PACiS MPP T101

Gateway and C264

MPP/EN T101/D10

PACiS V5

Master Protocol Profile
T101

Issue A

Schneider Electric

CONTENTS

1. INTRODUCTION

1.1 Scope of the document

This document is a chapter of PACiS Gateway PC (GTW) and PACiS MiCOM C264 documentation binders. It describes in parallel the serial communication protocol T101 implemented on PACiS Gateway and MiCOM C264.

This document deals with communication with IED connected to C264 or PACiS Gateway.

The purpose of this chapter is not to describe the T101 protocol (see IEC 60870-5-101 documentation for that: ref. [1]) but to specify the use of the T101 protocol on a legacy bus of the C264 and PACiS gateway.

NOTE: It's supposed that the reader knows the T101 protocol.

1.2 Glossary

ASDU	Application-layer Service Data Unit
COT	Cause Of Transmission
GI	General Interrogation
GTW	For protocol PACiS Gateway PC
CP56Time2a	Time stamp on T101 on 7 bytes. See standard document for more details.
CP24Time2a	Time stamp on T101 on 3 bytes. See standard document for more details.
IED	Intelligent Electronic Device

1.3 Documentaion

[1]	IEC 60870-5-101 International Standard	Second Edition 2003-2

2. 870-5-101 IEC:1995-> 2001 EDITION 2 – INTEROPERABILITY

The interoperability of the T101 master protocol is based on the companion standard of the 870-5-101 standard referenced document and respects its organization and content.

The following paragraphs are then used to describe the parameters and alternatives that are supported by the master protocol independently by the gateway and the C264 PACiS equipment.

In the T101 companion standard: selected parameters and alternatives are marked in order to indicate and/or qualify the use of the selected parameter or alternative (the use selection can be exclusive or not depending on the parameter or alternative).

In the following chapters the companion standard parameters and alternatives will be marked, as follows, in order to indicate the availability of the options:

N Not supported

S Supported

S* Supported with special consideration (see comments)

2.1 System or device

C264	GTW	Description
N	**N**	System definition
S	**S**	Controlling station definition
N	**N**	Controlled station definition (Slave)

2.2 Network configuration (Network-specific parameter)

C264	GTW	Description
S	**S**	Point-to-point
S	**S**	Multiple point-to-point
S	**S**	Multipoint-party line
S	**S**	Multipoint-star

2.3 Physical layer (Network-specific parameter)

Transmission speed (control and monitor direction):

C264	GTW	Description
S	**S**	300 bit/s
S	**S**	600 bit/s
S	**S**	1 200 bit/s
S	**S**	2 400 bit/s
S	**S**	4 800 bit/s
S	**S**	9 600 bit/s
S	**S**	19 200 bit/s
S	**S**	38 400 bit/s

C264 uses RS232 or RS485 depending on configuration (Hardware part).

2.4 Link layer (Network-specific parameter)

(Network-specific parameter, all options that are used should be filled up (**N** => **S**). 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.

2.4.1 Link transmission procedure

C264	GTW	Description
S	**S**	Balanced transmission
S	**S**	Unbalanced transmission

2.4.2 Address field of the link

C264	GTW	Description
N	**N**	Not present (balanced transmission only)
S	**S**	One octet
S	**S**	Two octets
S	**S**	Structured
S	**S**	Unstructured

2.4.3 Frame length

C264	GTW	Description
64 to 255	64 to 255	Length L (number of bytes in control direction)
64 to 255	64 to 255	Length L (number of bytes in monitor direction)

2.4.4 Repetition parameters

C264	GTW	Description
S	**S**	Number of repetitions on non-acknowledge frame.
S	**S**	Maximum time between information frame and controlling station acknowledgement.

2.4.5 Class1 data

Controlling station in T101 unbalanced mode send Class 1 request if controlled station raise ACD bit in previous reply.

2.4.6 Class 2 data

Controlling station in T101 unbalanced mode send Class 2 request if controlled station reset ACD bit in previous reply.

2.5 Application layer

2.5.1 Transmission mode for application data

Mode 1 (Least significant octet first), as defined in clause 4.10 of IEC 870-5-4, is used exclusively in this companion standard.

2.5.2 Common address of ASDU

(System-specific parameter)

The address field of the link and the common address of ASDU could have a different number of bytes.

C264	GTW	Description
S	**S**	One octet
S	**S**	Two octets

NOTE: T101 Master manage only one Common Address per IED. That common address is often associated to the link address of the IED.

2.5.3 Information object address

(System-specific parameter)

C264	GTW	Description
S	**S**	One octet
S	**S**	Two octets
S	**S**	Three octets
S	**S**	Structured
S	**S**	Unstructured

2.5.4 Cause of transmission

(System-specific parameter)

C264	GTW	Description
S	**S**	One octet
S	**S**	Two octets (with originator address)

2.5.5 Selection of standard ASDUs

2.5.5.1 Process information ASDUs in monitor direction

C264	GTW	Description	Comment
S	**S**	<1>: = Single-point information	M-SP-NA-1
S	**S**	<2>: = Single-point information with time tag	M-SP-TA-1
S	**S**	<3>: = Double-point information	M-DP-NA-1
S	**S**	<4>: = Double-point information with time tag	M-DP-TA-1
S	**S**	<5>: = Step position information	M-ST-NA-1
S	**S**	<6>: = Step position information with time tag	M-ST-TA-1
N	**N**	<7>: = Bit-string of 32 bit	M-BO-NA-1
N	**N**	<8>: = Bit-string of 32 bit with time tag	M-BO-TA-1
S	**S**	<9>: = Measured value, normalised value	M-ME-NA-1
S	**S**	<10>: = Measured value, normalised value with time tag	M-ME-TA-1
S	**S**	<11>: = Measured value, scaled value	M-ME-NB-1
S	**S**	<12>: = Measured value, scaled value with time tag	M-ME-TB-1
S	**S**	<13>: = Measured value, short floating point value	M-ME-NC-1
S	**S**	<14>: = Measured value, short floating point value with time tag	M-ME-TC-1
S	**S**	<15>: = Integrated totals	M-IT-NA-1
S	**S**	<16>: = Integrated totals with time tag	M-IT-TA-1
N	**N**	<17>: = Event of protection equipment with time tag	M-EP-TA-1
N	**N**	<18>: = Packed starts events of protection equipment with time tag	M-EP-TB-1
N	**N**	<19>: = Packed output circuit information of protection equipment with time tag	M-EP-TC-1
N	**N**	<20>: = Packed single-point information with status change detection	M-PS-NA-1
S	**S**	<21>: = Measured value, normalised value without quality descriptor	M-ME-ND-1

2.5.5.2 Process information ASDUs in monitor direction with the Extension of time tag

C264	GTW	Description	Comment
S	**S**	<30>: = Single-point information with time tag CP56Time2a	M-SP-TB-1
S	**S**	<31>: = Double-point information with time tag CP56Time2a	M-DP-TB-1
S	**S**	<32>: = Step position information with time tag CP56Time2a	M-ST-TB-1
N	**N**	<33>: = Bit-string of 32 bit with time tag CP56Time2a	M-BO-TB-1
S	**S**	<34>: = Measured value, normalised value with time tag CP56Time2a	M-ME-TD-1
S	**S**	<35>: = Measured value, scaled value with time tag CP56Time2a	M-ME-TE-1
S	**S**	<36>: = Measured value, short floating point value, time tag CP56Time2a	M-ME-TF-1
S	**S**	<37>: = Integrated totals with time tag CP56Time2a	M-IT-TB-1
N	**N**	<38>: = Event of protection equipment with time tag CP56Time2a	M-EP-TD-1
N	**N**	<39>: = Packed start event of protection equipment, time tag CP56Time2a	M-EP-TE-1
N	**N**	<40>: = Packed output circuit information of protection equipment with time tag CP56Time2a	M-EP-TF-1

2.5.5.3 Process information in control direction

C264	GTW	Description	Comment
S	**S**	<45>: = Single command	C-SC-NA-1
S	**S**	<46>: = Double command	C-DC-NA-1
S	**S**	<47>: = Regulating step command	C-RC-NA-1
S	**S**	<48>: = Set point command normalised value	C-SE-NA-1
S	**S**	<49>: = Set point command scaled value	C-SE-NB-1
S	**S**	<50>: = Set point command, short floating point value	C-SE-NC-1
N	**N**	<51>: = Bit-string of 32 bit	C-BO-NA-1

2.5.5.4 System information in monitor direction

C264	GTW	Description	Comment
S	**S**	<70>: = End of initialisation	M-EI-NA-1

2.5.5.5 System information in control direction

C264	GTW	Description	Comment
S	**S**	<100>: = Interrogation commands	C-IC-NA-1
S	**S**	<101>: = Counter interrogation command	C-CI-NA-1
N	**N**	<102>: = Read command	C-RD-NA-1
S	**S**	<103>: = Clock synchronisation command	C-CS-NA-1
S	**S**	<104>: = Test command	C-TS-NA-1
N	**N**	<105>: = Reset process command	C-RP-NA-1
N	**N**	<106>: = Delay acquisition command	C-CD-NA-1

2.5.5.6 Parameter in control direction

C264	GTW	Description	Comment
N	**N**	<110>: = Parameter of measured value, normalised value	P-ME-NA-1
N	**N**	<111>: = Parameter of measured value, scaled value	P-ME-NB-1
N	**N**	<112>: = Parameter of measured value, short floating point value	P-ME-NC-1
N	**N**	<113>: = Parameter activation	P-AC-NA-1

2.5.5.7 File transfer

C264	GTW	Description	Comment
N	**N**	<120>: = File ready	F-FR-NA-1
N	**N**	<121>: = Section ready	F-SR-NA-1
N	**N**	<122>: = Call directory, select file, call file, call section	F-SC-NA-1
N	**N**	<123>: = Last section, last segment	F-LS-NA-1
N	**N**	<124>: = Ack file, ack section	F-AF-NA-1
N	**N**	<125>: = Segment	F-SG-NA-1
N	**N**	<126>: = Directory	F-DR-TA-1

2.5.5.8 Mapping PACiS of C264 and GTW

PACiS Objects	ASDU	Format
Single Point Status (SPS)	<1>, <2>, <30>	
Double Point Status (DPS)	<3>, <4>, <31>	
Tape Position Indicator (TPI)	<5>, <6>, <32>	
Measurement (MV)	<9>, <10>, <34>	Normalised
	<11>, <12>, <35>	Adjusted
	<13>, <14>, <36>	Float
Counter (CT)	<15>, <16>, <37>	
Single Point Command (SPC)	<45>	
Double Point Command (DPC)	<46>	
Set point Command (SP)	<48>	Normalised
	<49>	Adjusted
	<50>	Float

2.6 Cause of transmission assignments

Type identifier and cause of transmission assignments of C264 and GTW:

Shaded boxes are not required.

Blank = function or ASDU is not used.

Mark type identification/cause of transmission combinations:

'**X**' if used only in the standard direction.

'**R**' if used only in the reverse direction.

'**B**' if used in both directions.

Type ID		Cause of transmission																	
		periodic, cyclic	background scan3	spontaneous	initialized	request	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	Return cause of remote cmd	Return cause of local cmd	File tranfer	Interro by gen	Req by gen co	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		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								X	X		X					
<2>	M_SP_TA_1			X								X	X							
<3>	M_DP_NA_1		X	X								X	X		X					
<4>	M_DP_TA_1			X								X	X							
<5>	M_ST_NA_1		X	X								X	X		X					
<6>	M_ST_TA_1			X								X	X							
<7>	M_BO_NA_1																			
<8>	M_BO_TA_1																			
<9>	M_ME_NA_1	X	X	X											X					
<10>	M_ME_TA_1			X																
<11>	M_ME_NB_1	X	X	X											X					
<12>	M_ME_TB_1			X																
<13>	M_ME_NC_1	X	X	X											X					
<14>	M_ME_TC_1			X																
<15>	M_IT_NA_1			X												X				
<16>	M_IT_TA_1			X																
<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	X	X	X																
<30>	M_SP_TB_1			X								X								

Type ID		Cause of transmission																		
		periodic, cyclic	background scan3	spontaneous	initialized	request	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	Return cause of remote cmd	Return cause of local cmd	File tranfer	Interro by gen	Req by gen co	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<31>	M_DP_TB_1			X								X								
<32>	M_ST_TB_1			X								X								
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1			X																
<35>	M_ME_TE_1			X																
<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						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1						X	X	X	X	X						X	X	X	X
<48>	C_SE_NA_1						X	X	X	X	X						X	X	X	X
<49>	C_SE_NB_1						X	X	X	X	X						X	X	X	X
<50>	C_SE_NC_1						X	X	X	X	X						X	X	X	X
<51>	C_BO_NA_1																			
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X									
<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1						X	X												
<104>	C_TS_NA_1						X	X												
<105>	C_RP_NA_1																			
<106>	C_CD_NA_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													X						
<121>	F_SR_NA_1													X						
<122>	F_SC_NA_1													X						

Type ID		Cause of transmission																		
		periodic, cyclic	background scan3	spontaneous	initialized	request	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	Return cause of remote cmd	Return cause of local cmd	File tranfer	Interro by gen	Req by gen co	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<123>	F_LS_NA_1													X						
<124>	F_AF_NA_1													X						
<125>	F_SG_NA_1													X						
<126>	F_DR_TA_1			X		X														

2.7 Behaviour

2.7.1 Station Initialization

2.7.1.1 Unbalanced Mode

The link of the controlling station establishes connection with the link of the IED by transmitting a **"request status of link**" that should be answered by a "**Status of link**" (optionally "**Confirm ACK**" or a "**single character**") response from the IED. The controlling station shall then transmits a "**Reset of remote link**" that shall be answered by an "**Confirm ACK** " (optionally a "**single character**") which confirms the start condition of the link layer of the master.

Immediately after this connection phase:

- A Time Synchronization message (ASDU 103) is sent to the IED (this time synchronization message will also be sent at every synchronization period).
- A GI request is sent to the IED (ASDU 100 "Interrogation command" and 101 "Counter Interrogation command" depending on configuration).

Once this initialization sequence performed the controlling station can start the polling class 2 for data report.

Computer specific:

- The computer may regularly look for Disturbance file presence (not available in GTW).

2.7.1.2 Balanced Mode

In balanced mode, in order to connect an IED:

Master sends "Status Link" frames to the IED. On slave answer: Master sends a "Reset Link" frame, and waits for an acknowledgement.

Slave sends "Status Link" frames, when the Master answers; the Slave sends a "Reset Link" frame, and waits for an acknowledgement.

Now the Master waits for an "End of Initialization" message, to send the "Global Interrogation" message and the "Counter Interrogation" message, if at least one counter is configured.

2.7.2 POLLING

2.7.2.1 Unbalanced Mode

The controlled station may return Class 1 data in response to a Class 2 request if no Class 2 data is available and Class 1 data is awaiting transmission.

At the controlled station, if a request for Class 2 data is received and no data is available a negative response, data not available, shall be returned to the controlling Station. The negative response may be a fixed length frame (FC=9) or the Single Control Character (E5), which in this case is treated as a NACK.

By default an IED is polled by a "Polling C2" frame, allowing to get "non priority information".

If an IED signals it has "priority information" (ACD bit set), it is polled with a "Polling C1" frame.

2.7.2.2 Balanced Mode

In balanced mode, there is no IED polling, as in the unbalanced mode.

In balanced mode, Master sends periodically a "Test command" message to known if connection with the IED is still active.

In balanced mode, Slave can also send a "Test command" message to known if connection with the C264 or GTW is still active.

In balanced mode, Slave sends spontaneously ASDU message, on DI change of state/quality or on MEAS and SPI change of value/quality.

NOTE: The Master balanced mode is managed by the T101 Level 2. Balanced/unbalanced mode is transparent for applicative level (T101 Master level 7).

2.7.3 Communication Failure

If the controlled station fails to communicate with the controlling station then the controlling station should perform a communications system initialization for that controlled station.

2.7.3.1 Unbalanced Mode

In unbalanced mode, a communication failure occurs when master didn't received a data reply within specific time and after the maximum number of repetitions.

2.7.3.2 Balanced Mode

In balanced mode, a communication failure occurs when master doesn't receive a data reply within specific time and after the maximum number of repetitions or master doesn't receive any reply of Test Link frame within specific time.

2.7.4 Synchronization

2.7.4.1 Common considerations

For unbalanced T101 master protocol, the default synchronization behaviour on "PACIS MiCOM C264" and "PACIS Gateway" is to send both "point to point" synchronization messages. "PACIS MiCOM C264" additionally sends "broadcast" synchronization messages.

For balanced T101 master protocol the only synchronization message used is the "point to point" one.

The "Master T101" use ASDU "103" to synchronize IEDs. No calculation of the transmission delay is performed.

When not synchronized, "PACIS MiCOM C264" and "PACIS Gateway" T101 master still send synchronization message to IEDs.

The synchronization state of the master is obtained though following time sources:

- For C264:
  - ⇒ IRIG-B if the C264 is SNTP Server of the PACIS configuration.
  - ⇒ C264 SNTP server of the PACIS configuration
- For GTW:
  - ⇒ C264 SNTP server of the PACIS configuration

Synchronization state of the master is used to fill the "IV" bit (invalidity indicator set to "1" when not synchronized) of the time stamp. The "IV" bit is set when sending synchronization messages to the IEDs and also when master timestamp events is to be done (on GI, when non Tim stamped events occurs or when requested by configuration).

Time stamping of events

- Time stamped events received from IED:
  - ⇒ When the time tamping of data points changes is done by the IED, the time stamp is not changed by the T101 master.
  - ⇒ The invalid bit in the timestamp is set or reset by the IED and is not changed by T101 master.

    NOTE: On "PACIS MiCOM C264" a parameter allows forcing time stamping by the T101 master (see below).

- Events received without time stamp

  ⇒ When an IED sends to T101 master non-dated data points, those data points are time stamped by the T101 Master. The invalid bit in the timestamp depends on the state of synchronization of the T101 master.

Elaboration of the state of synchronization of an IED:

- At initialization state of synchronization of IEDs is set to "UNKNOWN"
- On IED disconnection the synchronization state of the IED is set to not synchronized.
- If the difference between IED time and IED computer is higher than 1s the IED is considered not synchronized (the SPS status representing the state of synchronization of the IED is set to "not-synchronized"). This is obtained by reading the synchronization message answer from the IED. When synchronization status of an IED changes, then the synchronization status of the IED is updated.

"PACIS MiCOM C264" specific T101 master behaviour and parameters:

For balanced and unbalanced T101 master protocol on "PACIS MiCOM C264" and only on "PACIS MiCOM C264" two synchronization parameters allow the user to parameterize the way IEDs are to be synchronized and also where the time stamping of events is to be done (the time tag source):

- Parameter "***T101 Time Synchro usage***" is used to allow/forbid the "point to point" synchronization of IEDs:

  ⇒ Set to "Yes" (the default value): The "point to point" synchronization of IED is activated. The master will update the synchronization status of the IED using the IED master's synchronisation message answer. On the unbalanced master protocol, "broadcast" synchronization messages are still sent to IEDs. This is the standard behaviour.

  ⇒ Set to "No": The "point to point" synchronization of IED is deactivated. The synchronization status of IEDs is then never updated and will stay in "Unknown" state. On the unbalanced master protocol, "broadcast" synchronization messages are still sent to IEDs.

- Parameter "***Time stamping source***" is made available only when the parameter "***T101 Time Synchro usage***" is set to "No". This parameter allows to force the source of time stamp:

  ⇒ Set to "IED": The time stamp source of events is the IED. This is the default value.

  ⇒ Set to "MASTER": The time stamp source of events is the master (The time stamping of the information is always done by C264 T101 Master).

2.7.4.2 Unbalanced synchronization procedure

For differences between C264 and Gateway see previous paragraph.

IEDs are synchronized by master with ASDU "103" synchronization messages in two ways:

- By sending a point-to-point synchronization message:

  ⇒ At connection of the IED.

  ⇒ At synchronization timer time-out when polling the IED.

- For C26A master only, by sending broadcast synchronization messages at each "T101 network Link" polling cycle (of IEDs).

NOTES: - The point-to-point synchronization procedure is used in order for the master to know the state of synchronization of the IED (animation of SPS state of synchronization of the IED).

- The broadcast synchronization procedure is used for IEDs which are not able to manage point-to-point synchronization procedure.

2.7.4.3 Balanced synchronization procedure

- Only the point-to-point synchronization message is used.
- The synchronization message is sent at connection of the IED.
- The synchronization message is sent at each synchronization timer time-out.

2.7.5 General Interrogation

The GI returns the current status information directly from the controlled station database.

The GI groups are not supported, only the global general interrogation is supported

Time tags are not used for data items returned as part of the GI response.

2.7.6 Tunnelling

This function is not supported.

2.7.7 Time Stampping

Class 1 data can be time-tagged with the 3 bytes time-stamp (CP24Time2a), giving minutes and milliseconds within the hour, or with the 7 bytes time-stamp (CP56Time2a), giving minutes and milliseconds within the hours, day, month, year. The format of time-stamp can be defined, for all class1 data, in configuration.

Master treat them distinctively according to the Type ID of ASDU.

When the source of data-points is seen disconnected by a gateway, the associated data-points validity is changed to “UNKNOWN”.

On C264 gateway the data-point associate event can be time tagged in two ways depending on SCE parameter “***time-stamp ‘unknown’ for SCADA***”:

- If ***<“time-stamp ‘unknown’ for SCADA” = YES***>: The time-stamp used is the one of the transition to “UNKNOWN” state (the time when the server equipment is seen disconnected by the client, here the C264).
- If ***<“time-stamp ‘unknown’ for SCADA” = NO***>: The time tagged is unchanged (i.e. the time tag of the previous received event on the data-point is used instead of the time of the transition to UNKNOWN as seen by the client).

On the Gateway-PC, the time-stamp associated to the disconnection is always the time of the disconnection (the time of elaboration of the disconnection by the GTW-PC).

2.7.8 Events

2.7.8.1 Normal Acquisition

The default for all status changes are reported as Class 1 data (COT=3, spontaneous).

Values returned as Class 1 data shall have a time tag (either CP24Time2a, or CP56Time2a).

Depending on the configuration of the ”Time reference”, time tag reference can be “Local” or “UTC”.

Status changes at the controlled station shall cause the ACD bit to be set in the next Class 1 or Class 2 data response. The controlling station shall respond to ACD set by inserting a scan for Class 1 (spontaneous) data as the next scan.

The response to a Class 1 data request shall also have the ACD bit set if more Class 1 data is awaiting transmission. In this case a further scan for Class 1 data shall be scheduled by the controlling station.

Dated Events sent by IED have their State of Synchronization given by the IED. In the case of non-synchronized C264 or GTW(always seems as synchronized) with a synchronized IED, all dated events received by C264 or GTW are seen synchronized. In the second case, if the C264 or GTW receives non-dated events then C264 or GTW will date these events not synchronized.

The state of synchronization in the timestamp of an event is given by the dating equipment.

2.7.8.2 Abnormal Acquisition

At the controlled station, if a request for Class 1 data is received and no data is available an error should be raised and a negative response, data not available, returned to the controlling Station. The negative response shall be a fixed length frame (FC=9) or the single Control Character (E5), which in this case is treated as a NACK. This is configurable in C264's implementation. In GTW, these 2 kinds of response frame can all be treated, no need to configure.

2.8 Data received from IEDs

2.8.1 Digital Input

A DI is also identified by its configurable point information address.

Any change of state or quality is transmitted by the T101 master to the computer DI management process. In GTW, Any change of state or quality is transmitted by the T101 master to the kernel.

The DI without time tag are time tagged with the computer date.

The DI with a 3 bytes time tag, has the day, month and year taken in the computer date, and the rest of the time tag in the 3 bytes time tag received in the ASDU.

The DI with a 7 bytes time tag is time tagged with the received date.

If the IED has accepted the time synchronization, the time tag is considered as synchronous, not synchronous otherwise.

COT is not processed by C264 and GTW.

2.8.2 Analog Input

An AI is also identified by its configurable point information address.

Any change of value or quality is transmitted by the T101 master to the computer MEAS management process. In GTW, any change of value or quality is transmitted by the T101 master to the kernel.

3 AI formats are handled with T101 : normalized (ASDU 9,10,34), scaled (ASDU 11,12,35) and floating (ASDU 13,14,36).

The AI without time tag are time tagged with the computer date.

The AI with a 3 bytes time tag, has the day, month and year taken in the computer date, and the rest of the time tag in the 3 bytes time tag received in the ASDU.

The AI with a 7 bytes time tag is time tagged with the received date.

If the IED has accepted the time synchronization, the time tag is considered as synchronous, not synchronous otherwise.

COT is not processed by C264 and GTW.

2.8.3 Step Position Indication

A SPI is also identified by its configurable point information address.

Any change of value or quality is transmitted by the T101 master to the computer SPI management process. In GTW, any change of value or quality is transmitted by the T101 master to the kernel.

The SPI without time tag are time tagged with the computer date.

The SPI with a 3 bytes time tag, has the day, month and year taken in the computer date, and the rest of the time tag in the 3 bytes time tag received in the ASDU.

The SPI with a 7 bytes time tag is time tagged with the received date.

If the IED has accepted the time synchronization, the time tag is considered as synchronous, not synchronous otherwise.

COT is not processed by C264 and GTW.

2.8.4 Counters

A CT is also identified by its configurable point information address.

Any change of value or quality is transmitted by the T101 master to the computer SPI management process. In, GTW, Any change of value or quality is transmitted by the T101 master to the kernel.

The CT without time tag are time tagged with the computer date.

The CT with a 3 bytes time tag, has the day, month and year taken in the computer date, and the rest of the time tag in the 3 bytes time tag received in the ASDU.

The CT with a 7 bytes time tag is time tagged with the received date.

If the IED has accepted the time synchronization, the time tag is considered as synchronous, not synchronous otherwise.

COT is not processed by C264 and GTW.

2.8.5 BitString 32-bits

Not supported.

2.9 Data sent to IED

2.9.1 Controls

A CO is also identified by its configurable point information address.

The acknowledgement of a control is to be waited as :An ASDU 45,46,or 47 with an appropriate "Cause Of Transmission" (activation confirmation, deactivation confirmation, activation termination).

2.9.2 SetPoints Controls

A SP is identified by an ASDU number 48 (normalized), 49 (scaled), 50 (floating).

A SP is also identified by its configurable point information address.

The acknowledgement of a control is to be waited as :An ASDU 48,49,or 50 with an appropriate "Cause Of Transmission" (activation confirmation, deactivation confirmation, activation termination).

2.9.3 File Transfer

File Transfer is not implemented in GTW.

The C264 T101 Master allows to upload files from an IED.

3 kinds of file can be uploaded (Transparent, Disturbance or SOE files):

- Transparent files are stored in the "/RAMDEV" directory, with a name : T1MT_xxx.TRA (where xxx is a number given by counter)
- Disturbance files are stored in the "/RAMDEV/PERT_IED" directory, with a name : T1MD_xxx.DIS (where xxx is a number given by counter)
- SOE files are stored in the "/RAMDEV/SOE" directory, with a name : T1MS_xxx.SOE (where xxx is a number given by counter)

NOTE : There is no software to extract the uploaded file out of the computer. No feature is implemented to indicate the kind of file.

The sequence of File Transfer is as follows:

1. The IED sends a “Directory” (ASDU FDRTA) message to indicate a file ready to be uploaded.
2. The Master sends a “Select File” (ASDU FSCNA, with a SCQ=1)
3. The IED sends a “File Ready” (ASDU FFRNA)
4. The Master sends a “Call File” (ASDU FSCNA, with a SCQ=2)
5. The IED sends a “Section Ready” (ASDU FSRNA)
6. The Master sends a “Call Section” ” (ASDU FSCNA, with a SCQ=6)
7. The IED sends some “Segments” (ASDU FSGNA)
8. When all the data of the section are sent, the IED sent a “Last Segment”
9. The Master acknowledges the section with a “Ack Section” (ASDU FAFNA, with an AFQ=3)
10. The IED can either send some segments of a new section or a “Last Section” (ASDU FLSNA)
11. When the “Last Section” is received, the Master sends the “Ack File” (ASDU FAFNA, with an AFQ=1)

At this time the file transfer is over.

2.10 Commands

All control/set point commands shall be Select before Execute (SE) or Direct Execute (DE). Protocol and system sides can be set independently SE or DE.

For commands requests, Activation termination (C_SE_ACTTERM) can be returned to the controlling station to signal the end of a control sequence. This depends on Configuration (§3.e Tuning Configuration, “Command Activation Termination” and “Setpoint Activation Termination”). In GTW, Activation termination is ASDU COT 10.

The QU field of the Qualifier of Command is not taken into account. In GTW, there’s no such field in the interface of kernel and master library.

Specific to C264:

C264 has the possibility to use the ASDU 137, which is a Regulating Delay Command. This ASDU allows the SCADA to send a control with particular pulse duration. This message is available only for double contacts output or tap changer controls, and will be used with the Select before operate command procedure.

2.11 Limits and Performances

The implementation of the “Master T101” is limited to the ASDU indicated in §2.5.5 “Selection of standard ASDUs” which is a subset of the ASDU described in the official documentation of the IEC 60870-5-101 International Standard (ref. [1]).

The max number of IED in one link is 64.

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