the time in the response shall also exactly match the time in the request.

CAUSES OF TRANSMISSION used with

TYPE IDENT 107 := C\_TS\_TA\_1

CAUSE OF TRANSMISSION

In control direction:

<6> := activation

In monitor direction:

|         |                                    |
|---------|------------------------------------|
| <7> :=  | activation confirmation            |
| <44> := | unknown type identification        |
| <45> := | unknown cause of transmission      |
| <46> := | unknown common address of ASDU     |
| <47> := | unknown information object address |

## 8.9 TYPE IDENT 127: F\_SC\_NB\_1

### QueryLog – Request archive file

#### Single information object (SQ = 0)

|  |  |                                      |
|--|--|--------------------------------------|
| 0   1   1   1   1   1   1   1   1                    | TYPE IDENTIFICATION                      |                                      |
| 0   0   0   0   0   0   0   1                        | VARIABLE STRUCTURE QUALIFIER             | DATA UNIT<br>IDENTIFIER              |
| Defined in 7.2.3 of IEC 60870-5-101                  | CAUSE OF TRANSMISSION                    | Defined in 7.1<br>of IEC 60870-5-101 |
| Defined in 7.2.4 of IEC 60870-5-101                  | COMMON ADDRESS OF ASDU                   |                                      |
| Defined in 7.2.5 of IEC 60870-5-101                  | INFORMATION OBJECT ADDRESS               |                                      |
| Defined in 7.2.6.33 of IEC 60870-5-101               | Name of file                             | INFORMATION<br>OBJECT                |
| CP56Time2a<br>Defined in 7.2.6.18 of IEC 60870-5-101 | Seven octet binary time (RangeStartTime) |                                      |
| CP56Time2a<br>Defined in 7.2.6.18 of IEC 60870-5-101 | Seven octet binary time (RangeStopTime)  |                                      |

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**Figure 31 – ASDU: F\_SC\_NB\_1 QueryLog – Request archive file**

CAUSES OF TRANSMISSION used with

TYPE IDENT 127

#### CAUSE OF TRANSMISSION

- <13> := file transfer
- <44> := unknown type of file
- <45> := unknown cause of transmission
- <46> := unknown common address of ASDU
- <47> := unknown information object address

Depending on the values of the two time stamps, a part of, or the complete file (which represents the log) shall be transmitted:

| RangeStartTime | RangeStopTime | Resulting file transfer   |
|----------------|---------------|---|
| Available      | Available     | All records having a timestamp between RangeStartTime and RangeStopTime <sup>a)</sup> |
| 0 (all zeros)  | Available     | All records having a timestamp from the beginning to RangeStopTime <sup>a)</sup>      |
| Available      | 0 (all zeros) | All records having a timestamp between RangeStartTime and the end <sup>a)</sup>       |
| 0 (all zeros)  | 0 (all zeros) | All records   |

<sup>a)</sup> Including the records with timestamp RangeStartTime or RangeStopTime respectively.

NOTE A record is assumed to have a timestamp. The timestamp is assumed to be implicit.

The file transfer (defined in IEC 60870-5-101:2003, 7.4.11) shall start after a successful query request has been received by the controlled station. The query request pre-selects the content of the file to be transmitted in the subsequent call sections.

## 9 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of "structured" or "unstructured" fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike-through (corresponding check box is marked black).

**NOTE** In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows:

- Function or ASDU is not used
- Function or ASDU is used as standardized (default)
- Function or ASDU is used in reverse mode
- Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

### 9.1 System or device

(system-specific parameter, indicate definition of a system or a device by marking one of the following with "X")

- System definition
- Controlling station definition (Master)
- Controlled station definition (Slave)

### 9.2 Network configuration

(network-specific parameter, all configurations that are used are to be marked "X")

- |                                     |                         |                                     |                 |
|-------------------------------------|-------------------------|-------------------------------------|-----------------|
| <input checked="" type="checkbox"/> | Point-to-point          | <input checked="" type="checkbox"/> | Multipoint-     |
| <input checked="" type="checkbox"/> | Multiple point-to-point | <input checked="" type="checkbox"/> | Multipoint star |

### 9.3 Physical layer

(network-specific parameter, all interfaces and data rates that are used are to be marked "X")

#### Transmission speed (control direction)

| Unbalanced interchange<br>Circuit V.24/V.28<br>Standard | Unbalanced interchange<br>Circuit V.24/V.28<br>Recommended if >1 200 bit/s | Balanced interchange<br>Circuit X.24/X.27 |
|---|--|---|
| <input type="checkbox"/> 100 bit/s                      | <input type="checkbox"/> 2 400 bit/s                                       | <input type="checkbox"/> 2 400 bit/s      |
| <input type="checkbox"/> 200 bit/s                      | <input type="checkbox"/> 4 800 bit/s                                       | <input type="checkbox"/> 4 800 bit/s      |
| <input type="checkbox"/> 300 bit/s                      | <input type="checkbox"/> 9 600 bit/s                                       | <input type="checkbox"/> 9 600 bit/s      |
| <input type="checkbox"/> 600 bit/s                      |  | <input type="checkbox"/> 19 200 bit/s     |
| <input type="checkbox"/> 1 200 bit/s                    |  | <input type="checkbox"/> 38 400 bit/s     |

#### Transmission speed (monitor direction)

| Unbalanced interchange<br>Circuit V.24/V.28<br>Standard | Unbalanced interchange<br>Circuit V.24/V.28<br>Recommended if >1 200 bit/s | Balanced interchange<br>Circuit X.24/X.27 |
|---|--|---|
| <input type="checkbox"/> 100 bit/s                      | <input type="checkbox"/> 2 400 bit/s                                       | <input type="checkbox"/> 2 400 bit/s      |
| <input type="checkbox"/> 200 bit/s                      | <input type="checkbox"/> 4 800 bit/s                                       | <input type="checkbox"/> 4 800 bit/s      |
| <input type="checkbox"/> 300 bit/s                      | <input type="checkbox"/> 9 600 bit/s                                       | <input type="checkbox"/> 9 600 bit/s      |
| <input type="checkbox"/> 600 bit/s                      |  | <input type="checkbox"/> 19 200 bit/s     |
| <input type="checkbox"/> 1 200 bit/s                    |  | <input type="checkbox"/> 38 400 bit/s     |

### 9.4 Link layer

(network-specific parameter, all options that are used are to be marked "X". Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.)

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.~~

#### Link transmission

- Balanced transmission
- Unbalanced transmission

#### Address field of the link

- not present (balanced transmission only)
- One octet
- Two octets
- Structured
- Unstructured

#### Frame length

- Maximum length L  
(number of octets)

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

- ~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

| Type identification | Cause of transmission |
|---------------------|-----------------------|
| 9, 11, 13, 21       | <1>                   |

- ~~A special assignment of ASDUs to class 2 messages is used as follows:~~

| Type identification | Cause of transmission |
|---------------------|-----------------------|
|                     |                       |
|                     |                       |
|                     |                       |
|                     |                       |

Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).

## 9.5 Application layer

### Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

### Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked "X")

- One octet
- Two octets

### Information object address

(system-specific parameter, all configurations that are used are to be marked "X")

- |  |                                       |
|--|---------------------------------------|
| <input checked="" type="checkbox"/> One octet    | <input type="checkbox"/> Structured   |
| <input checked="" type="checkbox"/> Two octets   | <input type="checkbox"/> Unstructured |
| <input checked="" type="checkbox"/> Three octets |                                       |

### Cause of transmission

(system-specific parameter, all configurations that are used are to be marked "X")

- One octet
- Two octets (with originator address). Originator address is set to zero if not used

### Length of APDU

(system-specific parameter, specify the maximum length of the APDU per system)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

- |                                     |  |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | Maximum length of APDU per system in control direction |
| <input checked="" type="checkbox"/> | Maximum length of APDU per system in monitor direction |

## Selection of standard ASDUs

### Process information in monitor direction

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

|                                     |  |           |
|-------------------------------------|--|-----------|
| <input type="checkbox"/>            | <1> := Single-point information  | M_SP_NA_1 |
| <input checked="" type="checkbox"/> | <2> := Single-point information with time tag  | M_SP_TA_1 |
| <input type="checkbox"/>            | <3> := Double-point information  | M_DP_NA_1 |
| <input checked="" type="checkbox"/> | <4> := Double-point information with time tag  | M_DP_TA_1 |
| <input type="checkbox"/>            | <5> := Step position information   | M_ST_NA_1 |
| <input checked="" type="checkbox"/> | <6> := Step position information with time tag   | M_ST_TA_1 |
| <input type="checkbox"/>            | <7> := Bitstring of 32 bit   | M_BO_NA_1 |
| <input checked="" type="checkbox"/> | <8> := Bitstring of 32 bit with time tag   | M_BO_TA_1 |
| <input type="checkbox"/>            | <9> := Measured value, normalized value  | M_ME_NA_1 |
| <input checked="" type="checkbox"/> | <10> := Measured value, normalized value with time tag                                     | M_ME_TA_1 |
| <input type="checkbox"/>            | <11> := Measured value, scaled value   | M_ME_NB_1 |
| <input checked="" type="checkbox"/> | <12> := Measured value, scaled value with time tag   | M_ME_TB_1 |
| <input type="checkbox"/>            | <13> := Measured value, short floating point value   | M_ME_NC_1 |
| <input checked="" type="checkbox"/> | <14> := Measured value, short floating point value with time tag                           | M_ME_TC_1 |
| <input type="checkbox"/>            | <15> := Integrated totals  | M_IT_NA_1 |
| <input checked="" type="checkbox"/> | <16> := Integrated totals with time tag  | M_IT_TA_1 |
| <input checked="" type="checkbox"/> | <17> := Event of protection equipment with time tag  | M_EP_TA_1 |
| <input checked="" type="checkbox"/> | <18> := Packed start events of protection equipment with time tag                          | M_EP_TB_1 |
| <input checked="" type="checkbox"/> | <19> := Packed output circuit information of protection equipment with time tag            | M_EP_TC_1 |
| <input type="checkbox"/>            | <20> := Packed single-point information with status change detection                       | M_SP_NA_1 |
| <input type="checkbox"/>            | <21> := Measured value, normalized value without quality descriptor                        | M_ME_ND_1 |
| <br>                                |  |           |
| <input type="checkbox"/>            | <30> := Single-point information with time tag CP56Time2a                                  | M_SP_TB_1 |
| <input type="checkbox"/>            | <31> := Double-point information with time tag CP56Time2a                                  | M_DP_TB_1 |
| <input type="checkbox"/>            | <32> := Step position information with time tag CP56Time2a                                 | M_ST_TB_1 |
| <input type="checkbox"/>            | <33> := Bitstring of 32 bit with time tag CP56Time2a                                       | M_BO_TB_1 |
| <input type="checkbox"/>            | <34> := Measured value, normalized value with time tag CP56Time2a                          | M_ME_TD_1 |
| <input type="checkbox"/>            | <35> := Measured value, scaled value with time tag CP56Time2a                              | M_ME_TE_1 |
| <input type="checkbox"/>            | <36> := Measured value, short floating point value with time tag CP56Time2a                | M_ME_TF_1 |
| <input type="checkbox"/>            | <37> := Integrated totals with time tag CP56Time2a   | M_IT_TB_1 |
| <input type="checkbox"/>            | <38> := Event of protection equipment with time tag CP56Time2a                             | M_EP_TD_1 |
| <input type="checkbox"/>            | <39> := Packed start events of protection equipment with time tag CP56Time2a               | M_EP_TE_1 |
| <input type="checkbox"/>            | <40> := Packed output circuit information of protection equipment with time tag CP56Time2a | M_EP_TF_1 |

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

### Process information in control direction

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

|                          |  |           |
|--------------------------|--|-----------|
| <input type="checkbox"/> | <45> := Single command   | C_SC_NA_1 |
| <input type="checkbox"/> | <46> := Double command   | C_DC_NA_1 |
| <input type="checkbox"/> | <47> := Regulating step command  | C_RC_NA_1 |
| <input type="checkbox"/> | <48> := Set point command, normalized value                                    | C_SE_NA_1 |
| <input type="checkbox"/> | <49> := Set point command, scaled value  | C_SE_NB_1 |
| <input type="checkbox"/> | <50> := Set point command, short floating point value                          | C_SE_NC_1 |
| <input type="checkbox"/> | <51> := Bitstring of 32 bit  | C_BO_NA_1 |
| <br>                     |  |           |
| <input type="checkbox"/> | <58> := Single command with time tag CP56Time2a                                | C_SC_TA_1 |
| <input type="checkbox"/> | <59> := Double command with time tag CP56Time2a                                | C_DC_TA_1 |
| <input type="checkbox"/> | <60> := Regulating step command with time tag CP56Time2a                       | C_RC_TA_1 |
| <input type="checkbox"/> | <61> := Set point command, normalized value with time tag CP56Time2a           | C_SE_TA_1 |
| <input type="checkbox"/> | <62> := Set point command, scaled value with time tag CP56Time2a               | C_SE_TB_1 |
| <input type="checkbox"/> | <63> := Set point command, short floating point value with time tag CP56Time2a | C_SE_TC_1 |
| <input type="checkbox"/> | <64> := Bitstring of 32 bit with time tag CP56Time2a                           | C_BO_TA_1 |

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

### System information in monitor direction

(station-specific parameter, mark with an "X" if it is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

|                          |                               |           |
|--------------------------|-------------------------------|-----------|
| <input type="checkbox"/> | <70> := End of initialization | M_EI_NA_1 |
|--------------------------|-------------------------------|-----------|

### System information in control direction

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

|                                     |  |           |
|-------------------------------------|--|-----------|
| <input type="checkbox"/>            | <100>:= Interrogation command                          | C_IC_NA_1 |
| <input type="checkbox"/>            | <101>:= Counter interrogation command                  | C_CI_NA_1 |
| <input type="checkbox"/>            | <102>:= Read command                                   | C_RD_NA_1 |
| <input type="checkbox"/>            | <103>:= Clock synchronization command (option see 7.6) | C_CS_NA_1 |
| <input checked="" type="checkbox"/> | <104>:= Test command                                   | C_TS_NA_1 |
| <input type="checkbox"/>            | <105>:= Reset process command                          | C_RP_NA_1 |
| <input checked="" type="checkbox"/> | <106>:= Delay acquisition command                      | C_CD_NA_1 |
| <input type="checkbox"/>            | <107>:= Test command with time tag CP56Time2a          | C_TS_TA_1 |

### **Parameter in control direction**

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- <110>:= Parameter of measured value, normalized value P\_ME\_NA\_1
- <111>:= Parameter of measured value, scaled value P\_ME\_NB\_1
- <112>:= Parameter of measured value, short floating point value P\_ME\_NC\_1
- <113>:= Parameter activation P\_AC\_NA\_1

## File transfer

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

|                          |  |           |
|--------------------------|--|-----------|
| <input type="checkbox"/> | <120>:= File ready   | F_FR_NA_1 |
| <input type="checkbox"/> | <121>:= Section ready  | F_SR_NA_1 |
| <input type="checkbox"/> | <122>:= Call directory, select file, call file, call section                   | F_SC_NA_1 |
| <input type="checkbox"/> | <123>:= Last section, last segment   | F_LS_NA_1 |
| <input type="checkbox"/> | <124>:= Ack file, ack section  | F_AF_NA_1 |
| <input type="checkbox"/> | <125>:= Segment  | F_SG_NA_1 |
| <input type="checkbox"/> | <126>:= Directory {blank or X, only available in monitor (standard) direction} | F_DR_TA_1 |
| <input type="checkbox"/> | <127>:= Query Log – Request archive file                                       | F_SC_NB_1 |

## Type identifier and cause of transmission assignments

## Type parameter and station-specific parameters

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU not used.

Mark Type Identification/Cause of transmission combinations:

"X" if only used in the standard direction:

"R" if only used in the reverse direction:

"B" if used in both directions

| Type identification |            | Cause of transmission |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
|---------------------|------------|-----------------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----------|----|----------|----|----|----|
|                     |            | 1                     | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | to<br>36 | 37 | to<br>41 | 44 | 45 | 46 |
| <13>                | M_ME_NC_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <14>                | M_ME_TC_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <15>                | M_IT_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <16>                | M_IT_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <17>                | M_EP_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <18>                | M_EP_TB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <19>                | M_EP_TC_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <20>                | M_PS_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <21>                | M_ME_ND_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <30>                | M_SP_TB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <31>                | M_DP_TB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <32>                | M_ST_TB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <33>                | M_BO_TB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <34>                | M_ME_TD_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <35>                | M_ME_TE_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <36>                | M_ME_TF_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <37>                | M_IT_TB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <38>                | M_EP_TD_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <39>                | M_EP_TE_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <40>                | M_EP_TF_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <45>                | C_SC_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <46>                | C_DC_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <47>                | C_RC_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <48>                | C_SE_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <49>                | C_SE_NB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <50>                | C_SE_NC_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <51>                | C_BO_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <58>                | C_SC_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <59>                | C_DC_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <60>                | C_RC_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <61>                | C_SE_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <62>                | C_SE_TB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <63>                | C_SE_TC_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <64>                | C_BO_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <70>                | M_EI_NA_1* |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <100>               | C_IC_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <101>               | C_CI_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <102>               | C_RD_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <103>               | C_CS_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <104>               | C_TS_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <105>               | C_RP_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <106>               | C_CD_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <107>               | C_TS_TA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <110>               | P_ME_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <111>               | P_ME_NB_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <112>               | P_ME_NC_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <113>               | P_AC_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <120>               | F_FR_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <121>               | F_SR_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <122>               | F_SC_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <123>               | F_LS_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <124>               | F_AF_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <125>               | F_SG_NA_1  |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <126>               | F_DR_TA_1* |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |
| <127>               | F_SC_NB_1* |                       |   |   |   |   |   |   |   |   |    |    |    |    |    |          |    |          |    |    |    |

\* Blank or X only

## 9.6 Basic application functions

### Station initialization

(station-specific parameter, mark "X" if function is used)

- Remote initialization

### Cyclic data transmission

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions)

- Cyclic data transmission

### Read procedure

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions)

- Read procedure

### Spontaneous transmission

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions)

- Spontaneous transmission

### Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter, mark each information type "X" where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- Single-point information M\_SP\_NA\_1, M\_SP\_TA\_1, M\_SP\_TB\_1 and M\_PS\_NA\_1
- Double-point information M\_DP\_NA\_1, M\_DP\_TA\_1 and M\_DP\_TB\_1
- Step position information M\_ST\_NA\_1, M\_ST\_TA\_1 and M\_ST\_TB\_1
- Bitstring of 32 bit M\_BO\_NA\_1, M\_BO\_TA\_1 and M\_BO\_TB\_1 (if defined for a specific project)
- Measured value, normalized value M\_ME\_NA\_1, M\_ME\_TA\_1, M\_ME\_ND\_1 and M\_ME\_TD\_1
- Measured value, scaled value M\_ME\_NB\_1, M\_ME\_TB\_1 and M\_ME\_TE\_1
- Measured value, short floating point number M\_ME\_NC\_1, M\_ME\_TC\_1 and M\_ME\_TF\_1

**Station interrogation**

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- |                                  |                                   |                                   |
|----------------------------------|-----------------------------------|-----------------------------------|
| <input type="checkbox"/> global  | <input type="checkbox"/> group 7  | <input type="checkbox"/> group 13 |
| <input type="checkbox"/> group 1 | <input type="checkbox"/> group 8  | <input type="checkbox"/> group 14 |
| <input type="checkbox"/> group 2 | <input type="checkbox"/> group 9  | <input type="checkbox"/> group 15 |
| <input type="checkbox"/> group 3 | <input type="checkbox"/> group 10 | <input type="checkbox"/> group 16 |
| <input type="checkbox"/> group 4 |                                   |                                   |
| <input type="checkbox"/> group 5 | <input type="checkbox"/> group 11 |                                   |
| <input type="checkbox"/> group 6 | <input type="checkbox"/> group 12 |                                   |
- Information object addresses assigned to each group must be shown in a separate table.

**Clock synchronization**

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Clock synchronization
- Day of week used
- RES1, GEN (time tag substituted/ not substituted) used
- SU-bit (summertime) used

optional, see 7.6

**Command transmission**

(object-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Direct command transmission
  - Direct set point command transmission
  - Select and execute command
  - Select and execute set point command
  - C\_SE ACTTERM used
  - No additional definition
  - Short-pulse duration (duration determined by a system parameter in the outstation)
  - Long-pulse duration (duration determined by a system parameter in the outstation)
  - Persistent output
  - Supervision of maximum delay in command direction of commands and set point commands
- Maximum allowable delay of commands and set point commands

**Transmission of integrated totals**

(station- or object-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Mode A: Local freeze with spontaneous transmission
- Mode B: Local freeze with counter interrogation
- Mode C: Freeze and transmit by counter-interrogation commands
- Mode D: Freeze by counter-interrogation command, frozen values reported
  
- Counter read
- Counter freeze without reset
- Counter freeze with reset
- Counter reset
  
- General request
- Request counter group 1
- Request counter group
- Request counter group 3
- Request counter group 4

**Parameter loading**

(object-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Threshold value
- Smoothing factor
- Low limit for transmission of measured values
- High limit for transmission of measured values

**Parameter activation**

(object-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Act/deact of persistent cyclic or periodic transmission of the addressed object

**Test procedure**

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Test procedure

**File transfer**

(station-specific parameter, mark "X" if function is used).

File transfer in monitor direction

- Transparent file
- Transmission of disturbance data of protection equipment
- Transmission of sequences of events
- Transmission of sequences of recorded analogue values

File transfer in control direction

- Transparent file

**Background scan**

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Background scan

**Acquisition of transmission delay**

(station-specific parameter, mark "X" if function is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

- Acquisition of transmission delay

**Definition of time outs**

| Parameter | Default value | Remarks   | Selected value |
|-----------|---------------|---|----------------|
| $t_0$     | 30 s          | Time-out of connection establishment                              |                |
| $t_1$     | 15 s          | Time-out of send or test APDUs                                    |                |
| $t_2$     | 10 s          | Time-out for acknowledges in case of no data messages $t_2 < t_1$ |                |
| $t_3$     | 20 s          | Time-out for sending test frames in case of a long idle state     |                |

Maximum range for timeouts  $t_0$  to  $t_2$ : 1 s to 255 s, accuracy 1 s.Recommended range for timeout  $t_3$ : 1 s to 48 h, resolution 1 s.Long timeouts for  $t_3$  may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).**Maximum number of outstanding I format APDUs  $k$  and latest acknowledge APDUs ( $w$ )**

| Parameter | Default value | Remarks   | Selected value |
|-----------|---------------|---|----------------|
| $k$       | 12 APDUs      | Maximum difference receive sequence number to send state variable |                |
| $w$       | 8 APDUs       | Latest acknowledge after receiving $w$ I format APDUs             |                |

Maximum range of values  $k$ : 1 to 32767 ( $2^{15}-1$ ) APDUs, accuracy 1 APDU

Maximum range of values  $w$ : 1 to 32767 APDUs, accuracy 1 APDU (Recommendation:  $w$  should not exceed two-thirds of  $k$ ).

### **Portnumber**

| Parameter  | Value | Remarks      |
|------------|-------|--------------|
| Portnumber | 2404  | In all cases |

### **Redundant connections**

Number N of redundancy group connections used

### **RFC 2200 suite**

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

- Ethernet 802.3
- Serial X.21 interface
- Other selection from RFC 2200:

#### List of valid documents from RFC 2200

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. etc.

## **10 Redundant connections**

### **10.1 General**

This companion standard defines network access for IEC 60870-5-101 using the well known TCP/IP transport profile, and mainly focuses on the use of a single TCP connection.

In many cases, however, redundancy is required to increase the availability of the communication system. In these cases, multiple redundant connections should be established between the two stations. This clause describes the interoperability issues that arise when standby connections are used as redundant connections.

### **10.2 General requirements**

Redundant communication in a system using IEC 60870-5-104 can be achieved by providing the possibility to establish more than one logical connection between two stations. A logical connection is defined by a unique combination of two IP-addresses and two port-numbers, namely controlling station IP-address/port-number pair and controlled station IP-address/port-number pair.

Connection establishment is performed by the controlling station in the case of a controlled station as a partner, or by a fixed selection (parameter) in case of two equivalent controlling stations or partners, as stated in 7.1. The station that performs the connection establishment is in either case referred to as the controlling station (station A) in the subsequent description, while the partner station is referred to as the controlled station (station B).

The following general rules apply to this clause concerning redundant connections:

- 1) The controlling and controlled station shall be able to handle multiple ( $N$ ) logical connections.
- 2) The  $N$  logical connections represent one redundancy group.
- 3) Only one logical connection is in the started state and sending/receiving user data at a time for one redundancy group.
- 4) The controlling station decides which one of the  $N$  connections is be in started state.
- 5) All logical connections of a redundancy group shall be supervised by test frames as described in 5.2.
- 6) A redundancy group shall rely upon only one process image (database/event buffer).
- 7) If more than one controlling station need to access the same controlled station simultaneously, each controlling station must be assigned to a different redundancy group (process image).

The logical connection which is enabled for user data transfer (started) at any time is defined to be the started connection, while the others are stopped connections. Selection of started connection is performed by means of the unnumbered control functions (U-frames) STARTDT/STOPDT as in 5.3 and according to the State transition diagrams in Figure 36 and Figure 37.

As stated in rule 4 above, the selection and switchover of the started connection is always initiated by the controlling station, and is managed by the transport interface or higher layers. Selection of the started connection after station initialisation is performed by transmitting a STARTDT\_ACT on the desired connection. Similarly, connection switchover in the case of a failure (connection failover) is performed by transmitting a STARTDT\_ACT on the stopped connection that is selected to take over.

The controlled station (station B) always understands the connection on which it last received a STARTDT\_ACT as the started connection. It confirms the activation request by issuing a STARTDT\_CON. The whole activation procedure is completed when the STARTDT\_CON is received in the controlling station.

Manual connection switchover can be performed by first issuing a STOPDT\_ACT on the currently started connection and then a STARTDT\_ACT on the selected new started connection. This will gracefully terminate data transfer on the first connection before it is resumed on the new connection.

The controlling and/or controlled station shall regularly check the status of all established connections to detect any communication problems as soon as possible. This is done by sending TESTFR frames as described in 5.2.

Send and receive counters on each connection within a redundancy group continue their functionality independently of the use of STARTDT/STOPDT.

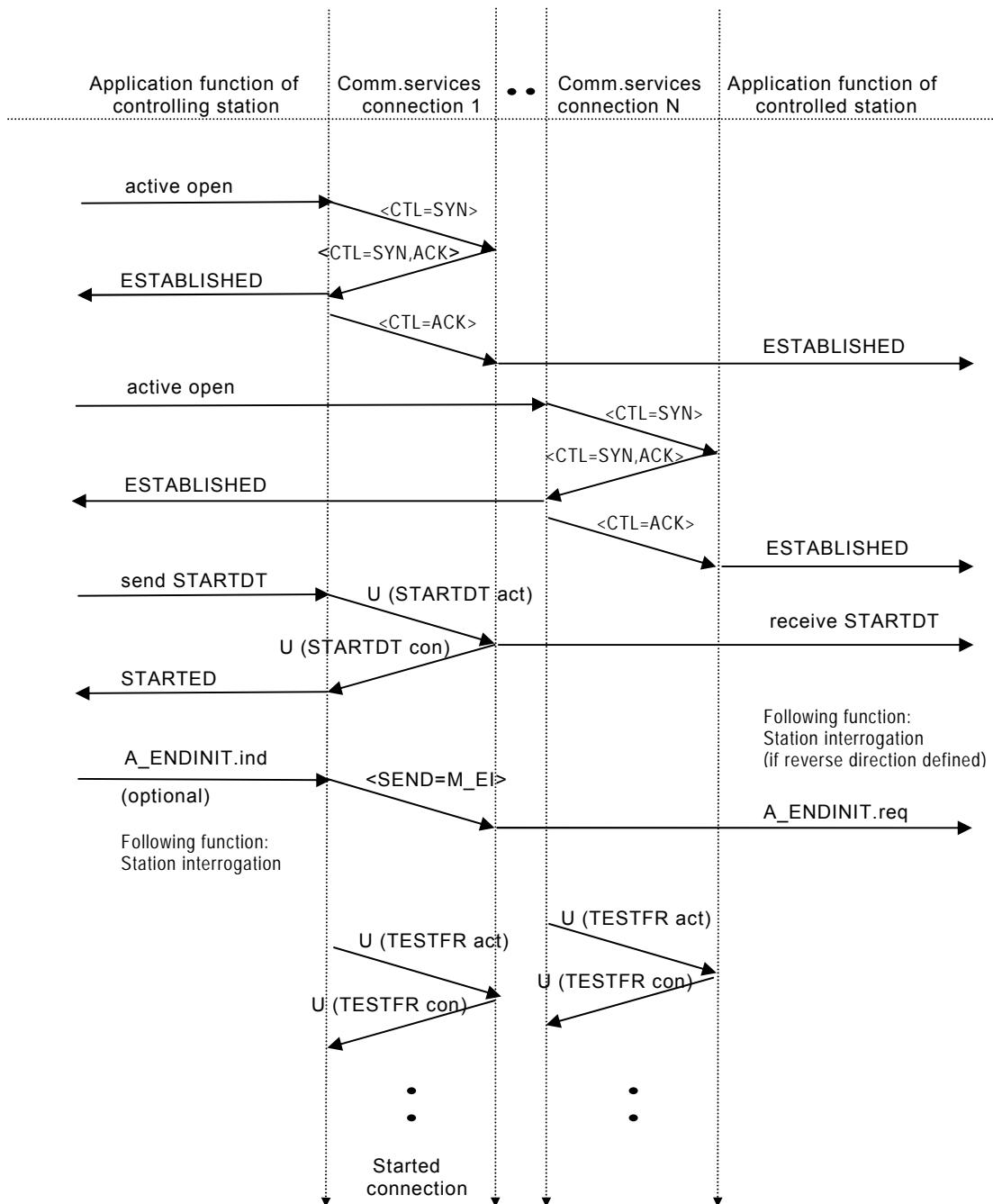
### 10.3 Initialisation of controlling station

The sequential procedure for initialisation of the controlling station with N redundant connections is shown in Figure 32.

After connection establishment, the stopped state is always default, and one of the connections (e.g. connection 1) is therefore changed from the stopped into the started state to enable user data transfer on this connection.

The ENDINIT.req (optional but recommended, Figures 32 and 33) may always be useful to advise the other station that the sending station is now ready to respond to an interrogation request. In case of initialisation of the controlling station, it is only issued if data in the reverse direction is defined.

The controlling station shall initiate a station interrogation procedure as soon as possible after the completion of making one of the connections in started state as shown in Figures 32 and 33.



IEC 940/06

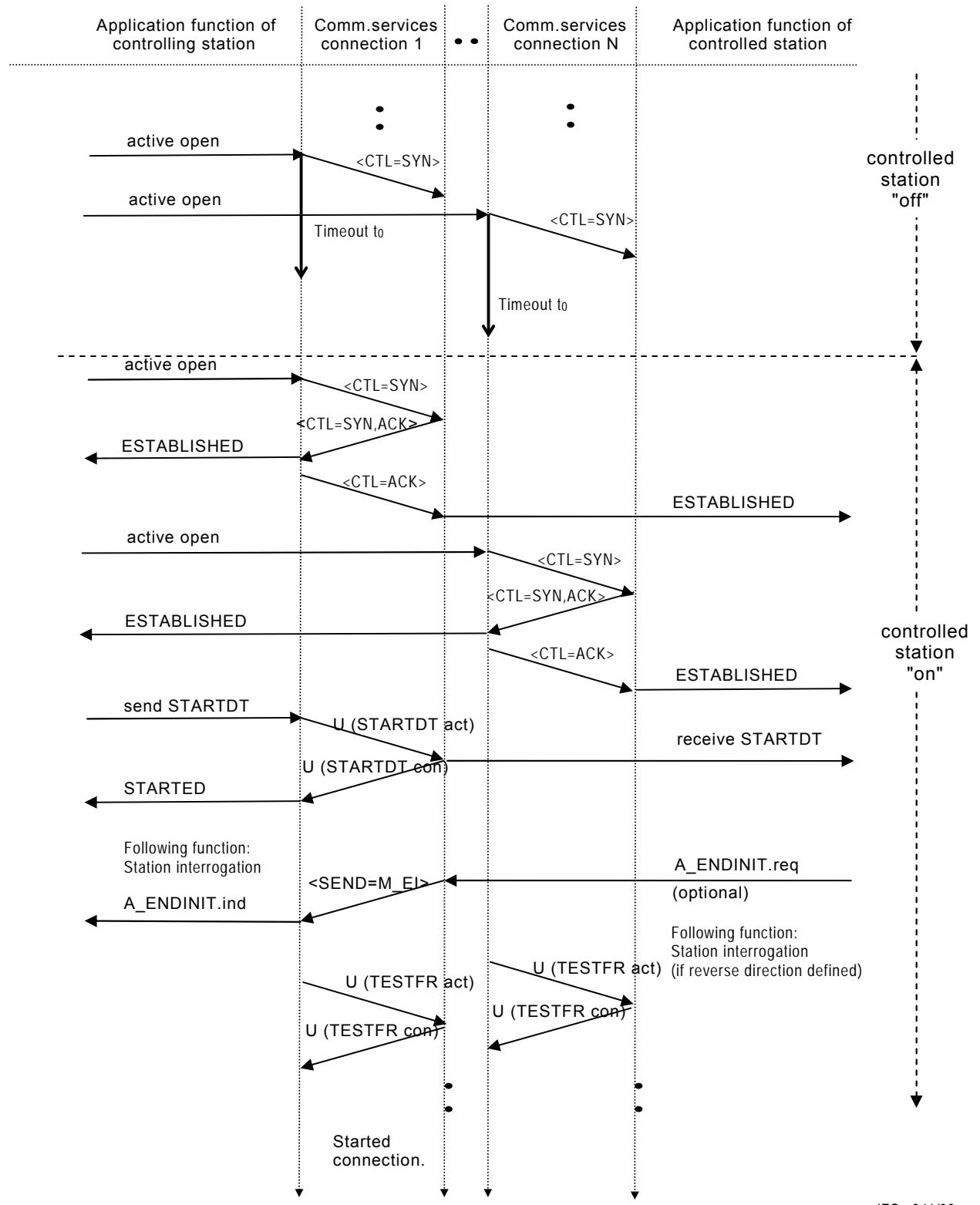
NOTE The sequential interrelationship between the procedures on the connections is not fixed. For example, establishment of the connections may be started and go on in parallel.

**Figure 32 – Initialisation of controlling station with redundant connections**

#### 10.4 Initialisation of controlled station

The sequential procedure for initialisation of the controlled station with N redundant connections within a single redundancy group is shown in Figure 33.

After restart of the controlled station, the connections are established according to 7.1, but no user data is transmitted from the controlled station until started state on one connection is established.



IEC 941/06

NOTE The sequential interrelationship between the procedures on the connections is not fixed. For example, establishment of the connections may be started and go on in parallel.

**Figure 33 – Initialisation of controlled station with redundant connections**

## 10.5 User data from controlling station

If communication fails on the currently started connection (e.g. connection m) when the controlling station attempts to transmit user data (e.g. a command ASDU), a connection switchover will be performed (preferably automatic). The sequential procedure in this case is shown in Figure 34. It is up to the controlling station to select a new started connection.

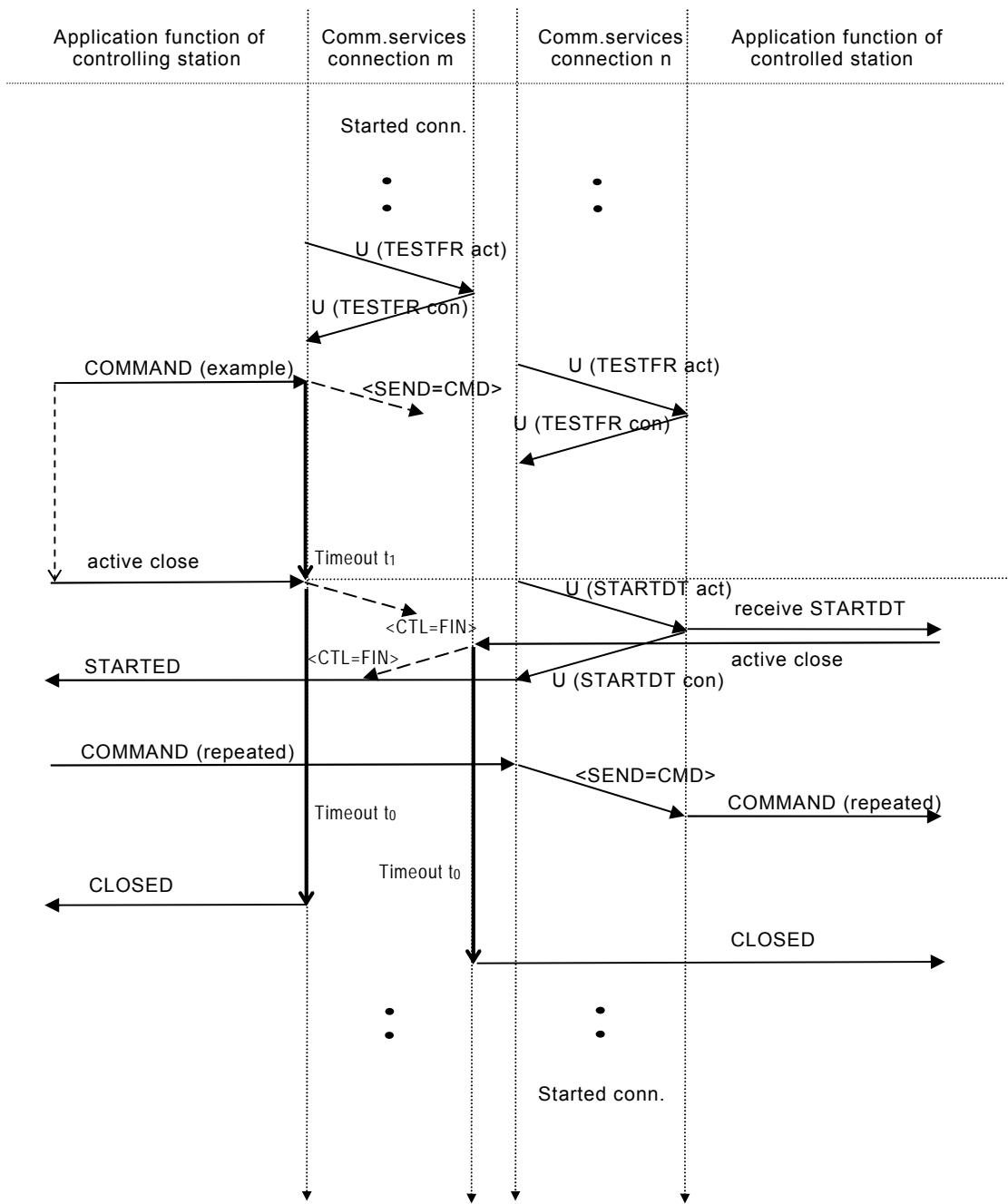
When transmission timeout ( $t_1$ ) has elapsed, one of the stopped connections (connection n) is started using the STARTDT function. The command is then directed to the new started connection, either by re-transmitting the ASDU on this connection or by terminating the ongoing application function and reinitiating it towards the new connection (it is left to the application if the ASDU is retransmitted). The failed connection is eventually closed by both sides, and reopening is regularly retried by the controlling station until the error has been corrected and the connection is re-established.

Any subsequent user data (e.g. events) are now transmitted on the new started connection.

A connection switchover will also be performed whenever a TESTFR\_ACT on the started connection fails and hence reports a communication error on this connection.

Care shall be taken that data are not lost during a connection switchover, for example by doing a station interrogation procedure after a switchover has been performed.

The controlled station shall only acknowledge user data received on the connection on which it last received a STARTDT\_ACT (the started connection).



IEC 942/06

NOTE The sequential interrelationship between the procedures on the two connections is not fixed, except when connection switch occurs.

**Figure 34 – Redundant connections – User data from controlling station**

## 10.6 User data from controlled station

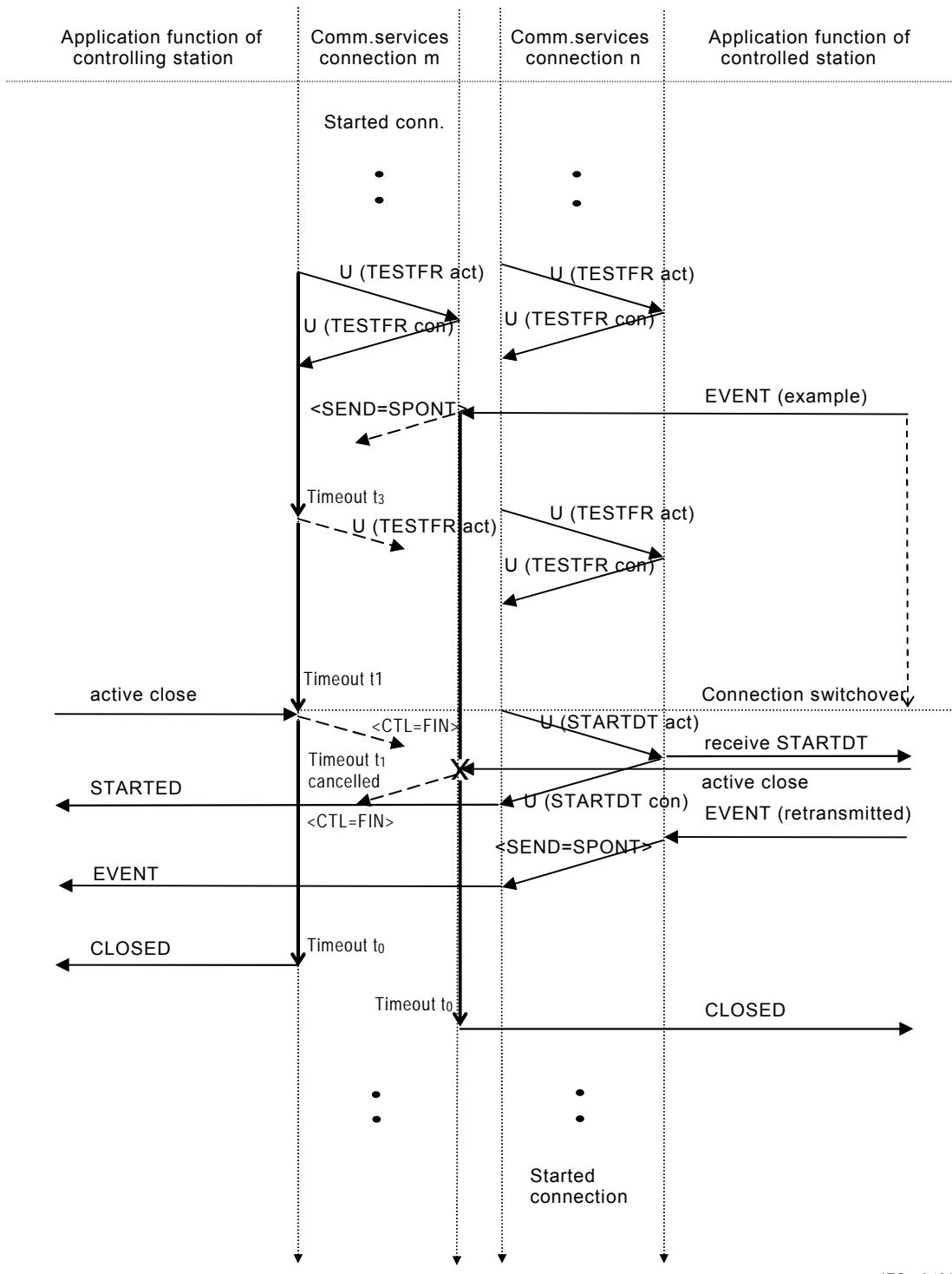
If communication fails on the started connection when the controlled station attempts to transmit user data (e.g. an event ASDU), the controlling station shall detect the failure and perform a connection switchover before the ASDU can be retransmitted on one of the previously stopped connections. A sequential procedure to illustrate this case is shown in Figure 35, with the use of asymmetric timeouts as explained in 10.7.

A STARTDT\_ACT will eventually be received on one of the stopped connections (connection m) as a result of a timeout ( $t_1$ ) in the controlling station to a TESTFR frame on the currently started but failed connection. The selected stopped connection now becomes the new started connection, and the pending event is retransmitted on this connection.

In general, any unconfirmed user data will be retransmitted on the new started connection after a connection switchover has been performed, including potential unconfirmed ACTCONs or ACTTERMs.

The failed connection is eventually closed by both sides, and reopening is then regularly retried until the error has been corrected and the connection is re-established.

The controlling station shall not acknowledge user data received on a connection which is not started.



IEC 943/06

NOTE 1 The sequential interrelationship between the procedures on the two connections is not fixed, except when connection switch occurs.

NOTE 2 The figure shows the use of asymmetric timeouts  $t_1$  as described in 10.7.

**Figure 35 – Redundant connections – User data from controlled station**

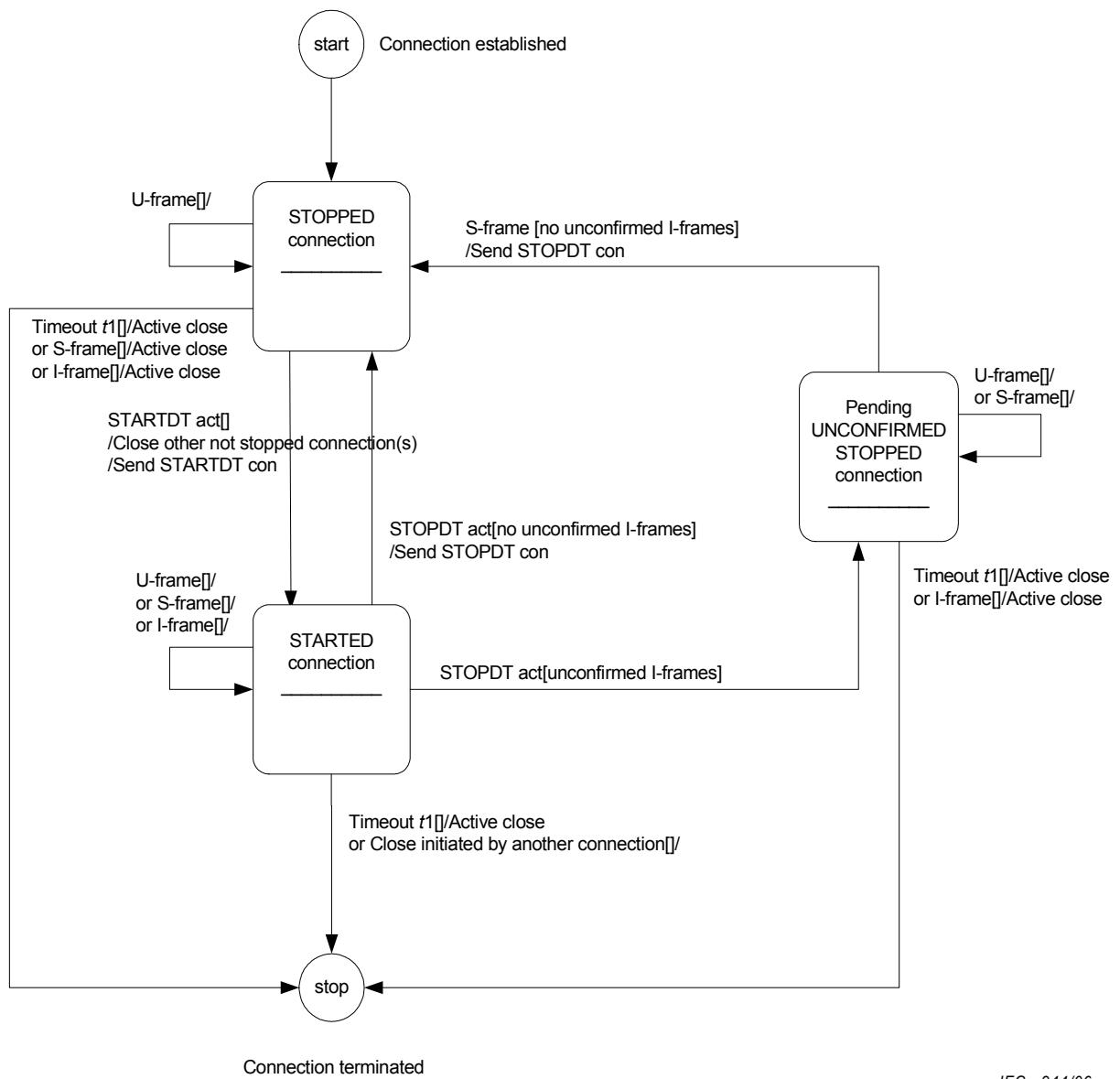
## 10.7 State transition diagrams

Figures 36 and 37 show state transition diagrams for the Start/Stop procedure of a connection that also supports automatic connection switchover, in case of redundant connections.

A timeout  $t_1$  in the controlling station on the started connection may automatically trigger the user application to issue a connection change request, and hence cause the start of a new (redundant) connection and an automatic connection switchover. Manual switchover is initiated by the user application either by a Stop on the started connection followed by a Start on another connection, or simply by issuing a connection change request.

Any connection that is not in the STOPPED state is immediately closed at the event of a Start on a new connection. This means that asymmetric timeouts  $t_1$  can also be used (and  $t_2$  correspondingly), i.e. shorter  $t_1$  in the controlling station than in the controlled station to reduce switchover time.

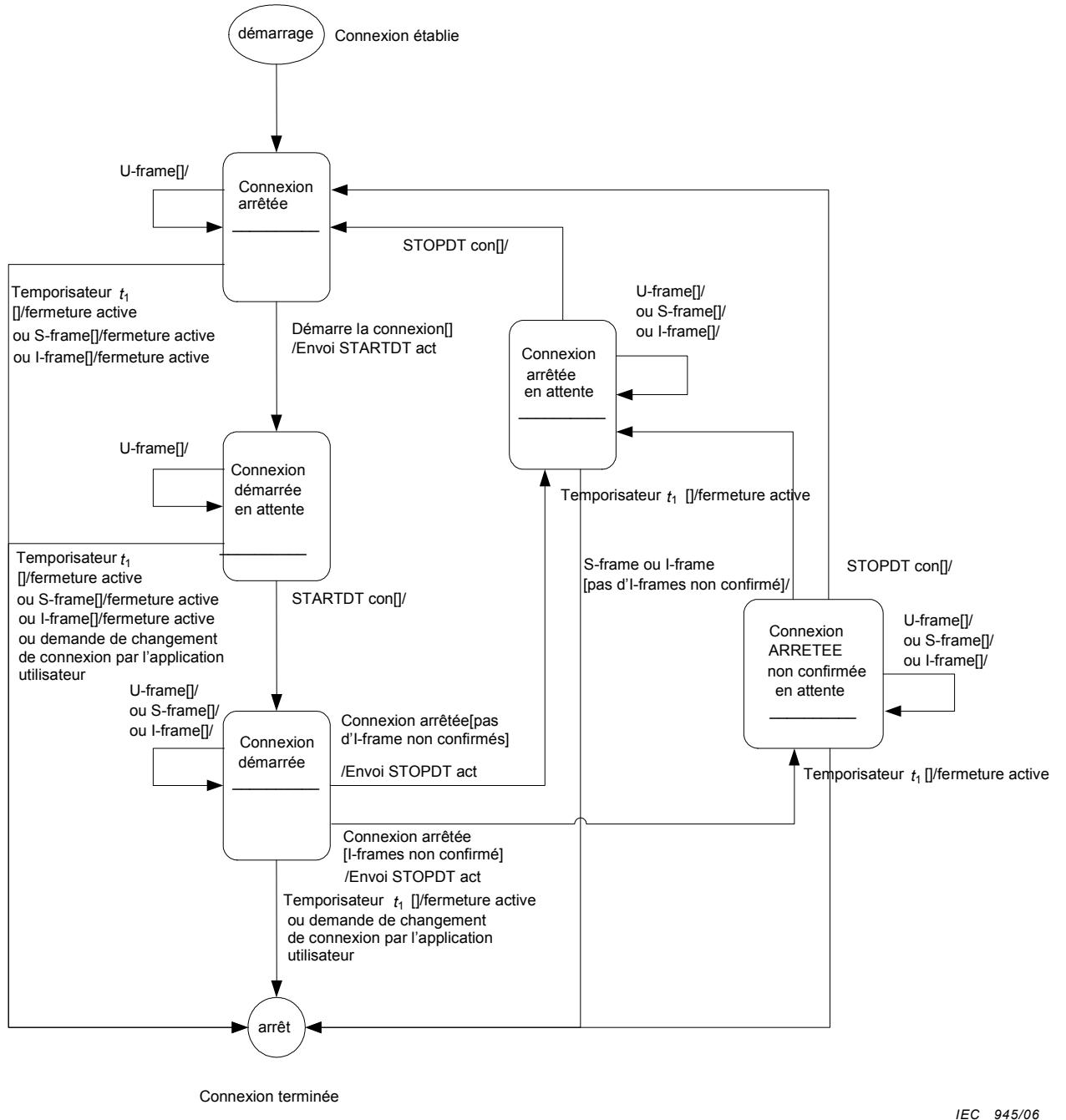
It should be possible to set the values of the timers  $t_0$  to  $t_3$  individually for each connection within a redundancy group.



NOTE 1 Connection terminated means that there is no longer any data exchange between TCP and the application protocol (CS104).

NOTE 2  $t_1$  is the time out of a sent U-frame or I-frame.

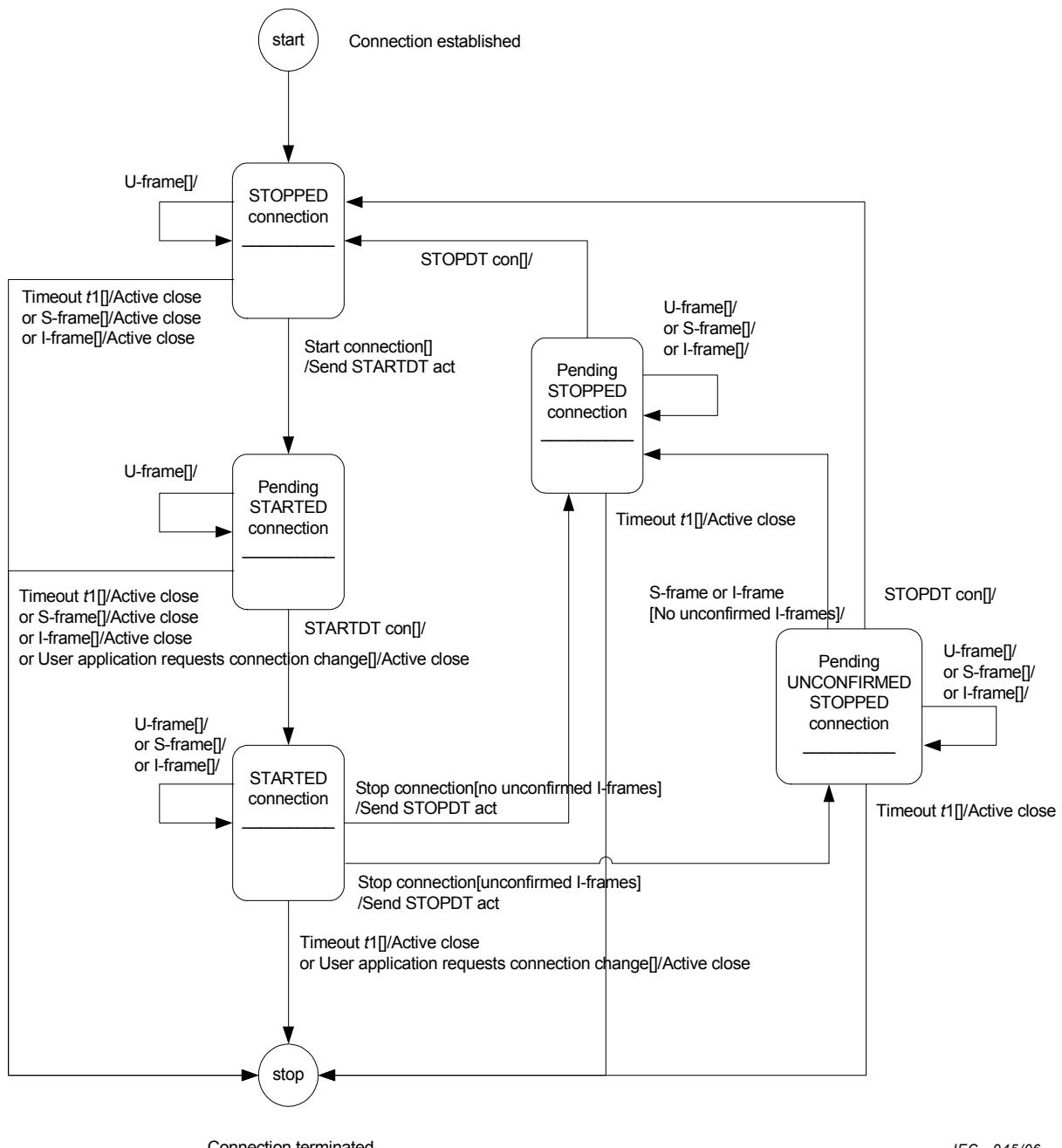
**Figure 36 – State transition diagram for redundant connections (controlled station)**



NOTE 1 Connexion terminée signifie qu'il n'y a plus d'échange de données entre TCP et le protocole d'application (CS104).

NOTE 2  $t_1$  est le temporisateur d'un envoi U-frame ou I-frame.

**Figure 37 – Diagramme de transition d'état pour des connexions redondantes (poste de commande)**



NOTE 1 Connection terminated means that there is no longer any data exchange between TCP and the application protocol (CS104).

NOTE 2  $t_1$  is the time out of a sent U-frame or I-frame.

**Figure 37 – State transition diagram for redundant connections (controlling station)**





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| <p><b>Q2</b> Please tell us in what capacity(ies) you bought the standard (<i>tick all that apply</i>). I am the/a:</p> <p>purchasing agent <input type="checkbox"/><br/>     librarian <input type="checkbox"/><br/>     researcher <input type="checkbox"/><br/>     design engineer <input type="checkbox"/><br/>     safety engineer <input type="checkbox"/><br/>     testing engineer <input type="checkbox"/><br/>     marketing specialist <input type="checkbox"/><br/>     other .....</p>  | <p><b>Q7</b> Please assess the standard in the following categories, using the numbers:<br/>     (1) unacceptable,<br/>     (2) below average,<br/>     (3) average,<br/>     (4) above average,<br/>     (5) exceptional,<br/>     (6) not applicable</p> <p>timeliness .....</p> <p>quality of writing.....</p> <p>technical contents.....</p> <p>logic of arrangement of contents .....</p> <p>tables, charts, graphs, figures.....</p> <p>other .....</p>                      |
| <p><b>Q3</b> I work for/in/as a: (<i>tick all that apply</i>)</p> <p>manufacturing <input type="checkbox"/><br/>     consultant <input type="checkbox"/><br/>     government <input type="checkbox"/><br/>     test/certification facility <input type="checkbox"/><br/>     public utility <input type="checkbox"/><br/>     education <input type="checkbox"/><br/>     military <input type="checkbox"/><br/>     other .....</p>  | <p><b>Q8</b> I read/use the: (<i>tick one</i>)</p> <p>French text only <input type="checkbox"/><br/>     English text only <input type="checkbox"/><br/>     both English and French texts <input type="checkbox"/></p>  |
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