

## TABLE OF CONTENTS

1	FOREWORD .....	1
2	APPLICATION LAYER TELEGRAM FORMATS .....	2
2.1	Interoperability list.....	2
2.2	Interoperability .....	2
2.2.1	Selection of standard ASDUs .....	5
2.2.1.1	Process information in monitor direction.....	6
2.2.1.2	Process information in control direction .....	8
2.2.1.3	System information in monitor direction .....	8
2.2.1.4	System information in control direction .....	8
2.2.1.5	Parameter in control direction.....	9
2.2.1.6	Type Identifier and Cause of Transmission Assignments .....	10
2.2.1.7	Station interrogation.....	13
2.2.1.8	Clock synchronization.....	13
2.2.1.9	Command transmission.....	13
2.2.1.10	Transmission of integrated totals .....	14
2.2.1.11	Parameter loading .....	14
2.2.1.12	Test procedure.....	14
3	REDUNDANT CONNECTIONS.....	17
3.1	General requirements.....	17
3.2	System topology .....	18

# 1 Foreword

The Norwegian User Conventions for IEC 60870-5-104 have been based on the Norwegian User Conventions for IEC 60870-5-101. Establishing User Conventions for IEC 60870-5-101 standard was conducted as a joint project involving many of the major companies in power generation and power distribution in Norway with financial support from The Research Council of Norway. The work has been driven by the Norwegian User Group – NUG.

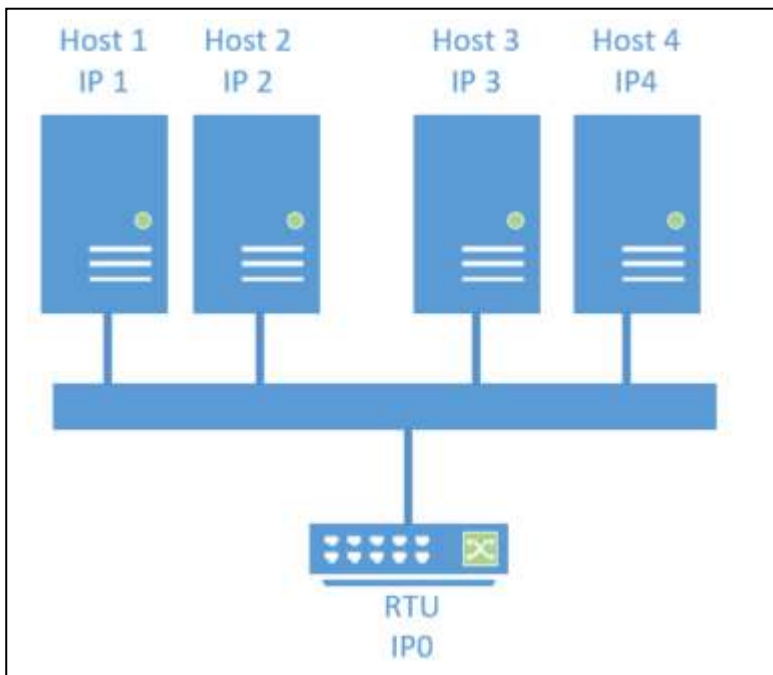
The Norwegian User Conventions for IEC 60870-5-104 are based on the IEC 60870-5-104 standard. According to the rules claimed by NVE, The Norwegian Water Resources and Energy Directorate, there is a requirement of redundant lines/connections to important stations.

## *Redundant connection*

The SCADA system SPECTRUM is master (controlling station) and the RTU is slave (controlled station). When the SCADA system open a session against the RTU, the RTU obligate to reply on the request regardless of which of the 4 master hosts addresses is active. But it is only one master at a time that can be active.

Normal procedure when a new host become master is to do General polling av all I/O on the slave RTU. Afterwards only status change is transferred.

The RTU must be delivered with a communication protocol compliant with the standard: Norwegian IEC 60870-5-104 User Conventions, approved version 1.2, dated 04.02.2000



Detailed specifications and demands explained later in this document under chapter **Redundant connection**.

## 2 Application layer telegram formats

### 2.1 Interoperability list

The marked functions and ASDUs in the interoperability list on the following pages represent the current maximum requirements for an IEC 60870-5-104 system according to the Norwegian User Conventions. Marks are to be removed or changed for unused or changed selections in specific projects.

Unmarked white boxes represent parameters that are currently not required. However, selections of such parameters can be agreed upon in specific projects.

### 2.2 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets must be selected to implement 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.**

#### *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)

### *Network configuration*

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

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

### Physical layer

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

Not valid for Ethernet interfaces.

#### Transmission speed (control direction)

Unbalanced interchange  
Circuit V.24/V.28  
Standard

- 100 bit/s
- 200 bit/s
- 300 bit/s
- 600 bit/s
- 1 200 bit/s

Unbalanced interchange  
Circuit V.24/V.28  
Recommended if >1 200bit/s

- 2 400 bit/s
- 4 800 bit/s
- 9 600 bit/s

Balanced interchange  
Circuit X.24/X.27

- 2 400 bit/s
- 4 800 bit/s
- 9 600 bit/s
- 19 200 bit/s
- 38 400 bit/s

- 56 000 bit/s
- 64 000 bit/s

#### Transmission speed (monitor direction)

Unbalanced interchange

Circuit V.24/V.28  
Standard

- 100 bit/s
- 200 bit/s
- 300 bit/s
- 600 bit/s
- 1 200 bit/s

Unbalanced interchange

Circuit V.24/V.28  
Recommended if >1 200bit/s

- 2 400 bit/s
- 4 800 bit/s
- 9 600 bit/s

Balanced interchange

Circuit X.24/X.27

- 2 400 bit/s
- 4 800 bit/s
- 9 600 bit/s
- 19 200 bit/s
- 38 400 bit/s

- 56 000 bit/s
- 64 000 bit/s

### 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 procedure

- 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).

### Application layer

#### Transmission mode for application data

Mode 1 (Least significant octet first), as defined in clause 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')

One octet  structured  
 Two octets  unstructured  
 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 specifies the maximum length of the APDU per system) The maximum length of the APDU is 255 (default). The maximum length may be reduced per system.

Maximum length of APDU per system

## Selection of standard ASDUs

### 2.2.1.1 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 checked="" type="checkbox"/>	<1>:=Single-point information	M_SP_NA_1
<input type="checkbox"/>	<2>:=Single-point information with time tag	M_SP_TA_1
<input checked="" type="checkbox"/>	<3>:=Double-point information	M_DP_NA_1
<input type="checkbox"/>	<4>:=Double-point information with time tag	M_DP_TA_1
<input checked="" type="checkbox"/>	<5>:=Step position information	M_ST_NA_1
<input type="checkbox"/>	<6>:=Step position information with time tag	M_ST_TA_1
<input checked="" type="checkbox"/>	<7>:=Bitstring of 32 bit	M_BO_NA_1
<input type="checkbox"/>	<8>:=Bitstring of 32 bit with time tag	M_BO_TA_1
<input checked="" type="checkbox"/>	<9>:=Measured value, normalized value	M_ME_NA_1
<input 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 type="checkbox"/>	<12> := Measured value, scaled value with time tag	M_ME_TB_1
<input checked="" type="checkbox"/>	<13> := Measured value, short floating point value	M_ME_NC_1
<input type="checkbox"/>	<14> := Measured value, short floating point value with time tag	M_ME_TC_1
<input checked="" type="checkbox"/>	<15> := Integrated totals	M_IT_NA_1
<input type="checkbox"/>	<16> := Integrated totals with time tag	M_IT_TA_1
<input type="checkbox"/>	<17> := Event of protection equipment with time tag	M_EP_TA_1
<input type="checkbox"/>	<18> := Packed start events of protection equipment with time tag	M_EP_TB_1
<input 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_PS_NA_1
<input type="checkbox"/>	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
<input checked="" type="checkbox"/>	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
<input checked="" type="checkbox"/>	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
<input checked="" 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 checked="" 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 checked="" type="checkbox"/>	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
<input checked="" 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

Either the ASDUs of the set <2>, <4>, <6>, <8>, <10>, <12>, <14>, <16>, <17>, <18>, <19> or of the set <30> – <40> are used.

### 2.2.1.2 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
<input checked="" type="checkbox"/>	<58> := Single command with time tag CP56Time 2a	C_SC_TA_1
<input checked="" type="checkbox"/>	<59> := Double command with time tag CP56Time 2a	C_DC_TA_1
<input checked="" type="checkbox"/>	<60> := Regulating step command with time tag CP56Time 2a	C_RC_TA_1
<input checked="" type="checkbox"/>	<61> := Set point command, normalized value with time tag CP56Time 2a	C_SE_TA_1
<input type="checkbox"/>	<62> := Set point command, scaled value with time tag CP56Time 2a	C_SE_TB_1
<input type="checkbox"/>	<63> := Set point command, short floating point value with time tag CP56Time 2a	C_SE_TC_1
<input checked="" type="checkbox"/>	<64> := Bitstring of 32 bit with time tag CP56Time 2a	C_BO_TA_1

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

### 2.2.1.3 System information in monitor direction

(station-specific parameter, mark 'X' if used)

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

### 2.2.1.4 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 checked="" 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 checked="" type="checkbox"/>	<103>:= Clock synchronization command	C_CS_NA_1
<input type="checkbox"/>	<del>&lt;104&gt;:= Test command</del>	<del>C_TS_NA_1</del>
<input checked="" type="checkbox"/>	<105>:= Reset process command	C_RP_NA_1
<input type="checkbox"/>	<del>&lt;106&gt;:= Delay acquisition command</del>	<del>C_CD_NA_1</del>
<input checked="" type="checkbox"/>	<107>:= Test command with time tag CP56time2a	C_TS_TA_1

### 2.2.1.5 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)

<input checked="" type="checkbox"/>	<110>:= Parameter of measured value, normalized value	P_ME_NA_1
<input type="checkbox"/>	<111>:= Parameter of measured value, scaled value	P_ME_NB_1
<input checked="" type="checkbox"/>	<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
<input type="checkbox"/>	<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

### 2.2.1.6 Type Identifier and Cause of Transmission Assignments

(station-specific parameters)

Shaded boxes are not required.

Black boxes are not permitted in this companion standard

Blank = Function or ASDU is 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 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X											X					
<2>	M_SP_TA_1			X		X						X								
<3>	M_DP_NA_1			X											X					
<4>	M_DP_TA_1			X		X						X								
<5>	M_ST_NA_1			X											X					
<6>	M_ST_TA_1			X		X						X								
<7>	M_BO_NA_1			X											X					
<8>	M_BO_TA_1			X		X														
<9>	M_ME_NA_1			X											X					
<10>	M_ME_TA_1			X		X														
<11>	M_ME_NB_1																			
<12>	M_ME_TB_1			X		X														
<13>	M_ME_NC_1			X											X					
<14>	M_ME_TC_1			X		X														
<15>	M_IT_NA_1																			
<16>	M_IT_TA_1			X													X			
<17>	M_EP_TA_1			X																
<18>	M_EP_TB_1			X																
<19>	M_EP_TC_1			X																
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X																
<31>	M_DP_TB_1			X																
<32>	M_ST_TB_1			X																
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1			X																
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1			X																
<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																			

Type Identification		Cause of transmission																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47	
<50>	C_SE_NC_1																				
<51>	C_BO_NA_1																				
<58>	C_SC_TA_1						X	X	X	X	X										
<59>	C_DC_TA_1						X	X	X	X	X										
<60>	C_RC_TA_1						X	X			X										
<61>	C_SE_TA_1						X	X	X	X	X										
<62>	C_SE_TB_1																				
<63>	C_SE_TC_1																				
<64>	C_BO_TA_1						X	X			X										
<70>	M_EI_NA_1*)			X																	
<100>	C_IC_NA_1						X	X			X										
<101>	C_CI_NA_1																				
<102>	C_RD_NA_1																				
<103>	C_CS_NA_1						X	X													
<104>	C_TS_NA_1																				
<105>	C_RP_NA_1						X	X													
<106>	C_CD_NA_1																				
<107>	C_TS_TA_1						X	X													
<110>	P_ME_NA_1						X	X													
<111>	P_ME_NB_1																				
<112>	P_ME_NC_1						X	X													
<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*)																				

\*) blank or X only

### 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

### 2.2.1.7 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 checked="" 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 11 |                                   |
| <input type="checkbox"/> group 5           | <input type="checkbox"/> group 12 |                                   |
| <input type="checkbox"/> group 6           |                                   |                                   |
- Information Object Addresses assigned to each group must be shown in a separate table

### 2.2.1.8 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 (optional)

### 2.2.1.9 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

### 2.2.1.10 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 spontaneously
  
- Counter read
- Counter freeze without reset
- Counter freeze with reset
- Counter reset
  
- General request counter
- Request counter group 1
- Request counter group 2
- Request counter group 3
- Request counter group 4

### 2.2.1.11 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 value
- High limit for transmission of measured value

#### 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

### 2.2.1.12 Test procedure

(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)

- 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 <sub>0</sub>	30s	Time out of connection establishment	
t <sub>1</sub>	15s	Time out of send or test APDUs	
t <sub>2</sub>	10s	Time out for acknowledges in case of no data messages $t_2 < t_1$	
t <sub>3</sub>	20s	Time out for sending test frames in case of a long idle state	

Maximum range of values for all time outs: 1 to 255 s, accuracy 1 s

**Maximum number of outstanding I format APDUs k and latest acknowledge**

Parameter	Default value	Remarks	Selected value
K	12 APDUs	Maximum difference receives 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 2/3 of k).

**Portnumber**

Parameter	Value	Remarks
Portnumber	2404	In all cases

**Redundant connections**

The Number N of redundancy group connection used. Must be at least 4. Each redundancy group handles N redundant connections from 104 Clients.

Supported number of redundancy groups at the same time. Must be at least 1. Each redundancy group is considered each as one driver instance – which means that each redundancy group is configured as a separate IEC60870-5-104 Server driver.

**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:

## 3 Redundant connections

### 3.1 General requirements

Redundancy in an IEC 60870-5-104 system 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, one IP-address/port-number pair in each station.

Connection establishment is performed by the controlling station in 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 sec. 6.1. The station that performs the connection is anyhow 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 specification of redundant connections:

1. The controlling station must be able to handle multiple (N) logical connections
2. Only one logical connection is active sending/receiving user data at a time
3. The controlling station decides which one of the N connections to be active
4. The N logical connections represent one redundancy group
5. All logical connections of a redundancy group must be supervised by the controlling station
6. A redundancy group must rely upon only one process database / event buffer
7. If more than one controlling station need to access the same controlled station, each controlling station must obtain its own redundancy group.

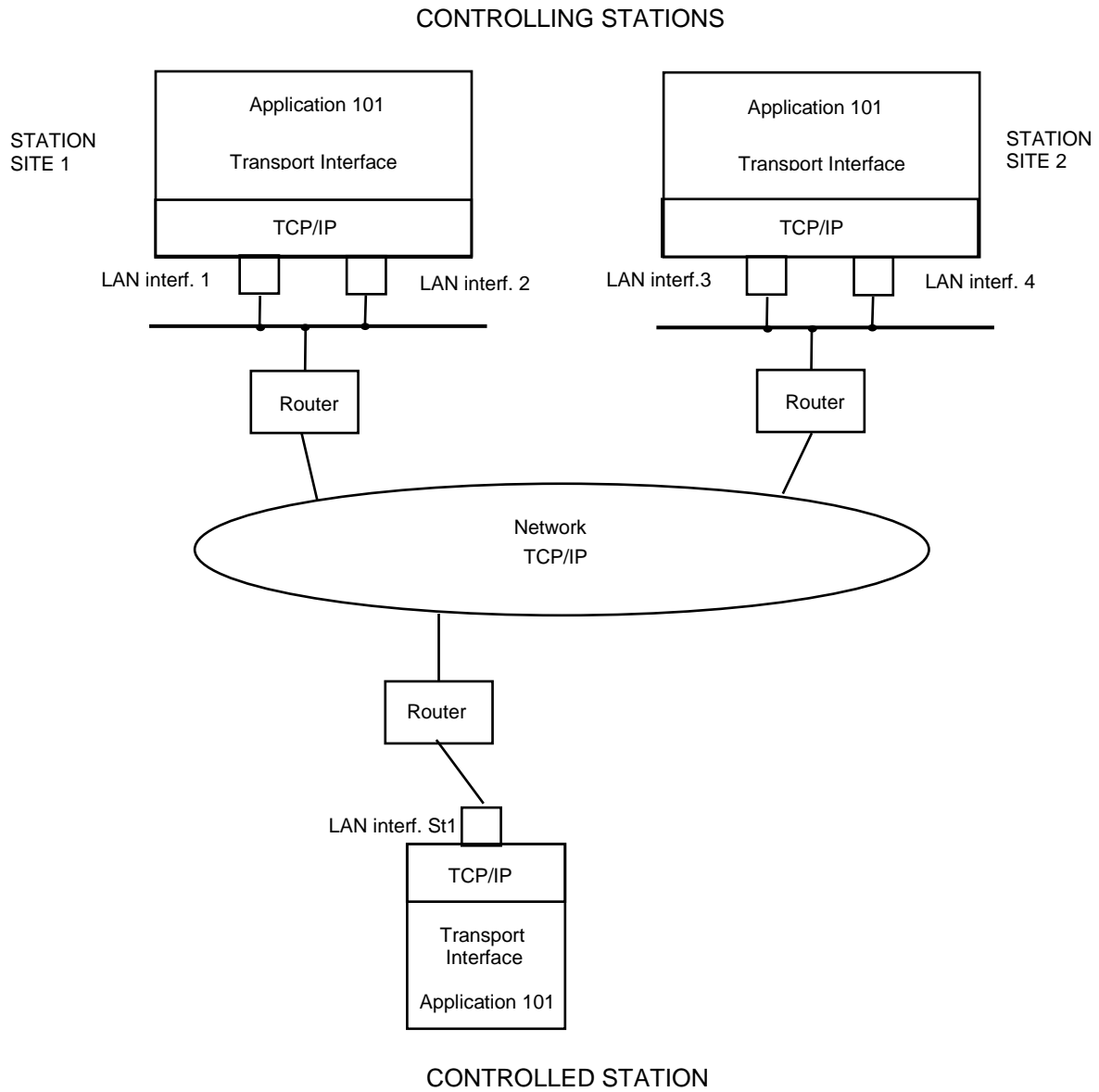
The logical connection which is enabled for user data transfer at any time is defined to be the active connection, while the others are standby connections. The controlled station (station B) always understands the connection on which it last received a STARTDT function as the active connection.

As stated in rule 3, selection and switch of connection is always the responsibility of the controlling station, and may be performed either automatically or manually, by e.g. the application layer (transport interface) or the user process. Switch of connection is performed by transmitting a STARTDT function on the standby connection that is selected to take over.

Manual switchover between two alive and operative connections is performed by first issuing a STOPDT function on the currently active connection and then a STARTDT function on the selected new active connection.

The controlling station must regularly check the status of all established connections to detect any communication problems as soon as possible. This is done by using the Unnumbered control function TESTFR, which is sent periodically after a period of no traffic on the connection. This connection check procedure may also be performed by the controlled station.

### 3.2 System topology



**Redundant system, One redundant group with four connections (Li1-St1/Li2-St1/Dr1-St1/Dr2-St1)**